



3. Plumbing and Drainage Part 1

3.2 Sanitation and drainage systems



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Contents



- Sanitary drainage
- Stormwater drainage
- Drainage below ground
- Drainage defects

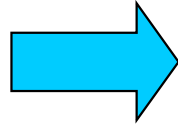
Sanitary drainage



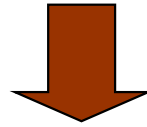
- Design of drainage systems
 - Sanitary fitments
 - Above ground drainage
 - Below ground drainage (+ sewage disposal)
- Aim: To remove waste, foul & surface water
 - Waste water (廢水) = basins, sinks, baths, showers
 - Soil or foul water (髒水) = from toilets or W.C.
 - Surface water (地面水) = rainwater or stormwater
- Systems will last as long as the building!!

Design of drainage systems 排水系統設計

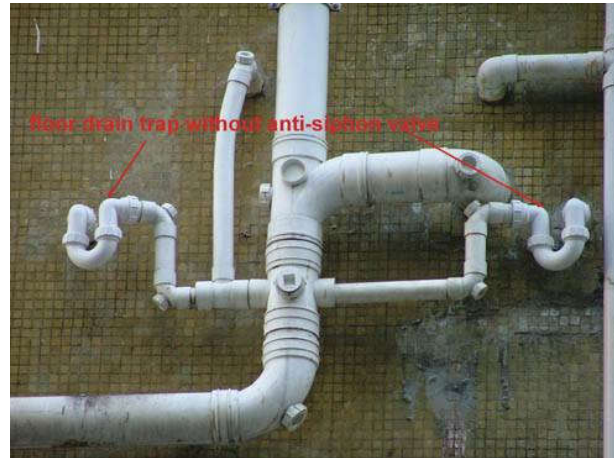
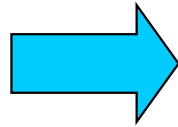
Plumbing
system
(water
supply)



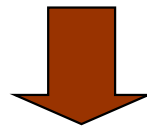
Sanitary
fitments
衛生設備



Rainfall,
surface
water &
stormwater

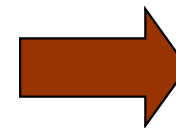


Above
ground
drainage
地上排水



Sometimes,
sump & pump
system is
required for
disposal e.g.
in basement

Below
ground
drainage
地下排水



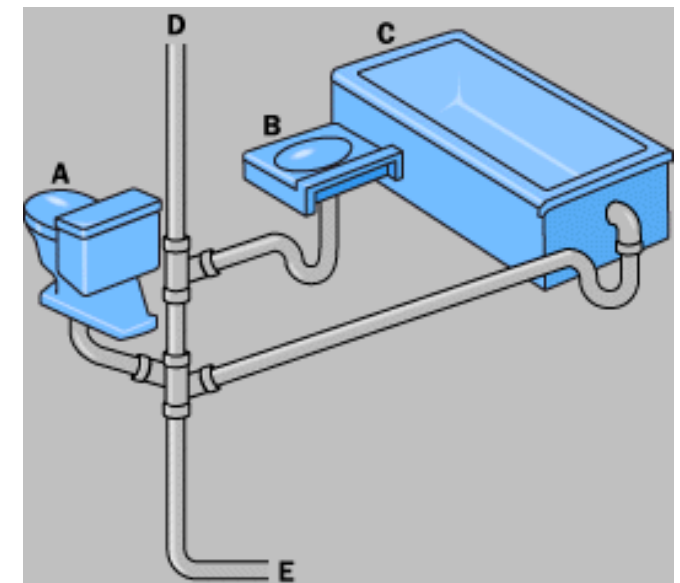
Sewage disposal (and
treatment) 污水處理



Sanitary drainage



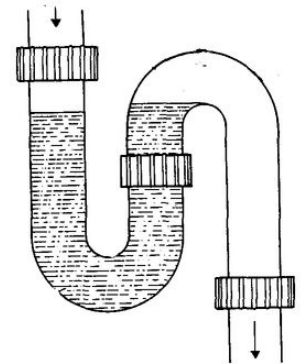
- Sanitary fitments or appliances
 - Common types:
 - Flushing cistern, flushing trough, automatic flushing cistern, flushing valve
 - Water closets (W.C.), urinal, bidets
 - Shower and bath tub
 - Sink, cleaner's sink
 - Drinking fountain
 - Wash basin or washing trough
 - Floor drain



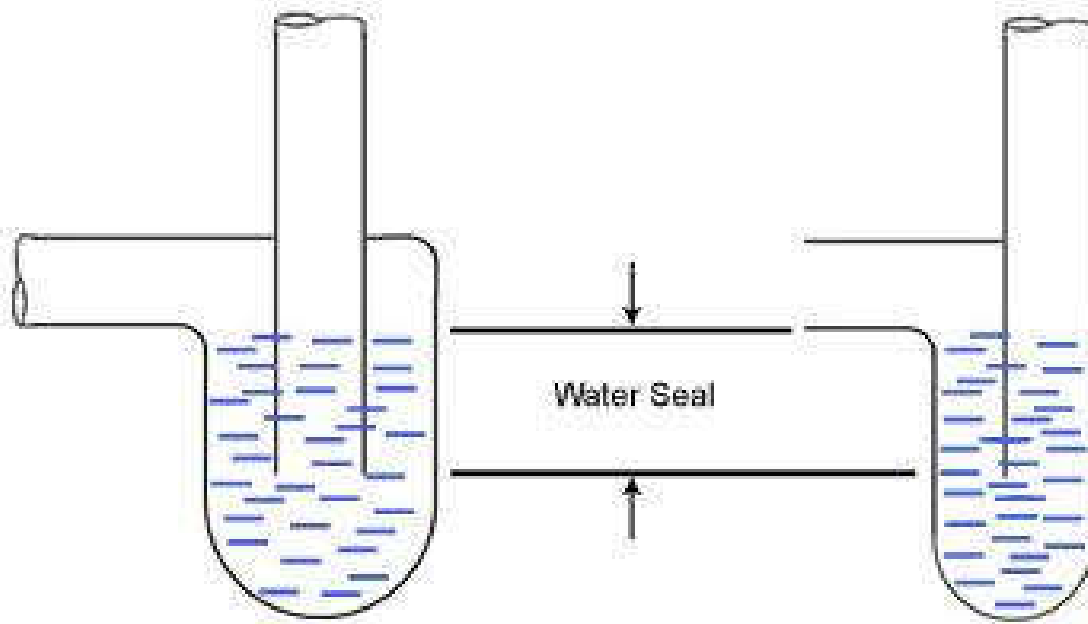
Sanitary drainage



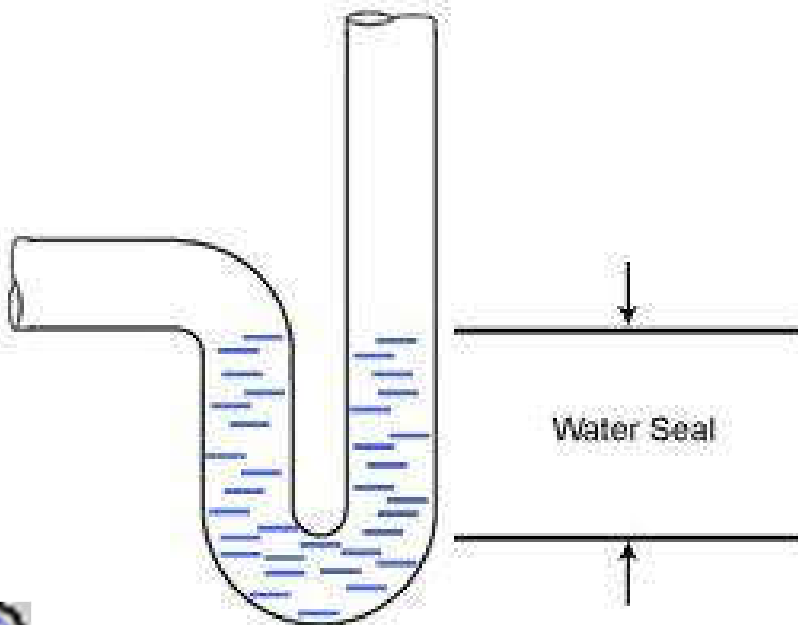
- Types of drainage pipes
 - Waste pipe (WP): e.g. connected to basins & baths
 - Soil pipe (SP): e.g. connected to W.C.
 - Ventilating/Vent pipe (VP)
 - Rain water pipe (RWP)
 - Anti-siphonage pipe: preserve water seals of traps
 - Air-conditioning condensation drainage pipe
- Use of traps (control foul gas or odour)
 - U-trap: a U-shaped running trap
 - P-trap and S-trap



Water seal of traps 隔氣的水封



S-trap S型隔氣



P-trap P型隔氣



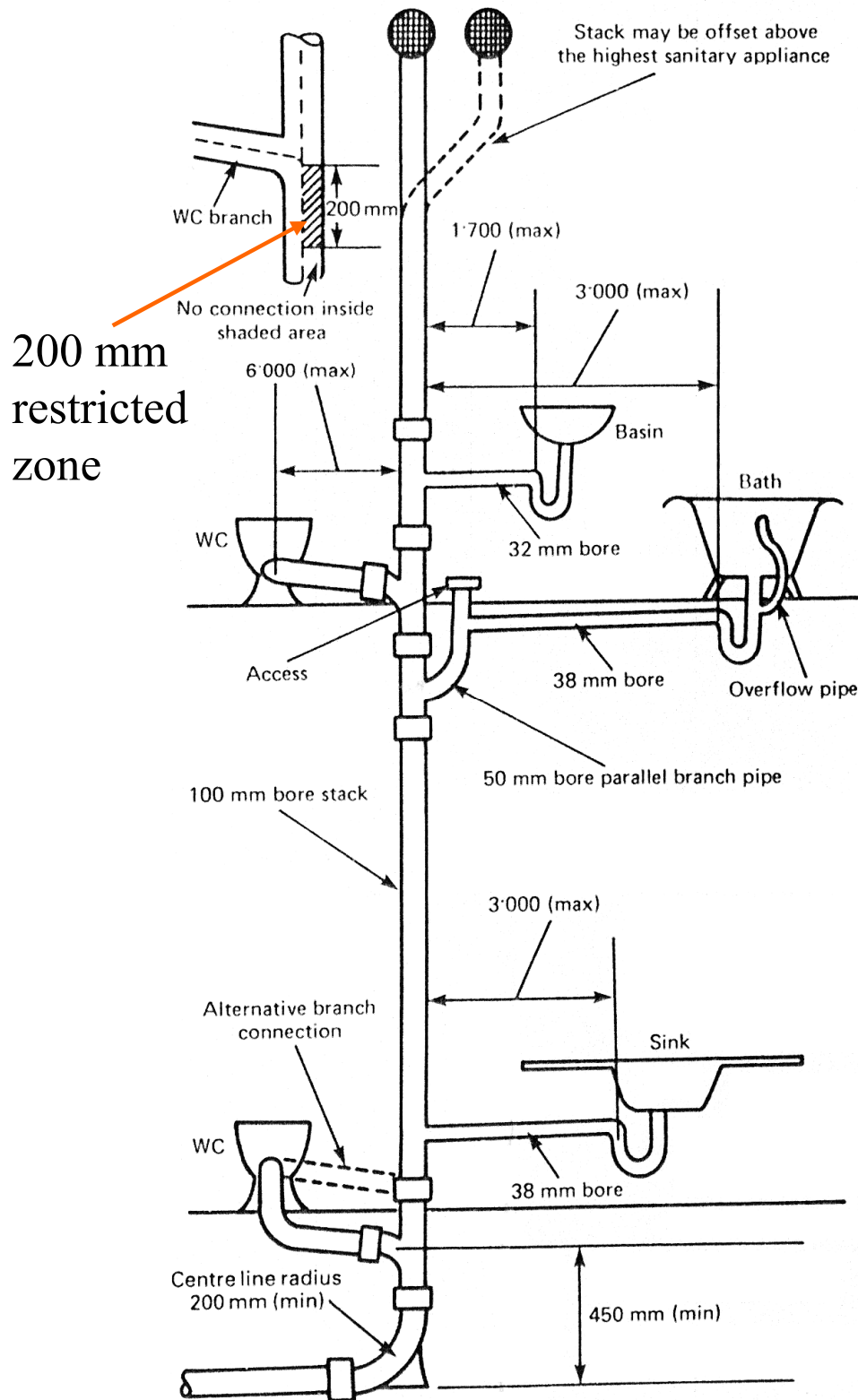
Video: How Do P-Traps Work? | Spec. Sense (2:23) <https://youtu.be/zGofkKOP2SU>

Sanitary drainage



- Types of sanitary drainage stack systems
 - Single stack system
 - Collar boss system
 - Modified single stack system
 - Fully ventilated one-pipe system
 - Two-pipe system
- Selection depends on situations, costs & local design practices
- Design considerations: e.g. pipe size, distance

Single stack system

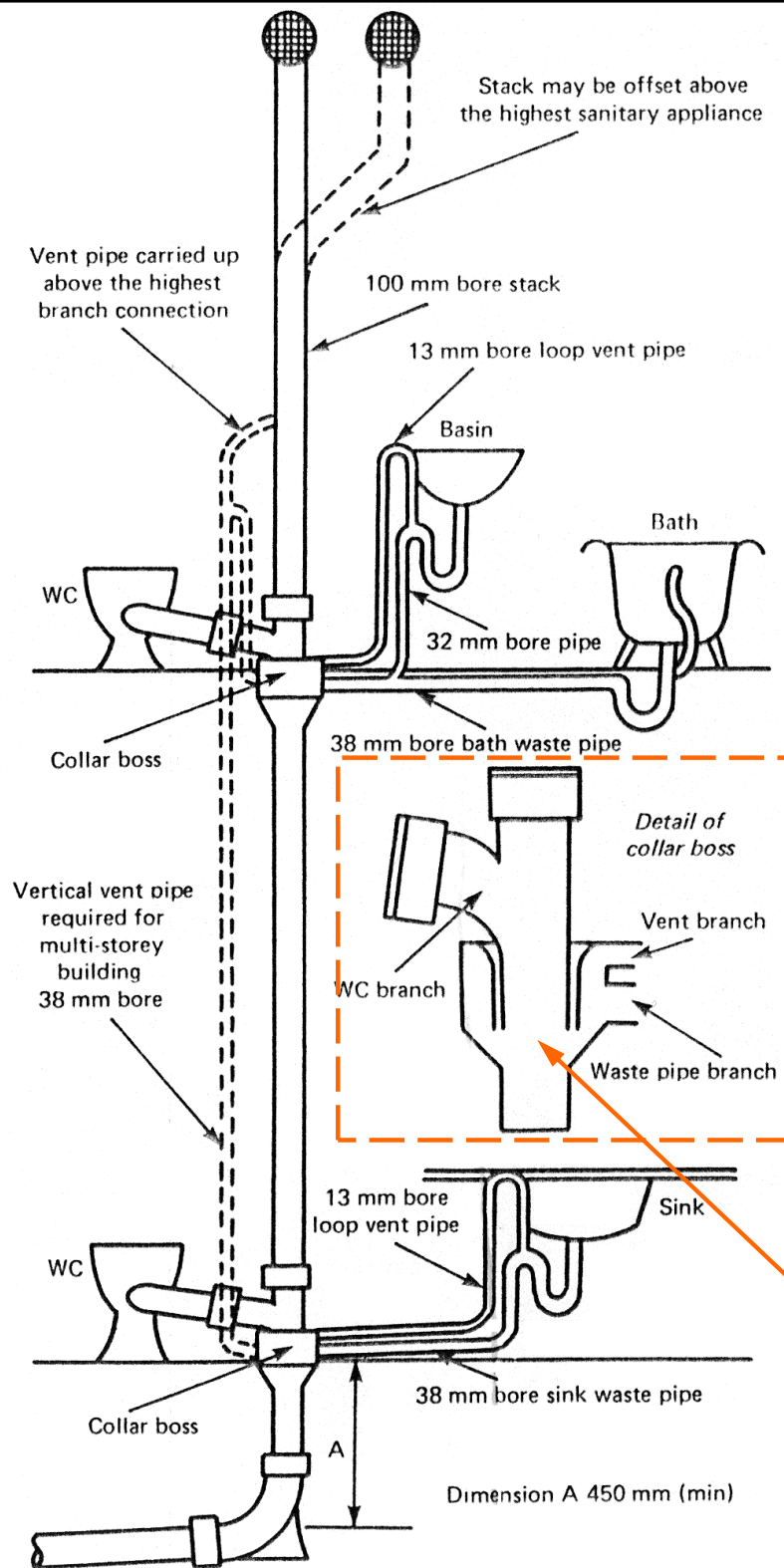


- Reduces the cost of soil and waste systems
- Branch vent pipes are not required
- But many restrictions in the design
- To prevent loss of trap water seals:-
 - The trap water seals on the waste traps must be 76 mm deep
 - The slopes of the branch pipes are: sink and bath, 18 to 19 mm/m; basin 20-120 mm/m; WC 18 mm/m (min.)
 - Vertical stack at 200 mm below the centre of the WC branch connection

Collar boss single stack system

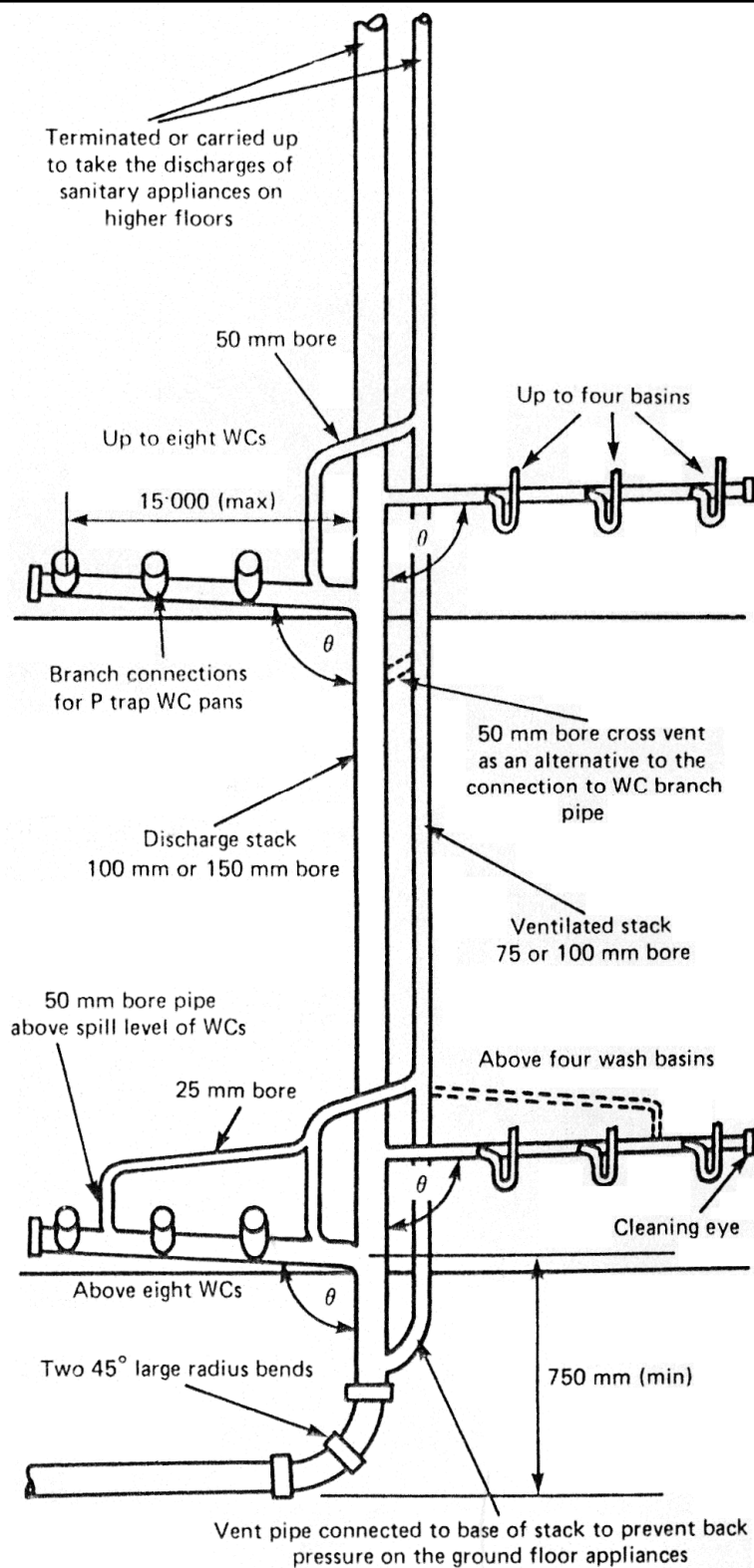
- Eliminates the restrictions imposed between bath waste pipe and stack
- Bath waste connect to the stack at a higher point (no risk of WC discharge backing up into bath waste pipe)
- Loop vent pipes to the basin/sink traps and connecting these to the collar boss, the waste pipes from these appliances drop vertically before running horizontally to stack
- Loop vent pipe on the basin trap prevent its siphonage when the bath is discharged

Annular chamber protects the small diameter connections from the WC discharge



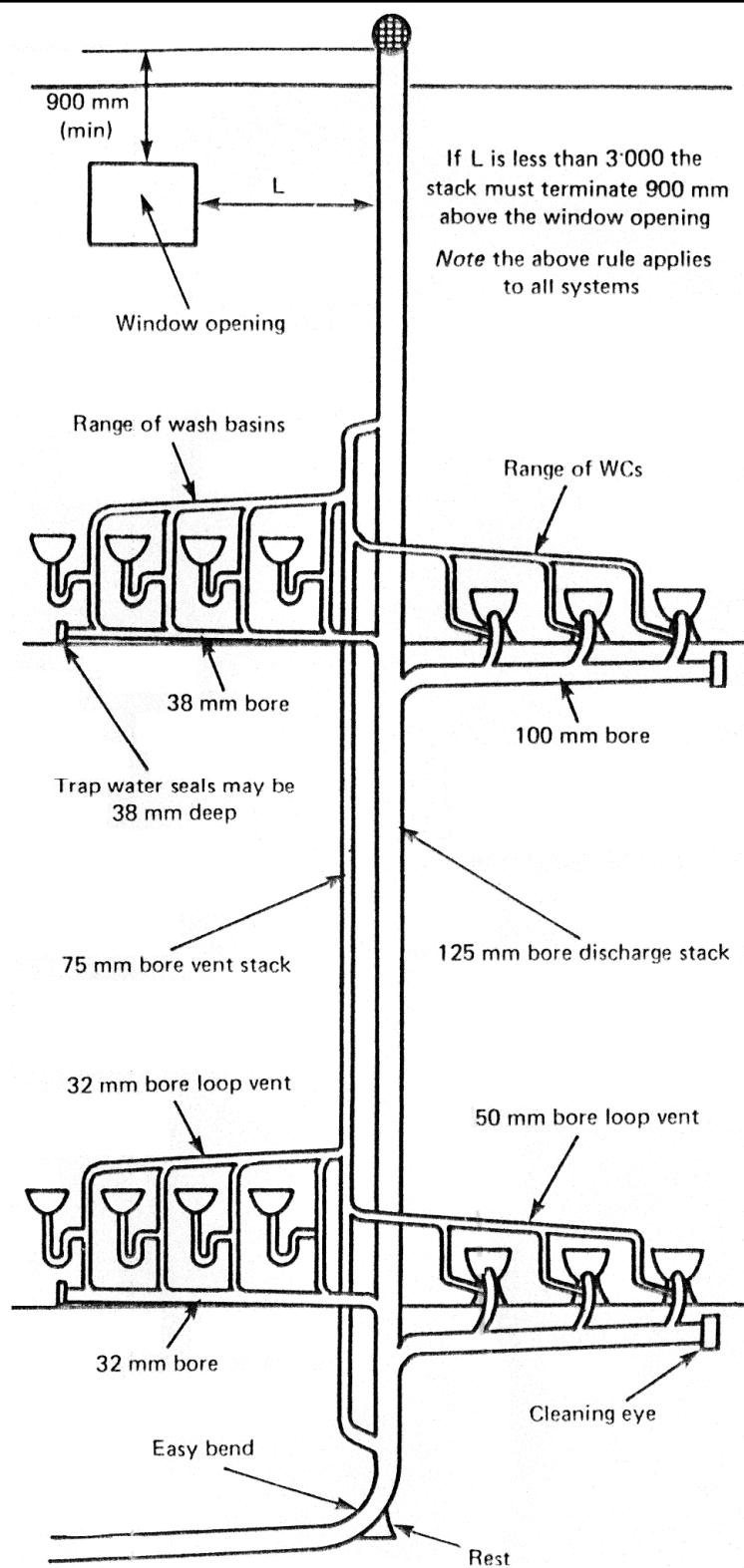
Modified single stack system

- Close grouping of sanitary appliances → install branch waste and soil pipes without the need for individual branch ventilating pipes
- To prevent the loss of trap water seals → WC branch pipe min. 100 mm bore & angle $\theta = 90.5^\circ - 95^\circ$
- To prevent the loss of trap water seals → basin main waste pipe min. 50 mm bore & angle $\theta = 91^\circ - 92.5^\circ$
- Five basins or more / length of the main waste pipe exceeds 4.5 m → a 25 mm bore vent pipe connected to main waste pipe at a point between the two basins farthest from the stack



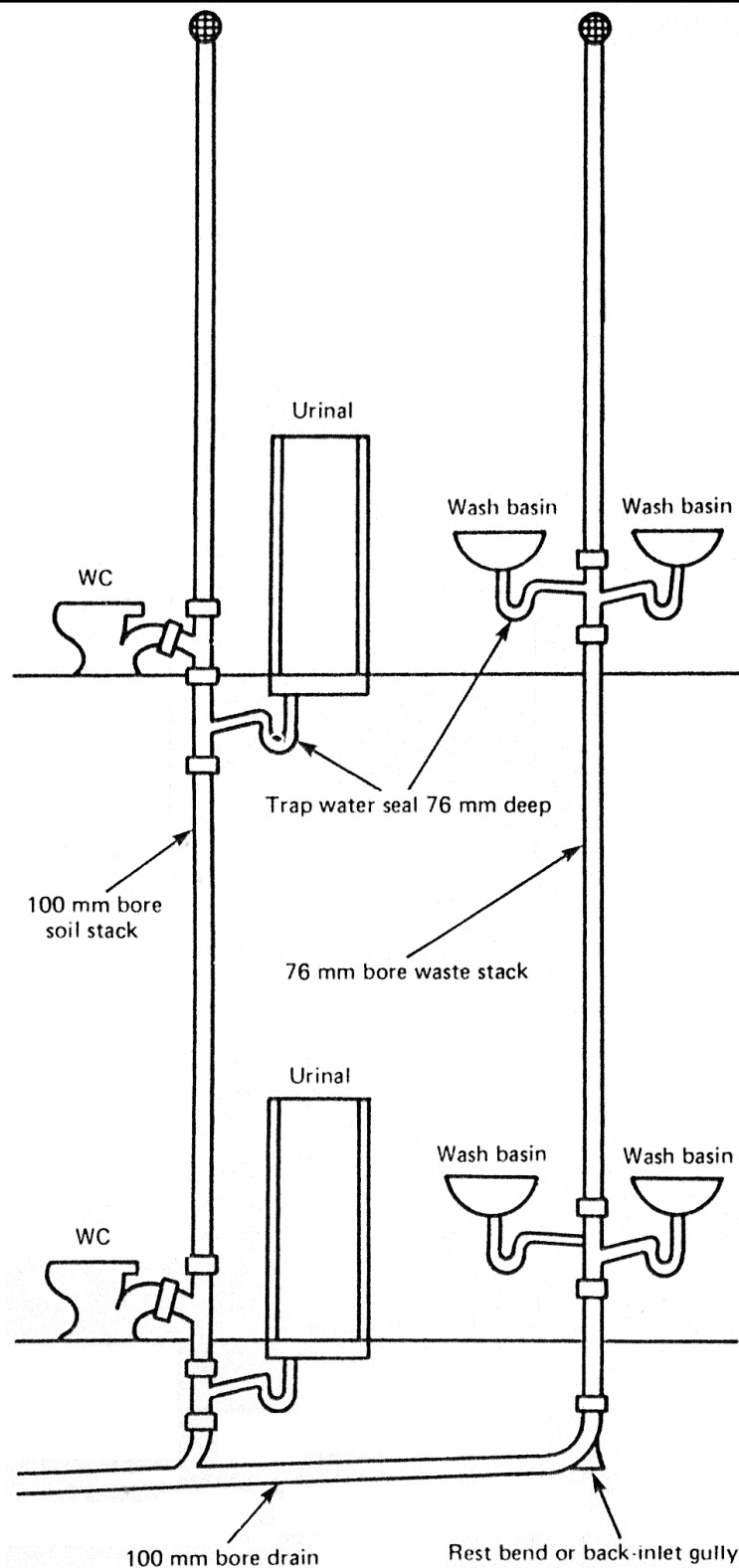
Fully ventilated one-pipe system

- A large number of sanitary appliances in ranges
- Each trap with an anti-siphon or vent pipe connected to the discharge pipe in direction of the flow of water at a point between 75 - 450 mm from trap crown
- Vent stack connected to the discharge stack near to the bend to remove compressed air at this point



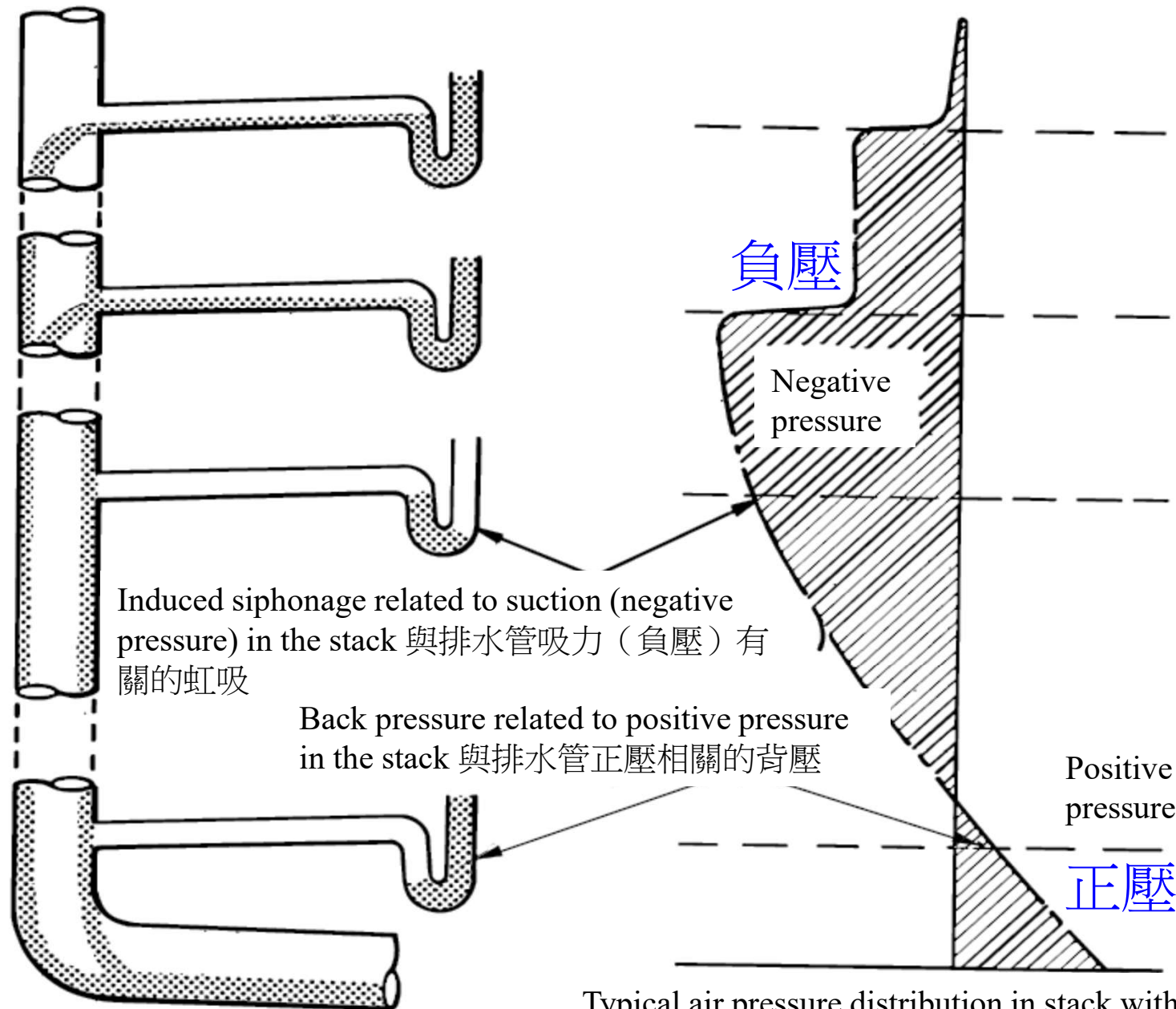
Two-pipe system

- The most expensive and in case with widely spaced sanitary appliances
- Wash basins or sinks in rooms far away from main soil stack → to connect these appliances to a separate waste stack
- The waste stack connected to the horizontal drain either via a rest bend



Pressure effects and seal losses due to water flow in a discharge stack 由於排水管中的水流而產生的壓力效應和密封損失

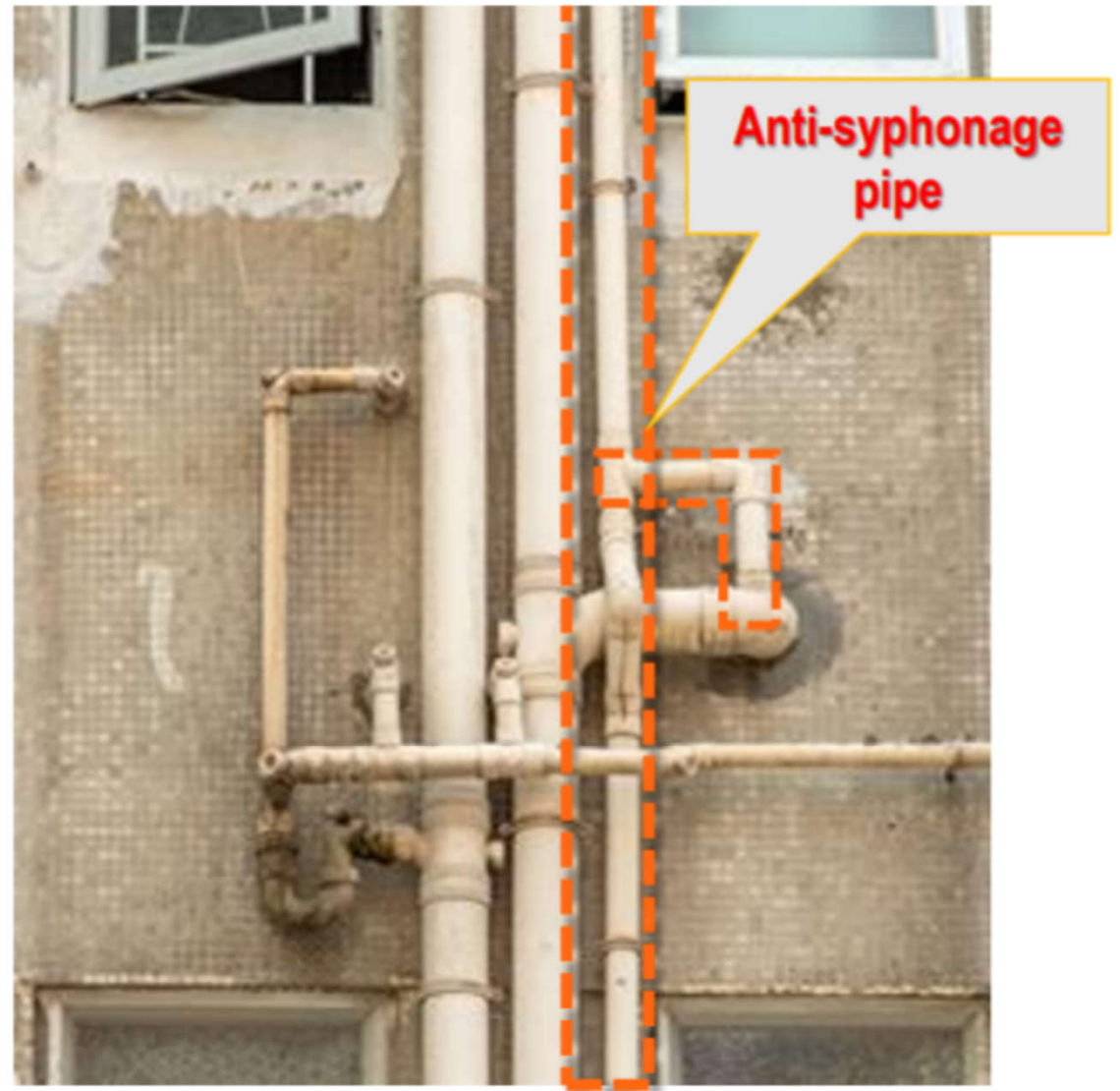
Open to atmosphere 向大氣開放



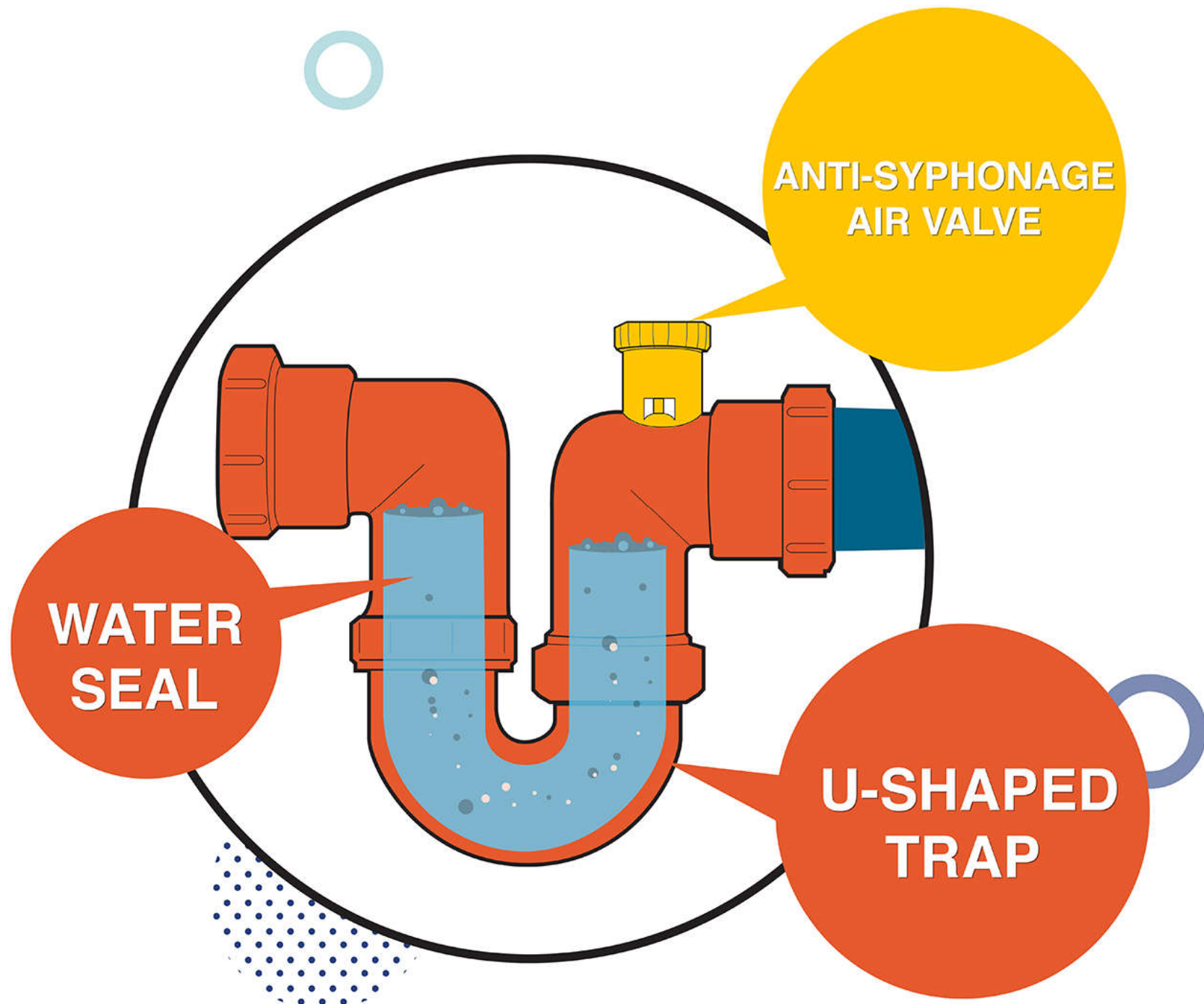
(Source: British Standard BS EN12056-2:2000)

Typical air pressure distribution in stack with two branches discharging 具有兩個分支排水管中典型的氣壓分佈

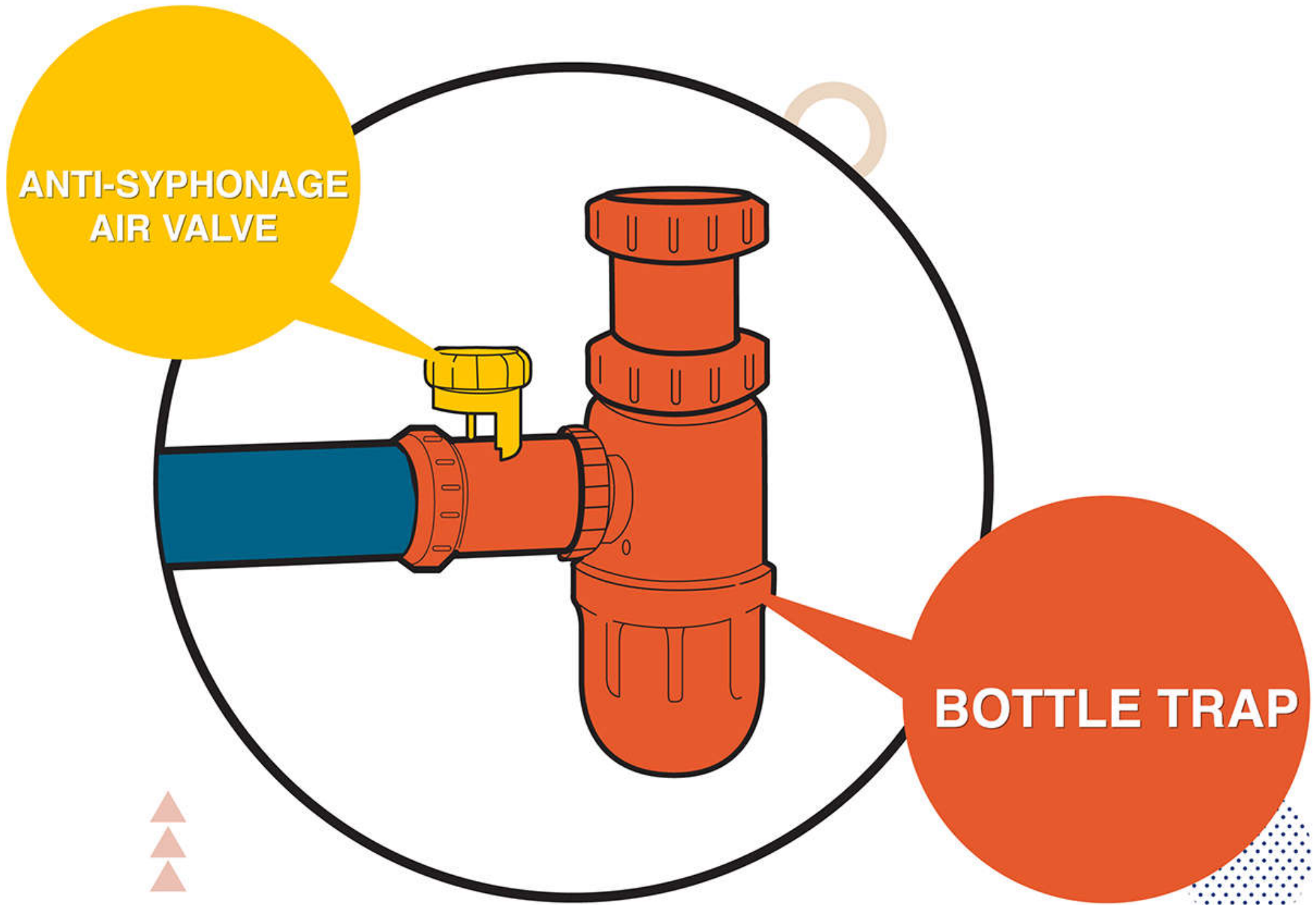
Anti-siphonage pipes



U-shaped trap with anti-siphonage air valve



Bottle trap with anti-siphonage air valve



Materials for sanitary pipework

Material	Application	Jointing
Cast iron	50 mm and above vent and discharge stacks	50 mm and above vent and discharge stacks
Galvanised steel	Waste pipe	Screwed
Copper	Waste pipes and traps	Compression, capillary, silver solder, bronze weld or push-fit rings seal
Lead	Waste pipes and discharge stacks	Soldered or lead welded
ABS (acrylonitrile butadiene styrene)	Up to 50 mm waste and vent pipes	Solvent cement and push-fit ring seal
High-density polyethylene	Up to 50 mm waste and ventilating pipes and traps	Push-fit ring seal and compression fittings
Polypropylene	Up to 50 mm waste and ventilating pipes and traps	Push-fit ring seal and compression couplings
Modified PVC	Up to 50 mm waste and vent pipes	Solvent cement and push-fit ring seal
Unplasticized PVC	Over 50 mm soil and vent stacks; vent pipes under 50 mm	Solvent cement and push-fit ring seal
Pitch fibre	Over 50 mm discharge and vent stacks	Driven taper or polypropylene fitting with a push-fit ring seal

(Source: Drainage Services Department, www.dsd.gov.hk)



Stormwater drainage

- Stormwater or rainwater drainage systems
 - Design for roofs, walls and ground drainage
 - Include rain water outlets, gutters, rain water stacks and occasional require sum and pump system for disposal
 - Require integration with architect
- Rain water flow rate, Q (l/s)
 - $Q = C \times A \times I / 3600$
 - C : impermeability factor or run-off coefficient
 - A : drainage or catchment area (m²)
 - I : rainfall intensity (mm/hr)

Ground impermeability factor

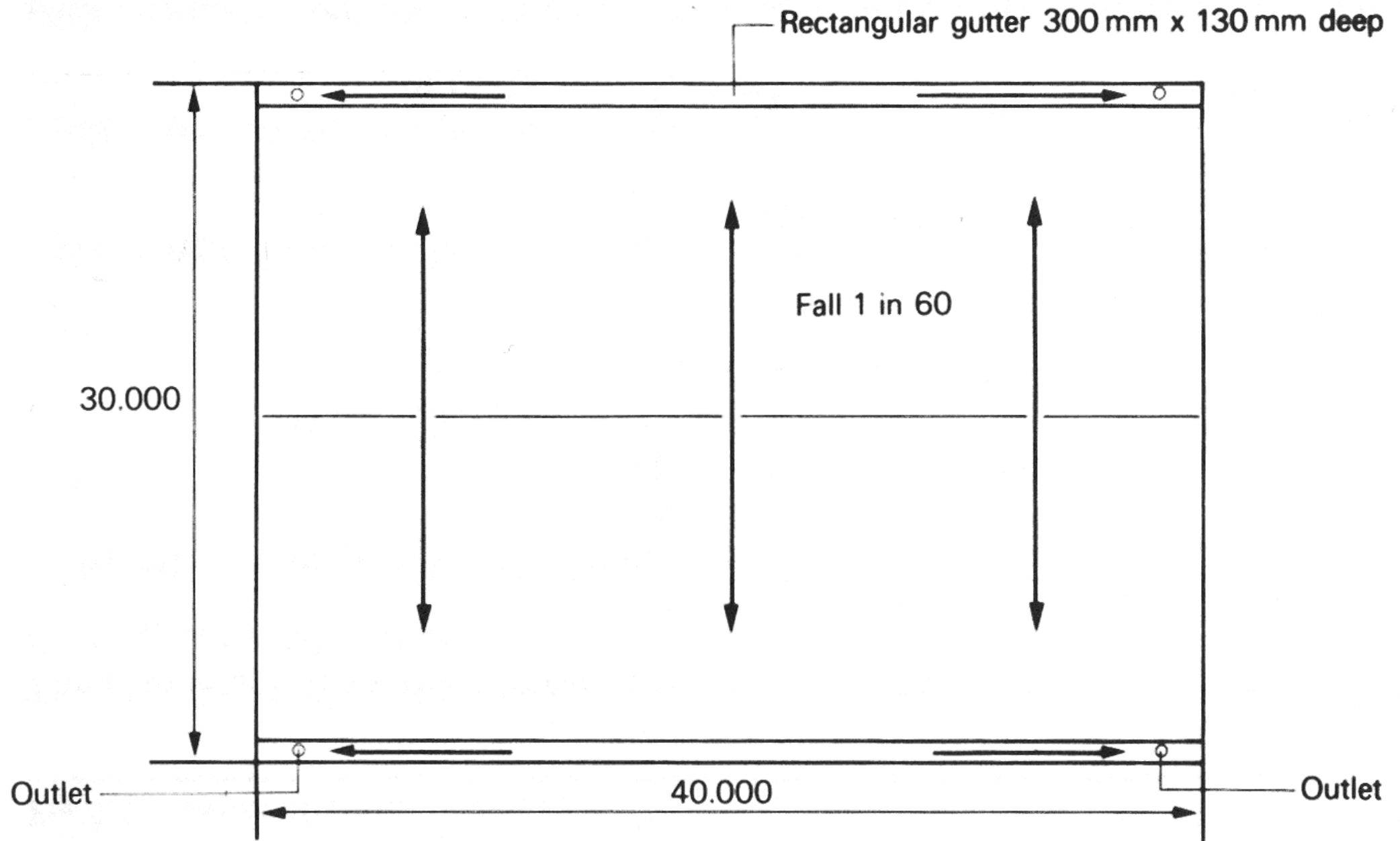
Nature of surface	Impermeability factor
Road or pavement	0.90
Roof	0.95
Path	0.75
Parks or gardens	0.25
Woodland	0.20



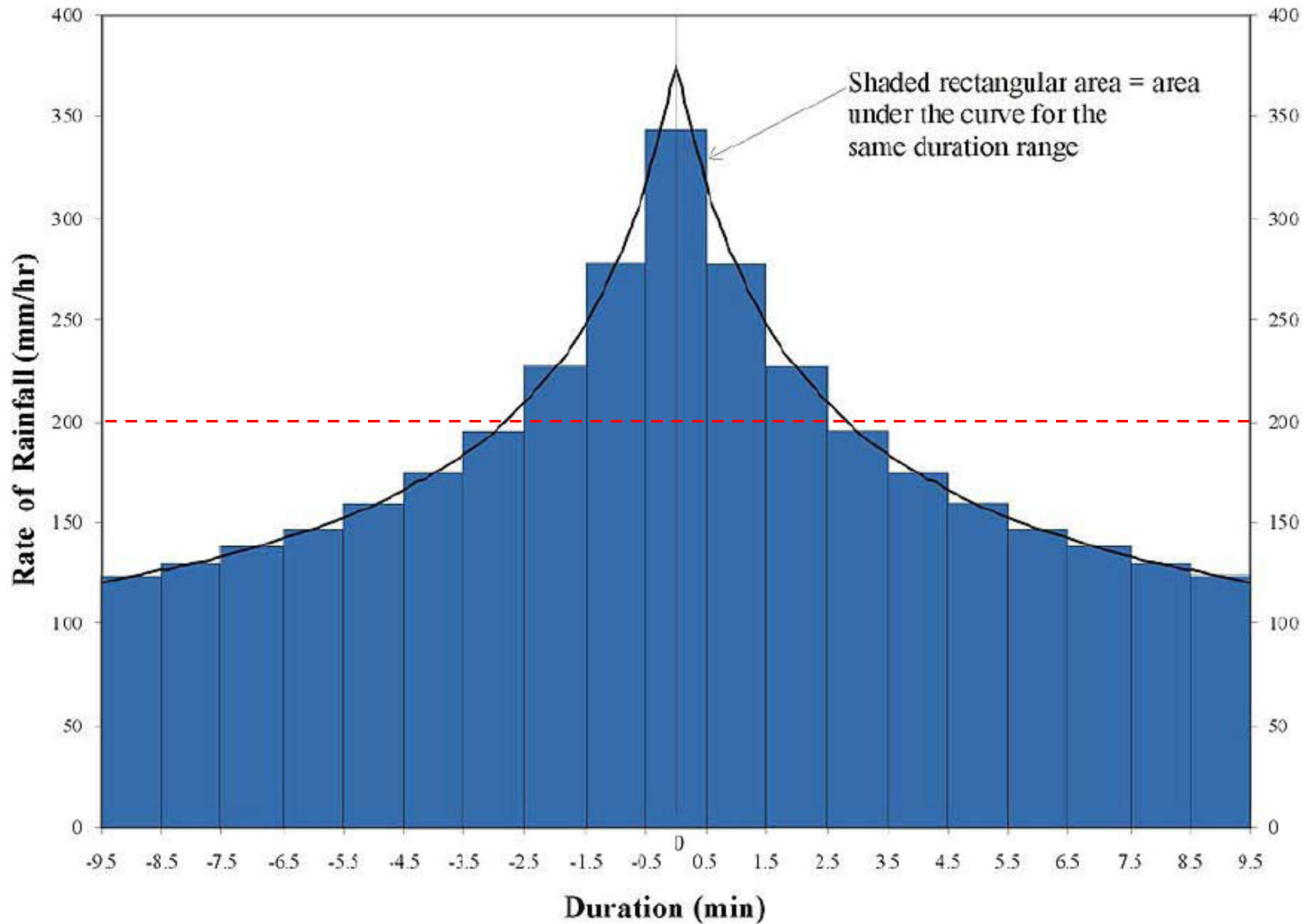
Stormwater drainage

- Drainage or catchment area, A (m^2)
 - It is the area that surface water will be collected and discharge to the drainage outlet
 - For catchment area with vertical wall exists, it shall include 50% of the vertical wall area:
 - $A = A_f + 0.5 A_w$
 - where A_f is the catchment floor area, A_w is the area of vertical wall
 - The surface area shall be laid in fall to the point of drain outlet of not less than 1:100 to facilitate effective water collection

Example of flat-roof drainage



Design storm profile statistics for HK



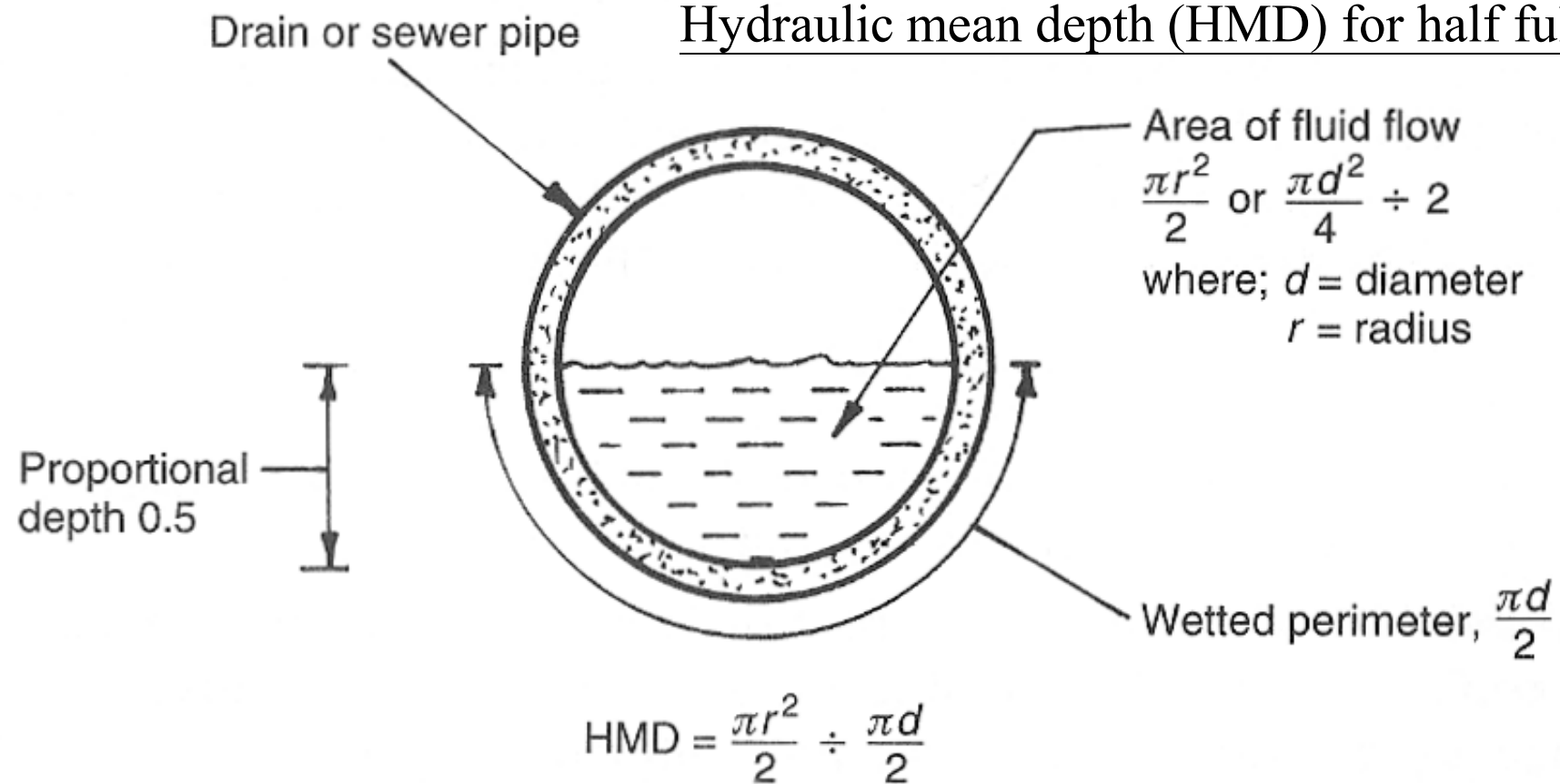
(Source: Hong Kong Observatory, www.hko.gov.hk)



Stormwater drainage

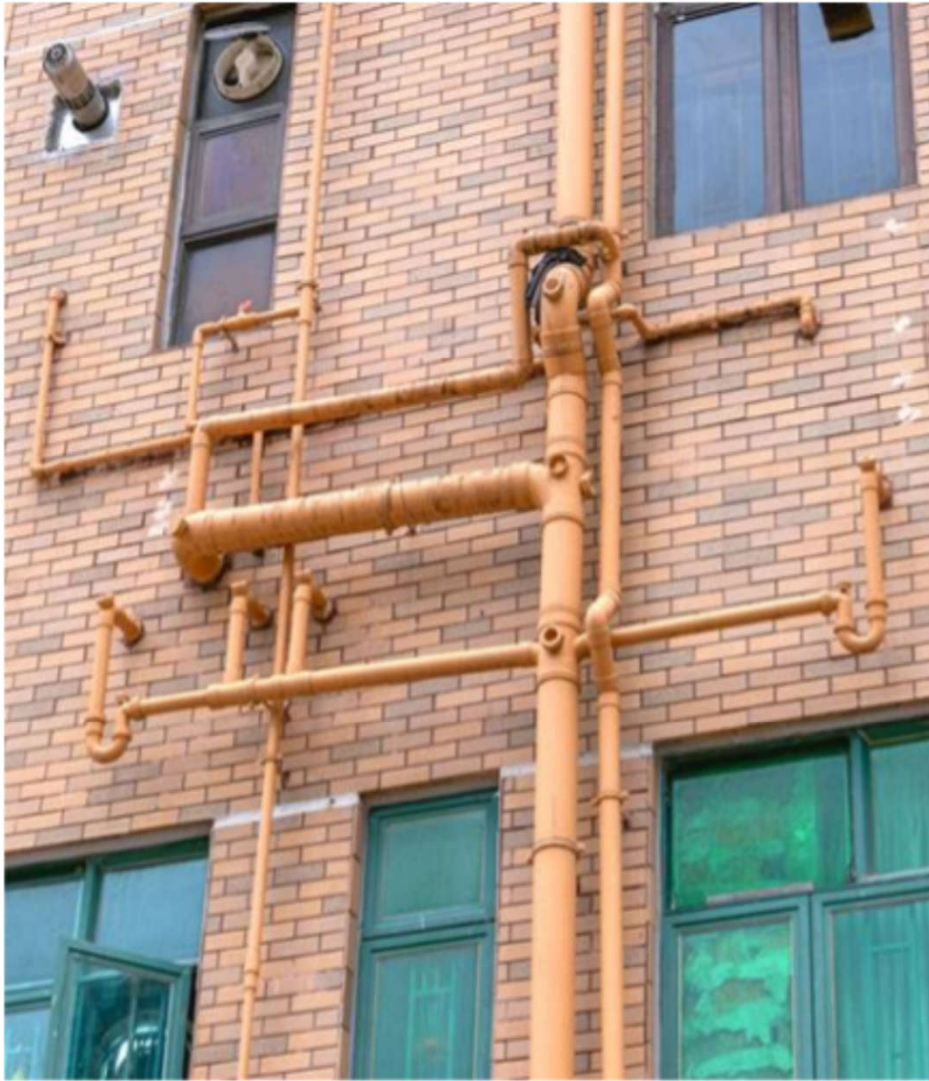
- Sizing vertical stacks
 - In HK, under Building Ordinance (Cap. 123), every 700 mm² of pipe cross-section area shall be provided for 10 m² of horizontal roof area
 - Also, diameter of rainwater pipe shall be 65 mm minimum
- Hydraulic design may be used to size the vertical and horizontal pipes
 - The static head should cater for the velocity head and pipe friction

Hydraulic mean depth (HMD) for half full bore



Depth of flow	HMD
0.25	Pipe dia. (m) / 6.67
0.33	Pipe dia. (m) / 5.26
0.50	Pipe dia. (m) / 4.00
0.66	Pipe dia. (m) / 3.45
0.75	Pipe dia. (m) / 3.33
Full	Pipe dia. (m) / 4.00

Importance of access for inspection, maintenance & repair of drain pipes

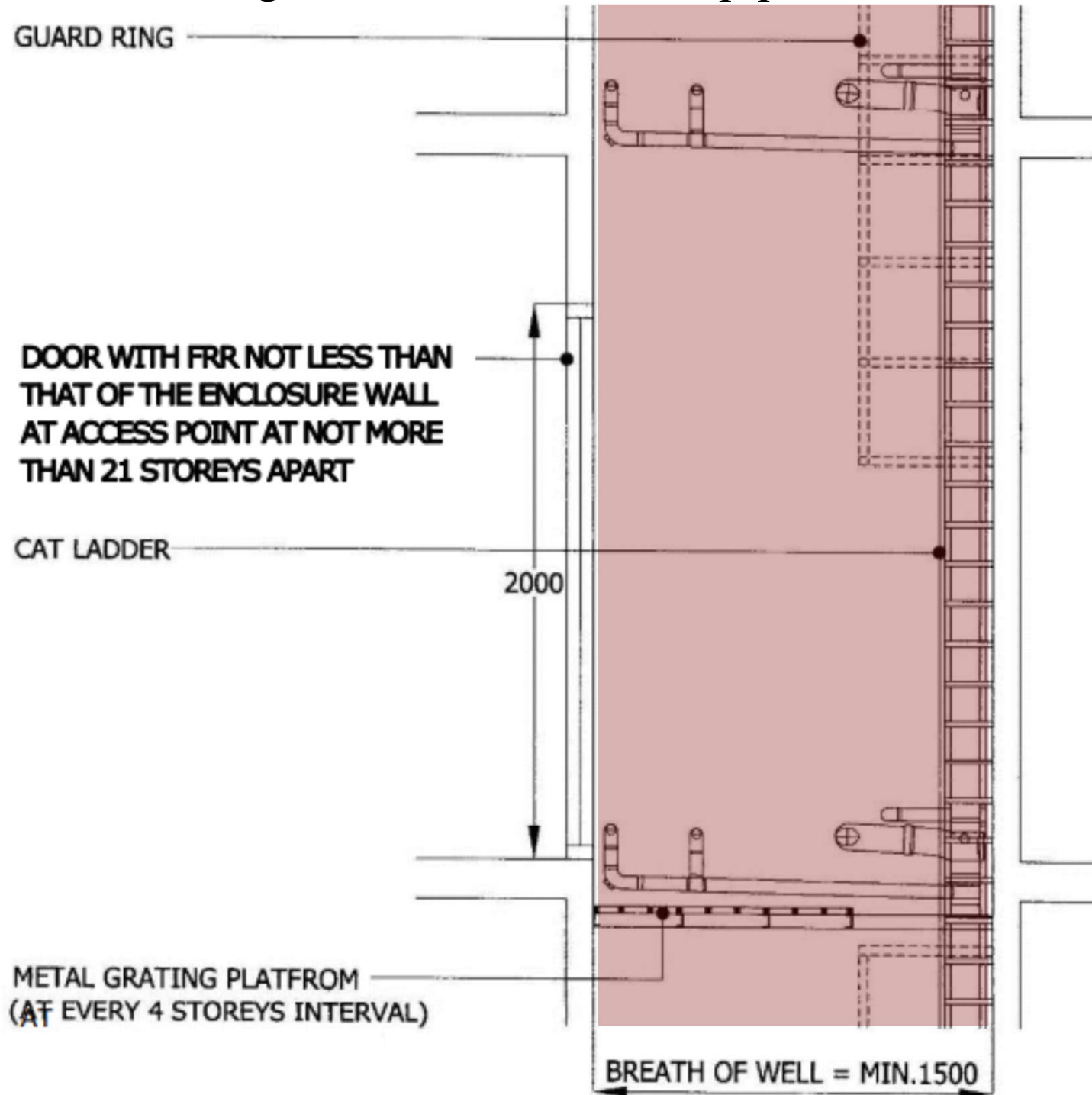


External wall of the building

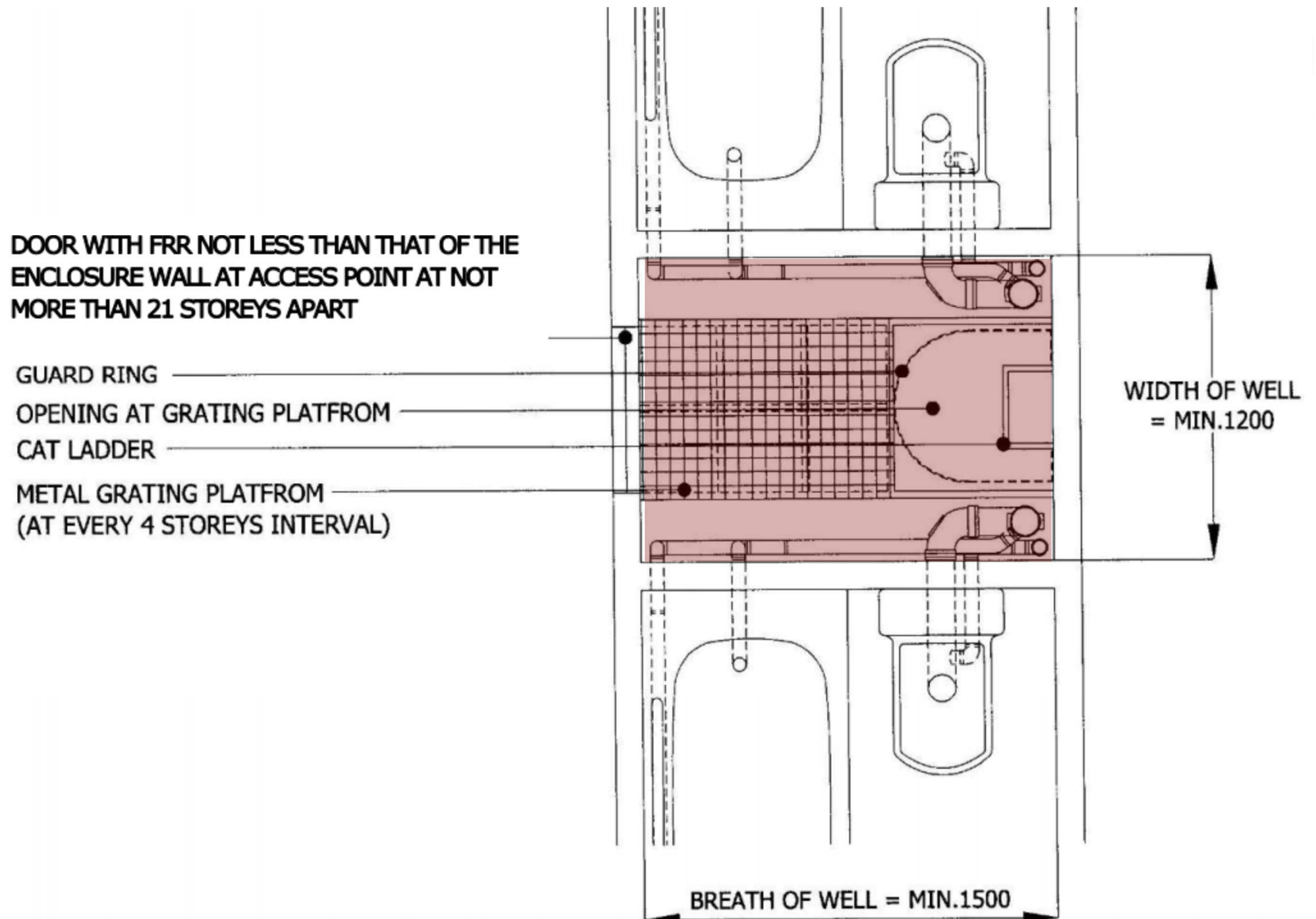


Internal pipe duct accessible from common parts

Diagrammatic section of a pipe well



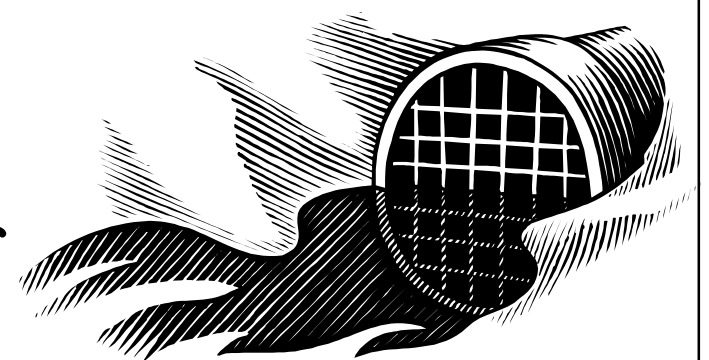
Sample arrangement of a pipe well





Drainage below ground

- Sewage (= domestic/municipal wastewater)
 - Pollute the environment & harm human health
 - Should be 'treated' before discharged
- Sewage 汚水 (wastewater) consists of:
 - Greywater (from sinks, bathtubs, showers, dishwashers, and clothes washers)
 - Blackwater (from toilets, combined with the human waste that it flushes away)
 - Soaps, detergents & toilet paper
- Rain/storm water/surface runoff





Drainage below ground

- System types
 - 1. Combined system (foul water + rainwater)
 - 2. Separate system
 - 3. Partially separate system
- Design considerations: costs, load on sewers
- Common fittings
 - Rainwater gully (RWG), yard gully (YG)
 - Inspection chamber (IC), rodding pod (RP)
 - Shoe and rest band (smooth connection)

Combined system

Key:

IC = Inspection chamber

RG = road gully

RP = rodding pod

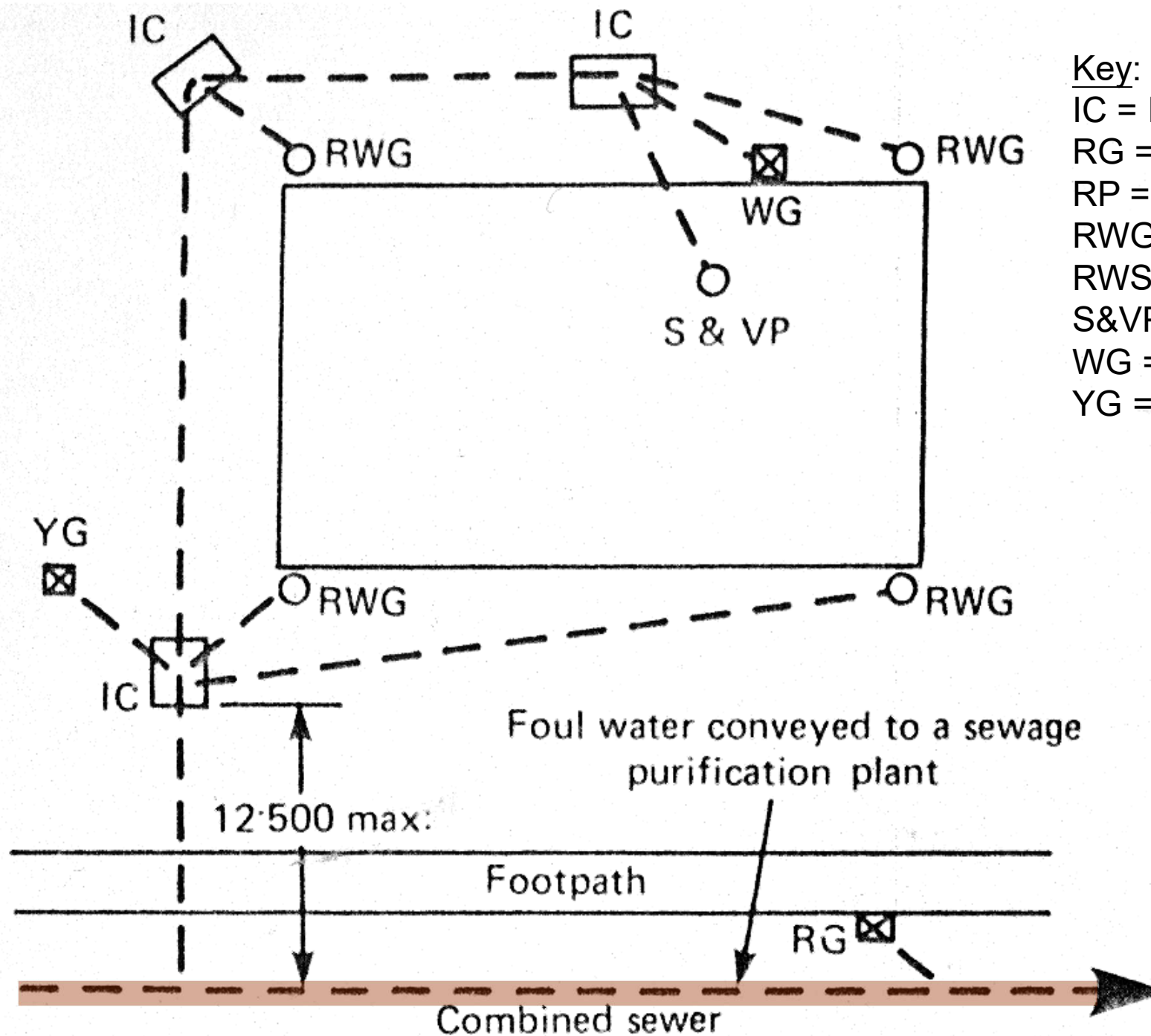
RWG = rainwater gully

RWS = rainwater shoe

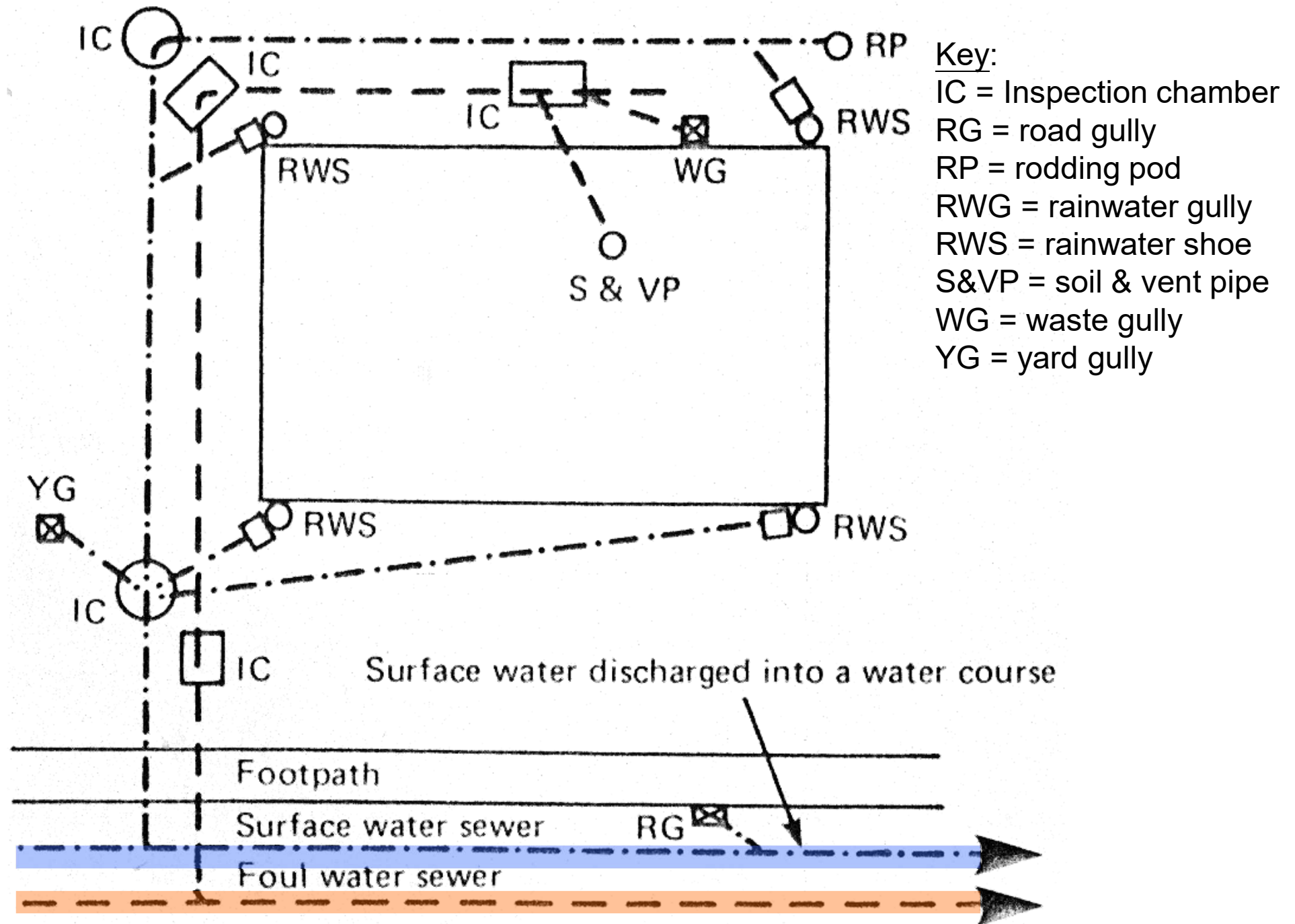
S&VP = soil & vent pipe

WG = waste gully

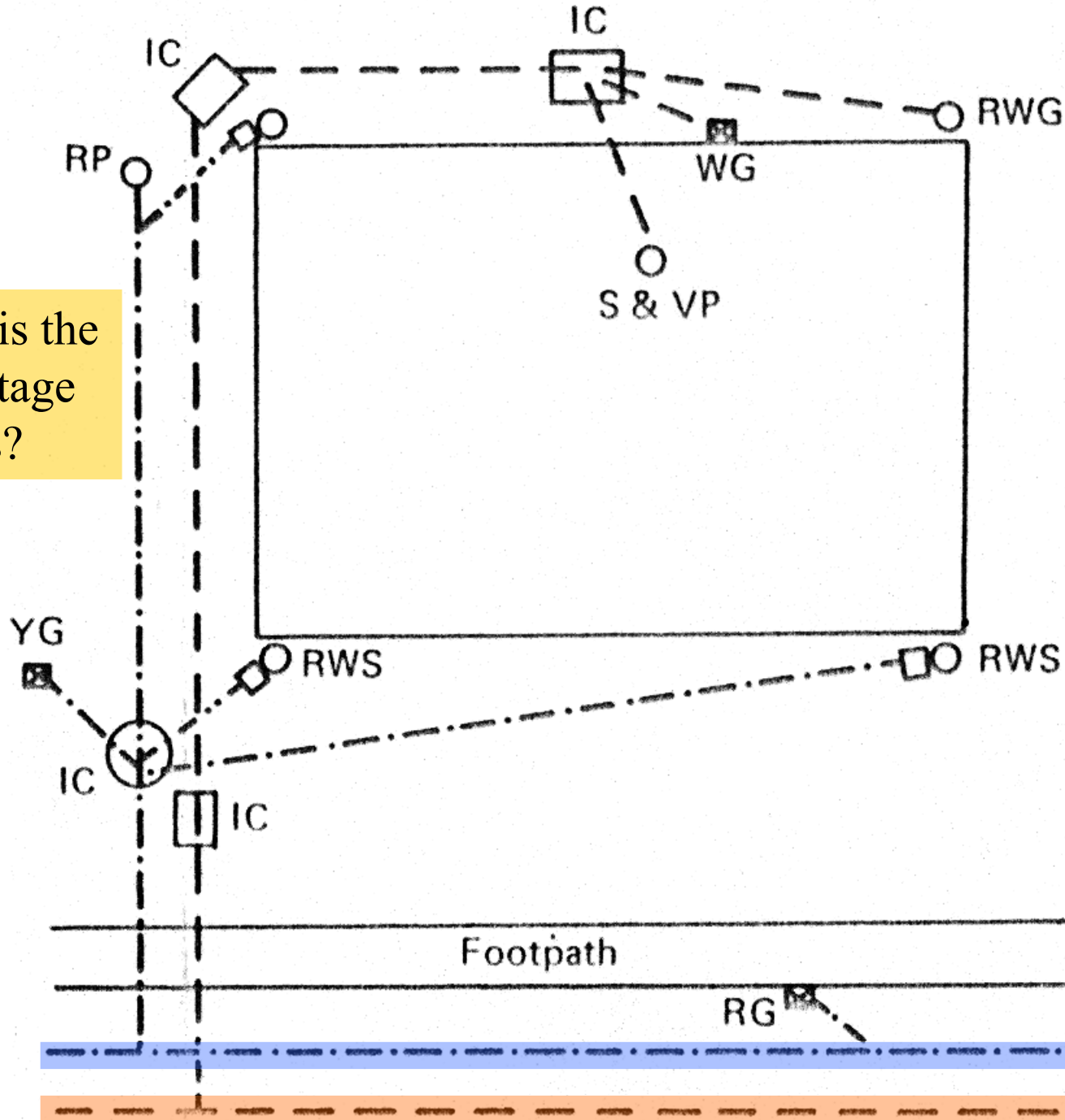
YG = yard gully



Separate system



Partially separate system



What is the advantage of this?

Key:

IC = Inspection chamber

RG = road gully

RP = rodding pod

RWG = rainwater gully

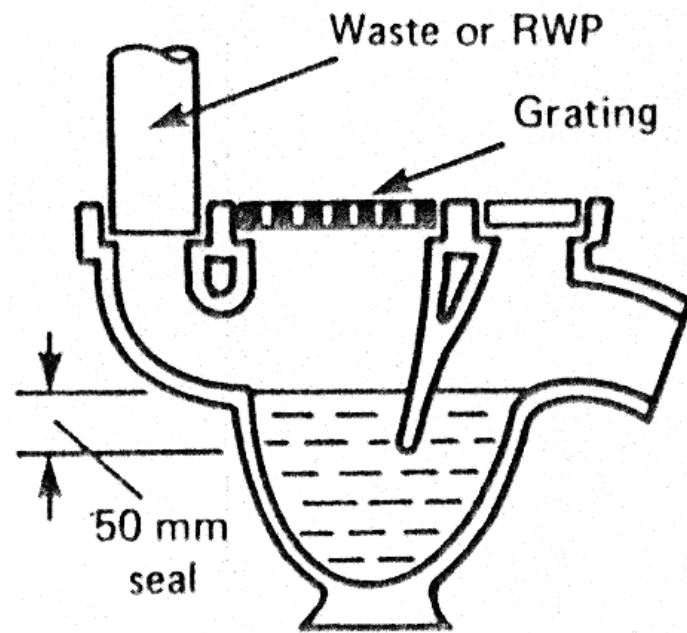
RWS = rainwater shoe

S&VP = soil & vent pipe

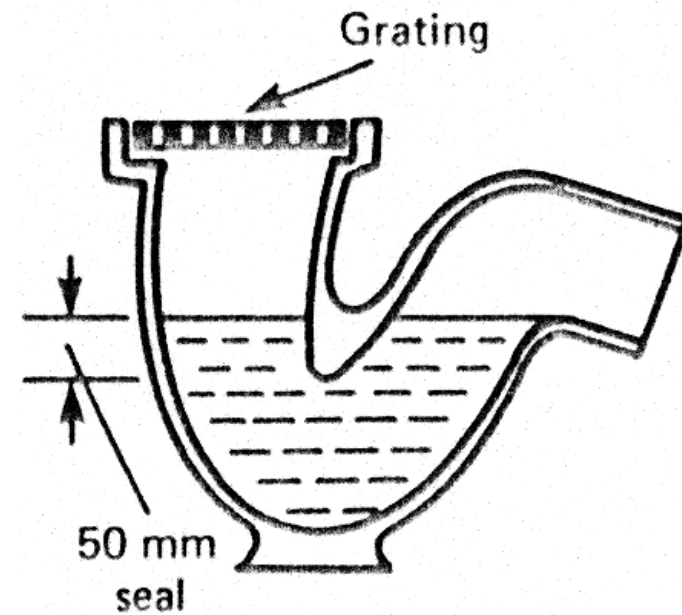
WG = waste gully

YG = yard gully

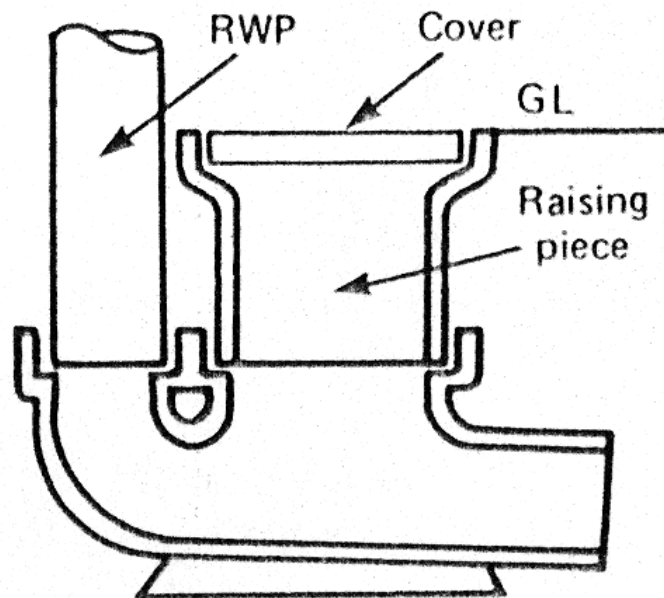
- Most of the surface water conveyed by a surface water drain to a surface water sewer or soakaway
- Some rainwater is discharged to the foul water drain. The rainwater can be conveniently connected to the foul water drain, usually at the rear of the building



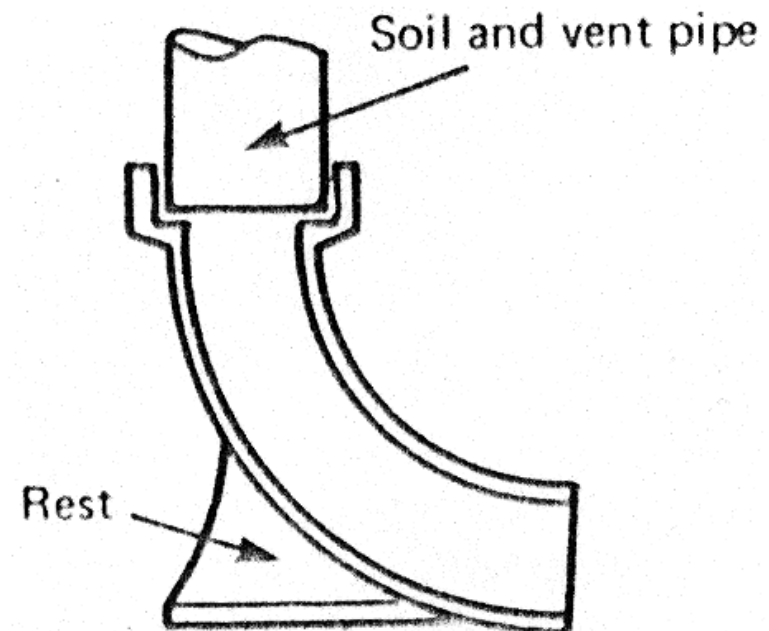
Waste or rainwater gully



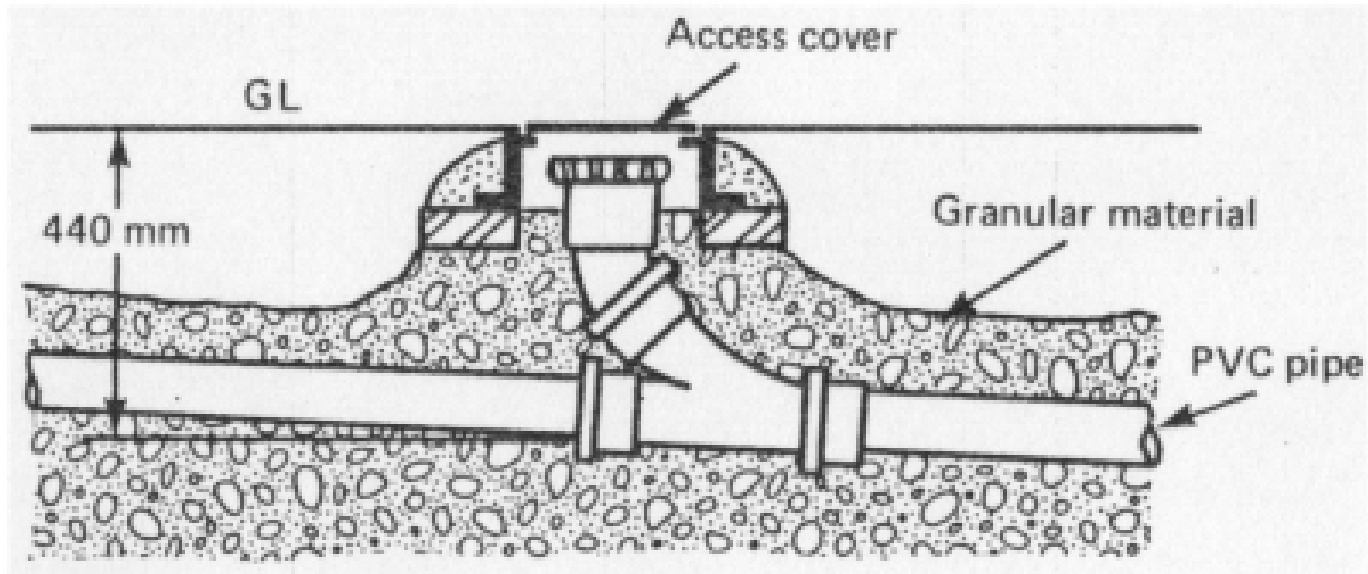
Yard gully



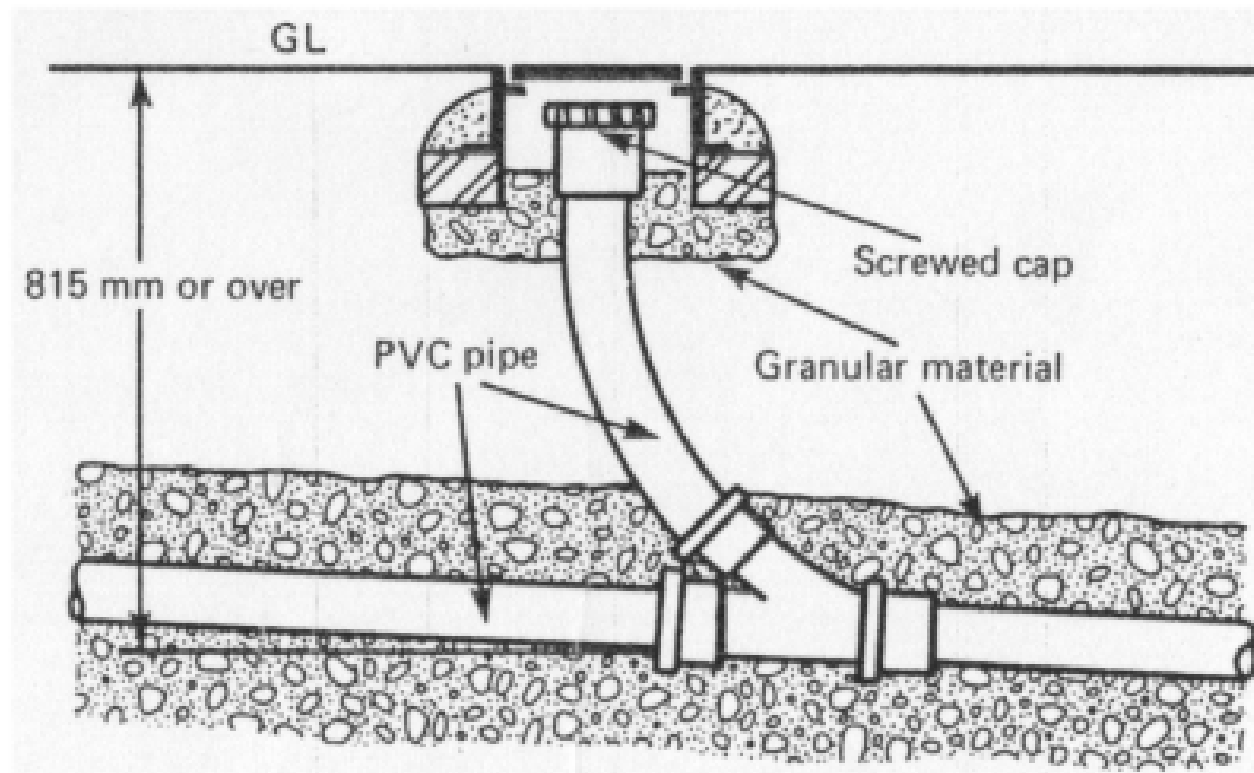
Rainwater shoe



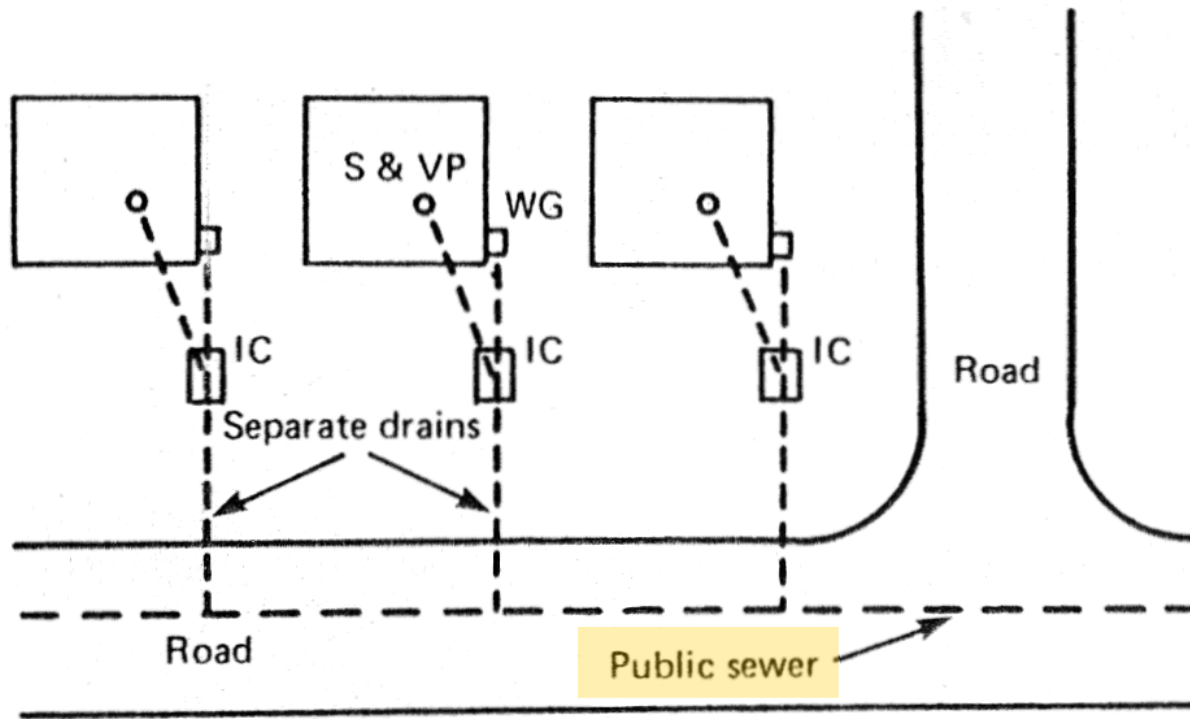
Rest bend



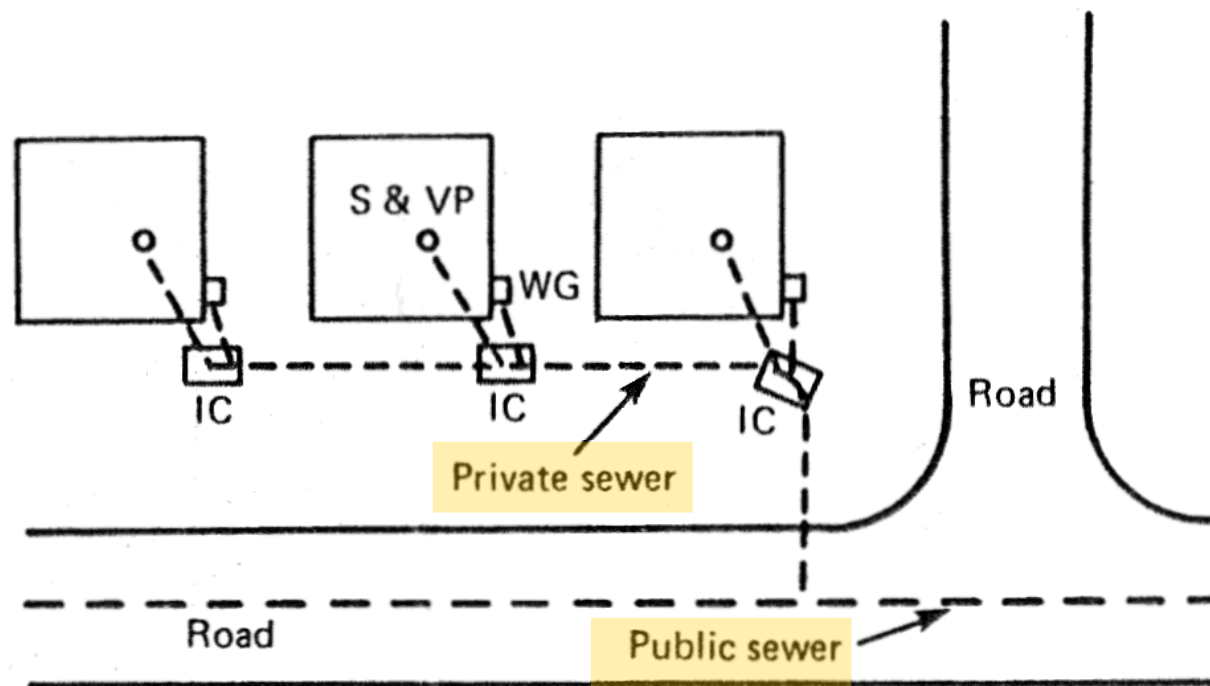
Shallow rodding point



Deep rodding point



Use of
separate
drains



Use of
private
sewer



Drainage below ground

- Connection of drainage to sewer
 - Must be made obliquely in the direction of flow
 - Drain to another drain
 - Drain to a private sewer (私家污水渠)
 - Drain to a public sewer (公共污水渠)
 - Cost and maintenance issues
 - Private sewer/drain up to & include terminal manhole: paid by building owner
 - Public sewer & sewer linking the terminal manhole: paid by government/authority



Drainage below ground

- Pipe materials and depth
 - A minimum diameter of 150 mm and be of the following materials or other approved materials:-
 - Foul sewer - vitrified clay, ductile iron, uPVC
 - Storm water drain - concrete, ductile iron, uPVC
 - Larger sewer: concrete
 - Smaller drains: clayware/uPVC
 - Drains should be laid at a depth of 900mm (minimum) under roads and at least 600mm below fields and gardens



Drainage below ground

- Underground drainage pipe
 - Foul sewers should be designed so that the velocity of the flow will exceed the self-cleansing velocity on a regular basis
 - As a general guide, the minimum fall of foul sewers is:
 - Pipe diameter 100 mm:- Fall 1:40
 - Pipe diameter 150 mm:- Fall 1:70
 - Pipe diameter 225 mm:- Fall 1:100
 - Pipe diameter 300 mm:- Fall 1:150



Drainage below ground

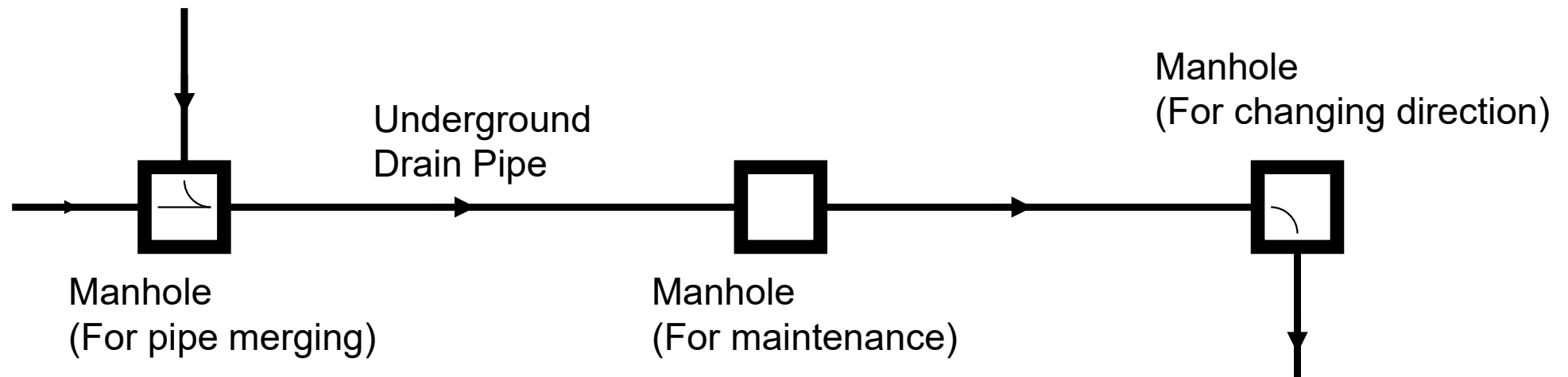
- Manholes (沙井)
 - They are required when
 - Pipes merge together
 - Change in direction >45 degree
 - Change in gradient
 - Maintenance, cleaning, inspection are needed



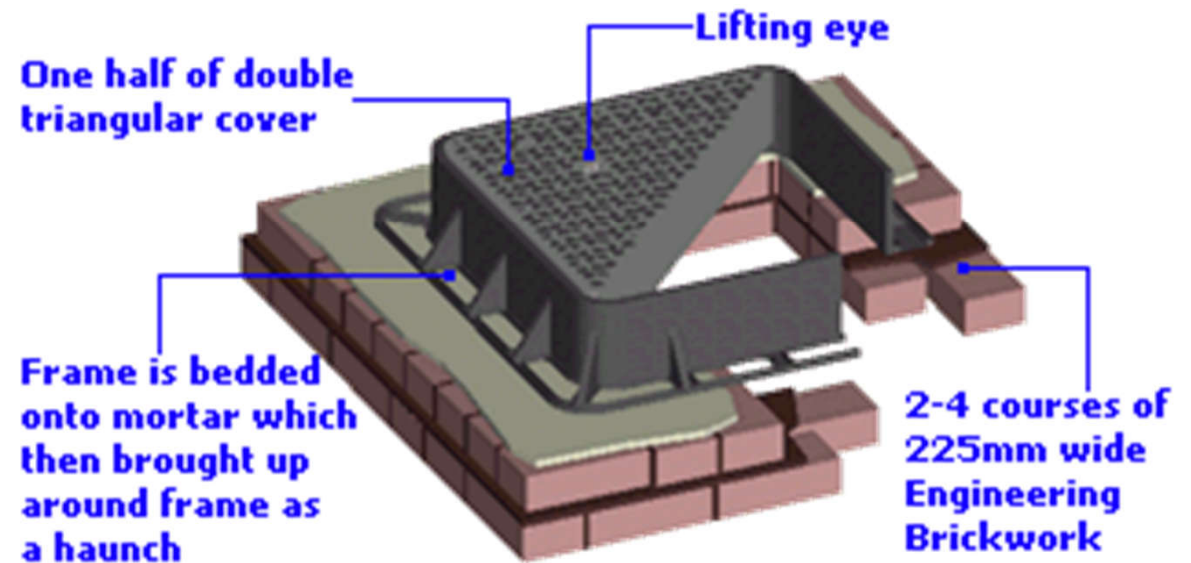
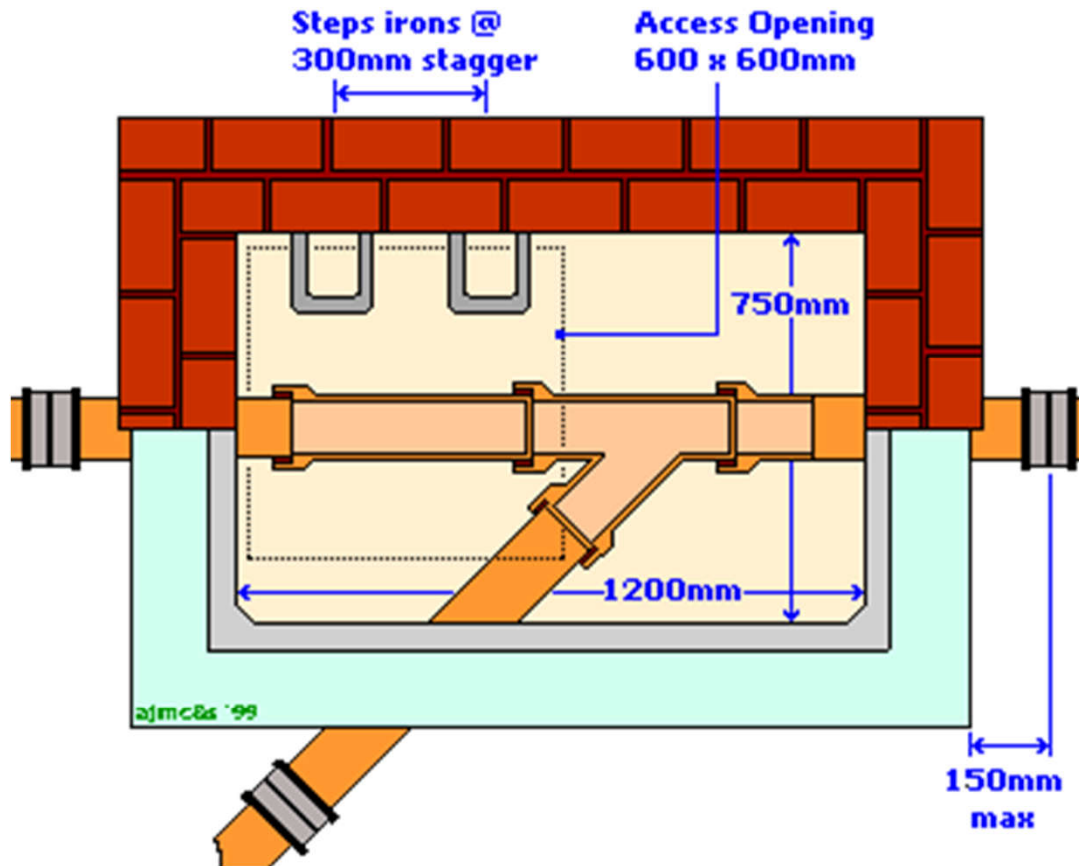
Sewage (small squares)



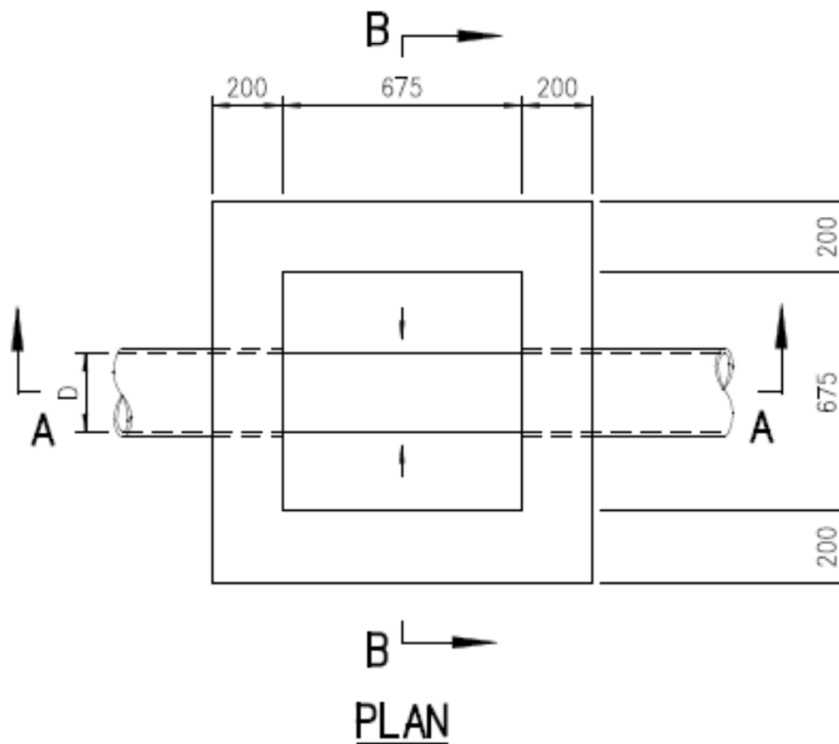
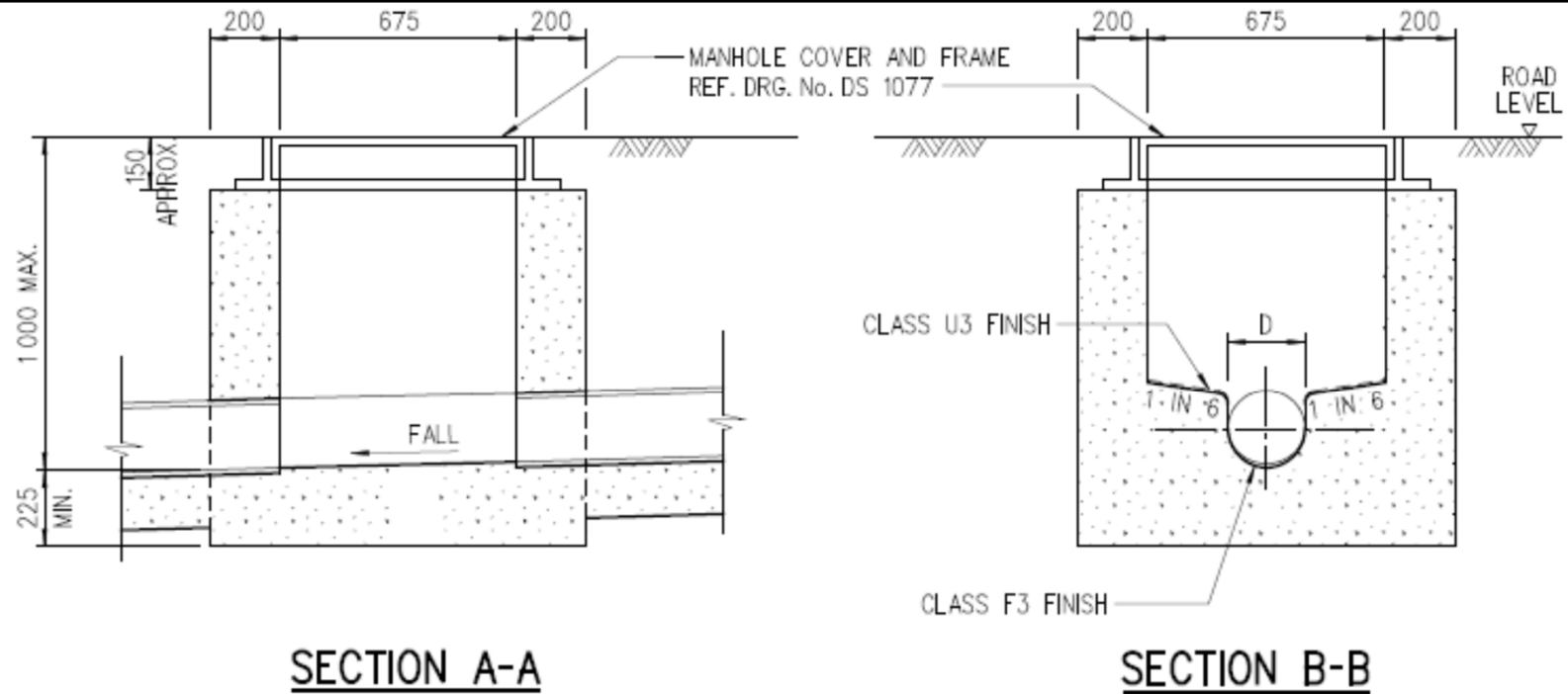
Stormwater (round & radial patterns)



Manhole in plan view and manhole covers

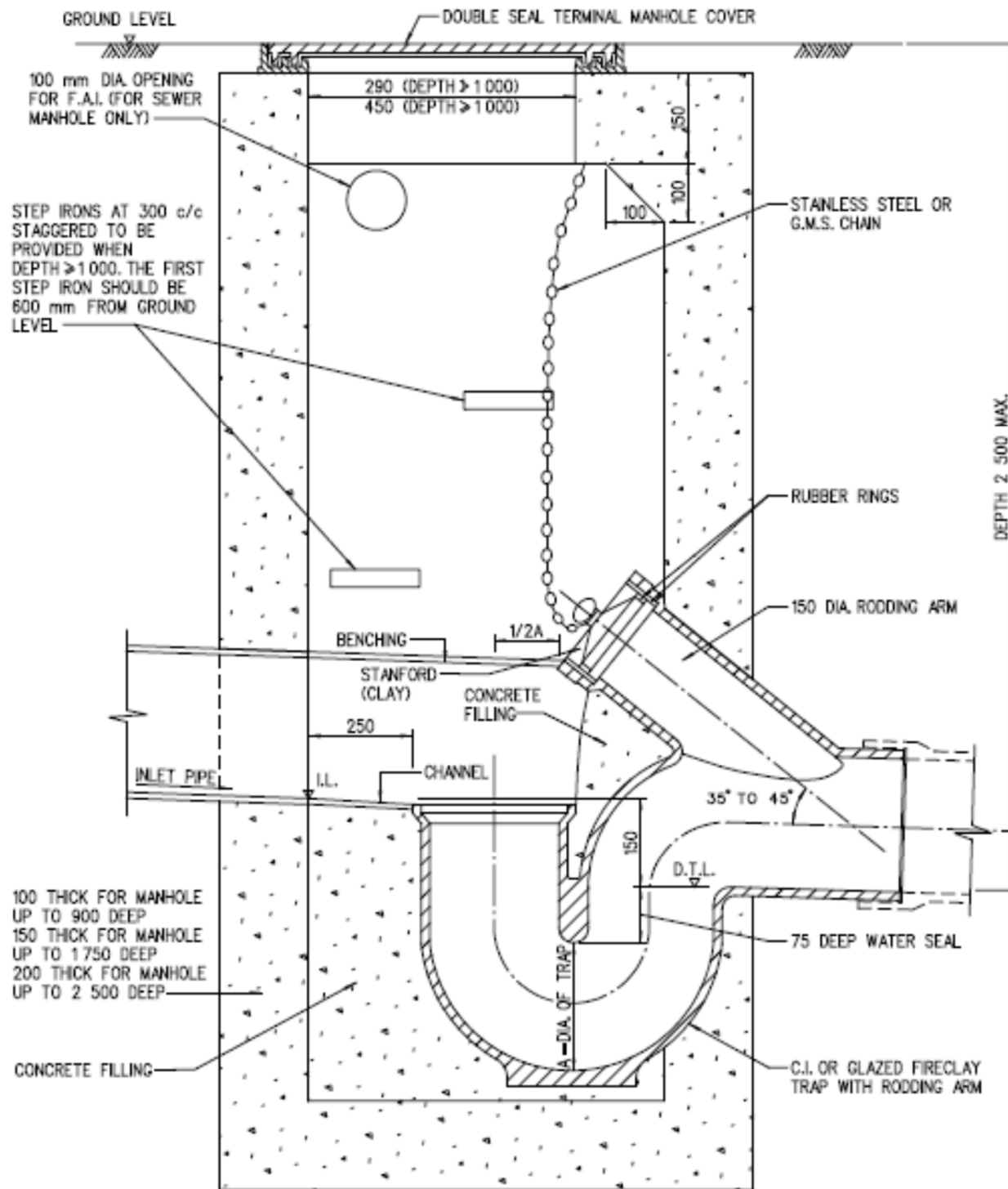


Standard manhole design



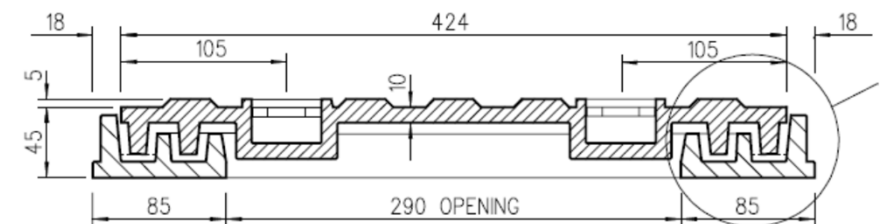
NOTES:

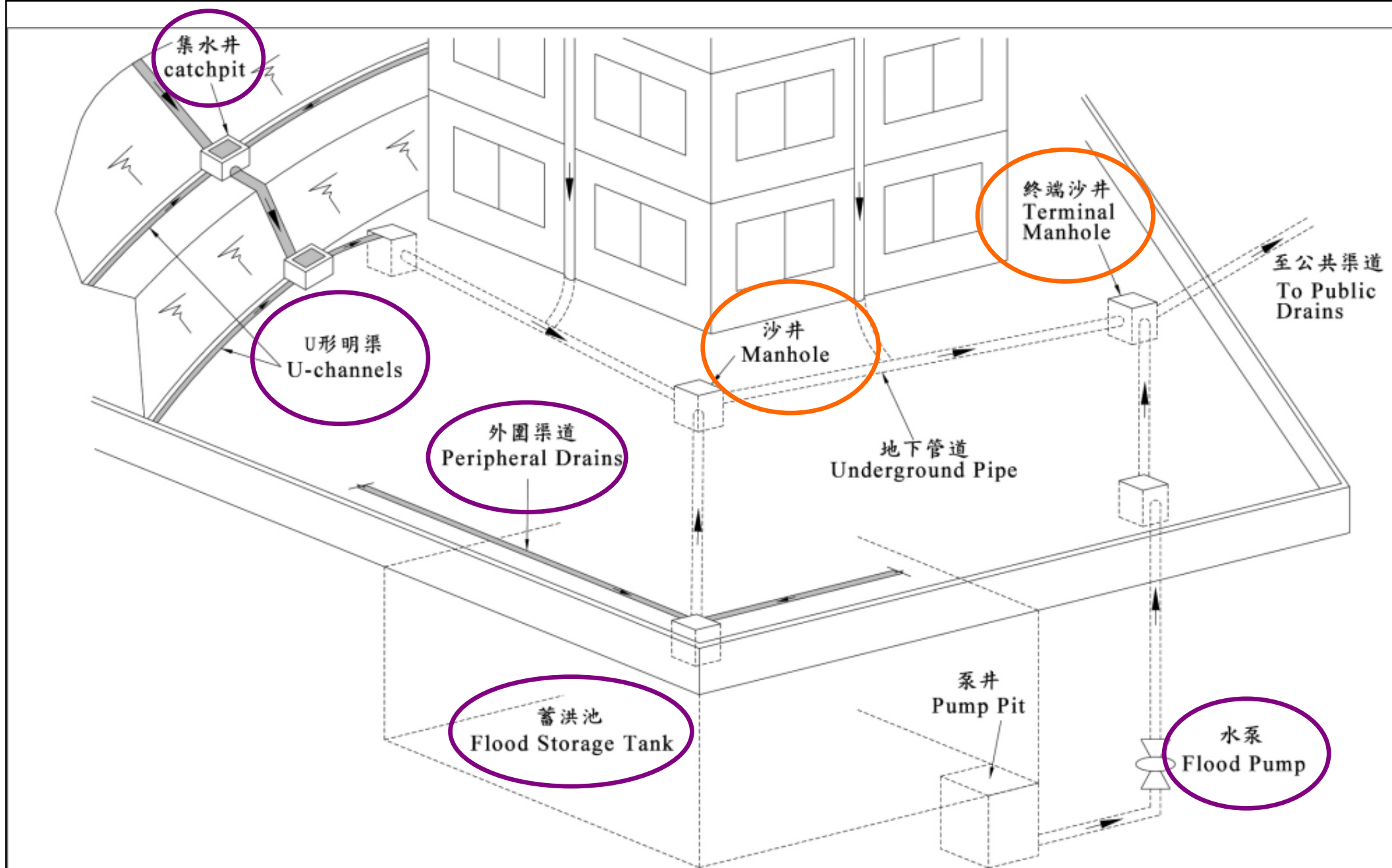
1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. PIPE DIAMETER : 150 TO 300 mm
3. NORMAL RANGE OF DEPTH : MAX. 1000 mm (MEASURED FROM ROAD LEVEL TO LOWEST INVERT)
4. USED IN : STORMWATER DRAIN AND SEWER
5. JUNCTION : POSITION OF JUNCTION TO BE DETERMINED IN INDIVIDUAL CASE.
6. TOP TREATMENT : SEE DRG. No. DS 1032
7. FOUNDATION : FOUNDATION OF MANHOLE VARIES WITH SITE CONDITION. THEREFORE, IT SHOULD BE DETERMINED ON SITE BY THE ENGINEER.
8. CONCRETE : GRADE 30/20
9. COVER AND FRAME NOT SHOWN ON PLAN FOR CLARITY



- Terminal manhole,
typical characteristics:
- Trapped
 - Rodding arm for cleaning
 - Opening for fresh air intake (FAI)
 - Steps for maintenance

Double-sealed manhole cover





drawing title 圖則名稱

排水系統的常見部份

Common Components of a Drainage System

drawing no. 圖則編號

圖一
Figure 1

scale 比例

不依比例
N.T.S.

date 日期

二〇〇三年四月
Apr 03

office 部門

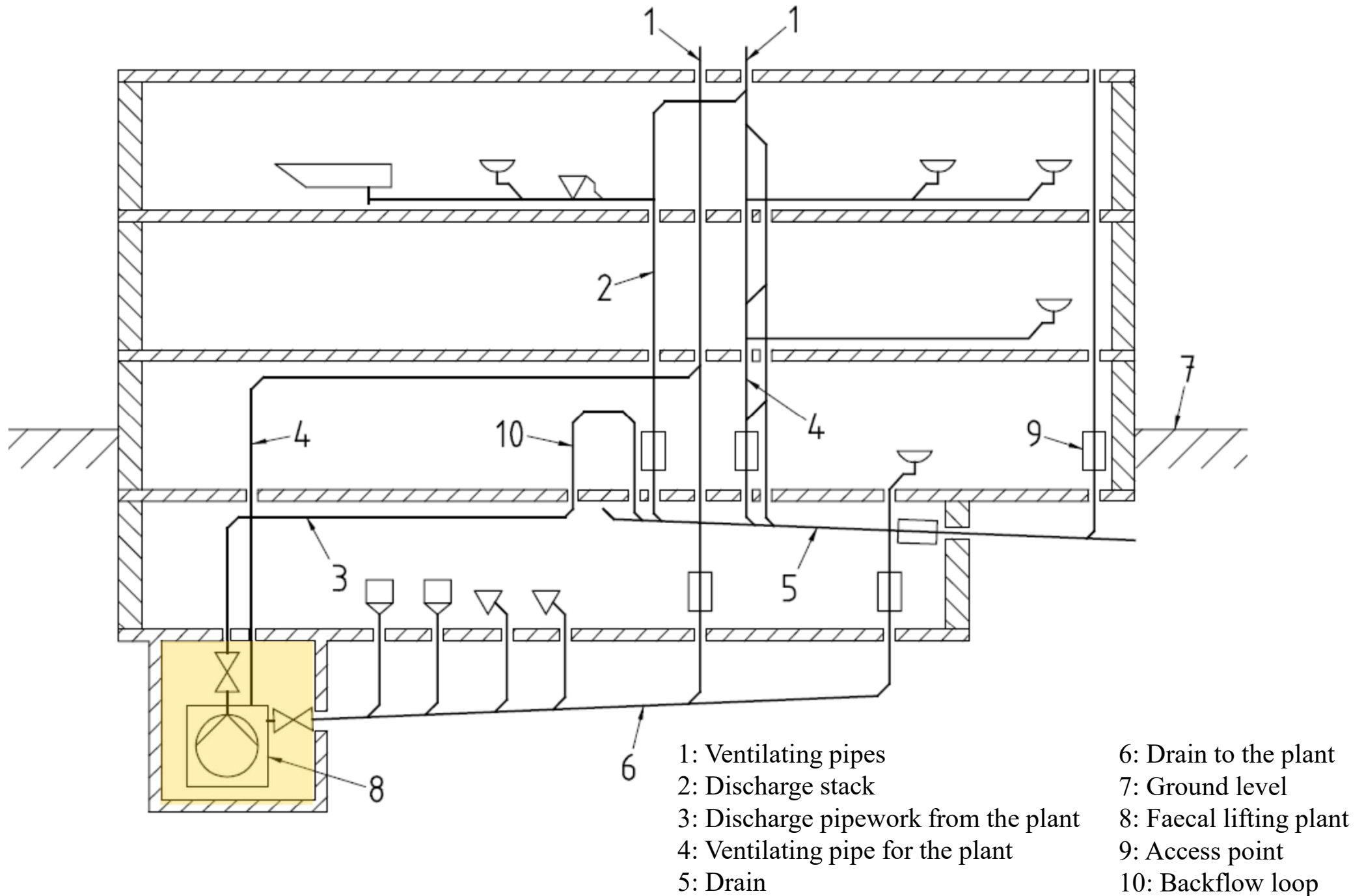
土地排水部
LAND DRAINAGE DIVISION



DRAINAGE SERVICES
DEPARTMENT
渠務署

(Source: Drainage Services Department, www.dsd.gov.hk)

Illustration of a faecal lifting plant to a drain



(Source: British Standard BS EN12056-4:2000)

Drainage defects



- Defective drainage systems https://www.bd.gov.hk/en/safety-inspection/building-safety/index_bsi_drainage.html
 - Important for a safe & healthy living environment
 - Regular inspection & proper maintenance
 - Drainage repair order (issued by Buildings Dept.)
 - Repair of drainage systems
 - Under the Minor Works Control System (MWCS)
https://www.bd.gov.hk/en/building-works/minor-works/minor-works-items/index_mwcs_items_c3a.html
 - Common defects
 - <https://www.brplatform.org.hk/en/defects-and-orders/common-building-defects/defective-drainage-system>

Examples and signs of drainage defects



Rusty external drainage pipes



Unauthorised alteration of drainage system

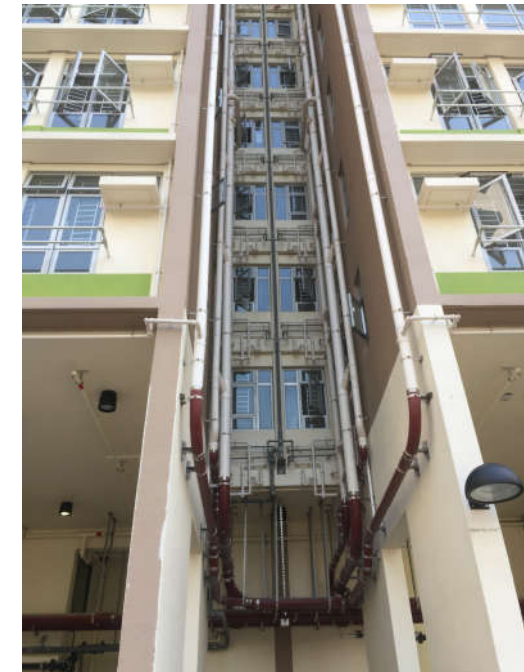
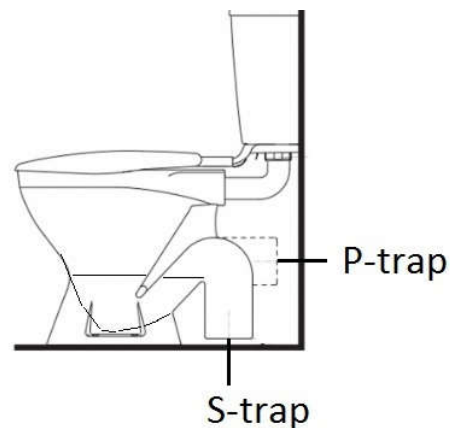
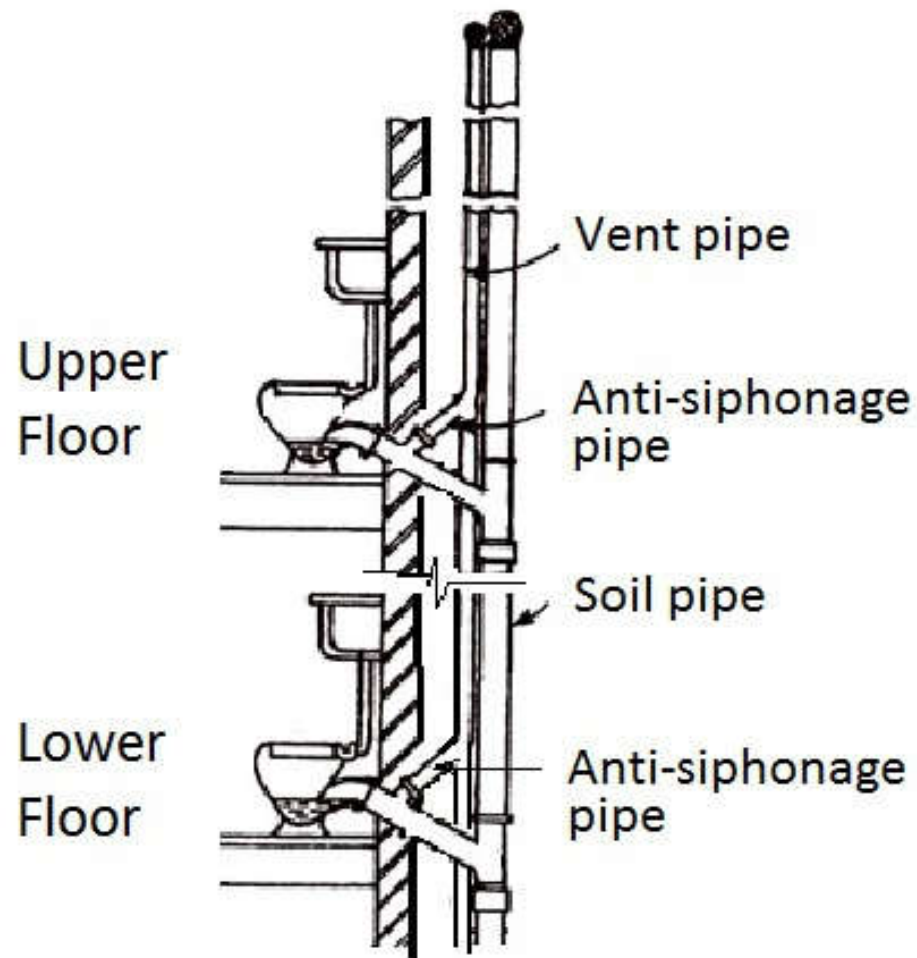


Leaking or broken drainage pipes at external wall



Rusty internal drainage pipes

Healthy building design & drainage system in response to COVID-19

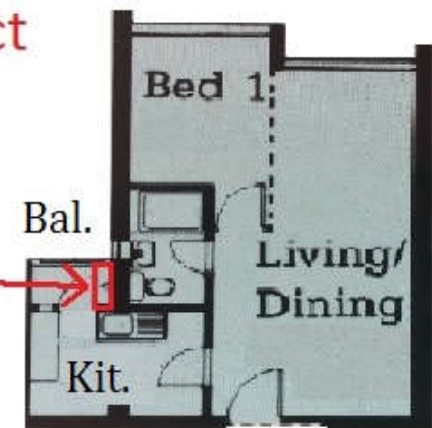


Private housing

Pipe duct

Pipe duct

Public housing



淘大花園E座 病毒可能傳播途徑



傳播方式
廁所污水渠系統

可能性
病者糞便或唾液經廁所水渠沖下時，病毒經通風管道傳至相連同一座向的其他單位

空氣

美國疾病控制及預防中心不排除此可能

飛沫

醫學界公認最有可能的傳播途徑，附在物件上的病毒至少可生存3小時



信箱

勞永樂醫生指7號和8號單位的信箱在同一直排，若同沾上帶病的口水或鼻涕，居民取信時可能感染



冷氣機滴水

勞永樂指可能性不大

晾衫滴水

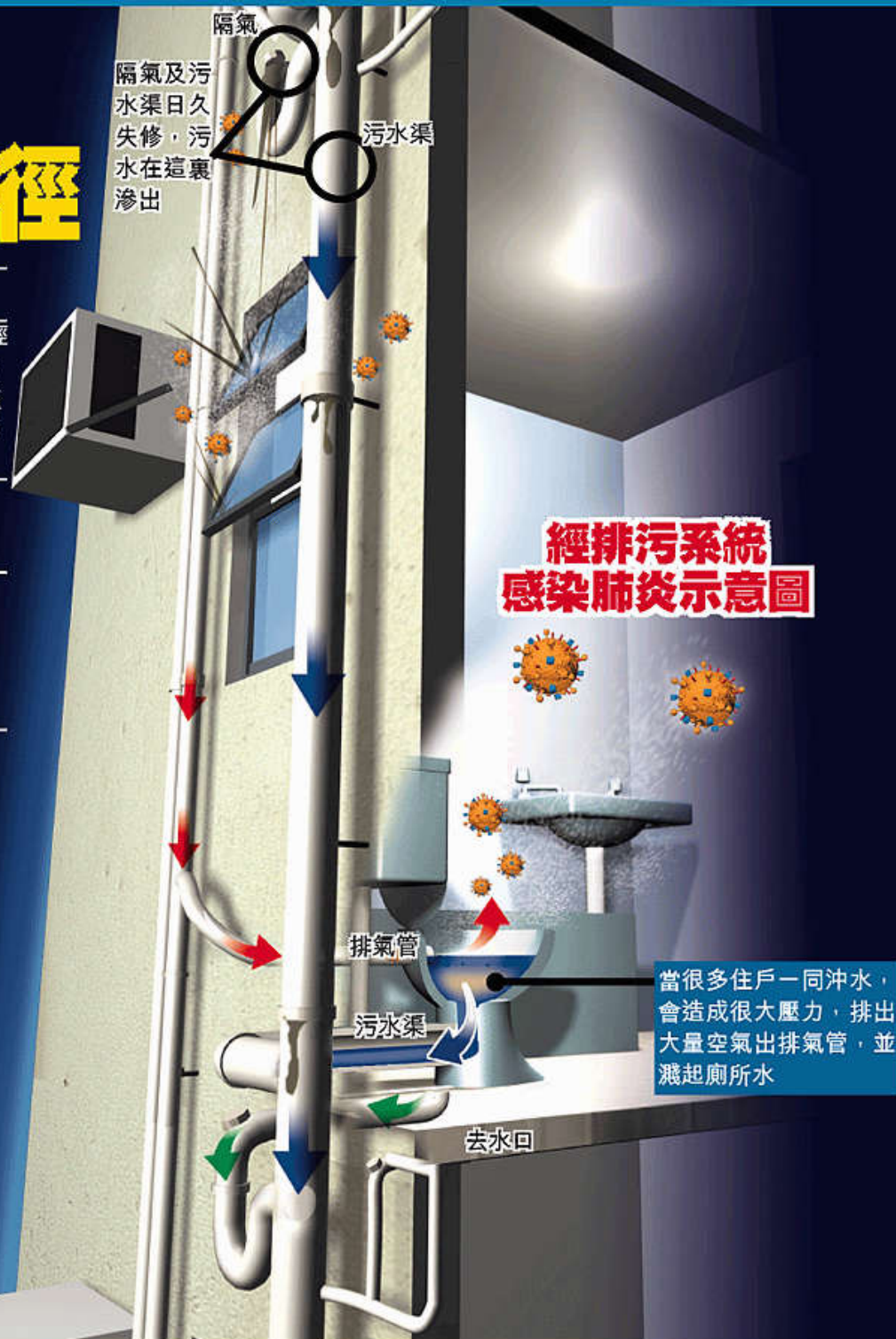
勞永樂指可能性不大

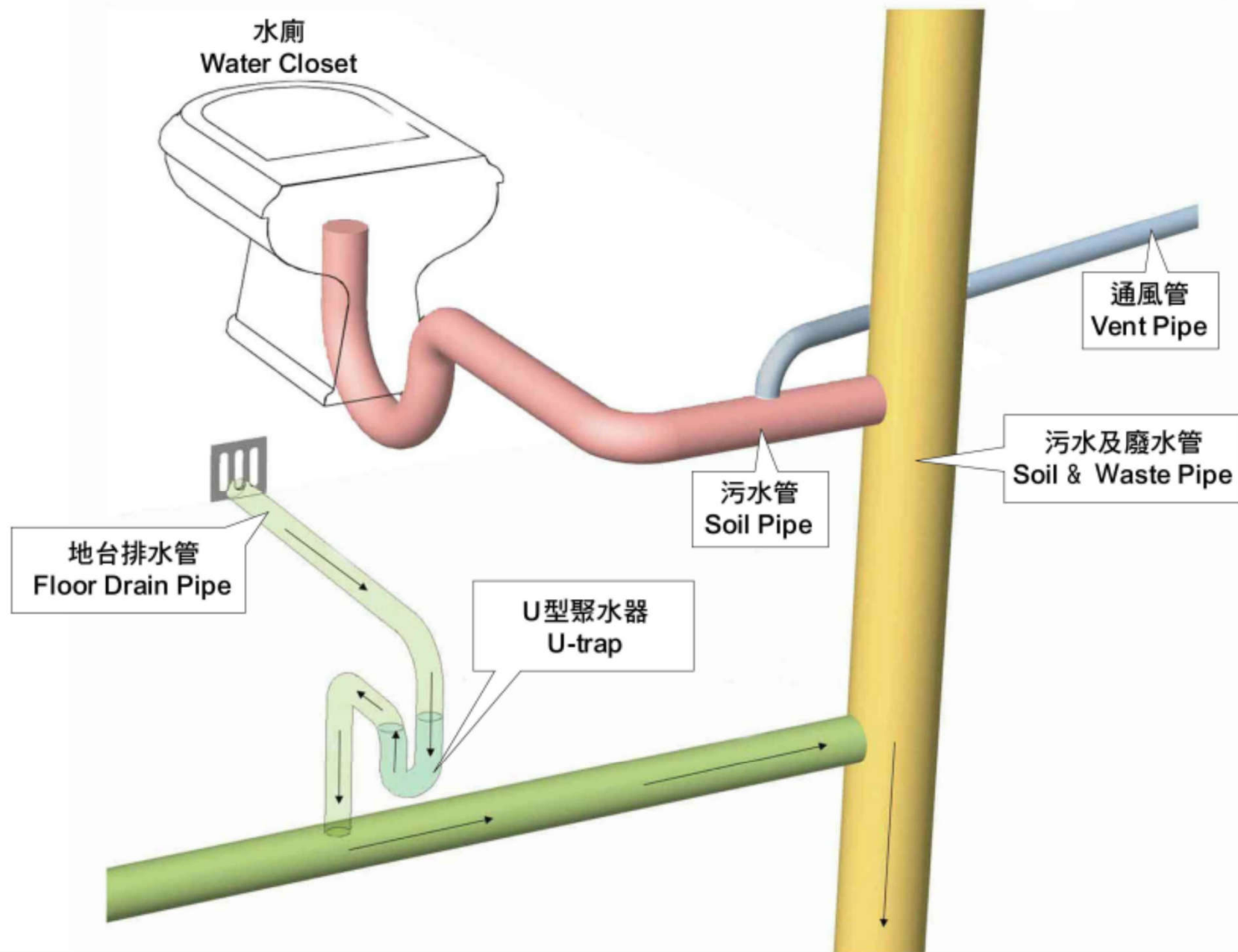


食水喉

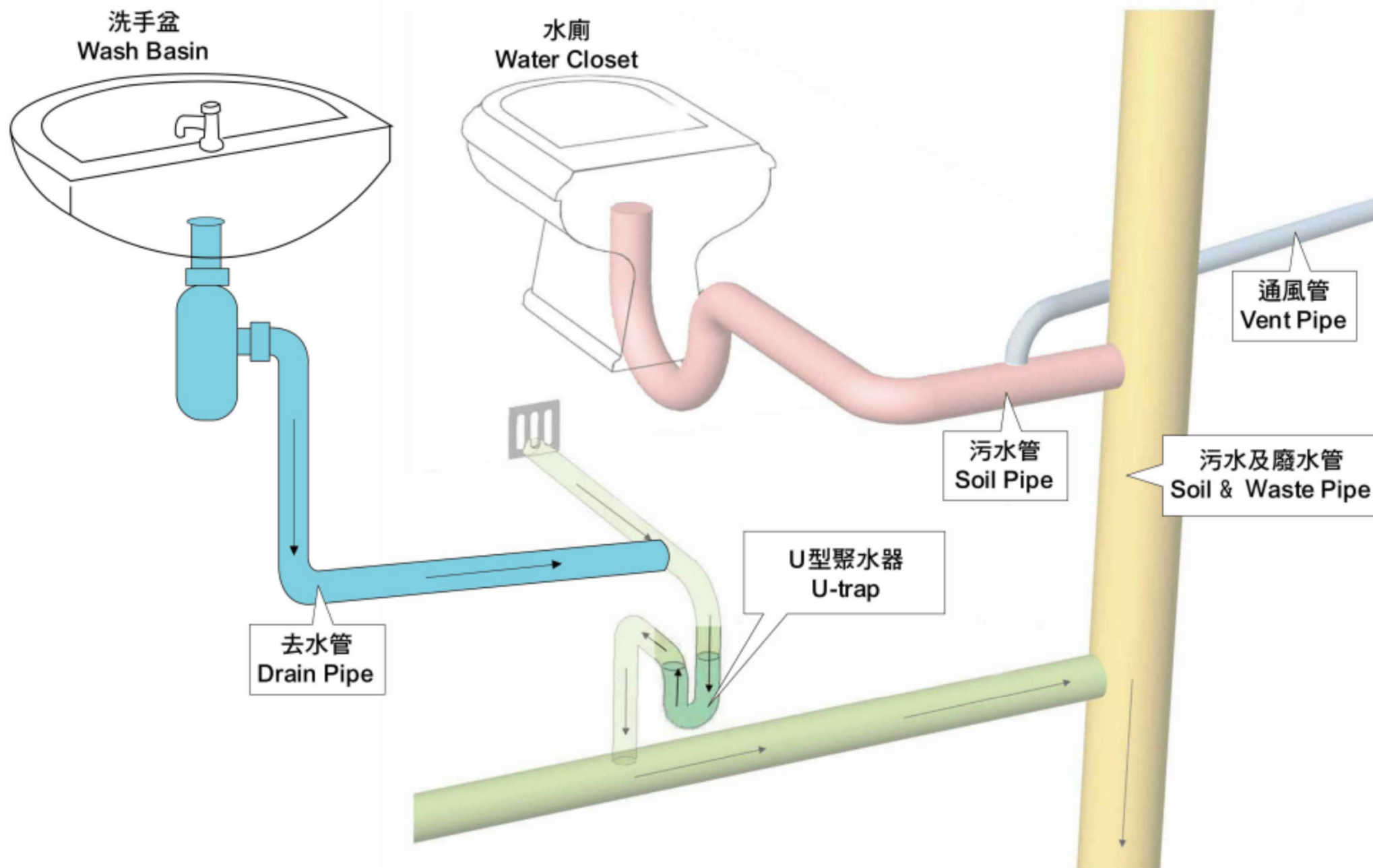
梁秉中教授指可能性不大

資料來源：各受訪者及《蘋果》資料室

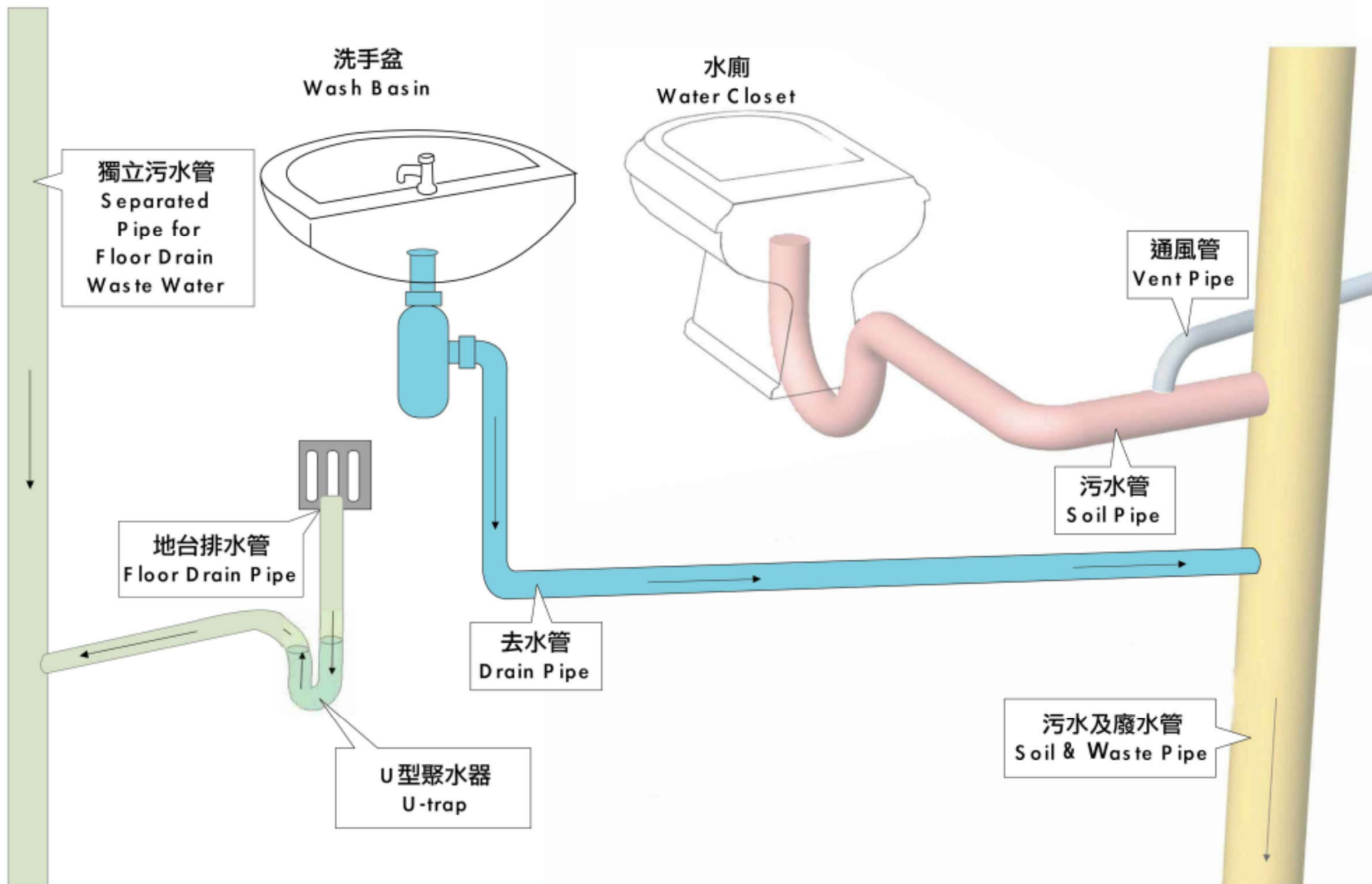




一般地台排水設計 General Pipe Work Design

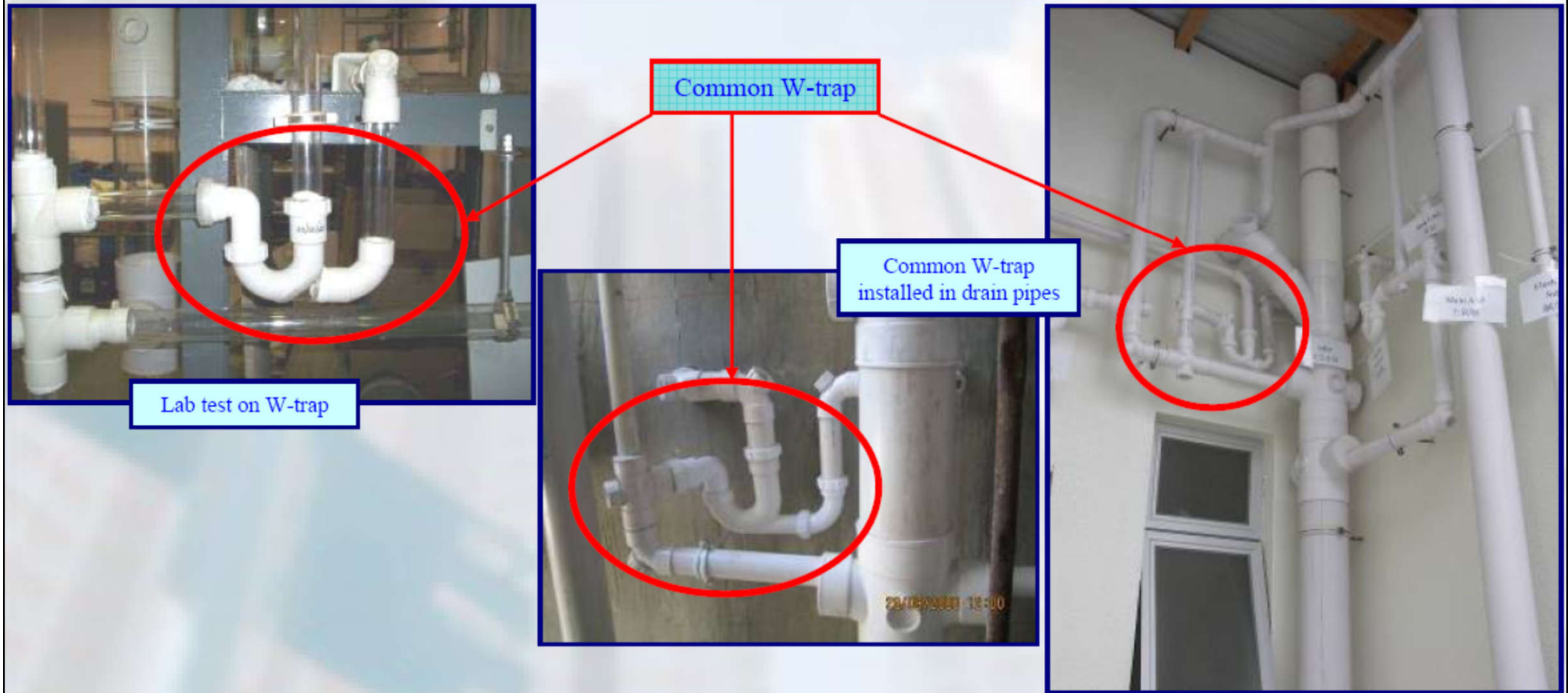


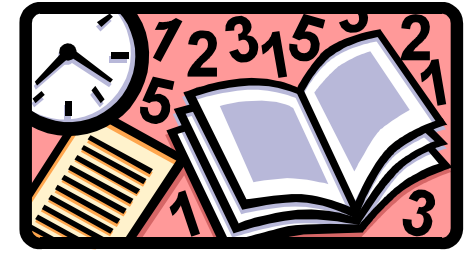
U型聚水設計 U-trap Refilling Design



分開喉管設計 Pipes Separation Design

W-trap (proposed by the Housing Authority)





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