



Water Supply Management to Improve Quality of life “ Water Quality Control ”

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Water Quality Control

Contents

1. Introduction
2. Purpose of Water Quality Control
3. An overview of PWA's Water Quality Control
4. Improving water quality in the PWA's WTP

1. Introduction

PWA's Vision

Customers are delighted with water quality and excellent services.

Responsibilities

- Produce and distribute quality water.
- Develop an efficient and effective water production and distribution system by promote a customer-centered service.
- Develop an information technology system in support of PWA's work management.
- Develop the personnel so that they possess high potential in response to the organization's demand.

PWA service area

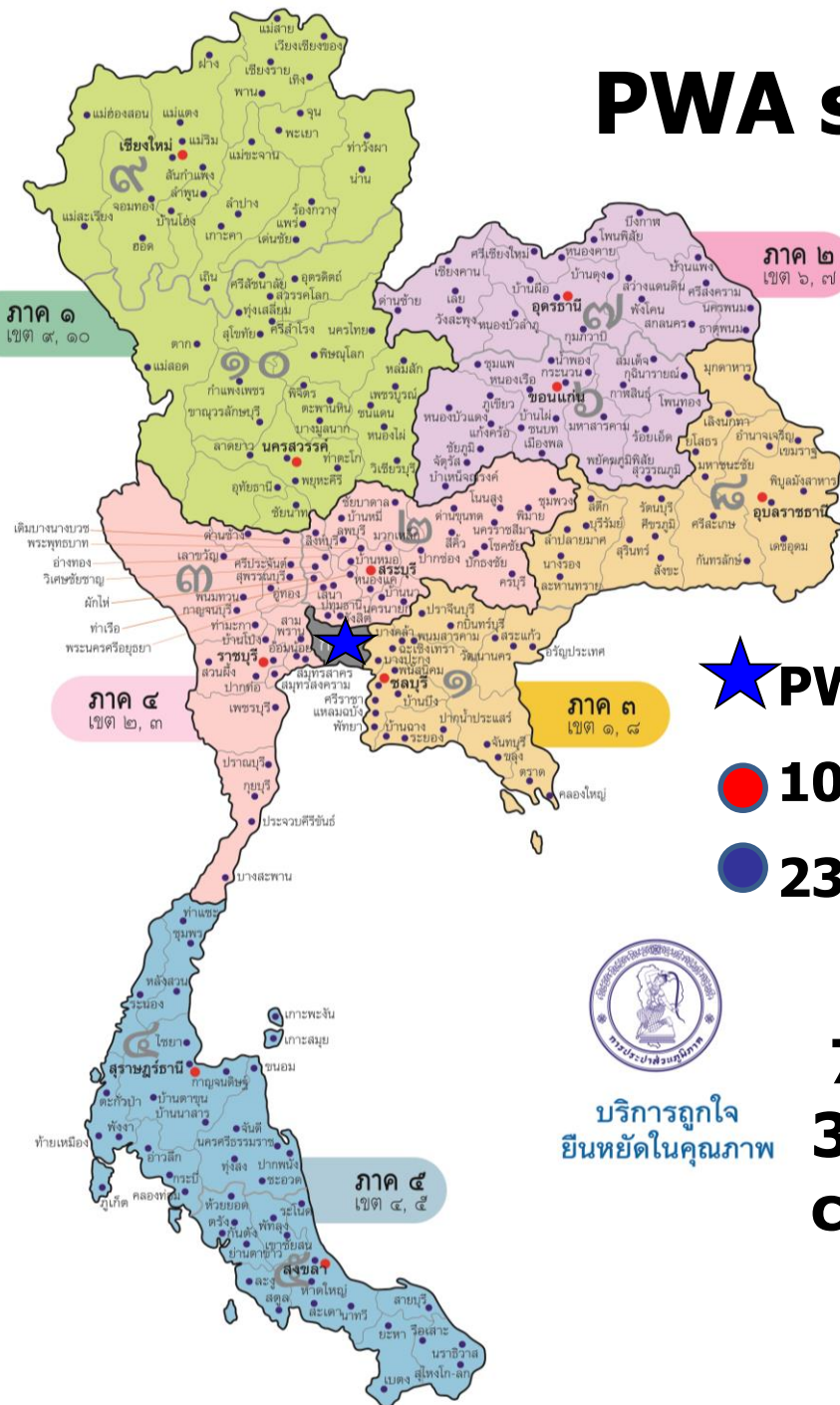


★ PWA Headquarters

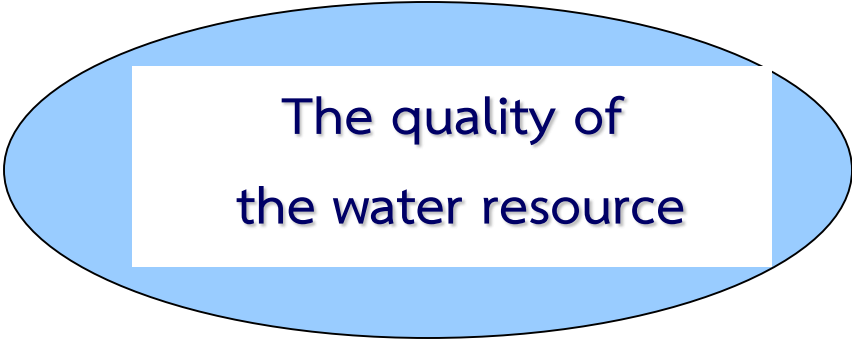
● 10 Regional Offices

● 234 Waterworks(357 Substations)

74 Provinces
3.923 million
connections(July,2015)



What is Water Quality??



The quality of
the water resource

Physical

Physical parameters
e.g., temp, pH, color, odour,
suspended solids

Non-toxic Pollutants
e.g., sediment,
nutrients

Chemical

Toxic Pollutants
acute and chronic

Synthetics
Pesticides, antibiotics,
industrial cpds, etc.

Biological

Fish and benthic
invertebrate
communities

Algae and aquatic
plants

Radio activity

Alpha and Beta

Safe Water

The definition of safe drinking water according to the World Health Organisation Guidelines is “does not represent any significant risk to health over the lifetime of consumption, including different sensitivities that may occur between life stages.”

Safe Water Characteristics

- Free of Pathogenic organisms
- Clear
- Tasteless and colorless
- Low in concentrations of toxic compounds
- No interaction with transmission pipes/fitting & storage containers

2.The purpose of water quality testing

- Monitoring water quality frequently and to apply the information to manage and minimize hazards from water source, water treatment system, water distribution system to provide clean & safe water and design or develop raw water , Water treatment system

2.1 The importance of water testing

- an increase in demand for water and water quality,
a lack of water supply and water quality deterioration
- water quality data that can be utilized must be kept for a long period of time
- water quality data from surveys and analysis can be applied for future use and for research and development
- accurate results will play a major role in effective water utility management

2.2 Standards for surface water

Notification of the National Environmental Board, No. 8,(1994),

To control and maintain the quality of water sources to be suitable for various uses (Multi Purposes) and that the standards are applicable to all these uses .

To conserve resources and the natural environment, with regard to the health and safety of human life and animals in the water.

Surface Water Quality Standards

Parameter ^{1/}	Units	<u>Standard Value for Class^{2/}</u>				
		Class1	Class2	Class3	Class4	Class5
1. Colour, Odour and Taste	-	n	n'	n'	n'	-
2. Temperature	C°	n	n'	n'	n'	-
3. pH	-	n	5-9	5-9	5-9	-
4. Dissolved Oxygen (DO) ^{2/}	mg/l	n	6.0	4.0	2.0	-
5. BOD (5 days, 20°C)	mg/l	n	1.5	2.0	4.0	-
6. Total Coliform Bacteria	MPN/100 ml	n	5,000	20,000	-	-
7. Fecal Coliform Bacteria	MPN/100 ml	n	1,000	4,000	-	-
8. NO ₃ -N	mg/l	n		5.0	-	-
9. NH ₃ -N	mg/l	n		0.5	-	-
10. Phenols	mg/l	n		0.005	-	-
11. Copper (Cu)	mg/l	n		0.1	-	-
12. Nickel (Ni)	mg/l	n		0.1	-	-
13. Manganese (Mn)	mg/l	n		1.0	-	-
14. Zinc (Zn)	mg/l	n		1.0	-	-

Surface Water Quality Standards						
Parameter ^{1/}	Units	Standard Value for Class ^{2/}				
		Class1	Class2	Class3	Class4	Class5
15.Cadmium (Cd)	mg/l	n		0.005*		-
				0.05**		
16.Chromium Hexavalent	mg/l	n		0.05		-
17.Lead (Pb)	mg/l	n		0.05		-
18.Total Mercury (Total Hg)	mg/l	n		0.002		-
19.Arsenic (As)	mg/l	n		0.01		-
20.Cyanide (Cyanide)	mg/l	n		0.005		-
21.Radioactivity	Becquerel	n		0.1		-
- Alpha	Bq/l			1.0		
- Beta						
22.Total Organochlorine Pesticides	mg/l	n		0.05		-
23.DDT	µg/l	n		1.0		-
24.Alpha-BHC	µg/l	n		0.02		-
25.Dieldrin	µg/l	n		0.1		-
26.Aldrin	µg/l	n		0.1		-
27.Heptachlor & Heptachlorepoxide	µg/l	n		0.2		-
28.Endrin	µg/l	n		None		-

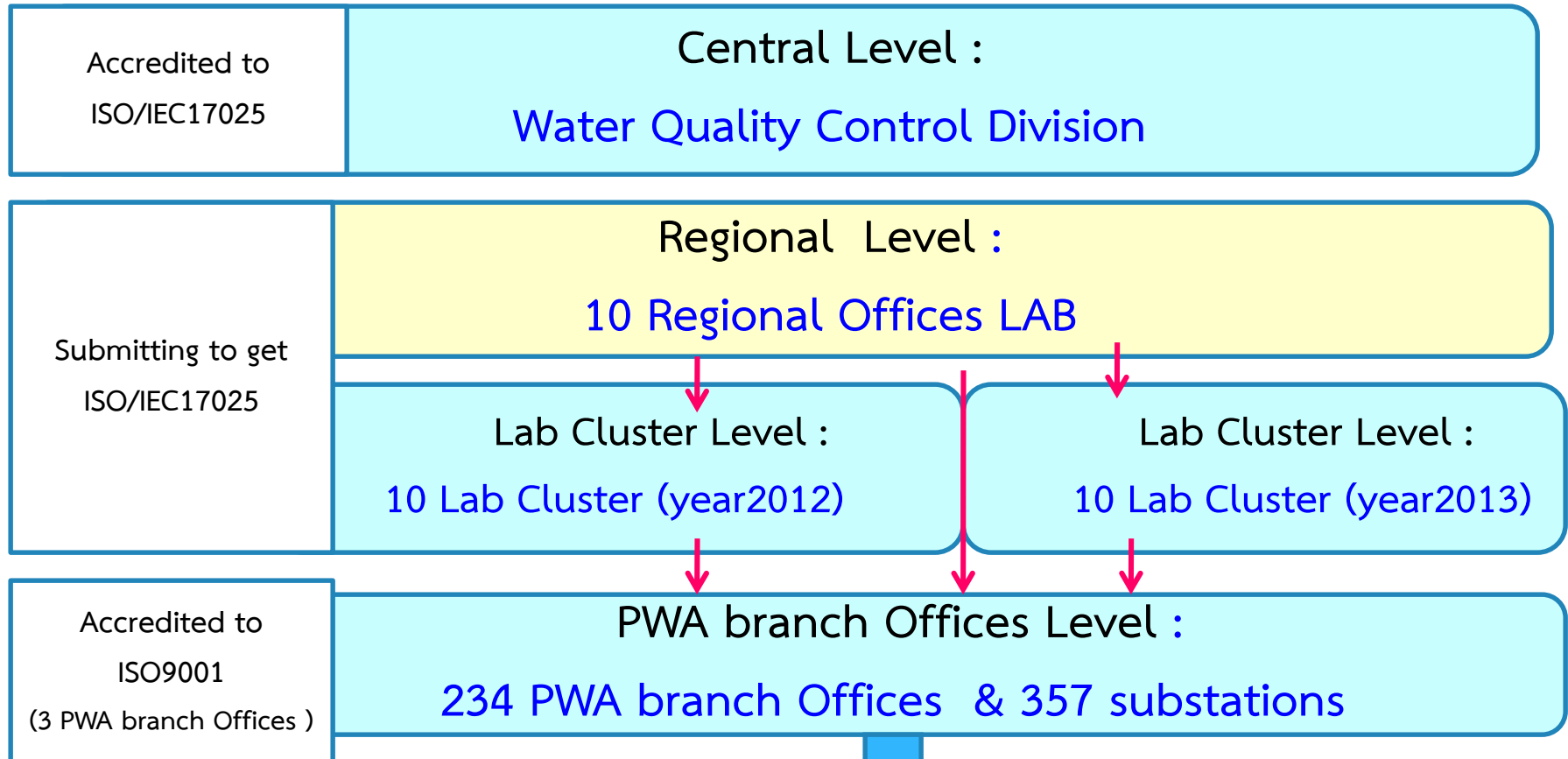
Classification and Objectives

Classification	Objectives/Condition and Beneficial Usage
Class 1	Extra clean fresh surface water resources used for : (1) conservation ,not necessary to pass through water treatment process requires only ordinary process for pathogenic destruction (2) ecosystem conservation where basic organisms can breed naturally
Class 2	Very clean fresh surface water resources used for : (1) consumption which requires ordinary water treatment process before use (2) aquatic organism of conservation (3) fisheries (4) recreation
Class 3	Medium clean fresh surface water resources used for : (1) consumption, needs passing through an ordinary treatment process before using (2) agriculture
Class 4	Fairly clean fresh surface water resources used for : (1) consumption, requires special water treatment process before using (2) industry
Class 5	The sources which are not classified in class 1-4 and used for navigation.

PWA water resources should be controlled in Class 3

2.3 Water Quality Control

PWA has 4 levels of water quality control

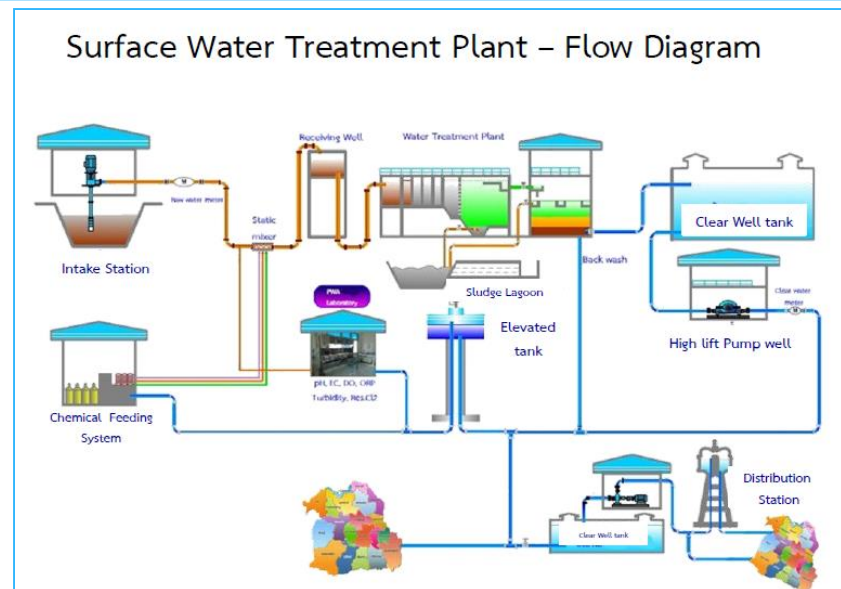


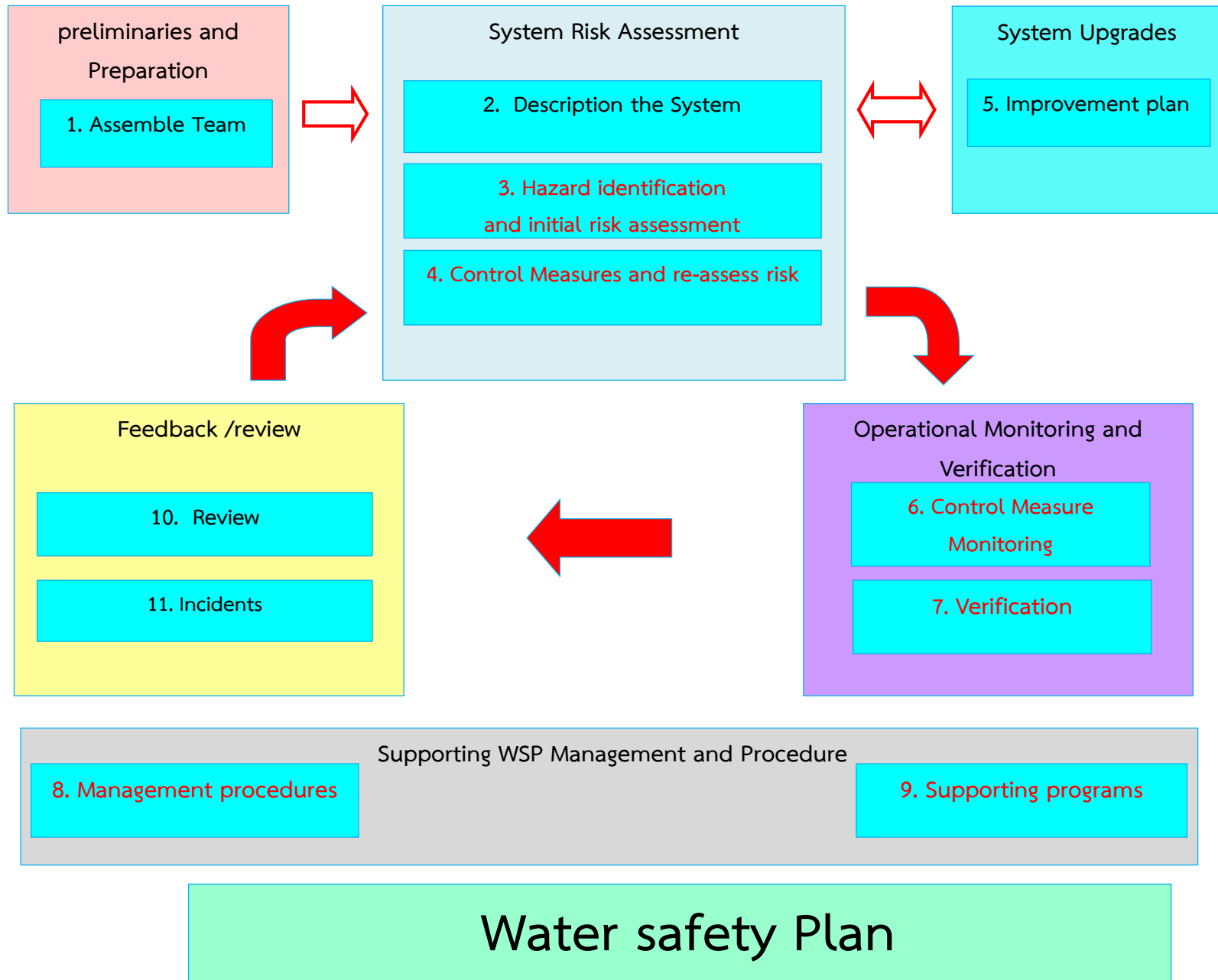
PWA Branch Offices acts according to WSP from water sources, water treatment and water distribution process in order to distribute safe and clean water

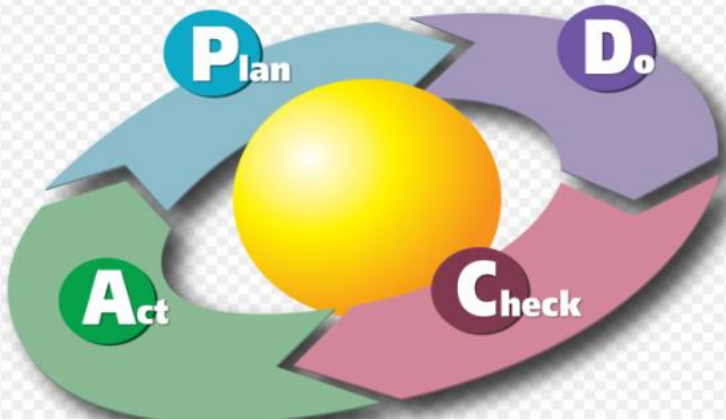


3.3. Water Quality Control : PWA branch Offices Level (Production Section)

In order to Control water treatment systems produce clean and safe drinking water , PWA'waterworks is committed to monitoring , managing and minimizing risks from water sources , water treatment process according to WSP.







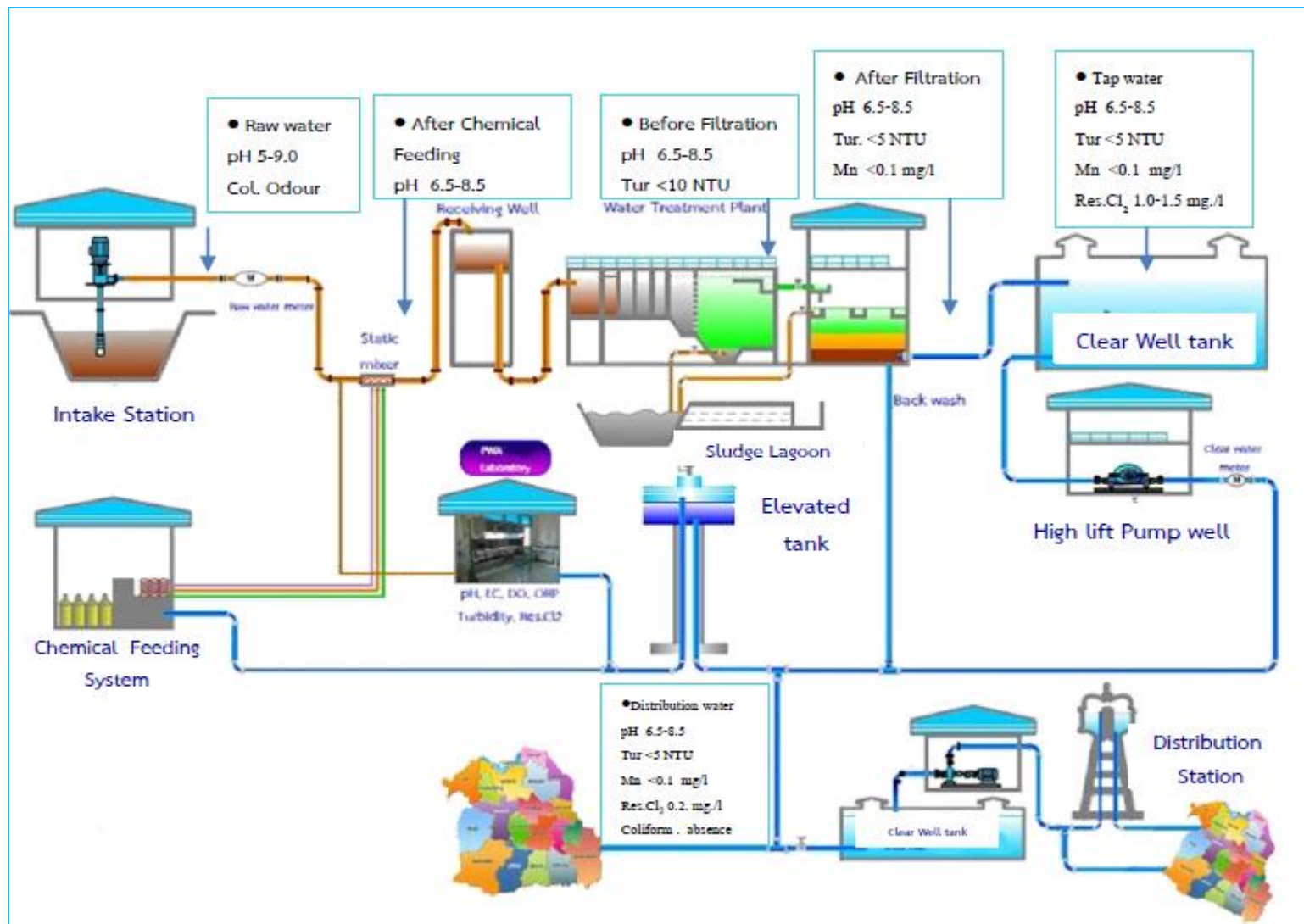
4.3.7 Water safety plans

In addition to testing of water quality, verification should include audits of WSPs to demonstrate that the plans have been properly designed, are being implemented correctly and are effective. Factors to consider include the following:

- all significant hazards and hazardous events have been identified;
- appropriate control measures have been included;
- appropriate operational monitoring procedures have been established;
- appropriate operational limits have been defined;
- corrective actions have been identified;
- appropriate verification monitoring procedures have been established.

Audits can be undertaken as part of internal or external reviews and may form part of surveillance by independent authorities. Auditing can have both an assessment and a compliance-checking function.

Surface Water Treatment Plant & Operation limit of water Quality



Device of Water Quality testing of operating WTP



Colorimetry



Jar Test



pH&Chlorine



turbidity

Sampling of DS for the microorganisms.
 The Guidelines for Drinking-Water Quality, WHO 2011
 Sample should be measured by Cl₂, pH & Turbidity

People	Sample/Year
5000	12
5000 to 100 000	12 Samples / 5 000 People
> 100 000 to 500 000	12 Samples/10 000 People + 120 Samples
> 500 000	12 Samples/ 50 000 People + 600 Samples



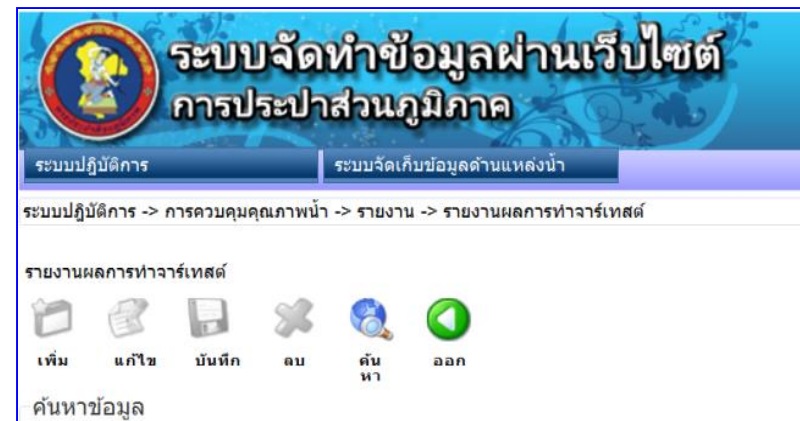
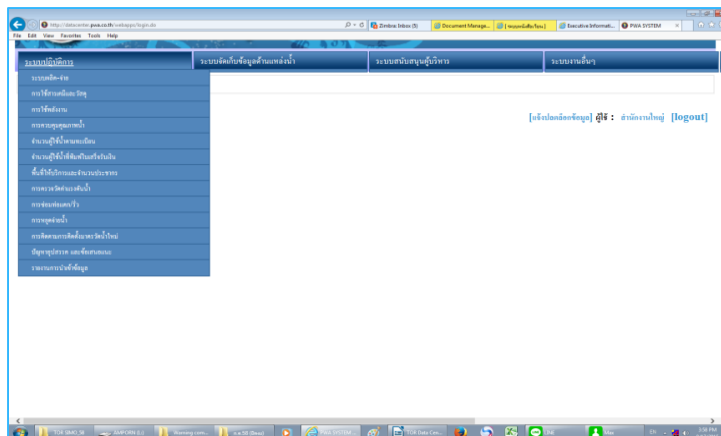
test kit for testing Coliform Bacteria in WTP and DW

Information Systems

to manage the water quality of the PWA

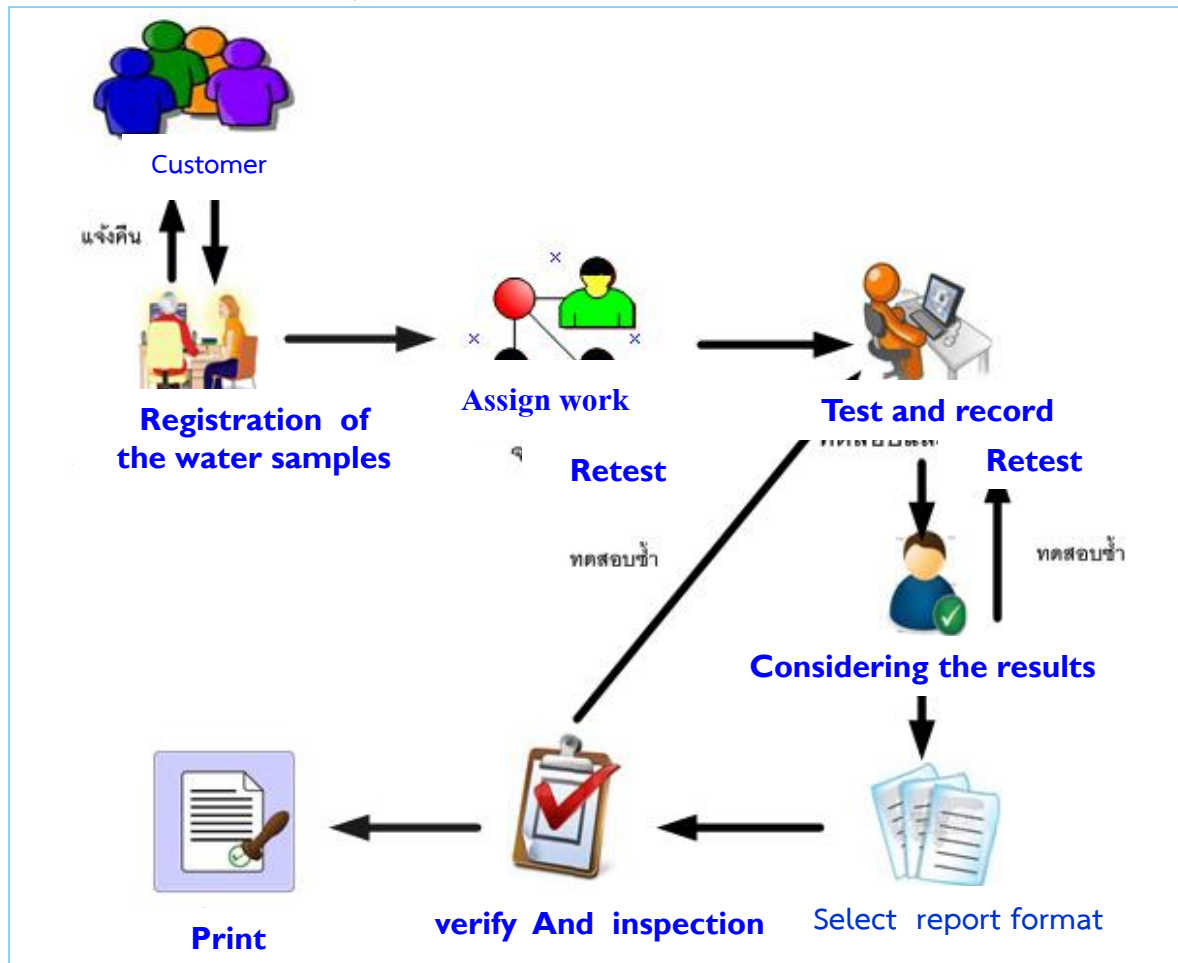
1) Data Center

- PWA's data center which is a web service records main variety of information such as water quality treatment process, chemical dosages, electricity, water users, water pressure, water meter installation, customers 'problems and our recommendations
- **For Water Quality :** PWA waterworks key in the water quality of raw water Process water ,distribution water and the amount of chemicals. The Regional office verify the data and import headquarter



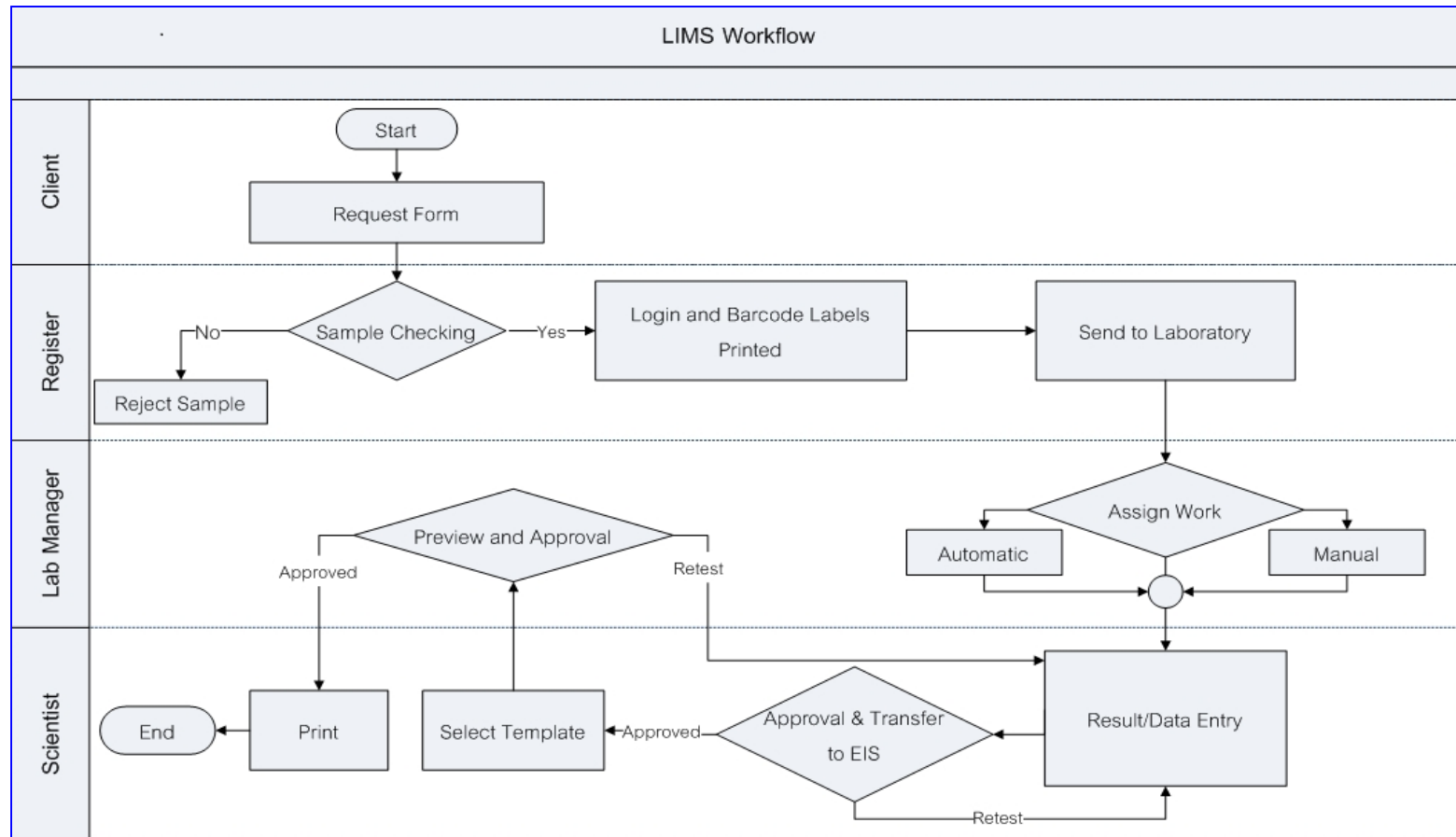
2) The laboratory information management system : LIMS

The computer system used to control the management information for analysis and quality control performance. This traceability system is reliable, fast and can cooperate with other systems.



•Currently our 31 PWA use LIMS to improve our lab testing process and help us achieve ISO IEC17025

2) The laboratory information management system :LIMS



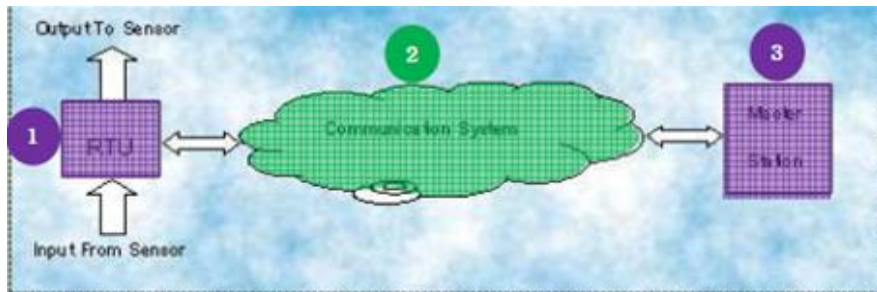
- The process as the picture shown begins with customers who want to test samples e.g. water, chemicals, filtering substances and pipes. Afterwards the system can be allowed to distribute work to our specific workers and then, we test ,record the results. until report and print .
- If we find that the results are incorrect, we will retest them.

2) The laboratory information management system :LIMS

- Can report warning signs before impairment and calibration and this data can be saved and recorded over time
- Can be connected with other testing instruments and the results are fast and free from errors from manual data entry
- Recording of the Reagent- Standard Preparation Stages
Warning the Reagents – Inventory and Cost for Management
amount of chemical remaining to automation
- Recording of Analysts Personal and Training Course and Schedule

PWA's Telemetry : raw water monitoring station

An automatic system sending water data to PWA's branches & headquarters



Main components :

Remote Terminal Unit ,Communication ,Master Station

To take a close watch on raw water sources.(both quality & quantity) used for water production both during the normal condition and a crisis.

- To get data on water Quality , level & flow rate via PWA's website

[URL:http://tele-wrd.pwa.co.th](http://tele-wrd.pwa.co.th) , with systematic data storage & display.

- To evaluate a trend of change in the quality & Quantity of water so that the water problem can be solved immediately at the site.

Water Quality Monitoring Systems

1. Monitoring with instrument (Physical & Chemical)



2. Fish Monitoring (Toxicity)



Evaluation the toxicity of water
- Monitor the movement of fish , 24 hours with CCTV



Fish Monitoring (Toxicity)



- Fish aged 3 Months
- Body length less than 3 cm



ที่มา : OECD Guideline for the testing of chemicals "Fish , Acute Toxicity Test" (Adopted by the Council on 17th July 1992)

We use baby Java Barb fish or Silver barb fish with aged less than 3 months as a biological index



Evaluation the toxicity of water

- Monitor the movement of fish , 24 hours with CCTV



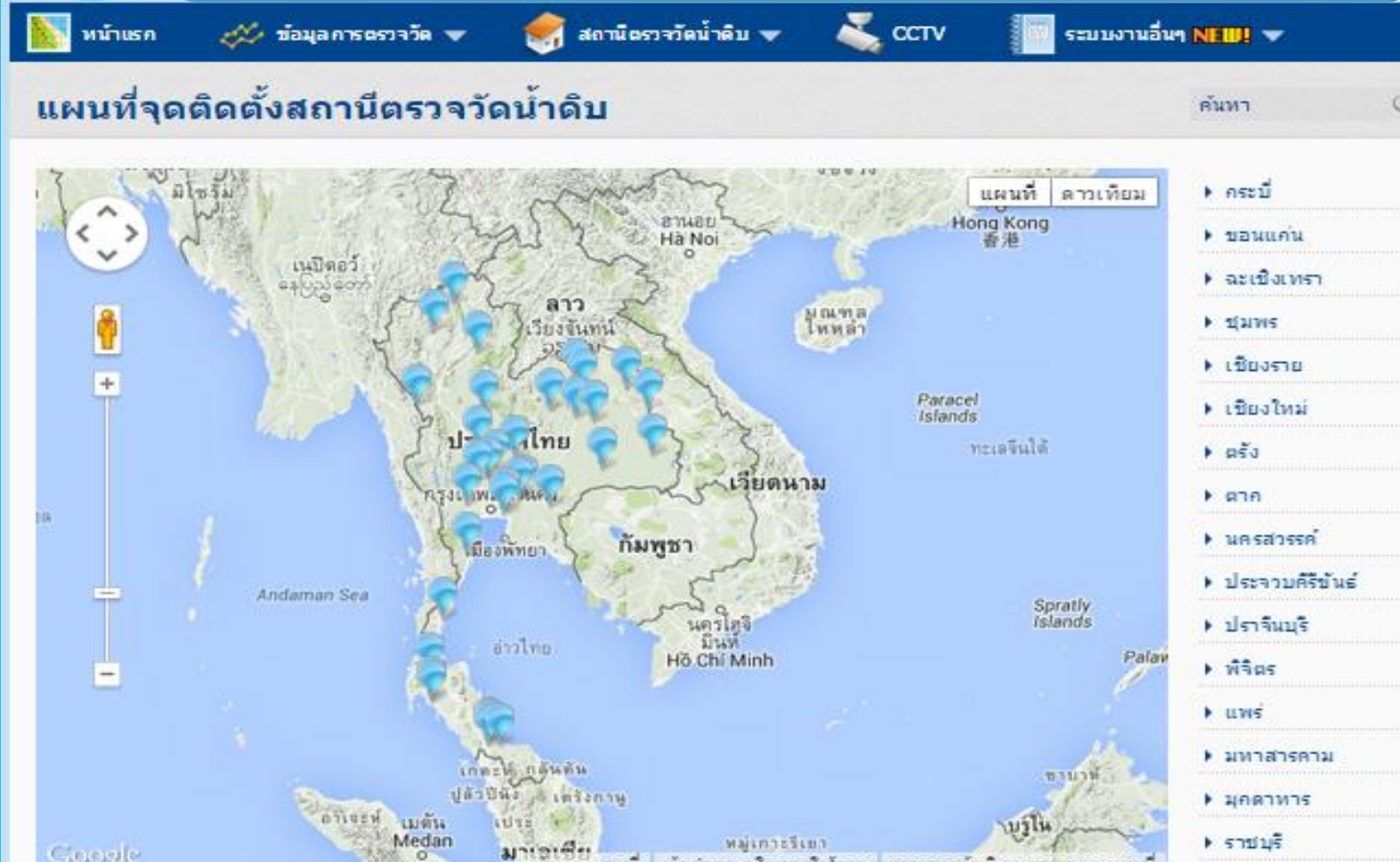


Fish Monitoring

Dead toll of fish (%)	Water Quality	Action
< 5	normal	- Record the no. of dead fish - Record water quality data ,24 hrs
5 - 10	Monitoring & surveillance	- Record the no. of dead fish and make a careful surveillance
> 10	Warning & surveillance	- Record the no. of dead fish - Collect sample water for analysis and Warning to the operation



Map of PWA's raw water monitoring station



30 stations across the country

(normally located in the area with problems of water quality)

Follow up data on water Quantity & quality from PWA's raw water monitoring stations

Level and water quality data in real time.

สถานการณ์ปัจจุบัน (real time)

อัพเดทล่าสุด :

ข้อมูลเปลี่ยนแปลงทุก 10 นาที

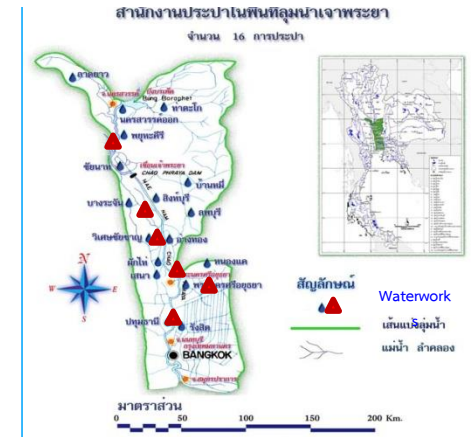
ลำดับที่	วัน, เวลา(น.)	ข้อมูลคุณภาพน้ำ							ข้อมูลระดับน้ำ		
		pH	DO (mg/L)	Turbidity (NTU)	EC (μS/cm)	Salinity (g/L)	ORP (mV)	Temp (°C)	เสาระดับ (ม.รทก.)	ระดับสมมุติ (ม.รทก.)	ระดับน้ำ (ม.รทก.)
สผ. สระแก้ว	2015-08-14 12:44:56	7.59	6.20	82.64	230.94	0.11	476.82	29.88	23.90	6.03	29.93
สผ. ชัยบาดาล	2015-08-14 12:44:41	7.42	5.23	1,053.26	188.58	0.09	494.82	30.99	-1.07	9.76	8.69
สผ. ลพบุรี	2015-08-14 12:44:39	7.02	5.49	65.19	254.78	0.12	474.75	31.91	0.00	x	x
สผ. ปรางบุรี	2015-08-14 12:44:39	7.63	4.27	24.29	384.64	0.19	381.34	29.27	1.42	1.32	2.74
สผ. ชุมพร	14/08/2558, 12:20	7.10	6.84	75.88	98.10	0.05	522.62	28.73	-6.13	8.10	1.97
สผ. พังงา	2015-08-14 12:45:05	5.98	0.31	102.76	149.04	0.07	612.69	28.13	-1.09	3.17	2.08
สผ. กันตัง	2015-08-14 12:44:38	6.78	4.63	53.84	123.62	0.06	531.51	28.77	-4.49	5.68	1.19
สผ. ชุมแพ	2015-08-14 12:45:05	7.30	6.00	127.25	293.26	0.14	454.97	28.02	216.24	4.62	220.86
สผ. กุมภวาปี	2015-08-14 12:44:50	6.65	0.09	37.79	345.42	0.17	-402.47	30.59	166.74	3.38	170.12
สผ. อุตรดิตถ์	2015-08-14 12:44:46	7.23	3.43	14.20	172.77	0.08	434.12	34.13	195.19	1.64	196.83
สผ. สุรินทร์	2015-08-14 12:44:36	8.59	6.00	34.32	107.47	0.05	555.53	31.76	143.20	1.77	144.97
สผ. แพร่	2015-08-14 12:44:50	7.87	5.55	355.68	147.98	0.07	447.59	30.56	142.60	3.94	146.54
สผ. เขียวใหม่	2015-08-14 12:44:51	6.96	5.74	221.37	154.16	0.08	-146.95	28.51	304.00	1.51	305.51
สผ. พยุหะคีรี	2015-08-14 12:45:04	7.58	5.12	114.19	212.08	0.10	454.11	32.24	11.20	4.00	15.20
สผ. ท่าพระ	14/08/2558, 12:20	6.84	2.72	19.63	600.00	0.29	468.00	31.41	144.74	0.83	145.57
สผ. ท่าวังหิน	14/08/2558, 11:20	7.75	5.47	100.00	216.00	0.11	548.00	31.53	107.10	0.86	107.96
สผ. ราชวังขวัญ	14/08/2558, 12:40	8.25	6.09	270.00	158.00	0.08	416.00	31.89	31.00	-	-
สผ. นาดใหญ่	14/08/2558, 12:40	7.06	2.90	155.00	83.00	0.04	528.00	29.57	x	2.89	2.89
ส. แร่งตำบอง	14/08/2558, 12:40	6.54	1.26	x	867.00	0.38	x	31.02	x	x	x
สผ. เทพราย	2015-08-14 12:45:06	6.89	0.89	32.50	967.60	0.48	689.65	31.60	0.00	-	-

แผนผังสถานการณ์ค่าความเค็มแม่น้ำเจ้าพระยา

ลุ่มน้ำเจ้าพระยา

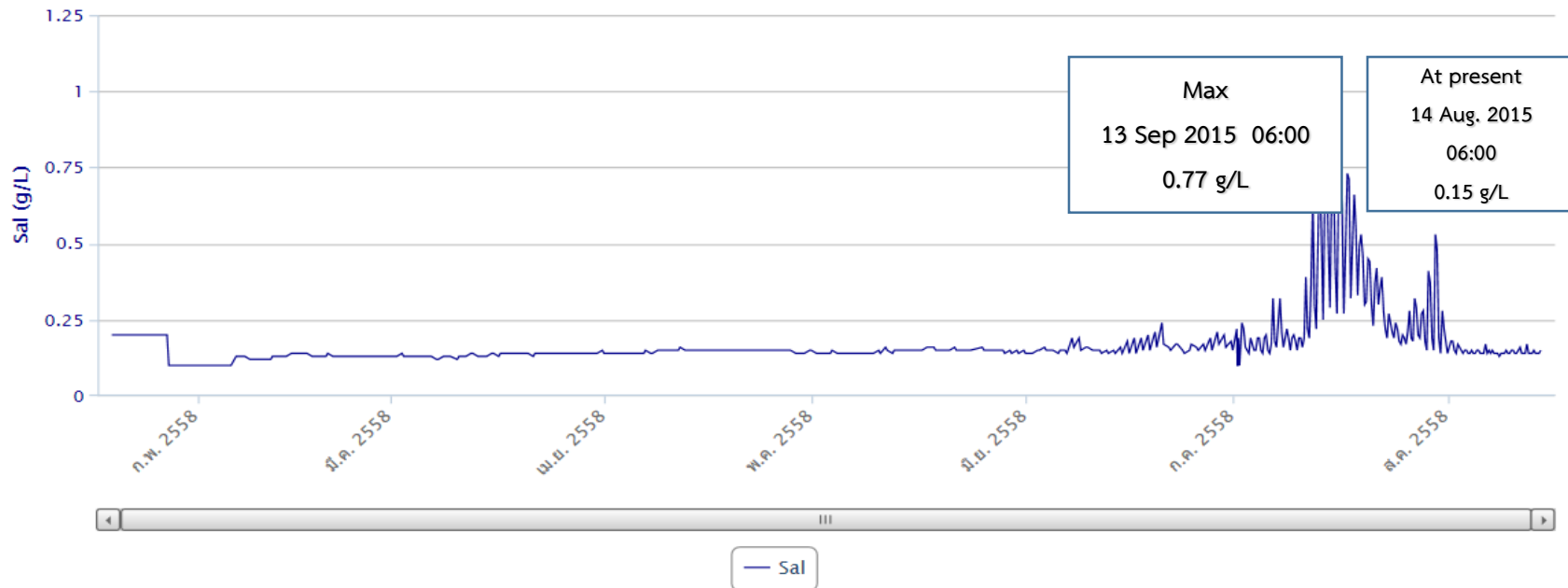


6 waterworks at Chao Phraya river



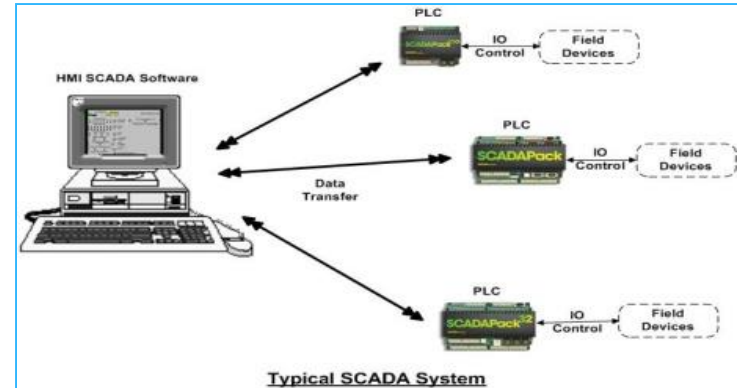
Statistic salinity

The graph shows the Chao Praya river water quality : Pathum-thanee Water Supply ,19 Jan. to Aug. 2015



4) PWA's Linking water quality : <http://wqc-portal.pwa.co.th/>

■ Monitoring Raw water Station



■ SCADA System (Supervisory Control and Data Acquisition)

is a system that compiles data from various sources and send the data to a control center for analysis & processing by a computer while analytical result can be sent to control the perform of tools in the systems, including displaying the perform status of those tool major component.

■ PWA's Automation tap water quality monitoring Tools



- Get the **water** sample from the production system through analysis of water quality , continuously for 24 hours

- Key Parameters : pH ,turbidity , chlorine

5) Linking water quality& level data from Monitoring Station with other organizations



Pollution Control
Department



Hydro and Agro
Informatics Institute



Provincial Waterworks
Authority

PWA has a Plan to link its 30 monitoring stations with Pollution Control Department and Hydro and Agro Informatics Institute for water conservation and warning system for natural disaster.

Monitoring quality of water supply

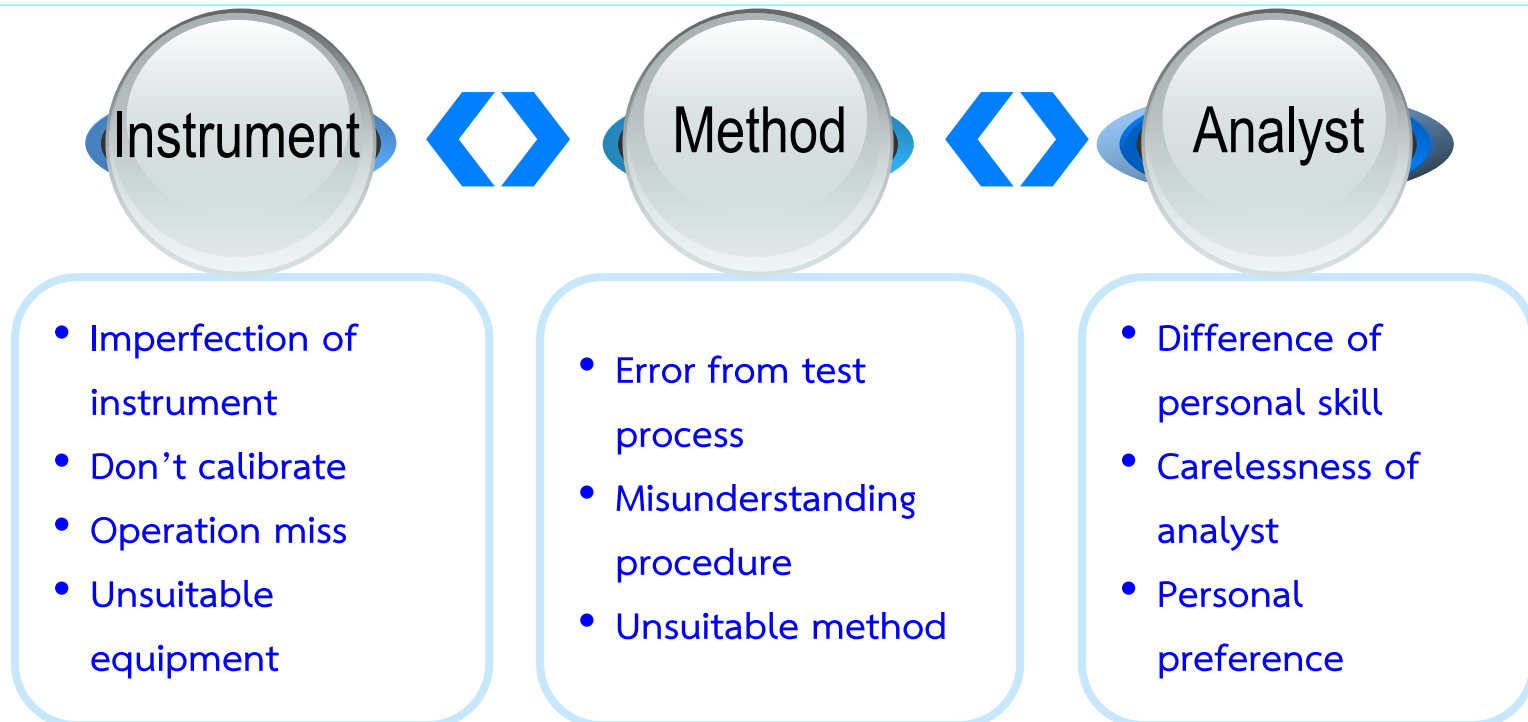
- **Objective**
- Planning, monitoring water quality since the Intake water , in the WTP and distribution systems and also the results are to improve water quality to meet the standards.
- Reporting of water quality test results are accurate and precise
- Enhance the credibility and public confidence in the quality of tap water

5. Quality assurance and Quality Control

QA include two major concept, quality control (QC) and quality assessment (QA)

- Scope
 - Sampling, carrying, storing of sample
 - Test method include baseline, reference material and sample analysis
 - Environmental of laboratory
 - Performance of instruments and analysts

Cause of systematic errors



5. Quality assurance and Quality Control

- Sampling

- Sample Storage

- Preservation

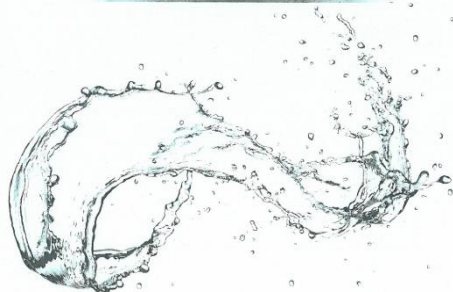
- Test Method



Standard Methods

For the Examination of
Water and Wastewater

22ND EDITION



American Public Health Association®
American Water Works Association®
Water Environment Federation®

1

Edited by
Eugene W. Rice
Rodger B. Baird
Andrew D. Eaton
Lenore S. Clesceri

APHA, AWWA and WEF ;

Standard Methods for the Examination of water
and Wastewater, 22nd Edition, 2012

5. Quality assurance and Quality Control

Sampling : The water samples collected are representative of the water and sufficient quantity to test. Including storage and delivery to the laboratory in an appropriate way making the quality of the water no changed.

Bottled water samples

Type : Polyethylene, HDPE ,glass

Considerations :

- The bottle of water may be contaminated with water.
- Some substances in the water adsorption on the walls inside the bottle.
- Certain substances in water may react with the water bottle.



Cleaning the water bottle

Glass : chromic acid.

Plastic bottles : HCl

Location Water Type

Sampling point

Sampling Date/time

Preservation

Test Parameter

Collecting name



Preservation of water samples

: To prevent changes in the properties of water samples while the quality has not been test

➔ Refrigeration ,the addition of chemicals

Assessment of analyst

- All analyst must pass certification process before joining actual analysis
- Confirm understanding of method, maintenance and operation ability of instrument, and skillful of analyst etc.
- Training, if necessary
- Assessment method
 - Join proficiency test
 - Quality assessment in laboratory
 - CRM analysis

Quality assurance and Quality Control (QA&QC)

- Appropriate quality assurance and analytical quality control procedures should be implemented for all activities linked to the production of drinking-water quality data.
- These procedures will ensure that the data are fit for purpose—in other words, that the results produced are of adequate accuracy. Fit for purpose, or adequate accuracy, will be defined in the water quality monitoring programme, which will include a statement about accuracy and precision of the data.
- Because of the wide range of substances, methods, equipment and accuracy requirements likely to be involved in the monitoring of drinking-water, many detailed, practical aspects of analytical quality control are concerned. These are beyond the scope of this publication.
- QA&QC are a part of requirements according with standard ISO/IEC 17025 : 2005, *General requirements for the competence of testing and calibration laboratories*, which provides a framework for the management and technical requirements in analytical laboratories.

THANK YOU

