## Appendix 6: Other Relevant Data

Data 1.　Result of Boring Survey in Nyaunghnapin First Phase WTP

The number of the target locations for boring survey is 5 and the soil boring log is shown in Figure 6.1.2. The N value of silty clay layer with depth 5 to 6 meters ranges N2 to N9 and it is soft soil layer. It is assumed that the supporting layer is silty sand layer 16 to 17 meters deep. In this location, since the soil condition is soft and depth of the supporting layer is deep, it is necessary to consider pipe foundation.

The groundwater level in 5 locations for boring survey ranges 1.9 to 2.3 meters under surface. This survey was carried out in dry season and it is assumed that the groundwater level is deep. There are ponds and paddy field in the surrounding area and it is assumed that the groundwater level is raised in rainy season. Moreover, it is poorly drained and it might be flood in the rainy season. Therefore, it is necessary to study floor level to prevent flood.

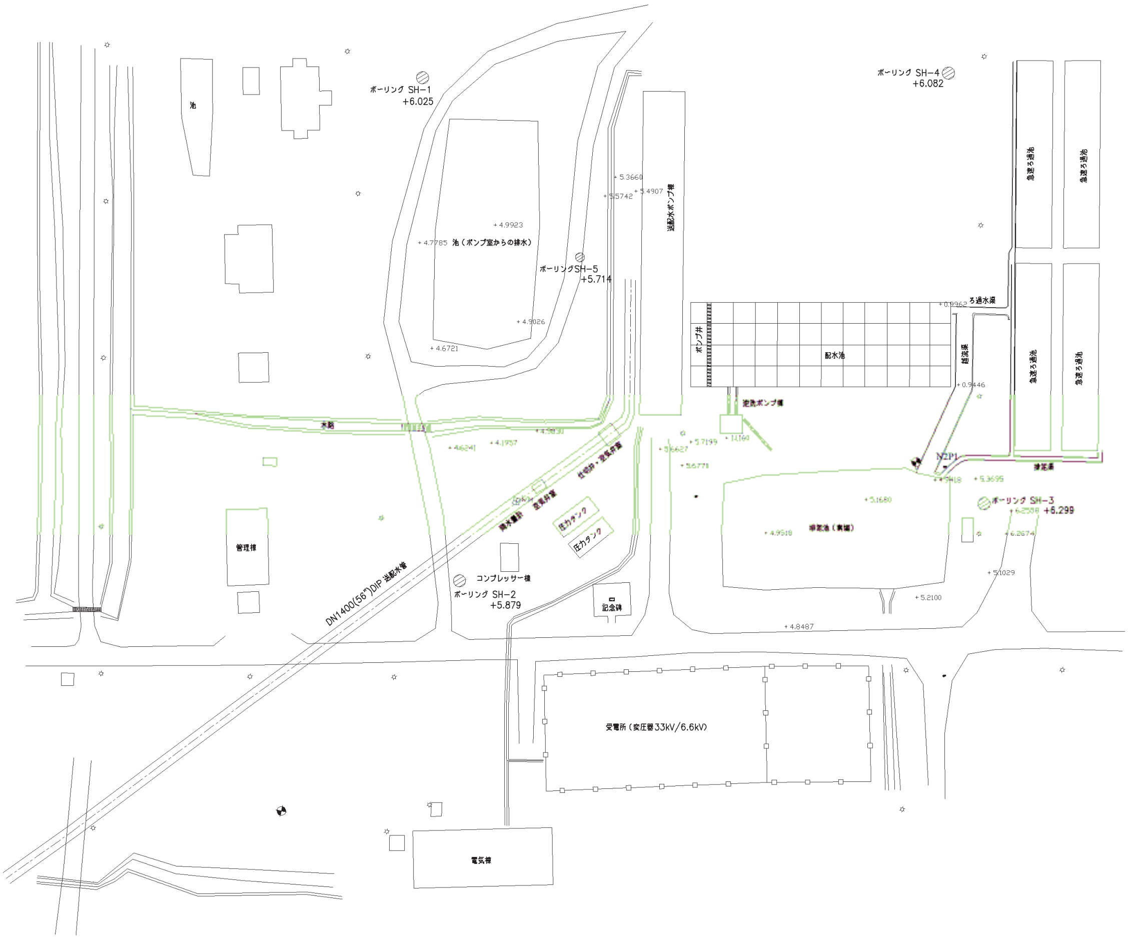


Figure 6.1.1　Location of Boring Survey (Nyaunghnapin First Phase WTP)

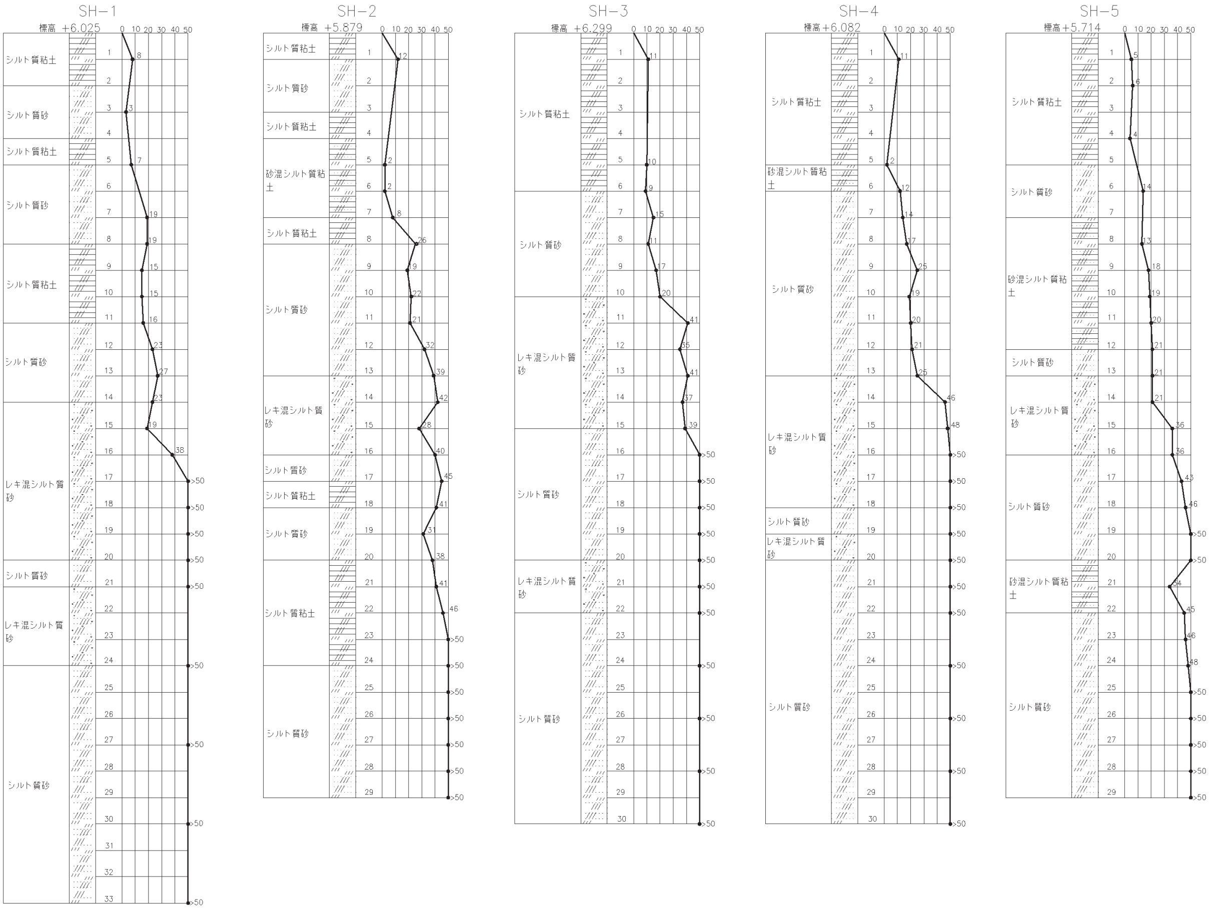


**Figure 6.1.2 Soil Boring Log (Nyaunghnapin First Phase WTP)**

## Data 2. Result of Trial Excavation Survey in Yankin Township

In order to understand the excavated soil condition in the time of pipe laying work, the trial excavation was carried out in 7 locations along with the route of pipe renewal in Yankin Township. The location map for trial excavation is shown below.

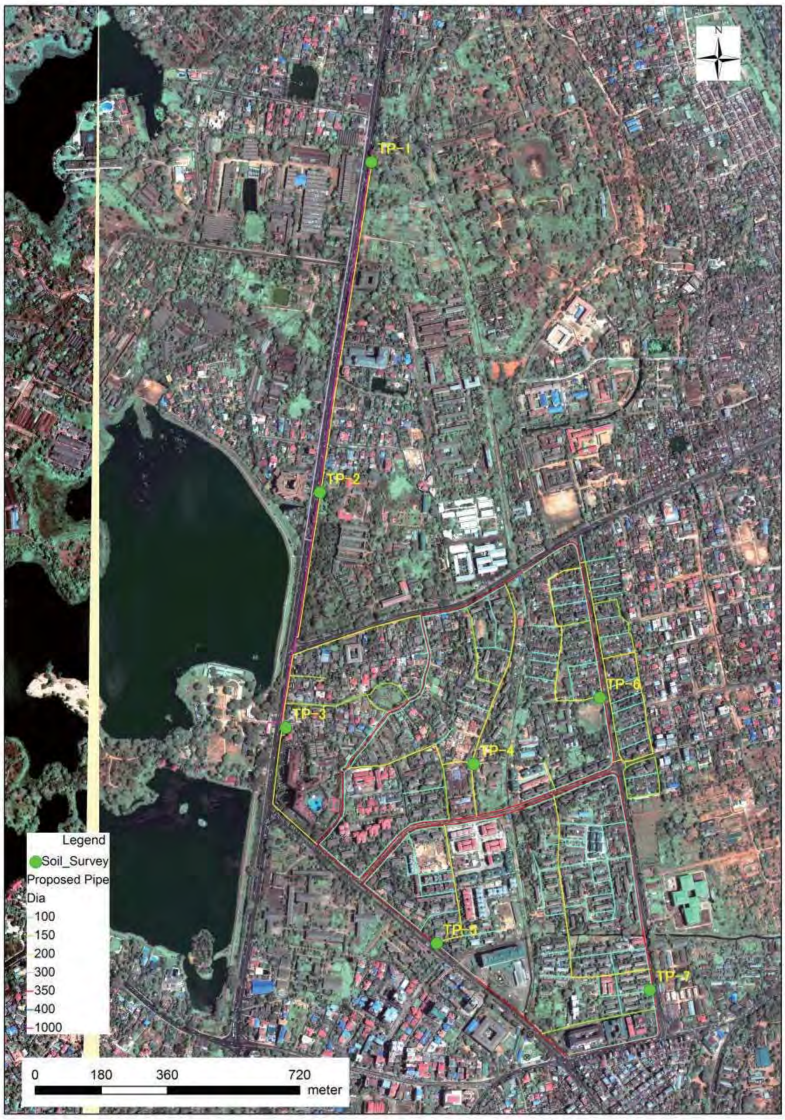


**Figure 6.2.1 Location Map of Trial Excavation**

According to the result of trial excavation, it consists mostly of silty clay. In pipe laying work, the excavation of rock is not considered. The groundwatrer is observed; however, it is judged that dewatering work is not required.

## Trial Pit Logging

| | | | |
|---|---|---|---|
| Project | : The Improvement Of Water Supply | Date | : 17. 03. 2013 |
| Location | : Yankin Township | Trial Pit No | : TP - 01 |
| Coordinates | : N 1864286.4, E 197414.95 | Trial Pit Depth (m) | : 1.5 m |
| Elevation (m) | : 12.38 m | Water Level (m) | : Nil |
| Excavation Method | : By Hand | Logged By | : Soe Min Naing |

| Depth (m) | Graphic Log | Sample photo | Elevation (m) | Soil and Rock Description | Remark |
|---|---|---|---|---|---|
| 0.1<br>0.2<br>0.3<br>0.4<br>0.5<br>0.6<br>0.7<br>0.8<br>0.9 0.9 | ▥ |  | 11.48 | Top Soil layer<br>landfill with some roots.<br>( 0.0 m ~ 0.9 m ) | Excavation effort is difficult. |
| 1.0<br>1.1<br>1.2 1.2 | 🟧 | | 11.18 | Yellowish brown,dry, medium plastic,<br>Silty **CLAY** with lateritic soil.<br>( 0.9 m ~ 1.2 m ) | Excavation effort is difficult. |
| 1.3<br>1.4<br>1.5 1.5 | 🟥 | | 10.88 | Reddish brown,dry, medium plastic,<br>Silty **CLAY** with lateritic soil.<br>( 1.2 m ~ 1.5 m ) | Excavation effort is difficult. |

Depth to bottom of hole : 1.5 m.

**Figure 6.2.2 Result of Trial Excavation (TP-01)**

## Trial Pit Logging

| | | | |
|---|---|---|---|
| Project | : The Improvement Of Water Supply | Date | : 17. 03. 2013 |
| Location | : Yankin Township | Trial Pit No | : TP - 02 |
| Coordinates | : N 1863406.74, E 197275.01 | Trial Pit Depth (m) | : 1.5 m |
| Elevation (m) | : 11.29 | Water Level (m) | : 1.0 m |
| Excavation Method | : By Hand | Logged By | : PHYO KO KO Oo |

| Depth (m) | Graphic Log | Sample Photo | Elevation (m) | Soil and Rock Description | Remark |
|---|---|---|---|---|---|
| 0.2 | |  | 11.09 | Reddish brown, dry, top soil layer is landfill.<br>( 0.0 m ~ 0.2 m ) | Excavation effort is difficult. |
| 0.5 | | | 10.79 | Grey, moist, medium plastic, Silty CLAY with some lateritic soil.<br>( 0.2 m ~ 0.5 m ) | Excavation effort is moderate. |
| 1.5 | | | 9.79 | Grey, wet, medium plastic, Silty CLAY with lateritic soil.<br>( 0.5 m ~ 1.5 m ) | Excavation effort is moderate. |

Depth to bottom of hole : 1.5 m.

**Figure 6.2.3 Result of Trial Excavation (TP-02)**

## Trial Pit Logging

| | | | |
|---|---|---|---|
| Project | : The Improvement Of Water Supply | Date | : 17. 03. 2013 |
| Location | : Yankin Township | Trial Pit No | : TP - 03 |
| Coordinates | : N 1862816.39, E 197173.24 | Trial Pit Depth (m) | : 1.5 m |
| Elevation (m) | : 15.93 | Water Level (m) | : 1.2 m |
| Excavation Method | : By Hand | Logged By | : Phyo Ko Ko Oo |

| Depth (m) | | Graphic Log | Sample Photo | Elevation (m) | Soil and Rock Description | Remark |
|---|---|---|---|---|---|---|
| 0.2 | 0.1<br>0.2 | ░ |  | 15.73 | Grey, dry, non plastic, **Silty SAND** with some roots. ( 0.0 m ~ 0.2 m ) | Excavation effort is easy. |
| 0.5 | 0.3<br>0.4<br>0.5 | ░ | | 15.43 | Grey, moist, non plastic, **Silty SAND**. ( 0.2 m ~ 0.5 m ) | Excavation effort is easy. |
| 0.9 | 0.6<br>0.7<br>0.8<br>0.9 | ▤ | | 15.03 | Reddish brown, moist, medium plastic, **Clayey SILT** with a little amount of sand. ( 0.5 m ~ 0.9 m ) | Excavation effort is easy. |
| 1.5 | 1.0<br>1.1<br>1.2<br>1.3<br>1.4<br>1.5 | ▤ | | 14.43 | Reddish brown, wet, medium plastic, **Clayey SILT** with a little amount of sand. ( 0.9 m ~ 1.5 m ) | Excavation effort is easy. |

Depth to bottom of hole : 1.5 m.

Figure 6.2.4 Result of Trial Excavation (TP-03)

## Trial Pit Logging

| | | | |
|---|---|---|---|
| Project | : The Improvement Of Water Supply | Date | : 17. 03. 2013 |
| Location | : Yankin Township | Trial Pit No | : TP - 04 |
| Coordinates | : N 1862680.19, E 197685.02 | Trial Pit Depth (m) | : 1.5 m |
| Elevation (m) | : 11.30 (CD) | Water Level (m) | : Nil |
| Excavation Method | : By Hand | Logged By | : Wai Phyo Aung |

| Depth (m) | | Graphic Log | Sample Photo | Elevation (m) | Soil and Rock Description | Remark |
|---|---|---|---|---|---|---|
| 0.2 | 0.1<br>0.2 | ▦ |  | 11.10 | Reddish brown, dry, top soil layer landfill. ( 0.0 m ~ 0.2 m ) | Excavation effort is difficult. |
| 1.5 | 0.3<br>0.4<br>0.5<br>0.6<br>0.7<br>0.8<br>0.9<br>1.0<br>1.1<br>1.2<br>1.3<br>1.4<br>1.5 | ▤ |  | 9.80 | Reddish brown, dry, medium plastic, **Clayey SILT** and lateritic soil. ( 0.2 m ~ 1.5 m ) | Excavation effort is moderate. |

Depth to bottom of hole : 1.5 m.

**Figure 6.2.5 Result of Trial Excavation (TP-04)**

# Trial Pit Logging

Project : The Improvement Of Water Supply
Location : Yankin Township
Coordinates : N 1862159.64, E 197595.42
Elevation (m) : 9.39 m
Excavation Method : By Hand

Date : 17. 03. 2013
Trial Pit No : TP - 05
Trial Pit Depth (m) : 1.5 m
Water Level (m) : 0.6 m
Logged By : Wai Phyo Aung

| Depth (m) | | Graphic Log | Sample Photo | Elevation (m) | Soil and Rock Description | Remark |
|---|---|---|---|---|---|---|
| 0.2 | 0.1<br>0.2 | ■ |  | 9.19 | Dark grey, moist, non plastic, **Silty SAND** with some peat and roots.<br>( 0.0 m ~ 0.2 m ) | Excavation effort is easy. |
| 1.0 | 0.3<br>0.4<br>0.5<br>0.6<br>0.7<br>0.8<br>0.9<br>1.0 | ▨ | | 8.39 | Yellowish brown, wet, medium plastic, **Silty SAND** with clay.<br>( 0.2 m ~ 1.0 m ) | Excavation effort is easy. |
| 1.5 | 1.1<br>1.2<br>1.3<br>1.4<br>1.5 | ▨ | | 7.89 | Yellowish brown, wet, medium plastic, Silty SAND with some clay.<br>( 0.2 m ~ 1.0 m ) | Excavation effort is easy. |

Figure 6.2.6 Result of Trial Excavation (TP-05)

## Trial Pit Logging

| | | | |
|---|---|---|---|
| Project | : The Improvement Of Water Supply | Date | : 17. 03. 2013 |
| Location | : Yankin township, | Trial Pit No | : TP - 06 |
| Coordinates | : N 1862026.42, E 198156.83 | Trial Pit Depth (m) | : 1.5 m |
| Elevation (m) | : 8.29 | Water Level (m) | : 1.0 m |
| Excavation Method | : By Hand | Logged By | : Wai Phyo Aung |

| Depth (m) | Graphic Log | Sample Photo | Elevation (m) | Soil and Rock Description | Remark |
|---|---|---|---|---|---|
| 0.1<br>0.2 0.2 | ■ |  | 8.09 | Reddish brown, non plastic, **Silty SAND** with fine gravels, peat and some roots.<br>( 0.0 m ~ 0.2 m ) | Excavation effort is easy. |
| 0.3<br>0.4<br>0.5<br>0.6<br>0.7<br>0.8<br>0.9<br>1.0<br>1.1<br>1.2<br>1.3<br>1.4<br>1.5 1.5 | ▥ |  | 6.79 | Yellowish brown, medium plastic, **Silty CLAY** with little sand.<br>(0.2 m ~ 1.5 m ) | Excavation effort is easy. |

Depth to bottom of hole : 1.5 m.

**Figure 6.2.7 Result of Trial Excavation (TP-06)**

# Trial Pit Logging

| | | | |
|---|---|---|---|
| Project | : The Improvement Of Water Supply | Date | : 17. 03. 2013 |
| Location | : Yankin township, | Trial Pit No | : TP - 07 |
| Coordinates | : N 1862805.23, E 198028.89 | Trial Pit Depth (m) | : 1.5 m |
| Elevation (m) | : 9.82 m | Water Level (m) | : 1.2 m |
| Excavation Method | : By Hand | Logged By | : Phyo Ko Ko Oo |

| Depth (m) | | Graphic Log | Sample Photo | Elevation (m) | Soil and Rock Description | Remark |
|---|---|---|---|---|---|---|
| 0.1 | 0.1 | ▦ |  | 9.72 | Reddish brown,Top Soil landfill.<br>( 0.0 m ~ 0.1 m ) | Excavation effort is difficult. |
| 0.7 | 0.2<br>0.3<br>0.4<br>0.5<br>0.6<br>0.7 | ▨ | | 9.12 | Grey, dry, non plastic, S**ilty SAND** with fine gravels and roots.<br>( 0.1 m ~ 0.7 m ) | Excavation effort is moderate. |
| 1.5 | 0.8<br>0.9<br>1.0<br>1.1<br>1.2<br>1.3<br>1.4<br>1.5 | ▨ | | 8.32 | Grey, moist, non plastic, **Silty SAND** with fine gravels and roots.<br>( 0.7 m ~ 1.5 m ) | Excavation effort is moderate. |
| Depth to bottom of hole : 1.5 m. | | | | | | |

Figure 6.2.8 Result of Trial Excavation (TP-07)

## Table 6.2.1 Result of Trial Excavation (1)

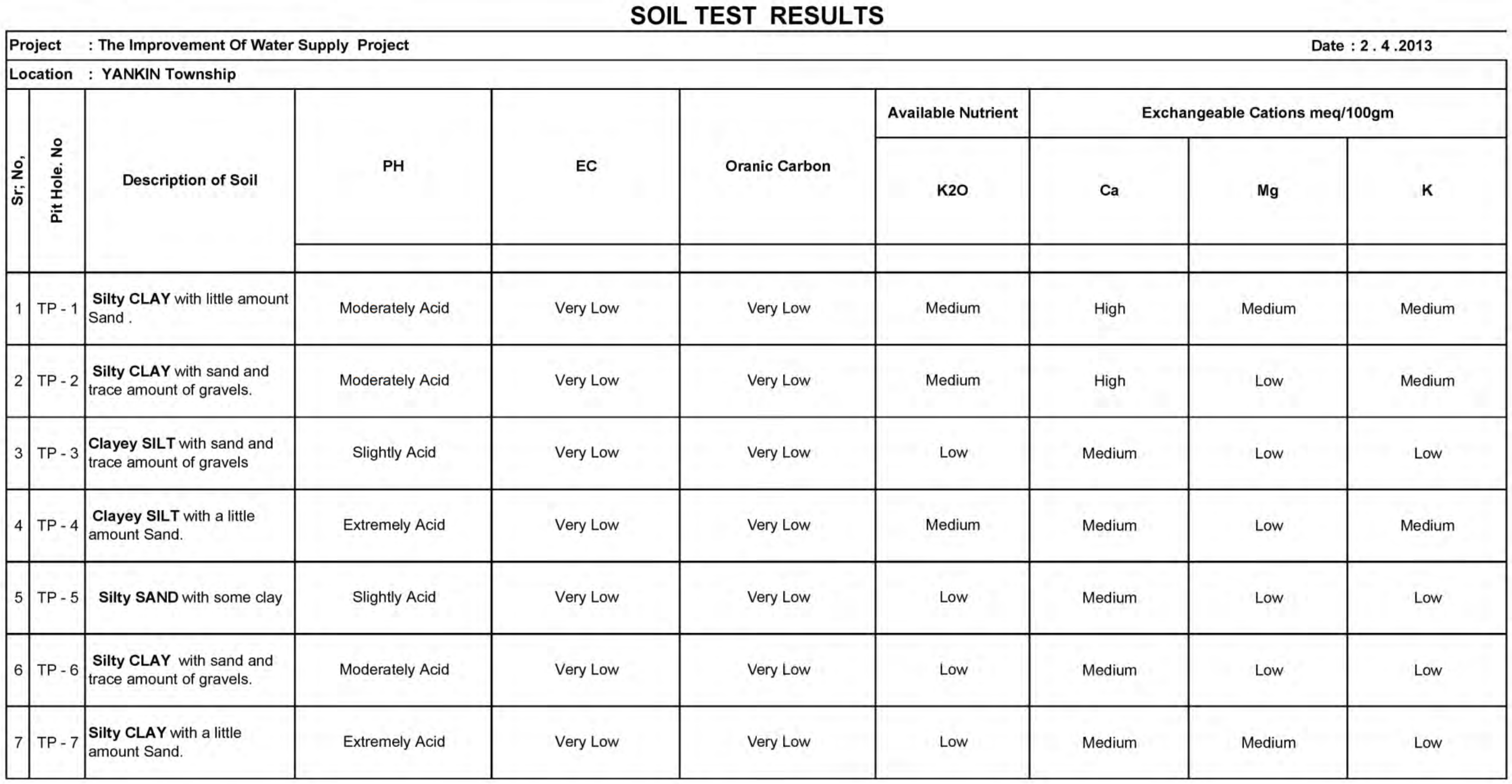
## SOIL TEST RESULTS

Project : The Improvement Of Water Supply Project  Date : 2 . 4 .2013

Location : YANKIN Township

| Sr; No, | Pit Hole. No | Description of Soil | Humus | Grain Size Analysis | | | | Oranic Carbon | PH | EC | Moisture | Bulk density | Dry density | Available Nutrient | Water Soluble Cl | Water Soluble SO4 | Exchangeable Cations meq/100gm | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Gravel | Sand | Silt | Clay | | | | | | | $K_2O$ | | | Ca | Mg | K |
| | | | ( % ) | ( % ) | ( % ) | ( % ) | ( % ) | ( % ) | | | ( % ) | g/cm$^3$ | g/cm$^3$ | mg/100g | meq/100gm | meq/100gm | | | |
| 1 | TP - 1 | **Silty CLAY** with little amount Sand . | 0.483 | 0.50 | 12.20 | 87.30 | | 0.280 | 5.55 | 0.101 | 12.43 | 1.510 | 1.340 | 17.82 | 0.358 | 0.634 | 12.650 | 2.664 | 0.379 |
| 2 | TP - 2 | **Silty CLAY** with sand and trace amount of gravels. | 0.069 | 2.90 | 31.80 | 65.30 | | 0.040 | 5.46 | 0.133 | 20.97 | 1.800 | 1.490 | 16.51 | 0.438 | 0.733 | 10.650 | 0.666 | 0.351 |
| 3 | TP - 3 | **Clayey SILT** with sand and trace amount of gravels | 1.560 | 0.60 | 28.70 | 70.70 | | 0.906 | 6.16 | 0.107 | 16.86 | 1.490 | 1.280 | 7.87 | 0.358 | 0.654 | 8.66 | 0.666 | 0.167 |
| 4 | TP - 4 | **Clayey SILT** with a little amount Sand. | 0.412 | 0.00 | 6.90 | 93.10 | | 0.239 | 3.79 | 0.127 | 12.15 | 1.520 | 1.360 | 17.17 | 0.716 | 0.634 | 6.660 | 1.330 | 0.366 |
| 5 | TP - 5 | **Silty SAND** with some clay | 0.269 | 0.00 | 57.30 | 42.70 | | 0.156 | 6.08 | 0.104 | 22.34 | 1.610 | 1.320 | 4.81 | 0.557 | 0.673 | 6.670 | 0.660 | 0.102 |
| 6 | TP - 6 | **Silty CLAY** with sand and trace amount of gravels. | 0.612 | 4.70 | 30.80 | 64.50 | | 0.355 | 5.31 | 0.140 | 21.23 | 1.530 | 1.260 | 8.50 | 0.438 | 0.812 | 9.99 | 0.660 | 0.181 |
| 7 | TP - 7 | **Silty CLAY** with a little amount Sand. | 0.746 | 0.00 | 5.90 | 94.10 | | 0.433 | 4.01 | 0.113 | 18.95 | 1.670 | 1.40 | 7.27 | 0.498 | 0.773 | 5.33 | 1.998 | 0.155 |

Table 6.2.2 Result of Trial Excavation (2)



## SOIL TEST RESULTS

Project : The Improvement Of Water Supply Project
Date : 2 . 4 .2013

Location : YANKIN Township

| Sr; No, | Pit Hole. No | Description of Soil | PH | EC | Oranic Carbon | Available Nutrient | Exchangeable Cations meq/100gm | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | K2O | Ca | Mg | K |
| 1 | TP - 1 | **Silty CLAY** with little amount Sand . | Moderately Acid | Very Low | Very Low | Medium | High | Medium | Medium |
| 2 | TP - 2 | **Silty CLAY** with sand and trace amount of gravels. | Moderately Acid | Very Low | Very Low | Medium | High | Low | Medium |
| 3 | TP - 3 | **Clayey SILT** with sand and trace amount of gravels | Slightly Acid | Very Low | Very Low | Low | Medium | Low | Low |
| 4 | TP - 4 | **Clayey SILT** with a little amount Sand. | Extremely Acid | Very Low | Very Low | Medium | Medium | Low | Medium |
| 5 | TP - 5 | **Silty SAND** with some clay | Slightly Acid | Very Low | Very Low | Low | Medium | Low | Low |
| 6 | TP - 6 | **Silty CLAY** with sand and trace amount of gravels. | Moderately Acid | Very Low | Very Low | Low | Medium | Low | Low |
| 7 | TP - 7 | **Silty CLAY** with a little amount Sand. | Extremely Acid | Very Low | Very Low | Low | Medium | Medium | Low |

Data 3. Study on Water Hammer for Transmission and Distribution Pump in Nyaunghnapin First Phase WTP (Analysis of Water Hammer Prevention)

# Water Hammer Analysis and Countermeasure

## 1. General

The Water/Transmission/Distribution Pump Station in Nyaunghnapin First phase WTP supplies water to the Yangon downtown area at a distance of about 40 km through the water transmission pipeline. When power failure has happens, the water transmission pumps stops suddenly. Then water hammer generates in the water transmission pipeline and result in water column separation and backflow. As a result of it, the said pump station and pipeline are damaged.

In order to avoid such damages, the water hammer analysis is made and water hammer preventive measures are made based on the water hammer analysis.

## 2. Water Transmission Pipeline Route and Pipeline Materials

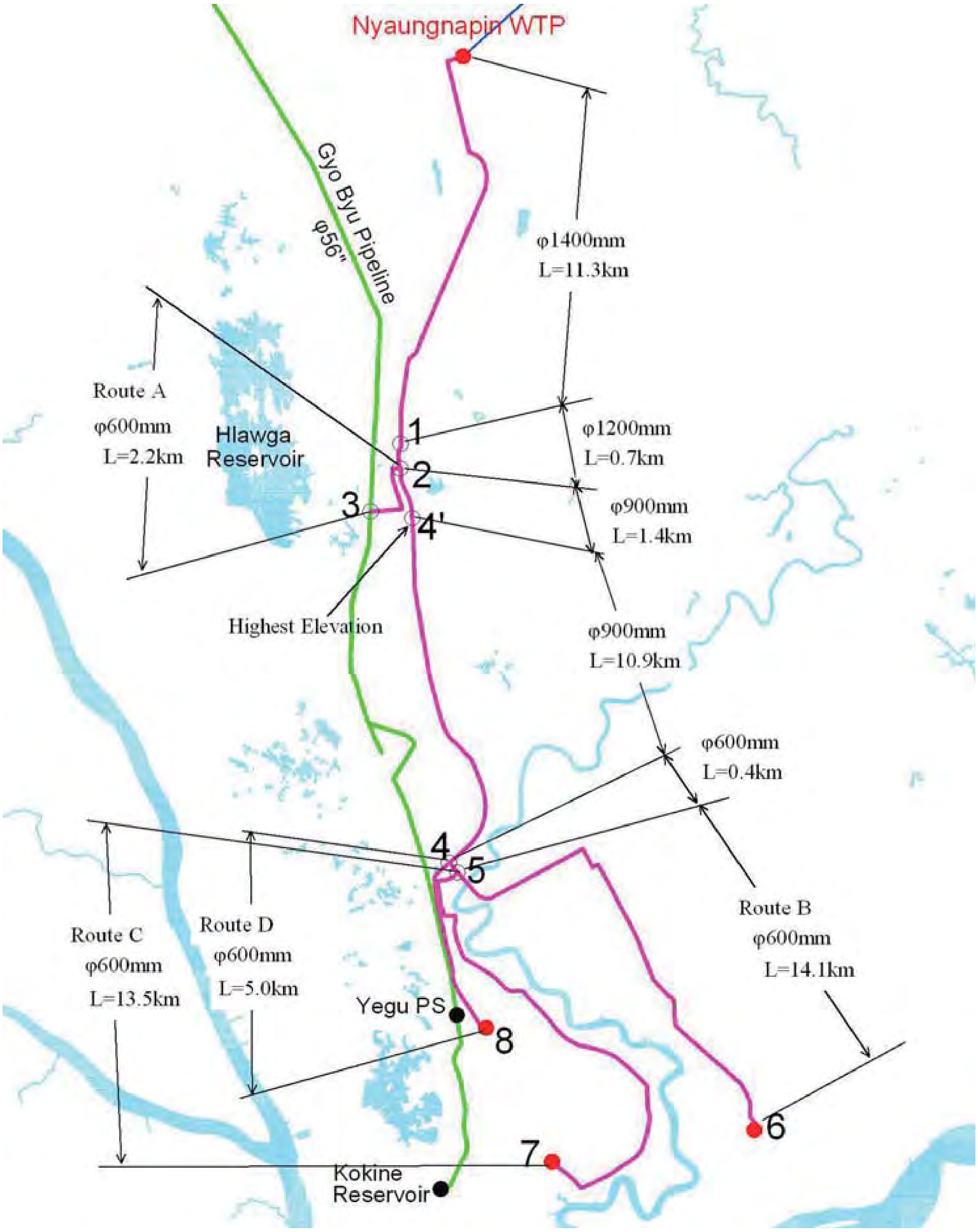
The water transmission pipeline route is shown below. On the elevation of the pipeline essential for water hammer analysis between the pump station and the maximum highest point (Node 4'), topographic survey was made. Meanwhile on the elevation of the pipeline between maximum highest point and the end points (Node 6, 7 & 8), GIS data were used for water hammer analysis.

The materials for the pipeline are as follows;

-Main pipeline from Pump Station to Node 1: Steel Pipe
-Main pipeline from Node 1 to the ends (Node 6, 7 & 8): Pre-stressed Concrete Pipe
-Branch pipeline from Node 2 to Node 3: Ductile Iron Pipe

The water analysis was made based on the abovementioned materials.

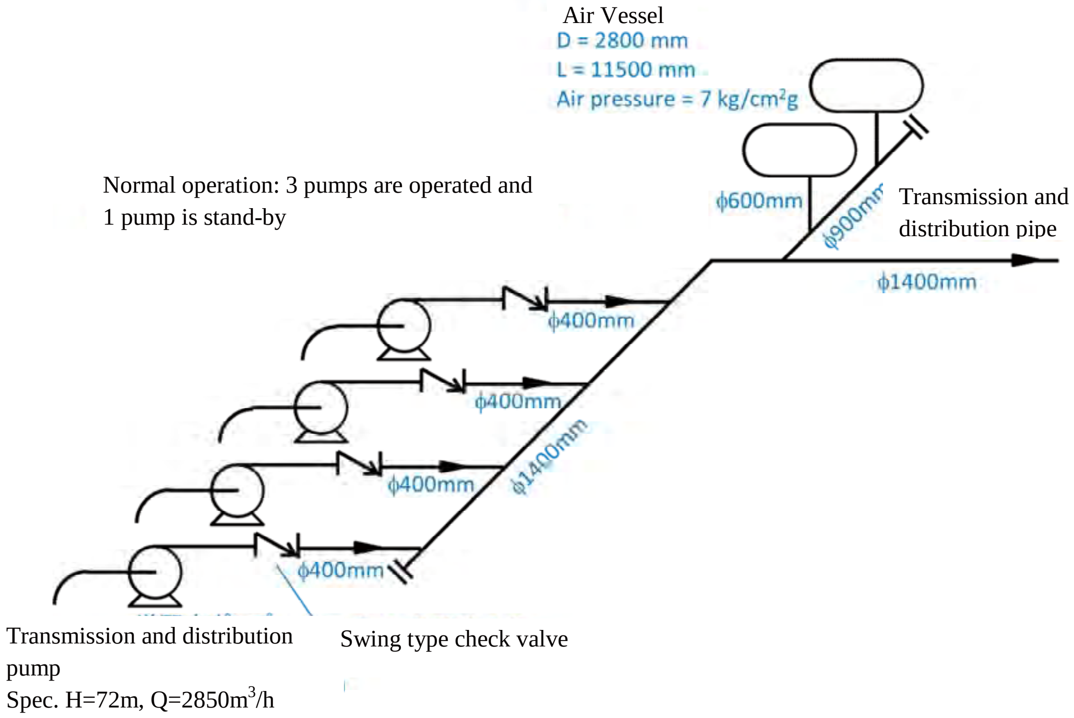
Water Transmission Pipeline Route



## 3. Existing Water Transmission/Distribution Pump Station

The schematic plan for the existing pump station system is shown below.

Nyaunghnapin First phase WTP Water Transmission/Distribution Pump Station System



As shown in the above figure, the existing pump station has two air vessels for water hammer prevention. Therefore water hammer analysis for the existing pump station is made with these two air vessels.

## 4. Flow Rate of Water Transmission/Distribution Pipeline

The flow rates were measured at a few points of the water treatment plant and the water transmission pipeline in order to grasp the flow rate in the water transmission pipeline. The flow rate of each Node was estimated based on the measured data and the capacity (204,500 $m^3$/day) of the water treatment plant. The result of it is shown below;

-Node 2: 1,313 $m^3$/hr
-Node 3: 3,333 $m^3$/hr
-Node 6:    979 $m^3$/hr
-Node 7: 1,033 $m^3$/hr
-Node 8: 1,863 $m^3$/hr

The water hammer analysis is made based on the above flow rate.

## 5. Water Hammer Analysis for Existing Water Transmission/Distribution System

The water hammer analysis for the existing water transmission/distribution system was made based on the above clause 3 & 4. The result of water hammer analysis for water transmission pipeline up to each Node is shown in Figure 6.3.1 to 6.3.4. The location where the maximum negative pressure occurs and its value are shown the below table.

| Pipeline Route of Water Hammer Analysis | Location of Max. Negative Pressure | Max. Negative Pressure | Remarks |
|---|---|---|---|
| From Pump Station to Node 3 | Around Node 2 | －7.9m | Refer to Attachment (Figure-6.3.4) |
| From Pump Station to Node 6 | Around Node 4‘（Highest Point） | －9.7m | Refer to Attachment (Figure-6.3.1) |
| | Around 7 km upper stream from Node 6 | －7.0m | Refer to Attachment (Figure-6.3.1) |
| From Pump Station to Node 7 | Around Node 4‘（Highest Point） | －9.7m | Refer to Attachment (Figure-6.3.2) |
| | Around 6.5 km upper stream from Node 7 | －7.0m | Refer to Attachment (Figure-6.3.2) |
| From Pump Station to Node 8 | Around Node 4‘（Highest Point） | －9.7m | Refer to Attachment (Figure-6.3.3) |

From the above table, the locations where water column separation may occur are four places as shown below;

1) Around Node 2 (Max. negative pressure: －7.9 m)
2) Around Node 4’(Highest point) (Max. negative pressure: －9.7 m)
3) Around 7 km upper stream from Node 6 (Max. negative pressure: －7.0 m)
4) Around 6.5 km upper stream from Node 7 (Max. negative pressure: －7.0 m)

## 6. Countermeasure for Water Hammer Prevention

When the temperature of clear water is 30℃, clear water evaporates below －9.9m of negative pressure. However, countermeasures for water hammer prevention are taken when water pressure becomes below －7.0 m of negative pressure taking safety factor into consideration.

Based on water hammer analysis described in the above clause 5, air valves at four places, where water column separation may occur, are installed. Accordingly water pressure at four places increase and no column separation occurs.

Meanwhile, the negative pressure between the pump station and the air vessels shows －3.0 m, Although no water column separation occurs at this place, the air valves shall be provided as back-up of air supply by the air vessels.

Finally the air valves are installed at five places. The installation places of the air valves are shown below.

| Number of Air Valve | Installation Place |
|---|---|
| Air Valve1 | Between Pump Station and Air Vessels |
| Air Valve2 | Approx. 0.5 m upstream from Node 2 |
| Air Valve3 | Around Node 4‘（highest elevation of pipeline） |
| Air Valve4 | Approx. 7 km upstream from Node 6 |
| Air Valve5 | Approx. 6.5 km upstream from Node 7 |

Meanwhile, when power failure happens at the pump station, backflow is generated and water hammer occurs by delay of shutoff of the check valve. As a result of it, water pressure is increased at upstream of the check valve. To avoid it, the swing type quick shutoff water hammer free check valve with counterweight and bypass valve is used instead of the existing swing type check valve. The water hammer free check valve has no pressure increase due to backflow when power failure happens.

## 7. Water Hammer Analysis after Countermeasure for Water Hammer Prevention

When the countermeasure shown in the above clause 6 is taken, the analysis of water hammer is made from the pump station to each Node. The result of analysis is shown in Figure 6.3.5 to 6.3.8 of the attachment. The maximum negative pressure and its place are shown below.

| Pipeline Route of Water Hammer Analysis | Location of Max. Negative Pressure | Max. Negative Pressure | Remarks |
|---|---|---|---|
| From Pump Station to Node 3 | Around Node 2 | －0.0 m | Refer to Attachment (Figure-6.3.8) |
| From Pump Station to Node 6 | Approx. 5.0 km upstream from Node 4 | －2.5 m | Refer to Attachment (Figure-6.3.5) |
| | Approx. 10.5 km upper stream from Node 6 | －3.6 m | Refer to Attachment (Figure-6.3.5) |
| From Pump Station to Node 7 | Approx. 5.0 km upstream from Node 4 | －2.5 m | Refer to Attachment (Figure-6.3.6) |
| | Approx, 10 km upper stream from Node 7 | －3.8 m | Refer to Attachment (Figure-6.3.6) |
| From Pump Station to Node 8 | Approx. 10.0 km upstream from Node 8 | －1.8 m | Refer to Attachment (Figure-6.3.7) |

From the above table, the maximum negative pressure is －3.8 m and there is no water column separation even if power failure happens.

## 8. Conclusion

As a result of the above water hammer analysis and countermeasure, water column separation and water pressure increase due to water hammer when power failure happens can be avoided. The summary of countermeasure for water hammer is described below;

1) The existing air vessels are used as it is.
2) The air valves are installed on five places of the water transmission pipeline so that the maximum negative pressure can become over －7.0 m. Two air valves are installed at one place because the air valve is required to take maintenance work periodically to keep proper function.
3) The swing type quick shutoff water hammer free check valve with counterweight and bypass valve is used instead of the existing swing type check valve. The water hammer free check valve has no pressure increase due to backflow when power failure happens.

## 9. Attachment

1) Figure 6.3.1 Water Hammer Analysis (without countermeasure): Node 6
2) Figure 6.3.2 Water Hammer Analysis (without countermeasure): Node 7

3) Figure 6.3.3 Water Hammer Analysis (without countermeasure): Node 8
4) Figure 6.3.4 Water Hammer Analysis (without countermeasure): Node 3
5) Figure 6.3.5 Water Hammer Analysis (with countermeasure): Node 6
6) Figure 6.3.6 Water Hammer Analysis (with countermeasure): Node 7
7) Figure 6.3.7 Water Hammer Analysis (with countermeasure): Node 8
8) Figure 6.3.8 Water Hammer Analysis (with counter measure): Node 3

図１． 水撃検討図（対策なし）：Node6

Figure 6.3.1 Water Hammer Analysis (without Counter measure)

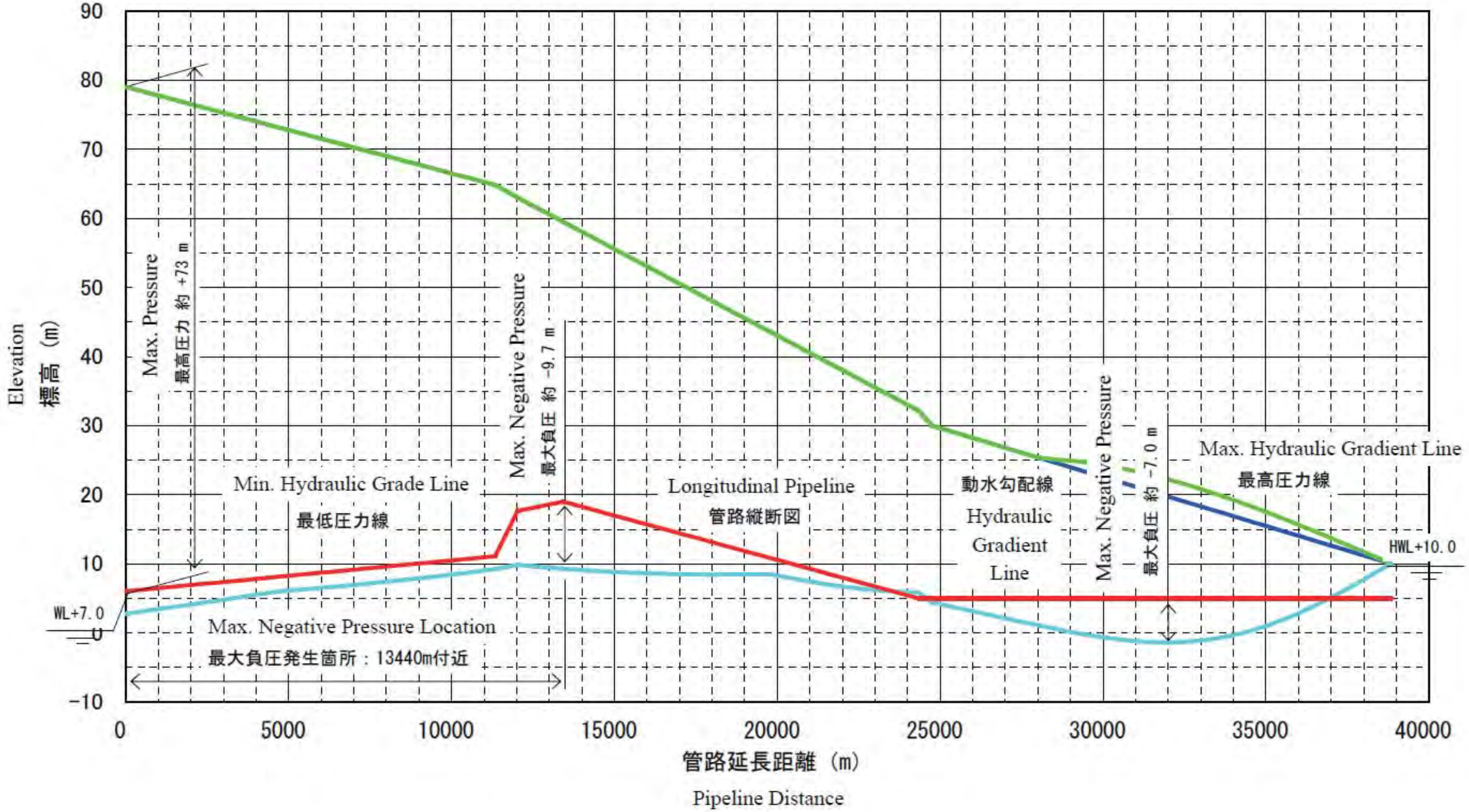


図２．水撃検討図（対策なし）：Node7

Figure 6.3.2 Water Hammer Analysis (without Counter measure)

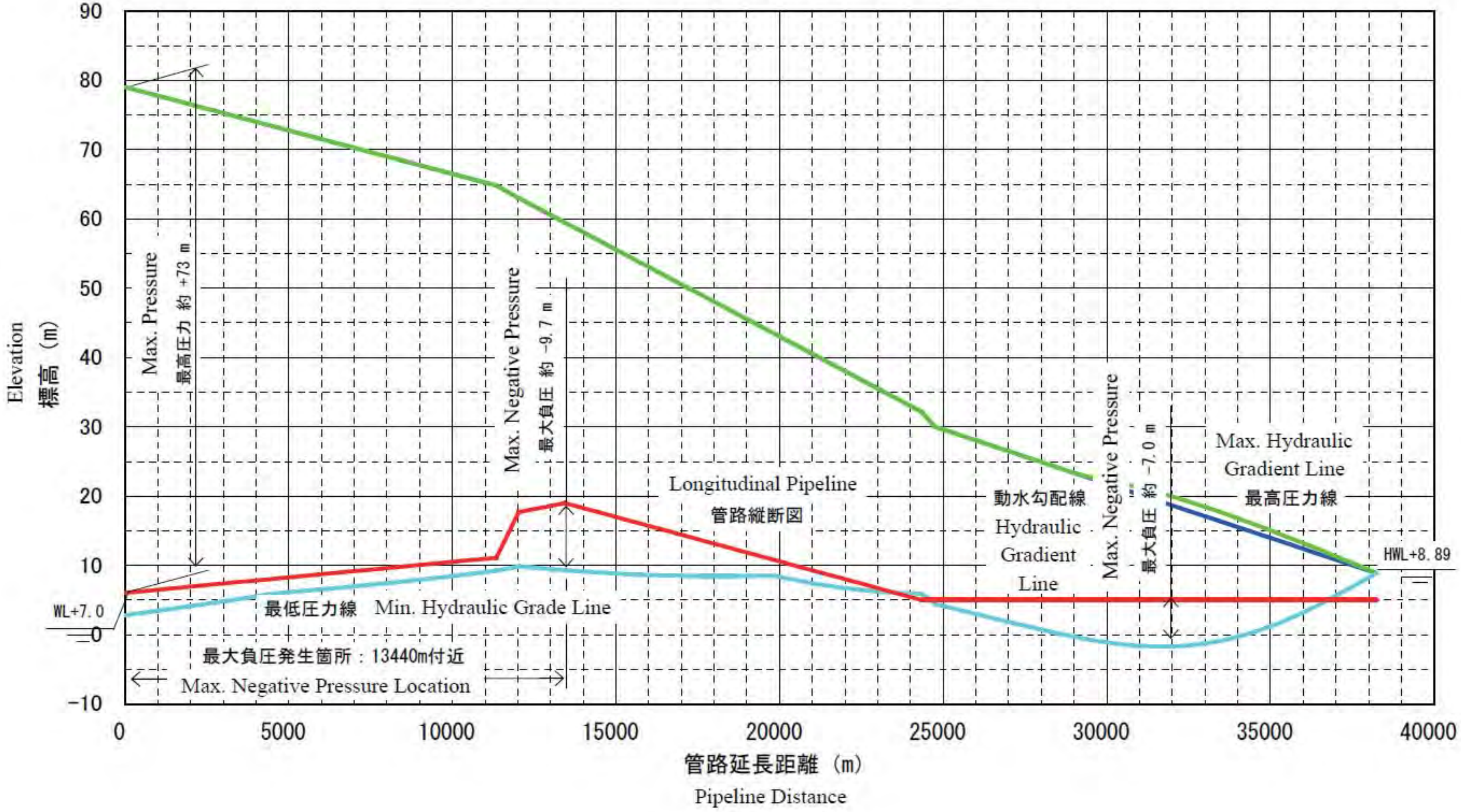


図３．水撃検討図（対策なし）：Node8

Figure 6.3.3 Water Hammer Analysis (without Counter measure)

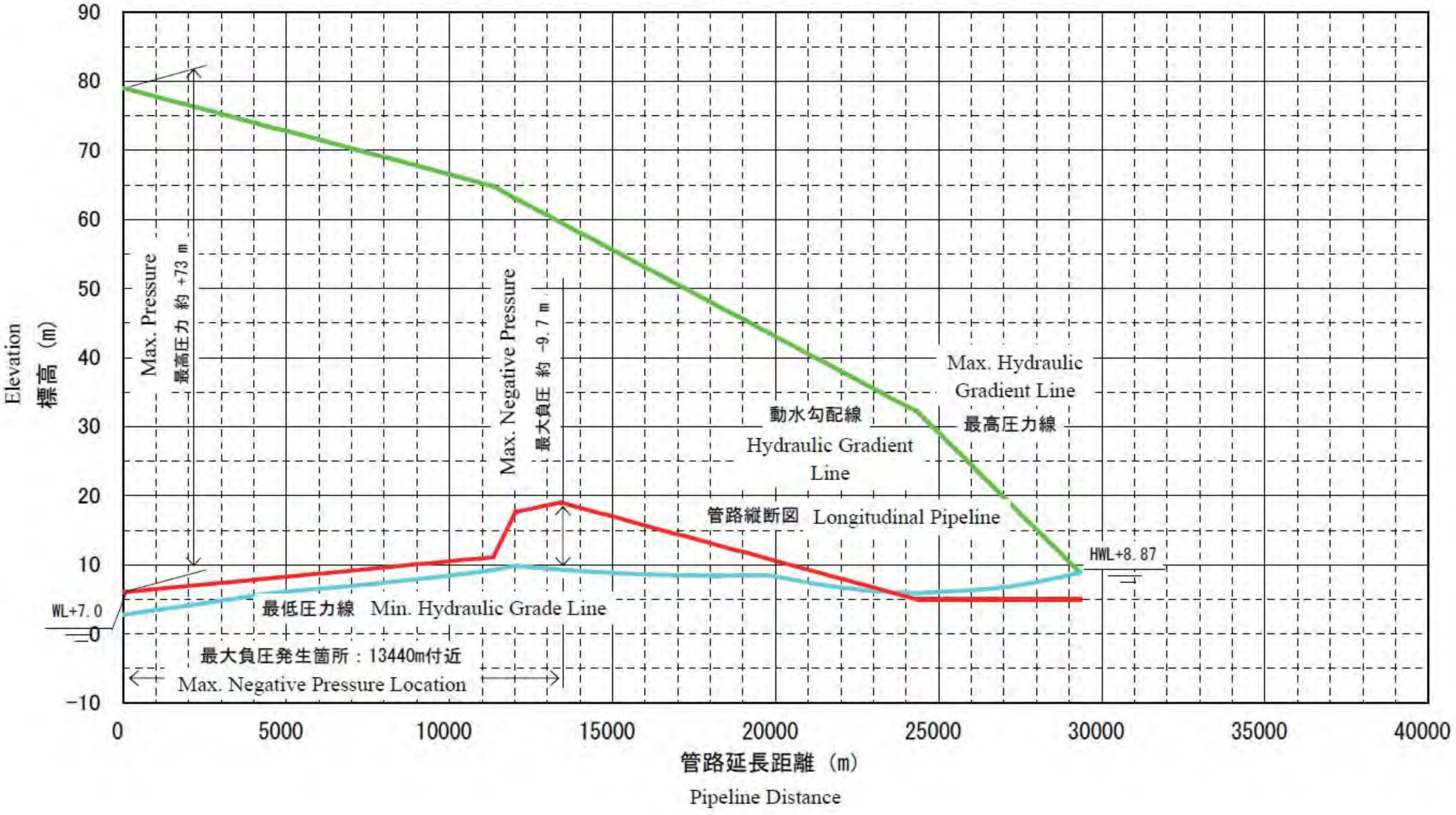


図４． 水撃検討図（対策なし）：Node3

Figure 6.3.4 Water Hammer Analysis (without Counter measure)

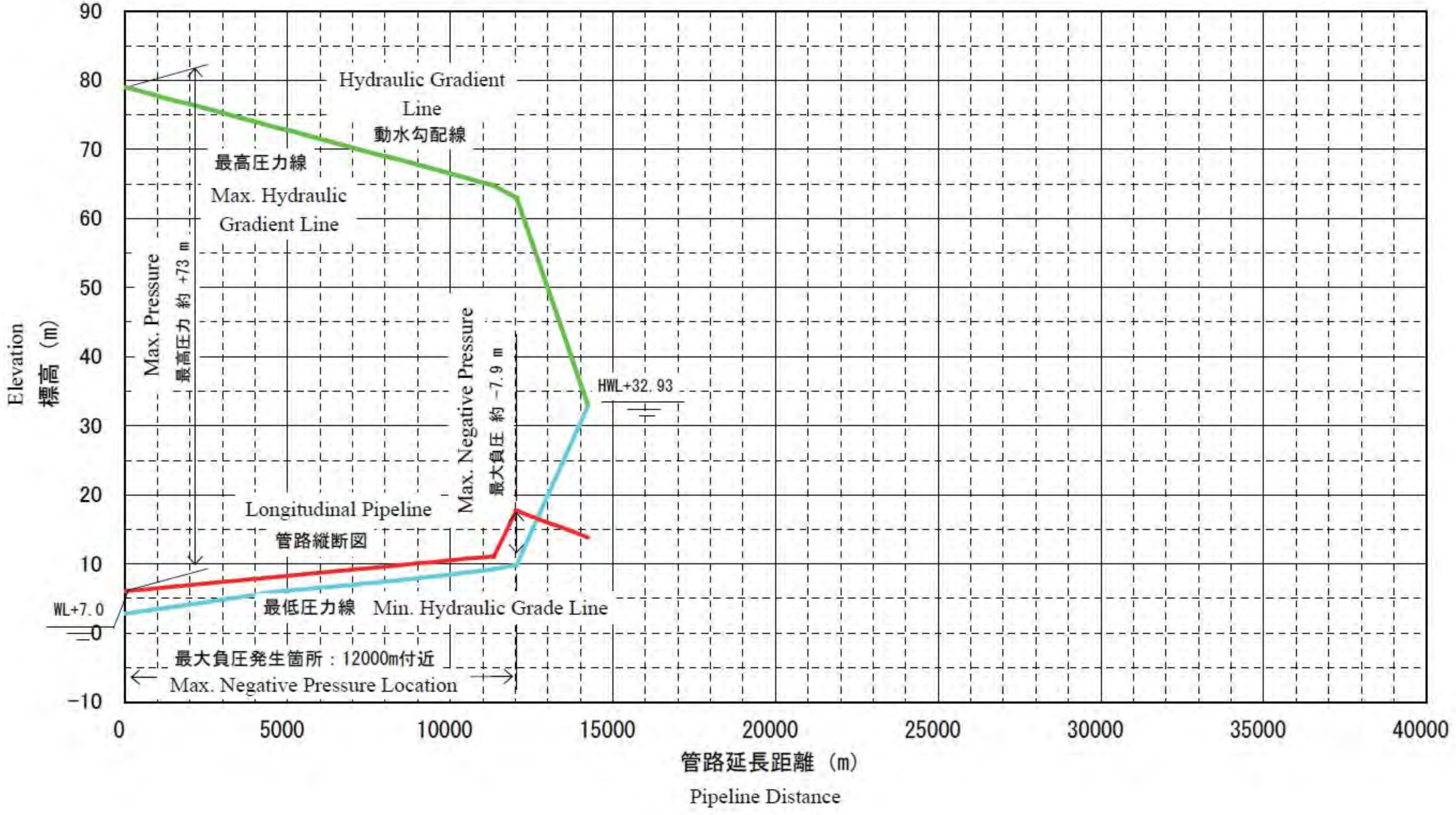


図５．水撃検討図（対策あり）：Node6

Figure 6.3.5 Water Hammer Analysis (without Counter measure)

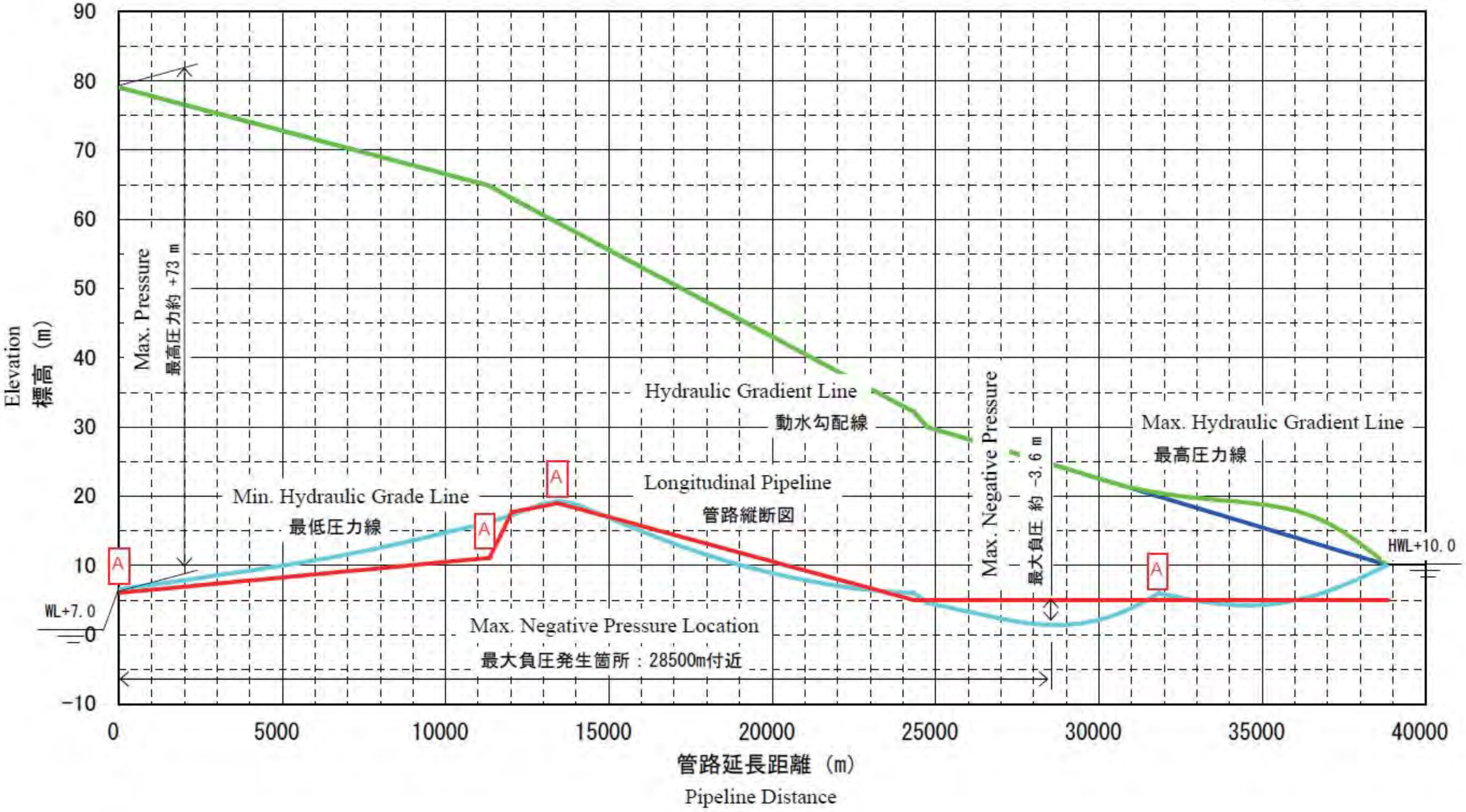


図６．水撃検討図（対策あり）：Node7

Figure 6.3.6 Water Hammer Analysis (without Counter measure)

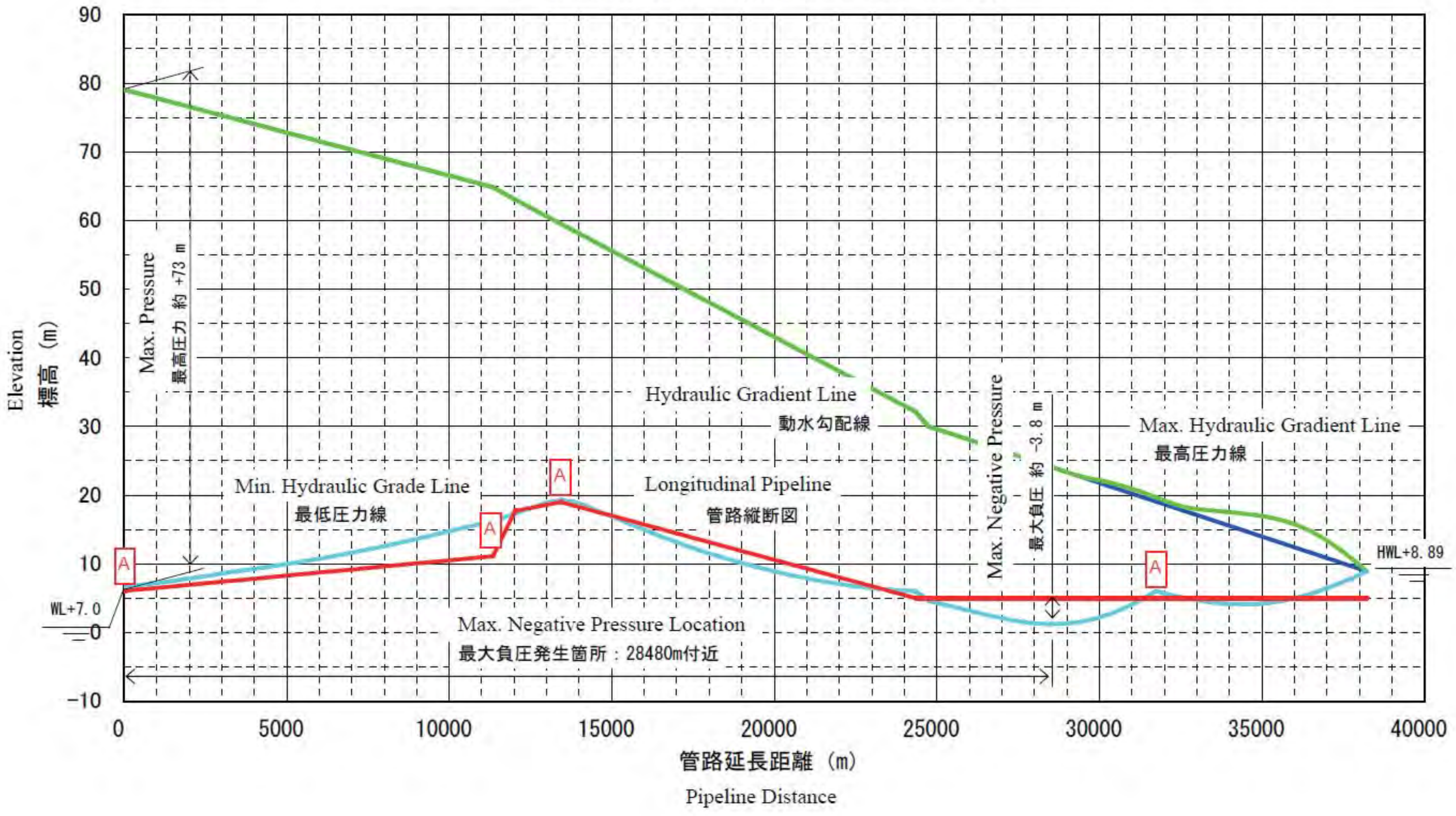


図７． 水撃検討図（対策あり）：Node8

Figure 6.3.7 Water Hammer Analysis (without Counter measure)

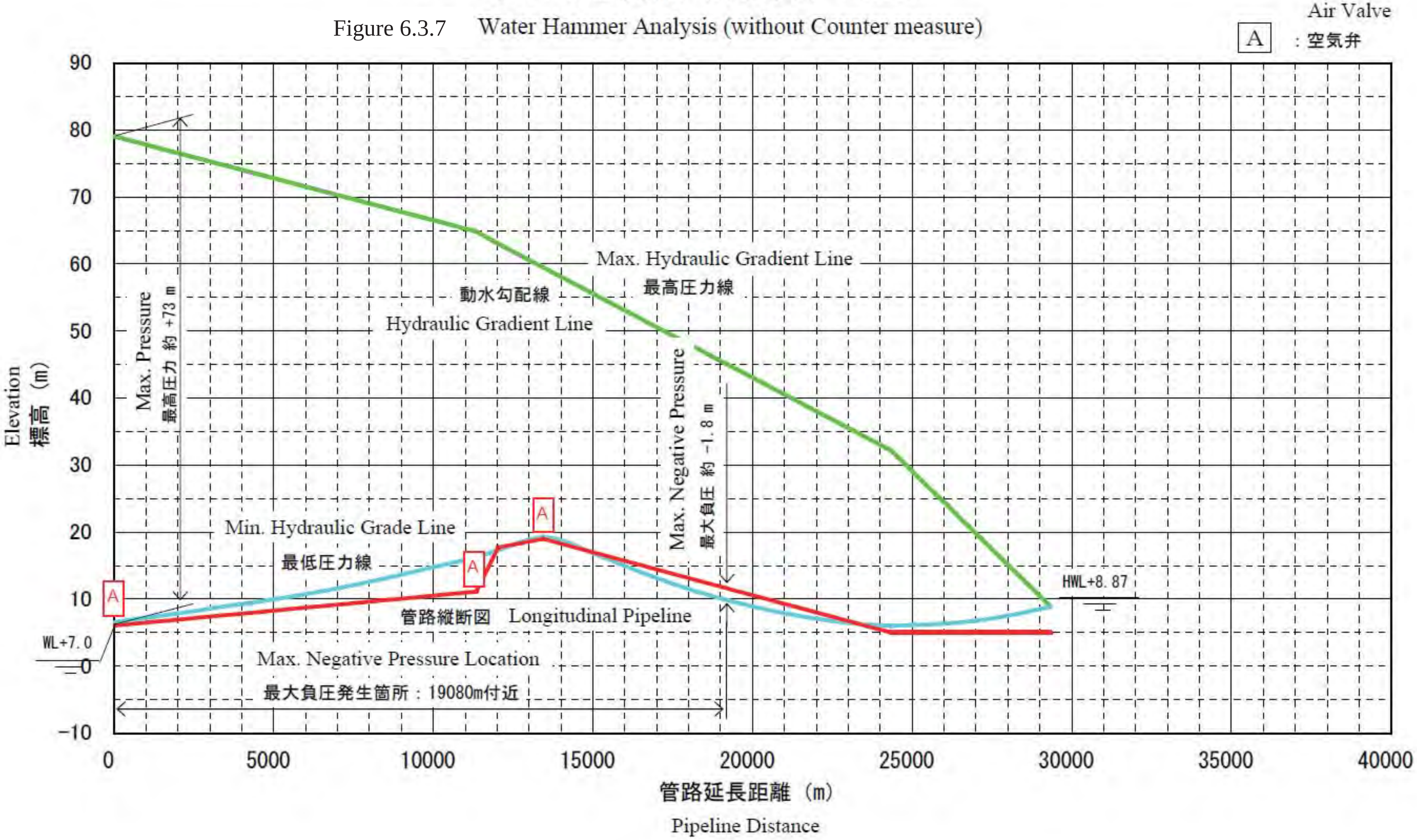
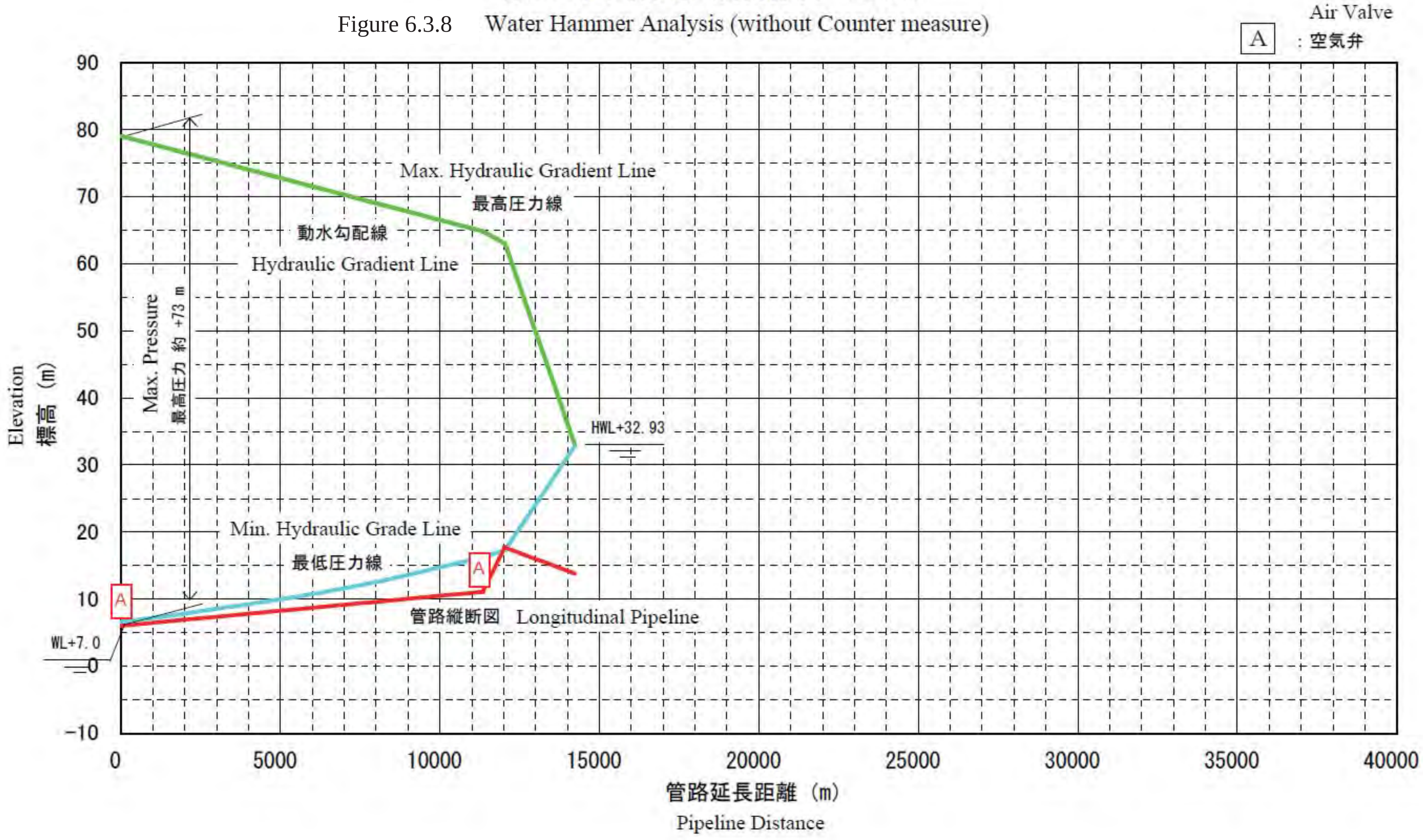


図８．水撃検討図（対策あり）：Node3

Figure 6.3.8 Water Hammer Analysis (without Counter measure)



Data 4. Replacement of distribution network in Block 1 to 6 in Yankin Township

(1) Target Year

The target year of replacement of distribution network is recommended as the completion year of this construction work; however, in order to meet the future water demand, the diameter of pipeline shall be made larger and replacement work shall be implemented again. Therefore, to avoid such a situation, the water distribution pipeline in Yankin Township is designed based on the target year planned as year 2025 which is after 10 years from completion year.

(2) Planned population served and Planned water supply amount

Based on the planned water supply amount in 2025 estimated in “The Preparatory Survey Study for the Improvement of Water Supply, Sewerage and Drainage System in Yangon City, the planned water supply amount in Block 1 to 6 where it is target area in the Project. The result of estimation is shown in the Table 6.4.2. The Table 6.4.1 shows design criteria for estimation of planned water supply amount.

**Table 6.4.1 Design criteria for estimation of planned water supply amount**

| Items | Year | 2011 | 2025 |
|---|---|---|---|
| Per capita water supply | lpcd | 139 | 150 |
| Rate of population served | % | 85% | 100% |
| Rate of domestic water supply and non-domestic water supply | % | 60:40 | 60:40 |
| Rate of water leakage | % | 50 | 25 |

**Table 6.4.2 Estimation of the planned water supply in Block 1 to 6 in Yankin Township**

| Items | Population | | Population served | | Daily average water supply ($m^3/d$) | | Daily maximum water supply ($m^3/d$) | |
|---|---|---|---|---|---|---|---|---|
| | 2011 | 2025 | 2011 | 2025 | 2011 | 2025 | 2011 | 2025 |
| Whole Yankin Township | 107,023 | 125,909 | | | 49,586 | 41,969 | 54,545 | 46,166 |
| Block 1 to 6 | 19,888 | 23,398 | 19,832 | 23,332 | 9,189 | 7,777 | 10,108 | 8,555 |

※Daily maximum coefficient: 1.1

(3) Planned water supply pressure

The planned minimum water pressure in this Project is 0.15Mpa.

(4) Distribution network analysis and flow system

The network analysis software EPANET2 of the US EPA is used to decide the diameters of the water transmission and distribution system. The Hazen-Williams equation below is used for loss calculations for pipelines.

$$H = 10.666\ C^{-1.85}\ D^{-4.87}\ Q^{1.85} \cdot L$$

H：Friction loss (m)
Q：Flow rate ($m^3$/sec)
D：Pipeline diameter (m)
L：Pipeline length (m)
C = Hazen-Williams Head Loss Coefficient
(110 used for new pipes for the project)

(5) Setting of DMAs (District Metering Area)

The whole distribution network in the Project area is divided into the DMAs from the viewpoint of administrative district boundaries, topography and geography

The whole distribution network in the Project area is divided into the DMAs from the viewpoint of administrative district boundaries, topography and geography. The setting of DMA is done by followings. As for a scale of DMA, according to Non-Revenue Water Control in World Bank Project or other similar Project, the recommended number of house connections is 2,000.

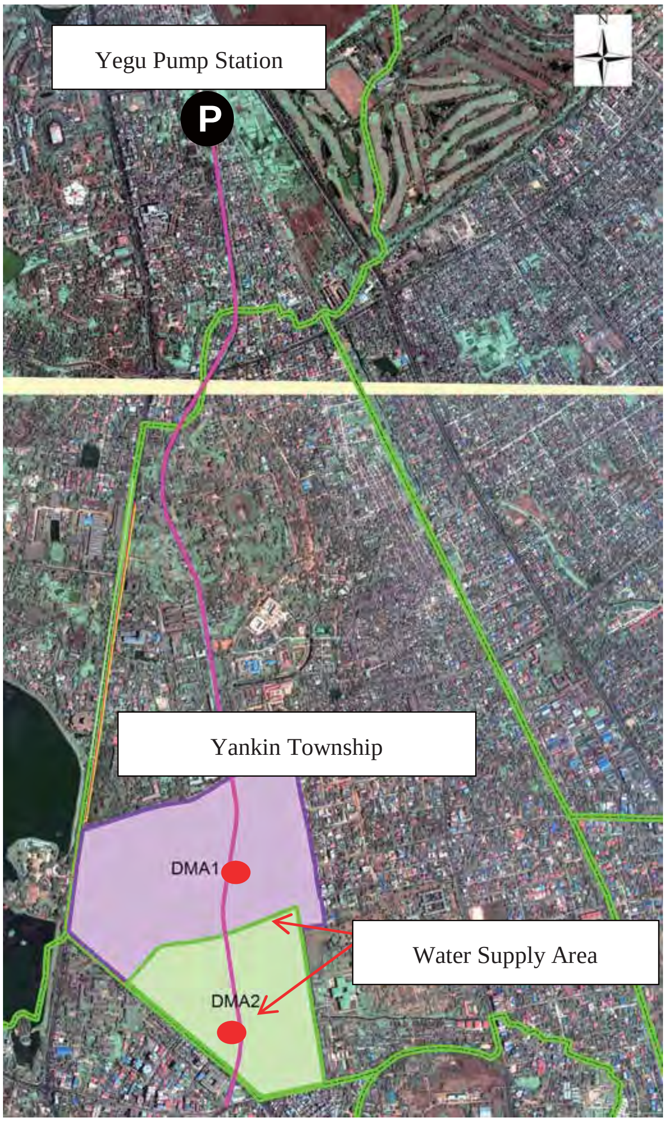


**Figure 6.4.1 Setting of DMA and Location of branch pipe**

The number of house connections is 4,350 and if the number of house connections per DMA is assumed 2,000, the total number of DMAs in Block 1 to 6 is 2. Considering viewpoints of topography and condition of the road, the planning of 2 DMAs is appropriate. The result of the study of setting of DMAs was reported to YCDC and the result was approved.

In each DMA, the distribution network to supply enough amount of water for peak demand is planned and it targets 24 hours water supply. If it reaches 24 hours water supply, it is possible to remove private wells, private pumps and roof tanks in each household. Furthermore, interfusion of sewage by negative pressure can be avoided and it is possible to carry out safety water supply.

Water supply to Block 1 to 6 in Yankin Township where it is the target area in this Project is shown in the Figure 6.4.2 and started from transmission and distribution pipe (dia. 1,400mm) of Yegu pumping station. Red marks in Figure 6.4.1 shows branch points from φ1400mm pipeline to each DMA.

(6) Distribution network plan

Based on the result of distribution network analysis, the replacement length of distribution network is estimated and shown in the following.

**Table 6.4.3 Outline length of replacement of distribution network in Block 1 to 6 in Yankin Township**

| Diameter (mm) | Length(m) | | |
|---|---|---|---|
| | DMA1 | DMA2 | Total(m) |
| 400 | 30 | 30 | 60 |
| 350 | 2,770 | 2,490 | 5,260 |
| 200 | 3,620 | 1,100 | 4,720 |
| 150 | 1,750 | 320 | 2,070 |
| 100 | 5,310 | 5,240 | 10,550 |
| Total (m) | 13,480 | 9,180 | 22,660 |

The pipe material with diameter of upper 200mm is ductile iron pipe (DIP) and the pipe material with diameter of 150mm and 100mm is polyvinyl chloride pipe (PVC, rubber ring type). In the existing distribution network, old type of cast-iron pipe, steel pipe and PVC pipe are mainly installed; however, DIP is adopted because it is generally used, high intensity and high workability. The pipe material with small diameter is PVC; however, the joint method of pipe is changed from an existing joint by adhesion bond to push-on joint by rubber ring to reduce water leakage by construction failure. The planned distribution network route is shown in Figure 6.4.2.

Figure 6.4.2 Planned distribution networks in Block 1 to 6 in Yankin Township

(7) Selection of the installation method of distribution pipe.

It is difficult to stop transmission and distribution water from Yegu pumping station in the time of implementation of connection construction for branch pipe which is starting point of replacement of distribution network, from the existing pipeline with diameter of 1400mm. Thus, the under pressure tapping method is adopted for this construction method. The number of lanes for the main road in the target area of a replacement of distribution network is 2 lanes each way. The main pipeline with diameter of 350mm is installed at the side of main road and the laying work is implemented by open cut method after transportation is controlled. As for crossing main road of pipeline with diameter of 200mm, open cut method is adopted for laying work in the time when a volume of traffic is low. According to the result of considering method for crossing drainage and pipeline with diameter of 1400mm for newly installed pipelines, crossing method under drainage and pipe with diameter of 1400mm has disadvantage from an economical and technical standpoint and Water Pipe Bridge is adopted. The types of Water Pipe Bridge are pipe beam type, if crossing length above drainage and pipe is short and πstiffening type, if it is long and it needs support intensity. The followings show diameter and length of Water Pipe Bridge.

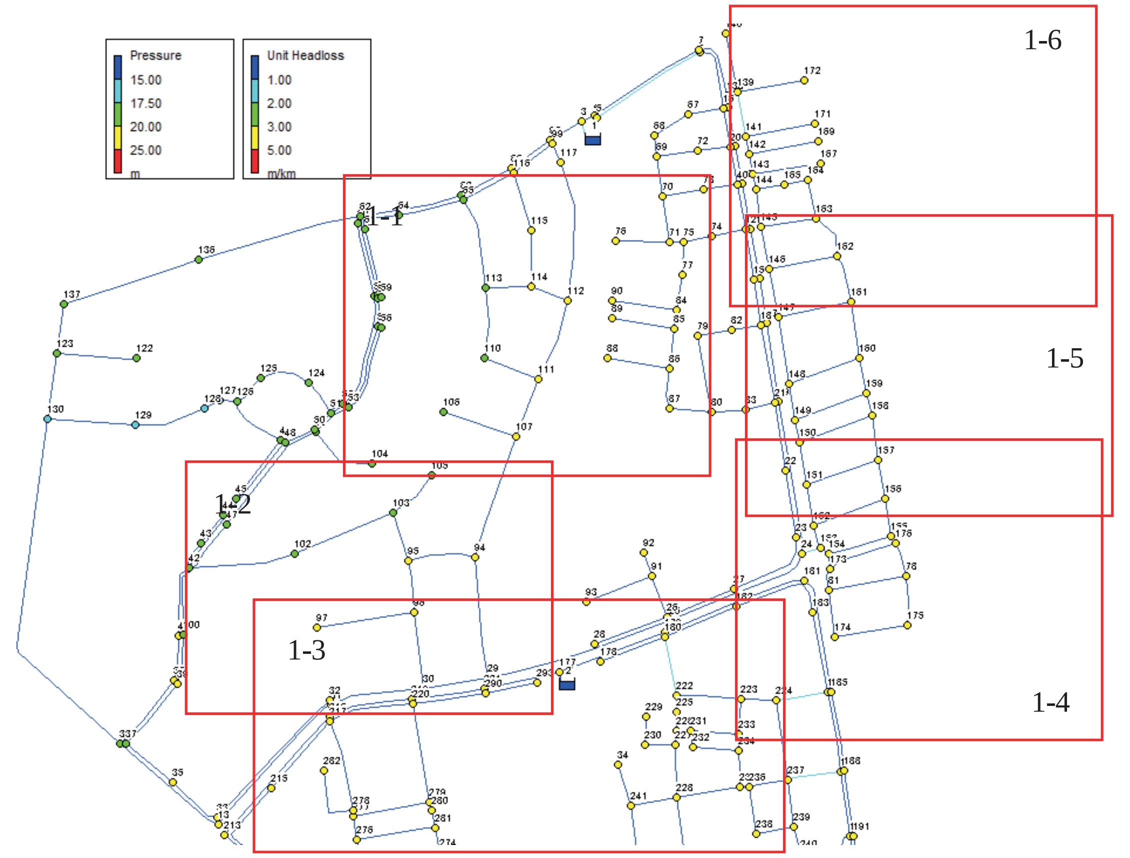
**Table 6.4.4 Diameter and length of Water Pipe Bridge**

| Diameter (mm) | Outline length of Water Pipe Bridge (m) |
|---|---|
| 350 | 25 |
| 350 | 20 |
| 350 | 20 |
| 350 | 20 |
| 350 | 20 |
| 200 | 10 |

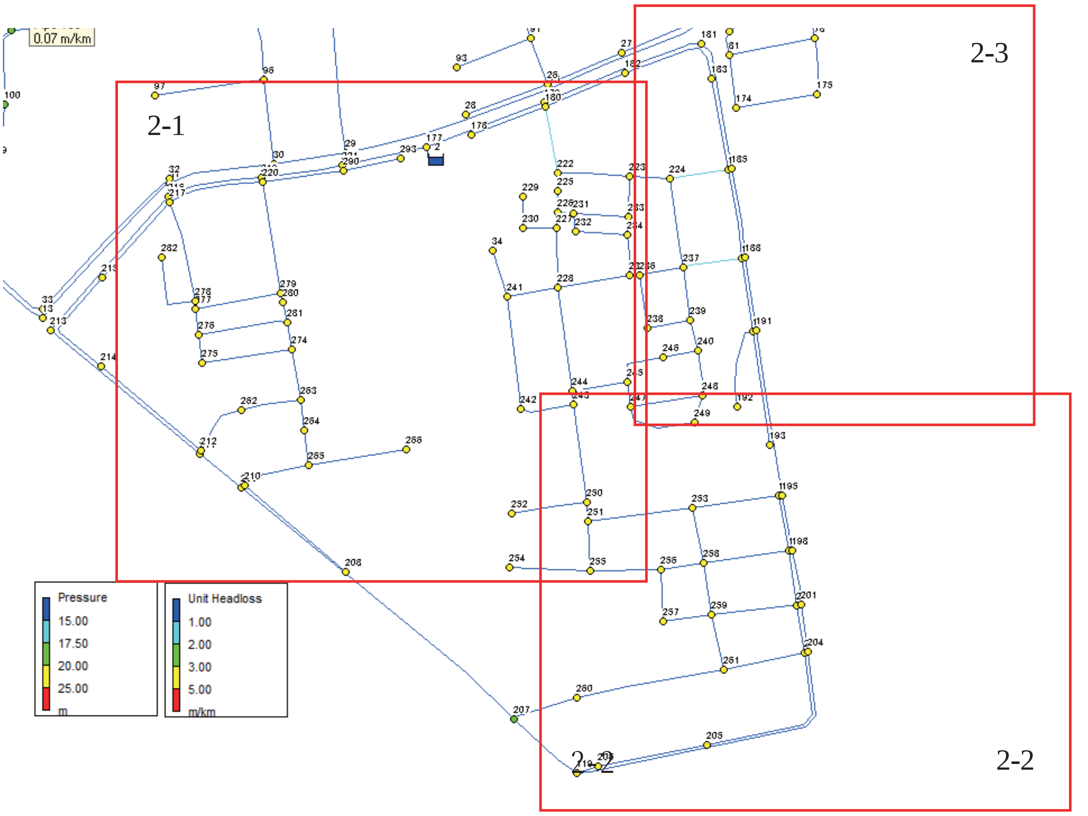
Data 5. Result of Hydraulic Calculation of Distribution Network in Block 1 to 6 in Yankin Township

(1) Network model

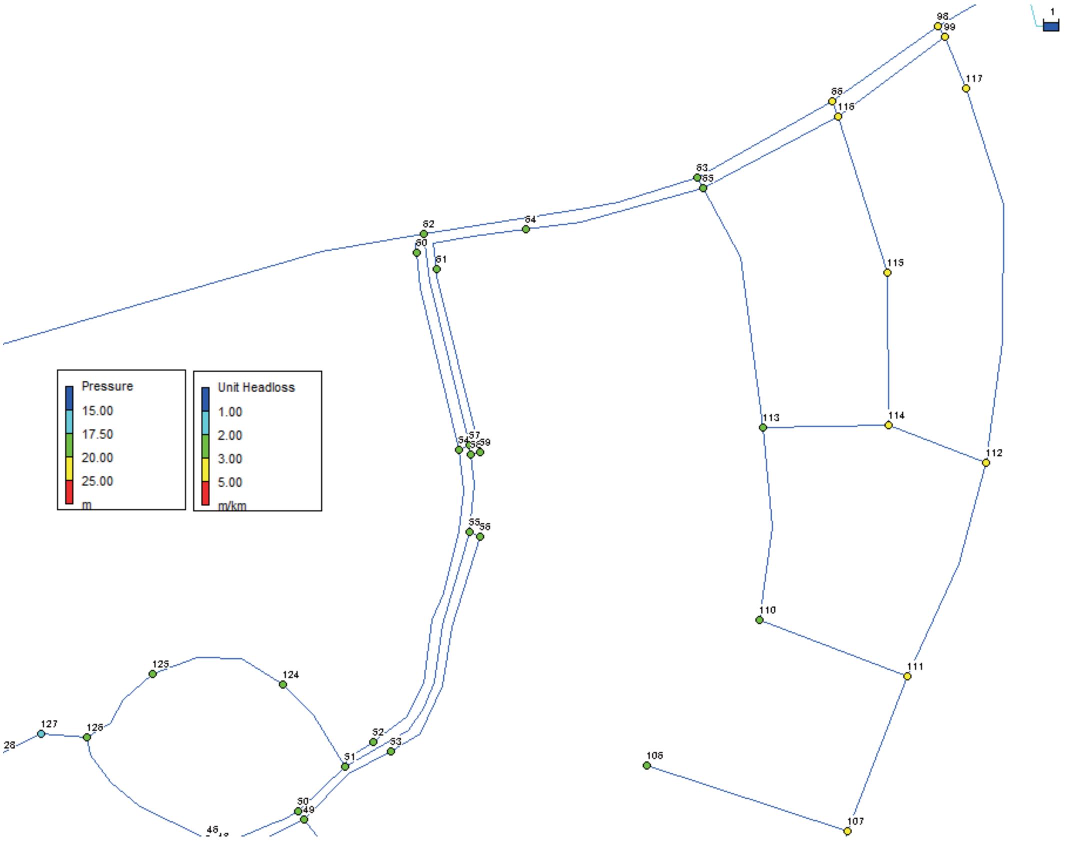
<DMA1>



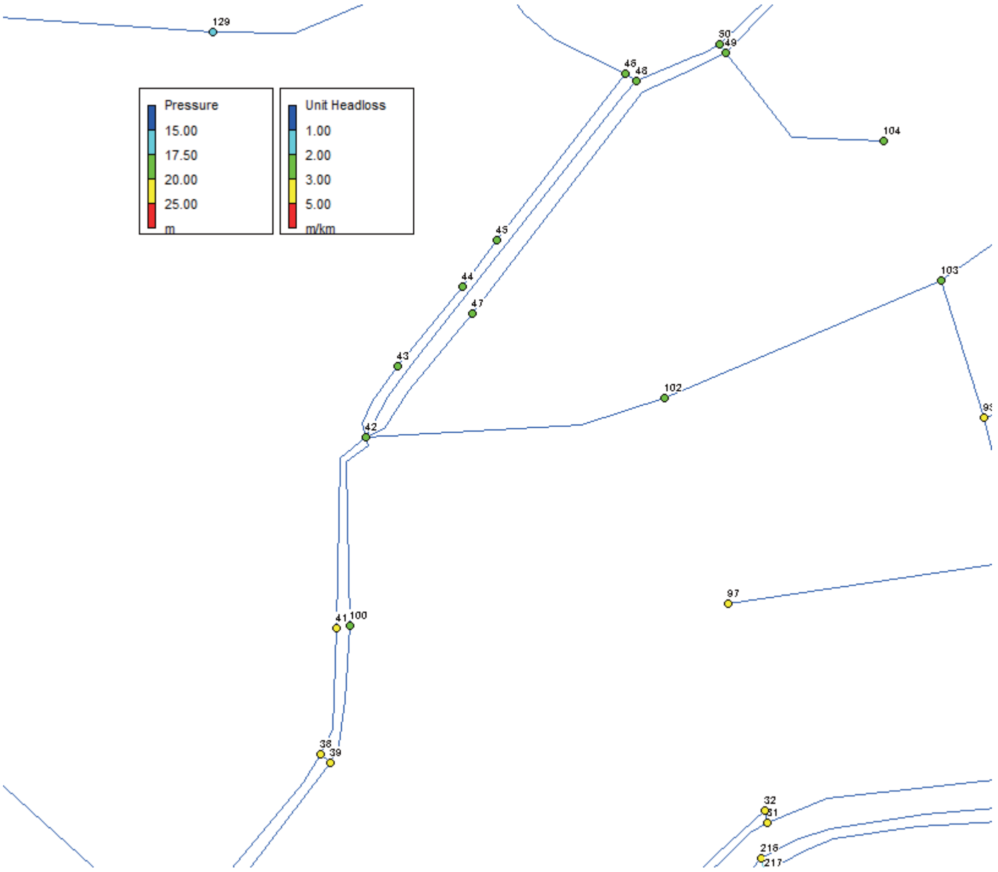
<DMA2>



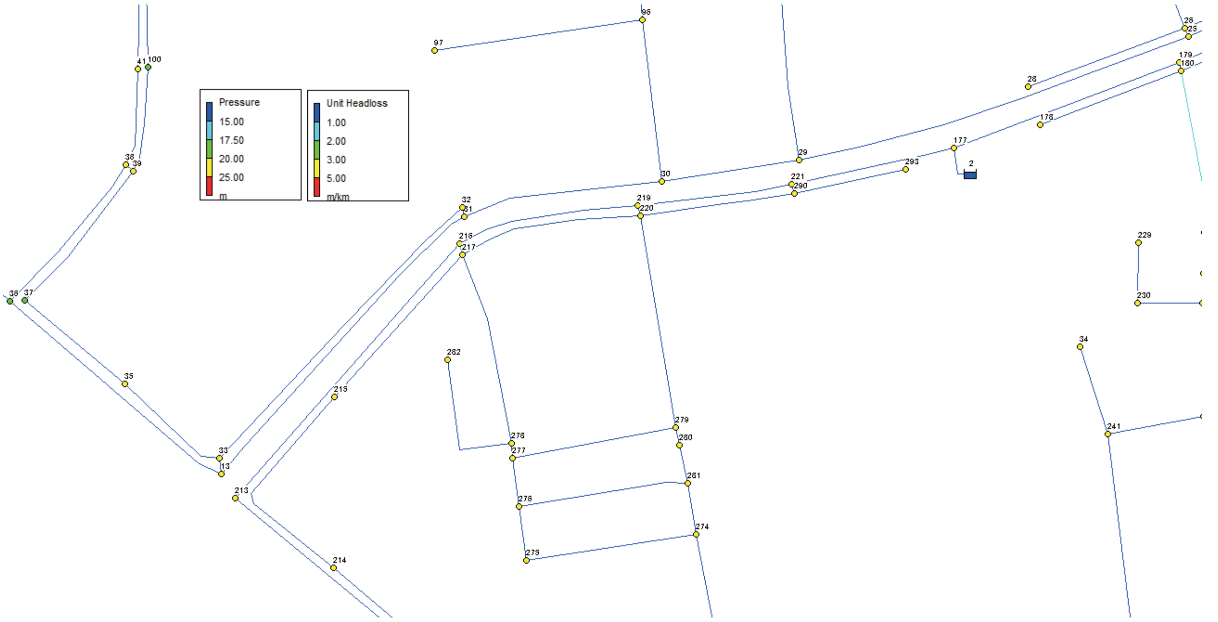
1-1 Node



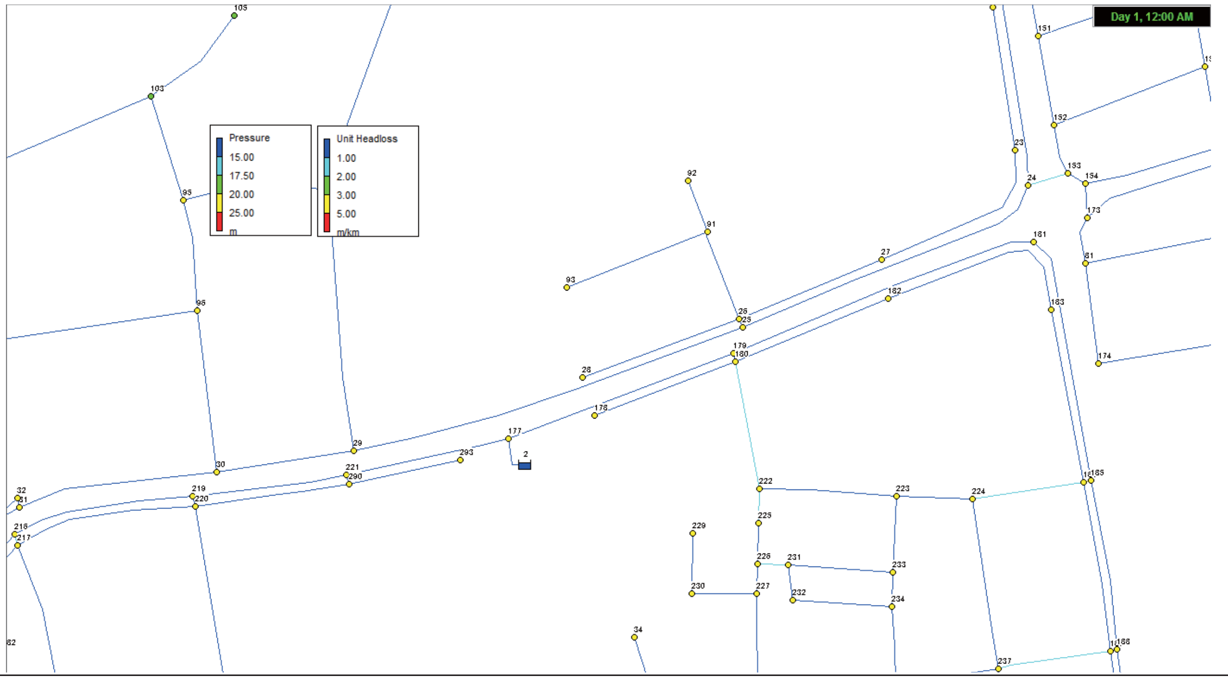
1-2 Node



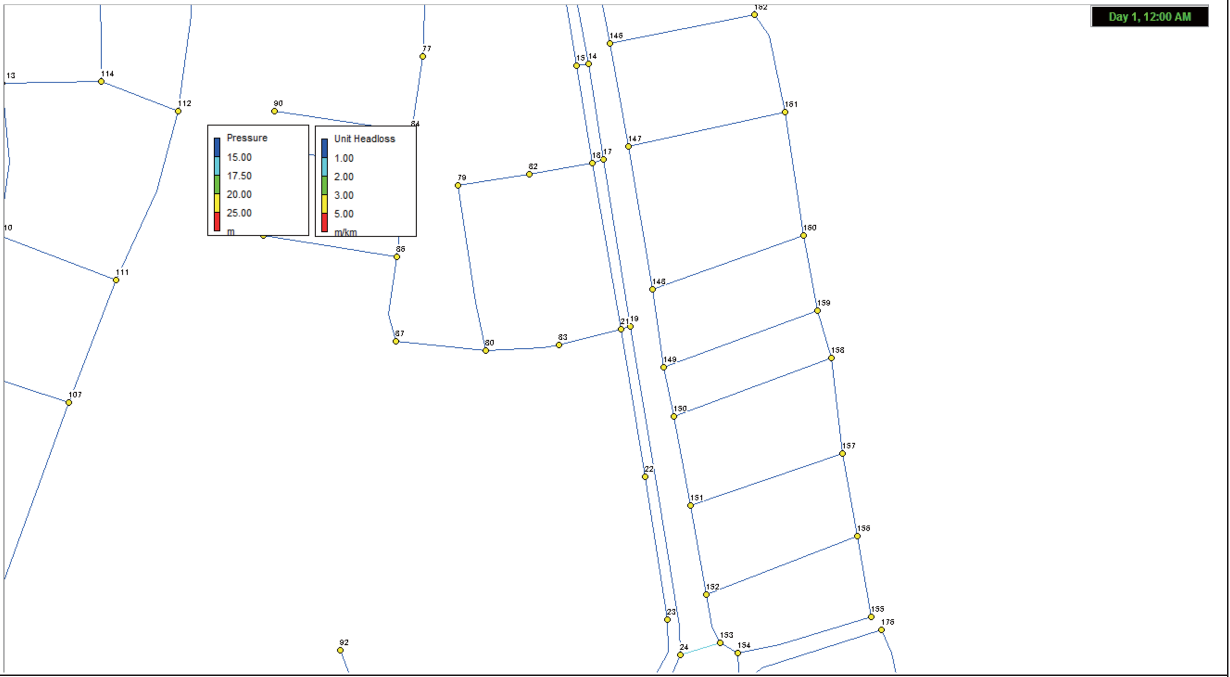
1-3 Node



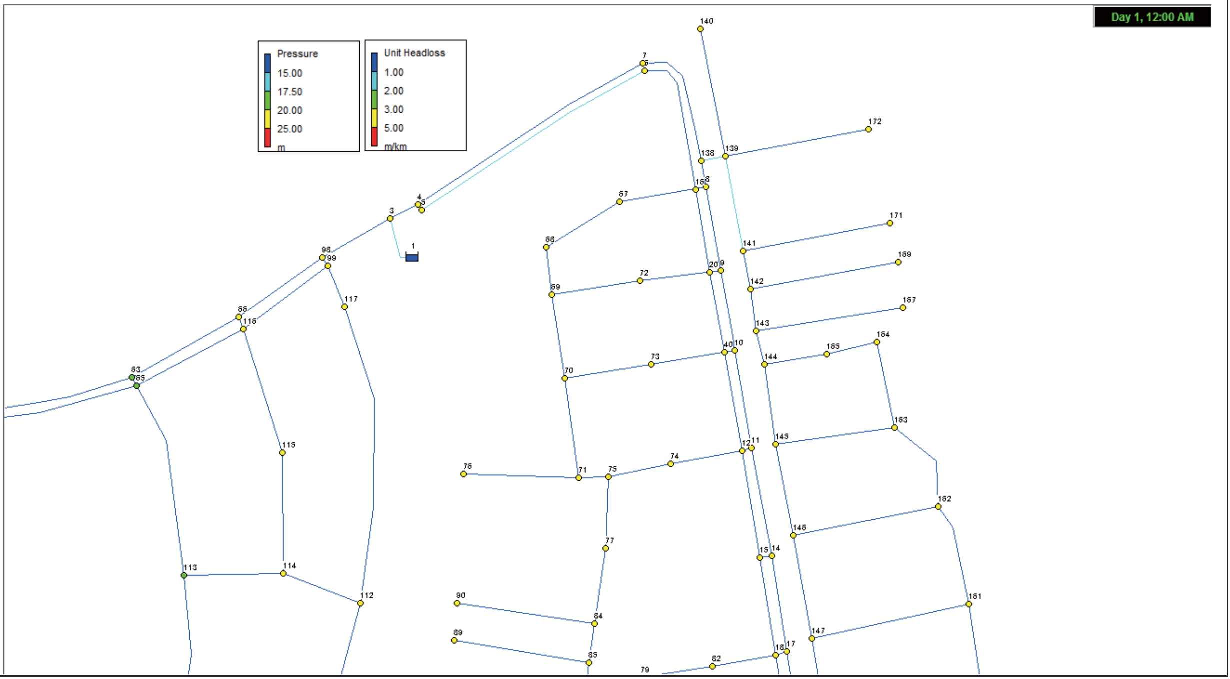
1-4 Node



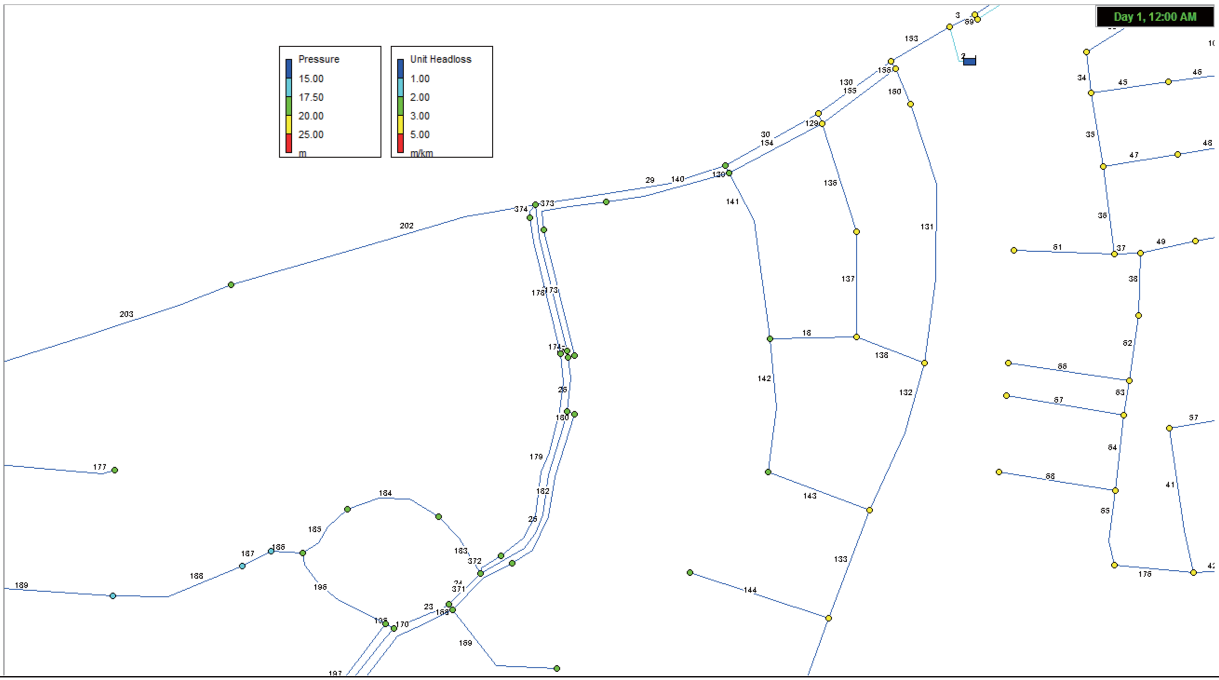
## 1-5 Node



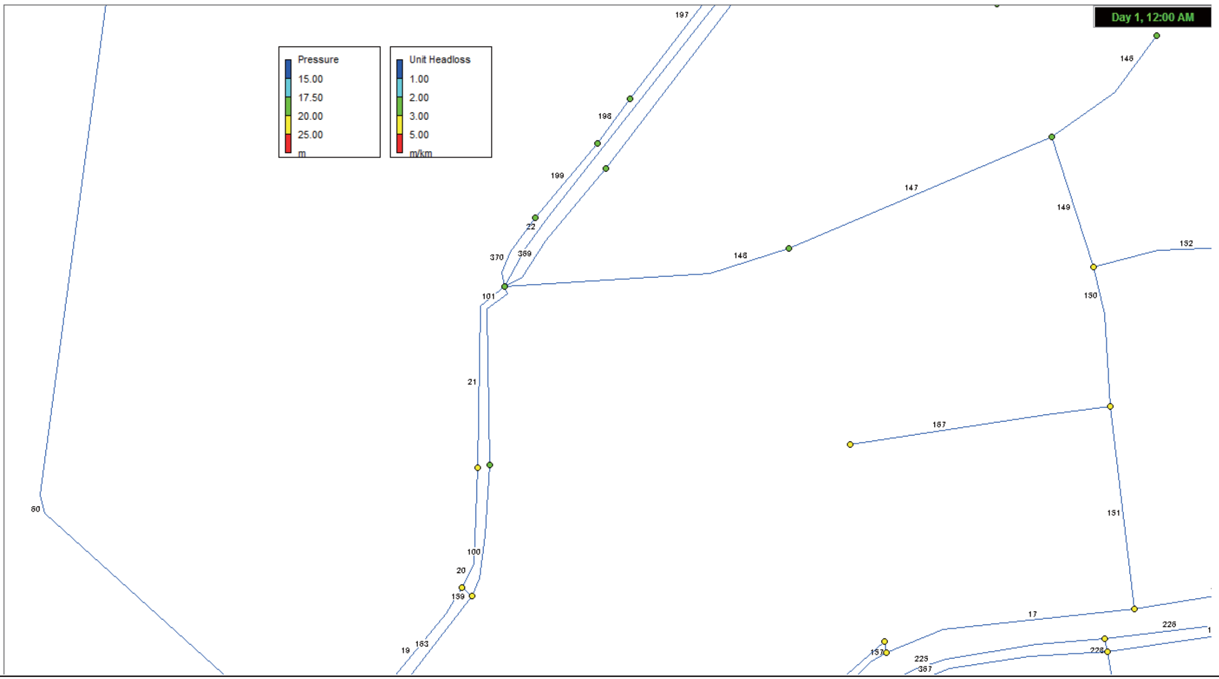
## 1-6 Node



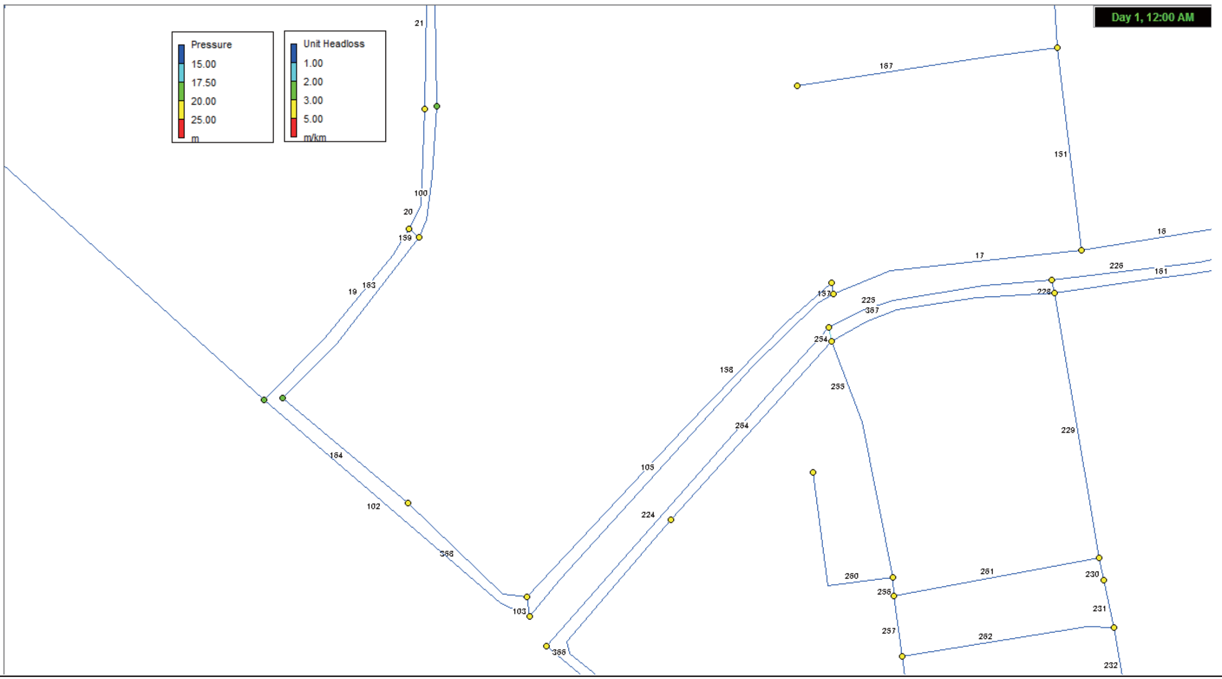
## 1-1 Link



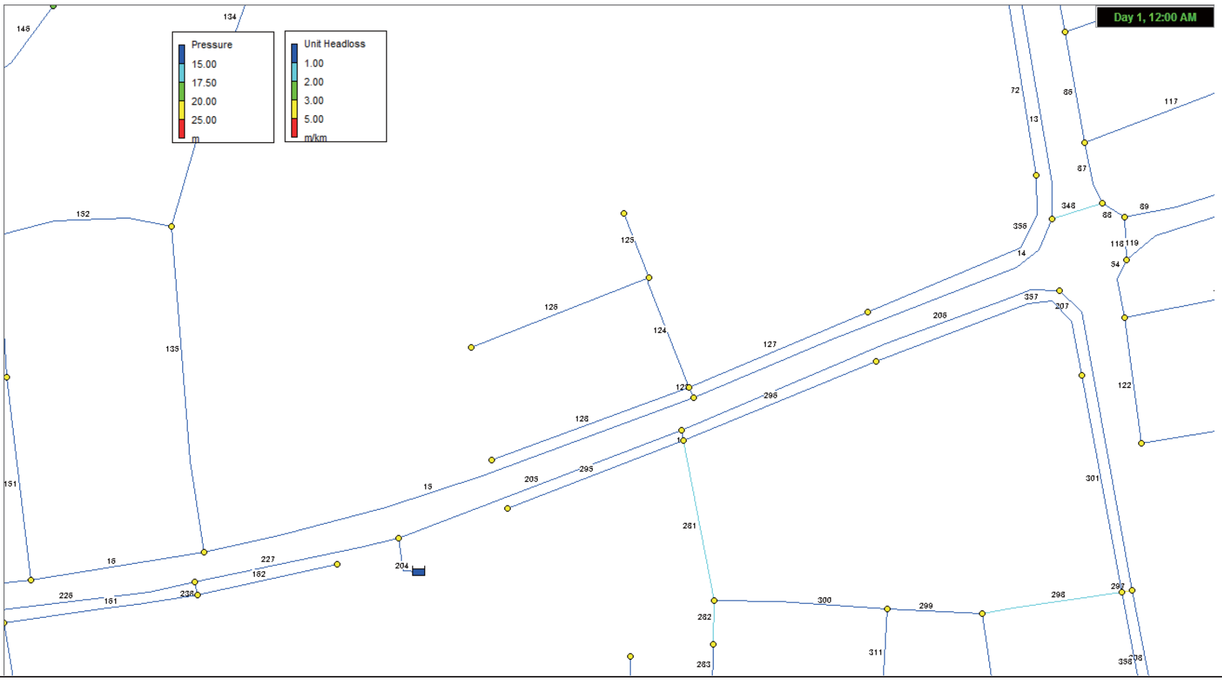
## 1-2 Link



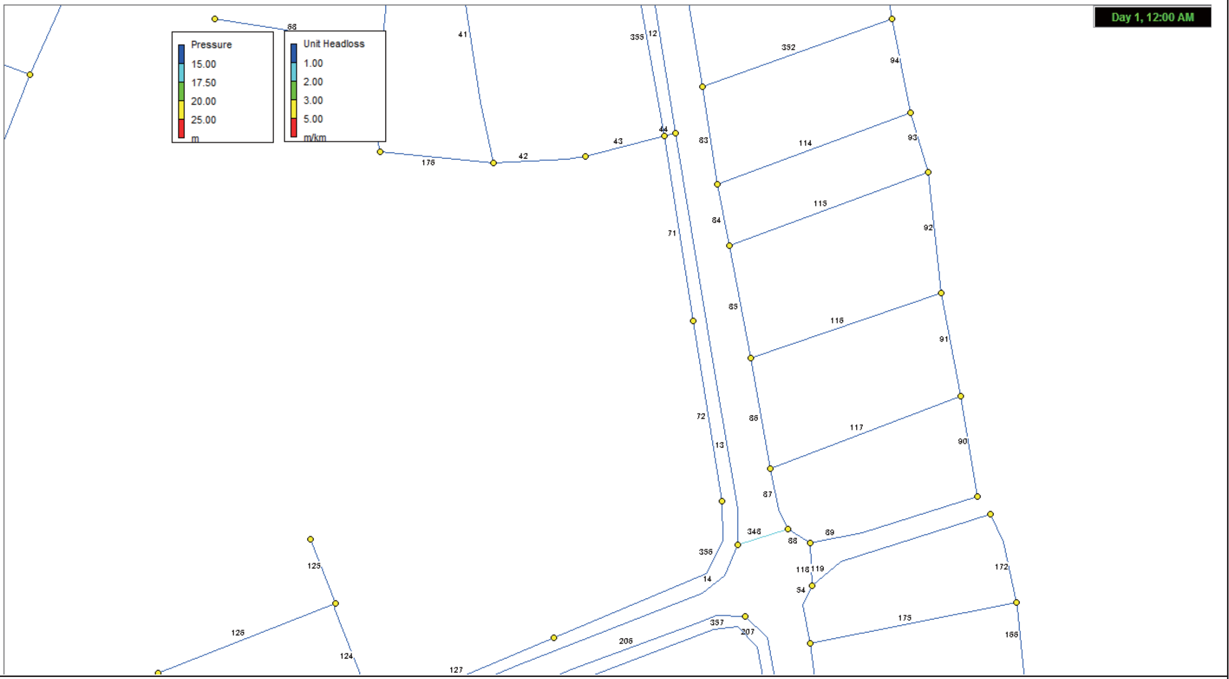
## 1-3 Link



## 1-4 Link



## 1-5 Link



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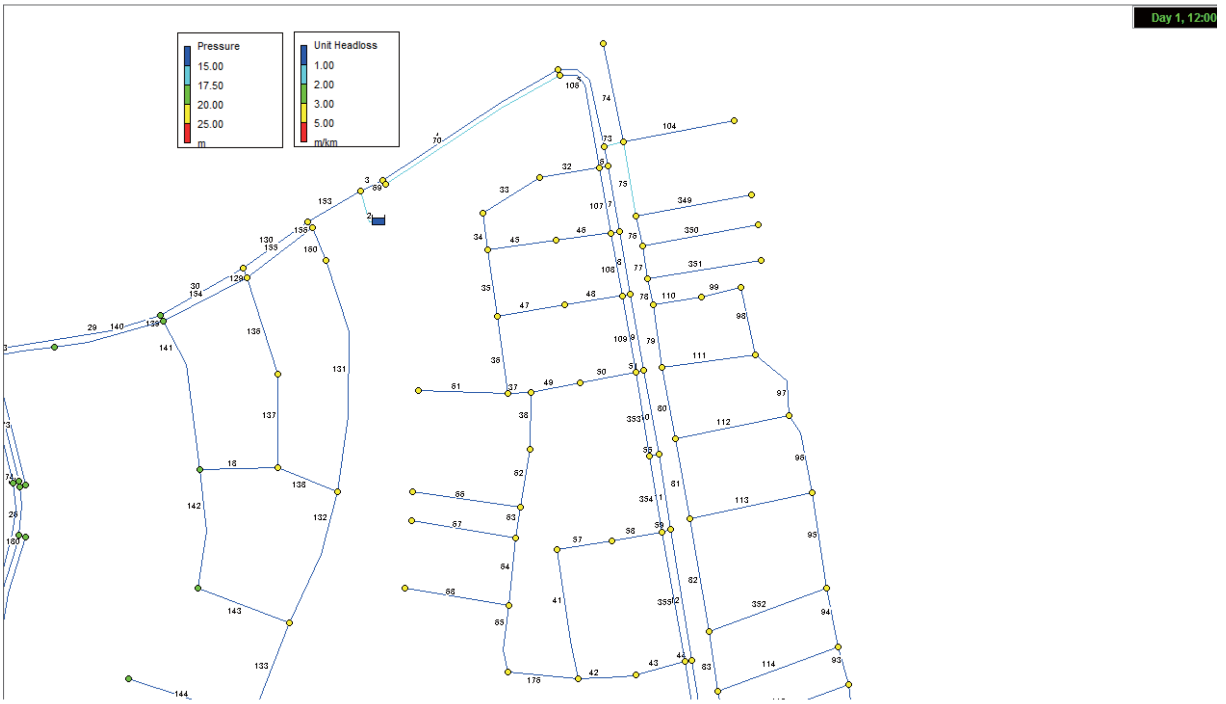
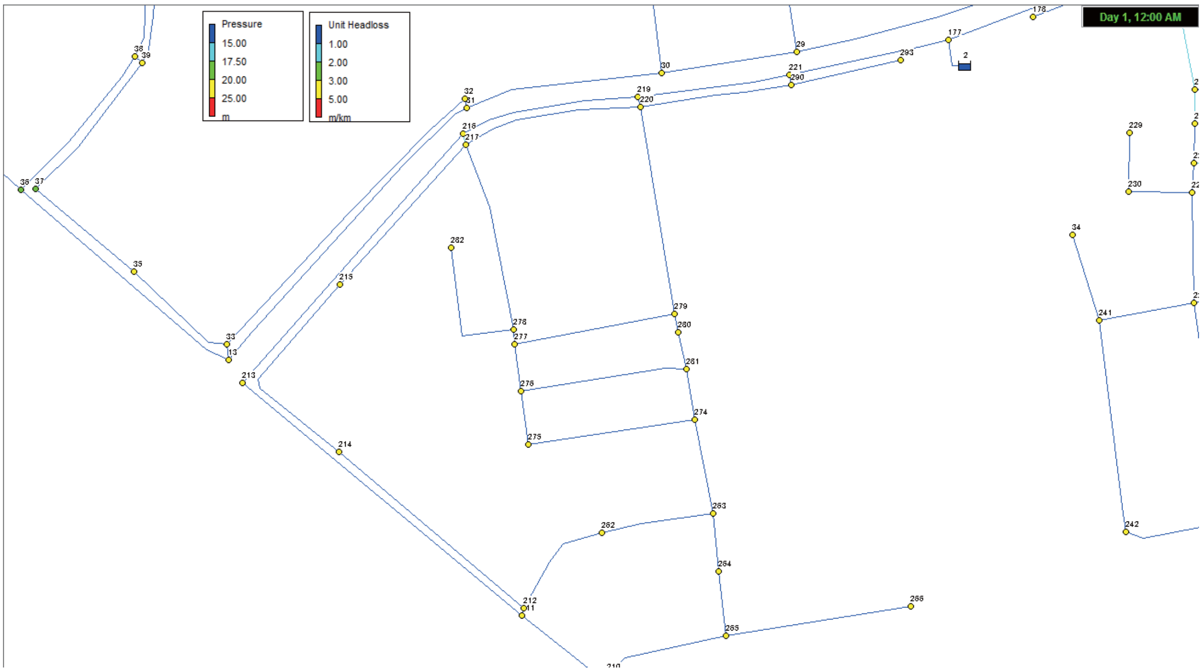
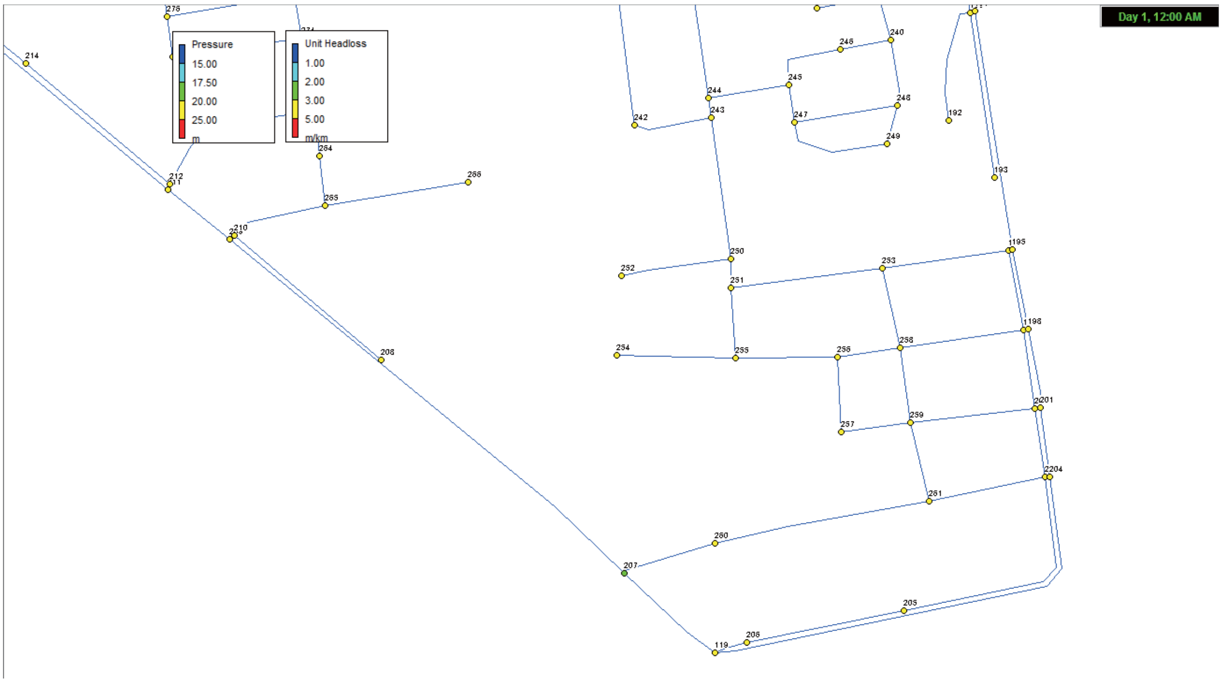


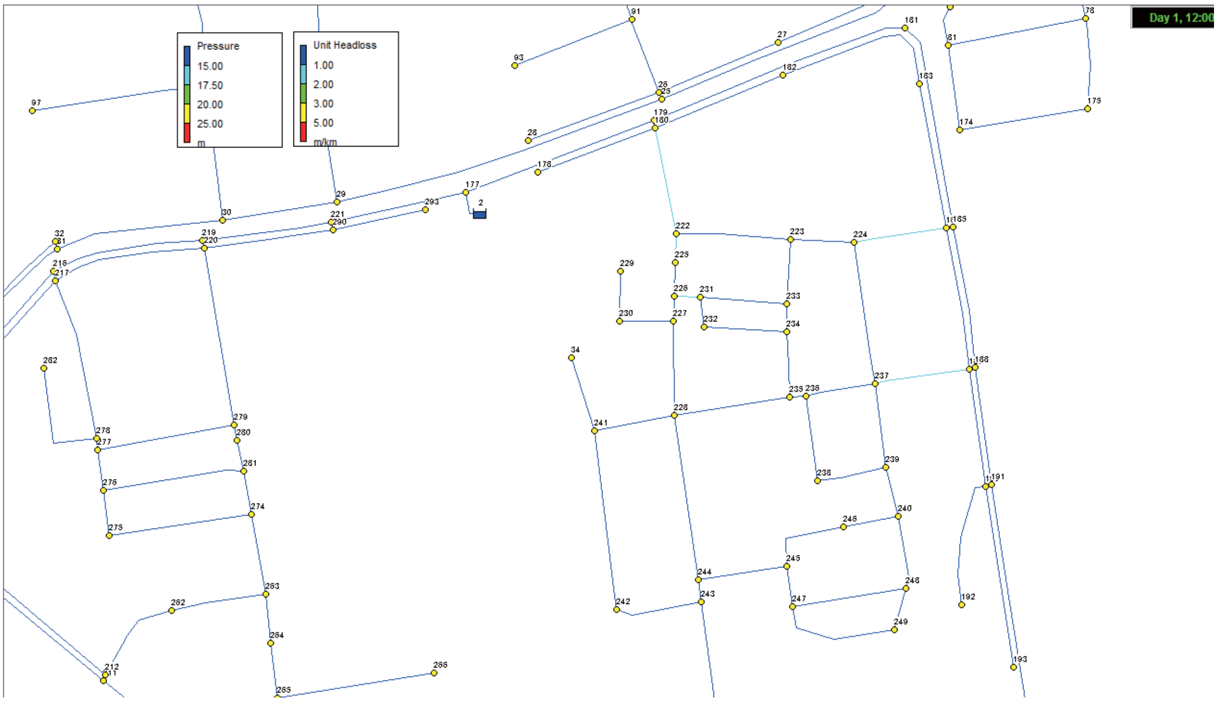
## 2-1 Node



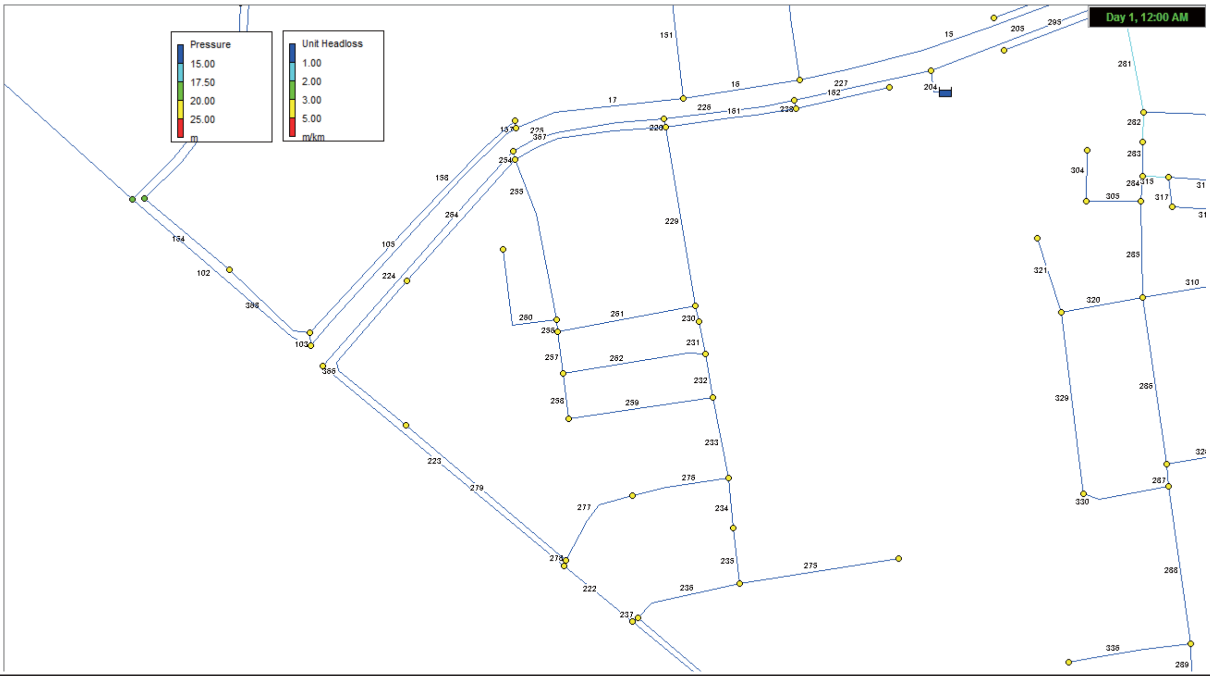
## 2-2 Node



## 2-3 Node



## 2-1 Link



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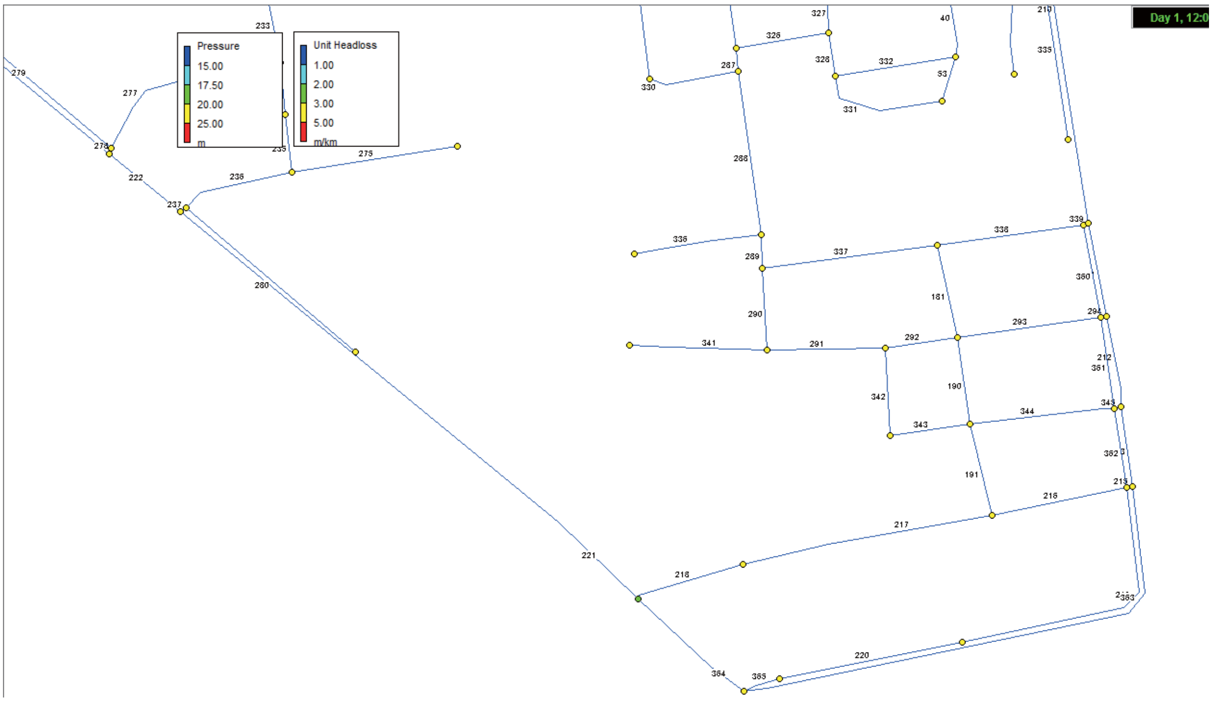

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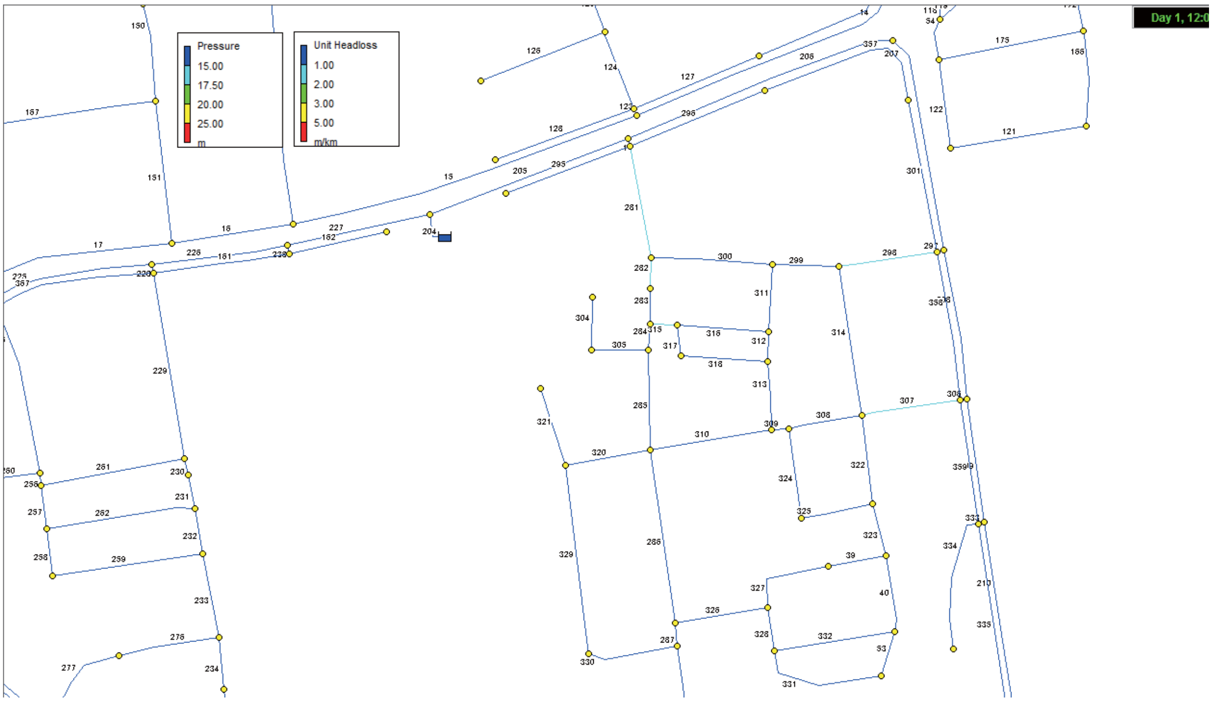

(2) Result of network analysis

Node

| ID | Elevation | Demand | Head | Pressure | ID | Elevation | Demand | Head | Pressure |
|---|---|---|---|---|---|---|---|---|---|
| | m | m3/d | m | m | | m | m3/d | m | m |
| Junc 3 | 10.8 | 0.00 | 32.85 | 22.05 | Junc 151 | 9.8 | 61.95 | 32.52 | 22.72 |
| Junc 4 | 10.8 | 0.00 | 32.83 | 22.03 | Junc 152 | 9.5 | 61.95 | 32.52 | 23.02 |
| Junc 5 | 10.4 | 61.95 | 32.82 | 22.42 | Junc 153 | 9.5 | 61.95 | 32.53 | 23.03 |
| Junc 6 | 10.1 | 61.95 | 32.63 | 22.53 | Junc 154 | 9.5 | 61.95 | 32.53 | 23.03 |
| Junc 7 | 10.2 | 0.00 | 32.70 | 22.50 | Junc 155 | 9.7 | 61.95 | 32.52 | 22.82 |
| Junc 8 | 10.5 | 0.00 | 32.63 | 22.13 | Junc 156 | 9.7 | 61.95 | 32.52 | 22.82 |
| Junc 9 | 10.6 | 0.00 | 32.62 | 22.02 | Junc 157 | 10.0 | 61.95 | 32.52 | 22.52 |
| Junc 10 | 10.6 | 0.00 | 32.61 | 22.01 | Junc 158 | 10.2 | 61.95 | 32.51 | 22.31 |
| Junc 11 | 10.6 | 0.00 | 32.60 | 22.00 | Junc 159 | 10.2 | 61.95 | 32.51 | 22.31 |
| Junc 12 | 10.6 | 61.95 | 32.59 | 21.99 | Junc 160 | 10.3 | 61.95 | 32.51 | 22.21 |
| Junc 14 | 10.7 | 0.00 | 32.59 | 21.89 | Junc 161 | 10.8 | 61.95 | 32.51 | 21.71 |
| Junc 15 | 10.5 | 61.95 | 32.59 | 22.09 | Junc 162 | 10.7 | 61.95 | 32.52 | 21.82 |
| Junc 17 | 10.5 | 0.00 | 32.58 | 22.08 | Junc 163 | 10.7 | 61.95 | 32.52 | 21.82 |
| Junc 18 | 10.6 | 61.95 | 32.57 | 21.97 | Junc 164 | 11.0 | 61.95 | 32.52 | 21.52 |
| Junc 19 | 10.1 | 0.00 | 32.57 | 22.47 | Junc 165 | 10.9 | 0.00 | 32.52 | 21.62 |
| Junc 21 | 10.1 | 61.95 | 32.57 | 22.47 | Junc 167 | 11.1 | 61.95 | 32.52 | 21.42 |
| Junc 22 | 9.7 | 61.95 | 32.53 | 22.83 | Junc 169 | 10.9 | 61.95 | 32.53 | 21.63 |
| Junc 23 | 9.4 | 61.95 | 32.52 | 23.12 | Junc 171 | 11.0 | 61.95 | 32.55 | 21.55 |
| Junc 24 | 9.4 | 0.00 | 32.56 | 23.16 | Junc 172 | 10.4 | 61.95 | 32.61 | 22.21 |
| Junc 25 | 8.9 | 0.00 | 32.56 | 23.66 | Junc 173 | 9.4 | 61.95 | 32.52 | 23.12 |
| Junc 26 | 9.0 | 61.95 | 32.56 | 23.56 | Junc 174 | 8.9 | 61.95 | 32.50 | 23.60 |
| Junc 27 | 9.0 | 61.95 | 32.53 | 23.53 | Junc 175 | 9.1 | 61.95 | 32.50 | 23.40 |
| Junc 28 | 9.0 | 61.95 | 32.54 | 23.54 | Junc 176 | 9.6 | 61.95 | 32.50 | 22.90 |
| Junc 29 | 9.7 | 61.95 | 32.57 | 22.87 | Junc 177 | 10.6 | 0.00 | 31.58 | 20.98 |
| Junc 30 | 10.2 | 61.95 | 32.57 | 22.37 | Junc 178 | 9.3 | 61.95 | 31.50 | 22.20 |
| Junc 31 | 10.4 | 0.00 | 32.57 | 22.17 | Junc 179 | 9.1 | 0.00 | 31.52 | 22.42 |
| Junc 32 | 10.4 | 61.95 | 32.57 | 22.17 | Junc 180 | 9.2 | 61.95 | 31.52 | 22.32 |
| Junc 33 | 10.8 | 61.95 | 32.57 | 21.77 | Junc 181 | 9.2 | 0.00 | 31.49 | 22.29 |
| Junc 35 | 11.8 | 61.95 | 32.55 | 20.75 | Junc 182 | 9.0 | 61.95 | 31.45 | 22.45 |
| Junc 36 | 13.0 | 0.00 | 32.58 | 19.58 | Junc 183 | 9.0 | 61.95 | 31.45 | 22.45 |
| Junc 37 | 12.7 | 61.95 | 32.55 | 19.85 | Junc 184 | 8.6 | 61.95 | 31.46 | 22.86 |
| Junc 38 | 12.4 | 0.00 | 32.58 | 20.18 | Junc 185 | 8.5 | 0.00 | 31.47 | 22.97 |
| Junc 39 | 12.5 | 61.95 | 32.58 | 20.08 | Junc 187 | 8.3 | 61.95 | 31.45 | 23.15 |
| Junc 41 | 12.5 | 0.00 | 32.58 | 20.08 | Junc 188 | 8.2 | 0.00 | 31.46 | 23.26 |
| Junc 42 | 13.3 | 61.95 | 32.59 | 19.29 | Junc 190 | 8.3 | 61.95 | 31.45 | 23.15 |
| Junc 43 | 14.1 | 61.95 | 32.57 | 18.47 | Junc 191 | 8.3 | 0.00 | 31.46 | 23.16 |
| Junc 44 | 14.6 | 61.95 | 32.57 | 17.97 | Junc 192 | 8.0 | 61.95 | 31.44 | 23.44 |
| Junc 45 | 14.7 | 61.95 | 32.57 | 17.87 | Junc 193 | 7.7 | 61.95 | 31.43 | 23.73 |
| Junc 46 | 15.0 | 61.95 | 32.60 | 17.60 | Junc 194 | 8.1 | 61.95 | 31.45 | 23.35 |
| Junc 47 | 14.5 | 61.95 | 32.59 | 18.09 | Junc 195 | 7.8 | 0.00 | 31.45 | 23.65 |
| Junc 48 | 15.0 | 0.00 | 32.60 | 17.60 | Junc 197 | 8.2 | 61.95 | 31.45 | 23.25 |
| Junc 49 | 14.7 | 61.95 | 32.60 | 17.90 | Junc 198 | 7.9 | 0.00 | 31.45 | 23.55 |
| Junc 50 | 14.7 | 0.00 | 32.61 | 17.91 | Junc 200 | 8.1 | 61.95 | 31.45 | 23.35 |
| Junc 51 | 14.9 | 0.00 | 32.61 | 17.71 | Junc 201 | 8.0 | 0.00 | 31.45 | 23.45 |

| ID | Elevation | Demand | Head | Pressure | ID | Elevation | Demand | Head | Pressure |
|---|---|---|---|---|---|---|---|---|---|
| | m | m3/d | m | m | | m | m3/d | m | m |
| Junc 52 | 14.8 | 61.95 | 32.61 | 17.81 | Junc 203 | 8.5 | 61.95 | 31.45 | 22.95 |
| Junc 53 | 14.7 | 61.95 | 32.61 | 17.91 | Junc 204 | 8.2 | 0.00 | 31.45 | 23.25 |
| Junc 54 | 14.0 | 61.95 | 32.65 | 18.65 | Junc 205 | 9.8 | 61.95 | 31.44 | 21.64 |
| Junc 55 | 14.3 | 0.00 | 32.64 | 18.34 | Junc 206 | 10.7 | 61.95 | 31.45 | 20.75 |
| Junc 56 | 14.4 | 61.95 | 32.64 | 18.24 | Junc 207 | 12.5 | 0.00 | 31.46 | 18.96 |
| Junc 57 | 14.0 | 0.00 | 32.65 | 18.65 | Junc 208 | 9.7 | 61.95 | 31.45 | 21.75 |
| Junc 58 | 14.0 | 0.00 | 32.65 | 18.65 | Junc 209 | 10.3 | 0.00 | 31.48 | 21.18 |
| Junc 59 | 14.0 | 61.95 | 32.65 | 18.65 | Junc 210 | 10.0 | 61.95 | 31.48 | 21.48 |
| Junc 60 | 13.1 | 61.95 | 32.67 | 19.57 | Junc 211 | 10.4 | 0.00 | 31.48 | 21.08 |
| Junc 61 | 13.2 | 61.95 | 32.65 | 19.45 | Junc 212 | 10.1 | 61.95 | 31.48 | 21.38 |
| Junc 62 | 13.2 | 0.00 | 32.68 | 19.48 | Junc 213 | 11.0 | 0.00 | 31.50 | 20.50 |
| Junc 63 | 13.3 | 0.00 | 32.73 | 19.43 | Junc 214 | 10.5 | 61.95 | 31.47 | 20.97 |
| Junc 64 | 13.3 | 61.95 | 32.66 | 19.36 | Junc 215 | 10.2 | 61.95 | 31.47 | 21.27 |
| Junc 65 | 12.9 | 61.95 | 32.73 | 19.83 | Junc 216 | 10.4 | 0.00 | 31.52 | 21.12 |
| Junc 66 | 11.3 | 0.00 | 32.77 | 21.47 | Junc 217 | 10.0 | 61.95 | 31.51 | 21.51 |
| Junc 67 | 10.5 | 61.95 | 32.62 | 22.12 | Junc 219 | 10.0 | 0.00 | 31.53 | 21.53 |
| Junc 68 | 10.5 | 61.95 | 32.60 | 22.10 | Junc 220 | 10.0 | 61.95 | 31.53 | 21.53 |
| Junc 69 | 10.5 | 61.95 | 32.59 | 22.09 | Junc 221 | 9.8 | 0.00 | 31.56 | 21.76 |
| Junc 70 | 10.5 | 61.95 | 32.58 | 22.08 | Junc 222 | 9.3 | 61.95 | 31.41 | 22.11 |
| Junc 71 | 10.9 | 61.95 | 32.57 | 21.67 | Junc 223 | 9.1 | 61.95 | 31.36 | 22.26 |
| Junc 72 | 10.5 | 61.95 | 32.60 | 22.10 | Junc 224 | 8.9 | 61.95 | 31.37 | 22.47 |
| Junc 73 | 10.5 | 61.95 | 32.59 | 22.09 | Junc 225 | 9.1 | 61.95 | 31.39 | 22.29 |
| Junc 74 | 10.7 | 61.95 | 32.58 | 21.88 | Junc 226 | 9.1 | 61.95 | 31.37 | 22.27 |
| Junc 75 | 10.8 | 61.95 | 32.57 | 21.77 | Junc 227 | 9.1 | 61.95 | 31.36 | 22.26 |
| Junc 76 | 11.0 | 61.95 | 32.56 | 21.56 | Junc 228 | 9.1 | 61.95 | 31.35 | 22.25 |
| Junc 77 | 11.3 | 61.95 | 32.57 | 21.27 | Junc 229 | 9.2 | 61.95 | 31.33 | 22.13 |
| Junc 79 | 11.0 | 61.95 | 32.56 | 21.56 | Junc 230 | 9.1 | 61.95 | 31.34 | 22.24 |
| Junc 80 | 10.5 | 61.95 | 32.56 | 22.06 | Junc 231 | 9.1 | 61.95 | 31.34 | 22.24 |
| Junc 82 | 10.8 | 61.95 | 32.56 | 21.76 | Junc 232 | 9.1 | 61.95 | 31.34 | 22.24 |
| Junc 83 | 10.2 | 61.95 | 32.56 | 22.36 | Junc 233 | 9.1 | 61.95 | 31.34 | 22.24 |
| Junc 84 | 11.5 | 61.95 | 32.56 | 21.06 | Junc 234 | 9.0 | 61.95 | 31.33 | 22.33 |
| Junc 85 | 11.5 | 61.95 | 32.56 | 21.06 | Junc 235 | 8.6 | 61.95 | 31.33 | 22.73 |
| Junc 86 | 11.4 | 61.95 | 32.56 | 21.16 | Junc 236 | 8.6 | 61.95 | 31.33 | 22.73 |
| Junc 87 | 11.0 | 61.95 | 32.56 | 21.56 | Junc 237 | 8.5 | 61.95 | 31.34 | 22.84 |
| Junc 88 | 11.5 | 61.95 | 32.54 | 21.04 | Junc 238 | 8.4 | 61.95 | 31.30 | 22.90 |
| Junc 89 | 12.0 | 61.95 | 32.54 | 20.54 | Junc 239 | 8.4 | 61.95 | 31.30 | 22.90 |
| Junc 90 | 12.0 | 61.95 | 32.55 | 20.55 | Junc 240 | 8.3 | 61.95 | 31.29 | 22.99 |
| Junc 91 | 10.0 | 61.95 | 32.55 | 22.55 | Junc 241 | 9.0 | 61.95 | 31.32 | 22.32 |
| Junc 92 | 10.2 | 61.95 | 32.55 | 22.35 | Junc 242 | 8.8 | 61.95 | 31.32 | 22.52 |
| Junc 93 | 10.4 | 61.95 | 32.53 | 22.13 | Junc 243 | 9.1 | 61.95 | 31.34 | 22.24 |
| Junc 94 | 11.7 | 61.95 | 32.58 | 20.88 | Junc 244 | 9.0 | 61.95 | 31.34 | 22.34 |
| Junc 95 | 11.8 | 61.95 | 32.58 | 20.78 | Junc 245 | 8.7 | 61.95 | 31.31 | 22.61 |
| Junc 96 | 11.3 | 61.95 | 32.57 | 21.27 | Junc 246 | 8.4 | 61.95 | 31.29 | 22.89 |
| Junc 97 | 11.5 | 61.95 | 32.55 | 21.05 | Junc 247 | 8.8 | 61.95 | 31.29 | 22.49 |
| Junc 100 | 12.6 | 61.95 | 32.57 | 19.97 | Junc 248 | 8.2 | 61.95 | 31.28 | 23.08 |
| Junc 102 | 13.3 | 61.95 | 32.58 | 19.28 | Junc 249 | 8.1 | 61.95 | 31.28 | 23.18 |
| Junc 103 | 13.2 | 61.95 | 32.58 | 19.38 | Junc 250 | 9.0 | 61.95 | 31.35 | 22.35 |

| ID | Elevation | Demand | Head | Pressure | ID | Elevation | Demand | Head | Pressure |
|---|---|---|---|---|---|---|---|---|---|
| | m | m3/d | m | m | | m | m3/d | m | m |
| Junc 104 | 14.0 | 61.95 | 32.59 | 18.59 | Junc 251 | 8.9 | 61.95 | 31.36 | 22.46 |
| Junc 105 | 13.2 | 61.95 | 32.56 | 19.36 | Junc 252 | 9.2 | 61.95 | 31.34 | 22.14 |
| Junc 106 | 13.4 | 61.95 | 32.61 | 19.21 | Junc 253 | 8.7 | 61.95 | 31.40 | 22.70 |
| Junc 107 | 11.2 | 61.95 | 32.63 | 21.43 | Junc 254 | 9.2 | 61.95 | 31.35 | 22.15 |
| Junc 110 | 13.2 | 61.95 | 32.67 | 19.47 | Junc 255 | 8.9 | 61.95 | 31.37 | 22.47 |
| Junc 111 | 11.2 | 61.95 | 32.66 | 21.46 | Junc 256 | 8.7 | 61.95 | 31.39 | 22.69 |
| Junc 112 | 12.0 | 61.95 | 32.70 | 20.70 | Junc 257 | 9.2 | 61.95 | 31.39 | 22.19 |
| Junc 113 | 13.0 | 61.95 | 32.70 | 19.70 | Junc 258 | 8.7 | 61.95 | 31.41 | 22.71 |
| Junc 114 | 12.5 | 61.95 | 32.70 | 20.20 | Junc 259 | 9.0 | 61.95 | 31.42 | 22.42 |
| Junc 115 | 11.9 | 61.95 | 32.71 | 20.81 | Junc 260 | 9.7 | 61.95 | 31.45 | 21.75 |
| Junc 116 | 11.2 | 61.95 | 32.77 | 21.57 | Junc 261 | 9.3 | 61.95 | 31.45 | 22.15 |
| Junc 117 | 10.4 | 61.95 | 32.79 | 22.39 | Junc 262 | 10.1 | 61.95 | 31.47 | 21.37 |
| Junc 122 | 15.0 | 61.95 | 32.58 | 17.58 | Junc 263 | 10.1 | 61.95 | 31.47 | 21.37 |
| Junc 123 | 14.8 | 61.95 | 32.59 | 17.79 | Junc 264 | 10.0 | 61.95 | 31.47 | 21.47 |
| Junc 124 | 14.7 | 61.95 | 32.60 | 17.90 | Junc 265 | 9.8 | 61.95 | 31.47 | 21.67 |
| Junc 125 | 14.8 | 61.95 | 32.59 | 17.79 | Junc 266 | 9.5 | 61.95 | 31.45 | 21.95 |
| Junc 126 | 14.9 | 61.95 | 32.59 | 17.69 | Junc 274 | 10.1 | 61.95 | 31.47 | 21.37 |
| Junc 127 | 15.1 | 61.95 | 32.59 | 17.49 | Junc 275 | 10.3 | 61.95 | 31.46 | 21.16 |
| Junc 128 | 15.2 | 61.95 | 32.59 | 17.39 | Junc 276 | 10.4 | 61.95 | 31.46 | 21.06 |
| Junc 129 | 15.7 | 61.95 | 32.59 | 16.89 | Junc 277 | 10.3 | 61.95 | 31.46 | 21.16 |
| Junc 130 | 16.1 | 61.95 | 32.59 | 16.49 | Junc 278 | 10.2 | 61.95 | 31.46 | 21.26 |
| Junc 136 | 13.9 | 61.95 | 32.63 | 18.73 | Junc 279 | 10.1 | 61.95 | 31.48 | 21.38 |
| Junc 137 | 14.0 | 61.95 | 32.60 | 18.60 | Junc 280 | 10.1 | 61.95 | 31.48 | 21.38 |
| Junc 138 | 10.5 | 0.00 | 32.64 | 22.14 | Junc 281 | 10.1 | 61.95 | 31.48 | 21.38 |
| Junc 139 | 10.2 | 61.95 | 32.62 | 22.42 | Junc 282 | 10.1 | 61.95 | 31.44 | 21.34 |
| Junc 140 | 10.2 | 61.95 | 32.61 | 22.41 | Junc 290 | 9.8 | 61.95 | 31.55 | 21.75 |
| Junc 141 | 10.8 | 61.95 | 32.57 | 21.77 | Junc 293 | 10.3 | 61.95 | 31.54 | 21.24 |
| Junc 142 | 10.7 | 61.95 | 32.55 | 21.85 | Junc 34 | 9.5 | 61.95 | 31.31 | 21.81 |
| Junc 143 | 10.9 | 61.95 | 32.54 | 21.64 | Junc 119 | 10.8 | 0.00 | 31.46 | 20.66 |
| Junc 144 | 10.8 | 61.95 | 32.53 | 21.73 | Junc 13 | 10.8 | 0.00 | 32.57 | 21.77 |
| Junc 145 | 10.5 | 61.95 | 32.52 | 22.02 | Junc 16 | 10.5 | 61.95 | 32.58 | 22.08 |
| Junc 146 | 10.5 | 61.95 | 32.52 | 22.02 | Junc 20 | 10.5 | 61.95 | 32.58 | 22.08 |
| Junc 147 | 10.6 | 61.95 | 32.52 | 21.92 | Junc 40 | 10.5 | 61.95 | 32.58 | 22.08 |
| Junc 148 | 10.1 | 61.95 | 32.52 | 22.42 | Junc 98 | 10.5 | 0.00 | 32.80 | 22.30 |
| Junc 149 | 10.0 | 61.95 | 32.52 | 22.52 | Junc 99 | 10.2 | 61.95 | 32.80 | 22.60 |
| Junc 150 | 10.0 | 61.95 | 32.52 | 22.52 | Junc 78 | 9.4 | 61.95 | 32.50 | 23.10 |
| | | | | | Junc 81 | 9.2 | 0.00 | 32.51 | 23.31 |

## Link

| Link ID | Length | Dia. | Roughn-ess | Flow | Velocity | Unit Headloss | Link ID | Length | Dia. | Roughn-ess | Flow | Velocity | Unit Headloss |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | m | mm | | m3/d | m/s | m/km | | m | mm | | m3/d | m/s | m/km |
| Pipe 2 | 28.8 | 400 | 110 | 7929.6 | 0.7 | 1.8 | Pipe 210 | 174.9 | 350 | 110 | 680.1 | 0.1 | 0.0 |
| Pipe 3 | 17.4 | 350 | 110 | 3953.4 | 0.5 | 1.0 | Pipe 211 | 59.0 | 350 | 110 | 530.0 | 0.1 | 0.0 |
| Pipe 4 | 145.9 | 350 | 110 | 3717.8 | 0.5 | 0.9 | Pipe 212 | 57.9 | 350 | 110 | -176.2 | 0.0 | 0.0 |
| Pipe 5 | 72.6 | 350 | 110 | 3717.8 | 0.5 | 0.9 | Pipe 213 | 50.4 | 350 | 110 | -281.9 | 0.0 | 0.0 |
| Pipe 6 | 14.2 | 350 | 110 | 2600.1 | 0.3 | 0.5 | Pipe 215 | 3.4 | 150 | 110 | 207.5 | 0.1 | 0.3 |
| Pipe 7 | 46.7 | 350 | 110 | 2049.9 | 0.3 | 0.3 | Pipe 216 | 86.3 | 150 | 110 | 91.1 | 0.1 | 0.1 |
| Pipe 8 | 44.7 | 350 | 110 | 1948.8 | 0.2 | 0.3 | Pipe 217 | 158.5 | 150 | 110 | -76.2 | 0.1 | 0.0 |
| Pipe 9 | 54.7 | 350 | 110 | 1851.5 | 0.2 | 0.2 | Pipe 218 | 70.2 | 150 | 110 | -138.2 | 0.1 | 0.1 |
| Pipe 10 | 59.9 | 350 | 110 | 1440.1 | 0.2 | 0.2 | Pipe 219 | 183.5 | 100 | 110 | 29.9 | 0.0 | 0.1 |
| Pipe 11 | 53.7 | 350 | 110 | 1361.7 | 0.2 | 0.1 | Pipe 220 | 116.3 | 100 | 110 | -32.1 | 0.1 | 0.1 |
| Pipe 12 | 93.2 | 350 | 110 | 1229.9 | 0.2 | 0.1 | Pipe 221 | 375.8 | 350 | 110 | -721.5 | 0.1 | 0.0 |
| Pipe 13 | 182.9 | 350 | 110 | 815.2 | 0.1 | 0.1 | Pipe 222 | 57.4 | 350 | 110 | -1006.2 | 0.1 | 0.1 |
| Pipe 14 | 179.7 | 350 | 110 | -235.3 | 0.0 | 0.0 | Pipe 223 | 203.7 | 350 | 110 | -1146.5 | 0.1 | 0.1 |
| Pipe 15 | 225.4 | 350 | 110 | -630.9 | 0.1 | 0.0 | Pipe 224 | 186.7 | 350 | 110 | -1146.5 | 0.1 | 0.1 |
| Pipe 16 | 76.7 | 350 | 110 | -445.7 | 0.1 | 0.0 | Pipe 225 | 101.2 | 350 | 110 | -1336.2 | 0.2 | 0.1 |
| Pipe 17 | 111.6 | 350 | 110 | -500.8 | 0.1 | 0.0 | Pipe 226 | 85.9 | 350 | 110 | -1947.9 | 0.2 | 0.3 |
| Pipe 19 | 98.5 | 350 | 110 | -575.6 | 0.1 | 0.0 | Pipe 227 | 91.2 | 350 | 110 | -2146.4 | 0.3 | 0.3 |
| Pipe 20 | 53.9 | 350 | 110 | -715.6 | 0.1 | 0.0 | Pipe 228 | 5.6 | 200 | 110 | 611.7 | 0.2 | 0.5 |
| Pipe 21 | 84.9 | 350 | 110 | -715.6 | 0.1 | 0.0 | Pipe 229 | 117.8 | 200 | 110 | 562.4 | 0.2 | 0.4 |
| Pipe 22 | 187.0 | 350 | 110 | -1125.9 | 0.1 | 0.1 | Pipe 230 | 10.4 | 200 | 110 | 422.9 | 0.2 | 0.2 |
| Pipe 23 | 38.2 | 350 | 110 | -1418.7 | 0.2 | 0.2 | Pipe 231 | 21.2 | 200 | 110 | 361.0 | 0.1 | 0.2 |
| Pipe 24 | 28.0 | 350 | 110 | -1575.8 | 0.2 | 0.2 | Pipe 232 | 28.7 | 200 | 110 | 232.5 | 0.1 | 0.1 |
| Pipe 25 | 123.0 | 350 | 110 | -1776.1 | 0.2 | 0.2 | Pipe 233 | 53.8 | 200 | 110 | 108.2 | 0.0 | 0.0 |
| Pipe 26 | 34.2 | 350 | 110 | -1915.5 | 0.2 | 0.3 | Pipe 234 | 32.7 | 200 | 110 | 25.1 | 0.0 | 0.0 |
| Pipe 27 | 4.0 | 350 | 110 | -1967.0 | 0.2 | 0.3 | Pipe 235 | 36.2 | 200 | 110 | -36.9 | 0.0 | 0.0 |
| Pipe 28 | 94.2 | 350 | 110 | -2034.9 | 0.2 | 0.3 | Pipe 236 | 71.6 | 200 | 110 | -160.8 | 0.1 | 0.0 |
| Pipe 29 | 122.2 | 350 | 110 | -2597.5 | 0.3 | 0.5 | Pipe 237 | 4.2 | 200 | 110 | -284.7 | 0.1 | 0.1 |
| Pipe 30 | 67.3 | 350 | 110 | -2913.2 | 0.4 | 0.6 | Pipe 238 | 5.6 | 150 | 110 | 198.5 | 0.1 | 0.2 |
| Pipe 32 | 48.4 | 200 | 110 | 550.2 | 0.2 | 0.4 | Pipe 254 | 6.1 | 100 | 110 | 189.7 | 0.3 | 1.6 |
| Pipe 33 | 47.6 | 200 | 110 | 488.2 | 0.2 | 0.3 | Pipe 255 | 107.7 | 100 | 110 | 103.3 | 0.2 | 0.5 |
| Pipe 34 | 26.0 | 200 | 110 | 426.3 | 0.2 | 0.2 | Pipe 256 | 8.0 | 100 | 110 | -20.6 | 0.0 | 0.0 |
| Pipe 35 | 46.9 | 200 | 110 | 403.5 | 0.2 | 0.2 | Pipe 257 | 26.9 | 100 | 110 | -5.0 | 0.0 | 0.0 |
| Pipe 36 | 55.2 | 200 | 110 | 376.9 | 0.1 | 0.2 | Pipe 258 | 29.8 | 100 | 110 | -0.4 | 0.0 | 0.0 |
| Pipe 37 | 16.3 | 200 | 110 | 253.0 | 0.1 | 0.1 | Pipe 259 | 94.8 | 100 | 110 | -62.3 | 0.1 | 0.2 |
| Pipe 38 | 39.6 | 200 | 110 | 360.1 | 0.1 | 0.2 | Pipe 260 | 79.0 | 100 | 110 | 62.0 | 0.1 | 0.2 |
| Pipe 41 | 92.2 | 100 | 110 | -28.7 | 0.0 | 0.1 | Pipe 261 | 91.6 | 100 | 110 | -77.6 | 0.1 | 0.3 |
| Pipe 42 | 40.5 | 200 | 110 | -226.2 | 0.1 | 0.1 | Pipe 262 | 94.0 | 100 | 110 | -66.5 | 0.1 | 0.2 |
| Pipe 43 | 35.7 | 200 | 110 | -288.1 | 0.1 | 0.1 | Pipe 264 | 105.6 | 100 | 110 | 86.3 | 0.1 | 0.4 |
| Pipe 44 | 5.2 | 200 | 110 | -414.8 | 0.2 | 0.2 | Pipe 275 | 104.8 | 100 | 110 | 62.0 | 0.1 | 0.2 |
| Pipe 45 | 48.8 | 100 | 110 | -39.2 | 0.1 | 0.1 | Pipe 276 | 63.5 | 100 | 110 | 21.1 | 0.0 | 0.0 |
| Pipe 46 | 45.0 | 100 | 110 | -101.1 | 0.2 | 0.5 | Pipe 277 | 64.7 | 100 | 110 | -40.8 | 0.1 | 0.1 |
| Pipe 47 | 47.8 | 100 | 110 | -35.3 | 0.1 | 0.1 | Pipe 278 | 4.0 | 100 | 110 | -140.4 | 0.2 | 0.9 |
| Pipe 48 | 46.6 | 100 | 110 | -97.3 | 0.1 | 0.5 | Pipe 279 | 136.3 | 100 | 110 | 37.6 | 0.1 | 0.1 |
| Pipe 49 | 35.3 | 150 | 110 | -169.1 | 0.1 | 0.2 | Pipe 280 | 139.7 | 100 | 110 | 62.0 | 0.1 | 0.2 |

| Link ID | Length | Dia. | Roughn-ess | Flow | Velocity | Unit Headloss | Link ID | Length | Dia. | Roughn-ess | Flow | Velocity | Unit Headloss |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | m | mm |  | m3/d | m/s | m/km |  | m | mm |  | m3/d | m/s | m/km |
| Pipe 50 | 40.2 | 150 | 110 | -231.0 | 0.2 | 0.3 | Pipe 1 | 4.7 | 250 | 110 | 1336.9 | 0.3 | 0.7 |
| Pipe 51 | 5.2 | 150 | 110 | -411.5 | 0.3 | 0.9 | Pipe 281 | 71.4 | 200 | 110 | 1124.9 | 0.4 | 1.5 |
| Pipe 55 | 6.9 | 100 | 110 | -78.3 | 0.1 | 0.3 | Pipe 282 | 19.0 | 200 | 110 | 944.0 | 0.4 | 1.1 |
| Pipe 57 | 39.8 | 100 | 110 | -33.2 | 0.1 | 0.1 | Pipe 283 | 22.4 | 200 | 110 | 882.1 | 0.3 | 0.9 |
| Pipe 58 | 35.6 | 100 | 110 | -95.2 | 0.1 | 0.4 | Pipe 284 | 16.5 | 200 | 110 | 627.7 | 0.2 | 0.5 |
| Pipe 59 | 6.4 | 100 | 110 | -131.8 | 0.2 | 0.8 | Pipe 285 | 62.1 | 200 | 110 | 441.8 | 0.2 | 0.3 |
| Pipe 61 | 63.4 | 100 | 110 | 62.0 | 0.1 | 0.2 | Pipe 286 | 109.7 | 200 | 110 | 204.0 | 0.1 | 0.1 |
| Pipe 62 | 41.7 | 200 | 110 | 298.2 | 0.1 | 0.1 | Pipe 287 | 14.5 | 200 | 110 | -143.0 | 0.1 | 0.0 |
| Pipe 63 | 21.9 | 200 | 110 | 174.3 | 0.1 | 0.1 | Pipe 288 | 103.7 | 200 | 110 | -286.5 | 0.1 | 0.1 |
| Pipe 64 | 47.4 | 200 | 110 | 50.4 | 0.0 | 0.0 | Pipe 289 | 20.7 | 200 | 110 | -410.4 | 0.2 | 0.2 |
| Pipe 65 | 47.6 | 200 | 110 | -73.5 | 0.0 | 0.0 | Pipe 290 | 51.2 | 200 | 110 | -381.5 | 0.1 | 0.2 |
| Pipe 66 | 76.8 | 100 | 110 | 62.0 | 0.1 | 0.2 | Pipe 291 | 73.9 | 200 | 110 | -505.4 | 0.2 | 0.3 |
| Pipe 67 | 74.8 | 100 | 110 | 62.0 | 0.1 | 0.2 | Pipe 292 | 46.0 | 200 | 110 | -544.0 | 0.2 | 0.4 |
| Pipe 68 | 74.4 | 100 | 110 | 62.0 | 0.1 | 0.2 | Pipe 293 | 90.6 | 200 | 110 | -607.7 | 0.2 | 0.5 |
| Pipe 69 | 3.7 | 100 | 110 | 235.6 | 0.4 | 2.3 | Pipe 294 | 3.5 | 250 | 110 | -706.3 | 0.2 | 0.2 |
| Pipe 70 | 144.5 | 100 | 110 | 173.6 | 0.3 | 1.3 | Pipe 295 | 82.8 | 100 | 110 | 62.0 | 0.1 | 0.2 |
| Pipe 71 | 82.4 | 100 | 110 | 100.1 | 0.2 | 0.5 | Pipe 296 | 159.8 | 100 | 110 | 88.0 | 0.1 | 0.4 |
| Pipe 72 | 79.8 | 100 | 110 | 38.1 | 0.1 | 0.1 | Pipe 297 | 4.3 | 100 | 110 | 301.7 | 0.4 | 3.7 |
| Pipe 73 | 13.8 | 200 | 110 | 1117.7 | 0.4 | 1.4 | Pipe 298 | 62.0 | 100 | 110 | 181.9 | 0.3 | 1.5 |
| Pipe 74 | 71.1 | 100 | 110 | -62.0 | 0.1 | 0.2 | Pipe 299 | 41.9 | 100 | 110 | 48.8 | 0.1 | 0.1 |
| Pipe 75 | 53.2 | 200 | 110 | 931.9 | 0.3 | 1.0 | Pipe 300 | 75.8 | 100 | 110 | -118.9 | 0.2 | 0.7 |
| Pipe 76 | 21.1 | 200 | 110 | 808.0 | 0.3 | 0.8 | Pipe 301 | 96.7 | 100 | 110 | 35.9 | 0.1 | 0.1 |
| Pipe 77 | 23.5 | 200 | 110 | 684.1 | 0.3 | 0.6 | Pipe 304 | 33.0 | 100 | 110 | -62.0 | 0.1 | 0.2 |
| Pipe 78 | 18.7 | 200 | 110 | 560.2 | 0.2 | 0.4 | Pipe 305 | 35.5 | 100 | 110 | -123.9 | 0.2 | 0.7 |
| Pipe 79 | 44.4 | 200 | 110 | 343.2 | 0.1 | 0.2 | Pipe 306 | 3.9 | 100 | 110 | 247.7 | 0.4 | 2.6 |
| Pipe 80 | 51.2 | 200 | 110 | 243.8 | 0.1 | 0.1 | Pipe 307 | 62.5 | 100 | 110 | 203.2 | 0.3 | 1.8 |
| Pipe 81 | 57.5 | 200 | 110 | 158.9 | 0.1 | 0.0 | Pipe 308 | 46.5 | 100 | 110 | 88.3 | 0.1 | 0.4 |
| Pipe 82 | 80.1 | 200 | 110 | 27.5 | 0.0 | 0.0 | Pipe 309 | 11.0 | 100 | 110 | -60.1 | 0.1 | 0.2 |
| Pipe 83 | 43.1 | 200 | 110 | -46.1 | 0.0 | 0.0 | Pipe 310 | 77.0 | 100 | 110 | -71.6 | 0.1 | 0.3 |
| Pipe 84 | 27.6 | 200 | 110 | -120.7 | 0.0 | 0.0 | Pipe 311 | 42.3 | 100 | 110 | 105.7 | 0.2 | 0.5 |
| Pipe 85 | 50.3 | 200 | 110 | -198.1 | 0.1 | 0.1 | Pipe 312 | 18.6 | 100 | 110 | 82.2 | 0.1 | 0.3 |
| Pipe 86 | 49.3 | 200 | 110 | -285.3 | 0.1 | 0.1 | Pipe 313 | 43.2 | 100 | 110 | 50.4 | 0.1 | 0.1 |
| Pipe 87 | 28.0 | 200 | 110 | -386.0 | 0.1 | 0.2 | Pipe 314 | 94.5 | 100 | 110 | 71.2 | 0.1 | 0.3 |
| Pipe 88 | 11.4 | 200 | 110 | 602.6 | 0.2 | 0.5 | Pipe 315 | 16.9 | 100 | 110 | 192.5 | 0.3 | 1.6 |
| Pipe 89 | 76.3 | 200 | 110 | 230.9 | 0.1 | 0.1 | Pipe 316 | 57.6 | 100 | 110 | 38.5 | 0.1 | 0.1 |
| Pipe 90 | 45.0 | 200 | 110 | 168.9 | 0.1 | 0.0 | Pipe 317 | 19.6 | 100 | 110 | 92.1 | 0.1 | 0.4 |
| Pipe 91 | 46.0 | 200 | 110 | 145.7 | 0.1 | 0.0 | Pipe 318 | 54.6 | 100 | 110 | 30.1 | 0.0 | 0.1 |
| Pipe 92 | 53.1 | 200 | 110 | 109.0 | 0.0 | 0.0 | Pipe 320 | 53.7 | 100 | 110 | 104.2 | 0.2 | 0.5 |
| Pipe 93 | 27.3 | 200 | 110 | 62.5 | 0.0 | 0.0 | Pipe 321 | 72.9 | 100 | 110 | 62.0 | 0.1 | 0.2 |
| Pipe 94 | 42.2 | 200 | 110 | 13.2 | 0.0 | 0.0 | Pipe 322 | 55.8 | 100 | 110 | 124.2 | 0.2 | 0.7 |
| Pipe 95 | 68.4 | 200 | 110 | -37.1 | 0.0 | 0.0 | Pipe 323 | 33.1 | 100 | 110 | 86.7 | 0.1 | 0.4 |
| Pipe 96 | 57.5 | 150 | 110 | -29.6 | 0.0 | 0.0 | Pipe 324 | 56.3 | 100 | 110 | 86.4 | 0.1 | 0.4 |
| Pipe 97 | 54.1 | 150 | 110 | -68.6 | 0.0 | 0.0 | Pipe 325 | 45.7 | 100 | 110 | 24.5 | 0.0 | 0.0 |
| Pipe 98 | 47.9 | 150 | 110 | -93.1 | 0.1 | 0.1 | Pipe 326 | 59.0 | 150 | 110 | 285.0 | 0.2 | 0.5 |
| Pipe 99 | 28.6 | 150 | 110 | -155.1 | 0.1 | 0.2 | Pipe 327 | 57.3 | 100 | 110 | 86.5 | 0.1 | 0.4 |
| Pipe 104 | 80.0 | 100 | 110 | 62.0 | 0.1 | 0.2 | Pipe 328 | 26.9 | 100 | 110 | 136.6 | 0.2 | 0.9 |
| Pipe 110 | 34.7 | 150 | 110 | 155.1 | 0.1 | 0.2 | Pipe 329 | 119.2 | 100 | 110 | -19.7 | 0.0 | 0.0 |

| Link ID | Length | Dia. | Roughn-ess | Flow | Velocity | Unit Headloss | Link ID | Length | Dia. | Roughn-ess | Flow | Velocity | Unit Headloss |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | m | mm | | m3/d | m/s | m/km | | m | mm | | m3/d | m/s | m/km |
| Pipe 111 | 66.1 | 100 | 110 | 37.4 | 0.1 | 0.1 | Pipe 330 | 56.8 | 100 | 110 | -81.6 | 0.1 | 0.3 |
| Pipe 112 | 81.0 | 100 | 110 | 23.0 | 0.0 | 0.0 | Pipe 331 | 80.5 | 100 | 110 | 38.3 | 0.1 | 0.1 |
| Pipe 113 | 88.2 | 200 | 110 | 69.4 | 0.0 | 0.0 | Pipe 332 | 76.1 | 100 | 110 | 36.3 | 0.1 | 0.1 |
| Pipe 114 | 90.5 | 100 | 110 | 12.7 | 0.0 | 0.0 | Pipe 333 | 3.9 | 100 | 110 | 181.3 | 0.3 | 1.4 |
| Pipe 115 | 92.8 | 100 | 110 | 15.5 | 0.0 | 0.0 | Pipe 334 | 86.5 | 100 | 110 | 62.0 | 0.1 | 0.2 |
| Pipe 116 | 88.4 | 100 | 110 | 25.2 | 0.0 | 0.0 | Pipe 335 | 120.9 | 100 | 110 | 62.0 | 0.1 | 0.2 |
| Pipe 117 | 89.6 | 100 | 110 | 38.8 | 0.1 | 0.1 | Pipe 336 | 80.3 | 100 | 110 | 62.0 | 0.1 | 0.2 |
| Pipe 118 | 18.6 | 150 | 110 | 309.8 | 0.2 | 0.5 | Pipe 337 | 110.8 | 100 | 110 | -90.9 | 0.1 | 0.4 |
| Pipe 119 | 85.2 | 100 | 110 | 61.0 | 0.1 | 0.2 | Pipe 338 | 92.1 | 100 | 110 | -104.8 | 0.2 | 0.5 |
| Pipe 121 | 86.1 | 150 | 110 | -78.3 | 0.1 | 0.0 | Pipe 339 | 3.1 | 100 | 110 | -150.1 | 0.2 | 1.0 |
| Pipe 123 | 4.9 | 150 | 110 | 395.6 | 0.3 | 0.9 | Pipe 341 | 85.8 | 100 | 110 | 62.0 | 0.1 | 0.2 |
| Pipe 124 | 51.5 | 150 | 110 | 185.9 | 0.1 | 0.2 | Pipe 342 | 54.6 | 100 | 110 | -23.4 | 0.0 | 0.0 |
| Pipe 125 | 30.3 | 150 | 110 | 62.0 | 0.0 | 0.0 | Pipe 343 | 61.2 | 100 | 110 | -85.3 | 0.1 | 0.4 |
| Pipe 126 | 83.5 | 100 | 110 | 62.0 | 0.1 | 0.2 | Pipe 344 | 90.4 | 100 | 110 | -88.1 | 0.1 | 0.4 |
| Pipe 127 | 85.2 | 100 | 110 | 85.8 | 0.1 | 0.4 | Pipe 345 | 4.3 | 100 | 110 | -105.6 | 0.2 | 0.5 |
| Pipe 128 | 92.1 | 100 | 110 | 62.0 | 0.1 | 0.2 | Pipe 348 | 23.3 | 200 | 110 | 1050.5 | 0.4 | 1.3 |
| Pipe 129 | 7.0 | 200 | 110 | 197.7 | 0.1 | 0.1 | Pipe 349 | 82.5 | 100 | 110 | 62.0 | 0.1 | 0.2 |
| Pipe 131 | 165.8 | 200 | 110 | 635.6 | 0.2 | 0.5 | Pipe 350 | 82.9 | 100 | 110 | 62.0 | 0.1 | 0.2 |
| Pipe 132 | 99.4 | 200 | 110 | 542.1 | 0.2 | 0.4 | Pipe 351 | 81.3 | 100 | 110 | 62.0 | 0.1 | 0.2 |
| Pipe 133 | 72.5 | 200 | 110 | 624.8 | 0.2 | 0.5 | Pipe 352 | 88.5 | 100 | 110 | 11.7 | 0.0 | 0.0 |
| Pipe 134 | 150.5 | 200 | 110 | 500.9 | 0.2 | 0.3 | Pipe 353 | 59.9 | 100 | 110 | 44.3 | 0.1 | 0.1 |
| Pipe 135 | 143.5 | 200 | 110 | 247.1 | 0.1 | 0.1 | Pipe 354 | 54.0 | 100 | 110 | 60.7 | 0.1 | 0.2 |
| Pipe 136 | 71.6 | 100 | 110 | 128.9 | 0.2 | 0.8 | Pipe 355 | 92.8 | 100 | 110 | 35.4 | 0.1 | 0.1 |
| Pipe 137 | 66.0 | 100 | 110 | 67.0 | 0.1 | 0.2 | Pipe 356 | 106.1 | 100 | 110 | -23.9 | 0.0 | 0.0 |
| Pipe 138 | 45.5 | 100 | 110 | -31.6 | 0.1 | 0.1 | Pipe 357 | 118.4 | 100 | 110 | 26.1 | 0.0 | 0.0 |
| Pipe 139 | 5.2 | 150 | 110 | 315.6 | 0.2 | 0.6 | Pipe 358 | 94.2 | 100 | 110 | 22.0 | 0.0 | 0.0 |
| Pipe 140 | 79.4 | 100 | 110 | 134.4 | 0.2 | 0.8 | Pipe 359 | 78.1 | 100 | 110 | 4.6 | 0.0 | 0.0 |
| Pipe 141 | 108.9 | 150 | 110 | 231.9 | 0.2 | 0.3 | Pipe 360 | 58.9 | 100 | 110 | -16.7 | 0.0 | 0.0 |
| Pipe 142 | 84.3 | 150 | 110 | 206.7 | 0.1 | 0.3 | Pipe 361 | 57.6 | 100 | 110 | 19.9 | 0.0 | 0.0 |
| Pipe 143 | 68.7 | 150 | 110 | 144.7 | 0.1 | 0.1 | Pipe 362 | 50.1 | 100 | 110 | -24.5 | 0.0 | 0.0 |
| Pipe 144 | 91.6 | 100 | 110 | 62.0 | 0.1 | 0.2 | Pipe 363 | 329.3 | 350 | 110 | -489.4 | 0.1 | 0.0 |
| Pipe 146 | 64.7 | 100 | 110 | -62.0 | 0.1 | 0.2 | Pipe 364 | 87.7 | 350 | 110 | -583.4 | 0.1 | 0.0 |
| Pipe 147 | 125.3 | 200 | 110 | -124.8 | 0.1 | 0.0 | Pipe 365 | 23.8 | 100 | 110 | -94.0 | 0.1 | 0.4 |
| Pipe 148 | 126.7 | 200 | 110 | -186.8 | 0.1 | 0.1 | Pipe 366 | 132.0 | 100 | 110 | 24.4 | 0.0 | 0.0 |
| Pipe 149 | 59.9 | 200 | 110 | 0.9 | 0.0 | 0.0 | Pipe 367 | 101.7 | 100 | 110 | -61.9 | 0.1 | 0.2 |
| Pipe 150 | 61.9 | 150 | 110 | 130.8 | 0.1 | 0.1 | Pipe 368 | 91.4 | 100 | 110 | -57.4 | 0.1 | 0.2 |
| Pipe 151 | 89.6 | 150 | 110 | 6.9 | 0.0 | 0.0 | Pipe 369 | 68.9 | 100 | 110 | -13.2 | 0.0 | 0.0 |
| Pipe 152 | 81.1 | 200 | 110 | -191.8 | 0.1 | 0.1 | Pipe 370 | 34.5 | 100 | 110 | -98.0 | 0.1 | 0.5 |
| Pipe 157 | 5.1 | 150 | 110 | -73.7 | 0.1 | 0.0 | Pipe 371 | 48.5 | 100 | 110 | -15.5 | 0.0 | 0.0 |
| Pipe 158 | 192.2 | 100 | 110 | 11.7 | 0.0 | 0.0 | Pipe 372 | 17.8 | 100 | 110 | 10.7 | 0.0 | 0.0 |
| Pipe 159 | 5.6 | 100 | 110 | 140.0 | 0.2 | 0.9 | Pipe 373 | 52.6 | 100 | 110 | -72.4 | 0.1 | 0.3 |
| Pipe 163 | 92.9 | 100 | 110 | 66.5 | 0.1 | 0.2 | Pipe 374 | 9.0 | 100 | 110 | -128.7 | 0.2 | 0.8 |
| Pipe 164 | 71.8 | 100 | 110 | 4.6 | 0.0 | 0.0 | Pipe 52 | 58.2 | 200 | 110 | 310.1 | 0.1 | 0.1 |
| Pipe 167 | 115.7 | 100 | 110 | -62.0 | 0.1 | 0.2 | Pipe 56 | 78.9 | 200 | 110 | 186.2 | 0.1 | 0.1 |
| Pipe 168 | 4.1 | 100 | 110 | 157.2 | 0.2 | 1.1 | Pipe 60 | 439.5 | 200 | 110 | 106.5 | 0.0 | 0.0 |
| Pipe 169 | 83.3 | 100 | 110 | 62.0 | 0.1 | 0.2 | Pipe 100 | 58.6 | 100 | 110 | 11.5 | 0.0 | 0.0 |
| Pipe 170 | 155.2 | 100 | 110 | 48.7 | 0.1 | 0.1 | Pipe 101 | 82.8 | 100 | 110 | -50.5 | 0.1 | 0.1 |

| Link ID | Length | Dia. | Roughn-ess | Flow | Velocity | Unit Headloss | Link ID | Length | Dia. | Roughn-ess | Flow | Velocity | Unit Headloss |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | m | mm | | m3/d | m/s | m/km | | m | mm | | m3/d | m/s | m/km |
| Pipe 171 | 4.4 | 100 | 110 | 51.5 | 0.1 | 0.1 | Pipe 102 | 151.0 | 400 | 110 | 682.1 | 0.1 | 0.0 |
| Pipe 173 | 81.8 | 100 | 110 | -10.5 | 0.0 | 0.0 | Pipe 103 | 8.6 | 100 | 110 | -107.6 | 0.2 | 0.6 |
| Pipe 174 | 4.5 | 200 | 110 | 67.9 | 0.0 | 0.0 | Pipe 105 | 195.0 | 400 | 110 | 574.5 | 0.1 | 0.0 |
| Pipe 177 | 217.1 | 150 | 110 | -62.0 | 0.0 | 0.0 | Pipe 106 | 80.8 | 100 | 110 | 111.7 | 0.2 | 0.6 |
| Pipe 178 | 88.0 | 100 | 110 | -66.7 | 0.1 | 0.2 | Pipe 107 | 46.4 | 100 | 110 | 49.7 | 0.1 | 0.1 |
| Pipe 179 | 138.5 | 100 | 110 | 72.7 | 0.1 | 0.3 | Pipe 108 | 44.9 | 100 | 110 | -12.2 | 0.0 | 0.0 |
| Pipe 180 | 5.2 | 100 | 110 | 139.4 | 0.2 | 0.9 | Pipe 109 | 54.6 | 100 | 110 | -74.2 | 0.1 | 0.3 |
| Pipe 182 | 105.0 | 100 | 110 | 77.4 | 0.1 | 0.3 | Pipe 130 | 56.3 | 350 | 110 | -3110.9 | 0.4 | 0.6 |
| Pipe 183 | 45.0 | 150 | 110 | 211.0 | 0.1 | 0.3 | Pipe 153 | 43.1 | 350 | 110 | -3976.2 | 0.5 | 1.0 |
| Pipe 184 | 61.5 | 150 | 110 | 149.1 | 0.1 | 0.1 | Pipe 154 | 66.5 | 100 | 110 | -112.6 | 0.2 | 0.6 |
| Pipe 185 | 40.2 | 150 | 110 | 87.1 | 0.1 | 0.1 | Pipe 155 | 57.7 | 100 | 110 | -105.8 | 0.2 | 0.5 |
| Pipe 186 | 20.3 | 150 | 110 | 168.1 | 0.1 | 0.2 | Pipe 156 | 5.4 | 200 | 110 | 865.3 | 0.3 | 0.9 |
| Pipe 187 | 20.4 | 150 | 110 | 106.2 | 0.1 | 0.1 | Pipe 160 | 24.5 | 200 | 110 | 697.6 | 0.3 | 0.6 |
| Pipe 188 | 85.5 | 150 | 110 | 44.2 | 0.0 | 0.0 | Pipe 161 | 85.7 | 100 | 110 | -74.6 | 0.1 | 0.3 |
| Pipe 189 | 104.3 | 150 | 110 | -17.8 | 0.0 | 0.0 | Pipe 162 | 62.7 | 100 | 110 | 62.0 | 0.1 | 0.2 |
| Pipe 195 | 5.7 | 150 | 110 | 292.8 | 0.2 | 0.5 | Pipe 18 | 54.6 | 100 | 110 | -36.7 | 0.1 | 0.1 |
| Pipe 196 | 72.2 | 150 | 110 | 142.9 | 0.1 | 0.1 | Pipe 39 | 37.1 | 100 | 110 | 24.5 | 0.0 | 0.0 |
| Pipe 197 | 87.6 | 100 | 110 | 87.9 | 0.1 | 0.4 | Pipe 40 | 48.4 | 100 | 110 | 49.3 | 0.1 | 0.1 |
| Pipe 198 | 24.1 | 100 | 110 | 26.0 | 0.0 | 0.0 | Pipe 53 | 28.7 | 100 | 110 | 23.6 | 0.0 | 0.0 |
| Pipe 199 | 42.8 | 100 | 110 | -36.0 | 0.1 | 0.1 | Pipe 54 | 26.6 | 150 | 110 | 186.8 | 0.1 | 0.2 |
| Pipe 202 | 198.5 | 200 | 110 | 434.0 | 0.2 | 0.3 | Pipe 122 | 55.8 | 150 | 110 | 140.3 | 0.1 | 0.1 |
| Pipe 203 | 167.4 | 200 | 110 | 372.0 | 0.1 | 0.2 | Pipe 166 | 59.5 | 150 | 110 | 16.4 | 0.0 | 0.0 |
| Pipe 204 | 21.2 | 400 | 110 | 4894.1 | 0.5 | 0.8 | Pipe 172 | 40.7 | 150 | 110 | 1.0 | 0.0 | 0.0 |
| Pipe 205 | 132.9 | 350 | 110 | 2747.7 | 0.3 | 0.5 | Pipe 175 | 92.3 | 100 | 110 | 46.5 | 0.1 | 0.1 |
| Pipe 206 | 177.5 | 350 | 110 | 1410.8 | 0.2 | 0.1 | Pipe 176 | 49.9 | 200 | 110 | -135.5 | 0.1 | 0.0 |
| Pipe 207 | 137.6 | 350 | 110 | 1410.8 | 0.2 | 0.1 | Pipe 181 | 59.0 | 100 | 110 | -48.0 | 0.1 | 0.1 |
| Pipe 208 | 94.1 | 350 | 110 | 1109.1 | 0.1 | 0.1 | Pipe 190 | 54.8 | 100 | 110 | -46.2 | 0.1 | 0.1 |
| Pipe 209 | 78.1 | 350 | 110 | 861.4 | 0.1 | 0.1 | Pipe 191 | 59.1 | 100 | 110 | -105.4 | 0.2 | 0.5 |

Data 6. Minutes of Stakeholder Meeting

# **Meeting Minutes of Stakeholder Meeting**

Date: 11th July 2013 (Thursday)
Venue:

Hu San Restaurant, Kabar Aye Pagoda Road
Time:

10:00 AM - 11:10 AM
Attendance: As attached

Minutes:

1. Master announced the opening of the Stakeholder Meeting on the Project for Urgent Improvement of Water Supply System in Yangon City a10:10 am.
2. Master called for Opening Speech of Mr. Myo Thein, Assistant Chief Engineer (ACE), YCDC. Mr. Myo Thein gave an opening speech.

   He explained that YCDC is cooperating with international countries like Japan, Denmark and Korea in water sector to improve the water supply system in Yangon City. He outlined the objectives and components of the Project supported by JICA, and explained that this meeting is to inform to the customers that during construction not to interrupt water supply as much as possible and asked the cooperation from the customers.
3. Master called for Opening Remark of Mr. Masahiro Tanaka, Chief Representative of JICA Myanmar Office. Mr. Tanaka gave an opening remark.
4. Master called for the presentation of Ms. Yamada, JICA Study Team and Ms. Yamada presented the details of each component, benefits of customers and possible impacts to the customers which may happen during the construction period. Mr. Myo Thein, ACE, YCDC added the technical explanation in Myanmar.
5. Master called for questions from audience.
   1. The person made the question: Sometimes, the supplying water in Yankin contains small fishes and shrimps and not clean. It needs to be cleaned.
      Mr. Myo Thein answered: Long ago, YCDC did not have treatment system and the raw water which mainly rain water was the only water source near the forests. In 2005, YCDC built Water Treatment Plant in Nyaungnhapin. Now Second Water Treatment Plant is constructed. Long ago, YCDC could only provide 160 million gallons per day. After the Second Phase has finished, it can give 205 million gallons per day. YCDC can provide 90 million gallons from

first and second water treatment plant and 27 million from Gyobyu at present. YCDC has a plan to use Hlawga Reservoir. Later, only all clean water will arrive to Yangon.

2. The person made the question: In second component, the pipeline will be cut. And that will be connected to the new pipeline. There will be stopped for water so many times. How long will water be stopped? And when will you start this project?
   Ms. Yamada answered: For first question, we estimate maximum around half day. Main pipeline will be installed first, and then the existing line will be cut and reconnected. We expected the water stops around half day. As for second question, this project will be divided into two implementation stages. The first will be pumping station in Nyaungnhapin Water Treatment Plant. That will start in next year. And distribution pipeline, that will be a little late. This may be next year around August. This is still tentative schedule.

3. Mr. Myo Myint, Deputy District Chief (Auxiliary Fire Brigade), Myanmar Fire Brigade made the question: How can you plan for 24 hour lines for Fire Brigades in this DMA pilot area?
   Mr. Myo Thein answered: YCDC has the pipelines for Fire Brigades in some places. In Yankin, the water pressure is high but in some places not. It can only provide water about 12 hours a day. If there is a Fire Brigade in DMA Pilot Area, YCDC will provide 24 hour-line. But 24 hours electricity is necessary as to give 24 hours water supply.

4. Mr. Phyu Win Maung, Sedona Hotel made the question: If the electricity goes off, how can the pump station be run?
   Mr. Myo Thein answered: If the electricity went off, some pump stations also stop. But, mostly, electricity went off rarely at these places. There are also 24 hour water supply pump stations like Nyaungnhapin, Phugyi. But, the 24 hour electricity supply is needed for continuous water supply. So water supply and electricity depends upon each other.

5. Mr. Phyu Win Maung, Sedona Hotel made the question: In some places Like Sedona, when the electricity goes on again, water supply cannot be got from YCDC.
   Mr. Myo Thein answered: If the duration that the electricity goes off is short, it is not so. But if the duration is about half an hour or an hour, it will be caused like this. Because the transmission line like Gyobyu, the water is distributed by pressure. Only when the water pressure height is about 30 feet, the water can be provided to some townships like Tharketa and Dagon Seikkan. When the duration of electricity failure takes long, the water pressure of the pipelines are lost and thus although the electricity goes on again, we had to wait to get enough water pressure in some places. We heard such comments like that although the electricity goes on, water supply is off. Only when the transmission line has much pressure, distribution line also gets pressure. But, in this pilot area, we will maintain water pressure. But it will not be like with 24 hours water supply station like Nyaungnhapin as it needs continuous 24 hours electricity.

6. Mr. Myo Thein made the closing remarks.

Now YCDC is preparing Master Plan with JICA up to 2040 and it is almost finished. The population becomes much more and more so we have to find new raw water source for the expected population of 2040. According to topography, it cannot be possible anymore to build new reservoirs so we have to take river water as raw water like the methods used in international. But river water has more contamination than reservoir water. So we tried to find the place free from such contamination source and the sea water intrusion, to build the Treatment Plant to provide water to everywhere in Yangon. We are doing these cooperating with JICA.

Next, there is the problem of contamination of piped water. Some pipes are very old even over one hundred years. So, these pipes are decayed and usually cause leakage. And also there are illegal connections somewhere and some places called free connection to where we have to supply freely like the religion buildings. There is also wasting of water as opening the switch bar continuously without using water. So the pressure also decreases. So, there is low pressure in some places. Thus, we are now trying both to find new sources for water source and not to waste unnecessarily by making DMA system cooperating with JICA, Denmark and later also with France dividing the places. Today is to inform about them all of you. JICA usually inform the plans and projects before whatever they do. So today we made this meeting.

7. Master announced the closing of the stakeholder meeting at 11:10 am.

Appendix-I: List of participants
Appendix-II: Comments/questions from the participants and answers

## List of Participants

| No | Name | Title | Organization |
|---|---|---|---|
| Township Officer | | | |
| 1 | U Myint Aye | Yankin EO | Admin, Yankin EO Office |
| 2 | U Aung Min | Mayangone EO (Temporary) | Admin, Mayangone EO Office |
| 3 | U Aung San Win | Second Head of T/S | Yankin Township Office |
| 4 | U Ko Ko Win | Second Head of T/S | Mayangone T/S |
| 5 | U Tun Wai | Admin/Clerk | No 7 Ward, Administrator Office |
| 6 | U Kyaw Win Aung | Myakyunthar | No.1 Ward, North/Okkala |
| 7 | U Myint Swe | Administrator | No.10 Ward, Administrator Office |
| 8 | U Thant Zin Oo | EE | Head of South District (Water and Sanitation) |
| 9 | U Nay Lynn | Head of District(North) | Engineer Department(Water and Sanitation) |
| 10 | U Aung Khin Zaw | AE | Deputy Head of S/D(W/S) |
| 11 | U Khaing Soe Win | Ward Administrator | |
| Residents, Hotel, Factory | | | |
| 12 | U Than Oo | | 10 Ward, Mayangone T/S |
| 13 | U Maung Myint | | No.5/6 , Yaekuu |
| 14 | U Phyu Win Maung | | Sedona Hotel (Yangon) |
| 15 | U Lay Naing | CE | Marina Residence |
| 16 | Ko Ye Aung | | Micasa Hotel, No.17, Kabaraye pagoda road |
| 17 | U Zar Ni Aung | CE | Inya Lake Hotel |
| 18 | Ko Tint Swe | Garment Factory (4) | U Tun Nyein Street |
| 19 | U Than Lwin | Factory Director | Militarily factory of Tea-leaf |
| Fire, Militarily, Others | | | |
| 20 | U Myo Myint | Deputy Commander | Fire Station |
| 21 | U Tun Lin Oo | | No.1, Higher Communication Militarily |
| 22 | U Mg Mg Than | | |
| YCDC | | | |
| 23 | U Myo Thein | ACE | Engineer Department(Water and Sanitation) |
| 24 | U Tun Tun Win | Engineer (2) | Engineer Department(Water and Sanitation) |
| 25 | U Min Thant Zin | Junior Engineer | Engineer Department(Water and Sanitation) |
| 26 | U Chit Ko Ko | AE | Engineer Department(Water and Sanitation) |
| 27 | U Aung Htoo Naing | AE | Engineer Department(Water and Sanitation) |
| 28 | U Aung Ko Oo | AE | Pipe (Water and Sanitation) |
| JICA Study Team | | | |
| 29 | Ms. Shoko Yamada | Environmental and Social Considerations | JICA Study Team |
| 30 | Ms. Hsu Mon Win | Interpreter | TEC International |

Appendix-II

Comments/questions from the participants by comment sheet and answers

1. Mr. Myo Myint, Deputy Division Chief (Auxiliary Fire Brigade), Myanmar Fire Brigade

   We will also cooperate in this project for supplying water to public by informing about these plans.

   But, in water supply, it needs also to arrange and plan for 24 hours pipelines for Fire Brigades to be free from dangers of public.

   <Answer>

   YCDC has the pipelines for Fire Brigades in some places. In Yankin, the water pressure is high but in some places not. It can only provide water about 12 hours a day. If there is a Fire Brigade in DMA Pilot Area, YCDC will provide 24 hour-line. But 24 hours electricity is necessary as to give 24 hours water supply.

2. Mr. Zarni Aung, Chief Engineer, Inya Lake Hotel
    1. Estimated Expected Project Starting period?
    2. Estimated working period, portion by portion?
    3. Estimated water distribution shortage period during 1050mm DI pipe re-connection period?
    4. Any increment in water usage cost?

    Email : zarniaung@inyalakehotel.com

    <Answer>

   1. The design will be started from September of this year and the construction may starts in next year.
   2. The detail is not fixed yet. The construction will be implemented part by part and expected period is around 9 months.
   3. Around half day is expected.
   4. No by this Project. But in future, the water tariff will be increased and this is proposed in another JICA Study.

3. Mr. Aung San Win, Deputy Administrator of Township, General Administrative Department (Yankin Township)

- During the period for testing in DMA and Pilot area for exchanging 42” diameter pipe by using Pipe Jacking method, it can be encountered with interruption of water daily. So, will you inform to public about the schedule and the periods for implementation before you do?

- I want to know how long it can take time for implementation in Pilot Area.

<Answer>

- Yes, before the construction starts, the information will be provided to the affected persons.
- This is tentative but around 9 months is expected.

4. Mr. Ko Ko Win, Deputy Administrator of Township, General Administrative Department (Mayangone Township)
    1. We want you to inform the public to know widely about this project and the benefits of it.
    2. Also it needs to arrange and manage in advance not to be traffic-congestion on the roads in the area of project .
    3. To inform in advance to public about that water will be stopped for temporarily during construction.

<Answer>

1. We will try to disclose the information to wider population.
2. The contractor shall arrange and manage and construction plan will be open before construction starts.
3. Yes, we will inform you.

5. Mr. Than Myaing, Production Expert Grade (4) (Military Tea-leaf Factory)
    1. To give clean, clear and healthful water.
    2. The existing distribution pipes which come from main pipe are used with iron pipe and the pipes are rusted and the water contains rust.
    3. In summer, sometimes there are many times of shortage of water.
       Please carry out to be minimum times of shortage of water as much as you can.

<Answer>

1. In another JICA Study, the road map is prepared to provide clean, clear and healthful water.
2. Yes. So the new pipe will be ductile cast iron pipe and PVC.
3. Yes, we will try it.

6. Mr. Myint Swe, No (10) Ward Administrator, Ward Administrative Department (Mayangone Township)
    1. Thank you for your good explanation about the water supply system to be implemented by JICA.
    2. It needs to inform in advance the public living in the blocks about that the water will be stopped for temporarily.

3. We believe that Yangon city will be developed and improved more because of the cooperation of JICA and YCDC.

<Answer>

1. Yes, before the construction starts, more detail information will be provided to the customers.

7. Mr. Kyaw Win Aung, Assistant Supervisor (Mya Kyun Thar Park)

- The arrangement and plans of Water & Sanitation Department are good.

8. Mr. Htut Lin Oo, Lieutenant Warrant Officer
   1. There are a lot of sediments in the iron pipes along the Kabar Aye Road as these pipes are very old.
   2. It is found that the force of water is weak when it comes from that iron pipes to households/ row houses/ apartments.
   3. It will be more convenient if the old pipes will also be cleaned.

<Answer>

1. The replacement of all pipe is better but due to the budget constraint and urgency, 1.7 km of pipeline will be implemented first.
2. The pressure will be monitored in DMA. So if DMA is set up, the problem of pressure may be reduced.
3. Thank you for your opinion. We agree on your comment.

9. Mr. Chit Ko Ko, Assistant Engineer, Department of Engineering (Water & Sanitation)
   1. It should be considered to get full power of electricity in renovation of No (1) Pumping Station at Nyaungnhapin.
   2. It should be arranged in advance extra generators not to go off the electricity and to get electrical power full time in Yegu Pumping Station concerned with this project.
   3. It will be better if the valves which control mainly to water supply from Kokkine Reservoir can be exchanged. If this is implemented, it will be improved more in water supply and the aspect of protection from wasting water.
   4. Value of water and about wasting water protection aspect should be informed to public widely until they understand.

<Answer>

1. The electricity for pumping station will be taken from the priority electricity line to reduce the risk of electricity failure.
2. These prevention measures will be proposed in another JICA Project (Master Plan).

3. Thank you for your comment.
4. As you suggest, the public awareness is important.

10. Mr. Aung Htoo Naing, Section Head, YCDC

- It should be advised to all of public to install water meters and to pay regular water meter charges monthly.
- It should be informed to public about the laws and regulations to be followed by them. (For example – advertisements from newspaper and MRTV.)

<Answer>

- Yes we agree on your comment.
- Thank you for your comment.