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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

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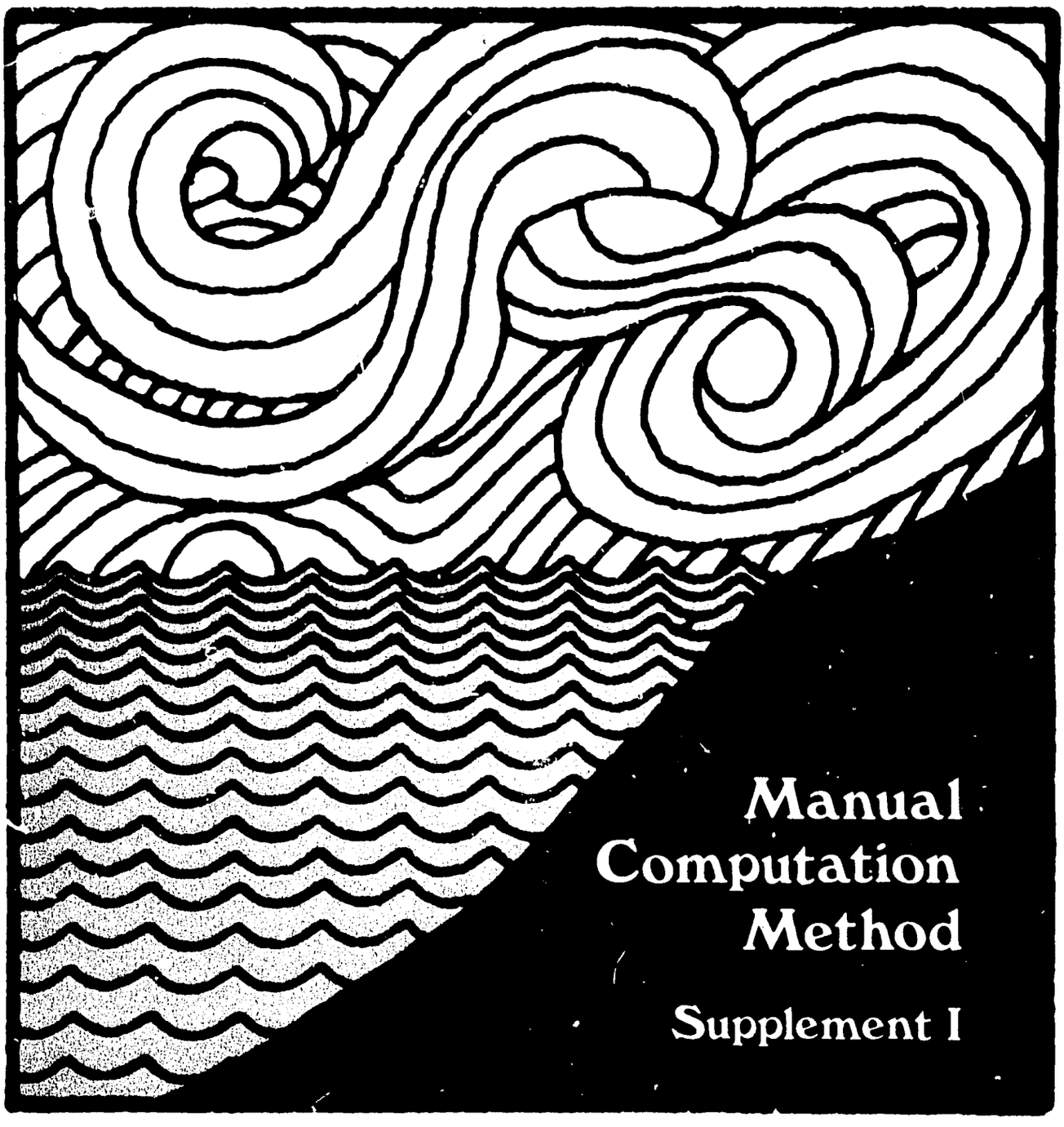

Manual Computation Method

Supplement I

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.

PREDICTION METHODOLOGY FOR SUITABLE WATER & WASTEWATER PROCESSES

SUPPLEMENT I

MANUAL COMPUTATION METHOD

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INTRODUCTION

The selection of the most appropriate water and wastewater treatment method for developing countries by using the predictive model is not limited to situations where an electronic computer is available. A manual computation method has also been devised. The purpose of this supplement is to present the manual computation method in a step by step manner so that a planner can take advantage of the systematic approach developed within the computerized model. The steps presented yield the same results as the computerized approach. This supplement will only deal with the simple manual computation method. The detail approach of the model is not included here and it should be found in the model publication.

The twelve steps to manually determine the most plausible treatment method are as follows:

1. Assign weights to the data sheet questions necessary for determining the STL level for the community under consideration. Weighting factors are shown in Table 1, and an example of a complete data sheet is shown in Figure 1 on page B-1 to B-8.

2. Total the assigned weights as specified in Table 1 for each of the designed individual questions.

3. Compare the above total to Table 2 to determine the socio-technical level of the community.

4. Determine the operation equipment availability.

5. Determine the process materials availability.

6. Determine the operation and maintenance supplies available.

7. Determine the chemical supplies availability.

Table 1. Data Sheet Weighting Factors for Technology Level Determination for Communities in Less Developed Countries.

Variable Description	Data Sheet Part III Question No.'s 1-19	Feasible Choices	Weighting Factor
Level of Educ.	1	1	0
		2	5
		3	10
		4	15
Distribution of Labor force	2	1	0
		2	5
		3	10
		4	15
Income Characteristics	3	1	0
		2	4
		3	8
		4	12
		5	15
% non-idigenous workers in Gov't and Industry	4	1	4
		2	3
		3	2
		4	1
		5	0
School operators	5	1	0
		2	5
Highest grade offered by local	6	0	0
		1-6	2
		7-10	4
		11-12	7
		12+	10
Distance to nearest high school	7	1	3
		2	2
		3	1
		4	0
Availability of technical & vocational training	8	1	5
		2	0
Compulsory Primary Education	9	1	10
		2	0
Availability of inservice training programs	10	1	5
		2	0
Local College or University	11	1	10
		2	0
Chemistry in local college	12	1	3
		2	0
Unemployment level	14	1	0
		2	5
Availability of extension services	15	1	3
		2	0
Schools of local college students	16	1	0
		2	3
Level of technology available	17	1	0
		2	5
		3	10
		4	15
Gov't as a labor user	18	1	0
		2	5
Availability of public employment services	19	1	5
		2	0

Table 2. Socio-Technical Level (STL) and Their Corresponding Weights

Socio-Technical Level (STL)	Total Weighted Factors
I	1-23
II	24-51
III	51-93
IV	93+

8. Compare the basic processes and their requirements (Table 3) against the physical resource groups (these are determined by Steps 4-7).

9. Compare the various combinations of treatment processes as outlined in Table 4 to the water quality of the community obtained from the data sheet for the community.

10. Compute the population scale as given in the data sheet (Figure 1) according to the following guidelines.

Estimated Population	Population Scale
500 - 2,499	1
2,500 - 14,999	2
15,000 - 49,999	3
50,000 - 100,000	4

11. Determine the total cost of construction and operation over twenty years for the remaining combinations (determined by Step 9) of feasible processes using the appropriate scale (see Step 10) and the appropriate STL level (see Step 3).

12. Select the lowest total cost process or the lowest maintenance cost combination of processes determined by Step 11.

A MANUAL COMPUTATION EXAMPLE

In the preceeding section the basic steps were presented. This section illustrates how to implement these steps. The example data sheet is presented in Figure 1, the Water and Wastewater Treatment Planning Model Data Sheet (page B-1 to B-8).

1. Using the data supplied in Figure 1, assign the correct weights as specified in Table 1.

Data Sheet Question, Part III No.*	Weighting Factor
1	10
2	5

Table 3. Water & Sewage Treatment Processes With Essential Components for Operation

	Treatment Methods \ Process Requirements	Process Number	Manpower Operation			Resources Required				
			Unskilled	Skilled	Professional	Operation Equipment	Process Materials	Maintenance Supplies	Chemical Supplies	Groundwater Availability
WATER PROCESSES	No Treatment	PW1	●				●			●
	Pre-Treatment	PW2	●					●		
	Slow Sand Filtration	PW3	●					●		
	Rapid Sand Filter-Conv.	PW4		●	●	●	●	●	●	
	Rapid Sand Filter-Adv.	PW5		●	●	●	●	●	●	
	Softening	PW6		●	●	●	●	●	●	
	Disinfection	PW7		●		●	●	●	●	
	Taste-Odor - Fe, Mn	PW8		●		●	●	●	●	
	Desalting-Salt	PW9		●	●	●	●	●	●	
	Desalting-Brackish	PW10		●	●	●	●	●	●	
	Containment Filter	PW11	●					●		
WASTE PROCESSES	Primary-Conventional	PS1	●							
	Primary-Stab. Pond	PS2	●							
	Sludge-Conventional	PS3	●	●			●	●	●	
	Sludge-Advanced	PS4	●	●		●	●	●	●	
	Sludge-Combined (Imhoff)	PS5	●			●		●		
	Secondary - Standard Filter	PS6	●	●		●		●		
	Secondary - High Rate Filter	PS7	●	●	●	●	●	●	●	
	Secondary - Activated Sludge	PS8	●	●	●	●	●	●		
	Secondary - Extended Aeration	PS9	●	●		●		●		
	Disinfection	PS10		●		●	●			
	Aqua Culture	PS11	●							
	Dilution	PS12	●							
	Individual	PS13	●							●
	Individual (adv)	PS14		●		●		●		●

Table 4. Acceptable Combination of Treatment Processes for Potable Water

	Combination CODE	PROCESS COMBINATIONS	CRITERIA LEVEL: Raw Water Concentration: Coli MPN/100 ml	Raw Water Concentration: Solids mg/l: Turb	Raw Water Concentration: Solids mg/l: Other	Receiving Water: Receiving Water Volume (7-day Low Flow Level)/Waste Volume
WATER TREATMENT	W1	PW1	1 - 2	10		
	W2	PW1 + PW7	100	10		
	W3	PW3	100	100		
	W4	PW2 + PW3	300	800		
	W5	PW11	300	800		
	W6	PW4 + PW7	2,000	100		
	W7	PW2 + PW4 + PW7	3,000	1,000		
	W8	PW5 + PW7	2,000	100		
	W9	PW2 + PW5 + PW7	3,000	1,000		
	W10	(any one of W1 to W8) + PW6			300 Hardness	
	W11	(any one of W1 to W8) + PW8			1-3 Fe & Mn	
	W12	PW7 + PW9			>3000 TDS	
	W13	PW7 + PW10			>2000 TDS	
SEWAGE TREATMENT	S1	PS1 + PS5				20 (or 3-4 CFS/1000 PE*)
	S2	PS1 + PS3				20 (")
	S3	PS2				10 (or 1.5-2 ")
	S4	S1 + PS6				6 (or 0.9-1.2 ")
	S5	PS1 + PS9				3 (or 0.45-0.6")
	S6	S2 + PS6				6 (or 0.9-1.2 ")
	S7	S2 + PS7				5 (or 0.75-1 ")
	S8	S2 + PS8				4 (or 0.6-0.8 ")
	S9	(any one of S1 to S7) + PS10	250			2 (or 0.3-o.4 ")
	S10	PS3 (Without water carriage)				- NA
	S11	PS11				10 (or 1.5-2 ")
	S12	PS12				40 (or 6-8 ")
	S13	PS2 + PS12				8 (or 1.2-1.6 ")

* The unit is defined as cubic feet per second of receiving water flow rate/1000 populaiton equivalent. A population equivalent is a waste equivalent to one person per day, normally taken as 0.17 lb.BOD/day.

Data Sheet Question, Part III No.*	Weighting Factor
3	8
4	2
5	5
6	10
7	–
8	5
9	0
10	5
11	0
12	0
14	0
15	0
16	0
17	10
18	5
19	5

2. Total the weighting factors from Step 1:

Total Weights: 70

3. Compare the total of the weighting factors to Table 2 as follows:

Socio-Technical Level (STL)	Total Weighted Factors Range	Average Per Capita Consumption of Water Per Day (gal/cap/day)
I	1 - 23	25
II	24 - 51	50
III	51 - 93	75
IV	93+	100

STL for this community = 3

Estimated per capita consumption 75 gcd

4. Examine question No. III-20 (Figure 1) on the data sheet. If three or less of the eight items are checked, then this group of operation equipment is considered available:

Operation Equipment Available Yes

Not Available _____

* No. 13 is omitted; it is used for a purpose other than weighting.

5. Examine question No. III-21 (Figure 1) on the data sheet. If three or less of the seven items are checked, then this group of progress materials are considered available.

Process Materials — Available Yes

Not available ____

6. Examine question No. III-22 (Figure 1) on the data sheet. If two or less of the maintenance items are checked, then this group of operation and maintenance supplies are considered available.

Operation and Maintenance Supplies — Available Yes

Not available ____

7. Examine question No. III-23 (Figure 1) on the data sheet. If three or less of the eight items are checked, then this group of chemical supplies is considered available.

Chemical Supplies — Available Yes

Not Available ____

Summary of Physical Resource Availability

Physical Resource	Availability (yes or no)
Operation Equipment	Yes
Process Materials	Yes
Operation and Maintenance Supplies	Yes
Chemical Supplies	Yes

8. This step involves a comparison of several factors to determine if any or all of the basic processes must be eliminated because the community does not have the resources available. The primary tool for this comparison is Table 3, Water and Sewage Treatment Processes with Essential Components for Operation (Table 3 is also shown on page 21 of the Model). Two general categories of requirements are considered. They are manpower and resources required. In the category of manpower the following guidelines should be used.

   a. In Level I communities basically only unskilled manpower is available. (category C only--see definition below).

b. Level II communities have unskilled and semi-skilled, and some skilled labor available (categories C and B only).

c. Level III communities with populations under 50,000 have unskilled and semi-skilled and some skilled labor available. In Level III communities with population over 50,000 and all Level IV communities every categories of manpower are available.

Manpower categories - Category A : Professional
Category B : Skilled and Craftsmen
Category C : Unskilled-Semiskilled

Category A and B occupations require a substantial amount of special formal training. Hence the sources, volume, and timing of their supply is relatively easy to identify. In category C, by contrast, most individuals master these skills by relatively non-formal means in the plant and on the job and do not undergo formal courses nor pass through formal in-plant training schemes. This is true even in those craft occupations that for generations have been termed "apprenticeable". It is even more true in most of the new "industrial" skilled manual occupations, which have emerged since the industrial revolution. The skills cannot normally be gained away from or outside the employing institution because of the nature of the operation or the special machinery and equipment involved or the working environment itself.

The main supply of category B occupations, which require a secondary school education plus two to three years of vocational training, is produced by the training schools and schemes maintained by ministries of the government which operate them to meet their own specialized requirements. In many LDC's these facilities are generally well-established.

A check on the data sheet (Figure 1, Part II) shows that the population is above 50,000. Therefore none of the processes are eliminated because of the availability of manpower in the larger cities.

For the resources required, it is necessary to carefully compare each of the processes and its requirements against the summary of resources available listed above. If a process requires a resource that is not locally available then the process should be eliminated from the number of feasible processes. (In this example no processes

have been eliminated because all physical resources and manpower requirements have been met.)

List of the Feasible Processes

Water	Wastewater
PW 1	PS 1
PW 2	PS 2
PW 3	PS 3
PW 4	PS 4
PW 5	PS 5
PW 6	PS 6
PW 7	PS 7
PW 8	PS 8
PW 9	PS 9
PW 10	PS 10

9. At this point the process combinations obtained from Table 4, Acceptable Combinations of Treatment Processes for Potable Water (also shown a Table 3 in the Model), can only be made up of the above basic processes, and they are examined to see if they can be used to process the water given that the water quality is as specified on Part IV of the model data sheet (page B-8).

   In short, the above processes are compared to Table 4. The combinations selected as feasible are those that are capable of treating the raw water concentration as specified on the data sheet and within the constraints given in Table 4 and contain only those feasible basic processes as listed in Step 8 above. The same technique applies to the selection of feasible wastewater treatment processes.

   List the feasible combinations:

Water
1. PW 1 + PW 7
2. PW 2 + PW 3
3. PW 4 + PW 7
4. PW 2 + PW 4 + PW 7
5. PW 5 + PW 7
6. PW 2 + PW 5 + PW 7
7.
8.
9.
10.

Wastewater	
1.	PS 1 + PS 5
2.	PS 1 + PS 3
3.	PS 2
4.	PS 1 + PS 5 + PS 6
5.	PS 1 + PS 9
6.	PS 1 + PS 3 + PS 7
7.	PS 1 + PS 3 + PS 8
8.	
9.	
10.	

10. The population scale is determined from the following table:

Estimated Population	Population Scale Factor
500 - 2,499	1
2,500 - 14,999	2
15,000 - 49,999	3
50,000 - 100,000	4

The population scale factor for the community under study is determined by taking the population given in Part II of the data sheet (Figure 1) and comparing it to the estimated population groups as given above.

The results of this comparison are given belcw

Actual Population 60181

Population Scale Factor 4

11. At this point the cost determination for the feasible combinations can be determined. The objective of this step is to determine the construction, and operation and maintenance costs for a 20-year period for all of the feasible combinations that have been selected. To determine these cost, costs associated with each of the basic processes are calculated and then combined together to arrive at the estimated costs of the feasible combinations of processes. The source data for the various water treatment costs is contained in Appendix D of the Model. There is one table for each of the processes in Step 9 above. The first feasible combination is PW 1 + PW 7. The cost and manpower

requirement for the basic process PW1 can be determined as follows:

Type of Cost	Estimated Population	Cost/Capita by Scale & STL	Number of Years	Total Cost*	Maintenance Manpower Required		
					Unskill	Skill	Prof
Construction	60,181		1				
Operation	60,181		20				

Total Cost = _____

The cost and manpower requirement for PW7 can be determined as follows:

Type of Cost	Estimated Population	Cost/Capita by Scale & STL	Number of Years	Total Cost*	Maintenance Manpower Required		
					Unskill	Skill	Prof
Construction	60,181		1				
Operation	60,181		20				

Total Cost = _____

Summarizing

Basic Process for Combination 1	Total Cost
PW 1	_____
PW 7	_____
Combination Total Cost	307120

Each of the feasible combinations must be calculated in the same manner and thus total costs for all of the feasible combinations for water treatment are obtained. The total cost for the various combinations is summarized as follows:

---

* Total Cost = Construction Cost + Operation and Maintenance Costs
= (Estimated Population)(Construction Cost/Capita by scale and by STL) + (Estimated Population)(Operation Cost/Capita by scale and by STL)(20 years)

Combination	Basic Processes	Total Cost	Operating Manpower		
			Unskill	Skill	Prof
1	PW 1 + PW 7	307120	4	0	0
2	PW 2 + PW 3	1005295	5	0	0
3	PW 4 + PW 7	6451526	6	2	2
4	PW 2 + PW 4 + PW 7	6162130	6	2	2
5	PW 5 + PW 7	1596342	2	1	1
6	PW 2 + PW 5 + PW 7	9114872	6	2	2

12. The final step in the process selection method involves the selection of the lowest total cost combination listed above.

Lowest total cost process combination selected: PW 1 + PW 7

The computerized version has an additional feature that the manual method does not have. That is the steps one through twelve are simulated at five year intervals for a period of twenty years. Inherent in these simulations are population increases and a modest growth in the technological level of the community.

Figure 1

AN EXAMPLE OF

THE WATER AND WASTEWATER TREATMENT PLANNING MODEL DATA SHEET

I. General Information

1. Location of Community

City Name Nakuru

State or Province Rift Valley Region

Country Kenya

2. Planning Group or Agency Rift Water Center

II. Demographic - The model requires some basic population data for the purposes of capacity planning. Two inputs are required. If local or site data is not available please use a national estimate and also indicate whether it is national or local source.

Answer either A or B.

A. 1. Present Population - The figure or estimate of the present population should reflect the number of inhabitants that the proposed water or wastewater treatment facility is going to serve.

Actual population 60181 or estimate the following:

_____ (1) Between 500 and 2,500 people

_____ (2) 2,500 - 15,000

_____ (3) 15,000 - 50,000

X (4) 50,000 - 100,000

_____ (5) Source _____

2. Annual population growth rate 1.8 or estimate in the following:

_____ (1) Less than 1%

_____ (2) 1% - 1.5%

(Figure 1 Continued)

____ (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 _____

B. Population estimate at last census _____

Date of Census _____ Source of Census _____

Annual Growth rate at time of last census or present annual growth rate _____

_____

III. Socio-Economic Data - The purpose of this section is to gather enough information about the community so that it can be classified into one of the four levels of development. The approach has been to request information that is generally available and can be obtained on a local level. Please include any other information you feel is relevant.

CHECK THE MOST APPROPRIATE CATEGORY FOR THE FOLLOWING QUESTIONS

1. Average level of education obtained by inhibitants living in the community.

	Level	None	Primary	High School	Technical Institute	College
____	(1)	95%	4%	1%	0%	0%
____	(2)	70%	19%	7%	3%	1%
x	(3)	55%	22%	14%	6%	3%
____	(4)	9%	34%	42%	8%	7%
____	(5)	Other				

(Figure 1 Continued)

2. Average distribution of labor force in the community.

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

3. Annual average income per family in your country's currency.

_____ amount _____ unit

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

____ (1) Less than $100

____ (2) $100 - $500

x (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 percentage of these is non-local or non-native people.

____ (1) Less than 10%

____ (2) 10% - 25%

x (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 the government itself?

____ (1) Yes x (2) No

(Figure 1 Continued)

6. What is the highest grade offered by 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 community?

__x__ (1) Yes _____ (2) No

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

_____ (1) Yes __x__ (2) No

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

__x__ (1) Yes _____ (2) No

11. Is there a college or universityin the local community?

_____ (1) Yes __x__ (2) No

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

_____ (1) Yes __x__ (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.

(Figure 1 Continued)

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

14. Is unemployment widespread?

__X__ (1) Yes _____ (2) No

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 inhibitants?

_____ (1) Yes __X__ (2) No

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

__X__ (1) 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)

__X__ (3) Chemical products (fertilizers, chlorine)

_____ (4) Electronic technology

18. Does the government dominate the labor market?

_____ (1) Yes __X__ (2) No

19. Are public employment services readily available?

__X__ (1) Yes _____ (2) No

Questions 20-23 relate to the availability of materials and equipment. Check those items that are never available in the community.

20. Operation equipment. Which of the following are never available in the local community?

_____ (1) Water meters

_____ (2) Soldering equipment

_____ (3) Acetylene torches

(Figure 1 Continued)

_____ (4) Recording devices - such as thermostats

_____ (5) Laboratory equipment i.e. test tubes

_____ (6) Portable power plants i.e. gasoline powered electric generators

_____ (7) Motors i.e. 1-3 horsepower electric motors

_____ (8) Water pumps

21. Process materials. 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) Silca sand

_____ (2) Graded gravel

_____ (3) Clean water

_____ (4) Gasoline

23. Chemicals supplies: 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)

(Figure 1 Continued)

_____ (5) $NaCo_3$ (Soda ash)

_____ (6) Cl_2 (Chlorine)

__x__ (7) O_3 (Ozone)

__x__ (8) Laboratory chemicals

24. Major Water Source (check appropriate category)

_____ (1) River or stream

__x__ (2) Lake or impoundment

_____ (3) Wells

_____ (4) Sea or brackish

25. Approximate per capita water demand (daily)

(1) Current demands __75__ in __gallons__ (units)

(2) 10 year projection: _____

26. Is ground water available?

__x__ (1) Yes _____ (2) No

27. Are wells already drilled? Current Capacity? _____ mgd

_____ (1) Yes __x__ (2) No

28. Is a central wastewater collection system in existence?

__x__ (1) Yes _____ (2) No

29. Is the following wastewater 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 _____ %

(Figure 1 Continued)

30. Are industrial and commercial concerns using the wastewater system and if so, in what quantity (in thousands of gallons)?

(1) Currently _____

(2) Within 5 years _____

(3) Within 10 years _____

IV. 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 75 (MPN/100 ml)

(2) *Turbidity 92 (mg/l or JTU)

(3) BOD _____ (mg/l)

(4) pH _____ (0 → 14)

(5) Dissolved oxygen _____ (mg/l)

(6) Temperature _____ (°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 predictive model