

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

**NATIONAL WATER SUPPLY AND DRAINAGE BOARD
MINISTRY OF URBAN DEVELOPMENT, CONSTRUCTION
AND PUBLIC UTILITIES
DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA**

**THE DETAILED DESIGN STUDY
ON
THE PROJECT FOR REDUCTION
OF NON-REVENUE WATER
IN THE GREATER COLOMBO AREA
IN
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA**

FINAL REPORT

**DESIGN REPORT ON THE CONTRACT
FOR LEAK REPAIR WORKS**

MARCH 2001

NIHON SUIDO CONSULTANTS CO., LTD.

CURRENCY EQUIVALENTS

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**DESIGN REPORT
ON
THE CONTRACT FOR LEAK REPAIR WORKS**

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ABBREVIATIONS

ABBREVIATIONS AND TERMINOLOGY

AC	-	Asbestos Cement
AGF	-	Above Ground Floor
AGM	-	Additional General Manager
AS	-	Australian Standards
AWWA	-	American Water Works Association
B/C	-	Benefit Cost Ratio
BOQ	-	Bill of Quantity
BS	-	British Standards
BWL	-	Bottom Water Level
CDC	-	Community Development Council
CEB	-	Ceylon Electricity Board
CI	-	Cast Iron
CMC	-	Colombo Municipal Council
CSPU	-	Clean Settlement Program Unit of the Ministry of Urban Development, Construction and Public Utilities
DG	-	Diesel Engine Generator
DGM	-	Deputy General Manager
DI	-	Ductile Iron
dia.	-	Diameter
E/N	-	Exchange Notes
GC	-	Greater Colombo
GI	-	Galvanized Mild Steel Pipe
GM	-	General Manager
GOJ	-	Government of Japan
GOSL	-	Government of Sri Lanka
GR	-	Ground Reservoir
GST	-	Goods and Services Tax
GWL	-	Ground Water Level
HP	-	Horsepower
HWL	-	High Water Level
I/O	-	Input-output
ICB	-	International Competitive Bidding
ICTAD	-	Institute for Construction Training and Development

IDA	-	International Development Agency
IEE	-	Institution of Electrical Engineers
IRR	-	Internal Rate of Return
ISO	-	International Organization for Standardization
JBIC	-	Japan Bank for International Cooperation
JICA	-	Japan International Cooperation Agency
JST	-	JICA Study Team
LCB	-	Local Competitive Bidding
LDB	-	Lighting Distribution Board
LECO	-	Lanka Electricity Corporation
LI	-	Langelier's Saturation Index
LV	-	Low Voltage
LWL	-	Low Water Level
M/D	-	Minutes of Discussion
MCCB	-	Molded Case Circuit Breaker
MDPE	-	Medium Density Polyethylene
MLD	-	Million Litre per Day
MS	-	Mild Steel
MSB	-	Main Switch Board
MSL	-	Mean Sea Level
MUDCP	-	Ministry of Urban Development, Construction and Public Utilities
NCCSL	-	National Construction Contractor Association
ND, DN	-	Nominal Diameter
NGO	-	Non-government Organization
NHDA	-	National Housing Development Authority
NPV	-	Nett Present Value
NRW	-	Non-revenue Water
NWSDB	-	Notional Water Supply and Drainage Board
O&M	-	Operation & Maintenance
ODA	-	Official Development Assistance
OPC	-	Ordinary Portland Cement
PDB	-	Power Distribution Board
PIU	-	Project Implementation Unit
PLC	-	Programmable Logic Controller
PQ	-	Prequalification
PRDA	-	Provincial Road Development Authority
PS	-	Polis Station
PVC, uPVC	-	(Unplasticized) Polyvinyl Chloride

R/C, RC	-	Reinforced Concrete
RDA	-	Road Development Authority
RSC	-	Regional Support Centre of the National Water Supply and Drainage Board
S/W	-	Scope of Work
SAPROF	-	Special Assistance for Project Formation
SAPS	-	Special Assistance for Project Sustainability
SDB	-	Socket Distribution Board
SLLRDC	-	Sri Lankan Land Reclamation and Development Corporation
SLS	-	Serviceability Limit State
SLT	-	Sri Lanka Telecom
SPSS	-	Statistical Package for Social Sciences
STP	-	Sustainable Township Programme of the Ministry of Urban Development, Construction and Public Utilities
TDH	-	Total Dynamic Head
TG	-	Tenement Garden
TM	-	Transmission Main
TOR	-	Terms of Reference
TP&N, TPN	-	Three Pole and Neutral
TWL	-	Top Water Level
UDA	-	Urban Development Authority
UFW	-	Unaccounted-for Water
ULS	-	Ultimate Limit State
UPDB	-	Utilities Power Distribution Board
VH	-	Valve House
WTP	-	Water Treatment Plant
XLPE	-	Cross-linked Polyethylene Insulated Vinyl Sheath

UNITS

A, amp, Amp	-	Ampere
°C	-	Celsius
cm	-	Centimetre
d	-	Day
dB	-	Decibel
h, hr, Hr	-	Hour
ha	-	Hectare
Hz	-	Hertz

kg	-	Kilogram
km	-	kilometre
kN	-	kilonewton
kVA	-	Kilovolt-ampere
kW	-	Kilowatt
L, l, ltr	-	Litre
lpcd, lcd	-	Liter per Capita per Day
m, M	-	Metre, Million
m ² , sqm	-	Square Metre
m ³ , cum	-	Cubic Metre
mg	-	Milligram
MG	-	Million Imperial Gallon
min	-	Minutes
mm	-	Millimetre
mm ² , sqmm	-	Square Millimetre
mph	-	Mile per Hour
N	-	Newton
pH	-	Potential of Hydrogen
ppm	-	Parts per Million
psi	-	Pounds per Square Inch
Rs.	-	Sri Lankan Rupee
s, sec	-	Second
V	-	Volt
W	-	Watt

1. INTRODUCTION

It is widely accepted that the Non-Revenue water (NRW) in Colombo City is around 50% of the total supply, and that leakage in the distribution system constitutes a great part of NRW.

The decrease in the volume of NRW by abatement of leakage and reduction of wastage is therefore indispensable for making adequate water available for the new service areas expanded by the Towns East, Towns South and Towns North projects, while, in the meantime, the new Kalu Ganga scheme is developed. If NRW remains at the present high levels, not only the recently completed Towns East and Towns South projects but also the proposed Towns North Project will face severe water shortages in the near future.

Furthermore, the present high NRW level is one of the major reasons for the weak financial conditions of NWSDB. In this context, the Japanese Government has agreed to finance this Project for Reduction of Non-Revenue Water.

As part of this Project, approximately 2,340 leaks in the distribution pipes with diameters 2 to 8 inches and 9,000 leaks in service pipes will be repaired within CMC area.

2. LEAK REPAIR WORK OF DISTRIBUTION PIPES (2" – 8")

2.1 GENERAL

National Water Supply and Drainage Board (NWSDB) supplies water to approximately 73,500 service connections in CMC area, encompassing nearly 36 square kilometers. According to the recent statistics, the CMC distribution system consists of approximately 500km of cast iron water mains ranging from 4" to 30" and very limited lengths of DI, PVC, AC and GI pipes.

Many main leaks have occurred due to aging cast iron pipes installed in the late 1800's and early 1900's. As can be seen in Table 2.1, 22% of cast iron pipes in CMC area are over 100 years old and nearly 80% are over 50 years old. Almost all cast iron pipes have been installed without a protective internal lining, which is the primary cause of many internal corrosion leaks. Insufficient covers to the pipe and the increasing traffic loadings have caused many structural failures in the pipeline. The compositions of existing cast iron pipes in terms of their age are given in Table 2.1.

2.2 DATA AVAILABLE

The majority of main leaks are currently repaired by Water Works Department of CMC under a contract with NWSDB, whilst very few main leak repairs are conducted by NRW Reduction Unit or the Area Engineers of NWSDB. The summary of the main leak repairs attended by CMC is given in Table 2.2.

Table 2.2 Main Leaks Attended by CMC in 1999

Month	Leaks Attended by CMC				
	Pipe Leaks	Joint Leaks	Hydrant Leaks	Valve Leaks	Total
Jan-99	57	23	3	8	91
Feb-99	67	20	12	32	131
Mar-99	71	28	2	10	111
Apr-99	68	23	0	20	111
May-99	50	34	15	20	119
Jun-99	92	48	10	20	170
Jul-99	89	51	4	7	151
Aug-99	72	68	1	30	171
Sep-99	61	47	5	20	133
Oct-99	67	26	11	22	126
Nov-99	158	81	8	20	267
Dec-99	68	41	9	18	136
Total	920	490	80	227	1,717

Unfortunately however, these leak records do not contain details, such as the type of leaks, repair materials used or repair costs involved.

Main leak repairs in CMC area average 143 leaks per month with the total being approximately 1,700 leaks per year.

Table 2.1 Details of Existing Cast Iron Water Mains in CMC

Age Group	Diameter (inch) & Length (m)													Total Length	% of Total
	3"	4"	5"	6"	7"	8"	9"	10"	12"	15"	16"	18"	20"		
Over 100 Years	18,101	39,310	10,952	12,814	5,323	4,020	2,907	5,210	5,570	1,080		2,515	4,102	111,904	22.31
70 – 100 Years	49,518	100,454	5,740	21,101	1,915	3,220	10,095	17,238	10,951	4,290	345	2,845	2,490	230,202	45.90
50 – 70 Years	9,365	20,272		2,229		415		715	2,110	400			6,849	42,355	8.44
20 – 50 Years	11,116	82,609		5,351		150	1,081	3,353	2,180	4,510			1,694	112,044	22.34
Less than 20 Years	202	2,198		2,640										5,040	1.00
Total (m)	88,302	244,843	16,692	44,135	7,238	7,805	14,083	26,516	20,811	10,200	345	5,360	15,135	501,545	100
% of Total	17.61	48.82	3.33	8.80	1.44	1.56	2.81	5.29	4.15	2.05	0.07	1.07	3.02	100	

2.3 TYPE OF LEAKS

Having examined the main leak repair records and discussed with CMC staffs in charge of leak repair, the following major types of leaks were identified.

- (a). Joint leaks (lead joints in CI pipes)
- (b). Leakage through pinholes and corrosion holes in the pipe
- (c). Leakage through circumferential cracks in the pipe
- (d). Leakage through longitudinal cracks in the pipe
- (e). Fire hydrant leaks
- (f). Gate valve leaks (Gland Leaks)
- (g). Air valve leaks
- (h). Leakage due to manmade damages as a result of
 - Extensive damage to the pipe barrel
 - Holes created by sharp objects such as tooth of a back hoe
 - Pulled-out service connections causing damage to the pipe at the tapping
 - Scraping/lining work conducted in the past

2.4 TYPE OF AVAILABLE REPAIR MATERIALS

The industry offers a variety of materials for quick and reliable repair of the above leaks. They are:

- (a). Saddle straps
- (b). Full circle repair clamps (Split Collar and Wrap-Around Types)
- (c). Full circle repair saddles (Split Collar and Wrap-Around Types with Threaded Outlets for service connections)
- (d). Bell joint leak clamps
- (e). Slip couplings
- (f). PVC repair sockets (for PVC pipes only)

Saddle Straps

Gunmetal saddle strap provides a quick and cost effective method to repair a point leak, which can be accommodated within the small circular gasket of the saddle strap.

Full Circle Repair Clamps

These types of clamps are similar to Viking Johnson EasiClamp made of Malleable Iron or Ductile Iron and Viking Johnson HandiClamp made of stainless steel or similar products.

This repair clamp is suitable for Cast Iron, Ductile Iron or PVC pipes for any given nominal diameters. These clamps guarantee a reliable, permanent seal even on badly corroded pipes. A circumferential waffle gasket provides a leaklight seal, which caters for pinholes and corrosion holes, impact damages, circumferential and longitudinal cracks. The length of the clamp for nominal pipe diameters of 3" – 8" is 200mm. The half housings are made of malleable iron or ductile iron.

VJ handiClamp or similar products are constructed of stainless steel and suitable for use on Cast Iron, Ductile Iron or PVC on nominal bore. These clamps are designed to seal pinholes and corrosion holes, impact damages and longitudinal cracks but do not provide seal for circumferential cracks. However, they are available in different clamp lengths exceeding 200mm as in the case of VJ EasyClamp and similar products.

If the extent of the pipe damage is greater than the available length of these clamps, it is recommended that a cutout repair be undertaken.

Full Circle Repair Saddles

These types of saddles are similar to Viking Johnson EasiTap made of Malleable Iron or Ductile Iron and Viking Johnson HandiTap made of stainless steel. These repair saddles are used when the leakage is associated with a service connection.

This type of saddles provides a quick and cost effective method to repair the leak and reinstall or replace the affected service pipe connection whilst under pressure. This type of clamps incorporates either a female threaded outlet or a drilled and tapped boss to allow a simple under pressure connections to be made using standard tapping machine.

Bell Joint Leak Clamps

This type of clamps is similar to VJ EasiCollar clamps and is suitable to repair joint leaks in Cast Iron, Ductile Iron and PVC pipes. This is an adaptable repair collar that provides an effective, permanent repair to leaking spigot and socket joint. Once installed the gasket reinforces the seal of the socket and spigot joint.

Slip Couplings

This type of couplings is similar to VJ MaxiFit Couplings and caters for all popular sizes and types of Cast Iron, Ductile Iron and PVC pipes. The damage length of pipe is cut off and replaced with a new piece of pipe with Slip Couplings on either side.

PVC Repair Sockets

This type of repair sockets provide a cost effective method of replacing a damaged length of PVC pipes with a new piece of PVC pipe with PVC repair sockets on either side.

2.5 CLASSIFICATION OF LEAKS

The type of leaks varies from one place to another and difficult to classify in a simple manner. However, as the cost of leak repair depends largely on the materials used, it is relatively easy to classify the leaks according to the type of repair methods to be adopted in the project implementation stage.

The following leakage types are thus identified for given pipe sizes so that each type of leak can be evaluated for the corresponding pipe sizes.

- | | |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Type A | Small point leaks that can be repaired with a typical Brass <u>Saddle Strap</u> , similar to Talbot Flat Boss Strap. |
| Type B | Corrosion holes, longitudinal cracks, impact damages and circumferential breaks with the affected width of the pipe not greater than 200mm (for the diameter range of 3” – 8”) that can be repaired with a Malleable Iron/Ductile Iron <u>Full Circle Repair Clamp</u> similar to VJ EasiClamp. (Split Collars) |
| Type B1 | Leak Type as in Type B above but associated with a service connection that can be repaired with a Malleable Iron / Ductile Iron, <u>Full Circle Repair Saddle</u> similar to VJ EasiTap. (Split Collar with threaded outlet for service pipe) |
| Type C | Corrosion holes, longitudinal cracks and impact damages with the affected width of the pipe between 300 – 400mm (diameter 3” – 8”) that can be repaired with a stainless steel <u>Full Circle Repair Clamp</u> similar to VJ HandiClamp. (Wrap-Around Collar) |
| Type C1 | Leak Type as in Type C above but associated with a service connection that can be repaired with a stainless steel <u>Full Circle Repair Saddle</u> similar to VJ HandiTap. (Wrap-Around Collar with threaded outlet for service pipe) |
| Type D | Point damage or localized damage in PVC pipes that can be repaired with a <u>PVC Bell Socketed Repair Socket</u> . |

Type E	Extensive damage, which require the replacement of the affected length of the CI pipe with two <u>Slip Couplings</u> similar to VJ MaxiFit on both sides.
Type E1	Extensive damage, which requires the replacement of the affected length of the PVC pipe with two <u>PVC Bell Ended Sleeve Joints</u> on both sides.
Type F	Joint leaks in Cast Iron pipes, which can be repaired by <u>Re-caulking</u> with or without additional lead with a variety of small to large pneumatic or hand caulking irons, forcing the lead back into the bells.
Type F1	Joint leaks in Cast Iron or PVC pipes, which require <u>Bell Joint Leak Clamp</u> similar to VJ EasiCollar.
Type G1	Fire Hydrants leaks (Wedge Gate Type), which require the replacement of damaged <u>Gaskets / O'Rings</u> or similar replaceable items.
Type G2	Fire Hydrants leaks (Wedge Gate Type), which require the replacement of the leaking <u>Hydrant</u> .
Type G3	Fire Hydrant leaks (Duck Foot Bend Type), which require the replacement of damaged <u>Gaskets / O'Rings</u> or similar replaceable items.
Type G4	Fire Hydrant leaks (Duck Foot Bend Type), which require the replacement of the leaking <u>Hydrant</u> .
Type H	Air Valve leaks which requires the replacement of damaged <u>Gaskets / O'Rings</u> or similar replaceable items.
Type H1	Air Valve leaks which requires the replacement of the leaking <u>Air Valve</u> .
Type J	Gate Valve leaks which can be repaired by replacing the damaged <u>Gaskets / O'Rings</u> or similar replacement items
Type J1	Gate Valve leaks which needs replacement of the leaking valve with new <u>Double Flange Valve</u> .

2.6 QUANTIFICATION OF LEAK TYPES

The Contract for main leak repair works will be awarded to local contractors on a unit price basis. However, it is necessary to quantify the leak types in order to prepare the Bill of Quantities for procurement of necessary repair materials as well as for evaluation of bids. Materials will be purchased under the project and handed over to the Contractor. NWSDB will furnish necessary repair materials to the contractor on a day-to-day basis.

The scope of work indicates that approximately 2,340 leaks in distribution pipes (2 to 8 inches) in the CMC area be repaired. As shown in Table 2.2, the following main leaks were attended by CMC in the year 1999.

Pipe Leaks	920 Nos	54%
Joint Leaks	490 Nos.	28%
Hydrant Leaks	80 Nos.	5%
<u>Valve Leaks</u>	<u>227 Nos.</u>	<u>13%</u>
Total	1,717 Nos.	100%

Applying the same percentages, 2,340 leaks are broken down into components as shown below.

Main Leaks	1,260 Nos.
Joint Leaks	660 Nos.
Hydrant Leaks	120 Nos.
<u>Valve Leaks</u>	<u>300 Nos.</u>
Total	2,340 Nos.

The CMC leak repair records do not indicate the pipe diameters on which repairs have been made. However, limited records available at CMC and discussions with CMC and NWSDB suggested that:

- These leaks occurred mainly on 4” pipes and to a lesser extent on 3” pipes
- Leaks on 5”, 6”, 7” and 8” were very few
- Leaks on pipe sizes exceeding 10” are seldom reported

This corresponds well with the diameter-wise proportions of CI water mains in CMC area as shown in Table 2.1.

When considering diameters only up to 8”, details of cast iron pipes are as follows:

Diameter	Length	%	Estimated Pipe Leaks	Estimated Joint Leaks
3”	88,302	21.59	273	141
4”	244,843	59.86	757	392
5”	16,692	4.08	52	27
6”	44,135	10.79	136	71
7”	7,238	1.77	22	12
8”	7,805	1.91	24	12
Total	409,015	100%	1,264	655

According to the SAPS report, existing fire hydrants in CMC area are of two types. They are:

- Wedge Gate Type Fire Hydrants
- Duckfoot Bend Type Hydrants

The details given in the report are as follows:

Type of Fire Hydrant	Nos.	Percentage
Wedge Gate Type	1,767	75%
Duck Foot Bend Type	593	25%
Total	2,360	100%

Total number of valve leaks is estimated at 300. Assuming that 10% of valve leaks are pertaining to fire hydrants, it is estimated that the number of fire hydrant leaks to be attended by the project will be 30. Therefore the total number of gate valve leaks will remain at 270.

According to the SAPS report, the number of 3” – 8” gate valves is as follows:

Diameter	No. of Valves	%
3”	593	25
4”	1,376	60
5”	92	4

6"	167	7
7"	38	2
8"	44	2
Total	2,301	100%

Applying the same percentages, the number of leaks expected to be made for each valve size is estimated as follows:

Valve Diameter	%	No. of Valve Leaks to be Attended
3"	25	68
4"	60	162
5"	4	10
6"	7	20
7"	2	5
8"	2	5
TOTAL	100	270

Cast Iron pipe leaks comprise leak types A, B, B1, C, C1 and E.

Type D and E1 are exclusively for PVC pipes and a reasonable allowance shall be made for repairing PVC pipes within the CMC area, as these pipes are more vulnerable to damages due to excavation work being carried out by various utility agencies.

Cast Iron Joint leaks comprise leak types F and F1 and some allowance shall be made in leak Type F1 for possible joint leaks in pipe materials other than CI.

Leak types G1, G2, G3 and G4 are for fire hydrant leaks of wedge gate type and duck-foot bend type.

Leak types H1 and H2 are for air valve leaks while leak types J and J1 are for gate valve leaks. These leak types are illustrated in the Standard Drawings.

The estimated quantification of leak types is indicated in Table 2.3.

Table 2.3 Quantification of Main Leaks

Leak Type	Assumed %	Category	Pipe Diameter						Total
			3"	4"	5"	6"	7"	8"	
Type A	20%	Main Leaks	54	152	10	28	4	4	252
Type B	20%		54	152	10	28	4	4	252
Type B1	10%		27	76	5	14	2	2	126
Type C	10%		27	76	5	14	2	2	126
Type C1	10%		27	76	5	14	2	2	126
Type D	10%		27	76		19		4	126
Type E	10%		27	76	5	14	2	2	126
Type E1	10%		27	76		19		4	126
Sub-Total	100%		270	760	40	150	16	24	1,260
Type F	90%	Joint Leaks	125	350	27	63	9	18	992
Type F1	10%		15	40	3	7	1	2	68
Sub-Total	100%		140	390	30	70	10	20	660
Type G1	67.5%	Fire Hydrant Leaks	Wedge Gate Type (75%)						81
Type G2	7.5%		Wedge Gate Type (75%)						9
Type G3	22.5%		Duck-Foot Type (25%)						27
Type G4	2.5%		Duck-Foot Type (25%)						3
Sub-Total	100%								120
Type H	66%	Air Valve Leaks	80mm Double Orifice Air Valve						20
Type H1	34%		80mm Double Orifice Air Valve						10
Sub-Total	100%								30
Type J	90%	Gate Valve Leaks	61	146	9	18	4	4	242
Type J1	10%		7	16	1	2	1	1	28
Sub-Total	100%		68	162	10	20	5	5	270
Total									2,340

2.7 BILL OF QUANTITIES

Item	Description	Unit	Rate Rs.	Qty	Amount Rs.
	<p>Repair of Main Leaks. Contractor shall take note on the following matters:</p> <p>(a). All pipe materials, fittings, jointing materials, specials etc., shall be provided by NWSDB.</p> <p>(b). Removal of surface, excavation and backfilling shall be paid separately based on unit rates.</p> <p>(c). The reinstatement cost for asphalt/premix/tar surfaces, walkways, kerb stones, fences and the like, which will be paid directly to the respective authorities by NWSDB.</p> <p>(d). All necessary excavation permits including security clearance shall be obtained by the Contractors prior to start any work, NWSDB shall issue letters to the different authorities, but it shall be the responsibility of the Contractor to acquire such permits.</p> <p>(e). Whenever ordered by the Engineer, the Contractor shall import sand or soil for backfilling. Such imported materials shall be paid separately based on the unit rates.</p> <p>(f). Contractor shall study all specifications and standard drawings thoroughly in order to get fully acquainted with the work.</p>				
1.0	Cuttings and removal of asphalt/premix/tar layer from the road surface.				
	The thickness of the layer				
1.1	Not exceeding 150mm	m ³		1,050	
1.2	Exceeding 150mm but not exceeding 300mm	m ³		600	
1.3	Exceeding 300mm	m ³		300	
2.0	Excavation of earth material including rubble/stone pavement. Rate to include for dewatering and shoring as required.				
2.1	Depth not exceeding 1m.	m ³		6,740	
2.2	Depth exceeding 1m.	m ³		1,680	

Item	Description	Unit	Rate Rs.	Qty	Amount Rs.
3.0	Carryout <u>Type A</u> repair as specified. Rate to include for cleaning the pipe surface, fastening of the clamp saddle according to manufacturers specification and testing repair work by re-pressurizing the main.				
3.1	3" main	No.		54	
3.2	4" main	No.		152	
3.3	5" main	No.		10	
3.4	6" main	No.		28	
3.5	7" main	No.		4	
3.6	8" main	No.		4	
4.0	Carryout <u>Type B</u> repairs as specified. Rate to include for cleaning the pipe surface fastening of the repair saddle according to manufacturers specifications and testing the repair work by re-pressurizing the main.				
4.1	3" main	No.		54	
4.2	4" main	No.		152	
4.3	5" main	No.		10	
4.4	6" main	No.		28	
4.5	7" main	No.		4	
4.6	8" main	No.		4	
5.0	Carryout <u>Type B1</u> repairs as specified. Rate to include for cleaning the pipe surface, fastening of the repair saddle according to manufacturers specifications, re-tapping the main using standard tapping equipment, restoration of the service connection and testing the repair work by re-pressurizing the main				
5.1	3" main	No.		27	
5.2	4" main	No.		76	
5.3	5" main	No.		5	
5.4	6" main	No.		14	

Item	Description	Unit	Rate Rs.	Qty	Amount Rs.
5.5	7" main	No.		2	
5.6	8" main	No.		2	
6.0	Carryout <u>Type C</u> repairs as specified. Rate to include for cleaning the pipe surface, fastening of the repair saddle according to manufacturers specifications and testing the repair work by re-pressurizing the main.				
6.1	3" main	No.		27	
6.2	4" main	No.		76	
6.3	5" main	No.		5	
6.4	6" main	No.		14	
6.5	7" main	No.		2	
6.6	8" main	No.		2	
7.0	Carryout <u>Type C1</u> repairs as specified. Rate to include for cleaning the pipe surface, fastening of the repair saddle according to manufacturers specifications, re-tapping the main using standard tapping equipment, restoration of the service connection and testing the repair work by re-pressurizing the main				
7.1	3" main	No.		27	
7.2	4" main	No.		76	
7.3	5" main	No.		5	
7.4	6" main	No.		14	
7.5	7" main	No.		2	
7.6	8" main	No.		2	
8.0	Carryout <u>Type D</u> repairs as specified. Rate to include for exposing the leaking PVC pipe, cutting and removal of the affected length of the pipe, insertion of the PVC bell socket repair socket and testing the repair work by re-pressurizing the main.				
8.1	3" (80mm) main	No.		27	

Item	Description	Unit	Rate Rs.	Qty	Amount Rs.
8.2	4" (110mm) main	No.		76	
8.3	6" (160mm) main	No.		19	
8.4	8" (225mm) main	No.		4	
9.0	Carryout Type E repairs as specified. Rate to include for exposing the leaking pipe, cutting and removal of the affected length of the pipe, preparation of the new pipe piece to suit the gap, fastening of two slip couplings on both sides and testing the repair work by re-pressurizing the main.				
9.1	3" main	No.		27	
9.2	4" main	No.		76	
9.3	5" main	No.		5	
9.4	6" main	No.		14	
9.5	7" main	No.		2	
9.6	8" main	No.		2	
10.0	Carryout <u>Type E1</u> repairs on PVC mains as specified. Rate to include for exposing the leaking pipe, cutting and removal of the affected length of the pipe, preparation of new pipe piece to suit the gap, fixing of PVC Bell Ended Sleeve Joints on both sides and testing the repair work by re-pressurizing the main.				
10.1	3" (80mm) main	No.		27	
10.2	4" (110mm) main	No.		76	
10.3	6" (160mm) main	No.		19	
10.4	8" (225mm) main	No.		4	
11.0	Carryout <u>Type F</u> repairs as specified. Rate to include for re-aligning the joint if necessary, re-caulking with or without additional lead with hand or pneumatic hand caulking tools to achieve a leak tight joint and testing the repair work by re-pressurizing the main.				
11.1	3" main	No.		125	
11.2	4" main	No.		350	

Item	Description	Unit	Rate Rs.	Qty	Amount Rs.
11.3	5" main	No.		27	
11.4	6" main	No.		63	
11.5	7" main	No.		9	
11.6	8" main	No.		18	
12.0	Carryout <u>Type F1</u> repairs as specified. Rate to include for re-aligning the joint if necessary, removing the lead protruding from the face of the bell in CI pipes, fastening of the Bell Joint leak clamp according to manufacturers specifications and testing the repair work by re-pressurizing the main.				
12.1	3" CI or 80mm PVC main	No.		15	
12.2	4" CI or 110mm PVC main	No.		40	
12.3	5" CI main	No.		3	
12.4	6" CI or 160mm PVC main	No.		7	
12.5	7" CI main	No.		1	
12.6	8" CI or 225mm PVC main	No.		2	
13.0	Carryout <u>Type G1</u> repairs to wedge gate type fire hydrants. Rate to include for cleaning and dewatering the manhole, temporary dismantling of the manhole (if necessary), effecting the repair, repairs to the manhole (if necessary), placing a new manhole cover (if necessary) and testing the repair work by re-pressurizing the main.	No.		81	
14.0	Carryout <u>Type G2</u> works to replace the existing wedge gate type fire hydrant. Rate to include for cleaning and dewatering the manhole, temporary dismantling of the manhole (if necessary), remove old and unserviceable fire hydrants, fixing of a new fire hydrant, re-assemble the manhole, placing a new manhole cover (if necessary) and testing the new fire hydrant by re-pressurizing the main.	No.		9	
15.0	Carryout <u>Type G3</u> repairs to Duck-Foot bend type fire hydrants. Rate to include for cleaning and dewatering the manhole,	No.		27	

Item	Description	Unit	Rate Rs.	Qty	Amount Rs.
16.0	temporary dismantling of the manhole (if necessary), conducting the repair, repairs to the manhole (if necessary), placing a new manhole cover (if necessary) and testing the repair work by re-pressurizing the main. Carryout <u>Type G4</u> works to replace the existing Duck-Foot bend type fire hydrant. Rate to include for excavating, cleaning and dewatering the manhole, temporary dismantling of the manhole (if necessary), remove old and unserviceable fire hydrant, fixing of a new fire hydrant, re-assemble the manhole, placing a new manhole cover (if necessary) and testing the new fire hydrant by re-pressurizing the main.	No.		3	
17.0	Carryout <u>Type H</u> repairs to Air valves. Rate to include for cleaning and dewatering the manhole, temporary dismantling of the manhole (if necessary), conducting the repair, repairs to the manhole (if necessary) and testing the repair, work by pressurizing the main.	No.		20	
18.0	Carryout <u>Type H1</u> works to replace the existing Air Valve. Rate to include for cleaning and dewatering the manhole, temporary dismantling of the manhole (if necessary), remove old and unserviceable Air Valve, fixing of a new Air Valve, re-assemble the manhole and testing the new Air Valve by re-pressurizing the main.	No.		10	
19.0	Carryout <u>Type J</u> repair work to existing Gate Valves. Rate to include for excavation, dismantling of protection tube/surface box assembly, dewatering, carrying out the necessary repair as specified, re-assemble of protection tube/surface box assembly (provide new assembly if necessary), testing the repair work by re-pressurizing the main.				
19.1	3" Gate Valve	No.		61	
19.2	4" Gate Valve	No.		146	
19.3	5" Gate Valve	No.		9	
19.4	6" Gate Valve	No.		18	
19.5	7" Gate Valve	No.		4	

Item	Description	Unit	Rate Rs.	Qty	Amount Rs.
19.6	8" Gate Valve	No.		4	
20.0	Carryout <u>Type J1</u> repair work to replace the existing unserviceable gate valve. Rate to include for dewatering, dismantling of the protection tube/surface box assembly removal of the valve, installation of new double flange gate valve with flanged spigot, flanged adapter and slip coupling as specified, re-assemble of protection tube/surface box assembly (provide new assembly if necessary), testing the repair work by re-pressurizing the main.				
20.1	3" Gate Valve	No.		7	
20.2	4" Gate Valve	No.		16	
20.3	5" Gate Valve	No.		1	
20.4	6" Gate Valve	No.		2	
20.5	7" Gate Valve	No.		1	
20.6	8" Gate Valve	No.		1	
21.0	Backfilling of the excavated area as specified. Rate to include for removal of excessively wet soil from site as directed by the Engineer, import of suitable backfill material from outside, carryout compaction in layers as specified, prepare the excavated surface suitable for vehicular traffic and cleaning the working area to the satisfaction by the Engineer.	m ³		8,420	
22.0	Import of sand as backfill material.	m ³		840	
23.0	Import of suitable soil as backfill material.	m ³		840	
24.0	Temporary road surface reinstatement at road crossings and other places as instructed by Engineer.	m ²		3,000	

3. LEAK REPAIR WORK OF SERVICE PIPES

3.1 GENERAL

Until 1972, all service connections in CMC were given using Galvanized Mild Steel (GI) pipes. The use of PVC pipes for service connections was started in 1972. Since then, NWSDB and CMC have been replacing GI pipes with PVC pipes wherever leaks were detected in GI service pipes. However, it is believed that a large number of GI service pipes still remain unreplaced in the CMC area. The exact number of such GI service pipes is unknown. This project intends to replace GI service pipes, which can be detected or identified during the implementation of the project.

It has been identified that a significantly large number of leaks exist in service pipes and the repair of service pipe leaks is an essential part of any leakage abatement program.

3.2 DATA AVAILABLE

The service pipe leaks are currently attended by CMC, as well as by NRW Unit and Area Offices (CB1, CB2 and CB3) of NWSDB. However, most of the leak repair records are incomplete and it is difficult to determine the type of leaks, repair materials used, and respective repair costs involved.

Table 3.1 gives a summary of the leak repairs in service pipes carried out by all parties during the year 1999. It can be seen in the table that most of the data are not available. It is however calculated that more than 1,082 service pipe leaks were repaired in 1999.

Table 3.1 Repair of Service Pipe Leaks in CMC in 1999

Month	CMC	NWSDB Area Office			NWSDB NRW Unit		
		CB1	CB2	CB3	CB1	CB2	CB3
January	44	NA	NA	7	17	44	16
February	48	NA	NA	2	39	27	12
March	48	NA	NA	7	31	51	NA
April	23	NA	NA	1	1	13	NA
May	51	NA	NA	5	27	13	NA
June	74	NA	NA	10	NA	37	NA
July	63	NA	NA	6	25	NA	NA
August	71	NA	NA	2	7	NA	NA
September	61	NA	NA	11	NA	NA	NA
October	53	NA	NA	5	NA	NA	NA
November	51	12	NA	9	NA	NA	NA
December	33	14	NA	11	NA	NA	NA
TOTAL	620	26+	NA	76	147+	185+	28+

NA – Records Not Available

3.3 TYPE OF SERVICE PIPE LEAKS

In general, leaks in service pipes can be classified into the following types.

1. Leak from the saddle (No pipe damage) due to failure in the saddle, loosening of the saddle due to corroded nuts and bolts, displacement or failure of the rubber gaskets.
2. Ferrule leak
3. Leakage of PVC fittings at the ferrule
4. Leakage in the communication pipe
5. Leakage at stopcocks near the meter
6. Leakage at meter unions

As the leak types 1,2,3 above occur at tapping points, they can be grouped into one leak type. Leaks at stopcocks require a minor repair of the taps or replacement of the same if they have been worn out beyond repair. Water meter leak requires mainly re-washing work to stop leaks. Service pipe leaks require the replacement of the damaged length.

Apart from the above leaks, it is also necessary to replace existing GI communication pipes, as they have already developed or will develop leaks shortly.

It should also be noted that some PVC service pipes are laid exposed across the drains and culverts, being quite vulnerable to damages by vehicles or vandalism. GI pipe casings shall be provided wherever possible at these locations.

It has been also observed that many long service pipes are laid along the same by-road. These service pipes are popularly known as the “spaghetti pipes”. A narrow road off Kelaniya Mill road in Modera has 18 such service connections all laid along the same road. Most of these connections are exposed to sunlight and flattened by vehicles. They were found to be leaking severely. Such roads need a common distribution main so that individual houses could get a connection with a short length of service pipe.

3.4 QUANTIFICATION OF LEAK TYPES

The contract for service pipe leak repair works will be awarded to local contractors on a unit price contract basis. However, it is necessary to quantify the leak types in order to prepare the Bill of Quantities for procurement of necessary repair materials as well as for evaluation of bids.

It is intended that approximately 9,000 leaks in service connection pipes in the CMC area will be repaired under this contract.

For the purpose of preparing Bill of Quantities, it is assumed that the service pipe leaks can be grouped into the following four main categories.

1. Leaks in PVC service pipes where the service pipes are laid underground at proper depths (6,000 service connections).
2. Leaks in existing old GI service pipes, which need complete replacements from the ferrule to the water meter (1,000 service connections).
3. Leaks in existing exposed PVC service pipes at drain crossings, which need repair and GI pipe encasement to protect the PVC pipe (1,000 service connections).
4. Leaks in existing PVC or GI multiple service pipes (spaghetti pipes), which require the laying of an additional common main, transferring of existing services to the common main and plugging off multiple taps on the distribution main (1,000 service connections).

3.4.1 Quantification of Leaks in Service Pipes

The data maintained by both CMC and NWSDB on service pipe repairs are insufficient to form a reasonable basis for quantification of different leak types identified under Section 3.3. However, discussion with NWSDB and CMC indicate that the number of leaks at tapping points, water meters and stopcocks is very small compared to the leaks at communication pipes. Meter leaks are attended by NWSDB based on the information provided by the meter readers. No records on meter repairs are maintained, since only re-washing is needed to rectify most of the meter leaks.

Table 3.2 shows a rough breakdown of service pipe leaks attended by CMC in 1999. The study team obtained this information by re-organizing available records from CMC, which are grossly incomplete and unorganized. The information gives some idea about the proportions of leak types.

Table 3.2 Service Pipe Leaks Attended by CMC in 1999.

Month	Saddle/Ferrule	Valve	Service Pipe	Total
January	1	3	40	44
February	2	4	42	48
March	2	5	41	48
April	-	2	21	23
May	2	4	45	51
June	3	6	65	74
July	2	4	57	63
August	4	5	62	71
September	2	4	55	61
October	3	5	45	53
November	1	3	47	51
December	1	2	30	33
Total	23	47	550	620
%	4%	8%	88%	100%

However, the study team evaluated that the number of leaks at saddle/ferrule connections are under-recorded, as they are located deep under the road surface and are difficult to detect. Apart from this, there is reluctance from all parties to attend these leaks, as the repair work requires the breakage of tarred surface or road pavement, deep excavation to expose the leaks and interruption of traffic.

As such, the percentages of various leak types are assessed in the following manner in order to quantify the leak types.

Leak Type	%	No. of leaks to be Attended
Saddle/Ferrule Leaks	10%	600
Service Pipe Leaks	70%	4,200
Stopcock Leaks	10%	600
Water Meter Leaks	10%	600
TOTAL	100%	6,000 Nos.

The distribution of service connections in terms of their size is assumed as follows.

Size of Service Connection	Ferrules	Service Pipes, Stopcocks and Meters etc.,
½" (20mm)	70%	70%
¾" (25mm)	20%	20%
1" (32mm)	5%	5%
1½" (50mm)	2%	1%
2" (63mm)	3%	2%
3" (90mm)	-	1%
4" (110mm)	-	1%

The corresponding numbers of leak types and the quantity of ferrules and stopcocks to be procured by NWSDB are given in Table 3.3. It is assumed that 50% of existing ferrules and stopcocks can be reused after repair. NWSDB shall furnish to the contractor all PVC pipes and fittings, ferrules, stopcocks and water meters to be required for repairing service pipe leaks.

Table 3.3 – Quantification of Service Pipe Leaks

Leak Type	Diameter							Total
	½” (70%)	¾” (20%)	1” (5%)	1½” (1%)	2” (2%)	3” (1%)	4” (1%)	
Saddle/Ferrule Leak	420	120	30	12	18	-	-	600
Communication Pipe Leak	2,940	840	210	42	84	42	42	4,200
Stopcock Leaks	420	120	20	6	12	6	6	600
Water Meter Leaks	420	120	30	6	12	6	6	600
Total	4,200	1,200	300	60	120	60	60	6,000

Materials to be Procured by NWSDB

(It is assumed that 50% of leaking ferrules and stopcocks need to be replaced.)

Item	Diameter							Total
	½”	¾”	1”	1½”	2”	3”	4”	
Ferrule	210	60	15	6	9	-	-	300
Stopcock	210	60	15	3	6	3	3	300
Water Meter	420	120	30	6	12	6	6	600

3.4.2 Quantification of Leaks in Existing GI Service Pipes

As discussed in Section 3.4, it is assumed that the number of existing GI service connections to be replaced will be 1,000. Requirements of MDPE materials to replace GI pipes are given in the following table.

GI Service Pipe		Case-1: Main & Property on the Same Side		Case-2: Main & Property on the Opposite Side		MDPE Pipe	
Diameter	Number	Number	Average Length (m)	Number	Average Length (m)	Diameter (mm)	Length Required (m)
½" GI	700	500	4	200	8	20	3,600
¾" GI	200	150	4	50	8	25	1,000
1" GI	100	75	4	25	8	32	500
TOTAL	1,000	725	-	275	-	-	5,100

3.4.3 Quantification of GI Pipe Encasements

It is assumed that 1,000 Nos. of leaking PVC service pipes will be repaired and encased at drain crossings.

Service Pipe (Dia.)	No. of Drain Crossings	Size of GI Encasement	Average Length (m)	Length of GI Pipe (m)
½" (20mm PVC)	700	1" GI	1	700m
¾" (25mm PVC)	200	1¼" GI	1	200m
1" (32mm PVC)	100	1½" GI	1	100m
TOTAL	1,000 Nos.	-	-	1,000m

3.4.4 Quantification of Common Mains

It is suggested to eliminate approximately 1,000 leaking PVC service pipes, which have been laid along by-roads over a long distance and without a sufficient cover. This problem can be rectified by laying a new common main along the road and by transferring the services on to the new main. All of the existing multiple tapping connections on the distribution main should be plugged and the leaking spaghetti pipes should be abandoned.

It is assumed that there are 10 service pipes on average on each by-road for replacement and the size of common main as 2". Therefore, common mains will be laid on 100 by-roads to eliminate 1,000 service pipes. The assumed quantities are as follows.

Main Size	Tapping Arrangement	No. of Tapings (Nos.)
3"	3" x 2" EasiTap	22
4"	4" x 2" EasiTap	60
5"	5" x 2" EasiTap	4
6"	6" x 2" EasiTap	10
7"	7" x 2" EasiTap	2
8"	8" x 2" EasiTap	2
TOTAL		100 Nos.

It is assumed that the average length of 2" common main as 50m. Therefore, the total pipe material required will be 5,000m of 2" (63mm) PVC pipes.

3.5 BILL OF QUANTITIES

Item	Description	Unit	Rate Rs.	Qty	Amount Rs.
	<p>Repair of service pipe leaks and replacing of GI service pipes with PVC pipes.</p> <p>Contractor shall take note on the following matters:</p> <p>(a). All pipe materials, fittings, jointing materials, specials etc., shall be provided by NWSDB.</p> <p>(b). Removal of surface, excavation and backfilling shall be paid separately based on unit rates.</p> <p>(c). The reinstatement cost for asphalt/premix/tar surfaces, walkways, kerb stores, fences and the like, which will be paid directly to the respective authorities by NWSDB.</p> <p>(d). All necessary excavation permits</p>				

Item	Description	Unit	Rate Rs.	Qty	Amount Rs.
	<p>including security clearance shall be obtained by the Contractors prior to start any work, NWSDB shall issue letters to the different authorities, but it shall be the responsibility of the Contractor to acquire such permits.</p> <p>(e). Whenever ordered by the Engineer, the Contractor shall import sand or soil for backfilling. Such imported materials shall be paid separately based on the unit rates.</p> <p>(f). Contractor shall study all specifications and standard drawings thoroughly in order to get fully acquainted with the work.</p>				
1.0	Cutting and removal of asphalt/premix/tar layer from the road surface as directed by the Engineer.				
	The thickness of the layer				
1.1	Not exceeding 150mm	m ³		3,400	
1.2	Exceeding 150mm but not exceeding 300mm	m ³		2,300	
1.3	Exceeding 300mm	m ³		1,100	
2.0	Excavations of earth material including rubble/stone pavement up to the required depth below the pipe invert. Rate to include for dewatering and shoring as required.	m ³		29,360	
3.0	Carryout repair to the clamp saddle ferrules or valve socket at the water main. Rate to	No.		600	

Item	Description	Unit	Rate Rs.	Qty	Amount Rs.
	include for continuous dewatering, replacement or re-adjustment of the clamp saddle (if necessary), replacement of the ferrule and valve socket (if necessary) and testing the repair work by re-pressurizing the main.				
4.0	Identify the leaking part of the PVC service pipe, remove the affected length and fix a new piece of service pipe of the same diameter using PVC Solvent Cement type repair sockets on both sides. Rate shall be quoted for the following diameters.				
4.1	20mm (½") PVC	No.		2,940	
4.2	25mm (¾") PVC	No.		840	
4.3	32mm (1") PVC	No.		210	
4.4	50mm (1½") PVC	No.		42	
4.5	63mm (2") PVC	No.		84	
4.6	90mm (3") PVC	No.		42	
4.7	110mm (4") PVC	No.		42	
5.0	Repair leaks at the water meter. Rate shall be quoted for the following meter sizes				
5.1	½" and ¾" water meters	No.		540	
5.2	1" to 2" water meters	No.		48	
5.3	3" to 4" water meters	No.		12	

Item	Description	Unit	Rate Rs.	Qty	Amount Rs.
6.0	Repair leaks at the stop-taps. Rate to include for replacement of the stop-taps (if necessary). Rate shall be quoted for the following stop-tap sizes.				
6.1	½” and ¾” stop-taps	No.		540	
6.2	1” to 2” stop-taps	No.		48	
6.3	3” to 4” stop-taps	No.		12	
7.0	Replacement of existing GI service pipes with MDPE pipes. Rate to include for cutting and removal of the GI pipe and fixing a new MDPE pipe from the distribution main upto the water meter. Rate shall be quoted for the following diameters. When the property and the water main are on the same side of the road.				
7.1	Replace ½” GI pipe with 20mm MDPE pipe	m		2,000	
7.2	Replace ¾” GI pipe with 25mm MDPE pipe	m		600	
7.3	Replace 1” GI pipe with 32mm MDPE pipe	m		300	
8.0	Same as in 7.0 but the property and the water main are on the opposite side of the road including road excavation.				
8.1	Replace ½” GI pipe with 20mm MDPE pipe	m		1,600	
8.2	Replace ¾” GI pipe with 25mm MDPE pipe	m		400	
8.3	Replace 1” GI pipe with 32mm MDPE pipe	m		200	

Item	Description	Unit	Rate Rs.	Qty	Amount Rs.
9.0	Replacement of multiple service pipes on approach roads with a larger diameter common main. Rate to include for re-connection of existing service pipes to the new common main and the plugging of multiple tapping points at the distribution main.				
9.1	63mm PVC common main	m		5,000	
10.0	Backfilling of the excavation as specified. Rate to include for removal of excessively wet soil from site as directed by the Engineer, import of sand or suitable backfill material from outside (to be paid separately), carryout compaction in layers as specified, prepare the excavated surface suitable for vehicular traffic and cleaning the working area of all debris and cleaning the site as directed by the Engineer.	m ³		29,360	
11.0	Import of sand as backfill material	m ³		3,000	
12.0	Import of suitable soil as backfill material	m ³		3,000	
13.0	Provision of GI pipe casings to exposed PVC pipes at drains, culverts and other vulnerable points.				
13.1	1" GI pipe for ½" PVC pipe	m		700	
13.2	1¼" GI pipe for ¾" PVC pipe	m		200	
13.3	1½" GI pipe for 1" PVC pipe	m		100	
14.0	Temporary road surface reinstatement at road	m ²		5,760	

Item	Description	Unit	Rate Rs.	Qty	Amount Rs.
	crossings and other places as instructed by Engineer.				

4. IMPLEMENTATION OF CONTACT

The contractor for leak repair work of distribution pipes (2” – 8”) and service pipes will be selected through local competitive bidding (LCB). Local contractors eligible for bidding will be determined in advance through the process of prequalification conforming to the standard procedures adopted in Sri Lanka.

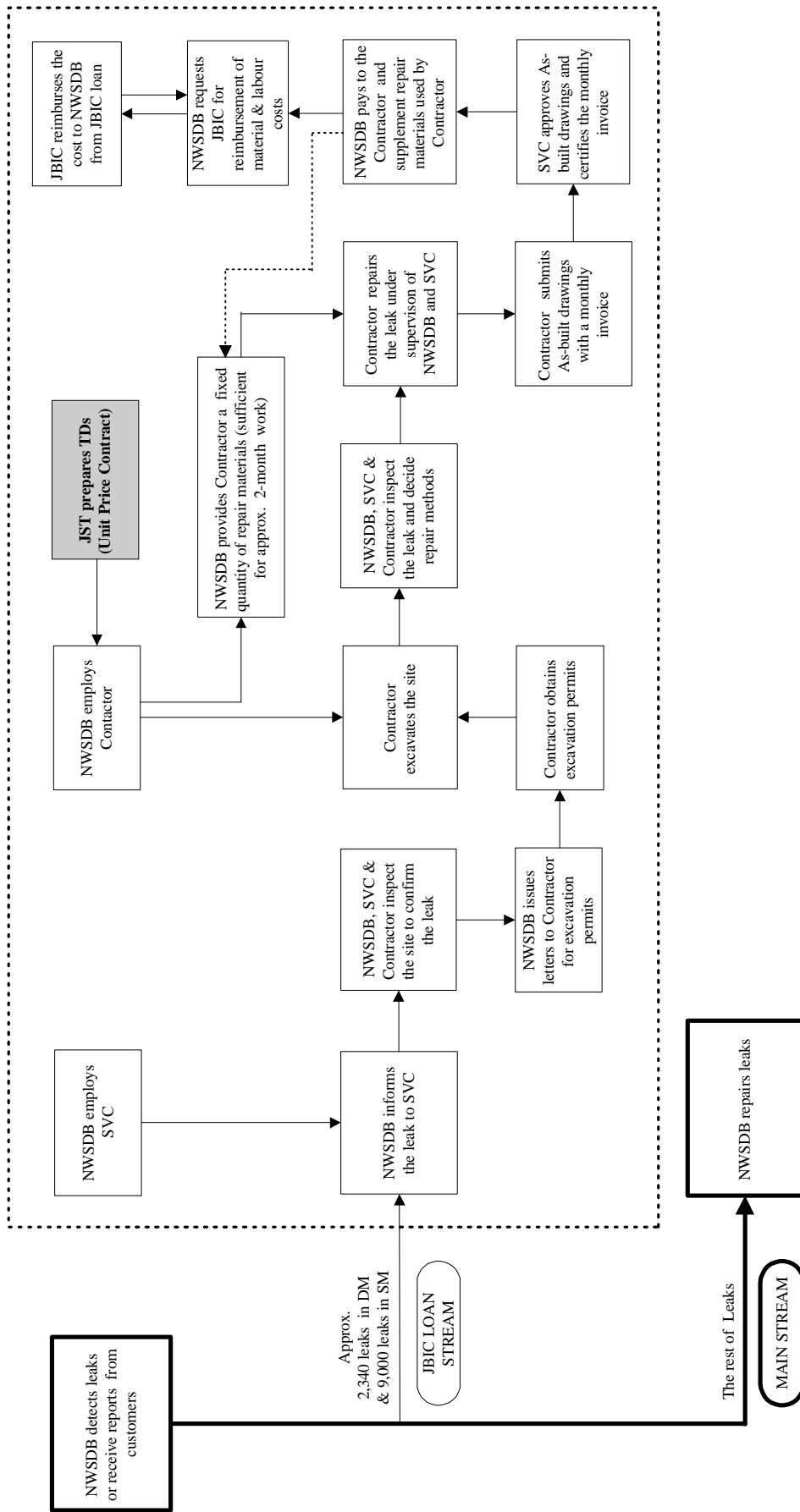
The materials required for leak repair will be purchased by NWSDB through already established procurement procedures and the costs will be reimbursed by JBIC through the JBIC loan (Loan Agreement No. SL-P66).

The contract will be based on unit rates. Payments to the contractor shall be made for actual volume of work performed by him based on the unit prices quoted in the Bill of Quantities. Tenderers shall be requested to indicate in a separate schedule for nighttime unit prices. (10p.m. to 5a.m.)

The duration of the contract will be approximately 24 months and it will run concurrently with the rest of the project components.

Fig.4.1 shows a recommended plan for implementation of the contract.

FIGURE 4.1 RECOMMENDED IMPLEMENTATION PROGRAMME FOR THE CONTRACT FOR LEAK REPAIR WORKS



Legend
 SVC: Construction Supervision Consultant; JST: JICA Study Team;
 DM: Distribution Main; SM: Service Main; TD: Tender Documents

5. DIFFICULTIES ENVISAGED AND REMEDIAL MEASURES

- (a) It is difficult to assess the nature of the repair works and the costs involved at the design stage, as the actual leak conditions vary from one place to another. Therefore, it is suggested that the contract shall be implemented on a basis of unit rates. The quantification of work, which is based on certain assumptions, will be used only for the purpose of tender evaluation.

It is recommended that NWSDB commence the repair work as soon as practicable by using repair materials already available at NWSDB at first and later get them replenished through the project funds.

- (b) As most of the pipeline sections cannot be isolated due to the complex nature of the junctions, non-availability of valves, non-functioning of valves and non-accessibility to valves due to over surfacing and other reasons, the contractor may have to carry out most of leakage repair works under running water. This is a highly undesirable situation, as this will hinder the progress of the contractor and cause adverse effects on the quality of the repair. This also runs the risk of contamination of the water in the pipe network. Therefore, it should be the responsibility of NWSDB to try their best and isolate the affected section to carryout the repair effectively. It should be noted that the repair of leak types D, E, E1, G2, and G4; H1 & J1 essentially require the complete stoppage of water.
- (c) Most of the working areas in CMC are congested with utilities such as water mains (other than the main to be repaired), telecommunication cables, electricity cables and sewers. Therefore, extreme care should be taken to safe guard these utilities while the repairs are being affected. As precautionary measures, excavating machinaries and tools are allowed for removing of the hard asphalt layer only. The subsequent excavation shall be done manually.
- (d) Most roads in the CMC area experience heavy traffic flows. Traffic flow has to be maintained uninterrupted while repairs are being made. This forces the contractor to carry out some of the work during the nighttime, which results in increased costs. Contractor must take this fact into account while quoting his tender prices.
- (e) The repair work will require the removal of asphalt layer and in some cases the removal of kerb stores, tiles in the workways, barricades, fences etc. While reinstatement of kerbs,

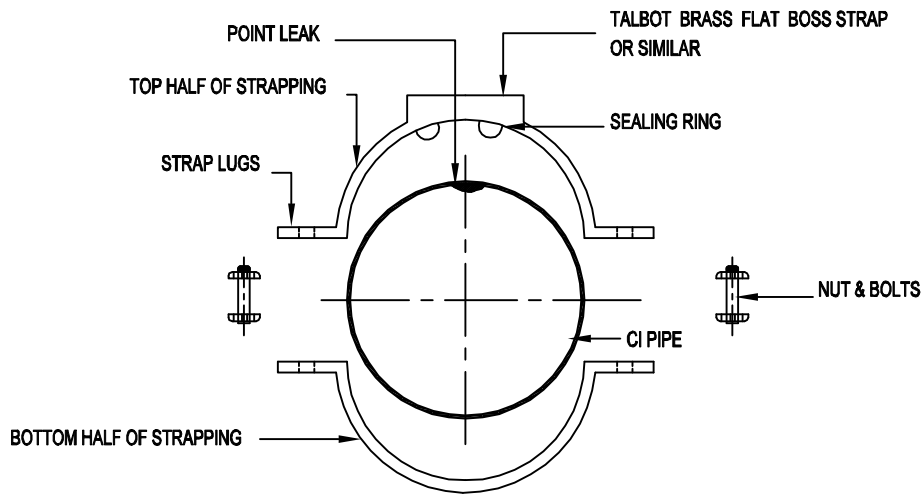
tiles, barricades and fences is the responsibility of CMC, this requires a proper coordination among all the parties. Any such additional work will increase the prices to be quoted by the Contractor.

- (f) The working area is densely populated and subjected to considerable pedestrian movements. The work shall ensure a complete safety to the pedestrian.

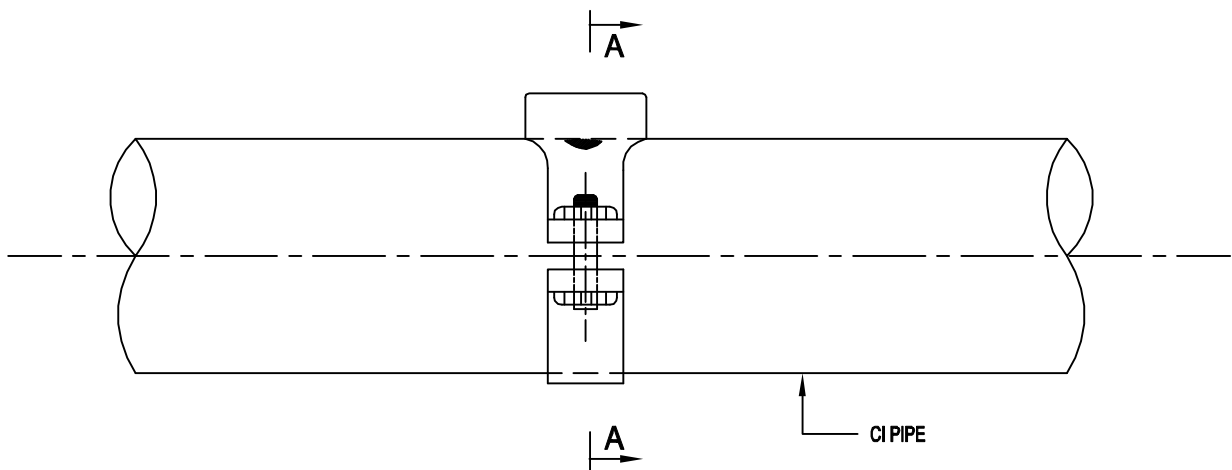
All such adverse effects will be highlighted in the project specification, so that the contractors can quote appropriate rates in their bids.

6. STANDARD DRAWINGS

No.	Drg.No.	Title
1	LR/SD/1	Leak Type A
2	LR/SD/2	Leak Type B
3	LR/SD/3	Leak Type B1
4	LR/SD/4	Leak Type C
5	LR/SD/5	Leak Type C1
6	LR/SD/6	Leak Type D
7	LR/SD/7	Leak Type E
8	LR/SD/8	Leak Type E1
9	LR/SD/9	Leak Type F
10	LR/SD/10	Leak Type F1
11	LR/SD/11	Leak Types G1, G2, G3 & G4
12	LR/SD/12	Leak Type J
13	LR/SD/13	Leak Type J1
14	LR/SD/14	Standard Service Connection – 1
15	LR/SD/15	Standard Service Connection – 2
16	LR/SD/16	Classification of Service Pipe Leaks
17	LR/SD/17	Laying of Common Mains in By-roads
18	LR/SD/18	GI Pipe Encasement



SECTION A - A

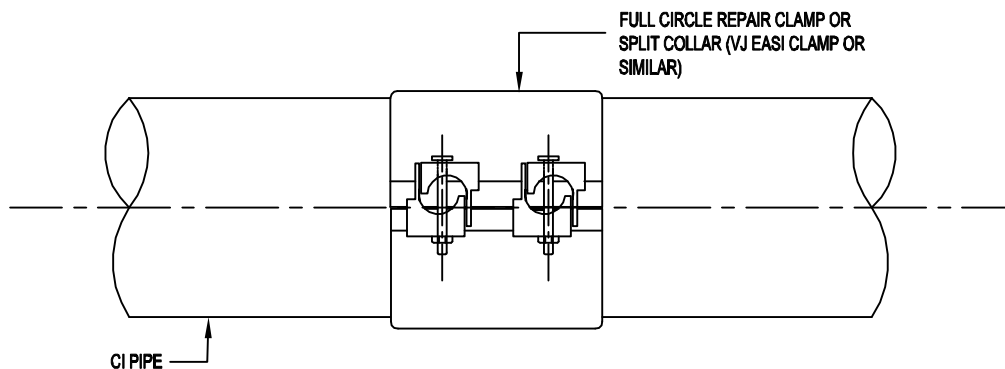


ELEVATION

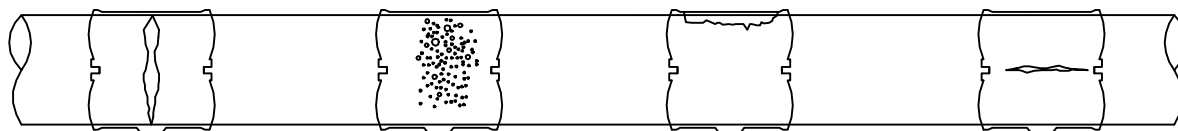
LEAK TYPE A

SMALL POINT LEAK THAT CAN BE REPAIRED WITH BRASS SADDLE STRAP

LR/SD/01	Leak Type - A
SCALE	Not to Scale
JICA STUDY TEAM THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	



ELEVATION



CIRCUMFERENTIAL BREAK

CORROSION HOLES

IMPACT DAMAGE

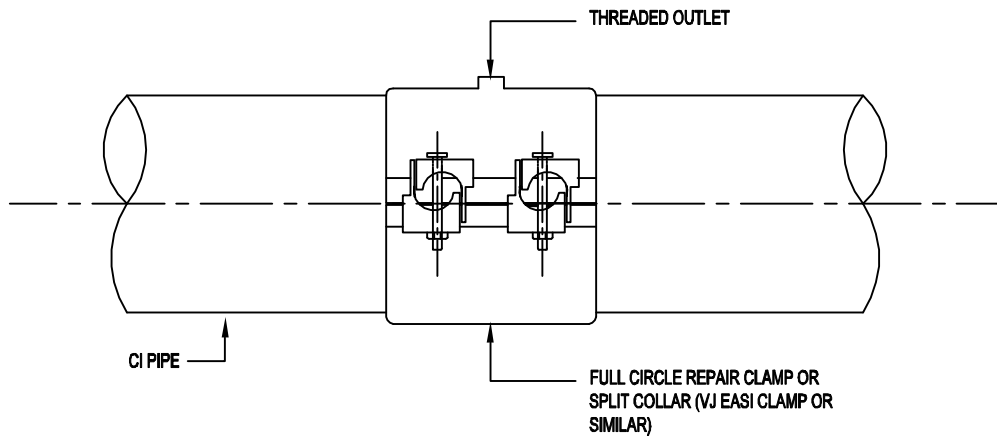
LONGITUDINAL CRACKS

**TYPE OF
LEAKS**

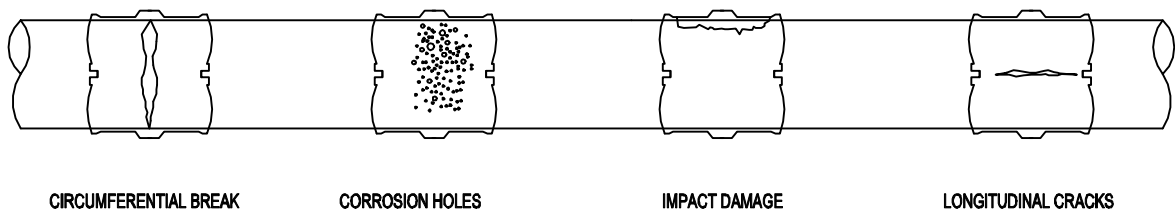
LEAK TYPE B

CORROSION HOLES, LONGITUDINAL CRACKS, IMPACT DAMAGES AND CIRCUMFERENTIAL BREAKS WITH THE AFFECTED WIDTH OF THE PIPE NOT GREATER THAN 200 mm (FOR THE DIAMETER RANGE OF 3" - 8") THAT CAN BE REPAIRED WITH A MALLEABLE IRON / DUCTILE IRON FULL CIRCLE REPAIR CLAMP SIMILAR TO VJ EASICLAMP. (SPLIT COLLARS)

LR/SD/02	Leak Type - B
SCALE	Not to Scale
JICA STUDY TEAM THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	



ELEVATION



CIRCUMFERENTIAL BREAK

CORROSION HOLES

IMPACT DAMAGE

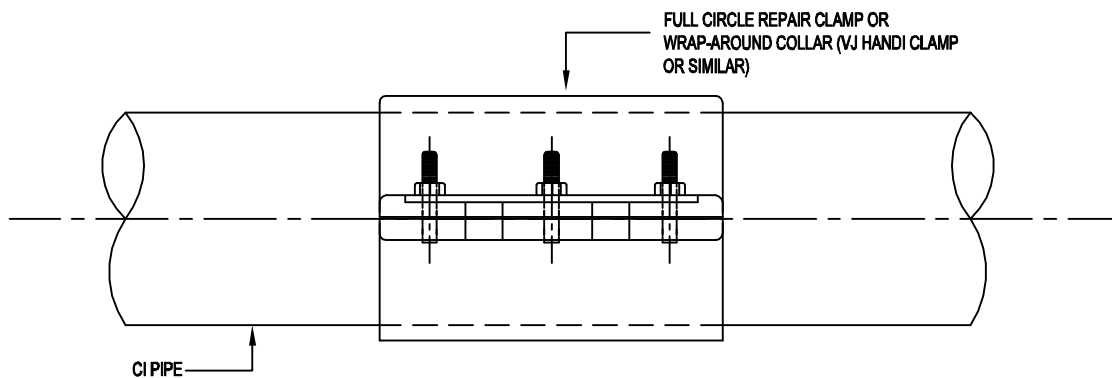
LONGITUDINAL CRACKS

**TYPE OF
LEAKS**

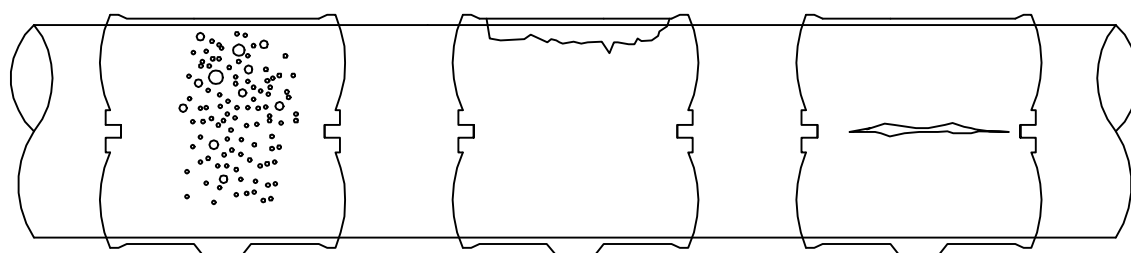
LEAK TYPE B1

LEAK TYPE AS IN TYPE B BUT ASSOCIATED WITH A SERVICE CONNECTION THAT CAN BE REPAIRED WITH A MALLEABLE IRON / DUCTILE IRON, FULL CIRCLE REPAIR SADDLE SIMILAR TO VJ EASITAP. (SPLIT COLLAR WITH THREADED OUTLET FOR SERVICE PIPE)

LR/SD/03	Leak Type - B1
SCALE	Not to Scale
JICA STUDY TEAM THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	



ELEVATION



CIRCUMFERENTIAL BREAK

IMPACT DAMAGE

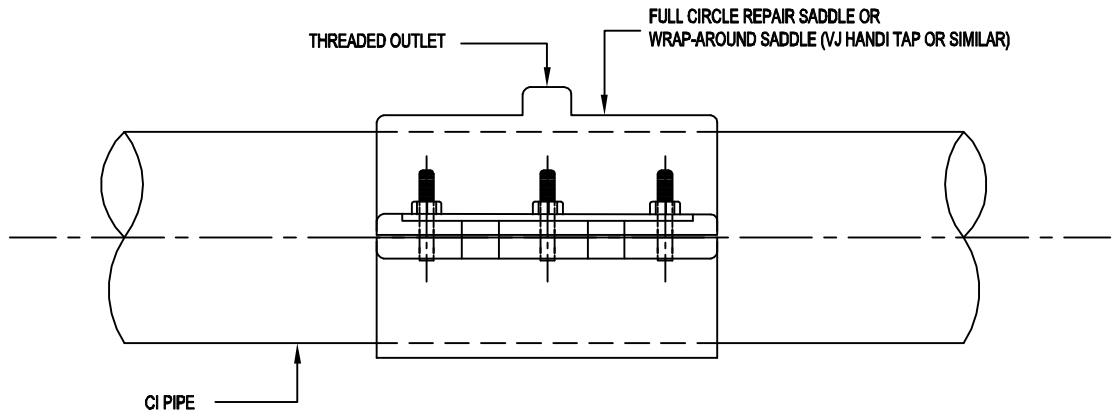
LOGITUDINAL CRACKS

**TYPE OF
LEAKS**

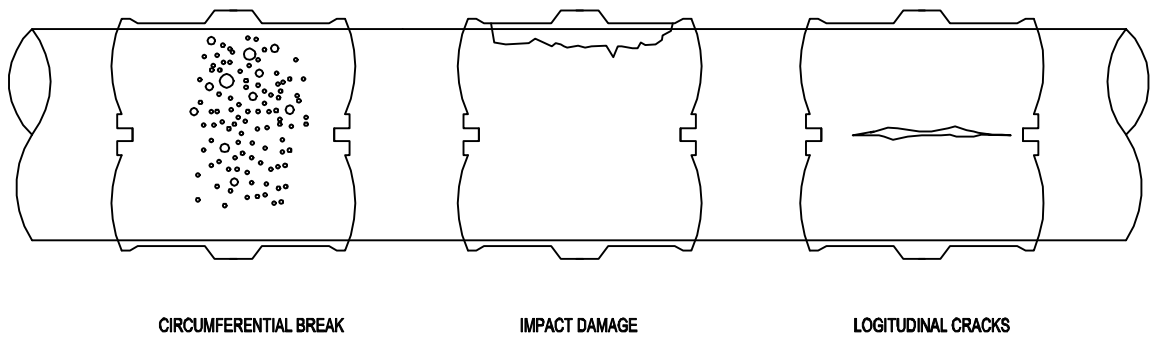
LEAK TYPE C

CORROSION HOLES, LONGITUDINAL CRACKS AND IMPACT DAMAGES WITH THE AFFECTED WITH OF THE PIPE BETWEEN 300 - 400 mm (DIAMETER OF 3" - 8") THAT CAN BE REPAIRED WITH A STAINLESS STEEL FULL CIRCLE REPAIR CLAMP SIMILAR TO VJ HANDI CLAMP. (WRAP - AROUND COLLAR)

LR/SD/04	Leak Type - C
SCALE	Not to Scale
JICA STUDY TEAM THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	



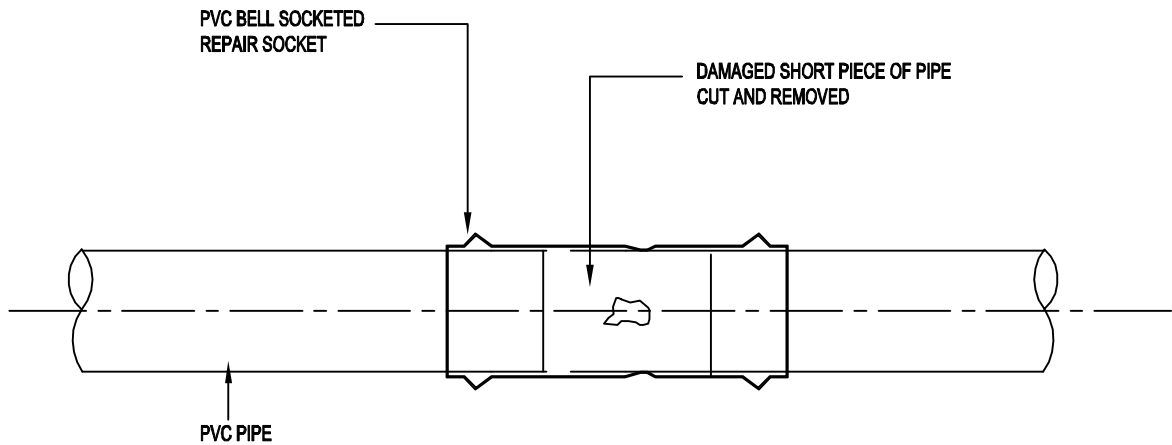
ELEVATION



LEAK TYPE C1

LEAK TYPE AS IN TYPE C BUT ASSOCIATED WITH A SERVICE CONNECTION THAT CAN BE REPAIRED WITH A STAINLESS STEEL FULL CIRCLE REPAIR SADDLE SIMILAR TO VJ HANDI TAP. (WRAP - AROUND COLLAR WITH THREADED OUTLET FOR SERVICE PIPE)

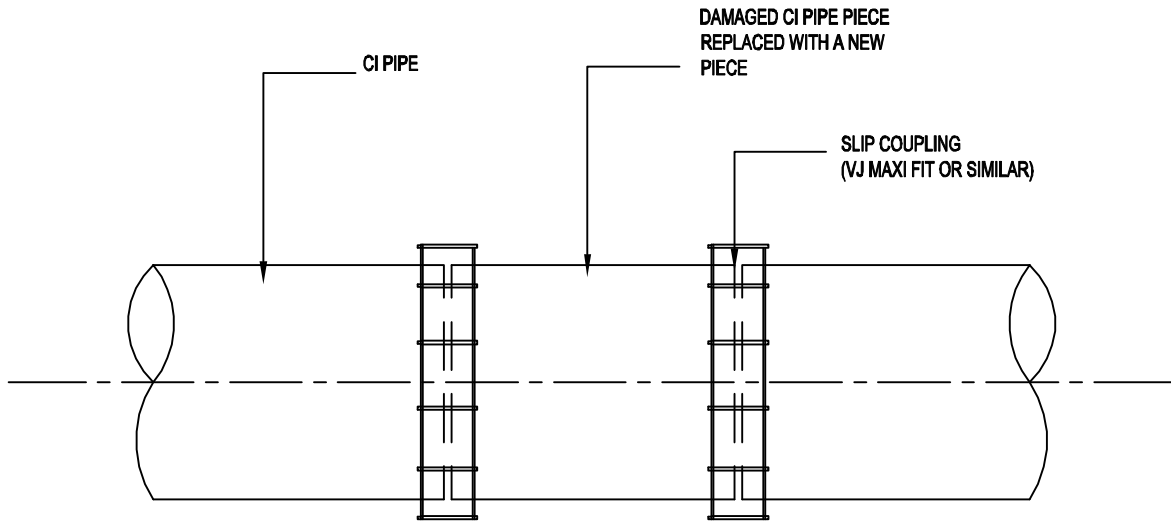
LR/SD/05	Leak Type - C1
SCALE	Not to Scale
JICA STUDY TEAM THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	



LEAK TYPE D

POINT DAMAGE OR LOCALIZED DAMAGE IN PVC PIPE THAT CAN BE REPAIRED WITH A PVC BELL SOCKETED REPAIR SOCKET

LR/SD/06	Leak Type - D
SCALE	Not to Scale
JICA STUDY TEAM THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	

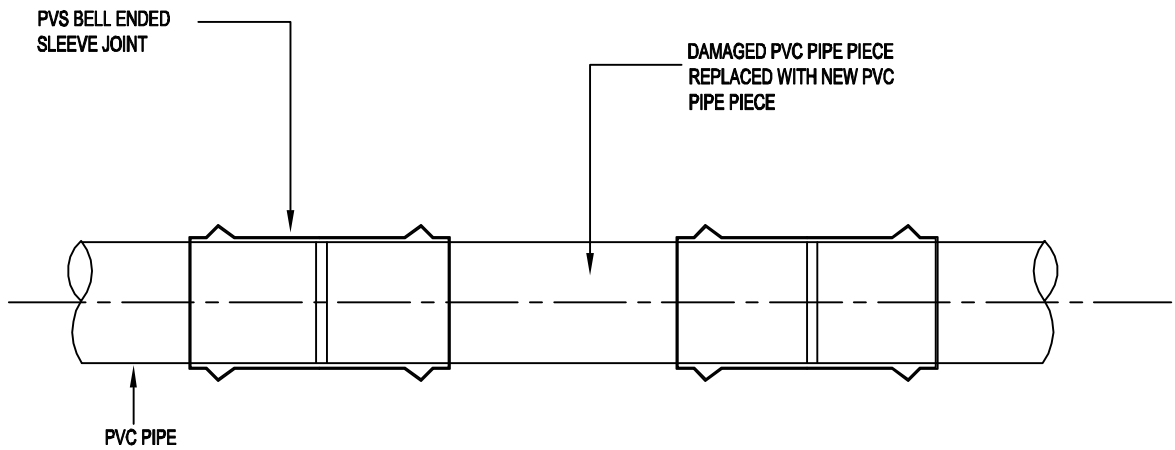


PLAN

LEAK TYPE E

EXTENSIVE DAMAGE WHICH REQUIRES THE REPLACEMENT OF THE AFFECTED LENGTH OF THE CI PIPE WITH TWO SLIP COUPLINGS SIMILAR TO VJ MAXI FIT ON BOTH SIDES.

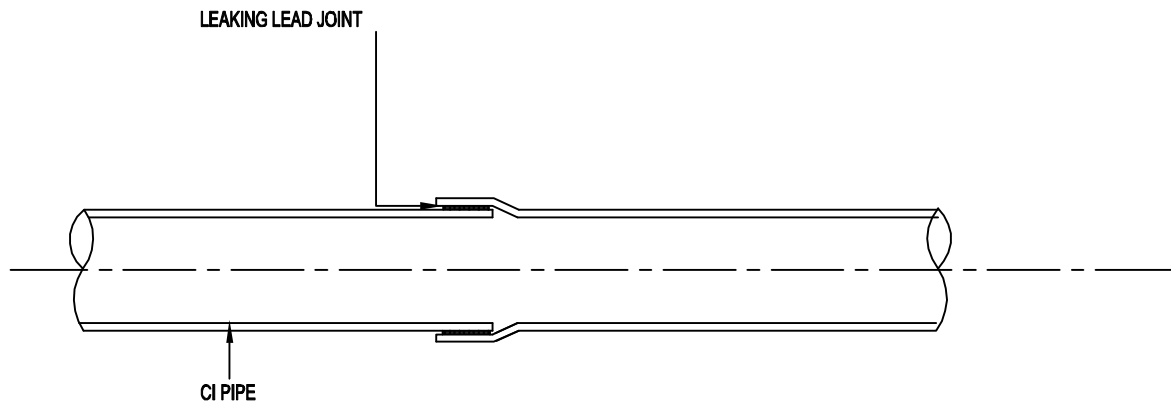
LR/SD/07	Leak Type - E
SCALE	Not to Scale
JICA STUDY TEAM THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	



LEAK TYPE E1

EXTENSIVE DAMAGE WHICH REQUIRES THE REPLACEMENT OF THE AFFECTED LENGTH OF THE PVC PIPE WITH TWO PVC BELL ENDED SLEEVE JOINTS ON BOTH SIDES.

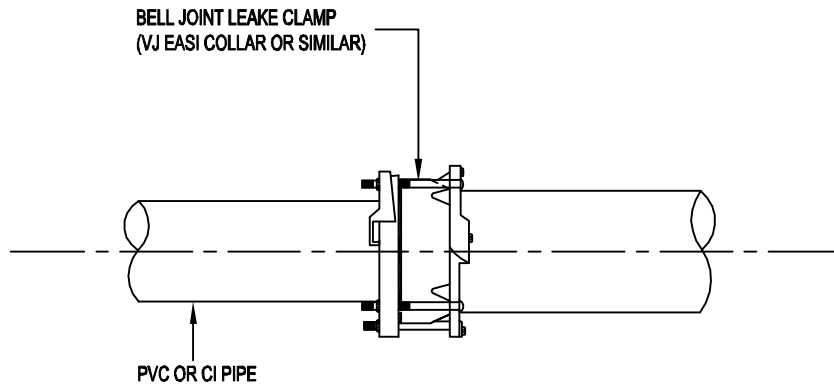
LR/SD/08	Leak Type - E1
SCALE	Not to Scale
JICA STUDY TEAM THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	



LEAK TYPE F

JOINT LEAKS IN CAST IRON PIPES WHICH CAN BE REPAIRED BY RE-CAULKING WITH OR WITHOUT ADDITIONAL LEAD WITH A VARIETY OF SMALL TO LARGE PNEUMATIC OR HAND CAULKING IRONS, FORCING THE LEAD BACK INTO THE BELLS.

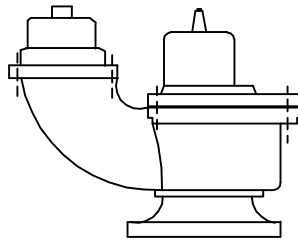
LR/SD/09	Leak Type - F
SCALE	Not to Scale
JICA STUDY TEAM THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	



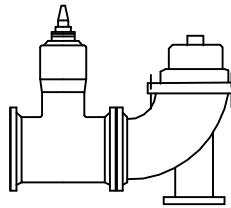
LEAK TYPE F1

JOINT LEAKS IN CAST IRON OR PVC PIPES WHICH REQUIRE BELL JOINT LEAKE CLAMP SIMILAR TO VJ EASI COLLAR.

LR/SD/10	Leak Type - F1
SCALE	Not to Scale
JICA STUDY TEAM THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	



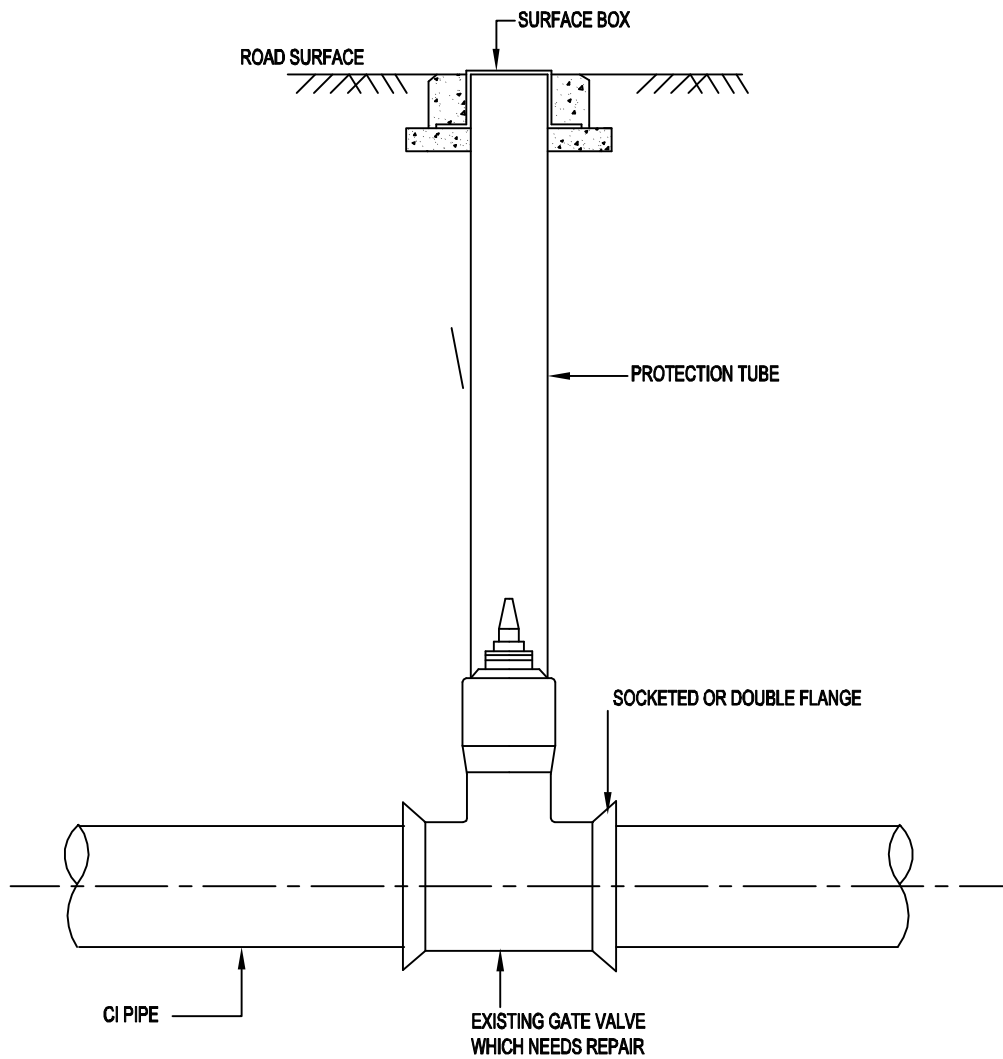
LEAK TYPES G1, G2
DN 80 WEDGE GATE TYPE FIRE HYDRANT



LEAK TYPES G3, G4
DN 80 DUCK FOOT TYPE FIRE HYDRANT

LEAK TYPES G1, G2, G3, & G4
-FIRE HYDRANT TYPES AVAILABLE IN CMC AREA.

LR/SD/11	Leak Types - G1, G2, G3, & G4
SCALE	Not to Scale
JICA STUDY TEAM THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	

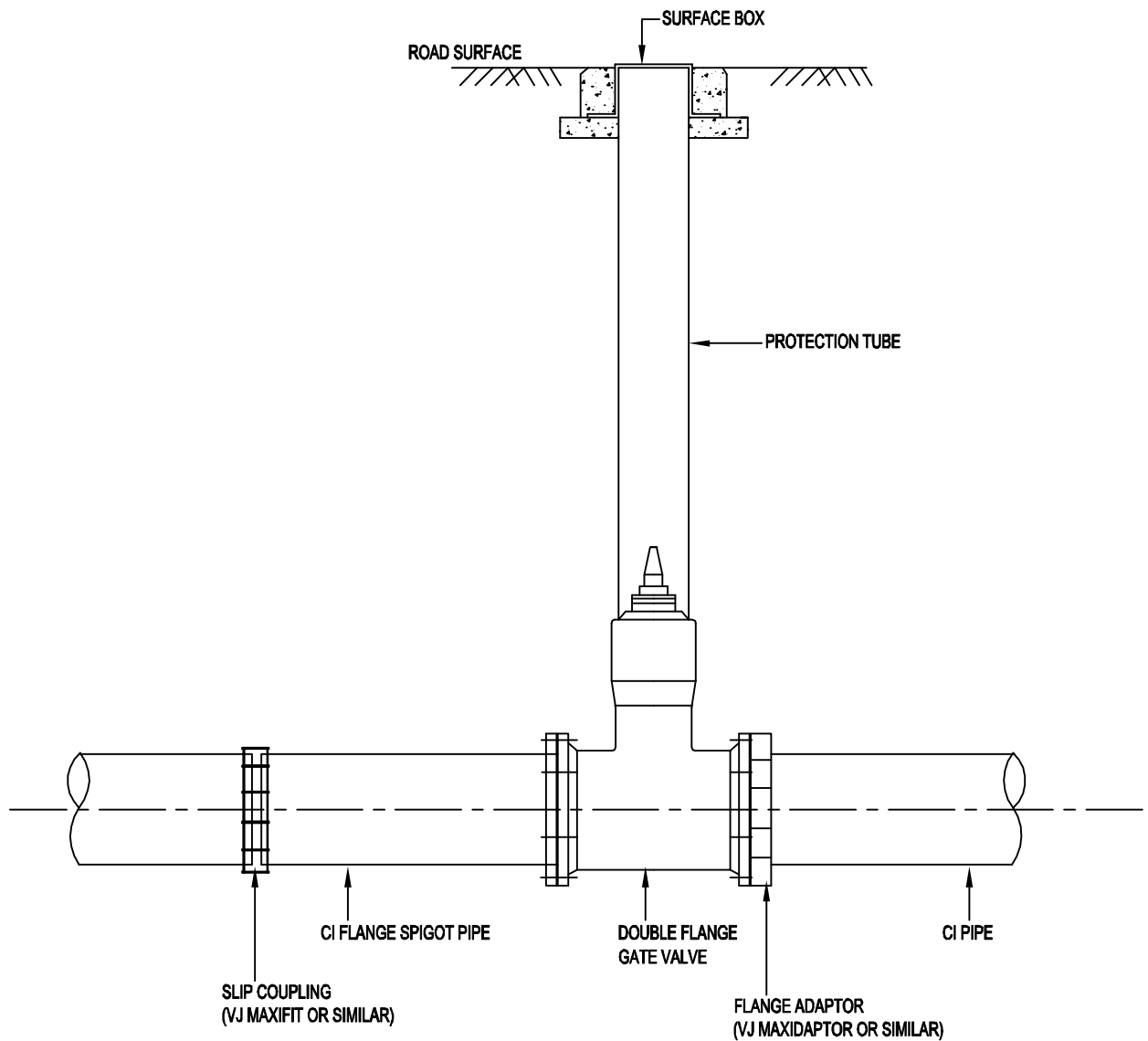


EXISTING LEAKING GATE VALVE

LEAK TYPE J

GATE VALVE LEAK WHICH CAN BE REPAIRED BY REPLACING THE GASKETS/ O-RINGS OR SIMILAR REPLACEABLE ITEMS

LR/SD/12	Leak Types - J
SCALE	Not to Scale
JICA STUDY TEAM THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	

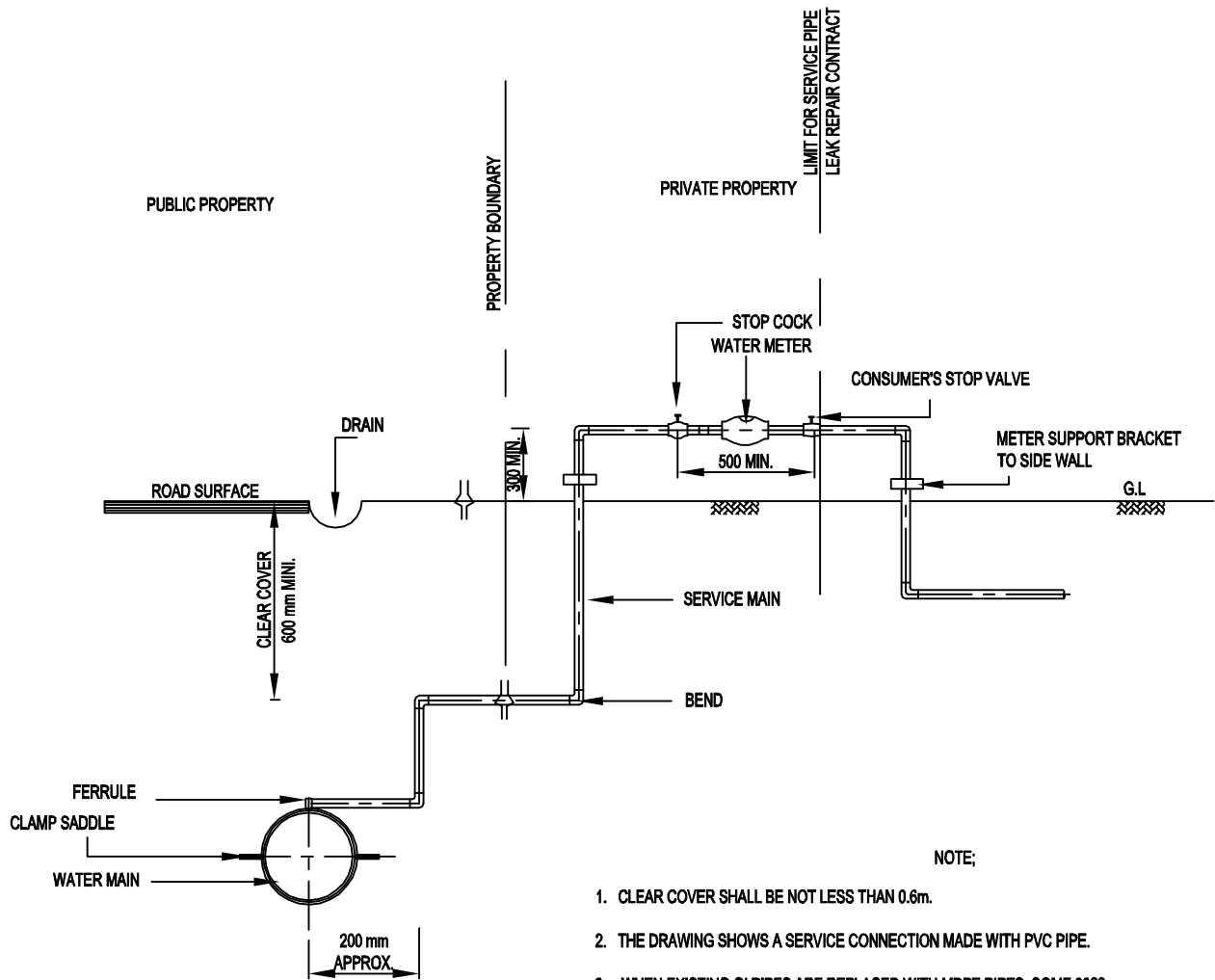


**LEAKING GATE VALVE REPLACED WITH A
DOUBLE FLANGED GATE VALVE**

LEAK TYPE J1

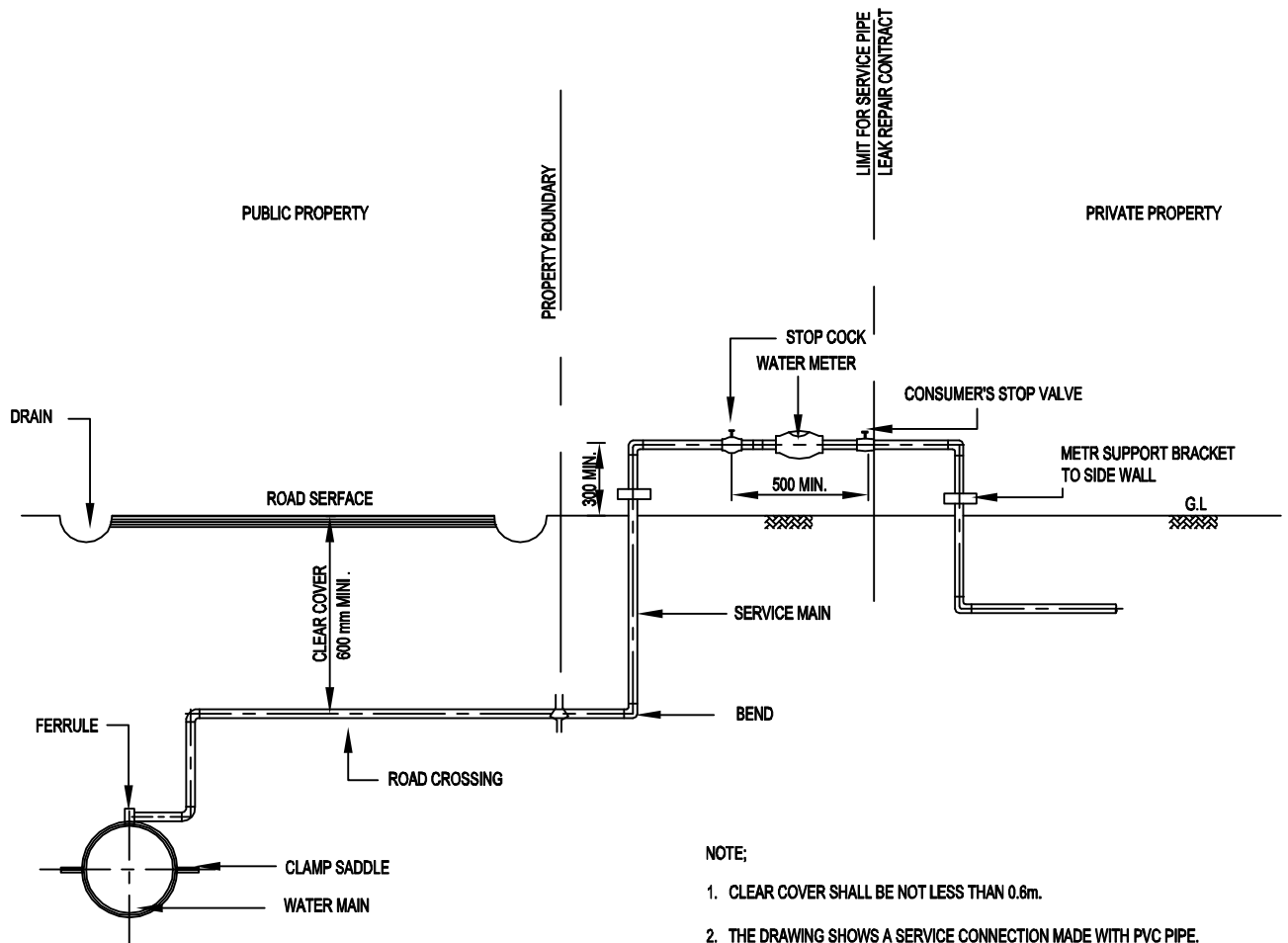
**GATE VALVE LEAKS WHICH NEEDS REPLACEMENT OF THE LEAKING VALVE WITH
A NEW DOUBLE FLANGE VALVE**

LR/SD/13	Leak Types - J1
SCALE	Not to Scale
JICA STUDY TEAM THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	



DETAILS OF SERVICE CONNECTION WHEN THE WATER MAIN AND THE PROPERTY ARE ON THE SAME SIDE OF THE ROAD.

LR/SD/14	Standard Service Connection - 1
SCALE	Not to Scale
JICA STUDY TEAM THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	

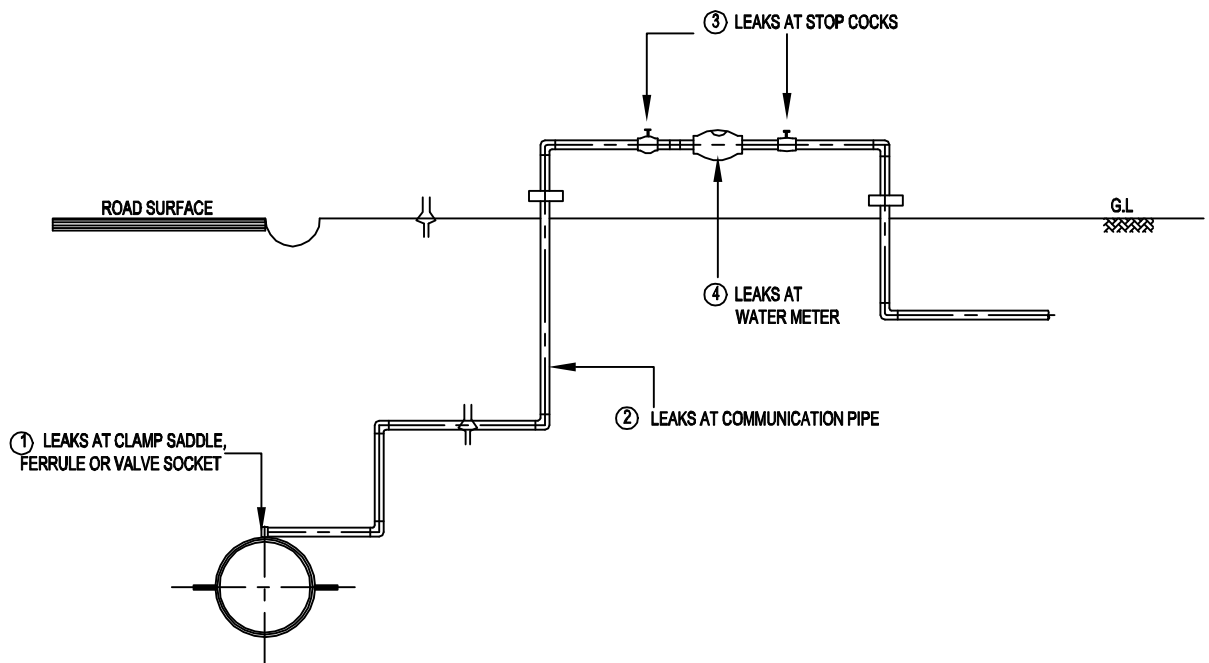


NOTE;

1. CLEAR COVER SHALL BE NOT LESS THAN 0.6m.
2. THE DRAWING SHOWS A SERVICE CONNECTION MADE WITH PVC PIPE.
3. WHEN EXISTING GI PIPES ARE REPLACED WITH MDPE PIPES, SOME 90?? ELBOWS BELOW THE GROUND SURFACE CAN BE AVOIDED BY BENDING THE MDPE PIPE TO A RADIUS NOT LESS THAN 20D, D BEING THE OUTER DIAMETER OF THE MDPE PIPE.

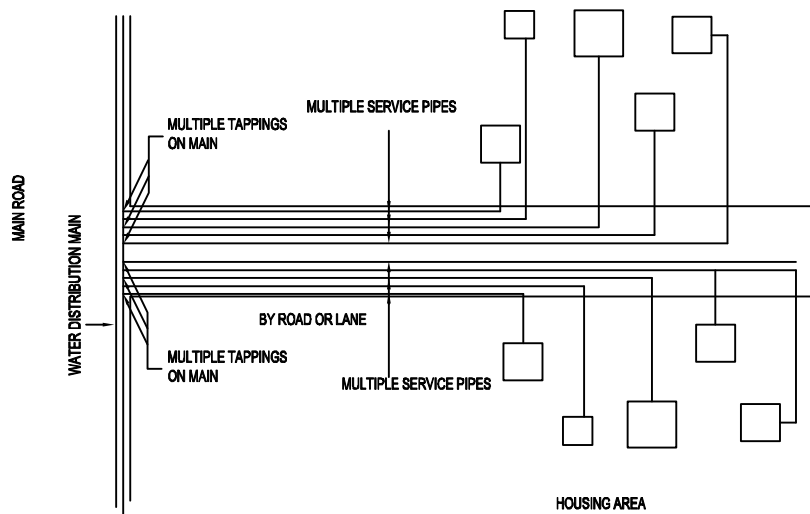
DETAILS OF SERVICE CONNECTION WHEN THE WATER MAIN AND THE PROPERTY ARE ON OPPOSITE SIDES OF THE ROAD.

LR/SD/15	Standard Service Connection - 2
SCALE	Not to Scale
JICA STUDY TEAM THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	

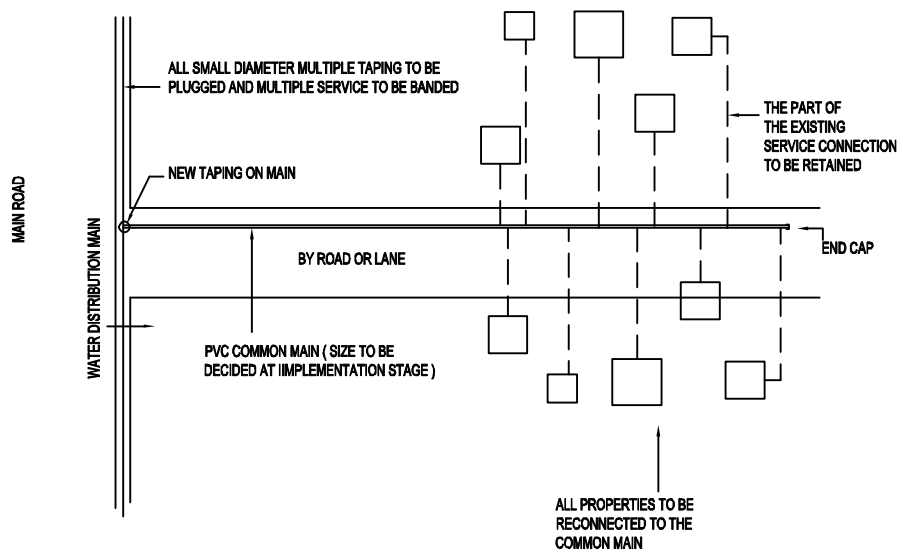


CLASSIFICATION OF LEAKS ON SERVICE PIPES
FOR LEAK REPAIR CONTRACT

LR/SD/16	Classification of Service Pipe Leaks
SCALE	Not to Scale
JICA STUDY TEAM THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	



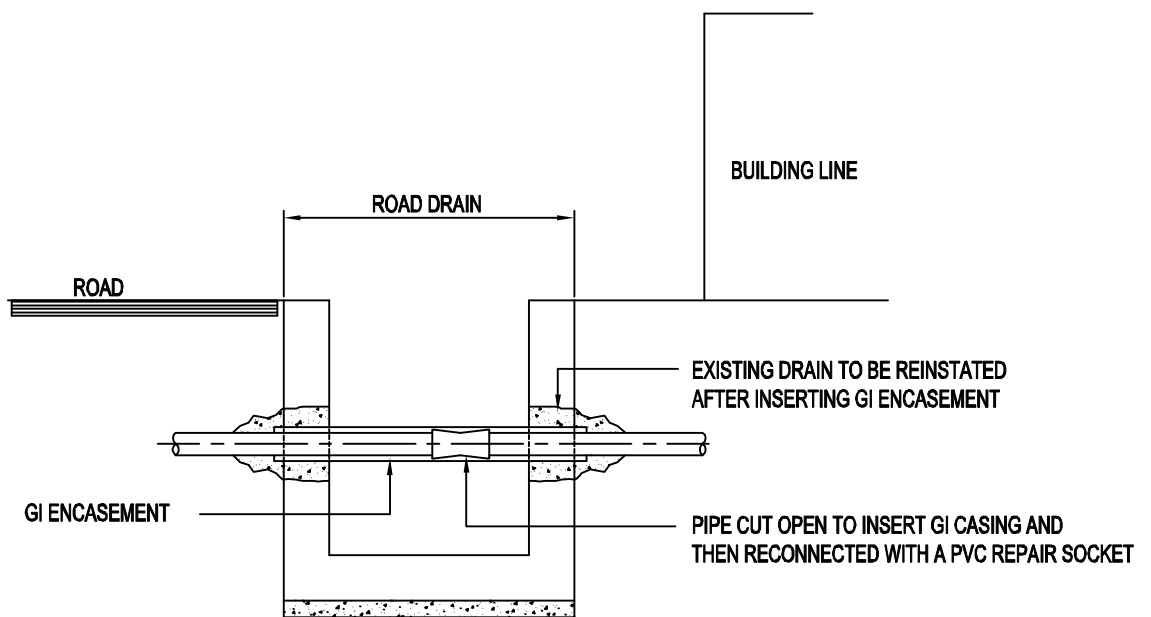
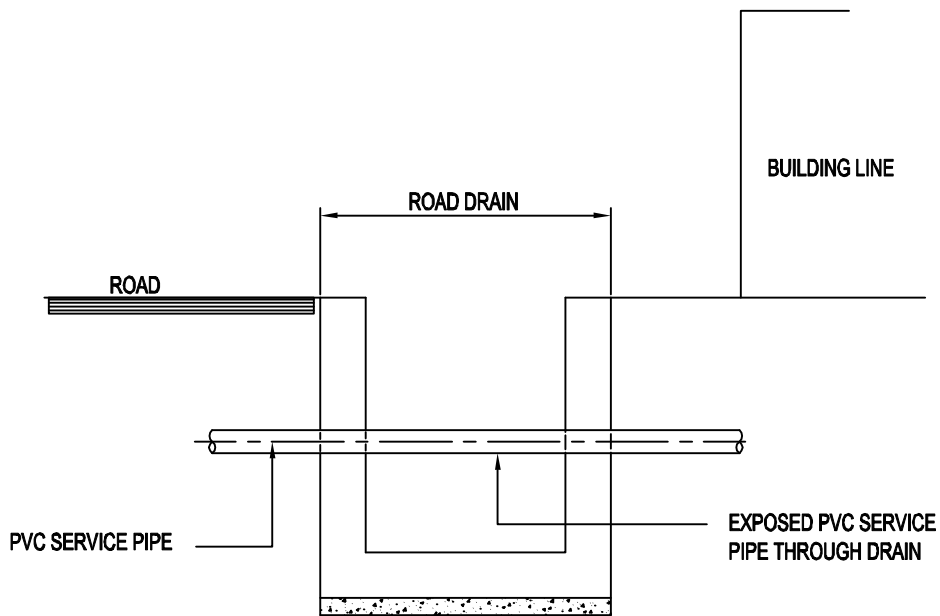
EXISTING MULTIPLE SERVICE CONNECTIONS ON BY ROADS



PROPOSED COMMON MAIN AND TRANSFERRING OF SERVICE CONNECTIONS ON TO THE COMMON MAIN

LAYING OF COMMON WATER MAINS ON BYROADS

LR/SD/17	Laying of Common Water Mains of Byroads
SCALE	Not to Scale
JICA STUDY TEAM THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	



PROVISION OF GI PIPE ENCASEMENTS TO EXISTING PVC SERVICE PIPES EXPOSED AT ROAD DRAINS

LR/SD/18	GI Pipe Encasement
SCALE	Not to Scale
JICA STUDY TEAM THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	