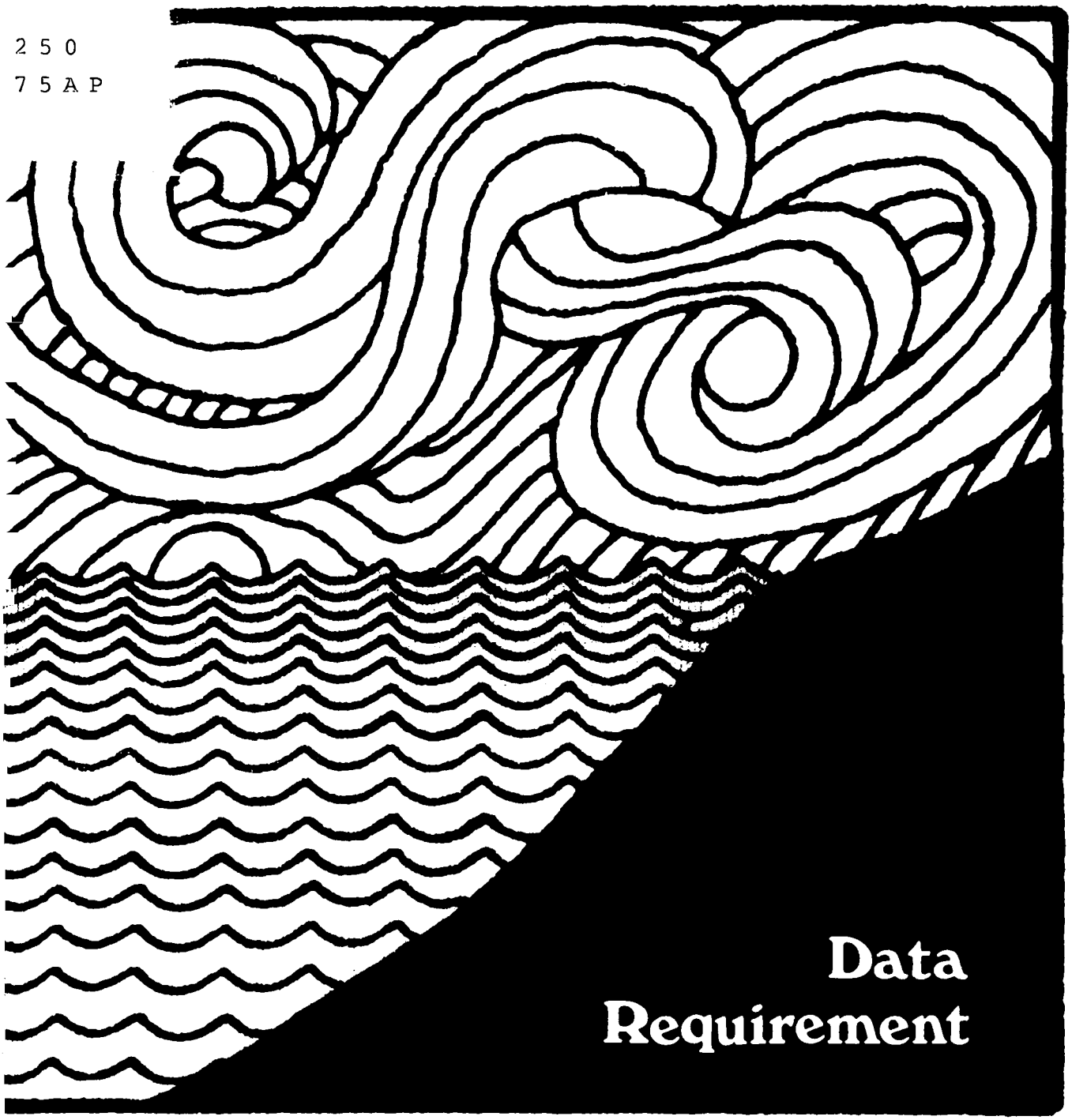


# APPROPRIATE METHODS OF TREATING WATER AND WASTEWATER IN DEVELOPING COUNTRIES

THE UNIVERSITY OF OKLAHOMA
BUREAU OF WATER AND ENVIRONMENTAL RESOURCES RESEARCH

Sponsored by: U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON

# 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



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## 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:

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# 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.
5. 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?

____ (1) Yes ____ (2) No

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 water treatment facility 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 wastewater treatment facility 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/1 or JTU)

(3) BOD _____(mg/1)

(4) pH _____(0 → 14)

(5) Dissolved oxygen _____(mg/1)

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

(7) Chlorine _____(mg/1)

B. Wastewater Quality:

(1) *Hardness _____(mg/1)

(2) *Total dissolved solid _____(mg/1)

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

(4) *Fe and Mn _____(mg/1)

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* 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/

____ (a) 10 - 30

____ (b) 30 - 60

____ (c) 60 - 75

d. Design capacity (Q)

| British Units | | Metric Units | |
|---|---|---|---|
| ____ (a) | Less than 0.5 MGD | ____ (a) | Less than 0.025 $m^3/s$ |
| ____ (b) | 0.5 - 5 | ____ (b) | 0.025 - 0.25 |
| ____ (c) | 5 - 20 | ____ (c) | 0.25 - 1.0 |
| ____ (d) | Greater than 20 | ____ (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-filte·
- ____ 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 loading

| | British Units | | | Metric Units |
|---|---|---|---|---|
| ____ | a. Less than 20 lb-BOD/acre/day | | ____ | a. Less than 2.2 g-BOD/$m^2$ |
| ____ | 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/$m^2$/d |
| ____ | 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 | WATER TREATMENT | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 processes.

* 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 inspection

____ a. Local

____ b. Regional

____ c. National

____ d. Other (specify) _____

____ (2) Active supervision at the plant

____ (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 of the total labor cost spent for skilled labor

____ (1) Less than 25%
____ (2) 25% - 50%
____ (3) 50% - 75%
____ (4) Greater than 75%

7. Approximate daily wage for unskilled 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 skilled 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%