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Appropriate methods of treating water and wastewater in developing countries, data requirements

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9. ABSTRACT
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Urban and industrial growth in developing countries has increased the demand for water and the related need for more information on water and sewage treatment. This project, conducted by the University of Oklahoma, focuses on that need by developing a global network of adaptive and innovative technologies based on economic, social, political and cultural factors. A series of detailed reports have been produced that are designed to assist planners in their selection of suitable water and wastewater treatment processes appropriate to the material and manpower resource capabilities of particular countries at particular times.

"Prediction Methodology for Suitable Water and Wastewater Processes," George W. Reid and Richard Discenza.
PN-AAB-491 English
PN-AAD-291 Spanish

"Prediction Methodology for Suitable Water and Wastewater Processes. Supplement I: Manual Computation Methods," George W. Reid and Richard Discenza.
PN-AAD-292

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"Prediction Methodology for Suitable Water and Wastewater Processes. Supplement II: Computer Program," George W. Reid and Richard Discenza.
PN-AAD-293

"Data Requirement," University of Oklahoma Bureau of Water and Environmental Resources Research.
PN-AAD-295

"A Mathematical Model for Predicting Water Demand, Wastewater Disposal and Cost of Water and Wastewater Treatment Systems in Developing Countries," George W. Reid and Michael I. Muiga.
PN-AAD-294

"Treatment Methods for Water Supplies in Rural Areas of Developing Countries," Ir. L. Huisman.
PN-AAD-284
PN-AAD-285

"Sewage Treatment in Developing Countries," L.W. Canter and J.F. Malina.
PN-AAD-286

"Contributions to a Mail Survey on Practical Solutions in Drinking Water Supply and Wastes Disposal for Developing Countries," International Reference Centre for Community Water Supplies, The Hague.
PN-AAD-287

"A Catalog of Water Supply and Waste Disposal Methods for Individual Units," George W. Reid.
PN-AAD-283

"Historic Implication for Developing Countries of Developed Countries' Water and Wastewater Technology," George W. Reid and Kay Coffey.
PN-AAD-288

"Evaluation of Lower Cost Methods of Water Treatment in Latin America," Odyer A. Sperandio and Jose Perez C.
PN-AAD-289

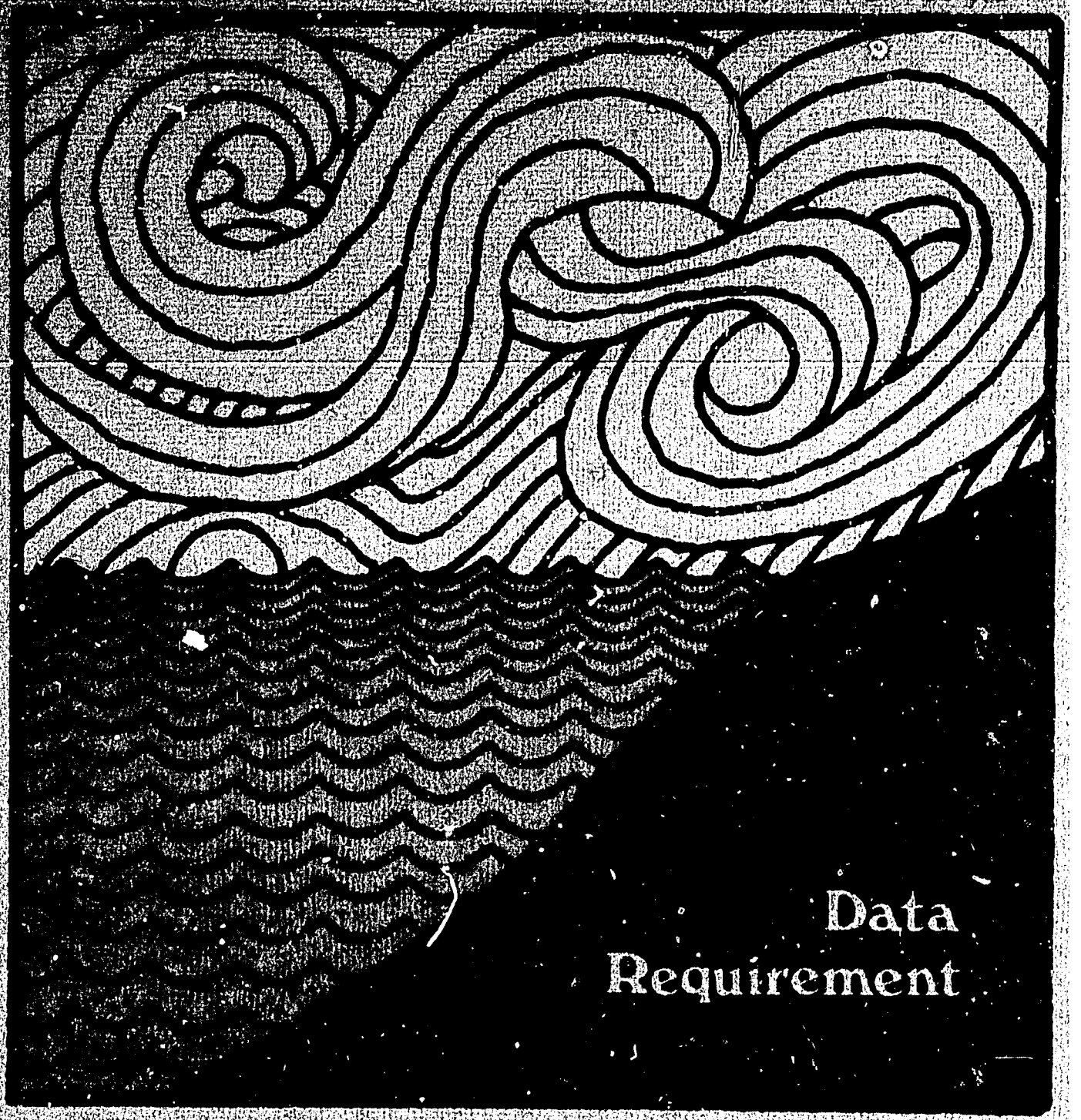
"Socio-Economic Conditions which Pertain to Cost of Construction and Operation of Water and Sewage Treatment Facilities and Quality of Water Consumption in Kenya," Erasto Muga.
PN-AAD-290

"A Water Sterilization Study in the Philippines," Reynaldo M. Lesaca.
PN-AAD-282

"The Study of Microbial Treatment of Nightsoil," Taiwan Institute of Environmental Sanitation.
PN-AAD-281

"Study of an Existing Water Treatment Plant on Simple Design and Operating System for Supplying Drinking Water to Rural Communities in the Lower Mekong Basin Countries," Thailand Ministry of Public Health, Department of Health, Rural Water Supply Division.
PN-AAD-280

AID/ENH, EU-C-78-1
PN-AAD-245



APPROPRIATE METHODS OF TREATING WATER AND WASTEWATER IN DEVELOPING COUNTRIES

THE UNIVERSITY OF OKLAHOMA
BUREAU OF WATER AND ENVIRONMENTAL RESOURCES RESEARCH
Sponsored by: U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C.

Appropriate Methods of Treating Water And Wastewater In Developing Countries

DATA REQUIREMENTS

Compiled by

The University of Oklahoma
Bureau of Water and Environmental
Resources Research
Norman, Oklahoma 73069

October 1975

FROM THE AUTHORS

The data requirement forms have been sent out several times for field validation. The format and contents have also been modified many times. However, in order to keep these forms up to date and useful, continuous modifications and improvements are necessary. Therefore, any suggestions on the content or the format of these data forms will always be welcomed. Please send your suggestions to:

Professor George W. Reid or Dr. Silas Law
The Bureau of Water & Environmental Resources Research
The University of Oklahoma
202 West Boyd, Room 301
Norman, Oklahoma 73069 U. S. A.

INTRODUCTION

The University of Oklahoma is conducting a project which will develop methodology to assist in the selection of the most appropriate water and wastewater treatment technology for sites in developing countries. The project involves and will produce reports on:

1. A state of the art study.

2. Data collection and reduction formats.

3. Development of a global network of adaptive and innovative technology for water and wastewater treatment process studies that involves unique and adaptive technology.

4. Development of a prediction model to help planners select suitable water and wastewater treatment processes appropriate to the material and manpower resources capabilities of particular countries at particular times.

It is important that the overall project look at and collect simular and standard information. For this purpose that data has been formatted by the following categories:

1. A mailing by IRC/NL on Innovative or Practical Application of Technology (not included herein).

2. A mailing by OU on Water Demands (not included herein).

3. Basic information necessary to use the Predictive Model - Data Form A and B. This is for all model validation studies, either as users or confirmation testing.

4. Process Information - Data Forms C, D, E and F. This is for detailed analyses of individual technology, its characterization its preferences and suggested analytical tests.

These data are formatted for completeness, easy comparison and easy reduction by a computer. Obviously, some data will not be available, others, particularly those studying processes, will want technological process evaluation data, such as turbidity vs. loading, etc. which is not being formatted herein.

LIST OF DATA FORMS

Data Form A: Demographic Data

Data Form B: Socio-Economic Data

Data Form C: Process Data

Data Form D: Analytical Tests

Data Form E: Operational Data

Data Form F: Facility Construction Cost Data

INSTRUCTIONS

1. Each project will need to fill out the appropriate Data Forms.

2. Any project in planning stage will need to fill out Data Form A (Demographic Data) and Data Form B (Socio-Economic Data).

3. Any project or process already in existence will need to fill out Data Form A, B, C (Process Data), E (Operational Data), and F (Facility Construction Cost Data).

4. If two projects are in the same community, one Data Form A and Data Form B can be used for both projects.

" Data Form D does not need to be filled out. It only shows all the tests which can be conducted by the water test field Kit I, II and III

DATA IDENTIFICATION

FACILITY TITLE:

RESPONDENT:

Name: _

Title: _

Address:

OWNERSHIP OF THE FACILITY

Owner's Address:

NAME OF COMMUNITY TO BE SERVED BY THE FACILITY:

Town or City: _____

State or Province: _

Country: _____

DATA FORM A

DEMOGRAPHIC DATA

Please check the appropriate category in each question. If exact figures are not available, give the closest estimate.

1. Present Population Served - The figure or estimate of the present population served should reflect the number of inhabitants that are being served by the present water or waste water treatment facility.

Actual population _____ or estimate the following:

___ (1) Between 500 and 2,500 people
___ (2) 2,500 - 15,000
___ (3) 15,000 - 50,000
___ (4) 50,000 - 100,000
___ (5) Other (specify) _____
___ (6) Source of estimate _____.

2. Annual population growth rate of the local community.

___ (1) Less than 1%
___ (2) 1% - 1.5%
___ (3) 1.5% - 2.0%
___ (4) 2.0% - 2.5%
___ (5) 2.5% - 3.0%
___ (6) 3.0% - 3.5%
___ (7) 3.5% - 4.0%
___ (8) Greater than 4%
___ (9) Source of this estimate _____.

3. Total Community Population estimate at last census _____.
Date of Census _____ Source of Census _____.
Annual Growth rate at time of last census or present annual growth rate _____.

DATA FORM B

SOCIO-ECONOMIC DATA

Check the appropriate category for the following.

1. Approximate level of education obtained by inhabitants living in the community.

Level	None	Primary	High School	Technical Institute	College
___ (1)	95%	4%	1%	0%	0%
___ (2)	70%	19%	7%	3%	1%
___ (3)	55%	22%	14%	6%	3%
___ (4)	9%	34%	42%	8%	7%

___ (5) Others (specify) _____

2. Approximate distribution of Labor Force in the community.

Level	Unskilled	Semi-Skilled	Professional
___ (1)	97%	2%	1%
___ (2)	80%	16%	4%
___ (3)	61%	27%	12%
___ (4)	45%	30%	25%

3. Average annual income per family in your country currency.

_____ amount _____ unit

If available, also check the approximated U. S. dollars equivalency of this amount shown in the following

___ (1) Less than $100

___ (2) $100 - $500

___ (3) $500 - $1,000

___ (4) $1,000 - $3,000

___ (5) Greater than $3,000

4. Among the highly skilled and technical workers (for example, engineer, chemist, etc.) what percentages of these are non-local or non-native people ?

____ (1) Less than 10%
____ (2) 10% - 25%
____ (3) 25% - 50%
____ (4) 50% - 75%
____ (5) 75% - 100%

5. Are there any primary and secondary schools operated by voluntary or missionary organizations rather than by the government itself?

____ (1) Yes ____ (2) No
If answer is yes, what percentage? _____%

6. What is the highest grade offered by any local schools on a regular basis? (Circle one)

1 2 3 4 5 6 7 8 9 10 11 12 12+

7. If the number selected in #6 above is less than 12, how far away is the nearest high school offering the 12th grade?

____ (1) Less than 10 miles (or less than 16 kilometers)
____ (2) 10 - 30 miles (or 16 - 48 kilometers)
____ (3) 30 - 50 miles (or 48 - 80 kilometers)
____ (4) Greater than 50 miles. (greater than 80 kilometers
____ (5) Other (specify) _____

8. Are there any technical or vocational schools in the local community?

____ (1) Yes ____ (2) No

9. Has the community achieved compulsory primary education of at least six years?

____ (1) Yes ____ (2) No

If answer is yes, when? _____

10. Are there any formal in-service training programs in the community sponsored by either the government, trade organization, or local industry for their employees?

11. Is there a college or university in the community?

____ (1) Yes ____ (2) No

12. Does the university have a chemistry department or laboratory?

____ (1) Yes ____ (2) No

13. How do you rate the ability of the community to finance a water and sewage treatment project?

___ (1) Unable to repay; the project is a gift because the beneficiaries are poor.

___ (2) Limited ability to repay; however, the benefits exceed the costs.

___ (3) Repayment prospects are good; the beneficiaries have relatively high incomes.

14. Is unemployment widespread by local standard?

___ (1) Yes ____ (2) No

If available, give the percentage of unemployment among the total population.

_____% of unemployment

15. Are advisory services widely available to farmers for community development or for other programs designed to upgrade the skills and enlist the participation of the inhabitants?

___ (1) Yes ____ (2) No

16. Do most college or university students of the community receive their education in neighboring communities, neighboring countries, or other foreign countries?

___ (2) Yes ___ (2) No

17. The level of technology available can generally be classified as

___ (1) Hand tools only
___ (2) Mechanical tools (i.e., gasoline powered equipment)
___ (3) Chemical products (i.e., fertilizers, chlorine, pharmacentical)
___ (4) Electronic technology (i.e., televisions, computers)

18. Is the government the primary employer of workers?

___ (1) Yes ___ (2) No

19. Are public employment services readily available?

___ (1) Yes ___ (2) No

Questions 20-23 relate to the availability of materials and equipment not directly related to the application of water and wastewater control. Check those items that are NEVER available in the Community.

20. Operation: Which of the following are NEVER available in the local Community?

___ (1) Water meters
___ (2) Soldering equipment
___ (3) Acetylene torches
___ (4) Recording devices, e.g., thermostats
___ (5) Laboratory equipment, e.g., test tubes
___ (6) Portable power plant. e.g., gasoline powered electric
___ (7) Motors, generators, e.g., 1-3 horsepower electric motors
___ (8) Water Pumps

21. Process: Which of the following are NEVER available in the local community?

____ (1) Pipe (clay, steel, cement, plastic, copper, etc.)
____ (2) Pipe fittings
____ (3) Paint
____ (4) Valves
____ (5) Tanks
____ (6) Vacuum Gauges
____ (7) Heat exchangers

22. Operation and Maintenance Supplies: Which of the following are NEVER available in the local community?

____ (1) Silica sand
____ (2) Graded gravel
____ (3) Clean water
____ (4) Gasoline (benzene, petrol)

23. Chemicals: Which of the following are NEVER available in the local community?

____ (1) $Al_2(SO_4)_3$ (aluminum sulfate)
____ (2) $FeCl_3$ (ferric chloride)
____ (3) Activated charcoal
____ (4) CaO (lime)
____ (5) $NaCO_3$ (soda ash)
____ (6) Cl_2 (chlorine)
____ (7) O_3 (ozone)
____ (8) Laboratory chemicals (i.e., normal NaOH, etc.)

24. Major Water Source (check appropriate category)

____ (1) River or stream
____ (2) Lake or impoundment
____ (3) Wells
____ (4) Sea or brackish water

25. Approximate per capita water demand daily (gal/c/d or l/c/d).

(1) Current demands _____ in _____ (units)
(2) 10 year projection: _____

26. Is groundwater available?

____ (1) Yes ____ (2) No

27. Are wells already drilled:

_ (1) Yes ____ (2) No

If answer is yes, current capacity? _____ mgd

Are wells deep (deeper than 100 ft. or 30 mi.) or shallow?

____ (1) Deep ____ (2) Shallow

28. Is a central wastewater (sewage) collection system in existence?

____ (1) Yes ____ (2) No

Is this system separated or combined with storm water drainage?

____ (1) Separated ____ (2) Combined

29. Is the following wastewater (sewage) data available? Please fill in the percentage of people in the community that are:

(1) Currently connected to the system _____%

(2) To be connected within 5 years of the start of the project _____%

(3) To be connected within 10 years _____%

30. Are industrial and commerical concerns using the waste water system and if so, in what quantity? (in thousands of gallons or percentage estimates)

(1) Currently _____ 10^3 gal. or _____ %

(2) Within 5 years _____ 10^3 gal. or _____ %

(3) Within 10 years _____ 10^3 gal. or _____ %

31. What percent of the population in the local community has water supply connected to private home?

____ (1) None
____ (2) 0 - 25%
____ (3) 25% - 50%
____ (4) 50% - 75%
____ (5) 75% - 100%

32. What percent of the population in the local community obtains water supply from central village or street hydrant?

____ (1) None
____ (2) 0 - 25%
____ (3) 25% - 50%
____ (4) 50% - 75%
____ (5) 75% - 100%

33. In the judgement of the respondent, which of the following most appropriately describes the present <u>water treatment facility</u> in the local community if there is one?

Technology Advancement

____ (1) Simply a transfer of a process that had been successful elsewhere.
____ (2) An adaptation of another process but altered to accommodate local characteristics.
____ (3) A unique process developed especially for the characteristics of this site.

Quality of the Facility

____ (4) A breakthrough for enhancing the development of this country.
____ (5) An important feature for the local people but not significant to overall development of the country.
____ (6) Of little use to the local people.

34. In the judgement of the respondent, which of the following most appropriately describes the <u>wastewater treatment facility</u> in the local community if there is one?

Technology Advancement

____ (1) Simply a transfer of a process that had been successful elsewhere.
____ (2) An adaptation of another process but altered to accommodate local characteristics.
____ (3) A unique process developed especially for the characteristics of this site.

34. (Continued)

Quality of the Facility

_ (4) A breakthrough for enhancing the development of this country.

_ (5) An important feature for the local people but not significant to overall development of the country.

_ (6) Of little use to the local people.

35. Raw Water and Wastewater Quality in your Community.

A. Raw Water Quality - The purpose of this section is to provide as input to the model the results of tests that have been carried out on the input or raw water. Presently, the results of seven tests are requested; however, only two are required, turbidity and coliform.

(1) *Number of coliforms _____ (MPN/100 ml)

(2) *Turbidity _____ (mg/l or JTU)

(3) BOD _____ (mg/l)

(4) pH _____ (0 → 14)

(5) Dissolved oxygen _____ (mg/l)

(6) Temperature _____ (^{o}C)

(7) Chlorine _____ (mg/l)

B. Wastewater Quality:

(1) *Hardness _____ (mg/l)

(2) *Total dissolved solid _____ (mg/l)

(3) *Dilution _____ (CFS/1000 PE)

(4) *Fe and Mn _____ (mg/l)

* Data needed for the predivtive model.

DATA FORM C

PROCESS DATA

Please supply the following data related to the treatment process of the project. If there is more than one treatment plant, please fill in ONE data sheet FOR EACH PLANT.

For Water treatment process, please fill in PART I; and for Sewage treatment, fill in PART II. Indicate the data either in metric units or in British units.

PART I: WATER TREATMENT PROCESS

1. Title of the process at your plant: _____.

2. Please check the appropriate water treatment process or processes in the following list which fit the one(s) used at your treatment plant.

____ PW1 No-Treatment
- ____ a. Groundwater (not construction, etc.)
- ____ b. Catchment Control

____ PW2 Pre-Treatment
- ____ a. Turbidity/Sand - Plain Sedimentation
- ____ b. Algal Control - Thermocline Control
- ____ c. Copper Sulfate ($CuSO_4$)
- ____ d. Microscreen

____ PW3 Slow Sand Filtration
- ____ a. Conventional, manually cleaned
- ____ b. Upflow
- ____ c. Crossflow (dynamic)
- ____ d. Dual media

____ PW4 Rapid Sand Filter-Conventional
- ____ a. Conventional
- ____ b. Surface Aggitation (air, water, mechanical)
- ____ c. Dual media (sand and artificial)
- ____ d. Upflow

PW5 Rapid Sand Filter - Advanced
____ a. Multi-media (sand, garnet, coal)
____ b. Plate or tube settling
____ c. Polelectrolytes (ionic and anionic)
____ d. Biflow
____ e. Dynamic
____ f. Valve-less

PW6 Softening
____ a. Lime soda
____ b. Zeolite

PW7 Disinfection
____ a. Disinfection-chlorine
____ b. Iodine
____ c. Ozone
____ d. Ultra violite
____ e. Lime, $CuSO_4$
____ f. Energy (Pasteurization)

PW8 Taste Odor - Fe, Mn
____ a. Aeration
____ b. Zeolite
____ c. Chlorine
____ d. Adsorbent - Char.

PW9 Desalting - Salt
____ a. Multiple effect
____ b. Freezing out
____ c. Pressure

PW10 Desalting-Brackish
____ a. Electrodialysis (ED)
____ b. Reverse Osmosis (RO)
____ c. Chemical

PW11 Containment Filters
____ a. Dunbar
____ b. Coconut fiber/charred rice
____ c. Asbestos/charred pine needle

3. Source

____ (1) River or stream

____ (2) Lake or impoundment

____ (3) Wells

____ (4) Sea or brackish water

Sub-treatment methods used

4. Settling

____ (1) Simple sedimentation

____ (2) Coagulation

____ (3) Tube or plate

____ (4) Upflow

____ (5) Coagulation material

____a. $Al_2(SO_4)_3$

____b. $FeCl_3$

____c. Polymer

____d. Other

____ (6) Approximate design criteria used

a. Loading rate, (Q/A)

British Units		Metric Units	
____ (a) Less than 500 gpd/ft^2,	or	____ (a) Less than 20 m/day	
____ (b) 500 - 1,000	or	____ (b) 20 - 40	
____ (c) Greater than 1,000	or	____ (c) Greater than 40	

b. Detention time in hours

____ (a) ½ - 1

____ (b) 1 - 2

____ (c) 2 - 4

____ (d) Greater than 4

c. Mixing: Mean velocity gradient, G (in units of sec^{-1} or ft/sec/ft)

____ (a) 10 - 30

____ (b) 30 - 60

____ (c) 60 - 75

d. Design capacity (Q)

British Units		Metric Units
____ (a) Less than 0.5 MGD	or	____ (a) Less than 0.025 m^3/sec
____ (b) 0.5 - 5	or	____ (b) 0.025 - 0.25
____ (c) 5 - 20	or	____ (c) 0.25 - 1.0
____ (d) Greater than 20	or	____ (d) Greater than 1.0

e. Stirring and/or mixing devices

____ (a) Baffle

____ (b) Impeller (paddle, turbine, propeller)

____ (c) Air

5. Filters

(1) Rate of flow

____a. Slow (0.05 to 0.10 gpm/ft^2 or 0.002 to 0.004 M/min)

____b. Rapid (approximately 2 gpm/ft^2 or 0.08 M/min)

____c. Greater than 2 gpm/ft^2 or 0.08 M/min

(2) Filter media

____a. Sand

____b. Multi-media

____c. Other

(3) Hydraulic mean size (10% by weight of the filter media will pass through this sieve size).

____a. 0.2 mm

____b. 0.6 mm

____c. 1.0 mm

(4) Depth of media

British Units		Metric Units
____a. Less than 40 inches	or	____a. Less than 100 cm
____b. 40 - 50	or	____b. 100 - 125
____c. Greater than 50	or	____c. Greater than 125

(5) Controls for backwash

____a. Mechanical or hydraulic

____b. Simplified or operator controlled

(6) Direction of flow through filter

____a. Upward flow

____b. Downward flow

____c. Both

(7) Control of filtration rate

____a. Rate controller

____b. Declining head

____c. Siphon head

____d. Other (specify) _____

6. Disinfection method

___ (1) Cl_2 (____ gas, or ____ liquid, or ____ HTH)

___ (2) Lime

___ (3) Ultra-violet

___ (4) Ozone

(5) Other

PART II: SEWAGE TREATMENT PROCESS

1. Title of the process at your plant: ____

2. Please check the appropriate treatment process or processes in the following which fit the one(s) used at your treatment plant.

____ PS1 Primary - Conventional
- ____ a. Separate
- ____ b. Combined

____ PS2 Primary Stabilization Pond
- ____ a. Single Cell
- ____ b. Multiple Cell

____ PS3 Sludge - Conventional
- ____ a. Conventional
- ____ b. Heated
- ____ c. Thickened
- ____ d. Staged, including mixing

____ PS 4 Sludge - Advanced
- ____ a. Zimpro-Pyrolysis
- ____ b. Incineration
- ____ c. Fertilizer

____ PS5 Sludge Combined - Imhoff

____ PS6 Secondary - Standard Filter

____ PS7 Secondary - High Rate Filter
- ____ a. Bio-filter
- ____ b. Accelo-filter
- ____ c. Aero-filter
- ____ d. Biosorption-filter

____ PS8 Secondary - Activated Sludge
- ____ a. Min. solids
- ____ b. Conventional

___ PS9 Secondary Extended Aeration (Oxidation Pond)
- ____ a. Dutch ditch
- ____ b. INKA
- ____ c. Aerated lagoon

___ PS10 Disinfection - Chlorine

___ PS11 Aqua - Culture
- ____ a. Fish, culture-milkfish, tilapia, bass
- ____ b. Vascular plants - Hyacinth, Kang Kung
- ____ c. Ecological
- ____ d. Irrigation

___ PS12 Dilution
- ____ a. Coarse screens
- ____ b. Fine screens
- ____ c. Chemical Precipitation, Guggenheim

___ PS13 Individual
- ____ a. Septic tank
- ____ b. Clivus multrum
- ____ c. Sanitary pit privy

___ PS14 Individual (Advanced)
- ____ a. Chemical
- ____ b. Thermal

3. Type of separate sludge treatment

- ____ (1) Anaerobic
- ____ (2) Heated
- ____ (3) Vacuum filter
- ____ (4) Aerobic
- ____ (5) Mixing

4. Sludge disposal

____ (1) Dumped at sea
____ (2) Incineration
____ (3) Used as fertilizer
____ (4) Disposed of as land fill
____ (5) Sludge lagoons
____ (6) Others (specify) _____

5. Design capacity

British Units		Metric Units
____ (1) Less than 0.1 MGD	or	____ (1) Less than 0.004 m^3/sec
____ (2) 0.1 - 1	or	____ (2) 0.004 - 0.05
____ (3) 1 - 5	or	____ (3) 0.05 - 0.25
____ (4) 5 - 10	or	____ (4) 0.25 - 0.5
____ (5) Greater than 10	or	____ (5) Greater than 0.5

6. Solids and Grease Removal

____ (1) Manually cleaned screens
____ (2) Mechanically cleaned screens,

and the Use of Screen is

____ (3) For grit removal only
____ (4) For grease or floating wastes removal only
____ (5) For all purposes (both grit and grease)

7. Primary treatment design

(1) Loading rate in clarifier, (Q/A

British Units		Metric Units
____ a. Less than 750 gpd/ft^2	or	____ a. Less than 30 m/day
____ b. 750 - 1000	or	____ b. 30 - 40
____ c. Greater than 1000	or	____ c. Greater than 40

(2) Detention time (t)

____ a. Less than 1 hour
____ b. 1 - 2 hours
____ c. More than 2 hours

8. Secondary treatment design

(1) Trickling filter

British Units		Metric Units
____ a. 0.1 - 1.0 lb-BOD/yd^3/day	or	____ a. 0.06 - 0.6 Kg-BOD/m^3/day
____ b. 1.0 - 4.5	or	____ b. 0.6 - 2.6
____ c. 4.5 - 6.0	or	____ c. 2.6 - 3.5
____ d. 6.0 - 25	or	____ d. 3.5 - 15
____ e. Greater than 25	or	____ e. Greater than 15

(2) Sand filter loading

British Units		Metric Units
____ a. Less than 50 lb-BOD/acre/day		____ a. Less than 5.0 g-BOD/m^2/day
____ b. 50 - 100	or	____ b. 5 - 10
____ c. 100 - 250	or	____ c. 10 - 28
____ d. 250 - 500	or	____ d. 28 - 56
____ e. Greater than 500	or	____ e. Greater than 56

(3) Activated sludge loading by MLSS (mixed liquor suspended solids), that is, #BOD/#SS.

____ a. 1/1 or less

____ b. 2/1 to 5/1

____ c. 10/1 to 20/1

or by aeration

British Units		Metric Units
____ a. 0 - 30 lb-BOD/1000 CF	or	____ a. 0 - 0.50 Kg-BOD/m^3
____ b. 30 - 60	or	____ b. 0.50 - 1.0
____ c. 60 - 300	or	____ c. 1.0 - 5.0

(4) Aeration devices

____ a. Compressed air

____ b. Brushed

____ c. Surface aerator

____ d. Paddles

____ e. Other (Oxygen, etc.)

(5) Stabilization pond loadin

British Units			Metric Units
____ a. Less than 20 lb-BOD/acre/day		____	a. Less than 2.2 g-BOD/m^2/day
____ b. 20 - 50	or	____	b. 2.2 - 5.5
____ c. 50 - 150	or	____	c. 5.5 - 17
____ d. Greater than 150	or	____	d. Greater than 17

(6) Extended aeration loading

British Units			Metric Units
____ a. Less than 100 lb-BOD/acre/day		____	a. Less than 10 g-BOD/m^2/day
____ b. 100 - 250	or	____	b. 10 - 28
____ c. 250 - 500	or	____	c. 28 - 56
____ d. Greater than 500	or	____	d. Greater than 56

DATA FORM D

ANALYTICAL TESTS

TEST KITS MATRIX

CODE	PROCESSES / TESTS	Algae	Alkalinity	BOD	Carbon Dioxide	Chlorides	Chlorine	COD	Coliform	Color	Dissolved Oxygen	Fe	Hardness	Jar	Mn	NO_3	Odor	Organic Nitrogen	pH	PO_4	Salinity	Suspended Solids	Temperature	Total Dissolved Solids	Turbidity	Volatile Solids
	WATER TREATMENT																									
PW1	No Treatment						K1		K1										K1						K1	
PW2	Pre-Treatment	K1*					K1		K1										K1						K1	
PW3	Slow Sand Filtration						K1		K1										K1			K1*			K1	
PW4	Rapid Sand Filter-Conven.		K2		K2		K2		K2	K2				K2					K2			K2*	K2		K2	
PW5	Rapid Sand Filter-Advanced		K3		K3		K3		K3	K3				K3					K3			K3	K3		K3	
PW6	Softening		K3		K3	K3	K3		K3				K3						K3		K3		K3		K3	
PW7	Disinfection		K3				K3		K3										K3						K3	K3
PW8	Taste Odor-Fe,Mn	K3				K3	K3		K3			K3			K3		K3		K3	K3					K3	
PW9	Desalting-Salt					K3	K3		K3												K3		K3	K3	K3	
PW10	Desalting - Brackish					K3	K3		K3												K3		K3	K3	K3	
PW11	Containment								K1																K1	
	WASTE WATER TREATMENT																									
PS1	Primary - Conventional			K1					K1		K1								K1			K1*	K1			
PS2	Primary - Stabilization Pond	K1*		K1					K1		K1								K1				K1		K1	
PS3	Sludge - Conventional			K2					K2		K2					K2*			K2				K2			
PS4	Sludge - Advanced			K3				K3	K3		K3					K3		K3	K3	K3			K3			
PS5	Sludge - Combined Imhoff			K2				K2*	K2		K2					K2*		K2*	K2			K2	K2			
PS6	Secondary - Standard Filter			K2				K2*	K2		K2											K2	K2			
PS7	Secondary-High Rate Filter			K3				K3	K3		K3											K3	K3			K3
PS8	Secondary-Activated Sludge			K3				K3	K3		K3											K3	K3			K3
PS9	Secondary-Ext. Aeration (Ox.Pd)			K3				K3	K3		K3											K3	K3			K3
PS10	Disinfection - Chlorine			K3			K3	K3	K3														K3			
PS11	Aqua-Culture	K3	K3	K3				K3	K3		K3									K3		K3	K3	K3*		K3
PS12	Dilution			K2*					K2		K2											K2	K2	K2*		
PS13	Individual								K1																	
PS14	Individual - Advanced								K1																	

Note: K1 Tests run by Kit I for Level I processes.
K2 Tests run by Kit II for Level II processes
K3 Tests run by Kit III for level III process.

* Proposed test, may not be in the kit.

DATA FORM E

OPERATIONAL DATA

Please check the appropriate category related to the operation of the treatment plant.

1. Type of treatment plant.

____ (1) Water treatment

____ (2) Sewage treatment

OPERATORS

2. Availability of trained or skilled operators

____ (1) Easy to find

____ (2) Difficult to find

3. Existence of a standard or system for evaluating the qualifications of operators

____ (1) Yes

____ (2) No

4. Short course or other training programs available for operators

____ (1) Yes

____ (2) No

5. Reason for leaving employment at the treatment plant

____ (1) Better job

____ (2) Discharged

____ (3) Others (specify) _____

6. Average age of operators

____ (1) Less than 20 years old

____ (2) 20 - 30

____ (3) 30 - 40

____ (4) Older than 40

7. Quality of operators

____ (1) Not dependable

____ (2) Fair

____ (3) Good

____ (4) Excellent

CHEMICALS

8. Location (distance) for obtaining chemicals

____ (1) Local

____ (2) In-country

____ (3) Out-of-country

9. Availability of chemicals

____ (1) Easy to obtain locally

____ (2) Difficult to obtain locally

____ (3) Easy to obtain non-locally

____ (4) Difficult to obtain non-locally

MACHINERY, PARTS, ETC.

10. Cause of machinery breakdown

____ (1) Operator error

____ (2) Product failure

____ (3) Others (specify) _____

11. Time interval for replacement of machinery or parts

____ (1) Too often as compared to the expected life of the item

____ (2) Not so often as compared to the expected life of the item

____ (3) Routine replacement

12. Delivery time of ordered parts

____ (1) Less than 1 week

____ (2) Between 1 and 4 weeks

____ (3) Between 1 and 6 months

____ (4) Between 6 months and a year

____ (5) More than one year

13. Parts replaced are usually

____ (1) Ordered specially

____ (2) Off the shelf (common parts)

____ (3) Other (specify) (e.g. ordered from out-of-country)

14. Repair of machinery

____ (1) Repaired locally

____ (2) Repaired in-country

____ (3) Repaired out-of-country

____ (4) No repair, replaced by new one

OPERATIONAL FAILURE (TECHNICAL)

15. Characteristic of raw water causing difficulty in treatment

____ (1) Turbidity

____ (2) Algae

____ (3) Other (specify) _____

16. Operational failure due to the following

____ (1) Storage, describe: _____

____ (2) Pumps, describe: _____

____ (3) Lack of water

____ (4) Other (specify) _____

17. Failure due to the process design.

____ (1) Under-designed

____ (2) Improper design

____ (3) Adequate design. Why _____

____ (4) Other (specify) _____

SUPERVISORY CONTROL

18. Inspection of plant

____ (1) Regular inspectio

____ a. Local

____ b. Regional

____ c. National

____ d. Other (specify

____ (2) Active supervision at the plan

____ (3) Other (specify) _____

19. Laboratory location available for testing water samples.

____ (1) At the plant

____ (2) Regional

____ (3) Central (National)

____ (4) Mobile

____ (5) Non-existent

PROBLEMS NOT SOLVED BY PRESENT FACILITY

20. Technical problems of effluent

____ (1) Odor of water

____ (2) Taste of water

____ (3) Color of water

____ (4) Turbidity of water

____ (5) None

____ (6) Other (specify) _____

21. Monetary problems in operations

____ (1) Extreme difficulty in financing

____ (2) Moderate difficulty in financing

____ (3) No problems

OTHERS

22. Operational cost and capacity

(1) Capacity in million gallons/day or in m^3/day.

_____ Amount _____ Unit

(2) Total annual operational cost

_____ Amount _____ Currency Unit

(3) Annual operational cost for personnel (payroll)

_____ Amount _____ Currency Unit

23. Administrative problems

____ (1) Personnel

____ (2) Managerial

____ (3) Supervisory

____ (4) None

____ (5) Others (specify) _____

DATA FORM F

FACILITY CONSTRUCTION COST DATA

Please answer the following related to the construction cost of the project. If there are more than one facility involved, please fill in ONE questionnaire FOR EACH.

1. Type of treatment: check whether it is water or sewage treatment.

____ Water treatment

Type of process: _____

____ Sewage treatment

Type of process: _____

2. (1) Year the plant was built _____

(2) Population served by the plant _____

(3) Construction cost in U.S. dollars $_____

or construction cost in your country's currency _____ _____

amount currency

3. Percent of total cost for labor

____ (1) Less than 10%

____ (2) 10% - 25%

____ (3) 25% - 50%

____ (4) 50% - 75%

____ (5) 75% - 90%

____ (6) Greater than 90%

4. Percent of total cost for material

____ (1) Less than 10%

____ (2) 10% - 25%

____ (3) 25% - 50%

____ (4) 50% - 75%

____ (5) 75% - 90%

____ (6) Greater than 90%

5. Percent of total cost for engineering fee

____ (1) Less than 2%

____ (2) 2% - 4%

____ (3) 4% - 6%

____ (4) 6% - 10%

____ (5) Greater than 10%, specify percentage ____%.

6. Percent <u>of the total labor cost</u> spent for <u>skilled</u> labor

____ (1) Less than 25%

____ (2) 25% - 50%

____ (3) 50% - 75%

____ (4) Greater than 75

7. Approximate daily wage for <u>unskilled</u> labor in your country's currency

amount currency unit

and if available, please check the category of U. S. dollar equivalent shown below

____ (1) Less than $1/day

____ (2) $1 - $3/day

____ (3) $3 - $5/day

____ (4) $5 - $10/day

____ (5) $10 - $15/day

____ (6) More than $15/day

8. Approximate daily wage for <u>skilled</u> labor in your country's currency

_____ _____

amount currency unit

and if available, please check the category of U. S. dollar equivalent shown below

____ (1) Less than U. S. $2/day

____ (2) $2 - $5/day

____ (3) $5 - $10/day

____ (4) $10 - $15/day

____ (5) $15 - $20/day

____ (6) More than $20/day

9. In terms of the total cost spent for material, what percent was spent for material that was found in-country?

____ (1) Less than 10%

____ (2) 10% - 25%

____ (3) 25% - 50%

____ (4) 50% - 75%

____ (5) 75% - 100%