

PLUMBING COURSE



What is a project

MEP Engineer

1- Design Engineer (Cad + Revit + Code)

يعمل في مكتب استشاري او المكتب الفني لشركة المقاولات وهو مسئول عن تصميم انظمة التكييف والحريق والصحي طبقا للاكواد بالاضافة للرسومات والحصر واعداد العرض الفني

2- Site Engineer (Cad + Code + Leadership)

مسئول عن تنفيذ وتسليم المشروع طبقا للاكواد او تصميم الاستشاري وله صلاحية التعديل على الرسومات بما يتوافق مع الموقع (As Build Drawing) وتقديم العرض المالي

3- Tender Engineer (BOQ + Cad)

مسئول عن حصر المواد ووضع الاسعار وتجهيز العروض الفنية و الـ (Bill Of Quantity) والعروض الماليه

خطوات تنفيذ اى مشروع

1- يقوم المالك باختيار استشاري لتنفيذ (فيلا & مستشفى ...)

2- يقوم الاستشاري بتجهيز الـ

الرسومات التصميمية

مقايسة الاسعار

قائمة بافضل الموردين

تفصيل لكل بند في الـ (B.O.Q)

الخامات تخضع لاي كود (ASME)

3- وارسال الـ (Tender Package) للمالك مرة اخرى

4- يقوم المالك بطرح الـ (Tender Work) كـ

1- مناقصة (محدودة او عامة)

2- ممارسة

5- تقوم شركات المقاولات بتقديم

1- العرض المالي (financial offer)

2- العرض الفني (technical offer)

6- يتم اختيار افضل عرض فني واقل عرض مالي (اختيار المقاول) والبدء في تنفيذ المشروع

7- يقوم المكتب الاستشاري بتقديم الرسومات الخاصة بالهيئات الحكومية (Authority Having Jurisdiction)

8- يقوم المقاول بتقديم الـ (Shop Drawing Approval) لاعتماده من الاستشاري

9- يقوم المقاول بتوريد المواد للموقع وتقديم (M.I.R)

10- يقوم المقاول بتقديم (I.R) للاستشاري لاستلام جزء معين من المشروع

What is a project

RFI ... Request For Information (TQ ... Technical Query)

وهذا الطلب يجعله مهندس المقاول " عن طريق المكتب الفني " ويقوم بإرساله الى الاستشاري للاستفسار عن شئ معين في الرسومات التنفيذية او الرسومات التصميمية او حتى جدول الكميات

IR ... Inspection Request

وده الطلب اللي بيقدمه مهندس المقاول " عن طريق مهندس الكواليتي كنترول في حالة وجوده " للاستشاري بغرض تسليم اعمال تم تنفيذها بالموقع ويرفق معها الرسومات المعتمدة التي على اساسها تم التنفيذ

Mir Material Inspection Request

وده طلب بتعمله عند دخول اى مواد للموقع فينبغي عليك انك تعمل شيت بتبين فيه اسم المادة وكميتها ونوعها ويتم ارفاق الاعتماد لها – ويتم تقديمها للاستشاري عن طريق مهندس الكواليتي " ان كان هناك مهندس كواليتي بالمشروع للتأكد من ان هذه المواد مطابقة للاعتماد

NCR ... Non Conformance Report

وده الاستشاري بيرسله الى المقاول عندما وجد شيئاً ما منفذ في الموقع على غير المعتمد من مواد او رسومات تنفيذيه او حتى على غير اصول الصنائه

SI ... Site Instruction

وده طلب بيرسله الاستشاري الى المقاول لتنفيذ بند جديد او التوجيه بتنفيذ اى عمل من الاعمال هو يراه انه من الممكن تنفيذه بشكل اخر

Vo Variation Order

وده بيكون في الاوقات اللي بيطلب فيها المالك عن طريق الاستشاري او ادارة المشروعات " في حالة وجوده " تغيير بند ما في العقد او في الرسومات التنفيذية او الرسومات التصميمية ، ومن خلاله يقدم المقاول امر تغييرى ومرفق به تحليل اسعار للبند المطلوب تنفيذه

CI ... Consultant Instruction

لما يكون في غلط بالمشروع والاستشاري يريد توجيه المقاول لذلك بدون خصم

What is a project

MEP Codes

HVAC Codes

1- ARI	Air Conditioning And Refrigeration Institute
2- ASHRAE	American Society Of Heating , Refrigeration And Air Conditioning Engineers
3- ASME	American Society Of Mechanical Engineers
4- ASTM	American Society Of Testing And Methods
5- NEMA	National Electrical Manufacturers Association
6- SMACNA	Sheet Metal And Air Conditioning Contractors National Association
7- UL	Underwriters Laboratories

Equipment's

1- ANSI	American National Standards Institute
2- BS	British Standards
3- ELQW	Egyptian License Of Quality Work

Fire fighting

1- NFPA	National Fire Protection Association
2- FOC	Fire Organization Committee
3- IFC	International Fire Code

Plumbing

	1- National Standard Plumbing Code
	2- Standard Plumbing Engineering Design
	3- Universal Plumbing Code
	4- International Plumbing Code

COLD WATER SUPPLY

- Plumbing Fixtures
- WATER TANK VOLUME
- PIPE SIZING
- PUMP FLOW RATE
- PUMP REQUIRED
PRESSURE

HOT WATER SUPPLY

- WATER HEATER CAPACITY
- HOW TO GET HOT WATER
WHEN YOU NEED (HOT
WATER RECIRCULATION.

DRAINAGE

- DRAINAGE PIPE SIZING
- SEPARATE WASTE AND
SOIL SYSTEM
- ONE PIPE SYSTEM
- DRAINAGE BELOW THE
DRAINAGE NETWORK
(BASEMENT)

SWIMMING POOLS

- SWIMMING POOLS
SYSTEM DESIGN
- WATER FOUNTAINS
DESIGN

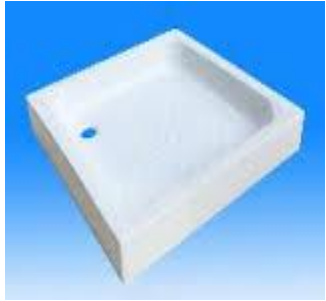
Plumbing Systems

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graph TD; A[Plumbing Systems] --> B[PRESSUREIZED FLOW]; A --> C[GRAVITY FLOW];
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**PRESSUREIZED
FLOW**

**GRAVITY
FLOW**

PLUMBING FIXTURE:



Shower



Bathtub



Water Closet



Urinal



Lavatory



(Lavatory Glass)



Kitchen Sink



**Service Sink or
Janitor Sink**

PLUMBING FIXTURE:

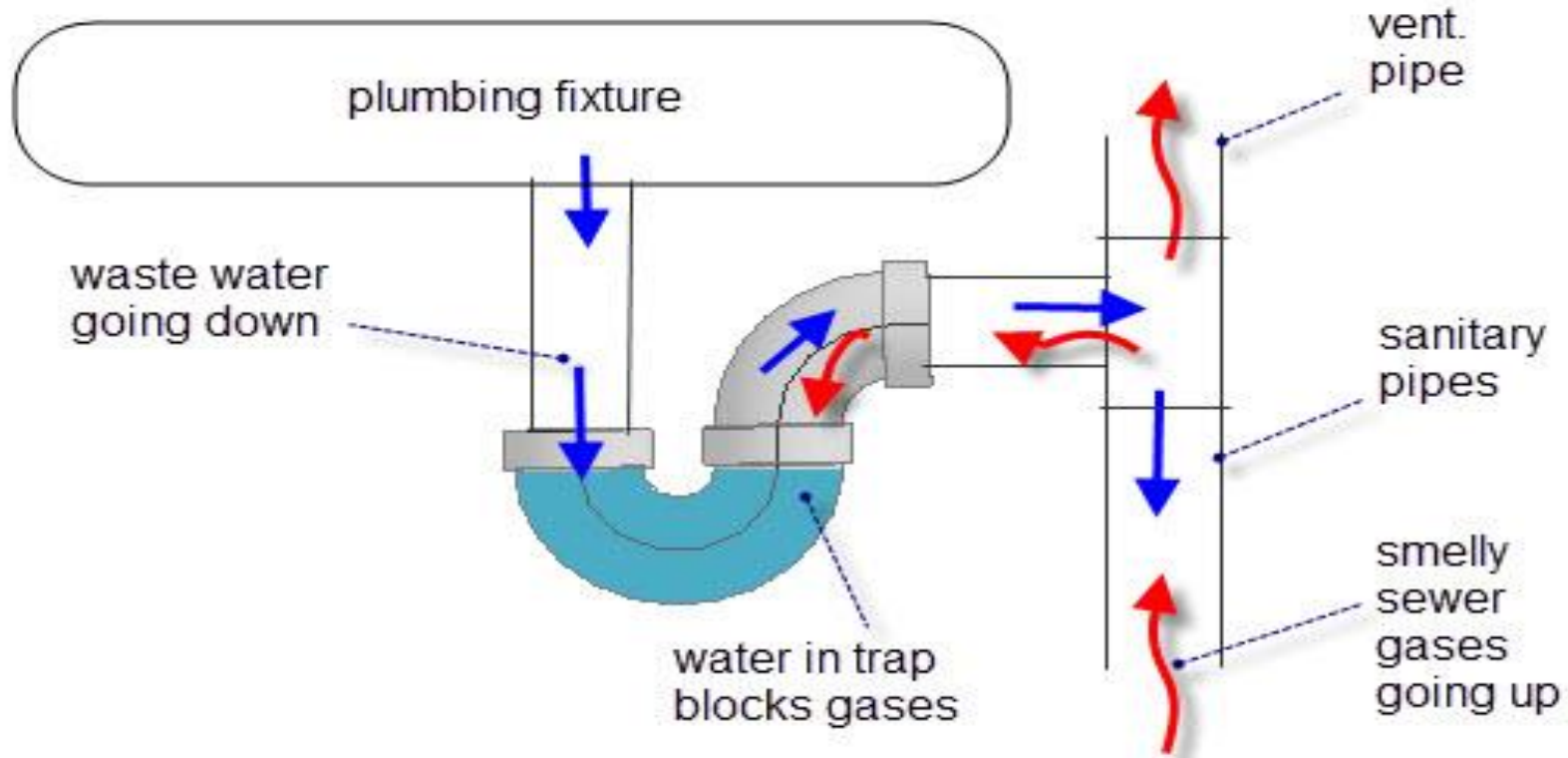
- Water closets (WC)
 - Urinals (UR)
 - Lavatories (LAV)
 - Kitchen sinks (KS)
 - Service sinks (Janitor Sink)
 - Sinks
 - Laundry trays
 - Drinking fountains
 - Showers (SH)
 - Bathtubs (BT)
 - Bidets (BD)
 - Floor drains (FD)
 - Emergency fixtures
 - Faucets and fixture fittings
 - Shower valves
 - Tub fillers
- دورات المياه
 - المبوله
 - الاحواض
 - أحواض المطبخ
 - احواض الخدمة
 - احواض الغسيل
 - احواض
 - نوافير الشرب
 - الدش
 - البانيو
 - بيديه
 - المصارف او البيبه
 - اجهزه الطوارئ
 - الحنفيات
 - صمامات دش
 - مالى البانيو

Trap:

A fitting or device that provides a liquid seal to prevent the emission of sewer gases without materially affecting the flow of sewage or waste water through the trap.

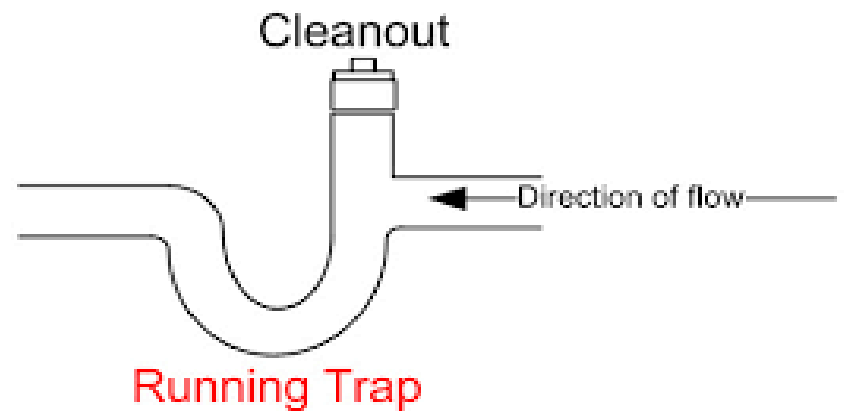
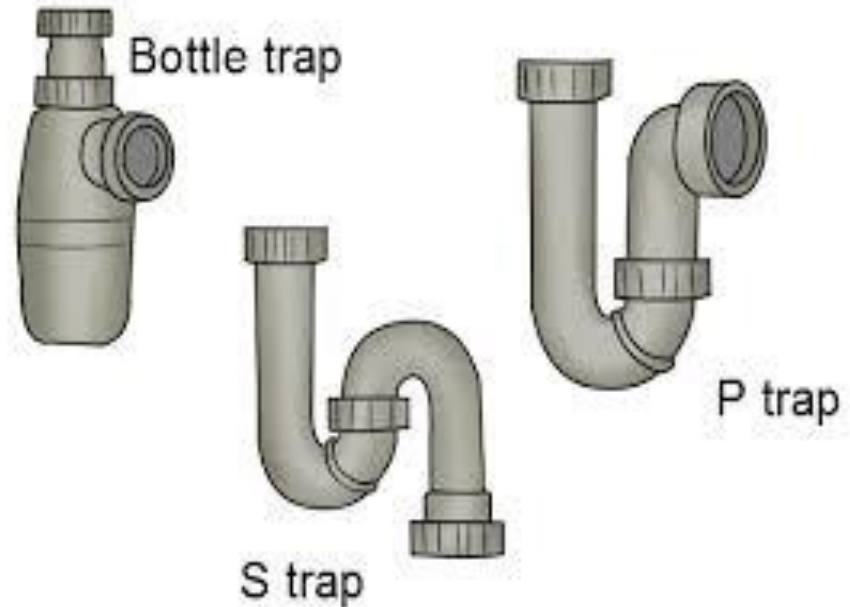
الحواجز المائية:

هو جهاز او قطعه توفر حاجز مائي لمنع انبعاث غازات المجاري دون أن يؤثر جوهريا على تدفق مياه الصرف الصحي من خلال الجهاز.



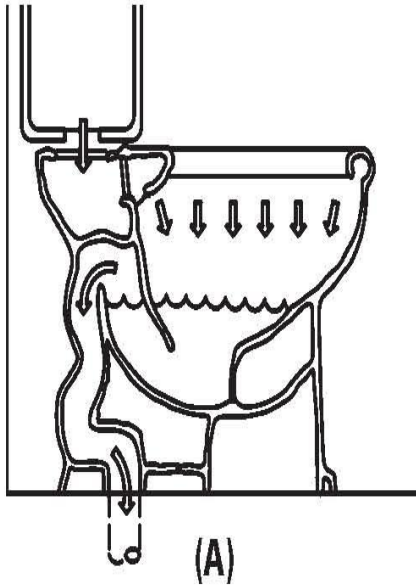
Trap types:

- P- Trap
- S- Trap
- Running Trap
- Bottle Trap

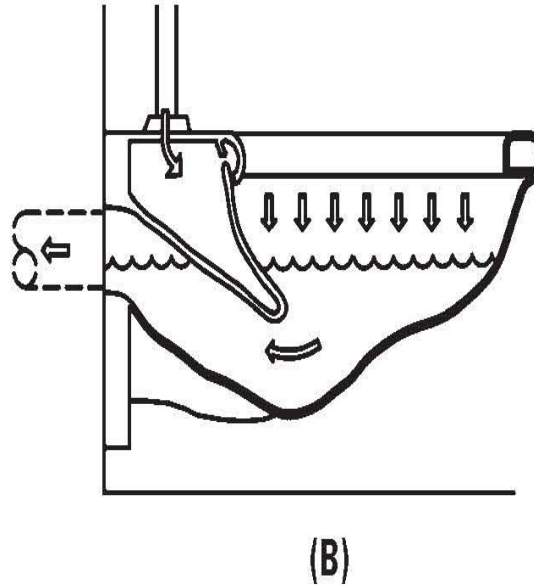


Water Closet (WC) Types:

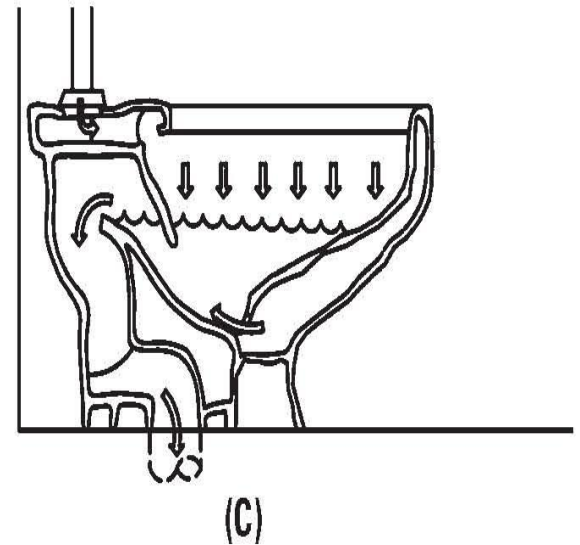
According to Flushing way & drainage direction



**Reverse Trap
S-Trap**



**Blowout
P-trap
Back outlet**

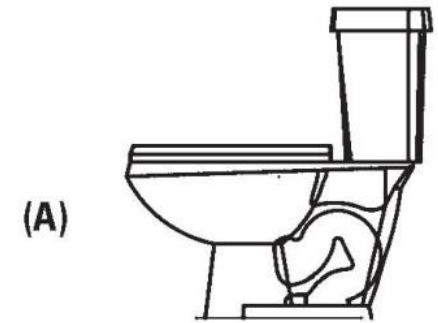


Siphon Jet

According to tank type



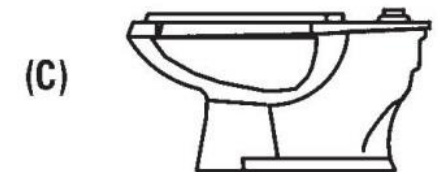
Close Coupled type



One Piece type

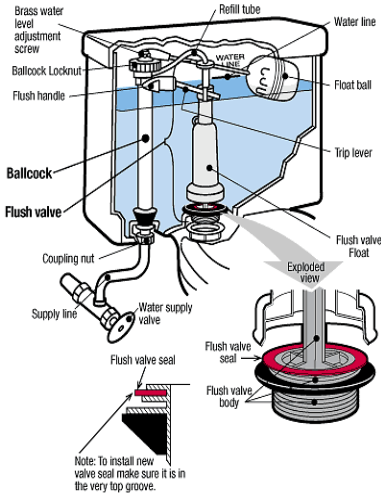


Flushometer type



According to flushing performance

Fixture Type	Flow (gpm)	Pressure (PSI)
Water Closet, blow out, flushometer valve	25	45
Water Closet, siphonic, flushometer valve	25	35
Water Closet, tank, close coupled	3	20
Water Closet, tank, one piece	6	20
Water Closet, flushometer tank	1.6	20



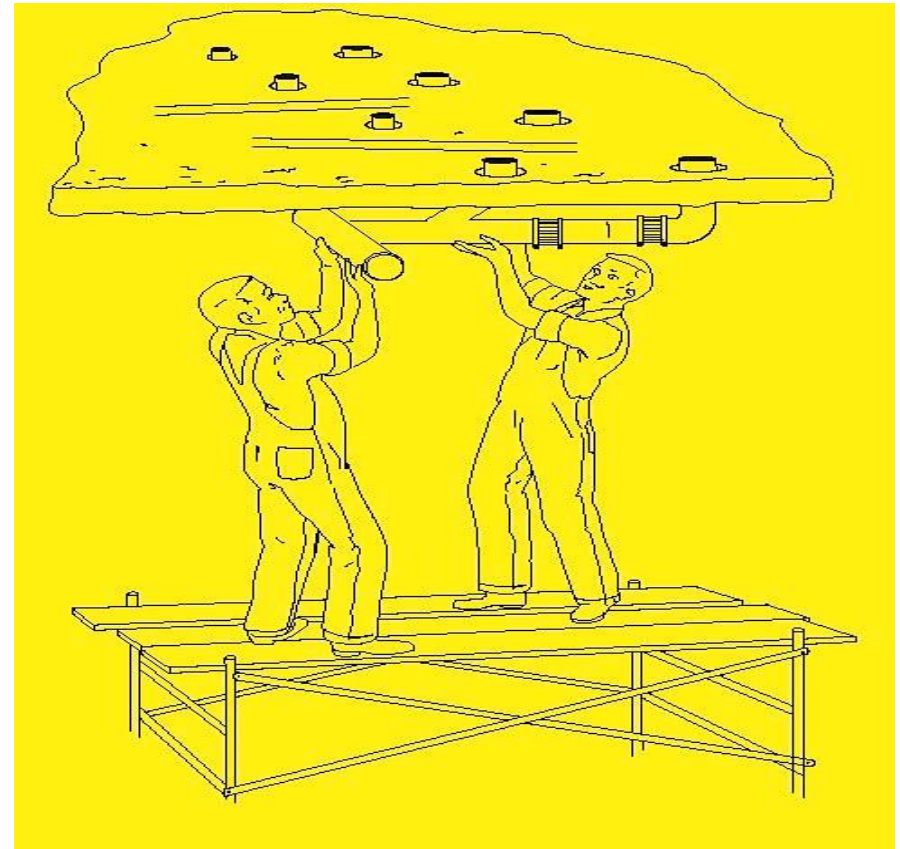
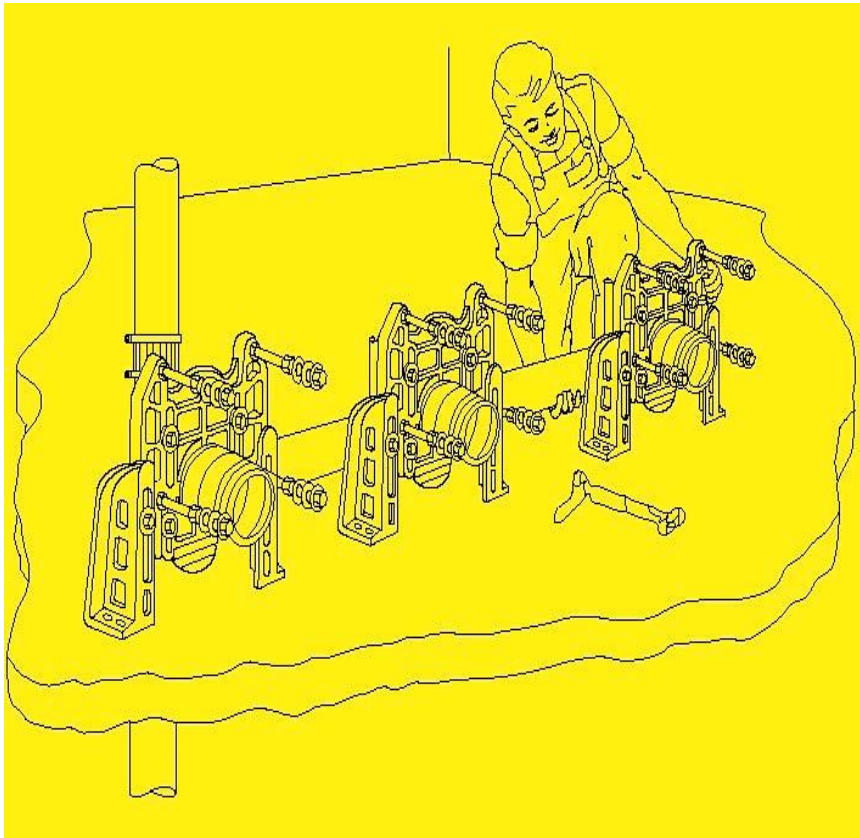
Flush Tank

Flushometer Tank

Flush Valve with Sensor

Flush Valve

Water Closet Installation:



Urinal Installation:



Urinal

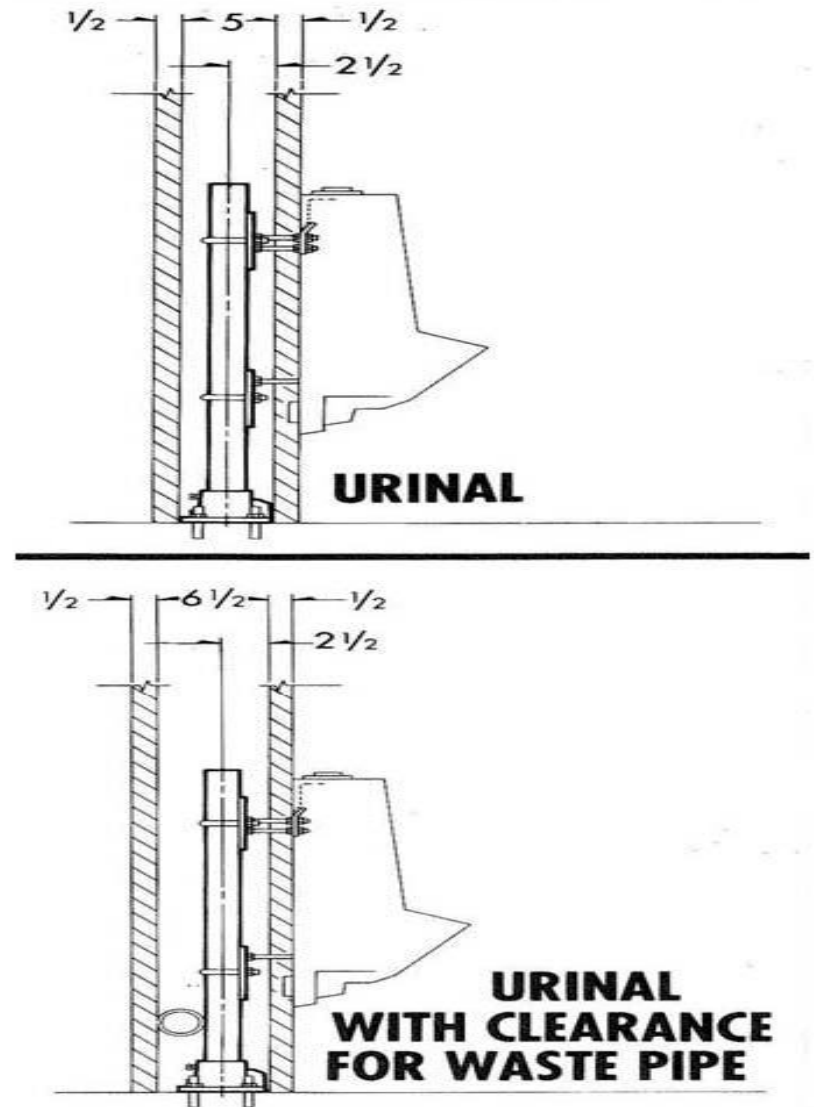


Figure 1-10 Minimum Chase Sizes for Urinals
Courtesy of Plumbing and Drainage Institute

Lavatory and Kitchen Sink Installation:

Fixture Type	Flow (gpm)	Pressure (PSI)
Lavatory	2	8
Kitchen Sink	2.5	8

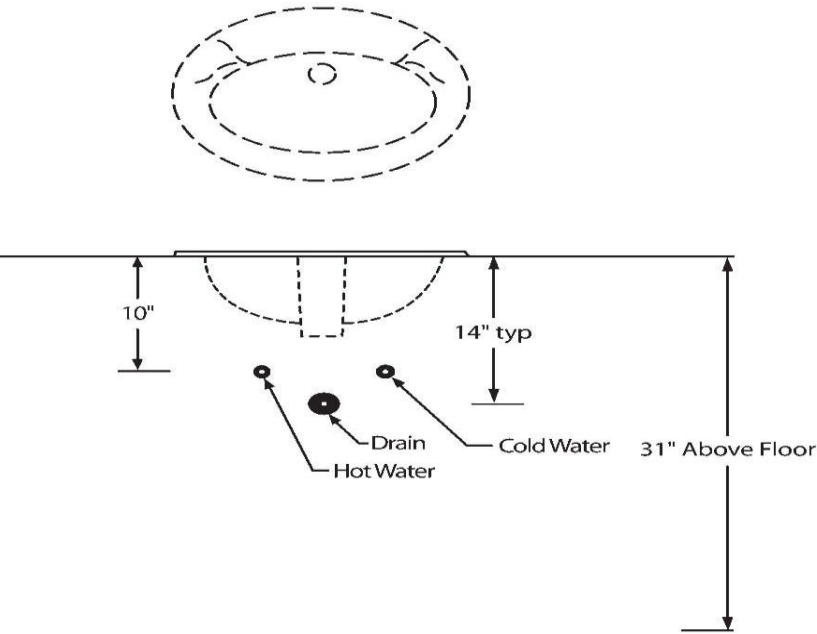


Figure 1-11 Recommended Installation Dimensions for a Lavatory

Lavatory

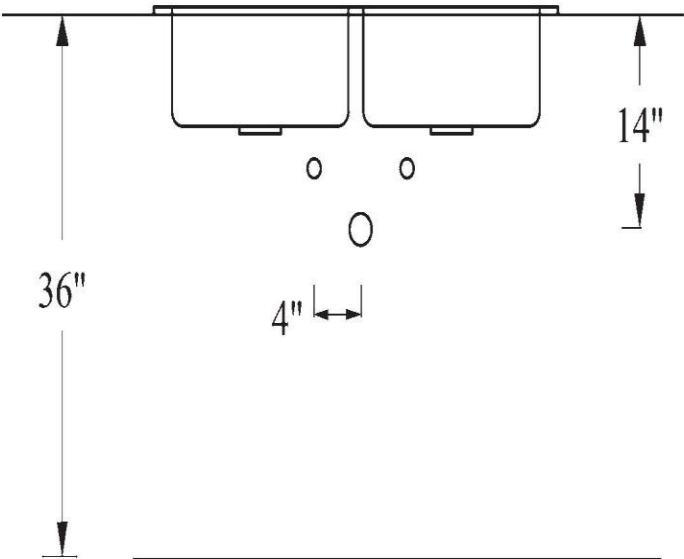


Figure 1-13 Standard dimensions for a kitchen sink include a counter height of 36 inches above the finished floor.

Kitchen Sink

Shower and Bathtub:

Fixture Type

Shower

Bathtub

Flow (gpm)

3

4

Pressure (PSI)

20

20



Shower



Bathtub

Emergency Fixture:

- 1- Emergency Shower
- 2- Emergency eye wash



Emergency Shower



Emergency eye Wash

Floor Drain Types:



Multi Inlet Floor Drain



Floor Drain Single Outlet



Trench Drain



Floor Drain Installation

Roof Drain Types



Roof Drain



Planter Drain



Side Roof Drain



Cold Water System:

The primary task of a building cold water service and distribution system is to provide adequate flow, pressure, and volume suitable for use at every device that uses water, even when the system is at peak demand.

المهمة الأساسية لنظام المياه الباردة هو توفير تدفق كاف، ضغط، وحجم مناسب للمياه للاستخدام في كل جهاز يستخدم الماء، حتى عندما يكون النظام في ذروت الطلب

Source of Water:

مصادر المياه

Municipality Water Network

شبكة البلديه

Water Tank (Suction)

خزان ارضي (سحب)

Roof Tank (Gravity)

خزان فوق السطح (بالجاذبيه)

Towers Tanks (Gravity)

خزان برجى

Hydro pneumatic Tank

خزان ضغط

Wells

مياه ابار



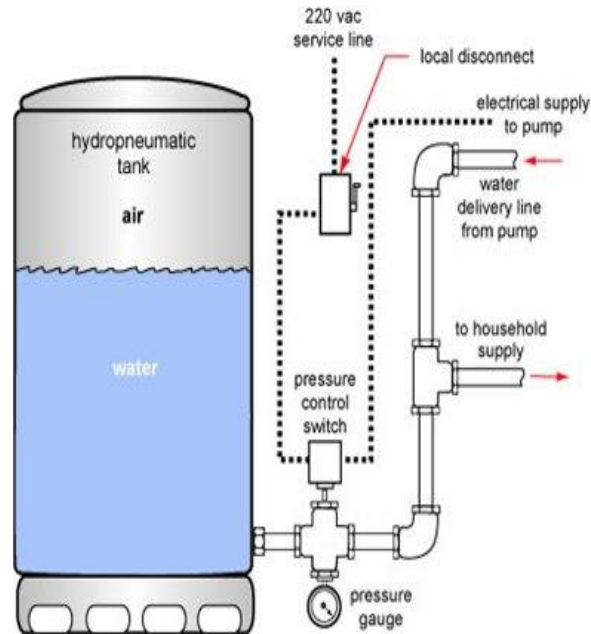
Roof Tank



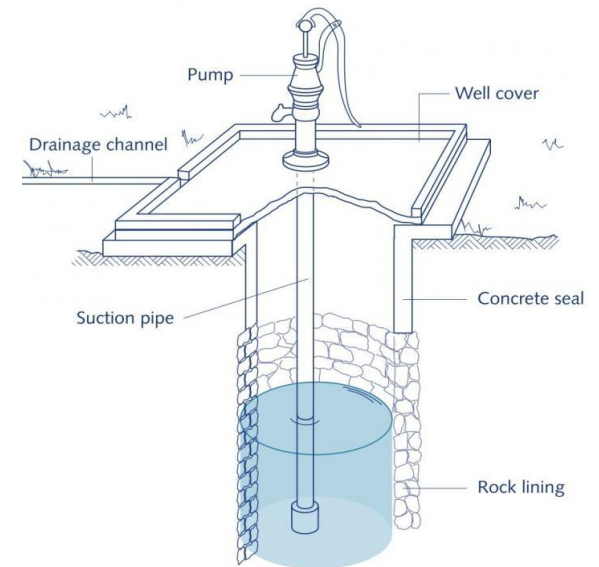
Water Tank



Towers Tanks



Hydro pneumatic Tank



Wells

WATER DEMAND CALCULATION

HIGH RISE PLUMBING DESIGN

FACILITY	Gal/Day/Capita	USAGE HRS.	FACTOR Average Flow x Factor = Peak Flow	SOURCE of DATA
Office Building	20	8 to 9	2.0 to 2.5	Water meter readings
Office Building with Restaurant	25			
Apartments, Housing	80 to 100	15	2.0 to 3.0	Estimates, field surveys
Hotel, Motel	130	11	3.0	Meter readings
Hospitals	Refer to Table ..	—	—	Meter readings
Classrooms (School, University) (non-resident students, faculty and staff)	25	16½	2.2	Meter readings
Dormitory (without food service or kitchenettes)	.75	16½	2.2	Meter readings
Dormitory (with food service or kitchenettes)	81	16½	2.2	Meter readings
Shopping Center	Refer to text: Area or Population	10	2.0	Meter readings
Court Houses & Detention (Jail)			2.0 to 2.5	Field surveys
a. Staff	20	8		
b. Office	20	8		
c. Visitors (Courts)	10	6		
d. Short Term Prisoners	10	6		
e. Long Term Prisoners	80	15		

TABLE 11
PRELIMINARY ESTIMATED WATER REQUIREMENTS

EXAMPLE : WATER DEMAND FOR AN OFFICE BUILDING

Assume a 4000 employee building offices.

DAILY CONSUMPTION

$$4,000 \times 20 \text{ G.P.D.C} = 80,000 \text{ GPD}$$

Total gallons per day = 80,000

AVERAGE FLOW RATE

$$80,000 / 9 \text{ hours (540 minute)} = 150 \text{ GPM}$$

PEAK FLOW RATE

$$150 \times 2.5 = 375 \text{ gpm peak flow rate}$$

EXAMPLE : WATER DEMAND FOR AN APARTMENT HOUSE

Assume a population of 1000 person.

DAILY CONSUMPTION

$$1000 \times 100 = 100,000 \text{ G.P.D.}$$

AVERAGE FLOW RATE

$$100,000 / 900 = 111 \text{ gpm average flow rate}$$

PEAK FLOW RATE

$$111 \times 3 = 333 \text{ gpm peak flow rate}$$

EXAMPLE : WATER DEMAND FOR A HOTEL

Assume a population of 1000 person.

DAILY CONSUMPTION

$$1000 \times 130 = 130,000 \text{ G.P.D.}$$

AVERAGE FLOW RATE

$$130,000 / 660 = 197 \text{ gpm average flow rate}$$

PEAK FLOW RATE

$$197 \times 3 = 591 \text{ gpm peak flow rate}$$

WATER DEMAND FOR A HOSPITAL

Hospitals

The estimated water requirements for hospitals are requested in various forms which differ from the usual jobs. Table 10 lists various quantities in the form they may be required.

TABLE 10
Estimated Water Requirements for Hospitals

A	Consumption per year, gal/bed/yr	100,000
B	Consumption per month, gal/bed/month	10,000
C	Consumption per day, gal/bed/day	235 to 300
D	Peak hourly flow, gal/bed/hr	30
E	Minimum hourly flow, gal/bed/hr	3
F*	Peak instantaneous flow, gpm	$\frac{\text{Peak Hourly Flow} \times 2}{60 \text{ minutes}}$
G	Average instantaneous flow, gpm	$\frac{\text{Peak Instantaneous flow}}{2}$
H	HVAC equipment and A.C. make-up	See HVAC dept.

* Peak instantaneous flow plus the HVAC water requirements and any large water demand equipment (such as a large laundry) should be used for sizing the water service and pumping equipment.

Notes:

Table 10 is based upon a general hospital with kitchen, laundry and hydrotherapy facilities.

2. The water requirements for air conditioning are not included in the table. Add the A.C. requirements as given by the HVAC department.
3. Fire flow for sprinkler and standpipe are not included. Rate of flow is generally from 500 to 1500 gpm.
4. Extremely high water demand equipment such as large laundry and hydrotherapy facilities must be evaluated separately in order to determine if special design is required.

EXAMPLE : WATER DEMAND FOR A HOSPITAL

Assume 500 bed general hospital

1- consumption per year = $500 \times 100,000 = 50,000,000$ gal/yr

2- consumption per month = $500 \times 10,000 = 5,000,000$ gal/month

3- consumption per day = $500 \times 300 = 150,000$ gal/day

4- peak hourly flow = $500 \times 30 = 15,000$ gal/hr

5- minimum hourly flow = $500 \times 3 = 1,500$ gal/hr

6- peak instantaneous flow = $(15,000 \times 2) / 60 \text{ mins} = 500$ gpm

7- average instantaneous flow = $500 / 2 = 250$ gpm

8- Total gallons per day = 150,000

WATER DEMAND FOR UNIVERSITIES

Universities

1. Dormitory Students (Residents)

Fixture	Usage/Day	Gal/Usage	Total Gal.
Water closets	3	5	15
Shower	1	20	20
Washup	2	10	20
Miscellaneous			20
Total			75 G.P.D.C.

Dormitory Kitchens

3 meals/day " 2 gal/meal/capita = 6 G.P.D.C.

2. Non-Resident Students

Fixture	Usage/Day	Gal/Usage	Total Gal.
Water closets	2	5	10
Washup	2	5	10
Miscellaneous			5
Total			25 G.P.D.C.

3. Faculty and Staff

Fixture	Usage/Day	Gal/Usage	Total Gal.
Water closets	2	5	10
Washup	2	5	10
Miscellaneous			5
Total			25 G.P.D.C.

WATER DEMAND FOR SHOPPING CENTERS

Shopping Centers

Area Method:

1. Use 10 hr. day.
2. Use 1/10 gal/sq. ft. of gross building area for the daily domestic water consumption.

Parking and Population Method:

1. Number of autos (parking spaces) \times 3 turnovers per day \times 2 occupants per auto = approximate number of customers per day.
2. Customers per day \times 1½ G.P.D./customer = water load for customers per day.
3. Number of employees per day \times 20 G.P.D. per employee = water load for employees per day.
4. Customer load plus employee load = total daily domestic water consumption in G.P.D.

EXAMPLE : WATER DEMAND FOR A SHOPPING CENTER

Assume a 500,000 ft² gross building area with 24,000 customers per day & 800 employees.

Area Method

$$500,000 \times 0.1 \text{ gal/ft}^2/\text{day} = 50,000 \text{ gal/day}$$

Population Method

$$24,000 \text{ customers} \times 1.25 \text{ G.P.D. / cust.} = 30,000 \text{ G.P.D.}$$

$$800 \text{ employees} \times 20 \text{ G.P.D. / employee} = 16,000 \text{ G.P.D.}$$

So, total is 46,000 G.P.D

Use the higher figure of the area method – 50,000 G.P.D.

Area Method

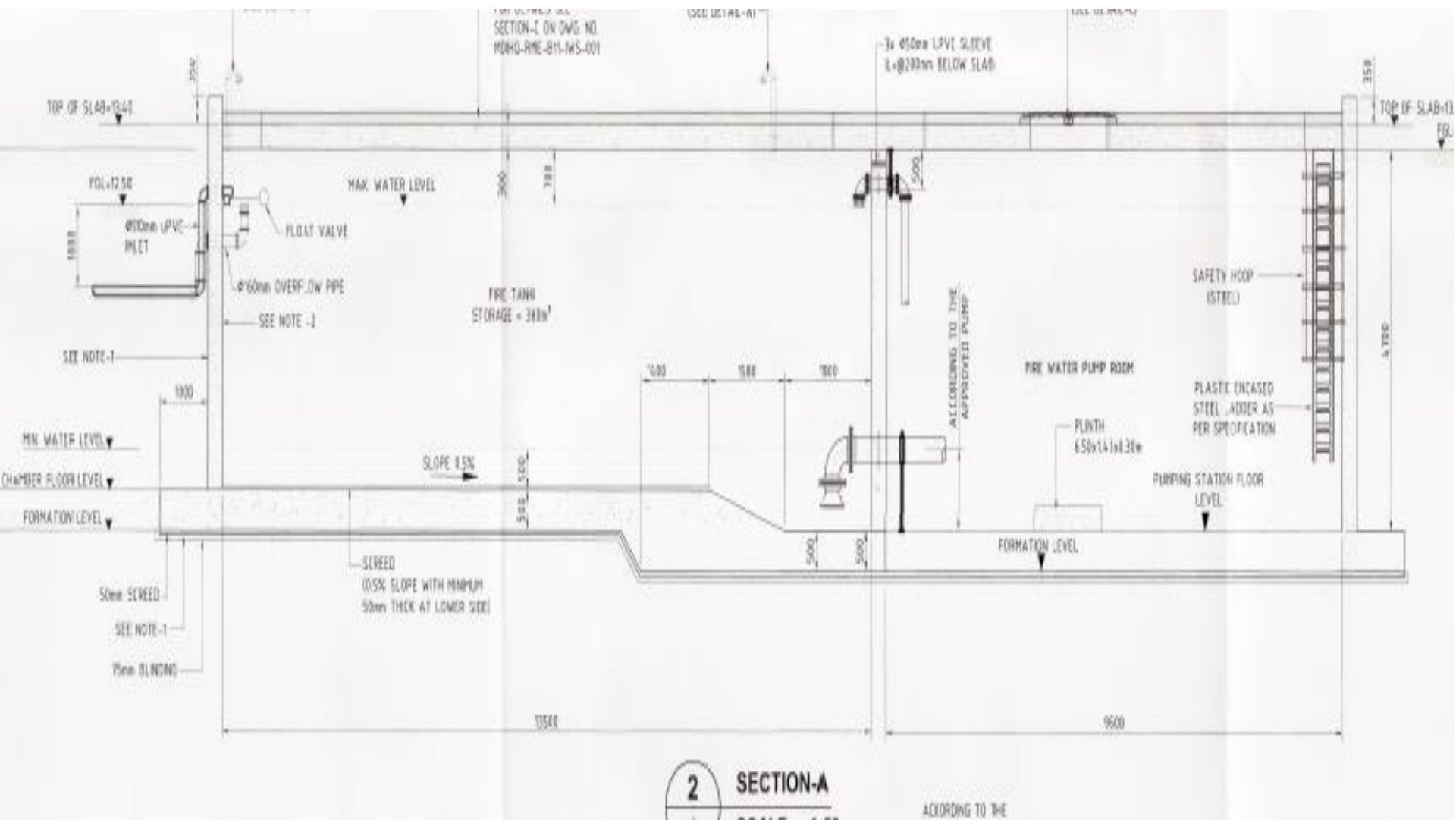
$$\text{Average rate} = 50,000 / (60 \times 10) = 84 \text{ gpm}$$

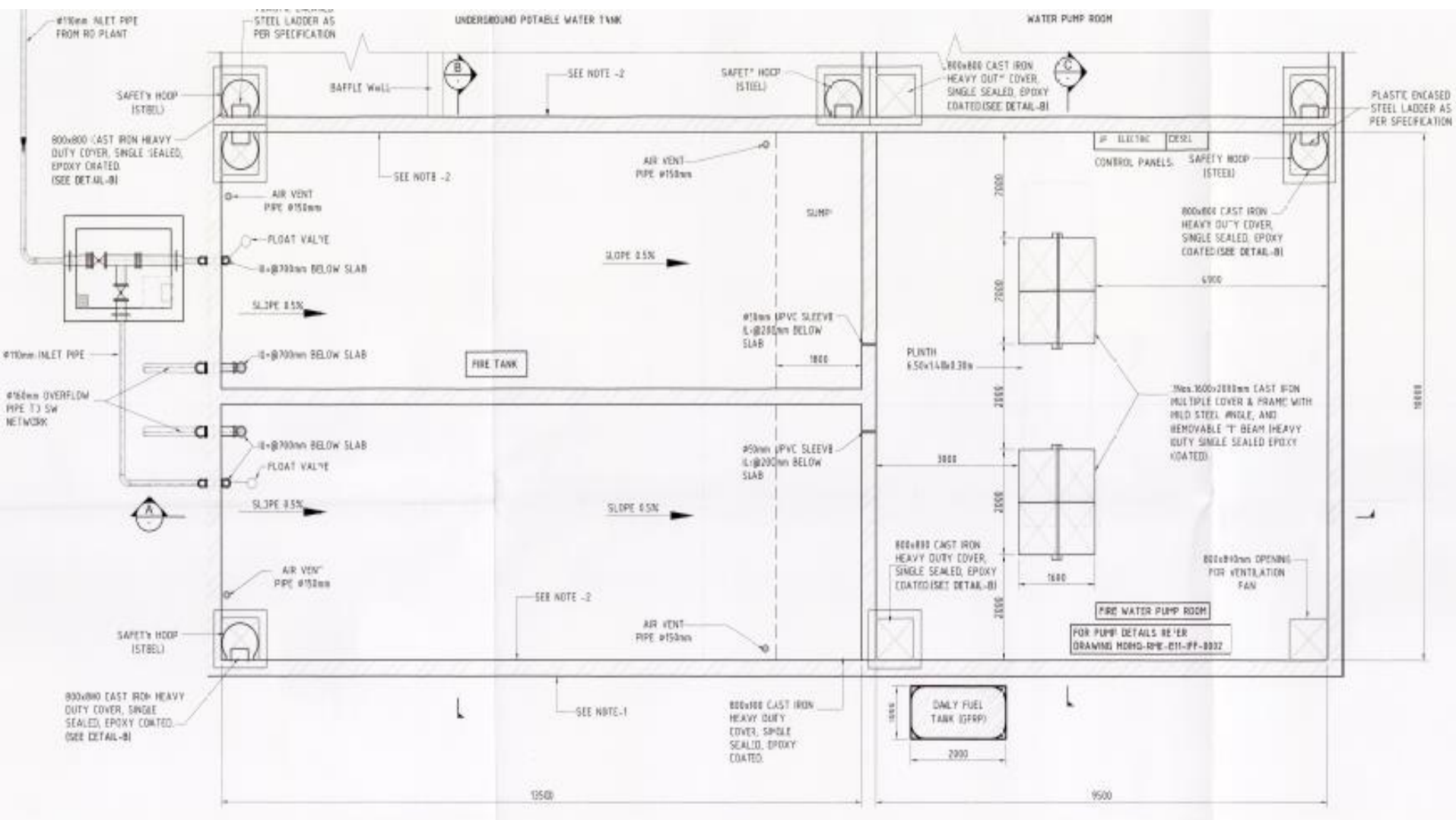
$$\text{Peak rate} = 84 \times 2 = 168 = 168 \text{ gpm}$$

What is the GPM used to fill this tank in 4 hours ??

Water tank requirements

1. tank size shall be considered to have empty 600 mm above water level for the float valve
2. Could be mixed with Fire water tank provided that suction pipe of domestic water shall be connected at level equal to height of fire water
3. Suction pipe should be higher than ground level by 100 mm at least
4. Anti vortex plate should be installed at suction elbow to vortex
5. Puddle flange should be installed
6. Provide over flow pipe connected to storm or waste pipe , alarm signal should be provided (Back valve)
7. Suction shall be through a sump provided at lowest point
8. Tank shall be vented
9. Ladder for maintenance shall be provided





Over Flow Pipes

TABLE 606.5.4
SIZES FOR OVERFLOW PIPES FOR WATER SUPPLY TANKS

MAXIMUM CAPACITY OF WATER SUPPLY LINE TO TANK (gpm)	DIAMETER OF OVERFLOW PIPE (inches)
0-50	2
50 - 150	2 $\frac{1}{2}$
150 - 200	3
200 - 400	4
400 - 700	5
700 - 1,000	6
Over 1,000	8

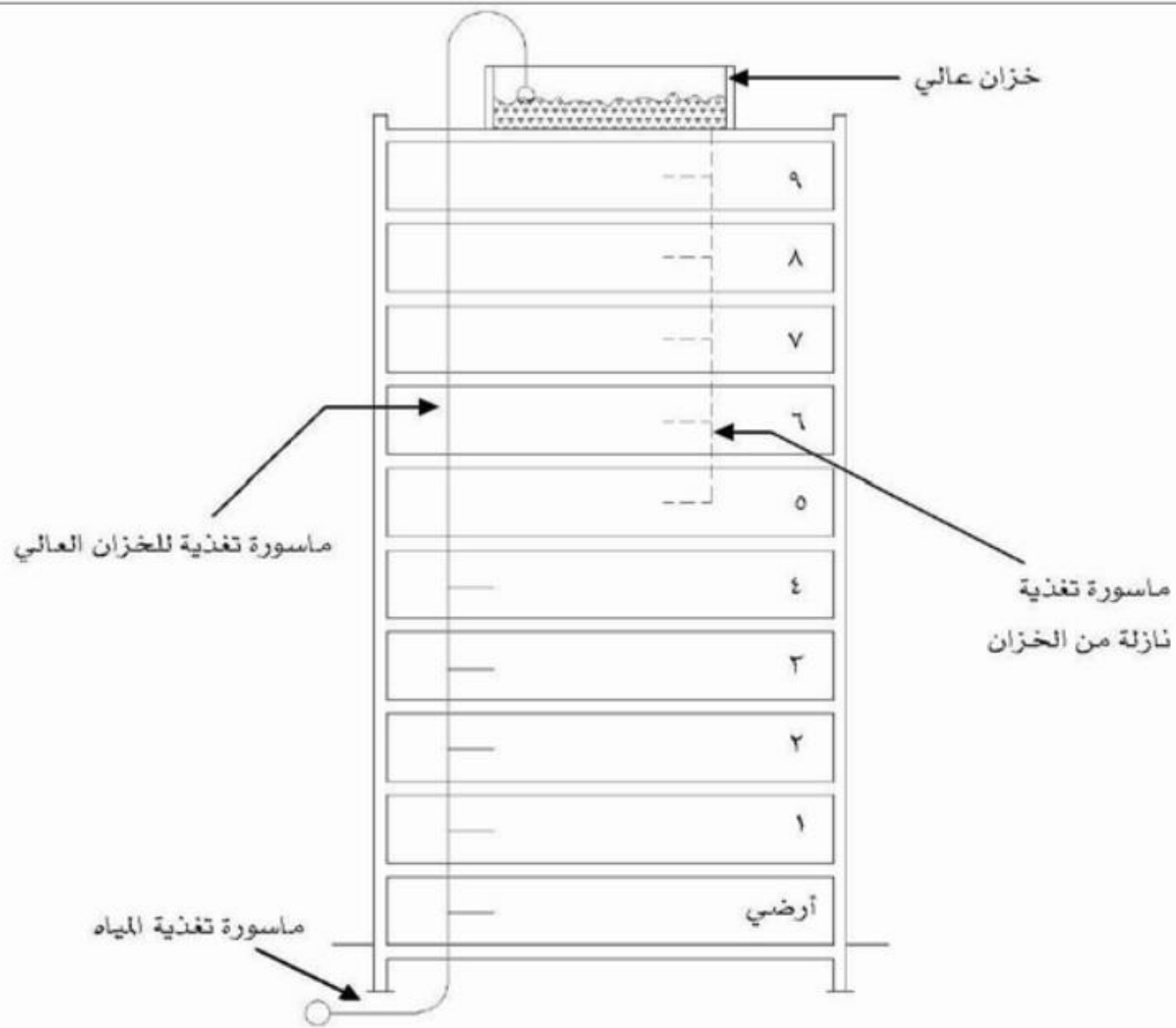
For SI: 1 inch = 25.4 mm, 1 gallon per minute = 3.785 *Lim.*

Drain Pipes

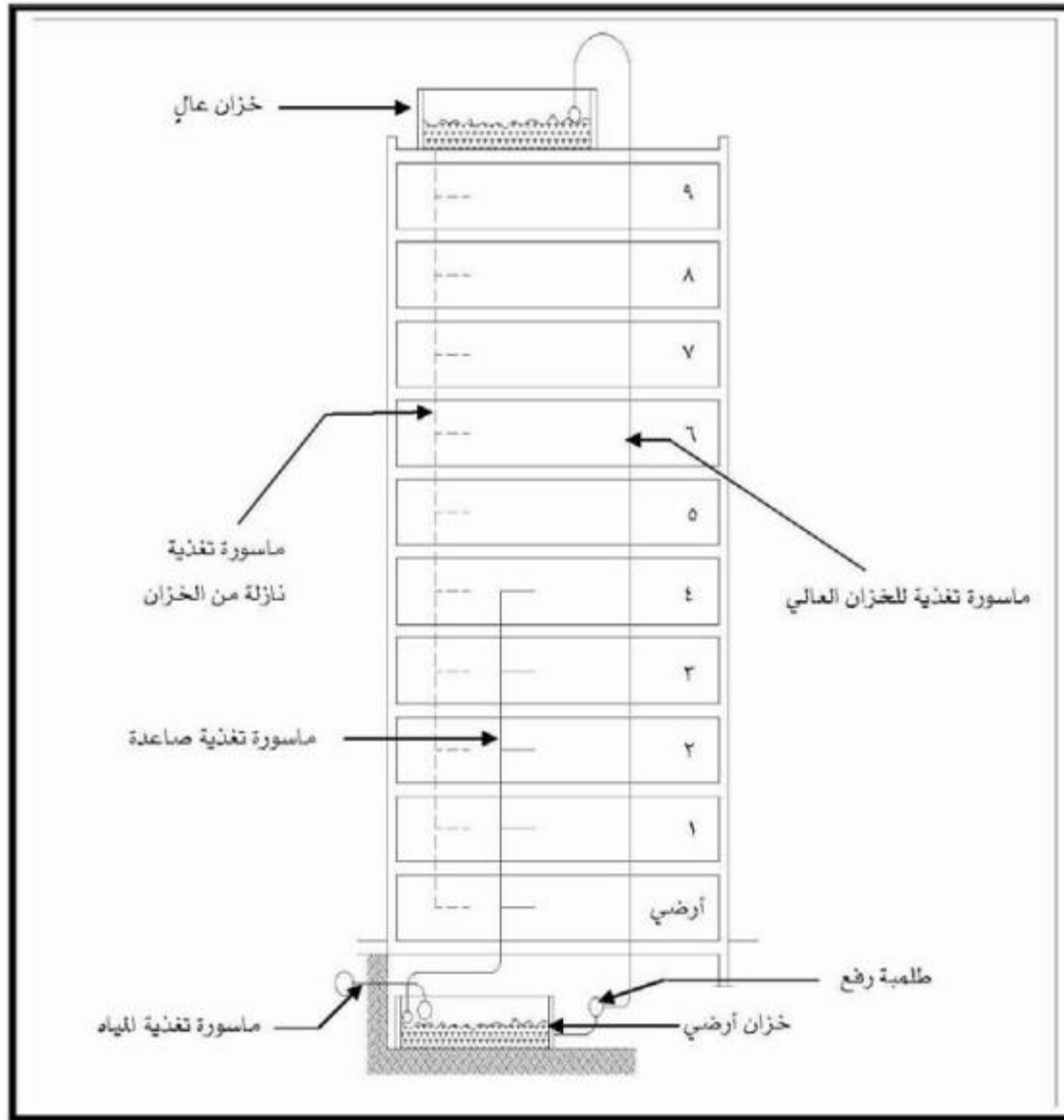
TABLE 606.5.7
SIZE OF DRAIN PIPES FOR WATER TANKS

TANK CAPACITY (gallons)	DRAIN PIPE (inches)
Up to 750	1
751 to 1,500	1½
1,501 to 3,000	2
3,001 to 5,000	2½
5,000 to 7,500	3
Over 7,500	4

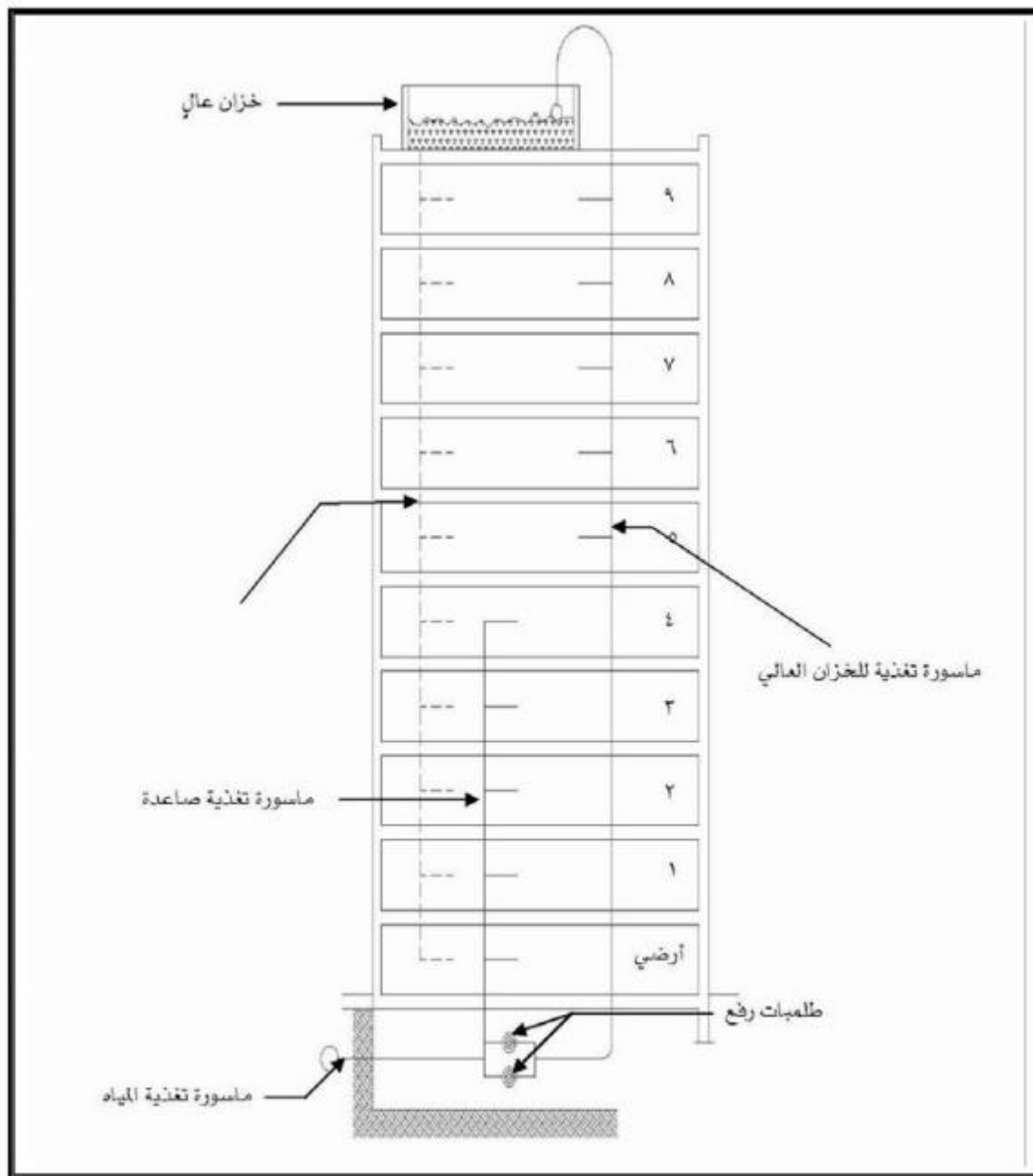
For SI: 1 inch = 25.4 mm, 1 gallon = 3.785 L.



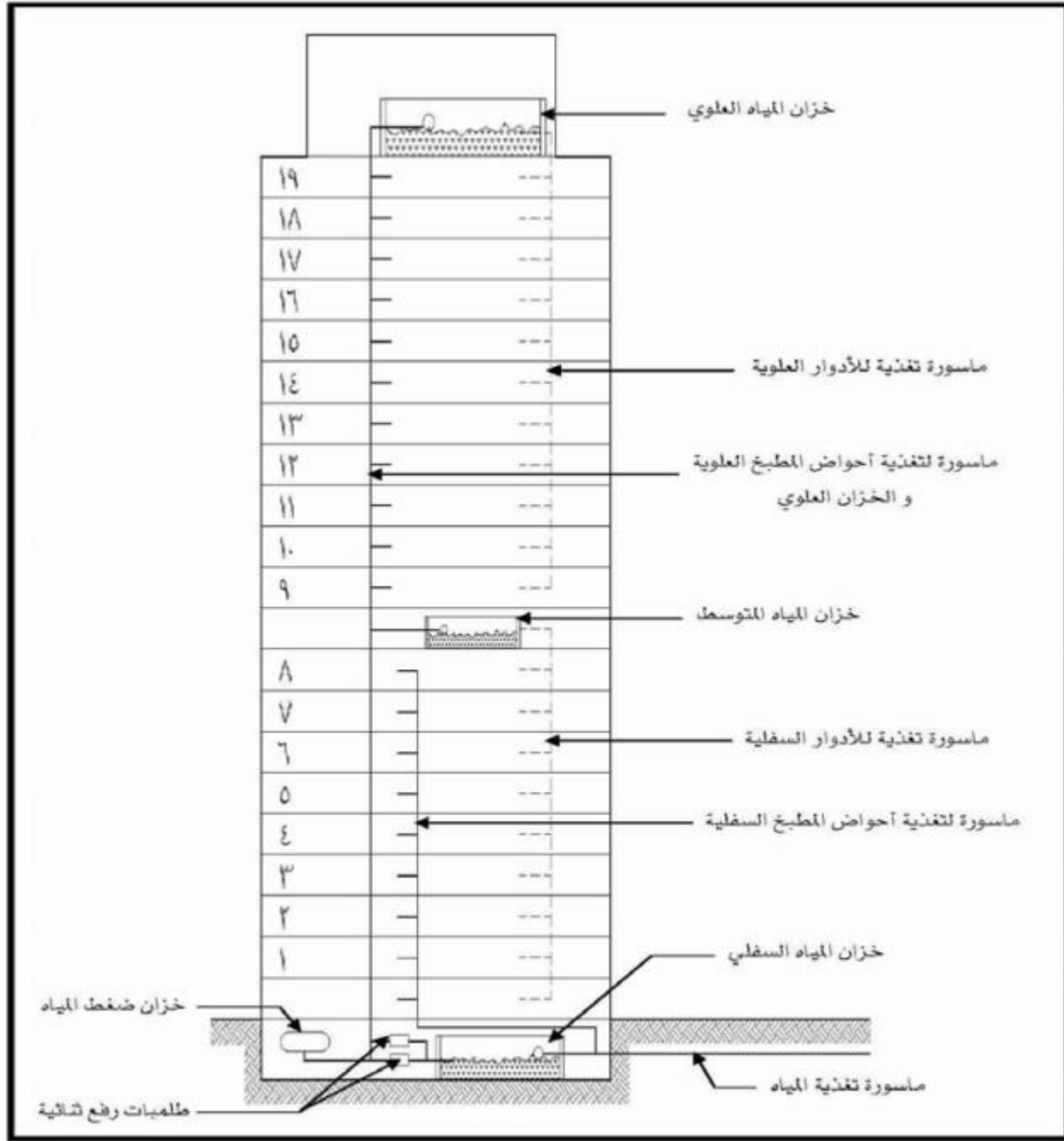
التغذية بتجميع ضغط الشبكة مع الخزان و الرفع يضغط الشبكة



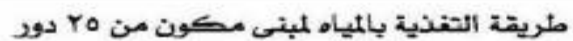
التغذية بتجميع ضغط الشبكة و ضغط الخزان و الرفع بطلمبات للخزان
العالي من خزان أرضي و تغذية الأدوار المنخفضة بضغط الشبكة

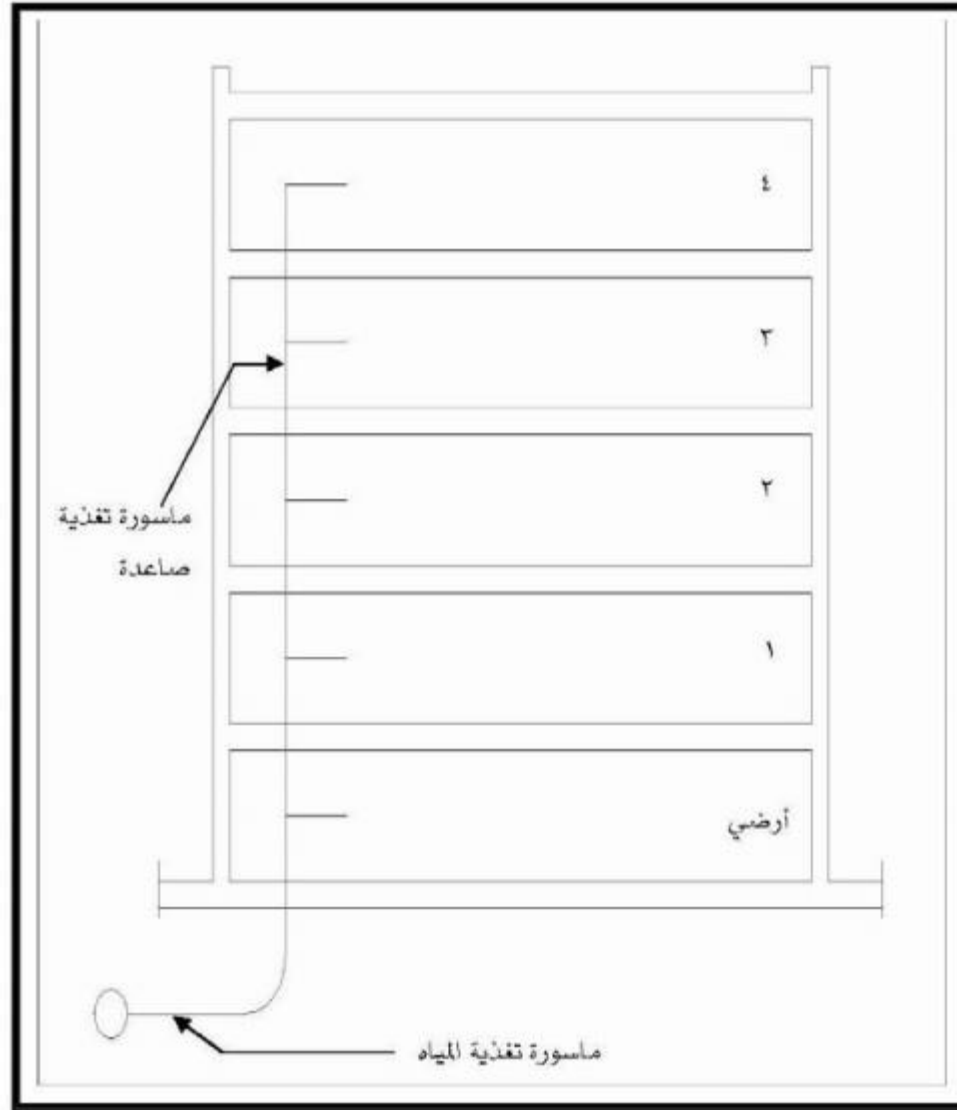


التغذية بتجميع ضغط الشبكة و ضغط الخزان و الرفع بطلمبات للخزان
العالي ولتغذية الأدوار العليا ، و تغذية الأدوار المنخفضة بضغط الشبكة

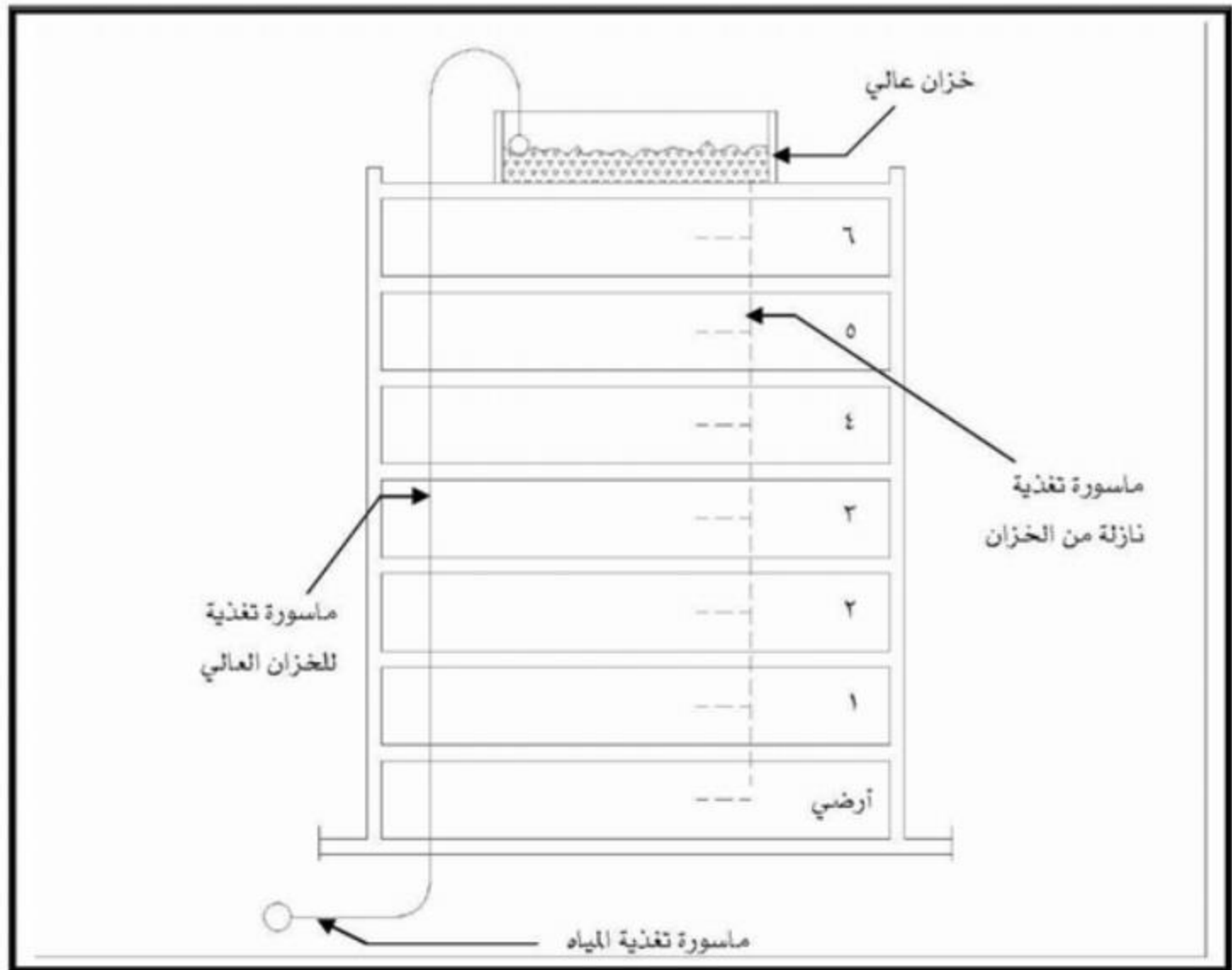


طريقة التغذية بالمياه لمبنى مكون من ١٩ دور

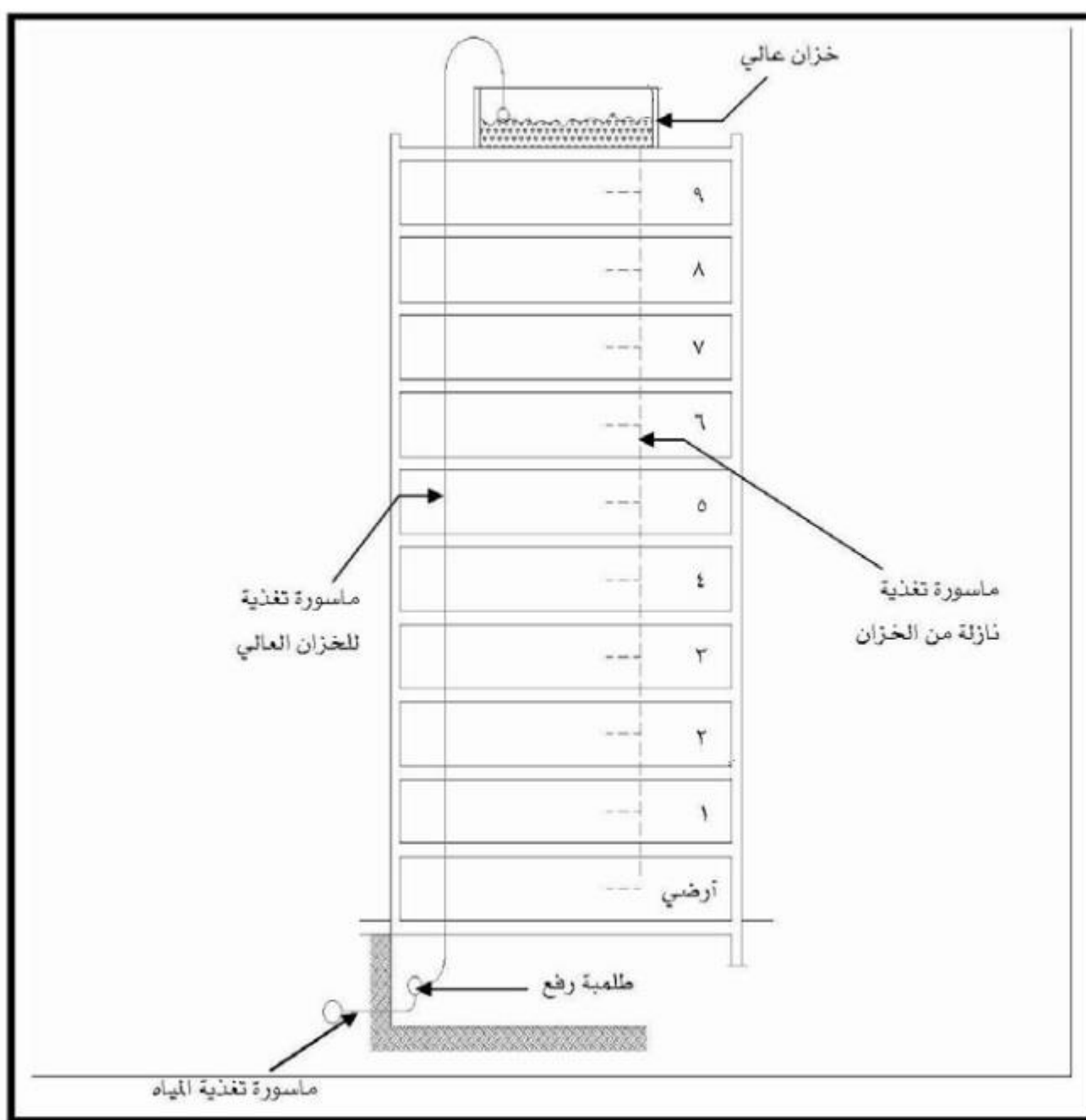




التغذية المباشرة بضغط المياه العمومي



التغذية بجاذبية السقوط و الرفع بضغط المياه العمومي



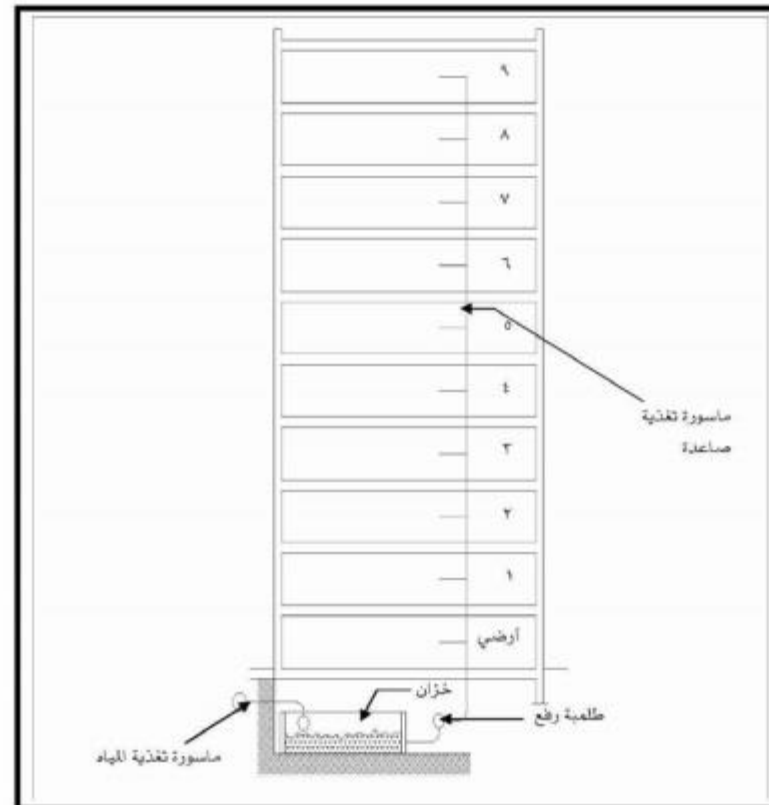
التغذية بجاذبية السقوط و الرفع بطلمبات رافعة



شكل يوضح شكل الفتحة العلوية للخرزان الأرضي
المصنوع من الخرسانة المسلحة



شكل يوضح شكل الخزان الأرضي المصنوع من
البلاستيك



التغذية بالرفع من خزان أرضي

Design steps

- 1- use hunter method to get WSFU for all fixture units
- 2- use hunter charts and tables to convert WSFU to GPM
- 3- size all fixture pipes according to code
- 4- design cold and hot water pipes

Two conditions should be achieved during the pipe sizing:

- 1) The velocity not exceeds 5 ft/s.
- 1) Pressure loss not exceeds 10 ft/100 ft.
(Recommended 4 ft/100 ft)

TABLE E103.3(2)
LOAD VALUES ASSIGNED TO FIXTURES^a

FIXTURE	OCCUPANCY	TYPE OF SUPPLY CONTROL	LOAD VALUES, IN WATER SUPPLY FIXTURE UNITS (wsfu)		
			Cold	Hot	Total
Bathroom group	Private	Flush tank	2.7	1.5	3.6
Bathroom group	Private	Flush valve	6.0	3.0	8.0
Bathtub	Private	Faucet	1.0	1.0	1.4
Bathtub	Public	Faucet	3.0	3.0	4.0
Bidet	Private	Faucet	1.5	1.5	2.0
Combination fixture	Private	Faucet	2.25	2.25	3.0
Dishwashing machine	Private	Automatic	-	1.4	1.4
Drinking fountain	Offices, etc.	3/8" valve	0.25	-	0.25
Kitchen sink	Private	Faucet	1.0	1.0	1.4
Kitchen sink	Hotel, restaurant	Faucet	3.0	3.0	4.0
Laundry trays (1 to 3)	Private	Faucet	1.0	1.0	1.4
Lavatory	Private	Faucet	0.5	0.5	0.7
Lavatory	Public	Faucet	1.5	1.5	2.0
Service sink	Offices, etc.	Faucet	2.25	2.25	3.0
Shower head	Public	Mixing valve	3.0	3.0	4.0
Shower head	Private	Mixing valve	1.0	1.0	1.4
Urinal	Public	1" flush valve	10.0	-	10.0
Urinal	Public	3/4" flush valve	5.0	-	5.0
Urinal	Public	Flush tank	3.0	-	3.0
Washing machine (8 lb)	Private	Automatic	1.0	1.0	1.4
Washing machine (8 lb)	Public	Automatic	2.25	2.25	3.0
Washing machine (15lb)	Public	Automatic	3.0	3.0	4.0
Water closet	Private	Flush valve	6.0	-	6.0
Water closet	Private	Flush tank	2.2	-	2.2
Water closet	Public	Flush valve	10.0	-	10.0
Water closet	Public	Flush tank	5.0	-	5.0
Water closet	Public or private	Flushometer tank	2.0	-	2.0

For SI: 1 inch = 25.4 mm, 1 pound = 0.454 kg.

- a. For fixtures not listed, loads should be assumed by comparing the fixture to one listed using water in similar quantities and at similar rates. The assigned loads for fixtures with both hot and cold water supplies are given for separate hot and cold water loads and for total load. The separate hot and cold water loads being three-fourths of the total load for the fixture in each case.

TABLE A-2

Water Supply Fixture Units (WSFU) and Minimum Fixture Branch Pipe Sizes³

Inch	mm
1/2	15
3/4	20
1	25

	Minimum Fixture Branch Pipe Size ^{1,4}	Private	Public	Assembly ⁵
Appliances, Appurtenances or Fixtures²				
Bathtub or Combination Bath/Shower (fill)	1/2"	4.0	4.0	
3/4" Bathtub Fill Valve	3/4"	10.0	10.0	
Bidet	1/2"	1.0		
Clotheswasher	1/2"	4.0	4.0	
Dental Unit, cuspidor	1/2"		1.0	
Dishwasher, domestic	1/2"	1.5	1.5	
Drinking Fountain or Watercooler	1/2"	0.5	0.5	0.75
Hose Bibb	1/2"	2.5	2.5	
Hose Bibb, each additional ⁷	1/2"	1.0	1.0	
Lavatory	1/2"	1.0	1.0	1.0
Lawn Sprinkler, each head ⁵		1.0	1.0	
Mobile Home, each (minimum)		12.0		
Sinks				
Bar	1/2"	1.0	2.0	
Clinic Faucet	1/2"		3.0	
Clinic Flushometer Valve				
with or without faucet	1"		8.0	
Kitchen, domestic	1/2"	1.5	1.5	
Laundry	1/2"	1.5	1.5	
Service or Mop Basin	1/2"	1.5	3.0	
Washup, each set of faucets	1/2"		2.0	
Shower	1/2"	2.0	2.0	
Urinal, 1.0 GPF	3/4"	3.0	4.0	5.0
Urinal, greater than 1.0 GPF	3/4"	4.0	5.0	6.0
Urinal, flush tank	1/2"	2.0	2.0	3.0
Washfountain, circular spray	3/4"		4.0	
Water Closet, 1.6 GPF Gravity Tank	1/2"	2.5	2.5	3.5
Water Closet, 1.6 GPF Flushometer Tank	1/2"	2.5	2.5	3.5
Water Closet, 1.6 GPF Flushometer Valve	1"	5.0	5.0	6.0
Water Closet, greater than 1.6 GPF Gravity Tank	1/2"	3.0	5.5	7.0
Water Closet, greater than 1.6 GPF Flushometer Valve	1"	7.0	8.0	10.0

Notes:

1. Size of the cold branch outlet pipe, or both the hot and cold branch outlet pipes.
2. Appliances, Appurtenances or Fixtures not included in this Table may be sized by reference to fixtures having a similar flow rate and frequency of use.
3. The listed fixture unit values represent their total load on the cold water service. The separate cold water and hot water fixture unit value for fixtures having both cold and hot water connections shall each be taken as three-quarters (3/4) of the listed total value of the fixture.
4. The listed minimum supply branch pipe sizes for individual fixtures are the nominal (I.D.) pipe size.
5. For fixtures or supply connections likely to impose continuous flow demands, determine the required flow in gallons per minute (GPM) and add it separately to the demand (in GPM) for the distribution system or portions thereof.
6. Assembly [Public Use (See Table 4-1)].
7. Reduced fixture unit loading for additional hose bibbs as used is to be used only when sizing total building demand and for pipe sizing when more than one hose bibb is supplied by a segment of water distributing pipe. The fixture branch to each hose bibb shall be sized on the basis of 2.5 fixture units.

CHART A-2

Estimate Curves for Demand Load

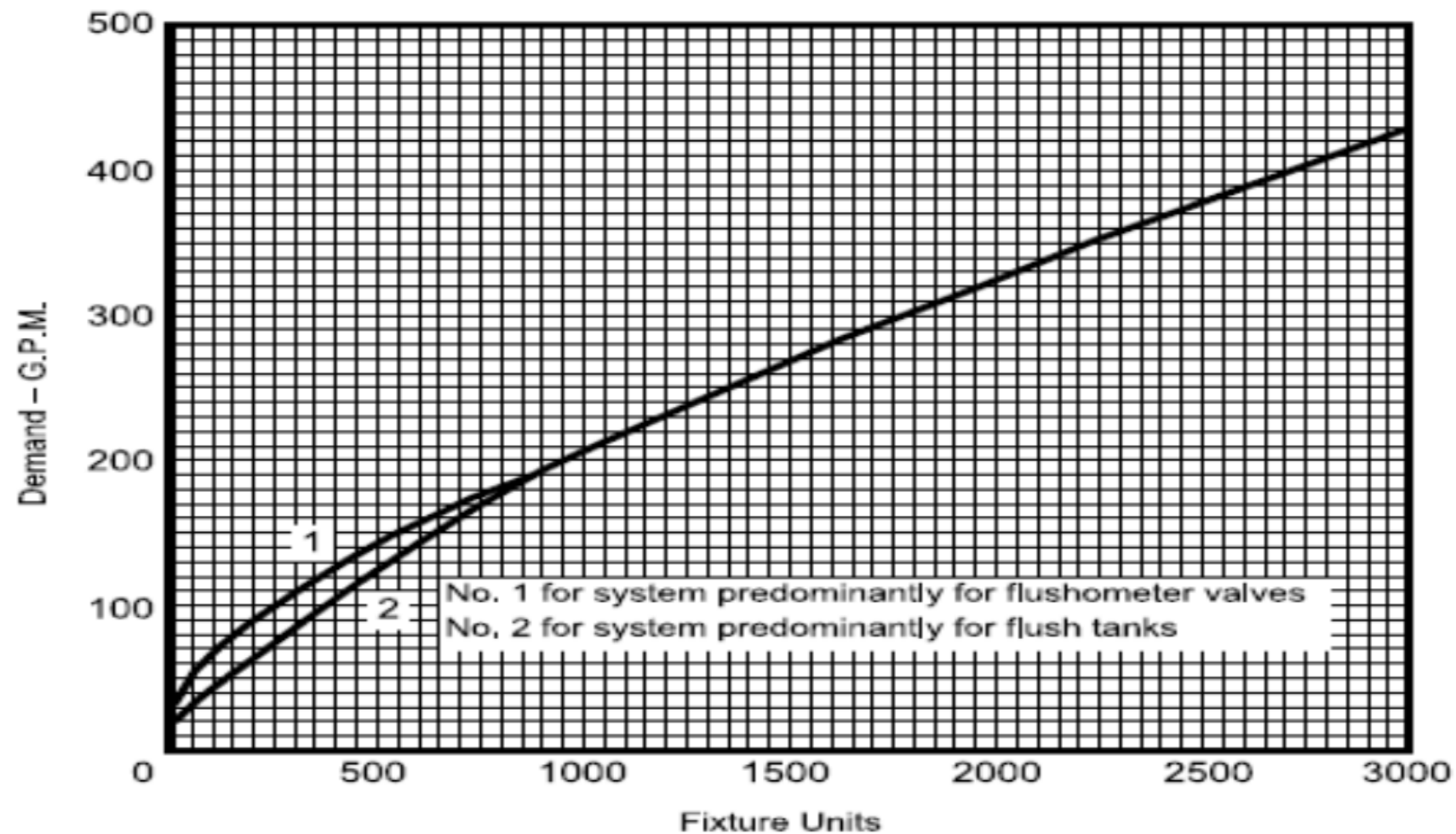


CHART A-3

Enlarged Scale Demand Load

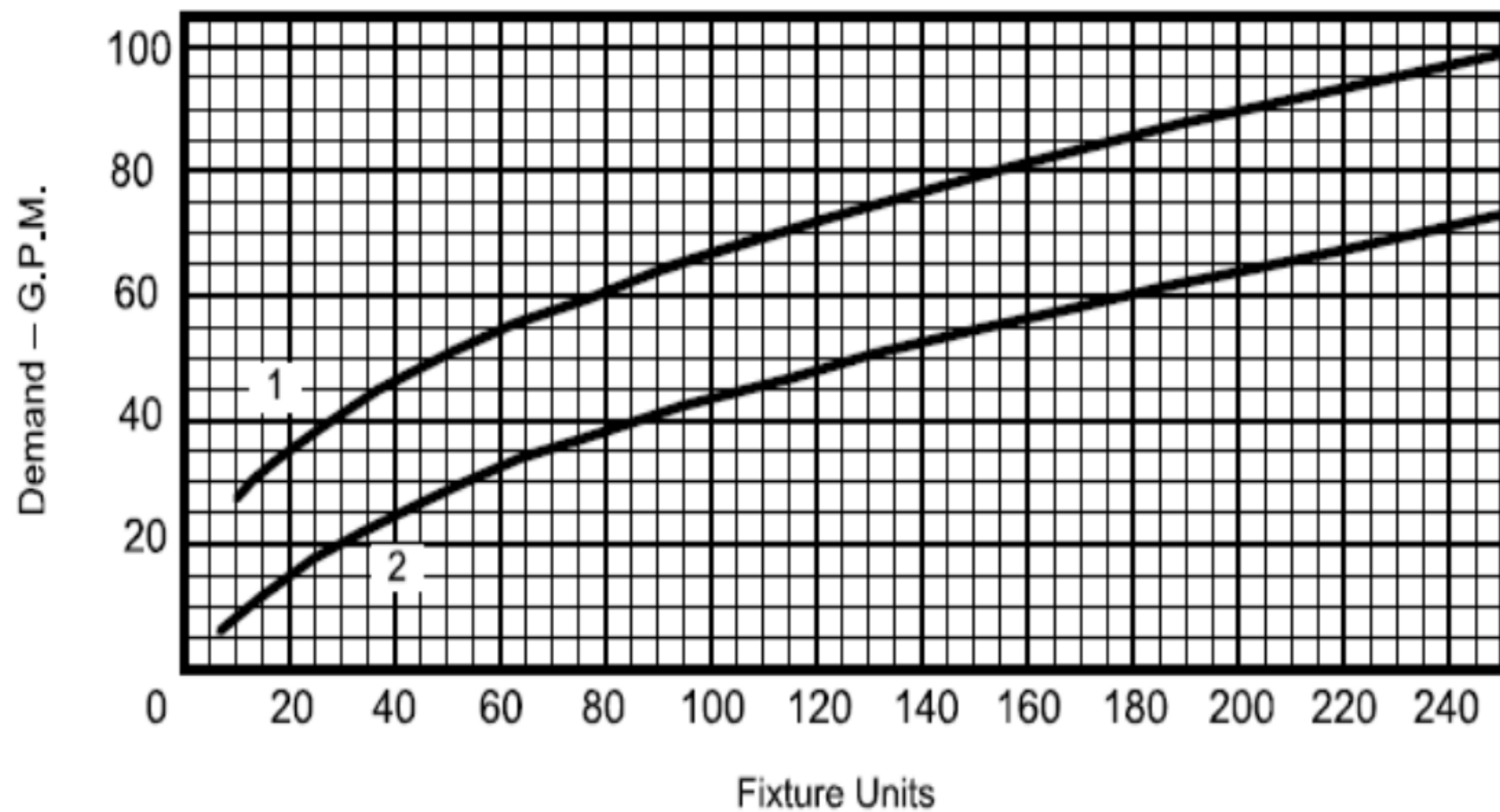


TABLE 10.14.2B
TABLE FOR CONVERTING DEMAND IN WSFU TO GPM¹

WSFU	GPM Flush Tanks ²	GPM Flush Valves ³	WSFU	GPM Flush Tanks ²	GPM Flush Valves ³
3	3		120	49	74
4	4		140	53	78
5	4.5	22	160	57	83
6	5	23	180	61	87
7	6	24	200	65	91
8	7	25	225	70	95
9	7.5	26	250	75	100
10	8	27	300	85	110
11	8.5	28	400	105	125
12	9	29	500	125	140
13	10	29.5	750	170	175
14	10.5	30	1000	210	210
15	11	31	1250	240	240
16	12	32	1500	270	270
17	12.5	33	1750	300	300
18	13	33.5	2000	325	325
19	13.5	34	2500	380	380
20	14	35	3000	435	435
25	17	38	4000	525	525
30	20	41	5000	600	600
40	25	47	6000	650	650
50	29	51	7000	700	700
60	33	55	8000	730	730
80	39	62	9000	760	760
100	44	68	10,000	790	790

NOTES:

1. This table converts water supply demands in water supply fixture units (WSFU) to required water flow in gallons per minute (GPM) for the purpose of pipe sizing.

2. This column applies to portions of piping systems where the water closets are the flush tank type (gravity or pressure) or there are no water closets, and to hot water piping.

3. This column applies to portions of piping systems where the water closets are the flush valve type.

**TABLE E103.3(3)
TABLE FOR ESTIMATING DEMAND**

SUPPLY SYSTEMS PREDOMINANTLY FOR FLUSH TANKS			SUPPLY SYSTEMS PREDOMINANTLY FOR FLUSH VALVES		
Load	Demand		Load	Demand	
(Water supply fixture units)	(Gallons per minute)	(Cubic feet per minute)	(Water supply fixture units)	(Gallons per minute)	(Cubic feet per minute)
1	3.0	0.04104	-	-	-
2	5.0	0.0684	-	-	-
3	6.5	0.86892	-	-	-
4	8.0	1.06944	-	-	-
5	9.4	1.256592	5	15.0	2.0052
6	10.7	1.430376	6	17.4	2.326032
7	11.8	1.577424	7	19.8	2.646364
8	12.8	1.711104	8	22.2	2.967696
9	13.7	1.831416	9	24.6	3.288528
10	14.6	1.951728	10	27.0	3.60936
11	15.4	2.058672	11	27.8	3.716304
12	16.0	2.13888	12	28.6	3.823248
13	16.5	2.20572	13	29.4	3.930192
14	17.0	2.27256	14	30.2	4.037136
15	17.5	2.3394	15	31.0	4.14408
16	18.0	2.90624	16	31.8	4.241024
17	18.4	2.459712	17	32.6	4.357968
18	18.8	2.513184	18	33.4	4.464912
19	19.2	2.566656	19	34.2	4.571856
20	19.6	2.620128	20	35.0	4.6788
25	21.5	2.87412	25	38.0	5.07984
30	23.3	3.114744	30	42.0	5.61356
35	24.9	3.328632	35	44.0	5.88192
40	26.3	3.515784	40	46.0	6.14928
45	27.7	3.702936	45	48.0	6.41664
50	29.1	3.890088	50	50.0	6.684
60	32.0	4.27776	60	54.0	7.21872
70	35.0	4.6788	70	58.0	7.75344
80	38.0	5.07984	80	61.2	8.181216
90	41.0	5.48088	90	64.3	8.595624
100	43.5	5.81508	100	67.5	9.0234
120	48.0	6.41664	120	73.0	9.75864
140	52.5	7.0182	140	77.0	10.29336
160	57.0	7.61976	160	81.0	10.82808
180	61.0	8.15448	180	85.5	11.42964
200	65.0	8.6892	200	90.0	12.0312
225	70.0	9.3576	225	95.5	12.76644
250	75.0	10.026	250	101.0	13.50168

(continued)

TABLE E 103.3(3)-continued
TABLE FOR ESTIMATING DEMAND

SUPPLY SYSTEMS PREDOMINANTLY FOR FLUSH TANKS			SUPPLY SYSTEMS PREDOMINANTLY FOR FLUSH VALVES		
Load	Demand		Load	Demand	
(Water supply fixture units)	(Gallons per minute)	(Cubic feet per minute)	(Water supply fixture units)	(Gallons per minute)	(Cubic feet per minute)
275	80.0	10.6944	275	104.5	13.96956
300	85.0	11.3628	300	108.0	14.43744
400	105.0	14.0364	400	127.0	16.97736
500	124.0	16.57632	500	143.0	19.11624
750	170.0	22.7256	750	177.0	23.66136
1,000	208.0	27.80544	1,000	208.0	27.80544
1,250	239.0	31.94952	1,250	239.0	31.94952
1,500	269.0	35.95992	1,500	269.0	35.95992
1,750	297.0	39.70296	1,750	297.0	39.70296
2,000	325.0	43.446	2,000	325.0	43.446
2,500	380.0	50.7984	2,500	380.0	50.7984
3,000	433.0	57.88344	3,000	433.0	57.88344
4,000	525.0	70.182	4,000	525.0	70.182
5,000	593.0	79.27224	5,000	593.0	79.27224

TABLE 604.5
MINIMUM SIZES OF FIXTURE WATER SUPPLY PIPES

FIXTURE	MINIMUM PIPE SIZE (inch)
Bathtubs ^a (60" × 32" and smaller)	1/2
Bathtubs ^a (larger than 60" × 32")	1/2
Bidet	3/8
Combination sink and tray	1/2
Dishwasher, domestic ^a	1/2
Drinking fountain	3/8
Hose bibbs	1/2
Kitchen sink ^a	1/2
Laundry, 1, 2 or 3 compartments ^a	1/2
Lavatory	3/8
Shower, single head ^a	1/2
Sinks, flushing rim	3/4
Sinks, service	1/2
Urinal, flush tank	1/2
Urinal, flushometer valve	3/4
Wall hydrant	1/2
Water closet, flush tank	3/8
Water closet, flushometer valve	1
Water closet, flushometer tank	3/8
Water closet, one piece ^a	1/2

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm,

1 pound per square inch = 6.895 kPa.

- a. Where the developed length of the distribution line is 60 feet or less, and the available pressure at the meter is 35 psi or greater, the minimum size of an individual distribution line supplied from a manifold and installed as part of a parallel water distribution system shall be one nominal tube size smaller than the sizes indicated.

TABLE 604.3
WATER DISTRIBUTION SYSTEM DESIGN CRITERIA REQUIRED
CAPACITY AT FIXTURE SUPPLY PIPE OUTLETS

FIXTURE SUPPLY OUTLET SERVING	FLOW RATE^a (gpm)	FLOW PRESSURE (psi)
Bathtub, balanced-pressure, thermo-static or combination balanced-pres-sure/thermo-static mixing valve	4	20
Bidet, thermostatic mixing valve	2	20
Combination fixture	4	8
Dishwasher, residential	2.75	8
Drinking fountain	0.75	8
Laundry tray	4	8
Lavatory	2	8
Shower	3	8
Shower, balanced-pressure, thermo-static or combination balanced-pres-sure/thermo-static mixing valve	3	20
Sillcock, hose bibb	5	8
Sink, residential	2.5	8
Sink, service	3	8
Urinal, valve	12	25
Water closet, blow out, flushometer valve	25	45
Water closet, flushometer tank	1.6	20
Water closet, siphonic, flushometer valve	25	35
Water closet, tank, close coupled	3	20
Water closet, tank, one piece	6	20

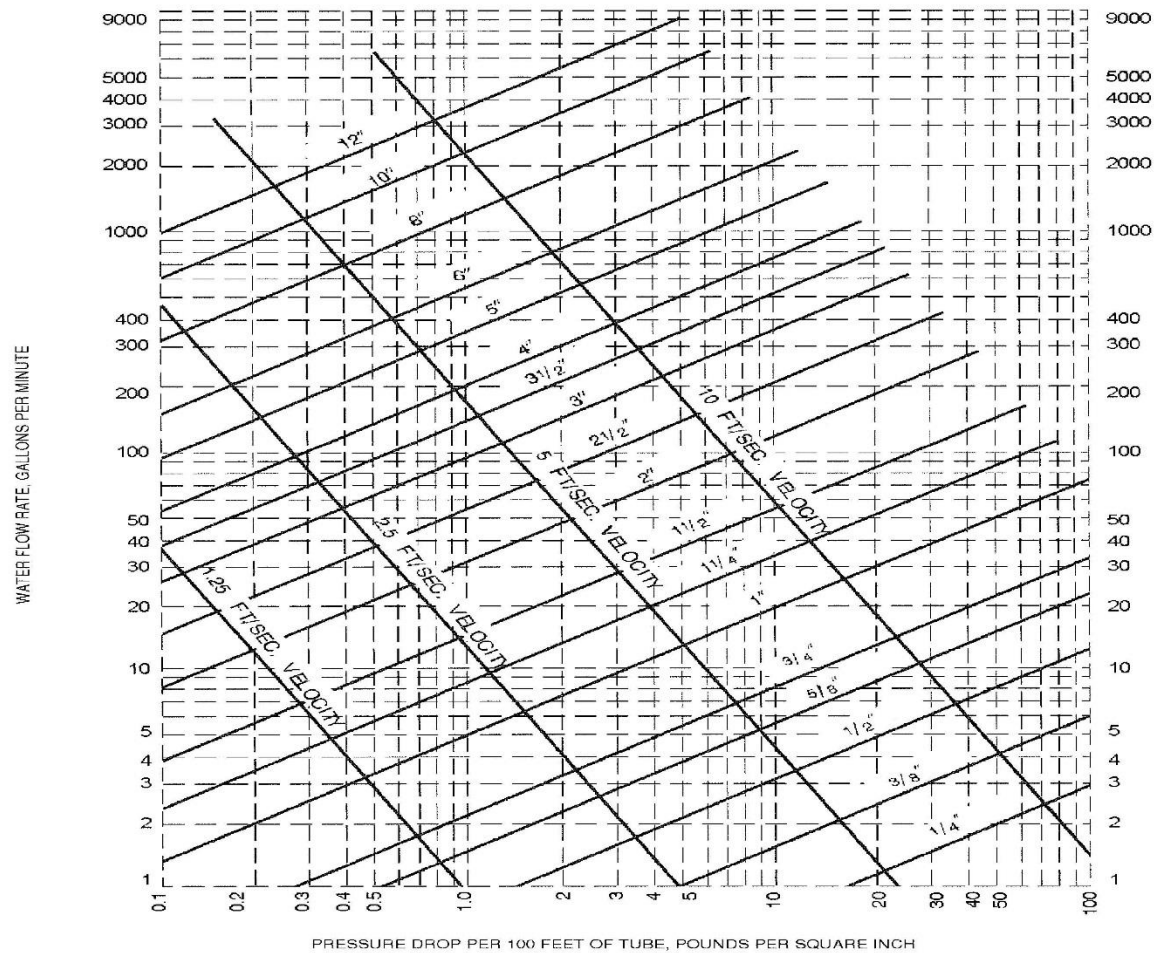
For SI: 1 pound per square inch = 6.895 kPa,
1 gallon per minute = 3.785 L/m.

a. For additional requirements for flow rates and quantities, see Section 604.4.

PUMP!

Open system or closed system ?

What is the head losses for system ?

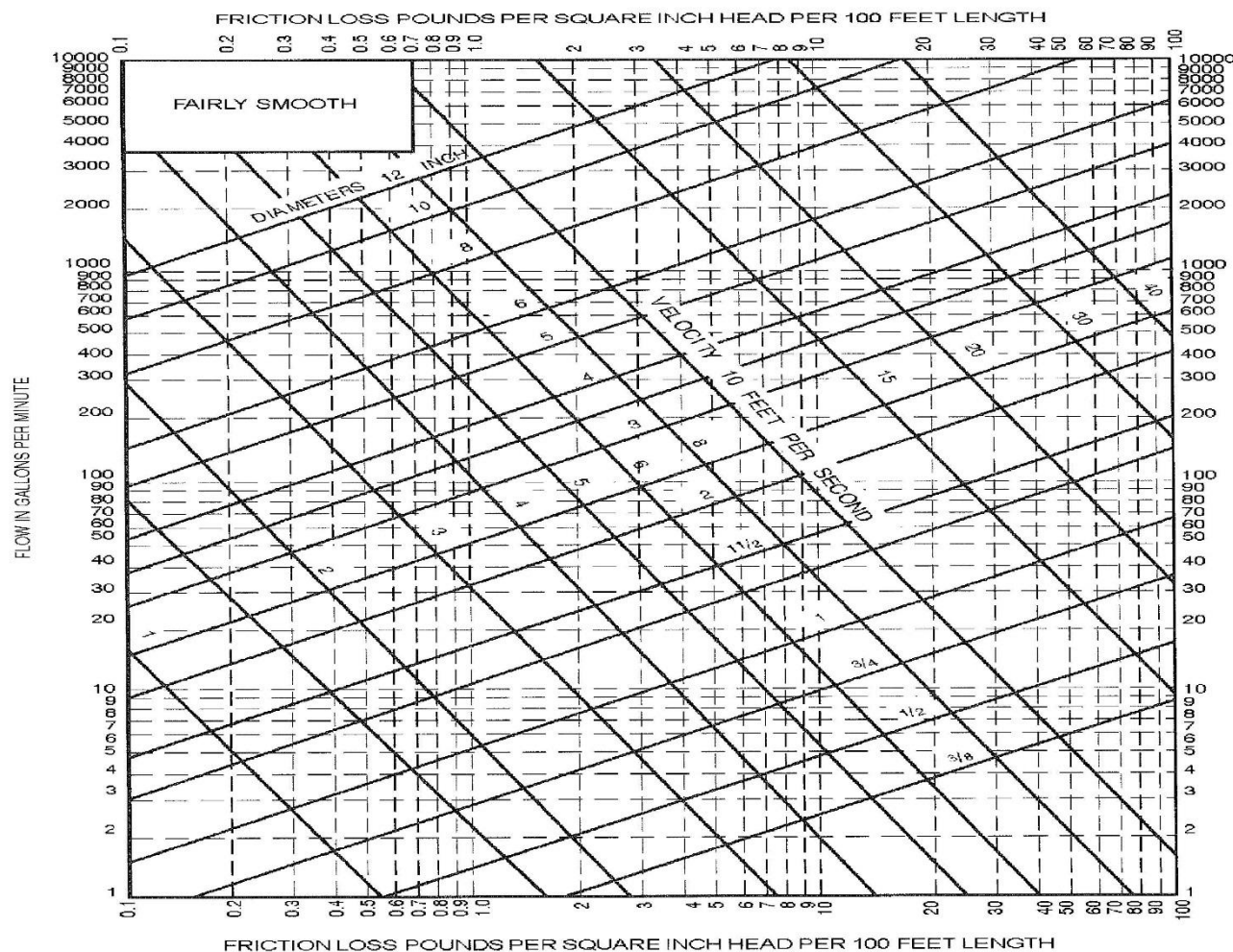


Note: Fluid velocities in excess of 5 to 8 feet/second are not usually recommended.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 gpm = 3.785 L/m, 1 psi = 6.895 kPa, 1 foot per second = 0.305 m/s.

a. This chart applies to smooth new copper tubing with recessed (streamline) soldered joints and to the actual sizes of types indicated on the diagram.

FIGURE E103.3(2)
FRICTION LOSS IN SMOOTH PIPE* (TYPE K, ASTM B 88 COPPER TUBING)



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 gpm = 3.785 L/m, 1 psi = 6.895 kPa, 1 foot per second = 0.305 m/s.

a. This chart applies to smooth new steel (fairly smooth) pipe and to actual diameters of standard-weight pipe.

FIGURE E103.3(5)
FRICTION LOSS IN FAIRLY SMOOTH PIPE^a

TABLE E103.3(5)
ALLOWANCE IN EQUIVALENT LENGTHS OF PIPE FOR FRICTION LOSS IN VALVES AND THREADED FITTINGS (feet)

FITTING OR VALVE	PIPE SIZE (inches)							
	$\frac{1}{2}$	$\frac{3}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3
45-degree elbow	1.2	1.5	1.8	2.4	3.0	4.0	5.0	6.0
90-degree elbow	2.0	2.5	3.0	4.0	5.0	7.0	8.0	10.0
Tee, run	0.6	0.8	0.9	1.2	1.5	2.0	2.5	3.0
Tee, branch	3.0	4.0	5.0	6.0	7.0	10.0	12.0	15.0
Gate valve	0.4	0.5	0.6	0.8	1.0	1.3	1.6	2.0
Balancing valve	0.8	1.1	1.5	1.9	2.2	3.0	3.7	4.5
Plug-type cock	0.8	1.1	1.5	1.9	2.2	3.0	3.7	4.5
Check valve, swing	5.6	8.4	11.2	14.0	16.8	22.4	28.0	33.6
Globe valve	15.0	20.0	25.0	35.0	45.0	55.0	65.0	80.0
Angle valve	8.0	12.0	15.0	18.0	22.0	28.0	34.0	40.0

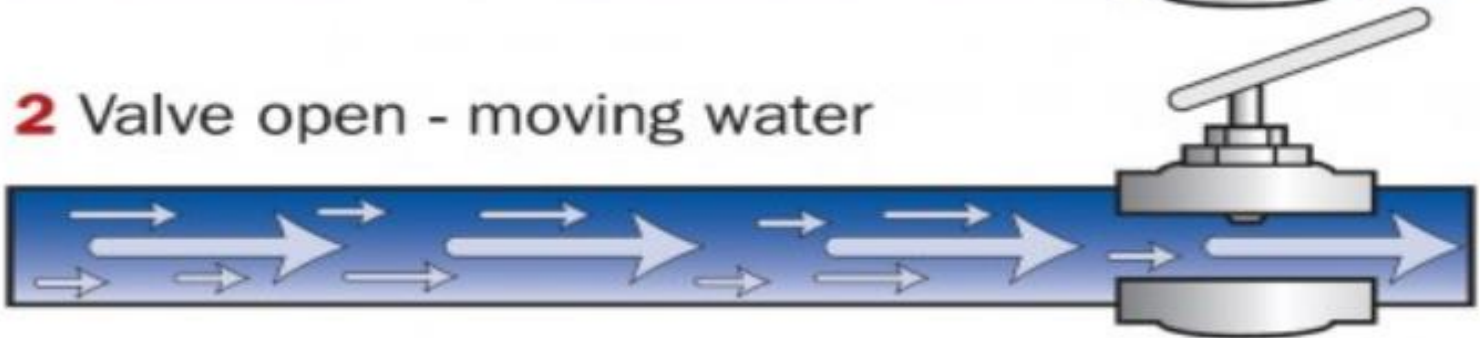
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 degree = 0.0175 rad.

Water Hammer

1 Valve closed - water still



2 Valve open - moving water



3 Valve closes - **WATER HAMMER**



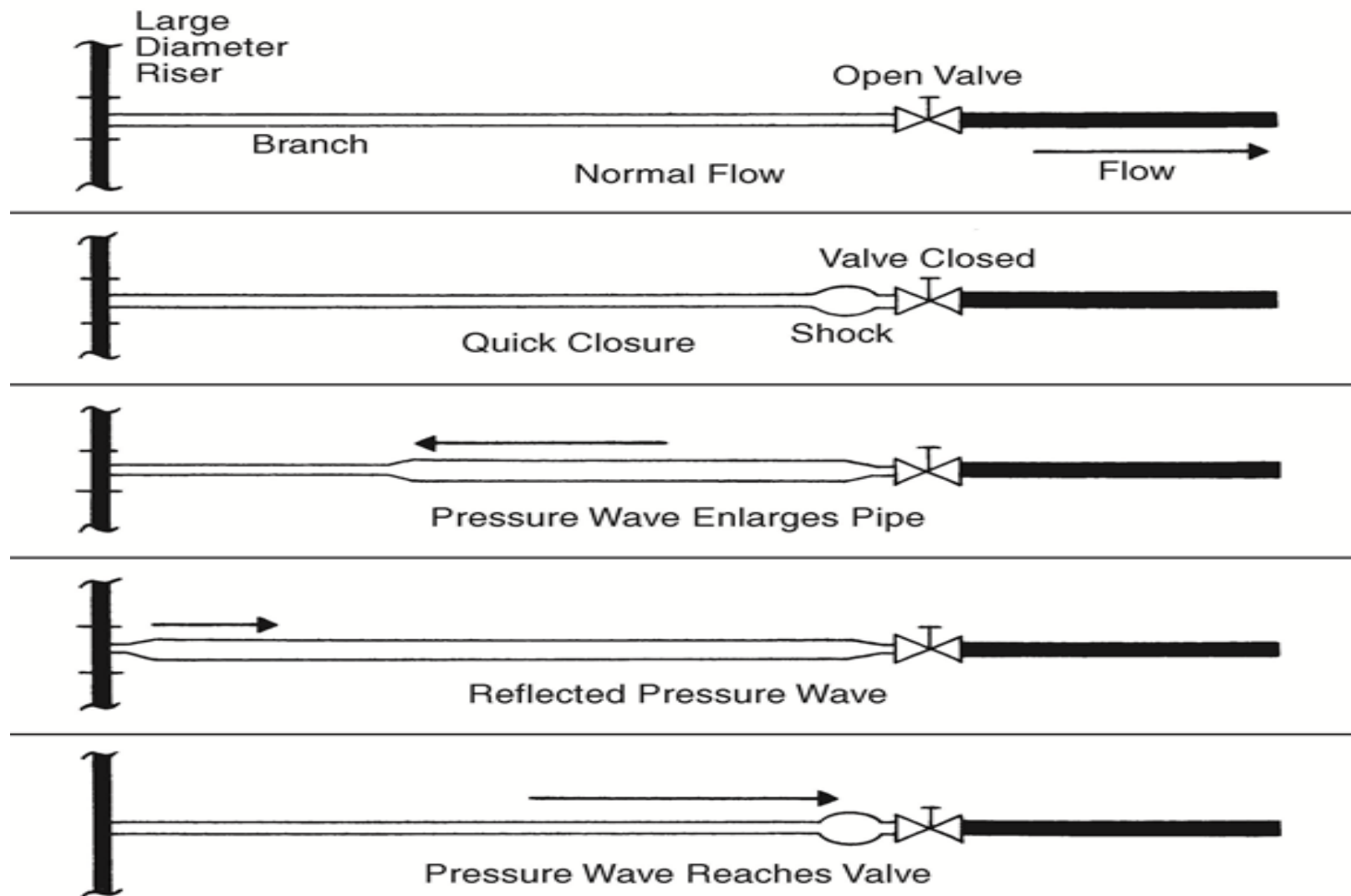


Illustration adapted from Plumbing & Drainage Institute, Standard PDI-WH201.

Figure 5-5 Illustrations of a Shock Wave

