Annex 2-3 :
Lecture Materials for Training

2.3.2 Basic Water Quality

Lecture Training for Basic Water Quality Monitoring (1st)

Lecture-3: Basis of Water Quality Monitoring (WQM)

June 2005

By Matsue Ryunan
(The JICA Expert Team)

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1. Parameters to be Covered by the Project

14 DFEAs		Damascus, Homs, Aleppo		Damascus DFEA
Basic Water Quality Analysis 1 pH 2 Water Temperature 3 Color 4 TDS 5 DO 6 SS 7 CODcr 8 BOD_5 9 NO_3-N 10 PO_4 11 Cl^- (not Cl_2) 12 NH_3-N 13 EC 14 Turbidity	=	**Basic Water Quality Analysis**	=	**Basic Water Quality Analysis**
		Air Quality Analysis 1 SOx 2 NOx 3 TSP 4 PM10 5 Pb	=	**Air Quality Analysis**
				Chemical & Biological Water Quality Analysis (Oil, Coliform, Heavy metals, etc.)

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2. Equipment and Instrument provided by JICA

pH, Temp., SS, Color, NO_3-N, PO_4, NH_3-N

COD_{Cr} →

pH meter **Colorimeter**

BOD_5 →

← **DO**

Turbidity →

← **Cl^-**

EC & TDS →

Reagents, Glassware, Computer, Digital Camera and others

1.Introduction of Water Quality Monitoring (WQM)

1) Definition of WQM

ISO: "The programmed process of sampling, measurement and subsequent recording or signaling, or both, of various water characteristics, often with the aim of assessing conformity to specified objectives.

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2) Necessity and Importance of WQM

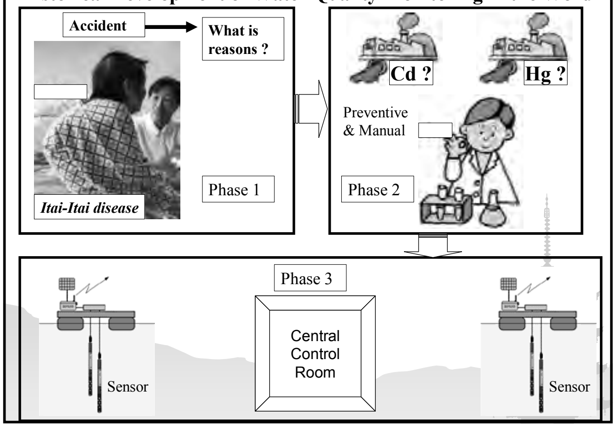
8 Environment tragedies in the world

- **5 tragedies – air pollution (** London, England; 1948-1963; around 10,000 deaths)
- **2 tragedies – water pollution (*Mina Mata disease*** and ***Itai-Itai disease***, Japan; 1930'-70'; around 300 deaths)

Historical Development of Water Quality Monitoring in the World

Phase 1: **Accident survey** (1950', passive monitoring)
Phase 2: **Pollution sources monitoring** (1960'-70', initiative)
Phase 3: **Water environmental quality monitoring** (1980'~present, automatic monitoring, GIS, RS, GPS)

Historical Development of Water Quality Monitoring in the Word



2) *Necessity and Importance of WQM*

- Freshwater resource:

Average of the world=**7,342** m^3/per capita

Syria=**483** m^3/per capita

Water pollution → **400?** → 200? — Decrease utilizable water quantity

- Protect human health
- Evaluation of environmental quality
- Environmental protection policies, plan and management (local and national levels)

WQM: Eye of Water Environmental Protection

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3) Water Pollution Sources

1) Industry Wastewater (point source)
(acid, alkali, organic substances, heavy metals, toxic substances etc.)

2) Domestic Wastewater (point source)
(organic substances, pathogenic organism etc.)

3) Agricultural Waster (no-point source, runoff)
(fertilizer, pesticides, livestock excreta etc.)

4) Others (hospital wastewater, acid rain etc.)

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4) Structure of Water Quality Monitoring Plan

- **Setting Objectives for WQM** — **Problem Finding**
- **Sampling Design** — Sampling stations, frequency, numbers, personnel and cost etc.
- **Field Sampling and Measurement** — Preparation, sample collecting method, measurement and recording etc.
- **Laboratory Analysis** — Analysis method and order, and QA/QC, safety etc.
- **Data Analysis and Interpretation** — Data check, statistical analysis, data management and re-evaluation of design etc.
- **Reporting and Informing the Public** — Summary report, yearly report, data trans. to GCEA, media etc.

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2. Setting Water Quality Monitoring Plan Objectives

- **Define the Issue** — Pollutants and their sources, irrigation, drinking water etc.
- **Define Information Requirements** — Weather, hydrologic, pollution sources, complaints, etc.
- **Collect and Compile Available Information** — Pollutants type, existing water quality data, water consumption, flowrate, etc.
- **Set Objectives**

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Objectives of Water Quality Monitoring Plan

1) Protect human health (next slide)
2) Checking whether effluent from factories comply with industrial wastewater discharge standard (next)
3) Determining whether water bodies meet environmental standards
4) Screening for potential water quality problems
5) Grasping water quality and trends over time (next slide)
6) Design pollution prevention or control programs
7) Assessing program goals and effectiveness
8) Responding to emergencies
9) Others (e.g. handling of complaints, EIA, educating citizens etc.)

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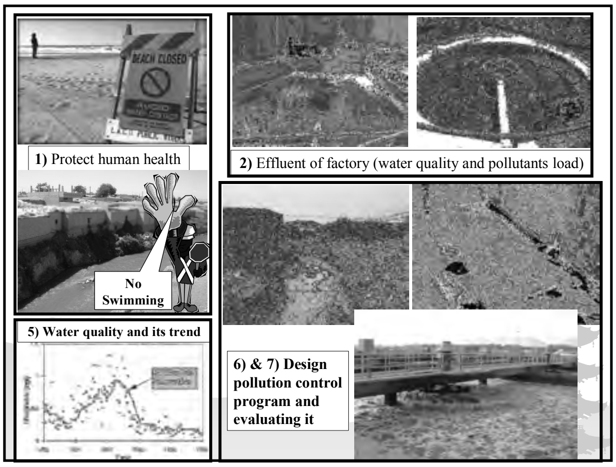


Environmental Quality Standard - Rivers, Japan

class	Item: Water use	Standard value: pH	BOD	SS	DO	Total coliform
AA	Water supply class 1, conservation of natural environment and uses listed in A-E	6.5-8.5	1 mg/l or less	25 mg/l or less	7.5 mg/l or more	50 MPN/100ml or less
A	Water supply class 2, fishery class 1, bathing and uses listed in B-E	6.5-8.5	2 mg/l or less	25 mg/l or less	7.5 mg/l or more	1000 MPN/100ml or less
B	Water supply class 3, fisheryclass 2, and uses listed in C-E	6.5-8.5	3 mg/l or less	25 mg/l or less	5 mg/l or more	5000 MPN/100ml or less
C	Fishery class 3, Industrial water class 1 and uses listed in D-E	6.5-8.5	5 mg/l or less	50 mg/l or less	5 mg/l or more	–
D	Industrial water class 2, agricultural water and uses listed in E	6.0-8.5	8 mg/l or less	100 mg/l or less	2 mg/l or more	–
E	Industry water class 3, and conservation of environment	6.0-8.5	10 mg/l or less	Floating Matter such as garbage should not be observed	2 mg/l or more	–

Drinking Water Resource | Water Treatment (SS<25) | Actual Condition of Rivers

Swimming (pH6.5-8.5) | Fishery (DO>5) | Agriculture (SS) | Daily Life (odor→BOD 10)

Environmental Quality Standard – Lakes, Japan

This Project ⇨ COD_{Cr}=2 to 3COD_{Mn}

class	Item: Water use	Standard value: pH	COD	SS	DO	Total coliform
AA	Water supply class 1, fishery class 1, conservation of natural environment, and uses listed in A-C	6.5-8.5	1 mg/l or less	1 mg/l or less	7.5 mg/l or more	50 MPN/100ml or less
A	Water supply class 2, and 3, fishery class 2, bathing and uses listed in B-C	6.5-8.5	3 mg/l or less	5 mg/l or less	7.5 mg/l or more	1000 MPN/100ml or less
B	Fishery class 3, industrial water class 1, agricultural water and uses listed in C	6.5-8.5	5 mg/l or less	15 mg/l or	5 mg/l or more	–
C	Industrial water class 2, and conservation of the environment	6.0-8.5	8 mg/l or less	Floating matter such as garbage not be observed	2 mg/l or more	–

Environmental Quality Standard – Lakes, Japan

class	Item: Water use	Standard Value: Total Nitrogen	Total Phosphorus
I	Conservation of natural environment and uses listed in II-V	0.1 mg/l or less	0.005 mg/l or less
II	Water supply classes 1, 2 and 3 (except special types), fishery class 1, bathing and uses listed in III-V	0.2 mg/l or less	0.01 mg/l or less
III	Water supply class 3 (special types) and uses listed in IV-V	0.4 mg/l or less	0.03 mg/l or less
IV	Fishery class 2 and uses listed in V	0.6 mg/l or less	0.05 mg/l or less
V	Fishery class 3, industrial, agricultural water and conservation of the environment	1 mg/l or less	0.1 mg/l or less

Eutrophication Control

Environmental Quality Standard – Coast, Japan

COD_{Mn}

class	Item: Water use	Standard value: pH	COD	DO	Total Coliform	N-hexane Extracts (oil content etc.)
A	Fishery class 1, bathing, conservation of the natural environment, and uses listed in B-C	7.8-8.3	2 mg/l or less	7.5 mg/l or less	1000 MPN/100ml or less	Not detectable
B	Fishery class 2, industrial water and the uses listed in C	7.8-8.3	3 mg/l or less le	5 mg/l or less	–	Not detectable
C	Conservation of the environment	7.0-8.3	8 mg/l or less	2 mg/l or less	–	–

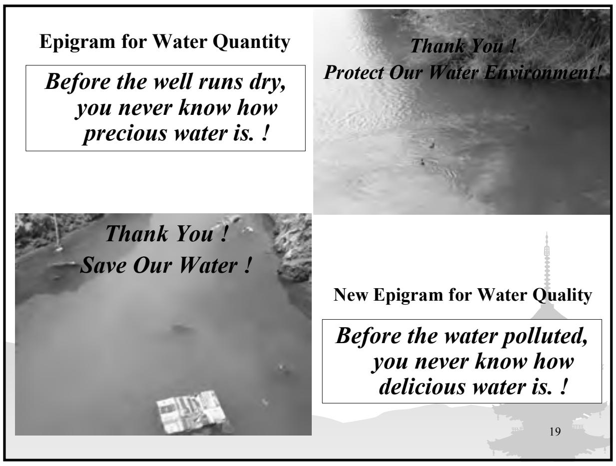
class	Item: Water use	Standard value: Total Nitrogen	Total Phosphorus
I	Conservation of the natural environment and uses listed in II-IV (except fishery classes 2 and 3)	0.2 mg/l or less	0.02 mg/l or less
II	Fishery class 1, bathing and the uses listed in III-IV (except fishery class 2 and 3)	0.3 mg/l or less	0.03 mg/l or less
III	Fishery class 2 and the uses listed in IV (except fishery class 3)	0.6 mg/l or less	0.05 mg/l or less
IV	Fishery class 3, industrial water, and conservation of habitable environments for marine biota	1 mg/l or less	0.09 mg/l or less

Water Quality Standard for Industrial Wastewater Discharging into Public Sewer System – Syria & Japan

No.	Parameter	Unit	Max. Admissible Concentration (Syria)	Max. Admissible Concentration (Japan)
1	pH	pH Unit	6.5 - 9.5	5.0 - 9.0 (5.7 - 8.7)*
2	Water Temp.	℃	35	45 (40)
3	Color	Unit	-	-
4	TDS	mg/l	2,000	-
5	DO	mg/l	-	-
6	SS	mg/l	500	600 (300)
7	COD_{Cr}	mg/l	1,600	-
8	BOD_5	mg/l	800	600 (300)
9	NO_3^-	mg/l	-	-
10	PO_4^{3-}	mg/l	20	(T-P) 32 (20)
11	Cl^-	mg/l	600	-
12	NH_3-N	mg/l	100	(T-N) 240 (150)
13	EC	μS/cm	-	-
14	Turbidity	NTU	-	-

Check it !

* ( ): Applying for manufacturing industry and gas supply industry


Epigram for Water Quantity
Before the well runs dry, you never know how precious water is. !
Thank You !
Protect Our Water Environment!
Thank You !
Save Our Water !
New Epigram for Water Quality
Before the water polluted, you never know how delicious water is. !
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Lecture Training for Basic Water Quality Monitoring (1st)

Lecture-4: Basis of Sampling Design

June 2005

By Matsue Ryunan

(The JICA Expert Team)

1

Structure of Water Quality Monitoring Plan

- **Setting Objectives for WQM**
- **Sampling Design** — Sampling stations, frequency, numbers, personnel and cost etc.
- **Field Sampling and Measurement** — Preparation, sample collecting method, measurement and recording etc.
- **Laboratory Analysis** — Analysis method and order, and QA/QC, safety etc.
- **Data Analysis and Interpretation** — Data check, statistical analysis, data management and re-evaluation of design etc.
- **Reporting and Informing the Public** — Summary report, yearly report, data trans. to GCEA, media etc.

2

Introduction of Sampling Design

Sampling Design

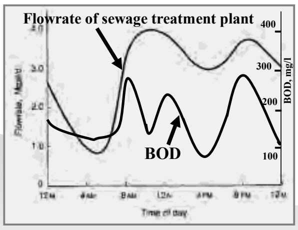
1) Selection of Sampling Stations
2) Determination of Sampling Frequency
3) Determination of Sampling Patterns
4) Determination of Sample Numbers
5) Selection of Measurement Parameters
6) Cost Effectiveness

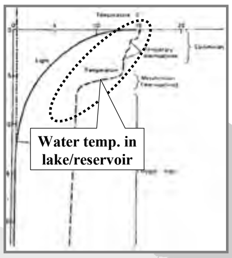
3

1. Selection of Sampling Stations

Water Quality Heterogeneity:

- **Temporal** (daily or seasonal effects)
- **Spatial** (environmental heterogeneity, pollutants diffusion)





1. Selection Criteria of Sampling Stations -River

1) Accessibility (bridges etc.) and safety
2) Source of river to get indication of its baseline quality (A-A section, next slide)
3) Downstream of big cities (C-C section, next slide)
4) Confluence of tributaries and main river (D-D, E-E)
5) Water intake point for community water supply in city (B-B)
6) Location of large/medium or cluster of small water polluting industries (F-F)
7) Place measuring flow-rate easily (G-G)
8) Place for swimming
9) Large section of irrigated area upstream
10) Others (boundaries of national or Governorates)

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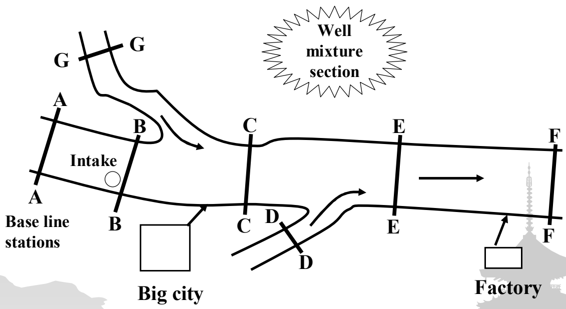
1. Selection of Sampling Stations (Criteria - River)



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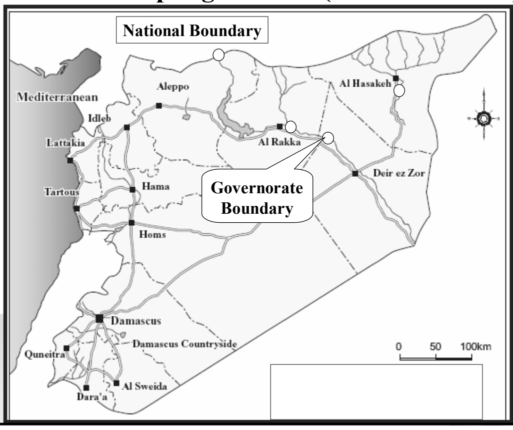
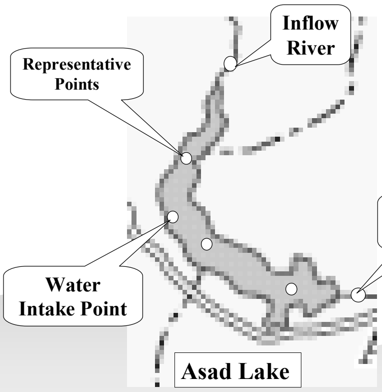
1. Selection of Sampling Stations (Criteria - River)



1. Selection Criteria of Sampling Stations - Lake

1) Accessibility and safety
2) Representative points for water quality (next slide)
3) Water intake points (next slide)
4) Inflow rivers (next slide)
5) Outflow rivers (next slide)
6) Place for swimming or recreation
7) Other special requirements

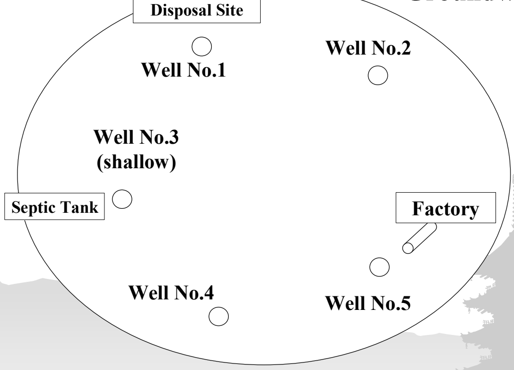
1. Selection Criteria of Sampling Stations - Lake



1. Selection Criteria of Sampling Stations - Groundwater

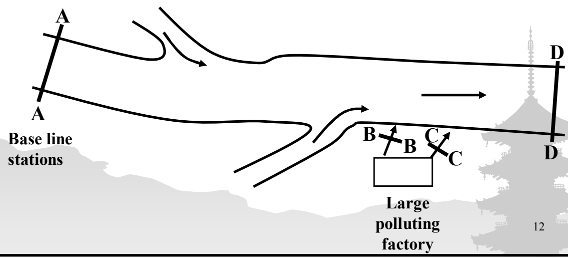
1) Drinking water sources located in insanitary conditions and the area being effected easily by sewage pollution (shallow aquifer in the vicinity of septic tanks, cess pools, lagoon for wastewater treatment, solid waste disposal site etc.) –
e.g. responding complaints
2) Tube-well, hand-pumps or dugwells located in industrial areas and the area being effected easily by industrial wastewater. – monitoring the impact of industrial wastewater
3) Vicinity of solid waste disposal site

1. Selection Criteria of Sampling Stations - Groundwater



1. Selection Criteria of Sampling Stations - Industrial Wastewater

1) Outlet(s) of large polluting factories – checking industrial wastewater quality and pollutants load (? kgSS/d, ? kgCOD/d, ? kgBOD/d) (Load=concentration × flowrate) – B-B, C-C sections
2) Downstream (tens-hundreds meters) of outlet(s) - D-D section



2. Determination of Sampling Frequency

1) Objectives of monitoring & the type of water body or medium (pollution sources, rivers or lakes, trend monitoring etc.)

2) Water quality variability (higher frequency at stations where water quality varies considerably)

a) River water quality monitoring – depending on parameters being measured (pH, DO), flow variability, seasons etc.

b) Lake water quality monitoring – low frequency

c) Groundwater – low frequency for deep and confined aquifers; high frequency for shallow and polluted aquifers

d) Industrial wastewater monitoring – depending industrial type and scale

3) Cost and the available resources

2. Determination of Sampling Frequency

Monitoring Target	Sampling Frequency (example)
Rivers	At least 1 time/month
Lakes & Reservoirs	4-12 times/year (for eutrophic lakes/reservoirs: 1 time/month=12 times/year)
Groundwater	1 – 2 times/year (1 time/year for large stable aquifers and 2 times/year for small, shallow aquifers) (for complains, sampling at any time)
Factories' Outlet(s)	1 – 4 times/year (composite sampling is recommended for pollutants load monitoring) (not inform in advance)

3. Determination of Sampling Patterns

1) Random or catch samples

example ⇩ Sites complained from residents

example ⇩ Rivers: different sites ⇩ Rivers: Fixed monitoring station

2) Composite samples (samples are collected at regular intervals in space or time. See next slide for example)

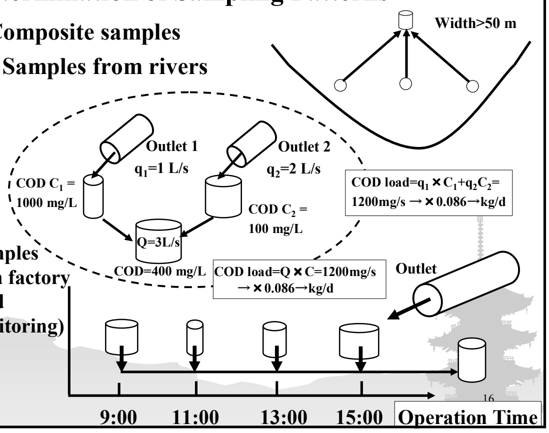
3) Stratified random samples (e.g. for water sampling to measure nutrients [N, P], a lake can be divided into the epilimion [surface] and hypolimion[bottom] water.)

3. Determination of Sampling Patterns

2) Composite samples

♣ Samples from rivers

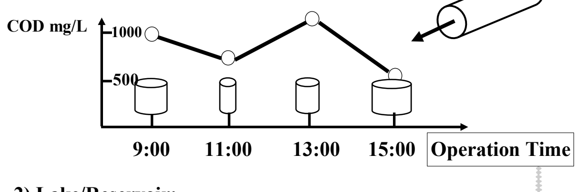
♣ Samples from factory (load monitoring)



4. Determination of Sampling Numbers

1) Industrial Wastewater:

Grasp concentration changes in time

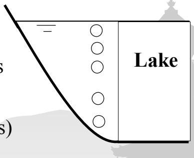


2) Lake/Reservoir:

Grasp concentration changes in depth

Case 1: Surface and bottom – 2 samples (Nitrogen, phosphorus, Fe, Mn)

Case 2: 1 sample/m (temp., DO changes)



5. Selection of Measurement Parameters

Item	Rivers	Lakes	Groundwater	Industrial Wastewater
pH	○	○	○	○
Water Temp.	○	○	○	○
Color	△	△	○	△
TDS	○	○	○	○
DO	○	○	△	△
SS	○	○	△	○
COD	○	○	○	○
BOD_5	○	○	○	○
NO_3^-	○	○	○	○
PO_4^{3-}	○	○	△	○
Cl^-	△	△	○	△
NH_3-N	○	○	○	○
EC	○	○	○	○
Turbidity	○	△	○	△
Flowrate	WRIC ○ Simple method	×	×	○ Simple method

Summary of Sampling Design

Example

	River	Lake/ Reservoir	Ground-water	Industrial Wastewater	Water Quality Accident
Sampleing Station	Accessibility, baseline, intake, pollution sources	Accessibility, intake, inflow & outflow rivers	Complaint & pollution sources	All of outlets	Accident points and surroundings
Sampling Frequency	At least 1 time/month	4-12 times/year	1-2 times/year	1-4 times/year	Depending on type & Num. of accident
Sampling Patters and Numbers	1 sample/time (or 3 points composit)	At least 2 samples in surface & bottom layer	At least 1 sample/time	Composit sample, each 2 hours during operation	At least 1 sample/time
Cost	High	High	Low	High	Low
Parameters	See 5. Selection of measuremnt parameters				Depending on the type of accident

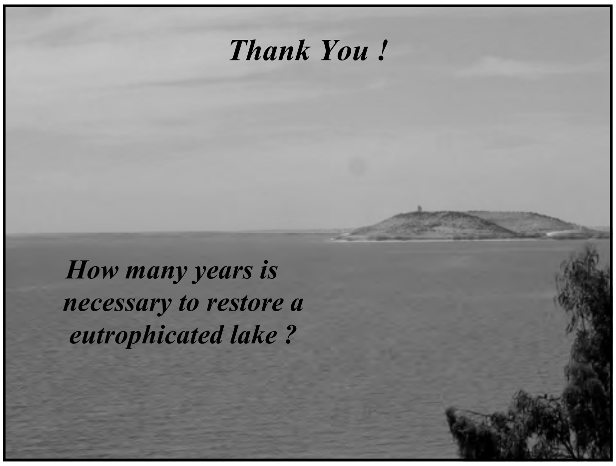
6. Cost Effectiveness

1) The number of sampling stations and sampling frequency
2) The cost of collecting samples (staff, transport, consumables)
3) The cost of analysis (reagents and glassware etc.)
4) The cost of data handling and interpretation (cost of reporting)
5) Others (participation of training course etc.)

Setting Objective for WQM and Sampling Design
↓
Cost Estimation
↓
Application of Budget
↓
Implementation of WQM

7. Requirements

1) Information collection
   - Pollution sources: location, type, water consumption, existing water quality data (raw materials)
   - Rivers: weather (rainfall etc.), existing water quality data (Ministry of Irrigation, WRIC etc.)
   - Analyzing complaints related water quality (the number and classification of complaints)
2) Pre-discussion on sampling stations and confirmation
3) Preparation of sampling vehicle
4) Preparation of equipment and instrument in laboratory (distilled water unit, cleaning sample bottles etc.)



Lecture Training for
Basic Water Quality Monitoring (1st)

Lecture-5: Field Sampling, Measurement and Observation

June 2005
By Matsue Ryunan
(The JICA Expert Team)

1

Introduction of Field Sampling and Measurement

1) Checklist Before Sampling
↓
2) Collecting Water Samples
↓
3) Field Measurement and Observation → **4) Filed Record** → **7) Delivering to Laboratory Staff**
5) Sample Labeling → **6) Sample Preservation and Storage** → **7) Delivering to Laboratory Staff**

2

1. Checklist Before Sampling

1) Document and equipment for recording data
2) Sampling tools
3) Field measurement equipment
4) Others

Checklist for Sampling

The following is a list of items, which should be checked before going to the field. (use tick i.e.√)

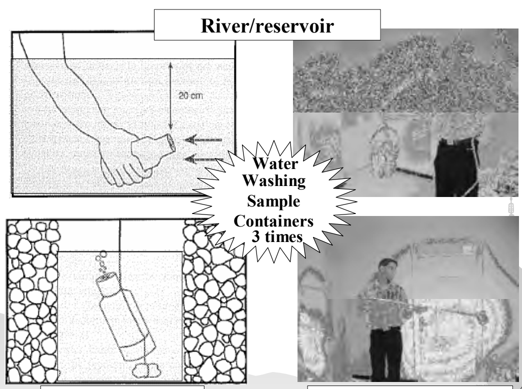
No.	Item	Date				Remarks
Documents and equipment for recording data		___Juen, 2005				
1	Itinerary for the trip (route, stations to be covered, start and return time)					
2	Area map (including sampling site station map)					
3	Data result sheets					
4	Filed notebook					
5	SOP and equipment manuals					
6	Digital camera with date					
Sampling Tools						
1	Sampler (long-handled sampler and bucket)					
2	Rope					
3	Icebox (with ice packs)					
4	Sample bottles					
5	Labels for sample containers					
6	Pen, pencils, marker (waterproof)					
7	Wash bottle within distilled water (for rinsing electrode and equipment)					
8	Knife/scissors					
9	Gloves/gum boots					
10	Tap water for washing hands/towel					
11	Drinking water					
12	portable electric light (especially for sampling during night)					
Field Measurement Equipment						
1	pH meter and calibration standards					
2	EC and TDS meter					
3	DO meter					
4	Check batters in meters, replace if necessary					
5	Check conditions of meters-no dirt etc.					
6	Thermometer					
7	Simple equipment for measuring velocity and flow					
8	Other field measurement kit, as required					
Others						
1	Emergency phone numbers:					
2						
3						
4						

Note: 1) Depending on the local conditions, water body, type of pollution source, etc., all items may not be necessary, or other items, not listed, may be required.
2) It is always safer to carry a few numbers in excess.

3

2. Collecting Water Samples

River/reservoir



Groundwater **Industrial Wastewater**

4

3. Field Measurement and Observation

4. Field Record


Photos for water and surroundings etc.

Field Measurement and Observation Record

Date: ________ Time: ________ Type of waterbody: ________

Name of sampling station: ________ Sampling station code: ________

Longitude: ________ Latitude: ________

Weather now: Clear/sunny ☐ Overcast ☐ Rain (steady) ☐ Rain (heavy) ☐

Past 24 hours: Clear/sunny ☐ Overcast ☐ Rain (steady) ☐ Rain (heavy) ☐

Width (m): <1 ☐ 1-2 ☐ 3-5 ☐ 6-10 ☐ 11-20 ☐ >20 ☐ ( )

Depth (m): <0.1 ☐ 0.1-0.3 ☐ 0.4-0.6 ☐ 0.7-1.0 ☐ 2-5 ☐ >5 ☐ ( )

Estimated velocity (m/s): <0.2 ☐ 0.2-0.4 ☐ 0.5-0.7 ☐ 0.7-1 ☐ >1 ☐ ( )

Rubbish: None ☐ Little ☐ Moderate ☐ Many ☐

Odor: Absent ☐ Little ☐ Moderate ☐ Strong ☐

Oil slick: None ☐ Little ☐ Moderate ☐ Many ☐

Brief description of site: ________

Comments: ________

Parameter	Color	SS	COD	BOD	NO_3	PO_4	Cl^-	NH_3	Turbidity
Sample Volume (L)									

Ovserver: Name: ____/____ Signature: ____/____

Sample received by: Name: ____/____ Signature: ____/____

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3. Field Measurement and Observation

4. Field Record (First Year)

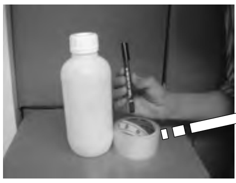
Water Quality Results

Parameter	Unit	Sample (No.1) Result	Replicate Sample (No.2) Result	Replicate Sample (No.3) Result	Final Result of the Sample	Name of Analyst	Date of Analysis
Field Measurement							
pH	pH units	7.5	7.8	7.4	7.6		
Air temp.	^0C						
Water temp.	^0C						
EC	µS/cm						
TDS	mg/l						
DO	mg/l						
Laboratory Analysis							
Color	Unit						
SS	mg/l						
COD_{Cr}	mg/l						
BOD_5	mg/l						
NO_3^--N	mg/l						
PO_4^{3-}	mg/l						
Cl^-	mg/l						
NH_3-N	mg/l						
Turbidity	NTU						

Average value

6

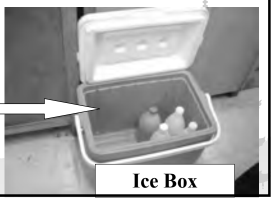
5. Sample Labeling



1) Sample Code: 3 letters-3 numbers
2) Name of river; lakes; well; factory
3) Date and time of sampling

6. Sample Preservation and Storage

Cold Pack



Ice Box

6. Sample Preservation and Storage

Suggested Preservation Methods and Storage Times

No.	Parameter	Recommended Container	Preservation Method	Max. Permissible Storage Time	Comments
1	pH	Plastic*	None, analyze immediately	6 hours	Should be measured on site
2	Water temp.	-	Not applicable	Not applicable	Must be measured on site.
3	EC	Plastic	Refrigeration	24 hours	Should be measured on site
4	TDS	Plastic	Refrigeration	24 hours	Should be measured on site
5	DO	-	None, analyze immediately	Analyze immediately	Must be measured on site.
6	Color	Plastic	Refrigeration	48 hours	
7	SS	Plastic	Refrigeration	24 hours	
8	COD_{Cr}	Plastic	Refrigeration	24 hours	Analyze as soon as possible
9	BOD_5	Plastic	Refrigeration	24 hours	Analyze as soon as possible
10	NO_3^--N	Plastic	Refrigeration	24 hours	Analyze as soon as possible
11	PO_4^{3-}	Glass**	Refrigeration	24 hours	
12	Cl^-	Plastic	Refrigeration	7 days	
13	NH_3-N	Plastic	Refrigeration	24 hours	Analyze as soon as possible
14	Turbidity	Plastic	None required	24 hours	Preferably tested in the field

*: Plastic= polyethylene **: Glass is recommended, however plastic containers will be used during first year.

8

7. Delivering to Laboratory Staff

Field Measurement and Observation Record (Including Water Quality Results) → Laboratory Staff for Analysis

Samples → Laboratory Staff for Analysis

Laboratory Staff for Analysis → Conducting Analysis in Same Day

9

What is Water Quality Monitoring (WQM) ?

How long does Mina Mata disease need to emerg?

Photo:1971, and the girl died in 1977 (21-years old)

Water	⇐ Patient
You, DFEA Staff	⇐ Doctor
WQM	⇐ Check (Tools)
Water Pollution Control Measures	⇐ Medicine
Good Water Quality ☺	⇐ Recover

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Video Display Time

"Sampling for Environment Monitoring"

11

Lecture Training for
Basic Water Quality Monitoring (1st)

Lecture-6: Water Quality Analytical Theory and Skill-1

June 2005
By Matsue Ryunan
(The JICA Expert Team)

Parameters Covered in the Project

Basic Water Quality Analysis

1 pH
2 Water Temperature
3 Color
4 TDS
5 DO
6 SS
7 CODcr
8 BOD5
9 NO3
10 PO4
11 Cl-
12 NH3
13 EC
14 Turbidity

pH

What is it and why does it matter?

pH: a measure of acidity (or alkalinity). Pure water has a pH of 7, acidic solutions have low pH values and alkaline solutions have higher values.

pH

$$PH = -\log [H^+]$$

Most of PH readings ranges from 0 to 14

Solutions with a higher [H+], then water (PH will be< than 7) are acidic.

Solutions with a lower [H+], then water (PH> 7) are alkaline.

pH

What factors affect pH?

- **Water temperature**
- **Discharge of industrial wastewater**
- **Geology and soils (e.g. acid sulfate soils)**
- **Rainfall**
- **Salinity**
- **Time of day**
- **Others**

pH

Measurement Method?

- **pH indicator paper method**
- **pH meter method (this project, sensION 1 pH meter, unit: pH unit)**

Interpreting Your Results

	Excellent	Good	Fair	Poor	Degraded
pH range	6.0-7.5	5.5-6.0 or <8.0	8.0-8.5	5.0-5.5 or 8.5-9.0	<5.0 or >9.0

Water Temperature

What is it and why does it matter?

Temperature: how hot or cold a substance is.

Temperature

What factors affect water temperature?

- Air temperature
- Groundwater inflows
- Discharge of warmed water from industry and power plants, or cold water from dams
- Types, depth, and flow of waterbody
- Others (exposure to sunlight and amount of shade, vegetation etc.)

Temperature

Measurement Method?

- Glass thermometer method
- Digital meter (used in this project, sensION 1 pH meter, unit: ^{o}C)

Interpreting Your Results

- High temperature is a problem to many aquatic organisms that take their oxygen from the water

Turbidity

What is it and why does it matter?

Turbidity: opacity or muddiness caused by particles of extraneous matter; not clear or transparent.

Turbidity

What factors affect turbidity?

- Rainfall and catchment runoff
- Catchment soil erosion
- Waste discharge
- Excessive algal growth
- Flow
- Others (soil type etc.)

Turbidity

Measurement Method?

- Turbidity tube method
- Turbidity meter (used in this project, 2100P turbidity meter, unit: NTU)

Interpreting Your Results

- High turbidity is a problem to water resources of drinking water
- Changes in ecosystem habitat
- Loss of sensitive species

Electrical Conductivity (EC)

What is it and why does it matter?

EC: the property of a substance which enable it to serve as a channel or medium for electricity.

Electrical Conductivity (EC)

What factors affect EC?

- Geology and soils
- Salinity
- Industrial wastewater discharge
- Groundwater inflows
- Temperature
- Others (soil type etc.)

Interpreting Your Results

Water type	EC (μ s/cm)
De-ionized water	0.5-3
Pure rainwater	<15
Freshwater rivers	0-800
Marginal river water	800-1,600
Brackish water	1,600-4,800
Saline water	>4,800
Seawater	51,500
Industrial waters	100-10,000

Color

What is it and why does it matter?

Color: the indicator for estimating overall water conditions. Appearances of sample water.

Color

What factors affect Color?

- Geology and soils
- Salinity
- pH
- Quantity and characteristics of dissolved substance and suspended solid
- Temperature
- Others (soil type etc.)

Color

Measurement Method?

- Color comparator method
- Digital meter (used in this project, APHA Platinum-Cobalt Method, unit: mg/L Pt Co)

Interpreting Your Results

- Industrial wastewater and sewage can contribute high level of color.
- Iron and manganese in the river/lake sediment contribute high level of color.

Total Dissolved Solids (TDS)

What is it and why does it matter?

TDS: the filterable residue (non-filterable residue correspond to the SS). Used to crosscheck the ion concentration.

TDS

What factors affect TDS?

- Concentration and constitution of all kinds ions (cation and anion)
- pH

TDS

Measurement Method?

- Electrode method
- Digital meter (used in this project, sensION 5 Portable EC and TDS)

Interpreting Your Results

- Use to check the correlation with the measured result of EC
- EC (μs/cm)÷TDS=0.5 to 0.8 (sensION 5, using 0.5 to measure TDS by EC)

Suspended Solids (SS)

What is it and why does it matter?

SS: undissolved substances suspended in sample water.
Diameter of particles; Normally larger than 1 micron

SS

What factors affect SS?

- Geology and Topography
- Industrial & Domestic wastewater discharge
- Flora and Fauna
- Climate
- Others (soil type etc.)

SS

Measurement Method?

- Photometric method
- Digital meter (used in this project, Hach CEL/890)

Interpreting Your Results

- Oligotrophic lake: < 1 mg/L
- Ordinary lake: < 15 mg/L
- Ordinary river: 25 to 100 mg/L
- Raw sewage: 100 to 350 mg/L
- Industrial wastewater: tens-thousands mg/L

Chloride (Cl^-)

What is it and why does it matter?

Cl^-: usually present in natural waters. Indicator that shows the influences of human activity and/or seawater.

Chloride (Cl^-)

What factors affect Cl^-?

- **Geology and Topography**
- **Industrial & Domestic wastewater discharge**
- **Climate**

Chloride (Cl^-)

Measurement Method?

- **Silver Nitrate method**
- **Digital titrator (this project, Model 16900)**

Interpreting Your Results

- **Non-contaminated surface water: 10 - 20 mg/L**
- **Groundwater: possibility of high Cl- concentration**
- **Raw sewage: 30 – 100 mg/L**
- **Industrial wastewater: tens-thousands mg/L**

How to measure pH, Temperature, Turbidity, EC, Color, TDS, SS, Cl-

Demonstration

Lecture Training for
Basic Water Quality Monitoring (1st)

Lecture-7: Water Quality Analytical Theory and Skill-2

June 2005
By Matsue Ryunan
(The JICA Expert Team)

Dissolved Oxygen (DO)

What is it and why does it matter?

DO: a measure of the quantity of oxygen present in water (not including oxygen atoms within the water molecules).

Dissolved Oxygen (DO)

What factors affect DO?

- **Water temperature**
- **Photosynthesis by aquatic plants**
- **Industrial and domestic wastewater discharge**
- **Breakdown of organic materials in water**
- **Water movement and mixing**
- **Others (altitude, depth)**

Dissolved Oxygen (DO)

Measurement Method?

- **Winkler method (titration)**
- **DO meter (this project, sensION 6 DO meter, unit: mg/L)**

Interpreting Your Results

- **DO<2.0 mg/L: not support fish**
- **DO<3.0 mg/L: stressful to most aquatic animals**
- **At least 5-6 mg/L: for fish growth and activity**

Biochemical Oxygen Demand (BOD)

What is it and why does it matter?

Biochemical Oxygen Demand (BOD) is defined : as the quantity of DO which is able to oxidize the organic components in water with the assistance of microorganisms and under defined experimental conditions

Biochemical Oxygen Demand (BOD)

Importance of BOD measurement

BOD of special importance in assessment of polluted surface water and wastewater.

Indispensable as basic data for sewage works.

Biochemical Oxygen Demand (BOD)

What factors affect BOD?

- Industrial and domestic wastewater discharge
- Temperature
- Toxic matters in the water
- Nitrogen (N) concentration in the water
- Water movement and mixing
- Others

Biochemical Oxygen Demand (BOD)

Measurement Method?

- Dilution method (titration, standard method)
- Manometer (pressure sensor) method (approved in German, used in this project; unit, mg/L)

BOD_5

Reaction time of 5 days is used for measurement of BOD_5.

Biochemical Oxygen Demand (BOD)

Interpreting Your Results

- River: BOD=1 - 3 mg/L (good for fish, bathing)
  BOD=3 - 8 mg/L (fair for industrial or agriculture water use)
  BOD=10 mg/L or more (polluted)
- Raw sewage: BOD=200-300 mg/L (around 20-30 mg/L in effluent of sewage treatment plant)
- Industrial wastewater: BOD=tens - several thousands mg/L

Chemical Oxygen Demand (COD_{Cr})

What is it and why does it matter?

Chemical Oxygen Demand (COD_{Cr}) is defined : as the quantity of oxygen consumed by organic matter from boiling acid potassium dichromate ($K_2Cr_2O_7$)

Chemical Oxygen Demand (COD_{Cr})

Importance of COD measurement

COD of special importance in assessment of polluted surface water and wastewater.

Rapid and frequent monitoring water quality (2 hours)

Indispensable as basic data for sewage works

Chemical Oxygen Demand (COD_{Cr})

What factors affect COD?

- Industrial and domestic wastewater discharge
- Water temperature
- Chloride (Cl^-) concentration in the water
- Organic matter characteristics
- Water movement and mixing
- Others

Chemical Oxygen Demand (COD_{Cr})

Measurement Method?

- Dilution method (titration, standard method)
- Reactor digestion method (approved by USEPA, used in this project ; unit, mg/L)

COD_{Cr}

A reaction time of 2 hours (BOD 5 days) is normally used for the measurement of COD_{Cr}

Chemical Oxygen Demand (COD_{Cr})

Interpreting Your Results

- Generally, COD_{Cr} value > BOD value for same water sample.
- Correlate with BOD (COD_{Cr}=1.5 to 3.0 × BOD)
- Raw sewage: COD=300-700 mg/L (around 60-150 mg/L in effluent of sewage treatment plant)
- Industrial wastewater: COD=tens - several thousands mg/L

How to measure
DO
BOD
COD_{Cr}

↓

Demonstration

Lecture Training for
Basic Water Quality Monitoring (1st)

Lecture-8: Water Quality Analytical Theory and Skill-3

June 2005
By Matsue Ryunan
(The JICA Expert Team)

Ammonia-Nitrogen (NH_3-N)

What is it and why does it matter?

Nitrogen (N): an element that is essential for all forms of life

---

Ammonia-Nitrogen (NH_3-N)

What is it and why does it matter?

The nitrogen compounds are:
- **Organic nitrogen:**
- **Ammonia (NH_3): a product of de decomposition organic waste and can be used as an indicator of the amount of organic matter in the water**
- **Nitrate (NO_3): soluble and easily taken up by aquatic organisms, it is the most meaningful form for water quality agency to test.**
- **Nitrite (NO_2): toxic to humans and other animals.**

Total N=organic-N + NH_3-N + NO_3-N + NO_2-N

Ammonia-Nitrogen (NH_3-N)

What factors affect NH_3-N?

- **Animal and human wastes (sewage)**
- **Industrial wastewater discharge**
- **Nitrogen-containing fertilizers**
- **Soil type**
- **pH (pH>7 NH_3 form; pH<7 NH_4^+ form)**
- **Others (DO, bacteria quantity and type etc.)**

Ammonia-Nitrogen (NH_3-N)

Measurement Method?

- **Titration method (difficult for operation)**
- **Specific-ion electrodes**
- **Colorimetric method (used in this project; unit: mg/L)**

Ammonia-Nitrogen (NH_3-N)

Interpreting Your Results

- **Raw sewage: 10 – 50 mg/L**
- **Industrial wastewater: concentration varies with the type of factory**
- **The natural concentration of ammonia in surface water is typically low (< 1mg/L)**
- **High concentration of ammonia-nitrogen indicates that water may be polluted by sewage or industrial wastewater.**

Nitrate-Nitrogen (NO_3-N)

What is it and why does it matter?

NO_3-N: the most common nitrogen compounds, and actually measured as total nitrogen in water.

Nitrate-Nitrogen (NO_3-N)

What factors affect NO_3-N?

- Animal and human wastes (sewage)
- Industrial wastewater discharge
- N-containing fertilizers
- Soil type
- Seasonal conditions
- Others (DO, bacteria quantity and type etc.)

Nitrate-Nitrogen (NO_3-N)

Measurement Method?

- Zinc reduction (Colorimeter/spectrophotometer) method
- Cadmium (color comparator) method (used in this project, unit: mg/L)

Nitrate-Nitrogen (NO_3-N)

Interpreting Your Results

- Raw sewage: NO_3-N≒0 mg/L (tens mg/L in effluent of sewage treatment plant, because organic-N and $NH_3 \Rightarrow NO_3$)
- Industrial wastewater: concentration varies with the type of factory
- The natural concentration of NO_3-N in surface water is low (0-tens mg/L)
- Present in freshwaters at higher concentrations than NH_3-N and phosphate.

Phosphate (PO_4)

What is it and why does it matter?

Phosphorus (P): a mineral nutrient that is essential for all forms of life

Phosphate (PO_4)

What is it and why does it matter?

The most common phosphorus compounds are:

- Organic phosphorus:
- Phosphate (PO_4): high concentration of PO_4 in lake/river waters stimulate great increases of the growth of algae

Total P= Organic-P + PO_4-P

Phosphate (PO_4)

What factors affect PO_4?

- Animal and human wastes (sewage)
- Industrial wastewater discharge
- Phosphorus-containing fertilizers
- Soil type
- Seasonal conditions
- Others (DO, bacteria quantity and type etc.)

Phosphate (PO_4)

Measurement Method?

- Reactive, molybdovanadate method
- Reactive, amino acid method (used in this project; unit: mg/L)

Phosphate (PO_4)

Interpreting Your Results

- Raw sewage: 3–30 mg/L
- The natural concentration of PO_4 in surface water varies from 0- 30 mg/L
- To convert phosphate (PO4) to phosphorus (P), divide by (31+16*4)/31=3
  (i.e. 30 mgPO_4/L is equivalent to only 10 mgP/L

How to measure
NH_3-N
NO_3-N
PO_4

Demonstration

Lecture Training for
Basic Water Quality Monitoring (1st)

Lecture-9. Laboratory Operation

June 2005
By Matsue Ryunan and Sato S.
JICA Expert Team

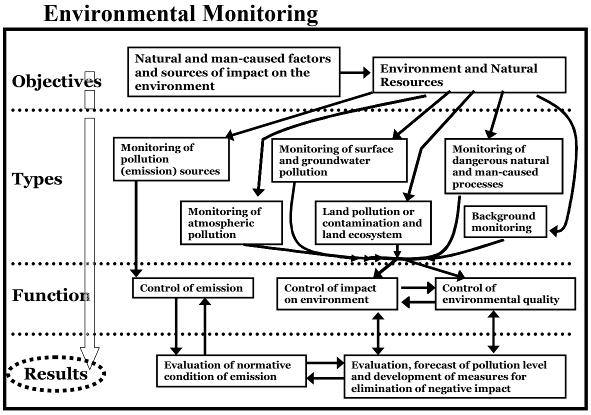
1

Laboratory Operation

1. Scheme of Environmental Monitoring System
2. Reliability of Analyzed Data
3. What to do to ensure accuracy and reliability of analyzed data in laboratory?
   3.1 Quality Assurance and Quality Control
   3.2 SOP
   3.3 Operation and Maintenance of Laboratory

2

1. Scheme of Functioning of the System of Environmental Monitoring



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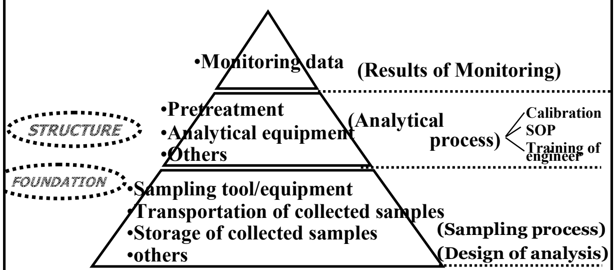
2. Reliability Pyramid of Monitored Data



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➢ **How to Ensure Accuracy and Reliability?**

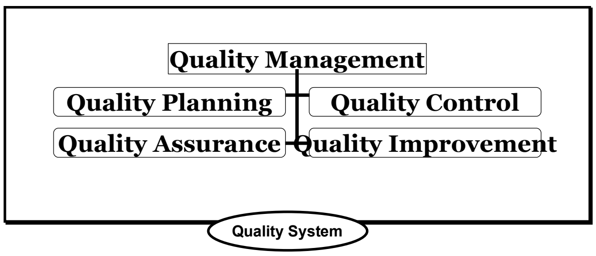
Implementation of QA/QC

⇧

Securement of Accuracy and Reliability of Analyzed Data

5

3.1.1Quality System
And Elements of Quality Management



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➢ **What is the Goal of QA/QC?**

► **Implement correct or standardized methodologies in every monitoring processes :**
- **Sampling process,**
- **Analysis process,**
- **Data handling process,**
- **Reporting process**

⇨ *GOAL*

► **Minimize or avoid the introduction of error in every monitoring processes**

7

3.1.2 Definitions Associated with Analytical Quality Assurance(1)

- **Quality management**

✓**Overall management function** to determine quality policy, objectives and responsibilities, and to implement by means of quality planning, quality control, quality assurance, and quality improvement

8

3.1.3 Definitions Associated with Analytical Quality Assurance(2)

- **Quality Control**

✓Part of quality management focused on **fulfilling quality requirements** [ISO9000]

✓Operational techniques and activities to fulfill requirements for quality

✓ "Internal quality control"

⇨ Conducted within a laboratory to monitor performance

✓ "External quality control"

⇨ Leading to comparison with other reference laboratories or consensus results amongst several laboratories

3.1.4 Definitions Associated with Analytical Quality Assurance(3)

- **Quality Assurance**

✓Part of quality management focused on **providing confidence** that quality requirements will be fulfilled [ISO 9000]

✓All planned and systematic activities implemented within the quality system to provide adequate confidence

✓System of documenting and cross referencing management procedures

10

- Objectives of QA

To have clear and concise records of all procedures related to data quality

⇧

Achieved by: Establishing protocols and quality criteria for all aspects of laboratory works

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3.1.5 Components of Q/A

Lab. Works	Actions Taken
• Operation of standard procedure	– Preparation of SOP – Examination of new method
• Maintenance of analytical equipment	– Regular calibration – Supply of consumables
• Securing of validity of analysis	– Securing of quality of reagent – Technical training
• Evaluation of analyzed data	– Recording of analytical condition – Examination of deviation
• Review of management system	– Reporting – Necessary revising

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3.2.1 SOP

What is SOP?

SOP stand for ;

Standard **O**peration **P**rocedure

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3.2.2 What is SOP?

- **A set of written instructions** followed by a laboratory
- Kind of unified instruction or manual for analysis
- SOPs **describe both technical and administrative operational elements** under a work plan or a Quality Assurance (QA) Project Plan

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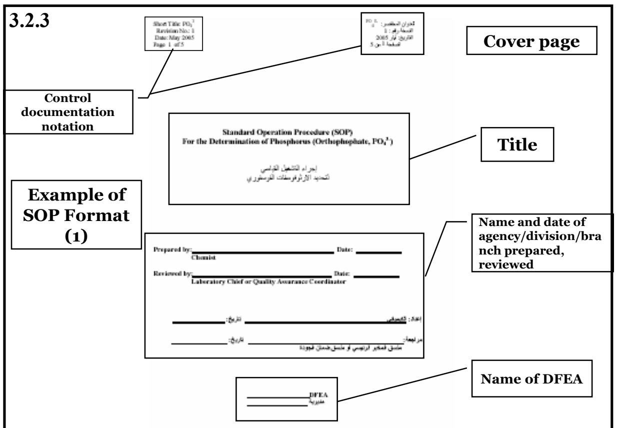
3.2.3



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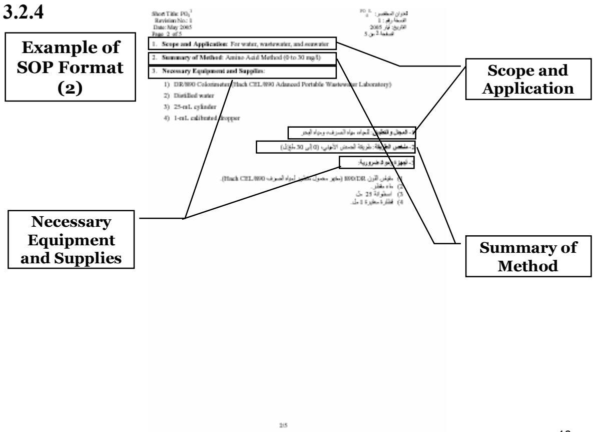
3.2.4



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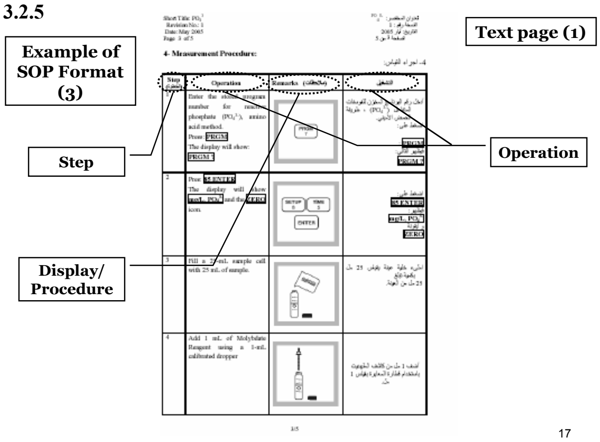
3.2.5



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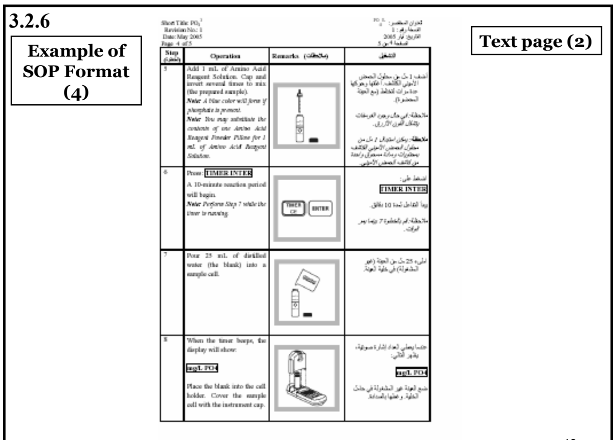
3.2.6



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3.2.7

Example of SOP Format (5)

Text page (3)

Short Title: PO_4^{3}
Revision No.: 1
Date: May 2005
Page 5 of 5

عنوان المختصر: PO_4^{3}
النسخة رقم: 1
التاريخ: أيار 2005
الصفحة 5 من 5

Step (الخطوة)	Operation	Remarks (ملاحظات)	التشغيل
9	Press: **ZERO** The cursor will move to the right, then the display will show: **0.0 mg/L PO4** *Note: If Reagent Blank Correction is on, the display may flash "limit".*		[illegible]
10	Place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap.		[illegible]
11	Press: **READ** The cursor will move to the right, then the result in mg/L PO_4 will be displayed. Record the result on the water quality sheet. *Note: Standard Adjust may be performed using a prepared standard.*		[illegible]

END النهاية

5/5

3.2.8 What is the purpose of SOP?

- **Standardization** of every analysis-related procedures to avoid or minimize error caused by analysts and equipment
- To **facilitate consistent conformance** to technical and quality system requirements
- To support data quality
- To maintain their quality control and quality assurance processes, and
- To ensure compliance with regulations

3.2.9 What is the benefit of having SOP?

- **Integral part of a successful quality system** as it provides analysts with the information to perform a job properly
- Facilitation of **consistency in the quality and integrity** of a product or end result
- A part of a **personnel training** program
- **Reduction of work effort** along with improving data comparability, credibility, and legal defensibility
- Person with limited experience or limited knowledge can **reproduce the analytical procedures without supervision**

3.2.9(2) Indirect Result of SOP

- **Decrease in mistakes during monitoring performance**
- **Proper layout of equipment and facilities**
- **Improvement of safety of work**
- **Improvement, maintenance and succession of techniques**

3.2.10 How much detail needs to be included in SOP?

- No one 'correct' format
- Vary with each laboratory and with the type of SOP
- Written with sufficient detail with a basic understanding

3.2.11 Writing Styles of SOPs

- In a concise, step-by-step, easy-to-read format
- Not be unambiguous and not overly complicated
- Active voice and present verb tense
- Not be wordy, redundant, or overly lengthy

3.2.12 Who should write a SOP?

- ❑ Prepared by analysts knowledgeable with the analytical performance and the laboratory's internal conditions
- ❑ Subject-matter experts who actually perform the work or use the process
- ❑ A team approach for multi-tasked processes

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3.3.1 Operation and Maintenance of Laboratory

1) Attitude to Accurate Analysis
2) Ensuring Safe Operation
3) Management and Handling of Reagents
4) Management & Maintenance of Facilities & Instrument

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1) Attitude to Accurate Analysis

① Overall Understanding of Background to the Environmental Analysis
② Cleaning up and Tidying of the Laboratory
③ Appropriate Solid Waste Treatment
④ Collection and Disposal of Liquid Waste

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2) Ensuring Safe Operation

①Storage of Dangerous Chemicals
②Electrical Wiring in Laboratory
③Handling of High Pressure Gases

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3) Management and Handling of Reagents

① Grasping the Stock Amount of Reagents
② Reagent Storage and Management Ledger (Inventory Control)
③ Storage of Standard Reagents and Maintenance of Accuracy
④ Safety Measures
⑤ Reagents Required Special Care for Storage

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4) Maintenance/Management of Facilities and Instrument

① Maintenance and Management of Facilities
- a. Air conditioners
- b. Ventilation system
- c. Electrical equipment
- d. Wastewater treatment plant

② Maintenance and Management of Equipment/Instruments
- a. Maintenance of equipment/instruments under normal status
- b. Management of equipment/instruments under abnormal condition
- c. Management of spare parts and consumables

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5) Other Key Factors

① **Standard Operating Procedure (SOP)**
② **Management of Analysis Records**
③ **Handling of Analysis Data**
- **a. Unit and Significant figures**
- **b. Anomalous value**
- **c. Accuracy management**

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□ Unit for Water Pollution Indicator

✓ Expression of Analyzed Data
NO_3-N **:** 7mg/L ◂⋯⋯▸ NO_3 **:** 31mg/L
✓Meaning of Analyzed Data
⇒ Understanding of analytical method adopted
✓Unit of Expression
μg/L, mg/L, kg/L, … (weight/volume)
%, ppm (parts per million), ppb, ..(ratio)

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□Significant Figures

pH=6.23 → 2 decimal places
pH=6.234 → 3 decimal places
pH=6.2 → 1 decimal place

Minimum detection limit : <u>0.01</u>
pH=6.234 → pH=6.23
pH=6.2 → pH=6.15 – pH=6.24
→ pH=6.15, 6.20, 6.23, ….

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Thank You for Your Kind Attention

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Lecture Training for
Basic Water Quality Monitoring (2nd)

Lecture 1
Basis of Water Quality Analysis

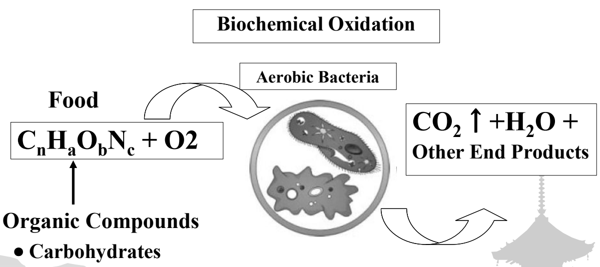
Jan. – Feb. 2006
By Matsue Ryunan
(JICA Expert Team)

1. Basis for BOD Measurement

1.1 Definition of BOD

Biochemical Oxygen Demand: is the amount of oxygen, expressed in mg/L or parts per million (ppm), that bacteria take from the water when they oxidize organic mater.

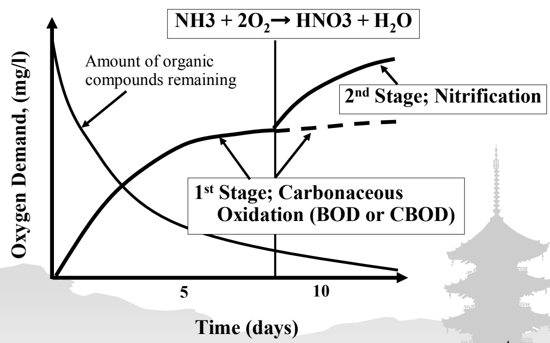
1.2 BOD Measuring Principle



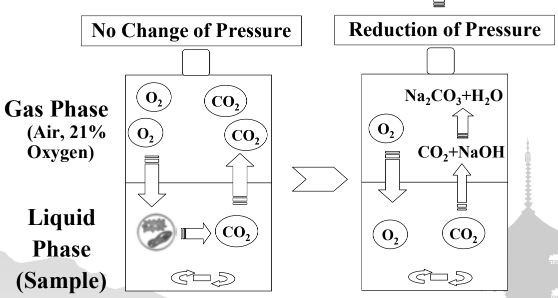
Organic Compounds
- **Carbohydrates**
- **Proteins**
- **Fats**

(All organic compounds contain carbon; such as Sugar $C_{12}H_{22}O_{11}$, Benzene C_6H_6)

1.2 BOD Measuring Principle



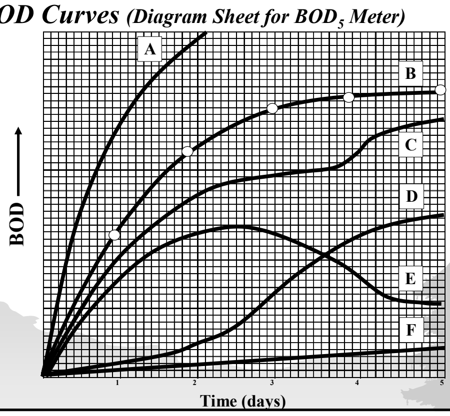
1.2 BOD Measuring Principle



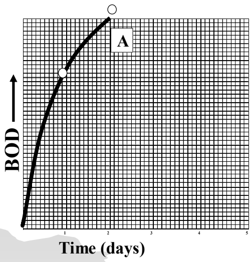
Greater reduction in pressure = Higher BOD
Lower reduction in pressure = Lower BOD

2 Major Problems and Countermeasures

2.1 BOD Curves (Diagram Sheet for BOD_5 Meter)



2.1 BOD Curves



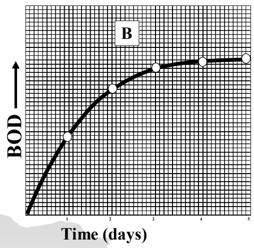
Possible Cause

1)The BOD value is too high, the oxygen content in the bottle was not sufficient.
2) Inhibitor is missing or lacking.

Countermeasures:

1) Another measurement rage should be selected.
2) In case of 22.7 ml of sample is taken, the sample must be diluted. (the BOD value should be multiplied by the dilution factor)
3) Add more nitrification inhibitor.

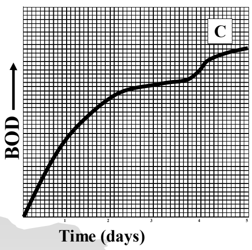
2.1 BOD Curves



CASE B

Normal course of a BOD graph.

2.1 BOD Curves



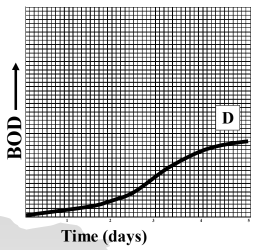
Possible Cause

An unwanted process occurred, e.g. unwanted nitrification.

Countermeasures:

1) Add more nitrification inhibitor. (especially for the sample with high conc. of NH_3 or NO_2)
2) Check the validated date of inhibitor and use new inhibitor.

2.1 BOD Curves



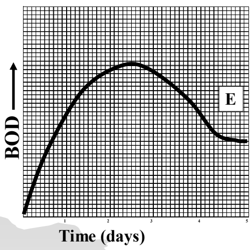
Possible Cause

Sample may contain inhibiting substances (such as phenols or heavy metals)

Countermeasures:

1) The sample should be diluted.
2) Add more Polyseed solution (both sample and blank).
3) Special seed should be used to supply sufficient number of bacteria.

2.1 BOD Curves



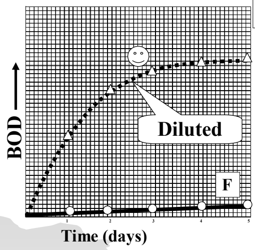
Possible Cause

A leak or no enough sodium hydroxide (NaOH) may occurred in the system

Countermeasures:

1) Check rubber sleeve, screw top and bottle.
2) Add more NaOH pellets.
3) Check the temperature of incubator.

2.1 BOD Curves



Possible Cause

1) Sample may contain toxic substances (such as cyanide or heavy metals in high conc.)
2) Scarcity of sample

Countermeasures:

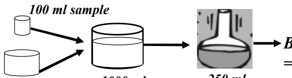
1) The sample should be diluted. (next slide)
2) Add more Polyseed solution.
3) Special seed should be used to supply sufficient number of bacteria. (next slide)
4) Use bigger overflow flask.
5) Check the temperature.

1) Sample Dilution

Measured Results

Example:
Estimated BOD conc. of industrial wastewater sample with toxic substances: 1,000 mg/l

10 times dilution
(estimated BOD=100 mg/l)



$BOD_{sample} = BOD_{diluted\ sample}$

Lecture Training for Basic Water Quality Monitoring (2^{nd})

Lecture 2
Basis of Water Quality Analysis

Jan. – Feb. 2006

By Matsue Ryunan and Sato S.
(JICA Expert Team)

Classification of Determination Method

Determination method		Analytical Item
Chemical analysis	Volumetric analysis	Hardness(Ca^{2+}, Mg^{2+}), Alkalinity, Acidity, DO, BOD, COD, etc.
	Gravimetric analysis	SS, VSS, CCE, Freon/N-Hexane extracts, etc.
Instrumental analysis	Absorption spectrophotometry (Colorimetric method) (Visible, UV, IR)	Turbidity, Cl, SO_4^{2-}, NH_4^{+}-N, NO_2-N, NO_3-N, PO_4^{3-}, Color, etc
	Gas chromatography (GC), (GC-MS) Liquid chromatography (LC) Ion chromatography	Volatile organic substances (benzene etc.) Soluble organic substances (pesticide etc.) Inorganic anion, Alkali metal
	Atomic absorption method ICP Emission spectrometer	Metal Metal element, etc.
	Others	Temp., DO, EC, etc.

Method and Instrument for Basic Water Analysis

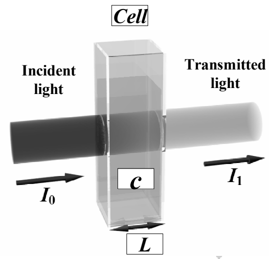
NO.	Parameter	Method	Instrument
1	pH	Electrode method	sensION1 Portable pH meter
2	Water temp.		Thermometer
3	Color	APHA Platinum-Cobalt method	Colorimeter (DR/890)
4	TDS	Electrode method	sensION5 Portable EC & TDS meter
5	DO	Membrane Electrode method	sensION 6 Portable DO meter
6	SS	Photometric method	Colorimeter (DR/890)
7	COD_{Cr}	Reactor Digestion method	Reactor (DRB 200-1) & Colorimeter (DR/890)
8	NO_3-N	Cadmium Reduction method	Colorimeter (DR/890)
9	NH_3-N	Salicylate method	Colorimeter (DR/890)
10	PO_4^{3+}	Amino Acid method	Colorimeter (DR/890)
11	Cl^-	Silver Nitrate Method	Digital Titrator (Model 16900)
12	BOD_5	Manometric (Pressure sensor) method	OxiTop
13	EC	Electrode method	sensION5 Portable EC & TDS meter
14	Turbidity	Nephelometric method	2100P Portable Turbidity

1. Principle of Colorimeter

- **Lambert-Beer Law – Basis of Spectrophotometry**

I_0 = intensity of the incident light
I_l = intensity after passing through the solution

$T = I_0/I_1$ (Absorptivity)



$A=\log_{10}(I_0/I_l)$ =

Absorptivity of a substance is proportional to its concentration (C) and length (L) of path traveled

Lecture Training for Basic Water Quality Monitoring (2nd)

Lecture 3
Environmental Monitoring Plan

Jan. – Feb. 2006
Matsue Ryunan
JICA Expert Team

Review Structure of Water Quality Monitoring Plan

[redacted] ← **Problem Finding**

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1. Objectives of Water Quality Monitoring Plan

1) Industrial wastewater (more than 10 types)
(Damascus, Damascus Countryside, Aleppo, Homs, Hama, Lattakia etc.)

2) Domestic wastewater ⇨ **Pollution sources monitoring (Major objective of the Project)**
(Lattakia, Dier ez Zor, Hasakeh, Rakka etc.)

3) Rivers ⟶ evaluating the effect of pollutants
(Homs, Lattakia, Dier ez Zor, Hasakeh, Rakka, Tartous etc.)

4) Lakes/reservoir ⟶ evaluating the effect of pollutants
(Homs, Lattakia, Rakka, Sweida, Tartous, Quneitra)

5) Groundwater ⟶ evaluating the effect of pollutants
(Sweida, Tartous, Quneitra)

2. Confirmation of Sample Stations

1) Location (map, address etc.)

2) Number (the capacity of sampling and analysis at each DFEA is estimated to be 240 samples/year.) **5 Samples/Week*4W*12M**

⇩

Sampling Frequency

Example: Sampling Frequency		Total Sampling Station
1 time/year		240 stations
2 times/year	➡	120 stations
4 times/year		60 stations
12 times/year		20 stations

3) Others (sampling vehicle)

3. Confirmation of Measurement Parameters

Item	Domestic Wastewater	Rivers	Lakes	Groundwater
pH	○	○	○	○
Water Temp.	○	○	○	○
Color	△	○	○	○
TDS	○	○	○	○
DO	△	○	○	△
SS	○	○	○	△
COD	○	○	○	○
BOD_5	○	○	○	○
NO_3^-	○	○	○	○
PO_4^{3-}	○	○	○	○
Cl^-	○	○	○	○
NH_3-N	○	○	○	○
EC	○	○	○	○
Turbidity	△	○	○	○
Flowrate	○ Simple method	○WRIC	×	×

3. Confirmation of Measurement Parameters

[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
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3. Confirmation of Measurement Parameters

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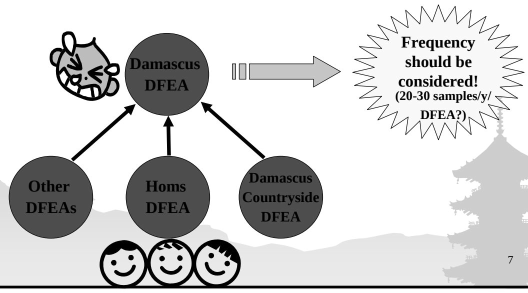

4. Annual Cost Estimation for Monitoring

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Calculation method of unit price should be discussed.

4. Annual Cost Estimation for Monitoring

[redacted]

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	Item	Usage	Quantity	Cost (US$)		Cost (SP)	Remarks
				Unit	Total		
1	Petrol (10 km/L, 100 km/d ×3d/w ×52w/y)	Information collection, field check and sampling etc.	1,560	0.47	736	39,000	Sampling vehicle
2	Consumables (tap, bottle, oil pen, note etc.)	Sampling	1 set	200	200	10,600	
	Sub-total				**936**	**49,600**	

4. Annual Cost Estimation for Monitoring

[redacted]

[redacted]

Reagents

	Item	Usage	Quantity	Cost (US$)		Cost (SP)	Remarks
				Unit	Total		
1	pH standards, pH 4.01	pH calibration	2	19	38	1,988	500 ml
	pH standards, pH 7.00		2	19	38	1,988	500 ml
	pH standards, pH 10.00		2	19	38	1,988	500 ml
2	Conductivity standards, 180 μs/cm	EC&TDS calibration	1	24	24	1,259	100ml
	Conductivity standards, 1,000 μs/cm		1	23	23	1,193	100ml
	Conductivity standards, 18,000 μs/cm		1	23	23	1,193	100ml
3	Turbidity Standards Kit for 2100 P Turbidity Meter	Turbidity calibration	1	644	644	34,119	500 ml for 0.1, 20, 100, 800
4	Reagents (High range 0-1,500 mg/l) for COD_{Cr}	COD_{Cr}	11	84	921	48,826	PK/25
5	Reagents (Low range 0-150 mg/l) for COD_{Cr}	COD_{Cr}	4	84	335	17,755	25/PK
6	Reagents for NO_3^--N	NO_3^--N	3	56	169	8,944	100 tests/set
7	Reagents for PO_4^{3-}	PO_4^{3-}	3	44	131	6,956	100 tests/set
8	Reagents for Cl^-	Cl^-	3	144	431	22,856	100 tests/set
9	Reagents for Ammonia-N	NH_3-N	6	175	1,050	55,650	50 tubes/PK
10	Nitrification Inhibitor	BOD	1	256	256	13,581	500g
11	BOD Nutrient Buffer Pillows	BOD	6	16	98	5,168	50 pillows/PK
12	BOD Seed Inoculum	BOD	6	281	1,688	89,438	50 capsules/bottle
13	NaOH Pack	BOD	1	13	13	663	1000g/PK
	Other low range reagents	Sub-total			**5,916**	**313,561**	

4. Annual Cost Estimation for Monitoring

[redacted]

[redacted]

Glassware, Consumables, Water Tariff, Electrical Tariff etc.

	Item	Usage	Quantity	Cost (US$)		Cost (SP)	Remarks
				Unit	Total		
1	Glassware (Pipettes, flasks, beakers, cylinders, funnels etc.)	All of parameters	1 set	143	143	7,571	Procured glassware×20%
2	Other Consumables (Batteries, tap, oil pen, cleaning tissue, detergent etc.)	All of parameters and laboratory salty etc.	1 set	800	800	42,400	Estimated from the results of procurement in first year
3	Water Tariff ($3m^3$/d×5d/w×52w/y)	All of Parameters	780	0.29	228	12,090	Lab.
4	Electrical Tariff (6 kW×5d/w×52w/y)	Data Analysis and Reporting etc.	1,560	0.05	74	3,900	Lab.
5	Cost of Equipment Repair and Maintenance	All of equipment	1 set	660	660	34,980	Procured equipment×2%
	Sub-total				**1,905**	**100,941**	

4. Annual Cost Estimation for Monitoring

[redacted]

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(sampling cost + analysis cost) × 10%

=(936 + 5,916 + 1,905) × 10%

=876 US$

4. Annual Cost Estimation for Monitoring

[redacted]

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For each DFEA (9,633 US$/240 samples = 40 $/sample)
(520,000 S.P/240 samples = 2200 S.P/sample)

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4. Annual Cost Estimation for Monitoring

[redacted]

No.	Parameters	Unit Price (USD)
1	pH	1.5
2	Water Temperature	1.5
3	Color	1.5
4	Total Dissolved Solids (TDS)	4
5	Dissolved Oxygen (DO)	3
6	Suspended Solids (SS)	4
7	COD (dichromate)	8
8	BOD_5	12
9	Nitrate (NO_3^-)	7
10	Phosphate ion (PO_4^{3-})	9
11	Chloride ion (Cl^-)	4
12	Ammonium Nitrogen (NH_3-N)	7
13	Conductivity (EC)	1.5
14	Turbidity	2
	Total	**66**

[redacted]

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5. Requirements

1) Information collection and confirmation
- **Factories**: Location, type, major raw materials and products, water consumption, operation time, existing water quality data, wastewater treatment facility etc. (MI)
- **Domestic wastewater**: Population (total and serviced by sewage system), location of outlet, water supply etc.
- **Lakes/reservoirs**: Population and area of catchment area, inflow river(s), major pollution sources, water use, outline (volume, surface area, depth etc.)
- **Rivers**: weather (monthly rainfall etc.), flow, major pollution sources in catchment area existing water quality data (Ministry of Irrigation, WRIC etc.)
- **Groundwater**: Complaints, major pollution sources, geological information etc.

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5. Requirements

2) Preparation of major pollution sources location and sapling station maps.

3) Determination of frequency and measurement parameters for each sampling station. ⇨ List

4) Confirmation of sampling vehicle and budget

5) Others (personnel source, cabinet for glassware, bookshelf etc.)

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6. Operation and Maintenance (O/M) Record

1) Equipment O/M Record
2) Reagents O/M Record
3) Laboratory Safety Management
4) Suppliers List
5) Waste Treatment O/M Record

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Lecture Training for
Basic Water Quality Monitoring (3rd)

Lecture 1
Introduction to O/M Manual and QA/QC

Jun. – Jul. 2006

Matsue Ryunan

(JICA Expert Team)

Training Contents (2006/06/03 – 2006/08/14)

(1) Lecture Training at each DFEA (Half-day)

- **-Introduction of laboratory O/M manual and O/M records**
- **-Analysis by using low rang reagents (4 new SOPs)**
- **-Use of standard solutions**

(2) Field Training in each DFEA (2 – 3 days)

- **-Check and review of monitoring activities**
- **-Check QA/QC**
- **-Check and review of annual monitoring plan**
- **-Interpretation of the results**
- **-Budget preparation for year 2007**
- **-Preparation for JICA mid-term evaluation**
- **-Correspondence of special problems at some DFEAs**

1. Operation and Maintenance (O/M) Manual & Records

1) Lab. safety
- **a) Analysis by following SOP (put SOP at each equip.)**
- **b) Electrical (capacity checking etc.), water**
- **c) Eating, drinking and smoking**
- **d) Housekeeping and filing**
- **e) Toxic reagents storage**
- **f) Clothing and emergency response etc.**

2) Management and handling of reagents
- **a) Reagents O/M Record**
- **b) Storage of standard reagents**

1. Operation and Maintenance (O/M) Manual & Records

3) Maintenance and Management of Equipment
- **a) Equipment O/M Record**

4) Laboratory Waste Treatment

5) Others
- **a) Name list of the staff in charge of laboratory management**
- **b) Suppliers list**

2. Analysis By Using Low Rang Reagents

Analysis of low rang NO_3-N, PO_4, NH_3-N and COD (4 new SOPs)

No.	Parameter	Method	Measuring Range	EDL
1	NO_3^--N	Cadmium reduction method	0 to 30.0 mg/L	**0.8 mg/L NO_3^--N**
2			0 to 5.0 mg/L	**0.2 mg/L NO_3^-N**
3	PO_4^{3-}	Amino acid method	0 to 30.00 mg/L	**0.14 mg/L PO_4^{3-}**
4		Ascorbic acid method	0 to 2.50 mg/L 0 to 2.50 mg/L (DAM)	**0.05 mg/L PO_4^{3-}** **0.02 mg/l PO_4^{3-}(DAM)**
5	NH_3-N	Salicylate method	0 to 50 mg/L	**1 mg/L NH_3-N**
6			0 to 2.50 mg/L 0 to 2.50 mg/L (DAM)	**0.08 mg/L NH_3-N** **0.02 mg/l NH_3-N (DAM)**
7	COD	Reactor digestion method	0 to 1,500 mg/L	**30 mg/L COD**
8			0 to 150 mg/L	**4 mg/L COD**

3. Use of Standard Solution

Standard solutions provided by JICA this time	
1) NO_3-N (1.0 mg/l)	**6) COD_{Cr} (300 mg/l)**
2) NO_3-N (10.0 mg/l)	**7) COD_{Cr} (1,000 mg/l)**
3) PO_4 (50 mg/l)	**8) BOD (300 mg/l)**
4) NH_3-N (10 mg/l)	**9) BOD (3,000 mg/l)**
5) NH_3-N (50 mg/l)	**10) Cl (1,000 mg/l)**

Standard solutions provided by JICA in Jun. 2005

1) pH standard (4.01, 7.00, 10.00)

2) EC standard (180, 1,000, 18,000 μ s/cm)

3) Turbidity standards (0.1, 20, 100, 800 NTU)

4. Requirements

1) Environmental monitoring plan modification

2) Code labeling of samples

- **a) Industrial wastewater sample ⇨ DEZ-I-001**
- **b) Domestic wastewater sample ⇨ DEZ-D-001**
- **c) River water sample ⇨ DEZ-R-001**
- **d) Lake, dam & reservoir water ⇨ DEZ-L-001**
- **e) Groundwater sample ⇨ DEZ-G-001**

3) Expiring reagents records ⇨ JICA Expert Team

4) Usage of monitoring data

5) Filing of catalog, training materials, SOPs, O/M manual and records, analysis results, data sheets etc.

6) Others (2007 budget preparation, staff, furniture, tomorrow schedule etc.)

Lecture Training for
Basic Water Quality Monitoring (3rd)

Lecture 2
Common Problems With Equipment

Jun. – Jul. 2006

Matsue Ryunan

(JICA Expert Team)

Lecture Content

1. Recommended Calibration Frequency.
2. Distilled Water Still Management.
3. pH Meter Management.
4. EC Meter Management.
5. DO Meter Management.
6. Colorimeter.

1. Recommended Calibration Frequency

No.	Instrument	Calibration Frequency
1	DR890 Colorimeter	Not Available
2	SensION1 pH meter	Each measurement (with 3 buffers)
3	SensION 5 Conductivity meter	Once a month
4	SensION 6 DO meter	Each measurement
5	Digital Titrator	Not Available
6	2100P Turbidity meter	Once each week
7	COD Reactor DRB200	Not Available

These frequencies are not fixed. They are just recommended.

2. Distilled Water Management

<u>The green light is on, but the instrument does not work</u>

- Check the water level inside the instrument.
- Unscrew the black cap.
- Press the white button.
- Restart the instrument.

2. Distilled Water Management

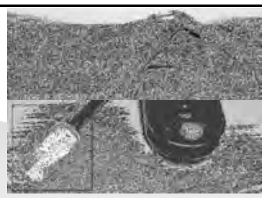
<u>The distilled water quality is not good</u>

- Wash the instrument with acids.
- Leave it working for about five hours, and throw the distilled water during this period.

3. pH Meter Management

<u>How should I save the electrode?</u>

The electrode should be saved in KCL, and if you can not find KCL , you can save in PH7 solution



3. pH Meter Management

Why does not PH meter calibrate?

- Check the buffer solution whether they are clean or not, whether they are fresh or not, and whether they are expired or not.
- Buffer solutions should be changed frequently.
- During calibration clean the electrode with distilled water to protect the buffers from carrying over.
- Check the gel cartridge whether it is empty or not.

3. pH Meter Management

Why does PH meter take long time to read?

- Because you do not calibrate it frequently.
- Because you did not calibrate it before this measurement.
- Try to swirl the electrode inside the sample.

3. pH Meter Management

BECAREFUL

- When you put the PH meter in the box , unplug the electrode to prevent bending it

4. EC Meter Management

What Solution should I choose to calibrate EC meter?

- Usually, we use 1000 µs solution for calibration, but in some cases when the conductivity of the measuring sample is high, we should calibrate with 18000 µs solution.

5. DO Meter Management

The readings are very high

- Filling the head with filling solution should be done once a month at least.
- Always keep the sponge wet.

6. Colorimeter

- It is not possible for the staff in the DFEAs to calibrate DR 890.
- The only thing that could be done, is to check the results with standards solutions.

Lecture Training For Basic Water Quality Monitoring (4th)

Industrial Wastewater Sampling, Interpretation of Analysis Results, Introduction of Reporting

Nov. – Dec. 2006

Matsue Ryunan

JICA Expert Team

Training for Basic Water Quality Monitoring (2006/10/31 – 2006/12/27)

1. Lecture Training at Each DFEA (Half-day)

- 1.1 Problems and measures of sampling methods
- 1.2 Interpretation of analysis results
- 1.3 Introduction of sample transport system to DAM from each DFEA
- 1.4 Introduction of reporting
- 1.5 Normal problems and solutions
- 1.6 Question and discussion

2. Field Training at Each DFEA (1.5 days)

- 2.1 Check and review of monitoring activities (especially for sampling method of industrial wastewater)
- 2.2 Check of lab. QA/QC and O/M records
- 2.3 Check of annual monitoring plan (2007)
- 2.4 Interpretation of the results
- 2.5 Confirmation of C/P changes
- 2.6 Use of standard solutions
- 2.7 Correspondence of special problems at some DFEAs
- 2.8 Laboratory safety (management of dangerous chemicals, fire extinguisher, safety shower)

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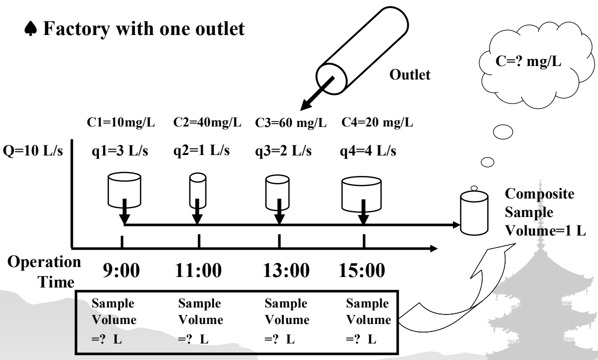
1. Composite Samples for Industrial Wastewater

♠ Factory with one outlet



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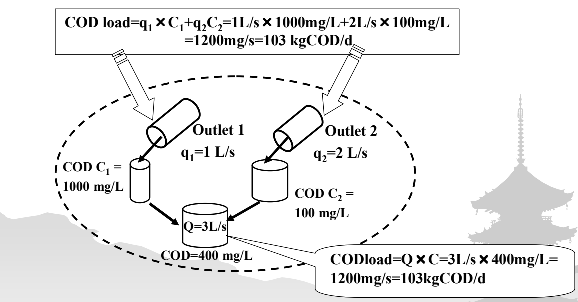
1. Composite Samples for Industrial Wastewater

♠ Factory with more than one outlet



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2. Interpretation of Analysis Results

1) BOD ↔ COD (such as BOD/COD, see next slide)

2) NH_3, NO_3 ↔ DO

3) Cl^- ↔ TDS, EC (Na^+, Ca^{2+}, NO_3^-, SO_4^{2-} …)

4) Mass balance check

5) Historical data, typical water quality (domestic wastewater, river, lake and groundwater)

Sampling Method ?

Analysis Problem?

Standard Solution

Cross Check

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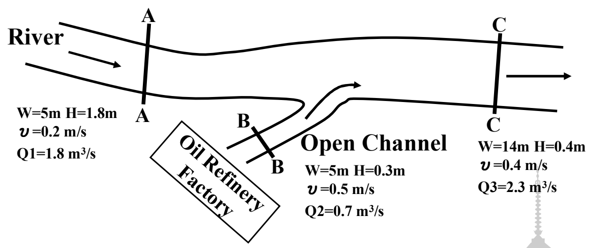
1) BOD/COD Ratio

Wastewater	BOD/COD
Industrial Wastewater with High Concentration of Organic Matter (Food processing, Slaughter, oil etc.)	Higher BOD/COD 0.5 – 0.8
Industrial Wastewater with Toxic or Heavy Metals (little of organic matter) (Tannery, chemical fertilizer, metal plating etc.)	Lower BOD/COD 0.1 – 0.4
Domestic Wastewater	Higher BOD/COD 0.3 – 0.8
Treated Domestic Wastewater of WTP	Lower BOD/COD 0.1 – 0.3

2) TDS and EC

Ion (1 mg/l)	EC(μS/cm) 25℃
Na^+ (Sodium)	2.13
K^+ (Potassium)	1.84
NH_3-N	5.24
Ca^{2+} (Calcium)	2.6
Mg^{2+} (Magnesium)	3.82
Cl^- (Chloride)	2.14
F^- (Fluorine)	2.91
NO_3^- (Nitrate)	5.1
SO_4^{2-} (Sulfate)	1.54

3) Mass Balance Check (Example at Homs)



Sec.	Q	NH_3 mg/l	Load	COD, mg/l	Load	PO4, mg/l	Load
A	1.8	2.5	4.5	34	61	4.5	8.1
B	0.7	13	9.1	30	21	1.5	1.0
C	2.3	7	16	44	101	4	9.2

4) Typical Domestic Wastewater Quality

Parameters		Concentration		
	Unit	Weak	Medium	Strong
Solids, Total (TS)	mg/l	350	720	1,200
1) Dissolved, Total (TDS)	mg/l	250	500	850
2) Suspended Solids (SS)	mg/l	**100**	**220**	**325**
BOD_5, 20℃	mg/l	**110**	**220**	**400**
COD_{Cr}	mg/l	**250**	**500**	**1,000**
Nitrogen (Total as N)	mg/l	**20**	**40**	**85**
1) Organic	mg/l	8	15	35
2) Ammonia (NH_3-N)	mg/l	**12**	**25**	**50**
3) Nitrites (NO_2-N)	mg/l	0	0	0
4) Nitrates (NO_3-N)	mg/l	0	0	0
Phosphorus (Total as P)	mg/l	**4**	**8**	**15**
1) Organic	mg/l	1	3	5
2) Inorganic	mg/l	3	5	10
Chloride (Cl^-)	mg/l	30	50	100
Sulfate (SO_4^{2-})	mg/l	20	30	50
Total Coliform	no/100 ml	10^6~10^7	10^7~10^8	10^8~10^9

3. Sample Transport System to DAM from each DFEA

Sample No. & Parameters Decision — (20-30 sample/year; Sulfide (S), Fluoride (F^-), Oil, CN-, Surfactant, Coliform, Heavy Metals ……)

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Sampling & Preservation — Sampling time: Sunday or Monday; Preservation methods

Mr. Sato & Mr. Kimura

⇩

Sending Samples to DAM — 1) Ice box with 6 cold packs; 2) Transportation methods; 3) Record, cost etc.

⇩

Receiving by DAM — 1) Receiving record; 2) Preservation & analysis

⇩

Sending Ice Box etc. to DFEAs — 1) Transportation methods; 2) Cost (receiver payment)

⇩

Sending Results to DFEAs — 1) Fax; 2) E-mail; 3) Records by DAM

4. Reporting (DFEA Level and GCEA Level)

1) Title Page

2) Executive Summary — Contents, function of the report, findings etc. 2 or 3 pages

3) Introduction — Objectives, area introduction, related monitoring activity etc.

4) Details — Details of factories, rivers, lakes, reservoirs, area (population etc.), location map of sampling station, analysis method, QA/QC etc.

5) Results and Discussion — Water quality assessment, major problems, etc. (tables and figures)

6) Recommendations for Future Work — Monitoring plan (station, parameter, frequency), water pollution control policy etc.

7) Appendix — Glossary, data tables and other detailed information etc.

5. Others (Normal Problems and Solutions)

1) When should we make reagent blank correction?

- **Run the reagent blank correction with each new lot of reagents.**
- **It is recommended to make the correction with each new bag of reagents.**

For more information about Reagent Blank Correction, please refer to the S.O.P.

2) What should we do with expired reagent or nearly expired?

a. When you buy reagent, make sure that they have long life time.
b. Classify the reagents by expired date, and start with the reagents which are going to be expired soon.
c. If you have some expired reagents, test them with standard solutions *periodically* . If the results are good, you can use these expired reagents.
d. In some cases like expired B.O.D seed you can adjust the amount of the reagents.

3) Why doesn't D.O meter work well?

- **It is very important to make maintenance and cleaning for the D.O probe.**
- **You should make it at least once each two months.**

For more information about Reagent Blank Correction, please refer to the S.O.P. and the attached paper.

4) Notes about preparing standards (dilution)

a. Do not use small pipettes, if possible. (using 5 or 10 ml)
b. Select suitable flasks.
c. Use one mark graduated pipettes.
d. If you are using the same pipette for different concentrations of standards, start with the low concentration then the bigger.

5) The Most Important parameters to be measured

Factory	Parameter
Oil refinery	pH, temp., TDS, SS, COD, BOD, PO_4, Cl^-, NH_3, S, oil
Olive oil	pH, temp., TDS, SS, COD, BOD, PO_4, Cl^-, NH_3, oil, etc.
Chemical fertilizer	pH, temp., TDS, SS, COD, BOD, PO_4, Cl^-, NH_3, S, F^-, CN^-, As, Cu
Tannery	pH, temp., TDS, SS, COD, BOD, PO_4, Cl^-, NH_3, S, oil, Cr
Textile	pH, temp., TDS, SS, COD, PO_4, Cl^-, NH_3, S, oil, Cr etc.
Slaughter	pH, temp., TDS, SS, COD, BOD, PO_4, Cl^-, NH_3, oil, etc.
Paper making	pH, temp., TDS, SS, COD, BOD, PO_4, Cl^-, NH_3
Food processing	pH, temp., TDS, SS, COD, BOD, PO_4, Cl^-, NH_3, oil, etc.
Detergent	pH, temp., TDS, SS, COD, BOD, PO_4, Cl^-, NH_3, surfactants

6. Questions and Discussion

Lecture Training For
Basic Water Quality Monitoring (5th)

Sample and Waste Liquid Transport System, QA/QC

Jun. – Jul. 2007

By Matsue Ryunan

(JICA Expert Team)

Training for Basic Water Quality Monitoring (2007/06/02 – 2007/07/23)

1. Lecture Training at Each DFEA (Half-day)

1.1 Sample transport system to DAM from each DFEA
1.2 Laboratory waste liquid transport system to DAM from each DFEA
1.3 Training plan (2008~) after the project
1.4 QA/QC and others
1.5 Question and discussion

2. OJT Training (Half-day)

2.1 Test at Each DFEA (COD , NO_3, NH_3-N, PO_4 etc.) - Starting to warm COD meter now
2.2 Training materials filing, O/M records etc.
2.3 Trainer training (including C/P evaluation)

1. Sampling & Preservation for Chemical & Biological and Heavy Metals Analysis (Mr. Kimura and Mr. Sato)

1) Sampling time: Sunday or Monday (Considering transportation period and receiving procedure by DAM. DFEA)
2) Preservation method:
a) Chemical
b) Biological (Coliform)
c) Heavy Metals
3) Recording form

2. Laboratory Waste Liquid Transportation to DAM

Contacting with DAM — 1) Informing the amount of waste, 2) Confirming the acceptability of DAM
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O/M Record — Recording form sheet: waste type, preservation methods and period
⇩
Sending Wastes to DAM — 1) Transportation methods 2) Cost etc.
⇩
Receiving by DAM — 1) Receiving record 2) Treatment record
⇩
Sending Containers etc. to DFEAs — 1) Transportation methods 2) Cost (receiver payment)

3. Proposed Self Training Courses After the Project

Title	Contents of Training	Remarks
Sampling	1. Selection of sampling point 2. Flow rate measurement 3. Sampling methods (composite) 4. Determination of sampling frequency 5. Selection of measuring parameters	1. Sampling for Environ. Monitoring 2. Video CD and internet
Analysis and QA/QC	1. Basic theory of water chemistry 2. Measuring principle of selected parameters 3. Basic theory & practice of QA/QC 4. Laboratory O/M (layout design, including safety manual etc.) 5. New parameters analysis	1. Text book of water chemistry 2. Standard Method (APHA, AWWA) 3. Hach's manuals 2. Video CD
Interpretation	1. Industrial wastewater characteristics 2. Elementary knowledge of water & wastewater treatment	1. Text book of industrial wastewater and treatment etc.

4. QA/QC and Others

1) Sampling location
a) Continuity for fixed stations
b) Individual stations (inspection and other purposes)

2) SOPs modification (especially for new methods)

3) Internal QC: Standard solution application

4) External QC: AEC QC system participation
(Measuring range and Estimates Detection Limit of the equipment for basic water quality analysis have to be considered.)

5) Additional parameters analysis
(Hach manual + reagents with Colorimeter Set)

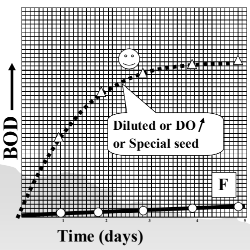
4. QA/QC and Others

5) BOD analysis

Damascus DFEA:

BOD_{actual} = 600 mg/l

$BOD_{measured}$ = 85 & 240 mg/l



Possible Cause

1) **Sample may contain toxic substances (such as cyanide or heavy metals in high conc.)**
2) **Lack of bacteria and DO**

Countermeasures:

1) **The sample should be diluted**
2) **Add more Polyseed solution (or little of domestic wastewater)**
3) **Special seed should be used to supply sufficient number of bacteria (especially for industrial wastewater)**
4) **Check the temperature (sample and incubator), blackout**
5) **Increasing DO of the sample**

Special Seed Method for BOD Analysis

a) Taking water from a stream where the wastewater is discharged (Seed)

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b) Measuring the BOD of seed

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C) Preparing seeded sample by adding 10%-30% of the seed into the sample

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d) Measuring the BOD of seeded sample

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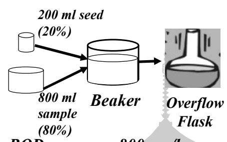
Example:

1 liter of seed water

BOD_{seed}=200 mg/l



$BOD_{seeded\ sample}$=800 mg/l

BOD_{Sample}= 800-(0.2

=950 mg/l