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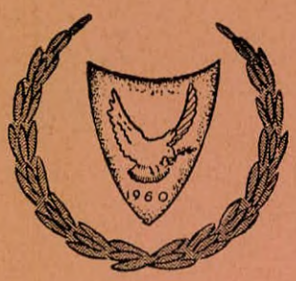


REPUBLIC OF CYPRUS

# ANNUAL REPORT

OF THE

# DEPARTMENT OF WATER DEVELOPMENT

FOR THE YEAR

1964

REPUBLIC OF CYPRUS

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# ANNUAL REPORT

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# WATER DEVELOPMENT

# FOR THE YEAR

# 1964

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Prepared by

Mr. C. A. C. Konteatis

Acting Head of
Department of Water Development

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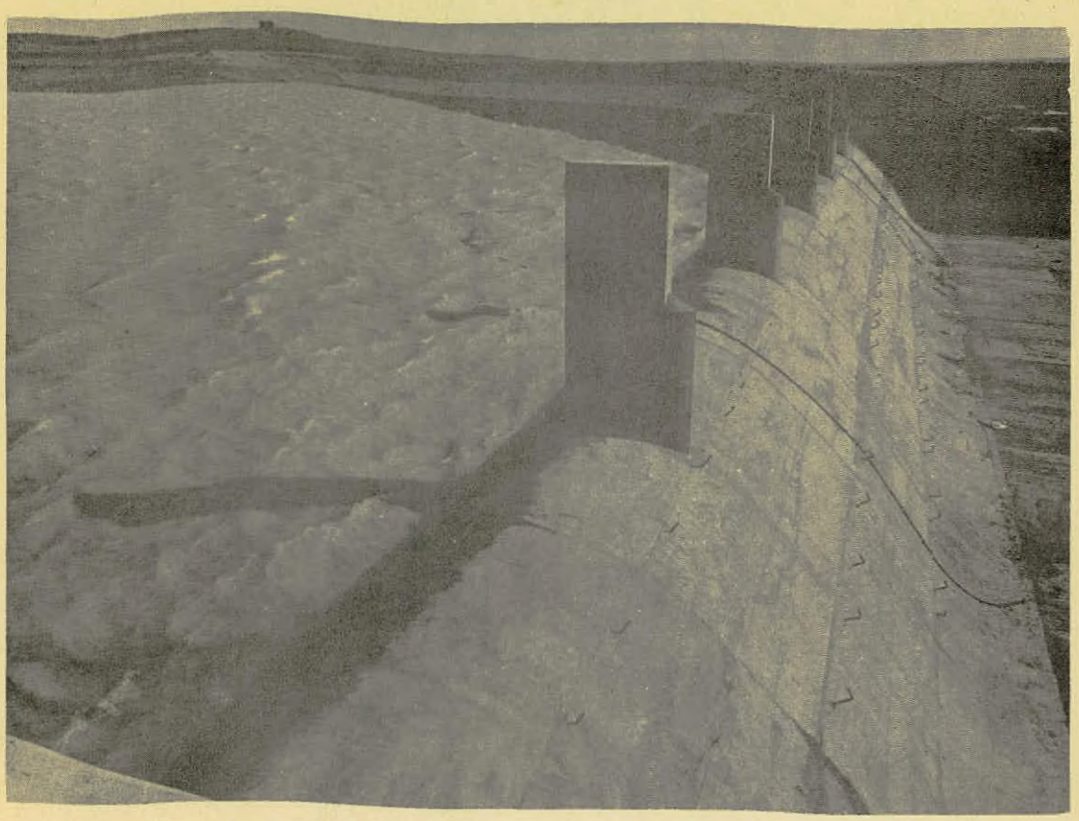
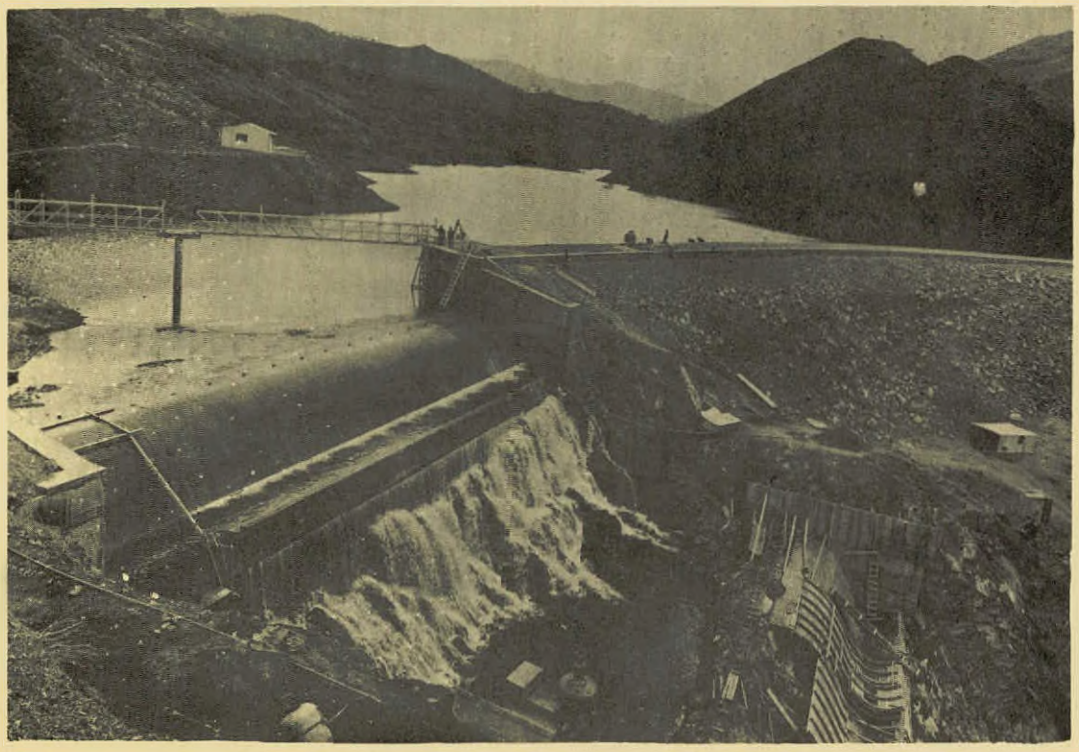


Kiti dam, constructed in 1963-64, was filled completely and overspilled. The benefits from this dam are to irrigate 2500 donums of spring crops, replenish the depleted aquifer of the area, as well as recharge the aquifer from which Larnaca receives its domestic water supply.

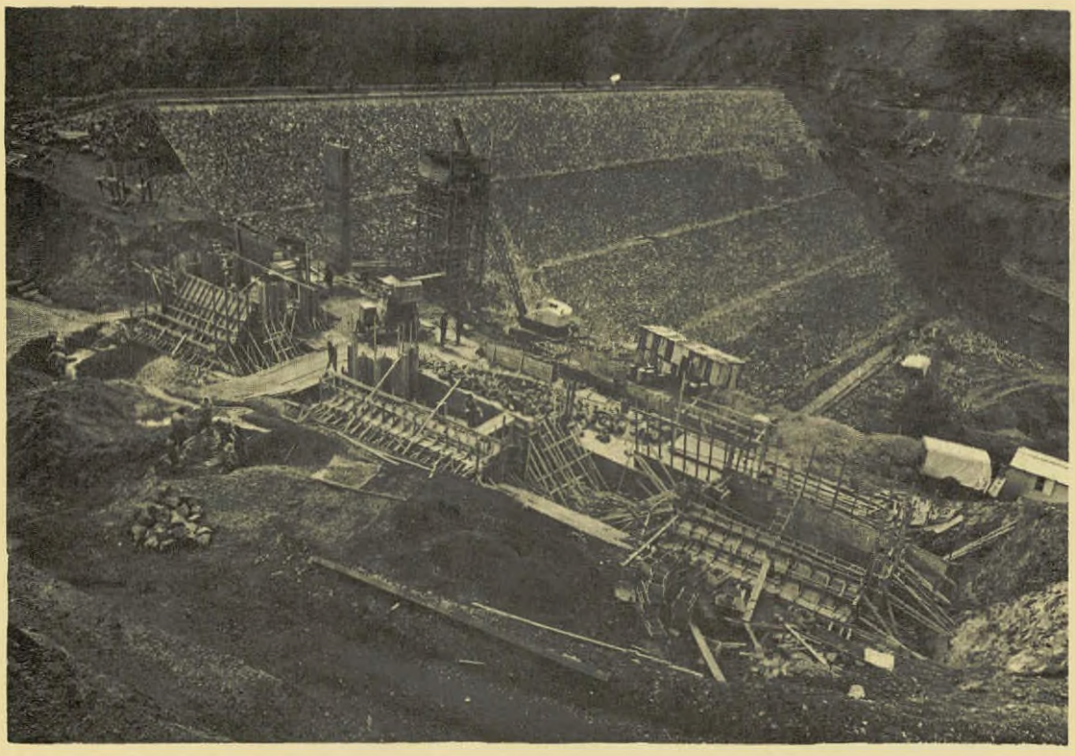
Polemidhia dam. When completed in summer 1965, the Polemidhia dam will be the largest in impounded capacity i.e. 750,000,000 gallons or 3,400,000 metric tons of water. The dam commands 4000 donums in the Limassol area of mainly orchards.

Ayia Marina (Rockfill) dam at Paphos, with 96 feet height and a capacity of 75 million gallons, will help irrigate 600 donums of spring and permanent crops.

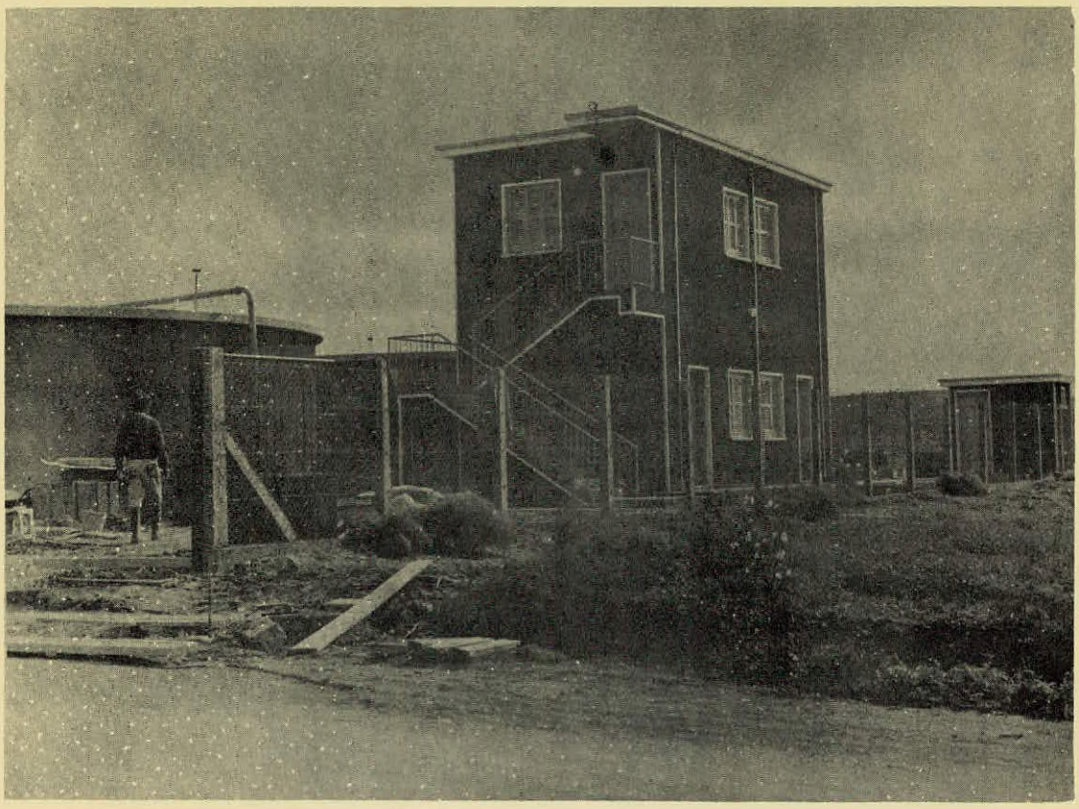


Argaka-Magounda rockfill dam, with 100 feet height and an impounded capacity of 280 million gallons commands an area of 1500 donums of spring crops and perennial crops.

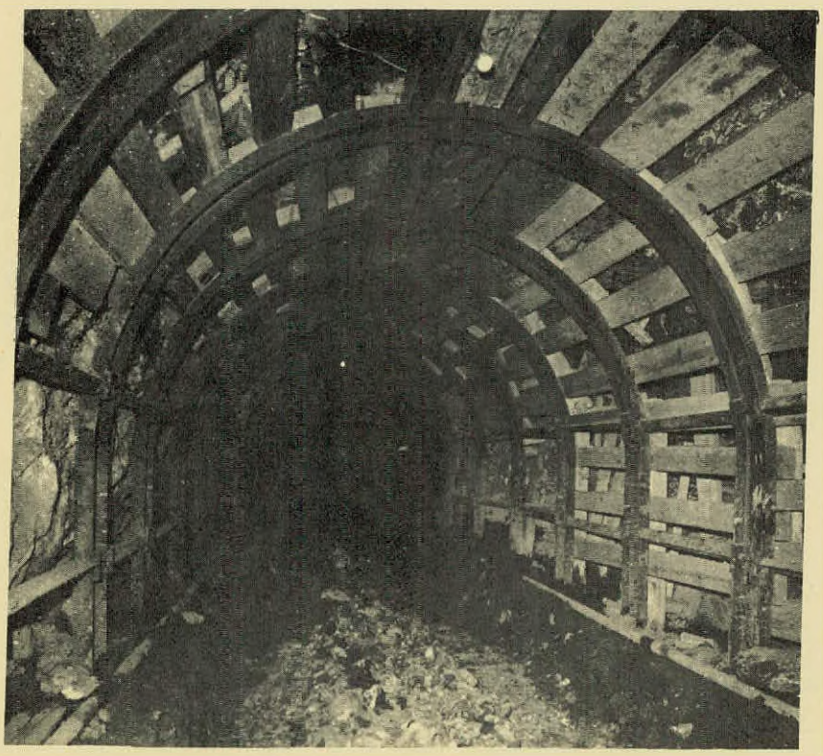
LIOPETRI earth fill dam, constructed in the 2nd half of 1964, will contribute in replenishing the depleted aquifer. The total capacity is 80 million gallons, and the dam is one of the largest of its kind in the Famagusta area.



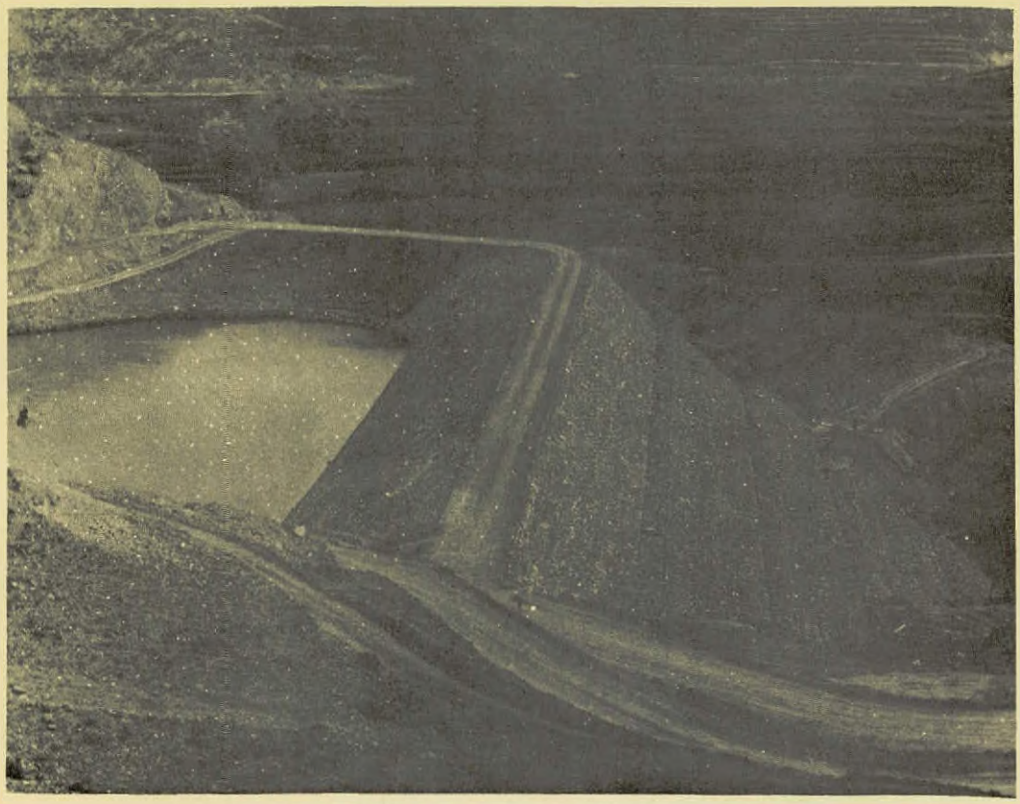
Pomos rockfill dam, has a height of 110 ft. and an impounded capacity of 270 million gallons of water, commands an area of 1500 donums of spring and perennial crops.



Chlorination Building, Pump House and storage tanks of the Paphos New Water Supply.



Steel supports at Mavrokolymbos tunnel. January 1965.



Agros earth fill dam with a height of 86 ft. at maximum section has an impounding capacity of 25 million gallons and will help irrigate 160 donums of orchards.

Ayios Loucas lake (Famagusta). 2 No. pumps with an output of 50,000 gallons per minute each are discharging the Sweet water lake waters into the Ayios Loucas lake which are in turn directed by tunnel to the Ayios Memnon spreading grounds.

Paralimni Panayia dam (Famagusta). The pictured dam is one of the many constructed in the Famagusta area with the purpose of replenishing the depleted aquifer in the area. Panayia dam has a capacity of 10 million gallons.

Ovgos dam, is 46 feet high and can impound 195 million gallons of water, thus commanding 3,000 donums of vegetables and orchards.

## 1. INTRODUCTION.

The Department of Water Development comes under the jurisdiction of the Ministry of Agriculture and Natural Resources and is the responsible Governmental body for the overall planning, design and execution of all waterworks on the island. It also advises the District Officers for the operation of the minor domestic water supply and irrigation projects, and to enforce the water laws. It further advises the Chairmen of the Town Water Boards and the Government Water Committees for the operation of the Town Water Supplies and the major irrigation projects.

The year 1964 was the first year of the Turkish rebellion and our Turkish staff on their own initiative abstained from work with the exception of one driver who is back at work.

Further, during most of the year a large part of the staff voluntarily helped the National Guard and many others joined the army having reached the age of conscription. In some cases, mainly clerical, we had to engage girls to carry out the work.

However, in spite of the decrease in the staff, in spite of the additional duties in the National Guard, in spite of the fighting flaring from time to time in many parts of the island, the work continued throughout the year and we achieved the amazing result of breaking all previous records on expenditure having spent £1,807,751. The second highest expenditure in the Department's history was that of last year at £1,744,680. I feel it my duty to extend my sincere thanks and deep appreciation to all the members of the staff and to the foreign experts who through their hard work and determination made this task possible.

---

## 2. STAFF & ORGANIZATION.

### (a) Staff.

The situation regarding the staff is shown in Appendix 1. Mr. P. de Gruyter, the Director, who was appointed jointly by the United Nations and the Government of Cyprus and started work on the 17th April, 1962, completed his two years' contract in Cyprus and decided to retire and go back to Holland. We owe a word of appreciation to

Mr. de Gruyter who in spite of his advanced age has worked hard and contributed positively towards the water development of the country. Many results of his work will remain with us as a happy memory of his stay here.

Mr. Y. Hji Stavrinou is still under secondment to the post of Director of the Geological Department whilst Mr. C. Konteatis who has been seconded to the post of Assistant Director has been acting as Head of Department since Mr. P. de Gruyter's departure on the 3rd June, 1964.

The two Senior Water Engineer posts are not occupied as the one is vacant and the other is the post of Mr. H. Suphi who is a Turk and does not come to work.

Out of the 18 Executive Engineers 10 were at work, two Turks were on scholarship abroad and another two Turks absented from work. The remaining 4 posts are vacancies.

Out of the three Geologists of the Department two are on scholarship abroad and the third a Turk is absent.

The Mechanical Engineer is loaned to the Special Fund Project for supervising the mechanical work of drilling.

In addition, there are one vacant post of Inspector of Works, 4 vacancies of Assistant Chief Foreman, five vacancies of Technical Assistants and five vacancies of Foremen. It is hoped that these posts will be filled in 1965. Obviously our most acute problem is that of the vacant senior posts and all efforts should be made to fill them the soonest possible.

(b) Labour.

The average number of labourers employed by the Department during 1964 was 2096, as compared with 1963 in 1963. About 14.3% were classed as regulars while about 35% were skilled employees. 1% of the labourers employed were Turks.

The approximate monthly averages were as follows:-

| | |
|---|---|
| January | 1067 |
| February | 1277 |
| March | 1733 |
| April | 1951 |
| May | 2005 |
| June | 2097 |
| July | 2401 |
| August | 2203 |
| September | 2295 |
| October | 2784 |
| November | 2673 |
| December | 2644 |
| Average | 2096 |

There were no labour disputes or strikes during the year. There were no appreciable variations in the wages structure during the year except the normal annual increases granted to regular employees.

(c) Organization.

The set up of the Department was as is shown on Appendix 1.

As the major projects now constitute the biggest part of the works undertaken by the Department it is considered advisable for economic and efficiency reasons to concentrate the various works under Planning, Design, Construction and Operation Sections.

This organization set up is now gradually being introduced.

Also the controversial issue of whether to have District Offices is again being considered aiming to achieve economies through the decentralization of services such as Hydrogeological Surveys, River discharges, spring discharges, water table measurements, water sampling and analyses, permits for well, control of extraction from wells, water rights determinations, meteorological observations, etc.

Departmental Staff Consultations.

(i) Staff Committee.

At the instructions of the Minister this Committee was formed and regular monthly staff consultations were held under the chairmanship of the Director with elected representatives from all grades of the staff both technical

and interchangeable. The matters brought up by the staff for discussion covered questions on organization, personnel matters, staff relations and schemes of service. An atmosphere of informality and cordiality prevailed in all these meetings and almost all grades in the Department brought up various subjects for discussion through their elected representatives. Participants raised themselves above personal claims or complaints and directed their attention to the general interests of the service and the effective performance of their duties. The staff welcomed this sort of consultations as a means of direct method of consultation of employer and employee at Departmental level.

(ii) Heads of Sections Meeting.

The Director set up this committee by which all Heads of Sections, Engineers and Foreign Experts attached to the Department meet once every month under the chairmanship of the Director of the Department. Suggestions for the improvement of existing services, constructive criticism, discussions on matters brought up by Heads of Sections, proposals for the Department's estimates and works, difficulties encountered by the staff during the performance of their work are among the main objects of these meetings. Heads of Sections exchange also views on the progress of the work in their Sections or under their charge and try to co-ordinate the activities of all, with a view to achieving more efficiency in the execution of the Development programmes entrusted to the Department.

These meetings proved to be a very useful and successful method of getting together all officers-in-charge of the Department's sections, for discussing the programme and execution of works and the progress of all projects of the Department and they are intended to become a monthly permanent feature.

# ANNUAL REPORT 1964

## TECHNICAL STAFF OF W.D.D. ON 31.12.1964

APPENDIX I

| SER No. | MONTHLY AND DAILY PAID TECHNICAL STAFF | | | D | A.D | SWE | E.H | E E | ME | Geo | SW | SIW | IW | CF | ACF | TA | F | S | EXP | TS | TOTAL Nos |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Permanent staff | | | 1 | 1 | 2 | 1 | 4 | - | 1 | 2 | 4 | 14 | 3 | 3 | 21 | 39 | 1 | - | - | 97 |
| 2 | Temporary staff | | | | | | | 14 | 1 | 2 | 1 | 2 | 5 | 1 | 9 | 57 | 14 | - | - | 4 | 110 |
| 3 | Foreign Experts | i | U.N. (OPEX) | | | | | | | | | | | | | | | | 1 | | |
| | | ii | U.N. (B.T.A.O) | | | | | | | | | | | | | | | | | | |
| | | iii | U.N. (F.A.O) | | | | | | | | | | | | | | | | 2 | | 5 |
| 4 | Foreign Missions | i | U.S.A. Aid Mission | | | | | | | | | | | | | | | | 2 | | |
| | SECTION | BRANCH | | DISTRIBUTION OF STAFF BY SECTIONS | | | | | | | | | | | | | | | | | |
| 5 | Irrigation | i | Planning | | | | | 1 | | | | | | | | | | | 1 | | |
| | | ii | Dam design | | | | | 4 | | | | | | | | | | | 1 | | |
| | | iii | Dam construction | | | | | 4 | | | | 1 | 2 | | | 6 | 9 | | 1 | | |
| | | iv | Distribution systems Design | | | | | 1 | | | | | | | | | | | 1 | | |
| | | v | Topography | | | | | | | | | | 2 | | | 9 | | | 1 | | |
| | | vi | Drawing office | | | | | | | | | | 1 | | | 10 | | | | | |
| | | vii | Soil laboratory | | | | | | | | | | | | | 4 | | | | | |
| | | viii | Managent of dams | | | | | | | | | | | | | | | | | 1 | |
| | | IX | Minor irrigation works | | | | | | | | 1 | 2 | 3 | 2 | 1 | 6 | 9 | | | 2 | |
| | | | | | | | | | | | | | | | | | | | | | |
| 6 | Town Water supplies | | | | | | | | | | | 1 | | | 1 | 2 | 4 | | | | |
| 7 | Village Water Supplies | | | | | | 1 | | | | | 1 | 5 | | 5 | 8 | 16 | | | | |
| 8 | Drilling | | | | | | | | 1 | | | 1 | 1 | | 1 | 8 | 4 | | | 1 | |
| 9 | Hydrology | | | | | | | | | | 1 | | 2 | | | 12 | 2 | | 1 | | |
| 10 | Workshops | | | | | | | | | | 1 | | | 2 | | | 2 | 1 | | | |
| 11 | Turkish Officers absent from duty | | | | | 1 | | 2 | | | | | 1 | | | 8 | 2 | | | | |
| 12 | On scholarship | | | | | | | 2 | | 2 | | | 1 | | | | | | | | |
| 13 | Vacancies | | | 1 | | 1 | | 4 | | 1 | | | 1 | | 4 | 5 | 5 | | | | |
| | TOTAL NUMBERS | | | 1 | 1 | 2 | 1 | 18 | 1 | 3 | 3 | 6 | 19 | 4 | 12 | 78 | 53 | 1 | 5 | 4 | 212 |

REFERENCE

D 2/2 See para. 2 of main report

AD Assistant Director
SWE Senior Water Engineer
EH Engineer Hydrologist
EE Executive Engineer
ME Mechanical Engineer
Geo Geologist
SW Superintendent of Works
SIW Senior Inspector of Works
IW Inspector of Works
CF Chief Foreman
ACF Ass[t] Chief Foreman
TA Technical Assistant, monthly and daily paid
F Foreman
S Storekeeper
Exp. Foreign Experts
TS Temporary Staff; includes four pensioners re-employed and paid on daily wages.

. FOREIGN ASSISTANCE.

(a) United Nations Experts.

1. Mr. P. de Gruyter as previously mentioned retired from Director and left the island on the 3rd June.

2. We were very fortunate to keep with us throughout the year Mr. Br. Milinusic of FAO, Mr. St. Hsu of the U.N. and Mr. E. Dahmen, Associate of FAO , whose keenness, interest and hard work here contributed largely towards the success of last year.

(b) U.S. A.I.D. Experts.

Early in the year two of the 4 US AID Experts were asked by their Government to leave the island and are not likely to return back. However, we are still happy to have with us Mr. B. Griffin and Mr. J. Maier whose interest and work for us are very much appreciated.

(c) United Nations Special Fund Project.

This Project continued its work throughout the year and a report by Mr. Mantell on the Preliminary Water Balance of Western Messaoria was submitted. The 4 rotary drilling rigs were received by the Fund and it is hoped to get much useful information next year through the work of this Project.

(d) West German Mission.

The West German Mission Worked hard in spite of the troublesome areas in the Kyrenia range where their drilling took place. Their work was completed by the end of the year and a report is expected early in 1965.

(e) French Mission.

In May 1964 the French Mission submitted its report on the Water Balance of Western Messaoria. According to this report the Potential run off in the aquifer region between the Serrachis river and the Elea river but excluding the Elea catchment itself is 69 mill. cu. meter per annum.

(Potential run off is taken as the sum of the actual river run off, the infiltration into the ground water stratum, the water used for irrigation and the losses through evaporation along the banks.)

The annual deficit in this part of the aquifer is estimated to be 11 million cu. meters.

The feeder basins for all the Western Messaoria water-bearing strata, including the coastal strata, up to the Xeros river inclusive, are stated to have a mean annual potential run off of 175 mill. cu. meters.

In the report it is also stated that "Marine intrusion has begun near Syrianochori and will accelerate if the water table fold along the seashore disappears. If this intrusion becomes general, the marine salts may reach the main planted soils west of Morphou. In this whole part of the aquifer, permeable formations are below elevation zero and are therefore liable of being invaded by sea water".

Obviously this report confirmed by actual figures what had been known since a long time now. This situation can only be classified as grave and immediate measures have to be taken to halt the coming disaster. The proposed measures are covered under the section "Hydrological Situation".

(f) U.S. A.I.D. Training Aid.

By the end of the year a training programme in surveying was initiated by the US AID Mission for training Water Development Department Surveyors. Mr. F. Grammaticas of Amman & Whitney, Athens, was employed as the Tutor.

(g) Scholarships.

1. Mr. N. Ioannides, Executive Engineer, returned from a training in France in Photo Interpretation in June, 1964.

2. Mr. Ch. Phanardjis left in December 1964 for the U.S.A. as a scholar of the USAID to follow a 4 year course in Hydrology.

3. Mr. T. Mirata and Mr. Atakol were both on scholarship, the former on a British Commonwealth Scholarship in London and the latter on a USAID Scholarship in the States. The former had to return back by October but as he requested an extension of his training his case was taken up by the Public Service Commission.

4. INTER-DEPARTMENTAL CO-ORDINATION AND CO-OPERATION.

As we get involved into more and larger projects it becomes evident that to ensure the successful planning of projects a co-ordination of the services of several Departments in addition to the Water Development Department are necessary the most important being:-

(i) The Special Fund Project which is expected to supply a considerable volume of information regarding the underground water resources during the course of their work.

(ii) The Geological Department is the Department expected to supply the geological information required for the construction of major projects and also to carry out the geological mapping for such projects.

(iii) The Agricultural Department contributes the soil surveys, soil conservation, water requirements, the agricultural need of the island and a study on the benefits for the proposed projects.

(iv) The Agricultural Research Institute is expected in time to supply more and more data regarding the water requirements of crops, costs of agricultural production and benefits derived therefrom.

(v) The District Officers are always closely connected with us and their co-operation is always necessary in selecting projects in operating projects, in permits for wells, water rights and many other problems.

(vi) The Land Registry Department helps us in our mapping programme and in land acquisition and requisition.

(vii) The Planning Bureau plays an important role in co-ordinating the various works and in finally going through the economics, analysing and approving the various projects.

Our Minister, Mr. T. Papadopoullos, whose interest in co-ordinating the various services is well known, has re-established the old Inter-Departmental Committee in which all the Heads of Departments of the Ministry of Agriculture and Natural Resources under the chairmanship of the Minister have monthly meetings to discuss and co-ordinate the various activities of the Ministry.

5. WATER LEGISLATION.

A new legislation was enacted on the 9th July "for the conservation and protection of water resources in certain areas within which there exist or could be observed a serious insufficiency of water supplies". The aim of the law is to control extraction and to stop the wastage of water. However, a few provisions of this law were not found to be satisfactory and certain discussions had to be carried out with the Attorney-General and the interested authorities, and ways and

means are considered as to how best this law could be applied. In the meantime regulations have been drafted.

All steps are taken to enable the application of this law in 1965, for it is a most important law and without its introduction there exist grave risks for the depletion of the ground water resources and subsequent economic disasters in the areas concerned with far reaching effects on the economy of the island.

6. HYDROLOGICAL SITUATION.

No doubt we are concerned with the rainfall run off and water table levels every year and we keep regular observations on all the above.

1964 was a very low rainfall year, the average precipitation having barely reached 12.06 in. from the 1st of October, 1963, to the end of September 1964 which is 60.85% of the normal 19.82 in. This figure is the lowest since 1932 when the precipitation was just below 12 inches average.

As a result, the flow in the rivers was considerably less than in previous years and the water of many of the rivers did not reach the sea. The springs were also similarly affected. The worst effect, however, was on the groundwater which even in good rainfall years is overpumped with a resulting decrease in the water resources and an increase in the salinity contents of the water due to pumping from deeper strata and sea intrusion at the coastal regions.

Our aim obviously for saving these aquifers can be summarized under the following headings:-

(i) The ruthless prosecution of illegal drilling.

(ii) The control of extraction and the enforcement of existing and new legislation. This measure will also indirectly control the unauthorized extension of plantations and other cultivations.

(iii) The efficient utilization of water by eliminating all losses through the lining of canals, the use of pipelines, land levelling, weed killing and the application of the correct quantity of water to the crops.

This can become possible by the application of the new law and the provision of a water meter on each borehole.

(iv) Carrying out recharge works where technically and economically feasible.

(v) The supplying of more water where it exists either from surface or groundwater resources.

(vi) Saving domestic water for irrigation by replacing it by desalting if and where it can be proved feasible.

The International Hydrological Decade.

This decade was initiated by UNESCO and all member countries were asked to participate.

On the 22nd September, 1964, a Cyprus National Committee for the International Hydrological Decade was formed.

The composition of the Committee is as follows:-

Chairman: Director, Water Development Department.

Secretary: Nicos Chr. Toufexis, Head of Hydrology Section, Water Development Department.

Members: Director, Department of Agriculture;
Director, Agricultural Research Institute;
Director, Department of Geological Survey;
Director, Department of Forests;
Government Meteorologist.

The objective of the International programme in the field of hydrology is to accelerate the study of Water Resources and the regimen of waters with a view to the rational management in the interest of mankind, to make known the need for hydrological research and education in all countries, and to improve their ability to evaluate their resources and use them to the best advantage.

7. FINANCE.

The expenditure incurred by the Department during the year is summarized in Appendix 2.

In the reports of the various sections the expenditure on the various projects is given separately. The projects were financed in the standard way as follows:

(a) Routine Irrigation Projects.

| | | |
|---|---|---|
| (i) Winter Crop Irrigation | 80% | Contribution by Govt. |
| (ii) Spring Crop Irrigation | 75% | " " " |
| (iii) Perennial Crop Irrigation | 66.7% | " " " |

(b) Drainage schemes full cost to Government except where irrigation works are also included in which case the irrigation part is financed according to the irrigation season.

(c) Flood protection schemes full cost to the Government except where irrigation is also incorporated in which case the irrigation part is financed according to the season of irrigation.

(d) Village domestic water supplies Government contribution 50%.

(e) Town water supplies no Government contribution.

(f) The Government contribution for Irrigation Association depends on the ownership of shares of water between the shareholders.

(g) For Major Irrigation Projects the financing is now full cost to the Government which then charges water rates per unit volume of water sold.

The village shares are made available by the Government in the form of a long term low interest loan.

In the case of private drilling, test pumping, and works for Water Boards and other non Government authorities, Departmental charges to cover overheads are also charged in addition to the actual cost.

On the subject of the Departmental overheads a study was made which indicates that the indirect costs and overheads including the amortization of machinery exceeds 20%. A recommendation is being passed to the Government for adding a fixed sum to the estimated cost of each project which will depend upon the previous year's overheads and indirect costs. In addition the machinery will have to be hired to the works according to rates which have already been calculated and submitted to Government by the Department. The recommendation is to base this fixed sum on the overheads and indirect costs of the Development budget only.

Adding the overhead costs on our projects will:

(i) Give a more clear picture of the cost of our projects.

(ii) Save some money for the Government.

(iii) A more correct cost-benefit ratio for the economic justification of the projects will be achieved.

Appendix 2.

## 1964 Expenditure - Water Development Department

| Details | Government Funds | Contribution by beneficiaries | Total |
|---|---|---|---|
| | £ | £ | £ |
| 1. Administration | 130,164 | - | 130,164 |
| 2. Irrigation, Drainage and Dams | 578,636 | 190,830 | 769,466 |
| 3. Town Water Supplies | 107,631 | 50,000 | 157,631 |
| 4. Village Water Supplies | 243,844 | 263,835 | 507,679 |
| 5. Drilling and Prospecting | 47,588 | - | 47,588 |
| 6. Hydrological Research & Weirs | 43,223 | - | 43,223 |
| 7. Workshops (Maintenance) | 16,150 | - | 16,150 |
| 8. Purchase of Machinery, tools & equipment | 46,030 | - | 46,030 |
| 9. Government Water Supplies | 10,400 | - | 10,400 |
| 10. Consultants' fees | 39,378 | - | 39,378 |
| 11. Major Projects Investigations | 10,202 | - | 10,202 |
| 12. Greater Nicosia Scheme | 29,840 | - | 29,840 |
| Includes Ordinary and Development Expenditure | £1,303,086 | £504,665 | £1,807,751 |

### Break down of Administration

| | | | |
|---|---|---|---|
| 1. Personal Emoluments | 72,000 | - | 72,000 |
| 2. Casual Assistance | 7,600 | - | 7,600 |
| 3. Technical Assistance | 13,000 | - | 13,000 |
| 4. Travelling | 18,380 | - | 18,380 |
| 5. Maintenance & Operation of M.T. | 8,855 | - | 8,855 |
| 6. Rents | 1,329 | - | 1,329 |
| 7. Leave pay to Regular Employees | 9,000 | - | 9,000 |
| | £130,164 | - | £130,164 |

8. 1964 PROJECTS.

As previously stated, 1964 was a record year of activities and expenditure. The biggest expenditure was on irrigation works which reached £769,466. The works carried out or under construction were:

Major Projects.

(i) Polemidhia dam.
(ii) Mavrokolymbos dam.
(iii) Pomos dam and distribution.
(iv) Ay. Marina dam and distribution.
(v) Argaka-Magounda dam.
(vi) Kiti dam.
(vii) Ovgos Morphou dam and distribution.
(viii) Mia Milia dam.
(ix) Kalopanayiotis dam.
(x) Agros dam.

In addition four minor recharge schemes involving the construction of a number of minor dams below 20 ft. high were constructed in Paralimni, Derinia, Ayia Napa and Phrenaros.

Two river training schemes, one at Yermasoyia and one at Vitsadha were also carried out and two drainage schemes one at Voroklini and one at Patriki were completed.

In addition 72 minor irrigation schemes such as pumping schemes, lining of canals, irrigation pipelines, river intakes, development of springs, storage reservoirs etc. were also undertaken during the year.

The next biggest expenditure was on rural water supplies which amounted to £507,679. 84 rural water supply schemes were undertaken during the year mainly from borehole supplies.

Only a handful of small villages of population 50-100 persons each remain now without piped supply, but of course some of the villages need additional supplies, improvements and maintenance.

The third big item is the town water supplies on which we spent £157,631 and it includes the supplementary water supply of Limassol from Yermasoyia boreholes, the supplementary supply of Paphos from the Xeros borehole and the supplementary supply of Kyrenia from the Bella Pais borehole.

Contractor's Work.

In February 1964 because of the emergency our contract with Mediterranean Constructors and Zachariades at Pomos and Ayia Marina Dams was terminated. Because of unreasonable demands by these contractors which we could not accept, an arbitration Committee was set up to settle the disputes. Pomos and Ayia Marina dams are now being completed by the Department.

Also because of the increased costs by Mowlem and Ridgways, contractors, due to the emergency, at Argaka dam, we had to ask them to stop work and move to the next job at Polemidhia. The Argaka dam was then taken over and is being completed by the Department.

At Polemidhia Mowlem and Ridgways started the work in April. Due to the anomalous situation a cost plus basis was accepted as a temporary arrangement with the understanding that rates will be applied retrospective the soonest it becomes possible.

The present contract agreement with Mowlem and Ridgways expires with the completion of the Polemidhia dam.

Cybarco was the successful tenderer for the Mavrokolymbos dam in Paphos and got the job at a surprisingly low bid.

Consultants work.

One Resident Engineer of Energoprojekt was working on Pomos and Ayia Marina dams to help our people to complete the projects.

One Resident Engineer and three Assistants of Energoprojekt were working on the Polemidhia dam and one Resident Engineer and one Assistant of Energoprojekt were working on the Mavrokolymbos dam. Lastly one Resident Engineer of Howard Humphreys was working at Kalopanayiotis dam.

9. PLANNING.

(a) Short Range Planning.

This is the planning of projects undertaken for the following 2-3 years. Our largest volume of work is still on short range planning.

Major projects need be studied for at least one and a half years in advance of the budgeting year and we now do

accordingly. Thus in 1964 we submitted proposals for 1966 and in 1965 we will submit proposals for 1967.

Consultants are engaged in detailed designing of some of our major projects due to our shortage of trained staff. In 1964 Energoprojekt of Yugoslavia designed for us the Polemidhia and Mavrokolymbos dams, Howard Humphreys of England designed for us the Kalopanayiotis dam and Techno-exportstroy of Bulgaria were the successful consultants for the design of the Mavrokolymbos distribution system.

(b) Long Range Planning.

This is something we were lacking in the past and it is now necessary to spend more time for such planning. Long range planning will give time for the proper study of all factors involved in water development projects, such as hydrological, hydrogeological, engineering, agricultural, marketing, economic, social and political, the careful assessment of which will enable Government to lay down priorities and make the appropriate selection of projects. We have decided appointing consultants for the watershed planning of the major river basins of the island. The three major basins which may be given to consultants are:-

(i) The Kouris-Garyllis-Yermasoyia including the Akrotiri Peninsula in the south;

(ii) The Kha-Potami - Dhiarizos - Xeros - Ezuza in the west; and

(iii) The Xeros - Marathassa - Karyotis - Atsas - Elea - Serrachis incorporating the Morphou aquifer in the north.

Before a final decision is taken by Government to proceed with appointing consultants, it was decided to await for the expected visit from the World Bank Experts who have shown interest in these projects.

10. OPERATION & MAINTENANCE OF PROJECTS.

(a) Minor Projects.

These are both rural domestic and irrigation projects. In both cases the operation is undertaken by the village Commissions, Divisions and Associations as the case may be under the chairmanship of the District Officer. In cases of major maintenance or improvement works, the Water Development Department is requested to render technical assistance.

(b) Major Projects.

(i) Town Water Supplies.

These are mainly operated and maintained by the Water Boards which were established in Nicosia, Limassol and Famagusta. In the other three towns, Larnaca, Paphos and Kyrenia, the District Officers, Mayors and the Water Development Department help in the operation until Water Boards are formed. In all Water Boards the Water Development Department is the technical adviser.

In Nicosia, one area of the supply is still directly under Water Development Department administration.

(ii) Major Irrigation Projects (Dams).

These projects are now financed at full cost to the Government and rates per unit volume of water sold to the beneficiaries will be charged according to the Government Water Works Law Cap. 341.

This enables the control of the projects by Governmental Committees which are made up of Agriculturists, Water Engineers, District Administrators and economists, thus ensuring the efficient and economical use of the water.

The rates according to the law are fixed by the Director of Agriculture and can be varied from crop to crop depending on the Government policy and on the returns derived from each crop.

The first Government Water Works declared are the Argaka-Magounda Dam, the Polemidhia Dam, the Mavrokolymbos Dam, the Kalopanayiotis Dam and the Kiti Dam. Argaka and Kiti will operate in 1965 and it is hoped that the other three will operate in 1966 as they are not yet complete.

The only projects that were in the past declared as Government Water Works are the Eastern Mesaoria Irrigation Works consisting of the Kouklia, Akhyritou and Syngrassis reservoirs.

## 11. THE DRAWING AND TOPOGRAPHY SECTIONS

By K. Hassabis, Executive Engineer

(a) The Drawing Office at present deals with projects of the Irrigation Section - Major and Minor Irrigation Projects Investigations and Topography.

Although output was seriously affected for most of 1964 by the emergency situation and the calling up of some experienced draughtsmen to the National Guard, by recruiting and training new staff this Section was functioning well by the end of 1964.

The present strength is nine members, plus the chief draughtsman.

During the year the D.O. was equipped with mechanical drawing boards and special reference tables were ordered with the Public Works Department.

A new system of rational numbering of drawings was introduced, and special bins for more convenient storing of drawings were constructed in the Department's workshop.

An effort to standardize drawings as regards size, lettering, symbols etc. was initiated and it is hoped that eventually a departmental instruction booklet will be issued so that all drawings produced in the Department are uniform.

(b) Topography Section

This section performed its usual tasks of carrying out topographical surveys and producing maps and drawings for major irrigation projects i.e. impounding and distribution schemes.

The staff is comprised of five Technical Assistants, one Inspector of Works and the Officer in charge of the Section.

Towards the end of 1964 a training scheme for the members of the section was initiated by the U.S. Aid Mission, by employing the services of an expert.

The schemes with which the topography section dealt are as shown below.

| Village | Type of Work | Remarks |
|---|---|---|
| Morphou | Ovgos Distribution System | Field work - Plans. Long Sections and design by Topography Section. |
| Lefkara | Dam Site and Reservoir | Surveyed and drawn by Topography Section. |
| Agros | Distribution System | Surveyed and designed by Topography Section. |
| Platres | Dam Site and Reservoir | Surveyed and drawn by Topography Section. |
| Kiti | Distribution System | Field work - Preparation of Plans and Long Sections and designed by Topography Section. |
| Yermasoyia | Dam Site and Reservoir | Surveyed and drawn by Topography Section. |
| Palekhori | Setting out of Roads at Dam Site | Field work only |
| Syngrasis | Topography | Surveyed and drawn by Topography Section. |
| Ayia Marina (Paphos) | Distribution System | Levelling and giving levels to Foremen for construction of channels. |
| Pomos (Paphos) | Distribution System | Levelling and giving levels to Foremen for construction of channels. |

## 12. REPORT ON THE HYDROLOGICAL SECTION

By Nicos Chr. Toufexis, Superintendent of Works

(This report covers the period from 1st October, 1963 to 30th September, 1964.)

### I. Meteorological data.

The main characteristics of the total precipitation during the year were:-

(a) The average rainfall over the whole island was 12.06 inches which is 60.85% of normal as compared with the average since 1908 which is 19.82. As it is seen from Appendix No. 4 this year's rainfall is the lowest of the last Decade.

(b) October was the only month with a little above normal rainfall. Precipitation during the other months was well below normal.

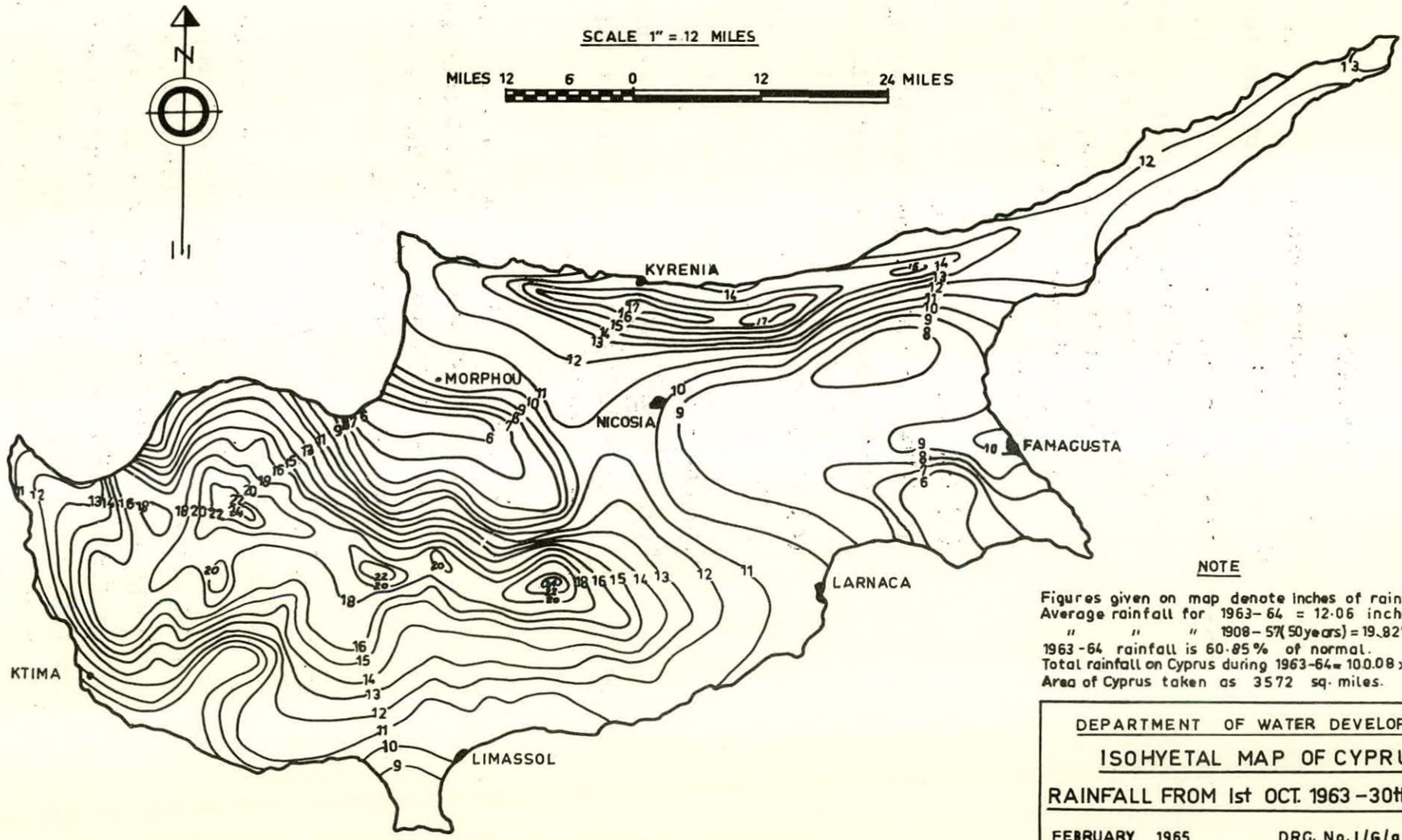
(c) The highest daily fall was 3.19 inches reported by Pano Amiandos on 25th January, 1964.

(d) Snow-fall started on Troodos area early in December, 1963 and continued till late in March 1964. Snow-cover persisted till the end of April, 1964.

(e) Temperatures were variable. The highest temperature recorded at Nicosia was 104° F on the 25th August and the lowest 27° F on the 20th January, 1964.

### II. Flood Discharges

No remarkable flash flows were reported during the year due to the low rainfall intensities experienced over the island. The highest floods reported were 1800 cusecs in Mylou tributary of the Syrgatis river near Kornos, on 15th June, 1964, 1140 cusecs in Syrgatis river near Skarinou, on 16th May, 1964, and 1130 cusecs in Meriki tributary of the Serrachis river near Kokkini Trimithia on 8th June, 1964.




NOTE

Figures given on map denote inches of rainfall.
Average rainfall for 1963–64 = 12·06 inches.
" " " 1908–57 (50 years) = 19.82" (normal).
1963-64 rainfall is 60·85% of normal.
Total rainfall on Cyprus during 1963-64 = 100.08 x $10^9$ cub. ft.
Area of Cyprus taken as 3572 sq. miles.

DEPARTMENT OF WATER DEVELOPMENT

ISOHYETAL MAP OF CYPRUS

RAINFALL FROM 1st OCT. 1963 – 30th. SEP. 1964

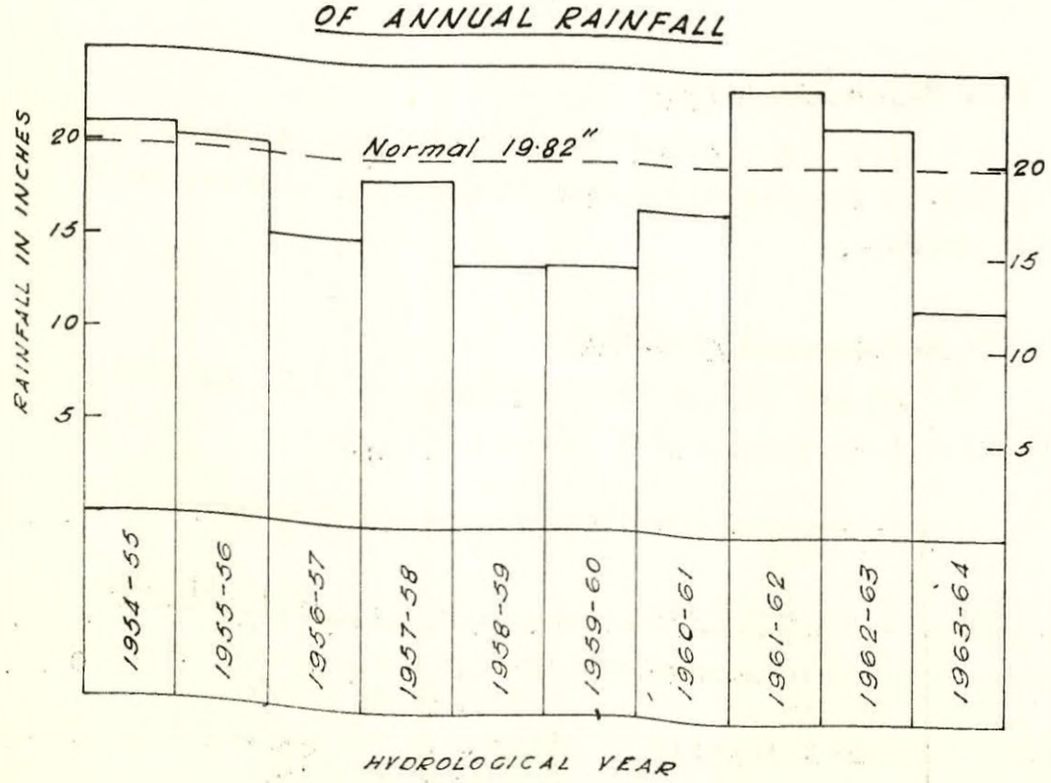
FEBRUARY 1965 DRG. No. 1/G/9/14

Prepared and drown by D. Pitsillides I.W.

# AVERAGE ANNUAL RAINFALL OF CYPRUS

| NORMAL | INCHES | PERCENTAGE | RAINFALL ON ISLAND IN MILLION FT$^3$ |
|---|---|---|---|
| (Determined from 50 years records 1908-57) | 19·82 | 100 | 164,476 |
| **Year** | | | |
| 1954-55 | 21·00 | 105·95 | 174,800 |
| 1955-56 | 20·30 | 102·42 | 167,700 |
| 1956-57 | 15·50 | 78·20 | 128,787 |
| 1957-58 | 18·66 | 94·15 | 154,850 |
| 1958-59 | 14·05 | 70·90 | 116,820 |
| 1959-60 | 14·09 | 71·09 | 116;900 |
| 1960-61 | 17·20 | 86·80 | 142,700 |
| 1961-62 | 23·96 | 120·88 | 198,832 |
| 1962-63 | 21·93 | 110·65 | 181,100 |
| 1963-64 | 12·06 | 60·85 | 100,080 |

## GRAPHICAL PRESENTATION OF ANNUAL RAINFALL



The table below summarizes some of the larger floods and gives an idea of the maximum rainfall measured in the catchment on the day of the flood or on the previous days. Floods of less importance have been ignored.

| River | Location | Peak flow | | Rainfall | | |
|---|---|---|---|---|---|---|
| | | Cusecs | Date | Inches | Place | Date |
| Pedhieos | Mia Milia | 780 | 16.5.64 | 1.74 | Nicosia | 16.5.64 |
| Vathys | Athalassa | 234 | 16.6.64 | 0.40 | Perakhorio | 16.6.64 |
| Mylou | Kornos | 1,800 | 15.6.64 | 1.20 | Kornos | 15.6.64 |
| Meriki | Kokkini-Trimithia | 370 | 16.5.64 | | Showers in Paleometokho | |
| | | 1,130 | 8.6.64 | No rainfall records available | | |
| Xeros | Phinikas | 301 | 8.12.63 | 1.08 | Kykko Monasteri | 6.12.63 |
| | | | | 0.62 | -do- | 7.12.63 |
| | | | | 0.43 | -do- | 8.12.63 |
| Yermasoyia | Yermasoyia | 240 | 25.3.64 | 0.75 | Kalokhorio L/ssol | 25.3.64 |
| | Police Station | 241 | 11.9.64 | 0.68 | -do- | 11.9.64 |
| Vasilikos | Kalavasos | 325 | 25.3.64 | 1.20 | Zyyi | 25.3.64 |
| Syrgatis | Skarinou | 1,140 | 16.5.64 | 0.93 | P/Lefkara | 16.5.64 |
| | | | | 0.87 | Kornos | 16.5.64 |
| Skylloura | Ay.Vasilios | 272 | 10.7.64 | 0.84 | Sisklipos | 10.7.64 |
| Pouzis | Mazotos | 715 | 11.9.64 | 0.26 | Larnaca | 11.9.64 |
| | | | | 0.80 | Kiti | 11.9.64 |

## III. River Discharges

The low rainfall during the Hydrological year resulted in keeping the basic flow of all streams well below average.

## IV. Water Level recorders

At the end of the hydrological year the following water level recorders were in operation:-

| No. | Catchment | Location | Type of installation |
|---|---|---|---|
| * 1 | Pedhieos | Nicosia Ex-Railway Bridge | Water level recorder on 40 ft. measuring weir. |
| * 2 | Yialias | Near Kotchatis | Water level recorder on 60 ft. measuring weir. |
| 3 | Ovgos | Morphou-Pnasi Monastery bridge | Water level recorder on bridge. |

| No. | Catchment | Location | Type of installation |
|---|---|---|---|
| 4 | Serakhis | Near Morphou | Water level recorder using natural section of river. |
| 5 | Xeros (Nicosia) | Xeros bridge | Water level recorder on bridge. |
| 6A | Marathasa | Near Xeros-Nicosia road. | Water level recorder on 50 ft. measuring weir. |
| 6B | Marathasa | Upstream of Lefka dam. | Water level recorder using natural section of river. |
| 8 | Avgorou | Near Avgorou | Water level recorder on 40 ft. measuring weir. |
| 9 | Paralimni | Near Paralimni lake. | Water level recorder on recharge channel. |
| 10 | Pyrgos | Near Phileyia | Water level recorder on 30 ft. measuring weir. |
| * 11 | Limnitis | Near Limnitis Saw-Mill | Water level recorder on 30 ft. measuring weir. |
| 13A | Kouris (Trimiklini) | Limassol-Troodos bridge. | Water level recorder on 18 ft. measuring weir. |
| 13B | -do- | Near 13 A | Water level recorder on 1' - 6' flume. |
| 14 | Peristerona (Nicosia) | Near Panayia Forest Station | Water level recorder on 20 ft. measuring weir. |
| 15 | Tremithios | Kiti | Water level recorder on 73 ft. irrigation weir. |
| 16 | Yermasoyia | Near Yermasoyia Police Station | Water level recorder on 80 ft. measuring weir. |
| 17A | Kouris(Erimi) | Erimi bridge | Water level recorder on bridge. |
| 17B | -do- | -do- | -do- |
| 18 | Kolopannes | Near Kalopsidha | Water level recorder on 25 ft. measuring weir. |
| 19 | Akhna | Near Akhna Police Station | Water level recorder on 40 ft. measuring weir. |
| 20 | Phrenaros | Near Asprovouniotissa church | Water level recorder on 40 ft. measuring weir. |
| 21 | Kokkini-Trimithia | Near Kokkini-Trimithia | Water level recorder on 55 ft. measuring weir. |
| 22 | Liopetri | Near Liopetri | Water level recorder on 40 ft. measuring weir. |
| 23 | Akaki | Malounda | -do- |
| 24 | Skylloura | Ayios Vasilios | Water level recorder on 60 ft. measuring weir. |
| * 25 | Ak-Sou | Petra-tou-Dhigheni | Water level recorder on 30 ft. measuring weir. |
| 27 | Khrysokhou | Skoulli | Water level recorder on 40 ft. measuring weir. |

| No. | Catchment | Location | Type of installation |
|---|---|---|---|
| 28 | Stavros-tis-Psokas | Evretou | Water level recorder on 25 ft. measuring weir. |
| 29 | Syrgatis | Skarinou Station | Water level recorder on bridge. |
| 30 | Dhiarizos | Kouklia (Paphos) | Water level recorder on 40 ft. measuring weir. |
| * 31 | Xeros(Paphos) | Phinikas | Water level recorder on 120 ft. measuring weir. |
| 32 | Alakati | Platimatis near Ay. Amvrosios(Kyrenia) | Water level recorder on 22 ft. measuring weir. |
| 33A | Karyiotis | Pendayia | Water level recorder on 60 ft. measuring weir. |
| 33B | -do- | Evrykhou | Water level recorder using natural section of river. |
| 34 | Tremithios | Ayia Anna | Water level recorder on 40 ft. measuring weir. |
| 35 | Elea | Ghazivera | Water level recorder on bridge. |
| 36A | Ay. Loucas Famagusta | Near Ay. Loucas (Famagusta) | Water level recorder on Ay. Loucas lake. |
| 36B | Ay. Loucas Famagusta | -do- | Water level recorder on conveyor channel. |
| 37 | Atsas | Evrykhou | Water level recorder on 25 ft. measuring weir. |
| 38A | Serakhis | Massari | Water level recorder on bridge. |
| 38B | -do- | -do- | -do- |
| 39 | Livadhi | Paleambela | Water level recorder on 70 ft. measuring weir. |
| 40 | Xeros(Polis) | Ay. Marina | Water level recorder on bridge. |
| 41 | Yialia(Polis) | Kato Yialia | Water level recorder on 14' - 10' measuring weir. |
| 42 | Magounda | Kato Argaka | Water level recorder on bridge. |
| 43 | Mavrokolymbos | Potima | Water level recorder on 40 ft. measuring weir. |
| 44 | Ezusa | Akhelia | Water level recorder on 85 ft. measuring weir. |
| 45 | Khapotami | Kouklia(Paphos) | Water level recorder on 50 ft. measuring weir. |
| 46 | Garyllis | Kato Polemidhia | Water level recorder on 66 ft. measuring weir. |
| 47 | Vasilikos | Kalavasos | Water level recorder on 75 ft. measuring weir. |
| 48 | Maroni | Khirokitia Station | Water level recorder on 40 ft. measuring weir. |

| No. | Catchment | Location | Type of installation |
|---|---|---|---|
| 49 | Kambos | Potamos-tou-Kambou | Water level recorder on 45 ft. measuring weir. |
| 50 | Kouzis | Mazotos | Water level recorder on 45 ft. measuring weir. |
| 51 | Mavravis | Alaminos | Water level recorder on 41 ft. measuring weir. |
| 52 | Kouris (Khalassa) | Khalassa-Lophou road bridge. | Water level recorder on bridge. |
| 53 | Kryos | Near Khalassa | Water level recorder on 100 ft. measuring weir. |
| 54 | Zygos | Mia-Kremmos | Water level recorder on 75 ft. measuring weir. |

* Situated in Turkish areas and they could not be inspected.

Note:- All recorders used on the above stations are of the Lea Abbey float operated type, except on stations No. 6 B, No. 14, No. 33 B, No. 53, No. 54 on which Pneumatic recorders have been installed.

V. Measured discharges 1963 - 1964

The discharges which could be measured during the year at the Gauging stations of the previous paragraph are as follows:-

| No. | Catchment | Rainfall during 1963-64 $10^6$ cub.ft. | Runoff during 1963-64 $10^6$ cub.ft. | Maximum discharge in a day $10^6$ cub.ft. | Maximum flow cusecs | Runoff in % Rainfall 1963-64 |
|---|---|---|---|---|---|---|
| 1 | Pedhieos | 1408.01 | - | - | - | - |
| 2 | Yialias | 939.86 | - | - | - | - |
| 3 | Ovgos | 2382.58 | - | - | - | - |
| 4 | Serakhis (Morphou) | 4572.05 | - | - | - | - |
| 5 | Xeros (Nicosia) | 1091.79 | 0.012 | - | - | 0.001 |
| 6 A | Marathasa Xeros - Nicosia road | 1054.90 | 4.10 | 0.44 | 7.9 | 0.39 |
| 6 B | Marathasa (Lefka dam) | 782.30 | 40.23 | 0.66 | - | 5.14 |
| 8 | Avgorou | 109.89 | - | - | - | - |

| No. | Catchment | Rainfall during 1963-64 $10^6$ cub.ft. | Runoff during 1963-64 $10^6$ cub.ft. | Maximum discharge in a day $10^6$ cub.ft. | Maximum flow cusecs | Runoff in % Rainfall 1963-64 |
|---|---|---|---|---|---|---|
| 9 | Paralimni | - | 0.172 | 0.15 | 22.6 | - |
| 10 | Pyrgos | 640.39 | 8.58 | - | - | 1.34 |
| 11 | Limnitis | 849.06 | 15.29 | - | - | 1.80 |
| 13AB | Kouris (Trimiklini) | 869.64 | 100.18 | 1.80 | 82.0 | 11.52 |
| 14 | Peristerona | 1032.27 | 100.16 | 7.71 | 169.0 | 9.70 |
| 15 | Tremithios (Kiti) | 1604.89 | 1.57 | 0.94 | 80.0 | 0.98 |
| 16 | Yermasoyia | 2168.75 | 8.97 | 2.59 | 241.0 | 0.41 |
| 17AB | Kouris(Erimi) | 4894.31 | 191.41 | 4.76 | 230.0 | 3.91 |
| 18 | Kolopannes | - | 0.04 | 0.04 | - | - |
| 19 | Akhna | 126.7 | - | - | - | - |
| 20 | Phrenaros | 51.74 | - | - | - | - |
| 21 | K/Trimithia | 276.00 | 1.57 | 0.86 | 125.0 | 0.57 |
| 22 | Liopetri | 66.03 | 0.04 | 0.04 | - | 0.06 |
| 23 | Akaki | 1206.74 | 66.70 | 5.46 | 156.5 | 5.53 |
| 24 | Skylloura | 874.54 | 6.79 | 3.65 | 272.0 | 0.78 |
| 25 | Ak-Sou | 124.40 | 1.34 | 0.62 | 33.0 | 1.08 |
| 27 | Khrysokhou | 1037.56 | 52.39 | 2.22 | 174.0 | 5.05 |
| 28 | Stavros-tis Psokas | 1518.40 | 43.75 | 1.54 | 160.0 | 2.88 |
| 29 | Syrgatis | 1810.05 | 45.70 | 7.01 | 1140.0 | 2.52 |
| 30 | Dhiarizos (Kouklia) | 3219.79 | 81.07 | 2.49 | 99.0 | 2.52 |
| 31 | Xeros (Phinikas) | 3017.29 | 33.11 | 5.07 | 367.0 | 1.10 |
| 32 | Alakati | 189.06 | 3.41 | 1.84 | 400.0 | 1.80 |
| 33A | Karyiotis (Pendayia) | 1151.65 | 3.11 | 0.25 | - | 0.27 |
| 33B | Karyiotis (Evrykhou) | 907.37 | 116.70 | 0.79 | - | 12.86 |
| 34 | Trimithios (Ay.Anna) | 936.74 | 1.24 | 1.24 | 123.0 | 0.13 |
| 35 | Elea | 1495.81 | - | - | - | - |
| 36B | Ay. Loucas | - | - | - | - | - |
| 37 | Atsas | 327.39 | 7.15 | 0.36 | 35.0 | 2.18 |
| 38AB | Serakhis (Massari) | 4226.18 | 5.99 | 2.06 | 47.0 | 0.14 |
| 39 | Livadhi | 566.09 | 5.64 | 0.12 | - | 1.00 |
| 40 | Xeros(Polis) | 118.83 | - | - | - | - |

| No. | Catchment | Rainfall during 1963-64 $10^6$ cub.ft. | Runoff during 1963-64 $10^6$ cub.ft. | Maximum discharge in a day $10^6$ cub.ft. | Maximum flow cusecs | Runoff in % Rainfall 1963-64 |
|---|---|---|---|---|---|---|
| 41 | Yialia (Polis) | 279.99 | 2.61 | 0.33 | 32.0 | 0.93 |
| 42 | Magounda | 936.09 | 1.58 | 0.28 | 18.0 | 0.17 |
| 43 | Mavrokolymbos | 601.52 | 2.74 | 0.28 | 66.0 | 0.46 |
| 44 | Ezusa | 3314.60 | 30.33 | 2.71 | 104.0 | 0.91 |
| 45 | Khapotami | 1455.58 | 21.53 | 2.04 | 172.0 | 1.48 |
| 46 | Garyllis | 968.87 | 7.19 | 1.86 | 123.0 | 0.74 |
| 47 | Vasilikos | 1773.67 | 72.62 | 6.02 | 325.0 | 4.10 |
| 48 | Maroni | 783.38 | 20.48 | 0.96 | 82.0 | 2.61 |
| 49 | Kambos | 669.08 | 0.10 | 0.09 | 3.9 | 0.01 |
| 50 | Pouzis | 634.16 | 3.82 | 3.31 | 715.0 | 0.60 |
| 51 | Mavravis | 320.95 | 0.88 | 0.51 | 175.0 | 0.27 |
| 52 | Kouris(Khalassa) | 1545.00 | 171.40 | 1.59 | 46.6 | 11.09 |
| 53 | Kryos | 2572.92 | 383.70 | 7.04 | 99.8 | 14.91 |
| 54 | Zygos | 1731.92 | 211.14 | 4.05 | 100.0 | 13.15 |

VI. Spring discharges

During the Hydrological year, 1366 spring discharges were measured, averaging to 114 measurements every month. The output of 256 springs is now being measured regularly; 110 of these at monthly intervals, 32 every 2 months, 24 every 3 months, 22 every 4 months, 42 every 6 months, 20 every year, and 6 every fortnight.

Because of the low rainfall, nearly all spring discharges were below average. The seasonal increase in the rate of flow, which is normally observed in all springs late in winter, was very small and the general outlook of the prevailing condition concerning the behaviour of the springs was a rather steady decrease throughout the year. Certainly, the decrease in the spring discharges would have been greater if the rainfall of the last two years was not above normal.

The Kephalovrysos of Karavas, in the Kyrenia mountains, had its seasonal increase early in April - 570,000 gallons per day and for the remaining months of the year the rate of flow was steadily decreasing to 542,000 g.p.d. It is worth mentioning that this spring is the only one in Cyprus which has shown a relatively constant flow with little variations during the last decade.

In the Troodos mountains the combined flow of the springs used for the water supply of the Troodos Summer Resort reached its maximum discharge of 40,000 gallons per day in May, just after the melting period of snow. By steady gradual decrease the yield at the end of the year was 20,000 gallons per day and this is the lowest rate of flow which has been recorded during the last four years.

In the Mesaoria plain the yield of the chain of wells followed same behaviour as springs. The Arab Ahmet chain of wells had its seasonal increase in its flow, 133,000 gallons per day, in March and by the end of the year the rate of flow gradually decreased to 62,000 gallons per day which is the lowest since regular measurements commenced in 1952.

VII. Ground water used for town water supplies

Details of the water extracted from underground reserves for the three largest towns of Cyprus are given below:-

| Nicosia | Quantity | | Percentage |
|---|---|---|---|
| | Million cubic meters | Million cubic feet | |
| Kokkini Trimithia, Akaki & Paleometokho | 2.5 | 87.1 | 42.7 |
| Morphou (Bay scheme) | 1.2 | 41.1 | 20.1 |
| Arab Ahmet at Strovolos | 0.2 | 6.8 | 3.3 |
| Laxia | 0.2 | 8.5 | 4.2 |
| Dhikomo | 0.5 | 18.6 | 9.1 |
| Dhali | 0.2 | 8.5 | 4.2 |
| Sykhari | 0.1 | 4.5 | 2.2 |
| Athalassa | 0.05 | 1.6 | 0.8 |
| Makedhonitissa | 0.4 | 13.9 | 6.8 |
| Others (Approx.) | 0.4 | 13.5 | 6.6 |
| Total extraction during 1963-64 = | 5.75 | 204.1 | 100.0 |

| Famagusta | Quantity | | Percentage |
|---|---|---|---|
| | Million cubic meters | Million cubic feet | |
| Phrenaros West | 0.5 | 18.4 | 31.5 |
| Phrenaros North | 1.1 | 38.6 | 66.1 |
| Others | 0.04 | 1.4 | 2.4 |
| Total extraction during 1963-64 = | 1.64 | 58.4 | 100.0 |

| Limassol | | | |
|---|---|---|---|
| Kephalovrysos, Mavrommata & Kria Pighadhia springs | 1.9 | 66.7 | 65.8 |
| Chiftlikoudhia Chain of Wells | 0.3 | 12.3 | 12.1 |
| Others | 0.6 | 22.4 | 22.1 |
| Total extraction during 1963-64 = | 2.8 | 101.4 | 100.0 |

## VIII. Ground Water Levels.

Six new observation boreholes were brought into use during the year 1963-64, the total now being 152. Of these only 76 may be considered as permanent observation boreholes.

A decrease in the underground water levels was recorded this year almost in all aquifers. This is due to the very low rainfall which has been recorded all over Cyprus in 1963-64. It is obvious that the extraction of the ground water continues to be greatly in excess of the replenishment.

Thus, in the Morphou Bay area, about 1½ miles inland the average water level towards the end of the year was 7.37 feet below sea level, which is 2.28 feet lower than last year same time. Measurements taken after the wet season, indicated that the water table was 1.68 feet below sea level.

In the Kokkini Trimithia area, which supplied Nicosia with 42.7% of the year's domestic water requirements, the water table towards the end of the year had declined by 2.48 feet compared with the early year's recovery of 1.22 feet. Thus, the fall during the year was 1.26 feet compared with 2.55 feet last year, when Nicosia drew 44.6% of its domestic

water requirements from this area.

In the Phrenaros North area, the rate of decline of the water table is increasing. Thus, after the wet season of the year a fall of 0.47 feet was recorded, while the summer fall was 5.43 feet. Now the total decrease since last year same time is 5.90 feet. The rainfall in this area for 1963-64 is 5.29 inches.

In the Phrenaros West the fall was about the same as last year's, i.e. 4.20 feet. The water table decreased by 33.50 feet since 1954.

In the Xylophagou reef limestone aquifer the average water table showed a fall of 3.70 feet since last year and 10.61 feet since 1952.

In Ormidhia area near the coast, the average water level after the wet season of the year, showed a recovery of 0.39 feet. Now at the end of the year the water level is 0.31 feet lower than last year.

In Makrasyka area the number of private irrigation boreholes in use has considerably increased and the water level is declining at a high rate. Thus, a fall of 7.13 feet was recorded during the year. The total fall since 1955 is 37.25 feet.

The average minimum water level in the two observation boreholes at Ayios Memnon, was 6.19 feet below sea level and the fall during the year was 0.89 feet. The total fall since 1953 is 3.80 feet.

The fall of the water table in the two observation boreholes at Ayios Andronikos, Karpas peninsular, was 2.00 feet compared with 2.78 feet last year. The total fall since 1959 is 7.38 feet.

Kolossi observation borehole has recorded very bad results this year. Thus, a fall of 6.09 feet was recorded in the water table compared with a rise of 6.34 feet last year same time. The average annual fall since 1955 is 0.86 feet.

Appendix 5 gives the water levels recorded at all permanent observation boreholes after drilling and during the years 1962-63 and 1963-64.

## IX. Recharge Activities

Surplus water from the town domestic water supply is fed into the Chiftlikoudhia chain-of-wells to replenish

the aquifer in the low-lying coastal area west of Limassol. During the summer, when the normal sources of the town supply are inadequate, water from the Chiftlikoudhia chain-of-wells is then pumped out to meet the additional demands.

During 1963-1964 the quantities of water involved in the above operations were:-

Total recharged into aquifer = 6.0 million cubic ft.
Total extracted from aquifer = 12.3 million cubic ft.

X. Chemical Analyses

During the year 3,900 samples were sent to Medical Department's Analyst for partial chemical analysis. Of these 1,089 samples were taken from springs, Wells or boreholes which are used or proposed as water supply sources. The remaining 2,811 samples derived from springs, observations boreholes and from other miscellaneous sources.

XI. Bacteriological Analyses

During the year, 804 samples of water taken mainly from town water supplies were analysed by the Government Pathologist.

The total number of samples taken and the number of unsatisfactory ones are as follows:-

| Water Supply | Number of Samples | Number of unsatisfactory samples |
|---|---|---|
| Nicosia | 558 | 54 |
| Famagusta | 119 | 4 |
| Limassol | 43 | 2 |
| Larnaca | 12 | 1 |
| Paphos | 48 | 8 |
| Kyrenia | 24 | 1 |
| Totals = | 804 | 70 |

At Nicosia most of the unsatisfactory samples came from private boreholes at Kokkini Trimithia and Paleometokho area which supply water to Nicosia Water Board. All chlorinated samples at all reservoirs were satisfactory.

The unsatisfactory samples at Limassol, Famagusta, Larnaca, Ktima and Kyrenia were usually of unchlorinated water. All chlorinated samples at the main reservoirs were satisfactory.

XII. New Measuring Sites.

(a) Weirs completed:-

By the end of the Hydrological year 1963-64 the following new measuring weirs were completed and automatic water level recorders were installed.

1. Weir on Vathys river near Athalassa.
   A 35' -0" broad-crested measuring weir.
2. Weir on Asinou river near Nikitari.
   A 25' -0" broad-crested measuring weir (with 2' -0" x 6" notch for low flows).
3. Weir on Vyzakia river near Vyzakia.
   A 29' -0" broad-crested measuring weir (with 3' -0" x 6" notch for low flows).
4. Weir on Aloupos river near Aloupos Chiftlick.
   A 55' -0" broad-crested measuring weir.
5. Weir on Mylou river near Kornos
   A 40' -0" broad-crested measuring weir (with 2' -0" x 6" notch for low flows).
6. Weir on Khapotami river near Kissousa.
   A 25' -0" broad-crested measuring weir (with 2' -0" x 6" notch for low flows).
7. Weir on Xeros river near Peyia
   A 40' -0" broad-crested measuring weir.
8. Weir on Ezusa river near Kannaviou.
   A 45' -0" broad-crested measuring weir (with 4' -0" x 6" notch for low flows).
9. Weir on Ayios Nicolaos (Steghis) river near Kakopetria.
   A 20' -0" broad-crested measuring weir (with 4' -0" x 6" notch for low flows).
10. Weir on Melini river near Ayia Trias (Yialousa).
    A 22' -0" broad-crested measuring weir (with 2' -0" x 6" notch for low flows).
11. Weir on Platania river near Kakopetria.
    A 20' -0" broad-crested measuring weir (with 2' -0" x 6" notch for low flows).

(b) Weirs under construction:-

The following weirs were put in hand during the Hydrological year 1963-64 but could not be completed. Work still continues:-

1. Weir on Evdhimou river near Evdhimou.
   A 40' -0' broad-crested measuring weir (with 2' -0' x 6' notch for low flows).
2. Weir on Dhiarizos river near Philousa.
   A 60' -0' broad-crested measuring weir (with 4' -0' x 6' notch for low flows).

XIII. Repairs and Improvements to the existing measuring sites:-

Besides the construction of new measuring weirs, repairs or improvements have been carried out to the following existing measuring weirs during the year:-

1. Syrgatis river measuring site:-
   Inlet pipes were changed and a float well was constructed on Syrgatis river near Skarinou.
2. Kryos river measuring site, Khalassa:-
   The sill of the weir was lowered by one foot at a length of 20 ft.
3. Kha potami river measuring site near Kouklia:-
   The apron of the weir which was undermined by floods was repaired and extended by 10 feet.
4. Dhiarizos river measuring site near Kouklia:-
   The apron of the weir was repaired and inlet pipes raised to the notch level.
5. Minor repairs were carried out to weirs on Tremithios river near Ay. Anna, Maroniou river near Khirokitia, and on Vasilikos river near Kalavasos.

## Hydrological Surveys and Construction of Measuring Weirs Costs.

During the year the following expenditure were incurred by the Hydrology Section:-

| | Approved Estimate Cost £ | Actual Expenditure £ |
|---|---|---|
| Hydrological Surveys | 20,000 | 12,640 |
| Construction of New Measuring Weirs | 36,000 | 30,590 |
| Totals = | £56,000 | £43,230 |

Appendix 5.

## WATER LEVEL IN CONTROL BOREHOLES.

(Feet above sea level)

| Ser. No. | Place | Bore-hole Number & Year | Maximum Water Level | | | Minimum Water Level | | |
|---|---|---|---|---|---|---|---|---|
| | | | Year after drill-ing | 62-63 | 63-64 | Year after drill-ing | 62-63 | 63-64 |
| 1 | Astromeritis | 91/50 | 372.14 | 332.16 | 332.90 | 336.54 | 328.24 | 327.66 |
| 2 | Ayios Andronikos | 249/55 | 391.30 | 384.56 | 382.39 | 389.89 | 382.56 | 379.56 |
| 3 | " | 322/55 | 386.25 | 383.97 | 383.57 | 385.38 | 383.05 | 382.05 |
| 4 | Ayios Memnon | 69/38 | - 1.20 | - 1.49 | - 4.24 | - 5.60 | - 6.49 | - 7.49 |
| 5 | " | 50/53 | 3.21 | 0.28 | - 1.22 | - 0.69 | - 4.12 | - 4.89 |
| 6 | " | 18/62 | - | - 4.89 | - 7.47 | - | - 9.64 | -11.35 |
| 7 | " | 30/62 | - | - 3.80 | - | - | - 7.05 | - |
| 8 | Ayios Nicolaos Famagusta | 89/56 | 29.50 | 26.92 | 25.75 | 28.80 | 25.75 | 24.38 |
| 9 | Dherinia | 2/62 | - | 29.93 | 17.65 | - | 15.49 | 12.07 |
| 10 | " | 12/62 | - | 24.13 | 13.68 | - | 1.97 | - 3.24 |
| 11 | Ephtakomi | 163/55 | 496.39 | 461.89 | 461.28 | 489.22 | 459.30 | 459.80 |
| 12 | Famagusta | 15/62 | - | -17.65 | -19.07 | - | -20.97 | -20.23 |
| 13 | " | 16/62 | - | -10.98 | -14.73 | - | -19.52 | -21.14 |
| 14 | " | 17/62 | - | -14.03 | -16.23 | - | -17.73 | -18.73 |
| 15 | " | 19/62 | - | - 7.09 | - 9.12 | - | -12.45 | -13.79 |
| 16 | " | 20/62 | - | -12.57 | -15.67 | - | -19.67 | -20.47 |
| 17 | " | 27/62 | - | -10.32 | - 3.78 | - | -14.78 | -16.36 |
| 18 | " | 29/62 | - | - 4.03 | - 5.00 | - | - 7.17 | - 8.00 |
| 19 | Ghaziveran | 94/50 | 22.52 | 9.44 | - | 18.22 | 5.77 | - |
| 20 | Kalopsidha | 54/54 | 68.55 | 41.05 | 35.05 | 60.30 | 33.97 | 28.55 |
| 21 | " | 55/54 | 73.86 | 52.20 | 48.45 | 71.87 | 48.45 | - |
| 22 | " | 56/54 | 75.31 | 58.02 | 54.60 | 73.85 | 55.27 | 50.60 |
| 23 | Khalassa | 23/58 | 547.58 | 549.59 | 547.00 | 544.21 | 546.30 | 541.67 |
| 24 | Kokkini-Trimithia | 90/50 | 686.60 | 652.75 | 650.33 | 682.40 | 650.50 | 647.75 |
| 25 | " | 160/50 | 682.70 | 654.67 | 652.42 | 679.40 | 649.75 | 650.17 |
| 26 | " | 161/50 | 686.00 | 630.58 | 618.50 | 679.40 | 617.33 | 615.88 |
| 27 | Kolossi | 88/54 | 12.29 | 11.04 | 8.13 | 5.79 | 4.13 | 1.96 |
| 28 | Laxia | 208/55 | 672.23 | 640.98 | 639.40 | 666.31 | 638.81 | 631.94 |
| 29 | Makrasyka | 48/54 | 117.00 | 90.50 | 80.50 | 110.70 | 75.92 | 64.83 |
| 30 | " | 49/54 | 120.10 | 98.32 | 92.90 | 116.90 | 92.07 | 88.90 |

| Ser. No. | Place | Bore-hole Number & Year | Maximum Water Level | | | Minimum Water Level | | |
|---|---|---|---|---|---|---|---|---|
| | | | Year after drill-ing | 62-63 | 63-64 | Year after drill-ing | 62-63 | 63-64 |
| 31 | Morphou | 168/50 | 89.27 | 71.99 | 67.32 | 83.57 | 67.24 | 66.07 |
| 32 | " | 92/50 | 86.43 | 45.31 | 41.56 | 76.13 | 16.15 | 8.40 |
| 33 | Ormidhia | 189/57 | -1.50 | -1.40 | -1.77 | -2.27 | -2.36 | -2.52 |
| 34 | " | 227/57 | 0.70 | -0.05 | -0.72 | 0.20 | -1.05 | -1.55 |
| 35 | " | 246/57 | 0.22 | 0.68 | -0.73 | -0.32 | -0.98 | -1.57 |
| 36 | Pendayia | 95/50 | 10.60 | 11.75 | 7.83 | 8.00 | 6.00 | 4.25 |
| 37 | Pergamos | 86/51 | 259.00 | 232.48 | - | 254.30 | 221.48 | - |
| 38 | Phrenaros North | 108/52 | 72.20 | 40.53 | 35.36 | 70.60 | 36.44 | 28.69 |
| 39 | " " | 109/52 | 70.60 | 39.18 | 34.41 | 66.08 | 34.66 | 28.20 |
| 40 | " " | 110/52 | 70.20 | 39.74 | 34.58 | 66.16 | 35.00 | 28.71 |
| 41 | " " | 76/56 | 58.13 | 39.38 | 34.55 | 56.47 | 34.97 | 29.22 |
| 42 | Phrenaros North | 77/56 | 64.13 | 57.88 | 56.88 | 62.80 | 56.84 | 55.97 |
| 43 | " " | 78/56 | 65.63 | 49.88 | 46.22 | 63.80 | 46.72 | 42.68 |
| 44 | " " | 79/56 | 72.77 | 49.68 | 41.85 | 71.27 | 42.52 | 32.35 |
| 45 | " West | 51/51 | 87.10 | 58.83 | 55.67 | 86.50 | 55.58 | 52.63 |
| 46 | " " | 52/51 | 86.00 | 53.40 | 50.07 | 85.30 | 49.73 | 47.07 |
| 47 | " " | 53/51 | 85.20 | 34.80 | 28.72 | 84.80 | 29.30 | 21.55 |
| 48 | " " | 67/53 | 81.10 | 56.92 | 53.83 | 78.70 | 54.08 | 50.75 |
| 49 | Prastio | 93/50 | 31.49 | 3.40 | 0.77 | 24.29 | -3.31 | -6.89 |
| 50 | " | 11/57 | 26.31 | 5.69 | 3.70 | 14.73 | -0.14 | -2.72 |
| 51 | Syrianokhori | 150/54 | 10.51 | 3.34 | - | 9.01 | 0.93 | 0.01 |
| 52 | " | 151/54 | 10.12 | 1.16 | 1.04 | 8.83 | 0.58 | 0.03 |
| 53 | " | 152/54 | 8.32 | 1.34 | 0.34 | 6.07 | 0.01 | -0.66 |
| 54 | " | 153/54 | 5.79 | 1.54 | - | 4.71 | 0.58 | 0.12 |
| 55 | " | 1/55 | 24.09 | 0.97 | -1.78 | 17.80 | -6.20 | -8.78 |
| 56 | " | 23/55 | 21.89 | -0.03 | -2.61 | 17.64 | -7.28 | -9.94 |
| 57 | " | 201/56 | 18.45 | -0.11 | -3.11 | 13.02 | -7.11 | -9.95 |
| 58 | " | 209/56 | 17.24 | 1.41 | -0.92 | 12.49 | -6.21 | -9.05 |
| 59 | " | 195/57 | 7.07 | 1.59 | 0.28 | 5.19 | -0.51 | -1.31 |
| 60 | " | 209/57 | 4.56 | 1.12 | - | 2.96 | 0.62 | - |
| 61 | " | 212/57 | 3.69 | 1.98 | - | 2.36 | 0.56 | - |
| 62 | " | 248/57 | 10.58 | 0.61 | -1.48 | 6.44 | -1.98 | -3.31 |
| 63 | " | 253/57 | 10.76 | 0.75 | -0.16 | 6.72 | -1.75 | -3.20 |
| 64 | Xylophagou | 70/51 | 19.10 | 7.63 | 5.97 | 17.50 | 5.80 | 3.47 |
| 65 | " | 71/51 | 13.10 | -1.75 | -5.42 | 11.20 | -6.50 | -14.08 |
| 66 | Xylophagou | 72/51 | 17.15 | 19.48 | 15.40 | 14.65 | 15.40 | 12.03 |
| 67 | " | 73/51 | 6.03 | 6.03 | 4.70 | 4.03 | 4.53 | 3.03 |

| Ser. No. | Place | Bore-hole Number & Year | Maximum Water Level | | | Minimum Water Level | | |
|---|---|---|---|---|---|---|---|---|
| | | | Year after drill-ing | 62-63 | 63-64 | Year after drill-ing | 62-63 | 63-64 |
| 68 | Xylophagou | 74/51 | 6.85 | 2.51 | - | 4.45 | 0.51 | - |
| 69 | Yermasoyia | 133/59 | - | 38.37 | 16.99 | 8.91 | 10.66 | 6.66 |
| 70 | " | 134/59 | - | 49.58 | 21.74 | 10.41 | 12.41 | 7.08 |
| 71 | " | 180/59 | - | 114.61 | - | 38.03 | 50.86 | - |
| 72 | " | 191/59 | - | 48.52 | 21.19 | 9.77 | 12.27 | 7.02 |
| 73 | " | 7/60 | - | 30.37 | 13.95 | - | 9.70 | 6.37 |
| 74 | " | 107/61 | - | 64.42 | - | 16.71 | 13.71 | - |
| 75 | " | 113/61 | - | 54.39 | 23.56 | 10.39 | 13.10 | 7.14 |
| 76 | " | 177/61 | - | 187.73 | 160.23 | 136.40 | 135.40 | - |

## 13. MAPPING, MAJOR PROJECTS INVESTIGATIONS AND LABORATORY

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### A. Mapping

After completion of flying for aerial photography of the whole of Cyprus in November, 1963, a contract was signed by Government with Faireys Ltd., for the execution of certain mapping programme for the Water Development Department.

This includes maps of 1:5000 with four foot contours of an area of about 163 square miles. It is the Kourris-Garyllis Watershed (62 sq. miles), the Morphou Watershed (1015 sq. miles) as well as three small areas at Paphos. These maps are needed very urgently for watershed planning studies. The contract sum is £12,471.

The areas at Paphos have been finished and it is expected to have these available within the month of January, 1965.

Meanwhile Lands and Survey Department and Water Development Department are supplying the company with ground control and vegetation classification for the other two main areas.

### B. Major Projects Investigations

These include: (a) Site investigation and preliminary calculations (b) Test pits and drilling (c) In situ permeabilities (d) detailed geological map of site and reservoir (e) Laboratory tests (f) Preliminary design and reports.

Schemes investigated in 1964 were as follows:-

#### 1. Mavrokolymbos Dam investigations

This job having been given to consultants, they have asked for some boreholes in the area. Craelius core drill was used to take samples and determine the apparent thrust fault in the river bed. Five holes were drilled to get all the information required. This was then passed over to consultants.

#### 2. Kalopanayiotis Dam investigations

This being one of the most difficult dam sites, the investigations continued from 1963 with some intervals up to November, 1964. Some twenty boreholes were drilled in

1964 and both the Overburden Drill and the Craelius Core drill were extensively used.

Investigations were carried in the river bed and mainly on the east abutment where the spillway is to be sited.

Permeability tests were also carried out to determine what the value would be, so that the data could be used for the proposed grouting programme.

3. Agros Dam Investigations

Here the Overburden drill was used for about one month, drilling holes to assess the ground permeability for the foundation of the side embankment.

4. Yermasoyia Dam Investigations

After site investigation and preliminary calculations were completed, the site was found suitable and we proceeded with drilling to determine the amount of gravel strata present before reaching parent rock.

A preliminary feasibility report was prepared and it is hoped to finish the drilling and proceed with permeability and other tests in 1965.

A design report is hoped to be prepared then.

5. Palekhori - Sklidros Dam Investigations

The site investigations and preliminary calculations are now complete; some test pits have also been made as well as permeability tests. A geological report has also been prepared by the Geological Department. It is hoped that the investigations will be finished in 1965 by drilling about five to six boreholes in the proposed centre line of the dam to determine the permeability of the diabase formations.

6. Platres Dam Investigations

Investigations have also been carried out for the construction of a dam on the Kryos potamos; this dam would store water for irrigation during the summer when some extra water for water supply for tourism would be needed.

7. Pano Lefkara Dam Investigations

These were started in 1963 and a design report was produced. However some tests pits were made in 1964 on the new centre line of the dam to determine the depth of overburden in the river bed and the depth to good rock in the abutments.

It is expected that before construction starts

in 1965 some boreholes will be drilled at the damsite to determine permeabilities. This could not be done until now because no funds were available to make an access road to the damsite.

8. Syngrassi Dam Investigations

This is to revise a dam built in Cyprus as early as 1900.

Investigations were carried out as to how it might be best repaired. Test pits were dug and field permeability results were obtained. Finally a design report was prepared.

The total cost on investigations reached by the end of 1964 was £9,448.

Reconnaissance reports were also prepared in 1964 for the following:-

1. Peyia Dam Reconnaissance

Preliminary investigations were carried out on the Xeros river to investigate the possibility of construction of a dam there. Majority of conditions are favourable.

2. Loumata tous Aetous Dam Reconnaissance

Here the possibility of erecting a dam above the Amiandos Mine and on the Amiandos river was investigated. It is thought that the construction of such a dam would contribute to the partial solution of the problem of the Amiandos debris present in the river.

3. Aradhippou Dam Reconnaissance

Reconnaissance was carried out to determine possibilities of erection of a dam at Aradhippou Diplo-potamos locality. Before any final decision is taken however, extensive investigation would have to take place.

4. Pitsilia region Reconnaissance

Possibilities of erecting dams at different regions in the Pitsilia area were investigated. Schemes where further investigation would prove fruitful are Ayios Theodhoros and Kalokhorio (Limassol).

It is thought that other schemes would best be investigated under a Watershed Planning programme.

C. Laboratory

The laboratory is considered very essential because we can have tests made during the planning stage to decide on the most appropriate design and also carry tests during construction in order that control is exercised on the execution of the design selected.

The W.D.D. laboratory is equipped with the following apparatus:

1. For tests on cement, aggregates and concrete

(i) Le Chatelier apparatus
(ii) Vicot apparatus
(iii) Sieves for aggregates
(iv) Aggregate crushing strength apparatus
(v) Silt and moisture content determination apparatus for aggregates.
(vi) Slump test and compacting factor apparatus
(vii) Cubes (different sizes)
(viii) Curing facilities
(ix) Crushing machine (capacity 100 Tons)

2. For tests on Soils

(i) Atterbergh limit apparatus
(ii) Normal and rapid moisture content determination apparatus.
(iii) Standard and modified proctor apparatus.
(iv) Sand replacement apparatus
(v) Sieve analysis, hydrometer and pipette apparatus
(vi) Permeameters (falling and constant head) for horizontal and vertical permeability.
(vii) Unconfined compression apparatus
(viii) Triaxial apparatus ($1\frac{1}{2}$ inch diameter specimens)
(ix) Shear box apparatus
(x) Consolidation apparatus
(xi) Model tank for dam design investigation

During 1964 some 997 tests were carried out on materials that were to have been used in future construction.

Also control was exercised during construction of the different dams and major works and some 3645 tests were carried out.

The total expenditure for the Laboratory in 1964 reached £737.-

Details of these tests are as shown below.

| Tests | Investigations — Scheme and Number of Tests | | | | | | | Construction — Scheme and number of tests | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mavrokolymbos Dam | Kalopanayiotis Dam | Agros Dam | Lefkara Dam | Polemidhia Dam | Liopetri Dam | Syngrassi Dam | Agros Dam | Polemidhia Dam | Liopetri Dam | Morphou Irrigation channels | |
| 1. Tests on cement, aggregates, concrete | Total No.=42 | Total No.=6 | Total No.=0 | Total No.=19 | Total No.=42 | Total No.=4 | Total No.=4 | Total No=102 | Total No=120 | Total No.=0 | Total No.=137 | Total No. = 476<br>Investigation = 117<br>Construction = 359 |
| i. Le Chatelier, initial & final setting time | | | | | | | | | | | | 0 |
| ii. Sieve Analysis | 4 | 6 | | 4 | 4 | 4 | | | | | 32 | 54 |
| iii. Aggregate crushing strength | 2 | | | 2 | 2 | | | | | | | 6 |
| iv. Silt & moisture content determination for aggregates | 4 | | | 1 | 2 | | | 2 | | | | 9 |
| v. Slump | 12 | | | 4 | 3 | | | 50 | 60 | | | 129 |
| vi. Compacting factor test | 4 | | | | 1 | | | | | | | 5 |
| vii. Cubes prepared and crushed | 12 | | | 4 | 12 | | | 50 | 60 | | 105 | 243 |
| viii. Water absorption | 2 | | | 2 | 9 | | 2 | | | | | 15 |
| ix. Specific gravity | 2 | | | 2 | 9 | | 2 | | | | | 15 |

| Tests | Investigations | | | | | | | Construction | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scheme and Number of Tests | | | | | | | Scheme and number of tests | | | | |
| | Mavrokolymbos Dam | Kalopanayiotis Dam | Agros Dam | Lefkara Dam | Polemidhia Dam | Liopetri Dam | Syngrassi Dam | Agros Dam | Polemidhia Dam | Liopetri Dam | Morphou Irrigation channels | |
| 2. Tests on soils | Total No=129 | Total No=107 | Total No=155 | Total No=0 | Total No=98 | Total No=297 | Total No=94 | Total No=820 | Total No=1319 | Total No=1147 | Total No=0 | Total No. = 4166<br>Investigation= 880<br>Construction = 3286 |
| i. Atterbergh Limits | 5 | 6 | 2 | | 6 | 5 | 4 | | | | | 28 |
| ii. Moisture content | 90 | 80 | 128 | | 72 | 246 | 70 | 510 | 761 | 646 | | 2603 |
| iii. Standard proctor | 10 | 6 | 14 | | 6 | 30 | 4 | 40 | 40 | 29 | | 179 |
| iv. Modified proctor | 2 | | | | | | | | | | | 2 |
| v. Sand replacement, water replacement | | | | | | | | 90 | 20 | 232 | | 342 |
| vi. Core cutter | | | | | | | 8 | 180 | 498 | 240 | | 926 |
| vii. Sieve analysis, hydrometer & pipette | 17 | 4 | 3 | | 8 | 4 | | | | | | 36 |
| viii. Permeability | | 4 | 5 | | | 9 | 4 | | | | | 22 |
| ix. Unconfined | | | | | | | | | | | | 0 |
| x. Triaxial | | 1 | | | | | | | | | | 1 |
| xi. Shear box | | | | | | | | | | | | 0 |
| xii. Consolidation | | | | | | | | | | | | 0 |
| xiii. Specific gravity | 5 | 6 | 3 | | 6 | 3 | 4 | | | | | 27 |

Summary: Total number of tests carried out in each project:-

| | | | No. of tests |
|---|---|---|---|
| 1. | Mavrokolymbos Dam | Investigations | 171 |
| 2. | Kalopanayiotis Dam | Investigations | 113 |
| 3. | Agros Dam | Investigations | 155 |
| 4. | Lefkara Dam | Investigations | 19 |
| 5. | Polemidhia Dam | Investigations | 140 |
| 6. | Liopetri Dam | Investigations | 301 |
| 7. | Syngrassi Dam | Investigations | 98 |
| 8. | Agros Dam | Construction | 922 |
| 9. | Polemidhia Dam | Construction | 1439 |
| 10. | Liopetri Dam | Construction | 1147 |
| 11. | Morphou Irrigation Channels | Construction | 137 |
| | | Total | 4642 |

## 14. VILLAGE DOMESTIC SUPPLIES

By H. P. Karakannas, M.ASCE., M.I.P.H.E., M.R.S.H.,
Engineer-Hydrologist.

The work of the village Domestic Water Supplies Section, is confined to the domestic supply for the village, but it also includes the Towns of Paphos and Kyrenia, all representing a population of 392.000 or 66% of the total population of the island. Moreover, this section has taken active part in the planning and execution of the major water supply schemes for Limassol and Larnaca. The section deals with all aspects of waterworks and water engineering: The investigation and development of springs, the planning and laying of supply and distribution mains, the construction of storage reservoirs pumping stations and pumping units, construction of public fountains and house water supply connections.

The activities of this section during the year have been as before on the intensive high rate, and it may safely be stated that practically every village of the island whether small or big, in central part or in isolation has a pure hygienic piped supply. Above all it is worth mentioning that 296 villages enjoy a house-to-house service, and 276,885 persons or 66.71% of the total rural population is served. The cost of each scheme is shared between the Government and the village on the fifty-fifty ratio as a practice. Any extra cost for a house-to-house service and all cost of house connection is borne entirely by the consumers. All supplies to the consumers are mostly controlled by water meters. The daily satisfactory supply per capita is considered at 20 gallons, but it will have to be raised to 25 or even 30 as the standard of living of the rural population rises steadily. This quantity per capita is well conformed to the universal standards for a country which may be classified as semi-arid.

Practically all schemes completed during the year, with the exception of a very small number in the high areas, have their source of supply a successful borehole. Therefore, the stability and safeguarding of the aquifers, in the districts of Nicosia, Famagusta and Larnaca is of a paramount importance, for the maintenance of the domestic supplies in these districts to a satisfactory degree. All pumped supplies, are operated by means of turbine pumps, either vertically driven or electrosubmersible. The power is a diesel engine but nowadays electricity is preferred whenever it can be made available. Water is pumped into an elevated or ground collecting reinforced concrete reservoir the function

of which is to provide at least one day's supply and in some cases to act as a collecting basin from where a 24 hours continuous quantity can be withdrawn. All dry villages, in the Eastern Mesaoria, Prastio, Gaidouras, Gypsos, Milea, Piyi, Peristerona, Ayios Georghios, Arnadhi, Spathariko, Limnia, Ayios Serghios, Salamis, which for so many centuries were living in the plight of water shortage, have been supplied with adequate piped water during the year. At this point it may be worth making reference the pact of the speech of his Excellency's the Minister of Finance at the House of Representatives on the 28th December, 1964 in which he stated that a sum of £2,150,000 has been spent for the provision of piped water supply to every village in the island, and that the villages remaining at present without a piped supply are less than the fingers of the one man's hand.

This part of the speech of his Excellency's the Minister of Finance, is really a great appreciation of the work that has been done in this field by the Department, and the whole small group of Technical people who put in so much work and have maintained their zeal and enthousiasm all during these 4 years of intensive and hard work, would wish to convey to His Excellency their thanks.

An amount of £615,631 was allocated for village domestic supplies during 1964. 45 village water supply schemes serving a population of 34,984 persons were completed. 282 miles of pipes varying from ½ - 12 inches in diameter were laid. 44 reinforced concrete tanks of a total capacity of 1,525,000 gallons, 6 pumping stations were constructed. A house-to-house service system was provided to 39 villages, and 7,000 house connections were made. It is estimated that an area of about 500 donums has been brought under perennial irrigation within the villages by the use of surplus water over their domestic requirements. This brings a very high return to the villages as a whole.

Two major schemes, for Paphos and Kyrenia have been executed and were at their final stage of completion at the end of 1964.

PAPHOS

A daily quantity of 750,000 gallons will be made available from two boreholes, drilled near the Xeros River. Water is being pumped into a circular collecting tank of 60,000 gallons capacity and from there it is gravitated to the Town, through a 12 inches main, 42,000 feet long. After the completion of this scheme estimated to cost £100,000, Paphos will enjoy a water supply of good quality and quantity

adequate to meet the requirements of the town for the next say 15 - 20 years. A total of £70,000 was spent on this project by the end of 1964.

KYRENIA

This Town has been supplied from a good borehole No. 50/61 which was drilled by the Bella Paise road, not very far from the Junction of the Kyrenia-Bella Paise road. The yield of this borehole remained steady at the rate of 15,000 gallons per hour, and so Kyrenia enjoys a satisfactory supply at present. Any future development of Tourism industry and in consequence increase of population, will undoubtedly necessitate the provision of more water. Part of the Headworks, (were completed in 1963) and during the year workwas concentrated on the provision of a new and up to-date distribution system. The estimated cost was £51,000, and at the end of the year, the scheme was in its final stage of completion. A total of £37,210 was spent on this project by the end of 1964.

Of the total 628 villages named in the cencus of 1960, the number of villages with a piped water supply was 619 or 98.56%. 558 or 88.85% are considered satisfactory and 61 or 9.71% need fundamental repairs, replacements or supplementary supply. 296 villages with a population of 276,885 persons or 66.7% of the rural population of the island have a house-to-house service, conforming with the Universal standards. Because of the increase of population, rise in the standard of living, the subnormal rainfall and the over-pumping of the aquifers, water supplies that were formerly considered satisfactory are now in need of improvements or additional supply. (Appendix 7.)

In addition to the 46 schemes completed in 1964, a further 38 schemes were under construction in their final stage at the end of the year. Plans were prepared for 78 schemes, all estimated to cost £723,442.

The following village water supply schemes could not be carried out in 1964 due to the emergency situation:-

(a) Included in 1963 and revoted for 1964

| | | |
|---|---|---|
| 1. | Lefka | £35,000 |
| 2. | Pergamos | £ 8,000 |
| | | £43,000 |

(b) Included in 1964

| | | |
|---|---|---|
| 1. | Ayia Kebir | £16,150 |
| 2. | Vroisha | £ 6,700 |
| 3. | Koloni (P) | £ 2,000 |
| 4. | Menoyia | £ 2,897 |
| 5. | Aplanta | £ 902 |
| 6. | Kivisil | £ 5,274 |
| | | £33,923 |

Appendix 6 gives an outline of the work executed during the year:-

Appendix 6.

## LENGTH OF PIPES LAID IN 1964

(Galvanized mild Steel Pipes)

| Size Nominal Diameter | ½" | ¾" | 1" | 1¼" | 1½" | 2" | 2½" | 3" | 4" | Vict. pipes 6" | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Length in miles | 25,854 | 2,566 | 14,545 | 69,076 | 19,102 | 17,473 | 24,367 | 27,462 | 19,557 | 7,698 | 227,705 |

(Asbestos-cement pressure pipes)

| Size Nominal Diameter | 2" | 3" | 4" | 6" | 8" | 10" | 12" | Total |
|---|---|---|---|---|---|---|---|---|
| Length in miles | 4,191 | 18,953 | 0,420 | 11,427 | 8,236 | 2,820 | 7,613 | 53,660 |

Reinforced concrete tanks:-

Elevated tanks I (20,000 gallons capacity)

Ground tanks 43 (1,505,000 gallons capacity)

School tanks 20

Pumping stations 6

Public fountains 6

House connections 39 villages (7,000 consumers)

Area of land brought under perennial irrigation about 500 donums.

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The schemes completed may be classified as shown below:-

"Village standard" means that the distribution of the water is effected by street fountains only, and not by house connections. A public fountain with trough and proper drainage system serves 6 - 10 houses.

"House-to-house" means that the distribution of the water is effected by individual house connections. Distribution mains are laid in all inhabited areas, and the consumer bears the cost of the service connections. The supply is controlled by means of water meters, or Break-pressure regulators securing an equal quantity of water to all houses, in those cases where the supply is fixed and limited. Practically in all the new schemes in Nicosia, Famagusta, and Larnaca Districts water meters were installed.

Lists showing the number of villages with piped water supply, schemes completed during the year, schemes in hand at the end of the year and schemes prepared for execution are given in appendices 8, 9 and 10.

Successful drilling carried out during the year made it possible to provide many villages in Nicosia, Kyrenia, Famagusta and Larnaca Districts with domestic water. A number of important schemes carried out during the year are shown below:-

a) A pumping scheme providing KATO and PANO DEFTERA with adequate water has been completed during the year.

The source of supply are two successful boreholes from where water is pumped into a 100,000 gallons capacity reinforced concrete reservoir. Six hundred house-connections controlled by water meters have been installed.

b) Another pumping scheme providing AYIA IRINI - DHIORIOS and KORMAKITI has also been executed in Kyrenia District. The source of supply are two successful boreholes situated west of Ayia Irini. This scheme involves the pumping of 10,000 gallons of water per hour into a 100,000 gallons capacity balancing tank, From this tank water flows by gravity to the pumping station of Dhiorios at Kipi locality and to the 50,000 gallons capacity of Kormakitis. Six hundred house-connections by means of water meters have been installed in the three villages.

c) A major combined pumping scheme serving five villages, namely Ayios Georghios, Arnadhi, Spathariko, Limnia and Ayios Serghios was also executed during 1964 in the Famagusta District. The source of supply is a well situated at Ayios Pappos locality in the Lapathos area from which water is pumped at the rate of 8,000 gallons per hour, by means of an automatically controlled electrosubmersible pump into a 100,000 gallons capacity reservoir. From this reservoir the water is distributed by means of 47,000 feet of 4" - 10" pipe-lines to the five villages. In all villages a house-to-house service has been implemented and 1,050 water meters have been installed.

d) Another major combined pumping scheme serving GYPSOS, MILIA, PIYI and PERISTERONA was also executed in the Messaoria area. Their source of supply is again a well in the Ayios Pappos area from which water is pumped at the rate of 10,000 gallons per hour by means of an automatically controlled electrosubmersible pump into two 60,000 capacity tanks. The water has been distributed from these twin tanks to the four villages and in all of them a house-to-house service scheme has been implemented. More than 1,100 house connections with water meters have been installed.

Appendix 7.

## DEPARTMENT OF WATER DEVELOPMENT

## NUMBER AND PERCENTAGE OF VILLAGES WITH PIPED SUPPLIES 1964.

| District | Satisfactory Piped Supply | | | | | | | | Unsatisfactory | | | | No piped supply | | | | Total No. of Villages | Total Population |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Villages with fountains | | Village | | Villages with House to House | | | | Villages | | | | Villages | | | | | |
| | No | % | Pop. | % | No | % | Pop. | % | No | % | Pop. | % | No | % | Pop. | % | | |
| Nicosia | 64 | 36.00 | 23,267 | 14.88 | 90 | 50.00 | 120,225 | 76.92 | 20 | 11.8 | 11,224 | 7.18 | 4 | 2.2 | 1,563 | 1.2 | 178 | 156,279 |
| Kyrenia | 25 | 53.20 | 11,201 | 40.70 | 14 | 29.78 | 11,374 | 41.34 | 7 | 14.90 | 3,750 | 13.62 | 1 | 2.12 | 1,192 | 4.34 | 47 | 27,517 |
| Famagusta | 23 | 23.46 | 10,160 | 12.80 | 58 | 59.20 | 53,323 | 66.85 | 17 | 17.34 | 16,132 | 20.35 | - | - | - | - | 98 | 79,615 |
| Limassol | 35 | 30.70 | 10,831 | 17.00 | 67 | 58.77 | 45,918 | 72.07 | 11 | 9.64 | 6,624 | 10.39 | 1 | 0.89 | 340 | 0.54 | 114 | 63,713 |
| Paphos | 86 | 65.75 | 24,756 | 50.45 | 46 | 34.85 | 24,320 | 49.55 | - | - | - | - | - | - | - | - | 132 | 49,076 |
| Larnaca | 29 | 49.15 | 12,178 | 31.35 | 21 | 35.59 | 21,725 | 55.94 | 6 | 10.16 | 3,878 | 9.98 | 3 | 5.10 | 1,055 | 2.73 | 59 | 38,836 |
| TOTAL | 262 | 41.72 | 92,393 | 22.26 | 296 | 47.13 | 276,885 | 66.71 | 61 | 9.71 | 41,608 | 10.03 | 9 | 1.44 | 4,150 | 1.00 | 628 | 415,036 |

Appendix 8.

## VILLAGE DOMESTIC WATER SUPPLY SCHEMES COMPLETED IN 1964

| Ser. No. | Village | Type of scheme | G.P.D. Daily quantity available | Population | Nature of work | Amount spent £ |
|---|---|---|---|---|---|---|
| | NICOSIA & KYRENIA DISTRICT | | | | | |
| 1 | Moutoullas | Gravity | 10,000 | 876 | + | 566.000 |
| 2 | Ay.Ioannis Malourdas | Pumping | 20,000 | 252 | * | 1,660.000 |
| 3 | Tsakistra | Gravity | 15,000 | 218 | * H | 1,010.000 |
| 4 | Asomatos | Pumping | 4,000 | 506 | H | 8,980.000 |
| 5 | Ay.Georghios Soleas | Gravity | 15,000 | 460 | H | 2,070.000 |
| 6 | Orounda | Pumping | 16,000 | 640 | * H | 9,500.000 |
| 7 | Dheftera Pano & Kato | Pumping | 30,000 | 1,448 | * H | 28,560.000 |
| 8 | Ayios Georghios Kafkallou | Gravity | 1,500 | 23 | + | 520.000 |
| 9 | Galata-Kakopetria | Gravity | 90,000 | 2,060 | + | 1,990.000 |
| 10 | Laxia (Yeri) | Pumping | 10,000 | 485 | * H | 8,050.000 |
| 11 | Nikitas | Gravity | 2,000 | 740 | + | 570.000 |
| 12 | Alambra | Pumping | 11,000 | 546 | * H | 12,800.000 |
| 13 | Yeri | Pumping | 20,000 | 846 | * H | 9,690.000 |
| 14 | Paleosophos | Gravity | 3,000 | 151 | + | 133.000 |
| | Total | | 247,500 | 9,251 | | £86,099.000 |
| | FAMAGUSTA DISTRICT | | | | | |
| 1 | Gaidhouras | Pumping | 10,000 | 366 | + H | 1,205.000 |
| 2 | Ayios Georghios | " | 10,000 | 446 | * H | 3,944.000 |
| 3 | Arnadhi | " | 10,000 | 408 | * H | 5,010.000 |
| 4 | Spathariko | " | 10,000 | 471 | * H | 5,729.000 |
| 5 | Limnia | " | 26,000 | 1,201 | * H | 7,860.000 |
| 6 | Ayios Serghios | " | 40,000 | 1,790 | * H | 14,150.000 |
| 7 | Gypsos | " | 25,000 | 1,184 | * H | 7,650.000 |
| 8 | Milea | " | 25,000 | 1,141 | * H | 7,780.000 |
| 9 | Piyi | " | 24,000 | 1,038 | * H | 6,775.000 |
| 10 | Peristerona | " | 15,000 | 571 | * H | 5,680.000 |
| 11 | Erastio | " | 20,000 | 977 | + H | 2,230.000 |
| | Total | | 215,000 | 9,593 | | £68,013.000 |

| Ser. No. | Village | Type of scheme | G.P.D. Daily quantity available | Population | Nature of work | Amount spent £ |
|---|---|---|---|---|---|---|
| | LIMASSOL DISTRICT | | | | | |
| 1 | Sotira | Gravity | 6,000 | 181 | * H | 2,628.000 |
| 2 | Limnatis | Gravity | 14,000 | 581 | + H | 2,344.000 |
| 3 | Zakaki | Pumping | 16,000 | 677 | * H | 8,950.000 |
| 4 | Asgata | Gravity | 12,000 | 608 | * H | 9,860.000 |
| 5 | Lophos | Gravity | 25,000 | 254 | + H | 900.000 |
| 6 | Ayios Therapon | Gravity | 10,000 | 520 | + H | 3,295.000 |
| 7 | Pakhna | Gravity | 28,000 | 1,564 | + H | 2,720.000 |
| 8 | Vassa (Kilani) | Gravity& Pumping | 70,000 | 741 | * H | 9,475.000 |
| | Total | | 181,000 | 5,106 | | £40,172.000 |
| | LARNACA DISTRICT | | | | | |
| 1 | Voroklini ) | | | 695 | + | |
| 2 | Livadhia ) | Pumping | 30,000 | 1,329 | + | 1,650.000 |
| 3 | Anglissides ) | | | 564 | + H | |
| 4 | Anaphotia ) | Pumping | 30,000 | 653 | + H | 13,630.000 |
| 5 | Aradhippou | Pumping | 80,000 | 3,632 | + H | 3,070.000 |
| | Total | | 140,000 | 6,873 | | 18,350.000 |
| | PAPHOS DISTRICT | | | | | |
| 1 | Neokhorio | Gravity | 30,000 | 663 | + H | 1,730.000 |
| 2 | Peyia | Gravity | 35,000 | 1,401 | + H | 16,280.000 |
| 3 | Stroumbi | Gravity | 16,000 | 715 | + H | 1,050.000 |
| 4 | Kedhares | Gravity | 10,000 | 259 | + H | 275.000 |
| 5 | Konia | Gravity | 9,000 | 394 | * H | 4,300.000 |
| 6 | Tremithousa | Gravity | 6,000 | 418 | * H | 3,940.000 |
| 7 | Anavargos | Gravity | 8,000 | 312 | * H | 3,670.000 |
| | Total | | 114,000 | 4,162 | | £31,245.000 |

\+ Improvement to an existing supply.

* New scheme.

H House-to-house service.

Appendix 9.

## VILLAGE WATER SUPPLY SCHEMES IN HAND AT THE END OF 1964

| Serial No. | Village | Amount Revoted |
|---|---|---|
| | NICOSIA & KYRENIA DISTRICT | |
| 1 | Livadhia | 861.000 |
| 2 | Ayia Marina (Skyl.) | 3,000.000 |
| 3 | Mia Milea, Koutsovendis | 6,330.000 |
| 4 | Ayia Erini. Dhiorios | 3,840.000 |
| 5 | Ayios Amvrosios | 5,600.000 |
| 6 | Meniko | 11,300.000 |
| 7 | Vasilia | 2,470.000 |
| 8 | Evrykhou | 1,840.000 |
| 9 | Linou - Phlasou | 11,500.000 |
| 10 | Kapedhes | 9,530.000 |
| 11 | Politiko | 2,350.000 |
| | | £58,621.000 |
| | FAMAGUSTA DISTRICT | |
| 1 | Ardana | 10,000.000 |
| 2 | Kantara | 8,043.000 |
| 3 | Akanthou | 3,450.000 |
| 4 | Ayios Andronikos | 10,400.000 |
| 5 | Boghaz | 2,080.000 |
| 6 | Gastria | 3,160.000 |
| | | £37,133.000 |
| | PAPHOS DISTRICT | |
| 1 | Kouklia | 7,620.000 |
| 2 | Yeroskipou | 15,750.000 |
| 3 | Mesana | 2,150.000 |
| 4 | Kissonerga | 5,800.000 |
| 5 | Kelokedhara | 1,750.000 |
| 6 | Salamiou | 4,300.000 |
| | | £37,370.000 |

| Serial No. | Village | Amount Revoted |
|---|---|---|
| | LIMASSOL DISTRICT | |
| 1 | Dhora | 11,840.000 |
| 2 | Tris Elies | 3,940.000 |
| 3 | Kaminaria | 10,280.000 |
| 4 | Apeshia | 5,440.000 |
| 5 | Apsiou | 1,700.000 |
| 6 | Mathikoloni ) | |
| 7 | Akrounda ) | 7,730.000 |
| 8 | Moni | 4,790.000 |
| 9 | Arakapas | 4,700.000 |
| 10 | Akapnou | 2,545.000 |
| 11 | Vassa | 4,250.000 |
| 12 | Yermasoyia | 3,180.000 |
| | | £60,395.000 |
| | LARNACA DISTRICT | |
| 1 | Troulli | 15,920.000 |
| 2 | Khirokitia | 4,270.000 |
| | | £20,190.000 |

Appendix 10.

## VILLAGE DOMESTIC SUPPLY SCHEMES
## PREPARED AND SUBMITTED FOR CONSIDERATION AND APPROVAL

### NICOSIA & KYRENIA DISTRICT

| Ser. No. | Village | Population 1960 Census | Nature of Scheme | Quantity of water to be available in G. P. D. | Estimated Cost £ |
|---|---|---|---|---|---|
| 1 | Vroisha | 235 | G * | 5,000 | 6,700 |
| 2 | Episkopio | 241 | | | |
| | Argates | 637 | | | |
| | Kambia | 267 | P * H | 40,000 | 45,000 |
| | Analiondas | 182 | | | |
| | Mathiatis | 409 | | | |
| 3 | Karavostasi | 1,510 | P + H | 30,000 | 17,000 |
| 4 | Morphou | 6,642 | P + H | 300,000 | 86,000 |
| 5 | Aredhiou | 355 | P * H | 7,000 | 8,460 |
| 6 | Gourri | 397 | G + | 8,000 | 1,900 |
| 7 | Kythrea | 2,955 | G + H | 60,000 | 23,500 |
| 8 | Kythrea Lower Villages | | | | |
| | Neokhorio | | | | |
| | Trakhoni | | | | |
| | Palekythro | 5,100 | G + H | 100,000 | 30,000 |
| | Voni | | | | |
| | Epikho | | | | |
| | Exometochi | | | | |
| | Bey Keuy | | | | |
| 9 | Lythrodontas | 1,448 | P + H | 30,000 | 5,000 |
| 10 | Pyroi | 466 | P + H | 10,000 | 2,000 |
| 11 | Lymbia | 1,383 | P + H | 30,000 | 6,500 |
| 12 | Ayia | 418 | P * H | 10,000 | 16,150 |
| 13 | Dhenia-Mammari | 1,163 | P * H | 24,000 | 25,000 |
| 14 | Ayios Epiktitos - Klepini | 1,425 | P + H | 30,000 | 25,000 |
| | Total | 25,233 | | 684,000 | £298,210 |

FAMAGUSTA DISTRICT

| Ser. No. | Village | Population 1960 Census | Nature of Scheme | Quantity of water to be available in G. P. D. | Estimated Cost £ |
|---|---|---|---|---|---|
| 1 | Korovia | 297 | P + H | 6,000 | 1,600 |
| 2 | Leonarissos | 707 | P + H | 14,000 | 2,500 |
| 3 | Yerani | 211 | G + | 4,000 | 500 |
| 4 | Komi Kebir | 952 | | | |
| | Ovgoros | 362 | | | |
| | Patriki | 581 | P + H | 50,000 | 25,910 |
| | Kridhia | 353 | | | |
| 5 | Ayia Napa | 836 | P + H | 16,000 | 4,000 |
| 6 | Dry Villages (Mesaoria) | - | P + | 100,000 | 20,000 |
| 7 | Agha | 2,209 | G + H | 44,000 | 19,500 |
| 8 | Ay. Theodhoros | 828 | P + H | 16,000 | 7,310 |
| 9 | Angastina | 778 | G + H | 16,000 | 6,800 |
| | Total | 8,114 | | 266,000 | 88,120 |

LIMASSOL DISTRICT

| Ser. No. | Village | Population 1960 Census | Nature of Scheme | Quantity of water to be available in G. P. D. | Estimated Cost £ |
|---|---|---|---|---|---|
| 1 | Pano Platres | 413 | G + H | 15,000 | 8,500 |
| 2 | Kato Mylos | 192 | G * H | 4,000 | 4,100 |
| 3 | Asomatos | 340 | P * H | 7,000 | 6,700 |
| 4 | Ay. Ioannis (Agros) | 875 | G + H | 18,000 | 5,600 |
| 5 | Alassa | 141 | G + H | 3,000 | 2,600 |
| 6 | Kilani | 1,034 | G + H | 20,000 | 2,300 |
| 7 | Sykopetra | 217 | G + H | 4,000 | 2,800 |
| 8 | Pendakomo | 598 | G + H | 12,000 | 11,900 |
| 9 | Pareklisha | 577 | G + H | 12,000 | 2,400 |
| 10 | Yermasoyia(including Potamos tis Yermasoyias & the Coastal Area) | 1,734 | P * H | 40,000 | 47,000 |
| 11 | Ay. Phyla | 5,231 | P + H | 100,000 | 5,600 |
| 12 | Pissouri | 1,072 | G + | 20,000 | 3,600 |
| 13 | Prastio (Evdhimou) | 342 | G + | 7,000 | 3,300 |
| 14 | Kerasa | 243 | G + | 5,000 | 1,200 |
| 15 | Agros | 1,477 | G + | 30,000 | 3,600 |
| 16 | Souni-Zanadja | 66 | G + | 1,000 | 900 |
| 17 | Vouni | 990 | G + | 20,000 | 2,300 |
| 18 | Erimi-Kolossi | 1,352 | G + | 27,000 | 2,400 |
| 19 | Pano Kividhes | 456 | G + | 9,000 | 4,150 |
| 20 | Kandou | 513 | G + | 10,000 | 700 |
| 21 | Ay. Demetrios | 223 | G + | 5,000 | 3,900 |
| 22 | Phini | 924 | G + | 20,000 | 5,000 |
| 23 | Paleomylos | 200 | G + | 4,000 | 1,700 |
| 24 | Anoyira | 620 | G + | 12,000 | 4,000 |
| 25 | Trimi[illegible]ini | 330 | G * H | 7,000 | 2,400 |
| 26 | Kouka | 63 | G * | 1,000 | 1,132 |
| 27 | Pyrgos | 702 | G + | 14,000 | 1,600 |
| 28 | Evdhimou | 912 | G + | 18,000 | 900 |
| 29 | Zoopiyi, Kellaki, Lefkara etc. | | G * H | 80,000 | 85,300 |
| | Total | 21,851 | | 527,000 | 227,782 |

LARNACA DISTRICT

| Ser. No. | Village | Population 1960 Census | Nature of Scheme | Quantity of water to be available in G. P. D. | Estimated Cost £ |
|---|---|---|---|---|---|
| 1 | Kivisil-Alethriko | 539 | P + H | 11,000 | 8,650 |
| 2 | Pyla | 961 | P + H | 20,000 | 8,800 |
| 3 | Arsos | 613 | P + H | 12,000 | 4,850 |
| 4 | Goshi | 167 | P + | 3,000 | 570 |
| 5 | Petrophani | 120 | G + | 2,500 | 1,340 |
| 6 | Tremetousha | 576 | G + | 10,000 | 10,500 |
| 7 | Tokhni | 843 | G + | 16,000 | 2,200 |
| | Total | 3,819 | | 74,000 | 36,910 |

PAPHOS DISTRICT

| | | | | | |
|---|---|---|---|---|---|
| 1 | Polis-Prodromi | 2,163 | G + H | 42,000 | 19,000 |
| 2 | Kritou Terra | 518 | G + H | 10,000 | 1,900 |
| 3 | Emba | 1,027 | G + H | 20,000 | 6,500 |
| 4 | Peristerona | 355 | G + H | 7,000 | 2,000 |
| 5 | Ay. Nicolaos | 418 | G + H | 8,000 | 3,200 |
| 6 | Episkopi | 726 | G + H | 14,000 | 5,600 |
| 7 | Ay. Ioannis | 819 | G + H | 16,000 | 2,900 |
| 8 | Lemona | 241 | G + H | 5,000 | 1,400 |
| 9 | Magounda | 196 | G + H | 4,000 | 700 |
| 10 | Akoursos | 194 | G + | 4,000 | 2,200 |
| 11 | Annadhiou | 203 | G + | 4,000 | 1,500 |
| 12 | Kilinia | 229 | G + | 4,000 | 500 |
| 13 | Kedhares | 259 | G + H | 5,000 | 1,800 |
| 14 | Loukrounou | 35 | G + | 1,000 | 350 |
| 15 | Polemi | 880 | G H | 17,000 | 8,400 |
| 16 | Pretori | 392 | G H | 8,000 | 720 |
| 17 | Stavrokonnou | 627 | G + | 12,000 | 1,000 |
| 18 | Tsadha | 907 | G H | 18,000 | 5,100 |
| 19 | Yiolou | 605 | G H | 12,000 | 2,150 |
| | Total | 10,794 | | 211,000 | 66,920 |

SUMMARY

| Serial No. | District | Amount | Remarks |
|---|---|---|---|
| 1 | Nicosia & Kyrenia | £298,210 | |
| 2 | Famagusta | £ 88,120 | |
| 3 | Limassol | £227,782 | |
| 4 | Larnaca | £ 36,910 | |
| 5 | Paphos | £ 66,920 | |
| | Total | £717,942 | |

G = Gravity Scheme.
P = Pumping Scheme.
* = New Scheme.
+ = Improvements.
H = House-to-house.

## 15. DRILLING & PROSPECTING HYDROGEOLOGICAL SURVEYS & GERMAN MISSION WORK

By C.S. Lytras, M.Sc.(Lond.) D.I.C.,
B.Sc.(Athens) F.G.S., Geologist

### Drilling & Prospecting

Since the last Annual Report the Drilling Section of this Department has been completely drained of its three geologists. Mr. Z. Koutrafali (Turk) has not turned up to work since the outbreak of the Turkish rebellion and Messrs. D. Kypris and G. Zafiris left the island in September to continue their studies. Until such time as replacements may be made available Mr. C. Lytras of the Geological Survey Department is dividing his time between his parent Department and the Drilling Section of this Department.

During 1964 drilling operations, by reason of the scattered locations throughout the island, and the need of transporting heavy plant and equipment from site to site, suffered many set-backs as a result of communal disturbances. Appendix 12 shows boreholes drilled since 1946, but no fair comparison can be made between the results of 1964 and those of previous years. Of a complement of 14 Bucyrus Drilling Rigs three were misappropriated by the Turks. Unfortunately, one of these, and the only one of its kind held, was adapted for rotary drilling. Another specialised drilling rig, and again the only one of its kind held - a heavy duty Bucyrus (60 R.L.)- was stranded near Polis and could not be brought into operation. Fortunately it is now secure and has recently been put into service.

Of the remaining ten operational rigs all of the percussion type, two worked throughout the year in co-operation with the German Mission along the Kyrenia Range. In this report the known footage drilled by the two Government Rigs operating with the German Mission has alone been recorded. Otherwhere the boreholes so drilled with the Mission have not been placed on record, and they (14 in number) are not included in the total number of 111 drilled by Government during 1964. The essential duty

of the two Government rigs was to carry out the initial shallow drilling of the boreholes to pave the way for the specialised rotary rigs of the Mission. A notable asset to the Drilling Section was the employment of two small bore generator operated drilling machines which were utilized to good effect technically by carrying out geological foundation tests for proposed dam sites. They relieved the water drilling rigs of that work. These two machines usually worked in combination; one by name Over Burden carried out speedy drilling through soft superficial deposits, and the other, as its name implies "Core Drill" obtained core samples of more solid rocks.

The eight drilling rigs left to the free disposal of the Drilling Section drilled 70 boreholes for water with an aggregate footage of 19,796 and an average depth of 282 feet. Appendix 11 gives a clear picture of results by districts and sub-divided districts. The average time taken to complete a borehole, including, when considered necessary, the laying of casings and a preliminary test pumping of about eight hours duration was 24.6 days. The average footage drilled per day was 9.5 feet. Sixteen old boreholes were renovated or pumping installations improved, and the days involved in that work - 119 - represented the equivalent time required to drill 5 new boreholes.

A total of 29 boreholes were subjected to lengthy test pumpings ranging from 48 hours to 306 hours continuous duration. The volume of water pumped was 38.3 million gallons over a total pumping time of 3946 hours. All but one of the boreholes were tested by means of an electrosubmersible pump of 7½" diameter with a specified capacity head range of 18,000 g.p.h. from 100 feet, to 15,000 g.p.h. from 450 feet. Experience has shown that potential test pumpings are essential in order to determine the reliability of the aquifers.

The number of successful irrigation boreholes drilled by Government since 1946 is now 1315 with a tested output of 272 million gallons per day, sufficient to irrigate 136,800 donums of trees and summer crops. Eight successful irrigation boreholes were drilled during 1964.

The area now being irrigated as a result of Government drillings is conservatively estimated to be 110,000 donums. The 1946 census estimated that in that year some 53,000 donums were being irrigated perennially by pumped water. By the end of 1964, as a result of Government drilling alone this had been increased by 208 per cent to 163,000 donums.

Drilling Costs

The average cost of departmental drillings in 1964 was £3,785 per borehole or £1.534 mils per foot of drilling. These costs are inclusive of the expenses of laying casing pipes as well as a preliminary short pumping test of boreholes with promise of a fair water yield. They are exclusive of the purchase price of borehole casing pipes and the capital cost and installation charges of permanent pumping plant. They include the wages of drilling crews, fitters and blacksmiths, and the cost of workshop maintenance of drilling tools and equipment. Depreciation of drilling plant and the salaries and expenses of the supervisory staff are not included.

Appendix 11.

## Boreholes Drilled for Water in 1964

### Summary of Results

| District | Locality | No. Drilled | No. * Successful | % age Successful | Total Tested Output G.P.D. ** | Average Yield per Successful Borehole G.P.D. |
|---|---|---|---|---|---|---|
| Nicosia | Makedhonitissa - Nicosia | 2 | 2 | 100.0 | 220,800 | 110,400 |
| | K. Trimithia - Akaki - Avlona | 5 | 5 | 100.0 | 904,800 | 180,960 |
| | Peristerona - Potami - K. Moni | 5 | 4 | 80.0 | 1,094,400 | 273,600 |
| | Malounda - Argates - Pera | 7 | 6 | 88.8 | 1,024,800 | 170,800 |
| | Nisou - Dhali | 8 | 1 | 12.5 | 165,600 | 165,600 |
| | Morphou | 3 | 3 | 100.0 | 1,011,600 | 337,200 |
| | Ay. Irini | 1 | 1 | 100.0 | 360,000 | 360,000 |
| Famagusta | Paralimni - Ay. Napa | 3 | 1 | 33.3 | 288,000 | 288,000 |
| | Akanthou | 1 | 1 | 100.0 | 90,000 | 90,000 |
| | Kondea | 2 | 2 | 100.0 | 192,000 | 96,000 |
| | Yialousa | 2 | - | - | - | - |
| | Lapathos | 1 | 1 | 100.0 | 96,000 | 96,000 |
| Larnaca | Klavdhia - Anglisidhes | 5 | 1 | 20.0 | 60,000 | 60,000 |
| | Aradhippou | 3 | 1 | 33.3 | 216,000 | 216,000 |
| | Dhekelia | 12 | 8 | 66.6 | 1,152,000 | 144,000 |
| Limassol | Moni | 4 | 4 | 100.0 | 542,400 | 135,600 |
| | Yermasoyia | 2 | 1 | 50.0 | 144,000 | 144,000 |
| | Kolossi | 1 | - | - | - | - |
| Paphos | Anatoliko - Mandria | 2 | 1 | 50.0 | 120,000 | 120,000 |
| | Kelokedhara | 1 | 1 | 100.0 | 134,400 | 134,400 |
| | | 70 | 44 | 62.9 | 7,816,800 | 177,700 |

* A successful borehole is one that yields on test not less than 1,000 gallons per hour of usable water.

** Figures include 10 potential tests with an Electric Submersible Pump, and the remainder of boreholes preliminary tested with a Deep-well pump only, of limited capacity.

Appendix 12.

## Number and Footage of Boreholes

## Number of Boreholes Drilled

## 1957 - 1964

| Purpose | 1946-1957 | 1958 | 1959 | 1960 | 1961 | 1962 | 1963 | 1964 |
|---|---|---|---|---|---|---|---|---|
| For Private Individuals and Companies | 1,658 | 106 | 155 | 165 | 55 | 22 | 12 | 11 |
| For Government | 511 | 35 | 9 | 13 | 126 | 207 | 190 | 86 |
| For W.D. | 265 | 16 | 27 | 10 | 18 | 18 | 11 | 14 |
| Total | 2,434 | 157 | 191 | 188 | 199 | 247 | 213 | 111 |
| Aggregate footage drilled | 454,663 | 32,842 | 48,250 | 49,887 | 49,681 | 51,292 | 40,301 | 22,825 |
| Average Depth | 187 | 209 | 253 | 265 | 245 | 208 | 189 | 206 |

## Boreholes Drilled in 1964

| Purpose | No. | Existing Well Footage | Footage Drilled | % age Successful | Total Tested Yield G.P.D. |
|---|---|---|---|---|---|
| Irrigation | 9 | 151 | 2,536 | 88.8 | 1,813,200 |
| Domestic W.S. | 15 | 122 | 1,916 | 73.3 | 1,732,800 |
| Prospecting | 45 | 92 | 15,184 | 53.3 | 4,126,800 |
| Industrial | 1 | - | 160 | 100.0 | 144,000 |
| Total for Water | 70 | 365 | 19,796 | 62.9 | 7,816,800 |
| Observation | 5 | - | 569 | - | - |
| Technical & Geological | 36 | - | 2,460 | - | - |
| Total Drilled | 111 | - | 22,825 | - | - |

Old Boreholes Renovated - 16

## Some notes on certain prospecting boreholes of special hydrogeological interest.

Prospecting drilling was carried out this year in various geological formations and useful information about new aquifers as well as a more detailed knowledge of the already known aquifers was obtained. A short hydrogeological description of a few selected boreholes is given below.

Drilling in the river valleys, where high yielding aquifers are known to exist, gave very good results. The aquifers are essentially made of gravels and sands which have infilled during recent times the older river beds. Drilling has proved that these coarse fluvial deposits have, at places, considerable thickness forming rich ground water basins. The success in selecting the borehole sites lies in the locating of the deeper depressions in the older river bed. For this, the results obtained from the 1958 seismic geophysical survey and the surface geomorphological evidence offered a very helpful guidance.

The most interesting boreholes drilled in this type of sediments are:

Serial No. 63/64 (Grid Ref.: N.180,920 E. 78,960)

Serial No. 64/64 (Grid Ref.: N.119,125 E. 78,960)

Both boreholes were drilled in the Yermasoyia river valley and the thickness of the river gravels for each site was 132 and 128 feet respectively.

Serial No. 40/64 (Grid Ref.: N. 17,580 E. 29,700) This borehole lies in the Xeropotamos river valley, near Mandria village, and it met a thickness of 124 feet coarse river deposits.

Serial No. 65/64 (Grid Ref.: N.29,200 E.36,750) This borehole was drilled in the Xeropotamos river valley near Kelokedhara and penetrated 94 feet thick gravel deposits.

None of the above boreholes has been test pumped yet with an electrosubmersible pump, but their specific yields are expected to be - judging from other boreholes in similar beds - in the order of 20,000 g.p.h. with a very small drawdown. When the Kelokedhara borehole was test pumped for 24 hours with a piston pump of a maximum capacity 5,625 g.p.h. the static water level was at 48'.0" below ground and at the end of the test the working level was at only 48'.4" below surface.

Drilling in the Pliocene marls (Myrtou Marl) proved the existence of thick intraformational conglomerates within the marls. These conglomerates have their origin on the igneous rocks of the Troodos Massif, and they form confined aquifers within the essentially marly succession of the Pliocene sediments at the northern foothills of the Troodos mountains. Little is known yet on the extent and distribution of these conglomeratic facies and further study and prospecting along the northern foothills of Troodos may discover good quantities of water from still unexploited aquifers. The Pera borehole Serial No. 37/64 (Grid Ref.: N. 53,100 E. 94,760) met these conglomerates at a depth of 420 feet and their thickness, including some marly and sandy intercalations, was about 200 feet.

Prospecting drilling carried out in the vicinity Potami village, near the exposed mass of reef limestones of the Pakhna Formation, proved that these coralline limestones extend underground west of their outcrops. (Their north-eastern underground continuation of their surface exposures was proved by drilling last year). Borehole Serial No. 8/64 (Grid Ref.: N. 60,490 E.74,040) was started on Pleistocene sediments of the Fanglomerate Series, which in this area form a thin cover over the Pakhna Formation. The reef limestone was met at only 3 feet below surface and continued up to 165 feet. Because of its abundant primary voids and secondary solution cavities this limestone absorbs and yields very good quantities of water. The borehole has not yet been tested with an electrosubmersible pump;

when tested with a piston pump for six hours, the output was 7,500 g.p.h. and the maximum drawdown was 11 feet (static water level 12' 4" below surface).

Another interesting finding in 1964 was the borehole Serial No. 27/64 drilled in the vicinity of Nisou village. A summarized geological log of this borehole is given below.

| | | |
|---|---|---|
| 0- 56 feet | Alluvial silt and gravel | RECENT |
| 56-120 " | Light grey marl | LOWER PLIOCENE (Myrtou Marl) |
| 120-162 " | Igneous gravels and gypsum fragments (basal conglomerate) | LOWER PLIOCENE (Myrtou Marl) |
| 162-215 " | Crystaline gypsum | UPPER TO MIDDLE MIOCENE (Pakhna Formation) |
| 215-255 " | Grey marl | UPPER TO MIDDLE MIOCENE (Pakhna Formation) |

Water was found in the alluvium, the Pliocene basal conglomerate and in the gypsum beds. The gypsum deposits of Cyprus are of particular hydrogeological significance as they usually form karstic aquifers, the water circulating through joints and solution cavities. Previous experience in drilling in gypsum aquifers has proved their good yields in water especially after the boreholes were exploded with dynamite so as to increase and widen their original fissures and joints.

Apart from the future prospecting in the known gypsum exposures which warrant exploitation for ground water, the geological study and further prospecting in the areas near the Pliocene/Upper Miocene contact may lead to the discovery of unknown gypsum aquifers buried under younger sediments. The water found in gypsum is usually highly mineralized and of high total hardness which renders it unsuitable for drinking purposes but it can be very useful for irrigation.

Similar to the Nisou borehole was the one drilled near Politiko Serial No. 35/64 (Grid Ref. N. 52,750 E 93,660) which found 80 feet thick gypsum aquifer below 240 feet thick Pliocene and other younger sediments.

From the prospecting drilling which was carried in the Lapithos chalks we note the Aradhippou borehole Serial No. 46/64 (Grid Ref.: N. 46,200 E. 22,000). The borehole went through a succession of chalks and chalky marls and water was found at various depths mainly among bedding places and joints. The borehole was tested with an electrosubmersible pump for 306 hours. The static water level was at 40' 0" and the pump suction at 224. For the first 184 hours the output was 12,000 g.p.h. and for the next 50 hours the hourly yield was 11,250 gallons. The yield was then adjusted to 9,000 g.p.h. and the working level rose progressively from 144 feet to 114' 6" where it remained steady for the last 18 hours of the test. The salinity of the water is rather high the chlorine content being 505 p.p.m. but compared to previous boreholes in the area this quality water can be considered more than satisfactory.

Hydrogeological Surveys

The hydrogeological surveys have as a target the evaluation of the water resources of the Island. For this, intensive field work, study and research is required. Field work includes the plotting and levelling of the wells and boreholes, the periodical measuring of the depth to the water table, the sampling for chemical analysis of the quality of ground water, especially the $Cl^-$ content, and the measuring or estimating the amount of water extracted from each well, borehole or spring.

The Water Development Department started an early accumulation of the hydrological data concerning the most important groundwater producing areas of the Western Mesaoria, Southeastern Cyprus, the Akrotiri Peninsula, Ayia Marina - Polis, the Kiti - Pervolia and Kyrenia coastal belts. The hydrogeological surveys are expanded year after year so as a close observation network is established over the whole Island and a good knowledge of the ground water inventory of Cyprus is obtained.

In addition to the geological and geophysical investigation of an area, the study of its hydrological conditions is absolutely essential for the discovery, development and conservation of its groundwater resources. This study is particularly necessary for a semi arid country like Cyprus, in which uncontrolled and irrational pumping - exceeding at several places the natural replenishment of the aquifers - has caused a progressive decline of the water table to a dangerous level. This excessive pumping in a number of coastal areas, such as Famagusta, Zakaki, Morphou and Kiti has resulted in the inland undergroud movement of sea water. The catastrophic results on the citrus groves of Famagusta due to the excess pumping are well known. The importance and scope of knowing the hydrogeological conditions of such an overdeveloped area is not limited in the estimation of the amount of water to be safely extracted from the underground reservoirs but it generally offers the necessary background on which all artificial recharge works are based so as to improve effectively the deteriorated conditions. The speeding up of the expansion of the hydrogeological surveys must be considered as a matter of top priority because this will serve as the diagnosis of a situation for which the general rule "it is better to prevent than to cure" fully applies.

The survey of Western Mesaoria, Kyrenia and Akrotiri Peninsula has now been completed in the sense that all wells and boreholes have now been plotted on L.R.O. sheets, and maps have now been produced on a scale of 1: 10,000 showing the topographical as well as the water table contours. Twice a year the Water Levels of a number of selected wells and boreholes are measured once in spring (just before pumping starts) when the water table reaches its maximum and once in autumn (after pumping has stopped and just after the first rains) when the water table goes down to its minimum. For both periods water table maps are prepared. At the same time springs and chain-of-wells are measured to determine their maximum and minimum yield. Figures of the area irrigated in donums and quantity of water extracted from each borehole or well or spring are also taken once a year.

In Akrotiri Peninusula where sea intrusion has occurred water samples for chemical analysis are taken once a month for which contours are prepared on 1:10,000 scale maps.

The most part of the field work this year was concentrated in the South Eastern Mesaoria where the levelling of wells and boreholes in seven villages was completed; viz: Varosha - Kato Varosha - Ayios Memnon, Dherinia, Paralimni, Ayia Napa, Sotira, Liopetri, and Xylophagou covering an area of 70 sq. miles while levelling in Ayios Loucas and Avgorou was commenced late this year to be completed in 1965. Figures of the area irrigated and quantity of water extracted have also been taken this year.

Water levels and water samples for chemical analysis from a selected number of wells was taken this autumn from 20 villages covering the area between Ayios Loucas - Vatyli - Pyla of a total area of 217 sq. miles. In Pergamos Hydrological area where it is inhabited by Turks no data have been taken due to the abnormal situation.

Early in the year maps of 1:10,000 scale were produced for Ayios Loucas and Avgorou thus completing the mapping of all the area covered by the end of 1963.

The South Eastern Mesaoria was extended to Akhna where the plotting of wells on L.R.O. sheets was completed late in 1964 covering an area of 13.3 sq. miles. It is hoped, however, that the survey will be extended in 1965 by 97 sq. miles.

For Polis (Khrysochous) 1:10,000 scale maps were prepared but the levelling of wells and boreholes could not be carried out due to the abnormal situation; it will be completed in 1965 if the situation permits it. It was made possible, however, for water level measurements and water samples for chemical analysis from selected number of wells and boreholes to be taken this autumn.

The Kiti - Pervolia hydrological survey was left at its primary stage i.e. levelling of wells could not be completed due to the shortage of staff in the hydrogeological section; figures of area irrigated and quantity of water extracted, water level measurements and water samples for

chemical analysis were taken, however. This area is proposed to be extended along the coast line and within the river valleys by 85 sq. miles upto Moni hydrological area.

In addition to the usual work done by this Section water level measurements and water samples were regularly taken from a number of boreholes around all recharge works in Morphou, Southeastern Mesaoria, and Kiti and will be continued until after the rainy season so as enough information is collected on the actual effect of the artificial recharge works on the underground water reservoirs.

The survey of Western Mesaoria is proposed to be extended in future by 200 sq. miles and Akrotiri by 22 sq. miles.

## REPORT ON THE WORK OF THE WEST GERMAN WATER MISSION

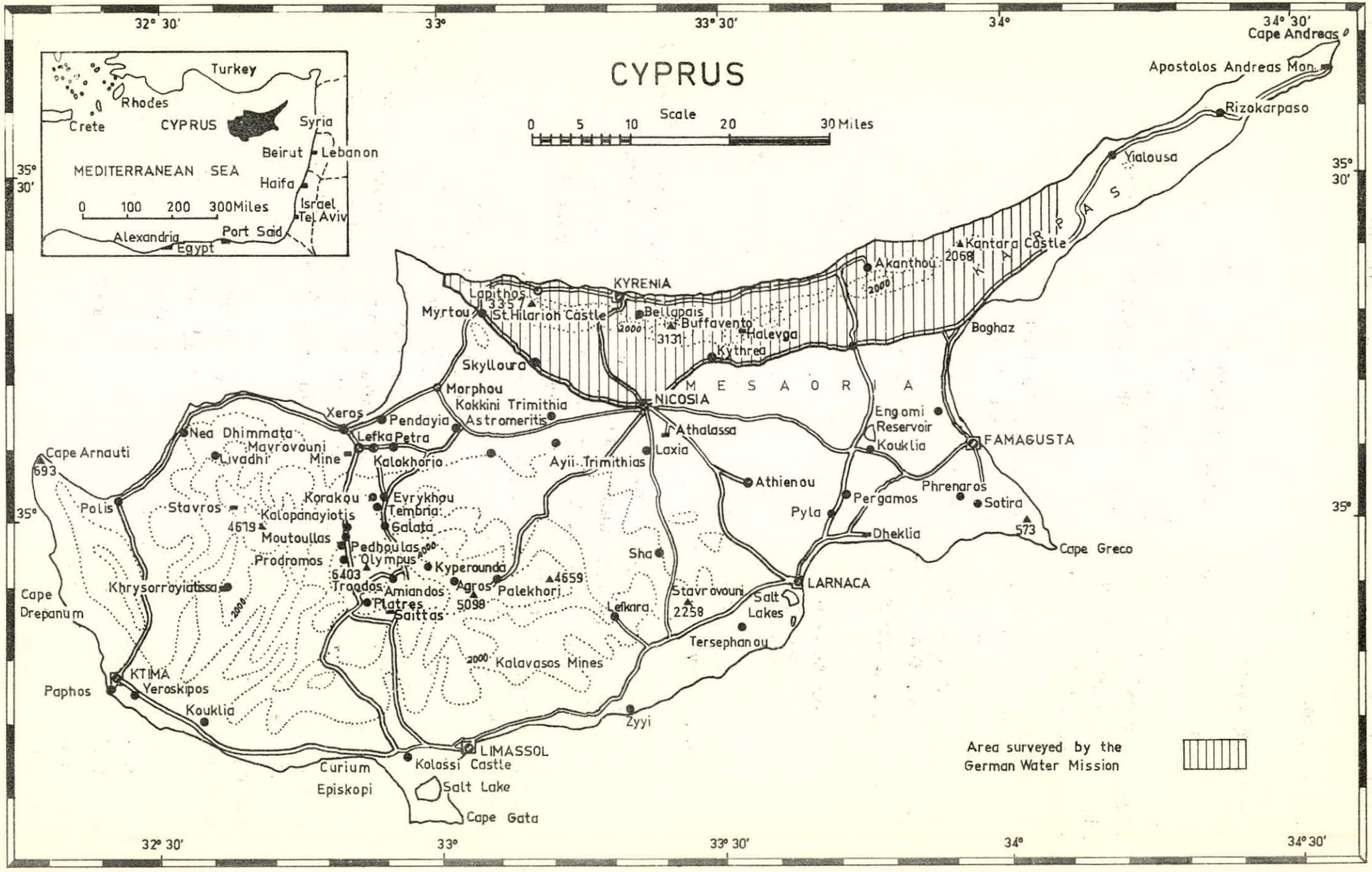
### I. Introduction

An agreement was signed on the 30th October, 1961 between the Federal Republic of Germany and the Cyprus Republic for Technical assistance for the execution of a water project in the Northern Range of the Island. The purpose of the project was to assess groundwater resources in the said region by means of geological and geophysical exploration as well as drilling of a number of boreholes. A soil survey of the most suitable lands that may be brought under irrigation is also envisaged in this project. The areas which were covered by this Survey are shown on Appendix 13.

For the above purpose 17 experts arrived in the Island and work commenced on the 22nd April, 1963. The team was headed by Dr. F. K. Mixius. The composition of the team is shown on Appendix 14.

### II. Field Work

By the end of 1963, reconnaissance survey of the Hilarion Limestone was carried out and a number of borehole


CYPRUS
Scale
0 5 10 20 30 Miles
Turkey
Rhodes
Crete
CYPRUS
Syria
Beirut
Lebanon
MEDITERRANEAN SEA
Haifa
0 100 200 300 Miles
Israel
Tel Aviv
Alexandria
Port Said
Egypt
32° 30'
33°
33° 30'
34°
34° 30'
35°
35° 30'
Cape Andreas
Apostolos Andreas Mon.
Rizokarpaso
Yialousa
Kantara Castle
2068
KARPAS
Akanthou
2000
KYRENIA
Lapithos
3357
Myrtou
St.Hilarion Castle
Bellapais
Buffavento
3131
Halevga
Kythrea
Boghaz
Skylloura
Morphou
Kokkini Trimithia
Astromeritis
NICOSIA
MESAORIA
Engomi
Reservoir
Kouklia
FAMAGUSTA
Xeros
Pendayia
Nea Dhimmata
Mavrovouni
Lefka
Petra
Athalassa
Laxia
Cape Arnauti
693
Livadhi
Mine
Kalokhorio
Ayii Trimithias
Athienou
Phrenaros
Sotira
Pergamos
Pyla
Dheklia
573
Cape Greco
Polis
Stavros
Korakou
Evrykhou
Tembria
Kalopanayiotis
4619
Moutoullas
Galata
Pedhoulas
Olympus
6403
Prodromos
Troodos
Kyperounda
Amiandos
Agros
4659
Palekhori
5098
Platres
Saittas
Sha
Stavrovouni
2258
Salt
Lakes
LARNACA
Lefkara
Tersephanou
Cape
Drepanum
Khrysorrogiatissa
Kalavasos Mines
KTIMA
Paphos
Yeroskipos
Kouklia
Zyyi
LIMASSOL
Curium
Episkopi
Kolossi Castle
Salt Lake
Cape Gata
Area surveyed by the
German Water Mission

sites have been selected by means of reconnaissance geological mapping and the use of aerial photographs. In addition the deleniation and structural details of the more or less incoherent units of the Hilarion Limestone have been completed.

III. Drilling

The team imported in the Island three rotary rigs. These are: One ITAGH of a normal capacity range of 6" diameter boreholes to depths of 1,350 feet and two S.G.750 rigs of a normal capacity range of 6" diameter boreholes to depths of 700 feet.

On the 21st October, 1963, drilling was started in the Kyrenia range and by the end of November, 1964, 25 boreholes were drilled with an aggregate footage of 10,617 feet. Out of these boreholes 12 of them were successful. A short description is shown below:-

Borehole Serial No. B.4 (Grid Ref.: N.88,750 E.36,600)

This borehole was drilled 5½" in diameter down to a depth of 98 feet. This borehole unfortunately was discontinued because while drilling, the rotary drilling bit was irretrievably lost in the borehole.

Borehole Serial No. B.8 (Grid Ref.: N.83,420 E.23,030)

This borehole was drilled 6¼" in diameter down to a depth of 675 feet. The water level was at a depth of 449 feet. No test pumping was carried out because this borehole was considered to be unsuccessful.

Borehole Serial No. B.9 (Grid Ref.: N.83,875 E.23,825)

This borehole was drilled 5⅝" in diameter down to a depth of 465 feet. The water level was at a depth of 341 ft. A short test pumping with an airlift pump was carried out on this borehole, for a period of 56 hours and the output was 2,690 g.p.h. The drawdown unfortunately could not be measured.

Borehole Serial No. B.9 (a) (Grid Ref.: N.83,875 E.23,825)

This borehole was drilled 5⅜" in diameter down to a depth of 682 feet. The water level was at a depth of 341 ft. This borehole was drilled by the side of borehole B.9 with the intention of being used as a stand-by.

Borehole Serial No. B.10 (Grid Ref.: N.85,250 E.26,250)

This borehole was drilled $8\frac{5}{8}$" in diameter down to a depth of 675 feet. The water level was at a depth of 222 feet; no test pumping to ascertain the capacity of this borehole was carried out.

Borehole Serial No. B.11 (Grid Ref.: N.80,300 E.13,500)

This borehole was drilled $5\frac{3}{8}$" in diameter down to a depth of 682 feet. The water level was at a depth of 456 feet. No test pumping was carried out on this borehole because it was considered as unsuccessful.

Borehole Serial No. B.12 (Grid Ref.: N.79,550 E.12,450)

This borehole was drilled down to a depth of 222 feet. No water was found.

Borehole Serial No. B.13 (Grid Ref.: N.79,300 E.10,400)

This borehole was drilled $6\frac{1}{4}$" in diameter down to a depth of 275 feet. The water level was at a depth of 41 feet. A short test pumping with an airlift pump was carried out on this borehole for a period of 44 hours and the output was 5,300 g.p.h. and the maximum drawdown $6\frac{1}{2}$ feet.

Borehole Serial No. B.13(a) (Grid Ref.: N.79,300 E.10,400)

This borehole was drilled $7\frac{3}{4}$" in diameter down to a depth of 150 feet. The water level was at a depth of 41 ft. A short test pumping with an electrosubmersible pump was carried out for a period of 54 hours and the output was 7,600 g.p.h. and the maximum drawdown was 36 feet.

Borehole Serial No. B.14 (Grid Ref.: N.79,900 E.09600)

This borehole was drilled $8\frac{1}{2}$" in diameter down to a depth of 541 feet. The water level was at a depth of 55'.7". No test pumping was carried out to determine the real capacity of this borehole.

Borehole Serial No.B.15 (Grid Ref.N.81,250 E.06500)

This borehole was drilled $6\frac{1}{4}$" in diameter down to a depth 1,151 feet but no water was found.

Borehole Serial No. B.16 (Grid Ref.: N.85,150 E.24,550)

This borehole was drilled $4\frac{1}{4}$" in diameter down to a depth of 708 feet. The water level was at a depth of 184 feet. A test pumping was carried out on this borehole with an

airlift pump for a period of 97 hours with an output of 4,950 g.p.h. and a drawdown of 1½ feet.

Borehole Serial No. B.16(a) (Grid Ref.:N.85,150 E.24,550)

This borehole was drilled (by the side of B.16) 10⅝" in diameter down to a depth of 452 feet. The water level was at a depth of 184 feet. A test pumping was carried out on this borehole with an electrosubmersible pump and the output was 7,600 g.p.h. and the maximum drawdown 75 feet.

Borehole Serial No. B.18 (Grid Ref.: N.80,400 E.16,650)

This borehole was drilled 5⅝" in diameter down to a depth of 761 feet. The water level was at a depth of 508 feet. This borehole is considered to be unsuccessful so no test pumping was carried out.

Borehole Serial No. B.18(a) (Grid Ref.: N.79,950 E.16,800)

This borehole was drilled 6¼" in diameter down to a depth of 610 feet. The water level was at a depth of 354 feet. A test pumping was carried out on this borehole with an airlift pump for a period of 76 hours with an output of 3,250 g.p.h. and a drawdown of 8 inches.

Borehole Serial No. B.18(b) was drilled by the side of B.18 (a) with the intention of being used as a stand-by. This borehole was drilled 8½" in diameter down to a depth of 528 feet. The water level was at a depth of 354 feet. A test pumping was carried on this borehole using an electrosubmersible pump for a period of 80 hours and the output was 7,850 g.p.h. and the maximum drawdown was 13 feet.

Borehole Serial No. B.30 (Grid Ref.: N.83,250 E.06,000)

This borehole was drilled 4¼" in diameter down to a depth of 584 feet. This borehole was test pumped using an airlift pump for a period of 48 hours and its output was 2,700 g.p.h. The water level could not be measured.

Borehole Serial No. B.31 (Grid Ref.: N.80,400 E.05,300)

This borehole was drilled 6¼" in diameter down to a depth of 416 feet. The water level was at a depth of 181 feet. A test pumping was carried out on this borehole using an airlift pump for a period of 49 hours and the output was 3,800 g.p.h.

Borehole Serial No. B.31 (a) was drilled by the side of B.31 and its diameter is 8½" and the total depth is 320 feet. The water level was at a depth of 181 feet. A test pumping was carried out using an electrosubmersible pump for

a period of 48 hours and with an output of 8,100 g.p.h. The maximum drawdown was 1 foot.

Borehole Serial No. B.35 (Grid Ref.: N.86,750 E.81,950)

This borehole was drilled 8½" in diameter down to a depth of 367 feet. The water level was at a depth of 159 feet. This borehole was test pumped for a short period with an electrosubmersible pump with an output of 9,000 g.p.h.

Boreholes Serial Nos. B.27 & B.27 (a) (Grid Ref.: N. 86,200 E. 85,500) were drilled by the side of the other north of Lapithos village but both of them were unsuccessful.

Borehole Serial No. B.20 (Grid Ref.:N.83,050 E.03,450)

This borehole was drilled down to a depth of 321 feet. The water level was at a depth of 147 feet. No test pumping was carried out on this borehole.

Borehole Serial No. B.26 (Grid Ref.: N.84,600 E.94,500)

This borehole was drilled near Karmi and it proved to be very successful; additional information about this borehole is not available now but they will be in the near future.

Government Contribution

The Government of Cyprus contribution to the above project is as follows:-

(a) Three drilling rigs drilling borings of 10' in diameter down to a depth of 40' - 60' feet; in this way the work of the rotary rigs is greatly facilitated.

(b) A total of 10 drilling foremen and 7 drilling assistants were working with the German drilling crews, the purpose being that these people acquire good experience in rotary drilling techniques.
The Government has also provided local transport. In addition it constructed all access roads to the drilling sites.

(c) Provided accommodation to the German Mission personnel and

(d) provided big quantities of water for the rotary drilling rigs for use during the process of drilling.

Appendix 14 shows the personnel of the German Water Mission and Appendix 14A shows local personnel attached to the Project.

Finance

The approximate contribution of the German Government to this Drilling Project was £150,000 while that of the Government of Cyprus is estimated to be £57,417.

The work of the German Water Mission was co-ordinated with the U.N. Special Fund on the Groundwater and Mineral Survey now operating in Cyprus. All drilling results including borehole samples as well as geological maps were passed to the Geological Survey Department.

APPENDIX 14.

COMPOSITION OF W. GERMAN TEAM

| NAME | POST | DATE OF ARRIVAL |
|---|---|---|
| 1. Dr. F.K. Mixius | Geologist | 22.4.1963 |
| 2. Dr. K. Kreysing | " | 22.4.1963 |
| 3. K. Gottschalk | Mining Engineer | 22.4.1963 |
| 4. Dipl.Eng.Staender | Water Engineer | 20.8.1963 |
| 5. R. Bubner | Exec. Engineer | 20.8.1963 |
| 6. P. Hansen | " " | 20.8.1963 |
| 7. H. Sparenberg | Drilling Superintendent | 6.10.1963 |
| 8. K. Eggers | Drilling Engineer | 13.10.1963 |
| 9. M. Lautenschlaeger | Driller | 13.10.1963 |
| 10. W. Graba | " | 13.10.1963 |
| 11. H. Bauernfeind | " | 13.10.1963 |
| 12. H. Fischer | " | 13.10.1963 |
| 13. H. Rodler | " | 13.10.1963 |
| 14. A. Bosse | " | 13.10.1963 |
| 15. H. Berendsen | " | 13.10.1963 |
| 16. Dr. H. Lueken | Dipl. Agronomy | 10.12.1963 |
| 17. A. Nitsch | Mining Engineer | 10.12.1963 |

APPENDIX 14A.

## CYPRIOT PERSONNEL ATTACHED TO THE WEST GERMAN WATER MISSION

| NAME | POST | REMARKS |
|---|---|---|
| G. Zafiris | Geologist | Part-time |
| M. Andreou | Chief Driller | Part-time |
| M. Antoniades | Inspector of Works | Liaison Officer full time |
| G. Kamindjis | Driller | Full time ) |
| Chr. Theologou | " | " " ) With German crews on rotating rigs |
| A. Zakheos | " | " " ) |
| H. Georghiou | " | " " ) |
| S. Avraam | " | " " ) |
| N. Nicolaou | " | " " ) |
| Chr. Chrysanthou | " | " " ) |
| Chr. Sotiri | " | " " ) Working on Government percussion rigs. |
| M. Akathiotis | " | " " ) |
| G. Agathangelou | " | " " |
| Ch. Solomou | Drilling Assistant | " " ) |
| Har. Khrysou | " " | " " ) With German crews on rotary rigs. |
| A. Christou | " " | " " ) |
| I. Louca | " " | " " |
| L. Savva | " " | " " ) With Government percussion rigs. |
| A. Theodorou | " " | " " ) |
| E. Photi | " " | " " |

16. TOWN WATER SUPPLIES

By G. Haralambous, Senior Inspector of Works.

The Section of the Town Water Supplies of the Water Development Department, although short-staffed, as a result of the Turkish insurgence, continued its activities with the same intensity as in 1963.

2. Nicosia Town and Suburbs: The demand for water within the areas of both the "Greater Nicosia Scheme" and the Water Board of Nicosia was met satisfactorily. Apart from losses due to breakages of the distribution system in certain areas controlled by the Turkish insurgents, water was made available to a number of camps occupied by the National Guard and the United Nations Forces.

3. The highest daily consumption was 20,330 c.m., 7,000 c.m. for Greater Nicosia Scheme and 13,330 c.m. for the Water Board of Nicosia (including the Nicosia Water Commission). This quantity was made available from all existing sources being pumped at maximum yield - including privately owned boreholes from which water is purchased - and the "Morphou Emergency Scheme". It should be noted that the main Morphou Bay Scheme which can produce 2.0 m.g. daily has since its completion remained idle because of the dropping of the water level in the area.

4. Between the 19th - 21st June, 1964, the water supply for Nicosia and Suburbs was put under restrictions due to the breakdown of the Boosters of the "Emergency Scheme" when the operation of the Morphou Bay Scheme was authorized. This Scheme worked continuously up to 12th July, 1964, the date on which the broken Boosters were replaced by new more powerful ones. Nevertheless, it so happened that in order to meet peak consumption, operation of this scheme went on periodically until 17th November, 1964.

5. During 1964, the distribution system of the Greater Nicosia Scheme was extended by approximately 16,000 ft. or 3.0 miles of asbestos cement pipes. These extensions were mostly carried out in newly developed areas at the expense of private developers. The number of consumers was increased by 306 and at the end of the year the total number of consumers reached the figure of 7,154.

6. Considering this year's peak consumption of 7,000 c.m. daily, in as far as Greater Nicosia Scheme "area of supply" is concerned, it is anticipated that existing sources will not be capable to "self-suffice" the demand during summer months and an additional quantity of 2,500 c.m. will be required. Under best conditions present sources of supply may produce a quantity of 4,500 c.m. daily as under:

| | | |
|---|---|---|
| a) | Kokkini-Trimithia and Akaki | 2,200 c.m. |
| b) | Paleometokho | 400 c.m. |
| c) | Dhali | 1,000 c.m. |
| d) | Dhikomo | 500 c.m. |
| e) | Sykhari | 400 c.m. |
| | Total | 4,500 c.m. |

Notes: a) The quantity from Kokkini-Trimithia represents the maximum capacity of the pumps.

b) The quantity from Dhikomo represents the yield of one pumping unit. The water level of the other two boreholes fell below suction.

c) The Sykhari Adit, where it is estimated that an amount of 60,000 c.m. would be stored by May next it can supplement the supply during summer months.

7. A statement of expenditure and revenue of the Greater Nicosia Scheme is given in Appendix No. 15.

8. Limassol. With the addition of a new borehole (Drousiotis) water supply for this town was continuous and uninterrupted during 1964. The maximum daily consumption was 9,980 c.m. on 1/8/1964. It is recorded that the yield of the springs in 1964 was the lowest since their development in 1952.

9. The "Yermasoyia River Scheme" which has been modified to a certain extent is in progress. During 1964, the laying of the delivery main 12" Ø steel for the length of 15,000 ft. and the 10" Ø steel connection main (between the proposed and the existing Reservoirs) has been completed. Following the alterations to the scheme, new plans have been prepared for a smaller service reservoir whereas at head works an order for more powerful submersible has been placed. These pumps will replace the originally proposed pumping station which has now been deleted. The remaining items of the scheme are: (a) the construction of the reservoir, (b) the installation of the pumping units at the sources and

(c) the distribution system within Mesayitonia village. It is hoped that this new scheme will be put in operation during May - June of 1965.

10. The Distribution system in the town was extended by 17,669 ft. and the total number of consumers at 31.12.64 was 11,639.

11. Famagusta. Regular and continuous water supply could be maintained for Famagusta during 1964, although no substantial improvements to the existing sources were carried out. Some deepening work of the existing boreholes at Frenaros area was undertaken with satisfactory results.

12. The maximum consumption rose to 5,743 c.m. daily against a total number of consumers of 8,737.

13. In view of the continued declination of the water level of the sources, water supply problem of this town will have to be considered in conjunction with the Hydrological survey now in progress. Desalting process is, however, still in mind. Under normal conditions existing sources may stand good for the supply of the town's requirements for the next one or two years.

14. Larnaca. Due to the abnormal political situation the administration of the water supply of Larnaca which was in the hands of the EVCAF Office, was taken up by the District Officer in his capacity as Chairman of the Improvement Board. Continuous supply was being maintained until early in Summer when due to the prevailing drought one of the main sources - the Bekir Pasha Chain of wells - had almost dried up and restrictions to a large scale were then imposed. Restrictions were lifted in December after a good rainfall.

15. In order to meet the immediate requirements of the town a new supplementary scheme is being designed. It will be carried out in three stages, the first one providing 300,000 gls. daily from the Anglissidhes area and will include the construction of a service reservoir near Tremithios and the laying of a trunk main upto "Kafenoudhia".

16. With this scheme in view, the establishment of a Water Board for Larnaca becomes a necessity.

17. Facts about Water Boards of Nicosia, Limassol and Famagusta are given on appendices Nos. 16, 17 and 18 respectively.

Appendix No. 15.

## Revenue and expenditure account of the Greater Nicosia Scheme for the year 1964.

| Expenditure | | | Revenue | |
|---|---|---|---|---|
| (a) Pumping charges | £12,400 | | (a) Sale of water and meter rent | £59,745 |
| (b) Purchase of water | 4,100 | | (b) Connection fees | 622 |
| (c) Maintenance charges | 2,467 | | (c) Usage of pipes by Water Board | 2,500 |
| (d) Collection fees | 9,055.102 | | (d) Other revenue (Stores etc.) | 5,350 |
| Total | | £28,022 | Total | £68,217 |
| Administration | £ 2,000 | | | |
| Amortization (£650,000 in 30 years at 6%) | 37,590 | 39,590 | | |
| Grand Total | | £67,612 | Profit for the year | £605.- |

(An approximate amount of £13,000 being value of water supplied to Turks could not be collected due to the abnormal political situation.)

Appendix No. 16.

## FACTS ABOUT NICOSIA WATER BOARD.

| | | |
|---|---|---|
| 1. | Total quantity of water supplied from all sources (including Nicosia Water Commission's sources) | 3,742,232 c.m. |
| 2. | Total quantity of water consumed, registered by area meters (including consumption within Nicosia Water Commission's Area) | 3,414,413 c.m. |
| 3. | Total maximum summer consumption per day (including Nicosia Water Commission) .. .. .. | 13,330 c.m. |
| 4. | Total number of consumers .. .. | 9,836 |
| 5. | a) Extension of Distribution system | 5,200 ft. of 4" Ø |
| | b) Total length of Distribution system .. .. .. .. | Figure not available |
| 6. | a) Number of hydrants installed in 1964 .. .. .. .. | 2 |
| | b) Total number of hydrants installed within water supply area .. | Figure not available |

Appendix No. 17.

## FACTS ABOUT LIMASSOL WATER BOARD.

| | | | |
|---|---|---|---|
| 1. | Total quantity of water supplied from all sources .. .. | 2,921,228 | c.m. |
| 2. | Total quantity of water registered by area meters .. .. .. | 2,550,925<br>144,452 | c.m.<br>c.m. overflow |
| 3. | Maximum consumption on any summer day (1.8.1964) .. .. .. | 9,980 | c.m. |
| 4. | No. of consumers as at 31.12.64 | 11,639 | |
| 5. | (a) Pipes laid: Feet 4" .. | 17298' | |
| | " 6" .. | 69' | |
| | " 8" .. | 302' | |
| | (b) Total length of distribution system (including extensions for 1964) (excluding house connections; excluding also pipes laid under "Yermassoyia Scheme") .. .. .. | 550,469 | feet |
| 6. | (a) No. of hydrants installed in 1964 | 23 | |
| | (b) No. of hydrants installed within water supply are as at 31.12.64 | 512 | |

Appendix No. 18.

## FACTS ABOUT FAMAGUSTA WATER BOARD.

| | | |
|---|---|---|
| 1. | Total quantity of water supplied from all sources .. .. | 1,619,936 c.m. |
| 2. | Total quantity of water consumed registered by area meters .. | 1,508,098 c.m. |
| 3. | Total maximum summer consumption per day in cubic meters .. | 5,257 c.m. |
| 4. | Total number of consumers .. | 8,837 |
| 5. | (a) Extension of distribution system in ft. run and size of pipes | 8,216 ft. ø 4" |
| | (b) Total length of distribution system (including extensions for last year) | 79.3 miles |
| 6. | (a) Number of hydrants installed in 1964 | 6 |
| | (b) Total number of hydrants installed within water supply area | 482 |

17. REPORT ON MINOR IRRIGATION, RECHARGE, ANTIFLOOD, DRAINAGE, AND THE LARGER DISTRIBUTION SCHEMES AT MORPHOU AND PRODROMOS

by P. Pantelides, Superintendent of Works.

A. MINOR IRRIGATION.

In spite of some difficulties encountered during the early part of the year the programme for minor irrigation schemes all over the island has been continued with the usual intensity.

The amount of money spent on new schemes completed during the year is £117,345 as per Appendix 19. The total area of land brought under perennial irrigation by the new completed schemes is 1600 donums, and under seasonal irrigation 23,000 donums. The money spent during the year on new schemes which have been started but not completed and the works are continuing over the new year amounts to £20,330 as per appendix 20.

In addition to the new schemes the balance of works carried forward from 1963 has been completed during 1964 with an expenditure of £49,790 revoted from the old budget as per appendix 21.

Thus, the total amount of money spent in 1964 for minor irrigation schemes is £187,465.

The expenditure during 1964 on Antiflood, River-Training, Drainage and Recharge Schemes which commenced late in 1963 and completed during 1964, amounts to £32,965 as per appendix 22. The expenditure on the larger irrigation distribution system of Morphou and Prodromos amounts to £53,500.

Thus, the total expenditure incurred in 1964 is £273,930 as summarized below.

SUMMARY OF ACTUAL EXPENDITURE INCURRED IN 1964

| | Appendix | | Total £ |
|---|---|---|---|
| 1. MINOR IRRIGATION | | | |
| (i) Minor Irrigation Works completed | 19 | £117,345 | |
| (ii) Minor Irrigation Works continuing 1965 | 20 | £ 20,330 | |
| (iii) Minor Irrigation Works continued from 1963 | 21 | £ 49,790 | |
| | | | £187,465 |
| 2. RECHARGE AND GENERAL WORKS COMPLETED AND CONTINUING AT THE END OF 1964 | 22 | | £ 32,965 |
| 3. MORPHOU (TERATSIA), MORPHOU (OVGOS), PRODROMOS DISTRIBUTION WORKS | | | £ 53,500 |
| Total Expenditure 1964 | | | £273,930 |

The following schemes which were scheduled for implementation in 1964 have not been started because the usual village contributions have not been made available to the Department.

| | | |
|---|---|---|
| 1. | Kilani (Limassol) | £ 6,650 |
| 2. | Pyrgos (Limassol) | £ 4,000 |
| 3. | Moniatis (Limassol) | £ 4,200 |
| 4. | Timi (Paphos) | £10,000 |
| 5. | Theletra (Paphos) | £11,200 |
| 6. | Drymou (Paphos) | £ 1,450 |
| 7. | Nata (Paphos) | £ 2,100 |
| | Total | £39,600 |

The following irrigation schemes had to be deferred because of unforeseen technical difficulties.

| | |
|---|---|
| (1) SOTIRA (Limassol) water has been diverted for village water supplies | £ 9,200 |
| (2) ANGLISSIDES (Larnaca) a new borehole has to be constructed for a pumping scheme | £ 8,000 |
| Total | £17,200 |

Detail Description of Selected Schemes:

(1) Kelokedara (P), estimated cost, first stage £15,000: This is a combination of several types of works designed in accordance with purely local conditions and requirements. The location is on a valley on the upper "Xeros" river and the land consists of a marshy strip alongside the riverbed and of gentle slopes rising towards the village. The meandering spate torrent of the river has washed away a large section of the marginal land.

The works consist of a system of perforated concrete drainage pipes, a series of gabion groynes for bank protection and consolidation, a gravity irrigation system with intake on the river and concrete channel distributaries and a pumping scheme on a borehole for late summer irrigation when the river dries.

On completion of the works an extent of about 100 donums of marshy and riverwashed land will be drained and reclaimed and a total area of about 555 donums will be converted into first class farmland. The safe yield of the borehole is estimated at over 20,000 gallons per hour.

A similar scheme has been designed for implementation at a later stage in the area upstream of the present works.

(2) Maroni (Larnaca). Estimated Cost £10,000.

The principal item of the scheme is a mass concrete sub-surface dam of 20 feet maximum depth and 350 feet cross length on the Maroni river, whereby a constant flow at 7,000 gallons per hour has been brought to the surface at the mouth of the irrigation channel. This flow which has been tapped in the underground gravels is estimated to be the minimum in years of continued drought. The dam as designed can also serve

for diversion of seasonal stream flows, and the scheme includes a total length of 6,300 ft. lined irrigation channels. It is estimated that the scheme will provide seasonal irrigation to 500 donums and perennial irrigation to about 100 donums.

(3) STYLLOS - LIMNIA. Estimated Cost £9,500.

This is a typical spate irrigation scheme consisting of a large concrete weir (175 feet spillway) and earth bank abutments across "Plakos" river who rises on the eastern slopes of the Kyrenia mountains and flows into the Famagusta sea near Salamis. The works which are being continued in 1965 will include a completely new system of canal distributaries with lock gates and ancillary works to serve an area of land of about 1130 donums under cereals.

(4) KYPEROUNDA £4,070.

Localities: Limni
Hassanis
Theotokos
Pefkos
Ladja.

These are typical works which have become a regular feature of the Pitsillia valleys. They consist of minor springs which have been developed by excavation, horizontal borings and collector works; the water is piped or channelled into small concrete irrigation tanks which serve for night storage and control distribution; an overall length of 5400 feet of distribution pipes and channels and 3 number irrigation tanks are included in the works. The total area coming under perennial irrigation is 73 donums.

B. RECHARGE.

(1) Paralimni. Estimated Cost 1964 Works £6,500.

The scheme of works carried out in 1963 has been enlarged during the year by the extension of the recharge canal and the construction of additional small earth dams serving as spreading grounds for artificial recharge. With these supplementary works the total number of small earth dams in Paralimni is 50 and the total length of the recharge canal is 36,500 feet. It can, therefore, be considered as one of the major recharge schemes in operation at present with an overall storage capacity of about 400 million gallons, including storage in the Paralimni Lake. Fortunately, at

about the end of the year, the lake and all dams have filled up with water to full capacity after intensive rainfall. This will give us a chance for testing these and other similar recharge schemes in the area of Famagusta where a great demand for this type of works has been created. The method employed is to impound rainfall water in artificial lakes constructed over permeable strata, in order to induce replenishment of the underground aquifer through vertical and side infiltration.

(2) Phrenaros. Estimated Cost £12,000
Amount spent 1964 £ 7,000.

This scheme consists of 6 small earth dams forming reservoirs of a total capacity of 30 million gallons. Work was started in 1964 but had to be temporarily suspended pending the acquisition of private land; it will, therefore, be completed in 1965.

(3) Dherinia. £1,500.

An earth dam of maximum 18 feet height with a 5 million gallon reservoir has been constructed on the upper "Farangas" for artificial local recharge.

C. ANTIFLOOD.

(1) Pakhna. Estimated Cost £3,500 (stage 1).

On the request of District Officer, Limassol, a scheme of works consisting of an underground flood drain (length = 1400 ft.) was undertaken in Pakhna, for flood protection within the village. The work will be continuing in 1965. The final stage of the works consisting of the extension of the drain from its present terminal in private fields to a natural watercourse at £6,800 has been put up to District Officer, Limassol.

(2) Livadhia (Larnaca). £3,500.

A system of concrete and earth dykes with diversion canals has been constructed along the higher outskirts of the village for flood diversion.

D. DRAINAGE AND RECLAMATION OF LAND.

(1) Patriki (Famagusta). £2,500.

This is an interesting scheme of land reclamation and drainage, whereby the former Patriki lake will be converted to 500 donums of pasture land for communal use.

(2) Vitsadha (Famagusta). £3,000.

A mass concrete weir and ancillary works has been completed during the year as part of a staged scheme of gully-erosion control and stabilization. Some similar works were carried out in the same area in earlier years with positive results.

(3) Voroklini Lake. £1,800.

An earth embankment 1200 ft. length, 6 feet maximum height with concrete spillweir has been constructed across the lake as part of a larger scheme of land reclamation carried out by the Department of Agriculture.

E. SOME LARGER IRRIGATION DISTRIBUTION SCHEMES.

(1) PRODROMOS.

| | |
|---|---|
| Estimated Cost | £27,000 |
| Amount Spent 1964 | £20,000 |
| Total Length (pipes) | 35,000 feet |
| Total Area Commanded | 160 donums. |

Following the completion of the "Prodromos" reservoir, the system for irrigation distribution has been undertaken and practically completed by the end of 1964. The system consists of steel pipes of variable diameter according to hydraulic conditions and draw-out gate valves where required.

The pipe net-work commands all the new land that has been included in the old Division and delivers water along commanding points of the old concrete distribution channels which are mainly used for irrigation from the "Khardji" stream.

The scheme as carried out includes the construction of a guard house near the dam, a pumping station on the main "Khardji" channel and delivery pipes rising to the reservoir for storage of surplus stream flows in winter and spring. Most of these latter works will be continued in 1965.

Morphou (Teratsia Division).

Lining of channels:-

| | |
|---|---|
| Estimated Cost | £90,000 |
| Amount spent 1964 | £32,000 |
| Total Length of channels | 90,000 feet |
| Length completed 1964 | 40,000 feet |
| Total Area of Land commanded | 4,000 donums. |

This is one of the largest distribution systems in operation commanding an area of near 4,000 donums of citrus

gardens within the area of Morphou. Only the principal main and secondary channels conveying water from pumps and from the new Dam on the Serakhis river are lined in reinforced concrete.

The method consists of casting on the site reinforced concrete channel sections of 13 feet length in timber moulds, with proper and appropriate expansion joints and foundations.

In view of the increasing demand for watertight canals in practically all stages of irrigation distribution the possibility of improving the present construction methods and reducing cost by the introduction of prefabricated concrete channels has been studied; in this connection a number of tests will be conducted in Morphou during 1965.

Morphou (Ovgos Division).

Distribution System Stage I.

| | |
|---|---|
| Estimated Cost | £40,000 |
| Amount spent 1964 | £ 1,500 |
| Total Length | 47,000 feet |
| Completed Length 1964 | 1,500 feet |
| Total Area of Land commanded | 7,000 donums. |

This scheme replaces the obsolete river water intake system of Ovgos and provides for new channel and pipe distribution system from the Ovgos dam to fields mainly in the Khrysiliou area near Morphou. The system has been designed for irrigation from boreholes and from the Ovgos dam. Methods of construction are similar with Morphou (Teratsia) with the exception that large diameter pipes are used where possible. The total area included in the Division is 7,000 donums.

Appendix 19.

IRRIGATION SCHEMES COMPLETED IN 1964.

| No. | VILLAGE & NAME OF DIVISION | TYPE OF WORKS | COST | APPROXIMATE EXTENT OF LAND IRRIGATED IN A NORMAL RUNOFF YEAR | | | REMARKS |
|---|---|---|---|---|---|---|---|
| | | | | WINTER | SPRING | PER-ENNIAL | |
| | | | | Donums | Donums | Donums | |
| | NICOSIA DISTRICT | | | | | | |
| 1 | PHILIA (Irrigation Division) | Deep-well pumping scheme, pipe distribution system | £ 7,200 | 50 | 50 | 60 | New Irrigation. |
| 2 | PHILIA (Dexamenitou-Khoriou) | Mass concrete Irrigation tank and reinforced concrete Irrigation channels | 5,500 | 218 | - | 60 | Improved and New Irrigation. |
| 3 | TYMBOU (Division No. 1) | River Diversion Intake & Distribution System (General improvements) | 1,500 | 1,500 | - | - | - do - |
| 4 | TYMBOU (Division No. 2) | Construction of Diversion Intake and General improvements to the Distribution System | 2,200 | 740 | - | 90 | - do - |
| 5 | KYTHREA (Kefalovryssos Upper Quarter) | Repairs to the concrete Intake channel | 600 | - | - | - | - do - |
| 6 | VONI (Irrigation Division) | Construction of Distribution Gates and General Improvements | 1,100 | 1,700 | - | - | - do - |
| 7 | XYLIATOS (Potimon & Kaizerli) | Diversion Weirs and Distribution System | 5,680 | - | 185 | - | - do - |
| | | C.F. | £23,780 | 4,208 | 235 | 210 | |

| NO. | VILLAGE & NAME OF DIVISION | TYPE OF WORKS | COST | APPROXIMATE EXTENT OF LAND IRRIGATED IN A NORMAL RUNOFF YEAR | | | REMARKS |
|---|---|---|---|---|---|---|---|
| | | | | WINTER | SPRING | PER-ENNIAL | |
| | | | | Donums | Donums | Donums | |
| | | B.F. | £ 23,780 | 4,208 | 235 | 210 | |
| 8 | EXO-METOKHI (Division No.1) | Irrigation Canals (Improvement Works) | 1,200 | 1,500 | - | - | Improved and New Irrigation. |
| 9 | STROVOLOS (Irrigation Division) | Irrigation Canals (General Improvements) | 1,600 | 519 | - | - | Improved and New Irrigation (309 olive-trees). |
| 10 | PYRGOS (Tyllirias) Division | Construction of reinforced concrete Distribution channels (extensions) | 3,200 | 1,600 | 600 | - | Improved and New Irrigation. |
| 11 | PSOMOLOPHOU (Irrigation Division) | Diversion Intake and Distribution Canal (construction) | 5,000 | 1,000 | 20 | - | - do - |
| 12 | TSAKKISTRA (Division) | Pipe Distribution Works | 2,200 | - | 60 | 40 | - do - |
| | KYRENIA DISTRICT | | | | | | |
| 13 | VASILIA | Lining of irrigation Distribution channels | 4,700 | 150 | 42 | 45 | - do - |
| 14 | KARAVAS "Palia Vrysi" Irrigation Division | Lining of Distribution channels | 1,500 | - | - | 700 | - do - |
| | | C.F. | £ 43,180 | 8,977 | 957 | 995 | |

| NO. | VILLAGE & NAME OF DIVISION | TYPE OF WORKS | COST | APPROXIMATE EXTENT OF LAND IRRIGATED IN A NORMAL RUNOFF YEAR | | | REMARKS |
|---|---|---|---|---|---|---|---|
| | | | | WINTER | SPRING | PER-ENNIAL | |
| | | | | Donums | Donums | Donums | |
| | | B.F. | £ 43,180 | 8,977 | 957 | 995 | |
| | FAMAGUSTA DISTRICT | | | | | | |
| 15 | MARATHOVOUNOS | River Diversion Works & Distribution channels | 2,400 | 600 | - | - | Improved and New Irrigation. |
| 16 | SYNGRASSI Kala-mouli Irrigation Division | General Improvements to the Intake system | 1,200 | 2,000 | - | - | - do - |
| 17 | STYLLOS, LIMNIA (Division No.1) (Strongyli Kouroukla) | Diversion Works and Distri-bution System (General Improvements) | 2,300 | 2,200 | - | - | - do - |
| 18 | ASHA (Division) | General Improvements to the flood Irrigation System | 1,000 | 5,566 | - | - | - do - |
| | LIMASSOL DISTRICT | | | | | | |
| 19 | DHIERONA (Division) | Lining of Irrigation channels | 2,840 | - | - | 70 | - do - |
| 20 | PLATRES (Kato) Division ("Des-potiko" locality) | Improvement and Development of Mountain Springs and Distribution Works | 2,800 | - | 30 | 35 | - do - |
| 21 | ATHRAKOS ("Halourakas") | Distribution Works (pipes and channels) | 1,350 | - | 10 | 60 | New Irrigation. |
| | | C.F. | £ 57,070 | 19,343 | 997 | 1160 | |

| NO. | VILLAGE & NAME OF DIVISION | TYPE OF WORKS | COST | APPROXIMATE EXTENT OF LAND IRRIGATED IN A NORMAL RUNOFF YEAR | | | REMARKS |
|---|---|---|---|---|---|---|---|
| | | | | WINTER | SPRING | PER-ENNIAL | |
| | | | | Donums | Donums | Donums | |
| | | B.F. | £ 57,070 | 19,343 | 997 | 1160 | |
| 22 | KYPEROUNDA | | | | | | |
| | (a) Pefkos<br>(b) Ladja | Irrigation Tank and Distribution pipes and channels | 1,930 | - | - | 42 | Improved and New Irrigation. |
| 23 | ARAKAPAS | | | | | | |
| | (a) Skoli<br>(b) Angoulos<br>(c) Petra-tis-Koutsis | Irrigation Tank and Distribution Works, pipes and channels | 4,830 | - | 380 | 204 | - do - |
| 24 | SYKOPETRA (Agridhia, Konomides) | Irrigation Channels (Improvements) | 240 | - | - | 12 | - do - |
| 25 | KALOKHORIO (Zoopiyis) "Marammenos" | Irrigation Tank and Distribution Works | 720 | - | 13 | 16 | - do - |
| 26 | AY. IOANNIS | | | | | | |
| | (a) Yerambela & Vrisha | Development of springs and distribution works | 955 | - | - | 25 | - do - |
| | (b) Spilios Koufovounos | Irrigation channels and General Improvements | 660 | - | - | 70 | - do - |
| | (c) Pano Akros )<br>(d) Ay. Marina ) | Development of springs and Distribution Works | 2,760 | - | - | 115 | - do - |
| | | C.F. | £ 69,165 | 19,343 | 1,390 | 1644 | |

| NO. | VILLAGE & NAME OF DIVISION | TYPE OF WORKS | COST | APPROXIMATE EXTENT OF LAND IRRIGATED IN A NORMAL RUNOFF YEAR | | | REMARKS |
|---|---|---|---|---|---|---|---|
| | | | | WINTER | SPRING | PER-ENNIAL | |
| | | | | Donums | Donums | Donums | |
| | | B.F. | £ 69,165 | 19,343 | 1,390 | 1644 | |
| 27 | KYPEROUNDA | | | | | | |
| | (a) Theotokos<br>(b) Limni<br>(c) Hassanis | Development of Springs, Tank, Distribution Works | 2,240 | - | 14 | 31 | Improved and New Irrigation. |
| 28 | EFTAGONIA | Development of Springs | 270 | 3 | 19 | 13 | - do - |
| 29 | MATHIKOLONI | Irrigation Tank and Distribution Works | 4,450 | - | - | 31 | New Irrigation. |
| 30 | AGRIDIA "Dhimma Arghyrou" | Distribution Tank and pipes | 690 | - | - | 28 | Improved and New Irrigation. |
| 31 | LEMYTHOU | Irrigation Tank and Distribution Works | 820 | - | 9 | 26 | - do - |
| 32 | APSIOU | Irrigation channels | 1,600 | - | 100 | 86 | - do - |
| 33 | MANDRIA "Xylopervolia & Liofantes" | Distribution pipes | 1,290 | - | - | 12 | New Irrigation. |
| 34 | DHYMES | Distribution Works | 1,250 | - | 15 | 12 | Improved and New Irrigation. |
| 35 | PLATRES (Pano) | Lining of Distribution Channels (Improvements and Extensions) | 3,000 | - | 54 | 76 | - do - |
| | | C.F. | £ 84,775 | 19,346 | 1,601 | 1,959 | |

| NO. | VILLAGE & NAME OF DIVISION | TYPE OF WORKS | COST | APPROXIMATE EXTENT OF LAND IRRIGATED IN A NORMAL RUNOFF YEAR | | | REMARKS |
|---|---|---|---|---|---|---|---|
| | | | | WINTER | SPRING | PER-ENNIAL | |
| | | | | Donums | Donums | Donums | |
| | | B.F. | £ 84,775 | 19,346 | 1,601 | 1,959 | |
| 36 | KAMINARIA (Potaminia) | Distribution Pipes and Channels | 640 | - | - | 13 | Improved and New Irrigation. |
| 37 | OMODHOS (Ayiasma) | Irrigation Tank and Distribution Works | 1,780 | - | 10 | 6 | - do - |
| 38 | AY. THERAPON | Irrigation Distribution Works | 1,060 | - | - | 100 | - do - |
| | LARNACA DISTRICT | | | | | | |
| 39 | PSEVDAS | Lining of channels | 250 | - | 23 | 18 | - do - |
| 40 | MARONI | Sub-surface Weir and Distribution channels | 10,000 | - | 500 | 114 | New Irrigation. |
| 41 | KHIROKITIA | Lining of Irrigation channels | 5,000 | 1,300 | 120 | - | Improved and New Irrigation. |
| | PAPHOS DISTRICT | | | | | | |
| 42 | P. & K. AKOURDALIA | Diversion Works, Irrigation Distribution Scheme | 8,160 | - | 60 | 35 | - do - |
| 43 | PENDALIA | Irrigation Distribution Works | 1,700 | - | 29 | 6 | New Irrigation. |
| 44 | PANAYIA Kapnias | Mountain Springs, Development and Distribution Works | 250 | - | 6 | 4 | Improved and New Irrigation. |
| 45 | KHOLI-SKOULLI | Distribution channels, Lining & General Improvements | 3,730 | - | 80 | 50 | - do - |
| | | Total | £117,345 | 20,646 | 2,429 | 2,305 | |

Appendix 20.

IRRIGATION SCHEMES IN HAND AT THE END OF 1964 AND CONTINUED IN 1965.

| No. | VILLAGE & NAME OF DIVISION | TYPE OF WORKS | TOTAL ESTIMATED COST | MONEY SPENT DURING 1964 | APPROXIMATE EXTENT OF LAND IRRIGATED IN A NORMAL RUNOFF YEAR | | | REMARKS |
|---|---|---|---|---|---|---|---|---|
| | | | | | WINTER | SPRING | PER-ENNIAL | |
| | | | | | Donums | Donums | Donums | |
| | NICOSIA | | | | | | | |
| 1 | PERISTERONARI | Intake and Distribution Works | £ 2,800 | £ 1,520 | 1,000 | - | - | Improved and New Irrigation. |
| 2 | XYLIATOS (Palevros) | Diversion and Distribution Works | 3,550 | 2,120 | 120 | 80 | - | New Irrigation. |
| 3 | GALATA | Development of Mountain Springs and Distribution Works | 8,200 | 2,660 | - | 49 | 77 | Improved and New Irrigation. |
| 4 | SPILIA | Diversion and Distribution Works | 4,335 | 620 | - | - | 35 | - do - |
| 5 | KOURTALIS (Vathys) | Storage Tank Distribution Works | 480 | | - | 5 | 4 | - do - |
| | KYRENIA | | | | | | | |
| 6 | KARAVAS (Platani) | Development of Springs and Distribution Works | 1,700 | 790 | - | - | 30 | - do - |
| | FAMAGUSTA | | | | | | | |
| 7 | STYLLOS LIMNIA (Plakos) | Diversion Weir and Distribution Works | 9,500 | 4,500 | 1,130 | - | - | New Irrigation |
| | | C.F. | £30,565 | £12,210 | | | | |

| NO. | VILLAGE & NAME OF DIVISION | TYPE OF WORKS | TOTAL ESTIMATED COST | MONEY SPENT DURING 1964 | APPROXIMATE EXTENT OF LAND IRRIGATED IN A NORMAL RUNOFF YEAR | | | REMARKS |
|---|---|---|---|---|---|---|---|---|
| | | | | | WINTER | SPRING | PER-ENNIAL | |
| | | | | | Donums | Donums | Donums | |
| | | B.F. | £30,565 | £12,210 | | | | |
| | LIMASSOL | | | | | | | |
| 8 | ARSOS | Lining Channels | 2,520 | 510 | - | 60 | 30 | Improved and New Irrigation. |
| 9 | PALEOMYLOS | Intake Works and Lining of Channels | 6,740 | 650 | - | - | 215 | - do - |
| | PAPHOS | | | | | | | |
| 10 | NEOKHORIO "Kephalovrysos" Spring | Distribution channels and pipes | 1,560 | - | - | 27 | 25 | - do - |
| 11 | KELOKEDARA (Ziripillis) | Pumping Scheme, Drainage, River Training and Distribution channels combined scheme | 15,000 | 6,550 | 400 | - | 155 | New Irrigation. |
| 12 | PANAYIA (Sarkas) | Development and Distribution Works | 870 | 410 | - | 6 | 4 | Improved and New Irrigation. |
| | | Total | £57,255 | £20,330 | | | | |

Appendix 21.

WORKS STARTED IN 1963 AND COMPLETED DURING 1964.

| NO. | VILLAGE & NAME OF DIVISION | TYPE OF WORKS | EXPENDITURE FOR COMPLETION 1964 | APPROXIMATE EXTENT OF LAND IRRIGATED IN A NORMAL RUNOFF YEAR | | | REMARKS |
|---|---|---|---|---|---|---|---|
| | | | | WINTER | SPRING | PER-ENNIAL | |
| | | | | Donums | Donums | Donums | |
| 1 | PEDOULAS | Lining of channels | £ 600 | | | | Improved and New Irrigation. |
| 2 | AKAKI "Riatikon" | Lining of channels | 590 | 2,000 | 2,000 | 500 | - do - |
| 3 | ARGAKI | Pumping Scheme & Irrigation Distribution System | 2,820 | - | 300 | 180 | New Irrigation. |
| 4 | KALOKHORIO KLIROU | Lining of channels | 4,800 | - | 950 | 150 | Improved and New Irrigation. |
| 5 | LAGOUDERA | Intake and Distribution Works | 950 | - | 30 | 20 | - do - |
| 6 | SARANDI "Pyrgos" Locality | General Irrigation Improvement Works | 660 | - | 8 | 8 | - do - |
| | LARNACA | | | | | | |
| 7 | ATHIENOU | Pumping Scheme and Distribution Works | 9,600 | - | - | 100 | New Irrigation |
| | LIMASSOL | | | | | | |
| 8 | LOUVARAS | Development of Springs Tanks & Distribution Works | 2,370 | - | 85 | 46 | Improved and New Irrigation. |
| | | C.F. | £22,390 | | | | |

| NO. | VILLAGE & NAME OF DIVISION | TYPE OF WORKS | EXPENDITURE FOR COMPLETION 1964 | APPROXIMATE EXTENT OF LAND IRRIGATED IN A NORMAL RUNOFF YEAR | | | REMARKS |
|---|---|---|---|---|---|---|---|
| | | | | WINTER | SPRING | PER-ENNIAL | |
| | | B.F. | £22,390 | Donums | Donums | Donums | |
| 9 | POTAMITISSA<br>(a) Angelina<br>(b) Vlou<br>(c) Yeratzes | Development of Mountain Springs, Tanks and Distribution Works | 1,000 | - | - | 55 | Improved and New Irrigation. |
| 10 | TRIS ELIES | Diversion Weirs & Distribution Channels | 5,000 | - | 120 | 80 | - do - |
| 11 | SYKOPETRA (Kountouris) | Lining of channels | 350 | - | - | 12 | - do - |
| 12 | AGRIDIA (Kalogiros) | Development of Springs and Lining of Channels | 350 | - | - | 10 | - do - |
| 13 | AYIOS THEODOROS | Intake and Distribution Works | 1,610 | - | - | 24 | - do - |
| 14 | LIMNATIS | Development of Springs and Distribution Works | 400 | - | 3 | 4 | New Irrigation. |
| 15 | PELENDRIA | - do - | 780 | - | 20 | 14 | Improved and New Irrigation. |
| 16 | K. AMIANDOS | - do - | 260 | - | 13 | 14 | - do - |
| 17 | YERMASOYIA (2ND STAGE) | Pumping Scheme and Distribution Works | 17,650 | - | - | 800 | - do - |
| | | Total | £49,790 | | | | |

Appendix 22.

ANTIFLOOD, RIVER TRAINING, DRAINAGE, RECHARGE SCHEMES.

| NO. | VILLAGE & NAME OF DIVISION | TYPE OF WORKS | MONEY SPENT IN 1964 | REMARKS |
|---|---|---|---|---|
| | CONTINUED FROM 1963 AND COMPLETED 1964 | | | |
| 1 | YERMASOYIA Limassol | River Control and Antiflood Works | £ 4,000 | |
| 2 | VOROKLINI Larnaca | Antiflood Works | 1,900 | |
| 3 | AY. NAPA Famagusta | Recharge Works (construction of small dams and spreading grounds) | 365 | |
| | SCHEMES UNDERTAKEN AND COMPLETED IN 1964 | | | |
| 4 | PHRENAROS | Recharge Scheme, small earth dams and spreading grounds | 12,000 | Works continued at the end of 1964. |
| 5 | PARALIMNI | Recharge Works (construction of recharge canal & spreading grounds) (Completion Stage) | 6,500 | |
| 6 | DHERINIA | Construction of Recharge Earth Dam of the Farangas River | 1,500 | |
| 7 | PATRIKI | LAND Reclamation & Drainage Works | 2,500 | |
| 8 | VITSADHA | River Training & Anti Erosion Weir | 3,000 | |
| 9 | MAMONIA | General Improvements to the conveyor system of Mamonia Chiftlik | 1,200 | |
| | | Total | £32,965 | |

## 18. POMOS - AY. MARINA - ARGAKA - OVGOS DAMS

By Y. Zambarloukos, Executive Engineer

### (a) POMOS DAM

This was another dam, together with Ayia Marina dam and Argaka-Magounda dam, the construction of which had to be abandoned early in 1964 due to the precarious situation in the Tylliria area.

The construction was carried out up to the beginning of 1964 by contractors, the Mediterranean Constructors. Work was resumed in June, 1964 for the completion of the dam by the Department. Work had to be suspended for a few weeks in August after the air attacks on the area. Work completed by the contractors included the tunnel, the main part of the embankment except for the top ten feet, more than half of the rip-rap and about 24,000 cu. yds of excavation for the spillway.

Work which still had to be completed after resumption of work, was the completion of the embankment, including side and toe channels and the rip-rap, inlet and outlet concrete works to the tunnel, the operating shaft, installation of the gate with its operating equipment, completion of the excavation of the spillway and concreting of the spillway wear and channel.

Grouting in the tunnel is necessary and a grouting blanket through the embankment will most probably be necessary but final decision on this will depend on the behaviour of the dam after its gate is closed.

A total of £139,000 has been spent for the construction of this dam out of which £41,980 in 1964.

The lining of canals also started in 1964 and a total of £9,000 was spent.

(b) AYIA MARINA DAM

This was a dam, the construction of which had to be abandoned early in 1964 due to the anomalous conditions in the area. The constructor as for Pomos dam were the Mediterranean Constructors.

Work was resumed by the Water Development Department in June, 1964 and as in the case of Pomos, it had to be suspended for a few weeks in August, after the air attacks in the area.

Work completed by the contractor was the tunnel, the main part of the embankment except for the top 17' - 0" and about two-thirds of the rip-rap. A large proportion of the excavations for the spillway was completed. Construction, which still had to be completed after resumption of work, was the completion of the embankment including side and toe channels and rip-rap, grouting and plastering of the tunnel, inlet and outlet works including protective walls where necessary and embedding in concrete of outlet pipe. Installation of operating gate in the tunnel, excavating and forming the spillway to the required dimensions, concreting of the spillway weir and lining channel where necessary.

Early in December the gate was closed and 15' - 6" of water was accumulated by the end of the year.

The total cost on the project up to the end of 1964 reached £78,420 out of which £29,800 were spent in 1964. On canals £2,000 were spent in 1964.

(c) ARGAKA-MAGOUNDA DAM

Construction for this dam had to stop early in 1964 due to the precarious situation created in the region after the disturbances.

The construction of this dam was undertaken by contractors, Mowlem Ridgway & Co., and when the work stopped, the embankment was already completed (though it was later decided to raise its height another 2' - 0') the hydraulic penstock was installed and excavation at the spillway entrance was started.

Although considerable work had still to be carried out, particularly on the spillway, it was possible to close the dam early in 1964. The water reached a height of 80' - 0' and 205 million gallons of water was accumulated and later used for irrigation. Work was resumed in June by the Department and the spillway weir and R.C. piers for foot-bridge has since been constructed, the excavation of the spillway route is progressing. The embankment was raised 2' - 0', the 15' pipe laid in the tunnel and grouting in the tunnel is progressing. The Argaka recharge scheme for Limni Mines was also completed.

A total of £263,810 was spent on this project out of which £13,120 in 1964.

(d) OVGOS DAM

The main construction work on this dam was completed in August, 1964, although work on the distribution system and certain minor works at the dam continued throughout the whole year.

The dam benefited from the heavy rains early in December and the maximum water level in the reservoir was 218' i.e. 2' - 0' below the spillway crest. The volume of water accumulated was 160 million gallons.

The level of the water dropped to 212' - 1" by the 31st of December. This was due to percolation of water through the gravel beds forming part of the reservoir basin and to a large extent this helped to recharge the underground water sources. The water level in the wells and boreholes of the surrounding area rose considerably but it is still too early to say up to what extent they have benefited.

Another probable effect of the dam was to cause the springs downstream of the dam to become active again with a total discharge of 2.5 cusecs which has been quite consistent. These springs existed before but because of the draught in later years and the more extensive use of water through wells and boreholes, practically caused them not to discharge any water for the last ten years.

The weir constructed upstream of the reservoir to divert the flow of saline water from entering the reservoir, worked satisfactorily and its usefulness was apparent when the flow of water in the river dropped to less than one cusec and its salinity increased considerably. The salinity of the water in the reservoir was kept low and varied from about 20 p.p.m. when the volume in the reservoir was at its maximum to about 80 p.p.m. at the end of December 1964.

The total cost of the dam by the end of 1964 reached £95,000 out of which £38,100 was spent in 1964.

On the lining of canals £1,430 was spent in 1964 out of the estimated cost of £40,000.

## 19. KITI AND KALOPANAYIOTIS DAMS

By T. Harmantas, Executive Engineer

### (a) KITI DAM

Kiti dam works had to stop on the 21st December, 1963, that is the date of the Turkish rebellion. The works have started again in February, 1964, with low output, due to the ubnormal political situation. Gradually the work reached its normal output and up to July the earth bank was completed by compacting 40,000 cubic yards of earth fill.

During this period the spillway weir was completed and most of the length of the spillway channel was constructed.

On the 14th of August the available amount of money (£120,000) was exhausted and the work was discontinued. An additional amount of £20,000 was allocated on 19th October and the construction started again by installing the gate of the tunnel and by continuing the construction of the spillway channel. During the year 1964 a quantity of 5,000 cubic yards of concrete have been poured.

The amount spent in 1964 is £55,000 which added to the £79,000 that was spent in 1963 makes a total amount of £134,000. The rest £6,000 will be spent in 1965 for the completion of the spillway channel, for land acquisition and as compensation. It is worth noting that the consultant's estimate for the same job was £216,000.

On the 11th of September the river discharged about 40 million gallons of water that flowed through the tunnel of the dam. From this quantity about 15 million gallons discharged into the sea and with the other 25 million gallons, about 1,000 donums of land were partly irrigated.

After the closing of the gate in December, a big flood occurred during which the dam was filled up to 10 inches below spillway level by 380 million gallons of water. The ground water resources of the area were

substantially recharged and the Larnaca chain-of-wells overflowed.

(b) KALOPANAYIOTIS DAM

Kalopanayiotis dam is being constructed on the Marathasa river about 2 miles downstream from Kalopanayiotis village on the road to Lefka. The investigations and planning for the dam was carried out by the Department whilst the design was prepared by "Howard & Humphreys", consulting Engineers of London and the construction was undertaken by our Department. A Resident Engineer from the consultants is supervising the work.

The dam was designed as an earth dam of a maximum height of 100 feet and is capable of storing 100 million gallons of water. The embankment consists of clay core in the middle and general fill on both sides with slopes 1:2.5 upstream and 1:2 downstream. The total quantity of fill material is 167,000 cubic yards that consists of 24,000 cubic yards of clay, 113,000 cubic yards of general fill, 16,000 cubic yards of filter material and 14,000 cubic yards of rock fill. A tunnel of 7 feet internal diameter and 330 feet long has been provided mainly for the diversion of the river, but it will also be used for desilting of the reservoir. A 12" diameter outlet pipe is embedded in the concrete of the tunnel, together with another 8' diameter pipe which will take the Lefka village water from upstream of the reservoir and discharge it downstream of the dam.

A coffer dam 20 feet high will be constructed for the river diversion.

Below the cut off trench, a grout curtain will be constructed.

A 60 feet wide shute spillway lined with 2,700 cubic yards of concrete, has been provided. The spillway will be founded on a 5 feet wide cut-off wall which will reach the sound rock at a maximum depth of 90 feet from the surface of the ground. In the wall will be placed 3" dia. grout pipes to grout the rock below the cut-off wall.

During 1964, a total amount of £7,700 was spent as from September when the work has started, on the following works:-

(a) Preparation of the site.
(b) Construction of access roads.
(c) Stripping the surface soil.
(d) Construction of the guard house, that will be used as offices for the period of construction.
(e) Excavation of 1,300 cu. yds of soil at the two faces of the tunnel.
(f) Excavation of the tunnel in rock, using blasting materials and supproting with timber supports where it was necessary. The total quantity of blasted rock is 800 cu. yds.

The main construction will take place during the year 1965, but the dam will be completed early in 1966.

The distribution system is scheduled to start in 1966 and is to command an area of about 700 donums of land.

## 20. AGROS AND LIOPETRI DAM

By J. Hadjigeorghiou, Executive Engineer

### (a) AGROS DAM

Agros dam is built on the uppermost reaches of Limnatis river, north west of Agros village.

The water available for storage is derived from the ¼ sq. mile catchment, two upstream springs and the surplus domestic water supply which comes from Troodos.

The original design by W.D.D. for this dam was of an earth fill type but on further explorations at the beginning of the construction period, a large quantity of gabbro rock and of good quality was made available and the design was altered.

It is of rock fill and earth fill type thus utilizing material available within 1 mile distance from the damsite and saving in the amount of fill. Clay for the cut off was obtained from the quarry at Khandria junction and filter material from the Lambadha-Mylos locality in Agros. Random fill material was obtained from the reservoir itself thus increasing the impounding capacity of the dam. The foundation of the dam had to be consolidated by means of grouting, because on excavation excessive cracking of the parent rock as well as evident flow of water through the foundation were observed. The grouting operations extended only along the cut off bottom and up half the reservoir depth on the left abutment of the dam. The construction period of the embankment as well as of the outlet works extended over 8 months in 1964. The height of the dam above river bed is 85 ft. length at crest is 580 ft. total fill 80,000 cu. yds including 15,000 cu. yds of rock . The spillway is 20 ft. wide of ogee crest design and can cater for a flood of 180 cusecs.

The dam can impound a capacity of 25 million gallons or 100,000 $m^3$ of water approximately. This will help irrigate 160 donums of fruit trees through 6,000 ft. of channels belonging to 150 small holders. The Agros dam

is one of the Government schemes in the Pitsilia district and it will help to:

(a) increase the low income of this area
(b) stop the constant flow of manpower to the big cities in search for jobs.

Its estimated cost is £50,000 including the distribution system.

By the end of 1964 £34,000 has been spent on this project.

(b) LIOPETRI DAM

This dam is being constructed on Potamos River, 2 miles south west of Liopetri village on the second half of 1964 with the purpose of replenishing by recharge the depleted aquifer in the area. The dam was planned and designed by W.D.D. It consists of an earth embankment of sandy silt material, an outlet pipe for desilting small quantities of silt and a 100 ft. wide spillway to cope with a maximum flood of 6,000 cusecs. The main fill 65,000 cu. yds compacted was obtained from the reservoir area and was found to possess a high impermeability when compacted. The water face of the dam was lined with 1 ft. of rip-rap, obtained from Xylophagou "Mouti" locality. The maximum height of the dam is 50 ft. and the length at crest of dam is 1,800 ft. maximum impounded capacity is 80 million gallons or 360,000 $m^3$ of water.

The total expenditure on this recharge scheme is envisaged to be £33,000.

In 1964 £17,000 was spent on this project.

## 21. MIA MILIA DAM

By K. Hassabis, Executive Engineer

By the end of 1963 the Mia Milia earth dam was substantially complete when the emergency situation necessitated the temporary suspension of construction. Work started again in the second quarter of 1964 and was completed in August 1964.

The main items constructed during 1964, were:-

(i) The side channel spillway with a concrete ogee-crest weir, 40 ft. wide, designed for taking the 100 year flood, estimated at 930 cusecs but with additional freeboard available to pass the 1,000 year flood estimated at 2,000 cusecs.

(ii) A stilling basin below the weir

(iii) Hand-placed rip-rap was placed on the upstream slope of the embankment for protection.

(iv) A steel pipeline 880 ft. long of 12" ø was laid from outlet valve chamber.

(v) 29,000 new earth irrigation channels were excavated and 100 irrigation ports installed.

The final cost of the project was £28,000 i.e. as estimated, of which £7,700 were spent in 1964.

By mid-December the dam was already full.

A small amount of leakage occurred at the right hand abutment (looking upstream), which was accompanied by sliding of unconsolidated spoil material at this location. As a temporary measure filter material was placed on the downstream side to prevent further sliding.

## 22. POLEMIDHIA DAM

By P. Stamatis, Executive Engineer

This is the largest dam constructed in Cyprus. It is being built on the Garyllis river, four miles from Limassol near Polemidhia village.

The site was selected by the Water Development Department and preliminary investigations were carried out to determine the feasibility of the dam. Energoprojekt Consulting Engineers of Beograd, Yugoslavia fimally designed the dam.

The construction of the dam was undertaken by Mowlem - Ridgway, of London, through a bilateral agreement involving finance facilities.

The grouting works were undertaken by Soil Mechanics Ltd., of London, in association with Messrs. Soletanche of Paris.

Due to the abnormal situation prevailing in Cyprus at the time of starting the work a cost plus method was accepted which is still continuing until negotiated rates can be introduced.

The purpose of the dam is to impound water to be used for surface irrigation, especially in the Zakaki area which is greatly affected by sea-intrusion. This is intended to replenish, indirectly, the Zakaki acquifer by reducing pumping through boreholes and wells, through surface irrigation from the dam and consequently stopping any further sea-intrusion in the area. There is a large area that can be irrigated from this dam in the Akrotiri peninsula but the water available can only suffice for about 3,000 donums of perennial crops.

### Description of Dam

The dam is an earthfill one, consisting of impervious thin clay core in the centre and two zones of filter material on either side of the clay core. The main body of the dam is made up of random material from river deposits upstream of the dam. The upstream slope is dressed up with stone rip-rap and the downstream slope is covered with 1'-0" of top-soil for seeding grass.

In the right abutment a 9' diameter concrete tunnel has been constructed to divert the river water during construction and to serve for desilting purposes in the future. Approximately in the middle of the tunnel, a vertical concrete shaft 9'-0" diameter is being constructed, for the installation and operation of a mechanically operated control gate. Below the tunnel a 15" diameter pipe has been laid, through which water will be supplied for irrigation. On the left abutment a concrete spillway is constructed for the diversion of flood waters when the reservoir is full.

A small house is to be built by the Water Development Department at a commanding spot near the dam, which will serve as a Guard House for the proper operation and maintenance of the project. It was not possible to build this house at the beginning of the job which could have served as a temporary office for the Resident Engineer and his staff during the construction period, because of blasting operations for the excavation of the spillway.

Design Data:-

| | | |
|---|---|---|
| 1. | Maximum height of dam .. .. | 119.00 ft. |
| 2. | Maximum depth of water in the reservoir (at spillway level) | 102.50 ft. |
| 3. | Capacity of reservoir .. .. | 750 million gallons |
| 4. | Surface Area of reservoir .. | 65 acres |
| 5. | Total volume of fill .. .. | 281,000 cu. yds |
| 6. | Upstream slope .. .. .. | 1:2 |
| 7. | Downstream slope .. .. | 1:2 (with two berms) |
| 8. | Maximum capacity of spillway .. | 20,000 cusecs |
| 9. | Catchment Area .. .. .. | 30 sq. miles |
| 10. | Average rainfall in catchment | 24 inches |
| 11. | Average annual run-off .. .. | 1,000 million gallons |

Construction:-

Work on the dam started on the 20th of April 1964, working at first one shift of 10 hours per day including Saturday. Later on it was found necessary to work two shifts of 8 hours each on filling works and three shifts of 8 hours each on the tunnel, in order to be able to complete the work to such stage so as to store water this year.

Some of the contractors' major equipment used for the excavation and filling works include: 2 No. 38 R.B., 2 No. 22 R.B., 3 No. D.8, 1 No. Traxcavator 977, 3 No. 600 cu. ft compressors, 5 No. 10 cu. yds A.E.C. Dump Trucks, 1 No. Grid roller, 2 No. Vibro rollers, Pneumatic road rippers, pneumatic hand drills etc.

The Water Development Department provided two sheep foot rollers and one Pneumatic roller. Locally hired machinery included traxcavators, bulldozers, lorries etc.

Blasting was used extensively for the excavation of the cut-off trench, spillway, tunnel and shaft.

The excavated material from the tunnel was removed by a small traxcavator, and from the shaft by a winch and skip. For concreting the tunnel two 14/10 concrete mixers and two concrete placers were used.

Excavation for the spillway started in October 1964.

Grouting

It is the first time that grouting to such a scale has been carried out in Cyprus.

Most of the grouting is on the mass of faulted sandstone blocks on the left river bank and some in the zone of thin bedded sandstone on the right river bank.

Drilling and grouting started on one shift of 10 hours per day, but now three shifts of 8 hours each are working, in order to complete the minimum amount of grouting required, before any water can be stored.

The grout mixture consists of cement, bentonite and screened clay, the proportions of which vary according to the geological strata and the grout consumption.

Two injectors are used for the pumping of the grout mixture.

The whole dam is scheduled to be completed in July 1965. The total expenditure on this project by the end of the year has reached £151,571.

This project is to be operated and controlled by Government and therefore no contribution has been paid by the beneficiaries, who will instead be asked to pay water rates according to the consumption they use.

## 23. MAVROKOLYMBOS DAM AND DISTRIBUTION

By A. Mavroudhis, Executive Engineer

A. General information on the project.

(i) Dam: Type: Earth dam
Height: 132 ft. above river bed
Capacity: 500 x $10^6$ gallons

| | | |
|---|---|---|
| Volume of excavations: | 30,000 c.yds | in foundations |
| | 144,000 " | in spillway |
| | 7,000 " | in tunnel |
| Total excavation | 181,000 c.yds | |
| Volume of fill | 350,000 c.yds | |
| Spillway capacity | 12,000 cusecs at 10 ft. head | |
| Outlet capacity (9 ft dia) | 3,600 cusecs at $\frac{2}{3}$ of max. water head. | |
| Capacity of the 16" draw-off pipe | 18 cusecs when head=0 | |
| Crest length | 600 ft. | |

(ii) Distribution system: This will cover an area of 4,000 donums situated within a strip along the coast between the Mavrokolymbos river and Ktima. Its dimensions are roughly 1 mile wide by 5 miles long and the water will be carried there by gravity, in channels. In addition to this there will be 250 donums about one mile upstream from the dam and 500 donums around the village Emba, to be irrigated by pumping.

(iii) Geology: The area at the dam site is made of typically metamorphic rock, mainly serpentine, in the shape of bulky brecciated masses, highly weathered and of low permeability. There is a mass of sedimentary limestone above the dam crest on the right abutment, while a hard pillow lava outcrop on the

right abutment near the downstream toe of the dam has produced a sharp bend in the route of the river. The main feature of the site is a tectonic trough fault along the left river bank. The catchment upstream from the dam is mostly made of sedimentary limestone, layered and faulted.

(iv) Pedology of the area to be irrigated: This area is of alluvial formation, the biggest part being terra rosa of variable depth lying on kafkalla.

(v) Meteorology: Average rainfall on the catchment of the river for the years 1908 to 1957 is 24.2 in. For the same period the average rainfall on the area to be covered by the distribution system was about 21 in. The climate is mild temperate.

(vi) Hydrology: Measurements of the river flow are available for 1962-63 only which had a high rainfall (31.9 in.) In this year the flow was found to be $610 \times 10^3$ gallons or 8.7% of the rainfall. However, no definite conclusions should be drawn from these short period measurements.

B. The main Contract

The planning and investigations for this dam were carried out by the Water Development Department in 1963 whilst the design of the dam was done by the Yugoslavian firm Energoprojekt according to the agreement between this firm and W.D.D. of the 7.11.1963 . The contract for the execution of the dam was awarded to the local construction Company CYBARCO Ltd., on 30th May 1964 and a notice to proceed with the work was finally issued to them on 23.6.64. The final contract price was raised by £15,000 to £204,915.444 after an alteration to the original programme was made. This change consisted of splitting the original programme (1st July 1964 to 15th March 1965) into two phases: a) The construction of the tunnel during 1st July 1964 to 31st October, 1964 and b) the construction of the dam and spillway during 15th April, 1965 to 15th November, 1965. This change was made imperative for safety reasons, due to the very late time at which construction could begin, the aim being to avoid having a low embankment during winter when floods may occur. The decision that the dam should start in 1964 was taken at a meeting at the Ministry of Finance on 19.6.1964.

The contractor moved in on the site with his camp equipment which he set up mostly on the right abutment (offices) and on the left abutment (stores) upstream from the dam. Both these sites are intended to be used as borrow areas for random fill and therefore the contractor was reminded in time that he will have to remove his camp in the second phase.

The excavation of the tunnel entrance and exit started simultaneously with bulldozers and traxcavators. No hard rock was found and no explosives were used. The face of the entrance into the tunnel has been shifted downstream by about 16 ft. to gain in crown thickness and to reach more solid material. From here on the excavations proceeded into the tunnel by explosives.

The rock along the line of the tunnel proved to be highly variable in soundness and degree of decomposition but in general it was found to be of low permeability. The work proceeded mostly in two shifts. The ceiling of the tunnel was supported for most of its length by steel supports at about 3 ft. between centres of consecutive supports, held in position by steel lagging. Timber was used as braces between the steel supports and the ceiling and as a protective roof against falling rock. Steel plates $\frac{3}{8}$" thick have been ordered by the contractors and will be used as ceiling instead of the timber which is used at present.

At the exit the ground was found to be fat clay. When the tunnel excavation at the exit reached about 22 ft. into the clay there occurred a collapse of the crown of the tunnel for all this length. The collapse may be due to several reasons, among which:

a) The fact that the contractor in his effort to remove the loose earth from the ground surface above the tunnel had scraped too much soil thus reducing the thickness of the tunnel crown.

b) The steel supports were not braced against the ceiling of the tunnel.

c) Explosives were used to excavate the clay, thus disturbing the layers above the tunnel.

The supports within the collapsed part were distorted and cannot be reused.

Two other collapses occurred within the tunnel but of minor extent. No accidents occurred except for a minor one of a Turkish labourer who was hit on the back by a falling stone, while leaning down.

After the collapse at the exit it was decided at the 3rd meeting to make surface excavation instead of the tunnel excavation, the extent of which was decided later by the Resident Engineer to be from station 0+570' up to the end, i.e. a length of about 53 ft.

It is thought that for most of the tunnel the supports will have to remain within the concrete lining as "permanent steel supports".

By the end of the year about 460 ft. of tunnel excavation was done, thus leaving about 100 ft. of excavation still to be done. This work has now stopped as the excavation has reached into clay. Work in the clay part should be resumed during January, or early February if the time schedule mentioned during the 5th meeting is to be adhered to.

The excavation in the shaft started at the end of November. By the end of the year it reached a depth of about 20 ft. by the use of breakers only and no blasting. The material excavated in the shaft is being dropped into the tunnel below through a 12" vertical borehole drilled on the axis of the shaft. From the tunnel it is carried away by a traxcavator and deposited near the intake for future use as embankment fill. Round supports are used for the whole depth of the shaft so far, as sound rock has not yet been reached.

During November a telephone was installed on the damsite at the request of W.D.D., in the name of the contractor.

By the last statement covering work upto the end of November a total of £18,172.359 has been paid to the contractor for work and materials on site worth £20,191.510 or 9.8% of the total contract price.

C. The permeability test was decided to be carried out during the second site meeting on the 6.10.1964. After considerable delays it was finally carried out in the river bed next to the right abutment. Here the foundation rock was proved to be highly impermeable down to a depth of about 72 ft. The highest value of seepage was 3.6 gallons per 12 ft. depth of borehole per 10 minutes at 10 atmospheres which was obtained at the depth of 30 ft. to 42 ft. The drilling machine was then carried to the left abutment where no test has yet been performed as the operator has abandoned work.

D. The 16" ϕ draw off pipes were supplied by tenders, invited on 28th July, 1964. On 12.9.64 the successful tenderer was given the contract and after a considerable delay the pipes arrived in Famagusta port from Israel on 27.11.64. 23 pieces, 20 ft. long are already on the site. The 2 hand operated slide valves are expected to be shipped from England on the 20th January, 1965.

E. The construction of the hydromechanical equipment was assigned, after international tenders were invited, to the Greek firm Drakos-Polemis. The final drawings have by now been inspected by Energoprojekt and approved after some modifications were made.

F. At the Permanent Guard house the roof is now being constructed. Some delays have occurred by the late arrival on the site of materials from the stores, and by the fact that the workers had to be used for repairing the road after heavy rains. The labour cost upto the end of the year reached about £400.

G. The access road from the main Ktima-Peyia road to the damsite was given to a private contractor, after tenders, on the 30.7.64. The road was ready for use by the middle of September. The contractor was finally paid off on 26.10.64 the cost being £2,144. As the biggest part of this road has been cut in completely decomposed rock some trouble has been experienced when the rains came (mud in the road and slides of the sides of the road). As a result an additional amount of about £100 has been spent for repairs, which included scraping and gravel surfacing of a small part, and cleaning of a major part of the road.

H. Distribution System: After inviting quotations on an international basis the W.D.D. awarded the design of the Mavrokolymbos distribution system to the Bulgarian firm Technoexportstroy of Sofia for the sum of £5,960. The agreement was signed on the 11.1.1965.

## 24. OPERATION AND MAINTENANCE OF DAMS

By Y. Zambarloukos, Executive Engineer

A start was made in 1964 as to the operation of dams controlled by the Government. This was in the case of the Argaka-Magounda dam which was closed at the beginning of 1964. As the closure took place at mid-winter the height of water rose 80 ft. (out of a total of 95 ft.) and about 205 million gallons of water was accumulated although the capacity of the reservoir is 270 million gallons. We tried to distribute this water as efficiently as possible but as the distribution system used was the existing one i.e. earth channels, a high percentage of water (40% was estimated) was wasted through losses.

Due to the draught in March 1964, the cereals badly needed irrigation and about 40 million gallons of water was allowed for this purpose to irrigate about 500 donums while the remaining water was used for early summer crops, irrigating about 600 donums mainly water melons, cucumbers and tomatoes.

On maintenance of dams £1,280 was spent. The Government contribution was £1,100 and the beneficiaries share £180. Although this expenditure was considerably less than the £5,000 approved in the estimates for 1964, this figure will rise substantially as more dams are being constructed. Further, due to the existing situation not all dams could possibly be inspected and repairs carried out where necessary.

Expenditure was distributed as follows:-

| | | |
|---|---|---|
| Ayios Loucas, Famagusta. Repairs to embankment | £ | 700 |
| Galini Dam. Repairs to gate and installing of grill | £ | 180 |
| Petra Dam. Repairs to gate and installing of grills | £ | 190 |
| Athalassa Dam. Repairs to embankment | £ | 50 |
| Mia Milea Dam and other minor works | £ | 160 |
| Total | £1,280 | |

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# DAMS IN CYPRUS

March 1965

Drg. No. AG/R9/1

## A. Dams constructed before 1962

| No. | NAME | TYPE | HT. | M.G. | YEAR |
|---|---|---|---|---|---|
| 1 | Lymbia | Masonry | 17 | 4 | 1945 |
| 2 | Lythrodhonda | " | 35 | 7.5 | 1945 |
| 3 | Kalokhorio (Kl.) | " | 30 | 18 | 1947 |
| 4 | Akrounda | " | 22 | 5 | 1947 |
| 5 | Galini | " | 36 | 5 | 1947 |
| 6 | Petra | " | 30 | 7 | 1948 |
| 7 | Petra | " | 30 | 5 | 1951 |
| 8 | Lythrodhonda | " | 34 | 7 | 1952 |
| 9 | Kafizes | " | 75 | 25 | 1953 |
| 10 | Ayios Loucas | Earth | 11 | 100 | 1955 |
| 11 | Gypsos | " | 11 | 22 | 1955 |
| 12 | Kandou | Masonry | 43 | 8 | 1956 |
| 13 | Peropedhi | Con. Grav. | 60 | 12 | 1956 |
| 14 | Pyrgos (Tyll.) | " | 60 | 30 | 1957 |
| 15 | Trimiklini | " | 105 | 75 | 1958 |
| 16 | Sotira | Earth | 25 | 10 | 1962 |
| 17 | Prodhromos | " | 20 | 25 | 1962 |
| 18 | Panayia (F) | " | 23 | 10 | 1962 |
| 19 | Morphou | " | 37 | 450 | 1962 |
| 20 | Lefka | Con. Grav. | 80 | 80 | 1962 |
| 21 | Geunyeli | Earth | 50 | 230 | 1962 |
| 22 | Ayios Yeorghios | " | 20 | 20 | 1962 |
| 23 | Athalassa | " | 42 | 178 | 1962 |
| 24 | Aloa | " | 15 | 4 | 1962 |

Total Storage Capacity 1334

HT. refers to height in ft. from foundation.
M.G. means capacity of water in million gallons.
YEAR. is the year of construction.

## B- 1963 Projects

| No. | NAME | TYPE | HT. | M.G. |
|---|---|---|---|---|
| 25 | Argaka-Magounda | Rockfill | 135 | 270 |
| 26 | Ayia Marina | " | 108 | 80 |
| 27 | Ayia Napa (7) | Earth | 27 | 12 |
| 28 | Psta Anti-Flood | " | 25 | 38 |
| 29 | Psta Recharge | " | 16 | 11 |
| 30 | Kanli Kevy | " | 63 | 245 |
| 31 | Mia Milea | " | 71 | 74 |
| 32 | Orgos | " | 52 | 186 |
| 33 | Pomos | Rockfill | 126 | 280 |
| 34 | Tremithios | Earth | 74 | 400 |
| 35 | Paralimni (45) | " | 15 | 25 |

Total Storage Capacity 1621

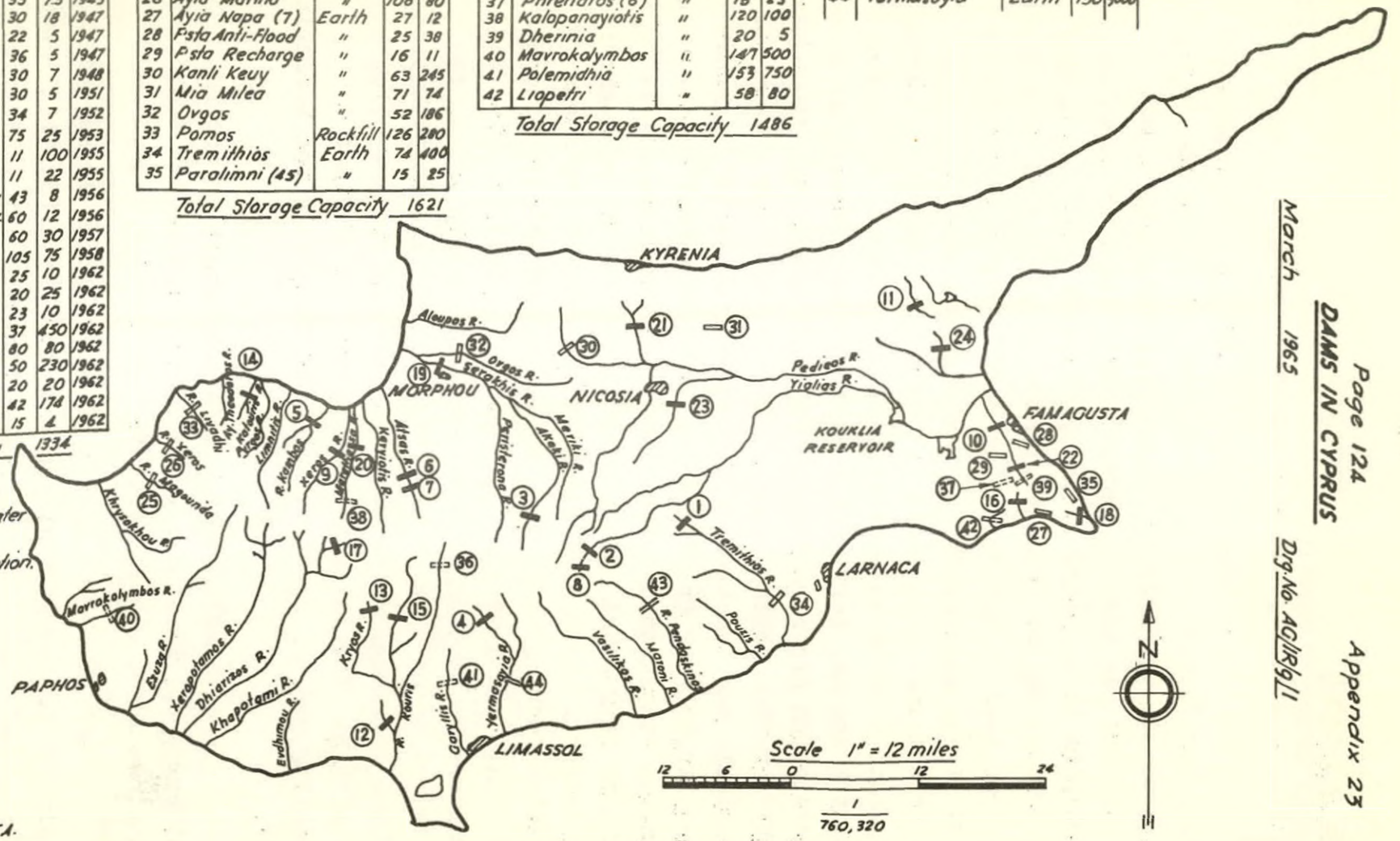
## C. 1964 Projects

| No. | NAME | TYPE | HT. | M.G. |
|---|---|---|---|---|
| 36 | Agros | Earth | 86 | 26 |
| 37 | Phrenaros (6) | " | 18 | 25 |
| 38 | Kalopanayiotis | " | 120 | 100 |
| 39 | Dherinia | " | 20 | 5 |
| 40 | Mavrokolymbos | " | 147 | 500 |
| 41 | Polemidhia | " | 153 | 750 |
| 42 | Liopetri | " | 58 | 80 |

Total Storage Capacity 1486

## D- 1965 Projects

| No. | NAME | TYPE | HT. | M.G. |
|---|---|---|---|---|
| 43 | Lefkara | Con. Grav. | 128 | 320 |
| 44 | Yermasoyia | Earth | 150 | 3000 |




Drawn by: C. Hadjiloizou. T.A.

## 25. THE WORKSHOPS

by A. Karoglanian, Superintendent of Works.

The first three months of 1964 the Department of Water Development had no Workshops facilities due to the Turkish disturbances, the permanent Workshops of the Department has been abandoned completely with Workshop Machinery tools which is in the Turkish sector. As the Department had to proceed with the projects all over Cyprus and the loss of the Workshops would have greatly affected most of the Development projects, a new Workshops had to be organized. Thus a new site has been allotted to this Department which is near the Central Stores. This area is about 9 donums, half of the site is open storage and is used for storing pipes, drilling tools and moulds and the other half for the Workshop sheds. As the Workshops labour was available the erection of new sheds took about one month for a 12,308 sq. ft. Workshops accommodation. In the meantime we continued on attending the maintenance of all Departmental Plant and in addition served the Geological Department. Also work continued on building of forms for concrete works, carpentry, the supply of precast concrete products, the installation of pumping plant, repairs and maintenance of Town and Village Water Supply plant, the fabrication of special pipe connections, the installation of dam gates and maintenance on existing ones, cutting and bending steel reinforcement, perforation of pipes and drilling casing, electrowelding drilling bits for boreholes etc.

The Workshops and Stores accommodation include Fitters shop, Plant maintenance bay, Blacksmiths and Electrowelders shops, Carpentry and Casting shop.

80% of the employees of Workshop and Stores are employed for development projects such as irrigation schemes, Village and Town Water Supplies, Hydrological Works and drilling, and 20% are employed for the maintenance of Plant and Tools.

In 1964 machinery to a value of £28,000 was bought for the needs of the Department such as concrete Mixers, Vibrators, Compressors, Concrete Placer etc.

A list of the chief items of Plant now on charge is given in appendix 24. Other plant is hired from contractors as required.

Pumping plants were installed by the Workshops for 39 Village Water Supplies and for 3 Irrigation Schemes.

Appendix 24.

## LIST OF MECHANICAL PLANT AS ON 31/12/64

| | No. | In Turkish Hands |
|---|---|---|
| Ruston Bucyrus Drilling rigs 22W .. | 14 | 3 |
| Ruston Bucyrus Drilling rigs 60RL .. | 1 | |
| Water Dev. Department (1959) drilling rigs | 1 | |
| Cheshire earth boring machine .. .. | 1 | 1 |
| Allen Trencher 12" - 21' .. .. | 2 | |
| Avelling-Barford Trencher .. .. | 1 | 1 |
| Caterpillar D8 .. .. .. | 2 | |
| Caterpillar Traxcavators 955 .. .. | 4 | |
| Caterpillar Traxcavator HT4 .. .. | 1 | 1 |
| Caterpillar Bulldozer .. .. | 1 | |
| International Bulldozer .. .. | 1 | |
| Ruston Bucyrus Excavator RB10 .. .. | 1 | |
| Ruston Bucyrus Excavator RB19 .. .. | 1 | |
| Compressors .. .. .. | 20 | 4 |
| Morrison diesel alternator on trailer .. | 3 | |
| Electrosubmersible test pumps .. .. | 10 | |
| Turbine deep-well test pumping units .. | 2 | |
| Plunger deep-well test pumping units .. | 2 | |
| Centrifugal pumping units .. .. | 4 | |
| Portable works pumps .. .. | 18 | 12 |
| Sheepfoot rollers .. .. .. | 26 | 10 |
| Cranes .. .. .. .. | 2 | 1 |
| Hoists .. .. .. .. | 3 | 1 |
| Concrete mixers .. .. .. | 54 | 12 |
| Vibrators .. .. .. .. | 50 | 13 |
| Austin Countryman Vans .. .. | 4 | 4 |
| Land Rovers .. .. .. | 28 | 4 |
| Fordson Lorry 3 ton .. .. .. | 1 | 1 |
| Thornycroft Tractive Unit for Low Loader | 1 | |
| Dumpers .. .. .. .. | 3 | 1 |
| Bray Loader .. .. .. | 1 | |
| Vibrating Rollers .. .. .. | 4 | 2 |
| 5 ton diesel lorry .. .. .. | 1 | 1 |
| Soil compactors .. .. .. | 6 | 3 |
| Lorry Mounted Portable 3 TON Borehole pump cranes .. .. .. .. | 4 | |
| Scraper .. .. .. .. | 1 | 1 |

| | No. | In Turkish Hands |
|---|---|---|
| Allis Chalmers Shovel 150D .. .. | 1 | |
| Allis Chalmers Bulldozer .. .. | 2 | |
| Excavator Smith 3/4 Cu. Yd. .. .. | 2 | |
| Rubber Tyred Compaction Rollers .. | 2 | 1 |
| Core Drill 200 ft. Depth .. .. | 1 | |
| Concrete Grouting machine .. .. | 1 | 1 |
| Grouting drill Pneumatic 150 ft. .. | 1 | 1 |
| Sludge Pump Pneumatic .. .. | 6 | 1 |
| WORKSHOP PLANT:- | | |
| Lathes .. .. .. .. | 4 | 4 |
| Shaping machine .. .. .. | 1 | 1 |
| Screwing machine .. .. .. | 1 | 1 |
| Drilling machine .. .. .. | 6 | 3 |
| Planning Timber Machine .. .. | 2 | 1 |
| Bandsaw timber .. .. .. | 2 | 1 |
| Bar Bender .. .. .. | 2 | 1 |
| Bar Cutter .. .. .. | 2 | 1 |
| Electric Welders .. .. .. | 10 | 5 |
| Forges .. .. .. .. | 5 | 3 |
| Pipe slotting machine oxy-acetylene .. | 1 | 1 |
| Vibrating table .. .. .. | 1 | 1 |
| Water Meter Testing Plant .. .. | 1 | 1 |
| Concrete block making machine .. .. | 2 | 2 |
| Compressor air (Tecalemit) .. .. | 2 | 1 |
| Milling machine .. .. .. | 1 | 1 |
| Grinding machine .. .. .. | 3 | 2 |
| Hack-saw Electrical .. .. .. | 3 | 1 |
| Concrete testing machine .. .. | 1 | |
| Slotting Machine .. .. .. | 2 | 2 |
| Electrowelding machine .. .. | 1 | 1 |
| Steel cutting machine (high speed) .. | 1 | 1 |

Appendix 25.

## Important Reports issued by the Department in 1964.

1. Improvement of Morphou Aquifer (Avant Project) — 30.3.64
   by Mr. Branko Milinusic, Senior Irrigation Engineer of FAO.

2. Some Notes on a Masterplan for the Development of Cyprus Water Resources — 12.5.64
   by Mr. P. de Gruyter, Director.

3. Instructions for Analytical Calculation of Areas — 31.5.64
   by Mr. Branko Milinusic, Senior Irrigation Engineer of FAO.

4. The Rainfall and Runoff of Cyprus — July, 1964
   by Mr. N. Chr. Toufexis, Superintendent of Works.

5. Lining of the Irrigation Channels in the Area of Morphou and Khrysiliou Village — September, 1964
   by Mr. Branko Milinusic, Senior Irrigation Engineer of FAO.

6. Water Balance of Western Mesaoria Final Report by French Mission (S.C.E.T.)

7. The Springs of Cyprus — December, 1964
   by Mr. N. Chr. Toufexis, Superintendent of Works.

8. A Note on Cyprus Water Resources and Development — January, 1965
   by Mr. C. A. C. Konteatis.

Mr. S. W. Hsu, United Nations Dam Expert, on assignment with the Water Development Department, issued 4 quarterly reports during the year, on the progress of dams in Cyprus.

LIST OF SENIOR STAFF EMPLOYED IN THE DEPARTMENT

| Ser. No. | Name | Appointment | Qualifications |
|---|---|---|---|
| 1 | C. A. C. Konteatis | Acting Head of Dept. | B.Sc.(Eng.) A.M.I.C.E. A.M.I.W.E., A.M.I.E.T. (Archit.) |
| 2 | Haralambos Karakannas | Engineer Hydrologist | M.A.C.C.E. M.R.S.I., M.I.P.H.E. |
| 3 | Kyprianos C. Hassabis | Executive Engineer | B.Sc.(Eng.) Grad. I.C.E. Stud. I.W.E. |
| 4 | Panayiotis Stamatis | " | A.M.I.C.E., A.M.I.W.E. Higher National Certif. in Civ. Eng. Ordinary National Certif. in Mechanical Eng. |
| 5 | Nicolaos C. Ioannides | " | B.Sc.(Eng.) (London) Grad. I.C.E., A.W.P. DENSPM (Photogeologie) M.S.I.C.F. MSGF |
| 6 | Andreas Y. Mavroudis | " | B.Sc.(Eng.) (Rand.) Grad. M.I.S.A.C.E. |
| 7 | John Zambarloukos | " | B.Sc.(Eng.) Un. of London |
| 8 | Tefkros Harmantas | " | Diploma of Metsovion Polytechnic School of Athens in Civ. Eng. |
| 9 | Haralambos Christofides | " | Diploma of Metsovion Polytechnic School of Athens in Civ. Eng. |
| 10 | Christodoulos Christodoulou | " | Diploma of Metsovion Polytechnic School of Athens in Civ. Eng. |
| 11 | Christos Marcoullis | " | Diploma of Metsovion Polytechnic School of Athens in Civ. Eng. |
| 12 | John Hji Georghiou | " | On contract. B.Sc. (Civ. Eng.) A.M.I.C.E. A.M.I.W.E. |
| 13 | Panos Pantelides | Supt. of Works | |
| 14 | Antranik Karoglanian | " | |
| 15 | Nicos Toufexis | " | |
| 16 | Georghios Haralambous | Senior Inspector of Works | |
| 17 | Neophytos Yiannakou | " | |
| 18 | Samuel Giragosian | " | |
| 19 | A. F. Butler | " | |
| 20 | Armand Josephin | " | |
| 21 | Ioannis Serghides | " | |
| 22 | Costas Hoplaros | Admin. Off. Grade I | c.rr., g.oo., f.i., s.ll., t.o. |
| 23 | Andreas Hji Kallis | Accounting Officer | c.rr., g.oo., f.i., h.a. |
| 24 | Chr. P. Loucaides | Chief Clerk | c.rr., g.oo., f.i., t.o. |