付属資料 4.

1) 第一次現地調査プレゼン①

Water Supply Planning
Outline of Survey

1. Service Condition of AWSD
2. Facility Condition of AWSD
3. Water Demand and Supply Capacity
4. Distribution Facility
5. Operation of AWSD
6. Criteria for Implementation of the Project

JICA Preparatory Survey on
Project for Asmara Water Supply Development

1. Service Condition of AWSD

We will grasp the present service condition of AWSD and make it the baseline condition of the water supply planning.

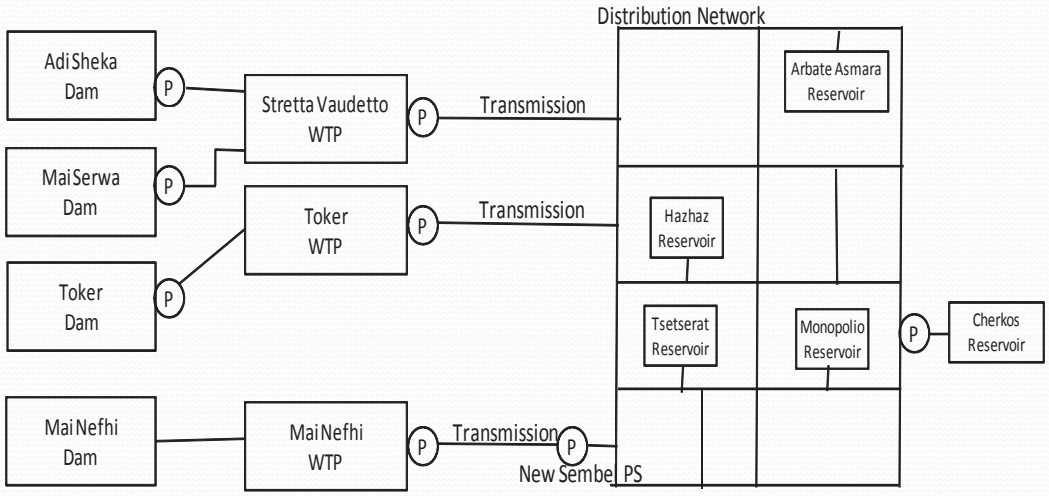
According to AWSD, the service condition as of 2009 was as follows:

Population in service area	: 576,807
Served population	: 538,550　(Service ratio: 93 %)
Billed Volume	: 3,896,588 m3　(10,675 m3/day) (including 837,581 m3 of water tanker supply)
Production Volume	: 6,052,616 m3　(16,582 m3/day)
Intake Volume	: 8,029,567 m3　(21,998 m3/day)

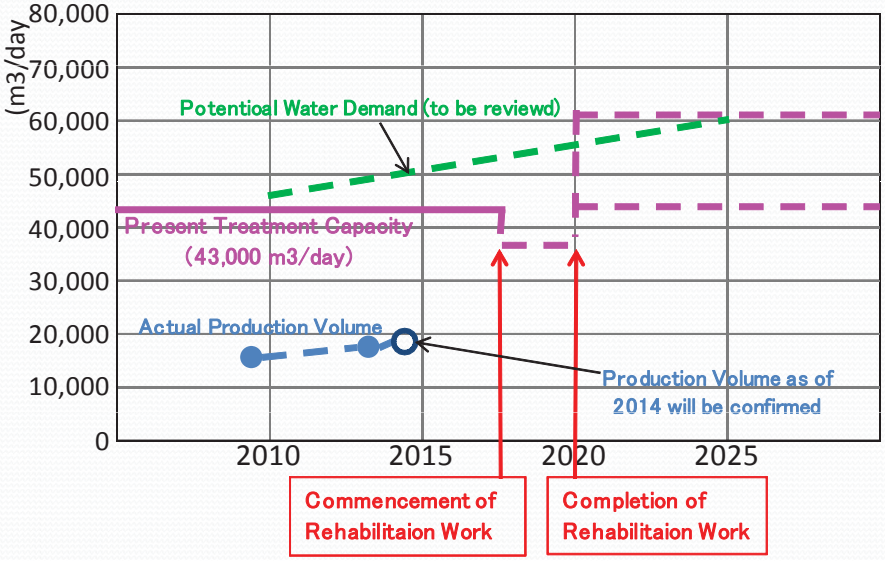
We will update the above information using the data as of 2014.

2. Facility Condition of AWSD

We will grasp the present conditions (operational& functional condition, aging status, etc.) and problems on the facilities and make it the basic information for facility improvement planning.



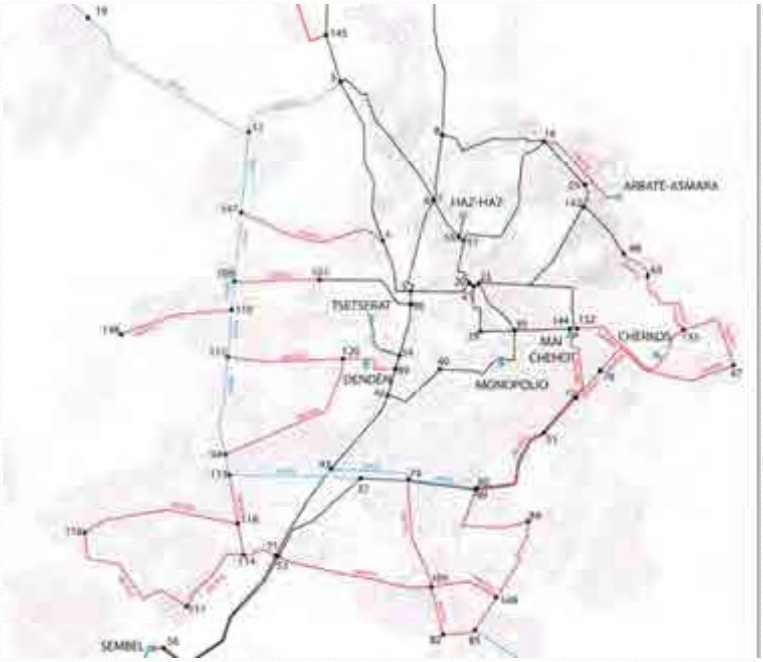
3. Water Demand and Supply Capacity



The facility rehabilitation/expansion plan will be proposed considering :

- Production volume (actual and future prospects),and
- Potential water demand

4. Distribution Facility



We will :

- Confirm the present condition of the distribution facilities as well as pump and valve control manners and function of the distribution reservoirs
- Check if the distribution facility has the sufficient capacity for the present and future demand

5. Sustainable Operation of AWSD

We will confirm the operational condition of AWSD that are important for sustainable operation of AWSD:

- Annual business plan
- Number of Connections (domestic and non-domestic)
- Annual revenue and expense
- Organizing condition of customer ledger
- Tariff collection system
- Repair record of customer meter
- Procurement record of material/equipment for O&M

We will confirm the procurement condition of the spare parts of the facility (Source of supply, purchase arrangement, budgeting procedure, etc.) that are indispensable for proper operation and maintenance of the facility.

6. Criteria for Implementation of the Project

- Priority (Necessity & Urgency)
- Prospect for Generation of the Project Effect
- Assurance about Effective Utilization of the Facility
- Assurance about Proper Operation and Maintenance including Staff Arrangement and Supply of Spare Parts

付属資料 4.

1) 第一次現地調査プレゼン②

Preparatory Survey on the Project for Asmara Water Supply Development

Water Supply Facility / Operation and Maintenance

by Koji Yoshikawa in JICA Study Team

Assigned area:

1, Water resource (Dam) Inc. environmental and social considerations

2, Water Treatment Plant Inc. environmental and social considerations

3, Operation and Maintenance (O&M)

1-1 Water resource (Dam)

1 ,TOKER (2002)
2, ADI SHEKA (1938)
3, MAI SERWA (1960)
4, STRETTA VAUDETTO (1941)
5, BELEZA (1953)
6, VALLE GNECCHI (?)
7, ELA NAHIB (1941)
8, MAI NEFHI (1968)

5nos Dams - Running (Red letters)
3nos Dams - No Running (Black letters)

1-2 Objective of the survey of dam

- **To classify the various factors or elements of each dam.**

  Various factors or elements of Dam ;

  River name, Intended use, Structure type,

  Dam size (Length, Height, Upper wide, Bottom wide, Dam volume),

  Catchment area, Water surface area,

  Gross storage capacity, Effective storage capacity,

  Landownership, Ownership of structure, Water rights,

  Conservation-Management for catchment area, Management for structure

- **To infer the available amount of water taken from each dam.**

1-3 Matters for Investigation of Dam

Data of water Level of each dam
Design Report (Inc. Drawings) of each dam
Customary water right or water right in Anseba River and Nefhi River basins
Topographical map in Maekel (Central) region (approx. scale 1:5000)
Various factors or elements of each dam
Condition of each dam's lake sediments
Condition of each dam body
Frequency of water discharge and sludge discharge from each dam
Condition of upper and lower sides of river at each dam
Condition of access road to each dam
Electric power circumstance for each raw-water pump

1-4 Survey Method

Questionnaire
Hearing survey
On-Site Survey

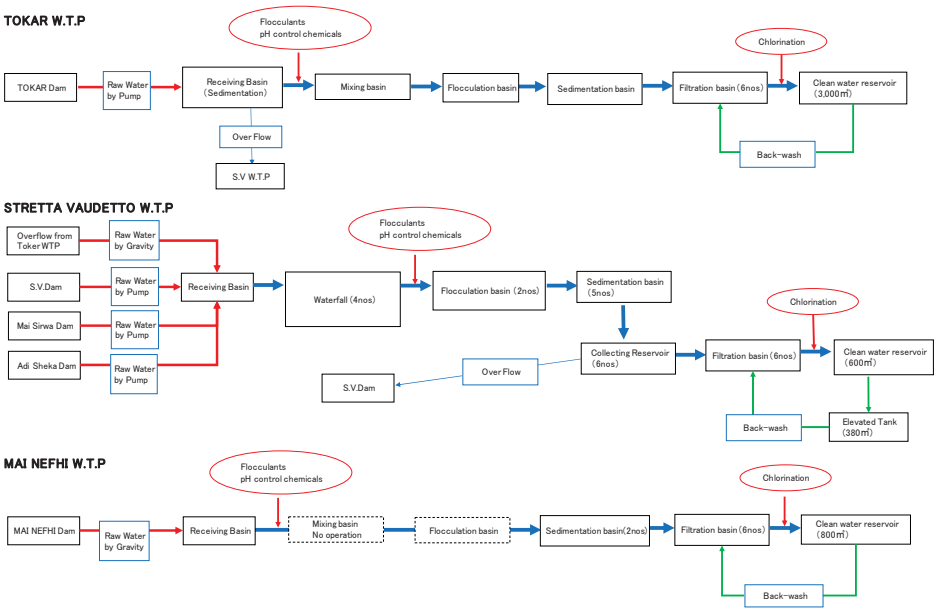
2－1 Water Treatment Plant (W.T.P)

1, TOKER (2002)

2, STRETTA VAUDETTO (1941)

3, MAI NEFHI (1967)

3nos W.T.Ps － Operation



2-2 Objective of the survey of W.T.P

- To classify the current condition and problem of each facility in each W.T.P.

W.T.P Facilities:

Receiving basin, Mixing basin, Flocculants (ALUM), pH control chemicals, Flocculation basin, Sedimentation basin, Filtration basin, Air-brow, Back-wash, Clean water reservoir, Chlorination, Control system, Water quality laboratory, Sludge disposal lagoon, Electric power circumstance (EEC and Generator)

- To select the facilities and equipment for rehabilitation.

2-3 Matters for Investigation of W.T.P

Problem of each facility in each W.T.P

Inlet and Outlet flow of each W.T.P

Design Report (Inc. Drawings) of each W.T.P

Data of inlet and outlet water qualities of each W.T.P

Condition of each building in each W.T.P

Safety measure of chlorine in each W.T.P

Condition of sludge disposal in each WTP

Electric power circumstance in each W.T.P

Condition of access road to each W.T.P

Condition of land of New W.T.P

2-4 Survey Method

Questionnaire

Hearing survey

On-Site Survey

3-1 Operation and Maintenance (O&M)

Water supply system in AWSD

Water Resource (Dam)

Intake Facility

Raw-water Facility

W.T.P Facility

Clean-Water Facility

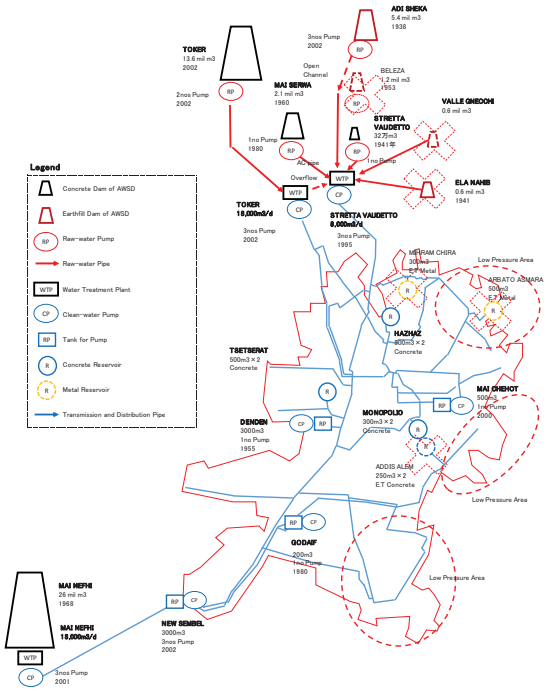
Distribution Facility

Service-pipe Facility

Water tariff collection

Pipe repair work

Water quality test



3-2 Objective of the survey of O&M

- **To classify the current condition of O&M of each facility.**

  Facilities

  Resource, Intake, Raw-water, W.T.P, Clean-Water, Distribution, Service-pipe

- **To classify the current condition**

  for water tariff collection, pipe repair work and water quality test.

- **To select the necessary capacity development.**

3-3 Matters for Investigation of O&M

Problem of O&M of each facility

Problem in Dam and Treatment Plants Unit

Condition of water quality test.

Problem in Water Distribution Unit.

Problem in New Connection and Maintenance Unit.

Number of pipe repair team and staff composition

Activity for leak Detection and pipe repair work

Presence or absence of a computerized mapping system (CAD or GIS)

Problem in Administration and Finance Division

Flow chart of water tariff collection system

Record and plan for staff training

3-4 Survey Method

Questionnaire

Hearing survey

On-Site Survey

付属資料 4.

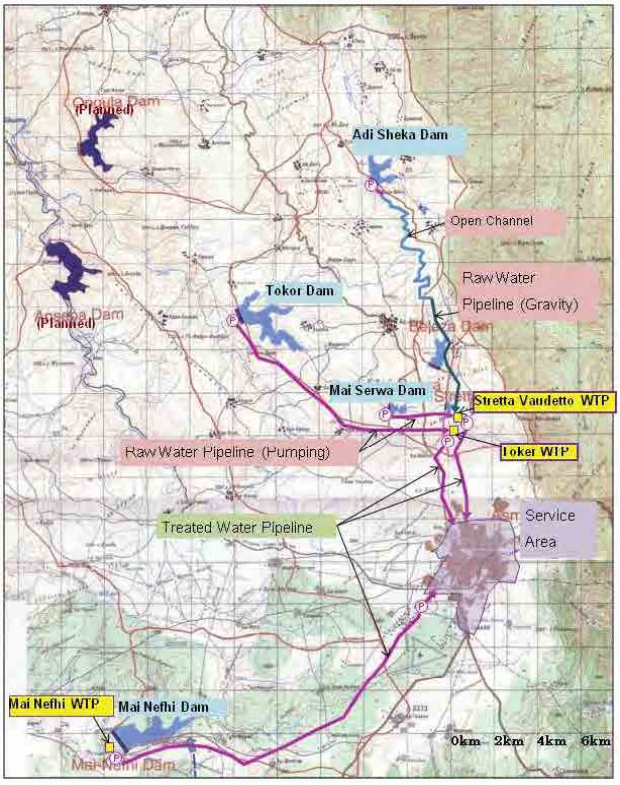
2) 第二次現地調査プレゼン①

Water Supply Planning
Results of Site Survey

1. Water Supply Condition in Asmara
2. Operational Condition of AWSD
3. Facility Conditions of AWSD
4. Water Demand and Water Balance

JICA Survey Team

1. Water Supply Condition in Asmara
1.1 Outline of Water Supply Facility

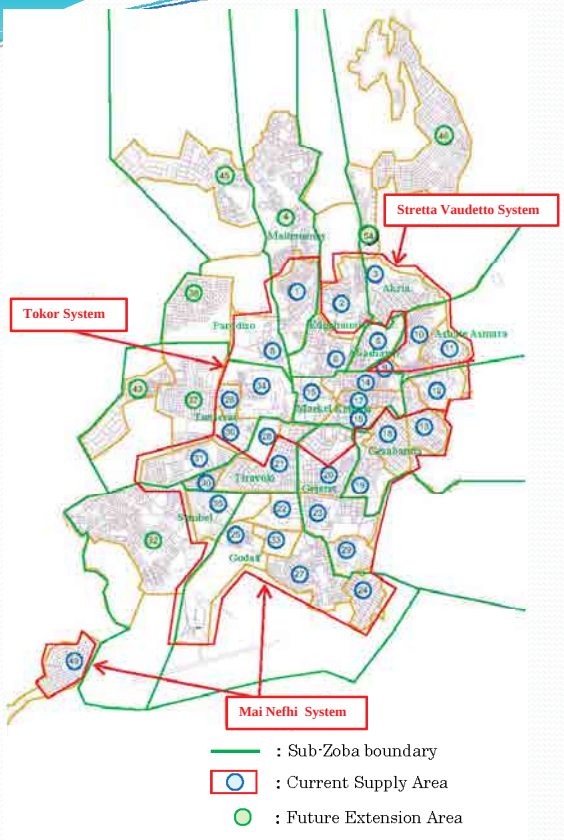


Stretta Vaudetto System:
Dam: Adi Sheka Dam, Mai Serwa Dam
WTP Capacity: 8,000 m3/day

Tokor System:
Dam: Tokor Dam
WTP Capacity: 18,000 m3/day

Mai Nefhi System:
Dam: Mai Nefhi Dam
WTP Capacity: 20,000 m3/day

1.2 Service Area



Population in AWSD piped service area

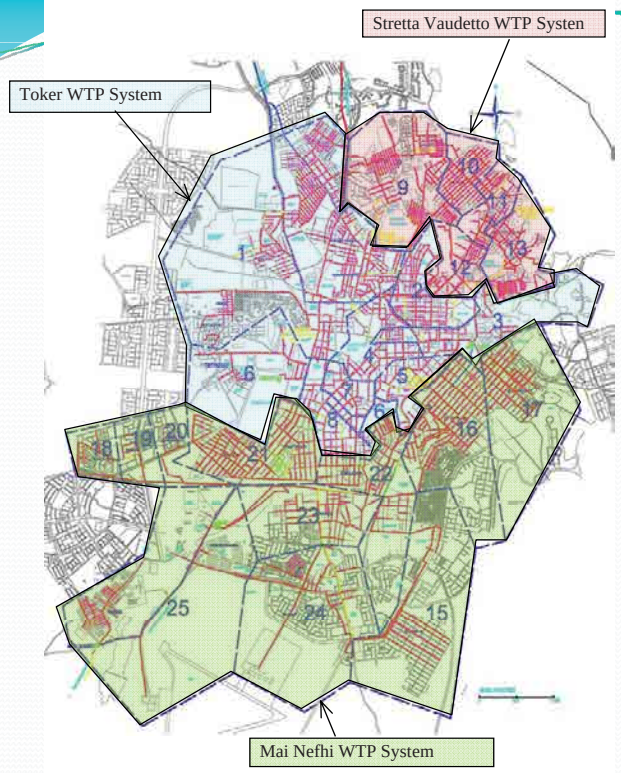
Sub-Zoba	2008 Census	2015 Census	Annual growth rate
Paradiso	29,442	32,457	1.0140
Maitemenai	24,482	24,257	0.9987
Edaga Hamus	32,179	34,016	1.0080
Akiria	51,182	55,057	1.0105
Abazhawl	40,342	40,957	1.0022
Arbate Asmara	35,197	34,484	0.9971
Tsetserat	19,851	22,532	1.0183
Maekel Ketema	21,312	21,868	1.0037
Tiravolo	20,955	21,260	1.0021
Geza banda	36,306	36,092	0.9992
Sembel	16,861	20,076	1.0252
Godaif	43,280	44,645	1.0044
Gejeret	39,487	39,728	1.0009
Outside of Asmara			
Daero Paulos TD	6,650	6,900	1.0053
	417,526	**434,329**	**1.0057**

1.3 Service Condition

	Unit	2014	Remarks
1. Population in Service Area	**No.**	**434,329**	427,429+6,900
2. Served Population in Service Area		**409,329**	434,329 - 25,000(assumed)
By Piped Supply	No.	339,472	409,329 – 69,857
By water truck	No.	69,857	339,971 x (3/4) x 1000/365/10
3. Population outside of Asmara served by water truck	**No.**	**23,286**	339,971 x (1/4) x 1000/ 365/10
4. Number of connection	**No.**	**35,483**	
Domestic	No.	29,722	Answer to questionnaire
Non-domestic	No.	5,761	Ditto
5. Billed water	**m3/year**	**2,611,509**	**7,155 m3/day**
Piped supply (Domestic)	m3/year	1,552,317	Answer to questionnaire
Piped supply (Non-domestic)	m3/year	519,144	Ditto
Sold to water truck (Domestic)	m3/year	339,971	2014 Annual report
Sold to truck (Non-domestic)	m3/year	200,077	Ditto
6. Water production (sent from WTP)	**m3/year**	**6,659,541**	**18,245 m3/day**
Stretta Vaudetto WTP	m3/year	756,575	2014 Annual report
Toker WTP	m3/year	2,740,396	Ditto
Mai Nefhi WTP	m3/year	3,162,570	Ditto
7. Ratio of Non-revenue water ((6. -5.)/6.) x 100	%	61	

- Approx. 2-3 households are using one house connection.
- Per capita consumption of domestic water is: (1,552,317 m3/year)/339,472 = 12.5 l/c/d
  Actual consumed water volume may be more than the billed water, due to old water meter.
- It takes more than 6 months for recording the billed water, so it is difficult to timely monitor the actual amount of water consumption.
- The amount of water production in Stretta Vaudetto WTP and Mai Nefhi WTP is estimated by the operation hours of the transmission pump, not by the bulk meter. It may be overestimated than the actual amount. Thus, the actual leakage amount cannot be known.

1.3 Service Condition



Water Ration Schedule

Zone No.	Area	Days
Tokor System		
1	Maitemenai, Edaga Hamus, Vilaggio, Adi segdo, Paradizo, Embagaliano	5
2	Abashawl+shuk, Around Saint Mary Church	3
3	Center Town (Marcato)	3
4	Taba (Cinema Roma + muagna)	3
5	Monopolio + Mufti	3
6	Denden Camp (Algien + Tsetserat)	3
7	Alformaio	3
8	Around San Francesco Church	3
1 Cycle =26 days		
Stretta Vaudetto System		
9	Haz HAz, Mihram Chira, Viya Jida	3
10	Akria (Left, Right)	3
11	Akria (Saint Gebriel church), Edaga Arbi	3
12	Around 2nd Police Station (Hadish Adi), Geza Brhanu (Geza Banda Habesha)	3
13	Arbaete Asmara, Debozito	3
1 Cycle = 15 days		
Mai-Nefhi System		
Brached from Mai Nefhi WTP – Sembel PS Transmission Pipeline		
14	Daero Paulos	3days/week
From Sembel PS via Godaif PS		
15	Kehawta	6
16	Geza Banda (Adis Alem)	6
17	Mai Chihot	6
1 Cycle =18 days		
From Sembel PS		
18	Space, Enda Germen	3
19	Enda Shewit, Michael Tedros	2
20	Jekaranda, Space 1	4
21	Tiravolo, Campopolo	3
22	Around Asmara Brewery, Around Enda Kisha	3
23	Barjima, Gejeret, Around Enda Nora (Lime Factory)	4
24	Godaif	3
25	Sembel+Dembe Sembel	Every day
1 Cycle =22 days		

Due to current insufficient supply capacity, water is being rationed as shown above.
Supply hours: approx 12 hours/day

2. Operational Condition of AWSD
2.1 Organization and Staffing, Machinery

Division	Permanent Staff	Contract Staff	National Service	Total
Head of AWSD	1			1
Water supply division Water Distribution unit New connection and maintenance unit Dam and treatment plant unit Planning and supervision unit	55	129	74	258 (Engineer: 2) (Assistant Engineer: 2)
Administration and Finance division Personnel unit Finance unit Customer's unit General service unit Store unit	35	46	63	144 (Bachelor of Administration: 1) (Accountant: 2)
Sewerage division	7	9	18	34 (Engineer: 1) (Assistant Engineer: 1)
Total	98	184	155	437

Only four engineers in Water Supply Division, so it is difficult to conduct proper technical management of water supply works.

Machinery	Type	Number
Truck with crane	Renault (France)	1
Back hoe	Rulong (China)	1
Dump truck	Fiat 110 (Italy)	1
Pick up double cabin	Tiyota Hilux 4WD	1

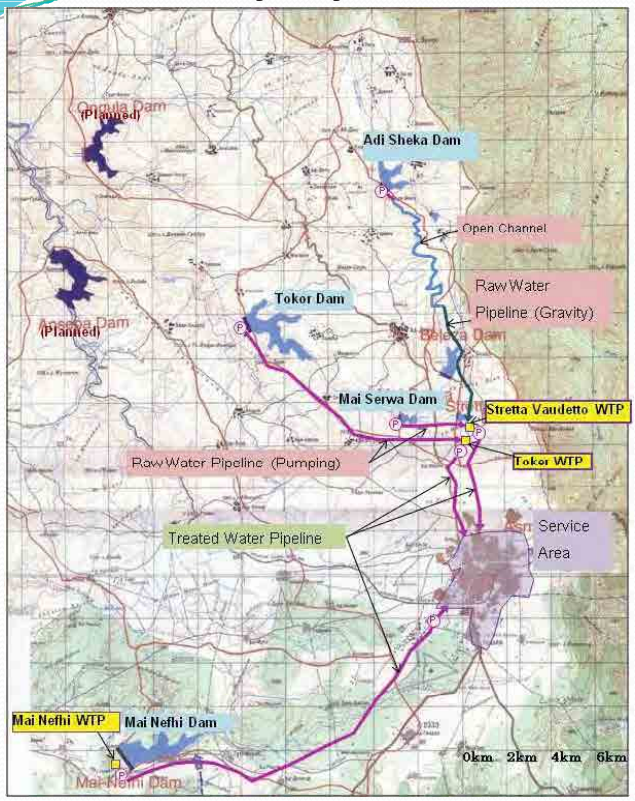
Shortage of transportation facility and construction machinery for proper O&M works of water supply works.

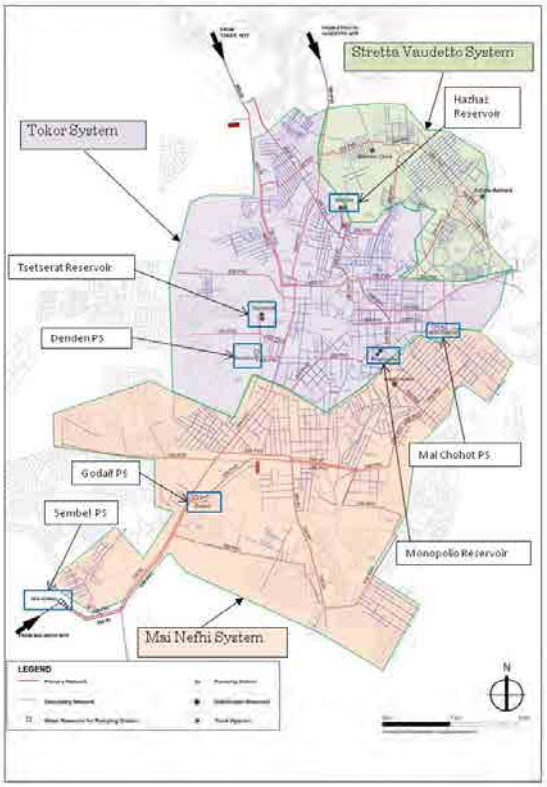
2. Operational Condition of AWSD
2.2 Revenue and Expenditure

	2012		2013		2014	
Revenue	(Thousand Nakfa)	%	(Thousand Nakfa)	%	(Thousand Nakfa)	%
Water (Domestic)	17,971	35	23,154	31	20,693	24
Water (Non-domestic)	21,175	41	12,678	17	11,665	14
Water sold to water truck	5,017	10	5,377	7	4,183	5
Others(Connection Fee, Penalty, etc.)	7,388	14	33,608	45	44,744	52
Subsidy, etc.	0	0	37	0	4,449	5
Total	51,551	100	74,854	100	85,734	100
Expenditure	(Thousand Nakfa)	%	(Thousand Nakfa)	%	(Thousand Nakfa)	%
Personnel	6,726	12	6,891	16	6,113	11
Electricity	15,387	29	8,069	19	7,286	14
Fuel for Tokor pump station	24,941	46	17,287	40	16,977	32
Fuel for AWSD water truck	861	2	1,158	3	1,039	2
Chemicals	266	0.5	1,244	3	1,252	2
Connection works	1,119	2	3,585	8	13,265	25
Maintenance, repair	4,054	8	2,462	6	3,888	7
Others	579	0.5	2,304	5	3,835	7
Total	53,963	100	43,000	100	53,655	100

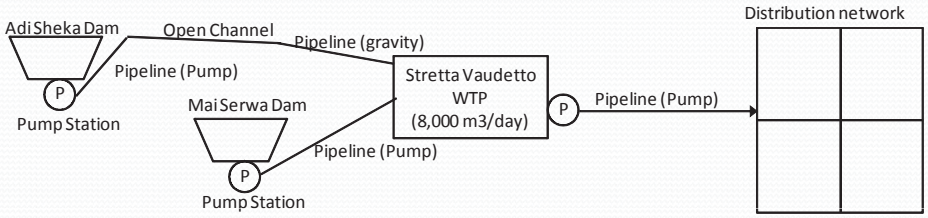
- The fuel cost of Tokor PS is a huge financial burden.
- In 2013 and 2014, large amount of penalty for late payment was paid. In 2014, many new connection were installed. That's why the revenue exceed the expenditure in 2013 and 2014.
- Water tariff has not been changed since November 2003.

3. Facility Condition of AWSD
3.1 Facility Layout



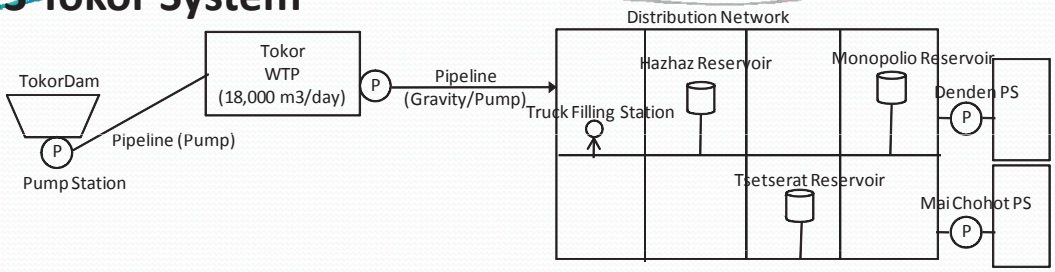


3. Facility Condition of AWSD
3.2 Stretta Vaudetto System



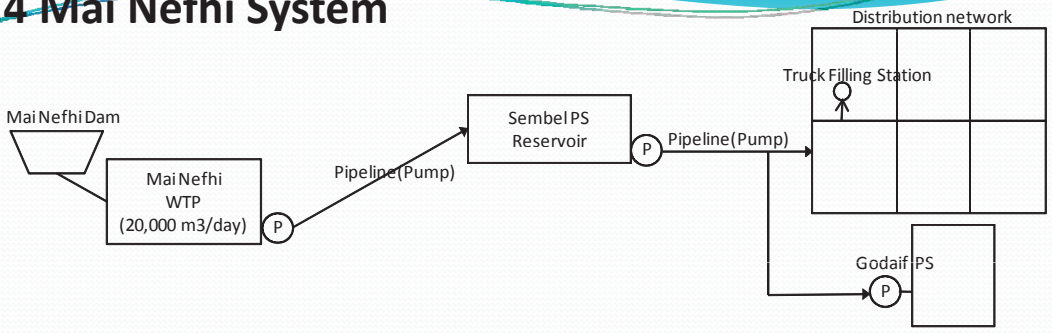
Facility	Present Condition/Problems
Raw water transmission pump station at Adi Sheka Dam	One pump including control panel is deteriorated. Instrumentation facility deteriorated.
Raw water transmission channel and pipeline from Stretta Vaudetto WTP	The soil enters into the open channel due to heavy rainfall every year. Six tunnels are deteriorated. Several concrete lining peeled off. There remains 2 km of deteriorated asbestos cement concrete pipe.
Raw water transmission pump station at Mai Serwa Dam	All facilities of pump station are heavily deteriorated.
Raw water transmission pipeline to Stretta Vaudetto WTP	The pipeline are of deteriorated asbestos cement concrete pipe.
Stretta Vaudetto WTP	All facilities are heavily deteriorated. The appropriate treatment is not being done. The current capacity is half of design capacity.
Treated water transmission pump station at Stretta Vaudetto WTP	The pump station is inside the WTP and is heavily deteriorated. One pump has been replaced recently.
Treated water transmission pipeline to the distribution network	The pipeline has been replaced from asbestos pipe to PVC pipe. Exact valve information is not available.
Distribution reservoir	There is no reservoir. (Old steel reservoirs were abolished.)
Distribution primary network	The pipeline has been replaced to PVC pipe, since 1997. Exact valve information is not available.
Distribution secondary network	There remains approx. 900m of deteriorated GI pipe

3. Facility Condition of AWSD
3.3 Tokor System



Facility	Present Condition/Problems
Raw water transmission pump station at Tokor Dam	The pump is currently of diesel engine driven. Due to deterioration and huge fuel consumption of the engine, the pump operation hour is limited to 10 hours/day. Thus, the WTP cannot produce design amount of treated water (18,000 m3/day). AWSD has a plan for electrification of the pump station. But the schedule is not determined.
Raw water transmission pipeline to Tokor WTP	No particular problems
Tokor WTP	All system are manually operated since 2007. The chlorinator has been broken down. The chlorine gas is being directly injected to clear water reservoir from the gas bombe.
Treated water transmission pump	No particular problems
Treated water transmission pipeline to the distribution network	No particular problems
Distribution Reservoir	Existing three reservoirs are all deteriorated. All piping are deteriorated. There are leakages from concrete tank. It is difficult to stop leakages by repairing.
Distribution primary network	The pipeline has been replaced to PVC pipe, since 1997. Exact valve information is not available.
Distribution secondary network	There remains approx. 1,100m of deteriorated GI pipe.

3. Facility Condition of AWSD
3.4 Mai Nefhi System



Facility	Present Condition/Problems
Mai Nefhi WTP	Coagulation & Sedimentation facility is broken. Also, chemical dosing facility is broken. The appropriate treatment is not being done.
Treated water transmission pump station	The pumps need replacement of pump impellor to restore the design capacity. Instrumentation and anti-water hammer facility are broken.
Treated water transmission pipeline to Sembel PS	The pipeline is of deteriorated steel pipe which was laid more than 40 years ago. The leakage from the pipeline occurs every year. The leakage may not be managed by the current temporally expedient measures, for the future. A pipeline to the newly constructed reservoir will be branched from this transmission pipeline. The water allocation measure need to be established.
Sembel pump station	The chlorine injection facility is broken.
Distribution reservoir	New distribution reservoir (1,600 m3) was constructed at sembel area.
Distribution primary network	The pipeline has been replaced to PVC pipe, since 1997. Exact valve information is not available.
Distribution secondary network	There remains approx. 1,200m of deteriorated GI pipe.

4. Water Demand and Water Balance
4.1 Water Demand

	2015 Potential Demand	2020 Demand Projection	2025 Demand Projection
Conditions/Assumptions			
Population in Service Area	434,329	446,744	459,513
AWSD service ratio	98 %	98 %	98 %
Piped water	80 %	82 %	84 %
Water truck	18 %	16 %	14 %
Served population (piped water)	348,628	364,557	386,285
Served population (water truck)	77,797	75,026	65,359
Per capita consumption (piped water)	50 l/c/d	50 l/c/d	50 l/c/d
Per capita consumption (water truck)	15 l/c/d	15 l/c/d	15 l/c/d
Water Consumption			
Domestic (piped water) (m3/day)	16,506	17,347	18,356
Domestic (water truck) (m3/day)	1,566	1,508	1,402
Non-domestic(piped water) (m3/day)	4,511	4,723	4,998
Non-domestic (water truck) (m3/day)	411	431	456
Total consumption (m3/day)	23,054	24,009	25,212
Water Demand			
Water loss rate (%)	33%	33%	32%
Total Water Demand (m3/day)	**34,409**	**35,834**	**37,076**

- Population in 2020 and 2025 was estimated based on the annual growth rate between 2008 and 2015 (0.57 %/year).
- Water loss rate on the condition that the water is always filled in the pipeline, was assumed to be 33 %, referring to the Feasibility study report in 2006.

4. Water Demand and Water Balance

4.2 Water Balance

		2015 Potential Demand	2020 Demand Projection	2025 Demand Projection
Stretta Vaudetto System				
Water Demand (m3/day)	(A)	5,627	5,816	6,456
2014 Actual supply (m3/day)	(B)	2,073		
Balance	(B)/(A)	0.37		
Supply Capacity (after rehabilitation) (m3/day)	(C)		8,000	8,000
Balance	(C)/(A)		1.38	1.24
Tokor System				
Water Demand (m3/day)	(A)	15,498	16,189	16,409
2014 Actual supply (m3/day)	(B)	7,508		
Balance	(B)/(A)	0.48		
Supply Capacity (after rehabilitation) (m3/day)	(C)		16,040	16,040
Balance	(C)/(A)		0.99	0.98
Mai Nefhi System				
Water Demand (m3/day)	(A)	13,287	13,829	14,211
2014 Actual supply (m3/day)	(B)	8,665		
Balance	(B)/(A)	0.65		
Supply Capacity (after rehabilitation) (m3/day)	(C)		17,360	17,360
Balance	(C)/(A)		1.26	1.22

- The actual supply in 2014 falls far below the potential demand.
- The supply capacity of Tokor system will be limited to the estimated source capacity (16,040 m3/day) The water demand after 2020 is estimated to exceed the source capacity.
- The supply capacity of Mai Nefhi system will be limited to the estimated source capacity (17,360 m3/day)

付属資料 4.

2) 第二次現地調査プレゼン②

Preparatory Survey on the Project for Asmara Water Supply Development

Water Supply Facilities / Operation and Maintenance

by Koji Yoshikawa, JICA Study Team

Outline of field survey results and analysis：

1. **Available quantity of water taken from each dam.**
2. **Current state of each Water Treatment Plant (W.T.P).**
3. **Current state of operation and maintenance (O&M) in each facility**
4. **Problems of O&M in AWSD**

1

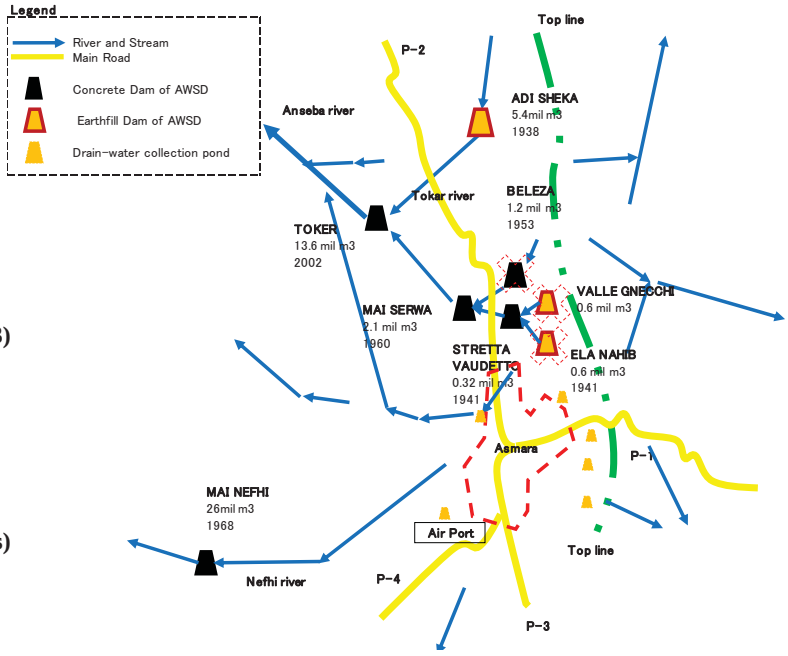
1. Available quantity of water taken from each dam.

1-1. Existing Dams

1. **TOKER (13,000,000m3)**
2. **ADI SHEKA (5,400,000m3)**
3. **MAI SERWA (2,100,000m3)**
4. **STRETTA VAUDETTO (320,000m3)**
5. **BELEZA (1,200,000m3)**
6. **VALLE GNECCHI (600,000m3)**
7. **ELA NAHIB (600,000m3)**
8. **MAI NEFHI (26,000,000m3)**

5nos Dams - Running (Red letters)

3nos Dams - No Running (Black letters)



2

1-2. Principal Terms of Calculation

- **Average annual rainfall is 419 mm**

  Data; Monthly rainfall for 22 years (1992 -2014) at Asmara meteorological station

- **Catchment area**

Valle Gnecchi	3.0km2	Stretta Vaudetto	9.0km2	Mai Serwa	8.8km2	Toker	69.6km2
Ela Nahib	4.3km2	Beleza	6.1km2	Adi Sheka	37.3km2	Mai Nefhi	94.5km2

- **Evaporation coefficient is 4.0㎜/day**

  Reference from 「Sunridge Gold Corporation Asmara Project Hydrometeorology report 12,2

- **Runoff coefficient is 0.21 (Mai Nefhi 0.19)**

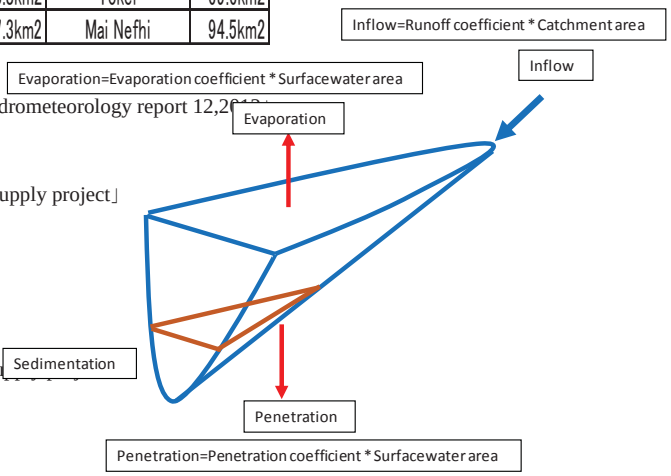
  Reference from 「Technical memorandum in Toker river water supply project」

- **Penetration coefficient (Inference)**

  Concrete Dam is 1mm/day, Earth Dam is 4mm/day

- **Sedimentation is 470m3/km2/year**

  Reference from 「Technical memorandum in Toker river water su



3

1-3. Result of Available quantity of water taken from each dam

W.T.P Group	Dam's Name	Potential quantity of water intaken (m3/day)	Available quantity of water intaken (m3/day)	Notes
Stretta Vaudetto W.T.P	Vall Gnecchi	150	0	The water isn't used as drinking water for a long time. The water is used for agriculture at present.
	Ela Nahib	0	0	The water isn't used as drinking water for a long time. The water is used for agriculture at present.
	Stretta Vaudetto	440	0	There are much sediment into the dam lake. Potential quantity of water intaken is little.
	Beleza	730	0	EEC has used the water as the cooling water of generator.
	Mai Serwa	2,350	**8,770**	Raw water transmission pipe is AC pipe.
	Adi Sheka	6,420		The pump stops for 2 months in the rainy season because muddy water inflow into the open channel.
Toker W.T.P	Toker	16,040	**16,040**	As a result of changing the average annual rainfall to 419mm from 500 mm, the available quantity of water intaken is below the design quantity of water intaken.
Mai Nefhi W.T.P	Mai Nefhi	17,360	**17,360**	

The best plan is to take water from 2 dams of Mai Serwa and Adi Sheka by reason of the various factors for Stretta Vaudetto W.T.P.

The available quantity of water is inferred 8,770m3/ day.

Therefore, 8,000m3/ day is proper for Stretta Vaudetto W.T.P (Design capacity 8,000m3/day).

16,000m3/ day is proper for Toker W.T.P (Design capacity 18,000m3/day).

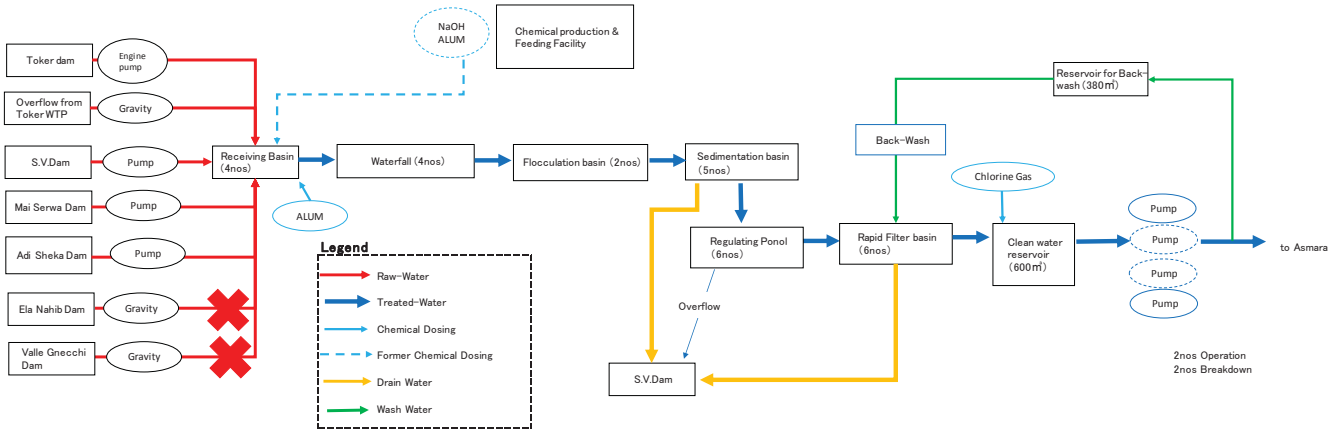
18,000m3/ day is proper for Mai Nefhi W.T.P (Design capacity 20,000m3/day).

4

2. Current state of each Water Treatment Plant (W.T.P).

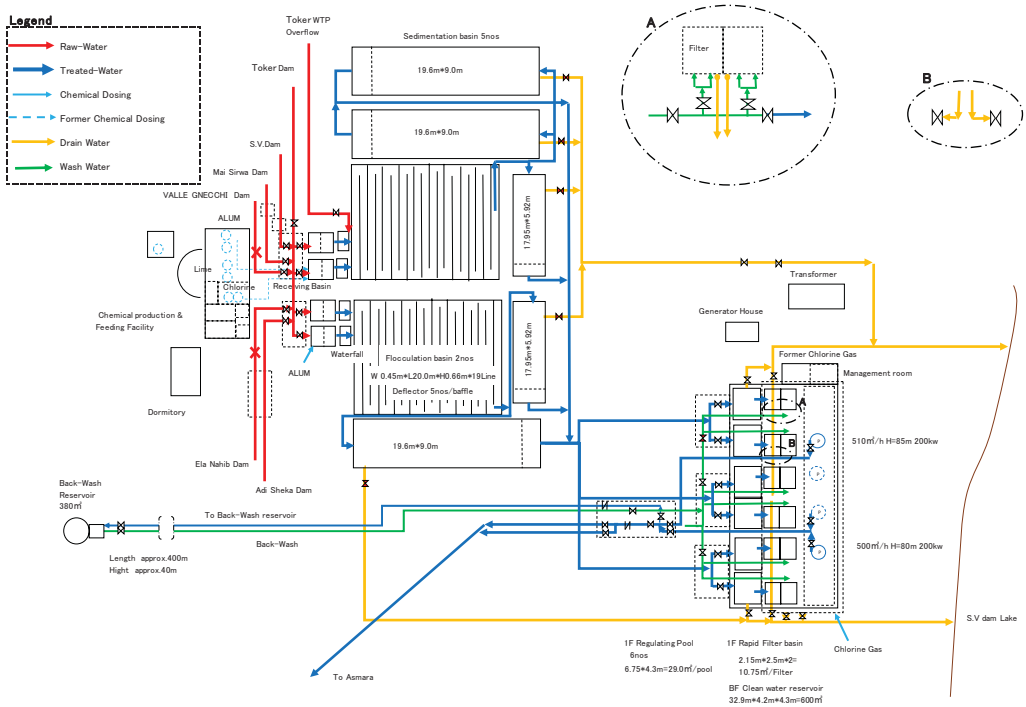
2-1. Stretta Vaudetto W.T.P (8,000m3/day)

- **Current Flow of Stretta Vaudetto W.T.P**



5

- **Schematic Drawing of Stretta Vaudetto W.T.P**



6

・Current state of Stretta Vaudetto W.T.P

・The chemical mixing and injection equipment are out of order for a long time. Therefore appropriate water treatment is not done at all.

・Solid alum is sporadically dosed into the receiving well directly without adjusting its concentration.

・The chlorinator is out of order for a long time. And chlorine gas is injected directly into the clear water reservoir by the rubber tube.

・Several deflectors in the flocculation basin are corroded.

・Sludge in the sedimentation basin is not discharged because the sludge discharge pipe is laid the easier slope. Several sludge valves are inoperable.

・Back-wash isn't done effectively so that there are thick sludge on the filter beds. Therefore the filter beds have break through cracks and holes.

・Water of approximately 1 m3/hours is leaking at the clear water reservoir.

・Land subsidence of approximately 5 cm is confirmed at the building of filtration and clear water reservoir.

・Most of valves are deteriorated due to old age.

・The water conveyance pump at Adi Sheka stops for 2 months in the rainy season because much soil inflow into the open channel.

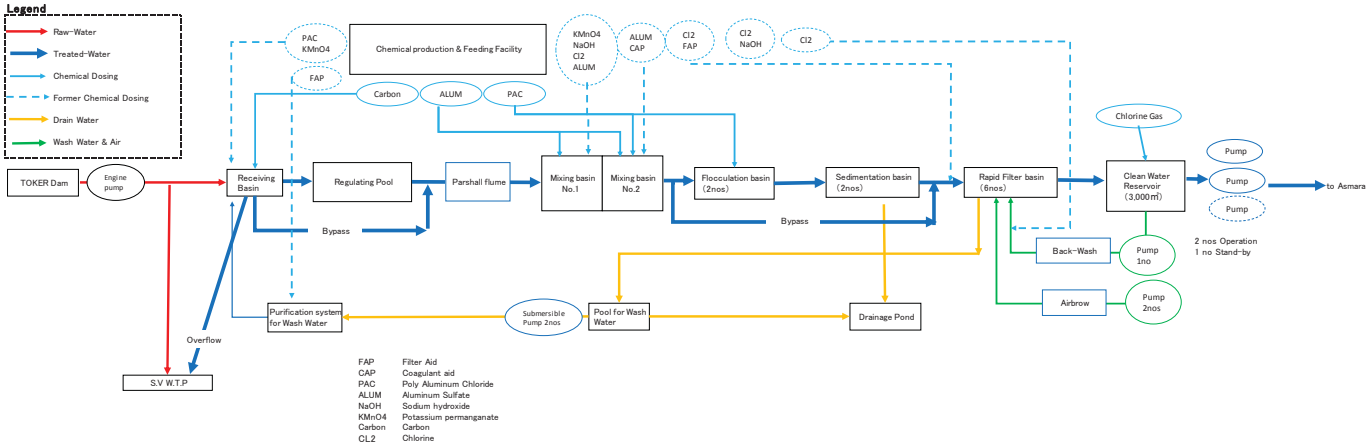
・A total coliform bacteria and fecal coliform bacteria are detected.

・Two transmission pumps are deteriorated due to old age.

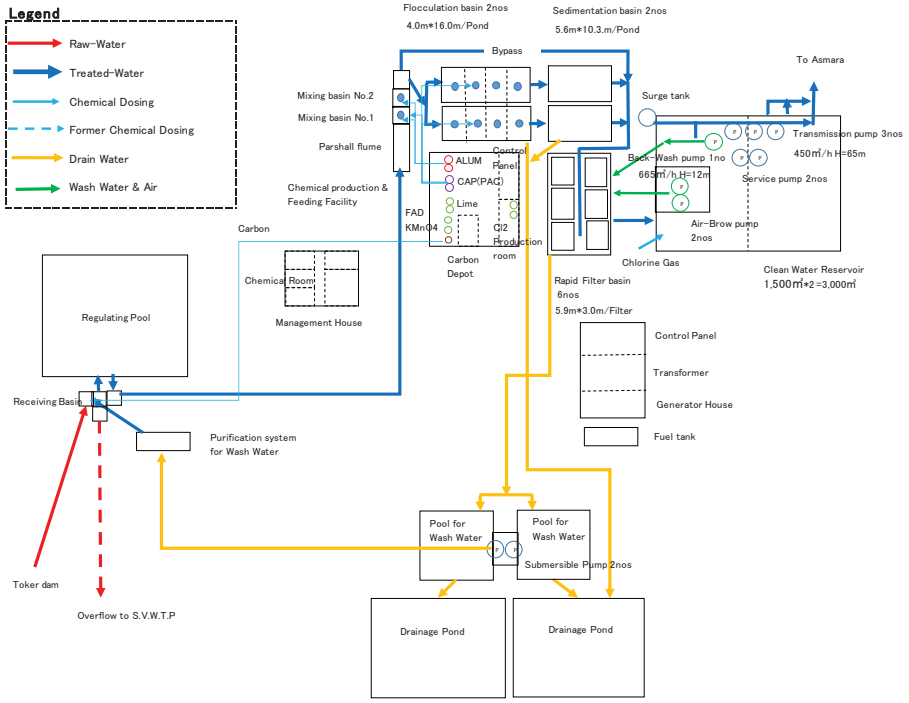
・The transmission pump (500m3/h) is operated only about 10 hours/day because of a blackout.

2-2. Toker W.T.P (18,000m3/day)

・Current Flow of Toker W.T.P



・Schematic Drawing of Toker W.T.P



9

・Current state of Toker W.T.P

・W.T.P is operated manually from 2007 because the central control system was out of order.

・Various chemicals were used at the starting time of the operation in 2002, but ALUM and chlorine gas are used mainly at present.

・In case of a electric power cut, solid alum is dosed into the mixing basin directly.

・A total coliform bacteria is detected.

・A Sodium hypochlorite generation apparatus was out of order in 2009, and chlorine gas is injected directly into the clean water reservoir without a chlorinator by the rubber tube.

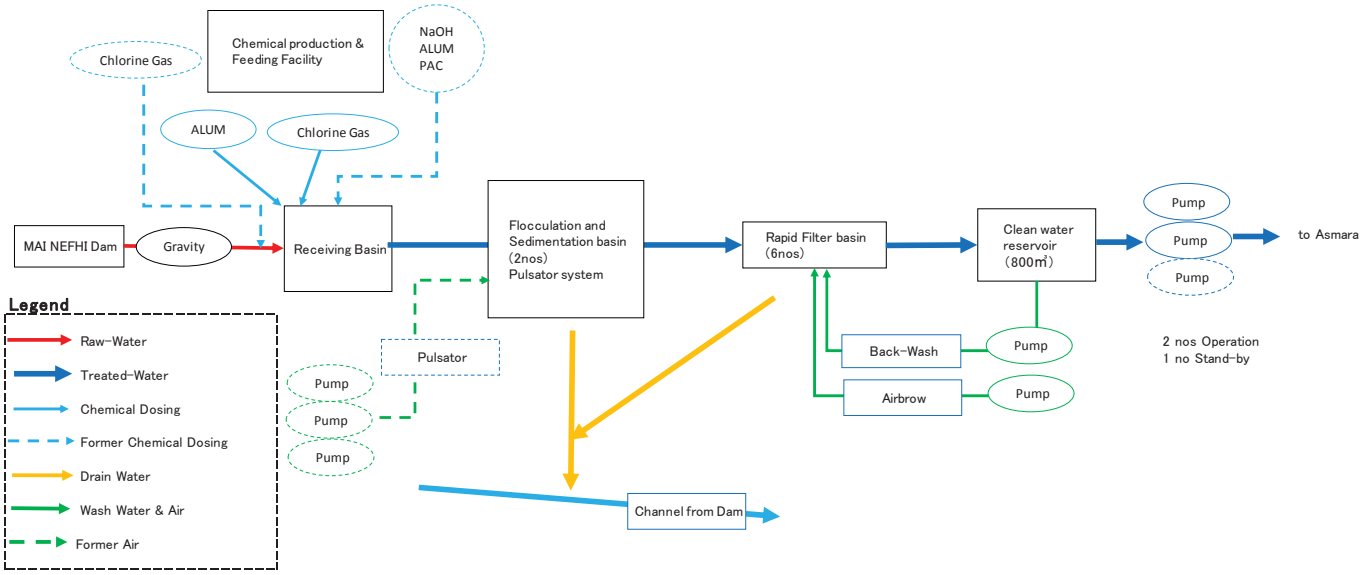
・Only the water of 9,900m3/day (990m3/hour ×10 hours) is supplied to the W.T.P from Toker dam in spite of the design capacity of 18,000m3/ day due to deterioration and huge fuel consumption of the engine

・Jar test is not practiced.

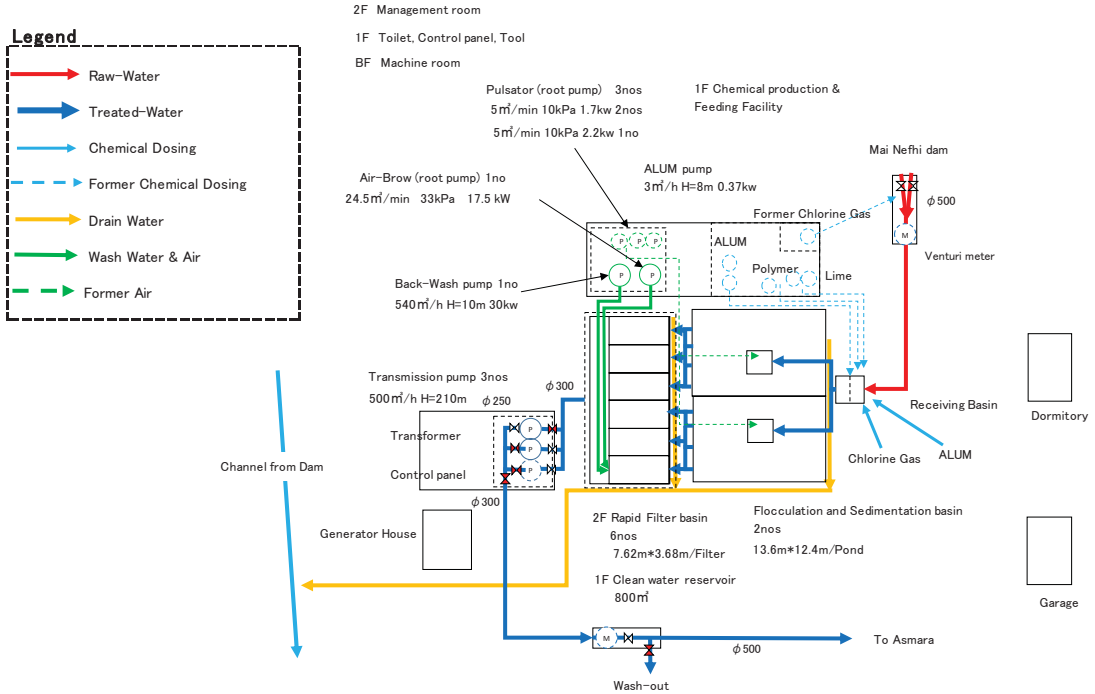
10

2-3. Mai Nefhi W.T.P (18,000m3/day)

・Current Flow of Mai Nefhi W.T.P



・Schematic Drawing of Mai Nefhi W.T.P



・Current state of Mai Nefhi W.T.P

・After the chemicals (alum and lime) mixing, the chemicals injection and the pulsator pumps were out of order more than 20 years ago, France donated the equipment of the chemicals (alum, lime and polymer) production and the chemicals injection equipment and the pulsator pump in 2000. But those were out of order 1 year later.

・Solid alum is sporadically dosed into the receiving well directly without adjusting its concentration.

・The chlorinator is out of order for a long time. And chlorine gas is injected directly into the receiving well by the rubber tube.

・The Pulsator isn't functioning because of the failure of vacuum pumps.

・Most of equipment at the vacuum tower are out of order for corrosion.

・Water is leaking at the link channel between Pulsators and filters.

・The crack valve, the partialization box and the clogging indicator(pressure) in each filtration basin are out of order.

・Most of valves are deteriorated due to old age.

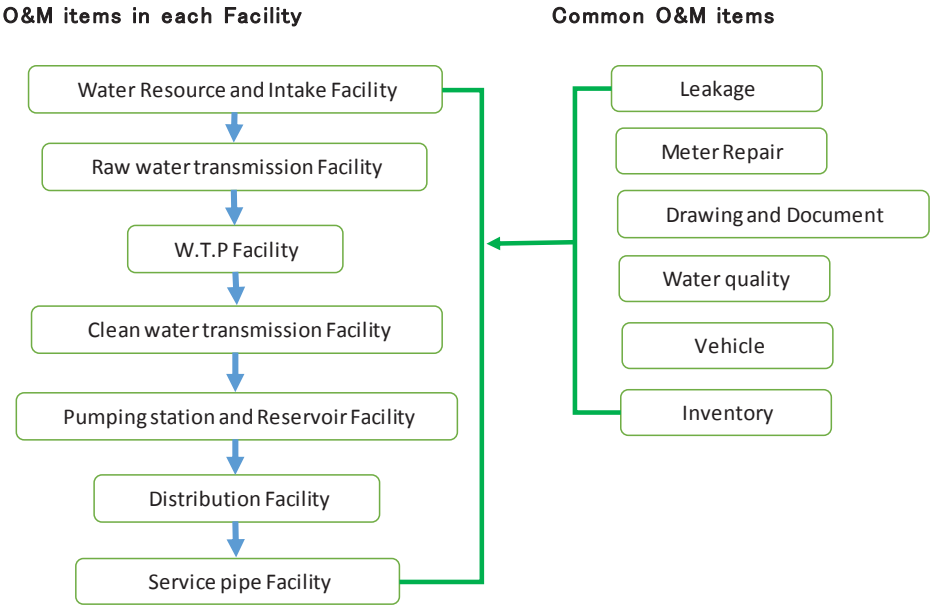
・Water is leaking at the transmission pumps and the valves.

・The water quality is satisfied with the national water quality standard.

13

3. Current state of O&M in each facility

3-1. Flow chart of O&M in each facility



14

3-2. Current state of O&M in each facility

a) Water source and Intake Facilities

・There isn‘t an engineer for managing the O&M of each water resources and dam.

・There are no vehicles to manage each water source and intake facilities.

・There aren't any young and middle-aged workers (Average age is 50 - 60).

・The preservation of water source isn't managed.

・A daily record about checking, repairing and operating isn't kept.

・There isn’t a water level indicator.

・There is no water meter to manage the outflow at each intake facility.

・There is no water quality equipment (turbidity, pH, electrical conductivity etc.) at each dam.

・Spare parts aren't purchased timely.

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b) W.T.P Facilities

・No one understands the current state of O&M in 3 W.T.Ps at AWSD.

（There isn‘t an engineer for managing the O&M of the 3 W.T.Ps.）

・There are no vehicles to manage the W.T.Ps.

・There aren't any young and middle-aged workers (Average age is 50 - 60).

・A daily record about checking, repairing and operating isn't arranged.

・There isn't any equipment and staff for chemical dosing test.

・There are no water meters to manage the inflow and outflow at the W.T.Ps.

・There is no water quality equipment at the W.T.Ps.

・Spare parts aren't purchased timely.

16

c) Raw water and treated water transmission and distribution（Inc. Pumping stations and Reservoirs）

・No one understands the current state of O&M each pipeline and pumping station and reservoir at AWSD.

(There isn't an engineer for managing the O&M of each pipeline and pumping station and reservoir.)

・There are no vehicles to manage the pipeline.

・There aren't any young and middle-aged workers (Average age is 50 - 60).

・A daily record about checking, repairing and operating isn't kept.

But, AWSD has managed the water leakage repairing record.

・The mechanician who repairs a pump doesn't have enough technical capacity.

・There are no water meters to manage the inflow and outflow at each pumping station and reservoir.

・Spare parts aren't purchased timely.

・A repair of water leakage is behind schedule due to shortage of construction vehicles and repair machines and tools.

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d) Water Leakage

・AWSD has only worked to handle a lot of current complaints, and can't do other work.

・There aren't any young and middle-aged workers (Average age is 50 - 60).

・Spare parts aren't purchased timely.

・Most of repair of pipe clogging are left.

・There is no leak detection equipment, and there are no staff.

・A repair of water leakage is behind schedule due to shortage of construction vehicles and repair machines and tools.

e) Meter Repair

・AWSD has repaired the water meter to the customer complaints by using the meter checking machine.

・There are no water meters in the warehouse. For that reason there are a lot of remaining works of new connection and meter repair.

18

f) Drawing and Document

・AWSD are not kept any past drawings and documents completely.

（Most of past drawings and documents are lost.）

・There are few staff who can operate CAD.

・The pipeline drawing of transmission and distribution pipelines isn’t managed.

（There are no staffs who manage and correct the CAD drawing ）

g) Water quality

・There isn't a water quality laboratory in AWSD.

・There is no water quality equipment in AWSD.

・There are no engineers of water quality test in AWSD.

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h) Vehicle and Machine

・There aren’t the construction vehicles sufficiently.

・There aren’t the vehicles to manage sufficiently.

・There aren’t the tools and the repair machines sufficiently.

・The mechanician which repairs the vehicle doesn't have enough technical capacity.

i) Inventory

・Inventory is managing correctly.

・Spare parts aren’t purchased timely.

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4. Problems of O&M in AWSD

- **Shortage of human resources**
  - Young and middle-aged workers
  - Engineers for O&M
  - Staff of water quality test
  - Staff of chemical dosing test
- **Capacity development**

- Staff of water quality test.
- Staff of chemical dosing test.
- Pump machanician.
- Staff of CAD operation.

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- **Purchase of spare parts timely.**
- **Arrangement of daily record at each facility about checking, repairing and operating etc.**
- **Update of pipeline drawing (Inc. Valve etc.) by CAD.**
- **Management of past drawings and documents.**
- **Measurement of inflow and outflow at required facilities.**
- **Implementation of water quality test at required facilities.**
- **Shortage of construction vehicles and machines and tools.**
- **Shortage of vehicles to manage.**
- **Electric power cut.**

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付属資料 4.

3) 各ダムの取水可能水量の算出

4. 参考資料

3) 水源（ダム）の取水可能量の計算

（1）雨量

1903 年から 2014 年までの年間降水量の散布図を図-1 に示す。

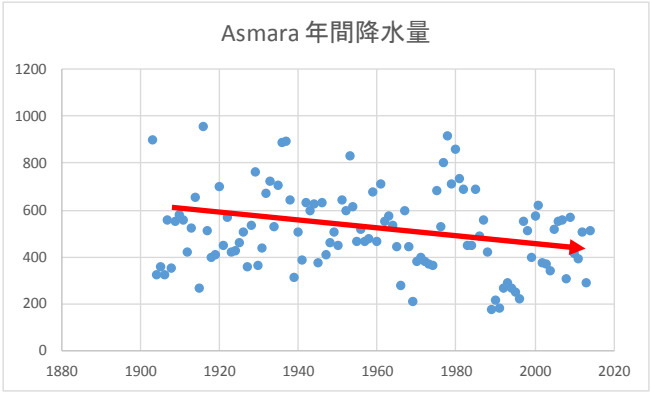


図-1　1903 年－2014 年の Asmara 年間降水量の散布図

Asmara では気候変動が大きいが、年々雨量の減少傾向がみられる。

1980 年頃は 500mm/年と推定されていたが、近年では 400mm/年と推定できる。

Asmara Airport 気象台の月間・年間降雨量とそのグラフを下記に示す。

7 月と 8 月の降雨量は、どの年でも多くなっている。

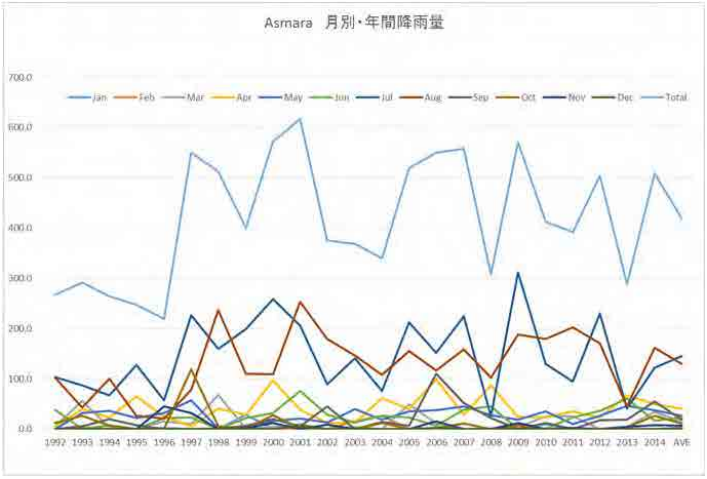
表－1　Asmara　月間・年間降雨量(mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1992	0.0	0.0	4.8	5.8	0.0	38.6	103.6	102.4	0.0	12.0	0.3	0.0	267.5
1993	0.0	3.8	56.4	39.2	31.5	0.0	86.5	42.3	5.7	25.9	0.0	0.0	291.3
1994	0.0	0.0	2.8	23.4	36.2	7.8	67.4	100.1	19.6	6.2	0.0	0.0	263.5
1995	0.0	0.0	0.0	64.5	22.2	0.0	127.6	26.2	7.2	0.0	0.0	0.0	247.7
1996	1.8	0.0	15.7	25.6	31.9	21.5	57.4	20.3	0.1	0.0	44.5	0.0	218.8
1997	0.0	0.0	9.6	5.2	57.2	22.8	226.7	78.3	0.0	119.0	31.6	0.0	550.4
1998	0.0	0.0	68.5	40.4	1.4	0.0	159.5	236.9	1.2	5.0	0.0	0.0	512.9
1999	28.0	0.0	0.0	28.2	2.8	21.6	199.3	109.5	6.7	0.9	2.2	0.8	400.0
2000	0.0	0.0	3.9	96.4	15.8	32.2	258.1	108.3	19.1	26.8	12.2	0.0	572.8
2001	0.0	0.0	9.2	38.5	21.0	76.2	206.1	253.2	4.9	2.2	0.0	6.5	617.8
2002	0.0	0.0	0.0	11.8	13.5	28.6	88.9	178.9	44.6	0.0	8.7	0.0	375.0
2003	0.0	15.0	3.9	11.7	38.9	12.7	140.9	145.9	0.0	0.0	0.0	0.0	369.0
2004	0.0	25.7	0.0	61.4	18.8	25.7	75.3	107.7	13.8	11.6	0.0	0.0	340.0
2005	0.0	0.0	49.7	39.2	35.0	22.6	212.4	154.6	6.0	0.0	0.0	0.0	519.5
2006	0.0	0.0	10.6	99.4	37.5	6.5	151.2	116.0	110.3	1.9	14.8	2.2	550.4
2007	0.0	0.0	0.0	28.3	45.1	38.5	224.4	158.8	51.5	11.0	0.0	0.2	557.8
2008	1.0	0.0	0.0	86.6	27.1	45.1	24.6	102.3	21.3	0.0	0.3	0.2	308.5
2009	0.0	6.9	3.2	23.6	18.5	0.0	311.2	187.9	0.0	7.8	11.8	0.0	570.9
2010	9.3	0.0	25.1	23.0	34.6	0.8	129.8	178.7	11.5	0.0	0.0	0.0	412.8
2011	0.0	0.0	25.0	34.8	10.2	23.3	94.1	202.8	0.0	0.0	1.8	0.0	392.0
2012	0.0	0.0	0.0	23.2	26.7	36.4	230.2	170.3	17.0	0.0	0.0	0.0	503.8
2013	0	0	4.2	67	46	60.7	40.4	44.9	18.6	3.1	4.2	0	289.1
2014	0	0	33.6	49.8	37.1	15.8	121.8	161.8	54.8	26.5	7.7	0	508.9
AVE	**1.7**	**2.2**	**14.2**	**40.3**	**26.5**	**23.4**	**145.1**	**129.9**	**18.0**	**11.3**	**6.1**	**0.4**	**419.1**

1992 年から 2014 年までの年平均雨量は 419mm となる。また、5 年周期で 300 mm/年の時期が来ている。2013 年は 289 mmで AWSD 職員も記憶に新しく、Toker ダムで最下段（5 段口）の取水口まで後 5mのところまで水位が下がった特別な年であった。

本調査での各ダムからの取水可能水量の算定における各諸係数は、ダム建設当時の平

均年間降雨量 500mm と推定してダムの設計、又は現ポンプ容量を決定したと判断して算出した。



図－2　Asmara　月間・年間降雨量(mm)

また、各ダムからの取水可能水量は、1992 年から 2014 年までの平均月間・年間雨量を使用する。また、2013 年のデータを 10 年間の最低雨量として使用する。

（2）ダムの位置図

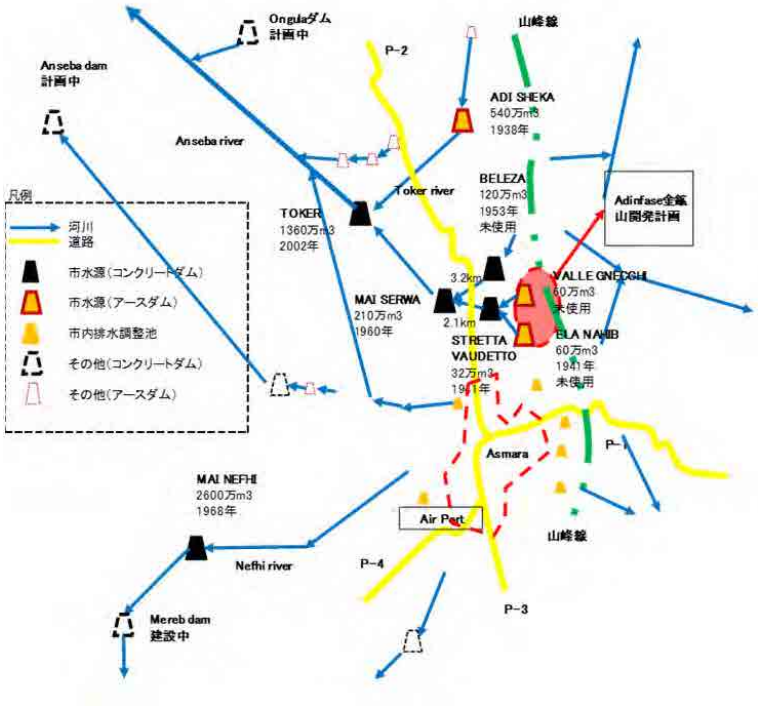


図-3 ダム位置概要図

（３）ダム湖内堆積土の状況

表-2 ダム堆積土の状況

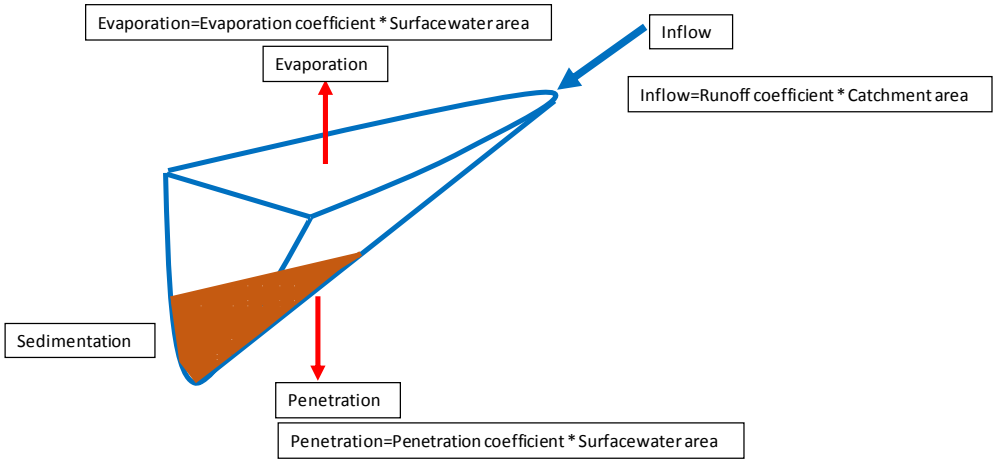
ダム名	建設年	総貯水量(m3)	堆積土(m3)	総貯水量に対する堆積土の割合	有効貯水量(m3)
VALLE GNECCHI	1941	600,000	104,340	17%	496,000
ELA NAHIB	1941	600,000	149,554	25%	450,000
Stretta Vaudetto	1941	320,000	194,666	61%	125,000
BELEZA	1953	1,200,000	177,754	15%	1,022,000
Mai Serwa	1960	2,100,000	315,446	15%	1,785,000
Adi Sheka	1938	5,400,000	1,349,887	25%	4,050,000
Toker	2002	13,000,000	425,256	3%	12,575,000
Mai Nefhi	1968	26,000,000	2,087,505	8%	23,912,000
合計		**49,220,000**			**44,503,000**

Toker ダムでは、年間堆積土 470m^3/km^2/年と推定しているためこの数値を採用する。尚、S.V ダムにおいては、総貯水量が小さく毎年越流するため、越流分の流量を差し引いて 292m^3/km^2/年と仮定する。よって、下流にある Mai Serwa ダムに S.V ダムの越流分の土砂が堆積すると考える。

結果、S.V ダムの堆積土は非常に多く、今後は堆積土の浚渫、又は乾期時に堆積土を掘削し搬出する必要がある。しかし、堆積土の除去がされず、十分な貯水が出来なくても、S.V ダムから越流した水は、下流にある貯水量が大きい Mai Serwa ダムで貯留できるため大きな問題とは言えない。また、排泥管の下方からの取水ができなくなっている Mai Serwa ダム、排泥管が詰っている Mai Nefhi ダムにおいては、排泥管の詰りを解消して、定期的に排出する必要がある。

（４）各ダムからの取水可能水量

取水可能水量の基本的考え方を図－4 に示す。



図－4　取水可能水量の基本的考え方

尚、大きな要因となるのは、Runoff coef.（流出係数)と月間雨量である。

a) 各係数の算出

・Evaporation coefficient

「Sunridge Gold Corporation Asmara Project Hydrometeorology report 12,2012」から蒸散係数は平均 3.2-5.5 ㎜/日であり、今回は 4.0 ㎜/日を採用する。

・Runoff coefficient

Mai Nefhi ダム

Toker river water supply project の Technical memorandum の中に 0.19 を採用したと記載されている。ポンプの容量と 0.19 を採用した貯水量がほぼ同程度となることから、0.19 を採用する。

Toker ダム

集水域が複雑で、広範囲であることから、各地域割りをして流出係数を 0.2-0.3 の範囲に分け、更に植生、地質等の多くの要因を考慮してダムに流入する貯水量を計算している。結果、河川流量が 7,480,000m^3/年以上であることから、平均 0.21 程度となり、今回これを採用する。

上記以外のダム

上記以外のダムに関しては、年間平均 500mm の降雨状態で既存のポンプが 22 時間運転された場合の取水量から推定すると、0.21 となる。

Penetration coefficient

主要な重力式コンクリートダムは岩盤に密着させていること、周辺は岩が露出していることから、浸透係数は 1㎜/日程度と推測する。

また、アースダムにおいては、岩盤の上に堤体が建設されたと推定できることから、4㎜/日と仮定する。

b)　各ダムからの取水可能水量

表-3　近年 10 年間の最低年間雨量(2013 年) 289.1mm の各ダムからの取水可能量

ダム名	ダム									導水			浄水場				
	諸元			年間						運転時間	月別降雨を考慮した場合の取水可能容量		浄水場名	月別を考慮した場合の取水可能容量(m3/d)		設計浄水能力(m3/d)	運転時間
	有効貯水量(m3)	集水面積(km2)	湛水面積(km2)	平均降雨量(mm)	降雨による貯水量(m3)	浸透による損失量(m3)	蒸発による損失量(m3)	年間有効貯水量(m3)		計画(h)	(m3/h)	(m3/d)		現稼働施設のみ	現未稼働施設を含む		計画(h)
VALLE GNECCHI	496,000	3.0	0.08	289	200,404	116,800	116,800	0		22	0	0	S.V WTP	5,130	5,350	8,000	22
											重力式	現未稼働					
ELA NAHIB	450,000	4.3	0.15	289	295,316	219,000	219,000	0		22	0	0					
											重力式	現未稼働					
Stretta Vaudetto	125,000	9.0	0.13	289	576,090	47,450	189,800	57,071		22	9	200					
							オーバーフロー	281,769		導水ポンプ1台の180m3/hで1.2時間稼働可能							バックウオッシュ等を考慮して最大22時間とする。
BELEZA	1,022,000	6.1	0.18	289	411,447	65,700	262,800	82,947		22	10	220					
												EEC使用					
Mai Serwa	1,785,000	8.8	0.18	289	575,367	65,700	262,800	246,867		22	63	1,390					
						SVのオーバーフロー考慮		528,636		導水ポンプ1台の200m3/hで7.0時間稼働可能							
Adi Sheka	4,050,000	37.3	0.36	289	2,346,740	525,600	525,600	1,295,540		22	161	3,540					
										導水ポンプ1台の450m3/hで7.9時間稼働可能							
Toker	12,575,000	69.6	0.18	289	4,266,596	65,700	262,800	3,938,096		22	490	10,780	Toker WTP	10,780	10,780	18,000	22
										導水ポンプ1台の990m3/hで10.9時間稼働可能							
Mai Nefhi	23,912,000	94.5	0.80	289	5,378,127	292,000	1,168,000	3,918,127		22	487	10,710	Mai Nefhi WTP	10,710	10,710	20,000	22
										送水ポンプ2台の500m3/hで10.7時間稼働可能							
TOTAL	44,415,000							9,737,470						26,620	26,840	46,000	

S.V 浄水場系統から年間を通じて取水可能なダムは、Beleza (現 EEC 使用)、Mai Serwa と Adi Sheka ダムだけである。合わせて日平均取水量は 5,350m^3/日で現 S.V 浄水場の設計浄水能 8,000m^3/日を下回る。

また、Toker ダムからは 10,780m^3/日で Toker 浄水場の設計浄水能力 18,000m^3/日を下回る。

更に Mai Nefhi ダムにおいても 10,710m^3/日で Mai Nefhi 浄水場の設計浄水能力 20,000m^3/日を大きく下回る。

2013 年当時、大きな問題なく給水できたのは、各ダムの貯水能力が大きく、前年又は前々年に貯留された水を使用できたためで、2 年間このような年が続くと、深刻な水不足となる。

表-4　1992～2014 年までの平均年間雨量 419.1mm の各ダムからの取水可能量

ダム名	ダム								導水			浄水場					
	諸元			年間					運転時間	月別降雨を考慮した場合の取水可能容量		浄水場名	月別を考慮した場合の取水可能容量(m3/d)			設計浄水能力(m3/d)	運転時間
	有効貯水量(m3)	集水面積(km2)	湛水面積(km2)	平均降雨量(mm)	降雨による貯水量(m3)	浸透による損失量(m3)	蒸発による損失量(m3)	年間有効貯水量(m3)	計画(h)	(m3/h)	(m3/d)		現稼働施設		現未稼働施設を含む		計画(h)
VALLE GNECCHI	496,000	3.0	0.08	419	290,520	116,800	116,800	56,920	22	7	150	S.V WTP	9,210	8,770	10,090	8,000	22
										重力式	現未稼働		Mai Serwa とAdi Shekaと S.Vのみ	Mai Serwa とAdi Shekaのみ			バックウオッシュ等を考慮して最大22時間とする。
ELA NAHIB	450,000	4.3	0.15	419	428,111	219,000	219,000	-9,889	22	0	0						
										重力式	現未稼働						
Stretta Vaudetto	125,000	9.0	0.13	419	835,141	47,450	189,800	241,164	22	20	440						
							オーバーフロー	356,727	導水ポンプ1台の180m3/hで2.5時間稼働可能								
BELEZA	1,022,000	6.1	0.18	419	596,463	65,700	262,800	267,963	22	33	730						
											EEC使用						
Mai Serwa	1,785,000	8.8	0.18	419	834,093	65,700	262,800	505,593	22	107	2,350						
						SVのオーバーフロー考慮		862,320	導水ポンプ1台の200m3/hで11.8時間稼働可能								
Adi Sheka	4,050,000	37.3	0.36	419	3,402,002	525,600	525,600	2,350,802	22	292	6,420						
									導水ポンプ1台の450m3/hで14.3時間稼働可能								
Toker	12,575,000	69.6	0.18	419	6,185,162	65,700	262,800	5,856,662	22	729	16,040	Toker WTP	16,040	16,040	16,040	18,000	22
									ポンプ1台の990m3/hで16.2時間稼働可能								
Mai Nefhi	23,912,000	94.5	0.80	419	7,796,517	292,000	1,168,000	6,336,517	22	789	17,360	Mai Nefhi WTP	17,360	17,360	17,360	20,000	22
									ポンプ2台の500m3/hで17.4時間稼働可能								
TOTAL	44,415,000							15,647,465					42,610	42,170	43,490	46,000	

S.V 浄水場系統から年間を通じて取水可能なダムは、5 箇所(Ela Nahib を除く)のダムから可能であるが、VALLE GNECCHI は現在農業等に使用されていること、更に導水管の配管状態も不明であること、取水可能量があまり多くないことから取水は見送るべきと考える。また、Beleza ダムは現在 EEC が発電機の冷却水として使用しており今後も使用継続する可能性があること、ダムからの取水可能量があまり多くないことから取水は見送るべきと考える。更に、S.V ダムは、ダム湖の堆積土が多く、ダムからの取水可能量が多くないことから取水は見送るべきと考える。よって、Mai Serwa と Adi Sheka ダムから取水することが最適であり、日平均取水量は 8,770m^3/日である。S.V 浄水場の設計浄水量 8,000m^3/日は妥当な量と判断し、増設工事は控えるべきと判断する。

また、Toker ダムからは 16,040m^3/日で Toker 浄水場の設計浄水能力 18,000m^3/日を下回る。

更に Mai Nefhi ダムにおいても 17,360m^3/日で Mai Nefhi 浄水場の設計浄水能力 20,000m^3/日を下回る。

結果、3 つの浄水場とも設計浄水量以上の取水は控えるべきと判断する。

付属資料 4.

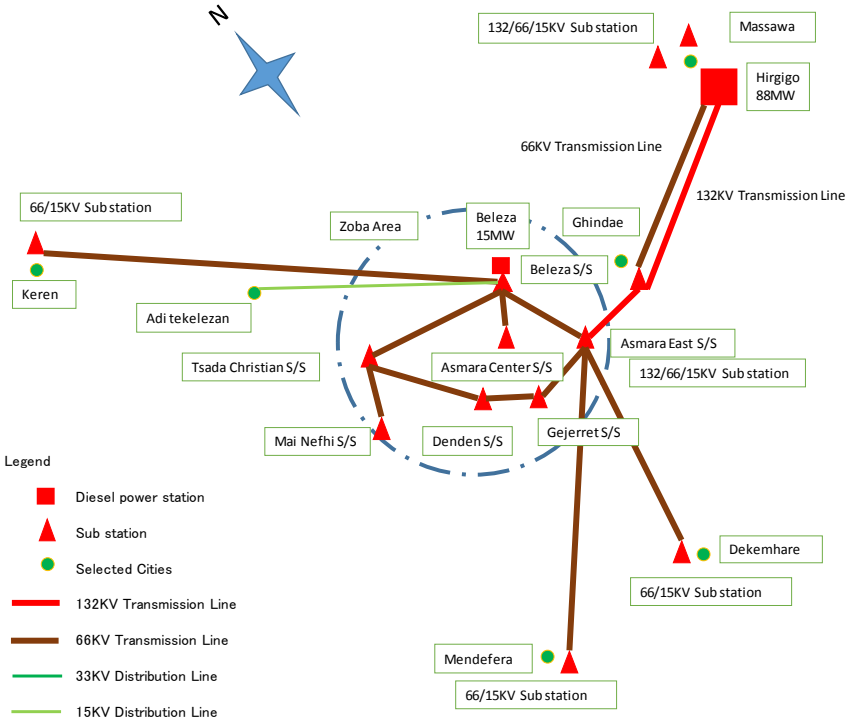
4) 電力事情

4. 参考資料

4) 電力事情

（1） 現在の供給電力量と電力生産量、将来計画

Inter-connected (Integrated) system (ICS)で Massawa の Hirgigo 火力発電所（22MW*4=88KW）と Asumara の Beleza 火力発電所（5MW*3=15KW）から電力が供給されている。よって、最大 103MW の電力生産が可能である。



図－1 Asmara 市内への供給電力と送電線網

Hirgigo から 66KV と 132KV の送電線で 71km 先の ASMARA 市内の Gihindae 変電所に送電されて 132kV の送電線で、ASMARA 市内の ASMARA EAST 変電所に送電される。ASMARA 市内の 6 か所の変電所、ASMARA 北西部（Keren 90km)、ASMARA 南部（Dekemhare 35km)、ASMARA 南西部（Mendefera 55km)、に送電される。

現在､Hirgigo 火力発電所は 4 つの発電機の内 2 つが整備中で 44MW しか発電できていない。更に、Beleza 火力発電所も 3 つの発電機の内 2 つが整備中で 5MW しか発電できていない。電力消費量は 65－70MW と推定しているが、現在 49MW しかなく、許容を超えると突発的又は計画的に停電している。整備中のタービンは全て 2，3 か月後には終了する予定である。

また､将来は 80MW 以上の電力需要があると考えているため､2016 年初めには Hirgigo に 2 基(23MW*2=46MW)の発電機が SFECO（中国企業）の施工で完成する予定である。

また、EU の EDF で配電線の整備計画が ABB（工事会社）で実施予定されている。

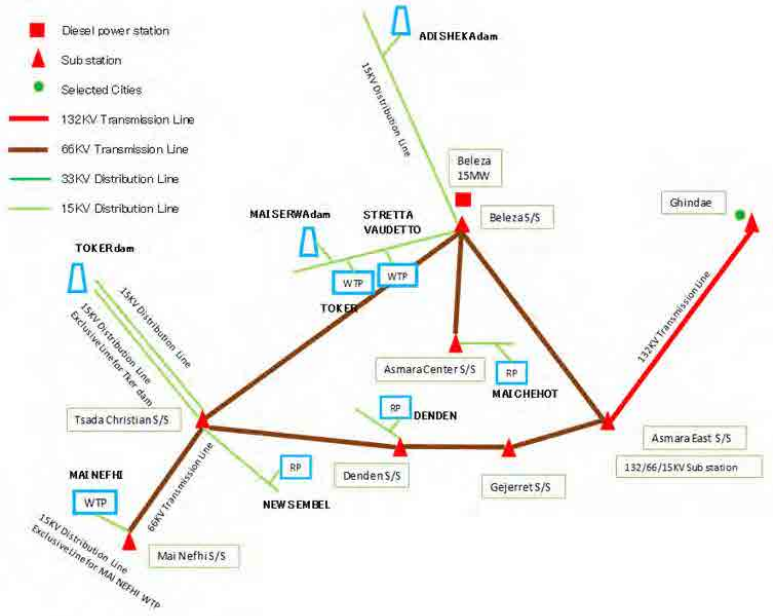
ASMRA 市内のセメント工場には 1MW 供給している。新セメント工場は自家発電設備であり、問題はない。

尚、EEC においても外貨問題があり、外貨が獲得できなければ、スペアパーツが購入できないため、上記工事の遅延が予想される。

（2） 水道施設の電力事情

中央州では 7 つの変電所がある。送電線は循環しており、どこかの送電線、又は変電所が問題を起こしてもカバーできるようになっている。

中央州の変電所と各主要水道施設の配電線を示す。



図－2　中央州の変電所と各主要水道施設の配電線

専用線は、Mai-Nefhi W.T.P と計画中の Toker 導水ポンプで 15KV 配電線がある。

他の水道施設の配電線は専用線ではなく、各家庭にも配電されている。そのため、多くの電力を配電しており、電力不足時には変電所で配電スイッチを切られる。専用線は、変電所で操作でき 24 時間体制とできる。

Mai Nefhi W.T.P の送水ポンプの稼働は、管理日誌から 18 時間稼働している。このことは、Mai Nefhi 変電所からの専用線であり、24 時間供給できる体制であることを示している。電気供給において、送水先の New Sembel ポンプ場との連動性はない。New Sembel ポンプ場から重力配水できる区域には水が供給できるが、ポンプアップが必要な区域は 14 時間程度しか供給できない状態である。

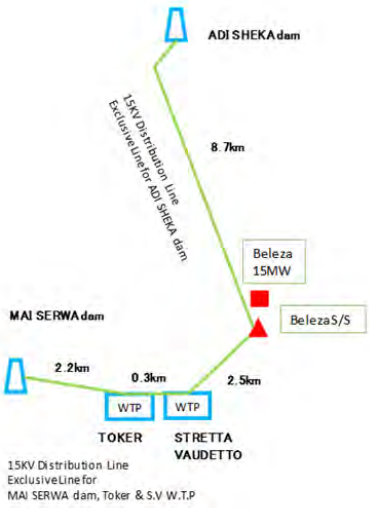
S.V W.T.P の稼働時間は、Adi Sheka ダムと Mai Serwa ダムの電力事情に影響される。

両方が同時刻に供給できれば良いが、多少異なった時間帯である。2015 年 4 月現在は、Adi Sheka ダムが 12：00－24：00、Mai Serwa ダムが 22：00－13：00 である。同時に稼働している時間帯は 12:00－13:00 と 22:00－24:00 の 3 時間である。尚、Mai Serwa ダムと S.V 浄水場は同配電線で、連動しているが、Adi Sheka ダムと S.V 浄水場は 3 時間しか連動できないため効果的に浄水処理できていない。

Toker ダムには 2 本の配電線が並列して供給されており、1 本は途中の村落等に供給され、残り 1 本は計画中の導水ポンプ専用線となっている。しかし、エンジンポンプからモーターポンプに変更され現 10 時間から 20 時間に変更されても、Toker 浄水場は 24 時間体制ではないため連動性はない。そのため、Toke 浄水場にも専用線が必要である。

尚、Mai Serwa ダムと S.V 浄水場と Toker 浄水場では大きな電力が必要ではないこと、割と近場に位置していることから、3 施設で 1 本の専用線で賄える。

市内までの水の供給を考えれば、Adi Sheka ダムと Mai Serwa ダムの専用線が出来れば、24 時間体制が可能である。



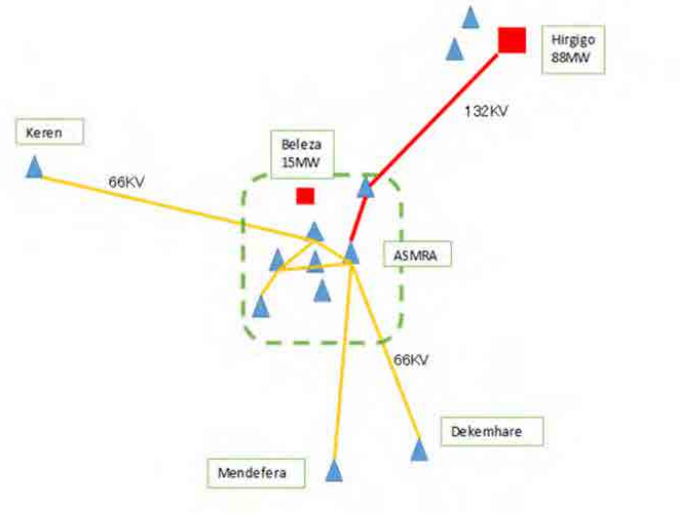
図－3　将来的に計画が必要な専用線

ＥＥＣ協議議事録　1
アスマラ給水開発計画準備調査（給水施設／運営・維持管理）
場所：　Eritrean Electric corporation (ECC) in ASMARA
実施日：　3月25日（水）14:30
JICA 側：　JICA；大村団長、山崎調査企画、鶴崎専門家、コンサル；田村、吉川
エリトリア側：　General Manager, ABRAHAM W. MICAEL

２つのシステムがある。
①Inter-connected (Integratied) system; (ICS)　1箇所
②Self-Contained System; (SCS)　5箇所

②SCS
SCS は5都市（Assab 5.1MW, Adikeih 1.0MW, Akurdat 1.5MW, Barentu 1.5MW, Alebu 2.0MW）で運営されている。
全てディーゼルによる火力発電

①ICS
Massawa の Hirgigo にディーゼルによる火力発電所があり、4つの発電機（22MW*4=88KW）がある。
Asumara の Beleza にも中規模のディーゼルによる火力発電所があり、3 つの発電機（5MW*3=15KW）がある。よって 103MW の電力生産が可能である。



高圧送電線は、132、66KV の2種類。
高圧配電線は 33、15KV の2種類。
一般配電線は 400V。

Hirgigo から 132KV の送電線で 71km 先の ASMARA 市内の Gihindae 変電所に送電されて 66kV に減圧、ASMARA 市内の各変電所、ASMARA 北西部（Keren 90km）、ASMARA 南東部（Dekemhare 35km）、ASMARA 南部（Mendefera 55km）、に送電され、66KV 送電線の総延長は 320 kmである。

現在､Hirgigo 火力発電所は 4 つの発電機の内 2 つが整備中で 44MW しか発電できていない。
更に、Beleza 火力発電所も 3 つの発電機の内 2 つが整備中で 5MW しか発電できていない。
電力消費量は　65－70MW と推定しているので、現在 49MW しかなく、許容を超えると突発的又は計画的に停電している｡整備中のタービンは全て 2,3 か月後には終了する予定である。

また、将来は 80MW 以上の電力需要があると考えている。
2016 年初めには Hirgigo に 2 基(23KW*2=46KW)の火力発電所が SFECO（中国企業）の施工で完成する予定である。
また、EU の EDF で配電線の整備計画が ABB（工事会社）で実施予定されている。
地方ではソーラー発電、Hirgigo 南部の Alia では地熱発電について計画検討されている。

ASMRA のセメント工場には 1MW 供給している。
新セメント工場は自家発電設備であり、問題はない。

尚、Toker ダムの 15KV の送電線は終了している。
また、Mai Nefhi ダム付近には 66KV の送電線で Mai Nefhi 変電所に送電している。
更に、Toker 浄水場と S.V 浄水場には Beleza から送電している。

資料：
Outline map of Existing thermal power plants and power grid system
The Eritrean Electric Corporation, General Information

ＥＥＣ協議議事録　２

アスマラ給水開発計画準備調査（給水施設／運営・維持管理）

場所：　　Eritrean Electric corporation (ECC) (Asmara Center S/S)

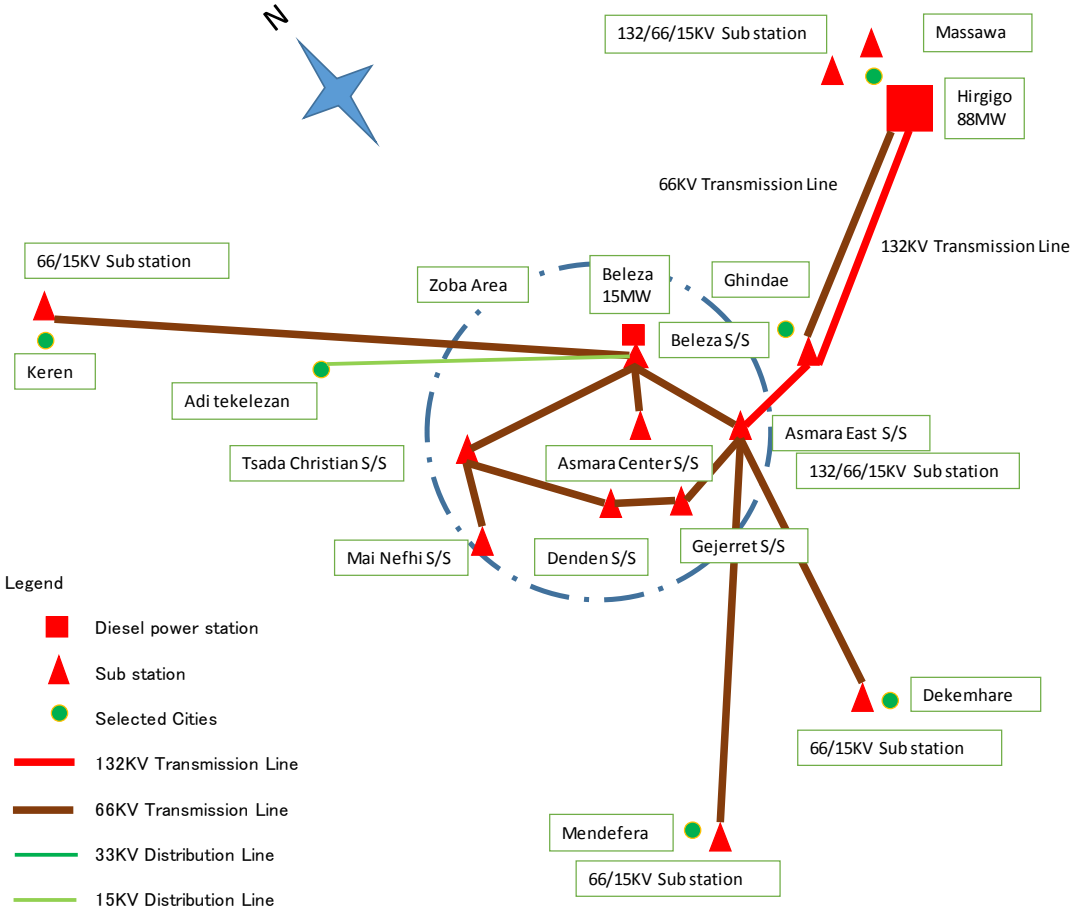
実施日：　　４月 21 日（火）15:00

JICA 側：　　JICA；鶴崎専門家、コンサル；吉川

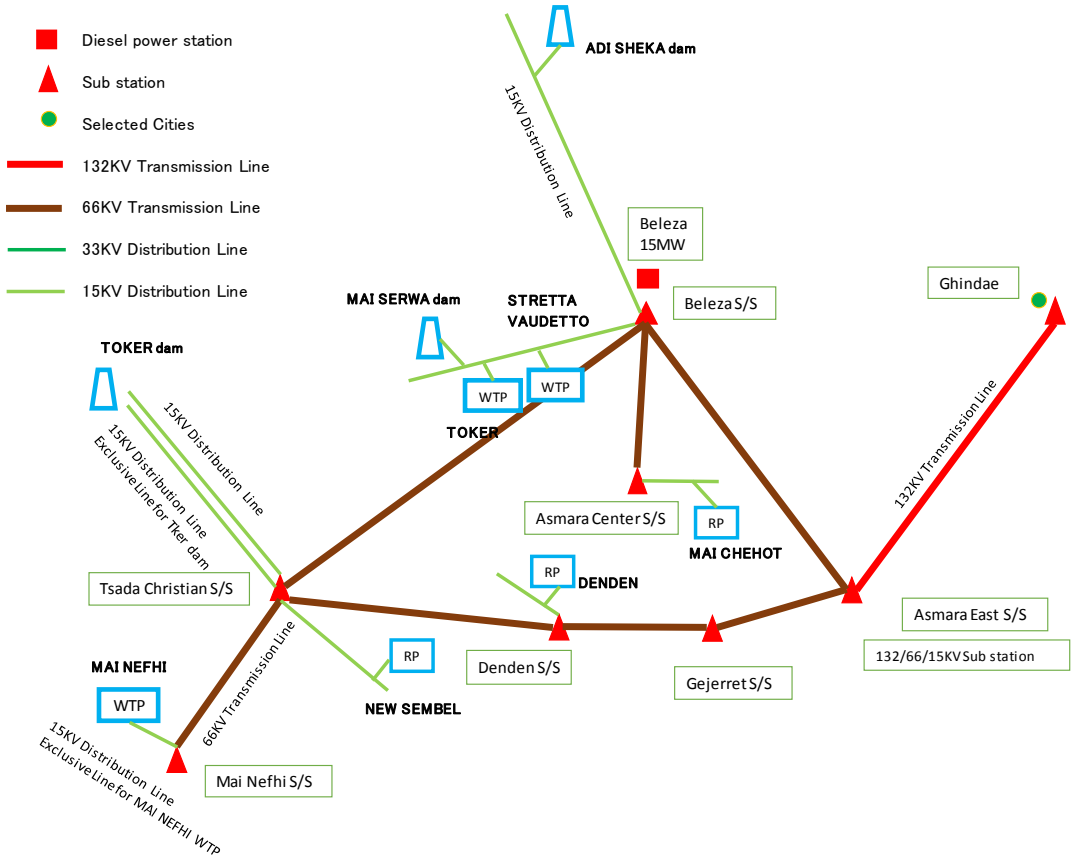
エリトリア側：　　General Manager, ABRAHAM W. MICAEL

中央州では７つの変電所がある。

送電線は循環しており、どこかの送電線、又は変電所が問題を起こしてもカバーできるようになっている。



中央州の変電所と各主要水道施設の配電線を示す。



専用線は、Mai-Nefhi 浄水場と計画中の Toker 導水ポンプで 15KV 配電線がある。
残りの施設の配電線は専用線ではなく、各家庭にも配電されている。そのため、多くの電力を配電しており、電力不足時には変電所でラインを切られる。
但し、専用線は、変電所で操作でき 24 時間体制とできる。

ただ、水道の場合は、現在の専用線が Mai-Nefhi 浄水場 WTP だけであり、市内のポンプ所は停電するため一連の水道システムが正常に供給できないことを危惧している。
水道関係だけの専用線ができれば、停電させないで水を供給できることは知っているが今のところ計画はない。

また、下記に電気料金を示す。
2008 年から値上げしていない。
製造コストと販売コストが合わないことも知っているが今のところ値上げはしない。
Mai-Nefhi WTP のポンプ容量が大きいので Big Industries の安い値段で供給しているが、
他の施設は Small Industries の値段となる。

Eritrean Electric Corporation
Existing Tariff as of May 10, 2008

Tariff Category		Unit Charge	Service Charge Nakfa/Month	
Code	Description	Nakfa/KWh	Single Phase	Three Phase
71	Domestic	2.52	10	20
72	General - Govement Offices - Non Govement Offices Shop, Restrants, Coffee House, Offices etc	3.25	15	41
73	Street Light	3.2	15	41
74	Small Industries - Workshop, Garages,Bakery etc - Other WTP, Pump station	2.6	-	82
75/76	Big Industries - Mai-Nefhi WTP	1.8	-	85

資料：
Existing Tariff of Eritrean Electric Corporation

付属資料 4.

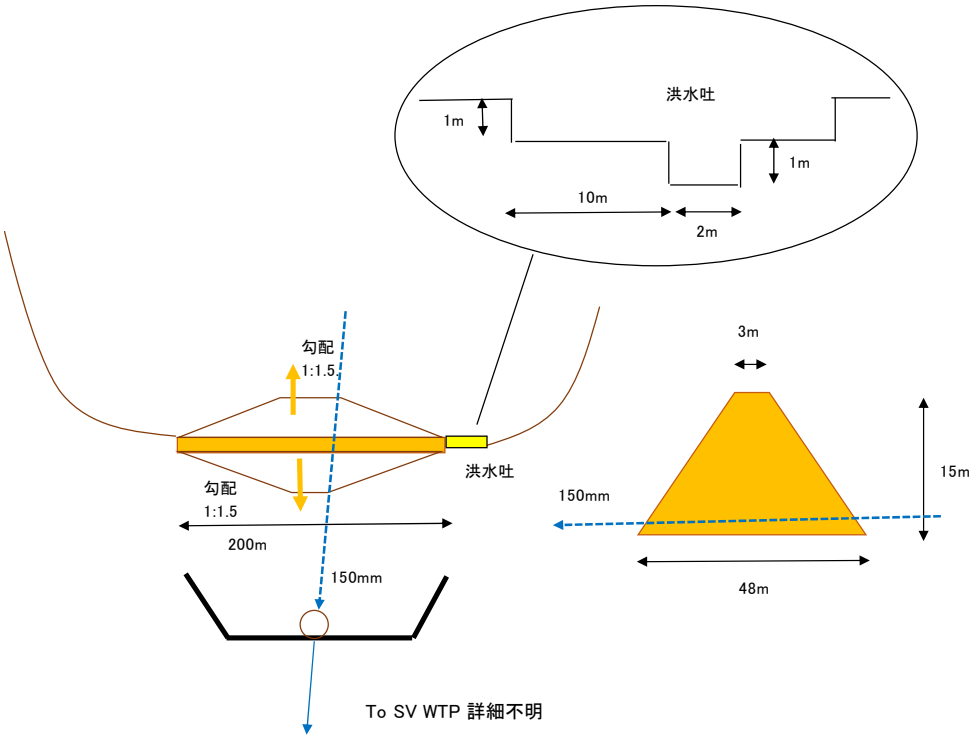
5) 各ダム・浄水場の概略図

4. 参考資料

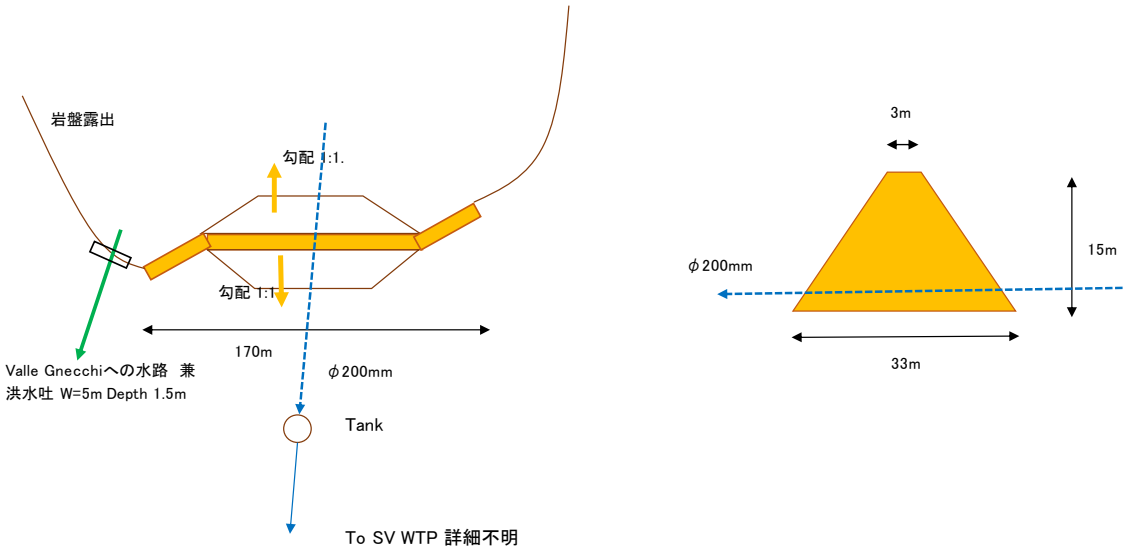
5) 各ダム・浄水場の概略図

（１） 各ダムの概要図（Non-Scale）

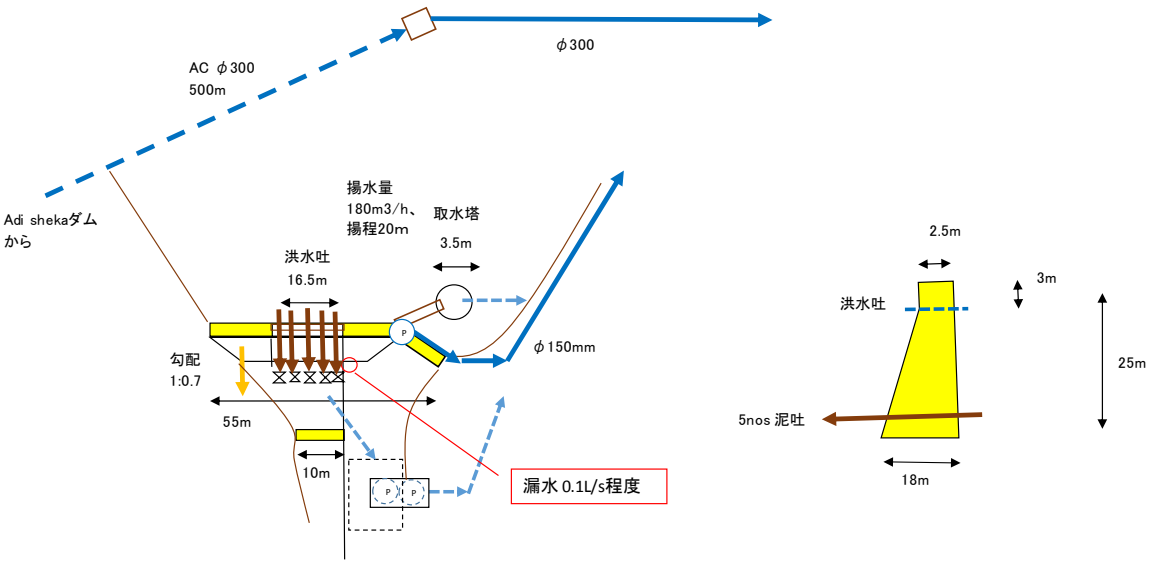
VALLE GNECCHI dam



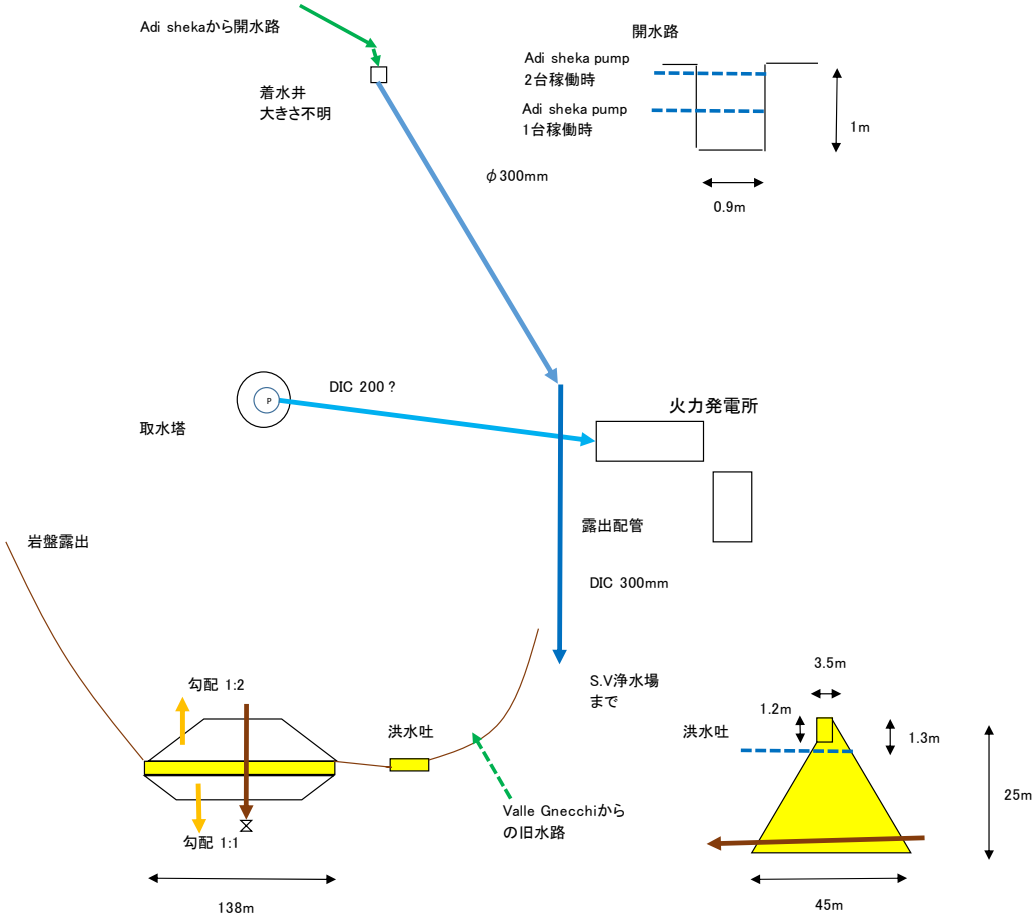
ELA NAHIB (Adi Nefas) dam



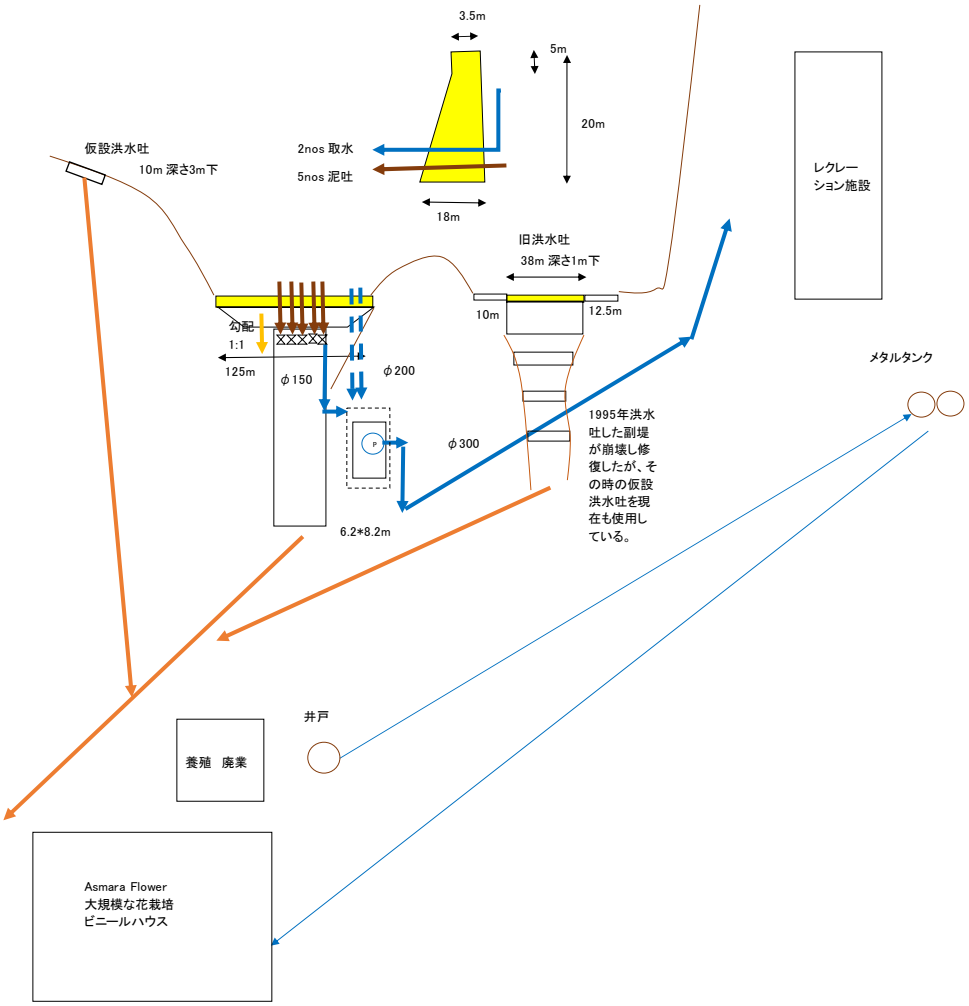
STRETTA VAUDETTO dam



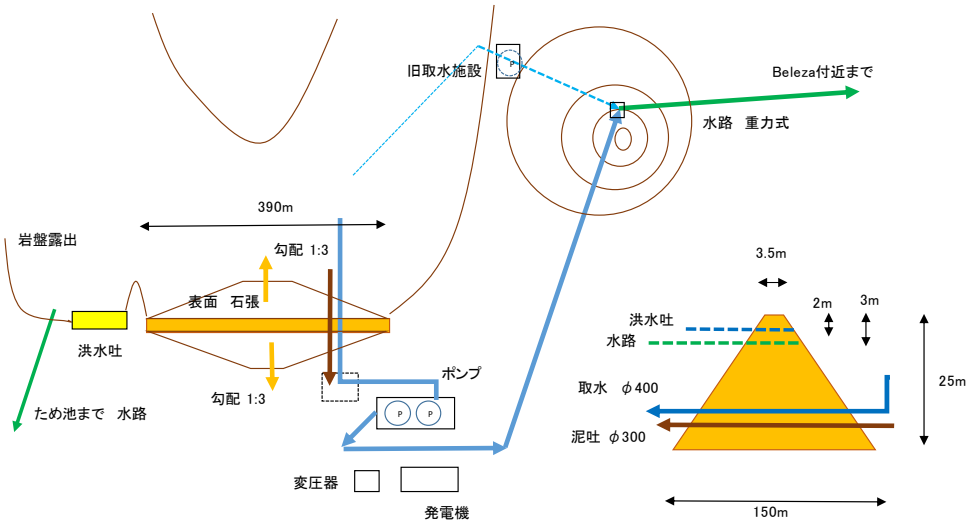
BELEZA dam



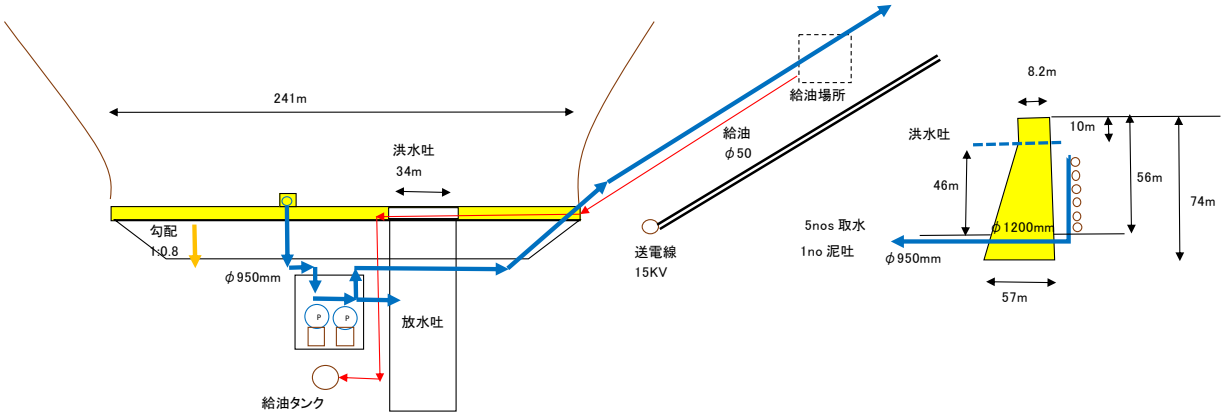
MAI SERWA dam



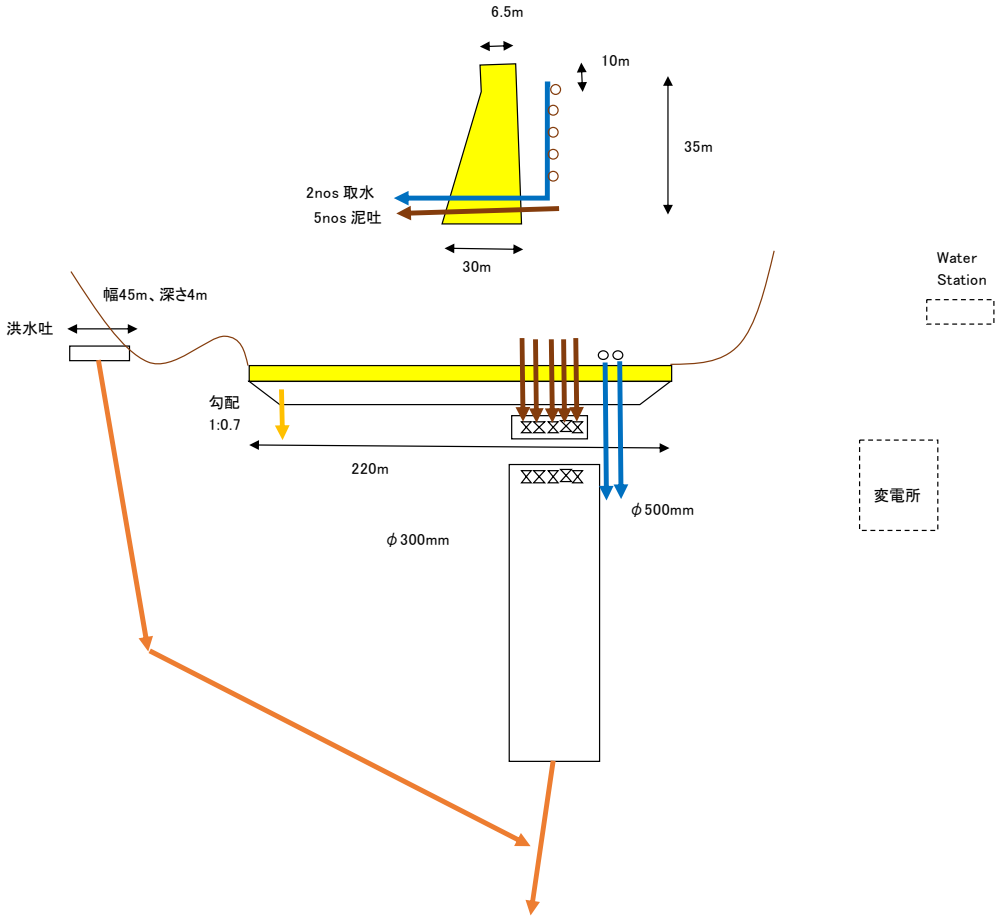
ADI SHEKA (Adi Sciana) dam



TOKER dam

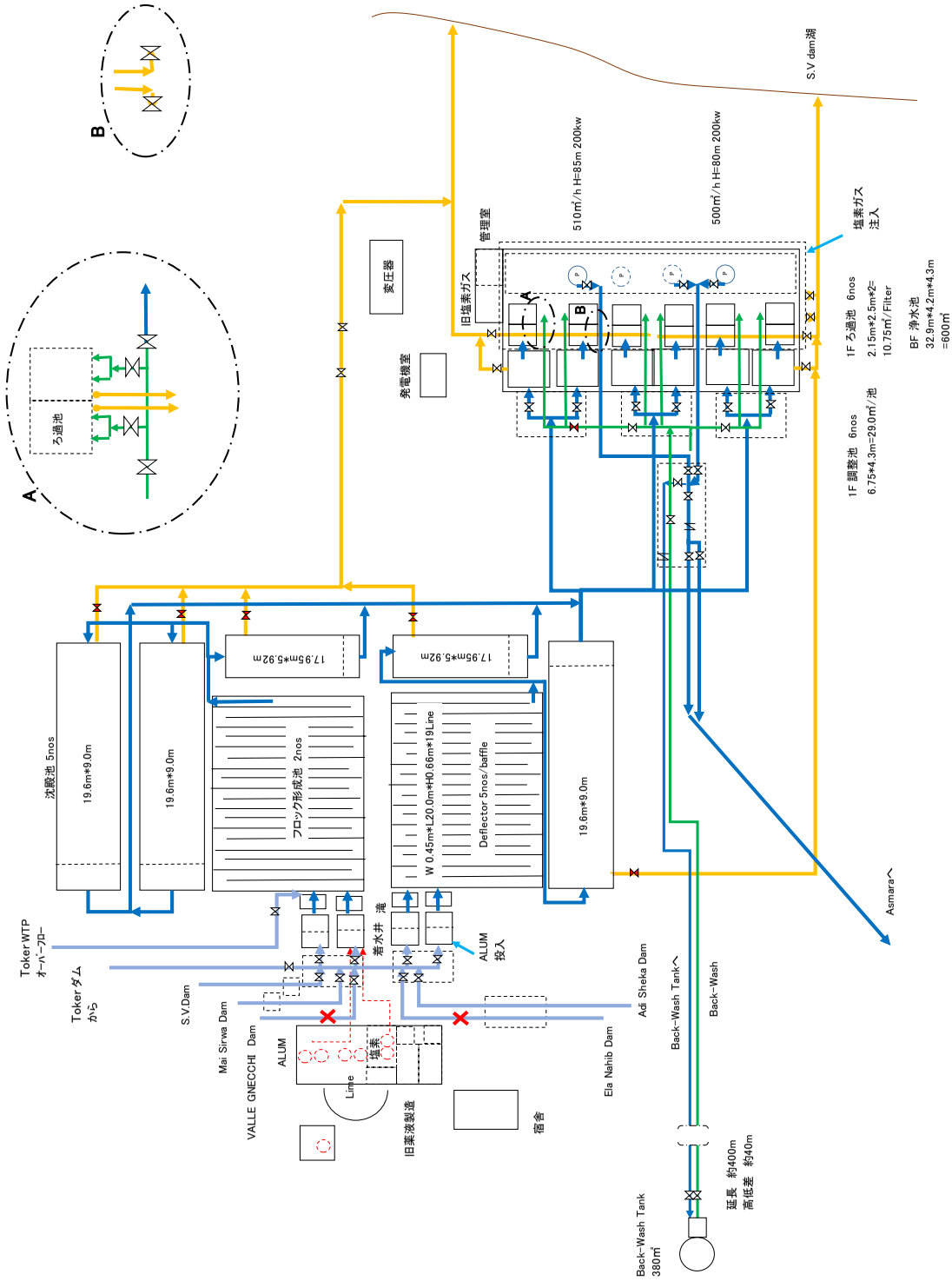


MAI NEFHI dam

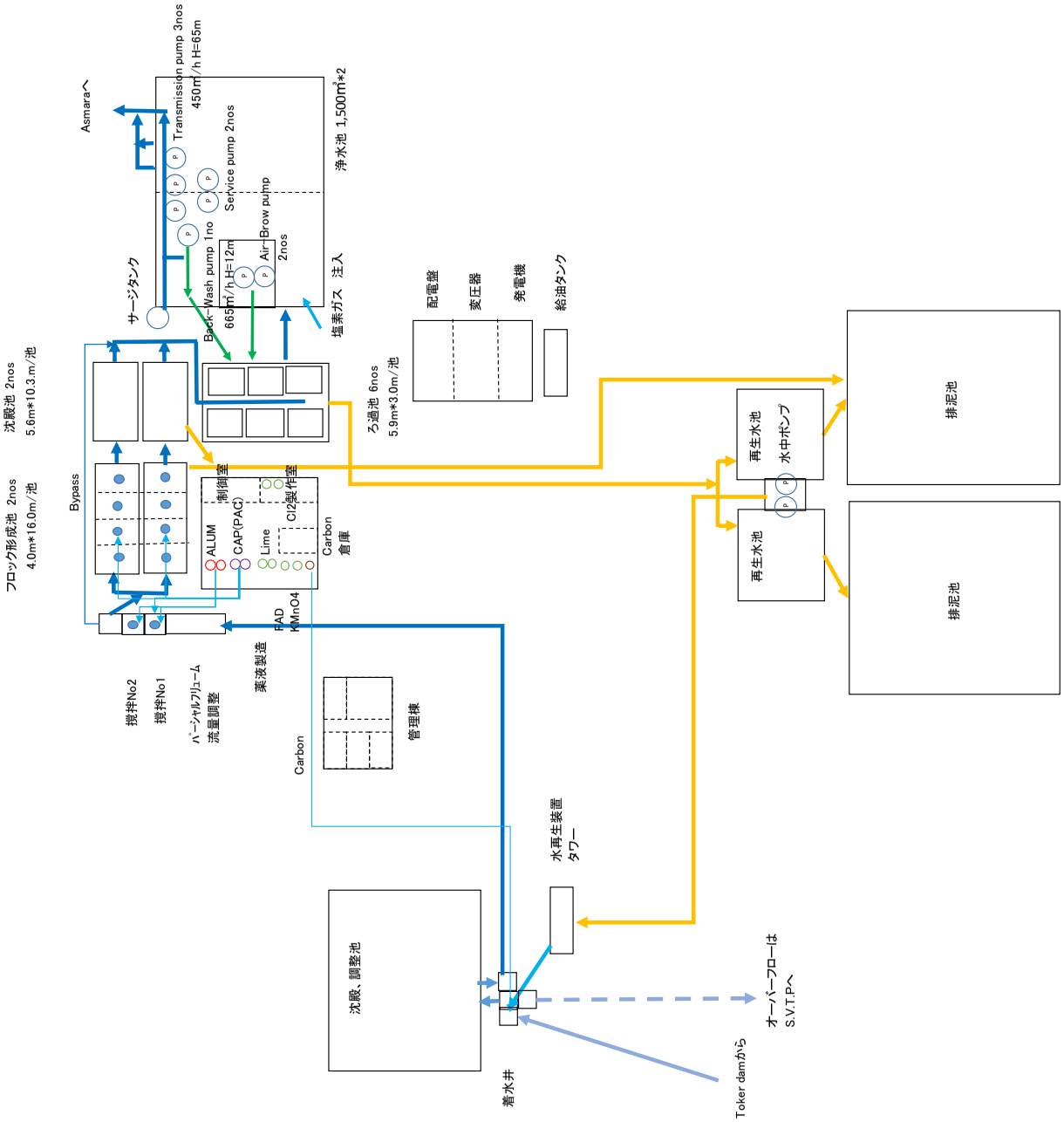


（２）　各浄水場の概要図（Non-Scale）

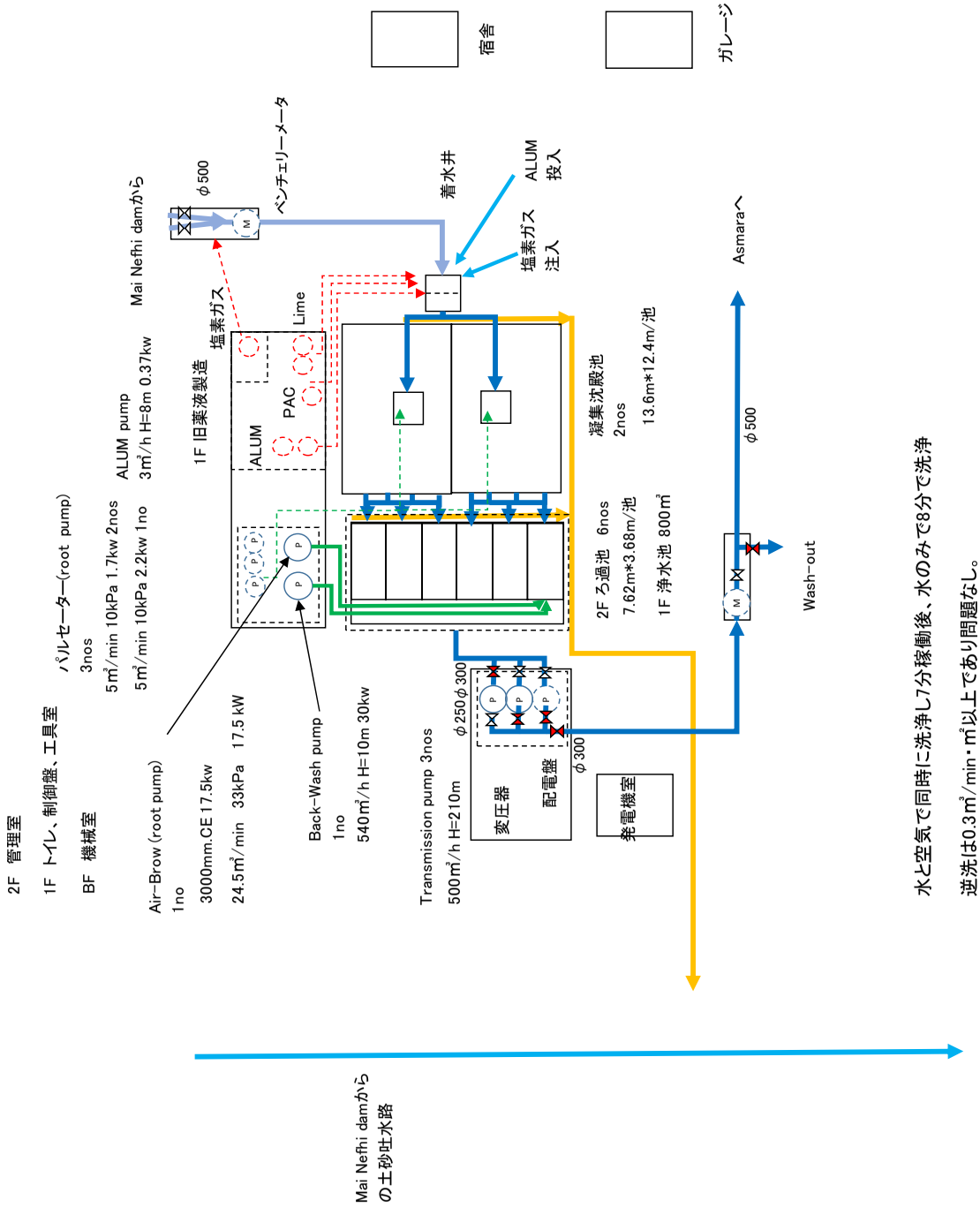
STRETTA VAUDETTO W.T.P



TOKER W.T.P


Asmaraへ
Transmission pump 3nos
450m³/h H=65m
浄水池 1,500m³*2
Service pump 2nos
Brow pump
2nos
Air
Back-Wash pump 1no
665m³/h H=12m
サージタンク
塩素ガス 注入
配電盤
変圧器
発電機
給油タンク
沈殿池 2nos
5.6m*10.3m/池
フロック形成池 2nos
4.0m*16.0m/池
Bypass
ろ過池 6nos
5.9m*3.0m/池
制御室
Cl2製作室
ALUM
CAP(PAC)
Lime
Carbon
倉庫
FAD
KMnO4
薬液製造
撹拌No2
撹拌No1
ﾊﾟｰｼｬﾙﾌﾘｭｰﾑ
流量調整
Carbon
管理棟
再生水池
水中ポンプ
再生水池
排泥池
排泥池
水再生装置
タワー
沈殿、調整池
着水井
Toker damから
オーバーフローは
S.V.T.Pへ

MAI NEFHI W.T.P



付属資料 4.

6) 需要予測

2015 Potential Demand

Assumed Leakage (%) 33

ID	Area Name	Domestic (by Connection) (m3/day)	Domestic (by Truck) (m3/day)	Non-domestic (by Connection) (m3/day)	Non-domestic (by Truck) (m3/day)	Total Daily Consumption (m3/day)	Total Daily Production (m3/day)
1. Paradiso							
8	Paradiso	995		520		1,516	2,263
38	Bet Mekae TD	0		45		45	67
45	Adi Abeito village and TD	0		37		37	55
2. Maitemenai							
1	Mai Temenai	636		441		1,077	1,607
4	Mai Temenai TD	0	830	55	293	1,178	1,758
3. Edaga Hamus							
2	Haz Haz	262		35		297	443
6	Idaga Hamus and Emba Galliano	1,217		178		1,395	2,082
4. Akiria							
3	Mirham Chira and Acria	1,860		140		2,000	2,985
46	Adi Nefas village + TD	0		17		17	25
54	Mirham Chira extension	0		0		0	0
5. Abazhawl							
5	Aba Shaul	1,659		250		1,909	2,849
6. Arbate Asmara							
9	Medeber	124		15		140	208
10	Arbate Asmara	1,074		145		1,219	1,819
11	Geza Tanika	88		10		98	146
7. Tsetserat							
26	Bet Mekae	177		32		209	312
31	Space 2000 - II	68		0		68	102
34	Tsetserat + Forto Complex	81		15		97	144
36	Tsetserat D2	15		2		17	25
37	Adi Segdo TD	0		63		63	93
43	Adi Segdo village	47		16		63	94
8. Maekel Ketema							
14	Maekel Ketema North	463		55		518	772
15	Maekel Ketema West	345		83		428	639
16	Maekel Ketema South	373		44		418	623
17	Harnet	175		21		196	292
9. Tiravolo							
21	Tiravolo	623		111		734	1,095
28	Denden Housing	0		243		243	363
30	Space 2000 - I	66		23		89	132
10. Geza banda							
12	Forobia	74		8		82	122
13	Mai Chehot	546		63		609	909
18	Addis Alem	809		110		919	1,371
19	Zeban Zinkei and Halibet Complex	456		303		759	1,133
11. Sembel							
32	Sembel Village + Sembel III	403		269		672	1,002
35	Sembel high rise A	110		151		261	390
12. Godaif							
22	Barijima	150	735	22	119	1,026	1,532
24	Kahawata	544		76		620	926
25	Dembe Sembel + Godaif II	178		26		204	305
27	Godaif + Godaif I	929		305		1,234	1,842
33	Kuteba + Gegeret II	100		13		113	169
13. Gejeret							
20	Gejeret Neishto	1,070		160		1,230	1,836
20	Algin Housing	0		278		278	415
23	Gejeret Abi	642		102		745	1,111
29	Gejeret I	0		0		0	0
Daero Paulos TD		206		27		233	348
		16,566	1,566	4,511	411	23,054	34,409

Potential Daily Demand by WTPs (m3/day)	Domestic (by Connection)	Domestic (by Truck)	Non-domestic (by Connection)	Non-domestic (by Truck)	Total Daily Consumption	Total Daily Production	
Stretta Vaudetto WTP System	3,408	0	363	0	3,770	5,627	m3/day
Toker WTP System	6,258	830	2,108	293	9,488	15,495	m3/day
Mai Nefhi WTP System	6,901	735	2,040	119	9,795	13,286	m3/day
Total	**16,566**	**1,566**	**4,511**	**411**	**23,054**	**34,409**	**m3/day**

2020 Demand Projection

Assumed Leakage (%) 33

ID	Area Name	Domestic (by Connection) (m3/day)	Domestic (by Truck) (m3/day)	Non-domestic (by Connection) (m3/day)	Non-domestic (by Truck) (m3/day)	Total Daily Consumption (m3/day)	Total Daily Production (m3/day)
1. Paradiso							
8	Paradiso	1,024		545		1,569	2,342
38	Bet Mekae TD	18		47		65	97
45	Adi Abeito village and TD	4		39		43	64
2. Maitemenai							
1	Mai Temenai	654		461		1,116	1,665
4	Mai Temenai TD	13	780	57	306	1,157	1,726
3. Edaga Hamus							
2	Haz Haz	269		37		306	457
6	Idaga Hamus and Emba Galliano	1,252		186		1,438	2,147
4. Akiria							
3	Mirham Chira and Acria	1,913		147		2,060	3,074
46	Adi Nefas village + TD	11		17		29	43
54	Mirham Chira extension	1		0		1	1
5. Abazhawl							
5	Aba Shaul	1,706		262		1,968	2,937
6. Arbate Asmara							
9	Medeber	128		16		144	215
10	Arbate Asmara	1,104		152		1,256	1,875
11	Geza Tanika	91		10		101	151
7. Tsetserat							
26	Bet Mekae	182		33		216	322
31	Space 2000 - II	70		0		70	105
34	Tsetserat + Forto Complex	84		16		100	149
36	Tsetserat D2	15		2		17	26
37	Adi Segdo TD	157		65		222	332
43	Adi Segdo village	48		17		65	97
8. Maekel Ketema							
14	Maekel Ketema North	476		57		533	796
15	Maekel Ketema West	355		87		442	659
16	Maekel Ketema South	384		47		430	642
17	Harnet	180		22		202	301
9. Tiravolo							
21	Tiravolo	640		116		757	1,130
28	Denden Housing	0		255		255	380
30	Space 2000 - I	68		24		92	137
10. Geza banda							
12	Forobia	76		8		84	126
13	Mai Chehot	561		66		628	937
18	Addis Alem	832		115		947	1,414
19	Zeban Zinkei and Halibet Complex	469		317		786	1,174
11. Sembel							
32	Sembel Village + Sembel III	518		282		799	1,193
35	Sembel high rise A	114		158		272	405
12. Godaif							
22	Barijima	155	728	23	124	1,030	1,538
24	Kahawata	560		80		640	955
25	Dembe Sembel + Godaif II	183		28		211	314
27	Godaif + Godaif I	956		319		1,275	1,903
33	Kuteba + Gegeret II	103		14		117	174
13. Gejeret							
20	Gejeret Neishto	1,101		167		1,268	1,893
20	Algin Housing	0		291		291	434
23	Gejeret Abi	661		107		768	1,146
29	Gejeret I	0		0		0	0
Daero Paulos TD		212		28		240	358
		17,347	1,508	4,723	431	24,009	35,834

Projected Daily Demand by WTPs (m3/day)	Domestic (by Connection)	Domestic (by Truck)	Non-domestic (by Connection)	Non-domestic (by Truck)	Total Daily Consumption	Total Daily Production	
Stretta Vaudetto WTP System	3,517	0	380	0	3,897	5,816	m3/day
Toker WTP System	6,628	780	2,207	306	9,921	16,189	m3/day
Mai Nefhi WTP System	7,202	728	2,136	124	10,190	13,829	m3/day
Total	**17,347**	**1,508**	**4,723**	**431**	**24,009**	**35,834**	**m3/day**

2025 Demand Projection

Assumed Leakage (%) 32

ID	Area Name	Domestic (by Connection) (m3/day)	Domestic (by Truck) (m3/day)	Non-domestic (by Connection) (m3/day)	Non-domestic (by Truck) (m3/day)	Total Daily Consumption (m3/day)	Total Daily Production (m3/day)
1. Paradiso							
8	Paradiso	1,053		577		1,630	2,397
38	Bet Mekae TD	37		50		87	128
45	Adi Abeito village and TD	8		41		49	72
2. Maitemenai							
1	Mai Temenai	673		488		1,161	1,708
4	Mai Temenai TD	26	682	61	324	1,094	1,609
3. Edaga Hamus							
2	Haz Haz	291		39		331	486
6	Idaga Hamus and Emba Galliano	1,288		197		1,485	2,184
4. Akiria							
3	Mirham Chira and Acria	2,071		156		2,227	3,274
46	Adi Nefas village + TD	38		18		56	83
54	Mirham Chira extension	3		0		3	5
5. Abazhawl							
5	Aba Shaul	1,755		277		2,032	2,988
6. Arbate Asmara							
9	Medeber	138		17		155	229
10	Arbate Asmara	1,336		161		1,497	2,202
11	Geza Tanika	110		11		121	177
7. Tsetserat							
26	Bet Mekae	187		35		223	327
31	Space 2000 - II	72		0		72	106
34	Tsetserat + Forto Complex	86		17		103	151
36	Tsetserat D2	16		2		18	26
37	Adi Segdo TD	161		69		231	339
43	Adi Segdo village	50		18		67	99
8. Maekel Ketema							
14	Maekel Ketema North	489		61		550	809
15	Maekel Ketema West	365		92		457	672
16	Maekel Ketema South	395		49		444	653
17	Harnet	185		23		208	306
9. Tiravolo							
21	Tiravolo	659		123		782	1,150
28	Denden Housing	0		269		269	396
30	Space 2000 - I	70		25		95	140
10. Geza banda							
12	Forobia	79		8		87	128
13	Mai Chehot	577		70		648	952
18	Addis Alem	856		122		978	1,438
19	Zeban Zinkei and Halibet Complex	482		336		818	1,203
11. Sembel							
32	Sembel Village + Sembel III	639		298		937	1,378
35	Sembel high rise A	117		167		284	418
12. Godaif							
22	Barijima	159	720	25	132	1,035	1,522
24	Kahawata	576		85		660	971
25	Dembe Sembel + Godaif II	188		29		217	320
27	Godaif + Godaif I	983		338		1,321	1,943
33	Kuteba + Gegeret II	106		15		120	177
13. Gejeret							
20	Gejeret Neishto	1,133		177		1,310	1,926
20	Algin Housing	0		308		308	453
23	Gejeret Abi	680		113		793	1,166
29	Gejeret I	0		0		0	0
Daero Paulos TD		218		30		248	364
		18,356	1,402	4,998	456	25,212	37,076

Projected Daily Demand by WTPs (m3/day)	Domestic (by Connection)	Domestic (by Truck)	Non-domestic (by Connection)	Non-domestic (by Truck)	Total Daily Consumption	Total Daily Production	
Stretta Vaudetto WTP System	3,988	0	402	0	4,390	6,456	m3/day
Toker WTP System	6,854	682	2,335	324	10,195	16,409	m3/day
Mai Nefhi WTP System	7,514	720	2,261	132	10,626	14,211	m3/day
Total	**18,356**	**1,402**	**4,998**	**456**	**25,212**	**37,076**	**m3/day**

Non-domestic demand

ID	Area Name	FS Forcast for 2010 (Low hyposesis)		2014 Actual Billed volume		2015 Potential Demand		2020 Demand Projection		2025 Demand Projection	
		by connection	by truck	by connection	by truck	by connection	by truck	by connection	by truck	by connection	by truck
		(m3/day)	(m3/day)	(m3/day)	(m3/day)	(m3/day)	(m3/day)	(m3/day)	(m3/day)	(m3/day)	(m3/day)
1. Paradiso						0.73		1.05		1.06	
8	Paradiso	712	0			520	0	545	0	577	0
38	Bet Mekae TD	62	33			45	24	47	25	50	27
45	Adi Abeito village and TD	50	10			37	7	39	7	41	8
2. Maitemenai											
1	Mai Temenai	602	28			441	20	461	21	488	22
4	Mai Temenai TD	75	13			55	9	57	10	61	10
3. Edaga Hamus											
2	Haz Haz	48	10			35	7	37	8	39	8
6	Idaga Hamus and Emba Galliano	243	30			178	22	186	23	197	25
4. Akiria											
3	Mirham Chira and Acria	192	41			140	30	147	32	156	33
46	Adi Nefas village + TD	23	17			17	13	17	13	18	14
54	Mirham Chira extension	0	3			0	2	0	2	0	2
5. Abazhawl											
5	Aba Shaul	342	102			250	75	262	78	277	83
6. Arbate Asmara											
9	Medeber	21	2			15	2	16	2	17	2
10	Arbate Asmara	199	39			145	29	152	30	161	32
11	Geza Tanika	13	5			10	3	10	3	11	4
7. Tsetserat											
26	Bet Mekae	44	3			32	2	33	2	35	3
31	Space 2000 - II	0	0			0	0	0	0	0	0
34	Tsetserat + Forto Complex	21	4			15	3	16	3	17	3
36	Tsetserat D2	3	1			2	1	2	1	2	1
37	Adi Segdo TD	86	35			63	25	65	27	69	28
43	Adi Segdo village	22	25			16	18	17	19	18	20
8. Maekel Ketema											
14	Maekel Ketema North	75	0			55	0	57	0	61	0
15	Maekel Ketema West	113	0			83	0	87	0	92	0
16	Maekel Ketema South	61	0			44	0	47	0	49	0
17	Harnet	29	0			21	0	22	0	23	0
9. Tiravolo											
21	Tiravolo	152	0			111	0	116	0	123	0
28	Denden Housing	333	0			243	0	255	0	269	0
30	Space 2000 - I	31	0			23	0	24	0	25	0
10. Geza banda											
12	Forobia	10	4			8	3	8	3	8	3
13	Mai Chehot	86	10			63	7	66	7	70	8
18	Addis Alem	150	0			110	0	115	0	122	0
19	Zeban Zinkei and Halibet Complex	414	2			303	1	317	2	336	2
11. Sembel											
32	Sembel Village + Sembel III	368	15			269	11	282	11	298	12
35	Sembel high rise A	206	4			151	3	158	3	167	3
12. Godaif											
22	Barijima	30	2			22	2	23	2	25	2
24	Kahawata	105	18			76	13	80	14	85	15
25	Dembe Sembel + Godaif II	36	0			26	0	28	0	29	0
27	Godaif + Godaif I	417	43			305	32	319	33	338	35
33	Kuteba + Gegeret II	18	7			13	5	14	5	15	6
13. Gejeret											
20	Gejeret Neishto	219	7			160	5	167	5	177	5
20	Algin Housing	380	0			278	0	291	0	308	0
23	Gejeret Abi	140	10			102	7	107	8	113	8
29	Gejeret I	0	0			0	0	0	0	0	0
Daero Paulos TD		37	42			27	30	28	32	30	34
	Total	**6,166**	**562**	**1,422**	**370**	**4,511**	**411**	**4,723**	**431**	**4,998**	**456**

Toker Station	**(4. Mai Temanai)**	**293**	**306**	**324**
Expo Station	**(22. Barijima)**	**119**	**124**	**132**

2015 Potential Domestic Demand

Pipe Supply Area (13 sub-Zoba and Daero Paulos)

No.	Area Name	FS Forcast for 2010	2008 Census	2015							2014 Potential Demand (HC)		2014 Potential Demand (WT)	
				Population (Census)	House connection		Tanker supply		Potential served population	%	Per Capita	Demand	Per Capita	Demand
					%	Population	%	Population			l/c/d	(m3/day)	l/c/d	(m3/day)
1. Paradiso		**34,062**	**29,442**	**32,457**										
8	Paradiso	18,721		17,839	90	16,055	10	1,784	17,839	100	62	995	15	27
38	Bet Mekae TD	12,150		11,577	0	0	70	8,104	8,104	70	50	0	15	122
45	Adi Abeito village and TD	3,191		3,041	0	0	60	1,824	1,824	60	43	0	15	27
2. Maitemenai		**30,419**	**24,482**	**24,257**										0
1	Mai Temenai	20,799		16,586	90	14,927	10	1,659	16,586	100	43	636	15	25
4	Mai Temenai TD	9,620		7,671	0	0	70	5,370	5,370	70	54	0	15	81
3. Edaga Hamus		**41,356**	**32,179**	**34,016**										0
2	Haz Haz	7,854		6,460	95	6,137	5	323	6,460	100	43	262	15	5
6	Idaga Hamus and Emba Galliano	33,502		27,556	95	26,178	5	1,378	27,556	100	47	1,217	15	21
4. Akiria		**37,547**	**51,182**	**55,057**										0
3	Mirham Chira and Acria	31,320		45,926	95	43,630	5	2,296	45,926	100	43	1,860	15	34
46	Adi Nefas village + TD	5,743		8,421	0	0	90	7,579	7,579	90	43	0	15	114
54	Mirham Chira extension	484		710	0	0	90	639	639	90	43	0	15	10
5. Abazhawl		**60,652**	**40,342**	**40,957**										0
5	Aba Shaul	60,652		40,957	95	38,909	5	2,048	40,957	100	43	1,659	15	31
6. Arbate Asmara		**34,666**	**35,197**	**34,484**										0
9	Medeber	2,425		2,412	95	2,292	5	121	2,412	100	54	124	15	2
10	Arbate Asmara	29,791		29,635	85	25,189	15	4,445	29,635	100	43	1,074	15	67
11	Geza Tanika	2,450		2,437	85	2,072	15	366	2,437	100	43	88	15	5
7. Tsetserat		**28,741**	**19,851**	**22,532**										0
26	Bet Mekae	5,273		4,134	85	3,514	15	620	4,134	100	50	177	15	9
31	Space 2000 - II	1,250		980	100	980			980	100	70	68		0
34	Tsetserat + Forto Complex	1,969		1,544	85	1,312	15	232	1,544	100	62	81	15	3
36	Tsetserat D2	359		281	85	239	15	42	281	100	62	15	15	1
37	Adi Segdo TD	12,870		10,090	0	0	100	10,090	10,090	100	50	0	15	151
43	Adi Segdo village	7,020		5,503	20	1,101	80	4,403	5,503	100	43	47	15	66
8. Maekel Ketema		**9,703**	**21,312**	**21,868**										0
14	Maekel Ketema North	3,311		7,462	100	7,462			7,462	100	62	463		0
15	Maekel Ketema West	2,470		5,567	100	5,567			5,567	100	62	345		0
16	Maekel Ketema South	2,671		6,020	100	6,020			6,020	100	62	373		0
17	Harnet	1,251		2,819	100	2,819			2,819	100	62	175		0
9. Tiravolo		**28,156**	**20,955**	**21,260**										0
21	Tiravolo	11,199		8,456	100	8,456			8,456	100	74	623		0
28	Denden Housing	15,707		11,860	Non Domestic	11,860			11,860		Non Domestic	0		0
30	Space 2000 - I	1,250		944	100	944			944	100	70	66		0
10. Geza banda		**36,528**	**36,306**	**36,092**										
12	Forobia	1,960		1,937	90	1,743	10	194	1,937	100	43	74	15	3
13	Mai Chehot	10,966		10,835	100	10,835		0	10,835	100	50	546	15	0
18	Addis Alem	15,094		14,914	100	14,914			14,914	100	54	809		0
19	Zeban Zinkei and Halibet Complex	8,508		8,406	100	8,406		0	8,406	100	54	456	15	0
11. Sembel		**22,533**	**16,861**	**20,076**										
32	Sembel Village + Sembel III	20,533		18,294	40	7,318	60	10,976	18,294	100	55	403	15	165
35	Sembel high rise A	2,000		1,782	100	1,782	0	0	1,782	100	62	110	15	0
12. Godaif		**49,576**	**43,280**	**44,645**										
22	Barijima	3,680		3,314	90	2,983	10	331	3,314	100	50	150	15	5
24	Kahawata	15,284		13,764	85	11,699	15	2,065	13,764	100	47	544	15	31
25	Dembe Sembel + Godaif II	3,921		3,531	100	3,531			3,531	100	50	178		0
27	Godaif + Godaif I	24,097		21,700	85	18,445	15	3,255	21,700	100	50	929	15	49
33	Kuteba + Gegeret II	2,594		2,336	85	1,986	15	350	2,336	100	50	100	15	5
13. Gejeret		**41,716**	**39,487**	**39,728**										
20	Gejeret Neishto	21,487		20,463	90	18,417	10	2,046	20,463	100	58	1,070	15	31
20	Algin Housing	3,491		3,325	Non Domestic	3,325			3,325		Non Domestic	0		0
23	Gejeret Abi	16,738		15,940	80	12,752	20	3,188	15,940	100	50	642	15	48
29	Gejeret I	0		0	50	0	50	0	0	100	47	0	15	0
Daero Paulos TD		**11,944**	**6,650**	**6,900**	70	4,830	30	2,070	6,900	100	43	206	15	31
		467,599	**417,526**	**434,329**		**348,628**		**77,797**	**426,425**		**50**	**17,325**	**15**	**1,167**
				1.0057		**80%**		**18%**	**98%**			**16,566**	**Toker Station**	**800** (4. Mai Temanai)
				96,001	SV系統	79,319	77,336	15,769					**Expo Station**	**367** (22. Barijima)
				185,768	TK系統	141,031	137,505	37,747						
				152,560	MN系統	128,277	125,071	24,282						

Tanker Supply Area (Outer villages)

No.	Village name	2004 Census	2008 Census	2015							2014 Potential Demand (HC)		2014 Potential Demand (WT)	
				Estimated Population	House connection		Tanker supply		Potential served population	%	Per Capita	Demand	Per Capita	Demand
					%	Population	%	Population			l/c/d	(m3/day)	l/c/d	(m3/day)
i	Adi Guadad	8,098	11,289	11,700			60	7,020	7,020	60			15	105
ii	Adi Ke	1,634	4,732	4,900			60	2,940	2,940	60			15	44
iii	Merhano	1,611		2,300			60	1,380	1,380	60			15	21
iv	Tselot	2,106	3,231	3,400			60	2,040	2,040	60			15	31
v	Kushet	5,893		8,500			60	5,100	5,100	60			15	77
vi	Tsaeda Emba	1,162		1,700			60	1,020	1,020	60			15	15
vii	Tsaedacristian	5,701		8,200			60	4,920	4,920	60			15	74
viii	Unagudo	170		200			60	120	120	60			15	2
ix	Wekiduba	2,366		3,400			60	2,040	2,040	60			15	31
				44,300		**0**		**26,580**	**26,580**					**399**
									60%				**Toker Station**	**31** (4. Mai Temanai)
													Expo Station	**368** (22. Barijima)

2020 Domestic Demand Projection
Pipe Supply Area (13 sub-Zoba and Daero Paulos)

No.	Area Name	2008 Census	2015 Census	2020 Projected Population	House connection %	House connection Population	Tanker supply %	Tanker supply Population	Expected served population	%	2020 Demand (HC) Per Capita l/c/d	2020 Demand (HC) Demand (m3/day)	2020 Demand (WT) Per Capita l/c/d	2020 Demand (WT) Demand (m3/day)
1. Paradiso		**29,442**	**32,457**	**33,385**										
8	Paradiso		17,839	18,349	90	16,514	10	1,835	18,349	100	62	1,024	15	
38	Bet Mekae TD		11,577	11,908	3	357	70	8,336	8,693	73	50	18	15	125
45	Adi Abeito village and TD		3,041	3,128	3	94	60	1,877	1,970	63	43	4	15	28
2. Maitemenai		**24,482**	**24,257**	**24,950**										
1	Mai Temenai		16,586	17,060	90	15,354	10	1,706	17,060	100	43	654	15	26
4	Mai Temenai TD		7,671	7,891	3	237	70	5,523	5,760	73	54	13	15	83
3. Edaga Hamus		**32,179**	**34,016**	**34,988**										
2	Haz Haz		6,460	6,645	95	6,312	5	332	6,645	100	43	269	15	5
6	Idaga Hamus and Emba Galliano		27,556	28,344	95	26,926	5	1,417	28,344	100	47	1,252	15	21
4. Akiria		**51,182**	**55,057**	**56,631**										
3	Mirham Chira and Acria		45,926	47,239	95	44,877	5	2,362	47,239	100	43	1,913	15	35
46	Adi Nefas village + TD		8,421	8,662	3	260	90	7,796	8,056	93	43	11	15	117
54	Mirham Chira extension		710	730	3	22	90	657	679	93	43	1	15	10
5. Abazhawl		**40,342**	**40,957**	**42,128**										
5	Aba Shaul		41,000	42,128	95	40,021	5	2,106	42,128	100	43	1,706	15	32
6. Arbate Asmara		**35,197**	**34,484**	**35,470**										
9	Medeber		2,412	2,481	95	2,357	5	124	2,481	100	54	128	15	2
10	Arbate Asmara		29,635	30,482	85	25,909	15	4,572	30,482	100	43	1,104	15	69
11	Geza Tanika		2,437	2,507	85	2,131	15	376	2,507	100	43	91	15	6
7. Tsetserat		**19,851**	**22,532**	**23,176**										
26	Bet Mekae		4,134	4,252	85	3,614	15	638	4,252	100	50	182	15	10
31	Space 2000 - II		980	1,008	100	1,008			1,008	100	70	70		0
34	Tsetserat + Forto Complex		1,544	1,588	85	1,350	15	238	1,588	100	62	84	15	4
36	Tsetserat D2		281	289	85	246	15	43	289	100	62	15	15	1
37	Adi Segdo TD		10,090	10,378	30	3,113	70	7,265	10,378	100	50	157	15	109
43	Adi Segdo village		5,503	5,661	20	1,132	80	4,529	5,661	100	43	48	15	68
8. Maekel Ketema		**21,312**	**21,868**	**22,493**										
14	Maekel Ketema North		7,462	7,675	100	7,675			7,675	100	62	476		0
15	Maekel Ketema West		5,567	5,726	100	5,726			5,726	100	62	355		0
16	Maekel Ketema South		6,020	6,192	100	6,192			6,192	100	62	384		0
17	Harnet		2,819	2,900	100	2,900			2,900	100	62	180		0
9. Tiravolo		**20,955**	**21,260**	**21,868**										
21	Tiravolo		8,456	8,698	100	8,698			8,698	100	74	640		0
28	Denden Housing		11,860	12,199	Non Domestic	12,199			12,199		Non Domestic	0		0
30	Space 2000 - I		944	971	100	971			971	100	70	68		0
10. Geza banda		**36,306**	**36,092**	**37,124**										
12	Forobia		1,937	1,992	90	1,793	10	199	1,992	100	43	76	15	3
13	Mai Chehot		10,835	11,145	100	11,145		0	11,145	100	50	561	15	0
18	Addis Alem		14,914	15,340	100	15,340			15,340	100	54	832		0
19	Zeban Zinkei and Halibet Complex		8,406	8,647	100	8,647		0	8,647	100	54	469	15	0
11. Sembel		**16,861**	**20,076**	**20,650**										
32	Sembel Village + Sembel III		18,294	18,817	50	9,408	50	9,408	18,817	100	55	518	15	141
35	Sembel high rise A		1,782	1,833	100	1,833	0	0	1,833	100	62	114	15	0
12. Godaif		**43,280**	**44,645**	**45,921**										
22	Barijima		3,314	3,409	90	3,068	10	341	3,409	100	50	155	15	5
24	Kahawata		13,764	14,157	85	12,034	15	2,124	14,157	100	47	560	15	32
25	Dembe Sembel + Godaif II		3,531	3,632	100	3,632			3,632	100	50	183		0
27	Godaif + Godaif I		21,700	22,320	85	18,972	15	3,348	22,320	100	50	956	15	50
33	Kuteba + Gegeret II		2,336	2,403	85	2,042	15	360	2,403	100	50	103	15	5
13. Gejeret		**39,487**	**39,728**	**40,864**										
20	Gejeret Neishto		20,463	21,048	90	18,943	10	2,105	21,048	100	58	1,101	15	32
20	Algin Housing		3,325	3,420	Non Domestic	3,420					Non Domestic	0		0
23	Gejeret Abi		15,940	16,396	80	13,117	20	3,279	16,396	100	50	661	15	49
29	Gejeret I		0	0	50	0	50	0	0	100	47	0	15	0
Daero Paulos TD		**6,650**	**6,900**	**7,097**	70	4,968	30	2,129	7,097	100	43	212	15	32
		417,526	**434,329**	**446,744**		**364,557**		**75,026**	**439,583**		**50**	**18,128**		**1,098**
			1.0057			**82%**		**17%**	**98%**			**17,347**	**Toker Station**	**748** (4. Mai Temanai)
				98,745	SV系統	81,868		16,219					**Expo Station**	**349** (22. Barijima)
				191,078	TK系統	148,863		35,712						
				156,920	MN系統	133,826		23,095						
						364,557		75,026						

Tanker Supply Area (Outer villages)

No.	Village name	2008 Census	2015 Census	2020 Projected Population	House connection %	House connection Population	Tanker supply %	Tanker supply Population	Expected served population	%	2020 Demand (HC) Per Capita l/c/d	2020 Demand (HC) Demand (m3/day)	2020 Demand (WT) Per Capita l/c/d	2020 Demand (WT) Demand (m3/day)
i	Adi Guadad	11,289	11,700	12,034			60	7,221	7,221	60			15	108
ii	Adi Ke	4,732	4,900	5,040			60	3,024	3,024	60			15	45
iii	Merhano		2,300	2,366			60	1,419	1,419	60			15	21
iv	Tselot	3,231	3,400	3,497			60	2,098	2,098	60			15	31
v	Kushet		8,500	8,743			60	5,246	5,246	60			15	79
vi	Tsaeda Emba		1,700	1,749			60	1,049	1,049	60			15	16
vii	Tsaedacristian		8,200	8,434			60	5,061	5,061	60			15	76
viii	Unagudo		200	206			60	123	123	60			15	2
ix	Wekiduba		3,400	3,497			60	2,098	2,098	60			15	31
			44,300	**45,566**		**0**		**27,340**	**27,340**					**410**
				1.0057					**60%**				**Toker Station**	**31** (4. Mai Temanai)
													Expo Station	**379** (22. Barijima)

2025 Domestic Demand Projection
Pipe Supply Area (13 sub-Zoba and Daero Paulos)

No.	Area Name	2015 Census	2020 Projection	2025							2025 Demand (HC)		2025 Demand (WT)	
				Projected Population	House connection		Tanker supply		Expected served population	%	Per Capita	Demand	Per Capita	Demand
					%	Population	%	Population			l/c/d	(m3/day)	l/c/d	(m3/day)
1. Paradiso		**32,457**	**33,385**	**34,339**										
8	Paradiso	17,839	18,349	18,873	90	16,986	10		16,986	100	62	1,053		
38	Bet Mekae TD	11,577	11,908	12,249	6	735	70	8,574	9,309	76	50	37	15	129
45	Adi Abeito village and TD	3,041	3,128	3,217	6	193	60	1,930	2,123	66	43	8	15	29
2. Maitemenai		**24,257**	**24,950**	**25,664**										
1	Mai Temenai	16,586	17,060	17,547	90	15,793	10	1,755	17,547	100	43	673	15	26
4	Mai Temenai TD	7,671	7,891	8,116	6	487	70	5,681	6,168	76	54	26	15	85
3. Edaga Hamus		**34,016**	**34,988**	**35,988**										
2	Haz Haz	6,460	6,645	6,835	100	6,835	0	0	6,835	100	43	291	15	0
6	Idaga Hamus and Emba Galliano	27,556	28,344	29,154	95	27,696	5	1,458	29,154	100	47	1,288	15	22
4. Akiria		**55,057**	**56,631**	**58,249**										
3	Mirham Chira and Acria	45,926	47,239	48,589	100	48,589	0	0	48,589	100	43	2,071	15	0
46	Adi Nefas village + TD	8,421	8,662	8,910	10	891	90	8,019	8,910	100	43	38	15	120
54	Mirham Chira extension	710	730	751	10	75	90	676	751	100	43	3	15	10
5. Abazhawl		**40,957**	**42,128**	**43,332**										
5	Aba Shaul	41,000	42,128	43,332	95	41,165	5	2,167	43,332	100	43	1,755	15	32
6. Arbate Asmara		**34,484**	**35,470**	**36,484**										
9	Medeber	2,412	2,481	2,552	100	2,552	0	0	2,552	100	54	138	15	0
10	Arbate Asmara	29,635	30,482	31,353	100	31,353	0	0	31,353	100	43	1,336	15	0
11	Geza Tanika	2,437	2,507	2,578	100	2,578	0	0	2,578	100	43	110	15	0
7. Tsetserat		**22,532**	**23,176**	**23,838**										
26	Bet Mekae	4,134	4,252	4,374	85	3,718	15	656	4,374	100	50	187	15	10
31	Space 2000 - II	980	1,008	1,037	100	1,037			1,037	100	70	72		0
34	Tsetserat + Forto Complex	1,544	1,588	1,633	85	1,388	15	245	1,633	100	62	86	15	4
36	Tsetserat D2	281	289	298	85	253	15	45	298	100	62	16	15	1
37	Adi Segdo TD	10,090	10,378	10,675	30	3,202	70	7,472	10,675	100	50	161	15	112
43	Adi Segdo village	5,503	5,661	5,823	20	1,165	80	4,658	5,823	100	43	50	15	70
8. Maekel Ketema		**21,868**	**22,493**	**23,136**										
14	Maekel Ketema North	7,462	7,675	7,895	100	7,895			7,895	100	62	489		0
15	Maekel Ketema West	5,567	5,726	5,890	100	5,890			5,890	100	62	365		0
16	Maekel Ketema South	6,020	6,192	6,369	100	6,369			6,369	100	62	395		0
17	Harnet	2,819	2,900	2,983	100	2,983			2,983	100	62	185		0
9. Tiravolo		**21,260**	**21,868**	**22,493**										
21	Tiravolo	8,456	8,698	8,946	100	8,946			8,946	100	74	659		0
28	Denden Housing	11,860	12,199	12,548	Non Domestic	12,548			12,548		Non Domestic	0		0
30	Space 2000 - I	944	971	999	100	999			999	100	70	70		0
10. Geza banda		**36,092**	**37,124**	**38,185**										
12	Forobia	1,937	1,992	2,049	90	1,844	10	205	2,049	100	43	79	15	3
13	Mai Chehot	10,835	11,145	11,463	100	11,463			11,463	100	50	577		0
18	Addis Alem	14,914	15,340	15,779	100	15,779			15,779	100	54	856		0
19	Zeban Zinkei and Halibet Complex	8,406	8,647	8,894	100	8,894			8,894	100	54	482		0
11. Sembel		**20,076**	**20,650**	**21,240**										
32	Sembel Village + Sembel III	18,294	18,817	19,355	60	11,613	40	7,742	19,355	100	55	639	15	116
35	Sembel high rise A	1,782	1,833	1,885	100	1,885	0	0	1,885	100	62	117	15	0
12. Godaif		**44,645**	**45,921**	**47,234**										
22	Barijima	3,314	3,409	3,506	90	3,156	10	351	3,506	100	50	159	15	5
24	Kahawata	13,764	14,157	14,562	85	12,378	15	2,184	14,562	100	47	576	15	33
25	Dembe Sembel + Godaif II	3,531	3,632	3,736	100	3,736			3,736	100	50	188		0
27	Godaif + Godaif I	21,700	22,320	22,958	85	19,515	15	3,444	22,958	100	50	983	15	52
33	Kuteba + Gegeret II	2,336	2,403	2,471	85	2,101	15	371	2,471	100	50	106	15	6
13. Gejeret		**39,728**	**40,864**	**42,032**										
20	Gejeret Neishto	20,463	21,048	21,650	90	19,485	10	2,165	21,650	100	58	1,133	15	32
20	Algin Housing	3,325	3,420	3,517	Non Domestic	3,517					Non Domestic	0		0
23	Gejeret Abi	15,940	16,396	16,865	80	13,492	20	3,373	16,865	100	50	680	15	51
29	Gejeret I	0	0	0	50	0	50	0	0	100	47	0	15	0
Daero Paulos TD		**6,900**	**7,097**	**7,300**	70	5110.061598	30	2,190	7,300	100	43	218	15	33
		434,329	**446,744**	**459,513**		**386,285**		**65,359**	**451,644**		**50**	**19,159**		**980**
			1.0057			**84%**		**14%**	**98%**			**18,356**	**Toker Station**	**650** (4. Mai Temanai)
				101,568	SV系統	92,873		8,694					**Expo Station**	**330** (22. Barijima)
				196,540	TK系統	153,826		34,845						
				161,406	MN系統	139,586		21,819						
						386,285		65,359						

Tanker Supply Area (Outer villages)

No.	Village name	2015 Estimate	2020 Projection	2025							2025 Demand (HC)		2025 Demand (WT)	
				Population	House connection		Tanker supply		Expected served population	%	Per Capita	Demand	Per Capita	Demand
					%	Population	%	Population			l/c/d	(m3/day)	l/c/d	(m3/day)
i	Adi Guadad	11,700	12,034	12,378			60	7,427	7,427	60			15	111
ii	Adi Ke	4,900	5,040	5,184			60	3,110	3,110	60			15	47
iii	Merhano	2,300	2,366	2,433			60	1,460	1,460	60			15	22
iv	Tselot	3,400	3,497	3,597			60	2,158	2,158	60			15	32
v	Kushet	8,500	8,743	8,993			60	5,396	5,396	60			15	81
vi	Tsaeda Emba	1,700	1,749	1,799			60	1,079	1,079	60			15	16
vii	Tsaedacristian	8,200	8,434	8,675			60	5,205	5,205	60			15	78
viii	Unagudo	200	206	212			60	127	127	60			15	2
ix	Wekiduba	3,400	3,497	3,597			60	2,158	2,158	60			15	32
		44,300	**45,566**	**46,869**		**0**		**28,121**	**28,121**					**422**
			1.0057						**60%**				**Toker Station**	**32** (4. Mai Temanai)
													Expo Station	**389** (22. Barijima)

Present Condition of AWSD

Population in Service Area	**Number**	**434,329**	=434,329+6,900
Estiated Served population			
1) By connection	Number	339,472	=409,329-69,857
2) By water tanker (Asmara city) (estimated by billed volume)	Number	69,857	=339,971x (3/4) x1000/ 365/10
1) + 2)		409,329	=434,329 - 25,000 (Estimated)
3) By water tanker (Outer village) (estimated by billed volume)	Number	23,286	=339,971 x (1/4) x 1000/ 365/10
Number of connection	**Number**	**35,483**	
Domestic	Number	29,722	
Non domestic	Number	5,761	
Billed volume	**m3/year**	**2,611,509**	
	m3/day	**7,155**	
By connection (Domestic)	m3/year	1,552,317	
	m3/day	4,253	
By conncection (Non domestic)	m3/year	519,144	
	m3/day	1,422	
By water tanker (Domestic)	m3/year	339,971	
	m3/day	931	
By water tanker (Non domestic)	m3/year	200,077	
	m3/day	548	
Production Volume	**m3/year**	**6,659,541**	
	m3/day	**18,245**	
Stretta Vaudetto WTP	m3/year	756,575	
	m3/day	2,073	
Toker WTP	m3/year	2,740,396	
	m3/day	7,508	
Mai Nefhi WTP	m3/year	3,162,570	
	m3/day	8,665	

Population of AWSD Piped Service Area

Sub-Zoba	2008 Census	2015 Census	Annual growth rate
1. Paradiso	29,442	32,457	1.0140
2. Maitemenai	24,482	24,257	0.9987
3. Edaga Hamus	32,179	34,016	1.0080
4. Akiria	51,182	55,057	1.0105
5. Abazhawl	40,342	40,957	1.0022
6. Arbate Asmara	35,197	34,484	0.9971
7. Tsetserat	19,851	22,532	1.0183
8. Maekel Ketema	21,312	21,868	1.0037
9. Tiravolo	20,955	21,260	1.0021
10. Geza banda	36,306	36,092	0.9992
11. Sembel	16,861	20,076	1.0252
12. Godaif	43,280	44,645	1.0044
13. Gejeret	39,487	39,728	1.0009
Daero Paulos TD	6,650	6,900	1.0053
	417,526	**434,329**	**1.0057**

2025 Demand Projection　Demand Distribution to EPANET nodes

ID	Area	Average demand per area		74.7 189.9 164.5																7.6 1.9							
		m3/day	l/s		3	4	5	7	9	10	11	12	13	14	15	16	17	19	20	22	23	24	25	29	30	31	32	33	34
	Total	**37,076**	**429.1**		**18.6**	**27.7**	**6.3**	**6.3**	**2.3**	**19.8**	**1.7**	**0.7**	**7.6**	**7.6**	**1.7**	**24.2**	**6.3**	**0.0**	**6.3**	**1.9**	**2.8**	**9.5**	**3.8**	**2.4**	**0.9**	**0.9**	**2.8**	**4.6**	**0.4**
1	Mai Temenai	1,708	19.8	100% N10	0.0	0.0	0.0	0.0	0.0	19.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Haz Haz	486	5.6	40% N9 + 30% N11 + 30% N15	0.0	0.0	0.0	0.0	2.3	0.0	1.7	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	Mirham Chira and Acria	3,274	37.9	20% N13 + 20% N14 + 10% N25 + 50% N141	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6	7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0
4	Mai Temenai D (I and II) + Mai Hutsa B	1,609	18.6	100% N3	18.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	Aba Shaul	2,988	34.6	70% N16 + 30% N143	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	Idaga Hamus and Emba Galliano	2,184	25.3	25% N5 + 25% N7 + 25% N17 + 25% N20	0.0	0.0	6.3	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	0.0	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	LC1 Paradiso extension		0.0	100% N3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	Paradiso	2,397	27.7	100% N4	0.0	27.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	Medeber	229	2.6	100% N143	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	Arbate Asmara	2,202	25.5	30% N24 + 20% N48 + 30% N65 + 20% N142	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	Geza Tanika	177	2.1	50% N48 + 50% N65	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	Forobia	128	1.5	70% N65 + 30% N133	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	Mai Chehot	952	11.0	25% N77 + 75% N78	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	Maekel Ketema North	809	9.4	20% N22 + 30% N23 + 20% N24 + 30% N32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	2.8	1.9	0.0	0.0	0.0	0.0	2.8	0.0	0.0
15	Maekel Ketema West	672	7.8	30% N33 + 30% N40 + 40% N89	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0
16	Maekel Ketema South	653	7.6	20% N29 + 30% N36 + 30% N39 + 20% N40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0
17	Harnet	306	3.5	25% N29 + 25% N30 + 25% N31 + 25% N101	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.9	0.9	0.0	0.0	0.0
18	Addis Alem	1,438	16.6	50% N52 + 50% N77	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	Zeban Zinkei and Halibet Complex	1,203	13.9	100% N51	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	Gejeret Neishto	1,926	22.3	30% N39 +20% N40 + 30% N41 + 20% N79	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	Algin Housing	453	5.2	100% N150	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	Tiravolo	1,150	13.3	40% N42 + 60% N43	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	Barijima	1,522	17.6	100% N81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	Gejeret Abi	1,166	13.5	25% N80 + 25% N81 + 25% N83 + 25% N84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	Kahawata	971	11.2	50% N73 + 50% N85	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	Dembe Sembel + Godaif II	320	3.7	100% N71	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	Bet Mekae	327	3.8	60% N33 + 40% N89	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0
27	Godaif + Godaif I	1,943	22.5	30% N82 + 30% N88 + 40% N105	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	Denden Housing	396	4.6	100% N150	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	Gejeret I	0	0.0	100% N73	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	Space 2000 - I	140	1.6	50% N92 + 50% N94	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	Space 2000 - II	106	1.2	20% N92 + 80% N94	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	Sembel Village + Sembel III	1,378	15.9	40% N115 + 20% N116 + 40% N117	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	Kuteba + Gegeret II	177	2.1	100% N88	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	Tsetserat + Forto Complex	151	1.8	20% N34 + 10% N45 + 50% N101 + 20% N120	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
35	Sembel high rise A (MD)	418	4.8	100% N44	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	Tsetserat D2	26	0.3	100% N120	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	Adi Segdo TD	339	3.9	30% N109 + 40% N110 + 30% N111	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
38	Bet Mekae TD	128	1.5	50% N12 + 50% N147	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39	Merhano Village + TD + extensions		0.0	100% N72	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40	Adi Guada, Adi Ke village + TD + ext.		0.0	100% N72	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	Tsaeda Cristian Village + TD		0.0	100% N148	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42	Tsaeda Emba		0.0	100% N148	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43	Adi Segdo Village	99	1.1	100% N148	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	Woki Diba Village + TD		0.0	100% N19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	Adi Abeito Village + TD	72	0.8	100% N146	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	Adi Nfas Village + TD	83	1.0	100% N127	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	Tselot +TD		0.0	100% N149	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	Kushet Village + TD + extension		0.0	100% N148	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	Daero Paulos + TD	364	4.2	100% N72	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	Arbaete Asmara I		0.0	100% N84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51	Arbaete Asmara II and III		0.0	100% N47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52	Arbaete Asmara IV		0.0	100% N84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
53	Haz Haz extension		0.0	100% N11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
54	Mihram Chira Extension	5	0.1	100% N14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	LC2 Acria extension		0.0	100% N25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
56	Sembel IV		0.0	100% N56	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
57	Paradiso extension		0.0	100% N3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

2025 Demand Projection　Demand Distribution to EPANET nodes

ID	Area	Average demand per area		74.7													8.7											
				189.9													1.0											
		m3/day	l/s	164.5	36	39	40	41	42	43	44	45	47	48	51	52	56	65	71	72	73	77	78	79	80	81	82	83	84
	Total	**37,076**	**429.1**		**2.3**	**9.0**	**8.3**	**6.7**	**5.3**	**8.0**	**4.8**	**0.2**	**0.0**	**6.1**	**13.9**	**8.3**	**0.0**	**9.7**	**3.7**	**4.2**	**5.6**	**11.1**	**8.3**	**4.5**	**3.4**	**21.0**	**6.7**	**3.4**	**3.4**
1	Mai Temenai	1,708	19.8	100% N10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Haz Haz	486	5.6	40% N9 + 30% N11 + 30% N15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	Mirham Chira and Acria	3,274	37.9	20% N13 + 20% N14 + 10% N25 + 50% N141	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	Mai Temenai D (I and II) + Mai Hutsa B	1,609	18.6	100% N3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	Aba Shaul	2,988	34.6	70% N16 + 30% N143	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	Idaga Hamus and Emba Galliano	2,184	25.3	25% N5 + 25% N7 + 25% N17 + 25% N20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	LC1 Paradiso extension		0.0	100% N3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	Paradiso	2,397	27.7	100% N4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	Medeber	229	2.6	100% N143	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	Arbate Asmara	2,202	25.5	30% N24 + 20% N48 + 30% N65 + 20% N142	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.1	0.0	0.0	0.0	7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	Geza Tanika	177	2.1	50% N48 + 50% N65	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	Forobia	128	1.5	70% N65 + 30% N133	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	Mai Chehot	952	11.0	25% N77 + 75% N78	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	8.3	0.0	0.0	0.0	0.0	0.0	0.0
14	Maekel Ketema North	809	9.4	20% N22 + 30% N23 + 20% N24 + 30% N32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	Maekel Ketema West	672	7.8	30% N33 + 30% N40 + 40% N89	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	Maekel Ketema South	653	7.6	20% N29 + 30% N36 + 30% N39 + 20% N40	2.3	2.3	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	Harnet	306	3.5	25% N29 + 25% N30 + 25% N31 + 25% N101	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	Addis Alem	1,438	16.6	50% N52 + 50% N77	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	Zeban Zinkei and Halibet Complex	1,203	13.9	100% N51	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	Gejeret Neishto	1,926	22.3	30% N39 +20% N40 + 30% N41 + 20% N79	0.0	6.7	4.5	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0	0.0
20	Algin Housing	453	5.2	100% N150	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	Tiravolo	1,150	13.3	40% N42 + 60% N43	0.0	0.0	0.0	0.0	5.3	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	Barijima	1,522	17.6	100% N81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.6	0.0	0.0	0.0
23	Gejeret Abi	1,166	13.5	25% N80 + 25% N81 + 25% N83 + 25% N84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4	3.4	0.0	3.4	3.4
24	Kahawata	971	11.2	50% N73 + 50% N85	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	Dembe Sembel + Godaif II	320	3.7	100% N71	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	Bet Mekae	327	3.8	60% N33 + 40% N89	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	Godaif + Godaif I	1,943	22.5	30% N82 + 30% N88 + 40% N105	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0
28	Denden Housing	396	4.6	100% N150	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	Gejeret I	0	0.0	100% N73	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	Space 2000 - I	140	1.6	50% N92 + 50% N94	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	Space 2000 - II	106	1.2	20% N92 + 80% N94	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	Sembel Village + Sembel III	1,378	15.9	40% N115 + 20% N116 + 40% N117	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	Kuteba + Gegeret II	177	2.1	100% N88	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	Tsetserat + Forto Complex	151	1.8	20% N34 + 10% N45 + 50% N101 + 20% N120	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	Sembel high rise A (MD)	418	4.8	100% N44	0.0	0.0	0.0	0.0	0.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	Tsetserat D2	26	0.3	100% N120	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	Adi Segdo TD	339	3.9	30% N109 + 40% N110 + 30% N111	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
38	Bet Mekae TD	128	1.5	50% N12 + 50% N147	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39	Merhano Village + TD + extensions		0.0	100% N72	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40	Adi Guada, Adi Ke village + TD + ext.		0.0	100% N72	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	Tsaeda Cristian Village + TD		0.0	100% N148	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42	Tsaeda Emba		0.0	100% N148	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43	Adi Segdo Village	99	1.1	100% N148	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	Woki Diba Village + TD		0.0	100% N19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	Adi Abeito Village + TD	72	0.8	100% N146	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	Adi Nfas Village + TD	83	1.0	100% N127	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	Tselot +TD		0.0	100% N149	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	Kushet Village + TD + extension		0.0	100% N148	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	Daero Paulos + TD	364	4.2	100% N72	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	Arbaete Asmara I		0.0	100% N84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51	Arbaete Asmara II and III		0.0	100% N47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52	Arbaete Asmara IV		0.0	100% N84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
53	Haz Haz extension		0.0	100% N11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
54	Mihram Chira Extension	5	0.1	100% N14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	LC2 Acria extension		0.0	100% N25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
56	Sembel IV		0.0	100% N56	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
57	Paradiso extension		0.0	100% N3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

2025 Demand Projection　Demand Distribution to EPANET nodes

ID	Area	Average demand per area		74.7 / 189.9 / 164.5																		2.6 / 10.4						
		m3/day	l/s		85	88	89	92	94	101	105	109	110	111	115	116	117	120	127	133	141	142	143	146	147	148	149	150	Total
	Total	**37,076**	**429.1**		**5.6**	**8.8**	**4.6**	**1.1**	**1.8**	**1.8**	**9.0**	**1.2**	**1.6**	**1.2**	**6.4**	**3.2**	**6.4**	**0.7**	**1.0**	**0.4**	**18.9**	**5.1**	**13.0**	**0.8**	**0.7**	**1.1**	**0.0**	**9.8**	**429.1**
1	Mai Temenai	1,708	19.8	100% N10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.8
2	Haz Haz	486	5.6	40% N9 + 30% N11 + 30% N15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6
3	Mirham Chira and Acria	3,274	37.9	20% N13 + 20% N14 + 10% N25 + 50% N141	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.9
4	Mai Temenai D (I and II) + Mai Hutsa B	1,609	18.6	100% N3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.6
5	Aba Shaul	2,988	34.6	70% N16 + 30% N143	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.4	0.0	0.0	0.0	0.0	0.0	34.6
6	Idaga Hamus and Emba Galliano	2,184	25.3	25% N5 + 25% N7 + 25% N17 + 25% N20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.3
7	LC1 Paradiso extension		0.0	100% N3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	Paradiso	2,397	27.7	100% N4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.7
9	Medeber	229	2.6	100% N143	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	2.6
10	Arbate Asmara	2,202	25.5	30% N24 + 20% N48 + 30% N65 + 20% N142	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0	25.5
11	Geza Tanika	177	2.1	50% N48 + 50% N65	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1
12	Forobia	128	1.5	70% N65 + 30% N133	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
13	Mai Chehot	952	11.0	25% N77 + 75% N78	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.0
14	Maekel Ketema North	809	9.4	20% N22 + 30% N23 + 20% N24 + 30% N32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.4
15	Maekel Ketema West	672	7.8	30% N33 + 30% N40 + 40% N89	0.0	0.0	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8
16	Maekel Ketema South	653	7.6	20% N29 + 30% N36 + 30% N39 + 20% N40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6
17	Harnet	306	3.5	25% N29 + 25% N30 + 25% N31 + 25% N101	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5
18	Addis Alem	1,438	16.6	50% N52 + 50% N77	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.6
19	Zeban Zinkei and Halibet Complex	1,203	13.9	100% N51	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.9
20	Gejeret Neishto	1,926	22.3	30% N39 +20% N40 + 30% N41 + 20% N79	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.3
20	Algin Housing	453	5.2	100% N150	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	5.2
21	Tiravolo	1,150	13.3	40% N42 + 60% N43	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.3
22	Barijima	1,522	17.6	100% N81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.6
23	Gejeret Abi	1,166	13.5	25% N80 + 25% N81 + 25% N83 + 25% N84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.5
24	Kahawata	971	11.2	50% N73 + 50% N85	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.2
25	Dembe Sembel + Godaif II	320	3.7	100% N71	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7
26	Bet Mekae	327	3.8	60% N33 + 40% N89	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8
27	Godaif + Godaif I	1,943	22.5	30% N82 + 30% N88 + 40% N105	0.0	6.7	0.0	0.0	0.0	0.0	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.5
28	Denden Housing	396	4.6	100% N150	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.6	4.6
29	Gejeret I	0	0.0	100% N73	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	Space 2000 - I	140	1.6	50% N92 + 50% N94	0.0	0.0	0.0	0.8	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6
31	Space 2000 - II	106	1.2	20% N92 + 80% N94	0.0	0.0	0.0	0.2	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2
32	Sembel Village + Sembel III	1,378	15.9	40% N115 + 20% N116 + 40% N117	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.4	3.2	6.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.9
33	Kuteba + Gegeret II	177	2.1	100% N88	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1
34	Tsetserat + Forto Complex	151	1.8	20% N34 + 10% N45 + 50% N101 + 20% N120	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8
35	Sembel high rise A (MD)	418	4.8	100% N44	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8
36	Tsetserat D2	26	0.3	100% N120	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
37	Adi Segdo TD	339	3.9	30% N109 + 40% N110 + 30% N111	0.0	0.0	0.0	0.0	0.0	0.0	1.2	1.6	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9
38	Bet Mekae TD	128	1.5	50% N12 + 50% N147	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	1.5
39	Merhano Village + TD + extensions		0.0	100% N72	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40	Adi Guada, Adi Ke village + TD + ext.		0.0	100% N72	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	Tsaeda Cristian Village + TD		0.0	100% N148	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42	Tsaeda Emba		0.0	100% N148	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43	Adi Segdo Village	99	1.1	100% N148	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	1.1
44	Woki Diba Village + TD		0.0	100% N19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	Adi Abeito Village + TD	72	0.8	100% N146	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.8
46	Adi Nfas Village + TD	83	1.0	100% N127	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
47	Tselot +TD		0.0	100% N149	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	Kushet Village + TD + extension		0.0	100% N148	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	Daero Paulos + TD	364	4.2	100% N72	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
50	Arbaete Asmara I		0.0	100% N84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51	Arbaete Asmara II and III		0.0	100% N47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52	Arbaete Asmara IV		0.0	100% N84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
53	Haz Haz extension		0.0	100% N11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
54	Mihram Chira Extension	5	0.1	100% N14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
55	LC2 Acria extension		0.0	100% N25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
56	Sembel IV		0.0	100% N56	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
57	Paradiso extension		0.0	100% N3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

付属資料 4.

7) 管網解析結果

2025 Demand

Network Table - Nodes at 8:00 Hrs

Node ID	Elevation m	Base Demand LPS	Demand LPS	Head m	Pressure m
Junc 3	2340	18.6	33.48	2365.49	25.49
Junc 4	2330	27.7	36.01	2360.89	30.89
Junc 5	2323	6.3	8.19	2360.07	37.07
Junc 6	2335	0	0.00	2360.75	25.75
Junc 7	2335	6.3	8.19	2360.73	25.73
Junc 8	2341	0	0.00	2419.09	78.09
Junc 9	2362	2.3	2.99	2412.88	50.88
Junc 10	2342	19.8	25.74	2361.48	19.48
Junc 11	2365	1.7	2.21	2408.24	43.24
Junc 13	2358	7.6	9.88	2402.70	44.70
Junc 14	2350	7.6	9.88	2400.11	50.11
Junc 15	2335	1.7	2.21	2400.06	65.06
Junc 16b	2330	0	0.00	2356.59	26.59
Junc 17	2334	6.3	8.19	2360.00	26.00
Junc 18	2335	0	0.00	2360.23	25.23
Junc 20	2326	6.3	8.19	2359.90	33.90
Junc 21	2326	0	0.00	2359.83	33.83
Junc 22	2326	1.9	2.47	2359.78	33.78
Junc 23	2333	2.8	3.64	2358.04	25.04
Junc 24	2345	1.9	2.47	2358.00	13.00
Junc 25	2356	3.8	4.94	2398.37	42.37
Junc 26	2395	0	0.00	2398.43	3.43
Junc 29	2336	2.4	3.12	2359.61	23.61
Junc 30	2335	0.9	1.17	2359.58	24.58
Junc 31	2338	0.9	1.17	2341.67	3.66
Junc 32	2332	2.8	3.64	2359.59	27.59
Junc 33	2328	4.6	5.98	2359.42	31.42
Junc 34	2338	0.4	0.52	2359.02	21.02
Junc 36	2342	2.3	2.99	2360.89	18.89
Junc 38	2350	0	0.00	2361.17	11.17
Junc 39	2345	9.0	11.70	2360.81	15.81
Junc 40	2338	8.3	10.79	2360.68	22.68
Junc 41	2339	6.7	8.71	2379.90	40.90
Junc 42	2338	5.3	6.89	2379.92	41.92

2025 Demand

Node ID	Elevation m	Base Demand LPS	Demand LPS	Head m	Pressure m
Junc 43	2328	8.0	10.40	2380.22	52.22
Junc 44	2322	4.8	6.24	2381.44	59.44
Junc 46	2324	0	0.00	2380.08	56.08
Junc 49	2337	0	0.00	2371.13	34.13
Junc 51	2350	13.9	18.07	2369.94	19.94
Junc 52	2353	8.3	10.79	2369.94	16.94
Junc 53	2324	0	0.00	2380.12	56.12
Junc 54	2319	0	0.00	2382.36	63.36
Junc 56	2320	0	0.00	2394.00	74.00
Junc 57	2320	0	0.00	2427.34	107.34
Junc 58	2320	0	0.00	2322.59	2.59
Junc 60	2375	0	0.00	2375.97	0.97
Junc 61	2375	0	0.00	2375.94	0.94
Junc 63	2350	0	0.00	2350.35	0.35
Junc 64	2350	0	0.00	2445.52	95.52
Junc 45	2352	0.2	0.26	2362.35	10.35
Junc 71	2319	3.7	4.81	2382.36	63.36
Junc 75	2359	0	0.00	2363.83	4.83
Junc 79	2330	4.5	5.85	2372.32	42.32
Junc 80	2337	3.4	4.42	2371.14	34.14
Junc 81	2330	21.0	37.80	2371.93	41.93
Junc 82	2336	6.7	8.71	2374.55	38.55
Junc 83	2335	3.4	4.42	2371.14	36.14
Junc 84	2342	3.4	4.42	2371.81	29.81
Junc 85+149	2338	5.6	7.28	2374.52	36.52
Junc 73	2338	5.6	7.28	2374.81	36.81
Junc 77	2350	11.1	14.43	2369.73	19.73
Junc 78	2350	8.3	10.79	2369.40	19.40
Junc 88	2330	8.8	11.44	2376.59	46.59
Junc 89	2340	4.6	5.98	2356.60	16.60
Junc 90	2348	0	0.00	2352.96	4.96
Junc 92	2330	1.1	1.43	2379.56	49.56
Junc 94	2320	1.8	2.34	2379.57	59.57
Junc 103	2335	0	0.00	2358.92	23.92
Junc 105	2334	9.0	11.70	2375.07	41.07

2025 Demand

Node ID	Elevation m	Base Demand LPS	Demand LPS	Head m	Pressure m
Junc 96	2325	0	0.00	2359.65	34.65
Junc 97	2317	0	0.00	2358.15	41.15
Junc 101	2319	1.8	2.34	2355.96	36.96
Junc 109	2315	1.2	1.56	2354.16	39.16
Junc 110	2315	1.6	2.08	2353.66	38.66
Junc 111	2315	1.2	1.56	2353.13	38.13
Junc 112	2310	0	0.00	2332.24	22.24
Junc 113	2320	0	0.00	2379.59	59.59
Junc 114	2318	0	0.00	2331.48	13.48
Junc 115	2318	6.4	8.32	2331.47	13.47
Junc 116	2308	3.2	4.16	2331.90	23.90
Junc 117	2309	6.4	8.32	2331.49	22.49
Junc 118	2319	0	0.00	2331.48	12.48
Junc 120	2345	0.7	0.91	2352.99	7.99
Junc 121	2325	0	0.00	2353.08	28.08
Junc 122	2318	0	0.00	2353.13	35.13
Junc 127	2355	1.0	1.30	2424.03	69.03
Junc 130	2340	0	0.00	2339.98	-0.02
Junc 132	2336	0	0.00	2426.22	90.22
Junc 133	2380	1.5	1.95	2425.69	45.69
Junc 141	2353	18.9	24.57	2398.37	45.37
Junc 142	2356	7.7	10.01	2395.64	39.64
Junc 143	2337	10.4	13.52	2357.41	20.41
Junc 144	2340	0	0.00	2340.03	0.03
Junc 145	2346	0	0.00	2366.23	20.23
Junc 146	2330	0.8	1.04	2366.19	36.19
Junc 147+12+19	2320	1.4	1.82	2360.88	40.88
Junc 148	2315	1.1	1.43	2353.65	38.65
Junc 150	2346	9.8	12.74	2351.70	5.69
Junc 48	2358	13.7	17.81	2379.13	21.13
Junc 65	2363	8.6	11.18	2377.52	14.52
Junc 70	2150	0	0.00	2378.06	228.06
Junc 72	2300	4.2	5.46	2332.48	32.48
Junc IN-MNF	2150	-164.5	-164.50	2152.79	2.79
Junc IN-STR	2350	-74.7	-74.70	2350.45	0.45

2025 Demand

Node ID	Elevation m	Base Demand LPS	Demand LPS	Head m	Pressure m
Junc IN-TOK	2375	-189.9	-189.90	2376.02	1.02
Junc 2	2150	0	0.00	2152.74	2.74
Junc 35	2336	0	0.00	2339.94	3.94
Junc 16	2330	24.2	31.46	2356.53	26.53
Tank T-HAZ	2359	#N/A	-19.88	2363.84	4.84
Tank T-ARB	2395	#N/A	-8.26	2398.43	3.43
Tank T-TSE	2360	#N/A	-107.86	2364.24	4.24
Tank T-MON	2359	#N/A	-48.52	2361.46	2.46
Tank T-DEN	2348	#N/A	129.12	2351.93	3.93
Tank T-MCH	2336	#N/A	24.80	2339.94	3.94
Tank T-MNF	2150	#N/A	-92.71	2152.78	2.78
Tank T-SEM1	2320	#N/A	47.69	2322.66	2.66
Tank T-STR	2350	#N/A	-14.02	2350.41	0.41
Tank T-TOK	2375	#N/A	-44.06	2376.00	1.00
Tank T-SEM2	2330	#N/A	-14.96	2332.36	2.36

2025 Demand

Network Table - Links at 8:00 Hrs

Link ID	Length m	Diameter mm	Roughness	Flow LPS	Velocity m/s	Status
Pipe 2	2100	400	120	109.98	0.88	Open
Pipe 3	820	400	120	72.15	0.57	Open
Pipe 4	1280	300	120	-24.02	0.34	Open
Pipe 5	10	300	120	39.70	0.56	Open
Pipe 7	810	300	120	0.00	0.00	Closed
Pipe 8	1400	350	120	89.46	0.93	Open
Pipe 9	480	350	120	63.72	0.66	Open
Pipe 10	440	250	120	87.42	1.78	Open
Pipe 11	350	250	120	84.43	1.72	Open
Pipe 13	260	250	120	72.34	1.47	Open
Pipe 14	1100	200	120	2.21	0.07	Open
Pipe 16	540	200	120	-31.46	1.00	Open
Pipe 17	110	300	120	-51.39	0.73	Open
Pipe 18	570	300	120	-31.51	0.45	Open
Pipe 22	480	250	140	-8.26	0.17	Open
Pipe 25	670	300	120	11.74	0.17	Open
Pipe 26	70	300	120	34.91	0.49	Open
Pipe 27	60	300	120	28.74	0.41	Open
Pipe 28	660	200	120	19.63	0.62	Open
Pipe 31	690	200	120	6.17	0.20	Open
Pipe 32	530	200	120	6.64	0.21	Open
Pipe 33	220	200	120	3.00	0.10	Open
Pipe 34	440	200	120	3.05	0.10	Open
Pipe 37	480	300	120	30.60	0.43	Open
Pipe 40	290	300	120	8.71	0.12	Open
Pipe 41	700	300	120	0.00	0.00	Closed
Pipe 42	450	250	120	-10.79	0.22	Open
Pipe 43	320	250	120	-22.49	0.46	Open
Pipe 44	60	250	120	-48.52	0.99	Open
Pipe 45	370	200	120	-23.04	0.73	Open
Pipe 47	800	350	120	63.52	0.66	Open
Pipe 48	1260	300	120	15.60	0.22	Open
Pipe 52	1450	250	120	18.75	0.38	Open
Pipe 53	10	300	140	36.01	0.51	Open

2025 Demand

Link ID	Length m	Diameter mm	Roughness	Flow LPS	Velocity m/s	Status
Pipe 59	1950	250	120	54.92	1.12	Open
Pipe 66	10	250	120	42.61	0.87	Open
Pipe 1	390	300	120	-107.60	1.52	Open
Pipe 6	220	300	120	-107.86	1.53	Open
Pipe 56	510	350	120	-69.76	0.73	Open
Pipe 82	190	250	120	26.03	0.53	Open
Pipe 20	280	250	120	-19.88	0.40	Open
Pipe 84	10	250	120	-19.88	0.40	Open
Pipe 92	1100	200	120	33.75	1.07	Open
Pipe 93	920	200	140	15.57	0.50	Open
Pipe 94	470	200	140	12.33	0.39	Open
Pipe 96	500	150	120	-0.32	0.02	Open
Pipe 97	870	150	120	-4.74	0.27	Open
Pipe 98	450	200	140	-3.22	0.10	Open
Pipe 46	500	150	120	-4.06	0.23	Open
Pipe 69	1150	150	120	9.16	0.52	Open
Pipe 87	470	300	140	-25.22	0.36	Open
Pipe 88	500	200	140	-10.79	0.34	Open
Pipe 101	1520	300	140	81.04	1.15	Open
Pipe 39	370	300	120	0.00	0.00	Closed
Pipe 99	180	300	120	-137.68	1.95	Open
Pipe 102	390	300	140	131.70	1.86	Open
Pipe 105	750	200	140	-1.43	0.05	Open
Pipe 119	130	200	120	27.92	0.89	Open
Pipe 120	230	200	120	27.92	0.89	Open
Pipe 121	530	300	140	69.60	0.98	Open
Pipe 122	980	200	140	25.47	0.81	Open
Pipe 123	660	200	140	11.93	0.38	Open
Pipe 35	160	300	120	56.62	0.80	Open
Pipe 36	200	300	120	36.58	0.52	Open
Pipe 51	240	200	140	-3.77	0.12	Open
Pipe 95	1100	250	140	1.39	0.03	Open
Pipe 100	1480	200	140	-6.93	0.22	Open
Pipe 103	420	300	140	1.39	0.02	Open
Pipe 106	640	300	140	0.00	0.00	Closed

2025 Demand

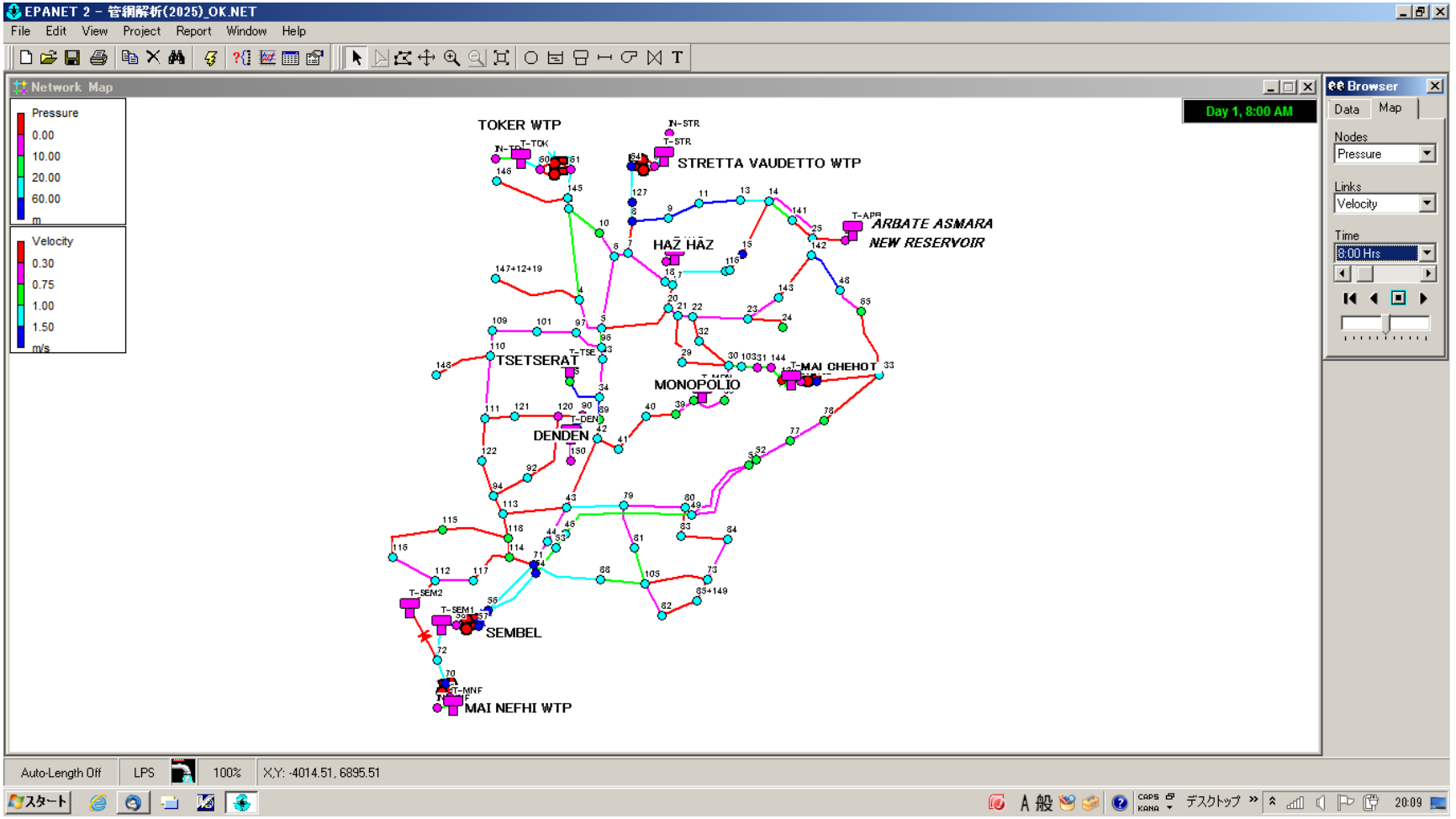
Link ID	Length m	Diameter mm	Roughness	Flow LPS	Velocity m/s	Status
Pipe 107	630	200	140	1.39	0.04	Open
Pipe 129	610	200	140	-12.63	0.40	Open
Pipe 130	360	200	140	-16.14	0.51	Open
Pipe 133	800	200	120	-20.04	0.64	Open
Pipe 134	550	200	120	-20.04	0.64	Open
Pipe 137	960	300	140	-11.07	0.16	Open
Pipe 138	560	300	140	-11.07	0.16	Open
Pipe 139	610	200	140	0.00	0.00	Closed
Pipe 140	660	200	140	0.00	0.00	Open
Pipe 144	1400	200	140	9.71	0.31	Open
Pipe 145	500	200	140	11.09	0.35	Open
Pipe 112	10	250	140	8.26	0.17	Open
Pipe 23	3600	300	120	88.72	1.26	Open
Pipe 73	850	300	120	87.42	1.24	Open
Pipe 151	10	200	120	26.75	0.85	Open
Pipe 154	350	200	120	-0.09	0.00	Open
Pipe 160	480	200	120	13.52	0.43	Open
Pipe 162	770	200	120	0.00	0.00	Closed
Pipe 168	290	200	120	-39.00	1.24	Open
Pipe 24	350	200	120	26.75	0.85	Open
Pipe 135	10	200	120	26.75	0.85	Open
Pipe 127	250	500	120	232.92	1.19	Open
Pipe 169	4200	200	140	-1.04	0.03	Open
Pipe 170	2800	300	140	-1.82	0.03	Open
Pipe 171	1100	200	140	17.70	0.56	Open
Pipe 172	1200	200	140	1.43	0.05	Open
Pipe 173	1380	200	140	0.00	0.00	Closed
Pipe 174	1250	150	120	-3.77	0.21	Open
Pipe 176	880	300	140	20.50	0.29	Open
Pipe 178	600	250	120	42.61	0.87	Open
Pipe 179	2400	250	120	42.61	0.87	Open
Pipe 180	200	200	120	12.74	0.41	Open
Pipe 181	350	300	140	-10.16	0.14	Open
Pipe 183	780	400	120	31.36	0.25	Open
Pipe 184	800	200	120	2.47	0.08	Open

2025 Demand

Link ID	Length m	Diameter mm	Roughness	Flow LPS	Velocity m/s	Status
Pipe 185	440	200	120	24.48	0.78	Open
Pipe 186	440	250	120	82.22	1.67	Open
Pipe 21	750	150	120	28.99	1.64	Open
Pipe 49	570	150	140	-11.18	0.63	Open
Pipe 58	12800	500	120	257.21	1.31	Open
Pipe 61	3000	500	120	245.91	1.25	Open
Pipe 63	10	400	120	198.22	1.58	Open
Pipe 75	10	500	120	164.50	0.84	Open
Pipe 76	10	300	120	74.70	1.06	Open
Pipe 78	10	300	120	88.72	1.26	Open
Pipe 79	10	500	120	189.90	0.97	Open
Pipe 70	10	500	120	233.96	1.19	Open
Pipe 71	3250	500	120	233.96	1.19	Open
Pipe 80	10	500	120	257.21	1.31	Open
Pipe 38	10	200	120	1.95	0.06	Open
Pipe 60	470	300	140	0.00	0.00	Closed
Pipe 12	1700	350	120	143.30	1.49	Open
Pipe 55	860	250	140	35.77	0.73	Open
Pipe 57	1080	250	140	0.00	0.00	Closed
Pipe 65	10	200	140	11.47	0.37	Open
Pipe 67	10	250	140	-12.30	0.25	Open
Pipe 72	10	500	120	233.96	1.19	Open
Pipe 104	1450	300	140	35.33	0.50	Open
Pipe 15	360	200	120	0.00	0.00	Closed
Pipe 29	10	200	120	31.46	1.00	Open
Pipe 19	500	100	120	1.95	0.25	Open
Pipe 30	500	200	120	0.00	0.00	Closed
Pipe 50	4500	300	140	5.84	0.08	Open
Pipe 54	400	300	140	20.80	0.29	Open
Pipe 62	10	200	120	141.86	4.52	Open
Pump P-SEM1	#N/A	#N/A	#N/A	99.11	0.00	Open
Pump P-TOK1	#N/A	#N/A	#N/A	0.00	0.00	Closed
Pump P-STR1	#N/A	#N/A	#N/A	44.36	0.00	Open
Pump P-MNF1	#N/A	#N/A	#N/A	128.60	0.00	Open
Pump P-MCH	#N/A	#N/A	#N/A	1.95	0.00	Open

2025 Demand

Link ID	Length m	Diameter mm	Roughness	Flow LPS	Velocity m/s	Status
Pump P-MNF2	#N/A	#N/A	#N/A	128.60	0.00	Open
Pump P-SEM2	#N/A	#N/A	#N/A	99.11	0.00	Open
Pump P-STR2	#N/A	#N/A	#N/A	44.36	0.00	Open
Pump P-TOK2	#N/A	#N/A	#N/A	0.00	0.00	Closed
Valve V-SEM	#N/A	400	#N/A	198.22	1.58	Active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20.00
60.00
m
Velocity
0.30
0.75
1.00
1.50
m/s
TOKER WTP
STRETTA VAUDETTO WTP
ARBATE ASMARA
NEW RESERVOIR
HAZ HAZ
TSETSERAT
MONOPOLIO
DENDEN
SEMBEL
MAI NEFHI WTP
Browser
Data
Map
Nodes
Pressure
Links
Velocity
Time
8:00 Hrs
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LPS
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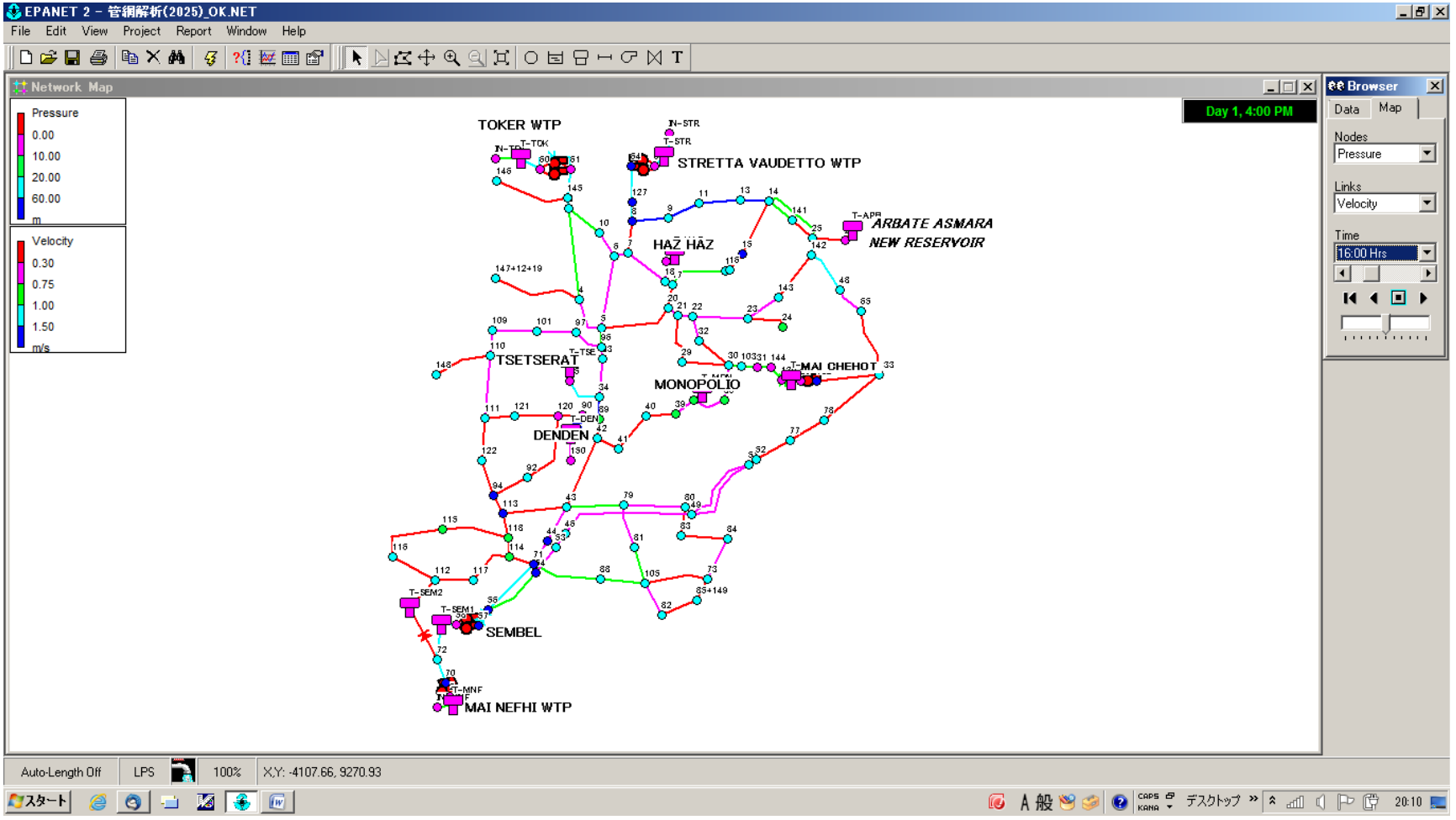
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Network Map
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10.00
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m
Velocity
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1.00
1.50
m/s
Day 1, 4:00 PM
TOKER WTP
STRETTA VAUDETTO WTP
ARBATE ASMARA
NEW RESERVOIR
HAZ HAZ
TSETSERAT
MONOPOLIO
DENDEN
SEMBEL
MAI NEFHI WTP
Browser
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Nodes
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Links
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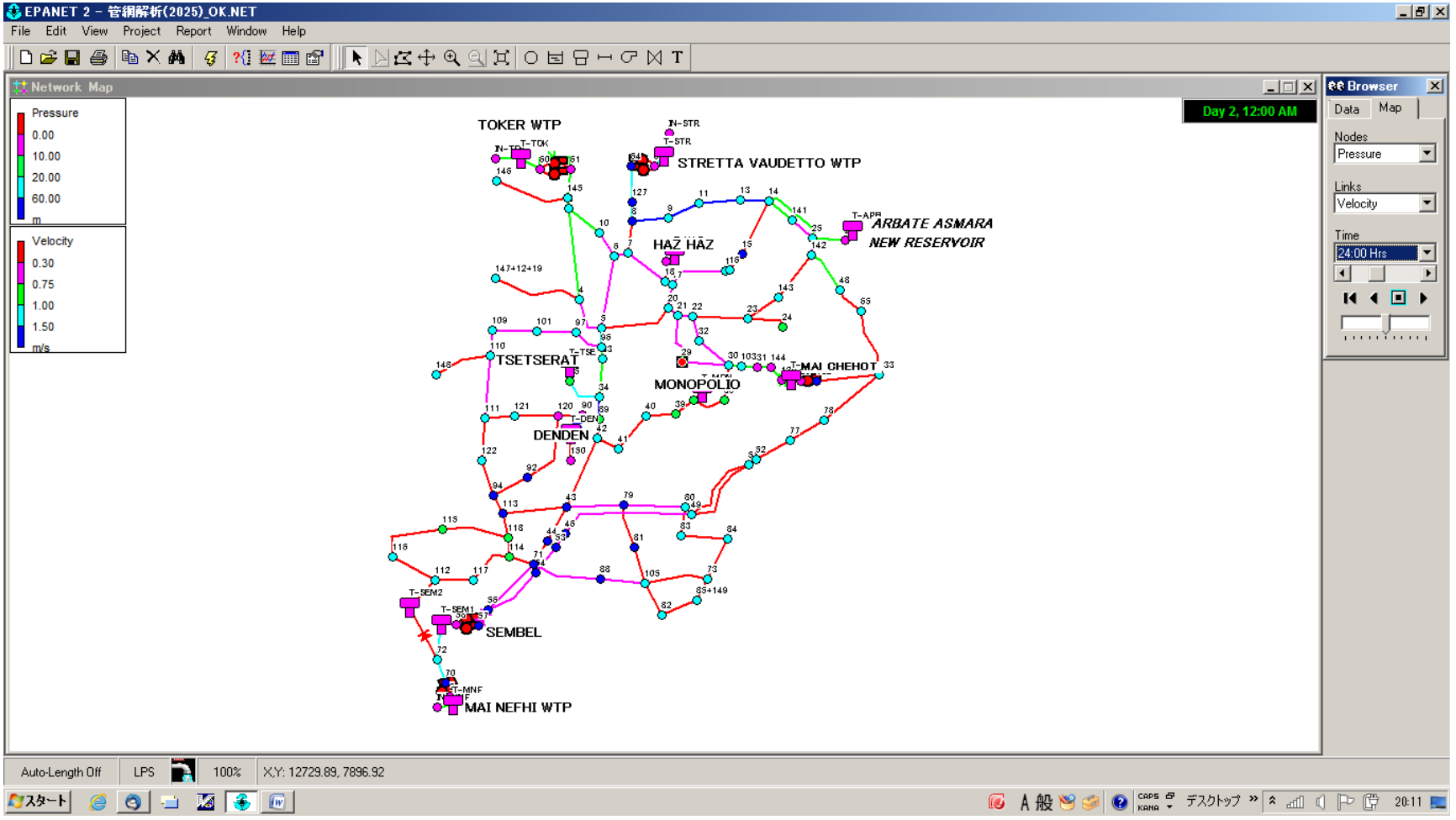
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File Edit View Project Report Window Help
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Pressure
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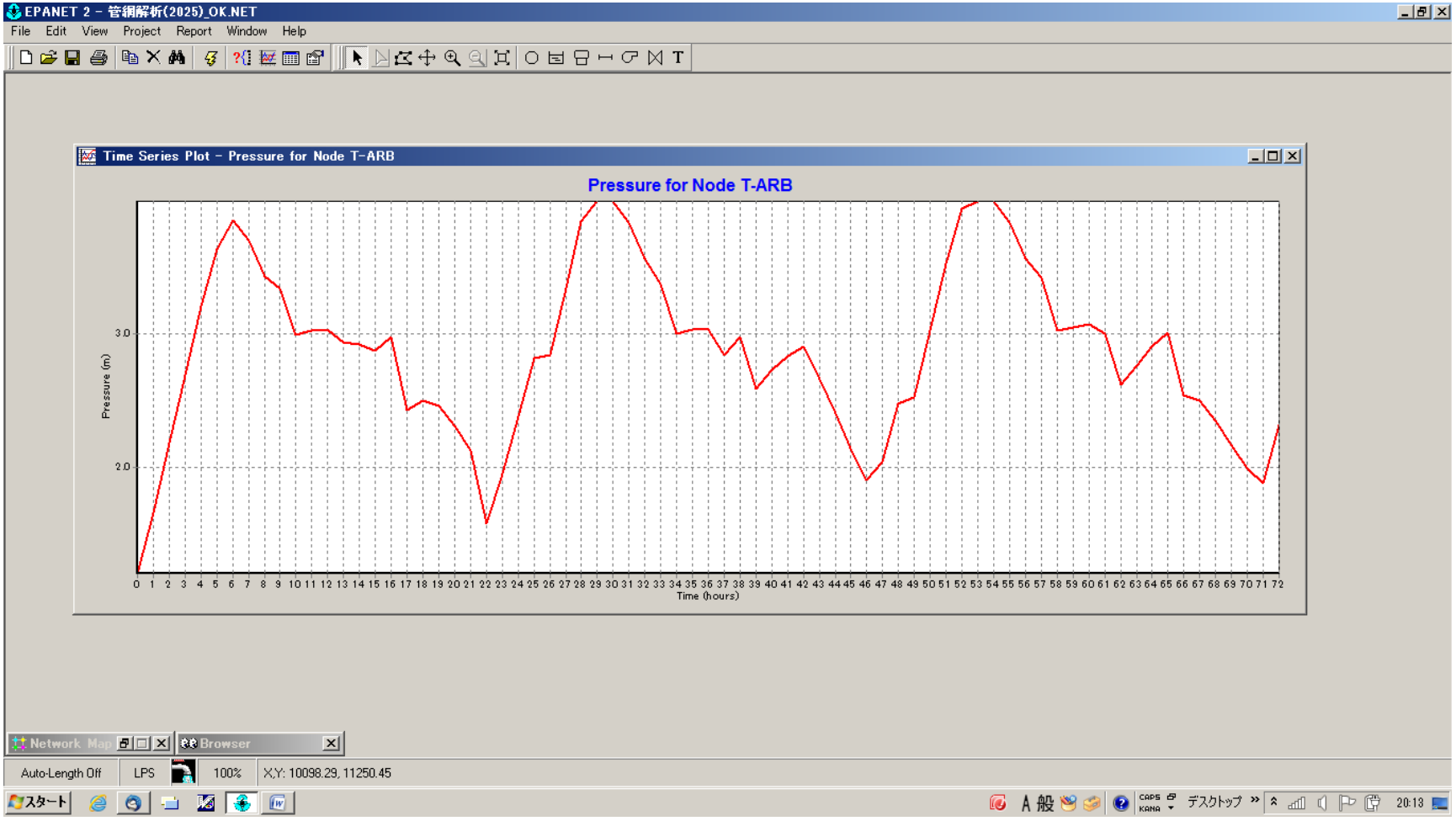
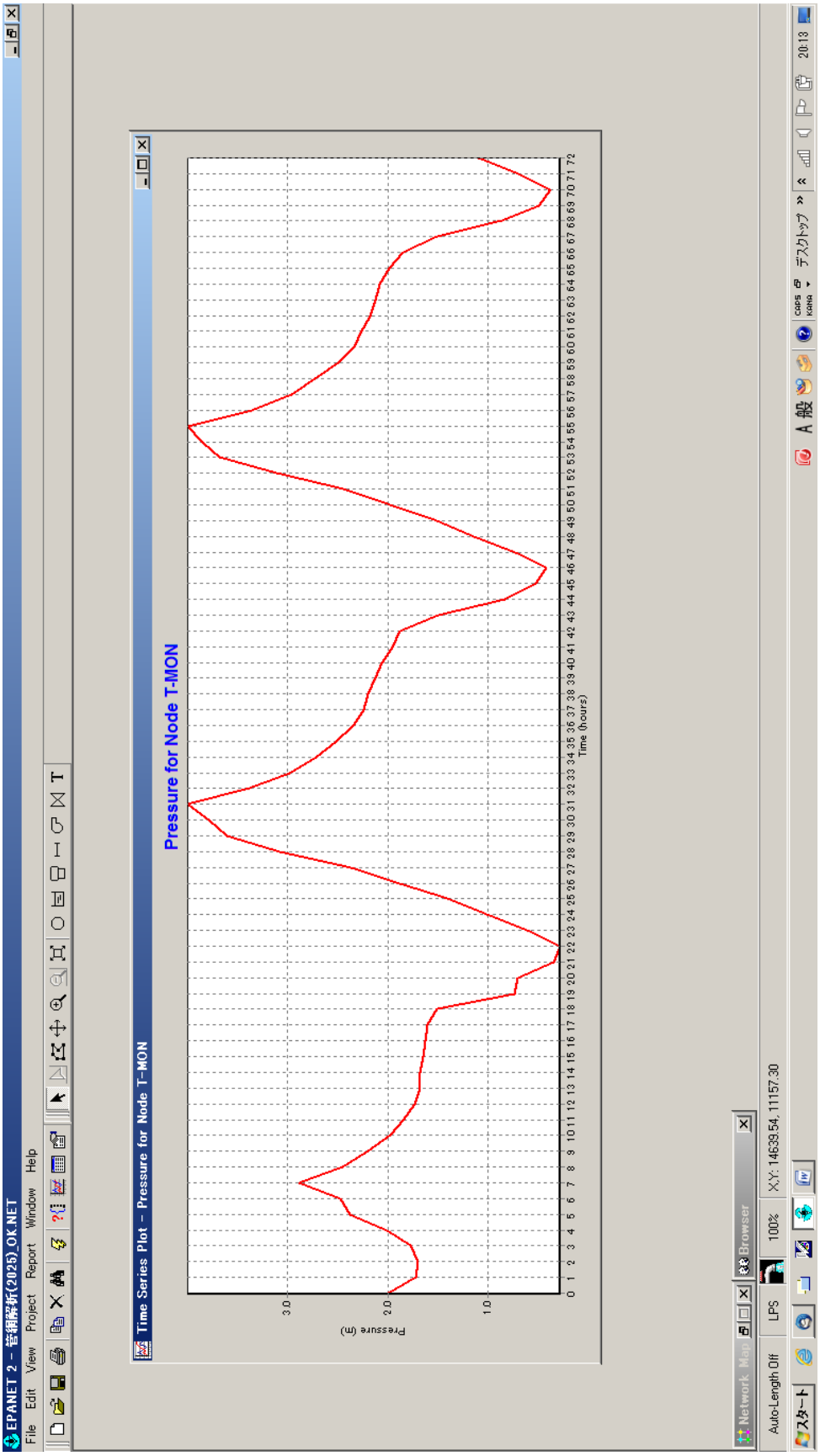
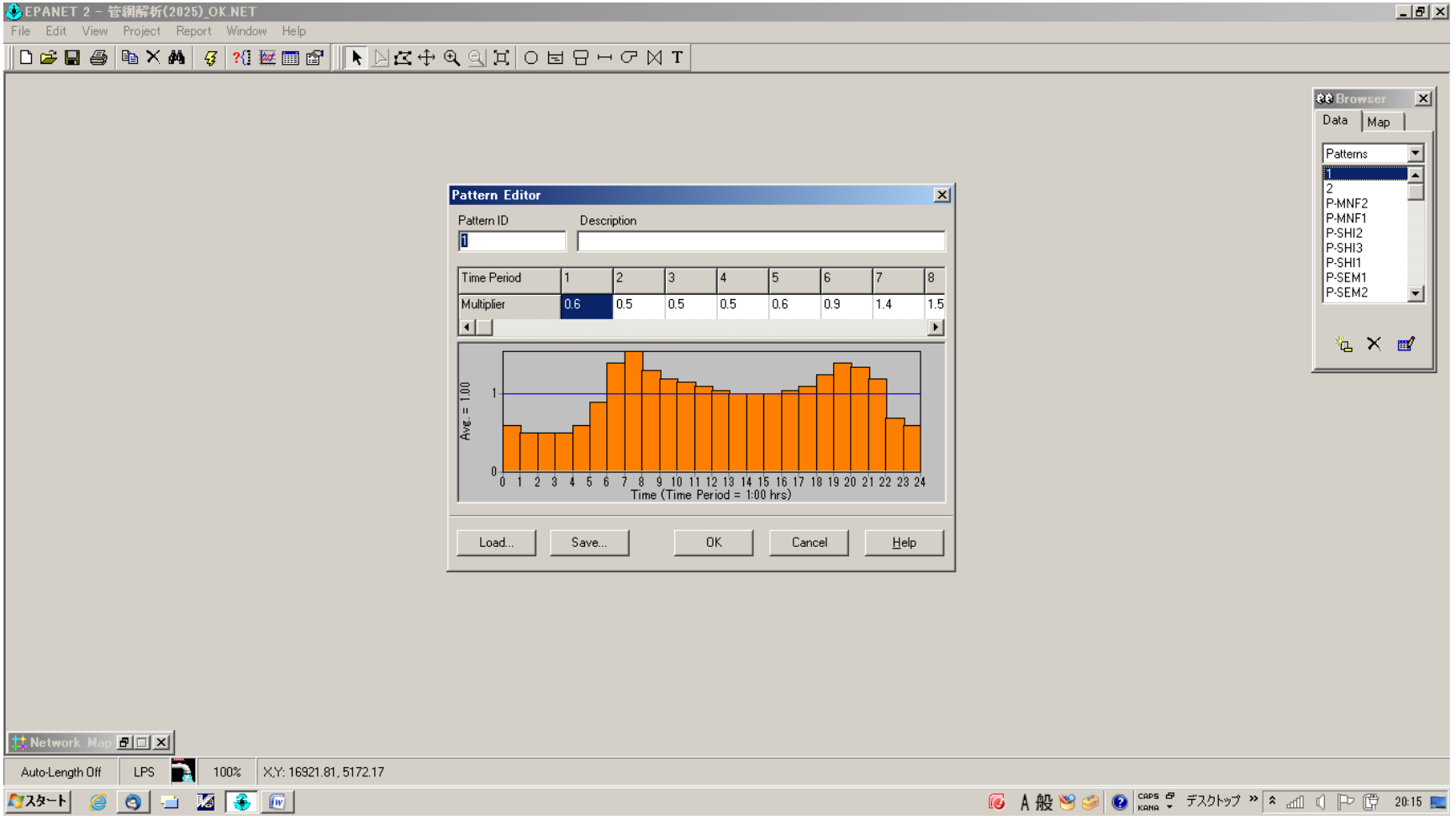
20.00
60.00
m
Velocity
0.30
0.75
1.00
1.50
m/s
Day 2, 12:00 AM
TOKER WTP
STRETTA VAUDETTO WTP
HAZ HAZ
ARBATE ASMARA
NEW RESERVOIR
TSETSERAT
MONOPOLIO
T-MAI CHEHOT
DENDEN
SEMBEL
MAI NEFHI WTP
Browser
Data
Map
Nodes
Pressure
Links
Velocity
Time
24:00 Hrs
Auto-Length Off
LPS
100%
X,Y: 12729.89, 7896.92


EPANET 2 - 管網解析(2025)_OK.NET
File Edit View Project Report Window Help
Time Series Plot - Pressure for Node T-ARB
Pressure for Node T-ARB
Pressure (m)
3.0
2.0
0 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
Time (hours)
Network Map
Browser
Auto-Length Off
LPS
100%
X,Y: 10098.29, 11250.45
スタート
20:13


EPANET 2 - 管網解析(2025)_OK.NET
File Edit View Project Report Window Help
Time Series Plot - Pressure for Node T-MON
Pressure for Node T-MON
Pressure (m)
Time (hours)
Network Map
Browser
Auto-Length Off
LPS
100%
X,Y: 14639.54, 11157.30


EPANET 2 - 管網解析(2025)_OK.NET
File Edit View Project Report Window Help
Browser
Data Map
Patterns
1
2
P-MNF2
P-MNF1
P-SHI2
P-SHI3
P-SHI1
P-SEM1
P-SEM2
Pattern Editor
Pattern ID
1
Description
Time Period 1 2 3 4 5 6 7 8
Multiplier 0.6 0.5 0.5 0.5 0.6 0.9 1.4 1.5
Avg. = 1.00
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Time (Time Period = 1:00 hrs)
Load... Save... OK Cancel Help
Network Map
Auto-Length Off LPS 100% X,Y: 16921.81, 5172.17
スタート
20:15

付属資料 4.

8) エリトリア国の水質基準

4. 参考資料

9) エリトリア水質基準

（1） 飲料水の水質基準

微生物

項目	A	B	C	D	WHO飲料水水質ガイドライン	EU指令	日本水質基準	
全ての飲用水								
大腸菌もしくは糞便性大腸菌群	100mL中に検出されてはならない				100mL中に検出されてはならない			E.coli and thermotolerant coliform bacteria)
配水システムに送られる浄水								
大腸菌もしくは糞便性大腸菌群	100mL中に検出されてはならない				100mL中に検出されてはならない			
大腸菌群	100mL中に検出されてはならない				100mL中に検出されてはならない			
配水システム中の浄水								
大腸菌もしくは糞便性大腸菌群	100mL中に検出されてはならない				100mL中に検出されてはならない			
大腸菌群	100mL中に検出されてはならない。大規模な水道システムで十分な試料が検査された場合には、12ヶ月間を通じて95%の試料中に検出されないこと。				100mL中に検出されてはならない。大規模な水道システムで十分な試料が検査された場合には、12ヶ月間を通じて95%の試料中に検出されないこと。			

化学物質、その他

項目	Eritria				水質基準等(mg/L)			
	A	B	C	D	WHO飲料水水質ガイドライン	EU指令	日本水質基準	
1. 無機物: Inorganics								
色度	10	20	20	20	15 (true color units)	消費者が許容し,異常がないこと	5度(性状)	Colour
電導度	1000	1500	3000	3000		2500 μS/cm at 20℃		Conductivity
pH(水素イオン濃度)	6.5-8.5	5.5-9.5	5.5-9.5	5.5-9.5	-(C)	6.5～9.5	5.8～8.6(性状)7.5程度(快適)	pH
TDS(総溶解性物質(日本は蒸発残留物))	650	1000	2000	2000	1000(C)		500(性状)30～200(快適)	Total dissolved solids
濁度	1	5	10	10	平均1NTU単一サンプル5NTU	消費者が許容し,異常がないこと	2度(性状)給水栓で1度送配水施設入口で0.1度(快適)	Turbidity
総硬度	200	350	600	600	-(C)		300(性状)10～100(快適)	Hardness
マグネシウム	30	50	80	80				Magnessium
カリウム	10	12	20	20				Potassium
塩素イオン	100	250	600	600	250(C)	250	200(性状)	Chloride
硝酸塩	20	40	50	50	50(急性)	50	硝酸性窒素及び亜硝酸性窒素として10(健康)、亜硝酸性窒素として0.05(監視P)	Nitrate
亜硝酸塩	1	3	3	3	3(急性)0.2 (P)(慢性)			Nitrite
硫酸イオン	100	250	500	500	250(C)	250		Sulfate
鉄	0.15	0.3	0.3	0.3	0.3(C)	0.2	0.3(性状)	Iron
マンガン	0.05	0.1	0.5	0.5	0.5 (P)、0.1(C)	0.05	0.05(性状)0.01(快適)	Manganese
亜鉛	1.5	3	3	3	3(C)		1(性状)	Zinc
銅	0.5	1.5	2	2	2 (P)、1(C)	2	1(性状)	Copper
アンモニア	0.13	0.64	1.5	1.5	1.5(C)	0.5		Ammonia
アルミニウム	0.1	0.2	0.2	0.2	0.2(C)	0.2	0.2(快適)	Aluminium
ヒ素	0.01	0.05	0.05	0.05	0.01 (P)	0.01	0.01(健康)	Arsenic
カドミウム	0.003	0.005	0.005	0.005	0.003	0.005	0.01(健康)	Cadmium
クロム	0.05	0.05	0.05	0.05	0.05 (P)	0.05	六価クロムとして0.05(健康)	Chromium
シアン	0.07	0.07	0.07	0.07	0.07	0.05	0.01(健康)	Cyanide
鉛	0.01	0.05	0.05	0.05	0.01	0.01	0.05(健康)H150401より0.01	Lead
水銀	0.001	0.001	0.001	0.001	0.001	0.001	0.0005(健康)	Mercury
ナトリウム	100	200	400	400	200(C)	200	200(性状)	Sodium
フッ素	1	1.5	3	3	1.5	1.5	0.8(健康)	Fluoride
	0.5	1	2.5	2.5				
ベリリウム	0.7	0.7	1	1	NAD			Beryllium
ほう素	**0.3**	0.3	0.3	0.3	0.5 (P)	1	1(監視)	Boron
モリブデン	0.05	0.07	0.07	0.07	0.07		0.07(監視)	Molybdenum
ニッケル	0.02	0.02	0.02	0.02	0.02 (P)	0.02	0.01(監視P)	Nickel
セレン	0.01	0.01	0.01	0.01	0.01	0.01	0.01(健康)	Selenium
アンチモン	0.03	0.03	0.03	0.03	0.005 (P)	0.005	0.002(監視P)	Antimony
硫化水素	0.05	0.05	0.1	0.1	0.05(C)			Hydrogen sulfide

項目	Eritria				水質基準等(mg/L)			
	A	B	C	D	WHO飲料水水質ガイドライン	EU指令	日本水質基準	
2. 有機物: Organics			(μg/L)					
四塩化炭素			2		0.002		0.002(健康)	Carbon tetrachloride
ジクロロメタン			20		0.02		0.02(健康)	Dichloromethane
1,2-ジクロロエタン			30		0.03	0.003	0.004(健康)	1,2-Dichloroethane
1,1,1-トリクロロエタン			2000		2 (P)		0.3(性状)	1,1,1-Trichloroethane
塩化ビニル			5		0.005	0.0005		Vinyl chloride
1,1-ジクロロエチレン			30		0.03		0.02(健康)	1,1-Dichloroethene
1,2-ジクロロエチレン			50		0.05		シス0.04(健康) トランス0.04(監視)	1,2-Dichloroethene
トリクロロエチレン			70		0.07 (P)	0.01	0.03(健康)	Trichloroethene
テトラクロロエチレン			40		0.04		0.01(健康)	Tetrachloroethene
ベンゼン			10		0.01	0.001	0.01(健康)	Benzene
トルエン			700		0.7、0.024-0.17(C)		0.6(監視)	Toluene
キシレン類			500		0.5、0.02-1.8(C)		0.4(監視)	Xylenes
エチルベンゼン			300		0.3、0.002-0.2(C)			Ethylbenzene
スチレン			20		0.02、0.004-2.6(C)			Styrene
ベンゾ(a)ピレン			0.7		0.0007	0.00001		Benzo(a)pyrene
モノクロロベンゼン			300		0.3、0.01-0.12(C)			Monochlorobenzene
1,2-ジクロロベンゼン			1000		1、0.001-0.01(C)			1,2-Dichlorobenzene
1,4-ジクロロベンゼン			300		0.3、0.0003-0.03(C)		0.3(監視)	1,4-Dichlorobenzene
アジピン酸ジ(2-エチルヘキシル)			20		0.08			Di(2-ethylhexyl)adipate
フタル酸ジ(2-エチルヘキシル)			8		0.008		0.06(監視)	Di(2-ethylhexyl)phthalate
アクリルアミド			0.5		0.0005	0.0001		Acrylamide
エピクロロヒドリン			0.4		0.0004 (P)	0.0001		Epichlorohydrin
ヘキサクロロブタジエン			0.6		0.0006			Hexachlorobutadiene
エチレンジアミン四酢酸			200		0.6			Edetic acid (EDTA)
ニトリロ三酢酸			200		0.2			Nitrilotriacetic acid (NTA)
3. 農薬: Pesticides			(μg/L)					
アラクロール			20		0.02			Alachlor
アルディカーブ			10		0.01			Aldicarb
アルドリン			0.03		0.00003	0.00003		Aldrin
アトラジン			2		0.002			Atrazine
ベンタゾン			30		0.3		0.2(監視)	Bentazone
カルボフラン			5		0.007		0.005(監視)	Carbofuran
クロルデン			0.2		0.0002			Chlordane
クロロトルロン			30		0.03			Chlorotoluron
DDT			2		0.002			DDT
1,2-ジブロモ-3-クロロプロパン(DBCP)			1		0.001			1,2-Dibromo-3-chloropropane
2,4-ジクロロフェノキシ酢酸(2,4-D)			30		0.03		0.03(監視)	2,4-Dichlorophenoxyacetic acid (2,4-D)
1,2-ジクロロプロパン			20		0.04 (P)		0.06(監視P)	1,2-Dichloropropane
1,3-ジクロロプロパン			20		NAD			1,3-Dichloropropane
ヘプタクロルエポキシド			0.03			0.00003		Heptachlor epoxide
ヘキサクロロベンゼン			1		0.001			Hexachlorobenzene
イソプロツロン			9		0.009			Isoproturon
リンデン			2		0.002			Lindane
MCPA			2		0.002			MCPA
メトキシクロル			20		0.02			Methoxychlor
メトラクロール			10		0.01			Metolachlor
モリネート			6		0.006			Molinate
ペンディメタリン			20		0.02		0.05(ゴルフ)	Pendimethalin
ペンタクロロフェノール			9		0.009 (P)			Pentachlorophenol
ペルメスリン			20		0.02			Permethrin
プロパニル			20		0.02			Propanil
ピリデート			100		0.1			Pyridate
シマジン(CAT)			2		0.002		0.003(健康)	Simazine
トリフルラリン			20		0.02			Trifluralin
ジクロロプロップ			100		0.1			dichlorprop
			90					(2,4-DP)
2,4,5-T			9		0.009			2,4,5-T
シルベックス(除草剤)			9					silvex
メコプロップ(MCPP)			10		0.01		0.005(ゴルフ)	Mecoprop

項目	Eritria				水質基準等(mg/L)			
	A	B	C	D	WHO飲料水水質ガイドライン	EU指令	日本水質基準	
4. 消毒剤及び消毒副生成物: Disinfectants and disinfectant by-products								
			(mg/L)					
モノクロラミン			3		3			Monochloramine
塩素			5		5、0.6-1.0(C)効果的な消毒のため、pH8未満30分接触の後、遊離で0.5mg/L残留すべきである		遊離で0.1以上等(省令)1程度(快適)	Chlorine
			(μg/L)					
臭素酸			25		0.025 (P)	0.01		Bromate
亜塩素酸			200		0.2 (P)		0.6(監視)	Chlorite
2,4,6-トリクロロフェノール			200		0.2			2,4,6-Trichlorophenol
					0.002-0.3(C)			
ホルムアルデヒド			900		0.9		0.08(監視P)	Formaldehyde
総トリハロメタン			(各物質とガイドライン値との比の和が1を超えない)		(各物質とガイドライン値との比の和が1を超えない)	0.1	0.1(健康)	Total Trihalomethanes (TTHMs)
ブロモホルム			100		0.1		0.09(健康)	Bromoform
ジブロモクロロメタン			100		0.1		0.1(健康)	Dibromochloromethane
ブロモジクロロメタン			60		0.06		0.03(健康)	Bromodichloromethane
クロロホルム			200		0.2		0.06(健康)	Chloroform
ジクロロ酢酸			50		0.05 (P)		0.02(監視P)	Dichloroacetic acid
トリクロロ酢酸			100		0.1 (P)		0.3(監視P)	Trichloroacetic acid
抱水クロラール			10		0.01 (P)		0.03(監視P)	Chloral hydrate (Trichloroacetaldehyde)
ジクロロアセトニトリル			90		0.09 (P)		0.08(監視P)	Dichloroacetonitrile
ジブロモアセトニトリル			100		0.1 (P)			Dibromoacetonitrile
トリクロロアセトニトリル			1		0.001 (P)			Trichloroacetonitrile
塩化シアン			70		0.07			Cyanogen chloride

（2）　エリトリアの河川に関する水質基準

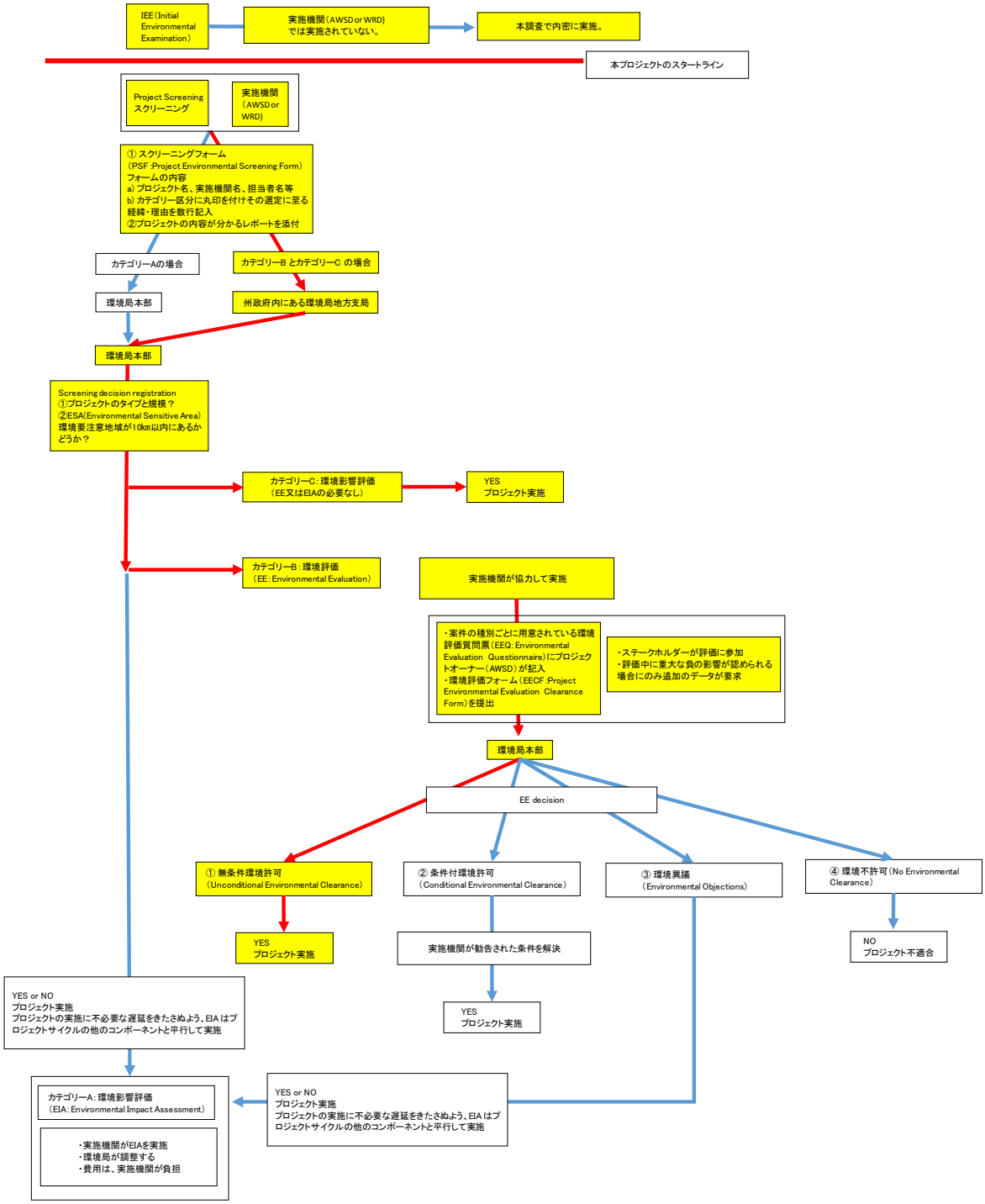
Parameter	Maximum allowable discharge into streams
Temperature(°C)	35
pH (-units)	5.5-9
Dissolved oxygen (%-sat)	75
BOD, mg/l	30
COD, mg/l	75
Ammonia (as N), mg/l	10
Color, (TCU)	50
Total coliform, nos./100ml	20000
Faecal coliform, nos./100ml	500
Arsenic (As), mg/l	0.5
Boron (B), mg/l	1
Zinc (Zn),mg/l	5
Copper (Cu), mg/l	1
Phenols	0.01
Lead (Pb), mg/l	0.05
Cyanide (CN), mg/l	0.1
Chromium (Cr), mg/l	0.5
Cadmium (Cd), mg/l	0.05
Mercury (Hg), mg/l	0.02
Selenium (Se), mg/l	0.05
Iron (Fe), mg/l	1
Manganese (Mn), mg/l	0.5
Sodium (Na), mg/l	600
Sulphate (SO4), mg/l	600
Chloride (Cl), mg/l	1000
Fluoride (F), mg/l	2.5
TDS(total dissolved solids)	2000
Oil and Scum	nil

付属資料 4.

9) 環境手続きのフロー―チャート

4. 参考資料

10）環境手続きのフローチャート図



付属資料 4.

10) 質問票回答

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

QUESTIONNAIRE

FOR

Preparatory Survey on the Project for Asmara Water Supply Development

Prepared by JICA Survey Team

March 2015

To AWSD:

(Asmara Water Supply and Sewerage Department, Administration of Zoba Maekel)

JICA is going to conduct "Preparatory Survey on the Project for Asmara Water Supply Development" in middle of March to middle of May, 2015.

Objectives of this survey are to collect required information of water supply sector of the Eritrea, as general condition, and Asmara city in details, and to analyze the possibility of drinking water supply improvement.

We would appreciate your cooperation in answering the following questions, and provide available data and information requested herein by March 27, 2015, for the sake of smooth implementation of the Survey.

- Form of response:
  We would like to receive the response in the form of soft data (Word/Excel/Auto CAD). We will bring our flush memory when we visit your office.
  In case the soft data is not available, please show us the hard copy of documents/drawings.
- Contact person:
  - Hidehisa Tamura (E-mail: a5361@n-koei.co.jp)
  - Koji Yoshikawa (E-mail: kingdom@heart.ocn.ne.jp)

Contents of the Questionnaire

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

I. Background and History of the Application for Japanese Grant Aid

We would like to confirm the background and history of the Application for Japanese Grant Aid.

- **To upgrade the system capacity of all the components of the water distribution system to improve service coverage and efficiency.**
- **To supply the population of Asmara with reliable, adequate and safe water which is beneficial for public health and economic activities.**

II. Current Status of Water Supply Sector in Eritrea

(1) National Development Plan

We would like to know the current overall national development plan in Eritrea.

WRD

(2) Laws/Regulation and Policy regarding Water Supply Service and Drinking Water

1) Water Resources Management

Please provide us with the Laws/Regulations and Policy on Water Resources Management in Eritrea.

See the attachment Proclamation 162/2010 and Water Resources Policy 2009

2) Water Supply Service

Please provide us with the Laws/Regulations and Policy on Water Supply Service in Eritrea.

There is no document for the whole Eritrea, but a separate draft document prepared for Massawa Water Supply is attached to this document.

3) Water Quality

Please provide us with the current regulation regarding water quality

Please see the attached Draft Document Water Quality standard of Eritrea 2004

(3) Governmental Organization related to Urban Water Supply Service in Eritrea

Please provide us with the following information.

Organization	Function

(4) Budget for Construction/Rehabilitation of Urban Water Supply Facility in Eritrea

Please provide us with past and current budget for construction/rehabilitation of urban water supply facility.

(Thousand Nakfa)

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

Zoba	2011	2012	2013	2014	2015
Maekel (AWSD)	( )	( )	( )	( )	( )

*** Data will be given from AWSD**

III. Asmara Water Supply and Sewerage Department (AWSD)

(1) Regulation on Establishment of AWSD

Please provide us with regulation/decree on establishment of AWSD.

AWSD is established during the Italian time. MEDA

(2) Organization and Staffing

Please provide us with current organization chart of AWSD. Please provide us with current staffing in the form below.

Staffing of Each Division

Division		Permanent	Contract	National Service	Total
Manager office		1			1
Water Supply Division					
Division Head		1	-	5	6
	Unit	15	26	26	67
	Unit	39	103	34	176
	Unit	-	-	9	9
Administration and Finance Division					
Division Head		1	-	2	3
	Unit	3	-	16	19
	Unit	21	24	29	74
	Unit	4	3	6	13
	Unit	2	8	6	16
	Unit	4	11	4	19
Sewerage Division					
Division Head		7	9	18	34
	Unit	-	-	-	-
	Unit	-	-	-	-
	Total	98	184	155	437

Number of Engineers/Specialist

Specialty	Manager office	Water Supply Division	Administration and Finance Division	Sewerage Division	Planning and Engineering Division
Civil engineer		1			
Assistant Engineer (Diploma)		1		1	
Junior Assistant Engineer (Technical School Diploma)		2		1	
Public Administration			1		

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

Accountants			**2**		

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

(3) Number of O& M Equipment

Please provide us with the information regarding the AWSD's O&M equipment

Equipment	Type/Specification	Number
Truck with hydraulic lift	Renualt (France)	1
Trench excavator	Luilong (China)	1
Damp truck	Fiat 110 (Italy)	1
4W drive cars	Toyota Helux 4WD	1

IV. Outline of Water Supply Service of AWSD

Please provide us with the annual report of AWSD as of 2012, 2013, and 2014 (tentative, if possible).

(1) Service Condition

1) Service Area, Service Population

Please provide us with the map showing service area of AWSD (both piped supply area and water tanker service area).

Please provide us with the following information as of 2014.

Item	Number
Population in the Service Area	**750,000**
Served Population	**550,000**
Number of connection	**Sirak**
Number of water tanker (Private)	**150**
Number of water tanker (AWSD)	**7**

2) Water Supply Schedule

Please provide us with the distribution area map showing the distribution pipeline and distribution zoning boundary. Please provide us with the current supply schedule as of 2014 for each distribution zone.

Zone No.	Supplied by (Name of WTP)	Supply Frequency (days/week)	On days (Sun, Mon, Tue, Wed, Thu, Fri, Sat)	Supply hours (Between)
	Mai Nefhi	**7**	**7 days**	**20 hours**
	Tokor Adi Nfas	**7**	**7 days**	**10 hours**
	Stretta Vaudetto	**7**	**7 days**	**13 hours**
	Sembel Pump Station	**7**	**7 days**	**16 hours**

***production by WTP is variable depending on the pumping hours per day based on availability of power and water conservation program (rationing regimes)**

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

(2) Operational Condition

1) Business Operation Record

Please provide us with the following information

Item	2012 (Actual)	2013 (Actual)	2014 (Tentative)
Intake volume (m3)			
Stretta Vaudetto, AdiSheka, Mai Serwa dam	No BM's	No BM's	No BM's
Toker dam	4,268,930	4,178,520	3,400,396
Mai Nefhi dam	No BM's	No BM's	No BM's
Total			
Production volume (m3)			
Stretta Vaudetto WTP	1,053,685	1,126,255	756,575
Toker WTP	3,573,650	3,929,120	2,740,396
Mai Nefhi WTP	2,833,797	3,654,972	3,162,570
Total	**7,461,132**	**8,710,347**	**6,659,541**
Billed volume (m3)			
Pipe connection	2,237038.53	2,462515.46	2,071461.37
Water tanker (AWSD)	68,761	54,126	42,528
Water tanker (Private)	490,763	640,584.4	339,971
Total	**2,796,562.53**	**3,157,225.86**	**2,453,960.37**
Number of pipe connection			
Length of distribution pipeline (km)	320	320	379
Revenue (Thousand Nakfa)			
Water sales revenue (pipe connection)	23,323,226.34	23,154,577.16	20,693,163.92
Water sales revenue Industrial	13,303,537.86	12,678,117.25	11,665,380.93
Water sales revenue (AWSD water tanker)	2,062,134.00	1,539,015.60	1,698,203.16
Water sales revenue (Private water tanker)	723,259.80	960,449.42	509,581.00
Water sales revenue (other water tanker)			
Other revenue	9,958,553.47	33,608,593.00	44,744,831.89
Other (subsidy, etc.)	43,208.78	37,029.94	4,449,651.01
Total	51,645,492.60	74,592,801.35	86,764,422.55
Expense (Thousand Nakfa)			
Personnel (Salary, Allowance, etc)	6,769,181.58	6,891,871.71	6,113,122.84
Energy (Electricity)	13,027,769.43	8,069,913.45	7,286,446.66
Energy (Fuel for Pumps)	24,940,691.36	17,287,656.25	16,977,781.07
Energy (Fuel for water tanker)	860,667.04	1,158,834.73	1,039,273.00
Chemical	266,000.00	1,244,369.50	1,252,851.65
House connection work	1,639,285,85	3,585,250.87	13,265,515.97
Maintenance/Repair	2,773,318.96	2,462,219.18	3,888,544.12
Other	1,731,196.81	2,304,170.66	3,835,099.20
Total	52,008,111.03	43,004,286.35	53,658,544.51

2) Customer Service and Tariff collection

Please provide us with:

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

- Current tariff table See attachment tariff table
- Sample customer contract. See attachment customer water contract
- List of Bulk users **Please see attachments Asmara drawings page 25 bulk users list**
- Sample of customer list **Please see attachment document number sample**
- Installation ratio of customer meter Sirak
- Method of billing **Customers read their water meter & present reading on the counter EVERY 3 MONTYHS**
- Method of tariff collection **Please see table 5**
- Installation record of water meter Sirak
- Repair record of water meter **NoT YET**
- Supplier of water meter **Bosco and Unimag schlumberger**

3) Financial Condition

Please provide us with the breakdown of revenue and expense record as of 2013 and 2014 (Tentative).

Please provide us with the capital expenditure record for last three years: 1) from Donors, 2) from own sources, 3) from Zoba, 4) from Central Government.

ESTIF

4) Procurement condition

Please provide us with the list of supplier of each equipment/material

Company Name	Address	Contact person	TEL&FAX(E-Mail)	Activity
				Pipe, valve, fittings
				Pump
				chlorine
				ALUM (aluminum sulfate) or PAC
				calcium hydroxide

Please provide us with the sample procurement documents

ESTIF

(3) Business Plan

Please provide us with the business plan of 2015 and long/medium term plan, if any. **NoT YET**

JOHN

Please provide us with output of Asmara Infrastructure Development Study including electric CAD data and pipeline network modeling data.

- Phase-1: Urban Development Plan
- Phase-2: Feasibility Study, Water Sector, Water Supply
- Phase-3: Detail Design of Priority Projects

Questionnaire for
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To AWSD

Please find attachment document on Asmara Infrastructure Development

1) Water Demand Projection

Please provide us with the water demand projection (target year, service area, service population, planned per capita consumption, target ratio of water loss, etc.) applied by AWSD.

Please see table 1

Please provide us with the latest population data in the service area.

Please see table of recent population on table (Maekel Population)

2) Upper Level Plan of Water Supply Development Plan

Please provide us with:

- Water Resources Management Plan of Zoba Maekel **Misghina**
- Urban Development Plan of Asmara city **Medhanie**

3) Plan for strengthening water production and distribution capacity

Please provide us with the current plan for strengthening water production and distribution capacity, if any. **The only plan is ASMARA INFRASTRUCTURE DEVELOPMENT STUDY 2005**

4) Major Issues for future development of water supply service

Please list up the major issues for safe, sufficient, stable, and sustainable water supply service of AWSD.

1. **Construction of Ungula and Demsebai Dams as sources of water supply**
2. **Their respective WTP, Pumping stations and Transmissions mains**
3. **Construction of Ababruk dam as a backup dam for Mainefhi dam, its raw water pumping station and transmission mains.**
4. **CAPCITY BUILDING**

V. Outline of Water Supply Facility of AWSD **Please see attached drawing document**

V-1. Intake Facility (River and Dam)

Please provide us with the following information.

V-1-1. Water utilization

(1) Construction project or water-utilization plan in Anseba river and Nefhi river basins (Upper River basin of TOKAR Dam and MAI NEFHI Dam)

Items	Upper River basin of TOKAR Dam	Upper River basin of MAI NEFHI Dam
	Water demand（m3/d or %）	Water demand（m3/d or %）
Drinking water by water supplier	No BM's at Adisheka, Streta vaudetto, Maiserwa and Elanahib dams	Nothing
Drinking water from river for local people	Nothing	Nothing
Industrial water	Nothing	Nothing
Irrigation water	Asmara Flowers No water meters	Nothing

Questionnaire for
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To AWSD

Water for electric power plant	No water meter Beleza Dam	Nothing
Water for fishery (aquaculture)	Not working at this time	Nothing
Others	Not quantified. Micro dams for micro-irrigation, soil and water conservation	Nothing
Total		

*** for more clarification please see hydrological map of Zoba Maekel**

(2) Customary water right or water right for drinking water, industrial water, drinking water from river, agricultural water, water for electric power plant, and water for fishery in Anseba river and Nefhi river basins **Mebrahtu Iyassu**

(3) Location and structure of existing dams in Maekel (Central) region

Please see the attached hydrological map of Zoba Maekel

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

V-1-2. Existing Dam (TOKAR, ADI SHEKA, MAI SERWA、STRETTA VAUDETTO, BELEZA, VALLE GNECCHI, ELA NAHIB, MAI NEFHI Dam)

Items		TOKAR	ADI SHEKA	MAI SERWA	STRETTA VAUDETTO	BELEZA	VALLE GNECCHI	ELA NAHIB	MAI NEFHI
River Name		Tokor		Mai Hutsa					Nefhi
Intended use		AWS	Hydro-electric	AWS	AWS	Thermo Electricity	Hydro-electric	Hydro-electric	AWS
Structure Type		RCC	Earth	Masonry	Concrete	Earth	Earth	Earth	Masonry
Dam Size	Length								
	Height(Max)								
	Upper Wide(Max)								
	Bottom Wide(Max)								
	Dam volume								
Catchment area		89	38	10	15	7			97
Water surface area									
Gross storage capacity		13.6	6	2.1	0.320	1.2	0.6	0.6	26
Effective storage capacity		9.2	4.2	1.47	0.22	0.84	0.42	0.42	19
Landownership		Gov	Gov	Gov	Gov	Gov	Gov	Gov	Gov
Ownership of structure		AWSD	AWSD	AWSD	AWSD	AWSD	AWSD	AWSD	AWSD
Water rights		Only given to AWSD	Only given to AWSD	Only given to AWSD	Only given to AWSD	Only given to AWSD	Only given to AWSD	Only given to AWSD	Only given to AWSD
Conservation-Management for Catchment area		MOA, zoba Maekel	MOA, zoba Maekel	MOA, zoba Maekel	MOA, zoba Maekel	MOA, zoba Maekel	MOA, zoba Maekel	MOA, zoba Maekel	MOA, zoba Maekel
Management for Structure		AWSD	AWSD	AWSD	AWSD	AWSD	MOA	AWSD	AWSD
Current Problem		No enough runoff due to climate chang	No enough runoff due to climate chang	High leakage & sedimentation, No enoug	High sedimentation accumulated, No	High sedimentation accumulated, No enough runoff due	High sedimentation accumulated, No enough	High sedimentation accumulated	No enough runoff due to climate change,

Questionnaire for
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To AWSD

	e,	e,	h runoff due to climate chang e,	enoug h runoff due to climate chang e,	to climate change,	runoff due to climate change ,	, No enoug h runoff due to climat e chang e,	

V-1-3. Erosion and flood control

Please describe the detailed contents of the Disasters Report (flood, drought, overflowing of river, landslide etc.) in Anseba river and Nefhi river basins (Upper River basin of TOKAR Dam and MAI NEFHI Dam) (last decade) with the following information

Location		Date	cause	situation of damage
Upper River basin of TOKAR Dam	Between TOKAR and ADI SHEKA Dam	**WRD**		
	Upper side of ADI SHEKA Dam			
	Between TOKAR and MAI SERWA Dam			
	Between MAI SERWA and STRETTA VAUDETTO Dam			
	Between STRETTA VAUDETTO and BELEZA Dam			
	Upper side of BELEZA Dam			
	Between STRETTA VAUDETTO and VALLE GNECCHI Dam			
	Between STRETTA VAUDETTO and ELA NAHIB Dam			
	Upper side of VALLE GNECCHI Dam			
	Upper side of ELA NAHIB Dam			
Upper River basin of MAI NEFHI Dam	Upper side of MAI NEFHI Dam			

*** Generally**

Questionnaire for
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To AWSD

V-2. Raw Water Conveyance Facility

Please provide us with the following information.

	Adi Sheka dam to Stretta Vaudetto WTP	Stretta Vaudetto dam to Stretta Vaudetto WTP	Mai Serwa dam to Stretta Vaudetto WTP	Toker dam to Toker WTP	Mai Nefhi dam to Mai Nfhi WTP
Raw water conveyance pump station					
Pump capacity and number	400m^3/hr each, 2 pumps	400m3/hr, 1 pump	250m3/hr, 1 pump	1200m3/hr, 2 pumps with diesel engines	Gravity
Year of construction	1997	1998	1963	2000	1970
Condition	Need replacement	Need replacement on its original location	Need replacement	Need replacement with electrical motors	Need replacement
Raw water conveyance pipeline					
Pipe material	Open channel	GI	Asbestos + Cast Iron	ductile Iron	Cast Iron
Pipe diameter		150mm	300mm	600mm	500mm
Pipe length		500m	2700m	20000m	150m
Year of construction	1942	1941	1963	2000	1970
Condition	Fair	Need replacement	Urgently need replacement	Good	Urgently need replacement

Please provide us with the location map and drawings showing pipe alignment, longitudinal and cross section, valve location, etc. of the above facility.

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

V-3. Water Treatment Facility

Please provide us with the following information.

(1) Inlet, Outlet Volume and Operation Time

WTP Name	Inlet (m3/day)	Outlet (m3/day)	Operation Time (hour/day)
STRETTA VAUDETTO (S.V.) WTP	12600	5000	13
TOKER WTP	11000	7200	10
MAI NEFHI WTP	Depends on water level of dam	12000	20

(2) Problem of each Facility

Items	STRETTA VAUDETTO (S.V.) WTP	TOKER WTP	MAI NEFHI WTP
Intake Basin			
Mixer			
ALUM(aluminum sulfate) or PAC			
Calcium hydroxide			
Flocculation Basin			
Sedimentation Basin			
Filter basin			
Air Blow			
Back Wash			
Clean water Tank			
chlorination			
Electric System			

V-4. Treated Water Transmission Facility from WTP to Service Area

Please provide us with the following information.

V-4-1. Transmission Pump Station

	Stretta Vaudetto WTP	Toker WTP	Mai Nefhi WTP
Pumps			
Pump capacity and number	500m3/hr, 2 pumps	450m3/hr, 3 pumps	500m3/hr, 3 pumps
Year of construction	1941 and 2013	2000	1971
Condition	One need replacement	Fair	Need replacement
Pump well			
Elevation	2350	2375	2150
Volume	600m3	5000m3	800m3
Year of construction	1941	2000	1971
Condition	Bad	Need maintenance	Need maintenance

Please provide us with the drawings of the above facility.

Questionnaire for
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To AWSD

V-4-2. Treated Water Transmission Pipeline

	Stretta Vaudetto WTP to Service Area	Toker WTP to Service Area	Mai Nefhi WTP to Service Area (New Sembel PS)
Pipe material	PVC	Ductile Iron	Cast Iron
Pipe diameter	300mm	400mm	500mm
Pipe length	About 3.6 Km	About 3.25 Km	25 Km
Pipe bridge (type, span)	-		?
Year of construction	1999	2000	1971
Condition	Good	Good	Urgently Need replacement

Please provide us with the location map and drawings showing pipe alignment, longitudinal and cross section, valve location, etc. of the above facility.

V-5. Treated Water Transmission/Distribution Facility in the Service Area

Please provide us with the following information.

V-5-1. Transmission/Distribution Pump Station

	Sembel	Godaif	MaiChhot	Denden
Pumps				
Pump capacity and number	450m3/hr, 3 pumps	500m3/hr, 300m3/hr, 2 pumps	200m3/hr, 150m3/hr, 2 pumps	200m3/hr, 2 pumps
Year of construction	1998	2013, 1971	2013, before 1971	1956
Condition	Fair	1 need replacement	1 need replacement	Need replacement
Pump well				
Elevation	2320	2324	2336	2348
Volume	3000m3	Relay station or buster pump	480m3	3000m3
Year of construction	1971	1971	Before 1971	1956
Condition	Need maintenance	Should be abandoned	Need maintenance	Need maintenance

Please provide us with the drawings of the above facility.

V-5-2. Distribution Reservoir

	Tsetserat	Hazhaz	Mihram Chira	Arbate Asmara	Monopolio	Addis Alem
Elevation	2361	2361	2375	2394	2360	2372
Capacity	2x500	2x500	300	500	2x300	250
Year of construction						
Condition	Need maintenance	Need maintenance	Not in use	Not in use	Need maintenance	Need maintenance

Please provide us with the drawings of the above facility.

Questionnaire for
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To AWSD

Please provide us with current reservoir operation (water level fluctuating pattern)

V-5-3. Transmission/Distribution Pipeline Network

- General network drawings showing:
  - Location, material, diameter, construction year of primary network
  - Location of secondary network
  - Location of major valves
  - Boundary of distribution zoning
- Detail network drawings showing:
  - Location, material, diameter, of primary and secondary network
  - Location of service connection on the primary pipe
- Detail drawings of the major valve chamber
- Pipe Inventory (pipe length by material, construction year, and diameter)
- Repair record of distribution pipeline
- Standard cross section drawings of pipe installation

*** Please see the attachment document on Asmara infrastructure Development Study; Water Sector: Drainage- Water Supply – Sanitation Drawings**

V-5-4. Current valve operation for scheduled water supply restriction

Please provide us with the current valve operation for scheduled water supply restriction

*** Data From John**

V-5-5. Schematic drawing and modeling data for pipe network analysis

Please provide us with the modeling data for pipe network analysis made by the Asmara Infrastructure Development Study.

Please see the attachment document on Asmara infrastructure Development Study; Water Sector: Drainage- Water Supply – Sanitation Drawings

V-6. Water Service Facility

Please provide us with the following information.

- Location of water tanker filling station and bulk user.
- Supply hour and average daily supply volume of each filling station
- Average daily consumption of the bulk users
- Standard drawings of customer connection
  - i) Direct connection to tap
  - ii) Connection to receiving tank
- Approximate ratio of the number of i) and ii) (if data is available)
- **Please see the attachment document on Asmara infrastructure Development Study;**

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

Water Sector: Drainage- Water Supply – Sanitation Drawings

VI. Operation and Maintenance by AWSD

Please provide us with the following information.

VI-1. Current Problem in Operation and Maintenance of each water supply facility.

Facility	Problem of Operation and Maintenance
Dam and Intake Facilities	
VALLE GNECCHI Dam	High sedimentation (mud) inside the dam, pipeline connecting to the S.V. WTP is destroyed, no BM's meters to WTP
ELA NAHIB Dam	High sedimentation (mud) inside the dam no BM's to WTP
STRETTA VAUDETTO (S.V.) Dam	High sedimentation (mud) inside the dam, primary and secondary Intake structure not working, Leakage from dam, no BM's to WTP
BELEZA Dam	High sedimentation (mud) inside the dam
MAI SERWA Dam	High sedimentation (mud) inside the dam, high leakage from dam , no BM's meters to WTP, We are not using the hydraulic pressure from the dam elevation since we first put in the pumping station reservoir.
ADI SHEKA Dam	High sedimentation (mud) inside the dam, in pumping station one motor is working, no BM's meters to WTP
TOKER Dam	High running cost due to Diesel engine and should be replaced by electric motors
MAI NEFHI Dam	Moderate sedimentation problem. no BM's meters to WTP
Raw Water Pipe and Open Channel (Inc. Pump Station)	
ADI SHEKA Dam - S.V.WTP	500m asbestos pipe line, contamination on Open channel
MAI SERWA Dam - S.V.WTP	Replacement of 2.5Km asbestos pipeline
S.V Dam - S.V.WTP	No BM's meters
TOKER Dam - TOKER WTP	
MAI NEFHI Dam - MAI NEFHI WTP	no BM's meters
Water Treatment Plant	
STRETTA VAUDETTO (S.V.) WTP	Requires high maintenance, need to be replaced by new WTP
TOKER WTP	Automatic equipment are not functioning, liquid chlorine producing plant is not working, chlorine hypochlride mixer is not working, electric motors for mixing and string need replacement, need backup generator
MAI NEFHI WTP	Generally requires full maintenance on main structure, Gas chlorine should be stopped and need to be replaced as in Tokor WTP, mixers of aluminum sulphate together with injectors need maintenance and/or replacement, need backup generator, no BM's to WTP and BM's

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To AWSD

	from WTP to Sembel pumping station need to be replaced.
Clean Water Pipe (Inc. Pump Station)	
S.V.WTP - P.S or Reservoir in City	No BM's meters
TOKER WTP - P.S or reservoir in City	Backup pumps are required
MAI NEFHI WTP - NEW SEMBEL P.S.	pumps are old and need to be replaced, pipe line is old and need to be replaced, BM's meter is not working and need to be replaced
NEW SEMBEL P.S. - P.S or reservoir in City	The reservoir itself require maintenance, backup generator required. Pumps need to be replaced with better head and efficiency so as to supply with Godaif pumping station
Pump Station in city	
MAI CHEHOT P.S.	
DENDEN P.S.	
NEW SEMBEL P.S.	
GODAIF P.S.	Not required if the Sembel is replaced
Reservoir	
MIHRAM CHIRA E.T.	Not use
ARBATO ASMARA E.T.	Not use
ADDIS ALEM Reservoir	Not use
HAZHAZ Reservoir	Requires maintenance
TSETSERAT Reservoir	Requires maintenance
MONOPOLIO Reservoir	Requires maintenance
Distribution Pipe	
North East (From S.V.WTP mainly)	
North West and Central (From TOKAR WTP mainly)	
South (From MAI NEFHI WTP mainly)	
Service Pipe	
Public Water Tap	
Private	
Large Consumer (Industry)	They are suffering from shortage of water supply. Therefore, they have to assess their own groundwater sources.
Truck Hydrant (LC1 P.E, Haz Haz, Sembel)	

VI-2. Non-Revenue Water (NRW) Reduction

(1) Action plan for NRW reduction

(2) Activity for leak Detection and pipe repair work

(a) Record of number of leakage repaired in 2014

Items	No
Major leak and pipe burst	
Minor leak and service connection leakage	
Meter leak	

Broken meter	

(b) Number of pipe repair team and staff composition

・Number of pipe repair team

・Number of staff

・List of equipment and vehicle

(3) If you have established a computerized mapping system (CAD or GIS), please describe the contents of the mapping system (e.g. kind of software, kind of data compiled, coverage of network, linkage to water tariff collection system and number of computer installed).

(4) What is the most critical problem which you encounter in NRW reduction at present?

VI-3. Water quality management

(1) Water sampling point, frequency of test and parameter of water quality test, and the latest water quality test records of raw water and treated water.

(2) List of laboratory and its staff composition (number, level and specialty).

(3) List of available laboratory equipment for water quality analysis.

(4) Current issues and problems on drinking water quality which you encounter at present.

*** We are using Water Resources Department Water Quality laboratory. All information can be provided from Mr Efrem Teferi**

VI-4. Staff training

(1) Records of staff training in the year 2014

(a) Number of trainees (managers, engineers and operators/office clerks/workers) by each training course.

(b) Budget for staff training.

(2) Do you have trainers for staff training in your office? If you have, please describe their name and training course they teach, and records of staff training in your office.

(3) Your plan for staff training in the year 2015.

(4) Do you have job description or qualification system for each post?

(5) Do you have any incentive system for trainers and trainees such as promotion and salary rise?

(6) If you have any problem in staff training, please describe it in detail.

VI-5. Assistance for O&M

Please list up required assistance for O&M

VII . Environment and Social Consideration

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To AWSD

Please provide us with the following information

VII -1. Environmental Impact Assessment (EIA)

(1) Please provide us with the legal system, competent authorities and procedure of following information.

1) Initial Environmental Examination(IEE)

2) Project Environmental Screening

3) Project Environmental Evaluation (EE)

4) Environmental Impact Assessment (EIA)

*** The Department of Environment has National Environmental Impact Assesment Guideline. All the IEE, PSF, EE AND EIA are included in it.**

(2) Have you surveyed the IEE for the project which you requested to Japan?

*** No.**

(3) Have you submitted the project environmental screening form (PSF) for the requested project to the environment department?

*** Department of Environment was part of the study and already PSF is done. The whole study of Asmara infrastructure development study.**

(4) How do you think that the requested project is necessary to do EIA ?

*** Yes it is good to review EIA due to that the fact the last study was carried before 10 years back.**

VII -2. Environment (esp. Maekel (Central) region)

Please provide us with the following information and map.

(1) Reserve, national park *** No National Park**

(2) Habitat of Vegetation flora *** Yes, but information we could not find in map form other than the land cover map.**

(3) Habitat of water creatures, rare animals and plants *** No information**

(4) Migratory fish *** No migratory fish in the project area.**

(5) Breeding place, feeding area for wild animals *** The breeding and feeding place is the Semenawi Bahri and Eastern Escarpment protected area which is out of the project development site.**

VII -3. Culture (esp. Maekel (Central) region)

Please provide us with information and maps of (cultural, natural, religious, archaeological) heritages and historic spot, Nationally-designated important cultural property

For a time being it is not yet mapped. It can be mapped during the EIA process.

VII -4. Ethnic group (esp. Maekel (Central) region)

Please provide us with the following information and map.

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To AWSD

(1) Residence area of ethnic group and segment *** there is no residence by ethnic groups**

(2) Ethnic group conflict *** no ethnic conflict in the project area even within the country**

(3) Culture and life pattern of minority or indigenous group *** there is no such things in Eritrea. All ethnic, culture, language and religion have equal rights and live together with respecting each other.**

VII -5. Region (esp. Maekel (Central) region)

Please provide us with the following information

(1) Average earnings and family structure per household *** At this time we could not find census data.**

(2) Regional industry *** refer to maps provided as a potential point source pollutant industries.**

(3) Data of water disease (diarrhea, typhoid (fever), cholera, schistosomiasis) *** we do not have at hand in this time.**

VIII . Electric Power Supply

Please provide us with the following information.

(1) Electricity supply time per day (Average) in Maekel (Central) region *** it is completely variable**

(2) Current tariff applied by EEC * **Please look the bill attached**

IX. Others

Please provide us with the following information.

IX-1. Condition of Access Road

Access Road	Problem
STRETTA VAUDETTO (S.V.) Dam	Need minor maintenance and increase width
MAI SERWA Dam	No problem
ADI SHEKA Dam	No problem
TOKER Dam	Require maintenance especially with in the Tokor valley
MAI NEFHI Dam	No problem
STRETTA VAUDETTO (S.V.) WTP	Need minor maintenance and increase width
TOKER WTP	Need minor maintenance and increase width
MAI NEFHI WTP	Road with in the valley need to be change to asphalt

IX-2. Construction Companies and Suppliers

(1) List of construction companies (civil, building, pipe installation and electricity) having experiences of water supply works

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To AWSD

Company Name	Address	Contact person	TEL&FAX(E-Mail)	Activity
				Civil
				Building
				Pipe installation
				Electricity

(2) List of suppliers (Pump, pipe, valve and fittings)

Company Name	Address	Contact person	TEL&FAX(E-Mail)	Activity
				Pipe, valve, fittings
				Pump
				chlorine
				ALUM (aluminum sulfate) or PAC
				calcium hydroxide

IX-3. Procedure and permission

(1) Competent authorities and Procedure of permission for Water supply facilities

(2) Competent authorities and procedure for land acquisition for water supply facilities

*** land is Government owned,. The responsibility department is Department of Land under the ministry of land, water and environment. There is no problem to own land for water supply.**

X. Related Document and Data

Please provide us with following document and data.

X-1. Law and regulation

River	River Law
	Law of customary water right or water right (Drinking, industry, drawing water from river, agriculture, fishery)
Water	Water Law (River and Drinking water quality standard, daily maximum water-consumption etc.) *** pls look the attached Water Law 162/2010**
	Water supply facility standard (intake, filtration, distribution) *** we use ISO standard.**
Hygiene	Hygiene Law (drinking water quality standard) *** pls see Draft Eritrea Water Quality Standard 2004**
Sewerage	Sewerage Act (Effluent standard; SS、BOD、COD、pH etc.) *** in draft form from DOE**
Waste Disposal	Waste Disposal Law *** in draft form from DOE**
Environment	Environmental Law (regulation of nature and wild animal reserve) *** in draft**

	form from DOE
	Environment Protection Law *** in draft form from DOE**
	Environmental Standards Law (Air pollution, noise, vibration) *** in draft form from DOE**
	Law of EIA for dam and Water supply **?????**
Land	Land Law (landownership) *** Land Law 1994**
	Land Law (land transfer) *** Land Law 1994**
	Regulation of Land Acquisition *** Land Law 1994**
	Regulation of compensation for resettlement ???????????
	Regulation of land utilization *** Land Law 1994**
Tax	Regulation of collect [levy] tax (real estate tax, consumption tax, customs duty etc.) *** Office of inland revenue and Municipality of Asmara and administrative regions.**
Labor	Labor Standards Act (Minimum wage etc.) *** Yes there is but we could not find copy at this time.**
	Industrial Safety and Health Law (safety statutes) *** Yes there is but we could not find copy at this time.**

X-2. Map

Basic	Topographical map in Maekel (Central) region (approx. scale 1:5000) *** We have 1:50,000 scale**
	Geological Map in Maekel (Central) region *** We have 1:50,000 scale for the project area**
	Hydrogeological Map in Maekel (Central) region *** We have 1:50,000 scale for the project area**
	Soil map in Maekel (Central) region *** We have 1:50,000 scale for the project area**
River	Location map of water flow observation station in Anseba river and Nefhi river basins *** We have 1:50,000 scale for the project area**
Meteorological	Location map of a precipitation station in Maekel (Central) region *** We have 1:50,000 scale for the project area**
Ecosystem	Natural vegetation map in Maekel (Central) region *** We do not have this**
	Inhabitation map of wildlife in Maekel (Central) region *** We do not have this**
	Nature reserve and protection area *** Pls see land cover map of project area**
Land	Land use map in Maekel (Central) region *** We have 1:50,000 scale for the project area**
	Land-block map in Maekel (Central) region **???????**
	Map of state-owned land municipal land *** All Land is owned by Government**
Water-utilization	Water-utilization distribution map in Anseba river and Nefhi river basins (Drinking, industry, drawing water from river, agriculture, fishery) *** pls refer to hydrological map**
Erosion and flood control	Erosion and flood control plan map in Anseba river and Nefhi river basins *** We could not find at this time**

X-3. Monitoring Data

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

Meteorological	Hourly rainfall, monthly rainfall, sunny day, rainy day, wind direction, wind velocity, evapotranspiration, temperature, humidity, atmospheric pressure, hourly sunlight, intensity of solar radiation (last decade) at precipitation station in Maekel (Central) region
River	Water level, water quality, discharge rate (last decade) at water flow observation station in Anseba river and Nefhi river basins
Dam	Water Level of each dam (TOKAR, ADI SHEKA, STRETTA VAUDETTO, BELEZA, VALLE GNECCHI, ELA NAHIB, MAI NEFHI Dam) *** pls refere to attached table**
Water quality	Water quality of Raw, Clean and Drinking water (3 years) at each WTP(TOKAR, STRETTA VAUDETTO, MAI NEFHI WTP)
Hygiene	Water disease in Maekel (Central) region (diarrhea, typhoid (fever), cholera, schistosomiasis**)** *** We could not find now, but is negligible at this time**.

X-4. Document

(1) Design Report (Inc. Drawings) for each existing dam (TOKAR, ADI SHEKA, STRETTA VAUDETTO, BELEZA, VALLE GNECCHI, ELA NAHIB, MAI NEFHI Dam)

(2) Design Report (Inc. Drawings) for each Water treatment Plant (TOKAR, STRETTA VAUDETTO, MAI NEFHI)

Table 1 Population Projection and Water Demand Analysis

WATER DEMAND FORECAST

			2005		LOW HYPOTHESIS				REFERENCE HYPOTHESIS			
			shortage	demand	2010	2015	2020	2025	2010	2015	2020	2025
GREAT ASMARA POPULATION		**Number**	**450 000**	**450 000**	**579 817**	**745 311**	**765 653**	**822 796**	**579 817**	**745 311**	**765 653**	**822 796**
		Growth rate			*5.2%*	*5.2%*	*0.5%*	*1.5%*	*5.2%*	*5.2%*	*0.5%*	*1.5%*
Households		Number	100 000	100 000	128 848	165 625	170 145	182 844	128 848	165 625	170 145	182 844
People per household		Number	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
NON SERVED POPULATION		**Number**	**40 000**	**40 000**	**40 587**	**44 719**	**38 283**	**41 140**	**40 587**	**40 992**	**30 626**	**32 912**
		%			**7.0%**	**6.0%**	**5.0%**	**5.0%**	**7.0%**	**5.5%**	**4.0%**	**4.0%**
SERVED POPULATION		**Number**	**410 000**	**410 000**	**539 230**	**700 592**	**727 370**	**781 656**	**539 230**	**704 319**	**735 027**	**789 884**
By connection		Number	266 500	266 500	377 461	525 444	581 896	664 408	377 461	549 369	602 722	695 098
		%	65%	65%	70%	75%	80%	85%	70%	78%	82%	88%
By water tank trucks or public taps		Number	143 500	143 500	161 769	175 148	145 474	117 248	161 769	154 950	132 305	94 786
		%	35%	35%	30%	25%	20%	15%	30%	22%	18%	12%
CONSUMPTION		**m3/day**	**19 000**	**24 134**	**32 586**	**43 515**	**46 402**	**51 272**	**34 767**	**52 244**	**60 982**	**68 560**
By connections		m3/day	16 100	20 690	28 704	39 311	42 911	48 458	30 884	48 112	57 454	66 033
Domestic		m3/day	13 100	15 990	22 648	31 527	34 914	39 864	24 535	39 555	48 218	55 608
Non domestic		m3/day	3 000	4 700	6 056	7 784	7 997	8 594	6 349	8 557	9 236	10 425
	Non domestic growth rate				*5.2%*	*5.2%*	*0.5%*	*1.5%*	*6.2%*	*6.2%*	*1.5%*	*2.5%*
By water tank trucks		m3/day	2 900	3 444	3 882	4 204	3 491	2 814	3 882	4 132	3 528	2 528
Domestic	75%	m3/day	2 175	2 583	2 912	3 153	2 619	2 110	2 912	3 099	2 646	1 896
Non domestic	25%	m3/day	725	861	971	1 051	873	703	971	1 033	882	632
Per capita domestic consumption		lpc/day	37	45	47	50	52	54	51	61	69	73
By connection		lpc/day	49	60	60	60	60	60	65	72	80	80
By water tank trucks or public taps		lpc/day	15	18	18	18	18	18	18	20	20	20
LOSSES		**m3/day**	**5 051**	**11 887**	**12 052**	**14 505**	**15 467**	**17 091**	**12 859**	**17 415**	**20 327**	**22 853**
		%	**21%**	**33%**	**27%**	**25%**	**25%**	**25%**	**27%**	**25%**	**25%**	**25%**
TOTAL DEMAND			**24 051**	**36 021**	**44 638**	**58 019**	**61 869**	**68 363**	**47 626**	**69 658**	**81 310**	**91 414**

End

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To WRD

QUESTIONNAIRE

FOR

Preparatory Survey on the Project for Asmara Water Supply Development

Prepared by JICA Survey Team

March 2015

To WRD

(Water Resources Department, Ministry of Land, Water and Environment)

JICA is going to conduct “Preparatory Survey on the Project for Asmara Water Supply Development” in middle of March to middle of May, 2015.

Objectives of this survey are to collect required information of water supply sector of the Eritrea, as general condition, and Asmara city in details, and to analyze the possibility of drinking water supply improvement.

We would appreciate your cooperation in answering the following questions, and provide available data and information requested herein by March 27, 2015, for the sake of smooth implementation of the Survey.

- Form of response:
  We would like to receive the response in the form of soft data (Word/Excel/Auto CAD). We will bring our flush memory when we visit your office.
  In case the soft data is not available, please show us the hard copy of documents/drawings.
- Contact person:
  - Hidehisa Tamura (E-mail: a5361@n-koei.co.jp)
  - Koji Yoshikawa (E-mail: kingdom@heart.ocn.ne.jp)

Contents of the Questionnaire

I. Background and History of the Application for Japanese Grant Aid

We would like to confirm the background and history of the Application for Japanese Grant Aid.

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To WRD

II. Current Status of Water Supply Sector in Eritrea

(1) National Development Plan

We would like to know the current overall national development plan in Eritrea.

- To upgrade the system capacity of all the components of the water distribution system to improve service coverage and efficiency.
- To supply the population of Asmara with reliable, adequate and safe water which is beneficial for public health and economic activities.

(2) Laws/Regulation and Policy regarding Water Supply Service and Drinking Water

1) Water Resources Management

Please provide us with the Laws/Regulations and Policy on Water Resources Management in Eritrea.

See IWRM action plan

2) Water Supply Service

Please provide us with the Laws/Regulations and Policy on Water Supply Service in Eritrea.

There is no document for the whole Eritrea, but a separate draft document prepared for Massawa Water Supply is attached to this document.

3) Water Quality

Please provide us with the current regulation regarding water quality

Please see the attached Draft Document Water Quality standard of Eritrea 2004

(3) Governmental Organization related to Urban Water Supply Service in Eritrea

Please provide us with the following information.

Organization	Function
All urban settlements in Eritrea are autonomous.	They carry out urban water supply under the municipality of each urban center. They will cover their O&M from their income.

(4) Budget for Construction/Rehabilitation of Urban Water Supply Facility in Eritrea

Please provide us with past and current budget for construction/rehabilitation of urban water supply facility.

(Thousand Nakfa)

Zoba	2011	2012	2013	2014	2015
Maekel (AWSD)	( )	( )	( )	( )	( )
Debubu					
Gash-Barka					

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To WRD

Anseba					
Northern Red Sea					
Southern Red Sea					

*** Data will be given from AWSD**

*** other data could be provided from Michael Yosief, Mr Misghina and DJ Mebrahtu**

(5) Current Assistance by Foreign Donors in Water Supply Sector in Eritrea

Please provide us with the following information.

Donor	Project Name	Project Area	Period	Amount (Million Nakfa)
UNICEF				
AfDB				
World Bank				
EU				
Other ( )				
Other ( )				

*** Data will be given from AWSD**

*** other data could be provided from Michael Yosief, Mr Misghina and DJ Mebrahtu**

III. Integrated Water Resources Management Plan (IWRM)

Do you have any plan of Integrated Water Resources Management regarding Anseba river and Nefhi river basins or around Asmara city ? *** Pls look the IWRM action plane;**

If you have, please show us the plan.

IV. Water quality management

(1) Water sampling point, frequency of test and parameter of water quality test, and the latest water quality test records of raw water and treated water.

(2) List of laboratory and its staff composition (number, level and specialty).

(3) List of available laboratory equipment for water quality analysis.

(4) Current issues and problems on drinking water quality which you encounter at present.

*** We are using Water Resources Department Water Quality laboratory. All information can be provided from Mr Efrem Teferi**

V. Environment and Social Consideration

Please provide us with the following information

V-1. Environmental Impact Assessment (EIA)

(1) Please provide us with the legal system, competent authorities and procedure of following information.

1) Initial Environmental Examination(IEE）

2) Project Environmental Screening

3) Project Environmental Evaluation (EE)

4) Environmental Impact Assessment (EIA)

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To WRD

*** The Department of Environment has National Environmental Impact Assesment Guideline. All the IEE, PSF, EE AND EIA are included in it.**

(2) Have you surveyed the IEE for the project which you requested to Japan?

*** No.**

(3) Have you submitted the project environmental screening form (PSF) for the requested project to the environment department?

*** Department of Environment was part of the study and already PSF is done. The whole study of Asmara infrastructure development study.**

(4) How do you think that the requested project is necessary to do EIA ?

*** Yes it is good to review EIA due to that the fact the last study was carried before 10 years back.**

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To WRD

V-2. Environment (esp. Maekel (Central) region)

Please provide us with the following information and map.

(1) Reserve, national park *** No National Park**

(2) Habitat of Vegetation flora *** Yes, but information we could not find in map form other than the land cover map.**

(3) Habitat of water creatures, rare animals and plants *** No information**

(4) Migratory fish *** No migratory fish in the project area.**

(5) Breeding place, feeding area for wild animals *** The breeding and feeding place is the Semenawi Bahri and Eastern Escarpment protected area which is out of the project development site.**

V-3. Culture (esp. Maekel (Central) region)

Please provide us with information and maps of (cultural, natural, religious, archaeological) heritages and historic spot, Nationally-designated important cultural property

For a time being it is not yet mapped. It can be mapped during the EIA process.

V-4. Ethnic group (esp. Maekel (Central) region)

Please provide us with the following information and map.

(1) Residence area of ethnic group and segment *** there is no residence by ethnic groups**

(2) Ethnic group conflict *** no ethnic conflict in the project area even within the country**

(3) Culture and life pattern of minority or indigenous group *** there is no such things in Eritrea. All ethnic, culture, language and religion have equal rights and live together with respecting each other.**

V-5. Region (esp. Maekel (Central) region)

Please provide us with the following information

(1) Average earnings and family structure per household *** we do not have census data**

(2) Regional industry *** refer to maps provided as a potential point source pollutant industries.**

(3) Data of water disease (diarrhea, typhoid (fever), cholera, schistosomiasis) *** we do not have at hand in this time.**

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To WRD

VI. Related Document and Data

Please provide us with following document and data.

V-1. Law and regulation

River	River Law
	Law of customary water right or water right (Drinking, industry, drawing water from river, agriculture, fishery)
Water	Water Law (River and Drinking water quality standard, daily maximum water-consumption etc.) * pls look the attached Water Law 162/2010
	Water supply facility standard (intake, filtration, distribution) * we use ISO standard.
Hygiene	Hygiene Law (drinking water quality standard) * pls see Draft Eritrea Water Quality Standard 2004
Sewerage	Sewerage Act (Effluent standard; SS、BOD、COD、pH etc.) * in draft form from DOE
Waste Disposal	Waste Disposal Law * in draft form from DOE
Environment	Environmental Law (regulation of nature and wild animal reserve) * in draft form from DOE
	Environment Protection Law * in draft form from DOE
	Environmental Standards Law (Air pollution, noise, vibration) * in draft form from DOE
	Law of EIA for dam and Water supply ?????
Land	Land Law (landownership) * Land Law 1994
	Land Law (land transfer) * Land Law 1994
	Regulation of Land Acquisition * Land Law 1994
	Regulation of compensation for resettlement ???????????
	Regulation of land utilization * Land Law 1994
Tax	Regulation of collect [levy] tax (real estate tax, consumption tax, customs duty etc.) * Office of inland revenue and Municipality of Asmara and administrative regions.
Labor	Labor Standards Act (Minimum wage etc.) * Yes there is but we could not find copy at this time.
	Industrial Safety and Health Law (safety statutes) * Yes there is but we could not find copy at this time.

X-2. Map

Basic	Topographical map in Maekel (Central) region (approx. scale 1:5000) * We have 1:50,000 scale
	Geological Map in Maekel (Central) region * We have 1:50,000 scale for the project area
	Hydrogeological Map in Maekel (Central) region * We have 1:50,000 scale for the project area
	Soil map in Maekel (Central) region * We have 1:50,000 scale for the project area
River	Location map of water flow observation station in Anseba river and Nefhi river basins * We have 1:50,000 scale for the project area

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To WRD

Meteorological	Location map of a precipitation station in Maekel (Central) region *** We have 1:50,000 scale for the project area**
Ecosystem	Natural vegetation map in Maekel (Central) region *** We do not have this**
	Inhabitation map of wildlife in Maekel (Central) region *** We do not have this**
	Nature reserve and protection area *** Pls see land cover map of project area**
Land	Land use map in Maekel (Central) region *** We have 1:50,000 scale for the project area**
	Land-block map in Maekel (Central) region **???????**
	Map of state-owned land municipal land *** All Land is owned by Government**
Water-utilization	Water-utilization distribution map in Anseba river and Nefhi river basins (Drinking, industry, drawing water from river, agriculture, fishery) *** pls refer to hydrological map**
Erosion and flood control	Erosion and flood control plan map in Anseba river and Nefhi river basins *** We could not find at this time**

X-3. Monitoring Data

Meteorological	Hourly rainfall, monthly rainfall, sunny day, rainy day, wind direction, wind velocity, evapotranspiration, temperature, humidity, atmospheric pressure, hourly sunlight, intensity of solar radiation (last decade) at precipitation station in Maekel (Central) region *** Information can be found from Water Assessment and Information Division of WRD**
River	Water level, water quality, discharge rate (last decade) at water flow observation station in Anseba river and Nefhi river basins region *** Information can be found from Water Assessment and Information Division of WRD**
Dam	Water Level of each dam (TOKAR, ADI SHEKA, STRETTA VAUDETTO, BELEZA, VALLE GNECCHI, ELA NAHIB, MAI NEFHI Dam) *** pls refere to attached table**
Water quality	Water quality of Raw, Clean and Drinking water (3 years) at each WTP(TOKAR, STRETTA VAUDETTO, MAI NEFHI WTP) *** Data can be found from WRD water quality lab**
Hygiene	Water disease in Maekel (Central) region (diarrhea, typhoid (fever), cholera, schistosomiasis) *** We could not find now, but is negligible at this time.**

X-4. Document

(1) Design Report (Inc. Drawings) for each existing dam (TOKAR, ADI SHEKA, STRETTA VAUDETTO, BELEZA, VALLE GNECCHI, ELA NAHIB, MAI NEFHI Dam)

*** all these information can be found from AWSD or Municipality of Asmara**

End

付属資料 4.

11) 写真集

水源･ダム編 （1/9）

Valle Gnecchiダム　アースダム全体
2015年4月時点で水位は低く十分な貯水量がない。ダム湖内の堆積土が多い。

Valle Gnecchiダム　堤体の上流のり面
表面ロックでのり面を保護している。

Valle Gnecchiダム　堤体の下流のり面

Valle Gnecchiダム　洪水吐
堤体の大きさと比較して規模が小さい。

Valle Gnecchiダム　堤体の下流側
取水施設があるが現在未使用。

Ela Nahib (Adi Nefas)ダム　重力式コンクリートダム全体
2015年4月時点で比較的十分な水量がある様に見えるが、水位は低い。

水源・ダム編 （2/9）

Ela Nahib (Adi Nefas)ダム　洪水吐
洪水吐き兼Valle Gnecchiダムまでの旧水路

Ela Nahib (Adi Nefas)ダム　堤体の下流側
取水施設があるが現在未使用。

Ela Nahib (Adi Nefas)ダム　堤体の下流側
浸透した水を利用して畑地が広がる。

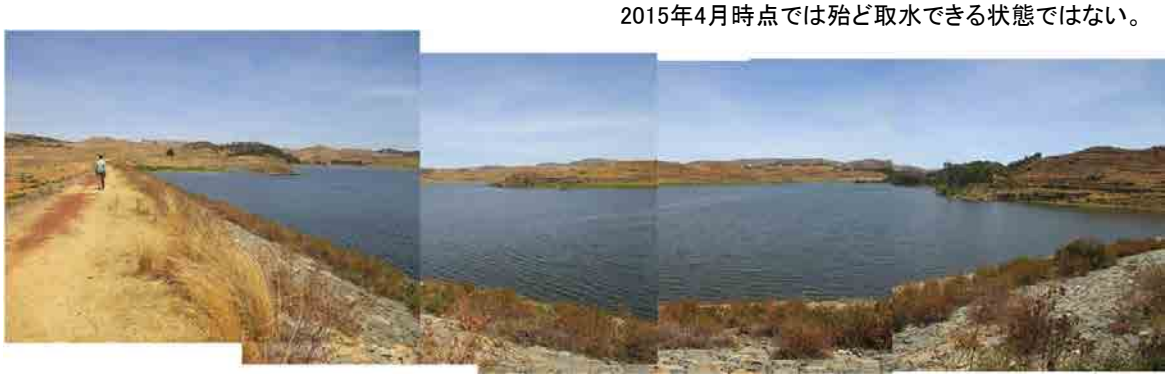
Belezaダム　重力式コンクリートダム全体
2015年4月時点で水がある様に思えるが堤体の部分のみである。

Belezaダム　ダム湖全体
EECが使用している取水塔と火力発電所。ダム湖内の堆積土が多い。

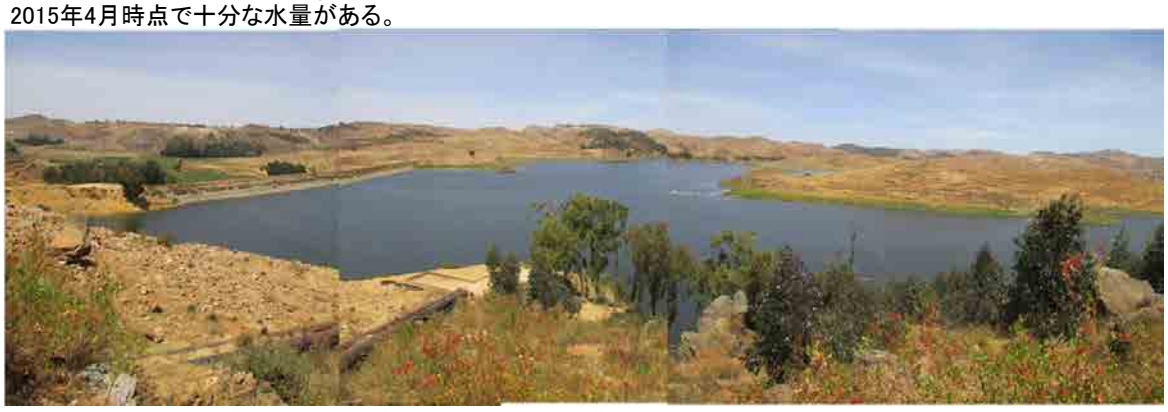
水源･ダム編 （3/9）

Belezaダム　洪水吐き

Belezaダム　EECが使用している取水塔
2015年4月時点では殆ど取水できる状態ではない。



Adi Shekaダム　アースダム全体
2015年4月時点で十分な水量がある。



Adi Shekaダム　アースダム全体

Adi Shekaダム　洪水吐き

Adi Shekaダム　堤体の上流側のり面
表面ロックでのり面を保護している。

水源・ダム編 （4/9）

Adi Shekaダム　ダム湖内
ダム湖内の堆積土が多い。

Adi Shekaダム　堤体の下流側
浸透した水を利用して畑地が広がる。

S.Vダム　重力式コンクリートダム全体
2015年4月時点で十分な水量があるように見えるが堆積土多く水位はない。

S.Vダム　堤体内洪水吐き

S.Vダム　現在使用中の取水管

S.Vダム　旧取水塔

S.Vダム　旧取水ポンプ場
排泥管から取水していた。

水源・ダム編 （5/9）

S.Vダム　取水ポンプ
堤体上に設置して使用中。

S.Vダム　排泥管
5つあるがどれも泥が詰り未稼働。

S.Vダム　左岸と堤体継ぎ目から漏水
約0.1ℓ/秒の漏水。

S.Vダム　ダム湖内の堆積
ダム湖内の堆積は顕著である。

Mai Serwaダム　重力式コンクリートダム全体
左にあるのは導水ポンプ場。

Mai Serwaダム　ダム湖内
2015年4月時点で十分な水がある。

Mai Serwaダム　堤体下流側
5つの排泥弁の内4つは泥詰りのため使用不可。
現在、排泥管から取水している。

水源・ダム編 （6/9）

Mai Serwaダム　取水管
取水管のバルブ故障で使用されていない。

Mai Serwaダム　取水管バルブ　堤体下流側

Mai Serwaダム　旧洪水吐き
下流部崩壊後、未使用。

Mai Serwaダム　洪水吐き
仮設洪水吐きが現在も使用されている。

Tokerダム　重力式コンクリートダム全体
十分な水量がある。

Tokerダム　堤体上流側

Tokerダム　堤体下流側　堤体内洪水吐き

水源･ダム編 （7/9）

Tokerダム　堤体一体型取水塔

Tokerダム　堤体一体型取水塔

Tokerダム　堤体内洪水吐き

Tokerダム　導水ポンプ場と放水吐き

Tokerダム　放水吐きバルブ

Tokerダム　15KVAの送電線

Tokerダム　アクセス道路
岩の急傾斜で車の乗り入れ困難。

水源・ダム編 （8/9）

Mai Nefhiダム　ダム湖全体

Mai Nefhiダム　重力式コンクリートダム全体

Mai Nefhiダム　堤体上流側

Mai Nefhiダム　堤体下流側

Mai Nefhiダム　取水管

Mai Nefhiダム　取水管

水源･ダム編 （9/9）

Mai Nefhiダム　洪水吐き

Mai Nefhiダム　排泥管
使用できるのかは不明。

Mai Nefhiダム　排泥管
使用できるのかは不明。

Mai Nefhiダム　排泥水路

S.V浄水場編　（1/7）

S.V浄水場　全体

S.V浄水場　流入口
Toker浄水場のオーバーフロー管

S.V浄水場　流入口

S.V浄水場　流入口

S.V浄水場　着水井

S.V浄水場　着水井

S.V浄水場　　滝部分

S.V浄水場　　滝部分

S.V浄水場編　（2/7）

S.V浄水場　滝部分

S.V浄水場　フロック形成池

S.V浄水場　フロック形成池

S.V浄水場　フロック形成池のデフレクター

S.V浄水場　フロック形成池のデフレクター
腐食で未稼働。

S.V浄水場　フロック形成池と沈殿池の水路

S.V浄水場　沈殿池

S.V浄水場　沈殿池 出口

S.V浄水場編　（3/7）

S.V浄水場　沈殿池 排泥弁
5つの沈殿池の排泥弁が稼働しない。

S.V浄水場　沈殿池と調整池の配管

S.V浄水場　逆洗管

S.V浄水場　調整池

S.V浄水場　調整池　出口

S.V浄水場　ろ過池
ろ床表面に泥が堆積している。

S.V浄水場　ろ過池
ろ床表面に穴が開いている。

S.V浄水場　ろ過池

S.V浄水場編　（4/7）

S.V浄水場　ろ過池
逆洗等のバルブ操作

S.V浄水場　ろ過池
逆洗等のバルブ操作の下側

S.V浄水場　逆洗タンク

S.V浄水場　逆洗タンク下部のバルブ

S.V浄水場　送水ポンプ

S.V浄水場　送水ポンプ

S.V浄水場　送水ポンプ
地下浄水池からの取水口。

S.V浄水場　送水ポンプ
地下浄水池からの取水口。

S.V浄水場編　（5/7）

S.V浄水場　送水ポンプ
送水管からの漏水。

S.V浄水場　送水管

S.V浄水場　送水管と逆洗の流入、流出管

S.V浄水場　ろ過逆洗の排泥バルブ

S.V浄水場　ろ過池の排泥バルブ等

S.V浄水場　調整池の排泥バルブ等

S.V浄水場　発電機室

S.V浄水場　発電機
送水ポンプ稼働できない容量で未使用。

S.V浄水場編　（6/7）

S.V浄水場　管理棟

S.V浄水場　受電変圧器

S.V浄水場　排水
未処理の排水をS.Vダム湖に放流。

S.V浄水場　雨期の水質
雨期に流入する水の濁度を示す。

S.V浄水場　旧薬液製造施設

S.V浄水場　旧薬液製造施設と薬品貯蔵

S.V浄水場　ALUM貯蔵

S.V浄水場　旧塩素ガス注入室

S.V浄水場編　（7/7）

S.V浄水場　旧塩素ガス注入室

S.V浄水場　塩素ガス注入
地下浄水池に直接注入。

S.V浄水場　ろ過池と浄水池の建屋

S.V浄水場　ろ過池と浄水池の建屋
老朽化する建屋。

S.V浄水場　ろ過池と浄水池の建屋
沈下約5cm。

S.V浄水場　ろ過池と浄水池の建屋
建物の亀裂と剥離が目立つ。

S.V浄水場　ろ過池と浄水池の建屋
建物の亀裂と剥離が目立つ。

S.V浄水場　ろ過池と浄水池の建屋
建物の亀裂と剥離が目立つ。

Toker浄水場　(1/6)

Toker浄水場 水再生処理施設

Toker浄水場　調整池

Toker浄水場　調整池

Toker浄水場　着水井

Toker浄水場　調整池から撹拌池への出口

Toker浄水場　調整池からの流入口
ﾊﾟｰｼｬﾙﾌﾘｭｰﾑ(流量調整)

Toker浄水場　撹拌池　No.1とNo.2

Toker浄水場　撹拌池　No.1
ALUM注入地点

Toker浄水場　(2/6)

Toker浄水場　フロック形成池

Toker浄水場　フロック形成池

Toker浄水場　傾斜板型沈殿池

Toker浄水場　傾斜板型沈殿池

Toker浄水場　ろ過池

Toker浄水場　ろ過池

Toker浄水場　ろ過池
ろ床の状態。

Toker浄水場　ろ過池
使用しているろ過砂。

Toker浄水場　(3/6)

Toker浄水場　ろ過池　下部

Toker浄水場　ろ過池　下部

Toker浄水場　浄水池

Toker浄水場　浄水池

Toker浄水場　塩素ガス
浄水池に直接注入。鋼製蓋が塩素ガスにより腐食。

Toker浄水場　塩素ガス

Toker浄水場　浄水池上　送水ポンプと逆洗ポンプ

Toker浄水場　浄水池上　送水ポンプと逆洗ポンプ

Toker浄水場　(4/6)

Toker浄水場　送水管

Toker浄水場　送水管

Toker浄水場　エアーブローポンプ

Toker浄水場　エアーブローポンプ

Toker浄水場　発電機室と受電変圧器室と給油タンク

Toker浄水場　発電機

Toker浄水場　排水池

Toker浄水場　排水池の水中ポンプ

Toker浄水場　(5/6)

Toker浄水場　排水池と排水処分池の水路(越流部)

Toker浄水場　排水処分池

Toker浄水場　薬品貯蔵と薬液製作と次亜塩素酸生成器室

Toker浄水場　ALUM保管

Toker浄水場　薬液製作

Toker浄水場　ケニカルポンプ

Toker浄水場　ケニカルポンプ

Toker浄水場　次亜塩素酸生成器

Toker浄水場　（6/6）

Toker浄水場　次亜塩素酸生成液タンク

Toker浄水場　次亜塩素粉末から製作するタンク

Toker浄水場　次亜塩素酸生成液のケミカルポンプ

Toker浄水場　次亜塩素酸生成液のケミカル配管

Toker浄水場　ジャーテスト
現在未使用。

Toker浄水場　pHと濁度と残留塩素器
濁度と残塩の試薬がない。

Mai Nefhi浄水場　(1/7)

Mai Nefhi浄水場 全体

Mai Nefhi浄水場 流入口

Mai Nefhi浄水場 流入口

Mai Nefhi浄水場 流入口
故障したベンチェリー計測器

Mai Nefhi浄水場 着水井

Mai Nefhi浄水場 塩素ガス
着水井に直接注入

Mai Nefhi浄水場 着水井

Mai Nefhi浄水場
着水井からパルセーター型凝集沈殿池への流入管
圧力感知型排出バルブ

Mai Nefhi浄水場　（2/7）

Mai Nefhi浄水場　パルセーター型凝集沈殿池

Mai Nefhi浄水場　パルセーター型凝集沈殿池
真空塔の設備

Mai Nefhi浄水場　パルセーター型凝集沈殿池
真空破壊弁の故障

Mai Nefhi浄水場　パルセーター型凝集沈殿池
マンホール蓋が腐食。

Mai Nefhi浄水場　パルセーター型凝集沈殿池
真空塔の設備

Mai Nefhi浄水場　パルセーター型凝集沈殿池
水位リレースイッチの故障。

Mai Nefhi浄水場　パルセーター型凝集沈殿池とろ過池
各バルブの開閉が十分機能しない。

Mai Nefhi浄水場　パルセーター型凝集沈殿池とろ過池
各バルブの開閉が十分機能しない。

Mai Nefhi浄水場　(3/7)

Mai Nefhi浄水場　連絡水路
パルセーター沈殿池とろ過池の連絡水路で漏水。

Mai Nefhi浄水場　アカズール型ろ過池

Mai Nefhi浄水場　アカズール型ろ過池

Mai Nefhi浄水場　アカズール型ろ過池
損失水頭計の故障。

Mai Nefhi浄水場　アカズール型ろ過池
パーシャリゼーションボックスの故障。

Mai Nefhi浄水場　アカズール型ろ過池
逆洗方法は、水と空気で同時に7分洗浄し、水のみで8分

Mai Nefhi浄水場　アカズール型ろ過池
ろ床砂。

Mai Nefhi浄水場　アカズール型ろ過池
クラックバルブが閉まらない。

Mai Nefhi浄水場　（4/7）

Mai Nefhi浄水場　アカズール型ろ過池
逆洗後のろ床に状況。

Mai Nefhi浄水場　アカズール型ろ過池
逆洗時の排水状況。

Mai Nefhi浄水場　逆洗ポンプとエアーブローポンプ

Mai Nefhi浄水場　エアーブローポンプ

Mai Nefhi浄水場　アカズール型ろ過池　下部
各バルブの開閉が十分機能しない。

Mai Nefhi浄水場　アカズール型ろ過池　下部
サイフォンが機能していない。

Mai Nefhi浄水場　アカズール型ろ過池　下部
ろ過後の水。

Mai Nefhi浄水場　送水ポンプ施設

Mai Nefhi浄水場　(5/7)

Mai Nefhi浄水場　送水ポンプ
漏水が顕著。

Mai Nefhi浄水場　送水管
メータの故障。

Mai Nefhi浄水場　受電変圧器

Mai Nefhi浄水場　排水
ダム汚排水路に放流。

Mai Nefhi浄水場　発電機室
故障のため撤去。

Mai Nefhi浄水場　管理室、旧薬液製作室、旧塩素室、機械室

Mai Nefhi浄水場　旧薬液製作室
旧ALUM製作。

Mai Nefhi浄水場　（6/7）

Mai Nefhi浄水場　旧薬液製作室
旧ALUM製作。

Mai Nefhi浄水場　旧薬液製作室
旧Lime製作。

Mai Nefhi浄水場　旧薬液製作室
旧Lime製作。

Mai Nefhi浄水場　旧薬液製作室
旧Polymer製作。

Mai Nefhi浄水場　地下機械室

Mai Nefhi浄水場　地下機械室
パルセーターが稼働していないため十分な凝集沈殿がされていない。

Mai Nefhi浄水場　旧塩素ガス室

Mai Nefhi浄水場　旧塩素ガス室
旧塩素注入器。

Mai Nefhi浄水場　(7/7)

Mai Nefhi浄水場　ジャーテスト

Mai Nefhi浄水場　pH、濁度故障。

維持管理編　(1/7)

Ela Nahib (Adi Nefas)ダム
ポンプアップされ農業用に使用されている。

Belezaダム
ロバによる水汲み。

Adi Shekaダム
家畜が直接水を飲んでいる。

Adi Shekaダム～Belezaダム付近までの開水路
水路内への落石多い。

Adi Shekaダム～Belezaダム付近までの開水路
水路内への落石多い。

Adi Sheka導水ポンプ
漏水しているが修理されていない。

Mai Serwaダム
故障中の導水ポンプ。

Tokerダム
水位計の目盛が読めない。

維持管理編　（2/7）

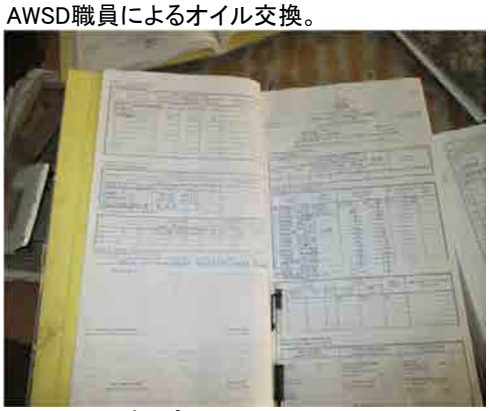
Toker導水エンジンポンプ
CATでメンテ中。

Toker導水エンジンポンプ
メンテスケジュール。

Toker導水エンジンポンプ
AWSD職員によるオイル交換。

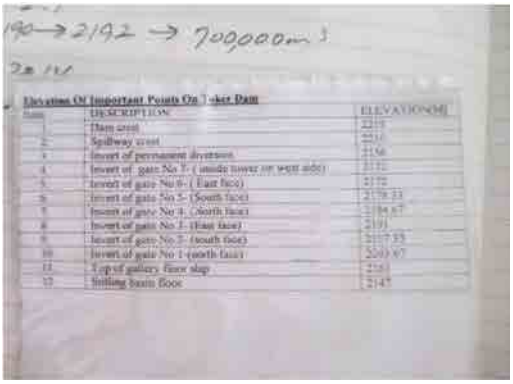
Toker導水エンジンポンプ
AWSD職員によるオイル交換。

Toker導水ポンプ場
ポンプ日誌。



Toker導水ポンプ場
伝統的な管理日誌。

Tokerダム
水位と貯水量の関係表。



Tokerダム
取水口と水位の関係表。

維持管理編　(3/7)

S.V浄水場　漏水
着水井脇で漏水。

S.V浄水場
散乱」する故障資材。

S.V浄水場
散乱」する故障資材。

S.V浄水場
高齢化する職員。

Toker浄水場
停電時はALUMを直接投入。

Toker浄水場
積み重ねられた塩素ガス。

Toker浄水場
カタログ（機材仕様）の保管。

Mai Nefhi浄水場
ALUMを直接投入。

維持管理編　(4/7)

Mai Nefhi浄水場
置きっぱなしのALUM。

Mai Nefhi浄水場
散乱する塩素ガス。

Mai Nefhi浄水場
送水ポンプ等で漏水し小型ポンプで排出。

New Sembelポンプ場
故障した塩素ガス注入器。

Monopolio配水池
配水池に溜まった泥。

Hazhaz配水池
水位計の故障。

Tsetserat配水池
配管からの漏水。

Godaifポンプ場
老朽化したポンプ。

維持管理編　（5/7）

市内配水管
バルブボックス。

市内配水管
バルブ操作。

市内配水管
バルブボックス。

市内給水管
給水管詰り解消工事。

メーター修理
2000年フランス供与のメータ検査器。

メーター修理
山積された故障メータ。

メーター修理
自転車でメータ修理に向かうAWSD職員。

Mai Nefhi給水所
出しっぱなしの水。

維持管理編　(6/7)

Mai Nefhi給水所
故障したメータと漏水。

AWSD本部
料金徴収窓口。

Expo給水所
混雑する給水車。

Expo給水所
AWSD給水販売所。

AWSD本部
苦情受付窓口。

AWSD本部
苦情申込み書。

AWSD本部
在庫資材保管室。

AWSD本部
在庫資材保管室。

維持管理編　（7/7）

AWSD本部
故障したPC。

AWSD本部
AWSA所持の2tユニック車。

AWSD本部
AWSA所持の2tダンプ車。

水質検査編(WRD所持の水質試験器) (1/2)

1、Dr/2000 and Dr/2800 spectrophotometer
NO3, NO2, SO4, F, NH3, Fe, Mn, Free Cl2

2, BWB flam photometer
Na, K, Ca, Mg, Ba,

3, Portable PHA-100plus
Hydrocarbon

4, Hanna HI88703 turbid meter
Turbidity

5, Portable HM3000 metalzer
Heavy metals (Not trained person)

6, Digital EC/TDS/PH meter
EC, TDS, PH,

7, 210/211 VGP atomic absorption spectrophotometer
Heavy metals (Not trained person)

8, BOD/COD incubators
BOD, COD (No reagents)

水質検査編(WRD所持の水質試験器) (2/2)

9, SBH200 block heater
COD reactor

10, Bacteriological incubators for faecal and total c. bac
Coliform bacteria

11, Digital colony counter
Counting bacteria

12, Oven for sterilization
Sterilization

13, Water distiller
Distell water production


ジャイカ
JICA