

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE REPUBLIC OF THE UNION OF MYANMAR

YANGON CITY DEVELOPMENT COMMITTEE (YCDC)

## **The Project for Improvement of Water Supply Management of YCDC**

### **Report on Institutional Improvement Plan**

#### **Base on the Third Country Research Study in PPWSA, Cambodia**

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### **Executive Summary**

### 3. Summary Current Issues and Contents to be studied

#### Course A

| Subject  | Current issues  | Research Contents  |
|--|---|--|
| <ul style="list-style-type: none"> <li>● Institutional Governance and Organization of water utility</li> </ul>                     | <ul style="list-style-type: none"> <li>✓ Water Supply Department is one section of city government, that is, does not have the independent account nor independent budget, or does not have the concept of financial autonomy.</li> </ul>                                     | <ul style="list-style-type: none"> <li>• Learn the (financial and autonomous) autonomous self-sufficient water utility management. Learn the administrative structure and position of water supply utility between the central government and local/municipal government (present status and its historical background) and advantages</li> <li>-----</li> <li>• For PPWSA: Since the establishment of PPWSA in 1959, especially after the end of Khmer Rouge era, how the institutional/organizational structure of water supply in Phnom Penh has transformed. City of Phnom Penh and/or Central government have been concerned the management of water supply? How the autonomous management has been kept?               <ul style="list-style-type: none"> <li>- How the organization/structure/governance of PPWSA has been stipulated in the Law historically since established in 1959?                   <ul style="list-style-type: none"> <li>- Who has had the authority on decision of water tariff revision and annual budget since 1959 and how the system has changed?</li> <li>- How about deficit/profit of the water utility. Central government/city government has been concerned it? Any subsidy from government?</li> <li>- How the autonomous management is implemented?</li> <li>- How the autonomous management works/functions?                       <ul style="list-style-type: none"> <li>* Authority of personnel hire/reshuffle</li> <li>* Authority of decision of big project</li> <li>* Motivation to self-efforts of cut costs</li> </ul> </li> <li>- Are there any difference between PPWSA and other local water supply utilities on the aspect of institutional governance?</li> </ul> </li> </ul> </li></ul> |
| <ul style="list-style-type: none"> <li>● Overall activities as water supply utility</li> </ul>                                     | <ul style="list-style-type: none"> <li>✓ Organization is still under structuring as a water supply utility (no section for planning, water treatment, commercial, etc.)</li> </ul>  | <ul style="list-style-type: none"> <li>• Learn mission and vision</li> <li>• Learn organizational structure of water supply utility and functions of sections/departments.</li> <li>• How to decide the number of staff of each section (procedures to increase staff number of a section), and how to improve working efficiency.</li> <li>• Learn activities of Commercial/Customer service section</li> </ul>   |
| <ul style="list-style-type: none"> <li>● Role and function of planning section</li> </ul>  | <ul style="list-style-type: none"> <li>✓ Management of water supply works is not in planning manner.</li> </ul>   | <ul style="list-style-type: none"> <li>• Learn function and activities of Planning section</li> <li>• Learn methods how to apply management cycle in water supply management such as planning, grasping operational performance by PI, improvement, revised planning.</li> </ul> <p><b>(Section research)</b></p> <ul style="list-style-type: none"> <li>• Planning functions and activities of Planning Section</li> <li>• Monitoring PIs system</li> <li>• Kinds of reports prepared</li> <li>• Kinds of Waterworks management plan/ Business plan</li> <li>• Strategic planning process</li> </ul>  |
| <ul style="list-style-type: none"> <li>● Learn practices of waterworks management/ planning by using PIs and PDCA cycle</li> </ul> | <ul style="list-style-type: none"> <li>✓ Difficult to know current waterworks without accurate and reliable data</li> <li>✓ Project planning tends to be ad hoc and reactive</li> <li>✓ YCDC has launched the activity of monitoring PIs.</li> <li>✓ No systematic</li> </ul> | <ul style="list-style-type: none"> <li>• Learn good practice on how to utilize PIs for waterworks management and planning in short-, middle- and long-term.</li> <li>• Learn on how PDCA cycle is carried out in waterworks management/ planning</li> <li>• Learn lessons and remarks on PI monitoring and PDCA cycle for waterworks management/ planning</li> </ul>   |

| Subject   | Current issues  | Research Contents   |
|---|---|---|
|   | waterworks management with PDCA cycle   |   |
| <ul style="list-style-type: none"> <li>Whole structure of standards, guidelines, and manual, SOPs.</li> </ul> | <ul style="list-style-type: none"> <li>Existing standards, guidelines and manuals are very limited in YCDC/ Myanmar</li> <li>The quality of design, construction and inspection works will be difficult to be standardized.</li> </ul>      | <ul style="list-style-type: none"> <li>Learn an overall legislation system relevant to waterworks</li> <li>Learn existing guideline and manuals and the main contents by using PPWSA, particularly at the utility level</li> <li>Learn relevant guidelines and manuals on design, construction and inspection works, equipment and material standard.</li> </ul> <p><b>(Section research)</b></p> <ul style="list-style-type: none"> <li>Development and enforcement process of Standard, Guideline, Manual and SOP</li> <li>A complete list of Standards, Guidelines, Manuals and SOPs</li> <li>Design works (standards, guideline and manuals)</li> <li>Construction and inspection works (standards, guideline and manuals)</li> <li>Equipment and material (standards)</li> <li>Water quality standards and monitoring</li> </ul> |
| <ul style="list-style-type: none"> <li>Actions for problem solving (such as leadership)</li> </ul>            | <ul style="list-style-type: none"> <li>YCDC has many issues such as coverage ratio, NRW ratio, collection ratio and safe water, and has not found effective clues to solve them yet.</li> <li>Delegation of power is not enough.</li> </ul> | <ul style="list-style-type: none"> <li>Learn good practices on major issues, especially planning for problem solving and leadership to implement.</li> <li>Learn discretion and delegation of power in organization</li> <li>Learn how to develop leadership (problem solving capacity)</li> <li>PPWSA (1990'-): actions against illegal connection, persuading stakeholders into water tariff rise, initiatives for improving water quality.</li> </ul>  |

### Course B

| Subject  | Necessity   | Subject   | Contents   |
|--|---|---|--|
| Financial Management (2.0 days)                  | <ul style="list-style-type: none"> <li>WSD is managed by government accounting system which included in the general account of YCDC.</li> <li>Financial situation of water supply is not clear. Costs of water supply is not clear.</li> <li>Facilities and equipments are not managed properly.</li> </ul> | <ul style="list-style-type: none"> <li>How to make P/L and B/S in water utility</li> </ul>              | <ul style="list-style-type: none"> <li>How PPWSA, as the listed company for Cambodia capital exchange market, is regulated by law and regulations regarding accounting?</li> </ul>   |
|  |   | <ul style="list-style-type: none"> <li>Making short/middle/long-term financial plan</li> </ul>          | <ul style="list-style-type: none"> <li>How law/act stipulate about making financial plans of water utility?</li> <li>How to estimate short/middle/long-term financial plan? <ul style="list-style-type: none"> <li>Capital expenditure/ income</li> <li>Current expenditure/ income</li> </ul> </li> <li>How capital investment project is decided?</li> <li>How to cope with the rapid expanding period when heavy capital investment required</li> <li>What kind of financial crisis has experienced?</li> </ul> |
| Business plan of water supply utility (2.0 days) | <ul style="list-style-type: none"> <li>Planning Section needs to be established</li> <li>Waterworks management needs to be monitored by PIs periodically</li> <li>Strategic planning process for waterworks needs to</li> </ul>   | <ul style="list-style-type: none"> <li>Planning functions and activities of Planning Section</li> </ul> | <ul style="list-style-type: none"> <li>Duty and responsibility of Planning Section</li> <li>Main functions of the section</li> <li>Main activities of the section</li> <li>Experiential view on why planning section is necessary</li> </ul>   |
|  |   | <ul style="list-style-type: none"> <li>Monitoring PIs</li> </ul>  | <ul style="list-style-type: none"> <li>Key PIs</li> <li>Monitoring method and data collection</li> <li>Analysis of key PIs</li> <li>Utilization of PIs for the planning</li> </ul>   |



|  |  |   |   |
|--|--|---|---|
|  | <ul style="list-style-type: none"> <li>be established with targets based on PIs</li> <li>✓ A mid- and long-term plan needs to be developed</li> <li>✓ Waterworks activities should be done based on the plans, reviewed and modified</li> <li>✓ Waterworks is managed in a planned manner</li> </ul>   | <ul style="list-style-type: none"> <li>✓ Strategic planning</li> </ul>  | <ul style="list-style-type: none"> <li>• Concept of strategic planning</li> <li>• Process for strategic planning, PDCA</li> <li>• Consideration process for prioritizing activity</li> <li>• Past lessons learnt</li> </ul>   |
|  |  | <ul style="list-style-type: none"> <li>✓ Waterworks management plan/ Business plan</li> </ul>                             | <ul style="list-style-type: none"> <li>• Existing plans, contents</li> <li>• Process for developing the plan</li> <li>• Coordination between the relevant sections</li> <li>• Interrelation between facility development, finance, human resources etc.</li> <li>• Utilization for utility management, review</li> </ul>            |
| Standard, guidelines, manuals (3 days) | <ul style="list-style-type: none"> <li>✓ Standards, guidelines and manuals related to waterworks need to be developed</li> <li>✓ Waterworks activities needs to be carried out based on standards, guidelines and manuals</li> <li>✓ The prepared standards, guidelines and manuals are shared and utilized by the staffs</li> <li>✓ Waterworks is managed based on the regulation, standards, guidelines and manuals</li> </ul> | <ul style="list-style-type: none"> <li>✓ Importance of standards, guideline and manuals</li> </ul>                        | <ul style="list-style-type: none"> <li>• Overall structure/picture of existing standards, guidelines and manuals</li> <li>• Experiential view on why standards/ guideline/ manuals are necessary?</li> </ul>  |
|  |  | <ul style="list-style-type: none"> <li>✓ Development process</li> </ul>   | <ul style="list-style-type: none"> <li>• Development process of standards, guidelines and manuals</li> <li>• Interrelation between the relevant sections for development</li> <li>• Interrelation between the central/ municipal gov. and PPWSA</li> <li>• Approval and revision</li> </ul>   |
|  |  | <ul style="list-style-type: none"> <li>✓ Design works (standards , guideline and manuals)</li> </ul>                      | <ul style="list-style-type: none"> <li>• Existing standards/ guideline/ manuals on design works</li> <li>• Design process/ procedure</li> <li>• Network design</li> <li>• Pipe laying design</li> <li>• Other facility design</li> <li>• Water meter and service pipe design</li> <li>• Remarks</li> <li>• On-site study</li> </ul> |
|  |  | <ul style="list-style-type: none"> <li>✓ Construction and inspection works (standards , guideline and manuals)</li> </ul> | <ul style="list-style-type: none"> <li>• Existing standards/ guideline/ manuals on construction and inspection works</li> <li>• Construction process/ procedure</li> <li>• Inspection process/ procedure</li> <li>• Remarks</li> <li>• On-site study</li> </ul>   |
|  |  | <ul style="list-style-type: none"> <li>✓ Equipment and material (standards )</li> </ul>                                   | <ul style="list-style-type: none"> <li>• Existing standards for equipment and materials (pipe,pump, valve, water mater, etc.)</li> <li>• Remarks on development of specification</li> <li>• On-site study (warehouse, manufacturing companies)</li> </ul>   |
| Human resource development (2 days)    | <ul style="list-style-type: none"> <li>✓ WSD had not set the official organization chart and their duties and responsibilities.</li> <li>✓ No section is designed for HR management nor development.</li> </ul>  | <ul style="list-style-type: none"> <li>✓ Organization and responsibilities</li> </ul>                                     | <ul style="list-style-type: none"> <li>• Whole organization structure and HRD related section</li> <li>• Duties and responsibilities of each section related to HRD</li> </ul>  |
|  | <ul style="list-style-type: none"> <li>✓ No HRD plan is set</li> </ul>   | <ul style="list-style-type: none"> <li>✓ HRD plan</li> </ul>  | <ul style="list-style-type: none"> <li>• Detail contents of HRD plan</li> <li>• Relation between business plan and HRD plan</li> <li>• Procedures to make HRD plan</li> </ul>   |

|  |  |  |  |
|--|--|--|--|
|  | <ul style="list-style-type: none"> <li>✓ No training center, specific budget.</li> <li>✓ No system to develop training materials, capacity of trainers.</li> </ul>   | <ul style="list-style-type: none"> <li>✓ Resource of HRD</li> </ul>      | <ul style="list-style-type: none"> <li>• Role and organization of training center</li> <li>• Procedures to improve training materials/textbooks</li> <li>• System to bring up internal trainers</li> <li>• Library/information management for staff reference</li> </ul> |
|  | <ul style="list-style-type: none"> <li>✓ WSD has a little experience to manage training course by themselves.</li> <li>✓ Training course is launched by idea of top management or development partners.</li> </ul> | <ul style="list-style-type: none"> <li>✓ Training management</li> </ul>  | <ul style="list-style-type: none"> <li>• PDCA cycles of training management</li> <li>• Steps to make training plan</li> <li>• Assessment of training achievement</li> <li>• Staff record on training participation</li> </ul>  |
|  | <ul style="list-style-type: none"> <li>✓ No official evaluation is conducted.</li> </ul>   | <ul style="list-style-type: none"> <li>✓ Personnel evaluation</li> </ul> | <ul style="list-style-type: none"> <li>• Detail system of personnel evaluation</li> <li>• Responsibilities of each manager</li> <li>• How to utilize the result of the evaluation</li> <li>• Relation between evaluation and incentives</li> </ul>                       |
|  | <ul style="list-style-type: none"> <li>✓ OJT is not actively conducted in workplace.</li> </ul>  | <ul style="list-style-type: none"> <li>✓ OJT</li> </ul>                  | <ul style="list-style-type: none"> <li>• Any system to enhance OJT? (including interview with some managers)</li> <li>• Role of supervisors for OJT</li> <li>• How to bring up OJT trainers?</li> </ul>  |

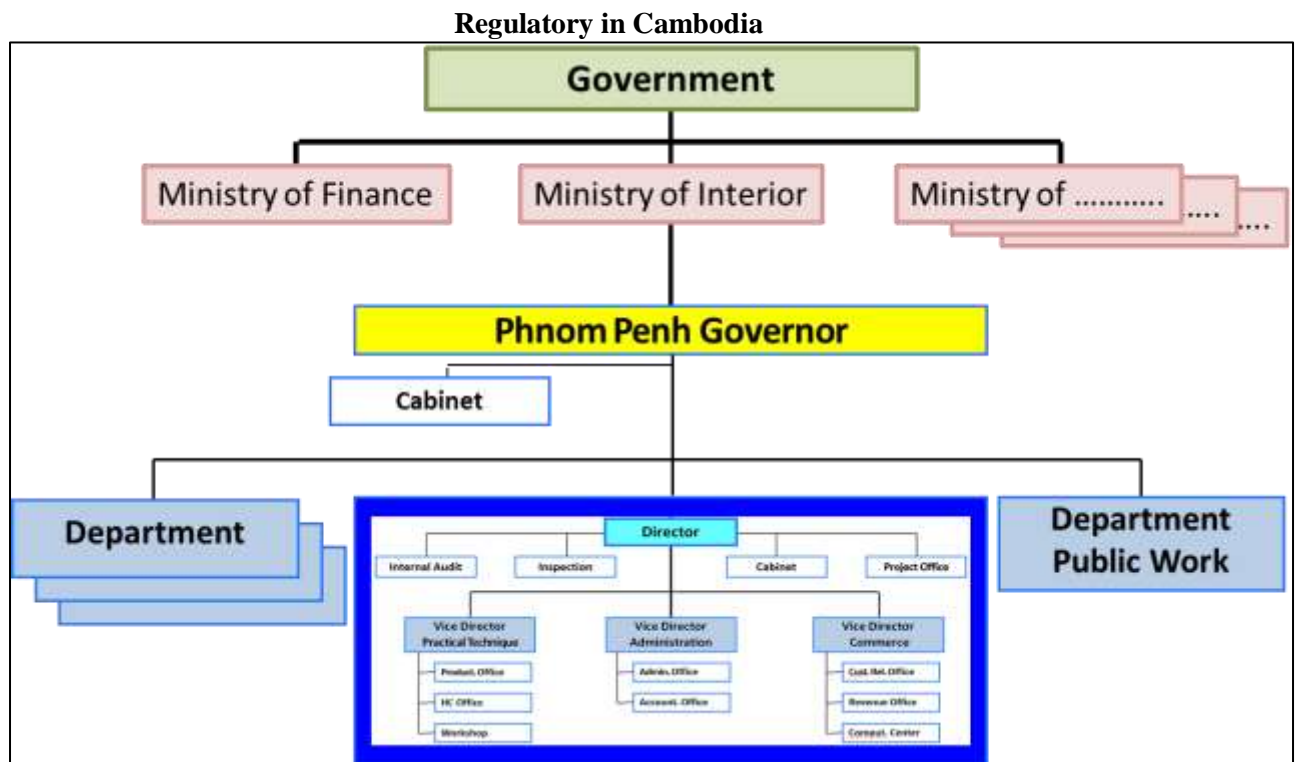
## Chapter (4) Study on PPWSA System

### 4.1 Institutional Governance

As PPWSA supplies water for the domestic, commercial and industrial usage of people in Phnom Penh, the condition of rapidly changing supply conditions is outlined in the following table.

| Content                    | 1993 - Year  | 2013 - Year  |
|----------------------------|--------------|--------------|
| water supply coverage area | 20%          | 85%          |
| Water Supply Period        | 10 hour/ day | 24 hour/ day |
| Water Pressure             | 2 meters     | 25 meters    |

In order to develop the water supply system as now, PPWSA had to perform the operation with infrastructures such as lawful maintenance works, foreign loan and support from local companies. Before PPWSA could stand as a Self-Management organization, it was listed under the Ministry of Interior. Phnom Penh government cabinet is under the Ministry of interior with only one director of PPWSA under it. The director divides three departments as Internal Audit, Inspection Cabinet and Project Office. As external help, government fundings from France Peace agreement in 1993, increasing the water bills from the customers and getting grant and loan from UNDP, WB, ADB, Japan and France.



Beside external helps, the association had managed to improve good leadership skills, promoting capacities, task delegations, using carrot and stick system to employees, implementation of new water supply system to operate successfully.

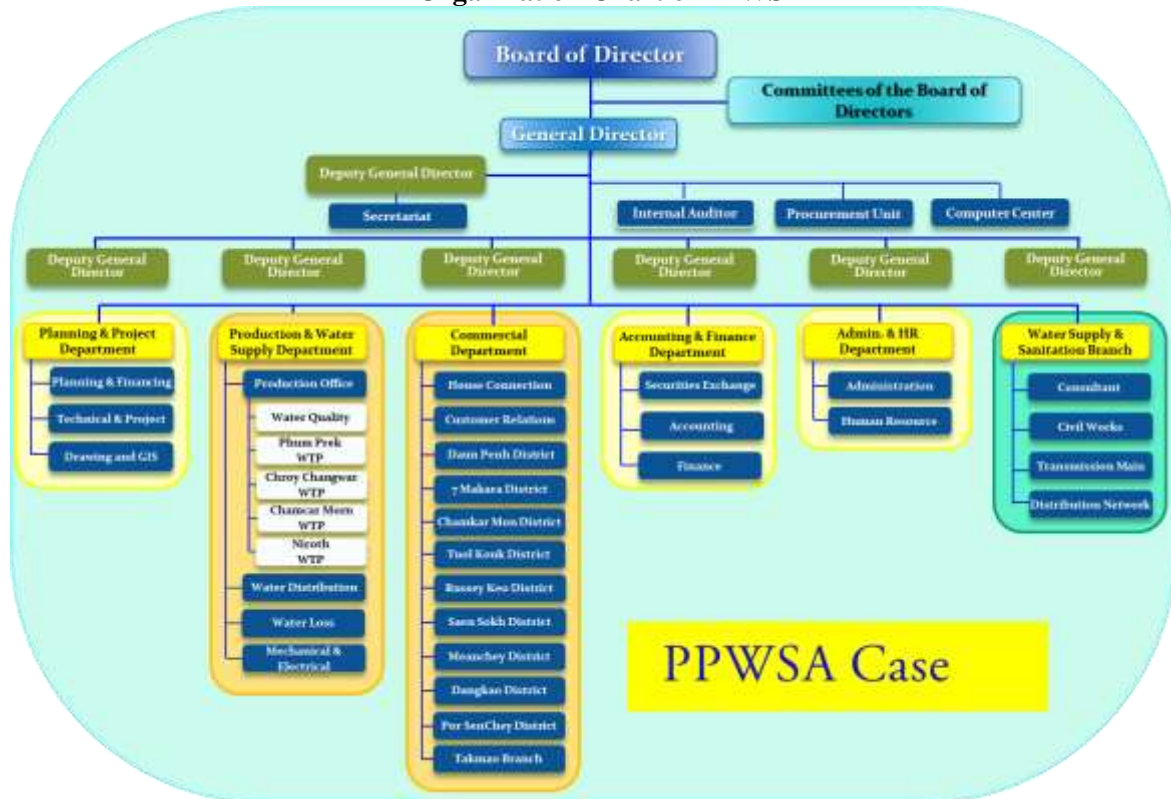
To be able to stand as a Self-Management association, PPWSA had to manage the balance between service delivery and the price to the customers with laws and regulations and also standardize the amount of water usage, water delivery time (water supply duration), water pressure, water quality, water bill and service for poor class people. Those are the steps PPWSA has gone through. In addition, PPWSA set the rules and regulations in district, township and region with contract system, submit the report, auditing incentives and punishment.

NWRB (National Water Resources Board), LWUA (Local Water Utilities Administration), LGUS (Local Government Units) and National Agencies (Industrial Zones, MUSS) are the

organizations in Philippine related to water supply. Under these associations, PPWSA operate water conveying/supply system in district, private, rural and industrialized zone.

PPWSA had administered as Self-Management association in 1996. Starting from 1997, PPWSA is still carrying out further tasks as drafting rules and regulations, releasing the orders within the organization, setting the daily objectives and goals. When charging the water usage bill to customers, PPWSA set up fire distinguisher with Free of Charge. The following chart is PPWSA's organizational structure.

**Organization Chart of PPWSA**



PPWSA Case has Board of Director with seven members; one General Director, Deputy General Director and Secretariat. It also has members of Internal Audit, Procurement Unit and Computer Center. Seven Members Board of Director are each Directors from Ministry of interior, Ministry of Finance, Ministry of industry and one Shareholders and one General Director, elected representative employee once in three years and one Independent Director selected from Shareholders.

#### 4.2 Organization Structure of Water Utility

PPWSA is associated with the following six departments

- (1) Planning & Water Project Department
- (2) Production & Water Supply Department
- (3) Commercial Department
- (4) Accounting & Finance Department
- (5) Admin & HR Department
- (6) WATSAN Branch

Five main objectives of PPWSA water supply operation are;

- (1) Sustainable Water Distribution
- (2) Drinkable Water Distribution
- (3) To be able to distribute Water 24/7
- (4) Distribution with Sufficient Water Pressure
- (5) Charge Water bills with reasonable price

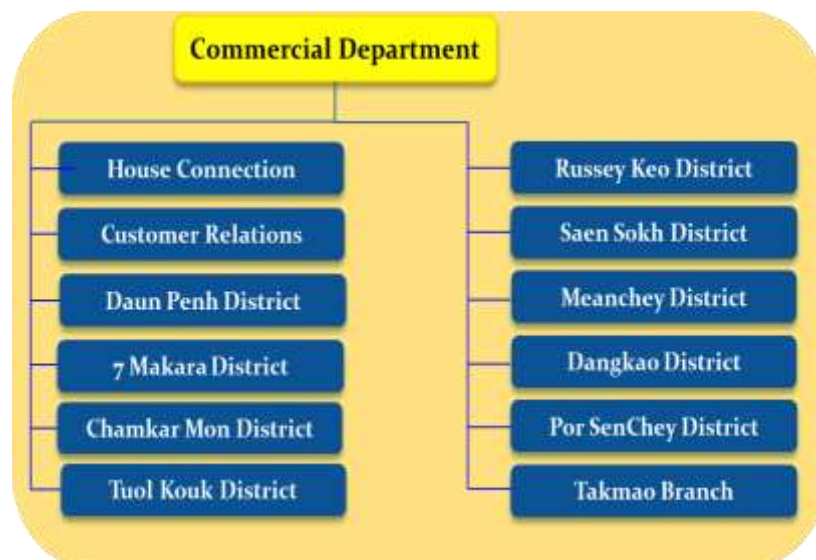
(1) Production & Water Supply Department

Production & Water Supply Department is associated with Production Office, Water Distribution, Water Loss and Mechanical & Electrical Section. Water distribution, water loss control, electrical and mechanical maintenance tasks have been done by Water Treatment Plants.



(2) Commercial Department

Commercial Department is associated with House Connection, Customer Relation in nine districts, Takmao Branch. The department carries out the tasks such as Home water conveying (house connection), raising awareness of water distribution to public, handling complaints, water pipeline conveying in districts and it is the largest one among six departments.



(3) Planning & Water Project Department

Planning & Water Project Department is associated with Planning & Financing section, Technical & Project section, Drawing and GIS section. For water supply, pre-target the budget plan and implement the planned technical works to be done sophisticatedly, produce the drawing and maintenance has been done in GIS section.



(4) Accounting & Finance Department

Securities Exchange, Accounting and Finance Section are under Accounting & Finance Department. It performs budget analysis, water billing process and balancing debit and credit.



(5) Admin & HR Department

Admin & HR Department consist of Administration and Human Resource Section and manage PPWSA employees, new recruitment process and also arrange training internationally and locally.



PPWSA organization uses both centralization and decentralization management system also can balance the performance, responsibility, unity and delegation. Top Manger has to do decision making and Lower- Level employee has to follow which is knownd as centralization. When Lower- Level employee can make decisions, it is called decentralization. By using both management styles, PPWSA perform the operation successfully.

**4.3 Planning System**

According to PPWSA organization structure, there have three sub departments under Planning and Project Department:

- I. Planning and Financing Office
- II. GIS Office
- III. Technical Office

**4.3.1 Tasks of Planning and Project**



Tasks of Planning and Project department are:

- (a) Annual investment and projects which are needed for running the operation are planned to be able to accept by the Board of Director.
- (b) Short term, medium term and long-term plans are planned.
- (c) Indicators of income and expenditure, detail informations of water distribution operation are collected.
- (d) Management of foregin loan, budget and development plans
- (e) Infrastructure of water distribution are set up. Investment pland and engineering plans are checked.
- (f) Management of Purchasing material for department, receiving support materials

#### 4.3.2 Monitoring Performance Indicators

(a) After the Board has confirmed, Planning and Project Department define the tasks of yearly plan and implementation of new action plan.

Objectives of Action Plans

- To monitor and evaluate development plans of PPWSA yearly plan.
- Perform the tasks by connecting department to department and implementation of development plans.
- Monitoring the planned operations.
- Find out strengths and weaknesses of Annual plan to be able to predict the future plans.

(b) Data Collection Process

Planning and Project Department collect necessary data from planning stage to impletation stage. It is carried out by departments and units uneder PPWSA supervision.

**Data Collection Process in PPWSA**

|   | Description                                  | Start | Finish | Data Indicator  |
|---|--|-------|--------|---|
| 1 | Planning and Project Department              | Jan   | Dec    | Pipeline Installation Program   |
| 2 | Production and Supply Department             | Jan   | Dec    | Water Production and Raw Material Consumption                           |
| 3 | Commercial Department                        | Jan   | Dec    | New Conn., Average Usage/Connection (m3/month), Average Tariff, NRW etc |
| 4 | Administration and Human Resource Department | Jan   | Dec    | Up to date information of number PPWSA employee                         |
| 5 | Accounting and Finance Department            | Jan   | Dec    | Profit and Expense Information  |
| 6 | Water and Sanitation Service Subsidiary      | Jan   | Dec    | Transmission and Distribution Network Extension                         |

(c) Planning using PIs

It can support to develop instructions of the implementation plans annually, quarterly and help PPWSA tasks successfully. Planning and Statistic officer check and analysis collected PIs Data with collaboration of other employess from different departments and also prepare and review short term and long-term plans of PPWSA through results.

#### 4.3.3 Strategic Planning

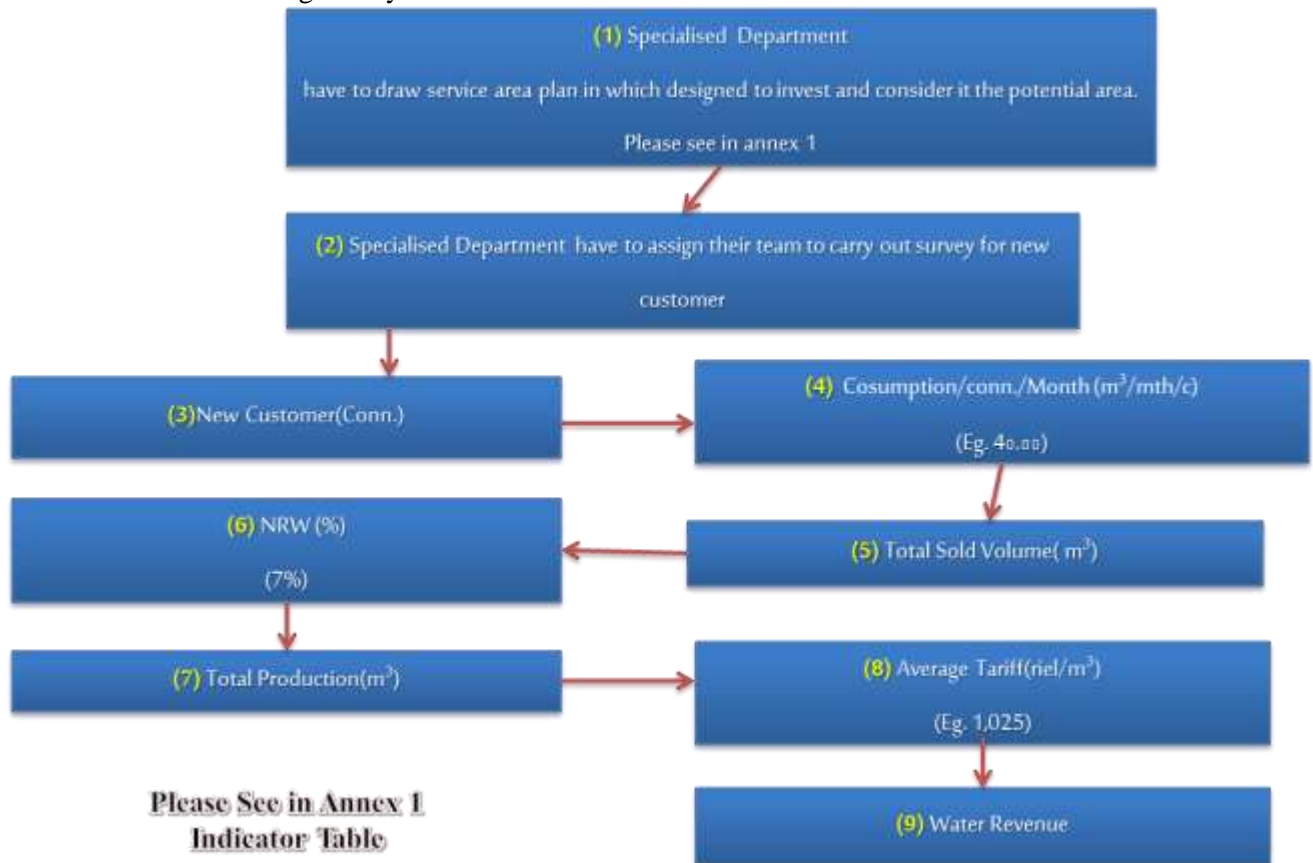
Planning is the main support of the whole PPWSA development in terms of concepts strategies, policies and plans.

The following indicators are the obligation when PPWSA produce a strategic plan.

- (a) Network Extension (km)
- (b) Total number of connection in Ending period (conn.)
- (c) Total Sold Volume (m<sup>3</sup>)
- (d) Total Production (m<sup>3</sup>)
- (e) Consumption / conn. / month (m<sup>3</sup> / mth / c)

- (f) Average Tariff (riel / m<sup>3</sup>)
- (g) NRW (%)

#### 4.3.3.1 Method of Making Yearly Plan



#### 4.3.3.2 Method for Calculation of Main Indication

1. Respective department has to responsible for targeting and surveying location to be yearly invested.
2. After selecting the Location, searching for the new Customers. At the end of the year, it results new comers by the formula (Number of Customer in ending period + new customer).
3. Consumption / conn; / month by using Past years data are used.
4. After that, (Number of Customer in ending period × Consumption/conn;/month) total number of Sold Volume (m<sup>3</sup>) is got.
5. Non-revenue water, NRW (%) can get from Past years data
6. Total Production (Total Sold Volume / Billing ratio) is calculatated from the Billing ratio (100 input – NRW)
7. (Average Tariff) is calculated based on Past years data and get the datat of Water revenue (Total Sold Volume × Average Tariff). So, the indicators are calculated and draw the following plan.

#### **Indicators Table for Next Year Plan**



| <b>ANNEX 1 INDICATORS TABLE</b> |   |                    |                    |                    |                    |                  |                         |                  |
|---------------------------------|---|--------------------|--------------------|--------------------|--------------------|------------------|-------------------------|------------------|
| <b>No.</b>                      | <b>Description</b>                        | <b>Actual 2011</b> | <b>Actual 2012</b> | <b>Actual 2013</b> | <b>Actual 2014</b> | <b>Plan 2015</b> | <b>Expected in 2015</b> | <b>Plan 2016</b> |
| 1                               | Number of new connection (conn.)          | 16,569             | 15,639             | 17,187             | 18,497             | 16,000           | 16,600                  | 16,000           |
| 2                               | Total connection in ending period (conn.) | 219,498            | 235,128            | 252,315            | 270,812            | 282,510          | 287,200                 | 302,000          |
| 3                               | Consumption/conn./month(M <sup>3</sup> )  | 39.54              | 40.5               | 42.05              | 42.78              | 43.45            | 43.45                   | 42.7             |
| 4                               | Average tariff(R / M <sup>3</sup> )       | 1,001.01           | 1,009.09           | 1,017.25           | 1,020.00           | 1,024            | 1,024                   | 1,022            |
| 5                               | Total production (M <sup>3</sup> )        | 99,766,425         | 111,127,811        | 123,642,601        | 134,667,497        | 146,758,400      | 146,397,923             | 153,162,441      |
| 6                               | Water sale revenue (Riel)                 | 99,867,189         | 112,139,478        | 125,778,913        | 137,360,847        | 150,280,602      | 150,024,892             | 156,532,015      |
| 7                               | Total sold volume(M <sup>3</sup> )        | 106,884,368        | 119,020,233        | 133,970,423        | 146,180,920        | 157,804,600      | 159,695,230             | 166,480,914      |
| 8                               | NRW (%)                                   | 6.66%              | 6.63%              | 7.71%              | 7.88%              | 7.00%            | 8.33%                   | 8.00%            |

Calculation shows plan for 2016 is to extend length of network in water distributin pipeline. When Plan is set and confimed, Department need to do field research and collect data

#### 4.3.4 Waterworks management plan (Business plan)

##### 4.3.4.1 Existing plan and contents

PPWSA draws the business plan for at least 4 to 5 years ahead and it includes:

1. Introduction
2. Extension of Water Transmission Main
3. Extension of Water Distribution Main
4. Customer
5. Production
6. Project Greater Phnom Penh Water Supply System Phase II
7. Investment Cost
8. Finance Principle
9. Expected Result in 2020, etc.

##### 4.3.4.2 Process for Developing Plan

Based on the data from previous years, PPWSA plans for coming next four years.

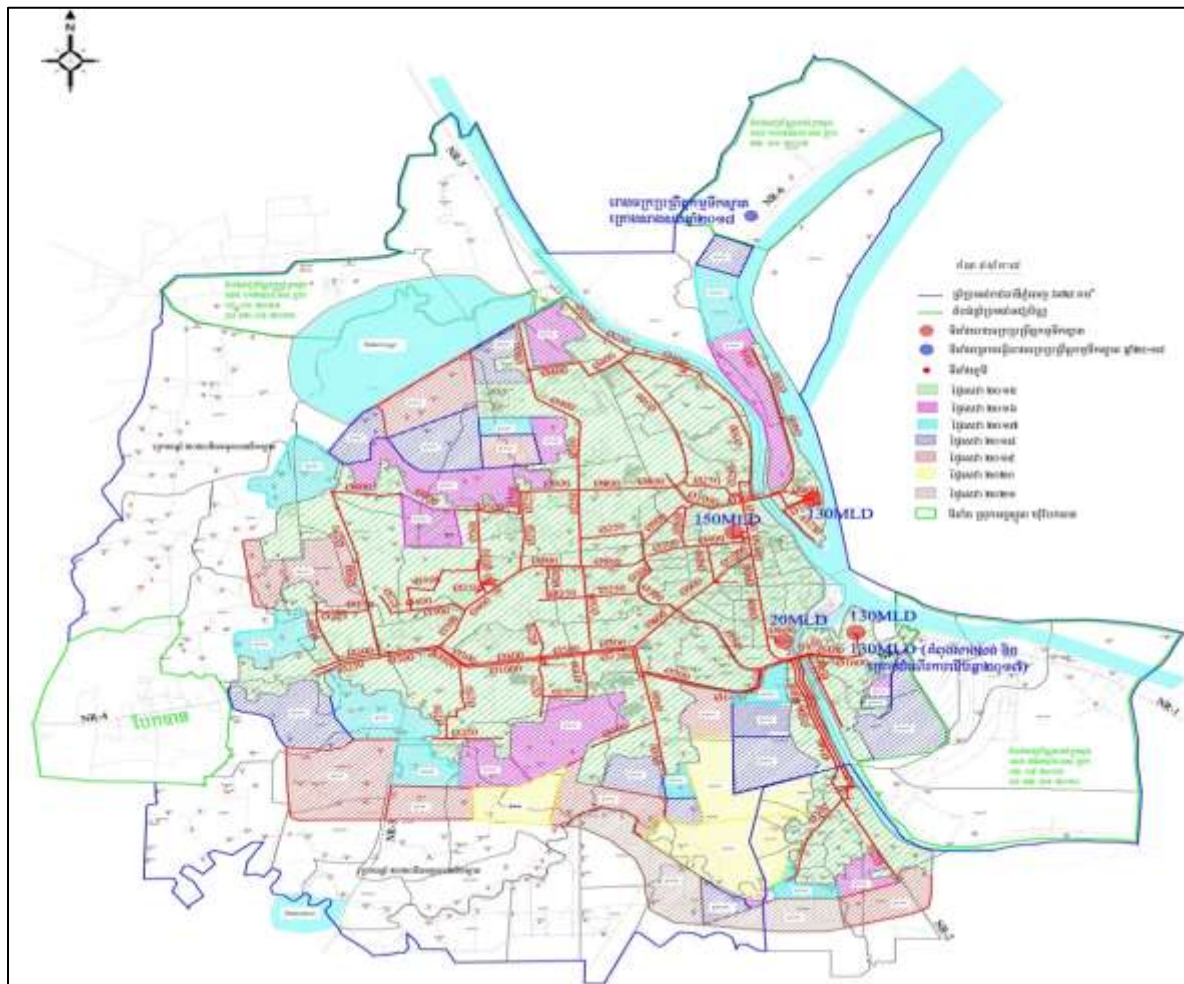
##### Past data for current year (2015)

| <b>Description</b>                           | <b>2009</b> | <b>2010</b> | <b>2011</b> | <b>2012</b> | <b>2013</b> | <b>2014</b> |
|--|-------------|-------------|-------------|-------------|-------------|-------------|
| 1. Total production (M <sup>3</sup> )        | 90,105,521  | 100,048,942 | 106,884,368 | 119,020,233 | 133,970,423 | 146,180,920 |
| 2. Total sold volume(M <sup>3</sup> )        | 84,754,045  | 94,197,104  | 99,766,425  | 111,127,811 | 123,642,601 | 134,667,497 |
| 3. Total connection in ending period (conn.) | 189,184     | 202,935     | 219,498     | 235,128     | 252,315     | 270,812     |
| 4. Water sale revenue (Riel)                 | 994.05      | 1,000.59    | 1,001.01    | 1,009.09    | 1,017.25    | 1,020       |
| 5. Billing Ratio(%)                          | 94.06       | 94.15       | 93.34       | 93.37       | 92.29       | 92.12       |
| 6. NRW(%)                                    | 5.94        | 5.85        | 6.66        | 6.63        | 7.71        | 7.88        |

(a) Extension of service area

Supervisors from water distribution department supervised their members for surveying customers in extension area. When choosing new Location, prioritize the area which can benefit in long term in terms of Socio-Economic.

**The Five-Year Extension Plan 2016-2020**



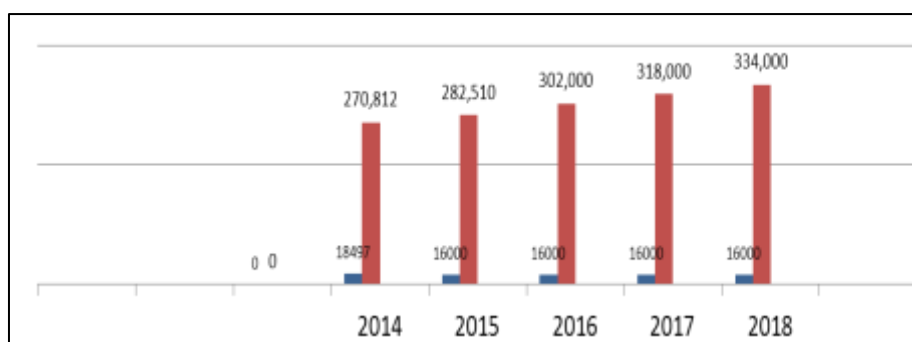
(b) Survey of new customer

After every Survey, new customers in planned area are found which is also managed by authorities from respective departments.

**Showing about number of new customers**

| Description  | 2014    | 2015    | 2016    | 2017    | 2018    |
|--|---------|---------|---------|---------|---------|
| New Customer                                       | 18,497  | 16,000  | 16,000  | 16,000  | 16,000  |
| Total Number of Connection in Ending Period(Conn.) | 270,812 | 282,510 | 302,000 | 318,000 | 334,000 |

**Graphic showing the increase of customers from year 2016 to 2018**



(c) Projection of Water Demand

When numbers of new customer are set, water usage calculations are projected.

**Projection of Water Demand**

| Description                               | 2014        | 2015        | 2016        | 2017        | 2018        |
|---|-------------|-------------|-------------|-------------|-------------|
| Number of new connection (conn.)          | 18,497      | 16,000      | 16,000      | 16,000      | 16,000      |
| Total connection in ending period (conn.) | 270,812     | 282,510     | 302,000     | 318,000     | 334,000     |
| Consumption/conn./month(M <sup>3</sup> )  | 42.78       | 43.45       | 42.70       | 43.00       | 42.80       |
| Average tariff(R / M <sup>3</sup> )       | 1,020       | 1,024       | 1,022       | 1,025       | 1,024       |
| Total production (M <sup>3</sup> )        | 134,667,497 | 146,758,400 | 153,162,441 | 159,660,003 | 165,082,881 |
| Water sale revenue (Riel)                 | 137,360,847 | 150,280,602 | 156,532,015 | 165,260,241 | 174,076,048 |
| Total sold volume(M <sup>3</sup> )        | 146,180,920 | 157,804,600 | 166,480,914 | 173,543,482 | 179,437,914 |
| NRW (%)                                   | 7.88        | 7.00        | 8.00        | 8.00        | 8.00        |

(d) Extension of Water Treatment Plant Capacity

Buliding new WTP is needed to be able to fulfill the water demand result in 4<sup>th</sup> projection year of 5 projection year.

**Extension of Water Treatment Plan Capacity**

| Water Treatment Plan              | Unit                    | 2014           | 2015           | 2016           | 2017           | 2018           |
|-----------------------------------|-------------------------|----------------|----------------|----------------|----------------|----------------|
| Phum Prek                         | M <sup>3</sup> /per day | 150,000        | 150,000        | 150,000        | 150,000        | 150,000        |
| Chamkar Morn                      | M <sup>3</sup> /per day | 20,000         | 20,000         | 20,000         | 20,000         | 20,000         |
| Chrouy Changwar                   | M <sup>3</sup> /per day | 130,000        | 130,000        | 130,000        | 130,000        | 130,000        |
| New Water Treatment Plan (Niroth) | M <sup>3</sup> /per day | 130,000        | 130,000        | 130,000        | 260,000        | 260,000        |
| <b>Total</b>                      | M <sup>3</sup> /per day | <b>430,000</b> | <b>430,000</b> | <b>430,000</b> | <b>560,000</b> | <b>560,000</b> |

Base on annually collected PI data from planning department, infrastructure needed for forthcoming water supply operation is projected and planned.

By that system, Mission of Master Plans are completed successfully and Visions are achieved.

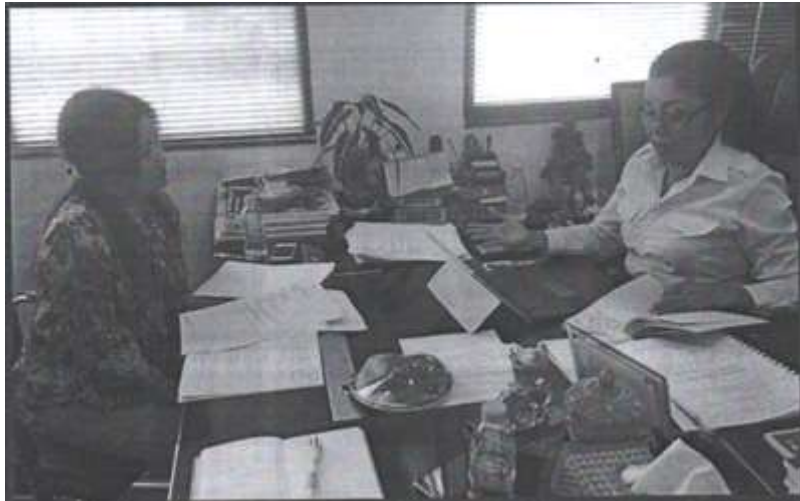
**4.4 Human Resource Development**

**4.4.1 Responsibilities of HRD**

The responsibilities of HRD are to successfully accomplish Vision and Mission of PPWSA. PPWSA has six departments and the department heads are called Deputy Director General (DDG). The six

departments will report to Director General and the Board of Directors is the highest stakeholder in the departmental hierarchy. Under Admiration & Human Recourses Department of HRD, there are two offices called Admin Office and HR office. The Admin Office embodies Security Section and HR Development Section. The role and responsibilities of HRD is different from that of HRM. The HRM is responsible for management of all employees' Salary, OT, Bonus, Promotion, Retirement, Recruitment and Punishment and the HRD is responsible for Training, OJT, Off JT and Self-Learning in relation to the Training Center. There are 100 employees in Admin & HR Department including Department heads, managers and many other position holders.

**Photo records of PPWSA**



#### **4.4.2 HRD Plan**

HRD will conduct trainings every year starting from the first week of July to the end of August. All the trainings are designed and planned according to the need of the participants from the six departments as reported to the HR Section. Then the Training Need Analysis (Subject, OJT, Off JT, Out-House, Trainer, Trainees, Equipment and Budget) is prepared according to the type of the training. After finishing the Draft Plan, it is presented to the Training Committee and then the Final Draft Plan is presented to the Director General for approval. Every year all employees are trained with 21 subjects according to their positions and responsibilities.

For SOP Training, there are 1021 in-house trainees every year and 77 out-house trainees. There are 21 Courses for in-house training and 17 Courses for out-house. PPWSA conducts about 45 trainings every year. There are currently 44 instructors in PPWSA. After getting the approval, the details of the trainings such as the type of the training, training period and the number of trainees are informed to the respective departments by the end of September. And these departments will have to reply to the HRD Section 3 days prior to the start of the training.

**Photo records of PPWSA**





**Photo records of PPWSA**



#### **4.4.3 Management of the trainings**

The Training Center is essential in conducting trainings which is one of the duties of the HRD. The Training Center of PPWSA was founded in 1996 and the training specialists from France were hired during that time. And those trainers were paid 8 Dollars per hour as an incentive and to keep them active. There were both SOP and Off-JT in the 21 subjects instructed in 2016 even though SOP was instructed more. The total budget for the year was \$, 32,330 (130 million Riel). There are 4 Trimesters in the training schedule of 2017 and there will be 46 trainings for the whole year. There will be 1021 trainees for the In-house SOP trainings and 77 trainees for Outside. There 44 Trainers in PPWSA for the In-house trainings. All the trainees will have to take Pre-test before the training and the Objective, Organization, History, Regulators and Policies will be explained at the beginning of the trainings.

SOP trainings such as Pipe laying, Leak detection and repair, Distribution and Maintenance are instructed to improve the skills and performance of the trainees in OJT. For Off-JT, SOP trainings such as Computer, Software, management Skills, Network Designing, Treatment Process, and NRW Management are instructed.

For Out Side Trainings, trainees are trained in Local institutes/ Universities such as English, French, Auto Card, MBA, Labor Laws, HRM & D,TOT. For Overseas trainings, trainees are sent abroad to participate in Seminars, Workshops, Trainings and M.Sc. courses. After the trainings are conducted, the increase in performance of the trainees are monitored by the respective Sections. And the increase of performance is reported as a feedback to the HR section by the respective Department

Director. The outstanding trainees are awarded with Promotion, Salary and Incentives. About 90% of PPWSA's employees are given incentives by the end of every year.

#### **Photo records of PPWSA**



#### **4.4.4 Employee Performance Determination System**

The improvement of the employee performance is based on the success of the trainings. The Trainers conducts Tests based on the understanding of the trainees concerning the Courses and how much they appreciate these Courses. Then the Trainers evaluate and comment on the performance of the trainees. These comments and evaluations are then reported back to the Training Committee. The Training Center and the Training Committee continues monitoring the trained employees after the end of the Training. After one week, the results are evaluated and the Trainer Feedback and the Trainees results are sent to the Training Center.

After the first 3-month training, the Training Center and the Trainers will have a discussion about the results. And then the Training Center will report back, to the Director General. After getting the approval from the Director General, the Training Committee will share these results with the respective departments as well as keep them as records. The evaluation levels are Grade A-(90-95), A<sup>+</sup> (96-100), B<sup>+</sup> (80-89), B (60-79), B<sup>-</sup> (50-59), C (Under 50). The trainees usually get Grade A or above.

After getting the respective Grade, the employee will fill out a form which is submitted to the Office Vice Manager and then to the Office Manager and then to the Vice Chief of Section and Chief of Section. The Chief of Section will then submit it to the Director and the Director will in turn submit it to the Director General with the comments after the checking the Staff Records. There are over 1000 employees in PPWSA and over 90% of them benefits from Promotion, Incentive, Bonus, OT by the end of the year. The Staff Quality Assessment Program is founded in 2000.

#### **4.4.5 Resources of HRD**

HRD Department has 100 employees. According to HR Department policies, the Recruiting Committee selects and recruits the new employees based on their background and qualification. After six months of probationary period, they will become Permanent Employees. There are 3 steps of Employment called Probation, Contractual and Permanent. HR Department remunerates Promotion, Bonus, and Incentive to the employees based on their grade (Grade A, B, C). Each employee is given duties and responsibilities and they are monitored closely to record if there is an increase in their performance. More than 90% of the 100 employees in the HR Department receives benefits and incentives and only few are punished.

#### **Photo records of PPWSA**



#### **4.4.6 Implementation of OJT**

When implementing OJT, the duties and responsibilities of the employees are already separated and defined so the trainee will just have to follow the standard procedures and perform daily routines. Whenever there is a new employee or the transferred employee, the seniors will share information with the juniors. For new recruits, they will be explained about the Internal Regulations, Policies, Duties and Responsibilities. OJT is not a separate training itself but daily operations and routines so it's more effective if the employees perform these duties with absolute focus. Non-Training is similar to OJT in effectiveness. Non-Training doesn't have extra set of Policies like OJT. They are the day-to-day operations of HRD so every new employee is given a Knowledge Sharing Session to give them an understanding of how the daily routines work.

#### **4.5 Corporate Accounting**

(a) PPWSA's Fiscal Year is started from 1<sup>st</sup> January to 31<sup>st</sup> December. PPWSA stood as a subsidiary of France CEEI naming OFFICE NAME-CEEI (Compagine des Eauxet Electricite de L'indochine) in 1895. Between 1959 and 1970, it changed CEEI to PPWSA. From 1970 to 1979, there was no water distribution team because of civil war but from 1979 to 1996, it named Govement Institution Phnom Penh Water Supply Authority and used France Accounting Standard. On 19<sup>th</sup> December 1996, it uses Local Standard and stand as Public Establishment having Economic Vocation.

Listed Public Enterprise had been changed on 18<sup>th</sup> April 2012 and being a part of CSX (Cambodia Service Exchange) and used International Financial Reporting Standard (IFRS) and International Accounting Standard (IAS) which are used in Independet Audit. In PPWSA they apply both IFRS and IAS.

1. STATEMENT OF FINANCIAL POSITION
2. STATEMENT OF PROFIT OR LOSS AND COMPREHENSIVE INCOME
3. STATEMENT OF CHANGE IN EQUITY
4. STATEMENT OF CASH FLOWS
5. NOTE TO THE FINANCIALS STATEMENT

(b) Besides, they do pre-budgeting and Long-Term Planning. When preparing the long-term plan, they also consider and predict uncertainty for coming 20 to 30 years. When doing Financial Statement, PPWSA compare budget from years to years, and plan annually, and precdit water production volume and sales. Best Case, Bad Case and Avg Case were used to calculate the demand.

(c) Group discussion of department heads on Business Plans and Master Plans to decide which kind of service improvement will be implemented for the next 20 to 30 years based on the information 3 years ago and the calculation of details and budget of the project by the department officials

(d) Annual Plan has been confirmed by Board before every year October 1<sup>st</sup> by covering profit and loss, investment, taxation and expenditures and government funding and liabilities. After the Board confirmed, wait the permission from Technical Guardianship Ministry Ministry of Economy and Finance.

#### 4.6 Standard, Guideline, Manual and SOP

Master plan was updated in 2005 and drew from 2016 to 2030. Business plan is updated to every five years from 2016 to 2020.

##### 4.6.1 Standard ,Guideline , Manuals and SOPs

Standard -is a level of quality something used as a measure, norm, or model in comparative evaluations .

Standardization -is the process of establishing standards.

Countless Standards are

1. Open Standard
  2. International Standard
  3. Technical Standard
  4. Standard operation procedure
1. Open Standard -is a standard that is publicly available
  2. International Standard -is standards suitable for worldwide use
  3. Technical Standard -is an established norm or requirement technical systems
  4. Standard operation procedure -is a step-by-step instruction to achieve desired result

SOPs means the process which follows the instructions step-by-step to be able to get better result. For example, when we drive a car, we have to follow these steps,

1. Unlock the car
2. Adjust your seat
3. Start the engine
4. Adjust the mirrors etc

The benefits of good SOPS are

1. Staff perform better
2. Tasks are done correctly
3. Tasks on time
4. Performed the same way and
5. Every time

A complete SOPS cycle has six steps.

1. Scope & Purpose
  - Scope
  - Existing or new?
  - Why is it needed?
  - What is the objective?
2. Audience & Authors
  - Who is it for?
  - Language skills
  - Existing knowledge
  - End user engagement
3. Format & Writing Style
  - Pre-existing layout
  - Flow charts
  - Hierarchical steps
  - Simple list
4. Test & Adjust
  - Tested fully
  - End user test and review
  - Adjust
5. Distribute & Train
  - SOP library
  - Targeted distribution
  - Ensure comprehension



6. Review & Update
  - Regular review
  - Validation process
  - Ensure feedback is considered

#### 4.6.2 Design Section

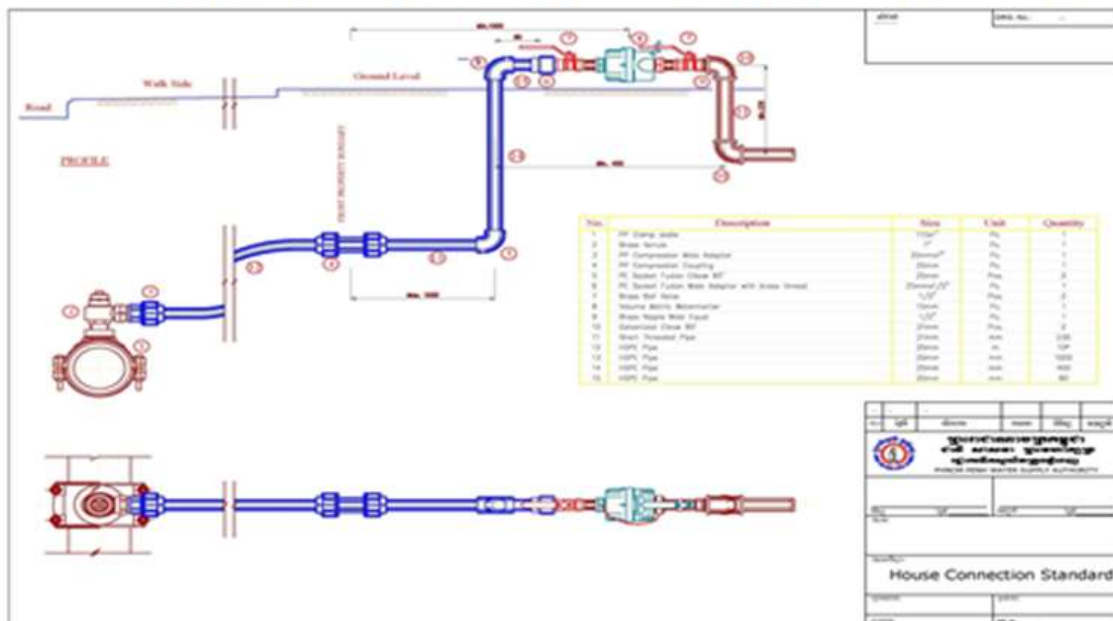
Design Section has five departments.

1. Survey
  2. GIS
  3. Projection Design
  4. Inspection the project
  5. Planning
1. Survey - Site survey and Customer Survey for waterpipeline set up area.
  2. GIS - KIS software from France has been bought to save the data. In GIS Customer Information, Last time Modified, Contract Number, Contract Date, Water Deposit, Date of Water Deposit, Meter Diameter, Meter Install Date, Meter Serial Number, Meter Type, Name, Address, Phone Number etc Date are put.
  3. Project Design- Planning  
Design every year and drawing project design.
  4. Inspection the project – The entire Project is checked and consulted by Inspect team.
  5. Planning - Cost Design are calculated and drawn

Design activities

- Network Design
- Pipe laying Design
- Other facility Design
- Water meter and service pipe design
- Fire Hydrant Design are leant with pictures. Design Drawings are described as follows.

### Standard of Installation Water Meter For House Connection



Types of pipeline which have been used in PPWSA are HDPE Ø(25,32,40,50) house connection from Italy, Germany, Malaysia and Thailand DI Ø(63 to 225) for distribution and DI Ø(250 to 1600) transmission from France □ KUBOTA and Japanese Company. Japan currency has increased so they no longer imported Japanese quality. PPWSA used to use Chinese quality but it is occurred with many

leakouts. In the pipe laying works, PPWSA pay purchase of the pipe with Loan money and for pipe connection works, they use PPWSA budget

There has 42 DMA in 2015 and 120 DMA in 2015 and it project to be 42 DMA in 2017. PE pipes are imported from Malaysia and mainly used PE Ø- (63,90,100) and PE Ø 80 is thicker than100.

Tender for Pipeline is both for private and government. Planning department is responsible for tendering.

- (1) Director general
- (2) Vice director general
- (3) MEF
- (4) MIH
- (5) Local Company

Those are the associations who responsible for tendering

HDPE Ø- (25,32,40,50) is mostly used in houseconnection. Water meter size is distinguished between domestic and commercial. Ø- (10,15,20,25, 40) is for domestic and commercial is for Ø- (80,100,150,200). Ø- (15,20) is usable for 4 to 5 people. HDPE pipeline is set up with PPWSA standard.

If the customers want to apply water meter without owning the water pipe, they may have to get it in the yearly plan. The main complaint is the pressure.

#### **4.6.3 Pressure**

2 bar distribution (29Psi)

4 or 5 bar transmissions (58Psi~72.5Psi)

3~4 bar (43Psi~58Psi) near plant

Sensors in flow meter are set up In District Metering Area (DMA) and data can be traced 24 hours through server with KIS system. Sensor battery lasts four to five years. KIS software are used since last year.

#### **4.6.4 Fire Hydrant**

Fire hydrants are set up according to Design Manual. Flow meters are set up in the pipe line where Fire hydrant exists. The reason why flow meter are set up in fire hydrant is to know the water usage in (m<sup>3</sup>). Customer occasionally request to set up Fire hydrant in private compound and water usage bills are collected which shows in Flow meter. If the customer wants to change the name, he or she can do free of charge in PPWSA. Fines are collected if customer proceeds the day they have to pay. Technician of PPWSA carried out water conveying process (water connection) with construction department. When carrying out the task, Deputy Department and office manager and technician have to sign. Record the detail pipeline drawing, material and length once the pipe is set up.

GIS is used for pipeline measuring. GIS is ±5. In order to get Total station in level 3 points have been marked from near pylon.

Levels of Air valve, washout, drainage, electrical line, cables are needed to mark in the drawing. People near pipeline are asked Drainage and cables are asked from respective department. Design team draws construction design new pipeline set up. Survey team responsible for estimating before new pipeline set up. Number of customers, type of roads: concrete or asphalt and availability of cable have been checked. Survey team sends the drawing design to France consultant after it has drawn drawing. France consultant has been hired for water pipeline and treatment plan.

Pipe and building are set up from the drawing sent from Consultant. PPWSA carry out the tasks instructed by consultant. Survey team is responsible for distribution and transmission Survey team has members from 5-to or 30. When setting up water pipeline, PPWSA follows the design described in project design. If it is found out different type, it has been reported. Extension tasks are needed to be reported before carrying out. Also, it can use only materials which are checked by PPWSA. PPWSA inspection team and consultant department check while carrying out the tasks. After the tasks, it is measured and recorded with total station

Pipe Ø 400~1000 mm=triple air valve

Ø300mm =single air valve is used

Employees from PPWSA carried out water works, setting up water pipeline with PPWSA standard.

#### 4.6.5 Customer service

Phnompenh water supply authority has water conveying system up to 289000 in 2015. Recommendation letter of township administrator are needed when poor people want to apply the water meter. And then employees of PPWSA from respective departments check the application form. The customers get water conveying permission once they met the defined percentage in the form.

There have two types of water conveying permission in Application forms:

- (1) Application for normal water conveying (connection)
- (2) Application for lower class people/poor people.

Water bill charges are described in the table.

| Type of Customer | Quantity of Consumption                        | In USD |
|------------------|--|--------|
| Domestic         | -From 0m <sup>3</sup> to 07 m <sup>3</sup>     | 0.14   |
|                  | -From 08 m <sup>3</sup> to 15 m <sup>3</sup>   | 0.19   |
|                  | -From 16 m <sup>3</sup> to 50 m <sup>3</sup>   | 0.25   |
|                  | -Over 50 m <sup>3</sup>                        | 0.32   |
| Administration   | Without Considering of quantity                | 0.26   |
| Commercial       | -From 0m <sup>3</sup> to 100 m <sup>3</sup>    | 0.24   |
|                  | -From 101 m <sup>3</sup> to 200 m <sup>3</sup> | 0.29   |
|                  | -From 201 m <sup>3</sup> to 500m <sup>3</sup>  | 0.34   |
|                  | -Over 500m <sup>3</sup>                        | 0.36   |

If poor citizens want to apply water meter, they can exempt subsidy 30% to 100% according to PPWSA data. Even if water meter application is 100% free of charge, no one can get free water bills. Some residences which are donated by government, water permit is 100% exempt. Service counter are opened for water bills. Remote areas which are far away from Customer Service Counters, they can also do

- (1) Bank Transfer
- (2) Opening Service Counters near Airport
- (3) Opening Counter near Water Tank

Customer Service Counter are opened now and DMA is carried out by Hand hill machine. Water bills are charged once in two months. Customers who do not pay the water bills have been noticed once in two weeks and also temporary water cut off. When collecting water bill in High-rise buildings, unlike Myanmar, PPWSA charge by reading one big water meter as a whole with one water bill receipt.

Water Charges are collected straightaway in DMA area and US\$ 15 is paid as fines.

If Water Meter has been moved, US\$40 has been paid. US\$25 is paid when the owner wants to move from deep down to upper place. Requests should be sent to Project Department when the customer wants to use water meter at above 40. If the customer has 12 years of water usage time, new water meter was set up with free of charges by PPWSA. If Water Pipeline is under Concrete or Asphalt Road, request for digging road should send to respective department. If employees from House Connection can read more than 1000, they can benefit from numbers of meter they read.

#### 4.6.6 Meter

Meter Sizes are 15mm, 20mm, 25mm, 40mm, 80mm, 100mm, 150mm, 200mm (15mm, 20mm, 25mm) Meter Size are set up at House Connection and (40mm, 80mm, 100mm, 150mm, 200mm) Meter Size are set up in Commercial & Factory.

|                  |        |           |
|------------------|--------|-----------|
| Meter Prices are | 15mm = | 40\$      |
|                  | 20mm = | 150\$     |
|                  | 25mm = | 250\$     |
|                  | 40mm = | 450\$ etc |

Customers pay water bills to Phnompenh Water Supply Authority (PPWS)

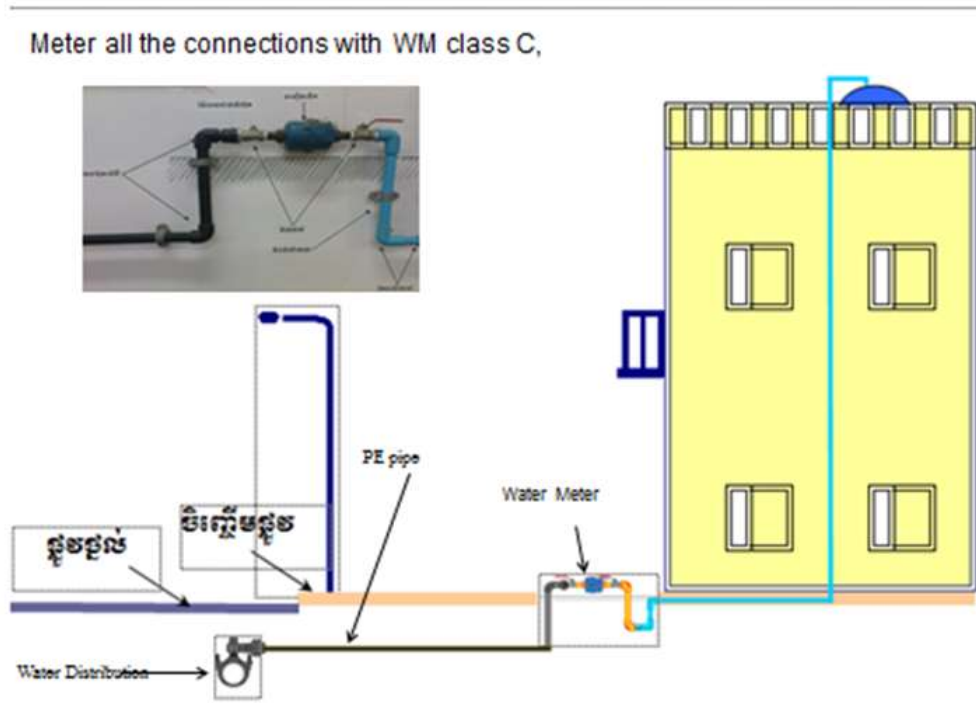
#### 4.6.7 NRW

Water supply operation had stopped before 1993 and it rehabilitated after 1993. Now it can keep abreast to southeastasia country, Singapore's water supply system. NRW was 72% in 1993 and decrease to 8% now. Phnom Penth Water Losses in Phnom Penth was 72% before.

To prevent the Real Losses, Old Transmission Pipes are changed since 1993. Pipe Replacement takes place near Treatment Plant. Pipe Replacement has been carried out immediately in leakage areas. Types of replaced pipes are (DI), Ductile Iron Pipes, High-density Poly Ethylene Pipes (HDPE). 24 hours checking has been divided to 3 work shifts for NRW.

According to Customers Survey, Total Population is 27623 and Service Population is 26681. Most parts of the Phnom Penh city use PPWSA water supply.

### Meter all the connections with Class C



Connections and found out abundant Apperant Losses.

DMA are chosen by PPWSA Inspection Team in 2003 and also Illegal Connections are solved by using rewarding system. DMA are increased up to 4 in 2006 with Incentive and Pentily system.

2007-5 DMA (Distract Metering Area)

2008-6 DMA (Distract Metering Area)

2012-7 DMA (Distract Metering Area)

PPWSA lawers summoned to court to resolve the Apparent Loss Improvement. 100% Connections were metered in 1997.

Good Service

Customer- Oriented Service

Customer- Information

Take Care of Customer Complaint

On Site Customer Education

Service is delivered.

Starting from 1993, both PPWSA employees and City hall employees outreach to ground level to collect customer survey data in three months and list water usage deamand with the occurance in ground level. Bill collecting staffs who are cheating reading water meter from 1993 to 1994 have been counter checked by employees from NRW team.



There have twelve groups of NRW and each group is associated with five employees. Leakage team work three work shifts per day and they search for leakage every night from 11 pm to 4 am. Minimum Night Flow is measured every night starting from 11 pm to 4 am. Three leakage teams have been used when measuring. Minimum Night Flow should be measured continuously. Bicycling is a good example of measuring MNF.

Both employee and customer are sued when PPWSA lawyer found out illegal water conveying (connection). If meter usage and the amount of received money is different, meter reader is sued in DMA. If NRW team missed the water leakout, they had been warned. It is good to inform when someone found of the thief and then the informant has been awarded thirty percent of the money calculated from the bill of period of time they illegally conveyed. Bonus is awarded when NRW can lower NRW percentage. Most of the business in Cambodia process operations by using the system rewards and vengeances.

#### **4.7 PPP (private sector involvement in water supply management)**

PPWSA water supply system has faced many challenges in the early 1993. Production capacity was merely 60,000 m<sup>3</sup>/day and the delivery time is 10 hr/day with service pressure under and used old aged waterpipe. NRW percentage is 72% higher according to JICA estimations because of illegal water conveying per day.

The Organization had experienced in abundance of unqualified employees and lack of skillful employees in every aspect with such weakness so that it had operated in Vicious Cycle.

## Vicious Cycle



### 4.7.1 Revolution (Time to Change)

PPWSA used to be government funding organization and self management organization in 1996 as Phnom Penh Water Supply Authority. Development plans are performed with government fundings, technical assistance from international organizations and Grant and Loans (UNDP, WB, ADB, Japan and France)

PPWSA organization structure and management system have transparency.

### 4.7.2 Ability of a good leader

1. Leading as a good example (Lead by example)
2. Having fully responsibility and accountability (Take responsibility)
3. Setting objectives and goals and achieving those (Vision)
4. Interpersonal Skills and Public relatiton skills (A Plan)
5. Stimuting willingnees to work of underlings (Great communication skills)
6. Know how to develop other (Motivator)
7. Know how to develop other
8. Building trust peer to peer (Inspire confidence in other)
9. Honesty (Integrity)
10. Patience and wise enough (Can deal with chaos)

### 4.7.3 Human Asset

As Human Asset, PPWSA promotes the capacity of employees and officials from every department.

When promoting employees's capacity, including Government officials and other contractors, they served according to their age with Doctoral Degree, Master Degree, Bachelor Degree (Engineer), Associal Degree, Technical Staff, Staff with over- 10 yrs experiences in every department. In order to get such qualified employees, HR department performed such development.

- Knowledge & Skill
- PPWSA performed the following tactics when promoting Discipline & Morale,
  1. Employ new employees (New recruitment)
  2. OJT (On Job Training)
  3. Implement Network design, Treatment process, NRW management and all SOPs (Job specific)
  4. Upgrading (Language, Specific education at national and international universities, Like MSc.)

PPWSA set new Operation procedures, draft and implement scheduled Annual Plan at the same time, monitor and evaluate the plans. Continuously learning from the obstables makes PPWSA not to commit the same mistake again.



Training has been carried out steps by steps. PPWSA carefully carried out employees' satisfaction by Promoting capacity of the employees, giving incentives, awarding trophy, awarding bonus yearly.

Important indicators are set and data are collected for water distribution operation. Collected data are utilize yearly for systematic development plans. Water distribution is performed effectively by observing requirements in every aspect of the operations, using high-tech and evaluate WTP requirement, intake and networks. At the same time, PPWSA speed up the lowering water loss management systematically. Illegal water conveying was strongly objected by PPWSA laws and regulations and learnt from PPWSA reformation Leader. PPWSA tried equipping Water meters in the whole water conveying system. By the time in 2000, all are equipped. PPWSA NRW (%) is lowered up to international standards

In realted to water quality control, PPWSA used WHO guidelines standards to perform monitoring and maintaining tasks. In WTPs, water Chlorination system has been used as refinement and supply Drinkable water to Phnom Penh citizens.

In order to gain Customer Satisfaction, Public Office Programs such as information desks, handling complaints, round the clock respond to customer calls and publishing Facebook page and Websites are technically arranged.

Besides the plan is implemented and performed monthly installments program for low income family group. Although those customers cannot afford the money, they can utilize the purified drinking water equally as other customers because of the installment program. So that the society gained the benefits by utilizing purified drinking water and it helps people to develop their lifestyles.

The following are the main supports which give when PPWSA successfully operated the purified drinking water system in its twenty-three years period of time.

(a) External support

- Government support (Self-Management/ autonomous system was granted)
- Technical assistance and grant from intenatonal organizations

(b) Deparmental Efficiency

- High work performances
- Sustainable efforts
- HR Development & Management
- Motivations
- Prioritization of Customer's needs and wants

In conclusion, these are the main driven forces which are also needed in problem solvings.

### **Drinking Water Supply by PPWSA**



## Chapter 5 Comparison (YCDC vs. PPWSA)

### 5.1 Organizational Management

| No. | Current Situation of YCDC   | Practices in PPWSA   | Characteristics and Advantages |
|-----|---|--|--------------------------------|
| 1.  | Ministry Level  | Organization under the Ministry of Industry  |                                |
| 2.  | Budget proposal has to be submitted to Yangon Regional Government, and then to Parliament. Final approval is decided by Parliament. | In PPWSA, Budget allocation is decided by Board of Director and gets approval from Ministry of Industry (MIE). |                                |

### 5.2 Organization Structure of Water Utility

| No | Current situation of YCDC   | Practices in PPWSA   | Characteristics and Advantages |
|----|---|--|--------------------------------|
| 1  | In Engineering Department (Water & Sanitation), there is one Chief Engineer, 3 Deputy Chief Engineers and 7 Assistant Chief Engineers and under them, it has 7 Divisions. | It has 7 members of BOD, 1 General Director, 1 Deputy General Director, 1 Secretary, and governs 3 sub-group, and 6 divisions. |                                |

### 5.3 Planning System

| No | Current Situation in YCDC  | Practices in PPSWA   | Characteristics and Advantages   |
|----|--|--|--|
| 1  | Planning section is started to establish in 2016 and under which there are two sub sections. | They have 3 divisions of Planning and Project Development and draft year plan and review on implementation.  | Can implement the designed projects in systematic way and meet the vision and operate the work efficiently.                |
| 2  | It's required to monitor by using PIs in Water Supply Works.                                 | They monitor and evaluate the performance and draft the plan using PIs in each department.   | Can improve the work capacity and perform Development plans successively/ continuously which are necessary for Department. |
| 3  | It's required to draft short-mid-long term plans.  | They draft 3 months, 6 months, 1 year, 5 years, 10 years and 30 years plan as Planning Strategy. They also review and revise all plans according to the term/period of time. | Becomes Sustainable Development using PDCA Cycle and clear to know the prior works.  |
| 4  | Water supply system should be managed and supervised by setting detail plan.                 | Based on the Business, Plan, they manage business profit, customer's reliance, and the staff's capacity improvement.   | Improving all sectors in equally and mutual sharing of work.   |

### 5.4 Human Resource Development

| No. | Current situation of YCDC   | Practice in PPWSA   | Characteristics and Advantages  |
|-----|---|---|---|
| 1.  | -HRD section is partly responsible to achieve the mission and vision of YCDC.<br>-Responsibilities of each section are not clear. | -HRD section is responsible to achieve the mission and vision of PPWSA<br>-With the coordination of Corporate Communication Department, HRD | -Create Plans and implement the plans.<br>- Strong link among each section. |



|   |  |   |  |
|---|--|---|--|
|   |  | section shares the responsibilities of each section to the respective sections.   |  |
| 2 | -No HRD plan from long term view.  | -Perform in organization level, Department Individual level and Key Changes.<br>-Business plan and Business policy<br>-HRD Meeting with Executives, Training Needs Analysis                 | - Make HRD plan in details including Organization needs, Department needs and Individual needs<br>- Make HRD Plan in accordance with Business Plan<br>- Can implement IDP (Individual Development Plan). |
| 3 | -No training center at EDWS.<br>-Coming soon library at EDWS<br>-rich experience staff<br>-  | -Firstly design vision and Mission<br>-Training room and facilities Library.<br>-Give training Coach system, trainer fee, aboard training.<br>-Build to e-Library and use internal website. | -Training improvement<br>-each staff improvement self-learning.<br>-Too busy so try trainer.<br>-easily know staff self learning and information.  |
| 4 | -Now we have training with PDCA cycle.<br>-Firstly more turnover WA staff to survey so training implementation.<br>-Training evaluation is the decided such as exam, site visit report, attend, obedient and discussion.-Staff record keep document. | -HRD Officer is monitoring training.<br>-About IDP to training implementation<br>-Level of Assessments, Type of Assessments and Tools.<br>-used internet internal online.(SAP system)       | -Because of take feedback next training.<br>-each staff need analysis.<br>-Assessment of training achievement including advantage and disadvantage.<br>-easily see training profile and record.          |
| 5 | -No official system for personal evaluation.<br>-Low awareness of mid-level managers for HRD.<br>-Give promotion<br>-Look Annual Report.   | -Especially IDP plan implementation.<br>-approve Responsibilities each section.<br>-Do complete MWA Straggly target.<br>-Look Annual Report.  | -easily know each staff improves.<br>-MWA's vision and mission implementation.<br>-Good service.<br>-staff try.  |
| 6 | -Difficulties to promote OJT activities in each workplace.<br>-Not yet.<br>-Not yet.   | -senior staff to Junior staff knowledge sharing.<br>-Sharing senior to Junior at Workplace.<br>-Do Non-class room training.   | -New staff know Responsibilities.<br>-OJT start Japan so continue.<br>-reduce cost.  |

## 5.5 Corporate Accounting

| No. | Current situation of YCDC  | Practice in PPWSA  | Characteristics and Advantages  |
|-----|--|--|---|
| 1   | Use Government Accounting System and make the accounts in cash basic. And we don't have/make P/L and B/S. In order to make P/L and B/S, we need Depreciation Account. In order to make depreciation account, we need Fixed Assets registration. But in EDWS, Fixed asset registration cannot be complied systematically and there are no rules and regulations for Depreciation Rate and Useful life specified for EDWS (especially for waterworks). | In PPWSA, International Financial Reporting Standard International Accounting Standard<br>1-Statement of Financial Position<br>2-Statement of Profit & Loss and Other Comprehensive Income<br>3-Statement of Change in Equity<br>4-Statement of Cash Flows<br>5-Make Notes to the Financial Statement.<br>Always check and analyze the difference of data on financial | If EDWS can apply suitable Accounting Principles using in PPWSA, it could make the waterworks operation smooth and make water tariff collection easier. |

|   |  |   |   |
|---|--|---|---|
|   |  | situation and financial performance, and regularly report.  |   |
| 2 | For expenditure, the in-charged engineer calculates the budget estimation and gets approval from respective senior officer and finally approved by CE. And then it is submitted to Budget Department of YCDC, and from Budget Department to Mayor. After approving by Mayor, it is proposed to Budget Department of Yangon Regional Government.  | PPWSA has to submit its Financial plans according to the International Financial Reporting Standard and International Accounting Standard to the Board.   | As PPWSA is Autonomy and it has exact and clear standards/regulations in all aspects and levels, their work load is effective and efficient, and can implement the plans systematically. And it can stand as a successful water work. |
| 3 | Calculate and estimate the Capital Income & Expenditure and current Income & Expenditure for the future by adjusting the capital income after implementing huge projects such as new water resource and new treatment plant, with the capital expenditure to implement those huge projects of EDWS.  | Set the objectives and strategies exactly and analyze the implementation of strategic plans, and it is evaluated by Executives whether it achieves the goals and objectives. Besides, in-charged persons make more plans and also monitor the implementation, check whether the implementation is in accordance with the plan or not. If any changes emerge during the plan implementation, Long term Plan is modified by comparing and analyzing the results with the previous year's results/records. | In EDWS, in order to make the financial Plans, the point to be done is to calculate and estimate the expenditure by analyzing the estimated demand for the future.  |
| 4 | Budget proposals of EDWS are submitted to Budget Department of Yangon Regional Government through Budget Department of YCDC. Budget Department (YRG) analyzes the proposals and submits it to Ministry of Finance. Ministry of Finance submits it to Parliament and Parliament allocates the budget for all proposals. After approving the budget allocations by Parliament, Yangon Regional government shares the budget according to the budget allocation and proposals by following financial law. | New projects which will be added in 20 or 30 years Master Plan and Business Plan are prepared and discussed by all respective sections/divisions based on the data of previous three years. Based on that, budget is estimated and the proposal is submitted.   | As PPWSA is Autonomy, decision making process for Plans is quick and easy.  |
| 5 | EDWS's in-charged engineers can submit budget proposal only for the projects which are really need to be implemented. If necessary, revised estimated budget can be requested.   | In PPWSA, always check the income & expenditure and profit & loss in Income Statement, to know whether the revenue has enough funds for the future, and do the estimation. If necessary, call for External Funding.   | External Funding benefits to the Utility.   |
| 6 | As EDWS's water tariff rate is very low if compared with neighboring countries and EDWS is not investing in Lagunpyin WTP, the revenue and expenditure does not balance and  | In 1993, got revenue (1109381 Riels) from water selling and faced with loss. In 2011, water selling increased up to 80% and got some amount of net profit.  | Water is essential for daily life of all beings and not for luxury. Can increase revenue of Water Utility by upgrading Water Utility Facility and service.  |

|  |   |  |  |
|--|---|--|--|
|  | Expenditure is much higher than income. |  |  |
|--|---|--|--|

## 5.6 Standard, Guideline, Manual and SOP (Construction & Inspection)

| No | Current situation of YCDC   | Practices in PPWSA   | Characteristics and Advantages   |
|----|---|--|--|
| 1  | Specific Regulation, Standard, Guideline, Manual And SOPs are necessary for department.   | They have set the useful Standard, Guideline and Manual for the organization so that the staff can know easily.                        | Can define necessary Standard, and Guideline and SOPs for Water Supply Work and facilities.  |
| 2  | We need a section which can repair and maintain the facilities with specific Standard, Guideline and Manual.  | They have a section which can check, repair and maintain the facilities with ISO Standard.   | Can use the standardize water supply facilities in full term.  |
| 3  | Meter are installed in convience places.  | Every connection has meter and meter are also installed in front of the customer's house in PPWSA boundary.                            | As the benefit, it can easily to read the meter in every connections.  |
| 4  | We are planning to install the flow meter in water inlet points.  | They have flow meters in every water inlet points and even in Fire Hydrant points, they install flow meter                             | By installing the flow meter, it can easily to know the water capacity (m3) and calcualte NRW rate.                                      |
| 5  | In Water Quality, we are trying to meet WHO Standard.   | Their Water Quality meets WHO Standard and it is drinkable.  | Can supply clean and drinkable water to Customer and can reduce Meter Damage.  |
| 6  | We have FOC (Free of Charge rate).  | All are to pay water charges (even Temple, Pagoda) except National Festival.   | They can reduce Apparent losses quickly and can collect water charges fully.   |
| 7  | We are preparing to draft Design Criteria.  | It is to send to Consult Department to implement Transmission Pipe Laying work. For distribution pipe, PPWSA drafts Design Criteria.   | By drafting the thorough design criteria, we can know who is in which project.   |
| 8  | To implement the work/project, the township in charge has to draw/draft Design, Drawing and Estimate and submit it step by step to get approval.                          | They have Work proporsal division, Survey and Drawing Division and Estimate division and link up with each other and perform the work. | By linking with Design, Drawing and Estimate division, the work can be done easily and smoothly by defining respective responsibilities. |
| 9  | When the work is implemented on ground, we have to cooperate with other organizations (Road & Bridge Dept, YESC (Yangon Electricity Supply Cooperation), Communications). | They start to cooperate with other organizations when it starts to draft Survey and Design.  | Being working/cooperating with other organizations, the design becomes the safest and suitable one and the work doesn't delay.           |
| 10 | We are using artesian well because the projects to supply water sufficiently are ongoing process.   | They can supply the water sufficiently from Mekon River by treating. They don't use artesian well.                                     | Can protect the ground water loss and soil settlement.   |
| 11 | We start to do Pilot Area.  | In 2015, they have already finished (118) DMA.   | By using DMA System, the management of water supply system becomes more successful and can reduce NRW.                                   |
| 12 | We have some diffculties to find Leakage becacuse we don't have final drawing.  | They store/keep Final Drawing in Computer so that they can easily to know locations/places   | Having Final Drawing can prevent NRW and can be reduced NRW (Non Revenue Water).   |

|  |  |  |  |
|--|--|--|--|
|  |  | of Leakage, Valve, Pipe Line, etc at any time. |  |
|--|--|--|--|

**5.7 PPP (Private sector involvement in water supply management)**

-

**5.8 Action for Problem Solving**

| No. | Current situation of YCDC   | Practice in PPWSA  | Characteristics and Advantages                                     |
|-----|---|--|--|
| 1   | EDWS needs to solve the challenges of Coverage Ratio, Collection Ratio, Safe water in urgent. | Build a strong relation with customers for the interest of utility | Can build trust and reliance between Customer and Utility Provider |
| 2   | Delegation of Power is limited especially for problem solving.                                | Manageability of a leader is the key of problem solving.           | Manageability of a leader is the key of problem solving.           |

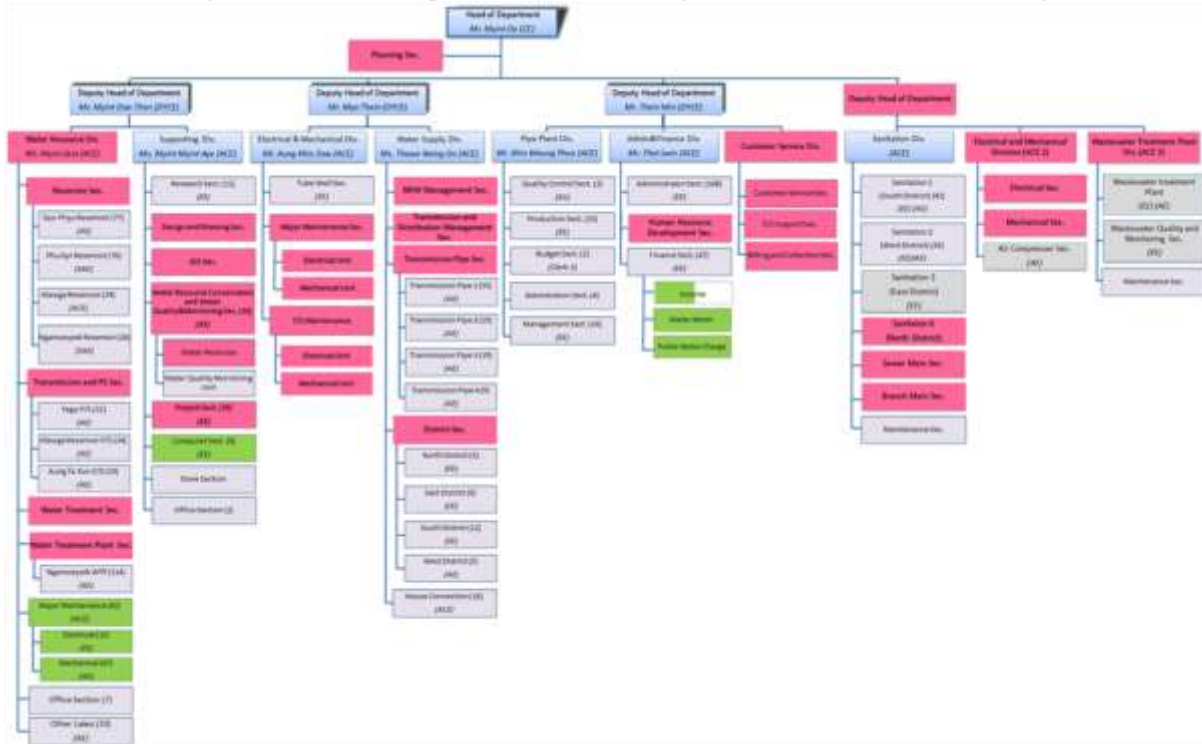
## Chapter 6 Improvement Plan Proposal

### 6.1 Institutional Governance

1. To practice Autonomy System.
2. For budget allocation, try to get the approval from respective ministry.

### 6.2 Organization Structure of Water Utility

According to the needs of Department, the following divisions and sections are reorganized as follow:



### 6.3 Planning System

- ✓ To set short-long term plan to cover the vision after drafting the Master Plan.
- ✓ To propose the Plans which are drafted by Planning Section (Study on various information regarding performance indicators)
- ✓ Setting KPI using collected PIs and drafts the Business Plan.
- ✓ According to PDCA Cycle, draft Mid-term Plan and evaluate the current activities in every 6 months
- ✓ To perform Capacity Development by the staffs who can do the Planning Section's work in systematic ways.

Based on our studies, we propose the facts mentioned above.

### 6.4 Proposal for Improvement of EDWS

To achieve the mission and vision of EDWS, Human Recourse Development plays in the main role. New staffs are the future image of EDWS. To train new staffs systematically is the most important.

Essential things to be done are as follow for HR development:

- (1) Establishing Training Center
- (2) Organizing Trainers
- (3) Shaping effective Organization
- (4) Clarify Duty Responsibilities
- (5) Supporting Training to New Staff
- (6) Supporting necessary trainings according to the level of Permanent Staff (junior level to senior level)
- (7) Monitoring the performance of New Staff and permanent Staff who have been supported trainings
- (8) Granting prizes to outstanding and qualifies staffs.
- (9) Implementing TOT (Training of Trainer)

(10) Following PDCA (Plan, Do, Check, Action)

(1) Establishing Training Center

Training Center is essential to provide trainings to all staffs in order to develop the capacity of the staffs for the future of EDWS. Necessary Facilities and teaching material need to be fully equipped in the training center.

(2) Organizing Trainers

Organizing Trainers is also the important matter. Respective trainers for each subject of New Staffs training and specialized trainings should be organized in advance and should be trained if necessary. Experienced and qualified senior staffs are the most suitable to be trainers and they should be motivated.

(3) Shaping effective Organization

The organization structure should be effective and supportive for the development of Department.

(4) Clarify Duty and Responsibilities

Duty and Responsibility of each Department and section are simplified and job description of each staff is clear in PPWSA. Each staff has to perform according to their job description and as directed. Based on their performance, the staffs are praised with bonus, incentive, OT and Promotion at the end of year. I suggest praising the staffs can make PPWSA as a successful Autonomous Water work.

(5) Supporting Training to New Staff

New staff trainings are required for all new staffs so that they can know the mission & vision of EDWS understand the overall process and help to achieve the future image.

(6) Supporting necessary trainings Permanent Staff according to their level (junior level to senior level)

Not only New-Staff but also all permanent-staff according to their levels should be provided specialized trainings based on their working background. Only if we can do so, capacity of staff and effectiveness of work will be improved, and the goal of EDWS could be achieved.

(7) Monitoring the performance of New Staff and permanent Staff who have been supported trainings

PPWSA provides its staffs trainings monthly and quarterly, and records the results of all training participants. Even after the trainings, section heads and supervisors monitor the participants' performance.

(8) Praising and granting and prizes to outstanding and qualifies staffs

Based on the performance of the staff, they should be dispatched short/long oversea trainings, outside and in-house trainings, granted prizes, promotion, incentives, salary increase. That system can attract the staffs to perform highly in the workplace, and it will lead to the effective performance of EDWS. Moreover, the root of Human Resources will become firm strongly and the future image of EDWS will be achieved proudly.

(9) Implementing TOT (Training of Trainer)

EDWS does not have specific Trainer. Experienced officers from each division/section perform as trainers in EDWS. Appointing specific trainers or hiring outside trainers will be more effective for Human Resources Development in EDWS. If necessary, should arrange to dispatch the trainers for TOT inside or outside of the country.

(10) Following PDCA (Plan, Do, Check, Action)

In achieving the mission of Department, PDCA Circle is very important. For example, to implement training, firstly we have to make a PLAN (P) in details for the training. Then Do (D) the implementation of training according to the plan. During the implementation, CHECK [C] the whole implementation process. Based on the results from checking, Act (A) the best in the next plans. By following PDCA circle, it will reduce the weakness in management, and will lead to complete the future image of EDWS.

As conclusion, ten points mentioned above are being applied in PPWSA since PPWSA until now. In EDWS, if we can apply those in EDWS from now, we can accomplish the improvement plan, future image and mission of EDWS quickly and effectively.

## 6.5 Proposal for Corporate Accounting

Things to be transformed in EDWS -

- (1) To improve water quality
- (2) To increase water tariff rate

(3) To extend water supply infrastructure

Concerning with Accounting System, PPWSA applies IFRS and IAS and to apply IFRS & IAS in EDWS, it has to be learned first. OR accounting Standard in Myanmar should be updated. Procurement data of each division should be kept in computer system. Fixed Assets registration, Useful Life setting and useful life calculation, Profit & Loss Account should be set and made. Water Tariff rate should be revised. Some wards in Dala, South Dagon, Shwe Pyi Thar, Hlaing Tharyar cannot be supplied water. If EDWS can arrange the installment payment system (one year or one and half year) for non-affordable customers, the customers will rely on the water work and EDWS will also gain the customers' trust which is the power to stand longer.

## **6.7 PPP (Private sector involvement in water supply)**

-

## **6.8 Proposal**

- ❖ To impress the staffs that the achievement of EDWS depends on their performance and capability
- ❖ To provide Leadership trainings (according to the staff levels)
- ❖ Organizing Problem Solving Team/Committee within the Department to analyze and solve the problems and difficulties, and members will make working discussion monthly and report the findings and results to upper level. Share suggestions of problem solving and, accept comments and appraisals for better problem solving.

The proposals mentioned above should be introduced in EDWS as Action for Problem solving. Only if we do so, we could lead to the virtuous cycle and achieve the goals of department.

## **Chapter 7 Executive Summary**

In conclusion, EDWS should do the followings to improve the water supply works -

### **7.1 Customer Base**

Keep the existing connection Data of Customers and New Customer Data systematically and separately

### **7.2 Installing meters for all connections**

As Customer has to pay Flat Rate for their non-meter connection and the amount of water loss cannot be known, every non-meter connections should be installed meters.

### **7.3 Transparency**

Should announce the clear information for new connection application such as required documents, water tariff rate table and calculation, payment system, rules to be obeyed by customers transparently to gain the customers' satisfaction and it can be supportive to collect water tariff fully.

### **7.4 Revise Tariff Setting**

It can be a Sustainable Water Utility by increasing the water tariff rate which recovers the cost.

### **7.5 NRW Reduction**

Need to replace all Old Aged Pipes with new pipe. Fixing pipe burst as much as fast by using the right fixing tools. Explore visible and Invisible Leakage.

### **7.6 DMA System**

DMA system should essentially be used in installing new pipeline network to maintain the water pressure to be in stable.

### **7.7 Planning**

Make Business Plan by using Performance Indicator. Set and implement Short-term Plan and Mid-term Plan to achieve the target of Master Plan. Analyze the performance of Department by using PDCA Cycle.

### **7.8 Human Resource**

Trainings should be provided for the capacity improvement of staffs, and Incentives, Bonus and Penalties should be arranged for motivation.

### **7.9 Subsidy, Loan, Grant and Technical Assistance**

Water supply work can gradually be developed with the Technological Assistance and subsidy from Government and International organizations.



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE REPUBLIC OF THE UNION OF MYANMAR

YANGON CITY DEVELOPMENT COMMITTEE (YCDC)

## **The Project for Improvement of Water Supply Management of YCDC**

### **Report on Institutional Improvement Plan**

#### **Base on the Third Country Research Study in MWA, Thailand**

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- 4.2 Organization Structure of Water Utility
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- 6.8 Actions for problem solving

#### **Executive Summary**

## Chapter 3

## Summary Current Issues and Contents to be studied

### Course A

| Subject  | Current issues  | Research Contents  |
|--|---|--|
| <ul style="list-style-type: none"> <li>● Institutional Governance and Organization of water utility</li> </ul>                     | <ul style="list-style-type: none"> <li>✓ Water Supply Department is one section of city government, that is, does not have the independent account nor independent budget, or does not have the concept of financial autonomy.</li> </ul>   | <ul style="list-style-type: none"> <li>▪ Learn the (financial and autonomous) autonomous self-sufficient water utility management. Learn the administrative structure and position of water supply utility between the central government and local/municipal government (present status and its historical background) and advantages</li> <li>▪ For MWA: Before establishing MWA in 1967 how the water supply in Bangkok had implemented. How and why the Law establish MWA in 1967?               <ul style="list-style-type: none"> <li>- How the organization/structure/governance of MWA has been stipulated in the Law historically since 1967?</li> <li>- Who has had the authority on decision of water tariff revision and annual budget since 1967?.</li> <li>- How about deficit/profit of the MWA. Central government has been concerned it? Any subsidy from central government?</li> <li>- How the autonomous management is implemented?</li> <li>- How the autonomous management works/functions?                   <ul style="list-style-type: none"> <li>* Authority of personnel hire/reshuffle</li> <li>* Authority of decision of big project</li> <li>* Motivation to self-efforts of cut costs</li> </ul> </li> <li>- Is there any difference between MWA and PWA on the aspect of institutional governance?</li> </ul> </li> </ul> |
| <ul style="list-style-type: none"> <li>● Overall activities as water supply utility</li> </ul>                                     | <ul style="list-style-type: none"> <li>✓ Organization is still under structuring as a water supply utility (no section for planning, water treatment, commercial, etc.)</li> </ul>  | <ul style="list-style-type: none"> <li>▪ Learn mission and vision</li> <li>▪ Learn organizational structure of water supply utility and functions of sections/departments.</li> <li>▪ Learn activities of Commercial/Customer service section</li> </ul>   |
| <ul style="list-style-type: none"> <li>● Role and function of planning section</li> </ul>  | <ul style="list-style-type: none"> <li>✓ Management of water supply works is not in planning manner.</li> </ul>   | <ul style="list-style-type: none"> <li>▪ Learn function and activities of Planning section</li> <li>▪ Learn methods how to apply management cycle in water supply management such as planning, grasping operational performance by PI, improvement, revised planning.</li> </ul> <p><b>(Section research)</b></p> <ul style="list-style-type: none"> <li>▪ Planning functions and activities of Planning Section</li> <li>▪ Monitoring PIs system</li> <li>▪ Kinds of reports prepared</li> <li>▪ Kinds of Waterworks management plan/ Business plan</li> <li>▪ Strategic planning process</li> </ul>  |
| <ul style="list-style-type: none"> <li>● Learn practices of waterworks management/ planning by using PIs and PDCA cycle</li> </ul> | <ul style="list-style-type: none"> <li>✓ Difficult to know current waterworks without accurate and reliable data</li> <li>✓ Project planning tends to be ad hoc and reactive</li> <li>✓ YCDC has launched the activity of monitoring PIs.</li> <li>✓ No systematic waterworks management with PDCA cycle</li> </ul> | <ul style="list-style-type: none"> <li>▪ Learn good practice on how to utilize PIs for waterworks management and planning in short-, middle- and long-term.</li> <li>▪ Learn on how PDCA cycle is carried out in waterworks management/ planning</li> <li>▪ Learn lessons and remarks on PI monitoring and PDCA cycle for waterworks management/ planning</li> </ul>   |

| Subject   | Current issues   | Research Contents  |
|---|--|--|
| <ul style="list-style-type: none"> <li>● HRD activities</li> </ul>  | <ul style="list-style-type: none"> <li>✓ A few training courses specialized in water supply.</li> <li>✓ HRD is not planned.</li> <li>✓ No specific section being in charge of HRD.</li> <li>✓ Few incentives (financial/non financial)</li> <li>✓ OJT in each work place is not active.</li> </ul> | <ul style="list-style-type: none"> <li>• HRD Plan responding to short-/mid-term business plan.</li> <li>• Improving staff productivities</li> <li>• Performance evaluation system and incentive to motivate.</li> <li>• Training activities and functions of training center.</li> <li>• Importance of OJT, how to enhance OJT, and sharing knowledge in each work place.(knowledge management)</li> <li>• Procedures for recruitment with transparency</li> <li>• PPWSA: Back-up system (bringing up the next generation)</li> </ul> <hr/> <p><b>(Section research)</b></p> <ul style="list-style-type: none"> <li>• Organization and responsibilities of HRD section</li> <li>• HRD plan</li> <li>• Training management</li> <li>• Personnel evaluation system</li> <li>• What resource of HRD</li> <li>• How to implement OJT</li> </ul>  |
| <ul style="list-style-type: none"> <li>● Corporate accounting system and Fixed asset management</li> </ul>      | <ul style="list-style-type: none"> <li>✓ No corporate accounting system is introduced and no fixed asset ledger exist.</li> <li>✓ Financial situation is not clear.</li> <li>✓ Fixed assets (Facilities and equipments) are not managed properly.</li> </ul>                                       | <p>&lt; For PPWSA and MWA&gt;</p> <ul style="list-style-type: none"> <li>• Learn the importance of corporate accounting system for management of water utility. <ul style="list-style-type: none"> <li>- How the P/L, B/S and cash-flow works for the management of water utility?</li> <li>- How the P/L, B/S and cash-flow works for setting/deciding water tariff and making short/middle/long-term financial plan?</li> <li>- What kind of law/act stipulated about the system of corporate accounting for PPWSA/MWA? Is it different from the accounting system for private company?</li> </ul> </li> <li>• Learn the importance of fixed asset accounting and “Asset Management”. <ul style="list-style-type: none"> <li>- How fixed asset accounting is managed systematically through whole divisions/sections of PPWSA/MWA?</li> <li>- How “Asset Management” is implemented? How to utilize fix asset accounting system for “Asset Management”?</li> <li>- What kind of depreciation method and depreciation rate is applied for pipeline, meter, etc.?</li> <li>- How much the dividing–line between capital expenditure (purchase/construct fixed assets) and current expenditure (purchase of consuming goods/repair of fixed assets)</li> </ul> </li> </ul> <hr/> <p><b>(Section research)</b></p> <ul style="list-style-type: none"> <li>• How to make P/L and B/S in water utility</li> <li>• How to implement fixed asset accounting</li> <li>• How to set/decide water tariff</li> <li>• How to prepare short/middle/long-term financial plan</li> </ul> |
| <ul style="list-style-type: none"> <li>● Whole structure of standards, guidelines, and manual, SOPs.</li> </ul> | <ul style="list-style-type: none"> <li>✓ Existing standards, guidelines and manuals are very limited in YCDC/ Myanmar</li> <li>✓ The quality of design, construction and inspection works will be difficult to be standardized.</li> </ul>   | <ul style="list-style-type: none"> <li>• Learn an overall legislation system relevant to waterworks</li> <li>• Learn existing guideline and manuals and the main contents by using PPWSA, particularly at the utility level</li> <li>• Learn relevant guidelines and manuals on design, construction and inspection works, equipment and material standard.</li> </ul> <hr/> <p><b>(Section research)</b></p> <ul style="list-style-type: none"> <li>• Development and enforcement process of Standard, Guideline, Manual and SOP</li> <li>• A complete list of Standards, Guidelines, Manuals and SOPs</li> <li>• Design works (standards, guideline and manuals)</li> <li>• Construction and inspection works (standards, guideline</li> </ul>   |

| Subject  | Current issues  | Research Contents  |
|--|---|--|
|  |   | and manuals)<br>• Equipment and material (standards)<br>• Water quality standards and monitoring   |
| <ul style="list-style-type: none"> <li>Utilization of PPP (private sector involvement in water supply management)</li> </ul> | <ul style="list-style-type: none"> <li>All works are directly managed by YCDC staff members</li> <li>Need big investments for these 30-40 years and need finance for them</li> </ul>  | <ul style="list-style-type: none"> <li>&lt; For PPWSA and MWA&gt;</li> <li>Principle thinking/attitude for outsourcing and PPP</li> <li>Case study of outsourcing and PPP/ Experience of outsourcing and PPP               <ul style="list-style-type: none"> <li>What types of outsourcing and PPP have PPWSA/MWA introduced?</li> <li>Advantages, disadvantages and points to be take care</li> </ul> </li> <li>How about BOT for new water treatment plant construction</li> <li>How about outsourcing contract or Performance Based Contract for Non-Revenue-Water project.</li> <li>How about PPP on industry water supply.</li> <li>How about PPP on expanding project for peri-urban water supply</li> <li>Without outsourcing or PPP, how PPWSA manage their work? How is it possible?</li> <li>&lt; For MWA&gt;</li> <li>Invite PWA staff as a lecturer to speak case study or experience of PWA</li> </ul> |
| <ul style="list-style-type: none"> <li>Actions for problem solving (such as leadership)</li> </ul>                           | <ul style="list-style-type: none"> <li>YCDC has many issues such as coverage ratio, NRW ratio, collection ratio and safe water, and has not found effective clues to solve them yet.</li> <li>Delegation of power is not enough.</li> </ul> | <ul style="list-style-type: none"> <li>Learn good practices on major issues, especially planning for problem solving and leadership to implement.</li> <li>Learn discretion and delegation of power in organization</li> <li>Learn how to develop leadership (problem solving capacity)</li> <li>PPWA (1990'-): actions against illegal connection, pursading stakeholders into water tariff rise, initiatives for improving water quality.</li> <li>MWA (1980'-): response to demand increase, persuading stakeholders into water tariff rise, corporate approach to utility management, securing clean and safe water source (shifting from ground water to surface water).</li> </ul>   |

### Course B

| Subject                       | Necessity   | Subject  | Contents  |
|-------------------------------|---|--|---|
| Financial Management (5 days) | <ul style="list-style-type: none"> <li>WSD is managed by government accounting system which included in the general account of YCDC.</li> <li>Financial situation of water supply is not clear. Costs of water supply is not clear.</li> <li>Facilities and equipments are not managed properly.</li> </ul> | <ul style="list-style-type: none"> <li>How to make P/L and B/S in water utility</li> </ul> | <ul style="list-style-type: none"> <li>How law/act and standards of accounting works for water utility's financial accounting system</li> <li>How in-house guideline/manual works for financial accounting system?</li> <li>Accounting items for water utility, accounting ledger, accounting system</li> <li>Budget and settlement of annual accounting</li> <li>How to make financial statements</li> <li>What kinds of events occurred annually for budget and accounting process from start of the financial year and end of it?</li> </ul> |
|                               |   | <ul style="list-style-type: none"> <li>How to implement fixed asset accounting</li> </ul>  | <ul style="list-style-type: none"> <li>How law/act and standards of accounting works for water utility's fixed accounting system</li> <li>How in-house guideline/manual works for fixed accounting system?</li> <li>System of fixed asset ledger</li> <li>How fixed asset accounting is managed systematically through whole divisions/sections of MWA?</li> </ul>  |

|  |  |   |  |
|--|--|---|--|
|  |  |   | <ul style="list-style-type: none"> <li>How "Asset Management" is implemented?</li> <li>How to utilize fix asset accounting system for "Asset Management"? <ul style="list-style-type: none"> <li>What kind of depreciation method and depreciation rate is applied for pipeline, meter, etc.?</li> <li>How much the dividing–line between capital expenditure (purchase/construct fixed assets) and current expenditure (purchase of consuming goods/repair of fixed assets)</li> </ul> </li> </ul>                                      |
|  |  | ✓ Setting/deciding water tariff                         | <ul style="list-style-type: none"> <li>History of revision of water tariff and water tariff table</li> <li>Concept of each tariff revision and concept of present tariff structure</li> <li>How to calculate water tariff costs (revenue requirements)</li> <li>How to set tariff table? (customer category, increasing block unit rates, etc)</li> <li>Decision process of tariff revision (Law and regulation for process of tariff revision)</li> <li>Compare with other utilities (electricity) on tariff setting process</li> </ul> |
|  |  | ✓ Making short/middle/long-term financial plan          | <ul style="list-style-type: none"> <li>How law/act stipulate about making financial plans of water utility?</li> <li>How to estimateshort/middle/long-term financial plan? <ul style="list-style-type: none"> <li>Capital expenditure/ income</li> <li>Current expenditure/ income</li> </ul> </li> <li>How capital investment project is decided?</li> <li>How to cope with the rapid expanding period when heavy capital investment required</li> <li>What kind of financial crisis has experienced?</li> </ul>                        |
| Business plan of water supply utility (2 days) | <ul style="list-style-type: none"> <li>A Planning Section needs to be established</li> <li>Waterworks management needs to be monitored by PIs periodically</li> <li>Strategic planning process for waterworks needs to be established with targets based on PIs</li> <li>A mid- and long-term plan needs to be developed</li> <li>Waterworks activities should be done based on the plans, reviewed and modified</li> <li>Waterworks is managed in a planned manner</li> </ul> | ✓ Planning functions and activities of Planning Section | <ul style="list-style-type: none"> <li>Duty and responsibility of Planning Section</li> <li>Main functions f the section</li> <li>Main activities of the section</li> <li>Experiential view on why planning section is necessary</li> </ul>  |
|  |  | ✓ Monitoring PIs  | <ul style="list-style-type: none"> <li>Key PIs</li> <li>Monitoring method and data collection</li> <li>Analysis of key PIs</li> <li>Utilization of PIs for the planning</li> </ul>   |
|  |  | ✓ Strategic planning                                    | <ul style="list-style-type: none"> <li>Concept of strategic planning</li> <li>Process for strategic planning, PDCA</li> <li>Consideration process for prioritizing activity</li> <li>Past lessons learnt</li> </ul>  |
|  |  | ✓ Waterworks management plan/ Business plan             | <ul style="list-style-type: none"> <li>Existing plans, contents</li> <li>Process for developing the plan</li> <li>Coordination between the relevant sections</li> <li>Interrelation between facility development, finance, human resources etc.</li> <li>Utilization for utility management, review</li> </ul>   |
| Standard, guidelines, manuals (3,5 days)       | <ul style="list-style-type: none"> <li>Standards, guidelines and manuals related to waterworks need to be developed</li> <li>Waterworks activities needs to be carried out based on standards, guidelines and manuals</li> <li>The prepared</li> </ul>   | ✓ Importance of standards, guideline and manuals A. B.  | <ul style="list-style-type: none"> <li>Overall structure/picture of existing standards, guidelines and manuals</li> <li>Experiential view on why standards/ guidelines/ manuals are necessary?</li> </ul>  |
|  |  | ✓ Development process A. B.                             | <ul style="list-style-type: none"> <li>Development process of standards, guidelines and manuals</li> <li>Interrelation between the relevant sections for development</li> </ul>  |

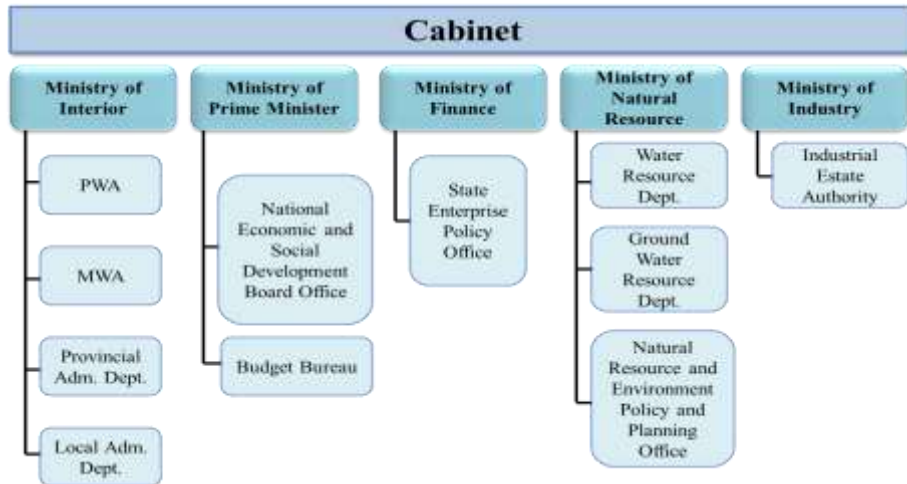
|                                     |  |  |  |
|-------------------------------------|--|--|--|
|                                     | standards, guidelines and manuals are shared and utilized by the staffs<br>✓ Waterworks is managed based on the regulation, standards, guidelines and manuals<br>Person A: 3 days for design.<br>Person B: 5 days for construction and inspection. |  | <ul style="list-style-type: none"> <li>• Interrelation between the central/ municipal gov. and PPWSA</li> <li>• Approval and revision</li> </ul>   |
|                                     |  | ✓ Design works (standards, guideline and manuals)<br>A.                      | <ul style="list-style-type: none"> <li>• Existing standards/ guidelines/ manuals on design works</li> <li>• Design process/ procedure</li> <li>• Network design</li> <li>• Pipe laying design</li> <li>• Other facility design</li> <li>• Water meter and service pipe design</li> <li>• Remarks</li> <li>• On-site study</li> </ul> |
|                                     |  | ✓ Construction and inspection works (standards, guideline and manuals)<br>B. | <ul style="list-style-type: none"> <li>• Existing standards/ guidelines/ manuals on construction and inspection works</li> <li>• Construction process/ procedure</li> <li>• Inspection process/ procedure</li> <li>• Remarks</li> <li>• On-site study</li> </ul>   |
|                                     |  | ✓ Equipment and material (standards)<br>B.                                   | <ul style="list-style-type: none"> <li>• Existing standards for equipment and materials (pipe,pump, valve, water mater, etc.)</li> <li>• Remarks on development of specification</li> <li>• On-site study (warehouse, manufacturing companies)</li> </ul>  |
| Human resource development (3 days) | ✓ WSD had not set the official organization chart and their duties and responsibilities.   | ✓ Organization and responsibilities  | <ul style="list-style-type: none"> <li>• Whole organization structure and HRD related section</li> <li>• Duties and responsibilities of each section related to HRD</li> </ul>   |
|                                     | ✓ No section is designed for HR management nor development.<br>✓ No HRD plan is set  | ✓ HRD plan   | <ul style="list-style-type: none"> <li>• Detail contents of HRD plan</li> <li>• Relation between business plan and HRD plan</li> <li>• Procedures to make HRD plan</li> </ul>  |
|                                     | ✓ WSD has a little experience to manage training course by themselves. Training course is launched by idea of top management or development partners.  | ✓ Training management  | <ul style="list-style-type: none"> <li>• PDCA cycles of training management</li> <li>• Steps to make training plan</li> <li>• Assessment of training achievement</li> <li>• Staff record on training participation</li> </ul>  |
|                                     | ✓ No official evaluation is conducted.   | ✓ Personnel evaluation   | <ul style="list-style-type: none"> <li>• Detail system of personnel evaluation</li> <li>• Responsibilities of each manager</li> <li>• How to utilize the result of the evaluation</li> <li>• Relation between evaluation and incentives</li> </ul>   |
|                                     | ✓ No trainig center, specific budget.<br>No system to develop training materials, capacity of trainers.  | ✓ Resource of HRD  | <ul style="list-style-type: none"> <li>• Role and organization of training center</li> <li>• Procedures to improve training materials/textbooks</li> <li>• System to bring up internal trainers</li> <li>• Library/information management for staff reference</li> </ul>   |
|                                     | ✓ OJT is not actively conducted in workplace.  | ✓ OJT  | <ul style="list-style-type: none"> <li>• Any system to enhance OJT? (including interview with some managers)</li> <li>• Role of supervisors for OJT</li> <li>• How to bringup OJT Trainers?</li> </ul>   |



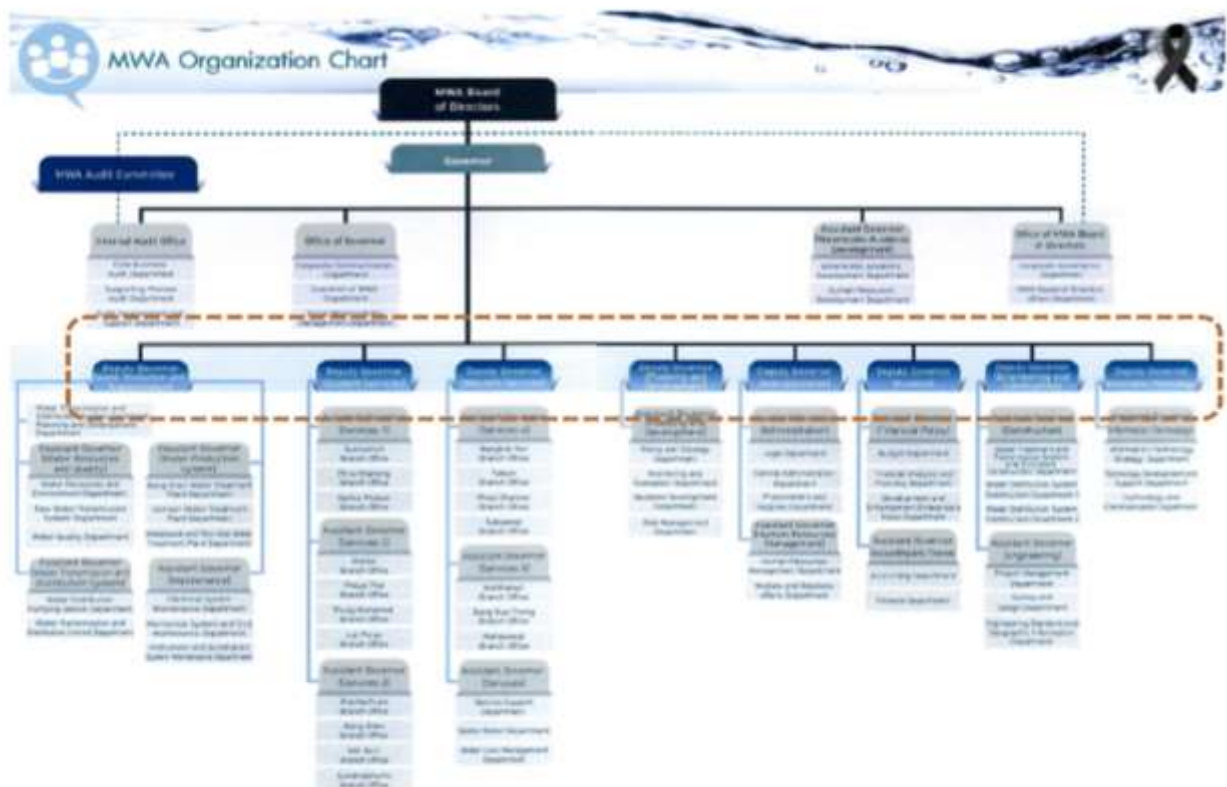
## 4. Study of MWA System

### 4.1 Administration of the Organization

Cabinet Organization structure is according to the following table.



Five ministries: Ministry of Home Affairs, Ministry of the Prime Minister, Ministry of Finance, Ministry of Natural Resources, Ministry of Industry are included and MWA is under the administration of Ministry of Home Affairs.



This is the organization structure of MWA. Governor and MWA Audit Committee are under the administration of Board of Director team consisting of the President and (11) external experts. Internal Audit Office, Governor Office, Assistant Governor (Waterworks Academic Development),

MWA Board of Director Office and (8) Deputy Governors are directly responsible to the Governor. The branch office which is administrated by (18) Assistant Governors and the total number of (56) branch offices are under the administration of Deputy Governors.

The objective is “To be the leading ASEAN water supply provider towards excellence in corporate governance and social responsibilities”

There were the total number of (5339) staffs; (4246) permanent staffs and (1093) contract based staffs in 2015. (2636.34) million Bahts for all staffs and the individual staff has 417 water connections. The following tables are the rate of water tariffs defined by MWA from 1999 to present.

| Type 1 Residence |                            | Type 2 Commerce, Government Agency, State Enterprise, Industry and Others |                                    |
|------------------|----------------------------|---|------------------------------------|
| Volume (cu.m.)   | Water Tariffs (baht/cu.m.) | Volume (cu.m.)  | Water Tariffs (baht/cu.m.)         |
| 0-30             | 8.50                       | 0-10  | 9.50<br>(Not less than 90.00 Baht) |
| 31-40            | 10.03                      | 11-20   | 10.70                              |
| 41-50            | 10.35                      | 21-30   | 10.95                              |
| 51-60            | 10.68                      | 31-40   | 13.21                              |
| 61-70            | 11.00                      | 41-50   | 13.54                              |
| 71-80            | 11.33                      | 51-60   | 13.86                              |
| 81-90            | 12.50                      | 61-80   | 14.19                              |
| 91-100           | 12.82                      | 81-100  | 14.51                              |
| 101-120          | 13.15                      | 101-120   | 14.84                              |
| 121-160          | 13.47                      | 121-160   | 15.16                              |
| 161-200          | 13.80                      | 161-200   | 15.49                              |
| Over 200         | 14.45                      | Over 200  | 15.81                              |

Remarks

- The above water tariffs do not include VAT.
- The average water tariff for bulk sale is as follows:
  - \* Residence: 10.50 baht/cu.m.
  - \* Others: 13.00 baht/cu.m.
- Since 1 June 2004, the MWA has included the raw water charge at the rate of 0.15 baht/cu.m. This amount of money is remitted to Royal Irrigation Department.

## New Connection Tariffs (Flat Rate) and Meter Fee

Unit : Baht

| Meter Size         | 1/2"  | 3/4"  | 1"    | 1 1/2" | 2"     | 3"     | 4"     | 6"        | 8"      | 12"     |
|--------------------|-------|-------|-------|--------|--------|--------|--------|-----------|---------|---------|
| New Connection Fee | 5,000 | 6,000 | 8,000 | 12,500 | 38,500 | 76,000 | 93,500 | 156,500 * | 210,000 | 431,500 |
| Deposit Fee        | 400   | 600   | 1,500 | 3,000  | 4,000  | 10,000 | 15,000 | 20,000    | 30,000  | 100,000 |
| Meter Fee          | 25    | 40    | 50    | 80     | 300    | 400    | 500    | 900       | 1,100   | 3,500   |

### Remarks

1. Additional fee for pipe installation and equipment for the connection 20 meters away from the MWA main pipeline is as follows:\*

| Pipe Size (mm.)       | 20  | 25  | 40  | 50  | 100   | 150   | 200   | 300   |
|-----------------------|-----|-----|-----|-----|-------|-------|-------|-------|
| Cost per meter (baht) | 355 | 386 | 452 | 997 | 1,981 | 2,160 | 2,364 | 3,017 |

2. The above fees do not include VAT

Based on the previous statistics, the future water consumption of MWA is depending on the economic condition and population within MWA's responsible area. According to the World Bank report, Thailand's economic growth of 1.8% in 2% is due to the development of export cargos in 2016.

Bangkok water supply development plan (9) among the key plans of MWA was earmarked to implement from 2016 to 2022 and the expected cost will be (44870) million Bahts and the approval from Cabinet is still in progress. The next plan (10) will be targeted towards the long-term water distribution to the northern portion of the western part of the Chao Phraya river.

In order to promote the service sector, the reduction of NRW up to 20% in the distribution pipes, increasing the water pressure to 10 meters will be able to perform by Customer Information System (CIS) through App MWA in IOS and android systems in 2017.

- The Manual on Governance, Risk Management and Compliance (GRC) was compiled and distributed to all units as an operation guideline for the whole organization.

- The MWA has carried out a project to promote safety, occupational health and working environment (SHE) at Bangkhen Water Treatment Plant, where the operation has run in accordance with ISO14001:2004 and OHSAS 18001:2007. In 2015, the plant undergone an ISO14001 assessment by the Management System Certification Institute (MASCI). The result showed that the ISO14001:2004 system was well maintained and there was no fault found.

- The MWA has raised awareness, communication and understanding of good corporate governance. The MWA Corporate Governance Manual was reviewed and Corporate Governance knowledge was constantly shared through various media to reach all 4 groups of stakeholders, that is, staff members, contract laborers, partners, and customers/ public.

- Mechanism and measures have been established to develop the operation process in accordance with the principle of good governance and anticorruption. KPIs and transparency criteria have been set to be used as department's KPIs.

To the successful operation of MWA, risk management is considered as the main fact. The combination of the imposed policy and action plan, risk management, is against to internal/ external risks. There is an effective control plan that aims the acceptable risk management within the administration and the staff cultures.

According to risk management, stability of water production, water supply and water distribution, services, human resources, finance, information technology and water safety plan were mainly grown in 2015 fiscal year. Internal Control of MWA is the Corporate Internal Control Policy and Principle Assignment from Internal Control Standards of the Regulation of State Audit Commission for the Effective Control Plan. Internal Control has been established with administrative level All Internal Control Committees that monitor to control the entire Internal Control System with appropriate performances. The Internal Audit Office of MWA has been formed to report the full capacity of the risk management and good governance.

The service performances of the branch offices.

| Branch Office      | Service Area    | Customer         | New Connection | Water Production | Water Consumption           |                        |                       | Pipe Length<br>Km. |
|--------------------|-----------------|------------------|----------------|------------------|-----------------------------|------------------------|-----------------------|--------------------|
|                    | Sq.km.          | Connection       | Connection     | Million cum.     | Water Sales<br>Million cum. | Others<br>Million cum. | Total<br>Million cum. |                    |
|                    |                 |                  |                |                  |                             |                        |                       |                    |
| <b>Region 1</b>    | <b>474.41</b>   | <b>431,081</b>   | <b>14,994</b>  | <b>442,986</b>   | <b>386,478</b>              | <b>5,471</b>           | <b>340,949</b>        | <b>6,702,729</b>   |
| Sukhumvit          | 94.46           | 116,982          | 3,469          | 134,440          | 104,411                     | 1,584                  | 106,975               | 1,896,257          |
| Phra Khanong       | 118.58          | 136,042          | 4,003          | 129,160          | 95,413                      | 2,754                  | 96,167                | 2,166,388          |
| Sarnut Prakan      | 261.37          | 178,057          | 6,822          | 179,376          | 137,654                     | 1,153                  | 138,807               | 2,640,084          |
| <b>Region 2</b>    | <b>226.32</b>   | <b>590,343</b>   | <b>6,221</b>   | <b>426,990</b>   | <b>386,147</b>              | <b>4,473</b>           | <b>340,620</b>        | <b>5,442,928</b>   |
| Phaya Thai         | 60.91           | 88,281           | 1,134          | 127,117          | 95,839                      | 1,778                  | 97,416                | 1,389,315          |
| Thung Maharek      | 31.66           | 72,594           | 501            | 82,616           | 63,756                      | 0,747                  | 64,503                | 728,704            |
| Manari             | 35.81           | 70,340           | 691            | 114,081          | 90,938                      | 1,338                  | 92,276                | 827,199            |
| Lat Phrao          | 97.75           | 159,328          | 2,895          | 103,177          | 85,814                      | 0,812                  | 86,426                | 2,497,680          |
| <b>Region 3</b>    | <b>726.73</b>   | <b>460,662</b>   | <b>21,048</b>  | <b>317,491</b>   | <b>265,132</b>              | <b>2,799</b>           | <b>267,931</b>        | <b>6,022,404</b>   |
| Prachachuen        | 77.87           | 110,755          | 2,890          | 79,894           | 64,084                      | 0,545                  | 64,629                | 1,571,012          |
| Bang Khen          | 80.99           | 114,127          | 4,120          | 65,222           | 52,092                      | 0,811                  | 52,903                | 1,689,954          |
| Min Buri           | 277.11          | 141,191          | 7,194          | 71,479           | 62,789                      | 0,220                  | 63,009                | 2,691,524          |
| Suvarnabhumi       | 290.76          | 94,836           | 7,294          | 101,096          | 86,173                      | 1,223                  | 87,396                | 2,069,914          |
| <b>Region 4</b>    | <b>519.60</b>   | <b>567,279</b>   | <b>16,033</b>  | <b>446,186</b>   | <b>291,863</b>              | <b>9,096</b>           | <b>300,949</b>        | <b>7,428,578</b>   |
| Bangkok Noi        | 111.76          | 131,782          | 2,054          | 104,949          | 68,439                      | 2,488                  | 70,821                | 1,821,425          |
| Taksin             | 111.57          | 160,841          | 3,006          | 121,138          | 81,317                      | 2,057                  | 83,374                | 1,828,073          |
| Phasi Charoen      | 127.83          | 159,505          | 4,557          | 115,856          | 74,808                      | 2,688                  | 77,473                | 1,638,090          |
| Suksawat           | 162.43          | 125,151          | 4,815          | 103,242          | 57,298                      | 1,883                  | 59,181                | 2,140,990          |
| <b>Region 5</b>    | <b>413.13</b>   | <b>377,342</b>   | <b>16,569</b>  | <b>202,603</b>   | <b>164,034</b>              | <b>1,861</b>           | <b>166,896</b>        | <b>5,690,123</b>   |
| Northaburi         | 91.96           | 124,837          | 2,909          | 84,685           | 67,311                      | 0,890                  | 68,201                | 1,789,035          |
| Bang Bua Thong     | 179.55          | 118,038          | 6,223          | 52,400           | 39,403                      | 0,340                  | 39,743                | 1,841,587          |
| Mahasawat          | 147.62          | 134,467          | 7,437          | 66,516           | 47,320                      | 0,631                  | 47,951                | 1,959,498          |
| <b>Grand Total</b> | <b>2,564.19</b> | <b>2,226,707</b> | <b>72,865</b>  | <b>1,856,154</b> | <b>1,382,644</b>            | <b>23,700</b>          | <b>1,406,344</b>      | <b>53,186,761</b>  |

In setting up the businesses, MWA Board of Directors definitely follow the rules and regulations of the good Governance Policy according to Clear Corporate Governance Policy, Corporate Governance Principles and Guidelines for State Enterprise 2009 and the Stock Exchange of Thailand (SET) Corporate Governance Principles which were defined in 2006.

#### 1. The Rule of Law

MWA defines the fair activities according to the respective sectors with clean and fair rules and principles.

The authority avoids any action which is suggested with double standard.

Meanwhile, the operations are certainly performed within the rules and time frame in order to avoid

abuse of the authority.

MWA always values and respects the freedom, accuracy while processing the rules to reflect the current situation.

2. Virtue

MWA not only makes the good activities to be typical but also encourages and supports the individual development of the staffs to create the cooperative team avoiding the destructible activities within the team together with righteousness, toleration and rules.

3. Transparency

MWA certainly performs the transparent administration system and processes in all fields including the clean and transparent processes, audits and announcement of the simple, accurate and correct information in time.

4. Participation

MWA offers and performs the consultation and cooperation to achieve the equal opportunities for the staffs in allocation of work between employer and employee, decision-making and administration management which are important in operation. Moreover, MWA cooperates in the provision of information, recommendations, requesting the feedbacks from the staffs about the accounting issues and project planning, implementation.

5. Accountability

MWA makes understand the right way to accomplish the duty, prioritize the important facts of the responsibility, intently pay attention to problem-solving as well as willing to prepare in audit and rating. This may reflect the accountability and responsibility of the operational impact.

6. Efficiency & Effectiveness

MWA complies with skilled and effective management system, optimism to the good results of the organization, ability to compete with the quality of the products and services, responsibilities of the environment and the team. Key performance indicators are prepared and the recognized organization or persons manage the review.

### Leadership and Vision

The skilled and effective policy for MWA can be obtained by considering the following processes.

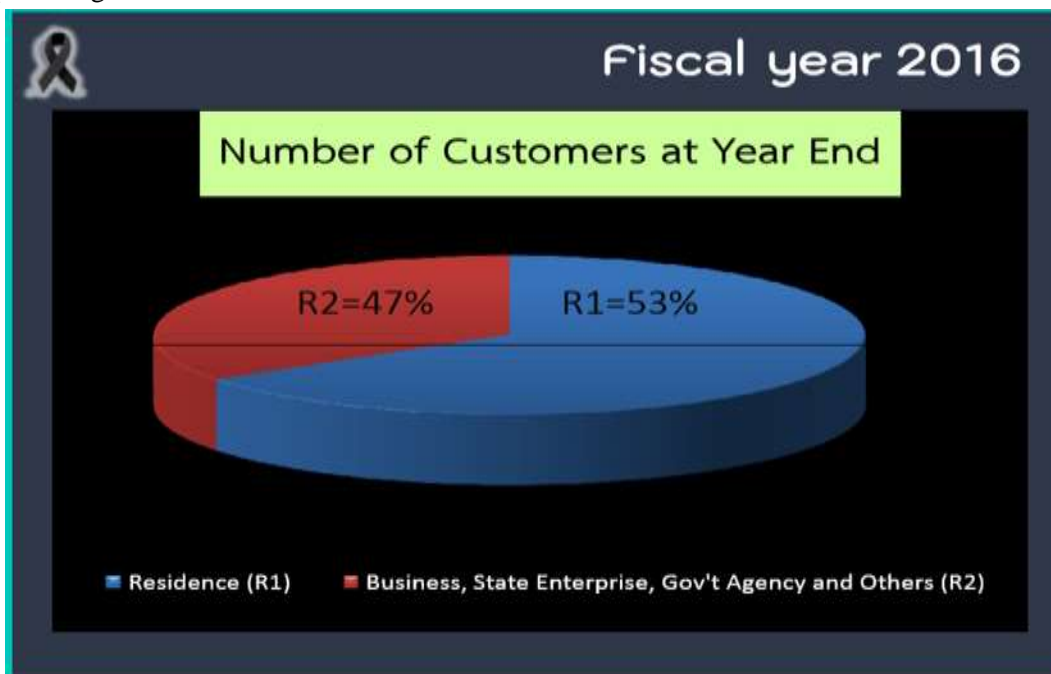
- Bangkok 9<sup>th</sup> Water Supply Project
- Papa Purified Drinking Water Project
- Water Safety Plan
- Thailand Water Supply Service Museum Project
- Law Amendment of the Metropolitan Waterworks Authority
- Construction of the canals and earth dams to prevent the flooding
- Improvement of the image of the public related service works and the organization
- Study and calculation of the water demand for high rise buildings
- Demand side management (DSM)

- Water loss management and water distribution system maintenance
- Access to water resources and improve the management

#### 4.2 Structure of Water Supply Enterprise

There are 65 million people and 22 million households in Thailand. The water supply service is carrying out with 4 water treatment plants, 14 pumping stations and 18 divisions. There are the total number of 2.2 million connections within MWA's responsible area and 11.5 million people can be received water supply.

The customers are divided into two types. The blue colored portion, R1, shows residences and has 53 percentages. The factories, enterprises and government owned enterprises are regarded as R2 and has 47 percentages.



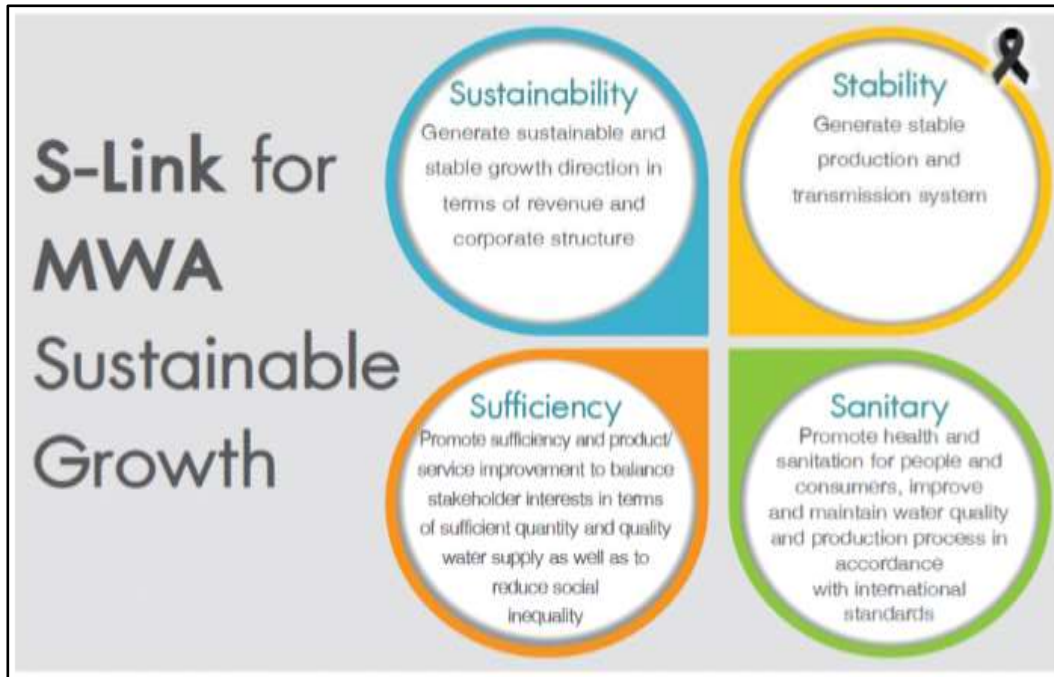
Although R1 has 53 percentages of water consumers, the collected payment is less than R2.





The sources are from Mae Klong and Chao Phraya River which begins at the confluence of the four rivers; the Ping, Wang, Yom and Nan. The Chao Phraya Dam was constructed on the Chao Phraya river. Then water conveying is carried out from Sam Lee Intake to Bang Khem Water Treat Plant by the 30 kilometers long earth canals. However, the water quality of the Chao Phraya river becomes not good, the new water resources are finding out. Bumibol Dam was constructed on the Mae Klong river and the water is conveying from Mae Klong Intake to Maha Sawat Water Treatment Plant by (107) kilometers long earth canals. The water quality of Mae Klong river is still good so that it is continued using. The water supply system of the water treatment plants of MWA are (4) million cubic meters per day from Bang Khem Water Treatment Plant, (1.6) million cubic meters per day from Maha Sawat Water Treatment Plant, (0.55) million cubic meters per day from Sam Sen Water Treatment Plant, (0.17) million cubic meters per day from Thonburi Water Treatment Plant to MWA's responsible districts; Bangkok, Northaburi, Samutprakhan. The total length of the water distribution pipe is 33186 kilometers.





In management sector, there are 4 sections defined for the long-term development which is so called S-Link. They are Sustainability for stable growth, Stability for stable production and transmission system, Sufficiency for sufficient quantity and quality of water supply, Sanitary for maintain water quality and production process in accordance with international standards. S-Link is mainly defined according to the water consumption. Without considering the demand, the long-term development can not be available.

The 30-year Master Plan was prepared for the entire MWA. Now, the respective teams are implementing the master plan in respective sector. As like the respective team builds the pumping station according to the master plan, other teams also act as their master plan. The approval from the government is required in order to approve and implement the master plan. The master plan is prepared with the help of the experts from an international organization.

This is a project which was implemented phase by phase according to the master plan.

The First Bangkok Water Supply  
Improvement Project

The Second Bangkok Water Supply  
Improvement Project



The Urgent Bangkhen Expansion Project Improvement Project



The Third Bangkok Water Supply Project Improvement Project



The Forth Bangkok Water Supply Project Improvement Project



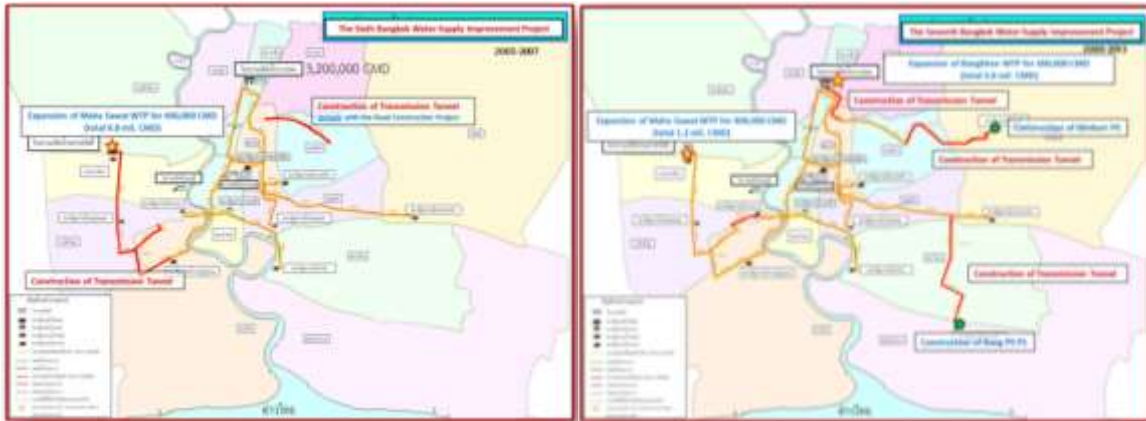
The Fifth Bangkok Water Supply Project Improvement Project



The Sixth Bangkok Water Supply Project Improvement Project

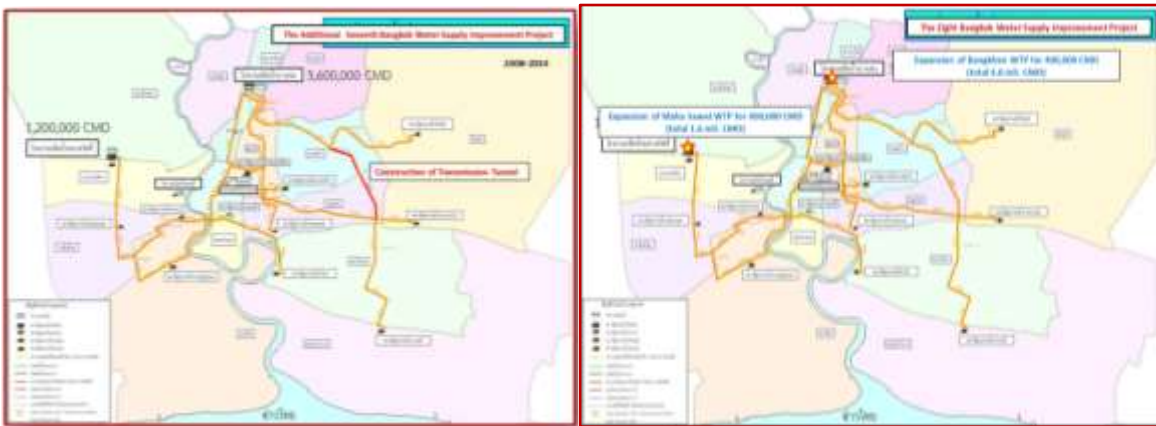


The Seventh Bangkok Water Supply Project Improvement Project



The Additional Seventh Bangkok Water Supply Improvement Project

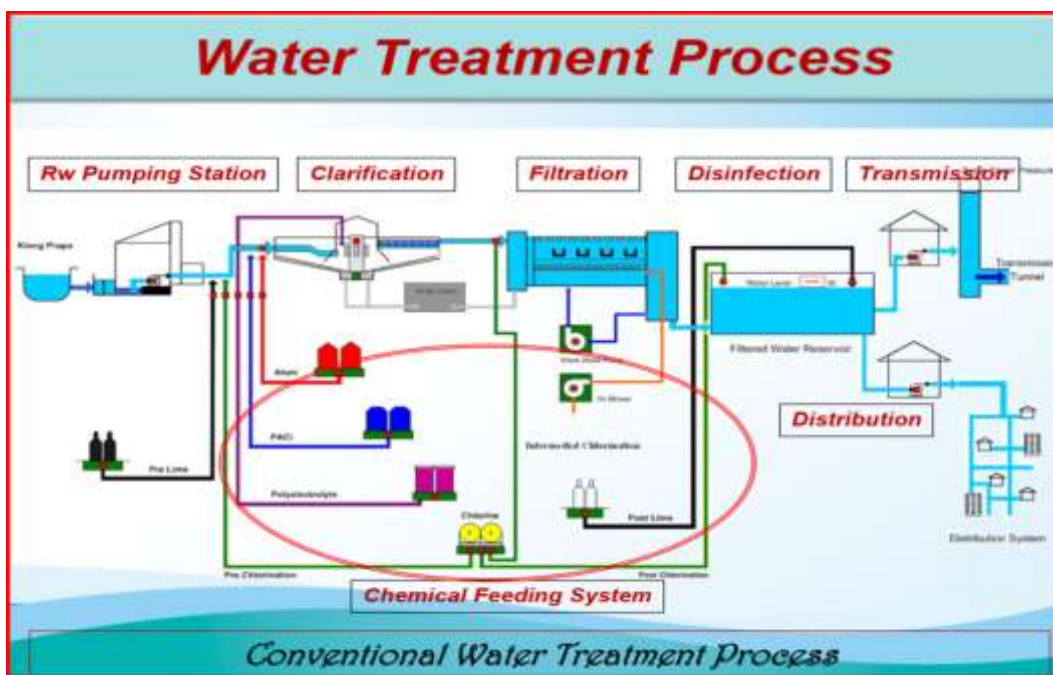
The Eighth Bangkok Water Supply Improvement Project



The Eighth Bangkok Water Supply Improvement Project



Site seeing to Bang Khan Water Treatment Plant among (4) water treatment plants.



MWA's water treatment plants are operating with conventional water treatment process. However, MWA is now finding out the new water resources due to the salt water intrusion, various growth of water plants, water pollution in the Chao Phraya river.

Moreover, in order to promote the water quality of tap water, the policy of enhancing water safety plan which includes defining MWA's 4<sup>th</sup> Strategic Plan (2017-2021) and enhancing the tap water quality, capacity promoting Disinfection Process, reduction of turbidity is defined.

#### 4.3 Planning System

There are (4) departments under Planning and Development Department of MWA. They are

1. Policy and Strategic Planning Department
2. Risk Management Department.
3. Monitoring and Evaluation Department
4. Business Development Department
- 5.



## Policy and Strategic Planning Department

There are (3) divisions under this department.

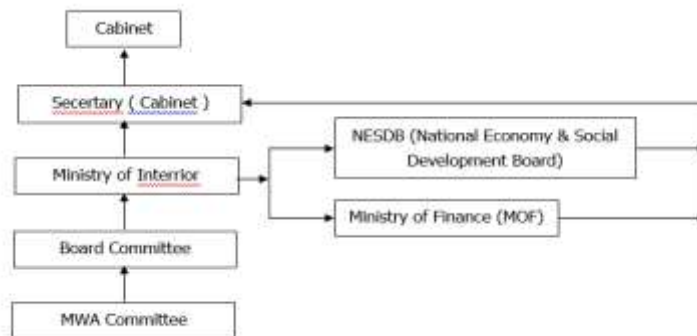
- (a) Investment Planning Division
- (b) Strateging Planning Division
- (c) Information System Management Division

The performances of these divisions were (3) master plans in MWA -

First Master Plan (1970 – 1990) 20 Year

Second Master Plan (1987 – 2017) 30 Year

Third Master Plan (2018 – 2048) 30 Year and the third master plan is revising. Based on that master plan and the sustainable growth (S-Link) (Sustainability, Stability, Sufficiency & Sanitary) of MWA, “The Ninth Water Supply Improvement Project (2016-2022)” was starting to implement from October 2016 and the project cost is 1200 million US\$. This project is to find out the new water resources preventing the water scarcity as the water quality of the Chao Phraya river becomes lower due to the salt water intrusion and the aim of the project is to increase the production rate of Mahasawat Water Treatment Plant to 800,000 Cu-m/day. Moreover, a pumping station and 500 kilometers long pipe (Trunk Main + Distribution) will be extended. The projects up to 100 million bahts prepared by that division can be allowed by Governor of MWA and the projects above 100 million bahts are required to request the permission according to the following.



5 Year Strategic Plan Division is prepared based on the master plan and S-Link. MWA was established in 1967 with Road Map, the 4<sup>th</sup> Issue of MWA Strategic Management Plan (2017-2021) was being able to prepare. The main purpose of that plan is to be High Performance Organization (HPO). The main requirement to be HPO is TQC Award which is Thailand Quality Class.

There are 6 sections in the **procedure of the 4<sup>th</sup> issue of MWA Strategic Management Planning** and

### 1. Stratgey Formulation

In analysis of organization context to get the data, it is divided into primary, secondary, internal and external and interview with the executives from MWA as the internal, holding meetings with the stakeholders as the external in primary and checking the finance, product and resources and collecting the data as the internal and checking the economic, market and law and collecting the data as the external in secondary.

1. Then, in **Analysis of Organization status**, these data are checked with

- SWOT Analysis- (Strength, Weakness, Opporatuities, Threats)
- 7S Framework- (Structure, Systems, Style, Staff, Skills, Strategy, Shared Value)
- EP – Economic Profit
- PESTEL Analysis – (Policies, Economy, Social, Technology, Environment, Legal)
- 5 Forces

3. The mission, vision and values of MWA are performed policy analysis in **Determination of Organization Direction**

4. In **Strategy Development Step**, strategy plan development is decided by TOWS Matrix and EP Driver. If there is a difficulty to meet the target of the strategic plan, the risk management plan has been prepared and it is divided into -

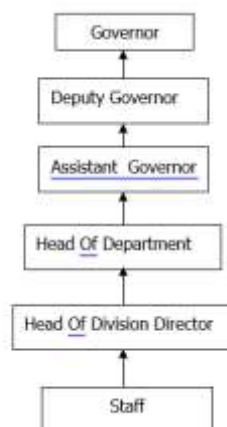
1. Strategic Risk.
2. Operational Risk.
3. Financial Risk.
4. Compliance Risk

5. In carrying out **the Strategy Implementation & Evaluation**, the strategy implementation is divided into corporate strategic objective, KPIs, target, project, responsible unit based on the strategy map.

6. In **Operation Plan Preparation level**, the project, activity, KPIs, target, timeline, methodology, responsible unit, budget are considered in preparing the yearly action plans.

7. In **Strategy Evaluation level**, Performance Monitoring and Evaluation and Action Plan’s Internal Control (Risk Management Division) do the checking according to Plan, Do, Check, Action Cycle.

Moreover, the vision, mission, values are defined to implement the 4<sup>th</sup> Issue of MWA’s Strategic Management Plan (2017-2021) and measuring and implementing with vision KPIs, mission KPIs are also successfully performed. The strategic plan is upgraded in every five years and the data collection for that plan is done by holding the interview according to the respective level, meetings and workshops and it takes about a year. The report system of this department is that all the divisions in Planning Department has to report together in every month. Moreover, they also have to answer the questions from MOI (Ministry of Interria) and the report system is according to the following figure.



### **Information System Management Division**

The websites are separately described as websites for the customers and for MWA staffs. These websites separately describe the data focusing, GIS (General Information System), CIS (Customer Information System), Financial Statistics, etc.

The data focus for the current fiscal year shows the project target, monthly performance, the accomplished work in numeric value, percentage and graphs. Moreover, it also shows a comparison between the previous year's completed work and that of this year.

The general statistics, customer statistics and financial statistics are also described according to the above as in numeric value, percentage, graphs and the data are put for at least (3) years.

### **Risk Management Department**

There are 3 divisions in this Department.

1. Risk Management Business Division.
2. Operational Risk Management Division.
3. Internal Control System Coordinating Division

### **Duty of Risk Management Department**

- To enhance the process for both of risk management and internal control into the overall organization.
- To arrange workshop for risk identification and risk assessment of MWA.
- To increase awareness and knowledge regarding risk management among senior manager and employees.
- To report progress in risk management and internal control activities to senior manager (Risk Management Committee and Board of Directors for approval)
- To coordinate with other sections for maintain internal control and mitigate risk in organization.

### **ERM (Enterprise Risk Management) and COSO (Committee of Sponsoring Organization of the Threadway Committee) Framework**

The following factors are considered as the Key Component of Effective.

- Internal Environment
- Objective Sharing
- Event Identification
- Risk assessment
- Risk Response
- Control Activities
- Information & Communication
- Monitoring



## **Risk Management Process of MWA**

- Objective Setting
- Event Identification (benefit available or not)
- Risk Assessment (the top level of MWA makes decision as it is an important section)
- Risk Response
- Control Activities (Management Prepare Plan)
- Monitoring (Key Risk Monitoring). The information and communication of all these steps are connected and planned to upgrade if necessary.

The following risk are found related to the Risk Management and Strategic Planning

Environment Risk (eg. Climate Change, Change in Technology)

Business Risk (eg. Water Quantity, Water Quality, Water loss)

Gold & Operational Risk (eg. Stability of Raw Water, Production and Distribution)

Resource Risk (eg. Lack of Knowledge and skill to get through the ASEAN, Availability of human resource to support the changing of strategic, Financial Costs do not meet the target, Information do not support the strategic decision.)

Project/ Plan Risk

## **Integrated Risk Management & Internal Control**

In Sub-Process Objective, Process Objective and Division Objective Levels, ORC (O=Objective, R=Risk, C=Control) system is done internal control by the Risk Management Department and Control Self Assessment Department.

In Corporate Objective, Vision and Mission Objective Levels, the control is done as the enterprise risk management.

As KRI (Key Risk Indicator),

- Water Loss
- Pressure
- Turbidity
- Quantity
- Quality
- Water Flow
- Raw Water Flow
- Financial
- Operation Cost and Sale are defined.

## **Business Continuity Management**

In MWA's water supply system, there are two sections as residence and business, state enterprise, government agency and others and the business continuity plan was prepared to avoid the difficulties in water supply for the economic businesses as the main income is from business, state enterprise, government agency and others. In preparing the business continuity plan, the potential threats

to MWA are divided into two portions and they are -

Natural Disaster (eg. flood, drought) and

Man Made Disaster (eg. power outage, contaminated raw water by chemicals, chlorine Leak, pump damage, reservoir damage, transformer explosion, IT disruption, supply chain interruption)

The key concept of the business continuity management is to **Reduce the negative impact and Speeds Recovery** and there are (4) steps in operational level. They are -

1. Protection & Prepare
2. Emergency Response Plan
3. Business Continuity Plan (BCP)
4. Recovery Plan

The emergency response plan is prepared by construction of the flood walls as the protection, clarifier tank to withstand the earthquakes as the preparation to prevent the oil or gasoline accidentally leakage at raw water canal in raw water system, chlorine leakage at WTP, power shortage at substation in water transmission and distribution system, water diversion in distribution networks due to power shortages at pumping station.

The customer information system and enterprise resource planning, SCADA system and call centers are trained and opened as the business continuity plan.

In preparation sector,

**Management Policy** - the pretraining and explanation of the emergency conditions to the staffs

**Water Production and Distribution Management** - the preparation of the business continuity plan, prestorage of the chemicals, improving the raw water quality, analysis of the scenario and cooperation with other agencies.

**Prevention (To Protect Infrastructure)** - monitoring the raw water quality of the dam by the risk board committee, organizing the appointed committees and cooperating with other associations and protecting the raw water system, plant system, transmission and distribution system and improving the raw water quality. Moreover, works to support sheet pile at water gate, accelerate the drainage of water into drainage canals, provide chemicals for treatment to water supply and prepare data information for the decision to flooding are also carried out as the support system.

**Recovery Plan** - rebuilt of broken dike, draining excess water operation, water level monitoring, improve the raw water and process water as the water quality improvement, notify the water supply situation as the public warning, define the safe and unsafe zone.

### **Water Safety Plan**

MWA complies with WHO's 2011 Guidelines for Drinking Water Quality 4<sup>th</sup> Edition.

According to 2004 WHO's guidelines, water safety plan is the most effective means of consistent ensuring the safety of a drinking water supply and aims to be clean in every step from catchment area to the consumer. The following (3) facts are required to prepare the water safety plan.

Identifying hazardous event and assessing their risks from Catchment to Customer.

Prioritising risk and then focusing on the highest risks.

Providing a tool to manage the risks, using barriers to stop contamination of water.

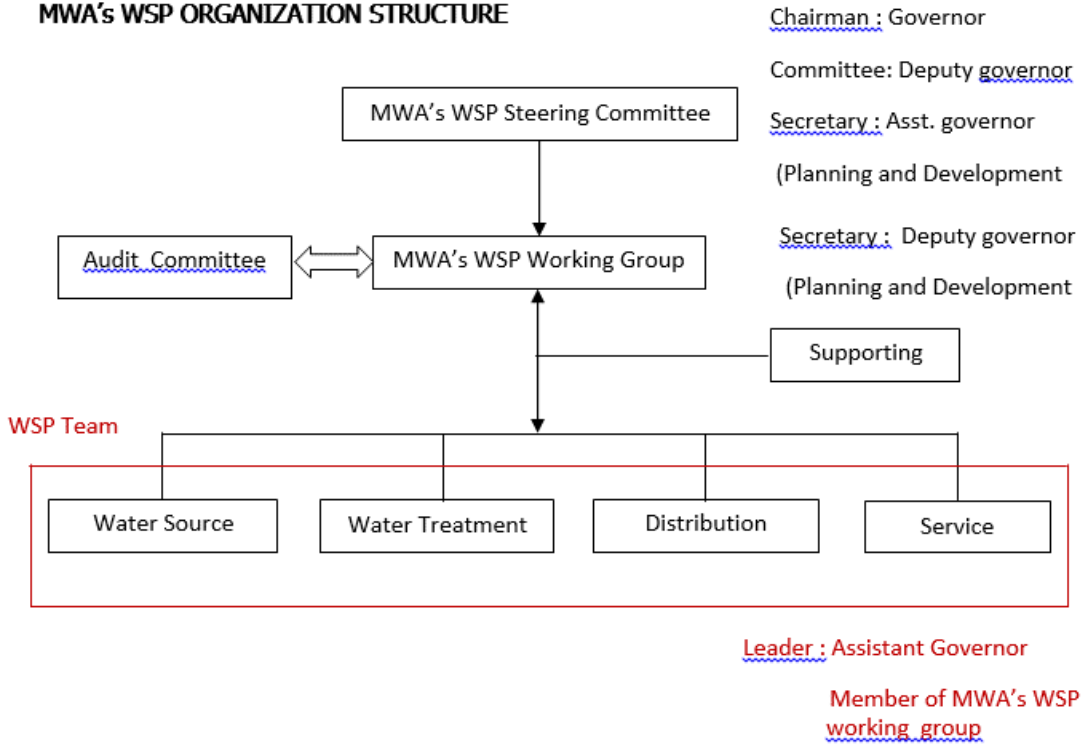
The process of the water safety plan is -

**Prevent** the sources from contamination.

**Remove** or reduce contamination by treatment.

**Prevent** re-contamination in distribution and handling

**MWA's WSP ORGANIZATION STRUCTURE**



**Example of Risk & Improvement/ Upgrade Plan**

| Risk   | Activity (Project)  | Remark     |
|--|---|------------|
| Contamination of flood water into raw water canals                                     | Construction of dike along canals                                       | Completed  |
| High turbidity of raw water in raining season  | Installation of chemical pretreatment system (alum, permanganate, lime) | On going   |
| Sudden change of water quality   | Improvement of real time water quality monitoring system                | Completed  |
| Power failure to disinfection unit   | Construction of dual power source                                       | On going   |
| Low Chlorine residual (residual chlorine <0.2mg/l) in distribution system              | Mid-way chlorination (re-chlorination)                                  | Completed  |
| Slime deposit in distribution system   | Improvement of pipeline cleaning  | Planning   |
| Deterioration of pipeline in distribution system                                       | Improvement of pipeline replacement plan                                | On going   |
| Incorrect use of household water purifier re-growth of gems in household storage tank. | Consumer education program  | In process |

## **Implementation of Water Safety Plan**

Improvement tap water quality.

Increase the efficiency of disinfection process

Tap water turbidity  $0.9 \text{ NTU} > 0.5 \text{ NTU}$

## **Monitoring and Evaluation Department**

There are (3) divisions under this department.

1. Organizational Performance Appraisal Division
2. Performance Monitoring Division
3. Performance Criteria Development Division

### **(4) Major types of KPIs**

1. KPIs for Vision
2. KPIs for Strategic Objective and Action Plans.
3. KPIs for Corporate Level
4. KPIs for Process/In Process

## **MWA's Performance Measurement System**

1. Identifying Key Performance Indicators.
2. Negotiating and Cascading KPIs
3. Communicating KPIs
4. Monitoring and Collecting Performance.
5. Analyzing and Evaluating Performance
6. Reviewing and Improving Performance.

In identifying the key performance indicators, the criteria are defined on the reflecting the corporate goals and impacting the services/ product.

The criteria are defined by SMART.

S = Specific

M= Measureable

A= Attainable

R= Relevent

T= Time Based

2. The Monitoring and Evaluation Department evaluates negotiating and cascading KPIs with performance management system. As the top down approach, the evaluation is steps by steps from corporate level, economic value management (EVM) center level, unit level and finally to individual level. In unit level and individual level performance evaluation, the performance based is defined as 80, competency based as 20 and the competency based is handled by Human Resource Department. In performance based, the evaluation is redivided into team work KPIs (30) and unit/ individual KPIs (70). Monitoring and evaluation of KPIs are,

Corpotate KPIs by Corporate Performance Management (CPM) System

Action Plan KPIs by E- Project System and  
Unit/Individual KPIs by Coach System

**Organizational Performance Appraisal Division**

That division monitors the corporate KPIs and the state enterprise performance appraisal is handled by the Ministry of Finance and State Enterprise Policy Office (SEPO).

**Jobs and Responsibilities**

1. Identifying and negotiating annual organizational KPIs with SEPO.
2. Monthly monitoring, collecting and analyzing corporate performance results and prepare performance report to submit the Management, the MWA Improvement Subcommittee and the Board of Directors on monthly basis and to State Enterprise Policy Office twice a year.
- 3.

**Example of MWA’s Corporate KPIs**

| Category                   | MWA’s Corporate KPIs   |
|----------------------------|--|
| Product & Service          | Quality of Water (Physical, Chemical, Biological)<br>Water Pressure Management |
| Customer Focused           | The Survey Result of Customer Satisfaction                                     |
| Finance and Market         | EBITDA Margin<br>Capital Budget Management Capability                          |
| Workforce-Focused          | The Survey Result of Workforce Satisfaction                                    |
| Work Process Effectiveness | Water Loss Management Efficiency<br>Water Supply Interruption (Plan, Unplan)   |
| Leadership                 | Demand Side Management<br>Integrity and Transparency Assessment (ITA) Score    |

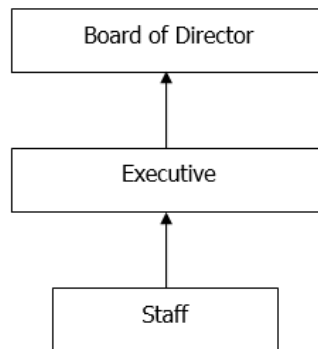
The KPIs results are rated according to the grading criteria (eg. 1, 2, 3, 4, 5) and SEPO makes the negotiation for KPIs and target.

**Corporate Performance Management (CPM KPIs System)**

The organizational overview and the monitoring and evaluation of KPIs results whether they meet the target in bar graph format or excel sheet are required to submit to the Board of Directors as the monthly report and State Enterprise Policy Office (SEPO) as the semi-annual report and annual report. The report system is according to the following figure.



### Monthly Report System



### Performance Monitoring Division

#### Jobs and Responsibilities

1. Monthly monitoring and collecting operational results according to the Annual Action Plan from responsible departments/ working groups.
2. Analyzing and reporting major operational performance to submit to the Management, the MWA Improvement Subcommittee and Board of Directors on a quarterly basis and the State Enterprise Policy Office twice a year.
3. Improving monitoring process and employing IT systems to collect operational results.

#### Performance Monitoring Process

The process is by E – Project System. The procedure is

- Input the data relating to the annual action plan to the computer by Policy and Strategy Department.
- Check the data whether they are correct or not.
- Define one or two responsible persons from the respective departments and fill out the report by computer.
- Inspect and watch that report
- Then report the findings to the executive, Board of Directors and Subcommittee once in three months and to SEPO once in six months.
- Report to the Internal Audit Office, Risk Management Department and Policy and Strategy Department
- Upload to the webpage as the public report of Monitoring and Evaluation Department

The Policy and Strategy Department checks that report and does the revision of action plan once in three months.

After completion of a project, the summary lists of KPIs are obtained and they are used in next action plans. In 2016, there were (38) projects and (112) KPI.

### Performance Criteria Development Division

## **Jobs and Responsibility**

1. Setting KPIs and performance criteria for executives and supervisors.
2. Negotiating and cascading KPIs to executives and supervisors.
3. Monitoring and collecting performance of executives and supervisors.
4. Evaluating performance of staff.
5. Summarizing and reporting to executives and supervisors.

Performance Criteria Development Division relates to the organization KPIs, unit KPIs and process KPIs and performs the monitoring and evaluation of the individual KPIs. The unit/ individual KPIs are defined based on the job description and special tasks and a staff gets the maximum KPIs of (4) to (7) KPIs. As KPIs score, the team work KPIs are defined as (30%) and the individual KPIs as (70%). The COACH system is used for unit/ individual performance monitoring and evaluation.

## **4.4 Human Resource Development**

### **(4.4.1) Organization and responsibilities of HRD section**

The responsibility of HRD is to empower the vision and mission of MWA. The organization structure of MWA is that Assitant Governor is under the administration of the Governor and directly responsible to HRD department director as three different divisions; (1) Administration and Promotion Training Division, (2) Professional Skills Training Division and (3) Special Affairs Training Division. Management Courses and Training for promotion Courses are under (1) Administration and Promotion Training Division. Technical and Engineering Courses, IT Courses and Safety, Health and Environment Courses are under (2) Professional Skills Training Division. Public Training Courses, Leadership Courses, Special Projects (Successors, HiPPS) and Scholarship are under (3) Special Affairs Training Division. The overall number of staffs in HRD Department is (40) and there are (7) to (10) staffs in each division. The (5) MWAIT's road map is defined from MWA HRD Section.

- (1) Training - Develop professional staffs in waterworks.
- (2) Schooling - Develop the standard and waterworks training courses.
- (3) KM - Organizational development and the center (Knowledge Management) of Waterworks training.
- (4) RDI - Create and support waterworks research development & innovation.
- (5) Supporting - Support all MWAIT's works for sustainable development)

Firstly, the duty and responsibility are required to identify for new section. The position needs to be defined. HRM Department links with Manpower Planning division, then reports to the Governor through HRM division and can establish the section by listening the suggestion either with the staffs of MWA or external. The reorganization can perform according to the suggestion of the Governor and BOD (external experts) by submitting the reports the individual designs from each department through HRM Department. In the last 2 years, the academic water supply development reported and subdivided as HRD Department from HRM.





Photo with HRD Department staffs from Thailand MWA □

#### **(4.4.2) HRD Plan**

The HRD Plan is preparation of the training plan, development plan and improvement plan. The input is divided into (3) steps in preparing the training plan.

The organization level has to prepare MWA Mission/ Vision/ Values, defining the strategy, MWA IT roadmap and organization policy. The core competency (CC)/ leadership competency (LC), HR strategy map, training road map are also defined. They are defined in Department/ individual level. The rating of the functional competency (FC) skills, surveying the capacity gap, specifying the required training for each staff are performed. The technical changes/ improvements (key changes) are also included. The new technical changes to the staffs are provided. For example, training the staffs to be able to operate when the water distribution related macheneries are arrived. Training the staffs to be familiar with the new IT systems bought from external.

There are (4) levels in training model. (1) Training need Analysis (2) Training Plan (3) Training Management (4) Training Evaluation. In (1) Training need Analysis, the policy is firstly report to the Governor and Deputy Governor and perform according to the policy which is defined by the Governor. The respective Department Directors and HRD Department hold the meeting and discuss about the future trainings to each department in this year and the staffs have to fill the forms through the Department Directors. Training names and training times are included in these forms. These forms are filled and sent to HRD Department. HRD Department reviews the organization needs, department needs, individual needs from these forms and prepares the draft training plan. The draft training plan has to be submitted to the Governor. After the Governor has approved the draft training plan, HRD Department has to share the training schedule for the entire year and the list of the staffs through the internal website. HRD Department also sends mails to the respective staffs. The training plan is prepared by the training annual plan, training monthly plan, individual development plan. The Special Project is providing the (Successors, HiPPS) trainings cooperating with HRM with IDP to the staffs who are substituted in Level 8 to 10 positions to be able to handle. MWA staffs have to provide 15%, 10%, 5% of the salary to MWA Fund as the social welfare. It is refundable after pension. The accommondation is provided to the project engineers. The staffs who are working at WTP also receive the accommondation due to night time assignments. If a staff has to hospitalize, he can entitle free of charge. His family including the parents and children are also allowed for treatment. According to the development plan prepared by HRD, the outstanding staffs are selected and provided the HiPPS (High Performance Protinal Staff) training. As it

is the successors' training, the level is high and the external experts hired by BOD (Board of Director) provide the suggestion. There is no rules and regulation relating to HRD. The rules and regulation are according to that of MWA. The website relating to HRD can be visited. ([www.mwa.co.th](http://www.mwa.co.th))



A visit to the Promotion Section of MWA Training Center in Thailand

#### **(4.4.3) Training management**

Vision and mission are firstly required to prepare to establish a training center. The plan should include the main objective, utility, continuity. The duties and responsibilities are defined and the persons relating to the training are selected. There are many Thai experts in the trainers and the training budget is planned by HRD Department. Every year 70 to 80 million bahts are earmarked and that data are sent to the Finance Department and the Finance Department defines the budget depending on the income/ outcome and the profits. In budget reducing year, the training courses are reduced to recover the training costs and the number of the training held are reduced from 200 times to necessary conditions. The staffs from HRD Department also attended the in-house training and the staffs are selected to attend the international trainings. There are (10) to (20) in-house trainers in HRD Section and they are part-time trainers. Most of the trainers in MWA are engineer trainers and the internal trainers are for organization and risk management majors. The staffs of MWA are selected based on the knowledge, proficiency to train with trainer expert. HRD Department finds the trainer expert. The training period is (2) or (3) days. On the first day, the expert teaches the required knowledge dealing with the training and the teaching plan and presentation skill in the second day. In training management process, the project proposal is prepared and submit to the director of HRD. Every section and department have to submit the project proposal and HRD officer defines the trainers and contents when the director approves the proposals. The curriculum design is that HRD officer explains the trainers about the learning objectives. It is like kick of meeting from EDWS. After receiving the powerpoints from the trainers, they are scanned and send as PDF file with QR Code to the participants to save the papers in printing. In future, MWA will

open E-Library and the required knowledge for the training can be prestudied. During the training period, the training participants list is signed everyday and the training will be half day in MWA and (3) days for the future trainers. During the training, HRD officer will sit at the later seats and do the monitoring. HRD officer reviews whether the teaching skills are good or not, the trainees are able to understand or not, interesting or not and fills the requirements in next trainings. Before starting the training, the trainers and trainees are introduced. After the training has finished, the feedback from the trainees are collected and HRD officer checks and prepares the training report to the department director. The half day course is from 9 o'clock to 12 o'clock. The free time is at 10:30 o'clock. There are two breaktimes and the lunch is treated at the full day course. The first breaktime is at 10:30 o'clock and the second is at 13:30 o'clock. A report has to be prepared if there will be external classes to attend outside the organization. MWA awards the certificates to every trainee who completes the courses and there is no specific defined level for the certificate. For promotion, it is defined as 80% for the training and level 3 to 5 (operating level) requires 2 years working experiences, the group project and daily report are required to submit and the knowledge sharing has to be done on KM block (Knowledge Management Block). The promotion decides on every factor. In level 6 to 7, the individual presentation has to do. There are (12) to (15) training room in MWA training center and (50) people can use each room. The rooms in the second floor can be used (80) people and that in the head quarter can be used (500) people. The number of meeting rooms is (5) to (6). HRD officer uses SAP System (application bought from external) in HRD department for the signed list and training list and the training matters are recorded in training profile. In the training profile, the training starting date, period, number of trainees, the training schedule can be watched on SAP System. The data of which staff has already attended which class can also be known. The training evaluation record is inserted in SAP System. This system is useful for Finance, HRM and HRD Sections. Admin is at every SAP System used divisions and responsible for the training evaluation model. The entire SAP System is controlled by IT Department and the requirements are responsible from the sold company. There is EHR System (Electronic Human Resources System) which supports HRM and HRD. The leave matters and salary matters can be viewed in this system. There are 6 types of leaves and the permanent staffs of MWA are entitled for (15) days sick leave. The vacation leave lasts for (10) days and can be collected up to two years that is (20) days. The vacation leave is (15) days for staffs whose working experience is above (10) years. The maternity leave lasts for (3) months. The outsource staffs are allowable for leaves depending on their company's policy. The outsource staffs have more chances than external candidates in sitting for in-house staff examination as they have more working experience. Although the external candidates have knowledge, they do not have enough experience. The external candidates apply for job just by viewing MWA's website. There are two ways to apply the job. The recruiting is according to MWA's policy. The salary rates are defined for the trainers. The salary range is different for internal trainers and outside trainers. If there will be meetings, seminars and workshops, the revenue has to be arranged. HRD Department has to estimate and insert these costs in budget. In HR integration of MWA, HRD section plans for the leadership program career development, talent development, successors development and individual development plans. MWA prepares the annual training plan with IDP (Individual Development Plan) and career development/ training road

map, talent development and succession plan and development will be considered in future planning. In MWA annual training program, for in-house staffs

- (1) Core Courses (Training for Promotion)
- (2) Managerial and Leadership Courses (for executive)
- (3) Professional Skill Courses (functional course) (for technician)
- (4) Water works special courses to learning university are considered in planning and for public
- (1) Training Program for Executive
- (2) Training Program for Staff to other outside university are considered.

The scholarships, e-learning, e-library, coaching, on-job training, job assignment, job rotation, self learning and site visit are planned as non-training.



Construction of new training center at MWA in Thailand

**(4.4.4) Personal Evaluation System**

Individual Development Plan (IDP)

The individual improvement is reviewed by the supervisor according to HRM plan. KPI for HRD is based on the Governor policy and the policy of IRDP (Institute of Research and Development for Public Enterprise) hired from outsource is used for KPI preparation based on the rotation job of a staff. There is also the combined planning of HRM and HRD for KPI preparation. The service section performs KPI calculation based on the number of connections and staffs.

HRD calculates the KPI based on the ratio of the number of staffs and staffs who have attended the training. IDP is hired from external and the coach system is prepared. There are the training class room and non-class room. The class room training lasts for (3) days. It costs much. In non-class room training, it is familiar with the trainers and the OJT trainings are held more and have more learning time. The OJT is started from Japan, so OJTs should be studied more cooperating with Japan. The coaching system is teaching the young learners from the seniors and it aims the youngers to be able to do when a leader

retires or relocates. A problem in last year of MWA is that there was a difficult to substitute to a retired staff's vacancy and it impacted the organization. Risk Management Section of MWA watches and decides how the risks in organization will be, how to solve the problem in future. IDP plan strategy is carried out two times a year. The promotion and salary increment are depending on the performance. If a staff becomes talent HiPPS (High Performance Professional Staff) and have (2) years working experience in level 3 to 5, he/ she can join the scholarship from special project section and if a staff achieves above 80% in training and have (2) years working experience, he/ she can sit for promotion examination. Tools from Training Evaluation for Kirkpatrick Model USA and there are (4) steps in training evaluation. They are

- (1) Reaction (attendant)
- (2) Learning (how much the participants can learn)
- (3) Behavior (how much effective for the working environment)
- (4) Result (compare the results)

For example, it is like teaching the computer basic skills in computer training and evaluates how the trainee can apply. The evaluation is divided into (4) types.

- (1) In level (1), HRD officer checks the reaction, satisfaction, impression
- (2) In level (2), HRD officer and trainer check the condition of knowledge, improvement before and after the training
- (3) In level (3), the behaviours are evaluated from (360) degree all aspects. After the working hour of that staff, the supervisor is asked for evaluation. HRD officer can evaluate level (1,2,3) via online. Surveying the satisfaction at level (1) and linking the QR Code with google docs and the trainees can change or delete. HRD officer asks the trainees and trainers the feedback relating to the training course and makes HRD Department send back via online.
- (4) In level (4), review the advantages and disadvantages that how the training defines the target, achieves or not, gets the benefits or not, is effective or not. The advantage of level (1) is receiving the feedback fastly dealing with the trainer's teaching skills. The disadvantage is that the trainees do not care about the evaluation. The advantage of level (2) is that there is a test before the training and a test after the training. So, it can be determined the teaching system that the trainees can be able to understand. The disadvantage is that there may be unbalancing cases. The advantage of level (3) is that the design can be modified which can develops the learning process in behavior. The disadvantages are that although the results are defined they are emotional in Southeast Asia. The people in UK and USA do not care the personal feelings. The advantage of level (4) is that the seniors receive the information from HRD plan and familiar with HRD as the achievement. HRD section is working well the HRD development. The budget is shared. The decision can be done by holding meeting before dividing the budget. The disadvantages cannot be shown with numeric values like other sections. It cannot be shown in figure.

Level 1 – Assess Every Training Course

Level 2 – Assess Promotions

Level 3 – Assess Leadership Course

Level 4 – Assess High Expect budget used course, external learning training, abroad training

#### **4.4.5 What Resource of HRD?**

There are (40) staffs in HRD department. There are about (7) persons in 1 section. Recruiting for HRD is based on HRD background, any behavior, office experience and skills according to the positions. There is no problem in MWA department and sections as the duties and responsibility are separated. The strategy target is tried to be filled to capacity. The head officer of HRD department holds meeting and shares the feedbacks dealing with the strategy in policy of Governor. Internal website is used to share if the entire MWA should know the information. If the public should know, the information will be shared through IT department. IRDP (Institute of Research and Development for Public Enterprise) reviews for bonus referencing the annual report. They provide incentive based on performances. IRDP reviews by (7) types of PMQA (Public Sector Management Quality Award Cartier). This method is derived from USA and used in evaluation for incentive and bonus.

- (1) Leadership
- (2) Planning and Strategy
- (3) Stakeholder and Customer
- (4) Human Resources
- (5) Knowledge Management System
- (6) Internal Process
- (7) Overall Performance

Knowledge Management Division (KMD) prepares the road map. KM division is under water work academic development. The road map of KM and MWA strategy is relating.



HRD Department at MWA Training Center in Thailand

#### **(4.4.6) How to Implement OJT**

When a new staff joins or a staff from other department moves, the senior explains and share the duties and responsibilities. There are training and non-training in Course system of IDP in MWA. Non-training is same as OJT and it saves time and budget. It is more used as it is effective. There is no specific policy



in OJT. The regular duties and tasks of HRD are performed and the new staff to HRD is shared and learnt the knowledge and duties.



#### **4.5 Corporate Accounting**

The fiscal year of MWA is from 1<sup>st</sup> October to 30<sup>th</sup> September. There are four sections in budget calendar of MWA. They are (1) Preparation (2) Collection and Analysis (3) Approval (4) Notification. The preparation has to be done before every March. Then the plans of each section have been continued collection and analysis and the approval from the Ministry has to be obtained. After receiving the approval, the budget is shared, the budgets for expenditures are provided, the performances are watched and reviewed whether they are effective or not and reported to the management officers. The data are linked in network and the responsible staffs can easily check the data as one iPad is provided to every management unit.

Financial Report (Financial Statement)

- (1) Monthly report
  - (2) Quarterly report
  - (3) Annual report
- are prepared according to Thai Financial Reporting Statement (TFRS).

Accounting System

In 1997, the manual accounting system was changed to Customer Information System (CIS) which is based on accounting receivable and revenue. In 2002, the accounting policy was defined to perform the reporting, evaluation, comparison with the previous statistics whether it is effective or not by networking combined with IT techniques based on procurement general ledger, HR, inventory management, project system. Setting Accounting Policy (SAP) was defined.

MWA Finance Organization

In finance organization structure of MWA, there are one Deputy Governor (Finance) and (2) Assistant Deputy Governors and the duty is separated into ADG (Accounting and Finance) and ADG (Financial Policy). Accounting Department and Finance Department are under the administration of ADG (AF) and Budget department, Financial analysis and Management and Development and Engagement Enterprise's Value Department are under the administration of ADG (FP). The total number of



departments is (5) and the administrative section is included in each department. There are about (170) staffs in Finance Organization of MWA and the organization structure of divisions and sections is as follows.

## **MWA Finance Organization**

- I. Deputy Governor (Finance)**
  - Secretary Section
  - ❖ **Assistant Governor (Financial Policy)**
    - Secretary Section
  - 1. Budget Department**
    - Administrative Section
    - 1.1 Operating Budget Management Division
      - (a) Operating Budget Management Section
      - (b) Operating Budget Control Section
    - 1.2 Capital Budget Management Division
      - (a) Capital Budget Management Section
      - (b) Capital Budget Control Section
    - 1.3 Planning and Budget Data Division
  - 2. Financial Analysis and Planning Department**
    - Administrative Section
    - 2.1 Financial Planning and Management Division
      - a) Financial Planning Section
      - b) Financial Management Section
    - 2.2 Financial Analysis Division
      - a) Financial Data Analysis Section
      - b) Financial Operation and Evaluation Section
  - 3. Development and Enhancement Enterprise's Value Department**
    - Administrative Section
    - 3.1 Enterprise Value Management Division
    - 3.2 Asset Management Division
- ❖ **Assistant Governor (Accounting and Finance)**
  - Secretary Section
  - 1. Accounting Department**
    - Administrative Section
    - 1.1 General Accounting Division
      - a) General Ledger Section
      - b) Financial Statement Report and Analysis Section
    - 1.2 Cost Accounting Division
      - a) Cost Accounting Information Section

- b) Cost Accounting Report Section

### 1.3 Tax Division

### 1.4 Asset Accounting Division

- a) Constructional Asset Accounting Section
- b) Pipe Networks Accounting Section
- c) Equipment and Water Meter Accounting Section

## 2. **Finance Department**

### Administrative Section

### 2.1 Finance Division

- a) Financial Operation Section
- b) Financial Receipt Section
- c) Financial Disbursement Section

## II. **Deputy Governor (Service)**

### Contract-Out and Project Payment Audit Division

- a) Contract-Out and Project Payment Audit Section

## III. **Deputy Governor (Other)**

- a) Contract of Payment Section
- b) Project Payment Audit Section
- c) Contract out and Project Payment Registration Section

### Purchase and Other Account Payable Payment Audit Division

- a) Purchase Payment Audit Section
- b) Other Account Payable Payment Audit Section
- c) Purchase and Other Account Payable Payment Registration Section
- d) Petty Cash and Advance Payment Audit Section

## **Accounting Department**

Accounting Policies are defined and the works are carried out according to the policy. The financial reports are prepared according to Thai Financial Report Stand (TFRS). The data of input and output taxes are collected and the accountings are checked. The tax matters are advised for internalk organizations of MWA. The asset accounts are reviewed and the management reports are prepared. The work processes are monitored whether they effectively improve or not.

### Financial Department

The income and outcome budgets are managed and monitored by preparing the plans. The lists of each account are kept as account payable, income and outcome. The value-added tax and withholding tax are checked by comparing with that of previous year. Management system is prepared to apply MWA's budget effectively.

### Budget Department

The budget plans are prepared according to organization strategy and investment. The annual income/ outcome lists are prepared. The budget is also monitored. The relevant parties and internal

organizations cooperate and carry out.

#### Financial Analysis and Management Department

The short-term plan and long-term plan are prepared by adjusting MWA's target and financial strategy. The possible financial risk from operations are reviewed. The investments are managed for the projects. The financial reports are prepared for business intelligent (BI). The financial outcomes are reviewed according to State Enterprise Performance Appraisal (SEPA) standards.

#### Development and Enhancement Enterprise's Value Department

The reports for economical profits are prepared. (EPR) Economic Value Management (EVM) is reviewed and monitoring reports are prepared. EP is monitored for the management teams. The management and internal management are carried out considering the future difficulties. The internal organizations of MWA cooperates with other teams and defines the cooperative standards.

#### Business Development Department

There are (22) staffs in the department and the three divisions are as follows.

- (1) Business Investment Analysis and Marketing Division
- (2) Business Process Development Division
- (3) Manufacture and Management of Water Division

The business of MWA is aimed to develop to ASEAN and BDD has to carry out according to the defined future plan for business development.

Bangkok is located in the gulf and consumes high amount of ground water. Therefore, the management plans that stirring up to change the water utilization from MWA, blocking the business in Bangkok and allowing the business to do in other regions of Thailand are performed due to the occurrence of dangerous problems which are the influx of salty, annual 5mm lowered ground surface of Bangkok. In 1999, the water tariff rate was increased as the required budget amount was high to fill the future water demand and extension of pipe lines. BDD increased the water tariff rate of MWA about 5 times from 1958 to 1999 and the current rate is the changed rate in 1999.

In MWA, the charges for water supply installation is calculated based on the sizes in meters, service fees, guarantee deposit and value added tax 7%. The value added tax 7% is included in water tariff collecting from the customers and the raw water charges is collected as 0.15 Baht per unit and paid to Royal Irrigation Department.

MWA produces and distributes 350 cc, 600 cc, 1500 cc drinking water bottles with the logo of Pa Pa and 600 cc drinking water bottles are distributed to other brands. MWA performs to promote the income by tank cleaning work also. For MWA water supply installation, the charges are applied from the customer one time according to the meter size and that meter is registered as MWA's permanent property and depreciation cost is calculated. If that meter damages, MWA will install another meter and the damaged one will be repaired and reused by MWA Maintain Department.

MWA's cost of the water connection, water tariff, meter maintenance fees, tank cleaning service fees are described as tables in reports.

#### Tank Cleaning Service Rate

| Capacity of tank (cu.m.) | Service rate(Baht) |
|--------------------------|--------------------|
| 3                        | 1500               |
| 10                       | 3200               |
| 20                       | 4800               |
| 30                       | 6100               |
| 40                       | 7300               |
| 50                       | 8300               |
| 70                       | 10200              |
| 90                       | 11800              |
| 110                      | 13300              |
| 140                      | 15400              |
| 170                      | 17300              |
| 200                      | 19100              |
| 250                      | 21800              |
| 300                      | 24400              |
| 500                      | 33100              |
| 600                      | 36900              |

**WATER TARIFFS**  
**EFFECTIVE DECEMBER 1999**

| <b>Type 1<br/>Residence</b> |                                  | <b>Type 2<br/>Commerce, Government Agency,<br/>State Enterprise and Industry</b> |                                  |
|-----------------------------|----------------------------------|--|----------------------------------|
| <b>Volume (cu.m.)</b>       | <b>Baht/ cu.m.</b>               | <b>Volume (cu.m.)</b>  | <b>Baht/ cu.m.</b>               |
| 1-30                        | 8.50<br>Not less than 45.00 Baht | 0-10   | 9.50<br>Not less than 90.00 Baht |
| 31-40                       | 10.03                            | 11-20  | 10.70                            |
| 41-50                       | 10.35                            | 21-30  | 10.95                            |
| 51-60                       | 10.68                            | 31-40  | 13.21                            |
| 61-70                       | 11.00                            | 41-50  | 13.54                            |
| 71-80                       | 11.33                            | 51-60  | 13.86                            |
| 81-90                       | 12.50                            | 61-80  | 14.19                            |
| 91-100                      | 12.82                            | 81-100   | 14.51                            |
| 101-120                     | 13.15                            | 101-120  | 14.84                            |
| 121-160                     | 13.47                            | 121-160  | 15.16                            |
| 161-200                     | 13.80                            | 161-200  | 15.49                            |
| Over 200                    | 14.45                            | Over 200   | 15.81                            |

MWA has been charged the untreated water at the rate of 0.15 baht or 15 satang/cubic meters to the Royal Irrigation Department.

**Note:**

1. Value added tax is not included.
2. Bulk sale:  
Type 1 = 10.50 Baht/cubic meter;  
Type 2 = 13.00 Baht/cubic meter

**The cost of the new water connection**

| Meter Size | Type R2        |            | Service Fee | Cost Collect | Guarantee Deposit |              |              |
|------------|----------------|------------|-------------|--------------|-------------------|--------------|--------------|
|            | Volume (cu.m.) | Baht(cu.m) |             |              | Perman            | Contemporary | Contemporary |

| (inch) |                 |           |      | 7% vat<br>not<br>Included | ent   | R1   | R2    |
|--------|-----------------|-----------|------|---------------------------|-------|------|-------|
| 0-1/2" | 0-10            | 90        | 25   | 5000                      | 400   | 2000 | 5000  |
| 1-3/4" | 0-10            | 90        | 40   | 6000                      | 600   | 3000 | 7000  |
| 2-1"   | Less than 50    | 579       | 50   | 8000                      | 1500  | 5000 | 12500 |
| 4-1/2" | Less than 120   | 1588.40   | 80   | 12000                     | 3000  | -    | 30000 |
| 5-2"   | Less than 200   | 2814.40   | 300  | 36000                     | 4000  | -    | 50000 |
| 7-3"   | Less than 450   | 6766.90   | 400  | 71000                     | 10000 | -    | 50000 |
| 8-4"   | Less than 800   | 12300.40  | 500  | 92000                     | 15000 | -    | 50000 |
| A-6"   | Less than 1800  | 28110.40  | 900  | 150000                    | 20000 | -    | 50000 |
| B-8"   | Less than 3200  | 50244.40  | 1100 | 210000                    | 30000 | -    | 50000 |
| D-12"  | Less than 54000 | 85026.40  | 3500 | 430000                    | -     | -    | -     |
| H-16"  | Less than 12800 | 202020.40 | 5000 | 680000                    | -     | -    | -     |

#### Meter Maintenance Rate

| Diameter | Baht |
|----------|------|
| 1/2      | 25   |
| 3/4      | 40   |
| 1        | 50   |
| 1 1/2    | 80   |
| 2        | 300  |
| 3        | 400  |
| 4        | 500  |
| 6        | 900  |
| 8        | 1100 |
| 12       | 3500 |
| 16       | 5000 |

#### 4.6 Standard, Guideline, Manual and SOP

MWA is a state enterprise which is under the administration of Ministry of Home Affairs. MWA directly complies with Metropolitan Waterworks Authority ACT, 1967 and Raw Water Canals Maintaing ACT, 1983. To study the currently using standards, guidelines, manuals and SOPs of MWA system, we visited Engineering Standard Department of MWA on (30-11-2016) in the morning.

MWA uses 1500 – 3400 mm Ø pipes and tunnels as transmission main, 600 mm, 800 mm, 1000 mm, 1200 mm, 1500 mm and 1800 mm Ø pipes as trunk main, 100 mm, 150 mm, 200 mm, 300 mm pipes as distribution pipes and 50 mm (2") Ø pipes as service pipes.

The types are divided into steel pipes for 600 – 1800 mm Ø pipes, PVC (Poly Vinyl Carbonate) pipes, GI (Galvanised Iron) pipes, steel pipes for 100 – 400 mm Ø underground pipelines, AC (Asbatose Cement) pipes, PE (Poly Ethylene) pipes for above ground pipelines, steel pipes to cross the tunnels, PE pipes to cross under the tunnels, GI pipes to use in public areas, PB (Poly Buthylene) pipes for 2" Ø and below service pipes. The pipe connectors are used as PVC, CI (Cast Iron), DI (Ductile Iron) connectors for 100 – 400 mm Ø PVC pipes, CI, DI for 100 – 400 mm Ø AC pipes.

The standards for pipes and pipe connectors of MWA are according to the following table.

| <b>Types of pipes and fittings</b>                    | <b>Specifications and standard of pipes and fittings</b>   |
|---|--|
| Aboveground steel pipe<br>Size Ø150mm– 1800mm         | As specified in AWWA C200 or BS 534 or JIS G3457 standard<br>Plain end pipe (beveled). Connect by end to end welding as specified in MWA standard                  |
| Underground steel pipe<br>Size Ø 800mm – 1500mm       | As specified in AWWA C200 or BS 534 or JIS G3457 standard<br>Bell-end pipe (Spherical spigot and socket ends) Surface sleeve welding as specified in MWA standard. |
| Underground steel pipe<br>Size Ø 150mm – 600mm        | As specified in AWWA C200 or BS 534 or JIS G3457 standard<br>Plain-end pipe. Connect by using mechanical coupling and conform to MWA standard                      |
| Steel Pipe for Pipe Driving                           | As specified in AWWA C200 or BS 534 or JIS G3457 standard<br>Steel concentric double cylinder pipe. Connect by end to end welding as specified in MWA standard.    |
| Underground steel fittings                            | As specified in AWWA C200 or BS 534 or JIS G3457 standard<br>Plain- end pipe. Connect by mechanical coupling and restrained joint as specified in MWA standard     |
| Aboveground steel fittings                            | As specified in AWWA C200 or BS 534 or JIS G3457 standard<br>Plain end pipe (beveled). Connect by end to end welding as specified in MWA standard                  |
| Asbestos cement pipes and fittings                    | As specified in TIS81 Class PP20 and TIS 126 Class PJ20 and MWA standard   |
| Cast iron fitting for asbestos cement pipes           | As specified in ISO 13 or TIS 918 and MWA standard   |
| PVC pipe<br>Size Ø100mm – 400mm                       | As specified in TIS 17 Class 8.5 and 13.5<br>Bell-end pipe. Connect by push on joint employing a rubber gasket as specified in MWA standard.                       |
| PVC fitting for PVC pipes<br>Size Ø100mm – 400mm      | Manufacture by injection molds or machining from extruded stock. Bell-end type. Connect by push on joint employing a rubber gasket as specified in MWA standard.   |
| Cast iron fitting for PVC pipes<br>Size Ø100mm– 400mm | As specified in ISO 13 or TIS 918.<br>Connect by push on joint employing a rubber gasket as specified in MWA standard  |
| PE pipe and fittings                                  | As specified in SFS 4231 and SFS 4232 or TIS 982<br>And also, MWA standard   |
| Polyethylene Pipe and Fitting                         | As specified in AWWA C902 or TIS 910 and MWA standards   |
| Butterfly Valves<br>Size Ø600mm – 1800mm              | As specified in AWWA C 504 Class 150A or TIS 382.<br>Fully-shut type. Class 10. The Body length conform to TIS382 and conform to MWA standard                      |
| Gate valves<br>Size Ø100mm – 400mm                    | As specified in TIS 1413 PN 10. And conform to MWA standard  |
| Air Release Valves<br>Size Ø25mm – 150mm              | As specified in JIS B 2063 or TIS 1368 and MWA standard. PN 7.5 Single type for AV Ø25mm. Double type for AV size Ø75mm – 150mm                                    |

### **Steel Pipes**

Steel pipes are used for conveying oil, petroleum, natural gas, drinking water and ventilation

system.

Steel can be obtained in various forms as thread ends, plain ends, flange ends, beveled, spigot & socket.

Underground Steel Pipes



Steel Concentric Double Cylinder Pipes



RCP (Steel) Pipes



RCP (Steel) Pipes



Above Ground with Polyurethane

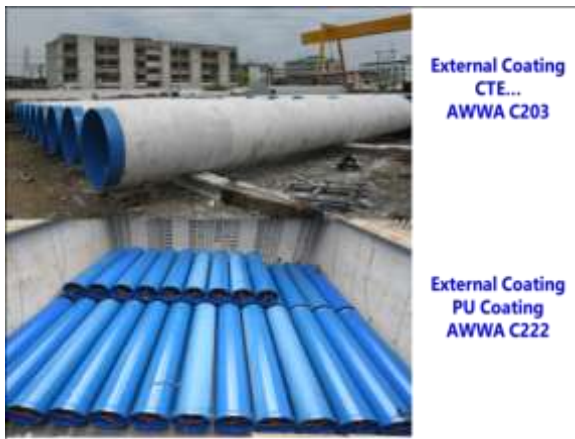
Underground Pipe with Poly Urethane Coating



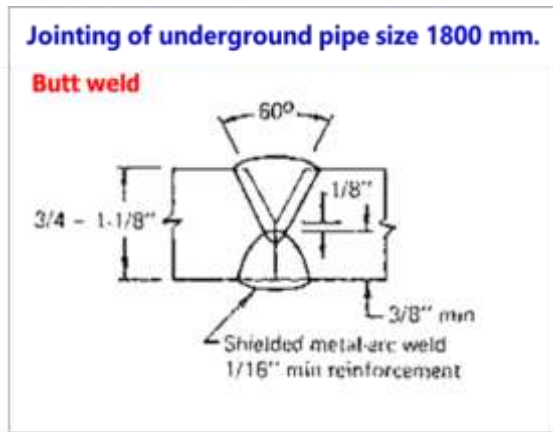
Coating



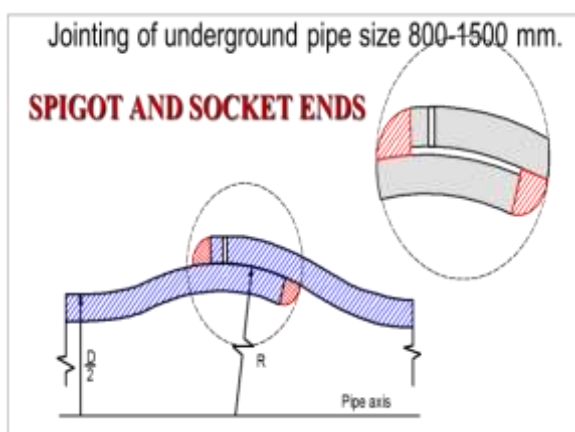
External Coating by AWWA Standard      Jointing of underground pipe



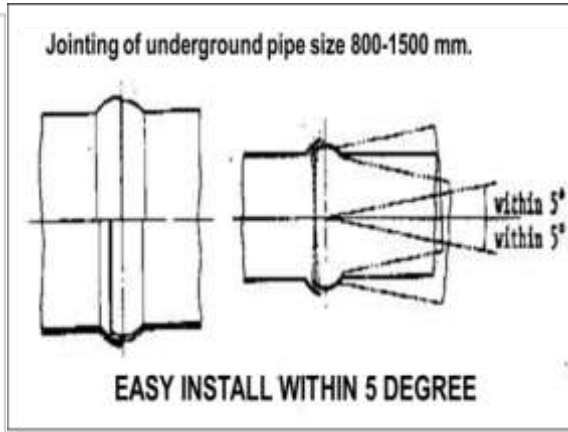
Jointing of underground pipe



Jointing of underground pipe



Steel Fitting



Underground Tee

STEEL FITTINGS



Under Ground Tee



Flange



Coupling



Metal Bellow



Metal Bellow



Galvanized Steel Pipe



Pipe Support



### Galvanized Steel Pipe

Steel pipes which are coated with zinc are known as Galvanized steel pipes. Coating is much useful in production of galvanized steel pipes & fittings and other materials.

Galvanized Steel Pipe



### Asbestos Cement (AC) Pipe

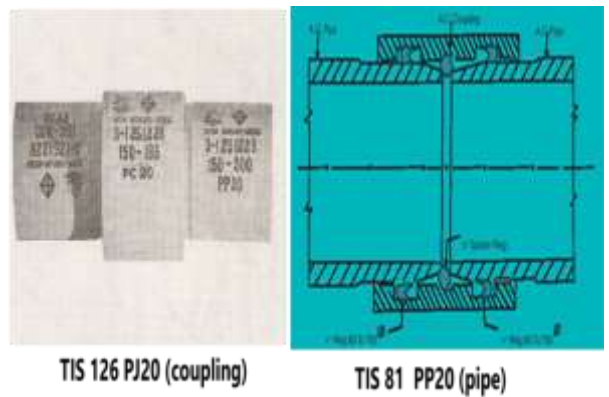
They are the second widely used pipes and used in swamp area and tide area in drinking water conveying.



Asbestos Cement Pipe



Asbestos Cement Pipe Joint



Asbestos Cement Pipe



Asbestos Cement Pipe with Thrust Block



### uPVC Pipe

uPVC (unplasticite Vinyl Chloride) pipes and connectors can withstand the environmental impacts caused by machines and natural impacts. They can withstand friction, chemicals or electro chemicals as well as cannot occur conducting, reacting with electro chemicals. uPVC pipes can be used in distribution of drinking water.

uPVC Pipe



uPVC Pipe



uPVC Pipe Laying



Working Temperature and Pressure of uPVC Pipe

| WORKING TEMPERATURE<br>Celcius | WORKING PRESSURE (Mpa) |         |          |
|--------------------------------|------------------------|---------|----------|
|                                | PVC 5                  | PVC 8.5 | PVC 13.5 |
| 20                             | 0.58                   | 0.98    | 1.57     |
| 27                             | 0.50                   | 0.85    | 1.35     |
| 30                             | 0.47                   | 0.79    | 1.25     |
| 40                             | 0.35                   | 0.59    | 0.94     |
| 50                             | 0.23                   | 0.39    | 0.62     |
| 60                             | 0.12                   | 0.20    | 0.31     |

General Size of Socket Joint with Rubber Gasket

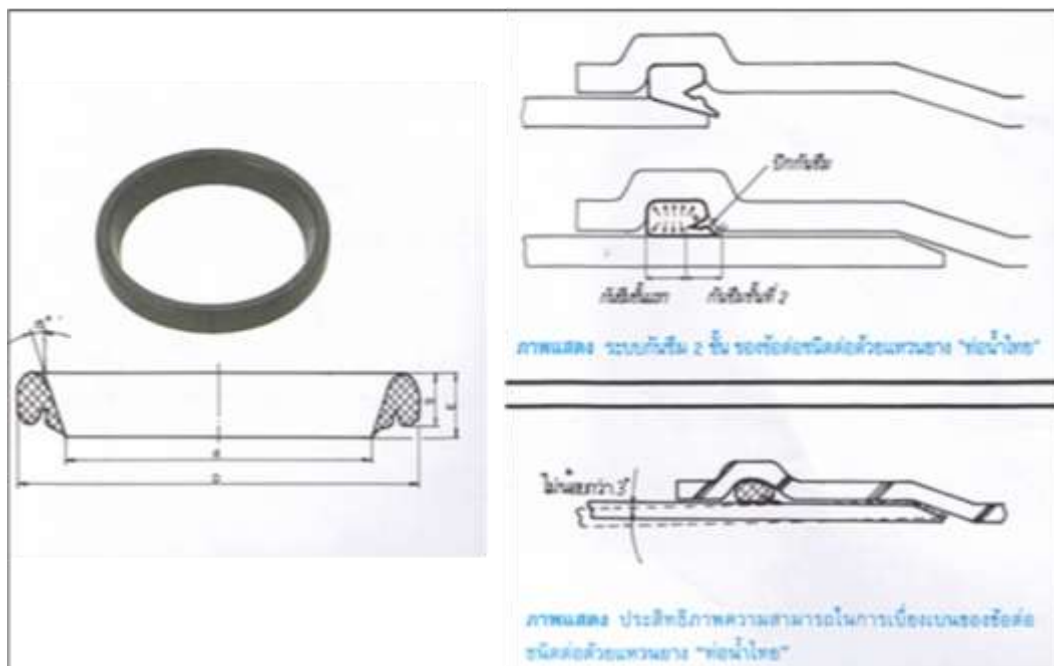


## General Size of Socket Joint with Rubber Gasket

unit : mm.

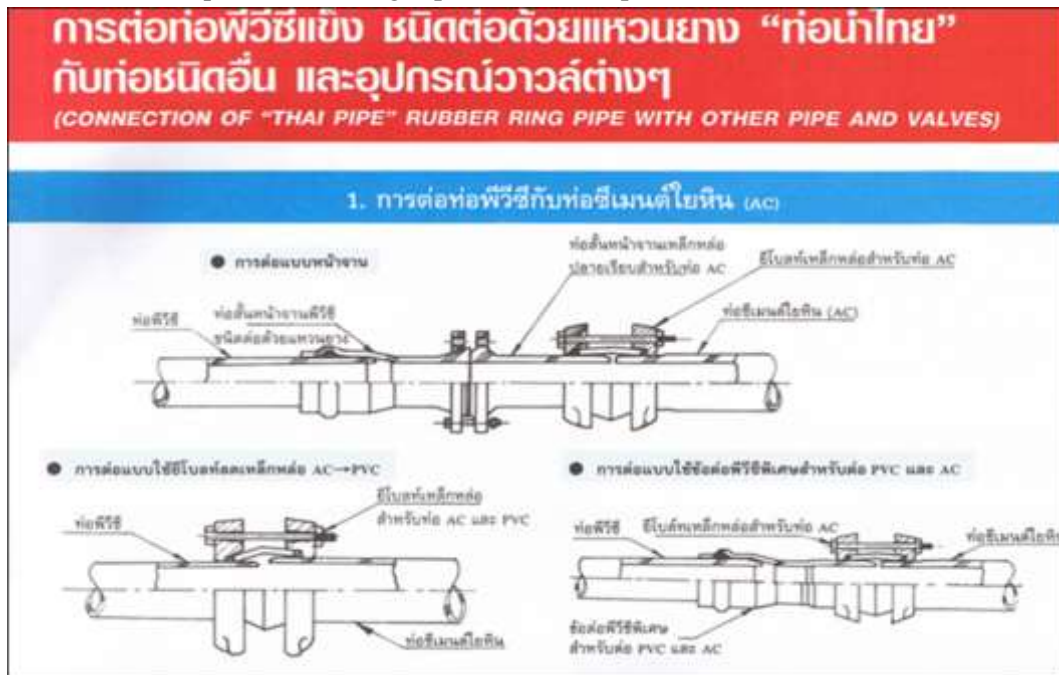
| ชื่อขนาด<br>NOMINAL SIZE<br>mm. (in.) | D        | d <sub>1</sub><br>ต่ำสุด<br>(min.) | M<br>ต่ำสุด<br>(min.) | L   | e         |            |             | c <sub>1</sub> ต่ำสุด (min.) |            |             | c <sub>2</sub> ต่ำสุด (min.) |            |             |
|---------------------------------------|----------|------------------------------------|-----------------------|-----|-----------|------------|-------------|------------------------------|------------|-------------|------------------------------|------------|-------------|
|                                       |          |                                    |                       |     | PVC<br>5  | PVC<br>8.5 | PVC<br>13.5 | PVC<br>5                     | PVC<br>8.5 | PVC<br>13.5 | PVC<br>5                     | PVC<br>8.5 | PVC<br>13.5 |
| 55(2")                                | 60±0.15  | 60.40                              | 38                    | 100 | 1.8±0.20  | 2.9±0.25   | 4.3±0.30    | 1.65                         | 2.85       | 4.65        | 1.45                         | 2.40       | 3.60        |
| 65(2½")                               | 76±0.20  | 76.40                              | 41                    | 105 | 2.2±0.20  | 3.5±0.25   | 5.4±0.35    | 2.10                         | 3.60       | 5.90        | 1.80                         | 2.95       | 4.55        |
| 80(3")                                | 89±0.20  | 89.50                              | 44                    | 110 | 2.5±0.20  | 4.1±0.30   | 6.4±0.40    | 2.45                         | 4.20       | 6.90        | 2.10                         | 3.45       | 5.40        |
| 100(4")                               | 114±0.30 | 114.50                             | 50                    | 135 | 3.2±0.25  | 5.2±0.35   | 8.1±0.50    | 3.10                         | 5.35       | 8.80        | 2.70                         | 4.40       | 6.85        |
| 150(6")                               | 165±0.40 | 165.70                             | 61                    | 155 | 4.6±0.30  | 7.5±0.45   | 11.7±0.65   | 4.50                         | 7.75       | 12.75       | 3.90                         | 6.35       | 9.95        |
| 200(8")                               | 216±0.50 | 216.90                             | 72                    | 170 | 5.4±0.35  | 8.8±0.50   | 13.7±0.75   | 5.25                         | 9.00       | 14.80       | 4.55                         | 7.50       | 11.70       |
| 250(10")                              | 267±0.70 | 268.10                             | 84                    | 195 | 6.6±0.40  | 10.9±0.60  | 16.9±0.90   | 6.50                         | 11.15      | 18.30       | 5.60                         | 9.30       | 14.40       |
| 300(12")                              | 318±0.80 | 319.30                             | 84                    | 220 | 7.8±0.45  | 12.9±0.70  | 20.1±1.05   | 7.75                         | 13.25      | 21.80       | 6.65                         | 11.00      | 17.15       |
| 350(14")                              | 370±0.90 | 371.50                             | 90                    | 235 | 9.1±0.55  | 15.0±0.80  | 23.4±1.20   | 9.00                         | 15.45      | 25.35       | 7.70                         | 12.80      | 20.00       |
| 400(16")                              | 420±1.10 | 421.70                             | 98                    | 275 | 10.3±0.60 | 17.0±0.90  | 26.5±1.35   | 10.20                        | 17.50      | 28.80       | 8.75                         | 14.50      | 22.65       |
| 450(18")                              | 470±1.20 | 471.90                             | 105                   | 285 | 11.5±0.65 | 19.0±1.00  | 29.7±1.50   | 11.40                        | 19.60      | 32.20       | 9.80                         | 16.20      | 25.40       |
| 500(20")                              | 520±1.30 | 522.10                             | 113                   | 300 | 12.7±0.70 | 21.0±1.10  | 32.8±1.65   | 12.65                        | 21.70      | 35.65       | 10.80                        | 17.95      | 28.05       |
| 600(24")                              | 630±1.60 | 633.80                             | 129                   | 340 | 15.3±0.80 | 25.4±1.30  | 39.7±2.00   | 15.36                        | 26.30      | 43.25       | 13.05                        | 21.70      | 33.95       |

## Rubber Gasket Installation





Connection of “Thai Pipe” Rubber Ring Pipe with other Pipe and Valves



**Poly Butylene (PB) Pipe**

PB pipe is manufactured with Poly Butylene Resin and an advanced product from Europe and USA. Poly Butylene Resin has high molecular weight and can withstand the cracking due to environmental impact. For these good properties, they are suitable to use in water supply system. These pipes can withstand -40°C ~ 48°C in cold water and -19°C ~ 90°C in hot water.



Poly Buthylene Pipe

Poly Buthylene Pipe Sizes and Dimension

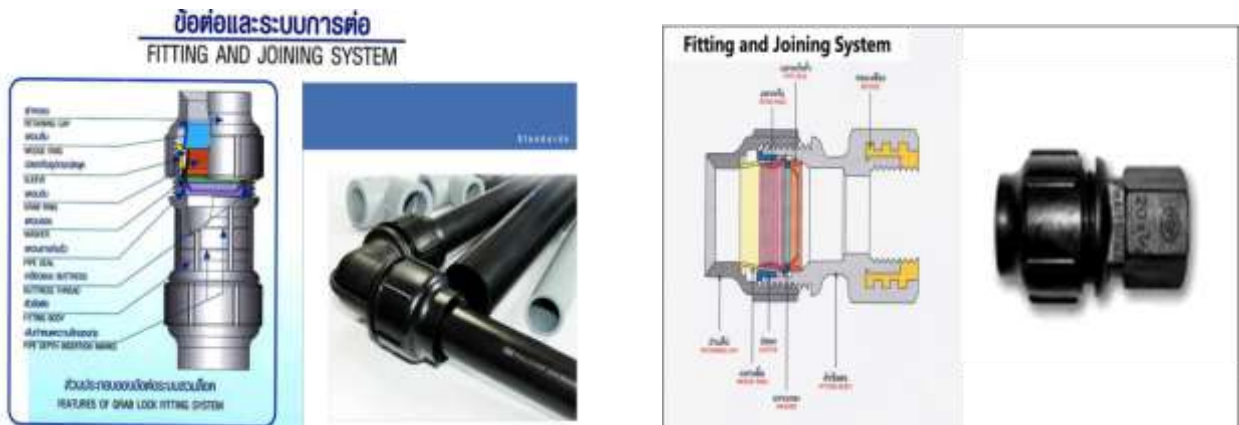


## ขนาดและมิติ SIZES AND DIMENSIONS

| ชื่อขนาด<br>NORMAL SIZE |                | เส้นผ่าศูนย์กลาง<br>ภายนอก<br>OUTSIDE<br>DIAMETER (mm) |             | ความหนาของผนังท่อ<br>WALL THICKNESS (mm) |                       |                     | ความยาว<br>LENGTH (m) |             |
|-------------------------|----------------|--|-------------|--|-----------------------|---------------------|-----------------------|-------------|
| มิลลิเมตร<br>(mm)       | นิ้ว<br>(inch) |  |             | SDR 17<br>(125 PSI)                      | SDR 13.5<br>(160 PSI) | SDR 11<br>(200 PSI) | ม้วน<br>COIL          | ท่อน<br>ROD |
| 15                      | 1/2            | 15.88  | + 0.20<br>0 | -  | -                     | 1.57 + 0.25<br>0    | 200                   | 6           |
| 20                      | 3/4            | 22.23  | + 0.20<br>0 | 1.57 + 0.25<br>0                         | 1.65 + 0.25<br>0      | 2.03 + 0.25<br>0    | 150                   | 6           |
| 25                      | 1              | 28.58  | + 0.25<br>0 | 1.68 + 0.25<br>0                         | 2.11 + 0.25<br>0      | 2.59 + 0.25<br>0    | 150                   | 6           |
| 40                      | 1 1/2          | 41.28  | + 0.30<br>0 | 2.42 + 0.25<br>0                         | 3.05 + 0.30<br>0      | 3.76 + 0.38<br>0    | 100                   | 6           |
| 50                      | 2              | 53.98  | + 0.30<br>0 | 3.17 + 0.30<br>0                         | 3.99 + 0.38<br>0      | 4.90 + 0.48<br>0    | 50                    | 6           |
| 65                      | 2 1/2          | 72.85  | + 0.36<br>0 | 4.29 + 0.51<br>0                         | 5.41 + 0.64<br>0      | 6.63 + 0.79<br>0    | 50                    | 6           |
| 80                      | 3              | 88.70  | + 0.40<br>0 | 5.23 + 0.64<br>0                         | 6.58 + 0.79<br>0      | 8.08 + 0.97<br>0    | 50                    | 6           |
| 100                     | 4              | 114.07   | + 0.46<br>0 | 6.71 + 0.81<br>0                         | 8.46 + 1.02<br>0      | 10.39 + 1.24<br>0   | 50                    | 6           |
| 150                     | 6              | 168.00   | + 0.56<br>0 | 9.91 + 1.19<br>0                         | 12.47 + 1.50<br>0     | 15.29 + 1.73<br>0   | -                     | 6           |
| 200                     | 8              | 218.09   | + 1.98<br>0 | 12.88 + 1.49<br>0                        | 16.23 + 1.83<br>0     | 19.92 + 2.19<br>0   | -                     | 6           |

6/7/2004

### Poly Buthylene Pipe Fitting and Jointing System



### Poly Buthylene Pipe Fitting and Notation



**High Density Poly Ethylene (HDPE) Pipe**

HDPE pipe can be used in conveying drinking water, waster water, slurries, chemicals and gases.

**HDPE Pipes**



**HDPE Pipe Jointing**

Seal making on HEPE Jpint



HDPE Stubend



HDPE Flange Type Joint



HDPE Stubend



Flange Type Joint

Joining with HDPE



CI Gate Valve and Standard

Joining with HDPE



Butterfly Valve and Standard





**CI Gate Valve  
TIS 256  
ND 100-400 mm**



**Butterfly Valve  
AWWA C504 TIS 382  
ND > 400 mm.**



Air Release Valve

T- Strainer



**Single**

**Air Release Valves**



**Double**



**Quick**

JIS B2063 TIS 1368

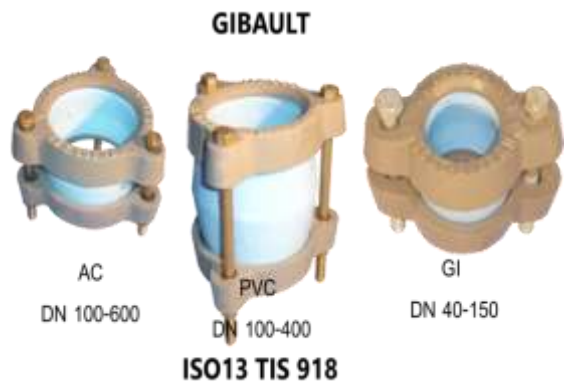


**T-Strainer**

Manhole and Surface Box

GI Bult

**Manhole & Surface Box**



**GIBALT**

AC

DN 100-600

PVC

DN 100-400

GI

DN 40-150

**ISO13 TIS 918**

Short Pipes

Reducers



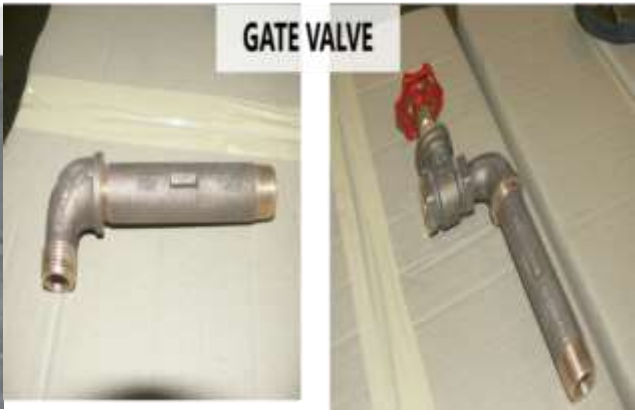
Fire Hydrants

Pipe Clamps



Corporation Stops

Gate Valves

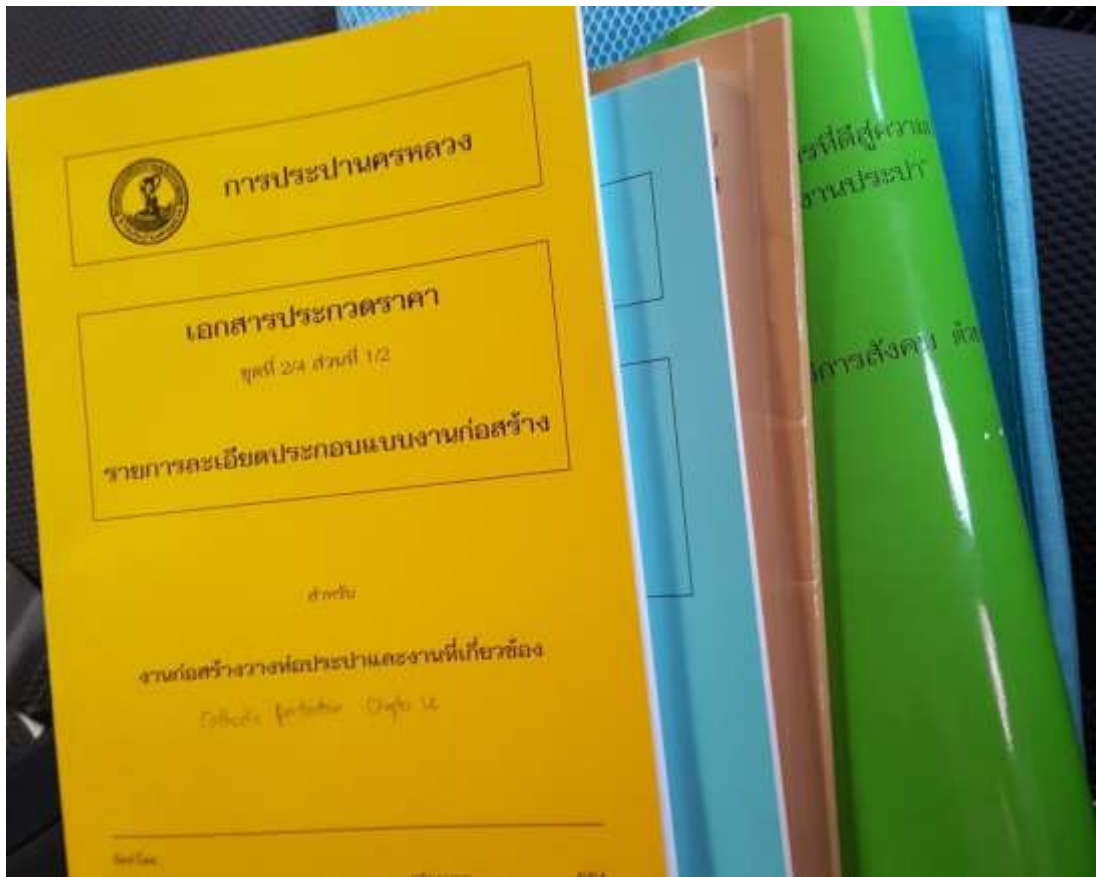


## Water Meter Installation



Moreover, MWA established E-Library system and the related departments can easily access the required books in Thailand language and read in Thailand and English languages. The following most common used books among these are obtained in not only soft copy but also hard copy.

Books obtained in hard copy



Books obtained in soft copy





## SPECIFICATION FOR COPPER ALLOY GATE VALVE

φ 15 mm. to φ 80 mm.

33 - 012 - 3 SPE.

### 1. General

Unless otherwise specified, copper alloy gate valves shall be made in accordance with BS 5154 "Copper Alloy Globe, Globe Stop and Check, Check and Gate Valves", or TIS 431 "Copper Alloy Gate Valves" of solid wedge, non-rising stem, screwed bonnet type, Class PN 10.

Screwed body ends of the valves shall be female-threaded complying with the requirements of ISO 7/1 "Pipe Threads Where Pressure-Tight Joints Are Made on The Threads-Part 1 : Designation, Dimensions and Tolerances" or TIS 281 "Pipe Threads for Water Service and General Purposes" which the angle between the flanks, measured in an axial plane section is, 55°.

### 2. Sizes and Dimensions



## SPECIFICATION FOR Ball Valves

φ 1/2 (15 mm.) to 2 inches (50 mm.)

33 - 013 - 1 SPE.

### I. General Requirements

The valve shall be one-piece or split body, screwed socket ends, non-lubricated, full bore ball valve.

The valves shall be designed for a minimum working pressure of 10 kg/cm<sup>2</sup>.

Screwed socket ends shall be internal thread according to BS 21 "Pipe Threads" or TIS 281 "Standard for Pipe Threads for Water Service".

The ball valve supplied shall have a keyhole to be closed and opened the valve by key and shall be designed by the manufacturer. The valves shall be so constructed as to be closed by clockwise turning and opened by counterclockwise turning and shall not capable of being opened or closed without a key. Stop limiting devices and the indicator of the opening shall be provided.

### II. Sizes and Dimensions

Minimum overall length shall be as shown in Table 1

Table 1 Overall Length

| Nominal Diameter<br>mm. (inch) | Minimum Overall<br>length (mm.) |
|--------------------------------|---------------------------------|
| 15 (1/2)                       | 55                              |
| 20 (3/4)                       | 60                              |
| 25 (1)                         | 70                              |
| 40 (1 1/2)                     | 90                              |



METROPOLITAN WATERWORKS AUTHORITY  
SPECIFICATION FOR WATER METERS (TURBINE TYPE)  
: NQ. WM. 008/2  
SIZE : 16 INCHES

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SECTION 1 - GENERAL

**Sec. 1.1 Scope**

This section covers the supply and delivery to the Metropolitan Waterworks Authority, Bangkok, Thailand of cold-water Turbine Type current meters, 16 inches for service in accordance with the following specified requirements of design, capacity, operating conditions, materials and workmanship.

**Sec. 1.2 General Design**

The general design of the meter submitted under this Specification shall be of the helical vane type of water meter operated by the current or velocity of the water passing through the meter.

The drive from the rotor shaft to the register may be of the direct mechanical drive type provided with suitable sealing against water leakage to the exterior of the meter or of the magnetic drive type with suitable protection against externally applied magnetic fields, conditioned under horseshoe-shape magnet, having magnetic flux density of not less than 5,000 lines/cm.<sup>2</sup> and minimum total line of flux 75,000 Lines.

Preference will be given to meter of the interchangeable mechanism type i.e. meter in



METROPOLITAN WATERWORKS AUTHORITY  
 SPECIFICATION FOR WATER METERS (CLASS C)  
 : NO. WM. 012/2

SIZES : 50 MM (2-INCH) THROUGH 150 MM (6-INCH)

**SECTION 1 - GENERAL**

**Sec.1.1 Scope**

This specification covers the both of Woltmann meter and Single-jet meter in sizes 50 mm (2-in.) through 150 mm (6-in.) for waterworks customer service and mainline applications with a nominal pressure of 1 MPa and at working temperature up to 40°C, and the materials and workmanship employed in their fabrication.

**Sec. 1.2 Reference**

This specification references the following documents. They form a part of this specification to the extent specified herein. In any case of conflict, the requirements of this specification shall prevail.

- ISO 4064-1:1977 & 1993 Measurement Of Water Flow In Closed Conduits – Meters for Cold Potable Water – Part 1 : Specifications
- ISO 7005 Metallic Flanges
- ASTM A 307 Carbon Steel Bolts and Studs, 60000 psi Tensile Strength
- TIS 171 Bolts, Screws, Nuts, and Studs (General Data)

The continuous checking of MWA is described in the following figures.

สรุปรายงานผลการก่อสร้างวางท่อ  ประชาน  จำหน่าย ประจำวัน สัญญา PITB-719

ประจำวันที่ 10 กรกฎาคม 2560 เวลา 8.30 น. ถึง 16.30 น. สถานที่ ถนนพหลโยธิน - ถนนรัตนโกสินทร์ซอย

สถานะภาพ  ปอดไปรง  ผสมเหล็กน้อย  ผสมปูนกลาง  ผสมปูนหัว

สภาพผิว  โพลีเอท  หางเท้า  ถนนคอนกรีต  ถนนลาดยาง

อื่นๆ  น. หัวน้ำคนงาน 3 คน คนงาน 4 คน เครื่องสูบน้ำ 1 เครื่อง

ลูกกระทุ้ง  ดัน เครื่องบดอัด  เครื่อง เครื่องตัดคอนกรีต  เครื่อง รบรวรทุก  คัน

| ลำดับที่ | ลักษณะงาน                           | บริเวณ<br>กม. ถึง กม. | ความยาวที่ใส่    |                |                     | อุปกรณ์ที่ใส่ |                    |                |
|----------|-------------------------------------|-----------------------|------------------|----------------|---------------------|---------------|--------------------|----------------|
|          |                                     |                       | ท่อเดิม<br>(ฟุต) | ท่อตัด<br>(ม.) | ความยาว<br>รวม (ม.) | ชนิด,<br>ขนาด | ความยาว<br>ต่อชิ้น | ความยาว<br>รวม |
| 1        | เปลี่ยนท่อ 500 มม. เส้นผ่าศูนย์กลาง | กม. 1-440             | -                | -              | -                   | -             | -                  | -              |
| 2        | เปลี่ยนท่อ 500 มม. เส้นผ่าศูนย์กลาง | กม. 1-440             | -                | -              | -                   | -             | -                  | -              |

**Daily progress Report by Project Engineer**

| อุปกรณ์ยาวท่อ + อุปกรณ์ |           |               | เดือน นายช่างโครงการ |              | บันทึกนายช่างโครงการ |                |
|-------------------------|-----------|---------------|----------------------|--------------|----------------------|----------------|
| ขนาด (ม.)               | ชนิด (ม.) | ชนิดอื่น (ม.) | ชื่อ                 | ผู้ควบคุมงาน | นายวิชาญ สุขศรีรัตน์ | นายช่างโครงการ |
| 50 (Bypass)             |           |               |                      |              |                      |                |
| 100 (Bypass)            |           |               |                      |              |                      |                |
| 150 (Bypass)            |           |               |                      |              |                      |                |
| 200 (Bypass)            |           |               |                      |              |                      |                |
| 150 PVC                 |           |               |                      |              |                      |                |
| 300 PVC                 |           |               |                      |              |                      |                |
| 300 ST                  |           |               |                      |              |                      |                |
| 400 ST                  |           |               |                      |              |                      |                |
| 800 ST                  |           |               |                      |              |                      |                |
| 1000 ST                 |           |               |                      |              |                      |                |
| 1200 ST                 |           |               |                      |              |                      |                |
| 200                     |           |               |                      |              |                      |                |

ชื่อ *วิชาญ สุขศรีรัตน์* ผู้ควบคุมงาน

(นายวิชาญ สุขศรีรัตน์) นายช่างโครงการ

**สรุปรายงานผลการก่อสร้างวางท่อ**  ประสาน  จ่ายน้ำ **ประจำวัน สัญญา PITB-719**

ประจำวันที่ 12 ตุลาคม 2559 เวลา 8.30 น. ถึง 16.30 น. สถานที่ ถนนพหลโยธิน - ถนนรัตนโกสินทร์ซอย 10

ผลการขาด  ป้อนค้ำประ  ส่วนค้ำค้ำมือ  ส่วนค้ำค้ำกลาง  ส่วนค้ำค้ำหัว

สภาพผิว  โหล่ทาง น.  ทางเท้า น.  ถนนคอนกรีต น.  ถนนลาดยาง น.

พื้นที่ น. หัวหน้าคนงาน 1 คน คนงาน 4 คน เครื่องสูบน้ำ เครื่อง

ลูกกระชัง คัน เครื่องขุดดิน เครื่อง เครื่องตัดคอนกรีต เครื่อง รถบรรทุก คัน

| ลำดับที่ | ลักษณะงาน       | ปริมาณ<br>กม. ถึง กม. | ความยาวที่ไว้   |                |                     | จุดประสงค์ที่ไว้ |                     |                |
|----------|-----------------|-----------------------|-----------------|----------------|---------------------|------------------|---------------------|----------------|
|          |                 |                       | ขุดดิน<br>(ฟุต) | ขุดลึก<br>(ม.) | ความยาว<br>รวม (ม.) | ชนิด,<br>ขนาด    | ความยาว<br>ตั้งขึ้น | ความยาว<br>รวม |
| 1.       | วางท่อ (Bypass) | 2+4-460               | 3               | -              | 18                  | -                | -                   | -              |

### Daily progress Report by Contractor

| สรุปความยาวท่อ + อุปกรณ์ |             |                | เดือน นายช่างโครงการ  | บันทึกงานช่างโครงการ                      |
|--------------------------|-------------|----------------|---|---|
| ขนาดท่อ (ม.)             | วันที่ (ม.) | ถึงวันที่ (ม.) |   |   |
| ∅ 50 (Bypass)            |             |                | <input checked="" type="checkbox"/> การวางท่อช่วงที่กล่าวถึงบนและระดับถูกต้องตามแบบแปลน<br><input type="checkbox"/> การบดอัดชั้นพื้นฐานและหน้าผิวถูกต้องตามรายละเอียดประกอบแบบ<br><input type="checkbox"/> อุปกรณ์ในสนามก่อสร้างผลการสังเกต<br><br>ลงชื่อ: <i>[Signature]</i> ผู้ควบคุมงาน<br>(นาย วิวัฒน์ ฐะระรัตน์) | (นาย วิวัฒน์ ฐะระรัตน์)<br>นายช่างโครงการ |
| ∅ 100 (Bypass)           |             | 11.4           |   |   |
| ∅ 150 (Bypass)           | 16          | 24             |   |   |
| ∅ 200 (Bypass)           |             |                |   |   |
| ∅ 150 PVC                |             |                |   |   |
| ∅ 300 PVC                |             |                |   |   |
| ∅ 300 ST                 |             |                |   |   |
| ∅ 400 ST                 |             |                |   |   |
| ∅ 800 ST                 |             |                |   |   |
| ∅ 1000 ST                |             |                |   |   |
| ∅ 1200 ST                |             |                |   |   |
| รวม                      | 16          | 11.4           |   |   |

As the mentioned table which can assess the work performance, the various type of tables assessing contractor, project engineer are printed in Thai Language in order to be used in MWA.

In implementing the projects by MWA, it is estimated that to expendit 25177.3 million Baht for Bangkok water distribution project No.7, 7454 million Baht for No.8 Project and 4275 million Baht for No.9 Project. The projects ae funded by the income of MWA, International Loan and JICA ODA Loan.

For the project progress and to solve the difficulties, each contractor is monitored by web project tracking system (WebPS). The information obtained from the project manager and finance are calculated with Web PS and submitted to the correspondence.

During the study in water distribution system construction department (2) of MWA, the Direct Jacking Method from the Trenchless Method for Trunk main construction was learned.

Land preparation is made to dig the hole at the start and end place for Jacking.



Earth excavation is doing.



While Steel Sheet Pile is driving





Tempory strut and bracing are installed in Steel Sheet Pile.



The drilled holes are covered not to disturb the vehicle movement in day time as shown in Photo.





Earth Pressure Balance weight and Jack Machine are used in Jacking.



Soft eye is installed for correct Jacking Alignment.



Dummy Pipe is inserted.



Pipe connection are made using inner and outter welding.





Welding Joint are checked by X-Ray Test.



After that, wrapped with pipe belt and pipe connection is proceeded.



In the visit, the water distribution project to Koh Kred island located in Nonthaburi district using 125-meter-long, 315 mm diameter HDPE pipe across the Kyauk Phayar river done by the mentioned department was explained.

Koh Kred island is located 20 km from Bangkok and population is around 6000. It is a famous and attractive place for tourism. Although, in the last 15 years, water is distributed with 150 mm diameter HDPE pipe and it is not sufficient at present condition and therefore, the new project is performed with contractor system.



From the side of Sala Moo (3) village of Nonthaburi district to Koh Kred island, the sub-river water supply pipeline is constructed as shown in photo.

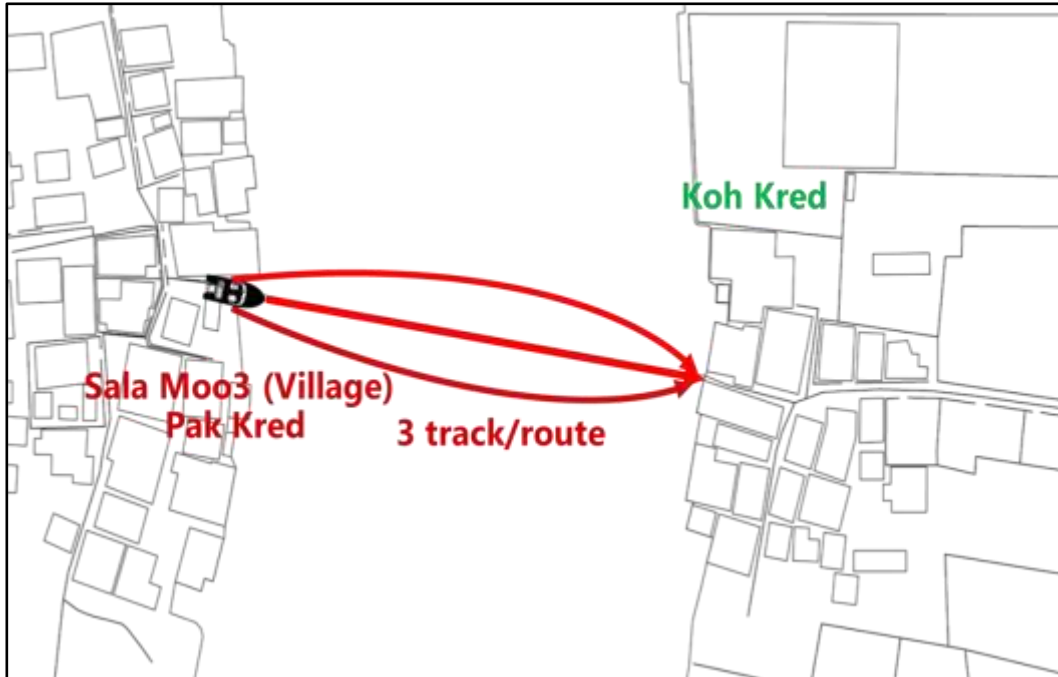




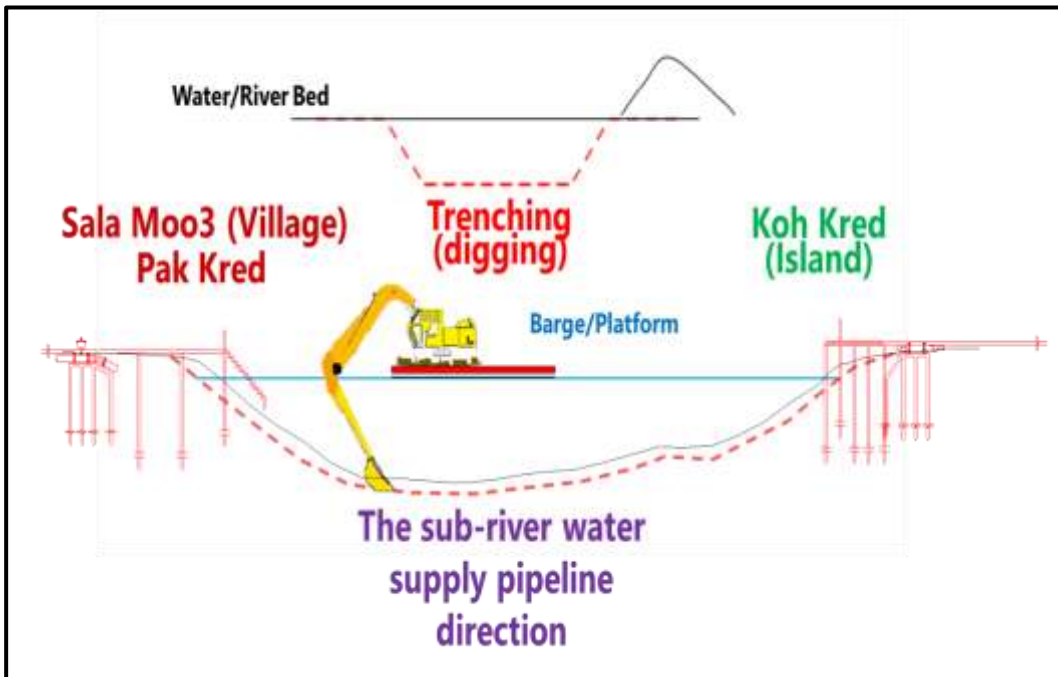
Water depth measurement is done by Hydrographic Survey.



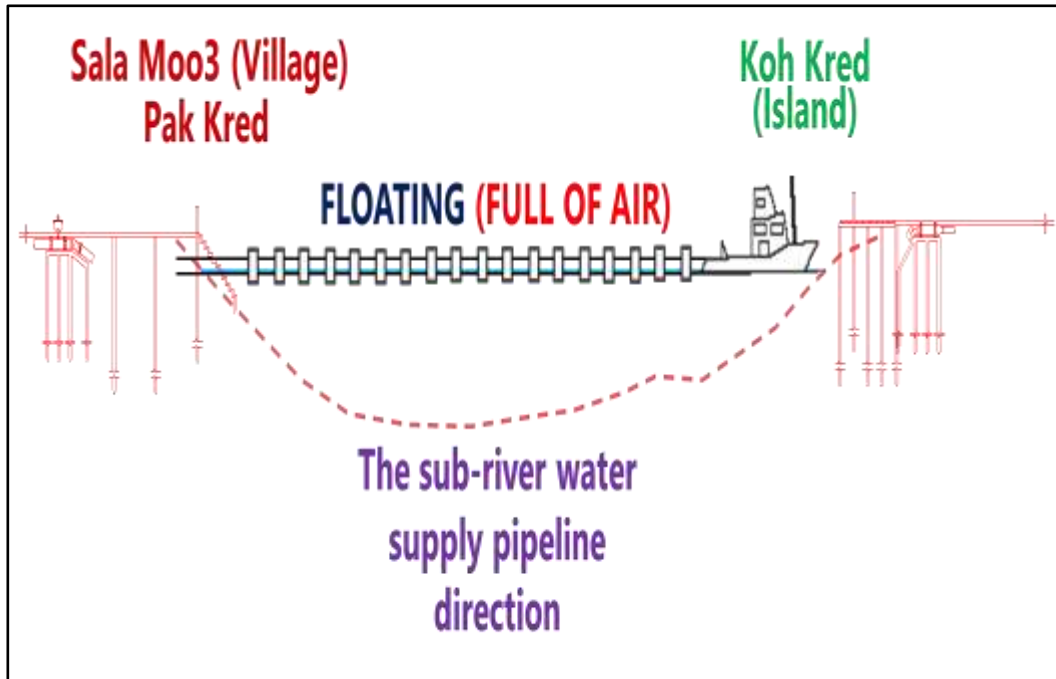
After measuring water depth, the route for water supply pipe is chosen.



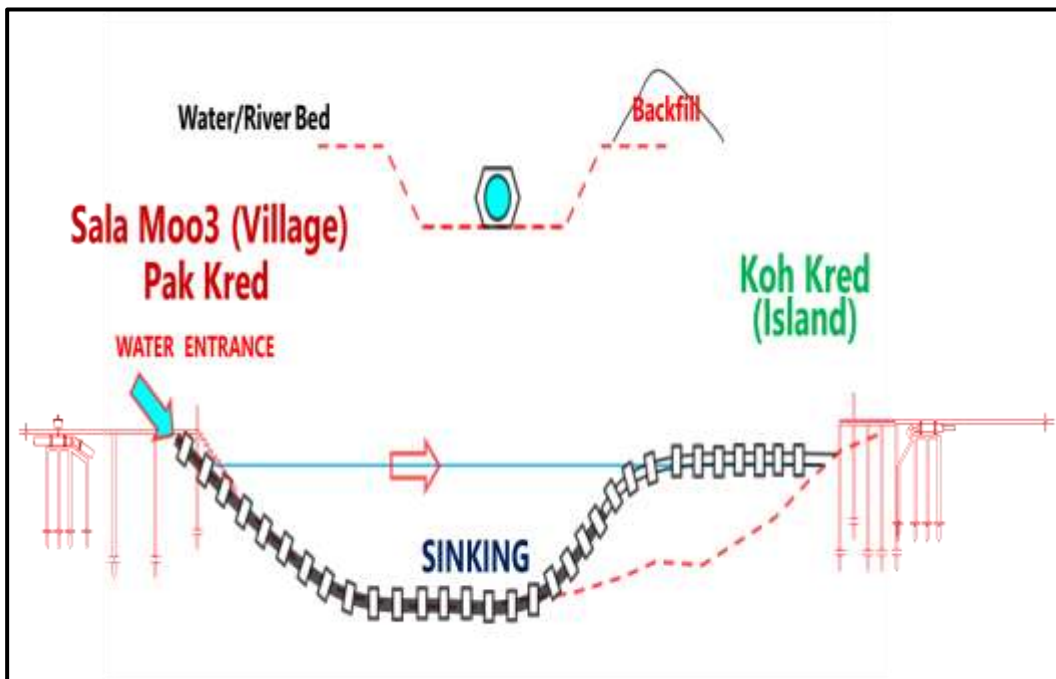
After that soil is excavated with Khrem Sheel.



After that the connected HDPE attached by the concrete counter weights are pulled to the other side bank by motor boat.



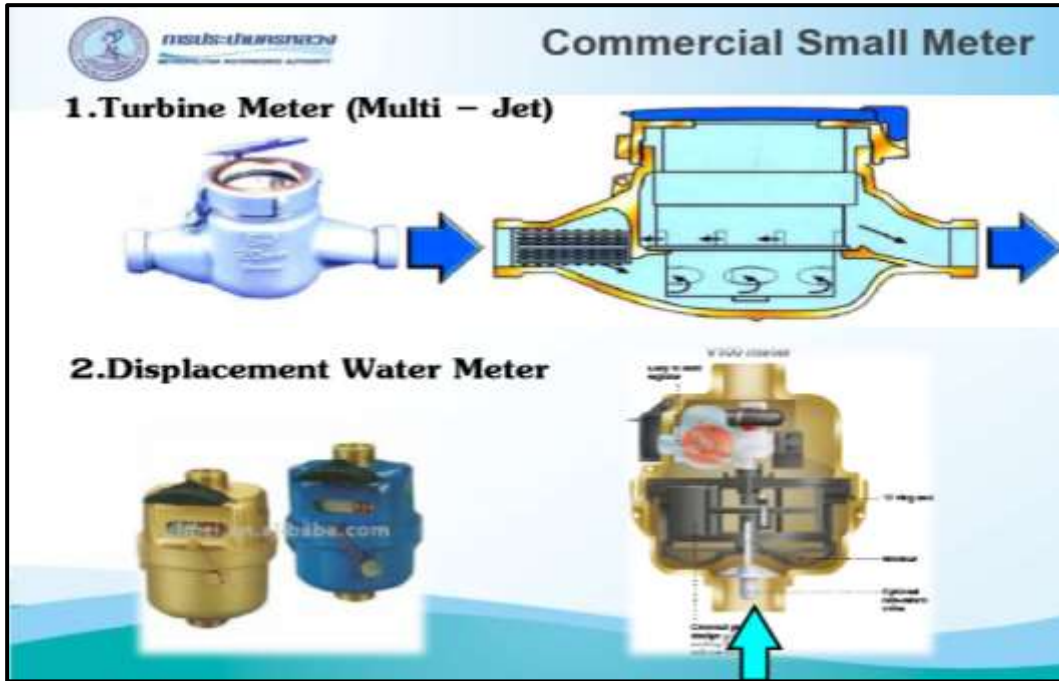
The pulled pipe line is filled with water from the other end of water pipe existed at Pak Kred village and the pipe is sunk into the river.



After finishing piping, the work is finished by earth filling.

Furthermore, in the visit to Water Meter Maintenance Division of MWA Water Meter Department, there was an explanation about the two types of small meter and four types of large meters which are presently used in MWA and the samples and figures were shown.





Turbine Meter (Multi - Jet)

Displacement Water Meter



**Commercial Large Meter**

**3. Woltmann Water Meter**




**4. Turbine Meter (Single Jet )**

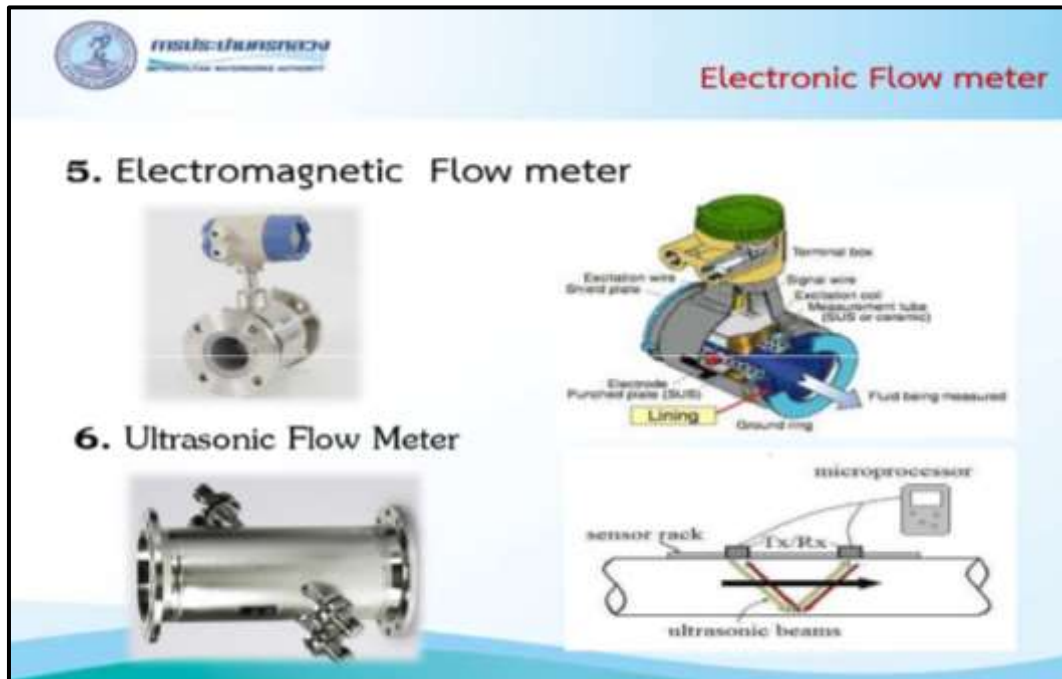




Woltmann Water Meter



Turbine Meter (Single Jet)

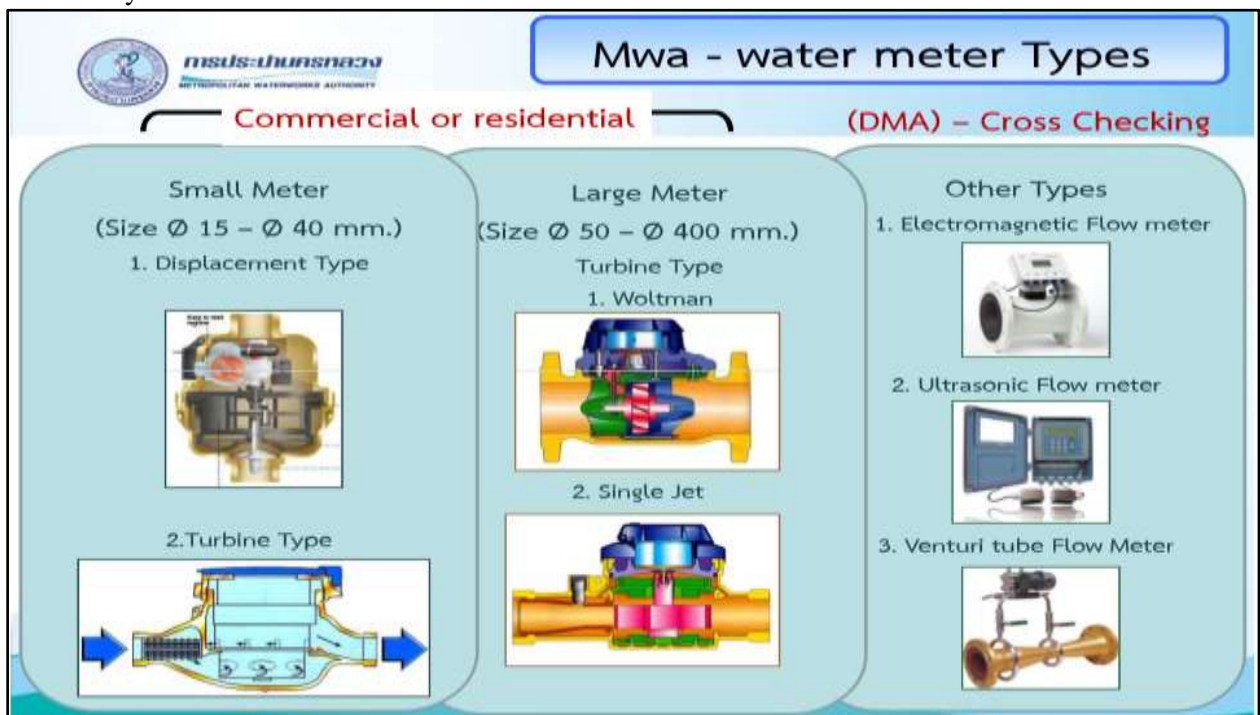


Water meters are classified according to their size as small meter (15 ~ 40 mm diameter) and large meter (50 ~ 400 mm diameter). Small meters are defined with TIS 1021-2534 Standard for Turbine Type and TIS 1271-2538 Standard for Displacement Type respectively. And large meter are defined with ISO 4064 Cold Portable Water Standard.

For commercial use and residential use, both types of meters, small and large are used and for DMA and corss check, other types are used.

MWA Specification and Reference for each size of meters are shown as the following figure.

The accuracy of meters is defined as the ISO 4064 Standard. The water meter of MWA branch offices





required to repair are delivered to Water Meter Maintenance Division. The water meters arrived to Maintenance Division are listed by separating, the repairing and damaged meter. Damage Meter are separated and sold. Repairing Meter are delivered to meter assembly yard and the main body of meter and the inner parts are removed one by one. The original old color and dust from the separated parts of meter body are removed and cleaned with sand from the blasting machine. The reusable parts of inner body parts are re-assembled. After that, the cleaned meter body and the re-assembled interior parts are reassembled together. The re-assembled water meter is checked with accuracy test. The failed meter from Accuracy Test are repaired again and the accuracy test is done once more. Meters passed from Accuracy Test are delivered to the painting yard and painted. After painting, two-point marking are made on the body of water meter with different color according to the repairing year. For example, the water meter repaired in 2016 is marked with green color. The repaired meters are parceled with paper box and reused in connection of water usage by the branch offices.

Water Meter Repairing Workshop



Painted Water Meter



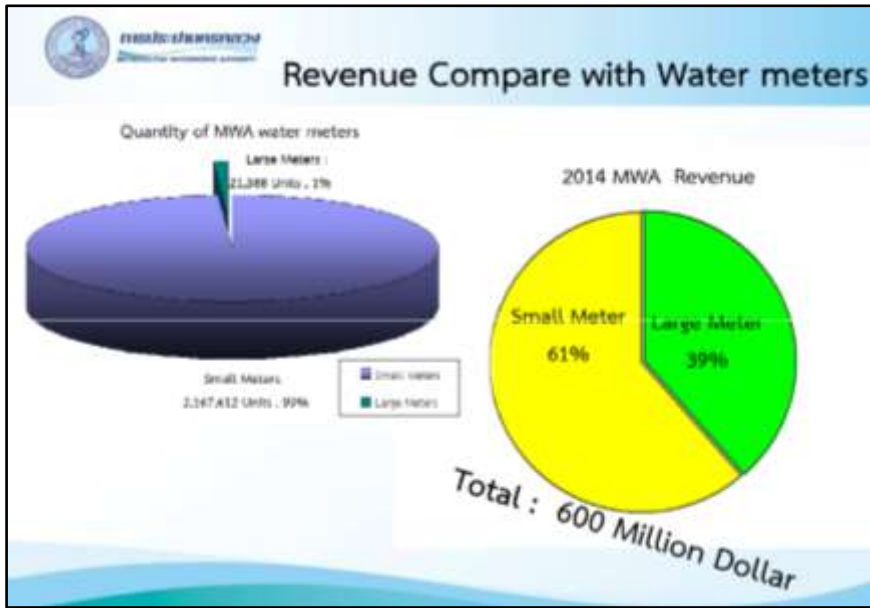
## Painting and Marking



## Water Meter Daily Records

**Daily Recorded by Boarding**

| Water Meter Daily Records |      |                 |         |         |         |         |         |         |         |         |         |
|---------------------------|------|-----------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Sl. No.                   | Area | Water Meter No. | Reading | Reading | Reading | Reading | Reading | Reading | Reading | Reading | Reading |
| 1                         |      |                 |         |         |         |         |         |         |         |         |         |
| 2                         |      |                 |         |         |         |         |         |         |         |         |         |
| 3                         |      |                 |         |         |         |         |         |         |         |         |         |
| 4                         |      |                 |         |         |         |         |         |         |         |         |         |
| 5                         |      |                 |         |         |         |         |         |         |         |         |         |
| 6                         |      |                 |         |         |         |         |         |         |         |         |         |
| 7                         |      |                 |         |         |         |         |         |         |         |         |         |
| 8                         |      |                 |         |         |         |         |         |         |         |         |         |
| 9                         |      |                 |         |         |         |         |         |         |         |         |         |
| 10                        |      |                 |         |         |         |         |         |         |         |         |         |
| 11                        |      |                 |         |         |         |         |         |         |         |         |         |
| 12                        |      |                 |         |         |         |         |         |         |         |         |         |
| 13                        |      |                 |         |         |         |         |         |         |         |         |         |
| 14                        |      |                 |         |         |         |         |         |         |         |         |         |
| 15                        |      |                 |         |         |         |         |         |         |         |         |         |
| 16                        |      |                 |         |         |         |         |         |         |         |         |         |
| 17                        |      |                 |         |         |         |         |         |         |         |         |         |
| 18                        |      |                 |         |         |         |         |         |         |         |         |         |
| 19                        |      |                 |         |         |         |         |         |         |         |         |         |
| 20                        |      |                 |         |         |         |         |         |         |         |         |         |
| 21                        |      |                 |         |         |         |         |         |         |         |         |         |
| 22                        |      |                 |         |         |         |         |         |         |         |         |         |
| 23                        |      |                 |         |         |         |         |         |         |         |         |         |
| 24                        |      |                 |         |         |         |         |         |         |         |         |         |
| 25                        |      |                 |         |         |         |         |         |         |         |         |         |
| 26                        |      |                 |         |         |         |         |         |         |         |         |         |
| 27                        |      |                 |         |         |         |         |         |         |         |         |         |
| 28                        |      |                 |         |         |         |         |         |         |         |         |         |
| 29                        |      |                 |         |         |         |         |         |         |         |         |         |
| 30                        |      |                 |         |         |         |         |         |         |         |         |         |
| 31                        |      |                 |         |         |         |         |         |         |         |         |         |
| 32                        |      |                 |         |         |         |         |         |         |         |         |         |
| 33                        |      |                 |         |         |         |         |         |         |         |         |         |
| 34                        |      |                 |         |         |         |         |         |         |         |         |         |
| 35                        |      |                 |         |         |         |         |         |         |         |         |         |
| 36                        |      |                 |         |         |         |         |         |         |         |         |         |
| 37                        |      |                 |         |         |         |         |         |         |         |         |         |
| 38                        |      |                 |         |         |         |         |         |         |         |         |         |
| 39                        |      |                 |         |         |         |         |         |         |         |         |         |
| 40                        |      |                 |         |         |         |         |         |         |         |         |         |
| 41                        |      |                 |         |         |         |         |         |         |         |         |         |
| 42                        |      |                 |         |         |         |         |         |         |         |         |         |
| 43                        |      |                 |         |         |         |         |         |         |         |         |         |
| 44                        |      |                 |         |         |         |         |         |         |         |         |         |
| 45                        |      |                 |         |         |         |         |         |         |         |         |         |
| 46                        |      |                 |         |         |         |         |         |         |         |         |         |
| 47                        |      |                 |         |         |         |         |         |         |         |         |         |
| 48                        |      |                 |         |         |         |         |         |         |         |         |         |
| 49                        |      |                 |         |         |         |         |         |         |         |         |         |
| 50                        |      |                 |         |         |         |         |         |         |         |         |         |
| 51                        |      |                 |         |         |         |         |         |         |         |         |         |
| 52                        |      |                 |         |         |         |         |         |         |         |         |         |
| 53                        |      |                 |         |         |         |         |         |         |         |         |         |
| 54                        |      |                 |         |         |         |         |         |         |         |         |         |
| 55                        |      |                 |         |         |         |         |         |         |         |         |         |
| 56                        |      |                 |         |         |         |         |         |         |         |         |         |
| 57                        |      |                 |         |         |         |         |         |         |         |         |         |
| 58                        |      |                 |         |         |         |         |         |         |         |         |         |
| 59                        |      |                 |         |         |         |         |         |         |         |         |         |
| 60                        |      |                 |         |         |         |         |         |         |         |         |         |
| 61                        |      |                 |         |         |         |         |         |         |         |         |         |
| 62                        |      |                 |         |         |         |         |         |         |         |         |         |
| 63                        |      |                 |         |         |         |         |         |         |         |         |         |
| 64                        |      |                 |         |         |         |         |         |         |         |         |         |
| 65                        |      |                 |         |         |         |         |         |         |         |         |         |
| 66                        |      |                 |         |         |         |         |         |         |         |         |         |
| 67                        |      |                 |         |         |         |         |         |         |         |         |         |
| 68                        |      |                 |         |         |         |         |         |         |         |         |         |
| 69                        |      |                 |         |         |         |         |         |         |         |         |         |
| 70                        |      |                 |         |         |         |         |         |         |         |         |         |
| 71                        |      |                 |         |         |         |         |         |         |         |         |         |
| 72                        |      |                 |         |         |         |         |         |         |         |         |         |
| 73                        |      |                 |         |         |         |         |         |         |         |         |         |
| 74                        |      |                 |         |         |         |         |         |         |         |         |         |
| 75                        |      |                 |         |         |         |         |         |         |         |         |         |
| 76                        |      |                 |         |         |         |         |         |         |         |         |         |
| 77                        |      |                 |         |         |         |         |         |         |         |         |         |
| 78                        |      |                 |         |         |         |         |         |         |         |         |         |
| 79                        |      |                 |         |         |         |         |         |         |         |         |         |
| 80                        |      |                 |         |         |         |         |         |         |         |         |         |
| 81                        |      |                 |         |         |         |         |         |         |         |         |         |
| 82                        |      |                 |         |         |         |         |         |         |         |         |         |
| 83                        |      |                 |         |         |         |         |         |         |         |         |         |
| 84                        |      |                 |         |         |         |         |         |         |         |         |         |
| 85                        |      |                 |         |         |         |         |         |         |         |         |         |
| 86                        |      |                 |         |         |         |         |         |         |         |         |         |
| 87                        |      |                 |         |         |         |         |         |         |         |         |         |
| 88                        |      |                 |         |         |         |         |         |         |         |         |         |
| 89                        |      |                 |         |         |         |         |         |         |         |         |         |
| 90                        |      |                 |         |         |         |         |         |         |         |         |         |
| 91                        |      |                 |         |         |         |         |         |         |         |         |         |
| 92                        |      |                 |         |         |         |         |         |         |         |         |         |
| 93                        |      |                 |         |         |         |         |         |         |         |         |         |
| 94                        |      |                 |         |         |         |         |         |         |         |         |         |
| 95                        |      |                 |         |         |         |         |         |         |         |         |         |
| 96                        |      |                 |         |         |         |         |         |         |         |         |         |
| 97                        |      |                 |         |         |         |         |         |         |         |         |         |
| 98                        |      |                 |         |         |         |         |         |         |         |         |         |
| 99                        |      |                 |         |         |         |         |         |         |         |         |         |
| 100                       |      |                 |         |         |         |         |         |         |         |         |         |



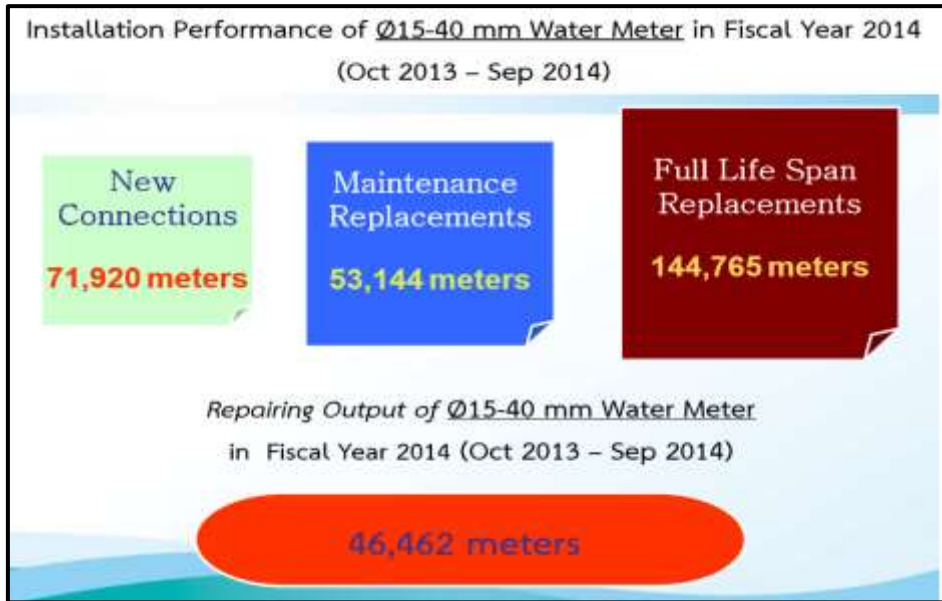
Life span of water meters are defined as shown in figure.



Full life span meters are replaced with the new ones with free of charge. However, the damaged one which of its age is under the defined life span are repaired and reinstalled. While the new one is wanted by the customer, it must be cost by the customer.

Installation Performance of 15-40mm Ø Water Meter in 2014 Fiscal Year





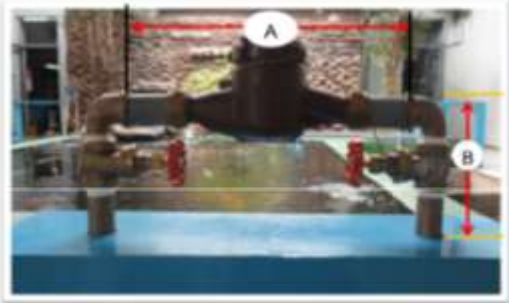
Installation Performance of 50-400mm  $\varnothing$  Water Meter in 2014 Fiscal Year



Installation of meters are done as the following photos.

Installation of small meters


**Small meter Installation**  
 Ø 15 - 40 mm.



| Dimension (mm.)                        | 15  | 20  | 25  | 40  |
|--|-----|-----|-----|-----|
| Length: Meter + Union (A)              | 250 | 310 | 380 | 380 |
| Height : ground to center of meter (B) | 110 | 120 | 140 | 170 |

Installation of large meters

**Large meter Installation**  
 size Ø 50 - Ø 400 mm.



**Water meter Installation Standard**  
 Compose meter set with Straight Cast Iron & Strainer

2 Types

|                        |                 |
|------------------------|-----------------|
| Type1. Up Stream = 10D | Down Stream= 5D |
| Type2. Up Stream = 5D  | Down Stream= 3D |

D = Pipe diameters

The main reasons causing unaccuracy of water meter are the quality of water meter, installation fault of water meter, turbidity content in water, unqualified gasket and the larger size of water meter than that of water conduit pipe. The adequacy of the size of water conduit pipe and that of the water meter can increase the NRW Ratio upto 1-2 %.

According to the site visit to the Engineering Material Testing Building of MWA Engineering Standard Department, the laboratory tests such as Tensile test for the Rubber Gasket according to the ASTM F477-02, Concrete Compressive Test, Sieve Analysis Test to get the grain size distribution of sand, Specific Gravity Test, Solubility Test, Tensile test for Bolt and Nut, Acetone Resistant Test and

Copper Alloy Chemical Composition Test to know the homogeneity of PVC pipes, can be carried out in that building. It is known that the results obtained from those tests are reported to Engineer, Sectional Chief and Department Director.

On 28<sup>th</sup> November, 2016, there was site visit to Survey & Design Department. Department was formed 40 years ago with 20 staffs which becomes around 200 staffs at present.

In Survey & Design Department,

There are four divisions as follows formed with twelve sections;

1. Civil Work Design Division
2. Trunk main Design Division
3. Water Distribution Pipeline System Design Division
4. Land Acquisition Management Division

During the site visit, MWA defined the design criteria which is nearly closed to that of AWWA and the amendment of MWA is to define the unit weight of soil and soil submerged unit weight according to the soil condition of the owned country. The reason is that Thailand used water from tube well only since the last 50 years . Therefore, at present they are facing soil settlement of 2cm-5cm per year and the design criteria of AWWA is defined based on that soil condition. Therefore, since the time of water distribution

the public, the underground

could provide to rule not to exploit water was issued.

|    |  |                          |                    |
|----|--|--------------------------|--------------------|
| 1  | Yield Strength of Steel                              | = 2,300                  | Kg/cm <sup>2</sup> |
| 2  | Allowable Tensile Strength of Steel                  | = 1,400                  | Kg/cm <sup>2</sup> |
| 3  | Specific Weight of Steel                             | = 7.85 x 10 <sup>3</sup> | Kg/cm <sup>3</sup> |
| 4  | Modulus of Elasticity of Steel                       | = 2,100,000              | Kg/cm <sup>2</sup> |
| 5  | Specific Weight of Water                             | = 1.00 x 10 <sup>3</sup> | Kg/cm <sup>3</sup> |
| 6  | Specific Weight of Cement Motar                      | = 1.8 x 10 <sup>3</sup>  | Kg/cm <sup>3</sup> |
| 7  | Specific Weight of Reinforced Concrete               | = 2.4 x 10 <sup>3</sup>  | Kg/cm <sup>3</sup> |
| 8  | Unit Weight of Soil                                  | = 1.6 x 10 <sup>3</sup>  | Kg/cm <sup>3</sup> |
| 9  | Soil Submerged Unit Weight                           | = 0.6 x 10 <sup>3</sup>  | Kg/cm <sup>3</sup> |
| 10 | Design Internal Pressure (Hydrostatic Pressure Test) | = 8                      | Kg/cm <sup>2</sup> |
| 11 | Compressive Strength of Concrete                     | = 180 Kg/cm <sup>2</sup> | or greater         |

### Design Criteria

In design calculation of pipe, the total external load are vertical pressure, lateral pressure and reaction pressure. There are the formule to calculate the weight of road and vehicles load passing the road. Those calculation methods are same as those of AWWA by replacing with MWA data. Those formale have been used since the City is established. In addition to this, the rule that prohibit the entering of the trucks which can cause the damage problem of road and distribution pipe into Bangkok is issued. The reason is that the loads of these trucks are not included in the design calculation. In Myanmar, it is suggested that seismic load should also be considered in design calculation.

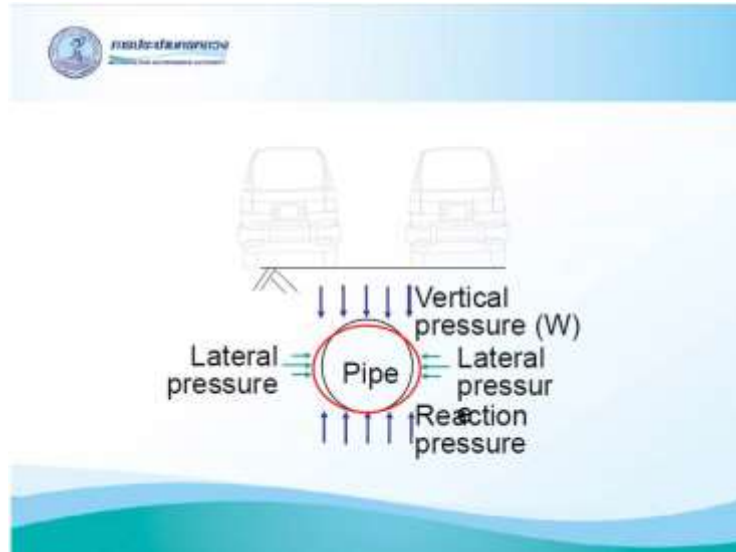
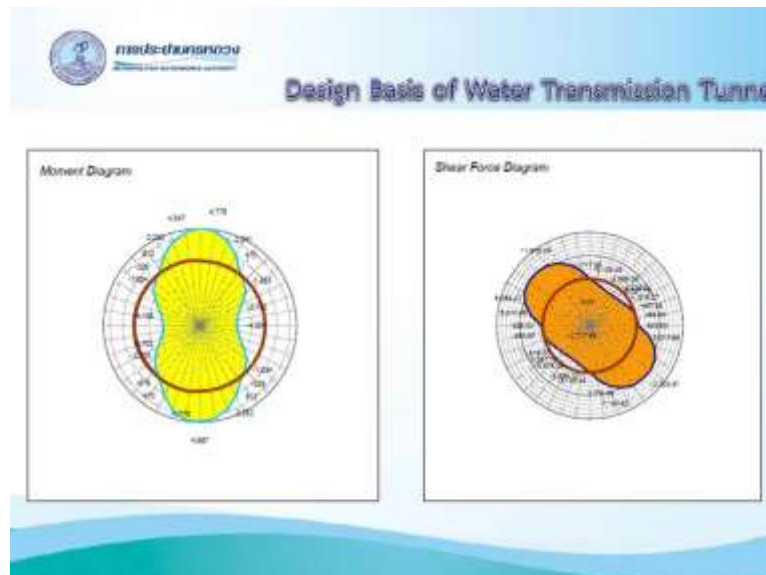


Figure showing Vertical pressure, Lateral Pressure and Reaction pressure to the pipe

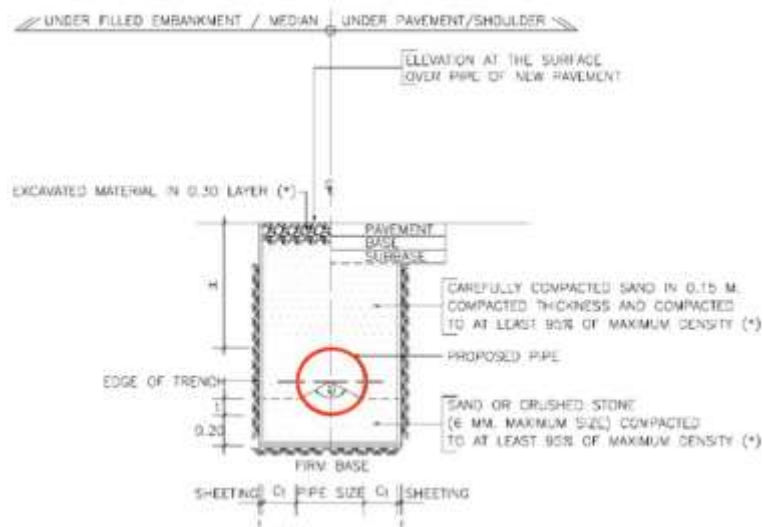


Moment Diagram & Shear Force Diagram

The Pipe Laying Design is according to AWWA.

$C_1$ =clearance on each side of pipe

$t$ =the submerged depth of pipe and there are sand layer and foundation under the pipe. Each layer of 30 cm (1') sand is compacted with compacting machine without pressing tightly in order to get the condition that the pipe can vibrate. Vacant place is left for the pavement thickness. The pavement thickness is discussed with the road design team.



**Pipe laying Design**

Pipe line classification is defined as

- Pipes from water treatment plant to pumping station (3400mmØ (134") ~ 2000mmØ (78")) are classified as Tunnel & Transmission conduit.
- Pipes from Trunk main to the alley (400mmØ (16") ~ 100mmØ (4")) are classified as Distribution pipe.
- Pipes from Distribution pipe to customers (20mmØ (3/4") ~ 50mmØ (1")) are classified as Service pipe.



**Pipe line Classification**

There are different kinds of valves to control water pressure such as Gate Valve, Butterfly Valve and Air Valves. BV can be damaged with the high-water pressure and therefore, GV should be used for high water pressure. Though BV is convenient for narrow space, it is inconvenient for controlling water

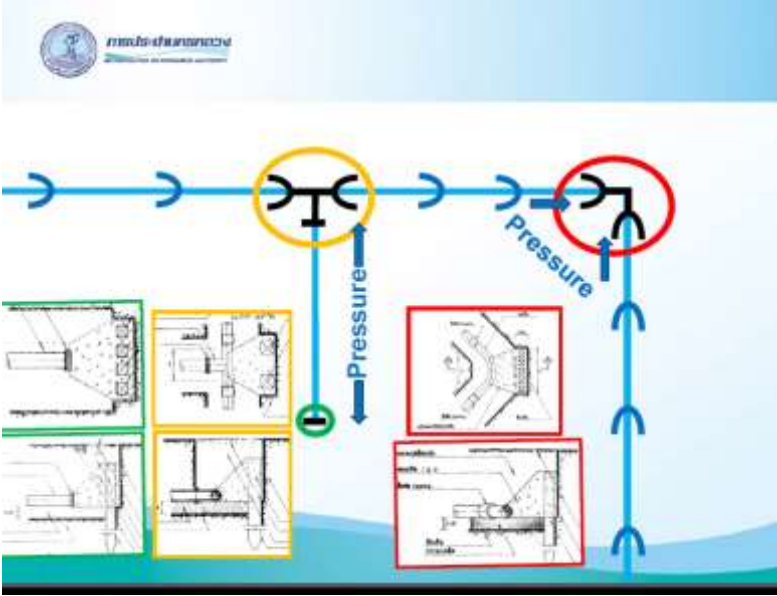


pressure. Therefore, in the places of controlling water pressure, GV is used and while in the process of shutting/opening, BV is used.

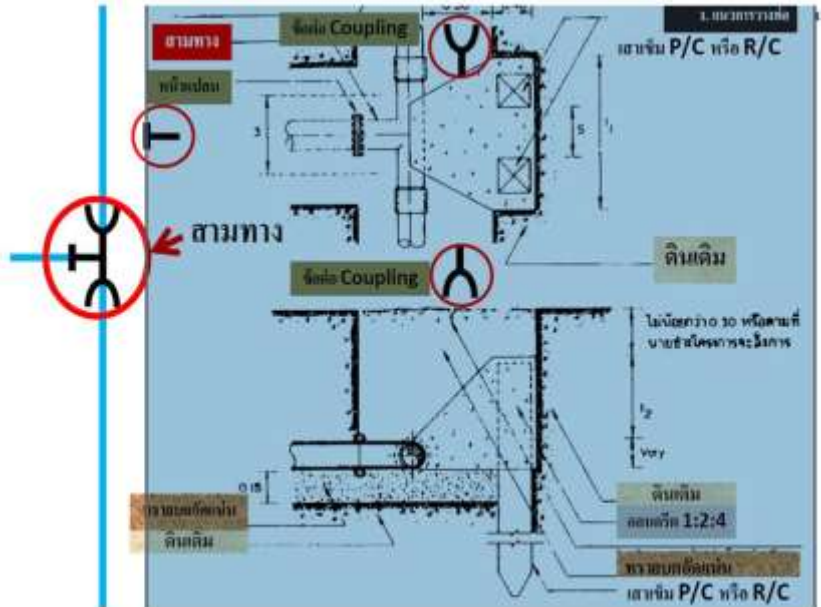


**Gate Valve and Butterfly Valve**

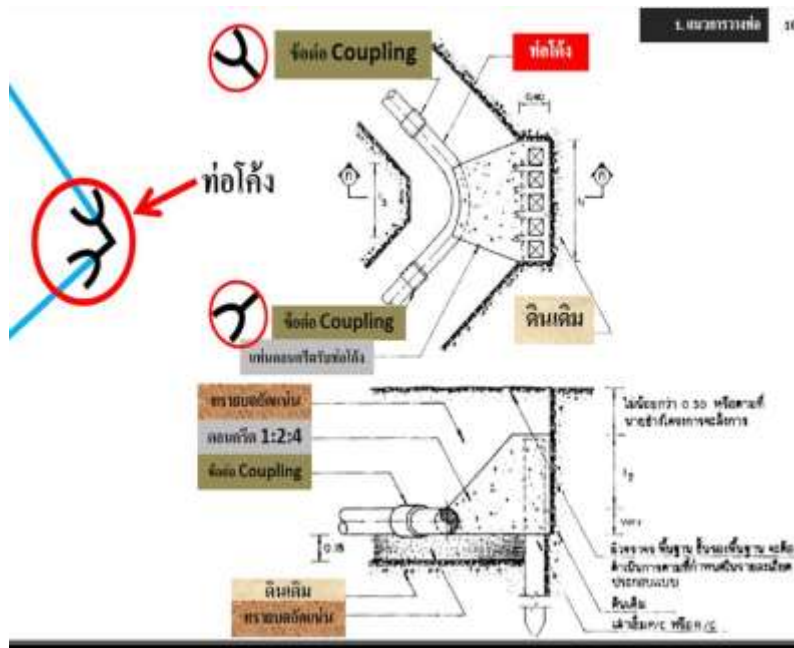
Pipe guide should be used due to the cause of pressure at Pipe fitting such as Tee, Elbow and End cap.



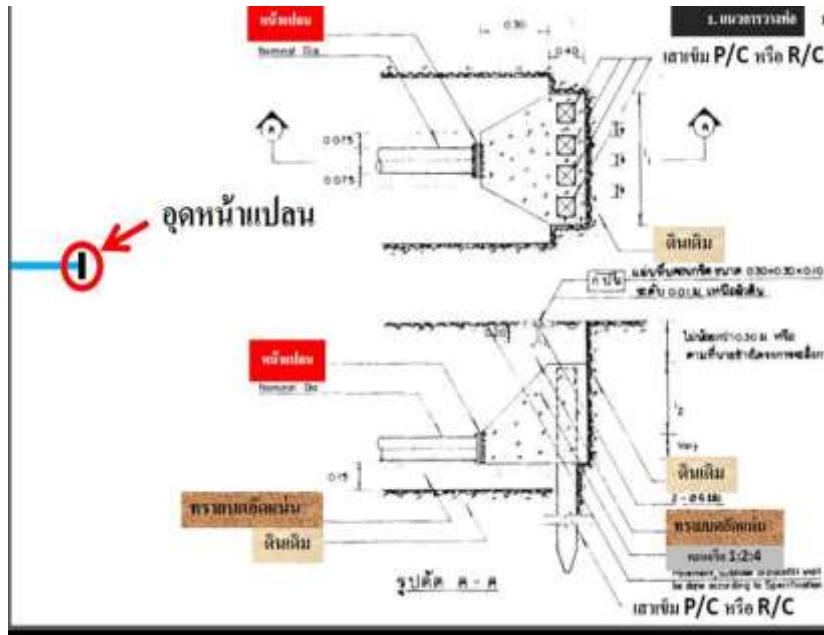
**Figure showing Pressure acted to Tee, Elbow and End cap**



Pressure acting to T junction



Pressure Acting to Bent



**For End cap**

Nowadays, pusher is used to lay the pipe line because the land owner used to make objection when the pipe line is laid over the residential area.

There are two main tasks to be carried out for Survey & Design Department. They should cooperate with City Water Supply Department and other departments such as road, electricity and irrigation departments. Therefore, the water pipe line team should cooperate with the road team. The design of the pipe line is produced with the cooperation of road team. In such cases, the water supply department can produce the pipe design which is fitted to the road. The road team have to understand about the related work of water supply and the water supply team also should know the road related work in vice versa.

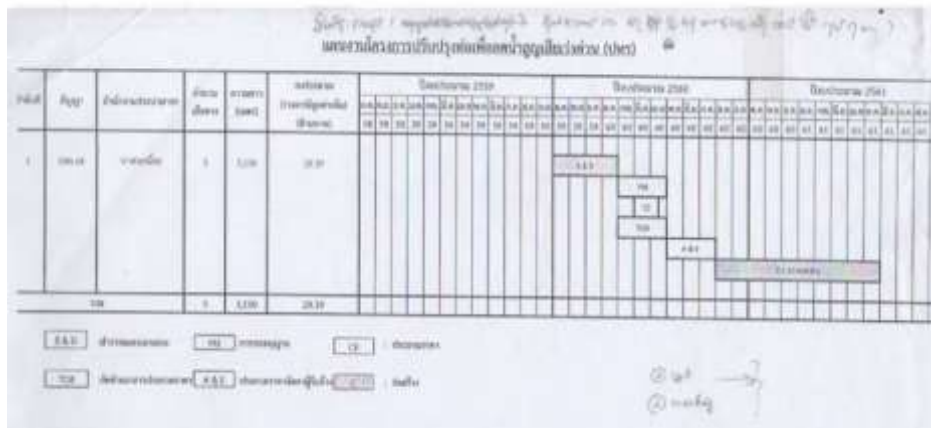
While the visit to Trunk Main Renovation Design Section and Trunk Main System Division, the list of the work was shown by the Project Implementation Division as the below figure. In this list, the location of the project, geographic condition, estimated budget, cost estimation, type and length of the pipe are tabulated according to the fisical year of the projects to be carried out.

The image shows a photograph of a document titled 'แผนการดำเนินงานโครงการปรับปรุงท่อส่งน้ำชุมชน (2563)'. It contains a table with the following columns: 'ชื่อโครงการ' (Project Name), 'พื้นที่โครงการ' (Project Area), 'รายละเอียด' (Details), 'งบประมาณ' (Budget), 'ปีงบประมาณ' (Fiscal Year), 'ปีดำเนินการ' (Implementation Year), and 'หมายเหตุ' (Remarks). The table lists several projects with their respective budgets and implementation years.

| ชื่อโครงการ            | พื้นที่โครงการ  | รายละเอียด             | งบประมาณ (บาท) |         |         |         |         | ปีงบประมาณ | ปีดำเนินการ            | หมายเหตุ |
|------------------------|-----------------|------------------------|----------------|---------|---------|---------|---------|------------|------------------------|----------|
|                        |                 |                        | ปี 2563        | ปี 2564 | ปี 2565 | ปี 2566 | ปี 2567 |            |                        |          |
| ปรับปรุงท่อส่งน้ำชุมชน | พื้นที่ 1.5 ไร่ | ปรับปรุงท่อส่งน้ำชุมชน |                |         | 2,000   |         | 2,000   | 2563       | ปรับปรุงท่อส่งน้ำชุมชน |          |
| ปรับปรุงท่อส่งน้ำชุมชน | พื้นที่ 1.5 ไร่ | ปรับปรุงท่อส่งน้ำชุมชน |                |         | 2,000   |         | 2,000   | 2564       | ปรับปรุงท่อส่งน้ำชุมชน |          |
| ปรับปรุงท่อส่งน้ำชุมชน | พื้นที่ 1.5 ไร่ | ปรับปรุงท่อส่งน้ำชุมชน |                |         | 800     |         | 800     | 2565       | ปรับปรุงท่อส่งน้ำชุมชน |          |
| รวมทั้งหมด             |                 |                        |                |         | 5,100   |         | 5,100   |            | ปรับปรุงท่อส่งน้ำชุมชน |          |

**Sample Project List shown by Project Implementation Division**

In addition to the project list, each project is mentioned according to the time period to be carried out by each corresponding department.

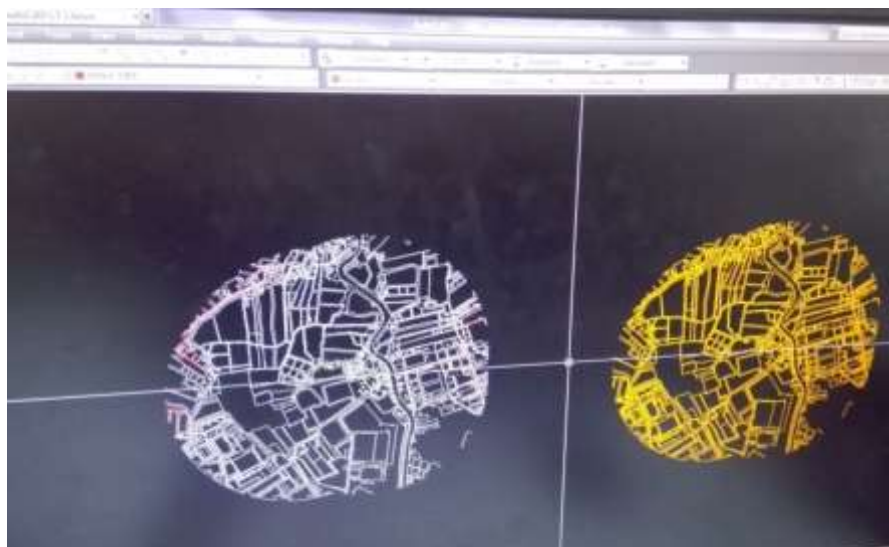


**Sample project time table for each corresponding department**

In this time table, the time breakdown is listed for respective department from the beginning to the completion of the project as follow:

1. 4 months for Survey and design for Survey and Design Department
2. 3 months for Budget Permission and Land Acquisition Management Division, S&D Department
3. 1. 5 months for Cost Estimation, Cost Estimating Division, Engineering Standard & Geographic Information Department
4. 3 months for TOR and tender document preparation, Contracting section, Project Management Department
5. 3 months for Tendering, Tender Management section, Project Management Department;
6. 10 months for construction stage, Construction Department;

The required map is requested to the GIS section with mail or phone from the department. AutoCAD drawing is made in the map sent from GIS section.



**Sample Auto CAD sent from GIS section**

The route is selected depending on the road intersection, creek crossing, trees, pipe line layout and road condition. For example, the risk of the electric shock with water is primary criteria to be considered if the existence of electricity pole is occurred. When the pipe is laid adjacent to the electricity pole, the location between the pole and road is the suitable place because it cannot cause the damage to the residences.



**Location causing the pipe laying problem**

In case of laying pipe on the residential area, the problem of relocation of pipe and compensation used to be occurred due to the complaint of the owner. The most important thing is not to be negative impact to the residential area. Furthermore, when location to lay the pipe is not available, it should be laid at road area. Therefore, it should discuss with road department. If there is no choice, it (pipe laying) should be done by compensating to the owner for the land price.

For the place of creek crossing, the depth of creek and water level are needed to be measured. If those creek is corresponding to the irrigation department, in case of no permission from that department, performance of pipe laying using saddle along the bridge. Therefore, A-shape RC pole have to be used as shown in the following figure. A-frame should be located beside the pole constructed by Irrigation department in order to get the smooth transportation by boats along the creek.



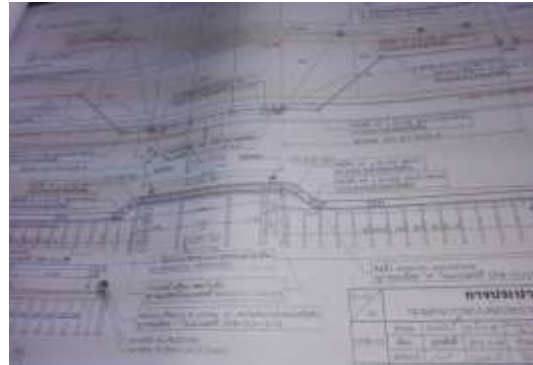
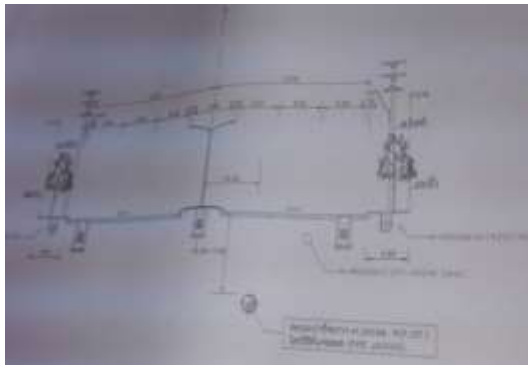


## 2.1 คุณสมบัติท่อ -- ท่อเหล็ก (ST)

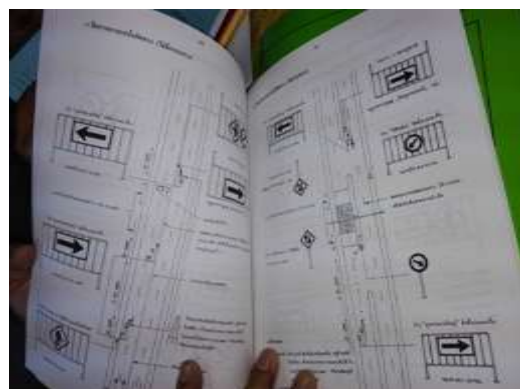


### Usage of Reinforced Concrete A type-frame pole in creek crossing

Project is carried out according to the implemented Auto Cad Drawing. Detail of Bend, Tee, Valve, trees and signboard are included in the Auto CAD drawing. Moreover, the list including type of pipes, pipe length, the location to be carried out, the place, time and period that the water will cut out while the work is doing must be prepared.



Detail Auto CAD drawing



Detail Auto CAD drawings

If the electric pole, residents and roads are located closely, there is a possibility of causing a car accident to the road user. If the pipe will be laid in such places, all conditions should be considered.



**Closely Located Electricity Pole, Residence and Road**

MWA discussed the difficulties experienced in performing the work and problem-solving ways.

✿ Formerly, there is no relation between road team and water supply team in laying water pipe. As a consequence of this fact, the remaining pipe line on the road can be seen by seeing the Gate Valve location.



**Existance of Gate Valve on the Road**

✿ The pipe line in this figure is extruded onto the road because of unsystematic pipe connection of the old system. Nowadays, demolishing of the old pipe are doing. If the removal of old pipe is not difficult, the old pipe are replaced with the new pipe line. If it is difficult to remove the old pipe line, the new pipe line is laid adjacent to the old pipe line.



**Unsystematic Pipe Connection**

❖ Difficulty in laying pipe line comes out because the road department take large space to construct platform. The electricity pole and trees are located along the pipe line and therefore, the pipe laying is carried out depending on the conditions. For trees cutting, permission from the respective authority must be requested.



**Field Survey to Lay Pipe Line on the Wide Platform**

❖ Pipe laying work of the below figure is a special case. Road is laid over the creek and the residences near the road were using the water from the creek and open channel in the past.

❖ Nowadays, using pipe support, PVC pipe laying has been done. It is very easy to lay pipe using pipe support. Considering the easy accesses of the villagers by boat, bends are used at the junction of creeks and channel.

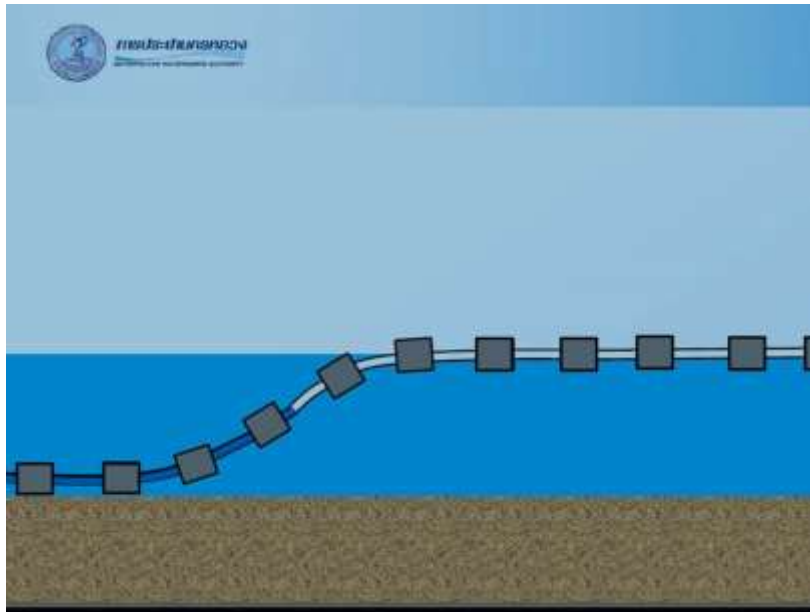


**Pipe laying on the concrete road constructed over the creek**

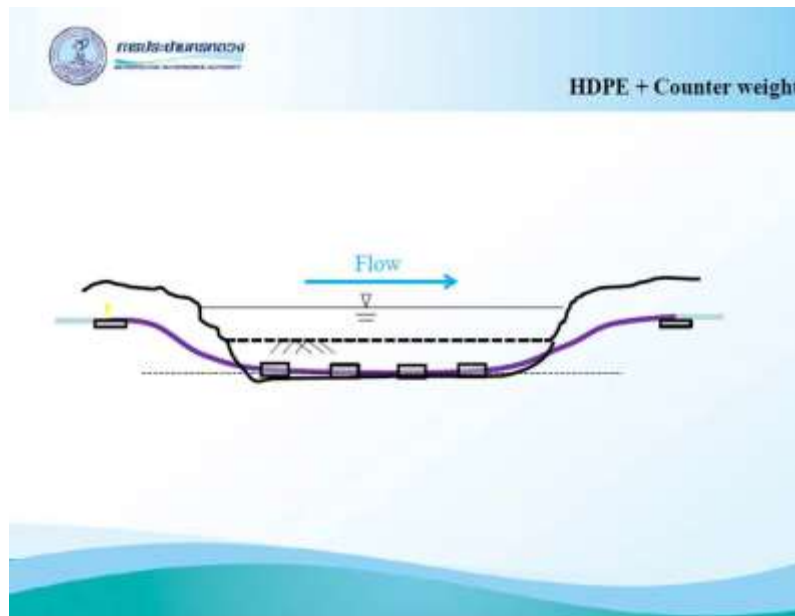


**Usage of bends at the junction of creeks and channel**

The figure shows the work of HDPE pipe laying over the river bed. In performing this work, counter weight is used together with the pipe. In the case to remove the pipe, when water is released out after shutting the GV, the pipe floats on the water surface. The signboard showing the existence of pipe line under the water must be installed. At the signboard's location, it is better to install water meter.



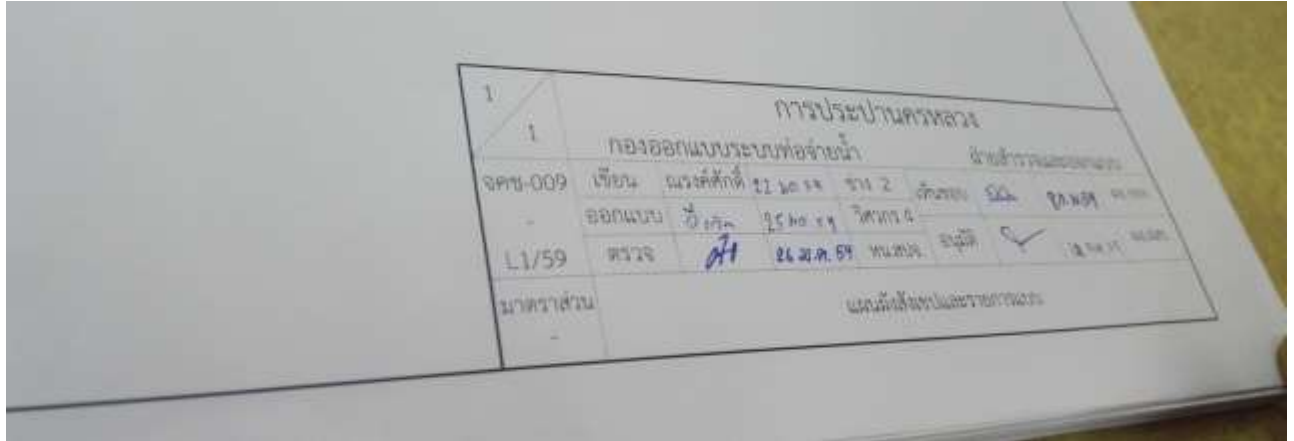
**Pipe laying on the river bed**



**Pipe Laying Work Finishing on the River Bed**

After making draft drawing after field survey and complete drawing with Auto Cad, the signatures of the drafter, designer, checker and the approved persons are necessary.





**Drawing with signatures of drafter, designer, checker and the approved person**

After that it should be submitted to until level 11 step by step.

Most of the works are pipe repairing work for the water loss problem found by DMA during inspection. Water losses are mostly occurred at the distribution and service pipe lines. Pipe line is concerned with S&D department and water loss problem in the pipe is concerned with DMA. The amount of water loss is large as long as the length of water pipe line distributed from MWA. Therefore, it is also necessary to control the water loss by rules and regulation. Water losses are frequently occurred in the old water pipe of long age, the old water storage tank, the place where water meter is installed, the places passed by the heavy trucks and mainly in service area. Systematic performance to find and investigate water loss by DMA is necessary. Therefore, it is needed to consider for DMA system while doing pipe line. And because of this, it is able to find the problem by step testing for NRW.

We have learnt that the contractors being selected to carry out the project have to submit shop drawing.

On 29<sup>th</sup> December, 206, the study is continued in Trunk Main Renovation Design Section and Trunkmain System Division. Explanation about DMA system was recieved. DMA must be considered at the beginning of pipe line connection. DMA should be divided by valves to prevent mixing with another DMA.

Branch office should be provided to make DMA and the numbers of DMA to be placed at each branch office should be considered ahead. Furthermore, environmental facts must be collected in ahead. Those DMA should be connected with township office and head office. In the wide region, small sub-DMA should be provided.

In one DMA, one branch is organized with sub-branches. These branch offices are doing water distribution, collecting water tariff, reading water meter and water loss prevention.

After that, discussions are made concerning with the performance of MWA. The topics are:

- a) At the beginning of the establishment of MWA, the works are done by hiring external organizations but it was inconvenient. Long term achievement can be obtained by working together with various organization and therefore organization was formed with own staff and the work are done.

- b) The design criteria of MWA is made according to the Engineering Council and confirmed with the National level.
- c) MWA defined the design criteria by themselves. Formerly, it was difficult to perform under ministry of construction. AV and WO valve should be located in 1km (3280') spacing. In MWA, Design criteria are drawn only for flat ground region.
- d) Design process is same as done by JICA but different with government policy. MWA need to connect with all organizations.
- e) In the time when enough water supply can be provided, water from tube well is not permitted to exploit.
- f) In order the work performance to be easy, cooperation and relation with other organizations is necessary. If it is necessary, it should connect and relate in every time. For example, in discussing with road team, if road team need to do the work, working together with road team make cost reduction and easy. (road team is given as an example and also it should be other organization such as electricity and irrigation)

The difficulties experienced in MWA are:

Main difficulties are occurred in cooperation with other organizations. The reason is that other organizations need to do a work. However, before starting the work, closely relation with those organization is necessary. The work they are performing, should be known. It is necessary to know how they are doing in drawing. By doing so, the appropriate way to do can be found. (Example, by seeing the performance of electricity and road team, negotiation with those organizations to change the route if their selected route is inconvenient for our work is possible and understanding and knowing the best way to lay pipe line depending on the work by other organization, parallel work of making drainage and pipe laying to avoid demolision of drainage and wall also can be achieved.

Technical Problems are always to be happened and at that time, the problems are solved by special techniques. For example, it is not convenient to lay pipe by collapsing residences and therefore, pusher is used to lay pipe. If there is no way to do, the special techniques are used even it is costly way. Such kind of discussion are made and learned in MWA.

After that, we visited to the project place of Rom Klao Bridge together with assistant engineer Daw Khin San Win (Inspection and Construction). For that project, BMA (Bangkok Management Administration) is hired as an only one contractor for water pip line work and electricity work. The works are related to each other and those are deviated from the work plan and therefore only one contractor is hired. MWA stationed at office and need to monitor and check the project.

The project is to construct 3km long 800 mmØ ST pipe and 1km long 300 mmØ PVC pipe. Gas pipe line are existing in 3 feet depth of that place. Pipe laying, sand compressing are done and checked by BMA (Bangkok management administration, Bangkok City)



**Discussion at the project of Rom Klao Bridge**



**Investigation at the project Rom Klao Bridge**

Then, while investigating in the site, works are done and pipe laying work could not be seen.

In this way, it is reported that standard, guideline, manual and SOP (Design) have been learnt at MWA.

#### **4.8 Problem Solving Methods and Performance**

In August 16 of 1967, Metropolitan Waterworks Authority (MWA) was formed and in 1974-1978, 800,000 m<sup>3</sup>/day of water are distributed with Bangkok Water Supply Improvement Project. And also, the following projects are planned and implemented by MWA. They are in 1978-1982, as 2<sup>nd</sup> Bangkok Water Supply Improvement Project, 800,000 m<sup>3</sup>/day and in 1982-1984, as 3<sup>rd</sup> Bangkok Water Supply Improvement Project, 400,000 m<sup>3</sup>/day, in 1988-1992, as 3<sup>rd</sup> Bangkok Water Supply Improvement Project, 800,000 m<sup>3</sup>/day, in 1991-2000 as 4<sup>th</sup> Bangkok Water Supply Improvement Project, 400,000 m<sup>3</sup>/day, in 1992-2002 as 5<sup>th</sup> Bangkok Water Supply Improvement Project, 400,000 m<sup>3</sup>/day, in 2005-2007 as 6<sup>th</sup> Bangkok Water Supply Improvement Project, 400,000 m<sup>3</sup>/day, in 2000-2011 as 7<sup>th</sup> Bangkok Water Supply Improvement Project, 800,000 m<sup>3</sup>/day, in 2006-2009, 2008-2014 as 8<sup>th</sup> Bangkok Water Supply Improvement Project, 800,000 m<sup>3</sup>, in 2006-2012 as 9<sup>th</sup> Bangkok Water Supply Improvement Project, 800,000 m<sup>3</sup>/day.

Furthermore, as a road map, MWA strategic Management Planning is prepared and implemented for the following projects.

In 1967, Improvement of water resource and domestic water Project,

In 1978, Improvement of the capacity of water supply project,

In 1988, Improvement of the amount of water supply and defining standards,

In 1999, Capacity Development of water supply, investigation of water resource and planning for satisfaction of water user

In 2008, Improvement of Water Supply Capacity Management, water user, supplier and information technology Assessment Project,

In 2012-2016

(1) To perform to get clean and sufficient water supply to the user,

(2) To be able to perform long term development of water supply, distribution and water usage by using high standard infrastructure,

(3) To come out the first international standard of south East Asia in the field of Administration, Social and environmental,

In 2017-2021, production of safe water in accordance with international standard.

Water resource of MWA are 73% from Chao Phraya River and 23% from Mekong Dam. Water intake building from Chao Phraya River is constructed 96 km from Thailand guard. Nowadays, global warming, defrozing of Ice Mountain, flooding and drought are occurred due to the climate changes and the water quality of Chao Phraya River has become poor in the last 20 years ago. Although sea water intrusion in the past was below 80km from the river mouth, at present it becomes over 96 km and the problem of sea water intrusion is occurred at the intake point.

To solve those problems, 4S policy is established. The meaning of 4S is Stability, Safety, Sufficient, and Sustainability and to implement that policy, preparation, short-term plan and long-term plan are implemented.

Pretreatment in Raw Water Intake, improvement of Water Treatment Plant Process from conventional system to advanced system and preparing emergency plan have been performed.

Annual Required staff are selected by Manpower Planning Section. Staff selection are done based on the following criteria such as, master plan and long term principle of the project, the nature of the work, scope of the work and required number of manpower.

The numbers of staff to be employed are limited and controlled by the facts such as the amount of water consumption, charges for water, ratio of staff, expense of each staff, income, outcome and fund of the department. Annual staff employment plan is made by adjusting the effect of newly employed staff on the existing staff, pension, and promotion.

Main work, master plan development project, customer relation, financial and main authority management task are performed with internal staff. Non-important work are done by employing external staff. By performing the work separately in such way, production cost can be reduced, ability of the staff is able to assess, production skill can be improved, and the challenge of the work can be shared. Such kind of positive results can be obtained. At the same time, the negative results such as decreasing water quality, decreasing assessment on the customer (water user) and causing long term promise, can be occurred also.

In collecting water tariff, two types are classified with different rates.

- (1) residence,
- (2) commerce, government agency, state enterprise and industry

Progressive rate is used in collecting water tariff.

**WATER TARIFFS**  
Effective December 1999

| Type 1<br>Residence |                                  | Type 2<br>Commerce, Government Agency,<br>State Enterprise and Industry |                                  |
|---------------------|----------------------------------|---|----------------------------------|
| Volume (cu.m.)      | Baht/cu.m.                       | Volume(cu.m.)   | Baht/cu.m.                       |
| 1-30                | 8.50<br>Not less than 45.00 Baht | 0-10  | 9.50<br>Not less than 90.00 Baht |
| 31-40               | 10.03                            | 11-20   | 10.70                            |
| 41-50               | 10.35                            | 21-30   | 10.95                            |
| 51-60               | 10.68                            | 31-40   | 13.21                            |
| 61-70               | 11.00                            | 41-50   | 13.54                            |
| 71-80               | 11.33                            | 51-60   | 13.86                            |
| 81-90               | 12.50                            | 61-80   | 14.19                            |
| 91-100              | 12.82                            | 81-100  | 14.51                            |
| 101-120             | 13.15                            | 101-120   | 14.84                            |
| 121-160             | 13.47                            | 121-160   | 15.16                            |
| 161-200             | 13.80                            | 161-200   | 15.49                            |
| over 200            | 14.45                            | over 200  | 15.81                            |

MWA has been charged the untreated water at the rate of 0.15 baht or 15 satang/cubic meter to the Royal Irrigation Department.

The main facts in defining the water tariff,

(1) It must be fair water tariff and it must cover the production cost, it must be able to implement the projects and it must be fit to the Government policy

(2) In planning the financial projects, it is based on the external facts such as GNP, currency fluctuation, currency exchange rate, time, rules and departmental facts such as investment rate, operational cost, and depreciation rate.

In planning, it is divided into annual project, 5-years project, and long-term project. Budget is defined as one year budget starting from this year of October 1<sup>st</sup> to the next year September 31. In budget, there are two items, income and expenditure. Water tariff and other income are included in income. In expenditure, operational cost and investment are included. Operational cost is requested and obtained from Board of Director and investment cost are requested from Union Government Cabinet. Budget usage are controlled by revising the budget after usage, reporting, and revising with standard.

In making list of fixed assets, official used things are listed systematically and depreciation rate calculation, defining life span of assets are done. Depreciation rate is calculated by straight line method and life span of the assets are estimated by engineers. Unusable assets are listed and removed by Asset



Accounting Division.

In managing Entitled Assets, it is mainly divided into (1) principal commercial entitlement, (2) information system and (3) non-principal commercial entitlement. In (1) principal commercial entitlement, water resource, intake canal, water pump, electrical system, sedimentation tank, filtration tank, water storage tank, chemicals, disposals, main pipe and distribution pipe are included. In information system, Scada, GIS, Internet are included. In non-principal commercial entitlement, land, building, vehicles and auxiliary things are included. As future entitlement, work promotion, improvement of planning, work performance upgrading are planned.

The following standards are used in MWA.

AASHTO (American Association of State Highway and Transportation Officials) □ACI (The American Concrete Institute) □ANSI (American National Standards Institute) □API (American Petroleum Institute) □ASTM (American Society for Testing and Material) □AS (Australian Standards) □AWS (American Welding Society) □AWWA (American Water Works Association) □BS (British Standard Specifications) □DIN (Deutsches Institut für Normung) □FDA (Food and Drug Administration) □ISO (International Organization for Standardization) □JIS (Japanese Industrial Standards) □TIS (Thai Industrial Standards) □ALA (American Lifelines Alliance (Seismic Guidelines for Water Pipelines))

Pipes are classified as from 2000-3400 mm as Transmission Conduit, 500~1800 mm as Trunk Mains, 100~400 mm as Distribution Pipes, 20~50 mm as Service Pipes. There are manuals and design guideline for calculating and designing those pipe lines.

MWA need to get the approval and permission from the land owner and authorized department in performing the project. The criteria to define Key Performance Indicator are accuracy, measurability, availability, work related and timely manner.

Those KPI will be used effectively for department vision, long term project relating to master plan, organization and work plan and will be implemented individually and organizationally. KPI will be carried out from the base level to upper by individually. In calculating KPI, performance is taken as 80% and quality is 20%.

In calculating KPI, Monitoring and Evaluation Department nominated the corresponding team and that team need to report back. Salary increment, position promotion and bonus are made based on the results.

## 5. Comparison between YCDC and MWA

### 5.1 Institutional Governance

| No s. | Situation of YCDC  | Practices in MWA   | Characteristics and Advantages |
|-------|--|--|--------------------------------|
| 1     | It's Cabinet level.  | It's a State Enterprise under Ministry of Interior.  |                                |
| 2     | For the budget allocation, confirmation will get step by step through Yangon Regional Government to Hluttaw (House of Parliament)  | BOD of MWA allocates the budget and gets confirmation step by step from Ministry of Interior.                        |                                |
| 3     | In Engineering Department (Water & Sanitation), there is one Chief Engineer, 3 members of Deputy Chief Engineers and 7 Assistant Chief Engineers and under them, it has 7 Divisions. | It has 12 members of BOD including Governor, 8 Deputy Governors and 18 Assistant Governors and governs 56 Divisions. |                                |
| 4     | Daily Water supply capacity is 0.93 cu-meters per day.   | Daily Water supply capacity is 6.32 cu-meters per day.   |                                |
| 5     | NRW is 60%.  | NRW is 23.37 %.  |                                |
| 6     | No.of Connection = million   | No.of Connection = 2.2 million   |                                |
| 7     | It takes 5 years to draft Master plan. 30 year Master Plan (2010-2040)   | It takes 7 years to draft Master plan. 30 year Master Plan (1987-2017)   |                                |

### 5.2 Organization Structure of Water Utility

| Nos. | Situation of YCDC  | Practices in MWA  | Characteristics and Advantages                    |
|------|--|---|---|
|      | Service Area sq-km<br>Production Capacity 0.914mil cu.m/day<br>No of Customers mil Pop; Served 1.7 mil Coverage Ratio 60% No of Personnels nos.<br>Water Sources Surface Water<br>NRW Ratio 60%<br>Type of connections 6 nos.<br>Total Pipe Length<br>No of WTP 6nos.No of Pumping Station 6nos.<br>No of Branch Office 33nos.<br>WaterQuality Parameters 25nos.<br>Avg;Water Supply Duration 9.1hr/day<br>Water Consumption 110 lpcd Alum,Aluminium Chlorohydrate, Chlorine dosing only | Service Area 3195 sq-km<br>Production Capacity 6.32 mil cu.m/day<br>No of Customers 2.23 mil Pop; Served 11.5 mil Coverage Ratio 99%<br>No of Personnels 5339 nos.<br>Water Sources Surface Water NRW Ratio 23.37%<br>Type of connections 2 nos.Total Pipe Length 33186 km<br>No of WTP 4nos.<br>No of Pumping Station 14nos.<br>No of Branch Office 18nos.<br>Water Quality Parameters 14nos.<br>Avg;Water Supply Duration 24hr/day<br>Water Consumption 200lpcd | Can get good quality of water.                    |
|      | Old aged pipe are using now.   | Replacing, laying new pipe line in accordance with Alum, PAC, Polyetectrolyte, PreChlorine, Post-Chlorine Doing pipe's standards.   | Can reduce NRW                                    |
|      | It has six kinds of water connections.   | Two types of water connections.   | Can get water tariff fully                        |
|      | There are also Non Revenue Connections. (FOC connection)   | Two types of water connections.   | Can get water tariff fully                        |
|      | 90 % of reservoir water and 10% of tube-well water are using now.  | 27% of reservoir water and 73 % of river water are using.   | Can reduce the cost of water quality maintenance. |

|  |  |  |   |
|--|--|--|---|
|  |  |  |   |
|  | In some tube-well, salty water is dissolved. | Salty water is dissolved in river water. | Can reduce the cost of water quality maintenance. |

### 5.3 Planning System

| Topic | Current situation of YCDC  | Practice In MWA  | Characteristics And Advantages  |
|-------|--|--|---|
| 5.3.1 | Planning section is started to establish in 2016 and under which there are two sub sections. | Planning development is formed of 4 departments and under which there are divisions.   | Division can allocate the work so that it can perform/operate the work effectively and efficiently.   |
| 5.3.2 | Based on the Master plan, improvement plan are drafted and implemented.                      | Beside Master plan and improvement plan, it has 5 years Strategic Management plan for the improvement of water supply and based on that they have drafted yearly action plan and define/make project according to departments. | Based on the 5 years Strategic Management plan, which is drafted by Strategic Management Plan division, projects will be implemented according to respective departments. |
| 5.3.3 | To set PI data, all are defined as Permanent data.   | Based on Vision, Mission and projects, KPIs are defined.   | After implementing the project, obtaining summary data are analyzed and used it for the next project as KPIs.   |
| 5.3.4 | For Monitoring and Evaluation, the staffs go on site and do it by handwriting.               | Monitoring and Evaluation Department monitors and evaluates KPIs for each division.  | They can perform/ work effectively and quickly using IT System.   |
| 5.3.5 |  | Deploy Business Continuity Plan.   | In the business works, water can be used safely and trustfully. So it can help increase of the department's income.   |
| 5.3.6 |  | Draft and deploy Water Safety Plan.  | It can help for the increase of department's income by gaining customer's trust and reliance.   |

### 5.4 Human Resources Development

| Topic  | Situation of YCDC  | Practices in MWA  | Characteristics and Advantages   |
|--|--|---|--|
| <b>HRD plan</b><br>-Detail contents of HRD plan                  | No HRD plan from long term view.                                     | Performing in organization level, Dept/Individual level and Key Changes   | Make HRD plan in details including Organization needs, Department needs and Individual needs |
| Relation between business plan and HRD plan                      |  | Look back Business plan and Business policy.  | Make HRD Plan in accordance with Business Plan   |
| Procedures to make HRD plan                                      | HRD meeting with executives first                                    | HRD Meeting with executives first, then make Training Needs Survey, Data Collection and Training Needs Analysis | Can implement IDP (Individual Development Plan)  |
| <b>Training management</b><br>PDCA cycles of training management | Now we have training with PDCA cycle.                                | -HRD Officer is monitoring training.  | Because of take feedback next training.  |
| Steps to make training plan                                      | Firstly more turnover WA staff to survey so training implementation. | About IDP to training implementation  | Each staff need analysis.  |
| Assessment of training achievement                               | Training evaluation is the decided such as                           | Level of Assessments, Type of Assessments and   | Assessment of training achievement including   |

|   |  |   |   |
|---|--|---|---|
|   | exam, site visit report, attend, obedient and discussion.                          | Tools.  | advantage and disadvantage.   |
| Staff record on training participation  | Staff record keep document.  | Used internet internal online. (SAP system)   | Easily see training profile and record  |
| <b>OJT</b><br>- Any system to enhance OJT?  | Difficulties to promote HRD activities in each workplace.                          | Senior staff to junior staff knowledge sharing.   | New staff knows Responsibilities.   |
| Role of supervisors for OJT   |  | Coach system  | OJT starts Japan so continue.   |
| How to bring up OJT Trainers?   |  | Do Non-class room training  | Reduce cost   |
| <b>Organization and responsibilities</b><br>-Whole organization structure and HRD related section | Responsibilities of YCDC are to support to achieve the mission and vision of YCDC. | Responsibilities of HRD are to support to achieve the mission and vision of MWA.                        | Make plans and implement the plans.   |
| Duties and responsibilities of each section related to HRD  | Responsibilities of each section are not clear.                                    | Share the responsibilities of each section with the coordination of Corporate Communication Department. | Link between sections is strong and it has a good communication among sections. |
| <b>Personnel evaluation</b><br>Detail system of personnel evaluation                              | No official system for Personal evaluation.  | Especially IDP Plan implementation.   | Easily know each staff improves.  |
| Responsibilities of each manager  | Low awareness of mid-level managers for HRD.                                       | Approve Responsibilities each section.  | MWA's vision and mission implementation.  |
| How to utilize the result of the evaluation   | Give Promotion   | Do complete MWA Straggly target   | Good service  |
| Relation between evaluation and incentives  | No incentives system   | Look Annual Report  | -staff try  |
| <b>Resource of HRD</b><br>Role and organization of training center                                | No training center at EDWS.  | Firstly design vision and Mission   | Training improvement  |
| Procedures to improve training materials/textbooks  | -Coming soon Library at EDWS   | Training room and facilities, Library and E-Library.  | Each staff improvement self-learning.   |
| System to bring up internal trainers  | Rich experience staff  | Give training Coach system, trainer fee, aboard training.   | Too busy so try trainer.  |
| Library/information management for staff reference  |  | Build to e-Library and use internal website.  | Easily know staff self-learning and information.                                |

## 5.5 Corporate Accounting

| Topic | Situation of YCDC   | Practices In MWA   | Characteristics and advantage   |
|-------|---|--|---|
| 5.5.1 | Although the organization chart is well organized, individual job description is not clear. As assigned duties and responsible section does not match and the duties are mixing, it is difficult to analyze and to make comparison for improvement. | In MWA, duties and responsibilities of each section are clarified and individual job description is clear. Moreover, the staffs have to perform only the duties according to their individual job description. | As the staffs have to work only the responsible part, they can analyze their implemented work, can compare with the previous year's record. |

|       |   |  |   |
|-------|---|--|---|
| 5.5.2 | Use Government Accounting System and make the accounts in cash basic. But we don't have/make P/L and B/S. Thus we cannot know the actual status of the organization.        | Apply Corporate Accounting System and Actual Basic. Make Financial Statement monthly, quarterly and annually and submit Financial Report to respective authority.  | By making Financial Statement, the actual situation/status can be known and the necessary management can be prepared to improve the work.   |
|       | We don't have Data recording/inputting system. Although there are some records, they are not secure and not reliable, and cannot help for analysis and comparison.          | Apply systematic Data input. Input Data in the system monthly, quarterly, annually. And can monitor and analyze & compare the data of each customer.   | As the result of Continuous analysis, we can do necessary management effectively. And it can prevent possible losses.   |
| 5.5.3 | As EDWS cannot apply IT fully, the department relies on the workforce with more staffs, on the other hand, the expenditure for salary and office materials cost a lot more. | As MWA applies IT effectively, it can reduce the current expenditure concerning with staffs.   | As it can reduce the current expenditure, it can increase profit percentage.  |
| 5.5.4 | Assets are not recorded systematically and the necessary information is not available.  | In MWA, from the state of ordering to receiving the item, registering in asset list, purchasing and giving out the item to the respective section/department are carried out systematically. Then input in depreciation account with necessary data by following Accounting Policy. And then do monitoring, analysis and comparison. | Continuous monitoring, comparison and analysis are effective for the work and can decrease the possibility of loss as much.   |
| 5.5.5 | Prepare BE, RE as budget proposal. Don't monitor Payable, Income, Outcome, Account receivable and each account.   | Expenditure process of each project implementation is monitored. Each account is recorded and kept systematically. Value-added Tax and Withholding Tax are regularly check and compared with the previous financial year's data of tax.  | As the result of Continuous analysis, we can do necessary management effectively. And it can prevent possible losses.   |
| 5.5.6 | The main income of EDWS is water tariff and it is 90% of total income.  | Revenue Structure of MWA is Water Sales 85.21% Water meter operating revenue 3.94%, Tab water connection fees 1.99% Under the title of Other Operating revenue, MWA has other income from selling "Pa Pa" Brand water bottle (350cc, 600cc, 1500cc). MWA sells 600cc water bottles to other Brands.                                  | As MWA considers the profit for the organization and is always finding, monitoring and analyzing the possible ways of income, the organization is getting profits form the services according to the tariff rate set in 1999 and it is still using that tariff rate till now. |

## 5.6 Standard, Guideline, Manual and SOP (Construction & Inspection)

| Nos. | Situation of YCDC  | Practices in MWA   | Characteristics and Advantages  |
|------|--|--|---|
| 1    | Starts to practice Contractor system.  | It's been practicing Contractor System.  | Standard, Guideline, Manual and SOPs which are designated by department are available. Manpower and machine power can reduce. |
| 2    | It's required to have Regulation, Standard, Guideline, Manual and SOPs which is separately defined for Department. | They compare and compile Standard and Guideline and select the useful S, G and M for the organization so that the employees can know/detect it | Can define/set the necessary Standard, Guideline for Water Supply Work and its materials/facilities and can make SOP.         |



|   |   |  |   |
|---|---|--|---|
|   |   | easily. Besides, they have Thai Industrial Standard (TIS) organization for Thailand.                     |   |
| 3 | We need Standard, Guideline and Manual of monitoring, repair and maintenance for Water supply facilities and repair and maintenance workshop. | They have the section which detects/tests the water supply facilities using ASTM Standard, ISO Standard. | Standardize Water Supply facilities and materials can be used in full term. |
| 4 | We have YCDC law.   | They have MWA Act 1967, Main Canal Act 1983.   | According to Act 1983, it can know the facts about Main Canal and Intake.   |

### 5.7 PPP (Private sector involvement in water supply management)

-

### 5.8 Actions for Problem solving

| Topic                                 | Situation of YCDC   | Practices in MWA  | Characteristics and Advantages  |
|---------------------------------------|---|---|---|
| 5.8.1 Institutional Governance        | YCDC is under Yangon Regional Government and Yangon Regional Minister is the same position/level with Union Minister.   | MWA is under Ministry of Interior and Minister of Interior is the same level with Union Minister.   | MWA can submit the work proposals to Minister directly and it can be proceed within a short time.   |
| 5.8.2 Organization and Responsibility | Water supply is managed by CE, three DYCEs and six ACEs and total number of staffs is 2152.   | Eight Deputy Governors, 19 Assistant Governors and total staff is 4222.   | Planning Department, HRM department, Training Center, Building Department, IT Department in MWA run the work according to their specific duties and responsibilities and thus, there is no heavy load and each department can implement their duties effectively. |
| 5.8.3 Planning                        | After independence, EDWS make plans such as Phugyi Project, Ngamoeyeik Project and Lagunpyin Project, and the projects were implemented in 1989, 2005 and 2013 respectively.<br>Phugyi project was implemented with loan from ADB by General Administration Department, Ministry of Home affairs and Ministry of Religion. The construction works of Reservoir, P/S and Pipe plant, and pipe laying works were commissioned to Ministry of Construction. The project was finished in 1989 and YCDC is now supplying 54 million gallons to Yangon City.<br>Ngamoeyeik Water supply | MWA could make plans and implement the projects for their efficient water supply; first phase (1974), second phase (1978), third phase (1985), fourth phase (1991), fifth phase (1992), sixth phase (1995), seventh phase (2006), eighth phase (2008), ninth phase (2016) respectively. | MWA could make planning projects and implementation continuously.   |

|  |   |   |  |
|--|---|---|--|
|  | <p>Project was implemented in 2004 and water from Ngamoeyeik Dam is conveyed with open channel to Ngamoeyeik WTP. After treating water at NNP WTP, the treated water is distributed to Yangon City. YCDC could supply 45MGD from Phase 1 in 2005 and 45 MGD from Phase 2 in 2013.</p> <p>Lagunpyin project was implemented in 2013 and the water resource is from Lagunpyin Dam. 40 Million gallons of water is conveyed per day. The purpose of the project is to supply 10MGD to Thilawa SEZ and 30 MGD to 4 new Dagon Townships, Tharkayta Tsh and Dawpon Tsh. In Lagunpyin project, YCDC implement Intake tower and WTP with the support from Japan and implemented P/S, Pipe laying and distribution with ODA Loan (23.643 billion Yen) from JICA.</p> |   |  |
| 5.8.4 Human Resources Development                    | There is no separated HRD section in EDWS. There is no training center in EDWS. There is no individual assessment system.   | Two human resources departments exist in MWA and the training center arranges and conducts oversea trainings, outside training within country, in-house trainings and internal trainings. The board of HRD is monitoring each staff and considers salary increase, promotion and bonus based on the results and performance.  | There is training center in MWA and the training center conducts over 200 trainings per year. Even after the training, staffs' capacity improvement and performance are monitored. |
| 5.8.5 Finance  | In YCDC, water tariff is structured as domestic, commercial, meter, Flat rate, FE and wide yard, and if compared with Asian countries, the water tariff rate is quite lower. The collected water tariff are transferred to YCDC and EDWS has to submit proposal for budget.   | Water tariff is Progressive Rate and the consumption has to be purchased according to the meter unit. The customers are categorized into two types; domestic and commercial. Some percent of all income has to be transferred to Government and some amount is spared for the urgent matter of organization. For huge investment, the Government subsidize partially. | As MWA is independent in setting water tariff and budgeting system, the organization can implement the plans quickly and effectively.  |
| 5.8.6 Regulations, Standards, Guidelines and Manuals | There are no dependable Regulations, Standards, Guidelines and Manuals in YCDC. The existing RSGMs are needed to be revised to be flexible with the circumstance and situation.   | MWA has perfect and dependable RSGMs.   | As MWA has standard RSGMs, the projects can easily be implemented in accordance with the RSGMs and can create quality results.   |

## **Chapter (6) Improvement Plan Proposal**

### **6.1 Institutional Governance**

1. To find out/search for the new water resource
2. To reduce NRW %
3. To draft targeted the NRW reduction plan in step by step
4. To amend water tariff setting in detail
5. To improve the capacity of staffs
- ❖ EDWS needs to become in depend freely and do fully organization.
- ❖ When submitting budget, we should reduce submitting many steps for EDWS can do effective projects in a short time.

### **6.2 Organization Structure of Water Utility**

Based on the studied, we would like to propose the followings for the improvement of water supply system.

1. Replace old aged pipe, distribution pipe and service pipe with good quality and standardize pipes.
2. Connect or lay the pipe network according to systematic DMA system.
3. Install the water meter for every water connections and reduce Non-Revenue Connections.
4. Reduce the types of connection and types of water tariff.
5. Revise the water tariff rate to Progressive rate.
6. Do Post Chlorine Dosing in the necessary places or points.
7. Changing the water tariff collecting system to modernize ones.
8. Improvement of Operation & Maintenance
9. Finding out/search the new water resources to distribute drinking water more.

#### **Organization Chart and Duties & Responsibilities**

Although the organization chart is well organized, individual job description is not clear. As assigned duties and responsible section do not match, the efficiency of section is affected. So, duties and responsibilities of each section and individual job description should be clarified so that staffs can perform their works effectively.

- (1) There are 5339 members in MWA and 2167 members in EDWS. So increase staff's power.
- (2) According to organization chart it need to input and draw NRW Section, HRD Section and Customer Service Section.
- (3) So organization chart should be prepared for improvement of water supply.

### **6.3 Planning System**

1. It's advisable/recommended to draft and practice Water Safety plan to distribute sufficient, clean and drinkable water to city dwellers every day, which is one of the five objectives of EDWS.
2. To improve the capacity of department, to collect water tariff fully, to protect NRW, and for the improvement of water supply system with modern technology, it's advisable/recommended to draft Strategic Management Plan.
3. To improve Planning System of EDWS
  - (1) To collect the accurate data of water supply from each division as much as possible
  - (2) Do data analysis on the collected data, and prepare PIs date and set KPIs which are effective for water supply works
  - (3) To make mid-term, long-term and annual plans which support Mission and Vision
  - (4) To make Strategic Plan

#### **Weakness**

It is found that to set PI data is difficult as the accurate data cannot be attained in planning section of EDWS.

### **6.4 Human Resource Development**

Human Resources Development should be prioritized for the improvement of water supply of EDWS. As infrastructure, facilities and financial resources have to be operated by human resources, Human Resources plays

in the main role. Thus, EDWS urgently needs HRD section for its human resource development.

The points that can be done for HR development are –

- (1) Making HRD Plan
- (2) Training management according to PDCA cycle
- (3) Setting Personal Evaluation Policy
- (4) Planning training program according to the levels of staffs
- (5) Improve OJT System
- (6) Bringing up internal trainers with TOT
- (7) Encourage Self-learning system
- (8) Allocating proper duties and responsibilities
- (9) Implementing HRD as soon as possible
- (10) Initiate incentive system
- (11) Allocate HRD budget

(1) Making HRD Plan

HRD Plan should be set in which includes short term plan and long term plan based on the needs of individual staffs and organization for the improvement of water supply works of EDWS.

(2) Training Management according to PDCA cycle

In managing training, planning, implementation, evaluation and action are performed step by step according to PDCA cycle and it is found that following PDCA cycle can enhance the effectiveness of the training.

(3) Setting Personal Evaluation Policy

Individual Development Plan (IDP) should be utilized for Personal Evaluation System that is easy

(4) Planning Training Programs according to the staff levels

Trainings are necessary for the capacity development of each staffs in all positions. Thus, annual plans consisting of Training Programs should be prepared.

(5) Improving OJT system

OJT system in which senior staff trains junior staffs and share their experience within the workplace, and which save time and money should be improved as it is more effective.

(6) Bringing up Internal Trainers with TOT

In order to relay or inherit the technology, new internal trainers should be brought up according to TOT system. By practicing TOT system, young generation can carry out technology distribution and inherit when old serviced employees retire.

(7) Encourage Self-learning system

Self-learning system can be improved by establishing the library within the department, by making contribution of tuition/training fees for the staff, and it can lead to build the capacity of employees up and develop their mindset.

(8) Allocating proper duties & responsibilities

Duties and responsibilities of each section must be properly allocated so that the staffs can know their duties and responsibilities and can carry out their tasks fully.

(9) Implementing HRD as soon as possible

To build training center is an urgent need for HRD and it is still in needs of training room facilities and library to be fulfilled. Implementing HRD can help each staff to emerge their capability and ability.

(10) Initiate incentive system

By initiating incentive system, the employee will perform hard in the workplace with joy and happiness, and will also be productive for the organization.

(11) Allocating budget for HRD

Budget is required for implementation of HRD operations. The success of HRD sector is not available to show in figures like other businesses. But the improvement of performance of employees and the success and achievement of organization can prove the success of HRD operations. The organization needs to adopt HRD budget in order to achieve the successful operation.

As a review, by implementing the above-mentioned 11 points in EDWS for human resources, the active and hard performance of employee will become evolved, and on the other hand, the right persons will become in the right place. Then, water supply industry will develop quickly.

## 6.5 Corporate Accounting

## Accounting Policy

Concerning with Accounting, exact and secure policy and rules & regulations should be set. Each division/section should follow the policy and rules. And accounts, figures and financial data will be kept systematically and it would be supportive for data checking and analysis. Systematic data recording will be helpful for future projects.

## Assets Accounting

As Assets data cannot be input correctly and assets list with all necessary data could not be collected, finance section is facing difficulty to make depreciation account. Asset data/figure in every step from procurement to throwing the expired asset has to be recorded. Moreover, exact and clear format, process and procedure of fixed asset registration should be initiated. Asset code setting and asset accounting trainings should be highlighted.

## Income and Expenditure

The statistics of EDWS's current income, current expenditure, capital expenditure and Loan from 2011-2012 to 2015-2016 is shown in the table.

| Content             | 2011-2012 | 2012-2013 | 2013-2014 | 2014-2015 | 2016-2017 |
|---------------------|-----------|-----------|-----------|-----------|-----------|
| Current Income      | 4709.119  | 6640.251  | 7598.614  | 9007.793  | 11020.927 |
| Water meter selling | -         | -         | -         | 280.002   | 731.830   |
| Current expenditure | 4810.337  | 6776.968  | 9377.231  | 13623.814 | 16496.029 |
| Capital expenditure | 10071.259 | 17585.879 | 34402.238 | 49362.282 | 65461.320 |
| ODA (Loan) Japan    |           |           |           |           | 2815.335  |

The income of EDWS is mainly from water tariff and it is around 90% of total income. Under the title of current expenditure, the charge of electricity is the highest cost and the cost is about 60% of total current expenditure. The big gap between income and expenditure can be seen in the table. To extend the pipeline network and to catch up the demand of water consumption in the future, the huge investment is required. Moreover, we need to consider the repayment and interest payment of ODA Loan (23683 Million Yen). Thus, EDWS needs to perform to collect full water tariff and needs to find the possible ways of other income.

The existing meter maintenance fee is 100 Ks for all meter sizes. According the data of 6/2016, total issued bill is 261795 (Flat – 66399, FOC – 2337) and total connection is 330431. EDWS should make a plan to collect meter maintenance fee according to the Diameter size, to collect meter rate for all Flat rate connections, and to install meters and collect water tariff for all FOC connections in order to increase income and on the other hand, to reduce NRW.

Ngamoeyeik Water Treatment Plant (NNP) is supplying water 90 MGD from 1<sup>st</sup> Phase and 2<sup>nd</sup> Phase by treating Raw Water conveyed from Ngamoeyeik Dam. For that raw water, EDWS has to purchase 10000 Ks per 1 Million Gallon to Irrigation Department. For 2015-2016 Fiscal Year, raw water costs 243.456 Million Kyats and the expenditure for electricity of WTP is 8964.176 Million Kyats. Besides, around 1200 tons of ACH Chemical is used in WTP per year and the price of ACH 1 ton is 650000 and totally 780 million Kyats has to be expensed in a year for ACH. Total expenditure of those three items in WTP is 9987.632 Million Kyats. Total income water tariff of that fiscal year 2015-2016 is 10193.468 MKs. According to the Cash Basic of 2015-2016 FY, income and expenditure is shown in the following table.

Income and expenditure according to Cash Basic of EDWS in 31/03/2016

| Particulars                     | 2015-2016 (million kyats) | Notes       |
|---------------------------------|---------------------------|-------------|
| <b>Operating Revenues</b>       |                           |             |
| Departmental Water charges      | 1696.523                  | } 10193.468 |
| Public water charges            | 8496.946                  |             |
| Water connection                | 535.506                   |             |
| Rental of shops and sites       | 68.065                    |             |
| Plumber licenses Fees           | 1.257                     |             |
| Road crossing charges           | 0.152                     |             |
| Other revenue                   | 222.478                   |             |
| <b>Total Operating revenues</b> | <b>11020.927</b>          |             |

| <b>Operating Expenses</b>                 |                    |            |
|---|--------------------|------------|
| Salary                                    | 2232.784           |            |
| Labor Charges                             | 1191.500           |            |
| Electricity                               | 8964.176           | } 9987.632 |
| Raw Water                                 | 243.456            |            |
| ACH                                       | 780.000            |            |
| Petrol & Lubricant                        | 45.402             |            |
| Operating Material                        | 168.951            |            |
| Printing & Publishing                     | 44.622             |            |
| Materials, repair, maintenance and sparer | 2789.175           |            |
| Other operating expenses                  | 35.963             |            |
| <b>Total Operating Expenses</b>           | <b>16496.029</b>   |            |
| <b>Loss from operating</b>                | <b>(-)5475.102</b> |            |

According to the table, Loss from operating is 5475.102 MKs. Capital expenditure for that FY is 65461.320 MKs and if include Assets Depreciation Cost, the amount of loss will be much more.

To improve the cost recovery

In considering the Loan repayment for ODA Loan (Japan) in 2025, EDWS should ruminant to plan some projects to set Water Tariff based on Full Cost Recovery Principle or Sustainable Cost Recovery in order to cover the financial crisis in the future. To do so, we should make a comparison of situation and management system of Waterworks in Japan, MWA in Thailand and EDWS and, should analysis it and perform to increase income mainly and urgently.

## **6.6 Standard, Guideline, Manual and SOP**

### **6.6.1 Standard, Guideline, Manual and SOP (Construction and Inspection)**

To practice contract system, it's better to define/set definite Standard, Guideline, Manual and SOP of Water supply system and facilities.

According to contract system, not to become/happen Luck of supervision between the implementation of work of Contractor and supervising Engineers and to asset project improvement, cash flow, there should be evaluation record/assessment lists

We would like to request TA team to help and cooperate with EDWS to select/define the suitable Standard and guideline which can apply in mother department by comparing the existing Standard and Guideline with other countries' Standard, and Guideline of Water Supply System.

We would like to request TA Team to collaborate with/help EDWS in setting RSGMs for the maintenance and procurement of water supply related machinery, equipment and materials, and to build maintenance and repair workshop.

### **6.6.2 Standard, Guideline, Manual and SOP (DESIGN)**

- It's necessary to draw up/draft Design Criteria to become the work in systematic ways.
- To implement the works systematically and quickly, it is necessary to draft the organization, work plan and periods (Schedule)
- It's necessary to cooperate with other organization from the start/beginning of drafting of working plan not to become/happen delay, losses and facilitate the work flow.
- It's required to fill up the necessary data detail in making Survey and Drawing.
- Technologies are required for Water pipeline, Air Valve, Washout Valve, Chamber and Concrete block.
- ICT technologies are also required to have section to section connection.
- It's also necessary to implement for closure of the artesian well and supply the water sufficiently.
- It's also required to consider the DMA system when making survey and design for pipeline.

## **6.8 Problem solving activities**

Precise and secure information is needed for planning. Thus, we should monitor for précised and secure information and make PIs and KPIs by using that information. We have to create Regulations, Standards,



Guidelines and Manuals firstly to plan short term, mid-term and long term projects and to implement those projects.

Supportive trainings for EDWS should be conducted continuously. Human Resources Development (HRD) section should be established and it should monitor PIs, and work for staffs' promotion and incentive. Budget for HRD section should be proposed and allocated.

For financial planning, Assets account, asset list, Depreciation Rate and useful life are needed to be set in prior. Water tariff should be revised. EDWS should be financially independent.

In order to implement the projects of EDWS, reliable and suitable Regulations, Standards, Guidelines and Manuals are essential. Thus, the existing Regulations, Standards, Guidelines and Manuals should be analyzed and revised according to the time and circumstance to implement Master Plan (2040).

## **Chapter 7      Executive Summary**

According to the advices of JICA Technical Assistance Team to solve the above issues, three Steering Committee is to be organized as follow:

- (1) Planning and Monitoring Steering Committee
- (2) Non-Revenue Water Steering Committee
- (3) Regulation, Standards, Guidelines and Manual (Kaizen & 5S) Steering Committee

Planning and Monitoring Steering Committee will be responsible to discuss about appropriate planning and monitoring data for water supply management, and responsible for information sharing among divisions/sections.

Non-Revenue Water Steering Committee will carry out to bring an understanding of all divisions/sections of EDWS on NRW reduction and to share all information to concerned sections.

Regulation, Standards, Guidelines and Manual (Kaizen & 5S) Steering Committee is to discuss and consider the additional required Regulations, Standards, Guidelines and Manuals, and perform for information sharing.

# The Project for Improvement of Water Supply Management of YCDC

## Report on Institutional Improvement Plan Base on the Training in Tokyo, Japan and discussions with Advisory Committee Members (Draft)

- Chapter 5 – Chapter 7 is shown in English language because Chapter 1 – Chapter 4 is written only in Burma language.

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## **1 Introduction**

### **1.1 Objective and Concept**

### **1.2 Program Schedule**

### **1.3 Participants**

## **2 Current Conditions of EDWS/YCDC**

### **2.1 Institutional Governance, and Financial Autonomy of Water Utility**

#### **2.1.1 Existing Governance**

- Explanation of YCDC Laws and regulations and Foundation of YCDC
- Organization of YCDC
- Autonomous system
  - ◇ Decision making process of YCDC
  - ◇ Decision making process of EDWS
- Budgeting Process in YCDC

#### **2.1.2 Issues**

#### **2.1.3 Study Item**

### **2.2 Planning System**

#### **2.2.1 Existing Planning System in YCDC**

- Existing planning system; vision, long term plan, mid-term plan, annual plan
- Procedures to formulate Long term plan, mid-term plan, annual plan
- Tariff setting process

#### **2.2.2 On-going Planning System by JICA TA**

#### **2.2.3 Proposed organization of Planning Section (Duty and responsibility)**

#### **2.2.4 Issues**

#### **2.2.5 Study Item**

- ✓ Planning functions and duties of Planning Section
- ✓ Process to formulate mid-term plan
- ✓ Kinds of Waterworks management plan/ Business plan
- ✓ Strategic planning process
- ✓ Monitoring PIs system
- ✓ Kinds of reports prepared
- ✓ Tariff setting process

### **2.3 Fixed Asset Management and Corporate Accounting**

#### **2.3.1 Current Financial Conditions of EDWS**

#### **2.3.2 Existing Corporate Accounting System in YCDC**

#### **2.3.3 On-going Activities on Financial Management by JICA TA**

#### **2.3.4 Issues**

#### **2.3.5 Study Item**



- ✓ Functions and duties of finance section in autonomous utility
- ✓ How to implement fixed asset accounting
- ✓ How to prepare short/middle/long-term financial plan

## **2.4 Laws and Regulations**

### **2.4.1 Existing Laws and Regulations of EDWS**

- Water supply regulation
- Sector governance; Relationship with other authorities

### **2.4.2 On-going Activities on Laws and Regulations by JICA TA**

#### **2.4.3 Issues**

#### **2.4.4 Study Item**

- ✓ Development and enforcement process of Law and Regulation
- ✓ Design works (standards, guideline and manuals)
- ✓ Construction and inspection works (standards, guideline and manuals)
- ✓ Equipment and material (standards)
- ✓ Water quality standards and monitoring

## **2.5 Human Resource Development**

### **2.5.1 Existing Human Resource System in YCDC**

- Current capacity of HR
- Training
- Promotion
- Incentive

### **2.5.2 On-going HRD by JICA TA**

### **2.5.3 Proposed organization of HRD (Duty and responsibility)**

#### **2.5.4 Issues**

#### **2.5.5 Study Item**

- ✓ Importance of HRD Plan
- ✓ Implementation of HRD plan
- ✓ Training management

## **2.6 Actions to Materialize the Missions/Master Plan**

### **2.6.1 Existing Actions to materialize M/P**

#### **2.6.2 Issues**

#### **2.6.3 Study Item**

- ✓ How to solve issues facing to implement M/P

### 3 Summary of Contents to be studied

| Subjects  | Objectives  |
|---|---|
| Waterworks and utility management                         | <ul style="list-style-type: none"> <li>▪ To learn water vision at the national level and business planning at the municipal level</li> <li>▪ To learn the process and the methods of business planning by water utility</li> </ul>  |
| Waterworks and utility management                         | <ul style="list-style-type: none"> <li>▪ To learn water vision at the national level and business planning at the municipal level</li> <li>▪ To learn the process and the methods of business planning by water utility</li> </ul>  |
| Organization of water utility                             | <ul style="list-style-type: none"> <li>▪ To learn an appropriate organizational structure and function for waterworks management</li> </ul>   |
| Financial autonomy  | <ul style="list-style-type: none"> <li>▪ To learn regulatory frameworks of autonomous management of waterworks as a public utility</li> </ul>   |
| Water administration and relevant laws and regulations    | <ul style="list-style-type: none"> <li>▪ To learn outline of water administration at the national level (roles, budget, main features)</li> <li>▪ To learn water supply law and relevant regulation at national level</li> <li>▪ To learn outline of water administration of TMG at the municipal level (roles, budget, main features)</li> <li>▪ To learn municipal regulation on waterworks of TMG</li> </ul> |
| Asset management  | <ul style="list-style-type: none"> <li>▪ To learn management of fixed assets and assets management</li> </ul>   |
| Human resource development (HRD) and personnel management | <ul style="list-style-type: none"> <li>▪ To learn basic policies on HRD and personnel management including HRD plan</li> </ul>  |
| Case study of problem-solving                             | <ul style="list-style-type: none"> <li>▪ To learn good practices and problem-solving experiences of TMG in the transition from the end of World War II</li> </ul>   |

### 4 Study on Tokyo System

#### 4.1 Institutional Governance, and Financial Autonomy of Water Utility

#### 4.2 Planning System

#### 4.3 Fixed Asset Management and Corporate Accounting

#### 4.4 Laws and Regulations

#### 4.5 Human Resource Development

#### 4.6 Actions to Materialize the Missions/Master Plan

## 5 Comparative Study (YCDC vs. Tokyo)

### 5.1 Institutional Governance, and Financial Autonomy of Water Utility

| Situation of EDWS   | Practices in Tokyo waterworks   | Characteristics and Advantages  |
|---|---|---|
| <ul style="list-style-type: none"> <li>- Budget proposals from in-charged officers are submitted to Ministry of Planning and Finance and Revenue Commission step by step.</li> <li>-Expenditure permission has to be submitted to Mayor for approval.</li> <li>- Apply Governmental Accounting (Single Entry with Hta-Sa Forms).</li> </ul> | <ul style="list-style-type: none"> <li>- Apply “Financial Autonomy” in which the business is operated with the income.</li> <li>- Although getting approval for the estimated expenditure is required under Mayor’s management, department head has the proper authority to make decision.</li> <li>- Water tariff income is used solely for cost of supply water. Subsidies from central and local Governments are limited to use for special purposes.</li> <li>- According to <b>Local Public Enterprise Act</b>, independent accounting system is applied based on the full cost recovery principle in which all expenses are covered.</li> </ul> | <ul style="list-style-type: none"> <li>- Depending on its own income/revenue and having authority to make decision by Head of Bureau helps work implementations be speedy and smooth.</li> <li>- Monitoring the accuracy of the project and project implementation could be carried out as planned purposes.</li> </ul> |

## 5.2 Planning System

| Situation of EDWS  | Practices in Tokyo waterworks  | Characteristics and Advantages   |
|--|--|--|
| <p>- Planning Section was organized with seven members in 12/08/2016 and reinforced with three new members later.</p> <p>- Planning section provides Data Entry training to each township. 147 PIs and 60 KPIs could be set.</p> | <p>- Management Planning under Planning Section was organized with members to perform the duties.</p> <p>- The section is divided into two departments as Budget Department and Facility Planning Department.</p> <p>- Water related policies have been set and Plans are being prepared and implemented.</p> <p>- Training Programs for the generations in water utility are made to be implemented for the development of Human Resources.</p> | <p>- Development of water related Laws and Regulations is urgently needed.</p> <p>- Planning section should be organized systematically and needs to carry out to collect the accurate data.</p> <p>- Learned what should be done to become a developed utility by using the data.</p> |

## 5.3 Fixed Assets Management & Corporate Accounting System

| Situation of EDWS   | Practices in Tokyo waterworks   | Characteristics and Advantages  |
|---|---|---|
| <p>Fixed Assets Management</p> <p>Finance section is performing to get approval on the draft estimated useful life which is essential in calculating depreciation rate to be applied in Depreciation account.</p> | <p>In Tokyo Waterworks, all of detail information such as address, total expense and list of fixed assets items are submitted to Finance Division after project implementation/completion.</p> <p>Depreciation expense is calculated based on the useful life of Fixed assets stipulated by Ministry of Interior.</p> | <p>As Finance Department needs to be notified for Fixed Assets Disposal, the cases of property losing could be eliminated.</p> <p>Sending the work or project related information after implementation/completion to Finance Division becomes a focal point and it is supportive in preparing list and documents.</p> |

|  |  |  |
|--|--|--|
| <p>Corporate Accounting System<br/>As EDWS applies the Governmental Accounting system (Single Entry), it doesn't need to prepare Profit &amp; Loss statement and Balance Sheet. Due to the lack of Profit &amp; Loss statement and Balance Sheet, the actual asset value or actual ownership value can not be known.</p> | <p>Tokyo Metropolitan Government is now performing the businesses related to Water Supply, Sewerage, Transportation, etc. and it prepares Local Public Enterprise Accounts for those businesses which separates from General Government Account or other accounts. And it is described as Water Utility Business Account. Under Local Public Enterprise Account, Profit &amp; Loss Account and Balance Sheet are prepared regularly.</p> | <p>Applying Corporate Accounting System in which Profit &amp; Loss has to be prepared in details regularly, can help to know the actual situation of business operation, and help to make the project planning easily.</p> |
|--|--|--|

#### 5.4 Standard, Guideline, Manual and SOP

| Situation of YCDC  | Practices in Tokyo waterworks  | Characteristics and Advantages   |
|--|--|--|
|  | <p>Resistance to earthquake and forming of DMA in water supply area are considered when the activities are implemented.</p>  | <p>It's to prevent unsteadiness of water pressure, non-revenue water and low water pressure, and the pipelines are to be able to resist the natural disaster.</p>  |
| <p>To implement the work or activities, Design &amp; Drawing Estimate section coordinated with township in charged officers for the estimation that has to be submitted to upper level for approval.</p> | <p>It is organized according to Construction process in order to communicate each section during work implementation.</p>  | <p>By coordinating among sections and divisions helps specify the allocation of duties, and makes the work implementation more accurate and smooth.</p>  |
| <p>Pipe laying standards for pipe laying works are designed only for up to 200mmØ.</p>   | <p>Pipe laying standards are designed for up to 350 mmØ, and for larger pipe size, individual standards are designed in each projects. TMG set up their standards following Design Criteria of JWWA according to</p> | <p>As the Standards had been stipulated, every project could be implemented easily by following the stipulations. Transmission pipelines projects have to follow the standards of respective projects.</p> |

|  |   |  |
|--|---|--|
|  | the local condition.  |  |
| Back-filling of soil is carried out according to the specification of depth in the standards. Some large pipelines include HDPE pipelines stops. | Up to 8” - 12” back-filling is carried out to reach the proper compaction and signature/mark is described to show the pipeline location.                            | It helps Compaction of back-filling reach to the compaction of original road and it can be known that there is a pipeline under that part of land. |
| Specifications for pipe materials are stipulated.  | JWWA provides third party certification to equipment and materials for water supply. JWWA inspect the pipe materials and only quality passed materials are stamped. | Qualified materials can be used easily.  |
| Inspection Department approves the completion after 100% work completion and inspection.   | Each step of working process is inspected following the standards, and if the work is well done and completed, the in-charged inspector approves the completion.    | The requirement in each step of work implementation can be known and the standardized quality can be achieved after completion.                    |
| Water tariff is collected based on the consumption unit.   | The water charges include service charge and commodity charge.  | Water tariff is fair and the customers can understand the tariff structure easily.   |

## 5.5 Human Resource Development

| Situation of YCDC  | Practices in Tokyo  | Characteristics and Advantages  |
|--|---|---|
| <b>Importance of HRD Plan</b><br>HRD Plan is urgently needed to be made. | HRD Plan has already made and it is being implemented systematically. | As HRD Plan for the development of Human Resources is systematically prepared and implemented, HR quickly develops.         |
| <b>Implementation of HRD Plan</b><br>HRD Plan is being formulated.       | HRD is being implemented according to HRD Plan.                       | As HRD is being implemented according to HRD Plan systematically, it is found that water supply works have been developing. |
| <b>Training Management</b>   | Implemented according to the  | As the effective Trainings can be   |



|   |                           |  |
|---|---------------------------|--|
| Effective Training Plan could not be performed yet. Now Training Plan is being prepared/formulated. | systematic Training Plan. | organized for the organization, the Human Resources become developed and water supply works become successful. |
|---|---------------------------|--|

## 5.6 Actions to Materialize the Missions/ Master Plan

| Situation of EDWS  | Practices in Tokyo waterworks   | Characteristics and Advantages  |
|--|---|---|
| Master Plan of EDWS was prepared to match with the country's National Development Plan. EDWS Master Plan was prepared with three periods: (2016-2020), (2020-2025), and (2026-2030). | Water supply service area was extended since 1973 and in 2010, 100% of service area was reached. For the future water supply, raw water from four rivers are treated in treatment plants and reduces water shortage issues. | In estimating income & expenditure and drawing Plan, activities are drafted in the Plan based on financial projection of income and expenditure. Then, when the Plan is formulated, it is delineated to the public transparently. |

## **6 Proposal for Improvement of EDWS**

### **6.1 Institution Governance, and Financial Autonomy of Water Utility**

#### **Institutional Governance**

In order to allocate the budget within the department for water supply works in time, to perform monitoring and evaluation systematically and speedily, and to stand as a financially independent organization which is able to screen and manage its income and expense, the approval for budgeting should be obtained from the relevant ministry with appropriate authority instead of getting approval from Union Government step by step.

#### **Financial Autonomy of Water Utility**

Independent Accounting System should be utilized in EDWS. Independent Accounting System with Financial Autonomy indicates the cost of business operation is solely covered by income of EDWS. The collected water tariff is not enough for all expenses of the whole operation. Thus, to initiate Independent Accounting System in EDWS, it should perform by establishing a specific account of YCDC to get subsidy from the General Account or by obtaining foreign assistances or loans for the required revenue of large scale projects.

### **6.2 Planning System**

#### **Planning**

Planning section should start to perform its main responsibilities such as making required plans in coordination with other divisions, implementing plans, analyzing the results and keeping continuous development. In order to get the accurate data, the staffs should be trained by providing trainings and refreshing courses to become skillful and to improve the capacity of the staffs within the department. Based on the collected data, selecting fundamental KPIs and the Business Plan should be prepared and implemented based on those selected KPIs.

Moreover, after preparing 3 to 5 years mid-term plans, monitoring the plan implementation situation according to PDCA cycle, taking action on the emerged difficulties/constraints or revising the activities should be carried out for the sustainable success of organization. The achievement status of the target KPIs should be checked regularly and modified if necessary.

As the Planning section is newly organized in EDWS, the staff is necessary to understand the duties and responsibilities of the section and to make the staffs qualify. The capacity of the staffs should be developed by providing them to join the trainings and to do self-learning so that the staff can understand the work flow and their responsibilities to achieve the objectives of the organization.

## **Water Tariff**

We need to prepare Guidelines of Tariff Setting in order to be able to set fair and reasonable water tariff applying Full Cost Recovery Principle for EDWS's self-sufficiency.

Only if YCDC get the public understanding or awareness that water supply costs shall be covered by water tariff, the customers can be able to accept water tariff raising. Moreover,

- (1) To get approved the proposal of block rate tariffs which cover the cost of EDWS by upper levels
- (2) To receive subsidies from government or other organization for the required revenue for investments
- (3) To avoid the large variance between the increased tariffs layers according to the customer categories.
- (4) The benefit from water supply business of EDWS is to be supportive for the interests/social development of customers
- (5) To regulate the precise Principles regarding water tariff collection as the outstanding water tariff is the part of EDWS's revenue.
  - (6) To screen the expenses of EDWS and to allow the budget only for the essential expense in order to reduce the production cost
- (7) Unit Cost is to be calculated based on consumption according to customer categories, and average tariff is also calculated.
- (8) To consider the social issues of the customers in setting water tariff

## **6.3 Fixed Asset Management and Corporate Accounting**

### **(1) Corporate Accounting System**

Corporate Accounting System should be utilized in EDWS. Applying Corporate Accounting System in which Profit & Loss has to be prepared in details regularly, can help to know the actual situation of business operation, and help to make the project planning easily.

### **(2) Fixed Asset Management**

EDWS needs to set Guidelines for fixed assets in order to initiate Independent Accounting System. Assets acquisition, assets disposal, asset management and setting Standard Value of asset have to be performed.

## **6.4 Standard, Guideline, Manual and SOP**

- ❖ Earthquake resistance and DMA area should be considered in carrying out the water supply works.
- ❖ Organizing structure and schedule should be prepared in order to implement the activities speedy and systematically.
- ❖ It needs to set stipulations or standards for standardized and qualified pipe materials.
- ❖ If the ground situation inspection is carried out with the inspection/check sheet, it will be more systematic.

- ❖ Require ICT technology for internal communication in the matter of cooperation among sections.
- ❖ If specific standards of pipe laying design for above 200 mmØ can be stipulated, the respective activities could be performed systematically.
- ❖ Water tariff should be calculated in a fair rate based on the pipe size of connection and should be easily understandable for customers.
- ❖ If the specifications for meter installing point are stipulated, NRW could be reduced.
- ❖ The present conditions and problem of the aging of pipe line graph should be recorded and pipe replacement should be prioritized according to the pipe age the pipe age.
- ❖ Inspection System should be developed.
- ❖ In order to set Regulation, Standard, Guideline & Manual in EDWS, the regulations of Pakistan, Kenya, Japan and Myanmar are being compared, analyzed and compiled.

## **6.5 Human Resource Development**

For the improvement of water supply works of Engineering Department (Water and Sanitation), Human Resources Development activities should be performed as a priority. As HRD means the bringing up of staff, who will be working longer for the organization, to become qualified, it is not only about the training but also bringing up of staff to be able to think critically and to become willing to work in the workplace. As only the staff of Engineering Department (Water and Sanitation) can perform the capacity improvement of the Department, the development of human resources is urgently required.

Hence, EDWS needs to perform the following items for its human resources development:

1. HRD Plan
2. Training Plan
3. OJT (On-Job Training)
4. Knowledge Bank

### **(1) HRD Plan**

HRD Plan should systematically be prepared in details. In preparing HRD Plan, six aspects: (1) HRD vision, (2) Promotion of OJT, (3) Motivation management system, (4) Personal Appraisal system, (5) Self-learning, and (6) Integrated training program proceeding from training needs should be included based on the needs of organization.

### **(2) Training Plan**

In preparing Training Plan, identifying the existing issues in EDWS regarding Human Resources development should be carried out, then training plan including various trainings according to staff levels is prepared and implemented accordingly.

### **(3) OJT (On-Job Training)**

OJT (On-Job Training) should be implemented by organizing OJT Plans and OJT can help

self-development and bring up expertized staff in the respective fields. To implement OJT, OJT Handbook should be compiled and OJT instructors should be selected and assigned.

#### **(4) Knowledge Bank**

Knowledge Bank should be initiated in Engineering Department (Water and Sanitation). Experience of long serviced officers and staff should be documented and sent to HRD section. Photo and video of the process of significant project should be captured and recorded by in charged engineer and sent to HRD section so that new staff can access those through HRD section. HRD Section should arrange the documents/handouts regarding internal training, Seminar and Workshops so that the staff can come and learn when they need.

#### **6.6 Actions to Materialize the Missions/Master Plan**

As the preparation of Mid-Term Plan (2018-2020) of EDWS, policy amendment and implementation plan were carried out within FY 2017-2018. In preparing Mid-Term Plan, water supply data collection and financial activities collection will be carried out to complete within 2017-2018 Half FY and next financial year. Coordinated inspection on activities, water demand calculation and water supply planning are scheduled to proceed within half FY of 2018 (April to September).

## **7 Executive Summary**

Hence, 3 Steering Committees organized according to the suggestions of JICA Technical Assistant Team in order to solve the above mentioned issues will perform the followings:

Planning and Monitoring Steering Committee (1) will perform discussion on planning & monitoring data and information dilever to each section in order to properly manage water supply works.

Non-Revenue Water Steering Committee (2) will perform to raise awareness of all sections and divisions within EDWS on the importance of NRW reduction and share information and data relating to NRW.

Regulation, Standards, Guidelines and Manual (Kaizen & 5S) Steering Committee (3) will perform to organize and set the necessary Regulations, Standards, Guidelines and Manual, and will share the progress information to related sections/divisions.

Furthermore, Local Public Enterprise Account will be initiated in EDWS, and Depreciation Account and Profit & Loss Account will be commenced to know the actual ownership value of EDWS. Financial Plans will be compiled and the required revenue shall be analyzed if water tariff is needed to be raised or not.

As Human Resource Development Section, HRD section will implement sharing knowledge and technology of water supply in EDWS by conducting OJT in the work place to improve the capacity of staffs and establishment of the library by collecting the documents of seminars, workshops and SOP from each section to expand self-learning culture.



Improvement Plan  
For NRW Management and Customer Service

Based on the Third Country Research Study in PPWSA, Cambodia

Engineering Department of Water and Sanitation  
YCDC

2018

\*Only Chapter 3 to Chapter 6 are given in English language because Chapter 1 and Chapter 2 are written only in Burma language.

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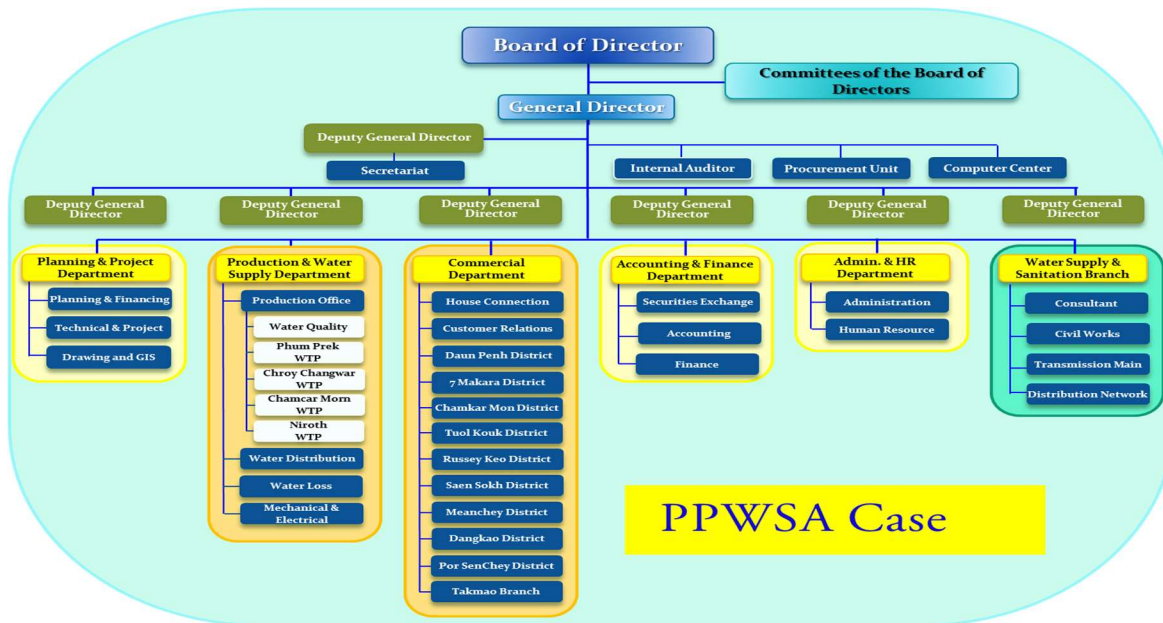
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## Chapter 3 Study on PPWSA NRW Management System and Customer Service Management

### 3.1 Organization System

The organization of PPWSA is as follow;

**Organization Chart of PPWSA**



PPWSA Case has Board of Director with seven members; one General Director, Deputy General Director and Secretariat. It also has members of Internal Audit, Procurement Unit and Computer Center. Seven Members of Board of Director are each Directors from Ministry of interior, Ministry of Finance, Ministry of industry and one Shareholders and one General Director, elected representative employee once in three years and one Independent Director selected from Shareholders.

# PPWSA HRM

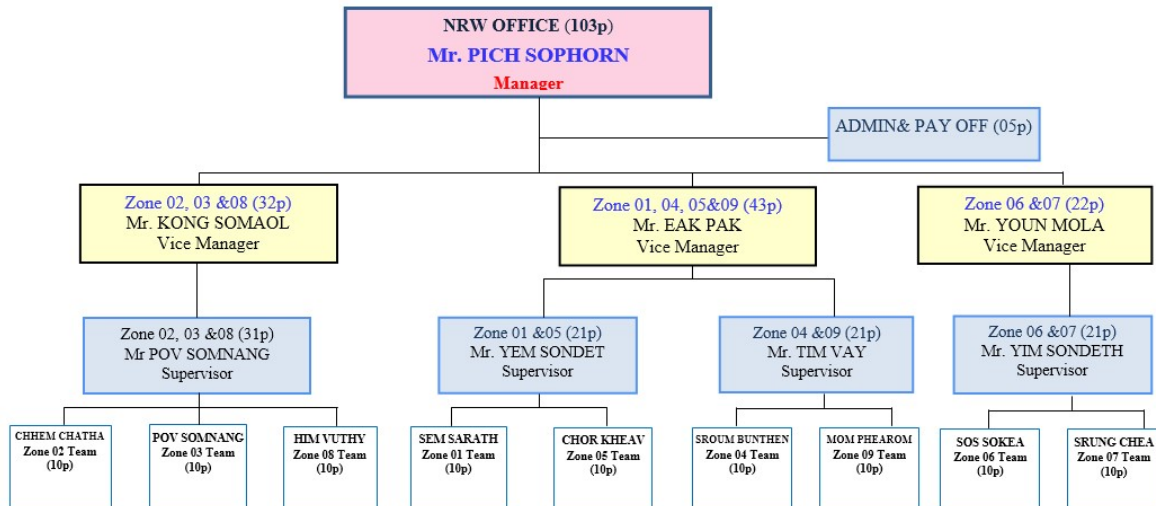
- Total staff (as of Jun 15) : 862 (142 females)
- Government officials : (Director General, and Deputy Director General  
02 In charge of Finance and Stock Exchange)
- Permanent staff : 807 (138 females)
- Contractual staff : 53 (04 females)

| Qualification                    | Age        |            |            |            | Total      |            |
|----------------------------------|------------|------------|------------|------------|------------|------------|
|                                  | ≤26        | 27-35      | 36-45      | ≥46        | Number     | %          |
| Doctoral Degree                  | 0          | 0          | 0          | 2          | 2          | 0.23       |
| Master Degree                    | 0          | 14         | 14         | 15         | 43         | 4.99       |
| Bachelor degree/ engineers       | 25         | 121        | 32         | 15         | 193        | 22.39      |
| Associated degree                | 5          | 12         | 18         | 11         | 46         | 5.34       |
| Baccalaureate/ short-            | 108        | 93         | 29         | 25         | 255        | 29.85      |
| Technical staff/ skilled workers | 2          | 11         | 15         | 13         | 41         | 4.76       |
| Staff with over 10-              | 0          | 13         | 39         | 57         | 109        | 12.65      |
| Unskilled workers                | 46         | 98         | 21         | 8          | 173        | 20.07      |
| <b>Total</b>                     | <b>186</b> | <b>362</b> | <b>168</b> | <b>146</b> | <b>862</b> | <b>100</b> |

There are 862 staff in Human Resource Management Department and 142 staff are women. The head of the department are Director General and Deputy Director General and they direct Finance and Stock Exchange. The number of permanent staff are 807 persons and 138 are women. 53 Contractual staff and 4 members are women. The duties and responsibilities of HRM are management matter and it conducts salary, OT, bonus, promotion, retirement, recruitment and punishment of PPWSA staff. The following duties are divided based on the staff's educational background, working experience and ages.

- 1- Accounting & Finance Dept.
- 2- Admin & HRM Dept.
- 3- Water Supply & Sanitation Brand
- 4- Internal Auditor
- 5- Planning & Project Dept.
- 6- Production Dept.
- 7- Commercial Dept.

## NRW Organization Chart



In NRW Office, there are altogether 103 members and the manager is the leader of the office and under the manager, there are 5 persons for Admin and Office, 3 Vice Manager and under each Vice Manager, there is 1 supervisor per zone and in a zone, there are ten members.

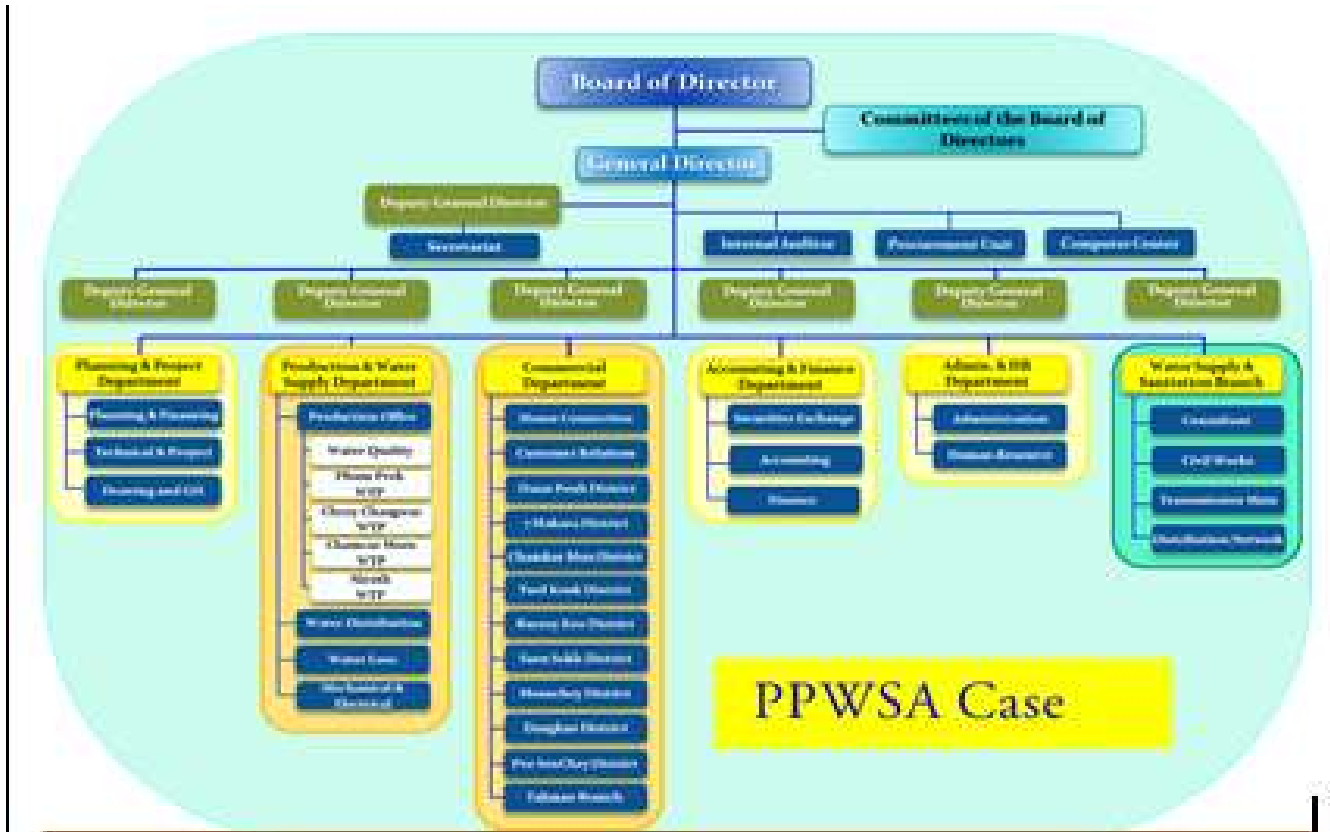
Under Vice Manager Mr. KONG SOMAOL, there is one supervisor who takes responsibilities for Zone 02, 03 and 08 and conduct the NRW matter timely with 30 members.

Under Vice Manager Mr. Eak Pak, there is a supervisor for Zone 01, 05 and another supervisor for Zone 04, 09 and conduct the NRW matter with 40 staff members.

Under Vice Manager Mr. Youn Mola, there is a supervisor for Zone 06,07 with 20 members and conduct the NRW matter in time.



The organization structure of PPWSA is as follow;



### 3.2 Budget Management and Water Tariff

When estimating the budget plan for NRW management, it's necessary to draft yearly and need to estimate the pipe repairing costs, incentive for pipe leakage prevention, cost for pipe connections, necessary equipment for site work, safety gear for NRW staff, and transportation fees for NRW work.

## Budget management, NRW

|              |   |                  |     |
|--------------|---|------------------|-----|
| 1            | Leakage Repair Expense                                | 140,000          | 8%  |
| 2            | Leakage Detection (Incentive)                         | 125,000          | 7%  |
| 2            | Network Maintenance Expense ( Mostly Pipe relocation) | 410,000          | 24% |
| 3            | Site Work Equipment for NRW Expense                   | 260,000          | 15% |
| 4            | Transportation & Leak Detection Expense               | 750,000          | 45% |
| <b>TOTAL</b> |   | <b>1,560,000</b> |     |

Water tariff rate in PPWSA has 3 types and the rates are as follow;

# Water Tariff

2017 : 2<sup>nd</sup> Adjustment. From 15-05-2017 till now

| Consumer Category    | Block                 | Tariff                  | Calculation (Domestic)                                   |                  |
|----------------------|-----------------------|-------------------------|--|------------------|
|                      | m <sup>3</sup> /month | (Riels/m <sup>3</sup> ) | Consumption: 200 m <sup>3</sup>                          | Period: 60 days  |
| Domestic             | < 4                   | 400 (10c)               | $[(3m^3 / 30d) \times 60d] \times 400r =$                | 2,400 r          |
|                      | 4 - 7                 | 500 (12c)               | $[(4m^3 / 30d) \times 60d] \times 500r =$                | 4,000 r          |
|                      | 8 - 15                | 770 (19c)               | $[(8m^3 / 30d) \times 60d] \times 770r =$                | 12,320 r         |
|                      | 16 - 50               | 1,010 (25c)             | $[(35m^3 / 30d) \times 60d] \times 1,010r =$             | 70,700 r         |
|                      | > 50                  | 1,270 (31c)             | $[200m^3 - 6m^3 - 8m^3 - 16m^3 - 70m^3] \times 1,270r =$ | 127,000 r        |
| Administr.           | flat rate             | 1,030 (25c)             | <b>Total Payment =</b>                                   | <b>216,420 r</b> |
| Commer. & Industrial | <101                  | 950 (23c)               |  |                  |
|                      | 101 - 200             | 1,150 (28c)             |  |                  |
|                      | 201 - 500             | 1,350 (33c)             |  |                  |
|                      | > 500                 | 1,450 (36c)             |  |                  |

Three types of water tariff are domestic (51%), commercial (42%) and departmental (7%). Some places which are far from the network and service pipe can't reach to that area (satellite township, ministry, only autonomy hospital, private (commercial) hospital) are collected with Flat rate. Only fire hydrant/ fire extinguishing case can get FOC.

### 3.3 Measures of Physical Loss and Commercial Loss

Learning over reducing Apparent Loss (Commercial Loss), it's necessary to get accurate and update customer data. They establish Inspection team for illegal connection, take action on illegal connection without bias, control the staff with systematic regulations, reward to those who give information on illegal connections, monitor and check the suspected customers who do illegal connection which becomes commercial loss. By establishing the inspection team and control the illegal connection, in 1994 they dismissed 16 staff and took action over 46 connections, and in 1999, they dismissed 2 staff and took action over 711 connections, and now, they only fine out 1 illegal connection all around a year. For public awareness, they use Social media, TV, and newspapers so that the customers get easily to know and understand on water well.

According to the meter installation policies, they have changed and replaced the damaged meters with high quality meters and since 1997, all connections have become water meter system. In 1995, they have started to utilize Computerized Billing System and in 2002, all bill connection can be managed by computerized system. They gain the trust from the customers by giving services such as Customer-Oriented service, Customer Information, Take Care of Customer Complaint, On site customer education, and on-site water quality test.

It's divided Real loss (Physical loss) into 7 sub-sections.

- 1- Pipe Replacement Program
- 2- Routine Maintenance
- 3- Water Loss Reduction Program

- 4- DMA's Program
- 5- Data Monitoring System
- 6- Leakage Detection at House Connection
- 7- Leakage Detection at Drainage System

In replacing pipes, it is prior to replace the pipes which are closely located in treatment plant where leakage often occurs due to the high pressure. The outskirts area of the town rarely happens leakage. While selecting the pipe materials, they use DI pipe for transmission and for distribution, they use HDPE pipe. As a Water Loss Reduction Program, they repair the pipe, and find out the pipe underneath and repair it, and also prevent the pipe leakage. They have 24/7 stand by shifts and check and monitor the pipe leakage and if there is leakage, they repair it within 2 hours. And also, they counter-measure after repairing work not to happen the leak again and also conduct leakage analysis. When checking pipe leakage, they start to do in pilot zone and then check and measure the DMA in the whole coverage area. The Leakage Detection teams can enjoy the bonus/incentive or penalty based on their performance. In practicing the bonus, penalty system, if the pipe break happens because of low quality of pipe and pipe materials, then they (PPWSA) adds the supplier company to Black List. If the pipe break happens because of the staff's fault, the staff's salary will be deducted. Every three months, they have evaluation process. As for incentive, the staff can be promoted or increase the salary and bonus.

After pipe leakage repairing works, the records and action taken are report to water distribution section and other related sections. When conducting leak prevention, they monitor the leakage in each zone in DMA by telemeter system on Block Distribution supported by JICA. Mostly, leakage happen in House Connection lines. Therefore, Leak detection team has to check Service Pipe Line one house after another. Along the road, if there is water leak, they make the pipelines as a leakage detection at drainage system.

### **3.4 Regulation/Standard/Guideline/Manual, SOP**

They have drafted systematically the RSGM for Study of Water Supply System, Water Supply Facilities and Construction, Water Supply System Management, Operation & Maintenance. When drafting the SOP, they draft the SOP for every PPWSA works in detail which are easy to understand and feasible for every staff and they update it every year.

**As for NRW reduction plan, they conduct it based on the following factors;**

1. Prioritize pipe replacement near Treatment Plant
2. Only use 1 or 2 types of pipes in laying the pipelines.

3. Establish the 24/7 leak repair team
4. Repair the leak within 2 hours as soon as we receive the information
5. Make daily records
6. Keep the check lists and records for whole distribution facilities maintenance
7. Set Rule & Regulations for inaccuracy of meter reading record & illegal connection
8. Set the specific RSGM & SOP for overflow, pipe burst and leakage which happen NRW every year

### **3.5 Construction & Inspection**

Before conducting construction work, they use high-quality pipes and pipe materials and practice specific SOP in actual work places.

They have internal audit and inspection team and if they find out illegal connection, they take action on it without bias and give bonus to those who inform about the illegal connections, and monitor and check to the suspected customers who seems misconduct illegal connection. They also establish NRW Inspection team with 123 members with 12 teams.

### **3.6 GIS**

In PPWSA, they can supply the water 24/7 from Phum Prek WTP (150,000 m<sup>3</sup>/day), Chroy Changwar WTP (130,000 m<sup>3</sup>/day), Chamkar Mon WTP (20,000 m<sup>3</sup>/day) and 260,000 m<sup>3</sup>/day from Niroth WTP. The detail database of WTP facility are input in GIS system.

The total area of Phnom Penh city is 678 Km<sup>2</sup> and the service area is 340 Km<sup>2</sup>. Transmission Pipe Network (250mm-1600mm) 212,523m, Distribution Pipe Network (32mm-225mm) 212,523m, (9359) valves, 104 Fire hydrants, 323,732 connections are kept in GIS Section.

Before practicing the data inputting in GIS system, PPWSA also faced difficulties such as Data analyzing, Modifying and updating the data and data accuracy, data collection and had many problems in Water Supply Management Works.

Now PPWSA practices/use GIS system in whole water supply work and therefore, they can get exact data it's required, can analyze, modify and update the data easily. They can manage the water supply work using accurate data.

In Head of GIS office of PPWSA, it's divided into (3) sections; GIS section, Water modeling section and As-build management section. In GIS, it has 3 layers for Administrator, 6 layers for Base map, 3 layers for customer management, 5 layers for events fon network, 6 layers for monitoring and 16 layers for network assets and total 39 layers and manage the water supply management work.

They input Administrator Boundary, Street, Satellite Images as a Base Map and as for Network Assets, they input Pipeline network, valves, air valves, hydrants, washout, WTP, tank, As-built drawings, monitoring and DMA data, Flow meter, pressure, leakage, customers location and complaints are also input in GIS System.

After using the data, firstly they converted Paper drawing to ERSI Shape File and input in current KIS GIS system.

While laying new pipeline network for water supply and after completion of the work, they draw As-built drawing and after checking these As-built drawing, the final correct data are kept in KIS GIS system of PPWSA.

By using GIS, easy to monitor network assets, easy to create report, easy to find location of maintained and leaked pipes, easy to view the data information about number customer in DMA can be conducted, can make report on pipe line pressure in each DMA, by inputting the pipe leakage history, they can easily to know the repair history and conduct pipe repair work effectively, by doing data analysis on current water supply network, they can easily to calculate the needs of project and water supply capacity if they want to extend the water supply network in future, by inputting detail customer data, they can easily to monitor customer information in GIS, by inputting customer complaints information, they can monitor complaints for Customer service in GIS, can manage End point of pipeline, valve location, As-built drawing of the whole network. They also have link of As-built drawing for pipe repair work and the data concerned above activities are kept in GIS Section.

KIS GIS in PPWSA can link/connect with Geo Dataset, customer system. Besides, it can also link with ENSEWATWR which is used for Water loss management system. PPWSA purchases the whole KIS GIS Package and can manage the water supply management work easily, effectively and efficiently. So, we got to know that GIS is the important application for water supply management work.

### **3.7 NRW Reduction Plan**

#### **As an NRW Reduction Plan**

1. For Distribution Network, they use Art Materials based on SOP.
2. Keep 24/7 Stand by Team to Repair Leakage.
3. To raise awareness the public to inform the pipe leakage information.
4. Setting specific DMA Zone.
5. Eliminating illegal connection
6. By adding newly GIS System, PPWSA can conduct NRW reduction works

**Studying on PPWSA's NRW Reduction history, the main causes of happening NRW are;**

- 1. Privilege Consumption*
- 2. Apparent Losses (Commercial Losses)*
- 3. Real Losses*

Apparent losses happened due to illegal connection, estimated water consumption amount and out of date of customer records. By tackling these things, they can reduce Apparent Losses.

When taking action on illegal connection, they set the rules and regulations clearly and the users/staff are to follow these regulations.

If the users don't follow the rules and regulations, they (the users) are served heavy sentence. By making sure to understand the customer, they can reduce illegal connection.

In correcting Estimated consumption, they make all connection metered, and replace the meter to get exact meter reading records.

Now, all of the connections become 100%-meter system and as for the meter standard, they use Class C meter. Every domestic water meter is to replace every four year and commercial water meters are to replace every 8 years. By doing so, they can reduce estimated water consumption.

When updating the customers data, the staff went on site and checked the records, and analyzed it. When checking the customer data in 1993, there were 12980 connections which had to pay the bill without having connection and there were 13901 connection which had connection but without paying the bill out of total 26881 connections.

Now, all of the water connection lists and customer data become up-to date using IT technology and can reduce apparent losses (commercial losses).

Repairing the pipe leakage effectively, searching and repairing the unseen pipe, and prevention work can reduce Real Losses (Physical Losses).

In replacing the old-aged pipes, they use high-quality pipes and pipe materials and now 99% of Distribution network are already replaced.

When doing Leak Detection, they set zone for Distribution network and get to know the water losses in each zone, and they also conduct night step test and OJT training.

They can prevent the pipe leakage by doing leak prevention using art material, use high-quality pipe and pipe materials in laying new pipe network and house connection lines, control the water pressure, and monitor the data by monitoring system. In studying NRW Improvement Strategy, we have learnt Apparent Loss Improvement and Real Loss Improvement. While studying on reducing Apparent Loss (Commercial Loss), it's necessary to get exact and update customer data. Taking action on illegal connection, they have inspection team, control the staff by keeping Regulations & SOP to inspect the illegal without bias and reward to those who inform about illegal connection and checking/monitoring to the customer who misconduct illegal connection. By establishing the inspection team and control the illegal connection, in 1994 they dismissed 16 staff and took action over 46 connections, and in 1999, they dismissed 2 staff and took action over 711 connections, and now, they only fine 1 illegal connection all around a year. For public awareness, they use Social media, TV, and newspapers so that the customers get easily to know and understand on water well.

According to the meter installation policies, they have changed and replaced the damaged meters with high quality meters and since 1997, all connections have become water meter system. In 1995, they have started to utilize Computerized Billing System and in 2002, all bill connection can be managed by computerized system.



They gain the trust from the customers by giving services such as Customer-Oriented service, Customer Information, Take Care of Customer Complaint, On site customer education, and on-site water quality test.

### **3.8 Meter-reading, Billing & Collection**

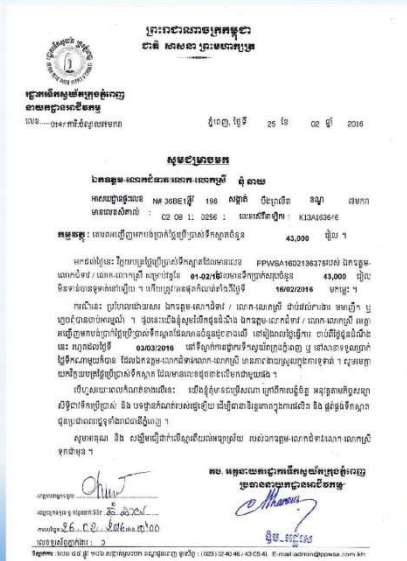
PPWSA's water tariff was revised in 1997 as first revision, in 2001 as second revision and in 2017 as third revision and collects the tariff in progressive rate. But the existing Progressive Rate favors the grassroots people for easy access of water. From 2007 to 2017 in PPWSA, everyday billing system was used but since July 2017, PPWSA initiates Spot Billing System in which prints bill with Hand Printer every two months and gives the bill to the customers in hand. For easy payment of customer, Revenue Section arranges six branch offices - Cashers where the customers can pay at, and the customers can also pay at the Banks, Convenience Stores, and Third Party, and via mobile phones & ATMs. Each cashier of PPWSA has 10 Counters/Desks and the business hours is from 8:00 to 16:30 within Monday to Friday. Ten thousand customers pay the water charges at the cashier in average and during the busy hours, Revenue Section sometimes helps. All the received cash is collected and saved in Main Cashier.

80% of customers pay at the cashiers of PPWSA and the rest 20% pays in other payment system. The service fee is not charged for the payment at PPWSA cashiers but for the payment at other place or through other payment system, 1000 Riel is charged as service fee.

The customer complaints are solved at once during the customer's payment at PPWSA cashier. PPWSA has a specific service for grassroots people in which they can pay the water charges two-or-three-time payment within one period or two months if they are unable to pay water charges in one-time payment but that service is not valid for commercial consumers. Concerning with late payment, for the absence of payment within 15 days after issuing bill, the customer is warned with first notice and waits for 3 days for payment. For the absence even after first notice, second notice is sent and waits for 3 more days. If the customer doesn't pay after second notice, water connection is cut off. If the customer wants to reconnect the water connection, he or she has to visit to PPWSA governor and sign the bail bond or pledge, then has to pay fine and only after that, the customer can apply for new connection. The cost of reconnection has to be paid by customer. The overdue bill payment is fined 1% of water charges per day.

# Late Payment (Old)

## Warning Letter



Concerning with the Customer Data Management, water charges were collected manually until 1994. Since 1994 July, Computerized Billing System was initiated with the assistance from France and the system was updated in 1995. During the period from 1995 to 2007, the bill was issued every two months – at the end of second month. But from 2007 to June 2017, every day Billing system was practiced instead of two-month period billing. In everyday Billing System, meter readers perform meter reading every two month and meter reading units are transferred/sent to Head Office, and then data inputting is carried out. After that, bills are printed out and bills are distributed to customers the next day. The customers have to pay the water charges within 16 days after the bill has been received. From July 2017, Spot Billing System is being introduced. In Spot Billing System, meter readers perform meter reading by using mobile phones and data is input and bill is printed out with Hand Printer at once. Then, the bill is directly passed to customer at once.

ADB assisted PPWSA in December 1996 to increase water tariff. In increasing water tariff, PPWSA announces and shares the information to customers and if the customers dissatisfy, it can be proceeded with the authority of Government.

In preventing PPWSA's commercial loss, PPWSA could install meters (100%) for all connections in 1998 even though only 23.19% of all connections could be installed meters in 1993, and water tariff could be collected fully after 100%-meter installation.

PPWSA could perform making the customers believe that full collection of water tariff can benefit to customers and also water supply services.

There is a process to become a customer. New connection applicant is just under the application stage before it has not been approved as customer. PPWSA staffs inspect and do ground survey at applicant's house in accordance with the 13 basic elements stipulated by PPWSA. Only if the inspected facts are conformable with 13 basic elements, the application is approved and the applicant is invited to office to pay the initial cost for new connection, then after the applicant had filled the form and signed to obey Rules and Regulations stipulated by PPWSA and approved by respective officer, the applicant is recognized as customer and informs the customer for

the recognition as customer. And Delivery Point Code is set for new customer in order to know the quantity of reconnection of each customer.

Illegal connection cannot be found out in Spot Billing System. But non-payment and consuming water by removing the meter can be found in Spot Billing system. PPWSA closes the plug and cuts water off. Only after the customers have signed the pledge, the customer is fined and allowed to apply for new connection. In order to avoid those cases, PPWSA staffs check and inspect monthly.

If the customers of suspended connections don't make request at PPWSA for reconnection within next period (next two months), the customer has to apply for new connection if he/she wants to reconnect. As the customer complaints are also recorded, the call or the customer is transferred to the respective department and can be solved at once if asked either by phone or in person. The complaints are divided into 5 categories.

PPWSA has over 300,000 connections and a meter reader can read 2800 meters/customers in Old Billing system. But in Spot Billing System, a reader can read 3200 meters. Spot Billing system was utilized since July 2017 and the meter readers can read the meters by using Mobile Phones, can print the bill by Hand Printer at once and give it to customer immediately. Then the customer just has to pay the water charges at the PPWSA Counter. Meter field book is filled manually and Computer Section checks it two times. Spot Billing includes the Auto Check function for Fluctuations meter gap and if suspected, meter water checks again carefully and reports to PPWSA.

Three irregular situations: (1) Meter Error, (2) Meter Slow and (3) Meter Lost, exist in meter reading. Water Tariff calculation is formulated for each situation.

PPWSA allows just to install meters outside of the house, doesn't allow to lock the meter and instruct to inform to PPWSA to relocate the meter in order to avoid difficulties such as breaking meter Seal, installing meter in the place where is difficult to read and to avoid to make appointment with house owner of locked house to read meter as the meter is installed inside the house.

If difficulties and problems happen during meter reading, the meter readers settle the problems on ground at once if the problems are under their ability to be solved. If those are not resolvable, the customers are invited to Office and transferred to Revenue Section, and a group will analyze the ground situation and solve the problems or complaints. Customers who act irregularly shall be charged with firmed evidence and the court's decision shall be comply.

Only good meter type is used in meter installation and meter maintenance fee is charged based on meter size.

In Old Billing System, meter reading staffs act irregular action and they are applied legal punishment. But the existing/new Billing System, meter readers can be controlled due to meter reading mobile phones installing GPS and legal punishment is barely.

Meter readers are constantly monitoring and checking the customers in far places because of the cases of water consumptions by removing meter and reinstallation of meter just before meter reader comes to read meter, and water consumptions by removing meter inside a closed house. Such kind of customers are found out and taken action legally.

PPWSA improves the mindset of its staffs (meter readers) by offering allowance and bonus depending on the distance and number of meter readings/bills. Outstanding employees are awarded and the award-winning employees get promoted once a year. Bad health Employees are supported from PPWSA fund for their treatment or cure and insurance system is being introduced for injures.

- Meter cannot be installed near or behind leakage area.
- Meter reader shall immediately inform to PPWSA if leakage is found and shall fix it.
- All meter readers shall wear Uniform.
- The behavior of meter readers should always be active in the view of customers.
- Meter readers shall carefully record the meter reading date and meter no.
- Meter readers shall always check the monthly average consumption.
- Meter readers shall report to PPWSA if found any changes on meter or if suspected.

### **3.9 Customer Data Management**

Regarding Customer Data Management, the water connection of non-payment is cut off according to Rules and Regulations of PPWSA and if the customer wants to reconnect, he or she has to sign the pledge and only after that, he or she can apply new connection. The customer has to pay the reconnection cost. If applied for new connection, PPWSA staffs shall visit the applicant's house and do ground survey and shall check and analyze the possibility with the following 13 basic facts: (1) Customer No. (2) Name (3) Address (4) Category (5) Tariff (6) Activity (7) Family Head Count (8) Water Deposit (9) Contract Number (10) Contract Date (11) Meter Serial Number (12) Meter Installation Date (13) Meter Installation Data.

### **3.10 PR Activities and Complaint Management**

Regarding PR Activities and Complaint Management, PPWSA staff and officers visit at the customers' houses to give awareness of water, and to test the quality of water form tap at customers' house. Customer Complaints are solved by relevant departments according to five strategies stipulated by PPWSA. The complaints are categorized by Customer Relation Office and it shares the Complaints to the responsible department to solve.

## Chapter 4 Comparative Study between YCDC and PPWSA

### 4.1 Organization System

| Y.C.D.C  | PPWSA  |
|--|--|
| The organization with Mayor, Committee Member, Secretary and joint-secretary | The organization with 7 Directors including 2 government officials, General Director and Deputy Director |

### 4.2 Budget Management and Water Tariff

| Y.C.D.C   | PPWSA   |
|---|---|
| There is 600 million kyats to conduct NRW reduction plan in 2018. At current the water tariff is 1.66\$ per unit. | They have budget estimation 1,560,000 USD to conduct NRW works.<br>unit=1.644\$ |

### 4.3 Measures of Physical Loss and Commercial Loss

| Y.C.D.C  | PPWSA   |
|--|---|
| <p>Measures of Physical Loss</p> <p>Estimate to conduct the night step test in Pilot Area, and the staff for leak repair are on OJT. The leak repair team are established in every townships and assign 24hours and start to practice DMA system.</p> <p>Commercial Loss</p> <p>Start to update the customer data, take action on illegal connections, make all connections (including Class B and YCDC logo meters) with meters 100%.</p> | <p><i>Measures of Physical Loss</i></p> <p>Establish leak repair team and check and monitor the leak 24/7 and practice DMA system. The leak repair staff are on OJT.</p> <p><i>Commercial Loss</i></p> <p>Update the customer data, taking serious action on illegal connections and set the policy to use high-quality meters and make all connections 100% meters</p> |

### 4.4 Regulation/Standard/Guideline/Manual, SOP

| Y.C.D.C  | PPWSA  |
|--|--|
| The former CI, DI, GI and Concrete pipes are still using and now PVC, HDPE pipes are used. It's planning to set and practice SOP in all section for the capacity development of the staff with the help of JICA. | <b>Regulation, Standard, Guideline and Manual.</b><br>They only use DI and HDPE pipes and DI pipe with 250 Diameter are used in transmission lines, and under 250 diameter HDPE pipes are used in distribution lines. 160 Diameter above pipes are used in service lines. With the help of JICA, they cultivate the staff's capacity and every work process has its own SOP and practice/perform the work as to the SOP. |

### 4.5 Construction and Inspection

| Y.C.D.C   | PPWSA  |
|---|--|
| <b>Construction</b><br>Though the notice boards for safety are kept on some sites, but some don't keep the notice boards, weak in | Before the construction work, first they check the pipes, make sure the form work installation to be safe, keep warning signboard. While |

|   |   |
|---|---|
| <p>practicing computerize system,<br/> <b>Inspection</b><br/> We have separated Inspection Department but lack of inspection team within department. We have research section and it checks and confirms the estimated construction cost.</p> | <p>laying/constructing 400m above pipe, they use Piccolo Software Water CAD software and Resocad Software and <i>control the capacity and skills with SOP</i></p> <p>They have internal audit and inspection team and take heavy action on illegal connection without bias and give reward to informer and check and monitor to suspected customers who might conduct illegal connection.</p> |
|---|---|

## 4.6 GIS

GIS Section of Engineering Department (Water & Sanitation) of Yangon City Development Committee was organized in 2014. With the intention of proper management of water supply, the section was comprised with 10 staffs including one leading section head who will emphasize on plan implementations.

### 4.6.1 Set up the GIS based Pipe Line Network

Current situation: GIS Section of EDWS is applying 2012 satellite images as Base-map supported by JICA for the Project of Urban Development. Township Boundaries, Water Bodies layer, Water Bodies in Yangon Region, Main Transmission Pipelines layer of Yangon City Water Supply System, Water supply Equipment data on tube wells layer, WTP layer, booster-PS layer, service-tank layer and boundary\_valve have already been inserted based on 2012 Satellite images.

### 4.6.2 Input Customer Data to GIS

EDWS has already carried out a Database during the Pilot Project conducted by the France Development Agency (AFD) which supports for NRW Reduction Management linking the Customer Layer of Pilot Area with GIS. In that Pilot Project for NRW reduction, in order to reduce Commercial Losses, we carried out Customer Survey, survey of Service Quality and unregistered connections from collected meter reading data. Data from surveys is input in Customer Data Attribute. Regarding customers and metering management, EDWS could issue the report for Anomalies, Big customers, damaged meters, Leaks location per category, and Customer Complaints Report by using GIS Application with Customer Data Attribute and could identify the huge volume of field data. Based on report of GIS Data Analysis, the best and feasible ways of reducing commercial losses for the future water supply management have been found out from NRW Reduction management Project implemented with the support of France Development Agency (AFD). At current, EDWS applies 2012 Satellite images as Base map to input the customer data in GIS. As for EDWS, it's not convenient as much to use the data because the Land Parcels Layer is the data input by Urban Planning and Land Management Department of YCDC. If we would like to input the customer data as to the pilot project conducted by AFD aid, it's necessary to do Update of Land Parcels Layer for Water Supply, Buildings and Data Attribute for each customer specifically, and besides that, it's required to do field survey like pilot project in order to input Customer Attribute Data.

## 4.7 NRW Reduction Plan

| Y.C.D.C   | PPWSA   |
|---|---|
| Establish NRW Leak Detection Team & Leak Repair Team and draft and manage NRW Reduction Plan by Steering Committee 1. It's also studied on water consumption amount based on meter size, made damaged meter lists and then calculate Service Coverage and manage Pilot Areas which are completed. | To conduct pipe repair and maintenance work within 2 hours when they receive leakage information. NRW rate must not to exceed 8%. |

#### 4.8 Meter-reading, Billing & Collection

| Y.C.D.C   | PPWSA  |
|---|--|
| Difficult situation of meter relocation or reposition, weak inspection/checking of monthly meter unit difference, eg: weakness in recording meter reading related issues such as charging the consumption in average for damaging meter, and lack of practice on existing policy,<br>To perform to check the difference of consumption unit (+/-) and make the list of meter collected the bill in average unit in New Customer database Management | Double checking Meter-reading units record with average consumption if in doubt, Checking the condition of meter installation, making record of Meter reading problems and other related issues, performing Billing & Collection every two months, setting the policy to collect water tariff fully in order to reduce NRW |

#### 4.9 Customer Data Management

| Y.C.D.C  | PPWSA  |
|--|--|
| Although Customer Data is updated in Computer, it is still needed to update up to now. All new connections are installed meters but all old connections haven't installed meters yet. Public wells are still being used. | Customer Data is updated by computers. All connections have been installed meters. Have eliminated all public wells since 1945 and replaced with water supply network. |

#### 4.10 PR Activities and Complaint Management

| Y.C.D.C   | PPWSA   |
|---|---|
| Issuing internal announcement to share Basic Information about promotions and transfer of officers and staffs, explaining customers to know and understand the facts and information via newsletters, publishing newsletters three times per year, publishing the first table calendar in 2017 as a Public Relation Material, broadcasting and announcing the emergency cases such as pipe burst or disruption, electricity going off, water shortages and low pressure through TV, City FM, City News, YCDC Website, Engineering Department Water & Sanitation Facebook Page and Daily Newspaper | Providing water related awareness program to Customer directly, testing quality of water from the tap of customer's house, settling the customers complaints by the respective department in accordance with five strategies stipulated by PPWAS. Five strategies are (1) cooperated action of utility and customers (2) communication through radio, (3) building relation (4) managing possible complaints in advanced, (5) educating the customers by arranging seminars and events/shows. |



## **Chapter 5 Proposals for Improvement**

### **5.1 Organization System**

It's intended to set up firm NRW section by cooperation with Customer Service Section, House Connection Section, Computer Section, Distribution Section, GIS Section and Design Section, etc. At current, NRW section has 15 staff. The township and district deputy offices are part-time members of NRW section.

#### **5.1.1 Establish inspection, detection and repair team**

It's to set/establish Inspection team within department and check the work on ground and on paper. It's firmly to establish leak detection and leakage repair teams and assign specific duties and practice incentive and penalty system.

EDWS should install the high-quality water meter by own budget and the cost of meter and installation fees should be cut off from the water tariff. Installed meters also should be checked with inspection team frequently and every 8 or 10 years, do meter testing and if necessary, replace the meter with new one.

#### **5.1.2 Setup Water Meter Inspection Unit**

It should install the high-quality meter systematically by the department and the charges should be deducted from water tariff or other maintenance fees. All installed meters should be checked and done meter testing every 8 or 10 years by inspection teams and replaced the meters if necessary. It's to get accurate meter reading records. It can reduce Commercial Loss. It's to be done by the NRW section and staff from district and townships.

#### **5.1.3 Setting IT Section**

EDWS's current Customer Database just includes User ID, User Name, meter no., House no, Apartment, road, pre-unit, cur unit, Debt, Water Consumption, Charge (MMK), Total Charge (MMK), Region id, Categories type, Month of meter-reading and Year, and there are various requirements. All sectors of Customer Data Management Activity in all townships are being carried out in paper works. Regarding Monthly Meter Billing and Collection System, all the works – from Yapha 1 to Yapha 8 – such as HO & township office counterchecking, sending detailed Demand related with water charges and billing, the condition of collected water charges, daily income, and the approval of water bill list by HO are undertaken in Manual Paper works.

Regarding all paper works of Yapha, as the first phase, it is needed to restructure the existing Customer Database Structure in order to supplement Damage meter list, Date of Paid to Bank, Voucher No., Collected Bill, Outstanding Bill, Detail Customers Data for Collected Bill, and Approval Demand by Townships in the existing Customer Database of EDWS, and it is scheduled to be undertaken in 2018-2019 Fiscal Year. Regarding the restructuring Customer Database Structure, new Customer Data Management Program will be set up in SQL Data Sever, then, Data migration will be carried out. One township will be selected and implemented as Pilot. After that, supplementary to New database based on the results of implementation in Pilot township shall be done and it will be continuously implemented in other townships step by step. As the second phase, township-head office operations,

ledger bookkeeping in townships, in addition to the meter reading record (Field Book), Data of new customers of new house connection applicants such as Connected Date, Service Pipe size, Permission No., Permission Date, Meter Location / Position is to be added in Customer Database in 2019-2020 Fiscal Year. For the need of IT assistance, CE has already been reported that it requires to communicate with outsource IT companies for the IT services.

Customer Service Section and JICA Expert Mr. Saitou have discussed to build New Customer Database with Data Transfer script by applying User-id and Excel Export of existing database as a Key after implementing the above plans in two phases according the scheduled fiscal year. New Customer Database will include Billing and Collection Application that will undertake billing & collection and Customer Service Management in which reducing Commercial Loss in NRW of EDWS will be prioritized.

As the operation is arranged for cooperation with an external IT company, EDWS requires to establish IT section in order to cooperate EDWS staffs (from computer section and customer service) and IT company. After the establishment of New Customer Database Program, EDWS is in need of IT skillful staffs to update the new Customer Database Program as require, and to accept and solve Customer Complaints in township office regarding Customer Service management. Thus, it is planned to provide the training of Database Structure to the staff in Computer section and Customer service section after the establishment of New Database Program in 2018-2019 and the training shall be offered by the cooperated IT Company outsourced by EDWS.

## **5.2 Budget Management and Water Tariff**

### **5.3 Measures of Physical Loss and Commercial Loss**

It's not just to use high-quality pipe and pipe materials but to cooperate with Detection and leakage repair team to reduce Physical Loss.

To reduce Commercial Loss, it's prior to eliminate illegal connection, the existing connections should be legal and not to lose water tariff and install high-end water meters. The above facts are to discuss in SC 1 meeting and make the decision.

#### **5.3.1 Planned Leak detection work by Detection Team**

It should establish Detection Team in each township and conduct leak detection work. As for the priority, it should do leak detection work in very first month of a year in pilot area and then increase the leak detection work frequency (one month, one ward or one township).

#### **5.3.2 Check completion of work by Inspection Team**

It should check using check list after completion of Leak detection work, leakage repairing, new connection work, new pipeline network laying process and after the checking process, completion drawing should be kept as a record.

## **5.4 Regulation, Standard, Guideline, Manual, SOP**

### **5.4.1 Formulate and establish SOP**

Though EDWS has existing RSGM, but it's required to modify and draft the necessity items. But the habit of applying/practicing RSGM on ground is still weak, so it's to draft specification and check with respective Inspection team.

It's necessary to separate the sections which have SOP and sections which don't have SOP and it's to practice in actual work. It's intended to be a systematic water supply system and organization.

RSGM related to NRW are submitted in SC1 and it's to discuss SC1 plan also.

### **5.4.2 Organize 5S Team and assign specific duties**

It's suggested to set up 5S team systematically in each section and check and monitor continuously. It's submitted that 5S Supervision Team should be set up in Top Management Level of EDWS and monitor the other sections every month. HRD Section and relevant sections should implement.

## **5.5 Construction and Inspection**

While laying the pipelines, it's to use high quality and standardize pipes and take all accountability and after finishing the work, the works are checked by the inspection team.

Procurement based on material quality

While choosing the pipes and pipe material's, it's primarily to consider and use the pipes not to become/happen NRW in long run. Though the pipe quality and price are the same, then we must choose the pipe which length is longer than other.

### **5.5.1 Check Completion of work by Inspection Team**

It's to check with inspection team after completion of the project/plan whether the staff use standardize materials or not, they conduct as to the check list or not, whether they follow the SOP and RSGM or not.

## **5.6 GIS**

GIS Section of Engineering Department (Water & Sanitation) of Yangon City Development Committee was organized in 2014. With the intention of proper management of water supply, the section was comprised with 10 staffs including one leading section head who will emphasize on plan implementations.

### **5.6.1 Set up the GIS based Pipe Line Network**

Current situation: GIS Section of EDWS is applying 2012 satellite images as Base-map supported by JICA for the Project of Urban Development. Township Boundaries, Water Bodies layer, Water Bodies in Yangon Region, Main Transmission Pipelines layer of Yangon City Water Supply System, Water supply Equipment data

on tube wells layer, WTP layer, booster-PS layer, service-tank layer and boundary\_valve have already been inserted based on 2012 Satellite images.

### **5.6.2 Input Customer Data to GIS**

EDWS has already carried out a Database during the Pilot Project conducted by the France Development Agency (AFD) which supports for NRW Reduction Management linking the Customer Layer of Pilot Area with GIS. In that Pilot Project for NRW reduction, in order to reduce Commercial Losses, we carried out Customer Survey, survey of Service Quality and unregistered connections from collected meter reading data. Data from surveys is input in Customer Data Attribute. Regarding customers and metering management, EDWS could issue the report for Anomalies, Big customers, damaged meters, Leaks location per category, and Customer Complaints Report by using GIS Application with Customer Data Attribute and could identify the huge volume of field data. Based on report of GIS Data Analysis, the best and feasible ways of reducing commercial losses for the future water supply management have been found out from NRW Reduction management Project implemented with the support of France Development Agency (AFD). At current, EDWS applies 2012 Satellite images as Base map to input the customer data in GIS. As for EDWS, it's not convenient as much to use the data because the Land Parcels Layer is the data input by Urban Planning and Land Management Department of YCDC. If we would like to input the customer data as to the pilot project conducted by AFD aid, it's necessary to do Update of Land Parcels Layer for Water Supply, Buildings and Data Attribute for each customer specifically, and besides that, it's required to do field survey like pilot project in order to input Customer Attribute Data.

## **5.7 NRW Reduction Plan**

It's necessary to establish NRW team in each township with the supervision of NRW Management Section in head office and conduct leak detection and leak repair work 24/7, install the flow meter in the inlet points of the townships, install the flow meters in Hlawga, Gyophyu, Ngamoeyeik, Phgyi Reservoirs to know the input volume, keep connection lists in House Connection section, eliminate the illegal connection and take action on it and while laying the new pipeline, it's mainly to consider the NRW rate, set the meter size based on the supply water pressure, if meter becomes damaged, need to replace it at once, keep the pipe leakage record and mark it on the map, and as to the record on map, repair and replace work should be done at once. Besides, survey the damaged meter conditions, plan to calculate the coverage and North Okkalapa Pilot Project are implementing.

It's to install the water meter systematically in Public Toilets, Parks and get/collect water tariff, and to construct the NRW Training Yard in Yegu pumping station compound to teach not just the staff of EDWS but also the plumbers in practical.

### **5.7.1 Set annual target of NRW reduction rate**

To know the NRW Rate of whole water supply area of YCDC, now it's installing 2 Flow meters in 56" ØDI of NyaungHnapin WTP and it's planning to install the Ultrasonic Flow Meter (21) nos in Gyophyu, Phgyi, Hlawga, Yegu, Kokkine and Shwedagon Pagoda Service Reservoirs with the help of JICA TA Team.

Besides, it's intended to adjust NRW Reduction Rate by doing Leak Detection and Repair every month in Pilot Project Area. After laying New Pipe Network in other distribution area, it's to do leak detection and leak repair work in every township in every month to cover the whole distribution area in a year and try to reach NRW Target of 2014 Master Plan.

**Target Level of Non-Revenue Water Rate and Leakage Rate**

| Items                      | 2013 | 2018 | 2020 | 2025 | 2030 | 2035 | 2040 |
|----------------------------|------|------|------|------|------|------|------|
| Non-Revenue Water Rate (%) | 66   | 51   | 46   | 35   | 26   | 20   | 15   |
| Leakage Rate (%)           | 50   | 37   | 33   | 25   | 18   | 13   | 10   |

### **5.8 Meter Reading, Billing and Collection**

In the present situation, being good condition of all water meters of customers is required in order to get accurate meter reading data according to water consumption and the project of damaged meters replacement should be undertaken with EDWS's or customer's budget. In replacing meters, the implementation should be carried out based on life-span and accuracy of meter as learnt in PPWSA. If the actual meter reading record can be collected as water consumption, those data shall be input in New Customer Database as expressed in 5.1.3 and water tariff collection can fully be collected by using New Billing and Collection Program.

In the New Billing and Collection Program, the necessary arrangement shall be prepared so that Township offices can input Data in the program and Head Office will perform bill issuing. In addition, we should proceed keeping the New program update in order to insert not only Billing application but also Collection application in the New Program, to eliminate paper works of township, and to be able by Head Office and District Office to monitor bill collection progress, income and outstanding in the new program.

#### **5.8.1 Train meter reader and assign duty by rotation**

The plan of awareness training will be prepared to provide to meter readers and billing & collection staffs in township offices to know the importance of water tariff to maintain the entire water supply network, to collect water tariff fully and to understand that O&M works has to depend on water tariff, and the implementation of training will be carried out by following the plan. Moreover, each staff will be trained to be able to read meter correctly and to understand that not only water wasted due to failure of water supply network but also being unable to collect water tariff fully as water consumption is NRW. Practicing duty station transfer, from one township to another township, for meter reading and billing & collection staff in townships can help identify any gaps about their duties. Thus, duty by rotation will be considered.

#### **5.8.2 Use incentive, bonus and penalty system**

#### **5.8.3 Arrange Easy access for Payment**

After establishment of New Customer Database, Billing and Collection Application will be designed to include bill payment function so that customers can pay the bill not only at respective township offices, and can also pay at the banks signed MOU with YCDC, Third Parties servicing for bill collection, and through Mobile Payment System and ATM.

## **5.9 Customer Data Management**

After establishment of New Customer Database, the existing customer data will be input by applying User-ID as Key-index. As New Customer Database is detailed customer data and can be analyzed by using GIS, it can be operated for all customer affairs including water supply operation and solving customer complaints. Moreover, it will be the greatest support for full water tariff collection which plays in the main role of water supply management and it will become the application which can solve the difficulties of EDWS customers.

### **5.9.1 Apply Customer Data Application**

Customer Data Application shall include detail customer data, Billing and Collection Application, and it can store Historical Data. Based on the necessity, Customer Data Application can be applied for Data analysis by linking with GIS and report can be exported as required.

### **5.9.2 Customer Information Desk**

As EDWS at present, township in-charged persons of EDWS and responsive persons in head office are handling all customer complaints received in head offices and townships and respond the enquires. Any enquires can be asked through YCDC website and if mentioned email address in enquires, the respective persons replies to email. Even though there are no specific Customer Information Desks in EDWS, Customer Information Desks will be initiated under the New Customer Database and Customer Complaints will be settled in time until reaching the customers' satisfaction.

## **5.10 PR Activities and Complain Management**

### **5.10.1 Public Awareness**

Regarding Development Material, calendars are yearly being published since 2017 as External Material and News Letters are being issued quarterly as internal.

### **5.10.2 School Activity**

School Activity was initiated since November 2017 and it is intended to carry out it in three schools per year at least.

### **5.10.3 Complaint Management**

Complaints of pipe burst, meter damaging, water supply interruption through official letter, phone, social media and daily newspaper or complaints in person at township/district offices are transferred to the respective township or district offices. The township staffs of responsible area perform customer's house visit, inspection, maintenance, repair and replacement.

### **5.10.4 Social Media**

As customer relation through social media, News are broadcasted from the state-owned Channel and City FM radio station as appropriate.

## Chapter 6 Action Plan

### Action plan after studying in Phnom Penh Water Supply Authority

| No         | a.<br>Activity  | Objective   |  |                     | Facts   |   |
|------------|---|---|--|---------------------|---|---|
|            |   | b.<br>Results/Outcomes  | c.<br>Index  | d.<br>Starting Date | e.<br>Concerned Organization  | f.<br>Required source   |
| Activity 1 | To enhance in collaboration with NRW Management Section and other sections.                   | To become successful water supply organization  | To have successful & efficient activities.   | 2020 ...            | SC (1) & Working Group  | Man power, coordination meeting   |
| Activity 2 | Setting meter inspection teams, pipe leakage detection team and repair team in each district. | To decrease/reduce the non-revenue water, illegal connection, to get high water pressure, and prevent the wasted water involved in pipe through leak. | To improve the condition of Competition drawing of pipe leak repair, and to reduce illegal connection. | Dec 2019            | NRW Section, Staff in district & township offices and Pipe section. | Man power, leak detector, record book, safety equipment, pipe line detail map, training |

| No         | a.<br>Activity  | Objective               |   |                     | Facts  |  |
|------------|---|-------------------------|---|---------------------|--|--|
|            |   | b.<br>Results/Outcomes. | c.<br>Index                               | d.<br>Starting date | e.<br>Concerned organization   | f.<br>Required source  |
| Activity 3 | Checking the root cause of happening Physical Loss & Commercial Loss. | To reduce NRW Rate      | Bulk Meter records, meter reading records | 2019                | NRW section, Water Supply Section, township office, Research Section, Pipe Section | Bulk Meter, Man power, computers, meter reading records, NRW activities records. |
| Activity 4 | Establishing the inspection team for construction works.              | To control the quality  | Quality Control Record, Check lists       | Dec 2019            |  | Man power, instructions  |

| No. | Activity | Objective        |       |               | Facts                  |         |
|-----|----------|------------------|-------|---------------|------------------------|---------|
|     |          | Results/Outcomes | Index | Starting Date | Concerned Organization | Sources |



|            |  |   |  |          |  |   |
|------------|--|---|--|----------|--|---|
| Activity 5 | To improve leak detection works                    | To reduce Physical Loss                       | Pipe leakage records, pipe leakage map | Dec 2019 | NRW Section, Planning Section, Staff in District & Township officers, Detection Team | Man power, Lead Detector, Lead Record, Books, Pipe Detail Map, Budget Plan  |
| Activity 6 | Checking the competition work of the construction. | To be better quality of the construction work | Completion Drawing and check lists     | 2019     | Inspection Team  | Man power, Leak Detector, Record books, Safety Equipment, Pipe Line Detail Map, Completion drawing, Pressure Test |

| No         | Activity   | Objective   |  |               | Facts                               |  |
|------------|--|---|--|---------------|-------------------------------------|--|
|            |  | Results/Outcomes  | Index                                      | Starting Date | Concerned organization              | Sources  |
| Activity 7 | To describe the SOP precisely                              | To be a systematic water supply system and organization | For the improvement of SOPs                | 2020          | All sections                        | Daily record, Technological Knowledge and experience |
| Activity 8 | Setting/establishing 5S Team and allocating specific works | To be a systematic and efficient workplace              | To improve the 5S activities continuously. | December 2019 | HRD Section and its related section | Man power and instructions                           |

| No         | Activity  | Objective                        |                            |               | Facts                       |                                     |
|------------|---|----------------------------------|----------------------------|---------------|-----------------------------|-------------------------------------|
|            |   | Results/Outcomes                 | Index                      | Starting Date | Concerned Organization      | Sources                             |
| Activity 9 | Based on the quality of materials/ equipment in site works. | To be a high-quality and durable | Checking quality standards | 2019          | Top Management Section, SC1 | NRW and its related data, man power |

|             |                             |   |                                      |      |  |                            |
|-------------|-----------------------------|---|--------------------------------------|------|--|----------------------------|
|             |                             | materials and facility.                         |                                      |      | and its related sections   |                            |
| Activity 10 | Drafting NRW Reduction plan | To meet the NRW goals which are in Master Plan. | Yearly Mid Term Plan, Long Term Plan | 2019 | Top Management Members of SC1, NRW management Section and Planning Section | Man power and instructions |

| No          | Activity                       | Objective   |                            |               | Facts  |   |
|-------------|--------------------------------|---|----------------------------|---------------|--|---|
|             |                                | Results/Outcomes  | Index                      | Starting Date | Concerned organization                               | Sources   |
| Activity 11 | Setting yearly NRW Target Rate | To be a high-quality and durable materials and facility | Checking quality standards | 2019          | Top Management Section, SC1 and its related sections | NRW and its related data and man power                  |
| Activity 12 | Drafting NRW Reduction Plan    | To be a supportive thing for NRW Reduction Plan         | The benefits of EDWS       | 2020          | Top Management                                       | Statement in New regulations & Approval from Government |

| No | Activity    | Duration        |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |
|----|-------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|    |             | 2018            |                 |                 |                 | 2019            |                 |                 |                 | 2020            |                 |                 |                 |
|    |             | 1 <sup>st</sup> | 2 <sup>nd</sup> | 3 <sup>rd</sup> | 4 <sup>th</sup> | 1 <sup>st</sup> | 2 <sup>nd</sup> | 3 <sup>rd</sup> | 4 <sup>th</sup> | 1 <sup>st</sup> | 2 <sup>nd</sup> | 3 <sup>rd</sup> | 4 <sup>th</sup> |
| 1  | Activity 1  |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |
| 2  | Activity 2  |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |
| 3  | Activity 3  |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |
| 4  | Activity 4  |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |
| 5  | Activity 5  |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |
| 6  | Activity 6  |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |
| 7  | Activity 7  |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |
| 8  | Activity 8  |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |
| 9  | Activity 9  |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |
| 10 | Activity 10 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |
| 11 | Activity 11 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |
| 12 | Activity 12 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |

# ***Arc GIS Operation Manual***

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Prepared by:


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JICA Expert (GIS)

## [How to plot a point according to the CSV-file of latitude and longitude.]

(1) Make a CSV-file that describes the latitude and longitude.

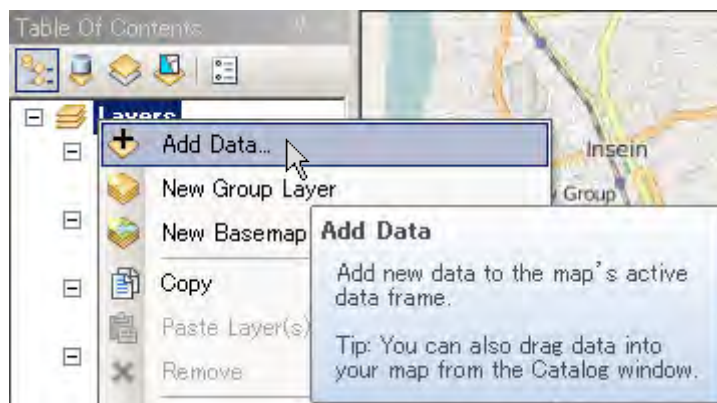
(Sample)

 text.csv

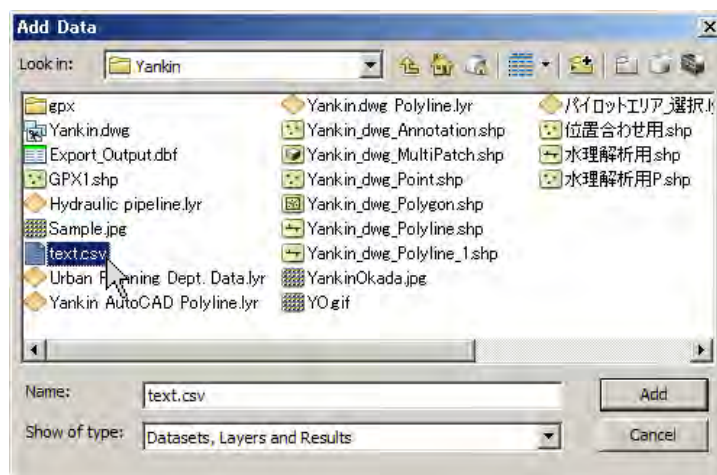
|   | A         | B        |
|---|-----------|----------|
| 1 | longitude | latitude |
| 2 | 96.11486  | 16.84429 |

(2) Add the CSV-file to Arc GIS.

1) Right-click on "Layers" of "Table of Contents" and select "Add Data"

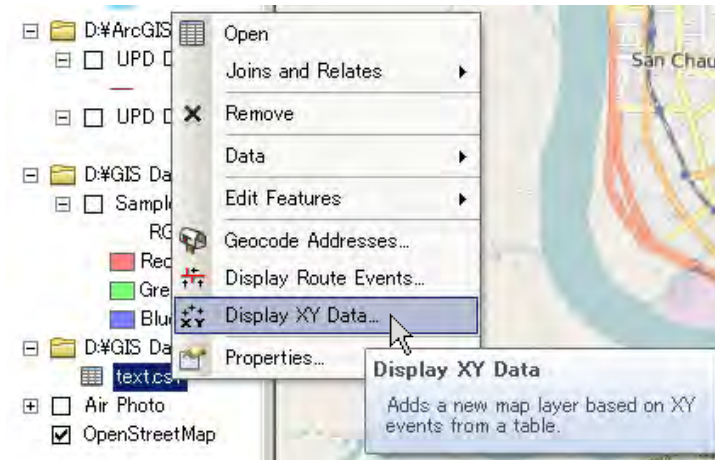


2) Select the CSV-file and click "Add".



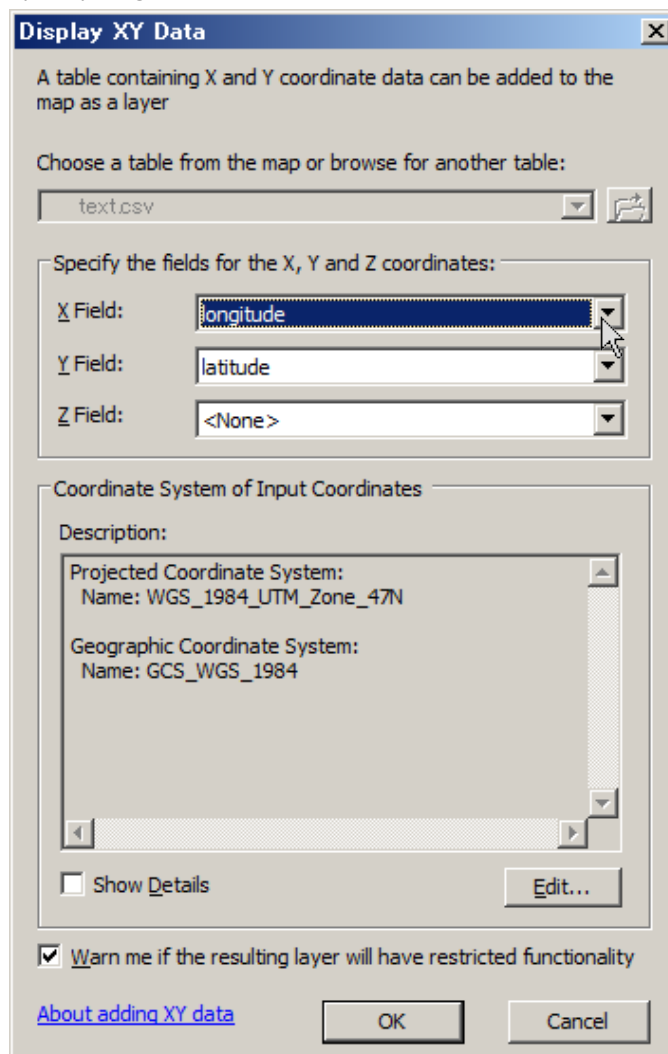
(3) Display the lat/long-data of the CSV-file.

1) Right-click on csv-file name of "Table of Contents" and select "Display XY Data".



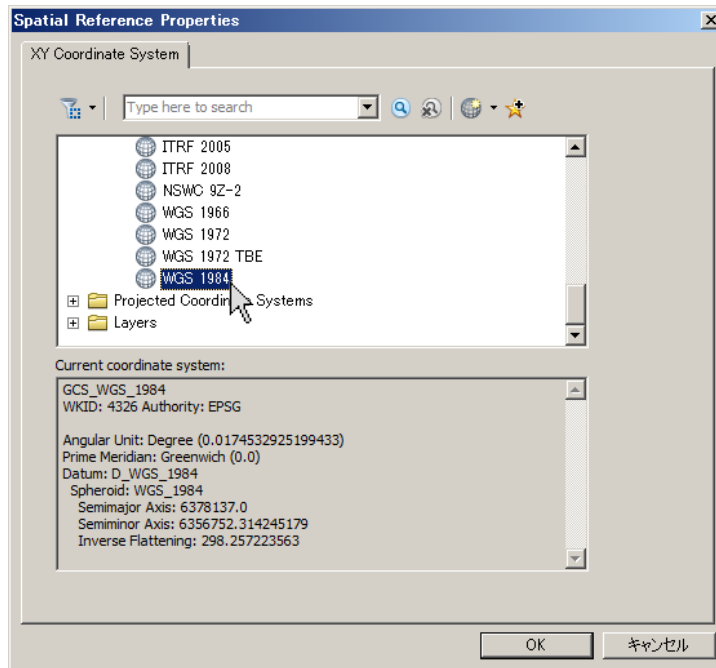
2) Specify the data fields.

Specify longitude for "X Field" and latitude for "Y Field".



3) Specify the coordinate system.

- Click "Edit" of "Display XY Data" window,
- Select "Geographic Coordinate Systems" -> "World" -> "WGS1984" as XY coordinate system,
- Click "OK".



4) Display a point according to the lat/long-data


(The point is automatically displayed)



**[How to plot a point according to the CSV-file of UTM Grid (Total Station).]**

(1) Make a CSV-file that describes the UTM Grid.

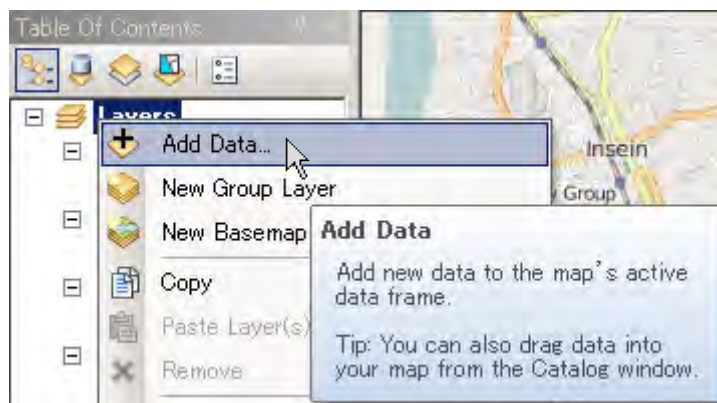
(Sample)

 text.csv

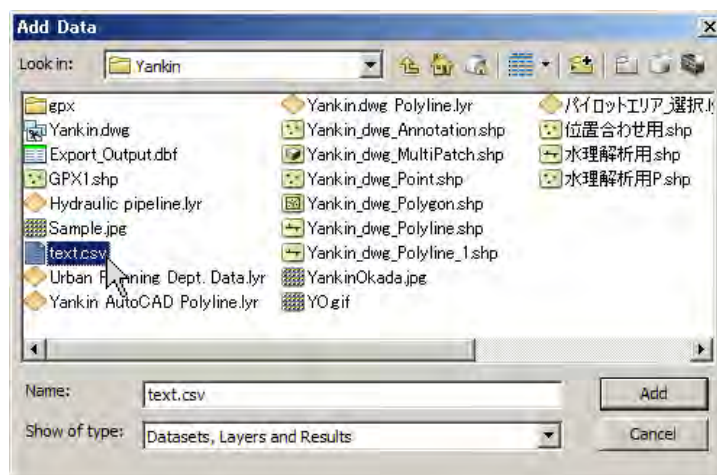
|   | A | B        | C       | D       | E  |
|---|---|----------|---------|---------|----|
| 1 | 1 | 197004.1 | 1868576 | 100.048 | DR |
| 2 | 2 | 196996.2 | 1868579 | 100.029 | DR |
| 3 | 3 | 196997.7 | 1868571 | 100.079 | DR |
| 4 | 4 | 196996.4 | 1868570 | 99.982  | DR |
| 5 | 5 | 196994.2 | 1868588 | 99.916  | DR |
| 6 | 6 | 197006.5 | 1868563 | 99.825  | DR |
| 7 | 7 | 196998.8 | 1868564 | 100.089 | DR |

(2) Add the CSV-file to Arc GIS.

1) Right-click on "Layers" of "Table of Contents" and select "Add Data"



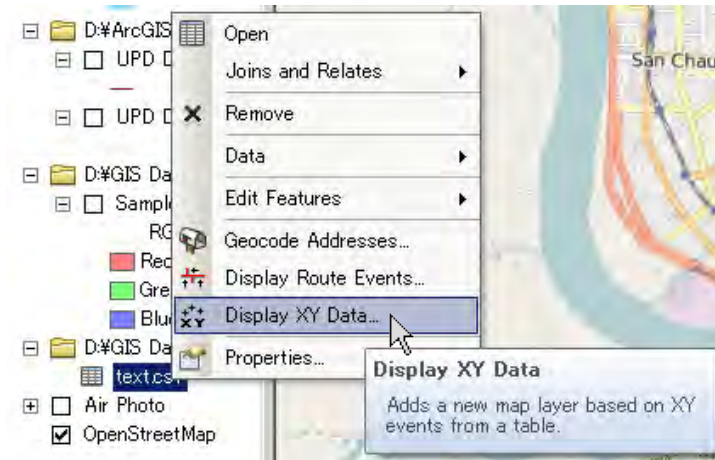
2) Select the CSV-file and click "Add".





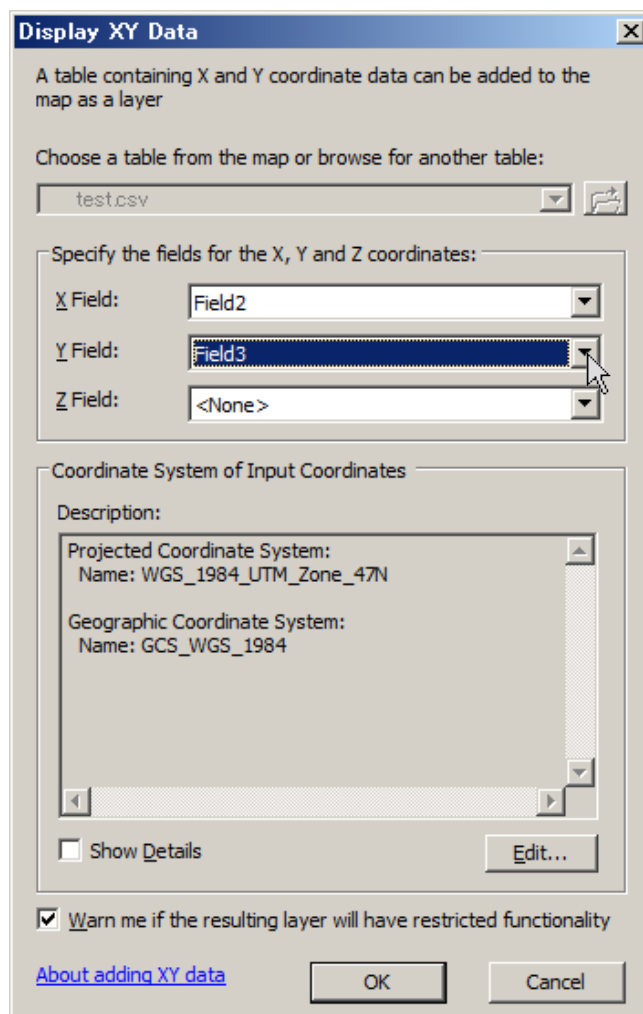
(3) Display the UTM Grid of the CSV-file.

1) Right-click on csv-file name of “Table of Contents” and select “Display XY Data”.



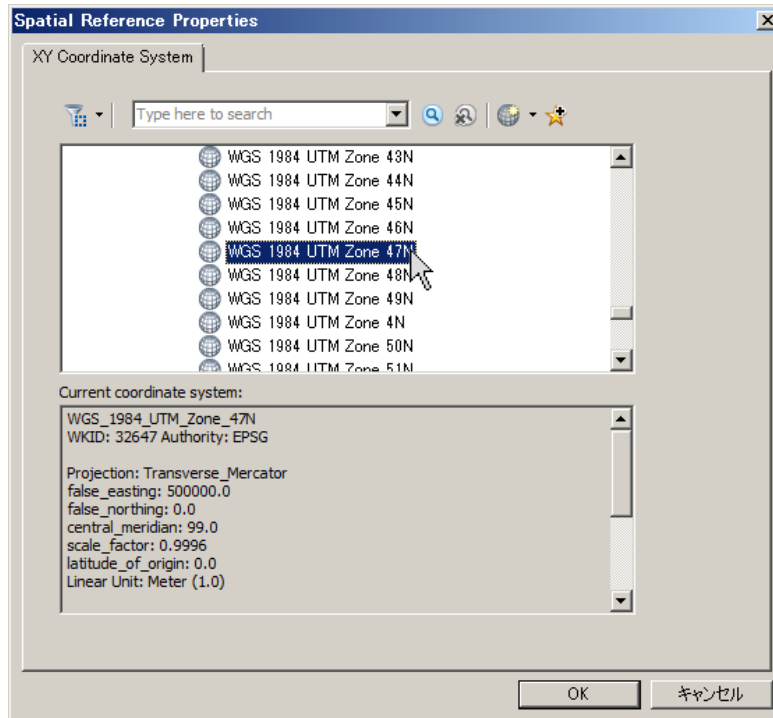
2) Specify the data fields.

Specify Field2 for “X Field” and field3 for “Y Field”.



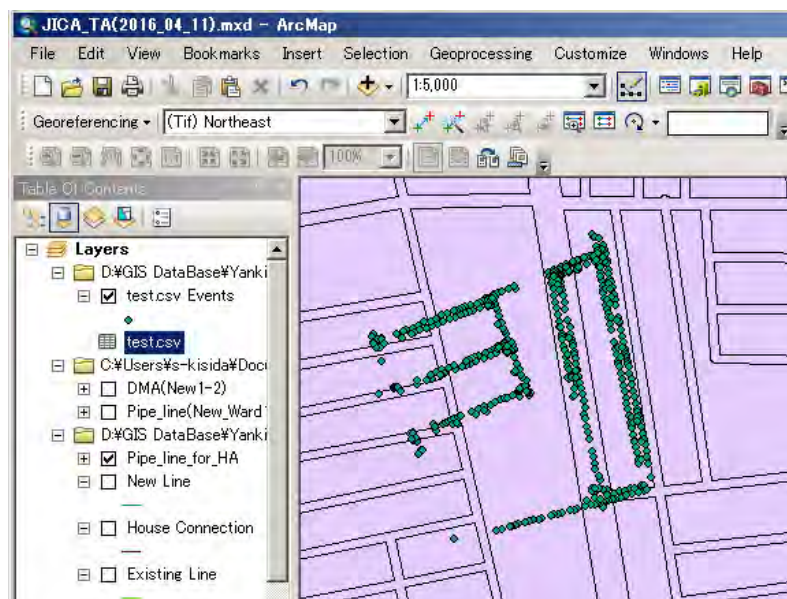
3) Specify the coordinate system.

- Click "Edit" of "Display XY Data" window,
- Select "Projected Coordinate Systems" -> "UTM" -> "WGS1984" -> "Northern Hemisphere"  
-> "WGS 1984 UTM Zone 47N" as XY coordinate system,
- Click "OK".



4) Display a point according to the UTM Grid

(The point is automatically displayed)



## [How to plot the GPS logging-data.]

- (1) Prepare a GPX-file as the result of GPS logging.

Refer to your GPS-logger's manual for export-import of the GPX-file.

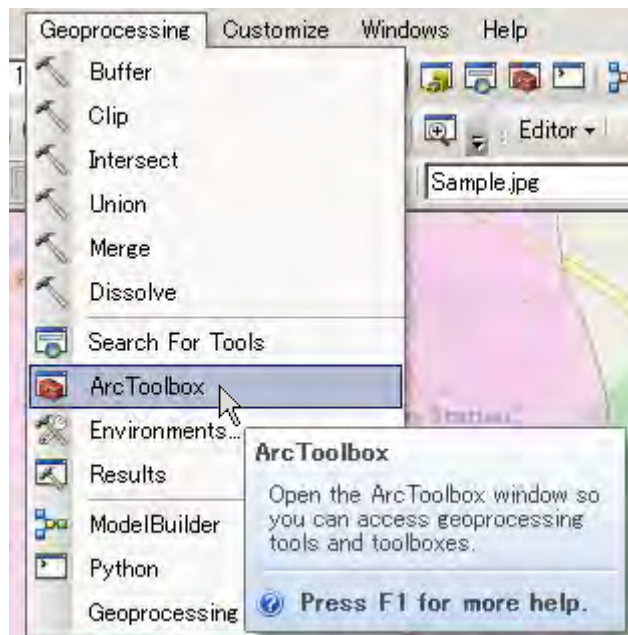
(Sample)

 15JULY2015(SouthOkkarapa).gpx

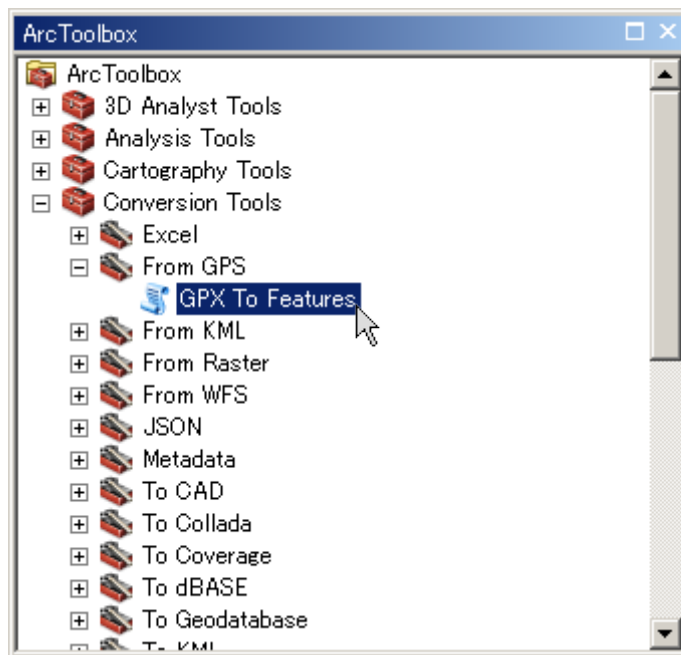
```
1 <?xml version="1.0" encoding="UTF-8" standalone="no" ?><gpx xmlns="http://www.topografix.com/GPX/1/1" xmlns:s:gpss="http://www.garmin.com/xmlschemas/GpxExtensions/v3" xmlns:wptx1="http://www.garmin.com/xmlschemas/WaypointExtension/v1" xmlns:gpstpx="http://www.garmin.com/xmlschemas/TrackPointExtension/v1" creator="elrex" version="1.1" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://www.topografix.com/GPX/1/1 http://www.topografix.com/GPX/1/1/gpx.xsd http://www.garmin.com/xmlschemas/GpxExtensions/v3 http://www.garmin.com/xmlschemas/GpxExtensionsv3.xsd http://www.garmin.com/xmlschemas/WaypointExtension/v1 http://www.garmin.com/xmlschemas/WaypointExtensionv1.xsd http://www.garmin.com/xmlschemas/TrackPointExtensionv1.xsd" ><metadata><link href="http://www.garmin.com"><text>Garmin International</text></link><time>2015-07-15T10:23:18Z</time></metadata><trk><name>15-07-15 16:53:16</name><extensions><gpss:TrackExtension><gpss:DisplayColor>Cyan</gpss:DisplayColor></gpss:TrackExtension></extensions><trkseg><trkpt lat="16.7752256803" lon="96.1597613990"><ele>45.80</ele><time>2015-07-09T05:22:11Z</time><extensions><gpstpx:TrackPointExtension><gpstpx:cad>0</gpstpx:cad></gpstpx:TrackPointExtension></extensions></trkpt><trkpt lat="16.7752533406" lon="96.1596447229"><ele>52.53</ele><time>2015-07-09T05:22:24Z</time><extensions><gpstpx:TrackPointExtension><gpstpx:cad>0</gpstpx:cad></gpstpx:TrackPointExtension></extensions></trkpt><trkpt lat="16.7751671746" lon="96.1596346647"><ele>75.12</ele><time>2015-07-09T05:22:50Z</time><extensions><gpstpx:TrackPointExtension><gpstpx:cad>0</gpstpx:cad></gpstpx:TrackPointExtension></extensions></trkpt><trkpt lat="16.7751327250" lon="96.1596505903"><ele>98.19</ele><time>2015-07-09T05:23:18Z</time><extensions><gpstpx:TrackPointExtension><gpstpx:cad>0</gpstpx:cad></gpstpx:TrackPointExtension></extensions></trkpt><trkpt lat="16.7751352396" lon="96.1597150471"><ele>93.39</ele><time>2015-07-09T05:23:41Z</time><extensions><gpstpx:TrackPointExtension><gpstpx:cad>0</gpstpx:cad></gpstpx:TrackPointExtension></extensions></trkpt><trkpt lat="16.7751267739" lon="96.1597536877"><ele>90.02</ele><time>2015-07-09T05:24:02Z</time><extensions><gpstpx:TrackPointExtension><gpstpx:cad>0</gpstpx:cad></gpstpx:TrackPointExtension></extensions></trkpt><trkpt lat="16.7751219124" lon="96.1597985309"><ele>80.41</ele><time>2015-07-09T05:24:26Z</time><extensions><gpstpx:TrackPointExtension><gpstpx:cad>0</gpstpx:cad></gpstpx:TrackPointExtension></extensions></trkpt><trkpt lat="16.7751293723" lon="96.1598385125"><ele>74.16</ele>
```

- (2) Add the GPS-file to Arc GIS.

- 1) Select "Geoprocessing" menu -> "Arc Toolbox".

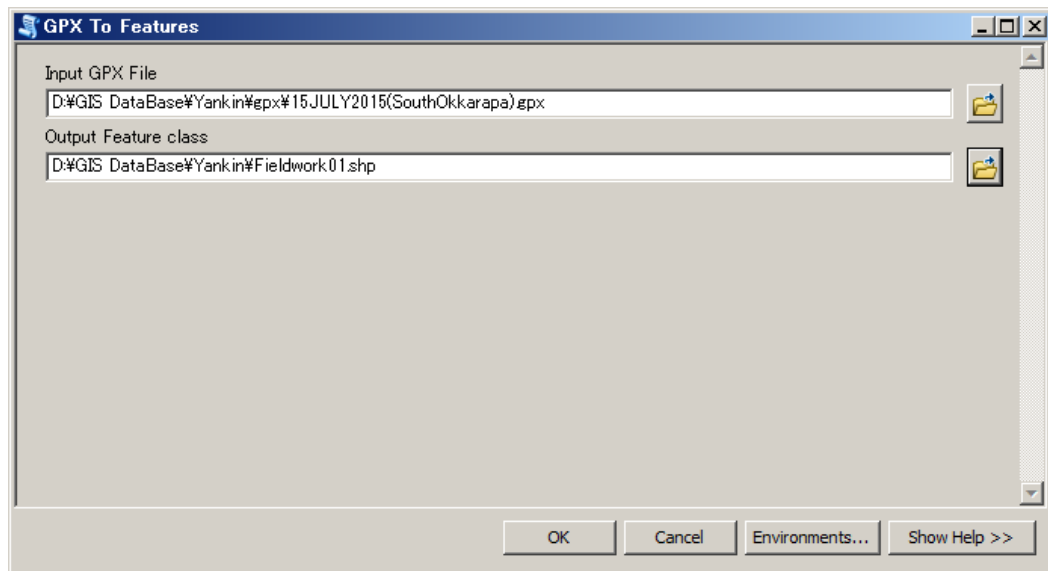


- 2) Select "Conversion Tools" -> "From GPS" -> "GPX To Features" of "Display XY Data" window and double-click it.

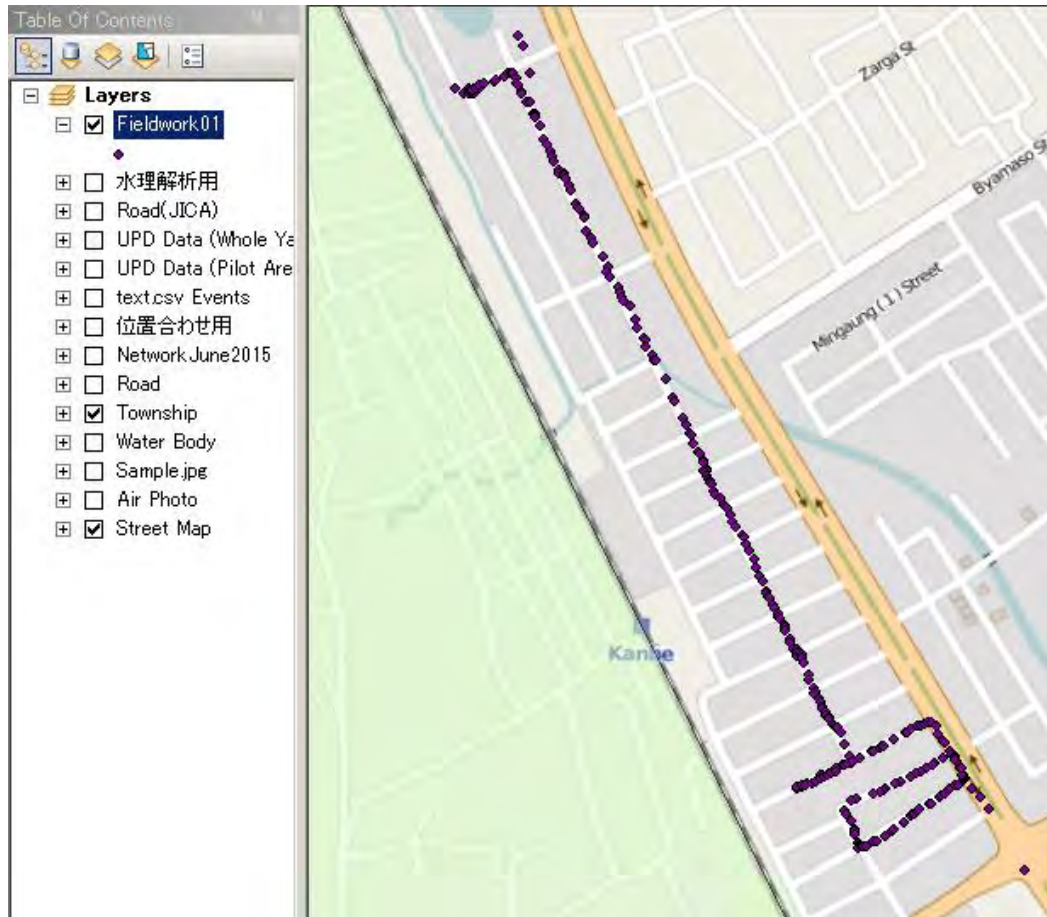


- 3) Specify the input-output files.

Specify the GPX-file for "Input GPX File" and a new SHP-file for "Output Feature class".

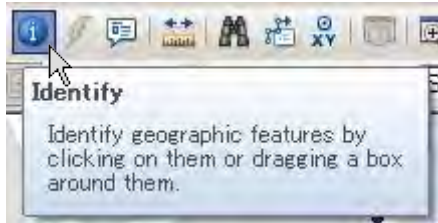


- 4) Display a point according to the lat/long-data  
(The GPS log is automatically displayed)





(You can identify elevation of the logging point.)



A screenshot of the Identify window in a GIS application. The window title is "Identify". It has a dropdown menu for "Identify from:" set to "<Top-most layer>". Below this is a tree view showing a folder "Fieldwork01" containing a feature "15-07-15 16:53:16". A "Location:" field shows coordinates "198,502.757 1,864,373.581 Meters". Below is a table of feature attributes:


| Field     | Value                |
|-----------|----------------------|
| FID       | 867                  |
| Shape     | Point ZM             |
| Id        | 0                    |
| Name      | 15-07-15 16:53:16    |
| Descript  |                      |
| Type      | TRKPT                |
| Comment   |                      |
| Symbol    |                      |
| DateTimeS | 2015-07-09T10:08:04Z |
| Elevation | 13.12                |

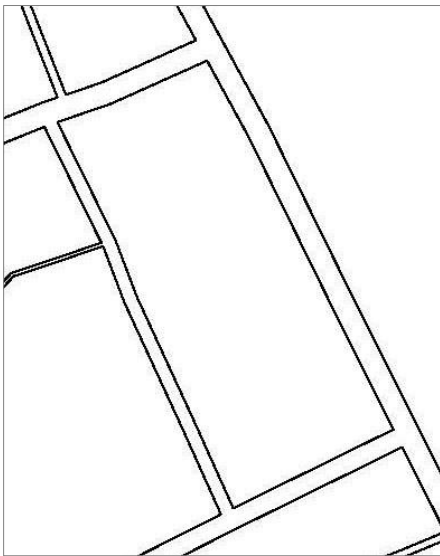
At the bottom of the window, it says "Identified 1 feature". The "Elevation" value of 13.12 is circled in red in the original image.

## [How to paste and match an image-file for tracing work.]

(1) Prepare an image-file such as the result of plane-table surveying.

(Sample)

 result\_of\_field-survey.jpg



(2) Plot preliminarily reference points for matching work.

Ref: “How to plot a point according to the CSV-file of latitude and longitude.” or “How to plot the GPS logging-data.”

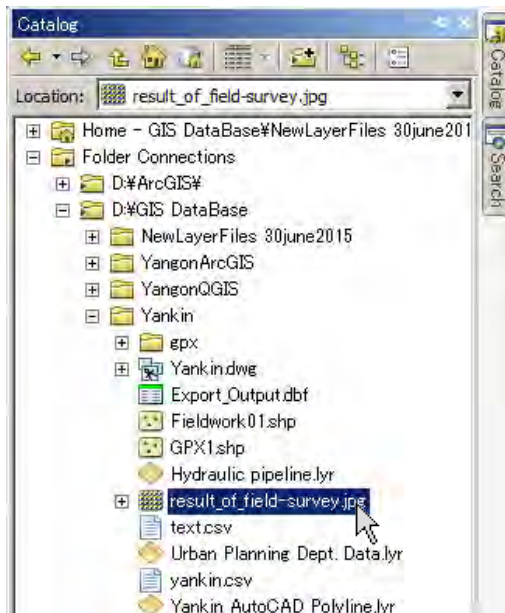
(Sample)



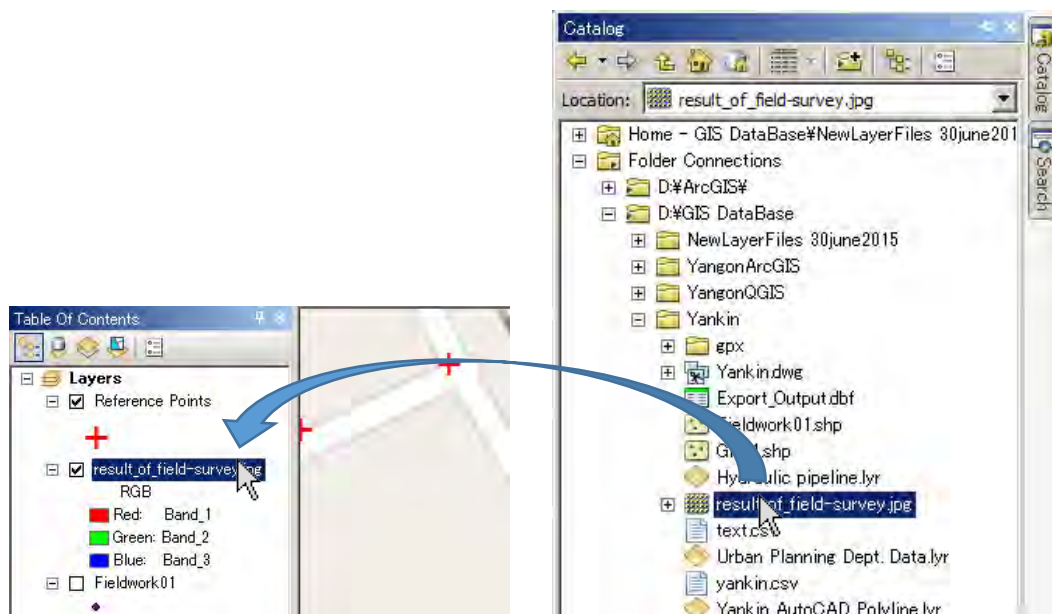


(3) Add the image-file to ArcGIS' layer.

1) Select the image-file in the ArcGIS's catalog.

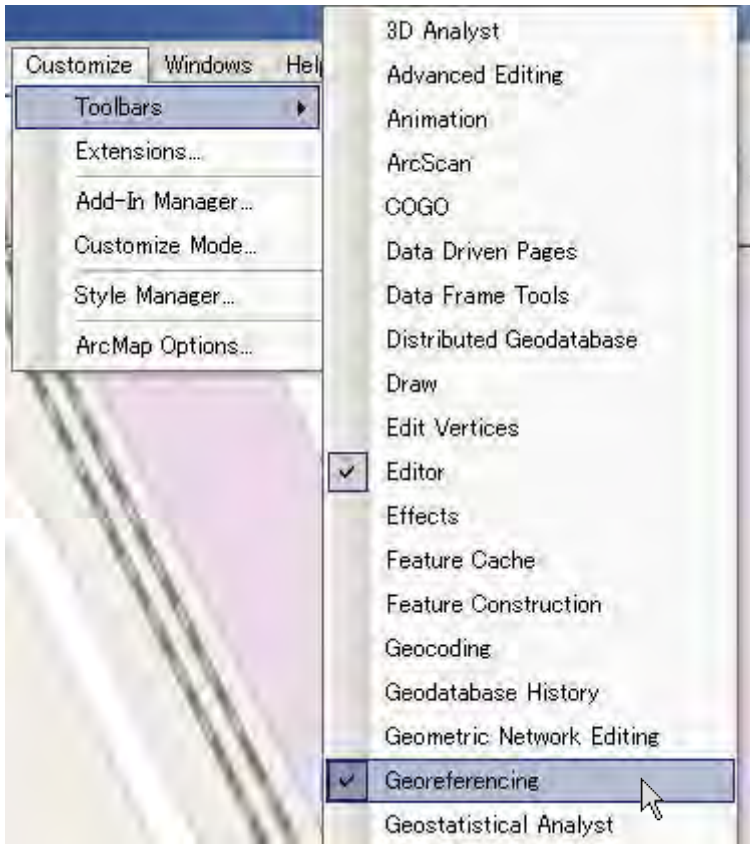


2) Drag the image-file in "Catalog" window and drop it on "Table Of Contents" window.



(4) Display "Georeferencing" toolbar.

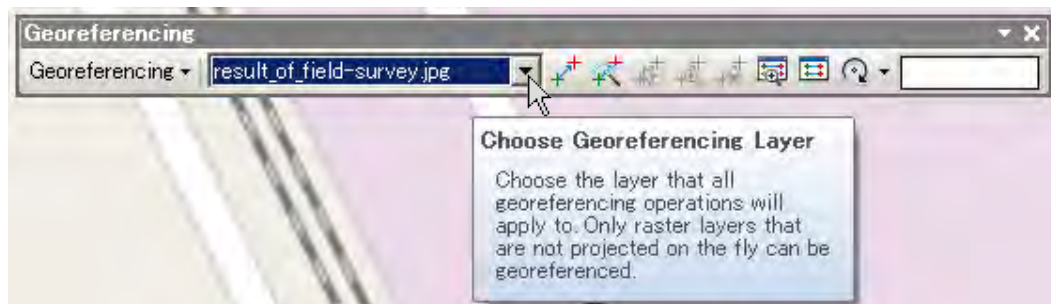
Select "Customize" menu -> "Toolbars" -> "Georeferencing".



(5) Display the image-file.

1) Specify display image.

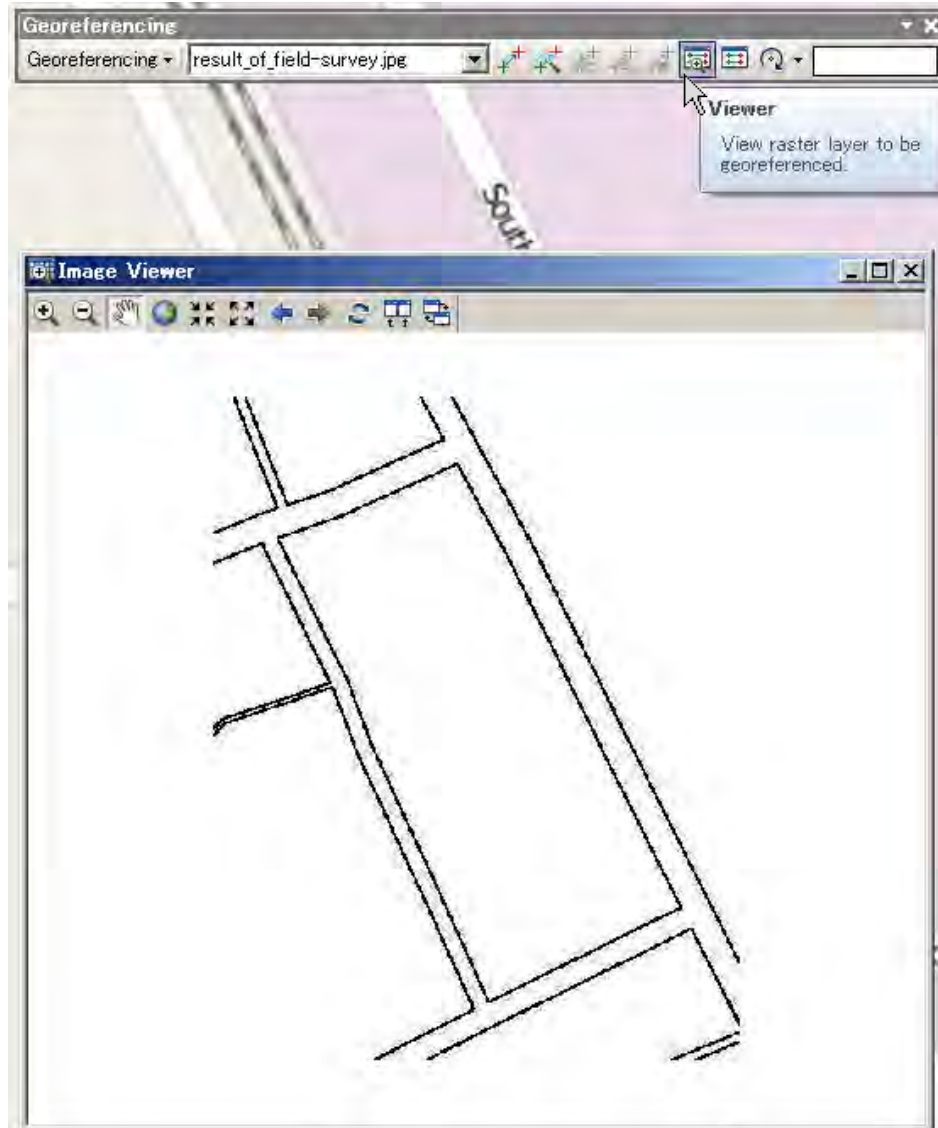
Select layer's name of the image-file on georeferencing layer list in "Georeferencing" toolbar.



2) Display the image-file.

Click "Viewer" icon on "Georeferencing" toolbar.

(The image is automatically displayed)

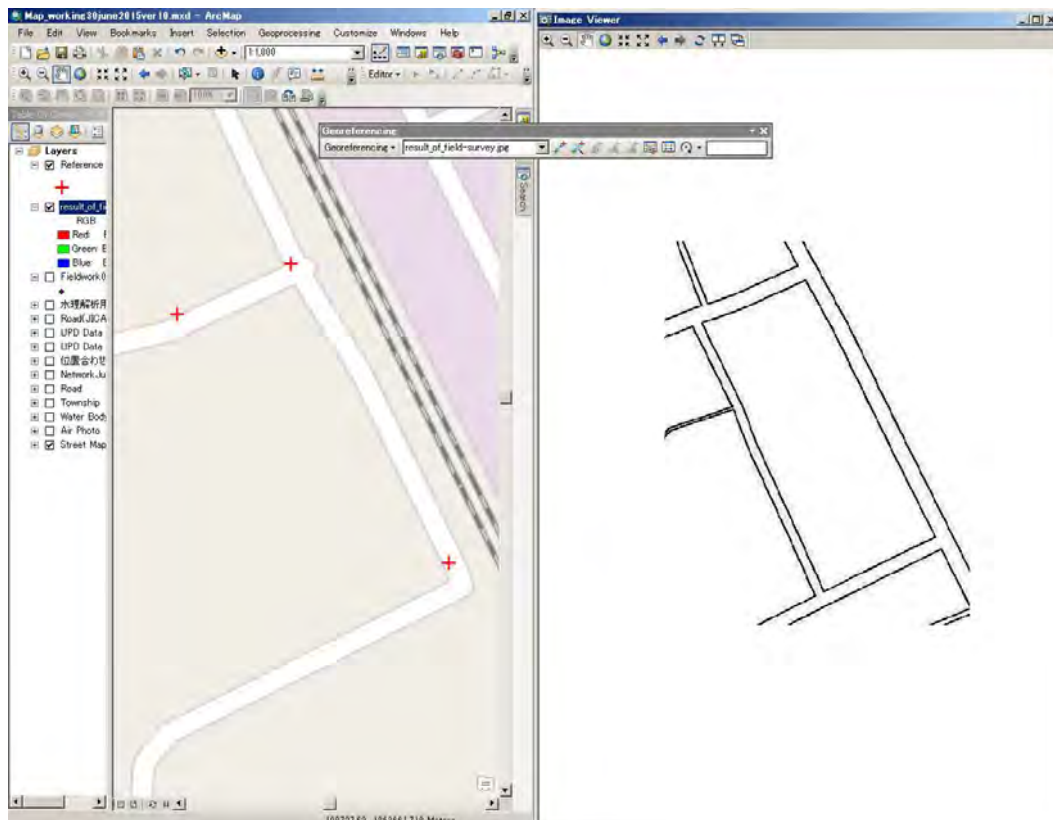


(6) Match the image layer position with the reference points.

1) Click "Reposition" icon on "Image Viewer" window.



(The reference points and the image are automatically placed side-by-side.)



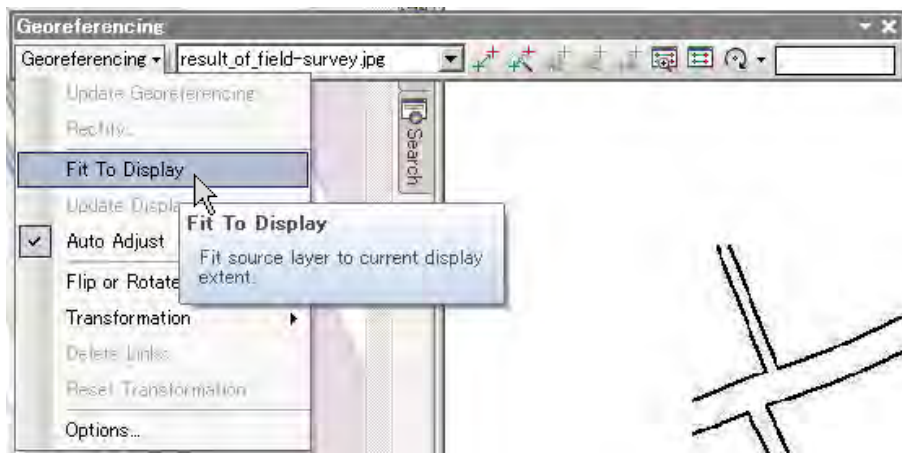
2) Match the left-right image roughly by hand.

By the later processing, you can automatically match these layers.

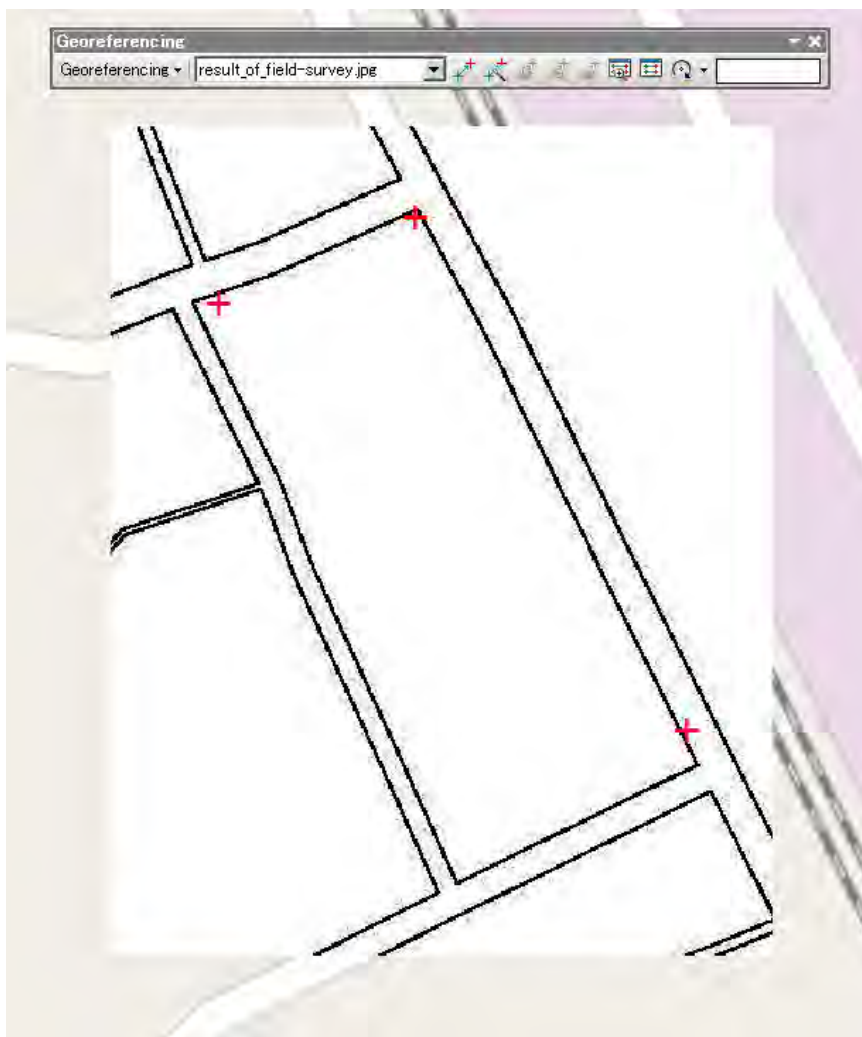
However, please match the left-right image roughly by hand in the above figure to facilitate the later processing.

3) Fit the image to display.

Select “Fit To Display” menu in “Georeferencing” pull-down menu of “Georeferencing” toolbar.



(The image is automatically displayed as the following figure.)



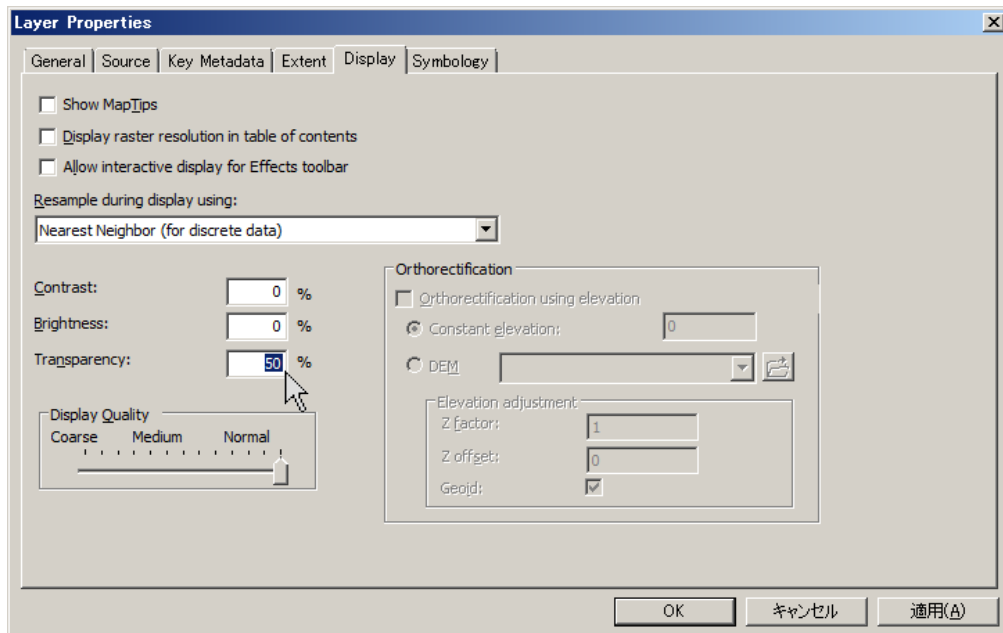


4) (If needed,) Make semi-transparent to the image layer.

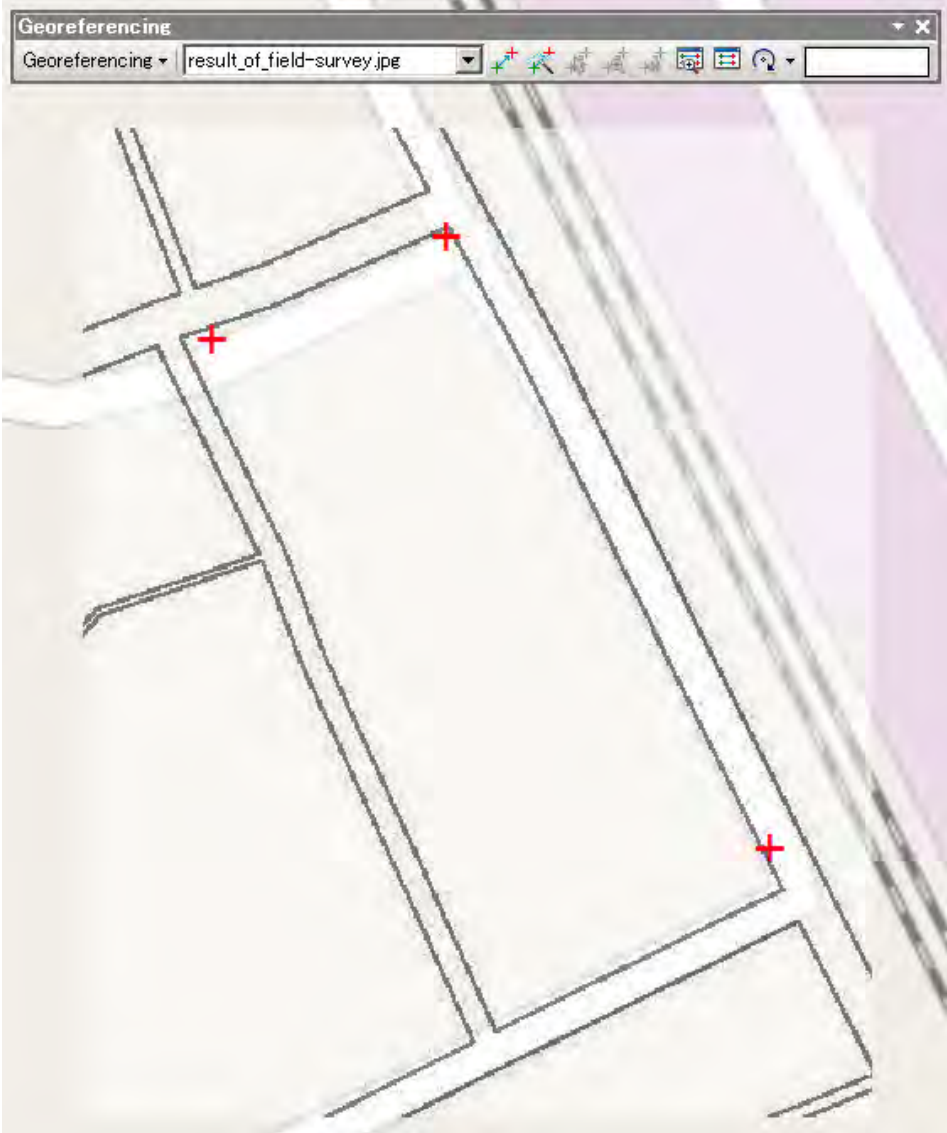
1) Right-click on image-file layer of “Table of Contents” and select “Properties”.



2) Type in 50 for “Transparency” of “Display” tab of “Layer Properties” window and click “OK”.



3) (The image is automatically displayed as the following figure.)

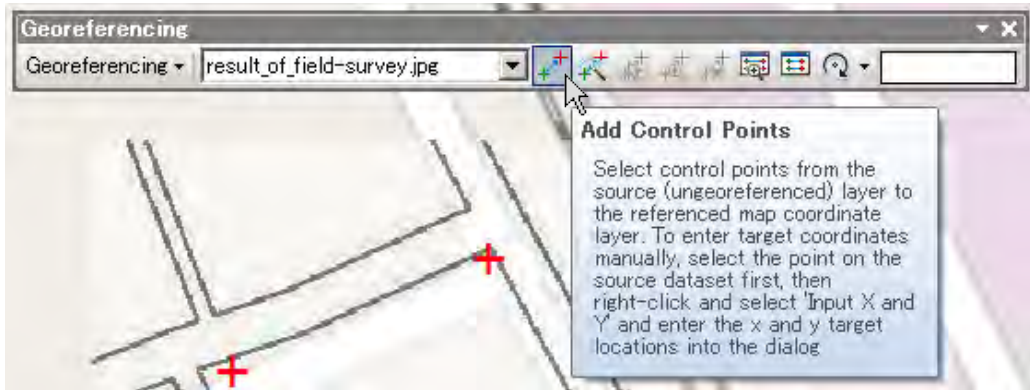


You can close the "image viewer" window.

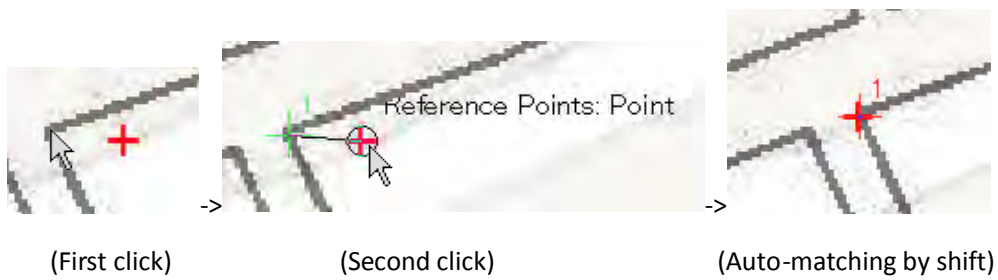


5) Match the image layer position with the reference points automatically.

1) Click on “Add Control Points” icon on the “Georeferencing” toolbar.

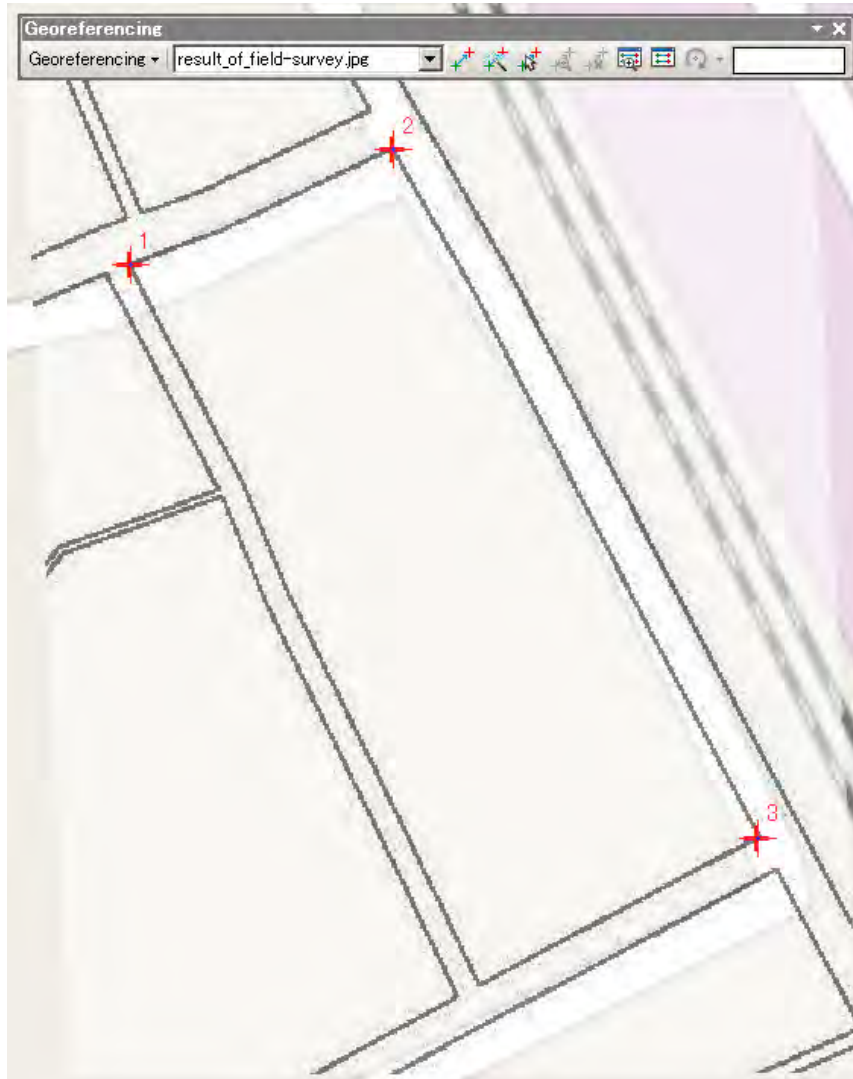


2) First click the reference position on the image layer, then click the reference point plotted preliminarily.

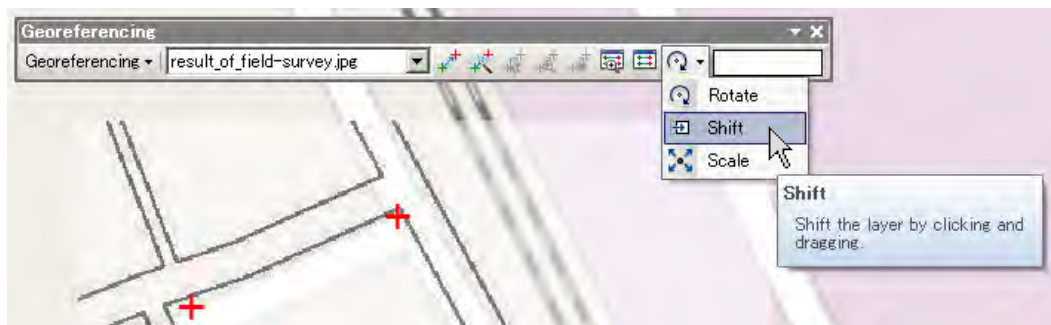


3) For the other 2 reference points, do the above work.

4) Adjusting procedure (Rotate/Shift/Scale) is carried out automatically and the image layer position just fits with the 3 reference points.

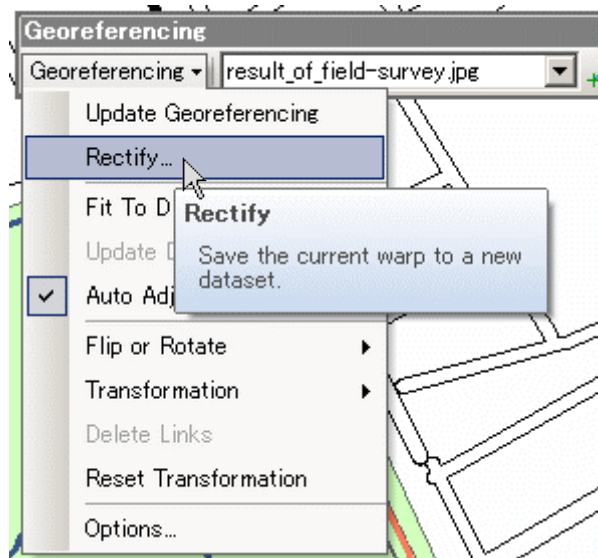


Ref: You can adjust the image layer position by hand. Please utilize “Rotate/Shift/Scale” function of “Georeferencing” toolbar.



(7) Save the result of matching

Click "Rectify" icon on the Georeferencing toolbar.



(The result of matching work is automatically saved.)

EOF

## ***Arc GIS and EPA-net Operation Manual***

### Contents;

|   |       |      |
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| 1. How to prepare GIS data for hydraulic analysis.                    | ----- | P.1  |
| 2. How to convert the data from GIS into hydraulic analysis software. | ----- | P.6  |
| 3. How to add condition-data for hydraulic analysis.                  | ----- | P.15 |
| 4. How to execute hydraulic analysis.                                 | ----- | P.28 |

May 17, 2016 (1st version)

Prepared by:  
Shinsuke KISHIDA  
JICA Expert (GIS)

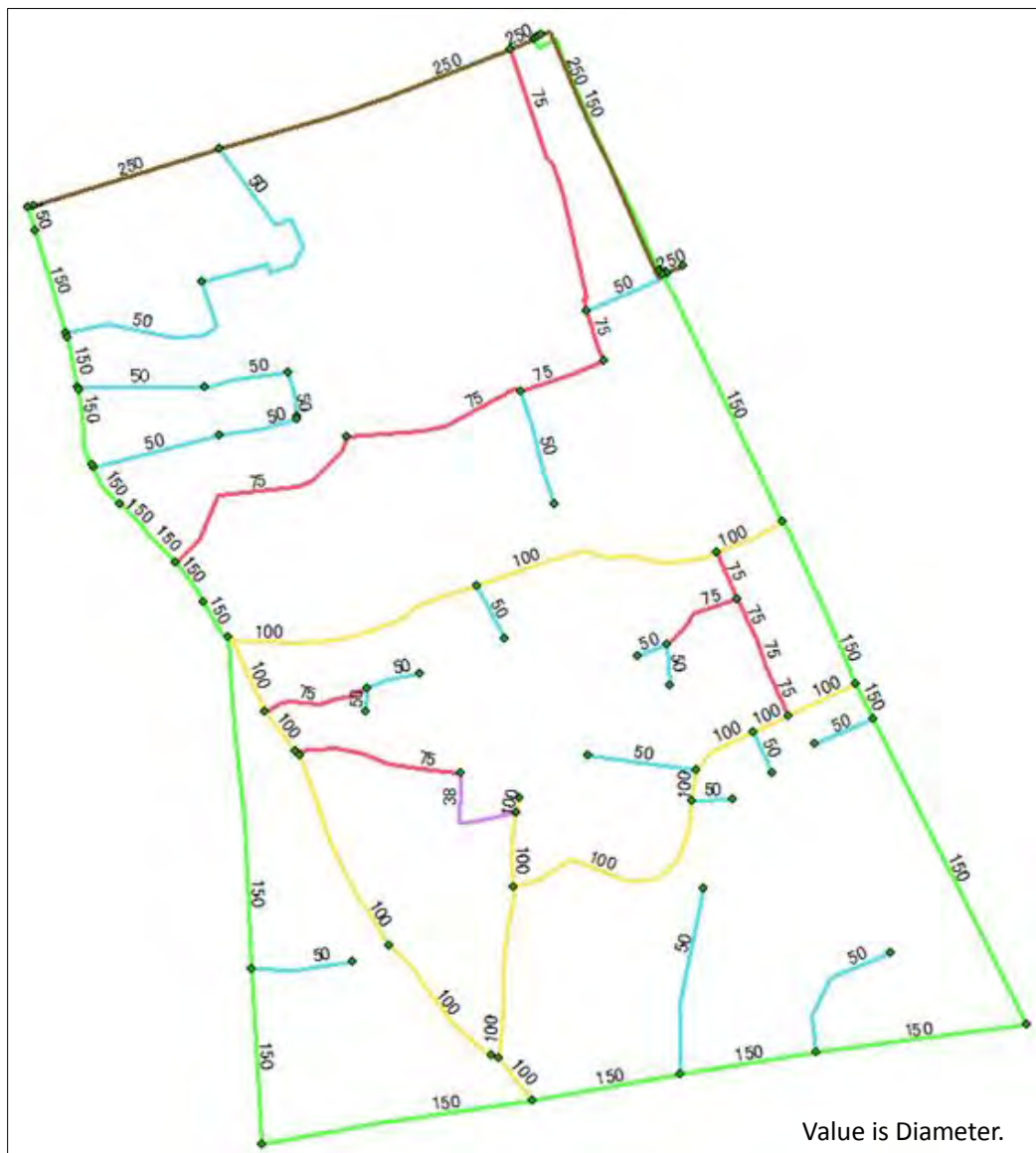
## [How to prepare GIS data for hydraulic analysis.]

(1) Make ArcGIS data of pipeline in the target area.

Here are needed data for hydraulic analysis.

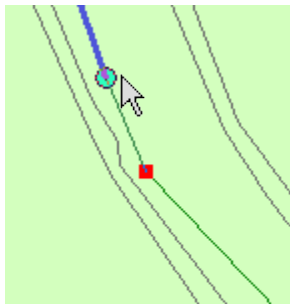
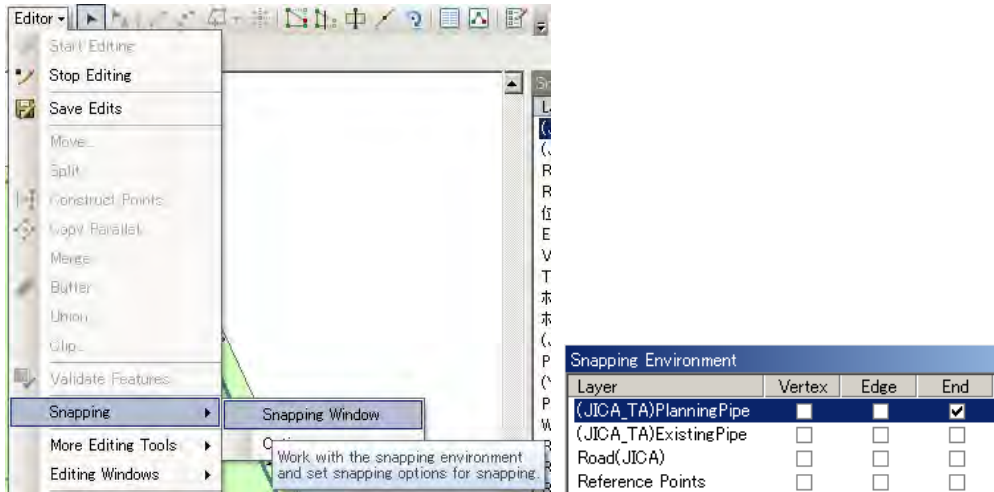
1) Data of shapes of pipelines

(Sample)



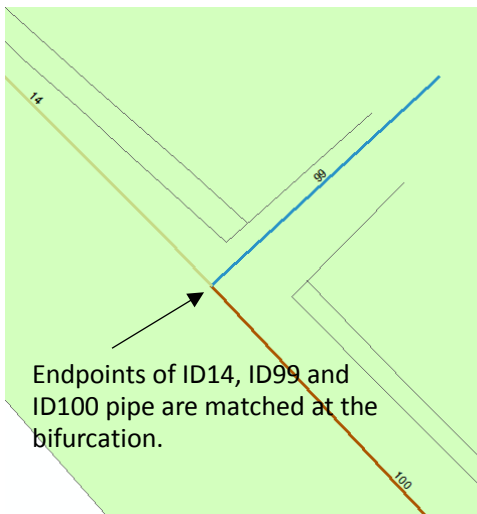
Note:

- a) To draw endpoints of polylines with the assistance of snapping and match the endpoints of neighboring polylines certainly.

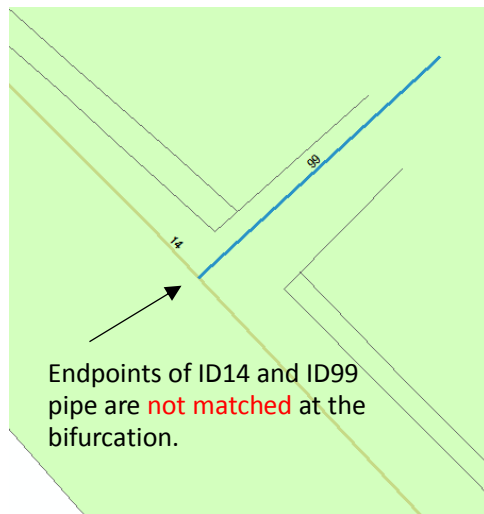


- b) To draw three endpoints at a triple bifurcation.

[Correct ]



[Incorrect ]



(2) Attribute data on diameter, length, velocity coefficient and number of household

For hydraulic analysis, these data are necessary about all pipelines.

Identify

Identify from: (JICA\_TA)PlanningPipe

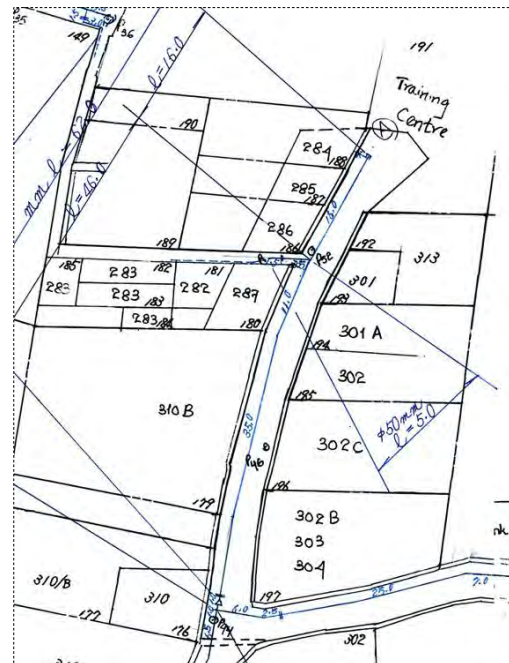
(JICA\_TA)PlanningPipe

Location: 198,445.670 1,863,598.957 Meter:

| Field              | Value                      |
|--------------------|----------------------------|
| OBJECTID_1         | 85                         |
| Shape              | Polyline                   |
| OBJECTID           | 0                          |
| Id                 | 85                         |
| System_type        | Distribution Sub-main Pipe |
| Township_Name      | Yankin                     |
| Ward               | 13                         |
| DMA                |                            |
| LMB                |                            |
| Water_System       | Yaegu_PS                   |
| Length             | 166.381263                 |
| Shape_Length       | 166.381263                 |
| Diameter           | 100                        |
| Material           | PolyVinyl Chloride pipe    |
| Joint_type         | Rubber Ring type joint     |
| Installati         | 0                          |
| Project_Na         | JICA TA Phase1             |
| Laying_type        | Buried under the ground    |
| Depth              | 0.9                        |
| Operational_Status | Planned                    |
| Data_Accuracy      | Based on design drawings   |
| Velocity_c         | 110                        |
| Household          | 27                         |
| Added_amou         | 0                          |
| Hourly_fac         | 1                          |
| Completion         |                            |
| Record_Lea         |                            |
| Repair_Wor         | 0:00:00                    |
| Tmp1               | 0                          |
| Tmp2               | 27                         |
| Tmp3               | Operated                   |

Identified 1 feature

To input it based on field survey, road length survey or "Calculate Geometry" of ArcGIS.

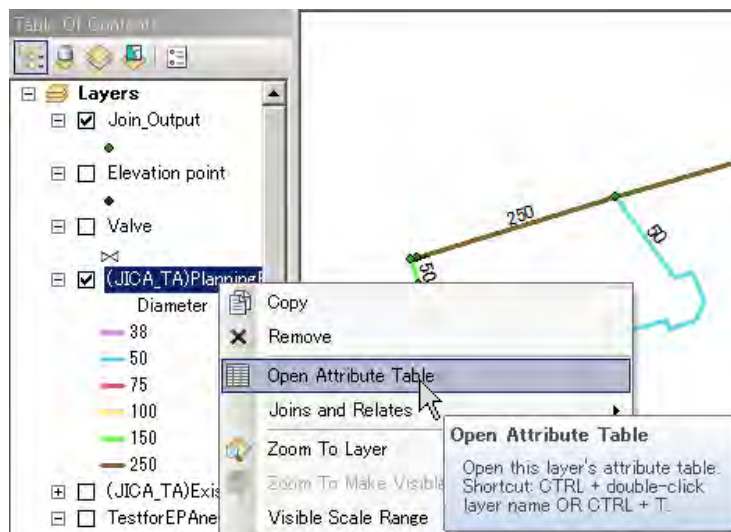


To entry the number of households which the pipeline has served with reference to the result of the above customer survey.

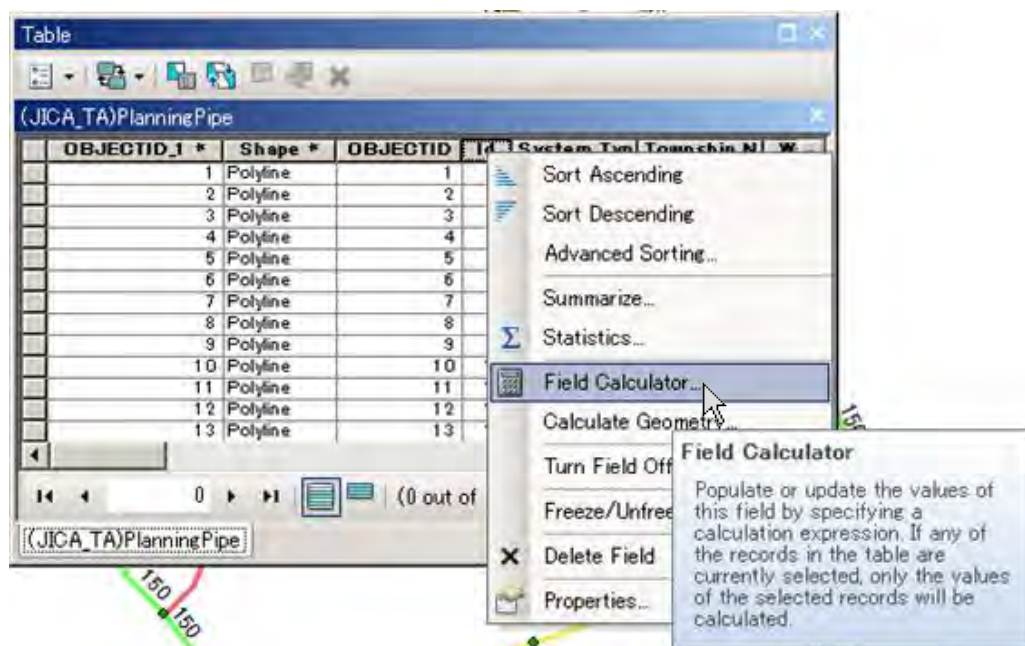


(2) Input sequential number into "Id" of pipeline automatically.

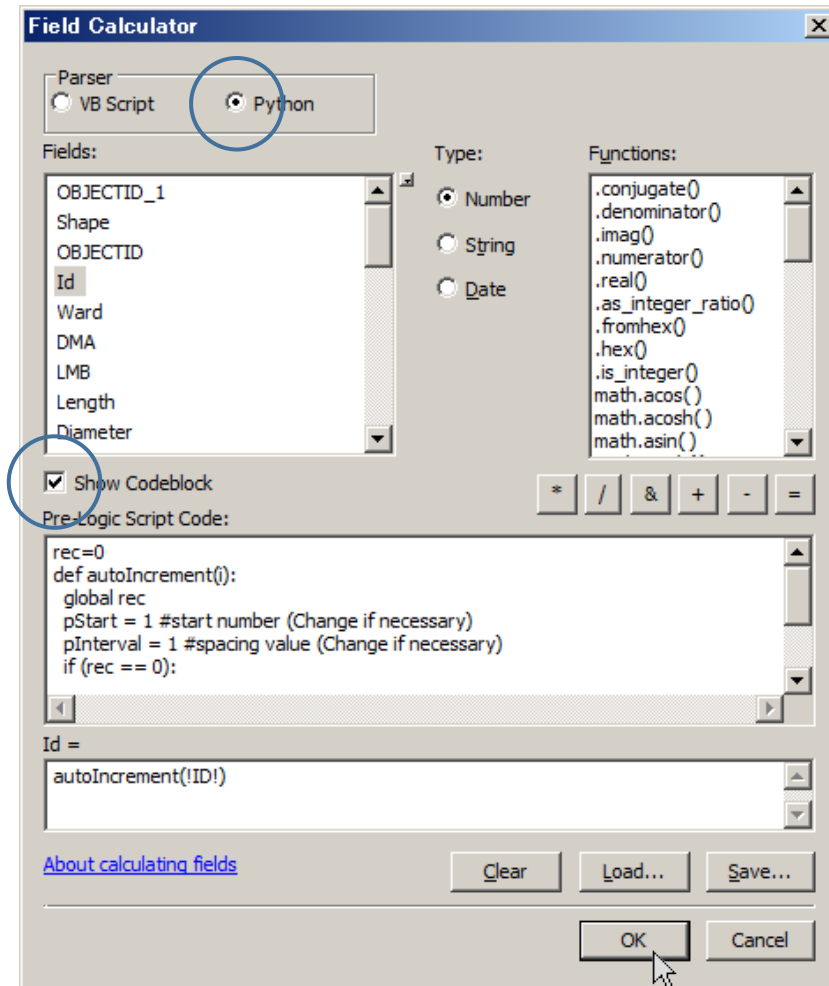
1) Right-click on the target layer of "Table of Contents" and select "Open Attribute Table".



2) Right-click on "Id" the attribute table and select "Field Calculator".



- 3) Select "Python" as Parser,  
click checkbox of "Show Codeblock",  
entry script\*1 in "Pre-Logic Script Code:" ,  
entry variable name\*2 in "Id=" ,  
and click "OK".



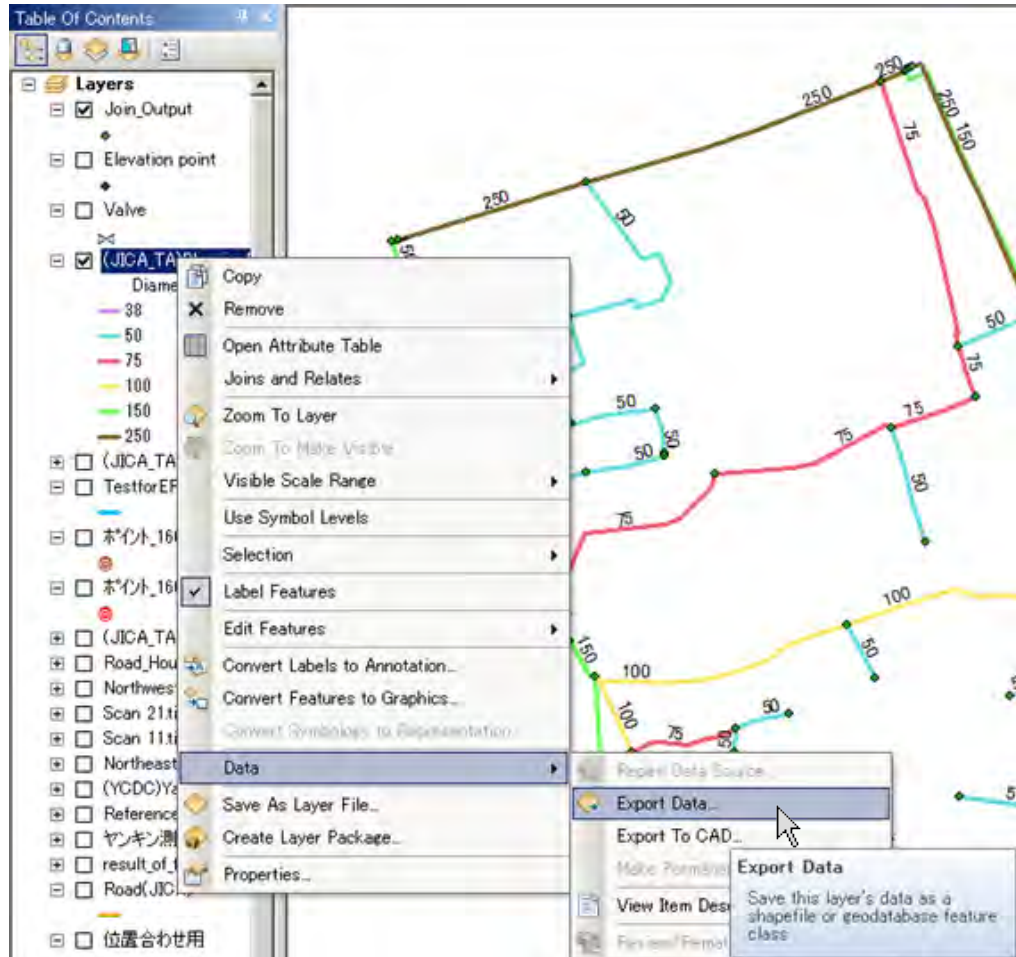
```
*1:
rec=0
def autoIncrement(i):
    global rec
    pStart = 1 #start number (Change if necessary)
    pInterval = 1 #spacing value (Change if necessary)
    if (rec == 0):
        rec = pStart
    else:
        rec = rec + pInterval
    return rec
*2:
autoIncrement(!ID!)
```

- 4) Close the attribute table window.

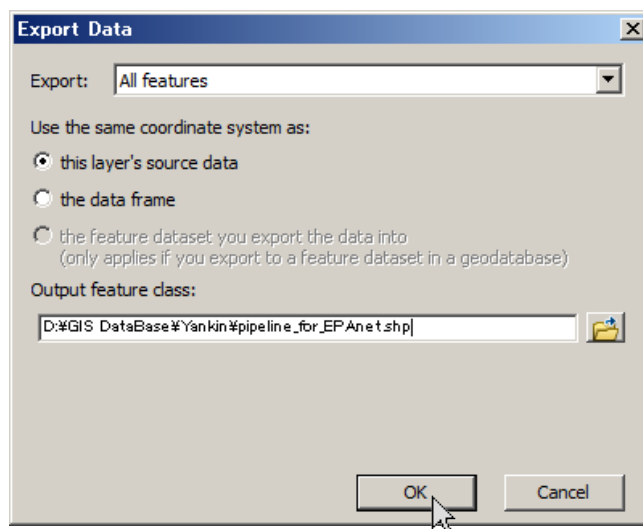
## [How to convert the data from GIS into hydraulic analysis software.]

(1) Make SHP-file and DBF-file from the GIS data.

1) Right-click on the target layer of "Table of Contents" and select "Data" -> "Export Data".



2) Input file-name and click "OK". ("pipeline\_for\_EPAnet.shp" is input here as)



3) Click "NO" on the dialogue.

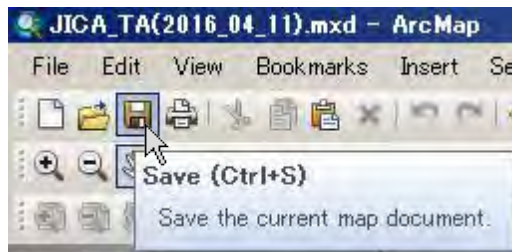


(The following files are exported automatically.)

|                             |        |
|-----------------------------|--------|
| pipeline_for_EPAnet.inp     | 12 KB  |
| pipeline_for_EPAnet.dbf     | 118 KB |
| pipeline_for_EPAnet.prj     | 1 KB   |
| pipeline_for_EPAnet.sbn     | 2 KB   |
| pipeline_for_EPAnet.sbx     | 1 KB   |
| pipeline_for_EPAnet.shp     | 11 KB  |
| pipeline_for_EPAnet.shp.xml | 26 KB  |
| pipeline_for_EPAnet.shx     | 1 KB   |

These files will be used at the later process.

4) Save the ArcGIS data.



5) Quit the ArcGIS.

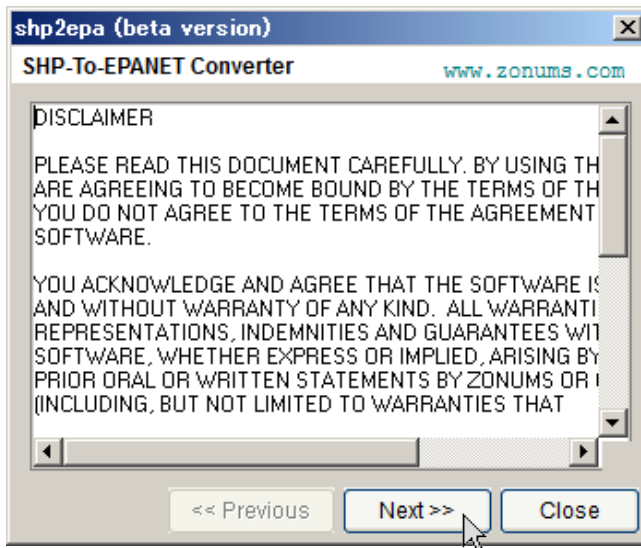
(2) Convert from SHP-file into INP-file (EPA-net format)

1) Launch "shp2epa.exe".

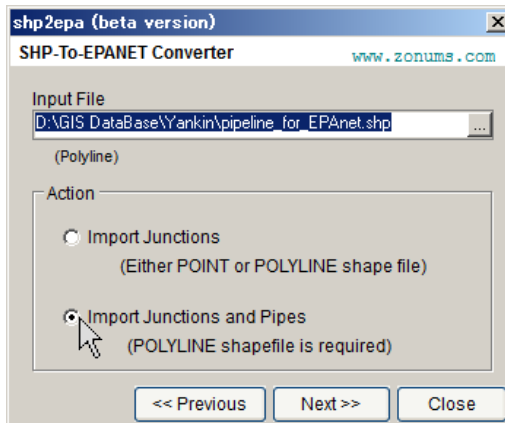
This software is a freeware. (URL-> <http://www.zonums.com/shp2epa.html>)



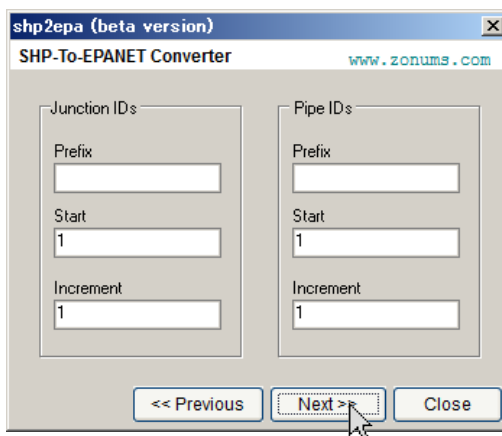
2) Click "Next>>" on the dialogue.



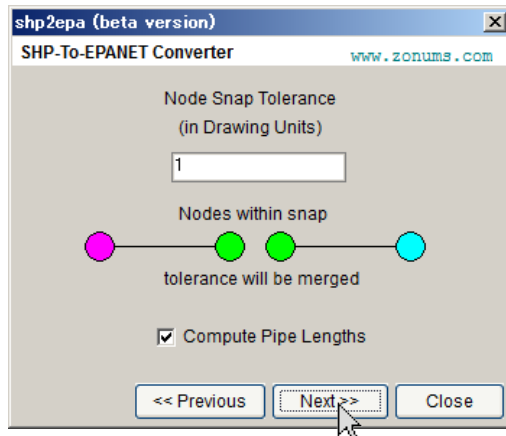
3) Entry the file exported from GIS as Input File, select "Import Junction and Pipes" as Action and click "Next>>".



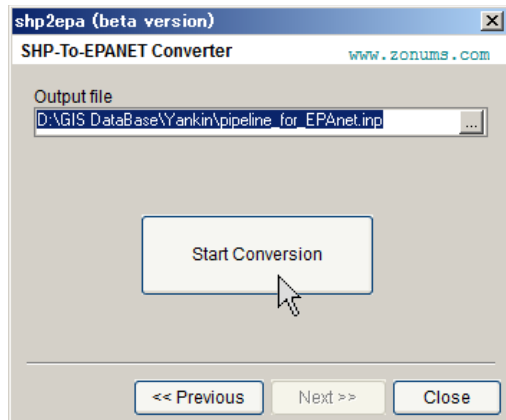
4) Click "Next>>" without requiring parameter changes.



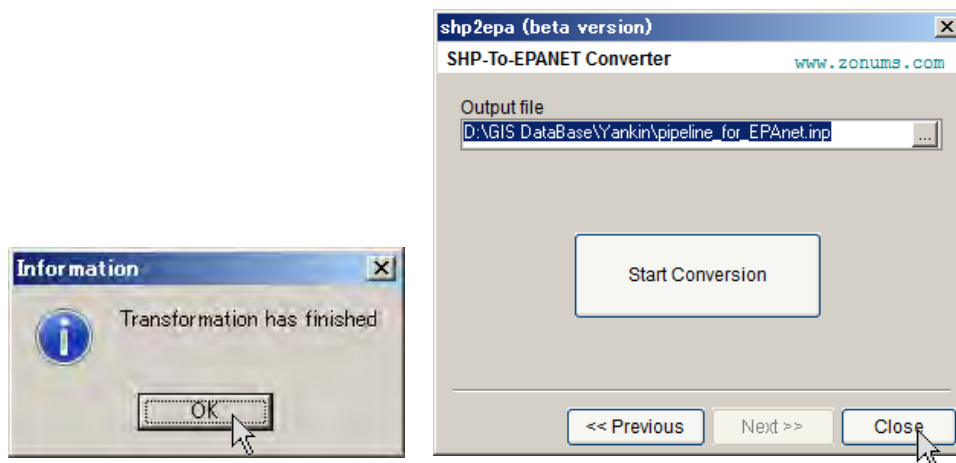
5) Click "Next>>" without requiring parameter changes.



6) Input file-name and click "Start Conversion". ("pipeline\_for\_EPANet.inp" is input here as)

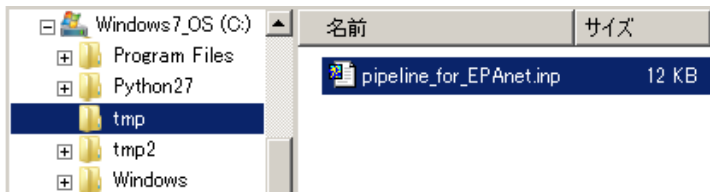


7) Click "OK" on the dialogue and Click "Close".



(3) Modify the INP-file for pipeline networking.

1) Copy the INP-file to c:\tmp\



2) Rename the INP-file to "a.inp".



3) Launch "Node-Matching Ver1.0.exe".

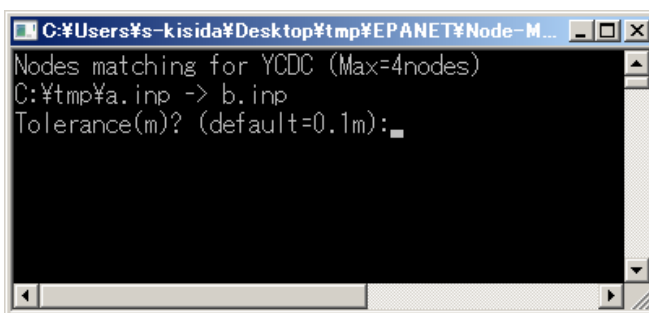
Please launch this software in situation that "SmallBasicLibrary.dll" is in the same holder.

This software was made for YCDC by the JICA expert and not provided with user interface.



4) Input tolerance-value for matching.

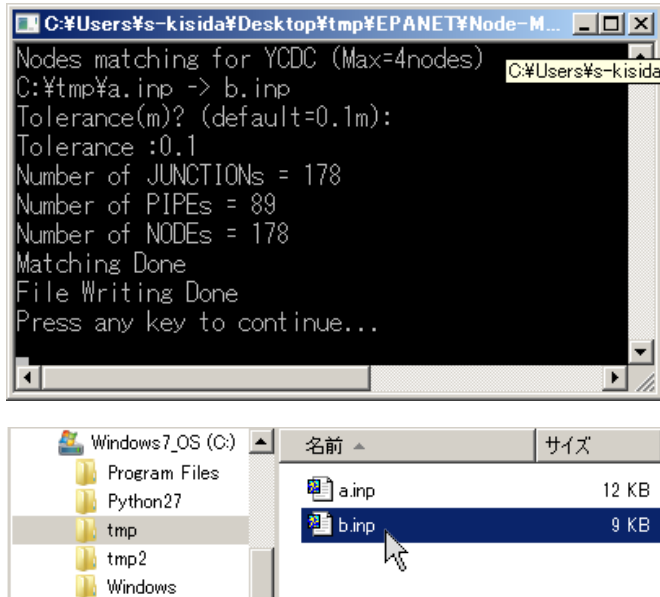
Nodes are considered to be identical within a range of set tolerance.





5) Hit "Enter" key and hit any key.

"b.inp" is output in c:\tmp\ automatically.



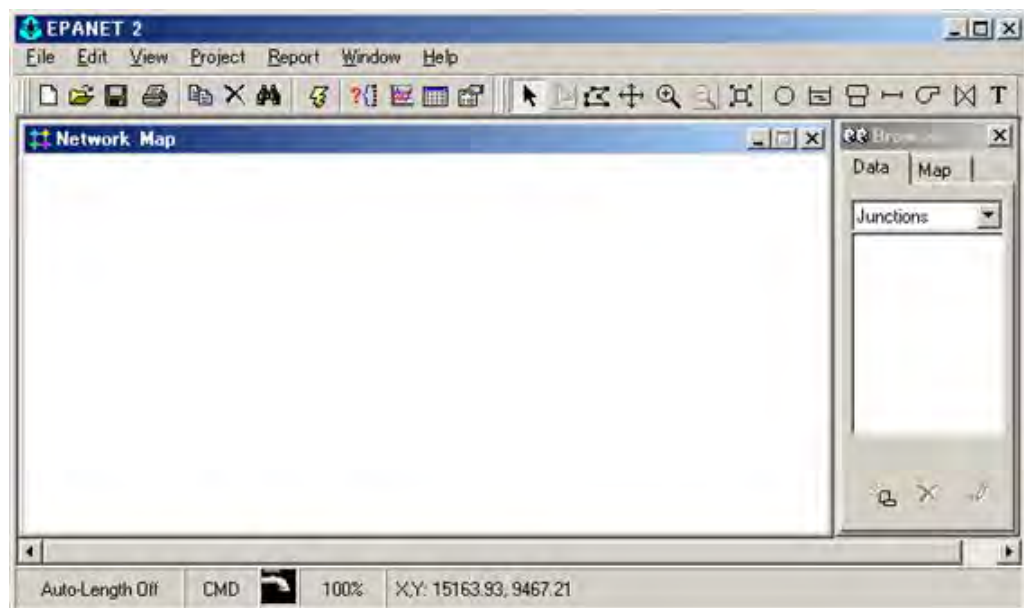
6) Check "b.inp" and save "b.inp" by EPA-net.

(The save operation is required for the conversion process.)

1) Launch "shp2epa.exe".

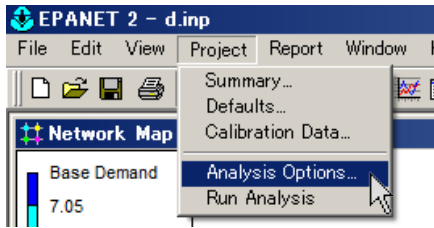
EPANET is a public domain, water distribution system modeling software package developed by the United States Environmental Protection Agency's (EPA).

(URL-> <https://www.epa.gov/water-research/epanet#downloads>)

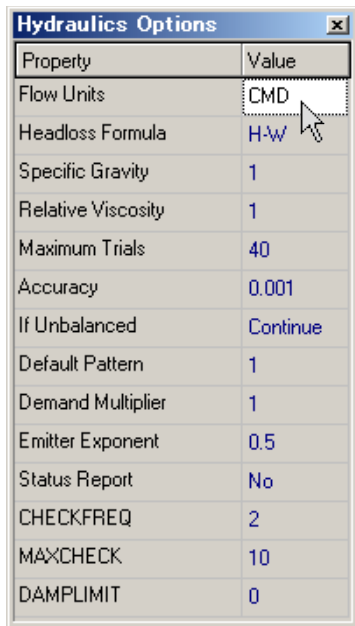


2) Set "Analysis Options".

a) Select "Analysis Options" of "Project" menu.

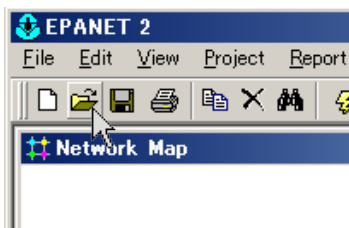


b) Set "CMD" as Flow Units and "H-W" as Head loss Formula.

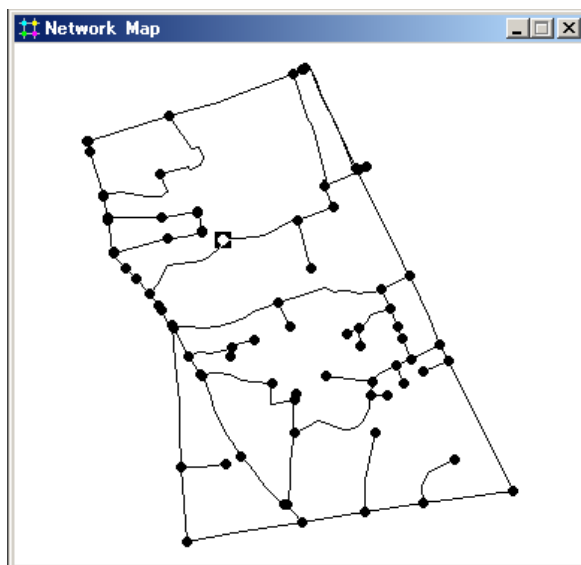
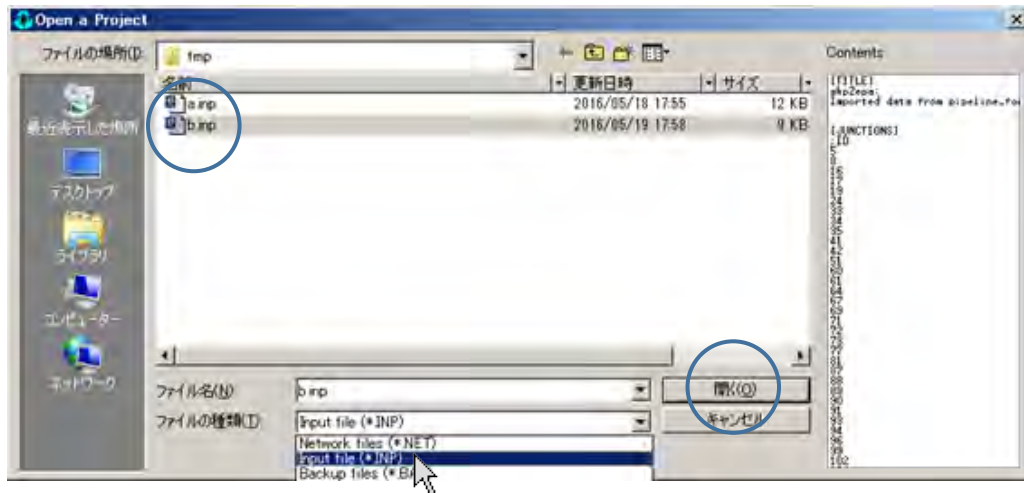


CMD: Cubic Meter per Day  
H-W: Hazen-Williams equation

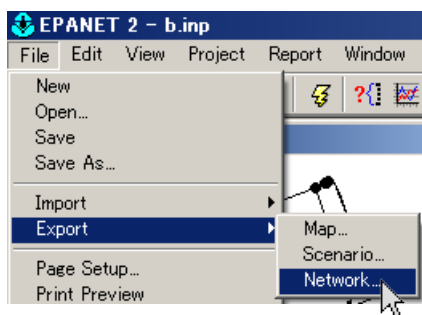
3) Click open icon and select the "b.inp".



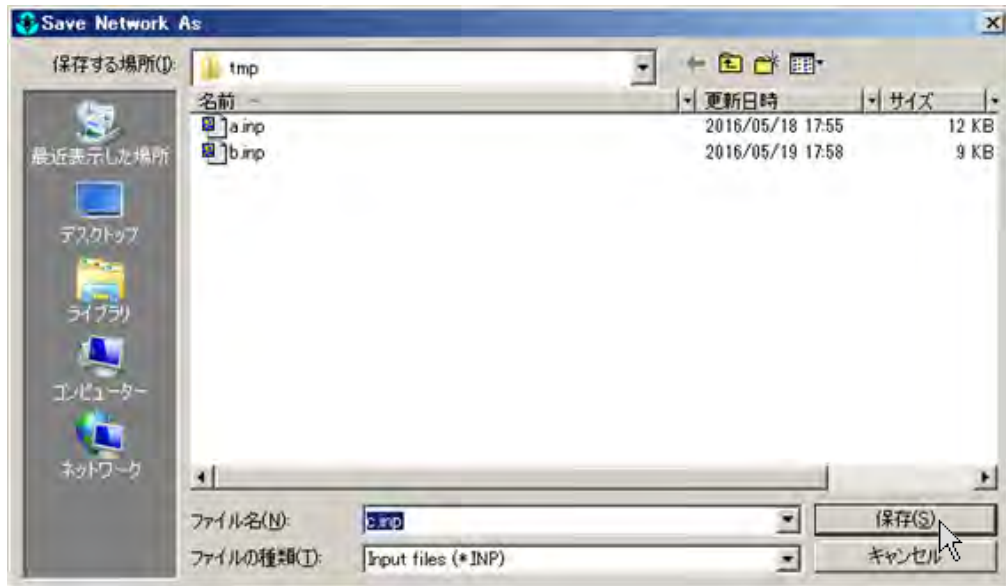
- 4) Select "Input file (\*.INP)" as file type on "Open a Project" window, select the "b.inp", click "open", then pipeline data is displayed automatically.



- 5) Select "Network" of "Export" of "File" menu.



- 6) Entry your arbitrary file-name on "Save Network As" window and click "Save".  
("c.inp" is input here as)



- 7) Quit the EPA-net.

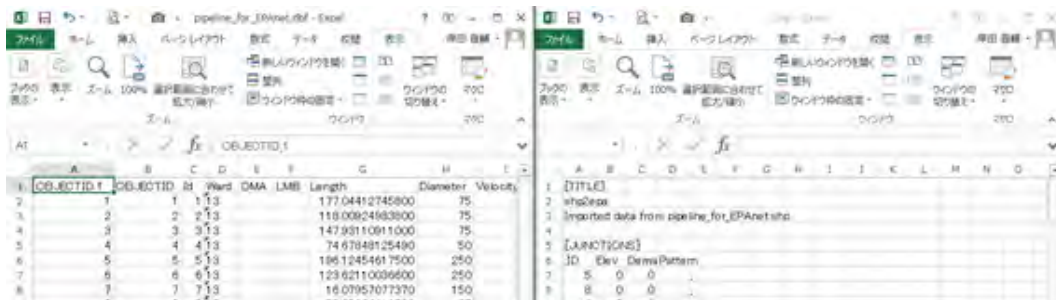
**[How to add condition-data for hydraulic analysis.]**

Please prepare Microsoft-Excel for this data-add process.

(1) Copy and paste regarding pipes.

1) Launch Microsoft-Excel and open the dbf-file exported from ArcGIS and the inp-file saved from EPA-net.

("pipeline\_for\_EPAnet.dbf" and "c.inp" are opened here as)



2) Copy columns of "Length", "Diameter" and "Velocity\_c" of all pipes on the dbf-file.

| Length          | Diameter | Velocity c | Insta |
|-----------------|----------|------------|-------|
| 177.04412745800 | 75       | 110        |       |
| 118.00924983800 | 75       | 110        |       |
| 147.93110911000 | 75       | 110        |       |
| 74.67848125490  | 50       | 110        |       |
| 196.12454617500 | 250      | 110        |       |
| 123.62110036600 | 250      | 110        |       |
| 16.07957077370  | 150      | 110        |       |
| 56.63064419780  | 75       | 110        |       |
| 166.53627658800 | 50       | 110        |       |
| 68.29440688900  | 150      | 110        |       |
| 32.05067848160  | 150      | 110        |       |



3) Paste in columns of "Length", "Diameter" and "Roughness" of all pipes on the inp-file.

(In this operation, it's important to match each row in reference to "ID".)

| 94  | [PIPES] |       |       |        |          |           |      |
|-----|---------|-------|-------|--------|----------|-----------|------|
| 95  | ID      | Node1 | Node2 | Length | Diameter | Roughness | Minc |
| 96  | 1       | 51    | 61    | 174.6  | 12       | 100       |      |
| 97  | 2       | 16    | 5     | 103.17 | 12       | 100       |      |
| 98  | 3       | 5     | 91    | 117.03 | 12       | 100       |      |
| 99  | 4       | 16    | 8     | 46.121 | 12       | 100       |      |
| 100 | 5       | 51    | 17    | 159.64 | 12       | 100       |      |
| 101 | 6       | 17    | 115   | 123.62 | 12       | 100       |      |
| 102 | 7       | 116   | 19    | 16.08  | 12       | 100       |      |
| 103 | 8       | 60    | 16    | 56.631 | 12       | 100       |      |
| 104 | 9       | 17    | 94    | 161.52 | 12       | 100       |      |
| 105 |         |       |       |        |          |           |      |
| 106 |         |       |       |        |          |           |      |



| 94  | [PIPES] |       |       |        |          |           |  |
|-----|---------|-------|-------|--------|----------|-----------|--|
| 95  | ID      | Node1 | Node2 | Length | Diameter | Roughness |  |
| 96  | 1       | 51    | 61    | 177.04 | 75       | 110       |  |
| 97  | 2       | 16    | 5     | 118.01 | 75       | 110       |  |
| 98  | 3       | 5     | 91    | 147.93 | 75       | 110       |  |
| 99  | 4       | 16    | 8     | 74.68  | 50       | 110       |  |
| 100 | 5       | 51    | 17    | 196.12 | 250      | 110       |  |
| 101 | 6       | 17    | 115   | 123.62 | 250      | 110       |  |
| 102 | 7       | 116   | 19    | 16.08  | 150      | 110       |  |
| 103 | 8       | 60    | 16    | 56.63  | 75       | 110       |  |
| 104 | 9       | 17    | 94    | 166.54 | 50       | 110       |  |

(2) Calculate water demand at each node and paste in the inp-file.

The water demand should be calculated according to your intended use.

Here is procedure for calculating water demand in 2040 based on the YCDC master plan.

1) Open "Template 2040 Demand Calculate Sheet.xlsx" (This file is provided by the JICA expert.)

| ID | Node1 | Node2 | Household |
|----|-------|-------|-----------|
| 1  | 51    | 61    | 20        |
| 2  | 16    | 5     | 30        |
| 3  | 5     | 91    | 21        |
| 4  | 16    | 8     | 12        |
| 5  | 51    | 17    | 58        |

2) Calculate total demand of each node.

- a) Copy [PIPES] of the dbf-file and paste in "Node1"(column B) and "Node2"(column C).
- b) Copy the dbf-file and paste in "Household"(column D).

|    | A   | B     | C     | D         | E | F                                     |
|----|---|-------|-------|-----------|---|---------------------------------------|
| 1  | 1) Please copy [PIPES] of the dbf-file and paste in "Node1" and "Node2".<br>2) Please copy the dbf-file and paste in "Household". |       |       |           |   | These columns<br>Please expand<br>ID. |
| 2  | V   |       |       |           |   |                                       |
| 3  | ID  | Node1 | Node2 | Household |   | Node1 Ho                              |
| 4  | 1   | 51    | 61    | 20        |   | 51                                    |
| 5  | 2   | 16    | 5     | 35        |   | 16                                    |
| 6  | 3   | 5     | 91    | 21        |   | 5                                     |
| 7  | 4   | 16    | 8     | 12        |   | 16                                    |
| 8  | 5   | 51    | 17    | 58        |   | 51                                    |
| 9  | 6   | 17    | 115   | 33        |   |                                       |
| 10 | 7   | 116   | 19    | 0         |   |                                       |
| 11 | 8   | 60    | 16    | 27        |   |                                       |
| 12 | 9   | 17    | 94    | 20        |   |                                       |
| 13 | 10  | 19    | 93    | 7         |   |                                       |
| 14 | 11  | 24    | 34    | 2         |   |                                       |
| 15 | 12  | 93    | 24    | 0         |   |                                       |
| 16 | 13  | 33    | 35    | 3         |   |                                       |
| 17 | 14  | 178   | 91    | 2         |   |                                       |
| 18 | 15  | 34    | 111   | 18        |   |                                       |

c) Expand the table(column F-I) up to the maximum ID. Columns (G and I) of household are automatically calculated.

|    | A   | B     | C     | D         | E | F   | G         | H     | I         | J                 |
|----|---|-------|-------|-----------|---|---|-----------|-------|-----------|-------------------|
| 1  | 1) Please copy [PIPES] of the dbf-file and paste in "Node1" and "Node2".<br>2) Please copy the dbf-file and paste in "Household". |       |       |           |   | These columns are automatically calculated.<br>Please expand this table up to the maximum ID. |           |       |           | Ple<br>"Nc<br>the |
| 2  | V   |       |       |           |   |   | V         |       |           |                   |
| 3  | ID  | Node1 | Node2 | Household |   | Node1   | Household | Node2 | Household |                   |
| 4  | 1   | 51    | 61    | 20        |   | 51  | 10        | 61    | 10        |                   |
| 5  | 2   | 16    | 5     | 35        |   | 16  | 17.5      | 5     | 17.5      |                   |
| 6  | 3   | 5     | 91    | 21        |   | 5   | 10.5      | 91    | 10.5      |                   |
| 7  | 4   | 16    | 8     | 12        |   | 16  | 6         | 8     | 6         |                   |
| 8  | 5   | 51    | 17    | 58        |   | 51  | 29        | 17    | 29        |                   |
| 9  | 6   | 17    | 115   | 33        |   | 17  | 16.5      | 115   | 16.5      |                   |
| 10 | 7   | 116   | 19    | 0         |   | 116   | 0         | 19    | 0         |                   |
| 11 | 8   | 60    | 16    | 27        |   | 60  | 13.5      | 16    | 13.5      |                   |
| 12 | 9   | 17    | 94    | 20        |   | 17  | 10        | 94    | 10        |                   |
| 13 | 10  | 19    | 93    | 7         |   | 19  | 3.5       | 93    | 3.5       |                   |
| 14 | 11  | 24    | 34    | 2         |   | 24  | 1         | 34    | 1         |                   |
| 15 | 12  | 93    | 24    | 0         |   | 93  | 0         | 24    | 0         |                   |
| 16 | 13  | 33    | 35    | 3         |   | 33  | 1.5       | 35    | 1.5       |                   |
| 17 | 14  | 178   | 91    | 2         |   | 178   | 1         | 91    | 1         |                   |
| 18 | 15  | 34    | 111   | 18        |   | 34  | 9         | 111   | 9         |                   |



d) Arrange "Node2" one behind the "Node1" in column K and L. (Copying and pasting in value)

| I                      | J         | K  | L         | M | N   |
|------------------------|-----------|--|-----------|---|---|
| calculated.<br>maximum |           | Please arrange<br>"Node2" one behind<br>the "Node1". |           |   | Please make pivot ta<br>"Node" and "House |
| V                      |           |  |           |   |   |
|                        | Household | Node   | Household |   | Cells for pivot table                     |
|                        | 10        | 51   | 10        |   |   |
|                        | 17.5      | 16   | 17.5      |   |   |
|                        | 10.5      | 5  | 10.5      |   |   |
|                        | 6         | 16   | 6         |   |   |
|                        | 29        | 51   | 29        |   |   |
|                        | 16.5      | 17   | 16.5      |   |   |
|                        | 0         | 116  | 0         |   |   |
|                        | 13.5      | 60   | 13.5      |   |   |
|                        | 10        | 17   | 10        |   |   |
|                        | 3.5       | 19   | 3.5       |   |   |
|                        | 1         | 24   | 1         |   |   |
|                        | 0         | 93   | 0         |   |   |

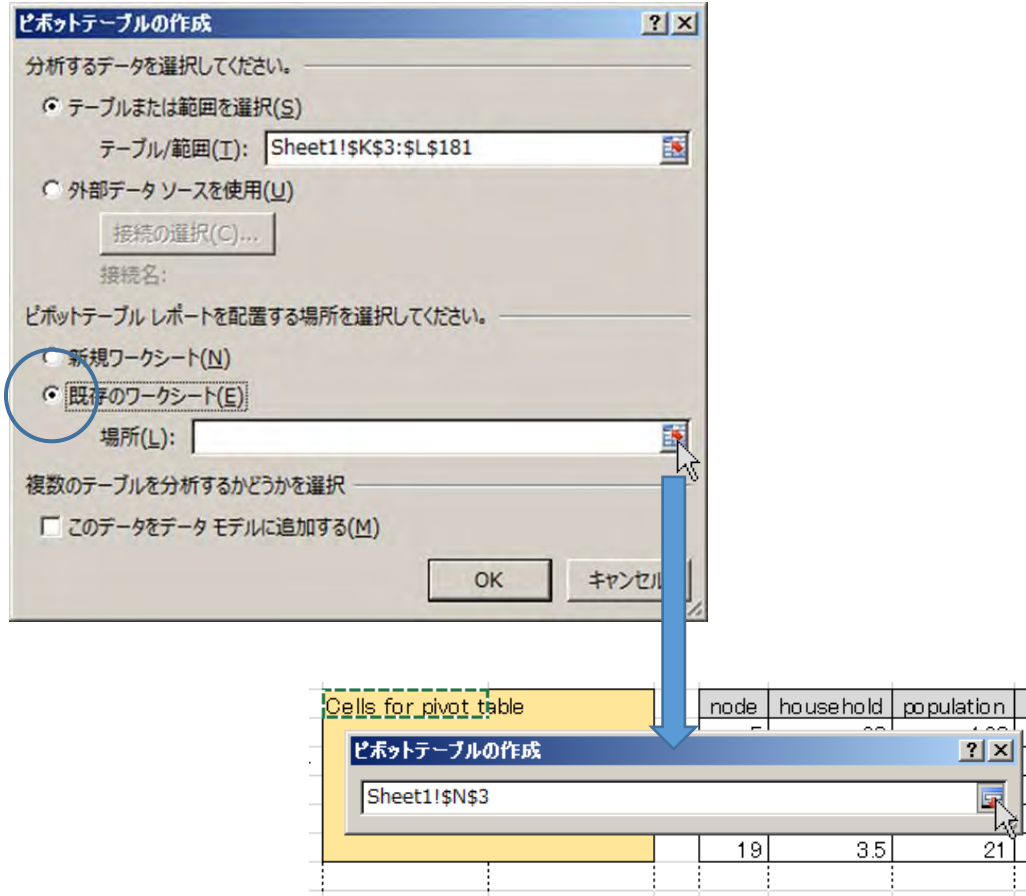
[arrangement rule]

| Node1 | Household | Node2 | Household | Node | Household |
|-------|-----------|-------|-----------|------|-----------|
| 51    | 10        | 61    | 10        |      |           |
| 16    | 17.5      | 5     | 17.5      |      |           |
| 5     | 10.5      | 91    | 10.5      |      |           |
| 16    | 6         | 8     | 6         |      |           |
| 51    | 29        | 17    | 29        |      |           |
| 17    | 16.5      | 115   | 16.5      |      |           |
| 116   | 0         | 19    | 0         |      |           |
| 60    | 13.5      | 16    | 13.5      |      |           |
| 17    | 10        | 94    | 10        |      |           |
| 19    | 3.5       | 93    | 3.5       |      |           |
| 24    | 1         | 34    | 1         |      |           |
| 93    | 0         | 24    | 0         |      |           |
| 33    | 1.5       | 35    | 1.5       |      |           |
| 178   | 1         | 91    | 1         |      |           |
| 34    | 9         | 111   | 9         |      |           |

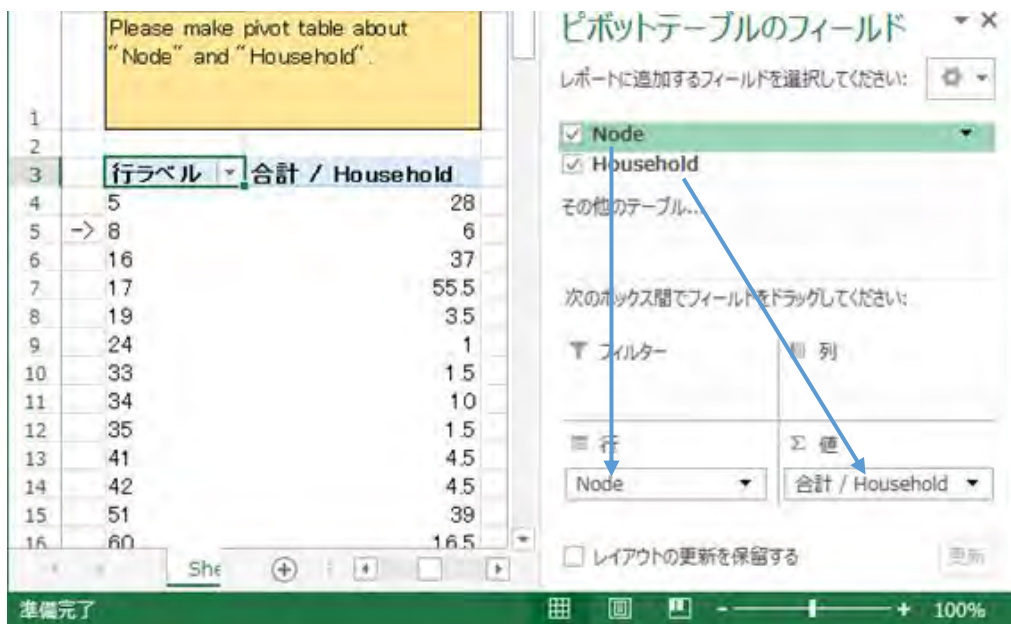
e) Select "Node" and "Household" data in column K and L and click "Pivot Table" on "Insert" tab.

The screenshot shows the Excel ribbon with the 'Insert' tab active. The 'PivotTable' button is highlighted. Below the ribbon, the spreadsheet shows columns K and L selected, with the 'Node' and 'Household' data visible.

f) Check "Existing sheet" and Select cell(Sheet1!\$N\$3) as location.



g) Drag "Node" and drop in Row on the Field of Pivot Table, and drag "Household" and drop in Sigma Value on the Field of Pivot Table.





- k) Save the inp-file as CSV (comma(TAB) separated value) format.  
("d.txt" is input here as.)



- l) Quit the Microsoft-Excel.

- m) Rename the CSV-file to "\*.inp".

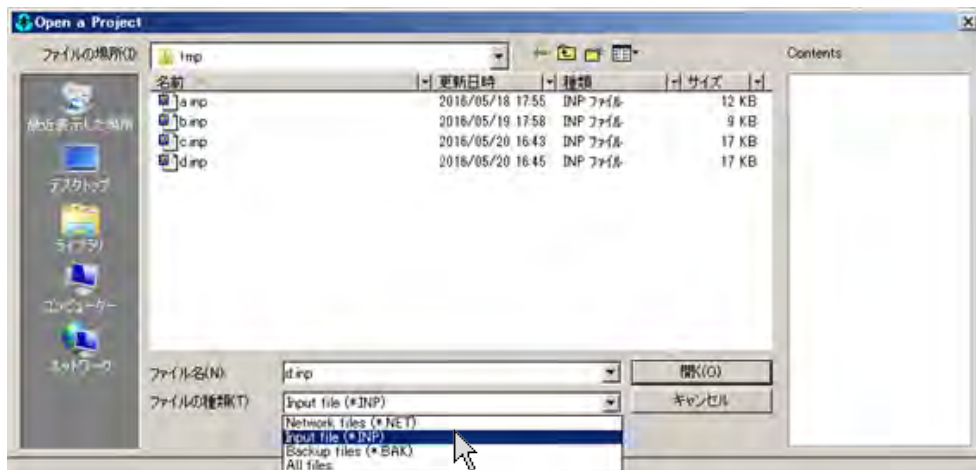
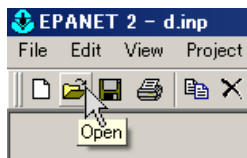


3) (If needed,) Calculate added demands.

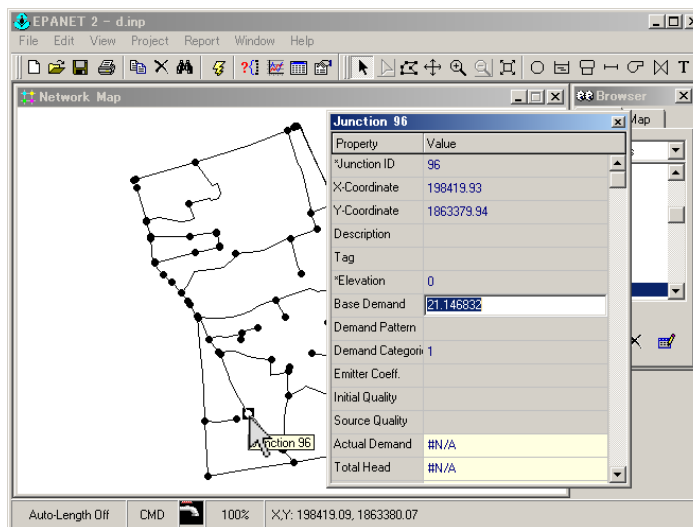
(Sample: Schools, monasteries, large-scale residences under construction and so on)

| Name                              | Nos of Room    | Staff(daytime) | Staff / Monk(stay) | Student / Customer | Demand (m3/day) |
|-----------------------------------|----------------|----------------|--------------------|--------------------|-----------------|
| NIEC                              | Private School | 80             | 25                 | 500                | 21.0            |
| Training center                   |                | 20             | 25                 | 50                 | 6.6             |
| Yadanar Dipa (MOM Monestary)      |                |                | 18                 |                    | 2.7             |
| Mya Nander Dama Yakkita Monestary |                |                | 11                 | 30                 | 3.5             |
| Shwe Hinthar New Monestary        |                |                | 65                 | 30                 | 11.6            |
| Extra-Area                        |                |                |                    |                    |                 |
| Name                              | Nos of Room    | Staff(daytime) | Staff / Monk(stay) | Student / Customer | Demand (m3/day) |
| BEPS2Yankin (Elementally school)  | National       |                | 3                  | 100                | 3.8             |
| Aung Academy                      | Private School |                |                    | 1200               | 38.4            |
| Namitavone                        | Monestry       |                | 60                 |                    | 9.0             |
| Condominium                       | 146            |                |                    |                    | 343.0           |
| Hosehold under construction       | 60             |                |                    |                    | 141.0           |

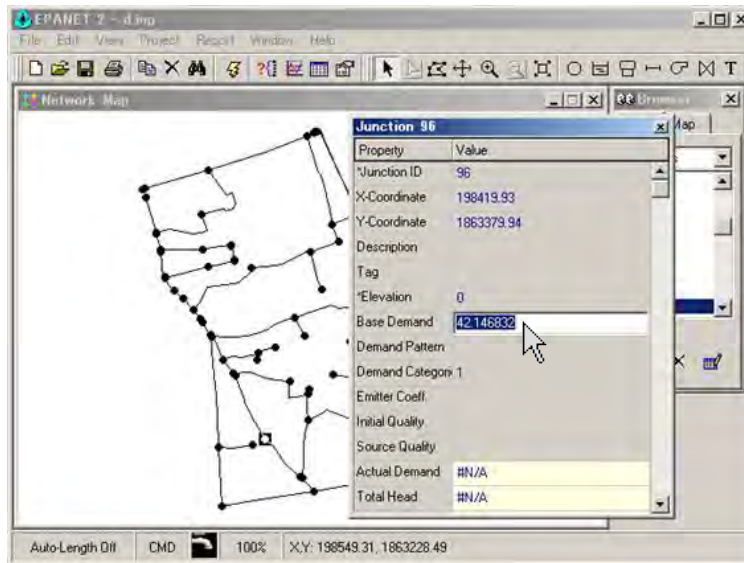
a) Launch EPA-net and open inp-file. ("d.inp" is opened here as.)



b) Double click a target node.



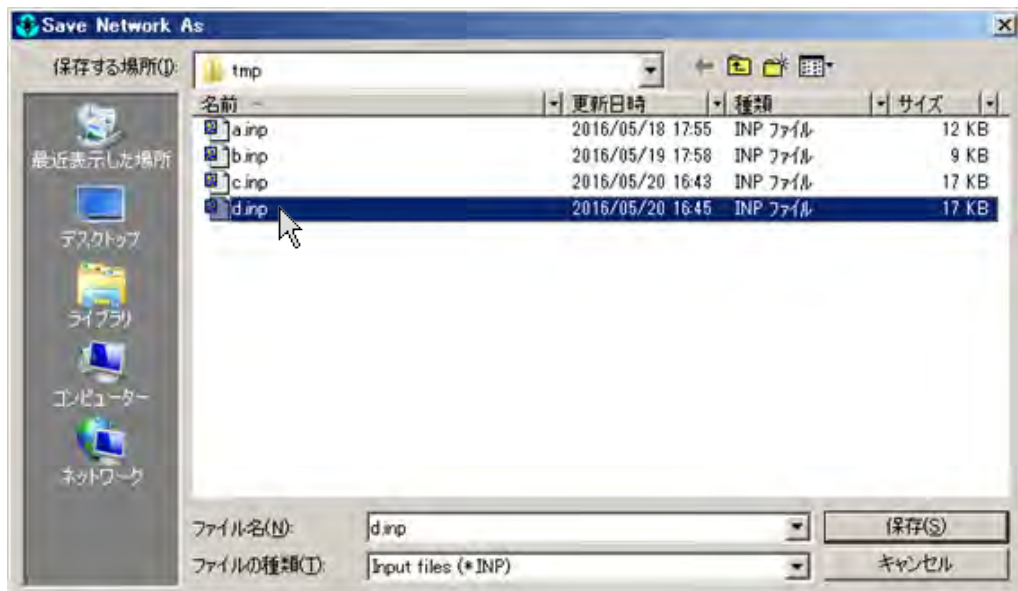
c) Input the sum of base demand and added demand in the "Base Demand".



5) After the input work, select "Network" of "Export" of "File" menu.

6) Entry your arbitrary file-name on "Save Network As" window and click "Save".

("d.inp" is input here as)

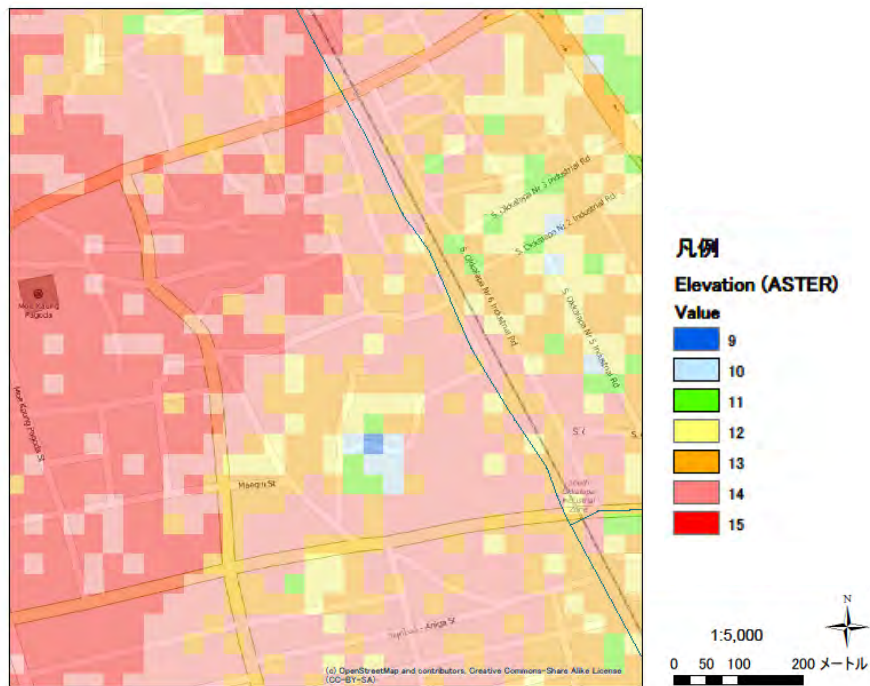


7) Quit the EPA-net.

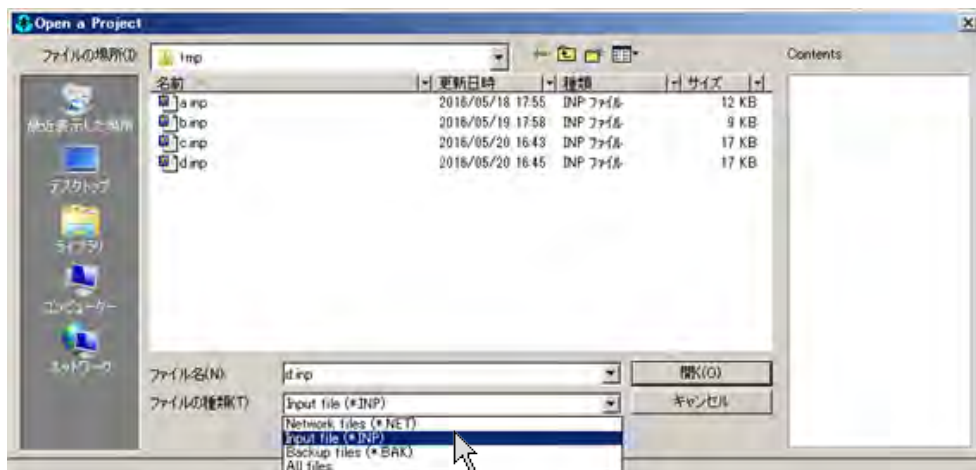
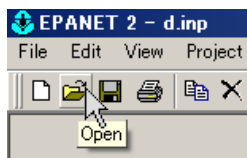
4) Input elevation data of each node with EPA-net.

Elevation data are input in reference to the result of field survey or map. The following is a free map of elevation provided by NASA and METI(Ministry of Economy, Trade and Industry in Japan).

(URL-><http://reverb.echo.nasa.gov/reverb/>)

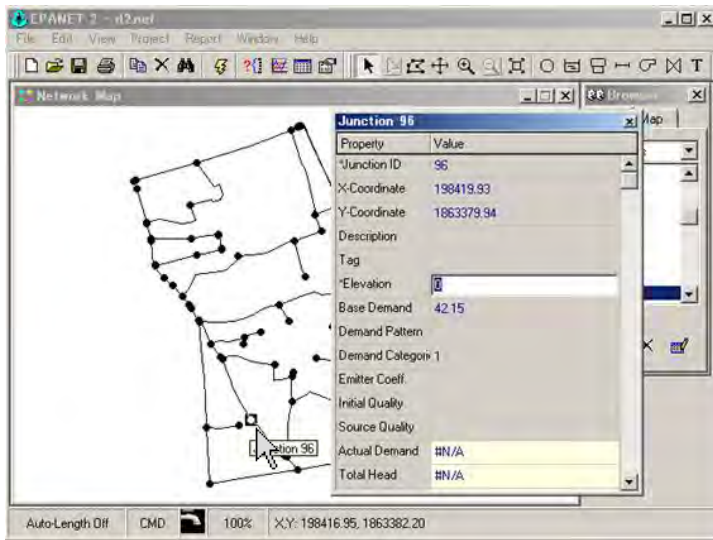


a) Launch EPA-net and open inp-file. ("d.inp" is opened here as.)

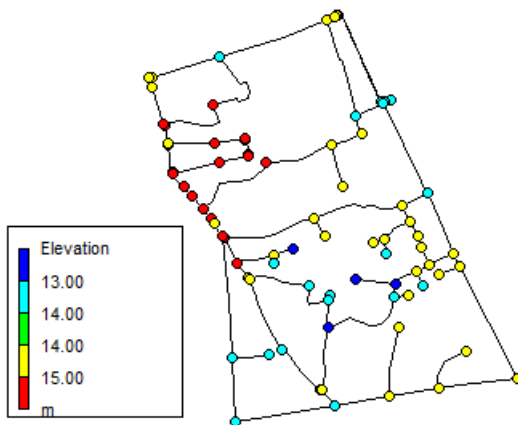
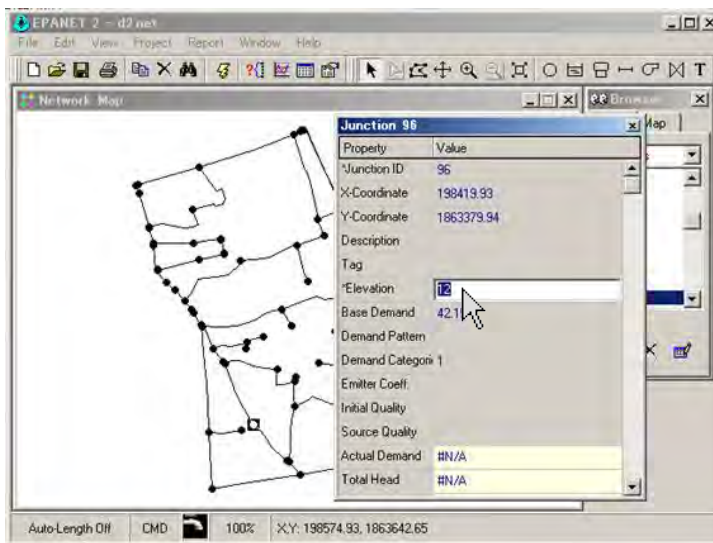




b) Double click a target node.

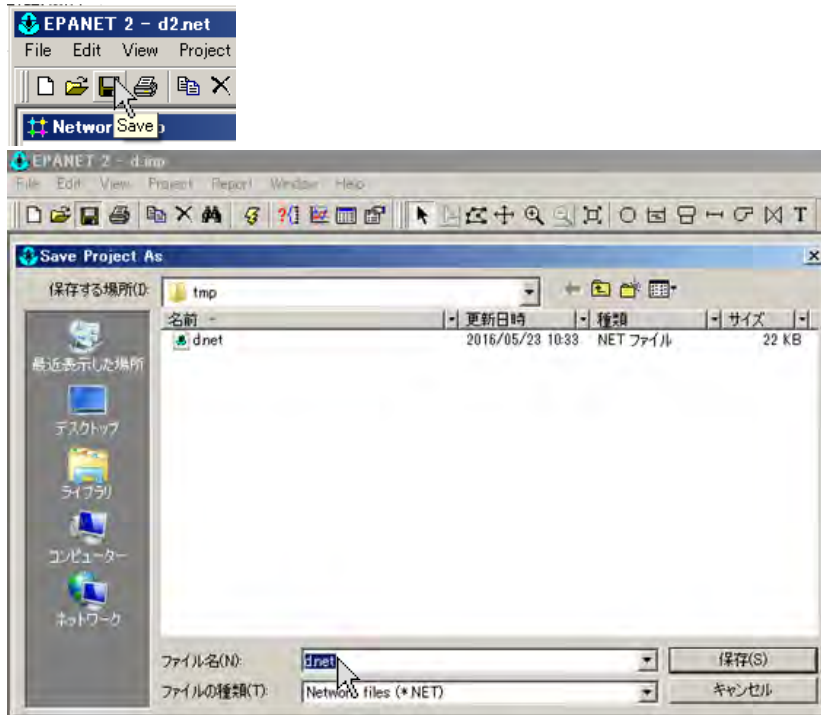


c) Input elevation in the "\*Elevation" in reference to the map.



d) After the input work, click the "Save" icon and save as net-file type.

("d.net" is input here as.)



e) Quit the EPA-net.

Ref:

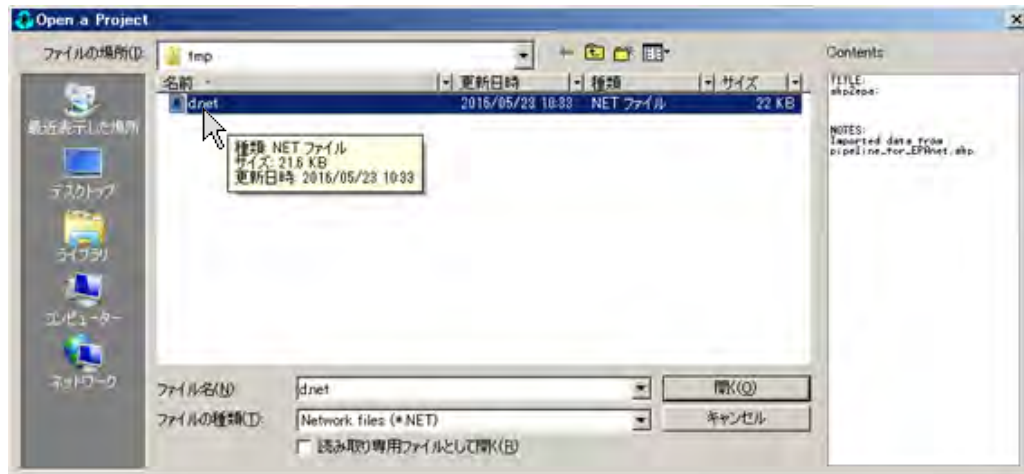
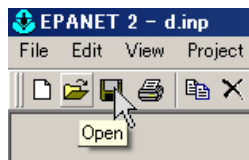
In a review of pipeline for replacement in the Yankin pilot area, it's demand was calculated according to the following guidelines in the 2040.

| Item                                   | Application value                                    | Reference    |
|--|--|--------------|
| Domestic consumption (Average)         | 200 liter/day/capita                                 | M/P 2040     |
| Non-domestic consumption (Average)     | 133 liter/day/capita                                 | M/P 2040     |
| Nos. of people per household (Average) | 4.6  | Census 2014  |
| Nos. of household                      | 933  | Field survey |
| Population growth rate                 | 17.6%<br>(2011 -> 2040)                              | M/P 2040     |
| Hourly factor                          | 1.5  | M/P 2040     |
| Physical loss ratio                    | 0%<br>(Because of replacement,<br>all pipes are new) | M/P 2040     |
| Velocity Coefficient                   | 110<br>(across-the-board)                            | M/P          |

## [How to execute hydraulic analysis.]

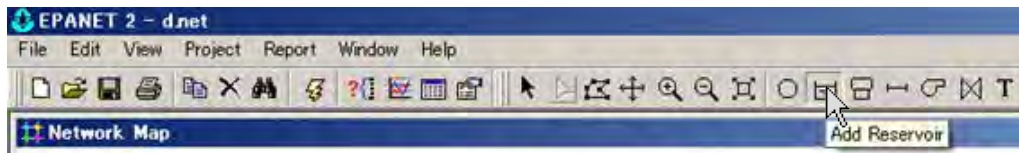
(1) Execute the hydraulic analysis

1) Launch EPA-net and open net-file. ("d.net" is opened here as.)

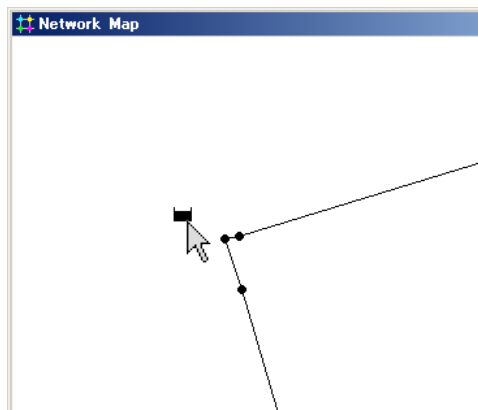


2) Add a tentative reservoir as a DMA inlet.

a) Click "Reservoir" icon



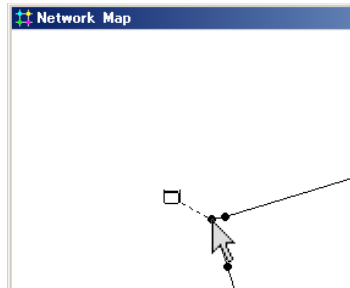
b) Click a point located near a DMA inlet and add a reservoir.



b) Click "Pipe" icon.

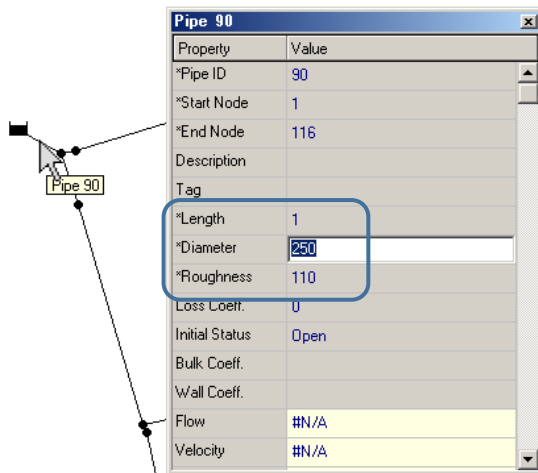


d) Click the reservoir and the DMA -inlet to add a pipe.



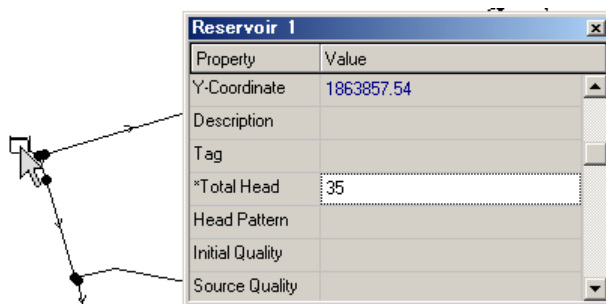
e) Input attribute data of the pipe added.

(In order to minimize head-loss, the followings are input here as.)



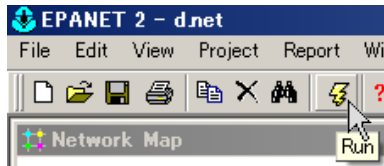
f) Input attribute data of the reservoir added.

(Here as, 35m as elevation 15m plus inlet-head 20m head is input.)

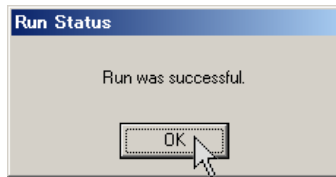


3) Run the hydraulic analysis.

a) Click "Run" icon.



b) Click "OK" of "Run Status" dialogue.



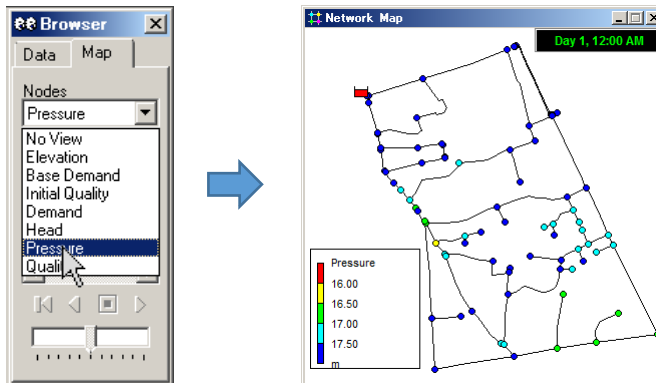
Ref:

- If a warning message is displayed, the hydraulic analysis is normally finished and it is suspected in the presence of negative pressure points(junctions).
- If an error message is displayed, it is suspected in the presence of some isolated points. In this case, please run analysis again after removing the isolated points.

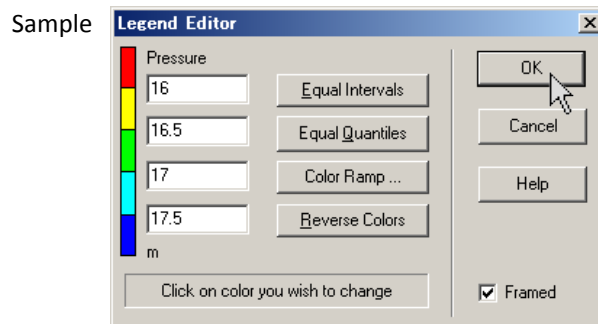
4) Display the result of the hydraulic analysis.

a) Display pressure of points.

- Select "Pressure" of Nodes on "Map" tab of "Browser" window.

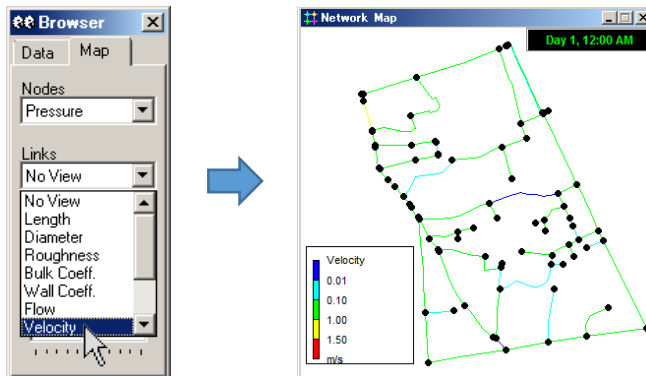


- Right click Legend window and input proper thresholds.

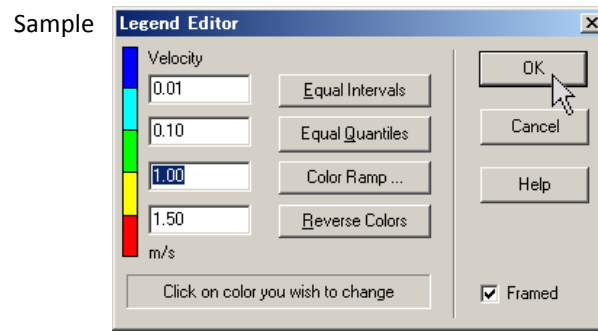


b) Display flow rate (velocity) of pipes.

- Select "Velocity" of Pipes on "Map" tab of "Browser" window.

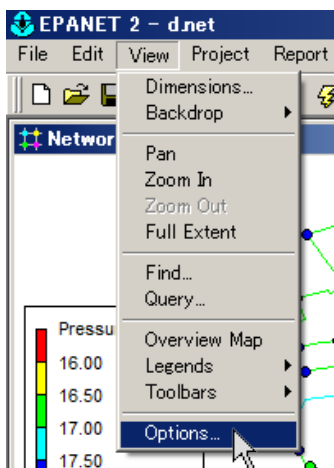


- Right click Legend window and input proper thresholds.



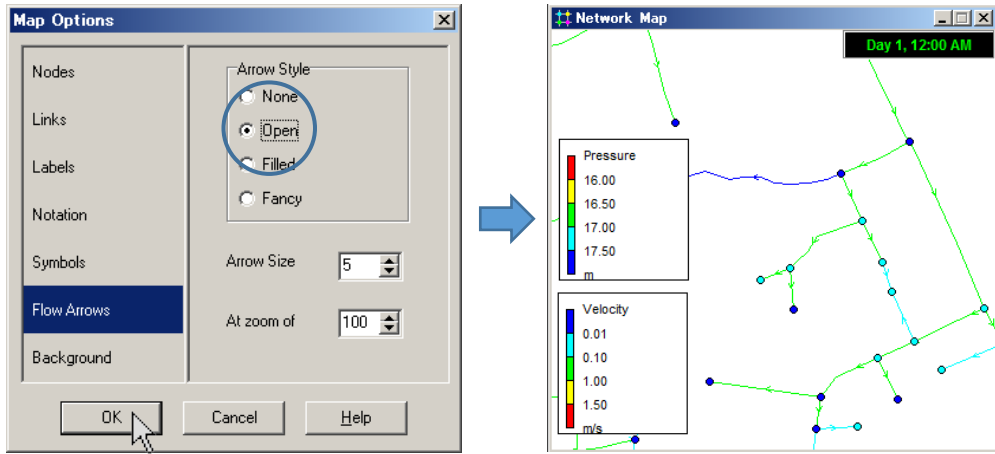
c) Indicate current direction by arrows

- Select "Options" of "View" menu.



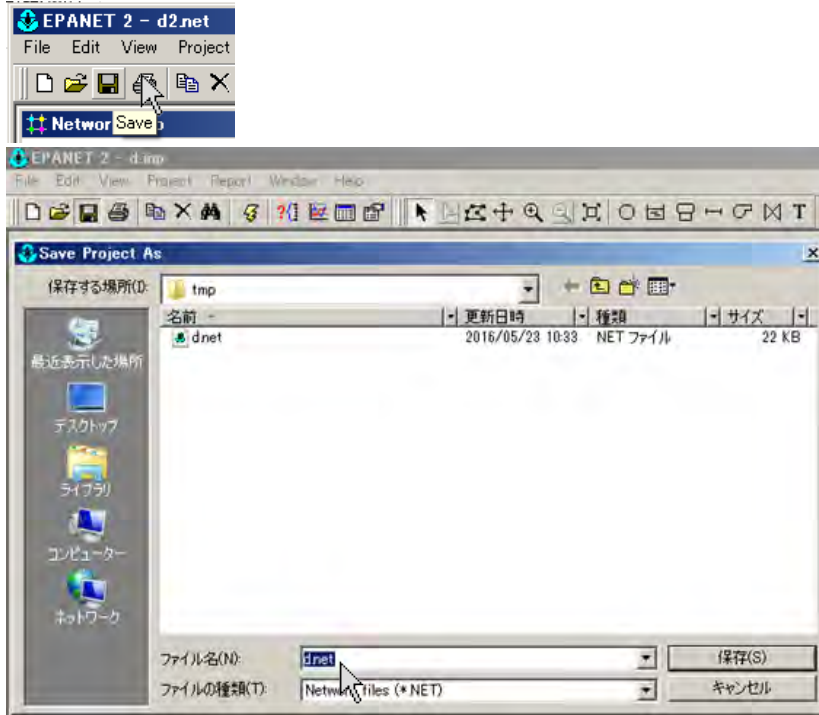


- Select "Open" as "Arrow Style" on "Flow Arrows" of "Map Options" window .



5) Click the "Save" icon and save as net-file type.

("d.net" is input here as.)



6) Quit the EPA-net.

Ref:

In a review of pipeline for replacement in the Yankin pilot area, its diameter and shape were designed according to the following guidelines for the 2040 situation.

- 1) Pressure ensured at DMA inlets is minimum 0.20MPa.
- 2) Pressure ensured at distribution sub mains is minimum 0.16MPa. (represent that if the DMA is on a flat area, pressure loss of distribution sub mains is maximum 0.04MPa.)
- 3) Pressure loss of house connection is maximum 0.10MPa.
- 4) Then pressure ensured at ground taps is minimum 0.06MPa. (represent that the taps can ensure pressure to supply water tanks at 1st floor.)

EOF

# The Project for Improvement of Water Supply Management of YCDC (Technical Assistance Project)

Output Group 2: Non-Revenue Water Management

[GIS Seminar1 ]

## Benefits of GIS and Operation of ArcGIS

JICA EXPERT  
OUTPUT 2 (NRW),  
S. KISHIDA



1

## Contents

1. Benefits of GIS in water works
2. Operation to browse ArcGIS data  
(File, Display, Search, Color-coding and Print )
3. Operation to edit ArcGIS data  
(Drawing of shape, Editing of attribute table,  
and Handling of image data)

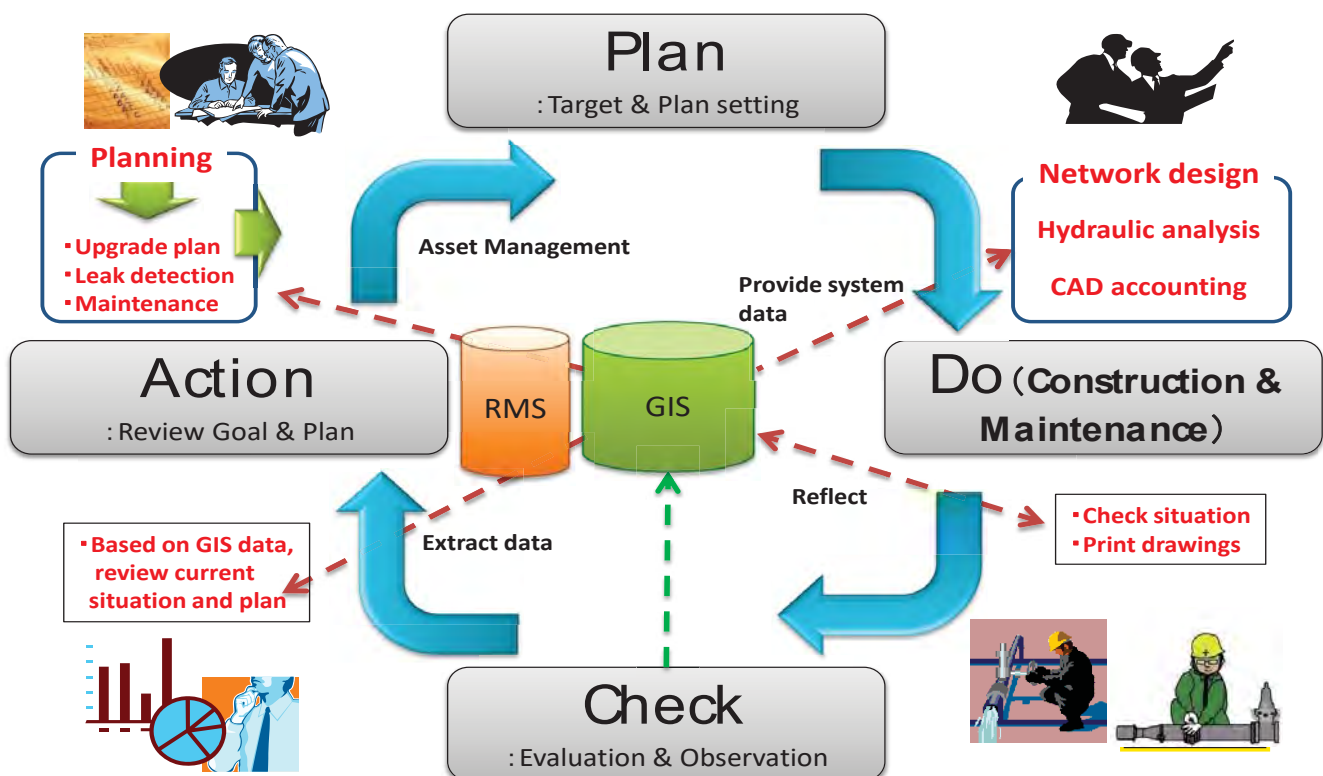
2

# Benefits of GIS in water works

- 1) Visualization of the facility and customer situation
- 2) Improvement of the efficiency and manpower-saving for daily works
- 3) Speedy response to customer and outsourcing contractor
- 4) Utilization for the asset management for sustainable growth

3

# GIS in PDCA cycle



4

# History of GIS for water works in Japan

## History

- \* **Needs** for management of water pipeline
- ↓
- \* Impossible to handle all the information by **paper drawing**
- ↓
- \* Introduction of the software to **manage** and **maintain** the pipeline (from construction to maintenance)
- ↓
- \* **IT revolution** by political movement occurred in Japan

## As of 2014

### Adoption Rate of GIS in Japan

**Large** water works bureaus: **92%**

(Population supplied: Over 250,000 people)

**Medium-sized** one: **87%**

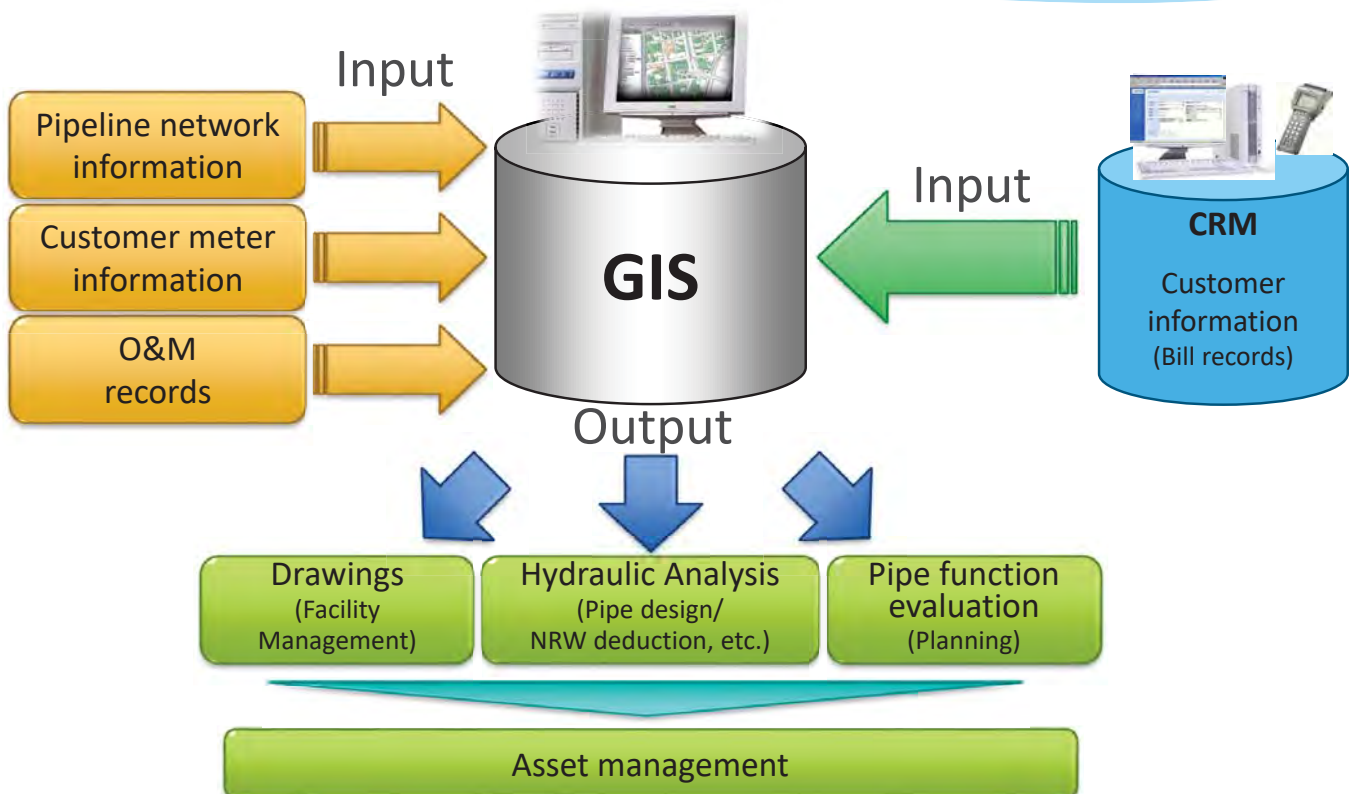
(Population supplied: 50,000 – 250,000 people)

**Small** one: **68%**

(Population supplied: Under 50,000 people)

5

# Utilization of information with GIS

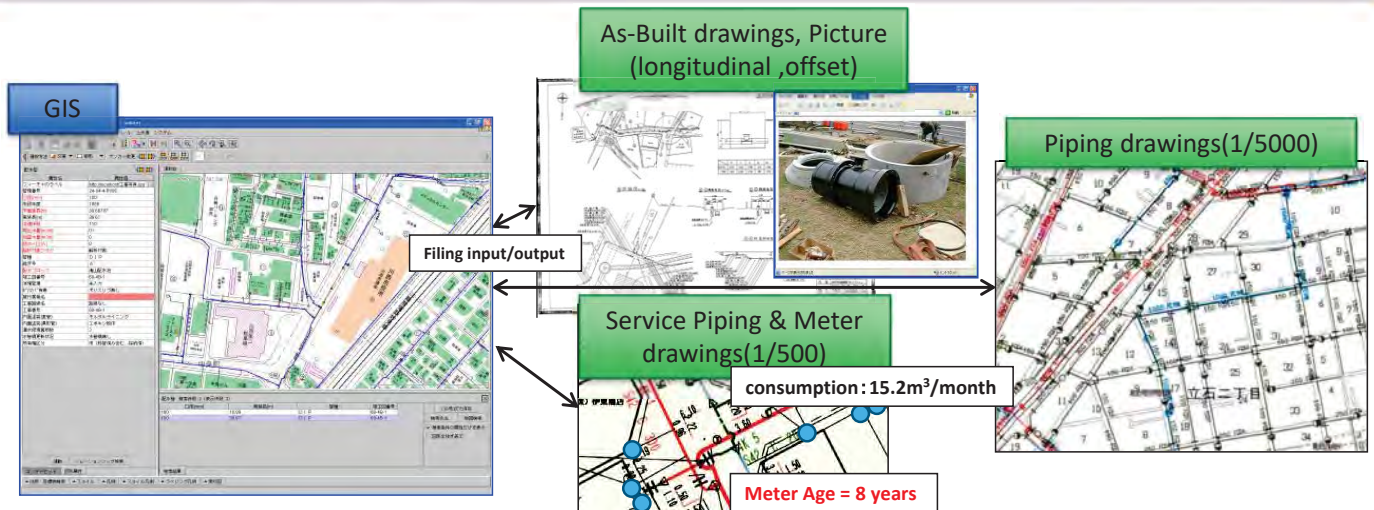


6

# ① Drawings for Facility Management

## Facility management by using latest data and drawings

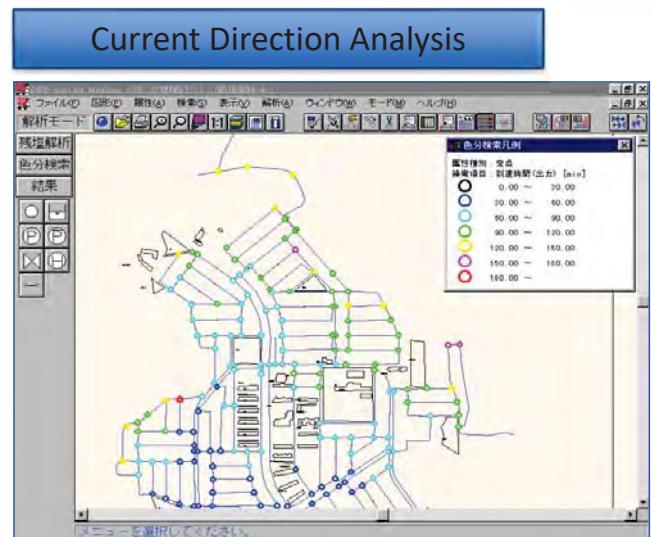
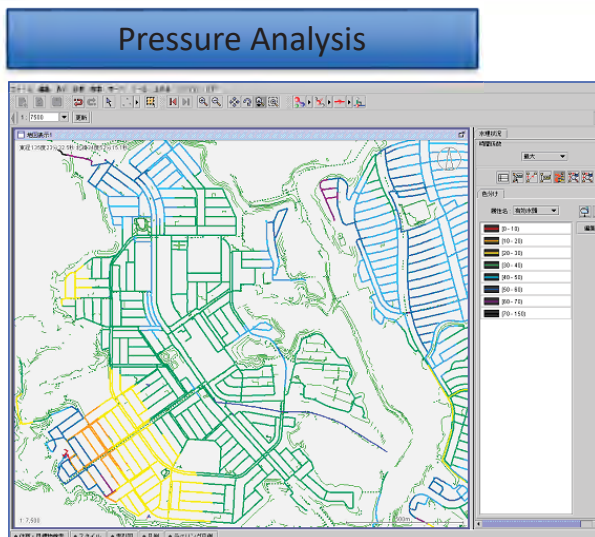
- Possible to search a information of facility location and attribute quickly
- Easy to make some drawings according to work purpose
- Possible to do uniform management of facility, customer and related documents



Possible to understand situation of facility from all aspects

# ② Hydraulic Analysis

## Simulation of pressure, flow velocity, volume and direction with pipeline data(GIS) and water consumption-data(CRM)



Possible to grasp water pressure and flow visually

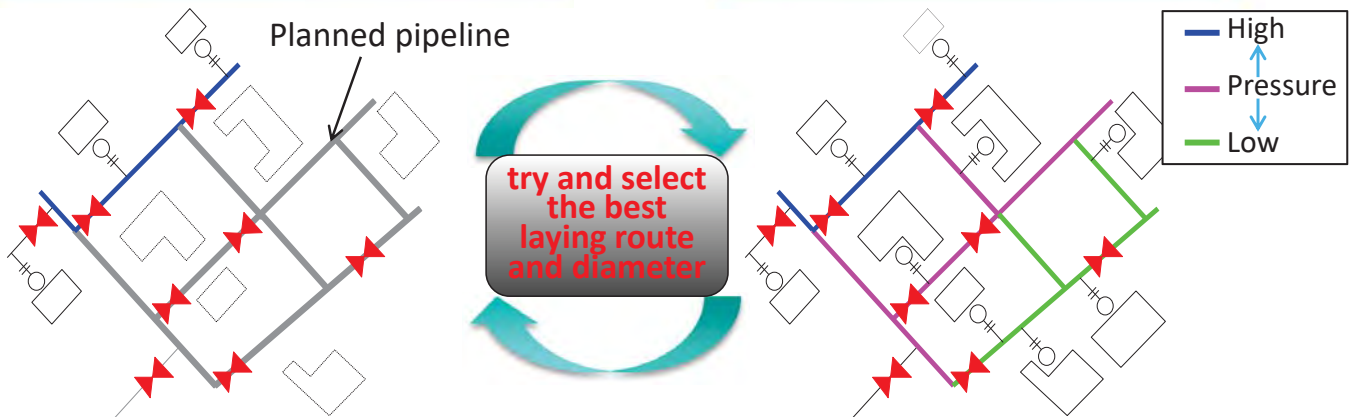


### ③ Pipeline design

- Determining the diameter and pipe laying route
- Checking the water flow situation after new customers are added (Especially large customers such as hotels, commercial facilities and plants.)

Provisional determination of Pipe laying route and diameter on GIS

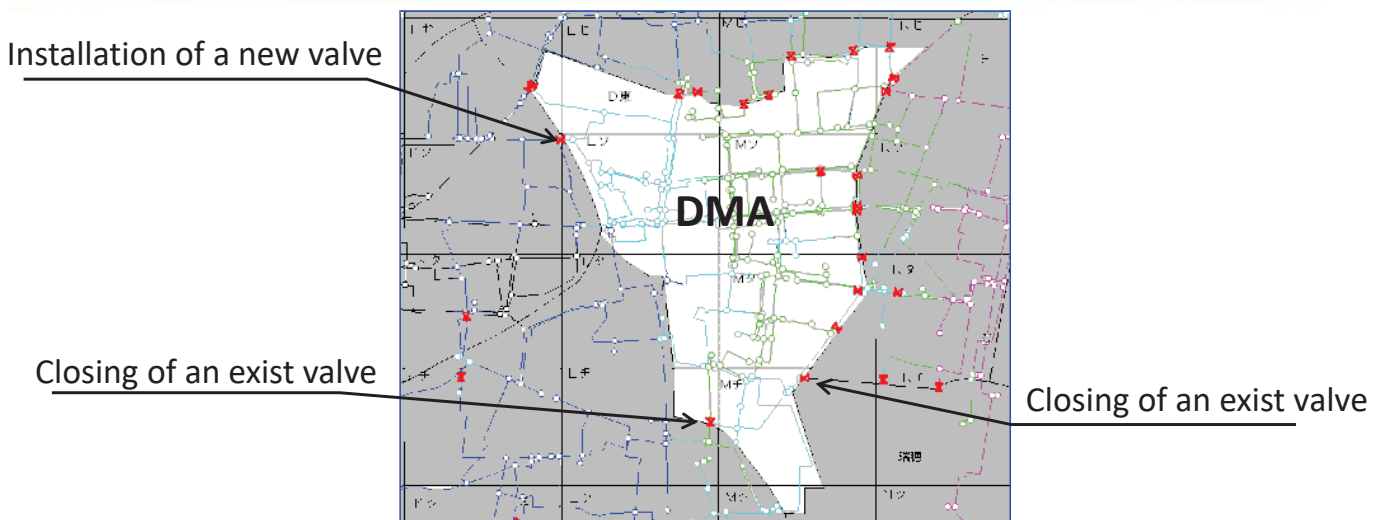
Check water pressure by hydraulic analysis



Possible to design complex pipeline

### ④ Utilization for NRW management ~DMA~

- Hydraulic Analysis for DMA establishment
  - Determination of DMA boundary (location of DMA-inlet, outlet and installation of new valves)
  - Simulation of pressure, flow volume and direction in the DMA.

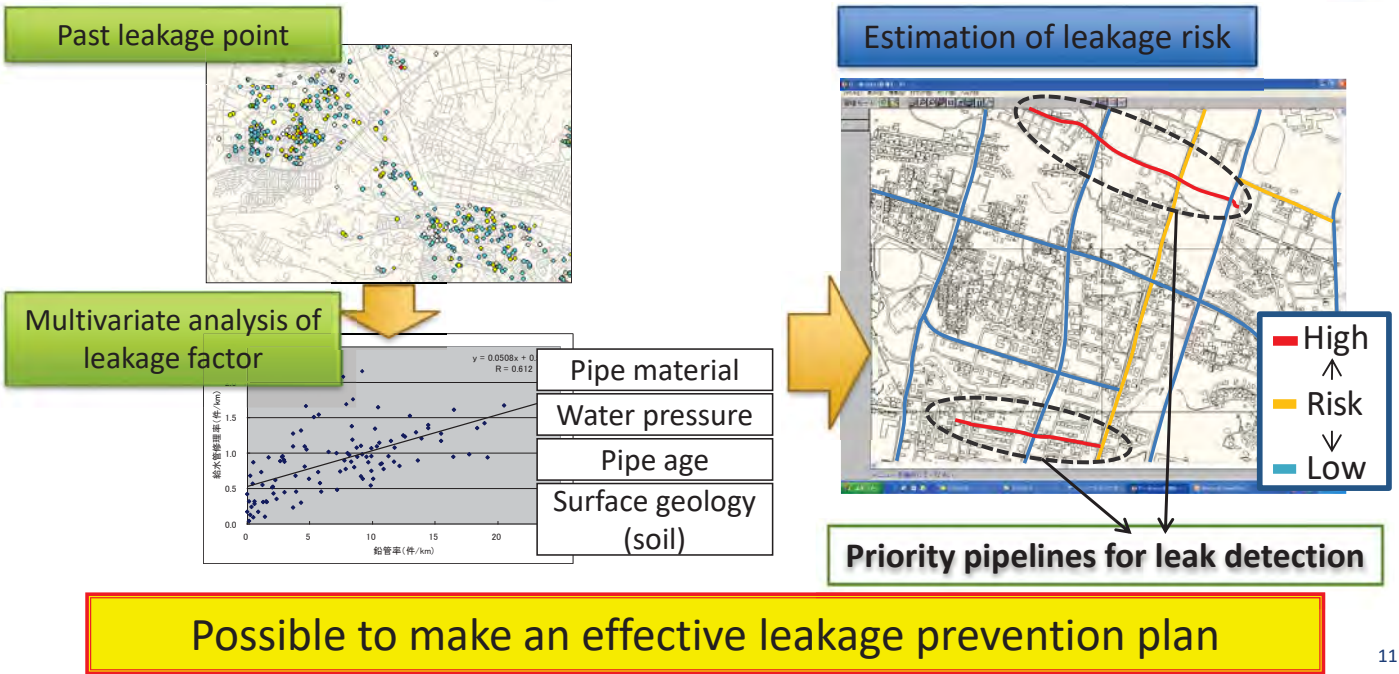


Possible to establish DMA for efficient NRW management



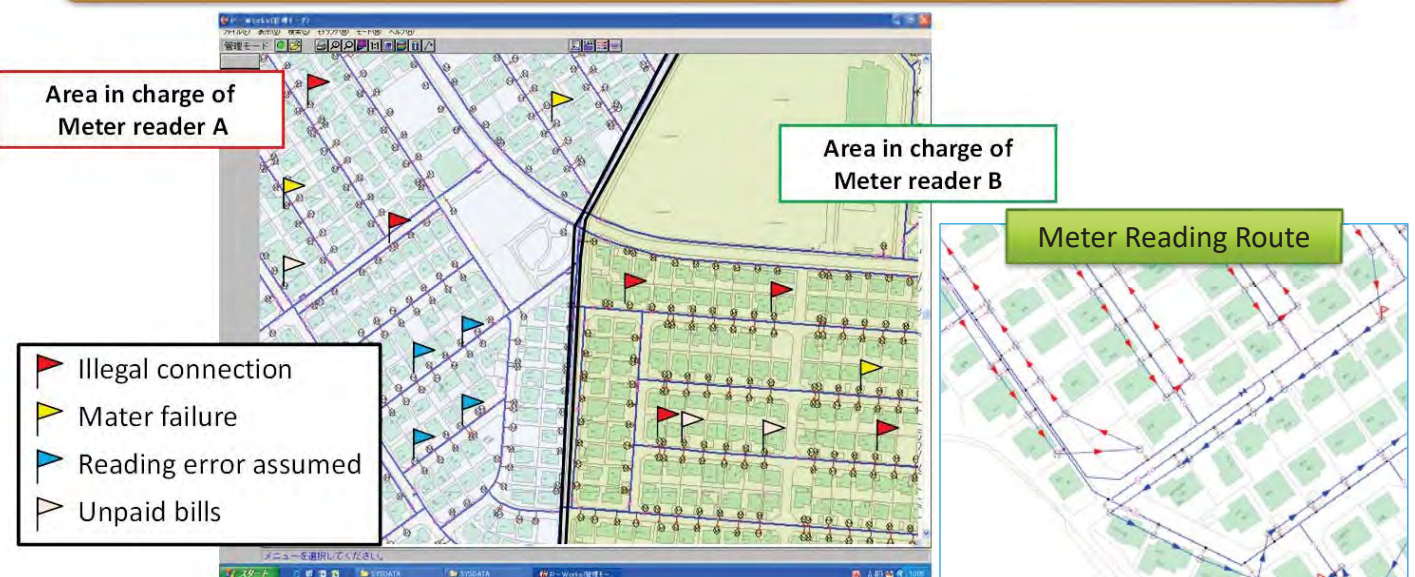
## ⑤ NRW management ~ Leakage prevention ~

■ Utilization of the history-data of leakages in order to narrow down the leak-detection area



## ⑥ NRW management ~ Reduction of metering loss ~

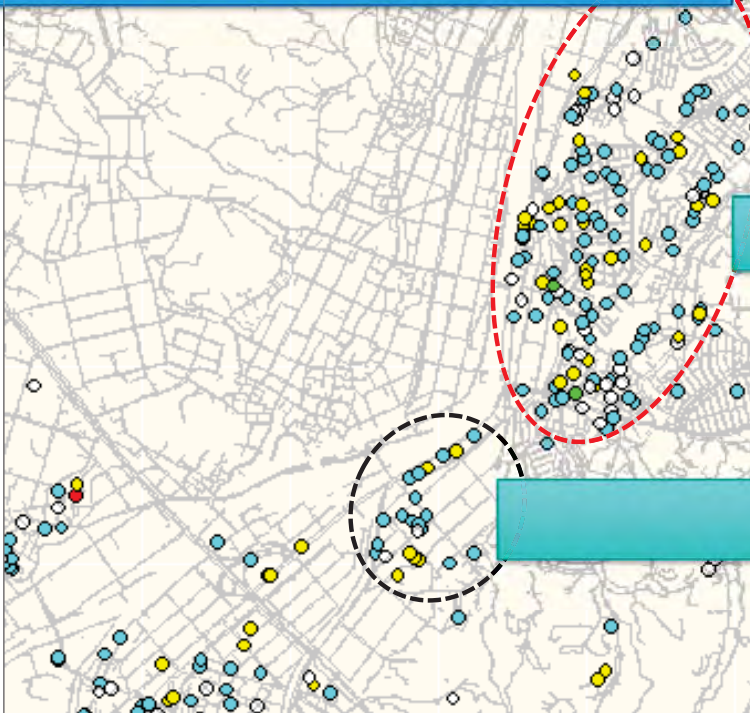
■ Improvement of efficiency and accuracy of meter reading work by using GIS and CRM



Possible to make countermeasures against illegal connection and metering error

## ⑦ Customer management ~Complaint Analysis~

### Complaint about “No water”



What trend can be seen in places where complaint about “Water not being supplied” exists?

Lack of source of water?

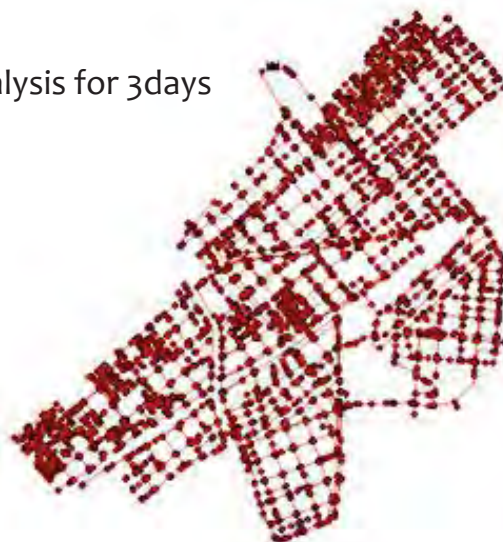
Problem in pipeline?

13

## ⑧ Residual Chlorine Management(1)

- Density of residual chlorine can be calculated depend on the time of transit as result of the hydraulic analysis.

A city in Japan  
Residual chlorine analysis for 3days



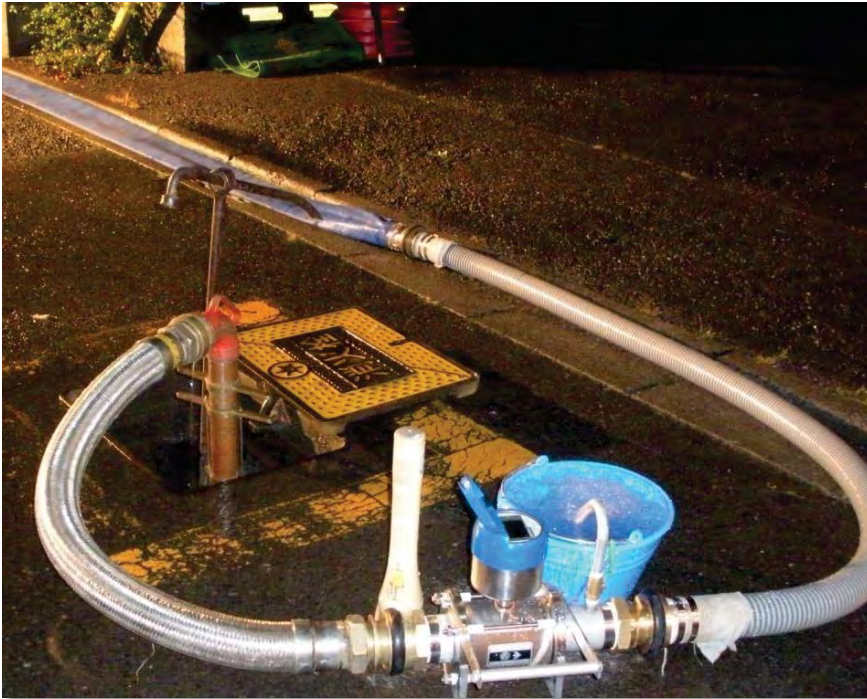
Possible to grasp area where has low density of residual chlorine

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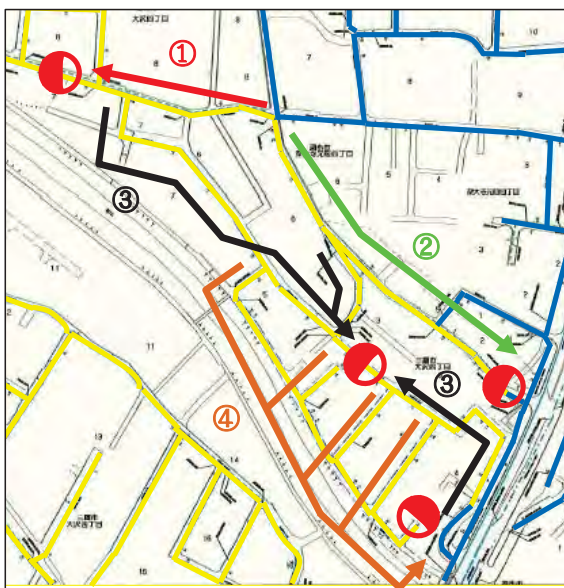


# Case1: Planned draining work with GIS in Tokyo(2)

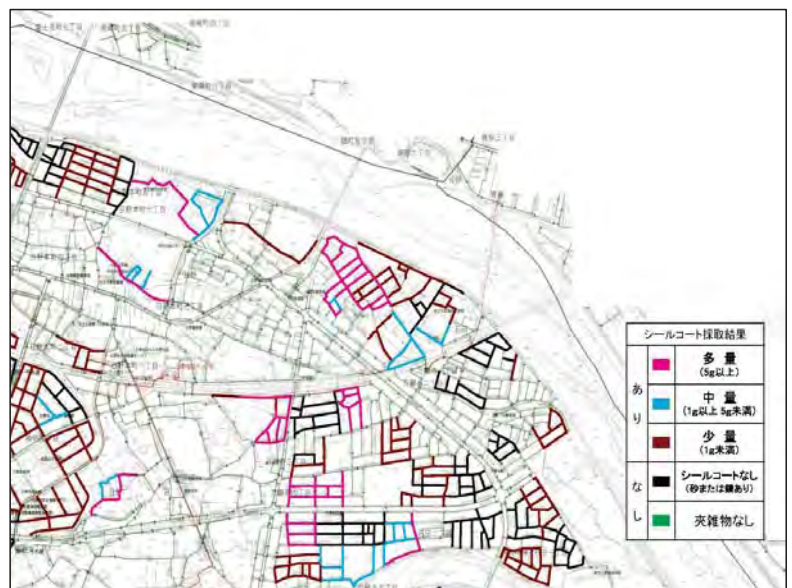


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# Case1: Planned draining work with GIS in Tokyo(3)



Draining routes  
 ① : Draining point

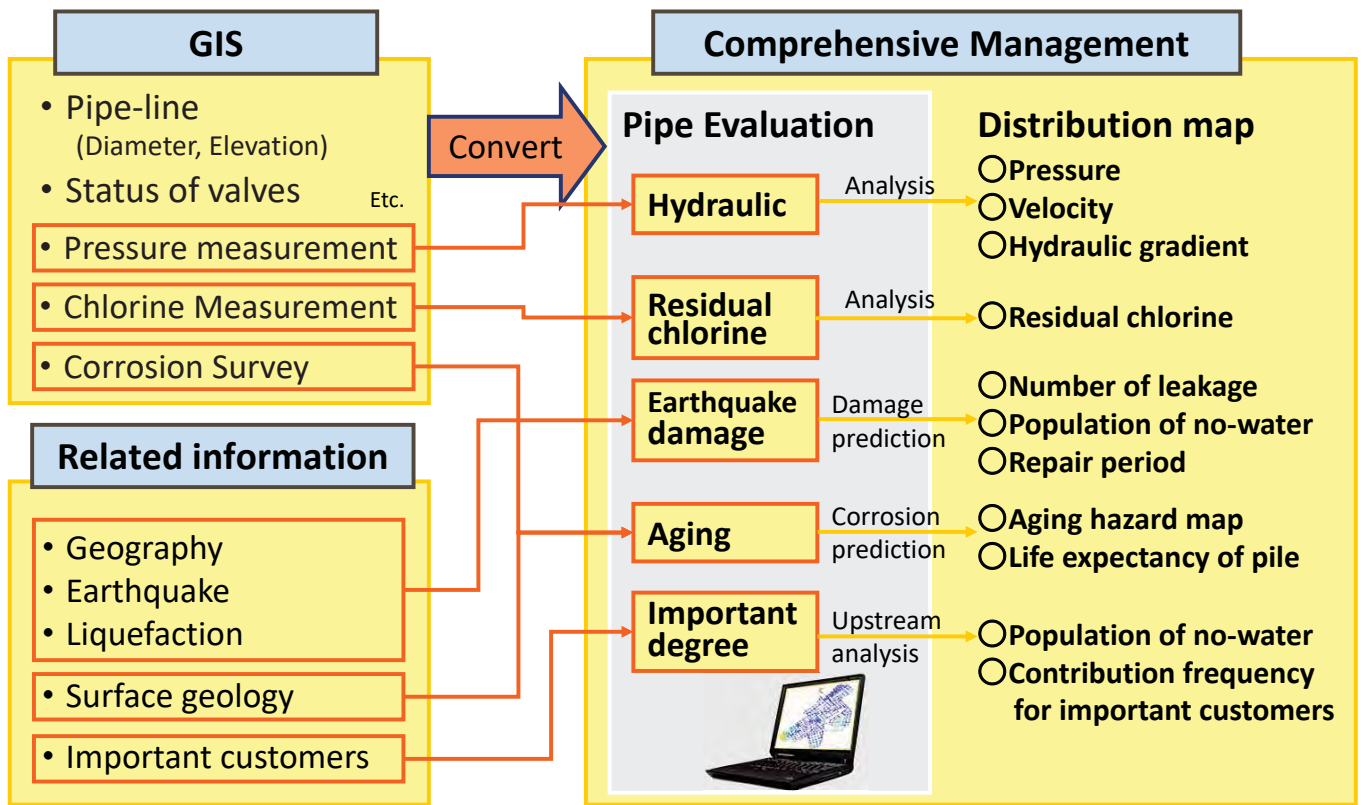


Result of draining works  
 (Coloring according to the amount of impurity)

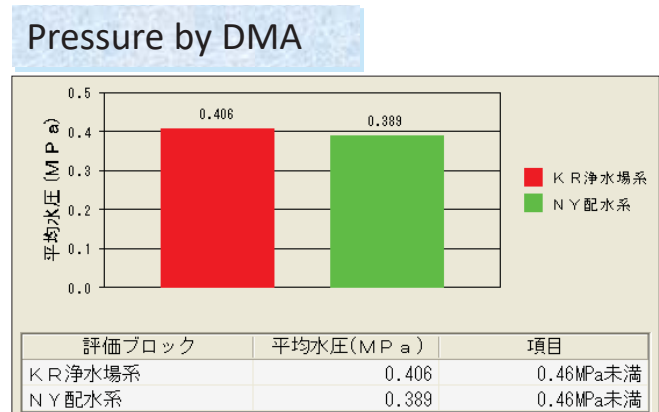
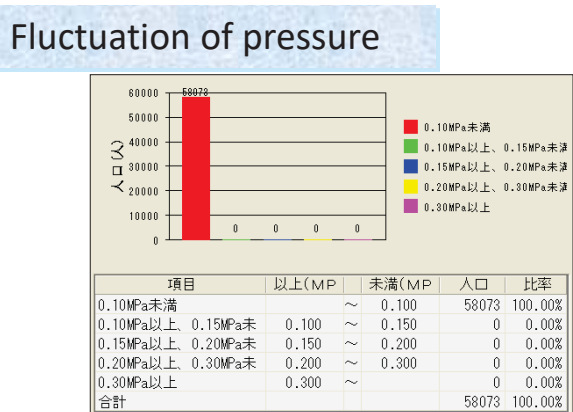
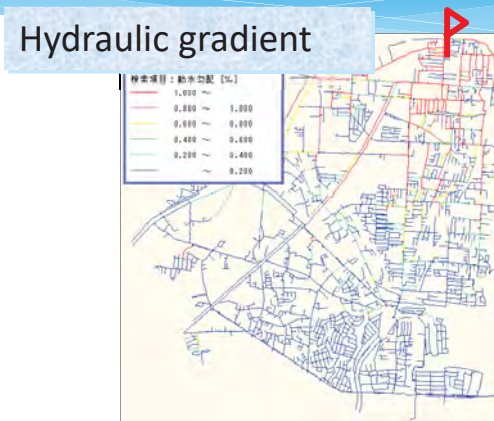
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# Case2: Comprehensive management of pipe-line with GIS in B city

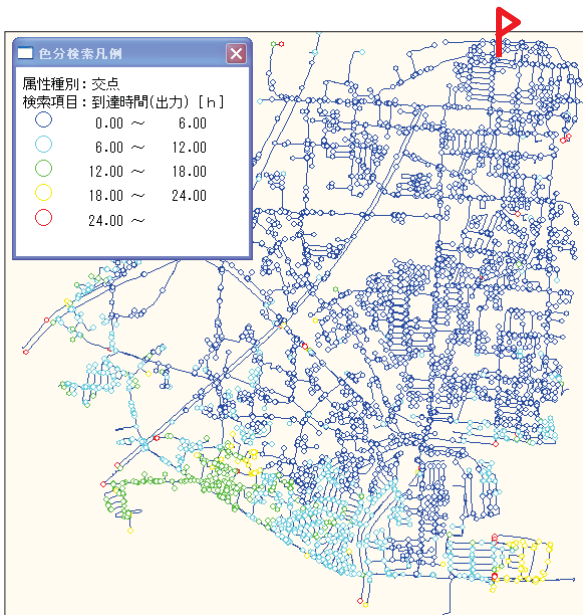


# Case2: Comprehensive management of pipe-line with GIS in B city

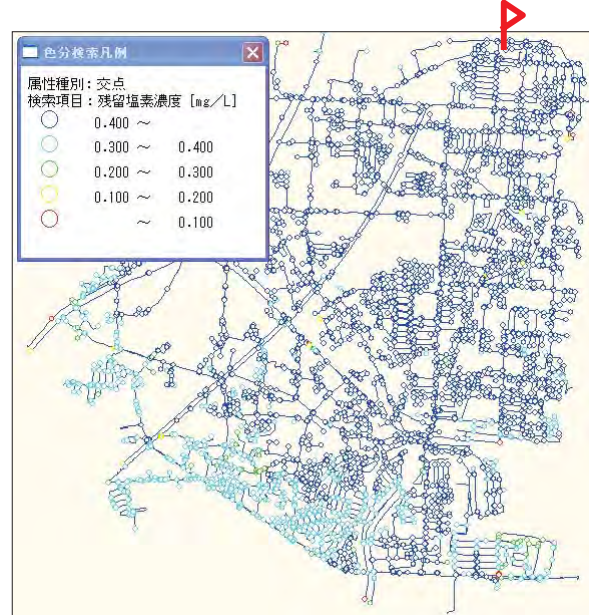


# Case2: Comprehensive management of pipe-line with GIS in B city

The time of water transit

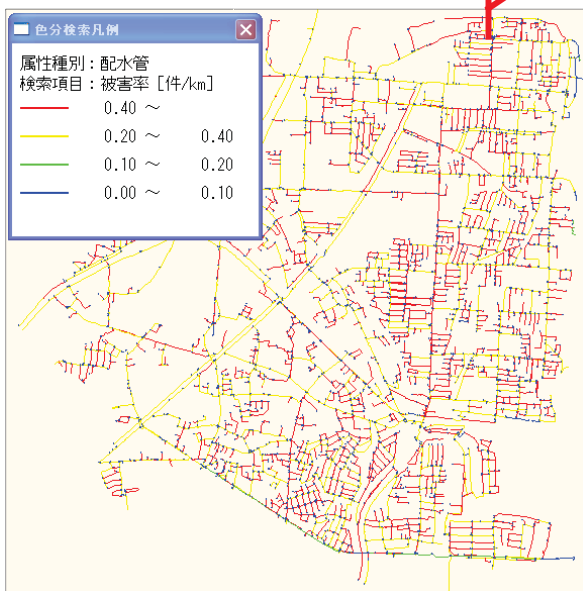


Residual chlorine

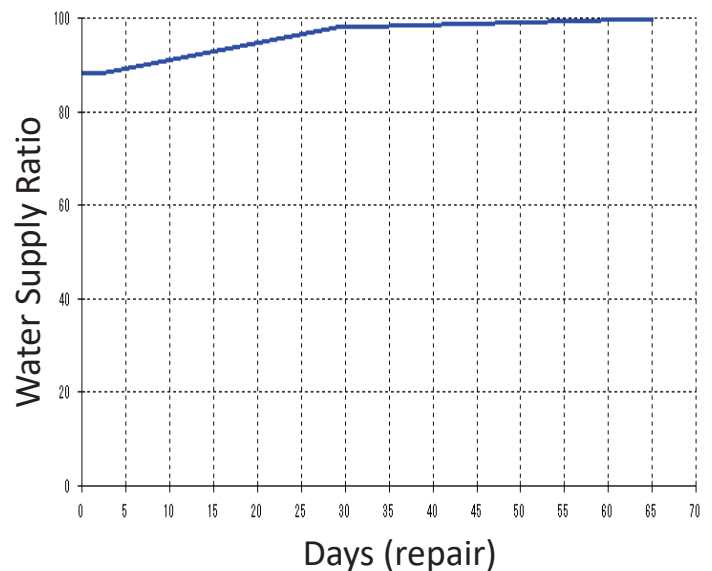


# Case2: Comprehensive management of pipe-line with GIS in B city

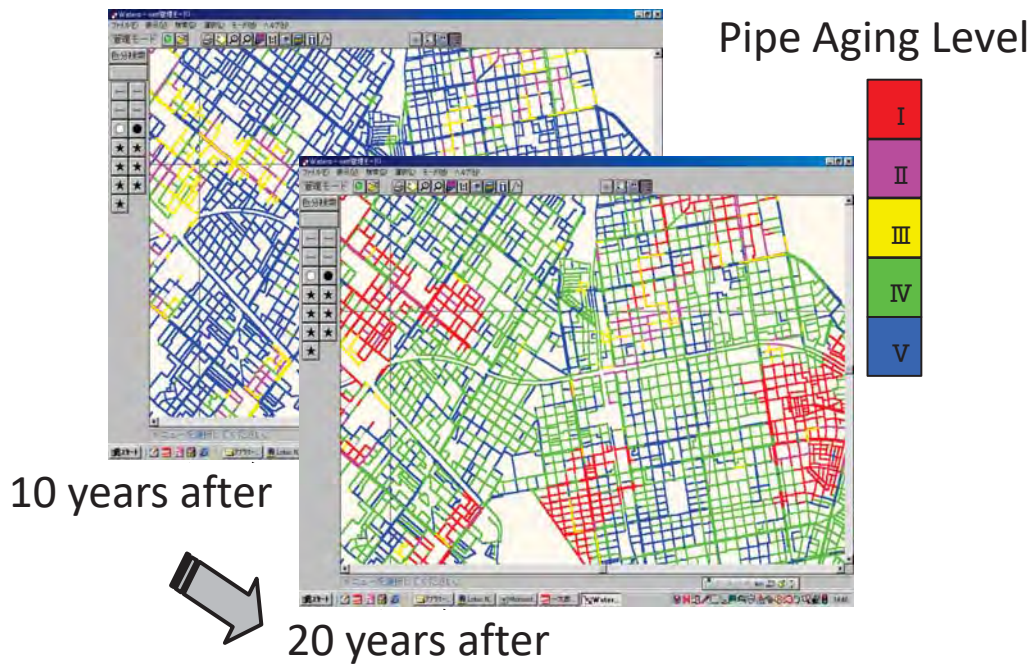
Damage ratio



Recovery prediction



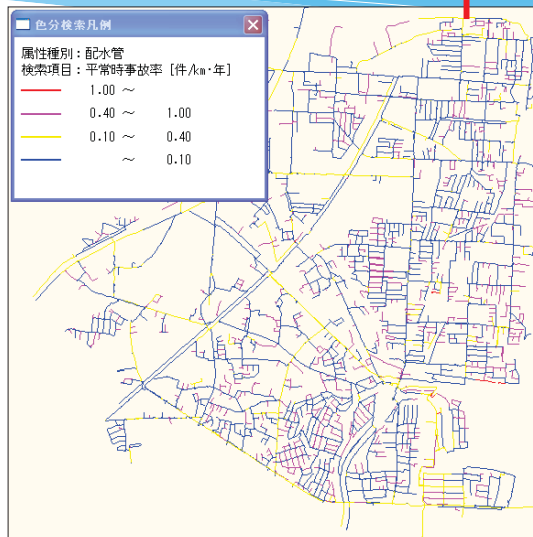
# Case2: Comprehensive management of pipe-line with GIS in B city



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# Case2: Comprehensive management of pipe-line with GIS in B city

Leakage Hazard Map



Leakage Record in Y city

| Materials | (km)<br>(件/年) | Diameter |                 |         |
|-----------|---------------|----------|-----------------|---------|
|           |               | 300mm未満  | 300mm以上 400mm未満 | 400mm以上 |
| CIP       | Length        | 95.12    | 7.59            | 4.21    |
|           | Leak Ratio    | 4.81     | 0.42            | 0.42    |
| MS        | Length        | 0.60     | 0.03            | 0.32    |
|           | Leak Ratio    | 0.82     | 0.01            | 0.03    |
| PVC       | Length        | 1.97     | 0.00            | 0.00    |
|           | Leak Ratio    | 0.94     | 0.00            | 0.00    |
| Others    | Length        | 30.05    | 0.00            | 0.00    |
|           | Leak Ratio    | 12.02    | 0.00            | 0.00    |

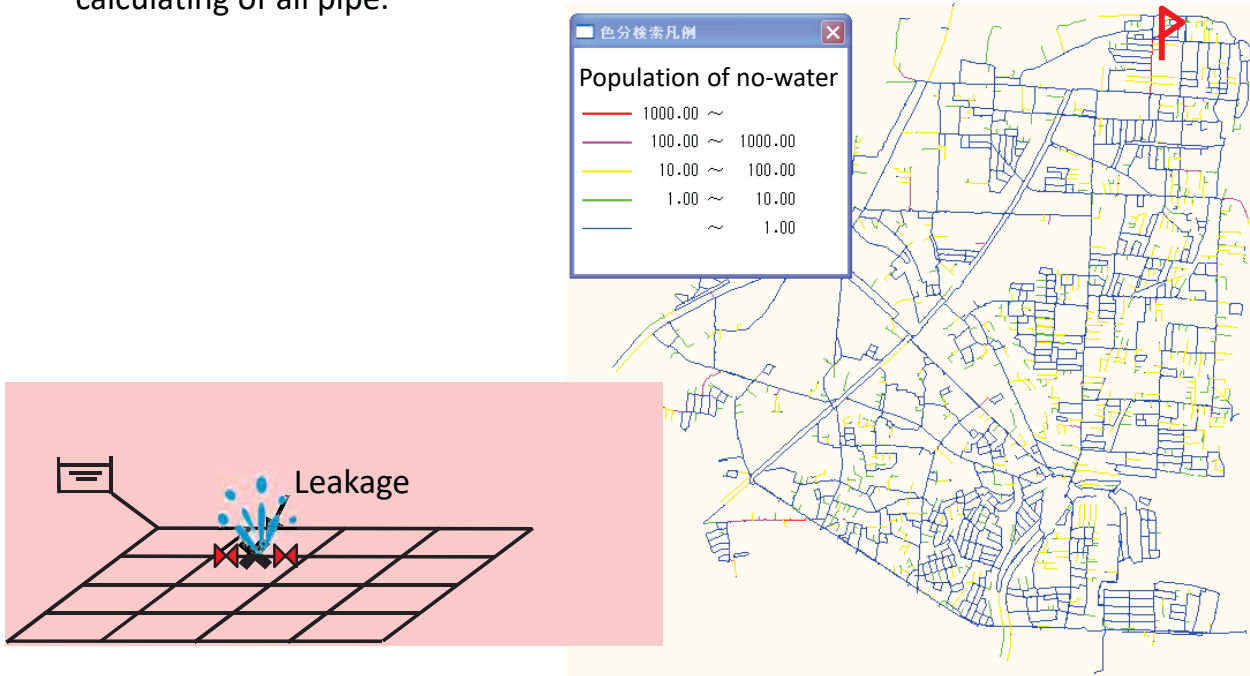
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# Case2: Comprehensive management of pipe-line with GIS in B city

## Importance in terms of continuous supply

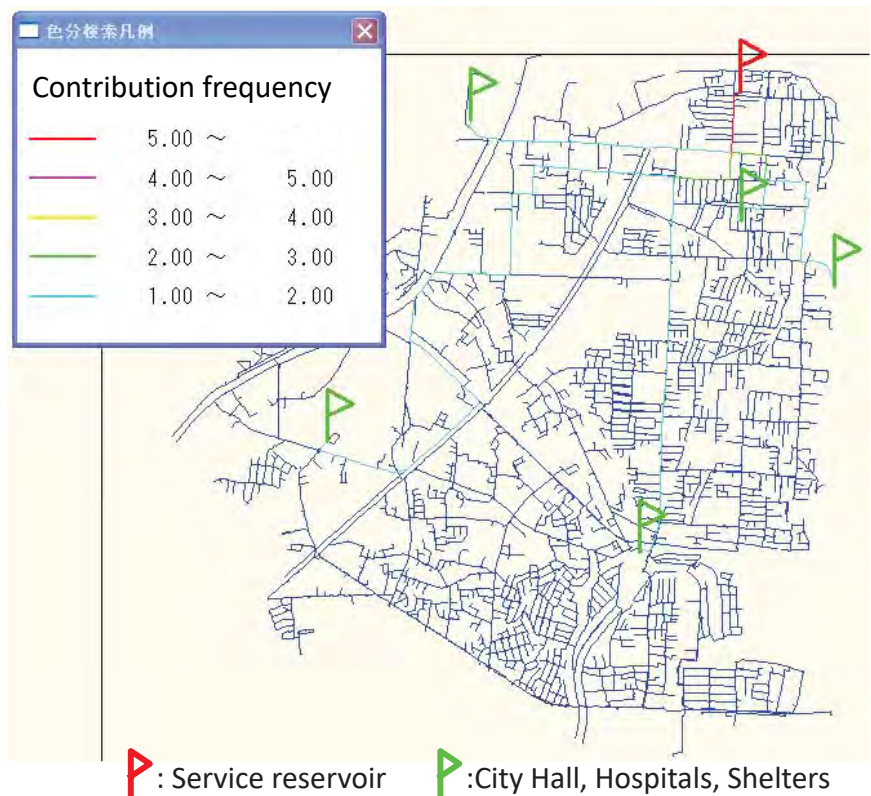
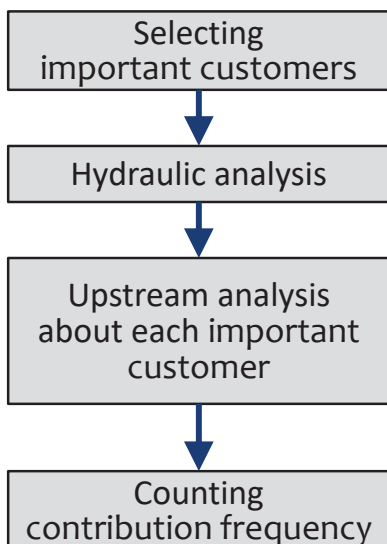
Population of no-water is calculated when leakage is occurred at a pipe, calculating of all pipe.



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# Case2: Comprehensive management of pipe-line with GIS in B city

## Contribution frequency for important customers



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# The importance of accuracy of the GIS



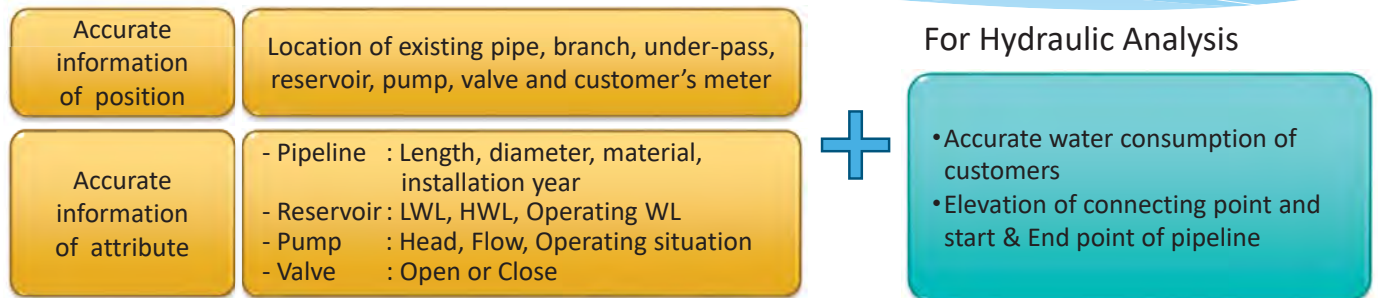
Leakage detection work



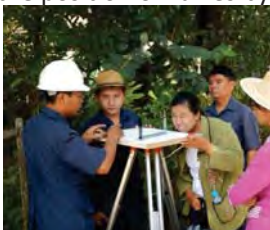
Surveyor found suspicious leak-sound.

Because the cover range of the leak-detector is approximately 1m, the positional information of the pipe is very important.

# Method to improve accuracy of the GIS



Fix the position of valves by offset survey.



Input / Up-date the data



Water consumption data of CRM

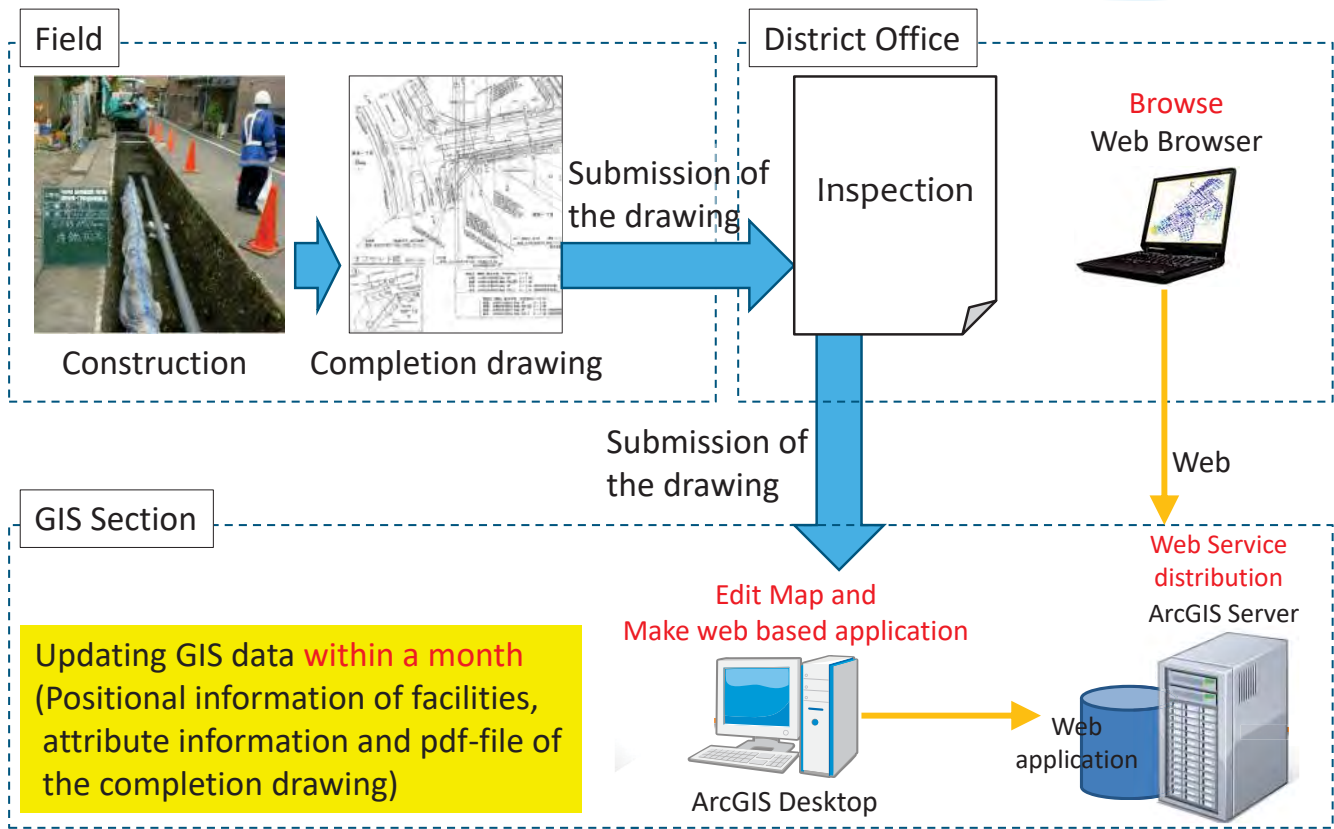


Grasp the accurate position of pipe by test digging or GPS logger.



Record of leak repair/ Metering area

# Data update in C city



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## 1. Benefits of GIS in water works

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## 3. Operation to edit ArcGIS data (Drawing of shape, Editing of attribute table, and Handling of image data)



# Contents

## 2. Operation to browse ArcGIS data

2-1. Selecting the map-file on startup

2-2. Displaying the map

2-3. Searching of data

2-4. Making color-coded map

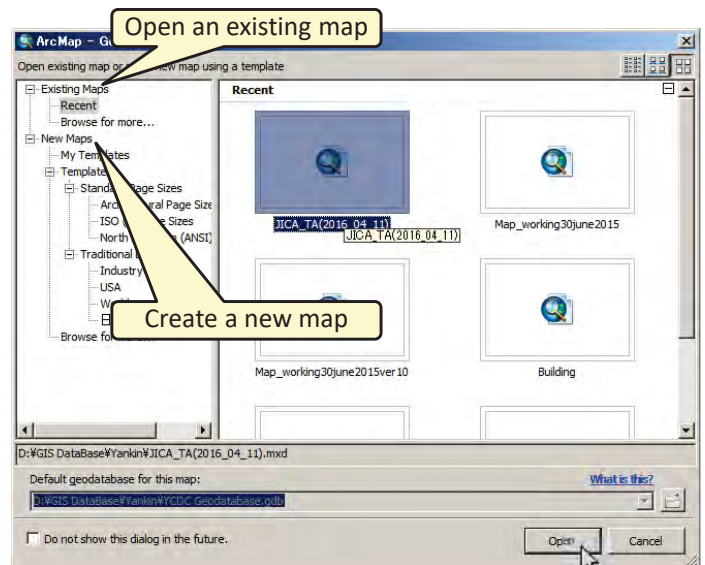
2-5. Printing of the map

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## Selecting the map-file on startup(1)



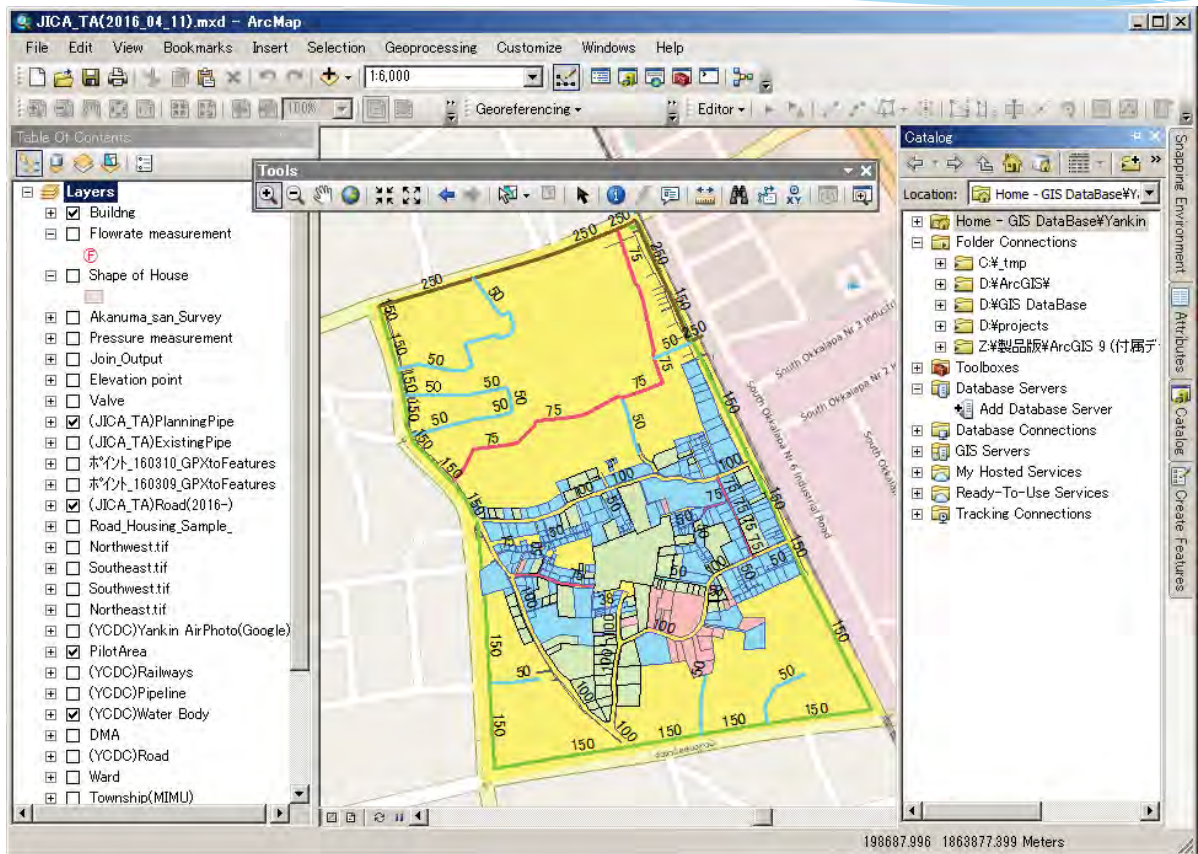
Start ArcMap from the Windows task bar



Pick an existing map or choose to create a new map.

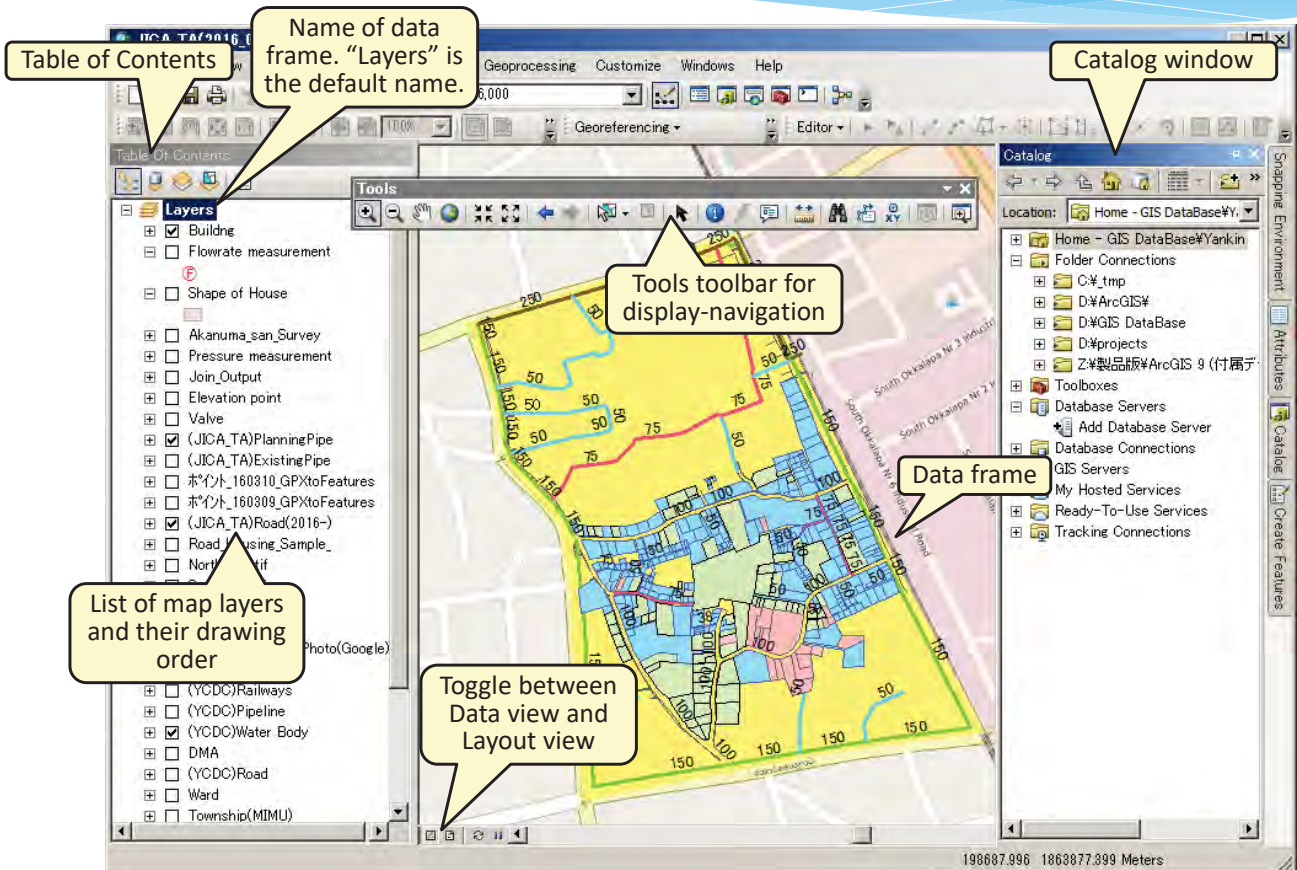
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# Selecting the map-file on startup(2)



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# Selecting the map-file on startup(3)



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# Contents

## 2. Operation to browse ArcGIS data

### 2-1. Selecting the map-file on startup

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### 2-3. Searching of data

### 2-4. Making color-coded map

### 2-5. Printing of the map

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## Displaying the map(1)

### Using the table of contents

The screenshot shows the 'Table of Contents' window in ArcGIS, listing various data layers. Callouts provide instructions on how to interact with the layers:

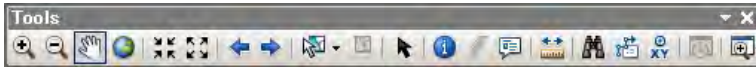
- List by drawing order:** Points to the top of the layer list.
- Turn a layer on or off:** Points to the checkboxes next to the layer names.
- Expand and contract items by clicking the + and - boxes:** Points to the plus and minus symbols used to expand or collapse sub-layers.
- Drag a layer to change its drawing order:** Points to a layer being moved up and down the list.
- Double-click a layer to open the layer properties dialog box:** Points to the 'Buildings' layer.
- Click a symbol to change its properties:** Points to a symbol in the 'Buildings' layer's sub-list.
- Right-click to open a menu containing commands to display the attribute table, set properties, save the layer:** Points to a right-click context menu over the 'Buildings' layer.

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# Displaying the map(2)

## Using the navigation tools



This is the primary toolbar one for pan, zoom and working with map layers.

| Button | Name                    | Function   |
|--------|-------------------------|--|
|        | Zoom In                 | Allows you to zoom in to a geographic window by clicking a point or dragging a box.  |
|        | Zoom Out                | Allows you to zoom out from a geographic window by clicking a point or dragging a box.   |
|        | Pan                     | Allows you to pan the data frame.  |
|        | Full Extent             | Allows you to zoom to the full extent of your map.   |
|        | Fixed Zoom In           | Allows you to zoom in on the center of your data frame.  |
|        | Fixed Zoom Out          | Allows you to zoom out on the center of your data frame.   |
|        | Back                    | Allows you to go back to the previous extent.  |
|        | Forward                 | Allows you to go forward to the next extent.   |
|        | Select Features         | Allows you to select features graphically, by clicking or dragging a box around them. You can also use the Select By Polygon, Lasso, Circle, and Line tools to select features using graphics drawn to the screen. |
|        | Clear Selection         | Unselects all the currently selected features in the active data frame.  |
|        | Select Elements         | Allows you to select, resize, and move text, graphics, and other objects placed on the map.  |
|        | Identify                | Identifies the geographic feature or place on which you click.   |
|        | Hyperlink               | Triggers hyperlinks from features.   |
|        | HTML Pop-up             | Triggers HTML pop-up windows from features.  |
|        | Measure                 | Measures distances and areas on your map.  |
|        | Find                    | Finds features in the map.   |
|        | Find Route              | Allows you to calculate point-to-point routes and driving directions.  |
|        | Go To XY Location       | Allows you to type an x, y location and navigate to it.  |
|        | Open Time Slider Window | Opens a time slider window for working with time-aware layers and tables.  |
|        | Create Viewer Window    | Allows you to create a new viewer window by dragging a rectangle.  |

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## 2. Operation to browse ArcGIS data

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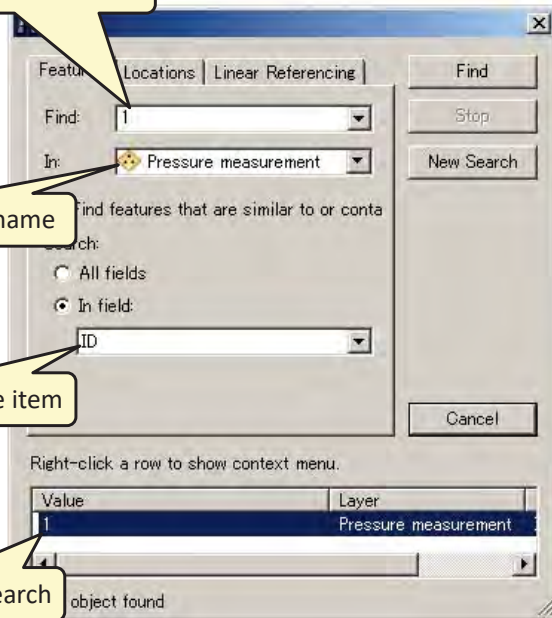
# Searching of data(1)

## Using "Find" function

① Click "Find" icon



② Input search value / text



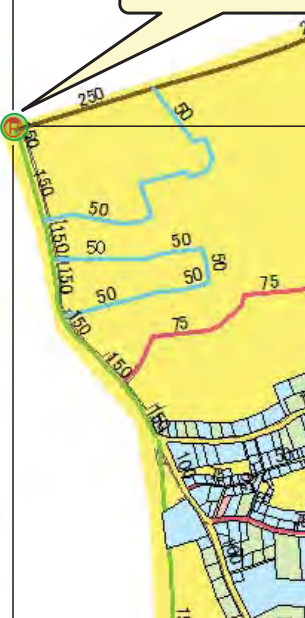
③ Set layer's name

④ Set attribute item

Result of the search

object found

Result of the search



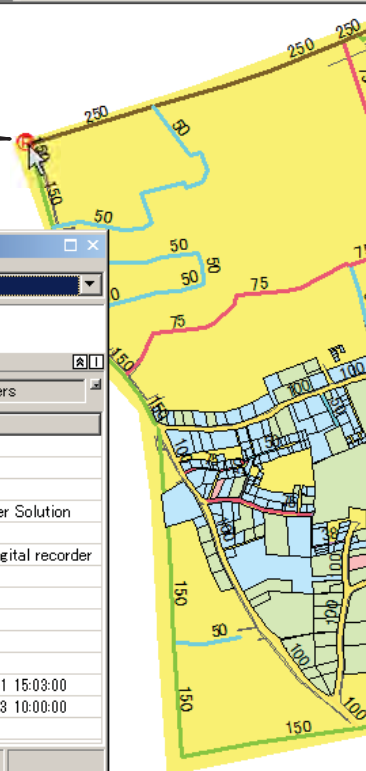
# Searching of data(2)

## Using "Identify" function

① Click "Identify" icon



② Click the target object



Receive attribute data of the object

| Field                            | Value                     |
|----------------------------------|---------------------------|
| OBJECTID                         | 1                         |
| SHAPE                            | Point                     |
| ID                               | 1                         |
| Manufacturer                     | Nihon Water Solution      |
| Model number                     | PPL-08                    |
| Measuring method                 | Portable digital recorder |
| Installation year or "temporary" | temporary                 |
| Periodic inspection date         | <null>                    |
| Pressure (mean) (MPa)            | 0.041                     |
| Pressure (max) (MPa)             | 0.055                     |
| Pressure (min) (MPa)             | 0.023                     |
| Start date-time                  | 2016/05/31 15:03:00       |
| End date-time                    | 2016/06/03 10:00:00       |
| Measurement report               | <null>                    |

Identified 1 feature

# Contents

## 2. Operation to browse ArcGIS data

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## Making color-coded map(1)

### ■ Displaying categorized symbols

Table Of Contents

- Building
- Shape of House
- Pressure measurement
- Flowrate measurement
- Join\_Output
- Elevation point
- Valve
- (JICA\_TA)PlanningPipe
- (JICA\_TA)ExistingPipe
- ホイノ\_160310\_GPXtoFeatures
- ホイノ\_160309\_GPXtoFeatures
- (JICA\_TA)Road(2016-)
- (Image) Field\_survey
- (YCDC)Yankin AirPhoto(Google)
- PilotArea
- (YCDC)Railways
- (YCDC)Pipeline
- (YCDC)Water Body
- DMA
- (YCDC)Road
- Ward
- (YCDC)Township
- (MINU)Township
- Street Map
- Air Photo
- (ASTER)Elevation
- Elevation

① Double-click the target layer

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# Making color-coded map(2)

② Select "Symbology" tab

③ Click "Unique values" of Categories

④ Select the target attribute item

⑤ Click "Add All Values"

| Symbol                              | Value              | Label      | Count |
|-------------------------------------|--------------------|------------|-------|
| <input checked="" type="checkbox"/> | <all other values> | <その他の値すべて> |       |

OK キャンセル 適用(A)

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# Making color-coded map(3)

All values are automatically selected

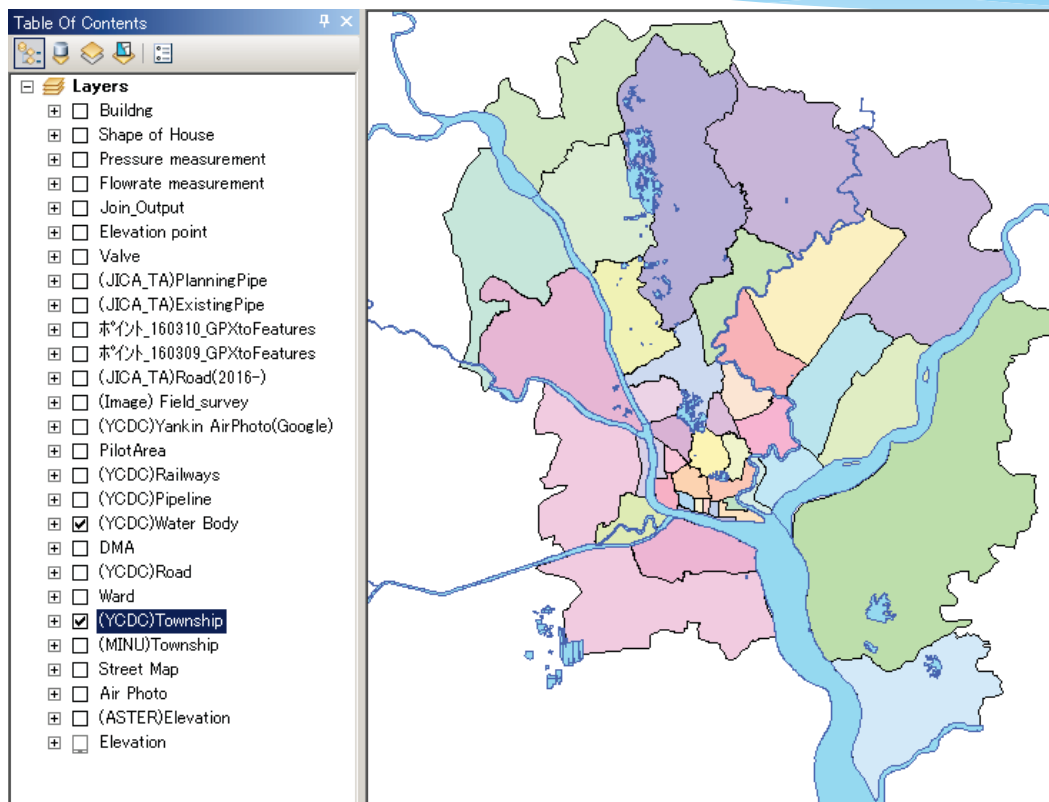
⑥ Click "OK"

| Symbol                              | Value              | Label         | Count |
|-------------------------------------|--------------------|---------------|-------|
| <input checked="" type="checkbox"/> | <all other values> | <その他の値すべて>    | 0     |
| <b>&lt;Heading&gt;</b>              |                    |               |       |
| <b>TS_NAME</b>                      |                    |               |       |
| <b>39</b>                           |                    |               |       |
|                                     | Ahlonge            | Ahlonge       | 1     |
|                                     | Bahan              | Bahan         | 1     |
|                                     | Botah taung        | Botah taung   | 1     |
|                                     | Dagon              | Dagon         | 1     |
|                                     | Dagon Seikkan      | Dagon Seikkan | 1     |
|                                     | Dala               | Dala          | 1     |
|                                     | Dawbon             | Dawbon        | 1     |

OK キャンセル 適用(A)

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# Making color-coded map(3)



The color-coded map is automatically displayed

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## 2. Operation to browse ArcGIS data

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# Printing of the map(1)

This screenshot shows a map layout titled "Classification map of EDWS's customers" with a date of 2016/09/21. The map is enclosed in a data frame. A north arrow is located in the bottom-left corner. A scale bar at the bottom indicates a scale of 1:2,500, with markings for 0, 50, 100, 150, and 200 meters. A legend in the bottom-right corner identifies symbols for Buildings (yellow), Water Sources (blue), Tubewells (green), and Suspended areas (red), as well as Existing Pipes with diameters of 38, 50, 75, and 100. An overview map in the bottom-left shows the location of the main map area within a larger region including Mayangone, South Okkalapa, Yankin, Thingangyun, Bohan, and Tarmwe. Logos for the organization are visible in the bottom-right corner.

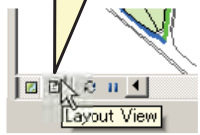
Callouts point to the following elements:

- Title of the map
- Data frame
- North Arrow
- Guide map
- Dynamic text
- Scale
- Scale bar
- Legend
- Logo

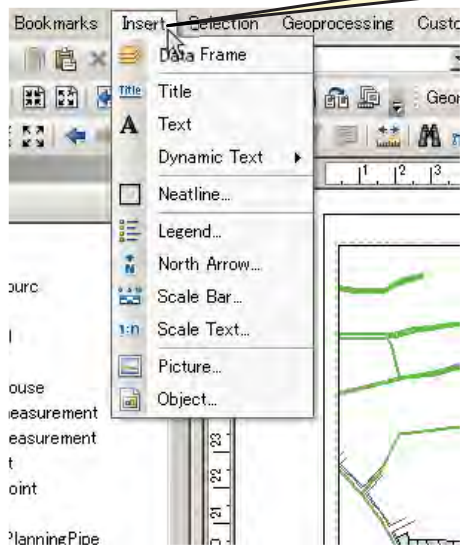
# Printing of the map(2)

## Using "Insert" function

① Click "Layout view" to toggle between data view and layout view



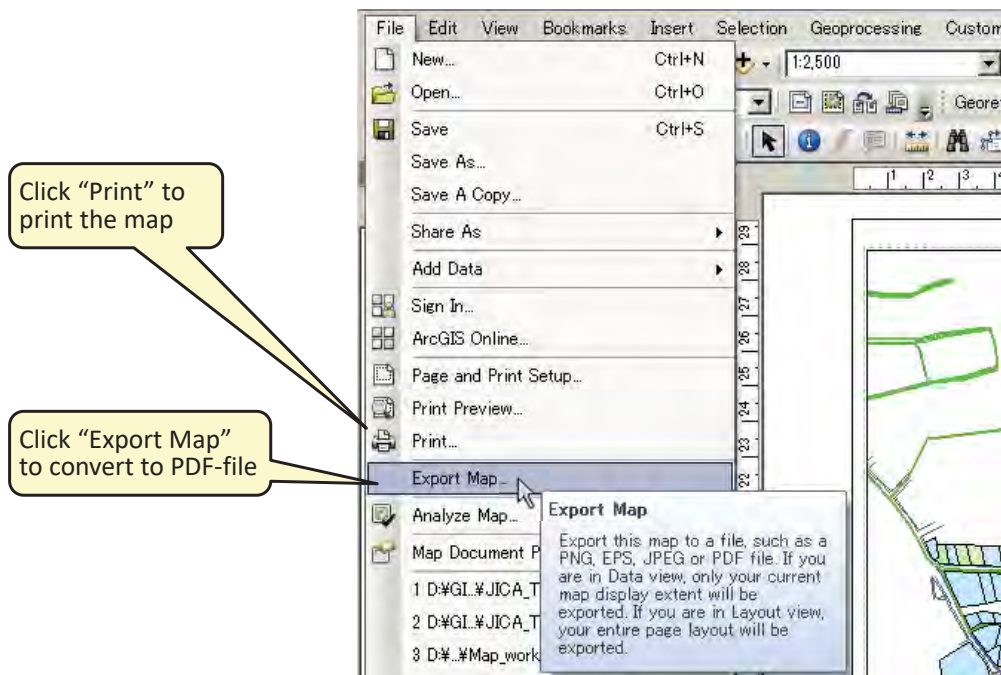
② Select "Insert" menu



You can insert the title, optional text, dynamic text (ex. the date), Legend, north-arrow, scale, picture (ex. overview-map and logo) to the map for printout.

# Printing of the map(3)

## ■ Printing and exporting the map



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# Contents

## 3. Operation to edit ArcGIS data

3-1. Drawing of shape

3-2. Editing of attribute table

3-3. Handling of image data

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# Contents

## 3-1. Drawing of shape

1) How to add a new feature.

2) How to create a new feature class.

3) Useful tips for editing

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# How to add a new feature(1)

## ■ Specifying the target layer for editing

① Click "Start Editing" in Editor tool bar

② Click "Create Features" tab

③ Click the target layer for editing

④ Click shape-type for editing

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# How to add a new feature(2)

## ■ Adding a new feature

⑤ Click position of the new feature

⑥ After the editing work, click "Save Edits"

⑦ Click "Stop Editing"

The editing work is finished

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# Contents

## 3-1. Drawing of shape

1) How to add a new feature.

2) How to create a new feature class.

3) Useful tips for editing

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# How to create a new feature class(1)

## ■ Making a new feature class in the existing DB

The screenshot shows the ArcGIS Catalog window with the following elements:

- Location:** YCDC Geodatabase.gdb
- Tree View:** Shows a hierarchy of folders including Home - GIS DataBase#Yankin, Folder Connections, C:\tmp, D:\ArcGIS#, D:\GIS DataBase, Yankin, gpx, and YCDC Geodatabase.gdb. The 'YCDC Geodatabase.gdb' folder is selected and right-clicked.
- Context Menu:** A right-click context menu is open over the selected folder. The 'New' option is selected, and a sub-menu is displayed with 'Feature Class...' highlighted.
- Feature Class Dialog:** A dialog box titled 'New Feature Class' is open, showing the 'Create a new standalone feature class or a new feature class in this feature dataset.' option.

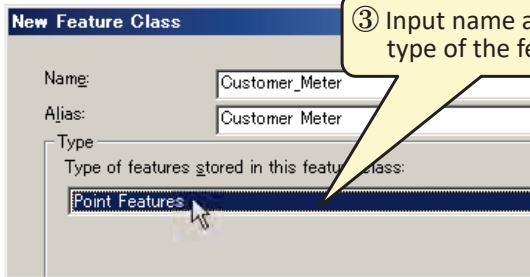
Two callout boxes provide instructions:

- ① Right-click the existing DB in the catalog window
- ② Click "Feature Class" of "New" menu

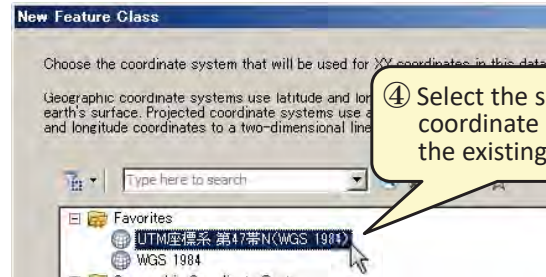
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# How to create a new feature class(2)

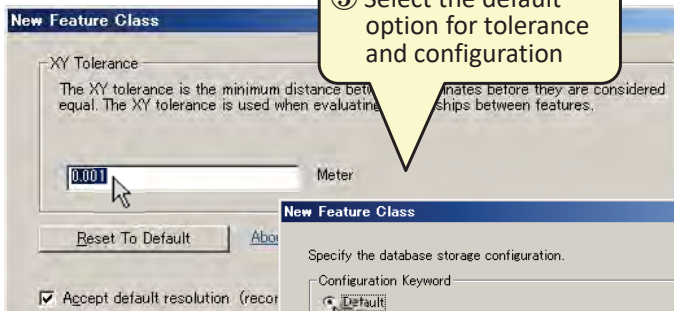
## Setting of type, coordinate system and attribute items of the content



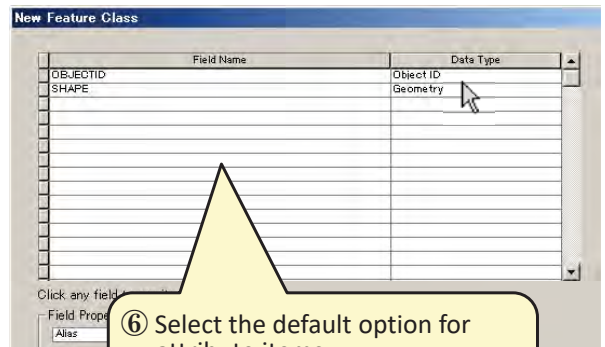
③ Input name and select type of the feature class



④ Select the same coordinate system as the existing layers



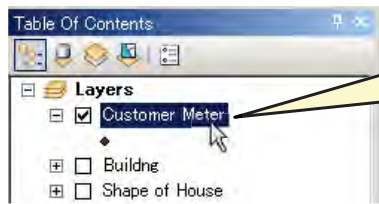
⑤ Select the default option for tolerance and configuration



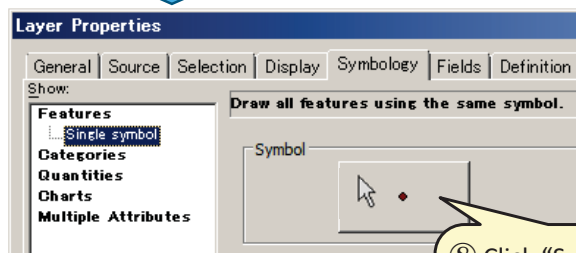
⑥ Select the default option for attribute items. You can add items after feature has been made.

# How to create a new feature class(3)

## Setting for symbol



⑦ Right-click the new feature class in "Table of Contents"

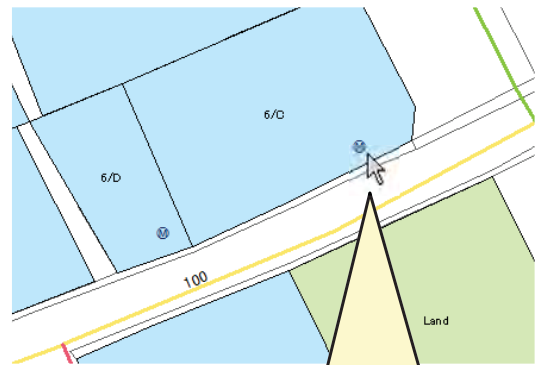


⑧ Click "Symbology" tab of "Layer Properties" and customize the symbol.



⑨ New symbol was set.

## Adding a new feature



You can add a new feature similarly as to how you did with 3-1-1) "How to add a new feature".

# Contents

## 3-1. Drawing of shape

- 1) How to add a new feature.
- 2) How to create a new feature class.

### 3) Useful tips for editing

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# Contents

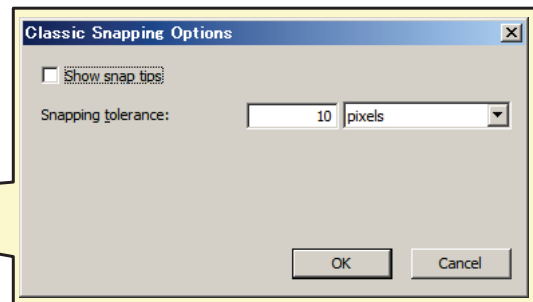
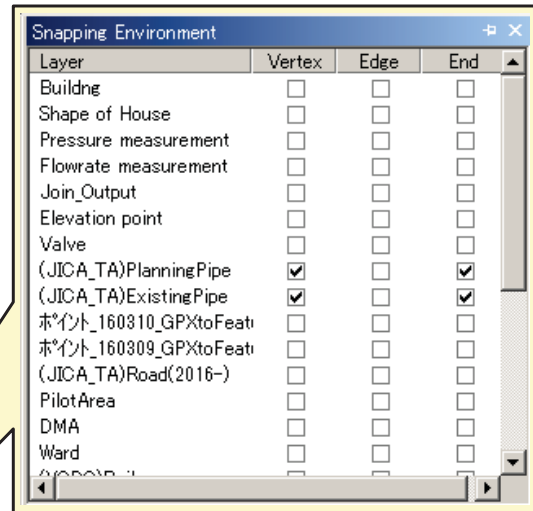
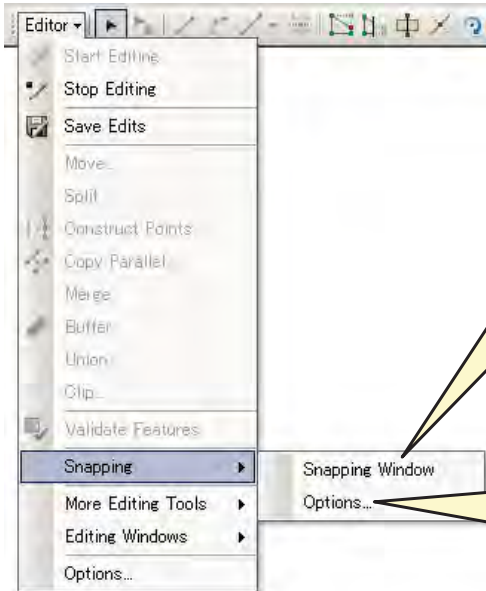
## 3) Useful tips for editing

- a) Snapping
- b) Reshaping a feature
- c) Split tool for line and cut polygons tool
- d) Creating adjoining polygons
- f) Keyboard shortcuts

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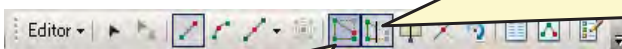
# Tips - a) Snapping

- ✓ For hydraulic analysis, it is important that all pipes are linked end to end.
- ✓ Using the snapping function, let's match an end and an end with the same position exactly.

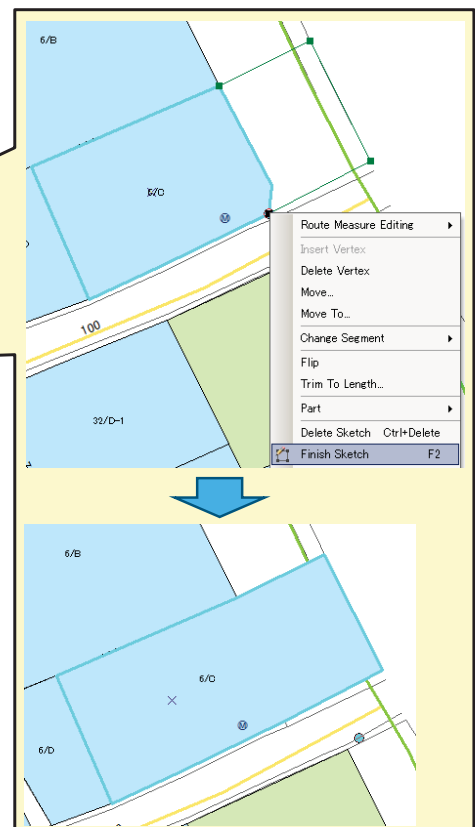
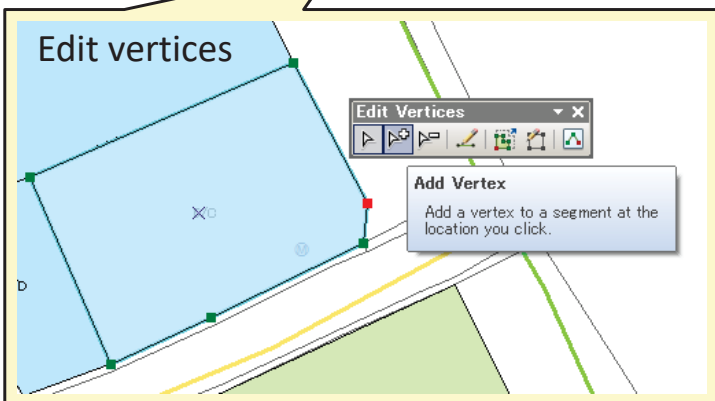


# Tips - b) Reshaping a feature

- ✓ Based on updated information, it is necessary to revise existing data.
- ✓ Using “Edit vertices” and “Reshape feature tool” function, let's reshape the feature.



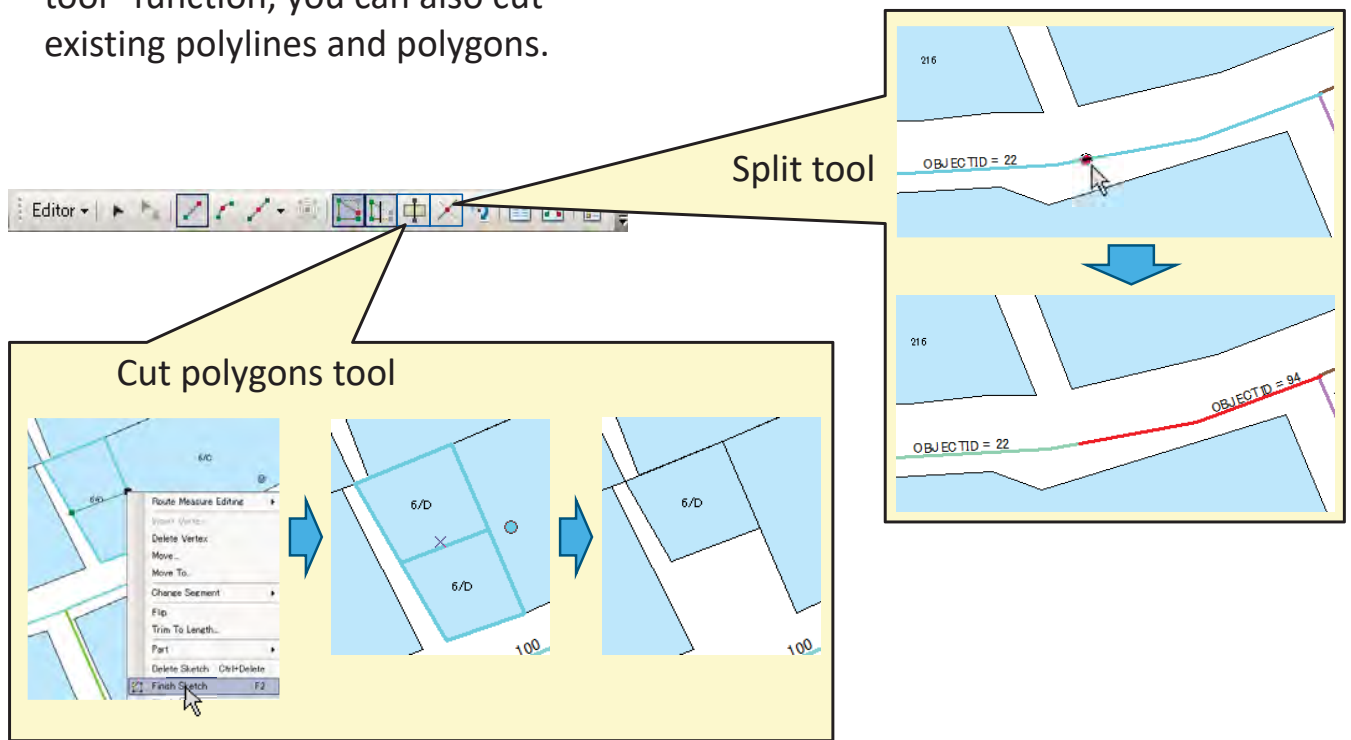
Reshape feature tool





# Tips - c) Split tool for line and cut polygons tool

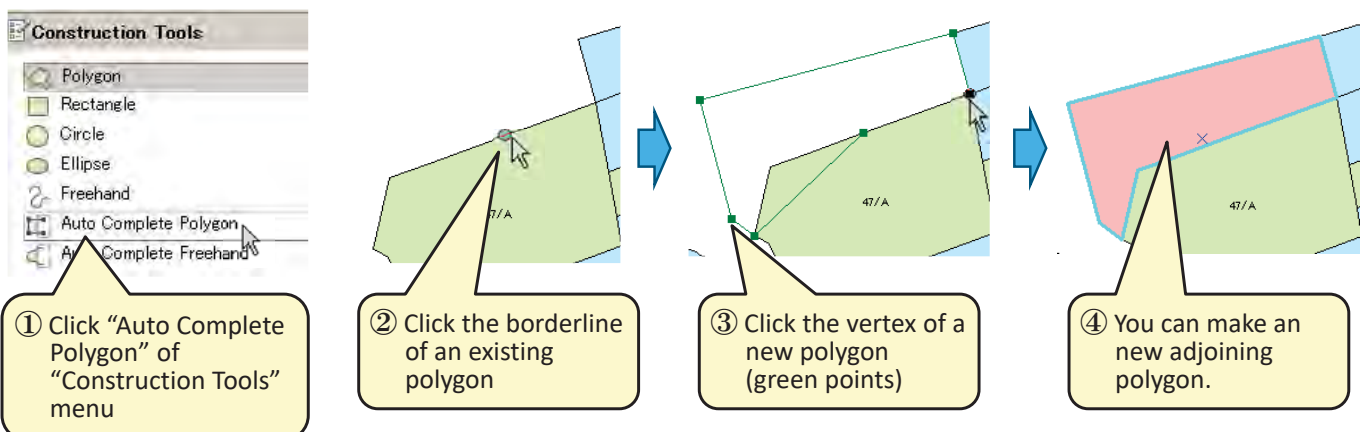
- ✓ Using “Split tool” and “Cut polygons tool” function, you can also cut existing polylines and polygons.



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# Tips - d) Creating adjoining polygons

- ✓ You often need to create polygons next to one another.
- ✓ Using “Auto Complete Polygon” function, you can make an adjoining polygon.



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## Tips - e) Keyboard shortcuts

### Keyboard shortcuts used frequently

| Shortcut | Command   | Menu                         |
|----------|---|------------------------------|
| Z        | Zoom In   | In data view and layout view |
| X        | Zoom Out  |                              |
| C        | Pan   |                              |
| B        | Continuous Zoom (Drag with mouse button zooms in/out) |                              |
| V        | Display vertices                                      | In editing for features      |
| Esc      | Cancel  | In general                   |
| Ctrl + Z | Undo  |                              |
| Ctrl + Y | Redo  |                              |

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## Contents

### 3. Operation to edit ArcGIS data

3-1. Drawing of shape

3-2. Editing of attribute table

3-3. Handling of image data

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# Contents

## 3-2. Editing of attribute table

1) How to input data to the table

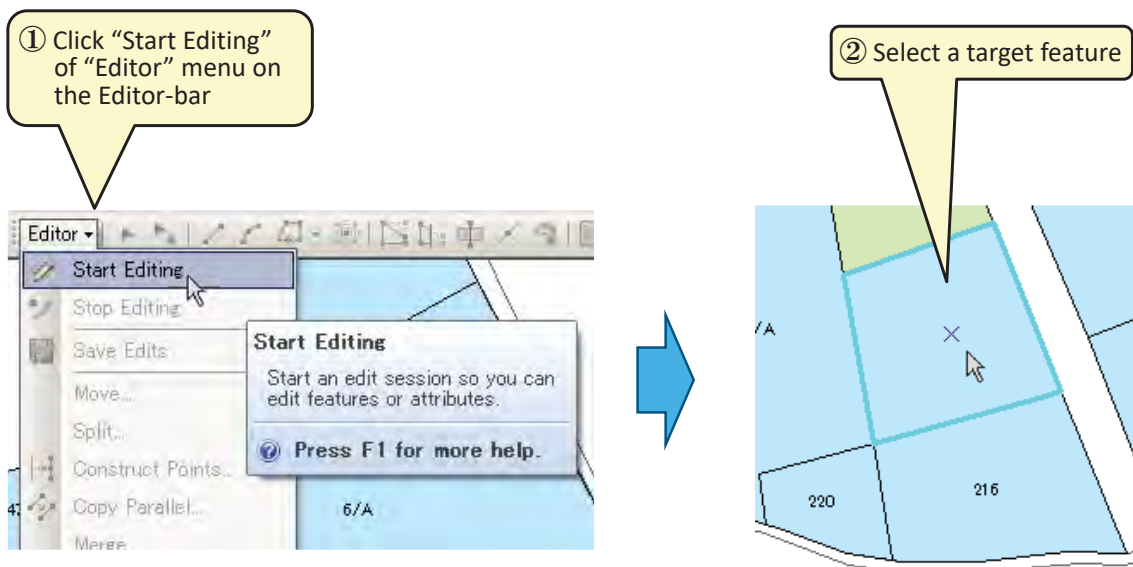
2) How to create a new field in the table

3) How to add geometric information to the table

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## How to input data to the table(1)

### Selecting a target feature in editing mode



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# How to input data to the table(2)

## Inputting data on the attribute window

③ Click "Attribute" icon on the Editor-bar

④ Input data to "Attribute" window

New attribute datum was added.

| OBJECTID_1  | 85                |
|-------------|-------------------|
| OBJECTID    | 86                |
| CustomerID  | 181300569         |
| HouseNo     | 217               |
| WaterSource | ycd               |
| SHAPE_Leng  | 44.185038         |
| Address     | Shwe Yin Mar      |
| Owner       | U Naing Htun Aung |
| Tariff_Con  |                   |
| WS_Code     | 0                 |
| NotFound    | 1                 |

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# Contents

## 3-2. Editing of attribute table

1) How to input data to the table

2) How to create a new field in the table

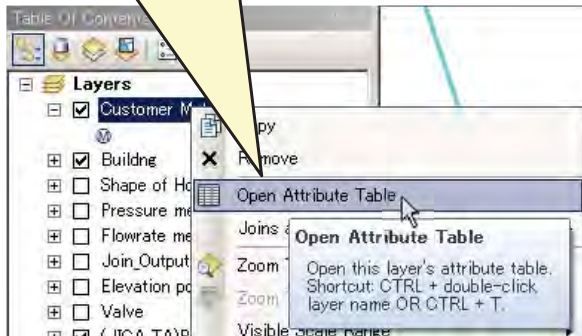
3) How to add geometric information to the table

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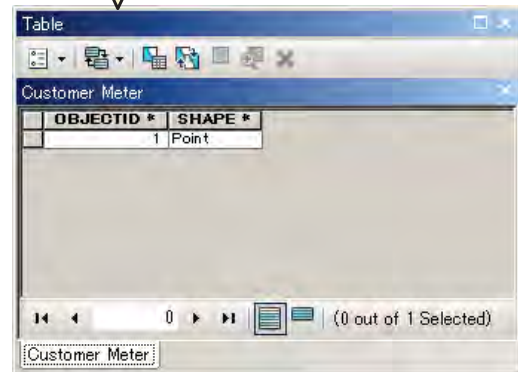
# How to create a new field in the table(1)

## Opening the attribute table of the target feature

① Right-click the target layer of "Table of Contents" and click "Open Attribute Table"



The target table was opened.

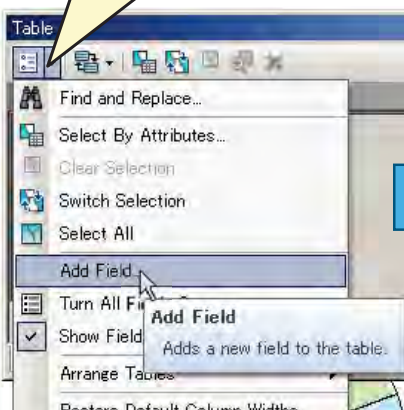


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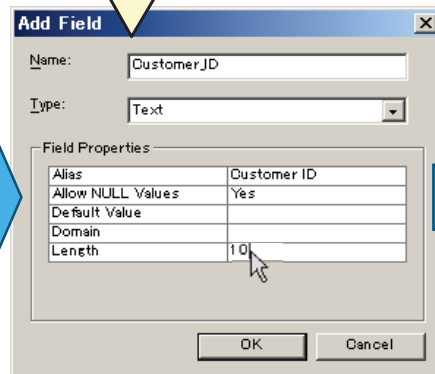
# How to create a new field in the table(2)

## Selecting a target feature in editing mode

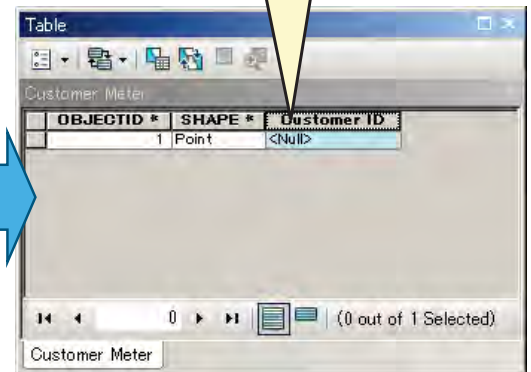
② Click "Table Option" icon on the Table menu and select "Add Field" menu



③ Setting of Name, type and properties of the new field



The new field was added.



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# Contents

## 3-2. Editing of attribute table

1) How to input data to the table

2) How to create a new field in the table

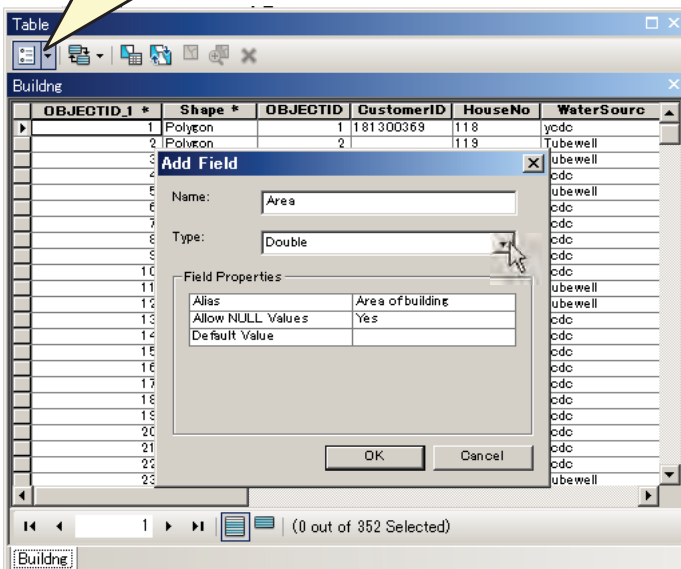
3) How to add geometric information to the table

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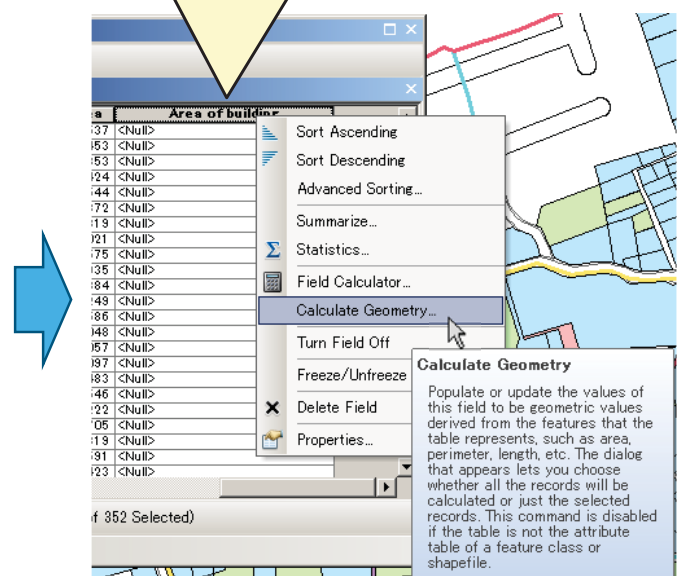
## How to add geometric information to the table(1)

### ■ Creating a new field for geometric information

① Create a new field as the previous page



② Right-click the new field-name and select "Calculate Geometry" menu.



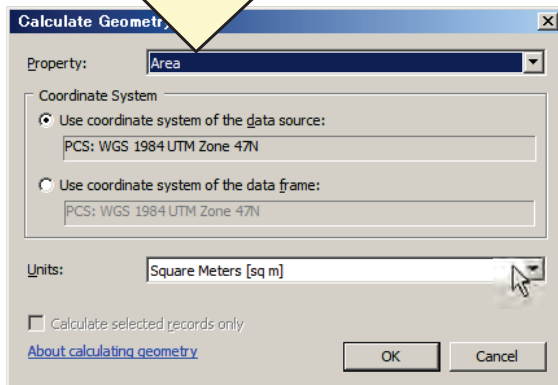
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# How to add geometric information to the table(2)

## Calculating the geometric data

① Select geometric type and unit on "Calculate Geometry" window



The geometric data were added in the new field.

Table

Building

| WS_Code | Notfound | Shape_Length | Shape_Area | Area of building |
|---------|----------|--------------|------------|------------------|
| 0       | 0        | 41.063408    | 95.134637  | 95.134637        |
| 1       | 1        | 44.45091     | 114.675453 | 114.675453       |
| 1       | 1        | 49.200336    | 142.708853 | 142.708853       |
| 0       | 1        | 53.887148    | 176.651424 | 176.651424       |
| 1       | 0        | 48.001022    | 137.171644 | 137.171644       |
| 0       | 0        | 45.569639    | 122.954872 | 122.954872       |
| 0       | 0        | 58.123739    | 209.300819 | 209.300819       |
| 0       | 0        | 57.000843    | 204.385021 | 204.385021       |
| 0       | 1        | 67.240959    | 279.504575 | 279.504575       |
| 0       | 0        | 88.471985    | 282.303935 | 282.303935       |
| 1       | 1        | 64.542224    | 252.523384 | 252.523384       |
| 1       | 1        | 63.407665    | 246.724249 | 246.724249       |
| 1       | 1        | 61.021692    | 232.123586 | 232.123586       |
| 0       | 1        | 102.781003   | 568.099048 | 568.099048       |
| 0       | 1        | 76.707684    | 346.597057 | 346.597057       |
| 0       | 0        | 83.054777    | 370.929087 | 370.929087       |
| 0       | 0        | 65.880698    | 234.929483 | 234.929483       |
| 0       | 0        | 26.344187    | 40.906546  | 40.906546        |
| 0       | 1        | 45.276364    | 121.504222 | 121.504222       |
| 0       | 1        | 71.893621    | 318.203705 | 318.203705       |
| 0       | 0        | 47.370736    | 124.744819 | 124.744819       |
| 0       | 0        | 74.920336    | 347.266591 | 347.266591       |
| 1       | 1        | 100.629074   | 609.035423 | 609.035423       |

(0 out of 352 Selected)

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# Contents

## 3. Operation to edit ArcGIS data

3-1. Drawing of shape

3-2. Editing of attribute table

3-3. Handling of image data

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## 3-3. Handling of image data

1) How to plot a point according to a CSV-file of latitude and longitude.

2) How to plot a GPS logging-data.

3) (Practical work) How to paste and match an image-file for tracing work.

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## How to plot a point according to the CSV-file (1)

Purpose: Creating point-data according to latitude and longitude

[Operation]

STEP 1: Adding the CSV-file

|   | A         | B        |
|---|-----------|----------|
| 1 | longitude | latitude |
| 2 | 96.11486  | 16.84429 |

Add the data into a new layer

Select the csv-file

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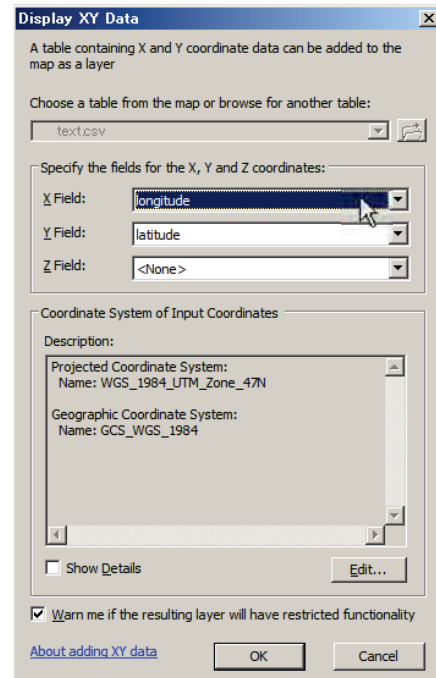
# How to plot a point according to the CSV-file (2)

[Operation]

STEP 2: Setting of contents



Select "Display XY Data"



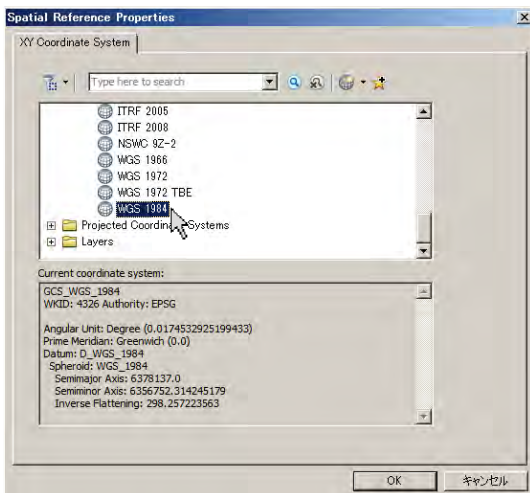
Specify longitude for "X Field" and latitude for "Y Field"

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# How to plot a point according to the CSV-file (3)

[Operation]

STEP 3: Display the point according to the lat/long-data



Specify the coordinate system



The point is automatically displayed

For details to p.1 ~ P.3 of "Arc GIS Operation Manual(Image-Matching)".

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# Contents

## 3-3. Handling of image data

1) How to plot a point according to a CSV-file of latitude and longitude.

2) How to plot a GPS logging-data.

3) (Practical work) How to paste and match an image-file for tracing work.

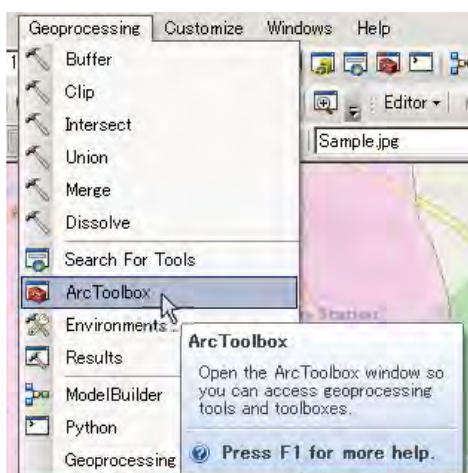
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## How to plot a GPS logging-data

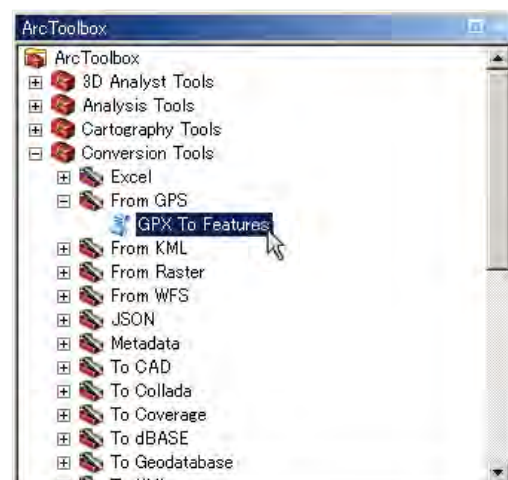
Purpose: Creating point-data according to GPS logging-data

[Operation]

STEP 1: Selecting "Conversion Tools"



Select "Geoprocessing" menu  
-> "Arc Toolbox"



Select "Conversion Tools" -> "From  
GPS" -> "GPX To Features"

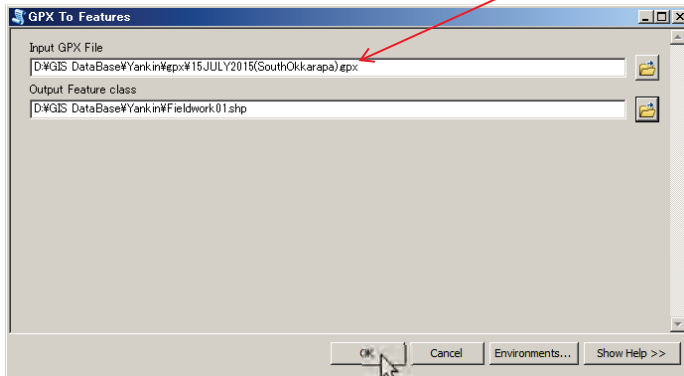
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# How to plot a point according to the CSV-file (3)

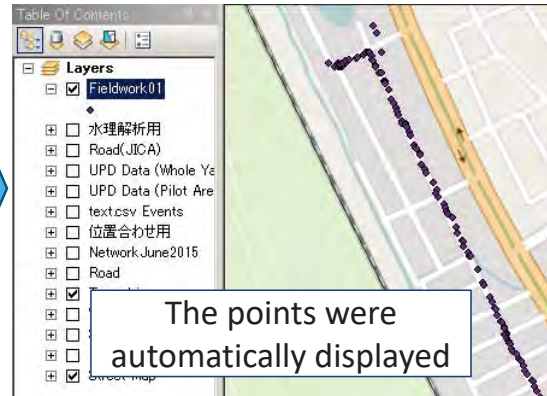
[Operation]

STEP 2: Converting gpx-data into feature

```
15JULY2015(SouthOkkarapa).gpx
1 <?xml version="1.0" encoding="UTF-8" standalone="no" ?>
2 s:spx="http://www.garmin.com/xmlschemas/GpxExtens
3 aypointExtension/v1" xmlns:spx="http://www.gar
4 10J" version="1.1" xmlns:xsi="http://www.w3.org
5 opografix.com/GPX/1/1 http://www.topografix.com/
6 ions/v3 http://www8.garmin.com/xmlschemas/GpxExt
7 ension/v1 http://www8.garmin.com/xmlschemas/Wayp
8 PointExtension/v1 http://www.garmin.com/xmlschen
9 /www.garmin.com" <text>Garmin International</te
10 <name>15-07-15 16:58:18</name><extensions><spx:
11 <spx:TrackExtension></extensions><trkseg><trk
12 <time>2015-07-09T05:22:11Z</time><extensions><sr
13 x:TrackPointExtension></extensions><trkpt><trk
14 <time>2015-07-09T05:22:24Z</time><extensions><sr
15 x:TrackPointExtension></extensions><trkpt><trk
16 <time>2015-07-09T05:22:50Z</time><extensions><sr
17 x:TrackPointExtension></extensions><trkpt><trk
18 <time>2015-07-09T05:23:18Z</time><extension
```



Specify the coordinate system



For details to p.4~P.7 of "Arc GIS Operation Manual(Image-Matching)".

## Contents

### 3-3. Handling of image data

1) How to plot a point according to a CSV-file of latitude and longitude.

2) How to plot a GPS logging-data.

3) (*Practical work*) How to paste and match an image-file for tracing work.

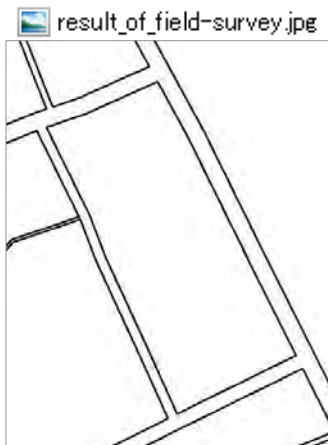


# How to paste and match an image-file(1)

Purpose: Pasting a field-survey drawing for tracing work

[Operation]

STEP 1: Prepare an image-file as the result of field survey and plot preliminarily reference points for matching.



(Sample)



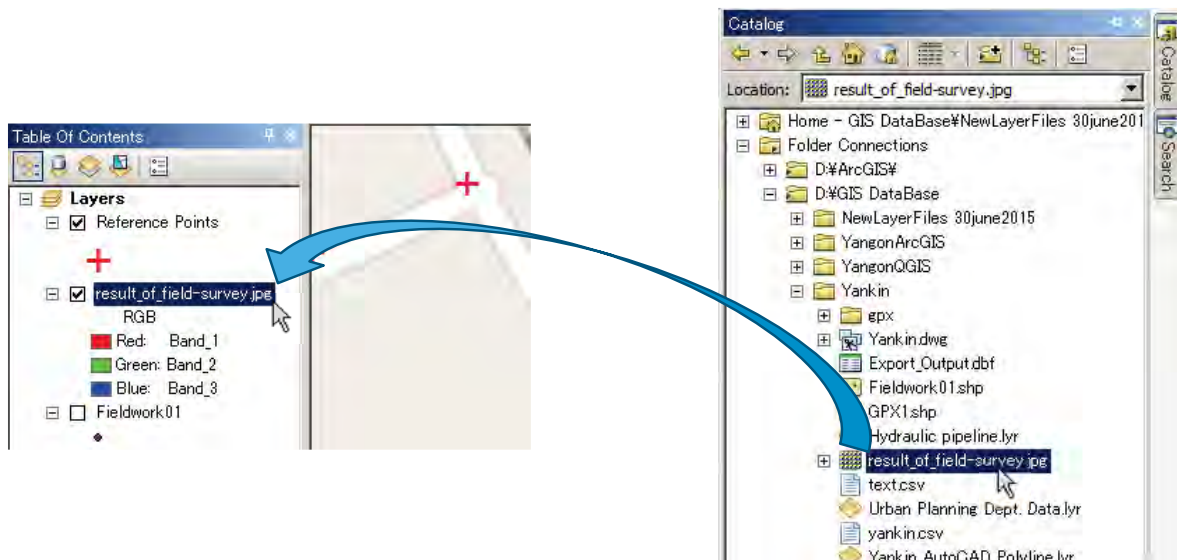
(Sample) Ref: "How to plot a GPS logging-data."

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# How to paste and match an image-file(2)

[Operation]

STEP 2: Drag the image-file in "Catalog" window and drop it on "Table Of Contents" window.



Please store preliminarily the image-file into the GIS DB folder.

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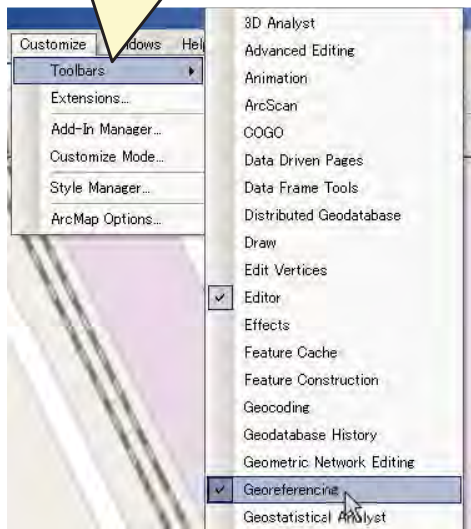


# How to paste and match an image-file(3)

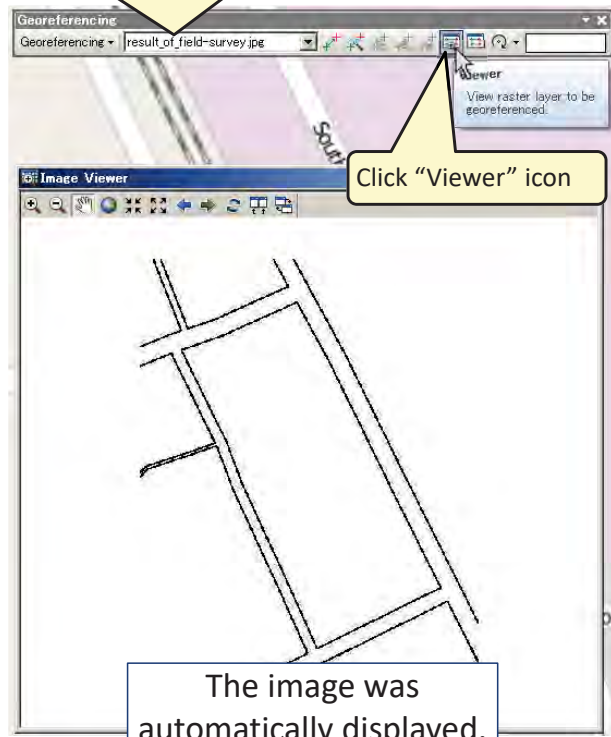
[Operation]

STEP 3: Display the image-file

Select "Customize" menu -> "Toolbars"  
-> "Georeferencing"



Select layer's name of the image-file



Click "Viewer" icon

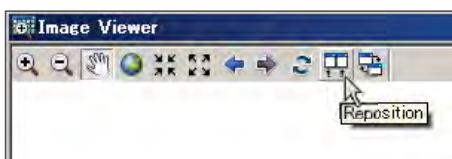
The image was automatically displayed.

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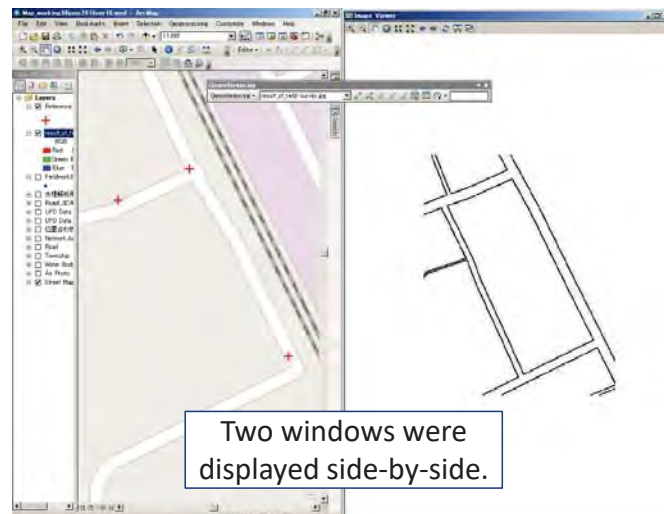
# How to paste and match an image-file(4)

[Operation]

STEP 4: Match the reference points and the image roughly by hand



Click "Reposition" icon on  
"Image Viewer" window



Two windows were  
displayed side-by-side.

Please match the left-right image roughly by hand.

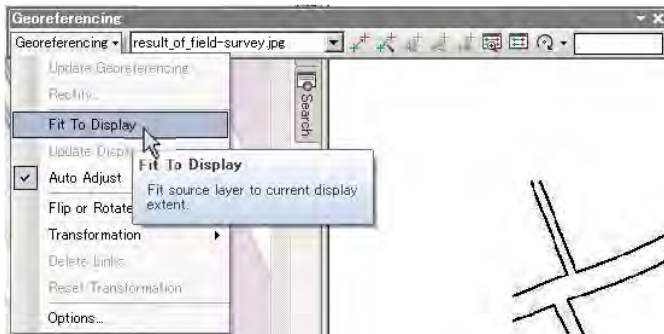
By the later processing, you can automatically match these layers. However, please match the left-right image roughly by hand in the above figure to facilitate the later processing.

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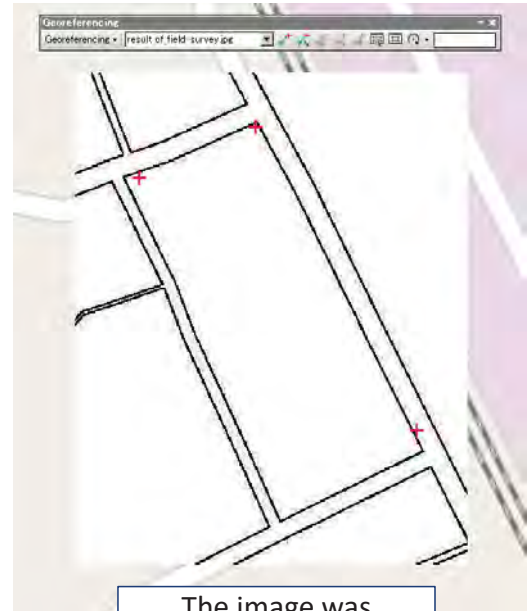
# How to paste and match an image-file(5)

[Operation]

STEP 5: Fit the image to display automatically



Select "Fit To Display" menu in "Georeferencing" pull-down menu of "Georeferencing" toolbar

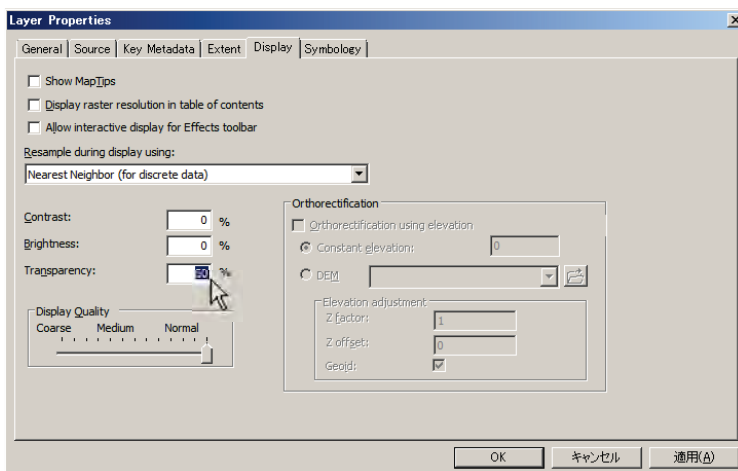


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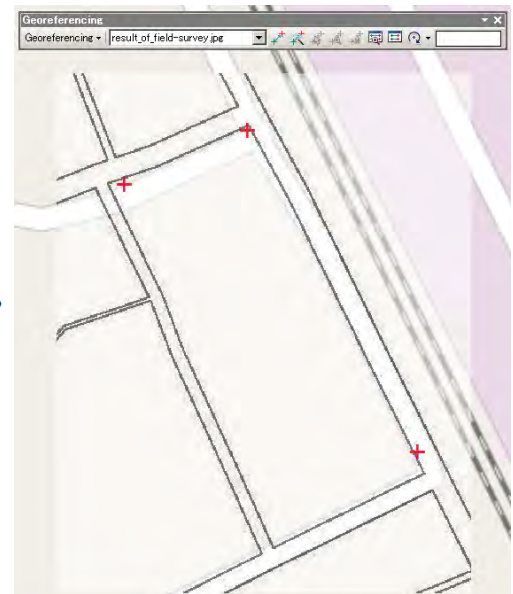
# How to paste and match an image-file(6)

[Operation]

STEP 6: (If needed,) Make semi-transparent to the image layer



Type in 50 for "Transparency" of "Display" tab of "Layer Properties" window of the image-file layer



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# How to paste and match an image-file(7-1)

[Operation]

STEP 7: Match the image-position with the reference points

- ① Click on “Add Control Points” icon on the “Georeferencing” toolbar



- ② First click the reference position on the image layer, then click the reference point



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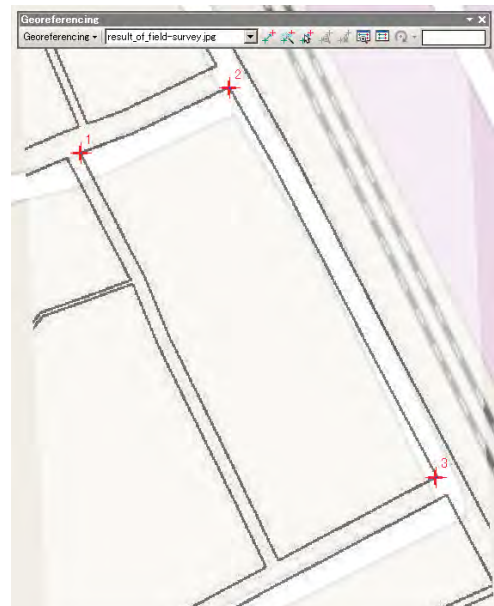
# How to paste and match an image-file(7-2)



- ③ For the other 2 reference points, do the above work.



- ④ Adjusting procedure (Rotate/Shift/Scale) is carried out automatically and the image layer position just fits with the 3 reference points.



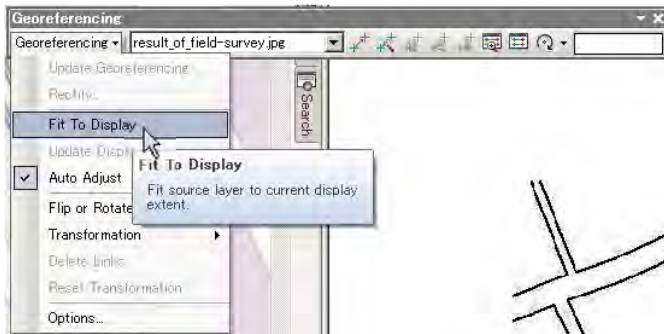
Ref: You can adjust the image layer position by hand also. Please utilize “Rotate/Shift/Scale” function of “Georeferencing” toolbar.

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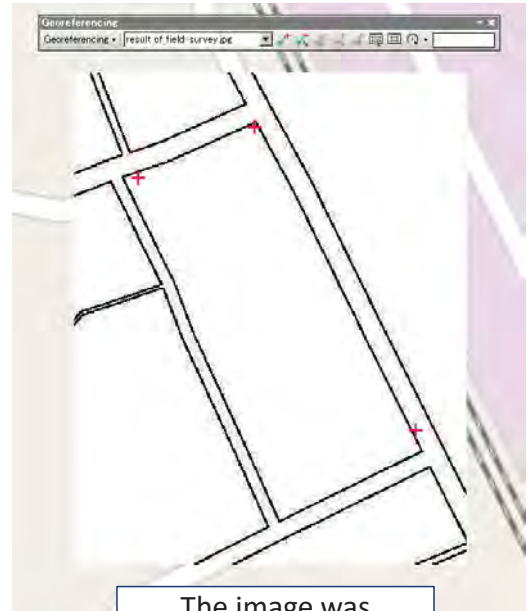
# How to paste and match an image-file(8)

[Operation]

STEP 8: Fit the image to display automatically



Select "Fit To Display" menu in "Georeferencing" pull-down menu of "Georeferencing" toolbar

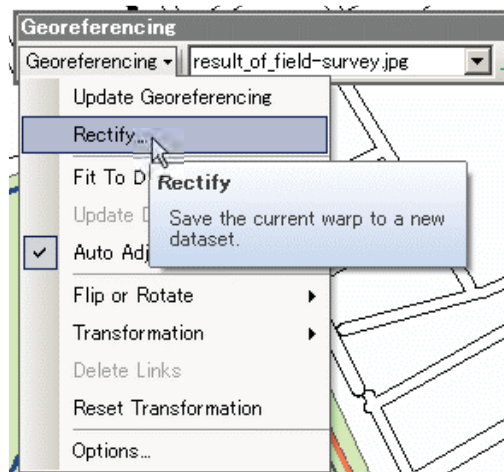


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# How to paste and match an image-file(8)

[Operation]

STEP 8: Save the result of the matching work



Click "Rectify" icon on the Georeferencing toolbar.

For details to p.8~P.18 of "Arc GIS Operation Manual(Image-Matching)".

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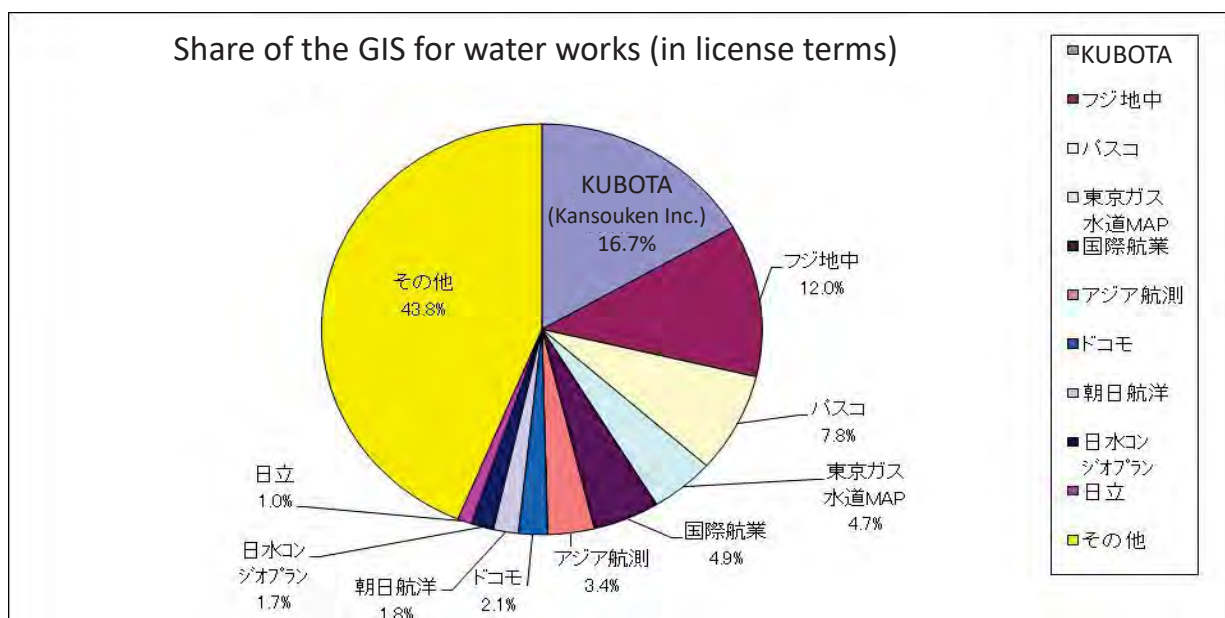
# ကျေးဇူးတင်ပါတယ်

Thank you for your attention



## FYI

There are as many as 20 GIS manufacturers in Japan.  
It is an extremely competitive market, as shown below.



The Project for Improvement of Water Supply Management  
of YCDC

(Technical Assistance Project)

Output Group 2: Non-Revenue Water Management

[GIS Seminar2 ]

## Hydraulic analysis for design of pipeline network

JICA EXPERT  
OUTPUT 2 (NRW),  
S. KISHIDA

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## Contents

1. Basis of hydraulic analysis

2. Operation of data conversion (ArcGIS to EPA-net)

-> *Practical work*

3. Setting up the analysis condition

-> *Practical work*

4. Executing analysis and checking the result

-> *Practical work*

2



# Contents

## 1. Basis of hydraulic analysis

1-1. The significance of pipeline design

1-2. Introduction to pipeline network

1-3. Basis of hydraulic analysis

1-4. *Practical work*

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# Purpose

a) Ideal state of waterworks

1. 24hour water supply

2. Appropriate water pressure

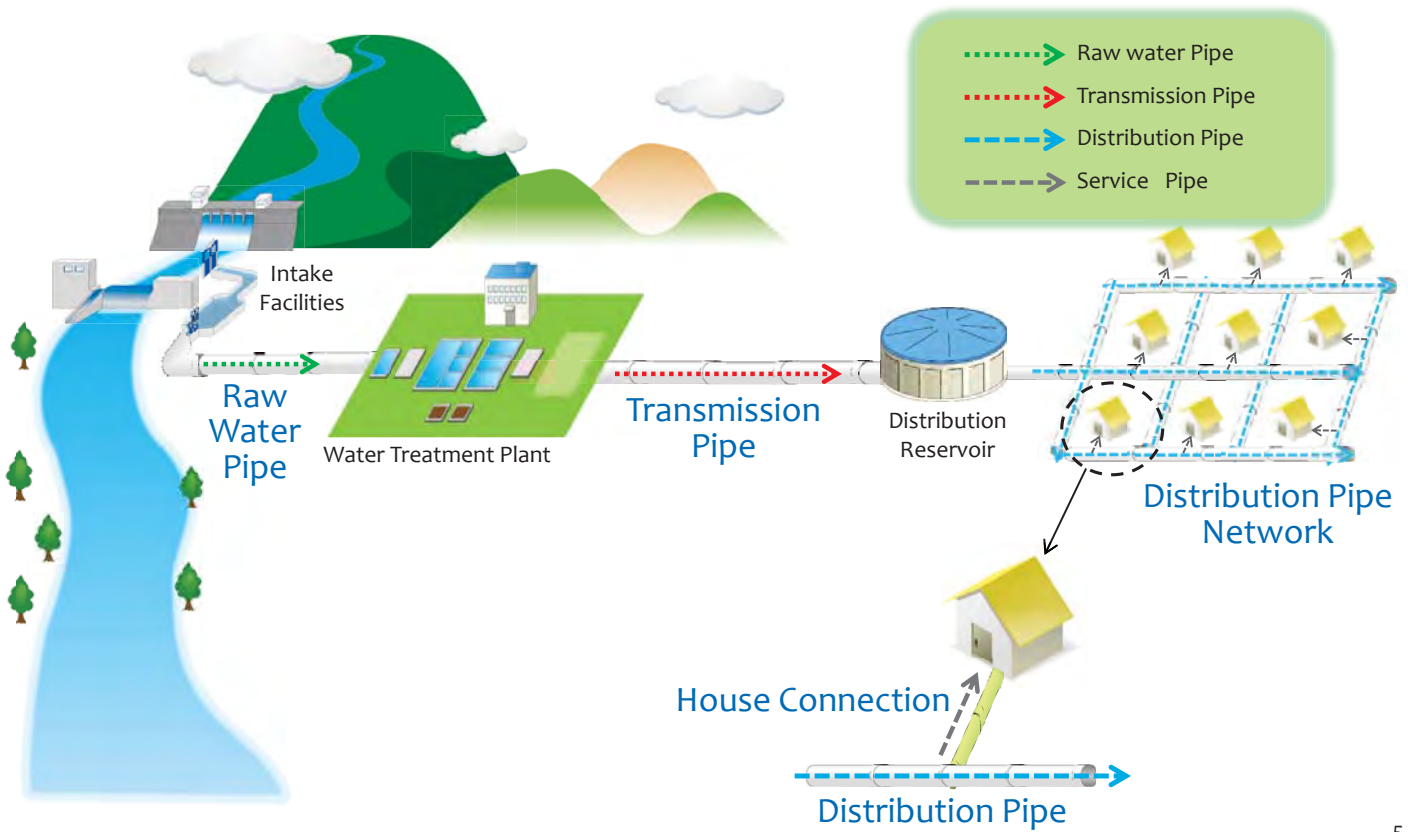
b) EDWS has to make...

1. Suitable planning

2. Suitable design

4

# Pipes in Waterworks



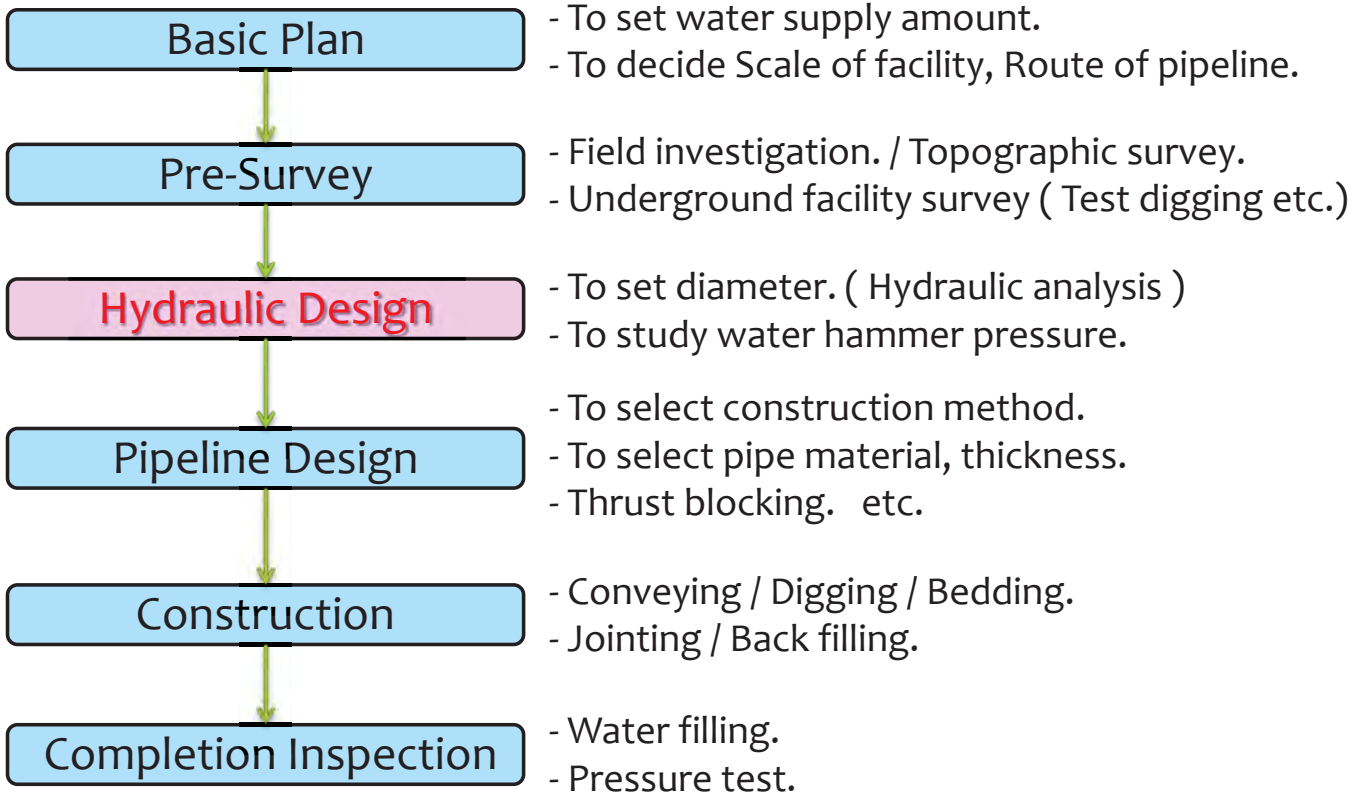
5

# To establish reliable facility



6

# Procedure of pipeline installation



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## Basic Plan

To secure appropriate water supply,

Improvement of pipe diameter & route



Can get suitable water pressure

**EDWS engineers should understand how to calculate pipe diameter**

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# Contents

## 1. Basis of hydraulic analysis

1-1. The significance of pipeline design

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1-3. Basis of hydraulic analysis

1-4. *Practical work*

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## 1-2. Introduction to pipeline network

(1) Transmission Pipe

(2) Service reservoir

(3) Distribution pipe-network

① Distribution trunk main and distribution sub-main

② Appropriate pipe-material

->Criteria for pipe and characteristic by material

③ Adequate pressure

->Criteria in Japan and guideline tentatively adopted in this seminar

④ Suitable diameter

⑤ Ideal network-form

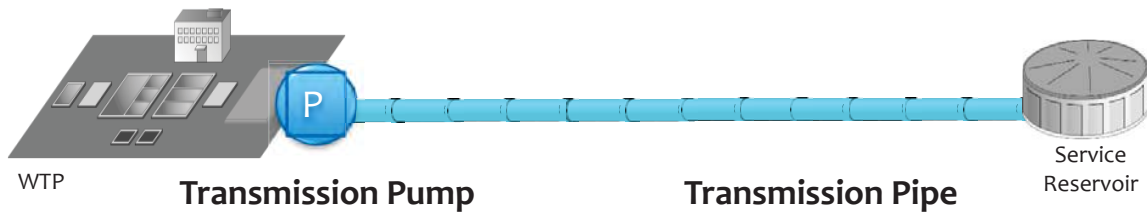
⑥ Ancillary Facilities

(4) Pipe design for installation works

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# (1) Transmission Pipe

Transmission pipe is the facilities which supply water from the water treatment plant to the service reservoir.

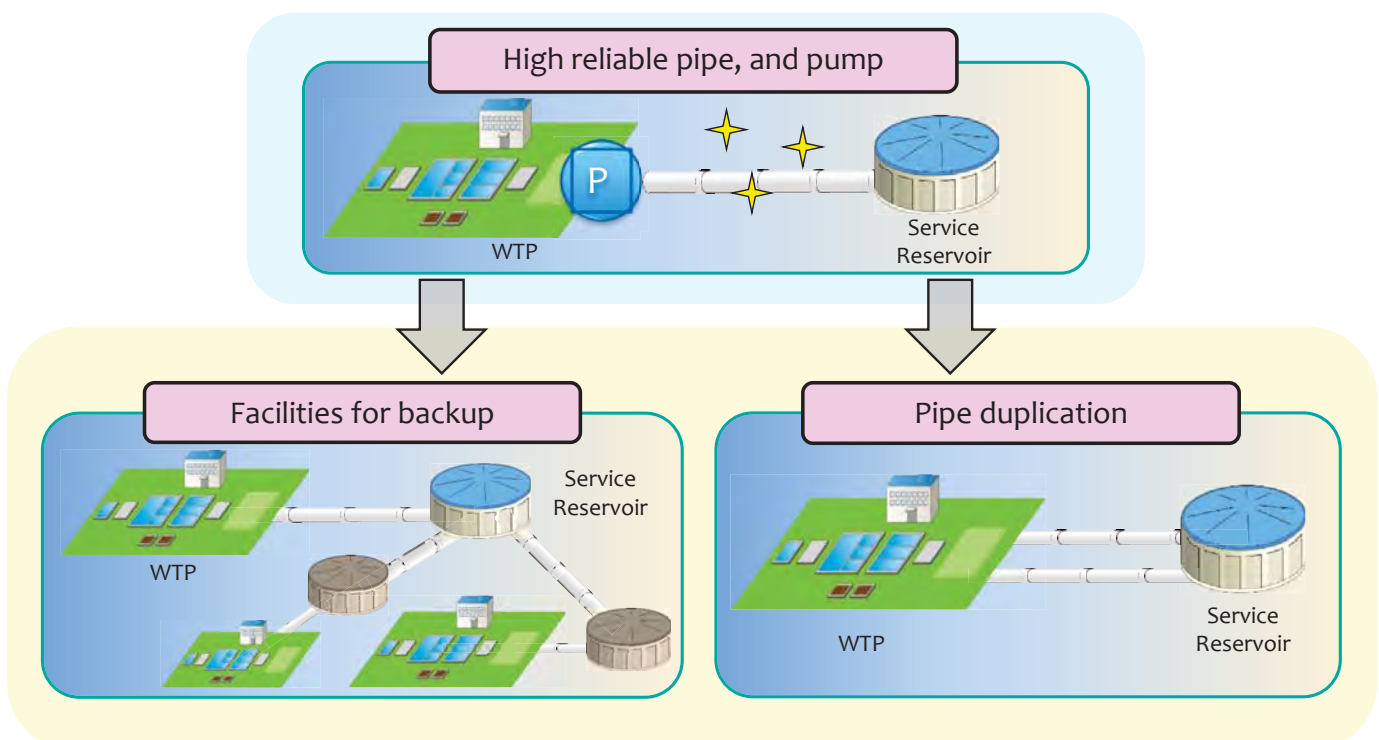


Transmission pump have to keep running 24h × 7days.

The accident on transmission facilities is **absolutely not allowed**.

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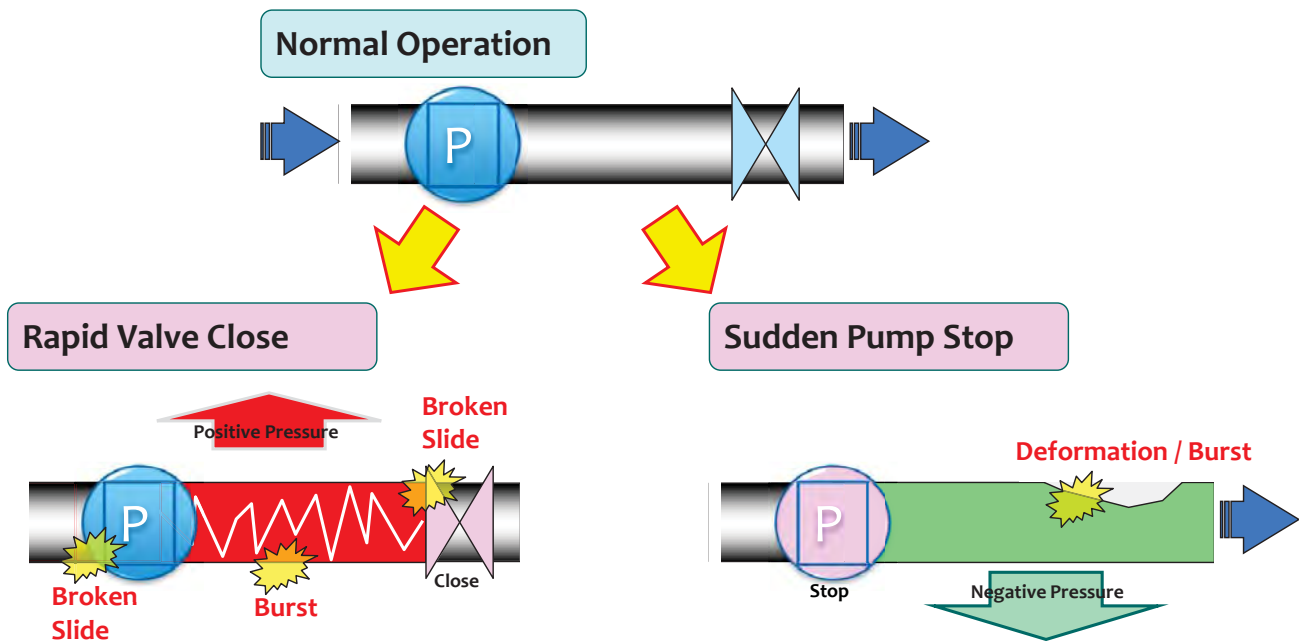
# Ideal transmission facility



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# CAUTION: Water-Hammer

Transmission pipe is often damaged by Water-Hammer.



Countermeasure;  
- Installation of surge tanks  
- Utilization of pumps with flywheel

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## (2) Service Reservoir

“Reservoir” is set to reserve water including correspond to movement of hourly distribution volume and adjusting for abnormal time like water suspension.

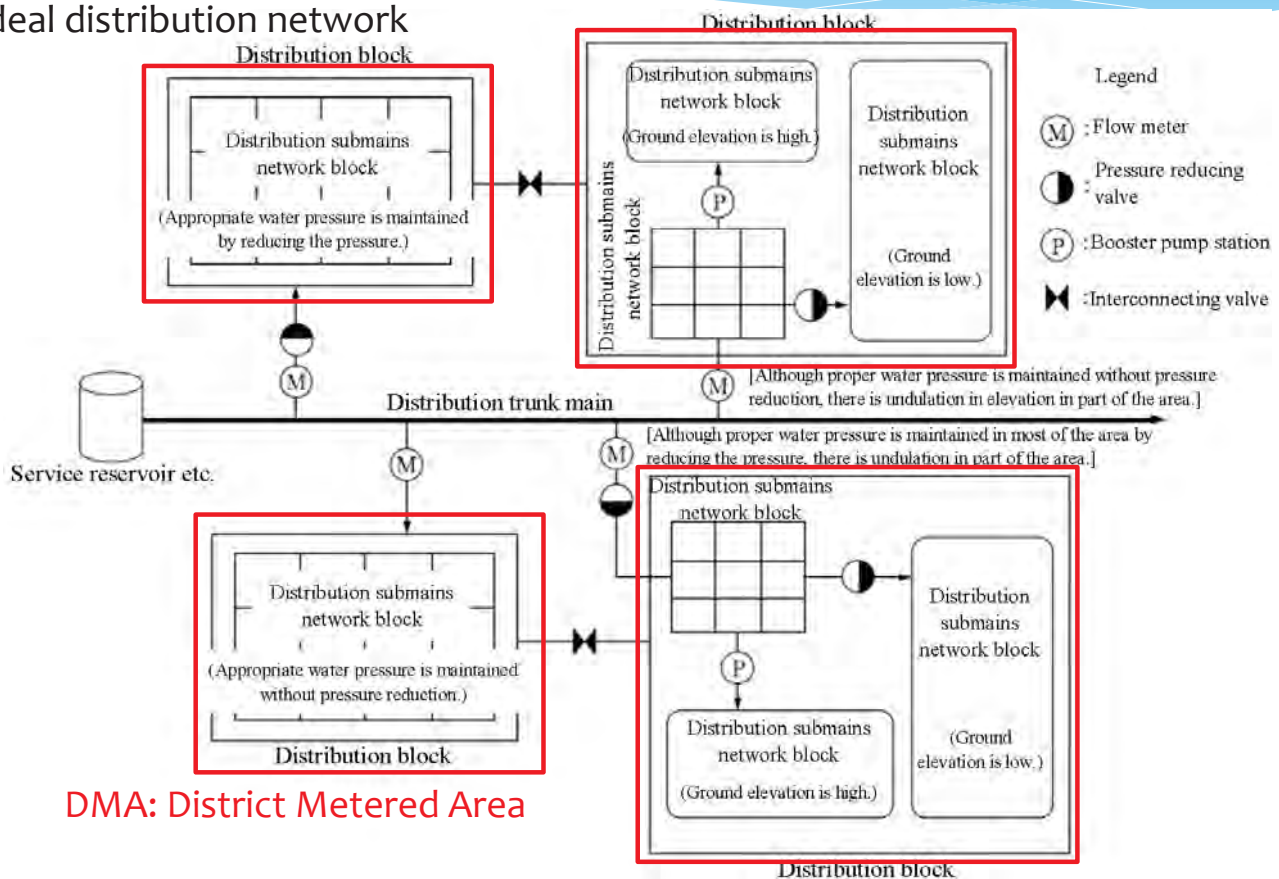
The standard capacity is designed by 8-12 hours of planned daily maximum water supply amount. One of the spec of reservoir is keeping potential energy with keeping water level.

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# (3) Distribution Network

## Ideal distribution network



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## ① Distribution trunk main and distribution sub-main

Distribution pipe is the pipe which supply water from the service reservoir to the service mains connection branch.

Distribution Network consists distribution trunk main and distribution sub main.

Distribution trunk main is backbone of the network, assumes a large role in water supply in the network.

Distribution sub main is the pipe which supply water from the distribution trunk main to the service connection branch, laid to front of customer's house.

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## ② Appropriate material for distribution pipe



Pipe material of distribution mains shall basically be in conformity with the following:

1. Pipe material, with which no risk of water contamination is brought about
2. It is safe against inside pressure and external forces.
3. It conforms to the burial condition.
4. It possesses good property of laying which conforms to the environment of burial.

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## Pipe materials

※Red Character : Situation or standard in Japan

| Material    | Concrete pipe   | Ductile Iron Pipe (DIP)   | Mild Steel Pipe (MS)  | HDPE   | GRP (Glass fiber Reinforced Plastics)   | PVC   |
|-------------|---|---|---|--|---|---|
| Aspect      |  |  |  |  |  |  |
| DN (mm)     | 150 – 3,000<br><b>150 – 3,000</b>   | 80 – 2,600<br><b>75 - 2,600</b>   | 80 – 3,000<br><b>80 - 3,000</b>   | 16 - 2,000<br><b>16 - 200</b>  | 100 - 4,000<br>-  | 18 – 600<br><b>18 - 300</b>   |
| Application | Raw Water   | ✓✓  | ✓✓  | ✓  | ✓   |   |
|             | Transmission  |   | ✓✓  | ✓  | ✓   |   |
|             | Distribution  |   | ✓✓  | ✓✓   | ✓   | ✓✓  |
|             | Service   |   |   | ✓✓   |   | ✓✓  |
| Remarks     | <u>Non-pressure use only</u>  |   |   | Small Diameter   | Poor impact resistance<br>Use for irrigation pipe                                     | Small Diameter  |

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# Characteristics of pipe materials

| Pipe Material                            | Ductile Iron Pipe (DIP) | Mild Steel Pipe (MS) | HDPE           |                | PVC         |             |
|--|-------------------------|----------------------|----------------|----------------|-------------|-------------|
|  |                         |                      | Butt Fusion    | Electro Fusion | TS          | Rubber Ring |
| 1. Toughness                             | Excellent               | Excellent            | Poor           |                | Poor        |             |
| 2. Joint(Pipe ) Flexibility              | Good                    | Poor                 | Excellent      |                | Poor        | Good        |
| 3. Degradation resistant due to sunlight | Good                    | Good                 | Poor           |                | Poor        |             |
| 4. Jointing Work                         | Excellent               | Poor                 | Poor           | Fair           | Poor        | Fair        |
| 5. Bedding and Backfilling               | Good                    | Poor                 | Poor           |                | Poor        |             |
| 5. Leakage occurrence ratio              | Excellent               | Fair                 | No enough data |                | Poor        |             |
| 6. Service Life                          | 60 years                | 30 years             | 30 years       |                | 30 years    |             |
| <b>Comprehensive evaluation</b>          | <b>Excellent</b>        | <b>Fair</b>          | <b>Poor</b>    | <b>Fair</b>    | <b>Poor</b> | <b>Fair</b> |

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## ③ Adequate pressure

### In Japan

#### Minimum dynamic water pressure(more than MPa)

|           |           |
|-----------|-----------|
| 2 stories | 0.15~0.20 |
| 3 stories | 0.20~0.25 |
| 4 stories | 0.25~0.30 |
| 5 stories | 0.30~0.35 |

#### Maximum static water pressure(less than MPa)

0.74

Source: Design Criteria for Waterworks Facility 2012  
(Japan Water Works Association)

#### Maximum dynamic water pressure(less than MPa)

0.49

### Recommendation for EDWS

#### Target of water pressure

|  |                    |
|--|--------------------|
| <b>Distribution trunk main</b><br>(at inlet of DMA, branch to distribution sub main) | more than 0.20 MPa |
| Water loss in DMA  | less than 0.04MPa  |
| <b>Distribution sub main</b><br>(in front of customer's house)                       | more than 0.16MPa  |
| Water loss in house connection   | less than 0.10MPa  |
| <b>Customer's tap</b>  | more than 0.06MPa* |

\*: Water can be directly stored in the customer's water tank on 1st floor!

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## ④ Suitable diameter

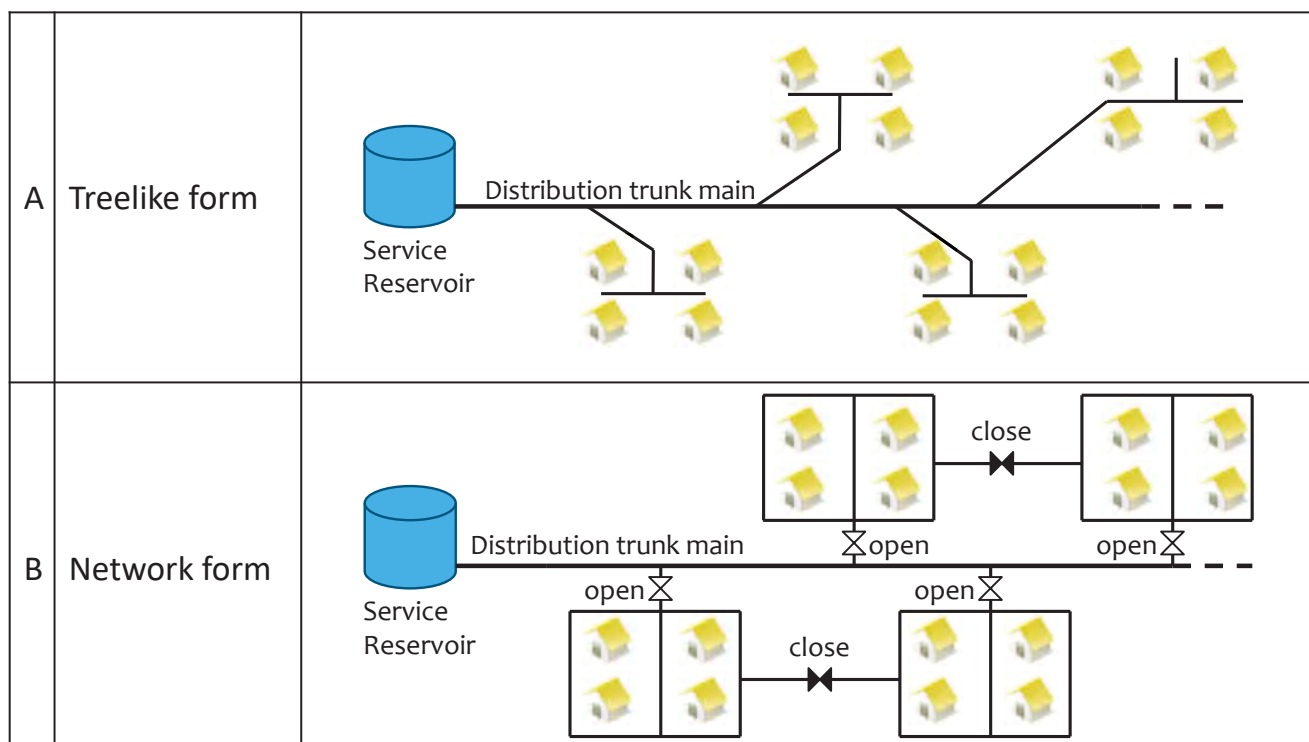
The diameter shall be determined based on the following:

1. The dynamic water pressure at normal times shall be so determined that it is higher than the minimum dynamic pressure; and that the distribution of the water pressure becomes as uniform as possible.
2. The low water level of the service reservoir, standpipe or elevated reservoir shall be the datum level for the computation of the diameter.
3. The water pressure shall be so planned that it does not become negative even at the fire fighting.

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## ⑤ Ideal network-form

### Distribution network-forms



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# Characteristics of distribution network-forms

| Distribution network-forms |               | Characteristics                           |                               |                               |                     |  |
|----------------------------|---------------|---|-------------------------------|-------------------------------|---------------------|--|
|                            |               | Distribution uniformity of water pressure | Elimination of retained water | Backup when pipe burst occurs | Installation budget | Ease of design   |
| A                          | Treelike form | Poor                                      | Poor                          | Poor                          | Normal              | Easy   |
| B                          | Network form  | Good                                      | Good                          | Good                          | Above treelike form | Complexity<br>Utilizing <u>GIS and hydraulic analysis software</u> , it is make possible to design it. |

The actual distribution network-form is depend very much on location and geography of service area, then it becomes a mixture of treelike and network.

However, the network form should be adopted as far as the budget permit, to the best of EDWS's design ability.

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## ⑥ Ancillary Facilities

Ancillary Facilities are closure valves, control valves, air valves, pressure reducing valves, fire hydrants, drainage facilities, flow meters, pressure gauges, etc. It is required for them to be able to properly secure the water flow .

| Item            | Purpose  |
|-----------------|--|
| Sluice valve    | On-off of water supply<br>(Sluice valve is typically either fully opened or fully closed.) |
| Butterfly valve | On-off of water supply and flow control  |
| Cone valve      | Flow control   |
| Check valve     | Flow direction control (one-way, no-return)  |
| Air valve       | Exhaust air and intake air   |
| Fire hydrant    | Fire fighting  |
| etc.            |  |

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## (4) Pipe design for installation works -1

### Field Survey

- Checking of width of road, pavement type, traffic and building occupancy.



### Measurement Survey

- Measuring of length and width of road, location of building, ditch and canal.
- Checking of soil type.



### Selection of laying method

- A laying method shall, as much as possible, be selected that does not require the suspension of water.



Make sure to visit the site!



Keep result of the measurement!

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## (4) Pipe design for installation works -2

### Selection of construction method



Open cut method



Jacking method



Piping in shield tunnel



Public utility conduit



Pipe-in-pipe method



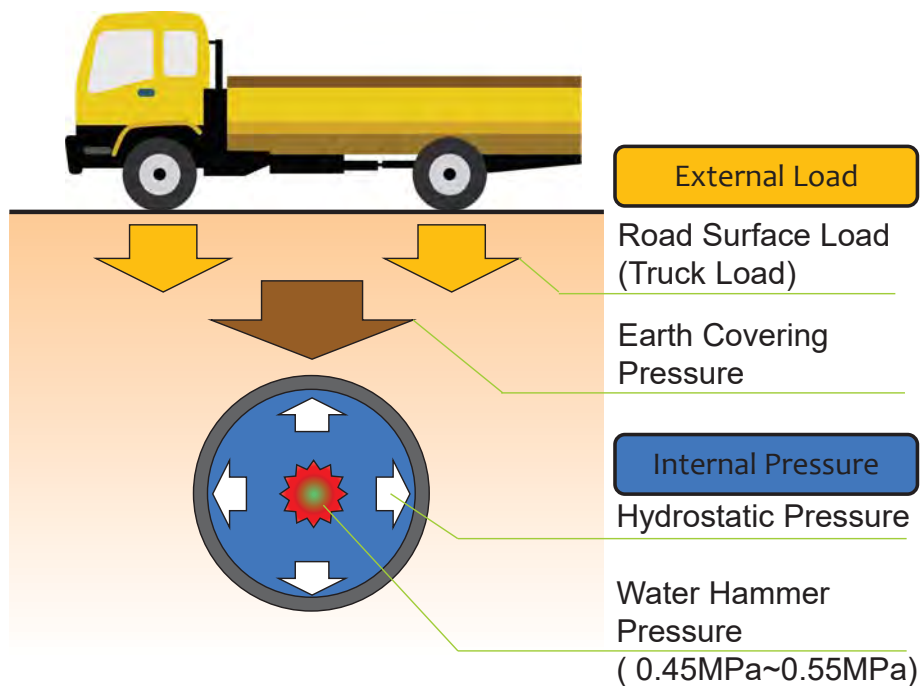
Water pipe bridge

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# (4) Pipe design for installation works -3

## Calculation of pipe thickness

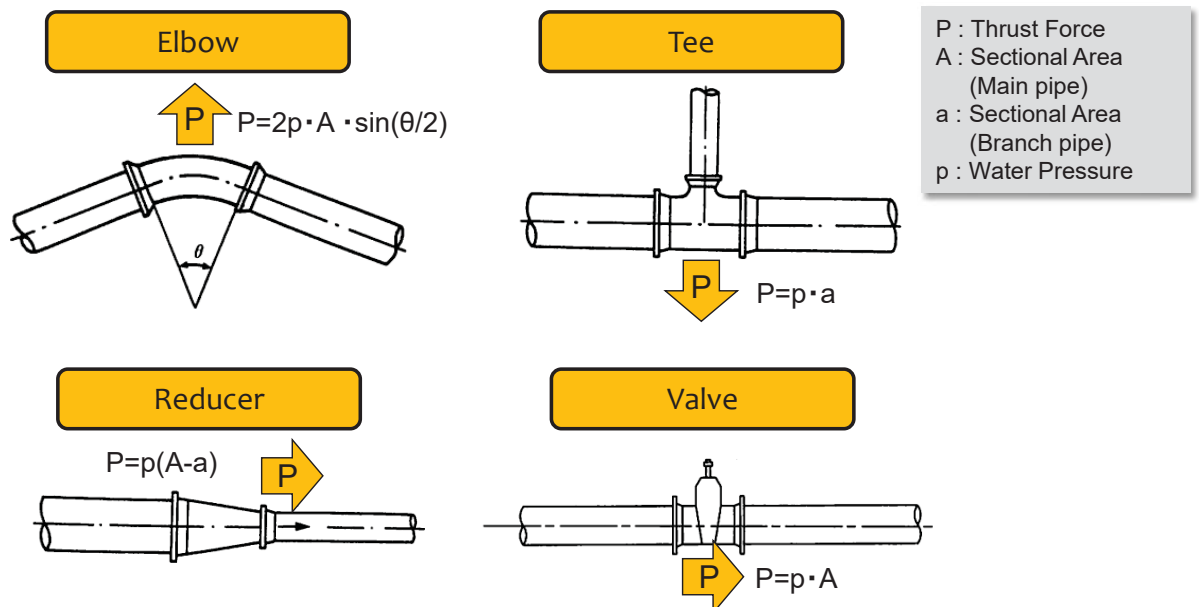


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# (4) Pipe design for installation works -4

## Measure against of thrust force

Special fittings such as elbows, tees and reducers are subject to **unbalanced force (Thrust force)** due to the water pressure.



Fittings are moved by thrust force, so countermeasure is required.

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# (4) Pipe design for installation works -5

## Selection of thrust blocking method

Countermeasure against Thrust force.

Concrete Block



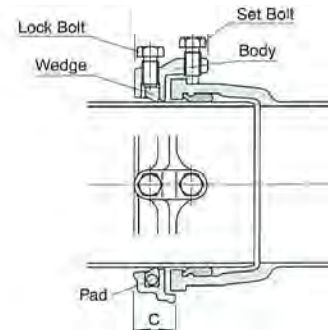
Concrete Block

Restraint Joint



KUBOLOCK-T

DN80 ~ DN1200

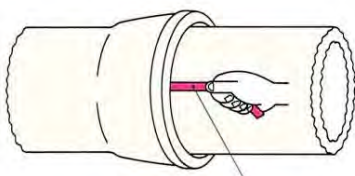


- No space for concrete block.
- No time to set and cure the concrete block.

# (4) Pipe design for installation works -6

## Selection of result of jointing

DIP



Feeler gauge

- Only to check a position of a rubber gasket with a feeler gauge.

MS



- X-ray or Ultrasonic test machine is required.

HDPE



- There is no checking method for Butt-Fusion quality.

Jointing of DIP can be checked easily and reliably. On the other hand, HDPE has no checking method. If Butt-Fusion is not done properly, Easy to cause water leakage.

# (4)Pipe design for installation works -7

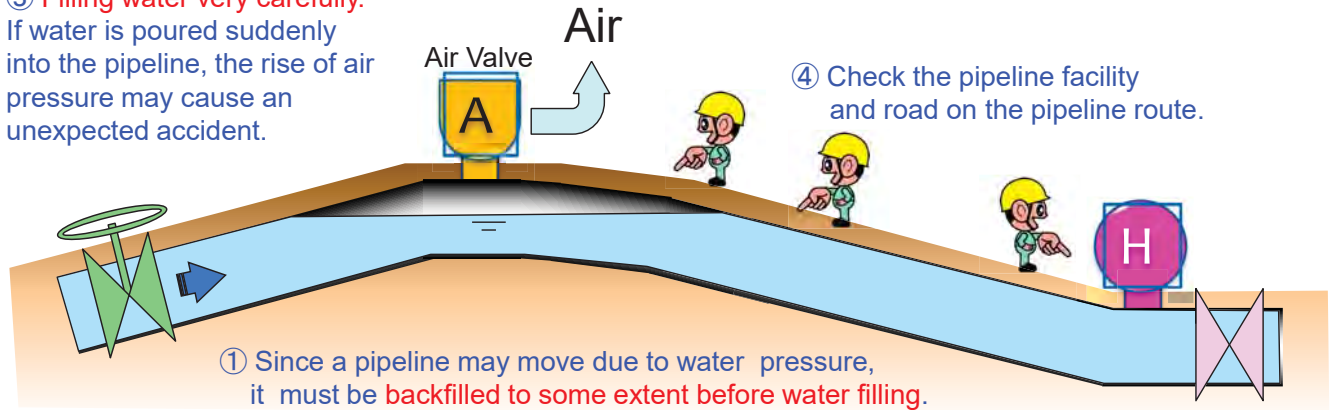
## Completion Inspection (Water Filling)

### Water Filling

③ Filling water very carefully. If water is poured suddenly into the pipeline, the rise of air pressure may cause an unexpected accident.

② Check air valve.

④ Check the pipeline facility and road on the pipeline route.



① Since a pipeline may move due to water pressure, it must be backfilled to some extent before water filling.

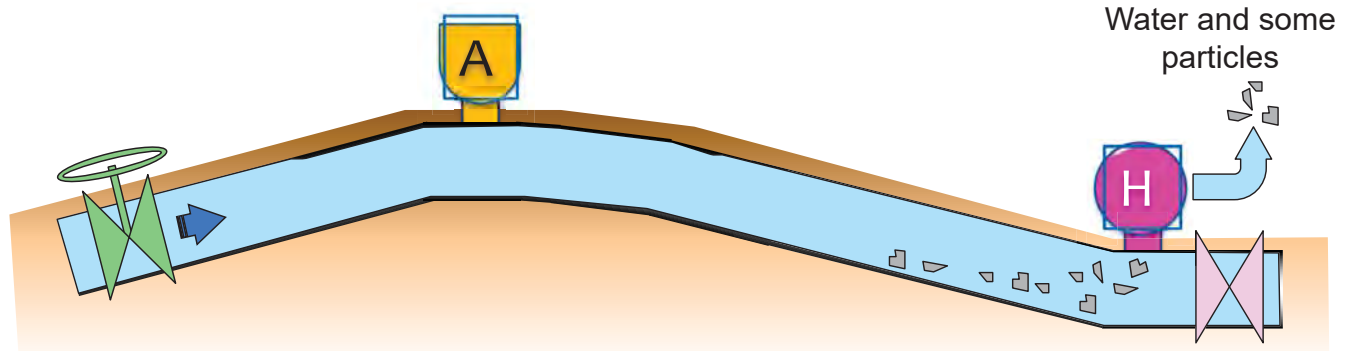
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# (4)Pipe design for installation works -8

## Completion Inspection (Flushing)

### Flushing

Discharge water and some particle from Water Hydrant or Drainage pipe. It is required flow velocity of at least 1m/s.



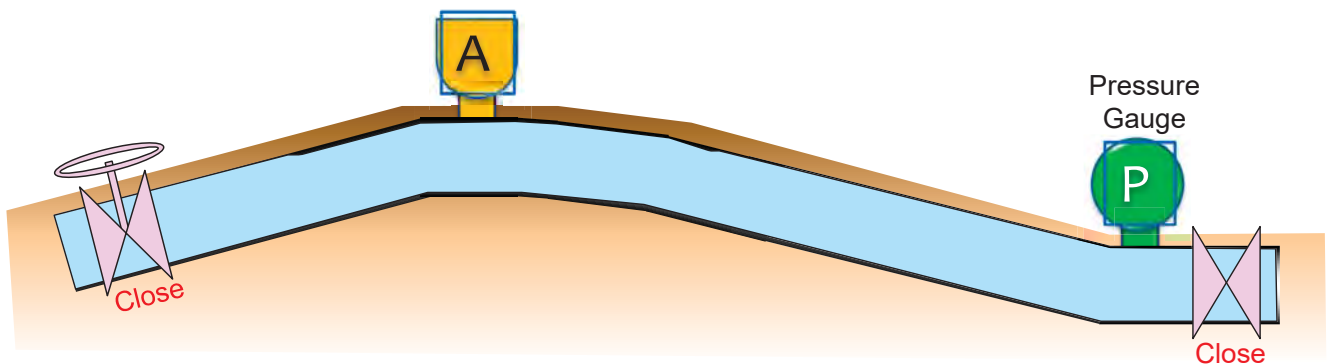
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## (4)Pipe design for installation works -9

### Completion Inspection (Pressure Test 1)

#### Pressure Test

- ① To remove the air remaining in the pipeline and to lessen the influence of water adsorption by mortar lining, it is desirable that the pressure test is performed after lapse of a whole day and night subsequent to the water filling of the pipeline.
- ② For the test pressure, retention time and allowable pressure drop, proper values must be set, considering the water pressure in working, pipeline length, condition of accessory equipment construction condition, etc.
- ③ Raise pressure to the test pressure, and kept at the pressure for a certain time. Record water pressure during retention time.



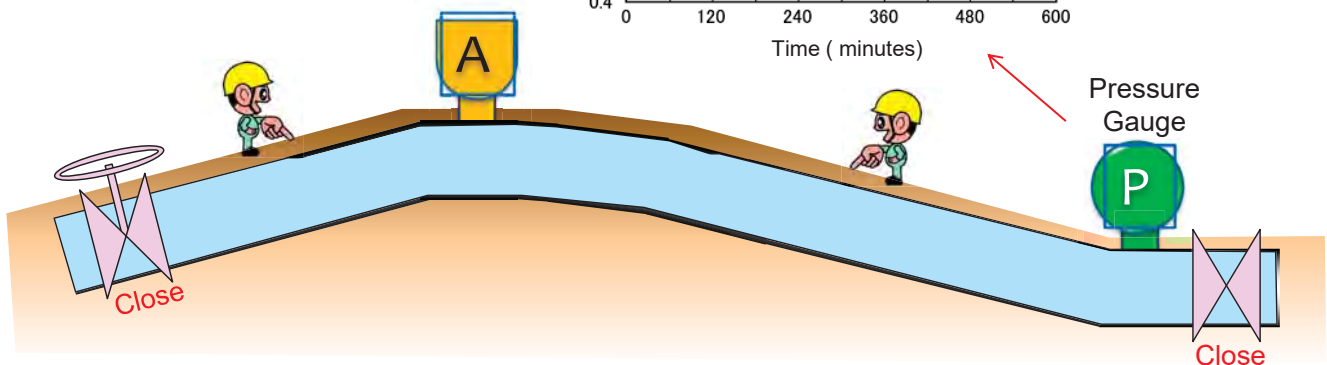
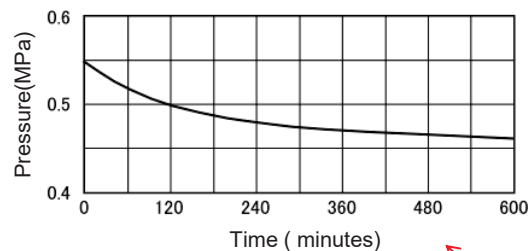
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## (4)Pipe design for installation works -10

### Completion Inspection (Pressure Test 2)

#### Pressure Test

- ① Examine any abnormality in the pipeline and the change of pressure during retention time.  
✖ Even if no leakage on the pipeline, water pressure could be down by 30% due to water permeation to the mortar lining or slightly moving of fitting.
- ② If water pressure is decreased significantly, water leakage inspection is required.



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1-3. Basis of hydraulic analysis

1-4. *Practical work*

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# Contents

## 1-3. Basis of hydraulic analysis

1) Basic knowledge

2) Formula for hydraulic analysis

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# What is the hydraulic analysis?

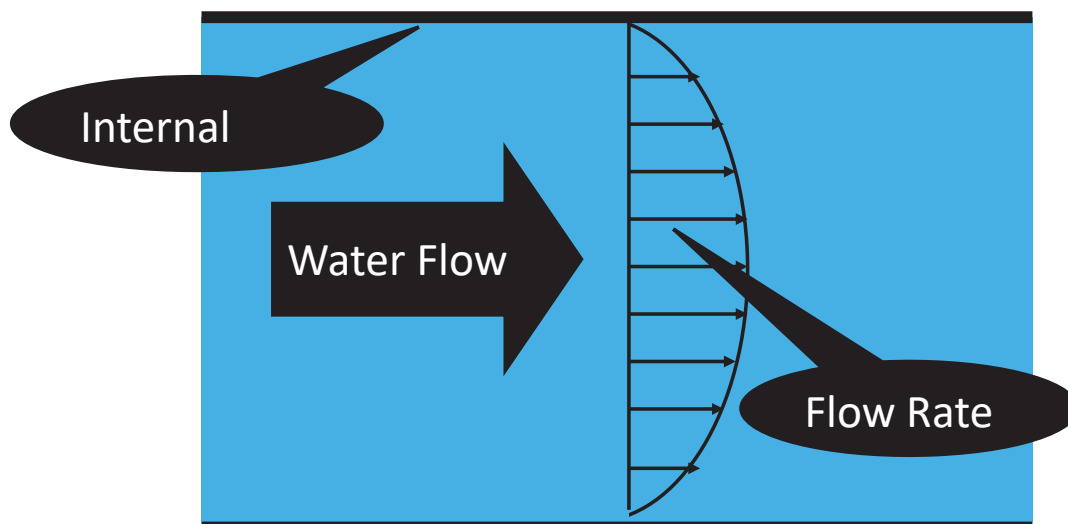
Hydraulic analysis is calculation of pressure and flow rate for meeting customer's demand, depend on diameter, length, LWL\* of reservoir and water consumption.

\*LWL: Low Water Level

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# Head loss

Water head loss is stemmed from friction between water and internal face of pipe.

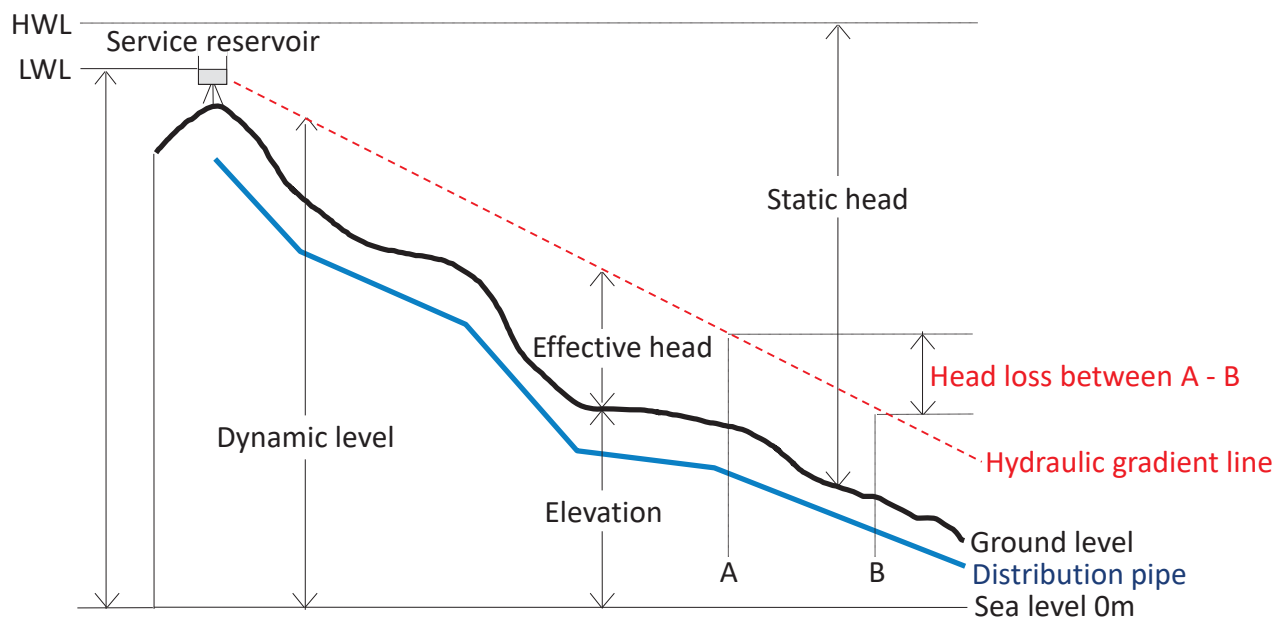


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# Head loss and



Effective head is usually called “pressure”.

- LWL (Low Water Level) is applied to calculation for customer’s demand.
- HWL (High Water level) is applied to calculation for safety of facilities.

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## Contents

### 1-3. Basis of hydraulic analysis

#### 1) Basic knowledge

#### 2) Formula for hydraulic analysis

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## 2) Formula for hydraulic analysis

Head loss is calculated by the Hazen–Williams equation.

$$(H=10.666 \times C^{-1.85} \times D^{-4.87} \times Q^{1.85} \times L)$$

H:Head loss (m)

C :velocity Coefficient (110 in general)

D:Diameter (m)

Q:Quantity (m<sup>3</sup>/sec)

L :Length of pipe (m)

The Hazen–Williams equation is adopted as standard in USA. Also, It is generally utilized in Japan.

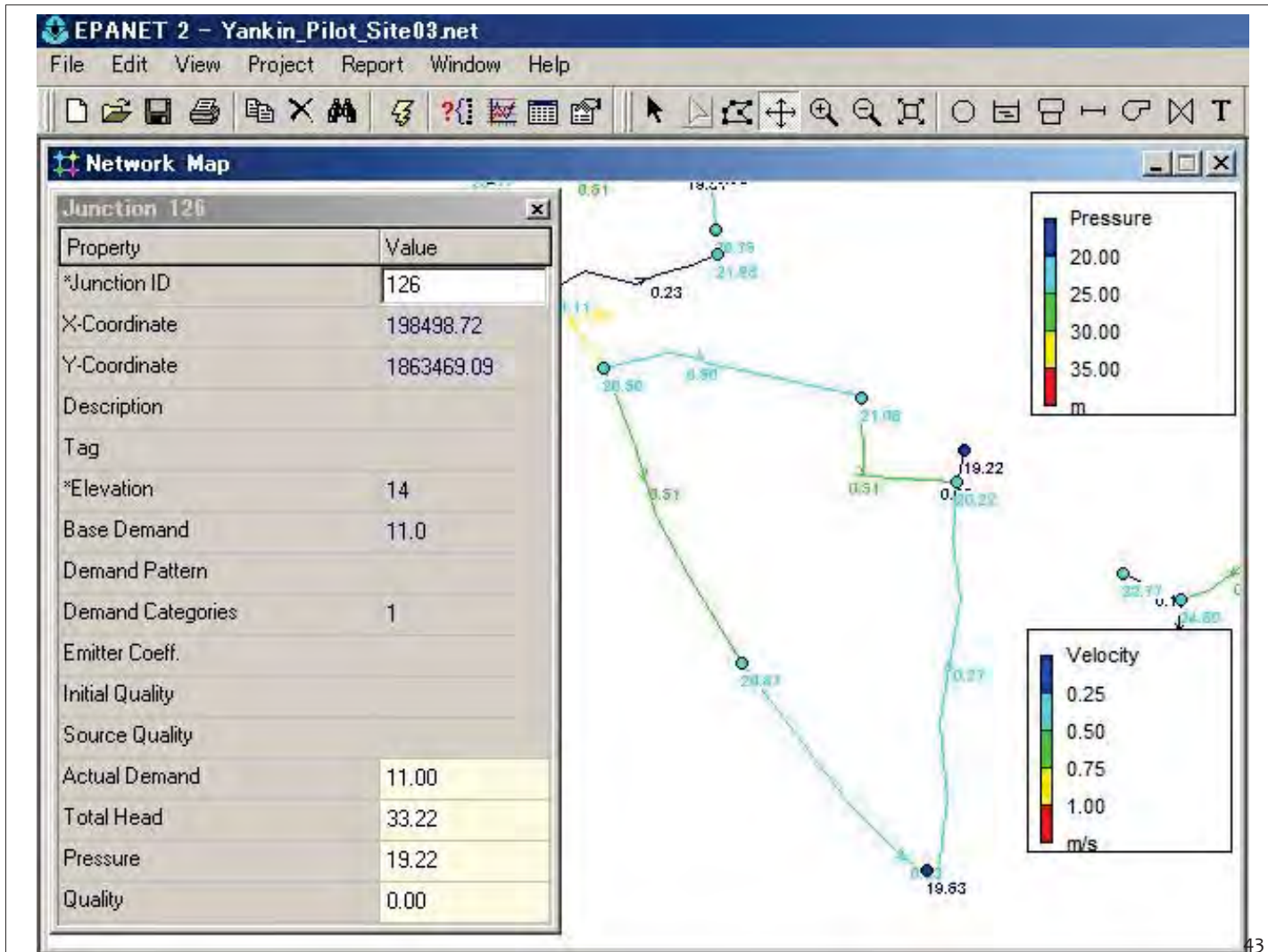
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## Result of calculation with the H-W equation

| Diameter (inch) | Flow rate (m/sec) | Length (m) | Head loss (m) |
|-----------------|-------------------|------------|---------------|
| 36              | 0.5               | 1,000      | 0.36          |
| 12              | 0.5               | 1,000      | 1.30          |
| 6               | 0.2               | 500        | 0.27          |
| 4               | 0.2               | 500        | 0.43          |
| 2               | 0.2               | 500        | 0.60          |

Assuming: C(velocity Coefficient) = 110

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### 1. Basis of hydraulic analysis

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# Practical work

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## Criteria for calculating diameter of distribution pipe (1)

| Criteria  | JAPAN (Tokyo)                                   | MYANMAR(Yankin)  |
|---|---|--|
| Population<br>(Household Nos. /people<br>per household) | According to census                             | Household =626 (Survey)<br>Person / household=4.6 (Census)<br>Grow Rate = 17.6% (M/P2011-40) |
| Consumption volume<br>(Domestic)(l/c/d)                 | 250 (l/c/d)                                     | 200  |
| Consumption volume<br>(Non-Domestic)(l/c/d)             |   | 133  |
| Physical loss   | N/A   | 0(new pipe-line)   |
| Hourly factor   | 1.4 ~ 1.8<br>(depend on area<br>characteristic) | 1.5(M/P)   |
| Peak factor   | 1.1   | 1.1(M/P)   |
| Grow Rate   | -   | 17.6% increase<br>(2011:107,023->2040:125,909)   |

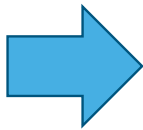


Can calculate supply volume for distribution area

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## Criteria for calculating diameter of distribution pipe (2)

- a. Velocity Coefficient --- According to Next Slide
- b. Pipe Diameter
- c. Quantity --- Data from previous slide
- d. Pipe Length



Can calculate head loss

$$(H=10.666 \times C^{-1.85} \times D^{-4.87} \times Q^{1.85} \times L)$$

And the following data are needed:

1. Water pressure (Inlet)
2. Elevation

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## Velocity Coefficient (C)

| Material                              | C         | Smoothness                      |
|---------------------------------------|-----------|---------------------------------|
| PVC (New)                             | 145 ~ 155 | Very Smooth                     |
| HDPE                                  | 140       | Very Smooth                     |
| Ductile Iron Pipe (New)               | 130       |                                 |
| Normal Pipe-line (including fittings) | 110       | Standard for hydraulic analysis |
| Old Pipe                              | 100       |                                 |
| Very Old Pipe                         | 60 ~ 80   | Terrible corrosion              |

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# Quantity

Water consumption of the target area

⇒ According to customer information

(ex. Household/Population, Average water consumption, Hourly factor, etc. )

<Exercise1>

Convert  $100\text{m}^3/\text{hour}$  to liter/sec.

(To adapt to Hazen & Williams Diagram)

$\text{m}^3 \Rightarrow \text{litter (l)} \dots (1\text{m}^3 = 1,000 \text{ l})$

Hour  $\Rightarrow$  Second (60min. x 60sec./min.)

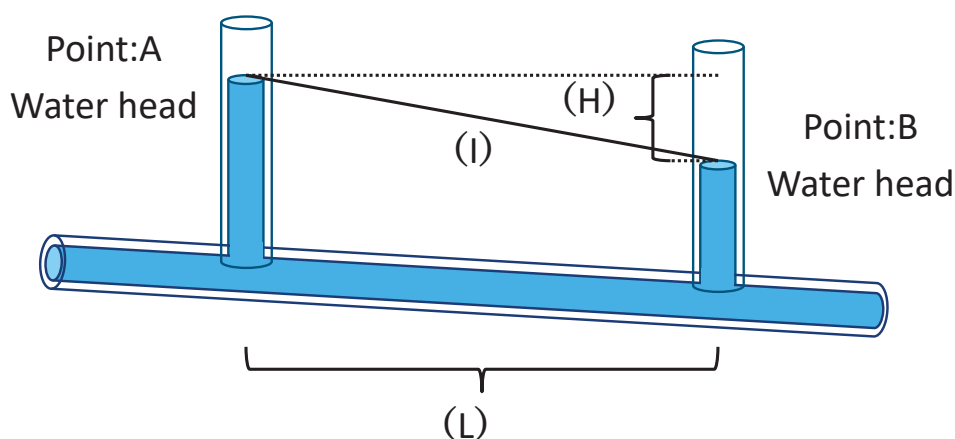
$100\text{m}^3/\text{h} \times 1,000 = 100,000\text{l}/\text{h} \div 3,600 \doteq 28\text{l}/\text{s}$

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# Hydraulic gradient(1)

Hydraulic gradient... Head loss/Length(‰)

$$\text{Hydraulic gradient (I)} = \frac{\text{Head loss (H)}}{\text{Length (L)}} \times 1,000 (\text{‰})$$



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## Hydraulic gradient(2)

<Exercise1>

Find the value of the hydraulic gradient.

(Pipe length = 10m, Head loss = 3m)

$$\text{Hydraulic gradient( I )} = \frac{3\text{m Head loss (H)}}{10\text{m Length (L)}} \times 1,000\text{‰} = 300\text{‰}$$

<Exercise2>

Find the value of the head loss.

Pipe Length 30m, Hydraulic gradient = 200 (‰)

$$\text{Head loss(H)} = 30\text{m} \times \frac{200}{1000} = 6\text{m}$$

Hydraulic gradient ( I )

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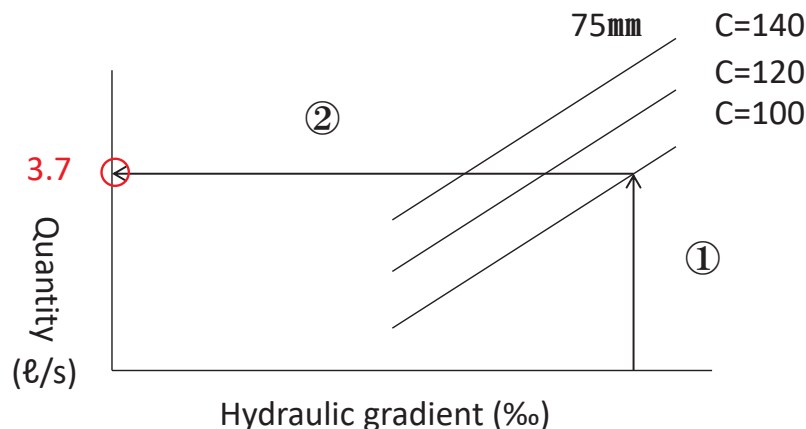
## Hazen & Williams Formula (1)

(With Diagram)

<Exercise 1>

How much the water flow quantity ?

(Hydraulic gradient = 20‰ , Diameter 75mm , C = 100)



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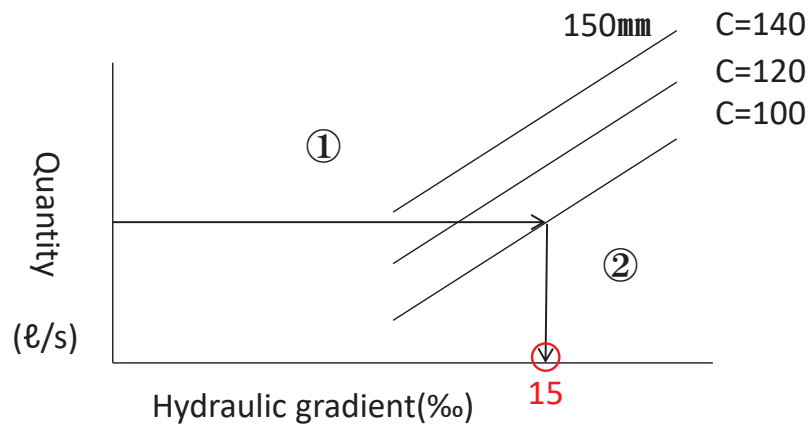
# Hazen & Williams Formula (2)

(With Diagram)

<Exercise2>

Find the value of hydraulic gradient.

(Diameter = 150mm , C=100 , Quantity 20 l/s)



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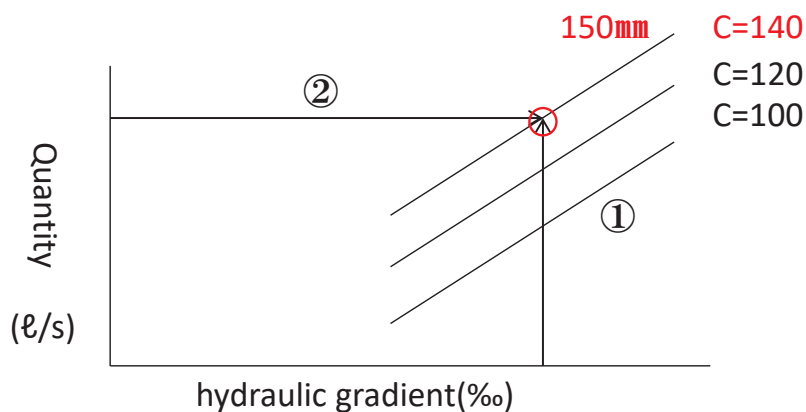
# Hazen & Williams Formula (3)

(With Diagram)

<Exercise3>

Find the value of pipe diameter.

(Hydraulic gradient 8‰, Quantity 20 l/sec)

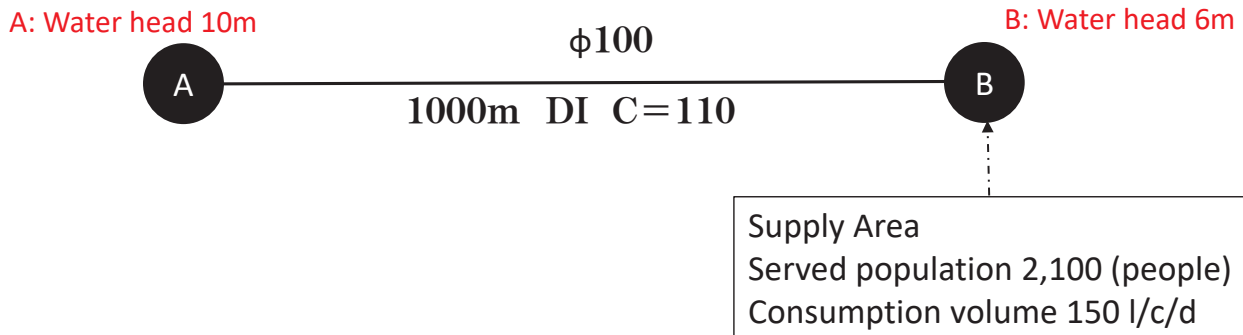


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# Diameter Estimation (Distribution pipe)

<Exercise 1>

Find the value of the distribution pipe diameter from point(A) to point (B).



1. Calculate the hydraulic gradient (A→B)
2. Calculate water consumption volume at point B.
3. Calculate the distribution pipe diameter. (A→B)

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### 1. Basis of hydraulic analysis

### 2. Operation of data conversion (ArcGIS to EPA-net)

-> Page 6-14 of the manual\*

### 3. Setting up the analysis condition

-> Page 15-27 of the manual\*

### 4. Executing analysis and checking the result

-> Page 28-33 of the manual\*

**Practical work**

\*:GIS+EPA-net Operation Manual (Data conversion, Hydraulic analysis)rev1

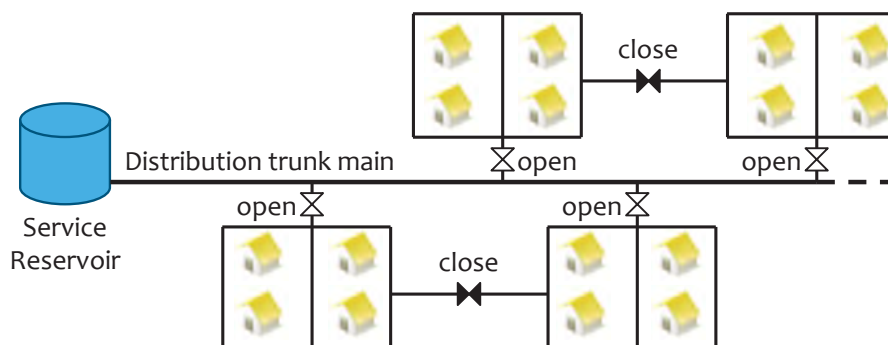
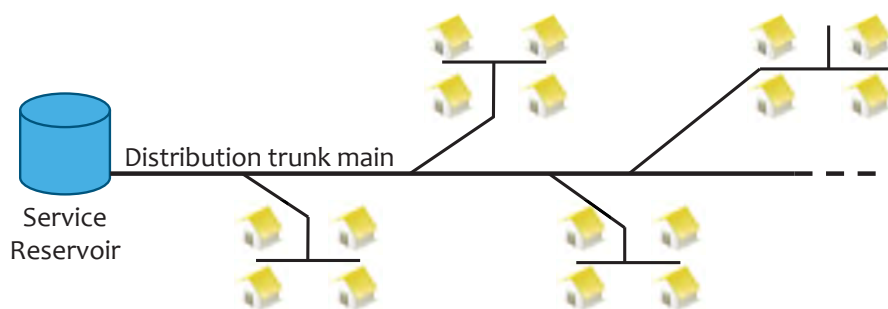
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# ကျေးဇူးတင်ပါတယ်

Thank you for your attention



## Network forms



FEATURE CLASS

:Default setting

PIPES

| ATR No. | Item                 | Name                           | Data Type     | Unit        | Default   | Remark                 |
|---------|----------------------|--------------------------------|---------------|-------------|-----------|------------------------|
| 1       | FID                  | FID                            | Object ID     |             | (system)  |                        |
| 2       | Shape                | Shape                          | Geometry      |             | (system)  |                        |
| 3       | ID                   | ID                             | Long Integer  |             |           |                        |
| 4       | System_type          | System type                    | Domain1       |             | not clear |                        |
| 5       | Township             | Township Name                  | Domain2       |             | not clear |                        |
| 6       | Ward                 | Ward Name                      | Text50        | -           | null      |                        |
| 7       | DMA                  | DMA Name                       | Text50        | -           | null      |                        |
| 8       | LMB                  | LMB Name                       | Text50        | -           | null      |                        |
| 9       | Water_system         | Water system                   | Domain9       |             |           |                        |
| 10      | Length               | Length                         | Double        | m           | 0         |                        |
| 11      | Shape_Length         | Shape_Length                   | Double        | m           | -         | Automatically          |
| 12      | Diameter             | Diameter                       | Short Integer | mm          | 0         |                        |
| 13      | Material             | Material                       | Domain3       |             | 0         |                        |
| 14      | Joint_type           | Joint Type                     | Domain4       |             | 0         |                        |
| 15      | Installation_year    | Installation year              | Short Integer | year        | 0         |                        |
| 16      | Project_Name         | Project Name                   | Text100       |             | 0         |                        |
| 17      | Laying_type          | Laying Type                    | Domain5       |             | 0         |                        |
| 18      | Depth                | Depth                          | Float         | m           | 0         |                        |
| 19      | Operational_Status   | Operational_Status             | Domain6       |             | not clear |                        |
| 20      | Data_Accuracy        | Data Accuracy                  | Domain8       |             | not clear |                        |
| 21      | Velocity_coefficient | Velocity coefficient           | Short Integer | -           | 0         |                        |
| 22      | Household            | Number of Household served     | Double        | number      | 0         | for hydraulic analysis |
| 23      | Added_amount         | Added amount                   | Double        | m3/h        | 0         |                        |
| 24      | Hourly_factor        | Hourly factor                  | Float         | -           | 0         |                        |
| 25      | Completion_Drawing   | Completion drawing (file path) | Text260       | (file path) | 0         |                        |
| 26      | Record_Leakages      | Record of leakages (file path) | Text260       | (file path) | 0         |                        |
| 27      | Repair_Work_Date     | Repair Work Date               | Date          |             | null      |                        |
| 28      | Tmp1                 | Tmp1                           | Long Integer  |             | null      | temporary              |
| 29      | Tmp2                 | Tmp2                           | Double        |             | null      |                        |
| 30      | Tmp3                 | Tmp3                           | Text50        |             | null      |                        |

Road

| ATR No. | Item          | Name          | Data Type    | Unit | Default   | Remark    |
|---------|---------------|---------------|--------------|------|-----------|-----------|
| 1       | FID           | FID           | Object ID    |      | (system)  |           |
| 2       | Shape         | Shape         | Geometry     |      | (system)  |           |
| 3       | ID            | ID            | Long Integer |      |           |           |
| 4       | Type          | Road type     | Domain7      |      | not clear |           |
| 5       | Pavement_type | Pavement type | Domain10     |      | not clear |           |
| 6       | Tmp1          | Tmp1          | Long Integer |      | null      | temporary |
| 7       | Tmp2          | Tmp2          | Double       |      | null      |           |
| 8       | Tmp3          | Tmp3          | Text50       |      | null      |           |

Meter Customer / Flat-rate Customer

| ATR No. | Item               | Name                           | Data Type     | Unit        | Default   | Remark                              |
|---------|--------------------|--------------------------------|---------------|-------------|-----------|-------------------------------------|
| 1       | FID                | FID                            | Object ID     |             | (system)  |                                     |
| 2       | Shape              | Shape                          | Geometry      |             | (system)  |                                     |
| 3       | ID                 | ID                             | Long Integer  |             |           |                                     |
| 4       | Meter_ID           | Meter ID                       | Text20        |             | null      |                                     |
| 5       | Customer_ID        | Customer ID                    | Text20        |             | null      |                                     |
| 6       | Township           | Township Name                  | Domain2       |             | not clear |                                     |
| 7       | Ward               | Ward Name                      | Text50        | -           | null      |                                     |
| 8       | DMA                | DMA Name                       | Text50        | -           | null      |                                     |
| 9       | LMB                | LMB Name                       | Text50        | -           | null      |                                     |
| 10      | Address            | Address                        | Text50        |             | null      | (Burmese language)                  |
| 11      | Customer_name      | Customer name                  | Text50        |             | null      |                                     |
| 12      | Meter_type         | Meter type                     | Domain        |             | not clear |                                     |
| 13      | Tarrif_category    | Tarrif category                | Domain18      |             | not clear |                                     |
| 14      | Meter_status       | Meter status                   | Domain        |             | not clear |                                     |
| 15      | Meter_location     | Meter location                 | Domain        |             | not clear |                                     |
| 16      | Meter_size         | Meter size                     | Short Integer | mm          | 0         |                                     |
| 17      | Consumption        | Water consumption              | Double        | m3/month    |           |                                     |
| 18      | Metering_Date      | Metering Date                  | Date          |             |           |                                     |
| 19      | Population_served  | Population served              | Short Integer | number      | 0         |                                     |
| 20      | Billing_status     | Billing status                 | Domain        |             |           |                                     |
| 21      | Connection_status  | Connection status              | Domain        |             |           |                                     |
| 22      | Installation_year  | Installation year              | Short Integer | year        | 0         |                                     |
| 23      | Completion_drawing | Completion drawing (file path) | Text260       | (file path) |           |                                     |
| 24      | Complaint_type     | Complaint type                 | Domain        |             |           | Information of the latest Complaint |
| 25      | Informer_name      | Informer name                  | Text50        | -           | null      |                                     |
| 26      | Action_report      | Action report (file path)      | Text260       | (file path) |           |                                     |
| 27      | Tmp1               | Tmp1                           | Long Integer  |             | null      |                                     |
| 28      | Tmp2               | Tmp2                           | Double        |             | null      | temporary                           |
| 28      | Tmp3               | Tmp3                           | Text50        |             | null      |                                     |

Survey of elevation

| ATR No. | Item           | Name             | Data Type    | Unit | Default  | Remark |
|---------|----------------|------------------|--------------|------|----------|--------|
| 1       | FID            | FID              | Object ID    |      | (system) |        |
| 2       | Shape          | Shape            | Geometry     |      | (system) |        |
| 3       | ID             | ID               | Long Integer |      |          |        |
| 4       | Elevation      | Elevation        | Float        | m    | null     |        |
| 5       | Geoid          | Geoid            | Text50       |      | null     |        |
| 6       | Method         | Measuring method | Text50       |      | null     |        |
| 7       | Measuring_date | Measuring date   | Date         |      | null     |        |

Domain Items

| System type | Domain1 (Data type = TEXT10) |
|-------------|------------------------------|
| RWTM        | Raw Water Transmission Main  |
| TM          | Transmission Main            |
| DM          | Distribution Main            |
| DSM         | Distribution Sub-main Pipe   |
| HC          | House Connection             |
| not clear   | not clear                    |

| Township Name       | Domain2 (Data type = TEXT20) |
|---------------------|------------------------------|
| Ahlon               | Ahlon                        |
| Bahan               | Bahan                        |
| Botataung           | Botataung                    |
| Dagon               | Dagon                        |
| Dagon Seikkan       | Dagon Seikkan                |
| Dala                | Dala                         |
| Dawbon              | Dawbon                       |
| East Dagon          | East Dagon                   |
| Hlaing              | Hlaing                       |
| Hlaingtharya        | Hlaingtharya                 |
| Insein              | Insein                       |
| Kamayut             | Kamayut                      |
| Kyauktada           | Kyauktada                    |
| Kyimyindaing        | Kyimyindaing                 |
| Lanmadaw            | Lanmadaw                     |
| Latha               | Latha                        |
| Mayangone           | Mayangone                    |
| Mingaladon          | Mingaladon                   |
| Mingalar Taungnyunt | Mingalar Taungnyunt          |
| North Dagon         | North Dagon                  |
| North Okkalapa      | North Okkalapa               |
| Pabedan             | Pabedan                      |
| Pazundaung          | Pazundaung                   |
| Sanchaung           | Sanchaung                    |
| Seikkan             | Seikkan                      |
| Seikkyi Kanaungto   | Seikkyi Kanaungto            |
| Shwepyithar         | Shwepyithar                  |
| South Dagon         | South Dagon                  |
| South Okkalapa      | South Okkalapa               |
| Tamwe               | Tamwe                        |
| Thaketa             | Thaketa                      |
| Thingangyun         | Thingangyun                  |
| Yankin              | Yankin                       |
| not clear           | not clear                    |

| Material  | Domain3 (Data type = TEXT10)         |
|-----------|--------------------------------------|
| DIP       | Ductile Iron Pipe                    |
| CIP       | Cast Iron Pipe                       |
| MS        | Mild Steel pipe                      |
| GIP       | Galvanized Iron Pipes                |
| HDPE      | High Density PolyEthylene pipe       |
| PVC       | PolyVinyl Chloride pipe              |
| R-PVC     | Recycled PolyVinyl Chloride pipe     |
| HIVP      | High Impact Vinyl Pipe               |
| ACP       | Asbestos Cement Pipe                 |
| PCP       | Prestressed Concrete Pipe            |
| HP        | Hume concrete Pipe (not prestressed) |
| not clear | not clear                            |

| Joint type | Domain4 (Data type = TEXT10)    |
|------------|---------------------------------|
| PUSH-ON    | PUSH-ON (ex. T-type) joint      |
| MECHANICAL | MECHANICAL (ex. K-type) joint   |
| RESTRAIT   | RESTRAIT (ex. GX-type) joint    |
| FAUCET     | FAUCET joint with lead and yarn |
| WELDED     | WELDED joint                    |
| SCREW      | SCREW joint                     |
| BUTT-F     | BUTT-Fusion jointing            |
| ELECTRO-F  | ELECTRO-Fusion jointing         |
| TS         | Taper Socket joint              |
| RR         | Rubber Ring type joint          |
| COLLAR     | COLLAR joint for ACP            |
| PC-S       | S-type joint for PCP            |
| PC-C/NC    | C/CN-type joint for PCP/HP      |
| OTHER      | OTHER                           |
| not clear  | not clear                       |

| Laying_type | Domain5 (Data type = TEXT10) |
|-------------|------------------------------|
| Buried      | Buried under the ground      |
| Exposed     | Exposed on the ground        |
| Ditch       | hid in a Ditch               |
| not clear   | not clear                    |

| Status    | Domain6 (Data type = TEXT10) |
|-----------|------------------------------|
| Operated  | currently Operated           |
| Abolished | Abolished                    |
| Planned   | Planned                      |

## Leakage

| ATR No. | Item              | Name               | Data Type    | Unit        | Default   | Remark             |
|---------|-------------------|--------------------|--------------|-------------|-----------|--------------------|
| 1       | FID               | FID                | Object ID    |             | (system)  |                    |
| 2       | Shape             | Shape              | Geometry     |             | (system)  |                    |
| 3       | ID                | ID                 | Long Integer |             |           |                    |
| 4       | Township          | Township Name      | Domain2      |             | not clear |                    |
| 5       | Ward              | Ward Name          | Text50       | -           | null      |                    |
| 6       | DMA               | DMA Name           | Text50       | -           | null      |                    |
| 7       | LMB               | LMB Name           | Text50       | -           | null      |                    |
| 8       | Address           | Address            | Text50       |             | null      | (Burmese language) |
| 9       | Detection_type    | Detection type     | domain       |             | not clear |                    |
| 10      | Facility_type     | Facility type      | domain       |             | not clear |                    |
| 11      | Place_of_facility | Place of facility  | domain       |             | not clear |                    |
| 12      | Cause_of_leakage  | Cause of leakage   | domain       |             | not clear |                    |
| 13      | Diameter          | Diameter           | mm           | mm          | 0         |                    |
| 14      | Material          | Material           | domain       |             | not clear |                    |
| 15      | Repair_work       | Repair work        | domain       |             |           |                    |
| 16      | Repair_method     | Repair work method | domain       |             |           |                    |
| 17      | Repair_date       | Repair work date   | Date         |             |           |                    |
| 18      | Repair_report     | Repair report      | Text260      | (file path) |           |                    |

## Pressure measurement

| ATR No. | Item               | Name                     | Data Type    | Unit        | Default  | Remark       |
|---------|--------------------|--------------------------|--------------|-------------|----------|--------------|
| 1       | FID                | FID                      | Object ID    |             | (system) |              |
| 2       | Shape              | Shape                    | Geometry     |             | (system) |              |
| 3       | ID                 | ID                       | Long Integer |             |          |              |
| 4       | Manufacturer       | Manufacturer             | Text50       |             | null     |              |
| 5       | Model_number       | Model number             | Text50       |             | null     |              |
| 6       | Method             | Measuring method         | domain17     |             | null     |              |
| 7       | Installation_year  | Installation year        | Text50       | year        |          | or temporary |
| 8       | Inspection_date    | Periodic inspection date | date         |             |          |              |
| 9       | Pressure_mean      | Pressure(mean)           | Float        | MPa         | 0        |              |
| 10      | Pressure_max       | Pressure(max.)           | Float        | MPa         | 0        |              |
| 11      | Pressure_min       | Pressure(min.)           | Float        | MPa         | 0        |              |
| 12      | Start_date_time    | Start date-time          | Datetime     |             | null     |              |
| 13      | End_date_time      | End date-time            | Datetime     |             | null     |              |
| 14      | Measurement_report | Measurement report       | Text260      | (file path) |          |              |

## Water flow measurement

| ATR No. | Item               | Name                     | Data Type     | Unit        | Default  | Remark       |
|---------|--------------------|--------------------------|---------------|-------------|----------|--------------|
| 1       | FID                | FID                      | Object ID     |             | (system) |              |
| 2       | Shape              | Shape                    | Geometry      |             | (system) |              |
| 3       | ID                 | ID                       | Long Integer  |             |          |              |
| 4       | Manufacturer       | Manufacturer             | Text50        |             | null     |              |
| 5       | Model_number       | Model number             | Text50        |             | null     |              |
| 6       | Diameter           | Diameter                 | Short Integer | mm          | 0        |              |
| 7       | Method             | Measuring method         | domain19      |             | null     |              |
| 8       | Installation_year  | Installation year        | Text50        | year        |          | or temporary |
| 9       | Inspection_date    | Periodic inspection date | date          |             |          |              |
| 10      | Flow_mean          | Flow(mean)               | Float         | m/sec       | 0        |              |
| 11      | Flow_max           | Flow(max.)               | Float         | m/sec       | 0        |              |
| 12      | Flow_min           | Flow(min.)               | Float         | m/sec       | 0        |              |
| 13      | Flow_amount_mean   | Flow amount(mean)        | Float         | m3/h        | 0        |              |
| 14      | Flow_amount_max    | Flow amount(max.)        | Float         | m3/h        | 0        |              |
| 15      | Flow_amount_min    | Flow amount(min.)        | Float         | m3/h        | 0        |              |
| 16      | Start_date_time    | Start date-time          | Datetime      |             | null     |              |
| 17      | End_date_time      | End date-time            | Datetime      |             | null     |              |
| 18      | Measurement_report | Measurement report       | Text260       | (file path) |          |              |

## Valves

| ATR No. | Item                  | Name                           | Data Type     | Unit        | Default   | Remark               |
|---------|-----------------------|--------------------------------|---------------|-------------|-----------|----------------------|
| 1       | FID                   | FID                            | Object ID     |             | (system)  |                      |
| 2       | Shape                 | Shape                          | Geometry      |             | (system)  |                      |
| 3       | angle                 | Angle                          | short         |             | (system)  |                      |
| 4       | ID                    | ID                             | Long Integer  |             |           |                      |
| 5       | Operational_Status    | Operational_Status             | Domain6       |             | not clear |                      |
| 6       | Status_O_C            | Status(O/C)                    | Domain11      |             | not clear |                      |
| 7       | Purpose               | Purpose (Valve)                | Domain15      |             | not clear |                      |
| 8       | Type                  | Type (Valve)                   | Domain16      |             | not clear |                      |
| 9       | Manufacturer          | Manufacturer                   | Text50        |             | null      |                      |
| 10      | Model_number          | Model number                   | Text50        |             | null      |                      |
| 11      | Diameter              | Diameter                       | Short Integer | mm          | 0         |                      |
| 12      | Status_working_not    | Status(Working/not)            | Domain12      |             | not clear |                      |
| 13      | Operating_type        | Operating type                 | Domain13      |             | not clear |                      |
| 14      | Direction_to_open     | Direction to open              | Domain14      |             | not clear |                      |
| 15      | Installation_year     | Installation year              | Short Integer | year        | 0         |                      |
| 16      | Setting_pressure_redu | Pressure reduce                | Double        | MPa         | 0         | Setting value in the |
| 17      | Setting_flow_rate     | Flow rate                      | Double        | m3/h        | 0         | case of the control  |
| 18      | Completion_Drawing    | Completion drawing (file path) | Text260       | (file path) | 0         |                      |
| 19      | Tmp1                  | Tmp1                           | Long Integer  |             | null      |                      |
| 20      | Tmp2                  | Tmp2                           | Double        |             | null      | temporary            |
| 21      | Tmp3                  | Tmp3                           | Text50        |             | null      |                      |

|           |           |
|-----------|-----------|
| not clear | not clear |
|-----------|-----------|

| Road type     | Domain7 (Data type = TEXT15) |
|---------------|------------------------------|
| Road          | Road                         |
| Ditch         | Ditch                        |
| House Boudary | House Boudary                |
| not clear     | not clear                    |

| Data Accuracy of Pipe | Domain8 (Data type = TEXT20) |
|-----------------------|------------------------------|
| Based_on_completion   | Based on completion drawings |
| Based_on_design_dra   | Based on design drawings     |
| Based_on_digging      | Based on test digging        |
| not clear             | not clear                    |

| Water System     | Domain9 (Data type = TEXT20)       |
|------------------|------------------------------------|
| Shwedagon_P_R    | Shwedagon Pagoda Reservoir         |
| Kokkine_R        | Kokkine Reservoir                  |
| Yaegu_PS         | Yaegu Pumping Station              |
| Hlawga_R         | Hlawga Reservoir                   |
| Gyobu_R          | Gyobu Reservoir                    |
| Nyaunghnapin_Ph1 | Nyaunghnapin WTP Phase1            |
| Nyaunghnapin_Ph2 | Nyaunghnapin WTP Phase2            |
| Thaephyu_WTP     | Thaephyu WTP                       |
| Lagunbyin_Z7_R   | Zone7 Reservoir from Lagunbyin WTP |
| Lagunbyin_Z8_R   | Zone8 Reservoir from Lagunbyin WTP |
| Central_R        | Central Reservoir                  |
| Yangonpauk_TW    | Yangonpauk Tube Well               |
| not clear        | not clear                          |

| Pavement type | Domain10 (Data type = TEXT15) |
|---------------|-------------------------------|
| Asphalt       | Asphalt Pavement              |
| Concrete      | Concrete Pavement             |
| Unpaved       | Unpaved                       |
| not clear     | not clear                     |

| Status(O/C) | Domain11 (Data type = TEXT15) |
|-------------|-------------------------------|
| Open        | Open                          |
| Close       | Close                         |
| OTHER       | OTHER                         |
| not clear   | not clear                     |

| Status(Working/not) | Domain12 (Data type = TEXT15) |
|---------------------|-------------------------------|
| Working             | Working                       |
| Not_woking          | Not woking                    |
| not clear           | not clear                     |

| Operating type | Domain13 (Data type = TEXT15) |
|----------------|-------------------------------|
| Manually       | Manually                      |
| Automatically  | Automatically                 |
| not clear      | not clear                     |

| Direction to open | Domain14 (Data type = TEXT15) |
|-------------------|-------------------------------|
| Clockwise         | Clockwise                     |
| Anticlockwise     | Anticlockwise                 |
| not clear         | not clear                     |

| Purpose (Valve)    | Domain15 (Data type = TEXT20) |
|--------------------|-------------------------------|
| Cut                | to cut off the flow           |
| Frow_control       | to control the flow           |
| Pressure_reduction | to reduce the pressure        |
| Check              | to check (non-return)         |
| OTHER              | OTHER                         |
| not clear          | not clear                     |

| Type (Valve) | Domain16 (Data type = TEXT15) |
|--------------|-------------------------------|
| Gate         | Gate(slucice)                 |
| Butterfly    | Butterfly                     |
| Ball         | Ball                          |
| Orifice      | Orifice                       |
| Needle       | Needle                        |
| Cone         | Cone                          |
| OTHER        | OTHER                         |
| not clear    | not clear                     |

| Measuring method (Pressure) | Domain17 (Data type = TEXT20) |
|-----------------------------|-------------------------------|
| Digital_recorder            | Portable digital recorder     |
| Papery_recorder             | Portable papery recorder      |
| Bourdon                     | Bourdon tube (visual)         |
| OTHER                       | OTHER                         |

| Tariff Category | Domain18 (Data type = TEXT20) |
|-----------------|-------------------------------|
| MDO             | Metered Domestic              |
| MCO             | Metered Commercial            |



## DMA

| ATR No. | Item          | Name          | Data Type | Unit | Default   | Remark |
|---------|---------------|---------------|-----------|------|-----------|--------|
| 1       | FID           | FID           | Object ID |      | (system)  |        |
| 2       | Shape         | Shape         | Geometry  |      | (system)  |        |
| 3       | Township_Name | Township Name | Domain2   |      | not clear |        |
| 4       | Ward_no       | Ward No.      | Short     | -    | null      |        |
| 5       | DMA_no        | DMA No.       | Text      | -    | null      |        |
| 6       | Shape_Length  | Shape_Length  | Double    | m    | (system)  |        |
| 7       | Shape_Area    | Shape_Area    | Double    | m2   | (system)  |        |
| 8       | NRW_Ratio     | NRW_Ratio     | Double    | %    | (system)  |        |
| 9       | NRW_P_Ratio   | NRW_P_Ratio   | Double    | %    | (system)  |        |
| 10      | NRW_C_Ratio   | NRW_C_Ratio   | Double    | %    | (system)  |        |
| 11      | NRW_Date      | NRW_Date      | Datetime  |      | null      |        |

## Ward

| ATR No. | Item          | Name          | Data Type | Unit | Default   | Remark |
|---------|---------------|---------------|-----------|------|-----------|--------|
| 1       | FID           | FID           | Object ID |      | (system)  |        |
| 2       | Shape         | Shape         | Geometry  |      | (system)  |        |
| 3       | Township_Name | Township Name | Domain2   |      | not clear |        |
| 4       | Ward_no       | Ward No.      | Short     | -    | null      |        |
| 5       | Shape_Length  | Shape_Length  | Double    | m    | (system)  |        |
| 6       | Shape_Area    | Shape_Area    | Double    | m2   | (system)  |        |

## Building

| ATR No. | Item          | Name          | Data Type | Unit | Default   | Remark |
|---------|---------------|---------------|-----------|------|-----------|--------|
| 1       | FID           | FID           | Object ID |      | (system)  |        |
| 2       | Shape         | Shape         | Geometry  |      | (system)  |        |
| 3       | Township_Name | Township Name | Domain2   |      | not clear |        |
| 4       | Ward_no       | Ward No.      | Short     | -    | null      |        |
| 5       | DMA_no        | DMA No.       | Text      | -    | null      |        |
| 6       | Address       | Address       | Text      | -    | null      |        |
| 7       | Condition     | Condition     | Domain20  |      | not clear |        |
| 8       | Shape_Length  | Shape_Length  | Double    | m    | (system)  |        |
| 9       | Shape_Area    | Shape_Area    | Double    | m2   | (system)  |        |

## Test Digging

| ATR No. | Item           | Name           | Data Type | Unit        | Default  | Remark |
|---------|----------------|----------------|-----------|-------------|----------|--------|
| 1       | FID            | FID            | Object ID |             | (system) |        |
| 2       | Shape          | Shape          | Geometry  |             | (system) |        |
| 3       | Digging_ID     | Digging ID     | Text      | -           | null     |        |
| 4       | Digging_date   | Digging Date   | Date      | -           | null     |        |
| 5       | Digging_report | Digging report | Text260   | (file path) | null     |        |

|           |                                 |
|-----------|---------------------------------|
| MEM       | Metered Employee                |
| MDD       | Metered Departmental Domestic   |
| MDC       | Metered Departmental Commercial |
| MFD       | Metered FE Domestic             |
| MFE       | Metered FE Commercial           |
| FDO       | Flat Rate Domestic              |
| FDD       | Flat Rate Departmental Domestic |
| FOC       | Free of Charge                  |
| not clear | not clear                       |

| Measuring method (Flow rate) | Domain19 (Data type = TEXT20) |
|------------------------------|-------------------------------|
| Electromagnetic              | Electromagnetic flowmeter     |
| Ultrasonic                   | Ultrasonic flowmeter          |
| Impeller                     | Impeller flowmeter            |
| Venturi                      | Venturi flowmeter             |
| Orifice-type                 | Orifice-type flowmeter        |
| Vortex                       | Vortex flowmeter              |
| OTHER                        | OTHER                         |

| Condition of building | Domain20 (Data type = TEXT30)        |
|-----------------------|--------------------------------------|
| Customer's            | YCDC-customer's building             |
| Long-term absent cust | Long-term absent customer's building |
| Non-customer's        | Non-YCDC-customer's building         |
| Empty building        | Empty building                       |
| Vacant lot            | Vacant lot                           |
| not clear             | not clear                            |

## Source Code of "Node-Matching Ver1.0.exe"

### 1) Execution software

SmallBasic(Microsoft)

"SmallBasicLibrary.dll" is required for execution.

### 2) Source Code

```
' Setting of variables
```

```
tolerance=0.1
```

```
JUNCTION_max_NO=1
```

```
PIPE_max_NO=1
```

```
NODE_max_NO=1
```

```
filename_read="C:¥tmp¥a.inp"
```

```
filename_write="C:¥tmp¥b.inp"
```

```
node[1][7] ="" '[1]=ID, [2]= x coordinate, [3]= y coordinate, [4]= Coordinate overlapping node
```

```
ID1, [5]= Coordinate overlapping node ID2, [6]= Coordinate overlapping node ID3, [7]=
```

```
Coordinate overlapping node ID4
```

```
pipe[1][4] ="" '[1]=ID, [2]=start node ID, [3]=end node ID, [4]=Length of pipe
```

```
'Title
```

```
TextWindow.WriteLine("Nodes matching for YCDC (Max=4nodes)")
```

```
TextWindow.WriteLine("C:¥tmp¥a.inp -> b.inp")
```

```
'GraphicsWindow.DrawText(10,10,"Nodes matching for YCDC (Max=4nodes)")
```

```
'Set of matching tolerance
```

```
TextWindow.Write("Tolerance(m)? (default=0.1m):")
```

```
tmp_str = TextWindow.Read()
```

```
tolerance = 0.1
```

```
if (tmp_str<>"" ) Then
```

```
    tolerance = tmp_str
```

```
endif
```

```
TextWindow.WriteLine("Tolerance : " + tolerance)
```

```
'Store the data line by line in the read array. If there is no change, write the data directly each time.
```

```
File.DeleteFile(filename_write)
```

```

'STEP1 read [JUNCTIONS]
i = 0
fileread_step01:
    i = i + 1
    lines[i] = File.ReadLine(filename_read, i)
    'TextWindow.WriteLine(lines[i])
    File.WriteLine(filename_write, i, lines[i])
    If (lines[i] <> "[JUNCTIONS]") Then
        Goto fileread_step01
    EndIf

fileread_step02:
    i = i + 1
    lines[i] = File.ReadLine(filename_read, i)
    If (Text.StartsWith(lines[i], ";")) Then
        'TextWindow.WriteLine(lines[i])
        File.WriteLine(filename_write, i, lines[i])
        Goto fileread_step02
    EndIf

fileread_step03:
    i = i + 1
    lines[i] = File.ReadLine(filename_read, i)
    If (lines[i] = "") Then
        TextWindow.WriteLine("Number of JUNCTIONs = " + JUNCTION_max_NO)
        Goto fileread_step04
    EndIf
    JUNCTION_max_NO = JUNCTION_max_NO + 1
    Goto fileread_step03

'STEP2 read [PIPES]
fileread_step04:
    i = i + 1
    lines[i] = File.ReadLine(filename_read, i)
    If (lines[i] <> "[PIPES]") Then
        Goto fileread_step04

```

```

EndIf
fileread_step05:
  i = i + 1
  lines[i] = File.ReadLine(filename_read, i)
  If (Text.StartsWith(lines[i], ";")) Then
    Goto fileread_step05
  EndIf
fileread_step06:
  'Storage of pipe[][1-4]
  'TextWindow.WriteLine("Check object = " + lines[i])
  'Tablocation(max 3 tabs) Tab=Text.GetCharacter(9)
  For j=1 To 3
    tab[j]=0
  EndFor
  le = Text.GetLength(lines[i])
  k=1
  For j=1 To le
    If (Text.GetSubText(lines[i], j, 1)=Text.GetCharacter(9)) Then
      tab[k]=j
      k=k+1
    EndIf
  EndFor
  'Storage of pipe[][1-4]
  pipe[PIPE_max_NO][1]=Text.GetSubText(lines[i], 1, tab[1]-1)
  pipe[PIPE_max_NO][2]=Text.GetSubText(lines[i], tab[1]+1, tab[2]-tab[1])
  pipe[PIPE_max_NO][3]=Text.GetSubText(lines[i], tab[2]+1, tab[3]-tab[2])
  pipe[PIPE_max_NO][4]=Text.GetSubText(lines[i], tab[3]+1, 20)
  'TextWindow.WriteLine("Results of storage = " + pipe[PIPE_max_NO][1] + ", "+
pipe[PIPE_max_NO][2] + ", " + pipe[PIPE_max_NO][3] + ", " + pipe[PIPE_max_NO][4])

  i = i + 1
  lines[i] = File.ReadLine(filename_read, i)
  If (lines[i] = "") Then
    TextWindow.WriteLine("Number of PIPES = " +PIPE_max_NO)
    Goto fileread_step07
  EndIf

```

```

PIPE_max_NO=PIPE_max_NO + 1
Goto fileread_step06

' STEP3 read [COORDINATES]
fileread_step07:
    i = i + 1
    lines[i] = File.ReadLine(filename_read, i)
    If (lines[i] <> "[COORDINATES]") Then
        Goto fileread_step07
    EndIf
fileread_step08:
    i = i + 1
    lines[i] = File.ReadLine(filename_read, i)
    If (Text.StartsWith(lines[i], ";")) Then
        Goto fileread_step08
    EndIf
fileread_step09:
    'Storage of node[][1-3]
    'TextWindow.WriteLine("Check object = " + lines[i])
    'Tab location(Max 2 tabs)  Tab=Text.GetCharacter(9)
    For j=1 To 2
        tab[j]=0
    EndFor
    le = Text.GetLength(lines[i])
    k=1
    For j=1 To le
        If (Text.GetSubText(lines[i], j, 1)=Text.GetCharacter(9)) Then
            tab[k]=j
            k=k+1
        EndIf
    EndFor
    'node[][1-3]格納
    node[NODE_max_NO][1]=Text.GetSubText(lines[i], 1, tab[1]-1)
    node[NODE_max_NO][2]=Text.GetSubText(lines[i], tab[1]+1, tab[2]-tab[1])
    node[NODE_max_NO][3]=Text.GetSubText(lines[i], tab[2]+1, 20)
    'TextWindow.WriteLine("Result of storage = " + node[NODE_max_NO][1] + ", "+

```

```

node[NODE_max_NO][2] +", " + node[NODE_max_NO][3])

i = i + 1
lines[i] = File.ReadLine(filename_read, i)
If (lines[i] = "") Then
    TextWindow.WriteLine("Number of NODEs = " +NODE_max_NO)
    Goto node_matching
EndIf
NODE_max_NO=NODE_max_NO + 1
Goto fileread_step09

' STEP4 Matching of neighboring nodes
node_matching:
    For j=1 To NODE_max_NO
        l=4
        For k=1 To NODE_max_NO
            If (j<>k) Then
                If ((Math.Abs(node[j][2]-node[k][2])<tolerance)And(Math.Abs(node[j][3]-
node[k][3])<tolerance)) Then
                    node[j][l] = k
                    l=l+1
                EndIf
            EndIf
        EndFor
    EndFor

    TextWindow.WriteLine("Result of Matching ")
    For j=1 To NODE_max_NO
        ' TextWindow.WriteLine(node[j][1] + "=" +node[j][4] + ", " +node[j][5] + ", " +node[j][6] + ", "
+node[j][7])
    EndFor
    TextWindow.WriteLine("Matching Done")

'STEP5 File output after matching (set the node number to the larger one)
'STEP6 Write [JUNCTIONS]

```



```

For j=1 To NODE_max_NO
    if
(node[j][1]>node[j][4])and(node[j][1]>node[j][5])and(node[j][1]>node[j][6])and(node[j][1]>node[
j][7]) then
        File.AppendContents(filename_write, j)
    EndIf
EndFor
File.AppendContents(filename_write, "")

'STEP7 Write [PIPES]
File.AppendContents(filename_write, "[PIPES]")
File.AppendContents(filename_write, ";ID          Node1          Node2
Length")
For j=1 To PIPE_max_NO
    node_start = pipe[j][2]
    k = pipe[j][2]
    'TextWindow.WriteLine(pipe[j][2] + "," +node[1][4])
    'TextWindow.WriteLine(pipe[j][2] + "," +node[Math.Abs(k)][4] + ", " +node[k][5] + ", "
+node[k][6] + ", " +node[k][7])
    node_start = Math.Max(node_start, node[Math.Abs(k)][4])
    node_start = Math.Max(node_start, node[Math.Abs(k)][5])
    node_start = Math.Max(node_start, node[Math.Abs(k)][6])
    node_start = Math.Max(node_start, node[Math.Abs(k)][7])
    node_end = pipe[j][3]
    k = pipe[j][3]
    node_end = Math.Max(node_end, node[Math.Abs(k)][4])
    node_end = Math.Max(node_end, node[Math.Abs(k)][5])
    node_end = Math.Max(node_end, node[Math.Abs(k)][6])
    node_end = Math.Max(node_end, node[Math.Abs(k)][7])
    le=Text.Append(pipe[j][1],Text.GetCharacter(9))
    le=Text.Append(le,node_start)
    le=Text.Append(le,Text.GetCharacter(9))
    le=Text.Append(le,node_end)
    le=Text.Append(le,Text.GetCharacter(9))
    le=Text.Append(le,pipe[j][4])
    File.AppendContents(filename_write, le)

```

```

EndFor
File.AppendContents(filename_write, "")

' STEP8 Write [COORDINATES]
File.AppendContents(filename_write, "[COORDINATES]")
File.AppendContents(filename_write, ";Node           X-Coord           Y-Coord")
For j=1 To NODE_max_NO
    If (node[j][1]>node[j][4]) and (node[j][1]>node[j][5]) and (node[j][1]>node[j][6]) and
(node[j][1]>node[j][7]) then
        le=Text.Append(node[j][1],Text.GetCharacter(9))
        le=Text.Append(le,node[j][2])
        le=Text.Append(le,Text.GetCharacter(9))
        le=Text.Append(le,node[j][3])
        File.AppendContents(filename_write, le)
    EndIf
EndFor
File.AppendContents(filename_write, "")

' STEP9 Write [VERTICES] & etc.
fileread_step10:
    i = i + 1
    lines[i] = File.ReadLine(filename_read, i)
    If (lines[i] = "") Then
        Goto fileread_step11
    EndIf
    File.AppendContents(filename_write, lines[i])
    Goto fileread_step10

fileread_step11:
    File.AppendContents(filename_write, "")
    TextWindow.WriteLine("File Writing Done")

```