JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NATIONAL WATER SUPPLY AND DRAINAGE BOARD
MINISTRY OF HOUSING AND PLANTATION INFRASTRUCTURE
DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

THE DETAILED DESIGN STUDY ON GREATER KANDY WATER SUPPLY AUGMENTATION PROJECT IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

FINAL REPORT

VOLUME III

DATA AND ATTACHMENTS

MAY 2002

NJS CONSULTANTS CO., LTD.
NIHON SUIDO CONSULTANTS CO., LTD.

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Abbreviations and Acronyms

1. Unit

cm	centimeter
ft.	foot
g	gram
gpcd	gram per capita per day
ha	hectare (1 ha = 10,000m^2)
hr	hour
kg	kilogram
km	kilometer
km^2, or sq.km	square kilometer
kV	kilovolt
kW	kilowatt
kWh	kilowatt hour
l, or L	liter
l/day, or l/d	liter per day
l/sec, or l/s	liter per second
lpcd, or Lpcd	liter per capita per day
m	meter
m/s, or m/sec	meters per second
m^2, or sq.m	square meter
m^3, or cu.m	cubic meter
m^3/d, or cu.m/day	cubic meter per day
m^3/min	cubic meter per minute
m^3/s, or cu.m/sec	cubic meter per second
MCM	million cubic meter
mgd	million gallons per day
mg/l	milligram per liter
mm	millimeter
Mpa	megapascal
ppm	parts per million
Rs.	Sri Lankan Rupee
V	volt

2. Water Quality

BOD$_5$	Biochemical Oxygen Demand (20°C, 5 days)
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
EC	Electrical Conductivity
pH	Hydrogen ion potential
SS	Suspended Solids
TS	Total Solids

3. Organizations

ADB	Asian Development Bank
CEA	Central Environmental Authority
CEB	Ceylon Electricity Board
CPC	Central Provincial Council
FINNIDA	Finnish International Development Agency
GS	Gramasevaka Divison (local administrative unit)
IBRD	International Bank for Reconstruction and Development (World Bank)

ICC	Interagency Co-ordinating Committee
IDA	International Development Association (soft loan facility of IBRD)
IMF	International Monetary Fund
JBIC	Japan Bank for International Cooperation (Japan)
JICA	Japan International Cooperation Agency (Japan)
KMC	Kandy Municipal Council
MASL	Mahaweli Authority of Sri Lanka
MHUD	Ministry of Housing and Urban Development
MOF	Ministry of Finance
MSL	Mean Sea Level
NJS	Nippon Jogesuido Sekkei Co., Ltd.
NSC	Nihon Suido Consultants Co., Ltd.
NWSDB, or NWS&DB	National Water Supply and Drainage Board
OECD	Organization for Economic Cooperation and Development
PS	Pradeshiya Sabha (local administrative unit)
RDA	Road Development Authority
RSC	Regional Support Center, NWSDB
UC	Urban Council
UDA	Urban Development Authority

4. Others

BOT	Build - Operate - Transfer
BWL	Bottom Water Level
CED	Central Environmental Division
CPI	Consumer Price Index
EAC	Environmental auditing Commission
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
FIRR	Financial Internal Rate of Return
FY	Fiscal Year
GDP	Gross Domestic Product
GL	Ground Level
GNP	Gross National Product
GST	Government Sales Tax
HWL	High Water Level
HH	Household
IEE	Initial Environmental Examination
LWL	Low Water Level
L/S	Lift Station
NGO	Non-Governmental Organization
NRW	Non-revenue Water
ODA	Official Development Assistance
PEU	Project Environmental Unit
P/S	Pumping Station
SLS	Sri Lankan Standards
STP	Sewage Treatment Plant
T.A	Technical Assistance
TWL	Top Water Level
UFW	Unaccounted-For-Water
VAT	Value Added Tax
WID	Women in Development
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant (=STP)

01 Intake and Water Treatment Plant Process Calculations

Grit Chamber

Dimension : Width (m) Length (m) (Sand sedimentation Depth h=0.5m at Inlet Mouth)
6.00 33.50

	Water Flow	Duty (units)	River Water Level (m)	Diameter of Sand (mm)	Sand Settling Velocity (cm/sec)	Sedi. Sand Depth in G.C.	Grit Chamber H.W.L. (m)	Grit Chamber L.W.L. (m)	Effective Depth (m)	Effective Volume	Required Length (m)	Retention Time (min)	Velocity (cm/sec)	Surface Load Ratio (mm/min)	Remark
Case 1	115,500	2	437.60	0.15	1.5	0.00	437.11	434.06	3.05	1226	7.4	15.29	3.7	200	
Case 2	115,500	2	437.60	0.15	1.5	1.00	437.09	435.06	2.03	816	7.4	10.17	5.5	200	
Case 3	115,500	2	437.60	0.15	1.5	1.94	437.01	436.00	1.01	406	7.4	5.06	11.0	200	
Case 4	115,500	2	438.30	0.15	1.5	1.94	437.80	436.00	1.80	724	7.4	9.02	6.2	200	
Case 5	115,500	2	440.74	0.15	1.5	1.94	440.29	436.00	4.29	1725	7.4	21.50	2.6	200	
Case 6	115,500	2	437.60	0.10	0.8	0.00	437.11	434.06	3.05	1226	13.9	15.29	3.7	200	
Case 7	115,500	2	437.60	0.10	0.8	1.00	437.09	435.06	2.03	816	13.9	10.17	5.5	200	
Case 8	115,500	2	437.60	0.10	0.8	1.94	437.01	436.00	1.01	406	13.9	5.06	11.0	200	
Case 9	115,500	2	438.30	0.10	0.8	1.94	437.80	436.00	1.80	724	13.9	9.02	6.2	200	
Case 10	115,500	2	440.74	0.10	0.8	1.94	440.29	436.00	4.29	1725	13.9	21.50	2.6	200	
Case 11	115,500	1	437.60	0.15	1.5	0.00	436.87	434.06	2.81	565	29.7	7.04	7.9	399	
Case 12	115,500	1	437.60	0.15	1.5	1.00	436.78	435.06	1.72	346	29.7	4.31	13.0	399	
Case 13	115,500	1	437.60	0.15	1.5	1.94	436.47	436.00	0.47	94	29.7	1.18	47.4	399	
Case 14	115,500	1	438.30	0.15	1.5	1.94	437.54	436.00	1.54	310	29.7	3.86	14.5	399	
Case 15	115,500	1	440.74	0.15	1.5	1.94	440.18	436.00	4.18	840	29.7	10.47	5.3	399	
Case 16	115,500	1	437.60	0.10	0.8	0.00	436.87	434.06	2.81	565	55.7	7.04	7.9	399	
Case 17	115,500	1	437.60	0.10	0.8	1.00	436.78	435.06	1.72	346	55.7	4.31	13.0	399	
Case 18	115,500	1	437.60	0.10	0.8	1.94	436.47	436.00	0.47	94	55.7	1.18	47.4	399	
Case 19	115,500	1	438.30	0.10	0.8	1.94	437.54	436.00	1.54	310	55.7	3.86	14.5	399	
Case 20	115,500	1	440.74	0.10	0.8	1.94	437.54	436.00	1.54	310	55.7	3.86	14.5	399	

Case 1 Capacity Calculation of Grit Chamber (River Water Level + 437.60m) 2 unit duty
(Grit Chamber High Water Level + 437.11 m)
(Grit Chamber Low Water Level + 434.06 m) no soil

Flow Rate	110000*	1.05=	115500 cum/day
Average Velocity			2-7 cm/sec
Surface Load Ratio			200-500mm/min
Width/Length			3-8
Effective Depth			3-4m
Retention Time			10-20min

Reqired Length		L=K*(H*V/U)/B=		7.4 m
	L:	Required Length(m)		
	K:	Safety Factor(-)		2
	H:	Effective Depth		3.05 m
	V:	Average Velocity		3.7 cm/sec
	U:	Sand Settling Velocity	(Dia.0.15mm)	1.5 cm/sec
	B:	Number of Basins		2
	W:	Width		6.0 m

Dia. of Sand(mm)	Sediment Velocity (cm/sec)
0.30	3.2
0.20	2.1
0.15	1.5
0.10	0.8
0.08	0.6

Water Level	Max. Flood	1447 ft	441.00 m
	Max. Operation	1446 ft	440.74 m
	Min. Operation	1438 ft	438.30 m
	Spillway Crest	1425 ft	434.34 m
River Bottom Level at Intake Point		1430 ft	436.00 m

Grit Chamber Dimension	Width(m)	Length(m)	Effective Depth(m)	Basin
	6.0×	33.5×	3.1×	2

Effective Volume per Basin(m3)		613
Basin		2 unit duty
Effective Volume Total(m3)		1226
Retention Time	15.29	min
Average Velocity	3.65	cm/sec
Surface Load Ratio	200	mm/min
Length/Width	5.6	

Case 2 Capacity Calculation of Grit Chamber (River Water Level + 437.60m) 2 unit duty

(Grit Chamber High Water Level + 437.09 m)

(Grit Chamber Low Water Level + 435.06 m) soil h=1.00m

Flow Rate	110000* 1.05=	115500 cum/day
Average Velocity		2-7 cm/sec
Surface Load Ratio		200-500mm/min
Width/Length		3-8
Effective Depth		3-4m
Retention Time		10-20min
Reqired Length	L=K*(H*V/U)/B=	7.4 m

L:	Required Length(m)		
K:	Safety Factor(-)		2
H:	Effective Depth		2.03 m
V:	Average Velocity		5.5 cm/sec
U:	Sand Settling Velocity	(Dia.0.15mm)	1.5 cm/sec
B:	Number of Basins		2
W:	Width		6.0 m

Dia. of Sand(mm)	Sediment Velocity (cm/sec)
0.30	3.2
0.20	2.1
0.15	1.5
0.10	0.8
0.08	0.6

Water Level	Max. Flood	1447 ft	441.00 m
	Max. Operation	1446 ft	440.74 m
	Min. Operation	1438 ft	438.30 m
	Spillway Crest	1425 ft	434.34 m
River Bottom Level at Intake Point		1430 ft	436.00 m

Grit Chamber Dimension	Width(m)	Length(m)	Effective Depth(m)	Basin
	6.0×	33.5×	2.0×	2

Effective Volume per Basin(m3)		408
Basin		2 unit duty
Effective Volume Total(m3)		816
Retention Time	10.17	min
Average Velocity	5.49	cm/sec
Surface Load Ratio	200	mm/min
Length/Width	5.6	

Case 3 Capacity Calculation of Grit Chamber (River Water Level + 437.60m) 2 unit duty
(Grit Chamber High Water Level + 437.01 m)
(Grit Chamber Low Water Level + 436.00 m) soil h=1.94m

Flow Rate	110000* 1.05=	115500 cum/day	
Average Velocity		2-7 cm/sec	
Surface Load Ratio		200-500mm/min	
Width/Length		3-8	
Effective Depth		3-4m	
Retention Time		10-20min	
Reqired Length	L=K*(H*V/U)/B=		7.4 m

L:	Required Length(m)		
K:	Safety Factor(-)		2
H:	Effective Depth		1.01 m
V:	Average Velocity		11.0 cm/sec
U:	Sand Settling Velocity	(Dia.0.15mm)	1.5 cm/sec
B:	Number of Basins		2
W:	Width		6.0 m

Dia. of Sand(mm)	Sediment Velocity (cm/sec)
0.30	3.2
0.20	2.1
0.15	1.5
0.10	0.8
0.08	0.6

Water Level	Max. Flood	1447 ft	441.00 m
	Max. Operation	1446 ft	440.74 m
	Min. Operation	1438 ft	438.30 m
	Spillway Crest	1425 ft	434.34 m
River Bottom Level at Intake Point		1430 ft	436.00 m

Grit Chamber Dimension	Width(m)	Length(m)	Effective Depth(m)	Basin
	6.0×	33.5×	1.0×	2

Effective Volume per Basin(m3)		203
Basin		2 unit duty
Effective Volume Total(m3)		406
Retention Time	5.06	min
Average Velocity	11.03	cm/sec
Surface Load Ratio	200	mm/min
Length/Width	5.6	

Case 4 Capacity Calculation of Grit Chamber (River Water Level + 438.30m) 2 unit duty

(Grit Chamber High Water Level + 437.80 m)

(Grit Chamber Low Water Level + 436.00 m) soil h=1.94m

Flow Rate	110000* 1.05=	115500	cum/day
Average Velocity		2-7 cm/sec	
Surface Load Ratio		200-500mm/min	
Width/Length		3-8	
Effective Depth		3-4m	
Retention Time		10-20min	

Reqired Length L=K*(H*V/U)/B= 7.4 m

L:	Required Length(m)			
K:	Safety Factor(-)		2	
H:	Effective Depth		1.80	m
V:	Average Velocity		6.2	cm/sec
U:	Sand Settling Velocity	(Dia.0.15mm)	1.5	cm/sec
B:	Number of Basins		2	
W:	Width		6.0	m

Dia. of Sand(mm)	Sediment Velocity (cm/sec)
0.30	3.2
0.20	2.1
0.15	1.5
0.10	0.8
0.08	0.6

Water Level	Max. Flood	1447 ft	441.00 m
	Max. Operation	1446 ft	440.74 m
	Min. Operation	1438 ft	438.30 m
	Spillway Crest	1425 ft	434.34 m
River Bottom Level at Intake Point		1430 ft	436.00 m

Grit Chamber Dimension	Width(m)	Length(m)	Effective Depth(m)	Basin
	6.0×	33.5×	1.8×	2

Effective Volume per Basin(m3)	362	
Basin	2 unit duty	
Effective Volume Total(m3)	724	
Retention Time	9.02	min
Average Velocity	6.19	cm/sec
Surface Load Ratio	200	mm/min
Length/Width	5.6	

Case 5 Capacity Calculation of Grit Chamber (River Water Level + 440.74m) 2 unit duty

(Grit Chamber High Water Level + 440.29 m)

(Grit Chamber Low Water Level + 436.00 m) soil h=1.94m

Flow Rate	110000* 1.05= 115500	cum/day
Average Velocity	2-7 cm/sec	
Surface Load Ratio	200-500mm/min	
Width/Length	3-8	
Effective Depth	3-4m	
Retention Time	10-20min	
Reqired Length	L=K*(H*V/U)/B=	7.4 m

L: Required Length(m)

K: Safety Factor(-) 2

H: Effective Depth 4.3 m

V: Average Velocity 2.6 cm/sec

U: Sand Settling Velocity (Dia.0.15mm) 1.5 cm/sec

B: Number of Basins 2

W: Width 6.0 m

Dia. of Sand(mm)	Sediment Velocity (cm/sec)
0.30	3.2
0.20	2.1
0.15	1.5
0.10	0.8
0.08	0.6

Water Level	Max. Flood	1447 ft	441.00 m
	Max. Operation	1446 ft	440.74 m
	Min. Operation	1438 ft	438.30 m
	Spillway Crest	1425 ft	434.34 m
River Bottom Level at Intake Point		1430 ft	436.00 m

Grit Chamber Dimension	Width(m)	Length(m)	Effective Depth(m)	Basin
	6.0×	33.5×	4.3×	2

Effective Volume per Basin(m3)	862	
Basin	2 unit duty	
Effective Volume Total(m3)	1725	
Retention Time	21.50	min
Average Velocity	2.60	cm/sec
Surface Load Ratio	200	mm/min
Length/Width	5.6	

Case 6 Capacity Calculation of Grit Chamber (River Water Level + 437.60m) 2 unit duty

(Grit Chamber High Water Level + 437.11 m)
(Grit Chamber Low Water Level + 434.06 m) no soil

Flow Rate	110000*	1.05=	115500	cum/day
Average Velocity				2-7 cm/sec
Surface Load Ratio				200-500mm/min
Width/Length				3-8
Effective Depth				3-4m
Retention Time				10-20min
Reqired Length		L=K*(H*V/U)/B=		13.9 m

L:	Required Length(m)		
K:	Safety Factor(-)		2
H:	Effective Depth		3.05 m
V:	Average Velocity		3.65 cm/sec
U:	Sand Settling Velocity	(Dia.0.10mm)	0.8 cm/sec
B:	Number of Basins		2
W:	Width		6.0 m

Dia. of Sand(mm)	Sediment Velocity (cm/sec)
0.30	3.2
0.20	2.1
0.15	1.5
0.10	0.8
0.08	0.6

Water Level	Max. Flood	1447 ft	441.00 m
	Max. Operation	1446 ft	440.74 m
	Min. Operation	1438 ft	438.30 m
	Spillway Crest	1425 ft	434.34 m
River Bottom Level at Intake Point		1430 ft	436.00 m

Grit Chamber Dimension	Width(m)	Length(m)	Effective Depth(m)	Basin
	6.0×	33.5×	3.1×	2

Effective Volume per Basin(m3)		613
Basin		2 unit duty
Effective Volume Total(m3)		1226
Retention Time	15.29	min
Average Velocity	3.65	cm/sec
Surface Load Ratio	200	mm/min
Length/Width	5.6	

Case 7 Capacity Calculation of Grit Chamber (River Water Level + 437.60m) 2 unit duty

(Grit Chamber High Water Level + 437.09 m)

(Grit Chamber Low Water Level + 435.06 m) soil h=1.00m

Flow Rate	110000*	1.05=	115500 cum/day	
Average Velocity			2-7 cm/sec	
Surface Load Ratio			200-500mm/min	
Width/Length			3-8	
Effective Depth			3-4m	
Retention Time			10-20min	
Reqired Length		L=K*(H*V/U)/B=		13.9 m
	L:	Required Length(m)		
	K:	Safety Factor(-)		2
	H:	Effective Depth		2.03 m
	V:	Average Velocity		5.5 cm/sec
	U:	Sand Settling Velocity	(Dia.0.10mm)	0.8 cm/sec
	B:	Number of Basins		2
	W:	Width		6.0 m

Dia. of Sand(mm)	Sediment Velocity (cm/sec)
0.30	3.2
0.20	2.1
0.15	1.5
0.10	0.8
0.08	0.6

Water Level	Max. Flood	1447 ft	441.00 m
	Max. Operation	1446 ft	440.74 m
	Min. Operation	1438 ft	438.30 m
	Spillway Crest	1425 ft	434.34 m
River Bottom Level at Intake Point		1430 ft	436.00 m

Grit Chamber Dimension	Width(m)	Length(m)	Effective Depth(m)	Basin
	6.0×	33.5×	2.0×	2

Effective Volume per Basin(m3)			408
Basin			2 unit duty
Effective Volume Total(m3)			816
Retention Time	10.17	min	
Average Velocity	5.49	cm/sec	
Surface Load Ratio	200	mm/min	
Length/Width	5.6		

Case 8 Capacity Calculation of Grit Chamber (River Water Level + 437.60m) 2 unit duty
(Grit Chamber High Water Level + 437.01 m)
(Grit Chamber Low Water Level + 436.00 m) soil h=1.94m

Flow Rate	110000*	1.05=	115500 cum/day	
Average Velocity			2-7 cm/sec	
Surface Load Ratio			200-500mm/min	
Width/Length			3-8	
Effective Depth			3-4m	
Retention Time			10-20min	
Reqired Length		L=K*(H*V/U)/B=		13.9 m
	L:	Required Length(m)		
	K:	Safety Factor(-)		2
	H:	Effective Depth		1.01 m
	V:	Average Velocity		11.0 cm/sec
	U:	Sand Settling Velocity	(Dia.0.10mm)	0.8 cm/sec
	B:	Number of Basins		2
	W:	Width		6.0 m

Dia. of Sand(mm)	Sediment Velocity (cm/sec)
0.30	3.2
0.20	2.1
0.15	1.5
0.10	0.8
0.08	0.6

Water Level	Max. Flood	1447 ft	441.00 m
	Max. Operation	1446 ft	440.74 m
	Min. Operation	1438 ft	438.30 m
	Spillway Crest	1425 ft	434.34 m
River Bottom Level at Intake Point		1430 ft	436.00 m

Grit Chamber Dimension	Width(m)	Length(m)	Effective Depth(m)	Basin
	6.0×	33.5×	1.0×	2

Effective Volume per Basin(m3)		203
Basin		2 unit duty
Effective Volume Total(m3)		406
Retention Time	5.06	min
Average Velocity	11.03	cm/sec
Surface Load Ratio	200	mm/min
Length/Width	5.6	

Case 9 Capacity Calculation of Grit Chamber (River Water Level + 438.30m) 2 unit duty
(Grit Chamber High Water Level + 437.80 m)
(Grit Chamber Low Water Level + 436.00 m) soil h=1.94m

Flow Rate	110000*	1.05=	115500 cum/day
Average Velocity			2-7 cm/sec
Surface Load Ratio			200-500mm/min
Width/Length			3-8
Effective Depth			3-4m
Retention Time			10-20min
Reqired Length		L=K*(H*V/U)/B=	13.9 m

L:	Required Length(m)		
K:	Safety Factor(-)		2
H:	Effective Depth		1.80 m
V:	Average Velocity		6.2 cm/sec
U:	Sand Settling Velocity	(Dia.0.10mm)	0.8 cm/sec
B:	Number of Basins		2
W:	Width		6.0 m

Dia. of Sand(mm)	Sediment Velocity (cm/sec)
0.30	3.2
0.20	2.1
0.15	1.5
0.10	0.8
0.08	0.6

Water Level	Max. Flood	1447 ft	441.00 m
	Max. Operation	1446 ft	440.74 m
	Min. Operation	1438 ft	438.30 m
	Spillway Crest	1425 ft	434.34 m
River Bottom Level at Intake Point		1430 ft	436.00 m

Grit Chamber Dimension	Width(m)	Length(m)	Effective Depth(m)	Basin
	6.0×	33.5×	1.8×	2

Effective Volume per Basin(m3)		362
Basin		2 unit duty
Effective Volume Total(m3)		724
Retention Time	9.02	min
Average Velocity	6.19	cm/sec
Surface Load Ratio	200	mm/min
Length/Width	5.6	

Case 10 Capacity Calculation of Grit Chamber (River Water Level + 440.74m) 2 unit duty
(Grit Chamber High Water Level + 440.29 m)
(Grit Chamber Low Water Level + 436.00 m) soil h=1.94m

Flow Rate	110000*	1.05=	115500	cum/day
Average Velocity				2-7 cm/sec
Surface Load Ratio				200-500mm/min
Width/Length				3-8
Effective Depth				3-4m
Retention Time				10-20min
Reqired Length		L=K*(H*V/U)/B=		13.9 m

L:	Required Length(m)		
K:	Safety Factor(-)		2
H:	Effective Depth		4.29 m
V:	Average Velocity		2.6 cm/sec
U:	Sand Settling Velocity	(Dia.0.10mm)	0.8 cm/sec
B:	Number of Basins		2
W:	Width		6.0 m

Dia. of Sand(mm)	Sediment Velocity (cm/sec)
0.30	3.2
0.20	2.1
0.15	1.5
0.10	0.8
0.08	0.6

Water Level	Max. Flood	1447 ft	441.00 m
	Max. Operation	1446 ft	440.74 m
	Min. Operation	1438 ft	438.30 m
	Spillway Crest	1425 ft	434.34 m
River Bottom Level at Intake Point		1430 ft	436.00 m

Grit Chamber Dimension	Width(m)	Length(m)	Effective Depth(m)	Basin
	6.0×	33.5×	4.3×	2

Effective Volume per Basin(m3)		862
Basin		2 unit duty
Effective Volume Total(m3)		1725
Retention Time	21.50	min
Average Velocity	2.60	cm/sec
Surface Load Ratio	200	mm/min
Length/Width	5.6	

Case 11 Capacity Calculation of Grit Chamber (River Water Level + 437.60m) 1 unit duty

(Grit Chamber High Water Level + 436.87 m)

(Grit Chamber Low Water Level + 434.06 m) no soil

Flow Rate	110000* 1.05=	115500	cum/day
Average Velocity		2-7 cm/sec	
Surface Load Ratio		200-500mm/min	
Width/Length		3-8	
Effective Depth		3-4m	
Retention Time		10-20min	
Reqired Length	L=K*(H*V/U)/B=		29.7 m

L: Required Length(m)

K: Safety Factor(-) 2

H: Effective Depth 2.81 m

V: Average Velocity 7.9 cm/sec

U: Sand Settling Velocity (Dia.0.15mm) 1.5 cm/sec

B: Number of Basins 1

W: Width 6.0 m

Dia. of Sand(mm)	Sediment Velocity (cm/sec)
0.30	3.2
0.20	2.1
0.15	1.5
0.10	0.8
0.08	0.6

Water Level	Max. Flood	1447 ft	441.00 m
	Max. Operation	1446 ft	440.74 m
	Min. Operation	1438 ft	438.30 m
	Spillway Crest	1425 ft	434.34 m

River Bottom Level at Intake Point 1430 ft 436.00 m

Grit Chamber Dimension	Width(m)	Length(m)	Effective Depth(m)	Basin
	6.0×	33.5×	2.8×	1

Effective Volume per Basin(m3)		565
Basin		1 unit duty
Effective Volume Total(m3)		565
Retention Time	7.04	min
Average Velocity	7.93	cm/sec
Surface Load Ratio	399	mm/min
Length/Width	5.6	

Case 12 Capacity Calculation of Grit Chamber (River Water Level + 437.60m) 1 unit duty

(Grit Chamber High Water Level + 436.78 m)

(Grit Chamber Low Water Level + 435.06 m) soil h=1.00m

Flow Rate	110000*	1.05=	115500	cum/day
Average Velocity				2-7 cm/sec
Surface Load Ratio				200-500mm/min
Width/Length				3-8
Effective Depth				3-4m
Retention Time				10-20min

Reqired Length L=K*(H*V/U)/B= 29.7 m

L:	Required Length(m)			
K:	Safety Factor(-)		2	
H:	Effective Depth		1.72	m
V:	Average Velocity		13.0	cm/sec
U:	Sand Settling Velocity	(Dia.0.15mm)	1.5	cm/sec
B:	Number of Basins		1	
W:	Width		6.0	m

Dia. of Sand(mm)	Sediment Velocity (cm/sec)
0.30	3.2
0.20	2.1
0.15	1.5
0.10	0.8
0.08	0.6

Water Level	Max. Flood	1447 ft	441.00 m
	Max. Operation	1446 ft	440.74 m
	Min. Operation	1438 ft	438.30 m
	Spillway Crest	1425 ft	434.34 m
River Bottom Level at Intake Point		1430 ft	436.00 m

Grit Chamber Dimension	Width(m)	Length(m)	Effective Depth(m)	Basin
	6.0×	33.5×	1.7×	1

Effective Volume per Basin(m3)		346
Basin		1 unit duty
Effective Volume Total(m3)		346
Retention Time	4.31	min
Average Velocity	12.95	cm/sec
Surface Load Ratio	399	mm/min
Length/Width	5.6	

Case 13 Capacity Calculation of Grit Chamber (River Water Level + 437.60m) 1 unit duty

(Grit Chamber High Water Level + 436.47 m)

(Grit Chamber Low Water Level + 436.00 m) soil h=1.94m

Flow Rate	110000*	1.05=	115500	cum/day
Average Velocity				2-7 cm/sec
Surface Load Ratio				200-500mm/min
Width/Length				3-8
Effective Depth				3-4m
Retention Time				10-20min

Reqired Length L=K*(H*V/U)/B= 29.7 m

L:	Required Length(m)			
K:	Safety Factor(-)		2	
H:	Effective Depth		0.47	m
V:	Average Velocity		47.4	cm/sec
U:	Sand Settling Velocity	(Dia.0.15mm)	1.5	cm/sec
B:	Number of Basins		1	
W:	Width		6.0	m

Dia. of Sand(mm)	Sediment Velocity (cm/sec)
0.30	3.2
0.20	2.1
0.15	1.5
0.10	0.8
0.08	0.6

Water Level	Max. Flood	1447 ft	441.00 m
	Max. Operation	1446 ft	440.74 m
	Min. Operation	1438 ft	438.30 m
	Spillway Crest	1425 ft	434.34 m

River Bottom Level at Intake Point	1430 ft	436.00 m

Grit Chamber Dimension	Width(m)	Length(m)	Effective Depth(m)	Basin
	6.0×	33.5×	0.5×	1

Effective Volume per Basin(m3)		94
Basin		1 unit duty
Effective Volume Total(m3)		94
Retention Time	1.18	min
Average Velocity	47.40	cm/sec
Surface Load Ratio	399	mm/min
Length/Width	5.6	

Case 14 Capacity Calculation of Grit Chamber (River Water Level + 438.30m) 1 unit duty

(Grit Chamber High Water Level + 437.54 m)

(Grit Chamber Low Water Level + 436.00 m) soil h=1.94m

Flow Rate	110000*	1.05=	115500	cum/day
Average Velocity				2-7 cm/sec
Surface Load Ratio				200-500mm/min
Width/Length				3-8
Effective Depth				3-4m
Retention Time				10-20min

Reqired Length L=K*(H*V/U)/B= 29.7 m

L:	Required Length(m)		
K:	Safety Factor(-)		2
H:	Effective Depth		1.54 m
V:	Average Velocity		14.5 cm/sec
U:	Sand Settling Velocity	(Dia.0.15mm)	1.5 cm/sec
B:	Number of Basins		1
W:	Width		6.0 m

Dia. of Sand(mm)	Sediment Velocity (cm/sec)
0.30	3.2
0.20	2.1
0.15	1.5
0.10	0.8
0.08	0.6

Water Level	Max. Flood	1447 ft	441.00 m
	Max. Operation	1446 ft	440.74 m
	Min. Operation	1438 ft	438.30 m
	Spillway Crest	1425 ft	434.34 m
River Bottom Level at Intake Point		1430 ft	436.00 m

Grit Chamber Dimension	Width(m)	Length(m)	Effective Depth(m)	Basin
	6.0×	33.5×	1.5×	1

Effective Volume per Basin(m3)		310
Basin		1 unit duty
Effective Volume Total(m3)		310
Retention Time	3.86	min
Average Velocity	14.47	cm/sec
Surface Load Ratio	399	mm/min
Length/Width	5.6	

Case 15 Capacity Calculation of Grit Chamber (River Water Level + 440.74m) 1 unit duty
(Grit Chamber High Water Level + 440.18 m)
(Grit Chamber Low Water Level + 436.00 m) soil h=1.94m

Flow Rate	110000* 1.05=	115500 cum/day	
Average Velocity		2-7 cm/sec	
Surface Load Ratio		200-500mm/min	
Width/Length		3-8	
Effective Depth		3-4m	
Retention Time		10-20min	
Reqired Length	L=K*(H*V/U)/B=		29.7 m

L:	Required Length(m)		
K:	Safety Factor(-)		2
H:	Effective Depth		4.18 m
V:	Average Velocity		5.3 cm/sec
U:	Sand Settling Velocity	(Dia.0.15mm)	1.5 cm/sec
B:	Number of Basins		1
W:	Width		6.0 m

Dia. of Sand(mm)	Sediment Velocity (cm/sec)
0.30	3.2
0.20	2.1
0.15	1.5
0.10	0.8
0.08	0.6

Water Level	Max. Flood	1447 ft	441.00 m
	Max. Operation	1446 ft	440.74 m
	Min. Operation	1438 ft	438.30 m
	Spillway Crest	1425 ft	434.34 m
River Bottom Level at Intake Point		1430 ft	436.00 m

Grit Chamber Dimension	Width(m)	Length(m)	Effective Depth(m)	Basin
	6.0×	33.5×	4.2×	1

Effective Volume per Basin(m3)		840
Basin		1 unit duty
Effective Volume Total(m3)		840
Retention Time	10.47	min
Average Velocity	5.33	cm/sec
Surface Load Ratio	399	mm/min
Length/Width	5.6	

Case 16 Capacity Calculation of Grit Chamber (River Water Level + 437.60m) 1 unit duty
(Grit Chamber High Water Level + 436.87 m)
(Grit Chamber Low Water Level + 434.06 m) no soil

Flow Rate	110000*	1.05=	115500	cum/day
Average Velocity			2-7 cm/sec	
Surface Load Ratio			200-500mm/min	
Width/Length			3-8	
Effective Depth			3-4m	
Retention Time			10-20min	

Reqired Length L=K*(H*V/U)/B= 55.7 m

L:	Required Length(m)			
K:	Safety Factor(-)		2	
H:	Effective Depth		2.81	m
V:	Average Velocity		7.9	cm/sec
U:	Sand Settling Velocity	(Dia.0.10mm)	0.8	cm/sec
B:	Number of Basins		1	
W:	Width		6.0	m

Dia. of Sand(mm)	Sediment Velocity (cm/sec)
0.30	3.2
0.20	2.1
0.15	1.5
0.10	0.8
0.08	0.6

Water Level	Max. Flood	1447 ft	441.00 m
	Max. Operation	1446 ft	440.74 m
	Min. Operation	1438 ft	438.30 m
	Spillway Crest	1425 ft	434.34 m
River Bottom Level at Intake Point		1430 ft	436.00 m

Grit Chamber Dimension	Width(m)	Length(m)	Effective Depth(m)	Basin
	6.0×	33.5×	2.8×	1

Effective Volume per Basin(m3)		565
Basin		1 unit duty
Effective Volume Total(m3)		565
Retention Time	7.04	min
Average Velocity	7.93	cm/sec
Surface Load Ratio	399	mm/min
Length/Width	5.6	

Case 17 Capacity Calculation of Grit Chamber (River Water Level + 437.60m) 1 unit duty
(Grit Chamber High Water Level + 436.78 m)
(Grit Chamber Low Water Level + 435.06 m) soil h=1.00m

Flow Rate	110000*	1.05=	115500	cum/day
Average Velocity				2-7 cm/sec
Surface Load Ratio				200-500mm/min
Width/Length				3-8
Effective Depth				3-4m
Retention Time				10-20min
Reqired Length		L=K*(H*V/U)/B=		55.7 m

L:	Required Length(m)		
K:	Safety Factor(-)		2
H:	Effective Depth		1.72 m
V:	Average Velocity		13.0 cm/sec
U:	Sand Settling Velocity	(Dia.0.10mm)	0.8 cm/sec
B:	Number of Basins		1
W:	Width		6.0 m

Dia. of Sand(mm)	Sediment Velocity (cm/sec)
0.30	3.2
0.20	2.1
0.15	1.5
0.10	0.8
0.08	0.6

Water Level	Max. Flood	1447 ft	441.00 m
	Max. Operation	1446 ft	440.74 m
	Min. Operation	1438 ft	438.30 m
	Spillway Crest	1425 ft	434.34 m
River Bottom Level at Intake Point		1430 ft	436.00 m

Grit Chamber Dimension	Width(m)	Length(m)	Effective Depth(m)	Basin
	6.0×	33.5×	1.7×	1

Effective Volume per Basin(m3)		346
Basin		1 unit duty
Effective Volume Total(m3)		346
Retention Time	4.31	min
Average Velocity	12.95	cm/sec
Surface Load Ratio	399	mm/min
Length/Width	5.6	

Case 18 Capacity Calculation of Grit Chamber (River Water Level + 437.60m) 1 unit duty
(Grit Chamber High Water Level + 436.47 m)
(Grit Chamber Low Water Level + 436.00 m) soil h=1.94m

Flow Rate	110000*	1.05=	115500	cum/day
Average Velocity				2-7 cm/sec
Surface Load Ratio				200-500mm/min
Width/Length				3-8
Effective Depth				3-4m
Retention Time				10-20min
Reqired Length		L=K*(H*V/U)/B=		55.7 m

L:	Required Length(m)		
K:	Safety Factor(-)		2
H:	Effective Depth		0.47 m
V:	Average Velocity		47.4 cm/sec
U:	Sand Settling Velocity	(Dia.0.10mm)	0.8 cm/sec
B:	Number of Basins		1
W:	Width		6.0 m

Dia. of Sand(mm)	Sediment Velocity (cm/sec)
0.30	3.2
0.20	2.1
0.15	1.5
0.10	0.8
0.08	0.6

Water Level	Max. Flood	1447 ft	441.00 m
	Max. Operation	1446 ft	440.74 m
	Min. Operation	1438 ft	438.30 m
	Spillway Crest	1425 ft	434.34 m
River Bottom Level at Intake Point		1430 ft	436.00 m

Grit Chamber Dimension	Width(m)	Length(m)	Effective Depth(m)	Basin
	6.0×	33.5×	0.5×	1

Effective Volume per Basin(m3)		94
Basin		1 unit duty
Effective Volume Total(m3)		94
Retention Time	1.18	min
Average Velocity	47.40	cm/sec
Surface Load Ratio	399	mm/min
Length/Width	5.6	

Case 19 Capacity Calculation of Grit Chamber (River Water Level + 438.30m) 1 unit duty
(Grit Chamber High Water Level + 437.54 m)
(Grit Chamber Low Water Level + 436.00 m) soil h=1.94m

Flow Rate	110000*	1.05=	115500 cum/day	
Average Velocity			2-7 cm/sec	
Surface Load Ratio			200-500mm/min	
Width/Length			3-8	
Effective Depth			3-4m	
Retention Time			10-20min	
Reqired Length		L=K*(H*V/U)/B=		55.7 m
	L:	Required Length(m)		
	K:	Safety Factor(-)		2
	H:	Effective Depth		1.54 m
	V:	Average Velocity		14.5 cm/sec
	U:	Sand Settling Velocity	(Dia.0.10mm)	0.8 cm/sec
	B:	Number of Basins		1
	W:	Width		6.0 m

Dia. of Sand(mm)	Sediment Velocity (cm/sec)
0.30	3.2
0.20	2.1
0.15	1.5
0.10	0.8
0.08	0.6

Water Level	Max. Flood	1447 ft	441.00 m
	Max. Operation	1446 ft	440.74 m
	Min. Operation	1438 ft	438.30 m
	Spillway Crest	1425 ft	434.34 m
River Bottom Level at Intake Point		1430 ft	436.00 m

Grit Chamber Dimension	Width(m)	Length(m)	Effective Depth(m)	Basin
	6.0×	33.5×	1.5×	1

Effective Volume per Basin(m3)		310
Basin		1 unit duty
Effective Volume Total(m3)		310
Retention Time	3.86	min
Average Velocity	14.47	cm/sec
Surface Load Ratio	399	mm/min
Length/Width	5.6	

Case 20 Capacity Calculation of Grit Chamber (River Water Level + 440.74m) 1 unit duty

(Grit Chamber High Water Level + 440.18 m)

(Grit Chamber Low Water Level + 436.00 m) soil h=1.94m

Flow Rate	110000*	1.05=	115500 cum/day
Average Velocity			2-7 cm/sec
Surface Load Ratio			200-500mm/min
Width/Length			3-8
Effective Depth			3-4m
Retention Time			10-20min

Reqired Length L=K*(H*V/U)/B= 55.7 m

L:	Required Length(m)		
K:	Safety Factor(-)		2
H:	Effective Depth		4.2 m
V:	Average Velocity		5.3 cm/sec
U:	Sand Settling Velocity	(Dia.0.10mm)	0.8 cm/sec
B:	Number of Basins		1
W:	Width		6.0 m

Dia. of Sand(mm)	Sediment Velocity (cm/sec)
0.30	3.2
0.20	2.1
0.15	1.5
0.10	0.8
0.08	0.6

Water Level	Max. Flood	1447 ft	441.00 m
	Max. Operation	1446 ft	440.74 m
	Min. Operation	1438 ft	438.30 m
	Spillway Crest	1425 ft	434.34 m
River Bottom Level at Intake Point		1430 ft	436.00 m

Grit Chamber Dimension	Width(m)	Length(m)	Effective Depth(m)	Basin
	6.0×	33.5×	4.2×	1

Effective Volume per Basin(m3)		840
Basin		1 unit duty
Effective Volume Total(m3)		840
Retention Time	10.47	min
Average Velocity	5.33	cm/sec
Surface Load Ratio	399	mm/min
Length/Width	5.6	

Existing Small Stream Reconstruction Plan outside of Intake site (W=2.0m,H=1.00m,Water Depth h=0.50mQ2,h=0.67mQ3)
Downstream (gate point of intake site - release point)

1 Existing Open Channel

Bottom Level	at gate point of intake site	h1=	443.500 m	GL	445.000 m
	at release point	h2=	442.000 m	EL	442.500 m
Length		L=	135.00 m		
Average Gradient	(I=(h1-h2)/L)	I=	0.0111		

2 Proposed Water Flow

2.1 Rainfall Discharge Flow

Q1=A*I*CR=		0.693 m3/sec	(Rainfall discharge)
where	A=	24.93 ha	(Catchment area)
	I=	50 mm/h	(Rainfall intensity)
	CR=	0.2	(Coefficient of run-off)

2.2 Balancing Tank Oveflow Discharge Flow

Q2=	1.273 m3/sec	(Overflow 110,000m3/day)
Q3=	1.910 m3/sec	(Overflow 110,000*1.5m3/day)

3 Proposed open channel

Bottom Level

at gate point of intake site	h1=	441.500 m	(EL	442.500 m) Channel Depth H=	1.000 m
at release point	h2=	441.000 m	(EL	442.500 m) Channel Depth H=	1.500 m
Mahaweli River	HHWL+441.00m				
Level Deference between gate and release point	h0=h1-h2=		0.500 m		
Length	L=	137.00 m	(0+325 - 0+462)		
Adopted Gradient (I=(h1-h2)/L)	I=	0.003650			

4 Water Depth and Channel Bottom Gradient for Q2=1.273m3/sec

Sectional Area of Reconstruction Stream

Q2= 1.273 m3/sec

Inflow sectional area

a=b*h= 1.01 m2

where b= 2.00 m (Channel Width)

h= 0.504 m (Water Depth)

Velocity

V2=Q2/a= 1.26 m/sec

Hydraulic radius

R=(h*b+(0.3*2*h)/2)/(b+1.044*2*h)= 0.380 m

Roughness coefficient

n= 0.025

Head losses are calculated using Manning Formula.

h=n^2*L*v^2/R^(4/3)

where L= 137.00 m

h= 0.497 = 0.500 m <= 0.500 (Proposed Bottom Level Deference h0) OK

I= h/L = 0.003649635

5 Water Depth and Channel Bottom Gradient for Q3=1.910m3/sec

Sectional Area of Reconstruction Stream

Q3= 1.910 m3/sec

Inflow sectional area

a=b*h= 1.34 m2

where b= 2.00 m (Channel Width)

h= 0.670 m (Water Depth)

Velocity

V3=Q3/a= 1.43 m/sec

Hydraulic radius

R=(h*b+(0.3*2*h)/2)/(b+1.044*2*h)= 0.453 m

Roughness coefficient

n= 0.025

Head losses are calculated using Manning Formula.

h=n^2*L*v^2/R^(4/3)

where L= 137.00 m

h= 0.499 = 0.500 m <= 0.500 (Proposed Bottom Level Deference h0) OK

Appendix 6.2 Sri Lanka - Kandy Water Supply Project
Capacity Calculation for Katugastota Treatment Plant Q=110,000 cu m/day

Item	Total System				First Stage			
Planned Flow	Q=	110,000 cu m/day			Q=	36,670 cu m/day		
Plant Capacity (Daily Max)	Q=	115,500 cu m/day			Q=	38,500 cu m/day		
	=	4,813 cu m/hour			=	1,604 cu m/hour		
	=	80.2 cu m/min			=	26.7 cu m/min		
	=	1.337 cu m/sec			=	0.446 cu m/sec		
(1) Balancing Tank								
Criteria	Retention Time		T =	1.5 min	Retention Time		T =	1.5 min
	Recirculation		a =	0.0 %	Recirculation		a =	0.0 %
Dimension	Rectangular		1 units		Rectangular		1 units	
	L m	x W	m x D m	x units	L m	x W	m x D m	x units
	7.0	9.0	2.0	1	7.0	9.0	2.0	1
	V=	126.0 cu m			V=	126.0 cu m		
	T=	1.57 min			T=	4.49 min		

Appendix 6.2 Sri Lanka - Kandy Water Supply Project
Capacity Calculation for Katugastota Treatment Plant Q=110,000 cu m/day

Item	Total System				First Stage			
Planned Flow	Q=	110,000 cu m/day			Q=	36,670 cu m/day		
Plant Capacity	Q=	115,500 cu m/day			Q=	38,500 cu m/day		
(Daily Max)	=	4,813 cu m/hour			=	1,604 cu m/hour		
	=	80.2 cu m/min			=	26.7 cu m/min		
	=	1.337 cu m/sec			=	0.446 cu m/sec		
(1) Receiving Well								
Criteria	Retention Time		T =	1.5 min	Retention Time		T =	1.5 min
	Recirculation		a =	3.0 %	Recirculation		a =	3.0 %
Dimension	Rectangular		1 units		Rectangular		1 units	
	L m	x W	m x D m	x units	L m	x W	m x D m	x units
	4.5	8.1	5.0	1	4.5	8.1	5.0	1
			4					
	V=	182.3 cu m			V=	182.3 cu m		
	T=	2.2 min			T=	6.3 min		
(2) Mixing Chamber								
Criteria	Retention Time	T=		1 - 5 min	Retention Time	T=		1 - 5 min
	Recirculation	a =		3.0 %	Recirculation	a =		3.0 %
Dimension	Rectangular		6 units		Rectangular		2 units	
	L m	x W	m x D m	x units	L m	x W	m x D m	x units
	3.5	2.5	3.90	6	3.5	2.5	3.90	2
Unit Volume	UV =	34.1 cu m/unit			UV =	34.1 cu m/unit		
Total Volume	V =	205 cu m			V =	68 cu m		
Retention Time	t =	2.5 min			t =	2.5 min		
Mixing	Hydraulic Mixing				Hydraulic Mixing			
(3) Flocculator								
Criteria	Retention Time		T =	20 - 40 min	Retention Time		T =	20 - 40 min
	Recirculation		a =	3.0 %	Recirculation		a =	3.0 %
	Required Volume		V =	1,652 cu.m to	Required Volume		V =	551 cu.m to
				3,305 cu.m				1,102 cu.m
Unit Flow	q =	13.4 cu m/min/basin			q =	13.4 cu m/min/basin		
Dimension		6 units				2 units		
Step 1	W m	x L m	x D m	x No.of Channel	W m	x L m	x D m	x No.of Channel
	1.1	11.0	3.5	2	1.1	11.0	3.5	2
Step 2	W m	x L m	x D m	x No.of Channel	W m	x L m	x D m	x No.of Channel
	1.5	11.0	3.5	2	1.5	11.0	3.5	2
Step 3	W m	x L m	x D m	x No.of Channel	W m	x L m	x D m	x No.of Channel
	2.3	11.0	3.5	2	2.3	11.0	3.5	2
Volume	Step 1		84.7 cu m/unit		Step 1		84.7 cu m/unit	
	Step 2		115.5 cu m/unit		Step 2		115.5 cu m/unit	
	Step 3		177.1 cu m/unit		Step 3		177.1 cu m/unit	
	Volume / Unit		377.3 cu m/unit		Volume / Unit		377.3 cu m/unit	
Total Volume	V =	2,264 cu m			V =	755 cu m		
Retention Time		28.2 minutes				28.2 minutes		

Appendix 6.2 Sri Lanka - Kandy Water Supply Project
Capacity Calculation for Katugastota Treatment Plant Q=110,000 cu m/day

Item	Total System	Phase 1
(4) Seddimentation Basin		
Type	Rectangular, Horizontal Flow	Rectangular, Horizontal Flow
Unit Flow	q = 826 cu m/hr/basin (Recirculation a= 3.0 %)	q = 826 cu m/hr/basin (Recirculation a= 3.0 %)
Criteria	Retention Time T = 2.5 hours Surface Load a = 15 - 30 mm/min Hor. Flow Velocity v < 0.40 m/min L/W Ratio L/W = 3 - 8 times Depth D = 3 - 4 m Depth of 50 cm or more is provided for sludge settlement.	Retention Time T = 2.5 hours Surface Load a = 15 - 30 mm/min Hor. Flow Velocity v < 0.40 m/min L/W Ratio L/W = 3 - 8 times Depth D = 3 - 4 m Depth of 50 cm or more is provided for sludge settlement.
Original Dimension	No. 6 basins W m x L m x D m x N 11 50 4.0 6	No. 2 basins W m x L m x D m x N 11 50 4.0 2
Volume Retention Time L/W Ratio Surface Load Hor. Flow Velocity	V = 2,200 cu m/basin T = 2.66 hours L/W = 4.5 a = 25.0 mm/min v = 0.313 m/min	V = 2,200 cu m/basin T = 2.7 hours L/W = 4.5 a = 25.0 mm/min v = 0.313 m/min
Revised Dimension	No. 6 basins W m x L m x D m x N 11 41 4.0 6 1st step 11.0 m 100 %Q 2nd step 10.0 m 100 %Q 3rd step 10.0 m 80 %Q 4th step 10.0 m 60 %Q Total Length 41.0 m	No. 2 basins W m x L m x D m x N 11 41 4.0 2 1st step 11.0 m 100 %Q 2nd step 10.0 m 100 %Q 3rd step 10.0 m 80 %Q 4th step 10.0 m 60 %Q Total Length 41.0 m
Volume Retention Time L/W Ratio Surface Load Hor. Flow Velocity	V = 1,804 cu m/basin T = 2.18 hours L/W = 3.7 a = 25.0 mm/min v = 0.313 m/min	V = 1,804 cu m/basin T = 2.18 hours L/W = 3.7 a = 25.0 mm/min v = 0.313 m/min
Overflow Weir Trough Length	Load = 500 m3/m/day L = 24 m or longer No. 8 troughs/unit L m x N 2.0 8 L = 32.0 m Weir Load L= 372 m3/m/day	Load = 500 m3/m/day L = 24 m or longer No. 8 troughs/unit L m x N 2.0 8 L = 32.0 m Weir Load L= 372 m3/m/day
Sludge Removal	Recipro Type Collector	Recipro Type Collector
Sludge Amount Solid Amount (ton-DS)	So = Q * (K*(T1-T2)+B*156/666)*10^-6 where So:Sludge dry weight(ton) Q :Treated water amount(m3/d) K :Coefficient converting turbidity to SS (0.8-1.5 ->>1.2) T1 :Turbidity in raw water (ave= 40 T2 :Turbidity after Sedimentation (ave = 0) B :Alum dosage rate (ave.= 10 B = 4 + 2 * (T1-T2) ^ 0.5 = 16.6 So = 5.81 ton-DS/day Water Contents of Drained Sludge (with wash-out water) w = 98.0 % Frequency of Cleaning : Once a Year	So = 1.94 ton-DS/day Water Contents of Drained Sludge (with wash-out water) w = 98.0 % Frequency of Cleaning : Once a Year
Sludge Volume	Total v = 106,115 cu.m/year So = 2,122 ton-DS/year Per tank v = 17,686 cu.m/basin/year So = 354 ton-DS/basin/year	Total v = 35,372 cu.m/year So = 707 ton-DS/year Per tank v = 17,686 cu.m/basin/year So = 354 ton-DS/basin/year

Appendix 6.2 Sri Lanka - Kandy Water Supply Project
Capacity Calculation for Katugastota Treatment Plant Q=110,000 cu m/day

Item	Total System	First Stage
(5) Rapid Sand Filter		
Type	Down Flow, Single Media	Down Flow, Single Media
No.	12 units (wash 3 group)	4 units (wash 1 group)
Unit Flow	q = 9,900 cu m/day/unit (Recirculation a= 3.0 %)	q = 9,900 cu m/day/unit (Recirculation a= 3.0 %)
Criteria	Filtration Rate Fr = 150 m/day (for normal operation) Filter Area per Unit A < 150 sq m	Filtration Rate Fr = 150 m/day (for normal operation) Filter Area per Unit A < 150 sq m
Dimension	W m x L m x N units 7.2 9.6 12 (4 filters/group) A = 69.1 sq m/unit	W m x L m x N units 7.2 9.6 4 (4 filters/group) A = 69.1 sq m/unit
Filtration Rate	Fr = 143.2 m/day	Fr = 143.2 m/day
Filtration Rate during washing	Fr'= 191.0 m/day 3 units out of 12 are washing	Fr'= 191.0 m/day 1 units out of 4 are washing
Filters for Backwashing	2.3 filters/group	2.3 filters/group
Filter Washing Frequency	Once a day for each filter	Once a day for each filter
Water Rate	Backwashing rate = 0.30 m3/m2/min duration = 12 min	Backwashing rate = 0.30 m3/m2/min duration = 12 min
Air Rate	Air Scouring rate = 1.00 m3/m2/min duration = 3 min	Air Scouring rate = 1.00 m3/m2/min duration = 3 min
Water Amount for washing	Backwashing Vb = 248.8 cu m/unit	Backwashing Vb = 248.8 cu m/unit
for Total Units	Total Amount for Washing 2,986.0 cu m/day Percentage for Planned Flow 2.6 %	Total Amount for Washing 995.3 cu m/day Percentage for Planned Flow 2.6 %
Solid Amount in Wastewater (ton-DS)	So = Q*K*(T1-T2)*10^-6 where So:Sludge dry weight(ton) Q :Treated water amount(m3/d) K :Coefficient converting turbidity to SS (0.8-1.5 ->>1.2) T1 :Turbidity before filter(ave= 5 T2 :Turbidity after filter(ave = 0 So = 0.69 ton-DS/day	So = 0.23 ton-DS/day
SS Contents	s = 232 mg/l	s = 232 mg/l
(6) Backwash Water Storage Tank		
Location	at the Outlet of the Filtration Units	at the Outlet of the Filtration Units
Criteria	V > Backwash Water for 1 unit	V > Backwash Water for 1 unit
Required Volume	V = 248.8 cu m	V = 248.8 cu m
Dimension	No. 1 units L m x W m x D m m x N units 17.7 8.0 2.09 1	No. 1 units L m x W m x D m m x N units 17.7 8.0 2.09 1
Total Volume	v = 296 cu m	v = 296 cu m

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Appendix 6.2 Sri Lanka - Kandy Water Supply Project
Capacity Calculation for Katugastota Treatment Plant Q=110,000 cu m/day

Item	Total System	First Stage
(7) Clear Water Reservoir		
Criteria	Retention Time T > 1.0 hours	Retention Time T > 1.0 hours
Required Volume	V = 4,580 cu m	V = 1,530 cu m
Dimension	No. 6 units	No. 2 units
	L m x W m x D m m x N units	L m x W m x D m m x N units
	21.0 13.8 3.0 6	21.0 13.8 3.0 2
Total Volume	V = 5,216 cu m	V = 1,739 cu m
Retention Time	T = 1.14 hours	T = 1.14 hours
(8) Alum Dissolving Tank		
Coagulant	Solid Aluminum Sulphate (Al2(SO4)3)	Solid Aluminum Sulphate (Al2(SO4)3)
	containing 15 % Al2-O3	containing 15 % Al2-O3
Criteria	Dosage Rate : 10-60 mg-solid alum/l	Dosage Rate : 10-60 mg-solid alum/l
	Average 30 mg/l	Average 30 mg/l
	Coagulant Solution : 10 % sg = 1.0525	Coagulant Solution : 10 % sg = 1.0525
	Retention Time 24 hours	Retention Time 24 hours
	Dissolving Time 2 hours	Dissolving Time 2 hours
Dosage Amount	Wt = 3,465 kg-Alum/day (Max dosage)	Wt = 1,155 kg-Alum/day (Max dosage)
Coagulant Solution	V = 32.9 cu m/day	V = 11.0 cu m/day
Solution Tank	Square 4 units	Square 2 units
Dimension	L m x W m x D m x units	L m x W m x D m x units
	2.0 2.0 2.5 4	2.0 2.0 2.5 2
Total Volume	V = 40.0 cu m	V = 20.0 cu m
Retention Time	T = 29.2 hours	T = 43.7 hours
Storage	Period 30 days	Period 30 days
	Bulk s. g. 0.60	Bulk s. g. 0.60
Storage Area	A = 87 m2 at 2.0 m height	A = 29 m2 at 2.0 m height
(9) Lime Dissolving Tank		
pH Control	Hydrated Lime (Ca(OH)2)	Hydrated Lime (Ca(OH)2)
	containing 72 % CaO	containing 72 % CaO
Criteria	Dosage Rate : 5-30 mg-solid Lime/l	Dosage Rate : 5-30 mg-solid Lime/l
	Requirement 10.4 mg/l	Requirement 10.4 mg/l
	(Pre5-30, Post5-20 mg/l)	(Pre5-30, Post5-20 mg/l)
	Average 15.0 mg/l (Pre10, Post5 mg/l)	Average 15.0 mg/l (Pre10, Post5 mg/l)
	Lime Solution 10 % sg = 1.0607	Lime Solution 10 % sg = 1.0607
	Retention Time 24 hours	Retention Time 24 hours
	Dissolving Time 2 hours	Dissolving Time 2 hours
Dosage Amount	Wt = 1,733 kg-Alum/day (Max dosage)	Wt = 578 kg-Alum/day (Max dosage)
Coagulant Solution	V = 16.3 cu m/day	V = 5.4 cu m/day
Solution Tank	Square 4 units	Square 2 units
Dimension	L m x W m x D m x units	L m x W m x D m x units
	2.0 2.0 2.5 4	2.0 2.0 2.5 2
Total Volume	V = 40.0 cu m	V = 20.0 cu m
Retention Time	T = 58.8 hours	T = 88.2 hours
Storage	Period 30 days	Period 30 days
	Bulk s. g. 0.40	Bulk s. g. 0.40
Storage Area	A = 65 m2 at 2.0 m height	A = 22 m2 at 2.0 m height

Appendix 6.2 Sri Lanka - Kandy Water Supply Project
Capacity Calculation for Katugastota Treatment Plant Q=110,000 cu m/day

Item	Total System	First Stage
(10) Chlorination Equipment		
Injection Point	at the Inlet of Clear Water Reservoir and outlet of Sedimentation Basin	at the Inlet of Clear Water Reservoir and outlet of Sedimentation Basin
Type	Liquid Chlorine (900 kg-cylinder)	Liquid Chlorine (900 kg-cylinder)
Criteria	Dosage Rate : 7.0 mg-Cl/l	Dosage Rate : 7.0 mg-Cl/l
	(Pre1.0-5.0, Post1.0-5.0)	(Pre1.0-5.0, Post1.0-5.0)
	Average 3.0 mg/l (Pre2.0, Post1.0 mg/l)	Average 3.0 mg/l (Pre2.0, Post1.0 mg/l)
Dosage Amount	Wt = 347 kg- Cl gas/day	Wt = 116 kg- Cl gas/day
	or 14 kg- Cl gas/hour	or 5 kg- Cl gas/hour
Chlorinator	Vacuum Type	Vacuum Type
No. of unit	3 units	1 units
	(excl. 1 unit stand-by)	(excl. 1 unit stand-by)
Rate	4.81 kg/hour/unit	4.81 kg/hour/unit
Operation Rate	60 percent	60 percent
Capacity	8 kg/hour/unit	8 kg/hour/unit
Storage	Period 30 days	Period 30 days
Storage Area	A = 24 m2 as 2.0 m2/container	A = 9 m2 as 2.0 m2/container
(11) Backwash Wastewater Storage Tank		
Retention Time	1 hours	1 hours
Backwash Water	Vs + Vb = 249 cu.m/filter unit	Vs + Vb = 249 cu.m/filter unit
Required Volume	1 filters 249 cu.m	1 filters 249 cu.m
No.	N = 2 units	N = 2 units
Dimension	L m x W m x D m m x N units	L m x W m x D m m x N units
	14.0 6.0 3.00 2	14.0 6.0 3.00 2
Total Volume	v = 504 cu m	v = 504 cu m
Frequency of Wash	Once a day = 12 filters/day	Once a day = 4 filters/day
(12) Sludge Lagoon	So = 5.81 ton-DS/day	So = 1.94 ton-DS/day
	Water Contents in Sludge Lagoon	Water Contents of Drained Sludge (with wash-out water)
	w = 70.0 %	w = 70.0 %
Sludge Amount	Total v = 7,074 cu.m/year	Total v = 2,358 cu.m/year
	So = 2,122 ton-DS/year	So = 707 ton-DS/year
Required Volume	v = 7,074 cu m	v = 2,358 cu m
Dimension	Rectangular 3 units + 1 unit for stand-by	Rectangular 1 units + 1 unit for stand-by
	L m x W m x D m x units	L m x W m x D m x units
	70.0 35.0 1.0 4	70.0 35.0 1.0 2
Total Volume	v = 7,350 cu m	v = 2,450 cu m

02 Intake and Water Treatment Plant Hydraulic Calculations

Intake Facilities Water Level (0.5m settling soil at 1nlet channel)

Quantity	Duty	R.W.L.(m)		G.W.L.	P.C.W.L.	Remark
Q=1.0	1 unit	LLWL	437.60	436.87	436.59	Bottom Level is 434.06m(no soil)
		LLWL	437.60	436.78	436.40	Sedimentation Level is 435.06m(h=1.0m)
		LLWL	437.60	436.47	435.94	Sedimentation Level is 436.00m(h=1.94m)
		LWL	438.30	437.54	437.36	Sedimentation Level is 436.00m(h=1.94m)
		HWL	440.74	440.18	440.12	Sedimentation Level is 436.00m(h=1.94m)
Q=1.0	2 units	LLWL	437.60	437.11	437.03	Bottom Level is 434.06m(no soil)
		LLWL	437.60	437.09	437.01	Sedimentation Level is 435.06m(h=1.0m)
		LLWL	437.60	437.01	436.93	Sedimentation Level is 436.00m(h=1.94m)
		LWL	438.30	437.80	437.75	Sedimentation Level is 436.00m(h=1.94m)
		HWL	440.74	440.29	440.27	Sedimentation Level is 436.00m(h=1.94m)

Note: R.W.L.: River Water Level
G.W.L.: Grit Chamber Water Level
P.C.W.L.: Pump Chamber Water Level

Intake facilities water loss (River water level +437.6m)

2 unit duty

1 River Water Level

L.L.W.L. 437.600 m

2 Intake Flow & Verosity

Q1= 38500 m3/day= 0.446 m3/sec

Q2= 77000 m3/day= 0.891 m3/sec

Q3= 115500 m3/day= 1.337 m3/sec

3 Bar Screen Loss

B= 2.00 m (37.5 *44= 1.650 m)

H= 1.10 m (Bottom Level 436.500 m) Including Sed. Depth h=0.50m

b= 37.5 mm

t= 12.5 mm

θ = 70 °

V= 0.368 m/s (Q= 1.337 /2= 0.668403)

H= 0.003 m

Threrfore h1= 0.300 m (WL+ 437.300 m, depth 0.800 m)

(Bottom Level 436.500 m) settling soil 0.5m

4 Head loss of Intake gate

Dimension of gate; 1500×1500

Head loss h=v2/(2*g*C^2)

where A=1.5m*Hm*2= 2.4 m2 : Sectional area (H= 0.80 m)

Q= 1.337 m3/sec

v=Q/A= 0.557 m/sec

g= 9.8 m/sec2

C= 0.6

h4= 0.0440 m = 0.050 m (WL+ 437.250 m, depth 0.750 m)

(Bottom Level 436.500 m)

5 Rubbish Remover

B= 2.00 m (20 *44= 0.880 m)

H= 0.75 m (Bottom Level 436.500 m)

b= 20.0 mm

t= 3 mm

θ = 70 °

V= 2.025 m/s (Q= 1.337 /2= 0.668403)

H= 0.028 m

Threrfore h2= 0.100 m (WL+ 437.150 m, depth 0.650 m)

(Bottom Level 436.500 m)

6 Head loss in the channel

Q1= 0.668 m3/sec : Water flow of 1 trough (Q= 1.337 /2= 0.668)

Inflow sectional area

A=B*H= 1.30 m2

where B= 2.00 m

H= 0.65 m

Velocity

V(a-b)=Q1/A= 0.51 m/sec

Hydraulic radius

R=A/(B+H*2)= 0.394 m

Roughness coefficient

n= 0.015

Head losses are calculated using Manning Formula.

h=n^2*L*v^2/R^(4/3)

where L= 26.0 m

h3= 0.00536 = 0.010 m (WL+ 437.140 m, depth 0.640 m)

(Bottom Level 436.500 m)

7 Head loss of diffusion wall

Diameter of holes and number of holes; ϕ 100@300×300
Head loss h=v2/(2*g*C^2)
where A=3.14/4*D^2*(a*b)= 1.554 m2 : Sectional area
D= 100 mmdia.
a= 18 pieces
b= 11 pieces (Bottom Level 434.060 m= 434.06 +0.00)
Q= 0.668 m3/sec (Q= 1.337 /2= 0.668)
v=Q/A= 0.43 m/sec
g= 9.8 m/sec2
C= 0.6
h5= 0.026 m = 0.030 m

8 Grit chamber water level 437.110 m

9 Head loss of diffusion wall

Diameter of holes and number of holes; ϕ 100@300×300
Head loss h=v2/(2*g*C^2)
where A=3.14/4*D^2*(a*b)= 0.989 m2 : Sectional area
D= 100 mmdia.
a= 18 pieces
b= 7 pieces (Bottom Level 434.06 m)
Q= 0.668 m3/sec (Q= 1.337 /2= 0.668)
v=Q/A= 0.68 m/sec
g= 9.8 m/sec2
C= 0.6
h5= 0.065 m = 0.070 m (WL+ 437.040 m, depth 2.980 m)
(Bottom Level 434.060 m)

10 Head loss of Intake gate

Dimension of gate; 1500×1500
Head loss h=v2/(2*g*C^2)
where A=1.5m*Hm*2= 4.8 m2 : Sectional area (H= 1.60 m)
Q= 0.668 m3/sec (Q= 1.337 /2= 0.668)
v=Q/A= 0.139 m/sec
g= 9.8 m/sec2
C= 0.6
h6= 0.00275 m = 0.010 m (WL+ 437.030 m, depth 3.870 m)
(Bottom Level 433.160 m)

11 Conveyance Pump chamber water level 437.030 m

Intake facilities water loss (River water level +437.6m)

2 unit duty

1 River Water Level

L.L.W.L. 437.600 m

2 Intake Flow & Verosity

Q1=	38500 m3/day=	0.446	m3/sec
Q2=	77000 m3/day=	0.891	m3/sec
Q3=	115500 m3/day=	1.337	m3/sec

3 Bar Screen Loss

B= 2.00 m (37.5 *44= 1.650 m)
H= 1.10 m (Bottom Level 436.500 m) Including Sed. Depth h=0.50m
b= 37.5 mm
t= 12.5 mm
θ = 70 °
V= 0.368 m/s (Q= 1.337 /2= 0.668403)
H= 0.003 m

Threrfore h1= 0.300 m (WL+ 437.300 m, depth 0.800 m)
(Bottom Level 436.500 m) settling soil 0.5m

4 Head loss of Intake gate

Dimension of gate; 1500×1500
Head loss h=v2/(2*g*C^2)
where A=1.5m*Hm*2= 2.4 m2 : Sectional area (H= 0.80 m)
Q= 1.337 m3/sec
v=Q/A= 0.557 m/sec
g= 9.8 m/sec2
C= 0.6
h4= 0.0440 m = 0.050 m (WL+ 437.250 m, depth 0.750 m)
(Bottom Level 436.500 m)

5 Rubbish Remover

B= 2.00 m (20 *44= 0.880 m)
H= 0.75 m (Bottom Level 436.500 m)
b= 20.0 mm
t= 3 mm
θ = 70 °
V= 2.025 m/s (Q= 1.337 /2= 0.668403)
H= 0.028 m

Threrfore h2= 0.100 m (WL+ 437.150 m, depth 0.650 m)
(Bottom Level 436.500 m)

6 Head loss in the channel

Q1= 0.668 m3/sec : Water flow of 1 trough (Q= 1.337 /2= 0.668)

Inflow sectional area

A=B*H= 1.30 m2
where B= 2.00 m
H= 0.65 m

Velocity
V(a-b)=Q1/A= 0.51 m/sec

Hydraulic radius
R=A/(B+H*2)= 0.394 m

Roughness coefficient
n= 0.015

Head losses are calculated using Manning Formula.

h=n^2*L*v^2/R^(4/3)
where L= 26.0 m

h3= 0.00536 = 0.010 m (WL+ 437.140 m, depth 0.640 m)
(Bottom Level 436.500 m)

7 Head loss of diffusion wall

Diameter of holes and number of holes; ϕ 100@300×300
Head loss h=v2/(2*g*C^2)
where A=3.14/4*D^2*(a*b)= 1.130 m2 : Sectional area
D= 100 mmdia.
a= 18 pieces
b= 8 pieces (Sedimentation Level 435.060 m= 434.06 + 1.0)
Q= 0.668 m3/sec (Q= 1.337 /2= 0.668)
v=Q/A= 0.59 m/sec
g= 9.8 m/sec2
C= 0.6
h5= 0.050 m = 0.050 m

8 Grit chamber water level 437.090 m

9 Head loss of diffusion wall

Diameter of holes and number of holes; ϕ 100@300×300
Head loss h=v2/(2*g*C^2)
where A=3.14/4*D^2*(a*b)= 0.989 m2 : Sectional area
D= 100 mmdia.
a= 18 pieces
b= 7 pieces (Bottom Level 434.06 m)
Q= 0.668 m3/sec (Q= 1.337 /2= 0.668)
v=Q/A= 0.68 m/sec
g= 9.8 m/sec2
C= 0.6
h5= 0.065 m = 0.070 m (WL+ 437.020 m, depth 2.960 m)
(Bottom Level 434.060 m)

10 Head loss of Intake gate

Dimension of gate; 1500×1500
Head loss h=v2/(2*g*C^2)
where A=1.5m*Hm*2= 4.8 m2 : Sectional area (H= 1.60 m)
Q= 0.668 m3/sec (Q= 1.337 /2= 0.668)
v=Q/A= 0.139 m/sec
g= 9.8 m/sec2
C= 0.6
h6= 0.00275 m = 0.010 m (WL+ 437.010 m, depth 3.850 m)
(Bottom Level 433.160 m)

11 Conveyance Pump chamber water level 437.010 m

Intake facilities water loss (River water level +437.6m)

2 unit duty

1 River Water Level
L.L.W.L. 437.600 m

2 Intake Flow & Verosity
Q1= 38500 m3/day= 0.446 m3/sec
Q2= 77000 m3/day= 0.891 m3/sec
Q3= 115500 m3/day= 1.337 m3/sec

3 Bar Screen Loss
B= 2.00 m (37.5 *44= 1.650 m)
H= 1.10 m (Bottom Level 436.500 m) Including Sed. Depth h=0.50m
b= 37.5 mm
t= 12.5 mm
θ = 70 °
V= 0.368 m/s (Q= 1.337 /2= 0.668403)
H= 0.003 m
Threrfore h1= 0.300 m (WL+ 437.300 m, depth 0.800 m)
(Bottom Level 436.500 m) settling soil 0.5m

4 Head loss of Intake gate

Dimension of gate; 1500×1500
Head loss h=v2/(2*g*C^2)
where A=1.5m*Hm*2= 2.4 m2 : Sectional area (H= 0.80 m)
Q= 1.337 m3/sec
v=Q/A= 0.557 m/sec
g= 9.8 m/sec2
C= 0.6
h4= 0.0440 m = 0.050 m (WL+ 437.250 m, depth 0.750 m)
(Bottom Level 436.500 m)

5 Rubbish Remover
B= 2.00 m (20 *44= 0.880 m)
H= 0.75 m (Bottom Level 436.500 m)
b= 20.0 mm
t= 3 mm
θ = 70 °
V= 2.025 m/s (Q= 1.337 /2= 0.668403)
H= 0.028 m
Threrfore h2= 0.100 m (WL+ 437.150 m, depth 0.650 m)
(Bottom Level 436.500 m)

6 Head loss in the channel

Q1= 0.668 m3/sec : Water flow of 1 trough (Q= 1.337 /2= 0.668)

Inflow sectional area

A=B*H= 1.30 m2
where B= 2.00 m
H= 0.65 m

Velocity
V(a-b)=Q1/A= 0.51 m/sec

Hydraulic radius
R=A/(B+H*2)= 0.394 m

Roughness coefficient
n= 0.015

Head losses are calculated using Manning Formula.

h=n^2*L*v^2/R^(4/3)
where L= 26.0 m

h3= 0.00536 = 0.010 m (WL+ 437.140 m, depth 0.640 m)
(Bottom Level 436.500 m)

7 Head loss of diffusion wall

Diameter of holes and number of holes; φ 100@300×300
Head loss h=v2/(2*g*C^2)
where A=3.14/4*D^2*(a*b)= 0.707 m2 : Sectional area
D= 100 mmdia.
a= 18 pieces
b= 5 pieces (Sedimentation Level 436.000 m= 434.06 + 1.94)
Q= 0.668 m3/sec (Q= 1.337 /2= 0.668)
v=Q/A= 0.95 m/sec
g= 9.8 m/sec2
C= 0.6
h5= 0.127 m = 0.130 m

8 Grit chamber water level 437.010 m

9 Head loss of diffusion wall

Diameter of holes and number of holes; φ 100@300×300
Head loss h=v2/(2*g*C^2)
where A=3.14/4*D^2*(a*b)= 0.989 m2 : Sectional area
D= 100 mmdia.
a= 18 pieces
b= 7 pieces (Bottom Level 434.06 m)
Q= 0.668 m3/sec (Q= 1.337 /2= 0.668)
v=Q/A= 0.68 m/sec
g= 9.8 m/sec2
C= 0.6
h5= 0.065 m = 0.070 m (WL+ 436.940 m, depth 2.880 m)
(Bottom Level 434.060 m)

10 Head loss of Intake gate

Dimension of gate; 1500×1500
Head loss h=v2/(2*g*C^2)
where A=1.5m*Hm*2= 4.8 m2 : Sectional area (H= 1.60 m)
Q= 0.668 m3/sec (Q= 1.337 /2= 0.668)
v=Q/A= 0.139 m/sec
g= 9.8 m/sec2
C= 0.6
h6= 0.00275 m = 0.010 m (WL+ 436.930 m, depth 3.770 m)
(Bottom Level 433.160 m)

11 Conveyance Pump chamber water level 436.930 m

Intake facilities water loss (River water level +438.3m)

2 unit duty

1 River Water Level

H.W.L. 438.300 m

2 Intake Flow & Verosity

Q1=	38500 m3/day=	0.446	m3/sec
Q2=	77000 m3/day=	0.891	m3/sec
Q3=	115500 m3/day=	1.337	m3/sec

3 Bar Screen Loss	B=	2.00 m	(37.5 *44=	1.650 m)		
	H=	1.80 m	(Bottom Level	436.500 m)	Including Sed. Depth h=0.50m	
	b=	37.5 mm				
	t=	12.5 mm				
	θ =	70 °				
	V=	0.225 m/s	(Q= 1.337 /2=	0.668403)		
	H=	0.001 m				
Threrfore	h1=	0.300 m		(WL+	438.000 m, depth	1.500 m)
				(Bottom Level	436.500 m) settling soil 0.5m	

4 Head loss of Intake gate

Dimension of gate; 1500×1500

Head loss h=v2/(2*g*C^2)

where	A=1.5m*Hm*2=	3.3 m2	: Sectional area	(H= 1.10 m)		
	Q=	1.337 m3/sec				
	v=Q/A=	0.405 m/sec				
	g=	9.8 m/sec2				
	C=	0.6				
	h4=	0.0233 m	= 0.030 m	(WL+	437.970 m, depth	1.470 m)
				(Bottom Level	436.500 m)	

5 Rubbish Remover	B=	2.00 m	(20 *44=	0.880 m)		
	H=	1.47 m	(Bottom Level	436.500 m)		
	b=	20.0 mm				
	t=	3 mm				
	θ =	70 °				
	V=	1.033 m/s	(Q= 1.337 /2=	0.668403)		
	H=	0.007 m				
Threrfore	h2=	0.100 m		(WL+	437.870 m, depth	1.370 m)
				(Bottom Level	436.500 m)	

6 Head loss in the channel

Q1= 0.668 m3/sec : Water flow of 1 trough (Q= 1.337 /2= 0.668)

Inflow sectional area

A=B*H=		2.74 m2
where	B=	2.00 m
	H=	1.37 m

Velocity

V(a-b)=Q1/A= 0.24 m/sec

Hydraulic radius

R=A/(B+H*2)= 0.578 m

Roughness coefficient

n= 0.015

Head losses are calculated using Manning Formula.

h=n^2*L*v^2/R^(4/3)

where L= 26.0 m

h3=	0.00072	= 0.000 m	(WL+	437.870 m, depth	1.370 m)
			(Bottom Level	436.500 m)	

7 Head loss of diffusion wall

Diameter of holes and number of holes; φ 100@300×300
Head loss h=v2/(2*g*C^2)
where A=3.14/4*D^2*(a*b)= 0.989 m2 : Sectional area
D= 100 mmdia.
a= 18 pieces
b= 7 pieces (Bottom Level 436.000 m= 434.06 + 1.94)
Q= 0.668 m3/sec (Q= 1.337 /2= 0.668)
v=Q/A= 0.68 m/sec
g= 9.8 m/sec2
C= 0.6
h5= 0.065 m = 0.070 m

8 Grit chamber water level 437.800 m

9 Head loss of diffusion wall

Diameter of holes and number of holes; φ 100@300×300
Head loss h=v2/(2*g*C^2)
where A=3.14/4*D^2*(a*b)= 1.413 m2 : Sectional area
D= 100 mmdia.
a= 18 pieces
b= 10 pieces (Bottom Level 434.06 m)
Q= 0.668 m3/sec (Q= 1.337 /2= 0.668)
v=Q/A= 0.47 m/sec
g= 9.8 m/sec2
C= 0.6
h5= 0.032 m = 0.040 m (WL+ 437.760 m, depth 1.760 m)
(Bottom Level 436.000 m)

10 Head loss of Intake gate

Dimension of gate; 1500×1500
Head loss h=v2/(2*g*C^2)
where A=1.5m*Hm*2= 4.8 m2 : Sectional area (H= 1.60 m)
Q= 0.668 m3/sec (Q= 1.337 /2= 0.668)
v=Q/A= 0.139 m/sec
g= 9.8 m/sec2
C= 0.6
h6= 0.00275 m = 0.010 m (WL+ 437.750 m, depth 4.590 m)
(Bottom Level 433.160 m)

11 Conveyance Pump chamber water level 437.750 m

Intake facilities water loss (River water level +440.74m)

2 unit duty

1 River Water Level
H.W.L. 440.740 m

2 Intake Flow & Verosity
Q1= 38500 m3/day= 0.446 m3/sec
Q2= 77000 m3/day= 0.891 m3/sec
Q3= 115500 m3/day= 1.337 m3/sec

3 Head loss of Inlet Orifice

where A=a*b= 11 m2 : Sectional area
a= 6 m
b= 1.9 m (Sedimentation Level 436.500 m= 436.000 + 0.5)
Q= 0.668 m3/sec (Q= 1.337 /2= 0.668403)
v=Q/A= 0.06 m/sec
g= 9.8 m/sec2
C= 0.6
h5= 0.0005 m = 0.000 m (WL+ 440.740 m, depth 4.240
(Bottom Level 436.500 m) settling soil 0.5m

4 Bar Screen Loss B= 2.00 m (37.5 *44= 1.650 m)
H= 4.24 m (Sedimentation Level 436.50 m)
b= 37.5 mm
t= 12.5 mm
θ = 70 °
V= 0.096 m/s (Q= 1.337 /2= 0.668403)
H= 0.000 m
Threrfore h1= 0.300 m (WL+ 440.440 m, depth 3.940 m)
(Bottom Level 436.500 m)

5 Head loss of Intake gate

Dimension of gate; 1500×1500
Head loss h=v2/(2*g*C^2)
where A=1.5m*Hm*2= 3.3 m2 : Sectional area (H= 1.10 m)
Q= 1.337 m3/sec
v=Q/A= 0.405 m/sec
g= 9.8 m/sec2
C= 0.6
h4= 0.0233 m = 0.030 m (WL+ 440.410 m, depth 3.910 m)
(Bottom Level 436.500 m)

6 Rubbish Remover B= 2.00 m (20 *44= 0.880 m)
H= 3.91 m (Bottom Level 436.500 m)
b= 20.0 mm
t= 3 mm
θ = 70 °
V= 0.389 m/s (Q= 1.337 /2= 0.668403)
H= 0.001 m
Threrfore h2= 0.100 m (WL+ 440.310 m, depth 3.810 m)
(Bottom Level 436.500 m)

7 Head loss in the channel

Q1= 0.668 m3/sec : Water flow of 1 trough (Q= 1.337 /2= 0.668)

Inflow sectional area

A=B*H= 7.62 m2
where B= 2.00 m
H= 3.81 m

Velocity
V(a-b)=Q1/A= 0.09 m/sec

Hydraulic radius
R=A/(B+H*2)= 0.792 m

Roughness coefficient
n= 0.015

Head losses are calculated using Manning Formula.

h=n^2*L*v^2/R^(4/3)
where L= 26.0 m

h3= 0.00006 = 0.000 m (WL+ 440.310 m, depth 3.810 m)
(Bottom Level 436.500 m)

8 Head loss of diffusion wall

Diameter of holes and number of holes; φ 100@300×300
Head loss h=v2/(2*g*C^2)
where A=3.14/4*D^2*(a*b)= 2.120 m2 : Sectional area
D= 100 mmdia.
a= 18 pieces
b= 15 pieces (Bottom Level 436.000 m= 434.06 + 1.94)
Q= 0.668 m3/sec (Q= 1.337 /2= 0.668)
v=Q/A= 0.32 m/sec
g= 9.8 m/sec2
C= 0.6
h5= 0.014 m = 0.020 m

9 Grit chamber water level 440.290 m

10 Head loss of diffusion wall

Diameter of holes and number of holes; φ 100@300×300
Head loss h=v2/(2*g*C^2)
where A=3.14/4*D^2*(a*b)= 2.543 m2 : Sectional area
D= 100 mmdia.
a= 18 pieces
b= 18 pieces (Bottom Level 434.06 m)
Q= 0.668 m3/sec (Q= 1.337 /2= 0.668)
v=Q/A= 0.26 m/sec
g= 9.8 m/sec2
C= 0.6
h5= 0.010 m = 0.010 m (WL+ 440.280 m, depth 6.220 m)
(Bottom Level 434.060 m)

11 Head loss of Intake gate

Dimension of gate; 1500×1500
Head loss h=v2/(2*g*C^2)
where A=1.5m*Hm*2= 4.8 m2 : Sectional area (H= 1.60 m)
Q= 0.668 m3/sec (Q= 1.337 /2= 0.668)
v=Q/A= 0.139 m/sec
g= 9.8 m/sec2
C= 0.6
h6= 0.00275 m = 0.010 m (WL+ 440.270 m, depth 7.110 m)
(Bottom Level 433.160 m)

12 Conveyance Pump chamber water level 440.270 m

Intake facilities water loss (River water level +437.6m)

1 unit duty

1 River Water Level

L.L.W.L. 437.60 m

2 Intake Flow & Verosity

Q1=	38500 m3/day=	0.446	m3/sec
Q2=	77000 m3/day=	0.891	m3/sec
Q3=	115500 m3/day=	1.337	m3/sec

3 Bar Screen Loss

	B=	2.00 m	(37.5 *44=	1.650 m)		
	H=	1.10 m	(Bottom Level	436.500 m)	Including Sed. Depth h=0.50m	
	b=	37.5 mm				
	t=	12.5 mm				
	θ =	70 °				
	V=	0.737 m/s				
	H=	0.011 m				
Threrfore	h1=	0.300 m		(WL+	437.300 m, depth	0.800 m)
				(Bottom Level	436.500 m) settling soil 0.5m	

4 Head loss of Intake gate

Dimension of gate; 1500×1500

Head loss h=v2/(2*g*C^2)

where A=1.5m*Hm=	1.2 m2 : Sectional area	(H= 0.80 m)		
Q=	1.337 m3/sec			
v=Q/A=	1.114 m/sec			
g=	9.8 m/sec2			
C=	0.6			
h4=	0.1759 m = 0.180 m	(WL+	437.120 m, depth	0.620 m)
		(Bottom Level	436.500 m)	

5 Rubbish Remover

	B=	2.00 m	(20 *44=	0.880 m)		
	H=	0.62 m	(Bottom Level	436.500 m)		
	b=	20.0 mm				
	t=	3 mm				
	θ =	70 °				
	V=	2.450 m/s				
	H=	0.041 m				
Threrfore	h2=	0.100 m		(WL+	437.020 m, depth	0.520 m)
				(Bottom Level	436.500 m)	

6 Head loss in the channel

Q1= 1.337 m3/sec : Water flow of 1 trough

Inflow sectional area

A=B*H= 1.04 m2

where B= 2.00 m

H= 0.52 m

Velocity

V(a-b)=Q1/A= 1.29 m/sec

Hydraulic radius

R=A/(B+H*2)= 0.342 m

Roughness coefficient

n= 0.015

Head losses are calculated using Manning Formula.

h=n^2*L*v^2/R^(4/3)

where L= 26.0 m

h3=	0.04040 = 0.040 m	(WL+	436.980 m, depth	0.480 m)
		(Bottom Level	436.500 m)	

7 Head loss of diffusion wall

Diameter of holes and number of holes; φ 100@300×300
Head loss h=v2/(2*g*C^2)
where A=3.14/4*D^2*(a*b)= 1.554 m2 : Sectional area
D= 100 mmdia.
a= 18 pieces
b= 11 pieces (Bottom Level 434.060 m= 434.06 + 0.00)
Q= 1.337 m3/sec
v=Q/A= 0.86 m/sec
g= 9.8 m/sec2
C= 0.6
h5= 0.105 m = 0.110 m

8 Grit chamber water level 436.870 m

9 Head loss of diffusion wall

Diameter of holes and number of holes; φ 100@300×300
Head loss h=v2/(2*g*C^2)
where A=3.14/4*D^2*(a*b)= 0.989 m2 : Sectional area
D= 100 mmdia.
a= 18 pieces
b= 7 pieces (Bottom Level 434.060 m)
Q= 1.337 m3/sec
v=Q/A= 1.35 m/sec
g= 9.8 m/sec2
C= 0.6
h5= 0.259 m = 0.260 m (WL+ 436.610 m, depth 2.550 m)
(Bottom Level 434.060 m)

10 Head loss of Intake gate

Dimension of gate; 1500×1500
Head loss h=v2/(2*g*C^2)
where A=1.5m*Hm*2= 4.8 m2 : Sectional area (H= 1.60 m)
Q= 1.337 m3/sec
v=Q/A= 0.279 m/sec
g= 9.8 m/sec2
C= 0.6
h6= 0.01099 m = 0.020 m (WL+ 436.590 m, depth 3.430 m)
(Bottom Level 433.160 m)

11 Conveyance Pump chamber water level 436.590 m

Intake facilities water loss (River water level +437.6m)

1 unit duty

1 River Water Level
L.L.W.L. 437.600 m

2 Intake Flow & Verosity
Q1= 38500 m3/day= 0.446 m3/sec
Q2= 77000 m3/day= 0.891 m3/sec
Q3= 115500 m3/day= 1.337 m3/sec

3 Bar Screen Loss B= 2.00 m (37.5 *44= 1.650 m)
H= 1.10 m (Bottom Level 436.500 m) Including Sed. Depth h=0.50m
b= 37.5 mm
t= 12.5 mm
θ = 70 °
V= 0.737 m/s
H= 0.011 m
Threrfore h1= 0.300 m (WL+ 437.300 m, depth 0.800 m)
(Bottom Level 436.500 m) settling soil 0.5m

4 Head loss of Intake gate

Dimension of gate; 1500×1500
Head loss h=v2/(2*g*C^2)
where A=1.5m*Hm= 1.2 m2 : Sectional area (H= 0.80 m)
Q= 1.337 m3/sec
v=Q/A= 1.114 m/sec
g= 9.8 m/sec2
C= 0.6
h4= 0.1759 m = 0.180 m (WL+ 437.120 m, depth 0.620 m)
(Bottom Level 436.500 m)

5 Rubbish Remover B= 2.00 m (20 *44= 0.880 m)
H= 0.62 m (Bottom Level 436.500 m)
b= 20.0 mm
t= 3 mm
θ = 70 °
V= 2.450 m/s
H= 0.041 m
Threrfore h2= 0.100 m (WL+ 437.020 m, depth 0.520 m)
(Bottom Level 436.500 m)

6 Head loss in the channel

Q1= 1.337 m3/sec : Water flow of 1 trough

Inflow sectional area

A=B*H= 1.04 m2
where B= 2.00 m
H= 0.52 m

Velocity
V(a-b)=Q1/A= 1.29 m/sec

Hydraulic radius
R=A/(B+H*2)= 0.342 m

Roughness coefficient
n= 0.015

Head losses are calculated using Manning Formula.

h=n^2*L*v^2/R^(4/3)
where L= 26.0 m

h3= 0.04040 = 0.040 m (WL+ 436.980 m, depth 0.980 m)
(Bottom Level 436.000 m)

7 Head loss of diffusion wall

Diameter of holes and number of holes; φ 100@300×300
Head loss h=v2/(2*g*C^2)
where A=3.14/4*D^2*(a*b)= 1.130 m2 : Sectional area
D= 100 mmdia.
a= 18 pieces
b= 8 pieces (Sedimentation Level 435.060 m= 434.06 + 1.0)
Q= 1.337 m3/sec
v=Q/A= 1.18 m/sec
g= 9.8 m/sec2
C= 0.6
h5= 0.198 m = 0.200 m

8 Grit chamber water level 436.780 m

9 Head loss of diffusion wall

Diameter of holes and number of holes; φ 100@300×300
Head loss h=v2/(2*g*C^2)
where A=3.14/4*D^2*(a*b)= 0.848 m2 : Sectional area
D= 100 mmdia.
a= 18 pieces
b= 6 pieces (Bottom Level 434.060 m)
Q= 1.337 m3/sec
v=Q/A= 1.58 m/sec
g= 9.8 m/sec2
C= 0.6
h5= 0.352 m = 0.360 m (WL+ 436.420 m, depth 2.360 m)
(Bottom Level 434.060 m)

10 Head loss of Intake gate

Dimension of gate; 1500×1500
Head loss h=v2/(2*g*C^2)
where A=1.5m*Hm*2= 4.8 m2 : Sectional area (H= 1.60 m)
Q= 1.337 m3/sec
v=Q/A= 0.279 m/sec
g= 9.8 m/sec2
C= 0.6
h6= 0.01099 m = 0.020 m (WL+ 436.400 m, depth 3.240 m)
(Bottom Level 433.160 m)

11 Conveyance Pump chamber water level 436.400 m

Intake facilities water loss (River water level +437.6m)   1 unit duty

1 River Water Level
L.L.W.L. 437.60 m

2 Intake Flow & Verosity
Q1= 38500 m3/day= 0.446 m3/sec
Q2= 77000 m3/day= 0.891 m3/sec
Q3= 115500 m3/day= 1.337 m3/sec

3 Bar Screen Loss
B= 2.00 m (37.5 *44= 1.650 m)
H= 1.10 m (Bottom Level 436.500 m) Including Sed. Depth h=0.50m
b= 37.5 mm
t= 12.5 mm
θ = 70 °
V= 0.737 m/s
H= 0.011 m
Threrfore h1= 0.300 m (WL+ 437.300 m, depth 0.800 m)
(Bottom Level 436.500 m) settling soil 0.5m

4 Head loss of Intake gate

Dimension of gate; 1500×1500
Head loss h=v2/(2*g*C^2)
where A=1.5m*Hm= 1.2 m2 : Sectional area (H= 0.80 m)
Q= 1.337 m3/sec
v=Q/A= 1.114 m/sec
g= 9.8 m/sec2
C= 0.6
h4= 0.1759 m = 0.180 m (WL+ 437.120 m, depth 0.620 m)
(Bottom Level 436.500 m)

5 Rubbish Remover
B= 2.00 m (20 *44= 0.880 m)
H= 0.62 m (Bottom Level 436.500 m)
b= 20.0 mm
t= 3 mm
θ = 70 °
V= 2.450 m/s
H= 0.041 m
Threrfore h2= 0.100 m (WL+ 437.020 m, depth 0.520 m)
(Bottom Level 436.500 m)

6 Head loss in the channel

Q1= 1.337 m3/sec : Water flow of 1 trough

Inflow sectional area

A=B*H= 1.04 m2
where B= 2.00 m
H= 0.52 m

Velocity
V(a-b)=Q1/A= 1.29 m/sec

Hydraulic radius
R=A/(B+H*2)= 0.342 m

Roughness coefficient
n= 0.015

Head losses are calculated using Manning Formula.

h=n^2*L*v^2/R^(4/3)
where L= 26.0 m

h3= 0.04040 = 0.040 m (WL+ 436.980 m, depth 0.480 m)
(Bottom Level 436.500 m)

7 Head loss of diffusion wall

Diameter of holes and number of holes; ϕ 100@300×300
Head loss h=v2/(2*g*C^2)
where A=3.14/4*D^2*(a*b)= 0.707 m2 : Sectional area
D= 100 mmdia.
a= 18 pieces
b= 5 pieces (Sedimentation Level 436.000 m= 434.06 + 1.94)
Q= 1.337 m3/sec
v=Q/A= 1.89 m/sec
g= 9.8 m/sec2
C= 0.6
h5= 0.507 m = 0.510 m

8 Grit chamber water level 436.470 m

9 Head loss of diffusion wall

Diameter of holes and number of holes; ϕ 100@300×300
Head loss h=v2/(2*g*C^2)
where A=3.14/4*D^2*(a*b)= 0.707 m2 : Sectional area
D= 100 mmdia.
a= 18 pieces
b= 5 pieces (Bottom Level 434.060 m)
Q= 1.337 m3/sec
v=Q/A= 1.89 m/sec
g= 9.8 m/sec2
C= 0.6
h5= 0.507 m = 0.510 m (WL+ 435.960 m, depth 1.900 m)
(Bottom Level 434.060 m)

10 Head loss of Intake gate

Dimension of gate; 1500×1500
Head loss h=v2/(2*g*C^2)
where A=1.5m*Hm*2= 4.8 m2 : Sectional area (H= 1.60 m)
Q= 1.337 m3/sec
v=Q/A= 0.279 m/sec
g= 9.8 m/sec2
C= 0.6
h6= 0.01099 m = 0.020 m (WL+ 435.940 m, depth 2.780 m)
(Bottom Level 433.160 m)

11 Conveyance Pump chamber water level 435.940 m

Intake facilities water loss (River water level +438.3m)

1 unit duty

1 River Water Level
L.W.L. 438.300 m

2 Intake Flow & Verosity
Q1= 38500 m3/day= 0.446 m3/sec
Q2= 77000 m3/day= 0.891 m3/sec
Q3= 115500 m3/day= 1.337 m3/sec

3 Bar Screen Loss
B= 2.00 m (37.5 *44= 1.650 m)
H= 1.80 m (Bottom Level 436.500 m) Including Sed. Depth h=0.50m
b= 37.5 mm
t= 12.5 mm
θ = 70 °
V= 0.450 m/s
H= 0.004 m
Threrfore h1= 0.300 m (WL+ 438.000 m, depth 1.500 m)
(Bottom Level 436.500 m) settling soil 0.5m

4 Head loss of Intake gate

Dimension of gate; 1500×1500
Head loss h=v2/(2*g*C^2)
where A=1.5m*Hm= 1.65 m2 : Sectional area (H= 1.10 m)
Q= 1.337 m3/sec
v=Q/A= 0.810 m/sec
g= 9.8 m/sec2
C= 0.6
h4= 0.0930 m = 0.100 m (WL+ 437.900 m, depth 1.400 m)
(Bottom Level 436.500 m)

5 Rubbish Remover
B= 2.00 m (20 *44= 0.880 m)
H= 1.40 m (Bottom Level 436.500 m)
b= 20.0 mm
t= 3 mm
θ = 70 °
V= 1.085 m/s
H= 0.008 m
Threrfore h2= 0.100 m (WL+ 437.800 m, depth 1.300 m)
(Bottom Level 436.500 m)

6 Head loss in the channel

Q1= 1.337 m3/sec : Water flow of 1 trough

Inflow sectional area

A=B*H= 2.60 m2
where B= 2.00 m
H= 1.30 m

Velocity
V(a-b)=Q1/A= 0.51 m/sec

Hydraulic radius
R=A/(B+H*2)= 0.565 m

Roughness coefficient
n= 0.015

Head losses are calculated using Manning Formula.

h=n^2*L*v^2/R^(4/3)
where L= 26.0 m

h3= 0.00331 = 0.000 m (WL+ 437.800 m, depth 1.300 m)
(Bottom Level 436.500 m)

7 Head loss of diffusion wall

Diameter of holes and number of holes; ϕ 100@300×300
Head loss h=v2/(2*g*C^2)
where A=3.14/4*D^2*(a*b)= 0.989 m2 : Sectional area
D= 100 mmdia.
a= 18 pieces
b= 7 pieces (Sedimentation Level 436.000 m= 434.06 + 1.94)
Q= 1.337 m3/sec
v=Q/A= 1.35 m/sec
g= 9.8 m/sec2
C= 0.6
h5= 0.259 m = 0.260 m

8 Grit chamber water level 437.540 m

9 Head loss of diffusion wall

Diameter of holes and number of holes; ϕ 100@300×300
Head loss h=v2/(2*g*C^2)
where A=3.14/4*D^2*(a*b)= 1.272 m2 : Sectional area
D= 100 mmdia.
a= 18 pieces
b= 9 pieces (Bottom Level 434.060 m)
Q= 1.337 m3/sec
v=Q/A= 1.05 m/sec
g= 9.8 m/sec2
C= 0.6
h5= 0.157 m = 0.160 m (WL+ 437.380 m, depth 3.320 m)
(Bottom Level 434.060 m)

10 Head loss of Intake gate

Dimension of gate; 1500×1500
Head loss h=v2/(2*g*C^2)
where A=1.5m*Hm*2= 4.8 m2 : Sectional area (H= 1.60 m)
Q= 1.337 m3/sec
v=Q/A= 0.279 m/sec
g= 9.8 m/sec2
C= 0.6
h6= 0.01099 m = 0.020 m (WL+ 437.360 m, depth 4.200 m)
(Bottom Level 433.160 m)

11 Conveyance Pump chamber water level 437.360 m

Intake facilities water loss (River water level +440.74m)

1 unit duty

1 River Water Level

H.W.L. 440.740 m

2 Intake Flow & Verosity

Q1= 38500 m3/day= 0.446 m3/sec

Q2= 77000 m3/day= 0.891 m3/sec

Q3= 115500 m3/day= 1.337 m3/sec

3 Head loss of Inlet Orifice

where A=a*b= 11 m2 : Sectional area

a= 6 m

b= 1.9 m (Sedimentation Level 436.500 m= 436.000 ######

Q= 1.337 m3/sec

v=Q/A= 0.12 m/sec

g= 9.8 m/sec2

C= 0.6

h5= 0.0019 m = 0.000 m (WL+ 440.740 m, depth 4.240 m)

(Bottom Level 436.500 m)

4 Bar Screen Loss B= 2.00 m (37.5 *44= 1.650 m)

H= 4.24 m (Bottom Level 436.50 m)

b= 37.5 mm

t= 12.5 mm

θ = 70 °

V= 0.191 m/s

H= 0.001 m

Threrfore h1= 0.300 m (WL+ 440.440 m, depth 3.940 m)

(Bottom Level 436.500 m) settling soil 0.5m

5 Head loss of Intake gate

Dimension of gate; 1500×1500

Head loss h=v2/(2*g*C^2)

where A=1.5m*Hm= 1.65 m2 : Sectional area (H= 1.10 m)

Q= 1.337 m3/sec

v=Q/A= 0.810 m/sec

g= 9.8 m/sec2

C= 0.6

h4= 0.0930 m = 0.100 m (WL+ 440.340 m, depth 3.840 m)

(Bottom Level 436.500 m)

6 Rubbish Remover B= 2.00 m (20 *44= 0.880 m)

H= 3.84 m (Bottom Level 436.500 m)

b= 20.0 mm

t= 3 mm

θ = 70 °

V= 0.396 m/s

H= 0.001 m

Threrfore h2= 0.100 m (WL+ 440.240 m, depth 3.740 m)

(Bottom Level 436.500 m)

7 Head loss in the channel

Q1= 1.337 m3/sec : Water flow of 1 trough

Inflow sectional area

A=B*H= 7.48 m2

where B= 2.00 m

H= 3.74 m

Velocity

V(a-b)=Q1/A= 0.18 m/sec

Hydraulic radius

R=A/(B+H*2)= 0.789 m

Roughness coefficient

n= 0.015

Head losses are calculated using Manning Formula.

h=n^2*L*v^2/R^(4/3)

where L= 26.0 m

h3= 0.00026 = 0.000 m (WL+ 440.240 m, depth 3.740 m)

(Bottom Level 436.500 m)

8 Head loss of diffusion wall

Diameter of holes and number of holes; ϕ 100@300×300

Head loss h=v2/(2*g*C^2)

where A=3.14/4*D^2*(a*b)= 2.120 m2 : Sectional area

D= 100 mmdia.

a= 18 pieces

b= 15 pieces (Sedimentation Level 436.000 m= 434.06 + 1.94)

Q= 1.337 m3/sec

v=Q/A= 0.63 m/sec

g= 9.8 m/sec2

C= 0.6

h5= 0.056 m = 0.060 m

9 Grit chamber water level 440.180 m

10 Head loss of diffusion wall

Diameter of holes and number of holes; ϕ 100@300×300

Head loss h=v2/(2*g*C^2)

where A=3.14/4*D^2*(a*b)= 2.543 m2 : Sectional area

D= 100 mmdia.

a= 18 pieces

b= 18 pieces (Bottom Level 434.060 m)

Q= 1.337 m3/sec

v=Q/A= 0.53 m/sec

g= 9.8 m/sec2

C= 0.6

h5= 0.039 m = 0.040 m (WL+ 440.140 m, depth 6.080 m)

(Bottom Level 434.060 m)

11 Head loss of Intake gate

Dimension of gate; 1500×1500

Head loss h=v2/(2*g*C^2)

where A=1.5m*Hm*2= 4.8 m2 : Sectional area (H= 1.60 m)

Q= 1.337 m3/sec

v=Q/A= 0.279 m/sec

g= 9.8 m/sec2

C= 0.6

h6= 0.01099 m = 0.020 m (WL+ 440.120 m, depth 6.960 m)

(Bottom Level 433.160 m)

12 Conveyance Pump chamber water level 440.120 m

Hydrodynamic Pressure of Conveyance Pipe Route Q=1.0Q

1.Phase 1

St.No.	S.D. (m)	A.D. (m)	G.L. (m)	Pipe Dia. (mm)	H.G.	W.L.L. (m)	W.L. (m)	Min.soil Coverage of Pipe (m)	A.D. of L.S. (m)	Remark
Balancing Tank			(HWL+476.00)							Balancing Tank
28-22.00	0.00	0.00	475.00	1000	0.00048	0.000	475.99	-0.99	537.14	Loss etc. 0.008 m
28+0.00	22.00	22.00	472.69	1000	0.00048	0.011	475.98	-3.29	559.14	
30+0.00	41.67	63.67	472.60	1000	0.00048	0.020	475.96	-3.36	600.81	
41+0.00	179.50	243.17	475.42	1000	0.00048	0.086	475.88	-0.46	780.31	
50+0.00	118.52	361.69	477.60	1000	0.00048	0.057	475.82	1.78	898.83	
51+0.00	41.00	402.69	477.48	1000	0.00048	0.020	475.80	1.68	939.83	
53+7.00	45.80	448.49	475.26	1000	0.00048	0.022	475.78	-0.52	985.63	
67+0.00	273.32	721.81	468.09	800	0.00141	0.385	475.39	-7.30	1258.95	
76+0.00	67.50	789.31	455.62	800	0.00141	0.095	475.30	-19.68	1326.45	Valve Loss etc. 11.07067 m
86+0.00	95.40	884.71	461.15	800	0.00141	0.135	475.16	-14.01	1421.85	
105+0.00	186.60	1071.31	446.50	800	0.00141	0.263	474.90	-28.40	1608.45	
105+85.00	91.00	1162.31	(HWL+451.82) 446.50	800	0.00141	0.128	463.70	-11.88	1696.45	Distribution Chamber Horizontal Pipe distance 3 m Valve Loss etc. 11.07067 m

23.371

2.Phase 2

St.No.	S.D. (m)	A.D. (m)	G.L. (m)	Pipe Dia. (mm)	H.G.	W.L.L. (m)	W.L. (m)	Min.soil Coverage of Pipe (m)	A.D. of L.S. (m)	Remark
Balancing Tank			(HWL+476.00)							Balancing Tank
28-22.00	0.00	0.00	475.00	1000	0.00172	0.000	476.00	-1.00	537.14	Loss etc. 0.033 m
28+0.00	22.00	22.00	472.69	1000	0.00172	0.038	475.96	-3.27	559.14	
30+0.00	41.67	63.67	472.60	1000	0.00172	0.072	475.89	-3.29	600.81	
41+0.00	179.50	243.17	475.42	1000	0.00172	0.309	475.58	-0.16	780.31	
50+0.00	118.52	361.69	477.60	1000	0.00172	0.204	475.38	2.22	898.83	
51+0.00	41.00	402.69	477.48	1000	0.00172	0.071	475.31	2.17	939.83	
53+7.00	45.80	448.49	475.26	1000	0.00172	0.079	475.23	0.03	985.63	
67+0.00	273.32	721.81	468.09	800	0.00510	1.394	473.83	-5.74	1258.95	
76+0.00	67.50	789.31	455.62	800	0.00510	0.344	466.22	-10.60	1326.45	Valve Loss etc. 7.274753 m
86+0.00	95.40	884.71	461.15	800	0.00510	0.487	465.73	-4.58	1421.85	
105+0.00	186.60	1071.31	446.50	800	0.00510	0.952	464.78	-18.28	1608.45	
105+85.00	91.00	1162.31	(HWL+451.82) 446.50	800	0.00510	0.464	451.72	0.10	1696.45	Distribution Chamber Horizontal Pipe distance 3 m Valve Loss etc. 12.59775 m

24.317

3.Phase 3

St.No.	S.D. (m)	A.D. (m)	G.L. (m)	Pipe Dia. (mm)	H.G.	W.L.L. (m)	W.L. (m)	Min.soil Coverage of Pipe (m)	A.D. of L.S. (m)	Remark
Balancing Tank			(HWL+476.00)							Balancing Tank
28-22.00	0.00	0.00	475.00	1000	0.00364	0.000	475.93	-0.93	537.14	Loss etc. 0.074 m
28+0.00	22.00	22.00	472.69	1000	0.00364	0.080	475.85	-3.16	559.14	
30+0.00	41.67	63.67	472.60	1000	0.00364	0.152	475.69	-3.09	600.81	
41+0.00	179.50	243.17	475.42	1000	0.00364	0.653	475.04	0.38	780.31	
50+0.00	118.52	361.69	477.60	1000	0.00364	0.431	474.61	2.99	898.83	
51+0.00	41.00	402.69	477.48	1000	0.00364	0.149	474.46	3.02	939.83	
53+7.00	45.80	448.49	475.26	1000	0.00364	0.167	474.29	0.97	985.63	
67+0.00	273.32	721.81	468.09	800	0.01079	2.949	471.34	-3.25	1258.95	
76+0.00	67.50	789.31	455.62	800	0.01079	0.728	467.48	-11.86	1326.45	Valve Loss etc. 3.132 m
86+0.00	95.40	884.71	461.15	800	0.01079	1.029	466.45	-5.30	1421.85	
105+0.00	186.60	1071.31	446.50	800	0.01079	2.013	464.44	-17.94	1608.45	
105+85.00	91.00	1162.31	(HWL+451.82) 446.50	800	0.01079	0.982	451.68	0.14 23.497	1696.45	Distribution Chamber Horizontal Pipe distance 3 m Valve Loss etc. 11.77611 m

Phase1	Q1=	38500 m3/d =	0.446 m3/s	(110000*1.05*(1/3))
Phase2	Q2=	77000 m3/d =	0.891 m3/s	(110000*1.05*(2/3))
Phase3	Q3=	115500 m3/d =	1.337 m3/s	(110000*1.05)

Pipe Friction Factor

c= 100

Note
St.No. : Station Number
S.D. : Single Distance
A.D. : Accumulated Distance
G.L. : Ground Level
H.G. : Hydraulic Gradient
W.L.L. : Water Level Loss
H.W.L. : Hydraulic Water Level
H.P. : Hydrodynamic Pressure
A.D. of L.S. : Accumulate Distance of Longitudinal Section

Water Treatment Inlet valve cavitation Incase of using butterfly valve) Q=1.0

1.Total flow

Phase1	Q1=	38500 m3/d =	1604 m3/h	(110000*1.05*(1/3))
Phase2	Q2=	77000 m3/d =	3208 m3/h	(110000*1.05*(2/3))
Phase3	Q3=	115500 m3/d =	4813 m3/h	(110000*1.05)

2.Water level

Balancing tank HWL	476.000 m	
Balancing tank LWL	474.980 m	
Inlet water level of Distribution Chamber	451.680 m	
Valve No.2 center level	454.199 m	(455.62-1.0-0.842/2)
Valve No.3 level	445.079 m	(446.5-1.0-0.842/2)

3.Valve Diameter and flow velocity

Valve Diameter (mm)	Flow velosity (m/sec)		
	Phase1	Phase2	Phase3
300	6.31	12.61	18.92
350	4.63	9.27	13.90
400	3.55	7.10	10.64
500	2.27	4.54	6.81
600	1.58	3.15	4.73
700	1.16	2.32	3.48
800	0.89	1.77	2.66

4.Phase3

Inlet Loss	(Diameter	1000 mm), f=	0.5	V(Q3)=	1.70 m/s	h=	0.074 m	Subtotal 0.074 m
Reducer Loss	(Diameter	800 600 mm), f=	0		V(Q3)= 2.66 m/s	h=	0.000 m	Subtotal
Valve 1 Loss	(Diameter	600 mm), f=	2.58 (60°)	V(Q3)=	4.73 m/s	h=	2.945 m	3.132 m
Orifice 1 Loss	(Diameter	600 mm), f=	0	a/A=1	V(Q3)= 4.73 m/s	h=	0.000 m	
Reducer Loss	(Diameter	800 600 mm), f=	0.5		V(Q3)= 2.66 m/s	h=	0.187 m	
Reducer Loss	(Diameter	800 600 mm), f=	0		V(Q3)= 2.66 m/s	h=	0.000 m	Subtotal
Valve 2 Loss	(Diameter	600 mm), f=	5.6 (53°)	V(Q3)=	4.73 m/s	h=	6.392 m	11.776 m
Orifice 2 Loss	(Diameter	600 mm), f=	4.24	a/A=0.70	V(Q3)= 4.73 m/s	h=	4.836 m	
Reducer Loss	(Diameter	800 600 mm), f=	0.5		V(Q3)= 2.66 m/s	h=	0.187 m	
Outlet Loss	(Diameter	800 mm), f=	1.0	V(Q3)=	2.66 m/s	h=	0.361 m	
Pipe Friction Loss	(Diameter	1000 mm), I=	0.00364	L=	448.49 m	h=	1.633 m	Subtotal
Pipe Friction Loss	(Diameter	800 mm), I=	0.01079	L=	340.82 m	h=	3.677 m	9.334 m
Pipe Friction Loss	(Diameter	800 mm), I=	0.01079	L=	313.00 m	h=	3.377 m	
Pipe Friction Loss	(Diameter	800 mm), I=	0.01079	L=	60.00 m	h=	0.647 m	

Total h= 24.316 m

where c= 100

Q3= 115500 m3/d= 1.337 m3/sec

1 Cavitation coefficient and opening degree of valve No.1

Cavitation coefficient

ρ =(H2+10)/(H1-H2)

where H1= 16.417 m :Hydrostatic head of upstream of valve

H2= 13.471 m :Hydrostatic head of downstream of valve

Δ H=H1-H2= 2.95 m :Head loss of valve

ρ=(H2+10)/(H1-H2)= 7.97 (>2.5-3.0) No Cavitation OK

Capacity coefficient (Cv)

Cv=1.167*Q3*(G/Δ P)^0.5

where Q3= 4813 m3/h (110000*1.05/24)

G= 10.0 m3/m2 (1kg/cm2)

Δ P= 3 m3/m2 :H1-H2= 2.95 m

Cv=1.167*Q3*(G/Δ P)^0.5= 10347

Opening degree of valve

θ = 60°

2 Orifice No.1 (No need Orifice)

ρ =(H2+10)/(H1-H2+(V^2/2/g))

where H1= 13.472 m :Hydrostatic head of upstream of valve
H2= 13.471 m :Hydrostatic head of downstream of valve
Δ H=H1-H2= 0.001 m :Head loss of valve

3 Cavitation coefficient and opening degree of valve No.2 (600mm)

Cavitation coefficient

ρ =(H2+10)/(H1-H2)

where H1= 19.028 m :Hydrostatic head of upstream of valve
H2= 12.635 m :Hydrostatic head of downstream of valve
Δ H=H1-H2= 6.39 m :Head loss of valve

ρ =(H2+10)/(H1-H2)= 3.54 (>2.5-3.0) No Cavitation OK

Capacity coefficient (Cv)

Cv=1.167*Q3*(G/ΔP)^0.5

where Q3= 4813 m3/h (110000*1.05/24)
G= 10.0 m3/m2 (1kg/cm2)
Δ P= 6.39 m3/m2 :H1-H2= 6.39 m

Cv=1.167*Q3*(G/ΔP)^0.5= 7024

Opening degree of valve

θ= 53°

4 Orifice No.2

ρ =(H2+10)/(H1-H2+(V^2/2/g))

where H1= 12.636 m :Hydrostatic head of upstream of valve
H2= 7.799 m :Hydrostatic head of downstream of valve
Δ H=H1-H2= 4.84 m :Head loss of valve

Distribution Chamber water level 451.683 m (476.000 - 24.317) >451.680 m

5.Phase2

Inlet Loss	(Diameter	1000 mm)、f=	0.5	V(Q3)=	1.14 m/s	h=	0.033 m	Subtotal 0.033 m
Reducer Loss	(Diameter	800 600 mm)、f=	0		V(Q3)= 1.77 m/s	h=	0.000 m	Subtotal
Valve 1 Loss	(Diameter	600 mm)、f=	2.8 (59°)	V(Q3)=	3.15 m/s	h=	1.418 m	7.275 m
Orifice 1 Loss	(Diameter	600 mm)、f=	11.40	a/A=0.6	V(Q3)= 3.15 m/s	h=	5.774 m	
Reducer Loss	(Diameter	800 600 mm)、f=	0.5		V(Q3)= 1.77 m/s	h=	0.083 m	
Reducer Loss	(Diameter	800 600 mm)、f=	0		V(Q3)= 1.77 m/s	h=	0.000 m	Subtotal
Valve 2 Loss	(Diameter	600 mm)、f=	13 (31°)	V(Q3)=	3.15 m/s	h=	6.581 m	12.598 m
Orifice 2 Loss	(Diameter	600 mm)、f=	11.40	a/A=0.6	V(Q3)= 3.15 m/s	h=	5.774 m	
Reducer Loss	(Diameter	800 600 mm)、f=	0.5		V(Q3)= 1.77 m/s	h=	0.083 m	
Outlet Loss	(Diameter	800 mm)、f=	1.0	V(Q3)=	1.77 m/s	h=	0.160 m	
Pipe Friction Loss	(Diameter	1000 mm)、I=	0.00172	L=	448.49 m	h=	0.771 m	Subtotal
Pipe Friction Loss	(Diameter	800 mm)、I=	0.0051	L=	340.82 m	h=	1.738 m	4.411 m
Pipe Friction Loss	(Diameter	800 mm)、I=	0.0051	L=	313.00 m	h=	1.596 m	
Pipe Friction Loss	(Diameter	800 mm)、I=	0.0051	L=	60.00 m	h=	0.306 m	

Total h= 24.317 m

where c= 100
Q2= 77000 m3/d= 0.891 m3/sec

1 Cavitation coefficient and opening degree of valveNo.1

Cavitation coefficient

ρ =(H2+10)/(H1-H2)

where H1= 19.259 m :Hydrostatic head of upstream of valve
H2= 17.841 m :Hydrostatic head of downstream of valve
Δ H=H1-H2= 1.42 m :Head loss of valve

ρ=(H2+10)/(H1-H2)= 19.63 (>2.5-3.0) No Cavitation OK

Capacity coefficient (Cv)

Cv=1.167*Q3*(G/Δ P)^0.5

where Q2= 3208 m3/h (110000*1.05*(2/3)/24)
G= 10.0 m3/m2 (1kg/cm2)
Δ P= 1 m3/m2 :H1-H2= 1.42 m

Cv=1.167*Q3*(G/Δ P)^0.5= 9941

Opening degree of valve

θ = 59°

2 Orifice No.1

ρ =(H2+10)/(H1-H2+(V^2/2/g))

where H1= 17.841 m :Hydrostatic head of upstream of valve
H2= 12.067 m :Hydrostatic head of downstream of valve
Δ H=H1-H2= 5.77 m :Head loss of valve

3 Cavitation coefficient and opening degree of valveNo.2 (600mm)

Cavitation coefficient
ρ =(H2+10)/(H1-H2)
where H1= 19.508 m :Hydrostatic head of upstream of valve
H2= 12.927 m :Hydrostatic head of downstream of valve
Δ H=H1-H2= 6.58 m :Head loss of valve

ρ =(H2+10)/(H1-H2)= 3.48 (>2.5-3.0) No Cavitation OK

Capacity coefficient (Cv)
Cv=1.167*Q3*(G/ΔP)^0.5
where Q2= 3208 m3/h (110000*1.05*(2/3)/24)
G= 10.0 m3/m2 (1kg/cm2)
Δ P= 6.58 m3/m2 :H1-H2= 6.58 m

Cv=1.167*Q3*(G/ΔP)^0.5= 4615

Opening degree of valve
θ= 31°

4 Orifice No.2
ρ =(H2+10)/(H1-H2+(V^2/2/g))
where H1= 12.927 m :Hydrostatic head of upstream of valve
H2= 7.153 m :Hydrostatic head of downstream of valve
Δ H=H1-H2= 5.77 m :Head loss of valve

Distribution Chamber water level 451.683 m (476.000 - 24.317) >451.680 m

6.Phase1

Inlet Loss	(Diameter	1000 mm)、f=		0.5	V(Q3)=	0.57 m/s	h=	0.008 m	Subtotal 0.008 m
Reducer Loss	(Diameter	800	600 mm)、f=	0		V(Q3)= 0.89 m/s	h=	0.000 m	Subtotal
Valve 1 Loss	(Diameter	600 mm)、f=		7 (49°)	V(Q3)=	1.58 m/s	h=	0.892 m	12.009 m
Orifice 1 Loss	(Diameter	600 mm)、f=		87.12	a/A=0.4	V(Q3)= 1.58 m/s	h=	11.096 m	
Reducer Loss	(Diameter	800	600 mm)、f=	0.5		V(Q3)= 0.89 m/s	h=	0.021 m	
Reducer Loss	(Diameter	800	600 mm)、f=	0		V(Q3)= 0.89 m/s	h=	0.000 m	Subtotal
Valve 2 Loss	(Diameter	600 mm)、f=		8.6 (47°)	V(Q3)=	1.58 m/s	h=	1.095 m	11.071 m
Orifice 2 Loss	(Diameter	600 mm)、f=		77.84	a/A=0.41	V(Q3)= 1.58 m/s	h=	9.915 m	
Reducer Loss	(Diameter	800	600 mm)、f=	0.5		V(Q3)= 0.89 m/s	h=	0.021 m	
Outlet Loss	(Diameter	800 mm)、f=		1.0	V(Q3)=	0.89 m/s	h=	0.040 m	
Pipe Friction Loss	(Diameter	1000 mm)、I=		0.00048	L=	448.49 m	h=	0.215 m	Subtotal
Pipe Friction Loss	(Diameter	800 mm)、I=		0.00141	L=	340.82 m	h=	0.481 m	1.222 m
Pipe Friction Loss	(Diameter	800 mm)、I=		0.00141	L=	313.00 m	h=	0.441 m	
Pipe Friction Loss	(Diameter	800 mm)、I=		0.00141	L=	60.00 m	h=	0.085 m	

Total h= 24.309 m
where c= 100
Q2= 38500 m3/d= 0.446 m3/sec

1 Cavitation coefficient and opening degree of valve No.1 (600mm)

Cavitation coefficient
ρ =(H2+10)/(H1-H2)
where H1= 21.097 m :Hydrostatic head of upstream of valve
H2= 20.204 m :Hydrostatic head of downstream of valve
Δ H=H1-H2= 0.89 m :Head loss of valve

ρ=(H2+10)/(H1-H2)= 33.84 (>2.5-3.0) No Cavitation OK

Capacity coefficient (Cv)
Cv=1.167*Q3*(G/Δ P)^0.5
where Q1= 1604 m3/h (110000*1.05*(1/3)/24)
G= 10.0 m3/m2 (1kg/cm2)
Δ P= 0.89 m3/m2 :H1-H2= 0.89 m

Cv=1.167*Q3*(G/Δ P)^0.5= 6266

Opening degree of valve
θ = 49°

2 Orifice No.1
ρ =(H2+10)/(H1-H2+(V^2/2/g))
where H1= 20.205 m :Hydrostatic head of upstream of valve
H2= 9.109 m :Hydrostatic head of downstream of valve

$\Delta H=H1-H2=$ 11.10 m :Head loss of valve

3 Cavitation coefficient and opening degree of valve No.2 (600mm)

Cavitation coefficient

$\rho=(H2+10)/(H1-H2)$

where H1= 17.767 m :Hydrostatic head of upstream of valve

H2= 16.672 m :Hydrostatic head of downstream of valve

$\Delta H=H1-H2=$ 1.10 m :Head loss of valve

$\rho=(H2+10)/(H1-H2)=$ 24.34 (>2.5-3.0) No Cavitation OK

Capacity coefficient (Cv)

$Cv=1.167*Q3*(G/\Delta P)^{0.5}$

where Q1= 1604 m3/h (110000*1.05*(1/3)/24)

G= 9.102 m3/m2 (1kg/cm2)

$\Delta P=$ 1.10 m3/m2 :H1-H2= 1.10 m

$Cv=1.167*Q3*(G/\Delta P)^{0.5}=$ 5396

Opening degree of valve

θ= 47°

4 Orifice No.2

$\rho=(H2+10)/(H1-H2+(V^2/2/g))$

where H1= 16.672 m :Hydrostatic head of upstream of valve

H2= 6.757 m :Hydrostatic head of downstream of valve

$\Delta H=H1-H2=$ 9.92 m :Head loss of valve

Distribution Chamber water level 451.690 m (476.000 - 24.310) >451.680 m

Pressure Dissipation with orifice and cavitations coefficient
Cavitations

Phase 3

Q3= 115500 m3/d= 1.337 m3/s

Proposed Orifice No.2 Diameter

Orifice Dia. d (mm)	Pipe Dia. D (mm)	Coefficient d/D	Flow velocity in Pipe V (m/s)	Flow velocity in Orifice V (m/s)	$\beta=(d/D)^2$	α	a	Δh_0	k	$\Delta\omega=\Delta h_0 * k$	ξ_0	σc
420	600	0.7	4.73	9.65	0.4900	0.6953	0.13847	9.83	0.4917	4.836	4.24	2.31

H1	H2	V^2/(2*g)	Cavitation Coefficient	
			K0	K0 (without V^2/(2*g))
12.636	7.799	1.142	2.98	3.68

$\sigma c <= K_0$ OK

Phase 2

Q2= 77000 m3/d= 0.891 m3/s

Proposed Orifice No.1 & No.2 Diameter

Orifice Dia. d (mm)	Pipe Dia. D (mm)	Coefficient d/D	Flow velocity in Pipe V (m/s)	Flow velocity in Orifice V (m/s)	$\beta=(d/D)^2$	α	a	Δh_0	k	$\Delta\omega=\Delta h_0 * k$	ξ_0	σc
360	600	0.6	3.15	8.76	0.3600	0.6490	0.10174	9.29	0.6212	5.774	11.38	1.98
360	600	0.6	3.15	8.76	0.3600	0.6490	0.10174	9.29	0.6212	5.774	11.38	1.98

H1	H2	V^2/(2*g)	Cavitation Coefficient	
			K0	K0 (without V^2/(2*g))
17.841	12.067	0.507	3.51	3.82
12.927	7.153	0.507	2.73	2.97

$\sigma c <= K_0$ OK

Phase 1

Q1= 38500 m3/d= 0.446 m3/s

Proposed Orifice No.1 & No.2 Diameter

Orifice Dia. d (mm)	Pipe Dia. D (mm)	Coefficient d/D	Flow velocity in Pipe V (m/s)	Flow velocity in Orifice V (m/s)	$\beta=(d/D)^2$	α	a	Δh_0	k	$\Delta\omega=\Delta h_0 * k$	ξ_0	σc
240	600	0.4	1.58	9.85	0.1600	0.6063	0.04522	13.48	0.8231	11.096	87.47	1.32
246	600	0.41	1.58	9.38	0.1681	0.6074	0.04751	12.17	0.8147	9.915	78.16	1.35

水理条件キャビテーション係数

H1	H2	V^2/(2*g)	K_0	V^2/(2*g) 含まず	
20.205	9.109	0.127	1.70	1.72	$\sigma c <= K_0$ OK
16.672	6.757	0.127	1.67	1.69	$\sigma c <= K_0$ OK

14.Balancing Tank Inlet Weir

1 Inlet weir loss

h=(Q/(1.84*b))^(2/3)

where Q= 1.337 m3/sec (110000*1.05/86400)

b= 6.10 m

h=(Q/(1.84*b))^(2/3)= 0.242 m

4 Water loss

The water level of inlet channel is 476.540 m (0.242)

The height of the inlet weir is 476.300 m

The water level at the Balancing tank is 476.000 m (Weir top level - 0.30 m)

17.Hydraulic Calculation of Overflow from Balancing Tank

Phase3

Overflow water level is 476.980 m (476.7000 + 0.276)

Overflow weir top level is 476.7000

Overflow weir loss is 0.276

Overflow Pipe Center Level at Blowoff Point 458.000 m

1 Overflow weir loss

h=(Q/(1.84*b))^(2/3)

where Q= 1.337 m3/sec (110000*1.05/86400)

b= 5 m (2.5*2)

h=(Q/(1.84*b))^(2/3)= 0.276 m

The water level at the downstream of the weir is 476.400 m in consideration of an allowance of

0.300 m.

1 Overflow pipe loss

Inlet Loss	(Diameter	600 mm)、f=	0.5	V=	4.73 m/s	h=	0.571 m
22.5°Bend Loss	(Diameter	600 mm)、f=	0.15	V=	4.73 m/s	h=	0.171 m
22.5°Bend Loss	(Diameter	600 mm)、f=	0.15	V=	4.73 m/s	h=	0.171 m
45°Bend Loss	(Diameter	600 mm)、f=	0.21	V=	4.73 m/s	h=	0.242 m
22.5°Bend Loss	(Diameter	600 mm)、f=	0.15	V=	4.73 m/s	h=	0.171 m
22.5°Bend Loss	(Diameter	600 mm)、f=	0.15	V=	4.73 m/s	h=	0.171 m
45°Bend Loss	(Diameter	600 mm)、f=	0.21	V=	4.73 m/s	h=	0.242 m
90°Bend Loss	(Diameter	600 mm)、f=	0.20	V=	4.73 m/s	h=	0.228 m
Outlet Loss	(Diameter	600 mm)、f=	1.0	V=	4.73 m/s	h=	1.142 m
Pipe Friction Loss	(Diameter	600 mm)、I=	0.03673	L=	59.20 m	h=	2.174 m

Total h= 5.283 m

where Q= 1.337 m3/sec (110000*1.05/86400)

C= 110

The water level at the Blow off site is 471.110 m(476.400 - 5.290)

> 458.0000

Outside Stream Bottom Level

No.	Distance (m)	Accumulate Distance (m)	Bottom Gradient (‰)	Bottom Level Diferance (m)	Proposed Channel Bottom Level (m)	Ground Level (m)	Existing Bottom Level (m)	Existing Bottom Gradient (‰)	Depth (m)	Average Depth (m)
1					457.600	458.50	458.00		0.90	
2	20	20	3.65	0.073	457.527	459.00	457.75	12.5	1.47	23.7
3	20	40	3.65	0.073	457.100	458.00	457.50	12.5	0.90	23.7
4	20	60	3.65	0.073	455.100	456.00	455.50	100.0	0.90	18.0
5	20	80	3.65	0.073	453.600	454.50	454.00	75.0	0.90	18.0
6	20	100	3.65	0.073	452.100	453.00	452.50	75.0	0.90	18.0
7	20	120	3.65	0.073	452.027	453.00	452.50	0.0	0.97	18.7
8	20	140	3.65	0.073	449.100	450.00	449.50	150.0	0.90	18.7
9	20	160	3.65	0.073	449.400	450.30	449.40	5.0	0.90	18.0
10	20	180	3.65	0.073	448.900	449.80	449.30	5.0	0.90	18.0
11	20	200	3.65	0.073	448.400	449.30	448.80	25.0	0.90	18.0
12	20	220	3.65	0.073	448.100	449.00	448.50	15.0	0.90	18.0
13	20	240	3.65	0.073	446.100	447.00	446.25	112.5	0.90	18.0
14	20	260	3.65	0.073	446.100	447.00	446.23	1.0	0.90	18.0
15	20	280	3.65	0.073	445.800	446.70	446.20	1.5	0.90	18.0
16	20	300	3.65	0.073	444.700	445.60	445.10	55.0	0.90	18.0
17	20	320	3.65	0.073	444.300	445.20	444.70	20.0	0.90	18.0
17+5000	5	325	3.65	0.01825	441.500	444.50	444.00	140.0	3.00	9.7
18	15	340	3.65	0.05475	441.445	446.00	443.90	6.7	4.55	56.7
19	20	360	3.65	0.073	441.372	446.00	443.70	10.0	4.63	91.8
20	20	380	3.65	0.073	441.299	444.00	443.50	10.0	2.70	73.3
21	20	400	3.65	0.073	441.226	444.00	443.50	0.0	2.77	54.7
22	20	420	3.65	0.073	441.153	443.00	442.50	50.0	1.85	46.2
23	20	440	3.65	0.073	441.080	443.00	442.50	0.0	1.92	37.7
24	22	462	3.65	0.0803	441.000	442.00	441.50	45.5	1.00	32.1
Average										1.522

Note : 1.Existing Bottom Level are assumed above mentioned formula.
Existing Bottom Level = Existing Ground Level - 0.5m
Proposed Channel Bottom Level = (Existing Ground Level - 0.9m) >= Bottom Level Diference (No.1 - 17+5000)

1.Receiving well

1 Receiving well inlet channel water level (6 units) 451.680 m

1 Baffle wall loss

Q= 1.375 m3/sec= 118800 m3/day (110000*(1.05+0.03))

h=v^2/(2*g*c^2)

where A= 1.88 m2 : Opening area 3.14/4*0.1^2*(15*16)

v= 0.73 m/sec

g= 9.8 m/sec2

c= 0.6

Baffle wall loss

h=v^2/(2*g*c^2)= 0.075 m

2 Receiving well water level 451.600 m

1 Overflow weir loss (6 line duty)

h=(Q/(1.84*B))^(2/3)

where Q= 0.229 m3/sec= 19800 m3/day (110000*(1.05+0.03)/6)

B= 2.0 m

Overflow weir loss

h=(Q/(1.84*B))^(2/3)= 0.157

The height of the overflow weir is accordingly 451.440 m (451.600 - 0.160).

2.Mixing Well

1 Design G Value

a) Canp's Proposition

GT Value

GT Value= 23,000 ～ 25,000

G=(23,000～25,000)/(40～100)= 230 ～ 625 sec-1

b) Dr. Tanpo

G=(1000/verg)^0.5

where

verg= 0.00898 cm2/sec at 25℃

G= 334 sec-1

c) Japanese Standard

G=(g*h/(v*T))^0.5

where

h= 0.50～ 0.60 m : Head loss at cone

g= 9.8 m/s2

v= 0.00898 cm2/sec

T= 60 sec

G=(g*h/(v*T))^0.5= 302～ 330 sec-1

Therefore, design G Value is 330 sec-1.

2 Required Head loss for mixing chamber

h= G^2* μ *V/(ρ *Q*g)

G= 330 sec-1 : Design G value

μ = 0.000898 kg/m/sec : Coefficient of viscosity of water at 25℃

ρ = 0.9971 g/cm2 at 25℃

g= 980 cm/sec2

V= 25500000 cm3 =26m3 : Volume of mixing chamber

(2.50m* 3.00m* 3.40m) Retention time 2 minute

Q= 459000 cm3/sec =39655m3/d : Design flow rate

h= G^2* μ *V/(ρ *Q*g)= 55.60 cm = 60 cm

3 Overflow weir loss (6 line duty)

h=(Q/(1.84*b))^(2/3)

where Q= 0.229 m3/sec (110000*(1.05+0.03)/6/86400)

b= 2.00 m

h=(Q/(1.84*b))^(2/3)= 0.157 m

4 Water loss

The water level of Receiving well is 451.600 m

The water loss of upstream of the weir is 0.160 m (0.157)

The water loss of downstream of the weir is 0.940 m.

Therefore the water loss (total) is 1.100 m

The height of the overflow weir is accordingly 451.440 m (451.600- 0.160)

The water level at the downstream of the weir (mixing chamber) is 450.500 m

3.Connection Pipe between Mixing chamber and Flocculation basin

1.Connection Pipe between Mixing chamber and Flocculation basin N0.1

Mixing chamber water level 450.470 m

Outlet pipe loss

Inlet Loss	(Diameter	700 mm)、f=	0.5	V=	0.60 m/s	h=	0.009 m
Valve Loss	(Diameter	700 mm)、f=	0.1	V=	0.60 m/s	h=	0.002 m
45°Bend Loss	(Diameter	700 mm)、f=	0.25	V=	0.60 m/s	h=	0.005 m
45°Bend Loss	(Diameter	700 mm)、f=	0.25	V=	0.60 m/s	h=	0.005 m
90°Bend Loss	(Diameter	700 mm)、f=	0.23	V=	0.60 m/s	h=	0.004 m
90°Bend Loss	(Diameter	700 mm)、f=	0.23	V=	0.60 m/s	h=	0.004 m
90°Bend Loss	(Diameter	700 mm)、f=	0.23	V=	0.60 m/s	h=	0.004 m
45°Bend Loss	(Diameter	700 mm)、f=	0.25	V=	0.60 m/s	h=	0.005 m
45°Bend Loss	(Diameter	700 mm)、f=	0.25	V=	0.60 m/s	h=	0.005 m
45°Bend Loss	(Diameter	700 mm)、f=	0.25	V=	0.60 m/s	h=	0.005 m
45°Bend Loss	(Diameter	700 mm)、f=	0.25	V=	0.60 m/s	h=	0.005 m
90°Bend Loss	(Diameter	700 mm)、f=	0.23	V=	0.60 m/s	h=	0.004 m
90°Bend Loss	(Diameter	700 mm)、f=	0.23	V=	0.60 m/s	h=	0.004 m
Outlet Loss	(Diameter	700 mm)、f=	1.0	V=	0.60 m/s	h=	0.018 m
Pipe Friction Loss	(Diameter	700 mm)、I=	0.00066	L=	64.96 m	h=	0.043 m

Total h= 0.122 m

where C= 110

Q= 19800 m3/d= 0.229 m3/sec (110000*(1.05+0.03)/6)

The Inlet chamber water level of Flocculation basin is 450.340 m (450.470 -0.130)

2.Connection Pipe between Mixing chamber and Flocculation basin N0.3

Mixing chamber water level 450.480 m

Outlet pipe loss

Inlet Loss	(Diameter	700 mm)、f=	0.5	V=	0.60 m/s	h=	0.009 m
Valve Loss	(Diameter	700 mm)、f=	0.1	V=	0.60 m/s	h=	0.002 m
45°Bend Loss	(Diameter	700 mm)、f=	0.25	V=	0.60 m/s	h=	0.005 m
90°Bend Loss	(Diameter	700 mm)、f=	0.23	V=	0.60 m/s	h=	0.004 m
90°Bend Loss	(Diameter	700 mm)、f=	0.23	V=	0.60 m/s	h=	0.004 m
90°Bend Loss	(Diameter	700 mm)、f=	0.23	V=	0.60 m/s	h=	0.004 m
45°Bend Loss	(Diameter	700 mm)、f=	0.25	V=	0.60 m/s	h=	0.005 m
45°Bend Loss	(Diameter	700 mm)、f=	0.25	V=	0.60 m/s	h=	0.005 m
45°Bend Loss	(Diameter	700 mm)、f=	0.25	V=	0.60 m/s	h=	0.005 m
45°Bend Loss	(Diameter	700 mm)、f=	0.25	V=	0.60 m/s	h=	0.005 m
90°Bend Loss	(Diameter	700 mm)、f=	0.23	V=	0.60 m/s	h=	0.004 m
90°Bend Loss	(Diameter	700 mm)、f=	0.23	V=	0.60 m/s	h=	0.004 m
Outlet Loss	(Diameter	700 mm)、f=	1.0	V=	0.60 m/s	h=	0.018 m
Pipe Friction Loss	(Diameter	700 mm)、I=	0.00066	L=	94.26 m	h=	0.062 m

Total h= 0.136 m

where C= 110

Q= 19800 m3/d= 0.229 m3/sec (110000*(1.05+0.03)/6)

The Inlet chamber water level of Flocculation basin is 450.340 m (450.480 -0.140)

3.Connection Pipe between Mixing chamber and Flocculation basin N0.6

Mixing chamber water level 450.500 m ✓

Outlet pipe loss

Inlet Loss	(Diameter	700 mm)、f=	0.5	V=	0.60 m/s	h=	0.009 m
Valve Loss	(Diameter	700 mm)、f=	0.1	V=	0.60 m/s	h=	0.002 m
45°Bend Loss	(Diameter	700 mm)、f=	0.25	V=	0.60 m/s	h=	0.005 m
45°Bend Loss	(Diameter	700 mm)、f=	0.25	V=	0.60 m/s	h=	0.005 m
90°Bend Loss	(Diameter	700 mm)、f=	0.23	V=	0.60 m/s	h=	0.004 m
45°Bend Loss	(Diameter	700 mm)、f=	0.25	V=	0.60 m/s	h=	0.005 m
45°Bend Loss	(Diameter	700 mm)、f=	0.25	V=	0.60 m/s	h=	0.005 m
45°Bend Loss	(Diameter	700 mm)、f=	0.25	V=	0.60 m/s	h=	0.005 m
45°Bend Loss	(Diameter	700 mm)、f=	0.25	V=	0.60 m/s	h=	0.005 m
90°Bend Loss	(Diameter	700 mm)、f=	0.23	V=	0.60 m/s	h=	0.004 m
90°Bend Loss	(Diameter	700 mm)、f=	0.23	V=	0.60 m/s	h=	0.004 m
Outlet Loss	(Diameter	700 mm)、f=	1.0	V=	0.60 m/s	h=	0.018 m
Pipe Friction Loss	(Diameter	700 mm)、I=	0.00066	L=	122.86 m	h=	0.081 m

Total h= 0.152 m

where C= 110

Q= 19800 m3/d= 0.229 m3/sec (110000*(1.05+0.03)/6)

The Inlet chamber water level of Flocculation basin is 450.340 m (450.500 -0.160) ✓

4.Flocculation Basin

Flocculation basin inlet channel water level 450.340 m

1 Head loss of Intake gate

Dimension of gate; 600×600
Head loss h=v2/(2*g*C^2)
where A=0.6m*0.6m= 0.36 m2 : Sectional area
Q= 0.229 m3/sec
v=Q/A= 0.637 m/sec
g= 9.8 m/sec2
C= 0.6
h= 0.05743 m = 0.060 m

Flocculation basin inlet water level 450.280 m

2 Required head loss for flocculation basin

h= 0.290 m (Confer Capacity calculation)

Flocculation basin outlet water level 449.990 m

3 Outlet Submerged weir loss
L=Q/(1.8*(h1+1.4*h2)*h1^0.5)
h2=Q/(2.52*L*h1^0.5)-h1/1.4
where Q= 0.229 m3/sec= 19800 m3/day (110000*(1.05+0.03)/3/2)
h1= 0.028 m
L= 11.0 m
h2=Q/(2.52*L*h1^0.5)-h1/1.4= 0.029 m

			h1	h2
The height of the overflow weir is accordingly	449.930 m	(449.990	-0.030	- 0.030).

The water level at the downstream of the weir (sedimentation basin) is 449.960 m

in consideration of an weir loss of 0.03 m (h1)

Treatment Capacity(m3/d/Unit) 39,600

Hydraulic Flocculation (Baffle Walls, Up and Down)

Item No.	Descriptions	Unit	Symbol	Nos. of Raws						Between Raws				
				No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No.1&2	No.2&3	No.3&4	No.4&5	No.5&6
1. General Descriptions														
1)	Design capacity	m3/d	(Q)	19,800	19,800	19,800	19,800	19,800	19,800	19,800	19,800	19,800	19,800	19,800
2)	Width of wall	m	(Ww)	1.100	1.100	1.500	1.500	2.300	2.300	0.965	0.965	0.965	0.965	0.965
3)	No. of wall in one raw	-	(Nw)	9	9	9	9	9	9	1	1	1	1	1
4)	Depth	m		3.80	3.80	3.60	3.60	3.50	3.50	3.80	3.80	3.60	3.60	3.50
5)	Length of raws	m		11.00	11.00	11.00	11.00	11.00	11.00					
2. Loss of down flow														
1)	Downflow depth	m	(Hb)	0.75	0.80	0.90	0.95	1.00	1.05	0.75	0.80	0.90	1.00	1.00
2)	Downflow velocity	m/s	(vb)	0.278	0.260	0.170	0.161	0.100	0.095	0.317	0.297	0.264	0.237	0.237
3)	Downflow coefficent of friction loss	-	(fb)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
4)	No. of down flow in one raw			4	4	4	4	4	4	1	1	1	1	1
5)	$hb = fb/2/9.8*vb^2*$no. of walls/2	m		0.055	0.048	0.021	0.018	0.007	0.006	0.018	0.016	0.012	0.010	0.010
3. Loss of over flow														
1)	Overflow depth	m	(Ho)	0.75	0.80	0.90	0.95	1.00	1.05					
2)	Oveflow velocity	m/s	(vo)	0.278	0.260	0.170	0.161	0.100	0.095					
3)	Downflow coefficent of friction loss	-	(fb)	1.0	1.0	1.0	1.0	1.0	1.0					
4)	No. of down flow in one raw			5	5	5	5	5	5					
5)	$ho = vo^2/2/9.8*$no. of walls/2	m		0.020	0.017	0.007	0.007	0.003	0.002					
4. Loss of friction														
1)	$R = W_w*Lc/2/(W_{w+Lc})$	m	(R)	0.257	0.257	0.294	0.294	0.340	0.340					
2)	n = roughness coefficient	-	(n)	0.015	0.015	0.015	0.015	0.015	0.015					
3)	vc=velocity	m/s	(vc)	0.216	0.216	0.158	0.158	0.103	0.103					
4)	$C^2 = 1/n^2*R^{1/3}$	-	(C^2)	2,826	2,826	2,954	2,954	3,102	3,102					
5)	Length of ditch	m	(L_l)	10.0	10.0	10.0	10.0	10.0	10.0					
6)	Length of wall	m	(L_w)	30.500	30.000	27.000	26.500	25.000	24.500					
7)	L = Ll + Lw	m	(L)	40.535	40.035	37.035	36.535	35.035	34.535					
8)	hf = L n^2vc^2/R^(4/3)	m		0.003	0.003	0.001	0.001	0.000	0.000					
5. Total Loss of Head														
1)	$H = h_1 + h_2 + h_3$	m	0.286	0.077	0.068	0.029	0.026	0.010	0.009	0.018	0.016	0.012	0.010	0.010
6. G-value										Total				
1)	Volume of raw	m3	(V)	45.98	45.98	59.40	59.40	88.55	88.55	**387.860**	**m3**	(TTL Volume of Flloculation Basin)		
2)	Detention time	min	(T)	3.34	3.34	4.32	4.32	6.44	6.44	**28.2**	**min**	(TTL Detention Time)		
3)	Density of Water (at 25 degree)	kg/m3	(ρ)	997.100										
4)	Viscosity of Water (x 10-3)	kg/m/s	(μ)	0.898								**Ave. Turbidity=**		**37.0**
5)	Acceleration of Gravity	m/s2	(g)	9.8						Ave G		GCT=		2,685,805
6)	$G=(H\cdot\rho\cdot Q\cdot g/(V\cdot\mu))^{0.5}$	s-1	(G)	**71.9**	**67.5**	**41.7**	**39.0**	**23.8**	**16.0**	**42.9**				
7)	Gt value	-		14,425	13,546	10,811	10,104	9,181	6,178	72,589	(23,000 to 210,00)			

Width of wall

(11-0.15*9)/10= 0.965 m

Water Level and Weir Level of Hydraulic Flocculation (Baffle Walls, Up and Down)

Item No.	Descriptions	Unit	Symbol	Nos. of Raws						
				No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No.1&2
1. Water level of each baffle wall										
1)	Inlet water level (No.1 section)	m		450.280	450.185	450.102	450.060	450.024	450.004	
2)	No.2 section			450.276	450.182	450.100	450.059	450.024	450.004	
3)	No.3 section			450.262	450.169	450.095	450.054	450.022	450.002	
4)	No.4 section			450.258	450.166	450.093	450.053	450.022	450.002	
5)	No.5 section			450.244	450.153	450.088	450.048	450.020	450.000	
6)	No.6 section			450.240	450.150	450.087	450.047	450.019	450.000	
7)	No.7 section			450.225	450.137	450.081	450.042	450.017	449.998	
8)	No.8 section			450.221	450.134	450.080	450.041	450.017	449.998	
9)	No.9 section			450.207	450.121	450.074	450.036	450.015	449.996	**Total**
10)	No.10 section			450.203	450.117	450.073	450.035	450.015	449.995	**Loss**
				0.0769	0.0678	0.0288	0.0259	0.0099	0.0090	**0.285**
2. Weir Top level of each baffle wall										
1)	Weir top level (No.1 section)			449.526	449.382	449.200	449.109	449.024	448.954	
2)	No.2 section									
3)	No.3 section			449.508	449.366	449.193	449.103	449.022	448.952	
4)	No.4 section									
5)	No.5 section			449.490	449.350	449.187	449.097	449.019	448.950	
6)	No.6 section									
7)	No.7 section			449.471	449.334	449.180	449.091	449.017	448.948	
8)	No.8 section									
9)	No.9 section			449.453	449.317	449.173	449.085	449.015	448.945	
10)	No.10 section									
3. Distance between Wall Top Level (451.100m) and Weir Top Level of each baffle wall										
1)	Depth of weir top level (No.1 section)			1.574	1.718	1.900	1.991	2.076	2.146	
2)	No.2 section									
3)	No.3 section			1.592	1.734	1.907	1.997	2.078	2.148	
4)	No.4 section									
5)	No.5 section			1.610	1.750	1.913	2.003	2.081	2.150	
6)	No.6 section									
7)	No.7 section			1.629	1.766	1.920	2.009	2.083	2.152	
8)	No.8 section									
9)	No.9 section			1.647	1.783	1.927	2.015	2.085	2.155	
10)	No.10 section									
4. Overflow Depth										
1)	Overflow depth (No.1 section)			0.754	0.803	0.901	0.951	1.001	1.050	
2)	No.2 section									
3)	No.3 section			0.754	0.803	0.901	0.951	1.001	1.050	
4)	No.4 section									
5)	No.5 section			0.754	0.803	0.901	0.951	1.001	1.050	
6)	No.6 section									
7)	No.7 section			0.754	0.803	0.901	0.951	1.001	1.050	
8)	No.8 section									
9)	No.9 section			0.754	0.803	0.901	0.951	1.001	1.050	
10)	No.10 section									

5.Sedimentation Basin

1 Sedimentation basin inlet water level 449.960 m

Head loss of diffusion wall (No.1)

Diameter of holes and number of holes; φ100@300×300
Head loss h=v2/(2*g*C^2)
where A1=3.14/4*D^2*(a*b)= 3.6738 m2 : Sectional area
D= 100 mmdia.
a= 13 pieces
b= 36 pieces
Q= 0.229 m3/sec (110000*(1.05+0.03)/86400/6)
v=Q/A= 0.0624 m/sec
g= 9.8 m/sec2
C= 0.6
h1= 0.00055 m

Head loss of diffusion wall (No.2-4)

Diameter of holes and number of holes; φ100@300×300
Head loss h=v2/(2*g*C^2)
where A=3.14/4*D^2*(a*b)= 3.3912 m2 : Sectional area
D= 100 mmdia.
a= 12 pieces
b= 36 pieces
Q= 0.229 m3/sec (110000*(1.05+0.03)/86400/6)
v=Q/A= 0.0676 m/sec
g= 9.8 m/sec2
C= 0.6
h2-4= 0.00065 *3units = 0.0019 m

Head loss of diffusion wall (No.5)

Diameter of holes and number of holes; φ100@300×300
Head loss h=v2/(2*g*C^2)
where A=3.14/4*D^2*(a*b)= 3.6738 m2 : Sectional area
D= 100 mmdia.
a= 13 pieces
b= 36 pieces
Q= 0.229 m3/sec (110000*(1.05+0.03)/86400/6)
v=Q/A= 0.0624 m/sec
g= 9.8 m/sec2
C= 0.6
h5= 0.00055 m

Total head loss
h=h1～h5= 0.00304 = 0.000 m

Sedimentation Basin Downstream Water Level 449.960 m

2 End Trough Bottom Level 449.700 m
Water Level above Trough Orifice 0.060 m
Depth between orifice and Trough Bottom 0.200 m
Trough Loss (Total) 0.260 m

The water level at the downstream of the end trough is 449.450 m in consideration of an

allowance of 0.25 m.

3 Intermediate trough bottom level 449.700 m same as End Trough Bottom Level

4 Intermediate trough channel (Intermediate trough - End channel)

Water Level at upstream of Intermediate Trough Channel 449.700 m same as End Trough Bottom Level

Head loss in the intermediated channel is calculated

Q1= 0.023 m3/sec : Water flow of 1 trough (20.4%)
Q2=2Q1= 0.047 m3/sec : Water flow of 2 trough (40.7%)

Inflow sectional area

A(a-d)=B*H= 0.15 m2 (Watrer Flow Area A= 0.060 m2)
where B= 0.50 m

H= 0.30 m (Watrer Depth h= 0.120 m)

Velocity
V(a-b)=Q1/A= 0.39 m/sec
V(b-c)=Q2/A= 0.78 m/sec

Hydraulic radius
R(a-c)=A/(B+H*2)= 0.136 m

Roughness coefficient
n= 0.015

Head losses are calculated using Manning Formula.

h=n^2*L*v^2/R^(4/3)
where L(a-b)= 10.0 m
L(b-c)= 12.6 m

h(a-b)= 0.00485 = 0.005 m
h(b-c)= 0.02445 = 0.025 m

I=n^2*v^2/R^(4/3)
I(a-b)= 0.00049
I(b-c)= 0.00194

Total head loss
h(a-c)= 0.030 m (0.030)

Critical Water Depth at the end of Intermediated Channel

hc=(α*Qt^2/(g*B^2))^(1/3)
where α = 1.1 速度エネルギーの補正係数
B= 0.4 m
g= 9.8 m/s2
hc=(α*Qt^2/(g*B^2))^(1/3)= 0.100 m (0.099 m) at downstream
ho=hc+h(a-c) 0.130 m (0.130 m) at upstream

Bottom level at the end of the intermediated channel is 449.500

Accordingly, water level at the end of the intermediated channel is 449.600 m (449.500 + 0.100)

Water level at the upstream of the intermediated channel is 449.630 m (Water Depth is 0.130 m)

The water level at the end channel is 449.450 m in consideration of an allowance of 0.15 m.

Outflow Troough of Sedimentation Basin

1.End trough (Inlet from both side)

1.1.Load factor of end trough weir design criteria

Q= 11733 m3/d : Flow Rate (59.3%)
n= 8 pieces : Number of trough
L= 2 m : Length of trough
Lf= 367 m3/m/d : Load factor (=<500m3/m/d)

1.2.Number of orifice holes per trough

N=Qt/(C'*π/4*d^2*(2gh)^0.5)

Qt= 0.0170 m3/sec : Collecting water amount per trough
C'= 0.6
d= 0.03 mm(φ30mm) : Orifice diameter
g= 9.8 m/sec2
h= 0.06 m(60mm) : Overflow depth of oridice

N=Qt/(C'*π/4*d^2*(2gh)^0.5)= 36 holes per each trough
18 holes per each side of trough

Interval between holes
In=L/(N/2) 100 mm (0.108 m)

1.3.Water level in the trough

hc=(α*Qt^2/(g*B^2))^(1/3)
where α= 1.1 : Suplementary factor of velocity energy
B= 0.4 m : Weir width

hc=(α*Qt^2/(g*B^2))^(1/3)= 0.060 m (0.059 m) at downstream
ho=hc*3^(1/2) 0.100 m (0.104 m) at upstream

1.4.Load factor of trough weir

Q= 11733.33333 m3/d : Flow Rate (59.3%)
n= 8 pieces : Number of trough per unit
Le= 2.0 m : length of trough
Lf= 367 m3/m/day : Load factor (=<500m3/m/d)

2.Intermediate trough (Inlet from one side)

2.1.Load factor of trough weir design criteria

Q= 8067 m3/d : Flow Rate (40.7%)
n= 2 pieces : Number of trough in one basin
L= 11.0 m : Length of trough
Lf= 500 m3/m/d : Load factor (=<500m3/m/d)

2.2.Number of orifice holes per 1/2trough

N=Qt/(C'*π/4*d^2*(2gh)^0.5)

Qt= 0.0467 m3/sec : Collecting water amount per 1/2trough
C'= 0.6
d= 0.03 mm(φ30mm) : Orifice diameter
g= 9.8 m/sec2
h= 0.06 m(60mm) : Overflow depth of oridice

N=Qt/(C'*π/4*d^2*(2gh)^0.5)= 102 holes per each trough

Interval between holes
In=L/(N/2) 100 mm (0.108 m)

2.3.Water level in the trough

hc=(α*(1/2*Qt)^2/(g*B^2))^(1/3)
where α= 1.1 速度エネルギーの補正係数
B= 0.4 m

hc=(α*(1/2*Qt)^2/(g*B^2))^(1/3)= 0.070 m (0.073 m) at downstream
ho=hc*3^(1/2) 0.120 m (0.121 m) at upstream

2.4.Load factor of trough weir (one side inflow)

Q= 8066.666667 m3/d : Flow Rate (40.7%)
n= 2 pieces : Number of trough per unit
Le= 11 m : length of trough
Lf= 367 m3/m/day : Load factor (=<500m3/m/d)

6.Rapid Sand Filter (in case of four units duty) Phase1

1 Water level at the upstream of the inflow channel of the filter 449.450 m

Head loss in the channel is calculated under the conditions that four units are operated

Q1= 0.458 m3/sec : Total flow rate for 4 units of 1 system
Q2=Q1/4= 0.115 m3/sec : flow rate for 1 units during 4 units duty in 1 system

Inflow sectional area

A(a-d)=B*H= 2.17 m2
where B= 1.50 m
H= 1.45 m

Velocity
V(a-b)=3*Q2/A= 0.11 m/sec
V(b-c)=2*Q2/A= 0.05 m/sec

Hydraulic radius
R(a-d)=A/(B+H*2)= 0.494 m

Roughness coefficient
n= 0.015

Head losses are calculated using Manning Formula.

h=n^2*L*v^2/R^(4/3)
where L(a-b)= 33.95 m
L(b-c)= 9.3 m

h(a-b)= 0.00022 =0 m
h(b-c)= 0.00001 =0 m

Total head loss
h(a-d)= 0 m

Accordingly, water level at the downstream of inflow channel is 449.450 m (449.450 - 0.000)

Inlet channel bottom level is 448.000 m (449.450 - 1.450)

2 Weir and inlet gate loss
1 Overflow weir loss
h=(Q2/(1.84*b))^(2/3)
where b= 0.80 m
h=(Q2/(1.84*b))^(2/3)= 0.182 m (0.190 m)

The height of the overflow weir is accordingly 449.260m (449.450- 0.190)

The water level at the downstream of the weir is 448.960 m in consideration of an allowance

of 0.30 m.
2 Inlet gate loss
h=v^2/(2*g*c^2)
where A= 0.16 m2 : Gate Area (400mm× 400mm)
Q2= 0.115 m3/sec
v=Q2/A= 0.72 m/sec
g= 9.8 m/sec2
c= 0.6
h=v^2/(2*g*c^2)= 0.073 m (0.080 m)

Total loss h= 0.255 m

The water level at the downstream of the weir is 448.880m (448.960- 0.080)

3 Inlet pipe loss

Inlet Loss	(Diameter	400 mm), f=	0.5	V(Q1)=	0.91 m/s	h=	0.021 m
Outlet Loss	(Diameter	400 mm), f=	1.0	V(Q2)=	0.91 m/s	h=	0.042 m
Pipe Friction Loss	(Diameter	400 mm), I=	0.00281	L=	0.70 m	h=	0.002 m

Total h= 0.065 m
(0.070 m)

where Q2= 0.115 m3/sec
C= 110

The high water level of filter is 448.810 m(448.880 - 0.070)

Rapid Sand Filter (in case of eight units duty)

1 Water level at the inflow channel of the filter 449.450 m

Head loss in the channel is calculated under the conditions that one unit is stopped its operation

and one unit is washed.

Q1= 0.458 m3/sec : Total flow rate for 6 units of 1 system
Q2=Q1/4= 0.115 m3/sec : flow rate for 1 units during 4 units duty in 1 system

Inflow sectional area

A(a-d)=B*H= 2.17 m2
where B= 1.50 m
H= 1.45 m

Velocity
V(a-b)=2*Q2/A= 0.16 m/sec
V(b-c)=Q2/A= 0.05 m/sec
V(c-d)=3*Q2/A= 0.16 m/sec
V(d-e)=2*Q2/A= 0.11 m/sec
V(e-f)=4*Q2/A= 0.21 m/sec
V(f-g)=3*Q2/A= 0.16 m/sec
V(g-h)=2*Q2/A= 0.11 m/sec
V(h-i)=4*Q2/A= 0.21 m/sec
V(I-j)=3*Q2/A= 0.16 m/sec
V(j-k)=2*Q2/A= 0.11 m/sec
V(k-l)=Q2/A= 0.05 m/sec

Hydraulic radius
R(a-d)=A/(B+H*2)= 0.494 m

Roughness coefficient
n= 0.015

Head losses are calculated using Manning Formula.

h=n^2*L*v^2/R^(4/3)
where L(a-b)= 12.85 m
L(b-c)= 8.25 m
L(c-d)= 6.15 m
L(d-e)= 6.55 m
L(e-f)= 6.15 m
L(f-g)= 9.3 m
L(g-h)= 5.65 m
L(h-i)= 33.95 m
L(i-j)= 9.3 m
L(j-k)= 17.8 m
L(k-l)= 9.3 m

h(a-b)= 0.00018 ≈0 m
h(b-c)= 0.00001 ≈0 m
h(c-d)= 0.00009 ≈0 m
h(d-e)= 0.00004 ≈0 m
h(e-f)= 0.00016 ≈0 m
h(f-g)= 0.00013 ≈0 m
h(g-h)= 0.00004 ≈0 m
h(h-i)= 0.00087 ≈0 m
h(I-j)= 0.00013 ≈0 m
h(j-k)= 0.00011 ≈0 m
h(k-l)= 0.00001 ≈0 m

Total head loss
h(a-d)= 0.00179 ≈0.000 m

Accordingly, water level at the inflow channel is 449.450 m (449.450 - 0.000)

Inlet channel bottom level is 448.000 m (449.450 - 1.450)

2 Weir and inlet gate loss

1 Overflow weir loss

h=(Q2/(1.84*b))^(2/3)

where b= 0.80 m

h=(Q2/(1.84*b))^(2/3)= 0.182 m (0.190 m)

The height of the overflow weir is accordingly 449.260m (449.450- 0.190)

The water level at the downstream of the weir is 448.960 m in consideration of an allowance

of 0.30 m.

2 Inlet gate loss

h=v^2/(2*g*c^2)

where A= 0.16 m2 : Gate Area (400mm× 400mm)

Q2= 0.115 m3/sec

v=Q2/A= 0.72 m/sec

g= 9.8 m/sec2

c= 0.6

h=v^2/(2*g*c^2)= 0.073 m (0.080 m)

The water level at the downstream of the gate is 448.880m (448.960- 0.080)

3 Inlet pipe loss

Inlet Loss	(Diameter	400 mm)、f=	0.5	V(Q1)=	0.91 m/s	h=	0.021 m
Outlet Loss	(Diameter	400 mm)、f=	1.0	V(Q2)=	0.91 m/s	h=	0.042 m
Pipe Friction Loss	(Diameter	400 mm)、I=	0.00281	L=	0.70 m	h=	0.002 m

Total h= 0.065 m

where Q2= 0.115 m3/sec

C= 110

The high water level of filter is 448.810 m(448.880 - 0.070)

7.Rapid Sand Filter Outflow Water Level (in case of four units duty)

Phase1

Filtered water level (Outlet box) is 447.060 m.

1 Filtered outlet pipe loss

Inlet Loss	(Diameter	350 mm)、f=	0.5	V=	1.19 m/s	h=	0.036 m
Valve	(Diameter	350 mm)、f=	0.1	V=	1.19 m/s	h=	0.007 m
Outlet Loss	(Diameter	350 mm)、f=	1.0	V=	1.19 m/s	h=	0.072 m
Pipe Friction Loss	(Diameter	350 mm)、I=	0.00539	L=	2.50 m	h=	0.013 m

Total h= 0.128 m

where Q= 0.115 m3/sec (110000*(1.05+0..03)/3/86400/4)

C= 110

The water level at upstream of weir (b=1.6m) is 446.930 m(447.060 - 0.130)

2 Overflow weir loss (in case of four units duty)

h=(Q/(1.84*b))^(2/3)

where Q= 0.115 m3/sec (110000*(1.05+0.03)/3/86400/4)

b= 1.60 m

h=(Q/(1.84*b))^(2/3)= 0.115 m

The height of the overflow weir is 446.810 m same as surface level of filter media.

The water level at the downstream of the weir is 446.600 m in consideration of an allowance of

0.21 m.

3 Overflow weir loss (b=8.0m)

h=(Q/(1.84*b))^(2/3)

where Q= 0.458 m3/sec (110000*(1.05+0.03)/3/86400)

b= 8.00 m

h=(Q/(1.84*b))^(2/3)= 0.099 m

The height of the overflow weir is 446.500 m(446.600 - 0.100)

The water level at the downstream of the weir (filtered water effluent channel) is 446.030 m in consideration

of an allowance of 0.470 m.

Rapid Sand Filter Outflow Water Level (in case of eight units duty)

Phase2

Filtered water level (Outlet box) is 447.060 m.

1 Filtered outlet pipe loss

Inlet Loss	(Diameter	350 mm)、f=	0.5	V=	1.19 m/s	h=	0.036 m
Valve	(Diameter	350 mm)、f=	0.1	V=	1.19 m/s	h=	0.007 m
Outlet Loss	(Diameter	350 mm)、f=	1.0	V=	1.19 m/s	h=	0.072 m
Pipe Friction Loss	(Diameter	350 mm)、I=	0.00539	L=	2.50 m	h=	0.013 m

Total h= 0.128 m

where Q= 0.115 m3/sec (110000*(1.05+0..03)/3/86400/4)

C= 110

The water level at upstream of weir (b=1.6m) is 446.930 m(447.060 - 0.130)

2 Overflow weir loss (in case of eight units duty)

h=(Q/(1.84*b))^(2/3)

where Q= 0.115 m3/sec (110000*(1.05+0.03)/3/86400/4)

b= 1.60 m

h=(Q/(1.84*b))^(2/3)= 0.115 m

The height of the overflow weir is 446.810 m same as surface level of filter media.

The water level at the downstream of the weir is 446.660 m in consideration of an allowance of

0.15 m.

3 Overflow weir loss (b=8.0m)

h=(Q/(1.84*b))^(2/3)

where Q= 0.917 m3/sec (110000*(1.05+0.03)/3*2/86400)

b= 8.00 m

h=(Q/(1.84*b))^(2/3)= 0.157 m

The height of the overflow weir is 446.500 m(446.660 - 0.160)

The water level at the downstream of the weir (filtered water effluent channel) is 446.020 m in consideration

of an allowance of 0.480 m.

Rapid Sand Filter Outflow Water Level (in case of four units duty)

Phase3

Filtered water level (Outlet box) is 447.060 m.

1 Filtered outlet pipe loss

Inlet Loss	(Diameter	350 mm)、f=	0.5	V=	1.19 m/s	h=	0.036 m
Valve	(Diameter	350 mm)、f=	0.1	V=	1.19 m/s	h=	0.007 m
Outlet Loss	(Diameter	350 mm)、f=	1.0	V=	1.19 m/s	h=	0.072 m
Pipe Friction Loss	(Diameter	350 mm)、I=	0.00539	L=	2.50 m	h=	0.013 m

Total h= 0.128 m

where Q= 0.115 m3/sec (110000*(1.05+0..03)/3/86400/4)

C= 110

The water level at upstream of weir (b=1.6m) is 446.930 m(447.060 - 0.130)

2 Overflow weir loss (in case of four units duty)

h=(Q/(1.84*b))^(2/3)

where Q= 0.115 m3/sec (110000*(1.05+0.03)/3/86400/4)

b= 1.60 m

h=(Q/(1.84*b))^(2/3)= 0.115 m

The height of the overflow weir is 446.810 m same as surface level of filter media.

The water level at the downstream of the weir is 446.600 m in consideration of an allowance of

0.21 m.

3 Overflow weir loss (b=8.0m)

h=(Q/(1.84*b))^(2/3)

where Q= 0.458 m3/sec (110000*(1.05+0.03)/3/86400)

b= 8.00 m

h=(Q/(1.84*b))^(2/3)= 0.099 m

The height of the overflow weir is 446.500 m(446.600 - 0.100)

The water level at the downstream of the weir (filtered water effluent channel) is 446.070 m in consideration

of an allowance of 0.430 m.

8.Connection Pipe between Filter and Clear Water Reservoir

1.Connection Pipe between Filter(No.1+No.2) and Clear Water Reservoir(No.1-1) Phase1

Filter Outlet water level 446.030 m ✓

Outlet pipe loss

Inlet Loss	(Diameter	1000 mm), f=	0.5	V=	1.17 m/s		h=	0.035 m
Tee Branch	(Diameter	1000	1000 mm), f=	0.99	V=	1.17 m/s	h=	0.069 m
Reducer	(Diameter	1000	800 mm), f=	0.00	V=	0.58 m/s	h=	0.000 m
Tee Branch	(Diameter	800	600 mm), f=	0.05	V=	0.91 m/s	h=	0.002 m
Reducer	(Diameter	800	600 mm), f=	0.00	V=	0.46 m/s	h=	0.000 m
90°Bend Loss	(Diameter	600 mm), f=	0.23	V=	0.81 m/s		h=	0.008 m
Valve Loss	(Diameter	600 mm), f=	0.30	V=	0.81 m/s		h=	0.010 m
Outlet Loss	(Diameter	600 mm), f=	1.0	V=	0.81 m/s		h=	0.033 m
Pipe Friction Loss	(Diameter	1000 mm), I=	0.00152	L=	8.75 m		h=	0.013 m
Pipe Friction Loss	(Diameter	800 mm), I=	0.00125	L=	7.60 m		h=	0.010 m
Pipe Friction Loss	(Diameter	600 mm), I=	0.00141	L=	17.71 m		h=	0.025 m

Total h= 0.205 m

where	C=	110		
	Q1=	19800 m3/d=	0.229 m3/sec	(110000*(1.05+0.03)/6)
	Q2=	39600 m3/d=	0.458 m3/sec	(110000*(1.05+0.03)/6*2)
	Q3=	59400 m3/d=	0.688 m3/sec	(110000*(1.05+0.03)/6*3)
	Q4=	79200 m3/d=	0.917 m3/sec	(110000*(1.05+0.03)/6*4)
	Q5=	99000 m3/d=	1.146 m3/sec	(110000*(1.05+0.03)/6*5)
	Q6=	118800 m3/d=	1.375 m3/sec	(110000*(1.05+0.03))

The Inlet water level of Clear Water Reservoir is 445.820 m (446.030 -0.210)

2.Connection Pipe between Filter(No.1+No.2) and Clear Water Reservoir(No.1-2) Phase1

Filter Outlet water level 446.030 m

Outlet pipe loss

Inlet Loss	(Diameter	1000 mm), f=	0.5	V=	1.17 m/s		h=	0.035 m
Tee Branch	(Diameter	1000	1000 mm), f=	0.99	V=	1.17 m/s	h=	0.069 m
Reducer	(Diameter	1000	800 mm), f=	0.00	V=	0.58 m/s	h=	0.000 m
Tee Branch	(Diameter	800	600 mm), f=	0.90	V=	0.91 m/s	h=	0.038 m
Valve Loss	(Diameter	600 mm), f=	0.30	V=	0.81 m/s		h=	0.010 m
Outlet Loss	(Diameter	600 mm), f=	1.0	V=	0.81 m/s		h=	0.033 m
Pipe Friction Loss	(Diameter	1000 mm), I=	0.00152	L=	5.75 m		h=	0.009 m
Pipe Friction Loss	(Diameter	1000 mm), I=	0.00042	L=	3.00 m		h=	0.001 m
Pipe Friction Loss	(Diameter	800 mm), I=	0.00125	L=	5.10 m		h=	0.006 m
Pipe Friction Loss	(Diameter	600 mm), I=	0.00141	L=	6.01 m		h=	0.008 m

Total h= 0.209 m

where	C=	110		
	Q1=	19800 m3/d=	0.229 m3/sec	(110000*(1.05+0.03)/6)
	Q2=	39600 m3/d=	0.458 m3/sec	(110000*(1.05+0.03)/6*2)
	Q3=	59400 m3/d=	0.688 m3/sec	(110000*(1.05+0.03)/6*3)
	Q4=	79200 m3/d=	0.917 m3/sec	(110000*(1.05+0.03)/6*4)
	Q5=	99000 m3/d=	1.146 m3/sec	(110000*(1.05+0.03)/6*5)
	Q6=	118800 m3/d=	1.375 m3/sec	(110000*(1.05+0.03))

The Inlet water level of Clear Water Reservoir is 445.820 m (446.030 -0.210)

3.Connection Pipe between Filter(No.1+No.2) and Clear Water Reservoir(No2-1) Phase2

Filter Outlet water level 446.020 m ✓

Outlet pipe loss

Inlet Loss	(Diameter	1000 mm), f=	0.5	V=	1.17 m/s		h=	0.035 m
Tee Branch	(Diameter	1000	1000 mm), f=	0.99	V=	1.17 m/s	h=	0.069 m
Tee Branch	(Diameter	1000	600 mm), f=	1.20	V=	0.58 m/s	h=	0.021 m
Valve Loss	(Diameter	600 mm), f=	0.30	V=	0.81 m/s		h=	0.010 m
Outlet Loss	(Diameter	600 mm), f=	1.0	V=	0.81 m/s		h=	0.033 m
Pipe Friction Loss	(Diameter	1000 mm), I=	0.00152	L=	5.75 m		h=	0.009 m
Pipe Friction Loss	(Diameter	1000 mm), I=	0.00042	L=	20.90 m		h=	0.009 m
Pipe Friction Loss	(Diameter	600 mm), I=	0.00141	L=	6.01 m		h=	0.008 m

Total h= 0.194 m

where C= 110

Q1= 19800 m3/d= 0.229 m3/sec (110000*(1.05+0.03)/6)

Q2= 39600 m3/d= 0.458 m3/sec (110000*(1.05+0.03)/6*2)

Q3= 59400 m3/d= 0.688 m3/sec (110000*(1.05+0.03)/6*3)

Q4= 79200 m3/d= 0.917 m3/sec (110000*(1.05+0.03)/6*4)

Q5= 99000 m3/d= 1.146 m3/sec (110000*(1.05+0.03)/6*5)

Q6= 118800 m3/d= 1.375 m3/sec (110000*(1.05+0.03))

The Inlet water level of Clear Water Reservoir is 445.820 m (446.020 -0.200)

4.Connection Pipe between Filter(No.1+No.2) and Clear Water Reservoir(No.2-2) Phase2

Filter Outlet water level 446.060 m

Outlet pipe loss

Inlet Loss	(Diameter	1000 mm), f=	0.5	V=	1.17 m/s		h=	0.035 m
Tee Branch	(Diameter	1000	1000 mm), f=	0.99	V=	1.17 m/s	h=	0.069 m
Tee Branch	(Diameter	1000	600 mm), f=	0.05	V=	0.58 m/s	h=	0.001 m
Tee Combine	(Diameter	1000	1000 mm), f=	0.36	V=	0.88 m/s	h=	0.014 m
Tee Branch	(Diameter	1000	600 mm), f=	1.20	V=	0.88 m/s	h=	0.047 m
Valve Loss	(Diameter	600 mm), f=	0.30	V=	0.81 m/s		h=	0.010 m
Outlet Loss	(Diameter	600 mm), f=	1.0	V=	0.81 m/s		h=	0.033 m
Pipe Friction Loss	(Diameter	1000 mm), I=	0.00152	L=	5.75 m		h=	0.009 m
Pipe Friction Loss	(Diameter	1000 mm), I=	0.00042	L=	20.90 m		h=	0.009 m
Pipe Friction Loss	(Diameter	1000 mm), I=	0.00012	L=	6.20 m		h=	0.001 m
Pipe Friction Loss	(Diameter	1000 mm), I=	0.00012	L=	8.00 m		h=	0.001 m
Pipe Friction Loss	(Diameter	600 mm), I=	0.00141	L=	6.01 m		h=	0.008 m

Total h= 0.237 m

where C= 110

Q1= 19800 m3/d= 0.229 m3/sec (110000*(1.05+0.03)/6)

Q2= 39600 m3/d= 0.458 m3/sec (110000*(1.05+0.03)/6*2)

Q3= 59400 m3/d= 0.688 m3/sec (110000*(1.05+0.03)/6*3)

Q4= 79200 m3/d= 0.917 m3/sec (110000*(1.05+0.03)/6*4)

Q5= 99000 m3/d= 1.146 m3/sec (110000*(1.05+0.03)/6*5)

Q6= 118800 m3/d= 1.375 m3/sec (110000*(1.05+0.03))

The Inlet water level of Clear Water Reservoir is 445.820 m (446.060 -0.240)

5.Connection Pipe between Filter(No.1+No.2+No.3) and Clear Water Reservoir(No.3-1) Phase3

Filter Outlet water level 446.080 m

Outlet pipe loss

Inlet Loss	(Diameter	1000 mm)、f=	0.5	V=	1.17 m/s		h=	0.035 m
Tee Branch	(Diameter	1000	1000 mm)、f=	0.99	V=	1.17 m/s	h=	0.069 m
Tee Branch	(Diameter	1000	600 mm)、f=	0.05	V=	0.58 m/s	h=	0.001 m
Tee Combine	(Diameter	1000	1000 mm)、f=	0.36	V=	0.88 m/s	h=	0.014 m
Tee Branch	(Diameter	1000	600 mm)、f=	0.05	V=	0.88 m/s	h=	0.002 m
Reducer	(Diameter	1000	800 mm)、f=	0.00	V=	0.58 m/s	h=	0.000 m
Tee Branch	(Diameter	800	600 mm)、f=	0.90	V=	0.91 m/s	h=	0.038 m
Valve Loss	(Diameter	600 mm)、f=	0.30	V=	0.81 m/s		h=	0.010 m
Outlet Loss	(Diameter	600 mm)、f=	1.0	V=	0.81 m/s		h=	0.033 m
Pipe Friction Loss	(Diameter	1000 mm)、I=	0.00152	L=	5.75 m		h=	0.009 m
Pipe Friction Loss	(Diameter	1000 mm)、I=	0.00042	L=	20.90 m		h=	0.009 m
Pipe Friction Loss	(Diameter	1000 mm)、I=	0.00012	L=	6.20 m		h=	0.001 m
Pipe Friction Loss	(Diameter	1000 mm)、I=	0.00089	L=	8.00 m		h=	0.007 m
Pipe Friction Loss	(Diameter	1000 mm)、I=	0.00042	L=	3.00 m		h=	0.001 m
Pipe Friction Loss	(Diameter	800 mm)、I=	0.00125	L=	16.60 m		h=	0.021 m
Pipe Friction Loss	(Diameter	600 mm)、I=	0.00141	L=	6.01 m		h=	0.008 m

Total h= 0.258 m

where	C=	110		
	Q1=	19800 m3/d=	0.229 m3/sec	(110000*(1.05+0.03)/6)
	Q2=	39600 m3/d=	0.458 m3/sec	(110000*(1.05+0.03)/6*2)
	Q3=	59400 m3/d=	0.688 m3/sec	(110000*(1.05+0.03)/6*3)
	Q4=	79200 m3/d=	0.917 m3/sec	(110000*(1.05+0.03)/6*4)
	Q5=	99000 m3/d=	1.146 m3/sec	(110000*(1.05+0.03)/6*5)
	Q6=	118800 m3/d=	1.375 m3/sec	(110000*(1.05+0.03))

The Inlet water level of Clear Water Reservoir is 445.820 m (446.080 -0.260)

6.Connection Pipe between Filter(No.1+No.2+No.3) and Clear Water Reservoir(No.3-2) Phase3

Filter Outlet water level 446.070 m ✓

Outlet pipe loss

Inlet Loss	(Diameter	1000 mm)、f=	0.5	V=	1.17 m/s		h=	0.035 m
Tee Branch	(Diameter	1000	1000 mm)、f=	0.99	V=	1.17 m/s	h=	0.069 m
Tee Branch	(Diameter	1000	600 mm)、f=	0.05	V=	0.58 m/s	h=	0.001 m
Tee Combine	(Diameter	1000	1000 mm)、f=	0.36	V=	0.88 m/s	h=	0.014 m
Tee Branch	(Diameter	1000	600 mm)、f=	0.05	V=	0.88 m/s	h=	0.002 m
Reducer	(Diameter	1000	800 mm)、f=	0.00	V=	0.58 m/s	h=	0.000 m
Tee Branch	(Diameter	800	600 mm)、f=	0.05	V=	0.91 m/s	h=	0.002 m
Reducer	(Diameter	800	600 mm)、f=	0.00	V=	0.91 m/s	h=	0.000 m
90°Bend Loss	(Diameter	600 mm)、f=	0.23	V=	0.81 m/s		h=	0.008 m
Valve Loss	(Diameter	600 mm)、f=	0.30	V=	0.81 m/s		h=	0.010 m
Outlet Loss	(Diameter	600 mm)、f=	1.0	V=	0.81 m/s		h=	0.033 m
Pipe Friction Loss	(Diameter	1000 mm)、I=	0.00159	L=	5.75 m		h=	0.009 m
Pipe Friction Loss	(Diameter	1000 mm)、I=	0.00042	L=	20.90 m		h=	0.009 m
Pipe Friction Loss	(Diameter	1000 mm)、I=	0.00012	L=	6.20 m		h=	0.001 m
Pipe Friction Loss	(Diameter	1000 mm)、I=	0.00089	L=	8.00 m		h=	0.007 m
Pipe Friction Loss	(Diameter	1000 mm)、I=	0.00042	L=	3.00 m		h=	0.001 m
Pipe Friction Loss	(Diameter	800 mm)、I=	0.00125	L=	19.10 m		h=	0.024 m
Pipe Friction Loss	(Diameter	600 mm)、I=	0.00141	L=	17.71 m		h=	0.025 m

Total h= 0.250 m

where	C=	110		
	Q1=	19800 m3/d=	0.229 m3/sec	(110000*(1.05+0.03)/6)
	Q2=	39600 m3/d=	0.458 m3/sec	(110000*(1.05+0.03)/6*2)
	Q3=	59400 m3/d=	0.688 m3/sec	(110000*(1.05+0.03)/6*3)
	Q4=	79200 m3/d=	0.917 m3/sec	(110000*(1.05+0.03)/6*4)
	Q5=	99000 m3/d=	1.146 m3/sec	(110000*(1.05+0.03)/6*5)
	Q6=	118800 m3/d=	1.375 m3/sec	(110000*(1.05+0.03))

The Inlet water level of Clear Water Reservoir is 445.820 m (446.070 -0.250)

9.Clear water reservoir

1 Clear water reservor Water Level 445.820 m

1 Head loss in the channel (under the conditions that two reservoirs are duty)

Q= 0.219 m3/sec= 18883 m3/day (110000*1.03/3/2)

Inflow sectional area

A=B*H= 12.30 m2
where B= 4.10 m
H= 3.00 m

Velocity
V=Q/A= 0.02 m/sec

Hydraulic radius
R=A/(B+H*2)= 1.218 m

Roughness coefficient
n= 0.015

Head losses are calculated using Manning Formula.

h=n^2*L*v^2/R^(4/3)
where L= 57.2 m

h= 0.00000 = 0.000 m

2 Head loss in the channel (under the conditions that one reservoir is duty)

Q= 0.437 m3/sec= 37767 m3/day (110000*1.03/3)

Inflow sectional area

A=B*H= 12.30 m2
where B= 4.10 m
H= 3.00 m

Velocity
V=Q/A= 0.04 m/sec

Hydraulic radius
R=A/(B+H*2)= 1.218 m

Roughness coefficient
n= 0.015

Head losses are calculated using Manning Formula.

h=n^2*L*v^2/R^(4/3)
where L= 57.2 m

h= 0.00001 = 0.000 m

3 Bend loss

h=(V1-V2)^2/(2*g)*n
where V1= 0.018 m/sec
V2= 0 m/sec
g= 9.8 m/sec2
n= 4
h=(V1-V2)^2/(2*g)*n= 0.0001 = 0.000 m

4 Total head loss 0.000 m

Therefore High water level in clear water reservoir is 445.820 m (445.820 - 0.000)

Effective Depth is 3.000 m.

Low Water Level in Clear Water Level is 442.820 m (445.820 - 3.000)

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10.Connection Pipe between Clear Water Reservoir (No.3) and Transmission Pump Station

1 Clear Water Reservoir Outlet water level (LWL) 442.820 m

utlet pipe loss

Inlet Loss	(Diameter	600 mm)、f=	0.5	V=	0.77 m/s		h=	0.015 m
Valve Loss	(Diameter	600 mm)、f=	0.1	V=	0.77 m/s		h=	0.003 m
90°Bend Loss	(Diameter	600 mm)、f=	0.1	V=	0.77 m/s		h=	0.003 m
Gradually Expanded Pipe	(Diameter	800	600 mm)、f=	0.494	θ=	22.6°	h=	0.003 m
Tee Combine	(Diameter	800	600 mm)、f=	0.47	V=	0.44 m/s	h=	0.005 m
Gradually Expanded Pipe	(Diameter	900	800 mm)、f=	0.416	θ=	19.7°	h=	0.001 m
Tee Combine	(Diameter	900	600 mm)、f=	0.05	V=	0.69 m/s	h=	0.001 m
Gradually Expanded Pipe	(Diameter	1000	900 mm)、f=	0.416	θ=	19.7°	h=	0.001 m
Tee Combine	(Diameter	1000	600 mm)、f=	0.05	V=	0.84 m/s	h=	0.002 m
Gradually Expanded Pipe	(Diameter	1100	1000 mm)、f=	0.416	θ=	19.7°	h=	0.001 m
Tee Combine	(Diameter	1100	600 mm)、f=	0.05	V=	0.92 m/s	h=	0.002 m
Gradually Expanded Pipe	(Diameter	1200	1100 mm)、f=	0.416	θ=	19.7°	h=	0.001 m
Tee Loss	(Diameter	1200	1200 mm)、f=	1.0	V=	1.16 m/s	h=	0.069 m
Pipe Friction Loss	(Diameter	1200 mm)、I=	0.00121	L=	9.54 m		h=	0.012 m
Pipe Friction Loss	(Diameter	1100 mm)、I=	0.00132	L=	8.43 m		h=	0.011 m
Pipe Friction Loss	(Diameter	1000 mm)、I=	0.00139	L=	10.33 m		h=	0.014 m
Pipe Friction Loss	(Diameter	900 mm)、I=	0.00137	L=	14.14 m		h=	0.019 m
Pipe Friction Loss	(Diameter	800 mm)、I=	0.00114	L=	19.64 m		h=	0.022 m
Pipe Friction Loss	(Diameter	600 mm)、I=	0.00129	L=	17.55 m		h=	0.023 m
	Total	h=	0.207 m					

where	C=	110		
	Q1=	18883 m3/d=	0.219 m3/sec	(110000*1.03/3/2)
	Q2=	37767 m3/d=	0.437 m3/sec	(110000*1.03/3/2*2)
	Q3=	56650 m3/d=	0.656 m3/sec	(110000*1.03/3/2*3)
	Q4=	75533 m3/d=	0.874 m3/sec	(110000*1.03/3/2*4)
	Q5=	94417 m3/d=	1.093 m3/sec	(110000*1.03/3/2*5)
	Q6=	113300 m3/d=	1.311 m3/sec	(110000*1.03/3/2*6)

The Inlet water level of Transmission Pump Station is 442.610 m (442.820 -0.210)

(Pipe center Level in the Clear Water Reservoir is 441.320 m (442.820 -0.6*2.5)

(Pipe center Level in the Transmission Pump Station is 440.860 m)

11 Hydraulic Calculation of Sedimentation Basin - Sludge Lagoon

In case of drainage from 4 hoppers (for the purpose of empty of sedimentation basin)

Sedimentation Basin Sludge Pipe - Manhole (DIP Pipe 150mm -250mm)

Manhole - Sludge Lagoon (RC Pipe 700mm)

1.Sedimentation Basin Water Level

H.W.L. 449.960 m

L.L.W.L. 445.160 m (Drain Pit Top Level in Sedimentation Basin)

2.Drain Pipe Center Level

W.L..+ 443.700 m (DIP 150 - 250 Drain Pipe Center Level)

3.First Manhole Water Level

W.L..+ 442.800 m (Drain Pit Top Level in Drain Pipe Gallery +443.000 - 0.20m)

4.Sludge Lagoon High Water Level

442.000 m

4.Actual Head Loss

6.260 m (449.960 - 443.700)

5 Intake Flow & Verosity

Q1=	0.0414 m3/sec=	3577 m3/day
Q2=	0.0828 m3/sec=	7154 m3/day
Q3=	0.1242 m3/sec=	10731 m3/day
Q4=	0.1656 m3/sec=	14308 m3/day

6.Water Level Loss

6.1. Suction Pipe Loss C= 100

6.1.1.	Inlet Loss	(Diameter	150		mm)、f=	0.5	V=	2.34 m/s	h=	0.140 m
6.1.2.	Valve Loss	(Diameter	150		mm)、f=	0	V=	2.34 m/s	h=	0.000 m
6.1.3.	Valve Loss	(Diameter	150		mm)、f=	10	V=	2.34 m/s	h=	2.794 m
6.1.4.	Tee Combine Loss	(Diameter	250	150	mm)、f=	7.00	V=	0.84 m/s	h=	0.252 m
6.1.5.	Tee Combine Loss	(Diameter	250	150	mm)、f=	2.00	V=	1.69 m/s	h=	0.291 m
6.1.6.	Tee Combine Loss	(Diameter	250	150	mm)、f=	0.60	V=	2.53 m/s	h=	0.196 m
6.1.7.	Tee Combine Loss	(Diameter	250	150	mm)、f=	0.20	V=	3.38 m/s	h=	0.117 m
6.1.8.	Tee Combine Loss	(Diameter	250	150	mm)、f=	0.00	V=	1.69 m/s	h=	0.000 m
6.1.9.	Tee Combine Loss	(Diameter	250	150	mm)、f=	0.00	V=	2.53 m/s	h=	0.000 m
6.1.10.	Tee Combine Loss	(Diameter	250	150	mm)、f=	0.00	V=	3.38 m/s	h=	0.000 m
6.1.11.	Tee Combine Loss	(Diameter	250	150	mm)、f=	0.00	V=	3.38 m/s	h=	0.000 m
6.1.12.	Outlet Loss	(Diameter	250		mm)、f=	1.0	V=	3.38 m/s	h=	0.583 m
6.1.13.	Pipe Friction Loss	(Diameter	150		mm)、I=	0.061	L=	2.6 m	h=	0.157 m
6.1.14.	Pipe Friction Loss	(Diameter	250		mm)、I=	0.065	L=	26.1 m	h=	1.704 m

Sub Total H= 6.234 m

<6.260 m

6.2. RC Pipe Loss (Sedimentation Basin → Sludge Lagoon)

6.2.1.	Pipe Loss	100%	(Diameter	600	mm)、I=	0.00080	L=	127.45 m	h=	0.102 m
6.2.2.	Pipe Loss	100%	(Diameter	600	mm)、I=	0.00080	L=	154.10 m	h=	0.123 m
6.2.3.	Manhole Loss		(Diameter	600	mm)	2.0	cm	8 ps	h=	0.160 m
6.2.4.	Pipe Loss	100%	(Diameter	450	mm)、I=	0.00340	L=	3.64 m	h=	0.012 m
6.2.5.	Outlet Loss		(Diameter	450	mm)、f=	1.0	V=	1.04 m/s	h=	0.055 m

Sub Total H= 0.452 m

7. Total Pipe Loss H= 6.686 m

8 Sludge Lagoon Inlet Water Leve 442.348 m (442.800 - 0.452) > 442.000 m OK

RC600mmPipe Loss Calculation (Sedimentation Basin - Sludge Lagoon)

Manhole No.	Dia.	Gradient(‰)	Length(ctc) (m)	Length(m)	Loss(m)			Inlet Pipe		Outlet Pipe		Water Level	Elevation Level(m)	Soil Cover Depth(m)	Manhole Depth(m)
					Pipe	Manhole	Total	Bottom Level	Top Level	Bottom Level	Top Level				
1										442.020	442.660	442.620	446.500	3.84	4.45
2	600	1.0	47.16	46.66	0.047	0.020	0.067	441.973	442.463	441.900	442.540	442.500	446.500	4.04	4.57
3	600	1.0	16.60	15.40	0.015	0.020	0.035	441.885	442.525	441.865	442.505	442.465	446.500	3.98	4.60
6	600	1.0	33.80	32.60	0.033	0.020	0.053	441.832	442.472	441.812	442.452	442.412	446.500	4.03	4.65
9	600	1.0	33.80	32.60	0.033	0.020	0.053	441.779	442.419	441.759	442.399	442.359	446.500	4.08	4.71
10	600	1.0	49.26	48.06	0.048	0.020	0.068	441.711	442.351	441.691	442.331	442.291	444.000	1.65	2.27
11	600	1.0	31.88	30.68	0.031	0.020	0.051	441.661	442.301	441.641	442.281	442.241	443.000	0.70	1.51
12	600	1.0	41.90	40.70	0.041	0.020	0.061	441.600	442.240	441.580	442.220	442.180	443.000	0.76	1.51
13	600	1.0	41.90	40.70	0.041	0.020	0.061	441.539	442.179	441.519	442.159	442.119	443.000	0.82	1.51
14	600	1.0	41.90	40.70	0.041	0.020	0.061	441.479	442.119	441.459	442.099	442.059	443.000	0.88	1.51
Inlet Mouth	450	4.5	2.5	1.65	0.007	0.000	0.007	441.451	442.091			442.051			
Total			338.19	329.74	0.289	0.160	0.449								

Note:		
	No.1 Manhole Water level	442.620 m (Filter Outlet Gallery Floor drain pipe center level +442.92-0.3m)
	No.1 Manhole Outlet Pipe Bottom level	442.020 m (No.1Manhole Water level +443.27 - Pipe diameter 0.60m)
	No.2 Manhole Water level	442.500 m (Sedimentation Drain Pit Floor Level +443.30-0.80m)
	No.2 Manhole Outlet Pipe Bottom level	441.900 m (No.2 Manhole Water level +442.50 - Pipe diameter 0.60m)
	Total loss	0.449 m

( ) RC 450mm Outlet Pipe Top Level

RC Pipe Top Level (Bottom Level + Innerdiameter 450mm + Thickness 40mm) = 0.49 m

RC Pipe Top Level (Bottom Level + Innerdiameter 600mm + Thickness 40mm) = 0.64 m

Table of Flow Rate (Manning Formula)

v = (1/n) R^(2/3) I^(1/2)

q = (1/n) (π * D^(2) / 4) R^ (2/3) I^(1/2) =(π /4n) D^(2) R^(2/3) I^(1/2)

n = 0.013

Q= 14308 m3/d = 0.166 m3/s

Dia Hydraulic Gradient	450 V	450 Q	600 V	600 Q	750 V	750 Q	900 V	900 Q
0.10	0.179	0.029	0.217	0.061	0.252	0.111	0.285	0.181
0.20	0.254	0.040	0.307	0.087	0.356	0.157	0.402	0.256
0.30	0.310	0.049	0.376	0.106	0.436	0.193	0.493	0.314
0.40	0.359	0.057	0.434	0.123	0.504	0.223	0.569	0.362
0.50	0.401	0.064	0.486	0.137	0.563	0.249	0.636	0.405
0.60	0.439	0.070	0.532	0.150	0.617	0.273	0.697	0.443
0.70	0.474	0.075	0.575	0.162	0.667	0.295	0.753	0.479
0.80	0.507	0.081	0.614	0.174	0.713	0.315	0.805	0.512
0.90	0.538	0.086	0.651	0.184	0.756	0.334	0.854	0.543
1.00	0.567	0.090	0.687	0.194	0.797	0.352	0.900	0.572
1.10	0.595	0.095	0.720	0.204	0.836	0.369	0.944	0.600
1.20	0.621	0.099	0.752	0.213	0.873	0.386	0.986	0.627
1.30	0.646	0.103	0.783	0.221	0.909	0.401	1.026	0.653
1.40	0.671	0.107	0.813	0.230	0.943	0.417	1.065	0.677
1.50	0.694	0.110	0.841	0.238	0.976	0.431	1.102	0.701
1.60	0.717	0.114	0.869	0.246	1.008	0.445	1.138	0.724
1.70	0.739	0.118	0.895	0.253	1.039	0.459	1.173	0.746
1.80	0.761	0.121	0.921	0.261	1.069	0.472	1.207	0.768
1.90	0.781	0.124	0.947	0.268	1.098	0.485	1.240	0.789
2.00	0.802	0.128	0.971	0.275	1.127	0.498	1.273	0.810
2.10	0.821	0.131	0.995	0.281	1.155	0.510	1.304	0.830
2.20	0.841	0.134	1.019	0.288	1.182	0.522	1.335	0.849
2.30	0.860	0.137	1.041	0.294	1.209	0.534	1.365	0.868
2.40	0.878	0.140	1.064	0.301	1.235	0.545	1.394	0.887
2.50	0.896	0.143	1.086	0.307	1.260	0.557	1.423	0.905
2.60	0.914	0.145	1.107	0.313	1.285	0.568	1.451	0.923
2.70	0.931	0.148	1.128	0.319	1.309	0.578	1.479	0.941
2.80	0.949	0.151	1.149	0.325	1.333	0.589	1.506	0.958
2.90	0.965	0.154	1.169	0.331	1.357	0.600	1.532	0.975
3.00	0.982	0.156	1.189	0.336	1.380	0.610	1.559	0.992
3.10	0.998	0.159	1.209	0.342	1.403	0.620	1.584	1.008
3.20	1.014	0.161	1.228	0.347	1.425	0.630	1.610	1.024
3.30	1.030	0.164	1.248	0.353	1.448	0.640	1.635	1.040
3.40	1.045	0.166	1.266	0.358	1.469	0.649	1.659	1.056
3.50	1.061	0.169	1.285	0.363	1.491	0.659	1.683	1.071
3.60	1.076	0.171	1.303	0.368	1.512	0.668	1.707	1.086
3.70	1.090	0.173	1.321	0.373	1.533	0.677	1.731	1.101
3.80	1.105	0.176	1.339	0.379	1.553	0.686	1.754	1.116
3.90	1.119	0.178	1.356	0.383	1.574	0.695	1.777	1.131
4.00	1.134	0.180	1.373	0.388	1.594	0.704	1.800	1.145
4.10	1.148	0.183	1.391	0.393	1.614	0.713	1.822	1.159
4.20	1.162	0.185	1.407	0.398	1.633	0.721	1.844	1.173
4.30	1.176	0.187	1.424	0.403	1.652	0.730	1.866	1.187
4.40	1.189	0.189	1.440	0.407	1.672	0.738	1.888	1.201
4.50	1.203	0.191	1.457	0.412	1.690	0.747	1.909	1.214
4.60	1.216	0.193	1.473	0.416	1.709	0.755	1.930	1.228
4.70	1.229	0.195	1.489	0.421	1.728	0.763	1.951	1.241
4.80	1.242	0.198	1.505	0.425	1.746	0.771	1.972	1.254
4.90	1.255	0.200	1.520	0.430	1.764	0.779	1.992	1.267
5.00	1.268	0.202	1.536	0.434	1.782	0.787	2.012	1.280

12. Hydraulic Calculation of Filter - Backwash Recycle Pump House

Filter - Backwash Recycle Pump House

Manhole - Backwash Recycle Pump House (RC Pipe 600mm, DIP 600mm)

1. Filter Backwash waste water Level

H.W.L.	444.750 m	(444.410 m Washwater channel bottom level)

2.Backwash Recycle Pump House Water Level

H.W.L..+	444.010 m	
L.W.L.+	441.010 m	(Effective Depth3.0 m)

5 Inllow Flow Rate

QI= 0.346 m3/sec = 20.74 m3/min (7.2m*9.6m*0.3m3/m2/min)

6.2.	RC Pipe Loss (Filter → Backwash Recycle Pump House)										
6.2.1.	Pipe Loss	100%	(Diameter	600	mm)、I=	0.0032	L=	6.73 m	h=	0.022 m
6.2.4.	Manhole Loss		(Diameter	600	mm)	2.0	cm	1 ps	h=	0.020 m
	Sub Total								H=	0.042 m

6.Water Level Loss

6.1.	DIP Pipe Loss (Filter → Backwash Recycle Pump House)									
6.1.1.	Inlet Loss	(Diameter	600	mm)、f=	0.5	V=	1.22 m/s	h=	0.038 m
6.1.2.	Tee Branch	(Diameter	600	600 mm)、f=	0.05	V=	1.22 m/s	h=	0.004 m
6.1.3.	90°Bend Loss	(Diameter	600	mm)、f=	0.23	V=	1.22 m/s	h=	0.017 m
6.1.4.	Valve Loss	(Diameter	600	mm)、f=	1.0	V=	1.22 m/s	h=	0.076 m
6.1.5.	Outlet Loss	(Diameter	600	mm)、f=	1.0	V=	1.22 m/s	h=	0.076 m
6.1.6.	Pipe Friction Loss	(Diameter	600	mm)、I=	0.004	L=	17.82 m	h=	0.064 m
	Sub Total							H=	0.275 m
	Total							H=	0.317 m)
									(0.400 m)

where C= 100

Table of Flow Rate (Manning Formula)

v = (1/n) R^(2/3) I^(1/2)

q = (1/n) (π * D^(2) / 4) R^ (2/3) I^(1/2) =(π/4n) D^(2) R^(2/3) I^(1/2)

n = 0.013

Q= 29851 m3/d = 0.346 m3/s

Dia	450	450	600	600	750	750	900	900
Hydraulic Gradient	V	Q	V	Q	V	Q	V	Q
0.10	0.179	0.029	0.217	0.061	0.252	0.111	0.285	0.181
0.20	0.254	0.040	0.307	0.087	0.356	0.157	0.402	0.256
0.30	0.310	0.049	0.376	0.106	0.436	0.193	0.493	0.314
0.40	0.359	0.057	0.434	0.123	0.504	0.223	0.569	0.362
0.50	0.401	0.064	0.486	0.137	0.563	0.249	0.636	0.405
0.60	0.439	0.070	0.532	0.150	0.617	0.273	0.697	0.443
0.70	0.474	0.075	0.575	0.162	0.667	0.295	0.753	0.479
0.80	0.507	0.081	0.614	0.174	0.713	0.315	0.805	0.512
0.90	0.538	0.086	0.651	0.184	0.756	0.334	0.854	0.543
1.00	0.567	0.090	0.687	0.194	0.797	0.352	0.900	0.572
1.10	0.595	0.095	0.720	0.204	0.836	0.369	0.944	0.600
1.20	0.621	0.099	0.752	0.213	0.873	0.386	0.986	0.627
1.30	0.646	0.103	0.783	0.221	0.909	0.401	1.026	0.653
1.40	0.671	0.107	0.813	0.230	0.943	0.417	1.065	0.677
1.50	0.694	0.110	0.841	0.238	0.976	0.431	1.102	0.701
1.60	0.717	0.114	0.869	0.246	1.008	0.445	1.138	0.724
1.70	0.739	0.118	0.895	0.253	1.039	0.459	1.173	0.746
1.80	0.761	0.121	0.921	0.261	1.069	0.472	1.207	0.768
1.90	0.781	0.124	0.947	0.268	1.098	0.485	1.240	0.789
2.00	0.802	0.128	0.971	0.275	1.127	0.498	1.273	0.810
2.10	0.821	0.131	0.995	0.281	1.155	0.510	1.304	0.830
2.20	0.841	0.134	1.019	0.288	1.182	0.522	1.335	0.849
2.30	0.860	0.137	1.041	0.294	1.209	0.534	1.365	0.868
2.40	0.878	0.140	1.064	0.301	1.235	0.545	1.394	0.887
2.50	0.896	0.143	1.086	0.307	1.260	0.557	1.423	0.905
2.60	0.914	0.145	1.107	0.313	1.285	0.568	1.451	0.923
2.70	0.931	0.148	1.128	0.319	1.309	0.578	1.479	0.941
2.80	0.949	0.151	1.149	0.325	1.333	0.589	1.506	0.958
2.90	0.965	0.154	1.169	0.331	1.357	0.600	1.532	0.975
3.00	0.982	0.156	1.189	0.336	1.380	0.610	1.559	0.992
3.10	0.998	0.159	1.209	0.342	1.403	0.620	1.584	1.008
3.20	1.014	0.161	1.228	0.347	1.425	0.630	1.610	1.024
3.30	1.030	0.164	1.248	0.353	1.448	0.640	1.635	1.040
3.40	1.045	0.166	1.266	0.358	1.469	0.649	1.659	1.056
3.50	1.061	0.169	1.285	0.363	1.491	0.659	1.683	1.071
3.60	1.076	0.171	1.303	0.368	1.512	0.668	1.707	1.086
3.70	1.090	0.173	1.321	0.373	1.533	0.677	1.731	1.101
3.80	1.105	0.176	1.339	0.379	1.553	0.686	1.754	1.116
3.90	1.119	0.178	1.356	0.383	1.574	0.695	1.777	1.131
4.00	1.134	0.180	1.373	0.388	1.594	0.704	1.800	1.145
4.10	1.148	0.183	1.391	0.393	1.614	0.713	1.822	1.159
4.20	1.162	0.185	1.407	0.398	1.633	0.721	1.844	1.173
4.30	1.176	0.187	1.424	0.403	1.652	0.730	1.866	1.187
4.40	1.189	0.189	1.440	0.407	1.672	0.738	1.888	1.201
4.50	1.203	0.191	1.457	0.412	1.690	0.747	1.909	1.214
4.60	1.216	0.193	1.473	0.416	1.709	0.755	1.930	1.228
4.70	1.229	0.195	1.489	0.421	1.728	0.763	1.951	1.241
4.80	1.242	0.198	1.505	0.425	1.746	0.771	1.972	1.254
4.90	1.255	0.200	1.520	0.430	1.764	0.779	1.992	1.267
5.00	1.268	0.202	1.536	0.434	1.782	0.787	2.012	1.280

13. Hydraulic Calculation of Connection Pipe between Backwash Recycle Pump - Receiving Well

Backwash Recycle Pump - Receiving Well

1 . Filter Backwash waste water Level

L.W.L.	440.130 m	(444.13 m Washwater channel bottom level)

2.Receiving Well Water level

W.L..+	451.200 m

3.Actual Pump Head

11.070 m

5 Recycle Flow

Q1=	0.104 m3/sec =	6.22 m3/min

6.Water Level Loss

6.1. RC Pipe Loss (Sedimentation Basin → Sludge Lagoon)

6.1.1.	45°Bend Loss	(Diameter	250	mm)、f=	0.16	V=	2.11 m/s		h=	0.037 m
6.1.2.	45°Bend Loss	(Diameter	250	mm)、f=	0.16	V=	2.11 m/s		h=	0.037 m
6.1.3.	45°Bend Loss	(Diameter	250	mm)、f=	0.16	V=	2.11 m/s		h=	0.037 m
6.1.4.	45°Bend Loss	(Diameter	250	mm)、f=	0.16	V=	2.11 m/s		h=	0.037 m
6.1.5.	90°Bend Loss	(Diameter	250	mm)、f=	0.23	V=	2.11 m/s		h=	0.052 m
6.1.6.	Outlet Loss	(Diameter	250	mm)、f=	1.0	V=	2.11 m/s		h=	0.227 m
6.1.7.	Pipe Friction Loss	(Diameter	250	mm)、I=	0.027	L=	103.48 m		h=	2.844 m
	Sub Total								H=	3.271 m

where C= 100

14.Receiving Well Overflow Weir

1 Overflow weir loss (2 line duty)

h=(Q/(1.84*b))^(2/3)

where	Q=	1.375 m3/sec	(110000*(1.05+0.03)/86400)
	b=	4.00 m	
h=(Q/(1.84*b))^(2/3)=		0.327 m	

4 Water loss

The water level of Receiving well is	451.680 m
The height of the overflsow weir is	451.900 m
The water level of upstream of the weir is	452.230 m (0.327)
The water loss of downstream of the weir is	4.570 m.
Therefore the water loss (total) is	4.897 m

The water level at the downstream of the weir (overflow chamber) is 447.330 m

15. Hydraulic Calculation of Overflow from Receiving Well

1.Water Level at Inlet Chamber of Distribution Chamber

Overflow Water Level 452.330 m (452.00 + 0.33)

2.Top Level of Overflow Weir

H.W.L. 452.000 m

3.Water Level at Downstream of Overflow Weir

H.W.L. 451.800 m (452.00 m Top Level of Overflow Weir. Allowance is 0.20 m)

4.Overflow Pipe Center Level at Blowoff Point

W.L..+ 442.930 m (446.50 m WTP site Elevation Level, Soil Cover 2.2m)

5.Water Loss

8.870 m (451.800 - 442.930 =8.870 m > 3.933 m OK)

6 Intake Flow & Verosity

Q1= 1.375 m3/sec = 118800.00 m3/day (110000*(1.05+0.03))

7.Water Level Loss

7.1.1.	Inlet Loss		(Diameter	600	mm)、f=	0.5	V=	4.87 m/s	h=	0.605 m
7.1.2.	Valve Loss	θ=5°	(Diameter	600	mm)、f=	0.3	V=	4.87 m/s	h=	0.363 m
7.1.3.	45°Bend Loss		(Diameter	600	mm)、f=	0.16	V=	4.87 m/s	h=	0.197 m
7.1.4.	45°Bend Loss		(Diameter	600	mm)、f=	0.16	V=	4.87 m/s	h=	0.197 m
7.1.5.	90°Bend Loss		(Diameter	600	mm)、f=	0.23	V=	4.87 m/s	h=	0.278 m
7.1.6.	Outlet Loss		(Diameter	600	mm)、f=	1.0	V=	4.87 m/s	h=	1.210 m
7.1.7.	Pipe Friction Loss		(Diameter	600	mm)、I=	0.046	L=	23.47 m	h=	1.083 m
	Sub Total								H=	3.933 m

where C= 100

16. Hydraulic Calculation of Overflow from Clear Water Reservoir

Overflow from Clear Water Reservoir
Clear Water Reservoir - Drainage Point

1.Water Level at Clear Water Reservoir		
	H.W.L.	445.820 m
2.Small Stream		
	W.L..+	441.820 m
	Stream Bed Level	441.320 m
3.Pipe Bottom Level at Drainage Point		
		442.090 m

(RC Pipe Bottom Level at starting point + 444.525)
(Small Stream Bottom Level + 441.323)

5 Overflow Flow Rate

Q1=	0.212 m3/sec =	18333 m3/day	(110000/6)
Q2=	0.424 m3/sec =	36667 m3/day	(110000/6*2)
Q3=	0.637 m3/sec =	55000 m3/day	(110000/6*3)
Q4=	0.849 m3/sec =	73333 m3/day	(110000/6*4)
Q5=	1.061 m3/sec =	91667 m3/day	(110000/6*5)
Q6=	1.273 m3/sec =	110000 m3/day	(110000/6*6)

6.1.	DIP Pipe Loss (Sedimentation Basin → Sludge Lagoon)									
6.1.1.	Inlet Loss		(Diameter	350	mm), f=	0.5	V=	2.21 m/s	h=	0.125 m
6.1.2.	90°Bend Loss		(Diameter	350	mm), f=	0.20	V=	2.21 m/s	h=	0.050 m
6.1.3.	Outlet Loss		(Diameter	350	mm), f=	1.0	V=	2.21 m/s	h=	0.249 m
6.1.4.	Pipe Friction Loss		(Diameter	350	mm), I=	0.020	L=	2.82 m	h=	0.057 m
	Sub Total								H=	0.481 m
6.2.	RC Pipe Loss (Sedimentation Basin → Sludge Lagoon)									
6.2.1.	Pipe Loss	100%	(Diameter	450	mm), I=	0.013	L=	13.70 m	h=	0.178 m
6.2.2.	Pipe Loss	100%	(Diameter	600	mm), I=	0.011	L=	18.60 m	h=	0.205 m
6.2.3.	Pipe Loss	100%	(Diameter	750	mm), I=	0.008	L=	13.20 m	h=	0.106 m
6.2.4.	Pipe Loss	100%	(Diameter	750	mm), I=	0.014	L=	6.80 m	h=	0.095 m
6.2.5.	Pipe Loss	100%	(Diameter	750	mm), I=	0.010	L=	13.20 m	h=	0.132 m
6.2.6.	Pipe Loss	100%	(Diameter	750	mm), I=	0.030	L=	5.00 m	h=	0.150 m
6.2.7.	Pipe Loss	100%	(Diameter	750	mm), I=	0.030	L=	22.95 m	h=	0.689 m
6.2.8.	Pipe Loss	100%	(Diameter	1050	mm), I=	0.005	L=	132.80 m	h=	0.664 m
6.2.9.	Manhole Loss		(Diameter	450 - 1050	mm)	2.0	cm	11 ps	h=	0.220 m
	Sub Total								H=	2.439 m
7.	Total Pipe Loss								H=	2.920 m

where C= 100

Pipe Loss Calculation for Clear Water Reservoir Overflow Pipe (RCP450 - 1050mm)

Manhole No.	Dia.	Pipe Thickness	Gradient (‰)	Length(m)	Loss(m)			Inlet Pipe		Outlet Pipe		Manhole Depth (m)	Water Level (m)	Elevation Level (m)	Soil Cover Depth (m)	Manhole Distance (ctc)
					Pipe	Manhole	Total	Bottom Level	Top Level	Bottom Level	Top Level					
1										444.500	444.990	1.96	444.950	446.500	1.51	
2	450	40	13	13.10	0.170	0.020	0.190	444.330	444.820	444.310	444.800	2.16	444.760	446.500	1.68	14.20
3	600	40	11	18.50	0.204	0.020	0.224	444.106	444.746	444.086	444.726	2.37	444.536	446.500	1.75	19.70
4	750	50	8	13.00	0.104	0.020	0.124	443.982	444.782	443.962	444.762	2.49	444.412	446.500	1.72	14.20
5	750	50	14	6.70	0.094	0.020	0.114	443.868	444.668	443.848	444.648	2.61	444.298	446.500	1.83	7.90
6	750	50	21	13.00	0.273	0.020	0.293	443.575	444.375	443.555	444.355	2.90	444.005	446.500	2.12	14.20
7	750	50	30	5.55	0.167	0.020	0.187	443.389	444.189	443.369	444.169	3.09	443.819	446.500	2.31	6.75
8	750	50	30	22.84	0.685	0.020	0.705	442.684	443.484	442.664	443.464	3.78	443.114	446.500	3.02	24.19
9	1050	60	4.9	47.85	0.234	0.020	0.254	442.429	443.539	442.409	443.519	4.04	442.859	446.500	2.96	49.35
10	1050	60	4.9	18.75	0.092	0.020	0.112	442.317	443.427	442.297	443.407	4.15	442.747	446.500	3.07	20.25
Small Steam	1050	60	4.9	40.49	0.198		0.198	442.099	443.209				442.549	446.500	3.29	41.24
Total				199.78	2.221	0.180	2.401									211.98

Note:		
	No.1Manhole Water level	444.950 m (Overflow pipe bottom Level +444.975m)
	No.1Manhole Outlet Pipe Bottom level	444.500 m (No.1Manhole Water level +444.950 - Pipe diameter 0.45m)
	Manhole Depth (m)	446.50-(Outlet Pipe Bottom Level)-(Pipe Thickness)
	Total loss	2.401 m

03 Transmission System Calculations

Transmission System Calculation

1. Basic Conditions

The following data/ conclusions/ information was also incorporated in the hydraulic calculation of the pipelines.

Pipeline Data:
The data such as the length, elevation of the existing and new pipelines, together with the type and diameter of the existing ones were collected during the topographical surveys.

High and Low Water Levels of Service Reservoirs (existing and new):
This information was tabulated in Table TM-1.

The Quantity of Flow to each Service Reservoir:
Maximum day demand (m^3/d) was assessed and tabulated in Figure TM-1 for each of the three Phases separately.

Peak Factors:
The peak factor (maximum daily demand to the daily average demand) is assumed to be 1.2.

2. Pipe Materials

For diameters 250mm and larger Ductile Cast Iron (DI) pipes, and for diameters less than 250mm, Unplasticized Polyvinyl Chloride (U-PVC) pipes were basically applied.

DI Pipes:
Straight Pipe -----------K=9
Tees ---------------------K=14
Other fittings -----------K=12

U-PVC Pipes:
The pipes shall have a minimum working pressure of 10kgf/sq.m or 10 bars for type 1000 pipes, at a temperature of 29^{0}C.

3. Hydraulic Design

Pipelines will be sized using the exponential equation developed by Hazen and Williams shown below in metric units.

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

Where, H: friction loss (m)
C: friction coefficient
D: diameter of pipe (m)
Q: rate of flow (m^3/sec)
L: Pipe length (m)

Pipelines will be sized using the same Hazen Williams friction coefficient (C) as indicated in Table TM-3.

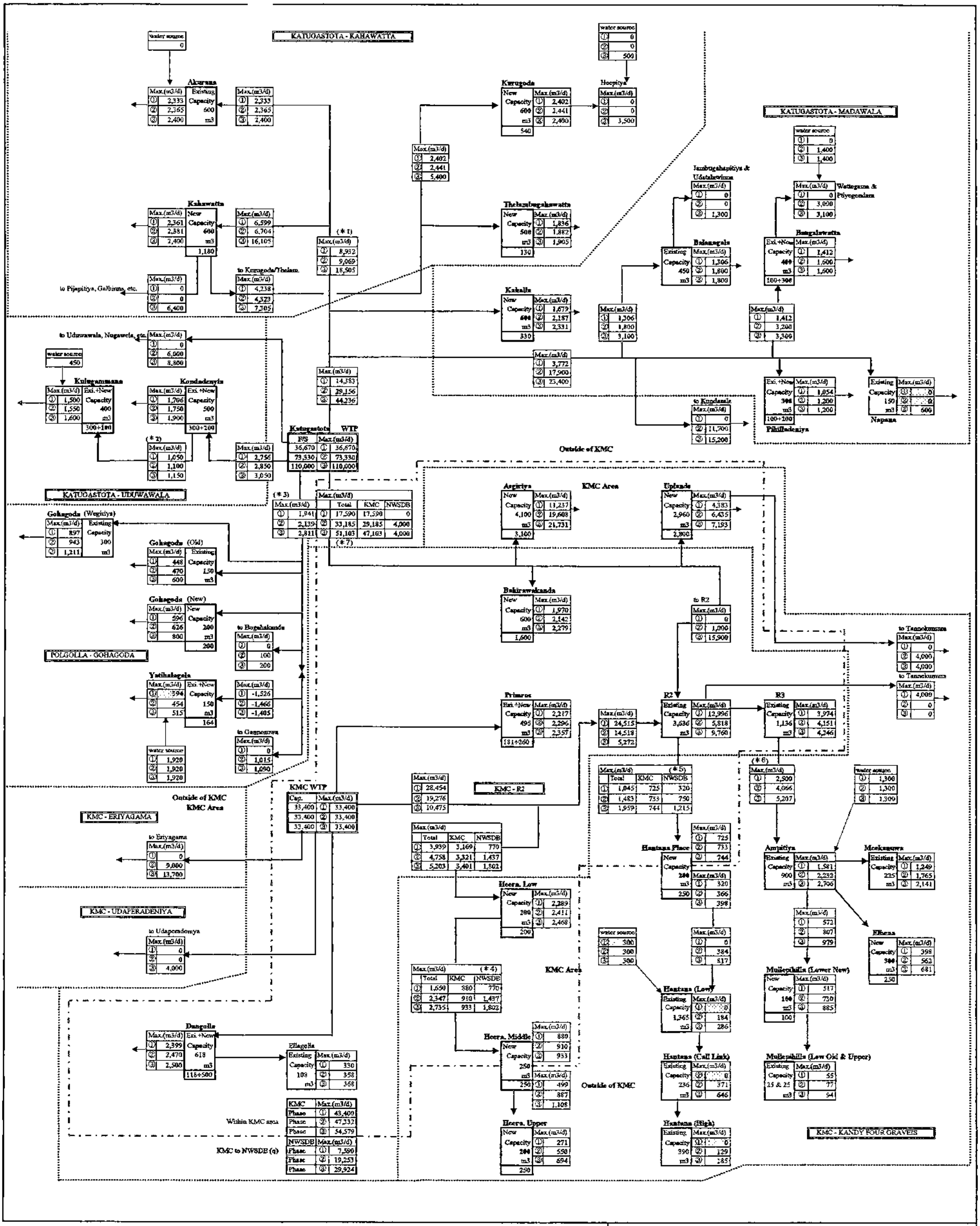
Table TM-3 Pipe Friction Coefficients

Pipe Material	Existing or New	Friction Coefficient (C)
Cast Iron	Existing	90
u-PVC, ACP	Existing	120
Ductile Iron	New	140
u-PVC	New	140

The appropriate flow velocity shall be taken as economical and reasonable velocity (approximately 1.0 m/sec). Residual pressure of hydraulic grade line at inlet to the Service Reservoir shall be more than 5m.

Table TM-1 Water Level of Service Reserrvoir

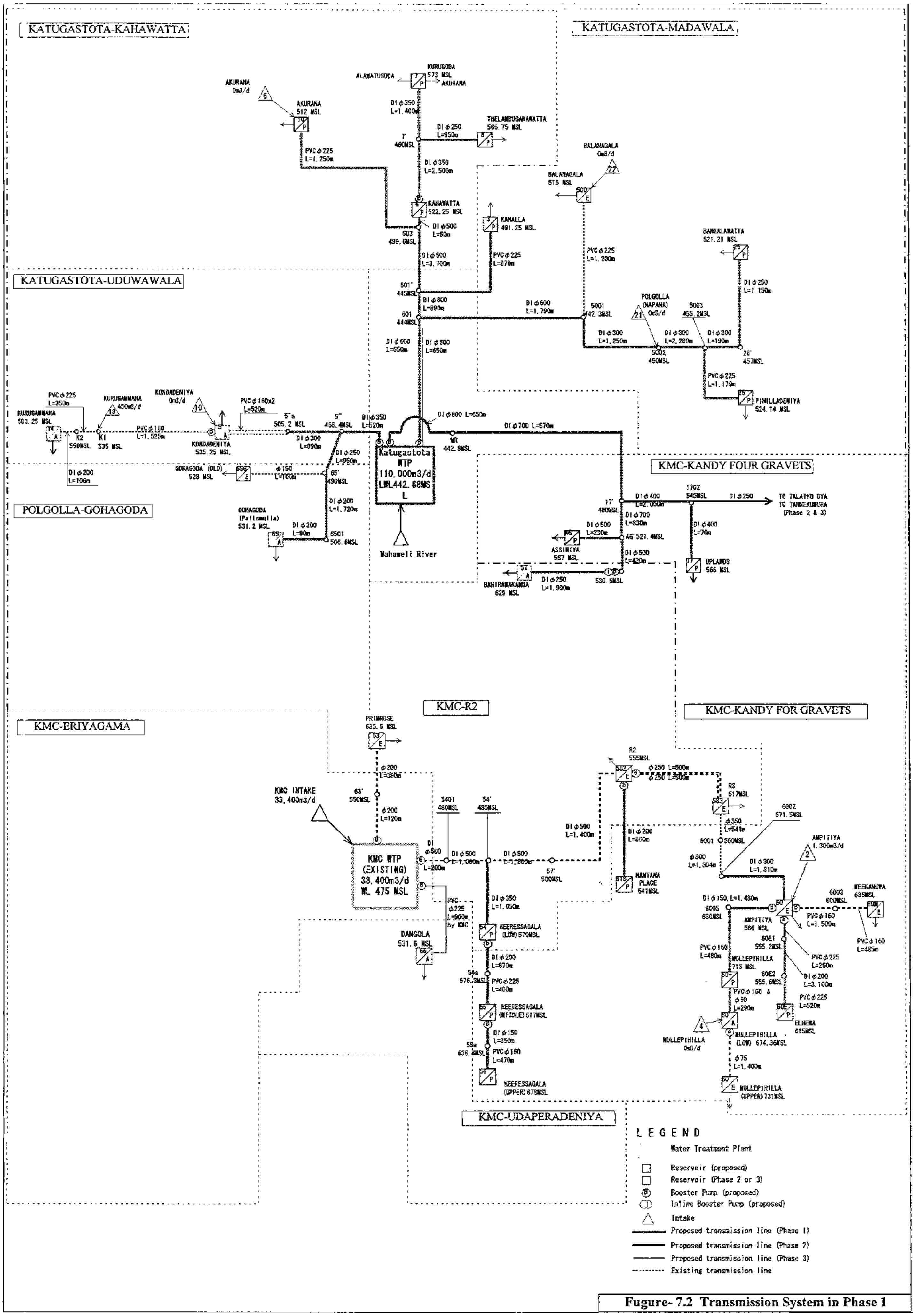
Node No.	Name of the site	Water Level (m)				Capacity (m3)	
		Existing		Proposed		Existing	Proposed
		LWL	HWL	LWL	HWL		
10	Akurana	508.00	512.00			600	
60	Ampitiya	582.50	586.00			900	
AG	Asgiriya			561.50	567.00		4,100
IB	Asgiriya P.S						
57	Bahirawakanda	619.10	620.90	625.00	629.00	204	600
500	Balanagala	513.00	515.00			450	
26	Bangalawatta	519.28	521.28	518.28	521.28		300
66	Dangolla	529.90	531.60	527.60	531.60	118	500
60E	Elhena			611.00	615.00		300
65	Gohagoda (Pallemulla New)			527.20	531.20		200
65	Gohagoda (Pallemulla Old)	521.90	524.10			150	
65G	Gohagoda (Wegiriya)	524.00	528.00			150	
61S	Hantana Place			637.00	641.00		200
54	Heerassagala Low			566.00	570.00		200
55	Heerassagala Middle			613.00	617.00		250
56	Heerassagala Upper			674.00	678.00		200
3	Kahalla			485.00	491.25		600
6	Kahawatta			516.00	522.25		600
5	Kondadeniya	531.25	535.25	531.25	535.25	300	200
-	Kondadeniya Sump.						
14	Kulugammana	579.25	583.25	579.25	583.25	300	100
7	Kurugoda			569.00	573.00		600
60'	Mullepihilla Low Old	672.50	674.36			25	
60+	Mullepihilla Low New			709.00	713.00		100
25	Pihilladeniya	522.14	524.14	522.14	524.14	100	200
582	R2 (KMC)	549.49	555.00			3,636	
8	Thelambugahawatta			561.50	566.75		500
17	Uplands	556.51	558.34	560.09	566.00	27	2,960



①	17,590	10,000
②	29,185	9,932
③	47,103	17,179
	to KMC (P)	Balance (P)-(q)

(P) - (q) = 10,000 m3/d in Phase 1

igure TM-1 Quantity of Flow to Each Service Reservoi



Fugure- 7.2 Transmission System in Phase 1

Hydraulic Calculation for Transmission Pipeline

(Phase 1)

Node	Node --->	Node	B/G	Flow Rate Q(m3/d)	Dia. D(mm)	Mixed Dia Dm(mm)	Exist.	Length L(m)	C	Velocity v(m/sec)	Hyd.Grd I(‰)	Loss h(m)	Dynamic Pressure Hd(MSL)	LWL HWL (MSL)	Dynamic Pressure He(m)	Pump Type	Required Pump Head H(m)	Remark
					2,005													
	KMC WTP ---> Primrose SR																	
	KMC												642.700	471.000	171.700			
KMC	-	63	B	2,220	201	201	K	500	120	0.810	4.297	2.148				B	171.7	Exist Pipe φ200
	63	= Primrose											640.552	635.500	5.052			
	KMC WTP ---> KFG																	
	KMC												580.300	471.000	109.300			
KMC	-	5401	B	28,460	502	502	K	200	120	1.664	5.583	1.117				B	109.3	Exist Pipe φ500
	5401												579.183	480.000	99.183			
5401	-	54'	(B)	28,460	502	502	K	1,000	120	1.664	5.583	5.583						Exist Pipe φ500
	54'												573.600	485.000	88.600			
54'	-	57'	(B)	24,520	502	502	K	1,800	120	1.434	4.238	7.628						Exist Pipe φ500
	57'												565.972	500.000	65.972			
57'	-	582	(B)	24,520	502	502	K	1,400	120	1.434	4.238	5.933						Exist Pipe φ500
	582	(= R2)											560.039	555.000	5.039			
	KMC												579.183	471.000	108.183			
KMC	-	66	B	2,730	199	199		900	130	1.016	5.704	5.133				B	70.8	
	66	(= Dangola)											574.050	531.600	42.450			
	54'												573.600	485.000	88.600			
54'	-	54	(B)	3,940	350	350		1,050	130	0.474	0.719	0.755						
	54	= Heeressagala (Low)											572.845	570.000	2.845			
	54												624.800	566.000	58.800			
54	-	54a	B	1,650	201	201		870	130	0.602	2.140	1.862				B	58.8	DIP
	54a												622.938	576.330	46.608			
54a	-	55	B	1,650	199	199		400	130	0.614	2.247	0.899						PVC
	55	= Heeressagala (Middle)											622.039	617.000	5.039			
	55												683.400	613.000	70.400			
55	-	55a	B	280	149	149		350	130	0.186	0.346	0.121				B	70.4	DIP
	55a												683.279	636.350	46.929			
55a	-	56	B	280	141	141		470	130	0.208	0.452	0.212						PVC
	56	= Heeressagala (Upper)											683.067	678.000	5.067			
	KMC R2 ---> KFG																	
	582	(= R2)											623.490	549.490	74.000			
582	-	583	B	6,480	328	328	K	500	120	0.888	2.872	1.436				B	74.0	Exist Pipe φ250×2
	583	(= R3)											622.054	617.000	5.054			
	582												646.890	549.490	97.400			
582	-	61S	B	1,050	201	201		860	130	0.383	0.927	0.798				B	97.4	
	61S	(= Hantana Place)											646.092	641.000	5.092			
	583												613.000	613.000	0.000			
583	-	6001	G	9,140	350	350	K	541	120	1.100	3.955	2.139						Exist Pipe φ350
	6001												610.861	560.000	50.861			3,980x1.67=6,640
6001	-	6002	(G)	9,140	299	299	K	1,304	120	1.507	8.515	11.104						Exist Pipe φ300
	6002												599.757	571.450	28.307			3,980x1.67=6,640
6002	-	60	(G)	2,500	299	299		1,810	130	0.412	0.667	1.208						Exist Pipe φ160
	60	(= Ampitiya)											598.549	586.000	12.549			

(Phase 1)

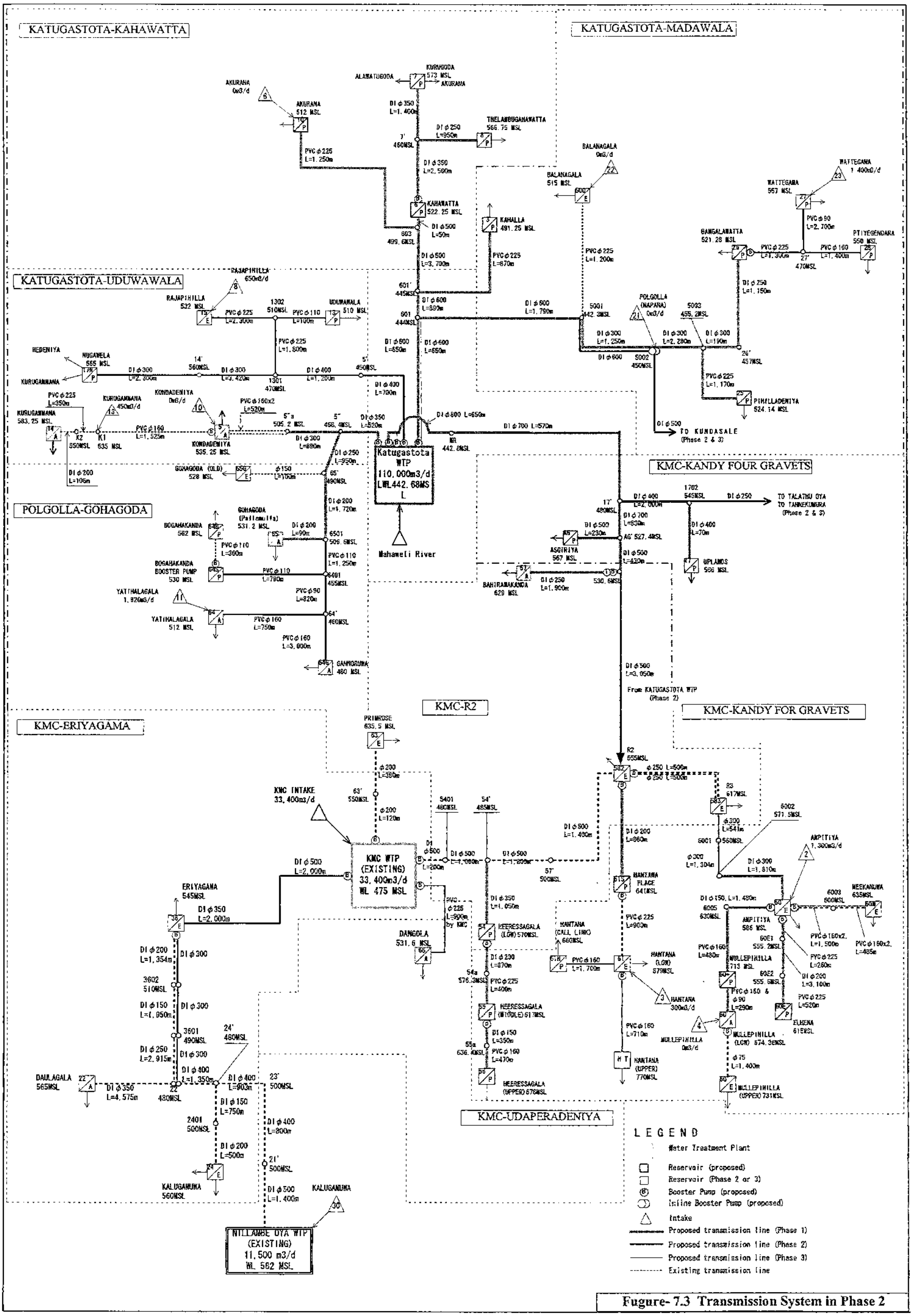
Node	Node --->	Node	B/G	Flow Rate Q (m3/d)	Dia. D (mm)	Mixed Dia Dm(mm)	Exist.	Length L (m)	C	Velocity v(m/sec)	Hyd.Grd I (‰)	Loss h(m)	Dynamic Pressure	LWL HWL	Dynamic Pressure	Pump Type	Required Pump Head	Remark
	60												620.700	582.500	38.200			
60	-	60E-1	B	400	199	199		260	130	0.149	0.163	0.042				B	38.2	PVC
	60E-1												620.658	555.170	65.488			
60E-1		60E-2		400	201	201		3,100	130	0.146	0.156	0.482						DIP
	60E-2												620.175	555.620	64.555			
60E-2		60E		400	199	199		520	130	0.149	0.163	0.085						PVC
	60E	(= Elhena)											620.090	615.000	5.090			
	60												720.900	582.500	138.400			
60	-	6005	B	580	149	149		1,480	130	0.385	1.329	1.967				B	138.4	DIP
	6005												718.933	648.760	70.173			
6005	-	60+	B	580	141	141		480	130	0.430	1.739	0.835						PVC
	60+	(= Mullpihilla)											718.098	713.000	5.098			
	60+												709.000	709.000	0.000			
60+	-	60+1	G	60	141	141		100	130	0.044	0.026	0.003						PVC
	60+1												708.997	664.330	44.667			
60+1		60'		60	79	79		190	130	0.142	0.439	0.083						PVC
	60'	(= Mullpihilla (Low))											708.914	674.360	34.554			
	60'												737.800	672.500	65.300			
60'	-	60"	B	60	66	66	K	1,400	120	0.203	1.223	1.712				B	65.3	Exist Pipe φ75
	60"	= Mullpihilla (Upper)											736.088	731.000	5.088			
	60												656.600	582.500	74.100			
60	-	6003	B	1,250	141	141	K	1,500	120	0.927	8.347	12.521				B	74.1	Exist Pipe φ160
	6003												644.079	600.000	44.079			
6003	-	60M	(B)	1,250	141	141	K	485	120	0.927	8.347	4.048						Exist Pipe φ160
	60M	= Meekanuwa											640.030	635.000	5.030			
	Katugastota ---> Madawala																	
	PG												532.580	442.680	89.900			
PG	-	601	B	14,390	603	603		650	130	0.583	0.558	0.363				B	89.9	
	601												532.217	444.020	88.197			
601	-	5001	(B)	3,780	603	603		1,790	130	0.153	0.047	0.084						
	5001												532.133	442.250	89.883			
5001	-	5002	(B)	2,480	299	299		1,250	130	0.409	0.657	0.822						
	5002												531.311	450.000	81.311			
5002	-	5003	(B)	2,480	299	299		2,280	130	0.409	0.657	1.499						
	5003												529.812	455.220	74.592			
5003	-	25-1	(B)	1,060	201	201		410	130	0.387	0.944	0.387					DI	
	25-1												529.425	455.200	74.225			
25-1		25		1,060	199	199		220	130	0.394	0.991	0.218					PVC	
	25	= Pihilladeniya											529.207	524.140	5.067			
	601												532.217	444.020	88.197			
601	-	601'	(B)	10,620	603	603		890	130	0.430	0.318	0.283						
	601'												531.934	443.000	88.934			
601'	-	3	(B)	1,680	199	199		870	130	0.625	2.323	2.021						
	3	= Kahalla											530.196	491.250	38.946			

(Phase 1)

Node	Node --->	Node	B/G	Flow Rate Q (m3/d)	Dia. D (mm)	Mixed Dia Dm (mm)	Exist.	Length L (m)	C	Velocity v (m/sec)	Hyd. Grd I (‰)	Loss h (m)	Dynamic Pressure	LWL / HWL	Dynamic Pressure	Pump Type	Required Pump Head	Remark
	5001												532.133	442.250	89.883			
5001	-	500	(B)	1,310	199	199	K	1,200	120	0.487	1.700	2.040						Exist Pipe φ225
	500	= Balanagala											530.093	514.350	15.743			
	5003												529.812	455.220	74.592			
5003	-	26’	(B)	1,420	299	299		190	130	0.234	0.234	0.045						
	26’												529.767	456.990	72.777			
26’	-	26	(B)	1,420	252	252		1,150	130	0.330	0.539	0.620						
	26	= Bangalawatta											529.148	521.280	7.868			
	Katugastota ---> Kahawatta																	
	601’												531.934	443.000	88.934			
601’	-	603	(B)	8,940	502	502		3,700	130	0.523	0.565	2.091						
	603												529.843	499.600	30.243			
603	-	6	(B)	6,600	502	502		50	130	0.386	0.322	0.016						
	6	= Kahawatta											529.826	522.250	7.576			
	603												529.826	499.600	30.226			
603	-	10	(B)	2,340	199	199		1,250	130	0.871	4.288	5.360						
	10	= Akurana											524.466	512.000	12.466			
	6												580.550	518.250	62.300			
6	-	7’	B	4,240	350	350		2,500	130	0.510	0.824	2.059				B	62.3	
	7’												578.491	455.030	123.461			
7’	-	7	(B)	2,410	350	350		1,400	130	0.290	0.290	0.405						
	7	= Kurugoda											578.086	573.000	5.086			
	7’												578.491	455.030	123.461			
7’	-	8	(B)	1,840	252	252		950	120	0.427	1.009	0.959						
	8	= Thelambugawatta											577.532	566.750	10.782			
	Katugastota ---> Kondadeniya, Kurugamana																	
	PG												546.780	442.680	104.100			
PG	-	5″	B	4,710	350	350		520	130	0.567	1.000	0.520				B	104.1	
	5"												546.260	468.410	77.850			
5"	-	5″a	(B)	2,760	299	299		890	130	0.455	0.801	0.713						
	5 a												545.547	505.180	40.367			
5″a	-	5	(B)	2,760	184	184	K	520	120	1.208	10.012	5.206						Exist Pipe φ160×2
	5	= Kondadeniya											545.547	535.250	10.297			
	5												598.550	531.250	67.300			
5	-	K1	B	1,050	141	141	K	1,525	120	0.778	6.046	9.220				B	67.3	Exist Pipe φ160 PVC
	K1												589.330	535.000	54.330			
K1	-	K2	(B)	1,500	199	199	K	350	120	0.558	2.184	0.765						Exist Pipe φ225 PVC
	K2												588.565	550.000	38.565			
K2	-	14	(B)	1,500	201	201	K	106	120	0.547	2.081	0.221						Exist Pipe φ200 DI
	14	= Kurugammana											588.345	583.250	5.095			

(Phase 1)

Node	Node --->	Node	B/G	Flow Rate Q (m3/d)	Dia. D (mm)	Mixed Dia Dm(mm)	Exist.	Length L (m)	C	Velocity v(m/sec)	Hyd.Grd I (‰)	Loss h(m)	Dynamic Pressure	LWL HWL	Dynamic Pressure	Pump Type	Required Pump Head	Remark
	Katugastota ---> KFG, R2																	
	PG												572.780	442.680	130.100			
PG	-	MR	B	17,600	802	802		650	130	0.403	0.202	0.131				B	130.1	
	MR												572.649	442.770	129.879			
MR	-	17'	(B)	17,600	700	700		570	130	0.529	0.392	0.223						
	17'												572.425	453.650	118.775			
17'	-	AG'	(B)	13,210	700	700		830	130	0.397	0.231	0.191						
	AG'												572.234	527.400	44.834			
AG'	-	AG	(B)	11,240	502	502		230	130	0.657	0.863	0.199						
	AG	= Asgiriya											572.035	567.000	5.035			
	AG'												572.234	527.400	44.834			
AG'	-	(IB)	(B)	1,970	502	502		430	130	0.115	0.034	0.015						
	(IB)												572.219	530.630	41.589			
(IB)	-	57	B	1,970	252	252		1,900	130	0.457	0.988	1.877				B	63.7	
	57	= Bahirawakand											634.043	629.000	5.043			
	17'												572.425	453.650	118.775			
17'	-	1702	(B)	4,390	395	395		2,000	130	0.415	0.487	0.975						
	1702												571.451	545.000	26.451			
1702	-	17	(B)	4,390	395	395		70	130	0.415	0.487	0.034						
	17	= Uplands											571.417	566.000	5.417			
	Katugastota ---> Gohagoda (Pallemulla)																	
	5"												546.260	468.410	77.850			
5"	-	65'	(B)	1,950	252	252		950	130	0.453	0.969	0.921						
	65'												545.339	490.310	55.029			
65'	-	6501	(B)	1,050	201	201		1,720	130	0.383	0.927	1.595						
	6501												543.744	506.600	37.144			
6501	-	65	(B)	1,050	201	201	K	90	130	0.383	0.927	0.083						
	65	= Gohagoda											543.660	531.200	12.460			
	65'												545.339	490.310	55.029			
65'	-	65G	(B)	900	149	149	K	100	120	0.597	3.475	0.347						Exist Pipe φ200
	65G	= Gohgoda (old)											544.992	528.000	16.992			



Fugure- 7.3 Transmission System in Phase 2

(Phase 2)

Node	Node --->	Node	B/G	Flow Rate Q (m3/d)	Dia. D (mm)	Dia. D (mm)	Mixed Dia Dm(mm)	Exist.	Length L (m)	C	Velocity v(m/sec)	Hyd.Grd I (‰)	Loss h(m)	Dynamic Pressure	LWL HWL	Dynamic Pressure	Pump Type	Required Pump Head	Remark
					2,005	2,010								Hd(MSL)	(MSL)	He(m)		H(m)	
	KMC-Primrose																		
	KMC													642.800	471.000	171.800			
KMC	-	63	B	2,300	0	201	201	K	500	120	0.839	4.588	2.294				B	171.8	Exist Pipe φ200
	63													640.506	635.500	5.006			
	KMC-Eliyagama																		
	KMC													557.800	471.000	86.800			
KMC	-	36'	B	9,000	0	502	502		2,000	130	0.526	0.572	1.144				B	86.8	
	36'													556.656	480.000	76.656			
36'	-	36	(B)	9,000	0	350	350		2,000	130	1.083	3.314	6.629						Exist Pipe φ450
	36													550.027	545.000	5.027			
	KMC-KFG																		
	KMC													575.800	471.000	104.800			
KMC	-	5401	B	19,280	0	502	502	K	200	120	1.127	2.716	0.543				B	104.8	Exist Pipe φ500
	5401													575.257	480.000	95.257			
5401	-	54'	B	19,280	0	502	502	K	1,000	120	1.127	2.716	2.716						Exist Pipe φ500
	54'													572.540	485.000	87.540			
54'	-	57'	(B)	14,520	0	502	502	K	1,800	120	0.849	1.608	2.894						Exist Pipe φ500
	57'													569.647	500.000	69.647			
57'	-	582	(B)	14,520	0	502	502	K	1,400	120	0.849	1.608	2.251						Exist Pipe φ500
	582													567.396	555.000	12.396			
	KMC													542.100	471.000	71.100			
KMC	-	66	B	2,830	199	0	199		900	130	1.053	6.096	5.486				B	71.1	
	66													536.614	531.600	5.014			
	54'													572.540	485.000	87.540			
54'	-	54	(B)	4,760	350	0	350		1,050	130	0.573	1.020	1.071						
	54													571.469	570.000	1.469			
	54													627.400	566.000	61.400			
54	-	54a	B	2,350	201	0	201		870	130	0.857	4.117	3.582				B	61.4	DIP
	54a													623.818	576.330	47.488			
54a	-	55	B	2,350	199	0	199		400	130	0.874	4.322	1.729						PVC
	55	= Heeressagala (Middle)												622.089	617.000	5.089			
	55													684.200	613.000	71.200			
55	-	55a	B	550	149	0	149		350	130	0.365	1.205	0.422				B	71.2	DIP
	55a													683.778	636.350	47.428			
55a	-	56	B	550	141	0	141		470	130	0.408	1.576	0.741						PVC
	56	= Heeressagala (Upper)												683.037	678.000	5.037			
	KMC-R2,KFG																		
	582													624.290	549.490	74.800			
582	-	583	B	8,230	0	328	328	K	500	120	1.127	4.469	2.235				B	74.8	Exist Pipe φ250×2
	583													622.055	617.000	5.065			

(Phase 2)

Node	Node --->	Node	B/G	Flow Rate Q (m3/d)	Dia. D (mm)	Dia. D (mm)	Mixed Dia Dm(mm)	Exist.	Length L (m)	C	Velocity v(m/sec)	Hyd.Grd I (‰)	Loss h(m)	Dynamic Pressure	LWL HWL	Dynamic Pressure	Pump Type	Required Pump Head	Remark
					2,005	2,010								Hd(MSL)	(MSL)	He(m)		H(m)	
	582													647.590	549.490	98.100			
582	-	61S	B	1,490	201	0	201		860	130	0.543	1.772	1.524				B	98.1	
	61S													646.066	641.000	5.066			
	61S													684.200	637.000	47.200			
61S	-	61	B	390	0	199	199	K	900	120	0.145	0.181	0.163				B	47.2	Exist Pipe φ225
	61													684.037	679.000	5.037			
	61													679.000	675.000	4.000			
61	-	61H	G	380	0	141	141		1,700	130	0.282	0.795	1.352						
	61H													677.648	660.000	17.648			
	61													775.100	675.000	100.100			
61	-	HT	B	130	0	141	141		710	130	0.096	0.109	0.078				B	100.1	
	HT													775.022	770.000	5.022			
	583													617.000	613.000	4.000			
583	-	6001	G	4,070	0	299	299		541	130	0.671	1.644	0.889						
	6001													616.111	560.000	56.111			
6001	-	6002	(G)	4,070	0	299	299		1,304	130	0.671	1.644	2.144						
	6002													613.967	571.450	42.517			
6002	-	60	(G)	4,070	299	0	299		1,810	130	0.671	1.644	2.976						
	60													610.991	586.000	24.991			
	60													621.200	582.500	38.700			
60	-	60E-1	B	570	199	0	199		260	130	0.212	0.314	0.082				B	38.7	PVC
	60E-1													621.118	555.170	65.948			
60E-1		60E-2		570	201	0	201		3,100	130	0.208	0.300	0.929						DIP
	60E-2													620.190	555.620	64.570			
60E-2		60E		570	199	0	199		520	130	0.212	0.314	0.164						PVC
	60E	(= Elhena)												620.026	615.000	5.026			
	60													723.200	582.500	140.700			
60	-	6005	B	810	149	0	149		1,480	130	0.538	2.466	3.649				B	140.7	DIP φ150
	6005													719.551	648.760	70.791			
6005	-	60+	(B)	810	141	0	141		480	130	0.600	3.226	1.548						PVC φ160
	60+													718.002	713.000	5.002			
	60+													709.000	709.000	0.000			
60+	-	60+1	G	80	141	0	141		100	130	0.059	0.045	0.004						
	60+1													708.996	664.330	44.666			
60+1		60'		80	79	0	79		190	130	0.189	0.748	0.142						
	60'	(= Mullpihilla (Low))												708.853	674.360	34.493			
	60'													739.000	672.500	66.500			
60'	-	60"	B	80	0	66	66	K	1,400	120	0.271	2.082	2.915				B	66.5	Exist Pipe φ75
	60"													736.085	731.000	5.085			

(Phase 2)

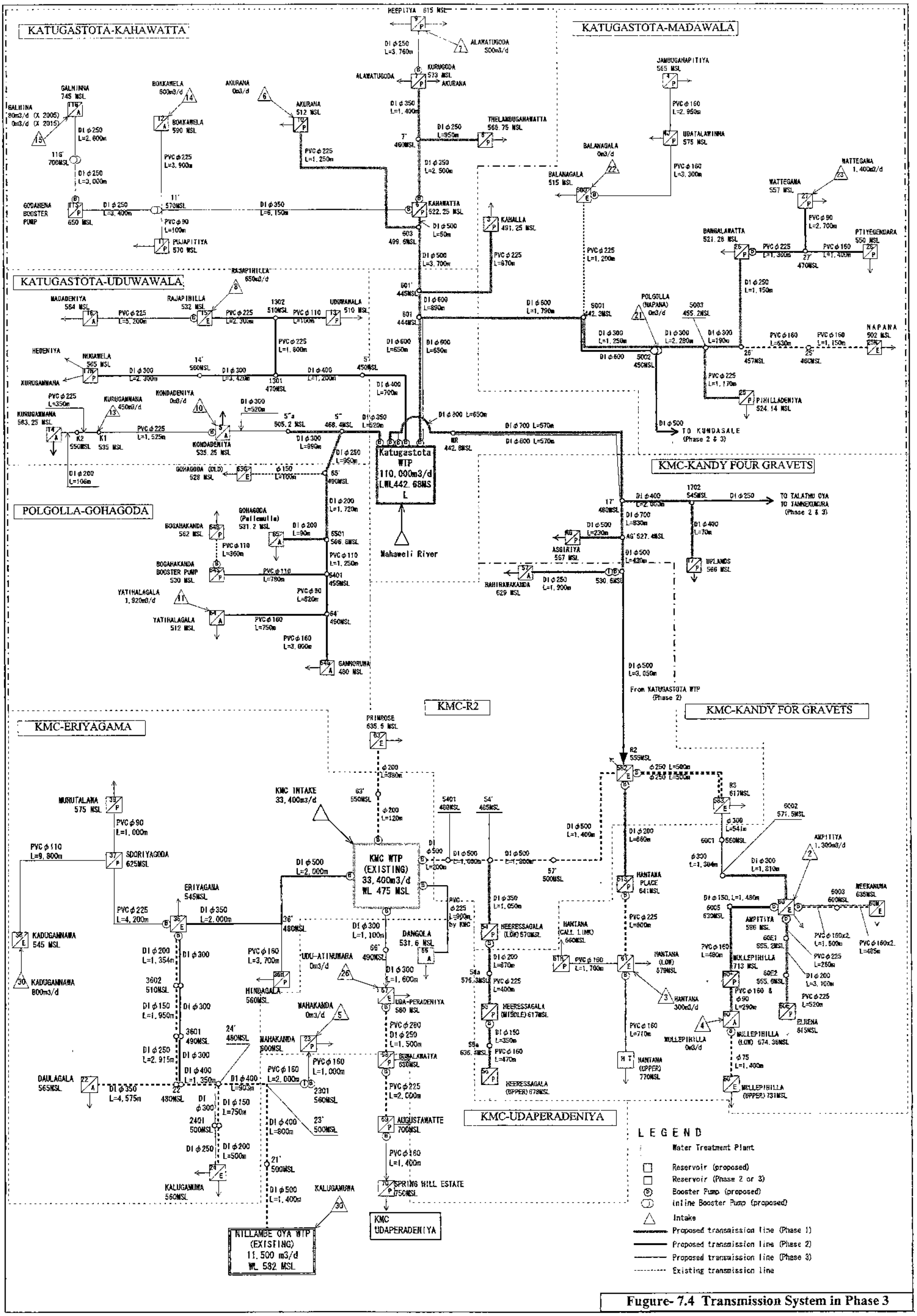
Node	Node --->	Node	B/G	Flow Rate Q (m3/d)	Dia. D (mm)	Dia. D (mm)	Mixed Dia Dm (mm)	Exist.	Length L (m)	C	Velocity v (m/sec)	Hyd. Grd I (‰)	Loss h (m)	Dynamic Pressure	LWL HWL	Dynamic Pressure	Pump Type	Required Pump Head	Remark
					2,005	2,010								Hd (MSL)	(MSL)	He (m)		H (m)	
	60													648.800	582.500	66.300			
60	-	6003	B	1,770	0	141	184	K	1,500	120	0.774	4.401	6.602				B	66.3	Exist Pipe φ160
	6003													642.198	600.000	42.198			
6003	-	60M	(B)	1,770	0	141	184	K	485	120	0.774	4.401	2.135						Exist Pipe φ160
	60M													640.063	635.000	5.063			
	Katugastota-Madawala																		
	PG													537.180	442.680	94.500			
PG	-	601	B	29,160	603	0	603		650	130	1.182	2.062	1.341				B	94.5	
	601													535.839	444.020	91.819			
601	-	5001	(B)	17,900	603	0	603		1,790	130	0.725	0.836	1.497						
	5001													534.343	442.250	92.093			
5001	-	5002	(B)	16,100	299	603	638		1,250	130	0.584	0.524	0.655						
	5002													533.688	450.000	83.688			
5002	-	5003	(B)	4,400	299	0	299		2,280	130	0.725	1.899	4.330						
	5003													529.358	455.220	74.138			
5003	-	26'	(B)	3,200	299	0	299		190	130	0.527	1.054	0.200						
	26'													529.158	456.990	72.168			
26'		26		3,200	252	0	252		1,150	130	0.743	2.423	2.787						
	26	= Bangalawatta												526.372	521.280	5.092			
	601													535.839	444.020	91.819			
601	-	601'	(B)	11,260	603	0	603		890	130	0.456	0.355	0.316						
	601'													535.524	443.000	92.524			
601'	-	3	(B)	2,190	199	0	199		870	130	0.815	3.794	3.301						
	3	(= Kahalla)												532.223	491.250	40.973			
	5001													534.343	440.000	94.343			
5001	-	500	(B)	1,800	199	0	199	K	1,200	120	0.670	3.061	3.673						
	500													530.670	514.350	16.320			
	26													575.780	517.280	58.500			
26	-	27'	B	1,600	0	199	199		1,300	130	0.595	2.123	2.759				B	58.5	
	27'													573.021	456.990	116.031			
27'	-	27	(B)	200	0	79	79		2,700	130	0.472	4.075	11.002						
	27													562.018	557.000	5.018			
	27'													573.021	470.000	103.021			
27'	-	28	(B)	1,400	0	141	141		1,400	130	1.038	8.878	12.429						
	28													560.592	550.000	10.592			
	5003													529.358	455.220	74.138			
5003	-	25-1	(B)	1,200	201	0	201		410	130	0.438	1.187	0.487						
	25-1													528.871	455.200	73.671			
25-1		25		1,200	199	0	199		220	130	0.447	1.247	0.274						
	25	= Pihilladeniya												528.597	524.140	4.457			

(Phase 2)

Node	Node --->	Node	B/G	Flow Rate Q(m3/d)	Dia. D(mm)	Dia. D(mm)	Mixed Dia Dm(mm)	Exist.	Length L(m)	C	Velocity v(m/sec)	Hyd.Grd I (‰)	Loss h(m)	Dynamic Pressure	LWL HWL	Dynamic Pressure	Pump Type	Required Pump Head	Remark
					2,005	2,010								Hd(MSL)	(MSL)	He(m)		H(m)	
	Katugastota-Kahawatta																		
	601'													535.839	443.000	92.839			
601'	-	603	(B)	9,070	502	0	502		3,700	130	0.530	0.581	2.148						
	603													533.692	499.600	34.092			
603	-	6	(B)	6,700	502	0	502		50	130	0.392	0.331	0.017						
	6													533.675	522.250	11.425			
	603													533.692	499.600	34.092			
603	-	10	G	2,370	199	0	199		1,250	130	0.882	4.391	5.488						
	10													528.203	512.000	16.203			
	6													580.650	518.250	62.400			
6	-	7'	B	4,330	350	0	350		2,500	130	0.521	0.856	2.140				B	62.4	
	7'													578.510	455.030	123.480			
7'	-	7	(B)	2,450	350	0	350		1,400	130	0.295	0.299	0.418						
	7													578.092	573.000	5.092			
	7'													578.510	455.030	123.480			
7'	-	8	(B)	1,890	252	0	252		950	130	0.439	0.915	0.869						
	8													577.641	566.750	10.891			
	Katugastota-Uduwawala																		
	PG													580.680	442.680	138.000			
PG	-	5'	B	6,000	0	400	400		700	130	0.553	0.817	0.572				B	138.0	
	5'													580.108	450.000	130.108			
5'	-	1301	(B)	6,000	0	400	400		1,200	130	0.553	0.817	0.980						
	1301													579.128	470.000	109.128			
1301	-	14'	(B)	4,000	0	299	299		3,420	130	0.659	1.592	5.445						
	14'													573.683	560.000	13.683			
14'	-	17N	(B)	4,000	0	299	299		2,300	130	0.659	1.592	3.662						
	17N													570.021	565.000	5.021			
	Katugastota-Kondadeniya, Kurugamana																		
	PG													547.180	442.680	104.500			
PG	-	5″	B	4,990	350	0	350		520	130	0.600	1.113	0.579				B	104.5	
	5″													546.601	468.410	78.191			
5″	-	5″a	(B)	2,850	299	0	299		890	130	0.470	0.850	0.757						
	5 a													545.844	505.180	40.664			
5″a	-	5	(B)	2,850	184	0	184	K	520	120	1.247	10.625	5.526						Exist Pipe φ160×2
	5	= Kondadeniya												545.844	535.250	10.594			
	5													599.350	531.250	68.100			
5	-	K1	B	1,100	0	141	141	K	1,525	120	0.815	6.589	10.049				B	68.1	Exist Pipe φ160 PVC
	K1													589.301	535.000	54.301			
K1	-	K2	(B)	1,550	0	199	199	K	350	120	0.577	2.321	0.812						Exist Pipe φ225 PVC
	K2													588.489	550.000	38.489			
K2	-	14	(B)	1,550	0	201	201	K	106	120	0.565	2.211	0.234						Exist Pipe φ200 DI
	K1													588.255	583.250	5.005			
	Katugastota-KFG, R2																		
	PG													576.680	442.680	134.000			
PG	-	MR	B	33,190	802	0	802		650	130	0.760	0.653	0.425				B	134.0	
	MR													576.255	442.770	133.485			
MR	-	17'	(B)	33,190	700	0	700		570	130	0.998	1.267	0.722						
	17'													575.533	453.650	121.883			
17'	-	AG'	(B)	22,750	700	0	700		830	130	0.684	0.630	0.523						
	AG'													575.010	527.400	47.610			
AG'	-	AG	(B)	19,610	502	0	502		230	130	1.147	2.417	0.556						
	AG													574.454	567.000	7.454			

(Phase 2)

Node	Node --->	Node	B/G	Flow Rate Q (m3/d)	Dia. D (mm)	Dia. D (mm)	Mixed Dia Dm (mm)	Exist.	Length L (m)	C	Velocity v (m/sec)	Hyd. Grd I (‰)	Loss h(m)	Dynamic Pressure	LWL HWL	Dynamic Pressure	Pump Type	Required Pump Head	Remark
					2,005	2,010								Hd (MSL)	(MSL)	He (m)		H (m)	
	AG'													575.010	527.400	47.610			
AG'	-	(IB)	(B)	3,150	502	0	502		430	130	0.184	0.082	0.035				(B)		
	(IB)													574.975	530.630	44.345			
(IB)	-	57	B	2,150	252	0	252		1,900	130	0.499	1.161	2.206				B	61.3	
	57													634.069	629.000	5.069			
	(IB)													574.975	530.630	44.345			
(IB)	-	582	(B)	1,000	0	502	502		3,050	130	0.058	0.010	0.030						
	582													574.945	555.000	19.945			
	17'													575.533	453.650	121.883			
17'	-	1702	(B)	10,440	400	0	400		2,000	130	0.962	2.276	4.552						
	1702													570.980	545.000	25.980			
1702	-	17	(B)	6,440	400	0	400		70	130	0.593	0.931	0.065						
	17													570.915	566.000	4.915			
	1072													570.980	545.000	25.980			
1072	-	18'	(B)	4,000	0	252	252		1,500	120	0.928	4.246	6.369						
	18'													564.612	480.000	84.612			
18'	-	18	(B)	4,000	0	252	252		1,350	120	0.928	4.246	5.732						
	18													558.880	540.000	18.880			
	Katugastota Gohagoda																		
	5"													546.601	456.990	89.611			
5"	-	65'	(B)	2,140	252	0	252		950	130	0.497	1.151	1.094						
	65'													545.508	490.310	55.198			
65'	-	6501	(B)	1,200	201	0	201		1,720	130	0.438	1.187	2.042						
	6501													543.465	506.600	36.865			
6501	-	6401	(B)	100	0	97	97		1,250	130	0.157	0.416	0.520						
	6401													542.945	455.000	87.945			
6401	-	64S	(B)	100	0	97	97		780	130	0.157	0.416	0.324						
	64S													542.621	530.000	12.621			
	65'													545.508	490.310	55.198			
65'	-	65G	(B)	950	0	149	201	K	100	120	0.347	0.894	0.089						Exist Pipe φ150
	65G													545.418	528.000	17.418			
	6501													543.465	506.600	36.865			
6501	-	65	(B)	1,100	201	0	201	K	90	130	0.401	1.011	0.091						
	65													543.374	531.200	12.174			
	64													512.000	512.000	0.000			
64	-	64'	G	1,020	0	141	141		750	130	0.756	4.942	3.706						
	64'													508.294	460.000	48.294			
64'	-	64G	(B)	1,020	0	141	141		3,000	130	0.756	4.942	14.825						
	64G													493.469	480.000	13.469			
	64S													567.200	526.000	41.200			
64S	-	64B	B	100	0	97	97	K	360	120	0.157	0.482	0.174				B	41.2	Exist Pipe φ110
	64B													567.026	562.000	5.026			



Fugure- 7.4 Transmission System in Phase 3

(Phase 3)

	Node		B/G	Flow Rate	Dia.	Dia.	Dia.	Mixed Dia	Exist.	Length	C	Velocity	Hyd. Grd	Loss	Dynamic Pressure	LWL	Dynamic Pressure	Pump	Required	Remark
Node	--->	Node		Q (m3/d)	D (mm)	D (mm)	D (mm)	Dm (mm)		L (m)		v (m/sec)	I (‰)	h (m)		HWL		Type	Pump Head	
					2,005	2,010	2,015								Hd (MSL)	(MSL)	He (m)		H (m)	
	KMC-Primrose																			
	KMC														643.000	471.000	172.000			
KMC	-	63	B	2,360	0	0	201	201	K	500	120	0.861	4.812	2.406				B	172.0	Exist Pipe φ200
	63	(= Primorose)													640.594	635.500	5.094			
	KMC-Eliyagama & Hindagala																			
	KMC														582.000	471.000	111.000			
KMC	-	36'	B	13,700	0	502	0	502		2,000	130	0.801	1.245	2.490				B	111.0	
	36'														579.510	480.000	99.510			
36'	-	36	B	900	0	0	141	141		3,700	130	0.667	3.920	14.505						
	36														565.005	560.000	5.005			
	KMC-Udaperdeniya																			
	KMC														589.300	471.000	118.300			
KMC	-	66'	B	4,000	0	0	299	299		1,100	130	0.659	1.592	1.751				B	118.3	
	66'														587.549	490.000	97.549			
66'	-	67	(B)	4,000	0	0	299	299		1,600	130	0.659	1.592	2.547						
	67	(= Udaperdeniya)													585.002	580.000	5.002			
	67														636.100	576.000	60.100			
67	-	68	B	3,000	0	0	325	325	K	1,500	120	0.418	0.718	1.077				B	60.1	Exist Pipe φ280 &
	68	(= Udaperdeniya)													635.023	630.000	5.023			φ250
	68														712.500	626.000	86.500			
68	-	69	B	2,000	0	0	199	199	K	2,000	120	0.744	3.719	7.439				B	86.5	Exist Pipe φ225
	69	(= Bowalawatta)													705.061	700.000	5.061			
	69														761.700	696.000	65.700			
69	-	70	B	1,000	0	0	141	141		1,400	130	0.741	4.764	6.669				B	65.7	
	70	(= Spring hill estate)													755.031	750.000	5.031			
	KMC-KFG																			
	KMC														576.100	471.000	105.100			
KMC	-	5401	B	10,480	0	0	502	502	K	200	120	0.613	0.879	0.176				B	105.1	Exist Pipe φ500
	5401														575.924	480.000	95.924			
5401	-	54'	B	10,480	0	0	502	502	K	1,000	120	0.613	0.879	0.879						Exist Pipe φ500
	54'														575.045	485.000	90.045			
54'	-	57'	(B)	5,280	0	0	502	502	K	1,800	120	0.309	0.247	0.445						Exist Pipe φ500
	57'														574.599	500.000	74.599			
57'	-	582	(B)	5,280	0	0	502	502	K	1,400	120	0.309	0.247	0.346						Exist Pipe φ500
	582	= R2													574.253	555.000	19.253			
	KMC														542.300	471.000	71.300			
KMC	-	66	B	2,870	199	0	0	199		900	130	1.068	6.256	5.631				B	71.3	
	66	= Dangola													536.669	531.600	5.069			
	54'														575.045	485.000	90.045			
54'	-	54	(B)	5,210	350	0	0	350		1,050	130	0.627	1.206	1.266						
	54	= Heeressagala low													573.779	570.000	3.779			

(Phase 3)

	Node		B/G	Flow Rate	Dia.	Dia.	Dia.	Mixed Dia	Exist.	Length	C	Velocity	Hyd. Grd	Loss	Dynamic Pressure	LWL	Dynamic Pressure	Pump	Required	Remark
Node	--->	Node		Q (m3/d)	D (mm)	D (mm)	D (mm)	Dm (mm)		L (m)		v (m/sec)	I (‰)	h (m)		HWL		Type	Pump Head	
					2,005	2,010	2,015								Hd (MSL)	(MSL)	He (m)		H (m)	
	54														629.100	566.000	63.100			
54	-	54a	B	2,740	201	0	0	201		870	130	0.999	5.469	4.758				B	63.1	
	54a														624.342	576.330	48.012			
54a	-	55	B	2,740	199	0	0	199		400	130	1.020	5.742	2.297						
	55	= Heeressagala (Middle)													622.045	617.000	5.045			
	55														684.900	613.000	71.900			
55	-	55a	B	700	149	0	0	149		350	130	0.465	1.882	0.659				B	71.9	DIP
	55a														684.241	636.350	47.891			
55a	-	56	B	700	141	0	0	141		470	130	0.519	2.463	1.157						PVC
	56	= Heeressagala (Upper)													683.084	678.000	5.084			
	KMC-R2, KPG																			
	582	= R2													626.190	549.490	76.700			
582	-	583	B	11,420	0	0	328	328	K	500	120	1.564	8.192	4.096				B	76.7	Exist Pipe φ250×2
	583	= R3													622.094	617.000	5.094			
	582														648.590	549.490	99.100			
582	-	61S	B	1,960	201	0	0	201		860	130	0.715	2.943	2.531				B	99.1	
	61S	= Hantana place													646.059	641.000	5.059			
	61S														684.700	637.000	47.700			
61S	-	61	B	820	0	0	199	199	K	900	120	0.305	0.715	0.643				B	47.7	Exist Pipe φ225
	61	= Hantana low													684.057	679.000	5.057			
	61														679.000	675.000	4.000			
61	-	61H	G	650	0	141	0	141		1,700	130	0.482	2.147	3.650						
	61H	= Hantana call link													675.350	660.000	15.350			
	61														775.200	675.000	100.200			
61	-	HT	B	190	0	141	0	141		710	130	0.141	0.221	0.157				B	100.2	
	HT	= Hantana upper													775.043	770.000	5.043			
	583	= R3													617.000	613.000	4.000			
583	-	6001	G	5,210	0	299	0	299		541	130	0.859	2.596	1.404						
	6001														615.596	560.000	55.596			
6001	-	6002	(G)	5,210	0	299	0	299		1,304	130	0.859	2.596	3.385						
	6002														612.211	571.450	40.761			
6002	-	60	(G)	5,210	299	0	0	299		1,810	130	0.859	2.596	4.699						
	60	= Ampitiya													607.512	586.000	21.512			
	60														624.700	582.500	42.200			
60	-	60E-1	B	1,200	199	0	0	199		260	130	0.447	1.247	0.324				B	42.2	
	60E-1														624.376	555.170	69.206			
60E-1		60E-2		1,200	201	0	0	201		3,100	130	0.438	1.187	3.681						
	60E-2														620.695	555.620	65.075			
60E-2		60E		1,200	199	0	0	199		520	130	0.447	1.247	0.648						
	60E	(= Elhena)													620.047	615.000	5.047			
	60														725.400	582.500	142.900			
60	-	6005	B	980	149	0	0	149		1,480	130	0.651	3.508	5.191				B	142.9	DIP φ150
	6005														720.209	630.000	90.209			
6005	-	60+	B	980	141	0	0	141		480	130	0.726	4.589	2.203						PVC φ160
	60+	= Mullepihilla													718.006	713.000	5.006			

(Phase 3)

	Node		B/G	Flow Rate	Dia.	Dia.	Dia.	Mixed Dia	Exist.	Length	C	Velocity	Hyd. Grd	Loss	Dynamic Pressure	LWL	Dynamic Pressure	Pump	Required	Remark
Node	--->	Node		Q (m3/d)	D (mm)	D (mm)	D (mm)	Dm (mm)		L (m)		v (m/sec)	I (‰)	h (m)		HWL		Type	Pump Head	
					2, 005	2, 010	2, 015								Hd (MSL)	(MSL)	He (m)		H (m)	
	60+														709. 000	709. 000	0. 000			
60+	-	60+1	G	100	141	0	0	141		100	130	0. 074	0. 067	0. 007						
	60+1														708. 993	664. 330	44. 663			
60+1		60'		100	79	0	0	79		190	130	0. 236	1. 130	0. 215						
	60'	(= Mullpihilla (Low))													708. 993	674. 360	34. 633			
	60'														740. 500	672. 500	68. 000			
60'	-	60"	B	100	0	0	66	66	K	1, 400	120	0. 338	3. 146	4. 405				B	68. 0	Exist Pipe φ75
	60"	(= Mullpihilla upper)													736. 095	731. 000	5. 095			
	60														652. 600	582. 500	70. 100			
60	-	6003	B	2, 150	0	141	141	184	K	1, 500	120	0. 941	6. 308	9. 461				B	70. 1	Exist Pipe φ160
	6003														643. 139	600. 000	43. 139			
6003	-	60M	(B)	2, 150	0	141	141	184	K	485	120	0. 941	6. 308	3. 059						Exist Pipe φ160
	60M	(= Meekanuwa)													640. 080	635. 000	5. 080			
	Katugastota-Madawala																			
	PG														540. 780	442. 680	98. 100			
PG	-	601	B	44, 240	592	0	592	771		650	130	1. 098	1. 351	0. 878				B	98. 1	
	601														539. 902	444. 020	95. 882			
601	-	5001	(B)	23, 400	592	0	0	592		1, 790	130	0. 984	1. 501	2. 688						
	5001														537. 214	442. 250	94. 964			
5001	-	5002	(B)	20, 300	299	592	0	628		1, 250	130	0. 760	0. 869	1. 086						
	5002														536. 128	450. 000	86. 128			
5002	-	5003	(B)	5, 100	299	0	0	299		2, 280	130	0. 841	2. 495	5. 690						
	5003														530. 439	455. 220	75. 219			
5003	-	26'	(B)	3, 900	299	0	0	299		190	130	0. 643	1. 519	0. 289						
	26'														530. 150	456. 990	73. 160			
26'	-	26	(B)	3, 300	252	0	0	252		1, 150	130	0. 766	2. 565	2. 950						
	26	(= Bangalawatta)													527. 200	521. 280	5. 920			
	601														539. 902	444. 020	95. 882			
601	-	601'	(B)	20, 850	592	0	0	592		890	130	0. 877	1. 213	1. 079						
	601'														538. 822	443. 000	95. 822			
601'	-	3	(B)	2, 340	199	0	0	199		870	130	0. 871	4. 288	3. 731						
	3	(= Kahalla)													535. 091	491. 250	43. 841			
	5001														537. 214	442. 250	94. 964			
5001	-	500	(B)	3, 100	0	0	199	199	K	1, 200	120	1. 154	8. 367	10. 040						Exist Pipe φ225
	500	(= Balangala)													527. 174	514. 350	12. 824			
	500														605. 550	510. 350	95. 200			
500	-	4J	B	1, 300	0	0	141	141		3, 300	130	0. 964	7. 740	25. 543				B	95. 2	
	4J														580. 007	575. 000	5. 007			
	4J														575. 000	571. 000	4. 000			
4J	-	4	G	700	0	0	141	141		2, 950	130	0. 519	2. 463	7. 265						
	4														567. 735	565. 000	2. 735			

(Phase 3)

	Node		B/G	Flow Rate	Dia.	Dia.	Dia.	Mixed Dia	Exist.	Length	C	Velocity	Hyd.Grd	Loss	Dynamic Pressure	LWL	Dynamic Pressure	Pump	Required	Remark
Node	--->	Node		Q (m3/d)	D (mm)	D (mm)	D (mm)	Dm(mm)		L (m)		v(m/sec)	I (‰)	h(m)		HWL		Type	Pump Head	
					2,005	2,010	2,015								Hd(MSL)	(MSL)	He(m)		H(m)	
	26														573.680	517.280	56.400			
26	-	27'	B	1,700	0	199	0	199		1,300	130	0.633	2.374	3.087				B	56.4	
	27'														570.593	456.990	113.603			
27'	-	27	(B)	300	0	97	0	97		2,700	130	0.470	3.175	8.573						
	27														562.020	557.000	5.020			
	27'														570.593	470.000	100.593			
27'	-	28	(B)	1,400	0	141	0	141		1,400	130	1.038	8.878	12.429						
	28														558.165	550.000	8.165			
	5003														530.439	450.000	80.439			
5003	-	25	(B)	1,200	199	0	0	199		1,170	130	0.447	1.247	1.459						
	25	(= Pihilladeniya)													528.980	524.140	4.840			
	26'														530.150	456.990	73.160			
26'	-	25'	(B)	600	0	0	141	141	K	630	120	0.445	2.147	1.353						Exist Pipe φ160
	25'														528.797	460.000	68.797			
25'	-	25N	(B)	600	0	0	141	141	K	1,150	120	0.445	2.147	2.469						Exist Pipe φ160
	25N	(= Napana)													526.328	502.000	24.328			
	Katugastota-Kahawatta																			
	601'														538.822	443.000	95.822			
601'	-	603	(B)	18,510	502	0	0	502		3,700	130	1.082	2.172	8.038						
	603														530.784	499.600	31.184			
603	-	6	(B)	16,110	502	0	0	502		50	130	0.942	1.680	0.084						
	6	(= Kahawatta)													530.700	522.250	8.450			
	6														585.500	516.000	69.500			
6	-	7'	B	7,310	350	0	0	350		2,500	130	0.879	2.256	5.639				B	69.5	
	7'														579.861	455.030	124.831			
7'	-	7	(B)	5,400	350	0	0	350		1,400	130	0.650	1.288	1.803						
	7	(= Kurugoda)													578.057	573.000	5.057			
	603														530.700	499.600	31.100			
603	-	10	B	2,400	199	0	0	199		1,250	130	0.893	4.494	5.617						
	10	(= Akurana)													525.083	512.000	13.083			
	6														624.800	516.000	108.800			
6	-	11'	B	6,400	0	0	350	350		6,150	130	0.770	1.764	10.848				B	108.8	
	11'														613.952	570.000	43.952			
11'	-	12	(B)	2,500	0	0	199	199		3,900	130	0.930	4.847	18.901						
	12	(= Bollawela)													595.050	590.000	5.050			
	11'														613.952	570.00	43.952			
11'	-	11	(B)	1,100	0	0	79	79		100	130	2.597	95.453	9.545						
	11														604.407	570.00	34.407			
	11'														660.652	566.00	94.652			
11'	-	11S	IB	2,600	0	0	252	252		3,400	130	0.603	1.650	5.611				IB	46.7	
	11S														655.041	650.00	5.041			

(Phase 3)

	Node		B/G	Flow Rate	Dia.	Dia.	Dia.	Mixed Dia	Exist.	Length	C	Velocity	Hyd.Grd	Loss	Dynamic Pressure	LWL	Dynamic Pressure	Pump	Required	Remark
Node	--->	Node		Q (m3/d)	D (mm)	D (mm)	D (mm)	Dm(mm)		L (m)		v(m/sec)	I (‰)	h(m)		HWL		Type	Pump Head	
					2,005	2,010	2,015								Hd(MSL)	(MSL)	He(m)		H(m)	
	11S														710.000	646.00	64.000			
11S	-	11G'	B	2,600	0	0	252	252		3,000	130	0.603	1.650	4.951				B	64.0	
	11G'														705.049	700.00	5.049			
	11G'														754.349	700.00	54.349			
11G'	-	11G	IB	2,600	0	0	252	252		2,600	130	0.603	1.650	4.291				IB	49.3	
	11G														750.059	745.00	5.059			
	7'														579.861	455.030	124.831			
7'	-	8	(B)	1,910	252	0	0	252		950	130	0.443	0.933	0.886						
	8	(= Thelambugahawatta)													578.975	566.750	12.225			
	7														628.100	569.000	59.100			
7	-	9	B	3,000	0	0	252	252		3,760	130	0.696	2.150	8.085				B	59.1	
	9														620.015	615.000	5.015			
	Katugastota-Uduwawala																			
	PG														584.980	442.680	142.300			
PG	-	5'	B	8,800	0	400	0	400		700	130	0.811	1.659	1.161				B	142.3	
	5'														583.819	450.000	133.819			
5'	-	1301	(B)	8,800	0	400	0	400		1,200	130	0.811	1.659	1.991						
	1301														581.827	470.000	111.827			
1301	-	14'	(B)	4,600	0	299	0	299		3,420	130	0.758	2.062	7.051						
	14'														574.776	560.000	14.776			
14'	-	17N	(B)	4,600	0	299	0	299		2,300	130	0.758	2.062	4.742						
	17N														570.034	565.000	5.034			
	Katugastota-Kondadeniya, Kurugamana																			
	PG														544.580	442.680	101.900			
PG	-	5″	B	5,870	350	0	0	350		520	130	0.706	1.503	0.782				B	101.9	
	5"														543.798	468.410	75.388			
5"	-	5″a	(B)	3,050	299	0	0	299		890	130	0.503	0.964	0.858						
	5 a														542.940	505.180	37.760			
5″a	-	5	(B)	3,050	0	0	299	299		520	130	0.503	0.964	0.501						
	5	= Kondadeniya													542.940	535.250	7.690			
	5														591.150	631.250	59.900			
5	-	K1	B	1,150	0	0	199	199		1,525	130	0.428	1.152	1.757				B	59.9	
	K1														589.393	535.000	54.393			
K1	-	k2	(B)	1,600	0	0	199	199	K	350	120	0.595	2.461	0.861						Exist Pipe φ225 PVC
	k2														588.531	550.000	38.531			
k2	-	14	(B)	1,600	0	0	201	201	K	106	120	0.584	2.344	0.249						Exist Pipe φ200 DI
	14	(= Kurugammana)													588.283	583.250	5.033			
	Katugastota-KFG, R2																			
	PG														576.880	442.680	134.200			
PG	-	MR	B	51,110	802	0	0	802		650	130	1.171	1.452	0.944				B	134.2	
	MR														575.936	442.770	133.166			
MR	-	17'	(B)	51,110	700	0	592	846		570	130	1.053	1.122	0.640						
	17'														575.296	453.650	121.646			
17'	-	AG'	(B)	39,920	700	0	0	700		830	130	1.201	1.783	1.480						
	AG'														573.816	527.400	46.416			
AG'	-	(IB)	(B)	18,180	502	0	0	502		430	130	1.063	2.101	0.904						
	(IB)														572.912	530.630	42.282			
(IB)	-	582	G	15,900	502	0	0	502		3,050	130	0.930	1.640	5.002						
	582	(= R2)													567.911	555.000	12.911			

(Phase 3)

	Node		B/G	Flow Rate	Dia.	Dia.	Dia.	Mixed Dia	Exist.	Length	C	Velocity	Hyd. Grd	Loss	Dynamic Pressure	LWL	Dynamic Pressure	Pump	Required	Remark
Node	--->	Node		Q (m3/d)	D (mm)	D (mm)	D (mm)	Dm (mm)		L (m)		v (m/sec)	I (‰)	h (m)		HWL		Type	Pump Head	
					2,005	2,010	2,015								Hd (MSL)	(MSL)	He (m)		H (m)	
	AG'														573.816	527.400	46.416			
AG'	-	AG	(B)	21,740	502	0	0	502		230	130	1.271	2.925	0.673						
	AG	**(= Asgiriya)**													573.143	567.000	6.143			
	(IB)														572.912	530.630	42.282			
(IB)	-	57	B	2,280	252	0	0	252		1,900	130	0.529	1.294	2.459				B	63.6	
	57	**(= Bahirawakand)**													634.053	629.000	5.053			
	17'														575.296	453.650	121.646			
17'	-	1702	(B)	11,200	400	0	0	400		2,000	130	1.032	2.592	5.185						
	1702														570.112	545.000	25.112			
1702	-	17	(B)	7,200	400	0	0	400		70	130	0.663	1.145	0.080						
	17	**(= Upland)**													570.032	566.000	4.032			
	Katugastota-Talathu Oya																			
	1702														570.112	545.000	25.112			
1702	-	18'	(B)	4,000	0	252	0	252		1,500	130	0.928	3.661	5.492						
	18'														564.620	480.000	84.620			
18'		18	(B)	4,000	0	252	0	252		1,350	130	0.928	3.661	4.943						
	18	(Talawatta)													559.677	540.000	19.677			
	Katugastota-Gohagoda																			
	5″														543.798	456.990	86.808			
5″	-	65'	(B)	2,820	252	0	0	252		950	130	0.654	1.918	1.822						
	65'														541.976	490.310	51.666			
65'	-	6501	(B)	1,600	201	0	0	201		1,720	130	0.584	2.022	3.477						
	6501														538.499	506.600	31.899			
6501	-	6401	(B)	200	0	97	0	97		1,250	130	0.313	1.500	1.875						
	6401														536.625	455.000	81.625			
6401	-	64S	(B)	200	0	97	0	97		780	130	0.313	1.500	1.170						
	64S														535.455	530.000	5.455			
	65'														541.976	490.310	51.666			
65'	-	65G	(B)	1,220	0	0	149	149	K	100	120	0.810	6.100	0.610						Exist Pipe φ200
	65G														541.366	528.410	12.956			
	6501														538.499	506.600	31.899			
6501	-	65	(B)	1,400	201	0	0	201	K	90	130	0.511	1.579	0.142						
	65	**=Gohagoda (Pallemulla)**													538.357	531.200	7.157			
	64														512.000	512.000	0.000			
64	-	64'	G	1,100	0	141	0	141		750	130	0.815	5.682	4.262						
	64'														507.738	460.000	47.738			
64'	-	64G	G	1,100	0	141	0	141		3,000	130	0.815	5.682	17.047						
	64G														490.691	480.000	10.691			
	64S														567.700	526.000	41.700			
64S	-	64B	B	200	0	0	97	97	K	360	120	0.313	1.739	0.626				B	41.7	Exist Pipe φ110
	64B														567.074	562.000	5.074			

04 Distribution System Calculations

Distribution System Calculation

1. General

This working paper as a report presents the methodology, basic conditions and design criteria, applied for the pipe network analysis for present study.

The network analysis is carried out using US software, which is a user-friendly program based on Kypipes and operated on MS-dos.

And the results of pipe network analysis are described in the following section.

Outline of work procedure for network analysis is presented in Figure 1-1.

2. Condition of Analysis

2.1 Methodology

In the JICA F/S Report on Greater Kandy Water Supply Augmentation Project、prepared in 1999, twenty (20) Service Reservoirs (S.R.) which are shown in Table 2.1-1, were proposed to be constructed newly or expanded for storing the water for distribution. This water is distributed to the consumers in the Phase 1 served area, through the new distribution feeder main, which is planned be installed from S.R. to the existing pipe and/or existing pipe network. To determine the proper pipe diameter of feeder main and pipelines in the distribution network for water supply scheme, the hydraulic network analysis is carried out to meet the design criteria.

The outline of methodology on distribution network analysis for Greater Kandy Water Supply Augmentation Project is presented in the following. Figure 1-1 shows the flow diagram for present pipe network analysis.

2.1.1 Existing Distribution Network of Each Water Scheme

The existing pipeline data is essential matter for analyzing the future pipeline network. For that purpose, the following data are required.

1) Drawings of existing distribution pipe network for each water supply scheme together with list of pipe length for each diameter and each material were collected.
2) Location of present reservoirs were put on the map of 1:10,000 scale..
3) High water, Low water and Ground elevation of existing reservoir were obtained.

2.1.2 Water Demand

The future water demand that was predicted by the F/S is reviewed by taking into account of the latest water consumption data. The water demand required in the new development area, which are not expected in the F/S, will be taken into consideration for the pipe network analysis. However, in principle, the predicted total water demand for Phase 1 project is not changed. Based on the projected and fixed future demand of each water supply scheme, in the years 2005, 2010 and 2015, water demand is distributed in the served area considering the population density, commercial demand, large size consumers and other water demand factors.

2.1.3 Future Distribution Pipeline

The NWSDB's water supply planning for the pipeline expansion for each Water Supply Scheme by the project's target year is indicated on the available map. Distribution pipeline routes from the new Service Reservoirs (SR) to pipe connection points are investigated and used as present data for the pipe network analysis.

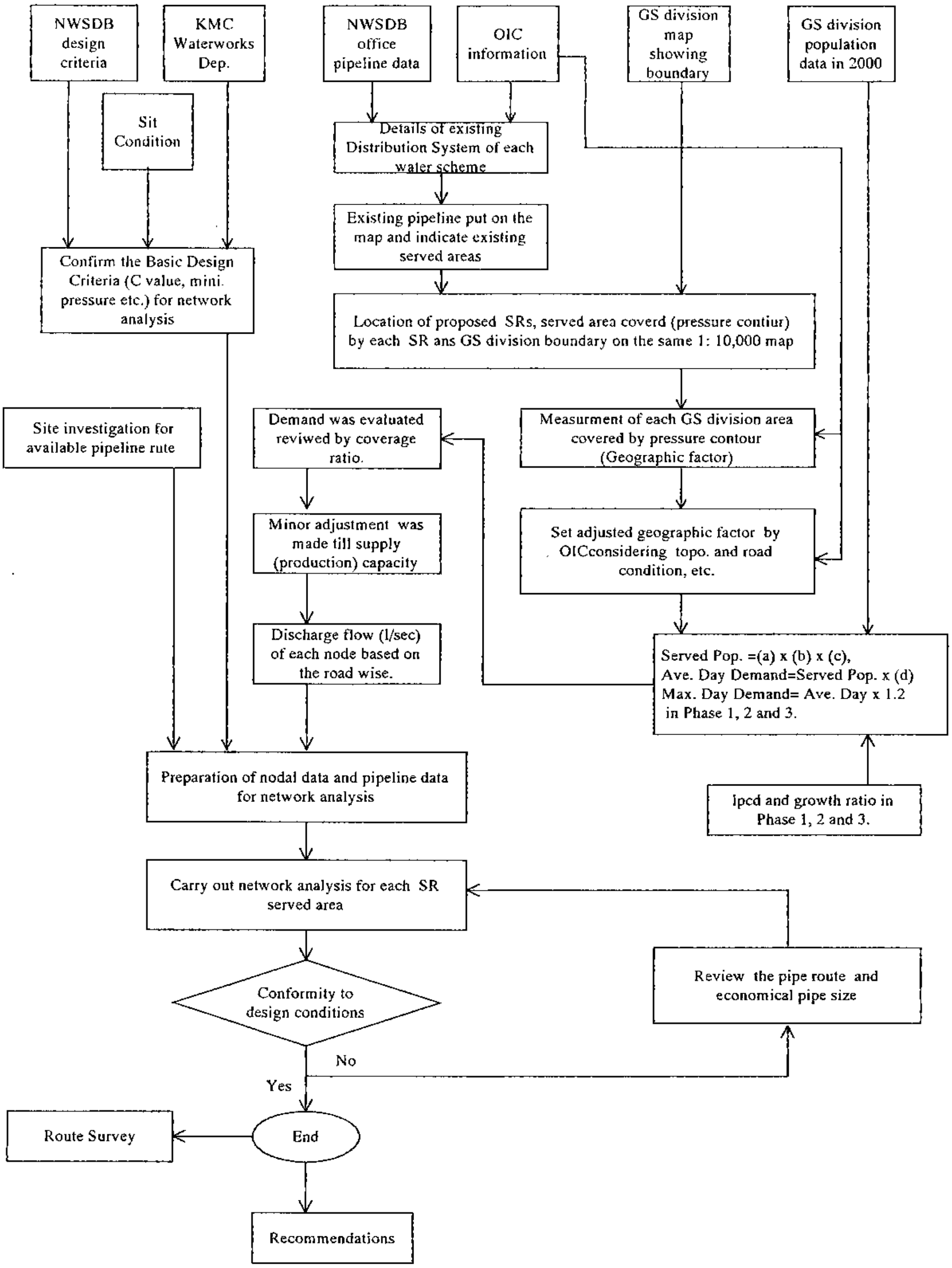


Figure 1.1 F LOW DIAGRAM FOR PIPE NETWORK ANALYSIS

Table 2.1-1 Capacities and Elevations of Proposed Service Reservoirs in Phase 1

SR No.	Name of Service Resevoir	Water Level (m)		Capacity (m3)	Type
		LWL	HWL		
SR-1	Asgiriya	561.50	567.00	4,100	Ground
SR-2	Bahirawakanda	625.00	629.00	600	Elevated
SR-3	Bangalawatta	518.28	521.28	300	Ground
SR-4	Dangolla	527.60	531.60	500	Ground
SR-5	Elhena	611.00	615.00	300	Ground
SR-6	Gohagoda (Pallemulla New)	527.20	531.20	200	Ground
SR-7	Hantana Place	637.00	641.00	200	Ground
SR-8	Heerassagala Low	566.00	570.00	200	Ground
SR-9	Heerassagala Middle	613.00	617.00	250	Ground
SR-10	Heerassagala Upper	674.00	678.00	200	Ground
SR-11	Kahalla	485.00	491.25	600	Elevated
SR-12	Kahawatta	516.00	522.25	600	Elevated
SR-13	Kondadeniya	531.25	535.25	200	Ground
SR-14	Kulugammana	579.25	583.25	100	Ground
SR-15	Kurugoda	569.00	573.00	600	Ground
SR-16	Mullepihilla Low New	709.00	713.00	100	Ground
SR-17	Pihilladeniya	522.14	524.14	200	Ground
SR-18	Thelambugahawatta	561.50	566.75	500	Elevated
SR-19	Uplands	560.09	566.00	2,960	Ground

2.1.4 Network Analysis

Such design criteria as C value, minimum pressure at the end of network and others, were studied for the present pipe network analysis. Nodal data and pipeline data were also prepared, based on the available information, as shown below.

The network analyses for each water scheme for Full Target Year 2015 (Phase 3) were carried out.

To design the proper diameter of new distribution feeder main/s, pipe route condition and economical pipe size are taken into consideration for the most economical and technically acceptable design.

Distribution of water demands to each node in pipe network is conducted as shown below. The Greater Kandy varies its population, in general, by the class of alongside roads in the district/area. Therefore, the projection of served population by the water system is considered to follow and depend on this characteristic.

The water demand distribution for pipe network analysis was made taking into account the above specialty, and the water demand density per 100m length of main road or pipeline was estimated with the method presented below, for demand distribution to the pipe network.

1. Classify the roads in the respective network, into the three classes, (1) Main road, (2) General road, and (3) Foot-pass.
2. Estimate the population per above classes as unit population per 100m pipelines.
3. Calculate the water demand, applying the length of pipeline, unit population density and the unit per capita water demand.
4. Each node's demand distribution was calculated basically as described in the above. And, the demand for such node, which has intersection of plural number of roads, was calculated by applying the proportional distribution.

2.1.5 KMC Network Analysis

Regarding the KMC distribution network, the Feasibility Study on Water Supply Augmentation and Distribution for Kandy (ADB LOAN NO.1632-SRI [SF]), prepared by Engineering

Consultants Limited in September 2000, has been reviewed. Distribution feeder mains to be implemented by the Phase 1 project were designed based on the result of discussion with KMC officials concerned.

2.2 Basic Conditions

2.2.1 Coverage of Distribution Pipe Design

Distribution feeder main pipe from the new Service Reservoirs (SR) to connected point of the nearby pipe network and the fundamental pipelines for strength or augmentation of network were selected and made detailed design.

2.2.2 Design Criteria for Distribution Network Analysis

The following design criteria for distribution network analysis are applied:

1) Peak Factor

- Maximum daily demand / average daily demand is 1.2
- Hourly demand / Maximum daily demand is 1.78
- Hourly demand / average daily demand is 2.0
- The required hourly peak demand for distribution network analysis of 10 WSS is presented in Table 2.1-2.

2) Node and Pipeline Data

- Discharge flow of each node is hourly demand (l/sec).
- In case of PVC, internal diameter is applied.

3) Software Program

The network analysis is carried out using US software, which is a user-friendly program based on Ky-pipes and operated on MS-dos.

4) C value of Hazen-Williams Formula

Material	DCIP	PVC	ACP	SS or GI
New Pipe	140	140	---	---
Existing Pipe	(CI=) 90	120	120	120

5) Residual Pressure

Minimum pressure is at the end of network is 0.1 Mpa (= 1.0 kgf/cm^2), ant any node. 0.6bar (6m water head) residual pressure at the house connection is designed.

6) Break Pressure Tank (BPT)

At the location where dynamic pressure is exceeding 0.7 Mpa (= 7.0 kgf/cm^2) break pressure tank facilities are designed.

3. Existing Distribution Network

3.1 Alawathugoda WSS

The present situation of Alawatthugota Water Supply Scheme is briefly presented below. In this scheme, the existing two water reservoirs of Villana with 75 m^3 water capacity and Owissa that with 50 m^3 is covering the Alwathugoda Scheme distribution system. The far north and the southern part distribution areas are supplied water via break pressure tank/s (BPT) by reducing the pipe system pressure.

3.2 Akurana WSS

The existing Akurana water system has a water reservoir with capacity $600m^3$, which is receiving the water from two boreholes and supplying to this entire scheme.

3.3 Balanagala WSS

The existing Balanagala water system is located adjacent to the Polgolla Scheme and has a water reservoir with capacity $450m^3$, which is supplying to the pipe network of this entire scheme.

3.4 Polgolla WSS

In this Scheme, there exist two water reservoirs of Bagalawatta: 100 m^3 and Pihilladeniya: 100 m^3, located in the Madawale area in north. These two reservoirs cover the entire supply area and have almost the same water level.

Further, there is another water reservoir at Napana: 150 m^3, in this Scheme, which is not used at present but, be re-used in the future. This reservoir has its water level/elevation 20m lower than that of the other two reservoirs.

And in the south area, there is an existing Polgolla reservoir, which is planned not be used in the future. As described in the above, this Scheme is adjacent to the Balanagala Scheme.

3.5 Kulugammana WSS

The Existing Kulugammana Service Reservoir ($300m^3$) is covering this entire scheme's water system.

3.6 Kondadeniya WSS

In this Scheme, the existing Kondadeniya Service Reservoir ($300m^3$) is covering the entire system water.

3.7 Gohagoda WSS

In this Scheme, the entire system is covered by the following two sub-systems, which are separated by the gate valve:

(1) Gohagoda Wegiriya Service Reservoir (Old: 300m^3) & Gohagoda Low Service Reservoir (Pallemulla: 150m^3)
(2) Yatihagala Service Reservoir: 150m^3

3.8 Ampitiya WSS

This Scheme's entire system is covered by the following two sub-systems:

(1) Existing Ampitiya Service Reservoir (900m^3), which covers the southern part of this Scheme,
(2) Existing Meekanuwa Service Reservoir (225 m^3), which covers the northern part.

This Scheme has not sufficiently developed the pipe network system, compared to the other Scheme. Further, along the trunk main road (Ampitiya Road) in this area, there exists asbestos cement pipe (AC pipe) with 6.1km in length. It is necessary be replaced with the other pipe material for this AC pipe, which has disadvantages as high rate carcinogenic material and less durability for heavy traffic load.

3.9 Mullepihilla WSS

In this Scheme, the entire system is covered by the following two sub-systems:

(1) Mullepihilla Low Service Reservoir (25 m^3) for lower elevation service area, and
(2) Mullepihilla High Service Reservoir (25 m^3) for higher elevation service area.

This Scheme has the most simple service system, as one distribution pipeline. And, the pipeline in high service area is functioning both as transmission and distribution pipeline.

3.10 Hantana WSS

This Scheme's entire system is covered by the following two sub-systems:

Hantana Low/R4 Service Reservoir (1365m^3), which covers the lower area this Scheme, and (2) Hantana High/R2 Service Reservoir (25m^3), which covers the high area.

3.11 Heeresasagala WSS

This Scheme is the newly included scheme for the present Design Study, for which water supply system is entirely less developed compared to the other WSS. The present water system is composed of as follows:

1. Untreated spring water supply for Heeresasagala Low SR, which is diverted from KMC system.
2. Treated spring water supply for Heeresasagala Middle SR, which is diverted from KMC system.
3. Untreated spring water supply for Heeresasagala Upper SR, which is diverted from the Regional Council.

4. Future Improvement Plan for Distribution Networks

4.1 General

Based on the preceding development plan for distribution system and existing network analysis, the future distribution network improvement has reviewed and studied for design as presented in the following.

4.2 Vilana & Owissa SR and Kurugoda SR Network (See Appendix- 5.1 Improvement of Distribution Network in 2015)

For this Scheme, a new Kurugoda Service Reservoir (SR) with the capacity 600 m^3 is designed in the south. From the system pressure contour line, the distribution area/s covered by the existing and new SRs are identified as follows:

(1) Area covered by Vilana & Owissa (SR):
- Northern part of Alawathugoda,

(2) Area covered by Kurugoda SR:
- Southern part of Alawathugoda and
- A part of northern part of Akurana.

By the above improvement, the coverage or lord for water distribution for two SRs Vilana and Owissa could be reduced or eased. And, in the northern part of Akurana, the higher elevation (GL above 510m) than that water elevation of Akurana SR, could be supplied from this improved system.

Through this pipe hydraulic analysis, a pipe system to connect the Kurugoda SR via A9 Road and to the east could be designed. That target is to improve the total system pressures, and to supply water not only the nearby SR but also to cover the higher elevation area.

4.3 Akurana SR, Thelambugahawatta SR and Kahawatta SR Network (See Appendix- 5.2 Improvement of Distribution Network in 2015)

For this Scheme following two new service reservoirs have been planned and designed:

(1) Thelambugahawatta SR (500 m^3) in the north-east of Akurana, and

(2) Kahawatta SR (600 m^3) in the south of Akurana.

In this Scheme, due above improvement, the existing Borehole system is considered as it could be used as the standby system in the future. From the system pressure contour line, the Thelambugahawatta SR is observed capable to supply water to the north-east of Akurana area.

The majority part of this Scheme has high potentiality of future water demand increase. Even though, this area has not covered by the existing pipe system from the Akurana SR.

Some part of this area has rather high ground elevation (GL540m above), compared to the proposed Service Reservoir. Due mainly this reason, it is observed hydraulically difficult to supply water from the proposed entire system. Considering this background, it is urgently required to improve the water system in this service area .

Under the present design/planning, the service reservoir in this area is proposed be elevated from the ground to meet the required system pressure for the Scheme. And, by forming the pipe mesh network, the total system could be analyzed hydraulically in flexible manner, which results for the optimum operation of the distribution network.

While, the system pressure contour line produced by the Akurana SR indicates that, the water supply boundary could be extended/covered to the southern part of this network. This is interpreted that, the present Borehole system, which supply water to almost all the existing system, could be substituted by the gravity/reservoir supply system. The gravity system supply system produces hydraulically more economical and stable water supply in the Scheme.

The network Nodes: 2080 – 2081 could be connected by pipeline, which objects the expanded water supply to the residents in/along this pipe line area. Further, the existing SR Akurana system pressure contour line indicated that, this SR could cover the northern part of Akurana.

As mentioned in the above section, the new construction of Thelambugahawatta and Kahawatta SRs could improve the water supply situation to the north of Akurana from Kurugoda SR. And the burden of the distribution load/coverage was eased or reduced from Akurana SR.

4.4 Balanagala SR and Kahalla SR Network (See Appendix- 5.3 Improvement of Distribution Network in 2015)

This Scheme is planned and designed to be constructed a new Kahalla Service Reservoir (600 m^3) in the western part of this Scheme/service area.

The system pressure contour line for this network indicates that, the water distribution coverage areas are:

(1) Kahalla SR could extend and serve to the Balanagala Scheme and the western part of service area where pipe network is not developed yet, and

(3) The existing Balanagala SR is planned be connected to the existing pipe network which is covered by the Polgolla SR. These networks are planned/designed to be combined to form bigger size of pipe network, which create more rational and practical water use.

4.5 Bangalawatta SR and Pihilladeniya SR Network (See Appendix- 5.4 Improvement of Distribution Network in 2015)

For this Scheme, any new reservoir construction is not planned. However, the existing two reservoirs are to be expanded: Bangalawatta is planed to expand its capacity by $300m^3$ to 400 m^3, and that of Pihilladeniya by 200 m^3 to 300 m^3, respectively.

From the system pressure contour line, the all area in this Scheme is observed capable for water supply from the existing/expanded SRs except for the southeastern part of the scheme. It is found that, in future, the Napana SR could be revived its use. Then, the nearby service area only is capable for service from this SR. Since, the water elevation of this SR is not high enough to cover far/remote area from this reservoir. Therefore, two options for the future have been proposed. (See Appendix 5.4, Option 1 & Option 2).

The above plan would result that, the Balanagala SR could be eased from heavy burden/load to cover larger service area.

While the Polgolla SR is scheduled be abandoned in the future, the connected pipe network should be combined with the aforementioned Balanagala SR service network to form larger pipe network for optimum operation.

4.6 Kulugammana SR Network (See Appendix- 5.5 Improvement of Distribution Network in 2015)

For this Scheme, any new reservoir construction is not planned. However, the existing reservoir Kulugammana SR is planed be expanded its capacity by 300m^3 to 400 m^3.

From the system pressure contour line, the all area in this Scheme is observed capable for water supply from the existing/expanded SRs, except for the northeastern part of the scheme. This particular area has now been proposed to be isolated and served using an in-line booster station as an interim measure until the proposed SR at Nugawela (Phase 2) is in place. Many reinforcements for the other areas have been proposed to enhance the performance of the scheme.

4.7 Kondadeniya SR Network (See Appendix- 5.6 Improvement of Distribution Network in 2015)

For this Scheme network, any new reservoir construction is not planned. However, the existing reservoir Kondadeniya SR could be expanded its capacity by 200m^3 to 500m^3.

From the system pressure contour line, the all area in this Scheme is considered as capable for water supply from the existing/expanded SRs. The existing pipe system of this Scheme forms tree-blanch structure. Further, from the geographical location, it is rather difficult to structure mesh type pipe network.

4.8 Gohagoda SR Network (See Appendix- 5.7 Improvement of Distribution Network in 2015)

For this Scheme network, a new service reservoir Gohagoda New SR (with capacity 200m^3 and elevation GL= 524m) is designed next to the existing Gohagoda Low SR, and total capacity is expanded to 350 m^3.

From the system pressure contour line, the all area in this Scheme is capable be supplied water from the existing/expanded SRs. However, the Yatihagala sub-system is not included but isolated with the boundary valve. With the pipe network analysis, the service areas of the respective SR were demarcated and the existing Gohagoda Low SR has been proposed to serve the low elevated areas in the southern part of the scheme. At the same time the New Gohagoda SR will contribute to reduce the service coverage burden for Gohagoda Wegiriya (Old) SR while serving the high elevated areas. Furthermore, in case of emergency, the service water could hydraulically be supplied to the Yatihagala Scheme.

4.9 Elhena SR Network (See Appendix- 5.8 Improvement of Distribution Network in 2015)

For this Scheme, a new service reservoir Elhena SR (with capacity 300m^3 and elevation GL= 611m) is designed in the eastern part.

From the system pressure contour line, the Elehena SR is capable to cover nearby this SR, which has comparatively higher elevation than that of western part of Ampitiya. With the pipe network analysis, it has been observed that certain areas in the vicinity of the SR would experience excessive pressures. Therefore, Elhena SR is proposed to serve only the high elevated areas in the northeastern and southwestern parts of the existing Ampitiya Scheme. The rest of the service area would continue to be served by the Ampitiya SR.

Further, The existing AC pipe augmenting pipeline (Node 8042 – 8045 line) could be improved, to increase the system pressure. At the same time, this will contribute to reduce the service coverage burden for Ampitiya SR. Furthermore, the aforementioned existing AC pipeline should replaced or improved to keep stable and safe water to the service.

4.10 Mullepihilla SR Network (See Appendix- 5.9 Improvement of Distribution Network in 2015)

For this Scheme, a new service reservoir Mullepihilla New SR (with capacity $100m^3$ and elevation GL= 710.5m) is designed next to the existing Mullepihilla Low SR(capacity 25 m^3), and total capacity is expanded to 125 m^3. From the system pressure contour line, it is observed that geographically capable service area is Mullepihilla Low area in this Scheme.

The existing Mullepihilla High SR could cover the Mullepihilla High area. Further, this could serve rationally to these area covered by Ampitiya SR which has the most highest elevation (GL = 586m).

4.11 Hantana Place SR Network (See Appendix- 5.10 Improvement of Distribution Network in 2015)

Under this Scheme network, a new service reservoir Hantana Place SR (with capacity $200m^3$) in the south-west.

From the system pressure contour line, it is observed that hydraulically capable service area by Hantana Place SR is the very limited area of south-western part of existing Hantana Scheme. This will contribute to the Hantana Low/R4 to ease and reduce its load of water service coverage.

On the other hand, the Hantana SR could cover the central part of this Scheme and the Hantana High/R2 could cover the higher elevation area with its elevation potential. Therefore, it has now been proposed to serve only the southwestern part of the existing scheme by this new SR. However, at the request of the KMC, some provision have been made to serve the Kandy

Hospital Quarters and the Nagastenna area which lie within the KMC limits.

4.12 Heeresasagala Middle and Upper SRs Network (See Appendix- 5.11 Improvement of Distribution Network in 2015)

For this Scheme, two new service reservoirs (1) Heeressagala Upper SR ($200m^3$) and Heeresasagala Middle SR ($250m^3$) are planned/designed.

From the system pressure contour line, it is geographically observed that the capable area covered by the two reservoirs is:

(1) Heeressagala Middle SR: Northern part of this Scheme, and

(2) Heeressagala Upper SR: Southern part of this Scheme.

The distribution networks are planned be supplied by the separate two systems.
One system: Heeresasagala Middle, will be constructed and operated by NWSDB.
From the pipe network analysis for the above, it could be expected the two separate systems will operate the stable and optimum water supply, from each SR respectively.

From the Heeressagala Upper SR, as requested by the KMC, supply to be extended to feed the existing Elagolla SR via a gravity distribution main.

5. Phase 1 Distribution Pipeline

The proposed pipelines in the outside of KMC service area and KMC area are presented in Table 5.1 shown below.

Distribution trunk feeder pipe from the new or expanded SR to the connection point to the distribution network shall be selected considering the economical size, and have some allowance taking consideration on unforeseen future water demand.

In addition, some new distribution pipes which are required to strengthen the existing distribution network and expanded service area, shall also be selected taking into account the opinions given by the OIC of present WSS, for such as future development area, area where ground well yield are poor, intermitted supply area, etc. Among such pipelines, high priority pipe that is quite effective for hydraulically might be selected and included in the detailed design.

The each service zone will be formed the independently of distribution network with existing and new pipelines, and as the result, the following improvement or betterment are predicted.

(1) Many houses which has been waiting the connection to water supply, can be connected and get clean water.
(2) Present intermittence water supply condition will be improved to supply continuously.
(3) Low or negative pressure area will be dissolved and appropriate pressure will be kept.
(4) Development and expanded area will get water anytime.

Table 5.1 Phase 1 Distribution Pipelines (1/3)

Name of Service Reservoir	Drawing Number	Route Number	Pipe Diameter (mm)	Material DI/PVC	Pipeline Length (m)
Kurugoda	40-C-01	1	250	DI	1,090
			225	PVC	760
			160	PVC	210
	40-C-02	2	225	PVC	220
			110	PVC	660
	40-C-03	3	90	PVC	1,030
	40-C-04	4	225	PVC	230
	40-C-05	5	160	PVC	560
	40-C-06	6	160	PVC	420
	40-C-07	7	90	PVC	440

(2/3)

Name of Service Reservoir	Drawing Number	Route Number	Pipe Diameter (mm)	Material DI/PVC	Pipeline Length (m)
Thelambugahawatta	40-C-08	8	225	PVC	200
			160	PVC	880
	40-C-09	9	110	PVC	890
	40-C-10	10	160	PVC	1,400
			90	PVC	750
	40-C-11	11	160	PVC	290
Kahawatta	40-C-12	12	110	PVC	560
			100	DI	30
	40-C-13	13	110	PVC	340
	40-C-14	14	225	PVC	800
	40-C-15	15	300	DI	220
			225	PVC	670
Kahalla	40-C-16	16	300	DI	580
			160	PVC	640
	40-C-17	17	250	DI	130
			225	PVC	720
			160	PVC	470
	40-C-18	18	160	PVC	440
			110	PVC	250
			100	DI	100
			90	PVC	880
	40-C-19	19	90	PVC	300
Bangalawatta &	40-C-20	20	250	DI	240
			225	PVC	1,030
Pihilladeniya	40-C-21	21	225	PVC	1,090
Kurugammana	40-C-22	22	250	DI	170
	40-C-23	23	100	DI	100
			90	PVC	430
Kondadeniya	40-C-24	24	250	DI	60
			225	PVC	170
Gohagoda New (Pallemulla)	40-C-25	25	300	DI	70
	40-C-26	26	225	PVC	340
Elhena	40-C-27	27	250	DI	140
			225	PVC	670
	40-C-28	28	160	PVC	430
	40-C-29	29	160	PVC	540
Mullepihilla Low New	40-C-30	30	160	PVC	0
Hantana Place	40-C-31	31	225	PVC	380

(3/3)

Name of Service Reservoir	Drawing Number	Route Number	Pipe Diameter (mm)	Material DI/PVC	Pipeline Length (m)
Heerassagala Upper	40-C-32	32	160	PVC	340
	40-C-33	33	225	PVC	140
			160	PVC	370
	40-C-34	34	110	PVC	590
Heerassagala Middle	40-C-35	35	250	DI	220
			200	DI	40
	40-C-36	36	110	PVC	160
Bahirawakanda	40-C-37	37	250	DI	120
Asgiriya	40-C-38	38	250	DI	190
	40-C-39	39	500	DI	680
			450	DI	1,210
	40-C-40	40	400	DI	330
Heerassagala Low	40-C-41	41	250	DI	280

Total 27,690

6 Recommendation/Comment

1) Thelambugahawatta and Kahalla Service Zones

These two service zones are installed less existing pipelines, hence new pipelines and house connections are required to meet the water demand in Phase 1.

When it is necessary, in addition to the pipes, which will be procured under the proposed Phase 1 Project, NWSDB is recommended to prepare the additionally required pipe materials and house-connection piping materials for future installation.

2) High Elevation Area

The Kandy District is geographically comprised of hilly terrain, with elevation varying from 300m to 2,000m above mean sea level (MSL). The major perennial river in this district is the Mahaweli Ganga (River), which has many tributaries in the district. In the service zones in Kandy, there exist some higher elevation areas where water cannot be supplied by gravity. Even in such areas, water is acutely needed for the resident's daily life. In such case, booster pump/s is required for water distribution.

3) Isolation Valve

This valve is designed for functioning not only isolation of the service zones, but also interconnection of each service zone, in the case of emergency. Therefore, the installed valve location shall be recorded and valve conditions shall be maintained properly, for normal future operation.

4) Reformation of WSS

The present water supply scheme/s might be reformed on the basis of the new service area. If, any scheme has necessary been reformed, a new organization shall be considered.

5) Supply Amount Measurement

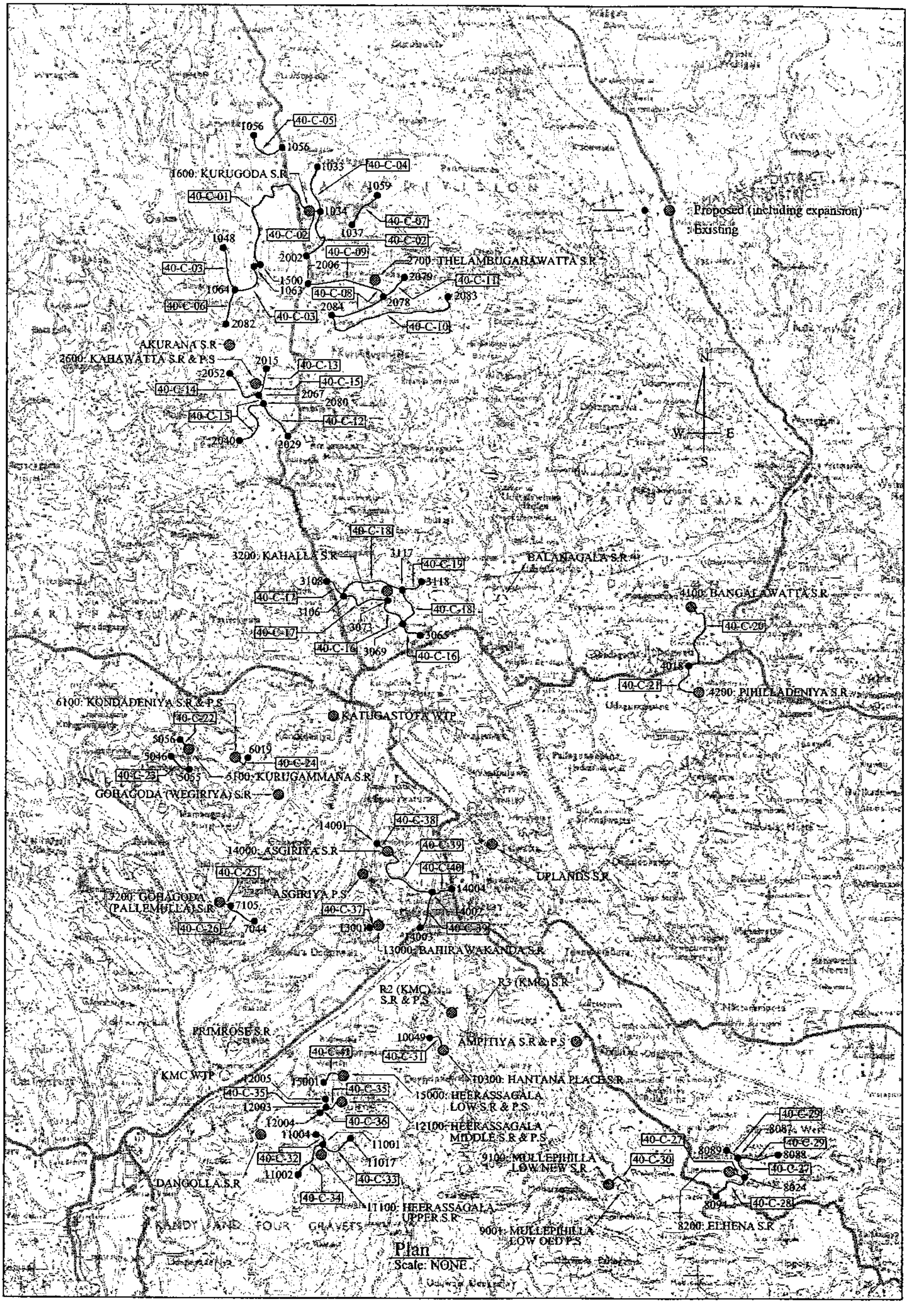
To monitor the total water amount supplied to the consumers and bulk supply to KMC area, flow meters shall be equipped, at the outlet pipe of service reservoirs.

Further, the water amount supplied to each service zone shall be recorded, and analyzed for the water demand situations, which could be reviewed for future water demand projections as well.

6) ACP in Ampitiya Service Area

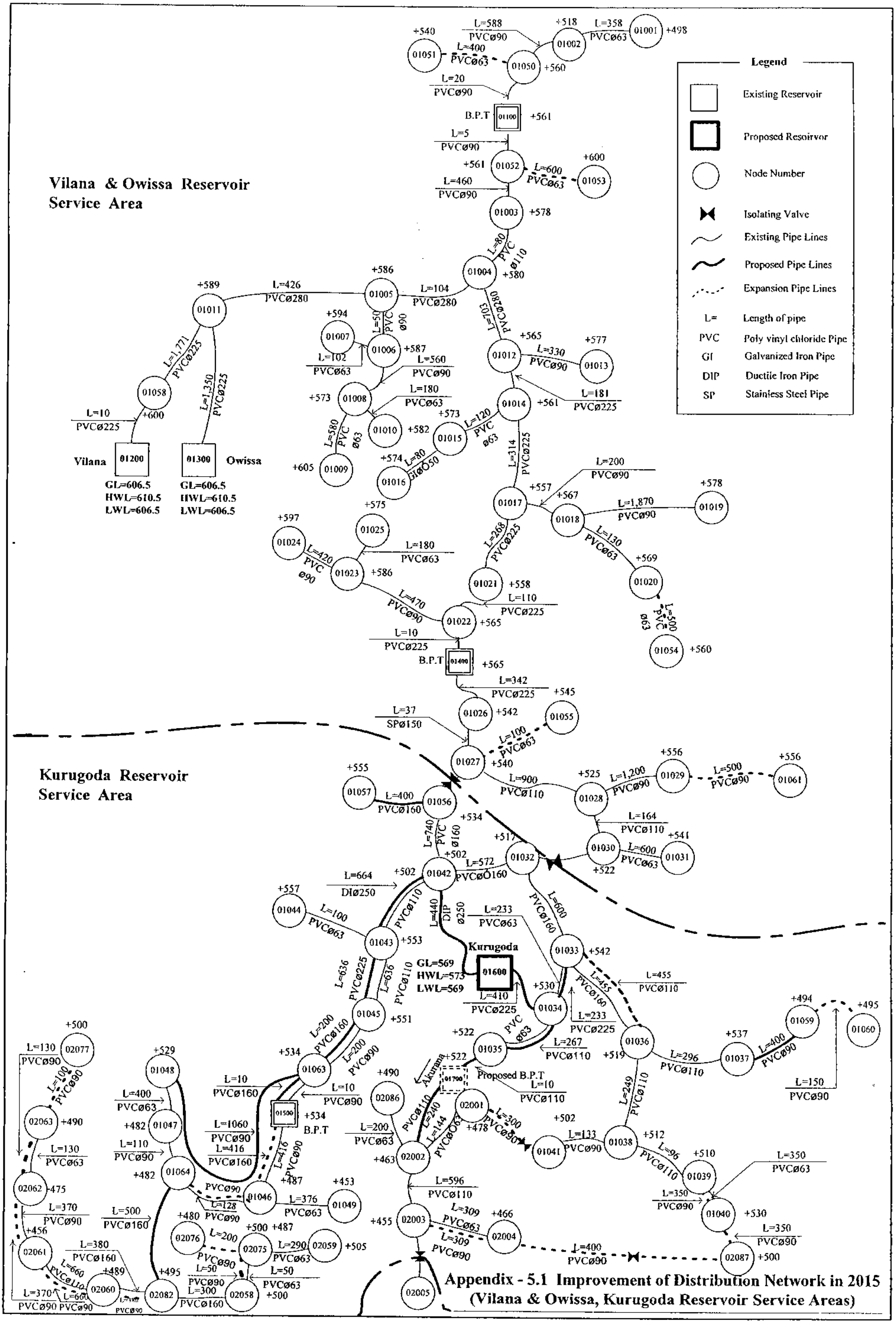
In this Water Supply Scheme, many AC pipelines were installed and are existing in use, which are weak material compare with PVC or DCIP, thus it is deteriorated and broken easily affected by external load.

In the future, these AC pipes are recommended replaced with PVC pipes or DCIP, to avoid leakage from broken pipes and to reduce pipe repair works, under a plan for strengthening pipeline.



Plan

Scale: NONE



Appendix - 5.1 Improvement of Distribution Network in 2015 (Vilana & Owissa, Kurugoda Reservoir Service Areas)

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         * * * * * * * * * *   K Y P I P E 2   * * * * * * * * * *
         *   University of Kentucky Hydraulic Analysis Program   *
         * Distribution of Pressure and Flows in Piping Networks *
         *        1000 PIPE VERSION - 1.10   (08/25/92)          *
         * * * * * * * * * * * * * * * * * * * * * * * * * * * * *



 DATE:  3/ 7/2002
 TIME: 10:29:32

 INPUT DATA FILENAME -------------- c:\D_nets\2015\KURU2015.DAT
 TABULATED OUTPUT FILENAME -------- c:\D_nets\2015\KURU2015.OUT
 POSTPROCESSOR RESULTS FILENAME --- c:\D_nets\2015\KURU2015.RES

               ************************************************
                S U M M A R Y   O F   O R I G I N A L   D A T A
               ************************************************


 U N I T S   S P E C I F I E D

    FLOWRATE ............ = liters/second
    HEAD (HGL) .......... = meters
    PRESSURE ............ = kpa


 R E G U L A T I N G   V A L V E   D A T A

 VALVE    POSITION    CONTROLLED     VALVE
 TYPE     JUNCTION       PIPE       SETTING
                                   (m or l/s)
 --------------------------------------------
 PRV-1      1500          14         534.00
 PRV-1      1500          47         534.00
 PRV-1      1700          59         525.30


 P I P E L I N E   D A T A

 STATUS CODE:   XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                CV -CHECK VALVE    RV -REGULATING VALVE

  PIPE       NODE NOS.     LENGTH   DIAMETER   ROUGHNESS   MINOR LOSS   FGN-H
 NUMBER      #1    #2       (m)       (cm)       COEFF.      COEFF.       (m)
 ----------------------------------------------------------------------------
   1        2077  2063     100.0      7.9       130.00         .00
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   2        2063  2062        130.0       5.5        120.00          .00
   3        2062  2061        370.0       7.9        120.00          .00
   4        2061  2060        660.0       9.7        120.00          .00
   5        2060  2082        380.0      14.0        120.00          .00
   6        2082  2058        300.0      14.0        120.00          .00
   7        2058  2075         50.0       5.5        120.00          .00
   8        1048  1047        400.0       5.5        120.00          .00
   9        1064  1046        128.0       7.9        120.00          .00
  10        1064  2082        500.0      14.0        130.00          .00
  11        2076  2075        200.0       7.9        130.00          .00
  12        1046  1049        376.0       5.5        120.00          .00
  13        2075  2059        290.0       5.5        120.00          .00
  14-RV     1500  1046        416.0       7.9        120.00          .00
  15        1045  1063        200.0       7.9        120.00          .00
  16        1045  1043        636.0       9.7        120.00          .00
  17        1043  1044        100.0       5.5        120.00          .00
  18        1043  1042        664.0       9.7        120.00          .00
  19        1042  1056        740.0      14.0        120.00          .00
  20        1056  1057        400.0       7.9        130.00          .00
  21        1042  1032        572.0      14.0        120.00          .00
  22-FG        0  1042        440.0      25.0        130.00          .00         569.
  23-FG        0  1034        410.0      19.8        130.00          .00         569.
  24        1034  1035        267.0       5.5        120.00          .00
  25        1035  1700         10.0       9.7        130.00          .00
  26        2001  2002        144.0       5.5        120.00          .00
  27        2002  2003        396.0       9.7        120.00          .00
  28        2003  2004        309.0       5.5        120.00          .00
  29        1032  1033        600.0      14.0        120.00          .00
  30        1033  1034        233.0       5.5        120.00          .00
  31        1033  1036        455.0      14.0        120.00          .00
  32        1036  1037        296.0       9.7        120.00          .00
  33        1037  1059        400.0       7.9        130.00          .00
  34        1059  1060        150.0       7.9        130.00          .00
  35        1036  1038        249.0       9.7        120.00          .00
  36        1038  1039         96.0       9.7        120.00          .00
  37        1039  1040        350.0       5.5        120.00          .00
  38        1038  1041        133.0       7.9        120.00          .00
  39        1063  1048       1060.0       7.9        130.00          .00
  40        1063  1500         10.0       7.9        120.00          .00
  41        1034  1035        267.0       9.7        130.00          .00
  42        1039  1040        350.0       5.5        120.00          .00
  43        1043  1042        664.0      25.0        130.00          .00
  44        2003  2004        309.0       7.9        130.00          .00
  45        1045  1043        636.0      19.8        130.00          .00
  46        1045  1063        200.0      14.0        130.00          .00
  47-RV     1500  1046        416.0      14.0        130.00          .00
  48        2058  2075         50.0       7.9        130.00          .00
  49        2062  2061        370.0       7.9        130.00          .00
  50        2063  2062        130.0       7.9        130.00          .00
  51        1033  1034        233.0      19.8        130.00          .00
  52        1063  1500         10.0      14.0        130.00          .00
  53        1064  1047        110.0       7.9        120.00          .00
  54        2002  2086        200.0       9.7        120.00          .00
```

```
   55-XX      2001   1041        300.0       7.9        130.00           .00
   56-XX      2004   2087        400.0       7.9        130.00           .00
   57         2087   1040        350.0       7.9        130.00           .00
   58         1039   1040        350.0       9.7        130.00           .00
   59-RV      1700   2002        240.0       9.7        130.00           .00
   60         2060   2061        660.0       7.9        130.00           .00
   61         2082   2060        380.0       7.9        130.00           .00
   62         1046   1064        120.0       7.9        130.00           .00
   63         1033   1036        455.0       9.7        130.00           .00


  J U N C T I O N   N O D E   D A T A


     JUNCTION     JUNCTION      EXTERNAL     JUNCTION
      NUMBER       TITLE         DEMAND      ELEVATION   CONNECTING PIPES
                                 (l/s)         (m)
 ----------------------------------------------------------------------------
       1032                       5.14        517.00     21    29
       1033                        .78        542.00     29    30    31    51    63
       1034                        .81        530.00     23    24    30    41    51
       1035                        .57        522.00     24    25    41
       1036                        .53        519.00     31    32    35    63
       1037                        .65        537.00     32    33
       1038                        .45        512.00     35    36    38
       1039                        .36        510.00     36    37    42    58
       1040                        .32        530.00     37    42    57    58
       1041                        .19        502.00     38    55
       1042                       2.74        502.00     18    19    21    22    43
       1043                        .90        553.00     16    17    18    43    45
       1044                        .05        557.00     17
       1045                        .44        551.00     15    16    45    46
       1046                       2.23        487.00      9    12    14    47    62
       1047                        .71        482.00      8    53
       1048                        .44        529.00      8    39
       1049                        .71        453.00     12
       1056                       1.34        534.00     19    20
       1057                        .14        555.00     20
       1059                        .18        494.00     33    34
       1060                       4.95        495.00     34
       1063                       1.19        534.00     15    39    40    46    52
       1064                        .85        482.00      9    10    53    62
       1500                        .00           .00     14    40    47    52
       1700                        .00           .00     25    59
       2001                        .21        478.00     26    55
       2002                        .93        463.00     26    27    54    59
       2003                       2.20        455.00     27    28    44
       2004                       3.25        466.00     28    44    56
       2058                        .42        500.00      6     7    48
       2059                        .31        505.00     13
       2060                        .87        489.00      4     5    60    61
       2061                       3.70        456.00      3     4    49    60
```

```
     2062                       1.41       475.00     2    3    49   50
     2063                        .65       490.00     1    2    50
     2075                        .84       500.00     7   11    13   48
     2076                        .10       480.00    11
     2077                        .44       500.00     1
     2082                       1.06       495.00     5    6    10   61
     2086                        .17       490.00    54
     2087                       3.06       500.00    56   57


 O U T P U T   O P T I O N   D A T A

 OUTPUT SELECTION:  ALL RESULTS ARE INCLUDED IN THE TABULATED OUTPUT


 S Y S T E M   C O N F I G U R A T I O N

     NUMBER OF PIPES ...................(p) =   63
     NUMBER OF JUNCTION NODES ..........(j) =   42
     NUMBER OF PRIMARY LOOPS ...........(l) =   20
     NUMBER OF FIXED GRADE NODES .......(f) =    2
     NUMBER OF SUPPLY ZONES ............(z) =    1


                     *************************************
                      S I M U L A T I O N   R E S U L T S
                     *************************************

 THE RESULTS ARE OBTAINED AFTER  8 TRIALS WITH AN ACCURACY =  .00246


 P I P E L I N E   R E S U L T S

 STATUS CODE:    XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                 CV -CHECK VALVE    RV -REGULATING VALVE    TK -STORAGE TANK

   PIPE        NODE NOS.      FLOWRATE    HEAD    PUMP   MINOR    LINE     HL/
  NUMBER      #1     #2                   LOSS    HEAD    LOSS    VELO.   1000
                                (l/s)      (m)     (m)     (m)    (m/s)   (m/m
 -----------------------------------------------------------------------------
     1      2077   2063           -.44     .02     .00     .00     .09      .1
     2      2063   2062           -.29     .07     .00     .00     .12      .5
     3      2062   2061          -1.20     .51     .00     .00     .24     1.3
     4      2061   2060          -3.80    2.82     .00     .00     .51     4.2
     5      2060   2082          -5.70     .58     .00     .00     .37     1.5
     6      2082   2058           1.67     .05     .00     .00     .11      .1
     7      2058   2075            .33     .04     .00     .00     .14      .7
     8      1048   1047           3.46   22.82     .00     .00    1.46    57.0
     9      1064   1046          -3.72    1.43     .00     .00     .76    11.1
```

```
    10       1064    2082          9.80     1.78     .00      .00      .64     3.5
    11       2076    2075          -.10      .00     .00      .00      .02      .0
    12       1046    1049           .71     1.14     .00      .00      .30     3.0
    13       2075    2059           .31      .19     .00      .00      .13      .6
    14-RV    1500    1046          1.84     1.26     .00      .00      .38     3.0
    15       1045    1063          2.71     1.24     .00      .00      .55     6.2
    16       1045    1043         -2.03      .85     .00      .00      .27     1.3
    17       1043    1044           .05      .00     .00      .00      .02      .0
    18       1043    1042         -1.26      .37     .00      .00      .17      .5
    19       1042    1056          1.48      .09     .00      .00      .10      .1
    20       1056    1057           .14      .01     .00      .00      .03      .0
    21       1042    1032          4.81      .63     .00      .00      .31     1.1
    22-FG       0    1042         26.35      .58     .00      .00      .54     1.3
    23-FG       0    1034         19.94     1.01     .00      .00      .65     2.4
    24       1034    1035          1.26     2.34     .00      .00      .53     8.7
    25       1035    1700          6.76      .11     .00      .00      .91    10.7
    26       2001    2002          -.21      .05     .00      .00      .09      .3
    27       2002    2003          5.45     3.30     .00      .00      .74     8.3
    28       2003    2004           .85     1.32     .00      .00      .36     4.2
    29       1032    1033          -.33      .00     .00      .00      .02      .0
    30       1033    1034          -.36      .20     .00      .00      .15      .8
    31       1033    1036          7.57     1.17     .00      .00      .49     2.5
    32       1036    1037          5.78     2.75     .00      .00      .78     9.2
    33       1037    1059          5.13     6.98     .00      .00     1.05    17.4
    34       1059    1060          4.95     2.45     .00      .00     1.01    16.3
    35       1036    1038          4.38     1.38     .00      .00      .59     5.5
    36       1038    1039          3.74      .40     .00      .00      .51     4.1
    37       1039    1040           .50      .55     .00      .00      .21     1.5
    38       1038    1041           .19      .01     .00      .00      .04      .0
    39       1063    1048          3.90    11.15     .00      .00      .80    10.5
    40       1063    1500          1.84      .03     .00      .00      .38     3.0
    41       1034    1035          6.07     2.34     .00      .00      .82     8.7
    42       1039    1040           .50      .55     .00      .00      .21     1.5
    43       1043    1042        -16.06      .35     .00      .00      .33      .5
    44       2003    2004          2.40     1.32     .00      .00      .49     4.2
    45       1045    1043        -14.34      .85     .00      .00      .47     1.3
    46       1045    1063         13.22     1.24     .00      .00      .86     6.2
    47-RV    1500    1046          8.99     1.26     .00      .00      .58     3.0
    48       2058    2075           .92      .04     .00      .00      .19      .7
    49       2062    2061         -1.30      .51     .00      .00      .27     1.3
    50       2063    2062          -.80      .07     .00      .00      .16      .5
    51       1033    1034        -11.43      .20     .00      .00      .37      .8
    52       1063    1500          8.99      .03     .00      .00      .58     3.0
    53       1064    1047         -2.75      .70     .00      .00      .56     6.3
    54       2002    2086           .17      .00     .00      .00      .02      .0
    55-XX    2001    1041
    56-XX    2004    2087
    57       2087    1040         -3.06     2.34     .00      .00      .62     6.7
    58       1039    1040          2.39      .55     .00      .00      .32     1.5
    59-RV    1700    2002          6.76     2.57     .00      .00      .91    10.7
    60       2060    2061          2.40     2.82     .00      .00      .49     4.2
    61       2082    2060          1.37      .58     .00      .00      .28     1.5
    62       1046    1064          4.17     1.43     .00      .00      .85    11.9
```

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   63       1033    1036           3.12     1.17      .00       .00      .42      2.5


  J U N C T I O N   N O D E   R E S U L T S

   JUNCTION   JUNCTION    EXTERNAL   HYDRAULIC   JUNCTION    PRESSURE   JUNCTIO
    NUMBER     TITLE       DEMAND      GRADE     ELEVATION     HEAD     PRESSUR
                           (1/s)        (m)         (m)         (m)      (kpa)
 ------------------------------------------------------------------------------
    1032                    5.14      567.78      517.00      50.78     498.03
    1033                     .78      567.79      542.00      25.79     252.90
    1034                     .81      567.99      530.00      37.99     372.59
    1035                     .57      565.65      522.00      43.65     428.09
    1036                     .53      566.62      519.00      47.62     467.03
    1037                     .65      563.87      537.00      26.87     263.55
    1038                     .45      565.24      512.00      53.24     522.11
    1039                     .36      564.84      510.00      54.84     537.82
    1040                     .32      564.30      530.00      34.30     336.34
    1041                     .19      565.23      502.00      63.23     620.12
    1042                    2.74      568.42      502.00      66.42     651.34
    1043                     .90      568.05      553.00      15.05     147.60
    1044                     .05      568.05      557.00      11.05     108.35
    1045                     .44      567.20      551.00      16.20     158.89
    1046                    2.23      532.74      487.00      45.74     448.51
    1047                     .71      532.01      482.00      50.01     490.43
    1048                     .44      554.82      529.00      25.82     253.26
    1049                     .71      531.60      453.00      78.60     770.77
    1056                    1.34      568.33      534.00      34.33     336.62
    1057                     .14      568.32      555.00      13.32     130.60
    1059                     .18      556.90      494.00      62.90     616.81
    1060                    4.95      554.45      495.00      59.45     582.99
    1063                    1.19      565.98      534.00      31.98     313.59
    1064                     .85      531.31      482.00      49.31     483.53
    1500                     .00      565.95
    1700                     .00      565.55
    2001                     .21      522.69      478.00      44.69     438.22
    2002                     .93      522.73      463.00      59.73     585.77
    2003                    2.20      519.43      455.00      64.43     631.88
    2004                    3.25      518.12      466.00      52.12     511.10
    2058                     .42      529.48      500.00      29.48     289.07
    2059                     .31      529.25      505.00      24.25     237.83
    2060                     .87      528.95      489.00      39.95     391.76
    2061                    3.70      526.13      456.00      70.13     687.73
    2062                    1.41      525.62      475.00      50.62     496.43
    2063                     .65      525.55      490.00      35.55     348.61
    2075                     .84      529.44      500.00      29.44     288.72
    2076                     .10      529.44      480.00      49.44     484.83
    2077                     .44      525.53      500.00      25.53     250.36
    2082                    1.06      529.52      495.00      34.52     338.57
    2086                     .17      522.73      490.00      32.73     320.96
    2087                    3.06      561.95      500.00      61.95     607.54
```

```
 R E G U L A T I N G   V A L V E   R E P O R T

 VALVE POSITION CONTROLLED  VALVE    VALVE     UPSTREAM DOWNSTREAM THROUGH
 TYPE     NODE      PIPE   SETTING  STATUS      GRADE      GRADE     FLOW
                         (m or l/s)              (m)        (m)      (l/s)
 ---------------------------------------------------------------------------
 PRV-1  1500         14    534.00  THROTTLED   565.95     532.74      1.84
 PRV-1  1500         47    534.00  THROTTLED   565.95     532.74      8.99
 PRV-1  1700         59    525.30  THROTTLED   565.55     522.73      6.76


 S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

 (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
 (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

              PIPE       FLOWRATE
             NUMBER        (l/s)
             --------------------
               22          26.35
               23          19.94

 NET SYSTEM INFLOW  =      46.29
 NET SYSTEM OUTFLOW =        .00
 NET SYSTEM DEMAND  =      46.29


 D A T A   C H A N G E S   F O R   N E X T   S I M U L A T I O N

      D E M A N D   C H A N G E S

 DEMAND TYPE =  1 -   GDF =   .300


                     *************************************
                      S I M U L A T I O N   R E S U L T S
                     *************************************

 THE RESULTS ARE OBTAINED AFTER  2 TRIALS WITH AN ACCURACY =  .00424


 P I P E L I N E   R E S U L T S

 STATUS CODE:   XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                CV -CHECK VALVE    RV -REGULATING VALVE    TK -STORAGE TANK
```

```
  PIPE        NODE NOS.        FLOWRATE     HEAD     PUMP    MINOR     LINE      HL/
 NUMBER      #1       #2                    LOSS     HEAD     LOSS     VELO.    1000
                                 (l/s)       (m)      (m)      (m)     (m/s)    (m/m
 ---------------------------------------------------------------------------------------
    1       2077     2063         -.13       .00      .00      .00      .03       .0
    2       2063     2062         -.09       .01      .00      .00      .04       .0
    3       2062     2061         -.36       .05      .00      .00      .07       .1
    4       2061     2060        -1.14       .30      .00      .00      .15       .4
    5       2060     2082        -1.71       .06      .00      .00      .11       .1
    6       2082     2058          .50       .01      .00      .00      .03       .0
    7       2058     2075          .10       .00      .00      .00      .04       .0
    8       1048     1047         3.54     23.74      .00      .00     1.49     59.3
    9       1064     1046          .06       .00      .00      .00      .01       .0
   10       1064     2082         2.94       .19      .00      .00      .19       .3
   11       2076     2075         -.03       .00      .00      .00      .01       .0
   12       1046     1049          .21       .12      .00      .00      .09       .3
   13       2075     2059          .09       .02      .00      .00      .04       .0
   14-RV    1500     1046          .13       .01      .00      .00      .03       .0
   15       1045     1063          .81       .13      .00      .00      .17       .6
   16       1045     1043         -.61       .09      .00      .00      .08       .1
   17       1043     1044          .02       .00      .00      .00      .01       .0
   18       1043     1042         -.37       .04      .00      .00      .05       .0
   19       1042     1056          .44       .01      .00      .00      .03       .0
   20       1056     1057          .04       .00      .00      .00      .01       .0
   21       1042     1032         1.44       .07      .00      .00      .09       .1
   22-FG       0     1042         7.91       .06      .00      .00      .16       .1
   23-FG       0     1034         5.98       .11      .00      .00      .19       .2
   24       1034     1035          .38       .25      .00      .00      .16       .9
   25       1035     1700         2.03       .01      .00      .00      .27      1.1
   26       2001     2002         -.06       .00      .00      .00      .03       .0
   27       2002     2003         1.63       .35      .00      .00      .22       .9
   28       2003     2004          .26       .14      .00      .00      .11       .4
   29       1032     1033         -.10       .00      .00      .00      .01       .0
   30       1033     1034         -.11       .02      .00      .00      .05       .0
   31       1033     1036         2.27       .13      .00      .00      .15       .2
   32       1036     1037         1.73       .30      .00      .00      .23      1.0
   33       1037     1059         1.54       .75      .00      .00      .31      1.8
   34       1059     1060         1.49       .26      .00      .00      .30      1.7
   35       1036     1038         1.31       .15      .00      .00      .18       .6
   36       1038     1039         1.12       .04      .00      .00      .15       .4
   37       1039     1040          .15       .06      .00      .00      .06       .1
   38       1038     1041          .06       .00      .00      .00      .01       .0
   39       1063     1048         3.67      9.95      .00      .00      .75      9.3
   40       1063     1500          .13       .00      .00      .00      .03       .0
   41       1034     1035         1.82       .25      .00      .00      .25       .9
   42       1039     1040          .15       .06      .00      .00      .06       .1
   43       1043     1042        -4.83       .04      .00      .00      .10       .0
   44       2003     2004          .72       .14      .00      .00      .15       .4
   45       1045     1043        -4.30       .09      .00      .00      .14       .1
   46       1045     1063         3.97       .13      .00      .00      .26       .6
   47-RV    1500     1046          .62       .01      .00      .00      .04       .0
   48       2058     2075          .28       .00      .00      .00      .06       .0
   49       2062     2061         -.39       .05      .00      .00      .08       .1
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    50       2063     2062           -.24       .01       .00       .00       .05        .0
    51       1033     1034          -3.43       .02       .00       .00       .11        .0
    52       1063     1500            .62       .00       .00       .00       .04        .0
    53       1064     1047          -3.33      1.00       .00       .00       .68       9.0
    54       2002     2086            .05       .00       .00       .00       .01        .0
    55-XX    2001     1041
    56-XX    2004     2087
    57       2087     1040           -.92       .25       .00       .00       .19        .7
    58       1039     1040            .72       .06       .00       .00       .10        .1
    59-RV    1700     2002           2.03       .28       .00       .00       .27       1.1
    60       2060     2061            .72       .30       .00       .00       .15        .4
    61       2082     2060            .41       .06       .00       .00       .08        .1
    62       1046     1064           -.07       .00       .00       .00       .01        .0
    63       1033     1036            .94       .13       .00       .00       .13        .2


 J U N C T I O N   N O D E   R E S U L T S

  JUNCTION   JUNCTION    EXTERNAL   HYDRAULIC   JUNCTION    PRESSURE   JUNCTIO
   NUMBER     TITLE       DEMAND      GRADE     ELEVATION     HEAD     PRESSUR
                          (l/s)        (m)         (m)         (m)      (kpa)
 ---------------------------------------------------------------------------
   1032                    1.54      568.87      517.00       51.87     508.67
   1033                     .23      568.87      542.00       26.87     263.50
   1034                     .24      568.89      530.00       38.89     381.40
   1035                     .17      568.64      522.00       46.64     457.38
   1036                     .16      568.74      519.00       49.74     487.83
   1037                     .20      568.45      537.00       31.45     308.41
   1038                     .14      568.60      512.00       56.60     555.02
   1039                     .11      568.55      510.00       58.55     574.21
   1040                     .10      568.49      530.00       38.49     377.50
   1041                     .06      568.59      502.00       66.59     653.08
   1042                     .82      568.94      502.00       66.94     656.44
   1043                     .27      568.90      553.00       15.90     155.92
   1044                     .02      568.90      557.00       11.90     116.69
   1045                     .13      568.81      551.00       17.81     174.64
   1046                     .67      533.99      487.00       46.99     460.83
   1047                     .21      534.99      482.00       52.99     519.65
   1048                     .13      558.73      529.00       29.73     291.54
   1049                     .21      533.87      453.00       80.87     793.05
   1056                     .40      568.93      534.00       34.93     342.52
   1057                     .04      568.93      555.00       13.93     136.57
   1059                     .05      567.70      494.00       73.70     722.74
   1060                    1.49      567.43      495.00       72.43     710.35
   1063                     .36      568.67      534.00       34.67     340.04
   1064                     .26      533.99      482.00       51.99     509.87
   1500                     .00      568.67
   1700                     .00      568.63
   2001                     .06      525.02      478.00       47.02     461.10
   2002                     .28      525.02      463.00       62.02     608.25
   2003                     .66      524.67      455.00       69.67     683.22
   2004                     .98      524.53      466.00       58.53     573.96
```
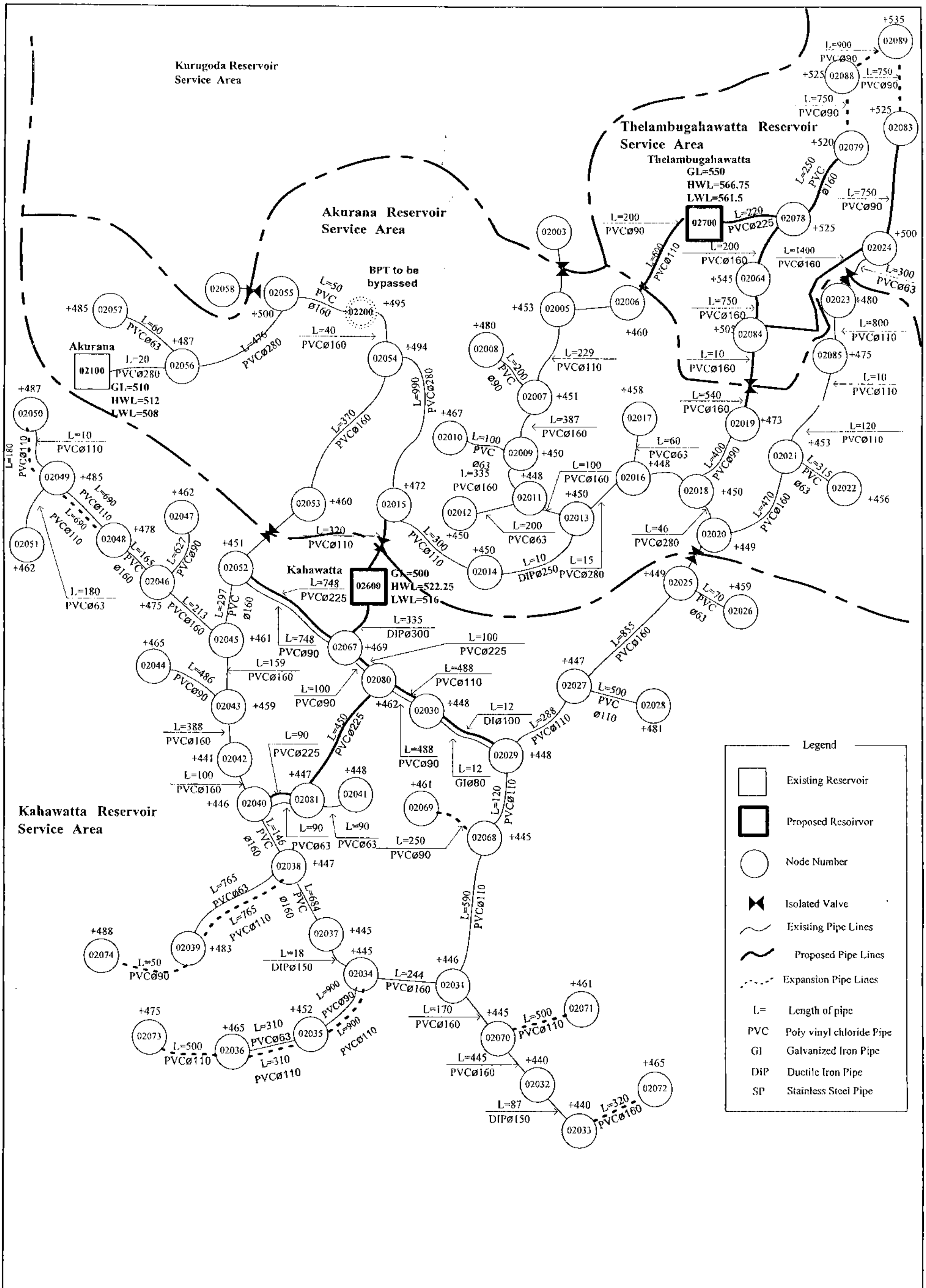

```
   2058                      .13      533.79      500.00      33.79      331.42
   2059                      .09      533.77      505.00      28.77      282.15
   2060                      .26      533.74      489.00      44.74      438.73
   2061                     1.11      533.43      456.00      77.43      759.38
   2062                      .42      533.38      475.00      58.38      572.52
   2063                      .20      533.37      490.00      43.37      425.34
   2075                      .25      533.79      500.00      33.79      331.38
   2076                      .03      533.79      480.00      53.79      527.51
   2077                      .13      533.37      500.00      33.37      327.25
   2082                      .32      533.80      495.00      38.80      380.50
   2086                      .05      525.02      490.00      35.02      343.46
   2087                      .92      568.24      500.00      68.24      669.23


 R E G U L A T I N G   V A L V E   R E P O R T

 VALVE POSITION CONTROLLED  VALVE     VALVE     UPSTREAM DOWNSTREAM THROUGH
 TYPE     NODE      PIPE   SETTING    STATUS     GRADE      GRADE     FLOW
                         (m or l/s)               (m)        (m)      (l/s)
 ---------------------------------------------------------------------------
 PRV-1  1500        14     534.00   THROTTLED   568.67     533.99       .13
 PRV-1  1500        47     534.00   THROTTLED   568.67     533.99       .62
 PRV-1  1700        59     525.30   THROTTLED   568.63     525.02      2.03


 S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

 (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
 (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

              PIPE        FLOWRATE
             NUMBER        (l/s)
             --------------------
               22           7.91
               23           5.98

 NET SYSTEM INFLOW  =      13.89
 NET SYSTEM OUTFLOW =        .00
 NET SYSTEM DEMAND  =      13.89


 **** KYPIPE SIMULATION COMPLETED ****


 DATE:  3/ 7/2002
 TIME: 10:29:32
```



Appendix - 5.2 Improvement of Distribution Network in 2015
(Akurana, Thelambugahawatta, Kahawatta Reservoir Service Areas)

```
         * * * * * * * * * *  K Y P I P E 2  * * * * * * * * * *
         *   University of Kentucky Hydraulic Analysis Program   *
         * Distribution of Pressure and Flows in Piping Networks *
         *         1000 PIPE VERSION - 1.10   (08/25/92)         *
         * * * * * * * * * * * * * * * * * * * * * * * * * * * * *



 DATE:  3/ 7/2002
 TIME: 10:30:33

 INPUT DATA FILENAME -------------- c:\D_nets\2015\THEL2015.DAT
 TABULATED OUTPUT FILENAME -------- c:\D_nets\2015\THEL2015.OUT
 POSTPROCESSOR RESULTS FILENAME --- c:\D_nets\2015\THEL2015.RES


               ************************************************
                S U M M A R Y   O F   O R I G I N A L   D A T A
               ************************************************



 U N I T S   S P E C I F I E D

    FLOWRATE ............ = liters/second
    HEAD (HGL) .......... = meters
    PRESSURE ............ = kpa



 P I P E L I N E   D A T A

 STATUS CODE:    XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                 CV -CHECK VALVE    RV -REGULATING VALVE

   PIPE        NODE NOS.      LENGTH   DIAMETER   ROUGHNESS   MINOR LOSS   FGN-H
  NUMBER       #1    #2        (m)       (cm)       COEFF.      COEFF.      (m)
 --------------------------------------------------------------------------------
    1-FG        0  2006       690.0       9.7      130.00         .00      561.
    2-FG        0  2078       220.0      19.8      130.00         .00      561.
    3        2078  2064       200.0      19.8      130.00         .00
    4        2064  2084       750.0      14.0      130.00         .00
    5        2078  2079       250.0      14.0      130.00         .00
    6        2084  2024      1400.0      14.0      130.00         .00
    7        2024  2083       750.0       7.9      130.00         .00
    8        2083  2089       750.0       7.9      130.00         .00
    9        2079  2088       750.0       7.9      130.00         .00
   10        2088  2089       900.0       7.9      130.00         .00
```

```
 J U N C T I O N   N O D E   D A T A


    JUNCTION    JUNCTION      EXTERNAL    JUNCTION
     NUMBER      TITLE         DEMAND     ELEVATION  CONNECTING PIPES
                               (l/s)         (m)
 ----------------------------------------------------------------------------
     2006                       3.50       460.00      1
     2024                       3.77       500.00      6    7
     2064                       6.40       545.00      3    4
     2078                       9.46       525.00      2    3    5
     2079                       2.50       520.00      5    9
     2083                       1.19       525.00      7    8
     2084                       7.53       505.00      4    6
     2088                       1.12       525.00      9   10
     2089                       1.29       535.00      8   10


 O U T P U T   O P T I O N   D A T A

 OUTPUT SELECTION:  ALL RESULTS ARE INCLUDED IN THE TABULATED OUTPUT


 S U P P L Y   Z O N E   D A T A

 THIS SYSTEM HAS MULTIPLE SUPPLY ZONES

      ZONE NO.   1 IS SUPPLIED THROUGH THESE PIPES:
                                                       2


 S Y S T E M   C O N F I G U R A T I O N

     NUMBER OF PIPES ...................(p) =   10
     NUMBER OF JUNCTION NODES ..........(j) =    9
     NUMBER OF PRIMARY LOOPS ...........(l) =    1
     NUMBER OF FIXED GRADE NODES .......(f) =    2
     NUMBER OF SUPPLY ZONES ............(z) =    2


                       *************************************
                        S I M U L A T I O N   R E S U L T S
                       *************************************

 THE RESULTS ARE OBTAINED AFTER  4 TRIALS WITH AN ACCURACY =  .00134


 P I P E L I N E   R E S U L T S
```

```
 STATUS CODE:    XX -CLOSED PIPE     FG -FIXED GRADE NODE     PU -PUMP LINE
                 CV -CHECK VALVE     RV -REGULATING VALVE     TK -STORAGE TANK

  PIPE          NODE NOS.         FLOWRATE      HEAD      PUMP     MINOR      LINE      HL/
 NUMBER        #1      #2                       LOSS      HEAD      LOSS     VELO.     1000
                                    (l/s)       (m)       (m)       (m)      (m/s)     (m/m
 ------------------------------------------------------------------------------------------
    1-FG        0    2006            3.50      2.18       .00       .00        .47      3.1
    2-FG        0    2078           33.26      1.39       .00       .00       1.08      6.3
    3        2078    2064           18.58       .43       .00       .00        .60      2.1
    4        2064    2084           12.18      4.00       .00       .00        .79      5.3
    5        2078    2079            5.22       .28       .00       .00        .34      1.1
    6        2084    2024            4.65      1.26       .00       .00        .30       .9
    7        2024    2083             .88       .50       .00       .00        .18       .6
    8        2083    2089            -.31       .07       .00       .00        .06       .1
    9        2079    2088            2.72      4.03       .00       .00        .55      5.3
   10        2088    2089            1.60      1.81       .00       .00        .33      2.0


 JUNCTION NODE RESULTS

  JUNCTION    JUNCTION     EXTERNAL    HYDRAULIC     JUNCTION      PRESSURE     JUNCTIO
   NUMBER      TITLE        DEMAND       GRADE       ELEVATION       HEAD       PRESSUR
                            (l/s)         (m)           (m)          (m)         (kpa)
 ------------------------------------------------------------------------------------------
   2006                      3.50       559.32        460.00        99.32       973.98
   2024                      3.77       554.42        500.00        54.42       533.66
   2064                      6.40       559.67        545.00        14.67       143.91
   2078                      9.46       560.11        525.00        35.11       344.28
   2079                      2.50       559.83        520.00        39.83       390.59
   2083                      1.19       553.92        525.00        28.92       283.57
   2084                      7.53       555.67        505.00        50.67       496.95
   2088                      1.12       555.80        525.00        30.80       302.00
   2089                      1.29       553.99        535.00        18.99       186.20


 SUMMARY OF INFLOWS AND OUTFLOWS

 (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
 (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

               PIPE         FLOWRATE
              NUMBER          (l/s)
              --------------------
                 1             3.50
                 2            33.26

 NET SYSTEM INFLOW   =        36.76
 NET SYSTEM OUTFLOW  =          .00
 NET SYSTEM DEMAND   =        36.76
```

```
 D A T A   C H A N G E S   F O R   N E X T   S I M U L A T I O N


      D E M A N D   C H A N G E S

 DEMAND TYPE =  1 -   GDF =   .300


                        ************************************
                         S I M U L A T I O N   R E S U L T S
                        ************************************

 THE RESULTS ARE OBTAINED AFTER  2 TRIALS WITH AN ACCURACY =  .00000


 P I P E L I N E   R E S U L T S

 STATUS CODE:   XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                CV -CHECK VALVE    RV -REGULATING VALVE    TK -STORAGE TANK

   PIPE        NODE NOS.      FLOWRATE     HEAD     PUMP    MINOR     LINE     HL/
  NUMBER       #1      #2                  LOSS     HEAD     LOSS    VELO.    1000
                                (l/s)       (m)      (m)      (m)    (m/s)    (m/m
 -----------------------------------------------------------------------------------
     1-FG       0    2006         1.05      .23      .00      .00      .14      .3
     2-FG       0    2078         9.98      .15      .00      .00      .32      .6
     3       2078    2064         5.57      .05      .00      .00      .18      .2
     4       2064    2084         3.65      .43      .00      .00      .24      .5
     5       2078    2079         1.57      .03      .00      .00      .10      .1
     6       2084    2024         1.40      .14      .00      .00      .09      .1
     7       2024    2083          .26      .05      .00      .00      .05      .0
     8       2083    2089         -.09      .01      .00      .00      .02      .0
     9       2079    2088          .82      .43      .00      .00      .17      .5
    10       2088    2089          .48      .19      .00      .00      .10      .2


 J U N C T I O N   N O D E   R E S U L T S

  JUNCTION   JUNCTION   EXTERNAL   HYDRAULIC   JUNCTION   PRESSURE   JUNCTIO
   NUMBER     TITLE      DEMAND      GRADE    ELEVATION     HEAD     PRESSUR
                         (l/s)        (m)        (m)         (m)      (kpa)
 -----------------------------------------------------------------------------
   2006                   1.05      561.27     460.00      101.27     993.08
   2024                   1.13      560.74     500.00       60.74     595.64
   2064                   1.92      561.30     545.00       16.30     159.89
   2078                   2.84      561.35     525.00       36.35     356.47
   2079                    .75      561.32     520.00       41.32     405.22
```

```
   2083                          .36       560.68      525.00      35.68      349.95
   2084                         2.26       560.87      505.00      55.87      547.93
   2088                          .34       560.89      525.00      35.89      351.93
   2089                          .39       560.69      535.00      25.69      251.95


 S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

 (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
 (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

              PIPE        FLOWRATE
             NUMBER        (1/s)
             --------------------
                1           1.05
                2           9.98

 NET SYSTEM INFLOW  =      11.03
 NET SYSTEM OUTFLOW =        .00
 NET SYSTEM DEMAND  =      11.03


 **** KYPIPE SIMULATION COMPLETED ****


 DATE:  3/ 7/2002
 TIME: 10:30:33
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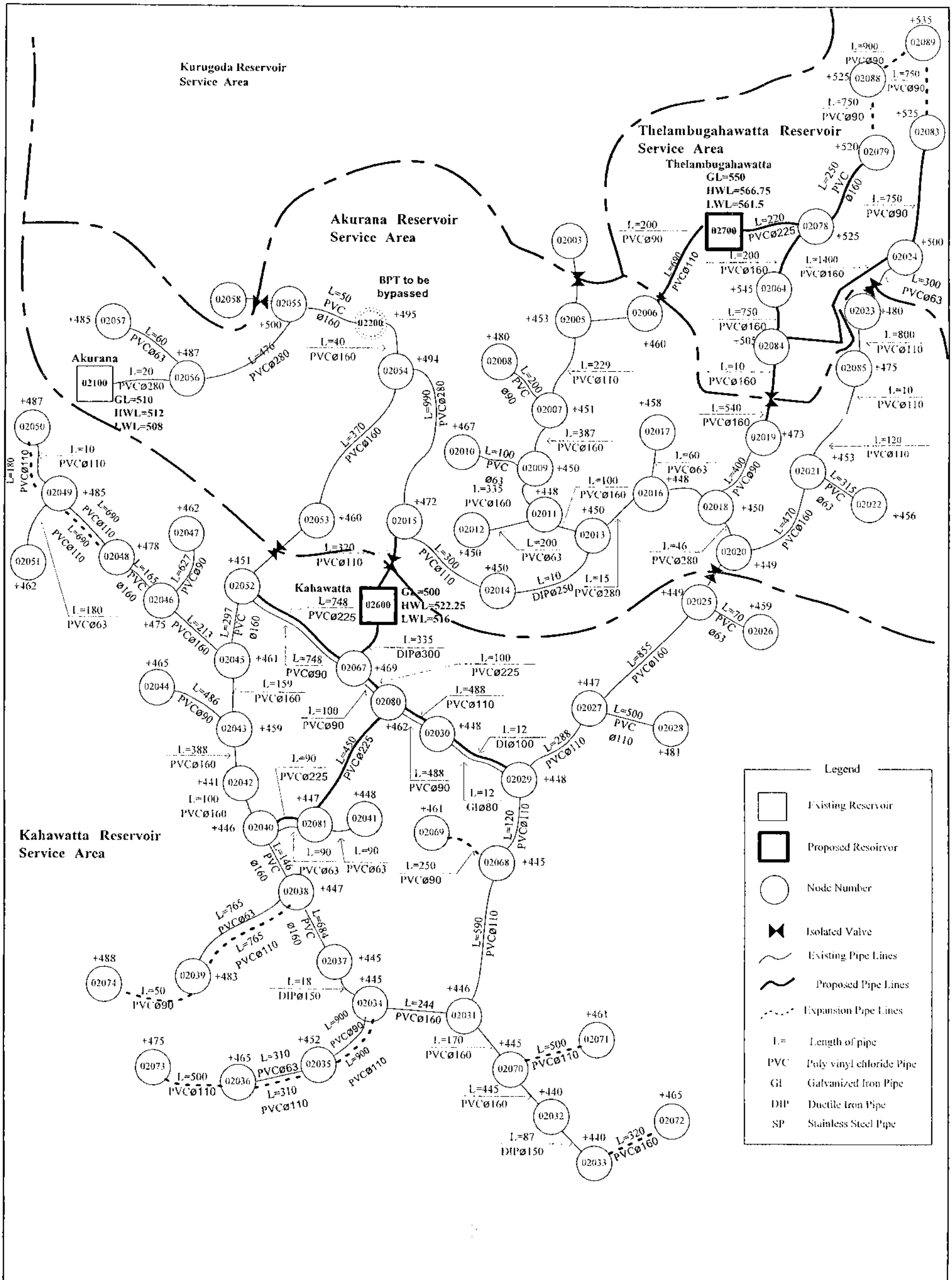


Appendix - 5.2 Improvement of Distribution Network in 2015
(Akurana, Thelambugahawatta, Kahawatta Reservoir Service Areas)

```
        * * * * * * * * * *   K Y P I P E 2   * * * * * * * * * *
        *   University of Kentucky Hydraulic Analysis Program   *
        * Distribution of Pressure and Flows in Piping Networks *
        *         1000 PIPE VERSION - 1.10   (08/25/92)         *
        * * * * * * * * * * * * * * * * * * * * * * * * * * * * *



 DATE:  3/ 7/2002
 TIME: 10:33: 4

 INPUT DATA FILENAME -------------- c:\D_nets\2015\KAHW2015.DAT
 TABULATED OUTPUT FILENAME -------- c:\D_nets\2015\KAHW2015.OUT
 POSTPROCESSOR RESULTS FILENAME --- c:\D_nets\2015\KAHW2015.RES


              ************************************************
               S U M M A R Y   O F   O R I G I N A L   D A T A
              ************************************************


 U N I T S   S P E C I F I E D

    FLOWRATE ............ = liters/second
    HEAD (HGL) .......... = meters
    PRESSURE ............ = kpa


 P I P E L I N E   D A T A

 STATUS CODE:    XX -CLOSED PIPE     FG -FIXED GRADE NODE     PU -PUMP LINE
                 CV -CHECK VALVE     RV -REGULATING VALVE

   PIPE        NODE NOS.       LENGTH    DIAMETER    ROUGHNESS    MINOR LOSS    FGN-H
  NUMBER        #1    #2         (m)       (cm)        COEFF.       COEFF.        (m)
 ------------------------------------------------------------------------------------
     1-FG        0  2067       335.0      30.0       130.00          .00       516.
     2        2067  2052       848.0       7.9       120.00          .00
     3        2067  2080       100.0       7.9       120.00          .00
     4        2052  2045       297.0      14.0       120.00          .00
     5        2045  2043       159.0      14.0       120.00          .00
     6        2045  2046       213.0      14.0       120.00          .00
     7        2043  2042       388.0      14.0       120.00          .00
     8        2043  2044       486.0       7.9       120.00          .00
     9        2042  2040       100.0      14.0       120.00          .00
    10        2040  2038       146.0      14.0       120.00          .00
    11        2040  2081        90.0       5.5       120.00          .00
    12        2081  2041        90.0       5.5       120.00          .00
    13        2081  2080       450.0      19.8       130.00          .00
```

```
    14         2038   2039         765.0        5.5         120.00            .00
    15         2038   2037         684.0       14.0         120.00            .00
    16         2039   2074          50.0        7.9         130.00            .00
    17         2037   2034          18.0       15.0         120.00            .00
    18         2034   2035         900.0        7.9         120.00            .00
    19         2034   2031         244.0       14.0         120.00            .00
    20         2035   2036         310.0        5.5         120.00            .00
    21         2036   2073         500.0        9.7         130.00            .00
    22         2031   2070         170.0       14.0         120.00            .00
    23         2031   2068         590.0        9.7         120.00            .00
    24         2070   2032         445.0       14.0         120.00            .00
    25         2070   2071         500.0        9.7         130.00            .00
    26         2032   2033          87.0       15.0         120.00            .00
    27         2033   2072         320.0       14.0         130.00            .00
    28         2068   2029         120.0        9.7         120.00            .00
    29         2068   2069         250.0        7.9         130.00            .00
    30         2029   2030          12.0        8.0         120.00            .00
    31         2029   2027         288.0        9.7         120.00            .00
    32         2030   2080         488.0        7.9         120.00            .00
    33         2027   2028         500.0        9.7         120.00            .00
    34         2027   2025         855.0       14.0         120.00            .00
    35         2025   2026          70.0        5.5         120.00            .00
    36         2046   2047         627.0        7.9         120.00            .00
    37         2046   2048         165.0       14.0         120.00            .00
    38         2048   2049         690.0        9.7         120.00            .00
    39         2049   2050          10.0        9.7         120.00            .00
    40         2049   2051         180.0        5.5         120.00            .00
    41         2067   2052         848.0       19.8         130.00            .00
    42         2067   2080         100.0       19.8         130.00            .00
    43         2040   2081          90.0       19.8         130.00            .00
    44         2038   2039         765.0        9.7         130.00            .00
    45         2035   2036         310.0        9.7         130.00            .00
    46         2029   2030          12.0       10.0         130.00            .00
    47         2030   2080         188.0        9.7         130.00            .00
    48         2048   2049         690.0        9.7         130.00            .00
    49         2049   2050          10.0        9.7         130.00            .00
    50         2034   2035         900.0        9.7         130.00            .00


 J U N C T I O N   N O D E   D A T A


     JUNCTION     JUNCTION      EXTERNAL     JUNCTION
      NUMBER       TITLE         DEMAND      ELEVATION   CONNECTING PIPES
                                 (l/s)          (m)
---------------------------------------------------------------------------
      2025                         .49        449.00     34    35
      2026                         .02        459.00     35
      2027                        1.31        447.00     31    33    34
      2028                         .14        481.00     33
      2029                         .35        448.00     28    30    31    46
      2030                         .18        448.00     30    32    46    47
```

```
     2031                        .74       446.00    19   22   23
     2032                       1.89       440.00    24   26
     2033                       1.90       440.00    26   27
     2034                       1.48       445.00    17   18   19   50
     2035                        .98       452.00    18   20   45   50
     2036                       1.10       465.00    20   21   45
     2037                       1.90       445.00    15   17
     2038                       4.39       447.00    10   14   15   44
     2039                       1.36       483.00    14   16   44
     2040                        .48       446.00     9   10   11   43
     2041                        .05       448.00    12
     2042                        .84       441.00     7    9
     2043                       1.22       459.00     5    7    8
     2044                        .28       465.00     8
     2045                        .65       461.00     4    5    6
     2046                       1.52       475.00     6   36   37
     2047                       1.61       462.00    36
     2048                       3.86       478.00    37   38   48
     2049                       1.63       485.00    38   39   40   48   49
     2050                        .43       487.00    39   49
     2051                        .39       462.00    40
     2052                        .98       451.00     2    4   41
     2067                       1.24       469.00     1    2    3   41   42
     2068                        .67       445.00    23   28   29
     2069                        .23       461.00    29
     2070                       1.97       445.00    22   24   25
     2071                        .40       461.00    25
     2072                       7.05       465.00    27
     2073                        .41       475.00    21
     2074                        .54       488.00    16
     2080                       1.18       462.00     3   13   32   42   47
     2081                        .44       447.00    11   12   13   43


 O U T P U T   O P T I O N   D A T A

 OUTPUT SELECTION:  ALL RESULTS ARE INCLUDED IN THE TABULATED OUTPUT


 S Y S T E M   C O N F I G U R A T I O N

     NUMBER OF PIPES ....................(p) =   50
     NUMBER OF JUNCTION NODES ...........(j) =   38
     NUMBER OF PRIMARY LOOPS ............(l) =   12
     NUMBER OF FIXED GRADE NODES ........(f) =    1
     NUMBER OF SUPPLY ZONES .............(z) =    1


                     *************************************
                      S I M U L A T I O N   R E S U L T S
```

```
                    ************************************

 THE RESULTS ARE OBTAINED AFTER  7 TRIALS WITH AN ACCURACY =  .00213


 P I P E L I N E   R E S U L T S

 STATUS CODE:   XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                CV -CHECK VALVE    RV -REGULATING VALVE    TK -STORAGE TANK

  PIPE       NODE NOS.      FLOWRATE     HEAD    PUMP   MINOR    LINE    HL/
 NUMBER      #1    #2                    LOSS    HEAD    LOSS   VELO.   1000
                             (l/s)       (m)     (m)     (m)    (m/s)   (m/m
---------------------------------------------------------------------------
    1-FG       0   2067        46.30      .52     .00     .00     .66    1.5
    2      2067   2052          .91      .69     .00     .00     .18     .8
    3      2067   2080         2.52      .54     .00     .00     .51    5.4
    4      2052   2045        10.92     1.50     .00     .00     .71    5.0
    5      2045   2043          .83      .01     .00     .00     .05     .0
    6      2045   2046         9.44      .82     .00     .00     .61    3.8
    7      2043   2042         -.67      .01     .00     .00     .04     .0
    8      2043   2044          .28      .05     .00     .00     .06     .0
    9      2042   2040        -1.51      .01     .00     .00     .10     .1
   10      2040   2038        20.03     2.27     .00     .00    1.30   15.5
   11      2040   2081         -.70      .27     .00     .00     .30    2.9
   12      2081   2041          .05      .00     .00     .00     .02     .0
   13      2081   2080       -22.50     1.38     .00     .00     .73    3.0
   14      2038   2039          .33      .55     .00     .00     .14     .7
   15      2038   2037        13.74     5.29     .00     .00     .89    7.7
   16      2039   2074          .54      .01     .00     .00     .11     .2
   17      2037   2034        11.84      .08     .00     .00     .67    4.1
   18      2034   2035          .87      .68     .00     .00     .18     .7
   19      2034   2031         7.87      .67     .00     .00     .51    2.7
   20      2035   2036          .26      .15     .00     .00     .11     .4
   21      2036   2073          .41      .03     .00     .00     .06     .0
   22      2031   2070        13.21     1.22     .00     .00     .86    7.1
   23      2031   2068        -6.08     6.02     .00     .00     .82   10.2
   24      2070   2032        10.84     2.22     .00     .00     .70    4.9
   25      2070   2071          .40      .03     .00     .00     .05     .0
   26      2032   2033         8.95      .22     .00     .00     .51    2.5
   27      2033   2072         7.05      .62     .00     .00     .46    1.9
   28      2068   2029        -6.98     1.58     .00     .00     .94   13.1
   29      2068   2069          .23      .01     .00     .00     .05     .0
   30      2029   2030        -3.15      .09     .00     .00     .63    7.7
   31      2029   2027         1.96      .36     .00     .00     .27    1.2
   32      2030   2080        -2.30     2.24     .00     .00     .47    4.6
   33      2027   2028          .14      .00     .00     .00     .02     .0
   34      2027   2025          .51      .01     .00     .00     .03     .0
   35      2025   2026          .02      .00     .00     .00     .01     .0
   36      2046   2047         1.61     1.48     .00     .00     .33    2.3
   37      2046   2048         6.31      .30     .00     .00     .41    1.8
   38      2048   2049         1.18      .34     .00     .00     .16     .4
```

```
    39      2049    2050            .21      .00      .00      .00      .03       .0
    40      2049    2051            .39      .18      .00      .00      .16      1.0
    41      2067    2052          11.00      .69      .00      .00      .36       .8
    42      2067    2080          30.63      .54      .00      .00      .99      5.4
    43      2040    2081         -21.31      .25      .00      .00      .69      2.7
    44      2038    2039           1.57      .55      .00      .00      .21       .7
    45      2035    2036           1.25      .15      .00      .00      .17       .4
    46      2029    2030          -6.14      .09      .00      .00      .78      7.7
    47      2030    2080          -7.17     2.24      .00      .00      .97     11.9
    48      2048    2049           1.27      .34      .00      .00      .17       .4
    49      2049    2050            .22      .00      .00      .00      .03       .0
    50      2034    2035           1.62      .68      .00      .00      .22       .7


 J U N C T I O N   N O D E   R E S U L T S

  JUNCTION   JUNCTION     EXTERNAL   HYDRAULIC   JUNCTION    PRESSURE   JUNCTIO
   NUMBER     TITLE        DEMAND      GRADE     ELEVATION     HEAD     PRESSUR
                           (l/s)        (m)         (m)         (m)      (kpa)
 -------------------------------------------------------------------------------
   2025                       .49     512.23      449.00       63.23     620.05
   2026                       .02     512.23      459.00       53.23     521.98
   2027                      1.31     512.24      447.00       65.24     639.81
   2028                       .14     512.24      481.00       31.24     306.33
   2029                       .35     512.60      448.00       64.60     633.54
   2030                       .18     512.70      448.00       64.70     634.45
   2031                       .74     505.00      446.00       59.00     578.61
   2032                      1.89     501.56      440.00       61.56     603.72
   2033                      1.90     501.34      440.00       61.34     601.59
   2034                      1.48     505.66      445.00       60.66     594.84
   2035                       .98     504.97      452.00       52.97     519.50
   2036                      1.10     504.83      465.00       39.83     390.58
   2037                      1.90     505.73      445.00       60.73     595.58
   2038                      4.39     511.02      447.00       64.02     627.81
   2039                      1.36     510.47      483.00       27.47     269.38
   2040                       .48     513.29      446.00       67.29     659.87
   2041                       .05     513.55      448.00       65.55     642.86
   2042                       .84     513.29      441.00       72.29     708.95
   2043                      1.22     513.28      459.00       54.28     532.32
   2044                       .28     513.24      465.00       48.24     473.04
   2045                       .65     513.29      461.00       52.29     512.78
   2046                      1.52     512.47      475.00       37.47     367.43
   2047                      1.61     510.98      462.00       48.98     480.37
   2048                      3.86     512.16      478.00       34.16     335.04
   2049                      1.63     511.83      485.00       26.83     263.11
   2050                       .43     511.83      487.00       24.83     243.49
   2051                       .39     511.65      462.00       49.65     486.90
   2052                       .98     514.79      451.00       63.79     625.57
   2067                      1.24     515.48      469.00       46.48     455.84
   2068                       .67     511.02      445.00       66.02     647.46
   2069                       .23     511.01      461.00       50.01     490.41
   2070                      1.97     503.78      445.00       58.78     576.44
```

```
  2071                        .40      503.75      461.00      42.75      419.25
  2072                       7.05      500.72      465.00      35.72      350.34
  2073                        .41      504.80      475.00      29.80      292.22
  2074                        .54      510.46      488.00      22.46      220.21
  2080                       1.18      514.94      462.00      52.94      519.15
  2081                        .44      513.56      447.00      66.56      652.69


 S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

 (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
 (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

           PIPE        FLOWRATE
          NUMBER        (l/s)
          --------------------
             1          46.30

 NET SYSTEM INFLOW  =   46.30
 NET SYSTEM OUTFLOW =     .00
 NET SYSTEM DEMAND  =   46.30


 D A T A   C H A N G E S   F O R   N E X T   S I M U L A T I O N


      D E M A N D   C H A N G E S

 DEMAND TYPE =  1 -   GDF =   .300


                      *************************************
                       S I M U L A T I O N   R E S U L T S
                      *************************************

 THE RESULTS ARE OBTAINED AFTER  2 TRIALS WITH AN ACCURACY =  .00036


 P I P E L I N E   R E S U L T S

 STATUS CODE:   XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                CV -CHECK VALVE    RV -REGULATING VALVE    TK -STORAGE TANK

  PIPE        NODE NOS.      FLOWRATE    HEAD    PUMP   MINOR    LINE     HL/
 NUMBER      #1     #2                   LOSS    HEAD    LOSS    VELO.   1000
                              (l/s)       (m)     (m)     (m)    (m/s)   (m/m
-----------------------------------------------------------------------------
    1-FG      0    2067       13.89      .06     .00     .00      .20      .1
    2      2067    2052         .27      .07     .00     .00      .06      .0
```

```
     3      2067   2080            .76      .06      .00      .00      .15       .5
     4      2052   2045           3.28      .16      .00      .00      .21       .5
     5      2045   2043            .25      .00      .00      .00      .02       .0
     6      2045   2046           2.83      .09      .00      .00      .18       .4
     7      2043   2042           -.20      .00      .00      .00      .01       .0
     8      2043   2044            .08      .00      .00      .00      .02       .0
     9      2042   2040           -.45      .00      .00      .00      .03       .0
    10      2040   2038           6.01      .24      .00      .00      .39      1.6
    11      2040   2081           -.20      .03      .00      .00      .09       .3
    12      2081   2041            .02      .00      .00      .00      .01       .0
    13      2081   2080          -6.75      .15      .00      .00      .22       .3
    14      2038   2039            .10      .06      .00      .00      .04       .0
    15      2038   2037           4.12      .57      .00      .00      .27       .8
    16      2039   2074            .16      .00      .00      .00      .03       .0
    17      2037   2034           3.55      .01      .00      .00      .20       .4
    18      2034   2035            .26      .07      .00      .00      .05       .0
    19      2034   2031           2.36      .07      .00      .00      .15       .3
    20      2035   2036            .08      .02      .00      .00      .03       .0
    21      2036   2073            .12      .00      .00      .00      .02       .0
    22      2031   2070           3.96      .13      .00      .00      .26       .7
    23      2031   2068          -1.82      .65      .00      .00      .25      1.1
    24      2070   2032           3.25      .24      .00      .00      .21       .5
    25      2070   2071            .12      .00      .00      .00      .02       .0
    26      2032   2033           2.69      .02      .00      .00      .15       .2
    27      2033   2072           2.12      .07      .00      .00      .14       .2
    28      2068   2029          -2.09      .17      .00      .00      .28      1.4
    29      2068   2069            .07      .00      .00      .00      .01       .0
    30      2029   2030           -.95      .01      .00      .00      .19       .8
    31      2029   2027            .59      .04      .00      .00      .08       .1
    32      2030   2080           -.69      .24      .00      .00      .14       .4
    33      2027   2028            .04      .00      .00      .00      .01       .0
    34      2027   2025            .15      .00      .00      .00      .01       .0
    35      2025   2026            .01      .00      .00      .00      .00       .0
    36      2046   2047            .48      .16      .00      .00      .10       .2
    37      2046   2048           1.89      .03      .00      .00      .12       .2
    38      2048   2049            .35      .04      .00      .00      .05       .0
    39      2049   2050            .06      .00      .00      .00      .01       .0
    40      2049   2051            .12      .02      .00      .00      .05       .1
    41      2067   2052           3.30      .07      .00      .00      .11       .0
    42      2067   2080           9.19      .06      .00      .00      .30       .5
    43      2040   2081          -6.40      .03      .00      .00      .21       .3
    44      2038   2039            .47      .06      .00      .00      .06       .0
    45      2035   2036            .38      .02      .00      .00      .05       .0
    46      2029   2030          -1.84      .01      .00      .00      .23       .8
    47      2030   2080          -2.15      .24      .00      .00      .29      1.2
    48      2048   2049            .38      .04      .00      .00      .05       .0
    49      2049   2050            .07      .00      .00      .00      .01       .0
    50      2034   2035            .49      .07      .00      .00      .07       .0
```

JUNCTION NODE RESULTS

```
 JUNCTION   JUNCTION     EXTERNAL   HYDRAULIC   JUNCTION    PRESSURE   JUNCTIO
  NUMBER     TITLE        DEMAND      GRADE     ELEVATION     HEAD     PRESSUR
                          (l/s)        (m)         (m)         (m)      (kpa)
 ----------------------------------------------------------------------------
   2025                     .15      515.59      449.00      66.59     653.07
   2026                     .01      515.59      459.00      56.59     555.00
   2027                     .39      515.60      447.00      68.60     672.70
   2028                     .04      515.60      481.00      34.60     339.27
   2029                     .10      515.63      448.00      67.63     663.27
   2030                     .05      515.64      448.00      67.64     663.37
   2031                     .22      514.82      446.00      68.82     674.87
   2032                     .57      514.45      440.00      74.45     730.08
   2033                     .57      514.42      440.00      74.42     729.85
   2034                     .44      514.89      445.00      69.89     685.38
   2035                     .29      514.82      452.00      62.82     616.02
   2036                     .33      514.80      465.00      49.80     488.38
   2037                     .57      514.90      445.00      69.90     685.46
   2038                    1.32      515.47      447.00      68.47     671.43
   2039                     .41      515.41      483.00      32.41     317.80
   2040                     .14      515.71      446.00      69.71     683.63
   2041                     .02      515.74      448.00      67.74     664.27
   2042                     .25      515.71      441.00      74.71     732.65
   2043                     .37      515.71      459.00      56.71     556.11
   2044                     .08      515.70      465.00      50.70     497.23
   2045                     .20      515.71      461.00      54.71     536.51
   2046                     .46      515.62      475.00      40.62     398.35
   2047                     .48      515.46      462.00      53.46     524.27
   2048                    1.16      515.59      478.00      37.59     368.61
   2049                     .49      515.55      485.00      30.55     299.61
   2050                     .13      515.55      487.00      28.55     279.99
   2051                     .12      515.53      462.00      53.53     524.97
   2052                     .29      515.87      451.00      64.87     636.16
   2067                     .37      515.94      469.00      46.94     460.37
   2068                     .20      515.46      445.00      70.46     691.03
   2069                     .07      515.46      461.00      54.46     534.10
   2070                     .59      514.69      445.00      69.69     683.39
   2071                     .12      514.68      461.00      53.68     526.45
   2072                    2.12      514.36      465.00      49.36     484.03
   2073                     .12      514.80      475.00      39.80     390.28
   2074                     .16      515.41      488.00      27.41     268.76
   2080                     .35      515.89      462.00      53.89     528.44
   2081                     .13      515.74      447.00      68.74     674.08


 S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

 (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
 (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

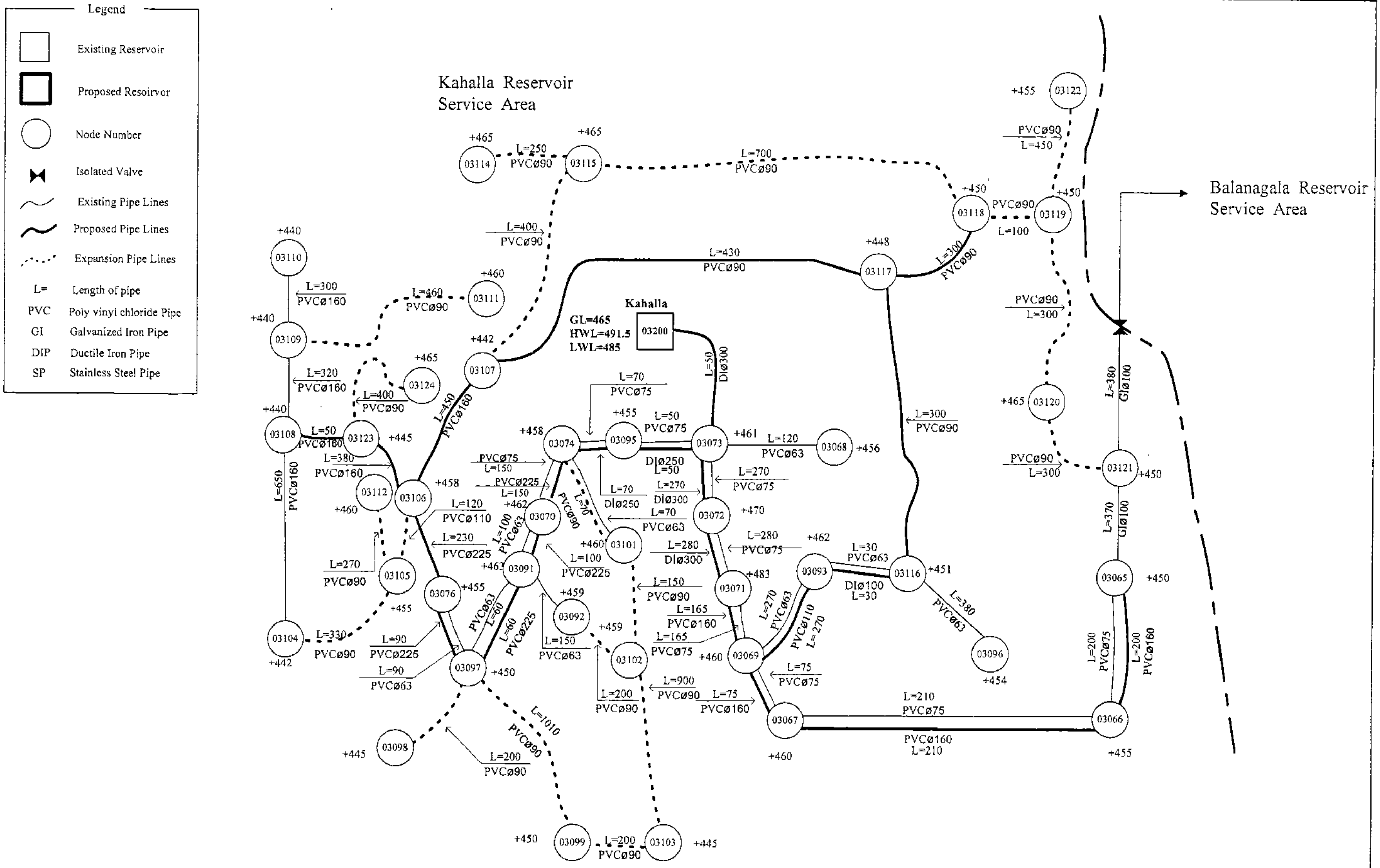
              PIPE        FLOWRATE
             NUMBER        (l/s)
             --------------------
```

```
              1          13.89

 NET SYSTEM INFLOW  =    13.89
 NET SYSTEM OUTFLOW =      .00
 NET SYSTEM DEMAND  =    13.89


 **** KYPIPE SIMULATION COMPLETED ****

 DATE:  3/ 7/2002
 TIME: 10:33: 4
```



Appendix - 5.3.2 Improvement of Distribution Network in 2015
(Kahalla Reservoir Service Area)

```
         * * * * * * * * * *   K Y P I P E 2   * * * * * * * * * *
         *   University of Kentucky Hydraulic Analysis Program   *
         * Distribution of Pressure and Flows in Piping Networks *
         *        1000 PIPE VERSION - 1.10   (08/25/92)          *
         * * * * * * * * * * * * * * * * * * * * * * * * * * * * *



 DATE:  3/ 7/2002
 TIME: 10:40:37

 INPUT DATA FILENAME -------------- c:\D_nets\2015\KAHL2015.DAT
 TABULATED OUTPUT FILENAME -------- c:\D_nets\2015\KAHL2015.OUT
 POSTPROCESSOR RESULTS FILENAME --- c:\D_nets\2015\KAHL2015.RES

               ************************************************
                S U M M A R Y   O F   O R I G I N A L   D A T A
               ************************************************


 U N I T S   S P E C I F I E D

    FLOWRATE ............ = liters/second
    HEAD (HGL) .......... = meters
    PRESSURE ............ = kpa


 P I P E L I N E   D A T A

 STATUS CODE:    XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                 CV -CHECK VALVE    RV -REGULATING VALVE

   PIPE      NODE NOS.     LENGTH   DIAMETER   ROUGHNESS   MINOR LOSS   FGN-H
  NUMBER      #1    #2       (m)      (cm)       COEFF.      COEFF.       (m)
 -----------------------------------------------------------------------------
    1-FG       0  3073      50.0      30.0      130.00         .00      485.
    2       3073  3095      50.0       6.5      120.00         .00
    3       3095  3074      70.0       6.5      120.00         .00
    4       3074  3070     150.0       6.5      120.00         .00
    5       3074  3101      70.0       5.5      120.00         .00
    6       3070  3091     100.0       5.5      120.00         .00
    7       3091  3092     150.0       5.5      120.00         .00
    8       3091  3097      60.0       5.5      120.00         .00
    9       3097  3076      90.0       5.5      120.00         .00
   10       3073  3068     120.0       5.5      120.00         .00
   11       3073  3072     270.0       6.5      120.00         .00
   12       3072  3071     280.0       6.5      120.00         .00
   13       3071  3069     165.0       6.5      120.00         .00
```

```
   14        3069  3067        75.0        6.5        120.00          .00
   15        3069  3093       270.0        5.5        120.00          .00
   16        3067  3066       210.0        6.5        120.00          .00
   17        3066  3065       200.0        6.5        120.00          .00
   18        3065  3121       370.0       10.0        120.00          .00
   19        3093  3116        30.0        5.5        120.00          .00
   20        3116  3096       380.0        5.5        120.00          .00
   21        3073  3095        50.0       25.0        130.00          .00
   22        3095  3074        70.0       25.0        130.00          .00
   23        3074  3070       150.0       19.8        130.00          .00
   24        3070  3091       100.0       19.8        130.00          .00
   25        3091  3097        60.0       19.8        130.00          .00
   26        3097  3076        90.0       19.8        130.00          .00
   27        3073  3072       270.0       30.0        130.00          .00
   28        3072  3071       280.0       30.0        130.00          .00
   29        3069  3067        75.0       14.0        130.00          .00
   30        3067  3066       210.0       14.0        130.00          .00
   31        3066  3065       200.0       14.0        130.00          .00
   32        3092  3102       200.0        7.9        130.00          .00
   33        3101  3102       150.0        7.9        130.00          .00
   34        3102  3103       900.0        7.9        130.00          .00
   35        3103  3099       200.0        7.9        130.00          .00
   36        3099  3097      1010.0        7.9        130.00          .00
   37        3097  3098       200.0        7.9        130.00          .00
   38        3076  3106       230.0       19.8        130.00          .00
   39        3106  3107       450.0       14.0        130.00          .00
   40        3106  3105       120.0        9.7        130.00          .00
   41        3106  3123       380.0       14.0        130.00          .00
   42        3105  3104       330.0        7.9        130.00          .00
   43        3105  3112       270.0        7.9        130.00          .00
   44        3104  3108       650.0       14.0        130.00          .00
   45        3108  3123        50.0       14.0        130.00          .00
   46        3108  3109       320.0       14.0        130.00          .00
   47        3109  3110       300.0       14.0        130.00          .00
   48        3109  3111       460.0        7.9        130.00          .00
   49        3123  3124       400.0        7.9        130.00          .00
   50        3107  3115       400.0        7.9        130.00          .00
   51        3107  3117       430.0        7.9        130.00          .00
   52        3115  3114       250.0        7.9        130.00          .00
   53        3115  3118       700.0        7.9        130.00          .00
   54        3117  3116       300.0        7.9        130.00          .00
   55        3117  3118       300.0        7.9        130.00          .00
   56        3118  3119       100.0        7.9        130.00          .00
   57        3119  3120       300.0        7.9        130.00          .00
   58        3119  3122       450.0        7.9        130.00          .00
   59        3120  3121       300.0        7.9        130.00          .00
   60        3071  3069       165.0       14.0        130.00          .00
   61        3069  3093       270.0        9.7        130.00          .00
   62        3093  3116        30.0       10.0        130.00          .00
   63        3074  3101        70.0        7.9        130.00          .00
```

```
 J U N C T I O N   N O D E   D A T A


    JUNCTION     JUNCTION      EXTERNAL     JUNCTION
     NUMBER       TITLE         DEMAND      ELEVATION  CONNECTING PIPES
                                (l/s)          (m)
 ----------------------------------------------------------------------------
      3065                       1.07        450.00     17    18    31
      3066                       1.47        455.00     16    17    30    31
      3067                        .43        460.00     14    16    29    30
      3068                        .15        456.00     10
      3069                        .69        460.00     13    14    15    29    60

      3070                        .29        462.00      4     6    23    24
      3071                       1.00        483.00     12    13    28    60
      3072                        .45        470.00     11    12    27    28
      3073                        .49        461.00      1     2    10    11    21

      3074                        .31        458.00      3     4     5    22    23

      3076                        .32        455.00      9    26    38
      3091                        .32        463.00      6     7     8    24    25
      3092                        .42        459.00      7    32
      3093                        .45        462.00     15    19    61    62
      3095                        .16        455.00      2     3    21    22
      3096                        .80        454.00     20
      3097                       1.33        450.00      8     9    25    26    36

      3098                        .25        445.00     37
      3099                       4.03        450.00     35    36
      3101                        .28        460.00      5    33    63
      3102                       1.52        459.00     32    33    34
      3103                       2.11        445.00     34    35
      3104                       2.44        442.00     42    44
      3105                        .55        455.00     40    42    43
      3106                        .77        458.00     38    39    40    41
      3107                       4.16        442.00     39    50    51
      3108                       2.07        440.00     44    45    46
      3109                       1.66        440.00     46    47    48
      3110                       1.46        440.00     47
      3111                        .30        460.00     48
      3112                        .27        460.00     43
      3114                        .38        465.00     52
      3115                       1.95        465.00     50    52    53
      3116                       1.06        451.00     19    20    54    62
      3117                       1.01        448.00     51    54    55
      3118                       1.59        450.00     53    55    56
      3119                       1.46        450.00     56    57    58
      3120                       1.03        465.00     57    59
      3121                       2.64        450.00     18    59
      3122                       1.21        455.00     58
      3123                        .30        445.00     41    45    49
      3124                        .33        465.00     49
```

```
 O U T P U T   O P T I O N   D A T A

 OUTPUT SELECTION:  ALL RESULTS ARE INCLUDED IN THE TABULATED OUTPUT


 S Y S T E M   C O N F I G U R A T I O N

     NUMBER OF PIPES ....................(p) =   63
     NUMBER OF JUNCTION NODES ...........(j) =   42
     NUMBER OF PRIMARY LOOPS ............(l) =   21
     NUMBER OF FIXED GRADE NODES ........(f) =    1
     NUMBER OF SUPPLY ZONES .............(z) =    1


                      ************************************
                       S I M U L A T I O N   R E S U L T S
                      ************************************

 THE RESULTS ARE OBTAINED AFTER  6 TRIALS WITH AN ACCURACY =  .00090


 P I P E L I N E   R E S U L T S

 STATUS CODE:    XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                 CV -CHECK VALVE    RV -REGULATING VALVE    TK -STORAGE TANK

   PIPE        NODE NOS.      FLOWRATE     HEAD     PUMP    MINOR     LINE     HL/
  NUMBER      #1     #2                    LOSS     HEAD     LOSS    VELO.    1000
                               (l/s)        (m)      (m)      (m)    (m/s)    (m/m
 ----------------------------------------------------------------------------------
     1-FG      0   3073          44.98      .07      .00      .00      .64      1.4
     2      3073   3095            .77      .08      .00      .00      .23      1.5
     3      3095   3074            .76      .11      .00      .00      .23      1.5
     4      3074   3070           1.17      .51      .00      .00      .35      3.4
     5      3074   3101           1.08      .46      .00      .00      .46      6.6
     6      3070   3091            .76      .34      .00      .00      .32      3.4
     7      3091   3092           1.12     1.06      .00      .00      .47      7.0
     8      3091   3097            .72      .18      .00      .00      .30      3.0
     9      3097   3076            .57      .18      .00      .00      .24      2.0
    10      3073   3068            .15      .02      .00      .00      .06       .1
    11      3073   3072            .25      .05      .00      .00      .07       .1
    12      3072   3071            .24      .05      .00      .00      .07       .1
    13      3071   3069           1.46      .84      .00      .00      .44      5.1
    14      3069   3067            .86      .14      .00      .00      .26      1.9
    15      3069   3093            .83     1.09      .00      .00      .35      4.0
    16      3067   3066            .81      .36      .00      .00      .24      1.7
    17      3066   3065            .65      .23      .00      .00      .20      1.1
```

```
   18      3065    3121          4.87      2.16       .00       .00       .62      5.8
   19      3093    3116           .70       .09       .00       .00       .30      2.9
   20      3116    3096           .80      1.44       .00       .00       .34      3.7
   21      3073    3095         28.76       .08       .00       .00       .59      1.5
   22      3095    3074         28.61       .11       .00       .00       .58      1.5
   23      3074    3070         23.76       .51       .00       .00       .77      3.4
   24      3070    3091         23.89       .34       .00       .00       .78      3.4
   25      3091    3097         22.49       .18       .00       .00       .73      3.0
   26      3097    3076         17.94       .18       .00       .00       .58      2.0
   27      3073    3072         14.56       .05       .00       .00       .21       .1
   28      3072    3071         14.12       .05       .00       .00       .20       .1
   29      3069    3067          6.99       .14       .00       .00       .45      1.9
   30      3067    3066          6.60       .36       .00       .00       .43      1.7
   31      3066    3065          5.29       .23       .00       .00       .34      1.1
   32      3092    3102           .70       .09       .00       .00       .14       .4
   33      3101    3102          3.84      1.53       .00       .00       .78     10.2
   34      3102    3103          3.02      5.90       .00       .00       .62      6.5
   35      3103    3099           .91       .14       .00       .00       .19       .7
   36      3099    3097         -3.12      7.00       .00       .00       .64      6.9
   37      3097    3098           .25       .01       .00       .00       .05       .0
   38      3076    3106         18.19       .48       .00       .00       .59      2.0
   39      3106    3107          8.04      1.11       .00       .00       .52      2.4
   40      3106    3105          2.39       .19       .00       .00       .32      1.5
   41      3106    3123          6.99       .72       .00       .00       .45      1.9
   42      3105    3104          1.57       .64       .00       .00       .32      1.9
   43      3105    3112           .27       .02       .00       .00       .06       .0
   44      3104    3108          -.87       .03       .00       .00       .06       .0
   45      3108    3123         -6.36       .08       .00       .00       .41      1.6
   46      3108    3109          3.42       .16       .00       .00       .22       .5
   47      3109    3110          1.46       .03       .00       .00       .09       .1
   48      3109    3111           .30       .04       .00       .00       .06       .0
   49      3123    3124           .33       .04       .00       .00       .07       .1
   50      3107    3115          2.66      2.07       .00       .00       .54      5.1
   51      3107    3117          1.22       .52       .00       .00       .25      1.2
   52      3115    3114           .38       .04       .00       .00       .08       .1
   53      3115    3118           .33       .08       .00       .00       .07       .1
   54      3117    3116         -2.52      1.40       .00       .00       .51      4.6
   55      3117    3118          2.72      1.62       .00       .00       .56      5.4
   56      3118    3119          1.47       .17       .00       .00       .30      1.7
   57      3119    3120         -1.20       .36       .00       .00       .25      1.1
   58      3119    3122          1.21       .54       .00       .00       .25      1.2
   59      3120    3121         -2.23      1.12       .00       .00       .46      3.7
   60      3071    3069         11.90       .84       .00       .00       .77      5.1
   61      3069    3093          4.00      1.09       .00       .00       .54      4.0
   62      3093    3116          3.67       .09       .00       .00       .47      2.9
   63      3074    3101          3.04       .46       .00       .00       .62      6.6


 J U N C T I O N   N O D E   R E S U L T S

  JUNCTION   JUNCTION    EXTERNAL   HYDRAULIC   JUNCTION    PRESSURE   JUNCTIO
   NUMBER     TITLE       DEMAND      GRADE     ELEVATION     HEAD     PRESSUR
```

```
                        (l/s)        (m)         (m)         (m)        (kpa)
------------------------------------------------------------------------------
  3065                   1.07      483.25      450.00       33.25      326.07
  3066                   1.47      483.48      455.00       28.48      279.27
  3067                    .43      483.84      460.00       23.84      233.77
  3068                    .15      484.91      456.00       28.91      283.48
  3069                    .69      483.98      460.00       23.98      235.17
  3070                    .29      484.23      462.00       22.23      218.02
  3071                   1.00      484.82      483.00        1.82       17.88
  3072                    .45      484.87      470.00       14.87      145.87
  3073                    .49      484.93      461.00       23.93      234.64
  3074                    .31      484.74      458.00       26.74      262.24
  3076                    .32      483.52      455.00       28.52      279.71
  3091                    .32      483.89      463.00       20.89      204.84
  3092                    .42      482.83      459.00       23.83      233.71
  3093                    .45      482.89      462.00       20.89      204.86
  3095                    .16      484.85      455.00       29.85      292.72
  3096                    .80      481.36      454.00       27.36      268.36
  3097                   1.33      483.70      450.00       33.70      330.52
  3098                    .25      483.69      445.00       38.69      379.43
  3099                   4.03      476.70      450.00       26.70      261.88
  3101                    .28      484.28      460.00       24.28      238.08
  3102                   1.52      482.74      459.00       23.74      232.86
  3103                   2.11      476.85      445.00       31.85      312.31
  3104                   2.44      482.22      442.00       40.22      394.38
  3105                    .55      482.86      455.00       27.86      273.20
  3106                    .77      483.05      458.00       25.05      245.61
  3107                   4.16      481.93      442.00       39.93      391.55
  3108                   2.07      482.24      440.00       42.24      414.25
  3109                   1.66      482.08      440.00       42.08      412.65
  3110                   1.46      482.05      440.00       42.05      412.35
  3111                    .30      482.04      460.00       22.04      216.11
  3112                    .27      482.84      460.00       22.84      223.97
  3114                    .38      479.82      465.00       14.82      145.36
  3115                   1.95      479.86      465.00       14.86      145.71
  3116                   1.06      482.80      451.00       31.80      311.86
  3117                   1.01      481.40      448.00       33.40      327.57
  3118                   1.59      479.78      450.00       29.78      292.06
  3119                   1.46      479.61      450.00       29.61      290.38
  3120                   1.03      479.97      465.00       14.97      146.78
  3121                   2.64      481.09      450.00       31.09      304.89
  3122                   1.21      479.07      455.00       24.07      236.04
  3123                    .30      482.32      445.00       37.32      366.00
  3124                    .33      482.28      465.00       17.28      169.44


 SUMMARY OF INFLOWS AND OUTFLOWS

 (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
 (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

           PIPE       FLOWRATE
```

```
            NUMBER         (l/s)
            --------------------
               1          44.98

 NET SYSTEM INFLOW  =     44.98
 NET SYSTEM OUTFLOW =       .00
 NET SYSTEM DEMAND  =     44.98


 D A T A   C H A N G E S   F O R   N E X T   S I M U L A T I O N


      D E M A N D   C H A N G E S

 DEMAND TYPE =  1 -   GDF =   .300


                       ************************************
                        S I M U L A T I O N   R E S U L T S
                       ************************************

 THE RESULTS ARE OBTAINED AFTER  2 TRIALS WITH AN ACCURACY =  .00017


 P I P E L I N E   R E S U L T S

 STATUS CODE:    XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                 CV -CHECK VALVE    RV -REGULATING VALVE    TK -STORAGE TANK

   PIPE        NODE NOS.      FLOWRATE    HEAD     PUMP    MINOR     LINE     HL/
  NUMBER      #1     #2                   LOSS     HEAD     LOSS     VELO.   1000
                                (l/s)      (m)      (m)      (m)     (m/s)   (m/m
----------------------------------------------------------------------------------
     1-FG      0    3073         13.49     .01      .00      .00      .19      .1
     2      3073    3095           .23     .01      .00      .00      .07      .1
     3      3095    3074           .23     .01      .00      .00      .07      .1
     4      3074    3070           .35     .05      .00      .00      .11      .3
     5      3074    3101           .32     .05      .00      .00      .14      .7
     6      3070    3091           .23     .04      .00      .00      .10      .3
     7      3091    3092           .34     .11      .00      .00      .14      .7
     8      3091    3097           .21     .02      .00      .00      .09      .3
     9      3097    3076           .17     .02      .00      .00      .07      .2
    10      3073    3068           .05     .00      .00      .00      .02      .0
    11      3073    3072           .07     .01      .00      .00      .02      .0
    12      3072    3071           .07     .01      .00      .00      .02      .0
    13      3071    3069           .44     .09      .00      .00      .13      .5
    14      3069    3067           .26     .02      .00      .00      .08      .2
    15      3069    3093           .25     .12      .00      .00      .10      .4
    16      3067    3066           .24     .04      .00      .00      .07      .1
    17      3066    3065           .19     .02      .00      .00      .06      .1
```

```
   18      3065    3121         1.46      .23      .00      .00      .19       .6
   19      3093    3116          .21      .01      .00      .00      .09       .3
   20      3116    3096          .24      .15      .00      .00      .10       .4
   21      3073    3095         8.63      .01      .00      .00      .18       .1
   22      3095    3074         8.58      .01      .00      .00      .17       .1
   23      3074    3070         7.13      .05      .00      .00      .23       .3
   24      3070    3091         7.17      .04      .00      .00      .23       .3
   25      3091    3097         6.75      .02      .00      .00      .22       .3
   26      3097    3076         5.38      .02      .00      .00      .17       .2
   27      3073    3072         4.37      .01      .00      .00      .06       .0
   28      3072    3071         4.24      .01      .00      .00      .06       .0
   29      3069    3067         2.10      .02      .00      .00      .14       .2
   30      3067    3066         1.98      .04      .00      .00      .13       .1
   31      3066    3065         1.59      .02      .00      .00      .10       .1
   32      3092    3102          .21      .01      .00      .00      .04       .0
   33      3101    3102         1.15      .16      .00      .00      .24      1.1
   34      3102    3103          .91      .63      .00      .00      .19       .7
   35      3103    3099          .27      .02      .00      .00      .06       .0
   36      3099    3097         -.93      .75      .00      .00      .19       .7
   37      3097    3098          .08      .00      .00      .00      .02       .0
   38      3076    3106         5.46      .05      .00      .00      .18       .2
   39      3106    3107         2.41      .12      .00      .00      .16       .2
   40      3106    3105          .72      .02      .00      .00      .10       .1
   41      3106    3123         2.10      .08      .00      .00      .14       .2
   42      3105    3104          .47      .07      .00      .00      .10       .2
   43      3105    3112          .08      .00      .00      .00      .02       .0
   44      3104    3108         -.26      .00      .00      .00      .02       .0
   45      3108    3123        -1.91      .01      .00      .00      .12       .1
   46      3108    3109         1.03      .02      .00      .00      .07       .0
   47      3109    3110          .44      .00      .00      .00      .03       .0
   48      3109    3111          .09      .00      .00      .00      .02       .0
   49      3123    3124          .10      .00      .00      .00      .02       .0
   50      3107    3115          .80      .22      .00      .00      .16       .5
   51      3107    3117          .37      .06      .00      .00      .07       .1
   52      3115    3114          .11      .00      .00      .00      .02       .0
   53      3115    3118          .10      .01      .00      .00      .02       .0
   54      3117    3116         -.75      .15      .00      .00      .15       .5
   55      3117    3118          .82      .17      .00      .00      .17       .5
   56      3118    3119          .44      .02      .00      .00      .09       .1
   57      3119    3120         -.36      .04      .00      .00      .07       .1
   58      3119    3122          .36      .06      .00      .00      .07       .1
   59      3120    3121         -.67      .12      .00      .00      .14       .4
   60      3071    3069         3.57      .09      .00      .00      .23       .5
   61      3069    3093         1.20      .12      .00      .00      .16       .4
   62      3093    3116         1.10      .01      .00      .00      .14       .3
   63      3074    3101          .91      .05      .00      .00      .19       .7


 J U N C T I O N   N O D E   R E S U L T S

  JUNCTION   JUNCTION    EXTERNAL   HYDRAULIC   JUNCTION    PRESSURE   JUNCTIO
   NUMBER     TITLE       DEMAND      GRADE     ELEVATION     HEAD     PRESSUR
```

```
                          (l/s)        (m)         (m)         (m)       (kpa)
 ----------------------------------------------------------------------------
   3065                     .32     484.81      450.00       34.81      341.39
   3066                     .44     484.84      455.00       29.84      292.60
   3067                     .13     484.88      460.00       24.88      243.95
   3068                     .05     484.99      456.00       28.99      284.30
   3069                     .21     484.89      460.00       24.89      244.10
   3070                     .09     484.92      462.00       22.92      224.74
   3071                     .30     484.98      483.00        1.98       19.43
   3072                     .14     484.99      470.00       14.99      146.97
   3073                     .15     484.99      461.00       23.99      235.28
   3074                     .09     484.97      458.00       26.97      264.51
   3076                     .10     484.84      455.00       29.84      292.64
   3091                     .10     484.88      463.00       21.88      214.57
   3092                     .13     484.77      459.00       25.77      252.69
   3093                     .14     484.77      462.00       22.77      223.33
   3095                     .05     484.98      455.00       29.98      294.04
   3096                     .24     484.61      454.00       30.61      300.18
   3097                     .40     484.86      450.00       34.86      341.87
   3098                     .08     484.86      445.00       39.86      390.89
   3099                    1.21     484.11      450.00       34.11      334.48
   3101                     .08     484.92      460.00       24.92      244.41
   3102                     .46     484.76      459.00       25.76      252.60
   3103                     .63     484.12      445.00       39.12      383.67
   3104                     .73     484.70      442.00       42.70      418.75
   3105                     .17     484.77      455.00       29.77      291.94
   3106                     .23     484.79      458.00       26.79      262.72
   3107                    1.25     484.67      442.00       42.67      418.45
   3108                     .62     484.70      440.00       44.70      438.39
   3109                     .50     484.69      440.00       44.69      438.22
   3110                     .44     484.68      440.00       44.68      438.19
   3111                     .09     484.68      460.00       24.68      242.04
   3112                     .08     484.77      460.00       24.77      242.89
   3114                     .11     484.44      465.00       19.44      190.68
   3115                     .59     484.45      465.00       19.45      190.72
   3116                     .32     484.76      451.00       33.76      331.11
   3117                     .30     484.61      448.00       36.61      359.06
   3118                     .48     484.44      450.00       34.44      337.74
   3119                     .44     484.42      450.00       34.42      337.56
   3120                     .31     484.46      465.00       19.46      190.83
   3121                     .79     484.58      450.00       34.58      339.12
   3122                     .36     484.36      455.00       29.36      287.95
   3123                     .09     484.71      445.00       39.71      389.44
   3124                     .10     484.71      465.00       19.71      193.26


 SUMMARY  OF  INFLOWS  AND  OUTFLOWS

 (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
 (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

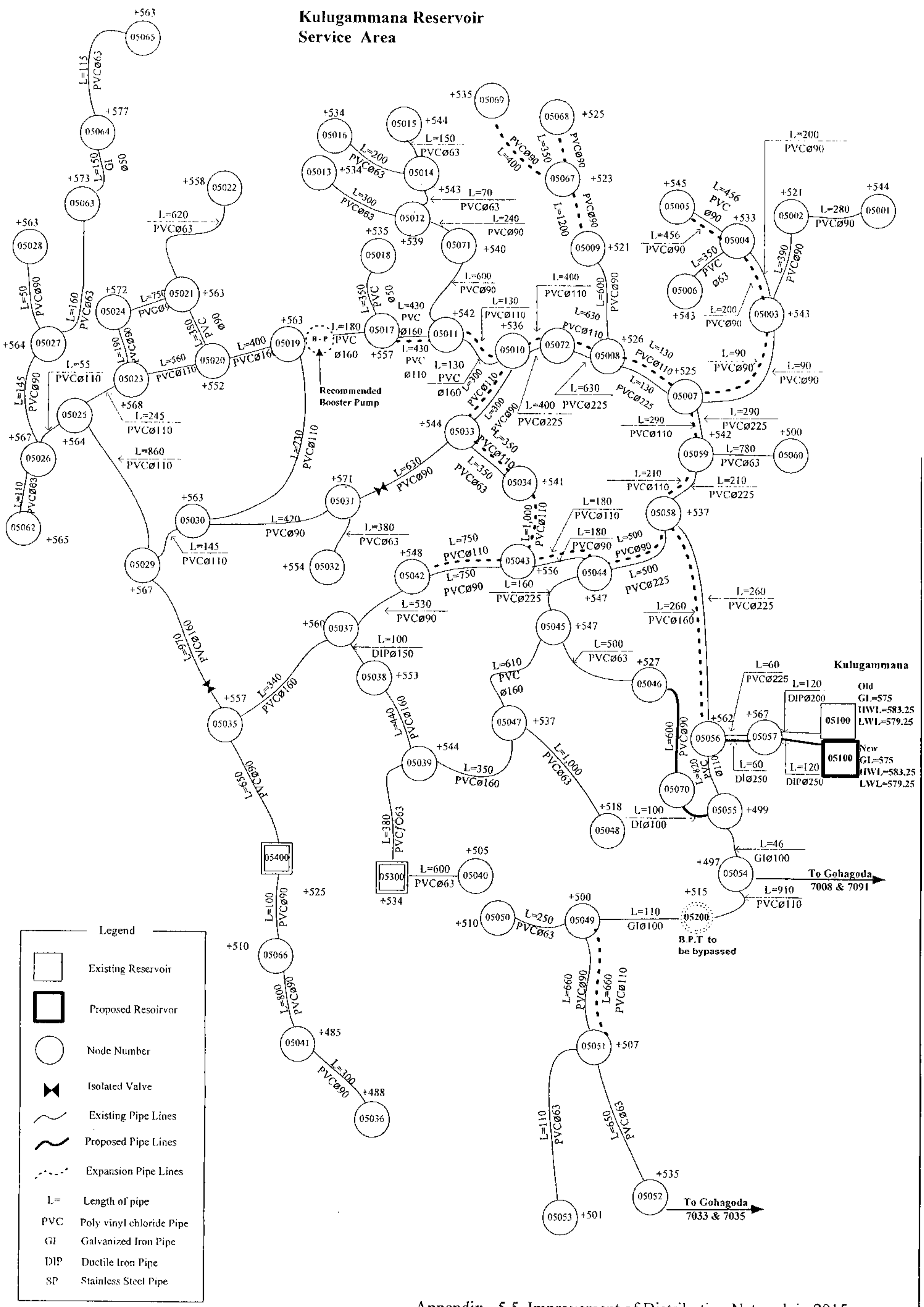
             PIPE       FLOWRATE
```

```
            NUMBER        (l/s)
            --------------------
               1          13.49

 NET SYSTEM INFLOW  =     13.49
 NET SYSTEM OUTFLOW =       .00
 NET SYSTEM DEMAND  =     13.49


 **** KYPIPE SIMULATION COMPLETED ****


 DATE:  3/ 7/2002
 TIME: 10:40:37
```


Kulugammana Reservoir Service Area

Appendix - 5.5 Improvement of Distribution Network in 2015
(Kulugammana Reservoir Service Area)

```
         * * * * * * * * * * *   K Y P I P E 2   * * * * * * * * * * *
         *   University of Kentucky Hydraulic Analysis Program   *
         * Distribution of Pressure and Flows in Piping Networks *
         *        1000 PIPE VERSION - 1.10   (08/25/92)          *
         * * * * * * * * * * * * * * * * * * * * * * * * * * * * *



 DATE:  3/ 7/2002
 TIME: 13:53: 9

 INPUT DATA FILENAME -------------- c:\D_nets\2015\KULU2015.DAT
 TABULATED OUTPUT FILENAME -------- c:\D_nets\2015\KULU2015.OUT
 POSTPROCESSOR RESULTS FILENAME --- c:\D_nets\2015\KULU2015.RES

               ************************************************
                S U M M A R Y   O F   O R I G I N A L   D A T A
               ************************************************


 U N I T S   S P E C I F I E D

    FLOWRATE ............ = liters/second
    HEAD (HGL) .......... = meters
    PRESSURE ............ = kpa


 R E G U L A T I N G   V A L V E   D A T A

 VALVE     POSITION    CONTROLLED     VALVE
 TYPE      JUNCTION       PIPE       SETTING
                                    (m or l/s)
 -----------------------------------------------
 PRV-1       5300          77        534.00
 PRV-1       5400          73        525.00


 P I P E L I N E   D A T A

 STATUS CODE:    XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                 CV -CHECK VALVE    RV -REGULATING VALVE

  PIPE         NODE NOS.     LENGTH   DIAMETER   ROUGHNESS   MINOR LOSS    FGN-H
  NUMBER       #1     #2       (m)      (cm)       COEFF.      COEFF.        (m)
 --------------------------------------------------------------------------------
    1-FG        0   5057     120.0     20.0      120.00          .00       579.
    2        5057   5056      60.0     19.8      120.00          .00
```

```
     3       5056  5055       820.0      9.7       120.00           .00
     4       5055  5054        46.0     10.0       120.00           .00
     5       5054  5200       910.0      9.7       120.00           .00
     6       5200  5049       110.0     10.0       120.00           .00
     7       5049  5050       250.0      5.5       120.00           .00
     8       5049  5051       660.0      7.9       120.00           .00
     9       5051  5053       110.0      5.5       120.00           .00
    10       5051  5052       650.0      5.5       120.00           .00
    11       5056  5058       260.0     19.8       120.00           .00
    12       5058  5059       210.0     19.8       120.00           .00
    13       5059  5060       780.0      5.5       120.00           .00
    14       5059  5007       290.0     19.8       120.00           .00
    15       5007  5003        90.0      7.9       120.00           .00
    16       5003  5004       200.0      7.9       120.00           .00
    17       5004  5005       456.0      7.9       120.00           .00
    18       5004  5006       350.0      5.5       120.00           .00
    19       5003  5002       390.0      7.9       120.00           .00
    20       5001  5002       280.0      7.9       120.00           .00
    21       5007  5008       130.0     19.8       120.00           .00
    22       5008  5009       600.0      7.9       120.00           .00
    23       5009  5067      1200.0      7.9       130.00           .00
    24       5067  5069       400.0      7.9       130.00           .00
    25       5058  5044       500.0     19.8       120.00           .00
    26       5044  5045       160.0     19.8       120.00           .00
    27       5045  5046       500.0      5.5       120.00           .00
    28       5046  5055       600.0      7.9       130.00           .00
    29       5008  5072       630.0     19.8       120.00           .00
    30       5072  5010       400.0     19.8       120.00           .00
    31       5010  5011       130.0     14.0       120.00           .00
    32       5011  5071       600.0      7.9       120.00           .00
    33       5071  5012       240.0      7.9       120.00           .00
    34       5012  5013       300.0      5.5       120.00           .00
    35       5012  5014        70.0      5.5       120.00           .00
    36       5014  5015       150.0      5.5       120.00           .00
    37       5014  5016       200.0      5.5       120.00           .00
    38       5011  5017       430.0     14.0       120.00           .00
    39       5017  5018       350.0      4.4       120.00           .00
    40-XX    5017  5019       180.0     14.0       120.00           .00
    41       5019  5020       400.0     14.0       120.00           .00
    42       5020  5021       380.0      7.9       120.00           .00
    43       5021  5022       620.0      5.5       120.00           .00
    44       5020  5023       560.0      9.7       120.00           .00
    45       5023  5024       190.0      7.9       120.00           .00
    46       5024  5021       750.0      7.9       120.00           .00
    47       5023  5025       245.0      9.7       120.00           .00
    48       5025  5026        55.0      9.7       120.00           .00
    49       5026  5062       110.0      5.5       120.00           .00
    50       5026  5027       145.0      7.9       120.00           .00
    51       5027  5028        50.0      7.9       120.00           .00
    52       5027  5063       160.0      5.5       120.00           .00
    53       5063  5064       150.0      5.5       120.00           .00
    54       5064  5065       115.0      5.5       120.00           .00
    55       5025  5029       860.0      9.7       120.00           .00
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  56      5029  5030     145.0      9.7     120.00         .00
  57      5030  5019     730.0      9.7     120.00         .00
  58      5030  5031     420.0      7.9     120.00         .00
  59      5031  5032     380.0      5.5     120.00         .00
  60-XX   5031  5033     630.0      7.9     120.00         .00
  61      5033  5034     350.0      5.5     120.00         .00
  62      5042  5043     750.0      7.9     120.00         .00
  63      5043  5044     180.0      7.9     120.00         .00
  64      5042  5037     530.0      7.9     120.00         .00
  65      5037  5038     100.0     15.0     120.00         .00
  66      5038  5039     440.0     14.0     120.00         .00
  67      5039  5047     350.0     14.0     120.00         .00
  68      5047  5045     610.0     14.0     120.00         .00
  69      5047  5048    1000.0      5.5     120.00         .00
  70-XX   5029  5035     970.0     14.0     120.00         .00
  71      5035  5037     340.0     14.0     120.00         .00
  72      5035  5400     650.0      7.9     120.00         .00
  73-RV   5400  5066     100.0      7.9     120.00         .00
  74      5066  5041     800.0      7.9     120.00         .00
  75      5041  5036     300.0      7.9     120.00         .00
  76      5039  5300     380.0      5.5     120.00         .00
  77-RV   5300  5040     600.0      5.5     120.00         .00
  78      5010  5033     300.0      7.9     120.00         .00
  79      5034  5043    1000.0      9.7     130.00         .00
  80      5067  5068     350.0      7.9     130.00         .00
  81-FG      0  5057     120.0     25.0     130.00         .00      579.
  82      5057  5056      60.0     25.0     130.00         .00
  83      5033  5034     350.0      9.7     130.00         .00
  84      5042  5043     750.0      9.7     130.00         .00
  85      5043  5044     180.0      9.7     130.00         .00
  86      5058  5044     500.0      7.9     130.00         .00
  87      5010  5033     300.0      9.7     130.00         .00
  88      5007  5003      90.0      7.9     130.00         .00
  89      5003  5004     200.0      7.9     130.00         .00
  90      5004  5005     456.0      7.9     130.00         .00
  91      5056  5058     260.0     14.0     130.00         .00
  92      5058  5059     210.0      9.7     130.00         .00
  93      5059  5007     290.0      9.7     130.00         .00
  94      5007  5008     130.0      9.7     130.00         .00
  95      5008  5072     630.0      9.7     130.00         .00
  96      5010  5011     130.0      9.7     130.00         .00
  97      5011  5017     430.0      9.7     130.00         .00
  98-FG      0  5019      90.0     14.0     130.00         .00      590.
  99      5049  5051     660.0      9.7     130.00         .00


 J U N C T I O N   N O D E   D A T A


   JUNCTION    JUNCTION     EXTERNAL    JUNCTION
    NUMBER      TITLE        DEMAND     ELEVATION  CONNECTING PIPES
                             (l/s)         (m)
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 ---------------------------------------------------------------------------
     5001                      .08        544.00    20
     5002                      .19        521.00    19    20
     5003                      .28        543.00    15    16    19    88    89
     5004                      .51        533.00    16    17    18    89    90
     5005                     3.40        545.00    17    90
     5006                      .21        543.00    18
     5007                      .23        525.00    14    15    21    88    93

     5008                      .54        526.00    21    22    29    94    95
     5009                      .75        521.00    22    23
     5010                      .50        536.00    30    31    78    87    96
     5011                      .70        542.00    31    32    38    96    97
     5012                      .48        539.00    33    34    35
     5013                      .09        534.00    34
     5014                      .12        543.00    35    36    37
     5015                      .05        544.00    36
     5016                      .07        534.00    37
     5017                      .66        557.00    38    39    40    97
     5018                      .09        535.00    39
     5019                      .70        563.00    40    41    57    98
     5020                      .42        552.00    41    42    44
     5021                      .39        563.00    42    43    46
     5022                      .40        558.00    43
     5023                      .07        568.00    44    45    47
     5024                      .03        572.00    45    46
     5025                      .53        564.00    47    48    55
     5026                      .15        567.00    48    49    50
     5027                      .19        564.00    50    51    52
     5028                      .05        563.00    51
     5029                      .26        567.00    55    56    70
     5030                      .16        563.00    56    57    58
     5031                      .25        571.00    58    59    60
     5032                      .33        554.00    59
     5033                      .18        544.00    60    61    78    83    87
     5034                     1.18        541.00    61    79    83
     5035                     1.44        557.00    70    71    72
     5036                      .29        488.00    75
     5037                      .48        560.00    64    65    71
     5038                      .14        553.00    65    66
     5039                      .58        544.00    66    67    76
     5040                      .32        505.00    77
     5041                      .82        485.00    74    75
     5042                      .45        548.00    62    64    84
     5043                      .44        556.00    62    63    79    84    85
     5044                      .28        547.00    25    26    63    85    86
     5045                      .34        547.00    26    27    68
     5046                      .37        527.00    27    28
     5047                      .38        537.00    67    68    69
     5048                      .19        518.00    69
     5049                      .73        500.00     6     7     8    99
     5050                      .12        510.00     7
     5051                      .52        507.00     8     9    10    99
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     5052                        .49       535.00    10
     5053                       1.27       501.00     9
     5054                        .92       497.00     4    5
     5055                        .47       499.00     3    4   28
     5056                        .43       562.00     2    3   11   82   91
     5057                        .07       567.00     1    2   81   82
     5058                        .45       537.00    11   12   25   86   91

     5059                        .37       542.00    12   13   14   92   93
     5060                        .22       500.00    13
     5062                        .04       565.00    49
     5063                        .06       573.00    52   53
     5064                        .06       577.00    53   54
     5065                        .03       563.00    54
     5066                       1.04       510.00    73   74
     5067                       1.04       523.00    23   24   80
     5068                        .57       525.00    80
     5069                        .19       535.00    24
     5071                        .41       540.00    32   33
     5072                        .60       532.00    29   30   95
     5200                        .00       515.00     5    6
     5300                        .00       534.00    76   77
     5400                        .00       525.00    72   73


 O U T P U T   O P T I O N   D A T A

 OUTPUT SELECTION:  ALL RESULTS ARE INCLUDED IN THE TABULATED OUTPUT


 S Y S T E M   C O N F I G U R A T I O N

     NUMBER OF PIPES ...................(p) =   99
     NUMBER OF JUNCTION NODES ..........(j) =   73
     NUMBER OF PRIMARY LOOPS ...........(l) =   24
     NUMBER OF FIXED GRADE NODES .......(f) =    3
     NUMBER OF SUPPLY ZONES ............(z) =    1


                     ************************************
                      S I M U L A T I O N   R E S U L T S
                     ************************************

 THE RESULTS ARE OBTAINED AFTER  8 TRIALS WITH AN ACCURACY =  .00016


 P I P E L I N E   R E S U L T S

 STATUS CODE:   XX -CLOSED PIPE   FG -FIXED GRADE NODE   PU -PUMP LINE
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            CV -CHECK VALVE    RV -REGULATING VALVE    TK -STORAGE TANK

   PIPE        NODE NOS.       FLOWRATE     HEAD     PUMP    MINOR     LINE     HL/
  NUMBER       #1     #2                    LOSS     HEAD     LOSS     VELO.    1000
                                 (l/s)       (m)      (m)      (m)     (m/s)    (m/m
-------------------------------------------------------------------------------------
     1-FG       0   5057          9.07       .08      .00      .00      .29       .6
     2       5057   5056          8.89       .04      .00      .00      .29       .6
     3       5056   5055          3.92      3.70      .00      .00      .53      4.5
     4       5055   5054          4.05       .19      .00      .00      .52      4.1
     5       5054   5200          3.13      2.71      .00      .00      .42      2.9
     6       5200   5049          3.13       .28      .00      .00      .40      2.5
     7       5049   5050           .12       .03      .00      .00      .05       .1
     8       5049   5051           .80       .43      .00      .00      .16       .6
     9       5051   5053          1.27       .98      .00      .00      .53      8.8
    10       5051   5052           .49       .99      .00      .00      .21      1.5
    11       5056   5058         15.55       .47      .00      .00      .51      1.8
    12       5058   5059         11.07       .20      .00      .00      .36       .9
    13       5059   5060           .22       .27      .00      .00      .09       .3
    14       5059   5007         10.56       .25      .00      .00      .34       .8
    15       5007   5003          2.24       .39      .00      .00      .46      4.3
    16       5003   5004          1.98       .69      .00      .00      .40      3.4
    17       5004   5005          1.63      1.11      .00      .00      .33      2.4
    18       5004   5006           .21       .11      .00      .00      .09       .3
    19       5003   5002           .27       .03      .00      .00      .06       .0
    20       5001   5002          -.08       .00      .00      .00      .02       .0
    21       5007   5008          6.36       .04      .00      .00      .21       .3
    22       5008   5009          2.55      3.33      .00      .00      .52      5.5
    23       5009   5067          1.80      3.01      .00      .00      .37      2.5
    24       5067   5069           .19       .02      .00      .00      .04       .0
    25       5058   5044          8.18       .27      .00      .00      .27       .5
    26       5044   5045          5.81       .05      .00      .00      .19       .2
    27       5045   5046           .97      2.72      .00      .00      .41      5.4
    28       5046   5055           .60       .20      .00      .00      .12       .3
    29       5008   5072          3.71       .08      .00      .00      .12       .1
    30       5072   5010          3.73       .05      .00      .00      .12       .1
    31       5010   5011          1.89       .03      .00      .00      .12       .2
    32       5011   5071          1.22       .85      .00      .00      .25      1.4
    33       5071   5012           .81       .16      .00      .00      .17       .6
    34       5012   5013           .09       .02      .00      .00      .04       .0
    35       5012   5014           .24       .03      .00      .00      .10       .4
    36       5014   5015           .05       .00      .00      .00      .02       .0
    37       5014   5016           .07       .01      .00      .00      .03       .0
    38       5011   5017           .53       .01      .00      .00      .03       .0
    39       5017   5018           .09       .07      .00      .00      .06       .2
    40-XX    5017   5019
    41       5019   5020          2.22       .11      .00      .00      .14       .2
    42       5020   5021           .75       .22      .00      .00      .15       .5
    43       5021   5022           .40       .65      .00      .00      .17      1.0
    44       5020   5023          1.04       .22      .00      .00      .14       .3
    45       5023   5024           .07       .00      .00      .00      .01       .0
    46       5024   5021           .04       .00      .00      .00      .01       .0
    47       5023   5025           .91       .07      .00      .00      .12       .3
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    48      5025   5026            .58      .01      .00      .00      .08       .1
    49      5026   5062            .04      .00      .00      .00      .02       .0
    50      5026   5027            .39      .02      .00      .00      .08       .1
    51      5027   5028            .05      .00      .00      .00      .01       .0
    52      5027   5063            .15      .03      .00      .00      .06       .1
    53      5063   5064            .09      .01      .00      .00      .04       .0
    54      5064   5065            .03      .00      .00      .00      .01       .0
    55      5025   5029           -.20      .02      .00      .00      .03       .0
    56      5029   5030           -.46      .01      .00      .00      .06       .0
    57      5030   5019          -1.20      .37      .00      .00      .16       .5
    58      5030   5031            .58      .15      .00      .00      .12       .3
    59      5031   5032            .33      .28      .00      .00      .14       .7
    60-XX   5031   5033
    61      5033   5034            .06      .01      .00      .00      .03       .0
    62      5042   5043           -.57      .26      .00      .00      .12       .3
    63      5043   5044          -1.01      .18      .00      .00      .21       .9
    64      5042   5037           1.18      .71      .00      .00      .24      1.3
    65      5037   5038          -2.89      .03      .00      .00      .16       .3
    66      5038   5039          -3.03      .21      .00      .00      .20       .4
    67      5039   5047          -3.93      .27      .00      .00      .26       .7
    68      5047   5045          -4.50      .60      .00      .00      .29       .9
    69      5047   5048            .19      .26      .00      .00      .08       .2
    70-XX   5029   5035
    71      5035   5037          -3.59      .22      .00      .00      .23       .6
    72      5035   5400           2.15     2.63      .00      .00      .44      4.0
    73-RV   5400   5066           2.15      .40      .00      .00      .44      4.0
    74      5066   5041           1.11      .95      .00      .00      .23      1.1
    75      5041   5036            .29      .03      .00      .00      .06       .1
    76      5039   5300            .32      .26      .00      .00      .13       .6
    77-RV   5300   5040            .32      .42      .00      .00      .13       .6
    78      5010   5033            .20      .01      .00      .00      .04       .0
    79      5034   5043           -.80      .21      .00      .00      .11       .2
    80      5067   5068            .57      .10      .00      .00      .12       .3
    81-FG      0   5057          17.67      .08      .00      .00      .36       .6
    82      5057   5056          17.78      .04      .00      .00      .36       .6
    83      5033   5034            .31      .01      .00      .00      .04       .0
    84      5042   5043          -1.06      .26      .00      .00      .14       .3
    85      5043   5044          -1.87      .18      .00      .00      .25       .9
    86      5058   5044            .79      .27      .00      .00      .16       .5
    87      5010   5033            .36      .01      .00      .00      .05       .0
    88      5007   5003           2.43      .39      .00      .00      .50      4.3
    89      5003   5004           2.14      .69      .00      .00      .44      3.4
    90      5004   5005           1.77     1.11      .00      .00      .36      2.4
    91      5056   5058           6.77      .47      .00      .00      .44      1.8
    92      5058   5059           1.84      .20      .00      .00      .25       .9
    93      5059   5007           1.75      .25      .00      .00      .24       .8
    94      5007   5008           1.06      .04      .00      .00      .14       .3
    95      5008   5072            .62      .08      .00      .00      .08       .1
    96      5010   5011            .78      .03      .00      .00      .11       .2
    97      5011   5017            .22      .01      .00      .00      .03       .0
    98-FG      0   5019           4.12      .06      .00      .00      .27       .7
    99      5049   5051           1.48      .43      .00      .00      .20       .6
```

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 J U N C T I O N   N O D E   R E S U L T S

  JUNCTION   JUNCTION    EXTERNAL   HYDRAULIC   JUNCTION    PRESSURE   JUNCTIO
   NUMBER     TITLE       DEMAND      GRADE     ELEVATION     HEAD     PRESSUR
                          (l/s)        (m)         (m)         (m)      (kpa)
 ------------------------------------------------------------------------------
   5001                      .08      577.78      544.00       33.78     331.30
   5002                      .19      577.79      521.00       56.79     556.88
   5003                      .28      577.82      543.00       34.82     341.47
   5004                      .51      577.13      533.00       44.13     432.74
   5005                     3.40      576.02      545.00       31.02     304.21
   5006                      .21      577.02      543.00       34.02     333.59
   5007                      .23      578.21      525.00       53.21     521.84
   5008                      .54      578.17      526.00       52.17     511.60
   5009                      .75      574.84      521.00       53.84     528.01
   5010                      .50      578.04      536.00       42.04     412.25
   5011                      .70      578.01      542.00       36.01     353.16
   5012                      .48      577.00      539.00       38.00     372.69
   5013                      .09      576.98      534.00       42.98     421.53
   5014                      .12      576.98      543.00       33.98     333.18
   5015                      .05      576.97      544.00       32.97     323.34
   5016                      .07      576.97      534.00       42.97     421.36
   5017                      .66      578.00      557.00       21.00     205.98
   5018                      .09      577.94      535.00       42.94     421.05
   5019                      .70      589.94      563.00       26.94     264.15
   5020                      .42      589.83      552.00       37.83     370.99
   5021                      .39      589.61      563.00       26.61     260.95
   5022                      .40      588.96      558.00       30.96     303.62
   5023                      .07      589.61      568.00       21.61     211.94
   5024                      .03      589.61      572.00       17.61     172.70
   5025                      .53      589.54      564.00       25.54     250.44
   5026                      .15      589.53      567.00       22.53     220.95
   5027                      .19      589.51      564.00       25.51     250.13
   5028                      .05      589.51      563.00       26.51     259.93
   5029                      .26      589.55      567.00       22.55     221.18
   5030                      .16      589.57      563.00       26.57     260.52
   5031                      .25      589.42      571.00       18.42     180.60
   5032                      .33      589.14      554.00       35.14     344.58
   5033                      .18      578.02      544.00       34.02     333.65
   5034                     1.18      578.01      541.00       37.01     362.95
   5035                     1.44      577.03      557.00       20.03     196.43
   5036                      .29      523.62      488.00       35.62     349.27
   5037                      .48      577.25      560.00       17.25     169.16
   5038                      .14      577.28      553.00       24.28     238.11
   5039                      .58      577.49      544.00       33.49     328.39
   5040                      .32      533.58      505.00       28.58     280.32
   5041                      .82      523.65      485.00       38.65     378.98
   5042                      .45      577.96      548.00       29.96     293.78
   5043                      .44      578.22      556.00       22.22     217.88
   5044                      .28      578.40      547.00       31.40     307.88
   5045                      .34      578.35      547.00       31.35     307.43
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  5046                         .37      575.63      527.00      48.63      476.91
  5047                         .38      577.75      537.00      40.75      399.65
  5048                         .19      577.49      518.00      59.49      583.39
  5049                         .73      572.25      500.00      72.25      708.49
  5050                         .12      572.22      510.00      62.22      610.15
  5051                         .52      571.82      507.00      64.82      635.67
  5052                         .49      570.83      535.00      35.83      351.37
  5053                        1.27      570.84      501.00      69.84      684.92
  5054                         .92      575.24      497.00      78.24      767.30
  5055                         .47      575.43      499.00      76.43      749.55
  5056                         .43      579.14      562.00      17.14      168.05
  5057                         .07      579.17      567.00      12.17      119.39
  5058                         .45      578.67      537.00      41.67      408.63
  5059                         .37      578.47      542.00      36.47      357.62
  5060                         .22      578.20      500.00      78.20      766.86
  5062                         .04      589.53      565.00      24.53      240.55
  5063                         .06      589.48      573.00      16.48      161.60
  5064                         .06      589.47      577.00      12.47      122.27
  5065                         .03      589.47      563.00      26.47      259.56
  5066                        1.04      524.60      510.00      14.60      143.14
  5067                        1.04      571.83      523.00      48.83      478.89
  5068                         .57      571.73      525.00      46.73      458.25
  5069                         .19      571.82      535.00      36.82      361.05
  5071                         .41      577.16      540.00      37.16      364.44
  5072                         .60      578.09      532.00      46.09      451.97
  5200                         .00      572.53      515.00      57.53      564.16
  5300                         .00      577.22      534.00      43.22      423.88
  5400                         .00      574.40      525.00      49.40      484.48


 R E G U L A T I N G   V A L V E   R E P O R T

 VALVE POSITION CONTROLLED  VALVE     VALVE     UPSTREAM  DOWNSTREAM  THROUGH
 TYPE    NODE      PIPE    SETTING    STATUS     GRADE      GRADE      FLOW
                          (m or l/s)              (m)        (m)       (l/s)
 ----------------------------------------------------------------------------
 PRV-1  5300        77     534.00   THROTTLED   577.22     533.58        .32
 PRV-1  5400        73     525.00   THROTTLED   574.40     524.60       2.15


 S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

 (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
 (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

              PIPE       FLOWRATE
             NUMBER       (l/s)
             --------------------
                1          9.07
               81         17.67
               98          4.12
```

```
 NET SYSTEM INFLOW  =      30.86
 NET SYSTEM OUTFLOW =        .00
 NET SYSTEM DEMAND  =      30.86


 D A T A   C H A N G E S   F O R   N E X T   S I M U L A T I O N

      D E M A N D   C H A N G E S

 DEMAND TYPE =  1 -   GDF =   .300


                       ************************************
                        S I M U L A T I O N   R E S U L T S
                       ************************************

 THE RESULTS ARE OBTAINED AFTER  2 TRIALS WITH AN ACCURACY =  .00000


 P I P E L I N E   R E S U L T S

 STATUS CODE:   XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                CV -CHECK VALVE    RV -REGULATING VALVE    TK -STORAGE TANK

   PIPE       NODE NOS.      FLOWRATE    HEAD    PUMP   MINOR    LINE    HL/
  NUMBER     #1      #2                  LOSS    HEAD    LOSS    VELO.   1000
                               (l/s)     (m)     (m)     (m)    (m/s)   (m/m
 ----------------------------------------------------------------------------
     1-FG      0    5057        2.72     .01     .00     .00     .09      .0
     2      5057    5056        2.67     .00     .00     .00     .09      .0
     3      5056    5055        1.17     .40     .00     .00     .16      .4
     4      5055    5054        1.22     .02     .00     .00     .15      .4
     5      5054    5200         .94     .29     .00     .00     .13      .3
     6      5200    5049         .94     .03     .00     .00     .12      .2
     7      5049    5050         .04     .00     .00     .00     .02      .0
     8      5049    5051         .24     .05     .00     .00     .05      .0
     9      5051    5053         .38     .11     .00     .00     .16      .9
    10      5051    5052         .15     .11     .00     .00     .06      .1
    11      5056    5058        4.67     .05     .00     .00     .15      .1
    12      5058    5059        3.32     .02     .00     .00     .11      .1
    13      5059    5060         .07     .03     .00     .00     .03      .0
    14      5059    5007        3.17     .03     .00     .00     .10      .0
    15      5007    5003         .67     .04     .00     .00     .14      .4
    16      5003    5004         .59     .07     .00     .00     .12      .3
    17      5004    5005         .49     .12     .00     .00     .10      .2
    18      5004    5006         .06     .01     .00     .00     .03      .0
    19      5003    5002         .08     .00     .00     .00     .02      .0
    20      5001    5002        -.02     .00     .00     .00     .00      .0
```

```
    21       5007    5008           1.91      .00      .00      .00      .06      .0
    22       5008    5009            .77      .36      .00      .00      .16      .6
    23       5009    5067            .54      .32      .00      .00      .11      .2
    24       5067    5069            .06      .00      .00      .00      .01      .0
    25       5058    5044           2.45      .03      .00      .00      .08      .0
    26       5044    5045           1.74      .00      .00      .00      .06      .0
    27       5045    5046            .29      .29      .00      .00      .12      .5
    28       5046    5055            .18      .02      .00      .00      .04      .0
    29       5008    5072           1.11      .01      .00      .00      .04      .0
    30       5072    5010           1.12      .01      .00      .00      .04      .0
    31       5010    5011            .57      .00      .00      .00      .04      .0
    32       5011    5071            .37      .09      .00      .00      .07      .1
    33       5071    5012            .24      .02      .00      .00      .05      .0
    34       5012    5013            .03      .00      .00      .00      .01      .0
    35       5012    5014            .07      .00      .00      .00      .03      .0
    36       5014    5015            .02      .00      .00      .00      .01      .0
    37       5014    5016            .02      .00      .00      .00      .01      .0
    38       5011    5017            .16      .00      .00      .00      .01      .0
    39       5017    5018            .03      .01      .00      .00      .02      .0
    40-XX    5017    5019
    41       5019    5020            .67      .01      .00      .00      .04      .0
    42       5020    5021            .23      .02      .00      .00      .05      .0
    43       5021    5022            .12      .07      .00      .00      .05      .1
    44       5020    5023            .31      .02      .00      .00      .04      .0
    45       5023    5024            .02      .00      .00      .00      .00      .0
    46       5024    5021            .01      .00      .00      .00      .00      .0
    47       5023    5025            .27      .01      .00      .00      .04      .0
    48       5025    5026            .17      .00      .00      .00      .02      .0
    49       5026    5062            .01      .00      .00      .00      .01      .0
    50       5026    5027            .12      .00      .00      .00      .02      .0
    51       5027    5028            .02      .00      .00      .00      .00      .0
    52       5027    5063            .05      .00      .00      .00      .02      .0
    53       5063    5064            .03      .00      .00      .00      .01      .0
    54       5064    5065            .01      .00      .00      .00      .00      .0
    55       5025    5029           -.06      .00      .00      .00      .01      .0
    56       5029    5030           -.14      .00      .00      .00      .02      .0
    57       5030    5019           -.36      .04      .00      .00      .05      .0
    58       5030    5031            .17      .02      .00      .00      .04      .0
    59       5031    5032            .10      .03      .00      .00      .04      .0
    60-XX    5031    5033
    61       5033    5034            .02      .00      .00      .00      .01      .0
    62       5042    5043           -.17      .03      .00      .00      .03      .0
    63       5043    5044           -.30      .02      .00      .00      .06      .1
    64       5042    5037            .35      .08      .00      .00      .07      .1
    65       5037    5038           -.87      .00      .00      .00      .05      .0
    66       5038    5039           -.91      .02      .00      .00      .06      .0
    67       5039    5047          -1.18      .03      .00      .00      .08      .0
    68       5047    5045          -1.35      .06      .00      .00      .09      .1
    69       5047    5048            .06      .03      .00      .00      .02      .0
    70-XX    5029    5035
    71       5035    5037          -1.08      .02      .00      .00      .07      .0
    72       5035    5400            .65      .28      .00      .00      .13      .4
    73-RV    5400    5066            .65      .04      .00      .00      .13      .4
```

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  74      5066    5041             .33      .10      .00      .00      .07      .1
  75      5041    5036             .09      .00      .00      .00      .02      .0
  76      5039    5300             .10      .03      .00      .00      .04      .0
  77-RV   5300    5040             .10      .04      .00      .00      .04      .0
  78      5010    5033             .06      .00      .00      .00      .01      .0
  79      5034    5043            -.24      .02      .00      .00      .03      .0
  80      5067    5068             .17      .01      .00      .00      .03      .0
  81-FG      0    5057            5.30      .01      .00      .00      .11      .0
  82      5057    5056            5.33      .00      .00      .00      .11      .0
  83      5033    5034             .09      .00      .00      .00      .01      .0
  84      5042    5043            -.32      .03      .00      .00      .04      .0
  85      5043    5044            -.56      .02      .00      .00      .08      .1
  86      5058    5044             .24      .03      .00      .00      .05      .0
  87      5010    5033             .11      .00      .00      .00      .01      .0
  88      5007    5003             .73      .04      .00      .00      .15      .4
  89      5003    5004             .64      .07      .00      .00      .13      .3
  90      5004    5005             .53      .12      .00      .00      .11      .2
  91      5056    5058            2.03      .05      .00      .00      .13      .1
  92      5058    5059             .55      .02      .00      .00      .07      .1
  93      5059    5007             .53      .03      .00      .00      .07      .0
  94      5007    5008             .32      .00      .00      .00      .04      .0
  95      5008    5072             .18      .01      .00      .00      .02      .0
  96      5010    5011             .23      .00      .00      .00      .03      .0
  97      5011    5017             .07      .00      .00      .00      .01      .0
  98-FG      0    5019            1.24      .01      .00      .00      .08      .0
  99      5049    5051             .44      .05      .00      .00      .06      .0


 J U N C T I O N   N O D E   R E S U L T S

 JUNCTION   JUNCTION    EXTERNAL   HYDRAULIC   JUNCTION    PRESSURE   JUNCTIO
  NUMBER     TITLE       DEMAND      GRADE     ELEVATION     HEAD     PRESSUR
                         (l/s)        (m)         (m)         (m)      (kpa)
 ----------------------------------------------------------------------------
  5001                     .02      579.09      544.00      35.09     344.14
  5002                     .06      579.09      521.00      58.09     569.70
  5003                     .08      579.10      543.00      36.10     353.98
  5004                     .15      579.02      533.00      46.02     451.32
  5005                    1.02      578.90      545.00      33.90     332.47
  5006                     .06      579.01      543.00      36.01     353.14
  5007                     .07      579.14      525.00      54.14     530.92
  5008                     .16      579.13      526.00      53.13     521.07
  5009                     .23      578.78      521.00      57.78     566.59
  5010                     .15      579.12      536.00      43.12     422.86
  5011                     .21      579.12      542.00      37.12     363.99
  5012                     .14      579.01      539.00      40.01     392.35
  5013                     .03      579.01      534.00      45.01     441.36
  5014                     .04      579.01      543.00      36.01     353.09
  5015                     .02      579.00      544.00      35.00     343.28
  5016                     .02      579.00      534.00      45.00     441.34
  5017                     .20      579.12      557.00      22.12     216.88
  5018                     .03      579.11      535.00      44.11     432.56
```

```
   5019                          .21      589.99      563.00      26.99      264.71
   5020                          .13      589.98      552.00      37.98      372.48
   5021                          .12      589.96      563.00      26.96      264.37
   5022                          .12      589.89      558.00      31.89      312.72
   5023                          .02      589.96      568.00      21.96      215.34
   5024                          .01      589.96      572.00      17.96      176.11
   5025                          .16      589.95      564.00      25.95      254.49
   5026                          .05      589.95      567.00      22.95      225.06
   5027                          .06      589.95      564.00      25.95      254.45
   5028                          .02      589.95      563.00      26.95      264.26
   5029                          .08      589.95      567.00      22.95      225.08
   5030                          .05      589.95      563.00      26.95      264.32
   5031                          .08      589.94      571.00      18.94      185.71
   5032                          .10      589.91      554.00      35.91      352.13
   5033                          .05      579.12      544.00      35.12      344.39
   5034                          .35      579.12      541.00      38.12      373.80
   5035                          .43      579.01      557.00      22.01      215.86
   5036                          .09      524.85      488.00      36.85      361.39
   5037                          .14      579.03      560.00      19.03      186.67
   5038                          .04      579.04      553.00      26.04      255.35
   5039                          .17      579.06      544.00      35.06      343.83
   5040                          .10      533.96      505.00      28.96      283.96
   5041                          .25      524.85      485.00      39.85      390.84
   5042                          .14      579.11      548.00      31.11      305.10
   5043                          .13      579.14      556.00      23.14      226.92
   5044                          .08      579.16      547.00      32.16      315.37
   5045                          .10      579.15      547.00      32.15      315.32
   5046                          .11      578.86      527.00      51.86      508.58
   5047                          .11      579.09      537.00      42.09      412.75
   5048                          .06      579.06      518.00      61.06      598.80
   5049                          .22      578.50      500.00      78.50      769.79
   5050                          .04      578.49      510.00      68.49      671.70
   5051                          .16      578.45      507.00      71.45      700.70
   5052                          .15      578.34      535.00      43.34      425.07
   5053                          .38      578.35      501.00      77.35      758.51
   5054                          .28      578.82      497.00      81.82      802.37
   5055                          .14      578.84      499.00      79.84      782.96
   5056                          .13      579.24      562.00      17.24      169.05
   5057                          .02      579.24      567.00      12.24      120.05
   5058                          .14      579.19      537.00      42.19      413.72
   5059                          .11      579.17      542.00      37.17      364.47
   5060                          .07      579.14      500.00      79.14      776.07
   5062                          .01      589.95      565.00      24.95      244.67
   5063                          .02      589.94      573.00      16.94      166.16
   5064                          .02      589.94      577.00      12.94      126.93
   5065                          .01      589.94      563.00      26.94      264.22
   5066                          .31      524.96      510.00      14.96      146.67
   5067                          .31      578.45      523.00      55.45      543.80
   5068                          .17      578.44      525.00      53.44      524.08
   5069                          .06      578.45      535.00      43.45      426.11
   5071                          .12      579.03      540.00      39.03      382.71
   5072                          .18      579.13      532.00      47.13      462.14
   5200                          .00      578.53      515.00      63.53      622.99
```

```
   5300                        .00       579.03       534.00       45.03      441.62
   5400                        .00       578.73       525.00       53.73      526.90


 R E G U L A T I N G   V A L V E   R E P O R T

 VALVE POSITION CONTROLLED  VALVE     VALVE     UPSTREAM  DOWNSTREAM  THROUGH
 TYPE    NODE      PIPE    SETTING    STATUS     GRADE      GRADE      FLOW
                          (m or l/s)              (m)        (m)       (l/s)
 ---------------------------------------------------------------------------
 PRV-1  5300        77     534.00   THROTTLED   579.03     533.96       .10
 PRV-1  5400        73     525.00   THROTTLED   578.73     524.96       .65


 S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

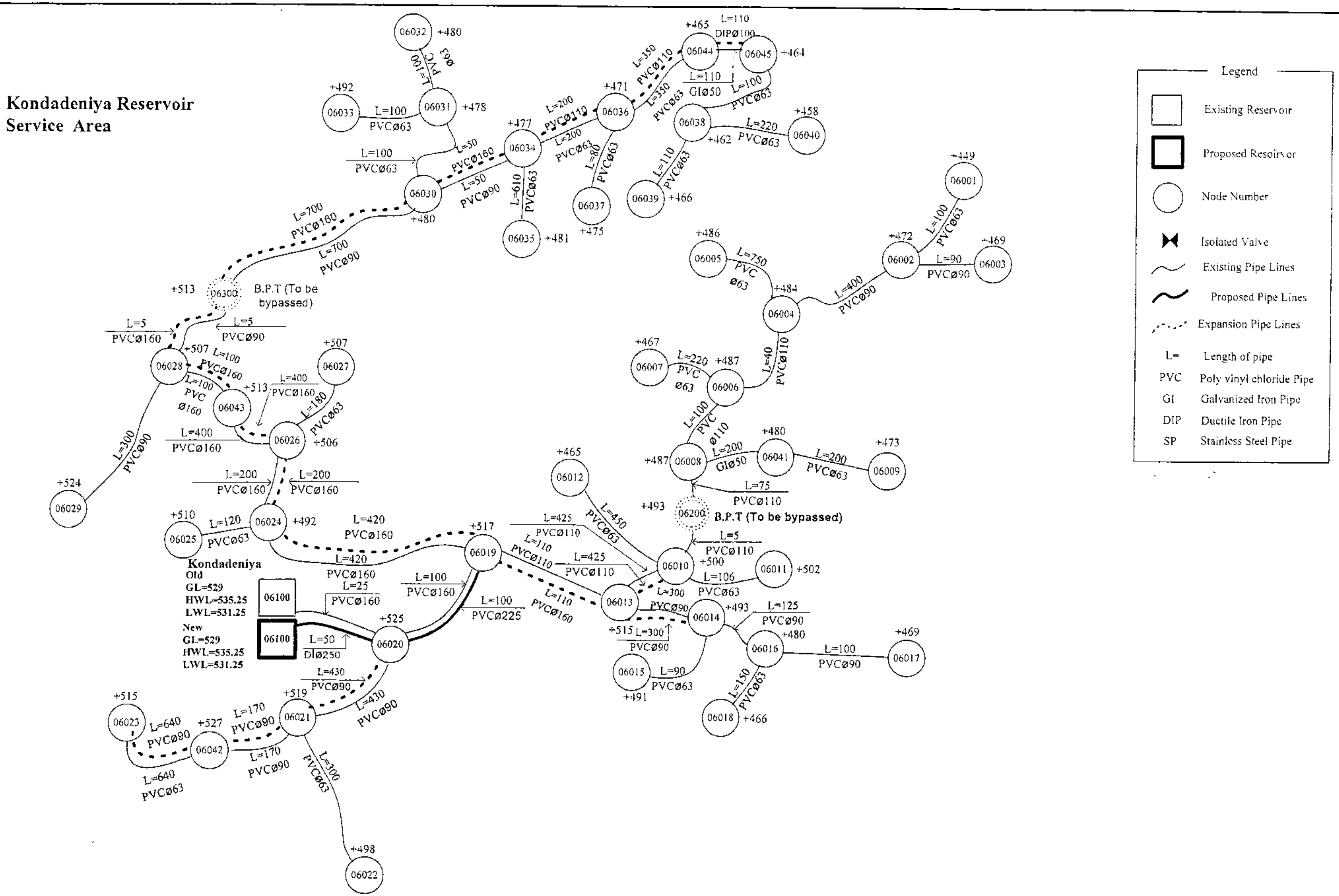
 (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
 (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

             PIPE       FLOWRATE
            NUMBER        (l/s)
            --------------------
               1           2.72
              81           5.30
              98           1.24

 NET SYSTEM INFLOW  =      9.26
 NET SYSTEM OUTFLOW =       .00
 NET SYSTEM DEMAND  =      9.26


 **** KYPIPE SIMULATION COMPLETED ****


 DATE:  3/ 7/2002
 TIME: 13:53: 9
```



Appendix - 5.6 Improvement of Distribution Network in 2015 (Kondadeniya Reservoir Service Area)

```
DATE = 03-07-2002                                              PAGE NO.  1
JOB NAME = GKWSAP - JICA - Kondadeniya SR



         * * * * * * * * * *   K Y P I P E 2   * * * * * * * * * *
         *   University of Kentucky Hydraulic Analysis Program   *
         * Distribution of Pressure and Flows in Piping Networks *
         *         1000 PIPE VERSION - 1.10   (08/25/92)         *
         * * * * * * * * * * * * * * * * * * * * * * * * * * * * *



 DATE:  3/ 7/2002
 TIME: 13:57:39

 INPUT DATA FILENAME -------------- c:\D_nets\2015\KOND2015.DAT
 TABULATED OUTPUT FILENAME -------- c:\D_nets\2015\KOND2015.OUT
 POSTPROCESSOR RESULTS FILENAME --- c:\D_nets\2015\KOND2015.RES

                 ************************************************
                  S U M M A R Y   O F   O R I G I N A L   D A T A
                 ************************************************



 U N I T S   S P E C I F I E D

    FLOWRATE ............ = liters/second
    HEAD (HGL) .......... = meters
    PRESSURE ............ = kpa



 P I P E L I N E   D A T A

 STATUS CODE:    XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                 CV -CHECK VALVE    RV -REGULATING VALVE

   PIPE       NODE NOS.     LENGTH   DIAMETER   ROUGHNESS   MINOR LOSS   FGN-H
  NUMBER      #1     #2       (m)      (cm)       COEFF.      COEFF.       (m)
 ------------------------------------------------------------------------------
    1-FG       0   6020      25.0     14.0      120.00         .00      531.
    2       6020   6021     430.0      7.9      120.00         .00
    3       6020   6019     100.0     14.0      120.00         .00
    4       6021   6042     170.0      7.9      120.00         .00
    5       6021   6022     300.0      5.5      120.00         .00
    6       6042   6023     640.0      5.5      120.00         .00
    7       6019   6024     420.0     14.0      120.00         .00
    8       6019   6013     110.0      9.7      120.00         .00
    9       6024   6026     200.0     14.0      120.00         .00
   10       6024   6025     120.0      5.5      120.00         .00
   11       6026   6043     400.0     14.0      120.00         .00
   12       6026   6027     180.0      5.5      120.00         .00
   13       6043   6028     100.0     14.0      120.00         .00
```

```
   14       6028  6029      300.0      7.9      120.00       .00
   15       6028  6300        5.0      7.9      120.00       .00
   16       6300  6030      700.0      7.9      120.00       .00
   17       6030  6034       50.0      7.9      120.00       .00
   18       6030  6031      100.0      5.5      120.00       .00
   19       6031  6032      100.0      5.5      120.00       .00
   20       6031  6033      100.0      5.5      120.00       .00
   21       6034  6036      200.0      5.5      120.00       .00
   22       6034  6035      610.0      5.5      120.00       .00
   23       6036  6044      350.0      5.5      120.00       .00
   24       6036  6037       80.0      5.5      120.00       .00
   25       6044  6045      110.0      5.0      120.00       .00
   26       6045  6038      100.0      5.5      120.00       .00
   27       6038  6039      110.0      5.5      120.00       .00
   28       6038  6040      220.0      5.5      120.00       .00
   29       6013  6010      425.0      9.7      120.00       .00
   30       6013  6014      300.0      7.9      120.00       .00
   31       6014  6016      125.0      7.9      120.00       .00
   32       6014  6015       90.0      5.5      120.00       .00
   33       6016  6017      100.0      7.9      120.00       .00
   34       6016  6018      150.0      5.5      120.00       .00
   35       6010  6200        5.0      9.7      120.00       .00
   36       6010  6011      106.0      5.5      120.00       .00
   37       6200  6008       75.0      9.7      120.00       .00
   38       6008  6006      100.0      9.7      120.00       .00
   39       6008  6041      200.0      5.0      120.00       .00
   40       6041  6009      200.0      5.5      120.00       .00
   41       6006  6004       40.0      9.7      120.00       .00
   42       6006  6007      220.0      5.5      120.00       .00
   43       6004  6002      400.0      7.9      120.00       .00
   44       6004  6005      750.0      5.5      120.00       .00
   45       6002  6003       90.0      7.9      120.00       .00
   46       6002  6001      100.0      5.5      120.00       .00
   47       6010  6012      450.0      5.5      120.00       .00
   48-FG       0  6020       25.0     25.0      130.00       .00         531.
   49       6020  6021      430.0     14.0      130.00       .00
   50       6020  6019      100.0     19.8      130.00       .00
   51       6021  6042      170.0      7.9      130.00       .00
   52       6042  6023      640.0      7.9      130.00       .00
   53       6019  6024      420.0     14.0      130.00       .00
   54       6019  6013      110.0     14.0      130.00       .00
   55       6024  6026      200.0     14.0      130.00       .00
   56       6026  6043      400.0     14.0      130.00       .00
   57       6043  6028      100.0     14.0      130.00       .00
   58       6028  6300        5.0     14.0      130.00       .00
   59       6300  6030      700.0     14.0      130.00       .00
   60       6030  6034       50.0     14.0      130.00       .00
   61       6034  6036      200.0      9.7      130.00       .00
   62       6036  6044      350.0      9.7      130.00       .00
   63       6044  6045      110.0     10.0      130.00       .00
   64-XX    6045  6038      100.0      9.7      130.00       .00
   65       6013  6010      425.0      9.7      130.00       .00
   66       6013  6014      300.0      7.9      130.00       .00
```

```
 J U N C T I O N   N O D E   D A T A


   JUNCTION    JUNCTION     EXTERNAL     JUNCTION
    NUMBER      TITLE        DEMAND     ELEVATION  CONNECTING PIPES
                             (l/s)         (m)
--------------------------------------------------------------------------
     6001                      .28       449.00    46
     6002                     1.41       472.00    43    45    46
     6003                      .21       469.00    45
     6004                     2.80       484.00    41    43    44
     6005                     1.04       486.00    44
     6006                      .86       487.00    38    41    42
     6007                      .30       467.00    42
     6008                      .86       487.00    37    38    39
     6009                      .38       473.00    40
     6010                     2.40       500.00    29    35    36    47    65
     6011                      .22       502.00    36
     6012                      .68       465.00    47
     6013                     1.70       515.00     8    29    30    54    65

     6014                     1.22       493.00    30    31    32    66
     6015                      .19       491.00    32
     6016                     1.04       480.00    31    33    34
     6017                      .32       469.00    33
     6018                      .32       466.00    34
     6019                     1.28       517.00     3     7     8    50    53

     6020                     1.14       525.00     1     2     3    48    49

     6021                     1.76       519.00     2     4     5    49    51
     6022                      .40       498.00     5
     6023                     1.09       515.00     6    52
     6024                     1.22       492.00     7     9    10    53    55
     6025                      .16       510.00    10
     6026                      .14       506.00     9    11    12    55    56
     6027                      .02       507.00    12
     6028                      .10       507.00    13    14    15    57    58
     6029                      .09       524.00    14
     6030                      .92       480.00    16    17    18    59    60
     6031                      .07       478.00    18    19    20
     6032                      .02       480.00    19
     6033                      .03       492.00    20
     6034                      .39       477.00    17    21    22    60    61
     6035                      .24       481.00    22
     6036                      .36       471.00    21    23    24    61    62
     6037                      .02       475.00    24
     6038                     3.45       462.00    26    27    28    64
     6039                      .63       466.00    27
     6040                     1.24       458.00    28
```

```
     6041                          1.02        480.00     39    40
     6042                          1.83        527.00      4     6    51    52
     6043                           .10        513.00     11    13    56    57
     6044                           .29        465.00     23    25    62    63
     6045                          2.40        464.00     25    26    63    64
     6200                           .00        493.00     35    37
     6300                           .00        513.00     15    16    58    59


 O U T P U T   O P T I O N   D A T A

 OUTPUT SELECTION:  ALL RESULTS ARE INCLUDED IN THE TABULATED OUTPUT


 S Y S T E M   C O N F I G U R A T I O N

     NUMBER OF PIPES ...................(p) =   66
     NUMBER OF JUNCTION NODES ..........(j) =   47
     NUMBER OF PRIMARY LOOPS ...........(l) =   18
     NUMBER OF FIXED GRADE NODES .......(f) =    2
     NUMBER OF SUPPLY ZONES ............(z) =    1


                       ************************************
                        S I M U L A T I O N   R E S U L T S
                       ************************************

 THE RESULTS ARE OBTAINED AFTER  5 TRIALS WITH AN ACCURACY =  .00061


 P I P E L I N E   R E S U L T S

 STATUS CODE:   XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                CV -CHECK VALVE    RV -REGULATING VALVE    TK -STORAGE TANK

  PIPE        NODE NOS.       FLOWRATE     HEAD     PUMP    MINOR     LINE     HL/
 NUMBER      #1      #2                    LOSS     HEAD     LOSS    VELO.    1000
                                (l/s)       (m)      (m)      (m)    (m/s)    (m/m
 ------------------------------------------------------------------------------------
     1-FG     0    6020           6.13      .04      .00      .00      .40     1.7
     2     6020    6021            .86      .32      .00      .00      .18      .7
     3     6020    6019           8.23      .30      .00      .00      .53     2.9
     4     6021    6042           1.40      .31      .00      .00      .29     1.8
     5     6021    6022            .40      .31      .00      .00      .17     1.0
     6     6042    6023            .29      .36      .00      .00      .12      .5
     7     6019    6024           5.71      .64      .00      .00      .37     1.5
     8     6019    6013           4.49      .64      .00      .00      .61     5.8
     9     6024    6026           5.04      .24      .00      .00      .33     1.2
    10     6024    6025            .16      .02      .00      .00      .07      .1
```

```
   11      6026   6043          4.97     .47     .00     .00     .32     1.1
   12      6026   6027           .02     .00     .00     .00     .01      .0
   13      6043   6028          4.92     .12     .00     .00     .32     1.1
   14      6028   6029           .09     .00     .00     .00     .02      .0
   15      6028   6300          1.71     .01     .00     .00     .35     2.6
   16      6300   6030          1.71    1.85     .00     .00     .35     2.6
   17      6030   6034          1.53     .11     .00     .00     .31     2.1
   18      6030   6031           .12     .01     .00     .00     .05      .1
   19      6031   6032           .02     .00     .00     .00     .01      .0
   20      6031   6033           .03     .00     .00     .00     .01      .0
   21      6034   6036          1.44    2.25     .00     .00     .61    11.2
   22      6034   6035           .24     .25     .00     .00     .10      .4
   23      6036   6044          1.38    3.62     .00     .00     .58    10.3
   24      6036   6037           .02     .00     .00     .00     .01      .0
   25      6044   6045          1.00    1.00     .00     .00     .51     9.1
   26      6045   6038          5.32   12.62     .00     .00    2.24   126.2
   27      6038   6039           .63     .27     .00     .00     .27     2.4
   28      6038   6040          1.24    1.87     .00     .00     .52     8.5
   29      6013   6010          5.98    4.20     .00     .00     .81     9.8
   30      6013   6014          1.48     .61     .00     .00     .30     2.0
   31      6014   6016          1.68     .32     .00     .00     .34     2.5
   32      6014   6015           .19     .02     .00     .00     .08      .2
   33      6016   6017           .32     .01     .00     .00     .07      .1
   34      6016   6018           .32     .10     .00     .00     .13      .6
   35      6010   6200          9.16     .11     .00     .00    1.24    21.7
   36      6010   6011           .22     .04     .00     .00     .09      .3
   37      6200   6008          9.16    1.63     .00     .00    1.24    21.7
   38      6008   6006          6.90    1.29     .00     .00     .93    12.8
   39      6008   6041          1.40    3.39     .00     .00     .71    16.9
   40      6041   6009           .38     .19     .00     .00     .16      .9
   41      6006   6004          5.74     .37     .00     .00     .78     9.1
   42      6006   6007           .30     .14     .00     .00     .13      .6
   43      6004   6002          1.90    1.29     .00     .00     .39     3.2
   44      6004   6005          1.04    4.61     .00     .00     .44     6.1
   45      6002   6003           .21     .00     .00     .00     .04      .0
   46      6002   6001           .28     .05     .00     .00     .12      .5
   47      6010   6012           .68    1.26     .00     .00     .29     2.8
   48-FG      0   6020         30.51     .04     .00     .00     .62     1.7
   49      6020   6021          4.22     .32     .00     .00     .27      .7
   50      6020   6019         22.19     .30     .00     .00     .72     2.9
   51      6021   6042          1.52     .31     .00     .00     .31     1.8
   52      6042   6023           .80     .36     .00     .00     .16      .5
   53      6019   6024          6.18     .64     .00     .00     .40     1.5
   54      6019   6013         12.76     .64     .00     .00     .83     5.8
   55      6024   6026          5.47     .24     .00     .00     .36     1.2
   56      6026   6043          5.38     .47     .00     .00     .35     1.1
   57      6043   6028          5.33     .12     .00     .00     .35     1.1
   58      6028   6300          8.35     .01     .00     .00     .54     2.6
   59      6300   6030          8.35    1.85     .00     .00     .54     2.6
   60      6030   6034          7.49     .11     .00     .00     .49     2.1
   61      6034   6036          6.95    2.25     .00     .00     .94    11.2
   62      6036   6044          6.63    3.62     .00     .00     .90    10.3
   63      6044   6045          6.72    1.00     .00     .00     .86     9.1
```

```
    64-XX     6045     6038
    65        6013     6010                6.48      4.20       .00       .00       .88       9.8
    66        6013     6014                1.61       .61       .00       .00       .33       2.0


  J U N C T I O N   N O D E   R E S U L T S

   JUNCTION    JUNCTION     EXTERNAL    HYDRAULIC    JUNCTION     PRESSURE    JUNCTIO
    NUMBER     TITLE         DEMAND       GRADE      ELEVATION      HEAD      PRESSUR
                             (l/s)         (m)          (m)          (m)       (kpa)
  ------------------------------------------------------------------------------------
     6001                      .28       521.32       449.00        72.32      709.27
     6002                     1.41       521.38       472.00        49.38      484.24
     6003                      .21       521.37       469.00        52.37      513.62
     6004                     2.80       522.66       484.00        38.66      379.17
     6005                     1.04       518.06       486.00        32.06      314.38
     6006                      .86       523.03       487.00        36.03      353.35
     6007                      .30       522.90       467.00        55.90      548.16
     6008                      .86       524.32       487.00        37.32      365.99
     6009                      .38       520.74       473.00        47.74      468.19
     6010                     2.40       526.06       500.00        26.06      255.60
     6011                      .22       526.03       502.00        24.03      235.62
     6012                      .68       524.81       465.00        59.81      586.49
     6013                     1.70       530.27       515.00        15.27      149.73
     6014                     1.22       529.66       493.00        36.66      359.50
     6015                      .19       529.63       491.00        38.63      378.88
     6016                     1.04       529.34       480.00        49.34      483.85
     6017                      .32       529.33       469.00        60.33      591.60
     6018                      .32       529.23       466.00        63.23      620.12
     6019                     1.28       530.91       517.00        13.91      136.38
     6020                     1.14       531.21       525.00         6.21       60.87
     6021                     1.76       530.88       519.00        11.88      116.55
     6022                      .40       530.57       498.00        32.57      319.41
     6023                     1.09       530.21       515.00        15.21      149.19
     6024                     1.22       530.27       492.00        38.27      375.30
     6025                      .16       530.25       510.00        20.25      198.55
     6026                      .14       530.03       506.00        24.03      235.63
     6027                      .02       530.03       507.00        23.03      225.82
     6028                      .10       529.44       507.00        22.44      220.08
     6029                      .09       529.44       524.00         5.44       53.34
     6030                      .92       527.57       480.00        47.57      466.55
     6031                      .07       527.56       478.00        49.56      486.05
     6032                      .02       527.56       480.00        47.56      466.43
     6033                      .03       527.56       492.00        35.56      348.75
     6034                      .39       527.47       477.00        50.47      494.91
     6035                      .24       527.22       481.00        46.22      453.25
     6036                      .36       525.21       471.00        54.21      531.67
     6037                      .02       525.21       475.00        50.21      492.44
     6038                     3.45       507.97       462.00        45.97      450.84
     6039                      .63       507.71       466.00        41.71      408.99
     6040                     1.24       506.10       458.00        48.10      471.71
     6041                     1.02       520.93       480.00        40.93      401.41
```

```
   6042                      1.83      530.57      527.00        3.57       35.05
   6043                       .10      529.56      513.00       16.56      162.37
   6044                       .29      521.60      465.00       56.60      555.05
   6045                      2.40      520.60      464.00       56.60      555.01
   6200                       .00      525.95      493.00       32.95      323.17
   6300                       .00      529.43      513.00       16.43      161.11


 S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

 (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
 (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

              PIPE       FLOWRATE
             NUMBER       (1/s)
             --------------------
               1           6.13
              48          30.51

 NET SYSTEM INFLOW  =     36.64
 NET SYSTEM OUTFLOW =       .00
 NET SYSTEM DEMAND  =     36.64


 D A T A   C H A N G E S   F O R   N E X T   S I M U L A T I O N

      D E M A N D   C H A N G E S

 DEMAND TYPE =  1 -   GDF =   .300


                       ************************************
                        S I M U L A T I O N   R E S U L T S
                       ************************************

 THE RESULTS ARE OBTAINED AFTER  2 TRIALS WITH AN ACCURACY =  .00001


 P I P E L I N E   R E S U L T S

 STATUS CODE:   XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                CV -CHECK VALVE    RV -REGULATING VALVE    TK -STORAGE TANK

  PIPE        NODE NOS.      FLOWRATE     HEAD     PUMP    MINOR     LINE     HL/
 NUMBER       #1     #2                   LOSS     HEAD     LOSS     VELO.   1000
                                (1/s)      (m)      (m)      (m)     (m/s)   (m/m
 ------------------------------------------------------------------------------
    1-FG       0   6020          1.84      .00      .00      .00      .12      .1
```

```
    2       6020   6021         .26     .03     .00     .00     .05     .0
    3       6020   6019        2.47     .03     .00     .00     .16     .3
    4       6021   6042         .42     .03     .00     .00     .09     .2
    5       6021   6022         .12     .03     .00     .00     .05     .1
    6       6042   6023         .09     .04     .00     .00     .04     .0
    7       6019   6024        1.71     .07     .00     .00     .11     .1
    8       6019   6013        1.35     .07     .00     .00     .18     .6
    9       6024   6026        1.51     .03     .00     .00     .10     .1
   10       6024   6025         .05     .00     .00     .00     .02     .0
   11       6026   6043        1.49     .05     .00     .00     .10     .1
   12       6026   6027         .01     .00     .00     .00     .00     .0
   13       6043   6028        1.48     .01     .00     .00     .10     .1
   14       6028   6029         .03     .00     .00     .00     .01     .0
   15       6028   6300         .51     .00     .00     .00     .10     .2
   16       6300   6030         .51     .20     .00     .00     .10     .2
   17       6030   6034         .46     .01     .00     .00     .09     .2
   18       6030   6031         .04     .00     .00     .00     .02     .0
   19       6031   6032         .01     .00     .00     .00     .00     .0
   20       6031   6033         .01     .00     .00     .00     .00     .0
   21       6034   6036         .43     .24     .00     .00     .18    1.2
   22       6034   6035         .07     .03     .00     .00     .03     .0
   23       6036   6044         .41     .39     .00     .00     .17    1.1
   24       6036   6037         .01     .00     .00     .00     .00     .0
   25       6044   6045         .30     .11     .00     .00     .15     .9
   26       6045   6038        1.60    1.36     .00     .00     .67   13.5
   27       6038   6039         .19     .03     .00     .00     .08     .2
   28       6038   6040         .37     .20     .00     .00     .16     .9
   29       6013   6010        1.79     .45     .00     .00     .24    1.0
   30       6013   6014         .44     .07     .00     .00     .09     .2
   31       6014   6016         .50     .03     .00     .00     .10     .2
   32       6014   6015         .06     .00     .00     .00     .02     .0
   33       6016   6017         .10     .00     .00     .00     .02     .0
   34       6016   6018         .10     .01     .00     .00     .04     .0
   35       6010   6200        2.75     .01     .00     .00     .37    2.3
   36       6010   6011         .07     .00     .00     .00     .03     .0
   37       6200   6008        2.75     .18     .00     .00     .37    2.3
   38       6008   6006        2.07     .14     .00     .00     .28    1.3
   39       6008   6041         .42     .36     .00     .00     .21    1.8
   40       6041   6009         .11     .02     .00     .00     .05     .1
   41       6006   6004        1.72     .04     .00     .00     .23     .9
   42       6006   6007         .09     .01     .00     .00     .04     .0
   43       6004   6002         .57     .14     .00     .00     .12     .3
   44       6004   6005         .31     .50     .00     .00     .13     .6
   45       6002   6003         .06     .00     .00     .00     .01     .0
   46       6002   6001         .08     .01     .00     .00     .04     .0
   47       6010   6012         .20     .14     .00     .00     .09     .3
   48-FG       0   6020        9.15     .00     .00     .00     .19     .1
   49       6020   6021        1.26     .03     .00     .00     .08     .0
   50       6020   6019        6.66     .03     .00     .00     .22     .3
   51       6021   6042         .46     .03     .00     .00     .09     .2
   52       6042   6023         .24     .04     .00     .00     .05     .0
   53       6019   6024        1.85     .07     .00     .00     .12     .1
   54       6019   6013        3.83     .07     .00     .00     .25     .6
```

```
     55        6024     6026              1.64        .03       .00       .00       .11         .1
     56        6026     6043              1.61        .05       .00       .00       .10         .1
     57        6043     6028              1.60        .01       .00       .00       .10         .1
     58        6028     6300              2.50        .00       .00       .00       .16         .2
     59        6300     6030              2.50        .20       .00       .00       .16         .2
     60        6030     6034              2.25        .01       .00       .00       .15         .2
     61        6034     6036              2.08        .24       .00       .00       .28        1.2
     62        6036     6044              1.99        .39       .00       .00       .27        1.1
     63        6044     6045              2.02        .11       .00       .00       .26         .9
     64-XX     6045     6038
     65        6013     6010              1.94        .45       .00       .00       .26        1.0
     66        6013     6014               .48        .07       .00       .00       .10         .2


   J U N C T I O N   N O D E   R E S U L T S

   JUNCTION    JUNCTION      EXTERNAL    HYDRAULIC    JUNCTION     PRESSURE    JUNCTIO
    NUMBER      TITLE         DEMAND       GRADE      ELEVATION      HEAD      PRESSUR
                              (l/s)         (m)          (m)          (m)       (kpa)
   ------------------------------------------------------------------------------------
     6001                        .08      530.18       449.00       81.18      796.13
     6002                        .42      530.19       472.00       58.19      570.64
     6003                        .06      530.19       469.00       61.19      600.05
     6004                        .84      530.33       484.00       46.33      454.31
     6005                        .31      529.83       486.00       43.83      429.84
     6006                        .26      530.37       487.00       43.37      425.28
     6007                        .09      530.35       467.00       63.35      621.27
     6008                        .26      530.50       487.00       43.50      426.64
     6009                        .11      530.12       473.00       57.12      560.16
     6010                        .72      530.69       500.00       30.69      300.99
     6011                        .07      530.69       502.00       28.69      281.34
     6012                        .20      530.56       465.00       65.56      642.90
     6013                        .51      531.14       515.00       16.14      158.32
     6014                        .37      531.08       493.00       38.08      373.43
     6015                        .06      531.08       491.00       40.08      393.02
     6016                        .31      531.04       480.00       51.04      500.58
     6017                        .10      531.04       469.00       62.04      608.44
     6018                        .10      531.03       466.00       65.03      637.76
     6019                        .38      531.21       517.00       14.21      139.38
     6020                        .34      531.25       525.00        6.25       61.25
     6021                        .53      531.21       519.00       12.21      119.75
     6022                        .12      531.18       498.00       33.18      325.36
     6023                        .33      531.14       515.00       16.14      158.27
     6024                        .37      531.14       492.00       39.14      383.88
     6025                        .05      531.14       510.00       21.14      207.33
     6026                        .04      531.12       506.00       25.12      246.33
     6027                        .01      531.12       507.00       24.12      236.52
     6028                        .03      531.06       507.00       24.06      235.91
     6029                        .03      531.06       524.00        7.06       69.19
     6030                        .28      530.85       480.00       50.85      498.72
     6031                        .02      530.85       478.00       52.85      518.32
     6032                        .01      530.85       480.00       50.85      498.70
```

```
   6033                          .01      530.85      492.00      38.85      381.02
   6034                          .12      530.84      477.00      53.84      528.02
   6035                          .07      530.82      481.00      49.82      488.53
   6036                          .11      530.60      471.00      59.60      584.49
   6037                          .01      530.60      475.00      55.60      545.26
   6038                         1.04      528.75      462.00      66.75      654.56
   6039                          .19      528.72      466.00      62.72      615.05
   6040                          .37      528.55      458.00      70.55      691.81
   6041                          .31      530.14      480.00      50.14      491.71
   6042                          .55      531.18      527.00       4.18       40.97
   6043                          .03      531.07      513.00      18.07      177.19
   6044                          .09      530.21      465.00      65.21      639.51
   6045                          .72      530.10      464.00      66.10      648.26
   6200                          .00      530.68      493.00      37.68      369.52
   6300                          .00      531.05      513.00      18.05      177.05


 S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

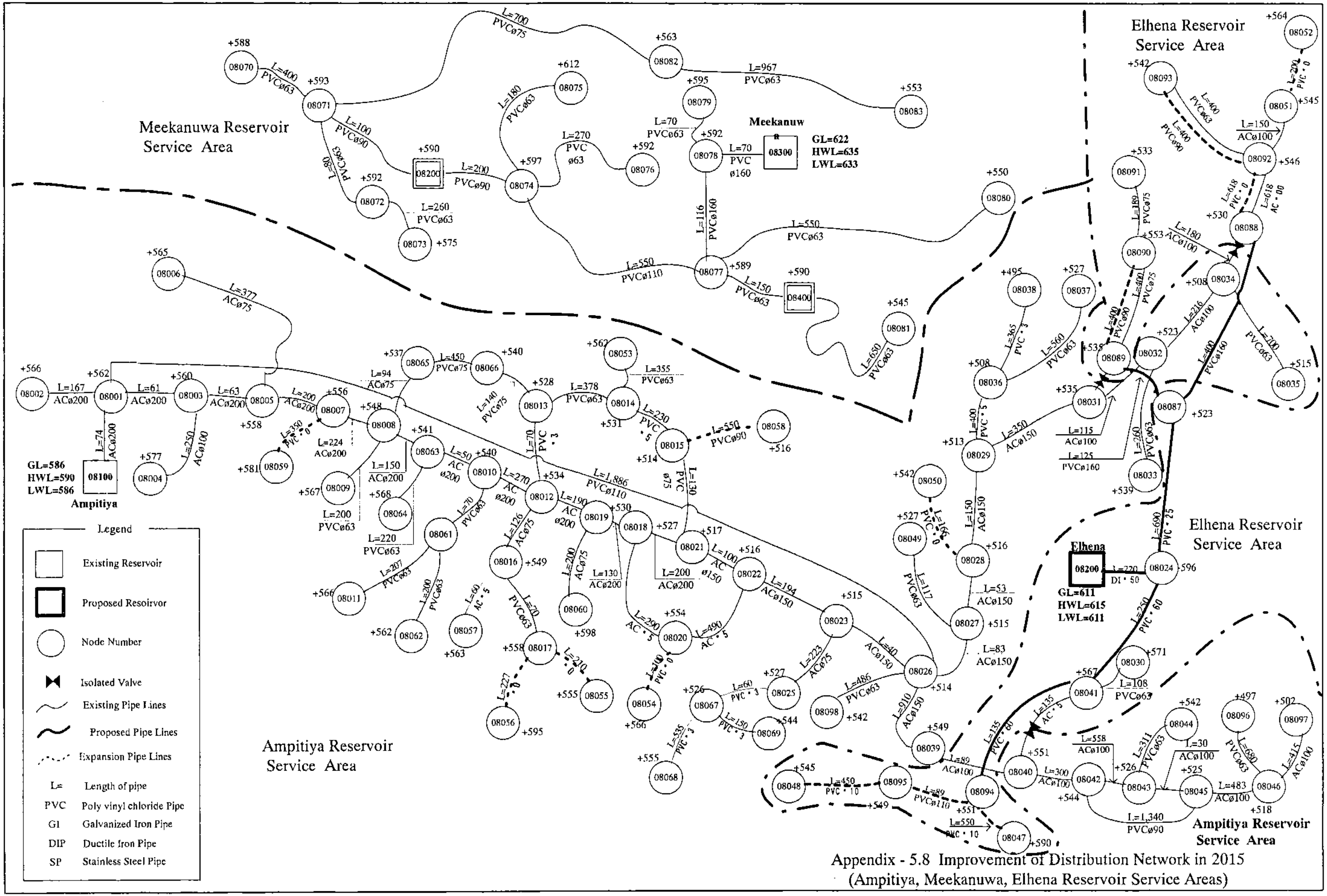
 (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
 (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

              PIPE        FLOWRATE
             NUMBER         (1/s)
             --------------------
                1            1.84
               48            9.15

 NET SYSTEM INFLOW   =      10.99
 NET SYSTEM OUTFLOW =         .00
 NET SYSTEM DEMAND   =      10.99


 **** KYPIPE SIMULATION COMPLETED ****


 DATE:  3/ 7/2002
 TIME: 13:57:39
```



Appendix - 5.8 Improvement of Distribution Network in 2015
(Ampitiya, Meekanuwa, Elhena Reservoir Service Areas)

```
         * * * * * * * * * *   K Y P I P E 2   * * * * * * * * * *
         *   University of Kentucky Hydraulic Analysis Program   *
         * Distribution of Pressure and Flows in Piping Networks *
         *         1000 PIPE VERSION - 1.10   (08/25/92)         *
         * * * * * * * * * * * * * * * * * * * * * * * * * * * * *



 DATE:  3/ 7/2002
 TIME: 13:58:47

 INPUT DATA FILENAME -------------- c:\D_nets\2015\ELHE2015.DAT
 TABULATED OUTPUT FILENAME -------- c:\D_nets\2015\ELHE2015.OUT
 POSTPROCESSOR RESULTS FILENAME --- c:\D_nets\2015\ELHE2015.RES

               ************************************************
                S U M M A R Y   O F   O R I G I N A L   D A T A
               ************************************************


 U N I T S   S P E C I F I E D

    FLOWRATE ............ = liters/second
    HEAD (HGL) .......... = meters
    PRESSURE ............ = kpa


 P I P E L I N E   D A T A

 STATUS CODE:    XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                 CV -CHECK VALVE    RV -REGULATING VALVE

   PIPE       NODE NOS.     LENGTH   DIAMETER   ROUGHNESS   MINOR LOSS    FGN-H
  NUMBER      #1    #2        (m)      (cm)       COEFF.      COEFF.        (m)
 ----------------------------------------------------------------------------
    1-FG       0  8024      220.0     20.0      130.00         .00        611.
    2       8024  8041      250.0     14.0      130.00         .00
    3       8041  8094      135.0     14.0      130.00         .00
    4       8094  8047      550.0      9.7      130.00         .00
    5       8094  8095       89.0      9.7      130.00         .00
    6       8095  8048      450.0      9.7      130.00         .00
    7       8024  8087      690.0     19.8      130.00         .00
    8       8087  8089      125.0     14.0      130.00         .00
    9       8087  8088      400.0     14.0      130.00         .00
   10       8089  8090      390.0      6.5      120.00         .00
   11       8090  8091      189.0      6.5      120.00         .00
   12       8088  8092      618.0     10.0      120.00         .00
   13       8092  8093      400.0      5.5      120.00         .00
```

```
   14       8092  8051       150.0     10.0       120.00         .00
   15       8051  8052       200.0      9.7       130.00         .00
   16       8041  8030       108.0      5.5       130.00         .00


 J U N C T I O N   N O D E   D A T A


    JUNCTION    JUNCTION     EXTERNAL    JUNCTION
     NUMBER      TITLE        DEMAND     ELEVATION  CONNECTING PIPES
                              (l/s)          (m)
 -----------------------------------------------------------------------------
     8024                        .75       596.00     1    2    7
     8030                        .75       571.00    16
     8041                        .75       567.00     2    3   16
     8047                        .89       590.00     4
     8048                        .89       545.00     6
     8051                        .21       545.00    14   15
     8052                       1.21       564.00    15
     8087                        .00       523.00     7    8    9
     8088                        .00       520.00     9   12
     8089                        .75       535.00     8   10
     8090                        .75       553.00    10   11
     8091                       2.89       533.00    11
     8092                       1.21       546.00    12   13   14
     8093                       1.21       542.00    13
     8094                        .00       551.00     3    4    5
     8095                        .89       549.00     5    6


 O U T P U T   O P T I O N   D A T A

 OUTPUT SELECTION:  ALL RESULTS ARE INCLUDED IN THE TABULATED OUTPUT


 S Y S T E M   C O N F I G U R A T I O N

     NUMBER OF PIPES ...................(p) =   16
     NUMBER OF JUNCTION NODES ..........(j) =   16
     NUMBER OF PRIMARY LOOPS ...........(l) =    0
     NUMBER OF FIXED GRADE NODES .......(f) =    1
     NUMBER OF SUPPLY ZONES ............(z) =    1


                     *************************************
                      S I M U L A T I O N   R E S U L T S
                     *************************************

 THE RESULTS ARE OBTAINED AFTER  2 TRIALS WITH AN ACCURACY =  .00000
```

```
 P I P E L I N E   R E S U L T S

 STATUS CODE:   XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                CV -CHECK VALVE    RV -REGULATING VALVE    TK -STORAGE TANK

   PIPE        NODE NOS.       FLOWRATE     HEAD     PUMP    MINOR    LINE     HL/
  NUMBER      #1     #2                     LOSS     HEAD    LOSS     VELO.    1000
                                 (l/s)      (m)      (m)     (m)     (m/s)    (m/m
 ------------------------------------------------------------------------------------
     1-FG      0    8024         13.15      .24      .00     .00      .42     1.0
     2      8024    8041          4.17      .18      .00     .00      .27      .7
     3      8041    8094          2.67      .04      .00     .00      .17      .3
     4      8094    8047           .89      .14      .00     .00      .12      .2
     5      8094    8095          1.78      .08      .00     .00      .24      .9
     6      8095    8048           .89      .11      .00     .00      .12      .2
     7      8024    8087          8.23      .33      .00     .00      .27      .4
     8      8087    8089          4.39      .10      .00     .00      .29      .8
     9      8087    8088          3.84      .25      .00     .00      .25      .6
    10      8089    8090          3.64    10.81      .00     .00     1.10     27.7
    11      8090    8091          2.89     3.42      .00     .00      .87     18.0
    12      8088    8092          3.84     2.32      .00     .00      .49      3.7
    13      8092    8093          1.21     3.25      .00     .00      .51      8.1
    14      8092    8051          1.42      .09      .00     .00      .18      .5
    15      8051    8052          1.21      .09      .00     .00      .16      .4
    16      8041    8030           .75      .31      .00     .00      .32      2.8


 J U N C T I O N   N O D E   R E S U L T S

  JUNCTION   JUNCTION    EXTERNAL   HYDRAULIC   JUNCTION    PRESSURE   JUNCTIO
   NUMBER     TITLE       DEMAND      GRADE     ELEVATION     HEAD     PRESSUR
                          (l/s)        (m)         (m)         (m)       (kpa)
 ------------------------------------------------------------------------------------
    8024                    .75      610.76      596.00      14.76     144.77
    8030                    .75      610.27      571.00      39.27     385.08
    8041                    .75      610.58      567.00      43.58     427.36
    8047                    .89      610.40      590.00      20.40     200.04
    8048                    .89      610.34      545.00      65.34     640.79
    8051                    .21      607.77      545.00      62.77     615.59
    8052                   1.21      607.68      564.00      43.68     428.39
    8087                    .00      610.43      523.00      87.43     857.43
    8088                    .00      610.18      520.00      90.18     884.38
    8089                    .75      610.33      535.00      75.33     738.76
    8090                    .75      599.53      553.00      46.53     456.27
    8091                   2.89      596.11      533.00      63.11     618.90
    8092                   1.21      607.86      546.00      61.86     606.65
    8093                   1.21      604.61      542.00      62.61     613.99
    8094                    .00      610.54      551.00      59.54     583.85
    8095                    .89      610.46      549.00      61.46     602.67
```

```
 S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

 (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
 (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

             PIPE        FLOWRATE
            NUMBER         (l/s)
            --------------------
              1           13.15

 NET SYSTEM INFLOW   =    13.15
 NET SYSTEM OUTFLOW  =      .00
 NET SYSTEM DEMAND   =    13.15


 D A T A   C H A N G E S   F O R   N E X T   S I M U L A T I O N

      D E M A N D   C H A N G E S

 DEMAND TYPE =  1 -   GDF =   .300


                       ************************************
                        S I M U L A T I O N   R E S U L T S
                       ************************************

 THE RESULTS ARE OBTAINED AFTER  2 TRIALS WITH AN ACCURACY =  .00000


 P I P E L I N E   R E S U L T S

 STATUS CODE:   XX -CLOSED PIPE   FG -FIXED GRADE NODE   PU -PUMP LINE
                CV -CHECK VALVE   RV -REGULATING VALVE   TK -STORAGE TANK

  PIPE        NODE NOS.     FLOWRATE    HEAD    PUMP   MINOR    LINE    HL/
 NUMBER      #1      #2                 LOSS    HEAD    LOSS    VELO.  1000
                              (l/s)      (m)     (m)     (m)    (m/s)  (m/m
 ------------------------------------------------------------------------------
     1-FG     0    8024        3.95      .03     .00     .00     .13     .1
     2     8024    8041        1.25      .02     .00     .00     .08     .0
     3     8041    8094         .80      .00     .00     .00     .05     .0
     4     8094    8047         .27      .01     .00     .00     .04     .0
     5     8094    8095         .53      .01     .00     .00     .07     .1
     6     8095    8048         .27      .01     .00     .00     .04     .0
     7     8024    8087        2.47      .04     .00     .00     .08     .0
     8     8087    8089        1.32      .01     .00     .00     .09     .0
```

```
     9       8087   8088             1.15      .03      .00      .00      .07      .0
    10       8089   8090             1.09     1.16      .00      .00      .33     2.9
    11       8090   8091              .87      .37      .00      .00      .26     1.9
    12       8088   8092             1.15      .25      .00      .00      .15      .4
    13       8092   8093              .36      .35      .00      .00      .15      .8
    14       8092   8051              .43      .01      .00      .00      .05      .0
    15       8051   8052              .36      .01      .00      .00      .05      .0
    16       8041   8030              .23      .03      .00      .00      .09      .3


 J U N C T I O N   N O D E   R E S U L T S

  JUNCTION   JUNCTION    EXTERNAL   HYDRAULIC   JUNCTION    PRESSURE   JUNCTIO
   NUMBER     TITLE       DEMAND      GRADE     ELEVATION     HEAD     PRESSUR
                          (l/s)        (m)         (m)         (m)      (kpa)
 -------------------------------------------------------------------------------
   8024                      .23      610.97      596.00      14.97     146.85
   8030                      .23      610.92      571.00      39.92     391.49
   8041                      .23      610.95      567.00      43.95     431.05
   8047                      .27      610.94      590.00      20.94     205.31
   8048                      .27      610.93      545.00      65.93     646.55
   8051                      .06      610.65      545.00      65.65     643.84
   8052                      .36      610.64      564.00      46.64     457.42
   8087                      .00      610.94      523.00      87.94     862.39
   8088                      .00      610.91      520.00      90.91     891.55
   8089                      .23      610.93      535.00      75.93     744.61
   8090                      .23      609.77      553.00      56.77     556.69
   8091                      .87      609.40      533.00      76.40     749.22
   8092                      .36      610.66      546.00      64.66     634.13
   8093                      .36      610.31      542.00      68.31     669.92
   8094                      .00      610.95      551.00      59.95     587.91
   8095                      .27      610.94      549.00      61.94     607.44


 S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

 (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
 (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

              PIPE      FLOWRATE
             NUMBER       (l/s)
             --------------------
                1          3.95

 NET SYSTEM INFLOW  =      3.95
 NET SYSTEM OUTFLOW =       .00
 NET SYSTEM DEMAND  =      3.94


 **** KYPIPE SIMULATION COMPLETED ****
```

```
 DATE:  3/ 7/2002
 TIME: 13:58:47
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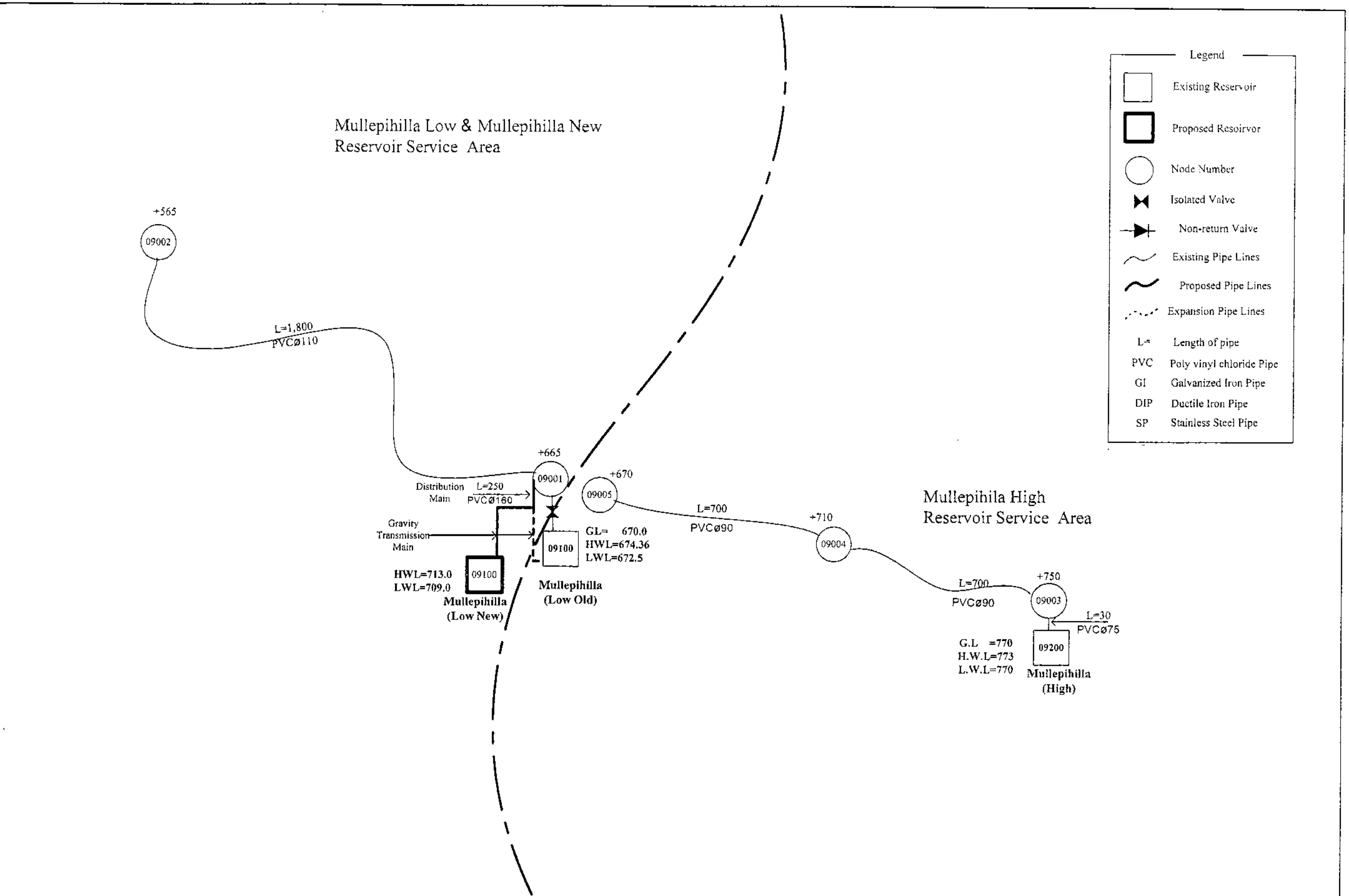


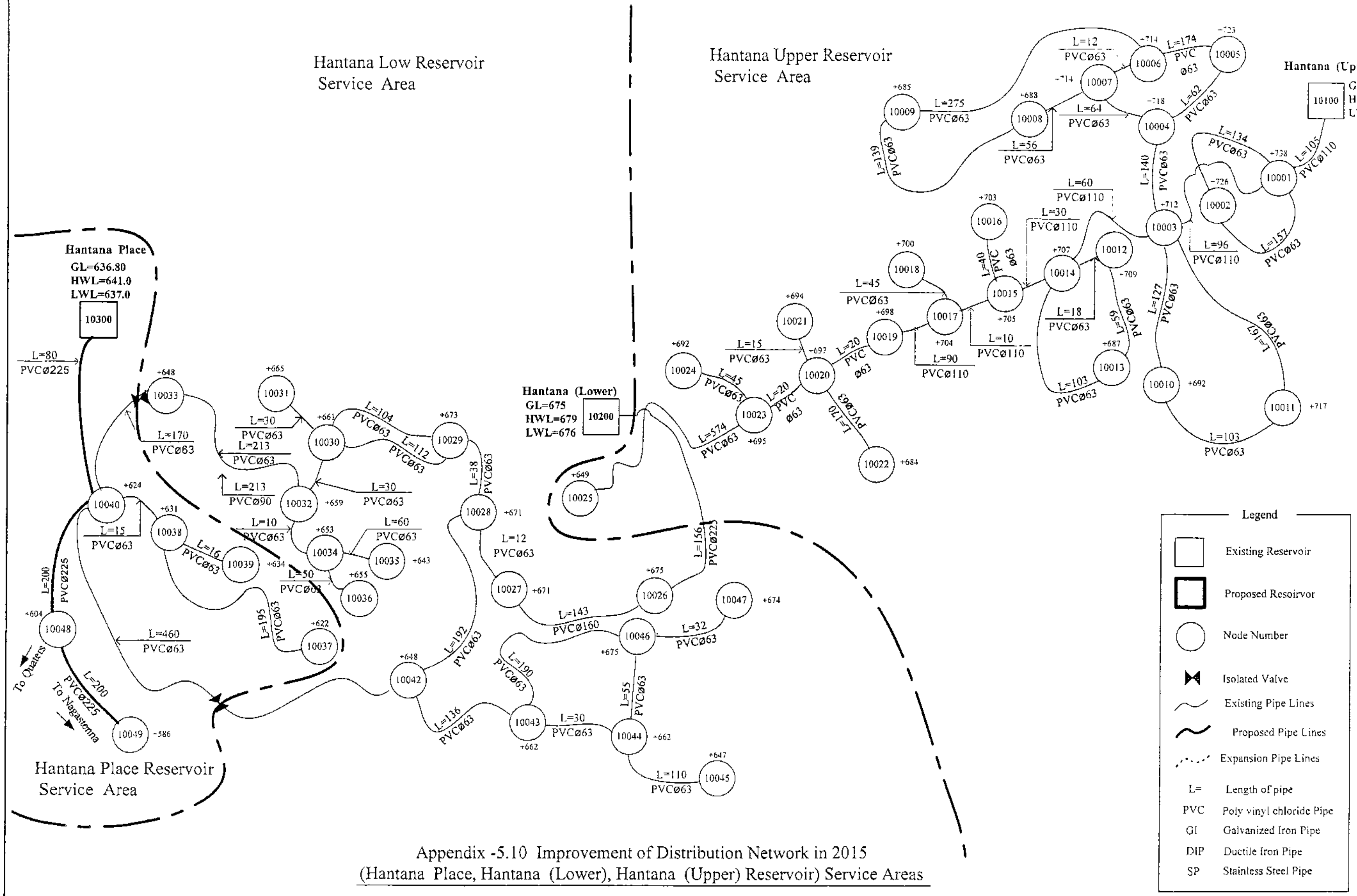
Appendix - 5.9 Improvement of Distribution Network in 2015
(Mullepihila Low (Old), Mullepihila Low (New), Mullepihilla(High) Reservoir Service Areas)

```
         * * * * * * * * * * *   K Y P I P E 2   * * * * * * * * * * *
         *   University of Kentucky Hydraulic Analysis Program   *
         * Distribution of Pressure and Flows in Piping Networks *
         *         1000 PIPE VERSION - 1.10   (08/25/92)         *
         * * * * * * * * * * * * * * * * * * * * * * * * * * * * *



 DATE:  3/ 7/2002
 TIME: 14: 0: 6

 INPUT DATA FILENAME -------------- c:\D_nets\2015\MULL2015.DAT
 TABULATED OUTPUT FILENAME -------- c:\D_nets\2015\MULL2015.OUT
 POSTPROCESSOR RESULTS FILENAME --- c:\D_nets\2015\MULL2015.RES

               ************************************************
                S U M M A R Y   O F   O R I G I N A L   D A T A
               ************************************************


 U N I T S   S P E C I F I E D

    FLOWRATE ............ = liters/second
    HEAD (HGL) .......... = meters
    PRESSURE ............ = kpa


 P I P E L I N E   D A T A

 STATUS CODE:   XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                CV -CHECK VALVE    RV -REGULATING VALVE

   PIPE      NODE NOS.     LENGTH   DIAMETER  ROUGHNESS  MINOR LOSS   FGN-H
  NUMBER     #1    #2       (m)       (cm)      COEFF.     COEFF.       (m)
 ----------------------------------------------------------------------------
    1-XXFG     0  9001       25.0      9.7     120.00         .00      672.
    2-FG       0  9001      250.0     14.0     130.00         .00      709.
    3       9001  9002     1800.0      9.7     120.00         .00


 J U N C T I O N   N O D E   D A T A


    JUNCTION    JUNCTION     EXTERNAL   JUNCTION
     NUMBER      TITLE        DEMAND    ELEVATION  CONNECTING PIPES
                              (l/s)        (m)
 ----------------------------------------------------------------------------
```

```
     9001                       2.43       665.00     1    2    3
     9002                      14.65       565.00     3


 O U T P U T   O P T I O N   D A T A

 OUTPUT SELECTION:  ALL RESULTS ARE INCLUDED IN THE TABULATED OUTPUT


 S Y S T E M   C O N F I G U R A T I O N

     NUMBER OF PIPES ...................(p) =    3
     NUMBER OF JUNCTION NODES ..........(j) =    2
     NUMBER OF PRIMARY LOOPS ...........(l) =    0
     NUMBER OF FIXED GRADE NODES .......(f) =    2
     NUMBER OF SUPPLY ZONES ............(z) =    1


                     *************************************
                      S I M U L A T I O N   R E S U L T S
                     *************************************

 THE RESULTS ARE OBTAINED AFTER  2 TRIALS WITH AN ACCURACY =  .00000


 P I P E L I N E   R E S U L T S

 STATUS CODE:   XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                CV -CHECK VALVE    RV -REGULATING VALVE    TK -STORAGE TANK

   PIPE        NODE NOS.      FLOWRATE    HEAD    PUMP   MINOR    LINE     HL/
  NUMBER      #1     #2                   LOSS    HEAD    LOSS    VELO.   1000
                                (l/s)      (m)     (m)     (m)    (m/s)   (m/m
 -----------------------------------------------------------------------------
     1-XXFG    0   9001
     2-FG      0   9001          17.08    2.49     .00     .00    1.11     9.9
     3      9001   9002          14.65   93.57     .00     .00    1.98    51.9


 J U N C T I O N   N O D E   R E S U L T S

  JUNCTION   JUNCTION    EXTERNAL   HYDRAULIC   JUNCTION    PRESSURE   JUNCTIO
   NUMBER     TITLE       DEMAND      GRADE     ELEVATION     HEAD     PRESSUR
                          (l/s)        (m)         (m)         (m)      (kpa)
 -----------------------------------------------------------------------------
   9001                     2.43      706.51      665.00      41.51     407.04
   9002                    14.65      612.93      565.00      47.93     470.05
```

```
 S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

 (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
 (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

             PIPE       FLOWRATE
            NUMBER        (l/s)
            ---------------------
               2          17.08

 NET SYSTEM INFLOW  =     17.08
 NET SYSTEM OUTFLOW =       .00
 NET SYSTEM DEMAND  =     17.08


 D A T A   C H A N G E S   F O R   N E X T   S I M U L A T I O N


      D E M A N D   C H A N G E S

 DEMAND TYPE =  1 -   GDF =   .300


                     *************************************
                      S I M U L A T I O N   R E S U L T S
                     *************************************

 THE RESULTS ARE OBTAINED AFTER  2 TRIALS WITH AN ACCURACY =  .00000


 P I P E L I N E   R E S U L T S

 STATUS CODE:   XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                CV -CHECK VALVE    RV -REGULATING VALVE    TK -STORAGE TANK

   PIPE        NODE NOS.      FLOWRATE    HEAD    PUMP   MINOR    LINE     HL/
  NUMBER      #1     #2                   LOSS    HEAD    LOSS    VELO.   1000
                                (l/s)      (m)     (m)     (m)    (m/s)   (m/m
 -----------------------------------------------------------------------------
     1-XXFG    0   9001
     2-FG      0   9001           5.12      .27     .00     .00     .33     1.0
     3      9001   9002           4.39    10.06     .00     .00     .59     5.5


 J U N C T I O N   N O D E   R E S U L T S

  JUNCTION   JUNCTION    EXTERNAL   HYDRAULIC   JUNCTION    PRESSURE   JUNCTIO
```

```
  NUMBER     TITLE        DEMAND      GRADE     ELEVATION     HEAD     PRESSUR
                          (l/s)        (m)         (m)         (m)      (kpa)
 ------------------------------------------------------------------------------
  9001                      .73      708.73      665.00       43.73     428.86
  9002                     4.39      698.67      565.00      133.67    1310.84


 S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

 (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
 (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

              PIPE        FLOWRATE
             NUMBER         (l/s)
             --------------------
                2            5.12

 NET SYSTEM INFLOW  =        5.12
 NET SYSTEM OUTFLOW =         .00
 NET SYSTEM DEMAND  =        5.12


 **** KYPIPE SIMULATION COMPLETED ****


 DATE:  3/ 7/2002
 TIME: 14: 0: 6
```



Appendix -5.10 Improvement of Distribution Network in 2015 (Hantana Place, Hantana (Lower), Hantana (Upper) Reservoir) Service Areas

```
         * * * * * * * * * *   K Y P I P E 2   * * * * * * * * * *
         *   University of Kentucky Hydraulic Analysis Program   *
         * Distribution of Pressure and Flows in Piping Networks *
         *        1000 PIPE VERSION - 1.10   (08/25/92)          *
         * * * * * * * * * * * * * * * * * * * * * * * * * * * * *



 DATE:  3/ 7/2002
 TIME: 14: 0:49

 INPUT DATA FILENAME -------------- c:\D_nets\2015\HANP2015.DAT
 TABULATED OUTPUT FILENAME -------- c:\D_nets\2015\HANP2015.OUT
 POSTPROCESSOR RESULTS FILENAME --- c:\D_nets\2015\HANP2015.RES

               ************************************************
                S U M M A R Y   O F   O R I G I N A L   D A T A
               ************************************************


 U N I T S   S P E C I F I E D

    FLOWRATE ............ = liters/second
    HEAD (HGL) .......... = meters
    PRESSURE ............ = kpa


 P I P E L I N E   D A T A

 STATUS CODE:   XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                CV -CHECK VALVE    RV -REGULATING VALVE

   PIPE      NODE NOS.     LENGTH   DIAMETER  ROUGHNESS   MINOR LOSS   FGN-H
  NUMBER      #1    #2      (m)       (cm)      COEFF.      COEFF.       (m)
 ------------------------------------------------------------------------------
    1-FG       0  1040      80.0      19.8     130.00         .00      637.
    2       1040  1048     180.0      19.8     130.00         .00
    3       1048  1049     200.0      19.8     130.00         .00
    4       1040  1038      15.0       5.5     120.00         .00
    5       1038  1037     195.0       5.5     120.00         .00
    6       1038  1039      16.0       5.5     120.00         .00


 J U N C T I O N   N O D E   D A T A


    JUNCTION     JUNCTION     EXTERNAL    JUNCTION
```

```
    NUMBER      TITLE          DEMAND      ELEVATION  CONNECTING PIPES
                               (l/s)          (m)
 -----------------------------------------------------------------------------
    1037                        1.92       622.00     5
    1038                        1.92       631.00     4    5    6
    1039                        1.92       634.00     6
    1040                        1.92       624.00     1    2    4
    1048                        6.10       600.00     2    3
    1049                        8.26       575.00     3


 O U T P U T   O P T I O N   D A T A

 OUTPUT SELECTION:  ALL RESULTS ARE INCLUDED IN THE TABULATED OUTPUT


 S Y S T E M   C O N F I G U R A T I O N

    NUMBER OF PIPES ...................(p) =    6
    NUMBER OF JUNCTION NODES ..........(j) =    6
    NUMBER OF PRIMARY LOOPS ...........(l) =    0
    NUMBER OF FIXED GRADE NODES .......(f) =    1
    NUMBER OF SUPPLY ZONES ............(z) =    1


                       ************************************
                        S I M U L A T I O N   R E S U L T S
                       ************************************

 THE RESULTS ARE OBTAINED AFTER  2 TRIALS WITH AN ACCURACY =  .00000


 P I P E L I N E   R E S U L T S

 STATUS CODE:   XX -CLOSED PIPE   FG -FIXED GRADE NODE    PU -PUMP LINE
                CV -CHECK VALVE   RV -REGULATING VALVE    TK -STORAGE TANK

   PIPE        NODE NOS.      FLOWRATE     HEAD     PUMP    MINOR     LINE      HL/
  NUMBER      #1      #2                   LOSS     HEAD    LOSS      VELO.    1000
                                (l/s)       (m)      (m)     (m)      (m/s)    (m/m
 -----------------------------------------------------------------------------
    1-FG       0    1040        22.04       .24      .00      .00       .72      2.9
    2       1040    1048        14.36       .24      .00      .00       .47      1.3
    3       1048    1049         8.26       .10      .00      .00       .27       .4
    4       1040    1038         5.76      2.19      .00      .00      2.42    146.2
    5       1038    1037         1.92      3.73      .00      .00       .81     19.1
    6       1038    1039         1.92       .31      .00      .00       .81     19.1
```

```
 J U N C T I O N   N O D E   R E S U L T S

  JUNCTION   JUNCTION    EXTERNAL   HYDRAULIC   JUNCTION    PRESSURE   JUNCTIO
   NUMBER     TITLE       DEMAND      GRADE       ELEVATION     HEAD       PRESSUR
                          (l/s)        (m)         (m)         (m)      (kpa)
 -----------------------------------------------------------------------------
   1037                      1.92      630.84      622.00       8.84      86.71
   1038                      1.92      634.57      631.00       3.57      35.01
   1039                      1.92      634.26      634.00        .26       2.59
   1040                      1.92      636.76      624.00      12.76     125.17
   1048                      6.10      636.52      600.00      36.52     358.17
   1049                      8.26      636.43      575.00      61.43     602.39


 S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

 (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
 (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

             PIPE        FLOWRATE
            NUMBER         (l/s)
            --------------------
               1           22.04

 NET SYSTEM INFLOW  =      22.04
 NET SYSTEM OUTFLOW =        .00
 NET SYSTEM DEMAND  =      22.04


 D A T A   C H A N G E S   F O R   N E X T   S I M U L A T I O N


      D E M A N D   C H A N G E S

 DEMAND TYPE =  1 -   GDF =   .300


                     *************************************
                      S I M U L A T I O N   R E S U L T S
                     *************************************

 THE RESULTS ARE OBTAINED AFTER  2 TRIALS WITH AN ACCURACY =  .00000


 P I P E L I N E   R E S U L T S

 STATUS CODE:   XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                CV -CHECK VALVE    RV -REGULATING VALVE    TK -STORAGE TANK
```

```
  PIPE         NODE NOS.        FLOWRATE     HEAD     PUMP    MINOR     LINE      HL/
 NUMBER        #1      #2                    LOSS     HEAD     LOSS     VELO.    1000
                                  (l/s)       (m)      (m)      (m)     (m/s)    (m/m
-------------------------------------------------------------------------------------
    1-FG        0    1040          6.61       .03      .00      .00      .21       .3
    2        1040    1048          4.31       .03      .00      .00      .14       .1
    3        1048    1049          2.48       .01      .00      .00      .08       .0
    4        1040    1038          1.73       .24      .00      .00      .73     15.7
    5        1038    1037           .58       .40      .00      .00      .24      2.0
    6        1038    1039           .58       .03      .00      .00      .24      2.0


 J U N C T I O N   N O D E   R E S U L T S

 JUNCTION   JUNCTION     EXTERNAL   HYDRAULIC   JUNCTION     PRESSURE   JUNCTIO
  NUMBER     TITLE        DEMAND      GRADE     ELEVATION      HEAD     PRESSUR
                          (l/s)        (m)         (m)          (m)      (kpa)
-------------------------------------------------------------------------------
   1037                      .58     636.34      622.00       14.34     140.60
   1038                      .58     636.74      631.00        5.74      56.28
   1039                      .58     636.71      634.00        2.71      26.53
   1040                      .58     636.97      624.00       12.97     127.24
   1048                     1.83     636.95      600.00       36.95     362.34
   1049                     2.48     636.94      575.00       61.94     607.41


 S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

 (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
 (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

              PIPE        FLOWRATE
             NUMBER         (l/s)
             --------------------
               1            6.61

 NET SYSTEM INFLOW  =       6.61
 NET SYSTEM OUTFLOW =        .00
 NET SYSTEM DEMAND  =       6.61


 **** KYPIPE SIMULATION COMPLETED ****


 DATE:  3/ 7/2002
 TIME: 14: 0:49
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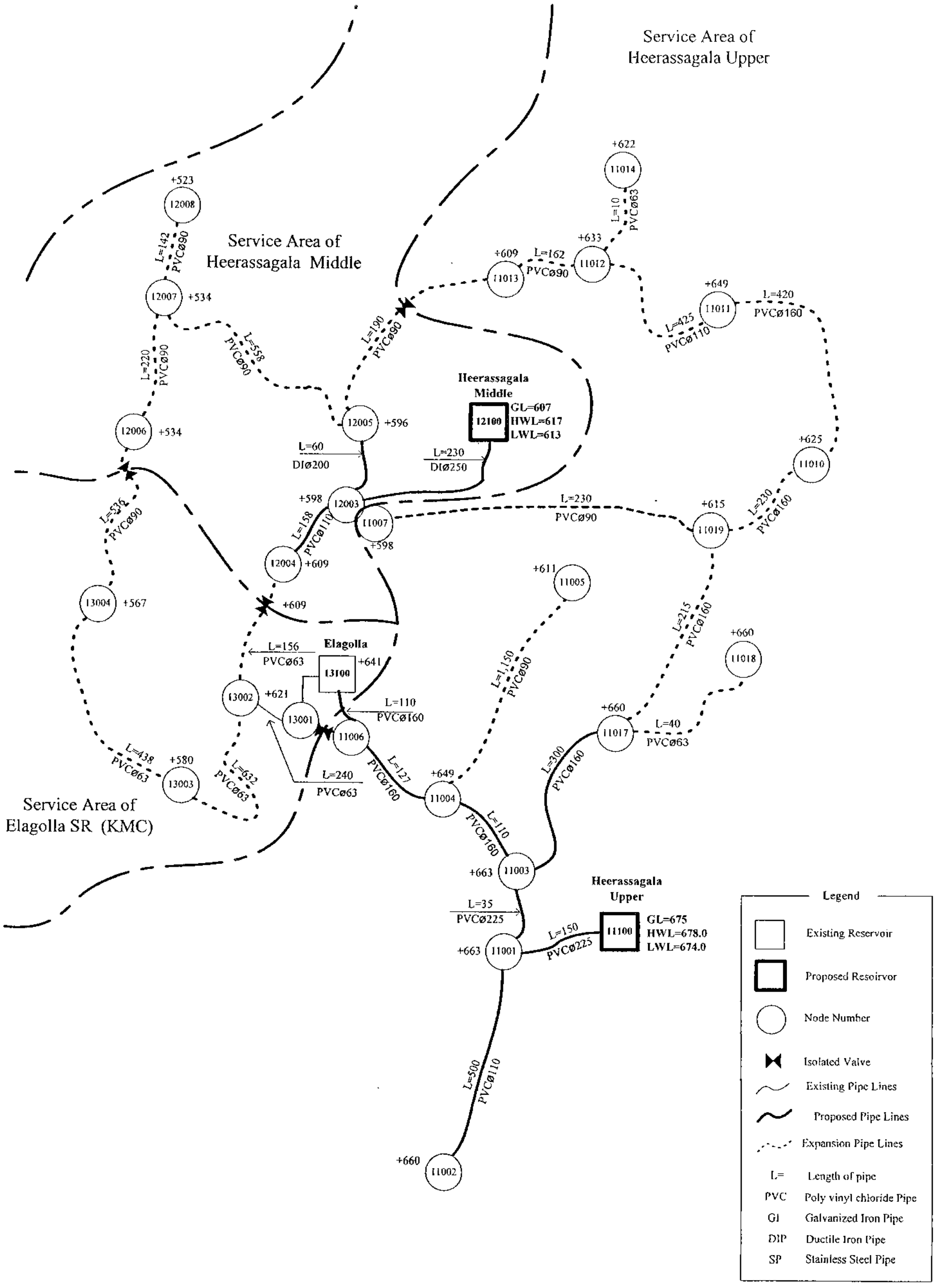

Appendix - 5.11 Improvement of Distribution Network in 2015
(Heeressagala Middle, Upper Reservoir Service Areas)

```
         * * * * * * * * * *   K Y P I P E 2   * * * * * * * * * *
         *   University of Kentucky Hydraulic Analysis Program   *
         * Distribution of Pressure and Flows in Piping Networks *
         *        1000 PIPE VERSION - 1.10   (08/25/92)          *
         * * * * * * * * * * * * * * * * * * * * * * * * * * * * *



 DATE:  3/ 7/2002
 TIME: 14:11:58

 INPUT DATA FILENAME ------------- c:\D_nets\2015\HEEU2015.DAT
 TABULATED OUTPUT FILENAME -------- c:\D_nets\2015\HEEU2015.OUT
 POSTPROCESSOR RESULTS FILENAME --- c:\D_nets\2015\HEEU2015.RES


               ************************************************
                S U M M A R Y   O F   O R I G I N A L   D A T A
               ************************************************


 U N I T S   S P E C I F I E D

    FLOWRATE ............ = liters/second
    HEAD (HGL) .......... = meters
    PRESSURE ............ = kpa


 P I P E L I N E   D A T A

 STATUS CODE:   XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                CV -CHECK VALVE    RV -REGULATING VALVE

   PIPE       NODE NOS.     LENGTH   DIAMETER   ROUGHNESS   MINOR LOSS   FGN-H
  NUMBER       #1    #2       (m)       (cm)       COEFF.      COEFF.       (m)
 ------------------------------------------------------------------------------
    1-FG        0  1101      150.0      19.8      130.00          .00     674.
    2        1101  1102      500.0       9.7      130.00          .00
    3        1101  1103        1.0      19.8      130.00          .00
    4        1103  1104      110.0      14.0      130.00          .00
    5        1103  1117      300.0      14.0      130.00          .00
    6        1104  1105     1150.0       7.9      130.00          .00
    7        1117  1118       40.0       5.5      130.00          .00
    8        1117  1119      215.0      14.0      130.00          .00
    9        1119  1110      230.0      14.0      130.00          .00
   10        1110  1111      420.0      14.0      130.00          .00
   11        1111  1112      425.0       9.7      130.00          .00
   12        1112  1113      162.0       7.9      130.00          .00
   13        1112  1114       10.0       5.5      130.00          .00
```

```
   14        1119  1107       230.0       7.9       130.00           .00
   15        1104  1106       127.0      14.0       130.00           .00
   16        1106  1300       110.0      14.0       130.00           .00


 J U N C T I O N   N O D E   D A T A

    JUNCTION    JUNCTION      EXTERNAL    JUNCTION
     NUMBER      TITLE         DEMAND     ELEVATION  CONNECTING PIPES
                               (l/s)          (m)
 -----------------------------------------------------------------------------
     1101                       .89       663.00     1    2    3
     1102                       .89       660.00     2
     1103                       .89       663.00     3    4    5
     1104                       .89       647.00     4    6   15
     1105                       .90       611.00     6
     1106                       .89       659.00    15   16
     1107                       .89       598.00    14
     1110                       .89       625.00     9   10
     1111                       .89       649.00    10   11
     1112                       .90       633.00    11   12   13
     1113                       .89       609.00    12
     1114                       .89       622.00    13
     1117                       .89       660.00     5    7    8
     1118                       .89       660.00     7
     1119                       .90       615.00     8    9   14
     1300                     17.99       649.00    16


 O U T P U T   O P T I O N   D A T A

 OUTPUT SELECTION:  ALL RESULTS ARE INCLUDED IN THE TABULATED OUTPUT


 S Y S T E M   C O N F I G U R A T I O N

     NUMBER OF PIPES ...................(p) =   16
     NUMBER OF JUNCTION NODES ..........(j) =   16
     NUMBER OF PRIMARY LOOPS ...........(l) =    0
     NUMBER OF FIXED GRADE NODES .......(f) =    1
     NUMBER OF SUPPLY ZONES ............(z) =    1


                     *************************************
                      S I M U L A T I O N   R E S U L T S
                     *************************************

 THE RESULTS ARE OBTAINED AFTER  2 TRIALS WITH AN ACCURACY =  .00000
```

```
 P I P E L I N E   R E S U L T S

 STATUS CODE:    XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                 CV -CHECK VALVE    RV -REGULATING VALVE    TK -STORAGE TANK

   PIPE        NODE NOS.      FLOWRATE    HEAD    PUMP    MINOR    LINE     HL/
  NUMBER      #1      #2                  LOSS    HEAD    LOSS     VELO.   1000
                                (l/s)     (m)     (m)     (m)     (m/s)   (m/m
 ------------------------------------------------------------------------------
     1-FG      0     1101      31.37      .85     .00     .00     1.02     5.6
     2      1101     1102        .89      .13     .00     .00      .12      .2
     3      1101     1103      29.59      .01     .00     .00      .96     5.1
     4      1103     1104      20.67     1.56     .00     .00     1.34    14.2
     5      1103     1117       8.03      .74     .00     .00      .52     2.4
     6      1104     1105        .90      .80     .00     .00      .18      .6
     7      1117     1118        .89      .16     .00     .00      .37     3.9
     8      1117     1119       6.25      .33     .00     .00      .41     1.5
     9      1119     1110       4.46      .19     .00     .00      .29      .8
    10      1110     1111       3.57      .23     .00     .00      .23      .5
    11      1111     1112       2.68      .82     .00     .00      .36     1.9
    12      1112     1113        .89      .11     .00     .00      .18      .6
    13      1112     1114        .89      .04     .00     .00      .37     3.9
    14      1119     1107        .89      .16     .00     .00      .18      .6
    15      1104     1106      18.88     1.53     .00     .00     1.23    12.0
    16      1106     1300      17.99     1.21     .00     .00     1.17    10.9


 J U N C T I O N   N O D E   R E S U L T S

  JUNCTION   JUNCTION   EXTERNAL   HYDRAULIC   JUNCTION    PRESSURE   JUNCTIO
   NUMBER     TITLE      DEMAND      GRADE     ELEVATION     HEAD     PRESSUR
                         (l/s)        (m)         (m)         (m)      (kpa)
 ------------------------------------------------------------------------------
   1101                    .89      673.65      663.00      10.65     104.41
   1102                    .89      673.52      660.00      13.52     132.61
   1103                    .89      673.64      663.00      10.64     104.36
   1104                    .89      672.08      647.00      25.08     245.95
   1105                    .90      671.28      611.00      60.28     591.16
   1106                    .89      670.55      659.00      11.55     113.32
   1107                    .89      672.41      598.00      74.41     729.74
   1110                    .89      672.38      625.00      47.38     464.63
   1111                    .89      672.15      649.00      23.15     227.00
   1112                    .90      671.33      633.00      38.33     375.87
   1113                    .89      671.22      609.00      62.22     610.15
   1114                    .89      671.29      622.00      49.29     483.36
   1117                    .89      672.90      660.00      12.90     126.53
   1118                    .89      672.74      660.00      12.74     124.97
   1119                    .90      672.57      615.00      57.57     564.57
   1300                  17.99      669.35      649.00      20.35     199.54
```

```
 S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

 (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
 (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

              PIPE        FLOWRATE
             NUMBER         (l/s)
             --------------------
                1          31.37

 NET SYSTEM INFLOW   =     31.37
 NET SYSTEM OUTFLOW =        .00
 NET SYSTEM DEMAND   =     31.37


 D A T A   C H A N G E S   F O R   N E X T   S I M U L A T I O N

      D E M A N D   C H A N G E S

 DEMAND TYPE =  1 -   GDF =   .300


                       ************************************
                        S I M U L A T I O N   R E S U L T S
                       ************************************

 THE RESULTS ARE OBTAINED AFTER  2 TRIALS WITH AN ACCURACY =  .00000


 P I P E L I N E   R E S U L T S

 STATUS CODE:   XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                CV -CHECK VALVE    RV -REGULATING VALVE    TK -STORAGE TANK

  PIPE         NODE NOS.      FLOWRATE    HEAD     PUMP    MINOR    LINE     HL/
 NUMBER       #1      #2                  LOSS     HEAD     LOSS    VELO.   1000
                                (l/s)      (m)      (m)      (m)    (m/s)   (m/m
 -------------------------------------------------------------------------------
    1-FG       0    1101         9.41      .09      .00      .00      .31     .6
    2       1101    1102          .27      .01      .00      .00      .04     .0
    3       1101    1103         8.88      .00      .00      .00      .29     .5
    4       1103    1104         6.20      .17      .00      .00      .40    1.5
    5       1103    1117         2.41      .08      .00      .00      .16     .2
    6       1104    1105          .27      .09      .00      .00      .06     .0
    7       1117    1118          .27      .02      .00      .00      .11     .4
    8       1117    1119         1.88      .04      .00      .00      .12     .1
```

```
     9       1119    1110           1.34      .02      .00      .00      .09      .0
    10       1110    1111           1.07      .02      .00      .00      .07      .0
    11       1111    1112            .80      .09      .00      .00      .11      .2
    12       1112    1113            .27      .01      .00      .00      .05      .0
    13       1112    1114            .27      .00      .00      .00      .11      .4
    14       1119    1107            .27      .02      .00      .00      .05      .0
    15       1104    1106           5.66      .16      .00      .00      .37     1.2
    16       1106    1300           5.40      .13      .00      .00      .35     1.1


 J U N C T I O N   N O D E   R E S U L T S

  JUNCTION   JUNCTION     EXTERNAL   HYDRAULIC   JUNCTION   PRESSURE   JUNCTIO
   NUMBER     TITLE        DEMAND      GRADE    ELEVATION     HEAD     PRESSUR
                           (l/s)        (m)        (m)         (m)      (kpa)
 ------------------------------------------------------------------------------
   1101                      .27      674.41     663.00      11.41     111.88
   1102                      .27      674.39     660.00      14.39     141.17
   1103                      .27      674.41     663.00      11.41     111.87
   1104                      .27      674.24     647.00      27.24     267.13
   1105                      .27      674.15     611.00      63.15     619.33
   1106                      .27      674.08     659.00      15.08     147.84
   1107                      .27      674.28     598.00      76.28     748.01
   1110                      .27      674.27     625.00      49.27     483.19
   1111                      .27      674.25     649.00      25.25     247.59
   1112                      .27      674.16     633.00      41.16     403.63
   1113                      .27      674.15     609.00      65.15     638.88
   1114                      .27      674.15     622.00      52.15     511.46
   1117                      .27      674.33     660.00      14.33     140.51
   1118                      .27      674.31     660.00      14.31     140.34
   1119                      .27      674.29     615.00      59.29     581.46
   1300                     5.40      673.95     649.00      24.95     244.64


 S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

 (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
 (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

               PIPE       FLOWRATE
              NUMBER        (l/s)
              --------------------
                 1          9.41

 NET SYSTEM INFLOW  =       9.41
 NET SYSTEM OUTFLOW =        .00
 NET SYSTEM DEMAND  =       9.41


 **** KYPIPE SIMULATION COMPLETED ****
```

```
 DATE:  3/ 7/2002
 TIME: 14:11:58
```

```
         * * * * * * * * * * *   K Y P I P E 2   * * * * * * * * * * *
         *   University of Kentucky Hydraulic Analysis Program    *
         * Distribution of Pressure and Flows in Piping Networks *
         *        1000 PIPE VERSION - 1.10   (08/25/92)           *
         * * * * * * * * * * * * * * * * * * * * * * * * * * * * *



 DATE:  3/ 7/2002
 TIME: 14:20:22

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 TABULATED OUTPUT FILENAME -------- c:\D_nets\2015\HEEM2015.OUT
 POSTPROCESSOR RESULTS FILENAME --- c:\D_nets\2015\HEEM2015.RES


               ************************************************
                S U M M A R Y   O F   O R I G I N A L   D A T A
               ************************************************


 U N I T S   S P E C I F I E D

    FLOWRATE ............ = liters/second
    HEAD (HGL) .......... = meters
    PRESSURE ............ = kpa


 P I P E L I N E   D A T A

 STATUS CODE:    XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                 CV -CHECK VALVE    RV -REGULATING VALVE

  PIPE       NODE NOS.     LENGTH   DIAMETER   ROUGHNESS   MINOR LOSS   FGN-H
  NUMBER      #1    #2       (m)       (cm)       COEFF.      COEFF.       (m)
 -----------------------------------------------------------------------------
    1-FG       0  1203     230.0     25.0      130.00         .00      613.
    2       1203  1204     158.0      9.7      130.00         .00
    3       1203  1205      40.0     20.0      130.00         .00
    4       1205  1207     558.0      7.9      130.00         .00
    5       1207  1206     220.0      7.9      130.00         .00
    6       1207  1208     142.0      7.9      130.00         .00


 J U N C T I O N   N O D E   D A T A


    JUNCTION     JUNCTION      EXTERNAL     JUNCTION
```

```
     NUMBER      TITLE        DEMAND     ELEVATION  CONNECTING PIPES
                              (l/s)          (m)
 ------------------------------------------------------------------------------
     1203                       3.56       598.00     1    2    3
     1204                       3.56       609.00     2
     1205                       3.57       596.00     3    4
     1206                       3.56       534.00     5
     1207                       3.56       534.00     4    5    6
     1208                       3.56       523.00     6


 O U T P U T   O P T I O N   D A T A

 OUTPUT SELECTION:  ALL RESULTS ARE INCLUDED IN THE TABULATED OUTPUT


 S Y S T E M   C O N F I G U R A T I O N

     NUMBER OF PIPES ...................(p) =    6
     NUMBER OF JUNCTION NODES ..........(j) =    6
     NUMBER OF PRIMARY LOOPS ...........(l) =    0
     NUMBER OF FIXED GRADE NODES .......(f) =    1
     NUMBER OF SUPPLY ZONES ............(z) =    1


                     *************************************
                      S I M U L A T I O N   R E S U L T S
                     *************************************

 THE RESULTS ARE OBTAINED AFTER  2 TRIALS WITH AN ACCURACY =  .00000


 P I P E L I N E   R E S U L T S

 STATUS CODE:   XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                CV -CHECK VALVE    RV -REGULATING VALVE    TK -STORAGE TANK

   PIPE        NODE NOS.      FLOWRATE    HEAD    PUMP   MINOR    LINE     HL/
  NUMBER      #1     #2                   LOSS    HEAD    LOSS    VELO.   1000
                                (l/s)      (m)     (m)     (m)    (m/s)   (m/m
 ------------------------------------------------------------------------------
     1-FG      0   1203            21.37     .21     .00     .00     .44      .9
     2      1203   1204             3.56     .52     .00     .00     .48     3.2
     3      1203   1205            14.25     .05     .00     .00     .45     1.2
     4      1205   1207            10.68   37.85     .00     .00    2.18    67.8
     5      1207   1206             3.56    1.95     .00     .00     .73     8.8
     6      1207   1208             3.56    1.26     .00     .00     .73     8.8
```

```
 J U N C T I O N   N O D E   R E S U L T S

  JUNCTION   JUNCTION     EXTERNAL   HYDRAULIC   JUNCTION    PRESSURE   JUNCTIO
   NUMBER     TITLE        DEMAND      GRADE     ELEVATION     HEAD     PRESSUR
                           (l/s)        (m)         (m)         (m)      (kpa)
 -------------------------------------------------------------------------------
   1203                      3.56     612.79      598.00       14.79     145.08
   1204                      3.56     612.28      609.00        3.28      32.15
   1205                      3.57     612.74      596.00       16.74     164.20
   1206                      3.56     572.94      534.00       38.94     381.91
   1207                      3.56     574.89      534.00       40.89     401.04
   1208                      3.56     573.63      523.00       50.63     496.56


 S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

 (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
 (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

              PIPE        FLOWRATE
             NUMBER         (l/s)
             --------------------
                1           21.37

 NET SYSTEM INFLOW  =       21.37
 NET SYSTEM OUTFLOW =         .00
 NET SYSTEM DEMAND  =       21.37


 D A T A   C H A N G E S   F O R   N E X T   S I M U L A T I O N


      D E M A N D   C H A N G E S

 DEMAND TYPE =  1 -   GDF =   .300


                       ************************************
                        S I M U L A T I O N   R E S U L T S
                       ************************************

 THE RESULTS ARE OBTAINED AFTER  2 TRIALS WITH AN ACCURACY =  .00000


 P I P E L I N E   R E S U L T S

 STATUS CODE:    XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                 CV -CHECK VALVE    RV -REGULATING VALVE    TK -STORAGE TANK
```

```
   PIPE        NODE NOS.      FLOWRATE    HEAD    PUMP   MINOR    LINE      HL/
  NUMBER      #1     #2                   LOSS    HEAD    LOSS    VELO.    1000
                                 (l/s)     (m)     (m)     (m)     (m/s)   (m/m
 ------------------------------------------------------------------------------
     1-FG       0  1203          6.41     .02     .00     .00     .13      .1
      2      1203  1204          1.07     .06     .00     .00     .14      .3
      3      1203  1205          4.27     .01     .00     .00     .14      .1
      4      1205  1207          3.20    4.07     .00     .00     .65     7.3
      5      1207  1206          1.07     .21     .00     .00     .22      .9
      6      1207  1208          1.07     .14     .00     .00     .22      .9


 J U N C T I O N   N O D E   R E S U L T S

  JUNCTION   JUNCTION    EXTERNAL   HYDRAULIC    JUNCTION    PRESSURE   JUNCTIO
   NUMBER     TITLE       DEMAND      GRADE      ELEVATION     HEAD     PRESSUR
                           (l/s)        (m)         (m)         (m)      (kpa)
 ------------------------------------------------------------------------------
   1203                       1.07    612.98      598.00      14.98     146.88
   1204                       1.07    612.92      609.00       3.92      38.46
   1205                       1.07    612.97      596.00      16.97     166.44
   1206                       1.07    608.69      534.00      74.69     732.48
   1207                       1.07    608.90      534.00      74.90     734.54
   1208                       1.07    608.77      523.00      85.77     841.08


 S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

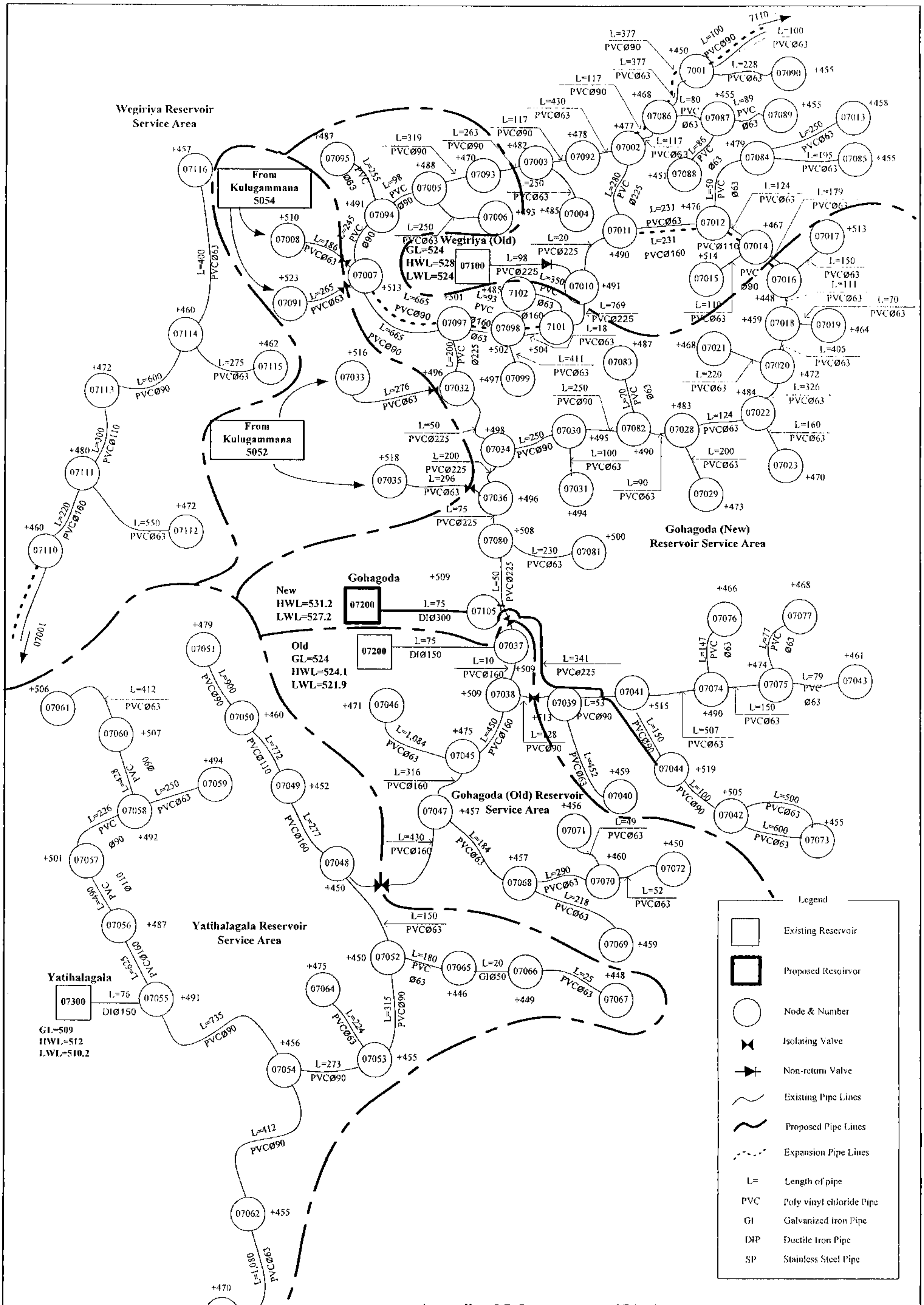
 (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
 (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

             PIPE       FLOWRATE
            NUMBER        (l/s)
            --------------------
               1           6.41

 NET SYSTEM INFLOW   =     6.41
 NET SYSTEM OUTFLOW =       .00
 NET SYSTEM DEMAND   =     6.41


 **** KYPIPE SIMULATION COMPLETED ****


 DATE:  3/ 7/2002
 TIME: 14:20:22
```



Appendix - 5.7 Improvement of Distribution Network in 2015
(Gohagoda Low (Old), Gohagoda Low (New), Wegiriya & Yatihagala Reservoir Service Areas)

```
         * * * * * * * * * *   K Y P I P E 2   * * * * * * * * * *
         *   University of Kentucky Hydraulic Analysis Program   *
         * Distribution of Pressure and Flows in Piping Networks *
         *         1000 PIPE VERSION - 1.10   (08/25/92)         *
         * * * * * * * * * * * * * * * * * * * * * * * * * * * * *



 DATE:  3/12/2002
 TIME:  8:50:25

 INPUT DATA FILENAME -------------- c:\D_nets\2015\GOHA2015.DAT
 TABULATED OUTPUT FILENAME -------- c:\D_nets\2015\GOHA2015.OUT
 POSTPROCESSOR RESULTS FILENAME --- c:\D_nets\2015\GOHA2015.RES

                ************************************************
                 S U M M A R Y   O F   O R I G I N A L   D A T A
                ************************************************


 U N I T S   S P E C I F I E D

    FLOWRATE ............ = liters/second
    HEAD (HGL) .......... = meters
    PRESSURE ............ = kpa


 P I P E L I N E   D A T A

 STATUS CODE:   XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                CV -CHECK VALVE    RV -REGULATING VALVE

   PIPE      NODE NOS.      LENGTH   DIAMETER  ROUGHNESS  MINOR LOSS  FGN-H
  NUMBER      #1    #2        (m)      (cm)       COEFF.     COEFF.     (m)
 ----------------------------------------------------------------------------
    1-FG       0  7037       75.0     15.0      120.00        .00      521.
    2       7037  7038       10.0     14.0      120.00        .00
    3       7038  7045      450.0     14.0      120.00        .00
    4       7045  7047      316.0     14.0      120.00        .00
    5       7045  7046     1084.0      5.5      120.00        .00
    6       7047  7068      184.0      5.5      120.00        .00
    7       7068  7069      218.0      5.5      120.00        .00
    8       7068  7070      290.0      5.5      120.00        .00
    9       7070  7072       52.0      5.5      120.00        .00
   10       7070  7071       49.0      5.5      120.00        .00
   11-XX    7038  7039      128.0      7.9      120.00        .00
   12       7039  7041       53.0      7.9      120.00        .00
   13       7039  7040      452.0      5.5      120.00        .00
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   14        7041  7074       507.0       5.5        120.00          .00
   15        7041  7044       150.0       7.9        120.00          .00
   16        7044  7042       100.0       7.9        120.00          .00
   17        7074  7076       147.0       5.5        120.00          .00
   18        7074  7075       150.0       5.5        120.00          .00
   19        7075  7043        79.0       5.5        120.00          .00
   20-XX     7037  7080        50.0      19.8        120.00          .00
   21        7081  7080       230.0       5.5        120.00          .00
   22        7036  7080        75.0      19.8        120.00          .00
   23-XX     7035  7036       296.0       5.5        120.00          .00
   24        7036  7034       200.0      19.8        120.00          .00
   25        7034  7030       250.0       7.9        120.00          .00
   26        7034  7032        50.0      19.8        120.00          .00
   27        7030  7031       100.0       5.5        120.00          .00
   28        7030  7082       250.0       7.9        120.00          .00
   29        7082  7083        70.0       5.5        120.00          .00
   30        7082  7028        90.0       5.5        120.00          .00
   31        7028  7029       200.0       5.5        120.00          .00
   32        7028  7022       124.0       5.5        120.00          .00
   33        7022  7023       160.0       5.5        120.00          .00
   34        7022  7020       326.0       5.5        120.00          .00
   35        7021  7020       220.0       5.5        120.00          .00
   36        7020  7018       405.0       5.5        120.00          .00
   37        7018  7019        70.0       5.5        120.00          .00
   38        7018  7016       111.0       5.5        120.00          .00
   39        7016  7017       150.0       5.5        120.00          .00
   40        7016  7014       179.0       5.5        120.00          .00
   41        7014  7015       110.0       5.5        120.00          .00
   42        7014  7012       124.0       5.5        120.00          .00
   43        7012  7011       231.0       5.5        120.00          .00
   44        7012  7084        50.0       5.5        120.00          .00
   45        7084  7013       250.0       5.5        120.00          .00
   46        7084  7085       195.0       5.5        120.00          .00
   47        7011  7010        20.0      19.8        120.00          .00
   48        7010  7101       769.0      19.8        120.00          .00
   49-FGCV      0  7010        98.0      19.8        120.00          .00       526.
   50        7101  7102       350.0       5.5        120.00          .00
   51        7101  7098        18.0       5.5        120.00          .00
   52        7098  7099       411.0       5.5        120.00          .00
   53        7098  7097        93.0       5.5        120.00          .00
   54        7097  7032       200.0      19.8        120.00          .00
   55-XX     7032  7033       276.0       5.5        120.00          .00
   56        7097  7007       665.0       7.9        120.00          .00
   57        7007  7091       265.0       5.5        120.00          .00
   58        7007  7008       186.0       5.5        120.00          .00
   59        7007  7094       245.0       7.9        120.00          .00
   60        7094  7095       255.0       5.5        120.00          .00
   61        7094  7005        98.0       7.9        120.00          .00
   62        7005  7006       250.0       5.5        120.00          .00
   63        7005  7093       319.0       7.9        120.00          .00
   64        7093  7003       263.0       7.9        120.00          .00
   65        7003  7004       250.0       5.5        120.00          .00
   66        7003  7092       117.0       7.9        120.00          .00
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   67        7092  7002       430.0      5.5       120.00         .00
   68        7011  7002       280.0     19.8       120.00         .00
   69        7002  7086       117.0      5.5       120.00         .00
   70        7086  7001       377.0      5.5       120.00         .00
   71        7086  7087        80.0      5.5       120.00         .00
   72        7087  7088        86.0      5.5       120.00         .00
   73        7087  7089        89.0      5.5       120.00         .00
   74        7001  7090       228.0      5.5       120.00         .00
   75        7001  7110       100.0      5.5       120.00         .00
   76        7110  7111       220.0     14.0       120.00         .00
   77        7112  7111       550.0      5.5       120.00         .00
   78        7111  7113       300.0      9.7       120.00         .00
   79        7113  7114       600.0      7.9       120.00         .00
   80        7114  7115       275.0      5.5       120.00         .00
   81        7114  7116       400.0      5.5       120.00         .00
   82        7075  7077        77.0      5.5       120.00         .00
   83-FG        0  7105        75.0     30.0       130.00         .00      527.
   84        7105  7080        50.0     19.8       120.00         .00
   85        7012  7011       231.0     14.0       130.00         .00
   86        7101  7098        18.0     14.0       130.00         .00
   87        7098  7097        93.0     14.0       130.00         .00
   88        7002  7086       117.0      9.7       130.00         .00
   89        7086  7001       377.0      9.7       130.00         .00
   90        7001  7110       100.0      7.9       130.00         .00
   91        7012  7014       124.0     14.0       130.00         .00
   92        7014  7016       179.0      9.7       130.00         .00
   93        7097  7007       665.0      9.7       130.00         .00
   94        7105  7044       341.0     19.8       130.00         .00
   95        7042  7073       500.0      5.5       120.00         .00
   96        7042  7073       600.0      5.5       120.00         .00
   97        7034  7030       250.0      7.9       130.00         .00
   98        7030  7082       250.0      7.9       130.00         .00
   99-FGCV      0  7010        98.0     19.8       130.00         .00      526.


 J U N C T I O N   N O D E   D A T A


   JUNCTION   JUNCTION    EXTERNAL    JUNCTION
    NUMBER     TITLE       DEMAND    ELEVATION  CONNECTING PIPES
                           (l/s)        (m)
 --------------------------------------------------------------------------
    7001                    1.53      450.00    70   74   75   89   90
    7002                     .89      477.00    67   68   69   88
    7003                     .89      482.00    64   65   66
    7004                    1.13      485.00    65
    7005                     .20      488.00    61   62   63
    7006                     .20      493.00    62
    7007                     .20      513.00    56   57   58   59   93
    7008                     .00      510.00    58
    7010                     .89      491.00    47   48   49   99
    7011                     .89      490.00    43   47   68   85
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     7012                          .71       476.00    42    43    44    85    91
     7013                          .89       458.00    45
     7014                          .71       467.00    40    41    42    91    92
     7015                          .71       514.00    41
     7016                          .89       448.00    38    39    40    92
     7017                          .89       513.00    39
     7018                          .15       459.00    36    37    38
     7019                          .18       464.00    37
     7020                          .15       472.00    34    35    36
     7021                          .15       468.00    35
     7022                          .15       484.00    32    33    34
     7023                          .15       470.00    33
     7028                          .15       483.00    30    31    32
     7029                          .15       473.00    31
     7030                          .12       495.00    25    27    28    97    98
     7031                          .18       494.00    27
     7032                          .65       496.00    26    54    55
     7033                          .00       516.00    55
     7034                          .18       498.00    24    25    26    97
     7035                          .00       518.00    23
     7036                          .18       496.00    22    23    24
     7037                          .72       509.00     1     2    20
     7038                          .72       509.00     2     3    11
     7039                          .10       513.00    11    12    13
     7040                          .10       459.00    13
     7041                          .10       515.00    12    14    15
     7042                          .10       512.00    16    95    96
     7043                          .10       461.00    19
     7044                          .10       519.00    15    16    94
     7045                          .72       475.00     3     4     5
     7046                         2.43       471.00     5
     7047                         1.17       457.00     4     6
     7068                         1.16       457.00     6     7     8
     7069                         1.17       459.00     7
     7070                         1.16       460.00     8     9    10
     7071                         1.17       456.00    10
     7072                         1.16       450.00     9
     7073                          .10       455.00    95    96
     7074                          .10       490.00    14    17    18
     7075                          .10       474.00    18    19    82
     7076                          .10       466.00    17
     7077                          .10       468.00    82
     7080                          .10       508.00    20    21    22    84
     7081                          .10       500.00    21
     7082                          .10       490.00    28    29    30    98
     7083                          .10       487.00    29
     7084                          .71       479.00    44    45    46
     7085                          .89       455.00    46
     7086                          .89       468.00    69    70    71    88    89
     7087                          .89       455.00    71    72    73
     7088                         1.60       451.00    72
     7089                         1.60       455.00    73
     7090                         1.60       455.00    74
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    7091                        .00       523.00    57
    7092                        .92       478.00    66    67
    7093                        .13       470.00    63    64
    7094                        .13       491.00    59    60    61
    7095                        .13       487.00    60
    7097                        .13       501.00    53    54    56    87    93
    7098                       1.03       502.00    51    52    53    86    87
    7099                        .13       497.00    52
    7101                       1.03       504.00    48    50    51    86
    7102                        .13       485.00    50
    7105                        .00       509.00    83    84    94
    7110                       1.60       460.00    75    76    90
    7111                       1.60       480.00    76    77    78
    7112                       1.60       472.00    77
    7113                       1.60       472.00    78    79
    7114                       1.60       460.00    79    80    81
    7115                       1.60       462.00    80
    7116                       1.60       457.00    81


 O U T P U T   O P T I O N   D A T A

 OUTPUT SELECTION:  ALL RESULTS ARE INCLUDED IN THE TABULATED OUTPUT


 S Y S T E M   C O N F I G U R A T I O N

    NUMBER OF PIPES ...................(p)  =   99
    NUMBER OF JUNCTION NODES ..........(j)  =   81
    NUMBER OF PRIMARY LOOPS ...........(l)  =   15
    NUMBER OF FIXED GRADE NODES .......(f)  =    4
    NUMBER OF SUPPLY ZONES ............(z)  =    1


                     ************************************
                      S I M U L A T I O N   R E S U L T S
                     ************************************


 *** WARNING - A PORTION OF THE SYSTEM IS DISCONNECTED BY CLOSED LINES FROM A
                   **** A FIX WILL BE ATTEMPTED


 *** WARNING - THE FOLLOWING  JUNCTION NODES ARE DISCONNECTED FROM THE SYSTEM
 DEMANDS AT THESE JUNCTION NODES ARE SET TO ZERO:
  7033  7035

 PIPE NO.    23 HAS BEEN OPENED TO REMOVE DISCONNECTION
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```
 *** WARNING - A PORTION OF THE SYSTEM IS DISCONNECTED BY CLOSED LINES FROM A
                   **** A FIX WILL BE ATTEMPTED


 *** WARNING - THE FOLLOWING  JUNCTION NODES ARE DISCONNECTED FROM THE SYSTEM
 DEMANDS AT THESE JUNCTION NODES ARE SET TO ZERO:
  7033

 PIPE NO.    55 HAS BEEN OPENED TO REMOVE DISCONNECTION

 THE RESULTS ARE OBTAINED AFTER  7 TRIALS WITH AN ACCURACY =  .00495


 P I P E L I N E   R E S U L T S

 STATUS CODE:   XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                CV -CHECK VALVE    RV -REGULATING VALVE    TK -STORAGE TANK

   PIPE         NODE NOS.       FLOWRATE     HEAD     PUMP    MINOR    LINE     HL/
  NUMBER       #1      #2                    LOSS     HEAD     LOSS    VELO.   1000
                                 (l/s)       (m)      (m)      (m)    (m/s)   (m/m
 ----------------------------------------------------------------------------------
     1-FG       0    7037        11.58       .30      .00      .00      .66     4.0
     2       7037    7038        10.86       .05      .00      .00      .71     5.0
     3       7038    7045        10.14      1.98      .00      .00      .66     4.4
     4       7045    7047         6.99       .70      .00      .00      .45     2.2
     5       7045    7046         2.43     32.06      .00      .00     1.02    29.5
     6       7047    7068         5.82     27.43      .00      .00     2.45   149.0
     7       7068    7069         1.17      1.67      .00      .00      .49     7.6
     8       7068    7070         3.49     16.77      .00      .00     1.47    57.8
     9       7070    7072         1.16       .39      .00      .00      .49     7.5
    10       7070    7071         1.17       .37      .00      .00      .49     7.6
    11-XX    7038    7039
    12       7039    7041         -.20       .00      .00      .00      .04      .0
    13       7039    7040          .10       .04      .00      .00      .04      .0
    14       7041    7074          .50       .80      .00      .00      .21     1.5
    15       7041    7044         -.80       .10      .00      .00      .16      .6
    16       7044    7042          .20       .00      .00      .00      .04      .0
    17       7074    7076          .10       .01      .00      .00      .04      .0
    18       7074    7075          .30       .09      .00      .00      .13      .6
    19       7075    7043          .10       .01      .00      .00      .04      .0
    20-XX    7037    7080
    21       7081    7080         -.10       .02      .00      .00      .04      .0
    22       7036    7080       -14.15       .11      .00      .00      .46     1.5
    23-XX    7035    7036          .00       .00      .00      .00      .00      .0
    24       7036    7034        13.97       .29      .00      .00      .45     1.4
    25       7034    7030          .72       .13      .00      .00      .15      .5
    26       7034    7032        12.29       .06      .00      .00      .40     1.1
    27       7030    7031          .18       .02      .00      .00      .08      .2
    28       7030    7082          .57       .09      .00      .00      .12      .3
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    29       7082    7083             .10       .01       .00       .00       .04       .0
    30       7082    7028            1.00       .51       .00       .00       .42      5.6
    31       7028    7029             .15       .03       .00       .00       .06       .1
    32       7028    7022             .70       .36       .00       .00       .29      2.9
    33       7022    7023             .15       .03       .00       .00       .06       .1
    34       7022    7020             .40       .33       .00       .00       .17      1.0
    35       7021    7020            -.15       .04       .00       .00       .06       .1
    36       7020    7018             .10       .03       .00       .00       .04       .0
    37       7018    7019             .18       .02       .00       .00       .08       .2
    38       7018    7016            -.23       .04       .00       .00       .10       .3
    39       7016    7017             .89       .69       .00       .00       .37      4.6
    40       7016    7014            -.54       .32       .00       .00       .23      1.8
    41       7014    7015             .71       .33       .00       .00       .30      3.0
    42       7014    7012            -.26       .06       .00       .00       .11       .4
    43       7012    7011            -.51       .38       .00       .00       .21      1.6
    44       7012    7084            2.49      1.55       .00       .00      1.05     30.9
    45       7084    7013             .89      1.15       .00       .00       .37      4.6
    46       7084    7085             .89       .90       .00       .00       .37      4.6
    47       7011    7010          -28.82       .11       .00       .00       .94      5.6
    48       7010    7101           -6.36       .26       .00       .00       .21       .3
    49-FGCV     0    7010           11.21       .10       .00       .00       .36       .9
    50       7101    7102             .13       .05       .00       .00       .05       .1
    51       7101    7098            -.55       .03       .00       .00       .23      1.9
    52       7098    7099             .13       .05       .00       .00       .05       .1
    53       7098    7097            -.64       .23       .00       .00       .27      2.4
    54       7097    7032          -11.64       .21       .00       .00       .38      1.0
    55-XX    7032    7033             .00       .00       .00       .00       .00       .0
    56       7097    7007             .99       .64       .00       .00       .20       .9
    57       7007    7091             .00       .00       .00       .00       .00       .0
    58       7007    7008             .00       .00       .00       .00       .00       .0
    59       7007    7094            2.63      1.44       .00       .00       .54      5.8
    60       7094    7095             .13       .03       .00       .00       .05       .1
    61       7094    7005            2.37       .48       .00       .00       .48      4.8
    62       7005    7006             .20       .07       .00       .00       .08       .2
    63       7005    7093            1.97      1.10       .00       .00       .40      3.4
    64       7093    7003            1.84       .80       .00       .00       .38      3.0
    65       7003    7004            1.13      1.79       .00       .00       .48      7.1
    66       7003    7092            -.18       .00       .00       .00       .04       .0
    67       7092    7002           -1.10      2.91       .00       .00       .46      6.7
    68       7011    7002           21.30       .90       .00       .00       .69      3.2
    69       7002    7086            3.32      6.17       .00       .00      1.40     52.7
    70       7086    7001            2.46     11.44       .00       .00      1.04     30.3
    71       7086    7087            4.09      6.21       .00       .00      1.72     77.5
    72       7087    7088            1.60      1.17       .00       .00       .67     13.6
    73       7087    7089            1.60      1.21       .00       .00       .67     13.6
    74       7001    7090            1.60      3.11       .00       .00       .67     13.6
    75       7001    7110            2.94      4.21       .00       .00      1.24     42.1
    76       7110    7111            9.60       .88       .00       .00       .62      3.9
    77       7112    7111           -1.60      7.50       .00       .00       .67     13.6
    78       7111    7113            6.40      3.36       .00       .00       .87     11.2
    79       7113    7114            4.80     10.73       .00       .00       .98     17.8
    80       7114    7115            1.60      3.75       .00       .00       .67     13.6
    81       7114    7116            1.60      5.46       .00       .00       .67     13.6
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   82       7075   7077            .10     .01     .00     .00     .04      .0
   83-FG       0   7105          15.44     .02     .00     .00     .22      .2
   84       7105   7080          14.35     .08     .00     .00     .47     1.5
   85       7012   7011          -6.13     .34     .00     .00     .40     1.4
   86       7101   7098          -6.96     .03     .00     .00     .45     1.8
   87       7098   7097          -8.04     .23     .00     .00     .52     2.4
   88       7002   7086          15.99    6.17     .00     .00    2.16    52.7
   89       7086   7001          11.87   11.44     .00     .00    1.61    30.3
   90       7001   7110           8.26    4.21     .00     .00    1.68    42.1
   91       7012   7014           3.18     .05     .00     .00     .21      .4
   92       7014   7016           1.48     .11     .00     .00     .20      .6
   93       7097   7007           1.84     .64     .00     .00     .25      .9
   94       7105   7044           1.10     .00     .00     .00     .04      .0
   95       7042   7073            .05     .01     .00     .00     .02      .0
   96       7042   7073            .05     .01     .00     .00     .02      .0
   97       7034   7030            .78     .13     .00     .00     .16      .5
   98       7030   7082            .62     .09     .00     .00     .13      .3
   99-FGCV     0   7010          12.14     .10     .00     .00     .39      .9


 J U N C T I O N   N O D E   R E S U L T S

  JUNCTION   JUNCTION     EXTERNAL   HYDRAULIC   JUNCTION    PRESSURE   JUNCTIO
   NUMBER     TITLE        DEMAND      GRADE     ELEVATION     HEAD     PRESSUR
                           (l/s)        (m)         (m)         (m)      (kpa)
 -----------------------------------------------------------------------------
   7001                     1.53      507.29      450.00      57.29     561.78
   7002                      .89      524.89      477.00      47.89     469.64
   7003                      .89      521.97      482.00      39.97     392.01
   7004                     1.13      520.18      485.00      35.18     345.02
   7005                      .20      523.87      488.00      35.87     351.80
   7006                      .20      523.80      493.00      30.80     302.05
   7007                      .20      525.79      513.00      12.79     125.44
   7008                      .00      525.79      510.00      15.79     154.86
   7010                      .89      525.90      491.00      34.90     342.29
   7011                      .89      525.79      490.00      35.79     350.99
   7012                      .71      525.41      476.00      49.41     484.59
   7013                      .89      522.72      458.00      64.72     634.65
   7014                      .71      525.36      467.00      58.36     572.29
   7015                      .71      525.02      514.00      11.02     108.11
   7016                      .89      525.04      448.00      77.04     755.46
   7017                      .89      524.34      513.00      11.34     111.25
   7018                      .15      524.99      459.00      65.99     647.16
   7019                      .18      524.98      464.00      60.98     597.97
   7020                      .15      525.02      472.00      53.02     519.97
   7021                      .15      524.98      468.00      56.98     558.83
   7022                      .15      525.61      484.00      41.61     408.03
   7023                      .15      525.58      470.00      55.58     545.06
   7028                      .15      525.97      483.00      42.97     421.39
   7029                      .15      525.94      473.00      52.94     519.12
   7030                      .12      526.57      495.00      31.57     309.57
   7031                      .18      526.54      494.00      32.54     319.14
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   7032                          .65      526.64      496.00      30.64      300.49
   7033                          .00      526.64      516.00      10.64      104.36
   7034                          .18      526.70      498.00      28.70      281.45
   7035                          .00      526.99      518.00       8.99       88.20
   7036                          .18      526.99      496.00      30.99      303.95
   7037                          .72      521.60      509.00      12.60      123.55
   7038                          .72      521.55      509.00      12.55      123.06
   7039                          .10      527.08      513.00      14.08      138.09
   7040                          .10      527.04      459.00      68.04      667.29
   7041                          .10      527.08      515.00      12.08      118.50
   7042                          .10      527.18      512.00      15.18      148.83
   7043                          .10      526.18      461.00      65.18      639.23
   7044                          .10      527.18      519.00       8.18       80.23
   7045                          .72      519.57      475.00      44.57      437.05
   7046                         2.43      487.51      471.00      16.51      161.89
   7047                         1.17      518.87      457.00      61.87      606.72
   7068                         1.16      491.44      457.00      34.44      337.72
   7069                         1.17      489.77      459.00      30.77      301.77
   7070                         1.16      474.67      460.00      14.67      143.86
   7071                         1.17      474.30      456.00      18.30      179.42
   7072                         1.16      474.28      450.00      24.28      238.09
   7073                          .10      527.16      455.00      72.16      707.69
   7074                          .10      526.28      490.00      36.28      355.80
   7075                          .10      526.19      474.00      52.19      511.81
   7076                          .10      526.27      466.00      60.27      591.05
   7077                          .10      526.18      468.00      58.18      570.59
   7080                          .10      527.11      508.00      19.11      187.38
   7081                          .10      527.09      500.00      27.09      265.65
   7082                          .10      526.48      490.00      36.48      357.74
   7083                          .10      526.47      487.00      39.47      387.11
   7084                          .71      523.87      479.00      44.87      440.00
   7085                          .89      522.97      455.00      67.97      666.56
   7086                          .89      518.72      468.00      50.72      497.42
   7087                          .89      512.52      455.00      57.52      564.06
   7088                         1.60      511.34      451.00      60.34      591.78
   7089                         1.60      511.30      455.00      56.30      552.15
   7090                         1.60      504.18      455.00      49.18      482.25
   7091                          .00      525.79      523.00       2.79       27.37
   7092                          .92      521.98      478.00      43.98      431.28
   7093                          .13      522.77      470.00      52.77      517.53
   7094                          .13      524.35      491.00      33.35      327.04
   7095                          .13      524.32      487.00      37.32      365.95
   7097                          .13      526.43      501.00      25.43      249.40
   7098                         1.03      526.20      502.00      24.20      237.34
   7099                          .13      526.15      497.00      29.15      285.85
   7101                         1.03      526.17      504.00      22.17      217.39
   7102                          .13      526.12      485.00      41.12      403.27
   7105                          .00      527.18      509.00      18.18      178.33
   7110                         1.60      503.07      460.00      43.07      422.39
   7111                         1.60      502.20      480.00      22.20      217.67
   7112                         1.60      494.69      472.00      22.69      222.56
   7113                         1.60      498.83      472.00      26.83      263.13
   7114                         1.60      488.10      460.00      28.10      275.56
```
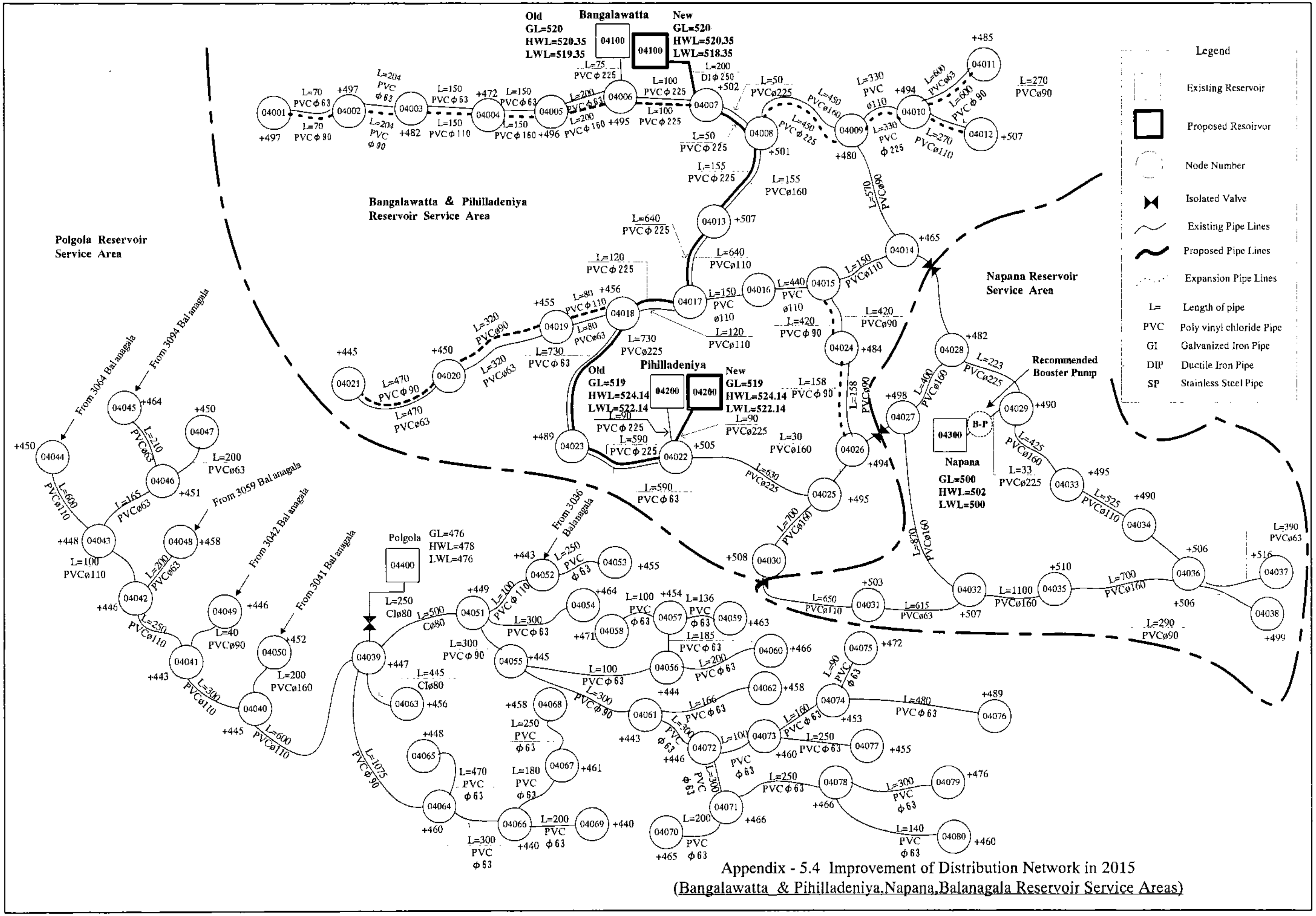

```
   7115                        1.60      484.35      462.00      22.35     219.17
   7116                        1.60      482.64      457.00      25.64     251.48


 S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

 (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
 (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

               PIPE        FLOWRATE
              NUMBER         (l/s)
              --------------------
                 1          11.58
                49          11.21
                83          15.44
                99          12.14

 NET SYSTEM INFLOW   =      50.38
 NET SYSTEM OUTFLOW  =        .00
 NET SYSTEM DEMAND   =      50.38


 **** KYPIPE SIMULATION COMPLETED ****


 DATE:   3/12/2002
 TIME:   8:50:25
```



Appendix - 5.4 Improvement of Distribution Network in 2015

(Bangalawatta & Pihilladeniya,Napana,Balanagala Reservoir Service Areas)

```
        * * * * * * * * * *   K Y P I P E 2   * * * * * * * * * *
        *   University of Kentucky Hydraulic Analysis Program   *
        * Distribution of Pressure and Flows in Piping Networks *
        *         1000 PIPE VERSION - 1.10   (08/25/92)         *
        * * * * * * * * * * * * * * * * * * * * * * * * * * * * *



 DATE:  3/12/2002
 TIME:  8:47:44

 INPUT DATA FILENAME -------------- c:\D_nets\2015\B&P2015.DAT
 TABULATED OUTPUT FILENAME -------- c:\D_nets\2015\B&P2015.OUT
 POSTPROCESSOR RESULTS FILENAME --- c:\D_nets\2015\B&P2015.RES


              ************************************************
               S U M M A R Y   O F   O R I G I N A L   D A T A
              ************************************************


 U N I T S   S P E C I F I E D

    FLOWRATE ............ = liters/second
    HEAD (HGL) .......... = meters
    PRESSURE ............ = kpa


 P I P E L I N E   D A T A

 STATUS CODE:   XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                CV -CHECK VALVE    RV -REGULATING VALVE

   PIPE      NODE NOS.     LENGTH   DIAMETER   ROUGHNESS   MINOR LOSS   FGN-H
  NUMBER     #1    #2       (m)       (cm)      COEFF.       COEFF.      (m)
 ----------------------------------------------------------------------------
    1-FGCV    0  4006       75.0      19.8      120.00          .00      519.
    2      4006  4005      200.0       5.5      120.00          .00
    3      4006  4007      100.0      19.8      120.00          .00
    4      4005  4004      150.0       5.5      120.00          .00
    5      4004  4003      150.0       5.5      120.00          .00
    6      4003  4002      204.0       5.5      120.00          .00
    7      4002  4001       70.0       5.5      120.00          .00
    8      4007  4008       50.0      19.8      120.00          .00
    9      4008  4013      155.0      14.0      120.00          .00
   10      4008  4009      450.0      14.0      120.00          .00
   11      4009  4010      330.0       9.7      120.00          .00
   12      4009  4014      570.0       7.9      120.00          .00
   13      4010  4011      600.0       5.5      120.00          .00
```

```
    14       4010  4012      270.0      7.9      120.00         .00
    15       4014  4015      150.0      9.7      120.00         .00
    16       4015  4016      440.0      9.7      120.00         .00
    17       4015  4024      420.0      7.9      120.00         .00
    18       4016  4017      150.0      9.7      120.00         .00
    19       4017  4013      640.0      9.7      120.00         .00
    20       4017  4018      120.0      9.7      120.00         .00
    21       4018  4019       80.0      5.5      120.00         .00
    22       4018  4023      730.0      5.5      120.00         .00
    23       4019  4020      320.0      5.5      120.00         .00
    24       4020  4021      470.0      5.5      120.00         .00
    25       4022  4023      590.0      5.5      120.00         .00
    26       4022  4025      640.0     19.8      120.00         .00
    27-FG       0  4022       90.0     19.8      120.00         .00       522.
    28       4024  4026      158.0      7.9      120.00         .00
    29       4025  4026       30.0     14.0      120.00         .00
    30       4025  4030      700.0     14.0      120.00         .00
    31-XX    4030  4031      650.0      9.7      120.00         .00
    32       4031  4032      615.0      5.5      120.00         .00
    33       4032  4035     1100.0     14.0      120.00         .00
    34       4035  4036      700.0     14.0      120.00         .00
    35       4036  4037      390.0      5.5      120.00         .00
    36       4036  4038      290.0      7.9      120.00         .00
    37-FGCV     0  4007      200.0     25.0      130.00         .00       518.
    38       4018  4019       80.0      9.7      130.00         .00
    39       4007  4008       50.0     25.0      130.00         .00
    40       4008  4013      155.0     19.8      130.00         .00
    41       4013  4017      640.0     19.8      130.00         .00
    42       4017  4018      120.0     19.8      130.00         .00
    43-FG       0  4022       90.0     19.8      130.00         .00       522.
    44       4022  4023      590.0     19.8      130.00         .00
    45       4023  4018      730.0     19.8      130.00         .00
    46       4008  4009      450.0     19.8      130.00         .00
    47       4009  4010      330.0     14.0      130.00         .00
    48       4010  4012      270.0      9.7      130.00         .00
    49-XX    4015  4024      420.0      7.9      130.00         .00
    50-XX    4024  4026      158.0      7.9      130.00         .00
    51       4031  4032      615.0      7.9      130.00         .00
    52       4006  4005      200.0     14.0      130.00         .00
    53       4005  4004      150.0     14.0      130.00         .00
    54       4004  4003      150.0      9.7      130.00         .00
    55       4003  4002      204.0      7.9      130.00         .00
    56       4002  4001       70.0      7.9      130.00         .00
    57       4010  4011      600.0      9.7      130.00         .00
    58       4019  4020      320.0      7.9      130.00         .00
    59       4020  4021      470.0      7.9      130.00         .00
    60       4006  4007      100.0     19.8      130.00         .00
    61-FG       0  4029       25.0     19.8      120.00         .00       540.
    62-XXFG     0  4029       33.0     19.8      120.00         .00       500.
    63       4029  4028      223.0     19.8      120.00         .00
    64       4029  4033      425.0     19.8      120.00         .00
    65       4028  4027      400.0     14.0      120.00         .00
    66       4033  4034      525.0      9.7      120.00         .00
```

```
   67-XX     4014   4028         300.0        9.7        120.00          .00
   68-XX     4026   4027         100.0        9.7        120.00          .00
   69        4027   4032         870.0       14.0        120.00          .00
   70        4034   4036         490.0        5.5        120.00          .00


 J U N C T I O N   N O D E   D A T A


    JUNCTION     JUNCTION      EXTERNAL     JUNCTION
     NUMBER       TITLE         DEMAND      ELEVATION   CONNECTING PIPES
                                (l/s)          (m)
 ------------------------------------------------------------------------------
     4001                         .79        497.00      7    56
     4002                        1.84        497.00      6     7    55    56
     4003                        1.64        482.00      5     6    54    55
     4004                        2.61        472.00      4     5    53    54
     4005                        3.51        496.00      2     4    52    53
     4006                        3.34        495.00      1     2     3    52    60
     4007                        4.59        502.00      3     8    37    39    60
     4008                        3.62        501.00      8     9    10    39    40

     4009                        4.66        480.00     10    11    12    46    47
     4010                        5.51        494.00     11    13    14    47    48

     4011                        3.92        485.00     13    57
     4012                        2.49        507.00     14    48
     4013                        2.22        507.00      9    19    40    41
     4014                        6.96        465.00     12    15    67
     4015                        1.05        463.00     15    16    17    49
     4016                         .89        456.00     16    18
     4017                         .61        457.00     18    19    20    41    42
     4018                         .55        456.00     20    21    22    38    42

     4019                         .35        455.00     21    23    38    58
     4020                         .56        450.00     23    24    58    59
     4021                         .44        445.00     24    59
     4022                         .71        505.00     25    26    27    43    44
     4023                         .34        489.00     22    25    44    45
     4024                         .13        484.00     17    28    49    50
     4025                         .15        495.00     26    29    30
     4026                         .16        494.00     28    29    50    68
     4027                         .52        498.00     65    68    69
     4028                        1.31        482.00     63    65    67
     4029                        1.51        490.00     61    62    63    64
     4030                         .37        503.00     30    31
     4031                        1.61        493.00     31    32    51
     4032                        3.01        507.00     32    33    51    69
     4033                        1.13        495.00     64    66
     4034                        1.13        490.00     66    70
     4035                        1.32        510.00     33    34
     4036                         .02        506.00     34    35    36    70
```

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     4037                              .01        516.00    35
     4038                              .01        499.00    36


  O U T P U T   O P T I O N   D A T A

  OUTPUT SELECTION:  ALL RESULTS ARE INCLUDED IN THE TABULATED OUTPUT


  S Y S T E M   C O N F I G U R A T I O N

     NUMBER OF PIPES ....................(p) =   70
     NUMBER OF JUNCTION NODES ..........(j) =   38
     NUMBER OF PRIMARY LOOPS ...........(l) =   27
     NUMBER OF FIXED GRADE NODES .......(f) =    6
     NUMBER OF SUPPLY ZONES ............(z) =    1


                  ************************************
                   S I M U L A T I O N   R E S U L T S
                  ************************************

  THE RESULTS ARE OBTAINED AFTER  7 TRIALS WITH AN ACCURACY =  .00159


  P I P E L I N E   R E S U L T S

  STATUS CODE:   XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                 CV -CHECK VALVE    RV -REGULATING VALVE    TK -STORAGE TANK

    PIPE        NODE NOS.       FLOWRATE    HEAD    PUMP   MINOR    LINE    HL/
   NUMBER      #1      #2                   LOSS    HEAD    LOSS   VELO.   1000
                                 (l/s)      (m)     (m)     (m)    (m/s)   (m/m
  -----------------------------------------------------------------------------
     1-FGCV     0    4006        30.86      .48     .00     .00    1.00     6.3
     2       4006    4005          .76      .69     .00     .00     .32     3.4
     3       4006    4007         8.22      .06     .00     .00     .27      .5
     4       4005    4004          .50      .24     .00     .00     .21     1.6
     5       4004    4003          .73      .48     .00     .00     .31     3.2
     6       4003    4002          .69      .59     .00     .00     .29     2.8
     7       4002    4001          .21      .02     .00     .00     .09      .3
     8       4007    4008         4.18      .01     .00     .00     .14      .1
     9       4008    4013        -2.60      .05     .00     .00     .17      .3
    10       4008    4009         5.01      .54     .00     .00     .33     1.1
    11       4009    4010         3.10      .97     .00     .00     .42     2.9
    12       4009    4014         1.94     1.91     .00     .00     .40     3.3
    13       4010    4011          .67     1.65     .00     .00     .28     2.7
    14       4010    4012          .87      .20     .00     .00     .18      .7
    15       4014    4015        -5.02     1.07     .00     .00     .68     7.1
```

```
    16        4015    4016            -3.01     1.22      .00      .00      .41     2.7
    17        4015    4024            -3.06     3.26      .00      .00      .62     7.7
    18        4016    4017            -3.90      .67      .00      .00      .53     4.4
    19        4017    4013             1.46      .47      .00      .00      .20      .7
    20        4017    4018            -2.03      .16      .00      .00      .27     1.3
    21        4018    4019              .23      .03      .00      .00      .10      .3
    22        4018    4023             -.56     1.43      .00      .00      .24     1.9
    23        4019    4020              .26      .15      .00      .00      .11      .4
    24        4020    4021              .12      .05      .00      .00      .05      .1
    25        4022    4023              .57     1.20      .00      .00      .24     2.0
    26        4022    4025             3.87      .09      .00      .00      .13      .1
    27-FG        0    4022            11.11      .09      .00      .00      .36      .9
    28        4024    4026            -3.19     1.32      .00      .00      .65     8.3
    29        4025    4026             3.35      .02      .00      .00      .22      .5
    30        4025    4030              .37      .01      .00      .00      .02      .0
    31-XX     4030    4031
    32        4031    4032             -.42      .71      .00      .00      .18     1.1
    33        4032    4035              .70      .03      .00      .00      .05      .0
    34        4035    4036             -.62      .02      .00      .00      .04      .0
    35        4036    4037              .01      .00      .00      .00      .00      .0
    36        4036    4038              .01      .00      .00      .00      .00      .0
    37-XXFG      0    4007
    38        4018    4019             1.12      .03      .00      .00      .15      .3
    39        4007    4008             8.36      .01      .00      .00      .17      .1
    40        4008    4013            -7.01      .05      .00      .00      .23      .3
    41        4013    4017           -10.36      .47      .00      .00      .34      .7
    42        4017    4018           -14.31      .16      .00      .00      .46     1.3
    43-FG        0    4022            12.04      .09      .00      .00      .39      .9
    44        4022    4023            18.00     1.20      .00      .00      .58     2.0
    45        4023    4018            17.68     1.43      .00      .00      .57     1.9
    46        4008    4009            13.51      .54      .00      .00      .44     1.1
    47        4009    4010             8.82      .97      .00      .00      .57     2.9
    48        4010    4012             1.62      .20      .00      .00      .22      .7
    49-XX     4015    4024
    50-XX     4024    4026
    51        4031    4032            -1.19      .71      .00      .00      .24     1.1
    52        4006    4005             9.63      .69      .00      .00      .63     3.4
    53        4005    4004             6.38      .24      .00      .00      .41     1.6
    54        4004    4003             3.54      .48      .00      .00      .48     3.2
    55        4003    4002             1.94      .59      .00      .00      .40     2.8
    56        4002    4001              .58      .02      .00      .00      .12      .3
    57        4010    4011             3.25     1.65      .00      .00      .44     2.7
    58        4019    4020              .74      .15      .00      .00      .15      .4
    59        4020    4021              .32      .05      .00      .00      .07      .1
    60        4006    4007             8.91      .06      .00      .00      .29      .5
    61-FG        0    4029            11.58      .03      .00      .00      .38     1.0
    62-XXFG      0    4029
    63        4029    4028             7.15      .09      .00      .00      .23      .4
    64        4029    4033             2.92      .03      .00      .00      .09      .0
    65        4028    4027             5.84      .63      .00      .00      .38     1.5
    66        4033    4034             1.79      .56      .00      .00      .24     1.0
    67-XX     4014    4028
    68-XX     4026    4027
```

```
    69       4027    4032              5.32     1.16       .00       .00       .35       1.3
    70       4034    4036               .66     1.31       .00       .00       .28       2.6


 J U N C T I O N   N O D E   R E S U L T S

  JUNCTION   JUNCTION    EXTERNAL   HYDRAULIC   JUNCTION    PRESSURE   JUNCTIO
   NUMBER     TITLE       DEMAND      GRADE     ELEVATION     HEAD     PRESSUR
                          (l/s)        (m)         (m)         (m)      (kpa)
 ----------------------------------------------------------------------------
   4001                      .79     516.78      497.00       19.78     193.94
   4002                     1.84     516.80      497.00       19.80     194.16
   4003                     1.64     517.39      482.00       35.39     347.02
   4004                     2.61     517.87      472.00       45.87     449.82
   4005                     3.51     518.11      496.00       22.11     216.83
   4006                     3.34     518.80      495.00       23.80     233.40
   4007                     4.59     518.75      502.00       16.75     164.22
   4008                     3.62     518.74      501.00       17.74     173.95
   4009                     4.66     518.20      480.00       38.20     374.62
   4010                     5.51     517.23      494.00       23.23     227.83
   4011                     3.92     515.58      485.00       30.58     299.91
   4012                     2.49     517.03      507.00       10.03      98.34
   4013                     2.22     518.79      507.00       11.79     115.64
   4014                     6.96     516.29      465.00       51.29     503.02
   4015                     1.05     517.37      463.00       54.37     533.15
   4016                      .89     518.59      456.00       62.59     613.76
   4017                      .61     519.26      457.00       62.26     610.55
   4018                      .55     519.42      456.00       63.42     621.93
   4019                      .35     519.39      455.00       64.39     631.44
   4020                      .56     519.23      450.00       69.23     678.97
   4021                      .44     519.19      445.00       74.19     727.52
   4022                      .71     522.05      505.00       17.05     167.24
   4023                      .34     520.85      489.00       31.85     312.38
   4024                      .13     520.62      484.00       36.62     359.17
   4025                      .15     521.97      495.00       26.97     264.44
   4026                      .16     521.95      494.00       27.95     274.08
   4027                      .52     539.25      498.00       41.25     404.48
   4028                     1.31     539.88      482.00       57.88     567.60
   4029                     1.51     539.97      490.00       49.97     490.08
   4030                      .37     521.96      503.00       18.96     185.93
   4031                     1.61     537.37      493.00       44.37     435.16
   4032                     3.01     538.09      507.00       31.09     304.86
   4033                     1.13     539.94      495.00       44.94     440.71
   4034                     1.13     539.38      490.00       49.38     484.27
   4035                     1.32     538.05      510.00       28.05     275.11
   4036                      .02     538.07      506.00       32.07     314.51
   4037                      .01     538.07      516.00       22.07     216.44
   4038                      .01     538.07      499.00       39.07     383.15


 S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S
```

```
 (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
 (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

             PIPE        FLOWRATE
            NUMBER         (l/s)
            --------------------
               1          30.86
              27          11.11
              43          12.04
              61          11.58

 NET SYSTEM INFLOW   =     65.59
 NET SYSTEM OUTFLOW  =       .00
 NET SYSTEM DEMAND   =     65.59


 D A T A   C H A N G E S   F O R   N E X T   S I M U L A T I O N


      D E M A N D   C H A N G E S

 DEMAND TYPE =  1 -    GDF =    .300


                       ************************************
                        S I M U L A T I O N   R E S U L T S
                       ************************************

 THE RESULTS ARE OBTAINED AFTER  3 TRIALS WITH AN ACCURACY =  .00408


 P I P E L I N E   R E S U L T S

 STATUS CODE:   XX -CLOSED PIPE    FG -FIXED GRADE NODE    PU -PUMP LINE
                CV -CHECK VALVE    RV -REGULATING VALVE    TK -STORAGE TANK

   PIPE        NODE NOS.     FLOWRATE     HEAD     PUMP    MINOR     LINE      HL/
  NUMBER      #1     #2                   LOSS     HEAD     LOSS     VELO.    1000
                               (l/s)       (m)      (m)      (m)     (m/s)    (m/m
 ------------------------------------------------------------------------------------
     1-XXFG    0    4006
     2      4006    4005          .23      .07      .00      .00      .10       .3
     3      4006    4007        -1.98      .00      .00      .00      .06       .0
     4      4005    4004          .15      .03      .00      .00      .06       .1
     5      4004    4003          .22      .05      .00      .00      .09       .3
     6      4003    4002          .21      .06      .00      .00      .09       .3
     7      4002    4001          .06      .00      .00      .00      .03       .0
     8      4007    4008        -1.83      .00      .00      .00      .06       .0
     9      4008    4013        -3.02      .07      .00      .00      .20       .4
```

```
    10      4008   4009            1.24     .04     .00     .00     .08      .0
    11      4009   4010             .93     .10     .00     .00     .13      .3
    12      4009   4014            -.38     .09     .00     .00     .08      .1
    13      4010   4011             .20     .18     .00     .00     .09      .3
    14      4010   4012             .26     .02     .00     .00     .05      .0
    15      4014   4015           -2.47     .29     .00     .00     .33     1.9
    16      4015   4016            -.91     .13     .00     .00     .12      .3
    17      4015   4024           -1.87    1.31     .00     .00     .38     3.1
    18      4016   4017           -1.18     .07     .00     .00     .16      .4
    19      4017   4013            1.47     .47     .00     .00     .20      .7
    20      4017   4018           -1.64     .11     .00     .00     .22      .9
    21      4018   4019             .07     .00     .00     .00     .03      .0
    22      4018   4023            -.42     .85     .00     .00     .18     1.1
    23      4019   4020             .08     .02     .00     .00     .03      .0
    24      4020   4021             .03     .01     .00     .00     .01      .0
    25      4022   4023             .43     .70     .00     .00     .18     1.1
    26      4022   4025            2.12     .03     .00     .00     .07      .0
    27-FG      0   4022            7.78     .04     .00     .00     .25      .5
    28      4024   4026           -1.91     .51     .00     .00     .39     3.2
    29      4025   4026            1.96     .01     .00     .00     .13      .2
    30      4025   4030             .11     .00     .00     .00     .01      .0
    31-XX   4030   4031
    32      4031   4032            -.13     .08     .00     .00     .05      .1
    33      4032   4035             .21     .00     .00     .00     .01      .0
    34      4035   4036            -.19     .00     .00     .00     .01      .0
    35      4036   4037             .00     .00     .00     .00     .00      .0
    36      4036   4038             .00     .00     .00     .00     .00      .0
    37-XXFG    0   4007
    38      4018   4019             .34     .00     .00     .00     .05      .0
    39      4007   4008           -3.66     .00     .00     .00     .07      .0
    40      4008   4013           -8.15     .07     .00     .00     .26      .4
    41      4013   4017          -10.38     .47     .00     .00     .34      .7
    42      4017   4018          -11.57     .11     .00     .00     .38      .9
    43-FG      0   4022            8.43     .04     .00     .00     .27      .5
    44      4022   4023           13.45     .70     .00     .00     .44     1.1
    45      4023   4018           13.35     .85     .00     .00     .43     1.1
    46      4008   4009            3.35     .04     .00     .00     .11      .0
    47      4009   4010            2.65     .10     .00     .00     .17      .3
    48      4010   4012             .49     .02     .00     .00     .07      .0
    49-XX   4015   4024
    50-XX   4024   4026
    51      4031   4032            -.36     .08     .00     .00     .07      .1
    52      4006   4005            2.89     .07     .00     .00     .19      .3
    53      4005   4004            1.91     .03     .00     .00     .12      .1
    54      4004   4003            1.06     .05     .00     .00     .14      .3
    55      4003   4002             .58     .06     .00     .00     .12      .3
    56      4002   4001             .17     .00     .00     .00     .04      .0
    57      4010   4011             .97     .18     .00     .00     .13      .3
    58      4019   4020             .22     .02     .00     .00     .05      .0
    59      4020   4021             .10     .01     .00     .00     .02      .0
    60      4006   4007           -2.14     .00     .00     .00     .07      .0
    61-FG      0   4029            3.47     .00     .00     .00     .11      .1
    62-XXFG    0   4029
```

```
    63       4029     4028               2.14       .01       .00       .00       .07        .0
    64       4029     4033                .88       .00       .00       .00       .03        .0
    65       4028     4027               1.75       .07       .00       .00       .11        .1
    66       4033     4034                .54       .06       .00       .00       .07        .1
    67-XX    4014     4028
    68-XX    4026     4027
    69       4027     4032               1.59       .12       .00       .00       .10        .1
    70       4034     4036                .20       .14       .00       .00       .08        .2


 J U N C T I O N   N O D E   R E S U L T S

  JUNCTION   JUNCTION    EXTERNAL   HYDRAULIC   JUNCTION    PRESSURE   JUNCTIO
   NUMBER     TITLE       DEMAND      GRADE     ELEVATION     HEAD     PRESSUR
                          (l/s)        (m)         (m)         (m)      (kpa)
 ----------------------------------------------------------------------------
   4001                     .24      519.67      497.00       22.67     222.33
   4002                     .55      519.67      497.00       22.67     222.36
   4003                     .49      519.74      482.00       37.74     370.08
   4004                     .78      519.79      472.00       47.79     468.65
   4005                    1.05      519.82      496.00       23.82     233.55
   4006                    1.00      519.89      495.00       24.89     244.08
   4007                    1.38      519.89      502.00       17.89     175.47
   4008                    1.09      519.89      501.00       18.89     185.30
   4009                    1.40      519.85      480.00       39.85     390.84
   4010                    1.65      519.75      494.00       25.75     252.52
   4011                    1.18      519.57      485.00       34.57     339.04
   4012                     .75      519.73      507.00       12.73     124.82
   4013                     .67      519.97      507.00       12.97     127.17
   4014                    2.09      519.94      465.00       54.94     538.82
   4015                     .31      520.23      463.00       57.23     561.25
   4016                     .27      520.36      456.00       64.36     631.19
   4017                     .18      520.44      457.00       63.44     622.10
   4018                     .17      520.54      456.00       64.54     632.96
   4019                     .10      520.54      455.00       65.54     642.74
   4020                     .17      520.52      450.00       70.52     691.61
   4021                     .13      520.52      445.00       75.52     740.59
   4022                     .21      522.10      505.00       17.10     167.65
   4023                     .10      521.40      489.00       32.40     317.70
   4024                     .04      521.55      484.00       37.55     368.21
   4025                     .05      522.07      495.00       27.07     265.43
   4026                     .05      522.06      494.00       28.06     275.18
   4027                     .16      539.92      498.00       41.92     411.09
   4028                     .39      539.99      482.00       57.99     568.66
   4029                     .45      540.00      490.00       50.00     490.31
   4030                     .11      522.07      503.00       19.07     186.97
   4031                     .48      539.72      493.00       46.72     458.14
   4032                     .90      539.79      507.00       32.79     321.60
   4033                     .34      539.99      495.00       44.99     441.24
   4034                     .34      539.93      490.00       49.93     489.68
   4035                     .40      539.79      510.00       29.79     292.15
   4036                     .01      539.79      506.00       33.79     331.39
```

```
   4037                     .00      539.79      516.00      23.79     233.33
   4038                     .00      539.79      499.00      40.79     400.04


 S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

 (+) INFLOWS INTO THE SYSTEM FROM FIXED GRADE NODES
 (-) OUTFLOWS FROM THE SYSTEM INTO FIXED GRADE NODES

            PIPE        FLOWRATE
           NUMBER        (l/s)
           --------------------
             27          7.78
             43          8.43
             61          3.47

 NET SYSTEM INFLOW  =     19.68
 NET SYSTEM OUTFLOW =       .00
 NET SYSTEM DEMAND  =     19.68


 **** KYPIPE SIMULATION COMPLETED ****


 DATE:  3/12/2002
 TIME:  8:47:44
```

05 Mechanical Design Calculations

Pump List

Location	NO.	Direction	Phase	Pump Capacity		Required Head	Total Head	Number of Units		Pump	Control
			(Year)	(m3/day)	(m3/min)	(m)	(m)	Duty	Standby		
Gohagoda Intake		To WTP	2005	38,500	26.74	40.5	44.0	1	1	C	A
			2010	77,000	53.47	39.4	43.0	2	1		
			2015	115,500	80.21	40.6	44.0	3	1		
Katugastota W.T.P.	A-1	To Upland, Asgiriya SR	2005	17,600	12.22	130.5	134.0	1	1	C	B
			2010	33,190	23.05	135.2	136.0	2	1		
			2015	51,110	35.49	135.6	137.0	3	1		
	A-2	To Gphagoda SR	2005	4,710	3.27	103.9		1	1	B	B
		To Kondadeniya SR	2010	4,990	3.47	104.3		1	1		
			2015	5,870	4.08	101.7	104.0	1	1		
	A-3	To Kahawatta SR & other SRs	2005	14,390	9.99	90.9	93.0	1	1	C	B
			2010	29,160	20.25	96.4	99.0	2	1		
			2015	44,240	30.72	99.5	102.0	3	1		
Heerasagala Low SR	B		2005	1,650	1.15	59.0		1	1	A	B
		To Heerasagala Middle SR	2010	2,350	1.63	61.8		1	1		
			2015	2,740	1.90	63.8	68.0	1	1		
Heerasagala Middle SR	C	To Heerasagala Upper SR	2005	280	0.19	54.5		1	1	A	B
			2010	550	0.38	71.7		1	1		
			2015	700	0.49	72.6	77.0	1	1		
Ampitiya SR	D-1	To Elhena SR	2005	400	0.28	38.1		1	1	A	B
(existing)			2010	570	0.40	38.7		1	1		
			2015	1,200	0.83	42.1	45.0	1	1		
	D-2	To Mullepihilla SR	2005	580	0.40	138.6		1	1	B	B
			2010	810	0.56	141.3		1	1		
			2015	980	0.68	143.7	146.0	1	1		
	D-3	To Meekanuwa SR	2005	1250	0.87	74.1		1	1	A	B
			2010	1770	1.23	66.2		1	1		
			2015	2150	1.49	70.0	73.0	1	1		
Kahawatta SR	E	To Kurugoda SR and	2005	4,240	2.94	62.4	65.0	1	1	A	B
		Telambugahawatta SR	2010	4,330	3.01	62.5		2	1		
			2015	7,310	5.08	70.0	73.0	2	1		
R2 SR	F	To Hantana Place SR	2005	1,050	0.73	97.3		1	1	A	B
(existing)			2010	1,490	1.03	98.0		1	1		
			2015	1,960	1.36	99.0	102.0	1	1		
Asgiriya SR	G	In-line pump to Bahirawakanda SR	2005	1,970	1.37	86.5		1	1	A	B
			2010	2,150	1.49	86.9		1	1		
			2015	2,280	1.58	87.2	68.0	1	1		
Kondadeniya	H	To Kulugamana SR	2005	1,050	0.73	67.2		1	1	A	B
(existing)			2010	1,100	0.76	68.1		1	1		
			2015	1,600	1.11	59.9	64.0	1	1		

Pump Type :
A End Suction Volute Pump
B Multi-Stage Volute Pump
C Double Suction Volute Pump

Control Type :
A Pump Speed Control Operation with Flowmeter/Pressure Sensor
B Pump On-Off Operation with Flowmeter

1-1. Intake (Stage 1)

Total Capacity 38,500 m^3/day = 26.74 m^3/min

Quantity of pump 1 sets + 1 set for stand-by

Pump Capacity 38,500 m^3/day

$Q=$ 26.74 m^3/min 1,604.2 m^3/hr

$q=$ 0.446 m^3/sec

Diameter Diameter = 146 x $(Q / v)^{(1/2)}$

= 616 mm to 436 mm

= 400 x 300 mm

where, $v=$ 1.5 to 3

Total Head Total Head $H = h_1 + h_2 + h_3$ = 42.5

= 44.0 m

actual head :

h_1 = hd - hs = 38.33 m

suction level hs = 436.67 m

delivery level hd = 475.00 m

friction loss : pipeline (Hazen Williams)

$h_2 = 10.666 \times c^{(-1.85)} \times D^{(-4.87)} \times q^{(1.85)} \times L =$ 2.13 m

where, $c=$ 110

$D=$ 800 mm dia /1000

$L=$ 1,800 m

($v=$ 0.886 m/sec)

friction loss : fittings around pump

$h_3 = f_1 \times (v_1^2 / 2g) + f_2 \times (v_2^2 / 2g)$

= 0.05 m + 1.98 m

= 2.03 m

where, $D=$ 500 mm dia /1000

($v_1 =$ 2.269 m/sec)

f1	Q'ty	f/pc	f
bell mouth	1	0.06	0.06
sluice valve	1	0.10	0.10
deducer	1	0.04	0.04
		f_1 total	0.20

where, $D=$ 400 mm dia /1000

($v_2 =$ 3.546 m/sec)

f2	Q'ty	f/pc	f
check valve	1	1.50	1.50
sluice valve	1	0.10	0.10
increase	1	0.15	0.15
90deg	1	0.18	0.18
tee	1	1.15	1.15
		f_2 total	3.08

Motor Output Motor Output = (0.163 x r x Q x H / e) x (1 + a)

= 265.7

= 280.0 kW

where, $r =$ 1.00

$e =$ 0.83

$a =$ 0.15

Specification

Type	Vertical Double-Suction Centrifugal Pump
Diameter	400 x 300 mm
Capacity	26.74 m^3/min
Head	44.0 m
Motor Outp	280 kW
Quantity	2 (1) sets including 1 set for future

1-2. Intake (Stage 2)

Total Capacity 77,000 m^3/day = 53.47 m^3/min

Quantity of pump 2 sets + 1 set for stand-by

Pump Capacity 38,500 m^3/day

Q= 26.74 m^3/min 1,604.2 m^3/hr

q= 0.446 m^3/sec

Diameter Diameter = 146 x $(Q / v)^{(1/2)}$

= 616 mm to 436 mm

= 400 x 300 mm

where, v= 1.5 to 3

Total Head Total Head $H = h_1 + h_2 + h_3$ = 41.4

= 44.0 m

actual head :

h_1 = hd - hs = 38.33 m

suction level hs = 436.67 m

delivery level hd = 475.00 m

friction loss : pipeline (Hazen Williams)

$h_2 = 10.666 \times c^{(-1.85)} \times D^{(-4.87)} \times q^{(1.85)} \times L$ = 1.05 m

where, c= 110

D= 1,204 mm dia /1000

L= 1,800 m

(v= 0.783 m/sec)

friction loss : fittings around pump

$h_3 = f_1 \times (v_1^2 / 2g) + f_2 \times (v_2^2 / 2g)$

= 0.05 m + 1.98 m

= 2.03 m

where, D= 500 mm dia /1000

(v_1 = 2.269 m/sec)

f1	Q'ty	f/pc	f
bell mouth	1	0.06	0.06
sluice valve	1	0.10	0.10
deducer	1	0.04	0.04
		f_1 total	0.20

where, D= 400 mm dia /1000

(v_2 = 3.546 m/sec)

f2	Q'ty	f/pc	f
check valve	1	1.50	1.50
sluice valve	1	0.10	0.10
increase	1	0.15	0.15
90deg	1	0.18	0.18
tee	1	1.15	1.15
		f_2 total	3.08

Motor Output Motor Output = (0.163 x r x Q x H / e) x (1 + a)

= 265.7

= 280.0 kW

where, r = 1.00

e = 0.83

a = 0.15

Specification

Type	Vertical Double-Suction Centrifugal Pump
Diameter	400 x 300 mm
Capacity	26.74 m^3/min
Head	44.0 m
Motor Outpu	280 kW
Quantity	3 (1) sets including 1 set for future

1-3. Intake (Stage 3)

Total Capacity 115,500 m^3/day = 80.21 m^3/min

Quantity of pump 3 sets + 1 set for stand-by

Pump Capacity 38,500 m^3/day

$Q=$ 26.74 m^3/min 1,604.2 m^3/hr

$q=$ 0.446 m^3/sec

Diameter Diameter = $146 \times (Q / v)^{(1/2)}$

= 616 mm to 436 mm

= 400 x 300 mm

where, $v=$ 1.5 to 3

Total Head Total Head $H = h_1 + h_2 + h_3 =$ 42.6

= 44.0 m

actual head :

$h_1 = hd - hs =$ 38.33 m

suction level $hs =$ 436.67 m

delivery level $hd =$ 475.00 m

friction loss : pipeline (Hazen Williams)

$h_2 = 10.666 \times c^{(-1.85)} \times D^{(-4.87)} \times q^{(1.85)} \times L =$ 2.22 m

where, $c=$ 110

$D=$ 1,204 mm dia /1000

$L=$ 1,800 m

($v=$ 1.174 m/sec)

friction loss : fittings around pump

$h_3 = f_1 \times (v_1^2 / 2g) + f_2 \times (v_2^2 / 2g)$

= 0.05 m + 1.98 m

= 2.03 m

where, $D=$ 500 mm dia /1000

($v_1 =$ 2.269 m/sec)

f1	Q'ty	f/pc	f
bell mouth	1	0.06	0.06
sluice valve	1	0.10	0.10
deducer	1	0.04	0.04
		f_1 total	0.20

where, $D=$ 400 mm dia /1000

($v_2 =$ 3.546 m/sec)

f2	Q'ty	f/pc	f
check valve	1	1.50	1.50
sluice valve	1	0.10	0.10
increase	1	0.15	0.15
90deg	1	0.18	0.18
tee	1	1.15	1.15
		f_2 total	3.08

Motor Output Motor Output = $(0.163 \times r \times Q \times H / e) \times (1 + a)$

= 265.7

= 280.0 kW

where, $r =$ 1.00

$e =$ 0.83

$a =$ 0.15

Specification

Type Vertical Double-Suction Centrifugal Pump

Diameter 400 x 300 mm

Capacity 26.74 m^3/min

Head 44.0 m

Motor Outp 280 kW

Quantity 4 (1) sets including 1 set for future

2-1. Clear Water Pump (A-1) - Phase 1

Total Capacity 20,360 m^3/day = 14.14 m^3/min

Quantity of pump 1 sets + 1 set for stand-by

Pump Capacity 20,360 m^3/day

$Q=$ 14.14 m^3/min 848.3 m^3/hr

$q=$ 0.236 m^3/sec

Diameter Diameter = 146 x $(Q / v)^{(1/2)}$

= 448 mm to 317 mm

= 300 x 200 mm

where, $v=$ 1.5 to 3

Total Head Total Head $H = h_1 + h_2 + h_3 + h_4 =$ 132.0

= 134.0 m

actual head : Asgiriya

h_1 = hd - hs = 124.39 m

suction header pipe hs = 442.61 m

delivery level hd = 567.00 m

friction loss : pipeline (Hazen Williams)

$h_2 = 10.666 \times c^{(-1.85)} \times D^{(-4.87)} \times q^{(1.85)} \times L =$ 0.91 m

friction loss : fittings around pump

$h_3 = f_1 \times (v_1^2 / 2g) + f_2 \times (v_2^2 / 2g)$

= 0.02 m + 1.71 m

= 1.73 m

where, D= 400 mm dia /1000

(v_1 = 1.875 m/sec)

f1	Q'ty	f/pc	f
sluice valve	1	0.10	0.10
reducer	1	0.03	0.03
		f_1 total	0.13

where, D= 300 mm dia /1000

(v_2 = 3.334 m/sec)

f2	Q'ty	f/pc	f
increase	1	0.48	0.48
check valve	1	1.00	1.00
butterfly valve	1	0.20	0.20
90deg	1	0.18	0.18
tee	1	1.15	1.15
		f_2 total	3.01

friction loss : float type butterfly valve

$h_4=$ 5.00 m

Motor Output Motor Output = (0.163 x r x Q x H / e) x (1 + a)

= 433.1 kW

= 450.0 kW

where, r = 1.00

e = 0.82

a = 0.15

Specification

Type Horizontal Double-Suction Centrifugal Pump

Diameter 300 x 200 mm

Capacity 14.14 m^3/min

Head 134.0 m

Motor Outp 450 kW

Quantity 2 (1) sets including 1 set for future

2-2. Clear Water Pump (A-1) - Phase 2

Total Capacity 36,040 m^3/day = 25.03 m^3/min
Quantity of pump 2 sets + 1 set for stand-by
Pump Capacity 18,020 m^3/day
Q= 12.51 m^3/min 750.8 m^3/hr
q= 0.209 m^3/sec

Diameter Diameter = 146 x $(Q / v)^{(1/2)}$
= 422 mm to 298 mm
= 300 x 200 mm
where, v= 1.5 to 3

Total Head Total Head H = $h_1 + h_2 + h_3 + h_4$ = 134.1
= 136.0 m
actual head : Asgiriya
h_1 = hd - hs = 124.39 m
suction header pipe hs = 442.61 m
delivery level hd = 567.00 m
friction loss : pipeline (Hazen Williams)
$h_2 = 10.666 \times c^{(-1.85)} \times D^{(-4.87)} \times q^{(1.85)} \times L$ = 3.31 m
friction loss : fittings around pump
$h_3 = f_1 \times (v_1^2 / 2g) + f_2 \times (v_2^2 / 2g)$
= 0.02 m + 1.34 m
= 1.36 m
where, D= 400 mm dia /1000
(v_1 = 1.660 m/sec)

f1	Q'ty	f/pc	f
sluice valve	1	0.10	0.10
reducer	1	0.03	0.03
		f_1 total	0.13

where, D= 300 mm dia /1000
(v_2 = 2.951 m/sec)

f2	Q'ty	f/pc	f
increase	1	0.48	0.48
check valve	1	1.00	1.00
butterfly valve	1	0.20	0.20
90deg	1	0.18	0.18
tee	1	1.15	1.15
		f_2 total	3.01

friction loss : float type butterfly valve
h_4 = 5.00 m

Motor Output Motor Output = (0.163 x r x Q x H / e) x (1 + a)
= 389 kW
= 400.0 kW
where, r = 1.00
e = 0.82
a = 0.15

Specification

Type	Horizontal Double-Suction Centrifugal Pump
Diameter	300 x 200 mm
Capacity	12.51 m^3/min
Head	136.0 m
Motor Outpı	400 kW
Quantity	3 (1) sets including 1 set for future

2-3 Clear Water Pump (A-1) - Phase 3

Total Capacity 54,160 m^3/day = 37.61 m^3/min

Quantity of pump 3 sets + 1 set for stand-by

Pump Capacity 18,053 m^3/day

Q= 12.54 m^3/min 752.2 m^3/hr

q= 0.209 m^3/sec

Diameter Diameter = 146 x $(Q / v)^{(1/2)}$

= 422 mm to 298 mm

= 300 x 200 mm

where, v= 1.5 to 3

Total Head Total Head H = $h_1 + h_2 + h_3 + h_4$ = 135.2

= 137.0 m

actual head : Asgiriya

h_1 = hd - hs = 124.39 m

suction header pipe hs = 442.61 m

delivery level hd = 567.00 m

friction loss : pipeline (Hazen Williams)

$h_2 = 10.666 \times c^{(-1.85)} \times D^{(-4.87)} \times q^{(1.85)} \times L$ = 4.41 m

friction loss : fittings around pump

$h_3 = f_1 \times (v_1^2 / 2g) + f_2 \times (v_2^2 / 2g)$

= 0.02 m + 1.34 m

= 1.36 m

where, D= 400 mm dia /1000

(v_1 = 1.663 m/sec)

f1	Q'ty	f/pc	f
sluice valve	1	0.10	0.10
reducer	1	0.03	0.03
		f_1 total	0.13

where, D= 300 mm dia /1000

(v_2 = 2.956 m/sec)

f2	Q'ty	f/pc	f
increase	1	0.48	0.48
check valve	1	1.00	1.00
butterfly valve	1	0.20	0.20
90deg	1	0.18	0.18
tee	1	1.15	1.15
		f_2 total	3.01

friction loss : float type butterfly valve

h_4 = 5.00 m

Motor Output Motor Output = (0.163 x r x Q x H / e) x (1 + a)

= 392.6 kW

= 400.0 kW

where, r = 1.00

e = 0.82

a = 0.15

Specification

Type	Horizontal Double-Suction Centrifugal Pump
Diameter	300 x 200 mm
Capacity	12.54 m^3/min
Head	137.0 m
Motor Outpu	400 kW
Quantity	4 (1) sets including 1 set for future

3-1. Clear Water Pump (A-2) - Phase 3

Total Capacity 2,820 m^3/day = 1.96 m^3/min

Quantity of pump 1 sets + 1 set for stand-by

Pump Capacity 2,820 m^3/day

Q= 1.96 m^3/min 117.5 m^3/hr

q= 0.033 m^3/sec

Diameter

Diameter = 146 x $(Q / v)^{(1/2)}$

= 167 mm to 118 mm

= 125 x 125 mm

where, v= 1.5 to 3

Total Head

Total Head H = $h_1 + h_2 + h_3 + h_4$ = 102.4 m

= 104.0 m

actual head : Asgiriya

h_1 = hd - hs = 87.40 m

suction header pipe hs = 442.60 m

delivery level hd = 530.00 m

friction loss : pipeline (Hazen Williams)

$h_2 = 10.666 \times c^{(-1.85)} \times D^{(-4.87)} \times q^{(1.85)} \times L$ = 9.30 m

friction loss : fittings around pump

$h_3 = f_1 \times (v_1^2 / 2g) + f_2 \times (v_2^2 / 2g)$

= 0.22 m + 0.52 m

= 0.74 m

where, D= 150 mm dia /1000

(v_1 = 1.847 m/sec)

f1	Q'ty	f/pc	f
sluice valve	1	0.10	0.10
tee	1	1.15	1.15
reducer	1	0.03	0.03
		f_1 total	1.28

where, D= 150 mm dia /1000

(v_2 = 1.847 m/sec)

f2	Q'ty	f/pc	f
increase	1	0.48	0.48
check valve	1	1.00	1.00
butterfly valve	1	0.20	0.20
90deg	1	0.18	0.18
tee	1	1.15	1.15
		f_2 total	3.01

friction loss : float type butterfly valve

h_4 = 5.00 m

Motor Output

Motor Output = (0.163 x r x Q x H / e) x (1 + a)

= 54.5 kW

= 55.0 kW

where, r = 1.00

e = 0.70

a = 0.15

Specification

Type Horizontal Multi-turbine Pump

Diameter 125 x 125 mm

Capacity 1.96 m^3/min

Head 104.0 m

Motor Outpu 55 kW

Quantity 2 (1) sets including 1 set for stand-by

4-1. Clear Water Pump (A-3) - Phase 1

Total Capacity 14,390 m^3/day = 9.99 m^3/min

Quantity of pump 1 sets + 1 set for stand-by

Pump Capacity 14,390 m^3/day

Q= 9.99 m^3/min 599.6 m^3/hr

q= 0.167 m^3/sec

Diameter Diameter = 146 x $(Q / v)^{(1/2)}$

= 377 mm to 266 mm

= 300 x 200 mm

where, v= 1.5 to 3

Total Head Total Head H = $h_1 + h_2 + h_3 + h_4$ = 91.7

= 93.0 m

actual head : Asgiriya

h_1 = hd - hs = 78.67 m

suction header pipe hs = 442.61 m

delivery level hd = 521.28 m

friction loss : pipeline (Hazen Williams)

$h_2 = 10.666 \times c^{(-1.85)} \times D^{(-4.87)} \times q^{(1.85)} \times L =$ 7.13 m

friction loss : fittings around pump

$h_3 = f_1 \times (v_1^2 / 2g) + f_2 \times (v_2^2 / 2g)$

= 0.01 m + 0.85 m

= 0.86 m

where, D= 400 mm dia /1000

(v_1 = 1.325 m/sec)

f1	Q'ty	f/pc	f
sluice valve	1	0.10	0.10
reducer	1	0.03	0.03
		f_1 total	0.13

where, D= 300 mm dia /1000

(v_2 = 2.356 m/sec)

f2	Q'ty	f/pc	f
increase	1	0.48	0.48
check valve	1	1.00	1.00
butterfly valve	1	0.20	0.20
90deg	1	0.18	0.18
tee	1	1.15	1.15
		f_2 total	3.01

friction loss : float type butterfly valve

h_4 = 5.00 m

Motor Output Motor Output = (0.163 x r x Q x H / e) x (1 + a)

= 212.4 kW

= 250.0 kW

where, r = 1.00

e = 0.82

a = 0.15

Specification

Type	Horizontal Double-Suction Centrifugal Pump
Diameter	300 x 200 mm
Capacity	9.99 m^3/min
Head	93.0 m
Motor Outpu	250 kW
Quantity	2 (1) sets including 1 set for future

4-2. Clear Water Pump (A-3) - Phase 2

Total Capacity 29,160 m^3/day = 20.25 m^3/min
Quantity of pump 2 sets + 1 set for stand-by
Pump Capacity 14,580 m^3/day
$Q=$ 10.13 m^3/min 607.5 m^3/hr
$q=$ 0.169 m^3/sec

Diameter Diameter = $146 \times (Q / v)^{(1/2)}$
= 379 mm to 268 mm
= 300 x 200 mm
where, $v=$ 1.5 to 3

Total Head Total Head $H = h_1 + h_2 + h_3 + h_4 =$ 97.2
= 99.0 m
actual head : Asgiriya
$h_1 = hd - hs =$ 78.67 m
suction header pipe hs = 442.61 m
delivery level hd = 521.28 m
friction loss : pipeline (Hazen Williams)
$h_2 = 10.666 \times c^{(-1.85)} \times D^{(-4.87)} \times q^{(1.85)} \times L =$ 12.63 m
friction loss : fittings around pump
$h_3 = f_1 \times (v_1^2 / 2g) + f_2 \times (v_2^2 / 2g)$
= 0.01 m + 0.88 m
= 0.89 m
where, D= 400 mm dia /1000
($v_1 =$ 1.343 m/sec)

f1	Q'ty	f/pc	f
sluice valve	1	0.10	0.10
reducer	1	0.03	0.03
		f_1 total	0.13

where, D= 300 mm dia /1000
($v_2 =$ 2.387 m/sec)

f2	Q'ty	f/pc	f
increase	1	0.48	0.48
check valve	1	1.00	1.00
butterfly valve	1	0.20	0.20
90deg	1	0.18	0.18
tee	1	1.15	1.15
		f_2 total	3.01

friction loss : float type butterfly valve
$h_4 =$ 5.00 m

Motor Output Motor Output = (0.163 x r x Q x H / e) x (1 + a)
= 229.1 kW
= 250.0 kW
where, r = 1.00
e = 0.82
a = 0.15

Specification

Type	Horizontal Double-Suction Centrifugal Pump
Diameter	300 x 200 mm
Capacity	10.13 m^3/min
Head	99.0 m
Motor Outpu	250 kW
Quantity	3 (1) sets including 1 set for future

4-3. Clear Water Pump (A-3) - Phase 3

Total Capacity 44,240 m^3/day = 30.72 m^3/min
Quantity of pump 3 sets + 1 set for stand-by
Pump Capacity 14,747 m^3/day
Q= 10.24 m^3/min 614.4 m^3/hr
q= 0.171 m^3/sec

Diameter Diameter = 146 x $(Q / v)^{(1/2)}$
= 381 mm to 270 mm
= 300 x 200 mm
where, v= 1.5 to 3

Total Head Total Head $H = h_1 + h_2 + h_3 + h_4 =$ 100.2
= 102.0 m
actual head : Asgiriya
h_1 = hd - hs = 78.67 m
suction header pipe hs = 442.61 m
delivery level hd = 521.28 m
friction loss : pipeline (Hazen Williams)
$h_2 = 10.666 \times c^{(-1.85)} \times D^{(-4.87)} \times q^{(1.85)} \times L =$ 15.63 m
friction loss : fittings around pump
$h_3 = f_1 \times (v_1^2 / 2g) + f_2 \times (v_2^2 / 2g)$
= 0.01 m + 0.9 m
= 0.91 m
where, D= 400 mm dia /1000
(v_1 = 1.358 m/sec)

f1	Q'ty	f/pc	f
sluice valve	1	0.10	0.10
reducer	1	0.03	0.03
		f_1 total	0.13

where, D= 300 mm dia /1000
(v_2 = 2.415 m/sec)

f2	Q'ty	f/pc	f
increase	1	0.48	0.48
check valve	1	1.00	1.00
butterfly valve	1	0.20	0.20
90deg	1	0.18	0.18
tee	1	1.15	1.15
		f_2 total	3.01

friction loss : float type butterfly valve
h_4 = 5.00 m

Motor Output Motor Output = (0.163 x r x Q x H / e) x (1 + a)
= 238.8 kW
= 250.0 kW
where, r = 1.00
e = 0.82
a = 0.15

Specification

Type	Horizontal Double-Suction Centrifugal Pump
Diameter	300 x 200 mm
Capacity	10.24 m^3/min
Head	102.0 m
Motor Outpu	250 kW
Quantity	4 (1) sets including 1 set for future

5-1. Ampitiya Booster Pump (D-1) - Phase 3

Total Capacity 1,200 m^3/day = 0.83 m^3/min

Quantity of pump 1 sets + 1 set for stand-by

Pump Capacity 1,200 m^3/day

Q= 0.83 m^3/min 50.0 m^3/hr

q= 0.014 m^3/sec

Diameter Diameter = 146 x $(Q / v)^{(1/2)}$

= 109 mm to 77 mm

= 80 x 65 mm

where, v= 1.5 to 3

Total Head Total Head H = $h_1 + h_2 + h_3 + h_4$ = 43.6 m

= 45.0 m

actual head : Elhena

h_1 = hd - hs = 32.50 m

suction level hs = 582.50 m

delivery level hd = 615.00 m

friction loss : pipeline (Hazen Williams)

$h_2 = 10.666 \times c^{(-1.85)} \times D^{(-4.87)} \times q^{(1.85)} \times L$ = 4.60 m

friction loss : fittings around pump

$h_3 = f_1 \times (v_1^2 / 2g) + f_2 \times (v_2^2 / 2g)$

= 0.12 m + 1.37 m

= 1.49 m

where, D= 80 mm dia /1000

(v_1 = 2.763 m/sec)

f1	Q'ty	f/pc	f
bell mouth	1	0.20	0.20
sluice valve	1	0.10	0.10
reducer	1	0.02	0.02
		f_1 total	0.32

where, D= 80 mm dia /1000

(v_2 = 2.763 m/sec)

f2	Q'ty	f/pc	f
increase	2	0.20	0.40
check valve	1	1.00	1.00
butterfly valve	1	0.20	0.20
90deg	1	0.18	0.18
tee	1	1.50	1.50
sluice valve	2	0.10	0.20
reducer	1	0.03	0.03
		f_2 total	3.51

friction loss : float type butterfly valve

h_4= 5.00 m

Motor Output Motor Output = (0.163 x r x Q x H / e) x (1 + a)

= 10.3 kW

= 11.0 kW

where, r = 1.00

e = 0.68

a = 0.15

Specification

Type	Horizontal End-Suction Centrifugal Pump
Diameter	80 x 65 mm
Capacity	0.83 m^3/min
Head	45.0 m
Motor Outpı	11 kW
Quantity	2 (1) sets including 1 set for future

5-2. Ampitiya Booster Pump (D-2) - Phase 3

Total Capacity 980 m^3/day = 0.68 m^3/min

Quantity of pump 1 sets + 1 set for stand-by

Pump Capacity 980 m^3/day

Q= 0.68 m^3/min 40.8 m^3/hr

q= 0.011 m^3/sec

Diameter Diameter = 146 x (Q / v)$^{(1/2)}$

= 98 mm to 70 mm

= 65 x 50 mm

where, v= 1.5 to 3

Total Head Total Head H = $h_1 + h_2 + h_3 + h_4$ = 144.7 m

= 146.0 m

actual head : Mullepihilla

h_1 = hd - hs = 130.50 m

suction level hs = 582.50 m

delivery level hd = 713.00 m

friction loss : pipeline (Hazen Williams)

$h_2 = 10.666 \times c^{(-1.85)} \times D^{(-4.87)} \times q^{(1.85)} \times L$ = 8.20 m

friction loss : fittings around pump

$h_3 = f_1 \times (v_1^2 / 2g) + f_2 \times (v_2^2 / 2g)$

= 0.08 m + 0.91 m

= 0.99 m

where, D= 80 mm dia /1000

(v_1 = 2.257 m/sec)

f1	Q'ty	f/pc	f
bell mouth	1	0.20	0.20
sluice valve	1	0.10	0.10
reducer	1	0.02	0.02
		f_1 total	0.32

where, D= 80 mm dia /1000

(v_2 = 2.257 m/sec)

f2	Q'ty	f/pc	f
increase	2	0.20	0.40
check valve	1	1.00	1.00
butterfly valve	1	0.20	0.20
90deg	1	0.18	0.18
tee	1	1.50	1.50
sluice valve	2	0.10	0.20
reducer	1	0.03	0.03
		f_2 total	3.51

friction loss : float type butterfly valve

h_4 = 5.00 m

Motor Output Motor Output = (0.163 x r x Q x H / e) x (1 + a)

= 28.7 kW

= 30.0 kW

where, r = 1.00

e = 0.65

a = 0.15

Specification

Type	Horizontal Multi-stage Pump
Diameter	65 x 50 mm
Capacity	0.68 m^3/min
Head	146.0 m
Motor Outpu	30 kW
Quantity	2 (1) sets including 1 set for future

5-3. Ampitiya Booster Pump (D-3) - Phase 3

Total Capacity 2,150 m^3/day = 1.49 m^3/min
Quantity of pump 1 sets + 1 set for stand-by
Pump Capacity 2,150 m^3/day
Q= 1.49 m^3/min 89.6 m^3/hr
q= 0.025 m^3/sec

Diameter Diameter = 146 x $(Q / v)^{(1/2)}$
= 146 mm to 103 mm
= 100 x 80 mm
where, v= 1.5 to 3

Total Head Total Head H = $h_1 + h_2 + h_3 + h_4$ = 72.0 m
= 73.0 m
actual head : Meekanuwa
h_1 = hd - hs = 52.50 m
suction level hs = 582.50 m
delivery level hd = 635.00 m
friction loss : pipeline (Hazen Williams)
$h_2 = 10.666 \times c^{(-1.85)} \times D^{(-4.87)} \times q^{(1.85)} \times L$ = 12.50 m
friction loss : fittings around pump
$h_3 = f_1 \times (v_1^2 / 2g) + f_2 \times (v_2^2 / 2g)$
= 0.16 m + 1.8 m
= 1.96 m
where, D= 100 mm dia /1000
(v_1 = 3.168 m/sec)

f1	Q'ty	f/pc	f
bell mouth	1	0.20	0.20
sluice valve	1	0.10	0.10
reducer	1	0.02	0.02
		f_1 total	0.32

where, D= 100 mm dia /1000
(v_2 = 3.168 m/sec)

f2	Q'ty	f/pc	f
increase	2	0.20	0.40
check valve	1	1.00	1.00
butterfly valve	1	0.20	0.20
90deg	1	0.18	0.18
tee	1	1.50	1.50
sluice valve	2	0.10	0.20
reducer	1	0.03	0.03
		f_2 total	3.51

friction loss : float type butterfly valve
h_4 = 5.00 m

Motor Output Motor Output = (0.163 x r x Q x H / e) x (1 + a)
= 28 kW
= 30.0 kW
where, r = 1.00
e = 0.73
a = 0.15

Specification
Type Horizontal End-Suction Centrifugal Pump
Diameter 100 x 80 mm
Capacity 1.49 m^3/min
Head 73.0 m
Motor Outpı 30 kW
Quantity 2 (1) sets including 1 set for future

6-1. Kahawatta Booster Pump (E) - Phase 1

Total Capacity 4,240 m^3/day = 2.94 m^3/min
Quantity of pump 1 sets + 1 set for stand-by
Pump Capacity 4,240 m^3/day
Q= 2.94 m^3/min 176.7 m^3/hr
q= 0.049 m^3/sec

Diameter Diameter = 146 x $(Q / v)^{(1/2)}$
= 205 mm to 145 mm
= 150 x 125 mm
where, v= 1.5 to 3

Total Head Total Head H = $h_1 + h_2 + h_3 + h_4$ = 63.9 m
= 68.0 m
actual head : Kurugoda
h_1 = hd - hs = 57.00 m
suction level hs = 516.00 m
delivery level hd = 573.00 m
friction loss : pipeline (Hazen Williams)
$h_2 = 10.666 \times c^{(-1.85)} \times D^{(-4.87)} \times q^{(1.85)} \times L =$ 0.40 m
friction loss : fittings around pump
$h_3 = f_1 \times (v_1^2 / 2g) + f_2 \times (v_2^2 / 2g)$
= 0.13 m + 1.38 m
= 1.51 m
where, D= 150 mm dia /1000
(v_1 = 2.777 m/sec)

f1	Q'ty	f/pc	f
bell mouth	1	0.20	0.20
sluice valve	1	0.10	0.10
reducer	1	0.02	0.02
		f_1 total	0.32

where, D= 150 mm dia /1000
(v_2 = 2.777 m/sec)

f2	Q'ty	f/pc	f
increase	2	0.20	0.40
check valve	1	1.00	1.00
butterfly valve	1	0.20	0.20
90deg	1	0.18	0.18
tee	1	1.50	1.50
sluice valve	2	0.10	0.20
reducer	1	0.03	0.03
		f_2 total	3.51

friction loss : float type butterfly valve
h_4 = 5.00 m

Motor Output Motor Output = (0.163 x r x Q x H / e) x (1 + a)
= 49.4 kW
= 55.0 kW
where, r = 1.00
e = 0.76
a = 0.15

Specification
Type Horizontal End-Suction Centrifugal Pump
Diameter 150 x 125 mm
Capacity 2.94 m^3/min
Head 68.0 m
Motor Outpu 55 kW
Quantity 2 (1) sets including 1 set for future

6-2. Kahawatta Booster Pump (E) - Phase 3

Total Capacity 7,310 m^3/day = 5.08 m^3/min

Quantity of pump 2 sets + 1 set for stand-by

Pump Capacity 3,655 m^3/day

Q= 2.54 m^3/min 152.3 m^3/hr

q= 0.042 m^3/sec

Diameter Diameter = 146 x $(Q / v)^{(1/2)}$

= 190 mm to 134 mm

= 150 x 125 mm

where, v= 1.5 to 3

Total Head Total Head H = $h_1 + h_2 + h_3 + h_4$ = 71.1 m

= 72.0 m

actual head : Kurugoda

h_1 = hd - hs = 57.00 m

suction level hs = 516.00 m

delivery level hd = 573.00 m

friction loss : pipeline (Hazen Williams)

$h_2 = 10.666 \times c^{(-1.85)} \times D^{(-4.87)} \times q^{(1.85)} \times L$ = 8.00 m

friction loss : fittings around pump

$h_3 = f_1 \times (v_1^2 / 2g) + f_2 \times (v_2^2 / 2g)$

= 0.09 m + 1.03 m

= 1.12 m

where, D= 150 mm dia /1000

(v_1 = 2.394 m/sec)

f1	Q'ty	f/pc	f
bell mouth	1	0.20	0.20
sluice valve	1	0.10	0.10
reducer	1	0.02	0.02
		f_1 total	0.32

where, D= 150 mm dia /1000

(v_2 = 2.394 m/sec)

f2	Q'ty	f/pc	f
increase	2	0.20	0.40
check valve	1	1.00	1.00
butterfly valve	1	0.20	0.20
90deg	1	0.18	0.18
tee	1	1.50	1.50
sluice valve	2	0.10	0.20
reducer	1	0.03	0.03
		f_2 total	3.51

friction loss : float type butterfly valve

h_4 = 5.00 m

Motor Output Motor Output = (0.163 x r x Q x H / e) x (1 + a)

= 45.1 kW

= 55.0 kW

where, r = 1.00

e = 0.76

a = 0.15

Specification

Type Horizontal End-Suction Centrifugal Pump

Diameter 150 x 125 mm

Capacity 2.54 m^3/min

Head 72.0 m

Motor Outpu 55 kW

Quantity 3 (1) sets including 1 set for future

7-1. R2 Booster Pump (F) - Phase 3

Total Capacity 1,960 m^3/day = 1.36 m^3/min
Quantity of pump 1 sets + 1 set for stand-by
Pump Capacity 1,960 m^3/day
Q= 1.36 m^3/min 81.7 m^3/hr
q= 0.023 m^3/sec

Diameter Diameter = 146 x (Q / v)$^{(1/2)}$
= 139 mm to 98 mm
= 100 x 80 mm
where, v= 1.5 to 3

Total Head Total Head H = $h_1 + h_2 + h_3 + h_4$ = 100.6 m
= 102.0 m
actual head : Hantana Place
h_1 = hd - hs = 91.51 m
suction level hs = 549.49 m
delivery level hd = 641.00 m
friction loss : pipeline (Hazen Williams)
$h_2 = 10.666 \times c^{(-1.85)} \times D^{(-4.87)} \times q^{(1.85)} \times L =$ 2.49 m
friction loss : fittings around pump
$h_3 = f_1 \times (v_1^2 / 2g) + f_2 \times (v_2^2 / 2g)$
= 0.14 m + 1.49 m
= 1.63 m
where, D= 100 mm dia /1000
(v_1 = 2.888 m/sec)

f1	Q'ty	f/pc	f
bell mouth	1	0.20	0.20
sluice valve	1	0.10	0.10
reducer	1	0.02	0.02
		f_1 total	0.32

where, D= 100 mm dia /1000
(v_2 = 2.888 m/sec)

f2	Q'ty	f/pc	f
increase	2	0.20	0.40
check valve	1	1.00	1.00
butterfly valve	1	0.20	0.20
90deg	1	0.18	0.18
tee	1	1.50	1.50
sluice valve	2	0.10	0.20
reducer	1	0.03	0.03
		f_2 total	3.51

friction loss : float type butterfly valve
h_4 = 5.00 m

Motor Output Motor Output = (0.163 x r x Q x H / e) x (1 + a)
= 36.7 kW
= 37.0 kW
where, r = 1.00
e = 0.71
a = 0.15

Specification
Type Horizontal End-Suction Centrifugal Pump
Diameter 100 x 80 mm
Capacity 1.36 m^3/min
Head 102.0 m
Motor Outpı 37 kW
Quantity 2 (1) sets including 1 set for future

8-1. Asgiriya In-Line Booster Pump (G) - Phase 3

Total Capacity 2,280 m^3/day = 1.58 m^3/min

Quantity of pump 1 sets + 1 set for stand-by

Pump Capacity 2,280 m^3/day

Q= 1.58 m^3/min 95.0 m^3/hr

q= 0.026 m^3/sec

Diameter Diameter = 146 x $(Q / v)^{(1/2)}$

= 150 mm to 106 mm

= 100 x 80 mm

where, v= 1.5 to 3

Total Head Total Head H = $h_1 + h_2 + h_3 + h_4$ = 66.7 m

= 68.0 m

actual head : Bahirawakanda

h_1 = hd - hs = 56.3 m

floor level hf = 532.50 m

suction pressure hs = 40.25 m

delivery level hd = 629.00 m

friction loss : pipeline (Hazen Williams)

$h_2 = 10.666 \times c^{(-1.85)} \times D^{(-4.87)} \times q^{(1.85)} \times L$ = 3.22 m

friction loss : fittings around pump

$h_3 = f_1 \times (v_1^2 / 2g) + f_2 \times (v_2^2 / 2g)$

= 0.18 m + 2.02 m

= 2.2 m

where, D= 100 mm dia /1000

(v_1 = 3.360 m/sec)

f1	Q'ty	f/pc	f
bell mouth	1	0.20	0.20
sluice valve	1	0.10	0.10
reducer	1	0.02	0.02
		f_1 total	0.32

where, D= 100 mm dia /1000

(v_2 = 3.360 m/sec)

f2	Q'ty	f/pc	f
increase	2	0.20	0.40
check valve	1	1.00	1.00
butterfly valve	1	0.20	0.20
90deg	1	0.18	0.18
tee	1	1.50	1.50
sluice valve	2	0.10	0.20
reducer	1	0.03	0.03
		f_2 total	3.51

friction loss : float type butterfly valve

h_4 = 5.00 m

Motor Output Motor Output = (0.163 x r x Q x H / e) x (1 + a)

= 28 kW

= 30.0 kW

where, r = 1.00

e = 0.72

a = 0.15

Specification

Type	Horizontal End-Suction Centrifugal Pump
Diameter	100 x 80 mm
Capacity	1.58 m^3/min
Head	68.0 m
Motor Outpu	30 kW
Quantity	2 (1) sets including 1 set for future

9-1. Kondadeniya Booster Pump (H) - Phase 3

Total Capacity 1,600 m^3/day = 1.11 m^3/min

Quantity of pump 1 sets + 1 set for stand-by

Pump Capacity 1,600 m^3/day

Q= 1.11 m^3/min 66.7 m^3/hr

q= 0.019 m^3/sec

Diameter Diameter = 146 x $(Q / v)^{(1/2)}$

= 126 mm to 89 mm

= 80 x 65 mm

where, v= 1.5 to 3

Total Head Total Head H = $h_1 + h_2 + h_3 + h_4$ = 62.6 m

= 64.0 m

actual head : Kulugammana

h_1 = hd - hs = 52.00 m

suction level hs = 531.25 m

delivery level hd = 583.25 m

friction loss : pipeline (Hazen Williams)

$h_2 = 10.666 \times c^{(-1.85)} \times D^{(-4.87)} \times q^{(1.85)} \times L$ = 2.90 m

friction loss : fittings around pump

$h_3 = f_1 \times (v_1^2 / 2g) + f_2 \times (v_2^2 / 2g)$

= 0.22 m + 2.43 m

= 2.65 m

where, D= 80 mm dia /1000

(v_1 = 3.684 m/sec)

f1	Q'ty	f/pc	f
bell mouth	1	0.20	0.20
sluice valve	1	0.10	0.10
reducer	1	0.02	0.02
		f_1 total	0.32

where, D= 80 mm dia /1000

(v_2 = 3.684 m/sec)

f2	Q'ty	f/pc	f
increase	2	0.20	0.40
check valve	1	1.00	1.00
butterfly valve	1	0.20	0.20
90deg	1	0.18	0.18
tee	1	1.50	1.50
sluice valve	2	0.10	0.20
reducer	1	0.03	0.03
		f_2 total	3.51

friction loss : float type butterfly valve

h_4 = 5.00 m

Motor Output Motor Output = (0.163 x r x Q x H / e) x (1 + a)

= 19 kW

= 30.0 kW

where, r = 1.00

e = 0.70

a = 0.15

Specification

Type	Horizontal End-Suction Centrifugal Pump
Diameter	80 x 65 mm
Capacity	1.11 m^3/min
Head	64.0 m
Motor Outpu	30 kW
Quantity	2 (1) sets including 1 set for future

Sri Lanka - Greater Kandy Water Supply Augumentation Project

Chemical Facility Capacity Calculation for Katugastota Treatment Plant Q=110,000 cu m/day

Item	Total System	First Stage
Plant Capacity (Daily Max)	Q= 110,000 cu m/day	Q= 36,670 cu m/day
Planned Flow	Q= 115,500 cu m/day	Q= 38,500 cu m/day
	= 4,813 cu m/hour	= 1,604 cu m/hour
	= 80.2 cu m/min	= 26.7 cu m/min
	= 1.337 cu m/sec	= 0.446 cu m/sec
(1) Alum Dissolving Tank		
Coagulant	Solid Aluminum Sulphate ($Al_2(SO_4)_3$)	Solid Aluminum Sulphate ($Al_2(SO_4)_3$)
	containing 15 % Al_2-O_3	containing 15 % Al_2-O_3
Criteria	Dosage Rate : 10-60 mg-solid alum/l	Dosage Rate : 10-60 mg-solid alum/l
	- Maximum 60 mg/l	- Maximum 60 mg/l
	- Average 30 mg/l	- Average 30 mg/l
	- Minimum 10 mg/l	- Minimum 10 mg/l
	Coagulant Solution : 10 % sg = 1.0525	Coagulant Solution : 10 % sg = 1.0525
	Retention Time 24 hours	Retention Time 24 hours
	Dissolving Time 2 hours	Dissolving Time 2 hours
Dosage Amount	Wt = 3,465 kg-Alum/day (Ave dosage)	Wt = 1,155 kg-Alum/day (Ave dosage)
Coagulant Solution	Vmax = 32.9 cu m/day (Max dosage)	Vmax = 11.0 cu m/day (Max dosage)
	Vave = 16.5 cu m/day (Ave dosage)	Vave = 5.5 cu m/day (Ave dosage)
Solution Tank	Square 4 units	Square 2 units
Dimension	L m x W m x D m x units	L m x W m x D m x units
	2.0 2.0 2.5 4	2.0 2.0 2.5 2
Total Volume	V = 40.0 cu m	V = 20.0 cu m
Retention Time	T = 29.2 hours for maximum dosing	T = 43.7 hours for maximum dosing
Alum Pump	2 units each (excl. 1 unit stand-by)	1 units (excl. 1 unit stand-by)
Capacity	Qmax = 11.4 liter/min 0.69 cu m/hr	Qmax = 7.6 liter/min 0.46 cu m/hr
	Qmin = 1.9 liter/min 0.11 cu m/hr	Qmin = 1.3 liter/min 0.08 cu m/hr
Storage	Period 30 days	Period 30 days
	Bulk s. g. 0.60	Bulk s. g. 0.60
Storage Area	A = 87 m2 at 2.0 m height	A = 29 m2 at 2.0 m height
(2) Lime Dissolving Tank		
pH Control	Hydrated Lime ($Ca(OH)_2$)	Hydrated Lime ($Ca(OH)_2$)
	containing 72 % CaO	containing 72 % CaO
Criteria	Dosage Rate : 5-30 mg-solid Lime/l	Dosage Rate : 5-30 mg-solid Lime/l
Requirement	- Maximum 20.8 mg/l	- Maximum 20.8 mg/l
by Alum Dosage	- Average 10.4 mg/l	- Average 10.4 mg/l
	- Minimum 3.5 mg/l	- Minimum 3.5 mg/l
	Lime Solution 10 % sg = 1.0607	Lime Solution 10 % sg = 1.0607
	Retention Time 24 hours	Retention Time 24 hours
	Dissolving Time 2 hours	Dissolving Time 2 hours
Dosage Amount	Wt max = 2,401 kg-Lime/day (for Max Alum dosage)	Wt max = 800 kg-Lime/day (for Max Alum dosage)
Alkali Solution	V max = 22.6 cu m/day (for Max Alum dosage)	V max = 7.5 cu m/day (for Max Alum dosage)
Solution Tank	Square 4 units	Square 2 units
Dimension	L m x W m x D m x units	L m x W m x D m x units
	2.0 2.0 2.5 4	2.0 2.0 2.5 2
Total Volume	V = 40.0 cu m	V = 20.0 cu m
Retention Time	T = 42.4 hours (for Max Alum dosage)	T = 63.6 hours (for Max Alum dosage)
Dosage Rate	Maximum Average Minimum	Maximum Average Minimum
	Pre (5-30 mg/l) 30 15 5	Pre (5-30 mg/l) 30 15 5
	Post (5-20 mg/l) 20 5 5	Post (5-20 mg/l) 20 5 5
Pump Capacity	Pre- 2 units each (excl. 1 unit stand-by)	Pre- 1 units each (excl. 1 unit stand-by)
	Qmax = 11.3 liter/min 0.68 cu m/hr	Qmax = 7.6 liter/min 0.45 cu m/hr
	Qmin = 1.9 liter/min 0.11 cu m/hr	Qmin = 1.3 liter/min 0.08 cu m/hr
	Post- 2 units each (excl. 1 unit stand-by)	Post- 1 units each (excl. 1 unit stand-by)
	Qmax = 7.6 liter/min 0.45 cu m/hr	Qmax = 5.0 liter/min 0.30 cu m/hr
	Qmin = 1.9 liter/min 0.11 cu m/hr	Qmin = 1.3 liter/min 0.08 cu m/hr
Storage	Period 30 days	Period 30 days
	Bulk s. g. 0.40	Bulk s. g. 0.40
Storage Area	A = 87 m2 at 2.0 m height	A = 29 m2 at 2.0 m height

(3) Chlorination Equipment										
Injection Point	Pre-Chlorine	at the Inlet of Distribution Chamber				Pre-Chlorine	at the Inlet of Distribution Chamber			
	Post-Chlorine	and outlet of Filter				Post-Chlorine	and outlet of Filter			
Type	Liquid Chlorine (900 kg-cylinder)					Liquid Chlorine (900 kg-cylinder)				
Dosage Rate			Maximum	Average	Minimum			Maximum	Average	Minimum
	Pre	(1.0-5.0 mg/	5.0	2.0	1.0	Pre	(1.0-5.0 mg/	5.0	2.0	1.0
	Post	(0.5-1.0 mg/	2.0	1.0	0.5	Post	(0.5-1.0 mg/	2.0	1.0	0.5
Dosage Amount	Wt =	347	kg- Cl gas/day (Average)			Wt =	116	kg- Cl gas/day (Average)		
	or	14.4	kg- Cl gas/hour (Average)			or	4.8	kg- Cl gas/hour (Average)		
Chlorinator Capacity	Vacuum Type					Vacuum Type				
	Pre-	2	units each	(excl. 1 unit stand-by)		Pre-	1	units each	(excl. 1 unit stand-by)	
	Qmax =	12.0	kg/hr	288.75	kg/day	Qmax =	8.0	kg/hr	192.50	kg/day
	Qmin =	2.4	kg/hr	57.75	kg/day	Qmin =	1.6	kg/hr	38.50	kg/day
	Post-	2	units each	(excl. 1 unit stand-by)		Post-	1	units each	(excl. 1 unit stand-by)	
	Qmax =	4.8	kg/hr	115.50	kg/day	Qmax =	3.2	kg/hr	77.00	kg/day
	Qmin =	1.2	kg/hr	28.88	kg/day	Qmin =	0.8	kg/hr	19.25	kg/day
Storage	Period		30 days			Period		30 days		
No. of Container		14	units				6	units		
Storage Area	A =	28	m2 as	2.0	m2/container	A =	12	m2 as	2.0	m2/container

Alum - Specific Gravity (% as Al2(SO4)3-18H2O)	
5	1.0254
10	1.0525
15	1.0804

Lime - Specific Gravity (% as Ca (OH)2)	
5	1.0308
10	1.0607
15	1.0923

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Sri Lanka - Greater Kandy Water Supply Augumentation Project

Chemical Facility Capacity Calculation for Kahawwatta Reservoir Q=7,310 cu m/day

Item	Total System				First Stage			
Plant Capacity (Daily Max)	Q=	7,310	cu m/day		Q=	4,240	cu m/day	
Planned Flow	Q=	7,310	cu m/day		Q=	4,240	cu m/day	
	=	305	cu m/hour		=	177	cu m/hour	
	=	5.1	cu m/min		=	2.9	cu m/min	
	=	0.085	cu m/sec		=	0.049	cu m/sec	
Chlorine Dissolving Tank								
Chlorine	Calcium Hypochlorite ($Ca(Ocl)_2\cdot 4H_2O$)				Calcium Hypochlorite ($Ca(Ocl)_2\cdot 4H_2O$)			
	containing	60	% cl_2		containing	60	% cl_2	
Criteria	Dosage Rate :	0.5 - 2	mg-solid alum/l		Dosage Rate :	0.5 - 2	mg-solid alum/l	
	- Maximum	2	mg/l		- Maximum	2	mg/l	
	- Average	1	mg/l		- Average	1	mg/l	
	- Minimum	0.5	mg/l		- Minimum	0.5	mg/l	
	Solution :	5	%	sg = 1.0247	Solution :	5	%	sg = 1.0247
	Retention Time	24	hours		Retention Time	24	hours	
	Dissolving Time	2	hours		Dissolving Time	2	hours	
Dosage Amount	Wt =	12.18	kg-chlorine/day	(Ave dosage)	Wt =	7.07	kg-Alum/day	(Ave dosage)
Chlorine Solution	Vmax =	0.48	cu m/day	(Max dosage)	Vmax =	0.28	cu m/day	(Max dosage)
	Vave =	0.24	cu m/day	(Ave dosage)	Vave =	0.14	cu m/day	(Ave dosage)
Solution Tank	Square	1	units		Square	1	units	
Dimension	L m x W	m x D m	x units		L m x W	m x D m	x units	
	0.9	0.9	0.9	1	0.9	0.9	0.9	1
Total Volume	V =	0.7	cu m		V =	0.7	cu m	
Retention Time	T =	36.8	hours for maximum dosing		T =	63.4	hours for maximum dosing	
Chlorination Pump		1	units each	(excl. 1 unit stand-by)		1	units	(excl. 1 unit stand-by)
Capacity	Qmax =	0.33	liter/min	0.02 cu m/hr	Qmax =	0.19	liter/min	0.01 cu m/hr
	Qmin =	0.08	liter/min	0.00 cu m/hr	Qmin =	0.05	liter/min	0.00 cu m/hr
Storage	Period	30	days		Period	30	days	
No. of Container		3	units			3	units	
Storage Area	A =	0.375	m2 as	0.125 m2/container	A =	0.375	m2 as	0.125 m2/container

Hypo-chlorite
(% as $Ca(Ocl)_2\cdot 4H_2O$)
5 1.0247

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SURGE ANALYSIS
ウォーターハンマ計算条件

Calculation No.
計算番号 C2-1010IN　　PAGE 1

Sample

Intake Pump

Standard Level 基準レベル 436.940 m
Calculation Time Unit 計算時間単位 .06140 sec

【 管路仕様 】 Pipeline Specifications

No. 管路名称	Length 管長 m	Materials 管種	Diameter 管径 mm	Thickness 管厚 mm	Modulus of Elasticity ヤング率	Upstream Pipeline 上流の管路	Pump No. ポンプ番号	Surge Tank No. サージタンク番号	Valve No. 弁番号	Pipeline End 終点条件	Flow 管路流量 m3/m	Pipe Loss 配管損失 m	Valve Loss 弁絞損失 m	Pressure Wave Reciprocation Time 圧力波往復時間 sec	Pipeline Constant 管路定数	Division 分割
1	420.0	SS 1	800	7.0	2.100		1 0 0	0	0	1	80.210	4.400	.000	.8596	1.6539	14

【 ポンプ仕様 】 Pump Specifications

No. 番号	Pump No. 台数	Type 形式	Valve Close 弁閉鎖	Valve No. 弁番号	Total Head 全揚程 m	Capacity 吐出量 m3/m	Motor Output 出力 kw	Pole 極数	Type 型式	Pump/Motor ﾎﾟﾝﾌﾟ･ﾓｰﾀ kg-m2	Flywheel ﾌﾗｲﾎｲｰﾙ kg-m2	Speed 回転数 min-1	Efficiency 効率 %	Inertial Effect 減衰定数 k	Initial Condition 初期状態 Head 揚程 m	Capacity 吐出量 m3/m	Speed 回転数	Torque トルク
1	3	1	1	0	44.000	26.740	250.0	4	1	30.000	.000	1480	87	1.2263	44.000	26.740	1.000	1.000

【 圧力線図仕様 】 Pressure Gradients

Pipeline No.
管路名称 1

【 縦断仕様 】 Pipeline Profile

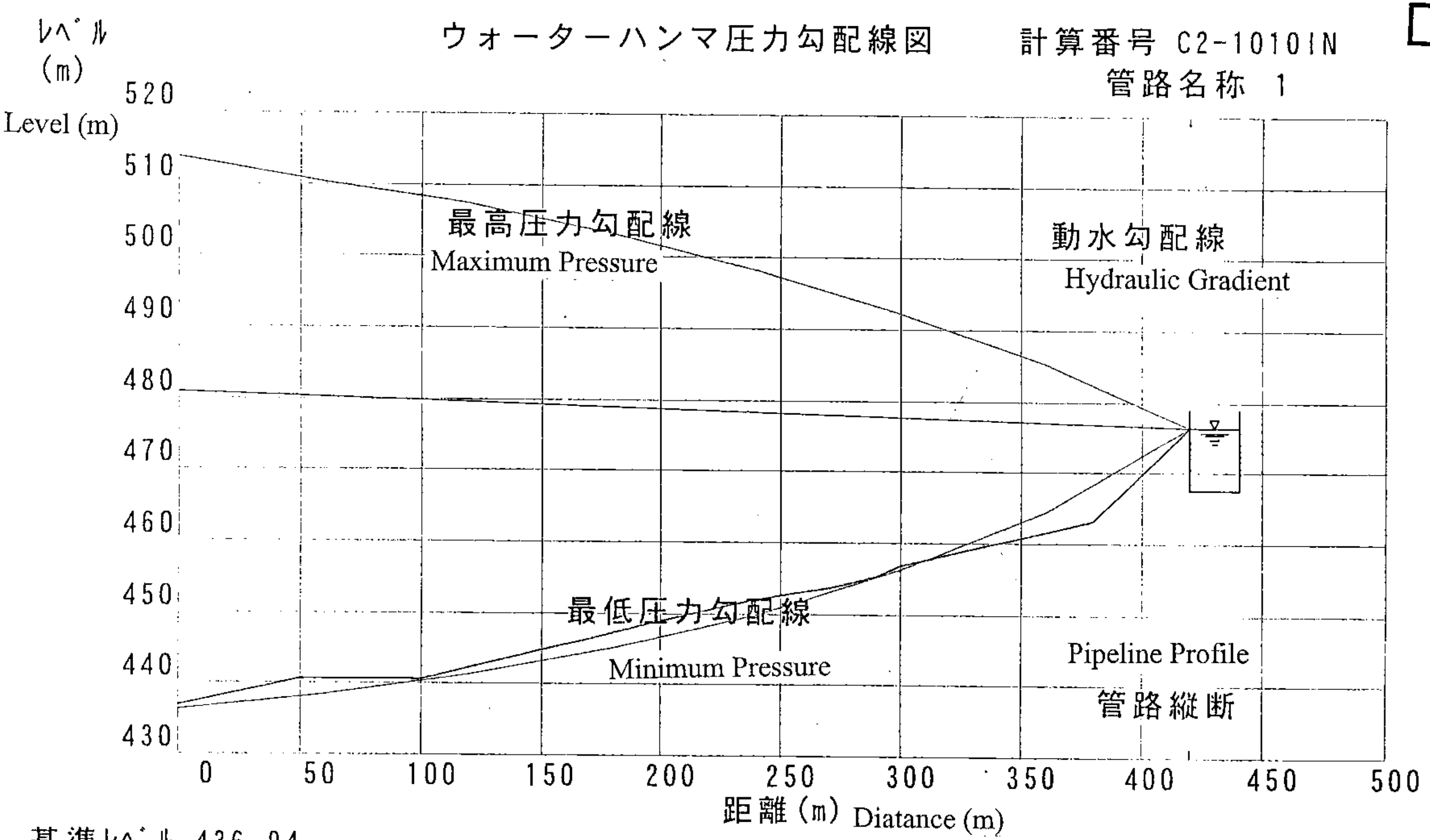
Pipeline No. 管路名称	Cumulative Distance (m) 追加距離 m	Level (m) レベル m	Cumulative Distance (m) 追加距離 m	Level (m) レベル m	Cumulative Distance (m) 追加距離 m	Level (m) レベル m	Cumulative Distance (m) 追加距離 m	Level (m) レベル m
1	.0	436.94	50.0	440.83	100.0	440.83	120.0	442.43
	150.0	444.83	170.0	446.43	200.0	448.83	240.0	452.03
	270.0	453.63	290.0	455.23	300.0	456.83	340.0	460.03
	360.0	461.63	380.0	463.23	410.0	472.83	420.0	476.54

47.5

Sample

ウォーターハンマ圧力勾配線図

計算番号 C2-1010IN
管路名称 1



基準レベル 436.94

INTAKE PUMP

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                        ウォーターハンマ計算条件                          計算番号 C2-1010IN        PAGE    1

                        Intake Pump

                        基準レベル              436.940 m
                        計算時間単位             .06140 sec

【 管路仕様 】
                                                                              ｻｰｼﾞ     弁                       配管      弁絞  圧力波
  管路     管長    管種   管径     管厚   ヤング  上流の管路       ポンプ     ﾀﾝｸ      番   終点  管路流量     損失      損失  往復時間   管路定数    分割
  名称        m            mm       mm     率                      番号      番号      号   条件      m3/m        m         m       sec
   1      420.0   SS 1    800      7.0   2.100                   1  0  0     0        0     1     80.210    4.400      .000     .8596     1.6539      14

【 ポンプ仕様 】
                     弁      弁                                                                              効     減衰    ---------- 初期状態 ----------
   番  台  形        閉      番   全揚程    吐出量      出力  極     型 ﾎﾟﾝﾌﾟ･ﾓｰﾀ    ﾌﾗｲﾎｲｰﾙ  回転数 率     定数        揚程    吐出量  回転数  トルク
   号  数  式        鎖      号        m      m3/m        kw  数     式     kg-m2       kg-m2   min-1  %        k           m      m3/m
    1   3   1         1       0  44.000    26.740     250.0   4      1    30.000        .000    1480 87  1.2263      44.000    26.740   1.000   1.000

【 圧力線図仕様 】

   管路名称    1

【 縦断仕様 】
  管路  追加距離    レベル      追加距離    レベル      追加距離    レベル      追加距離    レベル
  名称         m         m             m         m             m         m             m         m
   1          .0    436.94          50.0    440.83         100.0    440.83         120.0    442.43
           150.0    444.83         170.0    446.43         200.0    448.83         240.0    452.03
           270.0    453.63         290.0    455.23         300.0    456.83         340.0    460.03
           360.0    461.63         380.0    463.23         410.0    472.83         420.0    476.54
```
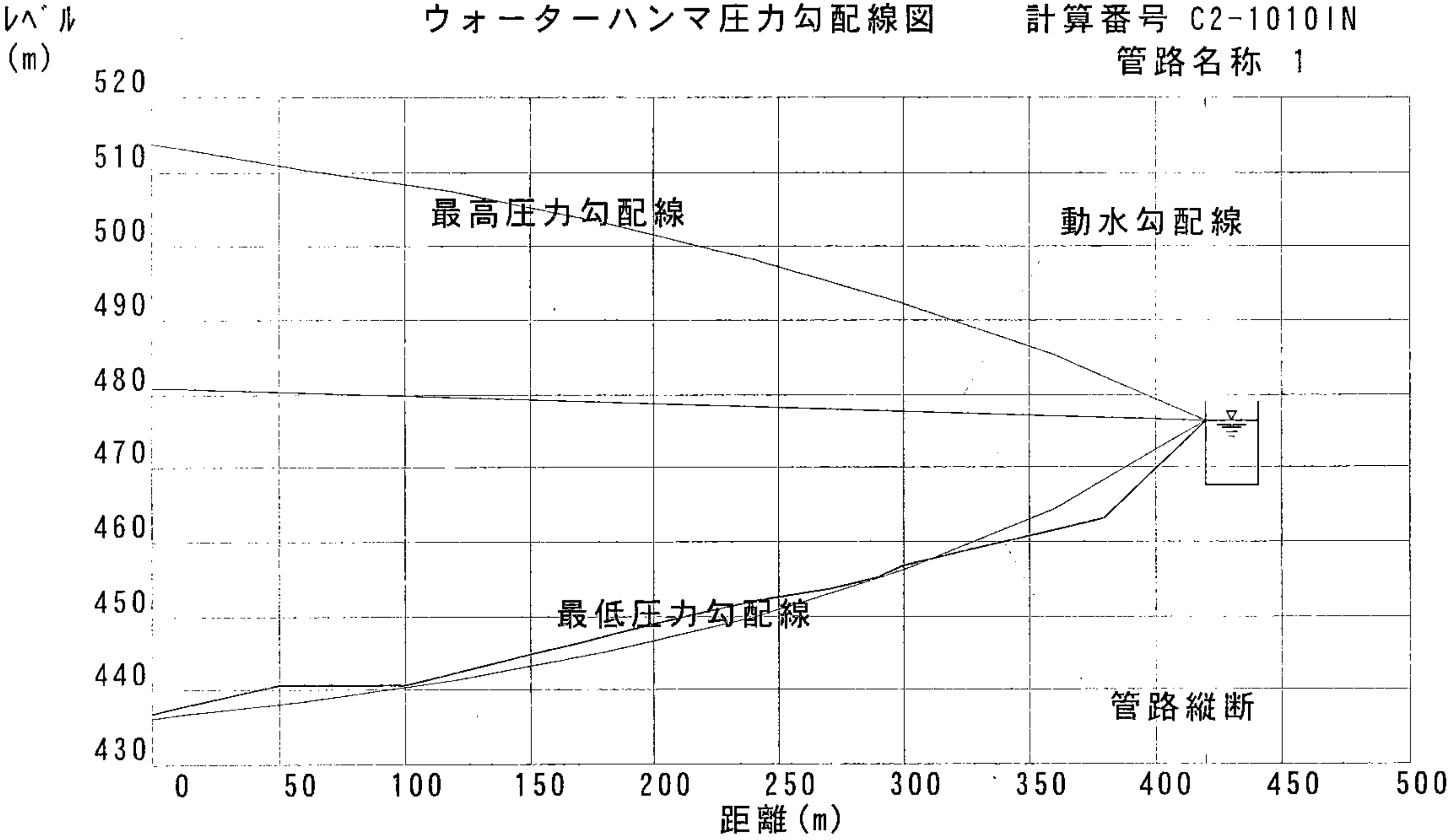

ウォーターハンマ圧力勾配線図

計算番号 C2-1010IN
管路名称 1



基準レベル 436.94

INTAKE PUMP

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                                     ウォーターハンマ計算条件                              計算番号 C2-1010-A1       PAGE    1

                                     Clear Water Pump (A1)

                                     基準レベル                442.610 m
                                     計算時間単位               .01023 sec

【 管路仕様 】
                                                                           ｻｰｼﾞ    弁                           配管     弁絞  圧力波
  管路     管長     管種   管径     管厚   ヤング  上流の管路       ポンプ    ﾀﾝｸ    番    終点  管路流量        損失     損失  往復時間    管路定数    分割
  名称        m                mm       mm     率                        番号     番号    号    条件      m3/m          m         m        sec
   1       10.0   SS 1    800      7.0   2.100                     1  0  0     0      0      0    12.215       .100     .000     .0205     1.6539       2
   2     1384.0   FCD3    700     10.0   1.600   1                 0  0  0     0      0      0    12.215       .800     .000    2.6815     2.2820     264
   3     2059.0   FCD3    400      7.0   1.600   2                 0  0  0     0      0      1     3.044      1.300     .000    3.8112     7.3153     372
   4     1308.0   FCD3    700     10.0   1.600   2                 0  0  0     0      0      0     9.171       .500     .000    2.5342     2.2820     248
   5      237.0   FCD3    500      8.0   1.600   4                 0  0  0     0      0      1     7.803       .300     .000     .4473     4.5912      44
   6      100.0   FCD3    200      6.0   1.600   4                 0  0  0     0      0      0     1.368       .100     .000     .1679    32.2567      16
   7     2198.0   FCD3    200      6.0   1.600   6                 2  0  0     0      0      1     1.368     10.000     .000    3.6906    32.2567     360

【 ポンプ仕様 】
                       弁     弁                                                                          効     減衰    ----------- 初期状態 -----------
   番   台   形        閉     番    全揚程      吐出量       出力  極    型  ﾎﾟﾝﾌﾟ･ﾓｰﾀ   ﾌﾗｲﾎｲｰﾙ  回転数  率     定数       揚程     吐出量  回転数  トルク
   号   数   式        鎖     号         m        m3/m         kw  数    式      kg-m2      kg-m2   min-1   %        k          m       m3/m
    1    1    1         1      0  130.300      12.215      450.0   4     1     63.000    100.000    1475  80    .3343    130.300     12.215   1.000   1.000
    2    1    1         1      0   60.000       1.368       30.0   4     1      1.960       .000    1470  77   1.4996     60.000      1.368   1.000   1.000

【 圧力線図仕様 】

   管路名称    1      2      4      6      7

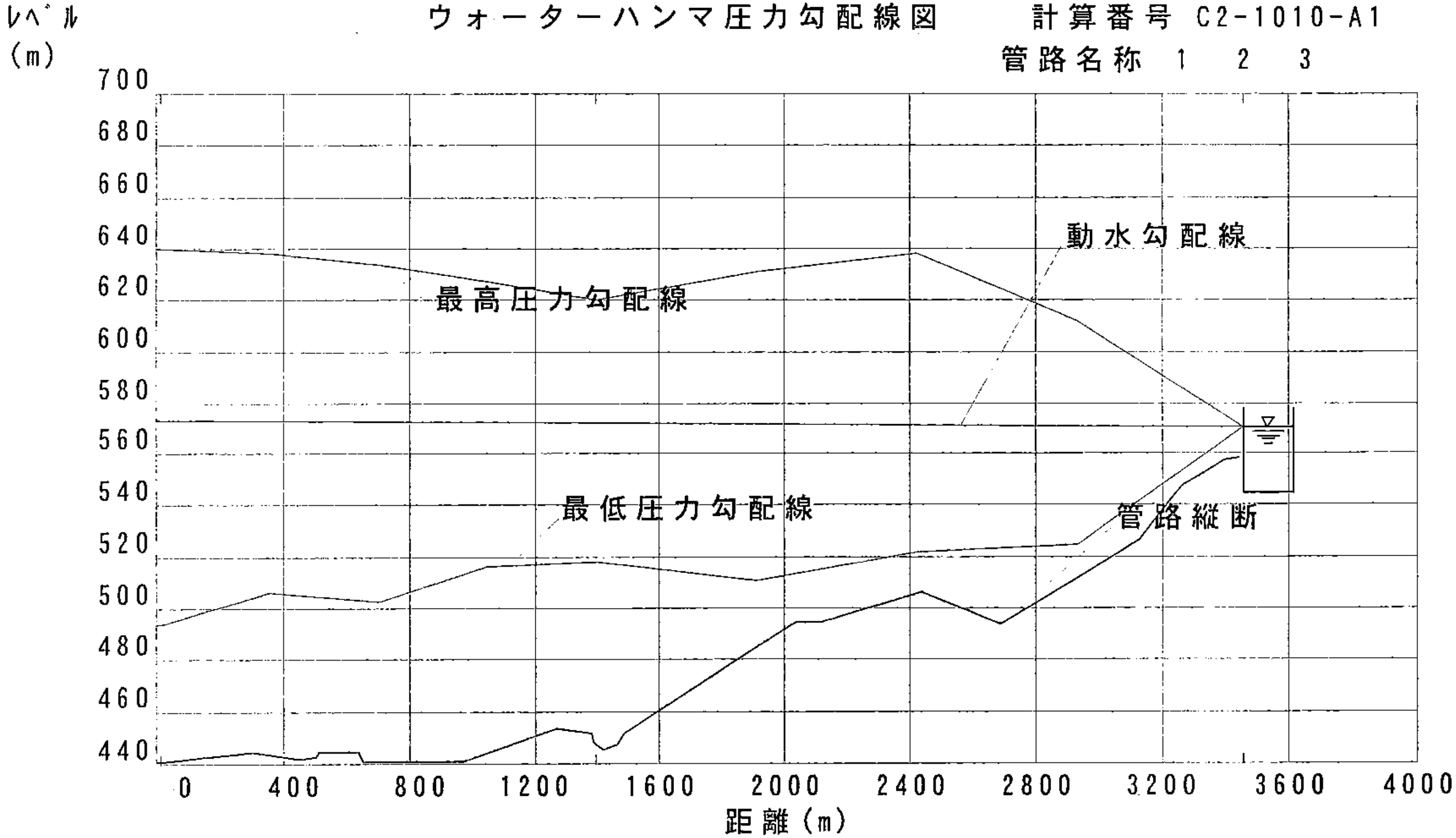
【 縦断仕様 】
  管路  追加距離      レベル      追加距離     レベル      追加距離     レベル      追加距離     レベル
  名称          m          m             m          m             m          m             m          m
   1           .0     440.86          10.0     440.86
   2         10.0     440.86         300.0     445.00         450.0     441.59         500.0     442.50
            510.0     445.00         640.0     445.00         650.0     441.25         970.0     440.90
           1270.0     454.00        1384.0     451.63
   3       1384.0     451.63        1391.0     448.09        1418.0     445.29        1464.0     447.75
           1486.0     451.70        2035.0     494.90        2114.0     494.90        2433.0     506.80
           2691.0     494.01        3129.0     526.80        3262.0     547.92        3393.0     557.92
           3443.0     558.50
```

【 縦断仕様 】

管路 名称	追加距離 m	レベル m	追加距離 m	レベル m	追加距離 m	レベル m	追加距離 m	レベル m
4	1384.0	451.63	1444.0	450.70	1958.0	483.25	2039.0	481.70
	2316.0	524.62	2586.0	524.30	2692.0	524.40		
5	2692.0	524.40	2716.0	527.03	2783.0	524.38	2833.0	535.58
	2879.0	562.98	2929.0	563.00				
6	2692.0	524.40	2702.0	524.40				
7	2702.0	524.40	2711.0	524.79	2793.0	519.34	3480.0	553.58
	3580.0	548.90	3697.0	554.22	3822.0	551.25	4172.0	570.03
	4665.0	552.25	4693.0	553.24	4809.0	562.07	4940.0	590.27
	4990.0	604.00						

ウォーターハンマ圧力勾配線図　　計算番号 C2-1010-A1

管路名称 1 2 3



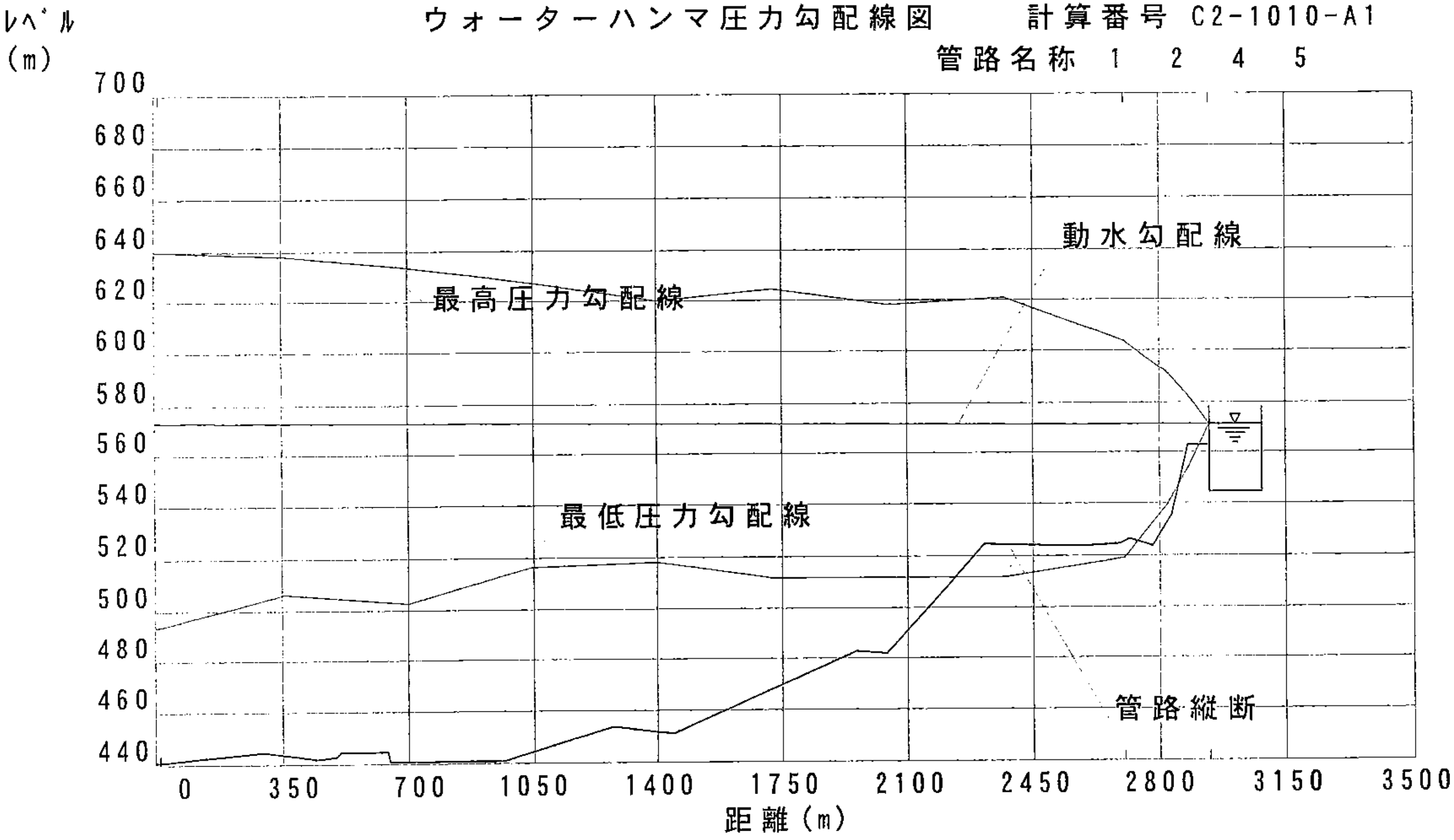
基準レベル 442.61

A1 Pump

無対策: To upland Reservoir

ウォーターハンマ圧力勾配線図　　計算番号 C2-1010-A1

管路名称　1　2　4　5



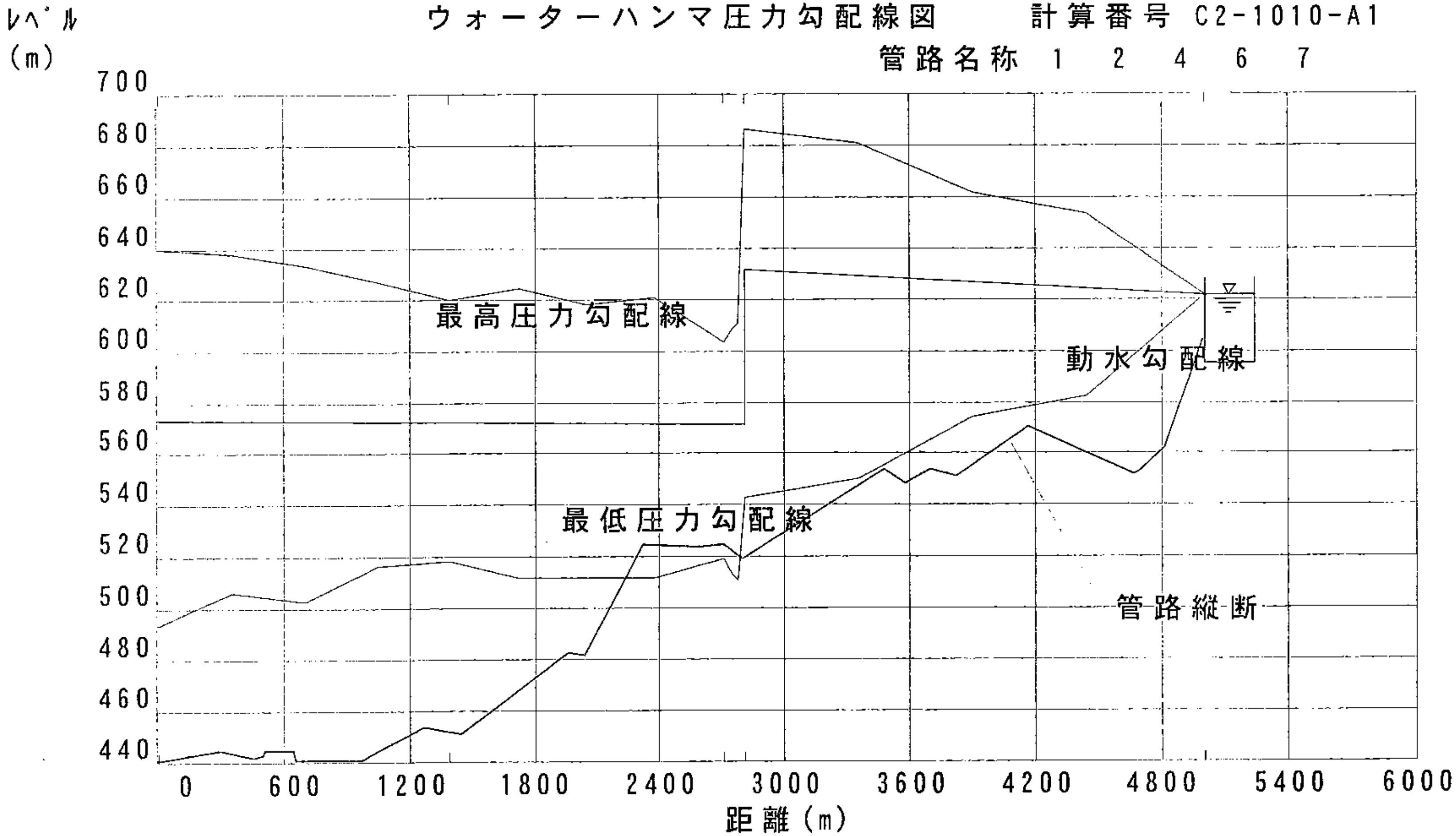
基準レベル 442.61

A1 Pump.

無対策:　　To Asgiriya Reservoir

ウォーターハンマ圧力勾配線図　計算番号 C2-1010-A1

管路名称 1 2 4 6 7



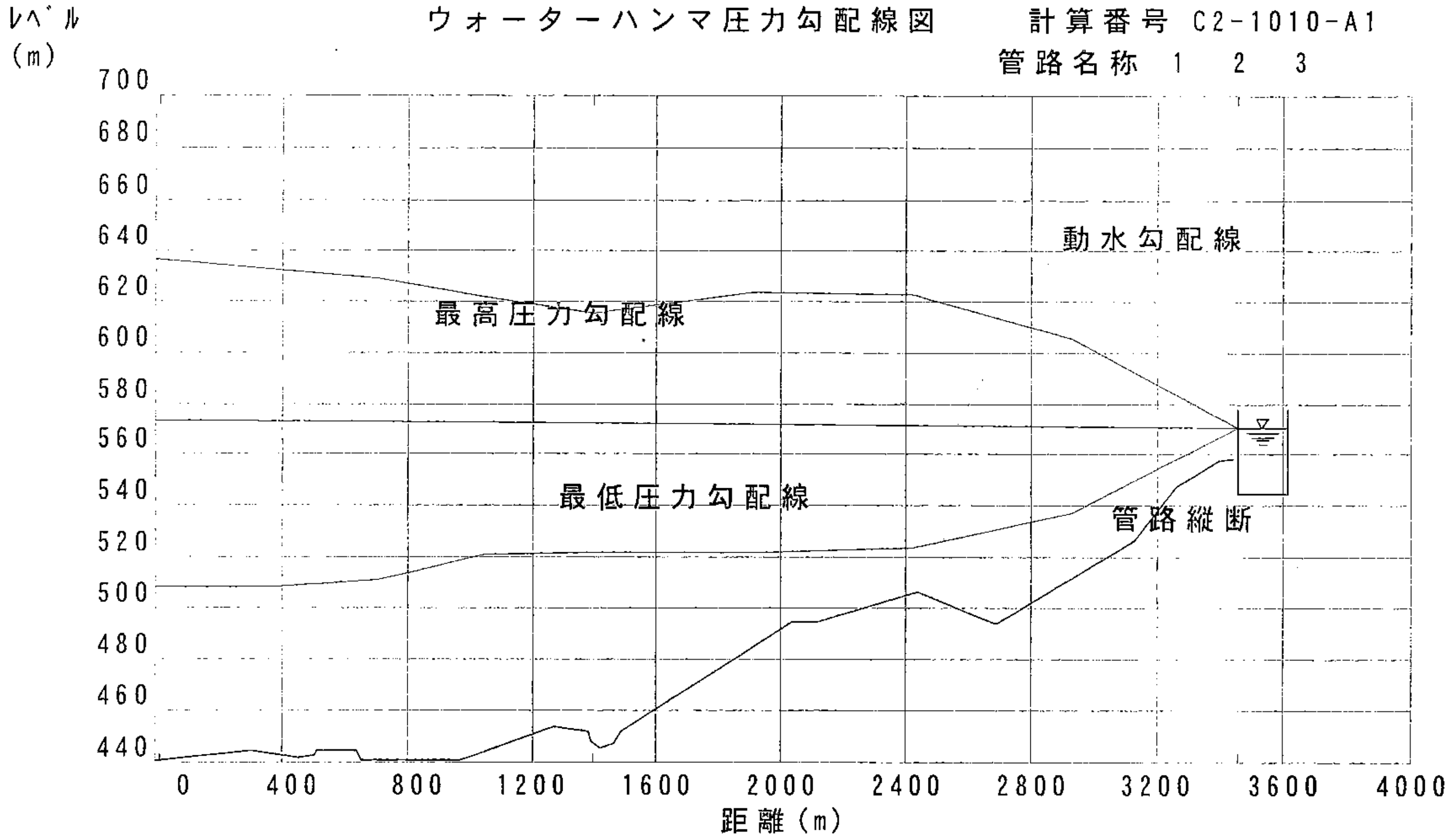
基準レベル 442.61

A1 Pump

無対策: To Bahirawakada Reservoir

ウォーターハンマ圧力勾配線図　計算番号 C2-1010-A1

管路名称 1 2 3

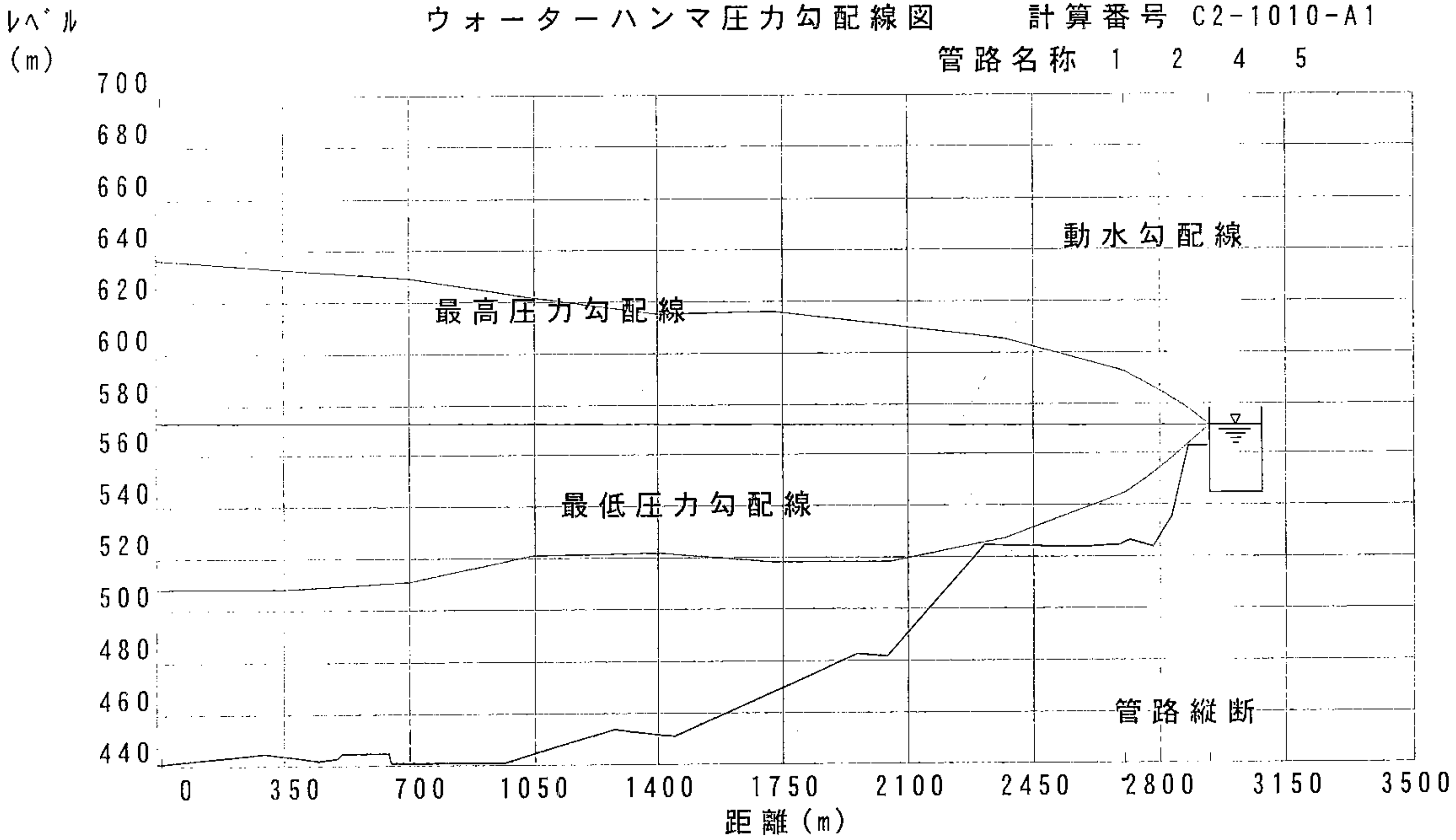


基準レベル 442.61

with Flywheel 100kgf-m^2 To Upland Reservoir

ウォーターハンマ圧力勾配線図　　計算番号 C2-1010-A1

管路名称 1 2 4 5

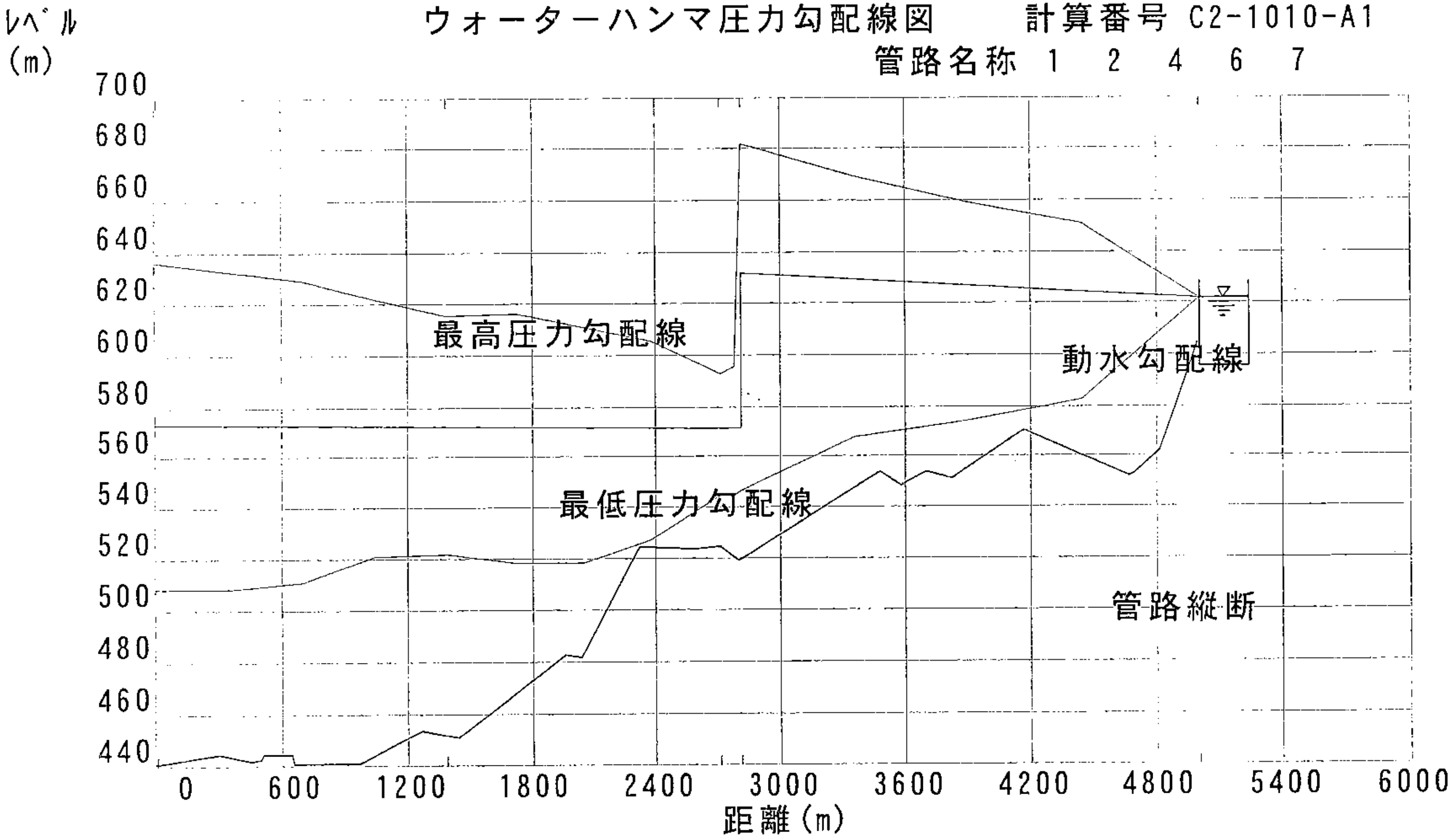


基準レベル 442.61

with Flywheel 1000kgf-m^2　　To Asgiriya Reservoir

ウォーターハンマ圧力勾配線図　　計算番号 C2-1010-A1

管路名称 1 2 4 6 7



基準レベル 442.61

with. Flywheel 100kg-m²

TO Bahirawakanda ReservoiR

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                    ウォーターハンマ計算条件                        計算番号 C2-1010-A1       PAGE    1

                    Clear Water Pump (A1)

                    基準レベル              442.610 m
                    計算時間単位             .01023 sec

【 管路仕様 】
                                                                     サージ   弁                          配管     弁絞  圧力波
  管路    管長     管種   管径    管厚   ヤング  上流の管路       ポンプ   タンク   番   終点  管路流量       損失     損失 往復時間    管路定数     分割
  名称      m              mm      mm     率                      番号    番号    号   条件      m3/m          m        m      sec
    1     10.0   SS 1    800     7.0   2.100                    1  0  0    0      0     0    12.215       .100     .000    .0205     1.6539       2
    2   1384.0   FCD3    700    10.0   1.600   1                0  0  0    0      0     0    12.215       .800     .000   2.6815     2.2820     264
    3   2059.0   FCD3    400     7.0   1.600   2                0  0  0    0      0     1     3.044      1.300     .000   3.8112     7.3153     372
    4   1308.0   FCD3    700    10.0   1.600   2                0  0  0    0      0     0     9.171       .500     .000   2.5342     2.2820     248
    5    237.0   FCD3    500     8.0   1.600   4                0  0  0    0      0     1     7.803       .300     .000    .4473     4.5912      44
    6    100.0   FCD3    200     6.0   1.600   4                0  0  0    0      0     0     1.368       .100     .000    .1679    32.2567      16
    7   2198.0   FCD3    200     6.0   1.600   6                2  0  0    0      0     1     1.368     10.000     .000   3.6906    32.2567     360

【 ポンプ仕様 】
                       弁    弁                                                                     効     減衰   ---------- 初期状態 ----------
   番   台   形        閉    番   全揚程      吐出量       出力  極    型 ポンプ・モータ  フライホイール 回転数 率     定数       揚程    吐出量 回転数 トルク
   号   数   式        鎖    号        m        m3/m         kw  数    式       kg-m2       kg-m2  min-1  %        k          m      m3/m
    1    1    1         1     0 147.000       2.400      450.0   4     1      63.000     100.000   1475 35    .1694   147.000     2.400  1.000  1.000
    2    1    1         1     0  46.000       2.400       30.0   4     1       1.960        .000   1470 55   2.8239    46.000     2.400  1.000  1.000

【 圧力線図仕様 】

   管路名称    1      2      4      6      7

【 縦断仕様 】
  管路  追加距離     レベル     追加距離    レベル     追加距離    レベル     追加距離    レベル
  名称         m          m            m         m            m         m            m         m
    1         .0     440.86         10.0    440.86
    2       10.0     440.86        300.0    445.00        450.0    441.59        500.0    442.50
           510.0     445.00        640.0    445.00        650.0    441.25        970.0    440.90
          1270.0     454.00       1384.0    451.63
    3     1384.0     451.63       1391.0    448.09       1418.0    445.29       1464.0    447.75
          1486.0     451.70       2035.0    494.90       2114.0    494.90       2433.0    506.80
          2691.0     494.01       3129.0    526.80       3262.0    547.92       3393.0    557.92
          3443.0     558.50
```

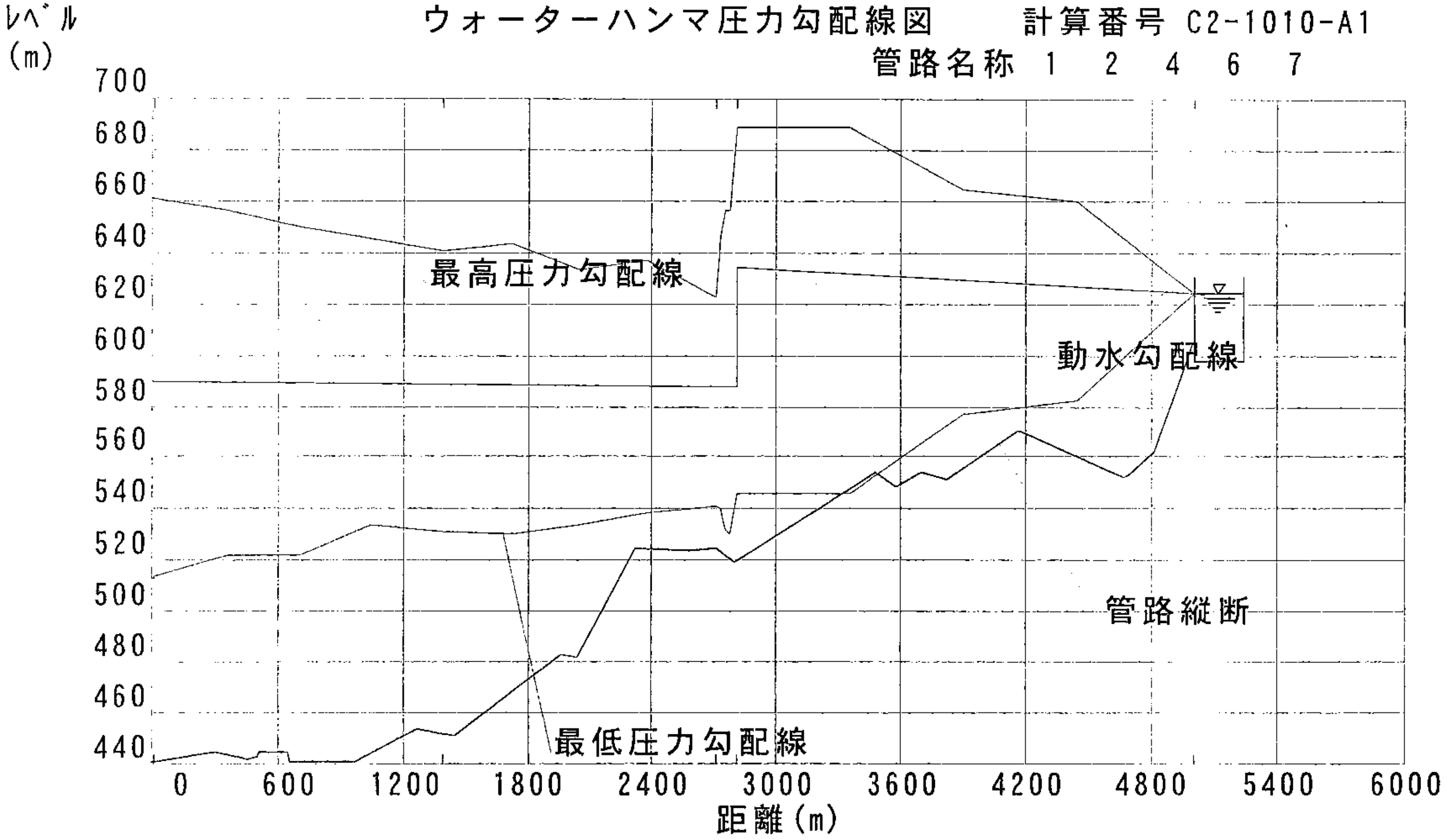
ウォーターハンマ計算条件

【 縦断仕様 】

管路名称	追加距離	レベル	追加距離	レベル	追加距離	レベル	追加距離	レベル
	m	m	m	m	m	m	m	m
4	1384.0	451.63	1444.0	450.70	1958.0	483.25	2039.0	481.70
	2316.0	524.62	2586.0	524.30	2692.0	524.40		
5	2692.0	524.40	2716.0	527.03	2783.0	524.38	2833.0	535.58
	2879.0	562.98	2929.0	563.00				
6	2692.0	524.40	2702.0	524.40				
7	2702.0	524.40	2711.0	524.79	2793.0	519.34	3480.0	553.58
	3580.0	548.90	3697.0	554.22	3822.0	551.25	4172.0	570.03
	4665.0	552.25	4693.0	553.24	4809.0	562.07	4940.0	590.27
	4990.0	604.00						

ウォーターハンマ圧力勾配線図　計算番号 C2-1010-A1

管路名称 1 2 4 6 7



基準レベル 442.61

A1 Pump :

Bahirawakada ReservoiR にのみ流れる場合

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                      ウォーターハンマ計算条件                          計算番号 1010A2PE        PAGE    1

                      ClearWaterPump(A2)Ph3

                      基準レベル             442.610 m
                      計算時間単位            .00848 sec

【 管路仕様 】
                                                                        ｻｰｼﾞ   弁
  管路     管長    管種   管径    管厚   ヤング  上流の管路      ポンプ   ﾀﾝｸ    番   終点  管路流量    配管    弁絞  圧力波
  名称       m            mm      mm      率                    番号    番号   号   条件     m3/m     損失    損失 往復時間   管路定数    分割
                                                                                                        m       m      sec
   1      612.0   FCD3    350     6.5    1.600                 1  0  0    0     0     0      3.852   2.510    .000   1.1188     9.6740     132
   2      890.0   FCD3    300     6.5    1.600   1             0  0  0    0     0     0      2.118   3.360    .000   1.5786    13.5715     188
   3      793.0   FCD3    250     6.0    1.600   1             0  0  0    0     0     0      1.734    .990    .000   1.3808    19.9081     164
   4      100.0   FCD3    200     6.0    1.600   3             0  0  0    0     0     1       .841    .180    .000    .1679    32.2567      20
   5     1785.8   FCD3    200     6.0    1.600   3             0  0  0    0     0     0       .893   1.210    .000   2.9985    32.2567     352
   6       50.0   FCD3    200     6.0    1.600   5             0  0  0    0     0     1       .476    .130    .000    .0840    32.2567      10
   7       10.0   FCD3    200     6.0    1.600   5             0  0  0    0     0     1       .417    .180    .000    .0168    32.2567       2
  10      520.0   FCD3    300     6.5    1.600   2             0  0  0    0     0     1      2.118   1.740    .000    .9223    13.5715     108

【 ポンプ仕様 】
                    弁     弁                                                                   効     減衰   ---------- 初期状態 ----------
   番   台   形      閉     番   全揚程      吐出量      出力   極     型  ﾎﾟﾝﾌﾟ･ﾓｰﾀ   ﾌﾗｲﾎｲｰﾙ 回転数  率     定数      揚程     吐出量 回転数 トルク
   号   数   式      鎖     号       m         m3/m        kw   数     式     kg-m2      kg-m2  min-1   %        k         m       m3/m
   1    1    1      1       0 104.000       3.852      90.0    4      1      8.300     20.000   1470 74    .5275  104.000     3.852  1.000  1.000

【 圧力線図仕様 】

    管路名称    1     2    10
    管路名称    1     3     4
    管路名称    1     3     5     6
    管路名称    1     3     5     7

【 縦断仕様 】
  管路   追加距離     レベル     追加距離    レベル     追加距離    レベル     追加距離    レベル
  名称         m          m            m         m            m         m            m         m
   1          .0     444.67        225.1    456.51        282.2    454.34        349.7    466.71
           487.0     467.00        612.0    467.00
   2       612.0     467.10        699.3    469.83        779.1    474.34        887.9    453.74
          1502.0     503.85
   3       612.0     467.00        833.7    476.33       1405.0    489.06
```

Flywheel : 20kgf-m²

A2.   Phase 3

【 縦断仕様 】

管路名称	追加距離 m	レベル m	追加距離 m	レベル m	追加距離 m	レベル m	追加距離 m	レベル m
4	1405.0	489.06	1505.0	524.00				
5	1405.0	489.06	1872.1	493.39	2230.7	502.73	2521.9	486.26
	2672.4	497.54	2824.9	505.23	2979.8	507.98	3124.0	507.42
	3190.8	519.59						
6	3190.8	519.59	3240.8	529.00				
7	3190.8	519.59	3200.8	529.00				
10	1502.0	503.85	1510.0	503.85	1585.0	496.42	1759.0	514.59
	1805.0	513.54	1865.0	515.98	1925.0	516.47	2012.0	523.27
	2022.0	529.75						

1．計算インターバル　14

3．管路の圧力変化

管路番号	追加距離	最高圧力				最低圧力			
		経過時間	流量	圧力(水頭)	圧力(ﾚﾍﾞﾙ表示)	経過時間	流量	圧力(水頭)	圧力(ﾚﾍﾞﾙ表示)
	m	sec	m3/m	m	m	sec	m3/m	m	m
1	.0	5.187	.000	164.599	607.209	2.060	.001	35.860	478.470
1	153.0	5.217	.014	161.972	604.582	2.199	-.030	36.443	479.053
1	306.0	5.399	.228	158.777	601.387	2.339	-.073	37.288	479.898
1	459.0	5.268	.021	154.513	597.123	2.259	.060	40.388	482.998
2	.0	5.136	.452	147.790	590.400	2.288	.072	44.953	487.563
2	222.5	5.717	.886	145.263	587.873	2.352	.082	44.041	486.651
2	445.0	5.670	.859	140.758	583.368	2.517	.094	43.619	486.229
2	667.5	5.734	.933	134.256	576.866	2.471	.254	47.751	490.361
3	.0	5.136	-.761	147.790	590.400	2.288	-.070	44.953	487.563
3	198.3	5.573	-.155	139.278	581.888	1.945	.453	52.614	495.224
3	396.5	11.536	-.541	129.901	572.511	1.771	.663	60.891	503.501
3	594.8	11.523	-.578	120.307	562.917	8.802	-.956	72.216	514.826
4	.0	11.697	-1.092	111.239	553.849	1.593	.311	87.121	529.731
4	25.0	4.420	-2.491	108.717	551.327	1.572	.359	90.190	532.800
4	50.0	4.399	-2.535	106.269	548.879	1.551	.409	93.411	536.021
4	75.0	4.403	-2.524	103.471	546.081	1.530	.462	96.788	539.398
5	.0	11.697	.741	111.239	553.849	1.593	.686	87.121	529.731
5	446.5	4.577	.806	115.680	558.290	8.272	.742	87.315	529.925
5	892.9	4.984	.875	111.474	554.084	9.578	.652	89.532	532.142
5	1339.4	5.221	.792	113.798	556.408	6.001	.809	87.386	529.996
6	.0	5.425	.406	99.915	542.525	2.831	.459	98.187	540.797
6	10.0	5.331	.385	99.874	542.484	2.822	.459	98.176	540.786
6	20.0	5.323	.385	99.828	542.438	2.814	.460	98.182	540.792
6	30.0	5.314	.384	99.753	542.363	2.806	.461	98.239	540.849
6	40.0	5.306	.382	99.596	542.206	2.797	.465	98.453	541.063

```
                                ウォーターハンマ計算結果                        計算番号 1010A2PE          PAGE    4

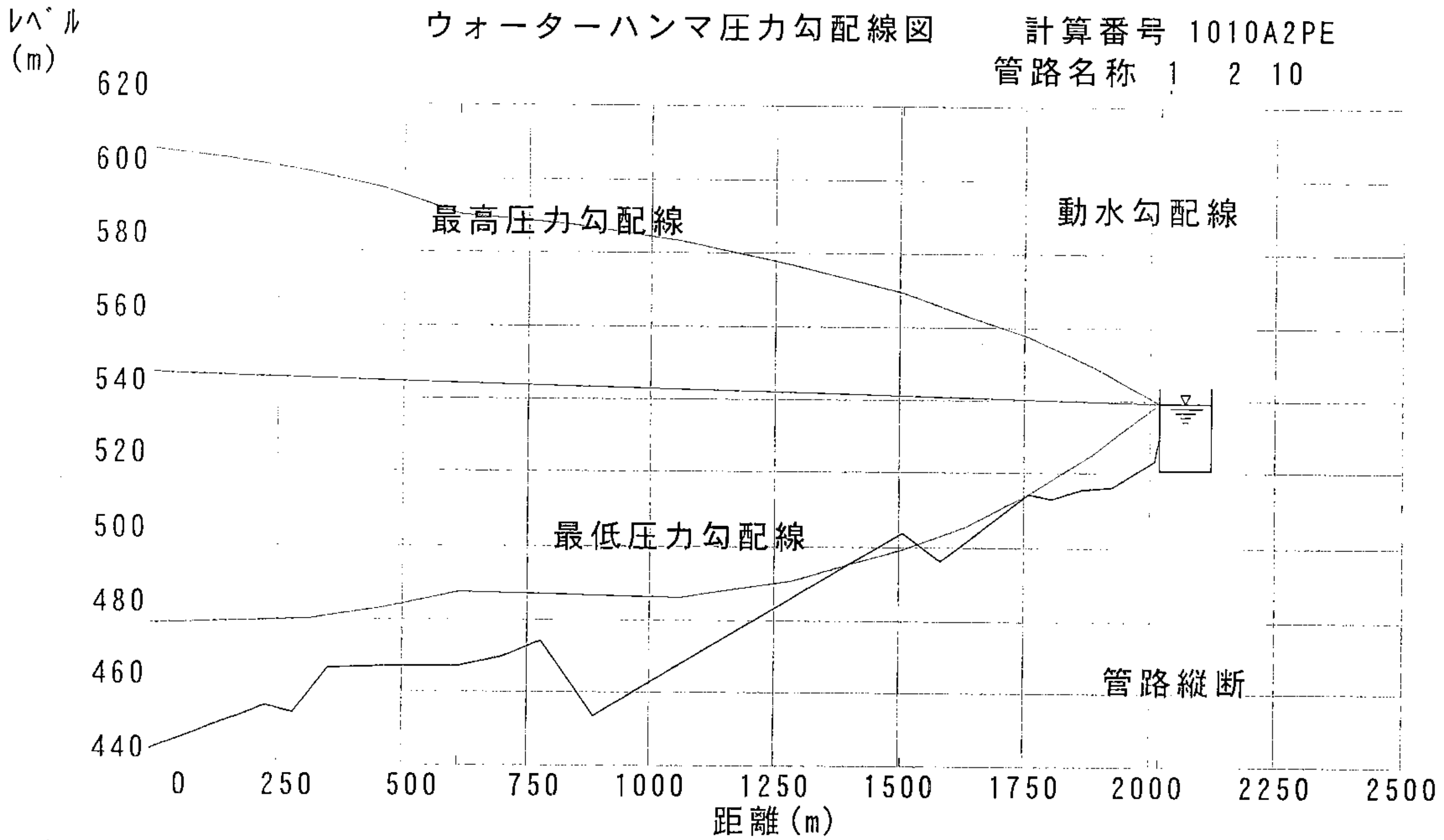
3. 管路の圧力変化
                    -------------- 最高圧力 --------------        -------------- 最低圧力 --------------
  管路      追加    経過時間        流量      圧力      圧力       経過時間        流量      圧力      圧力
  番号      距離                            (水頭) (ﾚﾍﾞﾙ表示)                             (水頭) (ﾚﾍﾞﾙ表示)
              m          sec        m3/m         m         m             sec       m3/m         m         m

    7        .0        5.425        .464    99.915   542.525          2.831       .287    98.187   540.797
    7       5.0        5.344        .390    99.514   542.124          2.835       .279    98.648   541.258

   10        .0        5.899       1.140   126.555   569.165          2.272       .593    56.737   499.347
   10     130.0        5.785        .911   120.243   562.852          2.157       .836    63.262   505.872
   10     260.0        5.670        .710   114.780   557.390          2.043      1.152    71.660   514.270
   10     390.0        5.556        .415   106.801   549.411          1.928      1.572    82.596   525.206
```

ウォーターハンマ圧力勾配線図

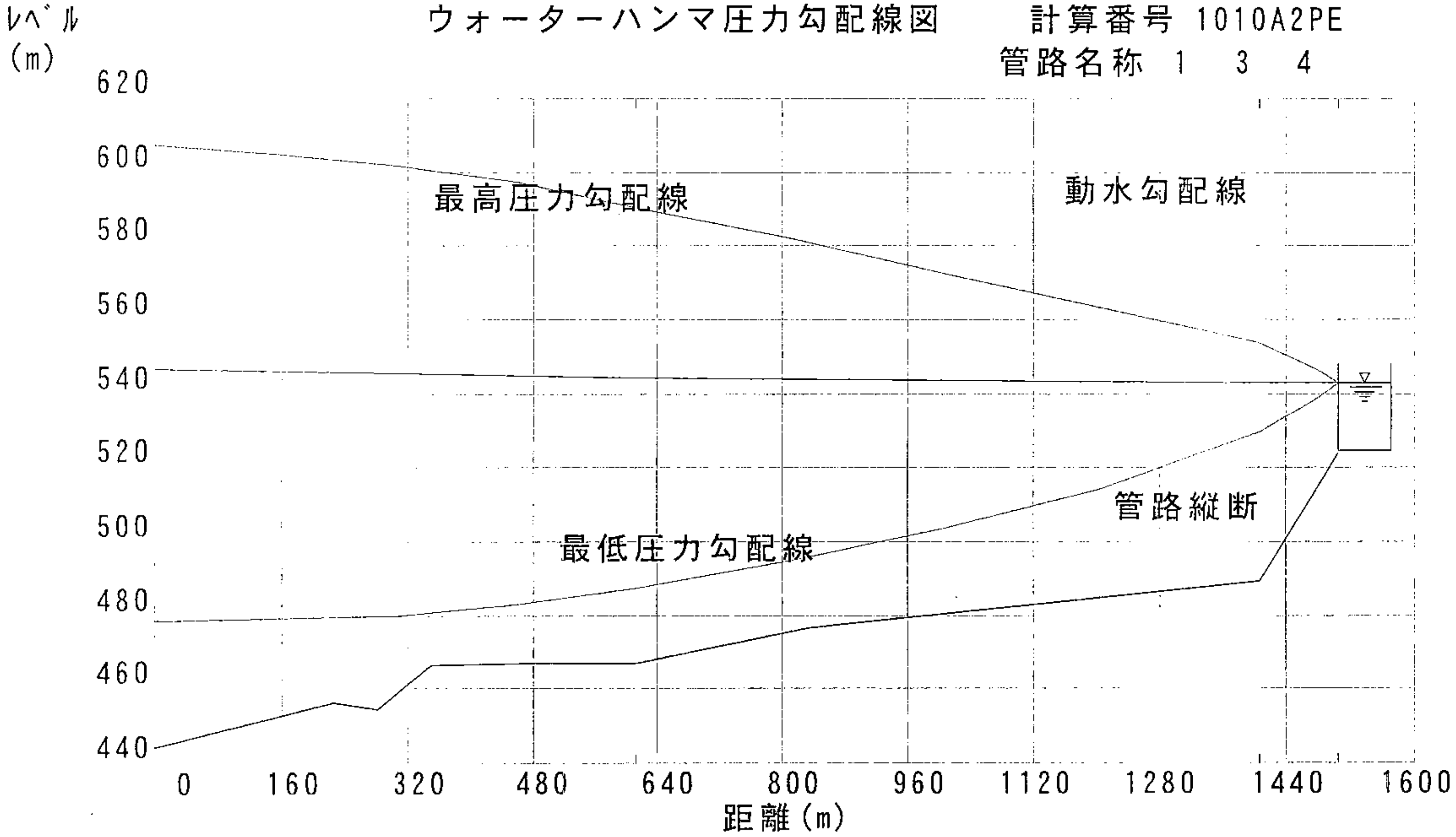
計算番号 1010A2PE
管路名称 1 2 10



基準レベル 442.61

to Kondadeniya Phase 3 Flywheel : 20kgf-m²

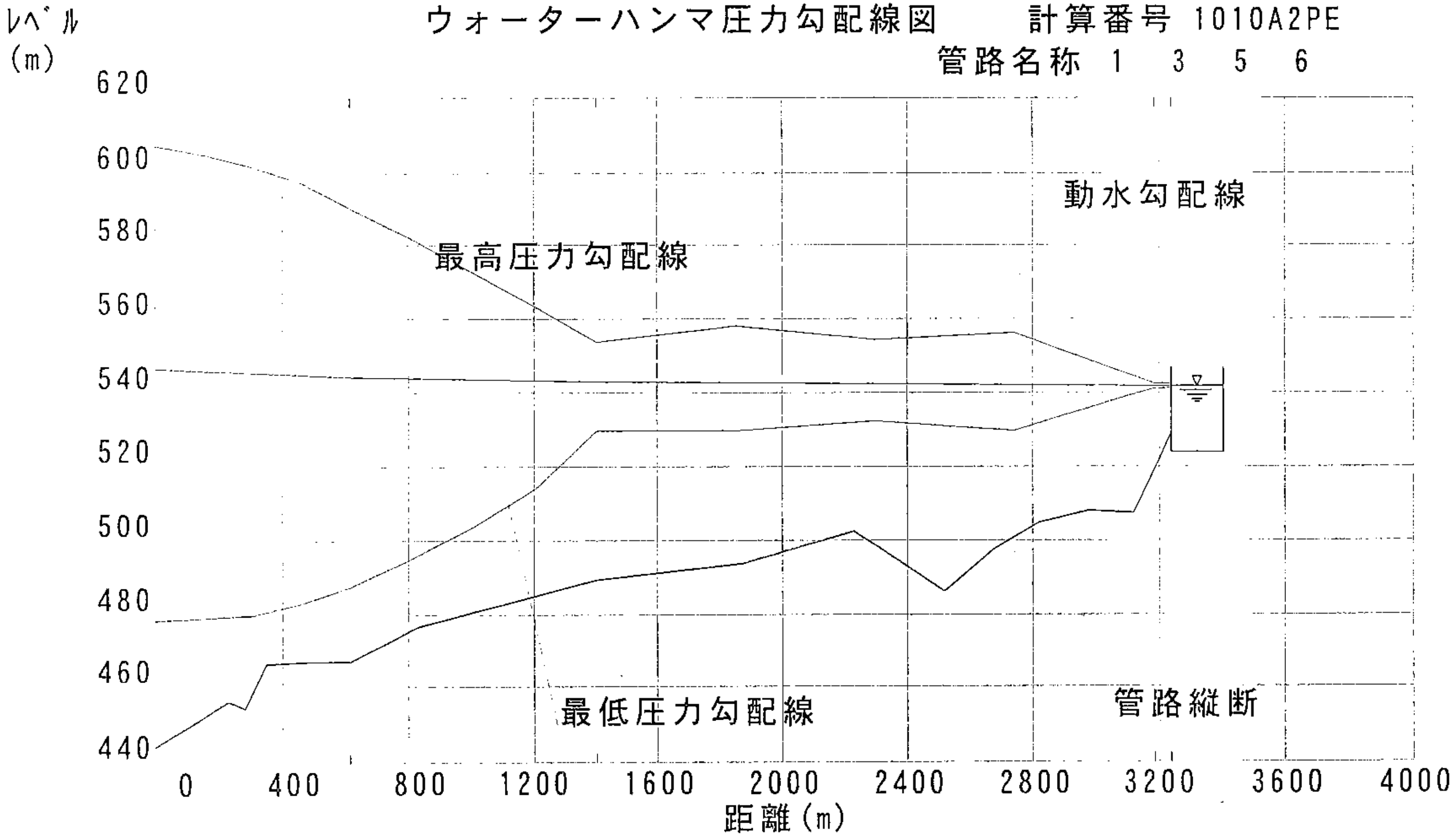
ウォーターハンマ圧力勾配線図　　計算番号 1010A2PE
管路名称 1 3 4



基準レベル 442.61

to Gohagoda (Wegiriya)　　Phase 3　　Flywheel : 20 kgf-m²

ウォーターハンマ圧力勾配線図　計算番号 1010A2PE
管路名称 1 3 5 6

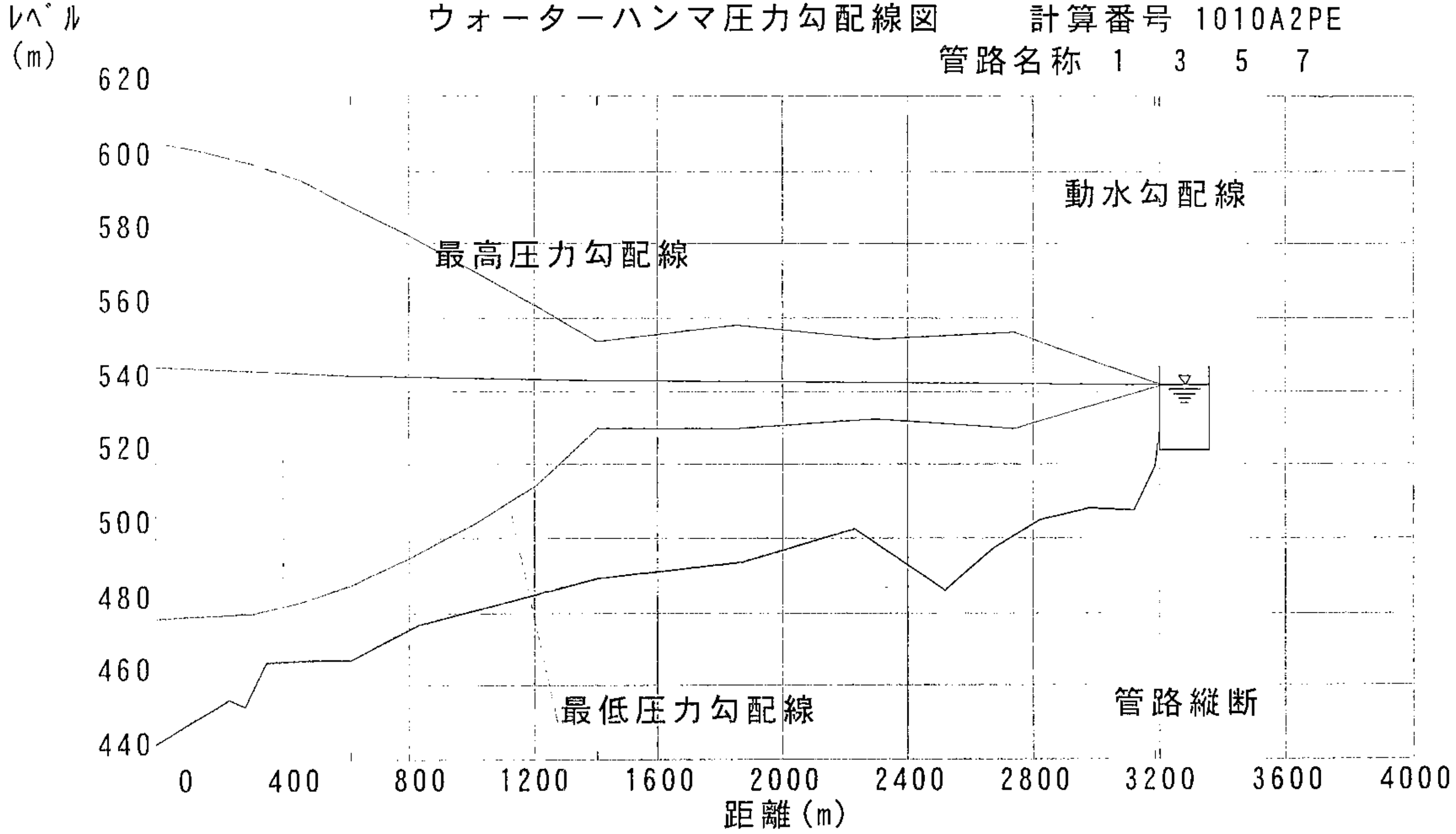


基準レベル 442.61

to Gohagoda (New)　Phase 3.　Flywheel : 20kgf-m²

ウォーターハンマ圧力勾配線図　　計算番号 1010A2PE

管路名称 1 3 5 7



基準レベル 442.61

to Gohagoda (Old)　　Phase 3.　　Flywheel : 20kgf-m²

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                    ウォーターハンマ計算条件                             計算番号 C2-1010-A3        PAGE    1

                    Clear Water Pump (A3)

                    基準レベル                  442.610 m
                    計算時間単位                 .04819 sec

【 管路仕様 】
                                                                      ｻｰｼﾞ    弁                        配管         弁絞  圧力波
 管路     管長    管種  管径    管厚   ヤング   上流の管路      ポンプ     ﾀﾝｸ    番  終点  管路流量     損失         損失 往復時間    管路定数     分割
 名称        m           mm      mm     率                     番号      番号   号  条件      m3/m        m            m      sec
  1     1107.0   FCD3   600     9.0   1.600                  1  0  0    0      0    0      9.989      .900         .000   2.1204      3.1419       44
  2      888.0   FCD3   600     9.0   1.600   1              0  0  0    0      0    0      7.369      .400         .000   1.7009      3.1419       36
  3     1783.0   FCD3   600     9.0   1.600   1              0  0  0    0      0    0      2.620      .200         .000   3.4152      3.1419       70
  4      882.0   FCD3   200     6.0   1.600   2              0  0  0    0      0    1      1.166     1.400       36.000   1.4810     32.2567       30
  5     3653.0   FCD3   500     8.0   1.600   2              0  0  0    0      0    0      6.203     2.900         .000   6.8950      4.5912      144
  6     3541.0   FCD3   300     6.5   1.600   3              0  0  0    0      0    0      1.713     3.200         .000   6.2807     13.5715      132
  7      904.0   VP 1   225    12.7    .027   3              0  0  0    0      0    1       .907      .900        7.000   4.8451      7.9846      100
  8      921.0   FCD3   200     6.0   1.600   6              0  0  0    0      0    0       .732      .600         .000   1.5464     32.2567       32
  10    1305.0   FCD3   250     6.0   1.600   6              0  0  0    0      0    1       .981     1.000        2.000   2.2722     19.9081       48
  9      252.0   VP 1   225    12.7    .027   8              0  0  0    0      0    1       .732      .200        1.000   1.3506      7.9846       28
  11    1294.0   FCD3   200     6.0   1.600   5              0  0  0    0      0    1      1.620     3.600       10.000   2.1727     32.2567       44
  12      50.0   FCD3   500     8.0   1.600   5              0  0  0    0      0    1      4.583      .100        4.000    .0944      4.5912        2

【 ポンプ仕様 】
                   弁    弁                                                                             効     減衰   ---------- 初期状態 ----------
  番  台  形       閉    番  全揚程     吐出量      出力  極    型 ﾎﾟﾝﾌﾟ･ﾓｰﾀ   ﾌﾗｲﾎｲｰﾙ 回転数 率     定数       揚程     吐出量 回転数 トルク
  号  数  式       鎖    号       m       m3/m        kw  数    式     kg-m2     kg-m2  min-1  %        k          m       m3/m
  1   1   1        1     0  93.000      9.990     250.0  4     1    29.000       .000   1475 78   1.1249     93.000      9.990  1.000  1.000

【 圧力線図仕様 】

   管路名称   1     3     6     10

【 縦断仕様 】
 管路  追加距離    レベル     追加距離   レベル     追加距離    レベル     追加距離    レベル
 名称        m         m            m        m            m          m            m         m
  1          .0    440.86         50.0   440.86        350.0     445.00        500.0    441.59
          509.0    442.85        522.0   441.23        701.0     446.85       1107.0    442.52
  2      1107.0    442.52       1366.0   443.49       1995.0     441.50
  3      1107.0    442.52       1367.0   444.57       1687.0     441.08       1906.0    445.22
```
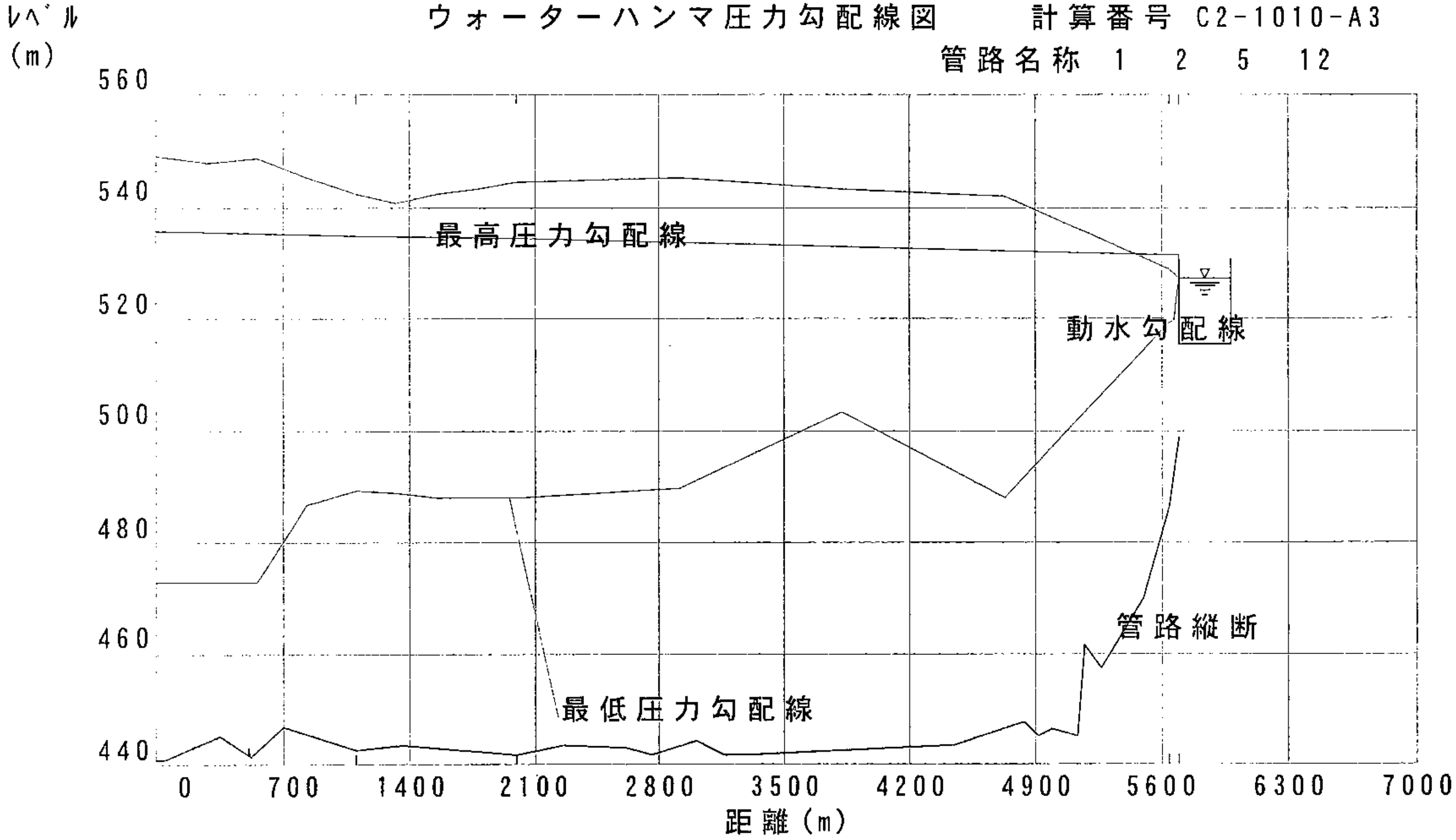

【 縦断仕様 】

管路名称	追加距離 m	レベル m	追加距離 m	レベル m	追加距離 m	レベル m	追加距離 m	レベル m
	2404.0	440.54	2890.0	440.74				
4	1995.0	441.50	2135.0	452.30	2276.0	455.76	2315.0	461.79
	2518.0	471.90	2639.0	465.30	2676.0	466.13	2785.0	457.89
	2827.0	460.88	2877.0	463.50				
5	1995.0	441.50	2254.0	443.33	2614.0	442.85	2750.0	441.67
	2997.0	444.30	3153.0	441.82	3293.0	441.63	4451.0	443.21
	4837.0	447.52	4912.0	445.08	4993.0	446.47	5131.0	445.05
	5171.0	461.28	5269.0	457.12	5494.0	469.87	5648.0	486.14
6	2890.0	440.74	3330.0	444.28	3509.0	443.59	3669.0	447.10
	3770.0	445.99	3890.0	448.68	4027.0	443.86	4570.0	449.46
	5064.0	442.95	6431.0	453.72				
7	2890.0	440.74	2895.0	441.42	2987.0	448.14	3053.0	449.40
	3078.0	452.65	3231.0	460.39	3261.0	461.12	3444.0	482.80
	3525.0	486.70	3548.0	490.70	3574.0	490.83	3696.0	505.07
	3722.0	510.68	3744.0	511.70	3794.0	511.50		
8	6431.0	453.72	6485.0	454.37	6700.0	476.21	6781.0	463.97
	6836.0	464.56	6918.0	480.58	7097.0	490.81	7135.0	486.09
	7176.0	486.09	7321.0	500.53				
9	7321.0	500.53	7352.0	503.62	7420.0	499.19	7479.0	504.30
	7504.0	510.79	7604.0	517.50				
10	6431.0	453.72	6602.0	456.24	6652.0	460.17	6672.0	466.20
	6691.0	465.15	6832.0	479.26	6931.0	484.09	7109.0	506.15
	7180.0	504.74	7230.0	506.01	7300.0	500.53	7350.0	501.53
	7459.0	500.05	7516.0	503.96	7636.0	494.99	7736.0	518.50
11	5648.0	486.14	5745.0	484.10	5833.0	487.52	5921.0	484.14
	6008.0	476.10	6084.0	475.32	6162.0	485.85	6484.0	495.12
	6524.0	498.43	6627.0	490.87	6665.0	494.40	6739.0	488.58
	6832.0	496.09	6892.0	507.61	6942.0	508.50		
12	5648.0	486.14	5698.0	498.50				

ウォーターハンマ圧力勾配線図　　計算番号 C2-1010-A3

管路名称 1 2 5 12



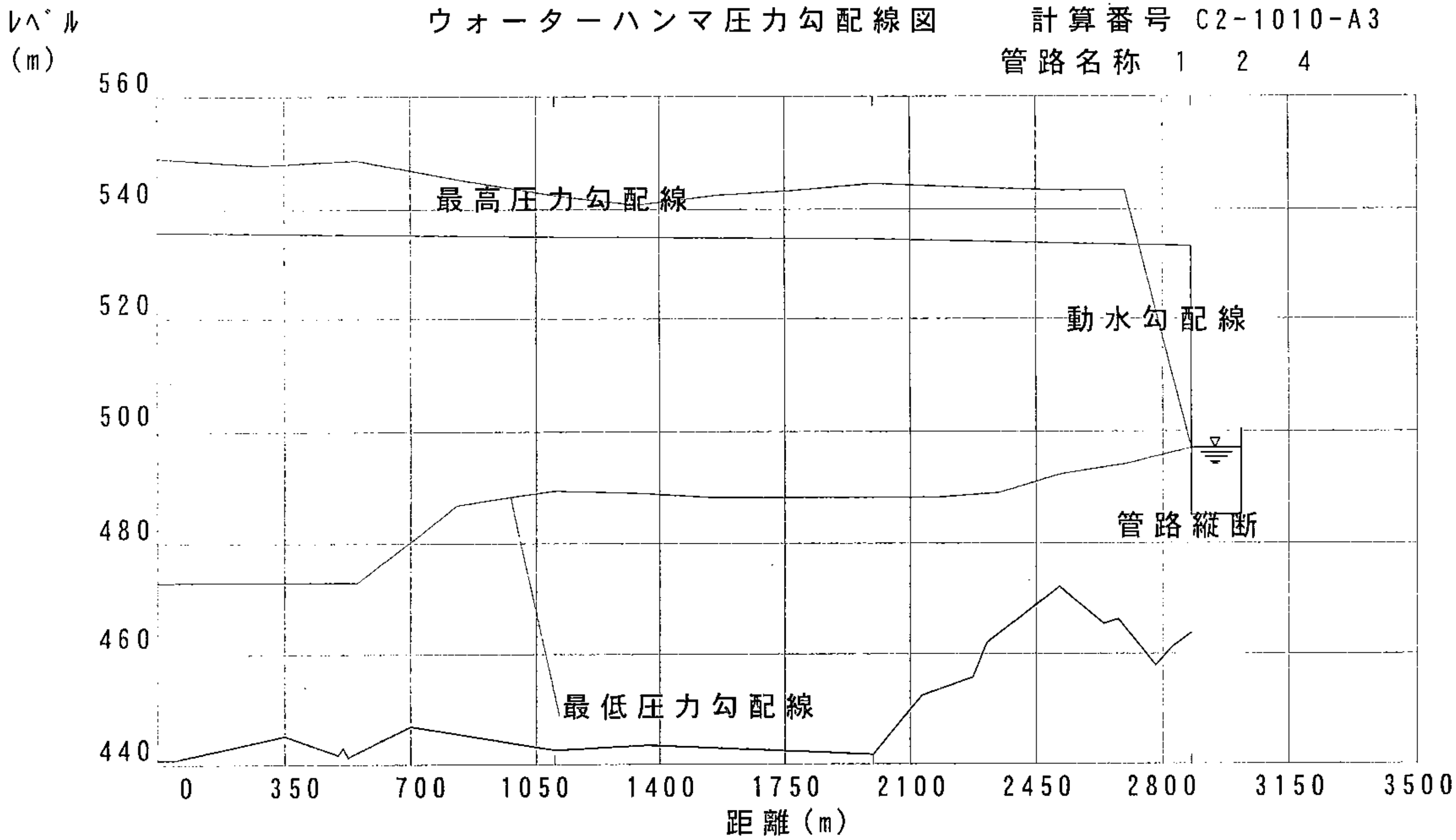
基準レベル 442.61

A3 Pump;

To Kahawatta Reservoir

ウォーターハンマ圧力勾配線図

計算番号 C2-1010-A3
管路名称 1 2 4



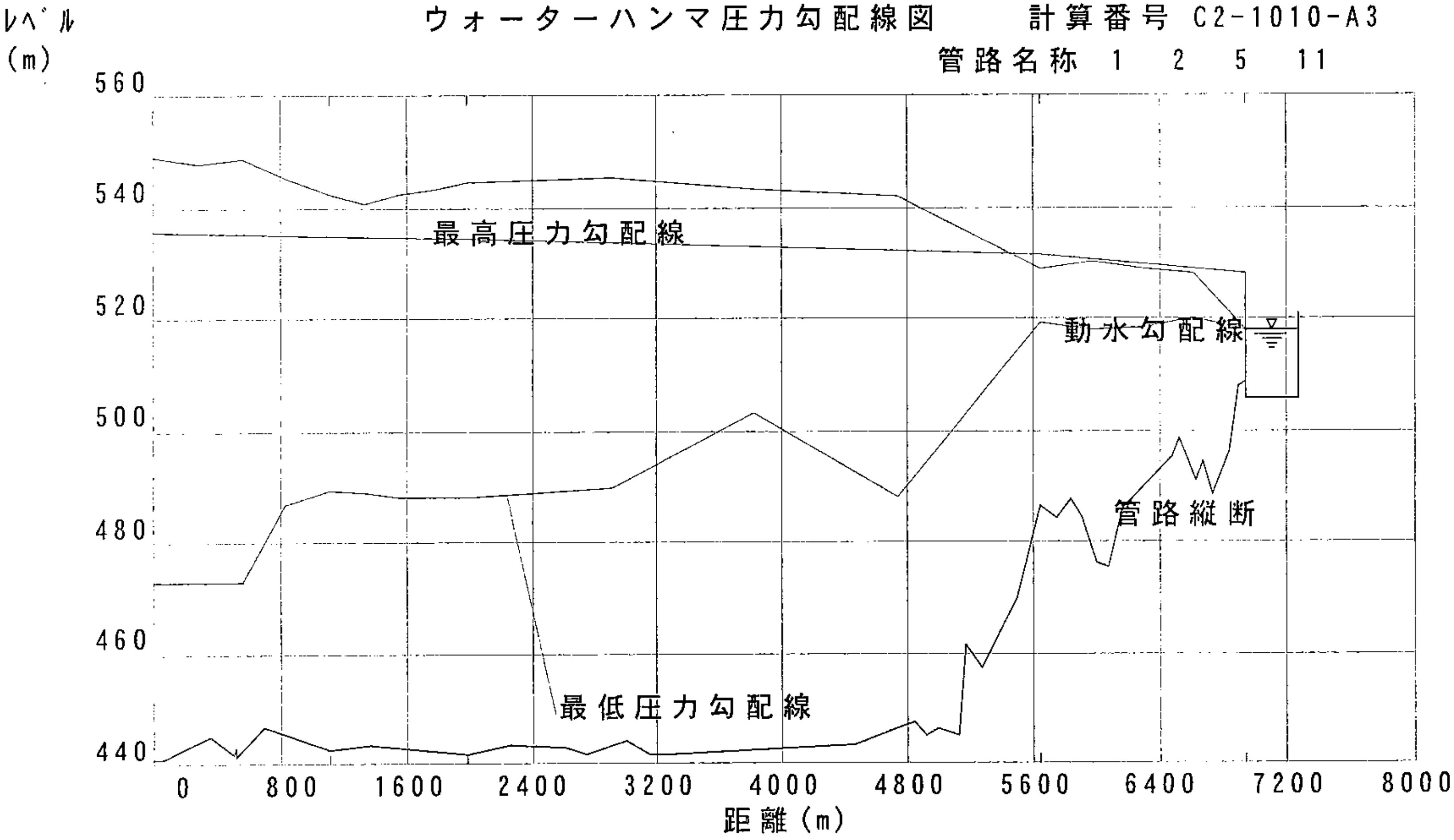
基準レベル 442.61

A3 Pump:

To Kakalla Reservoir

ウォーターハンマ圧力勾配線図　計算番号 C2-1010-A3

管路名称 1 2 5 11



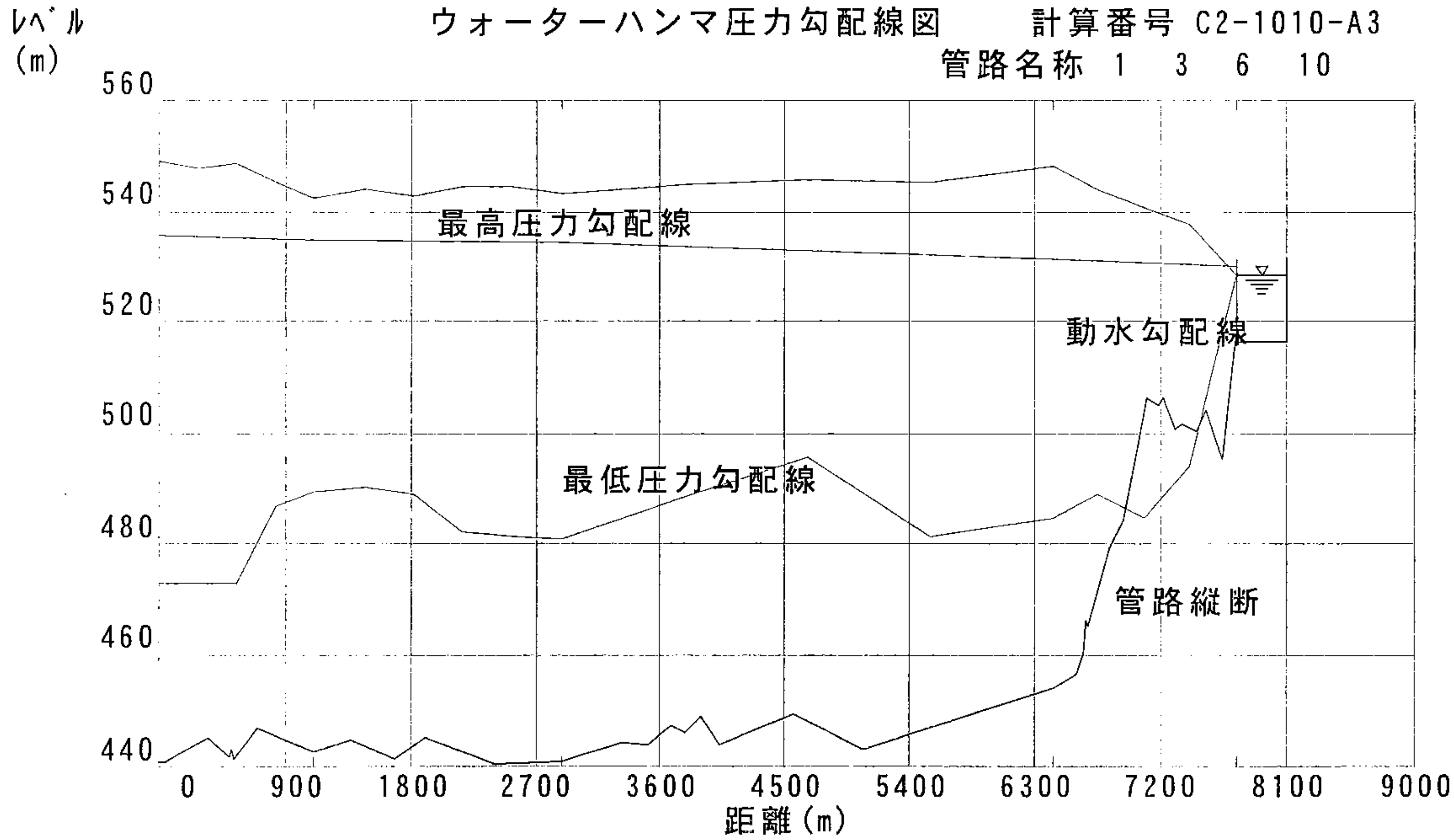
基準レベル 442.61

A3 Pump:

To Akurana Reservoir

ウォーターハンマ圧力勾配線図　計算番号 C2-1010-A3

管路名称 1 3 6 10



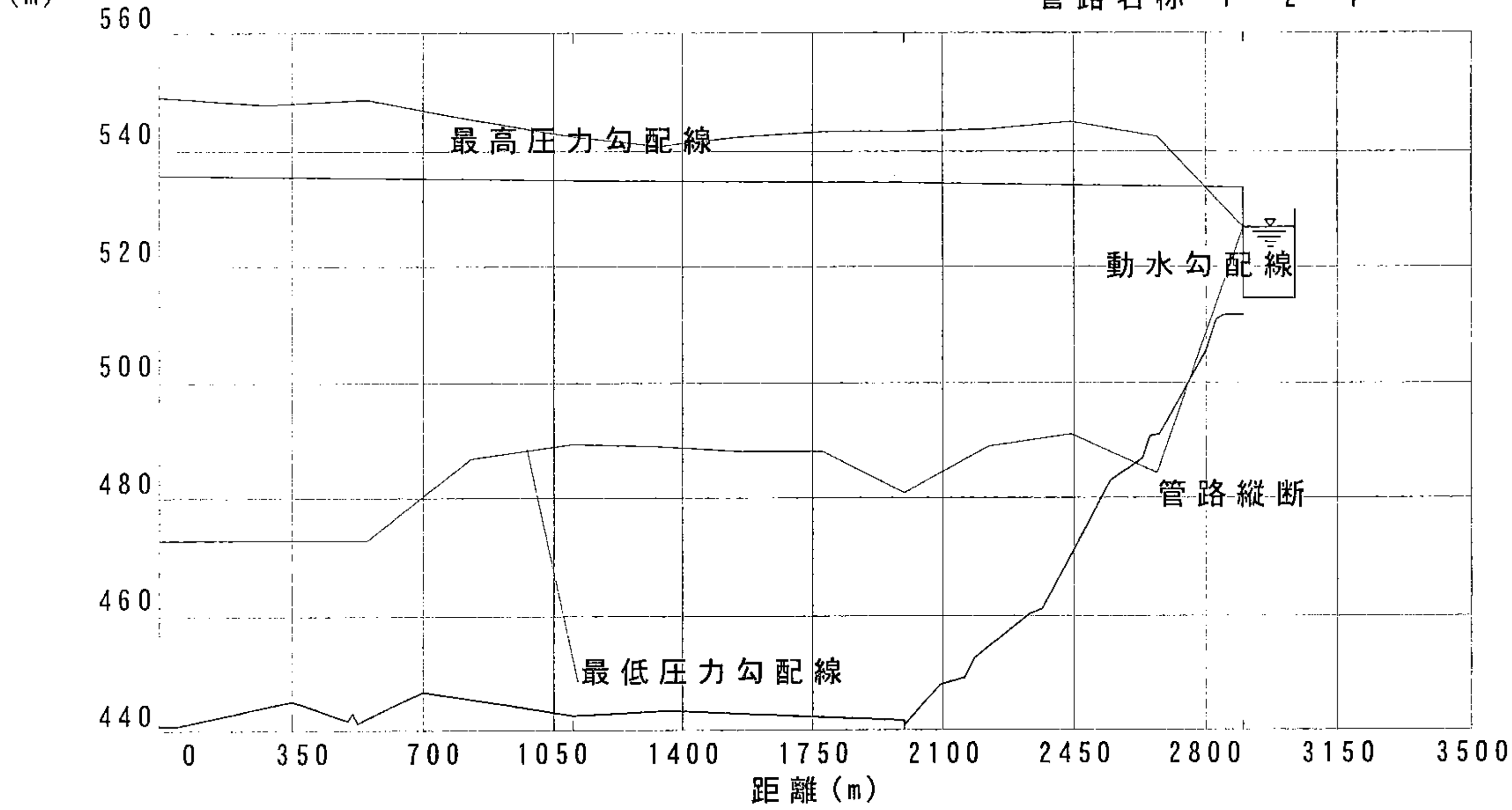
基準レベル 442.61

A3 Pump :

To Bangalawatta Reservoir

ウォーターハンマ圧力勾配線図　　計算番号 C2-1010-A3

管路名称 1 2 7



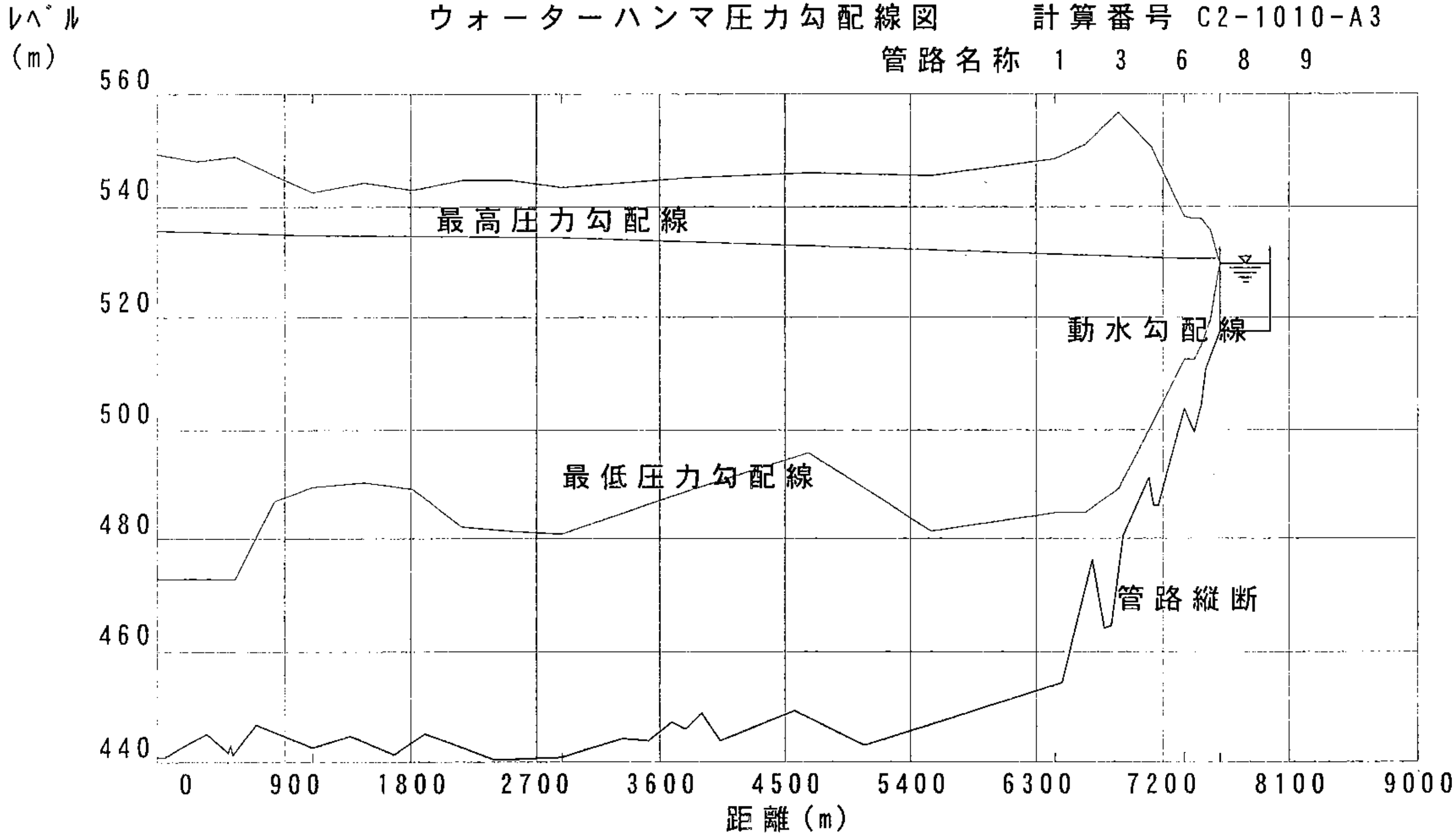
基準レベル 442.61

A3 Pump

To Balanagar Reservoir

ウォーターハンマ圧力勾配線図　　計算番号 C2-1010-A3

管路名称 1 3 6 8 9



基準レベル 442.61

A3 Pump:

To Pikiladoniya RosevoiR

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                              ウォーターハンマ計算条件                        計算番号 C2-1010-A3      PAGE    1

                              Clear Water Pump (A3)

                              基準レベル              442.610 m
                              計算時間単位             .04819 sec

【 管路仕様 】
                                                                                      ﾘｰｼﾞ   弁                      配管      弁絞   圧力波
  管路     管長    管種   管径    管厚   ヤング   上流の管路     ポンプ      ﾀﾝｸ    番   終点  管路流量    損失     損失  往復時間    管路定数     分割
  名称       m            mm      mm      率                     番号       番号    号   条件     m3/m       m        m      sec
    1    1107.0   FCD3   600     9.0   1.600                  1   0   0     0      0     0     9.989     .900     .000   2.1204      3.1419      44
    2     888.0   FCD3   600     9.0   1.600    1             0   0   0     0      0     0     7.369     .400     .000   1.7009      3.1419      36
    3    1783.0   FCD3   600     9.0   1.600    1             0   0   0     0      0     0     2.620     .200     .000   3.4152      3.1419      70
    4     882.0   FCD3   200     6.0   1.600    2             0   0   0     0      0     1     1.166    1.400   36.000   1.4810     32.2567      30
    5    3653.0   FCD3   500     8.0   1.600    2             0   0   0     0      0     0     6.203    2.900     .000   6.8950      4.5912     144
    6    3541.0   FCD3   300     6.5   1.600    3             0   0   0     0      0     0     1.713    3.200     .000   6.2807     13.5715     132
    7     904.0   VP 1   225    12.7    .027    3             0   0   0     0      0     1      .907     .900    7.000   4.8451      7.9846     100
    8     921.0   FCD3   200     6.0   1.600    6             0   0   0     0      0     0      .732     .600     .000   1.5464     32.2567      32
   10    1305.0   FCD3   250     6.0   1.600    6             0   0   0     0      0     1      .981    1.000    2.000   2.2722     19.9081      48
    9     252.0   VP 1   225    12.7    .027    8             0   0   0     0      0     1      .732     .200    1.000   1.3506      7.9846      28
   11    1294.0   FCD3   200     6.0   1.600    5             0   0   0     0      0     1     1.620    3.600   10.000   2.1727     32.2567      44
   12      50.0   FCD3   500     8.0   1.600    5             0   0   0     0      0     1     4.583     .100    4.000    .0944      4.5912       2

【 ポンプ仕様 】
                          弁    弁                                                                       効     減衰   ---------- 初期状態 ----------
  番   台   形            閉    番   全揚程     吐出量      出力   極     型 ﾎﾟﾝﾌﾟ･ﾓｰﾀ   ﾌﾗｲﾎｲｰﾙ 回転数 率     定数       揚程    吐出量  回転数  トルク
  号   数   式            鎖    号       m       m3/m        kw   数     式    kg-m2      kg-m2   min-1  %        k          m     m3/m
   1    1    1             1     0   93.000      9.990     250.0    4      1   29.000     50.000   1475 78    .4129     93.000     9.990   1.000   1.000

【 圧力線図仕様 】

    管路名称   1     3     6     10

【 縦断仕様 】
  管路  追加距離    レベル     追加距離    レベル     追加距離    レベル     追加距離    レベル
  名称       m        m            m         m            m         m            m         m
    1        .0    440.86        50.0     440.86        350.0    445.00        500.0    441.59
          509.0    442.85       522.0     441.23        701.0    446.85       1107.0    442.52
    2    1107.0    442.52      1366.0     443.49       1995.0    441.50
    3    1107.0    442.52      1367.0     444.57       1687.0    441.08       1906.0    445.22
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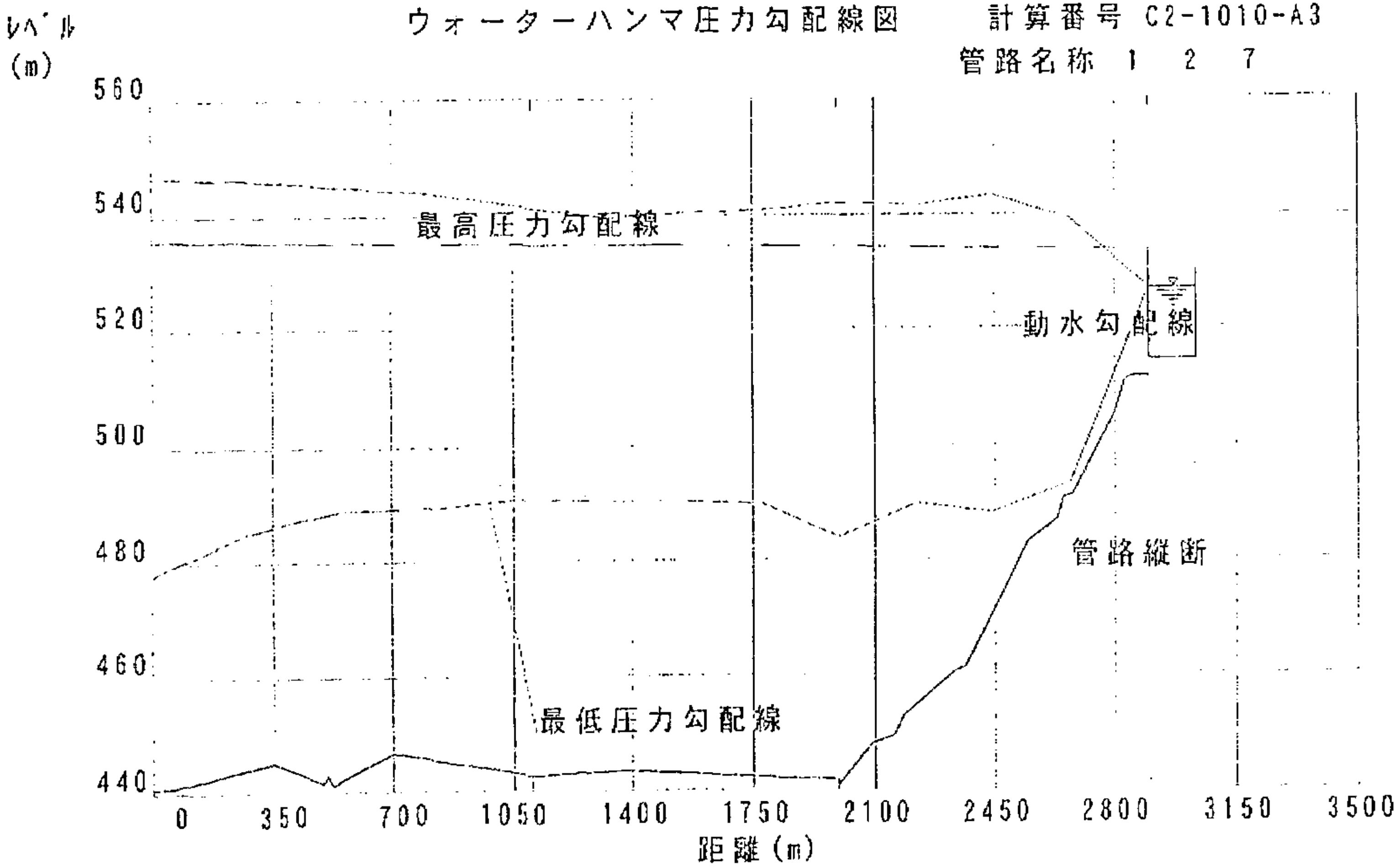
【 縦断仕様 】

管路名称	追加距離 m	レベル m	追加距離 m	レベル m	追加距離 m	レベル m	追加距離 m	レベル m
	2404.0	440.54	2890.0	440.74				
4	1995.0	441.50	2135.0	452.30	2276.0	455.76	2315.0	461.79
	2518.0	471.90	2639.0	465.30	2676.0	466.13	2785.0	457.69
	2827.0	460.88	2877.0	463.50				
5	1995.0	441.50	2254.0	443.33	2614.0	442.85	2750.0	441.67
	2997.0	444.30	3153.0	441.82	3293.0	441.63	4451.0	443.21
	4837.0	447.52	4912.0	445.08	4993.0	446.47	5131.0	445.05
	5171.0	461.28	5269.0	457.12	5494.0	469.87	5648.0	486.14
6	2890.0	440.74	3330.0	444.28	3509.0	443.59	3669.0	447.10
	3770.0	445.99	3890.0	448.68	4027.0	443.86	4570.0	449.46
	5064.0	442.95	6431.0	453.72				
7	2890.0	440.74	2895.0	441.42	2987.0	448.14	3053.0	449.40
	3078.0	452.65	3231.0	460.39	3261.0	461.12	3444.0	482.80
	3525.0	486.70	3548.0	490.70	3574.0	490.83	3696.0	505.07
	3722.0	510.68	3744.0	511.70	3794.0	511.50		
8	6431.0	453.72	6485.0	454.37	6700.0	476.21	6781.0	463.97
	6836.0	464.56	6918.0	480.58	7097.0	490.81	7135.0	486.09
	7176.0	486.09	7321.0	500.53				
9	7321.0	500.53	7352.0	503.62	7420.0	499.19	7479.0	504.30
	7504.0	510.79	7604.0	517.50				
10	6431.0	453.72	6602.0	456.24	6652.0	460.17	6672.0	466.20
	6691.0	465.15	6832.0	479.26	6931.0	484.09	7109.0	506.15
	7180.0	504.74	7230.0	506.01	7300.0	500.53	7350.0	501.53
	7459.0	500.05	7516.0	503.96	7636.0	494.99	7736.0	518.50
11	5648.0	486.14	5745.0	484.10	5833.0	487.52	5921.0	484.14
	6008.0	476.10	6084.0	475.32	6162.0	485.85	6484.0	495.12
	6524.0	498.43	6627.0	490.87	6665.0	494.40	6739.0	488.58
	6832.0	496.09	6892.0	507.61	6942.0	508.50		
12	5648.0	486.14	5698.0	498.50				

ウォーターハンマ圧力勾配線図　　計算番号 C2-1010-A3

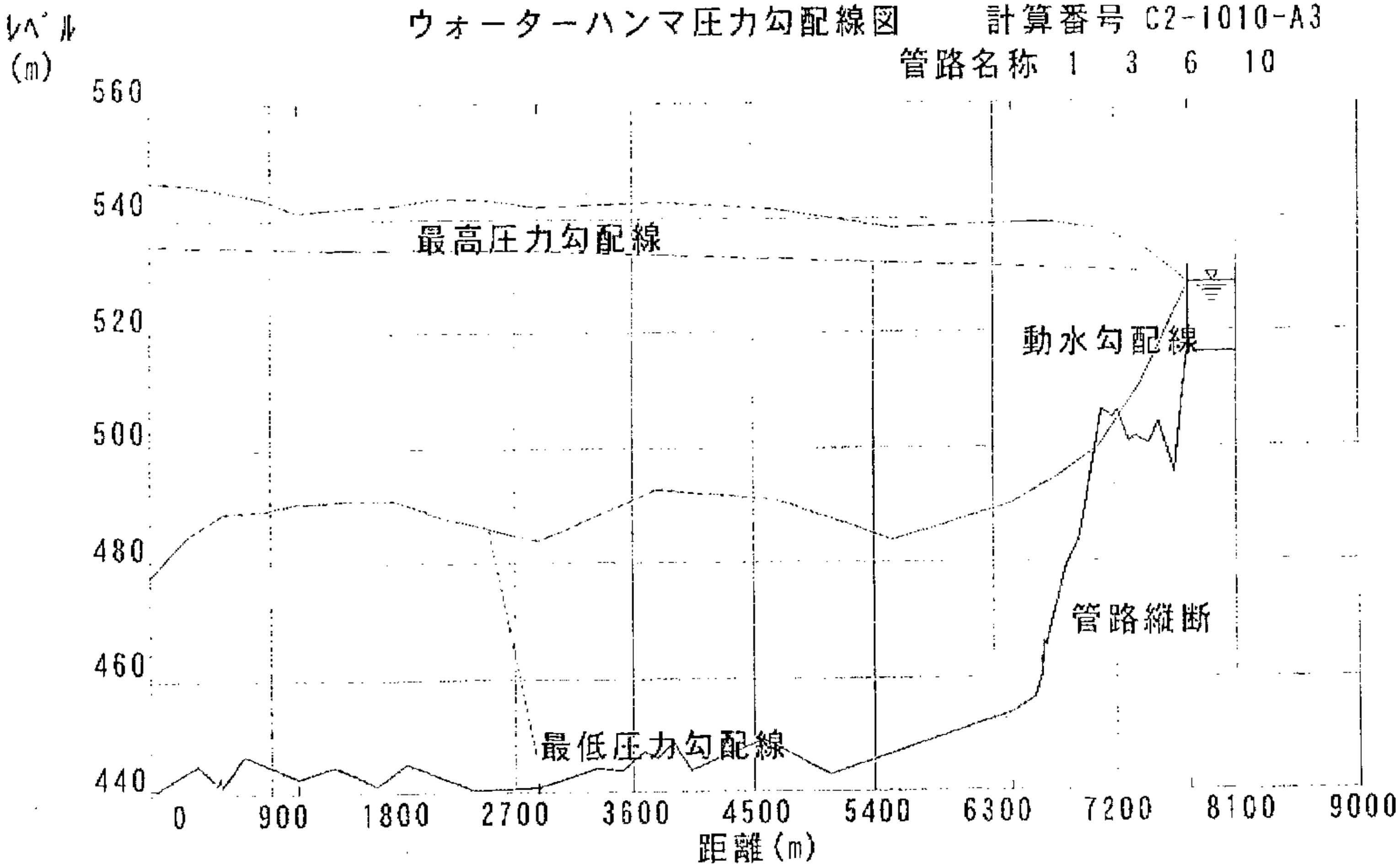
管路名称 1 2 7



基準レベル 442.61 A3 Pump

To Balanajala Reservoir

対策: Flywheel 50kg-m^2 取付



基準レベル 442.61

A3 Pump:

To Bangalawatta Reservoir

対策: Flywheel 50 $kg \cdot m^2$ 取付.

89-4

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                    ウォーターハンマ計算条件                            計算番号 C2-1010-B        PAGE    1

                    Transmission Pump (B)

                    基準レベル           566.000 m
                    計算時間単位          .05491 sec

【 管路仕様 】
                                                                          ｻｰｼﾞ   弁                       配管     弁絞  圧力波
   管路    管長    管種   管径    管厚  ヤング  上流の管路        ポンプ     ﾀﾝｸ   番  終点 管路流量    損失     損失 往復時間  管路定数   分割
   名称      m            mm      mm     率                         番号     番号   号  条件     m3/m       m        m      sec
    1     327.0  FCD3    200     6.0   1.600                     1  0  0     0     0    0      1.900   2.600     .000    .5491   32.2567    10
    2     564.0  FCD3    200     6.0   1.600   1                 0  0  0     0     0    0      1.900   4.400     .000    .9470   32.2567    18
    3     201.0  VP 1    225    12.7    .027   2                 0  0  0     0     0    0      1.900    .800     .000   1.0773    7.9846    20
    4     250.0  VP 1    225    12.7    .027   3                 0  0  0     0     0    1      1.900   1.000    5.200   1.3399    7.9846    24

【 ポンプ仕様 】
                      弁    弁                                                                     効    減衰   ---------- 初期状態 ----------
    番  台  形        閉    番  全揚程    吐出量     出力   極     型  ﾎﾟﾝﾌﾟ･ﾓｰﾀ   ﾌﾗｲﾎｲｰﾙ 回転数  率    定数      揚程    吐出量  回転数  トルク
    号  数  式        鎖    号     m       m3/m       kw   数     式     kg-m2      kg-m2   min-1  %       k          m      m3/m
    1   1   1         1     0  68.000     1.900     37.0    2     1       .850       .000    2900 69  1.5607    68.000     1.900   1.000   1.000

【 圧力線図仕様 】

    管路名称   1    2    3    4

【 縦断仕様 】
   管路  追加距離    レベル     追加距離    レベル      追加距離    レベル     追加距離    レベル
   名称       m         m           m          m            m          m           m          m
    1          .0    549.50        50.0    525.32        327.0    518.49
    2       327.0    518.49       891.0    575.88
    3       891.0    575.88      1092.0    596.33
    4      1092.0    596.33      1261.0    608.33       1292.0    604.62      1342.0    611.50
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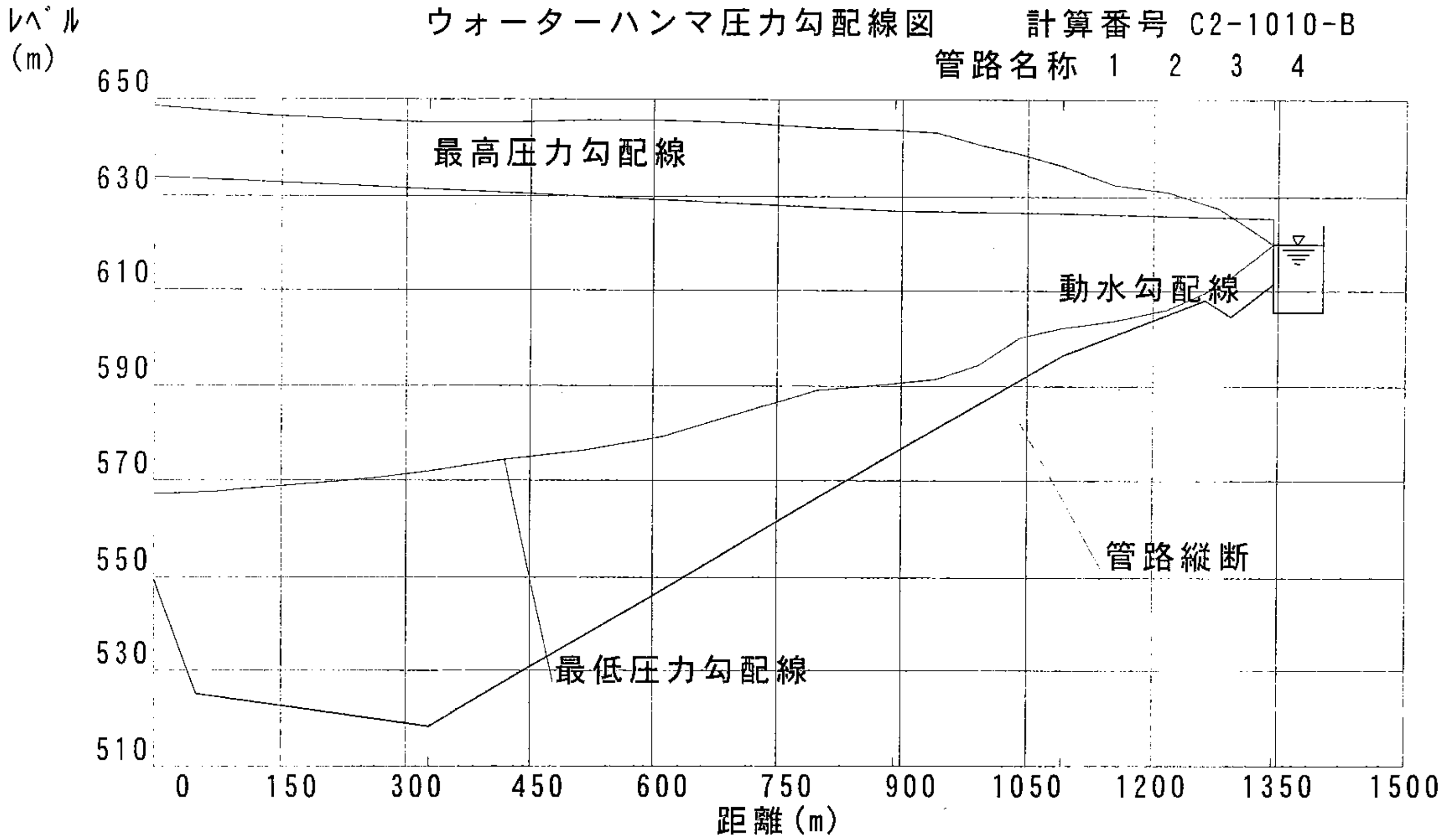
ウォーターハンマ圧力勾配線図　計算番号 C2-1010-B



基準レベル 566

TRANSMission Pmp (B):

Heerasafala Low SR → Heerasafala Middle SR.

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                    ウォーターハンマ計算条件                       計算番号 C2-1010-C       PAGE    1

                    Transmission Pump (C)

                    基準レベル          613.000 m
                    計算時間単位         .08880 sec

【 管路仕様 】
                                                                   ｻｰｼﾞ    弁                      配管     弁絞  圧力波
  管路   管長   管種   管径   管厚  ヤング  上流の管路      ポンプ    ﾀﾝｸ    番  終点 管路流量    損失     損失 往復時間  管路定数    分割
  名称     m            mm     mm    率                   番号    番号    号  条件    m3/m       m        m      sec
   1     110.0  FCD3   150    6.0  1.600                1  0  0    0      0    0      .490    .300    .000    .1776   59.6353      2
   2     200.0  FCD3   150    6.0  1.600   1            0  0  0    0      0    0      .490    .600    .000    .3229   59.6353      4
   3     350.0  VP 1   160   12.7   .027   2            0  0  0    0      0    1      .490    .600   7.500   1.6038   18.4690     18

【 ポンプ仕様 】
                  弁    弁                                                                効     減衰  ---------- 初期状態 ----------
  番  台  形      閉    番  全揚程   吐出量     出力  極   型 ﾎﾟﾝﾌﾟ･ﾓｰﾀ   ﾌﾗｲﾎｲｰﾙ 回転数 率     定数      揚程   吐出量 回転数 トルク
  号  数  式      鎖    号      m     m3/m       kw  数   式    kg-m2     kg-m2  min-1  %       k         m     m3/m
   1   1   1       1     0  77.000    .490     18.5   2    1     .460      .000   2900 47  1.2364   77.000     .490  1.000  1.000

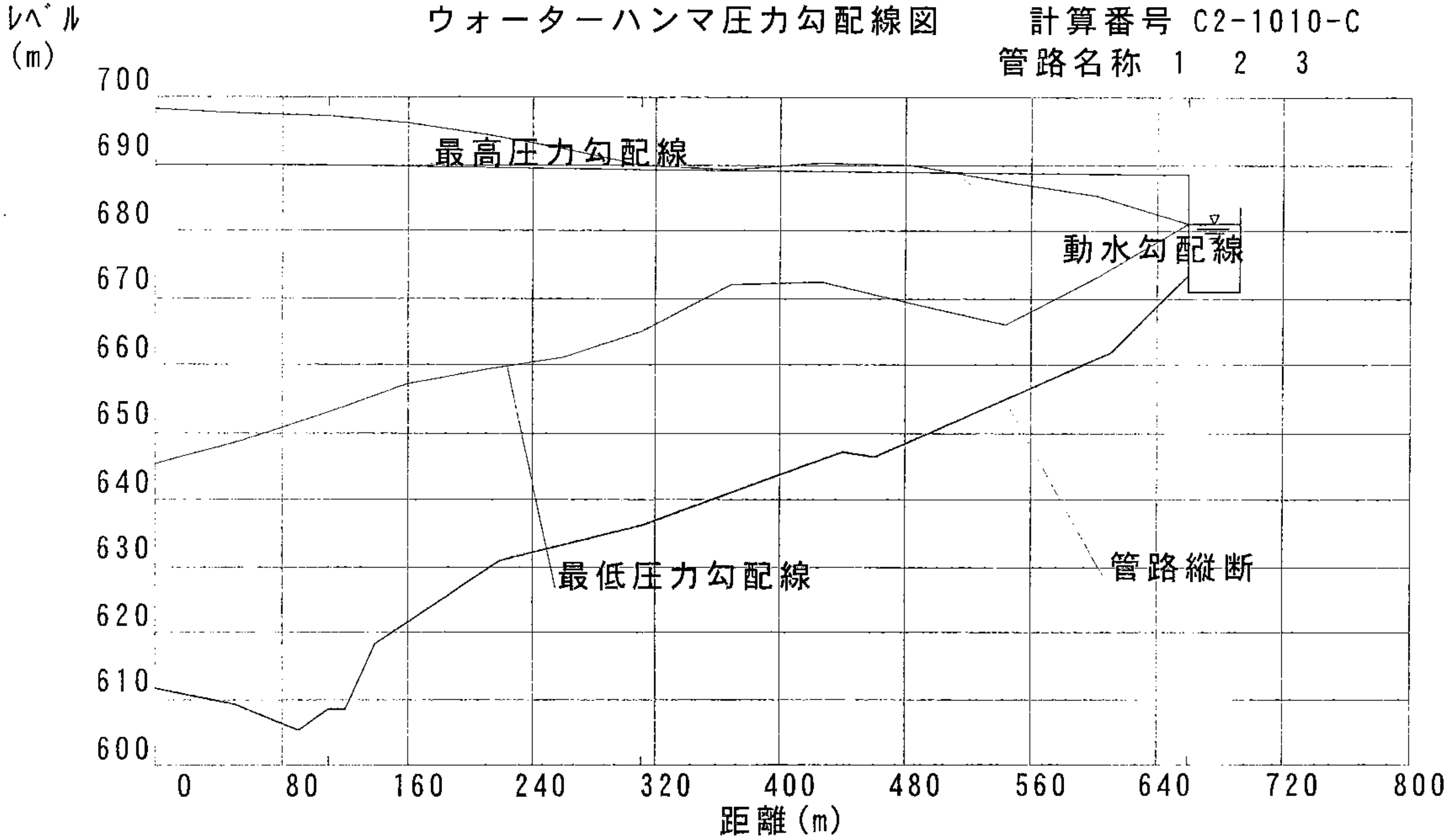
【 圧力線図仕様 】

   管路名称   1    2    3

【 縦断仕様 】
  管路  追加距離    レベル     追加距離    レベル     追加距離    レベル     追加距離    レベル
  名称        m         m            m         m            m         m            m         m
   1         .0    611.50         50.0    609.00         90.0    605.28        110.0    608.47
   2      110.0    608.47        120.0    608.37        140.0    618.19        220.0    630.85
          310.0    636.10
   3      310.0    636.10        440.0    646.97        460.0    646.20        610.0    661.64
          660.0    673.50
```

ウォーターハンマ圧力勾配線図　　計算番号 C2-1010-C

管路名称 1 2 3



基準レベル 613

TRANSMISSION PUMP (C):

Heerasagala Middle SR ⟶ Heerasagala High SR.

4-172

```
                    ウォーターハンマ計算条件                         計算番号 C2-1010-D1       PAGE     1

                    Transmission Pump (D1)

                    基準レベル              582.500 m
                    計算時間単位             .05248 sec

【 管路仕様 】
                                                                              サージ    弁
 管路     管長     管種   管径     管厚  ヤング   上流の管路      ポンプ   タンク    番   終点  管路流量    配管    弁絞  圧力波
 名称       m              mm       mm    率                      番号    番号     号   条件      m3/m    損失    損失  往復時間   管路定数    分割
                                                                                                          m       m      sec
   1     235.0  VP 1    225     12.7    .027                   1  0  0    0       0     0       .830    .200    .000   1.2595     7.9846      24
   2    2774.0  FCD3    200      6.0   1.600   1               0  0  0    0       0     0       .830   4.700    .000   4.6578    32.2567      88
   3     958.0  VP 1    225     12.7    .027   2               0  0  0    0       0     1       .830    .800   3.800   5.1345     7.9846      98

【 ポンプ仕様 】
                  弁    弁                                                                     効    減衰   ---------- 初期状態 ----------
  番  台  形      閉    番  全揚程     吐出量     出力  極   型  ポンプ・モータ  フライホイール 回転数 率    定数      揚程   吐出量  回転数 トルク
  号  数  式      鎖    号      m       m3/m       kw   数   式       kg-m2        kg-m2   min-1  %        k          m     m3/m
   1   1   1       1     0  45.000      .830     11.0   2    1         .270         .000    2900 66  1.4850    45.000     .830   1.000  1.000

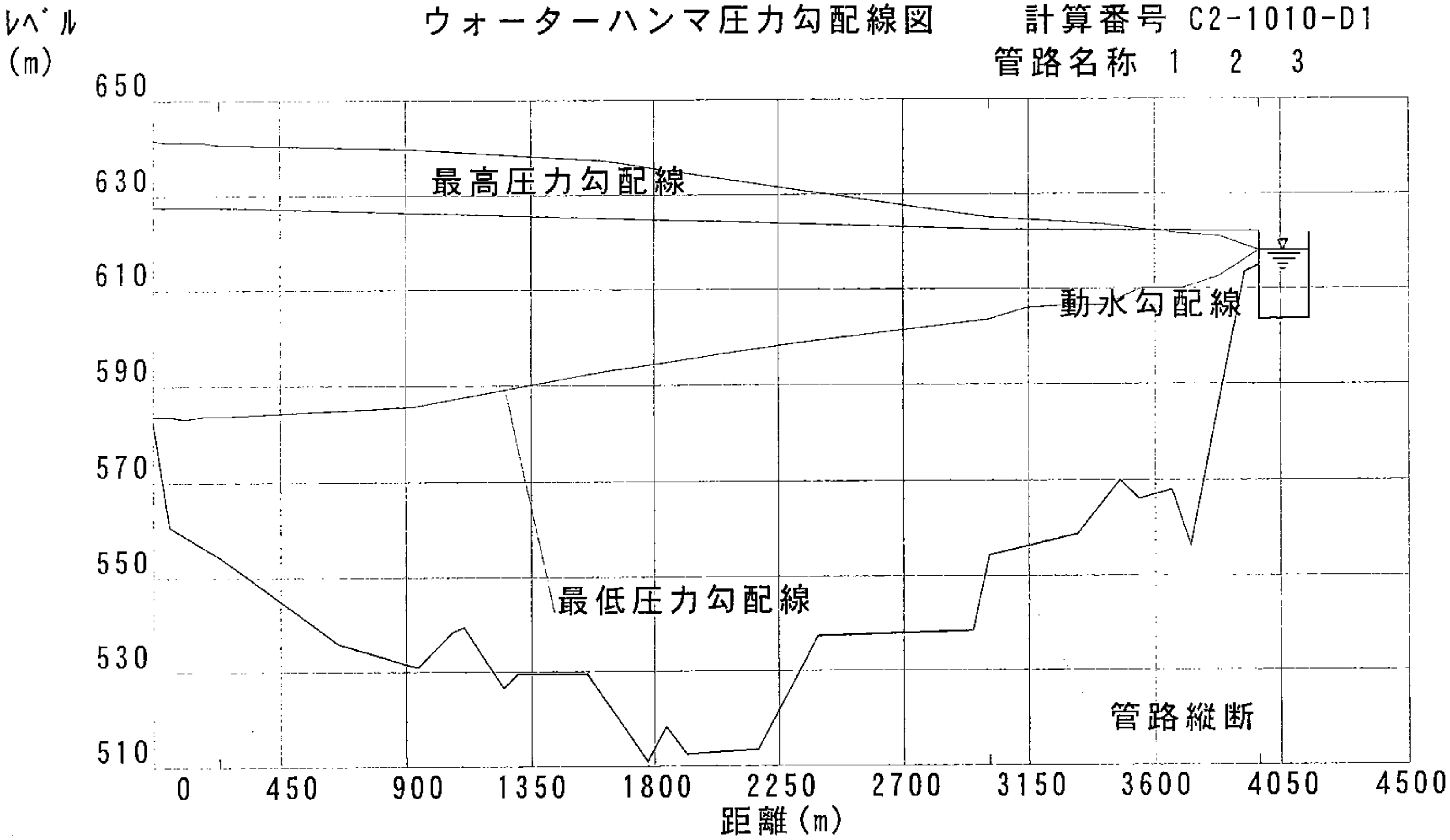
【 圧力線図仕様 】

   管路名称    1      2      3

【 縦断仕様 】
 管路  追加距離     レベル     追加距離     レベル     追加距離     レベル     追加距離     レベル
 名称       m          m           m           m            m           m            m           m
   1         .0     582.08        58.0     560.55        235.0     554.00
   2      235.0     554.00       662.0     536.23        940.0     531.00       1068.0     538.59
         1108.0     539.48      1250.0     526.64       1306.0     529.73       1551.0     529.79
         1767.0     510.75      1840.0     518.40       1915.0     512.30       2169.0     513.27
         2389.0     537.46      2949.0     538.39       3009.0     554.00
   3     3009.0     554.00      3330.0     558.58       3479.0     569.84       3547.0     565.77
         3657.0     568.00      3727.0     556.25       3917.0     613.50       3967.0     615.00
```

ウォーターハンマ圧力勾配線図　　計算番号 C2-1010-D1

管路名称 1 2 3



基準レベル 582.5

TRANSMission Pump (-D-1) :

Ampitiya SR → ethona SR,

ト-79

```
                      ウォーター-ハンマ計算条件                     計算番号 1010D2PC         PAGE    1

                      Trans.P(D2) Mulle Ph3

                      基準レベル             582.500 m
                      計算時間単位            .18784 sec

【 管路仕様 】
                                                                         サージ   弁                          配管     弁絞   圧力波
   管路    管長    管種  管径    管厚   ヤング  上流の管路        ポンプ   タンク   番   終点  管路流量     損失     損失  往復時間     管路定数     分割
   名称      m            mm      mm     率                        番号    番号    号   条件      m3/m         m        m       sec
    1     930.7   FCD3   150     6.0   1.600                     1  0  0    0      0     0      .680    4.415     .000   1.5027     59.6353       8
    2     961.8   FCD3   150     6.0   1.600   1                 0  0  0    0      0     1      .680    4.563    3.922   1.5529     59.6353       8

【 ポンプ仕様 】
                      弁    弁                                                                      効    減衰   ---------- 初期状態 ----------
    番   台   形      閉    番   全揚程     吐出量      出力   極    型 ポンプ・モータ   フライホイール 回転数 率    定数       揚程     吐出量  回転数  トルク
    号   数   式      鎖    号       m       m3/m        kw   数    式        kg-m2        kg-m2  min-1  %       k          m      m3/m
    1    1    1       1     0 146.000      .680      30.0    2    1          .541        2.000   2900 60   .4614   146.000      .680   1.000   1.000

【 圧力線図仕様 】

    管路名称    1      2

【 縦断仕様 】
   管路   追加距離     レベル     追加距離     レベル     追加距離     レベル     追加距離     レベル
   名称          m          m            m          m            m          m            m          m
    1           .0     588.83        127.0     567.07        930.7     619.30       1108.9     629.14
            1450.0     647.84       1818.2     663.13       1892.5     705.80       1892.5     713.00
```

D2   Phase 3   Flywheel : 2 kgf-m²

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                        ウォーターハンマ計算結果                     計算番号 1010D2PC        PAGE     2

 1. 計算インターバル       8

 3. 管路の圧力変化
                           -------------- 最高圧力 --------------      -------------- 最低圧力 --------------
   管路     追加          経過時間      流量      圧力       圧力         経過時間      流量      圧力       圧力
   番号     距離                                （水頭）（ﾚﾍﾞﾙ表示）                             （水頭）（ﾚﾍﾞﾙ表示）
                m             sec      m3/m         m          m              sec      m3/m         m          m

    1          .0           5.447      .000   192.627    775.127            3.005      .000    60.492    642.992
    1       232.7           5.447      .000   192.578    775.078            2.818      .000    60.549    643.049
    1       465.4           5.635      .001   192.452    774.952            2.630      .002    60.733    643.233
    1       698.0           5.447     -.002   192.026    774.526            2.442      .006    61.243    643.743

    2          .0           5.260     -.028   188.973    771.473            2.254      .035    64.608    647.108
    2       240.4           5.072     -.086   182.057    764.557            2.066      .114    74.038    656.538
    2       480.9           4.884     -.179   171.169    753.669            1.878      .227    87.313    669.813
    2       721.3           4.884     -.166   153.400    735.900            1.691      .398   106.798    689.298
```
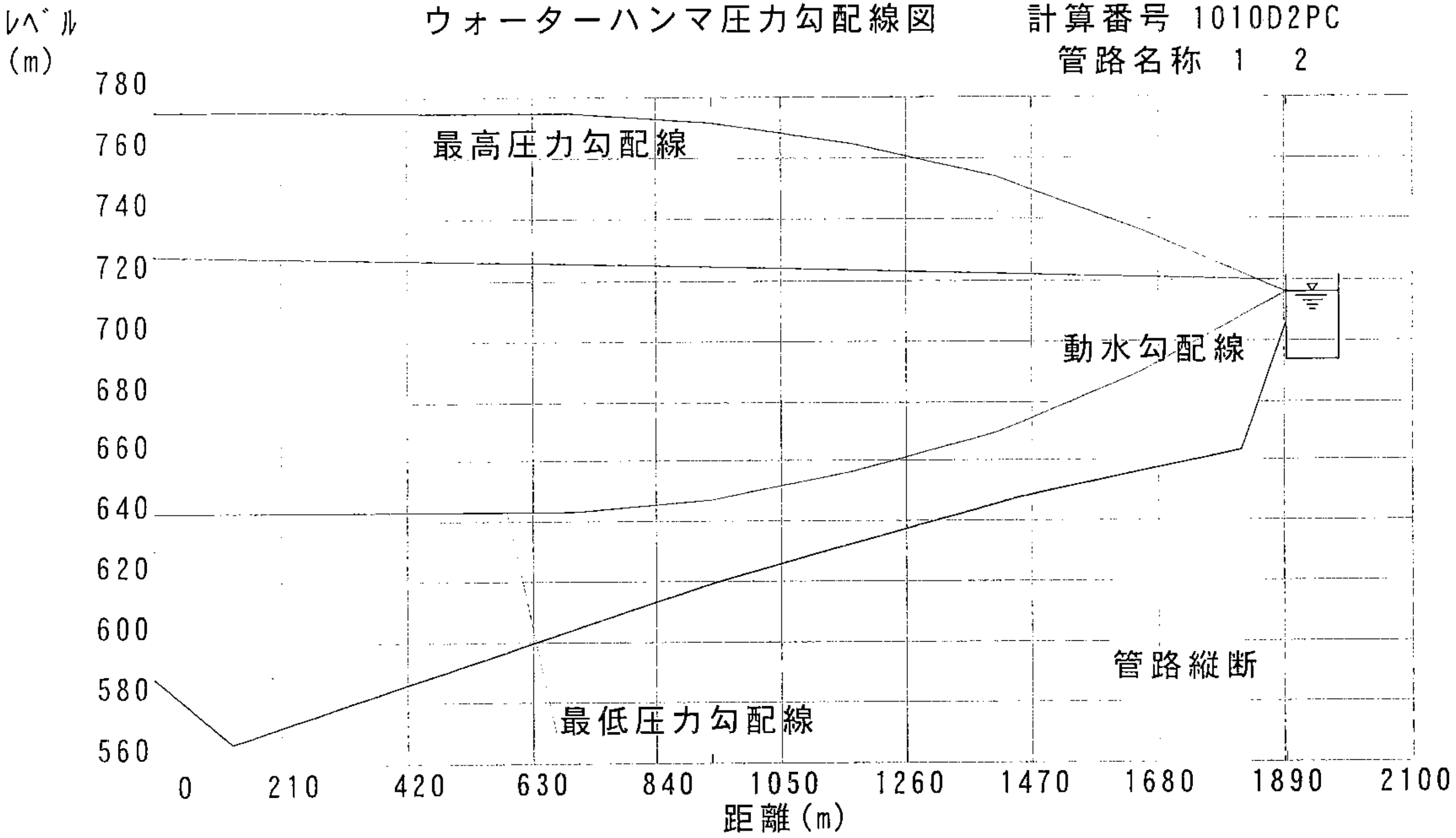

ウォーターハンマ圧力勾配線図

計算番号 1010D2PC
管路名称 1 2



基準レベル 582.5

D2 Phase 3 Flywheel : 2kgf-m²

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                     ウォーターハンマ計算条件                          計算番号 1010D3PA         PAGE    1

                     Trans.P(D3)  to Meeka.R

                     基準レベル              582.500 m
                     計算時間単位              .00807 sec

【 管路仕様 】
                                                                       ｻｰｼﾞ    弁                         配管      弁絞   圧力波
  管路     管長     管種    管径    管厚   ヤング  上流の管路        ポンプ     ﾀﾝｸ     番   終点  管路流量      損失      損失  往復時間    管路定数     分割
  名称        m              mm      mm     率                        番号      番号    号   条件      m3/m        m         m       sec
   1       10.0   FCD3    150     6.0   1.600                       1  0  0     0      0     0       .868      .062      .000     .0161     59.6353      2
   2      465.0   FCD3    150     6.0   1.600   1                   0  0  0     0      0     0       .868     2.865      .000     .7508     59.6353     92
   5     1625.0   VP 1    160    12.7    .027   2                   0  0  0     0      0     0       .868     7.312      .000    7.4460     18.4690    924
   8       10.0   VP 1    160    12.7    .027   5                   0  0  0     0      0     1       .868      .045      .000     .0458     18.4690      6

【 ポンプ仕様 】
                    弁     弁                                                                       効     減衰    ---------- 初期状態 ----------
   番   台   形     閉     番   全揚程     吐出量       出力   極      型 ﾎﾟﾝﾌﾟ･ﾓｰﾀ   ﾌﾗｲﾎｲｰﾙ 回転数 率      定数       揚程    吐出量 回転数 トルク
   号   数   式     鎖     号        m       m3/m         kw   数      式     kg-m2      kg-m2  min-1  %        k           m      m3/m
   1    1    1      1      0   73.000      .868       37.0    2       1       .860       .000   2900 67    .7791    73.000      .868  1.000  1.000

【 圧力線図仕様 】

    管路名称    1     2     5     8

【 縦断仕様 】
  管路  追加距離     レベル      追加距離     レベル      追加距離     レベル      追加距離     レベル
  名称         m          m             m          m             m          m             m          m
   1          .0     584.26          10.0     584.26          60.0     592.69         175.0     561.12
           375.0     567.73         475.0     564.70         495.0     564.12         695.0     579.34
           762.0     576.85        1455.0     616.85        1535.0     618.03        1675.0     616.86
          1875.0     611.23        1975.0     611.70        2010.0     624.69        2045.0     626.86
          2095.0     620.50        2105.0     620.50
```

D3 Phase 1

5.78

1. 計算インターバル　1638

3. 管路の圧力変化

管路番号	追加距離	最高圧力				最低圧力			
		経過時間	流量	圧力（水頭）	圧力（ﾚﾍﾞﾙ表示）	経過時間	流量	圧力（水頭）	圧力（ﾚﾍﾞﾙ表示）
	m	sec	m3/m	m	m	sec	m3/m	m	m
1	.0	9.550	.000	87.700	670.200	1.631	.004	18.855	601.355
1	5.0	9.546	.000	87.700	670.200	1.643	-.002	19.095	601.595
2	.0	9.550	.000	87.699	670.199	1.647	-.004	19.330	601.830
2	116.3	9.570	.000	87.529	670.029	1.740	-.043	23.972	606.472
2	232.5	9.712	.002	87.449	669.949	1.833	-.072	27.469	609.969
2	348.8	9.619	-.003	86.903	669.403	1.925	-.095	30.217	612.717
5	.0	9.526	-.021	84.741	667.241	2.018	-.122	33.495	615.995
5	406.3	10.604	.054	82.754	665.254	6.955	.013	37.684	620.184
5	812.5	11.609	.055	82.756	665.256	6.022	.019	37.911	620.411
5	1218.8	12.598	.046	82.992	665.492	5.042	-.051	36.162	618.662
8	.0	12.424	-.264	64.209	646.709	4.158	.818	60.920	643.420
8	1.7	12.420	-.271	63.967	646.467	4.154	.826	61.208	643.708
8	3.3	12.416	-.277	63.723	646.223	4.150	.834	61.501	644.001
8	5.0	12.412	-.284	63.475	645.975	4.146	.842	61.797	644.297
8	6.7	12.408	-.291	63.225	645.725	4.141	.851	62.099	644.599
8	8.3	12.404	-.298	62.972	645.472	4.137	.859	62.404	644.904

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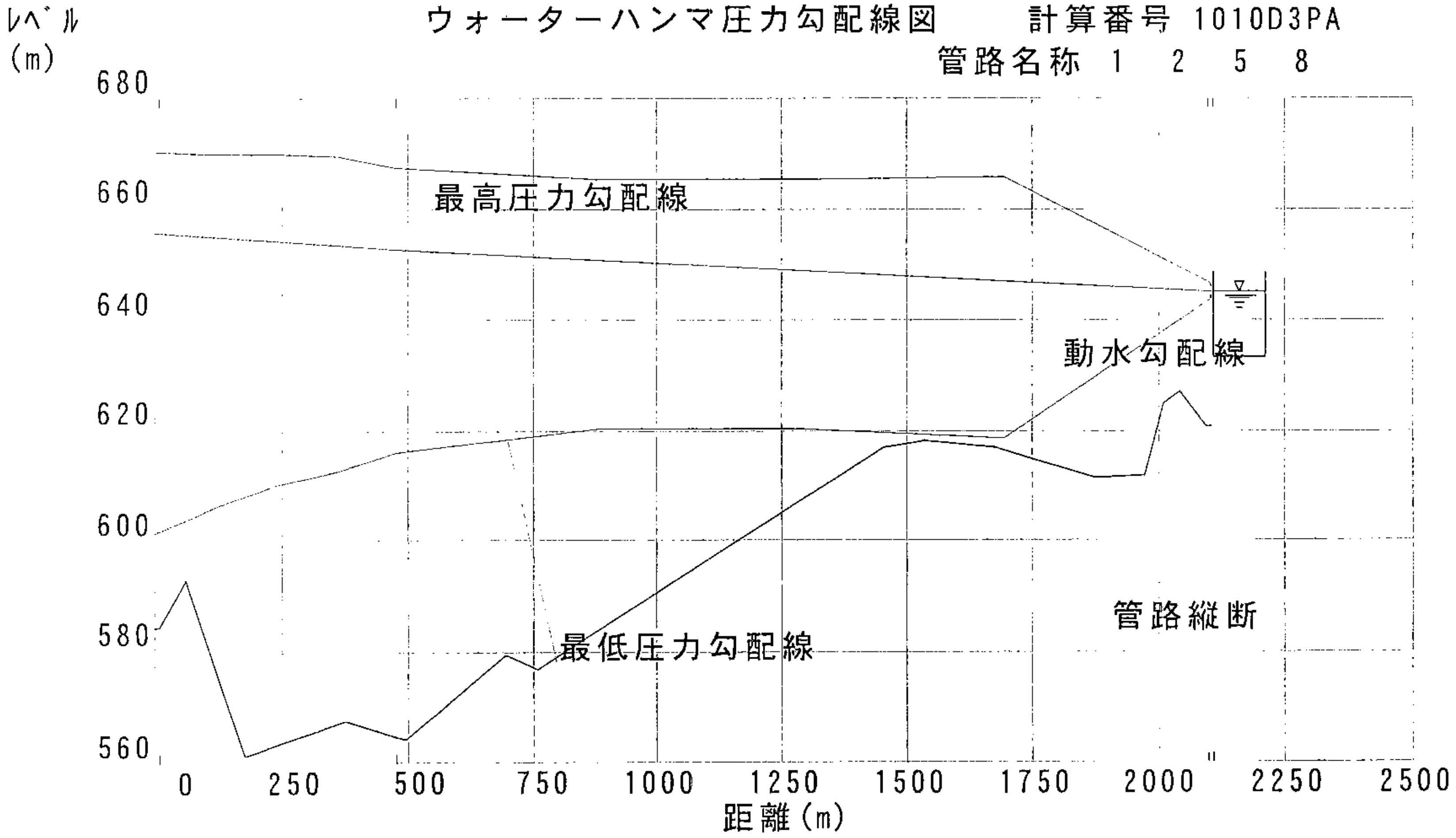
ウォーターハンマ圧力勾配線図　　計算番号 1010D3PA

管路名称　1　2　5　8



基準ﾚﾍﾞﾙ 582.5

D3　Phase 1.

```
                        ウォーターハンマ計算条件                       計算番号 C2-1010-D2      PAGE    1

                        Transmission Pump (D2)

                        基準レベル             582.500 m
                        計算時間単位            .03202 sec

【 管路仕様 】
                                                                      サージ     弁                              配管      弁絞   圧力波
  管路     管長    管種   管径     管厚   ヤング  上流の管路        ポンプ     タンク     番     終点  管路流量       損失      損失  往復時間    管路定数      分割
  名称        m              mm       mm     率                      番号      番号     号     条件      m3/m          m         m       sec
    1     119.0  FCD3    150      6.0   1.600                     1  0  0      0      0      0      .680       .600      .000     .1921     59.6353        6
    2    2031.0  FCD3    150      6.0   1.600   1                 0  0  0      0      0      1      .680      9.600     2.300    3.2793     59.6353      104

【 ポンプ仕様 】
                      弁     弁                                                                    効     減衰    ---------- 初期状態 ----------
   番   台   形       閉     番   全揚程     吐出量      出力   極    型  ポンプ・モータ   フライホイール 回転数  率     定数       揚程     吐出量  回転数  トルク
   号   数   式       鎖     号       m       m3/m        kw   数    式       kg-m2        kg-m2   min-1   %        k          m      m3/m
    1    1    1        1      0 146.000      .680      30.0    2     1        .541         .000    2900  60   2.1669   146.000      .680   1.000   1.000

【 圧力線図仕様 】

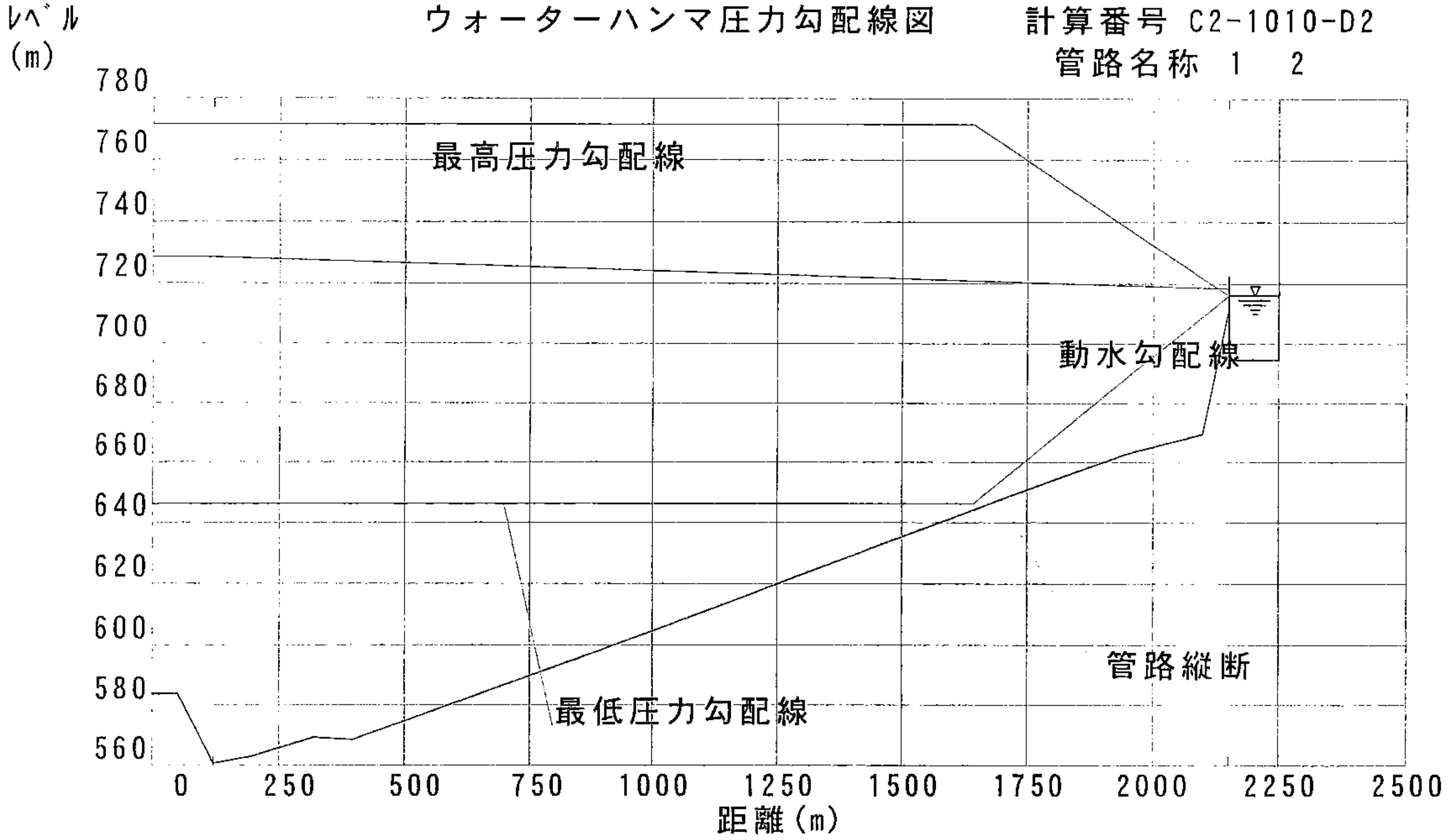
   管路名称    1     2

【 縦断仕様 】
  管路  追加距離      レベル       追加距離     レベル       追加距離     レベル       追加距離     レベル
  名称         m          m              m          m              m          m              m          m
    1          .0     584.26           50.0     584.26          119.0     561.12
    2       119.0     561.12          200.0     562.97          320.0     568.88          398.0     568.25
           1150.0     614.37         1450.0     632.78         1940.0     662.83         2100.0     669.41
           2150.0     711.50
```

18-5

ウォーターハンマ圧力勾配線図　　計算番号 C2-1010-D2

管路名称 1 2



基準レベル 582.5

Transmission Pump (D-2):

Ampitiya SR → Mullopitiella SR

ウォーターハンマ計算条件

計算番号 C2-1010-D3

Transmission Pump (D3)

基準レベル 582.500 m
計算時間単位 .00807 sec

【 管路仕様 】

管路名称	管長 m	管種	管径 mm	管厚 mm	ヤング率	上流の管路			ポンプ番号			サージタンク番号	弁番号	終点条件	管路流量 m3/m	配管損失 m	弁絞損失 m	圧力波往復時間 sec	管路定数	分割
1	10.0	FCD3	150	6.0	1.600				1	0	0	0	0	0	1.490	.100	.000	.0161	59.6353	2
2	355.0	FCD3	150	6.0	1.600	1			0	0	0	0	0	0	1.490	.900	.000	.5732	59.6353	72
3	355.0	FCD3	150	6.0	1.600	1			0	0	0	0	0	0	1.490	.900	.000	.5732	59.6353	72
4	355.0	FCD3	150	6.0	1.600	1			0	0	0	0	0	0	1.490	.900	.000	.5732	59.6353	72
5	1710.0	VP 1	160	12.7	.027	2			0	0	0	0	0	0	1.490	2.900	.000	7.8355	18.4690	972
6	1710.0	VP 1	160	12.7	.027	3			0	0	0	0	0	0	1.490	2.900	.000	7.8355	18.4690	972
7	1710.0	VP 1	160	12.7	.027	4			0	0	0	0	0	0	1.490	2.900	.000	7.8355	18.4690	972
8	10.0	VP 1	160	12.7	.027	5	6	7	0	0	0	0	0	1	1.490	.100	.000	.0458	18.4690	6

【 ポンプ仕様 】

番号	台数	形式	弁閉鎖	弁番号	全揚程 m	吐出量 m3/m	出力 kw	極数	型式	ポンプ・モータ kg-m2	フライホイール kg-m2	回転数 min-1	効率 %	減衰定数 k	----------- 初期状態 ----------- 揚程 m	吐出量 m3/m	回転数	トルク
1	1	1	1	0	73.000	1.490	37.0	2	1	.860	.000	2900	67	1.3374	73.000	1.490	1.000	1.000

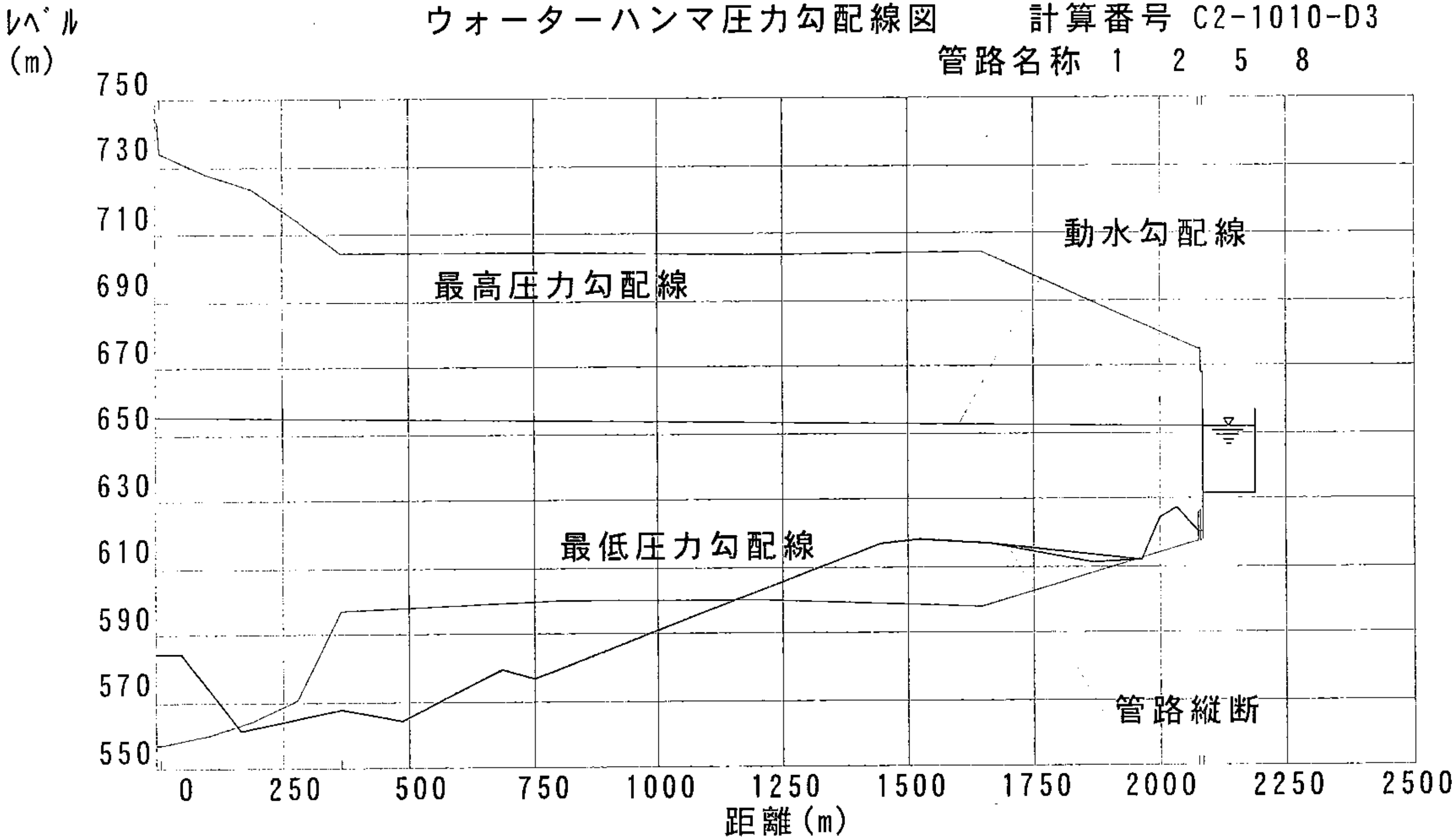
【 圧力線図仕様 】

管路名称 1 2 5 8

【 縦断仕様 】

管路名称	追加距離 m	レベル m	追加距離 m	レベル m	追加距離 m	レベル m	追加距離 m	レベル m
1	.0	584.26	10.0	584.26				
2	10.0	584.26	50.0	584.26	165.0	561.12	365.0	567.73
5	365.0	567.73	465.0	564.70	485.0	564.12	685.0	579.34
	752.0	576.85	1445.0	616.85	1525.0	618.03	1665.0	616.86
	1865.0	611.23	1965.0	611.70	1665.0	616.86	1965.0	611.70
	2000.0	624.69	2035.0	626.86	2075.0	620.50		
8	2075.0	620.50	2085.0	620.50				

ウォーターハンマ圧力勾配線図　計算番号 C2-1010-D3
管路名称 1 2 5 8



基準レベル 582.5

Transmission Pump (D-3):

Ampitiya SR → Meekanuwa SR.

無対策: 負圧発生

V-88

ウォーターハンマ計算条件

計算番号 C2-1010-D3　　PAGE 1

Fly wheel: 15kg-m^2.

Transmission Pump (D3)

基準レベル　582.500 m
計算時間単位　.00807 sec

【 管路仕様 】

管路名称	管長 m	管種	管径 mm	管厚 mm	ヤング率	上流の管路			ポンプ番号			サージタンク番号	弁番号	終点条件	管路流量 m3/m	配管損失 m	弁絞損失 m	圧力波往復時間 sec	管路定数	分割
1	10.0	FCD3	150	6.0	1.600				1	0	0	0	0	0	1.490	.100	.000	.0161	59.6353	2
2	355.0	FCD3	150	6.0	1.600	1			0	0	0	0	0	0	1.490	.900	.000	.5732	59.6353	72
3	355.0	FCD3	150	6.0	1.600	1			0	0	0	0	0	0	1.490	.900	.000	.5732	59.6353	72
4	355.0	FCD3	150	6.0	1.600	1			0	0	0	0	0	0	1.490	.900	.000	.5732	59.6353	72
5	1710.0	VP 1	160	12.7	.027	2			0	0	0	0	0	0	1.490	2.900	.000	7.8355	18.4690	972
6	1710.0	VP 1	160	12.7	.027	3			0	0	0	0	0	0	1.490	2.900	.000	7.8355	18.4690	972
7	1710.0	VP 1	160	12.7	.027	4			0	0	0	0	0	0	1.490	2.900	.000	7.8355	18.4690	972
8	10.0	VP 1	160	12.7	.027	5	6	7	0	0	0	0	0	1	1.490	.100	.000	.0458	18.4690	6

【 ポンプ仕様 】

															---------- 初期状態 ----------			
番号	台数	形式	弁閉鎖	弁番号	全揚程 m	吐出量 m3/m	出力 kw	極数	型式	ﾎﾟﾝﾌﾟ･ﾓｰﾀ kg-m2	ﾌﾗｲﾎｲｰﾙ kg-m2	回転数 min-1	効率 %	減衰定数 k	揚程 m	吐出量 m3/m	回転数	トルク
1	1	1	1	0	73.000	1.490	37.0	2	1	.860	15.000	2900	67	.0725	73.000	1.490	1.000	1.000

【 圧力線図仕様 】

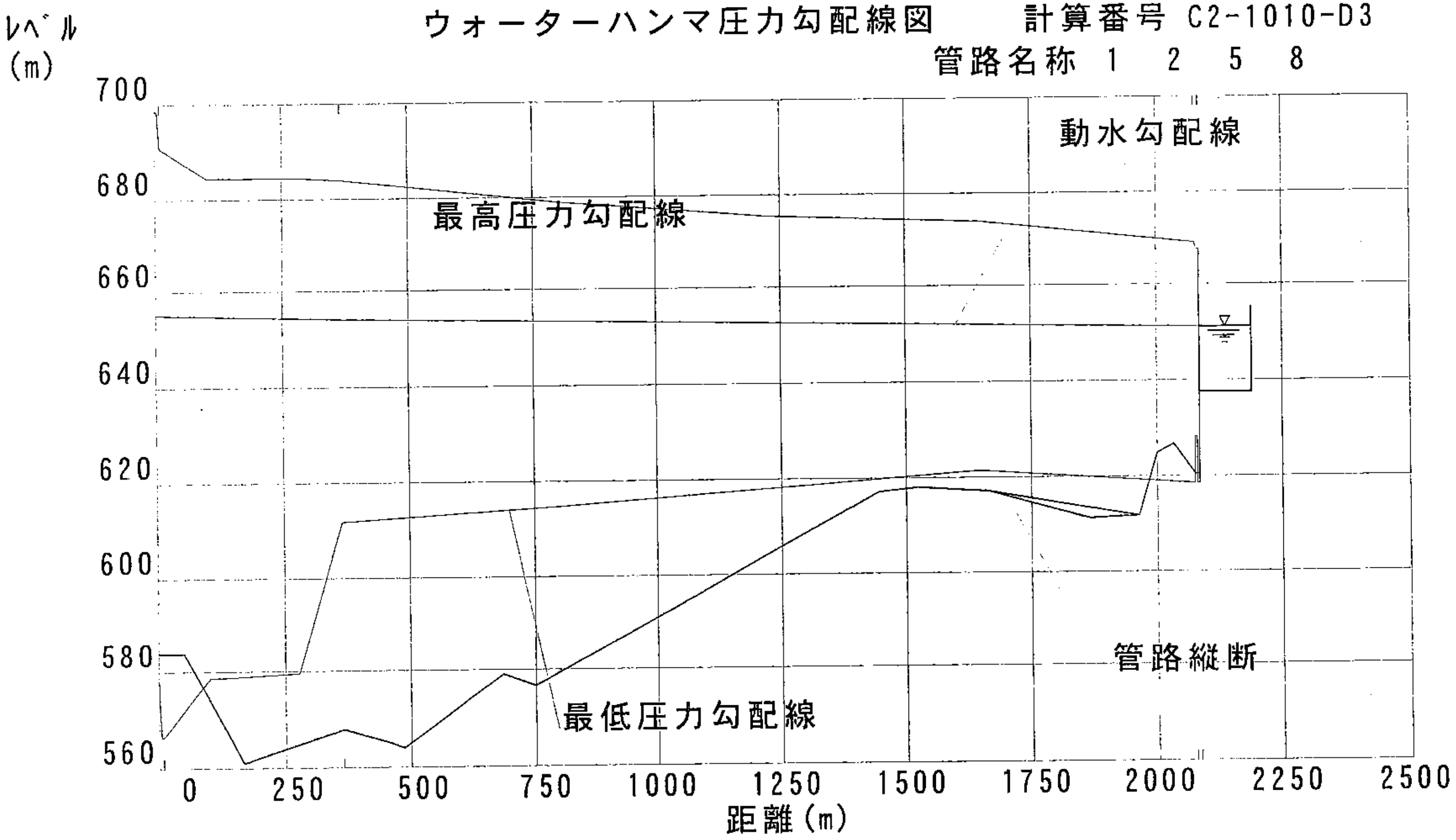
管路名称　1　2　5　8

【 縦断仕様 】

管路名称	追加距離 m	レベル m	追加距離 m	レベル m	追加距離 m	レベル m	追加距離 m	レベル m
1	.0	584.26	10.0	584.26				
2	10.0	584.26	50.0	584.26	165.0	561.12	365.0	567.73
5	365.0	567.73	465.0	564.70	485.0	564.12	685.0	579.34
	752.0	576.85	1445.0	616.85	1525.0	618.03	1665.0	616.86
	1865.0	611.23	1965.0	611.70	1665.0	616.86	1965.0	611.70
	2000.0	624.69	2035.0	626.86	2075.0	620.50		
8	2075.0	620.50	2085.0	620.50				

ウォーターハンマ圧力勾配線図　計算番号 C2-1010-D3

管路名称 1 2 5 8



基準レベル 582.5

Transmission Pump (D-3):

Ampitiya SR → Makanawe SR

対策 15g-m² Flywheel 付

ウォーターハンマ計算条件

計算番号 C2-1010-E

Transmission Pump (E)

基準レベル 516.000 m
計算時間単位 .04570 sec

【 管路仕様 】

管路 名称	管長 m	管種	管径 mm	管厚 mm	ヤング 率	上流の管路	ポンプ 番号	ｻｰｼﾞ ﾀﾝｸ 番号	弁 番 号	終点 条件	管路流量 m3/m	配管 損失 m	弁絞 損失 m	圧力波 往復時間 sec	管路定数	分割
1	50.0	FCD3	350	6.5	1.600		1 0 0	0	0	0	5.080	.100	.000	.0914	9.6740	2
2	836.0	FCD3	350	6.5	1.600	1	0 0 0	0	0	0	5.080	2.600	.000	1.5283	9.6740	34
3	1624.0	FCD3	350	6.5	1.600	2	0 0 0	0	0	0	5.080	5.100	.000	2.9689	9.6740	64
4	1396.0	FCD3	350	6.5	1.600	3	0 0 0	0	0	1	3.750	2.500	5.700	2.5521	9.6740	56
5	949.0	FCD3	200	6.0	1.600	3	0 0 0	0	0	1	1.330	3.900	11.800	1.5935	32.2567	34

【 ポンプ仕様 】

番 号	台 数	形 式	弁 閉 鎖	弁 番 号	全揚程 m	吐出量 m3/m	出力 kw	極 数	型 式	ﾎﾟﾝﾌﾟ・ﾓｰﾀ kg-m2	ﾌﾗｲﾎｲｰﾙ kg-m2	回転数 min-1	効 率 %	減衰 定数 k	---------- 初期状態 ---------- 揚程 m	吐出量 m3/m	回転数	トルク
1	2	1	1	0	73.000	2.540	55.0	2	1	.960	.000	2900	68	2.0124	73.000	2.540	1.000	1.000

【 圧力線図仕様 】

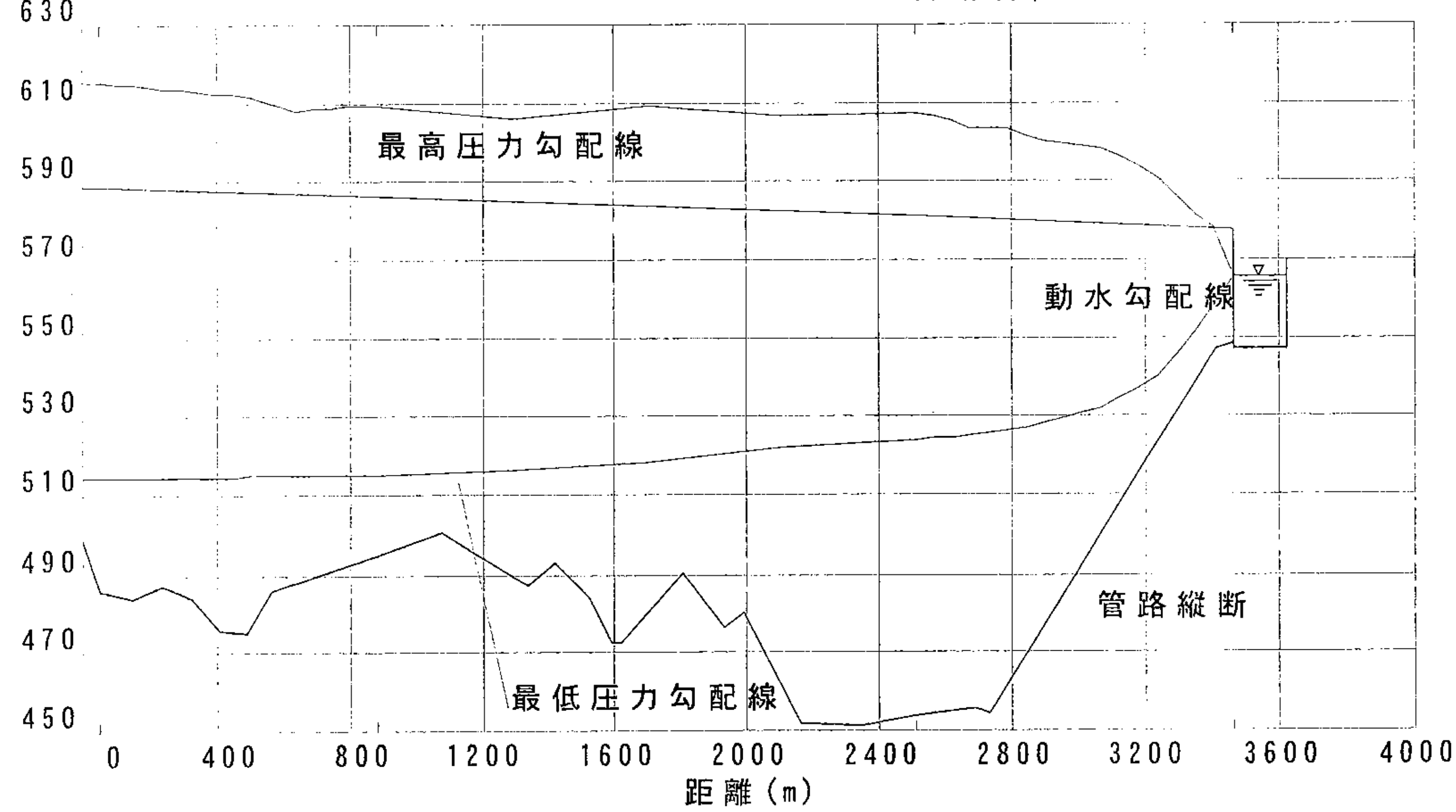
管路名称 1 2 3 4

【 縦断仕様 】

管路 名称	追加距離 m	レベル m	追加距離 m	レベル m	追加距離 m	レベル m	追加距離 m	レベル m
1	.0	498.50	50.0	486.14				
2	50.0	486.14	147.0	484.10	235.0	487.52	323.0	484.14
	410.0	476.10	486.0	475.32	564.0	485.85	886.0	495.12
3	886.0	495.12	1078.0	500.46	1333.0	487.24	1418.0	493.21
	1523.0	483.87	1586.0	473.01	1622.0	472.93	1807.0	490.55
	1932.0	476.41	1990.0	480.34	2160.0	451.89	2349.0	451.01
	2510.0	453.53						
4	2510.0	453.53	3013.0	461.30	3354.0	518.97	3492.0	522.09
	3586.0	534.91	3650.0	530.52	3856.0	561.75	3906.0	567.50
5	2510.0	453.53	2690.0	455.90	2732.0	454.58	3409.0	547.02
	3459.0	548.50						

ウォーターハンマ圧力勾配線図　計算番号 C2-1010-E

管路名称 1 2 3 5

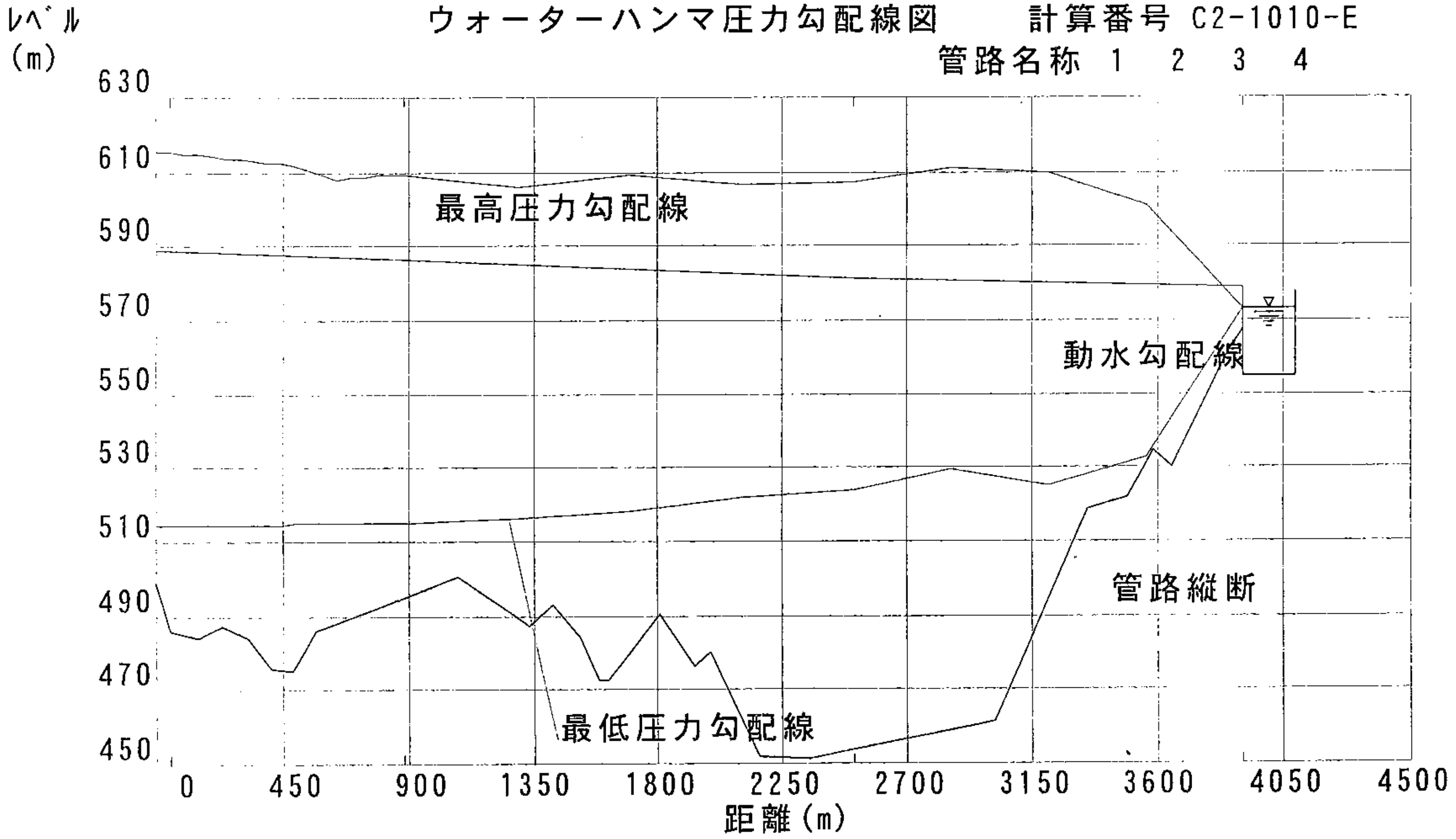


基準レベル 516

FoR Telambugahawatta ReservoiR

ウォーターハンマ圧力勾配線図　計算番号 C2-1010-E

管路名称 1 2 3 4



基準レベル 516

FoR Kurufoda Reservoir

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                          ウォーターハンマ計算条件                      計算番号 C2-1010-E1       PAGE    1

                          Transmission Pump (E)

                          基準レベル            516.000 m
                          計算時間単位           .04570 sec

【 管路仕様 】
                                                                         ｻｰｼﾞ   弁                       配管      弁絞  圧力波
  管路    管長    管種   管径    管厚  ヤング   上流の管路        ポンプ    ﾀﾝｸ    番   終点  管路流量     損失      損失  往復時間    管路定数    分割
  名称       m              mm      mm    率                      番号     番号   号   条件      m3/m        m         m       sec
   1      50.0   FCD3    350     6.5  1.600                     1  0  0    0     0     0      5.250      .100      .000     .0914     9.6740      2
   2     836.0   FCD3    350     6.5  1.600   1                 0  0  0    0     0     0      5.250     2.800      .000    1.5283     9.6740     34
   3    1624.0   FCD3    350     6.5  1.600   2                 0  0  0    0     0     0      5.250     5.400      .000    2.9689     9.6740     64
   4    1396.0   FCD3    350     6.5  1.600   3                 0  0  0    0     0     1      5.250     4.700      .000    2.5521     9.6740     56

【 ポンプ仕様 】
                      弁    弁                                                                        効    減衰   ----------- 初期状態 ----------
  番   台   形        閉    番   全揚程     吐出量      出力   極    型 ﾎﾟﾝﾌﾟ･ﾓｰﾀ   ﾌﾗｲﾎｲｰﾙ 回転数 率    定数        揚程    吐出量 回転数 トルク
  号   数   式        鎖    号        m       m3/m        kw   数    式     kg-m2      kg-m2  min-1  %       k           m      m3/m
   1    2    1         1     0  70.000      2.625      55.0    2     1      .960       .000   2900 67  2.0240      70.000     2.625  1.000  1.000

【 圧力線図仕様 】

    管路名称    1     2     3     4

【 縦断仕様 】
  管路  追加距離     レベル     追加距離     レベル      追加距離     レベル      追加距離     レベル
  名称         m          m            m          m             m          m             m          m
   1          .0     498.50         50.0     486.14
   2        50.0     486.14        147.0     484.10         235.0     487.52         323.0     484.14
           410.0     476.10        486.0     475.32         564.0     485.85         886.0     495.12
   3       886.0     495.12       1078.0     500.46        1333.0     487.24        1418.0     493.21
          1523.0     483.87       1586.0     473.01        1622.0     472.93        1807.0     490.55
          1932.0     476.41       1990.0     480.34        2160.0     451.89        2349.0     451.01
          2510.0     453.53
   4      2510.0     453.53       3013.0     461.30        3354.0     518.97        3492.0     522.09
          3586.0     534.91       3650.0     530.52        3856.0     561.75        3906.0     567.50
   5      2510.0     453.53       2690.0     455.90        2732.0     454.58        3409.0     547.02
          3459.0     548.50
```
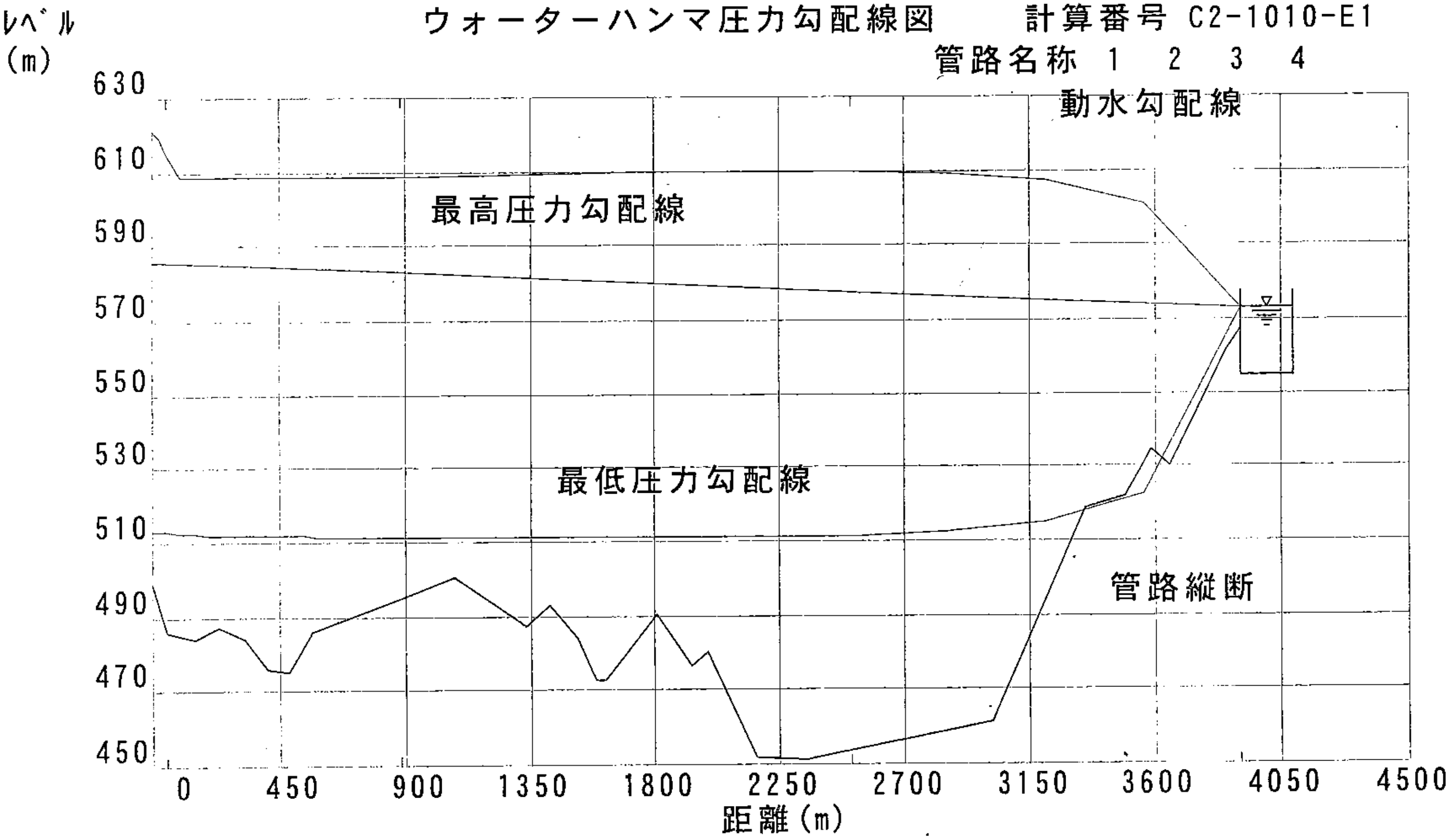

ウォーターハンマ圧力勾配線図　計算番号 C2-1010-E1

管路名称 1 2 3 4



基準レベル 516

FoR Kubugoda Reservoir の[illegible]の場合

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                         ウォーターハンマ計算条件                     計算番号 C2-1010-F        PAGE     1

                         Transmission Pump (F)

                         基準レベル            549.490 m
                         計算時間単位           .06786 sec

【 管路仕様 】
                                                                    ｻｰｼﾞ   弁                        配管      弁絞  圧力波
   管路    管長   管種  管径   管厚  ヤング  上流の管路        ポンプ  ﾀﾝｸ   番  終点  管路流量    損失      損失 往復時間   管路定数    分割
   名称     m           mm     mm    率                       番号   番号   号  条件     m3/m        m         m      sec
    1     970.0  FCD3   200    6.0  1.600                   1  0  0   0     0    1     4.100    3.400     .000   1.6287    32.2567     24

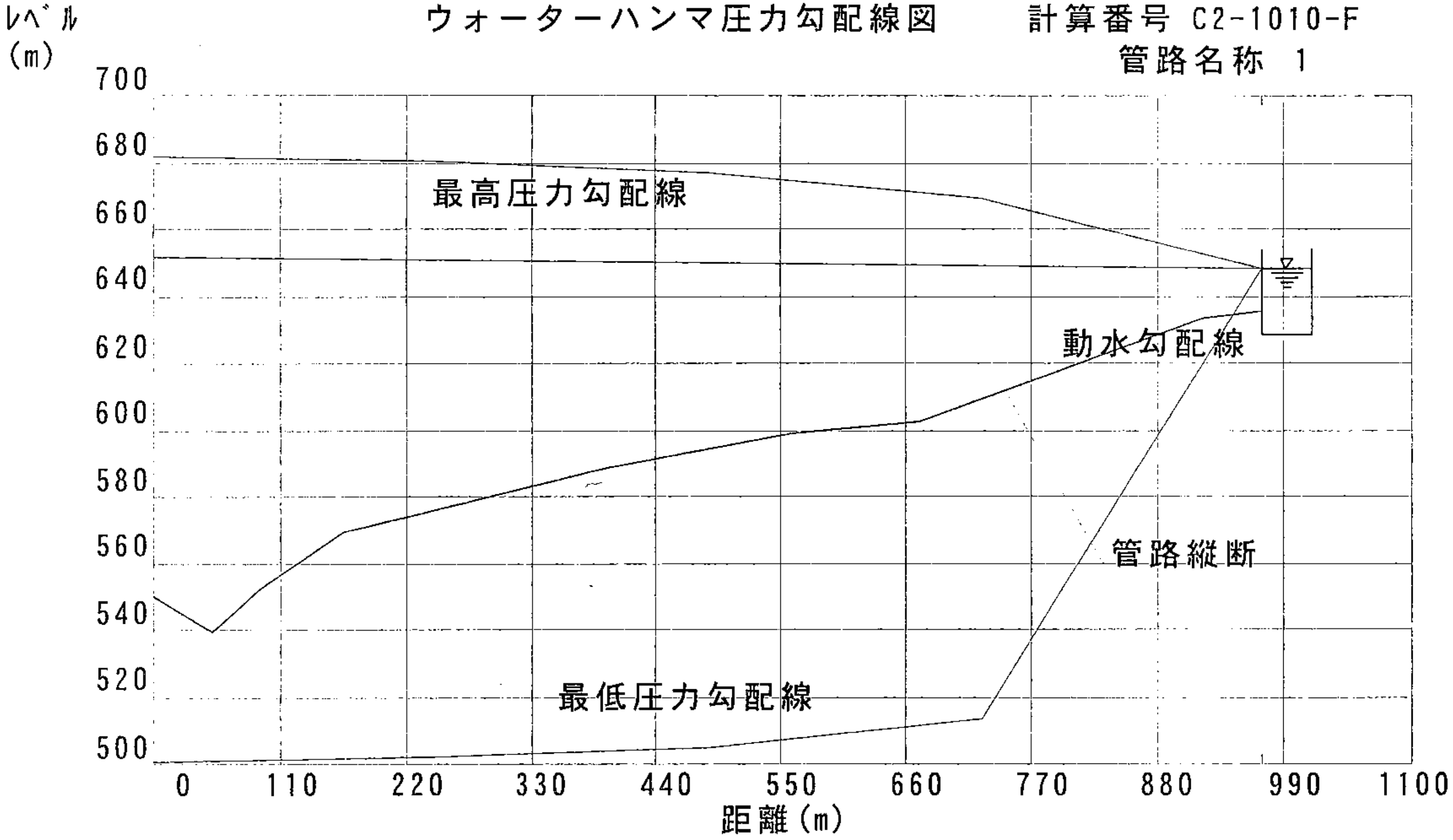
【 ポンプ仕様 】
                     弁   弁                                                                     効    減衰  ---------- 初期状態 ----------
   番  台  形        閉   番   全揚程    吐出量     出力  極   型 ﾎﾟﾝﾌﾟ･ﾓｰﾀ   ﾌﾗｲﾎｲｰﾙ 回転数 率    定数       揚程    吐出量 回転数 トルク
   号  数  式        鎖   号      m      m3/m       kw   数   式    kg-m2     kg-m2  min-1  %      k          m      m3/m
    1   1   1         1    0 102..000    1.360     55.0   2    1    1.440      .000   2900 58  1.1767  102.000     1.360  1.000  1.000

【 圧力線図仕様 】

    管路名称    1

【 縦断仕様 】
   管路  追加距離    レベル     追加距離    レベル     追加距離    レベル     追加距離    レベル
   名称       m        m             m        m             m        m             m        m
    1         .0    549.50         50.0    539.49         91.0    552.24        164.0    569.40
           397.0    588.57        559.0    599.15        672.0    602.37        920.0    633.36
           970.0    635.30
```

ウォーターハンマ圧力勾配線図　　計算番号 C2-1010-F
管路名称 1



基準レベル 549.49

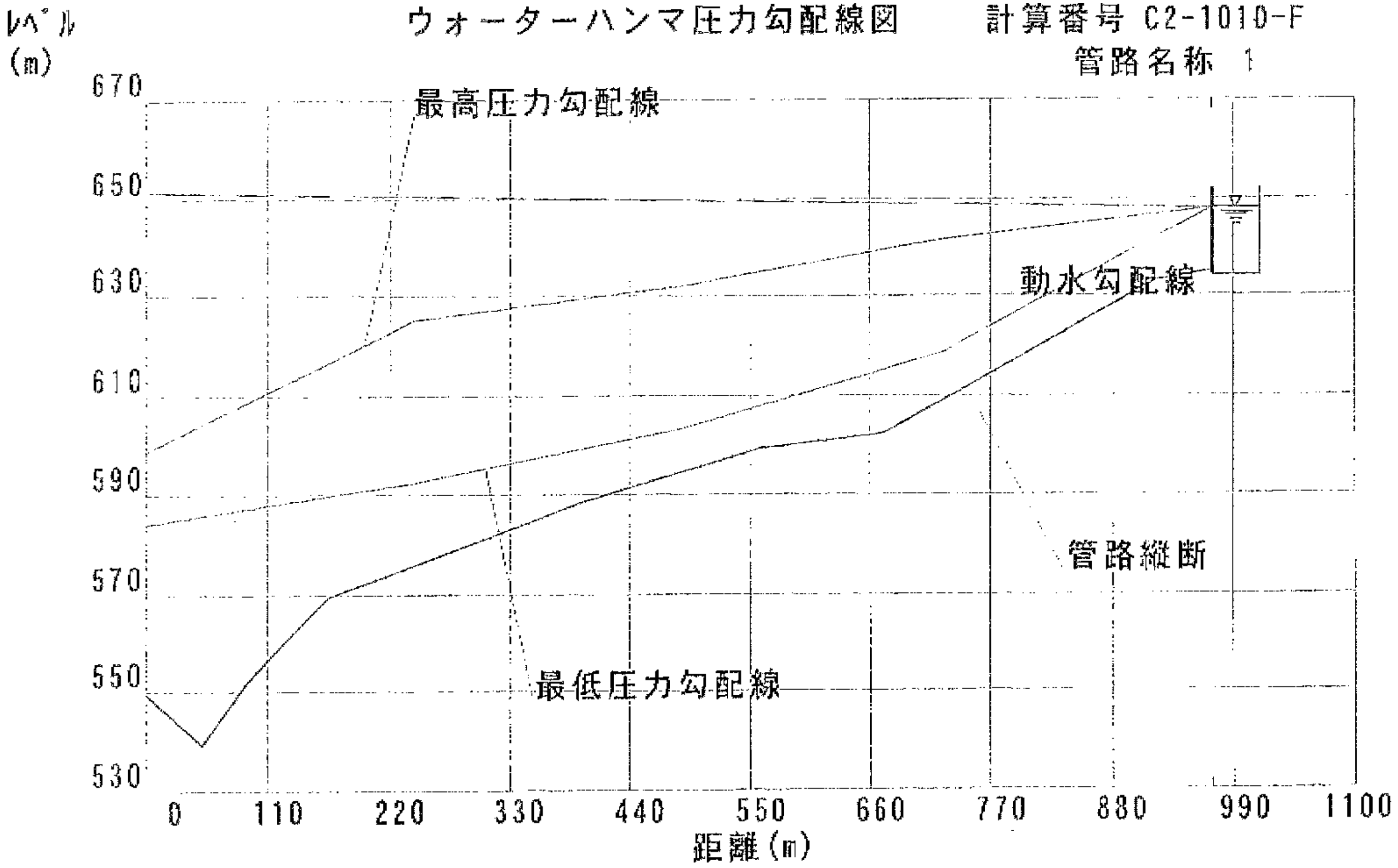
Transmission Pump(F):

R2 SR → Hantana Place SR.

無対策：負圧発生

ウォーターハンマ圧力勾配線図

計算番号 C2-1010-F
管路名称 1



基準レベル 549.49 Transmission Pump (F) :

R2 SR → Horitana Place SR

対策：(中タンク)(1m附) → 既解済

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                    ウォーターハンマ計算条件                    計算番号 C2-1010-F        PAGE    1

                    Transmission Pump (F)

                    基準レベル              549.490 m
                    計算時間単位             .06786 sec

【 管路仕様 】
                                                              ｻｰｼﾞ    弁                       配管     弁絞  圧力波
  管路    管長   管種   管径   管厚  ヤング  上流の管路      ポンプ   ﾀﾝｸ     番   終点 管路流量   損失     損失 往復時間  管路定数    分割
  名称      m            mm     mm    率                     番号    番号     号   条件    m3/m      m        m     sec
    1    970.0  FCD3    200    6.0  1.600                 1  0  0     1      0    1     4.100   3.400    .000  1.6287   32.2567     24

【 ポンプ仕様 】
                 弁   弁                                                                   効    減衰   ----------- 初期状態 -----------
  番  台  形     閉   番   全揚程    吐出量     出力  極   型 ﾎﾟﾝﾌﾟ･ﾓｰﾀ  ﾌﾗｲﾎｲｰﾙ 回転数 率    定数      揚程   吐出量 回転数 トルク
  号  数  式     鎖   号       m      m3/m       kw  数   式    kg-m2     kg-m2  min-1  %       k          m     m3/m
   1   1   1      1    0 102.000    1.360     55.0   2    1    1.440      .000   2900 58  1.1767  102.000    1.360  1.000  1.000

【サージタンク仕様】
             弁   水位                  連絡管  空気弁 連絡管                           ヤング  圧力波        管路       分     初期     戻り管
  番    形   番   高さ      断面積       損失    個数    長さ      管種 管径  管厚       率   往復時間       定数       割   空気量     損失
  号    式   号      m         m2          m                m               mm    mm                 sec                 数      m3        m
   1     3    0    .100      .000       7.347     0        .0         0    0    .0     .000    .0000        .000       0       .1    5.000

【 圧力線図仕様 】

    管路名称    1

【 縦断仕様 】
  管路  追加距離    レベル      追加距離   レベル       追加距離   レベル      追加距離    レベル
  名称        m        m            m        m             m        m             m         m
    1         .0    549.50        50.0    539.49         91.0    552.24        164.0    569.40
           397.0    588.57       559.0    599.15        672.0    602.37        920.0    633.36
           970.0    635.30
```

5-25

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                    ウォーターハンマ計算条件                    計算番号 C2-1010-H       PAGE    1

                    Transmission Pump (H)

                    基準レベル              531.250 m
                    計算時間単位              .04811 sec

【 管路仕様 】
                                                                サージ   弁                          配管      弁絞  圧力波
 管路     管長     管種   管径    管厚   ヤング  上流の管路         ポンプ   タンク  番   終点  管路流量    損失      損失  往復時間   管路定数      分割
 名称       m               mm      mm    率                      番号    番号   号   条件     m3/m        m         m      sec
   1      42.0   VP 1    160    12.7    .027                    1  0  0    0     0     0     1.110     .310      .000   .1925    18.4690         4
   2    1483.0   VP 1    160    12.7    .027   1                0  0  0    0     0     0     1.110   10.900      .000  6.7953    18.4690       140
   3     160.0   VP 1    225    12.7    .027   2                0  0  0    0     0     0     1.110     .220      .000   .8575     7.9846        18
   4     296.0   FCD3    200     6.0   1.600   3                0  0  0    0     0     1     1.110     .850      .000   .4970    32.2567        10

【 ポンプ仕様 】
                     弁    弁                                                                  効   減衰   ---------- 初期状態 ----------
  番  台  形         閉    番   全揚程    吐出量     出力  極    型 ポンプ・モータ  フライホイール 回転数 率   定数      揚程    吐出量  回転数  トルク
  号  数  式         鎖    号      m       m3/m       kw  数    式       kg-m2        kg-m2  min-1  %       k         m      m3/m
   1   1   1          1     0   70.000     1.110     30.0   2     1        .555         .000   2900 53  1.8715    70.000     1.110   1.000   1.000

【 圧力線図仕様 】

  管路名称   1    2    3    4

【 縦断仕様 】
 管路   追加距離    レベル      追加距離    レベル       追加距離    レベル       追加距離    レベル
 名称        m          m            m          m             m          m             m          m
   1         .0      529.75        42.0      524.66
   2       42.0      524.66        90.0      527.14        304.0      510.40        380.0      512.86
          460.0      518.88       650.0      526.76        738.0      519.25        840.0      512.14
          950.0      511.53      1130.0      522.13       1210.0      523.54       1310.0      522.40
         1525.0      535.84
   3     1525.0      535.84      1563.0      539.32       1625.0      550.31       1685.0      555.94
   4     1685.0      555.94      1875.0      565.00       1921.0      568.42       1981.0      577.94
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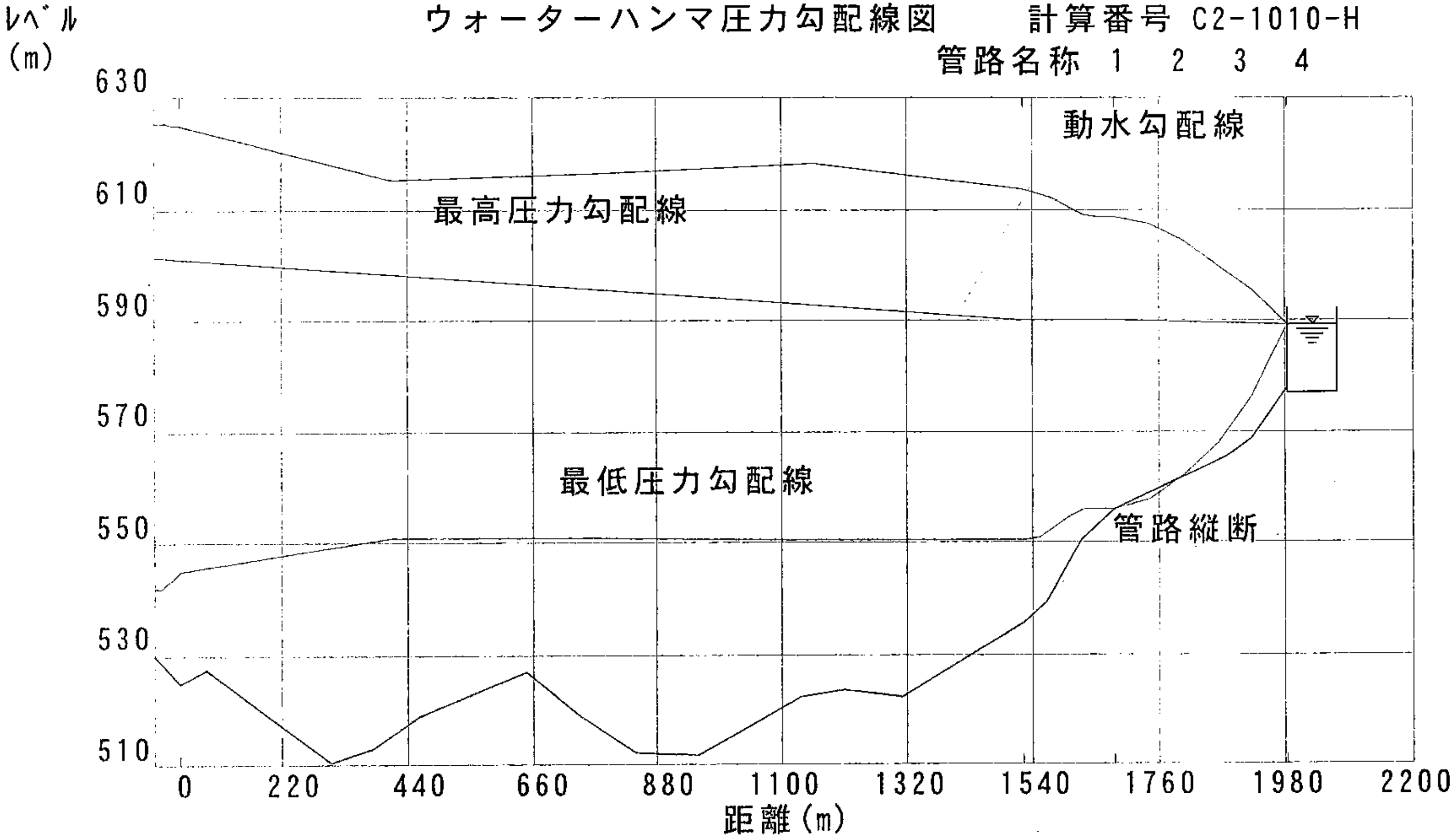
ウォーターハンマ圧力勾配線図　　計算番号 C2-1010-H
管路名称 1 2 3 4



基準ﾚﾍﾞﾙ 531.25

Transmission Pump (H) :

Kondadeniya SR. → Kulyamana SR.

06 Electrical Design Calculations

A. INTAKE [Phase 1]

1. LOAD LIST FOR ELECTRICAL WORKS

SUMMARY SHEET

Facility name	Equipment name		Numbers (Duty)	Numbers (Stand-by)	Numbers (Total)	Commer. Power (kW)	Generator (Nummbers)	Generator (kW)	Remarks
GOHAGODA Intake									
	1. Intake		7	4	11	298.30	6	297.10	NO.1Tr
	2.Architectural and others								
	Architectural (1)	kW	1		1	35.00	1	35.00	NO.1Tr
	Architectural (1)	kVA	2		2	4.70		4.70	NO.1Tr
	Total (NO.1 Transformer)	kW				333.30		332.10	Σ1 , Three Phase
		kVA				4.70		4.70	Σ2 , Three Phase
		kVA							Σ3 , Single Phase
	Total					337.53		336.33	

Total(kW)=Σ1+Σ2×0.9+Σ3×0.8

A. INTAKE [Phase 1]
2. LOAD LIST FOR ELECTRICAL WORKS

1. Intake

↓ Not including stand-by

Load tag No.	Load name	Power (kW)	Numbers (Duty)	Numbers (Stand-by)	Numbers (Total)	Commer. Power (kW)	Generator (Numbers)	Generator (kW)	Remarks
01 MH 01	Screening Hoist	1.20	1		1	1.20			
01 FS 11/21	Fine Screen	2.20	2		2	4.40	2	4.40	
01 SW 01/02	Screen Wash Pump	11.00	1	1	2	11.00	1	11.00	
01 RW 11to41	Raw Water Pump	280.00	1	1	2	280.00	1	280.00	SC is to be installed at each load.
01 MV 11to 41	Discharge Valve	0.20	1	1	2	0.20	1	0.20	
01 DP 01/02	Sump Drainage Pump	1.50	1	1	2	1.50	1	1.50	
									Duty load for SC (1) 16.80
	TOTAL kW		7	4	11	298.30	6	297.10	
	(Distribution Tank and Grit Chamber Facility) kVA								

A. INTAKE [Phase 1]
2. LOAD LIST FOR ELECTRICAL WORKS

2.Architectural and others

↓ Not including stand-by

Load tag No.	Load name	Power (kW)	Numbers (Duty)	Numbers (Stand-by)	Numbers (Total)	Commer. Power (kW)	Generator (Numbers)	Generator (kW)	Remarks
	Architectural Power	25.00	1		1	25.00	1	25.00	
	DC Power (kVA)	1.70	1		1	1.70	1	1.70	
	UPS Power (kVA)	3.00	1		1	3.00	1	3.00	
	Generator Panel	10.00	1		1	10.00	1	10.00	
	TOTAL kW		2		2	35.00	2	35.00	Three Phase
	(Architectural Facility) kVA		2		2	4.70	2	4.70	Three Phase
	kVA								Single Phase

A. INTAKE [Phase 1]

3-1. Capacity Calculation Sheet for Transformer

Calculation Condition	Duty Transformer Name	Three Phase Load Capacity (Σ P1) (kW)	kVA Load Equipment (Σ P2) (kVA)	Single Phase Load Equipment (Σ P3) (kVA)
	NO.1 Power Transformer	333.30	4.70	
	NO.2 Power Transformer			

Capacity Calculation Formula

[Calculation Formula for Power Transformer]

$$\mathbf{TR} = \left(\frac{\Sigma \mathbf{P1}}{\eta \times \phi} + \Sigma \mathbf{P2} + \sqrt{3} \times \Sigma \mathbf{P3} \right) \times \alpha \times \beta$$

R	: Required Transformer Capacity in kVA	
ΣP1～3	: Total Capacity for each facility in kW/kVA	
η	: General Efficiency	0.85
ϕ	: General Power Factor	0.85
α	: Surplus Factor	1
β	: Demand Factor	1

Calculation Result	Transformer Name	Required Transformer Capacity in kVA	Remarks
	NO.1-1 Power Transformer	**466.01**	
	NO.1-2 Power Transformer		

Rated capacity of transformer in kVA										
	10	15	20	30	50	75	100	150	200	300
	500		750		1000		1500		2000	

Proposed Transformer

	kVA	Number	Rated Voltage	
			Primary	Secondary
NO.1 Transformer	**500**			
NO.2 Transformer				

The upper rated transformer capacity is to be proposed through the capacity calculation.

A. INTAKE [Phase 1]

3-2. Calculation for Transformer Voltage Regulation (Motor-starting)

Calculation Formula

[Calculation Formula for Power Transfomer Voltage Regulation]

① Base Load Capacity (kVA)

$$K1 = \text{Load Capacity} - \text{Max. Motor Capacity (kVA)}$$

② Starting Load Capacity (kVA)

$$K2 = \text{Max. Motor Capacity (kVA)} \times \text{Starting Factor}$$

③ Active Power (kW)

$$P = P1 + P2 = K1\cos\theta 1 + K2\cos\theta 2$$

④ Reactive Power (kVar)

$$Q = Q1 + Q2 = K1\sin\theta 1 + K2\sin\theta 2$$

⑤ Total Starting Capacity (kVA)

$$K = \sqrt{}(P^2 + Q^2)$$

⑥ Voltage Regulation (%)

$$\varepsilon = \frac{\text{Total Starting Capacity}}{\text{Transformer Capacity}} \times \text{Transformer Z (\%)}$$

	500kVA		
η : General Efficien	0.85		
$\cos\theta 1$:Power Factor	0.85		(at steady)
$\cos\theta 2$:Power Factor	0.40		(at motor starting)
Starting Factor	1.80		
Transfomer Z (%)	5.30		
Voltage Regulation	10%≧		

Calculation Result

Item	500kVA	
Max. Load Capacity (kW)	280	
1. Base Load Capacity (kVA)	112.46	
2. Starting Load Capacity	697.58	
3. Active Power (kW)	374.62	
4. Reactive Power	698.58	
5. Total Starting Capacity (kVA)	792.69	
6. Voltage Regulation (%)	8.40	
Result	10% > 8.40% O.K.	

A. INTAKE [Phase 1]

4. Calculation Sheet for Static Capacitor (SC)

Equipment Name	Duty Load for SC				
	For SC (1) (kW)	For SC (2) (kW)			
Distribution Tank and Grit chamber	16.80	-			
Total	16.80	0.00			

Calculation Formula

[Formula]

$$Q = \frac{P\times \beta}{\eta} \times \left\{ \sqrt{\frac{1}{(\cos\theta 1)^2} - 1} - \sqrt{\frac{1}{(\cos\theta 2)^2} - 1} \right\} + \Sigma Ti \times \gamma T$$

Q : Required Static Capacitor Capacity in kVar

P : Duty Load Output in kW

η : Efficiency 0.85

β : Demand Factor 0.7~ 0.8

COS θ 1 : Power Factor without SC at Bus Bar 0.85

COS θ 2 : Power Factor with SC at Bus Bar 0.95

ΣT : Capacity of Transformer (kVA) 0

γ T : Transformer Exciting Factor 0.01~ 0.03

Result	SC (1) (For NO.1 Transformer)	4.03	~	4.60
	SC (2) (For NO.2 Transformer)	0.00	~	0.00

Proposed Capacity	SC (1)	NO.1 SC	5	kVar
		NO.2 SC		kVar
				kVar
	SC (2)	NO.1 SC		kVar
		NO.2 SC		kVar
		NO.3 SC		kVar

Rated Capacity (JIS - C - 4902)	10	15	20	25	30	50	75
	150	200	250	300	400	500	750
	1000						

A. INTAKE [Phase 1]

5. Capacity Calculation of Alternator

Calculation Condition	Description			Value
ΣP0	Load Capacity Covered by Alt. (kW)			336.33
Pm	Max. Motor	Load Name		Raw Water Pump
		Starting Method		SOFT STERTER
		kW		280.00
R	Harmonic wave generating load			0.00
Unbalanced load capacity		A	(kW)	0.00
		B	(kW)	0.00
		C	(kW)	0.00

Calculation Result	Value	Remarks	Rated Alternator Capacity				
PG 1	494.60		20	37.5	50	62.5	75
PG 2	378.00		100	150	200	250	300
PG 3	368.58		375	500	625	750	875
PG 4	13.33		1000	1250	1500	2000	2500
PG max	494.60		3125				
			JEM-1354				
Selected (kVA)	750 ×1set	Diesel-engine , Radiator type					

Calculation Formula

The rated alternator capacity is to be proposed on the basis of the maximum value among the following calculation.

a. Required for all load operation PG1 [kVA]

$$PG1 = \frac{\Sigma P0}{\eta L \times \phi L} \times \alpha \times Sf$$

b. Required from allowable voltage drop PG2 [kVA]

$$PG2 = Pm \times \beta \times C \times Xd' \frac{1-\Delta E}{\Delta E}$$

c. Required for starting the max. motor lastly PG3 [kVA]

$$PG3 = \frac{fv1}{\gamma G} \{(\Sigma P0 - Pm) \times \frac{\alpha}{\eta L \times \phi m} + Pm \times \beta \times C\}$$

d. Required from allowable negative phase current PG4 [kVA]

$$PG4 = \frac{1}{KG4} \sqrt{\{(0.432R)^2 + (1.23\Delta P)^2 \times (1-3U+3U^2)\}}$$

β : Starting kVA for max. motor per kW 7.20
C : Motor starter factor 0.25
KG4 : Factor due to allowable negative phase current 0.15
R : Total harmonic wave generating load in kW
ΔP : Total single phase unbalance capacity in kW 0.00
Where $A \geqq B \geqq C$, $\Delta P = A+B-2C$
U : Single phase unbalance factor $U = \frac{A-C}{\Delta P}$ 0.00
fv1 : Decrease factor of load starting 0.95

Value of decrease factor of load starting (fv)

Number of Poles	Pm / ΣP0				Remarks
	0~	0.8	0.9	1	
2P	1	0.9	0.85	0.8	PG3 , fv1
Over 4P	1	0.95	0.95	0.9	PE2-2 , fv3
2P	0.9	0.85	0.85	0.8	PE2-1 ,fv2
Over 4P	0.9	0.9	0.9	0.9	

Where

ηL : General Efficiency 0.85
ϕL : General Power Factor 0.80
α : Demand Factor 1.00
Xd' : Alternator Factor 0.25
$\Sigma P0$: Total load capacity covered by generator in kW (Excluding Stand-by) Note 1
Sf : Current increasing factor due to unbalanced load ($= 1+0.6 \times (\Delta P \div \Sigma P0)$) 1.00
ΔE : Allowable voltage drop factor 0.25
γG : Tolerant capacity for momentary overload of Alternator 1.5
ϕm :Max. motor power factor 0.85

Note1 : To exchange kVA load into kW , single phase load to be multiplied by 0.8 , rectifier to be calculated as multiplying of rated Dc voltage and DC current, UPS to be calculated as multiplying of rated output in kVA and 0.9 , and these exchanged value to be added to three phase load capacity in kW.

A. INTAKE [Phase 1]

6. Capacity Calculation of Engine

Calculation Condition

Description			Value
PG	Generator Output in kVA		750
Pm	Maximum Motor	Load name	Raw Water Pump
		Starting Method	SOFT STERTER
		kW	280
ΣP0	Load Capacity Covered by Alt. (kW)		168.165

Calculation Result

	Value	Remarks
PE 1	887.92	
PE 2-1	175.59	
PE 2-2	132.35	
PE max	887.92	
Selected (PS)	900	Diesel-engine generator , Radiator type

Generator efficiency		
Rate	η G effi. (%)	
kVA	2～8P	10～18P
20	79.0	-
37.5	82.5	-
50	84.3	-
62.5	85.2	-
75	85.7	-
100	86.7	-
125	87.6	-
150	88.1	-
200	88.9	-
250	89.5	-
300	90.0	-
375	90.6	-
500	91.3	-
625	91.9	-
750	92.3	91.7
875	92.5	92.0
1000	92.8	92.3
1250	93.2	92.8
1500	93.4	93.1
2000	93.8	93.5
2500	93.9	93.7
3125	94.0	93.8

Calculation Formula

Maximum value or over among the following calculation is to be proposed as engine capacity.

a. PE1 in PS is to be derived from requirement for full load running

$$PE1 = \frac{PG\times \phi G}{\eta G} \times 1.36\times \Delta H$$

b. PE2 in PS is to be derived from requirement of max. motor starting lastly

① PE2-1 is to be derived from based on allowable load starting factor

$$PE2\text{-}1 = fv2\left\{\ 0.75\times \frac{1}{\eta 'G} \times (\Sigma P0-Pm)\times \frac{\alpha}{\eta L} + \frac{1}{\varepsilon\times\eta 'G} \times Pm\times \beta \times C\times \phi s\ \right\} \times 1.36\times \Delta H$$

② PE2-2 is to be derived from tolerant capacity for momentary overload

$$PE2\text{-}2 = \frac{fv3}{\eta 'G\times \gamma E}\times\left\{\ (\Sigma P0-Pm)\times \frac{\alpha}{\eta L} + \ Pm\times \beta \times C\times \phi s\ \right\} \times 1.36\times \Delta H$$

Where

ΣP0	: Total load capacity covered by generator in kW	
η L	: General Efficiency	0.85
φ L	: General Power factor	0.8
α	: Demand Factor	0.8
φ G	: Generator Power factor	0.8
γ E	: Tolerant capacity for momentary overload of Engine	1.1
β	: Starting kVA for max. motor of per kW	7.2
C	: Motor starter factor	0.25
φ s	: Motor starting Power Factor for max. motor starting kVA , Squirrel cage	0.4
η G	: Generator efficiency	0.919
η 'G	: Generator overload efficiency	0.855
fv2	: Decreased factor due to motor starting	0.9
fv3	: Decreased factor due to motor starting	1.0
ε	: Tolerant capacity due to non-motor starting of Engine	1.0
Δ H	: Altitude compensation	1.0

Starting method

β ×C	Starter Name
7.2×1	Direct on-line
7.2×2 / 3	Star - delta
7.2×1 / 3	Star - delta with resistor
1.2	VVVF
1.2	Wound - rotor type
7.2×0.5	Reactor 50%
7.2×0.65	Reactor 65%
7.2×0.8	Reactor 80%
7.2×0.25	Auto - transformer 50%
7.2×0.42	Auto - transformer 65%
7.2×0.64	Auto - transformer 80%

A. INTAKE [Phase 1]

7. Fuel Calculation

Calculation Condition

	Description	Value , Type
PG	Generator output in kVA	750
P	Engineoutput in PS	900
	Engine Type	Diesel-engine , Radiator type
	Fuel Type	Light oil

Calculation Result

Description	Value	Remarks
Fuel tank	5677.6 → 6000 L × 1 set	

Calculation Formula

Fuel Tank Volume is to be derived from the following calculation.

a. Q [m3] Fuel Tank Volume

$$\mathbf{Q} = \frac{\mathbf{P\times be\times H}}{\mathbf{d}} \times \alpha$$

be : Fuel consumption factor [unit : kg/PS･h]

Output (PS)	Diesel	Gas turbine
30 or less	0.23	-
over 30 and 250 or less	0.22	0.5
over 250 and 450 or less	0.2	0.48
over 450 and 750 or less	0.18	0.43
over 750	0.17	0.38

be : Fuel consumption factor 0.17 kg/PS･h

H : Running hour 28 hours

d : Fuel density 830 kg/m3
(A heavy oil 850kg/m3)
(Light oil 830kg/m3)
(Kerosine 790kg/m3)

α : Surplus Factor 1.1

B. INTAKE [Phase 3]

1. LOAD LIST FOR ELECTRICAL WORKS

SUMMARY SHEET

Facility name	Equipment name		Numbers (Duty)	Numbers (Stand-by)	Numbers (Total)	Commer. Power (kW)	Generator (Nummbers)	Generator (kW)	Remarks
GOHAGODA Intake									
	1. Intake		**11**	**4**	**15**	**858.70**	**10**	**857.50**	NO.1Tr
	2.Architectural and others								
	Architectural (1)	kW	1		1	45.00	1	45.00	NO.1Tr
	Architectural (1)	kVA	2		2	4.70		4.70	NO.1Tr
	Total (NO.1 Transformer)	kW				903.70		902.50	Σ1 , Three Phase
		kVA				4.70		4.70	Σ2 , Three Phase
		kVA							Σ3 , Single Phase
	Total (NO.2 Transformer)	kW							Σ1 , Three Phase
		kVA							Σ2 , Three Phase
		kVA							Σ3 , Single Phase
	Total					**907.93**		**906.73**	

Total(kW)= Σ1+ Σ2×0.9+ Σ3×0.8

B. INTAKE [Phase 3]

2. LOAD LIST FOR ELECTRICAL WORKS

1. Intake

↓ Not including stand-by

Load tag No.	Load name	Power (kW)	Numbers (Duty)	Numbers (Stand-by)	Numbers (Total)	Commer. Power (kW)	Generator (Numbers)	Generator (kW)	Remarks
01 MH 01	Screening Hoist	1.20	1		1	1.20			
01 FS 11/21	Fine Screen	2.20	2		2	4.40	2	4.40	
01 SW 01/02	Screen Wash Pump	11.00	1	1	2	11.00	1	11.00	
01 RW 11to41	Raw Water Pump	280.00	3	1	4	840.00	3	840.00	SC is to be installed at each load.
01 MV 11to 41	Discharge Valve	0.20	3	1	4	0.60	3	0.60	
01 DP 01/02	Sump Drainage Pump	1.50	1	1	2	1.50	1	1.50	
									Duty load for SC (1) 16.80
	TOTAL kW		11	4	15	858.70	10	857.50	
	(Distribution Tank and Grit Chamber Facility) kVA								

B. INTAKE [Phase 3]

2. LOAD LIST FOR ELECTRICAL WORKS

2.Architectural and others

↓ Not including stand-by

Load tag No.	Load name		Power (kW)	Numbers (Duty)	Numbers (Stand-by)	Numbers (Total)	Commer. Power (kW)	Generator (Numbers)	Generator (kW)	Remarks
	Architectural Power		25.00	1		1	25.00	1	25.00	
	DC Power (kVA)		1.70	1		1	1.70	1	1.70	
	UPS Power (kVA)		3.00	1		1	3.00	1	3.00	
	Generator Panel		10.00	2		2	20.00	2	20.00	
	TOTAL (Architectural Facility)	kW		2		2	45.00	2	45.00	Three Phase
		kVA		2		2	4.70	2	4.70	Three Phase
		kVA								Single Phase

B. INTAKE [Phase 3]

3-1. Capacity Calculation Sheet for Transformer

Calculation Condition	Duty Transformer Name	Three Phase Load Capacity (Σ P1) (kW)	kVA Load Equipment (Σ P2) (kVA)	Single Phase Load Equipment (Σ P3) (kVA)
	NO.1 Power Transformer	903.70	4.70	
	NO.2 Power Transformer			

Capacity Calculation Formula

[Calculation Formula for Power Transformer]

$$\mathbf{TR} = \left(\frac{\Sigma \mathbf{P1}}{\eta \times \phi} + \Sigma \mathbf{P2} + \sqrt{3} \times \Sigma \mathbf{P3} \right) \times \alpha \times \beta$$

R : Required Transformer Capacity in kVA

ΣP1～3 : Total Capacity for each facility in kW/kVA

η	: General Efficiency	0.85
ϕ	: General Power Factor	0.85
α	: Surplus Factor	1
β	: Demand Factor	1

Calculation Result	Transformer Name	Required Transformer Capacity in kVA	Remarks
	NO.1-1 Power Transformer	**1255.50**	
	NO.1-2 Power Transformer		

Rated capacity of transformer	10	15	20	30	50	75	100	150	200	300
in kVA	500		750		1000		1500		2000	

Proposed Transformer

	kVA	Number	Rated Voltage	
			Primary	Secondary
NO.1 Transformer	**1500**	×1	**33000**	**415**
NO.2 Transformer				

The upper rated transformer capacity is to be proposed through the capacity calculation.

B. INTAKE [Phase 3]

3-2. Calculation for Transformer Voltage Regulation (Motor-starting)

Calculation Formula

[Calculation Formula for Power Transfomer Voltage Regulation]

① Base Load Capacity (kVA)

$K1 = \text{Load Capacity} - \text{Max. Motor Capacity (kVA)}$

② Starting Load Capacity (kVA)

$K2 = \text{Max. Motor Capacity (kVA)} \times \text{Starting Factor}$

③ Active Power (kW)

$P = P1 + P2 = K1\cos\theta 1 + K2\cos\theta 2$

④ Reactive Power (kVar)

$Q = Q1 + Q2 = K1\sin\theta 1 + K2\sin\theta 2$

⑤ Total Starting Capacity (kVA)

$K = \sqrt{}(P^2 + Q^2)$

⑥ Voltage Regulation (%)

$$\varepsilon = \frac{\text{Total Starting Capacity}}{\text{Transformer Capacity}} \times \text{Transformer Z (\%)}$$

	1500kVA		
η : General Efficien	0.85		
$\cos\theta 1$:Power Factor	0.85		(at steady)
$\cos\theta 2$:Power Factor	0.40		(at motor starting)
Starting Factor	1.80		
Transfomer Z (%)	5.30		
Voltage Ragulation	10%≧		

Calculation Result

Item	1500kVA	
Max. Load Capacity (kW)	280	
1. Base Load Capacity (kVA)	1112.46	
2. Starting Load Capacity	697.58	
3. Active Power (kW)	1224.62	
4. Reactive Power	1225.36	
5. Total Starting Capacity (kVA)	1732.40	
6. Voltage Regulation (%)	6.12	
Result	10% > 6.12% O.K.	

B. INTAKE [Phase 3]

4. Calculation Sheet for Static Capacitor (SC)

Equipment Name	Duty Load for SC				
	For SC (1) (kW)	For SC (2) (kW)			
Distribution Tank and Grit chamber	16.80	-			
Total	16.80	0.00			

Calculation Formula

[Formula]

$$Q = \frac{P \times \beta}{\eta} \times \left\{ \sqrt{\frac{1}{(\mathrm{COS}\,\theta\,1)^2} - 1} - \sqrt{\frac{1}{(\mathrm{COS}\,\theta\,2)^2} - 1} \right\} + \Sigma Ti \times \gamma T$$

Q : Required Static Capacitor Capacity in kVar

P : Duty Load Output in kW

η : Efficiency 0.85

β : Demand Factor 0.7~ 0.8

COS θ 1 : Power Factor without SC at Bus Bar 0.85

COS θ 2 : Power Factor with SC at Bus Bar 0.95

Σ T : Capacity of Transformer (kVA) 1500

γ T : Transformer Exciting Factor 0.01~ 0.03

Result	SC (1) (For NO.1 Transformer)		19.03	~	49.60
	SC (2) (For NO.2 Transformer)		0.00	~	0.00
Proposed Capacity	SC (1)	NO.1 SC	5		kVar
		NO.2 SC	30		kVar
					kVar
	SC (2)	NO.1 SC			kVar
		NO.2 SC			kVar
		NO.3 SC			kVar

Rated Capacity (JIS - C - 4902)	10	15	20	25	30	50	75
	150	200	250	300	400	500	750
	1000						

B. INTAKE [Phase 3]

5. Capacity Calculation of Alternator

		Description		Value
Calculation Condition	ΣP0	Load Capacity Covered by Alt. (kW)		906.73
	Pm	Max. Motor	Load Name	Raw Water Pump
			Starting Method	SOFT STERTER
			kW	280.00
	R	Harmonic wave generating load		0.00
	Unbalanced load capacity		A (kW)	
			B (kW)	
			C (kW)	

		Value	Remarks	Rated Alternator Capacity				
Calculation Result	PG 1	1333.43		20	37.5	50	62.5	75
	PG 2	378.00		100	150	200	250	300
	PG 3	868.58		375	500	625	750	875
	PG 4	13.33		1000	1250	1500	2000	2500
	PG max	1333.43		3125				
				JEM-1354				
	Selected (kVA)	750 ×2set	Diesel-engine , Radiator type					

Calculation Formula

The rated alternator capacity is to be proposed on the basis of the maximum value among the following calculation.

a. Required for all load operation PG1 [kVA]

$$PG1 = \frac{\Sigma P0}{\eta L \times \phi L} \times \alpha \times Sf$$

b. Required from allowable voltage drop PG2 [kVA]

$$PG2 = Pm \times \beta \times C \times Xd' \frac{1-\Delta E}{\Delta E}$$

c. Required for starting the max. motor lastly PG3 [kVA]

$$PG3 = \frac{fv1}{\gamma G} \{(\Sigma P0 - Pm) \times \frac{\alpha}{\eta L \times \phi m} + Pm \times \beta \times C\}$$

d. Required from allowable negative phase current PG4 [kVA]

$$PG4 = \frac{1}{KG4} \sqrt{\{(0.432R)^2 + (1.23 \Delta P)^2 \times (1-3U+3U^2)\}}$$

β : Starting kVA for max. motor per kW 7.20

C : Motor starter factor 0.25

KG4 : Factor due to allowable negative phase current 0.15

R : Total harmonic wave generating load in kW

ΔP : Total single phase unbalance capacity in kW 0.00

Where $A \geqq B \geqq C$, $\Delta P = A+B-2C$

U : Single phase unbalance factor $U = \frac{A-C}{\Delta P}$ 0.00

fv1 : Decrease factor of load starting 0.95

Value of decrease factor of load starting (fv)

Number of Poles	Pm / ΣP0				Remarks
	0~	0.8	0.9	1	
2P	1	0.9	0.85	0.8	PG3 , fv1
Over 4P	1	0.95	0.95	0.9	PE2-2 , fv3
2P	0.9	0.85	0.85	0.8	PE2-1 ,fv2
Over 4P	0.9	0.9	0.9	0.9	

Where

ηL : General Efficiency 0.85

ϕL : General Power Factor 0.80

α : Demand Factor 1.00

Xd' : Alternator Factor 0.25

ΣP0 : Total load capacity covered by generator in kW (Excluding Stand-by) Note 1

Sf : Current increasing factor due to unbalanced load ($= 1+0.6 \times (\Delta P \div \Sigma P0)$) 1.00

ΔE : Allowable voltage drop factor 0.25

γG : Tolerant capacity for momentary overload of Alternator 1.5

ϕm :Max. motor power factor 0.85

Note1: To exchange kVA load into kW , single phase load to be multiplied by 0.8 , rectifier to be calculated as multiplying of rated Dc voltage and DC current, UPS to be calculated as multiplying of rated output in kVA and 0.9 , and these exchanged valuc to be added to three phase load capacity in kW.

B. INTAKE [Phase 3]

6. Capacity Calculation of Engine

Calculation Condition	Description		Value
	PG Generator Output in kVA		750
	Pm Maximum Motor	Load name	Raw Water Pump
		Starting Method	SOFT STERTER
		kW	280
	Σ P0 Load Capacity Covered by Alt. (kW)		453.365

Calculation Result		Value	Remarks
	PE 1	887.92	
	PE 2-1	463.80	
	PE 2-2	501.09	
	PE max	887.92	
	Selected (PS)	900	Diesel-engine generator , Radiator type

Generator efficiency		
Rate	η G effi. (%)	
kVA	2~8P	10~18P
20	79.0	-
37.5	82.5	-
50	84.3	-
62.5	85.2	-
75	85.7	-
100	86.7	-
125	87.6	-
150	88.1	-
200	88.9	-
250	89.5	-
300	90.0	-
375	90.6	-
500	91.3	-
625	91.9	-
750	92.3	91.7
875	92.5	92.0
1000	92.8	92.3
1250	93.2	92.8
1500	93.4	93.1
2000	93.8	93.5
2500	93.9	93.7
3125	94.0	93.8

Calculation Formula

Maximum value or over among the following calculation is to be proposed as engine capacity.

a. PE1 in PS is to be derived from requirement for full load running

$$PE1 = \frac{PG\times \phi G}{\eta G} \times 1.36\times \Delta H$$

b. PE2 in PS is to be derived from requirement of max. motor starting lastly

① PE2-1 is to be derived from based on allowable load starting factor

$$PE2\text{-}1 = fv2\left\{ 0.75\times \frac{1}{\eta 'G} \times (\Sigma P0\text{-}Pm)\times \frac{\alpha}{\eta L} + \frac{1}{\varepsilon \times \eta 'G} \times Pm\times \beta \times C\times \phi s \right\} \times 1.36\times \Delta H$$

② PE2-2 is to be derived from tolerant capacity for momentary overload

$$PE2\text{-}2 = \frac{fv3}{\eta 'G\times \gamma E}\times \left\{ (\Sigma P0\text{-}Pm)\times \frac{\alpha}{\eta L} + Pm\times \beta \times C\times \phi s \right\} \times 1.36\times \Delta H$$

Where

Σ P0	: Total load capacity covered by generator in kW	
η L	: General Efficiency	0.85
ϕ L	: General Power factor	0.8
α	: Demand Factor	0.8
ϕ G	: Generator Power factor	0.8
γ E	: Tolerant capacity for momentary overload of Engine	1.1
β	: Starting kVA for max. motor of per kW	7.2
C	: Motor starter factor	0.25
ϕ s	: Motor starting Power Factor for max. motor starting kVA , Squirrel cage	0.4
η G	: Generator efficiency	0.919
η 'G	: Generator overload efficiency	0.855
fv2	: Decreased factor due to motor starting	0.9
fv3	: Decreased factor due to motor starting	1.0
ε	: Tolerant capacity due to non-motor starting of Engine	1.0
Δ H	: Altitude compensation	1.0

Starting method

β ×C	Starter Name
7.2×1	Direct on-line
7.2×2 / 3	Star - delta
7.2×1 / 3	Star - delta with resistor
1.2	VVVF
1.2	Wound - rotor type
7.2×0.5	Reactor 50%
7.2×0.65	Reactor 65%
7.2×0.8	Reactor 80%
7.2×0.25	Auto - transformer 50%
7.2×0.42	Auto - transformer 65%
7.2×0.64	Auto - transformer 80%

B. INTAKE [Phase 3]

7. Fuel Calculation

Calculation Condition

	Description	Value , Type
PG	Generator output in kVA	750
P	Engineoutput in PS	900
	Engine Type	Diesel-engine , Radiator type
	Fuel Type	Light oil

Calculation Result

Description	Value	Remarks
Fuel tank	5677.6 → 6000 L × 2 sets	
	or 12000 L × 1 set	

Calculation Formula

Fuel Tank Volume is to be derived from the following calculation.

a. Q [m3] Fuel Tank Volume

$$Q = \frac{P \times be \times H}{d} \times \alpha$$

be : Fuel consumption factor [unit : kg/PS･h]

Output (PS)	Diesel	Gas turbine
30 or less	0.23	-
over 30 and 250 or less	0.22	0.5
over 250 and 450 or less	0.2	0.48
over 450 and 750 or less	0.18	0.43
over 750	0.17	0.38

be	: Fuel consumption factor	0.17	kg/PS･h
H	: Running hour	28	hours
d	: Fuel density (A heavy oil 850kg/m3) (Light oil 830kg/m3) (Kerosine 790kg/m3)	830	kg/m3
α	: Surplus Factor	1.1	

C. WTP [Phase 1]

1. LOAD LIST FOR ELECTRICAL WORKS

SUMMARY SHEET

Facility name	Equipment name		Numbers (Duty)	Numbers (Stand-by)	Numbers (Total)	Commer. Power (kW)	Generator (Nummbers)	Generator (kW)	Remarks
	1. Flocculation & Sedimentation Basins		**13**	**0**	**13**	**5.00**	**13**	**5.00**	
						5.00			NO.1Tr
						0.00			NO.2Tr
	2.Filter Units		**26**	**4**	**30**	**99.90**	**27**	**154.90**	
						154.90			NO.1Tr
						0.00			NO.2Tr
	3.Clear Water Pump Station		**9**	**8**	**17**	**805.10**	**9**	**805.10**	
						805.10			NO.1Tr
						0.00			NO.2Tr
	4.Chemical Building		**10**	**3**	**13**	**17.45**	**10**	**17.45**	
						17.45			NO.1Tr
									NO.2Tr
	5.Backwash Recovery Facility		**1**	**1**	**2**	**30.00**	**1**	**30.00**	
						30.00			NO.1Tr
									NO.2Tr
	8. Architectural and others								
	Architectural (1)	kW	1		1	80.00	1	80.00	NO.1Tr
	Architectural (2)	kW	1		1	30.00	1	30.00	NO.1Tr
	Architectural (3)	kW							NO.2Tr
	Generator-1	kW	1		1	20.00	1	20.00	NO.1Tr
	Generator-1	kW							NO.2Tr
	UPS	kVA	1		1	33.00	1	33.00	NO.1Tr
	Total (NO.1 Transformer)	kW				1142.45		1142.45	Σ1 , Three Phase
		kVA				33.00		33.00	Σ2 , Three Phase
		kVA							Σ3 , Single Phase
	Total (NO.2 Transformer)	kW							Σ1 , Three Phase
		kVA							Σ2 , Three Phase
		kVA							Σ3 , Single Phase
	Total					**1172.15**		**1172.15**	

Total(kW)=Σ1+Σ2×0.9+Σ3×0.8

C. WTP [Phase 1]

2. LOAD LIST FOR ELECTRICAL WORKS

1. Flocculation & Sedimentation Basins

↓ Not including stand-by

Load tag No.	Load name		Power (kW)	Numbers (Duty)	Numbers (Stand-by)	Numbers (Total)	Commer. Power (kW)	Generator (Numbers)	Generator (kW)	Remarks
06 SC 11/21	Sludge Collector		0.75	4		4	3.00	4	3.00	
06 MV 11to24	De-sludge Valve		0.20	8		8	1.60	8	1.60	
06 SP 01	Sampling Pump		0.40	1		1	0.40	1	0.40	
										Duty load for SC (1) 5.00
	TOTAL	kW		13		13	5.00	13	5.00	Duty load for SC (2)
	(Distribution Tank and Grit Chamber Facility)	kVA								

C. WTP [Phase 1]

2. LOAD LIST FOR ELECTRICAL WORKS

2.Filter Units

↓ Not including stand-by

Load tag No.	Load name	Power (kW)	Numbers (Duty)	Numbers (Stand-by)	Numbers (Total)	Commer. Power (kW)	Generator (Numbers)	Generator (kW)	Remarks
07 MG 11to41	Inflow Gate	0.40	4		4	1.60	4	1.60	
07 MG 12 to 42	Backwash Drainage Gate	0.40	4		4	1.60	4	1.60	
07 MV 11to41	Effluent Valve	0.20	4		4	0.80	4	0.80	
07 MV 12to42	Backwash Valve	0.20	4		4	0.80	4	0.80	
07 MV 13to43	Air Scour Valve	0.20	4		4	0.80	4	0.80	
07 BP 11to31	Backwash Pump	18.50	2	1	3	37.00	2	37.00	
07 AB 11to21	Air Blower	55.00	1	1	2	55.00	2	110.00	
07 DP 01/02	Sump Drainage Pump	1.50	1	1	2	1.50	1	1.50	
07 MM 11	Lime Mixer	0.40	1		1	0.40	1	0.40	
07 LP 11/21	Lime Feed Pump	0.40	1	1	2	0.40	1	0.40	
									Duty load for SC (1) 154.90
	TOTAL kW		26	4	30	99.90	27	154.90	Duty load for SC (2)
	(Distribution Tank and Grit Chamber Facility) kVA								

C. WTP [Phase 1]

2. LOAD LIST FOR ELECTRICAL WORKS

3.Clear Water Pump Station

↓ Not including stand-by

Load tag No.	Load name		Power (kW)	Numbers (Duty)	Numbers (Stand-by)	Numbers (Total)	Commer. Power (kW)	Generator (Numbers)	Generator (kW)	Remarks
09 CP 11to14	Transmission Pump (A-1)		450.00	1	1	2	450.00	1	450.00	SC is to be installed at each load.
09 CP 21/22	Transmission Pump (A-2)		90.00	1	1	2	90.00	1	90.00	SC is to be installed at each load.
09 CP 31to31	Transmission Pump (A-3)		250.00	1	1	2	250.00	1	250.00	SC is to be installed at each load.
09 CP 41/42	Transmission Pump (A-4)		250.00							SC is to be installed at each load.
09 MV 11to14	Discharge Valve (A-1)		0.20	1	1	2	0.20	1	0.20	
09 MV 21/22	Discharge Valve (A-2)		0.20	1	1	2	0.20	1	0.20	
09 MV 31to31	Discharge Valve (A-3)		0.20	1	1	2	0.20	1	0.20	
09 MV 41/42	Discharge Valve (A-4)		0.20							
09 DP 01/02	Sump Drainage Pump		1.50	1	1	2	1.50	1	1.50	
09 PU 01	Plant Water Supply Unit		7.50	1		1	7.50	1	7.50	
09 PP 11/21	Chlorination Booster Pump		5.50	1	1	2	5.50	1	5.50	
										Duty load for SC (1) 15.10
	TOTAL	kW		9	8	17	805.10	9	805.10	Duty load for SC (1)
	(Distribution Tank and Grit Chamber Facility)	kVA								

C. WTP [Phase 1]

2. LOAD LIST FOR ELECTRICAL WORKS

4.Chemical Building

↓ Not including stand-by

Load tag No.	Load name		Power (kW)	Numbers (Duty)	Numbers (Stand-by)	Numbers (Total)	Commer. Power (kW)	Generator (Numbers)	Generator (kW)	Remarks
10 MM 11/21	Alum Mixer		1.50	2		2	3.00	2	3.00	
10 AP 11/21	Alum Pump		0.40	1	1	2	0.40	1	0.40	
10 MM 11/21	Lime Mixer		2.20	2		2	4.40	2	4.40	
10 LP 11/12	Lime Pump		5.50	1	1	2	5.50	1	5.50	
10 LP 21/22	Lime Feed Pump		0.40	1	1	2	0.40	1	0.40	
10 EF 11	Exhaust Fan		0.75	1		1	0.75	1	0.75	
10 MC 01	Chemical Crane		1.50	1		1	1.50	1	1.50	
10 MC 02	Chemical Crane		1.50	1		1	1.50	1	1.50	
										Duty load for SC (1) 17.45
	TOTAL	kW		10	3	13	17.45	10	17.45	
	(Distribution Tank and Grit Chamber Facility)	kVA								

C. WTP [Phase 1]

2. LOAD LIST FOR ELECTRICAL WORKS

5.Backwash Recovery Facility

↓ Not including stand-by

Load tag No.	Load name	Power (kW)	Numbers (Duty)	Numbers (Stand-by)	Numbers (Total)	Commer. Power (kW)	Generator (Numbers)	Generator (kW)	Remarks
11 WP 11/21	Backwash Recovery Pump	30.00	1	1	2	30.00	1	30.00	
									Duty load for SC (1) 30.00
	TOTAL kW		1	1	2	30.00	1	30.00	
	(Distribution Tank and Grit Chamber Facility) kVA								

C. WTP [Phase 1]

2. LOAD LIST FOR ELECTRICAL WORKS

6.Architectural and others

↓ Not including stand-by

Load tag No.	Load name		Power (kW)	Numbers (Duty)	Numbers (Stand-by)	Numbers (Total)	Commer. Power (kW)	Generator (Numbers)	Generator (kW)	Remarks
A7-001	Architectural Power-1		80.00	1		1	80.00	1	80.00	
A7-001	Architectural Power-2		30.00	1		1	30.00	1	30.00	
A7-001	Architectural Power-3									
A7-004	Generator Panel		20.00	1		1	20.00	1	20.00	
A7-005	UPS Power (kVA)		33.00	1		1	33.00	1	33.00	
A7-006	DC Power for Generator-starter (kVA)									
	TOTAL (Architectural Facility)	kW		5		5	130.00	5	130.00	Three Phase
		kVA		1		1	33.00	1	33.00	Three Phase
		kVA								Single Phase

C. WTP [Phase 1]

3-1. Capacity Calculation Sheet for Transformer

Calculation Condition

Duty Transformer Name	Three Phase Load Capacity (ΣP1) (kW)	kVA Load Equipment (ΣP2) (kVA)	Single Phase Load Equipment (ΣP3) (kVA)
NO.1 Power Transformer	1142.45	33.00	0.00
NO.2 Power Transformer	0.00	0.00	0.00

Capacity Calculation Formula

[Calculation Formula for Power Transformer]

$$\mathbf{TR} = \left(\frac{\Sigma \mathbf{P1}}{\eta \times \phi} + \Sigma \mathbf{P2} + \sqrt{3} \times \Sigma \mathbf{P3} \right) \times \alpha \times \beta$$

R : Required Transformer Capacity in kVA

ΣP1～3 : Total Capacity for each facility in kW/kVA

η	: General Efficiency	0.85
ϕ	: General Power Factor	0.85
α	: Surplus Factor	1
β	: Demand Factor	1

Calculation Result

Transformer Name	Required Transformer Capacity in kVA	Remarks
NO.1-1 Power Transformer	**1614.25**	
NO.1-2 Power Transformer	**0.00**	

Rated capacity of transformer in kVA	10	15	20	30	50	75	100	150	200	300
	500		750		1000		1500		2000	

Proposed Transformer

	kVA	Number	Rated Voltage	
			Primary	Secondary
NO.1 Transformer	**2000**	×1	**33000**	**415**
NO.2 Transformer				

The upper rated transformer capacity is to be proposed through the capacity calculation.

C. WTP [Phase 1]

3-2. Calculation for Transformer Voltage Regulation (Motor-starting)

Calculation Formula

[Calculation Formula for Power Transfomer Voltage Regulation]

① Base Load Capacity (kVA)

K1 =Max. Load Capacity - Motor Capacity (kVA)

② Starting Load Capacity (kVA)

K2 =Max. Motor Capacity (kVA) × Starting Factor

③ Active Power (kW)

$$P = P1 + P2 = K1\cos\theta 1 + K2\cos\theta 2$$

④ Reactive Power (kVar)

$$Q = Q1 + Q2 = K1\sin\theta 1 + K2\sin\theta 2$$

⑤ Total Starting Capacity (kVA)

$$K = \sqrt{}(P^2 + Q^2)$$

⑥ Voltage Regulation (%)

$$\varepsilon = \frac{\text{Total Starting Capacity}}{\text{Transformer Capacity}} \times \text{Transformer Z (\%)}$$

	2000kVA		
η : General Efficien	0.85		
$\cos\theta$ 1 :Power Factor	0.85		(at steady)
$\cos\theta$ 2 :Power Factor	0.40		(at motor starting)
Starting Factor	1.80		
Transfomer Z (%)	5.30		
Voltage Ragulation	10%≧		

Calculation Result

Item	2000kVA	
Max. Load Capacity (kW)	280	
1. Base Load Capacity (kVA)	1612.46	
2. Starting Load Capacity	697.58	
3. Active Power (kW)	1649.62	
4. Reactive Power	1488.75	
5. Total Starting Capacity (kVA)	2222.08	
6. Voltage Regulation (%)	5.89	
Result	10% > 5.89% O.K.	

C. WTP [Phase 1]

4. Calculation Sheet for Static Capacitor (SC)

Equipment Name	Duty Load for SC				
	For SC (1) (kW)	For SC (2) (kW)			
1. Flocculation & Sedimentation Basi	5.00	0.00			
2.Filter Units	154.90	0.00			
3.Clear Water Pump Station	15.10	0.00			
4.Chemical Building	17.45				
5.Backwash Recovery Facility	30.00				
Total	222.45	0.00			

Calculation Formula

[Formula]

$$Q = \frac{P \times \beta}{\eta} \times \left\{ \sqrt{\frac{1}{(\text{COS}\,\theta\,1)^2} - 1} - \sqrt{\frac{1}{(\text{COS}\,\theta\,2)^2} - 1} \right\} + \Sigma Ti \times \gamma T$$

Q : Required Static Capacitor Capacity in kVar				
P : Duty Load Output in kW			Σ T : Capacity of Transformer (kVA)	2000
η : Efficiency	0.85			
β : Demand Factor	0.7～ 0.8			
COS θ 1 : Power Factor without SC at Bus Bar	0.85			
COS θ 2 : Power Factor with SC at Bus Bar	0.95		γ T : Transformer Exciting Factor	0.01～ 0.03

Result	SC (1) (For NO.1 Transformer)		73.32 ～ 120.94	
	SC (2) (For NO.2 Transformer)			
Proposed Capacity	SC (1)	NO.1 SC	**50**	kVar
		NO.2 SC	**25**	kVar
		NO.3 SC	**15**	kVar
	SC (2)	NO.1 SC		kVar
		NO.2 SC		kVar
		NO.3 SC		kVar

Rated Capacity (JIS - C - 4902)	10	15	20	25	30	50	75
	150	200	250	300	400	500	750
	1000						

Note:

1. SC is to be installed all load except VVVF.
2. SC(5) is to be installed at each load.

C. WTP [Phase 1]

5. Capacity Calculation of Alternator

Calculation Condition	Description			Value
	Σ P0	Load Capacity Covered by Alt. (kW)		1172.15
	Pm	Max. Motor	Load Name	Raw Water Pump
			Starting Method	SOFT STERTER
			kW	450.00
	R	Harmonic wave generating load		0.00
	Unbalanced load capacity		A (kW)	4.00
			B (kW)	4.00
			C (kW)	4.00

Calculation Result		Value	Remarks	Rated Alternator Capacity				
	PG 1	1551.38		20	37.5	50	62.5	75
	PG 2	607.50		100	150	200	250	300
	PG 3	1082.72		375	500	625	750	875
	PG 4	13.33		1000	1250	1500	2000	2500
	PG max	1551.38		3125				
				JEM-1354				
	Selected (kVA)	2000 ×1set	Diesel-engine , Radiator type					

Calculation Formula

The rated alternator capacity is to be proposed on the basis of the maximum value among the following calculation.

a. Required for all load operation PG1 [kVA]

$$PG1 = \frac{\Sigma P0}{\eta L \times \phi L} \times \alpha \times Sf$$

b. Required from allowable voltage drop PG2 [kVA]

$$PG2 = Pm \times \beta \times C \times Xd' \frac{1-\Delta E}{\Delta E}$$

c. Required for starting the max. motor lastly PG3 [kVA]

$$PG3 = \frac{fv1}{\gamma G} \{(\Sigma P0 - Pm) \times \frac{\alpha}{\eta L \times \phi m} + Pm \times \beta \times C\}$$

d. Required from allowable negative phase current PG4 [kVA]

$$PG4 = \frac{1}{KG4} \sqrt{\{(0.432R)^2 + (1.23 \Delta P)^2 \times (1-3U+3U^2)\}}$$

β : Starting kVA for max. motor per kW 7.20

C : Motor starter factor 0.25

KG4 : Factor due to allowable negative phase current 0.15

R : Total harmonic wave generating load in kW

Δ P : Total single phase unbalance capacity in kW 0.00

Where A≧ B≧ C , Δ P = A+B-2C

U : Single phase unbalance factor $U = \frac{A-C}{\Delta P}$ 0.00

fv1 : Decrease factor of load starting 0.95

Value of decrease factor of load starting (fv)

Number of Poles	Pm / Σ P0				Remarks
	0~	0.8	0.9	1	
2P	1	0.9	0.85	0.8	PG3 , fv1
Over 4P	1	0.95	0.95	0.9	PE2-2 , fv3
2P	0.9	0.85	0.85	0.8	PE2-1 ,fv2
Over 4P	0.9	0.9	0.9	0.9	

Where

η L : General Efficiency 0.85

ϕ L : General Power Factor 0.80

α : Demand Factor 0.90

Xd' : Alternator Factor 0.25

Σ P0 : Total load capacity covered by generator in kW (Excluding Stand-by) Note 1

Sf : Current increasing factor due to unbalanced load (= 1+0.6× (Δ P÷ Σ P0) 1.00

Δ E : Allowable voltage drop factor 0.25

γ G : Tolerant capacity for momentary overload of Alternator 1.5

ϕ m :Max. motor power factor 0.85

Note1: To exchange kVA load into kW , single phase load to be multiplied by 0.8 , rectifier to be calculated as multiplying of rated Dc voltage and DC current, UPS to be calculated as multiplying of rated output in kVA and 0.9 , and these exchanged value to be added to three phase load capacity in kW.

C. WTP [Phase 1]

6. Capacity Calculation of Engine

Calculation Condition

Description		Value
PG Generator Output in kVA		2000
Pm Maximum Motor	Load name	Raw Water Pump
	Starting Method	SOFT STARTER
	kW	450
ΣP0 Load Capacity Covered by Alt. (kW)		586.075

Calculation Result

	Value	Remarks
PE 1	2367.79	
PE 2-1	601.34	
PE 2-2	621.03	
PE max	2367.79	
Selected (PS)	2400	Diesel-engine generator , Radiator type

Generator efficiency		
Rate	η G effi. (%)	
kVA	2～8P	10～18P
20	79.0	-
37.5	82.5	-
50	84.3	-
62.5	85.2	-
75	85.7	-
100	86.7	-
125	87.6	-
150	88.1	-
200	88.9	-
250	89.5	-
300	90.0	-
375	90.6	-
500	91.3	-
625	91.9	-
750	92.3	91.7
875	92.5	92.0
1000	92.8	92.3
1250	93.2	92.8
1500	93.4	93.1
2000	93.8	93.5
2500	93.9	93.7
3125	94.0	93.8

Calculation Formula

Maximum value or over among the following calculation is to be proposed as engine capacity.

a. PE1 in PS is to be derived from requirement for full load running

$$PE1 = \frac{PG\times \phi G}{\eta G}\times 1.36\times \Delta H$$

b. PE2 in PS is to be derived from requirement of max. motor starting lastly

① PE2-1 is to be derived from based on allowable load starting factor

$$PE2\text{-}1 = fv2\left\{ 0.75\times \frac{1}{\eta 'G}\times (\Sigma P0-Pm)\times \frac{\alpha}{\eta L} + \frac{1}{\varepsilon \times \eta 'G}\times Pm\times \beta \times C\times \phi s \right\}\times 1.36\times \Delta H$$

② PE2-2 is to be derived from tolerant capacity for momentary overload

$$PE2\text{-}2 = \frac{fv3}{\eta 'G\times \gamma E}\times \left\{ (\Sigma P0-Pm)\times \frac{\alpha}{\eta L} + Pm\times \beta \times C\times \phi s \right\}\times 1.36\times \Delta H$$

Where

ΣP0	: Total load capacity covered by generator in kW	
η L	: General Efficiency	0.85
ϕ L	: General Power factor	0.8
α	: Demand Factor	0.8
ϕ G	: Generator Power factor	0.8
γ E	: Tolerant capacity for momentary overload of Engine	1.1
β	: Starting kVA for max. motor of per kW	7.2
C	: Motor starter factor	0.25
ϕ s	: Motor starting Power Factor for max. motor starting kVA , Squirrel cage	0.4
η G	: Generator efficiency	0.919
η 'G	: Generator overload efficiency	0.855
fv2	: Decreased factor due to motor starting	0.9
fv3	: Decreased factor due to motor starting	1.0
ε	: Tolerant capacity due to non-motor starting of Engine	1.0
ΔH	: Altitude compensation	1.0

Starting method

$\beta\times$C	Starter Name
7.2×1	Direct on-line
7.2×2 / 3	Star - delta
7.2×1 / 3	Star - delta with resistor
1.2	VVVF
1.2	Wound - rotor type
7.2×0.5	Reactor 50%
7.2×0.65	Reactor 65%
7.2×0.8	Reactor 80%
7.2×0.25	Auto - transformer 50%
7.2×0.42	Auto - transformer 65%
7.2×0.64	Auto - transformer 80%

C. WTP [Phase 1]

7. Fuel Calculation

Calculation Condition

	Description	Value , Type
PG	Generator output in kVA	2000
P	Engineoutput in PS	2400
	Engine Type	Diesel-engine , Radiator type
	Fuel Type	Light oil

Calculation Result

Description	Value	Remarks
Fuel tank	15140.2 → 16000 L × 1 sets	

Calculation Formula

Fuel Tank Volume is to be derived from the following calculation.

a. Q [m3] Fuel Tank Volume

$$Q = \frac{P \times be \times H}{d} \times \alpha$$

be : Fuel consumption factor [unit : kg/PS·h]

Output (PS)	Diesel	Gas turbine
30 or less	0.23	-
over 30 and 250 or less	0.22	0.5
over 250 and 450 or less	0.2	0.48
over 450 and 750 or less	0.18	0.43
over 750	0.17	0.38

be : Fuel consumption factor 0.17 kg/PS·h

H : Running hour 28 hours

d : Fuel density 830 kg/m3
(A heavy oil 850kg/m3)
(Light oil 830kg/m3)
(Kerosine 790kg/m3)

α : Surplus Factor 1.1

D. WTP [Phase 3]

1. LOAD LIST FOR ELECTRICAL WORKS

SUMMARY SHEET

Facility name	Equipment name		Numbers (Duty)	Numbers (Stand-by)	Numbers (Total)	Commer. Power (kW)	Generator (Nummbers)	Generator (kW)	Remarks
	1. Flocculation & Sedimentation Basins		**37**	**0**	**37**	**14.20**	**40**	**14.20**	
						5.00			NO.1Tr
						9.20			NO.2Tr
	2.Filter Units		**67**	**5**	**72**	**112.60**	**68**	**167.60**	
						154.90			NO.1Tr
						12.70			NO.2Tr
	3.Clear Water Pump Station		**19**	**10**	**29**	**2456.10**	**19**	**2456.10**	
						1055.30			NO.1Tr
						1400.80			NO.2Tr
	4.Chemical Building		**20**	**3**	**23**	**37.45**	**20**	**37.45**	
						37.45			NO.1Tr
									NO.2Tr
	5.Backwash Recovery Facility		**1**	**1**	**2**	**30.00**	**1**	**30.00**	
						30.00			NO.1Tr
									NO.2Tr
	8. Architectural and others								
	Architectural (1)	kW	1		1	80.00	1	80.00	NO.1Tr
	Architectural (2)	kW	1		1	30.00	1	30.00	NO.1Tr
	Architectural (3)	kW	1		1	30.00	1	30.00	NO.2Tr
	Generator-1	kW	1		1	20.00	1	20.00	NO.1Tr
	Generator-1	kW	1		1	20.00	1	20.00	NO.2Tr
	UPS	kVA	1		1	33.00	1	33.00	NO.1Tr
	Total (NO.1 Transformer)	kW				1412.65		2885.35	Σ 1 , Three Phase
		kVA				33.00		33.00	Σ 2 , Three Phase
		kVA							Σ 3 , Single Phase
	Total (NO.2 Transformer)	kW				1472.70			Σ 1 , Three Phase
		kVA							Σ 2 , Three Phase
		kVA							Σ 3 , Single Phase
	Total					**2915.05**		**2915.05**	

Total(kW)=$\Sigma 1+\Sigma 2\times 0.9+\Sigma 3\times 0.8$

D. WTP [Phase 3]

2. LOAD LIST FOR ELECTRICAL WORKS

1. Flocculation & Sedimentation Basins

↓ Not including stand-by

Load tag No.	Load name		Power (kW)	Numbers (Duty)	Numbers (Stand-by)	Numbers (Total)	Commer. Power (kW)	Generator (Numbers)	Generator (kW)	Remarks
06 SC 11/21	Sludge Collector		0.75	12		12	9.00	12	9.00	
06 MV 11to24	De-sludge Valve		0.20	24		24	4.80	24	4.80	
								3		
06 SP 01	Sampling Pump		0.40	1		1	0.40	1	0.40	
										Duty load for SC (1) 5.00
	TOTAL	kW		37		37	14.20	40	14.20	Duty load for SC (2)
	(Distribution Tank and Grit Chamber Facility)	kVA								9.20

D. WTP [Phase 3]

2. LOAD LIST FOR ELECTRICAL WORKS

2.Filter Units

↓ Not including stand-by

Load tag No.	Load name	Power (kW)	Numbers (Duty)	Numbers (Stand-by)	Numbers (Total)	Commer. Power (kW)	Generator (Numbers)	Generator (kW)	Remarks
07 MG 11to41	Inflow Gate	0.40	12		12	4.80	12	4.80	
07 MG 12 to 42	Backwash Drainage Gate	0.40	12		12	4.80	12	4.80	
07 MV 11to41	Effluent Valve	0.20	12		12	2.40	12	2.40	
07 MV 12to42	Backwash Valve	0.20	12		12	2.40	12	2.40	
07 MV 13to43	Air Scour Valve	0.20	12		12	2.40	12	2.40	
07 BP 11to31	Backwash Pump	18.50	2	1	3	37.00	2	37.00	
07 AB 11to21	Air Blower	55.00	1	1	2	55.00	2	110.00	
07 DP 01/02	Sump Drainage Pump	1.50	2	2	4	3.00	2	3.00	
07 MM 11	Lime Mixer	0.40	1		1	0.40	1	0.40	
07 LP 11/21	Lime Feed Pump	0.40	1	1	2	0.40	1	0.40	
									Duty load for SC (1) 154.90
	TOTAL kW		67	5	72	112.60	68	167.60	Duty load for SC (2)
	(Distribution Tank and Grit Chamber Facility) kVA								12.70

D. WTP [Phase 3]

2. LOAD LIST FOR ELECTRICAL WORKS

3.Clear Water Pump Station

↓ Not including stand-by

Load tag No.	Load name		Power (kW)	Numbers (Duty)	Numbers (Stand-by)	Numbers (Total)	Commer. Power (kW)	Generator (Numbers)	Generator (kW)	Remarks
09 CP 11to14	Transmission Pump (A-1)		450.00	3	1	4	1350.00	3	1350.00	SC is to be installed at each load.
09 CP 21/22	Transmission Pump (A-2)		90.00	1	1	2	90.00	1	90.00	SC is to be installed at each load.
09 CP 31to31	Transmission Pump (A-3)		250.00	3	1	4	750.00	3	750.00	SC is to be installed at each load.
09 CP 41/42	Transmission Pump (A-4)		250.00	1	1	2	250.00	1	250.00	SC is to be installed at each load.
09 MV 11to14	Discharge Valve (A-1)		0.20	3	1	4	0.60	3	0.60	
09 MV 21/22	Discharge Valve (A-2)		0.20	1	1	2	0.20	1	0.20	
09 MV 31to31	Discharge Valve (A-3)		0.20	3	1	4	0.60	3	0.60	
09 MV 41/42	Discharge Valve (A-4)		0.20	1	1	2	0.20	1	0.20	
09 DP 01/02	Sump Drainage Pump		1.50	1	1	2	1.50	1	1.50	
09 PU 01	Plant Water Supply Unit		7.50	1		1	7.50	1	7.50	
09 PP 11/21	Chlorination Booster Pump		5.50	1	1	2	5.50	1	5.50	
										Duty load for SC (1) 15.30
	TOTAL	kW		19	10	29	2456.10	19	2456.10	Duty load for SC (1)
	(Distribution Tank and Grit Chamber Facility)	kVA								0.80

D. WTP [Phase 3]

2. LOAD LIST FOR ELECTRICAL WORKS

4.Chemical Building

↓ Not including stand-by

Load tag No.	Load name		Power (kW)	Numbers (Duty)	Numbers (Stand-by)	Numbers (Total)	Commer. Power (kW)	Generator (Numbers)	Generator (kW)	Remarks
10 MM 11/21	Alum Mixer		1.50	4		4	6.00	4	6.00	
10 AP 11/21	Alum Pump		0.40	3	1	4	1.20	3	1.20	
10 MM 11/21	Lime Mixer		2.20	4		4	8.80	4	8.80	
10 LP 11/12	Lime Pump		5.50	3	1	4	16.50	3	16.50	
10 LP 21/22	Lime Feed Pump		0.40	3	1	4	1.20	3	1.20	
10 EF 11	Exhaust Fan		0.75	1		1	0.75	1	0.75	
10 MC 01	Chemical Crane		1.50	1		1	1.50	1	1.50	
10 MC 02	Chemical Crane		1.50	1		1	1.50	1	1.50	
										Duty load for SC (1) 37.45
	TOTAL	kW		20	3	23	37.45	20	37.45	
	(Distribution Tank and Grit Chamber Facility)	kVA								

D. WTP [Phase 3]

2. LOAD LIST FOR ELECTRICAL WORKS

5.Backwash Recovery Facility

↓ Not including stand-by

Load tag No.	Load name	Power (kW)	Numbers (Duty)	Numbers (Stand-by)	Numbers (Total)	Commer. Power (kW)	Generator (Numbers)	Generator (kW)	Remarks
11 WP 11/21	Backwash Recovery Pump	30.00	1	1	2	30.00	1	30.00	
									Duty load for SC (1) 30.00
	TOTAL kW		1	1	2	30.00	1	30.00	
	(Distribution Tank and Grit Chamber Facility) kVA								

D. WTP [Phase 3]

2. LOAD LIST FOR ELECTRICAL WORKS

6.Architectural and others

↓ Not including stand-by

Load tag No.	Load name		Power (kW)	Numbers (Duty)	Numbers (Stand-by)	Numbers (Total)	Commer. Power (kW)	Generator (Numbers)	Generator (kW)	Remarks
A7-001	Architectural Power-1		80.00	1		1	80.00	1	80.00	
A7-001	Architectural Power-2		30.00	1		1	30.00	1	30.00	
A7-001	Architectural Power-3		30.00	1		1	30.00	1	30.00	
A7-004	Generator Panel		20.00	2		2	40.00	2	40.00	
A7-005	UPS Power (kVA)		33.00	1		1	33.00	1	33.00	
A7-006	DC Power for Generator-starter (kVA)									
	TOTAL (Architectural Facility)	kW		5		5	180.00	5	180.00	Three Phase
		kVA		1		1	33.00	1	33.00	Three Phase
		kVA								Single Phase

D. WTP [Phase 3]

3-1. Capacity Calculation Sheet for Transformer

Calculation Condition

Duty Transformer Name	Three Phase Load Capacity (Σ P1)	kVA Load Equipment (Σ P2)	Single Phase Load Equipment (Σ P3)
	(kW)	(kVA)	(kVA)
NO.1 Power Transformer	1412.65	33.00	0.00
NO.2 Power Transformer	1472.70	0.00	0.00

Capacity Calculation Formula

[Calculation Formula for Power Transformer]

$$\mathbf{TR} = \left(\frac{\Sigma \mathbf{P1}}{\eta \times \phi} + \Sigma \mathbf{P2} + \sqrt{3} \times \Sigma \mathbf{P3} \right) \times \alpha \times \beta$$

R : Required Transformer Capacity in kVA
ΣP1～3 : Total Capacity for each facility in kW/kVA
η : General Efficiency 0.85
ϕ : General Power Factor 0.85
α : Surplus Factor 1
β : Demand Factor 0.9

Calculation Result

Transformer Name	Required Transformer Capacity in kVA	Remarks
NO.1-1 Power Transformer	**1789.40**	
NO.1-2 Power Transformer	**1834.51**	

Rated capacity of transformer	10	15	20	30	50	75	100	150	200	300
in kVA	500		750		1000		1500		2000	

Proposed Transformer

	kVA	Number	Rated Voltage	
			Primary	Secondary
NO.1 Transformer	**2000**	1 set	**33000**	**415**
NO.2 Transformer	**2000**	1 set		

The upper rated transformer capacity is to be proposed through the capacity calculation.

D. WTP [Phase 3]

3-2. Calculation for Transformer Voltage Regulation (Motor-starting)

Calculation Formula

[Calculation Formula for Power Transfomer Voltage Regulation]

① Base Load Capacity (kVA)

K1 =Max. Load Capacity - Motor Capacity (kVA)

② Starting Load Capacity (kVA)

K2 =Max. Motor Capacity (kVA) × Starting Factor

③ Active Power (kW)

$P = P1 + P2 = K1\cos\theta 1 + K2\cos\theta 2$

④ Reactive Power (kVar)

$Q = Q1 + Q2 = K1\sin\theta 1 + K2\sin\theta 2$

⑤ Total Starting Capacity (kVA)

$K = \sqrt{\ }(P^2 + Q^2)$

⑥ Voltage Regulation (%)

$$\varepsilon = \frac{\text{Total Starting Capacity}}{\text{Transformer Capacity}} \times \text{Transformer Z (\%)}$$

	2000kVA		
η : General Efficien	0.85		
cos θ 1 :Power Factor	0.85		(at steady)
cos θ 2 :Power Factor	0.40		(at motor starting)
Starting Factor	1.80		
Transfomer Z (%)	5.30		
Voltage Ragulation	10%≧		

Calculation Result

Item	2000kVA	
Max. Load Capacity (kW)	280	
1. Base Load Capacity (kVA)	1612.46	
2. Starting Load Capacity	697.58	
3. Active Power (kW)	1649.62	
4. Reactive Power	1488.75	
5. Total Starting Capacity (kVA)	2222.08	
6. Voltage Regulation (%)	5.89	
Result	10% > 5.89% O.K.	

D. WTP [Phase 3]

4. Calculation Sheet for Static Capacitor (SC)

Equipment Name	Duty Load for SC				
	For SC (1) (kW)	For SC (2) (kW)			
1. Flocculation & Sedimentation Bas	5.00	9.20			
2.Filter Units	154.90	12.70			
3.Clear Water Pump Station	15.30	0.80			
4.Chemical Building	37.45				
5.Backwash Recovery Facility	30.00				
Total	242.65	22.70			

Calculation Formula

[Formula]

$$Q = \frac{P \times \beta}{\eta} \times \left\{ \sqrt{\frac{1}{(\cos\theta 1)^2} - 1} - \sqrt{\frac{1}{(\cos\theta 2)^2} - 1} \right\} + \Sigma Ti \times \gamma T$$

Q : Required Static Capacitor Capacity in kVar

P : Duty Load Output in kW

η : Efficiency — 0.85

β : Demand Factor — 0.7～ 0.8

COS θ 1 : Power Factor without SC at Bus Bar — 0.85

COS θ 2 : Power Factor with SC at Bus Bar — 0.95

Σ T : Capacity of Transformer (kVA) — 2000

γ T : Transformer Exciting Factor — 0.01～ 0.03

Result	SC (1) (For NO.1 Transformer)	78.16	～	126.47
	SC (2) (For NO.2 Transformer)	25.44	～	66.22

Proposed Capacity	SC (1)	NO.1 SC	50	kVar
		NO.2 SC	25	kVar
			15	kVar
	SC (2)	NO.1 SC	25	kVar
		NO.2 SC	20	kVar
		NO.3 SC	10	kVar

Rated Capacity (JIS - C - 4902)	10	15	20	25	30	50	75
	150	200	250	300	400	500	750
	1000						

Note:

1. SC is to be installed all load except VVVF.
2. SC(5) is to be installed at each load.

D. WTP [Phase 3]

5. Capacity Calculation of Alternator

Calculation Condition	Description			Value
	ΣP0	Load Capacity Covered by Alt. (kW)		2915.05
	Pm	Max. Motor	Load Name	Raw Water Pump
			Starting Method	SOFT STERTER
			kW	450.00
	R	Harmonic wave generating load		0.00
	Unbalanced load capacity		A (kW)	
			B (kW)	
			C (kW)	

Calculation Result	Value	Remarks	Rated Alternator Capacity				
PG 1	3858.15		20	37.5	50	62.5	75
PG 2	607.50		100	150	200	250	300
PG 3	2457.75		375	500	625	750	875
PG 4	13.33		1000	1250	1500	2000	2500
PG max	3858.15		3125				
			JEM-1354				
Selected (kVA)	2000 ×2set	Diesel-engine , Radiator type					

Calculation Formula

The rated alternator capacity is to be proposed on the basis of the maximum value among the following calculation.

a. Required for all load operation PG1 [kVA]

$$PG1 = \frac{\Sigma P0}{\eta L \times \phi L} \times \alpha \times Sf$$

b. Required from allowable voltage drop PG2 [kVA]

$$PG2 = Pm \times \beta \times C \times Xd' \frac{1-\Delta E}{\Delta E}$$

c. Required for starting the max. motor lastly PG3 [kVA]

$$PG3 = \frac{fv1}{\gamma G} \{(\Sigma P0 - Pm) \times \frac{\alpha}{\eta L \times \phi m} + Pm{\times}\beta{\times}C\}$$

d. Required from allowable negative phase current PG4 [kVA]

$$PG4 = \frac{1}{KG4} \sqrt{\{(0.432R)^2 + (1.23\Delta P)^2 \times (1-3U+3U^2)\}}$$

Where

ηL	: General Efficiency	0.85
ϕL	: General Power Factor	0.80
α	: Demand Factor	0.90
Xd'	: Alternator Factor	0.25
ΣP0	: Total load capacity covered by generator in kW (Excluding Stand-by) Note 1	
Sf	: Current increasing factor due to unbalanced load (= 1+0.6×(ΔP÷ΣP0))	1.00
ΔE	: Allowable voltage drop factor	0.25
γG	: Tolerant capacity for momentary overload of Alternator	1.5
ϕm	:Max. motor power factor	0.85

β	: Starting kVA for max. motor per kW	7.20
C	: Motor starter factor	0.25
KG4	: Factor due to allowable negative phase current	0.15
R	: Total harmonic wave generating load in kW	
ΔP	: Total single phase unbalance capacity in kW Where A≧B≧C , ΔP = A+B-2C	0.00
U	: Single phase unbalance factor $U = \frac{A-C}{\Delta P}$	0.00
fv1	: Decrease factor of load starting	0.95

Value of decrease factor of load starting (fv)

Number of Poles	Pm / ΣP0				Remarks
	0~	0.8	0.9	1	
2P	1	0.9	0.85	0.8	PG3 , fv1
Over 4P	1	0.95	0.95	0.9	PE2-2 , fv3
2P	0.9	0.85	0.85	0.8	PE2-1 ,fv2
Over 4P	0.9	0.9	0.9	0.9	

Note1: To exchange kVA load into kW , single phase load to be multiplied by 0.8 , rectifier to be calculated as multiplying of rated Dc voltage and DC current, UPS to be calculated as multiplying of rated output in kVA and 0.9 , and these exchanged value to be added to three phase load capacity in kW.

D. WTP [Phase 3]

6. Capacity Calculation of Engine

Calculation Condition

Description			Value
PG	Generator Output in kVA		2000
Pm	Maximum Motor	Load name	Raw Water Pump
		Starting Method	SOFT STERTER
		kW	450
Σ P0	Load Capacity Covered by Alt. (kW)		1457.525

Calculation Result

	Value	Remarks
PE 1	2367.79	
PE 2-1	1481.96	
PE 2-2	1747.75	
PE max	2367.79	
Selected (PS)	2400	Diesel-engine generator , Radiator type

Generator efficiency		
Rate	η G effi. (%)	
kVA	2~8P	10~18P
20	79.0	-
37.5	82.5	-
50	84.3	-
62.5	85.2	-
75	85.7	-
100	86.7	-
125	87.6	-
150	88.1	-
200	88.9	-
250	89.5	-
300	90.0	-
375	90.6	-
500	91.3	-
625	91.9	-
750	92.3	91.7
875	92.5	92.0
1000	92.8	92.3
1250	93.2	92.8
1500	93.4	93.1
2000	93.8	93.5
2500	93.9	93.7
3125	94.0	93.8

Calculation Formula

Maximum value or over among the following calculation is to be proposed as engine capacity.

a. PE1 in PS is to be derived from requirement for full load running

$$\mathrm{PE1} = \frac{\mathrm{PG} \times \phi \mathrm{G}}{\eta \mathrm{G}} \times 1.36 \times \Delta \mathrm{H}$$

b. PE2 in PS is to be derived from requirement of max. motor starting lastly

① PE2-1 is to be derived from based on allowable load starting factor

$$\mathrm{PE2\text{-}1} = \mathrm{fv2}\left\{ 0.75 \times \frac{1}{\eta '\mathrm{G}} \times (\Sigma \mathrm{P0} - \mathrm{Pm}) \times \frac{\alpha}{\eta \mathrm{L}} + \frac{1}{\varepsilon \times \eta '\mathrm{G}} \times \mathrm{Pm} \times \beta \times \mathrm{C} \times \phi \mathrm{s} \right\} \times 1.36 \times \Delta \mathrm{H}$$

② PE2-2 is to be derived from tolerant capacity for momentary overload

$$\mathrm{PE2\text{-}2} = \frac{\mathrm{fv3}}{\eta '\mathrm{G} \times \gamma \mathrm{E}} \times \left\{ (\Sigma \mathrm{P0} - \mathrm{Pm}) \times \frac{\alpha}{\eta \mathrm{L}} + \mathrm{Pm} \times \beta \times \mathrm{C} \times \phi \mathrm{s} \right\} \times 1.36 \times \Delta \mathrm{H}$$

Where

Σ P0	: Total load capacity covered by generator in kW	
η L	: General Efficiency	0.85
φ L	: General Power factor	0.8
α	: Demand Factor	0.8
φ G	: Generator Power factor	0.8
γ E	: Tolerant capacity for momentary overload of Engine	1.1
β	: Starting kVA for max. motor of per kW	7.2
C	: Motor starter factor	0.25
φ s	: Motor starting Power Factor for max. motor starting kVA , Squirrel cage	0.4
η G	: Generator efficiency	0.919
η 'G	: Generator overload efficiency	0.855
fv2	: Decreased factor due to motor starting	0.9
fv3	: Decreased factor due to motor starting	1.0
ε	: Tolerant capacity due to non-motor starting of Engine	1.0
Δ H	: Altitude compensation	1.0

Starting method

β ×C	Starter Name
7.2×1	Direct on-line
7.2×2 / 3	Star - delta
7.2×1 / 3	Star - delta with resistor
1.2	VVVF
1.2	Wound - rotor type
7.2×0.5	Reactor 50%
7.2×0.65	Reactor 65%
7.2×0.8	Reactor 80%
7.2×0.25	Auto - transformer 50%
7.2×0.42	Auto - transformer 65%
7.2×0.64	Auto - transformer 80%

D. WTP [Phase 3]

7. Fuel Calculation

Calculation Condition

	Description	Value , Type
PG	Generator output in kVA	2000
P	Engineoutput in PS	2400
	Engine Type	Diesel-engine , Radiator type
	Fuel Type	Light oil

Calculation Result

Description	Value	Remarks
Fuel tank	15140.2 → 16000 L × 2 sets	

Calculation Formula

Fuel Tank Volume is to be derived from the following calculation.

a. Q [m3] Fuel Tank Volume

$$Q = \frac{P \times be \times H}{d} \times \alpha$$

be : Fuel consumption factor [unit : kg/PS・h]

Output (PS)	Diesel	Gas turbine
30 or less	0.23	-
over 30 and 250 or less	0.22	0.5
over 250 and 450 or less	0.2	0.48
over 450 and 750 or less	0.18	0.43
over 750	0.17	0.38

be	: Fuel consumption factor	0.17 kg/PS・h
H	: Running hour	28 hours
d	: Fuel density (A heavy oil 850kg/m3) (Light oil 830kg/m3) (Kerosine 790kg/m3)	830 kg/m3
α	: Surplus Factor	1.1