Task Force on Excessive Lead in Drinking Water

25 September 2015

Preliminary report

1. Preliminary findings
2. Testing
3. Recommendations

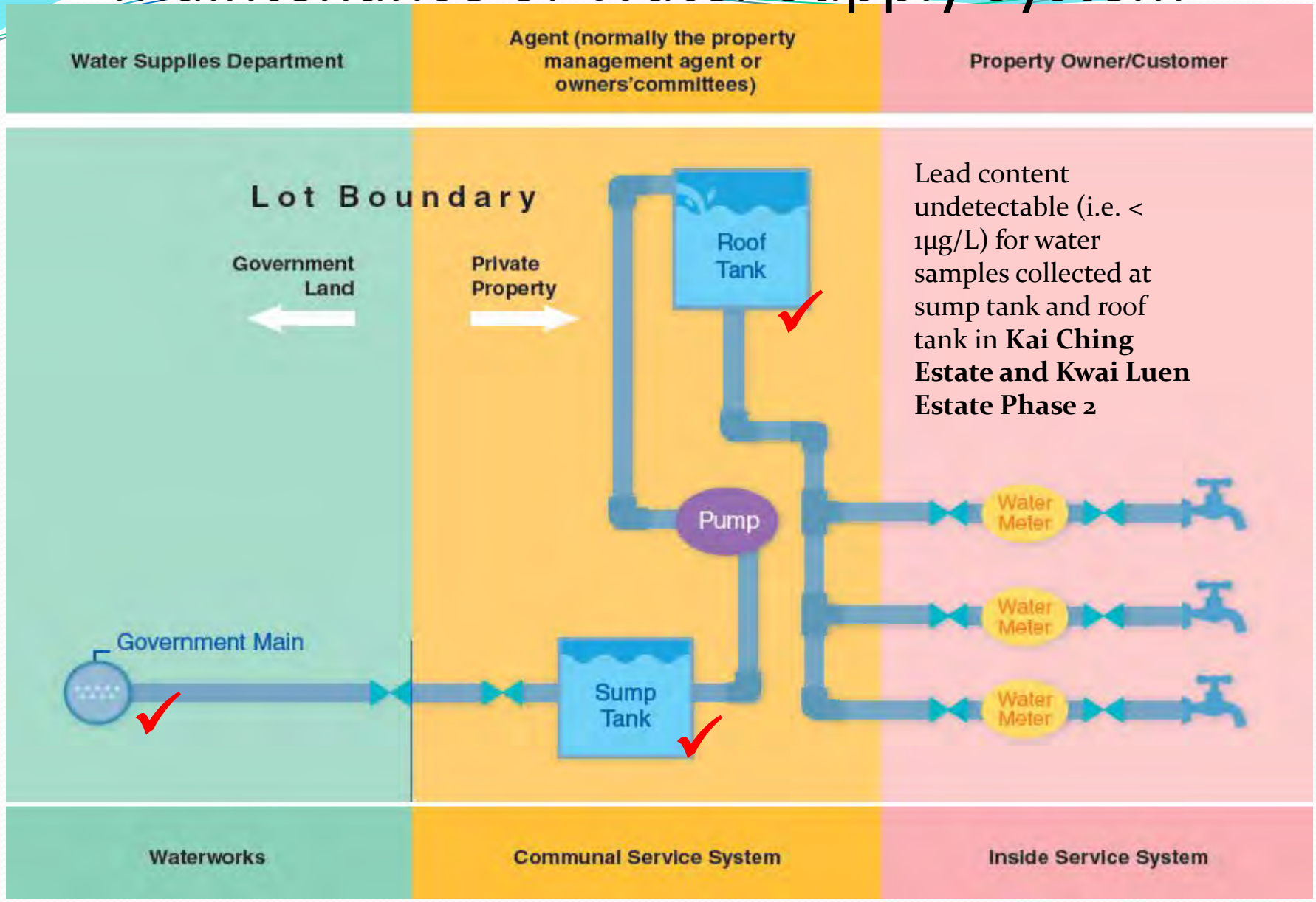
Preliminary findings
1. Excessive lead in water

- Leaded-solder joints are the source of excessive lead in drinking water in Kai Ching Estate and Kwai Luen Estate Phase II

- Copper alloy fittings also leach lead but do not result in excessive lead in drinking water

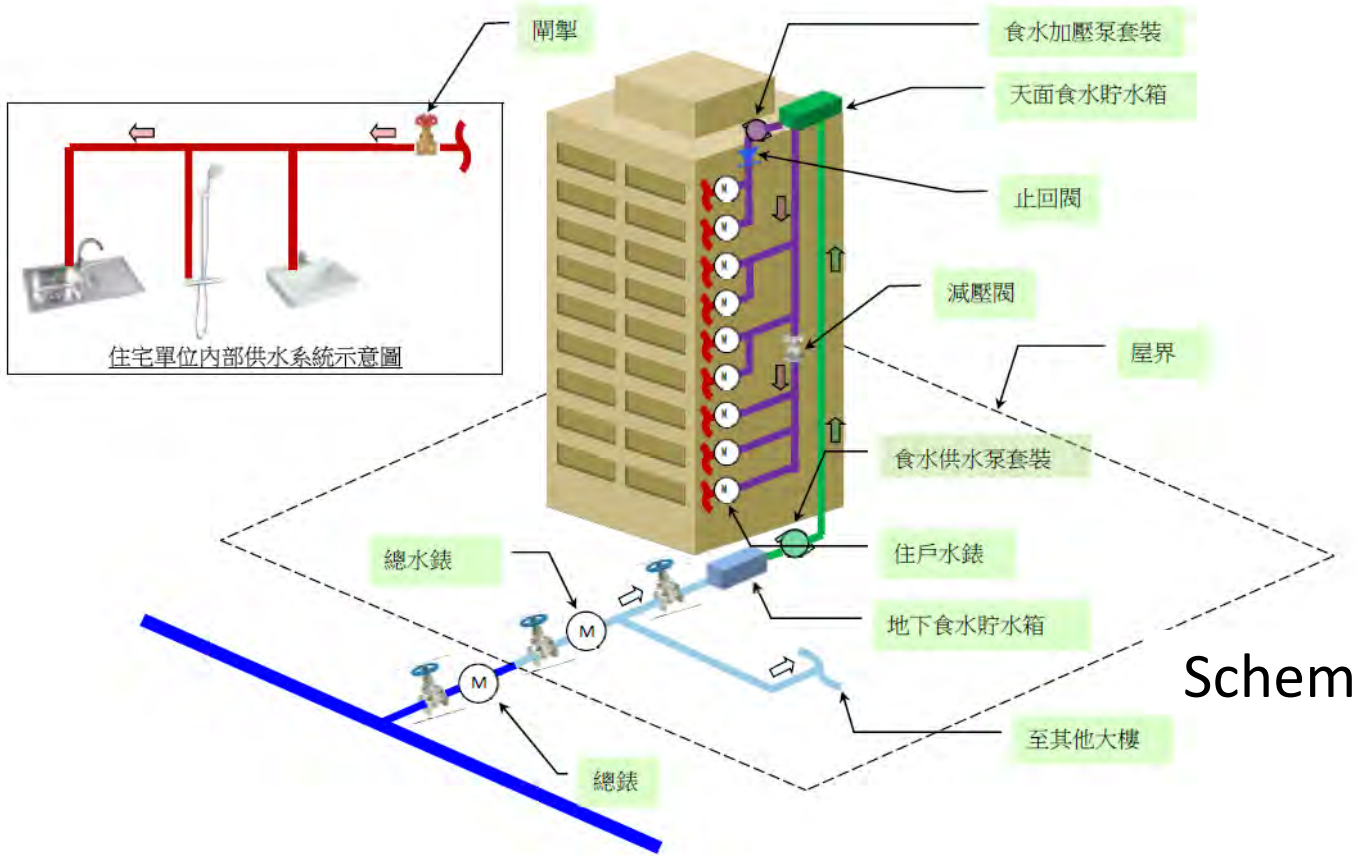
Testing

Maintenance of Water Supply System



Lead content undetectable (i.e. < 1μg/L) for water samples collected at sump tank and roof tank in **Kai Ching Estate and Kwai Luen Estate Phase 2**

As Constructed Inside Service in Kai Ching Estate and Kwai Luen Estate Phase II



Schematic Diagram

- Ductile Iron for risers (pipe in green)
- Copper for downpipes and branch pipes (pipes in purple and red)

Number of components from three water chains dismantled for examination/testing

Pipes, joints and fittings	Copper Pipes	Valves	Water Meter	Taps	Copper pipe Joints
Sample photos		 		 	 
Kai Ching Estate: Hong Ching Hse	15	8	1	4	17
Kai Ching Estate: Yuet Ching Hse	13	8	1	4	13
Kwai Luen Estate Phase II: Luen Yat Hse	16	12	1	4	17
Total	44	28	3	12	47
Hung Fuk Estate: Hung Hei Hse as 'control'	**3**	**11**	**1**	**4**	**3**

Leaching Test

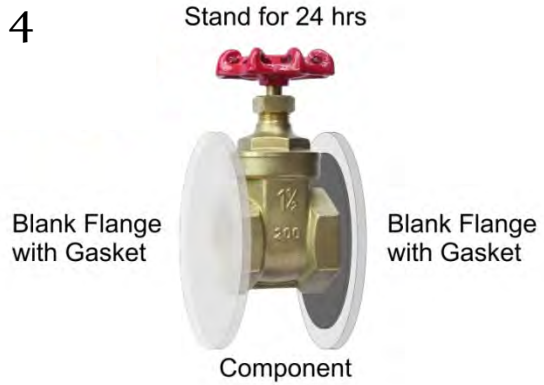
- Provide information on leaching of lead and other heavy metals from various components under 24-hr stagnant condition

1

2

3

4



5

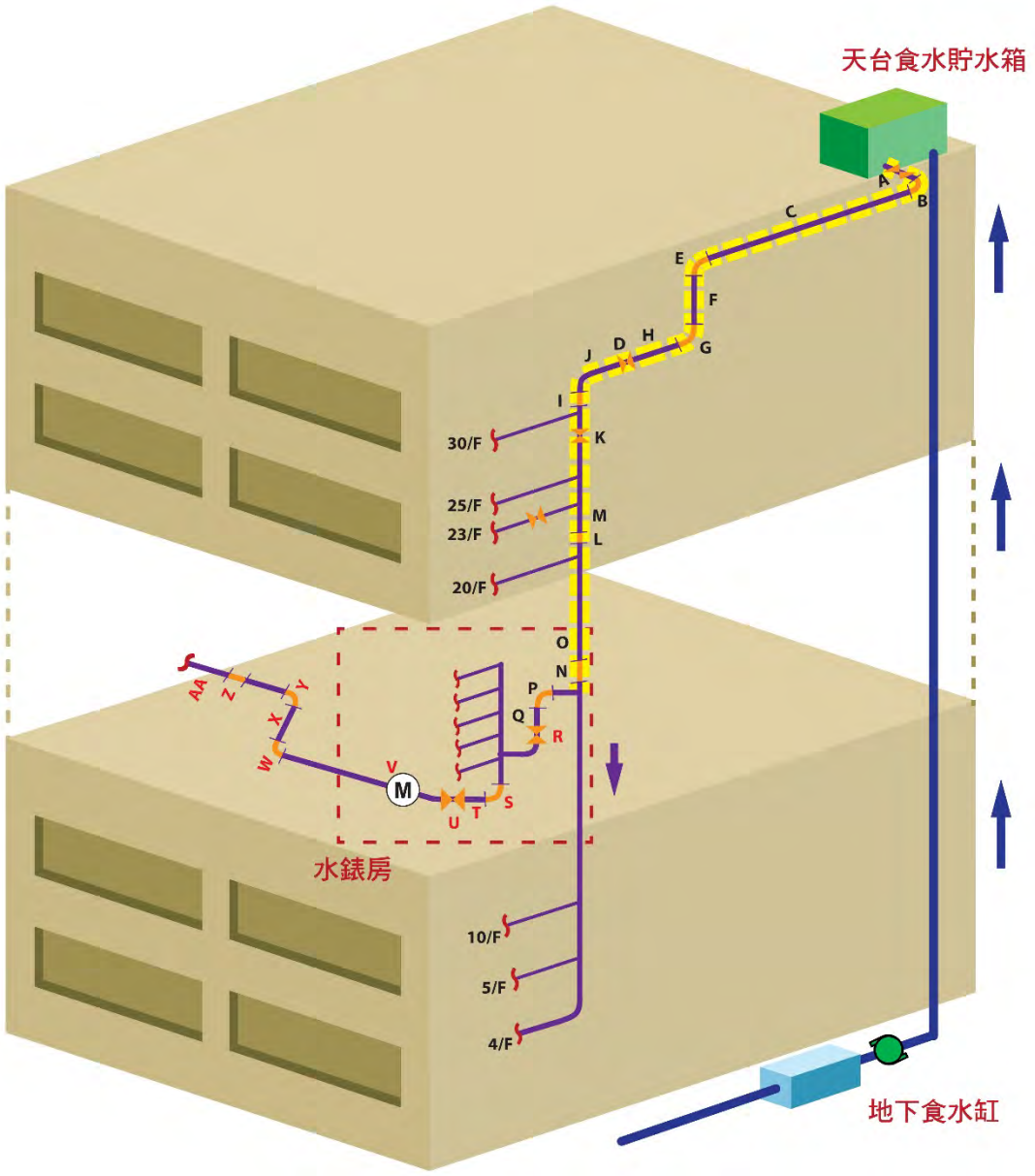
Check water samples for lead, chromium, cadmium and nickel by Inductively Coupled Plasma Mass Spectrometer (ICP – MS)

Lead Leaching Result for Kai Ching Estate (Hong Ching House) Downpipe from Roof to 14th Floor

Lead leaching from Cast Iron gate valves and copper downpipes / silver brazing joints with dia > 76mm **undetectable** or very minor*.

Item No.	Pipe / fittings	Test Result Pb* (µg)
A	150 mm dia. C.I. gate valve	0
B	150 mm dia. elbow	0
C	150 mm dia. copper pipe	0
D	150 mm dia. C.I. gate valve	0
E	150 mm dia. elbow	0
F	150 mm dia. copper pipe	0
G	150 mm dia. elbow	0
H	150 mm dia. copper pipe	0
I	100 mm dia. socket	0
J	100 mm dia. copper pipe	0
K	100 mm dia. C.I. gate valve	4.5
L	100 mm dia. socket	0
M	100 mm dia. copper pipe	0
N	80 mm dia. socket	0
O	80 mm dia. copper pipe	0

Note : *@24 hr

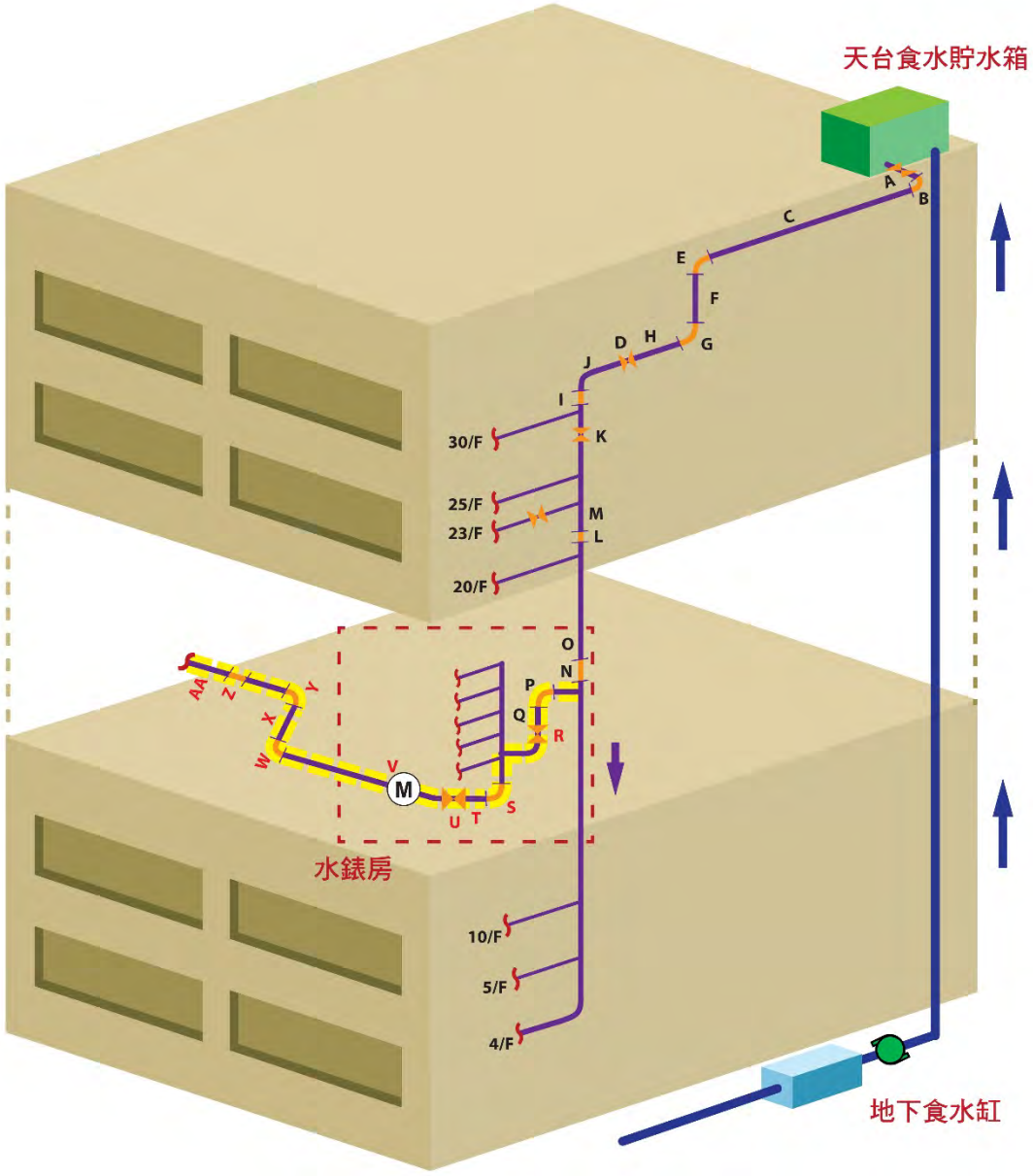


Lead Leaching Result for Kai Ching Estate (Hong Ching House)
Branch pipe leading to residential flat

Lead leaching from copper alloy valves , meters and copper pipes / solder joints with dia <= 76mm **detectable**.

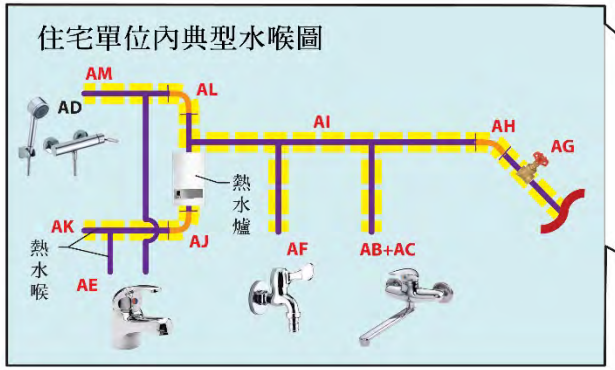
Item No.	Pipe / fittings	Test Result Pb* (µg)
P	40 mm dia. elbow	0.8
Q	40 mm dia. copper pipe	0
R	40 mm dia. copper alloy gate valve	10.3
S	20 mm dia. elbow	0.8
T	20 mm dia. copper pipe	2.5
U	20 mm dia. stop cock	13.8
V	15 mm dia. meter no. 12232841	3.7
W	20 mm dia. elbow	4.3
X	20 mm dia. copper pipe	1.3
Y	20 mm dia. elbow	17.3
Z	20 mm dia. socket	7.1
AA	20 mm dia. copper pipe	1.7

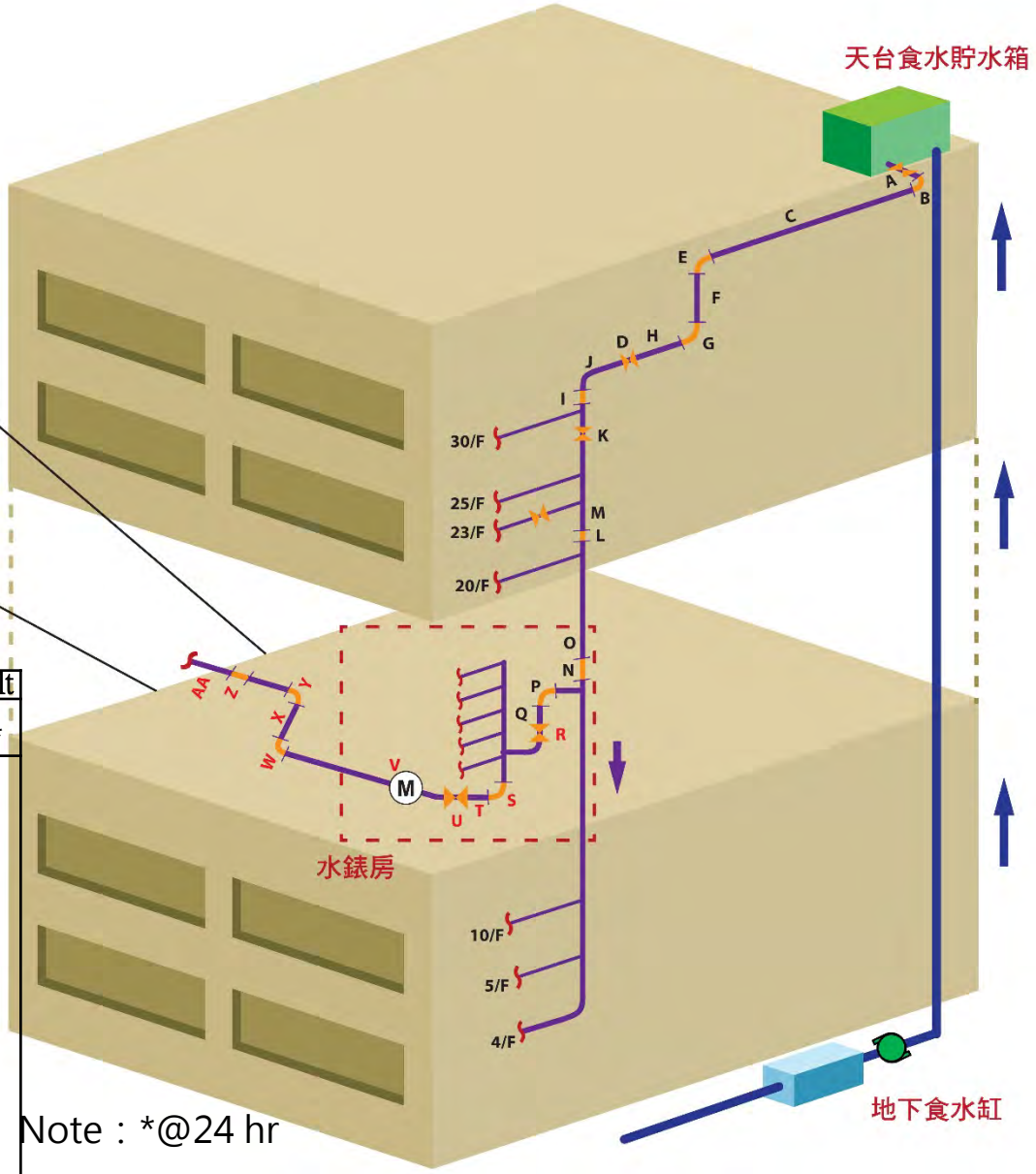
Note : *@24 hr



Lead Leaching Result for Kai Ching Estate (Hong Ching House)
Branch pipe within residential flat

Lead leaching from copper alloy valves, taps, and copper pipes / solder joints with dia <= 76mm **detectable**.





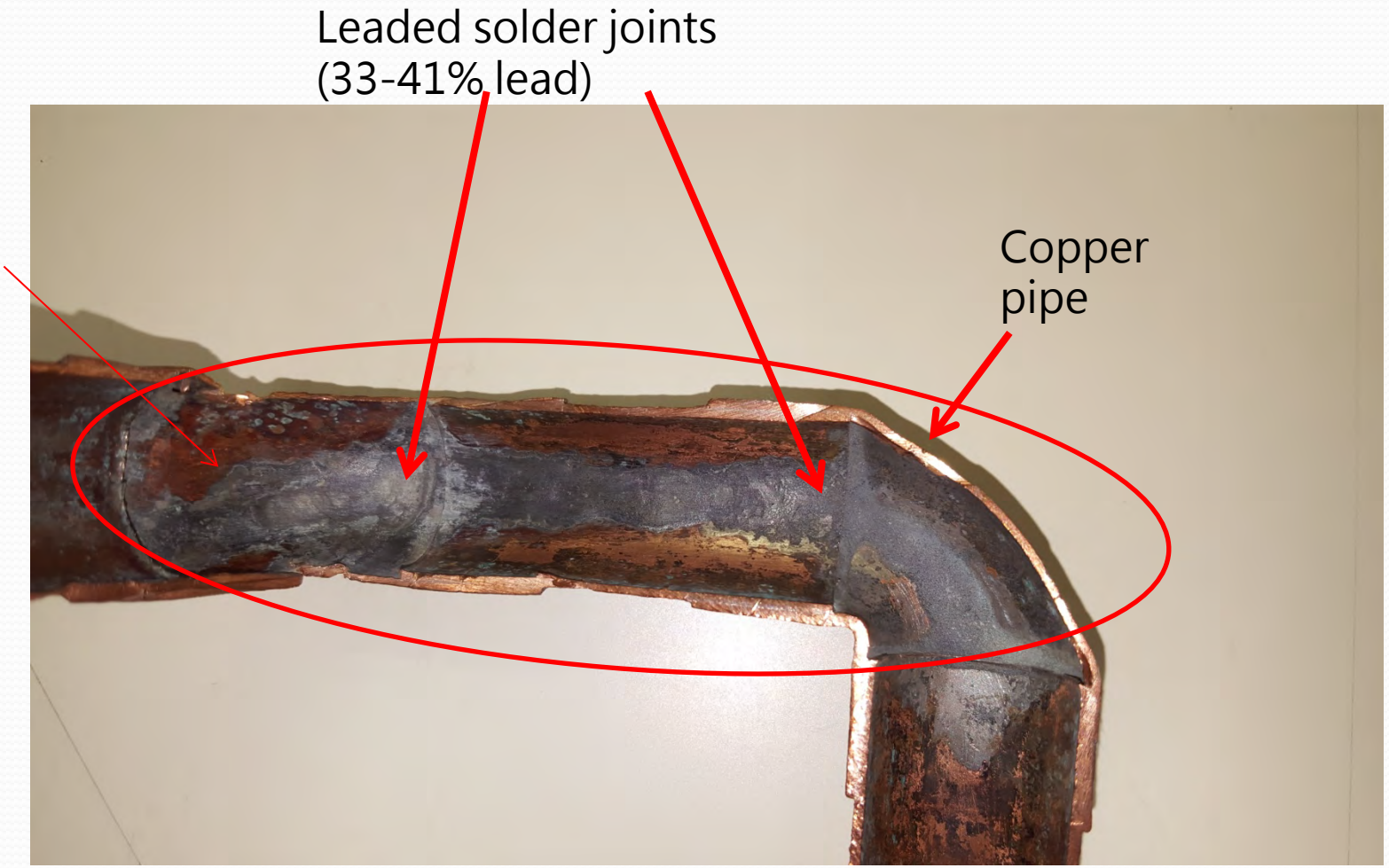
Item No.	Pipe / fittings	Test Result Pb (μg)*
AB	Tap at kitchen	4.1
AC	Tap at kitchen_part 2	2.1
AD	Shower tap at toilet	0
AE	Basin tap at toilet	4.6
AF	Tap for washing machine	13.7
AG	20 mm dia. gate valve	14.9
AH	20 mm dia. elbow at kitchen	14.9
AI	20 mm dia. copper pipe at kitchen	16
AJ	20 mm dia. elbow (hot water pipe) at toilet	639.8
AK	20 mm dia. copper pipe (hot water pipe) at toilet	7.7
AL	20 mm dia. elbow (cold water pipe) at toilet	3.5
AM	20 mm dia. copper pipe (cold water pipe) at toilet	5.5

Note : *@24 hr

Summary of lead leaching test

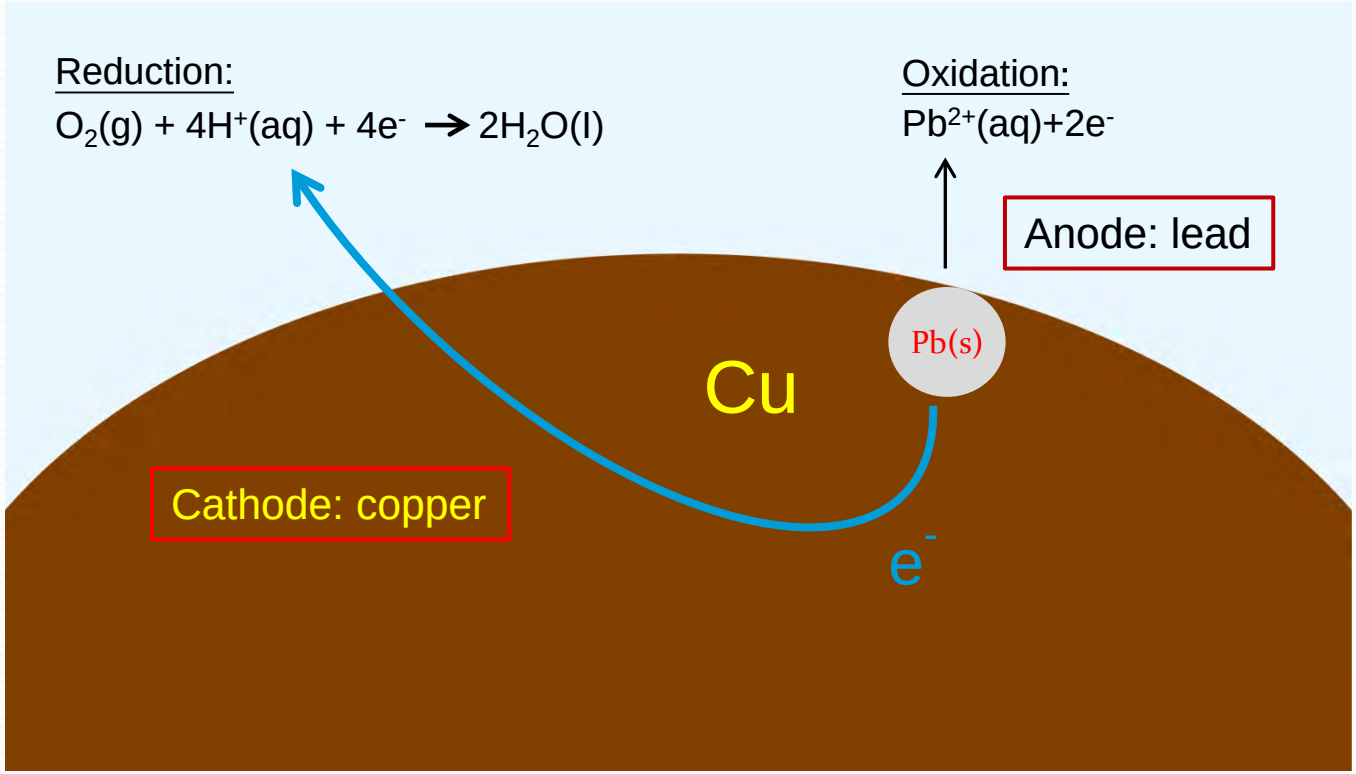
Pipes, joints and fittings		Copper Pipes	Valves	Water Meter	Taps	Copper pipe Joints
Sample photos			 		 	 
Total no. of components installed in Hong Ching House		**Numerous**	**8**	**1**	**4**	**194**
Lead Leaching (µg)*	Dia > 76mm	0	Cast iron 0– 4.5			Brazing joints 0
	Dia <=76mm	0 – 16	Copper alloy 10.3 – 14.9	3.7	0 – 13.7	Solder joints 1.4 – 639.8
Note: *@24 hr						

Leaded solder joints



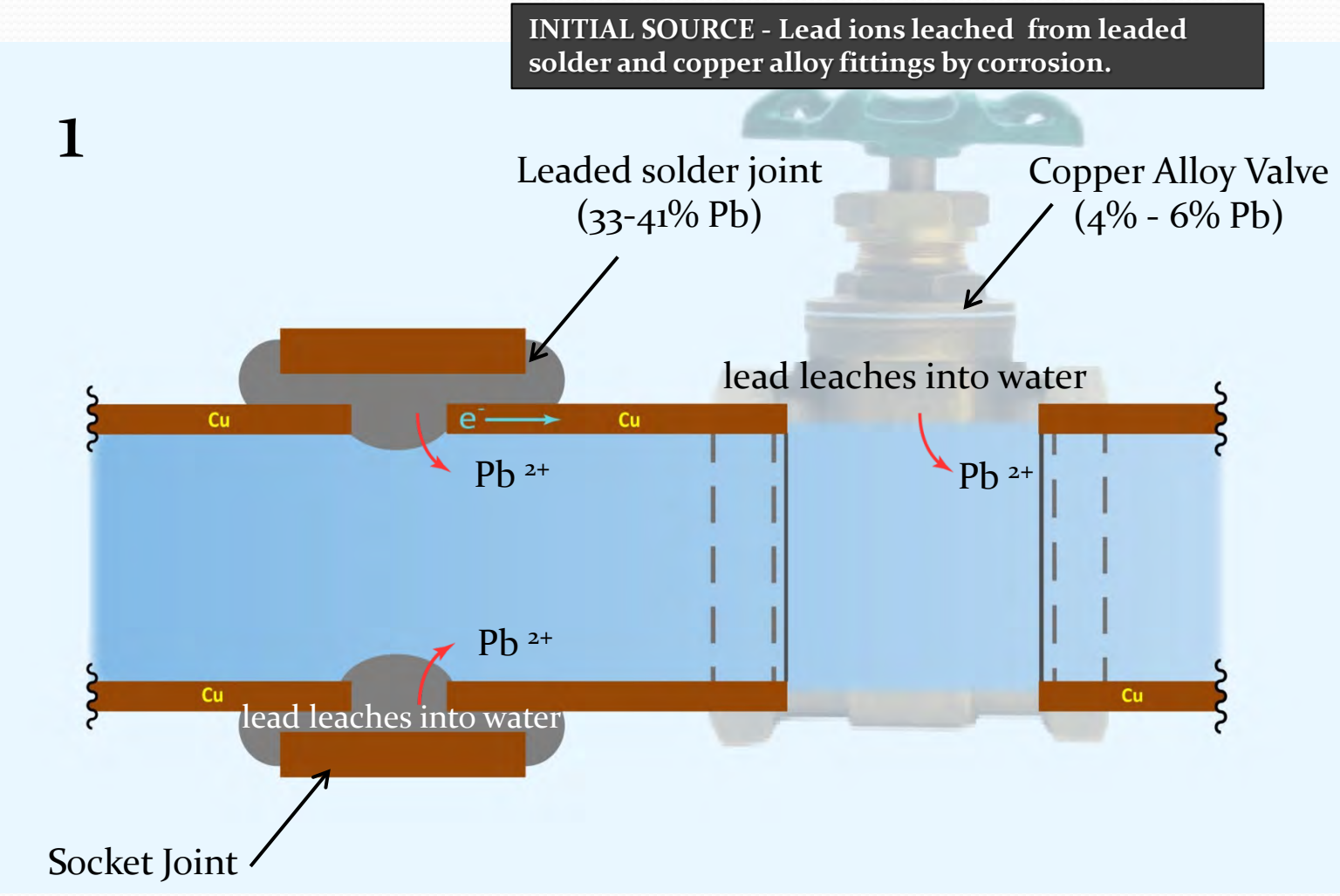
Lead solder seeped into the internal water surface due to unsatisfactory welding in some solder joints causing lead leaching.

Galvanic Corrosion



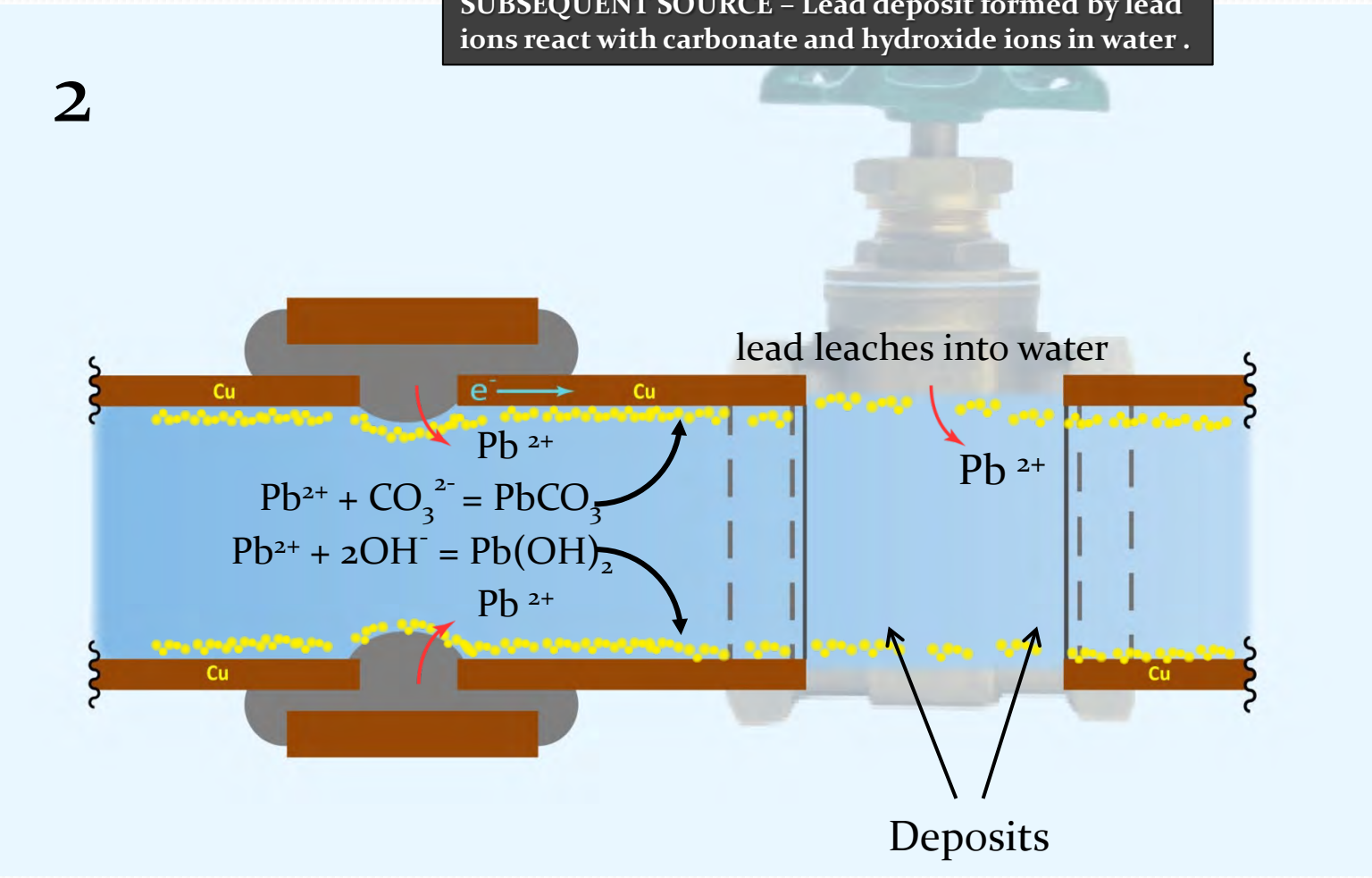
Cu: Copper alloy and copper pipe
Pb(s): From copper alloy and solder material (if leaded)

Lead leaching in water and formation of lead deposits



Lead leaching in water and formation of lead deposits

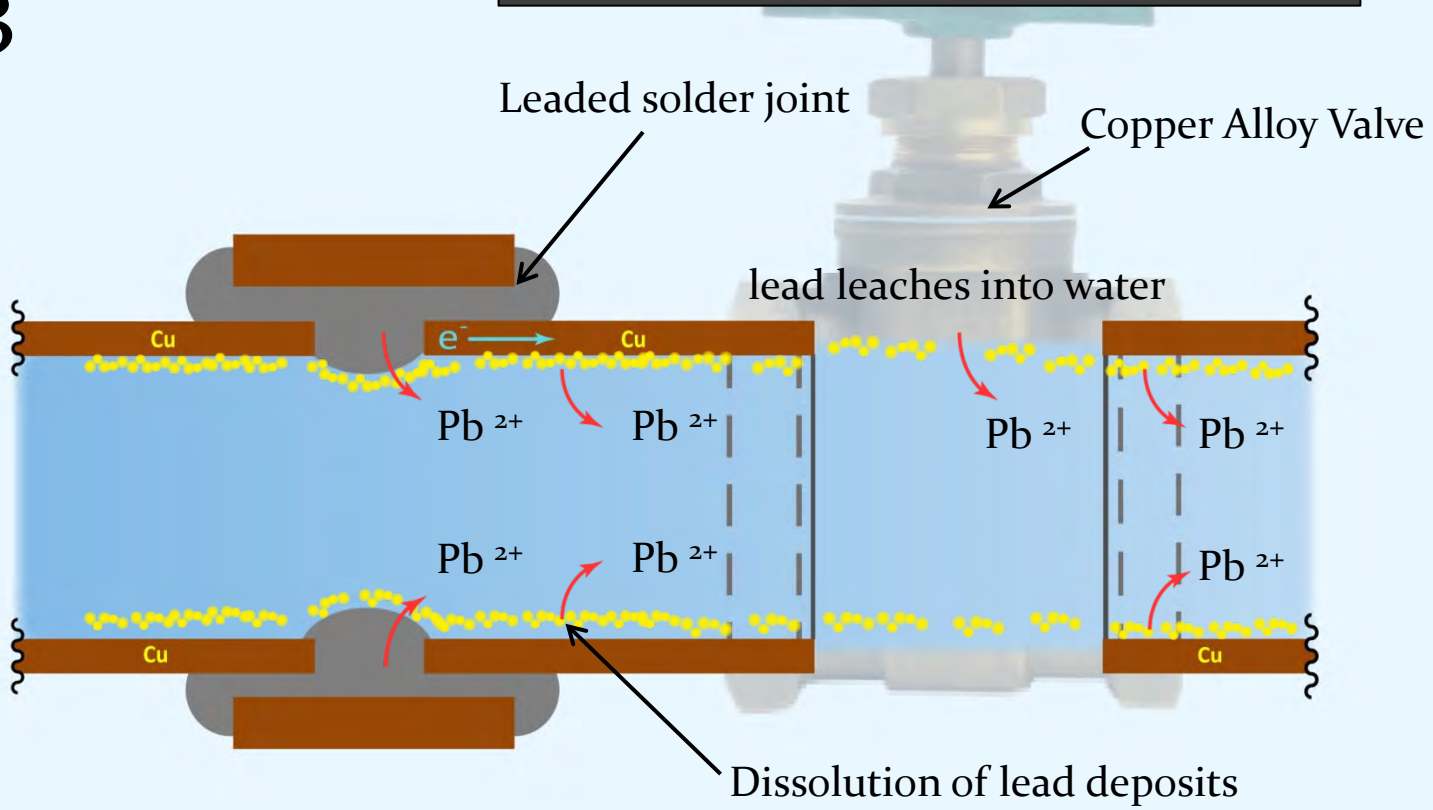
SUBSEQUENT SOURCE – Lead deposit formed by lead ions react with carbonate and hydroxide ions in water .



Lead leaching in water and formation of lead deposits

Source of Lead in water =
INITIAL SOURCE (lead leaching from leaded solder and copper alloy fittings) +
SUBSEQUENT SOURCE (lead deposits)

3



Lead deposits in branch pipes and pipe fittings

Copper Alloy Gate Valve

Copper pipe elbow

Copper pipe elbow

deposits

Lead leaching result after cleansing of lead deposits

Pipes, joints and fittings	Copper Pipes	Valves	Water Meter	Taps	Copper pipe Joints
Sample photos		 		 	 

	Lead Leaching?				
Before Cleansing	Yes	Yes	Yes	Yes	YES
After Cleansing	NO	Yes	Yes	Yes	YES

0.003 – 0.007 % impurities Comply with BS of less than 0.1% impurities

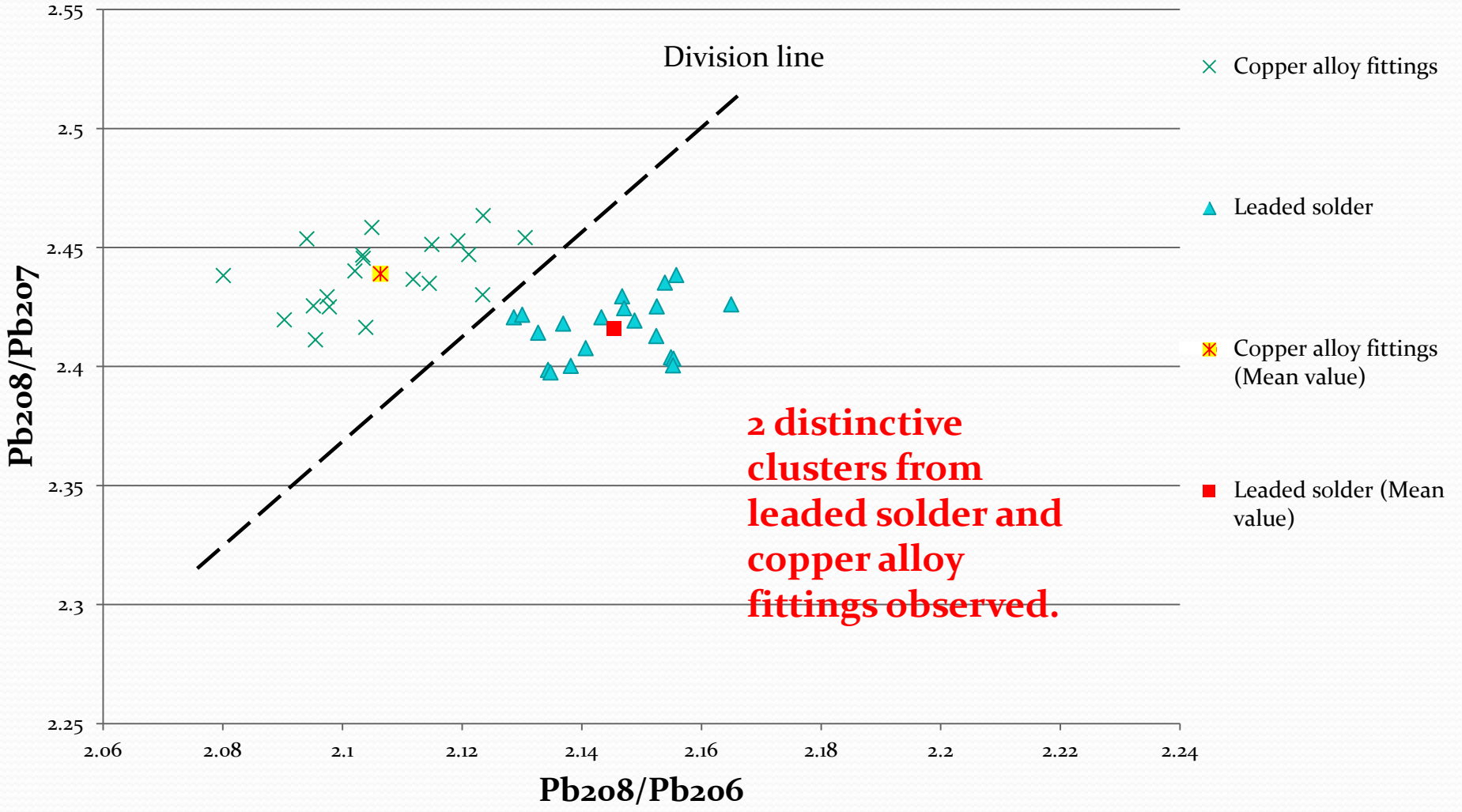
Observation
Copper pipes do not leach lead

33 – 41 % lead in solder
NOT comply with BS of 'lead free' solder i.e. less than 0.07 % lead

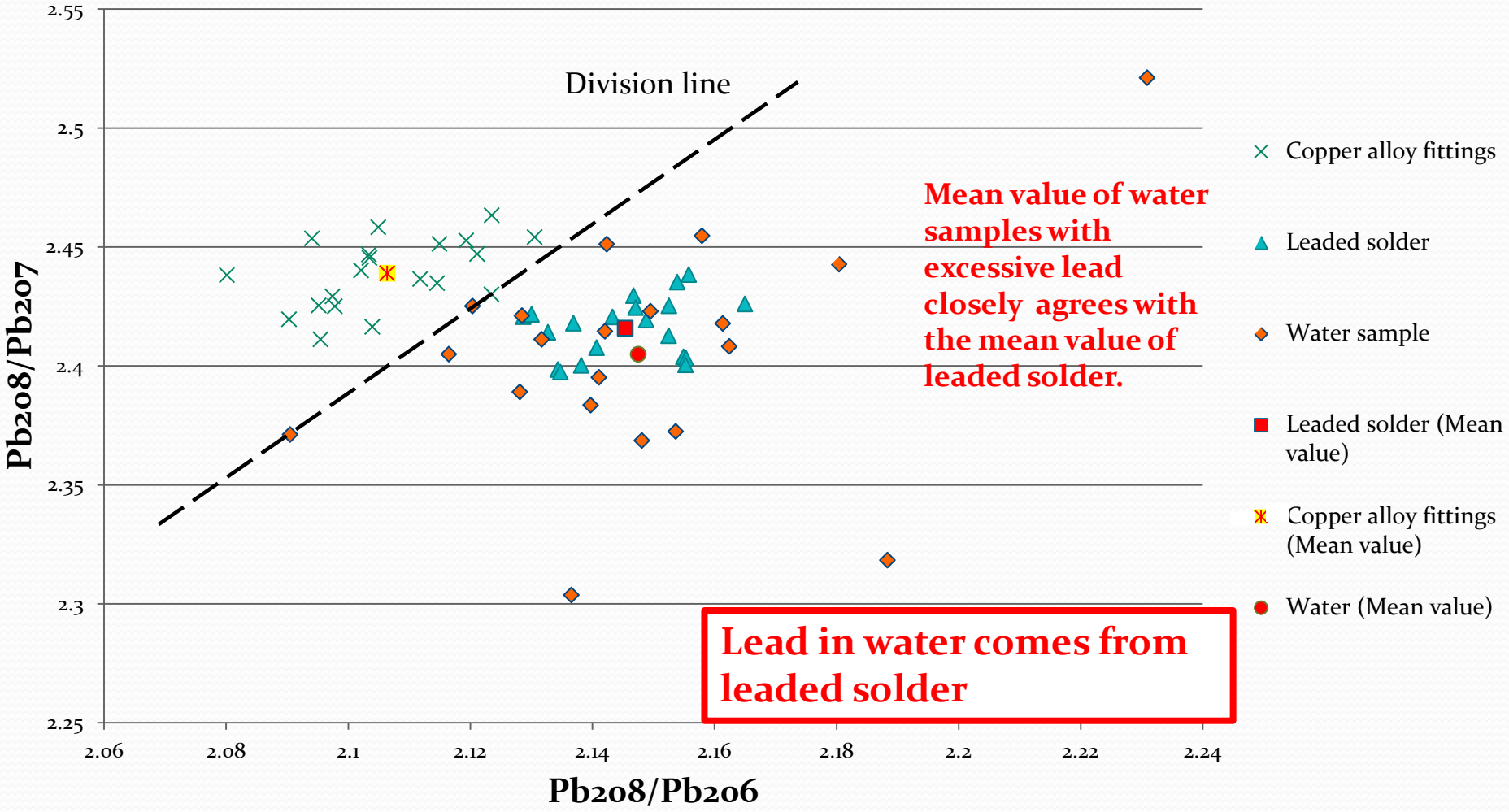
Lead isotopic analysis

- Lead contains three main isotopes – 206Pb: 207Pb: 208Pb.
- Lead from different origins has different isotopic ratios (like fingerprint)
- Precision instrument can measure the distribution of different isotopic ratios, thus locating the source of lead in water
- By working out the ratios of lead isotopes in leaded solder, copper alloy fittings and water samples with excessive lead content (fingerprints), we can find out the main source of lead in water

Isotopic analysis of leaded solder and copper alloy fittings

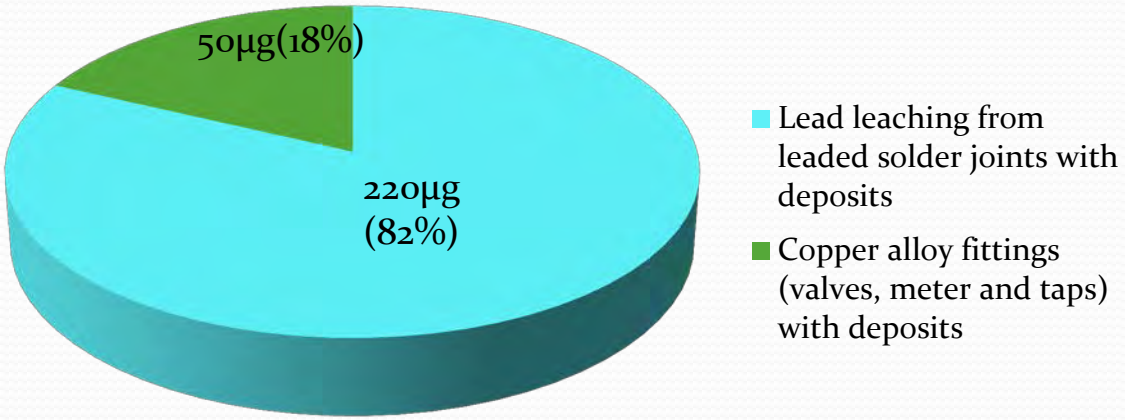


Isotopic analysis of leaded solder, copper alloy fittings and water samples with excessive lead

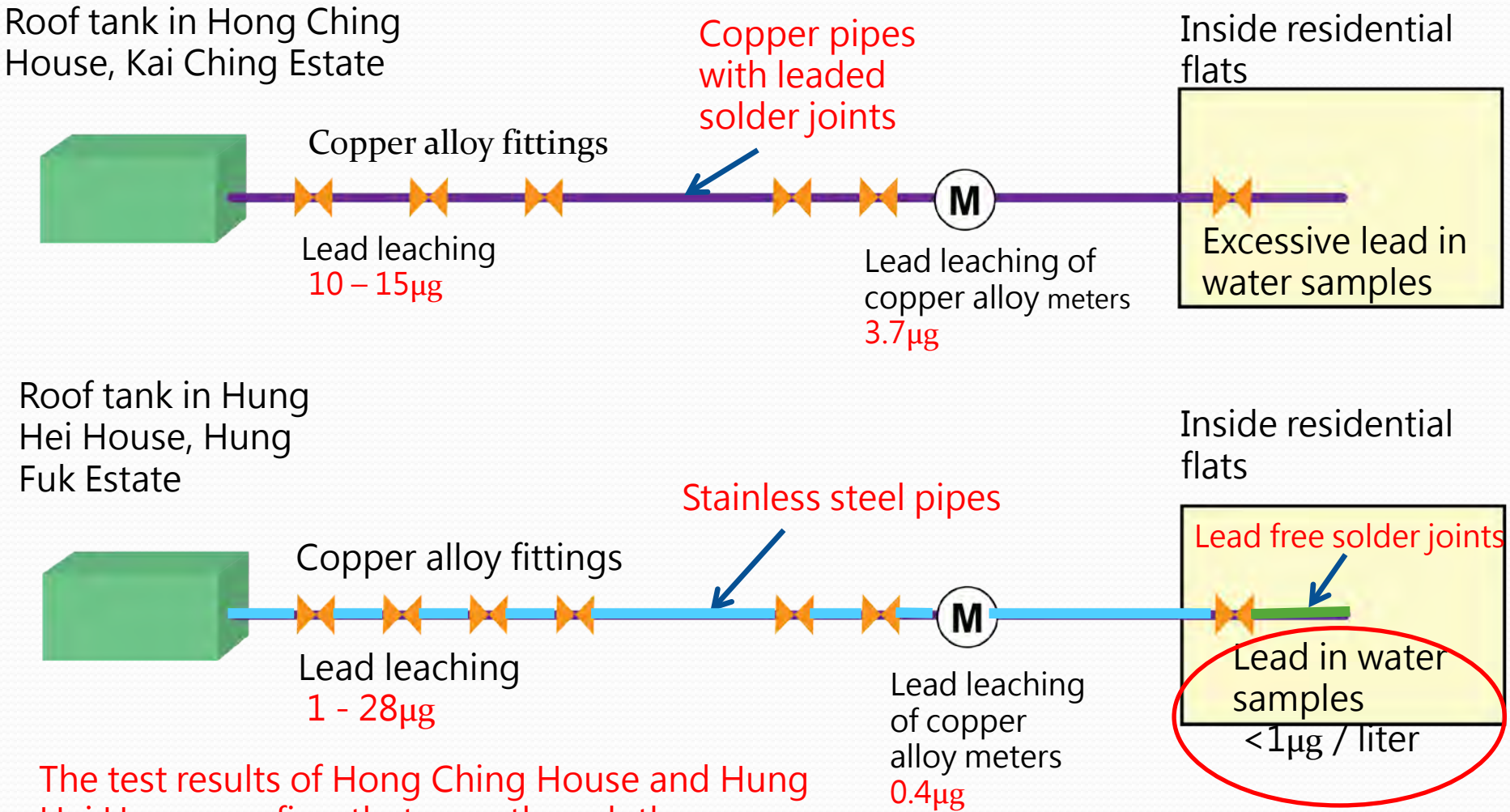


Mathematic modeling

- Calculate the total lead amount leached and the contribution from all pipe components by using the 24-hour leaching test results (see diagram below).
- Assuming only copper alloy fittings leach lead, calculated lead leaching: 2.7 µg/L, below WHO standard of 10 µg/L. Lead leached from copper alloy fittings does not result in excessive lead in drinking water.
- Mathematic modeling confirms that excessive lead in drinking water in Kai Ching Estate and Kwai Luen Estate Phase II is caused by leaded solder joints.



Can lead leaching from copper alloy fittings contribute to excessive lead in water?



The test results of Hong Ching House and Hung Hei House confirm that even though the copper alloy fittings leach lead, they do not result in excessive lead in water

- Similar findings were observed in Kai Ching Estate: Yuet Ching House, and Kwai Luen Estate Phase II: Luen Yat House

Conclusion

- Leaded solder joints are the source of excessive lead in drinking water in Kai Ching Estate and Kwai Luen Estate Phase II
- Copper alloy fittings also leach lead but do not result in excessive lead in drinking water
  - Confirmed by isotopic analysis
  - Mathematic modeling
  - Comparison between the findings in Hong Ching House and Hung Hei House

Preliminary findings
2. Leaching of other heavy metals

- Kitchen taps and washing machine taps in Kai Ching Estate leach **nickel** (under 24-hour stagnation condition)
- Taps contain very few amount of water (less than 150 ml), water with nickel can be flushed away in 1 to 2 seconds after turning on the tap
- Elemental analysis on the cross section of the taps show that nickel was seeped into internal surface of taps during electroplating
- Leaching test results for **chromium** and **cadmium** contents are undetectable, i.e. lower than 1 ug/L

Preliminary findings

3. Fittings non-complying with British Standard

Elemental analysis of fittings installed on site in Kai Ching Estate

Components		Installed on Site	Lead Content (%)	Submitted to WSD in WWO 46	On the directory list accepted by the WA
		Brand		Brand	
Copper alloy valve	65 mm dia Gate Valve	Victory	7.1 X , 5.9✓, 7.2 X	Waterfront	✓
	35 mm Gate Valve	Victory	7.5 X , 8.7 X	Ring	✓
	20 mm Gate Valve	Victory	7.8 X	Wealthmark	✓
	20 mm dia Stopcock	Victory	6.8 X, 5.9✓	Wealthmark	✓
Copper alloy tap	Shower mixer at toilet	Anspron	1.3✓, 1.5✓	Anspron	✓
	Basin mixer at toilet	Anspron	2.0✓ , 2.9 X	Anspron	✓
	Tap at washing machine	Daimler	1.4✓ , 1.8✓	A.T.A/Shing Shun	✓
	Single level Sink Mixer at kitchen	Anspron	2.0✓ , 2.1✓	Ansporn	✓

- **Some valves and taps installed were not those submitted to the Water Authority (WA), but they are on the directory list accepted by the WA and some valves and taps installed do not comply with BS requirement in respect of lead content. (According to BS EN 1982, the lead content of copper alloy valve and tap is 4%-6% and 0.5-2.5% respectively)**
- **Despite non-compliance with BS requirement, leaching test results of valves and taps not complying with BS requirement are similar to those complying with BS requirement. That is, they do not contribute to excessive lead in water.**

Review the existing control mechanism on inside service at the time of construction

Under Water Authority (WA)

- All pipes and fittings should comply with British Standards+
- Authorised Person^ (AP) and the Licensed Plumber (LP) need to submit a plumbing proposal and a list of pipes and major components of fittings
- The AP and LP have to confirm that all pipes and fittings are in compliance with the waterworks standards and requirements upon completion
- Inside service is inspected and approved by the WA
- Require LP to arrange water samples tested to be in compliance with specified standards before issue of the certificate regarding water supply connection by the WA (Testing for four heavy metals: lead, chromium, cadmium and nickel was not required before July 2015) #

  - + All pipes and fittings with certificates issued under Water Regulations Advisory Scheme or passed the laboratory test that in compliance with required standard are included in the directory list accepted by the WA
  - ^ AP as defined under Buildings Ordinance (Cap 123)
  - # The tests parameters include turbidity, colour, pH at 25°C, free residual chlorine, conductivity at 25°C, total coliforms, E. coli, heterotrophoc plate count. The above four heavy metals were not included. WSD Circular Letter 1/2015 dated 13.7.2015 specifies the requirement of testing for four heavy metals: lead, chromium, cadmium and nickel.

Review the existing control mechanism on inside service at the time of construction

Under Housing Authority (HA) contract

- **material specification** – (i) the use of lead-free solder materials for jointing of copper pipes; and (ii) the use of pipes and fittings complying with BS requirements
- a **material approval system** – requiring the Contractor's submission of documents/samples, and an undertaking by the Contractor that the materials are in full compliance with requirements. (For Kai Ching Estate, the Contractor's submission of lead-free solder checked and approved for use on site.)
- a **surveillance and control system** during the construction in which

  (i) Site staff checks materials upon delivery to site

  (ii) "Component and Materials Team" conducts laboratory tests of sink mixers and shower mixers to ensure compliance with the specified performance standards

  (iii) According to Building (Administration) Regulations, the Registered Contractor is to carry out continuous supervision, HA's Contract Manager serving as AP role and Technically Competent Persons (TCP) exercise periodic supervision by carrying out surveillance checks and test.

(The above control mechanism is being reviewed by the Review Committee on Quality Assurance Issues Relating to Fresh Water Supply of Public Housing Estates of HA)

Reasons for not knowing the existence of lead in water in advance

- Did not check whether the solder joints contain lead
- Testing of water samples did not include the four heavy metals

→ Inadequate knowledge about the consequences of leaded solder material

Measures needed to formulate to prevent recurrence of similar incidents in the future

Recommendations

Prevent recurrence of similar incidents in future

1. **Prevent use of leaded solder material**

An enhanced system for site inspection and testing during construction of plumbing works

- Qualified persons (e.g. BSE/BSI) to carry out adequate field inspection on the plumbing works
- Conduct systematic non-destructive test to soldering joints during construction (e.g. quick lead test or x-ray forensic spectrometer)
- Arrange random sampling and testing of soldering materials delivered to site
- Stipulate the testing of four additional heavy metals (lead, chromium, cadmium and nickel) for water samples and testing of solder joints samples in newly completed inside service by AP and LP (WSD Circular Letters 1/2015 & 5/2015 already issued)

Prevent recurrence of similar incidents in future

2. The WA to explore the use of pipe materials free from the risk of misuse of leaded joints in the plumbing works, e.g.:
   - use of silver brazing or compression joint for copper pipes
   - use of stainless steel pipes

3. The HA to consider requiring the adoption of central procurement for soldering materials

4. The WA to consider reviewing relevant legislations

Points to note

- If water has been standing in the pipes, for instance, after several hours of non-use, overnight, over a weekend or after a holiday, run water at a tap, usually for about two minutes, prior to using it for drinking or food preparation.

- As hot water increases the amount of lead that may leach from the pipe materials, use only water from the cold-water tap for cooking and drinking.

- For other pipe materials, such as stainless steel pipes, galvanized iron pipes or copper pipes with compression joints are used, the risk of excessive lead in drinking water will be low.

- For details, please refer to the brochure titled “Hong Kong’s Water Supply – Reducing Lead in Drinking Water” which can be obtained in the Public Enquiry Service Centres of all Home Affairs Department District Offices and all estate management offices of the Housing Department or downloaded from ISD designated website: www.isd.gov.hk/drinkingwater.

Thank you