MINISTRY OF INDUSTRY

BANGKOK, THAILAND

DEPARTMENT OF SCIENCE

11th REPORT

FROM 1941 TO 1942

FORWORD

In the 10th report of the Department of Science I have mentioned the fact that there remained to be published a number of reports from 1941 onwards. I am now presenting the 11th volume covering the activities of the Department during 1941 and 1942 which were under the directorship of Dr. Prachuab Bunnag. The collection and editing of materials appearing in this report was done after Dr. Prachuab Bunnag had been appointed Deputy Minister of Public Health.

During the period covered by the report there were two important changes which should be mentioned here :

The transfer of the Division of Pharmacy to the newly created Department of Medical Science under the Ministry of Public Health in March 1942.

The transfer of the Division of Agricultural Science to the Department of Agriculture under the Ministry of Agriculture in June 1942.

Accordingly the work of these two Divisions can not be included in this report.

Dr. Charng Ratanarat
Director-General.

STAFF

December 1942

Director-General

Prachuab Bunnag, Dr. phil. chem.

OFFICE OF THE SECRETARY OF THE DEPARTMENT

Assistant Director-General. Aree Supol, B.Sc.

Correspondence Section

Head of Section. Singto Ratanakasikara.
Assistant. Ong Thadasih.

Science Library Section

Librarian. Pue Rochanapurananda, B.S. (Chem.), Dip. Ind. Chem.

Accounts Section

Head of Section. Siri Juvidya, B.S.C.

Stores Section

Head of Section. Siri Suvanapathma.

SCHOOL OF PRACTICAL CHEMISTRY

Director. Prachuab Bunnag, Dr. phil. chem.
Assistant. Pue Rochanapurananda, B.S. (Chem.), Dip. Ind. Chem.
Instructor. Miss Proesiri Bhekanandhana, B.A.
Instructor. Mrs. Pathum Therawatana, B. Sc.

DIVISION OF CHEMISTRY

Senior Chemist. Luang Vichien Dhatukarn, L. ès Sc., I.C. (Poitiers).
Medical officer. Siri Tevayananda, M.B., Dip. Pharm.

Forensic Chemistry Section

Chemist. Chiad Abhaivongse, Dip. Pharm.
Medical officer. 2nd/Lieut. Thon Charusorn, M.B.
Chemist. Prem Banijpol, B. Sc.

Metallurgy Section

Chemist. Vongse Naewbanij, A.A.
Chemist. Miss Kruang Punyasingha, B.S. (Chem.)
Assistant Chemist. Bumpen Savavasu, B. Sc.
Assistant Chemist. Chom Sriamphai.

Opium Dross Control Section

Chemist. Thongkham Milindalek, Dip. Pharm.
Assistant Chemist. Chinda Bunyamit.
Assistant Chemist. Chamnong Pugglanandana.

Water Analysis Section

Chemist. Samroeng Vimuktanandana, B.S. (Chem.)
Assistant Chemist. Miss Tiraporn Phativatna

Fuel Section

Chemist. Banbota Sudhikam, B.S. (Chem.)
Assistant Chemist. Chong Bunnag.

General Analysis Section

Assistant Chemist. Miss Bun Lom Khachenchai, B.Sc.
Assistant Chemist. Pravat Isarankura Na Ayuthya, Dip. Ed.
Assistant Chemist. Miss Snithlaksana Sinadyodharaksa, B. Sc.
Assistant Chemist. Chalad Virayodhin.
Assistant Chemist. Miss Charoon Phalajivin, Dip. Pharm.

DIVISION OF INDUSTRIAL CHEMISTRY

Senior Chemist. Sangar Sharasuvana, C.D.A. (Hons.)
Chemist. Miss Chomchai Semorabunya, B.S.

Ceramics Section

Chemist. Manoon Prachankhadee Sc. B. Chem.
Chemist. Suebsukdi Punyaupaphat, Dip. Ed.

Foods Section

Chemist. Yos Bunnag, M.Sc., A.R.C.S., D.I.C.
Chemist. Mrs. Prabhanta Panphatana, B.Sc.
Chemist. Prateep Prateepasen, B.S.S.T.
Assistant Chemist. Miss Ratsamiepen Siribaed Bisudhi, B.S.E.
Assistant Chemist. Puan Proysuwana.

Fermentation Section

Assistant Chemist. M.L. Chaweepongse Rongsong, B.S.E.
Assistant Chemist. Chul Kanchanalaksana, Dip. Pharm.
Assistant Chemist. Choosri Eam-Udom.

Minerals and Ores Section

Chemist. Mrs. Skul Bhodhiprasât, B.Sc.
Assistant Chemist. Miss Poonsab Paulpantin.
Assistant Chemist. Klow Dejdamrong.

DIVISION OF INDUSTRIAL RESEARCH

Senior Chemist Vacant.

Physics Section

Assistant Chemist. M.L. Anong Nila-Ubol, B.Sc
Assistant Chemist. Parl Na Pombejra, B.Sc.
Assistant Chemist. Lau Lauhabandhu, Dip. Ed.

Strength of Material Testing Section

Chemist. Vacant.

Workshop Section

Assistant Machinist. Bunsom Saisanit.
Assistant Machinist. Pud Phakdhivichitr.

Industrial Process Testing Section

Assistant Chemist. Miss Noi Sucharitakul, B.Sc.
Assistant. Chemist. Miss Prayat Chandravekin, B.Sc.

APPOINTMENT

Yos Bunnag *June 1, 1941:* as
Chemist,
Division of Industrial Chemistry.

Parl Na Pombejra *April 1, 1941:* as
Assistant Chemist,
Division of Industrial Chemistry.

Mrs. Pathum Therawatana *April 18, 1941:* as
Assistant Chemist,
School of Practical Chemistry.

Bambhen Savavasu *April 18, 1941:* as
Assistant Chemist,
Division of Chemistry.

Miss Noi Sucharitakul *April 18, 1941:* as
Assistant Chemist,
Division of Agriculture. *November 1, 1942* Transferred to
Division of Industrial Research.

Miss Prayat Chandravekin *April 18, 1941:* as
Assistant Chemist,
Division of Agriculture. *November 1, 1942* Transferred to
Division of Industrial Research.

Miss Ratsamiepen Siribhaed Bisudhi *January 1, 1942:* as
Assistant Chemist,
Division of Industrial Chemistry.

Miss Kruang Punyasingha *January 1, 1942:* as
Assistant Chemist,
Division of Chemistry.

Pud Bhakdivichitr *December 14, 1942*
Division of Industrial Research
(Transferred from Royal State Railways Department)

Officials Who have Left the Department of Science

1. Dr. Toa Labanukrom, Director-General, died August 27, 1941.
2. Phra Krasarp Bhibhark, Assistant Director-General, retired on pension September 1, 1941.
3. Miss Somnuk Vongsratana, Assistant Chemist, Division of Chemistry, resigned January 1, 1941.
4. Sommart Malayman, Assistant Chemist, Division of Industrial Chemistry, resigned January 1, 1941.
5. Kapan Lauhabandhu, Assistant Chemist, Division of Industrial Chemistry, resigned January 1, 1941.
6. Ua Rasmithat, Assistant Chemist, Division of Chemistry, resigned January 14, 1941.
7. Kliau Bunnag, Chemist, Division of Chemistry, transferred to Department of Industrial Promotion, April 1, 1942.
8. Banbhot Savavasu, Assistant Chemist, Division of Chemistry, transferred to Department of Co-operation, November 1, 1942.
9. Sa-Nga Ruenvongsa, Assistant, Accounts Section, transferred to Department of Internal Commerce, November 1. 1942.

Special Missions Abroad

1. Aree Supol went to the Federated Malay States on the 8th of January 1941 to observe the dismantling of the Alcohol Plant which the government purchased through Messrs. Henry Waugh Co. Ltd. The plant will be reassembled at Ayuthya.
2. Pue Rochanapurananda went to Japan to purchase machinery for manufacturing caustic soda. He left on the 19th June 1942 and returned on 27th August of the same year.

Official Tours up Country

1. Suebsukdi Punyaupaphat went to Nondaburi to inspect loca production of earthen-wares and bricks, on the 17th January 1941.

2. Chiad Abhaivongse inspected Chinchona and Tobacco plantations in Chiengmai from 2nd to 19th March 1941.

3. Dr. Toa Labanukrom and Banbhot Savavasu visited Salt Cooperative Communities at Samud Sakorn from 13th to 15th April 1941.

4. Miss Snithlaksana Sinadyodharaksa visited Chiengmai and Lam boon, 28th May to 12th June 1941, inspecting native dyeing centres

5. Suebsukdi Punyaupaphat toured Lampang, Chiengmai, Utradit and Sukothai from 6th May to 14th June 1941, visiting ceramics, making communities and surveying soils suitable for ceramics industry.

Special Duty

Dr. Toa Labanukrom :	Director-General.
	Technical Adviser to the Department of Land and Mines.
Dr. Prachuab Bunnag :	Member of the Committee for Organization of State-Sponsored Industries.
	Member of the Committee for Supervision of National Industries.
	Chairman of the Sub-Committee for Provision of a Caustic-Soda Plant. Vice-Chairman of the Sub-Committee on Chemical Industries.
	Chairman of the Sub-Committee for Manufacture of Phosphorus and Potassium Chlorate.
	Chairman of the Sub-Committee for Estimation of Electric Power for Chemical and Pharmaceutical Industries.

Member of the Board of Directors of the Government Pharmaceutical Plant.

Member of the Committee for Promotion of a Match Industry.

Aree Supol :

Lecturer in the Faculty of Pharmacy, College of Medicine.

Thai Representative for the Dismantling of the purchased Alcohol Plant in the Federated Malay States.

Member of the Committee for Organization of State-sponsored Industries.

Member of the Sub-Committee for Provision of a Caustic-Soda Plant.

Member of the Sub-Committee for Building of a Wood Destructive Distillation Plant.

Member of the Sub-Committee for Manufacture of Phosphorus and Potassium chlorate.

Chairman of the Committee for Promotion of the Glass Industry.

Chairman of the Committee for Promotion of the Alcohol Industry.

Chairman of the Committee for Manufacture of Tannin.

Member of the Sub-Committee for Glass Industry Research.

Member of the Sub-Committee for Estimation of Electric Power for Chemical and Pharmaceutical Industries.

	Member of the Committee for Chemical Industries.
	Member of the Committee for Distillation of Petrol from Para-Rubber.
	Member of the Committee for Anti-Malarial Campaign.
	Member of the Committee for Air Raid Precautions.
	Member of the Committee for Tobacco Industry.
	Member of the Board of Directors, Government Distilleries.
Yos Bunnag :	Member of the Committee for Chemical Industries.
Pue Rochanapurananda :	Secretary of the Committee for Organization of State-sponsored Industries.
	Assistant Secretary of the Committee for Chemical Industries.
	Secretary of the Sub-Committee for Purchase of Materials for Caustic-Soda Plant.
	Secretary of the Sub-Committee for Estimation of Electric Power for Chemical and Pharmaceutical Industries.
	Member of the Sub-Committee for Provision of a Caustic-Soda Plant.
	Member of the Sub-Committee for Manufacture of Phosphoru and Potassium Chlorate.

	Representative of the Royal Thai Air Force for the Purchase of Raw Materials in Japan.
	Representative of the Department in the Committee for Promotion of Coconut Plantations.
Pravat Isarankura Na Ayuthya :	Secretary of the Committee for Promotion of Alcohol Industry. Secretary of the Sub-Committee for Technical Development of Wood Distillation Industry.
	Secretary of the Sub-Committee for Manufacture of Tannin.
	Acting Secretary of the Sub-Committee for Provision of a Caustic-Soda Plant.
	Acting Secretary of the Sub-Committee for Manufacture of Phosphorus and Potassium chlorate.
	Acting Secretary of the Sub-Committee for Estimation of Electric Power for Chemical and Pharmaceutical Industries.
Pradip Pradipasen :	Member of the Committee for Promotion of Sugar Industry.
Prem Bhanijpol :	Member of the Committee for Promotion of Soap Industry.
Manoon Prachankadee :	Member of the Committee for Promotion of Ceramics Industry.
Suebsukdi Punyaupaphat :	Member of the Committee for Promotion of Ceramics Industry.
Miss Ratsamiepen Siribaed Bisudhi :	Member of the Committee for Promotion of food.

	Member of the Committee for Promotion of Preserved Food Industry.
M.L. Chaweepongse Rongsong	Member of the Committee for Promotion of Preserved Food Industry.
Vongse Naewbhanij :	Member of the Committee for Promotion of the Non-Ferrous Metals Industry.
	Member of the Committee for the Tin Smelting Industry.

GENERAL REVIEW

During the period covered by this report many important events and changes which directly concerned the Department of Science should be mentioned here. The most unfortunate one was the untimely demise of the late Director-General, Dr. Toa Labanukrom whose ceaseless effort and industry were responsible for the establishment of this Department as a National Institution. A brief biography of Dr. Toa Labanukrom has already been given in the 10th report of the Department. Dr. Prachuab Bunnag, who had been until then the Chief of the Division of Pharmacy, was appointed the Director-General in succession to the late Dr. Toa Labanukrom on October 11, 1941.

After the outbreak of the East Asia Conflict the government created three new ministries, namely, the Ministry of Public Health, the Ministry of Commerce and the Ministry of Industry. The latter two were formed by dividing up the former Ministry of Economic Affairs. As the result the Department of Science became attached to the Ministry of Industry and at the same time the Division of Pharmacy was transferred to the Ministry of Public Health and the Division of Agricultural Science to theMinistry of Agriculture.

To compensate for the loss mentioned, the Department of Science set up a new Division of Industrial Research which consisted of four sections namely Physics, Strength of Materials Testing, Workshop, and Industrial Process Testing Sections.

The former Division of Industrial Chemistry, however, retained only 4 sections, namely Ceramics, Food, Alcoholic Beverages and Mineral Sections.

The transfer of the Division of Pharmacy and Agricultural Science to other Ministries included both staffs and fully equiped laboratories, consequently the Department of Science had to face the loss of trained personnel, limitation of working space as well as reduction of equipments.

The work of the Department during this period is summarized and tabulated below. The work of the three preceeding years is also shown for comparison.

	Number of Samples				
	1938	1939	1940 (9 months)	1941	1942
Total Samples	9,093	6,291	5,897	12,314	10,424
Opium Dross	2,619	1,437	994	1,008	511
Bronzes	2,162	541	252	5,970	5,009
Miscellaneous	4,311	4,413	4,651	5,336	3,088

Towards the end of 1942 there were 52 civil servants (from the 3rd grade upwards) working in the Department, nine of whom were newly appointed. The total number showing a decrease of 16 as compared with that at the end of 1940. Out of the 52 officials, 13 were assigned special services. However inspite of such handicaps, the Department managed to carry on its normal routine as well as other special activities namely, the publishing of the Science Magazine and Thai Science Bulletin, the broadcasting of scientific talks, and the training of technicians.

THE LIBRARY

The Library, formerly a part of the Correspondence and Library Section, was growing so fast that in 1940 it was found necessary to form it as a separate section. In the following year its expansion was hindered by the Japanese occupation of Thailand and the usual exchange of publications with foreign libraries came to an end. In the meantime Miss Proesiri Bhekanandhana and her assistants took the opportunity to rearrange and to re-label books according to Dewey's Library System.

The total number of books at the end of 1942 showed a substantial increase when compared with that at the end of 1940.

	Total number at the end of year	
	1940	1942
Scientific textbooks	794	2558
Scientific documents	655	1807
Scientific journals, periodicals etc. (bound vols.)	499	772
Miscellaneous documents	179	681
Miscellaneous journals, periodicals etc.	19	15

The decrease in the last item was due to the fact that many Thai publications were discontinued during the Japanese occupation. The substantial increase in textbooks and documents was partly due to the kindness of Madame Nian Labanukrom, mother of the late Director-General who donated to this department the entire contents of Dr. Toa Labanukrom's private library.

It is the policy of this department to welcome scientists and students to make use of its library. It has been found that quite a number of lecturers and students of our universities as well as officials from other departments have made full use of our library.

The Science Magazine

During the difficult period of the Japanese occupation the Department managed to publish the vernacular "Vidayasastra" as usual.

The staff of this publication for the year 1941 and 1942 were as follows :—

Editor	—	Pue Rochanapurananda.
Business manager	—	Singto Ratanakasikara
Treasurer	—	Siri Juvidya.
Advertiser	—	Siri Suvanapathma.

Public interest in this magazine increased noticeably. The fact that foreign imports were cut down to a minimum and prices of commodities consequently increased by leaps and bounds, home-made versions of many imported necessities began to appear in the market and the magazine staff was almost overwhelmed by inquiries on the methods of producing various articles.

The Thai Science Bulletin

To begin with, the Thai Science Bulletin was published every three months, but due to unforeseen difficulties, it was found possible to issue only 3 numbers a year. By the end of 1942 only 6 numbers of the Thai Science Bulletin were available for distribution.

Complimentary copies of this bulletin were sent to 452 libraries and scientific institutions of 29 foreign countries. Most of the recipients sent the Department their publications in exchange.

Since the outbreak of the South East Asia conflict, only 22 exchange publications reached this Department.

The editor of this bulletin, Pue Rochanapurananda wished to make known that the aim of this publication is to report the scientific progress in Thailand as a whole and is not restricted solely to the work of the Department. He was confident that scientific workers in this country send in reports of their work so that they could be made known to similar workers in other countries.

Staff Lectures.

Lectures by members of the staff of this Department already mentioned in the previous report were continued as before. During the years 1941–1942 four such lectures were arranged :—

1. Salt and Salt Industry in the East, by Banbhot Savavasu.
2. Simple Photomicrography with a Movie-Camera, by Adolf Schaller.
3. Mineral Oil Industry in Thailand, by Banbota Sudhikam.
4. Sugar Technology. by Pradip Pradipasen

The last mentioned lecture was the 29th of this series.

After the Japanese occupation, it was found necessary to discontinue these lectures because a large portion of the Department's Staff had been temporarily transferred to other government departments.

It was hoped that these lectures would be resumed as soon as peaceful conditions again prevail.

Science Broadcasts

In order to overcome the shortage of many essential articles during the war, the Department started a series of Science Broadcasts which consisted of practical instructions simple enough for the layman to understand and to follow in the preparation of certain articles necessary for everyday use.

During the period covered by this report 6 such broadcasts were made :—

1. Soap-making from Wood Ashes and Coconut Oil, by Prem Bhanijbol.
2. Extraction of Caustic Lye from Wood Ashes, by Prem Bhanijbol.
3. Some Dishes prepared from Siamese Fruits, by M.L. Chaweepongse Rongsong.
4. Simple Methods for Egg and Vegetable Preservation, by M.L. Chaweepongse Rongsong.
5. Dye from Laundry Blue and Dyeing with Laundry Blue, by Miss Snithlaksana Sinadyodharaksa.
6. Khakhi Dye from Betel Nut and Kaelae Bark, by Miss Snithlaksana Sinadyodharaksa.

These broadcasts were quite successful and a large number of people came to the Department or sent for more detailed instructions. Many brought problems concerning the manufacture of certain goods and the Department was only too happy to give advice.

THE CERTIFICATION OF LOCALLY MANUFACTURED PRODUCTS

As recorded in the 10th report, the official approval of merchandise by this Department was started in 1939 and carried on until this date.

In 1941 there were 38 samples sent in for official approval, of which only 25 were certified. In 1942 there were 18 samples sent in for the same purpose and the Department approved only 5 of them.

The official approval of merchandise holds good for one year only and must be renewed in the event that the holder wishes to continue advertising the merchandise as having been officially approved. Each renewal must be accompanied by a re-analysis.

The fact that merchandise sent in for approval dropped from 38 samples in 1941 to 18 samples in 1942 was due to a misunderstanding. Most certificate holders assumed that the certification held good indefinitely, and did not trouble to renew the same. Moreover since the sales of approved merchandise usually rose steadily, some manufacturers did not find it necessary to have a renewal.

The following is the list of merchandise approved by this Department during 1941 :-

1. Vichitr Tooth Powder, Vichitrosoth Work.
2. Printed Fabrics (Ramasura & Mekhala Brand), Silpa-Thai Factory.
3. Distilled Water, Krungdeb Distillers.
4. Elephant Brand Plaster of Modelling, Pradit Patimakorn Factory.
5. Printed Fabrics (Leader Brand) from Silpa-Thai Factory.
6. Printed Fabrics (Ramasura & Mekhala Brand) from above Factory.
7. Printed Fabrics (Narayana bearing a Conchshell Brand) from above factory.
8. Carbolic Soft Soap (Coconut Brand), Thai Charoen Bhanij Company.

9. Dr. See's Tooth Paste, Dr. See's Factory.
10. Disinfectant (Elephant Brand), Hathayij Dispensary.
11. "Raden" Hair Pomade, Raden Cosmetics Factory.
12. "Raden" Hair Cream, the above factory.
13. "Bayan" Dental Powder, Benpraba Works.
14. "Bayan" Hair Pomade, the above factory.
15. Disinfectant, Hathayij Dispensary.
16. Laundry Blue (Hare Brand), Thai Chemi Company.
17. "Chula" Toilet soap, Elephant Soap Factory.
18. Heat-resistant Bricks, Silabhand Banij Company.
19. Disinfectant, Nebabhand Company.
20. Hair Tonic "1.77", "1.77" Factory.
21. Baby Powder "1.77", above Factory.
22. Face Powder "Samaggi", the Samaggi Cosmetics Company.
23. Hair oil "Curl set", Raden Cosmetics Factory.
24. Powder Lotion "Bayan", Benpraba Factory.
25. Distilled Water (Naga Brand), Thai Distillers, Dhonburi.

Local merchandise approved by this Department during 1942 :-

1. "Raden" Tooth powder, Raden Cosmetics Factory.
2. Rubber Cement solution (Matcha Brand), Nagnoi Banij Company.
3. Rubber Cement solution "Donald", Sarom Banij Company.
4. "Cock and Sun" Sauce, New Era Enterprise Company.
5. Rubber Cement solution (S. Dumbitak Brand), S. Dumbitak Company.

EXHIBITION AT THE CONSTITUTIONAL FAIR

For years past this Department has taken an active part in the Exhibition at the annual Constitutional Fair.

In 1941 the Japanese occupation of Thailand took place on the 8th of December, just a few days ahead of the scheduled opening of the Fair, thus the Fair had to be cancelled.

In 1942 the Government decided to hold the Fair in an attempt to stimulate trade and home industries. This Department was invited to participate in the Exhibition in co-operation with the Military Science Department and the Medical Science Department.

The Assistant Director-General of the Department presided over a committee of nine members who were in charge of this combined exhibition.

The exhibits contributed by the Department were as follows:-

1. Demonstration of textile dyeing with indigenous vegetable dyes.
2. Chemical products from sea water.
3. Production of Potassium chlorate for the Match Industry.
4. Laboratory appliances made in the Department's workshop.
5. Products obtained from the destructive distillation of wood.
6. Alloys produced by this Department for the manufacture of household utensils.

The main purpose of this scientific exhibition was to stimulate public interest in manufacturing homemade products during the increasing shortage of imported merchandise.

BUILDING PROJECTS

It has been recorded in the 10th report that the foundation of the Department's new building at Phya Thai had been completed at a cost of 112,543 Bahts. But, unfortunately, work on the building proper had to be postponed on the outbreak of the South-East Asia conflict.

Up to this date appropriations for resuming work on the building proper had not been granted. But it was hoped that this building project would not be abandoned altogether as a large sum had already been expended.

The transference of two Divisions to other Ministries deprived the Department of two buildings which normally housed the above mentioned Divisions. The situation became worse when the Industrial Research Division was set up. We were then really short of working space.

THE SCHOOL OF PRACTICAL CHEMISTRY

At the beginning of the period covered by this report Dr. Prachuab Bunnag, the Director-General, took over the post of superintendent of the school, left vacant by the demise of the late Dr. Toa Labanukrom.

In 1941, out of 239 applicants the School admitted 15 students to its preparatory class (This compares favourably with the 22 admissions out of 147 applications in 1940). There were six graduates at the end of the year.

In 1942 there were 215 students who applied for admission to the preparatory class but only 47 were admitted. The increase in the number of students admitted this year was due to the desire to produce technicians for numerous factories set up during the war. There were 13 students graduated at the end of 1942.

During this period it was found necessary to lay a greater emphasis on the practical part of the curriculum.

NEW DIVISIONS

During the period covered by this report the Department underwent a re-organization as the result of its having been placed under the newly formed Ministry of Industry.

In the meantime two of the Department's Divisions were transferred elsewhere, namely: the Pharmaceutical Division to the newly formed Ministry of Public Health and the Agricultural Division to the Ministry of Agriculture. Simultaneously the Department was given permission to form another new Division i.e. the Industrial Research Division. As this newly formed Division still lacked the necessary facilities and personnel, the bulk of the Department's work had to be shouldered by the Chemical division and the Industrial Chemistry Divisions.

Moreover during this peried a considerable number of the Department's staff were recruited for special service elsewhere so that it was found inconvenient to separate the work of the two old Divisions Therefore in this report, the work of both Divisions appears together without separate headings. Only items of interest are selected for this report.

DIVISIONS OF CHEMISTRY AND INDUSTRIAL CHEMISTRY

Since the Industrial Research Division was set up towards the end of 1942, the work performed by this Division can not be reported. The transference of the Pharmaceutical and Agricultural Divisions to other Ministries deprived the Department of Science not only of its buildings but also its equipment and trained personnel. Furthermore the fact that members of the Departmental Staff were recruited for special services elsewhere also greatly affected the work of the various Divisions.

It is thus probably more appropriate to give a combined report of the Divisions of Chemistry and Industrial Chemistry.

METALS FOR COINAGE

Metal samples for coinage sent here by the Mint for analysis totalled as follows:-

Year	Silver	Copper	Tin
1941	5,964	420	-
1942	2,012	419	2,997

These figures show a great increase over the figures of preceeding years.

OPIUM

The greater part of the routine work of the opium section concerned opium dross sent in by the Excise Department for analysis. This opium dross was purchased from opium-smoking establishments as partial compensation for the owners according to agreements of the former League of Nations. In addition to opium dross this section also dealt with police exhibits suspected to be or to contain opium. During the period covered by this report the opium section also undertook the analysis of raw opium purchased from cultivators in the Northern regions.

The number of samples of opium dross analysed appears below:—

OPIUM DROSS :

1941 1,008 samples.

1942 511 samples.

The decrease in 1942 was due to the fact that the Excise Department had then ceased the control of opium dross.

RAW AND PREPARED OPIUM :

	No. of Samples	
	Raw	Prepared
1941	40	19
1942	75	47

EXHIBITS SUSPECTED TO BE OPIUM OR DROSS

In 1941 twenty three samples were sent for analysis, of which only 7 proved to contain opium or dross (i.e. 30 % of the number submitted).

In 1942 twenty five samples were submitted for the same purpose. Only 6 samples (or 24 % of the number sent in) were found to contain opium or opium dross.

THAI RAW OPIUM

The following are the results of analyses of samples of raw opium from the various provinces of Thailand, during 1941 and 1942:—

Source	Lab. No.	Percentage of Moisture	Percentage of Morphine
Chiengmai	AI. 599	25.0	2.5
,,	AI. 600	11.8	2.9
,,	AI. 601	23.2	2.6
Nan	AJ. 248	55.6	2.4
,,	AJ. 249	58.8	2.4
,,	AJ. 250	21.9	10.9
,,	AJ. 251	20.9	11.1
,,	AJ. 252	19.4	10.9
,,	AJ. 253	20.3	11.0
,,	AJ. 254	25.0	11.6
,,	AJ. 255	19.3	10.3
,,	AJ. 256	23.0	12.4
,,	AJ. 257	23.6	13.0
,,	AJ. 258	24.3	9.6
Mae Hongson	AJ. 411	25.34	9.09
,,	AJ. 412	21.15	9.7
,,	AJ. 413	19.89	8.3
,,	AJ. 414	16.85	8.0
,,	AJ. 415	20.67	10.4
,,	AJ. 416	22.38	8.7
Chiengrai	AJ. 417	24.1	11.9
,,	AJ. 418	24.7	9.7
,,	AJ. 419	16.9	8.6
,,	AJ. 420	15.8	8.6

Source	Lab. No.	Percentage of Moisture	Percentage of Morphine
Chiengrai	AJ. 421	20.3	8.7
,,	AJ. 422	23.4	10.3
,,	AJ. 423	25.3	10.9
,,	AJ. 424	21.5	9.9
,,	AJ. 425	29.0	11.9
Chiengmai	AJ. 426	21.4	10.6
,,	AJ. 427	22.4	8.3
,,	AJ. 428	18.5	9.9
,,	AJ. 429	23.0	9.4
,,	AJ. 430	17.0	11.1
,,	AJ. 431	21.6	9.1
,,	AJ. 432	19.1	11.5
,,	AJ. 433	21.8	9.0
,,	AJ. 434	7.9	10.8
Nan	AO. 776	23.9	12.0
,,	AO. 777	23.7	13.5
,,	AO. 778	23.7	13.5
,,	AO. 779	24.1	13.3
,,	AO. 780	23.7	13.6
,,	AO. 781	23.8	13.7

From above the results it is evident that Thai raw opium has a rather high moisture content, when compared with that containing 10% imported from Iran. Yet Thai opium has a higher morphine content which is mostly above 13 % compared with that from Iran containing 11% morphine. If the Thai raw opium could be made drier its morphine content would be considerably higher,

HARMFUL HABIT-FORMING DRUGS.

During the period covered by this report 29 samples, suspected to be harmful habit-forming drugs, were sent to this Department for analysis. These samples were submitted by the Department of Customs (5 samples), the Department of Public Health (3 samples), the Police Department (20 samples), and a Provincial Commissioner (1 sample). Only 11 samples were found to be harmful habit-forming drugs (i.e. about 38 % of the total number of samples).

POISONS

In 1941, forty samples, suspected to be poisons, were submitted for analysis. Only 11 samples were found to contain poisons that is to say, the findings were positive in 28 % of the samples submitted.

In 1942 twenty-eight samples were submitted for the same purpose. Ten samples were found to contain poisons that is to say, the findings were positive in about 58 % of total samples submitted.

CANTHARIDES

The Executive Committee of Changvad Khon Kaen sent to this Department a sample suspected to have caused the death of a man who took it as a medicine. The sample was a species of insect closely allied to the Spanish fly. The deceased who suffered from a chronic venereal disease ground three of these flies with some white pepper, adding one raw egg and some alcohol, and then took the mixture as a medicine, the symptoms were stomach-ache, vomitting, and diarrhoea and then death followed within 24 hours. Unfortunately the viscera and vomit of the deceased were not sent for analysis. The flies sent as sample were also incorrectly described as "mamiew" an insect resembling the fruit-fly, having red eyes and feeding mostly on corn. The sample was found to be Chinese blistering beetles or Chinese cantharides (Mylabris sidoe, Fab.).

The poisonous ingredient found in this insect is cantharidine which acts as a strong irritant on the mucous membrane and the kidney. Symptoms are thirst, vomitting, and dysuria or hematuria. The fatal dose is approximately 1.5-3.5 g. of dry pulverized insect.

Pure cantharidine was extracted from the sample. When the chemical was experimentally applied to tender parts of the human skin, hot blisters resulted within an hour. It is known that for humans the fatal dose of pure cantharidine is 0.0064 g. It was calculated that one

insect contained 3.2 % of cantharidine, so that the total amount in 3 insects would be 0.106 g. It was concluded that the deceased in this case died from an over dose of cantharidine.

BLOOD STAINS

In 1941 sixty one exhibits, suspected to be human blood stains were submitted for analysis. Twenty two of the above were found to be human blood, i.e. about 38 % of the exhibits were confirmed as blood stains. In 1942 ninety-three exhibits were submitted. The finding was positive in 40 exhibits or approximately 43 % of the total number.

FIRE-ARMS

In 1941, thirty-seven exhibits of fire-arms were submitted for ascertaining whether each exhibit had ever been fired since its last cleaning of the barrel. Twenty-one exhibits gave positive results, i.e. about 57 % of the total had been fired since the last cleaning of the barrels.

In 1942 twenty five exhibits were submitted for the same purpose. The findings were positive in 10 exhibits, or 40 % of the total.

DOCUMENT

In 1942 one suspected document was submitted for examination. It was found that some parts of the document had been tampered with.

SEMINAL STAIN

In 1942 one exhibit from a case of assault and rape, suspected to be human seminal stain, was submitted for analysis. It was found positive.

EXPLOSIVES

In 1942 two exhibits, suspected to be explosives were sent for analysis. The samples were found to be ordinary gun powder.

ALLOYS FOR COUNTERFEIT COINS

In 1942, eleven exhibits, suspected to be intended for counterfeit coins, were sent for analysis. In all cases the alloys were found to be of a composition very close to that used at the Mint. It should be mentioned that this Department co-operates closely with the Mint in order to keep the composition of alloys for coinage constant for all issues.

GOLD ORES

The Arsenal Department sent 2 samples of gold ores for analysis. These samples were collected while prospecting for ores at Ban Baw Thong, Nakorn Savarn. The result of the analysis showed that a sample (Lab. No. AH. 610) contained 56 g. of gold per metric ton while another sample (Lab. No. AH. 611) contained 35 g. of gold per metric ton.

The Quartermaster-General Department sent samples of rocks containing gold ores for analysis. These rocks were part of a calcium rock deposited 2 metres underground at Ban Kaw, Petjaboon. This deposit was once mined for gold about 50 years ago, but had been since abandoned. The samples were collected from fragments left as waste by previous miners. The technical staff of the Quartermaster-General Department considered the samples to be acid ores containing mostly quartz garnet (Ca, Fe, Al silicate) with small quantities of calcite, pyrites and gold. The following is the result of the analysis made by this Department :—

Lab. No. of Samples	g. of gold per metric ton
AJ. 714	3.5
AJ. 715	89.0
AJ. 716	traces
AJ. 717	2.5
AJ. 718	10.0
AJ. 719	99.5
AJ. 720	13.5
AJ. 721	1.5

LEAD ORES

One sample of lead ore was sent for analysis from Amphur Srisavat, Kanchana Buri. It was mostly Galena with some Zinc Blende. The result of the analysis is tabulated below :—

Pb	70.00 %
Zn	7.20 %
Sb	0.20 %
Cd	0.76 %
Ag	0.03 %
Fe_2O_3	0.54 %
As	0.06 %
Se	0.05 %
S	14.20 %

From above it was computed that the ores contained 9 oz. of silver per metric ton. As it is known that only ores with more than 14 oz. of silver per metric ton can be profitably worked, the smelting of this ore for silver was not advised. However it could be worked for lead.

TANNINS FROM BARKS

Samples of barks from various trees were submitted by the Forestry Department for determination of tannin content.

1. Bark of big-leafed Kongkarng (Rhizophora mucronata) from trunk of 162 cm. circumference (Lab. No. AJ. 639).

2. Bark of small-leafed Kongkarng (Rhinzophora candelaria) from trunk of 150 cm. circumference (Lab. No. AJ. 640).

3. Bark of Presak (Bruguiera gymnorrhiza) from trunk of 85 cm. circumference (Lab. No. AJ. 641).

4. Bark of Prong (Carops candolleana) from trunk of 65 cm. circumference (Lab. No. AJ. 642).

The results of the analyses appear below:—

	Moisture as received %	Tannin as received %	Moisture air dried %	Tannin air dried %	Tannin dry basis %
AJ. 639	38.97	16.4	12.35	23.5	26.8
AJ. 640	31.53	16.8	11.70	21.7	24.6
AJ. 641	36.84	7.8	12.12	10.9	12.4
AJ. 642	24.76	13.6	10.00	16.3	18.1

MENTHOL OIL

Through the courtesy of the Department of Agriculture this Department obtained some menthol leaves, for analysis. By steam distillation of the leaves an oil obtained showed the following properties:-

Refractive index at 20°C.	1.439
Ester (as menthyl acetate)	3.8%
Total menthol	77.6%

According to the Department of Agriculture, these leaves belong to the plant Mentha arvensis, var. piperascens, which is different from the plant Mentha piperite, Linn. mentioned in the B.P. and U.S.P.

According to the B. P. and U.S. P. the oil from the Mentha piperite, Linn. has the following properties :

	B.P.	U.S.P.
Refractive index at 20°C.	1.160–2.470	1.460–1.471
Ester as menthyl ester	4.5 –9	not less than 5%
Free menthol	not less than 46 %	—
Total menthol (free and esters)	—	not less than 50 %

By comparing the properties shown in the 2 tables above, it is evident that the oils of the 2 species of menthol plants are very similar. Further investigation is needed as to whether or not Mentha arvensis could be used pharmaceutically. It should be mentioned that the arvensis species can be grown and propagated in this country without difficulty.

OIL FROM PARA-RUBBER SEEDS

Though para rubber trees are plentiful in Southern Thailand, the seeds of para rubber trees are discarded and never put to useful purposes. As it is known that the oil from para seeds has properties similar to semi-drying oils, this Department started a series of experiments in extracting oil from para seeds and analysing the extracted oil to determine its properties as compared with linseed oil.

The following are the results of analysis of para seeds compared with known properties of linseed oil :—

	Linseed oil	Para seed oil
Specific gravity 15.5°C	0.932–0.937	0.924–0.927
Refractive index 10°C	72–74	61–64
Saponification value	189–194	190–195
Iodine value	175–200	135–140
Unsaponifiable matter	0.5–2	0.5–3
Acid value varies up to	10	15.5
Oil content	35–38%	42–45%

Further research should be made to determine whether para rubber seed oil could replace linseed oil in the paint industry.

DIPTEROCARPUS OLEORESIN

During the war the shortage of the fuel oil resulted in frantic attempts to find suitable substitutes. People owning heavy-fuel oil engines had resorted to the use of the balsam (oleoresin) of the Yang tree, Dipterocarpus sp. A study on oleoresin was made at the Department, the immediate purpose being to investigate the suitability of the balsam as a diesel oil substitute.

The distillate obtained from the balsam when left exposed in air or when heated turned viscous rapidly. Such a defect could not be remedied by sodium hydroxide treatment of the oil.

The balsam obtained from the Sian Tree (a variety of Dipterocarpus sp.) was similarly investigated.

At the time it was also well known in certain parts of Thailand that a mixture of this balsam and kerosene in the ratio of 3:1 could be used as a fuel but engines required more frequent cleaning owing to excessive carbon deposit. The table below showed the results of analysis of the raw balsam, the distillates and the mixture:-

A: Distillate from the balsam of the Yang tree (57–78 cm. Hg.)
B: Distillate from the balsam of the Sian tree, (10 mm. Hg.)
C: Raw balsam from the Sian tree.
D: Kerosene used in the mixture.
E: 3:1 Mixture of the Sian balsam and kerosene.
F: Standard heavy-fuel oil

	A	B	C	D	E	F
Specific Gravity, 60°F.	0.9212	0.9230	0.9567	0.8241	0.9248	0.8623
Viscosity (Redwood, 30°C) Second	43.0	72.0	111.5	—	52.0	37.4
Flash Point °C.	103.0	106.0	115.0	48	73.0	81.0
Moisture ·/.	—	traces	0.3	—	0.2	traces
Carbon residue ·/.	—	traces	0.02	—	0.02	0.02
Saponification value	3.13	—	—	—	—	—
Calorific value, B. Th./lb.	19,168	—	—	—	—	—
Distillation: Initial Boiling, °C.	250.0	155.0		158.7	159.2	242.0
10·/. distilled at, °C.	258.5	181.0		208.0	246.0	
20·/. ,, ,, ,,	259.0	187.0		220.0	255.0	
30·/. ,, ,, ,,	259.5	191.0		227.0	261.0	
40·/. ,, ,, ,,	260.0	194.0		234.0	263.0	
50·/. ,, ,, ,,	260.2	200.0		238.0	265.0	277.0
60·/. ,, ,, ,,	261.0	203.0		242.0	268.0	
70·/. ,, ,, ,,	261.5	206.0		245.0	271.0	
80·/. ,, ,, ,,	261.8	213.0		250.0	280.0	
90·/. ,, ,, ,,	265.0	—		256.0	—	338.0
End Point °C.	276.0			271.5		
Total Distillate ·/.	98.2			98.5		
Residue ·/.	1.2			0.9		
Loss ·/.	0.6			0.6		

It was seen that on distillation of the mixture E, the viscous portion began to distil over after 85 % of the distillate had been obtained, i. e. at 300 °C. The mixture had a lower flash-point and a higher viscosity than the standard heavy-fuel oil.

Should the balsam be freshly distilled under a reduced pressure before mixing with kerosene, the resulting mixture could serve the purpose required. But such a costly procedure could not be recommended for a general practice. The viscous resin left behind in the engine was harmless but very annoying

The fact that the amount of carbon residue in the samples as determined by the Conradson Method at 550°C. was the same indicated that the viscous resin of the balsam had been completely carbonised. Probably the mixture would be more suitable for engines with higher valve temperatures.

COAL

Analysis was made of samples of lignite from Amphur Kusinarai and Amphur Sahaskandha, the province of Mahasarakarm.

	Amphur Kusinarai	Amphur Sahaskandha
Moisture	7.4 %	16.5 %
Ash	5.5 %	15.5 %
Volatile matter	47.7 %	32.8 %
Fixed carbon	43.4 %	35.2 %
Sulphur	1.0 %	0.7 %
Calorific value (Cal/gm)	7,430	4,959

Another sample from Krabee Province analysed gave the following result :—

Moisture	18.10 %
Ash	7.35 %
Nitrogen	1.12 %
Iron	1.60 %
Total sulphur	3.72 %
Organic sulphur	2.93 %
Sulphate Sulphur	0.52 %
Sulphide Sulphur (pyritic)	0.27 %
Volatile matter on dry–ashless basis (less moisture at 900°C)	75.50 %
Calorific value (Cal./gm.)	4,974 or 10,950 B. T. U. per lb. (dry basis)

The residue after extraction of all volatile matters was non-caking. This sample is evidently a common lignite. It is comparable with lignites from other sources.

Lignite	Moisture %	Vol. matter %	Ash %	Sulphur %	Cal. value (drybasis) B.T.U./lb.
Malay state (Selangor)	18.23	35.50	5.08	0.38	9,840
Malayan Colleries Ltd.	21.03	–	9.07	-	11,700
Australian briquette	11.15	–	–	0.204	10,750
Australian lignite	40–60	21–28	1.2–8.25	0.3–0.94	–
Thai lignite	18.10	75.50	7.31	3.72	10,950

WOOD ASHES

As a result of the shortage of caustic soda for making soap, the alkali from wood ashes was used. Ashes of Coconut shells and fibrous coverings which are available everywhere in large quantities, can serve the purpose.

Part of Coconut Used	Ash %	Percentage of K_2O in Ash
Hard shell	3.1	28.2
Fibrous outer covering	3.34	29.0

ARMY RATIONS

In 1941 the Quartermaster-General's Department manufactured canned foods for the Army and asked the co-operation of this Department, in the determination of their calorific and food values. Seven varieties were analysed.

The above mentioned foodstuffs were made into 3 compressed blocks, well wrapped and sealed in an air tight container. The content of each can weighed 600 g. and were sufficient for 3 separate meals daily. The chief ingredients of these packaged foodstuffs were soybean, rice, beef and sugar.

Sample No.	Lab. No.	Variety	Moisture %	Starch %	Total invert sugar %	Fat %	Protein (N x 6.25) %	Ash %	cal. / 100 gm.
1	AK. 567	Sweet and salty (slightly)	9.84	24.7	2.88	6.44	44.2	5.44	345.1
2	AK. 568	Sweet and salty (strongly)	10.70	18.75	6.05	6.84	37.5	7.23	300.8
3	AK. 569	Very sweet	10.35	31.8	4.28	5.96	31.5	5.01	325.0
4	AK. 570	Hot (white pepper)	10.16	33.9	7.22	5.94	29.2	5.21	334.7
5	AK. 571	Hot (red chili)	10.39	25.8	6.56	5.96	37.3	4.97	332.3
6	AK. 572	Powdered dried fish	8.41	26.7	6.06	7.57	25.7	3.81	302.0
7	AK. 573	Salted fish	8.37	—	4.65	14.13	47.6	22.20	336.2

N. B. The daily ration of 600 g. yields 1800–2100 calories.

The average adult, performing moderate work, requires about 2,500 calories per day. The daily requirement of a soldier at the front would be approximately 3,000–3,500 calories.

The daily ration of the Army as mentioned above is probably adequate in fuel value, since it would be used in supplementing the normal allowance during an emergency. It was recommended that the bulk should be increased if possible.

One characteristic of these foodstuffs which should be taken into consideration is the high concentration of salt and spices. The consumption of such ingredients usually results in unbearable thirst after a short interval. As the supply of drinking water is always limited at the front line, the Department recommended that in preparation less salt and spices should be used and if possible citrus fruits and yeast should be supplied as well.

In 1942 the Quartermaster-General's Department started experimenting with two breakfast rations. These were beef-soup concentrates made from beef and soybean milk, sugar, salt powder and cocoa. Ten c.c. of the concentrate was to be diluted with 200 c.c. of hot water and taken with 200 g. of roasted rice. The second variety consisted 10 g. of soybean milk powder to be dissolved in 200 c.c. of hot water and taken with 200 g. of roasted rice.

Lab. No.	Breakfast Ration	Moisture %	Ash %	Fat %	Protein %	Crude fibre %	Carbohydrate %	cal. / 100 gm.	Protein factor
AM. 777	Roasted rice	8.57	3.68	—	7.04	0.41	88.87	383.6	5.7
AM. 776	Soybean powder	3.49	4.26	9.60	20.32	4.10	61.72	414.6	5.8
AM. 775	Soup concentrate	32.20	20.73	12.12	41.13	—	26.02	377.7	6.25

From the above tabulated results the calorific value of each breakfast ration was found to be as follows:—

(a) Beef concentrate, 10 c.c. and roasted rice, 200 g.:
805 calories.

(b) Soybean powder 10 g. and 200 g. roasted rice:
808 calories.

It was concluded that the two breakfast ration mentioned above were quite suitable but probably the beef concentrate was more palatable.

In the same year the Quartermaster General's Department produced four other rations. To decrease the amount of meat by 50 % soybean substituted the meat.

The new rations were :—

A. Beef with soybean.

B. Pork with soybean.

C. Fish (lang khiew) in cotton seed oil.

D. Fish (lang khiew) in tomato sauce.

The rations A and B were intended for consumption with cooked rice ; each tin to supply 2 soldiers with a meal. The daily allowance was 1 tin per solider. C and D were only to be taken when A and B were not available.

Lab. No.	Ration	Moisture %	Ash %	Fat %	Protein %	Crude fibre %	Carbohydrate %	Cal. /100 gm.	Protein factor
AM. 874	Beef with soybean	54.97	3.81	9.32	22.36	1.75	7.79	204.5	6.25
AM. 875	Pork with soybean	60.27	2.72	2.11	19.86	0.71	14.33	155.8	6.25
AM. 876	Fish in cotton seed oil	70.79	3.38	5.01	12.79	0.28	7.75	127.3	6.25
AM. 877	Fish in tomato sauce	69.99	3.53	4.27	13.29	0.28	10.64	134.2	6.25
AM. 878	Salted beef stew	54.53	3.53	4.16	33.95	0.05	3.78	188.4	6.25

The contents of each tin of ration and its calorific value are tabulated below.

Lab. No.	Contents of 1 tin in g.	calorific value of 1 tin in calories
AM. 874	170	347.7
AM. 875	140	218.0
AM. 876	140	178.2
AM. 877	160	214.6
AM. 878	160	320.2

From the results of the analysis the calorific values of beef with soybean and salted beef stew were practically the same, while that of pork with soybean was lower. Taking the calorific value of rice into account, the total calorific value of each meal would be greatly increased. The Department recommended that for emergency purposes these canned stuffs would be of great value since each contributed a substantial amount of protein. For its use in a prolonged feeding program, it should be supplemented with fresh eggs, vegetables and fruits.

WATER ANALYSIS

During the period covered by this report samples of water from various sources had been analysed:—

	Nember of samples	
Samples from	1941	1942
City Water Supply	203	235
River Water	754	754
Sea Water	591	539
Miscellaneous	123	47
Total	1671	1575

There was an interesting case of underground water. In 1941 the Co-operative Department commissioned a firm to bore for underground water in the precincts of the Salt Co-operative Community at Kok Kharm, Samud Sakorn, which is situated some 3 km. from the sea. It was found that fresh water, without taste of salt, could be drawn up only at a level of 665 ft. under the surface of the ground. This water was sent here for analysis in April 1941. The result of the analysis (sample Lab. No. AI. 484) showed that the hardness of the water was rather high. It could however, be used for drinking purpose after treatment.

On 14th May, 1941, the Co-operative Department sent another sample of water from the same source, stating that boring experts were of the opinion that the quality of the water for drinking purpose improved as more water was drawn up. The result of the analysis of the sample (Lab No. AJ. 269) showed that the electrical conductivity decreased, the amount of total solids decreased and no suspended solids remained. There was only slight decrease of total hardness. The Chlorides decreased appreciably, while other items remained practically the same.

On 11th September, 1941, another sample of underground water was sent from the same source. The result of analysis (AK. 491) showed very slight improvement over the second sample, as drinking water.

The results of the analyses of the 3 samples are tabulated below :—

	AI. 484	AJ. 269	AK. 491
pH value	7.3	7.5	7.5
Electrical Conductivity at 28°C	810	570	520
Total solids	68.1	49.4	48.5
Suspended solids	0.1	nil	0.6
Dissolved solids	68.0	49.4	47.9
Total hardness	31.0	30.0	29.0
Temporary hardness	29.1	28.8	28.5
Permanent hardness	1.9	1.2	0.5

	AI. 484	AJ. 269	AK. 491
Chlorides expressed as chlorine	20.0	8.4	7.7
Chlorides expressed as NaCl	33.0	13.8	12.7
Oxygen consumed	0.09	0.07	0.04
Saline ammonia	0.012	0.012	0.012
Albuminoid ammonia	0.010	0.004	0.008
Nitrates expressed as nitrogen	0.015	0.012	0.013
Nitrites	nil	nil	nil
Loss on ignition	1.5	1.3	1.0
Iron	nil	nil	nil

The tabulated results of analyses of samples from the City Water Supply and Water Supplies of certain provinces appear in the following pages.

Hardness is expressed as parts of calcium carbonate per 100,000; other constituents as parts per 100,000.

Oxygen consumed is determined at 100°C for 10 minutes.

City Water, Supply, Bangkok
1941.

Month	pH Value	Electrical conductivity	Total solids	Suspended solids	Dissolved solids	Total hardness	Temporary hardness	Permanent hardness	Chlorides expressed as Chlorine	Chlorides expressed as Sodium Chloride	Oxygen consumed	Saline ammonia	Albuminoid ammonia	Nitrates expressed as nitrogen	Nitrite	Loss on Ignition	Iron
January	7.2	170	14.8	—	14.8	10.0	8.2	1.8	1.4	2.3	0.20	0.003	0.012	0.011	—	1.7	—
February	7.2	200	17.8	—	17.8	10.0	8.3	1.7	2.5	4.1	0.12	0.001	0.012	0.027	—	1.3	—
March	7.2	183	16.2	—	16.2	11.0	9.1	1.9	1.6	2.6	0.10	0.002	0.012	0.015	—	1.2	—
April	7.2	212	18.5	—	18.5	11.5	9.2	2.3	2.2	3.6	0.10	0.002	0.009	0.018	—	1.3	—
May	7.2	240	21.5	—	21.5	17.0	10.2	2.8	2.7	4.4	0.14	0.001	0.007	0.016	—	1.5	—
June	7.1	245	22.1	—	22.1	13.0	7.2	5.2	2.3	3.8	0.12	0.001	0.012	0.020	—	1.9	—
July	7.1	138	14.6	—	14.6	8.0	6.4	1.6	0.9	1.5	0.18	0.001	0.011	0.018	—	1.7	—
August	7.1	114	11.5	—	11.5	6.5	5.2	1.3	0.9	1.5	0.11	0.001	0.008	0.017	—	1.0	—
September	7.1	105	11.0	—	11.0	7.0	4.6	2.4	0.6	1.0	0.10	0.001	0.007	0.015	—	1.1	—
October	7.0	160	16.2	—	16.2	9.5	2.0	7.5	1.0	1.6	0.11	0.002	0.010	0.020	—	1.7	—
November	7.0	110	12.1	—	12.1	6.5	1.6	4.9	0.8	1.3	0.17	0.001	0.012	0.015	—	2.1	—
December	7.0	110	10.9	—	10.9	6.0	3.2	2.8	0.8	1.3	0.22	0.001	0.012	0.015	—	1.7	—
Average	7.1	166	15.6	—	15.6	9.3	6.3	3.0	1.5	2.4	0.14	0.001	0.010	0.017	—	1.5	—

City Water Supply, Bangkok.
1942.

Month	pH Value	Electrical conductivity	Total solids	Suspended solids	Dissolved solids	Total hardness	Temporary hardness	Permanent hardness	Chlorides expressed as Chlorine	Chlorides expressed as Sodium Chloride	Oxygen consumed	Saline ammonia	Albuminoid ammonia	Nitrates expressed as nitrogen	Nitrite	Loss on Ignition	Iron
January	7.0	148	14.1	—	14.1	8.5	7.3	1.2	1.1	1.8	0.15	0.001	0.011	0.015	—	1.7	—
February	7.1	168	15.5	—	15.5	9.5	7.9	1.6	1.4	2.3	0.13	0.001	0.006	0.016	—	1.7	—
March	7.1	174	16.8	—	16.8	10.0	8.3	1.7	1.6	2.6	0.17	0.002	0.010	0.025	—	2.2	—
April	7.2	197	17.8	—	17.8	11.5	9.8	1.7	1.8	3.0	0.11	0.001	0.005	0.018	—	1.5	—
May	7.2	183	17.4	—	17.4	10.3	8.9	1.6	1.7	2.8	0.15	0.002	0.012	0.025	—	1.9	—
June	7.0	128	14.0	0.5	13.5	7.0	5.2	1.8	0.9	1.5	0.18	0.002	0.011	0.025	—	2.3	—
July	6.9	102	12.0	0.2	11.8	6.0	3.8	2.2	0.6	1.0	0.19	0.001	0.009	0.016	—	2.3	—
August	7.0	100	10.4	0.2	10.2	6.0	4.7	1.3	0.5	0.8	0.17	0.002	0.010	0.015	—	2.0	—
September	7.0	105	10.7	—	10.8	6.0	4.0	2.0	0.6	1.0	0.19	0.002	0.008	0.012	—	2.2	—
October																	
November																	
December	6.9	100	12.3	0.8	11.5	5.5	2.5	3.0	0.6	1.0	0.30	0.002	0.019	0.017	—	3.1	0.02
Average	7.0	141	14.1	0.2	13.9	8.0	6.2	1.8	1.1	1.8	0.17	0.002	0.010	0.018	—	2.1	—

Municipal Water Supply, Nakorn Rajasima.
1941

Month	pH Value	Electrical conductivity	Total solids	Suspended solids	Dissolved solids	Total hardness	Temporary hardness	Permanent hardness	Chlorides expressed as Chlorine	Chlorides expressedas as Sodium Chloride	Oxygen consumed	Saline ammonia	Albuminoid ammonia	Nitrates expressed as nitrogen	Nitrite	Loss on Ignition	Iron
January	7.3	285	24.7	—	24.7	16.0	15.0	1.0	3.4	5.6	0.33	0.002	0.012	0.022	traces	2.2	—
February	7.3	350	30.0	—	30.0	18.0	17.2	0.8	5.5	9.1	0.38	0.003	0.015	0.025	traces	2.2	—
March	7.3	460	39.0	—	39.0	18.0	16.7	1.3	10.4	17.1	0.38	0.004	0.015	0.023	—	2.3	—
April	7.3	580	49.1	—	49.1	18.5	15.9	2.6	15.4	25.4	0.37	0.006	0.025	0.025	—	2.3	—
May	7.3	760	64.7	—	64.7	18.0	15.5	2.5	25.0	41.2	0.41	0.003	0.020	0.025	traces	2.4	—
June	7.1	250	24.8	—	24.8	9.5	7.0	0.5	5.7	9.4	0.41	0.002	0.017	0.925	traces	2.4	—
July	7.2	600	51.9	—	51.9	17.0	11.4	5.6	14.5	23.9	0.51	0.003	0.023	0.033	—	2.9	—
August	7.2	165	156.7	—	156.7	26.5	12.6	13.9	70.5	116.2	0.43	0.003	0.022	0.030	traces	2.7	—
September	7.1	159	16.9	—	16.9	9.0	5.8	3.2	2.0	3.3	0.39	0.003	0.024	0.025	—	1.8	—
October	7.2	142	13.9	—	13.9	9.0	8.0	1.0	0.9	1.5	0.33	0.002	0.015	6.019	—	1.7	—
November	7.1	150	14.4	—	14.4	9.5	7.9	1.6	1.3	2.1	0.31	0.002	0.014	0.015	—	1.5	—
December	7.2	205	20.2	—	20.2	11.5	10.6	0.9	2.5	4.1	0.40	0.002	0.020	0.025	—	2.2	—
Average	7.2	466	42.2	—	42.2	15.0	11.9	3.1	13.1	21.6	0.39	0.003	0.019	0.024	—	2.2	—

Municipal Water Supply, Nakorn Rajasima.
1942.

Month	pH value	Electrical conductivity	Total solids	Suspended solids	Dissolved solids	Total hardness	Temporary hardness	Permanent hardness	Chlorides expressed as Chlorine	Chlorides expressed as Sodium Chloride	Oxygen consumed	Saline ammonia	Albuminoid ammonia	Nitrates expressed as nitrogen	Nitrite	Loss on Ignition	Iron
January	7.1	255	23.7	—	23.7	14.0	13.8	0.2	3.5	5.8	0.28	0.001	0.019	0.025	—	2.0	—
February	7.2	470	40.6	—	40.6	17.0	16.7	0.3	11.2	18.5	0.31	0.002	0.016	0.025	—	2.2	—
March	7.2	495	42.6	—	42.6	16.5	16.0	0.5	12.3	20.3	0.45	0.004	0.018	0.026	traces	3.1	—
April	7.3	450	38.9	—	38.9	17.5	17.0	0.5	10.3	17.0	0.39	0.002	0.014	0.025	traces	2.0	—
May	7.2	230	20.0	—	20.0	9.0	7.1	1.9	3.8	6.3	0.29	0.002	0.016	0.020	—	2.0	—
June	7.0	162	15.6	—	15.6	7.5	3.4	4.1	2.2	3.6	0.18	0.002	0.011	0.020	—	2.0	—
July	7.1	195	20.3	0.5	19.8	9.5	5.5	4.0	3.3	5.4	0.16	0.002	0.018	0.019	—	2.0	0.01
August	7.3	820	81.5	—	81.5	22.0	12.3	9.7	30.6	50.4	0.37	0.004	0.018	0.025	traces	3.9	—
September	7.1	135	12.9	—	12.9	7.0	6.0	1.0	1.4	2.3	0.25	0.001	0.012	0.015	—	2.2	0.01
October	7.1	132	12.9	0.2	12.7	8.0	6.8	1.2	1.0	1.6	0.23	0.002	0.010	0.025	—	2.0	0.01
November	7.1	152	14.5	—	14.5	9.0	8.1	0.9	1.4	2.3	0.26	0.002	0.014	0.025	—	2.3	0.01
December	7.1	145	13.7	—	13.7	8.5	7 9	0.6	1.4	2.3	0.25	0.002	0.017	0.027	—	2.1	—
Average	7.2	303	28.1	—	28.0	12.1	10.0	2.1	6.9	11.3	0.29	0.002	0.015	0.023	—	2.3	—

Municipal Water Supply, Ayuthya.
1941.

Month	pH value	Electrical conductivity	Total solids	Suspended solids	Dissolved solids	Total hardness	Temporary hardness	Permanent hardness	Chlorides expressed as Chlorides	Chlorides expressed as Sodium Chloride	Oxygen consumed	Saline ammonia	Albuminoid ammonia	Nitrates expressed as nitrogen	Nitrite	Loss on Ignition	Iron
January	7.1	167	14.5	—	14.5	11.0	6.4	4.6	0.8	1.3	0.11	0.001	0.012	0.014	—	1.2	—
February	7.1	170	14.7	—	14.7	10.0	7.2	2.8	1.2	2.0	0.10	0.001	0.010	0.015	—	1.2	—
March	7.2	180	15.7	—	15.7	11.0	9.4	1.6	1 3	2.1	0.11	0.001	0.011	0.017	—	1.3	—
April	7.2	2.25	19.9	—	19.9	13.5	11.2	2.3	1.9	3.1	0.14	0.001	0.012	0.020	—	1.6	—
May	7.2	2.20	19.6	—	19.6	13.0	10.7	2.3	1.9	3.1	0.15	0.002	0.017	0.017	—	1.7	—
June	7.1	145	13.9	—	13.9	7.5	5.1	2.4	1.1	1.8	0.15	0.002	0.008	0.028	—	1.6	—
July	7.1	125	12.7	—	12.7	7.0	5.5	1 5	1.0	1.6	0.15	0.002	0.014	0.015	—	1.5	—
August	7.1	98	10.6	—	10.6	6.5	5.1	1.5	0.6	1.0	0.11	0.001	0.007	00.15	—	1.0	—
September	7.1	91	12.0	2.0	10.0	6.0	3.9	2.1	0.5	0.8	0.10	0.001	0.012	0.023	—	1.1	0.01
October	7.1	91	9.8	—	9.8	6.5	4.5	2.0	0.4	0.7	0.11	0.001	0.016	0.018	—	0.9	—
November	7.1	91	10.1	—	10.1	6.0	4.9	1.1	0.4	0.7	0.31	0.001	0.008	0.015	—	1.6	—
December	7.1	120	11.9	—	11.9	8.0	6.4	1.6	0.3	0.5	0.20	0.001	0.017	0.016	—	4.1	—
Average	7.1	144	13.8	—	13.6	8.8	6.7	2.1	1.0	1.6	0.15	0.001	0.011	0.018	—	1.3	—

Municipal Water Supply, Ayuthya.
1942.

Month	pH value	Electrical conductivity	Total solids	Suspended solids	Dissolved solids	Total hardness	Temporary hardness	Permanent hardness	Chlorides expressed as Chlorine	Chloride expressed as Sodium Chloride	Oxygen consumed	Saline ammonia	Albuminoid ammonia	Nitrates expressed as nitrogen	Nitrite	Loss on Ignition	Iron
January	7.1	142	13.8	—	13.8	9.0	7.8	1.2	1.1	1.8	0.09	0.001	0.008	0.017	—	1.1	—
February	7.1	150	13.9	—	13.9	9.0	8.2	0.8	1.0	1.6	0.09	0.002	0.016	0.018	—	1.3	—
March	7.1	170	15.4	—	15.4	10.5	9.7	0.8	1.5	2.5	0.06	0.001	0.005	0.015	—	1.0	—
April	7.2	170	16.6	—	16.6	10.5	9.4	1.1	1.5	2.3	0.12	0.001	0.008	0.025	—	1.8	—
May	7.2	154	15.2	—	15.2	9.0	7.9	1.1	1.2	2.0	0.14	0.002	0.010	0.020	—	2.1	—
June	7.0	108	17.9	5.5	12.4	5.5	3.2	2.3	0.5	0.8	0.22	0.001	0.010	0.022	—	2.4	0.10
July	7.0	—	11.6	—	11.6	6.5	3.1	3.4	0.4	0.7	0.20	0.002	0.012	0.019	—	2.1	—
August	7.0	96	9.7	—	9.7	6.0	3.9	2.1	0.5	0.8	0.14	0.001	0.012	0.015	—	1.2	—
September	7.0	109	11.6	—	11.6	7.0	4.1	2.9	0.5	0.8	0.12	0.001	0.008	0.016	—	1.5	0.01
October																	
November	7.0	95	10.6	—	10.6	6.0	2.9	3.1	0.4	0.7	0.22	0.001	0.011	0.028	—	2.0	—
December	7.0	109	12.0	—	12.0	8.0	4.2	3.8	0.4	0.7	0.14	0.002	0.012	0.027	—	1.3	—
Average	7.1	130	13.5	—	13.0	7.9	5.9	2.0	0.8	1.3	0.14	0.001	0.010	0.020	—	1.6	—

Municipal Water Supply, Bisanulok.
1941.

Month	pH value	Electrical conductivity	Total solids	Suspended solids	Disolved solids	Total hardness	Temporary hardness	Permanent hardness	Chlorides expressed as Chlorine	Chlorides expressed as Sodium Chloride	Oxygen consumed	Saline ammonia	Albuminoid ammonia	Nitrates expressed as nitrogen	Nitrite	Loss on Ignition	Iron
January	7.2	900	95.5	12.4	83.1	18.0	8.6	9.4	37.2	61.3	0.14	0.002	0.009	0.031	—	1.1	1.11
February	7.2	900	84 5	1.4	83.1	18.0	8.8	9.2	37.2	61.3	0.11	0.002	0 005	0.030	traces	1.2	0.04
March	7.2	900	86.9	3.5	83.4	18.0	8.5	9.5	36.8	60.6	0.10	0.002	0.011	0.033	traces	1.3	0.32
April	7.2	920	87.7	1.9	85.8	20.5	12.6	7.9	36.8	60.6	0.12	0.060	0.008	0.028	—	2.0	0.11
May	7.2	900	88.0	3.5	84.5	18.5	8.7	9.8	36.8	60.6	0.10	0.040	0.007	0.030	traces	1.4	0.20
June	7.2	880	89.9	3.8	86.1	18.0	8.0	10.0	36.8	60.6	0.12	0.001	0.010	0.031	traces	1.6	0.26
July	7.2	900	90.1	2.6	87.5	17.5	8.5	9.0	37.6	62.0	0.09	0.005	0.004	0.028	—	1.5	0.27
August	7.2	900	88.9	1.9	87.0	18.0	8.5	9.5	37.2	61.3	0.14	0.008	0.007	0.025	traces	1.6	0.29
September	7.2	880	85.4	1.1	84.3	17.5	8.5	9.0	36.8	60.6	0.09	0.004	0.008	0.026	—	1.6	0.10
October	7.2	890	91.6	6.5	85.1	18.0	8.2	9.8	36.8	60.6	0.18	0.003	0.015	0.029	traces	2.1	0.85
November	7.1	870	89.4	5.8	83.6	18.0	8.6	9.4	36.8	60.6	0.09	0.003	0.010	0.026	—	1.5	0.45
December	7.1	840	110.6	27.9	82.7	16.0	8.6	7.4	36.4	60.0	0.45	0.001	0.005	0.028	traces	2.0	3.57
Average	7.2	890	90.7	6.0	84.7	18.0	8.8	9.2	36.9	60.8	0.14	0.011	0.008	0.029	—	1.6	0.63

Municipal Water Supply, Bisanulok.
1942.

Month	pH value	Electrical conductivity	Total solids	Suspended solids	Dissolved solids	Total hardness	Temporary hardness	Permanent hardness	Chlorides expressed as Chlorine	Chlorides expressed as Sodium Chloride	Oxygen consumed	Saline ammonia	Albuminoid ammonia	Nitrates expressed as nitrogen	Nitrite	Loss on Ignition	Iron
January	7.1	840	95.4	12.9	82.5	17.0	8.2	8.8	36.0	59.3	0.07	0.003	0.012	0.030	—	1.3	1.61
February	7.1	870	98.2	12.5	85.7	17.5	8.6	8.9	36.8	60.6	0.29	0.024	0.012	0.030	traces	3.1	1.37
March	7.1	870	93.2	8.1	85.1	17.5	9.0	8.5	36.8	60.6	0.08	0.010	0.011	0.025	traces	1.8	0.76
April	7.2	880	104.8	18.2	86.6	18.0	8.5	9.5	36.4	60.0	0.26	0.002	0.015	0.030	—	2.8	2.62
May	7.2	860	98.5	14.1	84.4	17.0	8.4	8.6	36.4	60.0	0.23	0.002	0.018	0.025	—	2.8	2.0
June	7.2	870	93.0	8.1	84.9	17.0	8.5	8.5	37.2	61.3	0.14	0.003	0.012	0.041	traces	2.5	1.31
July	7.2	870	100.5	15.4	85.1	16.5	8.9	7.6	37.2	61.3	0.28	0.016	0.010	0.025	—	3.5	2.85
August	7.2	850	87.0	2.9	84.1	18.0	8.2	9.8	36.4	60.0	0.08	0.021	0.007	0.029	traces	2.0	0.15
September	7.2	880	119.2	31.3	87.9	18.0	8.3	9.7	36.4	60.0	0.49	0.001	0.023	0.060	—	5.3	6.90
October																	
November	7.2	870	88.6	3.5	85.1	18.0	8.5	9.5	36.8	60.7	0.12	0.013	0.008	0.040	traces	2.3	0.32
December	7.1	840	87.3	5.4	81.9	17.5	8.4	9.1	36.0	59.3	0.22	0.002	0.012	0.043	traces	2.7	0.89
Average	7.2	864	96.9	12.1	84.8	17.5	8.5	9.0	36.6	60.3	0.21	0.009	0.013	0.034	—	2.7	1.89

Municipal Water Supply, Nakorn Sawan
1941.

Month	pH value	Electrical conductivity	Total Solids	Suspended solids	Dissolved solids	Total hardness	Temporary hardness	Permanent hardness	Chlorides expressed as Chlorine	Chlorides expressed as Sodium Chloride	Oxygen consumed	Saline ammonia	Albuminoid ammonia	Nitrates expressed as nitrogen	Nitrite	Loss on Ignition	Iron
January	7.1	127	11.8	—	11.8	8.5	7.2	1.3	0.3	0.5	0.09	0.001	0.012	0.015	—	1.0	—
February	7.2	140	12.8	—	12.8	9.0	8.2	0.8	0.5	0.8	0.09	0.001	0.007	0.014	—	1.0	—
March	7.2	160	13.8	—	13.8	10.5	8.9	1.6	0.4	0.7	0.07	0.001	0.006	0.012	—	0.9	—
April																	
May	7.2	165	15.0	—	15.0	11.5	9.6	1.9	0.5	0.8	0.09	0.001	0.008	0.013	—	1.1	—
June	7.1	120	12.6	—	12.6	8.0	4.9	3.1	0.4	0.7	0.21	0.001	0.005	0.015	—	1.7	—
July	7.1	112	11.4	—	11.4	7.0	6.2	0.8	0.4	0.7	0.19	0.002	0.009	0.018	—	1.5	—
August	7.1	102	10.4	—	10.4	7.0	5.8	1.2	0.3	0.5	0.10	0.001	0.007	0.010	—	1.1	—
September	7.1	90	9.5	—	9.5	6.5	4.9	1.6	0.3	0.5	0.07	0.001	0.009	0.013	—	0.8	—
October	7.1	91	9.2	—	9.2	6.5	4.0	2.5	0.4	0.7	0.06	0.001	0.007	0.013	—	0.8	—
November	7.1	104	11.2	—	11.2	7.5	5.0	2.5	0.3	0.5	0.17	0.001	0.012	0.015	traces	1.5	—
December	7.1	119	11.9	—	11.9	8.5	7.1	1.4	0.3	0.5	0.09	0.001	0.006	0.015	—	1.3	—
Average	7.1	121	11.8	—	11.8	8.2	6.5	1.7	0.4	0.6	0.11	0.001	0.008	0.014	—	1.2	—

Municipal Water Supply, Nakorn Sawan
1942

Month	pH value	Electrical conductivity	Total solids	Suspended solids	Dissolved solids	Total hardness	Temporary hardness	Permanent hardness	Chlorides expressed as Chlorine	Chlorides expressed as Sodium Chloride	Oxygen Consumed	Saline ammonia	Albuminoid ammonia	Nitrates expressed as nitrogen	Nitrite	Loss on Ignition	Iron
Jauuary	7.1	135	12.9	—	12.9	9.5	8.0	1.5	0.3	0.5	0.04	0.001	0.004	0.015	—	1.0	—
February	7.1	132	12.4	—	12.4	9.0	8.5	0.5	0.3	0.5	0.03	0.001	0.008	0.015	—	0.8	—
March	7.1	150	14.1	—	14.1	10.5	9.5	1.0	0.3	0.5	0.06	0.002	0.011	0.015	—	1.2	—
April	7.2	152	14.2	—	14.2	10.5	9.6	0.9	0.3	0.5	0.07	0.001	0.008	0.013	—	1.3	—
May	7.2	127	12.4	—	12.4	8.0	7.2	0.8	0.4	0.7	0.17	0.001	0.008	0.012	—	2.0	—
June	7.0	109	10.5	—	10.5	6.5	3.8	2.7	0.4	0.7	0.14	0.001	0.008	0.013	—	1.8	0.01
July	7.0	110	10.8	—	10.8	6.5	3.0	3.5	0.4	0.7	0.13	0.002	0.010	0.014	—	1.6	—
August	7.0	96	10.3	—	10.3	6.5	4.9	1.6	0.3	0.5	0.10	0.002	0.008	0.020	—	1.2	0.01
September	7.0	97	10.4	—	10.4	6.0	2.9	3.1	0.5	0.8	0.12	0.001	0.014	0.016	—	1.4	0.01
October																	
November	7.0	110	11.2	—	11.2	7.0	5.4	1.6	0.4	0.7	0.14	0.001	0.007	0.029	—	1.7	0.01
December	7.0	125	13.1	—	13.1	9.0	4.8	4.2	0.2	0.3	0.10	0.001	0.004	0.014	—	1.3	—
Average	7.1	122	12.0	—	12.0	8.1	6.1	2.0	0.3	0.6	0.10	0.001	0.008	0.016	—	1.4	—

Municipal Water Supply, Lopburi
1941

Month	pH value	Electrical conductivity	Total solids	Suspended solids	Dissolved solids	Total hardness	Temporary hardness	Permanent hardness	Chlorides expressed as Chlorine	Chlorides expressed as Sodium Chloride	Oxygen consumed	Saline ammonia	Albuminoid ammonia	Nitrates expressed as nitrogen	Nitrite	Loss on Ignition	Iron
January																	
February																	
March	7.6	475	40.9	—	40.9	34.5	34.5	nil	0.7	1.2	0.03	0.002	0.004	0.014	traces	0.9	—
April	7.4	395	34.7	0.2	34.5	29.0	28.5	0.5	0.7	1.2	0.08	0.001	0.004	0.010	—	1.3	—
May	7.6	465	42.1	—	42.1	36.5	36.0	0.5	0.7	1.2	0.09	0.001	0.005	0.013	—	1.5	—
June	7.4	410	35.4	—	35.4	28.0	25.2	2.8	0.7	1.2	0.05	0.001	0.003	0.013	—	1.4	—
July	7.6	475	45.3	—	45.3	38.0	37.2	0.8	0.7	1.2	0.03	0.001	0.006	0.012	—	1.3	—
August	7.6	470	44.3	1.3	43.0	37.0	36.5	0.5	0.7	1.2	0.05	0.001	0.004	0.010	—	1.3	—
September	7.6	460	41.8	—	41.8	36.5	36.3	0.2	0.7	1.2	0.06	0.001	0.006	0.013	—	1.1	—
October	7.6	450	41.0	—	41.0	36.5	36.1	0.4	0.7	1.2	0.03	0.001	0.004	0.012	—	0.9	—
November	7.5	420	37.9	0.4	37.5	33.0	32.8	0.2	0.7	1.2	0.06	0.001	0.005	0.014	—	1.2	—
December	7.3	380	32.4	0.8	31.6	24.5	23.4	1.1	0.7	1.2	0.08	0.001	0.007	0.018	—	1.7	—
Average	7.5	440	39.6	—	39.3	33.4	32.7	0.7	0.7	1.2	0.06	0.001	0.005	0.013	—	1.3	—

Municipal Water Supply, Lopburi
1942

Month	pH value	Electrical conductivity	Total solids	Suspended solids	Dissolved solids	Total hardness	Temporary hardness	Permanent hardness	Chlorides expressed as Chlorine	Chlorides expressed as Sodium Chloride	Oxygen consumed	Saline ammonia	Albuminoid ammonia	Nitrates expressed as nitrogen	Nitrite	Loss on Ignition	Iron
January	7.4	400	35.9	—	35.9	31.0	30.5	0.5	0.7	1.2	0.03	0.001	0.004	0.014	—	1.0	—
February	7.4	450	40.2	—	40.2	35.0	34.7	0.3	0.7	1.2	0.04	0.001	0.004	0.017	—	1.2	—
March	7.3	430	37.1	—	37.1	26.0	25.8	0.2	0.7	1.2	0.01	0.002	0.008	0.012	traces	0.9	—
April	7.5	380	41.0	—	41.0	29.5	29.4	0.1	0.7	1.2	0.05	0.001	0.004	0.015	traces	1.4	—
May	7.6	460	41.3	—	41.3	37.0	36.6	0.4	0.8	1.3	0.04	0.001	0.005	0.013	—	1.3	—
June	7.5	455	41.7	—	41.7	28.0	27.9	0.1	0.7	1.2	0.01	0.001	0.003	0.012	—	1.0	—
July	7.6	455	41.8	—	41.8	37.0	36.8	0.2	0.7	1.2	0.03	0.001	0.004	0.013	—	1.0	—
August	7.5	380	36.8	—	36.8	26.5	26.2	0.3	0.7	1.2	0.04	0.001	0.003	0.015	—	1.5	—
September	7.6	455	42.0	0.5	41.5	33.5	33.2	0.3	0.8	1.3	0.07	0.001	0.003	0.014	—	1.5	—
October	7.5	395	37.2	—	37.2	27.0	25.8	1.2	2.2	3.6	0.01	0.001	0.005	0.018	—	1.9	—
November	7.6	450	42.2	0.5	41.7	36.0	35.6	0.4	1.0	1.6	0.07	0.002	0.006	0.014	traces	1.5	—
December	7.4	320	32.3	—	32.3	23.5	23.2	0.3	0.9	1.5	0.08	0.001	0.006	0.017	—	1.5	—
Average	7.5	419	39.1	—	39.0	30.8	30.5	0.4	0.9	1.5	0.05	0.001	0.005	0.015	—	1.3	—

Municipal Water Supply Nakorn Pathom
1942

Month	pH value	Electrical conductivity	Total solids	Suspended solids	Dissolved solids	Total hardness	Temporary hardness	Permanent hardness	Chlorides expressed as Chlorine	Chlorides expressed as Sodium Chlorid	Oxygen consumed	Saline ammonia	Albuminoid ammonia	Nitrates expressed as nitrogen	Nitrite	Loss on Igniton	Iron
January	7.3	380	34.5	0.1	34.4	27.0	26.1	0.9	2.7	4.5	0.05	0.001	0.004	0.005	—	0.7	—
February	7.3	380	34.1	—	34.1	27.0	26.4	0.6	2.7	4.5	0.01	0.001	0.003	0.004	—	0.8	—
March	7.3	375	34.3	—	34.3	27.0	25.5	1.5	2.7	4.5	0.02	0.001	0.004	0.005	—	1.2	—
April	7.4	365	32.1	—	32.1	22.5	20.9	1.6	2.7	4.5	0.01	0.001	0.006	0.005	traces	1.0	—
May	7.5	375	34.8	—	34.8	27.5	26.0	1.5	2.7	4.5	0.03	0.001	0.005	0.005	—	1.3	—
June	7.5	375	34.5	—	34.5	27.0	26.4	0.6	2.7	4.5	0.01	0.001	0.003	0.003	—	1.2	—
July	7.5	375	34.3	—	34.3	27.0	26.2	0.8	2.7	4.5	0.04	0.001	0.004	0.005	—	1.6	—
August	7.5	380	34.9	—	34.9	27.5	26.5	1.0	2.7	4.5	0.03	0.001	0.003	0.008	—	1.4	—
September	7.5	375	34.9	—	34.9	28.0	25.8	2.2	2.6	4.3	0.03	0.001	0.009	0.010	—	1.2	—
October	7.5	380	35.2	—	35.2	28.0	26.1	1.9	2.7	4.5	0.02	0.001	0.003	0.012	—	1.0	—
November	7.5	380	35.1	—	35.1	28.0	26.3	1.7	2.7	4.5	0.04	0.001	0.004	0.012	—	1.8	—
December	7.4	370	34.3	—	34.3	26.0	22.7	3.3	2.6	4.3	0.04	nil	0.003	0.014	—	1.9	—
Average	7.4	376	34.4	—	34.4	26.9	25.4	2.5	2.7	4.5	0.03	0.001	0.004	0.007	—	1.1	—

TRAINEES AND VISITORS. FROM OTHER DEPARTMENTS

In 1941 a number of instructors in the School of Forestry, Prae, were sent here by the Forest Department to study certain technique. They were given a thorough training in the making of permanent profiles of earth samples and in the determination of calorific values of wood by the Bomb Calorimeter Method.

In 1942 the Government Paper Mill sent some of its officials to study the methods of analysis of materials used in the paper making industry.

The Penitentiary Department sent some officials here to study methods of dyeing textiles with native vegetable dyes. These officials would then become instructors to the inmates of prisons all over the country.

On the 15th of September 1941 the Military Academy sent here 168 second year cadets to see for themselves the working of the different sections of the Department. The heads of sections and divisions obligingly explained the various activities under their supervision to the visiting cadets.

STATISTICS FOR 1941–1942

From	Items	No. of Samples 1941	1942
Ministry of Finance			
Department of Customs	Fuel oil	225	10
	Lubricating oil	14	—
	Butter and Milk	161	8
	Milk and Food Powder	20	1
	Chinese Liquors	23	25
	Harmful Habit Forming Drugs	—	5
	Imports to determine Alcoholic Strength	2	—
	Wood Naphtha	13	—
	Textiles	67	27

From	Items	No. of Samples 1941	1942
	Edibles	—	3
	Metals	5	—
	Fats and oils	28	13
	Paper	3	—
	Germicide, Insecticide and Fungicide	29	—
	Mineral oil	2	—
	Medicines and Chemicals	23	9
	Ores	—	4
	Miscellaneou	2	—
	Total	617	105
Excise Department	Raw opium	40	75
	Prepared opium	19	47
	Opium dross	1008	511
	Opium, morphine suspects	23	25
	Liquors and allied products	45	—
	Metals	20	24
	Miscellaneous	1	5
	Total	1156	687
Treasury Department	Silver	5964	2012
	Gold	824	1
	Copper	420	419
	Tin	6	6992
	Zinc	6	—
	Acids	22	—
	Miscellaneous	1	1
	Total	7243	9425
Ministry of Agriculture Department of Land and Mines	Wolfram ores	226	196
	Tin ores	107	249
	Other ores	23	17
	Rocks, Sands and Soils	2	—
	Gold	22	24
	Total	380	486

From	Items	No. of Samples 1941	1942
Department of Agriculture and Fishery	Water	1	—
	Soils	168	170
	Fertilizer	—	1
	Cattle Feeds	6	—
	Plants	7	—
	Total	182	171
Co-operative Department	Water	5	—
	Salt	9	1
	Total	14	1
Forestry Department	Plants and seeds	6	29
	Vegetable products	—	4
	Total	6	33
Animal Husbandry Department	Cattle feeds	—	3
	Total	—	3
Irrigation Department	Mineral oil	1	—
	Chemicals	—	4
	Total	1	4
Ministry of Interior Changvad, Amphur Councils	Poison suspects	12	1
	Harmful habit forming drug (suspected)	1	—
	Morphine (suspected)	2	—
	Blood stains	13	3
	Fire arm and explosives	—	2
	Fish sauce	15	—
	Ores	8	—
	Rocks and soils	—	123
	Salt	—	13
	Miscellaneous	9	5
	Total	60	147

From	Items	No. of Samples 1941	1942
Penitentiary Department	Medicinal herb	1	—
	Ores	1	2
	Total	2	2
Police Department	Blood stains	62	93
	Fire arms and explosives	38	32
	Harmful habit forming drugs (suspected)	9	11
	Poison (suspected)	28	17
	Seminal stains	3	7
	Forgeries	—	22
	Foodstuffs	15	1
	Medicines and Chemicals	1	11
	Liquors	2	—
	Miscellaneous	12	33
	Total	170	227
Department of Public Health	City Water	82	82
	Water	42	51
	Foodstuffs	58	8
	Harmful habit forming drugs (suspected)	1	2
	Chemical	1	—
	Miscellaneous	8	4
	Total	192	147
Public and Municipal Works Department	Water	119	150
	Alum	3	4
	Chemicals	3	—
	Miscellaneous	2	—
	Total	127	154
City Water Works	Water	23	18
	Alum	5	13
	Total	28	31

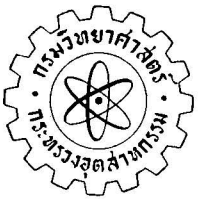
From	Items	No. of Samples 1941	1942
City Electric Supply	Water	2	—
	Total	2	—
Ministry of Economic Affairs.			
Department of Commerce	Foods	11	1
	Textiles	4	—
	Cosmetics	12	—
	Medicines and Chemicals	6	2
	Coal and Ores	20	—
	Paper	1	1
	Oils	1	3
	Miscellaneous	31	2
	Total	86	9
Department of Science	Water (from the Menam)	519	726
	Foodstuffs	28	14
	Medicines and beverages	39	11
	Chemicals	2	5
	Ores	2	4
	Metals	4	—
	Soils	27	13
	Rocks and Ceramics raw materials	14	—
	Guano	—	22
	Miscellaneous	18	20
	Total	653	815
Department of State Railways	Metals	28	5
	Oils	—	6
	Chemicals	1	1
	Coal	6	—
	Miscellaneous	4	2
	Total	39	14
Post and Telegraph Department	Acids	1	2
	Total	1	2

From	Items	No. of Samples 1941	1942
Ministry of justice	Foodstuffs	8	—
	Documents	6	2
	Total	14	2
Ministry of Comunication			
Department of Ways (Ways Div.)	Oils	1	3
	Metals	—	9
	Coal, Charcoal	—	3
	Miscellaneous	—	19
	Total	1	34
Transport Department	Lubricating oils	—	8
	Total	—	8
Office of the Premier			
Department of Fine Arts	Raw material for casting Buddha's images	4	—
	Total	4	—
Department of Public Welfare	Synthetic lac	1	—
	Modelling Clay	1	—
	Total	2	—
Ministry of Industry			
Industrial Promotion Department	Foodstuffs	—	6
	Medicines	—	5
	Soap	—	6
	Cosmetics	—	2
	Dyes	—	5
	Miscellaneous	—	28
	Total	—	52
Industrial Works Department	Medicines and Chemicals	—	7
	Water, rocks, soils and sands	—	10

From	Items	No. of Samples 1941	1942
	Charcoal and ashes	—	2
	Metal	—	1
	Essence	—	1
	Total	—	21
Council of Ministers Secretariate	Foodstuffs	—	2
	Chemicals	—	2
	Fertilizers	—	2
	Miscellaneous	—	4
	Total	—	10
Ministry of Defence Army Medical Department	Poison (suspected)	1	—
	Total	1	—
Royal Military Survey Department	Chemicals	2	—
	Soils, rocks, and ores	9	—
	Metals	2	—
	Miscellaneous	3	—
	Total	16	—
Military Supply Section	Comestible	1	1
	Medicines and Chemicals	2	—
	Total	3	1
Military Arsenal Section	Tin	—	1
	Ores	2	1
	Miscellaneous	7	3
	Total	9	5
Quartermaster Generals Department	Gold ores	8	—
	Comestibles	7	8
	Oils	—	2
	Metals	—	9
	Chemicals	—	6
	Miscellaneous	—	1
	Total	15	26

From	Items	No. of Samples 1941	1942
Fuel Department	Oil	30	4
	Miscellaneous	—	1
	Total	30	5
Military Scientific Section	Sands	14	—
	Chemicals	—	16
	Metals	—	2
	Miscelleneous	1	7
	Total	15	25
Military Works Section	Vegetable oils	8	—
	Total	8	—
Department of Aeronautical Works	Metals	1	2
	Miscellaneous	—	3
	Total	1	5
Naval Science Laboratory	Fuel	—	1
	Total	—	1
Hydrographic Department	Water	576	539
	Soils	—	108
	Total	576	647
Naval Medical Section	Water	1	—
	Total	1	—
Thai Weaving Mills	Vegetable oil	1	—
	Dyes	—	6
	Total	1	6
Ministry of Commerce Trade Supervision Department	Dye	—	1
	Chemicals	—	5
	Medicines	—	2
	Total	—	8
Department of Commercial Intelligence	Barks	—	2
	Total	—	2

From	Items	No. of Samples 1941	1942
Industrial Promotion Committee	Metals	—	5
	Vegetable and Animal oils	—	2
	Mineral oil	—	1
	Chemicals	—	2
	Soil	—	1
	Miscellaneous	—	2
	Total	—	13
Market Control Committee	Medicines	—	4
	Chemical	—	1
	Dye	—	1
	Total	—	6
Semi-Official Organizations	Ores	—	224
	Chemicals	—	15
	Metals	—	4
	Comestible	—	1
	Miscellaneous	—	1
	Total	—	245
Private	Damaged goods	2	1
	Water	57	3
	Medicines and Chemicals	18	38
	Ores	203	556
	Metals	16	63
	Textiles	2	—
	Foods and beverages	34	33
	Fuel oil	1	—
	Lubricating oil	2	3
	Charcoal	—	73
	Miscellaneous	121	64
	Total	456	834
	Grand total	12,098	14,419



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