Block D: Drainage Systems

Block D: Drainage Systems

BC Plumbing Apprenticeship, Level 2

SKILLED TRADES BC

BC PIPING ARTICULATION AND CURRICULUM SUBCOMMITTEE; ROD LIDSTONE; AUDREY CURRAN; AND PAUL SIMPSON

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In the field, there are many similarities or overlaps with the work of plumbers and gas fitters. Many plumbing and heating contractors employ both plumbers and gas fitters as well as tradespeople with dual certifications.

Upon completion of a Plumbing Apprenticeship, a plumber can receive cross-program credit for a portion of the Gas fitter apprenticeship. As such, training in fuel gas has been incorporated into all levels of the Plumbing Apprenticeship.

Block D of the **Plumbing Apprenticeship Program Level 2 Series** focuses on the fundamentals of sanitary and storm drainage systems, providing apprentices with a comprehensive understanding of installation, maintenance, and repair processes. This section equips apprentices with essential skills to handle the complexities of both sanitary and storm drainage systems, ensuring effective installation and upkeep in various settings.

Plumbing Apprenticeship Program Level 2 Series

The *Plumbing Apprenticeship Program Level 2 Series* offers comprehensive training materials designed to build on foundational skills and knowledge. The series is divided into four main blocks, each focusing on critical areas of plumbing systems and installations.

Block A: Fuel Gas Systems (https://a-fuelgas-bcplumbingapprl2.pressbooks.tru.ca/)

A-1: Gas Fired Appliances
A-2: Gas Codes Regulations and Standards
A-3: Gas Appliance and Building Air Requirements
A-4: Technical Instruments and Testers

Block B: Heating and Cooling Systems (https://b-heating-bcplumbingapprl2.pressbooks.tru.ca/)

B-1: Types of Heating and Cooling Systems
B-2: Hydronic Heating and Cooling Generating Equipment
B-3: Hydronic Heat Transfer Units
B-4: Hydronic Heating Piping and Components

Block C: Install Fixtures and Appliances (https://c-plumbfixappliance-bcplumbingapprl2.pressbooks.tru.ca/)

C-1: Plumbing Fixtures and Trim
C-2: Plumbing Appliances

Block D: Drainage Systems (https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/)

D-1: Sanitary Drain, Waste and Vent Systems
D-2: Planning and Installation of DWV Systems
D-3: Storm Drainage Systems
D-4: Test and Drainage Systems
D-5: Drainage System Maintenance and Repairs

Plumbing Apprenticeship Program Overview and Upcoming Resources

- **Plumbing Apprenticeship Program Level 1 Series** is coming soon to TRU Open Press in 2025–2026!
- **Plumbing Apprenticeship Program Level 3 Series (https://collection.bccampus.ca/search/?q=%22pl3%22)** can be found in the BCCampus Open Collection (https://collection.bccampus.ca/).
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Safety Advisory

The current Standards and Regulation in BC can be obtained at the WorkSafeBC (http://www.worksafebc.com) website: http://www.worksafebc.com

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Symbol Legend

Important Information

Potentially Toxic/ Poisonous Situation

Required or Optional Resources

Potentially Flammable Situation

Complete a Self-Test

Possibly Explosive Situation

Use Protective Equipment

Potential Electric Shock

Acknowledgments

The development of the *Piping Trades Learning Guides* was a collaborative effort driven by a commitment to excellence in trades education. These guides were created to support apprentices and journeypersons in mastering the skills and knowledge essential to the piping trades. This achievement would not have been possible without the dedication and expertise of *Skilled Trades BC* and the *Piping Trades Articulation Committee*, whose leadership and guidance have been instrumental in shaping high-quality training resources. We extend our sincere gratitude for their contributions and ongoing stewardship in advancing the piping trades.

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The Open Press combines TRU's open platforms and expertise in learning design and open resource development to support the creation and reuse of open educational resources, while encouraging open scholarship and research.

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References

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Trades Training BC. (2021). A-1: Introduction to gas-fired appliances. In: *Plumber Apprenticeship Program: Level 2*. Industry Training Authority, BC.

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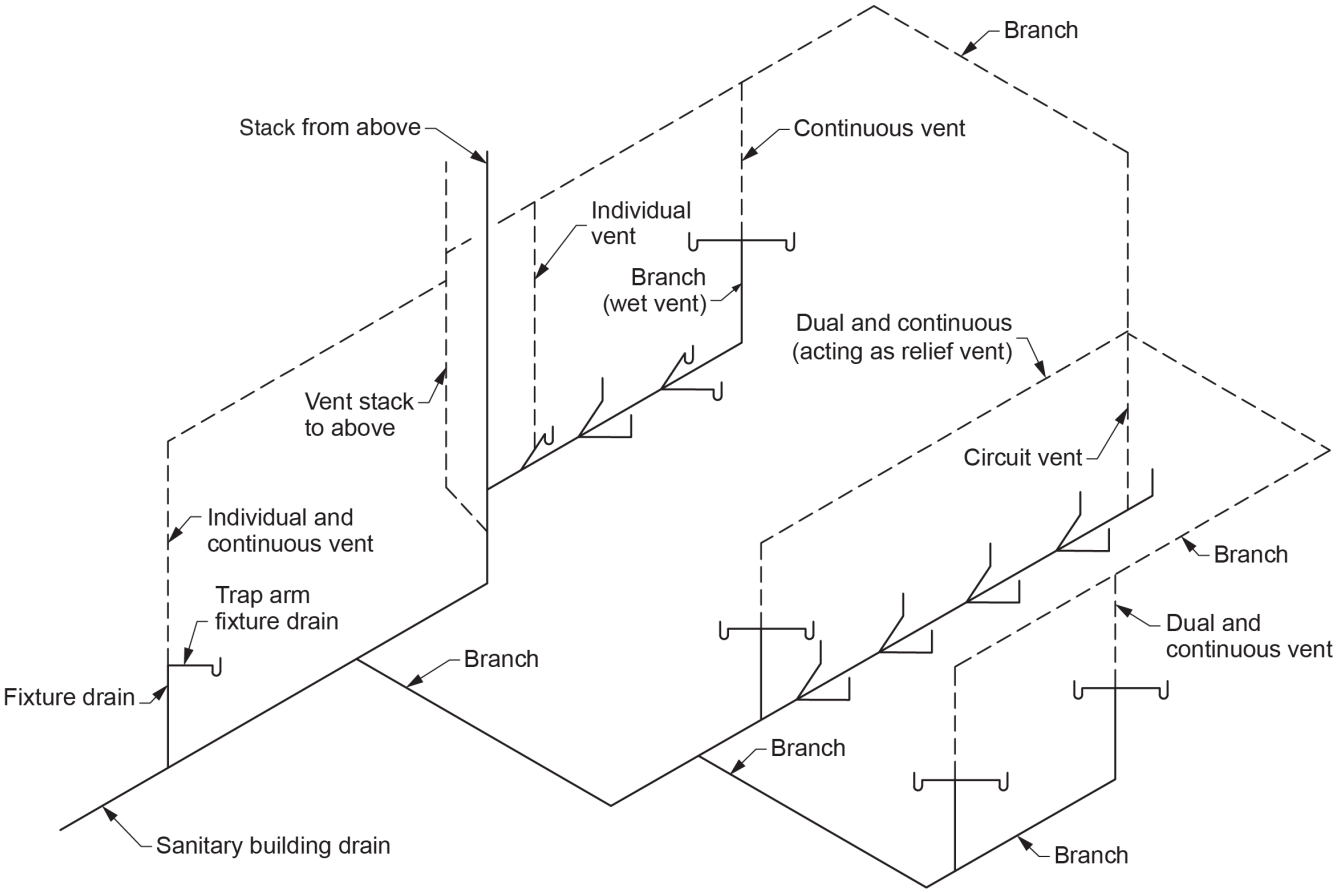
Plumber Apprenticeship Program – Level 2



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D-1 Sanitary Drain, Waste, and Vent Systems Introduction

The drain, waste, and vent (DWV) system is perhaps the most important part of the total plumbing system in a building. The sanitary drainage system is a circuit of piping designed to remove the wastewater from the plumbing fixtures in a building and drain the fixtures safely, reliably, and efficiently. Sanitary and storm drainage systems are required to meet the code regulations set out by the British Columbia Plumbing Code.

Learning Objectives

After completing the chapters in this section, you should be able to:

- Describe codes, regulations, standards, and agencies related to the plumbing industry.
- Describe terminology and definitions for DWV systems used in the National Plumbing Code.
- Describe functions of pipes used in DWV systems.
- Identify code requirements for drainage piping in DWV systems.
- Identify code requirements for venting piping in DWV systems.
- Identify prohibitions and requirements when installing DWV systems.
- Identify requirements of trade waste systems.

Resources

You will be required to reference the most current National Plumbing Code.

Terminology

The following terms will be used throughout this section. A complete list of terms for this section can be found in the **Glossary**.
Please also see the separate NPC Definitions for DWV Systems in Section D-1.2.

- **acrylonitrile-butadiene-styrene (ABS) pipe**: A type of plastic pipe that is lightweight, strong, and resistant to damage. It is often used in homes and buildings for carrying waste and venting air. However, because it can catch fire, it is usually only used in certain types of buildings. (Section D-1.4)
- **Applied Science Technologists and Technicians of BC (ASTTBC):** The association for technology professionals and regulatory body that certifies wastewater professionals in BC. The ASTTBC registers practitioners once they have obtained the proper training. (Section D-1.1)
- **BC Plumbing Code (BCPC):** The plumbing standard for British Columbia, historically based on the National Plumbing Code of Canada. (Section D-1.1)
- **bell trap:** A type of drain used in the past, often in floor drains. Installation is prohibited by the NPC because it can cause problems with draining. (Section D-1.10)
- **certification mark**: A special symbol or label on a product (such as ASME) that shows it has been tested and approved to meet safety and quality standards. It proves that the product is safe to use and works properly. Note about ASME certification marks: the ASME "H" or "U" stamp is used on pressure vessels, boilers, and piping systems to indicate compliance with ASME codes. In plumbing, ASME standards apply to products like pipes, fittings, and fixtures, but the products themselves often carry certification marks from testing organizations like CSA, NSF, or UL, which certify that they meet ASME standards. (Section D-1.1)
- **chemical-dosing neutralization systems:** Systems that use controlled injection of acid or base into a waste stream to neutralize chemicals. The chemicals react to form a salt and water mixture, which is then discharged. (Section D-1.11)
- **cleanout:** An access point installed in drainage and venting systems for cleaning and inspection services. **(**Section D-1.2; Section D-1.3; Section D-2.3)
- **co-extruded dual-wall pipe:** A pipe that has two layers, with a smooth inside and a stronger outside. The extra layer makes it more durable and better for certain drainage and sewer systems. (Section D-1.4)
- **combustible piping:** Pipes made from materials that can burn, such as ABS and PVC, which have specific installation restrictions. (Section D-1.4)
- **drainage system:** An assembly of pipes, fittings, fixtures, and traps used to convey sewage, clear-water waste, or stormwater to a public sewer or private sewage disposal system. It does not include subsoil drainage pipes. (Section D-1.1)
- **DWV system:** Stands for Drain, Waste, and Vent system, which removes wastewater and vent gases from a building, ensuring proper drainage and pressure balance. (Section D-1.3; Section D-2.3)
- ***Environmental Management* Act:** A law that helps protect the environment by making sure people and businesses follow rules about pollution, waste, and how they use natural resources. It helps keep the air, water, and land clean and safe for everyone. (Section D-1.1)
- **fixture unit load:** A way to measure how much water a plumbing fixture, like a sink or toilet, uses. It helps plumbers figure out how big the pipes need to be to handle the amount of water that flows through them. Each fixture has a specific number of fixture units based on how much water it uses. The higher the

number of fixture units, the more water the fixture needs. (Section D-1.5)

- **flame spread rating (FSR):** A classification that indicates how quickly flames spread along a material's surface, relevant for building code compliance. (Section D-1.4)
- **forcemain:** A pressurized sewer system that transports wastewater using pumps when gravity flow is insufficient. (Section D-1.4)
- **grease interceptor:** A device used to trap fats, oils, or grease from wastewater before it enters the drainage system, often used in kitchens, restaurants, or care facilities. (Section D-1.10)
- **hydraulic load:** The amount of water moving through a system, like pipes or drains, over a certain time. Imagine pouring water into a funnel—if you pour too much too fast, it overflows. In plumbing and wastewater systems, hydraulic load helps us understand how much water a system can handle before it gets too full or backs up. (Section D-1.5)
- **indirect connections:** Plumbing connections where a fixture or device is not directly connected but instead terminates above the flood level rim of a directly connected fixture, forming an air break. This type of connection is designed to prevent backflow. (Section D-1.10)
- **limestone chip neutralization:** A method where acidic waste is neutralized by mixing it with limestone chips (calcium carbonate). The process produces a chemical reaction that neutralizes the acid, and the mixture is then discharged. (Section D-1.11)
- **municipal bylaws**: Rules made by a city or town to help keep things safe and organized, like where buildings can be built and how plumbing systems should be set up. (Section D-1.1)
- **National Plumbing Code (NPC):** A model plumbing code developed by the National Research Council of Canada, updated every five years. (Section D-1.1)
- **non-combustible piping:** Pipes made from materials like cast iron and copper that do not burn and are often required in fire-rated construction. (Section D-1.4)
- **p-trap:** A U-shaped pipe that prevents sewer gases, odors, and pests from entering a building by maintaining a water seal. (Section D-1.3)
- **S-trap:** (Section D-1.10)
- **sanitary building drain:** A building drain that conducts sewage to a building sewer from the most upstream stack, branch, or fixture drain serving a water closet. (Section D-1.2; Section D-1.3)
- **seismic restraint:** The components and systems installed to protect mechanical systems, including piping, from seismic forces, ensuring that the system can withstand the stresses of an earthquake. (Section D-1.10)
- **trap arm:** The portion of a fixture drain between the trap weir and the vent pipe connection. (Section D-1.3)
- **vent hierarchy:** A system that classifies plumbing vents based on their role in the drainage system. As vents connect, their names change, determining their size and function. Smaller vents, like individual and branch vents, combine into larger ones, such as vent stacks and headers. This system ensures proper airflow and prevents sewer gas buildup. (Figure 22, Section D-1.3)

D-1.1 Codes and Standards

Codes and Standards

A standards organization's primary activities are developing technical codes and standards that are intended to address the needs of the industries that adopt them. The main purpose of building codes is to protect public health, safety, and general welfare because building codes relate to the construction and occupancy of buildings and structures. A standard is a document that provides requirements, specifications, guidelines, or characteristics that can be used consistently to ensure that materials, products, processes, and services are fit for their purpose.

Standards used in the construction industry cover a range of topics but are usually in one of the following categories:

- **Test or measurement standards** that provide information on the acceptability (pass/fail) in a performance category, usually under some standard condition (fire separation ratings), or that provide data that can be used to determine acceptability or performance.
- **Procedural standards** that detail how products or systems are to be installed, used, maintained, tested, or operated to be safe, reliable, and fit for their intended use.

National Standards System

The National Standards System is the network of organizations and individuals involved in voluntary standards development, promotion, and implementation in Canada. Under the Standards Council of Canada Act, the Standards Council of Canada (SCC) is mandated with overseeing the National Standards System. The SCC is a federal non-profit Crown corporation responsible for coordinating voluntary standardization in Canada. It is also responsible for Canada's activities in voluntary international standardization.

Canadian Standards

Plumbing codes contain many references to standards published by accredited standards development organizations in Canada. As part of the accreditation requirements, these organizations adhere to the principles of consensus. This generally means substantial majority agreement of a committee — comprising a balance of producer, user, and general-interest members — and the consideration of all negative comments. The organizations also have formal procedures for the second-level review of the technical preparation and balloting of standards prepared under their auspices. The Canadian Commission on Building and Fire Codes (CCBFC) follows these same principles of consensus in the operation of its code development process.

The following organizations are accredited as standards development organizations in Canada:

- American Society for Testing and Materials International (ASTM)
- Bureau de normalisation du Quebec (BNQ)
- Canadian General Standards Board (CGSB)

- Canadian Standards Association (CSA)
- ULC Standards (ULC)
- Underwriters' Laboratories (UL)

Non-Canadian Standards

A number of subject areas for which the Canadian standards development organizations have not developed standards are covered in the National Plumbing Code of Canada. In these cases, the code often references standards developed by organizations in other countries, such as the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), and the National Fire Protection Association (NFPA). These standards are developed using processes that may differ from those used by the Canadian standards development organizations; nevertheless, these standards have been reviewed by the relevant standing committees and were found to be acceptable.

Certifications

Products are considered "listed" or "approved" when they have been tested and certified by an accredited certification organization. They appear in a list of certified products in either an electronic or hard copy directory published by that organization. Testing and certification involves an initial independent, third-party evaluation of a product to determine if the product conforms to applicable standards.

The following certification organizations have been accredited to test/certify plumbing products for Canada: BNQ, IAPMO, ICC, LabTest, NSF, QAI, UL & ULC, and the Water Quality Association (Figure 1). Products that do not bear one of the following marks may not be appropriate for sale and installation in all jurisdictions and, in some cases, may create health and safety issues.

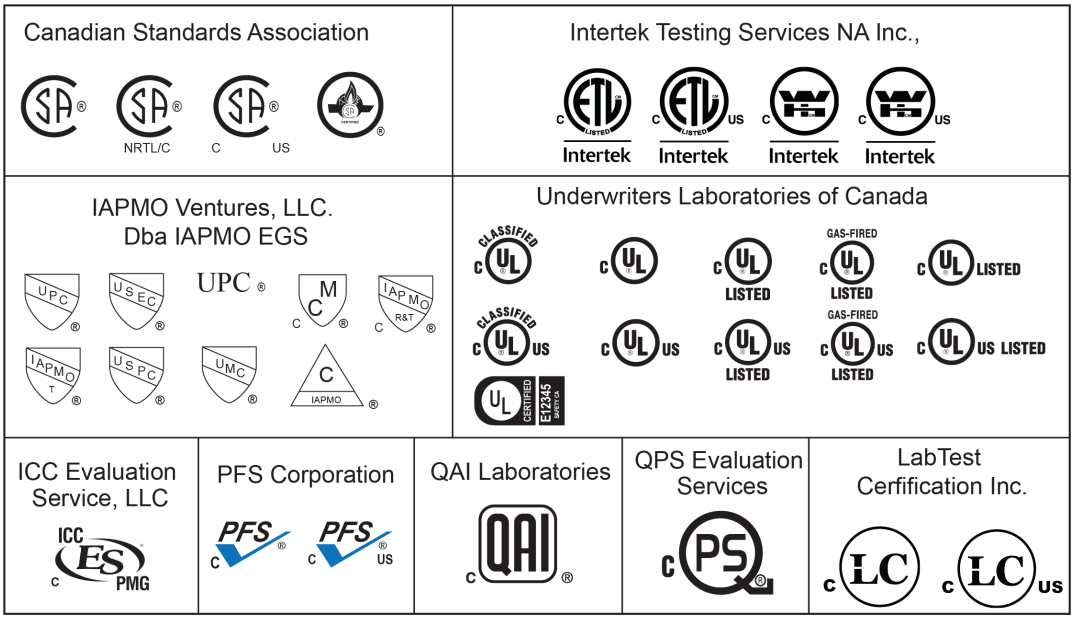

Figure 1 *Certification marks currently accepted in Canada. (CSA, 2020). Used with permission.*

Each organization's scope of accreditation and certification marks can also be accessed at the Standards Council of Canada (SCC) (https://scc-ccn.ca/accreditation).

A certified product is required to bear the certification mark. Some fixture manufacturers acknowledge that customers want an mark-free aesthetic and choose to mark their product with a permanent adhesive label designed to be removed after inspection and that will also self-destruct so that it cannot be placed on another product. If an adhesive label is accidentally removed prior to inspection, the inspector has no choice but to assume that the product is uncertified and request its removal. Therefore, it is important that contractors and consumers maintain proof of the product certification compliance on the product (in addition to the carton, installation instructions, warranty and homeowner's manual, and specification sheet) until after inspection.

Government Roles in Code Enforcement

Provincial and territorial authorities with jurisdiction are responsible for:

- Adopting and enforcing laws and regulations
- Providing interpretation of these laws and regulations
- Providing training and education
- Establishing roles and responsibilities of trades people and professionals

Local Government Systems in BC

BC's local government system is unique in Canada, accommodating diverse local governance structures within a federated model that provides local services and governance to communities throughout BC. One hundred and 62 municipalities and 27 regional districts serve urban and rural communities in virtually all areas of BC.

The first municipalities predate the establishment of British Columbia as a province. Regional districts were created in the mid-1960s. Other local service bodies, such as improvement districts (not local governments), continue to exist in some areas.

Municipalities in BC

Municipalities in BC are responsible for providing local services and governance to approximately 89% of the province's population. There are currently 162 municipalities, ranging in population from just over 100 to over 630,000 people and ranging in size from 63 hectares to over 8,500,000 hectares.

Municipalities can be classified as either a town, village, district, or city, depending on the size and density of their population. An older classification, township, is still referenced in the names of some municipalities; townships are currently classified as districts. Municipalities were first established in BC in the late 1800s. Since then, the roles and responsibilities of municipalities have evolved to become more complex. The BC government sets the legislation that provides municipalities with the authority and flexibility to respond to the varying needs and changing circumstances of each community. Within that framework, the BC government regards municipalities as autonomous, responsible, and accountable governments directed by democratically elected councils.

Most municipalities are incorporated by the BC government through the issuance of a legal document called a letters patent. Each letters patent contains the name of the municipality, describes or represents its boundary, and establishes its classification. Early municipalities were incorporated by the colonial or provincial legislature under legislative acts, although the power to create new municipalities in response to local interest was granted to the Provincial Cabinet in 1910.

The City of Vancouver is an enduring example of a municipality created and operating under a distinct piece of legislation (Vancouver Charter). On rare occasions, a municipality has also been created by special legislation, such as the City of Powell River and the Resort Municipality of Whistler.

Municipal Powers

Core municipal powers and responsibilities are set out in the Local Government Act and Community Charter. For the City of Vancouver, its key powers and responsibilities are set out in the Vancouver Charter. Other legislation may also provide important authorities or requirements for municipalities, including the Motor Vehicle Act, Environmental Management Act, and the Building Act.

Municipalities generally have some of the broadest service authorities in Canada to provide whichever services they consider necessary or desirable for the community. Municipalities may provide services directly or indirectly — for example, through the regional district, with a private partner, or with another government. Municipalities are not responsible for schools, social assistance, or hospitals. These are a provincial responsibility exercised directly or through other bodies.

Municipal Bylaws

Municipal councils and regional district boards may only make decisions by bylaw or resolution. Bylaws are laws that formalize rules made by a council or board. Local governments may use bylaws for various purposes, especially to regulate, prohibit, or impose requirements. Local bylaws will require you to apply for building and plumbing permits, for example.

Bylaws are laws passed by municipal councils and regional district boards to exercise their statutory authority. Bylaws may be used for a variety of different purposes, including:

- Establishing meeting procedures
- Regulating services
- Prohibiting an activity
- Requiring certain actions

Bylaws and the Building Act

The Community Charter of BC states that municipalities are "... subject to any specific conditions and restrictions established under this or another Act" and that "a provision of a municipal bylaw has no effect if it is inconsistent with a Provincial enactment."

The Building Act of BC (enacted 2015) also states that "… a local building requirement … has no effect to the extent that it relates to a matter that is subject to a requirement, in respect of building activities, of a (provincial) building regulation…."

Prior to the Building Act, local governments had the authority to set technical building requirements in their bylaws that differed from those set by the province in the BC Building Code. To bring greater consistency to the technical building requirements in force across BC, the Building Act gives the province sole authority to establish these requirements.

Under Section 5 of the Building Act, if a matter is regulated in a provincial building regulation, any requirements for that matter established in bylaws by local governments will be of no legal force after December 15, 2017.

When a provincial building regulation does not regulate a matter (e.g., requirements relating to fencing or erecting a freestanding sign), local governments may regulate such matters if they determine they have legislative authority to do so.

Basically, this means that local bylaws cannot supersede the requirements of building codes.

Note that the Building Act does not apply to the city of Vancouver. Under the Vancouver Charter, Vancouver has authority to set its own building requirements through bylaw and to determine the qualification requirements for the city's building officials. It also has its own appeal process for building bylaw disputes.

Permits

Depending on the scope of the work you are proposing, you may also need a building permit, development permit, or both.

Building Permits

You will need a building permit if you plan to:

- Construct a new building
- Make any addition to an existing building
- Alter the structure of a building
- Renovate, repair, or add to a building
- Demolish or remove all or a portion of a building
- Change a building's use
- Build a garage, balcony, or deck
- Excavate a basement or construct a foundation

Plumbing Permits

Plumbing permits are required for the construction of all associated systems and must be obtained before construction begins.

A plumbing permit is required if you want to:

- Install, change, or upgrade any part of a plumbing system
- Do repair or replacement work if you have to:
    - Open walls
    - Move pipes
    - Change other plumbing or pipes

If your company is a licensed gas contractor, you will require a gas permit to install or replace a gas-fired appliance, such as a fireplace, hot water tank, boiler, furnace, or kitchen stove. A permit is also required if you are installing or altering the associated gas pipes and appliance vents.

If you are constructing a new dwelling, you will require a building permit prior to being issued a gas or plumbing permit. A plumbing permit is NOT required for clearing stoppages or repairing leaks in pipes, valves, or fixtures.

Plumbing permits are issued by your local municipal building department. Gas permits are typically issued by Technical Safety BC. In some instances, gas installation permits might also be offered by municipal departments.

The permit process is generally the same for all types of projects, but there may be more specific requirements for some commercial construction and industrial projects.

Permit Application

A completed permit application is required prior to beginning the permit-issuing process. Permit applications are available through the authority having jurisdiction (AHJ). Typical required information includes who will perform the work and what, where, and how the work will be completed. Drawings, plans, or other documentation of the proposed work may be required. Permit fees are usually due at the time of application.

Review Process

During the review process, staff determine if the project is in compliance with the applicable codes and other local ordinances and statutes. The length of the review process depends on the type and complexity of the project. Many small residential applications can be processed in one day.

Permit Approval

When compliance with the code and other applicable statutes is determined, the permit application is approved. Once all final permit fees are paid, the permit is issued.

However, if the permit application is not approved or a review has failed, the permit application as submitted will be denied. When a permit application is denied, corrections to the application shall be made and the application is resubmitted for final approval.

Permit Execution

There are various stages involved in executing any building permit.

Construction

During the entire construction phase, the permits must be placed in a prominent place at the project site. A copy of the approved building plan and other related documents must also be maintained at the site.

Inspections

Each major phase of construction must typically be inspected by an inspector or similar authority to ensure that the work conforms to the code, permit, and approved plans. Inspection requests may be made via internet, by phone, or in person. Normally, the response is one business day after the request is made.

Field Changes

Most changes will require a review and approval in the same manner as the original application. Proposed revisions or alterations must be brought to the attention of the permit staff before making changes in the field.

Project Completion

When the project is completed and code compliance is determined, the inspector issues a final inspection. The final inspection marks the completion of the project and grants permission to occupy a building with the knowledge that it has met the minimum safety standards as required by the code.

Plumbing Codes

The **BC Plumbing Code (BCPC)** is the standard for the province of BC and has historically been substantially based on the National Plumbing Code (NPC) of Canada.

The NPC was developed by the National Research Council with collaboration from provinces and territories. The National Codes are updated approximately every five years. The NPC is a model code in the sense that it helps promote consistency among provincial and territorial plumbing codes.

In Canada, provincial and territorial governments have the authority to enact legislation that regulates the design and installation of plumbing systems within their jurisdictions. This legislation may include adopting the NPC without change or with modifications to suit local needs and enacting other laws and regulations regarding plumbing system

design and installation, including the requirements for professional involvement. People involved in designing or installing plumbing systems should consult the provincial or territorial government with jurisdiction to find out which plumbing code is applicable

In the past, BC has produced an updated consolidated BCPC to reflect NPC updates and any unique provincial needs. Over time, these two codes have become harmonized to the point that, in 2024, the province of BC announced they would adopt the NPC rather than produce a separate BCPC.

The BC Information Bulletin stated that as of March 8, 2024, "The British Columbia Building Code 2024 Book I (General) (Building Code) adopts the British Columbia Building Code Book II (Plumbing Systems) by reference in Part 7 of Division B, it also effectively states that the British Columbia Building Code 2024 Book II (Plumbing Systems) is the National Plumbing Code of Canada 2020" (NPC 2020).

Plumbing code users will follow the provisions relevant to plumbing systems in the BC Building Code, such as Part 1 of Division A and Part 7 of Division B, together with the NPC. This means that even though provincial documents — and this textbook — may still refer to the relevant plumbing code as the BCPC, the official document is essentially the NPC. The electronic versions of the BC Codes are available on the BC Codes (https://www.bccodes.ca) website.

The NPC sets out technical provisions for designing and installing new plumbing systems. It also applies to the extension, alteration, renewal, and repair of existing plumbing systems. The NPC establishes requirements to address the following four objectives, which are fully described in Division A of the code:

- Safety
- Health
- Protection of buildings and facilities from water and sewage damage
- Environment

The NPC is not a textbook on plumbing system design or installation. The design of a technically sound plumbing system depends upon many factors beyond simple compliance with plumbing regulations. Such factors include the availability of knowledgeable practitioners who have received appropriate education, training, and experience and who have some degree of familiarity with the principles of good plumbing practice and experience using textbooks, reference manuals, and technical guides.

The NCPC provides the minimum requirements for:

- Drainage systems for water-borne wastes and storm water for buildings to the point of connection with public services,
- Venting systems
- Water service pipes
- Water distribution systems

The NPC does not list acceptable proprietary plumbing products. It establishes the criteria that plumbing materials, products, and assemblies must meet. Some of these criteria are explicitly stated in the NPC, while others are incorporated by reference to material or product standards published by standards development organizations.

Numbering System

A consistent numbering system has been used throughout codes in Canada: The first number indicates the part of the

code; the second is the section in the part; the third is the subsection; the fourth is the article in the subsection; and so on. The detailed provisions are found at the sentence level (indicated by numbers in brackets), and sentences may be broken down into clauses and subclauses. This structure is illustrated in Table 1.

Table 1: Numbering System for Codes

Number	Category	Example
1st	Part	3.
2nd	Section	3.5.
3rd	Subsection	3.5.2
4th	Article	3.5.2.1.
5th	Sentence	3.5.2.1.(2)
6th	Clause	3.5.2.1.(2)(a)
7th	Subclause	3.5.2.1.(2)(a)(i)

Change Indication

Where a technical change or addition has been made relative to a new edition, a vertical line has been added in the margin next to the affected provision to indicate the approximate location of new or modified content. No change indication is provided for renumbered or deleted content.

Wastewater Treatment and Disposal

Wastewater is approximately 99% water. The remainder is composed of a mix of organic wastes, detergents, cleaning chemicals, and anything else poured or flushed down indoor drains. Wastewater contains chemicals and micro-organisms that can threaten public health and damage the environment.

A building permit cannot be issued unless the building is connected to a public or private onsite sewage system.

Onsite Sewage Systems

Onsite sewage systems are installed in areas that are not served by a public **sanitary sewer** network. Onsite sewage systems are effective at treating household sewage if they are designed and installed properly in appropriate soil and maintained regularly. In typical onsite sewage systems, the wastewater from toilets and other drains flows from your house into a tank that separates the solids and scum from the liquid. Bacteria help break down the solids into sludge. The liquid flows out of the tank into a network of pipes buried in a disposal field of gravel and soil. Holes in the pipes allow the wastewater to be released into the disposal field. These systems can be efficient and cost-effective and can protect health and the environment. However, they must be properly planned, installed, and, above all, properly maintained.

Enacted in 2005, the Sewerage System Regulation (SSR) applies to all smaller systems, including those for houses, small businesses, and even small community systems. Compared to the previous Sewage Disposal Regulation, the SSR includes a significant change in approach. The new approach is performance-based, and responsibility for the proper design and

installation of onsite systems has been transferred for the most part from health authorities to "authorized persons," as defined by the SSR.

BC Sewerage System Regulation

The **Sewerage System Regulation** replaced the old **Sewage Disposal Regulation**. This regulation — along with the companion document, the Sewerage System Standard Practice Manual — shifted the focus of managing onsite sewerage systems by using an outcome-based approach to wastewater management to allow for greater flexibility in how the systems are regulated.

An onsite sewerage system is usually located on the land from which sewage originates. This type of system locally treats effluent that is not serviced by a larger municipal or regional sewerage system.

The Sewerage System Regulation, under the Public Health Act, covers holding tanks for sewage effluent or onsite sewerage systems that:

- Process a sewage flow of less than 22,700 L per day
- Serve single-family systems or duplexes
- Serve different buildings on a single parcel of land
- Serve one or more parcels on strata lots or on a shared interest of land

The regional health authorities are responsible for accepting applications and fees for onsite sewerage systems submitted by homeowners or by industry professionals acting on their behalf. Authorized people install, repair, and maintain onsite sewerage systems.

Site investigations of sewerage systems may be initiated in cases where systems are suspected to be negatively affecting a drinking water supply (e.g., as a result of system failure) or causing a health hazard, as per the Public Health Act.

Agencies and Organizations

Wastewater is regulated by two provincial agencies:

- **The Ministry of Environment and Climate Change Strategy:** regulates large community wastewater systems under the Environmental Management Act and the Municipal Wastewater Regulation.
- **The Ministry of Health:** regulates smaller, generally private, domestic sewerage systems, including on-site septic systems, under the Public Health Act and the Sewerage System Regulation.

There are a number of associations that support the wastewater treatment and disposal industry:

- **BC Onsite Sewage Association (BCOSSA) and Western Canada Onsite Wastewater Management Association (WCOWMA):** develop educational programs for onsite wastewater practitioners and provide technical information to industry stakeholders and practitioners.
- **Applied Science Technologists and Technicians of BC (ASTTBC):** the association for technology professionals in British Columbia. The ASTTBC also registers practitioners once they have obtained the proper training.
- **Association of Professional Engineers and Geoscientists of British Columbia (APEGBC):** the licensing body for professional engineers and geoscientists. Only professional engineers and geoscientists are permitted to construct

and/or maintain a Type 3 sewerage system.

- **BC Water and Waste Association (BCWWA):** supports over 3,700 water and wastewater professionals in BC and the Yukon with training, educational opportunities, technology transfer, and networking opportunities.
- **Onsite Wastewater Registration Program (ASTTBC):** provides information for onsite wastewater service providers.

Self-Test D-1.1: Codes and Standards

Complete Self-Test D-1.1 and check your answers.

If you are using a printed copy, please find Self-Test D-1.1 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=5#h5p-1 (https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=5#h5p-1)

References

Government of British Columbia. (2024). *British Columbia Building Codes*. https://www.bccodes.ca/index.html

Skilled Trades BC. (2021). *Book 2: Install fixtures and appliances, install sanitary and storm drainage systems.* Plumber apprenticeship program level 2 book 2 (Harmonized). Crown Publications: King's Printer for British Columbia.

Standards Council of Canada. (n.d.). *Accreditation*. https://scc-ccn.ca/accreditation

Trades Training BC. (2021). D-1: Install sanitary drain, water and vent systems. In: *Plumber Apprenticeship Program: Level 2*. Industry Training Authority, BC.

Media Attribution

- Figure 1 CSA B149.1:20, Natural gas and propane installation code. ©2020 Canadian Standards Association. (Please visit store.csagroup.org (http://store.csagroup.org))

D-1.2 DWV Terminology

Terminology: NPC Definitions for DWV Systems

Standardized terminology is an important communication tool for interpreting code regulations and for on-site communication with co-workers and local inspectors. For professional plumbers, knowing these terms and their applications is essential.

This section defines key terms related to DWV (Drainage, Waste, and Vent) Systems, many of which be used throughout *Block D: Drainage Systems*. The terminology provided here is based on the 2020 *National Plumbing Code* (NPC), available online.

additional circuit vent: a vent pipe installed between a circuit vent and a relief vent (Figure 1) to provide additional air circulation.

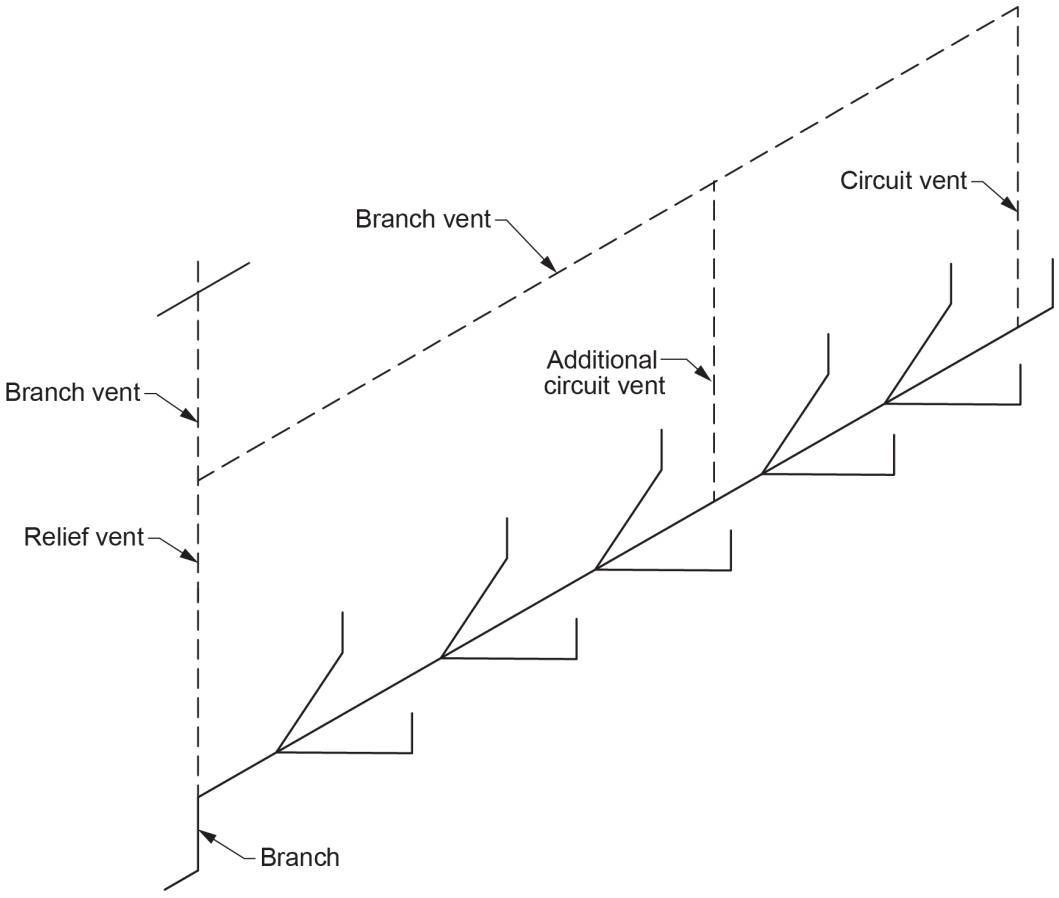

Figure 1 *Additional circuit vent. (Skilled Trades BC, 2021) Used with permission.*

air admittance valves: mechanical valves that simulate vents. They allow air to be drawn into the waste plumbing system under negative pressure to prevent siphoning but prevent any air from escaping the plumbing system under positive pressure. Air admittance valves (Figure 2) should be installed in an accessible, ventilated area. These devices are sometimes an acceptable alternative to conventional venting in applications where installing a conventional vent is not possible.

Figure 2 *Air admittance valve. (Skilled Trades BC, 2021) Used with permission.*

To meet the conditions required by British Columbia Plumbing Code, ensure that your valve conforms to the ASSE 1051 standard.

air break: a method of indirectly connecting a drainage pipe to another drainage pipe. An air break (Figure 3) is created by leaving an unobstructed vertical gap between the discharge of a fixture and the receptacle that receives it. This distance must be at least 25 mm (1 in.) or the size of the upper drain pipe, whichever is greater. This is commonly used to protect fixtures used to store and prepare food, drinking fountains, ice makers, and many other devices that must be protected from contamination due to a direct connection.

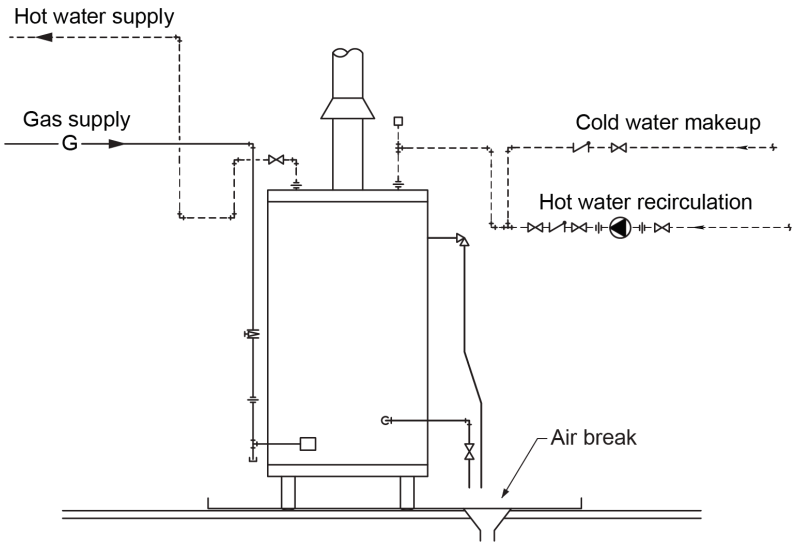

Figure 3 *Air break. (Skilled Trades BC, 2021) Used with permission.*

authority having jurisdiction (AHJ): the governmental body responsible for enforcing any part of the NPC.

backflow: a reversal of the normal direction of the flow.

backwater valve: a one-way flow control valve installed in a drainage system. Backwater valves (Figure 4) are required to protect fixtures and drainage openings installed below grade, such as in a basement, where the possibility exists for the municipal sewage or stormwater systems to become overloaded and force wastewater back through your drains. Backwater valves are also required on any subsoil drainage pipe that connects into the sanitary drain to protect it from sewage backups.

Figure 4 *Backwater valve. (Skilled Trades BC, 2021) Used with permission.*

Under normal conditions, it allows the wastewater to drain out of the system (Figure 5), but if a reversal of flow should occur, the valve is forced closed and protects the interior of the building from sewage backup.

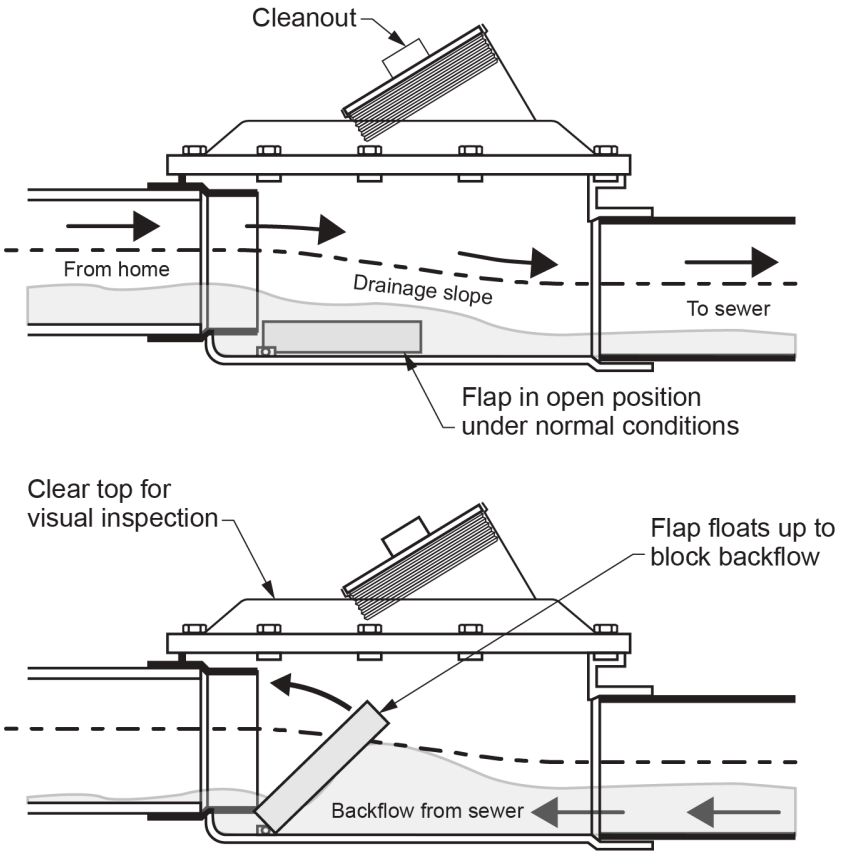

Figure 5 *Backwater valve operation. (Skilled Trades BC, 2021) Used with permission.*

bathroom group: a group of plumbing fixtures installed in the same room, consisting of one domestic lavatory, one water closet, and either one bathtub (with or without a shower) or one single-head shower. The intent is that these three fixtures are located in a room occupied by only one person, so they are not normally in simultaneous use.

branch: a sanitary drainage pipe connected at its upstream end to the junction of two or more sanitary drainage pipes or to a stack and connected at its downstream end to another branch, a sump, a stack, or a building drain (Figure 6).

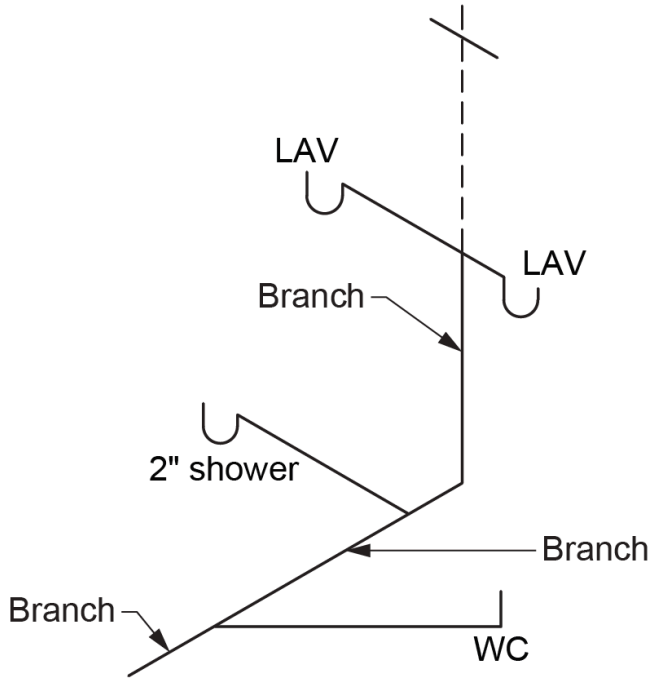

Figure 6 *Branch. (Skilled Trades BC, 2021) Used with permission.*

branch vent: a vent pipe connected at its lower end to the junction of two or more vent pipes. At its upper end, it either terminates in the open air or connects to another branch vent, stack vent, vent stack, or vent header (Figure 7).

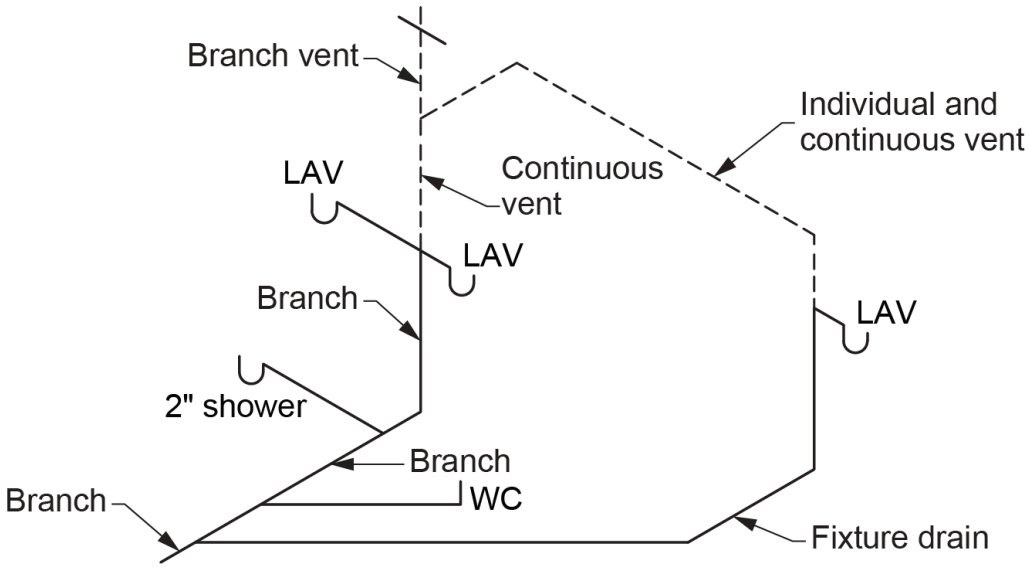

Figure 7 *Branch vent. (Skilled Trades BC, 2021) Used with permission.*

building drain: the lowest horizontal piping, including any vertical offset that conducts sewage, clear-water waste, or stormwater by gravity to a building sewer (Figure 8).

building sewer: a pipe that connects to a building drain 1 m (39 in.) outside the wall of a building and connects to a public sewer or private sewage disposal system (Figure 8).

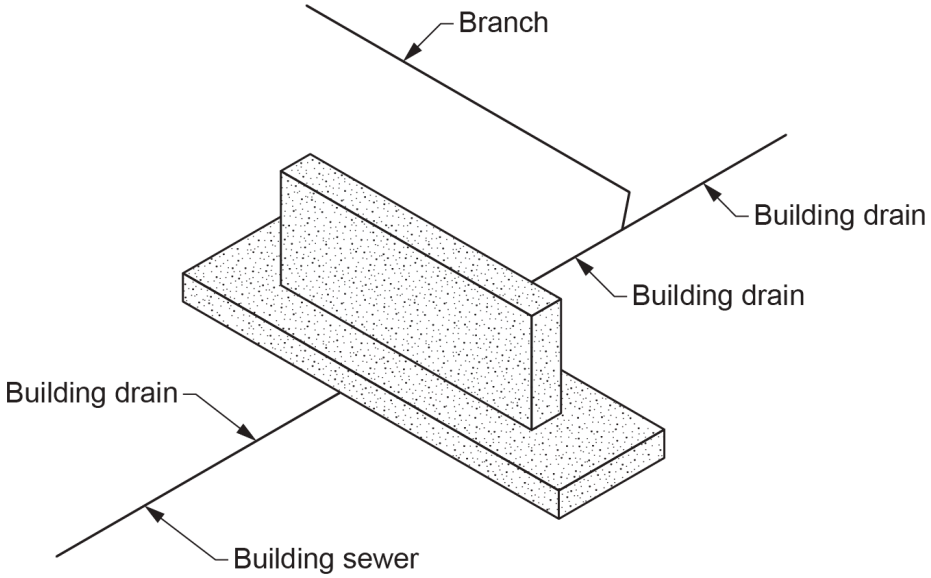

Figure 8 *Building drain and building sewer. (Skilled Trades BC, 2021) Used with permission.*

building trap: a trap installed in a building drain or building sewer to prevent the circulation of air between a drainage system and a public sewer. New buildings do not have building traps installed, but these traps still exist in older homes and buildings (Figure 9).

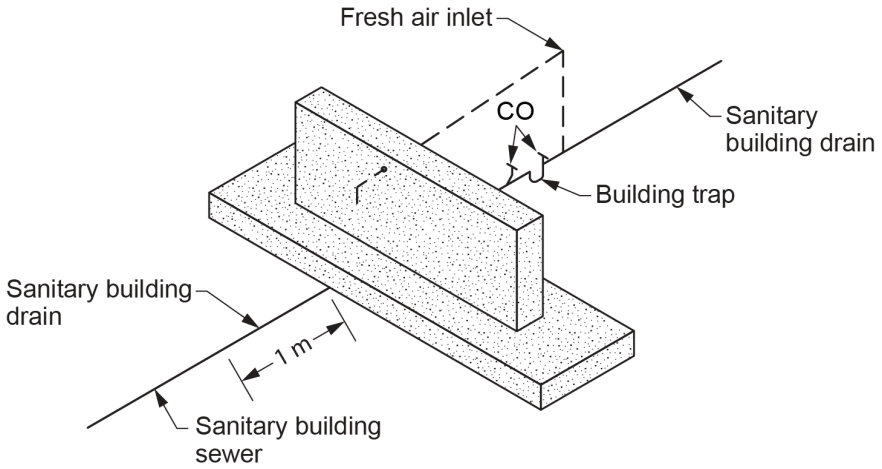

Figure 9 *Building drain and building sewer with building trap. (Skilled Trades BC, 2021) Used with permission.*

cleanout: an access point installed in drainage and venting systems for cleaning and inspection services.

clear-water waste: wastewater with impurity levels not harmful to health. It may include cooling water and condensate drainage from refrigeration and air-conditioning equipment and cooled condensate from steam heating systems, but it does not include stormwater.

combined building drain: a building drain intended to conduct sewage and stormwater (Figure 10).

combined building sewer: a building sewer intended to conduct sewage and stormwater.

combined sewer: a sewer intended to conduct sewage and stormwater.

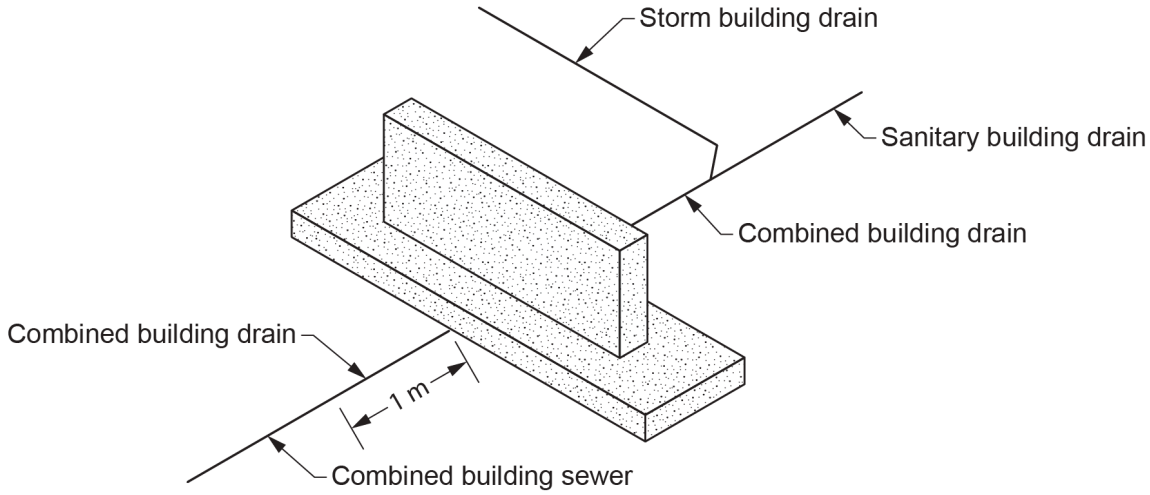

Figure 10 *Combined building drain and combined building sewer. (Skilled Trades BC, 2021) Used with permission.*

continuous vent: a vent pipe that is an extension of a vertical section of a branch or fixture drain.

Figure 11 *Continuous vent. (TRU Open Press).* CC-BY-NC-SA (*https://creativecommons.org/licenses/by-nc-sa/4.0/deed.en*)

dead end: a pipe that terminates with a capped fitting.

developed length: the length along the centreline of the pipe and fittings (Figure 12).

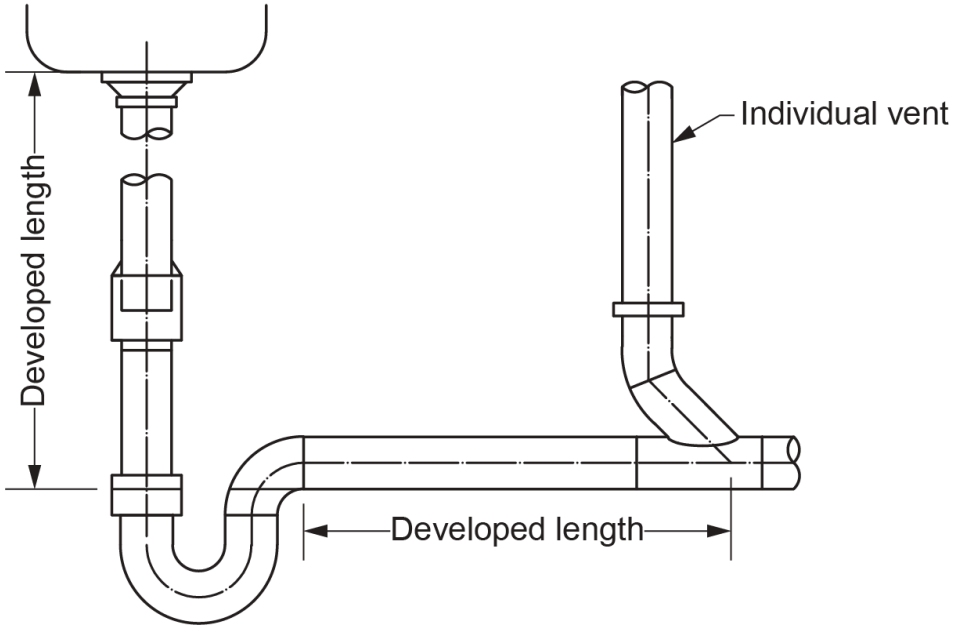

Figure 12 *Developed length of fixture outlet pipe and trap arm. (Skilled Trades BC, 2021) Used with permission.*

directly connected: implies that two pipes are physically connected in such a way that water or gas cannot escape from the connection.

drainage system: an assembly of pipes, fittings, fixtures, and traps used to convey sewage, clear-water waste, or stormwater to a public sewer or private sewage disposal system. It does not include subsoil drainage pipes.

dual vent: a vent pipe that serves two fixtures and connects at the junction of the trap arms (Figure 13).

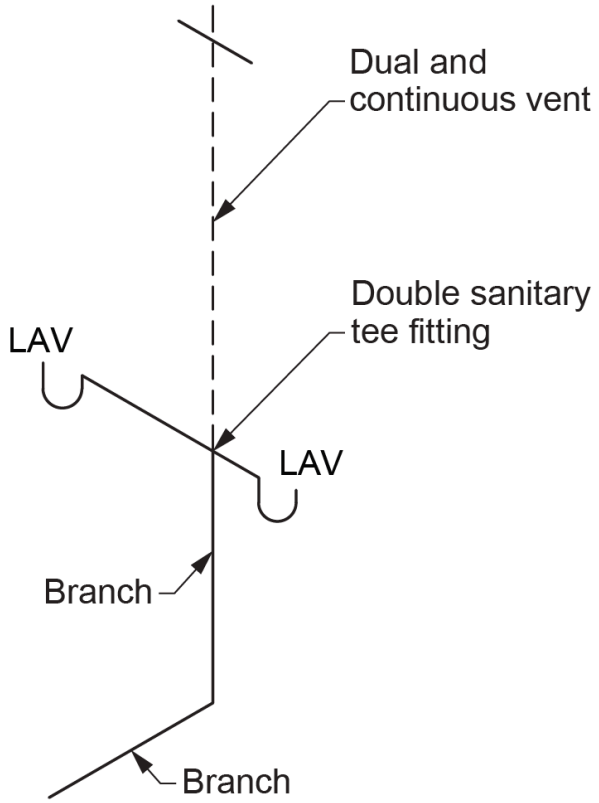

Figure 13 *Dual and continuous vent. (Skilled Trades BC, 2021) Used with permission.*

emergency floor drain: a fixture used for overflow protection that does not receive regular discharge from other fixtures, other than from a trap primer. Any floor drain installed in a washroom is considered an emergency floor drain.

fixture: a receptacle, appliance, apparatus, or other device that discharges sewage or clear-water waste and includes a floor drain.

fixture drain: the pipe that connects a trap serving a fixture to another part of a drainage system (Figure 14).

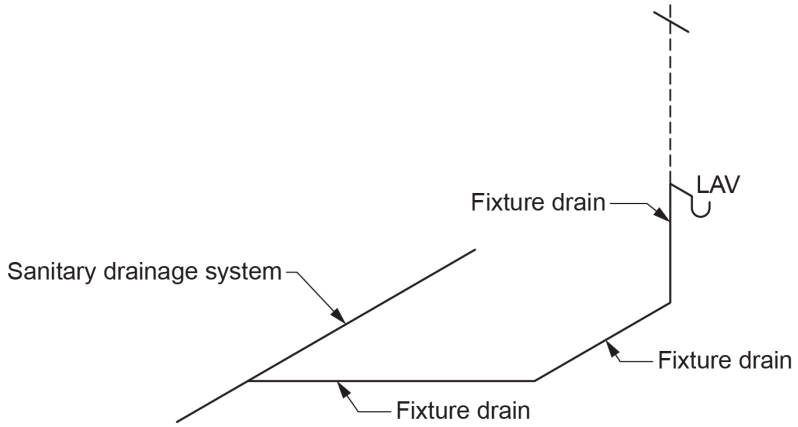

Figure 14 *Fixture drain. (Skilled Trades BC, 2021) Used with permission.*

fixture outlet pipe: a pipe that connects the waste opening of a fixture to the inlet of the trap serving the fixture (Figure 15).

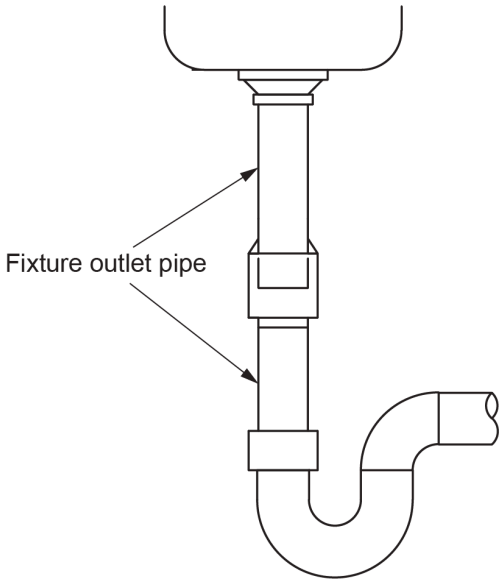

Figure 15 *Fixture outlet pipe. (Skilled Trades BC, 2021) Used with permission.*

fixture unit (DWV): the unit of measure based on the rate of discharge, time of operation, and frequency of use of a fixture that expresses the hydraulic load imposed by that fixture on the drainage system.

flood level rim: the top edge at which water can overflow from a fixture or device (Figure 16).

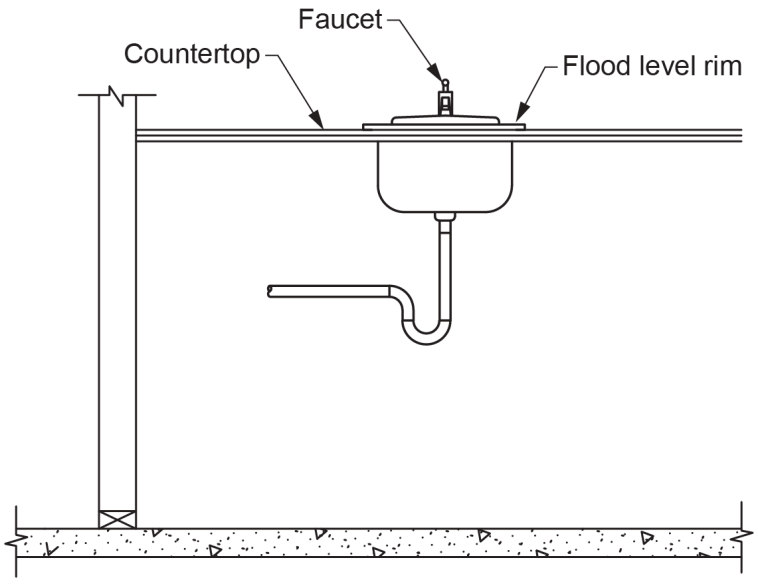

Figure 16 *Cabinet-mounted sink flood level rim. (Skilled Trades BC, 2021) Used with permission.*

fresh air inlet: a vent pipe installed in conjunction with a building trap and that terminates outdoors. It is used to

prevent an air lock between the fixture traps and the building trap by allowing air circulation through the DWV system (Figure 17).

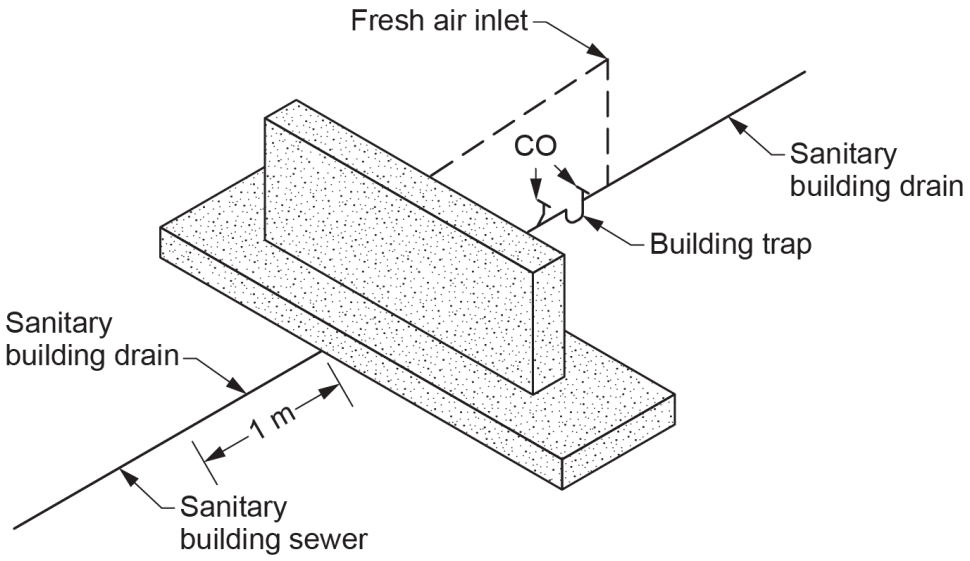

Figure 17 *Fresh air inlet. (Skilled Trades BC, 2021) Used with permission.*

indirectly connected: a pipe that does not connect directly with the drainage system but conveys liquid wastes by discharging into a plumbing fixture, interceptor, or receptacle directly connected to the drainage system. An air break separates the two systems. The air break prevents the possibility of wastes backing up into a compartment or device and contaminating it (Figure 18).

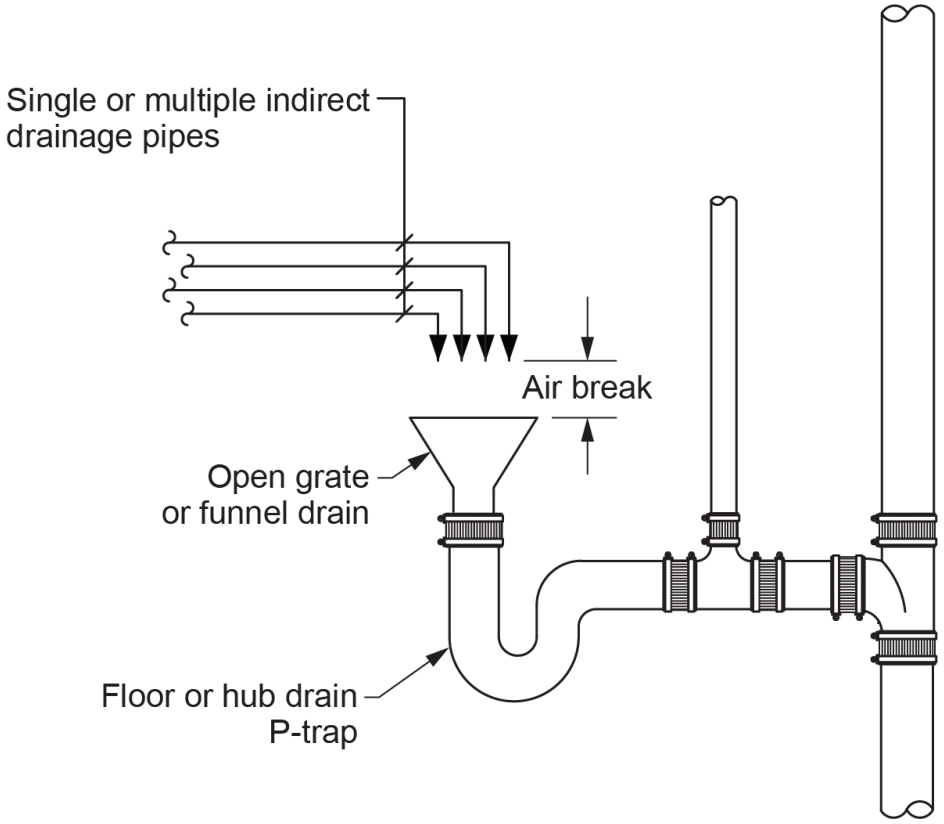

Figure 18 *Indirectly connected waste piping terminating with an air break. (Skilled Trades BC, 2021) Used with permission.*

individual vent: a vent pipe that serves one fixture (Figure 19).

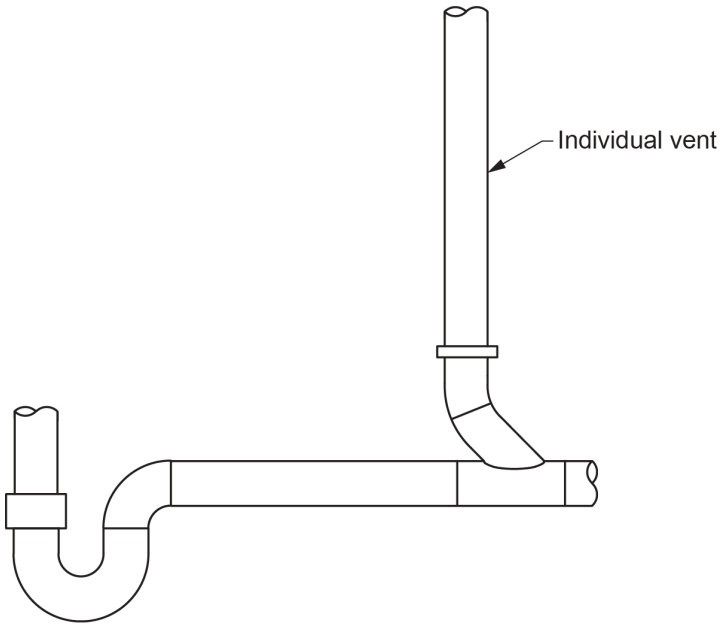

Figure 19 *Individual vent. (Skilled Trades BC, 2021) Used with permission.*

interceptor: a receptacle installed to prevent unwanted materials from passing into a drainage system. There are three

main types of interceptors: grease, oil, and solids. Each of them requires different considerations for sizing, operation, and maintenance (Figure 20).

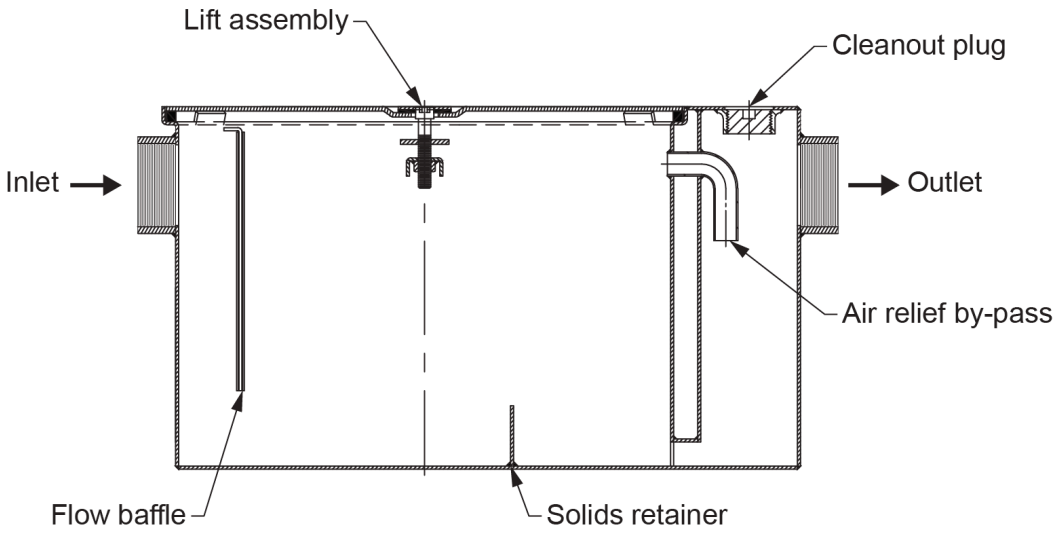

Figure 20 *Commercial-grade grease interceptor. (Skilled Trades BC, 2021) Used with permission.*

nominally horizontal: a DWV piping arrangement installed at an angle of less than 45° with the horizontal.

nominally vertical: a DWV piping arrangement installed at an angle of not more than 45° with the vertical (Figure 21).

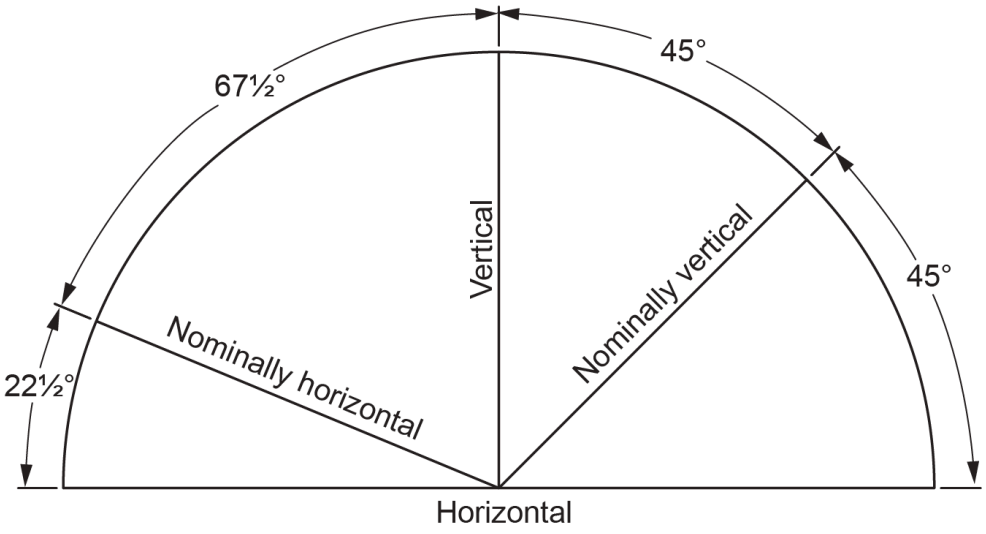

Figure 21 *Nominally horizontal and vertical. (Skilled Trades BC, 2021) Used with permission.*

nominal pipe size (NPS): the nominal diameter by which a pipe, fitting, trap, or other similar item is commercially designated.

offset: the piping that connects the ends of two parallel pipes (Figure 22).

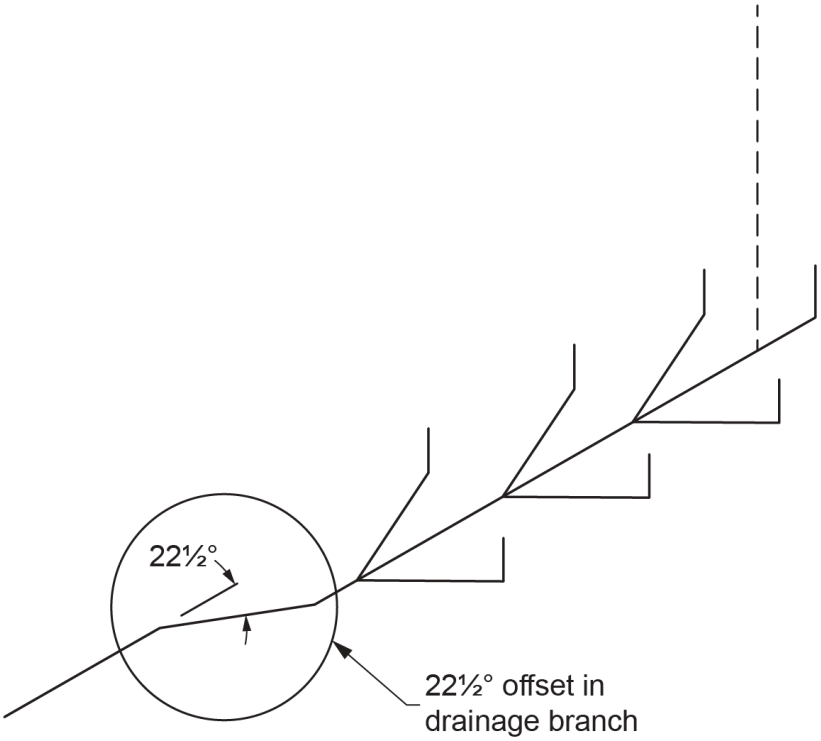

Figure 22 *Offset connecting two parallel drainage pipes. (Skilled Trades BC, 2021) Used with permission.*

offset relief vent: a relief vent that provides additional air circulation upstream and downstream of an offset in a stack (Figure 23).

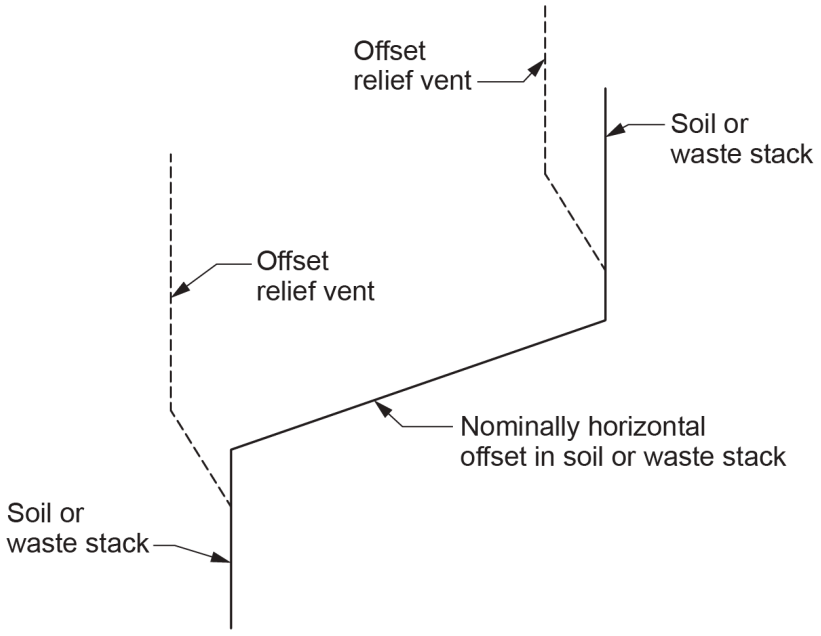

Figure 23 *Offset relief vents. (Skilled Trades BC, 2021) Used with permission.*

private sewage disposal system: a privately owned plant for treating and disposing of sewage (e.g., a septic tank with an absorption field).

private use (plumbing fixtures): fixtures in residences, apartments, or in private bathrooms of hotels or other buildings intended for use by one family or an individual.

public use (plumbing fixtures): fixtures that may be used by multiple users in a public setting, such as washrooms in schools, gymnasiums, hotels, bars, public comfort stations, and other installations where fixtures are installed so that their use is unrestricted.

relief vent: a vent pipe used in conjunction with a circuit vent to provide additional air circulation within a circuit-vented system (Figure 24).

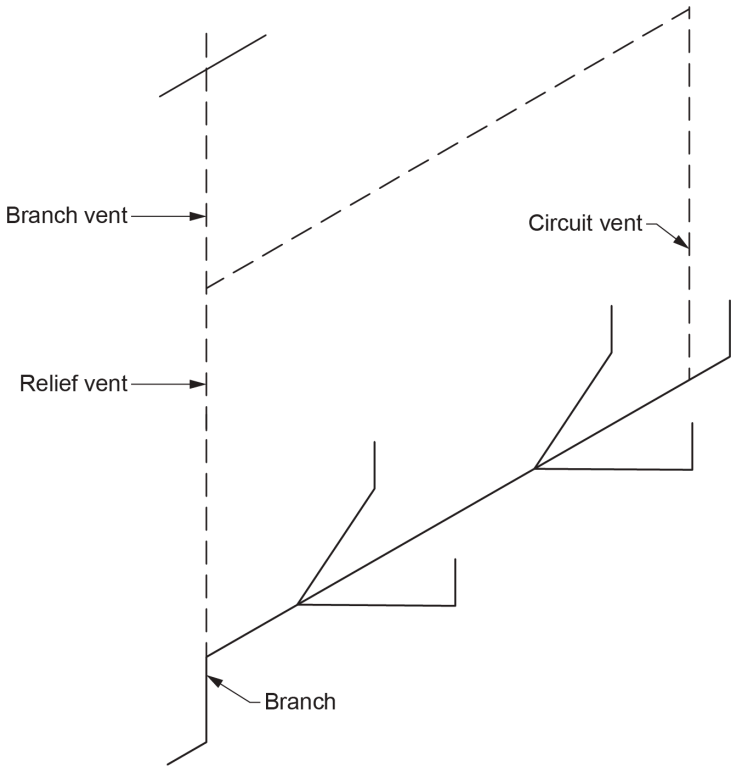

Figure 24 *Relief vent. (Skilled Trades BC, 2021) Used with permission.*

sanitary building drain: a building drain that conducts sewage to a building sewer from the most upstream stack, branch, or fixture drain serving a water closet.

sanitary building sewer: a building sewer that conducts sewage (Figure 25).

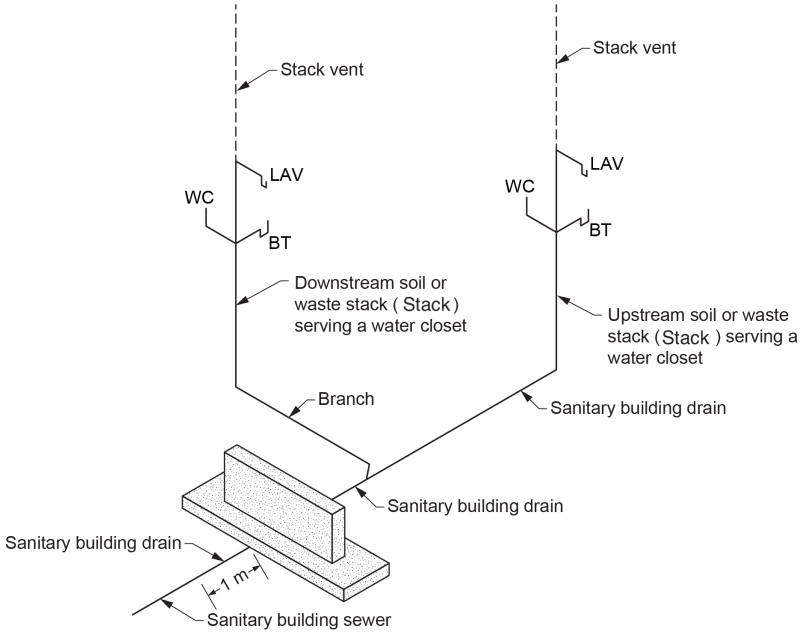

Figure 25 *Sanitary building drain and building sewer locations. (Skilled Trades BC, 2021) Used with permission.*

sanitary drainage pipe: a pipe in a sanitary drainage system.

sanitary drainage system: a drainage system that conducts sewage.

sanitary sewer: a sewer that conducts sewage.

sewage: any liquid waste other than clear-water waste or stormwater.

stack: a vertical sanitary drainage pipe that passes through one or more storeys and includes any offset in the stack. Previously referred to as a soil-or-waste stack or SOWS.

stack vent: a vent pipe that connects the top of a stack to a vent header or terminates to outside air (Figure 26).

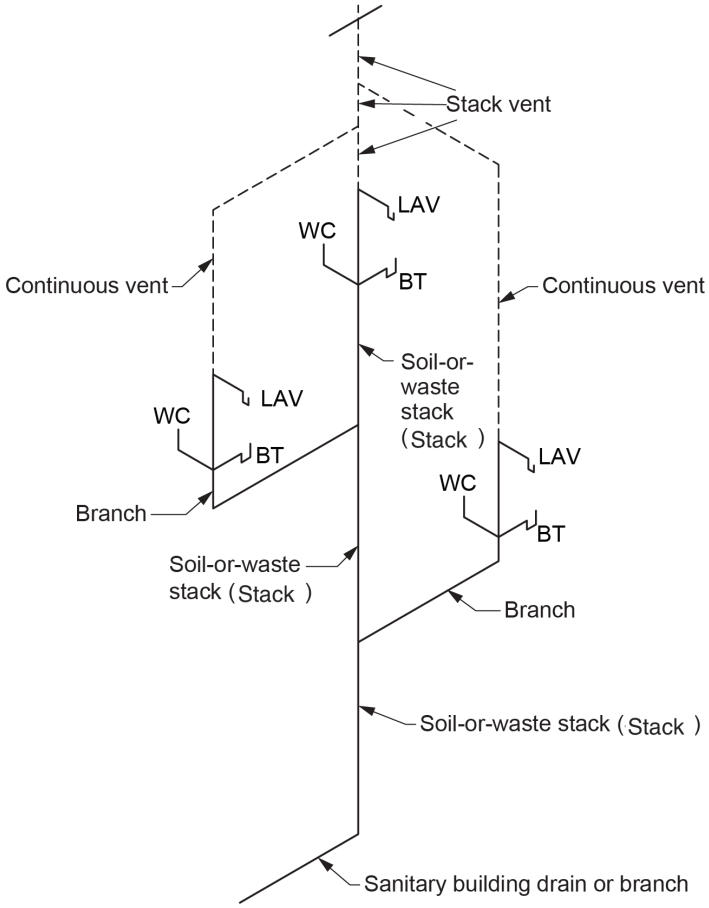

Figure 26 *Stack and stack vent locations. (Skilled Trades BC, 2021) Used with permission.*

storey (as applied to plumbing): the interval between two successive floor levels, including mezzanine floors that contain plumbing fixtures, or between a floor level and roof.

subsoil drainage pipe (drain tile/weeping tile): a pipe installed underground to intercept and convey subsurface water.

trap: a fitting or device designed to hold a liquid seal that prevents the passage of gas while allowing the flow of liquid to continue without significant obstruction.

trap arm: the portion of a fixture drain between the trap weir and the vent pipe connection.

trap dip: the lowest part of the upper interior surface of a trap.

trap seal depth: the vertical distance between the trap dip and the trap weir.

trap weir: the highest part of the lower interior surface of a trap (Figure 27).

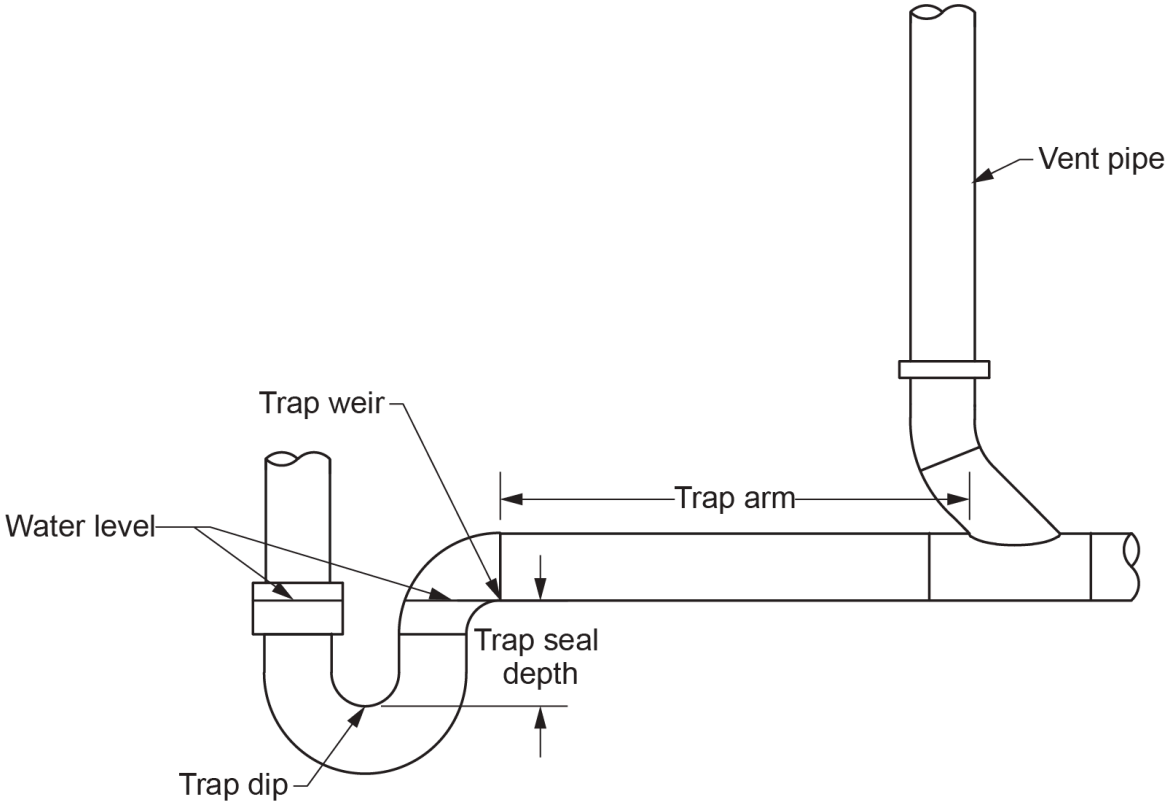

Figure 27 *P-trap terminology. (Skilled Trades BC, 2021) Used with permission.*

trap standard: a trap for a fixture that is integral to the support for the fixture (Figure 28).

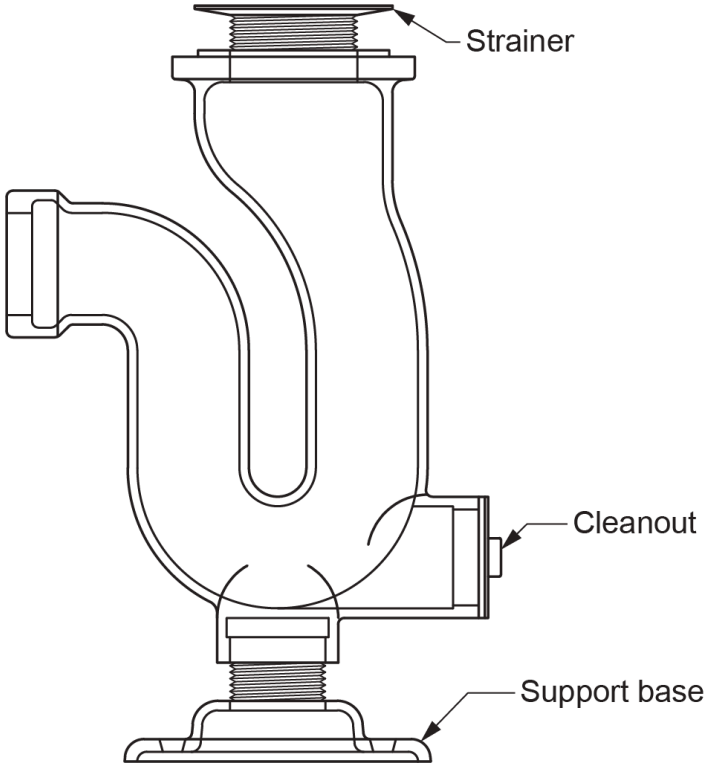

Figure 28 *P-trap standard. (Skilled Trades BC, 2021) Used with permission.*

vent header: a vent pipe that connects any combination of stack vents or vent stacks and terminates to outside air (Figure 29).

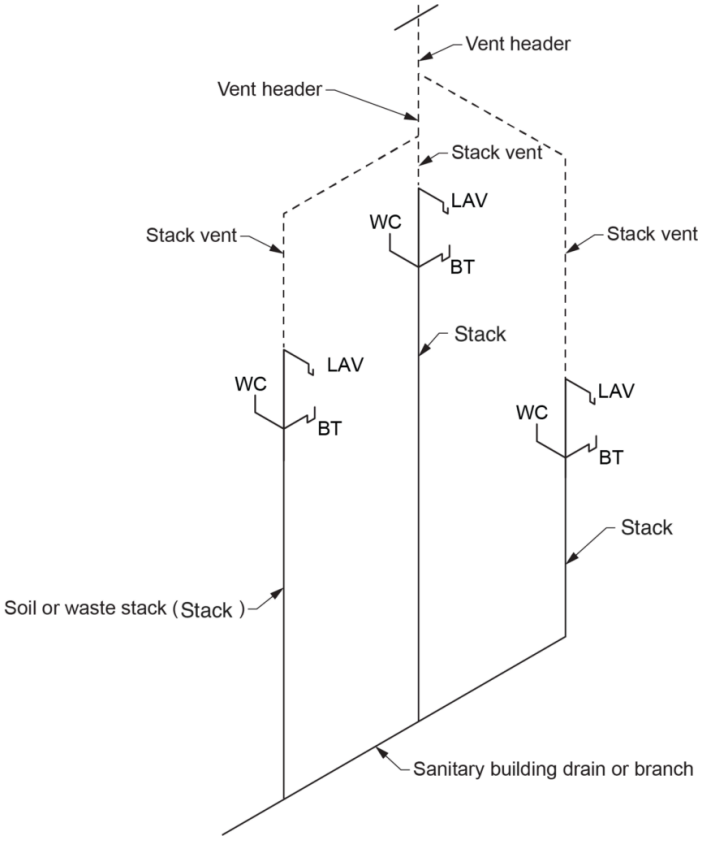

Figure 29 *Vent header. (Skilled Trades BC, 2021) Used with permission.*

vent pipe: a pipe that is part of a venting system.

vent stack: a vent pipe that is connected at its upper end to a vent header or that terminates to outside air. It connects at its lower end to the stack at or below the lowest sanitary drainage pipe connection (Figure 30).

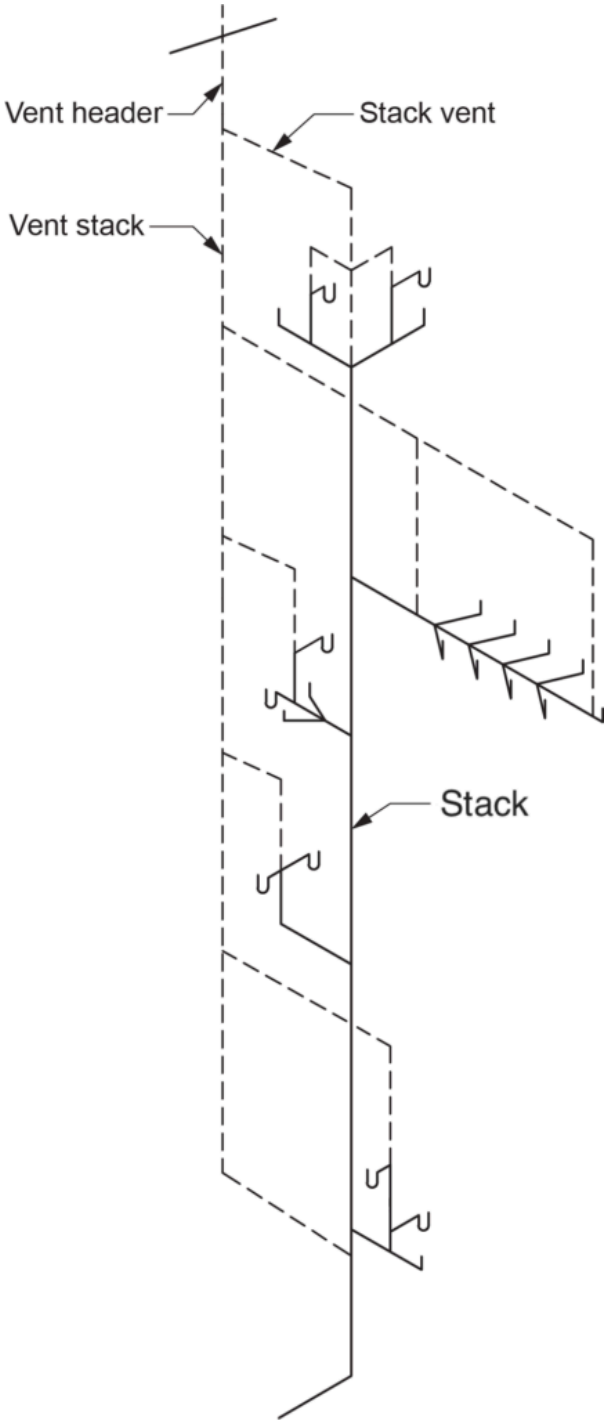

Figure 30 *Vent stack connected to a stack and becoming a vent header. (Skilled Trades BC, 2021) Used with permission.*

venting system: an assembly of pipes and fittings that connects a drainage system with outside air to circulate air and protect trap seals in the drainage system.

wet vent: a sanitary drainage pipe that also serves as a vent pipe and extends from the most downstream wet-vent fixture connection to the most upstream fixture dry-vent connection (Figure 31). A wet vent is a function of a branch, fixture drain, or stack and should be identified as a BR/WV, FD/WV, or a Stack/WV.

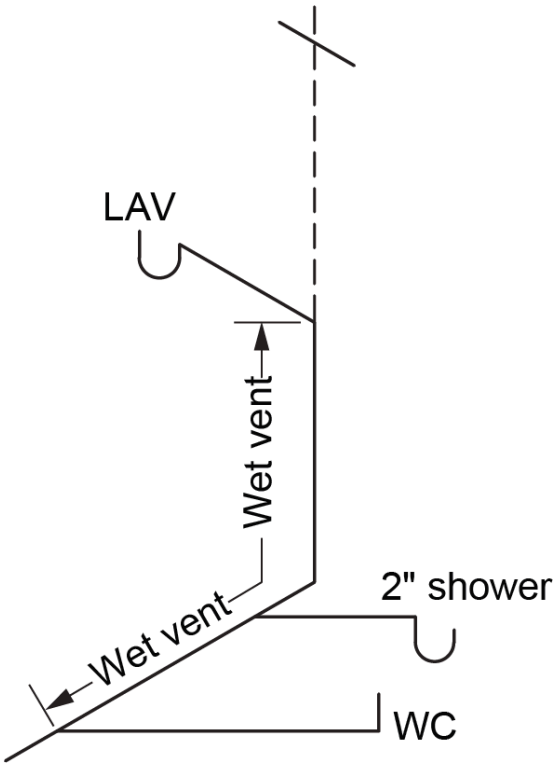

Figure 31 *Wet vent serving a bathroom group. (Skilled Trades BC, 2021) Used with permission.*

yoke vent: a vent pipe connected at its lower end to a stack and at its upper end to a vent stack or to a branch vent connected to a vent stack. A yoke vent is required when serving a stack receiving discharge from more than 11 storeys (Figure 32). A yoke vent provides extra air circulation for the operation of the stack.

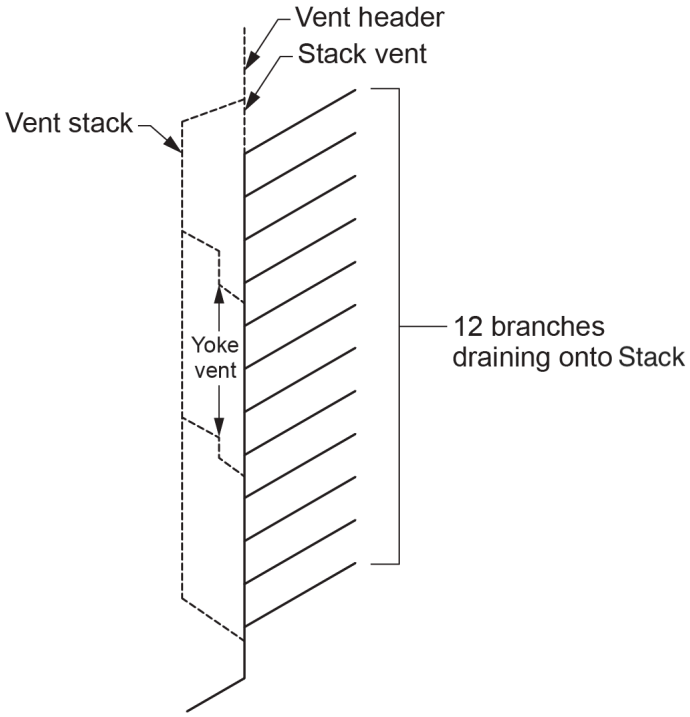

Figure 32 *Yoke vent. (Skilled Trades BC, 2021) Used with permission.*

Self-Test D-1.2: DWV Terminology

Complete Self-Test D-1.2 and check your answers.

If you are using a printed copy, please find Self-Test D-1.2 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=39#h5p-2 (https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=39#h5p-2)

References

National Research Council of Canada. (2020). *National Plumbing Code of Canada 2020*. Canadian Commission on Building and Fire Codes. https://nrc-publications.canada.ca/eng/view/ft/?id=6e7cabf5-d83e-4efd-9a1c-6515fc7cdc71

Skilled Trades BC. (2021). *Book 2: Install fixtures and appliances, install sanitary and storm drainage systems.* Plumber apprenticeship program level 2 book 2 (Harmonized). Crown Publications: King's Printer for British Columbia.

Trades Training BC. (2021). D-1: Install sanitary drain, water and vent systems. In: *Plumber Apprenticeship Program: Level 2*. Industry Training Authority, BC.

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- **Figure 11** Continuous vent is by TRU Open Press and can be used under the CC-BY-NC-SA (https://creativecommons.org/licenses/by-nc-sa/4.0/deed.en) license.

D-1.3 Functions of Different Pipes in a DWV System

Each DWV pipe has a specific name and function. Plumbers must thoroughly understand these terms to ensure the design and installation comply with code. Building drainage and venting systems must be appropriately sized based on the fixture unit load imposed on them by the fixtures and conform with other code clauses. Plumbers must also understand the mechanics of fluid flow in pipes to understand certain code regulations and their intent.

The DWV system is perhaps the most important part of the total mechanical system in a building. The sanitary drainage system is a circuit of piping designed to remove waterborne waste from the plumbing fixtures in a building and drain them safely, reliably, and efficiently. A sanitary drainage system typically consists of fixture drains, branches, and stacks conveying liquid waste to a building drain that, in turn, becomes a building sewer outside the building. The wastewater is then delivered to either a municipal sewer system at the street or to an on-site private sewage disposal system. A recent development in the handling of building waste is to have the drainage from sinks, showers, and dishwashers (known as grey water) drain to a tank, where it is treated and reused for toilet flushing and irrigation purposes.

Along with all the drain and waste pipes, there is a system of vent pipes integrated into the DWV system that is critical for plumbing fixtures to function correctly (Figure 1). These vent pipes provide a free flow of air to maintain equalized pressure throughout the DWV systems and allow sewer gas to be vented out above the building, where it can quickly mix with the ambient air and dissipate. The vent piping allows the admission or emission of air into the system, limiting the pressure differential on the trap seals to not more than 1 in. water column (WC) (250 Pa).

This pressure limitation prevents back pressure or siphonage from removing the water trap seals that serve the fixture.

Parts of a DWV System

The main components to a DWV system include:

- Fixture outlet pipe
- P-trap
- Trap arm
- Fixture drain
- Branch
- Stack
- Sanitary building drain
- Sanitary building sewer
- Cleanouts
- Vents

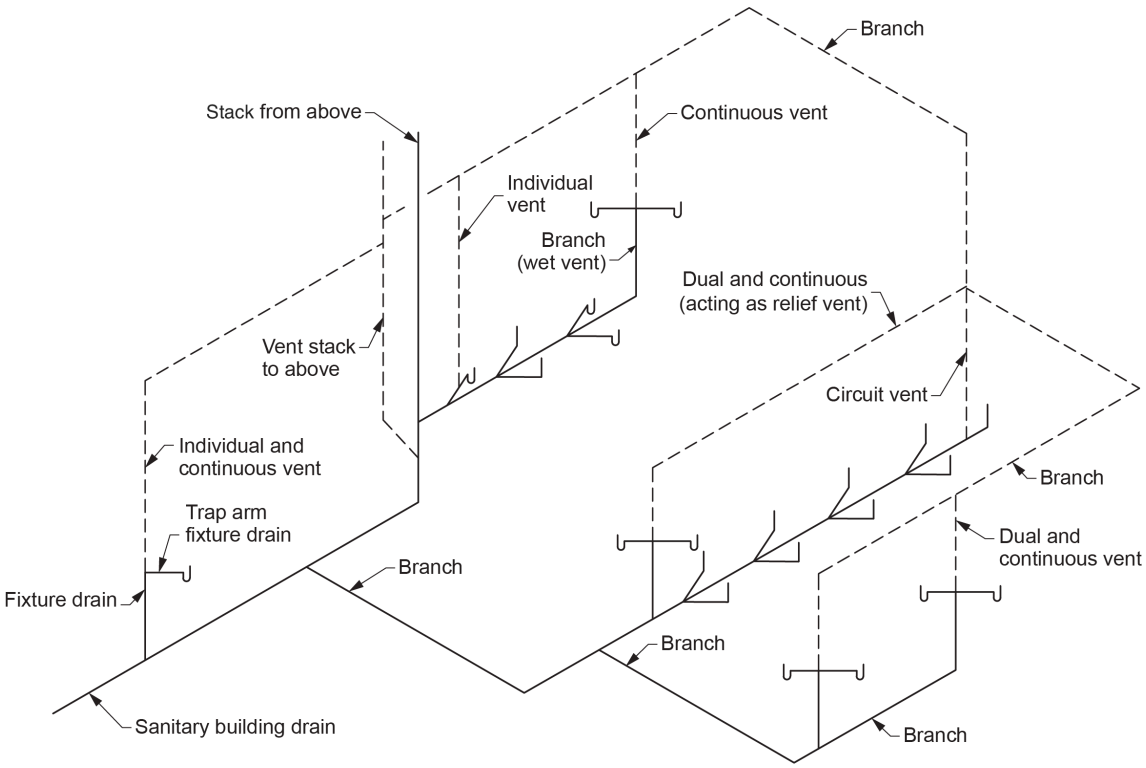

Figure 1 *DWV system component. (Skilled Trades BC, 2021) Used with permission.*

Fixture Outlet Pipe

The fixture outlet pipe is the section of drain pipe between the drain outlet of a fixture and the trap serving it. Fixture outlet pipes are typically sized by the tailpiece outlet of the fixture, with some exceptions, such as a three-compartment commercial kitchen sink served by a single trap (Figure 2). The portion of the fixture outlet pipe serving all three sinks is increased by one size. Some fixture outlet pipes may also be reduced from the size of the outlet of the fixture. For example, a shower base is usually supplied with a 50 mm (2 in.) outlet but only requires a 38 mm ($1\frac{1}{2}$ in.) fixture outlet pipe if there is only one showerhead installed.

The maximum length of a fixture outlet pipe is limited to 1,200 mm (4 ft) to prevent the velocity of the water draining through it from siphoning the trap; this is known as "self-siphonage." However, this length does create the ability to place a trap for a fixture under the floor and is useful for some installations.

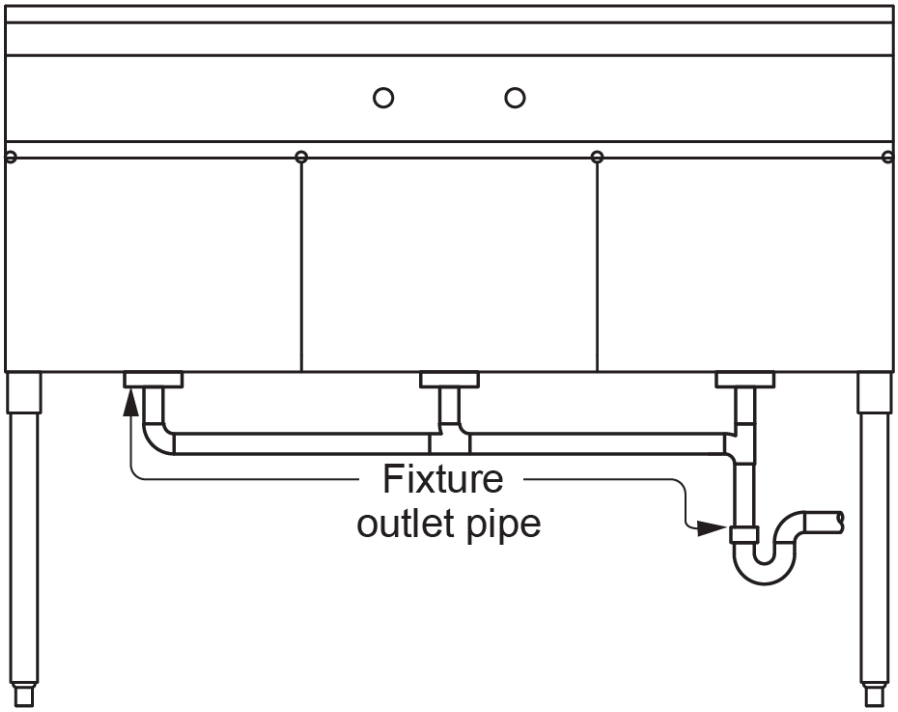

Figure 2 *Fixture outlet pipe serving a three-compartment commercial sink. (Skilled Trades BC, 2021) Used with permission.*

P-Trap

A trap is a non-mechanical device that prevents odours, animals, and drafts from entering the building through it while not affecting the flow from the fixture when it drains. It is important to recognize the other two functions of a trap seal. The velocity of water moving through a trap is important to its function. This is why there are limits to how far below the fixture the trap can be placed. If the liquid has too much velocity when it reaches the trap, it could self-siphon, which would remove the trap seal. The pipe (trap arm) exiting the trap has to be nominally horizontal so that the water does not rush through and siphon the trap. Most traps are installed external to the fixture, but a few fixtures — such as toilets and some urinals — have built-in traps known as "integral traps."

Trap Arm

A trap arm is the pipe between the trap weir and vent pipe serving the fixture. The National Plumbing Code regulates its minimum and maximum lengths. The minimum trap arm length shall be not less than two pipe diameters. For example, a 38 mm ($1\frac{1}{2}$ in.) trap arm shall not be less than 75 mm (3 in.) in length. The maximum length also depends on its size. The total fall in a trap arm due to its slope shall not exceed one pipe diameter. In other words, the vent pipe connection to a fixture drain cannot be below the weir of the trap.

To determine the maximum length of the trap arm, divide the pipe diameter by the required slope. The answer is the total feet of developed length of the trap arm from the trap weir to the vent connection. For example, a $1\frac{1}{2}$ in. trap arm

graded at $\frac{1}{4}$ in./ft (1:50 or 2%) could run 1.8 m (6 ft) before being vented ($1\frac{1}{2}$ in. $\div$ $\frac{1}{4}$ in. = 6 ft or 1.8 m). For a 2 in. pipe, the maximum run can be 2.4 m (8 ft), and so on.

Fixture Drain

A fixture drain is the section of drainage pipe between the outlet of a single fixture trap and another section of the drainage system, such as another fixture drain, a branch, or a stack. In Figure 3, the trap arm section is called a "trap arm fixture drain" because it falls under both definitions.

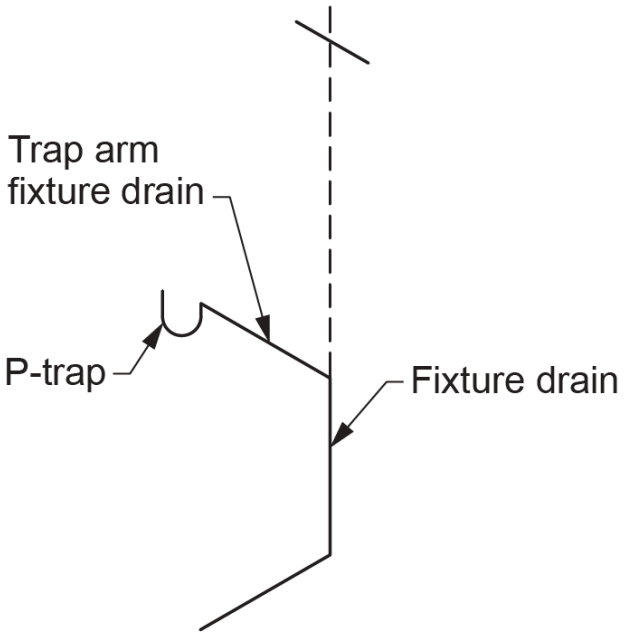

Figure 3 *Drainage pipe terminology serving a single fixture. (Skilled Trades BC, 2021) Used with permission.*

Branch

A branch in a drainage system is a sanitary drainage pipe that serves at least two fixtures located on a single storey and will connect at its downstream end to a stack, building drain, another branch, or possibly a sewage sump (Figure 4). The upstream end of a branch will connect two trap arms or fixture drains. A branch could also connect a stack to a building drain in the case where multiple stacks are installed in a building.

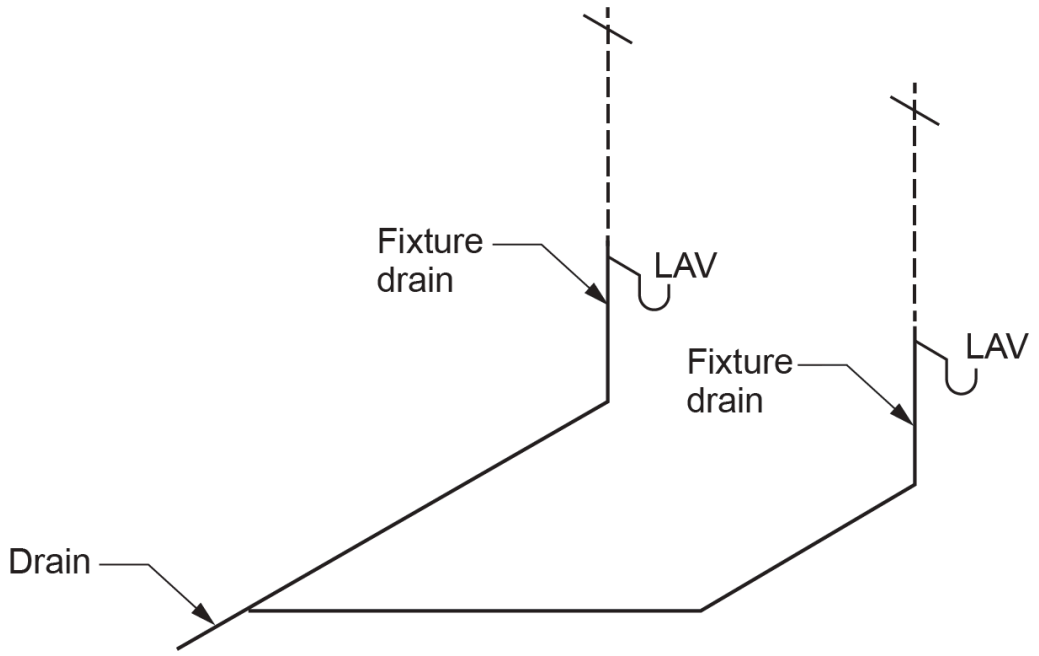

Figure 4 *Branch. (Skilled Trades BC, 2021) Used with permission.*

Stack

If a fixture drain or a branch carries waste through at least one storey, it is re-labeled as a stack. At its base, it will drain into either a branch or sanitary building drain, and it must have a cleanout near its lowest vertical point. The NPC also states that it must have a vent connected to the top of it, called a stack vent.

Wastewater flows through vertical pipes much differently than it does through nominally horizontal pipes. In order to understand the code requirements for piping connections at or near the base of stacks, a plumber must be aware of the pneumatic and hydraulic forces present in stacks.

Flow from a branch or fixture drain empties into the vertical stack using a wye and 45° fitting combination or a short-turn sanitary tee. When a high inflow rate is present, a slug of water is produced as the flow moves from horizontal to vertical (Figure 5). As the amount of inflow from the branch determines the size of the slug, there are limitations to the amount of flow entering the stack from any one floor level. This ensures discharge from the branch does not cause excessive interference with the sheet of liquid that may be flowing down the stack from above.

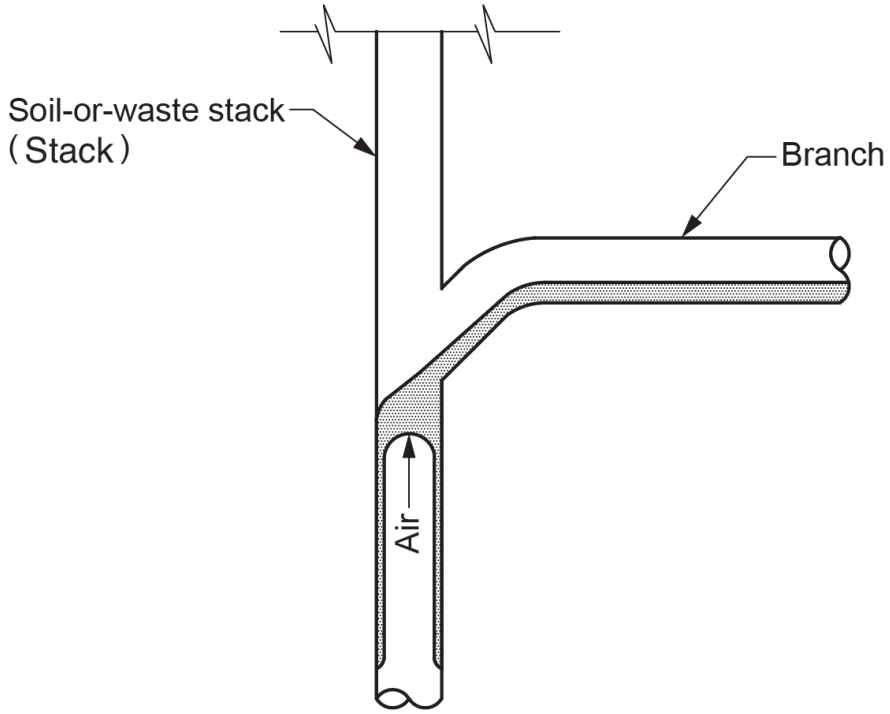

Figure 5 *Stack. (Skilled Trades BC, 2021) Used with permission.*

This slug is immediately accelerated at the rate of 9.8 m/sec/sec (32.2 ft/sec/sec) by the force of gravity. In a very short distance, air in the stack forces its way through this slug, sending the flow to the inner walls of the stack. This sheet of water — with a core of air in the centre — continues to accelerate until the frictional force exerted by the pipe wall on the falling sheet of water equals the gravitational force. The sheet of water will fall at a velocity that remains constant, provided that no additional flow enters the stack. This constant vertical velocity is called "terminal velocity," and the distance within which this maximum velocity is achieved is called the "terminal length." Field measurements have shown that a terminal velocity of 3–4.5 m/s (10–15 fps) is achieved within approximately 3–4.5 m (10–15 ft) from the point of entry to the stack. This constant velocity fact abolishes the myth that water falling from a great height will destroy the fittings at the base of a stack. In reality, the velocity at the base of an 80-storey stack is only slightly and insignificantly greater than the velocity at the base of a four-storey stack.

As the liquid falls down the stack, it exerts a frictional drag on the centre air core, dragging air with it. The air dragged downward is replenished by the stack vent to ensure negative pressures do not develop in the stack. The air being dragged down the stack can also cause positive pressure to build at the base of the stack. Therefore, the NPC requires that a vent stack be installed to serve any stack that conveys sewage through more than four storeys. The vent stack acts as a relief point for the air pressure created by the flow conditions at the base of the stack.

At the base of the vertical stack, flow enters the horizontal branch or building drain at stack terminal velocity. The velocity of the water flowing in the horizontal drain slowly decreases with a corresponding increase in the depth. This increase in depth is often great enough to completely fill the cross-sectional area of the pipe. This phenomenon of sudden rise in depth causes turbulence at the base of the stack and is called "hydraulic jump" (Figure 6).

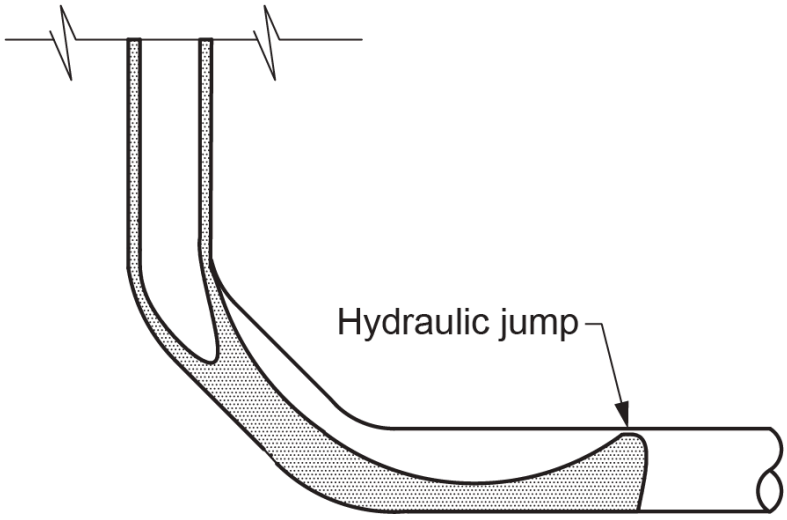

Figure 6 *Vertical to horizontal flow. (Skilled Trades BC, 2021) Used with permission.*

The turbulence resulting from hydraulic jump increases the static pressure, which can cause loss of trap seals in the downstream piping if the traps are installed too close to the base of the stack (Figure 7). The code requires that, in certain circumstances, fixture drains or branches be prohibited from connecting to a branch or sanitary building drain within 1.5 m (5 ft) of the bottom of the stack.

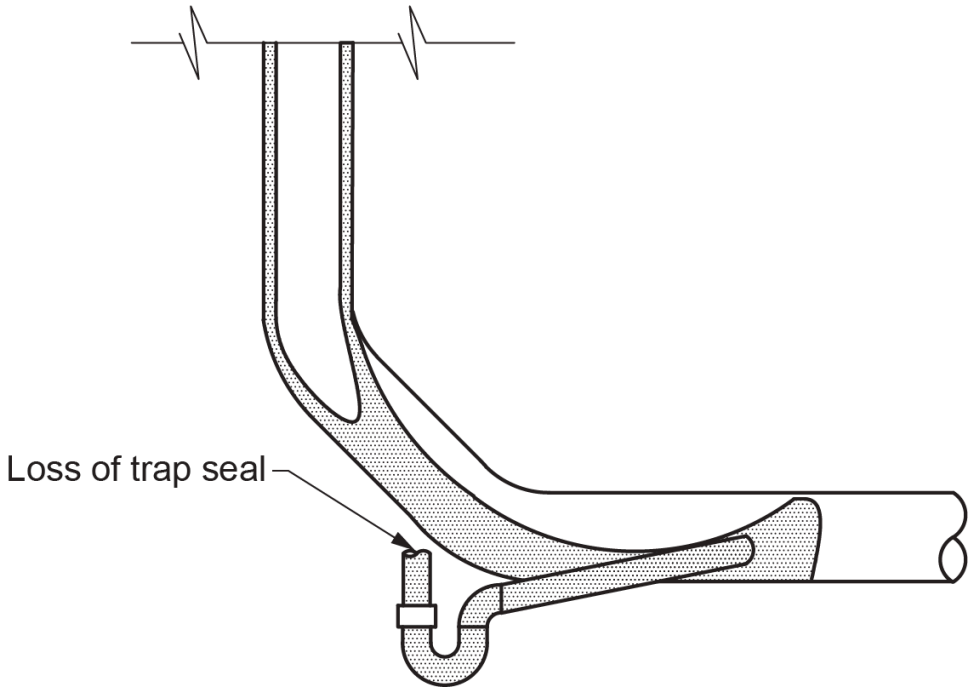

Figure 7 *Loss of trap seal. (Skilled Trades BC, 2021) Used with permission.*

Sanitary Building Drain

A sanitary building drain is always connected to a sanitary building sewer at its downstream end. Its path takes it to the most upstream stack, branch, or fixture drain that has a toilet draining through it. It becomes the main horizontal sanitary collection pipe within the building.

A cleanout must be installed on the sanitary building drain to serve the sanitary building sewer. The cleanout should always be installed as close as possible to where the building drain leaves the building — either inside or outside — and be accessible for sewer cleaning equipment. Some municipalities require backwater valves to be installed on the sanitary building drain to isolate the entire building in the event of sewer backup.

Sanitary Building Sewer

The sanitary building sewer is the part of the drainage system that extends from the end of the building drain (1 m/39 in. outside the building) and conveys its discharge to a public sewer, private sewer, on-site wastewater disposal system, or other points of disposal. Building sewers often have additional cleanouts between the building wall and the main sewer. The cleanout is usually a minimum size of 100 mm (4 in.) in diameter with a water- and gas-tight cap.

Building sewers are commonly constructed using sewer-grade thin wall piping, although DWV grade is also acceptable. The pipes in a sewer are installed over a compacted bed of sand that supports them, preventing them from settling and losing their grade. Typically, plumbers lay the sewer from the foundation wall to the property line, and the municipal sewer crew is in charge of the installation from the property line to the sewer main.

Sewage Sump Basins

A sewage sump basin is used when plumbing fixtures are installed at a lower elevation than the gravity building drain. Although not defined in the plumbing code, this type of arrangement is known in the industry as a "sub-drainage system." When used, the sewage is lifted into the building's gravity drainage system by automatic pump equipment.

A sewage sump basin must be airtight to prevent the escape of gases generated by sanitary waste from the sub-drainage system. Since it is airtight, a vent is required to relieve the air in the basin as wastes discharge into it and also to supply air to the basin while the contents are being pumped to the sanitary gravity drainage system.

The NPC requires that the minimum size of the vent pipe for a sewage sump shall be one size smaller than the size of the largest branch or fixture drain draining to the sump. This required vent shall be not less than 2 in. (50 mm) and not greater than 4 in. (100 mm).

As with all mechanical devices, equipment failure can occur, resulting in flooding at the pumping basin. Commercial installations reduce this risk by installing two pumps (duplex) in a duty/standby configuration, with each pump capable of handling peak flow. If pumping station capacity is based on two pumps operating in parallel, a third pump (triplex) is usually provided as a standby. Residential or other private pumping stations may be equipped with a single pump (simplex) (Figure 8), since the incoming sewage flow can easily be controlled by restricting the usage of facilities.

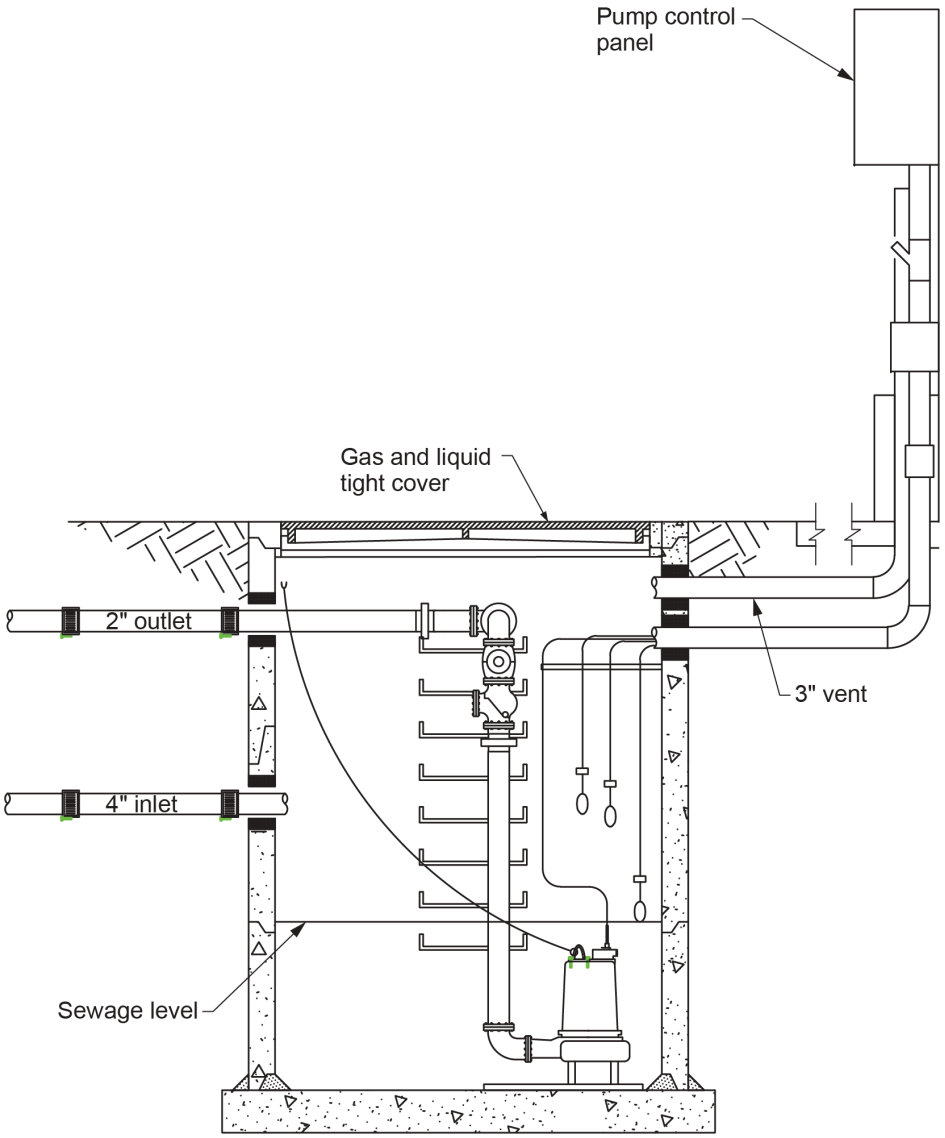

Figure 8 *Sewage sump basin with simplex pump. (Skilled Trades BC, 2021) Used with permission.*

Cleanouts

Cleanouts provide access to all parts of the drainage system so that obstructions can be removed. They should be located at intervals that conform to Table 2.4.7.2 of the NPC. The term "rodding" is an old term referring to the use of short pieces or "rods" of bamboo or similar material. These were coupled end-to-end and pushed into the drain to clear blockages. Because they did not bend easily around corners, there had to be many cleanouts installed, especially if the piping changed direction. Today's modern drain "snakes" are made from coils of spring steel and are capable of long lengths and tight turns, so distances between cleanouts are much greater than were previously allowed.

Cleanouts range from removable plugs in wyes installed in horizontal drainage piping to manhole covers in building sewers. One-way rodding means using a wye as a cleanout, while two-way rodding would be using a line cleanout or a manhole as the opening in the piping. If line cleanouts or manholes are used, the allowable distance between cleanouts doubles over what could be achieved when using wyes.

Manholes (Figure 9) are used as a cleanout for underground piping that is 200 mm (8 in.) or larger in diameter. They are constructed with metal covers of sufficient weight and strength for traffic and loading conditions. To direct flow through the manhole from the inlet pipe to the outlet pipe, a poured concrete channel — sometimes called "benching" — is used. It is shaped like a half-pipe. This channel is left open on top to allow access to the sanitary piping when required. To meet the applicable codes, manholes must be vented to open air if installed inside a building.

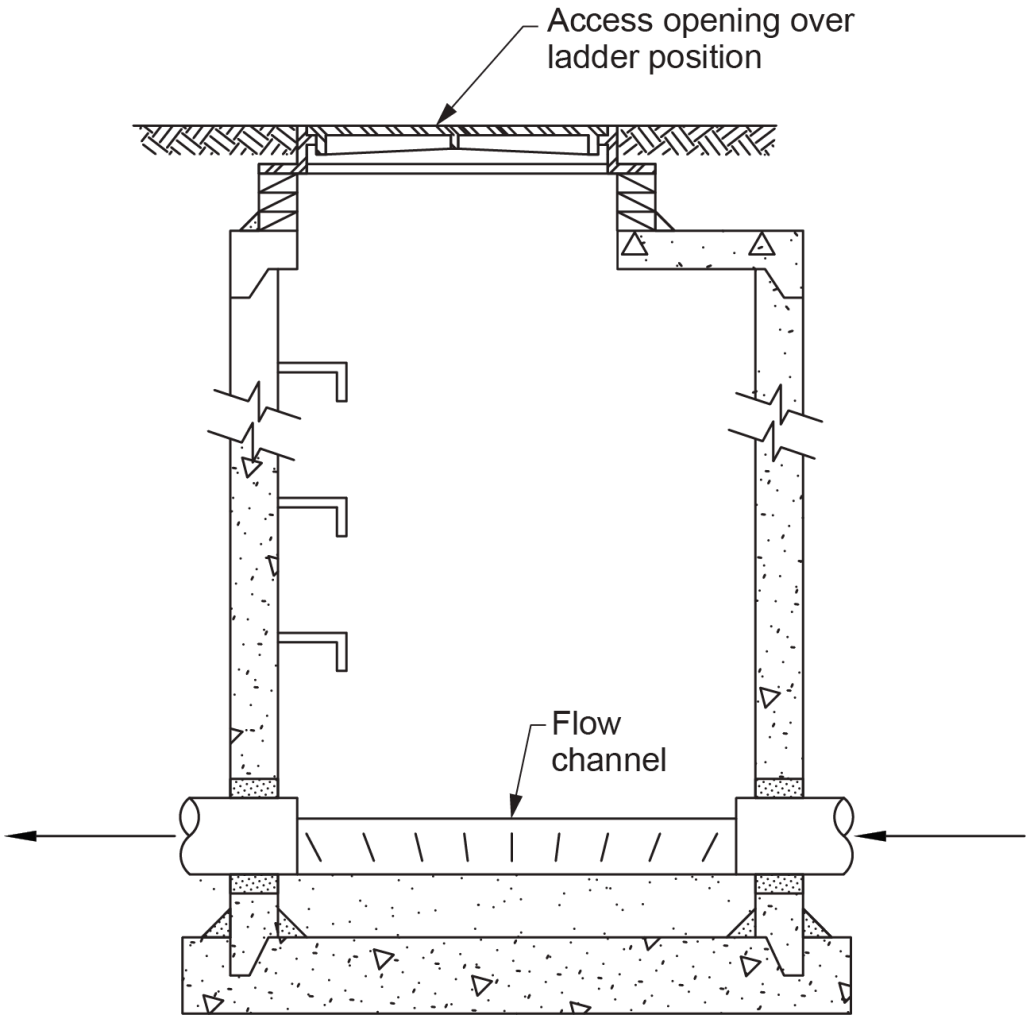

Figure 9 *Manhole used as a cleanout in large-diameter sanitary piping. (Skilled Trades BC, 2021) Used with permission.*

Vents

Vent piping allows the admission or emission of air into the system, limiting the pressure differential on the trap seals to not more than 1 in. WC (250 Pa). Venting lessens the likelihood of the removal of the water trap seals that serve the fixtures.

There are a variety of vents used in different applications. Common vents used include:

- Individual vents
- Dual vents

- Continuous vents
- Circuit vents
- Relief vents
- Additional circuit vents
- Offset relief vents
- Sump vents
- Branch vents
- Stack vents
- Vent stacks
- Vent headers

Individual Vents

An individual vent is a vent that serves one fixture only and is connected to its horizontal trap arm (Figure 10). The vent must be installed into the trap arm in a nominally vertical orientation. Individual vents may extend from the fixture being served to the outside air without joining another part of the venting system, or they may connect into another vent that will eventually extend to the open air.

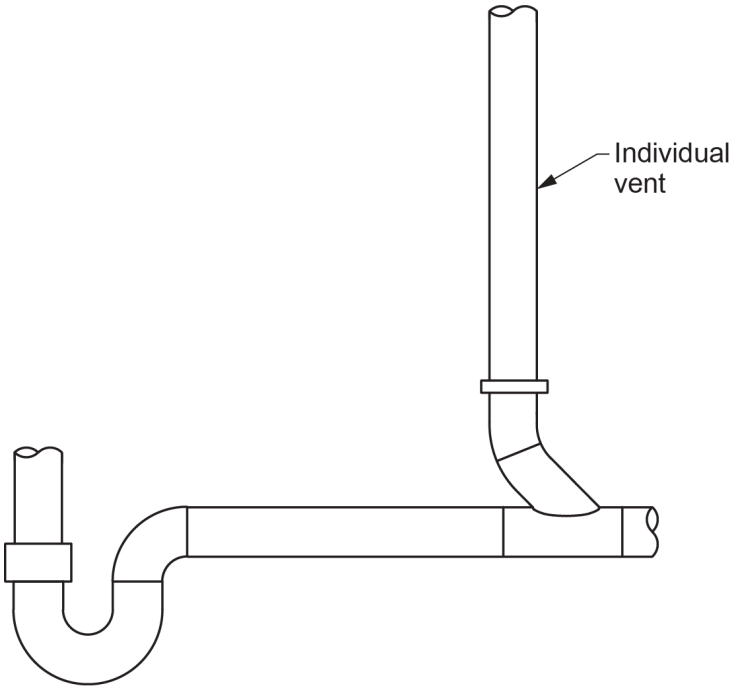

Figure 10 *Individual vent serving a fixture connected to the horizontal trap arm. (Skilled Trades BC, 2021) Used with permission.*

Dual Vents

Dual vents are similar in many ways to individual vents but with one main difference: dual vents serve two fixtures as opposed to one. When connecting the two fixtures to the branch, a double symmetrical fitting must be used (Figure 11).

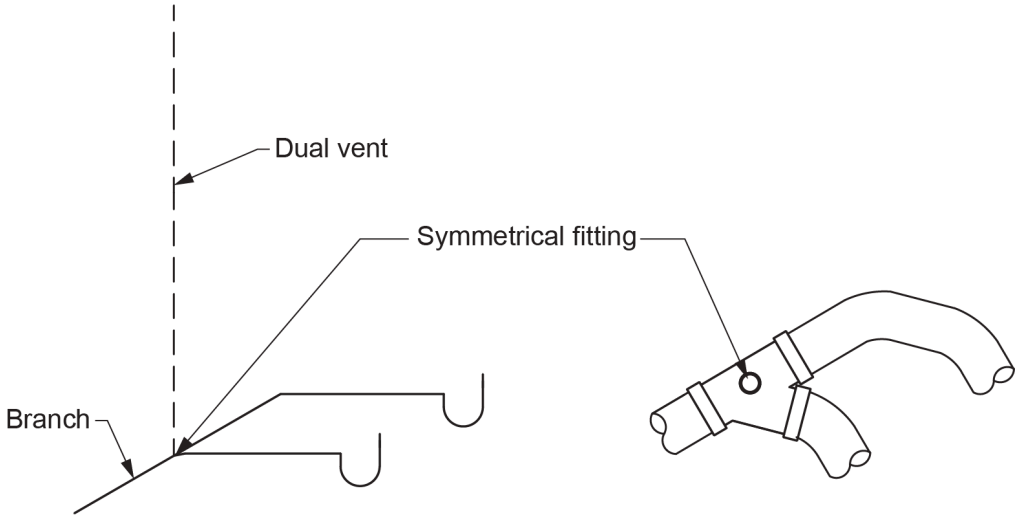

Figure 11 *Dual vent. (Skilled Trades BC, 2021) Used with permission.*

Continuous Vents

A continuous vent is a vent that extends from a vertical sanitary drainage pipe and can serve one or multiple fixtures located on the same storey. The most common application of continuous vents is to serve wet-vented branches (Figure 12). It may be important to remember that a continuous vent that is not also either an individual or dual vent will always be connected to either a fixture drain/wet vent or a branch/wet vent.

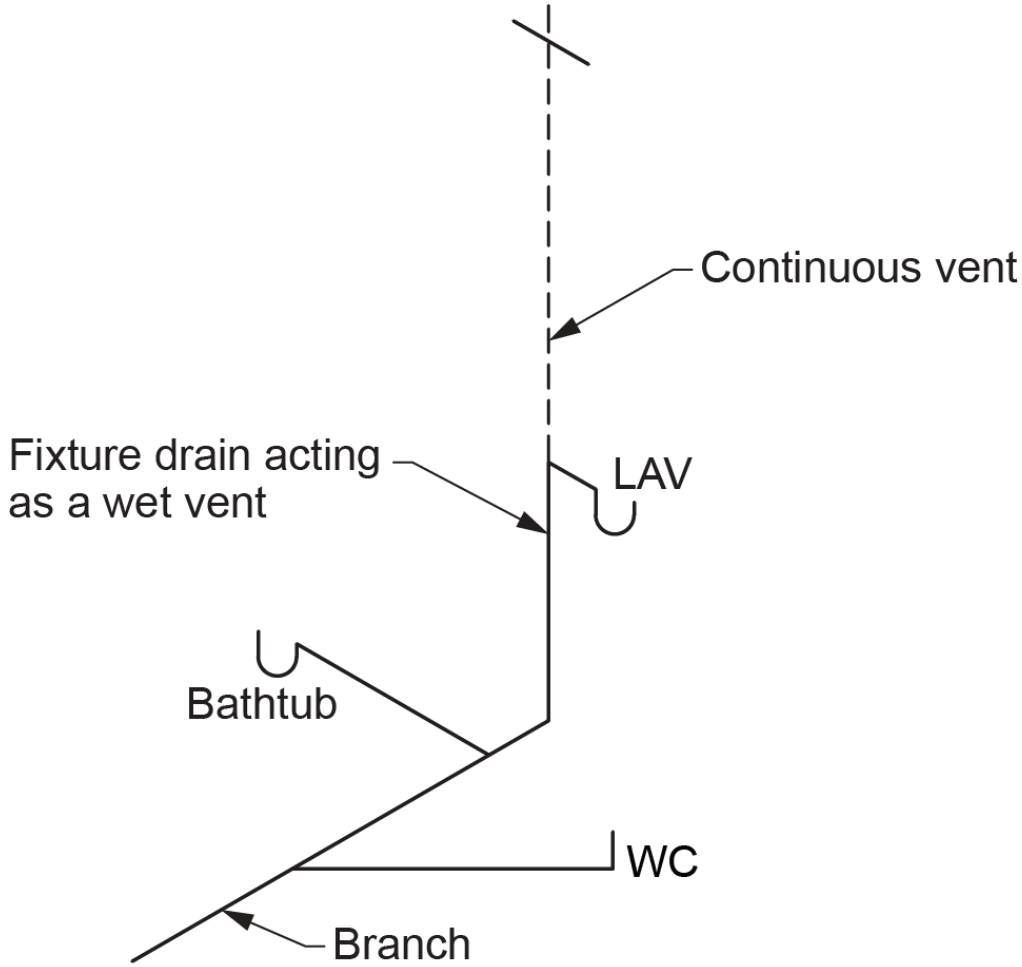

Figure 12 *Continuous vent serving a wet-vented bathroom group. (Skilled Trades BC, 2021) Used with permission.*

The naming of continuous vents overlaps with individual vents and dual vents if they are connected to a vertical sanitary drainage pipe, but the sizing requirements are different.

Individual and continuous vents (Figure 13) serve a single fixture connected to a vertical sanitary drainage pipe using a single sanitary tee.

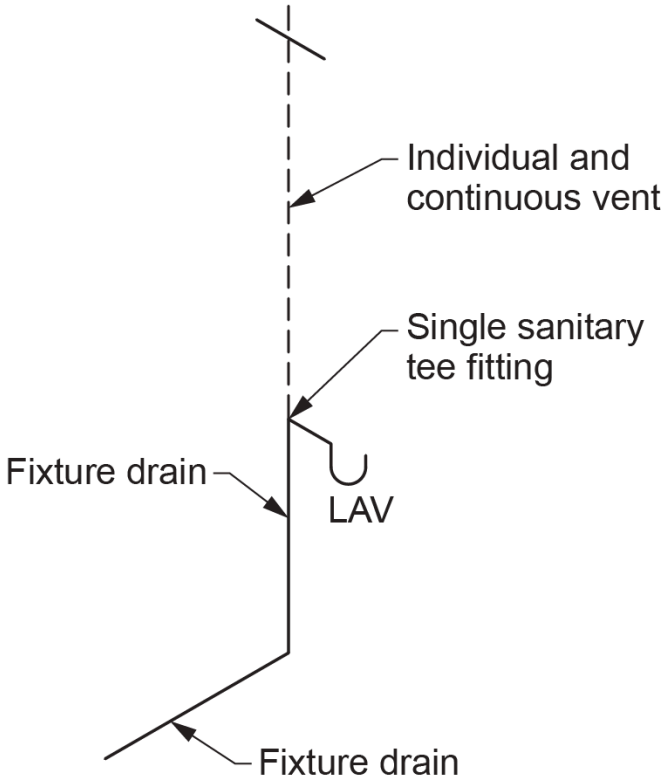

Figure 13 *Individual and continuous vent serving a single lavatory*

Dual and continuous vents (Figure 14) serve two fixtures connected to a vertical sanitary drainage pipe at the same level using a double sanitary tee.

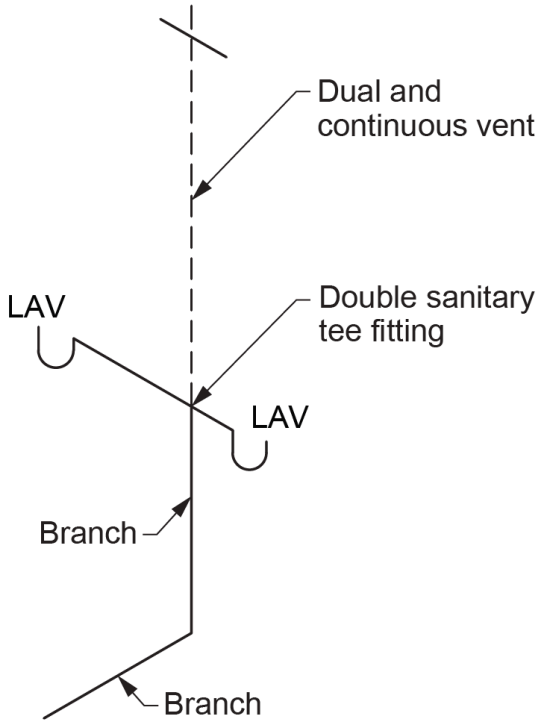

Figure 14 *Dual and continuous vent serving two lavatory basins. (Skilled Trades BC, 2021) Used with permission.*

Circuit Vents

Circuit venting is a method of commonly venting multiples of floor-outlet fixtures, most notably toilets. Circuit vents are typically used when serving a battery of fixtures with traps of 50 mm (2 in.) or larger in size (Figure 15). This configuration can also be used with 32–38 mm ($1\frac{1}{4}$–$1\frac{1}{2}$ in.) traps, but it must comply with certain code requirements related to circuit venting these small traps. Circuit vents are connected to the trap arm of the most upstream fixture of the battery. Once connected, the circuit vent is extended upward to the open air or tied into another vent that extends to open air.

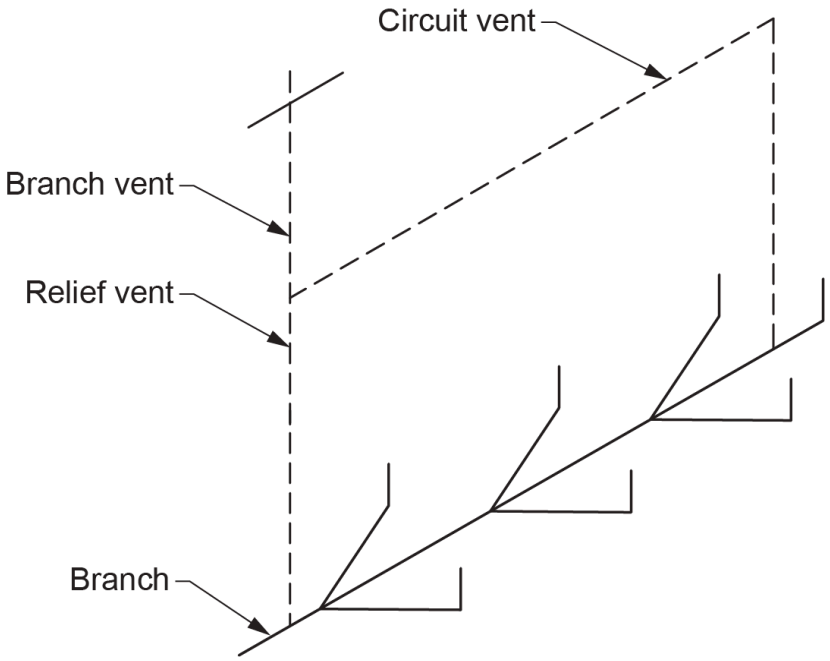

Figure 15 *Circuit vent serving a battery of WCs. (Skilled Trades BC, 2021) Used with permission.*

Relief Vents

Relief vents are required for circuit-vented branches to assist with air circulation and relieve pressure fluctuations caused by fluid flow in the branch (Figure 16). A relief vent may also be a fixture drain, a branch, or even a stack. When these drainage pipes are used as a relief vent, they are limited in the number of fixture units that can be drained into them.

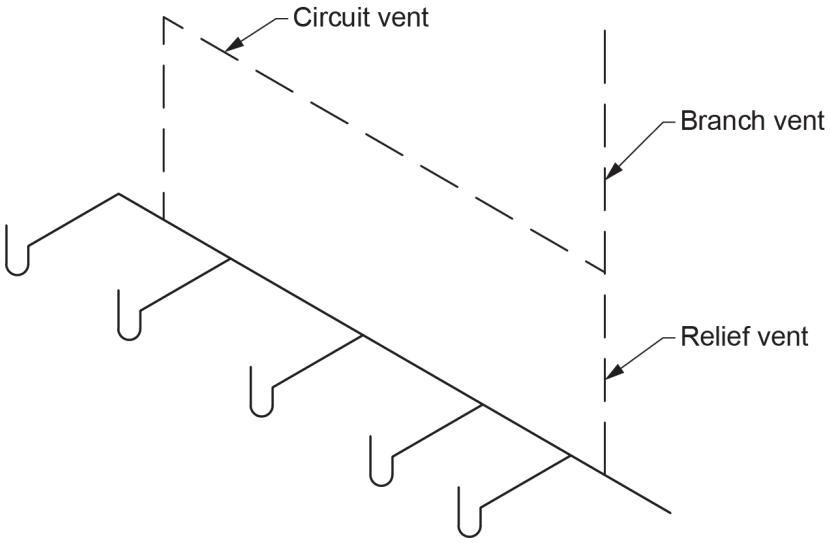

Figure 16 *Relief vent serving a circuit-vented branch. (Skilled Trades BC, 2021) Used with permission.*

Additional Circuit Vents

Additional circuit vents (Figure 17) are required on circuit-vented branches when there are more than eight fixtures connected between vent pipes or there is a cumulative change in direction of more than 45° between the circuit vent and relief vent.

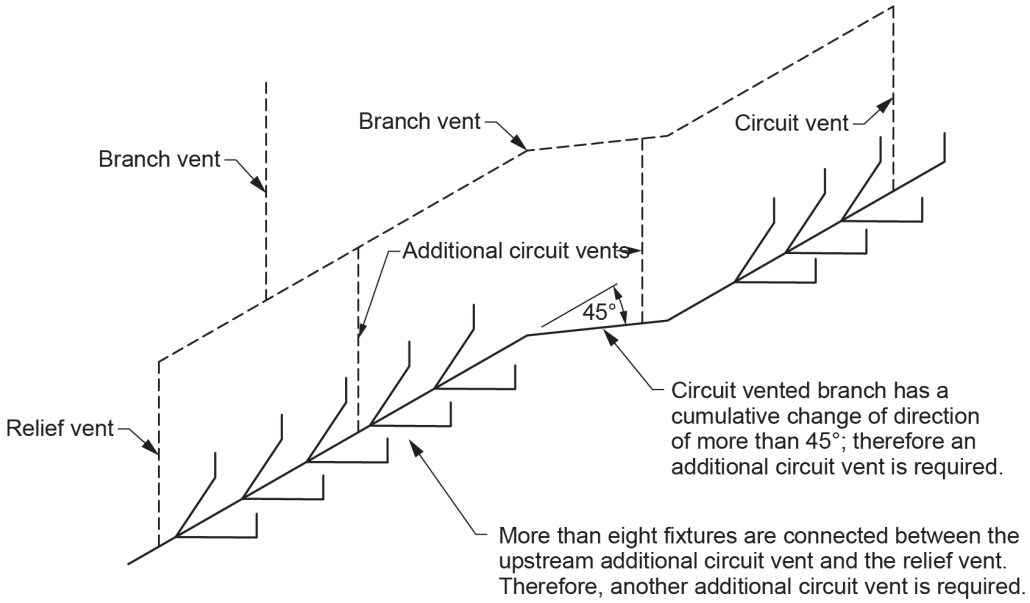

Figure 17 *Circuit-vented branch showing the requirements for additional circuit vents. (Skilled Trades BC, 2021) Used with permission.*

Offset Relief Vents

Offset relief vents provide additional air circulation to a stack with a nominally horizontal offset (Figure 18). An offset relief vent is required at A and B or A and C.

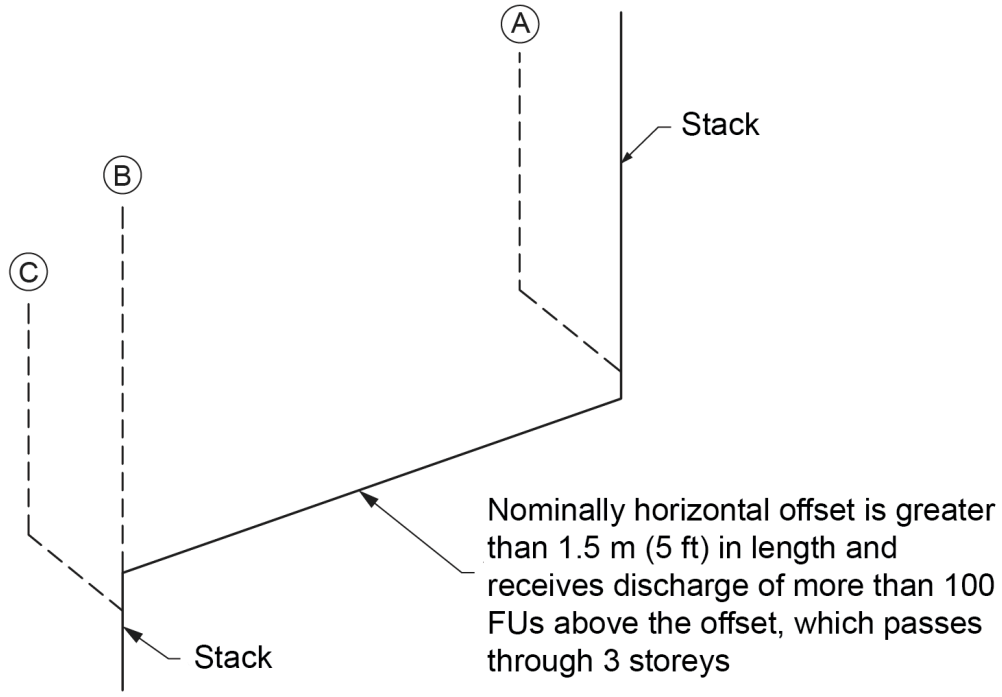

Figure 18 *Offset relief vents serving a nominally horizontal offset in a stack. (Skilled Trades BC, 2021) Used with permission.*

These vents are required if the offset is more than 1.5 m (60 in.) long and the upper portion of the stack passes through three or more storeys and has more than 100 fixture units on it. The offset relief vent connects at the lowest end of the upper stack after the last sanitary drainage pipe connection and at the upper end of the lower stack at a point higher than any drain connections.

Sump Vents

A sump vent (Figure 19) serves the sewage sump basin only to ensure that the basin operates at atmospheric pressure. It is not associated with venting the fixtures draining into the basin, which are vented normally even though they are connected to a sub-drainage system.

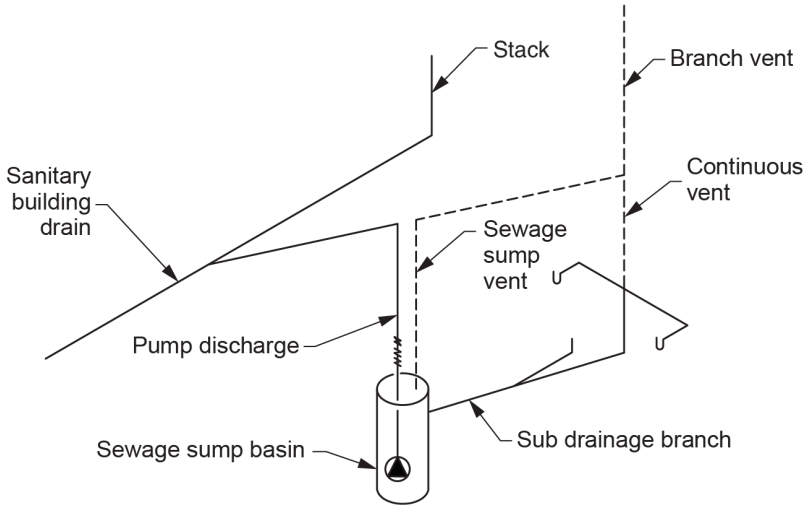

Figure 19 *Sewage sump vent. (Skilled Trades BC, 2021) Used with permission.*

Branch Vents

A branch vent is formed by combining two or more vent pipes that are not stack vents or vent stacks (Figure 20). Due to the hierarchy when naming vents, only some types of vents will become branch vents when tied into other vents.

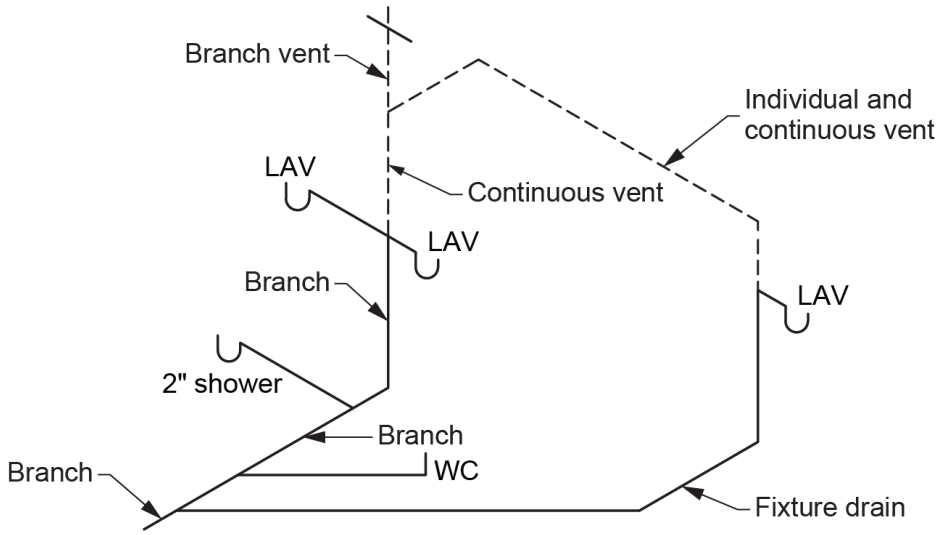

Figure 20 *Branch vent. (Skilled Trades BC, 2021) Used with permission.*

Stack Vents

A stack vent is the main vent for the stack. It begins at the highest fixture connection to the stack and typically extends through the roof. It may also connect to a vent stack or another stack vent, which would form a vent header. It reaches

open air either independently or through the vent header. The stack vent must be adequately sized to accommodate the necessary air flow created by the potential total liquid flow into the stack.

Vent Stacks

A vent stack protects the base of the stack by relieving the positive air pressures that accumulate from the air being dragged down the stack. The most effective connection point for the vent stack is at or immediately below the lowest vertical drainage connection to the stack. It is at this location that the pressure in the stack is at its maximum. Vent stacks are required when the stack has fixtures draining into it from more than four storeys. As with the stack vent, it must be adequately sized to accommodate the potential maximum flow at the base of the stack. Wet-vented stacks are exempt from this requirement as the increased wet vent size negates any positive pressure accumulation at the stack base.

Vent Headers

The vent header is the "king of the castle" in a venting system and always leads to outside air. Although a vent header is really not much different from a stack vent, it is named so that it can be sized by different rules. A vent header is the name of the pipe that results from two or more stack vents or vent stacks or any combination of these being joined (Figure 21). Once a vent pipe is named a vent header, connecting anything else to it will not change the name:

- stack vent + stack vent = vent header
- vent stack + vent stack = vent header
- stack vent + vent stack = vent header

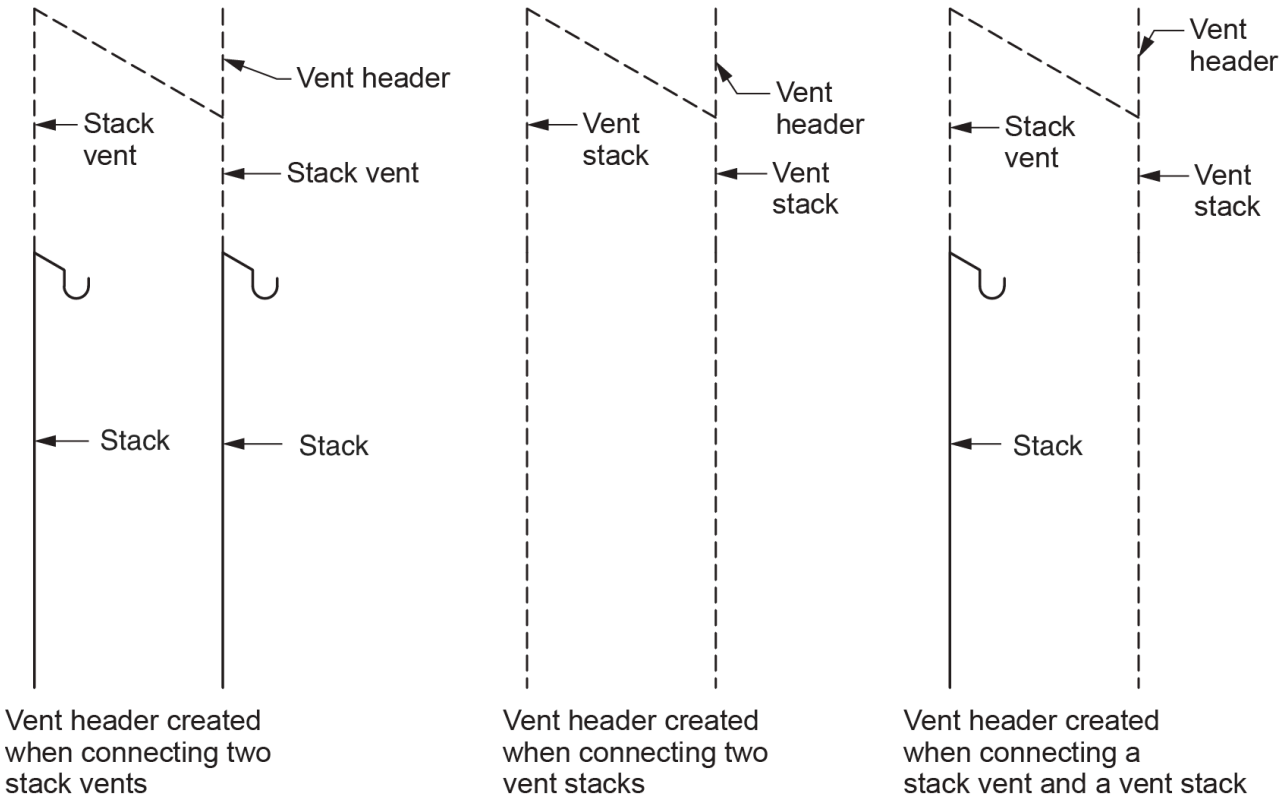

Figure 21 *Vent header combinations. (Skilled Trades BC, 2021) Used with permission.*

Vent Hierarchy

As stated earlier, there is a hierarchy when naming plumbing vents. The importance of a vent's role in the DWV system will determine not only its name but also when that name changes when connected to another vent type. It is very important to be able to identify the vents used in order to properly size them to code requirements. For example, if two individual vents are connected together, the resulting pipe becomes a branch vent. That single vent would be called a branch vent until it is connected to a higher class of vent — such as a vent stack, stack vent, or vent header — or until it terminates in open air. The first step is to understand that vents can be grouped into four categories, depending on their importance to the total system, as shown in Table 1. Note that Category 1 is the least important and Category 4 is the most important.

Table 1: Vent Hierarchy

Category 1	Category 2	Category 3	Category 4
Individual vent Dual vent Continuous vent Individual and continuous vent Dual and continuous vent Circuit vent Relief vent Additional circuit vent Sewage sump vent	Branch vent	Stack vent Vent stack	Vent header

Once a vent has been categorized, its name will follow the hierarchy rules for venting. Refer to the vent pyramid in Figure 22 to help you understand how to identify the vent names.

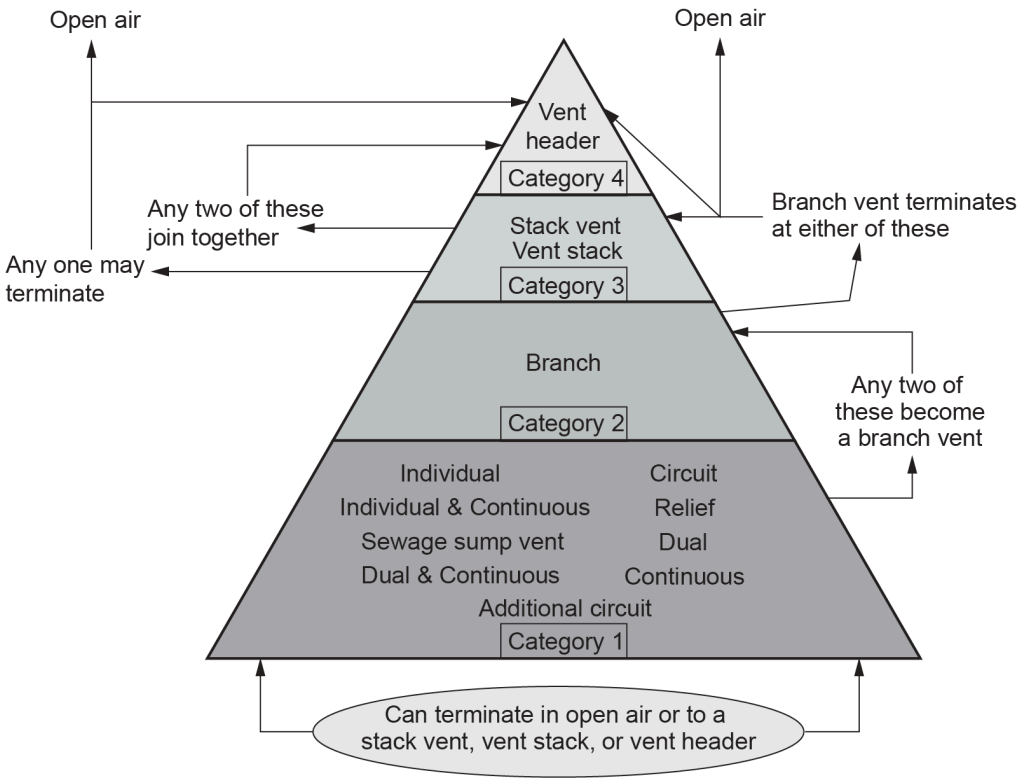

Figure 22 *Vent hierarchy pyramid. (Skilled Trades BC, 2021) Used with permission.*

Vent header (Category 4): created by connecting at least two Category 3 vents together (stack vents or vent stacks). Although a vent header is similar to a Category 3 vent, it is named differently so that it can be sized by a different code table.

Stack vent (Category 3): the vent at the top of a stack. It will remain a stack vent to open air unless it is connected to another stack vent or vent stack to form a vent header.

Vent stack (Category 3): a vertical vent pipe installed parallel to the stack and connected at its base. It will remain a vent stack to open air unless it is connected to another stack vent or vent stack to form a vent header.

Branch vent (Category 2): formed by joining two Category 1 vent pipes together. It will stay a branch vent until it is connected to a higher class of vent — such as a vent stack, stack vent or vent header — or it is terminated in open air.

Individual vent (Category 1): a vent that serves only one fixture and is connected at its lower end to the horizontal trap arm. The upper end may connect to a Category 2, 3, or 4 vent or terminate in open air.

Dual vent (Category 1): a vent that serves two fixtures. It connects with a double fitting where the horizontal trap arms meet to become a branch. The upper end may connect to a Category 2, 3, or 4 vent or terminate in open air.

Continuous vent (Category 1): a vent that extends from a vertical branch/wet vent or fixture drain/wet vent and can serve multiple fixtures located on the same storey. The upper end may connect to a Category 2, 3, or 4 vent or terminate in open air.

Individual and continuous vent (Category 1): a vent that serves only one fixture and is connected at its lower end to the junction of a vertical fixture drain and a horizontal trap arm. The upper end may connect to a Category 2, 3, or 4 vent

or terminate in open air. The naming of this vent combines two of its attributes. Because it is an extension of a vertical fixture drain, it is a continuous vent, and because it serves only one fixture, it is an individual vent.

Dual and continuous vent (Category 1): a vent that serves two fixtures and is connected at its lower end to the junction of a vertical branch and two symmetrically connected trap arms. The upper end may connect to a Category 2, 3, or 4 vent or terminate in open air. Similar to the individual and continuous vent, the naming of this vent combines two code definitions. Because it is an extension of a vertical branch, it is a continuous vent, and because it serves two fixtures connected at the junction of the trap arms, it is a dual vent.

Circuit vent (Category 1): A vent that serves multiple fixtures on a horizontal branch installed on the same storey. Its lower end is connected to the trap arm of the most upstream circuit vented fixture on the branch. The upper end may connect to a Category 2, 3, or 4 vent or terminate in open air. Circuit vents must always be paired with a relief vent located downstream of the most downstream circuit vented fixture and may also require an additional circuit vent.

Relief vent (Category 1): required for circuit vented branches to assist with air circulation in the branch. The lower end of the relief vent is connected to the circuit vented branch downstream of the most downstream circuit vented fixture. The upper end of the relief vent may connect to a Category 2, 3, or 4 vent or terminate in open air.

Additional circuit vent (Category 1): required on circuit vented branches if there are more than eight trap arms or a cumulative change in direction of more than 45° between the circuit and relief vent. The lower end of the additional circuit vent is connected to the circuit vented branch in the offset piping or between fixtures to limit the number of circuit vented fixtures between any two vent pipes to eight. The upper end of an additional circuit vent may connect to a Category 2, 3, or 4 vent or terminate in open air.

Sump vent (Category 1): The NPC requires that sewage sumps be watertight, airtight, and vented. The vent allows sewer gas to travel to open air, where it dissipates. Another purpose of the vent is to allow air to enter the sump when the liquid level drops during pump operation. The lower end of the vent attaches to the sump cover, while the upper end may connect to a Category 2, 3, or 4 vent or terminate in open air.

Self-Test D-1.3 Functions of Different Pipes in a DWV System

Complete Self-Test D-1.3 and check your answers.

If you are using a printed copy, please find Self-Test D-1.3 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=41#h5p-16 (https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=41#h5p-16)

References

Skilled Trades BC. (2021). *Book 2: Install fixtures and appliances, install sanitary and storm drainage systems.* Plumber apprenticeship program level 2 book 2 (Harmonized). Crown Publications: King's Printer for British Columbia.

Trades Training BC. (2021). D-1: Install sanitary drain, water and vent systems. In: *Plumber Apprenticeship Program: Level 2.* Industry Training Authority, BC.

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D-1.4 Acceptable Pipe Material Application

The **Plumbing Code** is a part of the Building Code and provides minimum requirements for plumbing installations in buildings to protect health and prevent water or sewer damage. The plumbing code specifies that all materials, systems, and equipment installed must be free of defects and possess the necessary characteristics to perform their intended functions when installed. Plumbers need to stay abreast of new regulations that may govern the types of pipes and fixtures acceptable to local inspectors. The purpose of this chapter is to help you correctly interpret plumbing code requirements for types of piping materials that may be used in DWV systems.

Identifying Piping

Every length of pipe and every **fitting** must have cast, stamped, or indelibly marked on it the maker's name or mark and the weight, class, or quality of the product, or be marked in accordance with the relevant standard. To help ensure the proper application of the different pipe materials, the code requires that these materials' identification markings must be visible after installation.

Piping Types

The acceptable piping materials for sanitary drainage systems are clearly listed in three tables in the Plumbing Code: Tables A-2.2.5., A-2.2.6., and A-2.2.7. The tables identify the acceptable material by reference to the appropriate ASTM or CSA standard and whether or not they are permitted above ground inside a building or below ground under a building in drainage and venting systems. The standard must properly address all technical matters in regulating a given material for use in a plumbing drainage and vent system.

One of the concerns with installing DWV systems is the impact the piping material has on the fire-protection aspects of a building. The building code requirements for pipe penetrations distinguish between **combustible piping** materials, such as ABS and PVC, and **non-combustible piping** materials, such as cast-iron soil pipe and copper tubing.

Another concern is the ability of DWV piping to withstand service pressures. This is usually not an issue with gravity systems, but when working with a pressure sewer "**forcemain**," it has some code restrictions. These systems are necessary when gravity flow is not sufficient to move sewage through a gravity line. Forcemains move wastewater under pressure using pumps or compressors located in lift stations. They convey wastewater from a lower to higher elevation or where construction of a gravity line would result in excessive excavation depths and prohibitive sewer line costs. The code requires that piping, fittings, and joints used in pressure sewer, forcemain, or sump pump discharge applications be capable of withstanding at least one and a half times the maximum potential pressure.

The following is a comprehensive list of piping materials used in DWV systems and the code requirements governing their use. The lists indicate:

- **Permitted application** with the letter **P**
- **Non-permitted application** with the letter **N**.

Fibrocement DWV Pipe

The material used to fabricate **fibrocement pipe** must conform to CAN/CSA-B127.3. This standard covers fibrocement Type 1 (Class 3000) and Type 2 (Class 4000) pipe and pipe fittings for installation in gravity-flow systems inside and outside of buildings, above and below grade

The pipe is formed under pressure and heat-cured in an **autoclave**. Using fibres rather than reinforcing steel provides adequate strength with lower weight. The standard was introduced in 2018 to replace the pipes that used asbestos as their reinforcing fibres.

DWV Application

Table 1: Fibrocement DWV Pipe Application

Drainage Systems			Venting Systems	
Above Ground Inside Building	**Underground Under Building**	**Building Sewer**	**Above Ground**	**Underground**
P	P	P	P	P

Polyethylene Plastic Pipe

Polyethylene plastic (PE) piping is considered "flexible" pipe and can withstand large amounts of deflection without damage. For practical purposes, however, PE pipes are limited to 7.5% deflection or less, depending on the **standard dimension ratio (SDR)** and application. Using polyethylene pipe for drainage systems resulted from the fairly recent practice of "pulling" a new building sewer into the space occupied by an old sewer without digging a trench to do so.

DWV Application

Table 2: Polyethylene Plastic Pipe Application

Drainage Systems			Venting Systems	
Above Ground Inside Building	**Underground Under Building**	**Building Sewer**	**Above Ground**	**Underground**
N	P	P	N	P

Plastic Sewer Pipe

These applications include both single-wall and co-extruded dual-wall pipe with a smooth interior.

DWV Application

Table 3: Plastic Sewer Pipe Application

Drainage Systems			Venting Systems	
Above Ground Inside Building	**Underground Under Building**	**Building Sewer**	**Above Ground**	**Underground**
N	P	P	N	N

ABS (Acrylonitrile-Butadiene-Styrene) Pipe

Due to its combustible property, **ABS** is primarily used in non-rated combustible construction, such as single-family dwellings. It is available in solid-wall and cellular-core construction in Schedule 40 dimensions. When used in non-combustible construction, it must meet the requirements of the building code, which requires that all combustible piping in buildings be of non-combustible construction and have a **flame-spread rating (FSR)** of not more than 25.

Combustible piping used in a high-rise building is also required to have a smoke developed classification (SDC) of not more than 50. Plastic piping not meeting the required FSR or SDC is only allowed if it is concealed in a wall or concrete floor slab and does not project outside of the concrete, even if concealed behind other components. ABS piping has an FSR exceeding 25; therefore, it cannot be used in buildings required to be non-combustible.

Solid-Wall Application

Table 4: ABS Pipe Solid-Wall Application

Drainage Systems			Venting Systems	
Above Ground Inside Building	**Underground Under Building**	**Building Sewer**	**Above Ground**	**Underground**
P (combustible construction)	P	P	P (combustible construction)	P

Cellular-Core Application

Table 5: ABS Pipe Cellular-Core Application

Drainage Systems			Venting Systems	
Above Ground Inside Building	**Underground Under Building**	**Building Sewer**	**Above Ground**	**Underground**
P (combustible construction)	P	P	P (combustible construction)	N

PVC (Polyvinyl Chloride) DWV Pipe

PVC DWV piping may have an FSR of less than 25, but its SDC may exceed 50; therefore, it may be used in buildings required to be non-combustible but not in high-rise buildings. Several commercially available combustible pipes meet the required FSR.

Solid-Wall Application

Table 6: PVC DWV Pipe Solid-Wall Application

Drainage Systems			Venting Systems	
Above Ground Inside Building	**Underground Under Building**	**Building Sewer**	**Above Ground**	**Underground**
P (combustible construction)	P	P	P (combustible construction)	P

Cellular-Core Application

Table 7: PVC DWV Pipe Cellular-Core Application

Drainage Systems			Venting Systems	
Above Ground Inside Building	**Underground Under Building**	**Building Sewer**	**Above Ground**	**Underground**
P (residential, combustible construction)	P	N	P (residential, combustible construction)	P

PVC (Polyvinyl Chloride) Sewer Pipe (All Classes) Application

Table 8: PVC Sewer Pipe (All Classes) Application

Drainage Systems			Venting Systems	
Above Ground Inside Building	**Underground Under Building**	**Building Sewer**	**Above Ground**	**Underground**
N	P	P	N	P

Profile Polyethylene Sewer Pipe

Profile wall pipe gains its strength through the geometry of the pipe wall. The pipe has a smooth interior wall with exteriors that may be ribbed or corrugated.

Application

Table 9: Profile Polyethylene Sewer Pipe Application

Drainage Systems			Venting Systems	
Above Ground Inside Building	**Underground Under Building**	**Building Sewer**	**Above Ground**	**Underground**
N	P	P	N	P

Polyolefin Laboratory Drainage Systems

Polyolefin pipe is used in a wide range of medical and laboratory applications that require non-corrosive material. The two most common classes are polyethylene (PE) and polypropylene (PP).

Application

Table 10: Polyolefin Pipe Application

Drainage Systems			Venting Systems	
Above Ground Inside Building	**Underground Under Building**	**Building Sewer**	**Above Ground**	**Underground**
P (combustible construction)	P	P	P (combustible construction)	P

Cast-Iron Pipe

Cast-iron soil pipe is used primarily in non-combustible building construction for sanitary, storm drain, waste, and vent piping applications. Because cast-iron pipe that penetrates fire separations will not allow the passage of flames from one compartment to another, fire retardants and cut-off devices are not required.

Application

Table 11: Cast-Iron Pipe Application

Drainage Systems			Venting Systems	
Above Ground Inside Building	**Underground Under Building**	**Building Sewer**	**Above Ground**	**Underground**
P	P	P	P	P

Copper Tubing

Copper tubing is available in both hard and soft tempers. Only hard copper tubing may be used for DWV systems. Copper tube must not be used for the fixture drain or the portion of the vent pipe below the flood level rim of a urinal.

Type K and L copper joints installed underground shall be made with either flared or compression fittings or be brazed using a brazing alloy within the American Welding Society's AWS-BCuP range. Compression fittings are not allowed underground under a building because the joint cannot withstand building settlement.

Type K and L Hard Temper Application

Table 12: Copper Tube Type K and L Temper Application

Drainage Systems			Venting Systems	
Above Ground Inside Building	**Underground Under Building**	**Building Sewer**	**Above Ground**	**Underground**
N	P	P	P	P

Type M Hard Temper Application

Table 13: Copper Tube Type M Hard Temper Application

Drainage Systems			Venting Systems	
Above Ground Inside Building	**Underground Under Building**	**Building Sewer**	**Above Ground**	**Underground**
P	N	N	P	N

DWV Types Application

Table 14: Copper Tube DWV Types Application

Drainage Systems			Venting Systems	
Above Ground Inside Building	**Underground Under Building**	**Building Sewer**	**Above Ground**	**Underground**
P	N	N	P	N

Welded Seamless Steel Galvanized Pipe

Galvanized pipe is a variety of steel piping coated in a layer of zinc. While the layer of zinc over the steel was originally intended to help avoid corrosion, it has since been discovered that zinc has a tendency to react with the minerals in the water it carries, producing scale.

Application

Table 15: Welded Seamless Steel Galvanized Pipe Application

Drainage Systems			Venting Systems	
Above Ground Inside Building	**Underground Under Building**	**Building Sewer**	**Above Ground**	**Underground**
P	N	N	P	N

Copper and Brass Pipe

These requirements refer to pipe that conforms to the same wall thickness standards as schedule steel pipe materials. If copper or brass pipes are used in drainage systems, they must use drainage fittings not threaded water fittings.

Copper and brass are two very similar-looking metals, but there are many occasions when it is useful to be able to differentiate between brass and copper pipes. Copper is a naturally occurring metal, while brass is an artificial alloy of copper and zinc mixed together.

Application

Table 16: Copper and Brass Pipe Application

Drainage Systems			Venting Systems	
Above Ground Inside Building	**Underground Under Building**	**Building Sewer**	**Above Ground**	**Underground**
P	P	P	P	P

Lead Waste Pipe

Lead piping has not been commonly used since the 1950s, but it still has approved applications in the Plumbing Code. The code requires that when there is a change in size of a lead closet bend, the change shall be in the vertical section of the bend or made in a manner that prevents the retention of liquid in the bend.

Application

Table 17: Lead Waste Pipe Application

Drainage Systems			Venting Systems	
Above Ground Inside Building	**Underground Under Building**	**Building Sewer**	**Above Ground**	**Underground**
P (combustible construction)	P	N	P (combustible construction)	P

Self-Test D-1.4: Acceptable Pipe Material Application

Complete Self-Test D-1.4 and check your answers.

If you are using a printed copy, please find Self-Test D-1.4 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=43#h5p-14 (https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=43#h5p-14)

References

Skilled Trades BC. (2021). *Book 2: Install fixtures and appliances, install sanitary and storm drainage systems.* Plumber apprenticeship program level 2 book 2 (Harmonized). Crown Publications: King's Printer for British Columbia.

Trades Training BC. (2021). D-1: Install sanitary drain, water and vent systems. In: *Plumber Apprenticeship Program: Level 2.* Industry Training Authority, BC.

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D-1.5 Sizing Sanitary Drainage Pipes

Trap arms, fixture drains, branches, stacks, sanitary building drains, sanitary building sewers, and sewage sumps are all part of the sanitary drainage system. Wet vents are part of the drainage and venting systems. Sizing wet vents will be covered in later chapters.

To begin, we must understand that the load that a fixture imposes on the drainage system is measured in fixture units (FU). Each plumbing fixture has an FU rating that is calculated using the rate of discharge, the frequency of use, and the time between each use of a plumbing fixture. The fixture unit rating represents the **hydraulic load** placed on the sanitary drainage system by that fixture.

Sizing pipe for a drainage system is a relatively straightforward process once you are familiar with the tables provided in the Plumbing Code book. These tables provide the minimum size of all drainage pipes based on the maximum **fixture unit load** it can carry for any particular size.

Because there are different tables for sizing each drainage pipe designation, you must be able to properly identify the different sections of the drainage system and their function.

Sizing Traps and Fixture Outlet Pipes

The individual fixtures are the place to start whenever you are sizing a drainage system. Table 2.4.9.3 provides two very important pieces of information:

1. The fixture unit load imposed on the drainage system based on the type of fixture
2. The minimum size of the fixture outlet pipe, which would also determine the minimum size of the trap and fixture drain serving the fixture

Table 2.4.9.3

Table 1 is an excerpt from Table 2.4.9.3 in the National Plumbing Code (NPC) of Canada (2020; Division B 2-31) and provides a list of common plumbing fixtures found in domestic and commercial drainage installations.

Table 1: (From NPC Table 2.4.9.3) Minimum Permitted Size of Fixture Outlet Pipe and Hydraulic Loads for Fixtures

Fixture	Minimum size of fixture outlet pipe (in.)	Hydraulic load (FUs)
Autopsy table	1.50	2
Bathroom group with flush tank	N/A	6
Bathroom group with direct flush valve	N/A	8
Bathtub (with or without shower)	1.50	1.50
Bath: foot, sitz, or slab	N/A	1.50
Beer cabinet	N/A	1.50
Bidet	N/A	1
Domestic clothes washer	N/A	2 with 2 in. trap
Commercial clothes washer	N/A	2 with 2 in. trap
Dental unit or cuspidor	N/A	1
Domestic dishwasher	N/A	1.50, no load when connected to garbage grinder or domestic sink
Commercial dishwasher	N/A	3
Drinking fountain	N/A	0.50
Floor drain	N/A	2 with 2 in. trap 3 with 3 in. trap

Hydraulic Load for Floor Drains

Some clarification is needed regarding the hydraulic load assigned to a floor drain. Floor drains can be classified under two general headings:

1. Non-emergency floor drains
2. Emergency floor drains

Non-Emergency Floor Drains

Non-emergency floor drains are installed in the floor of a structure and are mainly designed to remove any nearby standing water. When installed, the hydraulic load imposed on the drainage system would equal the values listed in Table 2.4.9.3., as shown above. Some floor drains are installed near a wall and are usually equipped with a funnel attached to the strainer. These are also not considered emergency floor drains.

Emergency Floor Drains

Unlike the non-emergency variety, **emergency floor drains**, by code definition, are in place for overflow protection and do not receive regular discharge. The code also requires — in Division B, Notes to Part 2, A-Table 2.4.9.3. — that any floor drain installed in a washroom be considered an emergency floor drain. When a floor drain is designated as an emergency

floor drain, there shall be no hydraulic load assigned to it. This provision allows the 0 FUs emergency floor drain to be connected to the drainage system without imposing additional fixture unit loading that might require an increase in drain pipe size.

If you require sizing information for a fixture that is not listed in Table 2.4.9.3., you must refer to Table 2.4.10.2. The fixture unit loads listed in this table are based on the trap size the fixture employs and not on the type of fixture. If this is the case, you would find the trap size by physically measuring the fixture outlet pipe on site or by referring to the manufacturer's information. This table would also be used if you were sizing a trap that may be used to serve drains from unspecified equipment on site. In Table 2, you can see that the fixture unit loads are, in most cases, larger than those in Table 2.4.9.3.

Example

A 3 in. non-emergency floor drain from Table 2.4.9.3. has a hydraulic load of 3 FUs, while the hydraulic load for a 3 in. trap from Table 2.4.10.2 (NPC, 2020, B 2-33) is 5 FUs.

Table 2: (From NPC Table 2.4.10.2) Permitted Hydraulic Load From a Fixture Based on Size of Trap

Trap Size (in.)	Hydraulic Load (FUs)
1.25	1
1.50	2
2	3
3	5
4	6

The reason for this inflated value is that the 3 in. trap serving as a floor drain will impose a load on the drainage system associated with the floor drain's function (3 FUs) (Figure 1). The 3 in. trap, on the other hand, could have an unknown flow rate; therefore, a larger FU load is assigned to it.

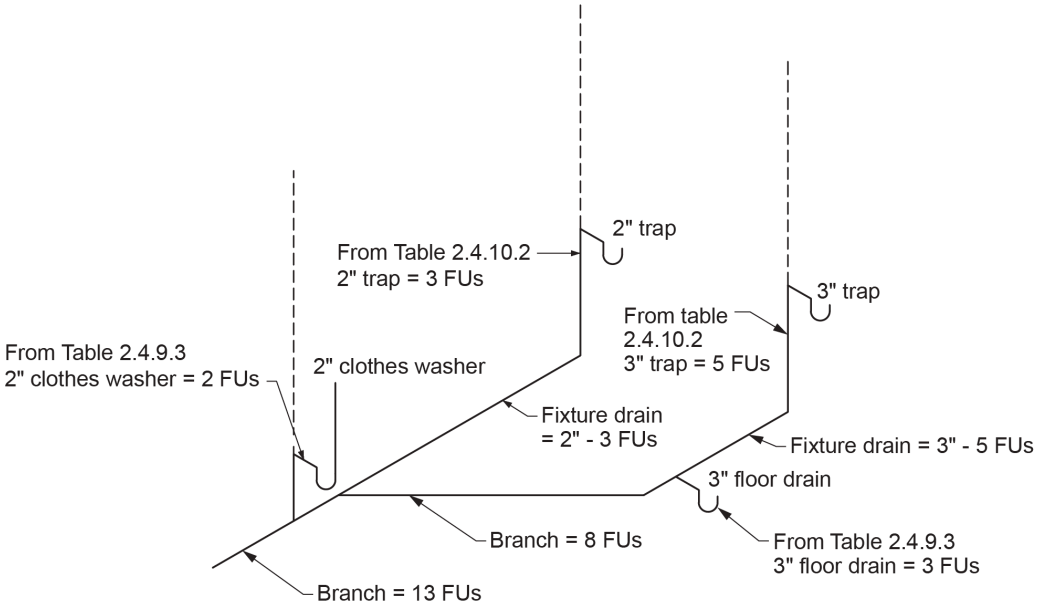

Figure 1 *Drainage system showing different fixture unit ratings for unknown traps and fixture designations. (Skilled Trades BC, 2021) Used with permission.*

Hydraulic Load from Fixtures with a Semi-Continuous Flow

Sometimes we need to size a drain receiving flow in litres/second (L/s) from a pump or other piece of equipment. The code is vague regarding a definition difference between continuous and **semi-continuous flow** and what produces it. When a pump operates and sends discharge to a drainage system, it is assumed that it will not be pumping forever and that it will cycle on and off. For that reason, both continuous and semi-continuous flows are treated the same.

In such cases, we need two pieces of information:

1. NPC Sentence 2.4.10.3.(1) is used to convert the pump flow rate (L/s) into fixture unit imposed on the sanitary system by the pump discharge.
2. If a trap is required to serve an indirect connection, the trap used to serve the pump discharge is sized using Table 2.4.10.12. (Table 3) in the NPC (2020, B 2-47).

Table 3: (From NPC Table 2.4.10.12) Maximum Permitted Hydraulic Load From Fixtures With a Semi-continuous Flow

Trap Size (in.)	Flow (L/s)	Hydraulic Load (FUs)
1.50	0.00–0.090	3
2	0.091–0.190	6
3	0.1910–0.850	27
4	0.85–5.700	180

Example

A pump discharges a continuous flow of 0.5 L/s into a sanitary drainage system.

What is:

1. The fixture unit load imposed on the system by the pump?
2. The trap and fixture drain size to accommodate the pump discharge?

Solution

1. First, we must covert the L/s discharge flow rate to drainage FUs. Clause 2.4.10.3 in the NPC gives us the conversion needed. It requires the load on a sanitary drainage system to be 31.7 FUs per L/s of flow. Using the equation below, we can determine that the hydraulic load on the system is 15.85 FUs

   $$(0.5\ \mathrm{L/s} \times 31.7 = 15.85\ \mathrm{FUs}).$$
2. With a drainage load of 15.85 FUs, we need to determine the trap size used for this installation. For that component, we use Table 2.4.10.12. For our example with a flow rate of 0.5 L/s, we would look down the centre column until we find a flow rate range that encompasses our flow rate. We can see that the third row with a flow rate ranging from 0.191–0.850 L/s is the proper choice. From this row, we can determine the trap size, which is 3 in.

Note that the table offers a third column, which gives a hydraulic load figure for all of the flow rate ranges. This hydraulic load is based on the maximum flow rate in all of the ranges. If you multiply the maximum flow rate in all of the ranges by 31.7, the product equals the hydraulic load given.

In our example with a flow rate of 0.5 L/s, our hydraulic load is 15.85 FUs and not 27 FUs, which is based on 0.85 L/s

(Figure 2). This is the maximum load that can be drained to a 3 in. trap from semi or continuous flow. While the discharge is within the sanitary system, it is considered to be 15.85 FUs and not 0.5 L/s.

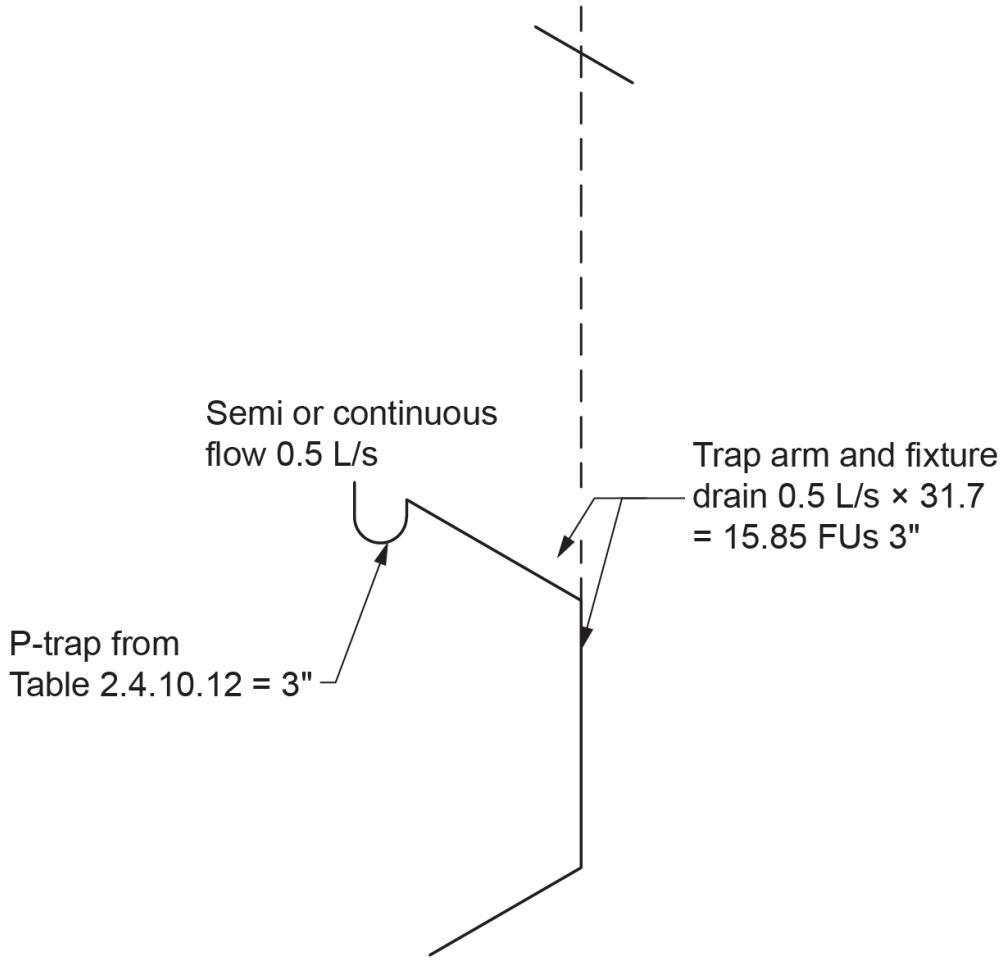

Figure 2 *Trap and fixture drain sizing based on semi or continuous flow. (Skilled Trades BC, 2021) Used with permission.*

Sizing Branches

A branch serves two or more fixtures or stack within a storey and may connect to another branch, building drain, sewage sump, or stack (Figure 3). When sizing a branch, use Table 2.4.10.6.-B to size each portion of the branch as the fixture load is applied, as shown in Table 4.

Table 4: (Table 2.4.10.6.-B) Maximum Permitted Hydraulic Load Drained to a Branch

Branch Size (in.)	Maximum Hydraulic Load (FUs)
1.25	2
1.50	3
2	6
3	27
4	180
5	390
6	700
8	1,600
10	2,500
12	3,900

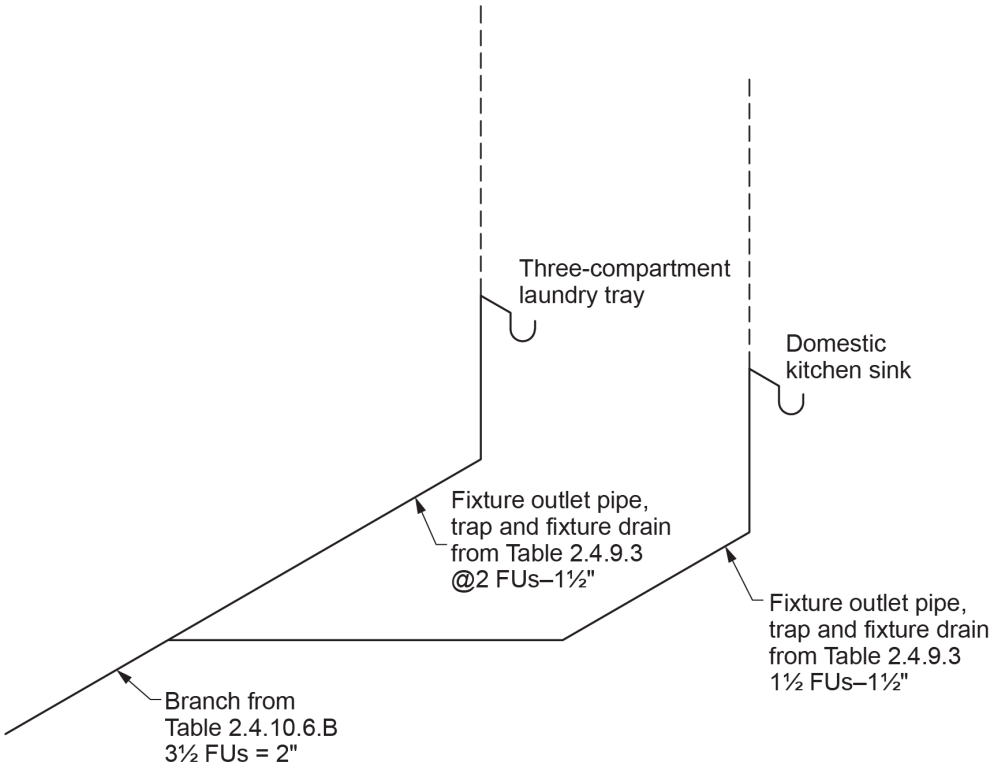

Figure 3 *Branch created by joining two fixture drains and sized from NPC Table 2.4.10.6.-B. (Skilled Trades BC, 2021) Used with permission.*

Sizing Stacks

A stack (also known as a soil-or-waste stack or SOWS) is a drainage pipe that passes through at least one storey as a drain pipe; this also includes any nominally horizontal offsets. A stack will typically receive waste from multiple fixtures connected to it. These may be located on a single floor or multiple storeys.

When sizing a stack, you would use Table 2.4.10.6.-A (Table 5). Notice that it states not only the maximum load that the stack can carry for any given size but also the maximum number of fixture units drained to it from any one storey for any given size.

Table 5: (Table 2.4.10.6.-A) Maximum Permitted Hydraulic Load Drained to a Stack

Stack Size (in.)	Maximum Hydraulic Load (FUs)	Maximum FUs Drained From Any One Storey
1.25	2	2
1.50	8	2
2	24	6
3	102	18
4	540	100
5	1,400	250
6	2,900	500
8	7,600	830
10	15,000	2,700
12	26,000	4,680
15	50,000	9,000

Example

A 3 in. stack can have a maximum load of 102 FUs in total. If the 3 in. stack receives a 20-FU load from any one storey, then the size of the stack would have to be 4 in. from that floor's connection point downward because, according to the third column of Table 2.4.10.6.-A, the maximum load from any one storey draining to a 3 in. stack is 18 FUs (Figure 4).

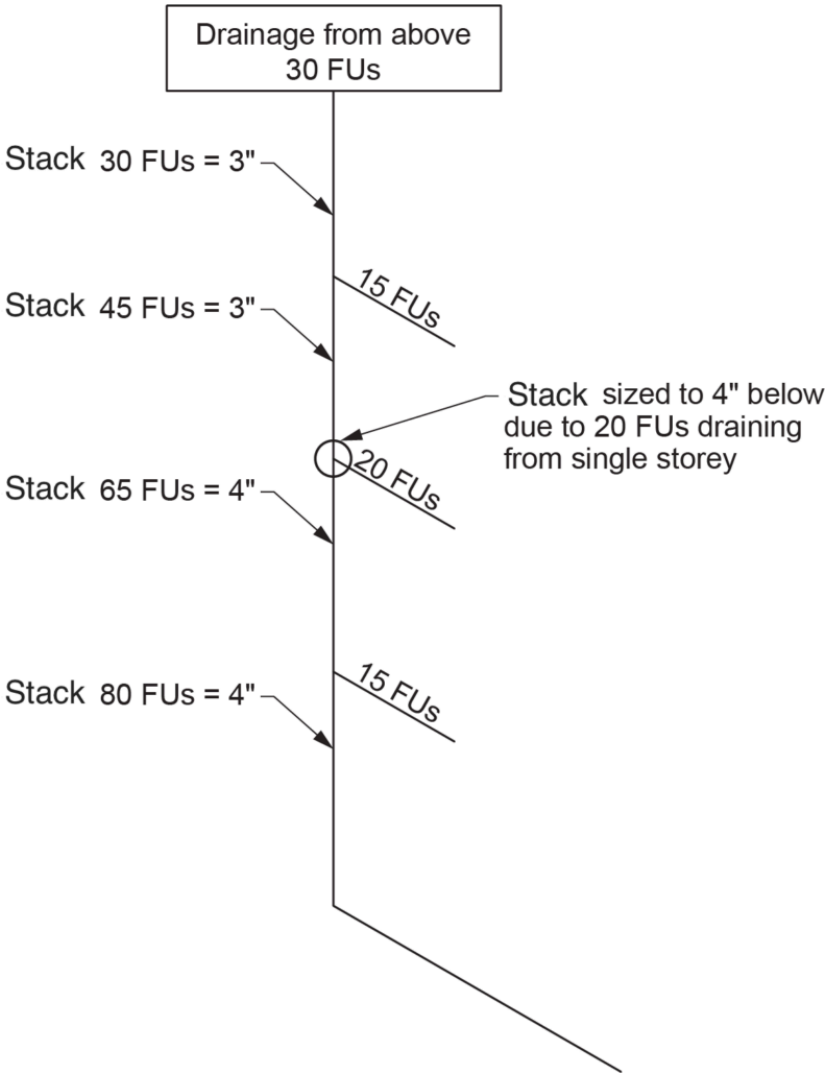

Figure 4 *Stack must be increased in size due to 20 FUs draining to it from any one storey. (Skilled Trades BC, 2021) Used with permission.*

Sizing a Sanitary Building Drain or Sewer

The sanitary building drain conducts sewage from the furthest upstream fixture drain, branch, or stack serving a water closet and terminates 1 meter (39 inches) outside the foundation. At this point, the sanitary building sewer is established and conducts the flow to the municipal disposal system or private disposal system.

To determine the size of any portion of the sanitary building drain or building sewer, you must know the drainage load and the pipe grade. Notice that for any pipe size, the load-carrying capacity of the pipe increases as the grade increases.

Table 6: (Table 2.4.10.6.-C) Maximum Permitted Hydraulic Load Drained to a Sanitary Building Drain or Sewer

Size of Drain or Sewer (in.)	Maximum Hydraulic Load (FUs)					
	Slope					
	1 in 400	1 in 200	1 in 133	1 in 100	1 in 50	1 in 25
3	N/A	N/A	N/A	N/A	27	36
4	N/A	N/A	N/A	180	240	300
5	N/A	N/A	380	390	480	670
6	N/A	N/A	600	700	840	1,300
8	N/A	1,400	1,500	1,600	2,250	3,370
10	N/A	2,500	2,700	3,000	4,500	6,500
12	2,240	3,900	4,500	5,400	8,300	13,000
15	4,800	7,000	9,300	10,400	16,300	22,500

Sizing the System

Now that the different tables have been explored, it is time to use them to size the entire sanitary system.

Sizing fixture drains:

- Fixture drains serve one fixture only and may run vertically or horizontally.
- The size of every fixture drain that serves a water closet must be at least 3 in., except for a macerating toilet, which must be at least $\frac{3}{4}$ in.
- Fixture drains begin at the trap weir and end at the connection point to a branch, stack, or sanitary building drain.
- The minimum size of a fixture drain is equal to the fixture outlet pipe and trap found in NPC Table 2.4.9.3. and 2.4.10.2.
- A fixture drain, fixture outlet pipe, and trap serving a semi or continuous flow fixture is sized from NPC Table 2.4.10.12.
- The portion of the fixture outlet pipe, trap arm, and fixture drain serving three or more compartments of a sink shall be increased one size larger than the largest fixture outlet pipe located upstream.
- The size of the fixture drain must not be smaller than the size of the individual vent connected to it.
- As long as proper grade and cleanout spacing are provided, there is no restriction to the length of a fixture drain.

Sizing branches:

- The size of a branch is found in Table 2.4.10.6.-B.
- The size of the branch shall not be smaller than the size of any vent connected to it.
- The load to consider on any section of a branch is the sum of the loads actually connected to — or future connections to — the branch upstream of the section being sized.
- A branch may never be smaller than any upstream drainage pipe connecting to the branch.
- Branches downstream of where a third water closet is connected must be 100 mm (4 in.) (Figure 5).
- As long as proper grade and cleanout spacing are provided, there is no restriction to the length of a branch

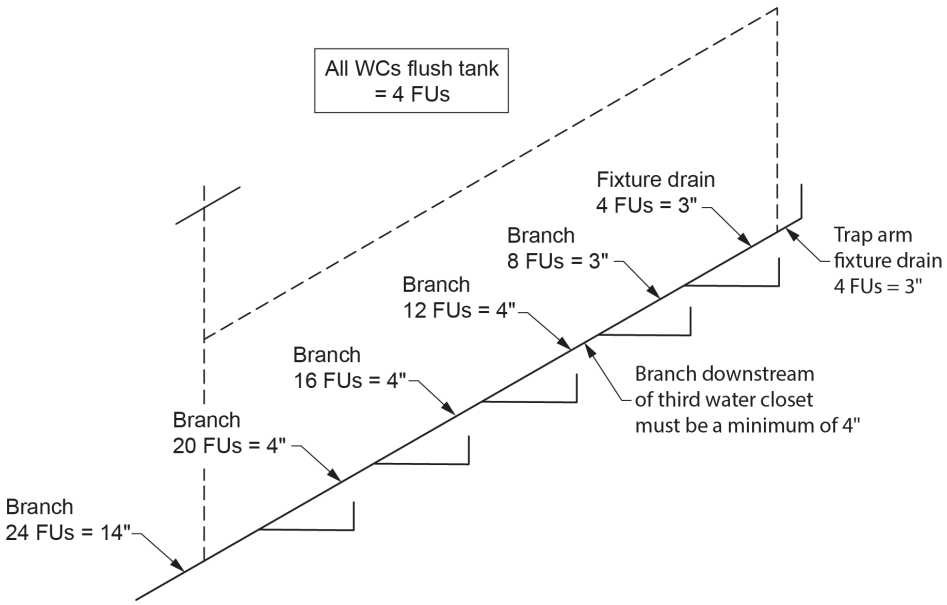

Figure 5 *Branch increasing to 4 in. in size due to the connection of a third water closet. (Skilled Trades BC, 2021) Used with permission.*

Fixture Unit Loads on Branches Serving Bathroom Groups

The NPC (Table 2.4.9.3.) requires that the drainage load imposed on the drainage system by bathroom groups are as follows:

- With flush tank water closet = 6 FUs
- With flush valve water closet = 8 FUs

These listed drainage fixture unit values reflect the load of entire bathroom groups on the sanitary drainage system. A closer look at these values shows that they are slightly lower than the total of all fixture unit loads of the fixtures that make up the bathroom group. The reason for this difference is that a diversity factor is placed on a bathroom group. In other words, the probability of all fixtures in the group discharging at once is extremely low, so the load imposed on the system can be reduced.

For example, suppose we have a standard bathroom group consisting of:

- A flush tank water closet (WC)
- An $1\frac{1}{4}$ in. lavatory basin
- A bathtub

The drainage fixture unit load total of all of the individual fixtures listed above would equal:

Table 7: Bathroom Group Drainage Load Example

Fixture	Drain Load (FUs)
WC with flush tank	4
1.25 in. lavatory basin	1
Bathtub	1.50
Total	**6.50**

In this case, by designating the fixtures as a bathroom group, the load is reduced by 0.50 FUs.

Whenever the opportunity presents itself, you should always use the reduced bathroom group values, as doing so will lower the total load on the DWV system. When you are sizing your drainage drawings, a good practice to employ is to identify all bathroom groups on your drawings with a circle or a cloud, as shown in Figure 6. This will help to indicate where load reduction may be utilized.

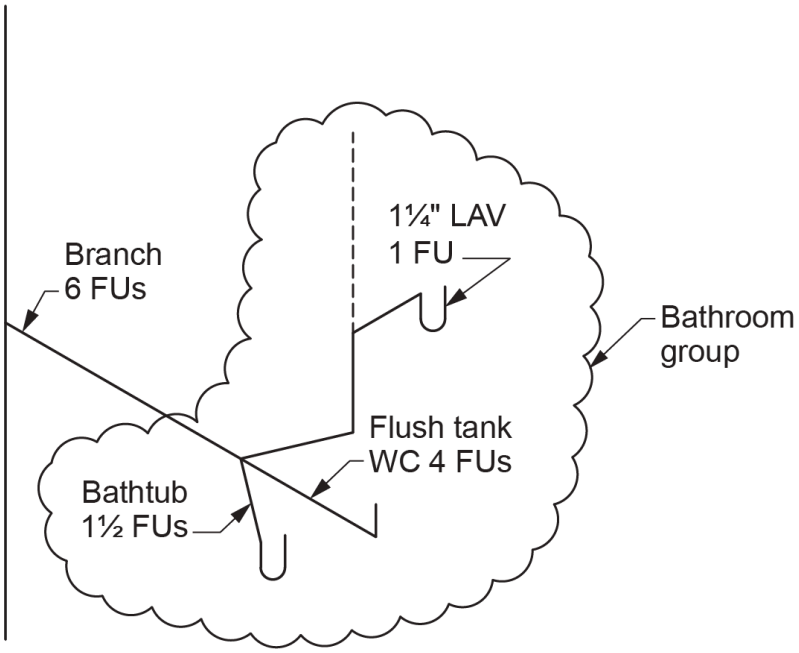

Figure 6 *Branch serving a bathroom group with a subsequent reduction in load on the system. (Skilled Trades BC, 2021) Used with permission.*

Fixture Unit Loads on Branches Serving Bathroom Groups with Additional Fixtures

The branch for a four- or five-piece bathroom has an additional fixture(s) that fall outside the NPC definition of a bathroom group. In order to gain the benefit of load reduction, you simply indicate the original bathroom group and add the fixture unit value of the additional fixture(s). The load on the branch serving the group is often referred to as a "bathroom group plus 1 in." or a "bathroom group plus 1.50 in." (Figures 7 and 8).

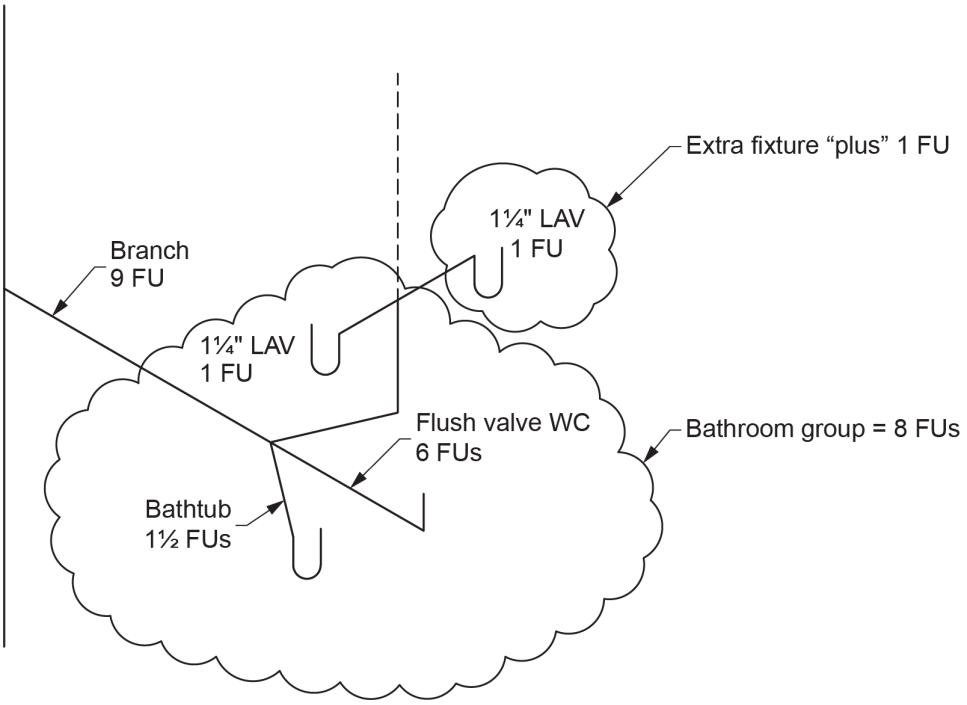

Figure 7 *Flush valve bathroom group with an additional lavatory basin. (Skilled Trades BC, 2021) Used with permission.*

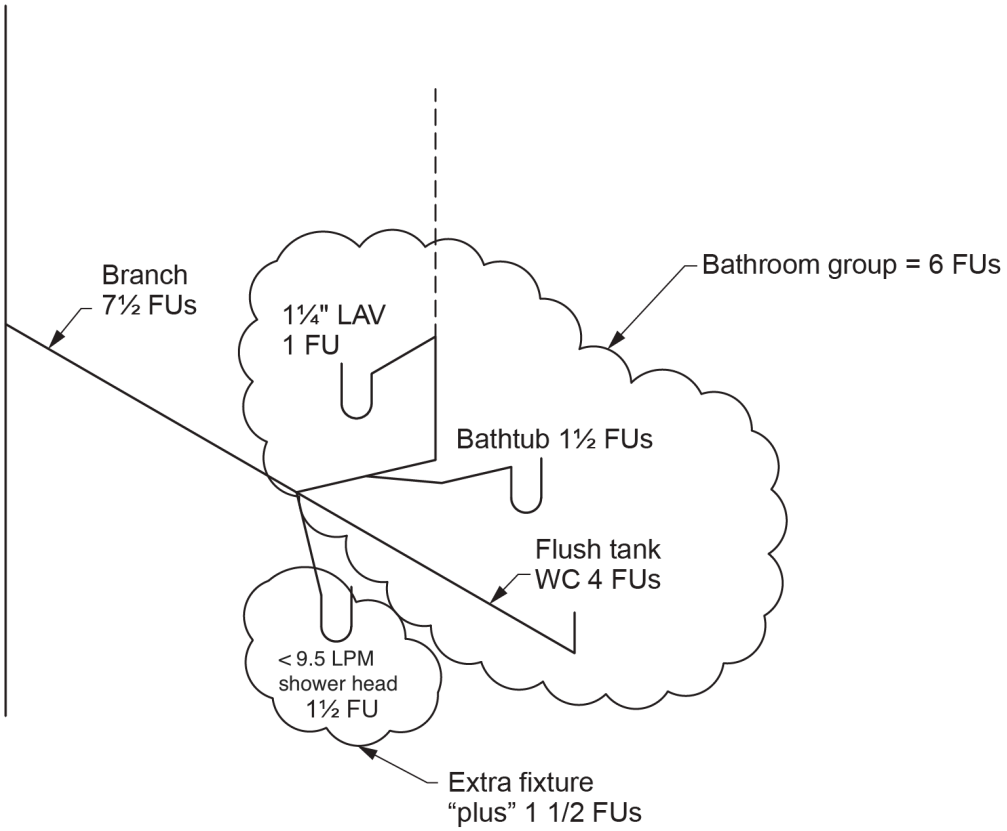

Figure 8 *Flush tank bathroom group with an additional single-headed shower. (Skilled Trades BC, 2021) Used with permission.*

Sizing stacks:

- The size of any section of a stack is found in Table 2.4.10.6.-A (NPC, 2020, B 2-34).
- A stack may never be smaller than any upstream drainage pipe connecting to the stack.
- The size of the stack shall not be smaller than the size of the stack vent connected to it.
- The size of any section of a stack is limited to a maximum number of fixture units draining to the stack from any one storey, as found in the third column of Table 2.4.10.6.-A.
- The load to consider on any section of a stack is the sum of the loads draining to the stack section from above.
- When a nominally horizontal offset in a stack is 1.5 m (5 ft) or more in length (Figure 9), the offset shall be sized as a branch using Table 2.4.10.6.-B (NPC, 2020, B 2-35) or a building drain using Table 2.4.10.6.-C (NPC, 2020, B 2-35). If the size of the offset in the two tables differs, the language states to go with "whichever is less restrictive". This is meant to be taken in a legal context, which translates to "whichever is larger." In the case of Figure 9, the offset would need to be increased to 4 in. due to both the table loads as well as the fact it is treated as a branch serving more than two water closets. If the offset increases in size, the larger stack size must be maintained due to the no reduction in drainage pipe size rule.
- A stack serving more than six water closets must be a minimum of 100 mm (4 in.).

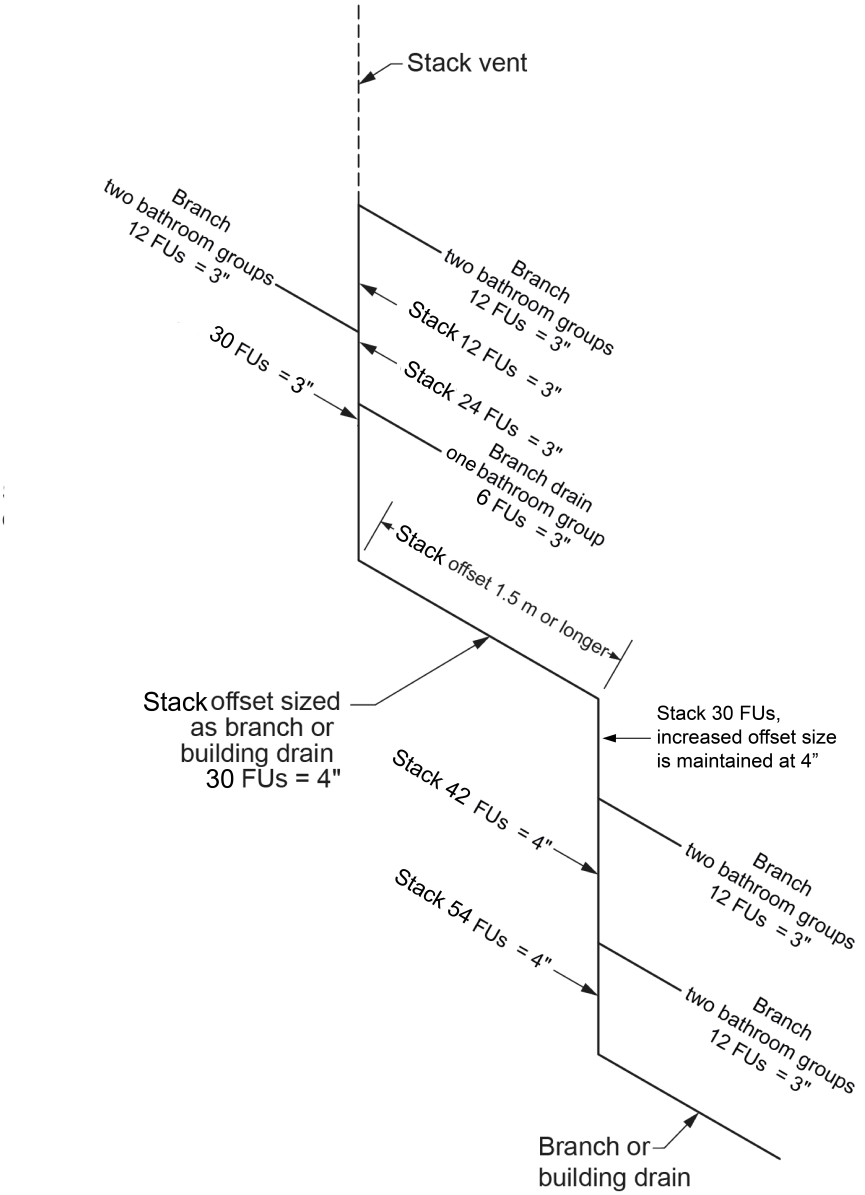

Figure 9 *Stack serving multiple bathroom groups with a nominally horizontal offset of 1.5 m or longer. (Skilled Trades BC, 2021) Used with permission.*

Sizing a sanitary building drain or sewer:

- The size of any section of a sanitary building drain or sewer is found in Table 2.4.10.6.-C using the hydraulic load draining to the section and the grade on the building drain or sewer.
- A sanitary building drain or sewer downstream of a main building cleanout fitting must be 100 mm (4 in.) in size.
- A sanitary building drain or sewer downstream of the third water close connected must be 100 mm (4 in.).
- A sanitary building drain or sewer may never be smaller than any upstream drainage pipe connecting to it.
- The load to consider on any section of the sanitary building drain or sewer is the sum of the loads actually connected to — or future connections to — the sanitary building drain or sewer upstream of the section being sized.
- If the building drain or sewer receives discharge from a sewage sump basin (Figure 10), the load to consider would be based on the load imposed by the sewage ejector pump not the FU load of the fixtures draining to the sump basin. For this example, the calculated load of the 2 in. discharge pipe would be:

$$0.75 \text{ L/s} \times 31.7 = 23.78 \text{ FUs } (24 \text{ FUs})$$

- As long as proper grade and cleanouts are provided, there is no restriction to the length of a sanitary building drain or sewer.

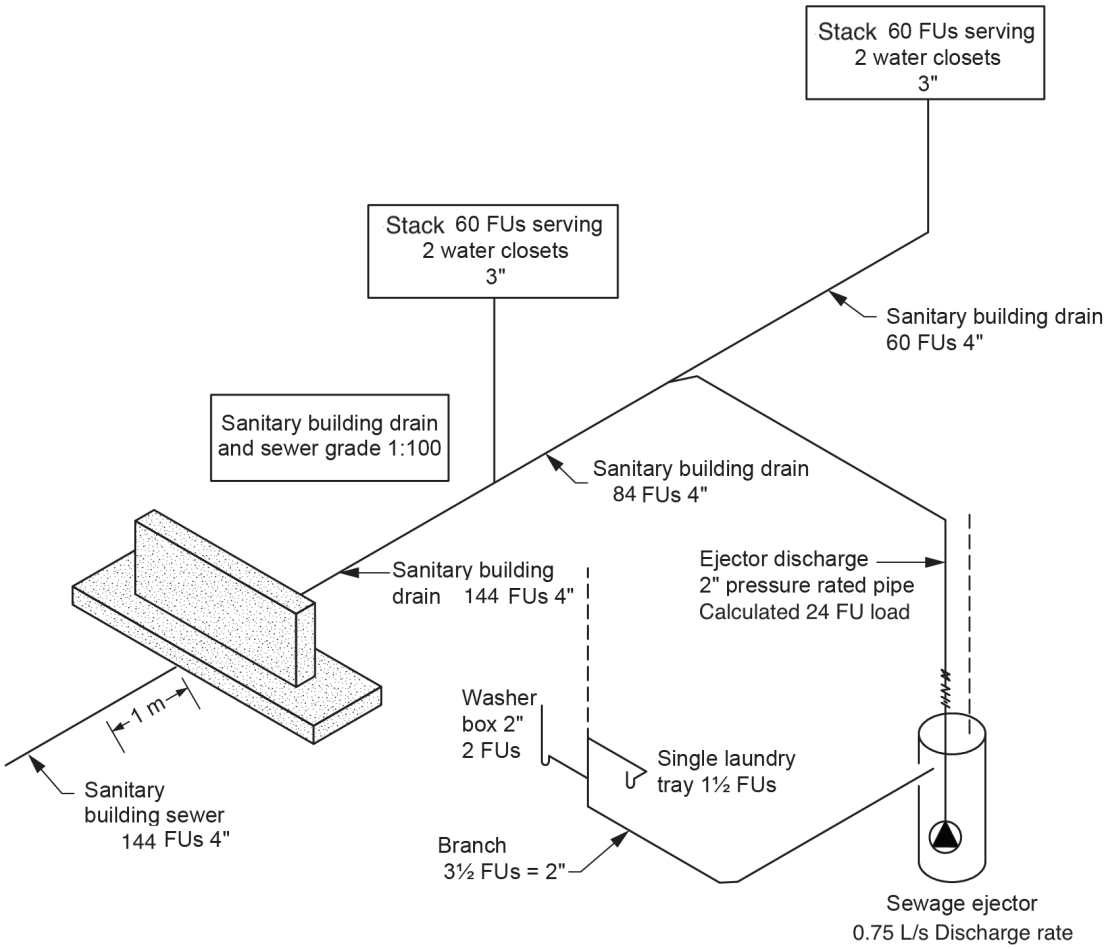

Figure 10 *Sanitary building drain sizing when receiving gravity and pumped discharge. (Skilled Trades BC, 2021) Used with permission.*

Self-Test D-1.5: Sizing Sanitary Drainage Pipes

Complete Self-Test D-1.5 and check your answers.

If you are using a printed copy, please find Self-Test D-1.5 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=45#h5p-17 (https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=45#h5p-17)

References

National Research Council of Canada. (2020). *National plumbing code of Canada* 2020. Canadian Commission on Building and Fire Codes. https://nrc-publications.canada.ca/eng/view/ft/?id=6e7cabf5-d83e-4efd-9a1c-6515fc7cdc71 (https://nrc-publications.canada.ca/eng/view/ft/?id=6e7cabf5-d83e-4efd-9a1c-6515fc7cdc71)

Skilled Trades BC. (2021). *Book 2: Install fixtures and appliances, install sanitary and storm drainage systems.* Plumber apprenticeship program level 2 book 2 (Harmonized). Crown Publications: King's Printer for British Columbia.

Trades Training BC. (2021). D-1: Install sanitary drain, water and vent systems. In: *Plumber Apprenticeship Program: Level 2*. Industry Training Authority, BC.

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D-1.6 Sizing Single-Storey Vents

The purpose of the venting system is to supply a free flow of air to maintain near-atmospheric-pressure conditions in the drainage system so fixtures can operate correctly.

Sizing a pipe for a venting system requires you to be familiar with both tables and clauses provided in the code book.

National Plumbing Code (NPC) Tables Used for Vents Serving Single Storey Fixtures

The NPC tables provide the minimum size of all vent pipes based on criteria, such as trap size, maximum fixture unit load it can carry, and the developed length of the vent.

The following are the tables you will need to refer to when sizing vents serving fixtures located on a single storey.

Table 2.5.7.1. — Minimum Permitted Size of Vent Pipe Based on Size of Trap Served

The NPC requires that the size of every vent pipe shall conform to Table 2.5.7.1. (NPC, 2020, B 2-43; refer to our Table 1), which takes precedence over all other venting tables. This is the only venting table that has an influence on the size of every vent pipe in the system, regardless of its name.

Table 1: (From NPC Table 2.5.7.1.) Minimum Permitted Size of Vent Pipe Based on Size of Trap Served

Trap Size Served (in.)	Minimum Vent Pipe Size (in.)
1.25	1.25
1.5	1.25
2	1.5
3	1.5
4	1.5
5	2
6	2

Table 2.5.8.1. — Maximum Permitted Hydraulic Loads Drained to a Wet Vent

A wet vent is simply a sanitary drainage pipe that serves as both a drain and a vent. Nearly every DWV system uses wet vents for material savings and space considerations. Because a wet vent must be able to drain the wastewater while providing air to protect the traps, it will be sized larger to accommodate the dual function.

Earlier in this section you were asked to identify certain DWV pipes by their function in the system. Whenever a sanitary

drainage pipe serves both a drain and a vent pipe, it is said to be “acting as a wet vent.” During your exercise, some of the piping that matched this description were:

- Fixture drain acting as a wet vet
- Branch acting as a wet vet
- Stack acting as a wet vent

Whenever a pipe is “acting as a wet vent,” you must use Table 2.5.8.1. (NPC, 2020, B 2-44; refer to our Table 2) to check it for minimum size as a wet vent against any other factors such as being a fixture drain, branch or a stack.

This table states the total fixture units that may discharge into a wet vent above the most downstream wet-vented fixture or two symmetrically connected wet-vented fixtures. The fixture unit load from the lowest connecting fixture or fixtures in a wet-vented group, whether a water closet or not, are not counted when determining the load on the wet vent. In the table below, the second column is for sizing wet vents that do not serve water closets, and the third column is for wet vents that do serve water closets. Of special note is that the minimum size of a wet vent not serving water closets is $1\frac{1}{2}$ in. and, the minimum size of a wet vent serving a water closet is 2 in.

Table 2: (From NPC Table 2.5.8.1.) Maximum Permitted Hydraulic Loads Drained to a Wet Vent

Size of Wet Vent (in.)	Maximum Hydraulic Load (FUs)	
	Not Serving Watering Closets	Fixtures Other Than Water Closets That Serve Not More Than Two Water Closets
1.5	2	—
2	4	3
3	12	8
4	36	14
5	—	18
6	—	23

Table 2.5.8.3. — Sizing of Branch Vents, Vent Headers, Circuit Vents and Continuous Vents

Table 2.5.8.3. (NPC, 2020, B 2-45; refer to our Table 3) provides the minimum size for four different vent types used in DWV systems and is based on the following information:

- Maximum fixture unit load it can carry
- The developed length of the vent
    - This component is the major difference between sizing drainage pipe and vent pipe. The length of the vent is important because when air flows in a pipe there is a pressure loss due to the friction between the air and the pipe wall. The maximum length of vent piping for any particular size will limit the pressure drop within the venting system to 1 in. of water column, which is not substantial enough to cause a trap seal loss.

Example

To size a branch vent with a hydraulic load of 47 FUs and a developed length of 13 m (42 ft 7 in.), you would follow these steps:

1. Find a hydraulic load in the left-hand column that is equal to or greater than the load in the example. In this case you have a load of 47 FUs, so the choice you would make is 60 FUs.
2. Move to the right until you find a developed length that is greater than or equal to the length in the example of 13 m. The table entry of 15 m is the correct choice.
3. Move vertically up the table to find the size of the vent = 2 in.

Table 3: (From NPC Table 2.5.8.3.) Sizing of Branch Vents, Vent Headers, Circuit Vents, and Continuous Vents

Total Hydraulic Load Served by Vent Pipe (FUs)	Size of Vent Pipe (in.)							
	1.25	1.5	2	3	4	5	6	8
	Maximum Length of Vent Pipe (m)							
2	9	NL	NL	NL	NL	NL	NL	NL
8	9	30	61	NL	NL	NL	NL	NL
20	7.5	15	46	NL	NL	NL	NL	NL
24	4.5	9	30	NL	NL	NL	NL	NL
42	NP	9	30	NL	NL	NL	NL	NL
60	NP	4.5	15	120	NL	NL	NL	NL
100	NP	NP	11	79	305	NL	NL	NL
200	NP	NP	9	76	275	NL	NL	NL
500	NP	NP	6	55	215	NL	NL	NL
1,100	NP	NP	NP	15	61	215	NL	NL
1,900	NP	NP	NP	6	21	61	215	NL
2,200	NP	NP	NP	NP	9	27	105	335
3,600	NP	NP	NP	NP	7.5	18	76	245
5,600	NP	NP	NP	NP	NP	7.5	18	76

Sizing Individual Vents

An individual vent is installed in the nominally vertical position until it is above the flood level rim of the fixture that it is serving, protecting the individual fixture trap. The individual vent usually connects to the trap arm through a **sanitary tee** fitting.

There are two types of individual vents used in a venting system:

- Individual
- Individual and continuous

Both types of individual vents are sized by Code Clause 2.5.8.2., which directs you to refer to Table 2.5.7.1. The only consideration when sizing an individual vent is the size of trap served by the vent (Figure 1). To find the size of the trap, you would refer to Table 2.4.9.3. The size of the trap is the same as the fixture outlet pipe, which is given in the second column. The hydraulic load of the fixture and the length of the individual vent are considered non-applicable (N/A), as noted in Clause 2.5.8.2.(2).

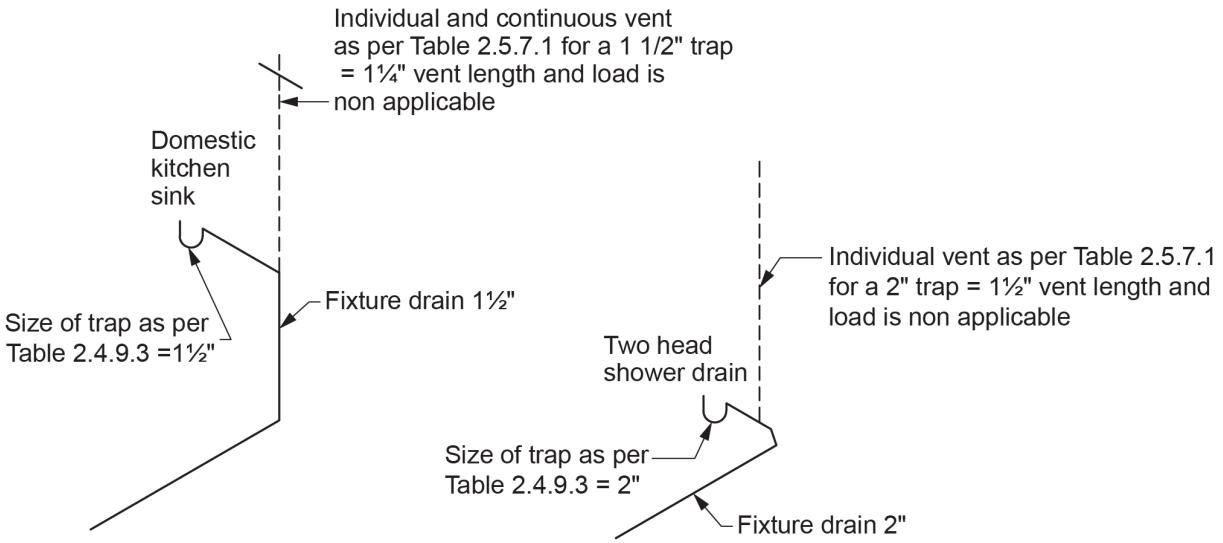

Figure 1 *Individual vent sizes based on trap size. (Skilled Trades BC, 2021) Used with permission.*

Sizing Dual Vents

Somewhat similar to individual vents, dual vents serve two fixtures, connected with a double fitting to a branch.

There are also two types of dual vents used in a venting system:

- dual
- dual and continuous

Like individual vents, dual vents are also sized by code Clause 2.5.8.2., which directs you to refer to Table 2.5.7.1 (NPC, 2020, B 2-43-44). The only difference is that the size of vent is dependent on the larger of the two traps served by the vent (Figure 2). To find the size of either trap, you would refer to Table 2.4.9.3. (NPC, 2020, B 2-31-32)., as before. The hydraulic load of the fixture and the length of the dual vent are considered non-applicable (N/A), as noted in Clause 2.5.8.2.(2).

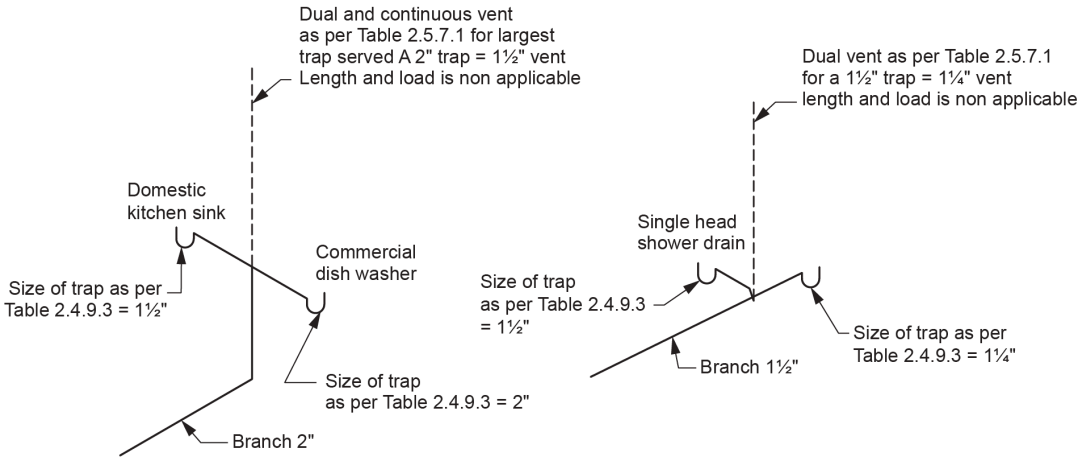

Figure 2 *Dual vents size based on largest trap size. (Skilled Trades BC, 2021) Used with permission.*

Vents for Floor Drains

As stated in the drainage section, floor drains can be categorized as either non-emergency or emergency, and this designation determines whether or not the drain is given a hydraulic load. When it comes to venting floor drains, the NPC Clause 2.5.1.1.(3) states that if a trap serves as a floor drain, it need not be protected by a vent if the following conditions are present (NPC, 2020, B 2-37):

- The size of the trap is not less than 75 mm (3 in.).
- The length of the fixture drain is not less than 450 mm (17.7 in.).
- The fall on the fixture drain does not exceed its size.

In general terms, a floor drain could have a venting load, drainage load, both drainage and venting loads, or no load at all, depending on its size and designation. To make things easier to understand, Table 4 summarizes the different combinations created by the various rules governing floor drains.

Table 4: Floor Drain Load Summary

Floor Drain Designation	Drain Load (FUs)	Venting Load (FUs)
2 in. non-emergency	2	2
2 in. emergency	0	2
3 in. non-emergency	3	0
3 in. emergency	0	0

The above summary table was laid out in the 1992 version of the BC Plumbing Code but has since escaped inclusion in subsequent editions of either the BCPC or NPC. Accordingly, most if not all jurisdictions still rely on this method of establishing loads on floor drains.

Sizing Wet Vents

Wet venting is a form of group venting based on the simple principle that wastewater clings to the side of a vertical waste pipe, leaving the centre core of the pipe open. This means a properly sized wet vent can have an open centre core of air to serve as a vent for fixtures downstream.

Plumbing code requirements for wet venting can be difficult to fully comprehend at first glance. With practice, the procedures presented here will become increasingly familiar. This skill will be advantageous to those performing plumbing layout work in the industry

Because wet vents can serve a group of fixtures on one or many levels, two categories of wet vents have been established by industry:

1. Single-storey wet vents (fixture drain/wet vents and branch/wet vents)
2. Multi-storey wet vents (stack wet vents)

The terms “single-storey wet vents” and “multi-storey wet vents” are not referenced in the code book as such. These terms are sometimes used as a learning tool or descriptor by educators to help learners visualize the concepts being explained. This textbook explores each category separately, keeping in mind that most of the following code requirements pertain to both types.

Sizing Single-Storey Wet Vents

The first step in sizing a wet vent is to become familiar with the code requirements stated in Section 2.5.2 of the NPC. (The remainder of this topic is quoted from this section of the NPC. Figures 3–9 illustrate bulleted points from this section.)

- The hydraulic load that drains to a wet vent shall conform to Table 2.5.8.1. This is the only table used to size the wet-vented portion of a drainage system.
- One or two water closets may connect to the wet vent, but they must be located furthest downstream, and if there are two water closets, they must be connected through a symmetrical fitting. This would be a double wye (if on a horizontal wet vent) or a sanitary cross (if on a vertical wet vent).

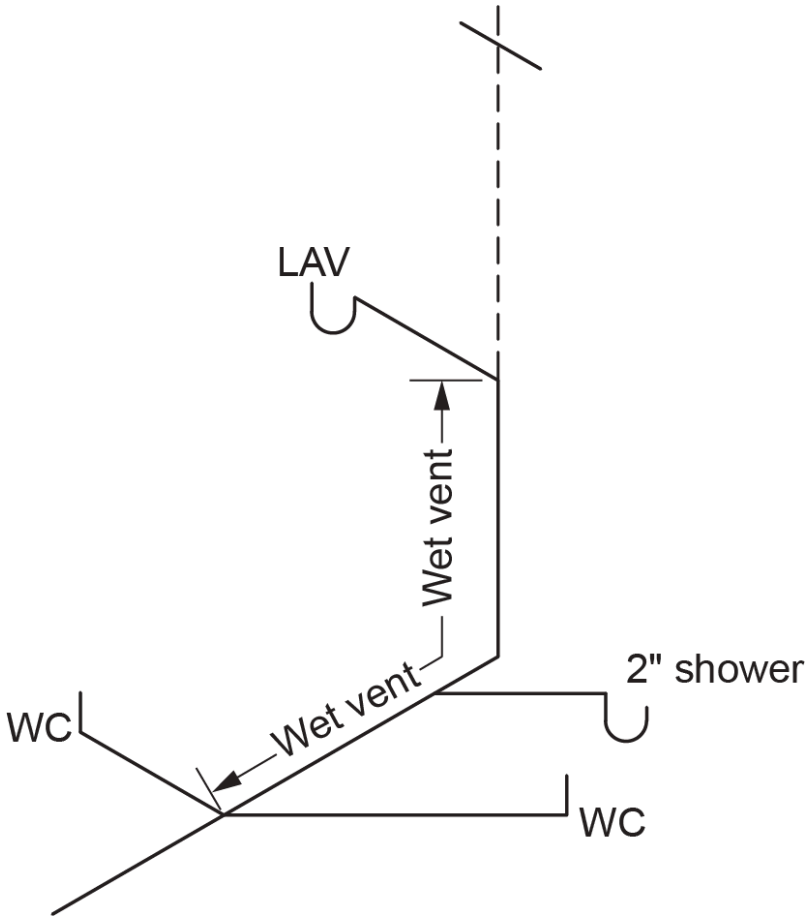

Figure 3 *Maximum of two water closets connected to a wet vent. (Skilled Trades BC, 2021) Used with permission.*

- Trap arms and fixture drains connected to the wet vent do not exceed 50 mm (2 in.) in size, except for connections from emergency floor drains (Figure 4).

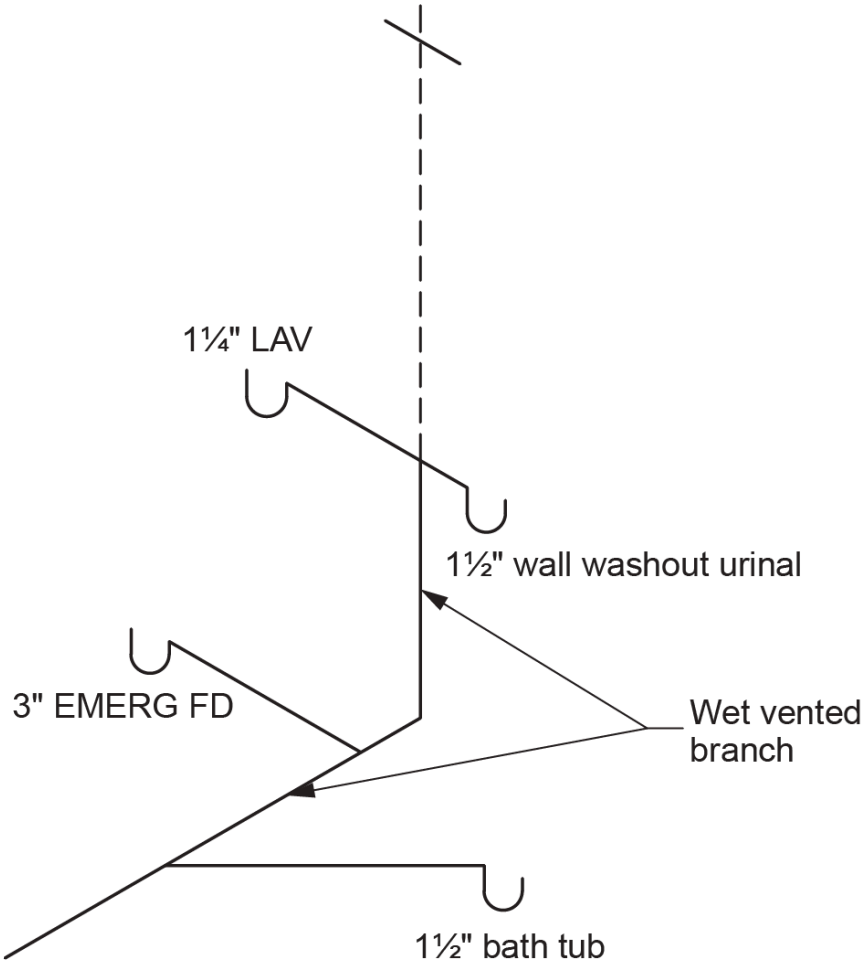

Figure 4 *A 3 in. emergency floor drain connected to a wet-vented branch. (Skilled Trades BC, 2021) Used with permission.*

- When determining the size of a wet vent, the hydraulic load to consider is the sum of all fixtures connected to the wet vent except for the most downstream fixture or symmetrically connected fixtures (Figure 5). Their load is not included when using Table 2.5.8.1. because the pipe below the lowest connection to the wet vent is only a drain and does not have to vent any fixtures through it. However, the lowest fixtures on the wet vent have to be included in the load of the drainage pipe, such as a branch, downstream of the wet vent.

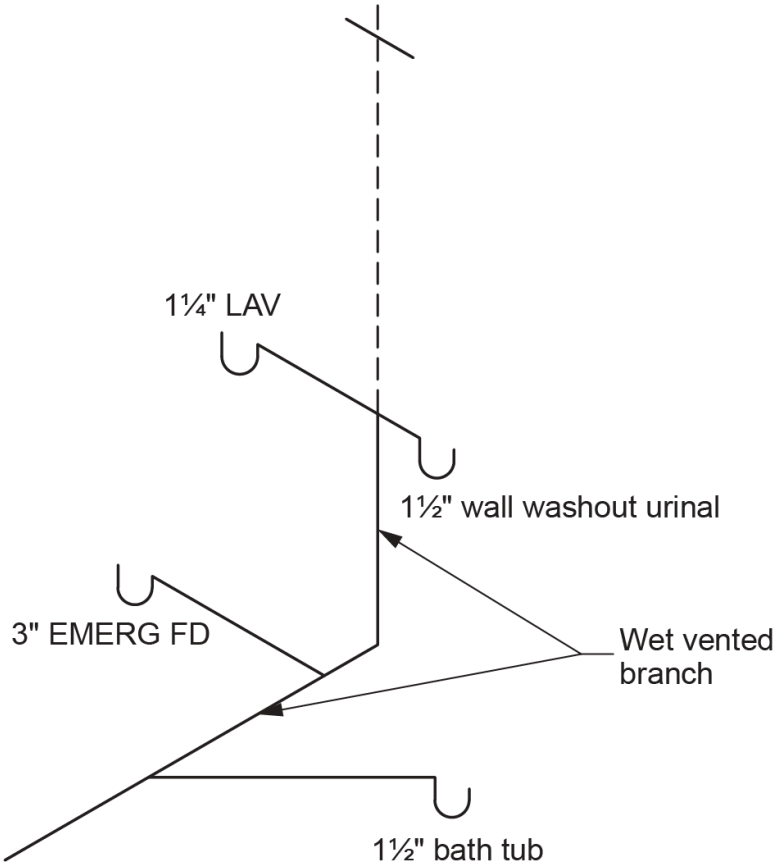

Figure 5 *Hydraulic load on a wet vent for the purpose of NPC Table 2.5.8.1. (Skilled Trades BC, 2021) Used with permission.*

- Other separately vented fixtures — located in the same storey and having a total hydraulic load not greater than 2 FUs — are allowed to tie into a wet vent or a wet-vented water closet trap arm (Figures 6 and 7). When this is done, their fixture unit load will be added to the wet vent load.
    - Figure 6:

        A. Fixture drain acting as a wet vent. 4 FUs serving water closets from Table 2.5.8.1. = 3 in. pipe (NPC, 2020, B 2-44). Furthest downstream fixture (WC) not included.
        B. Branch acting as a wet vent. 4 FUs serving water closets from Table 2.5.8.1. = 3 in. pipe. Furthest downstream fixture (WC) not included.
        C. Separately vented fixture connected to wet vent. The load of the kitchen sink must be added to the wet vent load.

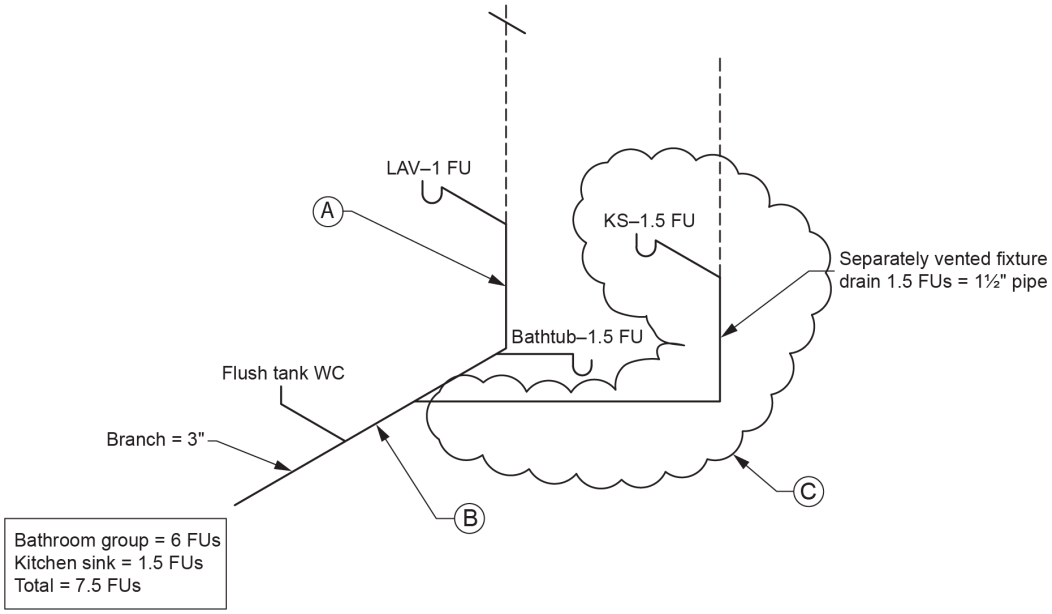

Figure 6 *The hydraulic load when a separately vented fixture is connected to a wet vent. (Skilled Trades BC, 2021) Used with permission.*

- Figure 7:
  A. Fixture drain acting as a wet vent. 4 FUs serving water closets from Table 2.5.8.1. = 3 in. pipe. Furthest downstream fixture (WC) not included.
  B. Branch acting as a wet vent. 4 FUs serving water closets from Table 2.5.8.1. = 3 in. pipe. Furthest downstream fixture (WC) not included.
  C. Separately vented fixture connected to wet vent. The load of the kitchen sink must be added to the wet vent load.

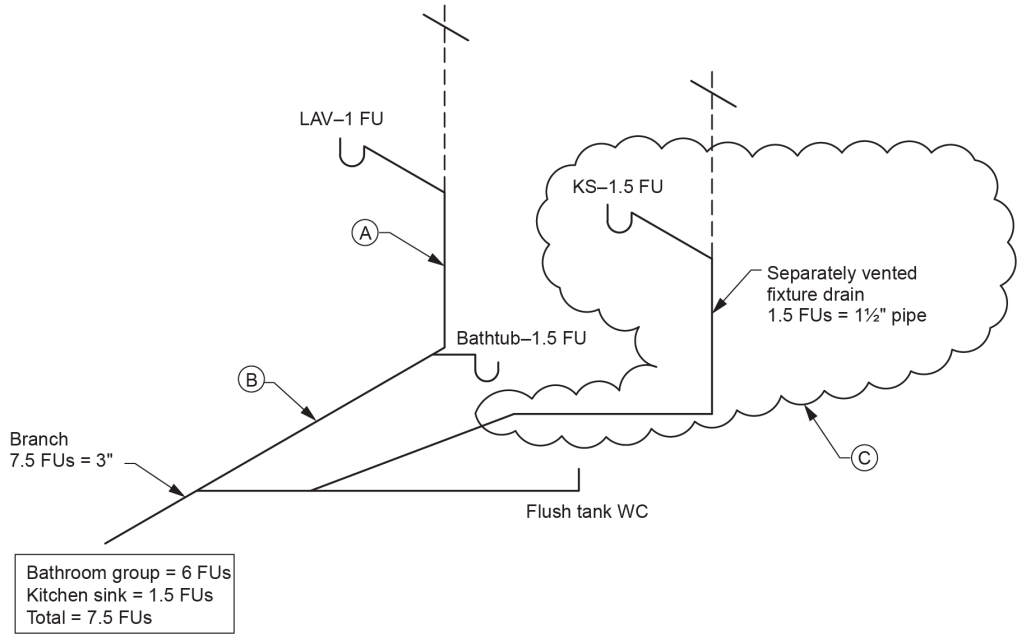

Figure 7 *The hydraulic load when a separately vented fixture is connected to the trap arm of a wet-vented water closet. (Skilled Trades BC, 2021) Used with permission.*

- The size of a wet vent will not reduce except for the portion upstream of the emergency floor drain (Figure 8).

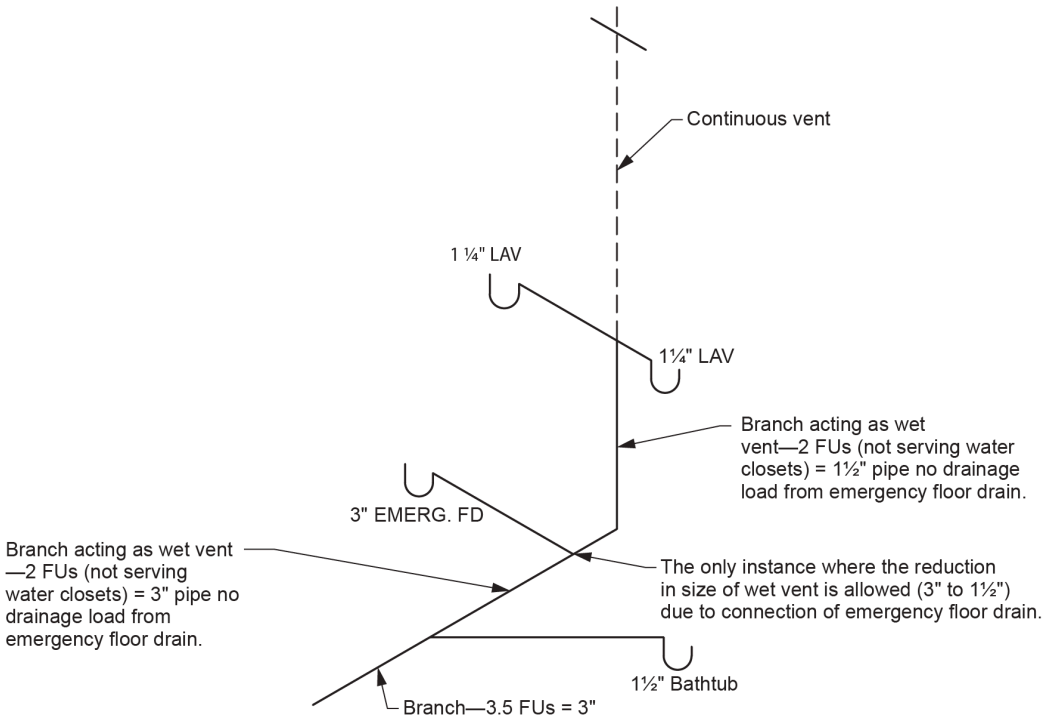

Figure 8 *A wet vent being reduced in size due to the connection of a 3 in. emergency floor drain. (Skilled Trades BC, 2021) Used with permission.*

- The length of a wet vent is not limited. Wet vents are sized by fixture unit load not by length (Figure 9).

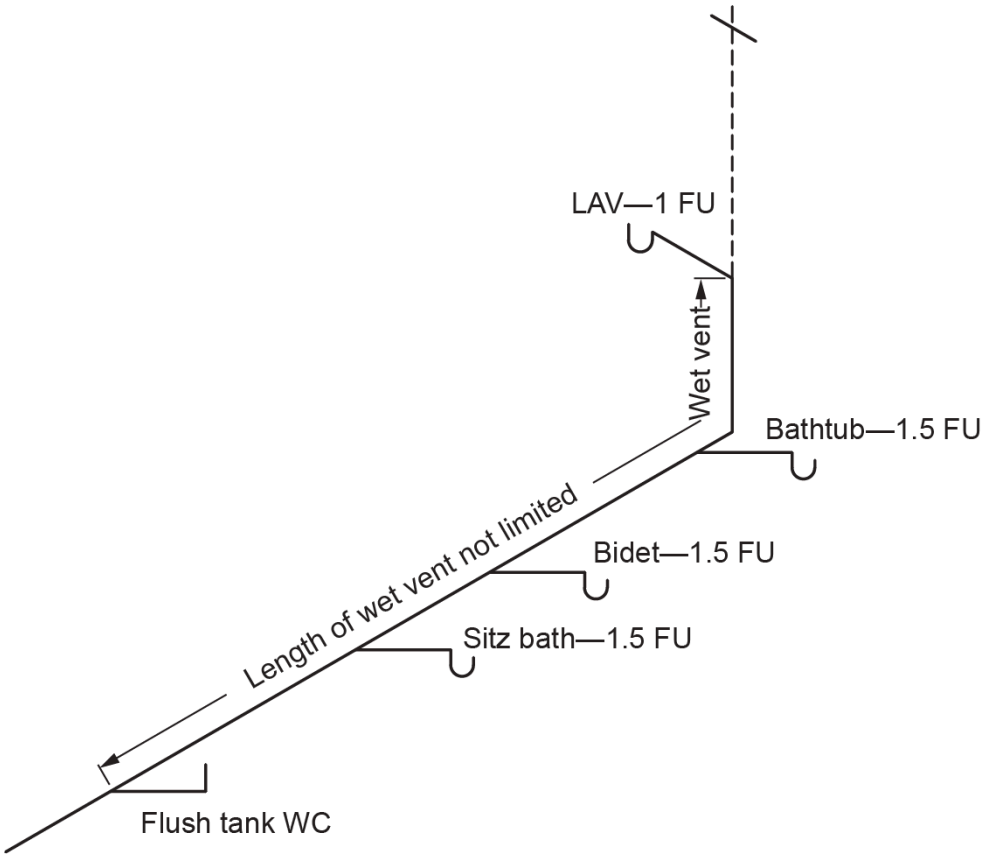

Figure 9 *The length of a wet vent is not limited. (Skilled Trades BC, 2021) Used with permission.*

Sizing Continuous Vents Serving Single-Storey Wet Vents

The most common applications of continuous vents are when serving single-storey wet-vented fixture drains and branches. The continuous vent connects to the vertical pipe where the most upstream wet-vented fixture is connected. Sizing of the continuous vent is found on Table 2.5.8.3. in the NPC.

Note: As with any vent, the continuous vent can never be smaller than permitted by Table 2.5.7.1. For example, if the continuous vent serves a water closet, Table 2.5.8.3 may permit a $1\frac{1}{4}$ in. vent. Table 2.5.7.1. overrides this value, as a $1\frac{1}{4}$ in. vent can only serve $1\frac{1}{4}$ in. and $1\frac{1}{2}$ in. traps.

You need the following information when using Table 2.5.8.3.:

1. The hydraulic load served by the continuous vent:
    - The hydraulic load to consider is the total number of wet-vented fixtures, including the most downstream connected fixture(s). The hydraulic load is most often identical to the drainage branch downstream of the wet vent portion. The one exception to this situation is explained below:

- The hydraulic load of separately vented fixtures draining into the wet vent is not included when sizing the continuous vent serving the wet vent (Figure 10).

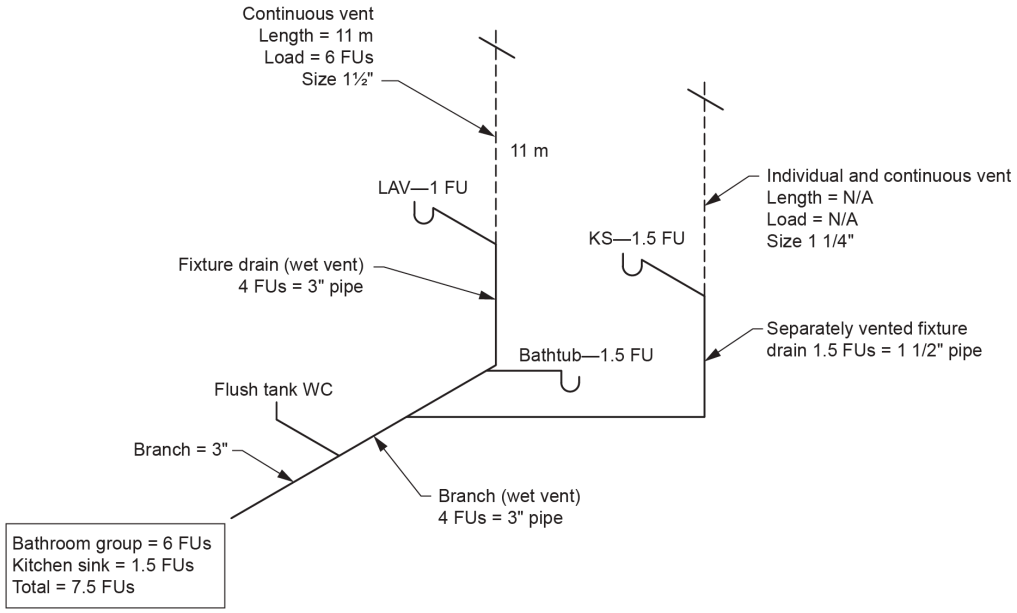

Figure 10 *Drainage load of separately connected fixtures draining into the wet vent. (Skilled Trades BC, 2021) Used with permission.*

2. The developed length of the vent measured from the vertical sanitary drainage pipe connection to where it joins a vent stack, stack vent, header (Category 3 or 4 vent) or measured through to open air (Figures 11 and 12).

The length and hydraulic load must be considered when sizing a continuous vent serving a single-storey wet-vented branch.

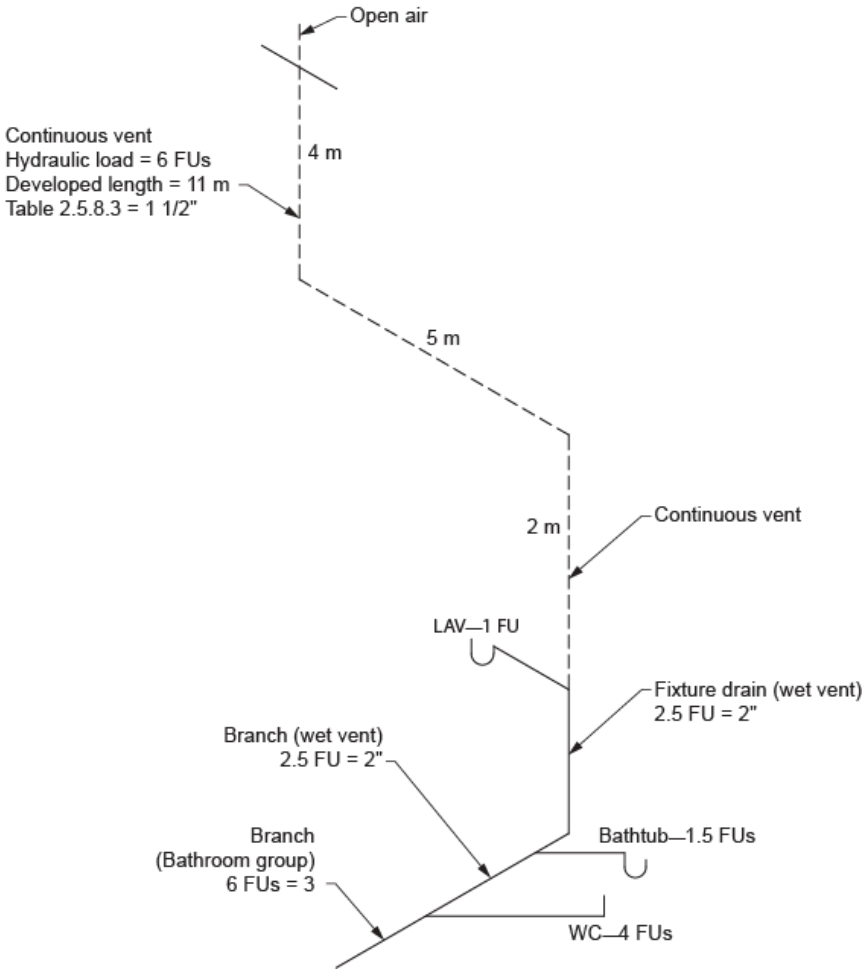

Figure 11 *Developed length and load of the vent. (Skilled Trades BC, 2021) Used with permission.*

For the example in Figure 12, Table 2.5.8.3. states the continuous vent size is $1\frac{1}{4}$ in. However, Table 2.5.7.1. states the minimum size of all vent pipes for 2 in. and 3 in. traps must be at least $1\frac{1}{2}$ in.

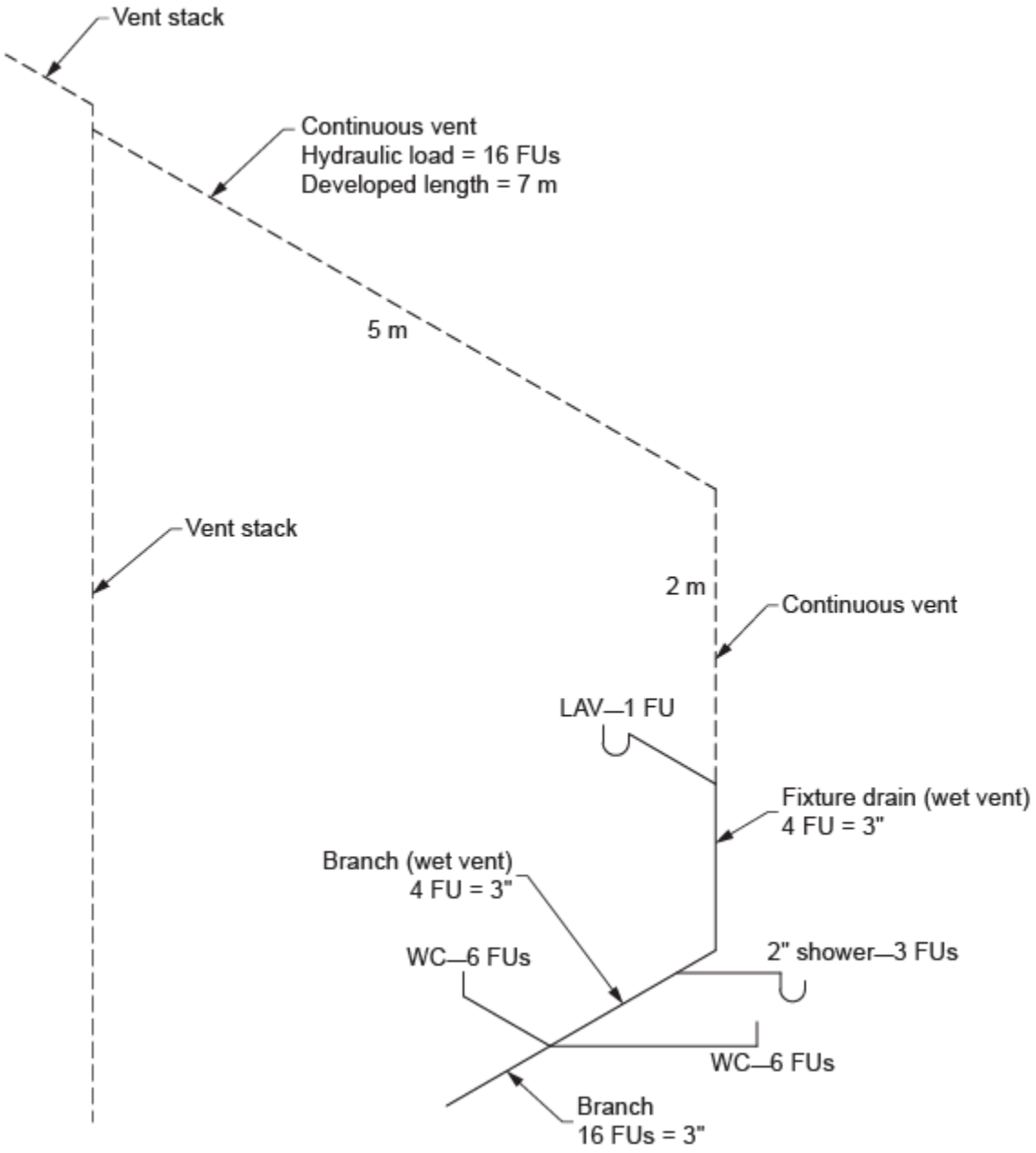

Figure 12 *Continuous vent sizing overridden by Table 2.5.7.1. (Skilled Trades BC, 2021) Used with permission.*

Self-Test D-1.6: Sizing Single-Storey Vents

Complete Self-Test D-1.6 and check your answers.

If you are using a printed copy, please find Self-Test D-1.6 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=47#h5p-18 (https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=47#h5p-18)

References

National Research Council of Canada. (2020). *National plumbing code of Canada* 2020. Canadian Commission on Building and Fire Codes. https://nrc-publications.canada.ca/eng/view/ft/?id=6e7cabf5-d83e-4efd-9a1c-6515fc7cdc71 (https://nrc-publications.canada.ca/eng/view/ft/?id=6e7cabf5-d83e-4efd-9a1c-6515fc7cdc71)

Skilled Trades BC. (2021). *Book 2: Install fixtures and appliances, install sanitary and storm drainage systems.* Plumber apprenticeship program level 2 book 2 (Harmonized). Crown Publications: King's Printer for British Columbia.

Trades Training BC. (2021). D-1: Install sanitary drain, water and vent systems. In: *Plumber Apprenticeship Program: Level 2*. Industry Training Authority, BC.

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D-1.7 Multi-Storey Wet Vents

Multi-storey wet vents have certain code regulations in common with the single-storey variety, including the following:

- The hydraulic load that drains to any wet vent shall conform to Table 2.5.8.1. Even though the drainage pipe is in fact a stack, it is "acting as a wet vent." Because of this, the wet-vented portion must be sized using Table 2.5.8.1. (See NPC and Section D-1.6 (#chapter-d-1-6-sizing-single-storey-vents))
- Two water closets may connect to a stack (wet vent) as long as they are installed at the same point with a double fitting. The fitting may be a **double sanitary tee** or **double wye and 45° combination** for multi-storey wet venting, as the connections to the wet vent are in the vertical plane.
- If a stack (wet vent) serves a water closet, it must be installed as the most downstream wet-vented fixture (Figure 1).

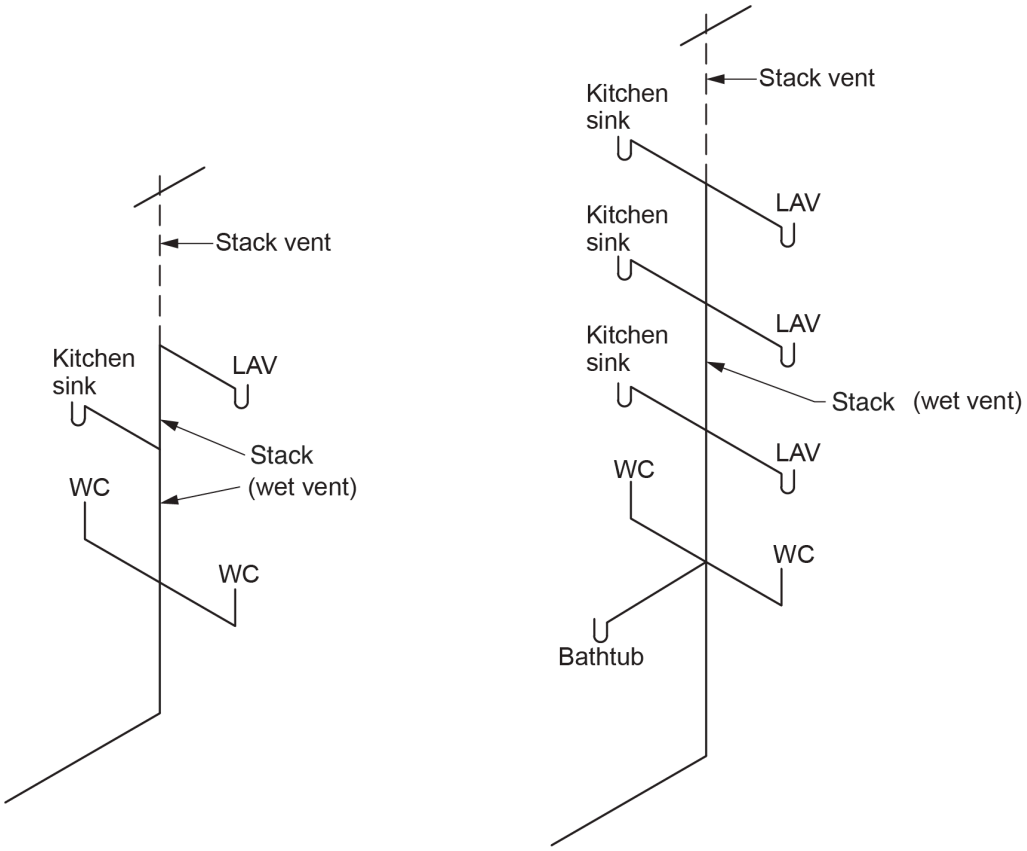

Figure 1 *Water closets connected to a multi-storey wet vent. (Skilled Trades BC, 2021) Used with permission.*

- Trap arms and fixture drains connected to the stack (wet vent) cannot exceed 50 mm (2 in.) in size, except for connections from emergency floor drains.
- The size of a stack (wet vent) will not reduce except for the portion upstream of an emergency floor drain.
- Other separately vented fixtures with a total hydraulic load not greater than 2 FUs are allowed to tie into a stack (wet vent), and their hydraulic load will be added to the stack (wet vent) load (Figure 2).
- The length of a stack (wet vent) is not limited.

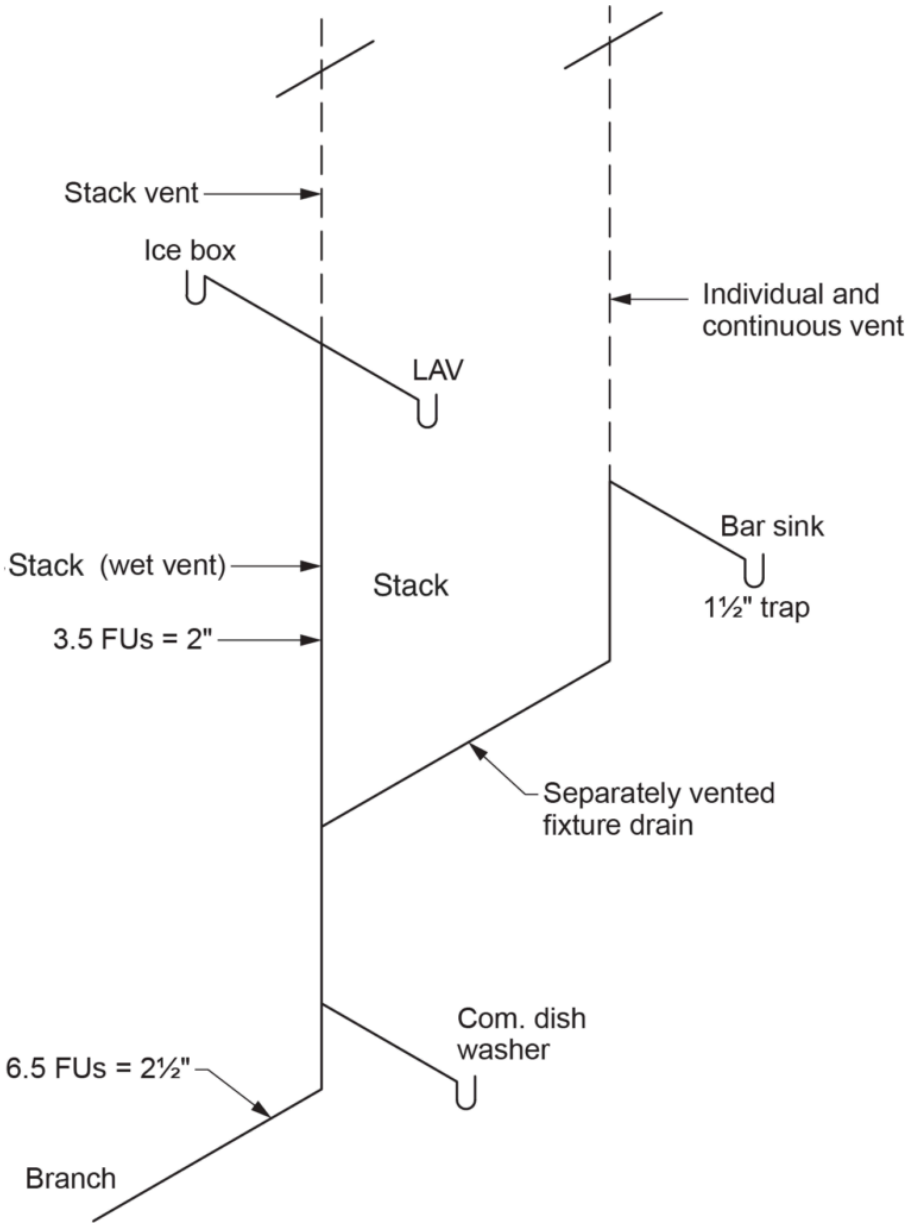

Figure 2 *Separately vented fixture draining to a multi-storey wet vent. (Skilled Trades BC, 2021) Used with permission.*

Code Requirements Exclusive to Multi-Storey Wet Vents

In addition to the unlimited length of a stack (wet vent), there are code regulations that do not apply to single-storey installations:

- A stack (wet vent) is limited to the number of fixture units that can be drained into the stack (wet vent) from the floors above the first storey.
- The total discharge from any one storey above the first storey is limited to 4 FUs as per Code Clause 2.5.2.1.(h).

Figure 3 shows a hydraulic load in excess of 4 FUs draining to a multi-storey wet vent above the first storey.

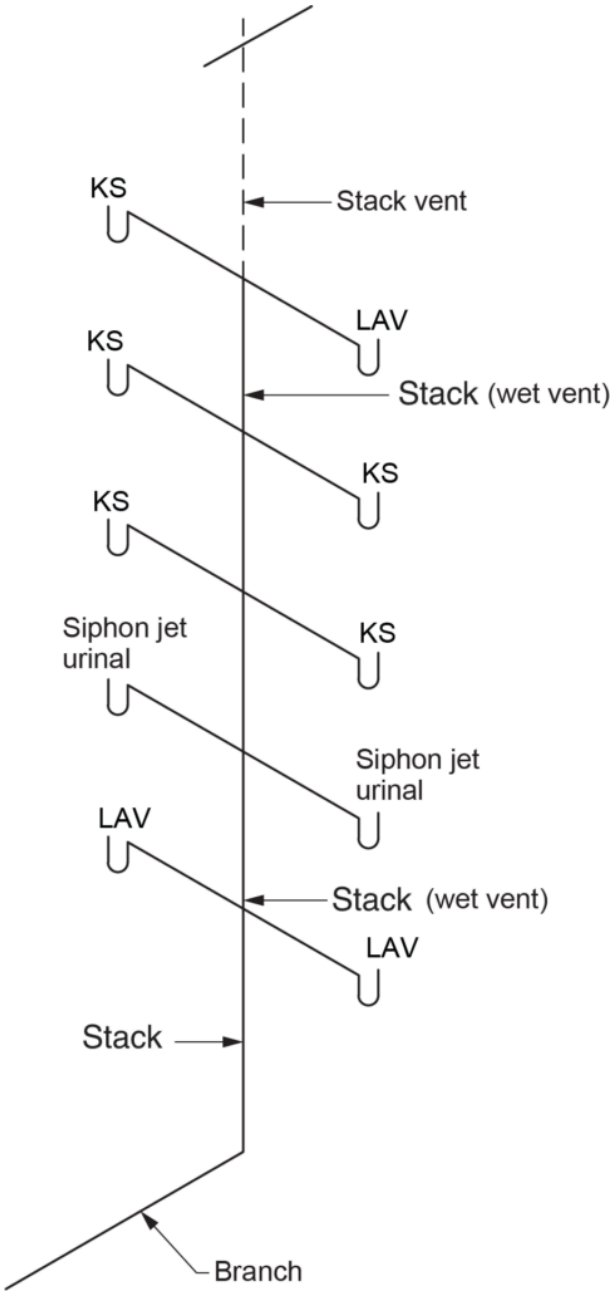

Figure 3 *Unapproved installation. (Skilled Trades BC, 2021) Used with permission.*

- A single offset may be installed in a stack (wet vent), but its length is limited depending on the size of the stack (wet vent) (Figure 4). When a single offset is installed, the length shall not exceed:
  - 1.2 m (47 in.) for stack (wet vent) 2 in. in size or less
  - 2.5 m ($90\frac{1}{2}$ in.) for stack (wet vent) larger than 2 in.

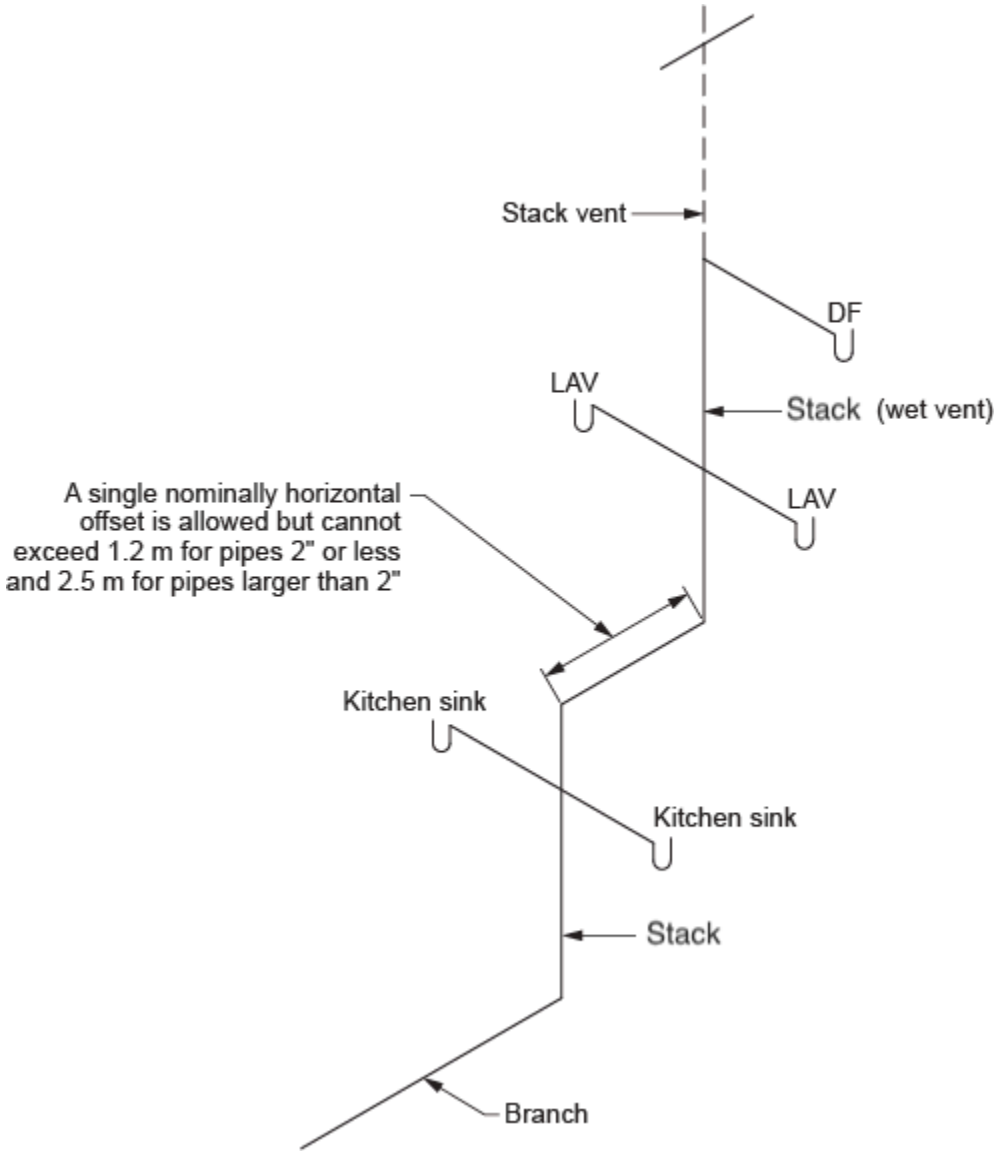

Figure 4 *Length limits of a nominally horizontal offset in a stack (wet vent). (Skilled Trades BC, 2021) Used with permission.*

Sizing Stack Vents Serving Multi-Storey Wet Vents

A stack (wet vent), like any other stack, must have a stack vent connecting to it where the most upstream wet-vented fixture connects. Stack vents are sized using Table 2.5.8.4.

Additionally, the code requires that:

- The stack vent never be smaller than permitted by Table 2.5.7.1.
- The minimum size be one-half the size of the stack at its base
- If the wet vent stack it serves is over four storeys, the stack vent must be the full size of the wet vent to open air

Table 2.5.8.4. — Size and Developed Length of Stack Vents and Vent Stacks

Table 2.5.8.4. (Table 1) is used for sizing stack vents and vent stacks only. You need three pieces of information to navigate through this table:

1. **The first column asks for the size of the stack**: the size of the stack at the base of the stack served by the stack vent or vent stack. Do not use the size of the stack at the top where the stack vent connects.
2. **The second column asks for the hydraulic load being vented**: the FU load at the base of the stack served by the stack vent or vent stack as well as any fixture unit vent loads being carried through the portion of the vent stack or stack vent being sized that were not drained to the base of the stack.
3. **The developed length of the stack vent or vent stack**: measured from the vent's lower end through to open air even if a vent header is installed.

Table 1: (Table 2.5.8.4.) Size and Developed Length of Stack Vents and Vent Stacks

Size of Stack (in.)	Total Hydraulic Load Being Vented (FUs)	Size of Stack Vent or Vent Stack (in.)									
		1.25	1.5	2	3	4	5	6	8	10	12
		Maximum Length of Stack Vent or Vent Stack (m)									
1.25	22	9	NL	NL	NL	NL	NL	NL	NL	NL	NL
1.5	8	15	46	NL	NL	NL	NL	NL	NL	NL	NL
2	12	9	23	61	NL	NL	NL	NL	NL	NL	NL
2	24	8	15	46	NL	NL	NL	NL	NL	NL	NL
3	10	NP	13	46	317	NL	NL	NL	NL	NL	NL
3	21	NP	10	33.5	247	NL	NL	NL	NL	NL	NL
3	53	NP	8	28.5	207	NL	NL	NL	NL	NL	NL
3	102	NP	7.5	26	189	NL	NL	NL	NL	NL	NL
4	43	NP	NP	10.5	76	299	NL	NL	NL	NL	NL
4	140	NP	NP	8	61	229	NL	NL	NL	NL	NL
4	320	NP	NP	7	52	177	NL	NL	NL	NL	NL
4	540	NP	NP	6.5	46	97.5	NL	NL	NL	NL	NL

Sizing a Stack Vent

If the stack (wet vent) measures four storeys or less in height (Figure 5), then Table 2.5.8.4. in the NPC (2020) code book is used (B 2-46). The information needed when using this table is:

- The size of the stack (wet vent) at its base
- The FU load of all fixtures draining into the stack (wet vent)
- The developed length of the stack vent measured from its lower end (the top of the wet vent portion) through to open air

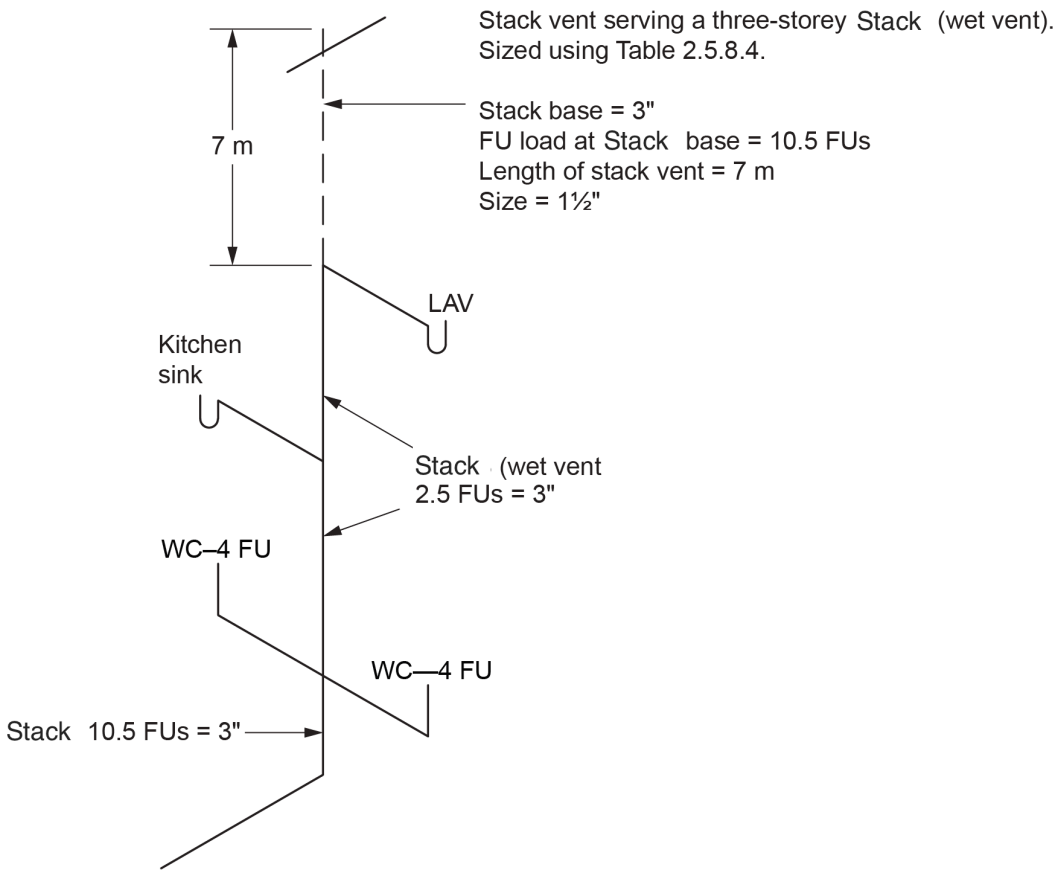

Figure 5 *Stack vent sizing when serving a stack (wet vent) measuring four storeys or less. (Skilled Trades BC, 2021) Used with permission.*

If the stack (wet vent) measures more than four storeys (Figure 6), then the stack vent must be the same size as the stack (wet vent) through to open air.

It is worth noting that although vent stacks are required to relieve air pressures when the stack has fixtures draining into it from more than four storeys, wet-vented stacks are exempt from this requirement, as they are sized as a wet vent and, therefore, are large enough to convey the air needed to protect the base of the stack.

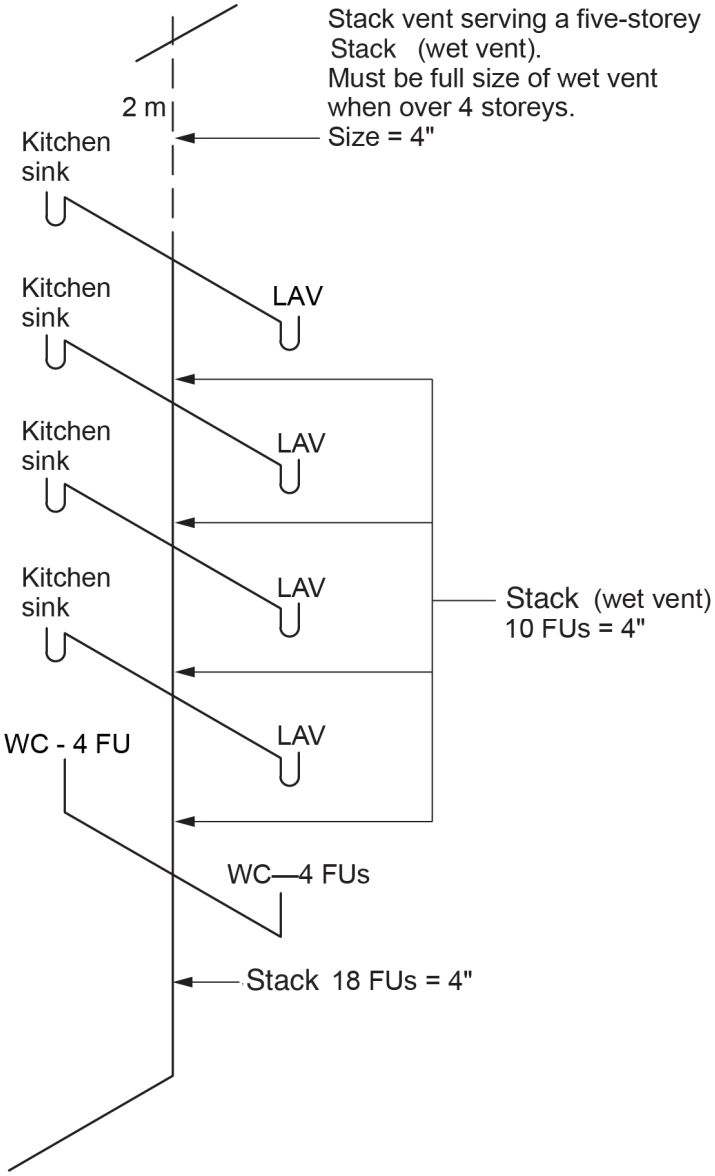

Figure 6 *Stack vent sizing when serving a stack. (Skilled Trades BC, 2021) Used with permission.*

Self-Test D-1.7: Multi-Storey Wet Vents

Complete Self-Test D-1.7 and check your answers.

If you are using a printed copy, please find Self-Test D-1.7 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=50#h5p-19 (https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=50#h5p-19)

References

National Research Council of Canada. (2020). *National plumbing code of Canada* 2020. Canadian Commission on Building and Fire Codes. https://nrc-publications.canada.ca/eng/view/ft/?id=6e7cabf5-d83e-4efd-9a1c-6515fc7cdc71 (https://nrc-publications.canada.ca/eng/view/ft/?id=6e7cabf5-d83e-4efd-9a1c-6515fc7cdc71)

Skilled Trades BC. (2021). *Book 2: Install fixtures and appliances, install sanitary and storm drainage systems.* Plumber apprenticeship program level 2 book 2 (Harmonized). Crown Publications: King's Printer for British Columbia.

Trades Training BC. (2021). D-1: Install sanitary drain, water and vent systems. In: *Plumber Apprenticeship Program: Level 2*. Industry Training Authority, BC.

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D-1.8 Sizing Branch and Circuit Vents

Although branch and **circuit vent**s are very different types of vents, they share some common sizing characteristics and have, therefore, been grouped together in this chapter.

Branch Vents

A branch vent is sized according to Table 2.5.8.3 (NPC, 2020, B 2-45). When using this table, you need to know the developed length of the branch vent and the hydraulic load (FUs) it serves at any given point.

The length to consider when sizing a branch vent is from the most distant sanitary drainage pipe connection to the point where it ties into a stack vent, vent stack, or vent header or where it continues as a branch vent to outside air (Figure 1).

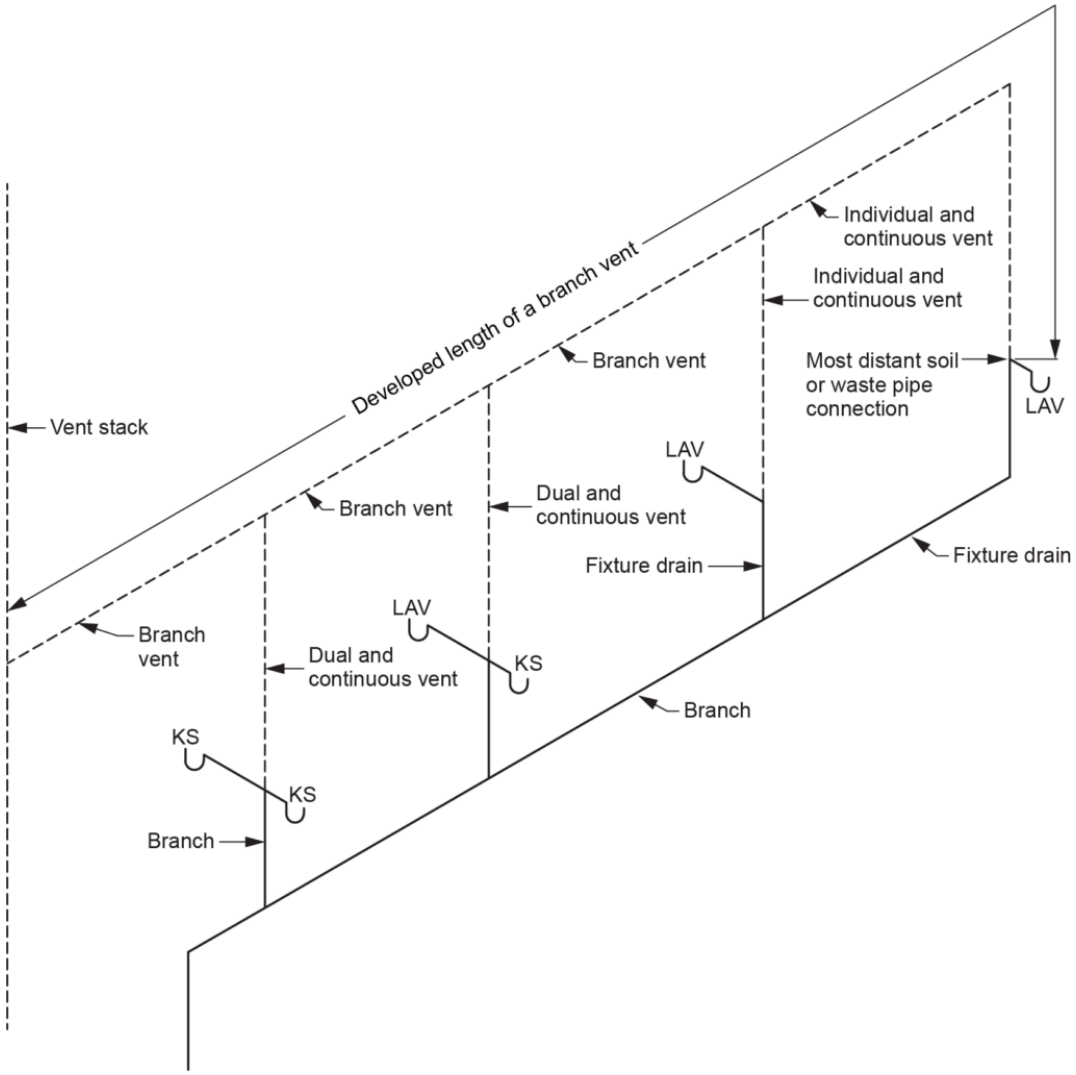

Figure 1 *Developed length of a branch vent. (Skilled Trades BC, 2021) Used with permission.*

The load to consider when sizing a branch vent is the sum of the FU loads for the fixtures it serves — in other words, the number of fixture units on the sanitary drainage pipes that it provides air for. As the fixtures are added to a branch vent, the load increases (Figure 2).

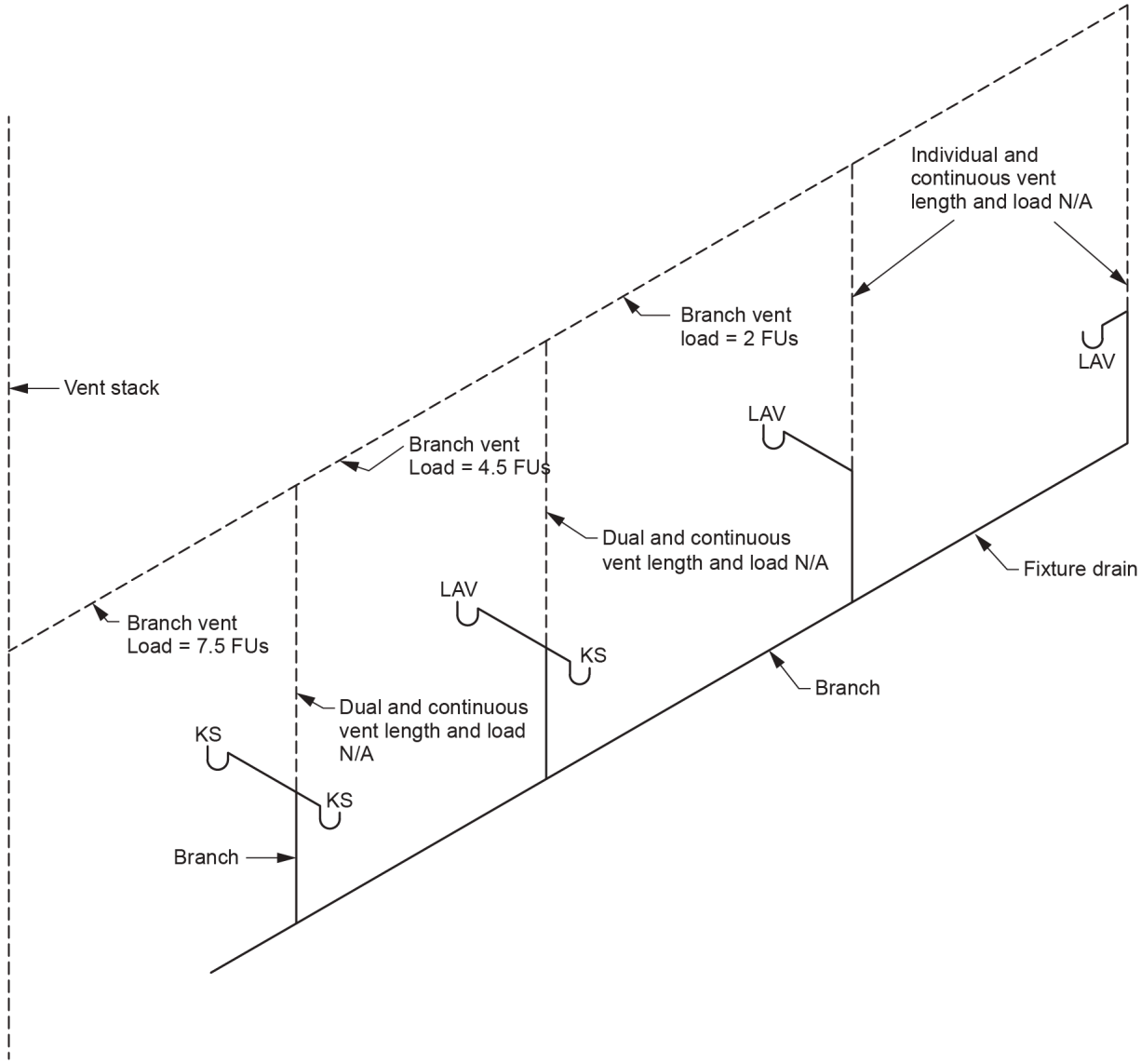

Figure 2 *Hydraulic load on certain branch vent sections. (Skilled Trades BC, 2021) Used with permission.*

Branch vents will increase in size as more vents are connected to them (provided Table 2.5.8.3. dictates) but will never be smaller than permitted by Table 2.5.7.1. and any vent connected to it.

The following example shows how the developed length of the branch vents remains the same (from the most distant sanitary drainage pipe connection) but the loads are additive as the other Category 1 vents join the branch vent (Figure 3 and Table 1).

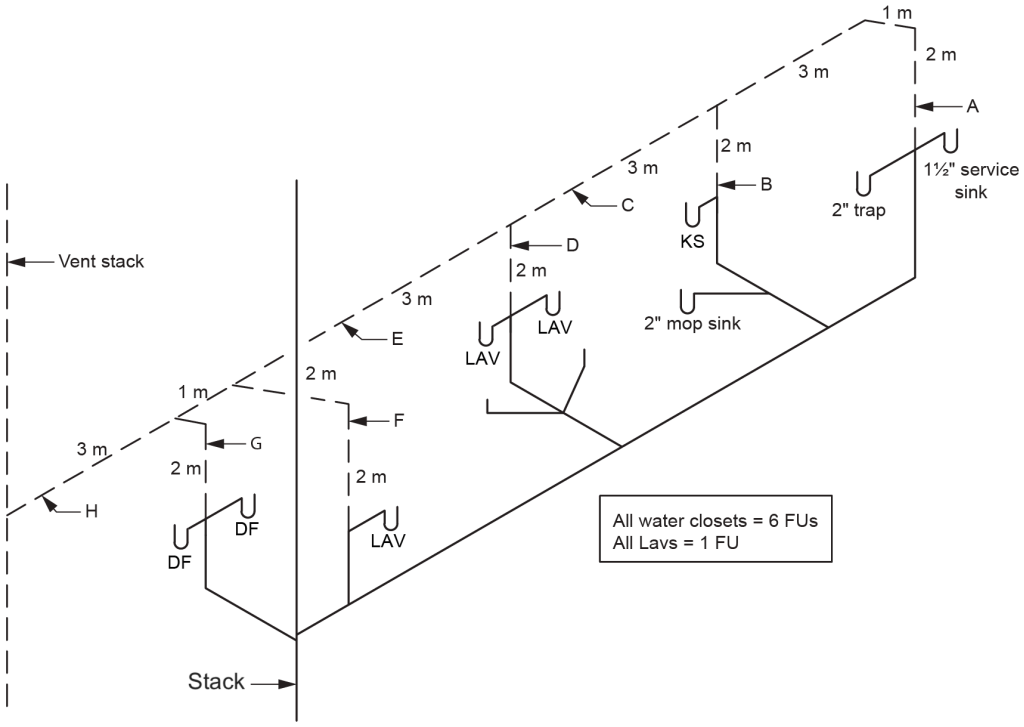

Figure 3 *Branch vent additive loads serving Category 1 vents. (Skilled Trades BC, 2021) Used with permission.*

Table 1: Figure 3 Components

Label	Name	Length (m)	Load (FU)	Size (in.)	Notes
A	Dual and continuous vent	N/A	N/A	1.5	Length and load N/A. Vent size from Table 2.5.7.1. using largest trap served
B	Continuous vent	12	3.5	1.5	Vent size from Table 2.5.8.3. Length from the connection of KS to the vent stack. Load is total of KS and mop sink
C	Branch vent	16	8	1.5	Vent size from Table 2.5.8.3. Length from the furthest sanitary drainage pipe connection to the vent stack. Load is total of fixtures served at that point
D	Continuous vent	9	14	1.5	Vent size from Table 2.5.8.3. Length from the connection of lavs to the vent stack. Load is total of lavs and WCs
E	Branch vent	16	22	2	Vent size from Table 2.5.8.3. Length from the furthest sanitary drainage pipe connection to the vent stack. Load is total of fixtures served at that point
F	Individual and continuous vent	N/A	N/A	1.25	Length and load N/A. Vent size from Table 2.5.7.1. using trap size served
G	Dual and continuous vent	N/A	N/A	1.25	Length and load N/A. Vent size from Table 2.5.7.1. using largest trap served
H	Branch vent	16	24	2	Vent size from Table 2.5.8.3. Length from the furthest sanitary drainage pipe connection to the vent stack. Load is total of fixtures served at that point

Circuit Vents

Circuit venting is a form of group venting sometimes confused with wet venting. Instead of using the core of air in a vertical pipe, circuit venting uses the top of a horizontal drainage pipe to vent the fixtures connecting to the horizontal branch. The drainage section is not sized as a wet vent but as a branch from Table 2.4.10.6.-B (NPC, 2020, B 2-35).

To size the circuit vent, you must use Table 2.5.8.3. in the NPC 2020 code book.

Note: As with any vent, the circuit vent can never be smaller than permitted by Table 2.5.7.1. For example, if the circuit vent serves a water closet, Table 2.5.8.3. may permit a 1.25 in. vent. Table 2.5.7.1. overrides this value, as a 1.25 in. vent can only serve 1.25 in. and 1.5 in. traps.

Using Table 2.5.8.3. requires the following information:

- **The hydraulic load served by the circuit vent** — The hydraulic load to consider is the total number of circuit-vented fixtures, not including the load of any fixtures that may be connected to the required relief vent. The hydraulic load is most often identical to the branch immediately upstream of the relief vent connection.
- **The developed length of the circuit vent** — The length to consider is from its lower end — where it connects to the trap arm of the furthest upstream circuit-vented fixture — to its upper end — where it joins a vent stack, stack vent, or header (Category 3 or 4 vent) — or measure through to open air.

To fully understand the circuit vent sizing procedures, a plumber must be well-versed in the Plumbing Code regulations for circuit vents.

The code requires that a section of a horizontal branch may be circuit-vented provided that:

- A circuit vent is connected to it.
- All fixtures served by the circuit vent are located in the same storey.
- No stack is connected to it upstream of a circuit-vented fixture (Figure 4).

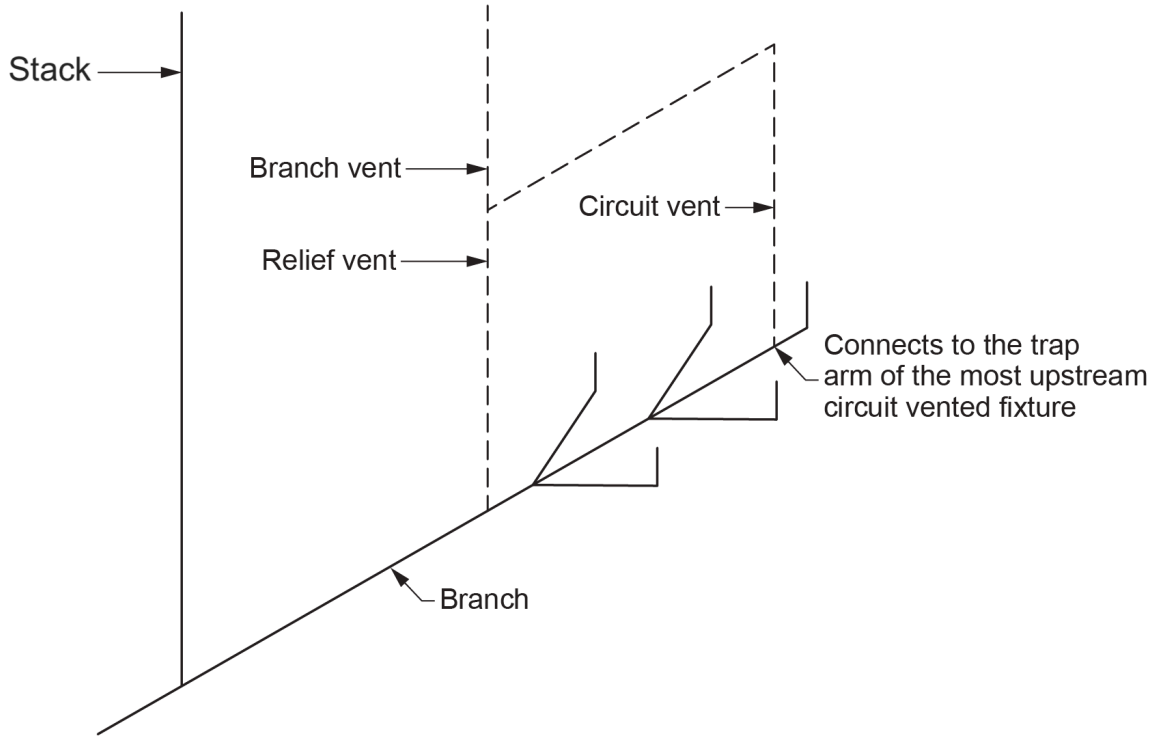

Figure 4 *Example of a circuit-vented branch. (Skilled Trades BC, 2021) Used with permission.*

Fixtures with fixture outlet pipes less than 50 mm (2 in.) in size must be separately vented or separately circuit-vented (Figure 6) as per Clause 2.5.3.1.(2).

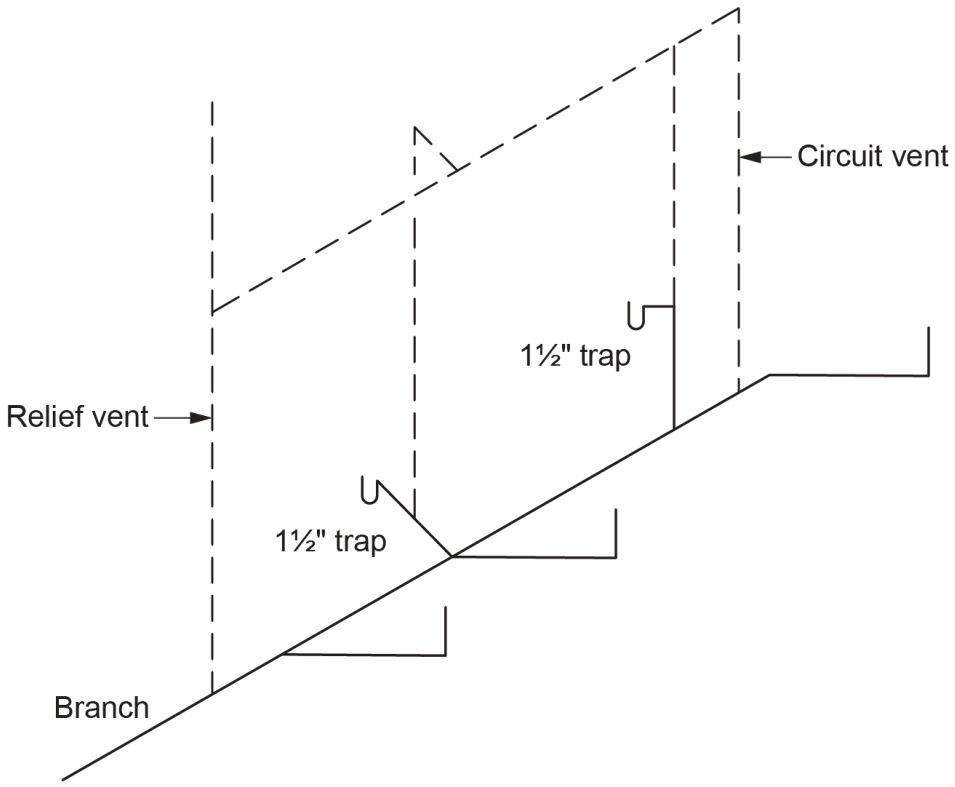

Figure 5 *Separately vented trap arm connected to a circuit-vented branch. (Skilled Trades BC, 2021) Used with permission.*

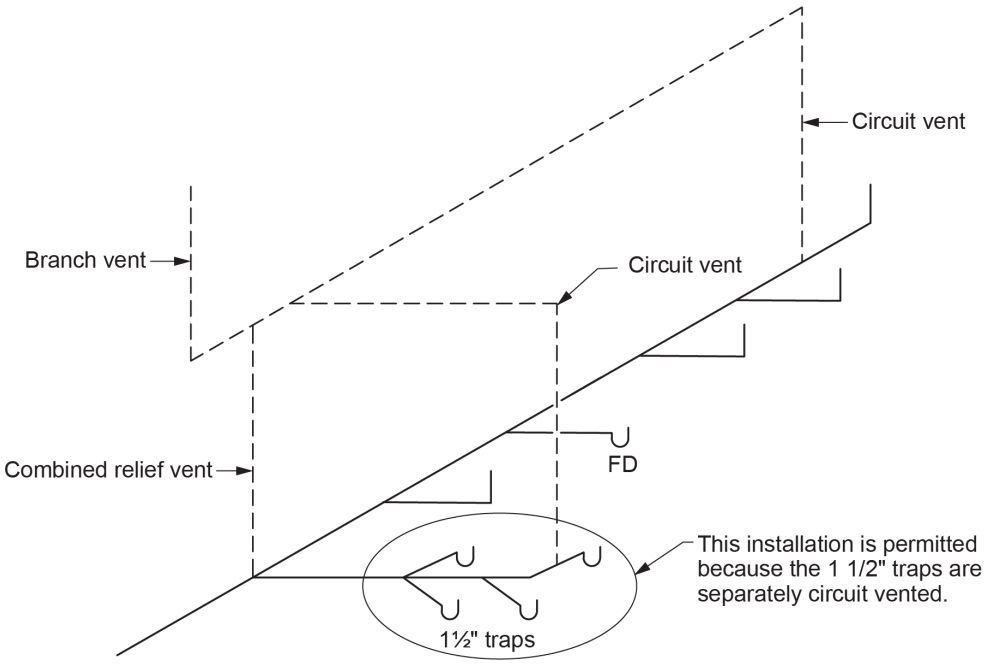

Figure 6 *The 1.5 in. traps are being separately circuit-vented when connecting to a circuit-vented branch. (Skilled Trades BC, 2021) Used with permission.*

A relief vent must be connected to the branch that forms part of a circuit-vented system, downstream of the connection of the most downstream circuit-vented fixture. This relief vent may be a dry vent (Figures 7 and 8).

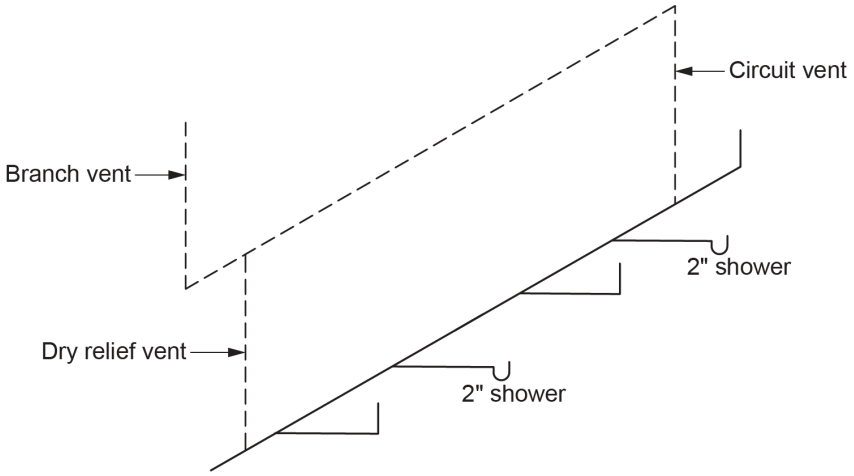

Figure 7 *A dry vent acting as a relief vent for a circuit-vented branch. (Skilled Trades BC, 2021) Used with permission.*

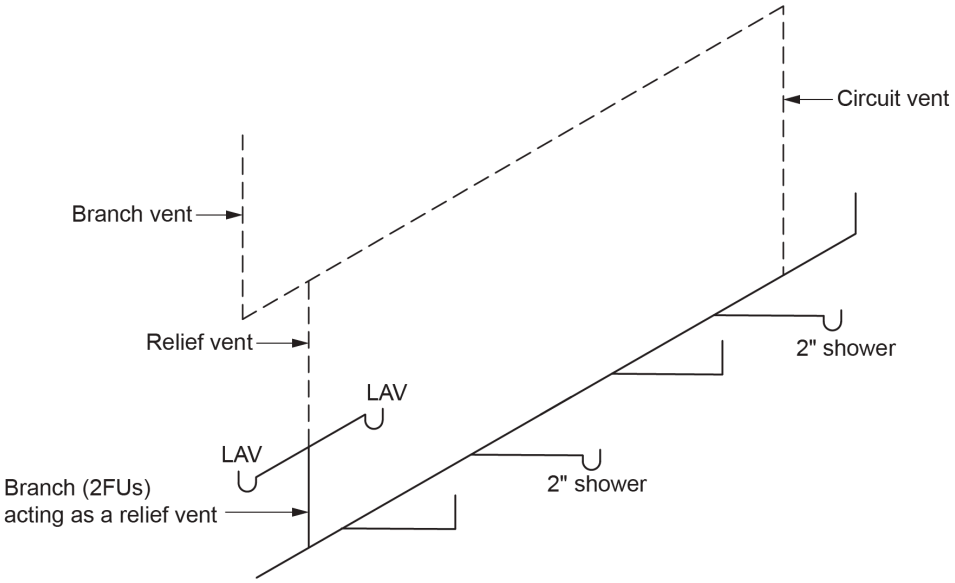

Figure 8 *A vertical branch acting as a relief vent for a circuit-vented branch. (Skilled Trades BC, 2021) Used with permission.*

A sanitary drainage pipe cannot have a hydraulic load of more than 6 FUs when acting as a relief vent. If the sanitary drainage pipe is acting as a relief vent, it may be installed either horizontally or vertically (Figures 9 and 10).

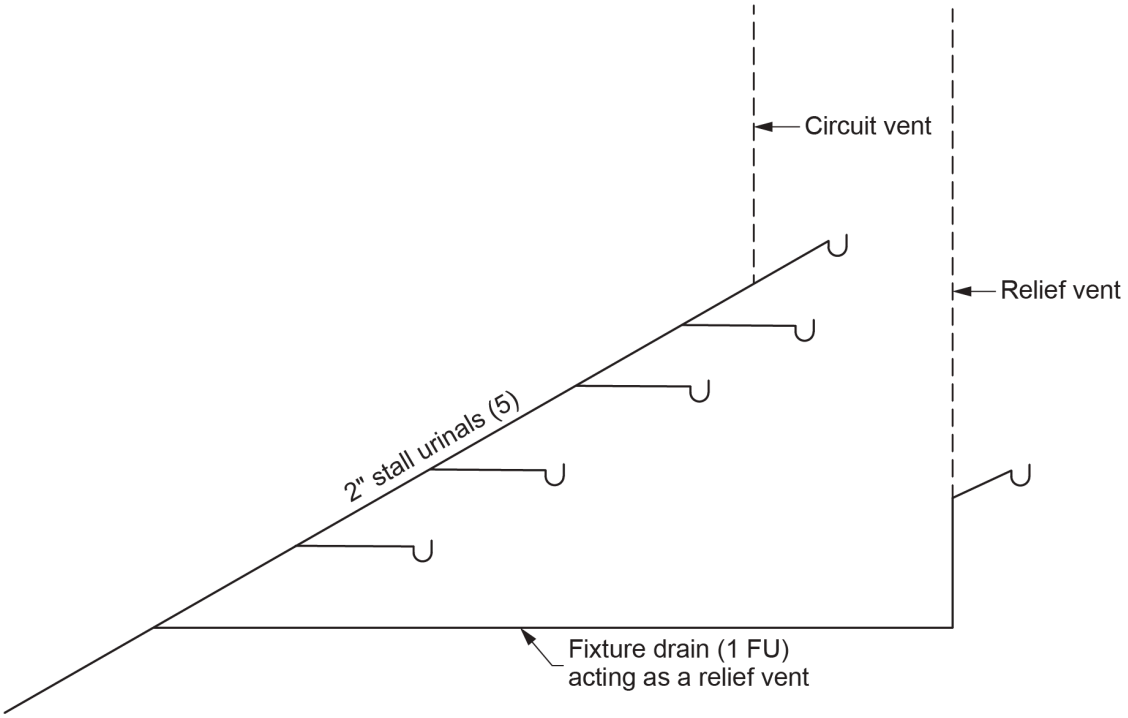

Figure 9 *A horizontal fixture drain acting as a relief vent for a circuit-vented branch. (Skilled Trades BC, 2021) Used with permission.*

A stack may act as a relief vent for a circuit-vented branch. If there are more than 6 FUs on the sanitary drainage pipe (stack), a relief vent must be added.

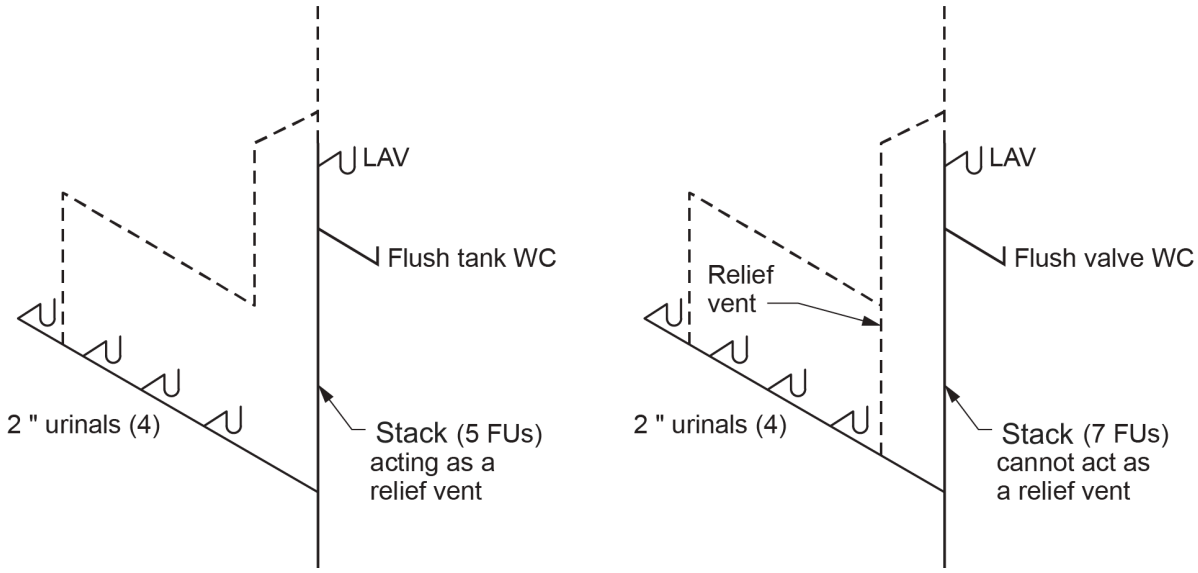

Figure 10 *Two examples of relief vents for a circuit-vented branch. (Skilled Trades BC, 2021) Used with permission.*

A symmetrically connected relief vent can serve as a combined relief vent for a maximum of two circuit-vented branches, provided there are not more than eight circuit-vented fixtures connected between the combined relief vent and each circuit vent (Figure 11).

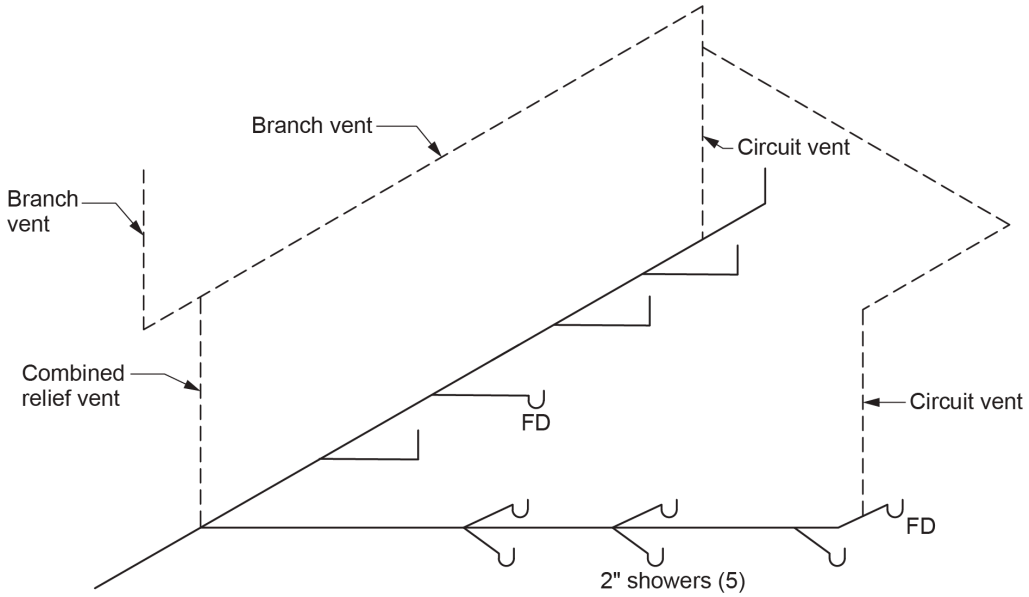

Figure 11 *A symmetrical connection used to join a combined relief vent when serving two circuit-vented branches. (Skilled Trades BC, 2021) Used with permission.*

Additional circuit vents are required where:

- Each cumulative horizontal change in direction of a branch served by a circuit vent exceeds 45° between vent pipe connections.
- More than eight circuit-vented fixtures are connected to a branch between vent pipe connections.

Figure 12 shows additional circuit vents serving a circuit-vented branch, thus allowing more than eight fixtures and the cumulative change of direction between vent pipes.

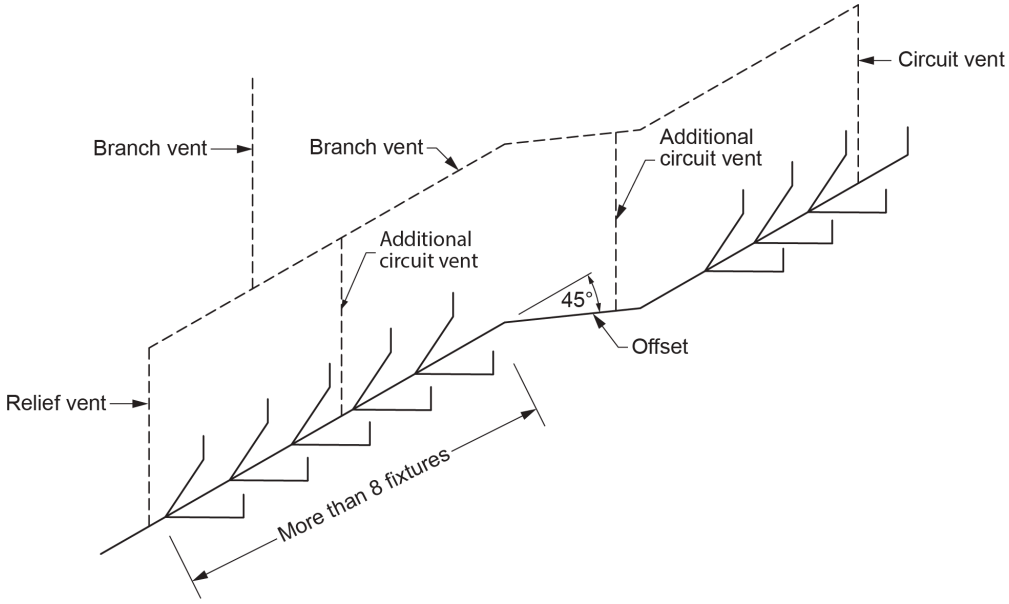

Figure 12 *Additional circuit vents added to meet Clause 2.5.3.1., with labeled branch vents, additional circuit vents, relief vent, and more than 5 fixtures connected with a 45-degree offset. (Skilled Trades BC, 2021) Used with permission.*

A sanitary drainage pipe can serve as an additional circuit vent provided:

- The sanitary drainage pipe is sized as a wet vent and is not less than 50 mm (2 in.) in size (Figure 13).

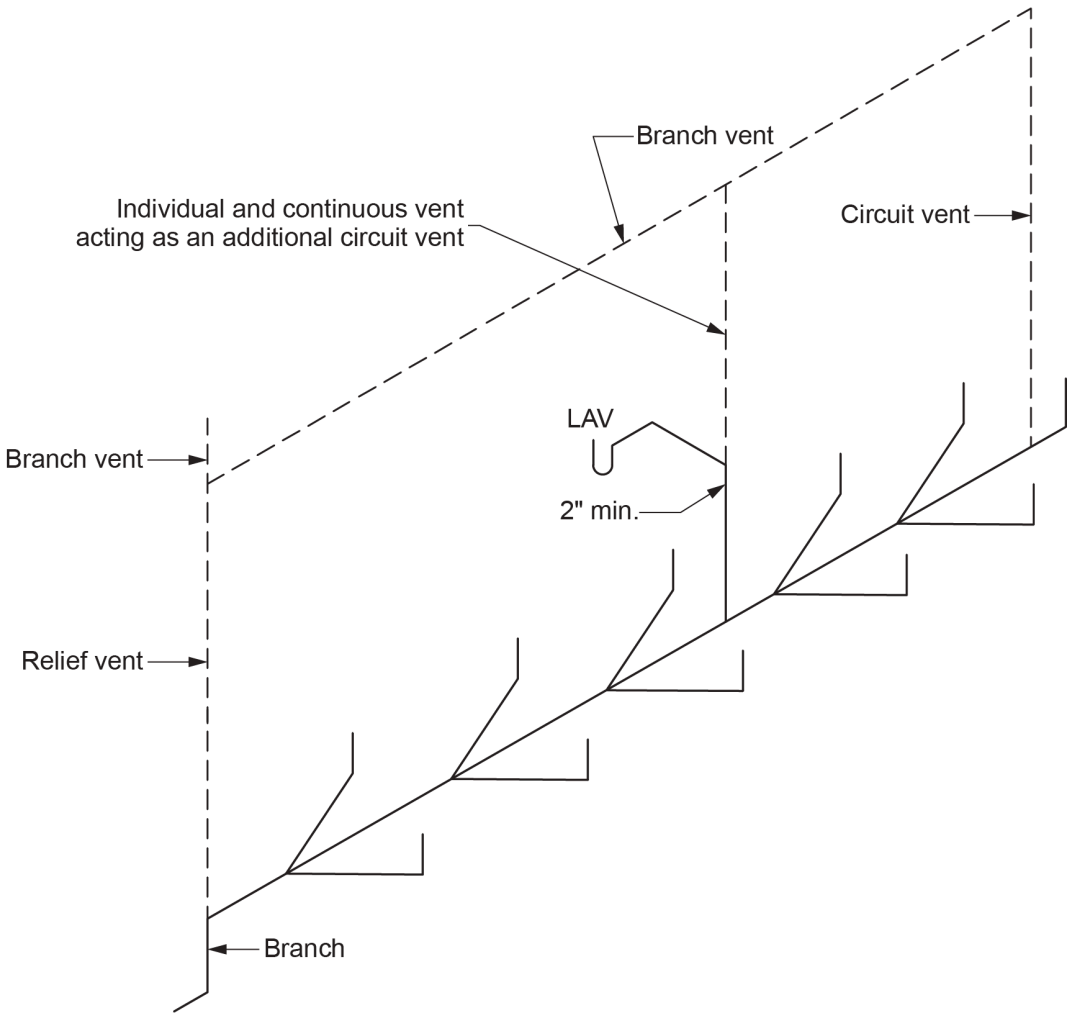

Figure 13 *Sanitary drainage pipe acting as an additional circuit vent. (Skilled Trades BC, 2021) Used with permission.*

- The maximum number of fixtures does not exceed two.
- The fixture(s) connected to the vent has a maximum hydraulic load of 1.5 FUs each.
- When two fixtures connect to the vent pipe, the connection is made using a double sanitary tee fitting.

Figure 14 shows a sanitary drainage pipe acting as an additional circuit vent. The branch is sized as a wet vent with a minimum diameter of 2 in.

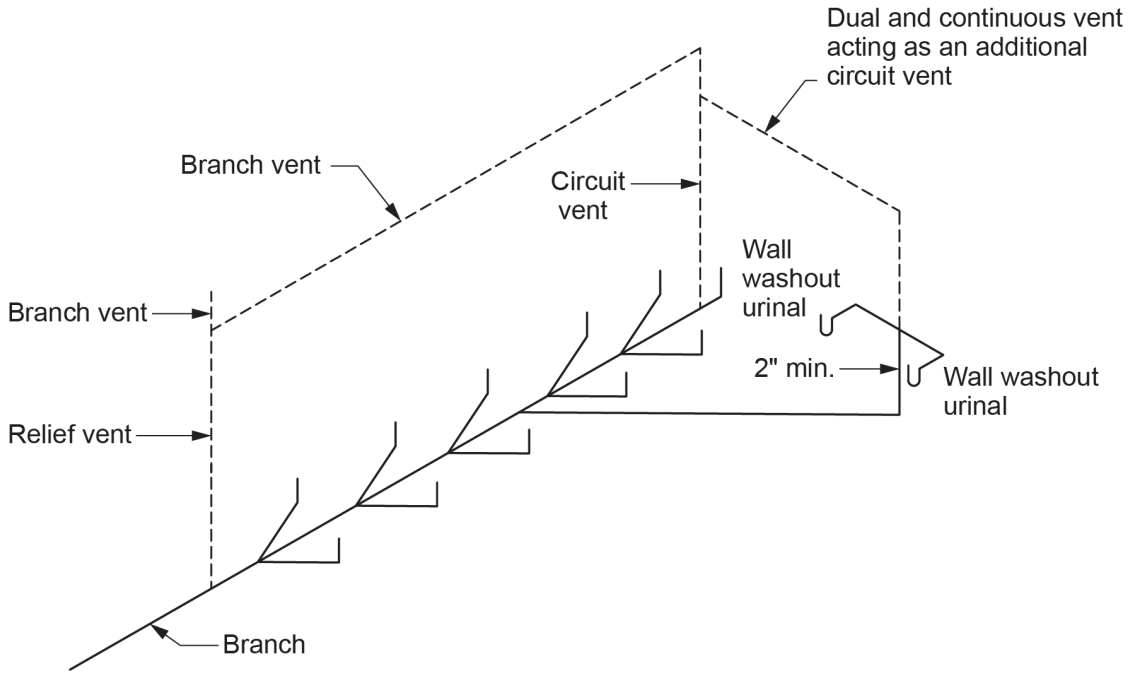

Figure 14 *Two maximum 1.5 FUs fixtures connected to the additional circuit vent by the use of a double sanitary tee fitting. (Skilled Trades BC, 2021) Used with permission.*

A trap arm(s) may be connected to a circuit vent (Figure 15), provided that:

- The branch or fixture drain is sized as a wet vent and is not less than 50 mm (2 in.) in size.
- The maximum number of fixtures does not exceed two.
- The fixture(s) connected to the circuit vent has a maximum hydraulic load of 1.5 FUs each.
- When two fixtures are connected to the vent pipe, the connection is made using a double sanitary tee fitting, as stated in Clause 2.5.4.5.(1).

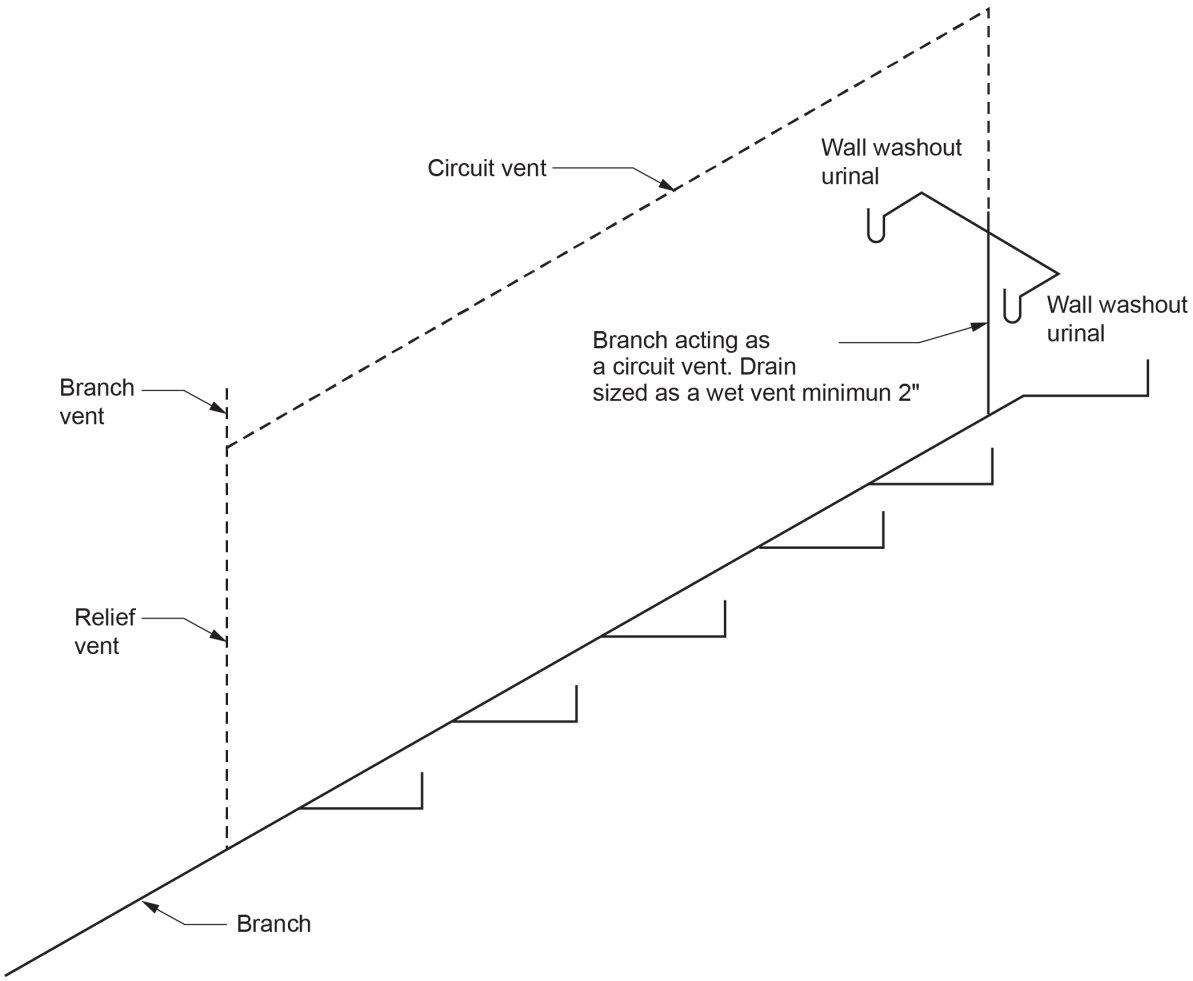

Figure 15 *Two maximum 1.5 FUs fixtures connected to the circuit vent by a double sanitary tee fitting. (Skilled Trades BC, 2021) Used with permission.*

Circuit-vented branches, including the fixture drain downstream of the circuit vent connection, shall be sized as a branch from Table 2.4.10.6.-B (NPC, 2020, B 2-35; refer to Figures 16–18 below), except that it shall be not less than:

- 50 mm (2 in.), where traps less than 50 mm in size are circuit-vented.
- 75 mm (3 in.), where traps 50 mm in size or larger are circuit-vented.

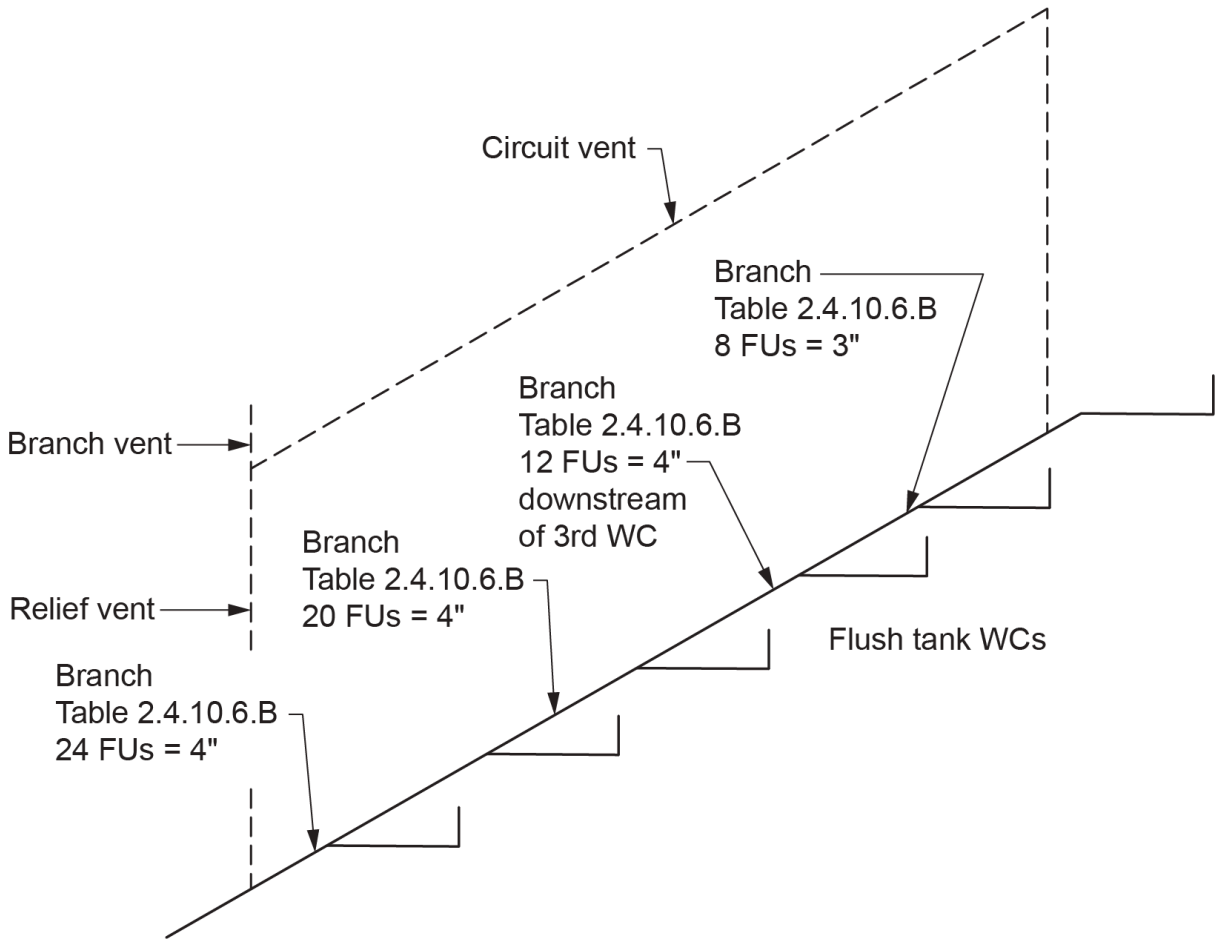

Figure 16 *Circuit-vented branch serving water closets sized as a branch from Table 2.4.10.6.-B. (Skilled Trades BC, 2021) Used with permission.*

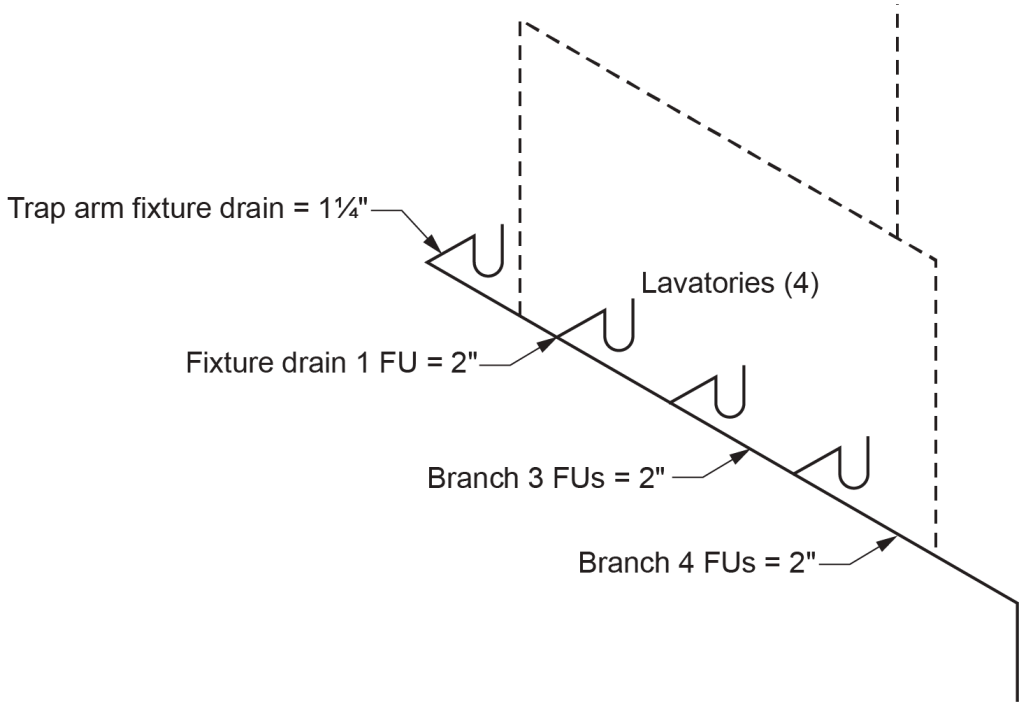

Figure 17 *Circuit-vented branch serving 1.25 in. lavatories increased to 2 in. fixture drain downstream of the circuit vent connection. (Skilled Trades BC, 2021) Used with permission.*

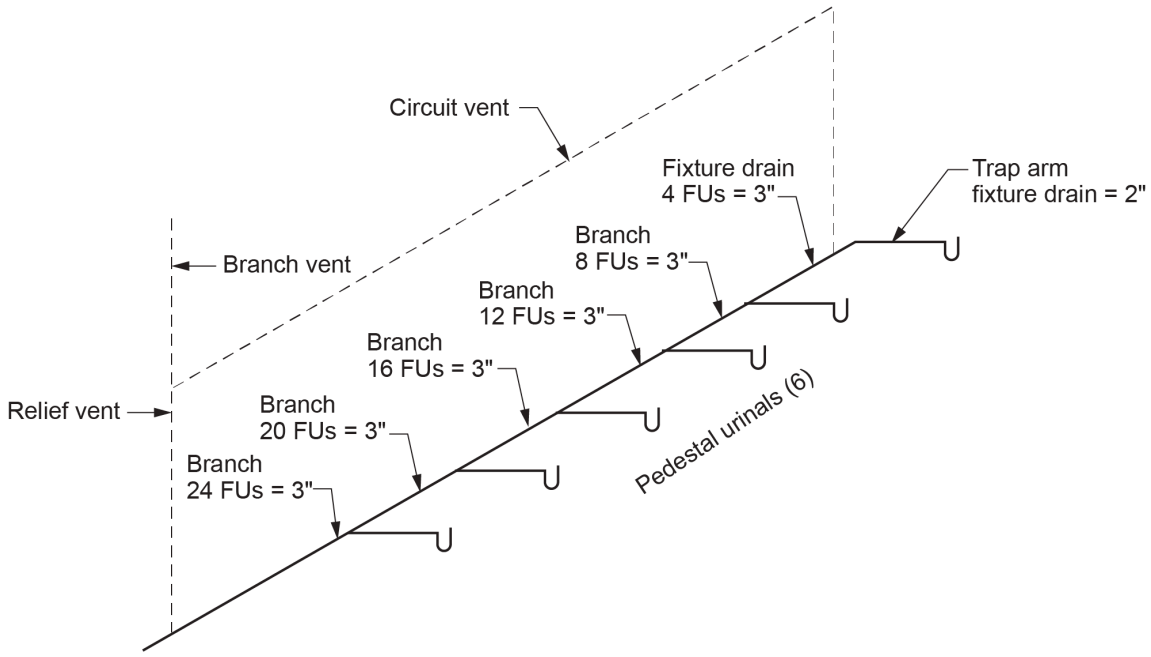

Figure 18 *Circuit-vented branch serving 2 in. urinals increased to 3 in. fixture drain downstream of the circuit vent connection. (Skilled Trades BC, 2021) Used with permission.*

The minimum size of an additional circuit vent or relief vent serving a circuit-vented branch need only be one size smaller than the size of the circuit vent, provided it conforms to the minimum vent requirements set out in Table 2.5.7.1., based on the size of the circuit-vented traps (Figures 19–21). If these requirements are met, the vents need not be larger than 50 mm (2 in.).

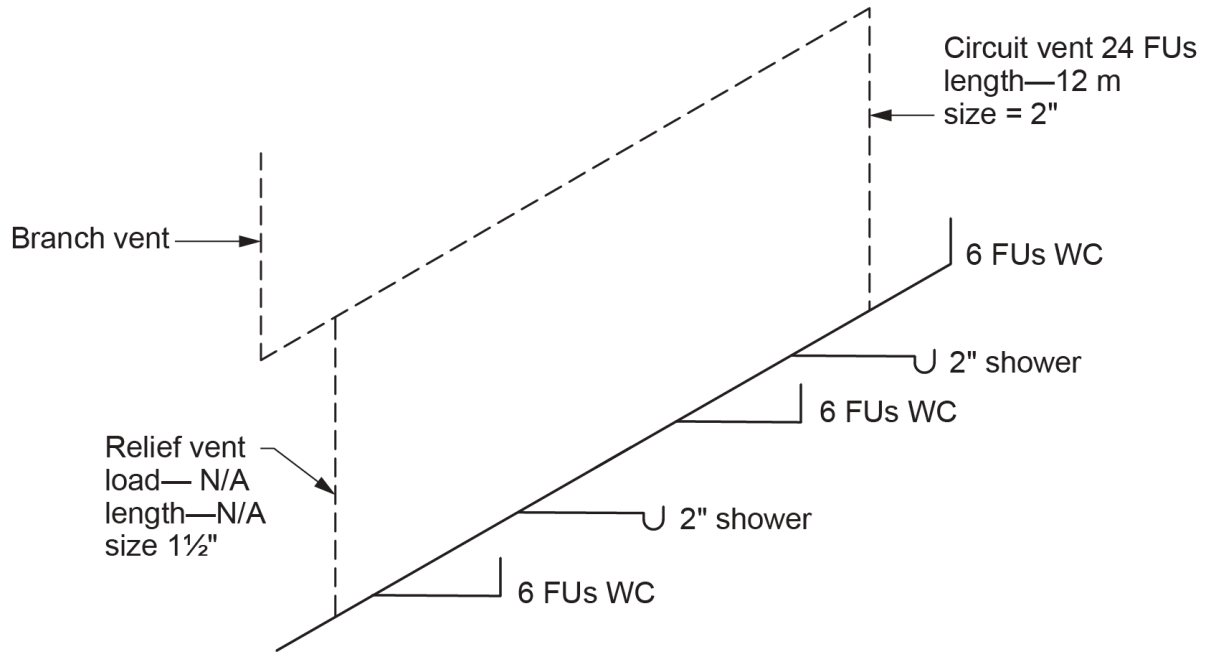

Figure 19 *Relief vent serving a circuit-vented branch one size smaller than circuit vent and in compliance with Table 2.5.7.1. (Skilled Trades BC, 2021) Used with permission.*

Figure 20 shows a relief vent and additional circuit vents serving a circuit-vented branch. The vents are sized one size smaller than the circuit vent and are in compliance with Table 2.5.7.1 (NPC, 2020, B 2-43).

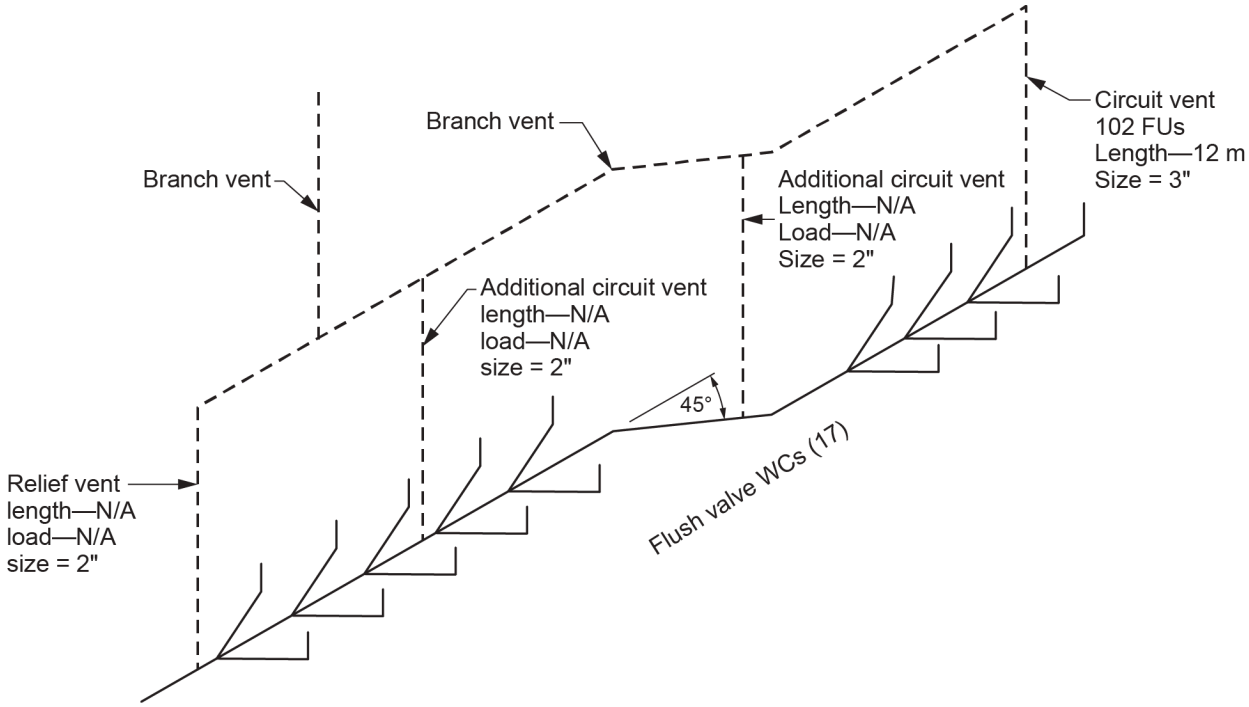

Figure 20 *Relief vent and additional circuit vents serving a circuit-vented branch. (Skilled Trades BC, 2021) Used with permission.*

Figure 21 shows a relief vent serving a circuit-vented branch. The relief vent is sized equal to the circuit vent in order to comply with Table 2.5.7.1.

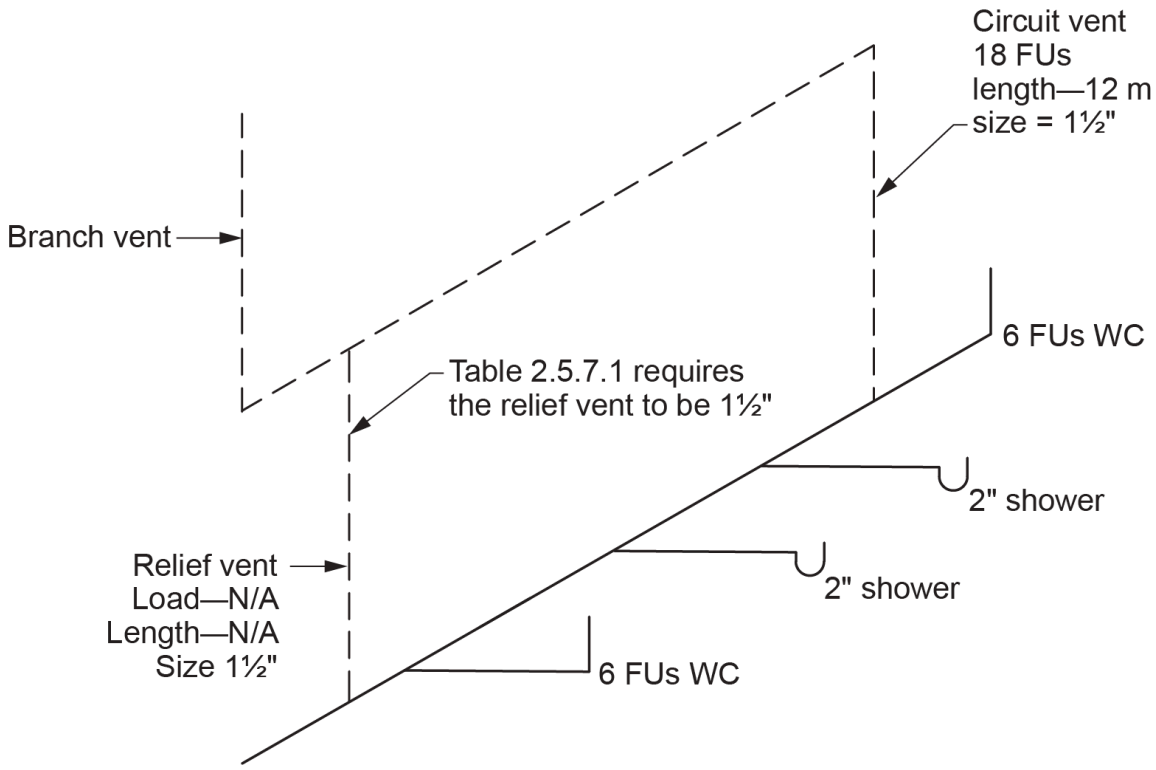

Figure 21 *Relief vent serving a circuit-vented branch. (Skilled Trades BC, 2021) Used with permission.*

The hydraulic load on a circuit vent must include the hydraulic load from fixtures connected to the branch served by the circuit vent but must not include the hydraulic load connected to the sanitary drainage pipe acting as the relief vent (Figures 22–25).

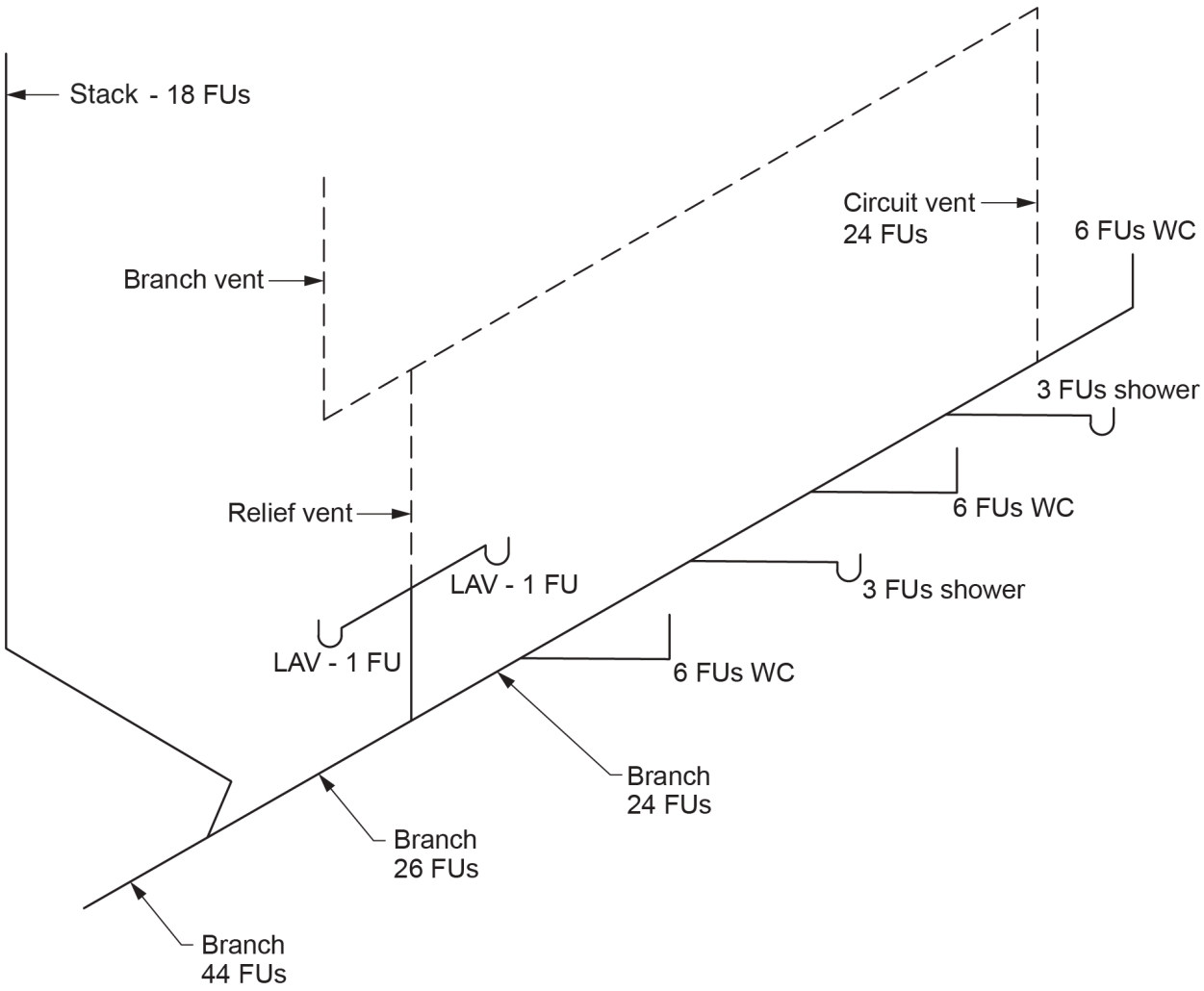

Figure 22 *The hydraulic load on a circuit vent is the connected load to the circuit-vented branch, not including the fixtures connected to the relief vent. (Skilled Trades BC, 2021) Used with permission.*

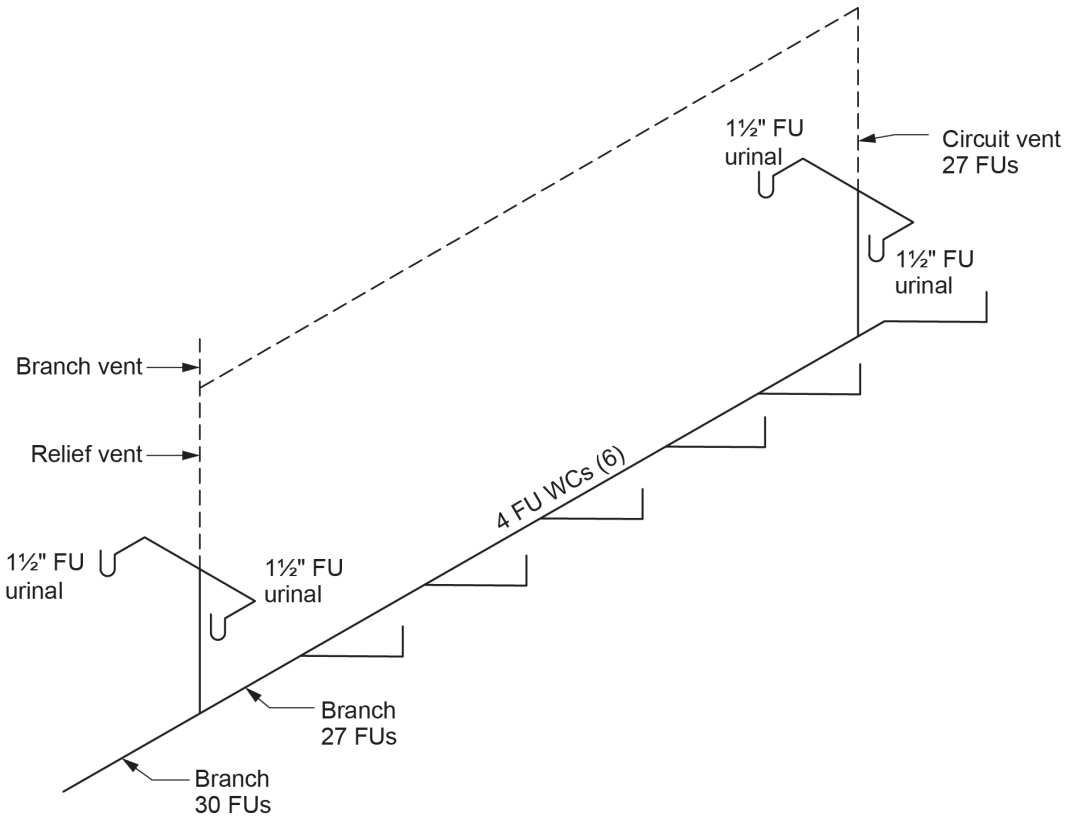

Figure 23 *The hydraulic load on a circuit vent is the connected load to the circuit-vented branch, including fixtures connected to the circuit vent. The load does not include the fixtures connected to the relief vent. (Skilled Trades BC, 2021) Used with permission.*

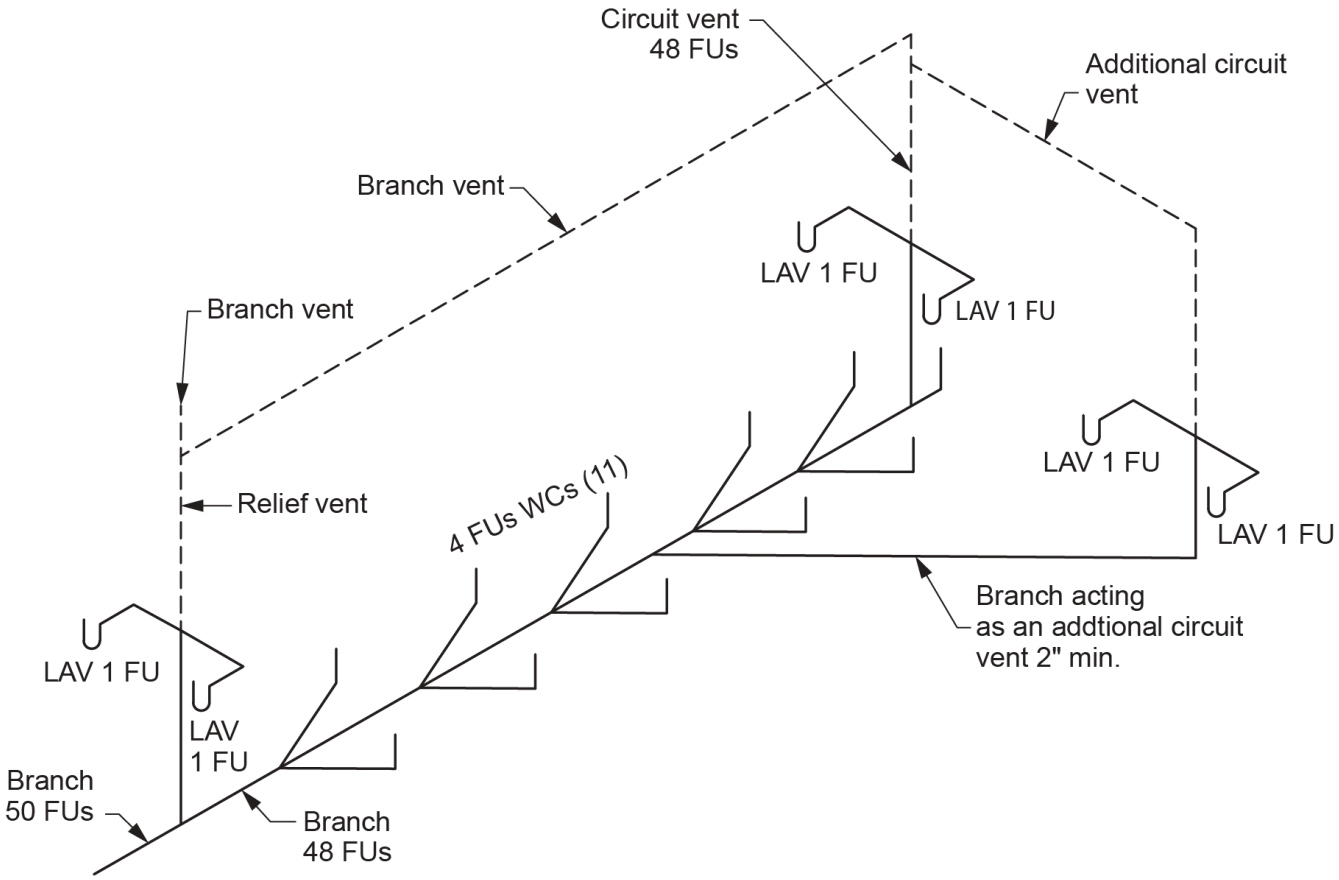

Figure 24 *The hydraulic load on a circuit vent is the connected load to the circuit-vented branch, including fixtures connected to the circuit vent and additional circuit vents. The load does not include the fixtures connected to the relief vent. (Skilled Trades BC, 2021) Used with permission.*

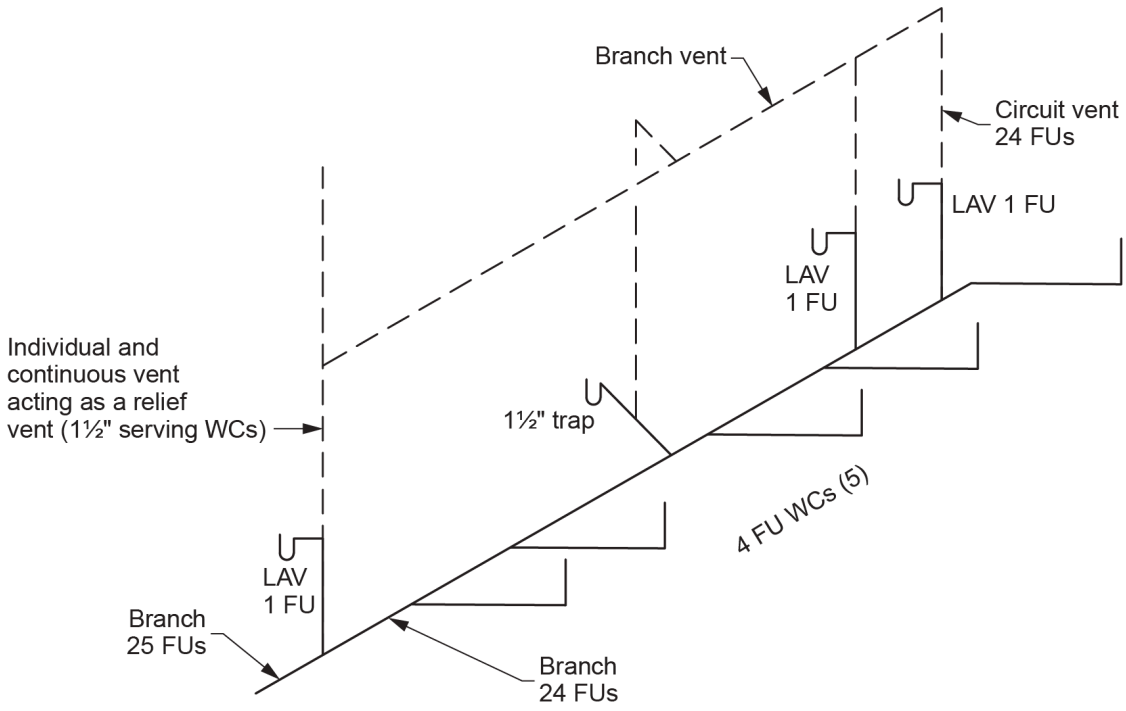

Figure 25 *The hydraulic load on a circuit vent is the connected load to the circuit-vented branch, including individually vented fixtures connected to the circuit vent. The load does not include the fixtures connected to the relief vent. (Skilled Trades BC, 2021) Used with permission.*

Self-Test D-1.8: Sizing Branch and Circuit Vents

Complete Self-Test D-1.8 and check your answers.

If you are using a printed copy, please find Self-Test D-1.8 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=52#h5p-21 (https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=52#h5p-21)

References

National Research Council of Canada. (2020). *National plumbing code of Canada* 2020. Canadian Commission on Building and Fire Codes. https://nrc-publications.canada.ca/eng/view/ft/?id=6e7cabf5-d83e-4efd-9a1c-6515fc7cdc71 (https://nrc-publications.canada.ca/eng/view/ft/?id=6e7cabf5-d83e-4efd-9a1c-6515fc7cdc71)

Skilled Trades BC. (2021). *Book 2: Install fixtures and appliances, install sanitary and storm drainage systems.* Plumber apprenticeship program level 2 book 2 (Harmonized). Crown Publications: King's Printer for British Columbia.

Trades Training BC. (2021). D-1: Install sanitary drain, water and vent systems. In: *Plumber Apprenticeship Program: Level 2*. Industry Training Authority, BC.

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D-1.9 Sizing Stack Vents, Vent Stacks, and Headers

The upper end of every **stack** becomes a stack vent above the highest fixture connection. The stack vent can extend individually to open air or connect into another stack vent or vent stack, becoming a vent header, and then extend to open air. It is important to note that the stack below the stack vent connection cannot be smaller than the size of the stack vent.

Sizing Stack Vents

Stack vents are sized using Table 2.5.8.4. in the NPC (2020, B 2-46; refer to Figure 1 below). When using this table to obtain the size of the stack vent, there are three things to consider:

1. The size of the stack served by the stack vent. Because a stack may become larger as the loads from floors are drained to it, the size at the base of the stack is the size to consider. Do not use the size of the stack at the top where the stack vent connects.
2. The hydraulic load (FU load) at the base of the stack served by the stack vent.
3. The developed length of the stack vent. This is measured from the lower end of the stack vent through to open air, even if a vent header is installed.

The NPC (2020) requires that the minimum size of a stack vent not be smaller than one-half the size of the stack at its base and never be smaller than permitted by Table 2.5.7.1.

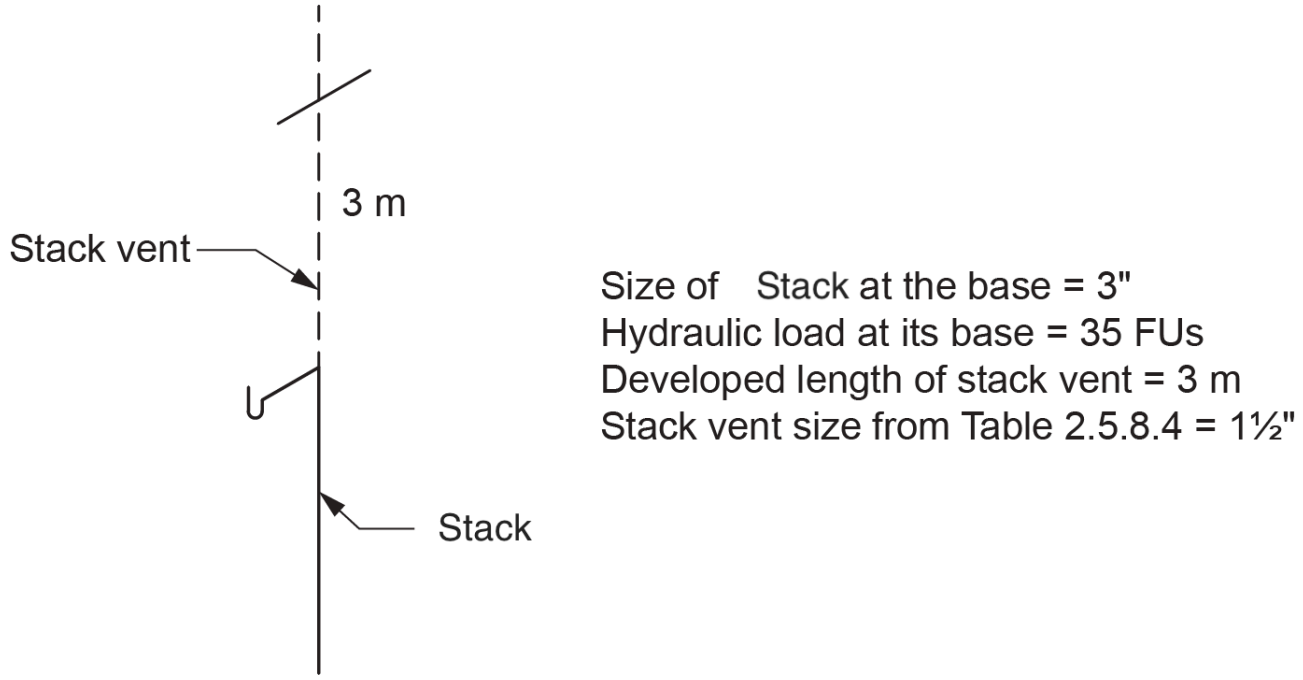

Figure 1 *Sizing of a stack vent using Table 2.5.8.4. (Skilled Trades BC, 2021) Used with permission.*

Clause 2.5.8.4.(5) states that "Every building drain shall be provided with at least one vent that is not less than 3 in. in size." This requirement would overrule Table 2.5.8.4. if there is only one 3 in. stack in a building, such as in a single-family dwelling. If a building has more than one 3 or 4 in. stack, then at least one of the stack vents must be at least 3 in. through to open air (Figure 2).

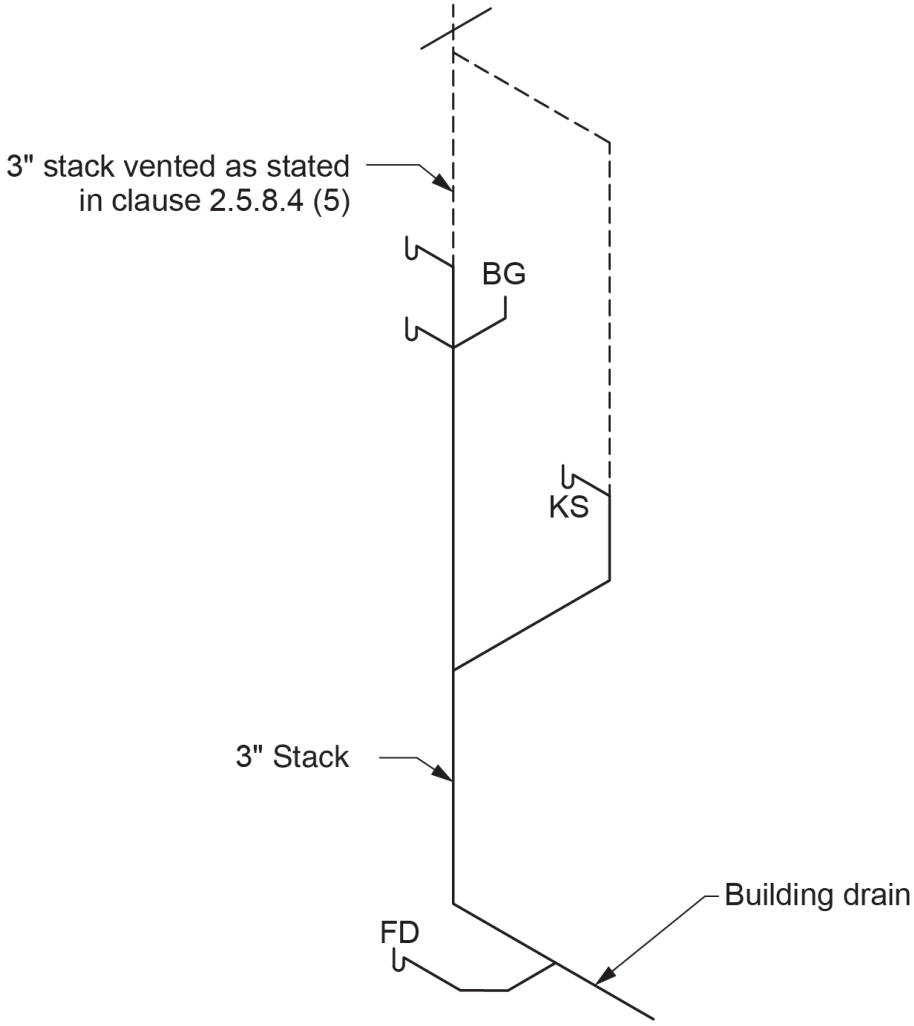

Figure 2 *Sizing of a stack vent in accordance with Clause 2.5.8.4.(5). (Skilled Trades BC, 2021) Used with permission.*

Sizing Vent Stacks

A vent stack is a vent installed in conjunction with a stack used to limit the pressure differential created between the drainage and venting systems. The NPC states that any stack that receives discharge from more than four storeys requires a vent stack. However, this rule does not apply to multi-storey wet vents sized to provide ample air circulation within the wet-vented stack.

Vent stacks are also sized using Table 2.5.8.4. in the NPC (2020, B 2-46). When using this table to obtain the size of the vent stack (Figure 3), there are three things to consider:

1. The size of the stack at the base served by the vent stack. This would be the location where the vent stack connects to the stack below the lowest fixture connection to the stack.
2. The hydraulic load (FU load) at the base of the stack served by the vent stack plus any additional vent loads connected to the vent stack.
3. The developed length of the vent stack. This is measured from the lower end of the vent stack through to open air,

even if a vent header is installed.

The NPC requires that the minimum size of a vent stack not be smaller than one-half the size of the stack at its base and never be smaller than permitted by Table 2.5.7.1.

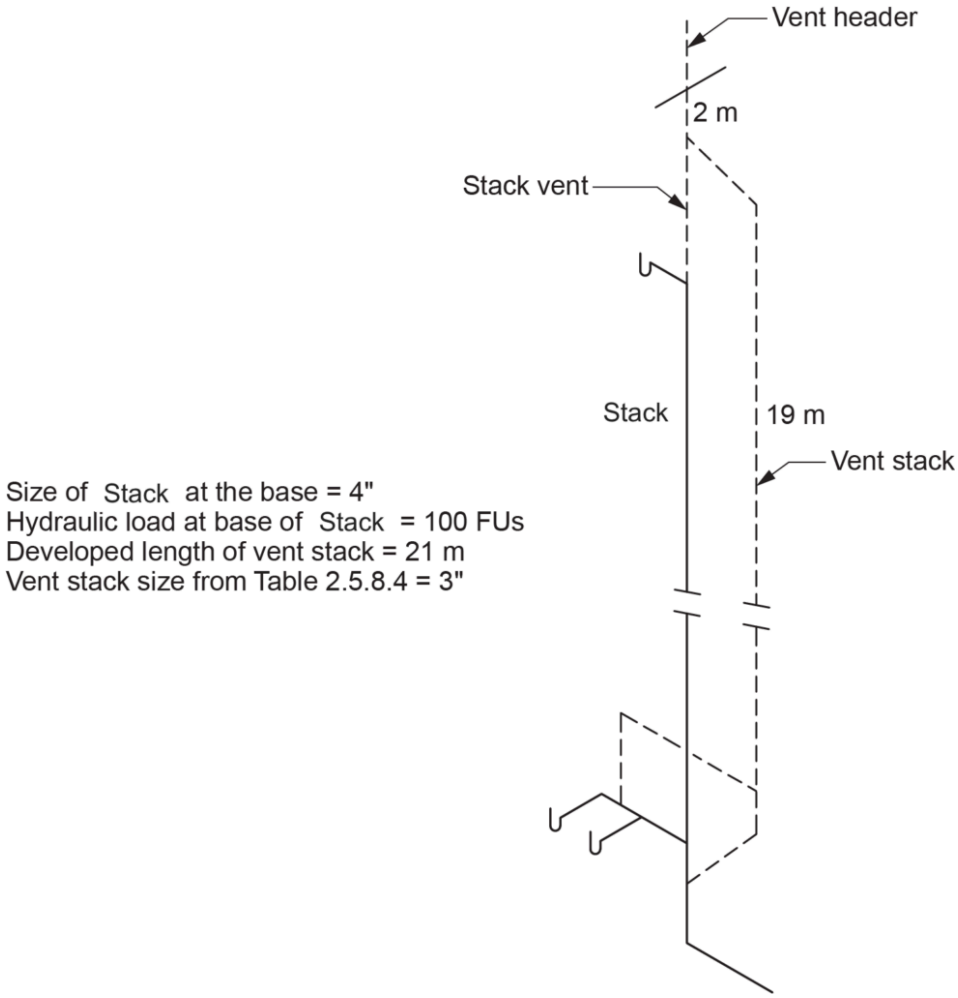

Figure 3 *Sizing of a vent stack using Table 2.5.8.4. (Skilled Trades BC, 2021) Used with permission.*

There are often instances when fixtures do not drain to a stack served by a vent stack, but the vents from these fixtures do connect to the vent stack. In such cases, the hydraulic load on the vent stack will increase from that point of connection as the additional venting loads are introduced to the vent stack (Figure 4).

Venting from similar scenarios, where additional fixtures vent loads may tie into a stack vent, are dealt with in the same manner.

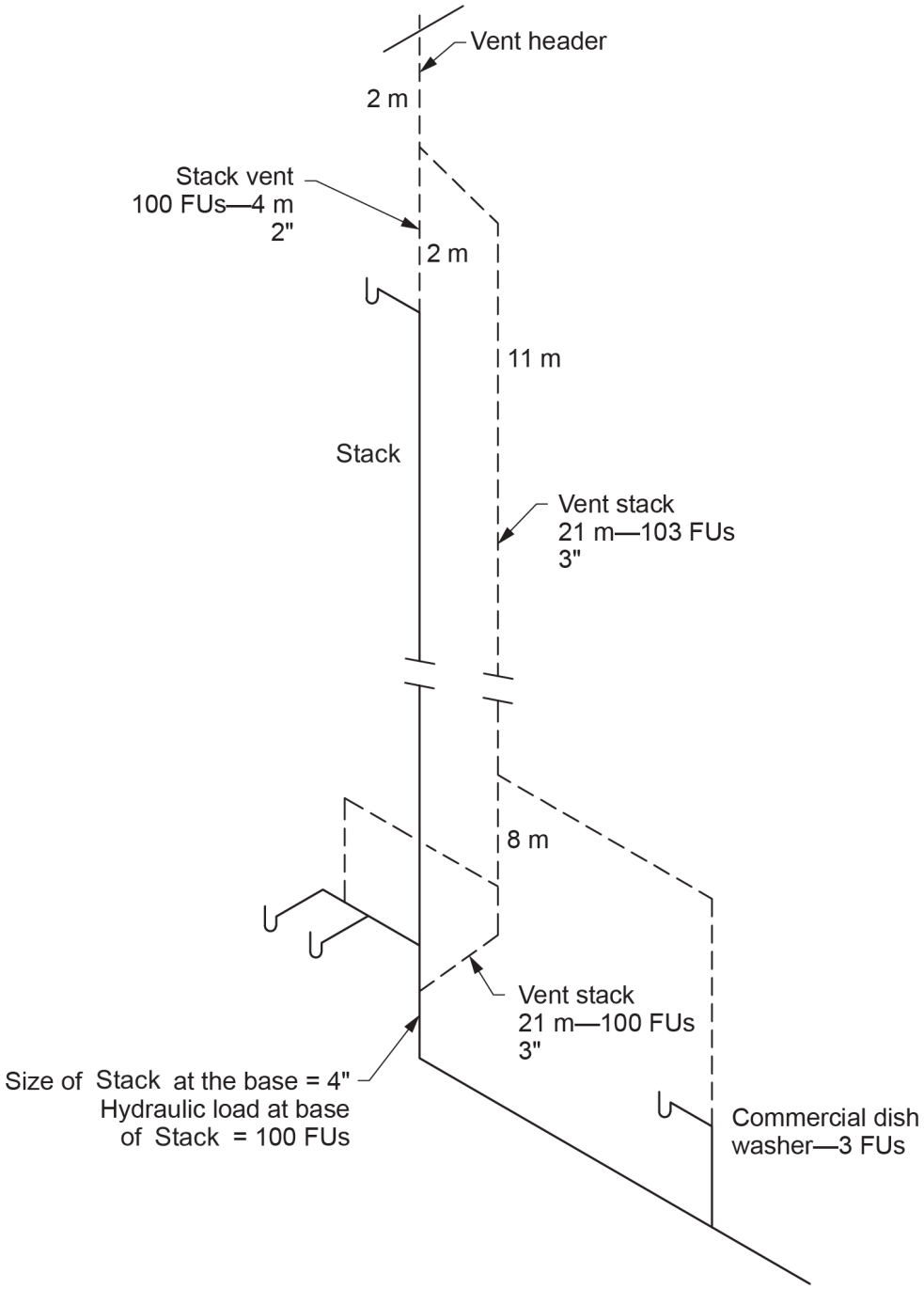

Figure 4 *Vent stack hydraulic load determination. (Skilled Trades BC, 2021) Used with permission.*

Fixtures Connecting to the Base of Vent Stacks

Clause 2.5.4.2.(4) of the NPC allows fixtures to connect to a vent stack (Figure 5), provided that the following conditions are met:

- The total hydraulic load of the connected fixtures does not exceed 8 FUs.
- At least one fixture is connected to a vertical portion of the vent stack and is upstream of any other fixtures.
- No other fixture is connected downstream of a water closet.
- All fixtures are located in the lowest storey served by the vent stack.
- The section of the vent pipe that acts as a wet vent conforms to the requirements regarding wet vents.
- The wet-vented portion described above cannot be smaller than the size of the vent stack above the wet vent.

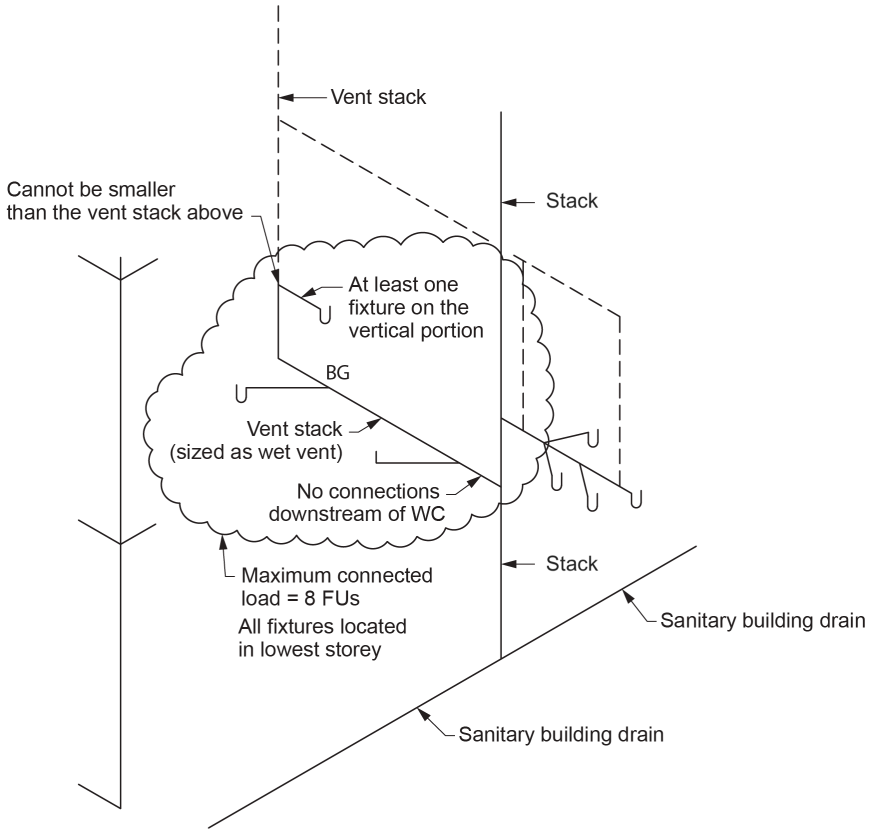

Figure 5 *Rules surrounding fixtures connecting to the base of vent stacks. (Skilled Trades BC, 2021) Used with permission.*

Size Vent Header

Vent headers are sized using Table 2.5.8.3. in the NPC (Figure 6). When using this table, you must consider two things:

1. The total number of fixture units being vented by the vent header
2. The total developed length of the vent header, which is measured from the furthest vented fixture through to open air

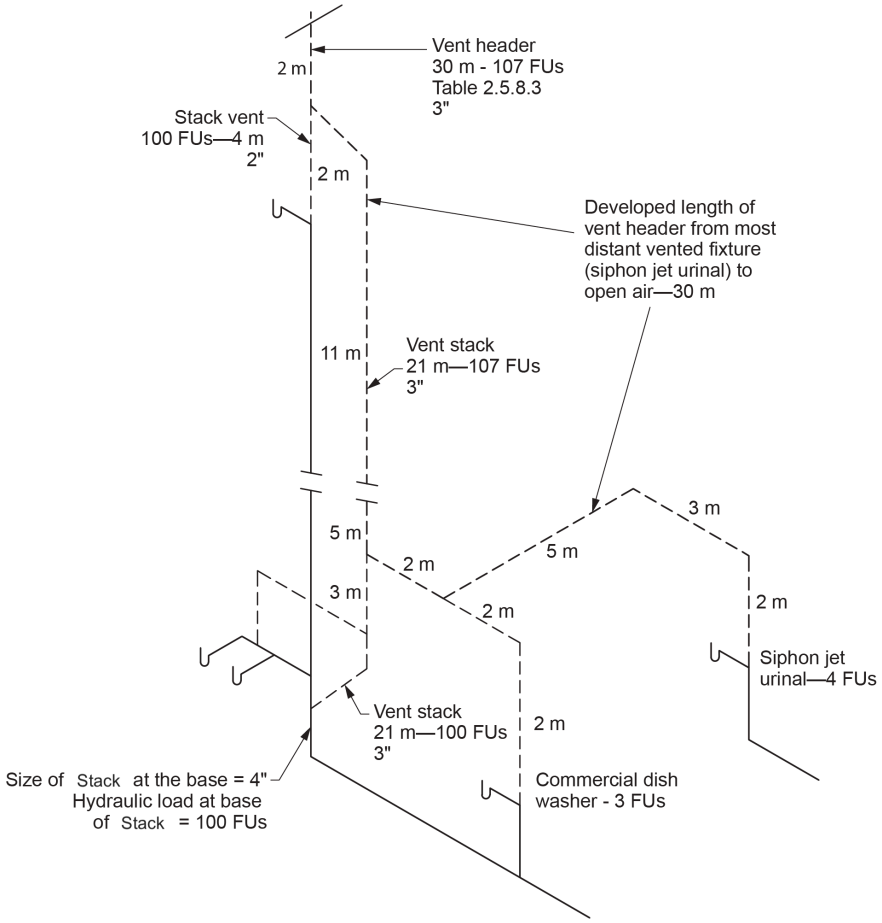

Figure 6 *Sizing a vent header using Table 2.5.8.3. (Skilled Trades BC, 2021) Used with permission.*

Sizing Miscellaneous Vent Pipes

A number of other miscellaneous special vents do not have an additional hydraulic venting load but may be required to provide proper air circulation within the DWV systems. These can include:

- Sump vents
- Yoke vents
- Offset relief vents

Sanitary Sewage Sumps

Every sump or tank that receives sanitary sewage shall be provided with a vent pipe connected to the top of the sump or tank. The lower end of the vent serving a **sanitary sewage sump** or tank connects to the lid or the upper interior side extending upward to any other part of the venting system. The size of the vent is found in Clause 2.5.7.7.:

> The minimum size of the vent pipe for a sanitary sewage sump or tank or a dilution tank shall be one size smaller

than the size of the largest branch or fixture drain draining to the sump or tank. The size shall be not less than 50 mm (2 in.) and need not be greater than 100 mm (4 in.).

In other words, a 2 in. vent is the minimum size for a sump vent if it receives waste from a 3 in. drain, a 3 in. vent is the minimum size if it receives waste from a 4 in. drain, and so on.

Unlike fixtures that drain to the sump, the sump vent does not have a hydraulic load associated with it. When it connects to a branch vent or vent stack, it does not increase the load at the connection point. The branch vent or vent stack may have to be increased in size above the connection point because Clause 2.5.7.2.(1) requires that the size of a branch vent or vent stack be not less than the size of the vent pipe to which it is connected (Figure 7).

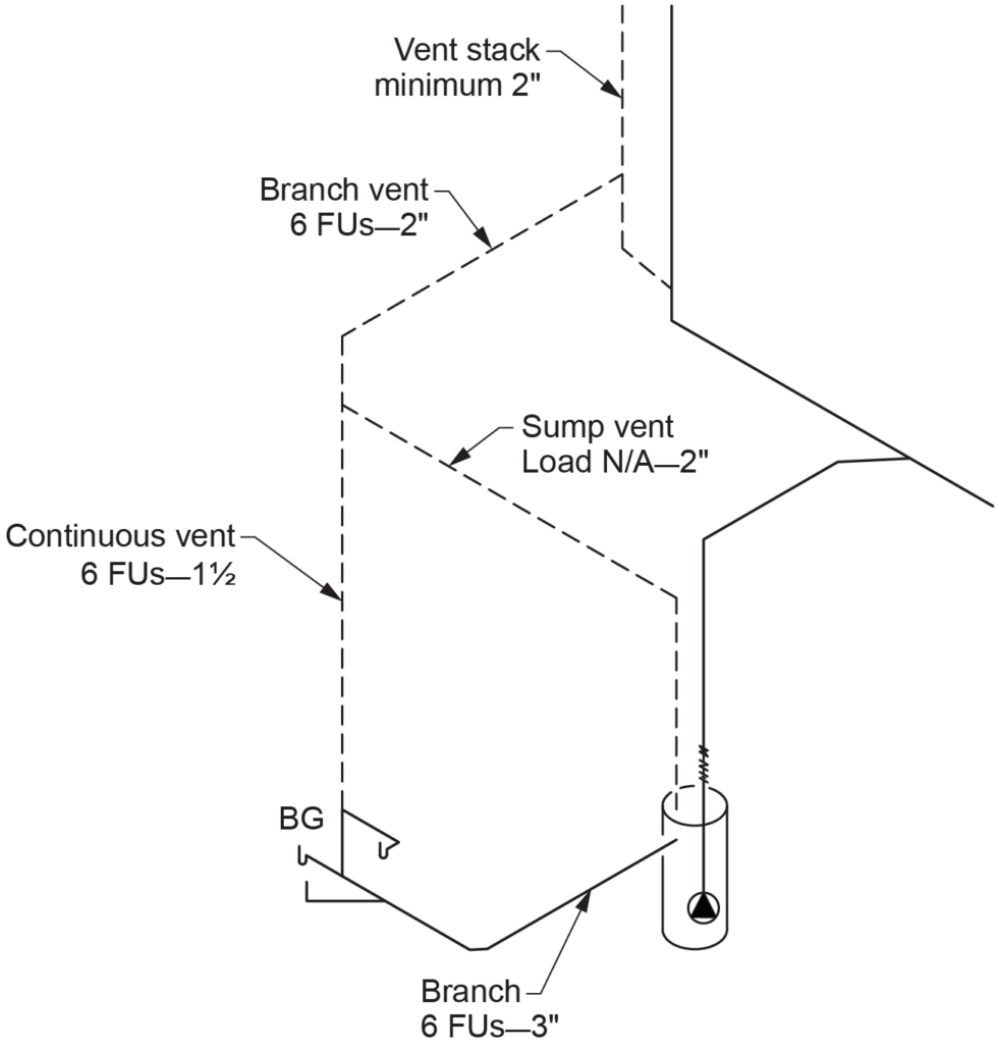

Figure 7 *Sump vent implications using Clause 2.5.7.2.(1). (Skilled Trades BC, 2021) Used with permission.*

Macerating Toilet Systems

The size of every vent pipe for a **macerating toilet system** with a sump or tank shall be not less than 38 mm ($1\frac{1}{2}$ in.).

Yoke Vents

Additional vents are sometimes required on buildings more than 11 storeys tall to minimize the effect of pressure changes in the DWV system. The need for these vents can be eliminated by interconnecting the stack with the vent stack in each storey where the fixtures are located. This can be done using a vent pipe equal in size to the branch or fixture drain or 50 mm (2 in.) in size, whichever is smaller.

- When required, yoke vents are installed on every fifth storey (counting from the top down) and immediately above each offset or double offset.
- The lower end is connected to the stack by a drainage fitting at or immediately below the last connected fixture on the lower floor of the five-storey section.
- Yoke vents are sized by the pipes to which they are connected and are allowed to be one pipe size smaller than the smallest pipe to which they are connected (Figure 8).

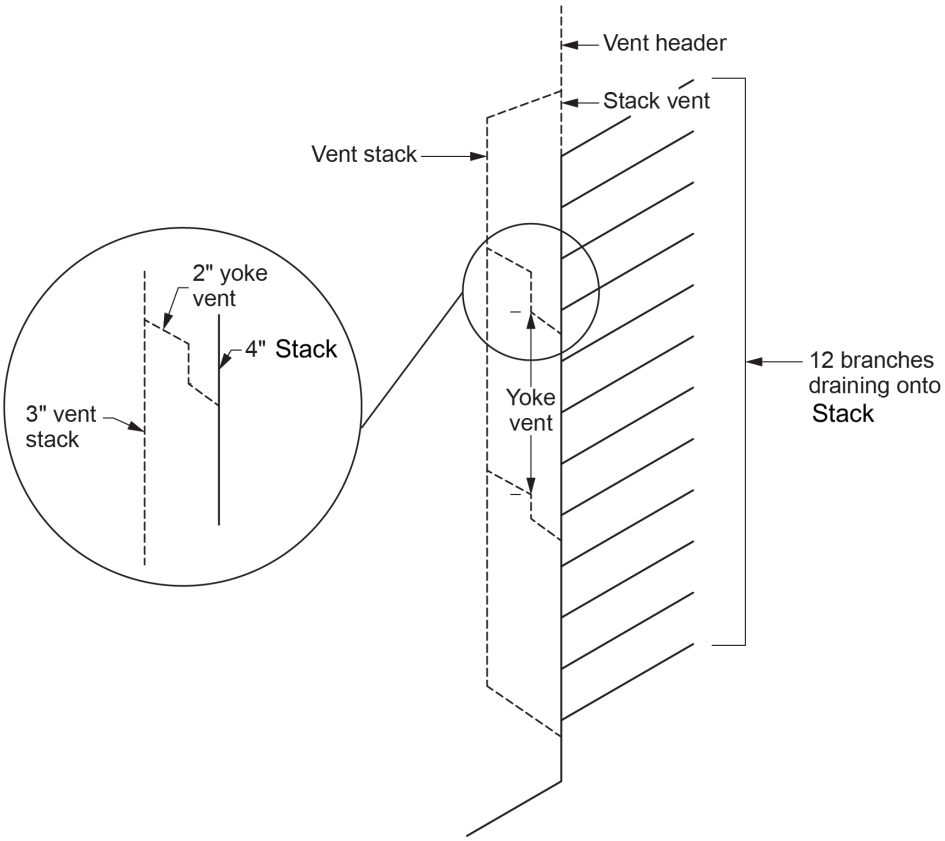

Figure 8 *NPC requirements for yoke vent connections. (Skilled Trades BC, 2021) Used with permission.*

Offset Relief Vents

An offset relief vent provides additional air circulation to a stack with a nominally horizontal offset of more than 1.5 m (60 in.) long and where the upper portion of the stack passes through three or more storeys and has more than 100 fixture units on it.

- The connection of the offset relief vent is made at the lowest end of the upper stack, after the last sanitary drainage pipe connection, and the upper end of the lower stack higher than any drain connections.
- The minimum size of an offset relief vent is permitted to be one size smaller than the size of the stack vent serving the stack (Figure 9).

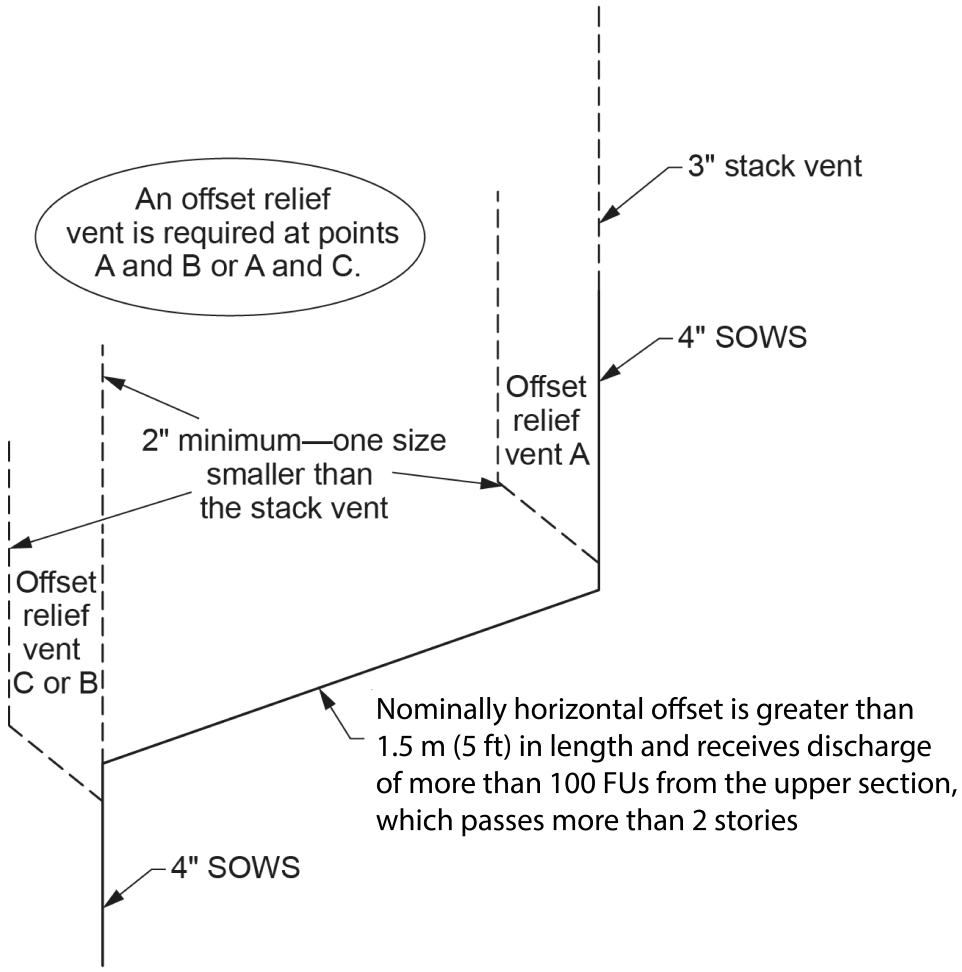

Figure 9 *NPC requirements for offset relief vent connections. (Skilled Trades BC, 2021) Used with permission.*

Putting it All Together

In the previous sections, you were asked to identify and determine hydraulic loads and size individual sections of a DWV

system. In the following self-test, you will be asked to use these skills to size "whole building" DWV systems. The ability to design and size a total DWV system to minimum code standards is essential to eliminate on-site code violations as an apprentice or journeyperson.

At first glance, the following drawings may look complicated, but in reality, they are just groups of fixtures and connected piping that you are familiar with. By following a simple procedure and practice, you will find that the sizing exercises become easier. Here are some hints to help you establish a sizing procedure:

- If a group of fixtures falls under the definition of a "bathroom group," the hydraulic load will either be 6 or 8 FUs, depending on the flushing mechanism of the water closet. Look for bathroom groups, circle them, and jot down the FU load.
- If an existing bathroom group has additional fixtures, such as an additional lavatory, then the hydraulic load for the total group will be a bathroom group plus the load of the additional fixture(s).
- When determining the hydraulic load on any part of the drainage section of the DWV system, it is best to start at the highest fixture and work your way down the drawing toward the building sewer. Because the drainage load is additive, it will be easier to determine the hydraulic load on any section.
- When determining the hydraulic load on any part of the venting section of the DWV system, it is best to start at the lowest fixture and work your way up the drawing to open air. As with the drainage section, the venting load is also additive. This will lessen the possibility of errors and omissions.
- Ensure that the proper sizing table is being utilized for the piping based on the definition of the pipe in question.
- Focus on the location of water closets, remembering that the minimum size of drainage piping downstream will be 3 in. and the minimum size of any venting from one will be 1.5 in.

Self-Test D-1.9: Sizing Stack Vents, Vent Stacks, and Headers

Complete Self-Test D-1.9 and check your answers.

If you are using a printed copy, please find Self-Test D-1.9 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=54#h5p-22 (https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=54#h5p-22)

References

National Research Council of Canada. (2020). *National plumbing code of Canada* 2020. Canadian Commission on Building and Fire Codes. https://nrc-publications.canada.ca/eng/view/ft/?id=6e7cabf5-d83e-4efd-9a1c-6515fc7cdc71 (https://nrc-publications.canada.ca/eng/view/ft/?id=6e7cabf5-d83e-4efd-9a1c-6515fc7cdc71)

Skilled Trades BC. (2021). *Book 2: Install fixtures and appliances, install sanitary and storm drainage systems.* Plumber apprenticeship program level 2 book 2 (Harmonized). Crown Publications: King's Printer for British Columbia.

Trades Training BC. (2021). D-1: Install sanitary drain, water and vent systems. In: *Plumber Apprenticeship Program: Level 2*. Industry Training Authority, BC.

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D-1.10 Requirements and Prohibitions for DWV Systems

This chapter summarizes some of the overriding requirements identified in various parts of the National Plumbing Code (NPC) of Canada 2020.

Slope

Drainage and waste systems rely on gravity to move solid and liquid wastes, so these piping systems must be installed at a **slope** downward in the direction of flow. In the plumbing industry, this slope is called grade and can be expressed as a ratio (1:50, 1:100, etc.), percentage (2%, 1%, etc.), or fraction of an inch fall for every foot of run ($\frac{1}{4}$ in./ft, $\frac{1}{8}$ in./ft, etc.).

Typically, plumbers select the grades according to the applicable plumbing code. Choosing the proper grade is very important to allow the liquid waste to flow at the right velocity (speed) to scour the inside of the pipe and carry away the solids. If the grade is too shallow, the liquid waste will not flow fast enough to scour the pipe and remove the solid wastes. If the grade is too steep, the liquid waste may flow too fast, leaving the solids behind. In either case, the pipe will soon become blocked with solid wastes. Vent piping should be free of sags and be graded to drain back by gravity to the fixture(s) it serves.

The NPC requires that every drainage pipe that has a size of 75 mm (3 in.) or less shall have a downward slope in the direction of flow of at least 1 in 50 ($\frac{1}{4}$ in./ft or 2%). As stated in Tables 2.4.10.6.-C and 2.5.6.3., a 100 mm (4 in.) trap arm, building drain, or sewer is permitted to be sloped at 1:100 ($\frac{1}{8}$ in./ft).

Building drain and building sewer grade allowances are provided in Table 2.4.10.6.-C (NPC, 2020, B 2-35; refer to Table 1 below). This table shows that when the size of a building drain or building sewer increases, the grade can be reduced accordingly.

Table 1: (From NPC Table 2.4.10.6.-C) Maximum Permitted Hydraulic Load Drained to a Sanitary Building Drain or Sewer

Size of Drain or Sewer (in.)	Maximum Hydraulic Load (FUs)					
	Slope					
	1 in 400	1 in 200	1 in 133	1 in 100	1 in 50	1 in 25
3	N/A	N/A	N/A	N/A	27	36
4	N/A	N/A	N/A	180	240	300
5	N/A	N/A	380	390	480	670
6	N/A	N/A	600	700	840	1,300
8	N/A	1,400	1,500	1,600	2,250	3,370
10	N/A	2,500	2,700	3,000	4,500	6,500
12	2,240	3,900	4,500	5,400	8,300	13,000
15	4,800	7,000	9,300	10,400	16,300	22,500

Drainage Fittings

Whenever a fitting is chosen to change flow direction, two primary DWV piping practices should be followed:

1. Install fittings so they provide a gradual curve in the direction of flow.
2. Install fittings to maintain the minimum slope.

The NPC has certain restrictions pertaining to the use and orientation of DWV fittings installed in a system. The use of the wrong fitting in the wrong place could cause the DWV system to be unreliable or stop working.

Tee and Cross Fittings

These fittings are not the sanitary tee fittings you are probably familiar with. These fittings do not have a radius throat on the fitting branch to change flow direction from horizontal to vertical (Figure 1).

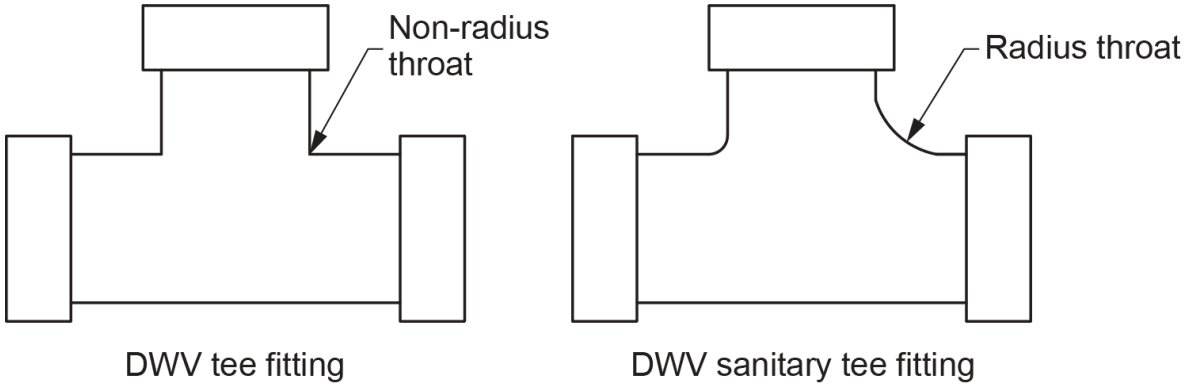

Figure 1 *The difference between a tee fitting and a sanitary tee fitting. (Skilled Trades BC, 2021) Used with permission.*

The NPC requires the following:

- A tee fitting shall not be used in a drainage system, except to connect a vent pipe (Figure 2).

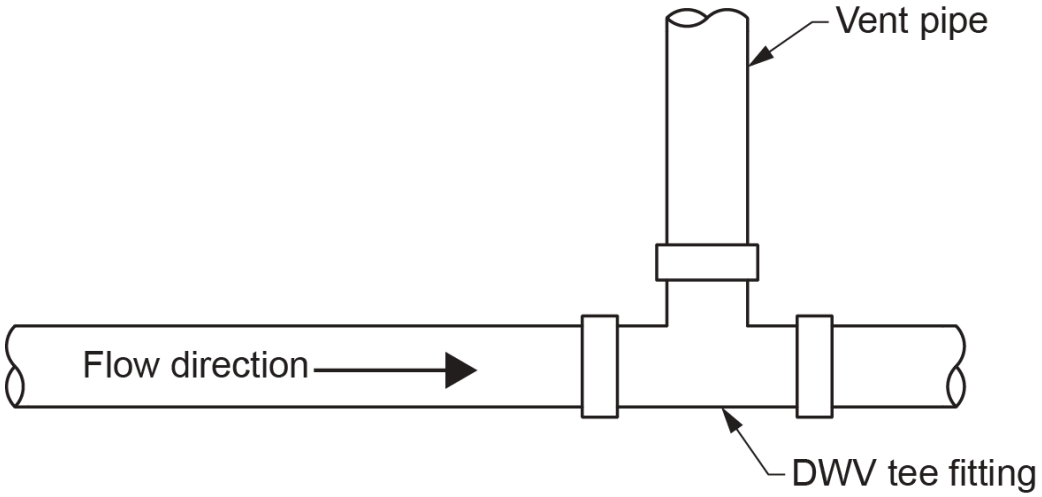

Figure 2 *Allowed installation for a DWV tee fitting. (Skilled Trades BC, 2021) Used with permission.*

- A cross fitting shall not be used in a drainage system (Figure 3).

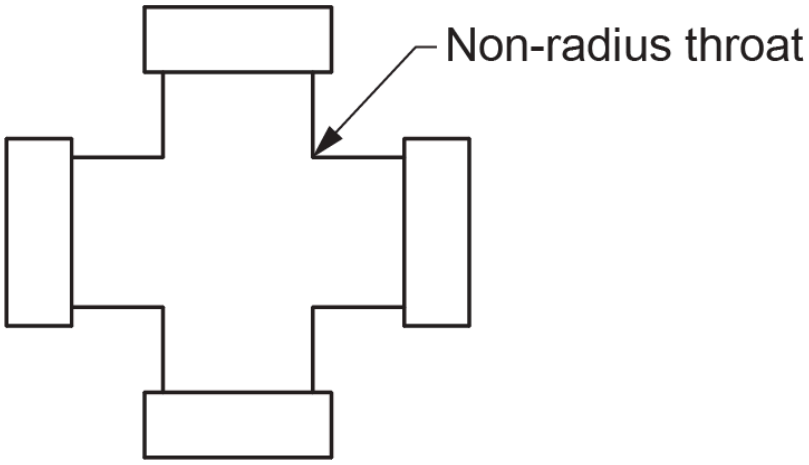

Figure 3 *Cross fitting is prohibited in a drainage system due to lack of throat radius. (Skilled Trades BC, 2021) Used with permission.*

Sanitary Tee Fittings

This fitting is often misused in a DWV system. Its proper use is to connect a horizontal branch or fixture drain to a nominally vertical branch or stack. The only time this fitting can be used in a horizontal drain pipe is to connect a nominally vertical dry vent to the system. Using a sanitary tee to change flow direction through its branch inlet from vertical to horizontal or to connect drainage pipes in the horizontal plane is never allowed.

The NPC requires that:

- A single or double sanitary tee fitting shall not be used in a nominally horizontal sanitary drainage pipe, except that a single sanitary tee fitting may be used to connect a vent pipe (Figure 4).

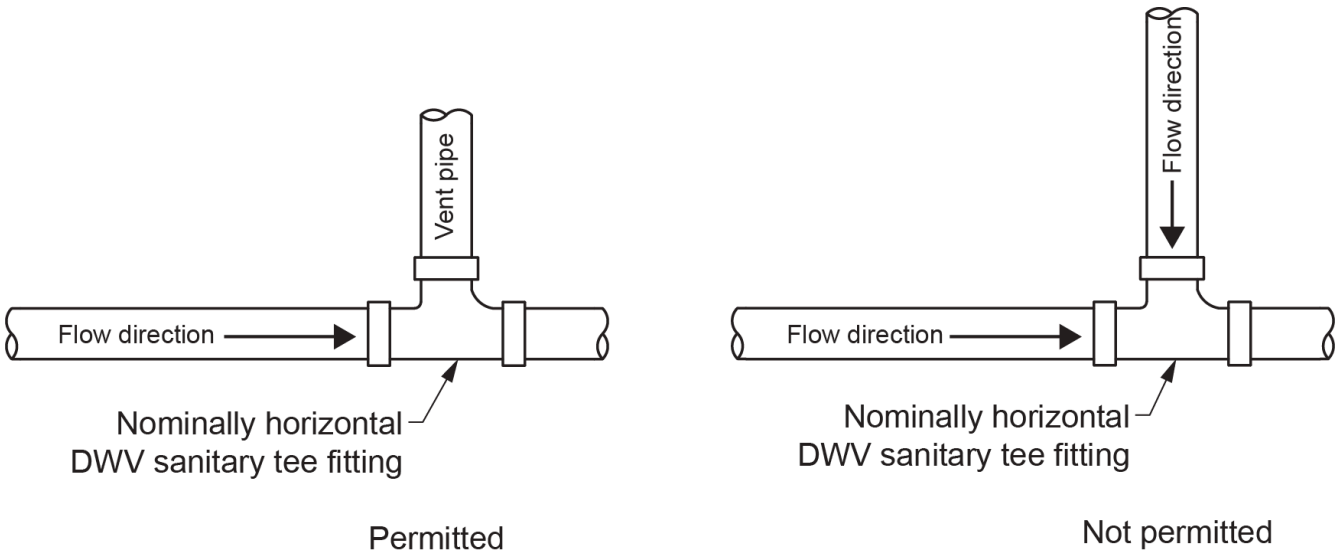

Figure 4 *NPC restrictions for single sanitary tee fittings. (Skilled Trades BC, 2021) Used with permission.*

- A double sanitary tee fitting cannot be used to connect the trap arms of back outlet water closets installed back-to-back (Figure 5) or two urinals with no cleanout fitting provided above the connection (Figure 6). Using a double wye fitting and 45° elbow combination is acceptable.

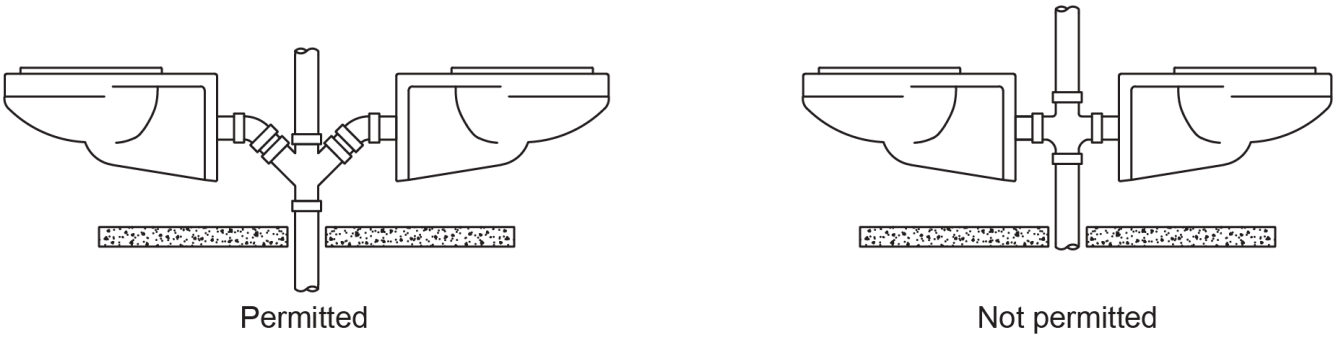

Figure 5 *NPC restrictions for double sanitary tee fittings serving back-to-back back outlet water closets. (Skilled Trades BC, 2021) Used with permission.*

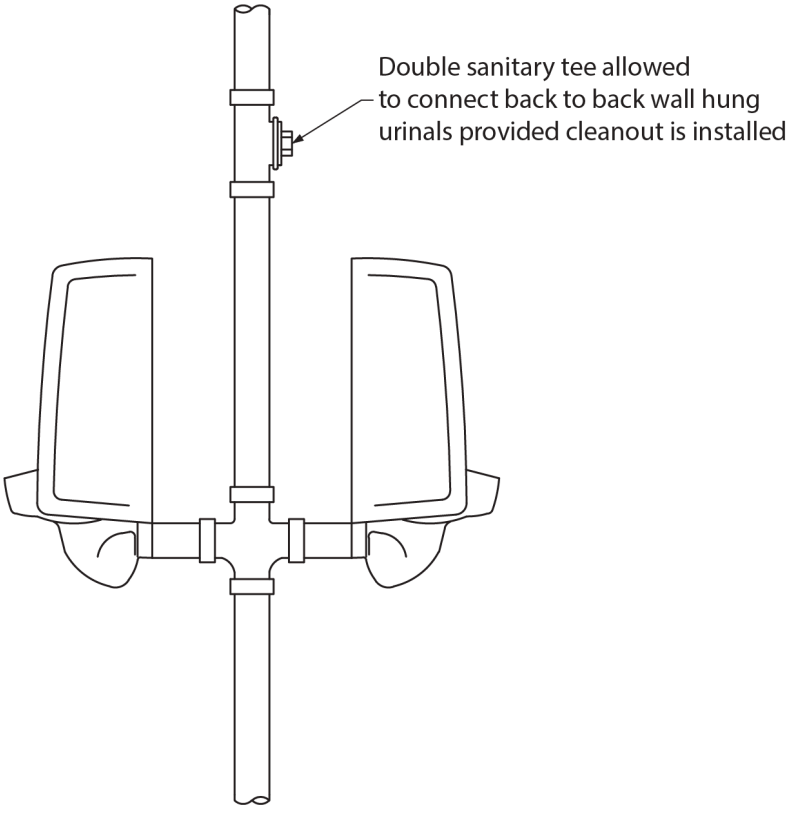

Figure 6 *NPC restrictions for double sanitary tee fittings serving wall hung urinals. (Skilled Trades BC, 2021) Used with permission.*

90° Elbows

These fittings are also called bends, which helps distinguish these DWV fittings from other **90° elbow**s that may be used in a pressurized system. Bends are described by the fraction of a circle that they sweep. A $\frac{1}{4}$ bend changes direction 90° ($\frac{1}{4}$ of 360°), a $\frac{1}{8}$ bend changes direction 45°, and so on. Bends may change flow in any direction, except for $\frac{1}{4}$ bends, which have some restrictions.

90° elbows (quarter bends) come in regular (short-radius) and long-radius styles. A long-radius bend is one whose centreline radius is at least equal to the diameter of the bend. Using long-radius bends to join two sanitary drainage pipes is unrestricted.

Short-radius bends used in systems of 100 mm (4 in.) in size or less are only permitted to do the following:

- Change flow direction from horizontal to vertical in the direction of flow or where a trap arm enters a wall (Figure 7)
- Connect trap arms — such as trap arms of water closets — s-trap standards, or any other fixture that also discharges vertically and depends on siphonic action to function properly

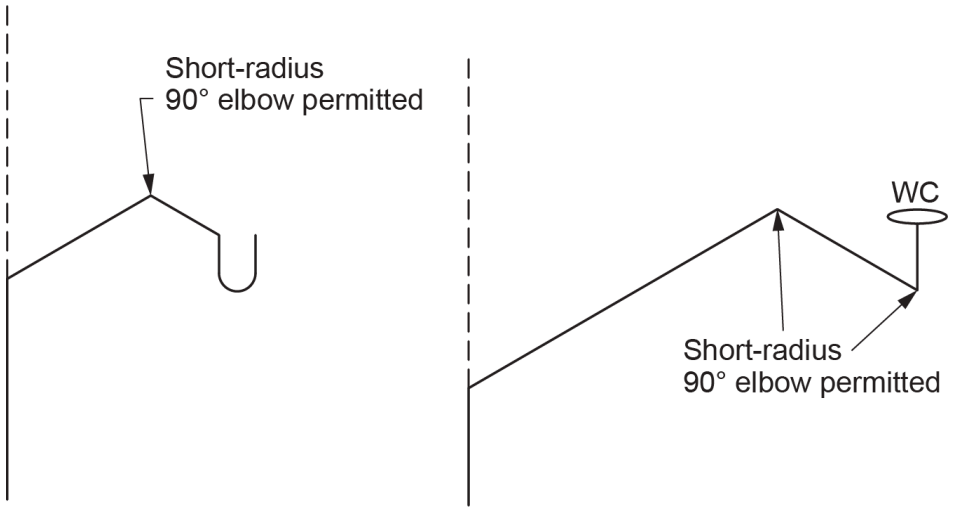

Figure 7 *NPC restriction for short-radius 90° elbows used in systems 100 mm (4 in.) in size or less. (Skilled Trades BC, 2021) Used with permission.*

Installing Fixtures and Associated Equipment

All plumbing fixtures shall not be installed in a room without lighting and ventilation. Every fixture, appliance, interceptor, cleanout, valve, device, or piece of equipment shall be located so that it is readily accessible for use, cleaning, and maintenance.

Additionally, there are a number of requirements specific to the type of fixture.

Showers

- Every shower receptor shall be constructed and arranged so that water cannot leak through the walls or floor.
- A single shower drain shall serve not more than six showerheads.
- Where a shower drain serves two or more showerheads, the floor shall be sloped and the drain located so that water from one head cannot flow over the area that serves another head.
- Except for column showers, when a battery of showerheads is installed, the horizontal distance between two adjacent showerheads shall be not less than 750 mm (30 in.).

Water Closets

- When a water closet is installed in a washroom for public use, it shall be of the elongated type and be provided with a seat of the open front type.
- When installing a water closet, the NPC requires that every screw, bolt, nut, and washer shall be of corrosion-resistant materials when used to:
    - Connect a water closet to a water closet flange
    - Anchor the water closet flange to the floor
    - Anchor the water closet to the floor

Clothes Washer

- Where clothes washers do not drain to a laundry tray, the trap inlet shall be fitted with a vertical standpipe not less than 600 mm (24 in.) long (measured from the trap weir) that terminates above the flood level rim of the clothes washer (Figure 8).

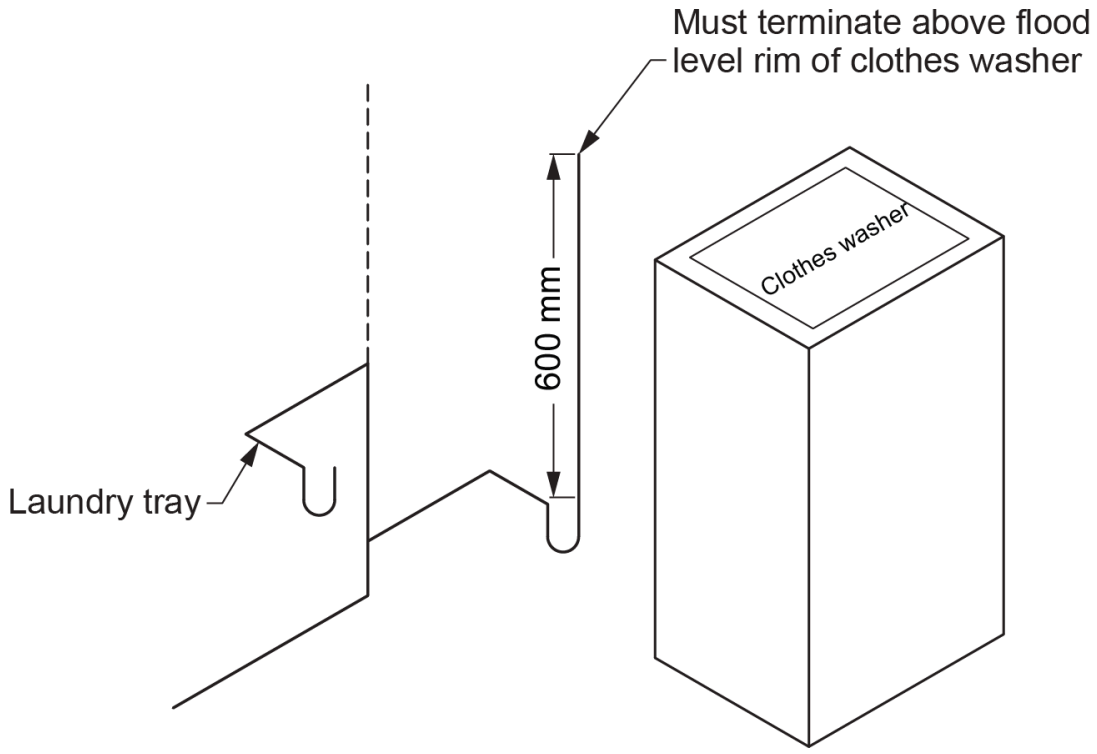

Figure 8 *NPC requirement for the installation of clothes washers. (Skilled Trades BC, 2021) Used with permission.*

Sumps or Tanks

- Piping that is too low to drain into a building sewer by gravity shall be drained to a **sump** or receiving tank.
- Where the sump or tank receives sewage, it shall be watertight, airtight, and vented.
- Equipment such as a pump or ejector that can lift the contents of the sump or tank and discharge it into the building drain or building sewer shall be installed.
- Where the equipment does not operate automatically, the capacity of the sump shall be sufficient to hold at least a 24-hour accumulation of liquid.
- Where there is a building trap, the discharge pipe from the equipment shall be connected to the building drain downstream of the trap.
- The discharge pipe from every pumped sump shall be equipped with a union, a check valve, and a shutoff valve installed, in that sequence, in the direction of discharge.
- The discharge piping from a pump or ejector shall be sized for optimum flow velocities at pump design conditions.

Manholes

- A manhole, including the cover, shall be designed to support all loads imposed upon it.
- A manhole shall be provided with the following (Figure 9):
    - A cover that provides an airtight seal, if located within a building
    - A rigid ladder of a corrosion-resistant material where the depth exceeds 1 m (39 in.)
    - A vent to the exterior, if located within a building

- A manhole shall have a minimum horizontal dimension of 1 m (39 in.), except that the top 1.5 m (60 in.) may be tapered from 1 m down to a minimum of 600 mm (24 in.).
- A manhole in a sanitary drainage system shall be channeled to direct the flow of effluent.

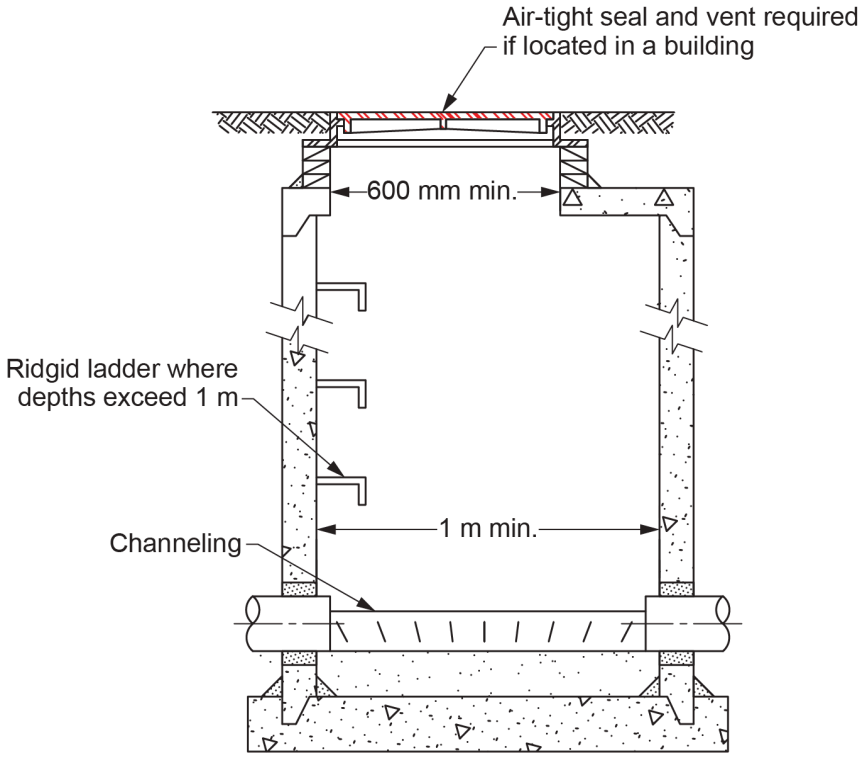

Figure 9 *NPC requirement for the installation of manholes. (Skilled Trades BC, 2021) Used with permission.*

Mobile Home Sewer Service

A building sewer intended to serve a mobile home shall be not less than 100 mm (4 in.) in size, terminated above ground, and provided with the following:

- A tamperproof terminal connection capable of being repeatedly connected, disconnected, and sealed
- A protective concrete pad
- A means to protect it from frost heave

Protection from Backflow in Drainage Systems

The NPC allows a **backwater valve** to be installed in a building drain provided that it is of a "normally open" design and does not serve more than one dwelling unit. As an alternative, where a building drain or a branch may be subject to backflow, a gate valve or backwater valve shall be installed on every fixture drain connected to it when the fixture is located below the level of the adjoining street. If more than one fixture is located on a storey and all are connected to

the same branch, the gate valve or backwater valve may be installed on the branch. If the alternative method is used and the fixture is a floor drain, a removable screw cap may be installed on the upstream side of the trap.

A subsoil drainage pipe that drains into a sanitary drainage system subject to surcharge shall be connected in such a manner that sewage cannot back up into the subsoil drainage pipe.

Prohibitions

Fixtures

- A dishwashing sink and a food preparation sink shall not have concealed overflows.

Connection to Public Services

- Piping in any building connected to public services shall be connected separately from the piping of any other building, except that an ancillary building on the same property may be served by the same service.

Restrictions

Fixture Locations

- Urinals shall not be installed adjacent to wall and floor surfaces that are pervious to water.
- **Indirect connections** or any trap that may overflow shall not be located in a crawl space or any other unfrequented area.
- Except for an organic solids interceptor, equipment discharging waste with organic solids shall not be located upstream of a **grease interceptor**.
- A floor drain or other fixture located in an oil transformer vault, a high-voltage room, or any room where flammable, dangerous, or toxic chemicals are stored or handled shall not be connected to a drainage system.
- A macerating toilet system shall only be installed where no connection to a gravity sanitary drainage system is available.
- Where a drain is provided in an elevator pit, it shall be connected directly to a sump located outside the elevator pit, and the drain pipe that connects the sump to the drainage system shall have a backwater valve.

Connections to the Drainage System

- A saddle hub or fitting shall not be installed in a DWV system.
- The NPC does not allow a fixture to be connected to a lead bend or stub serving a water closet.
- The connection of a sanitary drainage pipe to a nominally horizontal sanitary drainage pipe or a nominally horizontal offset in a stack shall be not less than 1.5 m (60 in.) measured horizontally from the bottom of a stack or the bottom of the upper vertical section of the stack that:
    - Receives a discharge from 30 or more fixture units
    - Receives a discharge from fixtures located on two or more storeys (Figure 10)

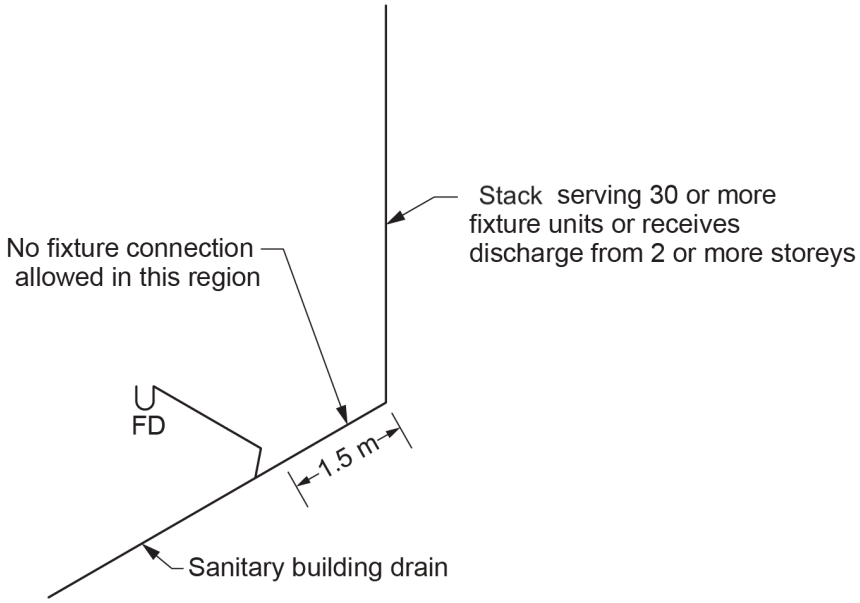

Figure 10 *NPC restrictions when connecting to a nominally horizontal sanitary drainage pipe serving a stack. (Skilled Trades BC, 2021) Used with permission.*

- Fixtures shall be directly connected to a sanitary drainage system, with the exception of a drinking fountain, which may be indirectly connected to a drainage system.

The following devices must be indirectly connected to a drainage system:

A. Device for displaying, storing, preparing, or processing food or drink
B. Sterilizer
C. Device that uses water as a cooling or heating medium
D. Water-operated device
E. Water treatment device
F. Drain or overflow from a water system or a heating system

For the fixtures listed above, the following methods of directly connecting to a shared drain pipe may also be used, as they will give the same level of protection as an indirect individual fixture connection.

- In reference to all of the above fixtures, two or more fixture outlet pipes that serve outlets from a single fixture may be directly connected to a branch that:
  - Has a size of not less than 32 mm (1.25 in.)
  - Is terminated above the flood level rim of a directly connected fixture to form an air break
- The above fixtures listed in A and B may be directly connected to a pipe that:
  - Is terminated to form an air break above the flood level rim of a fixture directly connected to a sanitary drainage system
  - Is extended through the roof when fixtures on three or more storeys are connected to it
- The above-fixtures listed in Items C through E may be directly connected to a pipe that:
  - Is terminated to form an air break above the flood level rim of a fixture directly connected to a storm drainage system
  - Is extended through the roof when fixtures on three or more storeys are connected to it

Suds Pressure Zones

Detergents that produce high volumes of suds in clothes washers have created a serious problem called suds pressure in all residential occupancy buildings and more notably in high-rise buildings. Whenever a sanitary drainage pipe receives waste from two or more clothes washers, the drainage and vent piping below the clothes washer connections must be arranged to avoid connecting to any zone where suds pressure exists.

High suds pressure zones occur at every change in direction — vertically or horizontally — greater than 45°. Because liquid discharge is heavier than suds, it easily flows through the suds-loaded drainage piping without carrying the suds along with it, leaving the most of the suds behind. The air and liquid flowing in the drainage pipe compresses the suds and forces them to move through any available path of relief, such as the building drain, any branches connected to the building drain, the vent stack, branch vents, individual vents, or combinations of these. Excessively high suds pressures are capable of blowing out the seals of traps, with suds also appearing in fixtures.

The NPC restricts the connection of sanitary drainage pipes to suds pressure zones within certain distances, as listed below:

- 40 times the size of the sanitary drainage pipe or 2.44 m (96 in.) maximum vertical, whichever is less, before changing direction (Figure 11)
- 10 times the size of the nominally horizontal sanitary drainage pipe after changing direction
- Where a vent pipe is connected into the suds pressure zone, no other vent pipe shall be connected to that vent pipe within the height of the suds pressure zone.

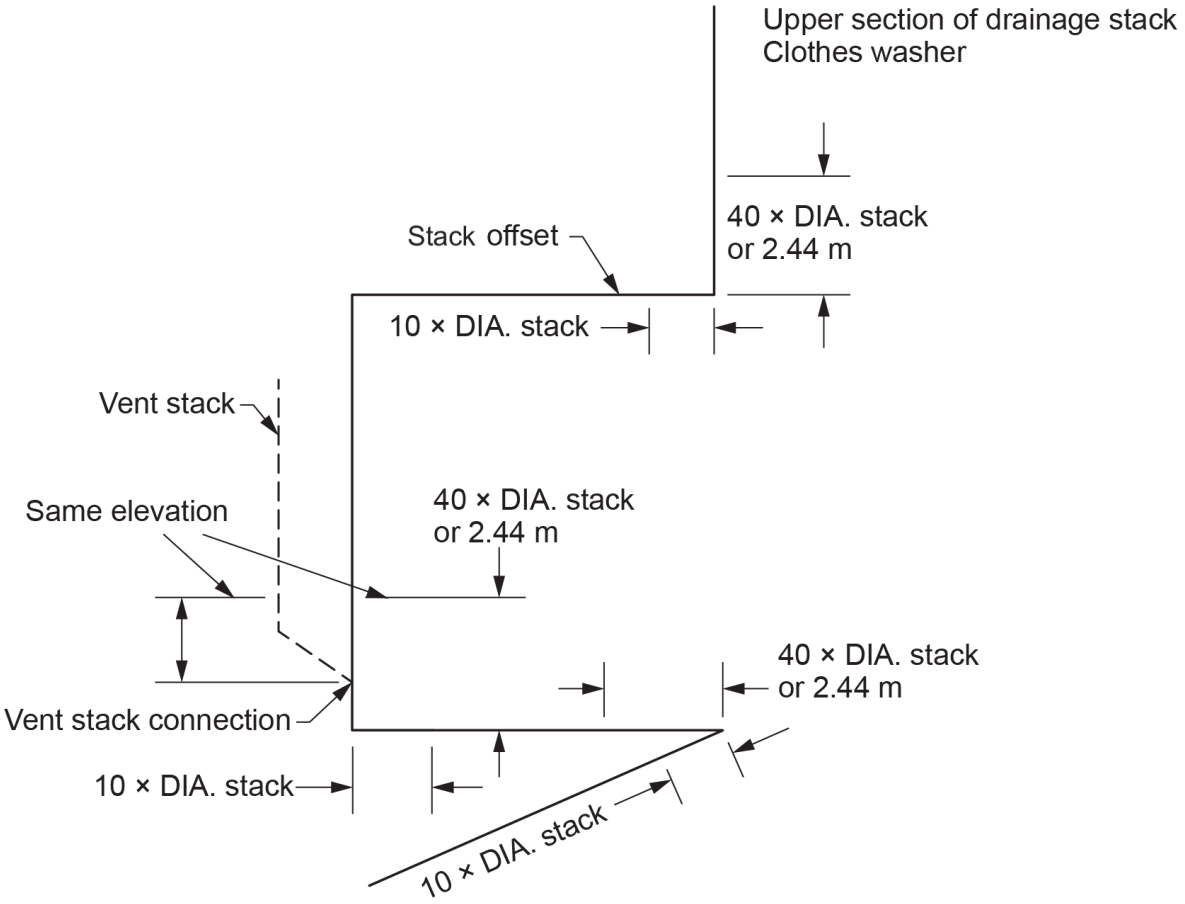

Figure 11 *NPC restrictions when connecting to a sanitary drainage pipe that serves two or more clothes washers. (Skilled Trades BC, 2021) Used with permission.*

High-Temperature Wastes

High-temperature wastes (above 75°C/167°F) must never discharge directly into the drainage system. High temperatures can cause piping to expand and contract excessively, resulting in harmful effects. Joints may be pulled apart or loosened, and solidly bedded pipe may be broken. The discharges from boiler blow-offs, steam exhaust, condensate, and so on must be cooled down to at least 75°C before connecting to the drainage system. This may be accomplished by piping the high-temperature discharge to a water-supplied sump or a cooling tank.

Acidic or Corrosive Wastes

All acidic or corrosive waste requires neutralization before being permitted to be discharged into any public sewer for disposal. The primary procedures used most often are:

- Dilution
- Direct continuous contact with limestone chips in an acid-neutralizing basin
- Continuous or batch treatment in an automated neutralization system using chemical feed neutralizing

The connection of the neutralizing basin to the sanitary drainage system shall be indirect or through a trap.

Sanitary Drainage Pipes Locations

To prevent contamination of potable water or food sources in the event of a DWV system leak, the NPC requires that a sanitary drainage pipe not be located directly above the following:

- Non-pressure potable water storage tanks
- Manholes in pressure potable water storage tanks
- Food-handling or food-processing equipment

Traps and Interceptors

Traps

The NPC (2020) places restrictions on how a p-trap is used and manufactured. The following are some of those limitations, restrictions, and clarifications:

- Every trap shall have a trap seal depth of not less than 38 mm (1.5 in.). For fixtures draining to an acid waste system, the trap seal depth shall be a minimum of 50 mm (2 in.).
- Traps shall be manufactured with single walls so that a failure of the trap seal wall will cause exterior leakage.
- Traps shall have a non-mechanical water seal so that it does not depend on the action of moving parts to be effective.
- Every trap that serves a lavatory, sink, or laundry tray shall be provided with a cleanout plug located at the lowest point of the trap. The cleanout plug shall be of the same material as the trap. The one exception to this requirement concerns a cast-iron trap, which must have a brass cleanout plug to facilitate removal. If a cleanout plug is not provided, then the trap shall be designed so that part or all of the trap can be removed for cleaning purposes.
- A drum trap shall not be used as a fixture trap unless required to serve as an interceptor and access for servicing is provided.
- A tubular trap shall be used only in accessible locations. A tubular trap is made of thin-walled material and is not of the thickness of DWV; therefore, it cannot be concealed.

Prohibited Traps

As mentioned, the NPC (2020) places restrictions on how a p-trap is used and manufactured. The following are some of those limitations, restrictions, and clarifications:

- **Bell trap:** were sometimes used in floor drains installed many years ago (Figure 12). Their installation is prohibited by the NPC.
- **S-trap:** was very common years ago when most plumbing drains came up through the floor instead of out from a

wall, but they are subject to losing their trap seal through self-siphoning. Except for an s-trap standard, the s-trap shown in Figure 12 is prohibited by Clause 2.5.6.3.(1)(b), which limits the maximum fall on a trap arm fixture drain to not more than the inside diameter of the pipe.

- **Crown vented trap:** has a vent rising from the top of the trap and is prohibited by Clause 2.5.6.3.(1)(a), which requires that the distance from the trap weir to the vent be not less than twice the size of the fixture drain.

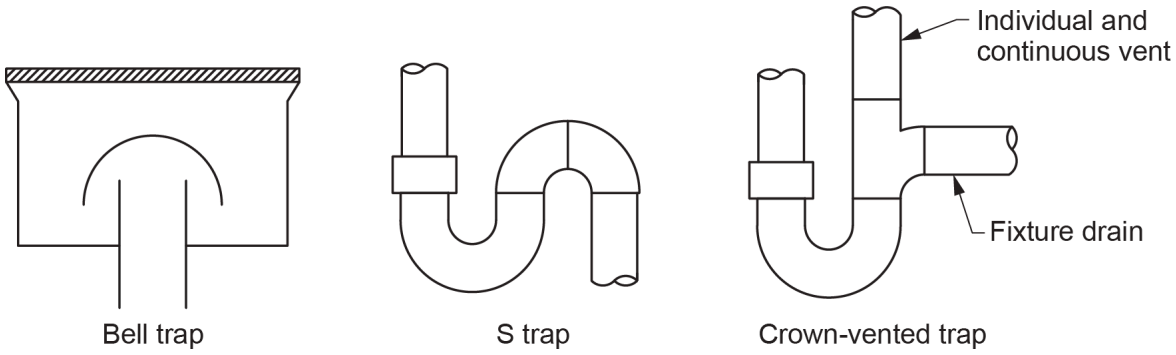

Figure 12 *Prohibited traps as defined in the NPC. (Skilled Trades BC, 2021) Used with permission.*

Sanitary Drainage System Traps

The NPC requires that every fixture shall be protected by a separate trap, with certain exceptions:

- One trap may protect all the trays or compartments of a two- or three-compartment sink, a two-compartment laundry tray, or two similar single-compartment fixtures located in the same room.
- One trap may serve a group of floor drains, shower drains, washing machines, or laboratory sinks if the fixtures are in the same room and not located where they can receive food or other organic matter.
- An indirectly connected fixture that can discharge only clear-water waste, other than a drinking fountain, need not be protected by a trap.
- Where a domestic dishwashing machine equipped with a drainage pump discharges through a direct connection into the fixture outlet pipe of an adjacent kitchen sink or disposal unit, the pump discharge line shall rise as high as possible to just under the counter and connect on the inlet side of the sink trap by means of a wye fitting or to the disposal unit.

Traps Used for Subsoil Drainage Pipes Connecting to a Sanitary Drainage System

The NPC requires that, when a subsoil drainage pipe is connected to a sanitary drainage system (Figure 13), a trap must be installed between the subsoil drainage pipe and the sanitary drainage system. The connection shall be made on the upstream side of the trap with a cleanout fitting. An alternative to this arrangement could be through the use of a trapped sump.

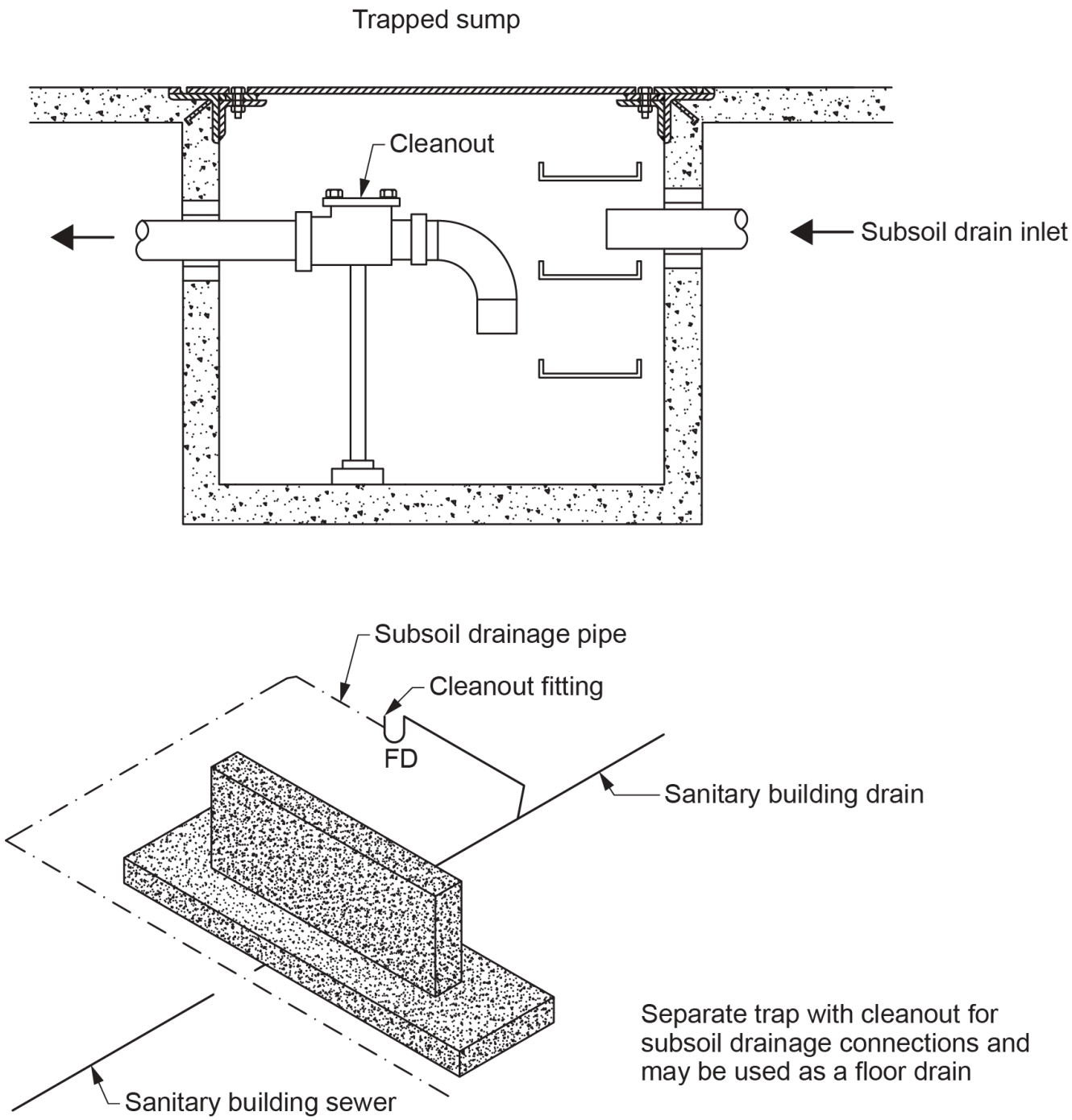

Figure 13 *Connecting subsoil drainage pipes to a sanitary drainage system. (Skilled Trades BC, 2021) Used with permission.*

Trap Seals

When a floor drain trap seal is lost, objectionable smells and gases may enter the building. Therefore, the water seal in floor drain traps must be maintained under all circumstances. The NPC requires that provision shall be made for maintaining the trap seal of a floor drain by using:

- A trap seal primer
- The drain as a receptacle for an indirectly connected drinking fountain
- Some other equally effective means

Interceptors

Interceptors are required when conditions provide an opportunity for harmful or unwanted materials to enter a sanitary drainage system. When oil, grease, sand, or other harmful substances are likely to enter a drainage system, an interceptor is required. The NPC has a number of regulations regarding interceptors used in drainage systems:

- An interceptor may serve as a trap, provided that it has an effective water seal of not less than 38 mm ($1\frac{1}{2}$ in.).
- Every interceptor shall be designed so that it can be readily cleaned.
- Every interceptor shall have sufficient capacity to perform the service for which it is provided.

Grease Interceptor

- Where a fixture discharges sewage that includes fats, oils, or grease and is located in a public kitchen, restaurant, or care or detention occupancy, it shall discharge through a grease interceptor.
- A grease interceptor shall be designed so that it does not become air bound (flow stoppage due to trapped air), and does not have a water jacket.

Oil Interceptor

- Where the discharge from a fixture may contain oil or gasoline, an **oil interceptor** shall be installed.

Solid Interceptor

- Where a fixture discharges sand, grit, or similar materials, an interceptor designed for the purpose of trapping such discharges shall be installed.

Cleanouts

Cleanouts are a means of accessing the interior of drainage pipes. They are needed so that blockages in drains may be cleared. Without cleanouts, it is much more difficult to clean the drain. The NPC has established minimums for the size of cleanouts and their placement in the drainage system.

Cleanouts for Drainage Systems

The NPC requires that:

- Every plug, cap, nut, or bolt intended to be removable from a ferrous fitting shall be of a non-ferrous material.
- A cleanout fitting that, as a result of normal maintenance operations, cannot withstand the physical stresses of removal and reinstallation or cannot ensure a gas-tight seal shall not be installed.
- Every sanitary drainage system shall be provided with cleanouts that will permit cleaning of the entire system through "one-way rodding" in the direction of flow or "two-way rodding" in either direction originating at the cleanout.
- Cleanouts and access covers shall be located so that their openings are readily accessible for drain cleaning purposes.
- A cleanout shall not be located in a floor assembly in a manner that may constitute a hazard or allow it to be used as a floor drain.
- Cleanouts that allow rodding in only one direction shall be installed to permit rodding in the direction of flow.
- There shall be no change of direction between a cleanout fitting and the trap that it serves.
- The piping between a cleanout fitting and the drainage piping or vent piping that it serves shall not change direction by more than 45°.
- Cleanouts shall be installed so that the cumulative change in direction is not more than 90° between cleanouts in a drip pipe from a food receptacle or in a fixture drain serving a kitchen sink.

Required Locations

- A cleanout fitting shall be provided on the upstream side and directly over every running trap.
- Where a running trap serves a building trap, it shall be provided with a cleanout fitting on the upstream side of and directly over the trap, be located upstream of the building cleanout, and be located inside the building as close as practical to the place where the building drain leaves the building or outside the building in a manhole.
- Every building drain shall be provided with a cleanout fitting located as close as practical to the place where the building drain leaves the building.
- Every stack shall be provided with a cleanout fitting at the bottom of the stack, not more than 3 m (9 ft 10 in.) upstream of the bottom of the stack, or on a wye fitting connecting the stack to the building drain or branch.
- A cleanout shall be provided to permit the cleaning of the piping downstream of an interceptor.
- Cleanouts serving fixtures in health care facilities, mortuaries, laboratories, and similar occupancies where contamination by body fluids is likely shall be located a minimum of 150 mm (6 in.) above the flood level rim of the fixture.

Minimum Size and Maximum Spacing

- Cleanouts are required to be the same size as the pipe they are serving unless the pipe is larger than 100 mm (4 in.). The maximum spacing between cleanouts depends on whether or not they provide one- or two-way rodding, as explained in Table 2.4.7.2. (NPC, 2020, B 2-29; refer to Table 2 below).
- Cleanouts for building drains shall be a minimum of 4 in. (100 mm) in size.

Table 2: (From NPC Table 2.4.7.2.) Permitted Sizes and Spacing of Cleanouts

Size of Drainage Pipe (m)	Minimum Size of Cleanout (in.)	Maximum Spacing — One-way Rodding (m)	Maximum Spacing — Two-way Rodding (m)
Less than 3	Same size as drainage pipe	7.5	15
3 and 4	3	15	30
Over 4	4	26	52

Regulations for Cleanouts Serving Building Sewers

- Where a cleanout is required on a building sewer 200 mm (8 in.) or larger in size, it shall be a manhole.
- A building sewer shall not change direction or slope between the building and public sewer or between cleanouts, except that pipes not more than 150 mm (6 in.) in size may change direction by not more than 5° every 3 m (9 ft 10 in.) or by using fittings with a cumulative change in direction of not more than 45°.
- Where a building sewer connects to another building sewer other than by a manhole, the developed length between the building and the building sewer to which it connects shall not exceed 30 m (98 ft 5 in.).
- The developed length of a building sewer between the building and the first manhole to which the building sewer connects shall not exceed 75 m (246 ft).
- The spacing between manholes serving a building sewer 600 mm (24 in.) or less in size shall not exceed 90 m (295 ft) and over 600 mm in size shall not exceed 150 m (490 ft).

Venting

Vent Pipe Drainage

When venting systems are installed, the vents should have a small amount of grade in the downstream direction to allow condensation to drain. Vents cannot be installed in a trapped position; this will fill the vent up with condensation and close it off. Unless it is impractical to do so, vents are required to be installed in a nominally vertical position, which will allow the condensation to flow to the drainage system and keep the venting system free-flowing.

The NPC requires that every vent pipe shall be installed without any depressions in which moisture can collect.

Vent Pipe Locations on Trap Arms

- Except for a wet vent, every vent pipe extends above the flood level rim of every fixture that it serves before turning nominally horizontal or being connected to another vent pipe.
- No vent pipe shall be connected in such a manner that a blockage in a sanitary drainage pipe would cause waste to drain through the vent pipe to the drainage system.
- When a vent pipe, other than a wet vent, is connected to a nominally horizontal sanitary drainage pipe, the connection shall be above the horizontal centreline of the sanitary drainage pipe.
- Except for water closets, s-trap standards, or any other fixture that depends on siphonic action to function

properly, a vent pipe that protects a fixture trap shall be located so that:

- The developed length of the trap arm is not less than twice the size of the fixture drain
- The total fall of the trap arm does not exceed its size
- The trap arm does not have a cumulative change in direction of more than 135° (Figure 14)

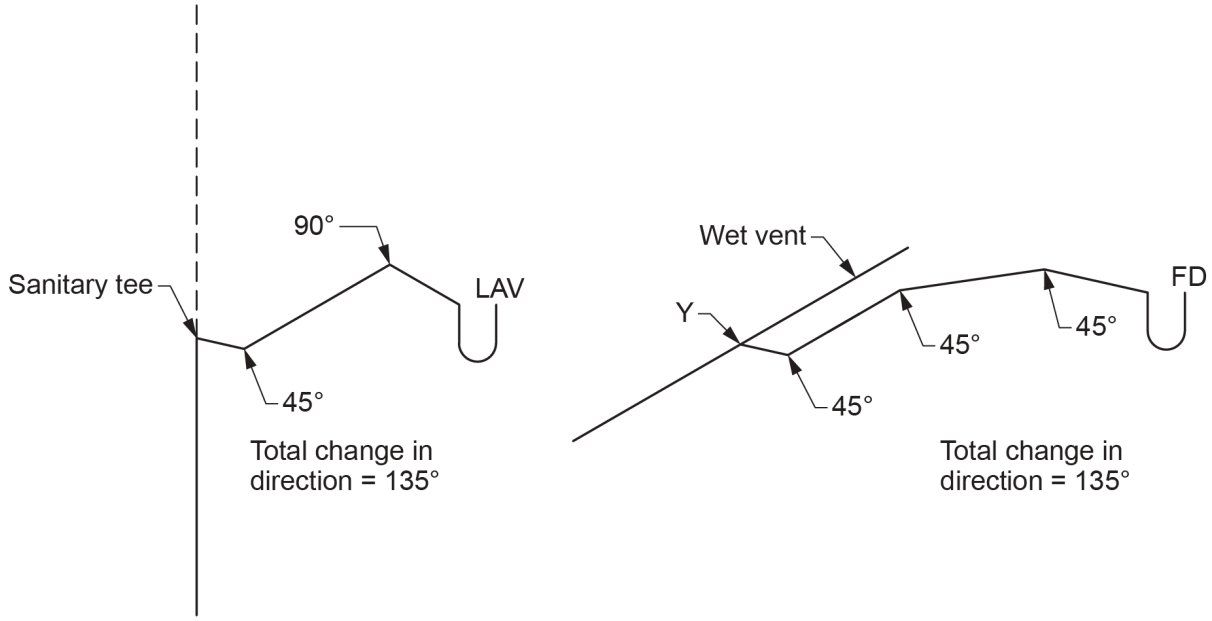

Figure 14 *NPC restriction on maximum change of direction of trap arms other than water closets. (Skilled Trades BC, 2021) Used with permission.*

The maximum length of a trap arm upstream of the vent connection shall not exceed the distances shown in Table 2.5.6.3. (Table 3) based on trap size:

Table 3: (From Table 2.5.6.3.) Trap Arm Length

Trap Size Served (in.)	Maximum Trap Arm Length (m)	Minimum Slope
1.25	1.5	$\frac{1}{50}$
1.50	1.8	$\frac{1}{50}$
2	2.4	$\frac{1}{50}$
3	3.6	$\frac{1}{50}$
4	9.8	$\frac{1}{100}$

Vent Pipe Locations on Trap Arms Serving Fixtures that Depend on Siphonic Action

The trap arm of water closets, s-trap standards, and any other fixture that also discharges vertically and depends on siphonic action to function properly shall not have a cumulative change in direction of more than 225° (Figure 15).

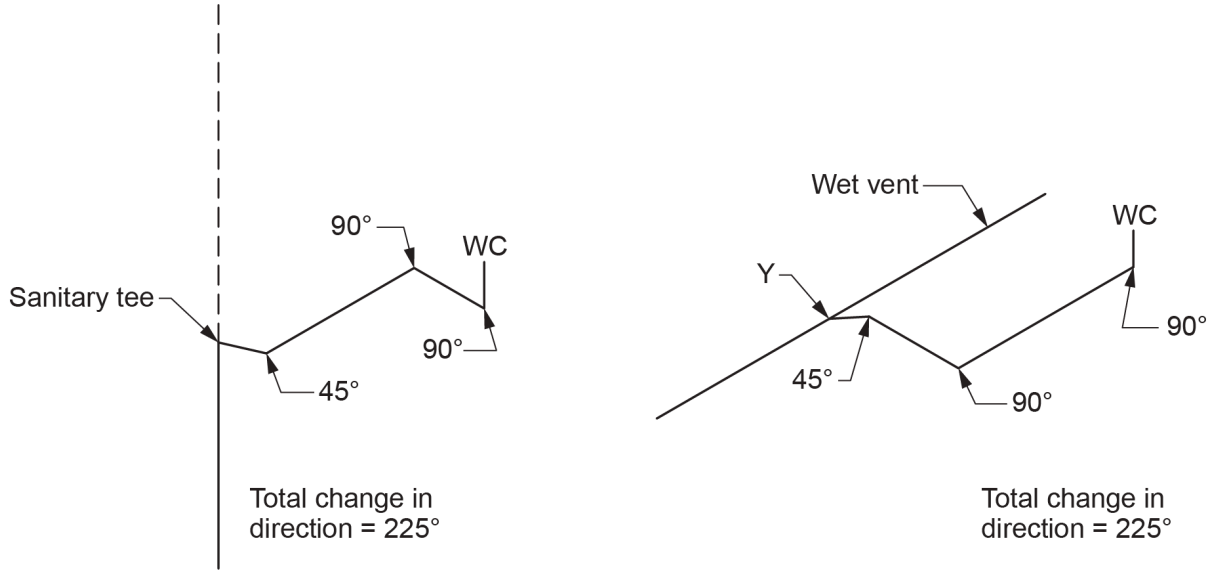

Figure 15 *Vent pipe location serving water closets. (Skilled Trades BC, 2021) Used with permission.*

A vent pipe that protects a water closet or any other fixture that also depends on siphonic action to function properly shall be located so that the distance between the connections of the fixture drain to the fixture and the vent pipe does not exceed:

- 1 m (39 in.) in the vertical plane
- 3 m (9 ft 10 in.) in the horizontal plane (Figure 16)

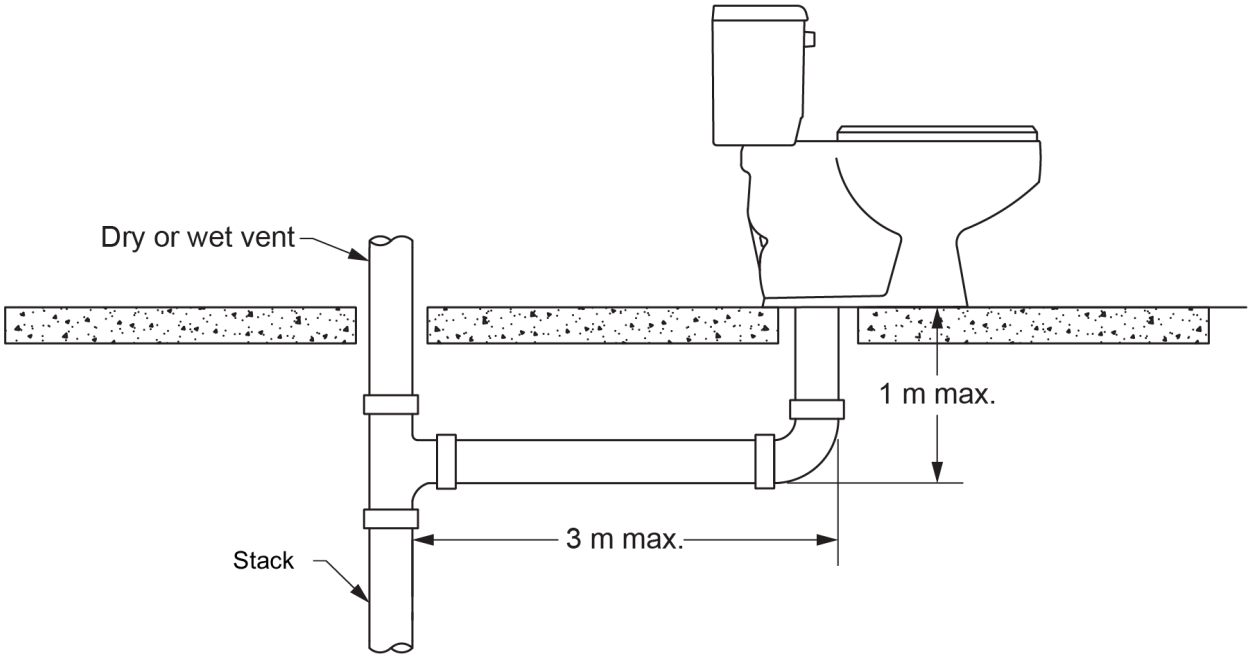

Figure 16 *Maximum length of WC trap arm. (Skilled Trades BC, 2021) Used with permission.*

Island Venting

With the acceptance of air admittance valves by the NPC, many island installations are being installed using this device. It is strongly suggested that this device only be used if the piping configurations shown in Figure 17 is not possible. Air admittance valves are a one-way check valve and, as such, do not allow free flow of air through the system. As well, they are a mechanical device that can and do fail, requiring replacement. Unfortunately, the NPC does not give much guidance to the installer with regard to this practice. In the "Notes to Part 2" section of the code, A.2.4.8.2.(1) illustrates two installations that limit the length of the fixture outlet pipe and the length of the trap arm in relation to the trap size (Figure 17).

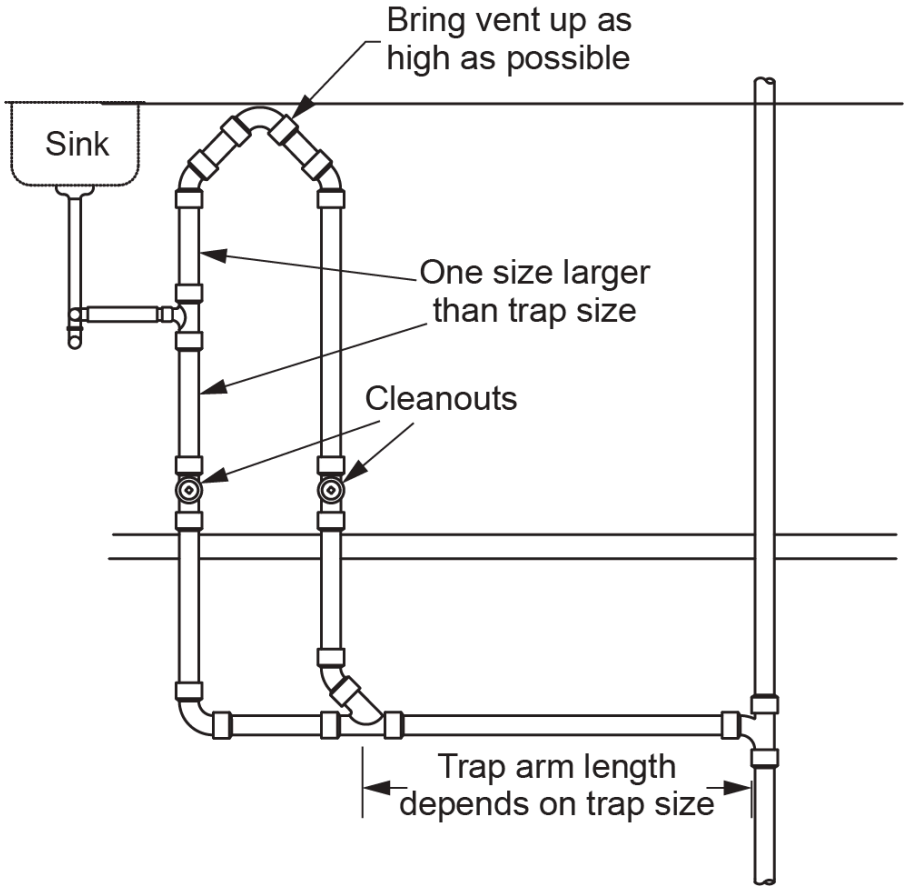

Figure 17 *Island venting method 1. (Skilled Trades BC, 2021) Used with permission.*

If the vent riser is further away from the fixture than permitted in Figure 17, some jurisdictions allow an alternative piping arrangement that uses a "foot vent" running below the floor, where there is no restriction to length (Figure 18).

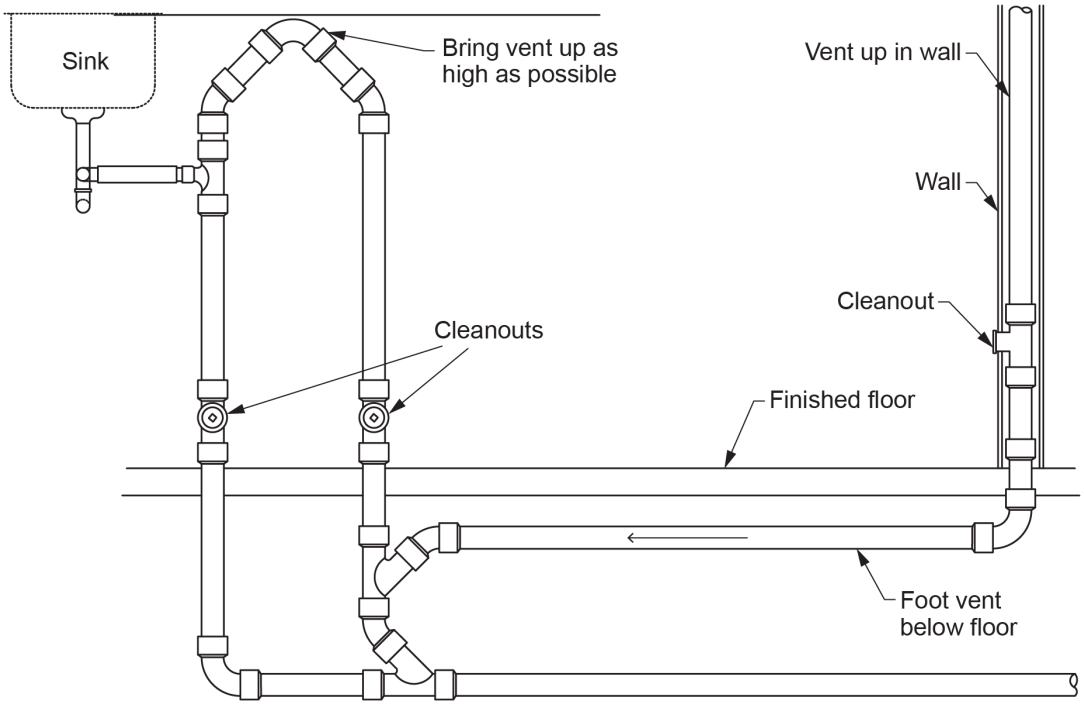

Figure 18 *Foot venting for island-vented sinks. (Skilled Trades BC, 2021) Used with permission.*

Always get approval from your local plumbing inspector before installing this type of vent.

Air Admittance Valves

Air admittance valves are not a replacement for the venting system but are only an added component of an existing sanitary system. This means that this type of valve is not intended to replace a vent extending to open air nor will it help circulate air as needed for relief vents or circuit vents. The valve will open only when a negative pressure or a pressure below atmospheric is present in the drainage system. It remains closed when subjected to a positive pressure.

Using air admittance valves is limited because the valve shall only be used under certain conditions and after the AHJ has determined it is warranted.

[Air admittance valves] shall only be used to vent:

- Fixtures located in island counters

- Fixtures that may be affected by frost closure of the vent due to local climatic conditions
- Fixtures in one- and two-family dwellings undergoing renovation
- Installations where connection to a vent may not be practical

[Air admittance valves] shall be located:

- Not less than 100 mm (4 in.) above the fixture drain served
- Within the maximum developed length permitted for the vent
- Not less than 150 mm (6 in.) above insulation materials

Installation Requirements

- Shall not be installed in supply or return air plenums or in locations where they may be exposed to freezing temperatures
- Shall be installed in accordance with the manufacturer's installation instructions
- Shall be rated for the size of vent pipe to which they are connected
- Shall be accessible and located in a space that allows air to enter the valve

Future Connections

- Where provision is made for a fixture to be installed in the future, the drainage system and venting system shall be sized accordingly, and provision shall be made for the necessary future connections.
- Except in a situation where a sewage sump is installed that requires a minimum 50 mm (2 in.) vent, every storey in which plumbing is or may be installed, including the basement of a single-family dwelling, shall have a vent pipe of at least 38 mm ($1\frac{1}{2}$ in.) in size extending into or passing through it for the provision of future connections.
- Unused vent pipes installed for future connections shall be permanently capped with an end cleanout or an adapter and plug.

Miscellaneous Vent Pipes

Venting Requirements for Corrosive Waste Piping or Dilution Tanks

Venting systems for drain piping or dilution tanks conveying corrosive waste shall extend independently and terminate in outside air.

The minimum size requirement for the vent pipe serving a dilution tank is identical to that serving a sewage sump. It is allowed to be one size smaller than the size of the largest branch or fixture drain draining to the tank but cannot be less than 50 mm (2 in.) nor does it need to be greater than 100 mm (4 in.).

Fresh Air Inlets Serving Building Traps

A fresh air inlet not less than 100 mm (4 in.) in size shall be connected upstream and within 1.2 m (47 in.) of the building trap and downstream of any other connection (Figure 19).

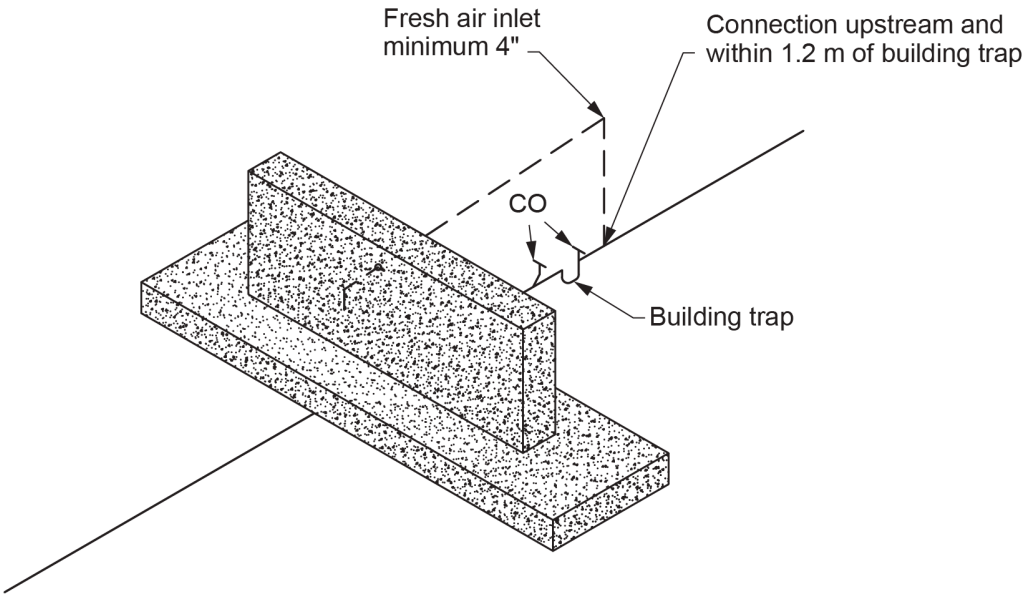

Figure 19 *NPC requirements for fresh air inlets. (Skilled Trades BC, 2021) Used with permission.*

Venting Requirements for Manholes Installed Inside a Building

The minimum size of a vent pipe that serves a manhole within a building shall be 50 mm (2 in.).

Venting Requirements for Oil and Grease Interceptors

In some instances, grease interceptors and, more often, oil interceptors are installed outside of the building structure. In this case, it is important to note that every vent pipe that serves an oil or grease interceptor located outside a building shall be not less than 75 mm (3 in.) in size in areas where it may be subject to frost closure.

An oil interceptor functions in the same way as a grease interceptor except that flammable fumes must be expelled using natural air currents. This is done by connecting the top area of adjacent compartments to allow air flow up through to individual "fume" vents that extend to open air. A vent is required on the outlet of the interceptors to prevent siphoning of the interceptor.

National Plumbing Code Requirements for Oil and Grease Interceptors

- Every oil interceptor shall be provided with two vent pipes that:
  - Connect to the interceptor at opposite ends
  - Do not connect to each other or any other vent pipe and extend independently to open air
  - Terminate not less than 2 m ($78\frac{3}{4}$ in.) above ground and at elevations differing by at least 300 mm (12 in.)
- The vent pipes are permitted to be one size smaller than the largest connected drainage pipe but not less than 32 mm (1.25 in.) in size or can be sized in accordance with the manufacturer's recommendations.
- Adjacent compartments within every oil interceptor shall be connected to each other by a vent opening (Figure 20).
- Where a secondary receiver for oil is installed in conjunction with an oil interceptor, it shall be vented in accordance with the manufacturer's recommendations, and the vent pipe shall:
  - In no case be less than 38 mm (1.25 in.) in size
  - Extend independently to outside air
  - Terminate not less than 2 m ($78\frac{3}{4}$ in.) above ground

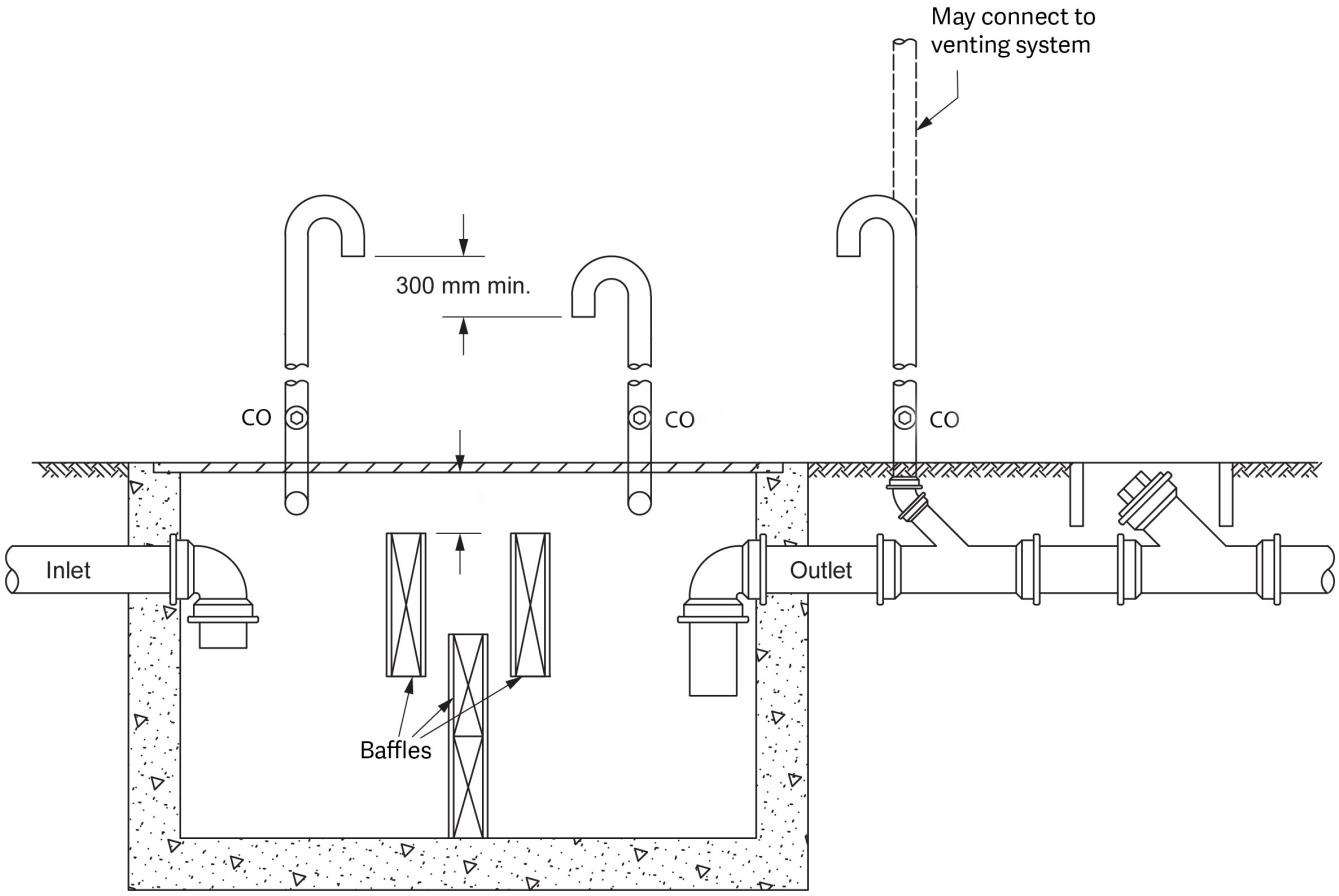

Figure 20 *NPC requirements for oil interceptor venting. (Skilled Trades BC, 2021) Used with permission.*

Vent Terminals

Vent terminals are fresh air inlets serving a building trap or vents serving an oil interceptor and must extend above the roof level. The proximity of the vent terminal location to windows, doors, or other ventilating openings must be considered.

National Plumbing Code Requirements for Vent Terminals

- The vent terminal should be located:
  - Not less than 1 m (39 in.) above or not less than 3.5 m (138 in.) in any other direction from every air inlet, openable window, or door
  - Not less than 2 m (47 in.) above or not less than 3.5 m in any other direction from a roof that supports an occupancy
  - Not less than 2 m above ground
  - Not less than 1.8 m (72 in.) from every properly line
- The vent terminal should be:
  - Terminated high enough to prevent the entry of roof drainage but not less than 150 mm (6 in.) above the roof or above the surface of storm water that could pond on the roof
  - Provided with flashing to prevent the entry of water between the vent pipe and the roof
  - Supported or braced if a vent pipe that may be subject to misalignment terminates above the surface of a roof
- The vent terminal shall be protected from frost closure by:
  - Increasing its diameter at least one size, but not less than 75 mm (3 in.) in size, immediately before it penetrates the roof
  - Insulating the pipe
  - Protecting it in some other manner
- Under certain conditions, a vent pipe is allowed to be installed outside a building, provided that the following conditions are met:
  - No single change in direction of the vent pipe exceeds 45°.
  - All parts of the vent pipe are nominally vertical.
  - In areas where the vent pipe may be subject to frost closure, it is increased to not less than 75 mm (3 in.) in size before penetrating a wall or roof.
  - Where the building is four storeys or less in height, the vent pipe terminates above the roof of the building.

Vent Pipe Flashing

Flashing fabricated on site for vent pipes shall be fabricated from one of the following:

- **Copper sheet:** not less than 0.33 mm (0.013 in.) thick
- **Aluminum sheet:** not less than 0.48 mm (0.0189 in.) thick
- **Alloyed zinc sheet:** not less than 0.35 mm (0.0138 in.) thick
- **Lead sheet:** not less than 1.73 mm (0.068 in.) thick
- **Galvanized steel sheet:** not less than 0.33 mm (0.013 in.) thick

- **Polychloroprene (neoprene):** not less than 2.89 mm (0.114 in.) thick

Hangers and Supports

The method of supporting pipes is regulated by the NPC. There are requirements for the type of materials you may use and how you may use them.

The hangers used to support pipe must be capable of supporting the pipe and its contents at all times. The hanger must be attached to the pipe and to the structural member holding the hanger in a satisfactory manner to maintain alignment. Where a hanger is attached to concrete or masonry, it shall be fastened by metal or expansion-type plugs inserted or built into the concrete or masonry.

Piping, fixtures, tanks, or devices shall be supported independently of each other, and every water-closet bowl shall be securely attached to the floor or wall by means of a flange and shall be stable. Wall-mounted fixtures shall be independently supported so that no strain is transmitted to the piping.

The hangers used must be compatible with the pipe they are supporting. You must use a hanger that will not have a detrimental effect on your piping. For example, you may not use a galvanized strap hanger to support copper pipe. As a rule of thumb, the hangers used to support a pipe should be made from the same material as the pipe being supported.

For example, copper pipe should be hung with copper hangers. This eliminates the risk of a corrosive action between two different types of materials. If you are using a plastic or plastic- coated hanger, you may use it with all types of pipe. The exception to this rule is for pipes carrying a liquid with a temperature that might affect or melt the plastic hanger.

Due to the flexibility and relatively soft wall composition of plastic pipe, the NPC has set out regulations regarding its support and requires that:

- When installing PVC, CPVC, or ABS plastic pipe:
  - The pipe shall be aligned without added strain on the piping.
  - The pipe shall not be bent or pulled into position after being welded.
  - Hangers shall not compress, cut, or abrade the pipe.
- Where PEX, PP-R, PE/AL/PE, or PEX/AL/PEX plastic pipe is installed, hangers shall not compress, cut, or abrade the pipe.
- Nominally horizontal piping inside a building shall be braced to prevent swaying and buckling and to control the effects of thrust.
- When supporting nominally horizontal piping, hangers with rods or metal strapping shall be:
  - If rods are used, they must be not less than:
    - 6 mm (0.25 in.) diameter to support piping 50 mm (2 in.) or less in size
    - 8 mm (0.315 in.) diameter to support piping 100 mm (4 in.) or less in size
    - 13 mm (0.50 in.) diameter to support piping over 100 mm in size
  - If solid or perforated metal straps are used, they must not be less than:
    - 0.6 mm (0.0236 in.) nominal thickness and 12 mm ($\frac{1}{2}$ or 0.50 in.) wide to support piping 50 mm or less in size
    - 0.8 mm (0.0315 in.) nominal thickness and 18 mm ($\frac{7}{10}$ or 0.70 in.) wide to support piping 100 mm or less in

size

Support Spacing

Depending upon the type of material being used and whether the pipe is installed horizontally or vertically, the spacing between hangers will vary. Both horizontal and vertical pipes require support. The regulations in the NPC apply to the maximum distance between hangers.

Vertical Piping Support Spacing

Vertical piping shall be supported at its base and at the floor level of alternate storeys by rests, each of which can bear the weight of the pipe between it and the rest above it. The maximum spacing of these supports shall be 7.5 m (24 ft 7.25 in.).

Horizontal Support Spacing

The maximum spacing of supports for nominally horizontal piping is dependent on the piping material, as shown in Table 2.3.4.5. (NPC, 2020, B 2-20; refer to Table 4 below).

Table 4: (From NPC Table 2.3.4.5.) Support for Nominally Horizontal Piping

Piping Material	Maximum Horizontal Spacing of Supports (m)	Additional Conditions
Galvanized iron or steel pipe: 150 mm (6 in.) NPS or larger	3.75	None
Galvanized iron or steel pipe: Less than 150 mm (6 in.) NPS	2.5	None
Lead Pipe	Throughout length of pipe	None
Cast-iron pipe	3.0	At or adjacent to each hub or joint
Cast iron pipe with mechanical joints measuring 300 mm (12 in.) or less between adjacent fittings	1.0	None
Stainless steel pipe or tube: 25 mm (1 in.) NPS or larger	3.0	None
Stainless steel pipe or tube: Less than 25 mm (1 in.)	2.5	None
ABS or PVC plastic pipe	1.2	At the end of branches or fixture drains and at changes in direction and elevation
ABS or PVC plastic trap arm or fixture drain pipe greater than 1 m (39 in.) long	N/A	As close as possible to the trap
CPVC pipe	1.0	None
Copper tube or copper and brass pipe, hard temper: Greater than 25 mm (1 in.) NPS	3.0	None
Copper tube or copper and brass pipe, hard temper: 25 mm (1 in.) NPS or less	2.5	None
Copper tube, soft temper	2.5	None
PE/AL/PE composite pipe	1.0	None
PEX/AL/PEX composite pipe	1.0	None
PEX plastic pipe	0.8	None
PE-RT tube	0.8	None
PP-R plastic pipe	1.0	At the end of branches and at changes in direction and elevation

Horizontal Underground Piping Support

- Nominally horizontal piping that is underground shall be supported on a base that is firm and continuous under the whole of the pipe.
- Nominally horizontal piping installed underground may be installed using hangers fixed to a foundation or structural slab, provided that the hangers are capable of keeping the pipe in alignment and supporting the weight of the pipe, its contents, and the fill over the pipe.

Protecting Piping

The NPC requires that the design and installation of every piping system shall include means to accommodate its expansion and contraction caused by temperature changes, movement of the soil, building shrinkage, or structural settlement.

Backfilling the Pipe Trench

Where piping is installed underground, the backfill shall be carefully placed and tamped to a height of 300 mm (12 in.) over the top of the pipe and be free of stones, boulders, cinders, and frozen earth.

Protecting Non-Metallic Pipe

Where asbestos-cement drainage pipe or vitrified clay is located less than 600 mm (24 in.) below a basement floor and the floor is constructed of other than 75 mm (3 in.) or more of concrete, the pipe shall be protected by a 75-mm layer of concrete installed above the pipe.

Isolation from Loads

Where piping passes through or under a wall, it shall be installed so that the wall does not bear on the pipe.

Protection from Frost

Where piping may be exposed to freezing conditions, it shall be protected from the effects of freezing.

Protection from Mechanical Damage

Plumbing, piping, and equipment exposed to mechanical damage shall be protected.

Seismic Restraint

British Columbia is a large and geographically diverse province. Seismic hazard varies across the province, covering the entire range from low to high risk. As a result, the building code has different **seismic restraint** requirements for mechanical system components in different regions of the province. Although the seismic restraints, including anchors

to building structure, shall be specified by a registered professional structural engineer (P. Eng), you will be responsible for installing these components.

Because of this, good coordination with the design professionals involved with the building project is vital for the following reasons:

- The seismic restraints installed for a system can and will interfere with those of another system unless restraint locations are well-coordinated.
- Typically, piping systems are restrained with rigid braces that run upward at an angle from the pipe to the ceiling. The space required for the installed restraints can cause problems if non-structural walls need to be penetrated or other mechanical components are in the designed load path for the restraints.

Figure 21 shows different seismic restraint assemblies for piping systems.

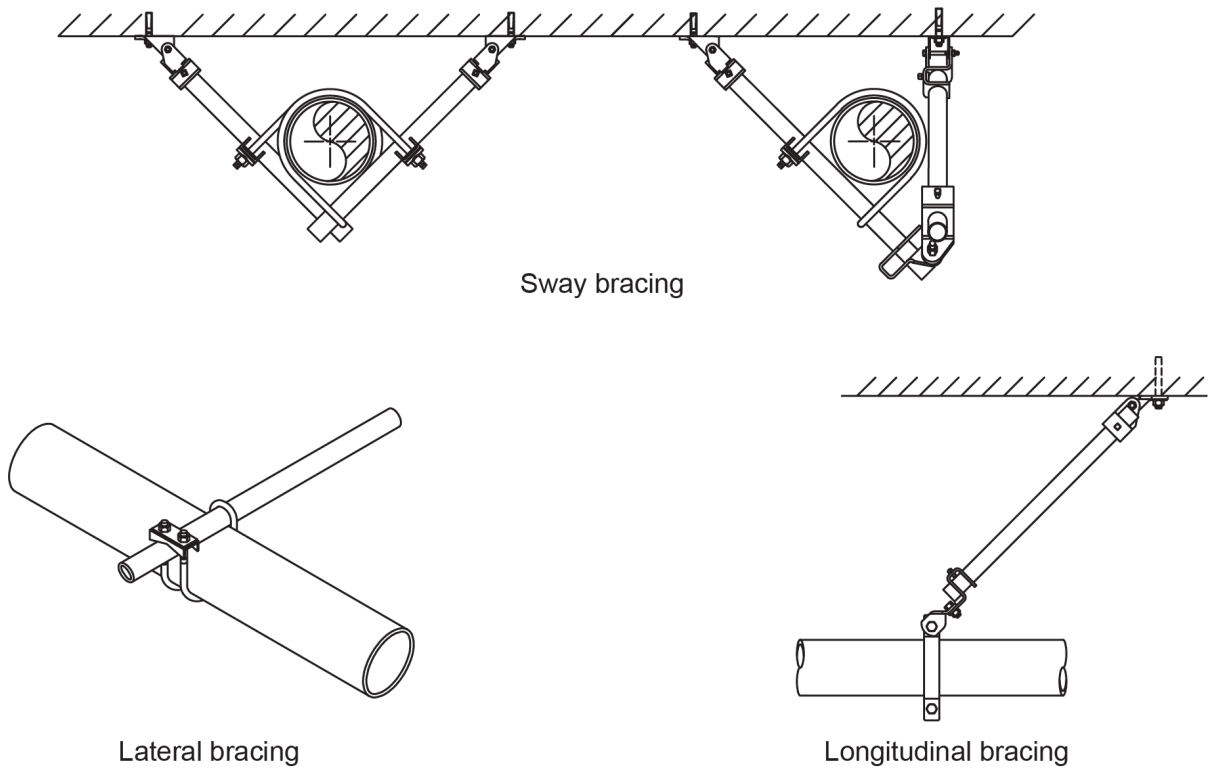

Figure 21 *Seismic restraint bracing assemblies. (Skilled Trades BC, 2021) Used with permission.*

Mechanical Component Anchorage

The purpose of a seismic restraint is to form a load path between the mechanical component and the building structure. It must be attached to a portion of the building structure capable of carrying the expected seismic loads.

Materials and Installation

Planning for the installation of seismic restraint components early in a project can greatly reduce the cost and complexity of the project. The P. Eng or manufacturer can provide comprehensive shop drawings and details to facilitate proper and cost-effective installation in accordance with existing standards and codes.

Installing seismic restraint hardware and seismic-rated vibration isolators requires the consideration of four aspects of the system:

1. **Attachment of the equipment to the restraint:** the equipment must be securely attached to the restraint, and this attachment must demonstrate sufficient strength to withstand the imposed forces and to allow for transfer of seismic forces into the restraint.
2. **Restraint design:** the strength of the seismic restraint must be sufficient to withstand the equipment-imposed forces.
3. **Attachment of restraint to the building structure:** this attachment is typically via bolts, welds, or concrete anchors. Typically this attachment is the "weakest link" of the overall system, especially when post-installed concrete anchors are used.
4. **Equipment fragility:** the ability of the equipment to continue to operate after being subjected to seismic force. This information must be obtained from the equipment manufacturer.

Joining Practices

Joints and connections in a DWV system must be water- and gas-tight at the required pressure for testing and their intended use. Many different material and joining practices may be used in a DWV system, and specific code requirements apply for each.

Plastic Pipe Transition

- Transition solvent cement shall only be used for joining an ABS drainage system to a PVC drainage system.

Caulked Lead Drainage Joints

- Caulked lead drainage joints shall not be used except for cast-iron pipe in a drainage system or venting system or between such pipe and:
  - Other ferrous pipe
  - Brass and copper pipe
  - A caulking ferrule
  - A trap standard
- Every caulked lead drainage joint shall be firmly packed with oakum and tightly caulked with lead to a depth of not less than 25 mm (1 in.).
- No paint, varnish, or other coating shall be applied on the lead until after the joint has been tested.
- A length of hub, spigot pipe, and pipe fillings in a drainage system shall be installed with the hub at the upstream end.

Wiped Joints (Lead Pipe)

- Wiped joints shall not be used except for sheet lead or lead pipe or between such pipe and copper pipe or a ferrule.
- Every wiped joint in straight pipe shall:
  - Be made of solder
  - Have an exposed surface on each side of the joint of at least 19 mm ($\frac{3}{4}$ in.) wide
  - Be not less than 10 mm (0.394 in.) thick at the thickest part
- Every wiped flanged joint shall be reinforced with a lead flange not less than 19 mm wide.

Screwed Joints

- When making a screwed joint, the ends of the pipe shall be reamed or filed out to the size of the bore, and all chips and cuttings shall be removed.
- No pipe-joint cement or paint shall be applied to the internal threads.

Flared Joints

- When making a flared joint, the pipe shall be expanded with a proper flaring tool and not be used for hard (drawn) copper tube.

Mechanical Joints (MJ and Victaulic)

- Mechanical joints shall be made with compounded elastomeric rings held in compression by stainless-steel or cast-iron clamps or groove and shoulder-type mechanical couplings.

Cold-Caulked Joints (Cement and Fibre Compound)

- **Cold-caulked joint**s shall not be used except for bell and spigot pipe in a water system, a drainage system, or a venting system.
- Caulking compound used in cold-caulked joints shall be applied according to the manufacturer's directions.
- Every cold-caulked joint in a drainage system shall be firmly packed with oakum and tightly caulked with cold-caulking compound to a depth of not less than 25 mm (1 in.).

Stainless Steel Welded Joints

- Stainless steel **welded joints** shall conform to ASME B31.9, "Building Services Piping."
- Butt weld pipe fittings shall be at least as thick as the wall of the pipe used.

Drilled and Tapped Joints

- Drilled and tapped joints shall not be made in a sanitary drainage pipe or vent pipe and fittings unless suitable provision has been made for drilling and tapping.

Welded Joint Restrictions

- Galvanized steel pipe and fittings as well as cast-iron soil pipe and fittings shall not be welded.

Unions and Slip Joints

- Running thread and packing nut connections and unions with a gasket seal shall not be used downstream of a trap weir in a drainage system or in a venting system.
- A slip joint shall not be used in a venting system or drainage system, except to connect a fixture trap to a fixture drain in an accessible location.

Increasing or Reducing Size

- Every connection between two pipes of different size shall be made with an increaser or a reducer fitting installed so that it will permit the system to be completely drained.

Joining Dissimilar Metals

- Adaptors, connectors, or mechanical joints used to join dissimilar materials shall be designed to accommodate the required transition.

Connection of Floor Outlet Fixtures

- Every pedestal urinal, floor-mounted water closet, or s-trap standard shall be connected to a fixture drain by a floor flange, except a cast-iron trap standard which may be caulked to a cast-iron pipe.
- Every floor flange shall be brass, except that where cast-iron or plastic pipe is used, a floor flange of the same material may be used.
- Every floor flange shall be securely set on a firm base and fastened to the floor or trap flange of the fixture.
- Water-closet bowls shall be securely attached to the floor flange, floor, or wall carrier.
- Every joint in a floor flange shall be sealed with a resilient watertight and gas-tight seal.
- Where a lead water-closet stub is used, the length of the stub below the floor flange shall be not less than 75 mm (3 in.).

Indirect Connections

- Where a fixture or device is indirectly connected, the connections shall be made by terminating the fixture drain above the flood level rim of a directly connected fixture to form an air break.
- The size of the air break shall at least equal the size of the fixture drain, branch, or pipe that terminates above the directly connected fixture, and it shall be not less than 25 mm (1 in.).

Self-Test D-1.10: Requirements and Prohibitions for DWV Systems

Complete Self-Test D-1.10 and check your answers.

If you are using a printed copy, please find Self-Test D-1.10 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=56#h5p-12 (https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=56#h5p-12)

References

National Research Council of Canada. (2020). *National plumbing code of Canada 2020*. Canadian Commission on Building and Fire Codes. https://nrc-publications.canada.ca/eng/view/ft/?id=6e7cabf5-d83e-4efd-9a1c-6515fc7cdc71 (https://nrc-publications.canada.ca/eng/view/ft/?id=6e7cabf5-d83e-4efd-9a1c-6515fc7cdc71)

Skilled Trades BC. (2021). *Book 2: Install fixtures and appliances, install sanitary and storm drainage systems.* Plumber apprenticeship program level 2 book 2 (Harmonized). Crown Publications: King's Printer for British Columbia.

Trades Training BC. (2021). D-1: Install sanitary drain, water and vent systems. In: *Plumber Apprenticeship Program: Level 2*. Industry Training Authority, BC.

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D-1.11 Trade Waste Systems

Provincial and federal plumbing codes have been developed with a focus primarily on the conveyance of liquid waste generated by domestic plumbing fixtures, such as toilets, basins, bathtubs/showers, kitchen sinks, and laundries. When used in a residential settings, these fixtures normally have a discharge with little fats, oils, grease ("FOGs"), and other constituents that may have a negative impact on the private or municipal sewage system to which they are connected. As such, they are routinely drained directly into such systems without needing any pre-treatment.

Establishments other than residential occupancies may be required to install special piping arrangements and pre-treatment systems, known as **trade waste system**s, when deemed necessary by the authority having jurisdiction (AHJ). Trade waste is sewage that may be of significantly increased organic strength compared to domestic sewage and may also contain other substances, such as high levels of fats and grease, heavy metals, organic solvents, and chlorinated organic substances. These pollutants can harm people, the environment, and the wastewater system; they are removed by installing some form of interceptor. As well, some commercial and industrial processes may wish to reclaim valuable constituents, such as silver in photo finishing labs, that may otherwise be lost through the drainage system.

An **interceptor** is defined in the National and BC Plumbing Codes as "a receptacle that is installed to prevent oil, grease, sand or other materials from passing into a drainage system." Interceptors come in a variety of types and sizes and are typically a manufactured item; however, they can also be constructed on-site, such as a concrete sump or catch basin for stormwater systems (covered in this textbook's section on storm drainage systems).

Many plumbing professionals of an "older vintage" may remember what trade waste systems are and why they may be necessary, but definitions for trade waste systems are no longer included within current versions of either the National Plumbing Code of Canada or the BC Plumbing Code. One would have to look back to the 2007 version of the BC Plumbing Code to find the last regulatory definition for a trade waste system, which is as follows:

> *Trade waste system means a system of drainage pipes from floor drains and hub drains located in food display areas that are intercepted by a trade waste sump and backwater valve before entering the sanitary building drain.*

Another definition for trade waste can found in a reference from a current regulation in Auckland, New Zealand, which reads:

> *Liquid trade waste is any discharge to a sewerage system other than domestic waste from a hand wash basin, shower, bath or toilet.*

Yet another reference is found within a current publication from the locality of Victoria, Australia:

> *Trade waste is any water that goes down the drain that has been used in a commercial environment for food preparation, cooking, cleaning dishes or cleaning the kitchen area.*

Regardless of the origin or jurisdiction of the definition, the intent seems clear: any discharge into a sewage system from fixtures or appurtenances other than those found in a residential setting may be referred to as "trade waste" and may therefore require special consideration by the AHJ and the installer.

Cities and municipalities are empowered under the provincial Environmental Management Act to regulate the discharge of waste into their sewers. As well, although not specifically mentioned in our federal and provincial plumbing codes, the requirement for a trade waste system can be interpreted from those codes in Clause 2.4.4.1.(1) "Sewage Treatment," which states:

> *Where a fixture or equipment discharges sewage or waste that may damage or impair the sanitary drainage system*

or the functioning of a public or private sewage disposal system, provision shall be made for treatment of the sewage or waste before it is discharged to the sanitary drainage system.

This means that the undesirable component(s) within the discharge must be either removed or rendered harmless to the system downstream. This would involve using some type of interceptor.

Grease Interceptors

There is some confusion in the field over the use of the terms "grease trap" and "grease interceptor." In the United States, their two main model codes have, in the past, determined that the use of the two terms was dependent upon the flow rates or maximum capacities involved. In Canada, we make no such distinctions, and the terms are synonymous, meaning that they both refer to the same piece of equipment. A grease interceptor cannot be used as a trap for the fixture feeding it unless it can be proven that the interceptor can provide a minimum 38 mm ($1\frac{1}{2}$ in.) trap seal. In most cases, this is difficult to prove, so any fixture draining into the grease interceptor will need its own trap. As well, if the interceptor qualifies as a trap, then it will have to be placed within 1,200 mm (4 ft) of the furthest outlet on the sink that feeds it, in order to comply with Clause 2.4.8.2.(1) in the code (NPC, 2020, B 2-30).

The most common type of trade waste system found in the field is a "passive" or "hydromechanical" grease interceptor serving a commercial pot sink or similar type of fixture. These systems are commonly required in any commercial kitchens that cook food on site, such as restaurants and fast food outlets. Only the grease-handling fixtures will be piped into the grease interceptor. This allows for more accurate sizing and cost effectiveness.

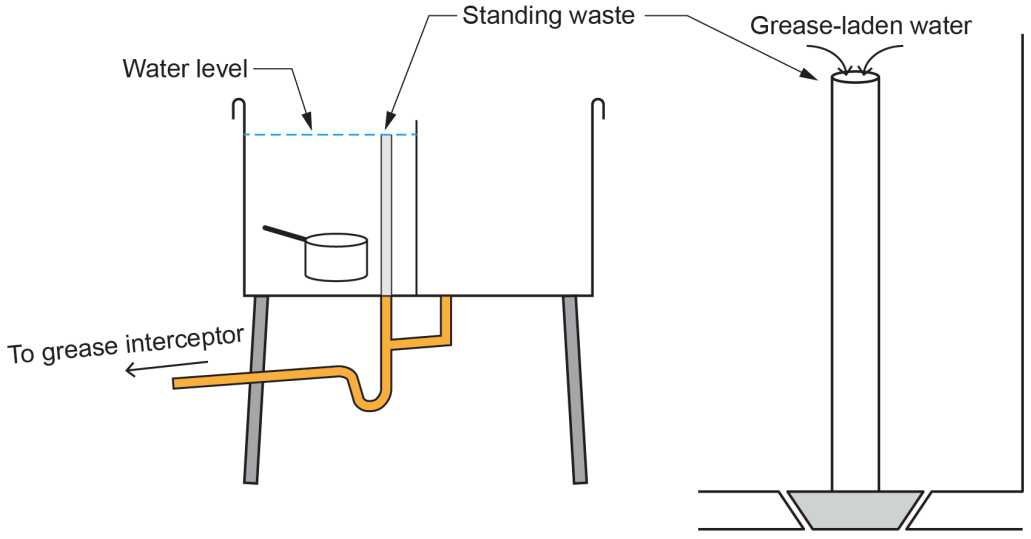


Figure 1 *Commercial pot sink with standing waste. (Skilled Trades BC, 2021) Used with permission.*

In a commercial kitchen, greasy pots and pans are submerged in a compartment of a pot sink that has a standing waste inserted into its drain opening. A slow supply of hot water is allowed to constantly run into the sink compartment. The resulting grease-laden water spills into the top of the standing waste and is directed via the sink's outlet piping to a grease interceptor.

Grease Interceptor Operation

It is a popular misconception that grease interceptors work best if the grease-laden discharge entering the interceptor is as cool as possible. This only serves to plug the inlet piping with grease that has come out of solution too soon. Rather, interceptors function best if the incoming fluid is kept as hot as possible. This allows the grease to separate, cool, and solidify inside the interceptor, where it can be stored until manually removed by hand or, more commonly, cleaned out on a regular interval by companies that use **"jet vac" trucks.** Also, keeping the interceptor as close as possible to the fixture feeding it ensures the water stays as hot as possible. A flow control fitting installed on the inlet piping or within the interceptor at its inlet ensures that the flow rate through the interceptor is kept to design limits and turbulence within the interceptor is kept to a minimum, which enhances its operation.

Most plumbing codes require a cleanout be installed immediately downstream of any grease interceptor, due to the probability that some grease will make its way through the unit and, over time, clog the piping.

Operationally, it is suggested to use as little detergent as possible. Soaps and detergents act to break down the **fats, oils, and greases (FOGs)** into much smaller particles that tend to move through the interceptor rather than rise and be trapped within it. This is problematic for all downstream piping as well as the treatment facility at the end of the system.

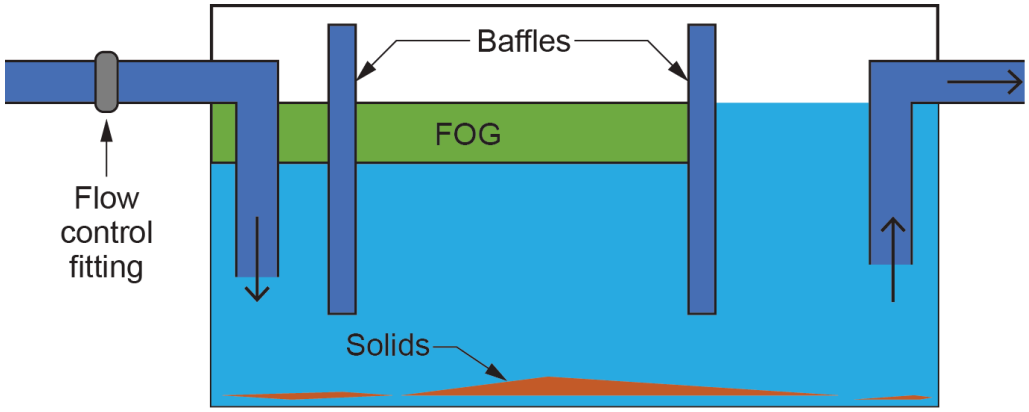


Figure 2 *Grease interceptor. (Skilled Trades BC, 2021) Used with permission.*

Grease interceptors are boxes constructed of stainless steel, plastic, or epoxy-coated steel. Wastewater or effluent enters the interceptor and fills the tank. A system of baffles may be used to slow down water and allow FOGs to cool and effectively separate. Solids settle or sink and either accumulate at the bottom or, if small and light enough, are carried off through the outlet and usually do not pose problems downstream. Some models may have a strainer to catch solids, reducing the quantity settling in the bottom of the interceptor. FOGs, having a specific gravity less than water, float and accumulate at the top. Effluent siphons out the outlet to the downstream drainage system piping.

FOGs and solids sit in the interceptor until emptied (a task advised when the box is approximately 25% full). The stagnant waste can often lead to bad smells, an increased risk of pest infestation, and less-than-sanitary kitchens. Be aware that if passive grease interceptors are neglected, they will become ineffective as the tank fills with FOGs, and the drainage rate slows or stops.

Automatic Grease Interceptors

Automatic grease interceptors are often considered a more sophisticated grease removal system than the passive variety, with solids and grease being separated from grey water into collection containers ready for daily disposal.

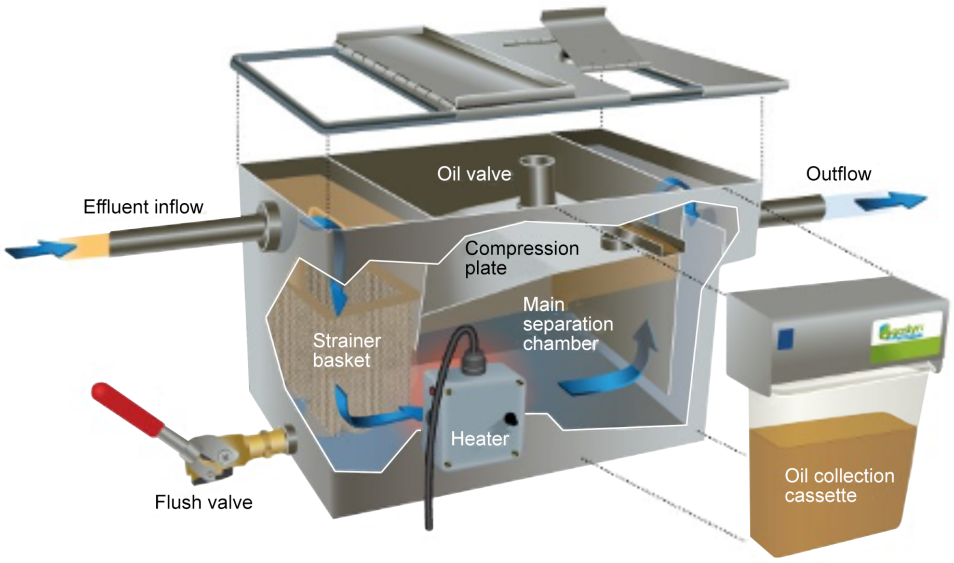


Figure 3 *Automatic grease interceptor (Image courtesy ACO, Inc.). All rights reserved.*

In an automatic grease interceptor, wastewater enters the grease trap and passes through a filter that collects solids. Water mixed with FOGs flows through to the main chamber. Non-mechanical grease recovery units employ a small heater that prevents FOGs from cooling and solidifying, using hydrostatic pressure to force FOGs out into an external oil container.

Automatic mechanical models allow FOGs to cool and separate to the surface (as with passive); however, they regularly skim the top layer into a separate collection container.

In either case, water continues the journey into the sewer via the outlet, unaccompanied by any unwanted additions. FOGs and solids are effectively separated into independent containers that can be easily disposed of by staff members without needing to shut the kitchen down and force down time. A major benefit of automatic grease separators is that they continuously remove FOGs to maintain the ongoing efficiency of the trap.

The addition of grease-busting enzymes to the waste entering interceptors is discouraged, as the now-minute particles of grease and fats move through the interceptor into the system downstream and become a problem there rather than being contained and removed within the interceptor.

Interceptors can be installed fully exposed on the floor, fully or semi-recessed into a floor, or located completely underground. The key point remains that they will need to be accessible for cleaning and servicing.

Sizing Grease Interceptors

Grease interceptors are sized according to the rate of incoming flow in US gallons per minute (USGPM). Associated with

the incoming flow rate is an interceptor's storage capacity. The rated capacity, in pounds (lb), is listed at twice the flow rate, in GPM. For example, a 10 GPM interceptor has a rated capacity of 20 lb of grease.

Example:

Suppose that a two-compartment commercial pot sink has compartments that measure 18 in. in length by 18 in. in width by 16 in. in depth. The two compartments will, therefore, have a capacity of $18 \times 18 \times 16 \times 2 = 0\,368 \text{ in.}^3$. One US gallon (the typical unit of measure) is 231 in.^{3}, which translates to a capacity of $10\,368 \div 231 = 44.88 \text{ USG}$.

A common assumption in grease interceptor sizing methods is that a full sink in use will have roughly 25% of its volume taken up by pots, pans, and other items being washed, so $44.88 \times 0.75 = 33.66$ US gallons of grease-laden water to process. Industry-standard drain down time is expected to be one minute, so the correct interceptor to choose should have a flow rate of at least 33.66 GPM and will, therefore, have a storage capacity of approximately 67.3 lb of grease.

One would then consult manufacturers' charts to select an appropriate model and size. When the desired flow rate falls between two model sizes, always defer to the larger size.

Interceptors are the intended terminus of unwanted materials being carried through any trade waste system, and there are many types to choose from. The following is an example list of interceptors that Watts Industries manufacture:

- **Art rooms, dental labs, metal recovery:** SI-742, SI-742-L, SI-762
- **Commercial laundry, washing machines:** LI-800
- **Cooking, prep sinks, dishwasher:** WD Series, GI-K Series
- **Elevator pits & oil spill areas:** OI Series, OI-K Series
- **Hair wash sinks:** SI-750, SI-750-TO
- **Pot, pan, scullery sinks:** WD Series, GI-K Series
- **Sand and sediment:** SA Series, See Also FD-410
- **Catch basin vehicle and maintenance areas:** OI Series, OI-K Series

Other Trade Waste Systems

Pot sinks draining into grease interceptors is an example of only one type of trade waste system. Figure 4 is an example of a trade waste system that might be found in a food processing plant. In essence, it is a type of circuit-vented system that is allowed to have flat dry vents as long as there are appropriately placed cleanouts installed.

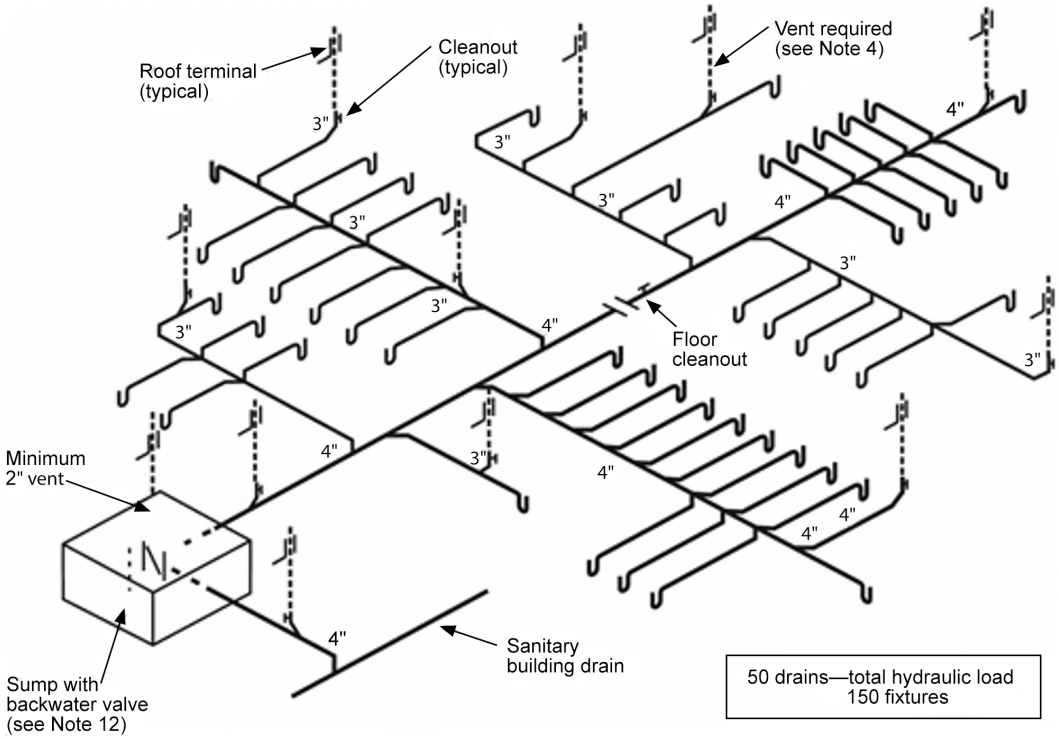


Figure 4 *Sump with backwater valve. (Skilled Trades, BC, 2007)*

The diagram above appeared in A-7.4.2.1.(5) of the appendix in the 2007 edition of the BC Plumbing Code but has not been published in the plumbing codes since. However, most plumbing officials are aware of its previous existence and intent and may refer to it when specifying to customers the mandated use of a trade waste system.

The following are the referenced clauses that accompanied the diagram in the appendix:

- This system is restricted to discharge only from product display cases, ice machines, cooler condensate, and emergency discharge from a heat reclaim pump.
- Hydraulic load for traps in trade waste systems should be:
  - 3 FUs for a 3 in. trap
  - 4 FUs for a 4 in. trap
- All drainage branches should be sloped at a minimum of a 1 in 50 slope for pipes up to 3 in. in diameter and 1 in 100 for 4 in. in diameter and over.
- Trap arms should have a downward slope in the direction of flow with a minimum of a 1 in 50 slope and shall not exceed the pipe diameter.
- Fixture outlet pipes should have a developed length not greater than 900 mm.
- A reduction of pipe size on a horizontal branch should leave a vent at the point of reduction.
- All vents should be not less than 1.5 in. in diameter
- Any dry vent should roll off the top of a horizontal waste pipe where possible.
- Heat reclaim trenches should be provided with an emergency pumped drain and an alarm system.
- Trade waste system sumps should be a minimum 24 in. square and up to 48 in. in depth. Larger sumps are required for greater depths. Sumps should have an 18 in. liquid depth and should be provided with a backwater valve at the outlet.
- Trade waste systems should be restricted to a single floor level.

As well, the two clauses below were included in the code reference above.

> **A-7.4.3.3.(1)** Waste with Organic Solids. Equipment such as garbage grinders and potato peelers produce waste with organic solids. These devices reduce most waste into small- sized particles that will flow easily through the drainage system. However, if they are located upstream of the interceptor, the particles could block the interceptor.

The above clause still exists in both the BC and national codes, in 2.4.3.3 (1) and (2), but is a bit more definitive in that it prohibits any equipment discharging waste that contains organic solids from being installed upstream of a grease interceptor unless an organic solids interceptor is installed in between them.

> **A-7.4.4.3.(1)** Grease Interceptors. Grease interceptors may be required when it is considered that the discharge of fats, oil or grease may impair the drainage system. Information on the design and sizing of grease interceptors can be found in ASPE Data Book, Volume 4, Chapter 8, Grease Interceptors.

The above clause has been replaced and expanded upon in the current codes. Clauses 2.4.4.3.(1), (2), (3), and (4) identify the code requirements for instances where a grease interceptor, oil interceptor, or interceptors for sand, grit, and other such materials must be installed. Any other locations or situations are left to the discretion of the authority having jurisdiction.

As well, Clauses 2.4.4.4.(1) and (2) of the current code editions spell out the requirements for the installation of neutralizing and dilution tanks for acid waste. These would also be considered a specific type of interceptor.

Oil Interceptors

Oil interceptors are designed for use in drain lines from areas where oils, sediment, and other liquids are found. These areas may be parking garages, machine shops, service stations, aircraft hangars, industrial and manufacturing facilities, etc., and all need an environmentally sensible way to be drained.

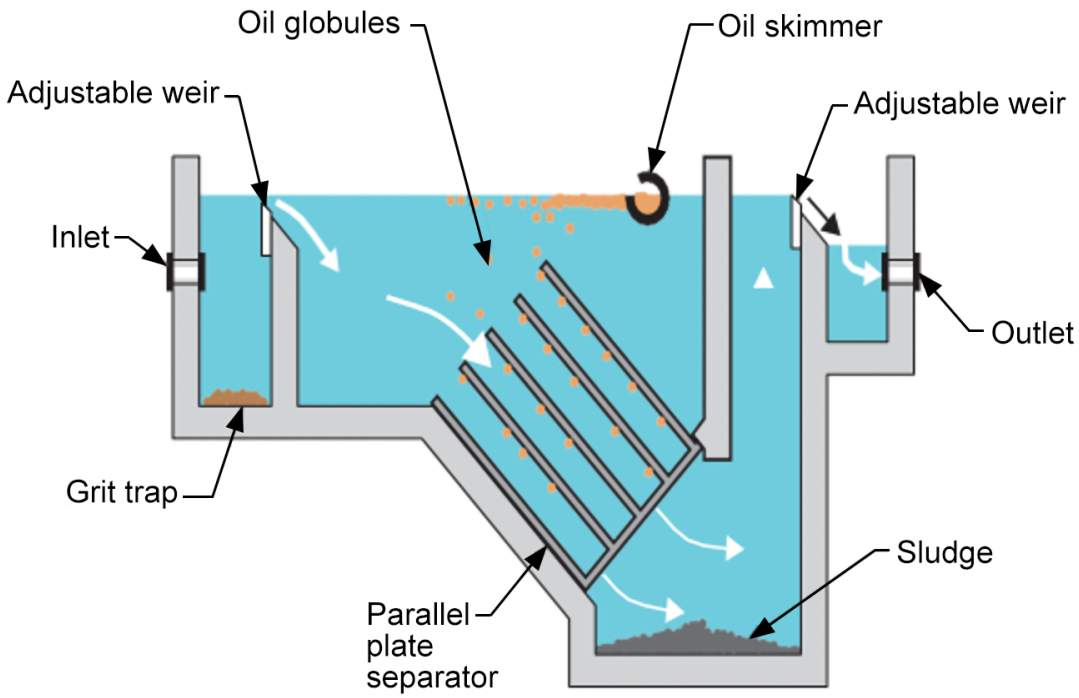


Figure 5 *Oil interceptor. (Skilled Trades BC, 2021) Used with permission.*

Operating an oil interceptor is very similar to that of a passive grease interceptor. The solid baffle plate opposite the inlet to the oil interceptor diffuses the flow into the interceptor and lessens the turbulence of the oil-laden water as it enters the intercepting chamber. Solids and sludge carried in the water are stopped by the baffle and collected in the solids retaining bucket between the inlet and the flow-retarding baffle. Such accumulation can then be removed. The resulting quiet, even flow of water through the interceptor permits the oils and other light density substances to rise to the surface by the "flotation" principle of separation. Oils are less dense than water; therefore, gravity causes the oil to float to the surface of the water. Maximum separation and interception is proportional to the elimination of turbulence of wastewater within the interceptor. The unique baffle/bucket design permits almost 90% of the interior of the interceptor to be used for oil separation.

Like in grease interceptors, oil interceptors are constructed of 100% epoxy-coated steel for long-lasting performance and durability.

Some models have an oil draw-off assembly that allows the separated oils and other similar light-density substances automatically drain out through a properly adjusted internal stand pipe. A pipe connection from the internal adjustable standpipe is connected to an oil drain line leading from the oil interceptor to an oil storage tank, which may be a component of the interceptor (Figure 7), or may be separate from the interceptor.

A standpipe sleeve (brass tube) within the oil containment compartment must be adjusted so the opening is $\frac{1}{8}$ in. above the top of the normal water flow level in the interceptor chamber. The oil that floats to the surface will drain off by gravity flow as waste water flows through the interceptor. When the adjustable sleeve in the standpipe is correctly set, no water will drain off with the oil, and there is no need to manually skim the oil.

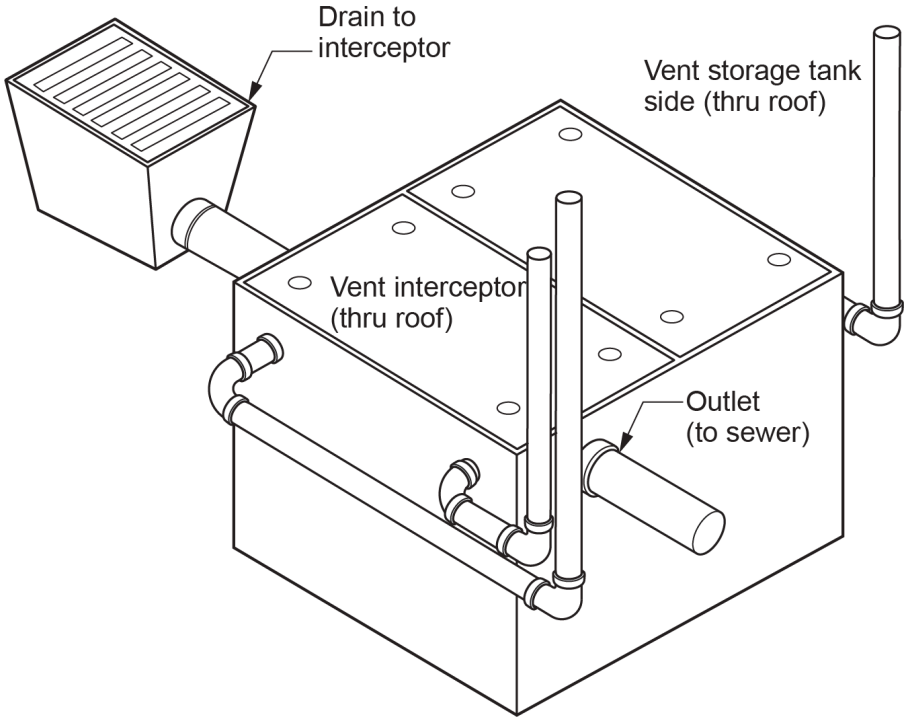


Figure 6 *Combination oil interceptor/oil storage tank. (Skilled Trades BC, 2021) Used with permission.*

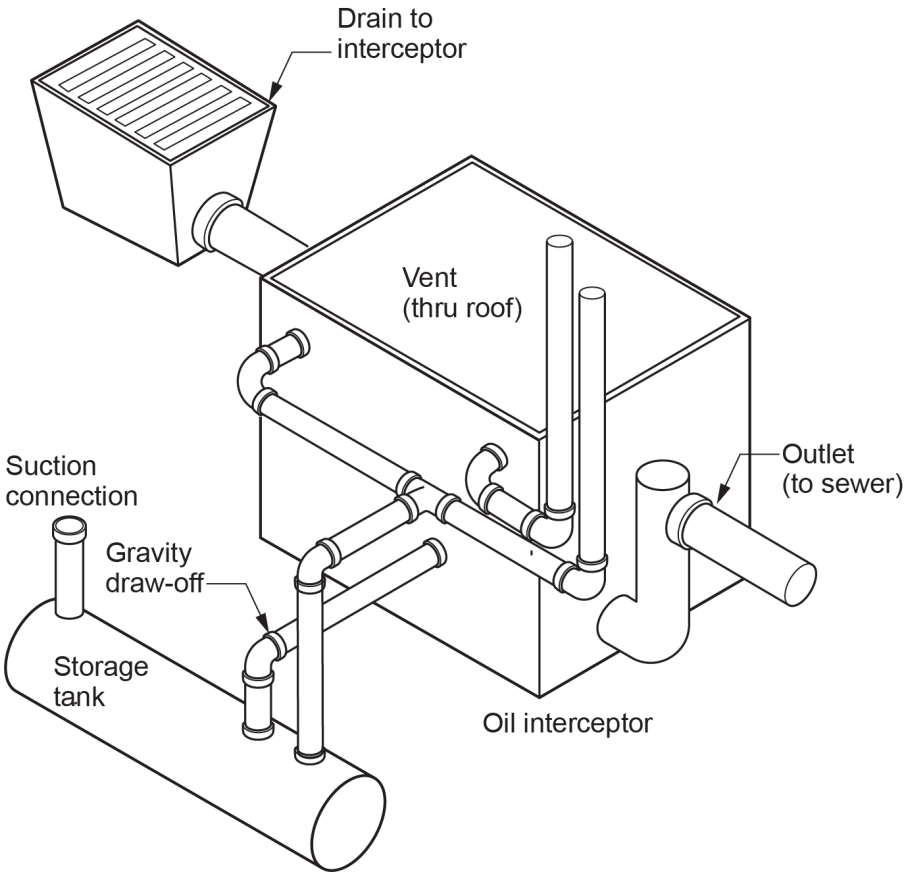


Figure 7 *Oil interceptor with separate storage tank. (Skilled Trades BC, 2021) Used with permission.*

Dilution and Neutralization Tanks

pH is a measure of the hydrogen ion (H^+) concentration in a liquid and classifies liquids as being acidic or caustic. pH values range from 0 to 14 and indicate the degree of acidity or alkalinity of a liquid. A liquid with a pH value below 7 is acidic, and a liquid with a pH value above 7 is alkaline. A pH of 7 indicates that a liquid is neutral.

Liquid discharges that are either too acidic or too caustic may cause corrosion damage to downstream piping systems and may also adversely affect the environment or create problematic conditions for **waste water treatment** plants. It should be noted that acidic and caustic liquids can be equally harmful; hence they should be treated with equal attention. Chemical effluent should be treated to ensure that the pH level is as close to 7 as possible or to other values dictated by the authority having jurisdiction.

Generally, effluent with a pH range of 5.5 to 8.5 can be disposed of without treatment, but local requirements may vary and must be adhered to. However, even mild caustics and acids within this range can cause severe damage to piping systems, depending on the piping material. Therefore, it is recommended that the composition of piping materials is checked against both the predicted pH discharge level and the individual chemicals being discharged to ensure compatibility.

Neutralization

Neutralization is a chemical reaction resulting from the physical mixing or extended contact of a base and an acid to form a neutral solution of water and salt. This neutral solution is suitable for discharge into sanitary sewer systems. Neutralization is accomplished by one of three methods:

1. Dilution
2. Limestone chips (calcium carbonate)
3. Chemical dosing

Dilution

Dilution involves physical mixing the chemical waste with water to stabilize (dilute) the waste. Initial dilution can be as simple as flushing the chemical with water at the sink and discharging the mixture through a p-trap and the associated drainage piping. Alternatively, dilution can be accomplished via a large dilution trap (dilution tank) located under the bench at each sink. In either case, the waste piping should discharge into a central neutralization system for further treatment prior to discharging into the sewer system.

Limestone Chip Neutralization

In a typical system, acidic waste is drained into a plastic tank filled with high purity limestone chips that are 1–3 in. in diameter with a calcium carbonate ($CaCO_3$) content of at least 90%. After a designed dwell time in the tank, the chemical is neutralized and subsequently discharged by gravity flow into the sewer. The chemical reaction creates an off-gassing, and therefore, these tanks should be vented. The limestone is used up in the process and must be replaced periodically. Dilution and neutralization using limestone chips is most commonly used as a small-scale point-of-use treatment.

Note that an alkaline solution can be as corrosive and problematic to systems and piping as an acidic solution. An alkaline solution with a pH of more than 7 would require an acid to neutralize it and bring its pH level down to near 7.

Chemical-Dosing Neutralization Systems

Instead of using limestone chips for neutralization, chemicals can be injected into the waste stream to achieve the same result. Sophisticated controls monitor the process and introduce a solution of acid, base (alkali), or both into the chemical waste holding tank via metering pumps, controls, and mixers. The resulting liquid mixture chemically reacts to form a salt and water composition, which is then discharged by gravity flow into the sewer. These systems are usually installed in large buildings that contain laboratories and similar operations. The tanks can sometimes be as large in volume as a classroom.

Solid Interceptors

Solids interceptors are perhaps the least sophisticated variety of interceptor. They are designed to recover all types of solids from precious metal particles to food waste, plaster, clay, or similar materials. This is accomplished through the principle of gravity separation. Particles of various sizes and weights are trapped in a bucket. Some varieties of solids interceptors have a replaceable filter bag (similar to a vacuum cleaner) for ease of disposal.

The wastewater flows from the inlet piping into the removable bucket or filter bag, passes through a screen into the main body chamber, and then exits the interceptor to the sanitary drainage system. An example of a solids interceptor would be a hair trap installed on the fixture outlet piping from a beauty parlour sink.

Figure 8 *Hair trap. (Skilled Trades BC, 2021) Used with permission.*

Interceptor Venting

The venting of interceptors should conform to the manufacturers' specifications but must also satisfy the requirements of the plumbing code. A-2.5.5.2 in the "Notes to Part 2" of the BC and National Plumbing Codes shows a graphic of suggested venting for an oil interceptor. The following are some examples of code requirements for venting sewage sumps, oil interceptors, and dilution tanks.

If a sewage sump is used as an interceptor, Clause 2.5.5.5.(1) states that it must be provided with a vent pipe connected to the top of the sump, and Article 2.5.7.7 states that it shall be a minimum size of one size smaller than the size of the largest branch or fixture drain connected to the sump and be at least 2 in. but need not be larger than 4 in.

Oil interceptors have many venting requirements found in Article 2.5.5.2, the most significant being that any vents from oil interceptors cannot be interconnected with other vents. They must extend independently to outside air and differ in elevations where they terminate.

Dilution tank venting requirements are found in Article 2.5.5.3 and 2.5.5.7 and are similar to those for venting sewage sumps.

Consult the applicable plumbing codes for the full scope of venting requirements for interceptors.

Self-Test D-1.11: Trade Waste Systems

Complete Self-Test D-1.11 and check your answers.

If you are using a printed copy, please find Self-Test D-1.11 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=58#h5p-13 (https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=58#h5p-13)

References

Skilled Trades BC. (2007). *Figure* A-7.4.2.1.(5): *Trade waste system.* In *Vancouver Building By-law 2007 – Part 7: Plumbing Services* (Appendix A). Retrieved January 20, 2025, from https://free.bcpublications.ca/civix/document/id/public/vbbl2007/building_B_appA_P7 (https://free.bcpublications.ca/civix/document/id/public/vbbl2007/building_B_appA_P7)

Skilled Trades BC. (2021). *Book 2: Install fixtures and appliances, install sanitary and storm drainage systems.* Plumber apprenticeship program level 2 book 2 (Harmonized). Crown Publications: King's Printer for British Columbia.

Trades Training BC. (2021). D-1: Install sanitary drain, water and vent systems. In: *Plumber Apprenticeship Program: Level 2.* Industry Training Authority, BC.

Media Attributions

All figures are used with permission from Skilled Trades BC (2021) unless otherwise noted.

- **Figure 3** Automatic grease interceptor (https://goslyn.com/product/4-gpm-grd-gos20/) [Goslyn diagram] is from ACO, Inc., and is used with permission. All rights reserved. [Note, this image is no longer on the original website.]
- **Figure 4** Sump with backwater valve is from Skilled Trades BC (2021). The original image (https://free.bcpublications.ca/civix/document/id/public/vbbl2007/building_B_appA_P7) is Figure A-7.4.2.1.(5). from the British Columbia Building Code 2007, also from Skilled Trades BC (2007).
- **Figure 5** Oil interceptor was modified by Skilled Trades BC (2021). The original image was from Mbeychok (https://en.wikipedia.org/wiki/User:Mbeychok) at English Wikipedia (https://en.wikipedia.org/wiki/), licensed under the CC BY-SA 3.0 (https://creativecommons.org/licenses/by-sa/3.0/deed.en) license.

Self-Test D-1.1 Codes and Standards

Complete Self-Test D-1.1 and check your answers.

1. Which governing body is responsible for issuing plumbing permits?
    a. Municipal
    b. Provincial
    c. Federal
    d. Technical safety branch

2. In the province of BC, which document provides the minimum requirements for building plumbing systems?
    a. BC Building Code
    b. National Plumbing Code
    c. BC Plumbing Code
    d. CSA Gas Code

3. Which document may be adopted by provincial and territorial governments to regulate the design and installation of plumbing systems with or without adaption to local needs?
    a. BC Building Code
    b. National Plumbing Code
    c. BC Plumbing Code
    d. Sewage System Regulation

4. Which of the following organizations maintains records of onsite sewage systems installed in BC?
    a. Ministry of Health
    b. AHJ or local municipal government
    c. BCWWA
    d. Ministry of Development

5. How does the National Plumbing Code identify any technical changes or additions found in the latest edition of the code?
    a. Bulletins
    b. Highlighted sections
    c. Vertical line in margin
    d. Italics

6. Which of the following processes would require a plumbing permit?
    a. Installing new piping
    b. Adding additional fixtures
    c. Opening a wall to replace piping
    d. All of the above

7. What does a municipal government use to require a plumber apply for a permit for work?
    a. Bylaws
    b. Decrees
    c. Amendments
    d. Regulations

8. What term describes a product that has been tested and certified by an accredited certification organization?
    a. Listed
    b. Applicable
    c. Standardized
    d. Harmonized

9. A typical standard used in the construction industry will outline the minimum acceptable performance of a material used in building.
    a. True
    b. False

10. A standard may outline procedural standards to detail how products are to be installed to be safe and reliable for the intended purpose.
    a. True
    b. False

Answer Key: Self-Test D-1.1 (#chapter-answer-key-self-test-d-1-1) is on the next page.

Answer Key: Self-Test D-1.1

1. a. Municipal
2. c. BC Plumbing Code
3. b. National Plumbing Code
4. a. Ministry of Health
5. c. Vertical line in margin
6. d. All of the above
7. a. Bylaws
8. a. Listed
9. a. True
10. a. True

Self-Test D-1.2 DWV Terminology

Complete Self-Test D-1.2 and check your answers.

1. According to the BC Plumbing Code, a bathroom group consists of which components installed in the same room?
    a. One domestic lavatory, one WC, and one bathtub
    b. One domestic lavatory, one WC, and one bathtub with a single showerhead
    c. One domestic lavatory, one WC, and one single showerhead
    d. All of the above

2. What is the name given to a vent connected at its lower end to the junction of two or more vent pipes and at its upper end to a stack vent, vent stack, vent header, or open air?
    a. Circuit vent
    b. Branch vent
    c. Wet vent
    d. Continuous vent

3. What is the name given to a vent that serves two fixtures and connects at the junction of the trap arms?
    a. Circuit vent
    b. Branch vent
    c. Dual vent
    d. Relief vent

4. What is the name given to the length along the centreline of a pipe and fittings for the purpose of sizing?
    a. Centreline length
    b. Equivalent length
    c. Developed length
    d. Combined length

5. What is the name given to a fixture designed for overflow protection that does not receive regular discharge from other fixtures?
    a. Emergency floor drain
    b. Emergency fixture
    c. Emergency scupper
    d. Emergency drain pan

6. A pipe installed at 47° to the horizontal is said to be in what plane?
    a. Nominally horizontal
    b. Nominally vertical
    c. Horizontal
    d. Vertical

7. A fresh-air inlet is a vent pipe installed in conjunction with which component in a sanitary drainage system?
    a. Manhole
    b. Sewage sump basin
    c. Building trap
    d. Oil interceptor

8. What is the name given to a drainage pipe that extends from the trap of a fixture to a point of connection with another part of the drainage system?
    a. Branch
    b. Fixture drain
    c. Individual drain
    d. Trap drain

9. The top edge of a fixture or receptacle from which water can overflow is given what designation in the NPC?
    a. Concealed overflow
    b. Waste and overflow
    c. Standing waste
    d. Flood-level rim

10. When a drainage pipe is physically connected in such a way that water or gas cannot escape from the connection, it is said to be connected in which way?
    a. Air break
    b. Air gap
    c. Indirectly
    d. Directly

11. What is the name given to the portion of a fixture drain between the trap weir and the vent pipe fitting?
    a. Fixture outlet pipe
    b. Waste and overflow
    c. Trap arm
    d. Continuous waste

12. Identify the trap dip in Figure 1.
13. Identify the traps seal in Figure 1.
14. Identify the trap weir in Figure 1.

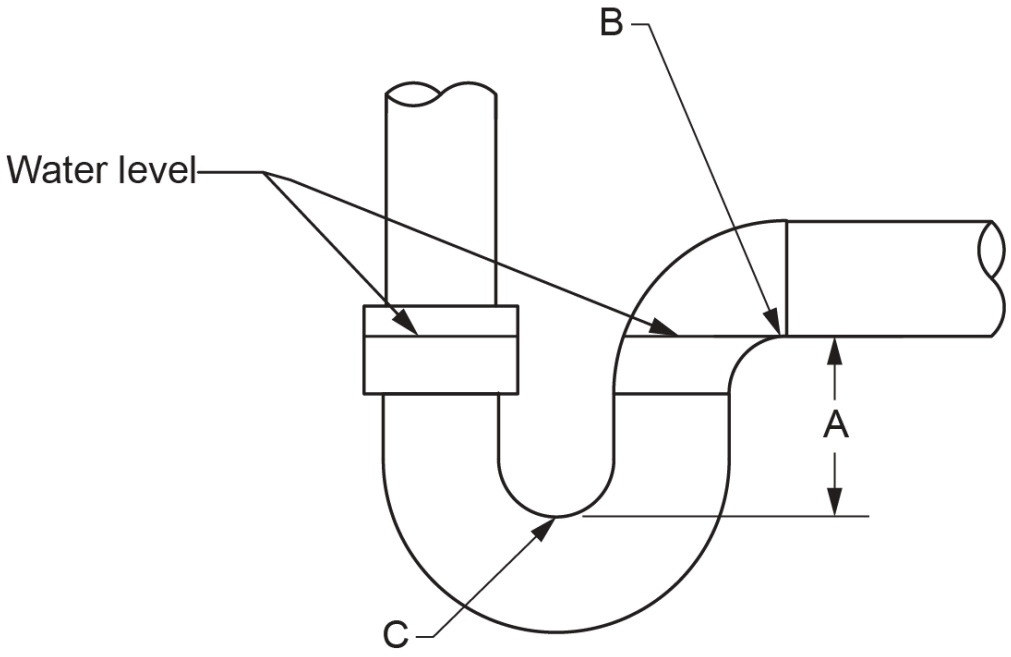


Figure 1

15. What is defined as a combination of elbows or bends that brings one section of pipe out of line but into a line parallel with the original section of pipe?

    a. Offset
    b. Barber's loop
    c. Jumper configuration
    d. Running trap

16. What is the name of a vertical main sanitary drainage pipe that passes through one or more storeys?

    a. Stack
    b. Vent stack
    c. Stack vent
    d. Riser

17. Which of the following terms best describes a vent that is the extension of a vertical branch or fixture drain?

    a. Individual vent
    b. Continuous vent
    c. Dual vent
    d. Branch vent

18. According to the National Plumbing Code, what name is given to the unobstructed vertical distance between the lowest point of an indirect drainage system and the flood-level rim of the fixture into which it discharges?

    a. Air gap
    b. Air break
    c. Critical level

d. Developed length

19. Which of the following terms best describes water with impurity levels that will not be harmful to health and may include HVAC condensate but does not include stormwater?

    a. Clear-water waste
    b. Sewage
    c. Effluent
    d. Potable water

20. What is the name given to a one-way valve that allows air to enter a plumbing drainage system when negative pressures develop in the piping?

    a. Backwater valve
    b. Check valve
    c. Pressure-reducing valve
    d. Air-admittance valve

21. Which of the following terms best describes a vent pipe that serves a number of fixtures and connects to the fixture drain of the most upstream fixture?

    a. Dual vent
    b. Vent stack
    c. Circuit vent
    d. Relief vent

22. What trade term is used to describe a trap for a fixture that is also used as the main support for the fixture?

    a. Drum trap
    b. Trap standard
    c. Crown-vented trap
    d. Bell trap

23. How far does a building drain continue outside the building wall before it can be considered a building sewer?

    a. 0.5 m
    b. 1 m
    c. 1.5 m
    d. 2 m

24. What is the main purpose of a venting system?

    a. Allows sewer gas to be taken to the roof terminal
    b. Protects the fixture traps
    c. Limits the fluid velocities in the stack
    d. Allows overflow to reach the building drain in the event of a blockage in the drainage line

25. What is the name given to a device installed in a building drain to prevent air from circulating between the drainage system and the public sewer?
    a. Backwater valve
    b. Air admittance valve
    c. Building trap
    d. Vacuum breaker

Answer Key: Self-Test D-1.2 (#chapter-answer-key-self-test-d-1-2) is on the next page.

Answer Key: Self-Test D-1.2

1. d. All of the above
2. b. Branch vent
3. c. Dual vent
4. c. Developed length
5. a. eEmergency floor drain
6. b. Nominally vertical
7. c. Building trap
8. b. Fixture drain
9. d. Flood level rim
10. d. Directly
11. c. Trap arm
12. c. Trap dip
13. a. Trap seal
14. b. Trap weir
15. a. Offset
16. a. Stack
17. b. Continuous vent
18. b. Air break
19. a. Clear-water waste
20. d. Air admittance valve
21. c. Circuit vent
22. b. Trap standard
23. b. 1 m
24. b. Protects the fixture traps
25. c. Build trap

Self-Test D-1.3 Functions of Different Pipes in a DWV System

Complete Self-Test D-1.3 and check your answers.

1. Using Figure 2P-1, fill in Table 1 by identifying the drains indicated by the numbers and the vents indicated by the letters.

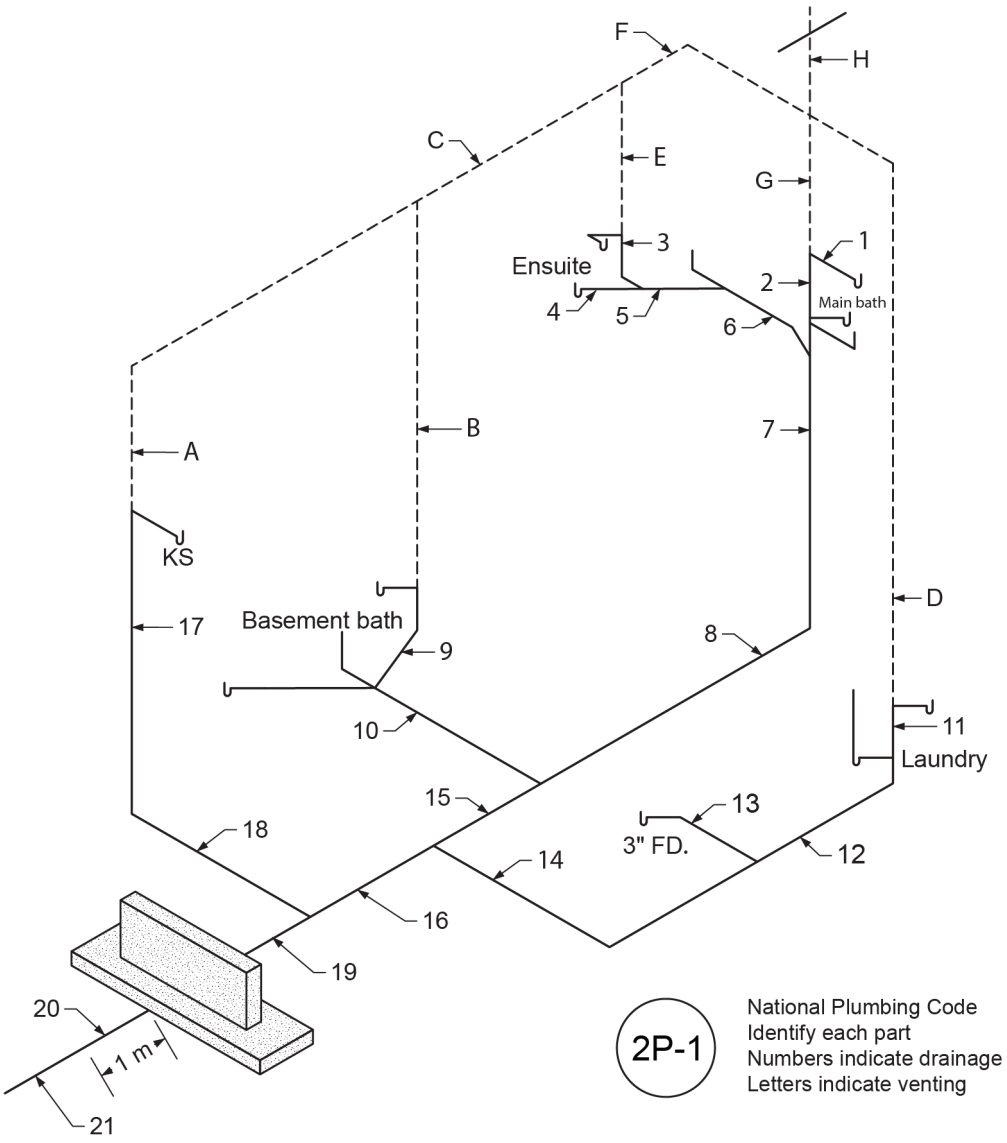


Figure 2P-1

Table 1

Drains	Name	Vents	Name
1		A	
2		B	
3		C	
4		D	
5		E	
6		F	
7		G	
8		H	
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			

2. Using Figure 2P-2, fill in Table 2 by identifying the drains indicated by the numbers and the vents indicated.

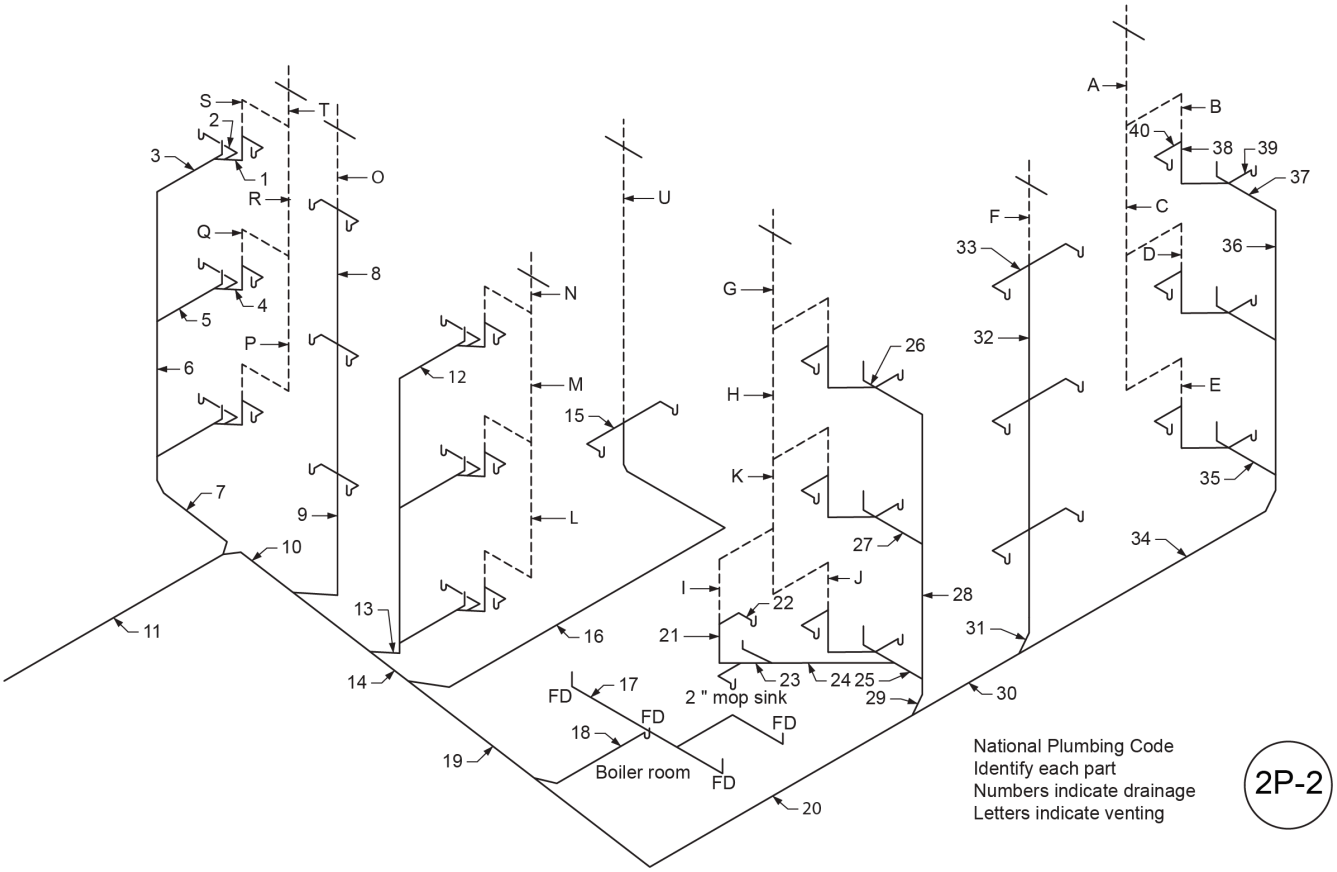

S
T
2
3
1
O
R
Q
8
4
5
P
6
N
12
M
15
U
G
26
H
K
7
9
L
10
27
I
J
22
28
13
11
16
21
23
24
25
29
31
30
14
FD
17
2 " mop sink
FD
FD
18
19
Boiler room
FD
20
A
B
40
38
39
37
C
F
33
D
36
32
E
35
34
National Plumbing Code
Identify each part
Numbers indicate drainage
Letters indicate venting
2P-2

Figure 2P-2

Table 2

Drains	Name	Vents	Name
1		A	
2		B	
3		C	
4		D	
5		E	
6		F	
7		G	
8		H	
9		I	
10		J	
11		K	
12		L	
13		M	
14		N	
15		O	
16		P	
17		Q	
18		R	
19		S	
20		T	
21		U	
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			
38			

39			
40			

3. Using Figure 2P-3, fill in Table 3 by identifying the drains indicated by the numbers and the vents indicated.

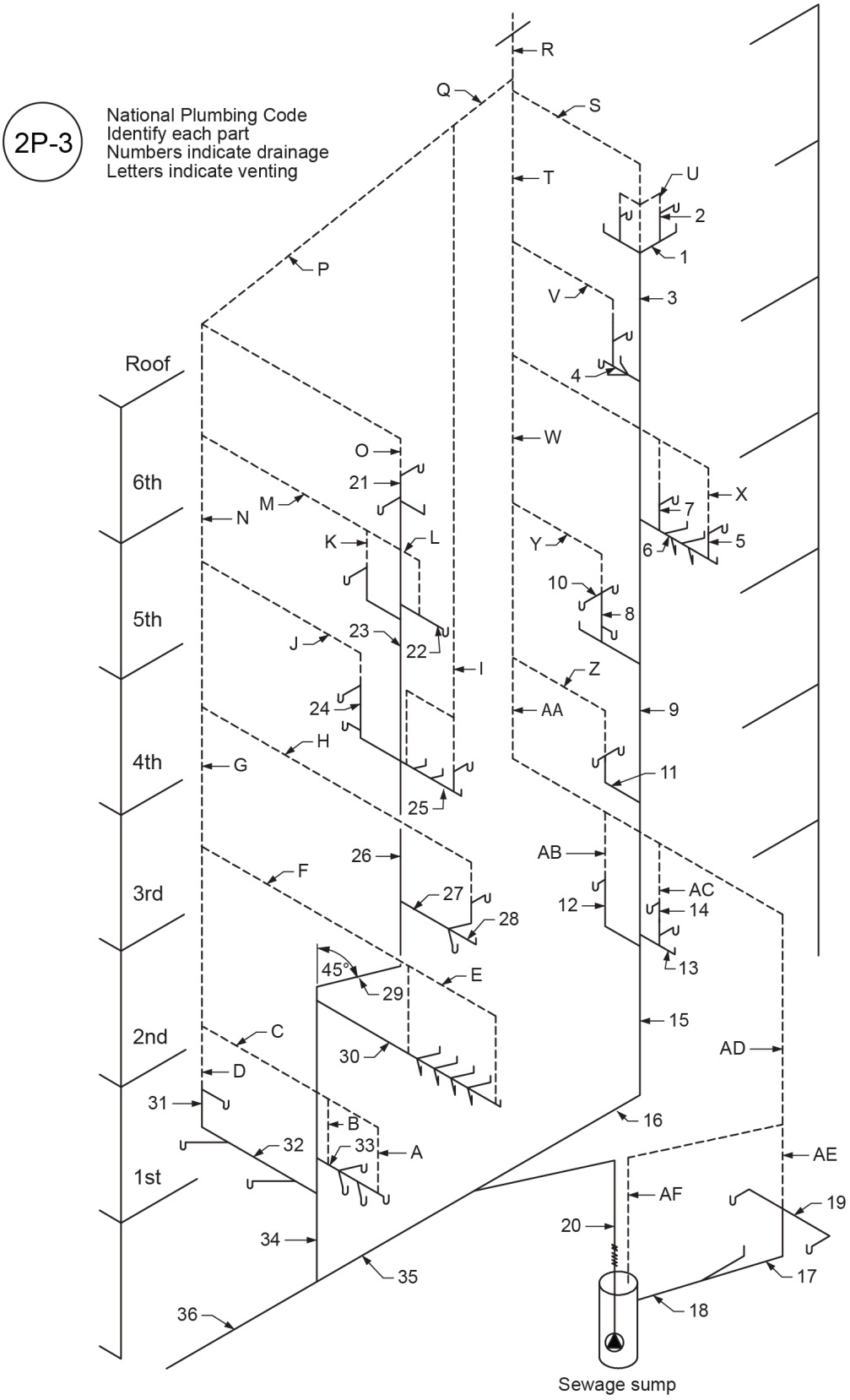

2P-3
National Plumbing Code
Identify each part
Numbers indicate drainage
Letters indicate venting
Roof
6th
5th
4th
3rd
2nd
1st
R
Q
S
T
U
2
1
P
V
3
4
W
O
21
M
N
K
L
X
7
6
5
Y
10
8
23
22
J
I
Z
24
AA
9
H
G
11
25
26
AB
F
27
AC
12
14
28
13
45°
29
E
15
C
30
AD
D
31
B
16
32
33
A
AE
AF
19
20
34
35
17
36
18
Sewage sump

Figure 2P-3

Table 3

Drains	Name	Vents	Name
1		A	
2		B	
3		C	
4		D	
5		E	
6		F	
7		G	
8		H	
9		I	
10		J	
11		K	
12		L	
13		M	
14		N	
15		O	
16		P	
17		Q	
18		R	
19		S	
20		T	
21		U	
22		V	
23		W	
24		X	
25		Y	
26		Z	
27		AA	
28		AB	
29		AC	
30		AD	
31		AE	
32		AF	
33			
34			
35			
36			

Answer Key: Self-Test D-1.3 (#chapter-answer-key-self-test-d-1-3) is on the next page.

Answer Key: Self-Test D-1.3

1. Figure 2P-1

Table 1 Answers

Drains	Name	Vents	Name
1	Trap arm — Fixture drain	A	Stack vent
2	Stack acting as a wet vent	B	Continuous vent
3	Fixture drain acting as a wet vent	C	Stack vent
4	Trap arm — Fixture drain	D	Continuous vent
5	Branch acting as wet vent	E	Continuous vent
6	Branch	F	Stack vent
7	Stack	G	Stack vent
8	Sanitary building drain	H	Vent header
9	Fixture drain acting as a wet vent		
10	Branch		
11	Fixture drain acting as a wet vent		
12	Branch		
13	Trap arm — Fixture drain		
14	Branch		
15	Sanitary building drain		
16	Sanitary building drain		
17	Stack		
18	Branch		
19	Sanitary building drain		
20	Sanitary building drain		
21	Sanitary building sewer		

2. Figure 2P-2

Table 2 Answers

Drains	Name	Vents	Name
1	Stack acting as a wet vent	A	Stack vent
2	Trap arm — Fixture drain	B	Stack vent
3	Stack	C	Branch vent
4	Fixture drain acting as a wet vent	D	Continuous vent
5	Branch	E	Continuous vent
6	Stack	F	Stack vent
7	Branch	G	Stack vent
8	Stack acting as a wet vent	H	Branch vent
9	Stack	I	Continuous vent
10	Sanitary building drain	J	Continuous vent
11	Sanitary building drain	K	Branch vent
12	Stack	L	Continuous vent
13	Branch	M	Branch vent
14	Sanitary building drain	N	Stack vent
15	Trap arm — Fixture drain	O	Stack vent
16	Branch	P	Continuous vent
17	Fixture outlet pipe	Q	Continuous vent
18	Trap arm — Fixture drain	R	Branch vent
19	Sanitary building drain	S	Stack vent
20	Sanitary building drain	T	Stack vent
21	Fixture drain acting as a wet vent	U	Dual and continuous vent
22	Trap arm — Fixture drain		
23	Branch acting as a wet vent		
24	Branch		
25	Branch		
26	Trap arm — Fixture drain		
27	Branch		
28	Stack		
29	Branch		
30	Sanitary building drain		
31	Branch		
32	Stack acting as a wet vent		
33	Trap arm — Fixture drain		
34	Sanitary building drain		
35	Branch		
36	Stack		
37	Stack		
38	Stack acting as a wet vent		

39	Trap arm — Fixture drain	
40	Trap arm — Fixture drain	

3. Figure 2P-3

Table 3 Answers

Drains	Name	Vents	Name
1	Branch	A	Circuit vent
2	Fixture drain acting as a wet vent	B	Relief vent
3	Stack	C	Branch vent
4	Branch acting as a wet vent	D	Vent stack
5	Fixture drain acting as a circuit vent and a wet vent	E	Circuit vent
6	Branch	F	Branch vent
7	Fixture drain acting as a relief vent	G	Vent stack
8	Branch acting as a wet vent	H	Continuous vent
9	Stack	I	Branch vent
10	Trap arm — Fixture drain	J	Continuous vent
11	Branch	K	Individual and continuous vent
12	Fixture drain acting as a vent stack and a wet vent	L	Individual vent
13	Trap arm — Fixture drain	M	Branch vent
14	Fixture drain acting as a wet vent	N	Vent stack
15	Stack	O	Stack vent
16	Sanitary building drain	P	Vent header
17	Branch acting as a wet vent	Q	Vent header
18	Branch	R	Vent header
19	Trap arm — Fixture drain	S	Stack vent
20	Sump discharge	T	Vent stack
21	Stack acting as a wet vent	U	Continuous vent
22	Trap arm — Fixture drain	V	Continuous vent
23	Stack	W	Vent stack
24	Fixture drain acting as a wet vent	X	Circuit vent
25	Branch	Y	Continuous vent
26	Stack	Z	Dual and continuous vent
27	Branch	AA	Vent stack
28	Trap arm — Fixture drain	AB	Vent stack
29	Stack	AC	Continuous vent
30	Branch	AD	Branch vent
31	Fixture drain acting as a vent stack and a wet vent	AE	Continuous vent
32	Branch acting as a vent stack and a wet vent	AF	Sewage sump vent
33	Branch		
34	Stack		
35	Sanitary building drain		
36	Sanitary building drain		

Self-Test D-1.4 Acceptable Pipe Material Application

Complete Self-Test D-1.4 and check your answers.

For each question, select all answers that apply.

1. According to the NPC, in what applications are copper and brass pipes permitted?
    a. Above-ground drainage inside building, any type of construction
    b. Above-ground drainage inside building, combustible construction only
    c. Underground drainage under building
    d. Building sewer
    e. Above-ground venting inside building, any type of construction
    f. Above-ground venting inside building, combustible construction only
    g. Underground venting under building

2. According to the NPC, in what applications are Type K and L hard temper copper tubes permitted?
    a. Above-ground drainage inside building, any type of construction
    b. Above-ground drainage inside building, combustible construction only
    c. Underground drainage under building
    d. Building sewer
    e. Above-ground venting inside building, any type of construction
    f. Above-ground venting inside building, combustible construction only
    g. Underground venting under building

3. According to the NPC, in what applications are polyolefin laboratory drainage pipes permitted?
    a. Above-ground drainage inside building, any type of construction
    b. Above-ground drainage inside building, combustible construction only
    c. Underground drainage under building
    d. Building sewer
    e. Above-ground venting inside building, any type of construction
    f. Above-ground venting inside building, combustible construction only
    g. Underground venting under building

4. According to the NPC, in what applications are lead waste pipes permitted?
    a. Above-ground drainage inside building, any type of construction
    b. Above-ground drainage inside building, combustible construction only
    c. Underground drainage under building
    d. Building sewer
    e. Above-ground venting inside building, any type of construction
    f. Above-ground venting inside building, combustible construction only
    g. Underground venting under building

5. According to the NPC, in what applications are cast iron drainage pipes permitted?

a. Above-ground drainage inside building, any type of construction
b. Above-ground drainage inside building, combustible construction only
c. Underground drainage under building
d. Building sewer
e. Above-ground venting inside building, any type of construction
f. Above-ground venting inside building, combustible construction only
g. Underground venting under building

6. According to the NPC, in what applications are PVC DWV pipes permitted?

a. Above-ground drainage inside building, any type of construction
b. Above-ground drainage inside building, combustible construction only
c. Underground drainage under building
d. Building sewer
e. Above-ground venting inside building, any type of construction
f. Above-ground venting inside building, combustible construction only
g. Underground venting under building

7. According to the NPC, in what applications are Type M hard temper copper tubes permitted?

a. Above-ground drainage inside building, any type of construction
b. Above-ground drainage inside building, combustible construction only
c. Underground drainage under building
d. Building sewer
e. Above-ground venting inside building, any type of construction
f. Above-ground venting inside building, combustible construction only
g. Underground venting under building

8. According to the NPC, in what applications are ABS DWV pipes permitted?

a. Above-ground drainage inside building, any type of construction
b. Above-ground drainage inside building, combustible construction only
c. Underground drainage under building
d. Building sewer
e. Above-ground venting inside building, any type of construction
f. Above-ground venting inside building, combustible construction only
g. Underground venting under building

9. According to the NPC, in what applications are PVC sewer pipes permitted?

a. Above-ground drainage inside building, any type of construction
b. Above-ground drainage inside building, combustible construction only
c. Underground drainage under building
d. Building sewer
e. Above-ground venting inside building, any type of construction
f. Above-ground venting inside building, combustible construction only
g. Underground venting under building

10. According to the NPC, in what applications are seamless galvanized steel pipes permitted?

    a. Above-ground drainage inside building, any type of construction
    b. Above-ground drainage inside building, combustible construction only
    c. Underground drainage under building
    d. Building sewer
    e. Above-ground venting inside building, any type of construction
    f. Above-ground venting inside building, combustible construction only
    g. Underground venting under building

11. According to the NPC, in what applications are plastic sewer pipes permitted?

    a. Above-ground drainage inside building, any type of construction
    b. Above-ground drainage inside building, combustible construction only
    c. Underground drainage under building
    d. Building sewer
    e. Above-ground venting inside building, any type of construction
    f. Above-ground venting inside building, combustible construction only
    g. Underground venting under building

12. According to the NPC, in what applications are DWV copper tubes permitted?

    a. Above-ground drainage inside building, any type of construction
    b. Above-ground drainage inside building, combustible construction only
    c. Underground drainage under building
    d. Building sewer
    e. Above-ground venting inside building, any type of construction
    f. Above-ground venting inside building, combustible construction only
    g. Underground venting under building

Answer Key: Self-Test D-1.4 (#chapter-answer-key-self-test-d-1-4) is on the next page.

Answer Key: Self-Test D-1.4

1. a, b, c, d, e, f, g
2. a, b, c, d, e, f, g
3. b, c, d, f, g
4. b, c, d, f, g
5. a, b, c, d, e, f, g
6. b, c, d, f, g
7. a, e
8. b, c, d, f, g
9. c, d, g
10. a, e
11. c, d
12. a, e

Self-Test D-1.5 Sizing Sanitary Drainage Pipes

Complete Self-Test D-1.5 and check your answers.

1. Using Figure 2P-4, fill in Table 1 by sizing the drainage piping indicated by the numbers.

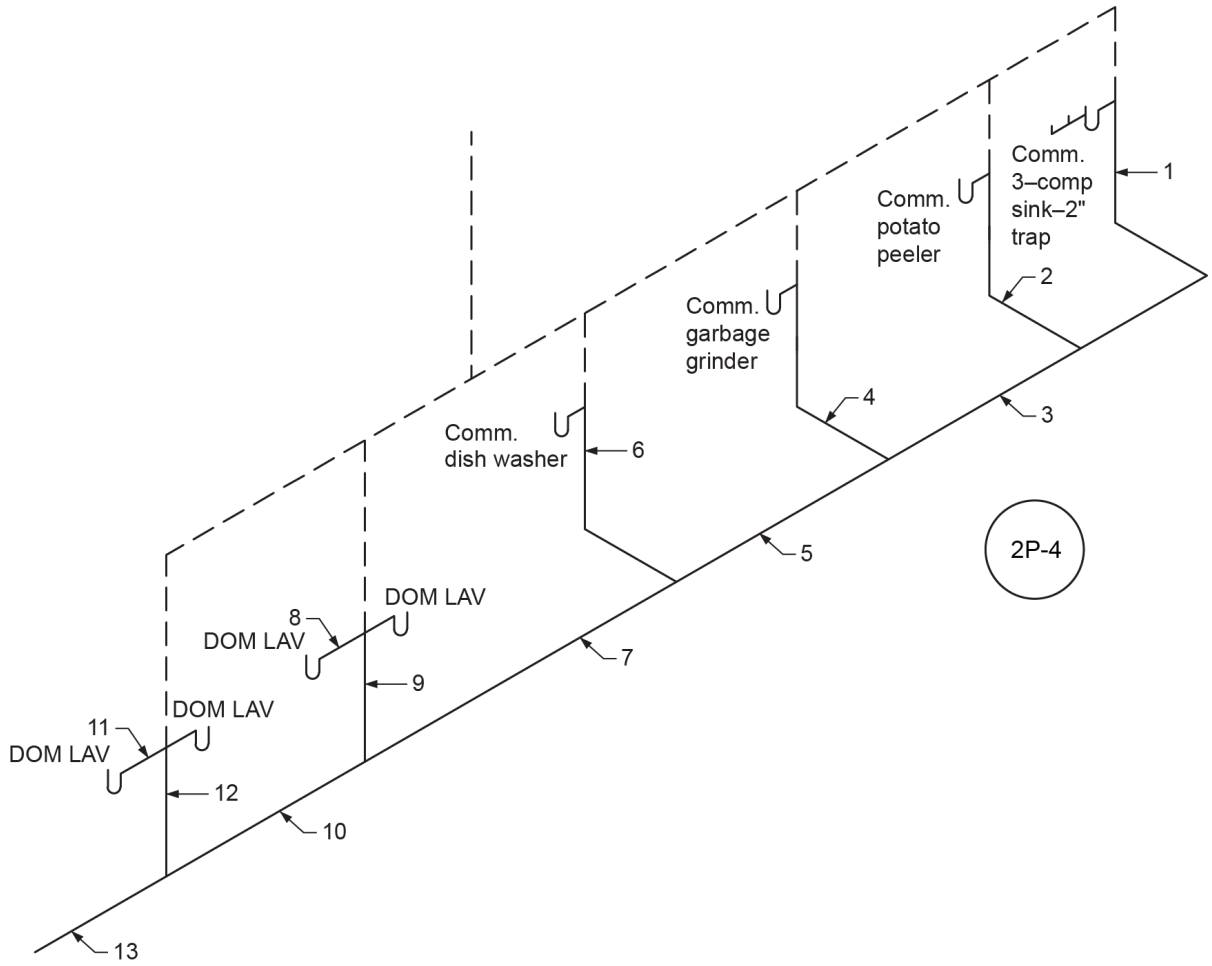
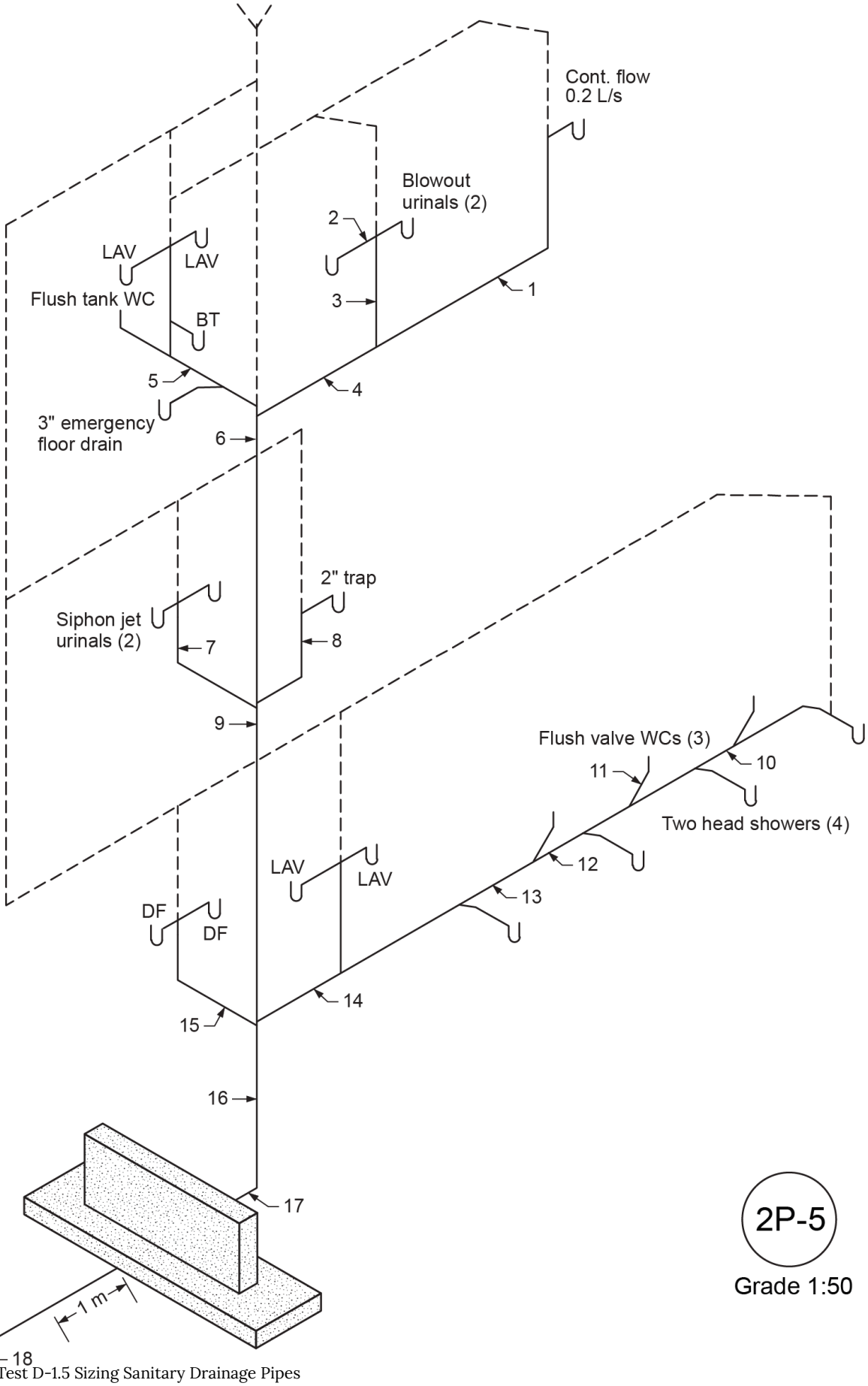


Figure 2P-4

Table 1

Number	Name	Fixture Units	Size
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			

2. Using Figure 2P-5, fill in Table 2 by sizing the drainage piping indicated by the numbers.



2P-5

Grade 1:50

Figure 2P-5

Table 2

Number	Name	Fixture Units	Size
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			

3. Using Figure 2P-6, fill in Table 3 by sizing the drainage piping indicated by the numbers.

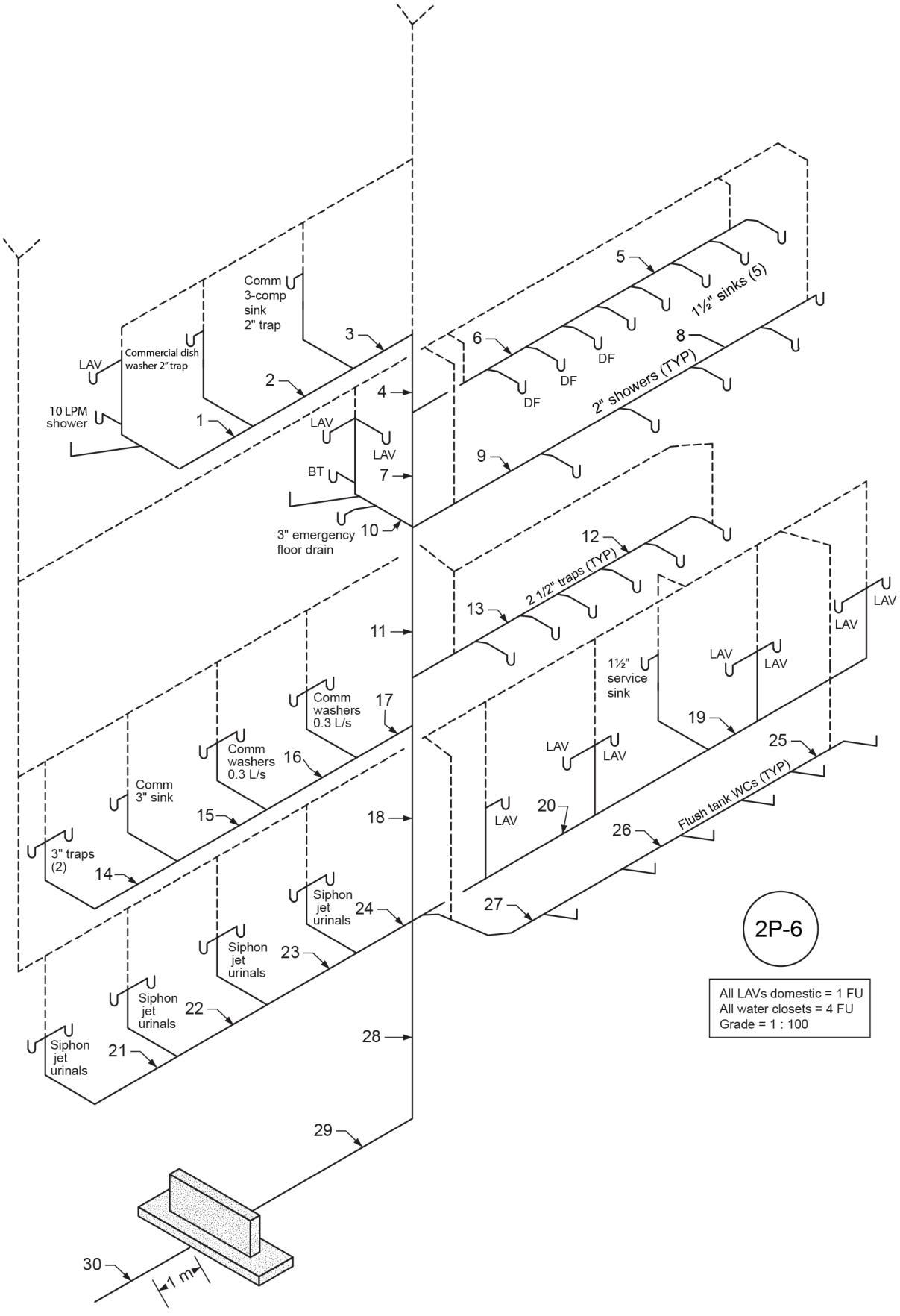

Comm
3-comp
sink
2" trap
Commercial dish
washer 2" trap
LAV
10 LPM
shower
1
2
3
4
5
1½" sinks (5)
6
DF
DF
DF
8
2" showers (TYP)
LAV
LAV
BT
7
9
3" emergency
floor drain
10
12
2 1/2" traps (TYP)
13
11
LAV
LAV
LAV
1½"
service
sink
Comm
washers
0.3 L/s
17
Comm
washers
0.3 L/s
16
19
LAV
LAV
25
Comm
3" sink
15
18
LAV
20
Flush tank WCs (TYP)
26
3" traps
(2)
14
Siphon
jet
urinals
24
27
Siphon
jet
urinals
23
Siphon
jet
urinals
22
Siphon
jet
urinals
21
28
29
30
1 m
2P-6
All LAVs domestic = 1 FU
All water closets = 4 FU
Grade = 1 : 100

Figure 2P-6

Table 3

Number	Name	Fixture Units	Size
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			

Answer Key: Self-Test D-1.5 (#chapter-answer-key-self-test-d-1-5) is on the next page.

Answer Key: Self-Test D-1.5

1. Figure 2P-4

Table 1 Answers

Number	Name	Fixture Units	Size
1	Fixture drain	2	2 in.
2	Fixture drain	3	2 in.
3	Branch	5	2 in.
4	Fixture drain	3	2 in.
5	Branch	8	3 in.
6	Fixture drain	3	2 in.
7	Branch	11	3 in.
8	Trap arm — Fixture drain	1	1.25 in.
9	Branch	2	1.25 in.
10	Branch	13	3 in.
11	Trap arm — Fixture drain	1	1.25 in.
12	Branch	2	1.25 in.
13	Branch	15	3 in.

2. Figure 2P-5

Table 2 Answers

Number	Name	Fixture Units	Size
1	Fixture drain	6.34	3 in.
2	Trap arm — Fixture drain	4	2 in.
3	Branch	8	3 in.
4	Branch	14.34	3 in.
5	Branch	7	3 in.
6	Stack	21.34	4 in.
7	Branch	8	3 in.
8	Fixture drain	3	2 in.
9	Stack	32.34	4 in.
10	Branch	9	3 in.
11	Trap arm — Fixture drain	6	3 in.
12	Branch	21	3 in.
13	Branch	27	4 in.
14	Branch	32	4 in.
15	Branch	1	1.25 in.
16	Stack	65.34	4 in.
17	Sanitary building drain	65.34	4 in.
18	Sanitary building sewer	65.34	4 in.

3. Figure 2P-6

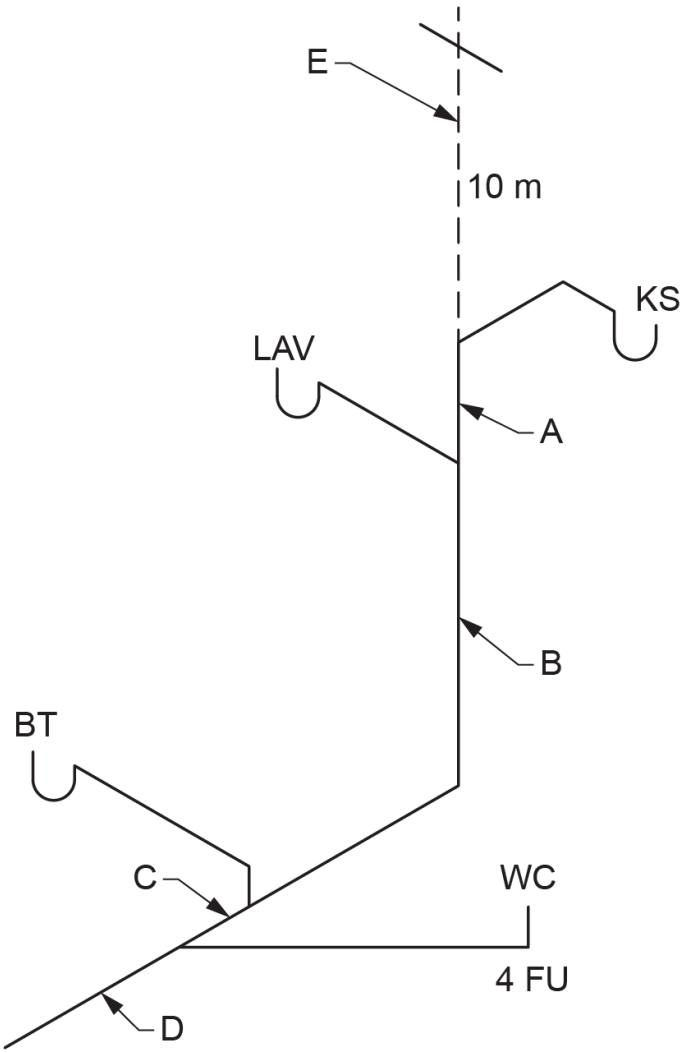
Table 3 Answers

Number	Name	Fixture Units	Size
1	Branch	8	3 in.
2	Branch	11	3 in.
3	Branch	13	3 in.
4	Stack	13	3 in.
5	Branch	4.5	2 in.
6	Branch	8.5	3 in.
7	Stack	22	3 in.
8	Branch	6	2 in.
9	Branch	15	3 in.
10	Branch	7	3 in.
11	Stack	44	4 in.
12	Branch	8	3 in.
13	Branch	20	3 in.
14	Branch	10	3 in.
15	Branch	13	3 in.
16	Branch	32.02	4 in.
17	Branch	51.04	4 in.
18	Stack	119.04	4 in.
19	Branch	4	2 in.
20	Branch	7.5	3 in.
21	Branch	8	3 in.
22	Branch	16	3 in.
23	Branch	24	3 in.
24	Branch	32	4 in.
25	Fixture drain	4	3 in.
26	Branch	16	4 in.
27	Branch	24	4 in.
28	Stack	183.54	4 in.
29	Sanitary building drain	183.54	4 in.
30	Sanitary building sewer	183.54	4 in.

Self-Test D-1.6 Sizing Single-Storey Vents

Complete Self-Test D-1.6 and check your answers.

1. Using Figure 2P-7, fill in Table 1 by identifying and sizing the wet vent installation as per the NPC.



2P-7

Figure 2P-7

Table 1

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				

2. Using Figure 2P-8, fill in Table 2 by identifying and sizing the wet vent installation as per the NPC.

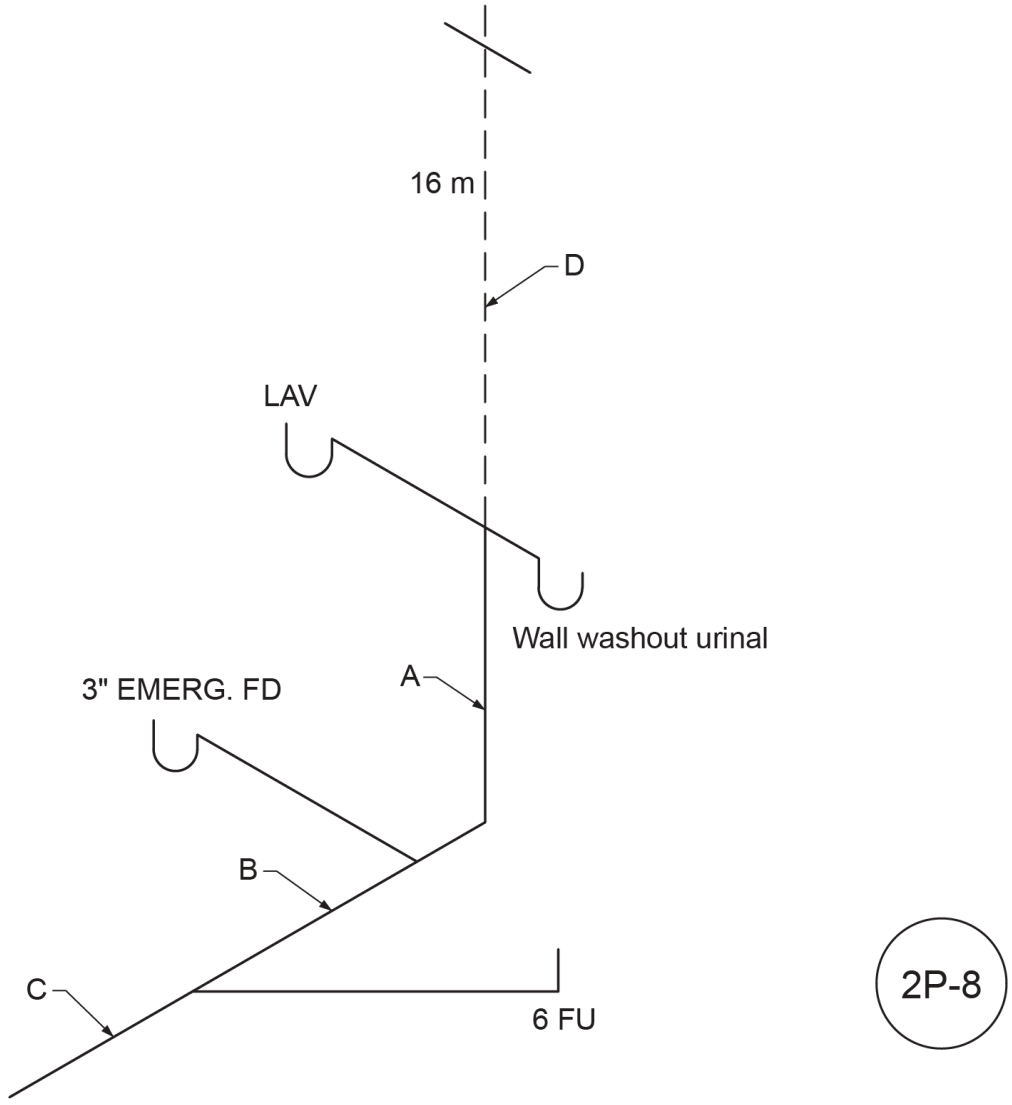


Figure 2P-8

Table 2

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				

3. Using Figure 2P-9, fill in Table 3 by identifying and sizing the wet vent installation as per the NPC.

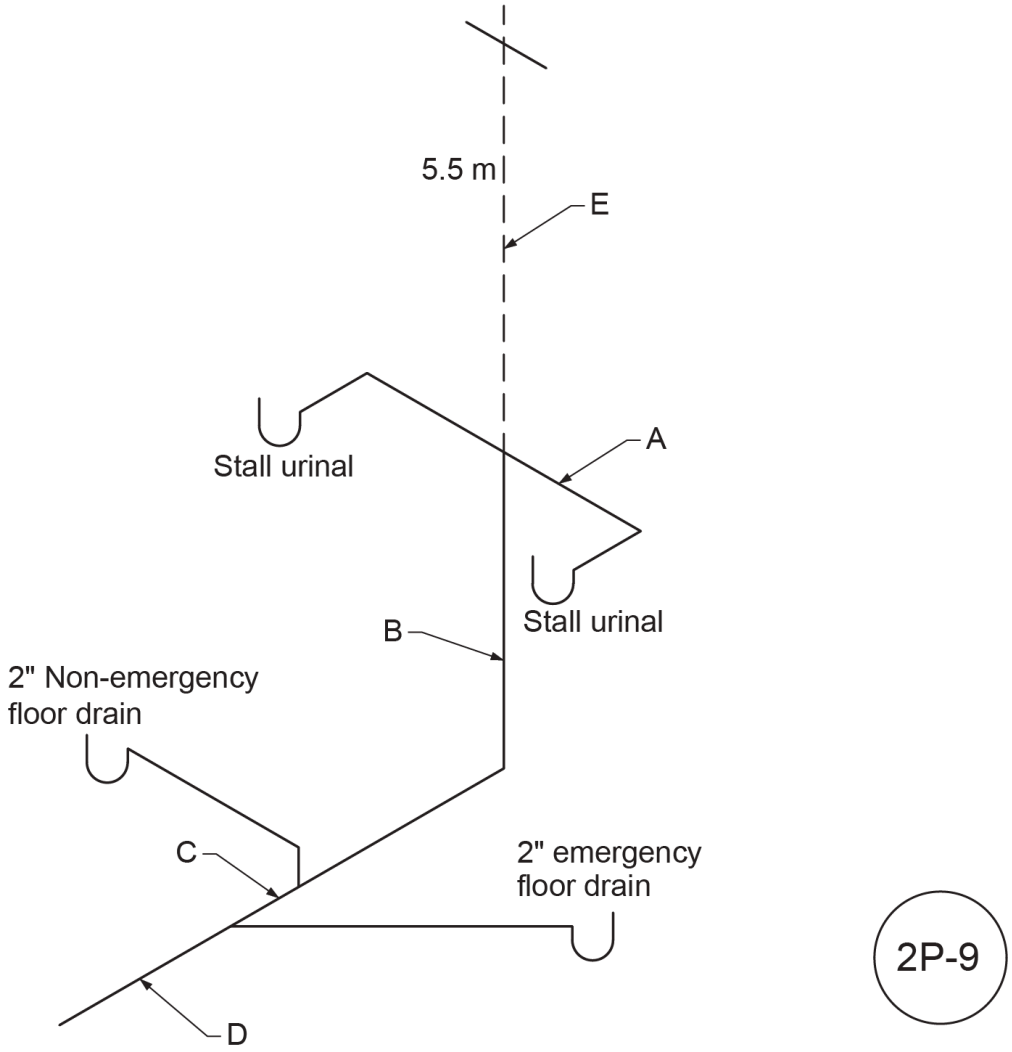


Figure 2P-9

Table 3

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				

4. Using Figure 4, fill in Table 4 by identifying and sizing the wet vent installation as per the NPC.

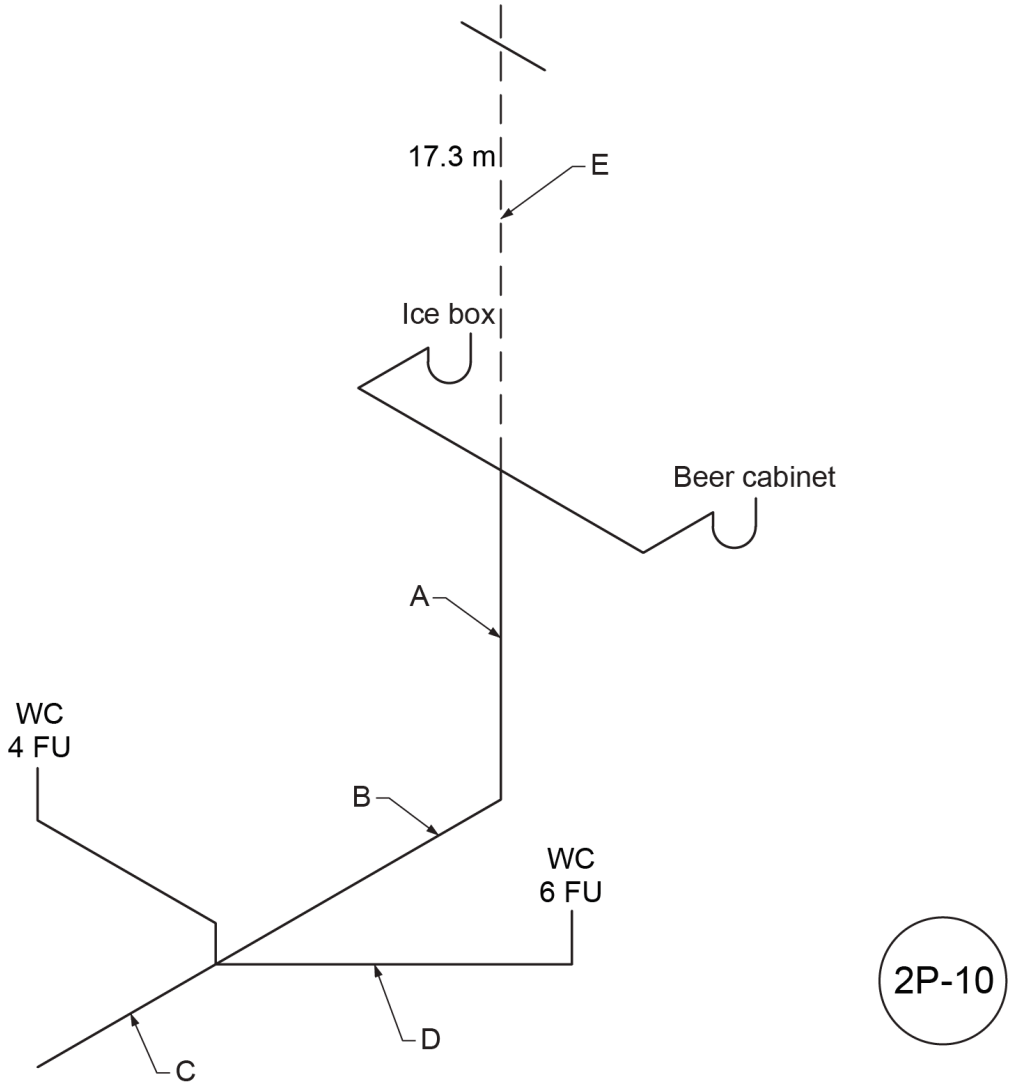


Figure 2P-10

Table 4

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				‘

5. Using Figure 2P-11, fill in Table 5 by identifying and sizing the wet vent installation as per the NPC.

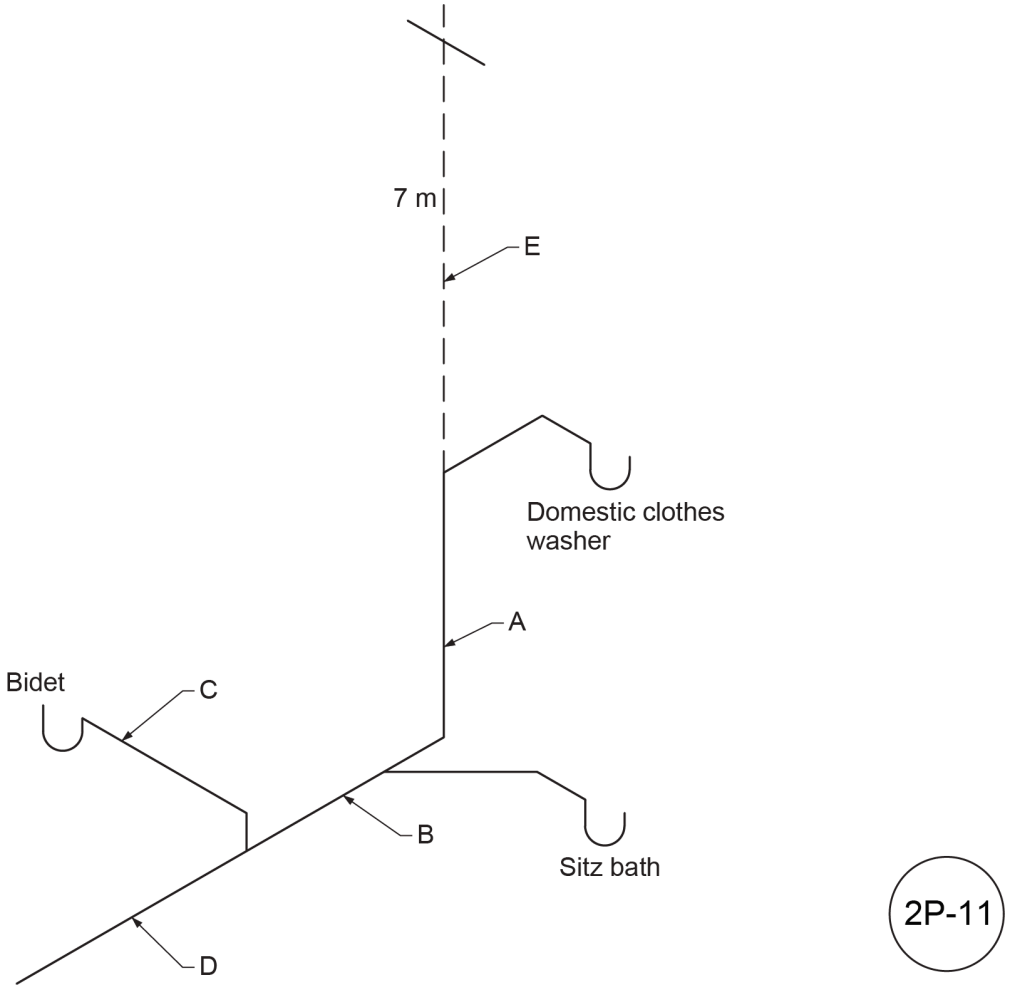


Figure 2P-11

Table 5

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				

6. Using Figure 2P-12, fill in Table 6 by identifying and sizing the wet vent installation as per the NPC.

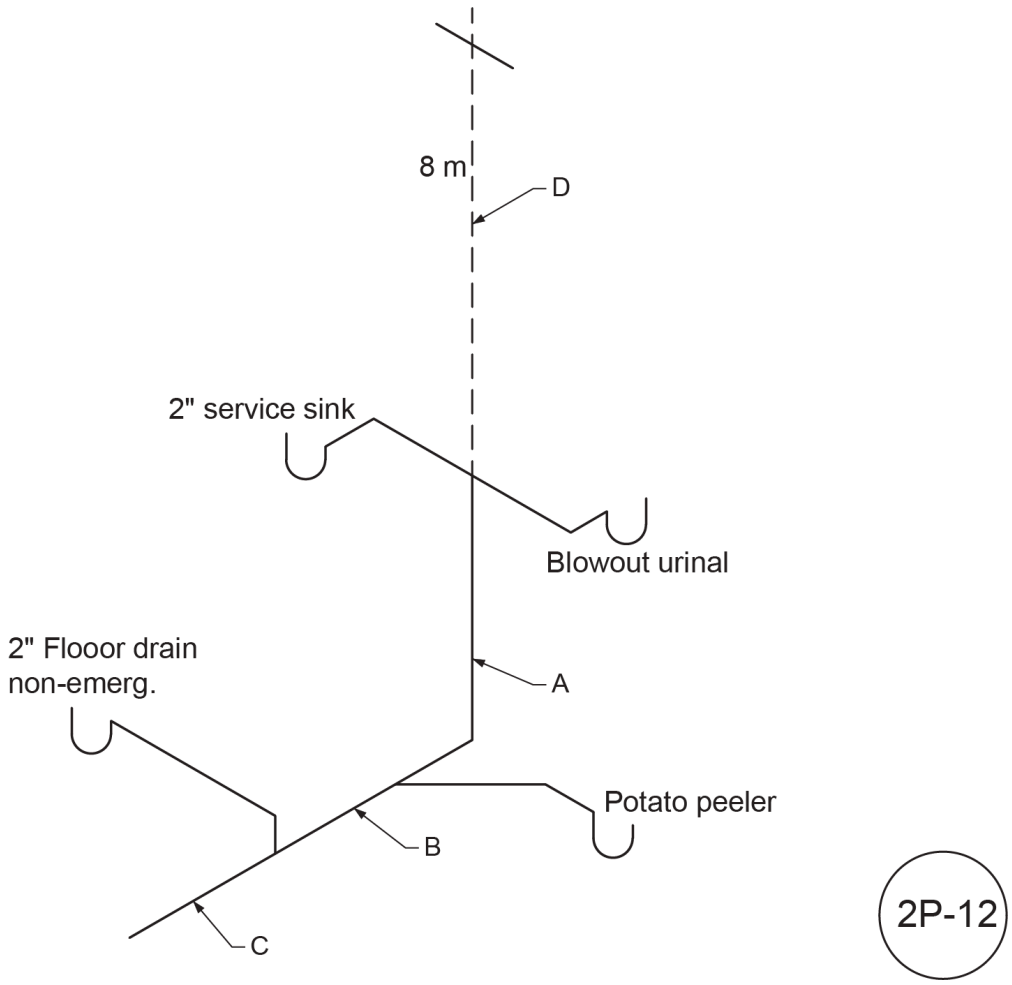


Figure 2P-12

Table 6

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				

7. Using Figure 2P-13, fill in Table 7 by identifying and sizing the wet vent installation as per the NPC.

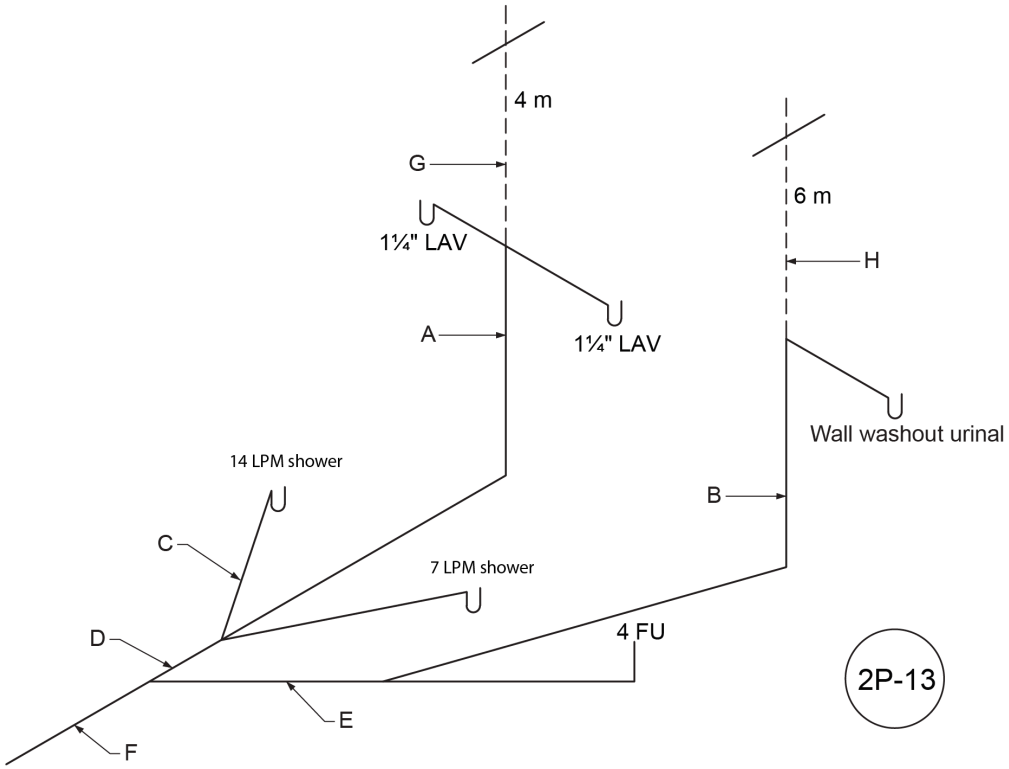


Figure 2P-13

Table 7

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				
H				

8. Using Figure 2P-14, fill in Table 8 by identifying and sizing the wet vent installation as per the NPC.

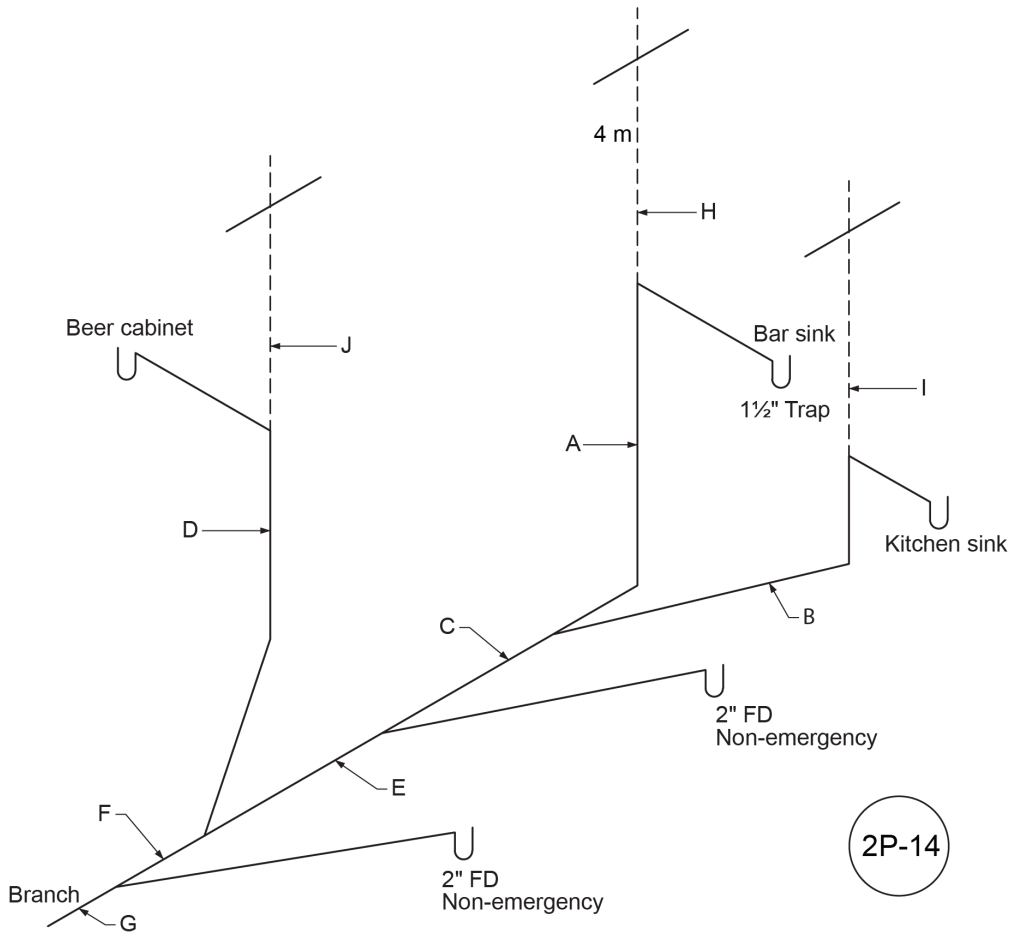


Figure 2P-14

Table 8

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				

9. Using Figure 2P-15, fill in Table 9 by identifying and sizing the wet vent installation as per the NPC.

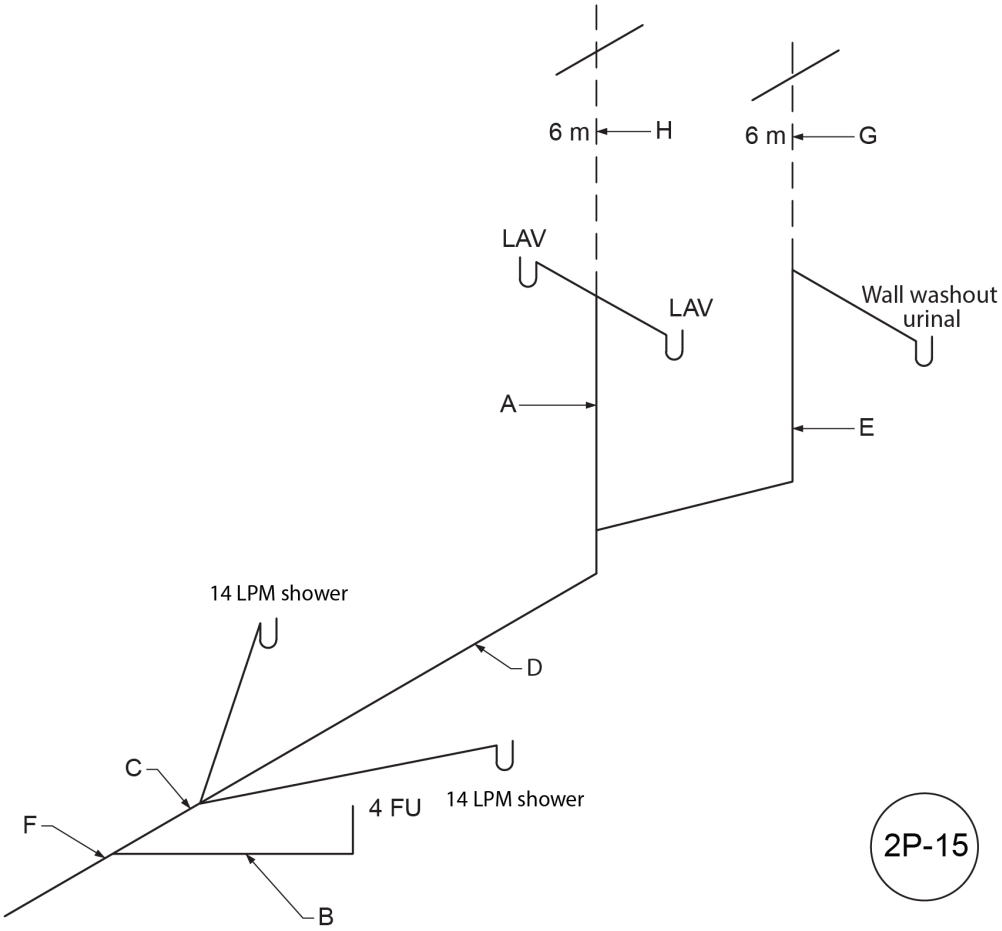


Figure 2P-15

Table 9

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				
H				

10. Using Figure 2P-16, fill in Table 10 by identifying and sizing the wet vent installation as per the NPC.

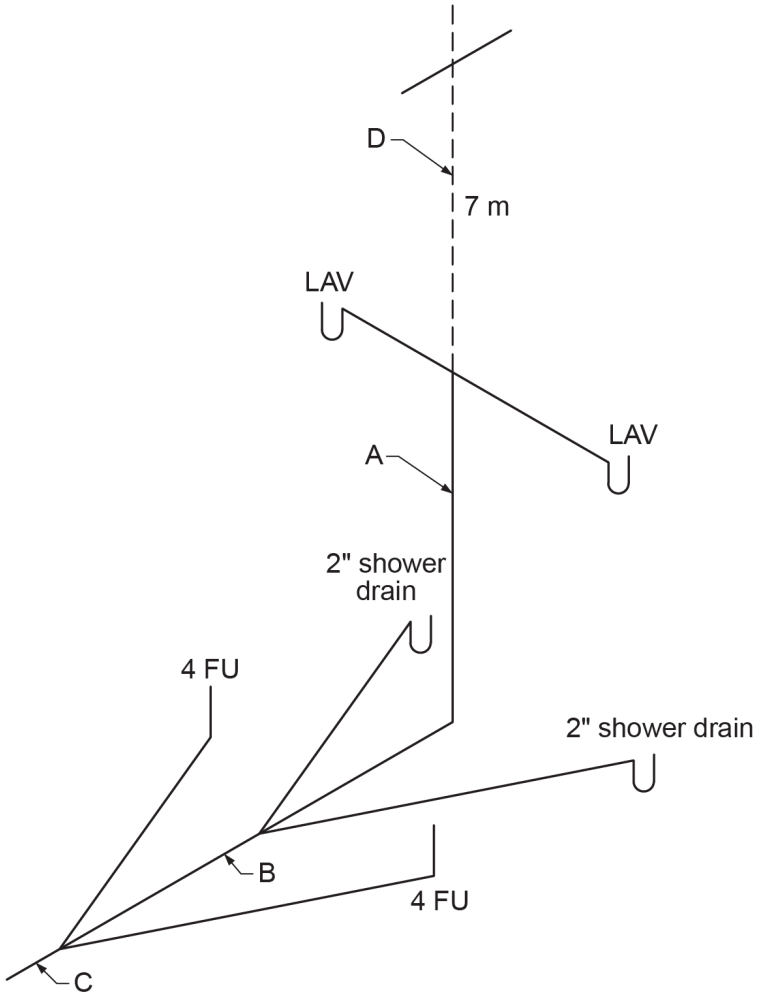


Figure 2P-16

Table 10

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				

11. Using Figure 2P-17, fill in Table 11 by identifying and sizing the wet vent installation as per the NPC.

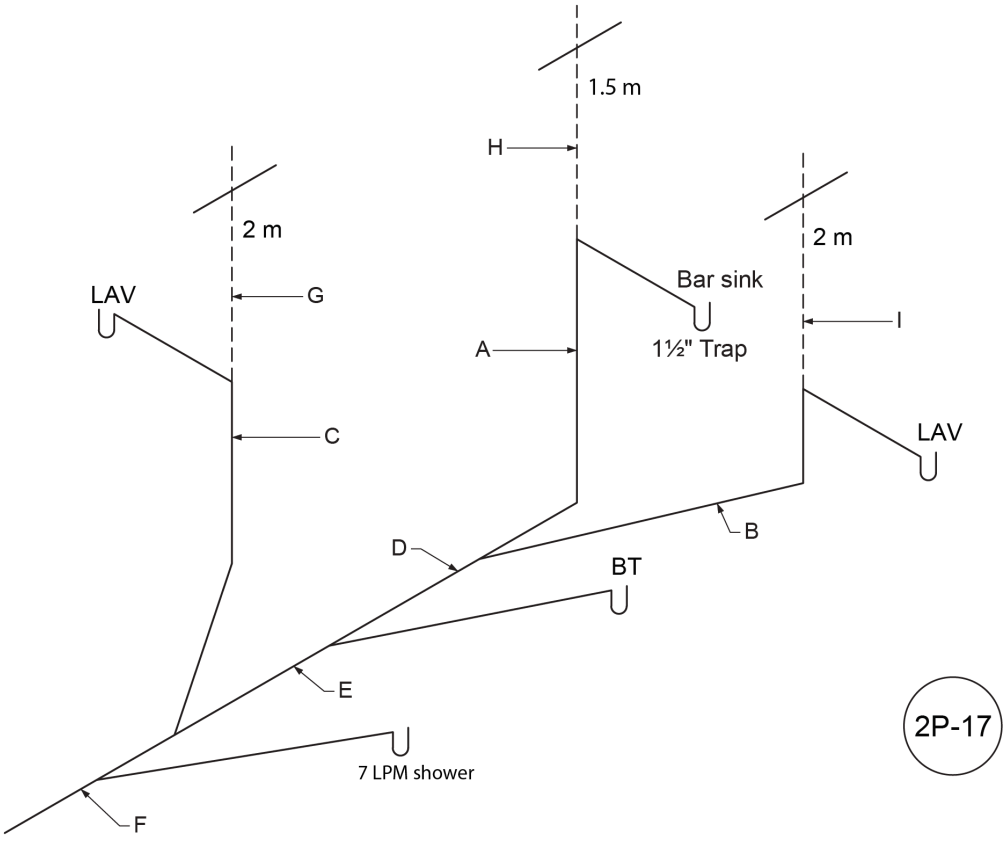


Figure 2P-17

Table 11

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				

Answer Key: Self-Test D-1.6 (#chapter-answer-key-self-test-d-1-6) is on the next page.

Answer Key: Self-Test D-1.6

1. Figure 2P-7

Table 1 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Fixture drain acting as a wet vent	4	N/A	3 in.
B	Branch — Wet vent	4	N/A	3 in.
C	Branch — Wet vent	4	N/A	3 in.
D	Branch	7.5	N/A	3 in.
E	Continuous vent	7.5	10 m	1.5 in.

2. Figure 2P-8

Table 2 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Branch — Wet vent	2.5	N/A	2 in.
B	Branch — Wet vent	2.5	N/A	3 in.
C	Branch	8.5	N/A	3 in.
D	Continuous vent	8.5	16 m	2 in.

3. Figure 2P-9

Table 3 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Trap arm — Fixture drain	2	N/A	2 in.
B	Branch — Wet vent	6	N/A	3 in.
C	Branch — Wet vent	6	N/A	3 in.
D	Branch	6	N/A	3 in.
E	Continuous vent	8	5.5 m	1.5 in.

4. Figure 2P-10

Table 4 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Branch — Wet vent	2.5	N/A	2 in.
B	Branch — Wet vent	2.5	N/A	2 in.
C	Branch	12.5	N/A	3 in.
D	Trap arm — Fixture drain	6	N/A	3 in.
E	Continuous vent	12.5	17.3 m	2 in.

5. Figure 2P-11

Table 5 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Fixture drain acting as a wet vent	3.5	N/A	2 in.
B	Branch — Wet vent	3.5	N/A	2 in.
C	Trap arm — Fixture drain	1	N/A	1.25 in.
D	Branch	4.5	N/A	2 in.
E	Continuous vent	4.5	7 m	1.5 in.

6. Figure 2P-12

Table 6 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Branch — Wet vent	9	N/A	3 in.
B	Branch — Wet vent	9	N/A	3 in.
C	Branch	11	N/A	3 in.
D	Continuous vent	11	8 m	1.5 in.

7. Figure 2P-13

Table 7 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Branch — Wet vent	8	N/A	3 in.
B	Fixture drain	1.5	N/A	1.5 in.
C	Trap arm — Fixture drain	3	N/A	2 in.
D	Branch — Wet vent	8	N/A	3 in.
E	Branch	5.5	N/A	3 in.
F	Branch	11.5	N/A	3 in.
G	Continuous vent	10	4 m	1.5 in.
H	Individual and continuous vent	N/A	N/A	1.25 in.

8. Figure 2P-14

Table 8 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Fixture drain acting as a wet vent	6.5	N/A	3 in.
B	Fixture drain	1.5	N/A	1.5 in.
C	Branch — Wet vent	6.5	N/A	3 in.
D	Fixture drain	1.5	N/A	1.5 in.
E	Branch — Wet vent	6.5	N/A	3 in.
F	Branch — Wet vent	6.5	N/A	3 in.
G	Branch	8.5	N/A	3 in.
H	Continuous vent	5.5	4 m	1.5 in.
I	Individual and continuous vent	N/A	N/A	1.25 in.
J	Individual and continuous vent	N/A	N/A	1.25 in.

9. Figure 2P-15

Table 9 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Branch — Wet vent	9.5	N/A	4 in.
B	Trap arm — Fixture drain	4	N/A	3 in.
C	Branch — Wet vent	9.5	N/A	4 in.
D	Branch — Wet vent	9.5	N/A	4 in.
E	Fixture drain	1.5	N/A	1.5 in.
F	Branch	13.5	N/A	4 in.
G	Individual and continuous vent	N/A	N/A	1.5 in.
H	Continuous vent	12	6 m	1.5 in.

10. Figure 2P-16

Table 10 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Branch — Wet vent	8	N/A	3 in.
B	Branch — Wet vent	8	N/A	3 in.
C	Branch	16	N/A	3 in.
D	Continuous vent	16	7 m	1.5 in.

11. Figure 2P-17

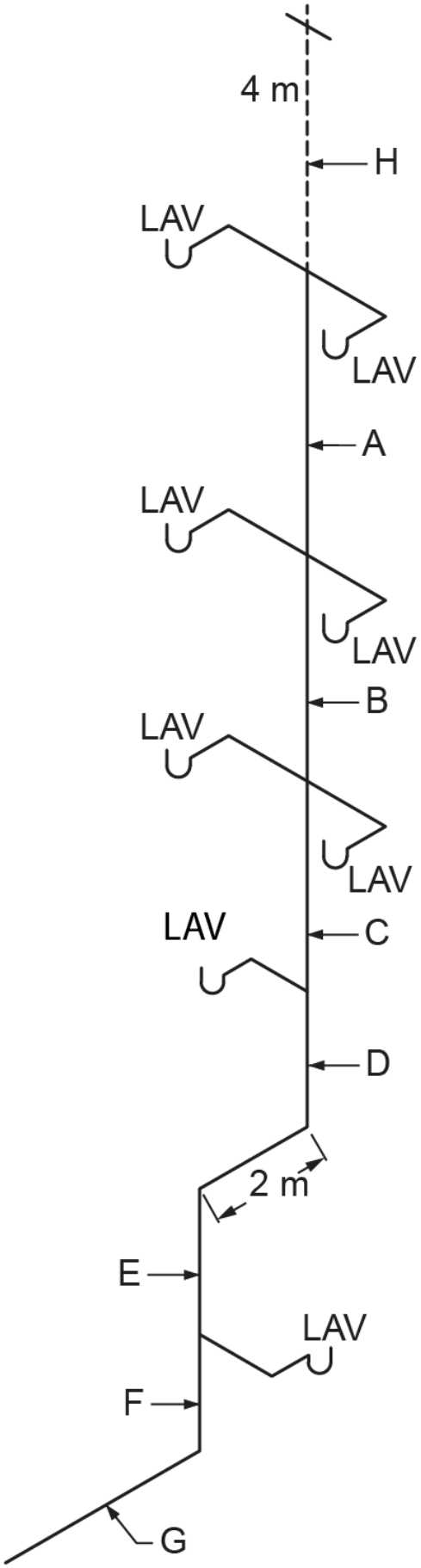
Table 11 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Fixture drain acting as a wet vent	5	N/A	3 in.
B	Fixture drain	1	N/A	1.25 in.
C	Fixture drain	1	N/A	1.25 in.
D	Branch — Wet vent	5	N/A	3 in.
E	Branch — Wet vent	5	N/A	3 in.
F	Branch	6.5	N/A	3 in.
G	Individual and continuous vent	N/A	N/A	1.25 in.
H	Continuous vent	4.5	1.5 m	1.25 in.
I	Individual and continuous vent	N/A	N/A	1.25 in.

Self-Test D-1.7 Multi-Storey Wet Vents

Complete Self-Test D-1.7 and check your answers.

1. Using Figure 2P-18, fill in Table 1 by identifying and sizing the multi-storey wet vent installation as per the NPC.



2P-18

***Figure* 2P-18**

Table 1

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				
H				

2. Using Figure 2P-19, fill in Table 2 by identifying and sizing the multi-storey wet vent installation as per the NPC.

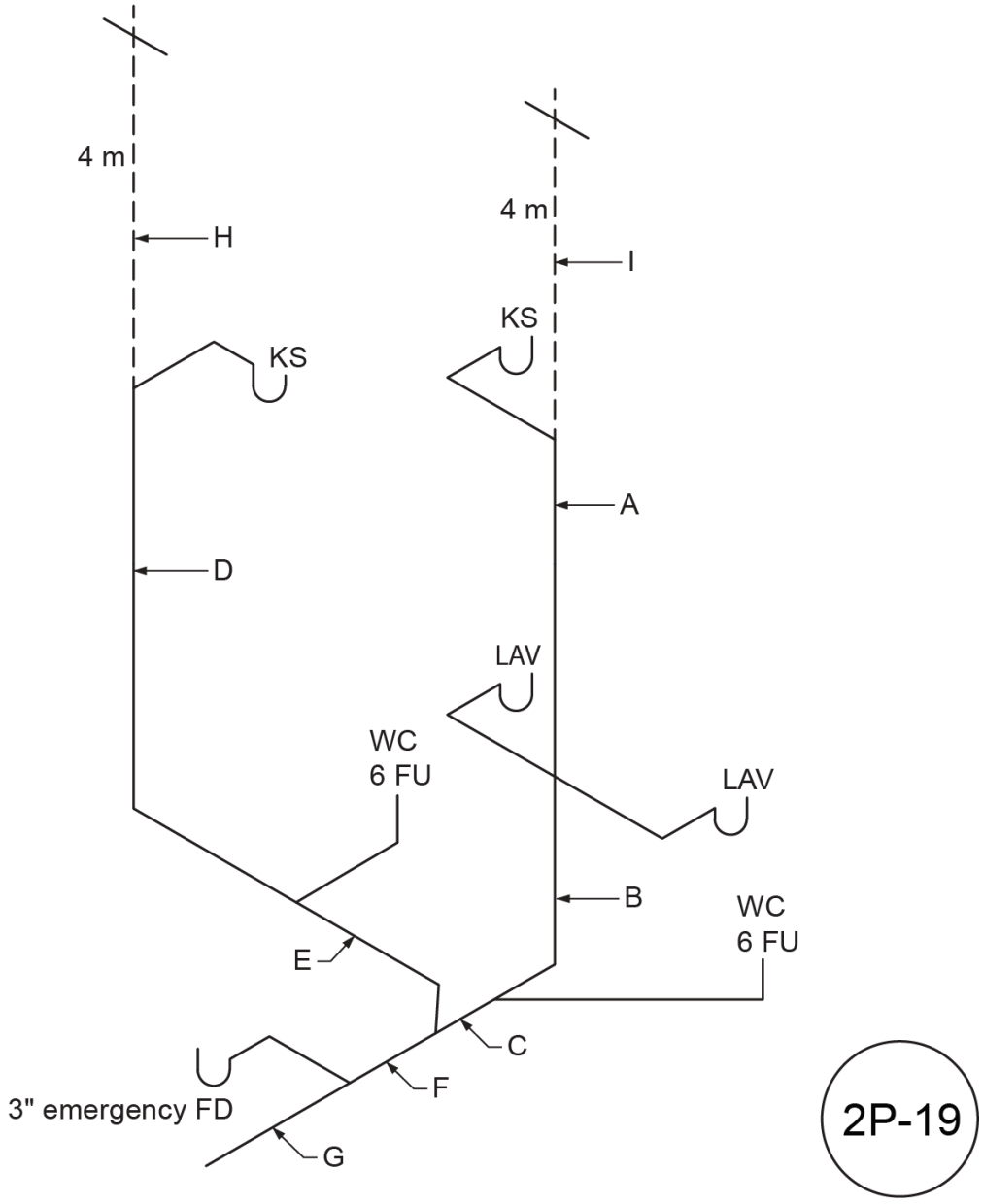


Figure 2P-19

Table 2

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				

3. Using Figure 2P-20, fill in Table 3 by identifying and sizing the multi-storey wet vent installation as per the NPC.

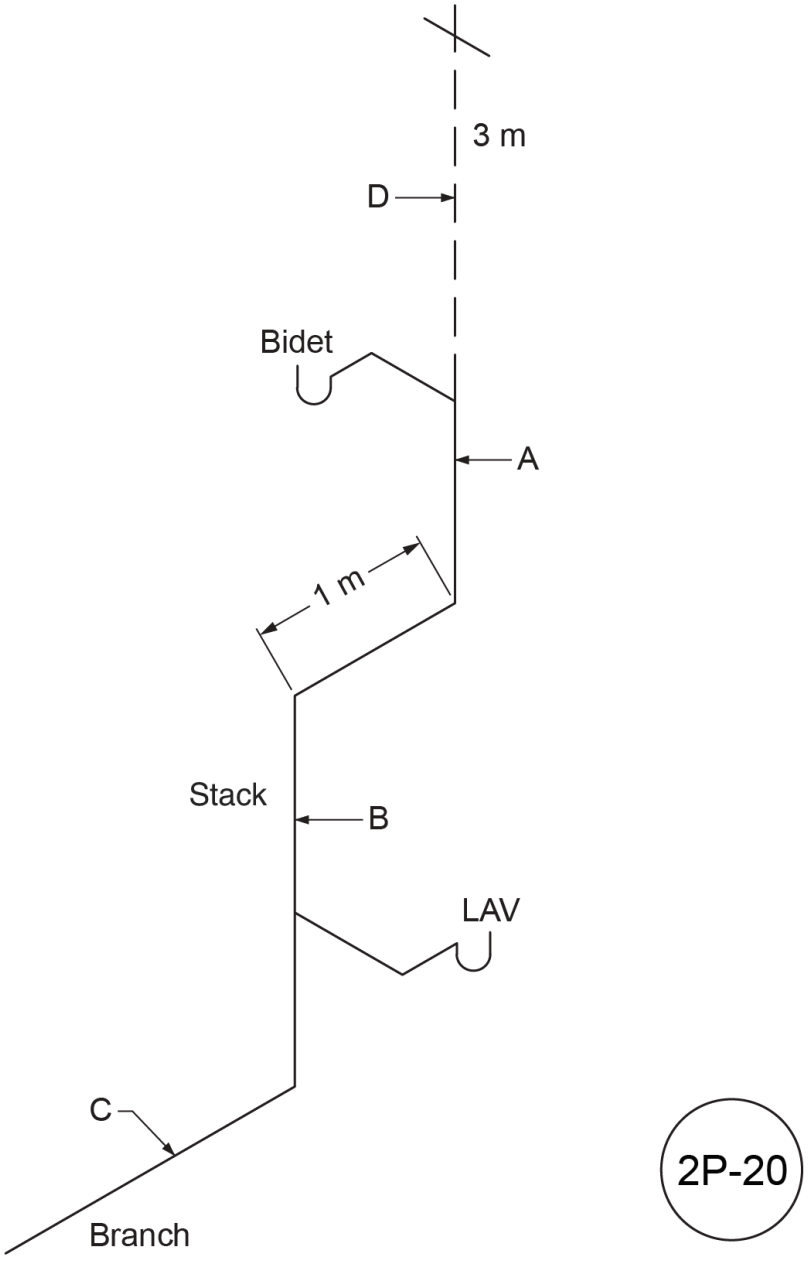


Figure 2P-20

Table 3

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				

4. Using Figure 2P-21, fill in Table 4 by identifying and sizing the multi-storey wet vent installation as per the NPC.

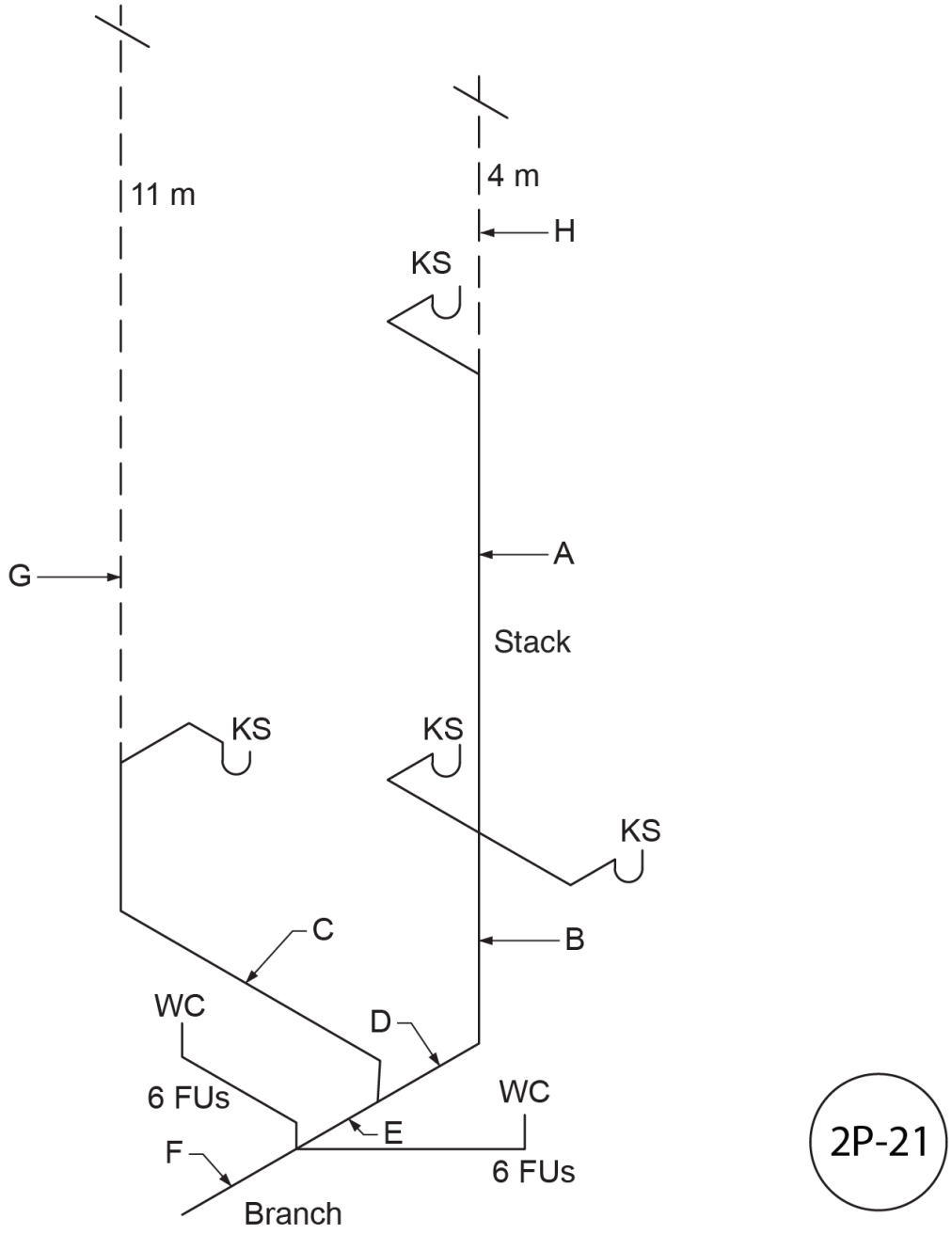
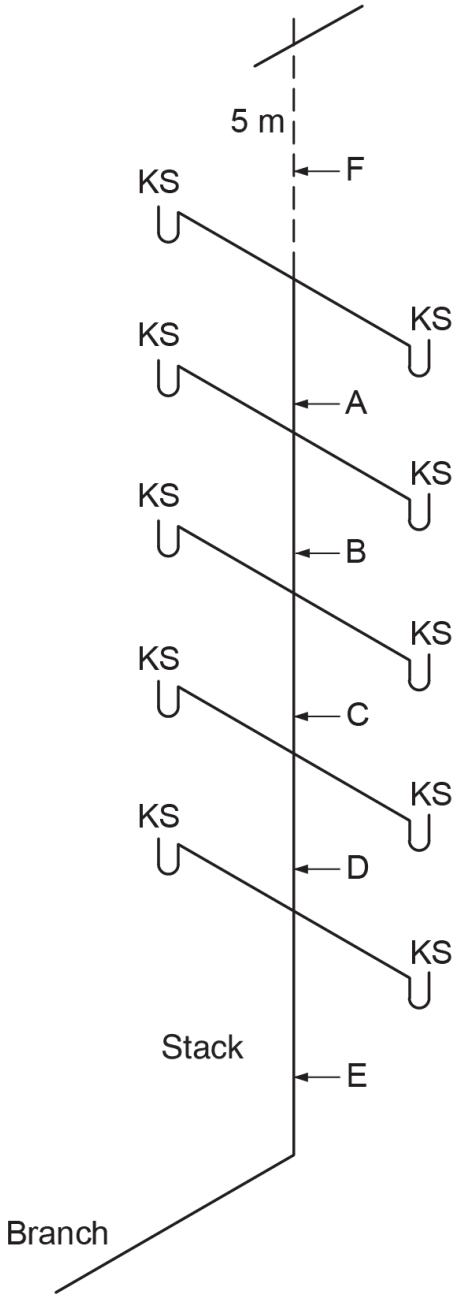


Figure 2P-21

Table 4

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				
H				

5. Using Figure 2P-22, fill in Table 5 by identifying and sizing the multi-storey wet vent installation as per the NPC.



2P-22

Figure 2P-22

Table 5

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				

6. Using Figure 2P-23, fill in Table 6 by identifying and sizing the multi-storey wet vent installation as per the NPC.

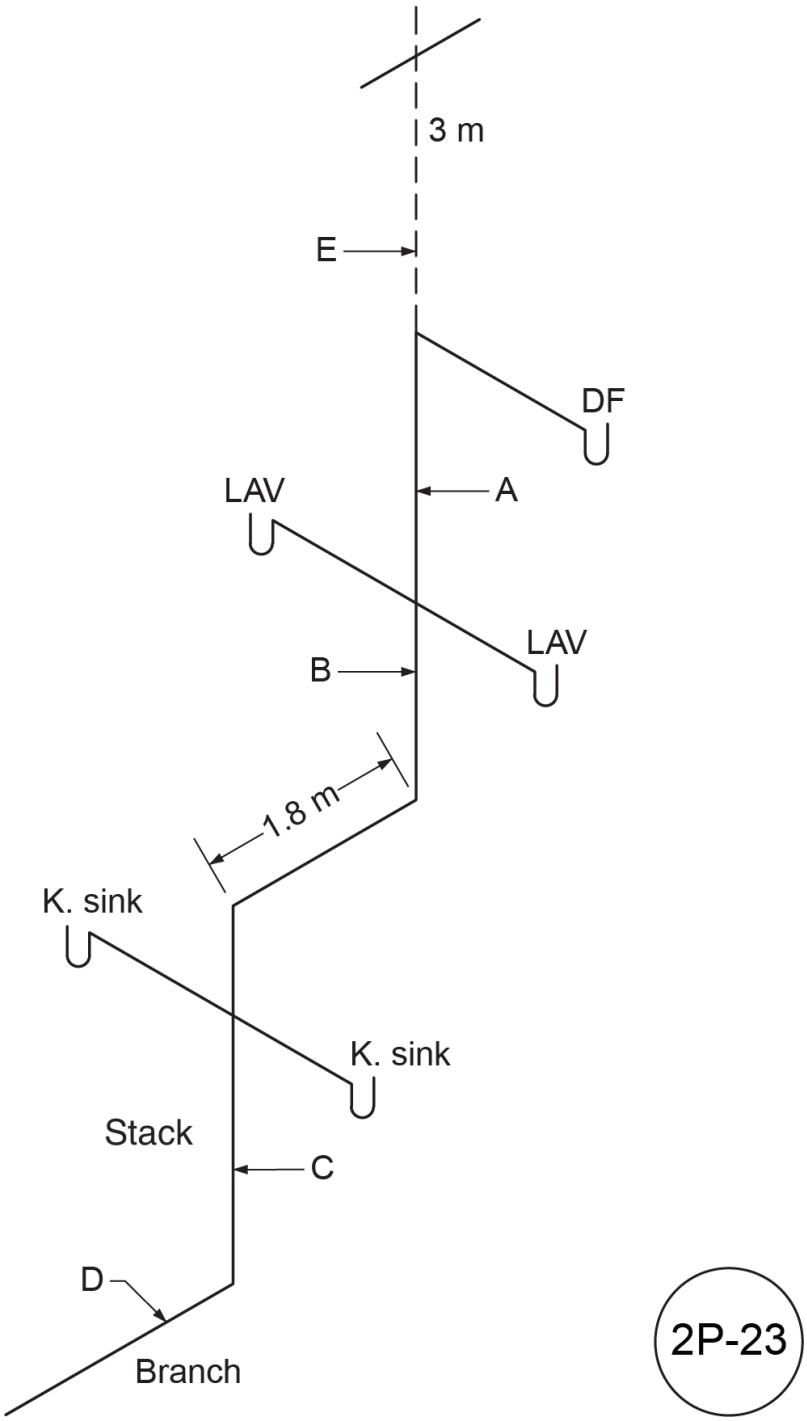


Figure 2P-23

Table 6

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				

7. Using Figure 2P-24, fill in Table 1 by identifying and sizing the multi-storey wet vent installation as per the NPC.

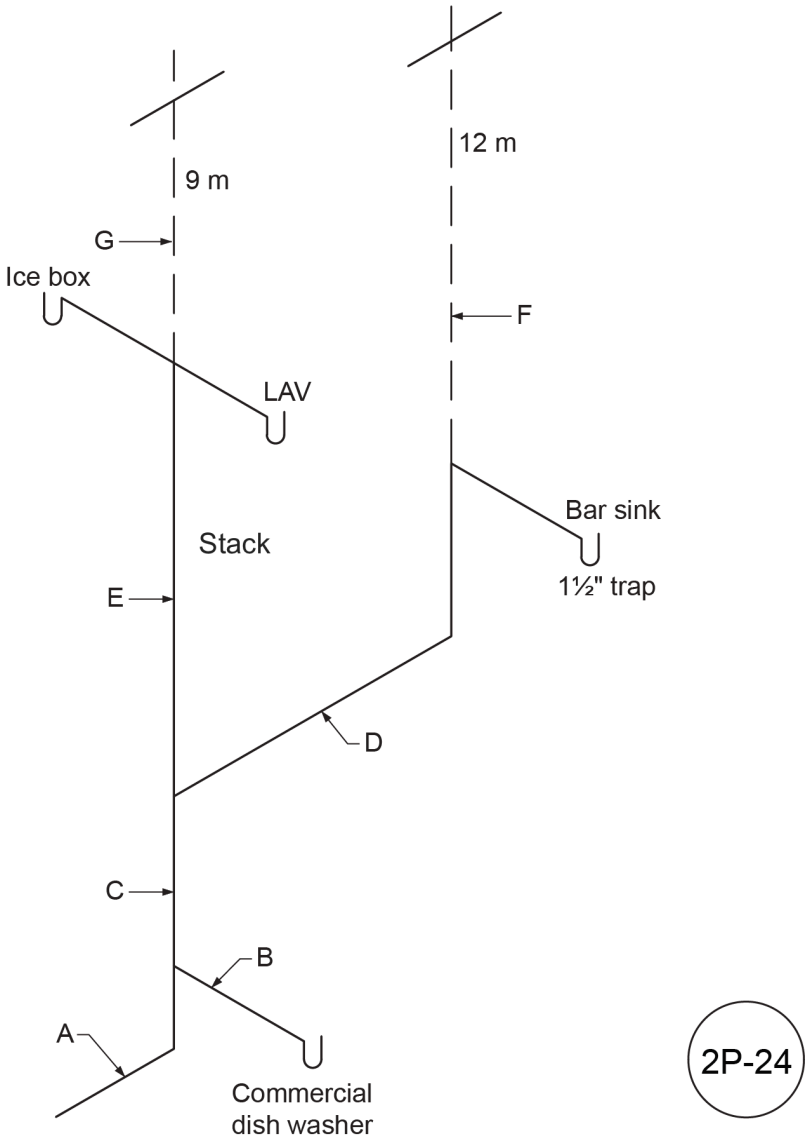


Figure 2P-24

Table 7

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				‘

8. Using Figure 2P-25, fill in Table 8 by identifying and sizing the multi-storey wet vent installation as per the NPC.

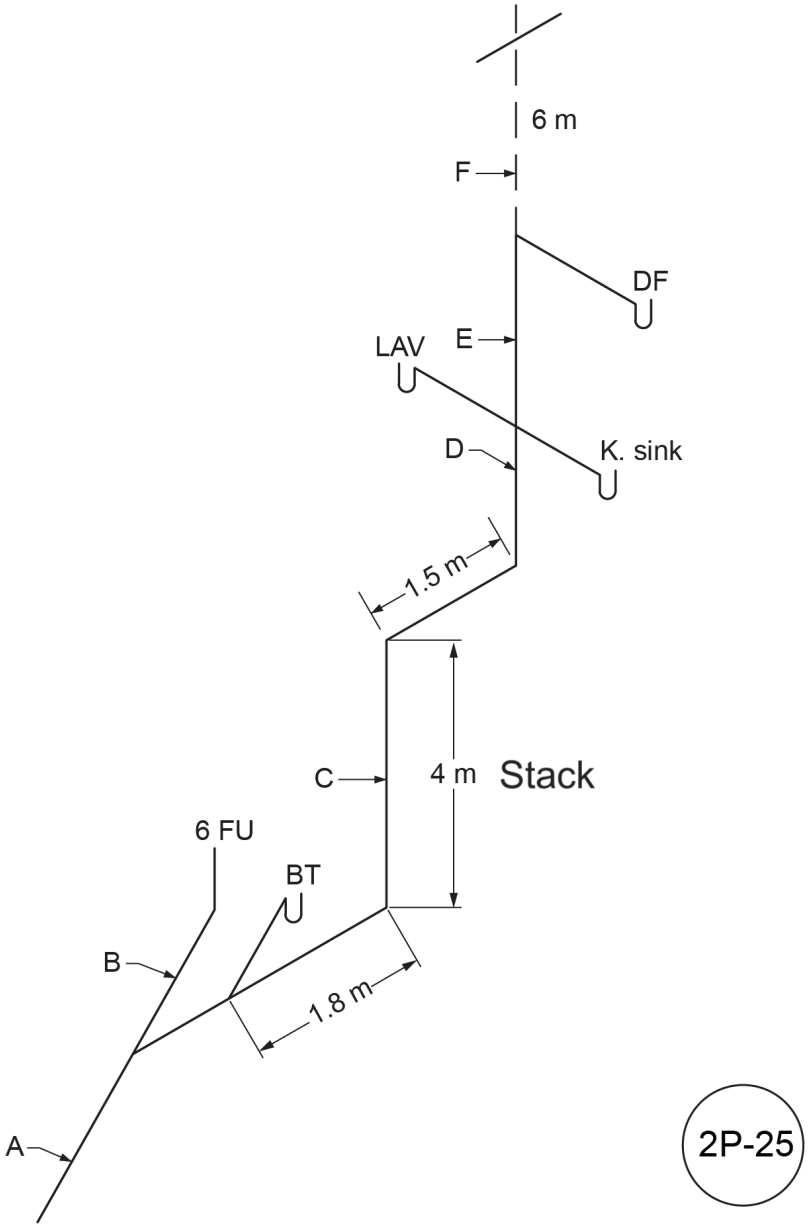
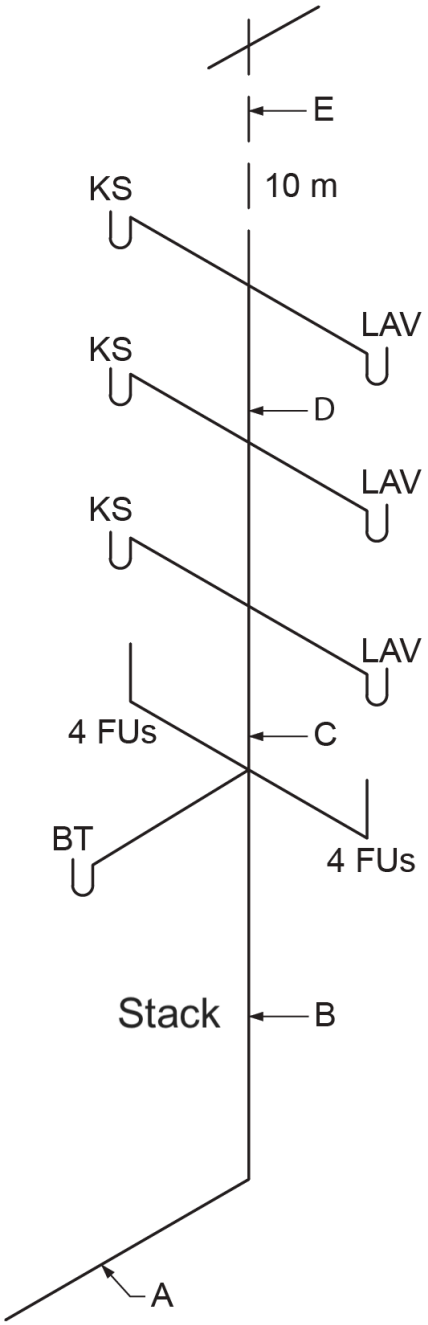


Figure 2P-25

Table 8

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				

9. Using Figure 2P-26, fill in Table 9 by identifying and sizing the multi-storey wet vent installation as per the NPC.



2P-26

Figure 2P-26

Table 9

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				

10. Using Figure 2P-27, fill in Table 10 by identifying and sizing the multi-storey wet vent installation as per the NPC.

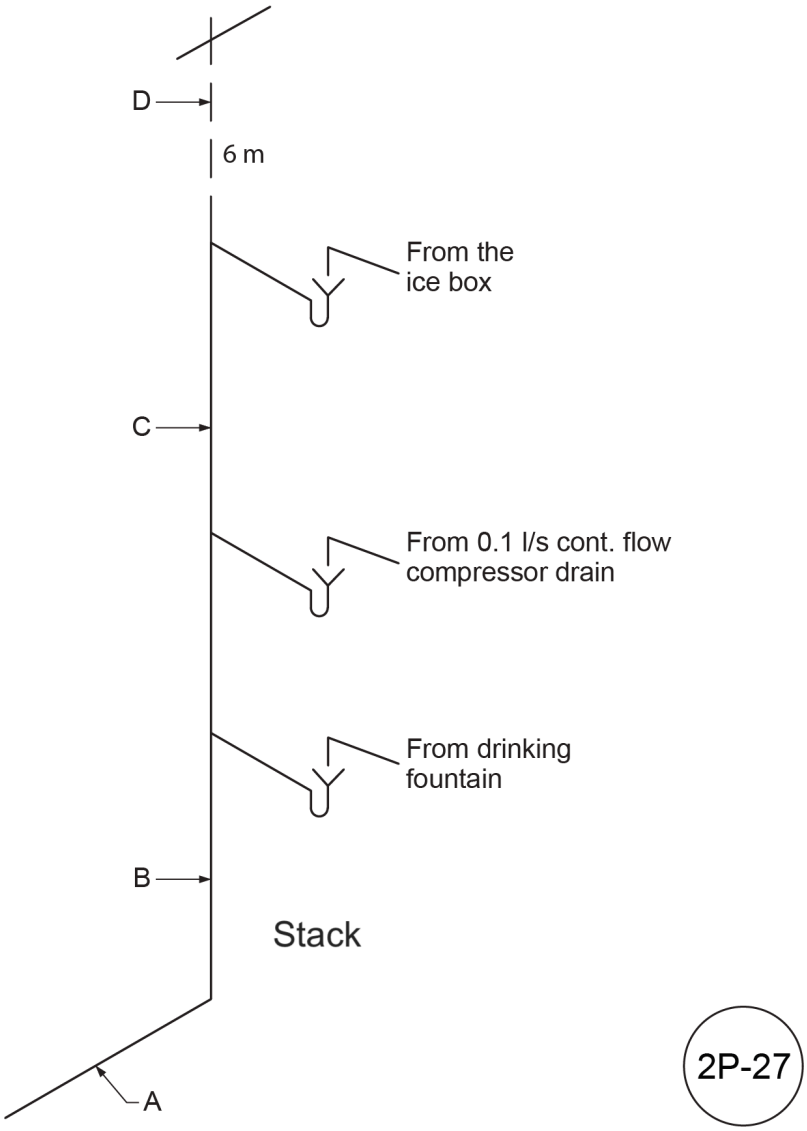


Figure 2P-27

Table 10

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				

Answer Key: Self-Test D-1.7 (#chapter-answer-key-self-test-d-1-7-2) is on the next page.

Answer Key: Self-Test D-1.7

1. Figure 2P-18

Table 1 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Stack acting as a wet vent	7	N/A	3 in.
B	Stack acting as a wet vent	7	N/A	3 in.
C	Stack acting as a wet vent	7	N/A	3 in.
D	Stack acting as a wet vent	7	N/A	3 in.
E	Stack acting as a wet vent	7	N/A	3 in.
F	Stack	8	N/A	3 in.
G	Branch	8	N/A	3 in.
H	Stack vent	8	4 m	3 in.

2. Figure 2P-19

Table 2 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Stack acting as a wet vent	3.5	N/A	3 in.
B	Stack acting as a wet vent	3.5	N/A	3 in.
C	Branch	9.5	N/A	3 in.
D	Stack acting as a wet vent	1.5	N/A	2 in.
E	Branch	7.5	N/A	3 in.
F	Branch	17	N/A	3 in.
G	Branch	17	N/A	3 in.
H	Stack vent	7.5	4 m	1.5 in.
I	Stack vent	9.5	4 m	1.5 in.

3. Figure 2P-20

Table 3 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Stack acting as a wet vent	1	N/A	1.5 in.
B	Stack acting as a wet vent	1	N/A	1.5 in.
C	Branch	2	N/A	1.5 in.
D	Stack vent	2	3 m	1.25 in.

4. Figure 2P-21

Table 4 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Stack acting as a wet vent	6	N/A	3 in.
B	Stack acting as a wet vent	6	N/A	3 in.
C	Fixture drain	1.5	N/A	1.5 in.
D	Branch – Wet vent	6	N/A	3 in.
E	Branch – Wet vent	6	N/A	3 in.
F	Branch	18	N/A	3 in.
G	Individual and continuous vent	N/A	N/A	1.25 in.
H	Stack vent	16.5	4 m	1.5 in.

5. Figure 2P-22

Table 5 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Stack acting as a wet vent	12	N/A	3 in.
B	Stack acting as a wet vent	12	N/A	3 in.
C	Stack acting as a wet vent	12	N/A	3 in.
D	Stack acting as a wet vent	12	N/A	3 in.
E	Stack	15	N/A	3 in.
F	Stack vent	15	5 m	3 in.

6. Figure 2P-23

Table 6 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Stack acting as a wet vent	2.5	N/A	3 in.
B	Stack acting as a wet vent	2.5	N/A	3 in.
C	Stack	5.5	N/A	3 in.
D	Branch	5.5	N/A	3 in.
E	Stack vent	5.5	3 m	1.5 in.

7. Figure 2P-24

Table 7 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Branch	6.5	N/A	2.5 in.
B	Trap arm — Fixture drain	3	N/A	2 in.
C	Stack acting as a wet vent	3.5	N/A	2 in.
D	Fixture drain	1.5	N/A	1.5 in.
E	Stack acting as a wet vent	3.5	N/A	2 in.
F	Individual and continuous vent	N/A	N/A	1.25 in.
G	Stack vent	5	9 m	1.5 in.

8. Figure 2P-25

Table 8 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Branch	10.5	N/A	3 in.
B	Trap arm — Fixture drain	6	N/A	3 in.
C	Stack acting as a wet vent	4.5	N/A	3 in.
D	Stack acting as a wet vent	4.5	N/A	3 in.
E	Stack acting as a wet vent	4.5	N/A	3 in.
F	Stack vent	10.5	6 m	1.5 in.

9. Figure 2P-26

Table 9 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Branch	17	N/A	3 in.
B	Stack	17	N/A	3 in.
C	Stack acting as a wet vent	7.5	N/A	3 in.
D	Stack acting as a wet vent	7.5	N/A	3 in.
E	Stack vent	17	10 m	1.5 in.

10. Figure 2P-27

Table 10 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Branch	4.67	N/A	3 in.
B	Stack	4.67	N/A	3 in.
C	Stack acting as a wet vent	4.17	N/A	3 in.
D	Stack vent	4.67	6 m	1.5 in.

Answer Key: Self-Test D-1.7 is on the next page.

Answer Key: Self-Test D-1.7

1. Figure 2P-18

Table 1 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Stack acting as a wet vent	7	N/A	3 in.
B	Stack acting as a wet vent	7	N/A	3 in.
C	Stack acting as a wet vent	7	N/A	3 in.
D	Stack acting as a wet vent	7	N/A	3 in.
E	Stack acting as a wet vent	7	N/A	3 in.
F	Stack	8	N/A	3 in.
G	Branch	8	N/A	3 in.
H	Stack vent	8	4 m	3 in.

2. Figure 2P-19

Table 2 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Stack acting as a wet vent	3.5	N/A	3 in.
B	Stack acting as a wet vent	3.5	N/A	3 in.
C	Branch	9.5	N/A	3 in.
D	Stack acting as a wet vent	1.5	N/A	2 in.
E	Branch	7.5	N/A	3 in.
F	Branch	17	N/A	3 in.
G	Branch	17	N/A	3 in.
H	Stack vent	7.5	4 m	1.5 in.
I	Stack vent	9.5	4 m	1.5 in.

3. Figure 2P-20

Table 3 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Stack acting as a wet vent	1	N/A	1.5 in.
B	Stack acting as a wet vent	1	N/A	1.5 in.
C	Branch	2	N/A	1.5 in.
D	Stack vent	2	3 m	1.25 in.

4. Figure 2P-21

Table 4 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Stack acting as a wet vent	6	N/A	3 in.
B	Stack acting as a wet vent	6	N/A	3 in.
C	Fixture drain	1.5	N/A	1.5 in.
D	Branch – Wet vent	6	N/A	3 in.
E	Branch – Wet vent	6	N/A	3 in.
F	Branch	18	N/A	3 in.
G	Individual and continuous vent	N/A	N/A	1.25 in.
H	Stack vent	16.5	4 m	1.5 in.

5. Figure 2P-22

Table 5 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Stack acting as a wet vent	12	N/A	3 in.
B	Stack acting as a wet vent	12	N/A	3 in.
C	Stack acting as a wet vent	12	N/A	3 in.
D	Stack acting as a wet vent	12	N/A	3 in.
E	Stack	15	N/A	3 in.
F	Stack vent	15	5 m	3 in.

6. Figure 2P-23

Table 6 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Stack acting as a wet vent	2.5	N/A	3 in.
B	Stack acting as a wet vent	2.5	N/A	3 in.
C	Stack	5.5	N/A	3 in.
D	Branch	5.5	N/A	3 in.
E	Stack vent	5.5	3 m	1.5 in.

7. Figure 2P-24

Table 7 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Branch	6.5	N/A	2.5 in.
B	Trap arm — Fixture drain	3	N/A	2 in.
C	Stack acting as a wet vent	3.5	N/A	2 in.
D	Fixture drain	1.5	N/A	1.5 in.
E	Stack acting as a wet vent	3.5	N/A	2 in.
F	Individual and continuous vent	N/A	N/A	1.25 in.
G	Stack vent	5	9 m	1.5 in.

8. Figure 2P-25

Table 8 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Branch	10.5	N/A	3 in.
B	Trap arm — Fixture drain	6	N/A	3 in.
C	Stack acting as a wet vent	4.5	N/A	3 in.
D	Stack acting as a wet vent	4.5	N/A	3 in.
E	Stack acting as a wet vent	4.5	N/A	3 in.
F	Stack vent	10.5	6 m	1.5 in.

9. Figure 2P-26

Table 9 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Branch	17	N/A	3 in.
B	Stack	17	N/A	3 in.
C	Stack acting as a wet vent	7.5	N/A	3 in.
D	Stack acting as a wet vent	7.5	N/A	3 in.
E	Stack vent	17	10 m	1.5 in.

10. Figure 2P-27

Table 10 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Branch	4.67	N/A	3 in.
B	Stack	4.67	N/A	3 in.
C	Stack acting as a wet vent	4.17	N/A	3 in.
D	Stack vent	4.67	6 m	1.5 in.

Self-Test D-1.8 Sizing Branch and Circuit Vents

Complete Self-Test D-1.8 and check your answers.

1. Using Figure 2P-28, fill in Table 1 by identifying and sizing the circuit vent installation as per the NPC.

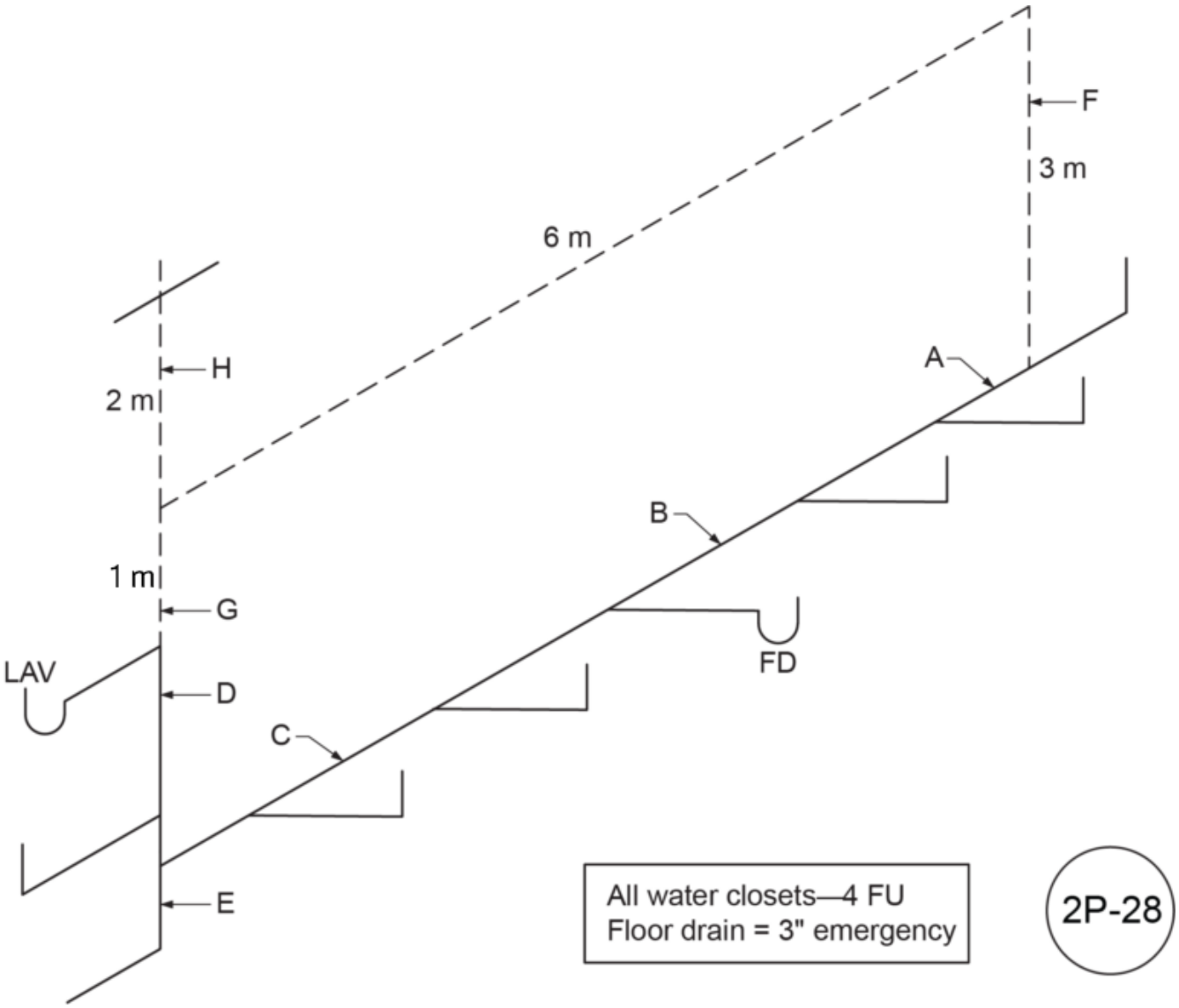


Figure 2P-28

Table 1

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				
H				

1. Using Figure 2P-29, fill in Table 2 by identifying and sizing the circuit vent installation as per the NPC.

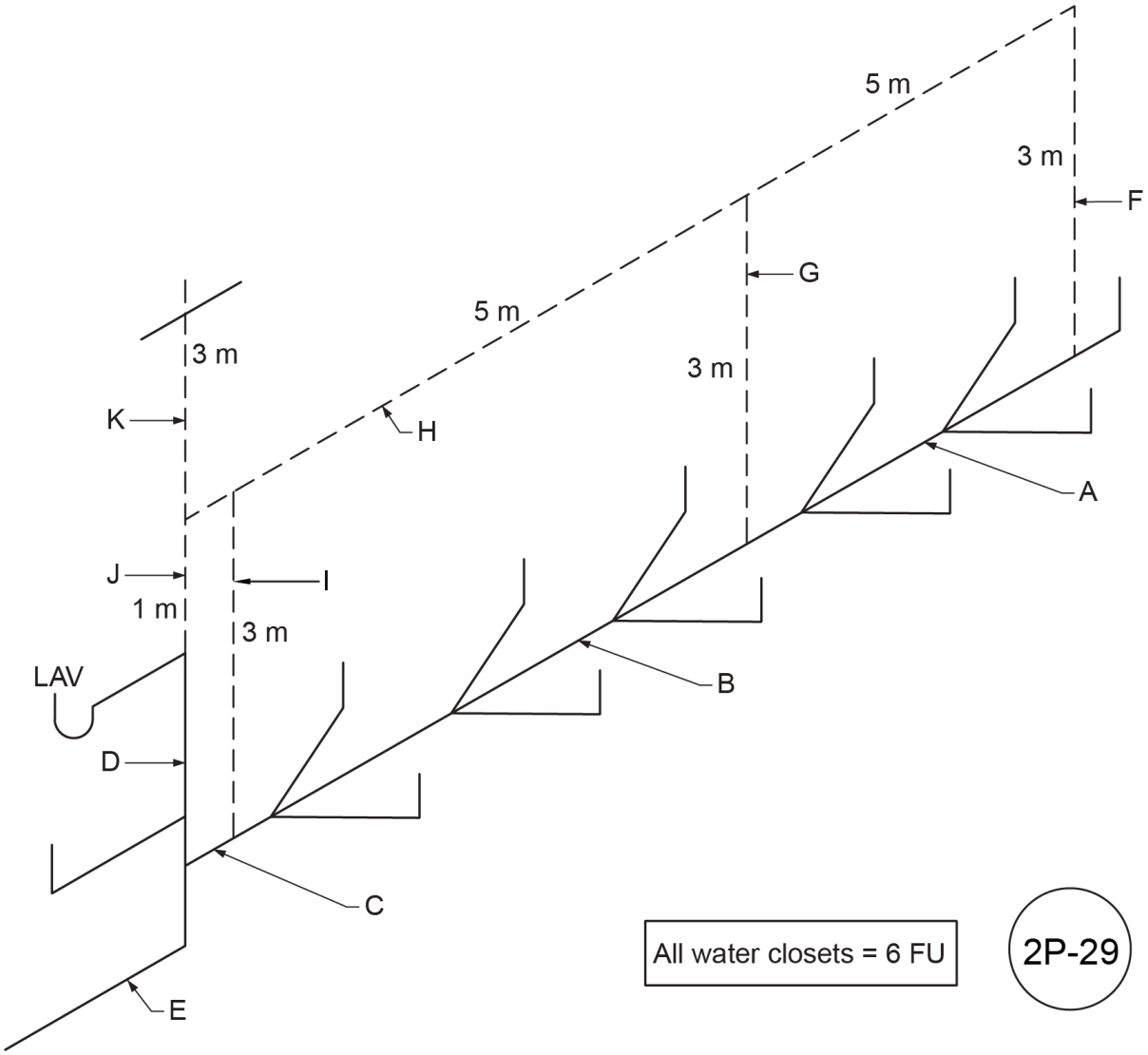


Figure 2P-29

Table 2

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				

1. Using Figure 2P-30, fill in Table 3 by identifying and sizing the circuit vent installation as per the NPC.

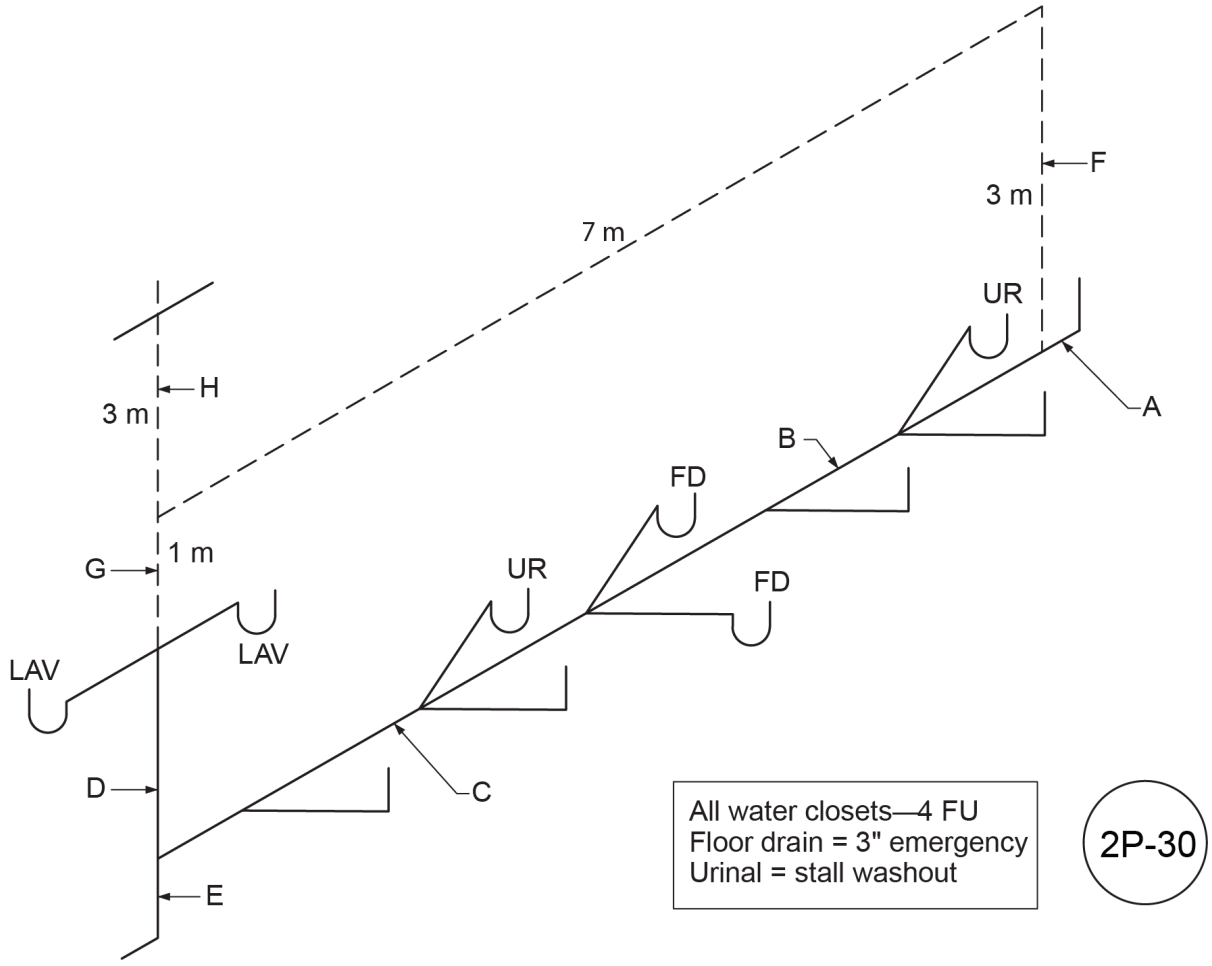


Figure 2P-30

Table 3

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				
H				

1. Using Figure 2P-31, fill in Table 4 by identifying and sizing the circuit vent installation as per the NPC.

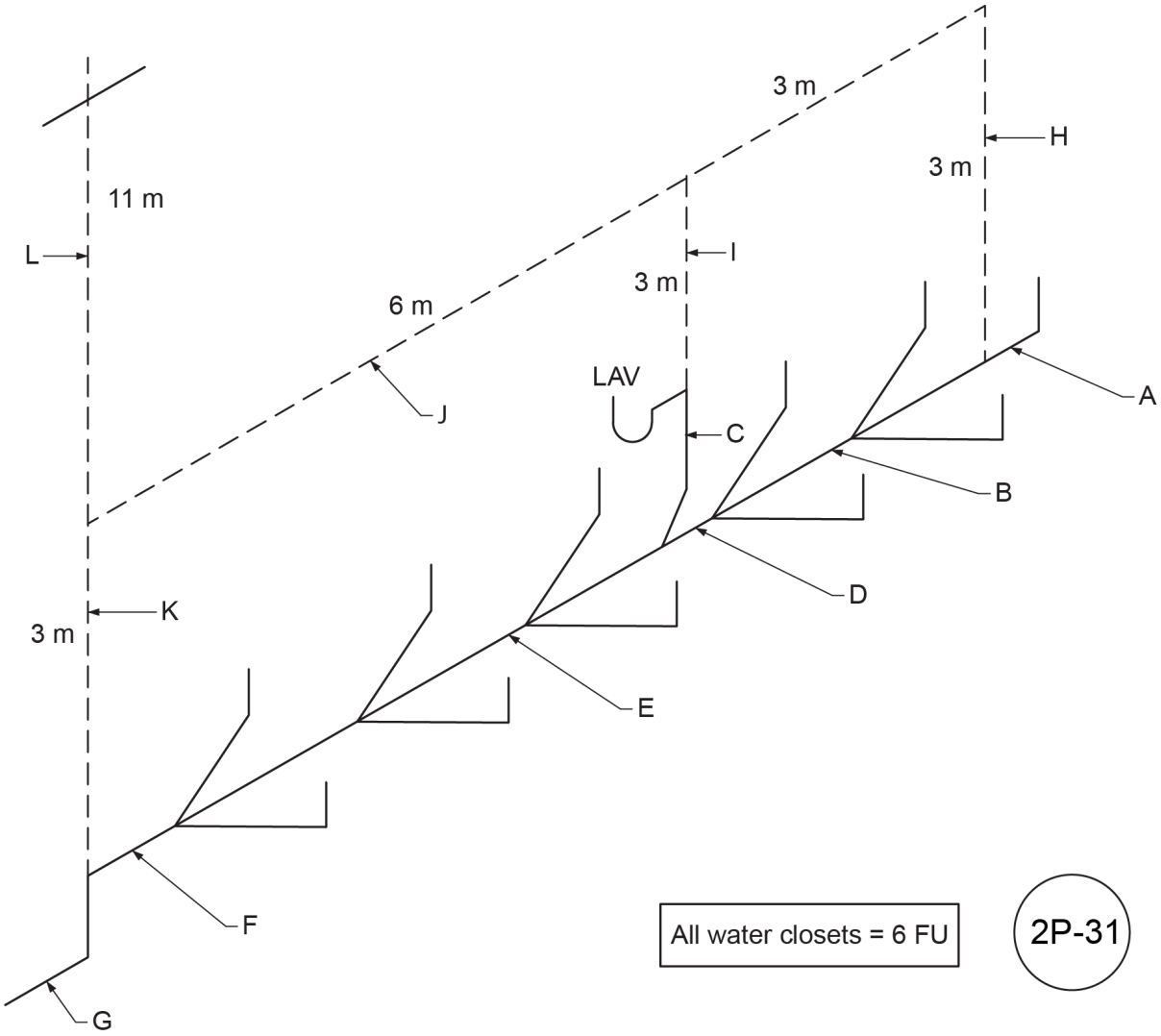


Figure 2P-31

Table 4

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				

1. Using Figure 2P-32, fill in Table 5 by identifying and sizing the circuit vent installation as per the NPC.

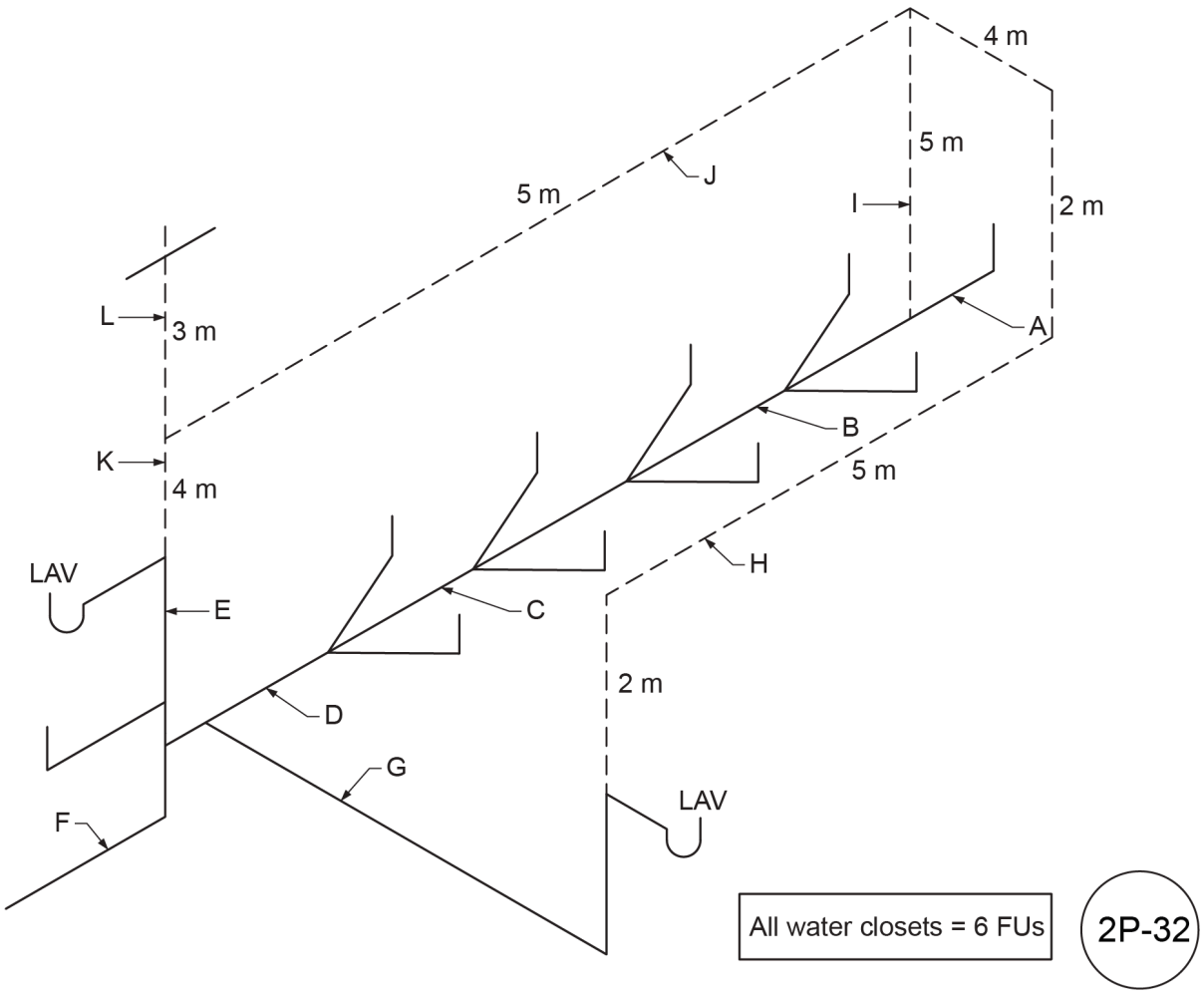


Figure 2P-32

Table 5

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				

1. Using Figure 2P-33, fill in Table 6 by identifying and sizing the circuit vent installation as per the NPC.

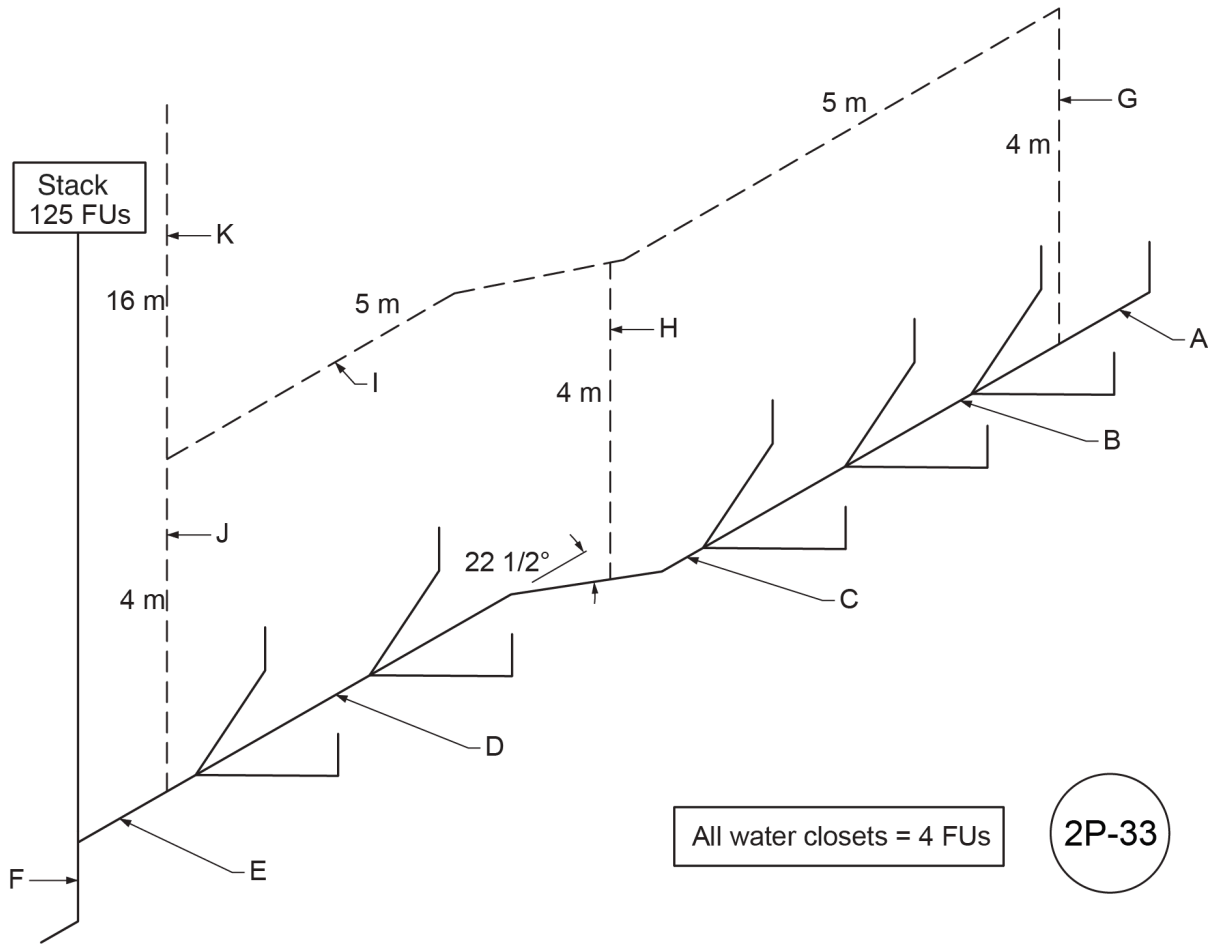


Figure 2P-33

Table 6

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				

1. Using Figure 2P-34, fill in Table 7 by identifying and sizing the circuit vent installation as per the NPC.

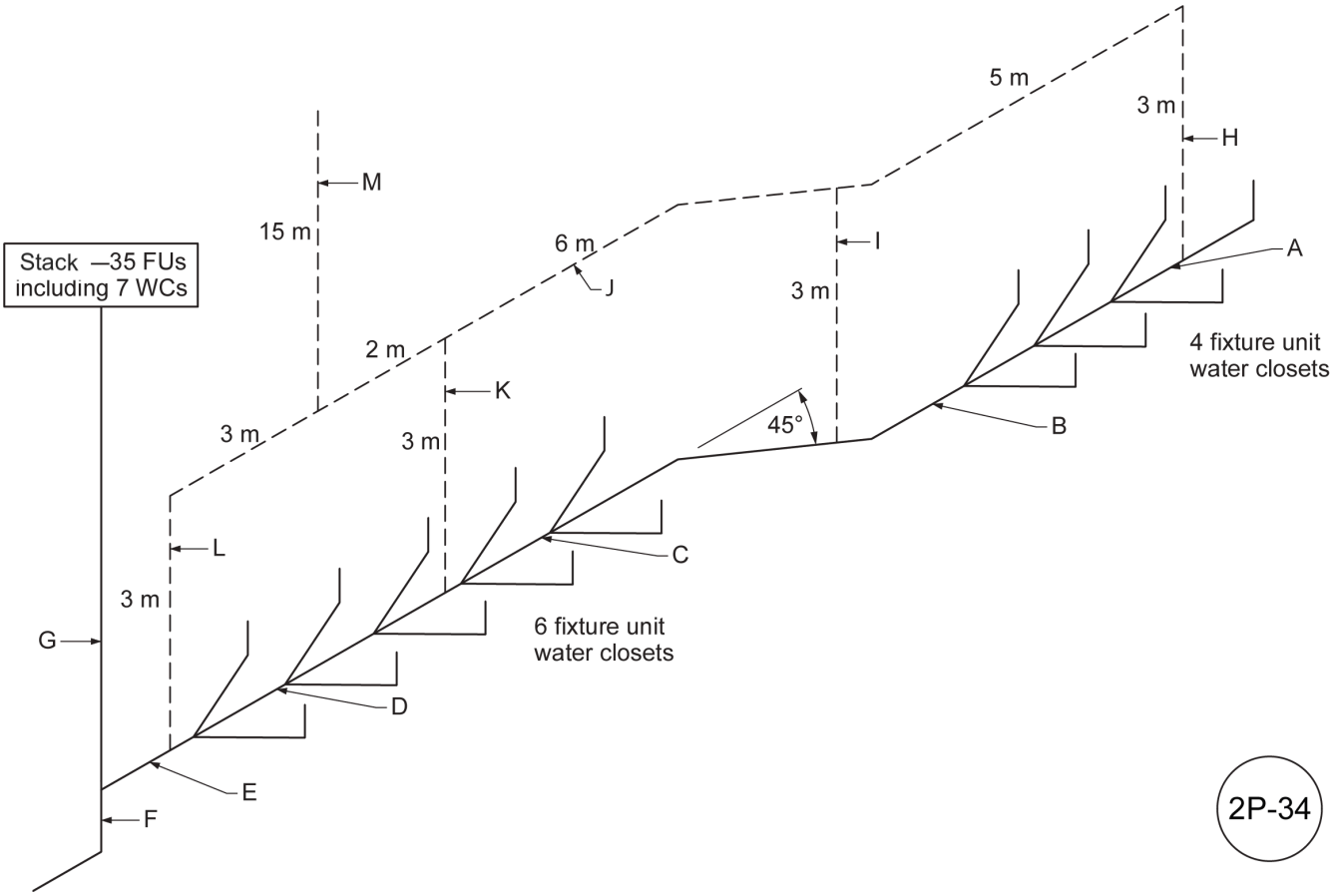


Figure 2P-34

Table 7

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				

1. Using Figure 2P-35, fill in Table 8 by identifying and sizing the circuit vent installation as per the NPC.

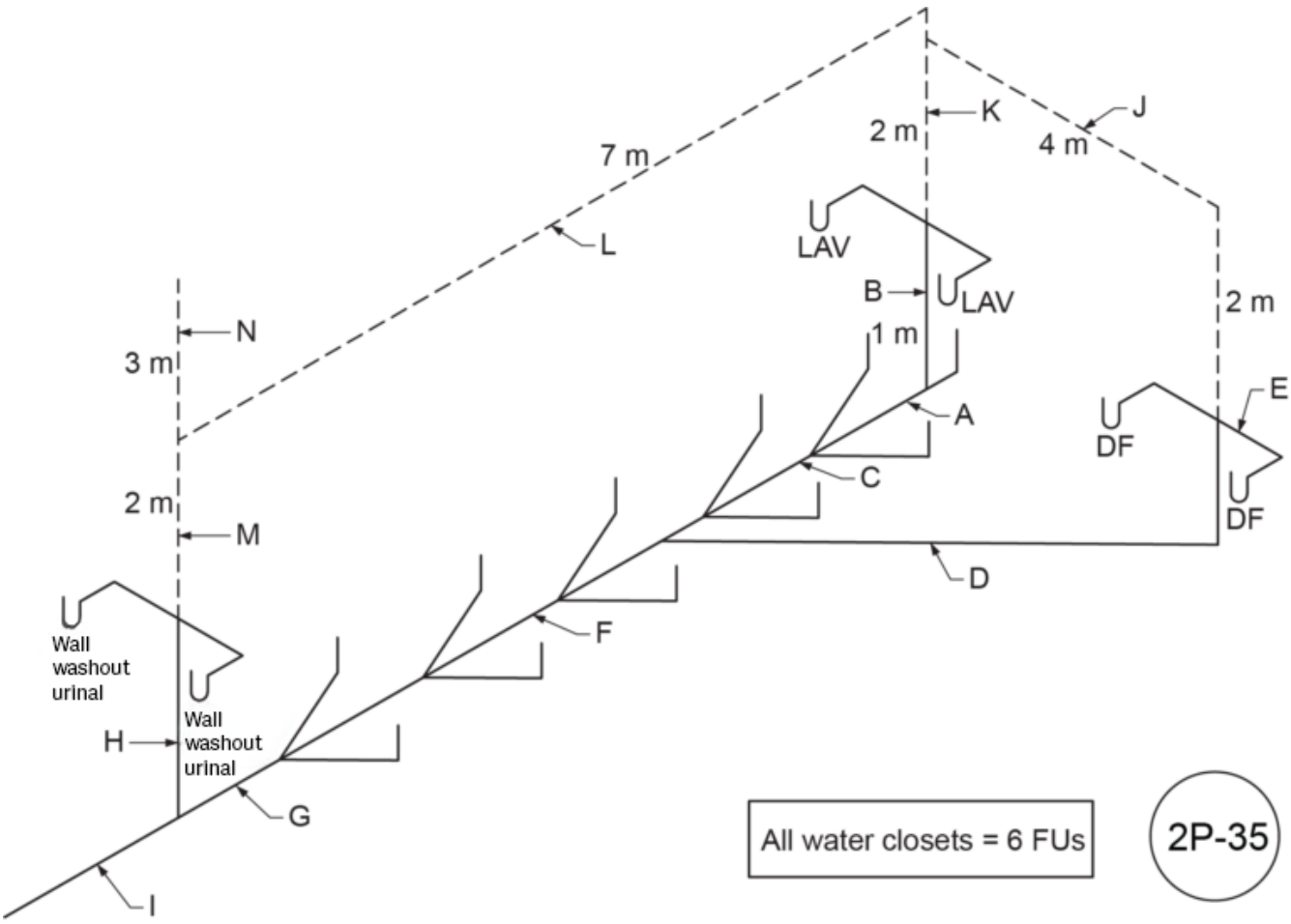


***Figure* 2P-35**

Table 8

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				
N				

1. Using Figure 2P-36, fill in Table 9 by identifying and sizing the circuit vent installation as per the NPC.

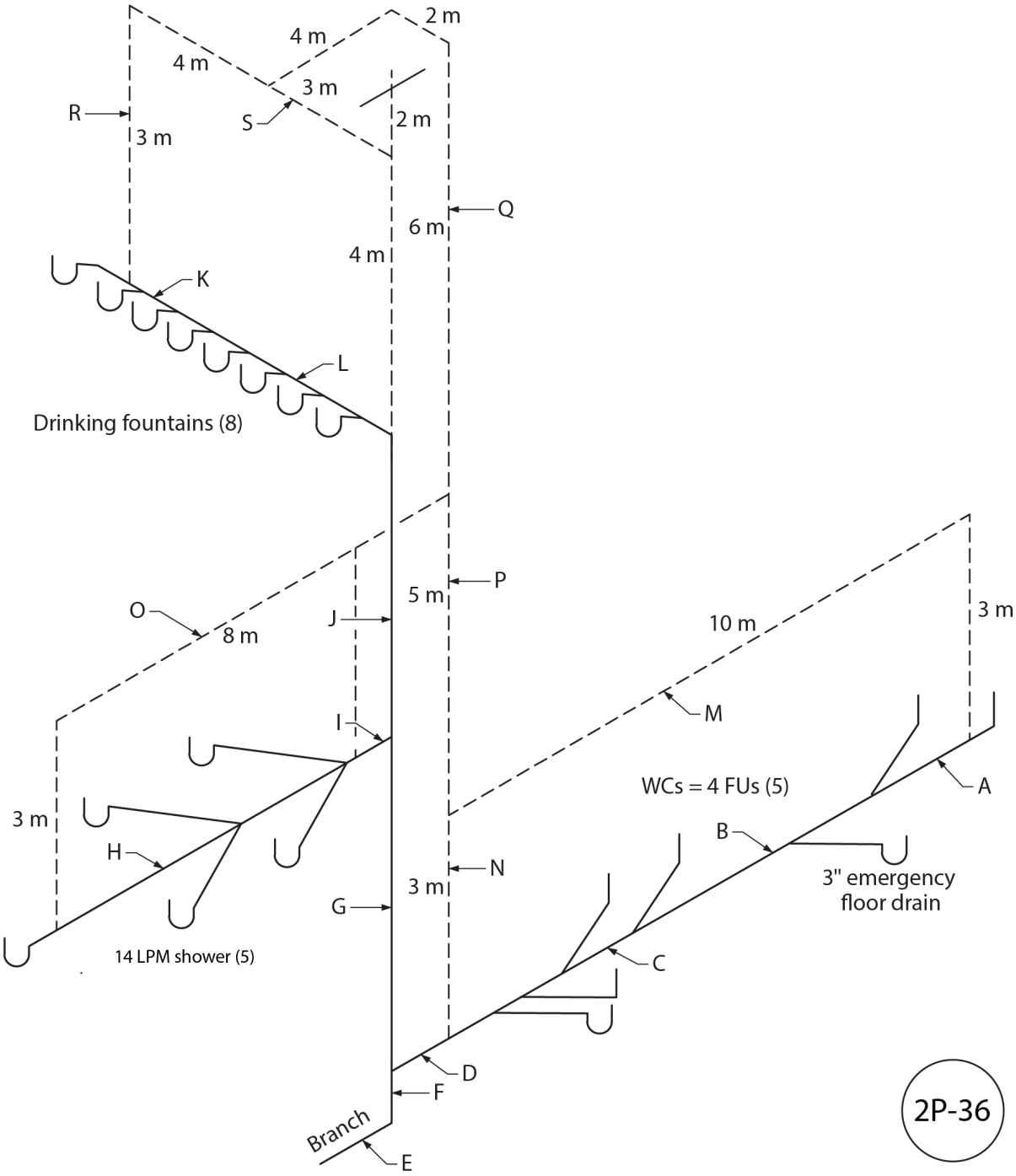


Figure 2P-36

Table 9

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				
N				
O				
P				
Q				
R				
S				

1. Using Figure 2P-37, fill in Table 10 by identifying and sizing the circuit vent installation as per the NPC.

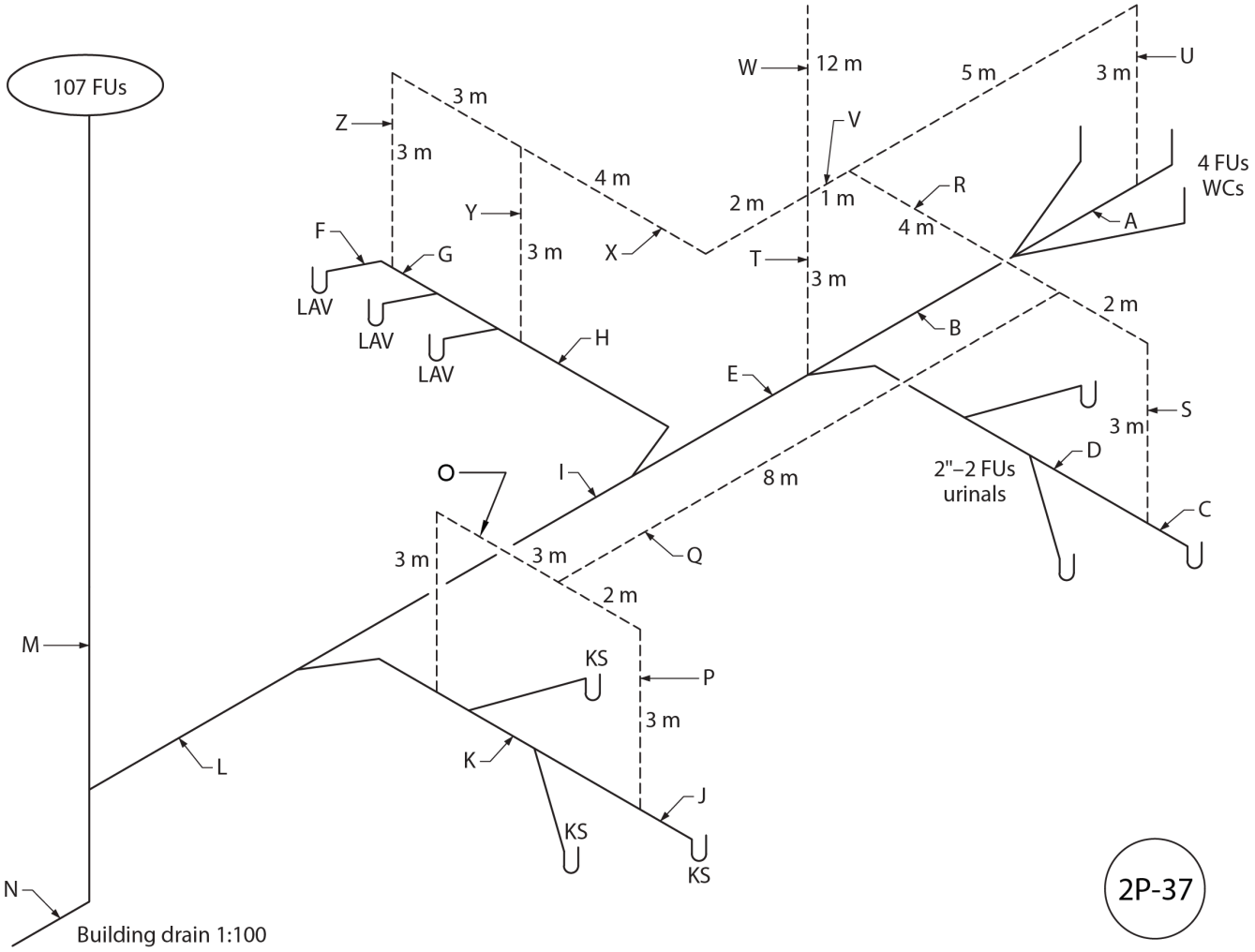

107 FUs
W
12 m
5 m
3 m
U
Z
3 m
V
3 m
4 m
2 m
1 m
R
4 FUs
WCs
Y
4 m
A
F
G
3 m
X
T
3 m
LAV
LAV
LAV
H
2 m
B
E
S
3 m
D
O
I
8 m
2"–2 FUs
urinals
C
3 m
3 m
Q
2 m
M
KS
P
3 m
L
K
J
KS
KS
N
Building drain 1:100
2P-37

***Figure* 2P-37**

Table 10

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				
N				
O				
P				
Q				
R				
S				
T				
U				
V				
W				
X				
Y				
Z				

Answer Key: Self-Test D-1.8 (https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?post_type=chapter&p=1828&preview=true) is on the next page.

Answer Key: Self-Test D-1.8

1. Figure 2P-28

Table 1 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Fixture drain	4	N/A	3 in.
B	Branch	12	N/A	4 in.
C	Branch	16	N/A	4 in.
D	Fixture drain — Sized as a wet vent — Acting as a relief vent	1	N/A	2 in.
E	Branch	25	N/A	4 in.
F	Circuit vent	20	11 m	1.5 in.
G	Continuous vent — Acting as a relief vent	5	3 m	1.5 in.
H	Branch vent	25	11 m	2 in.

2. Figure 2P-29

Table 2 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Branch	18	N/A	4 in.
B	Branch	42	N/A	4 in.
C	Branch	66	N/A	4 in.
D	Fixture drain — Acting as a wet vent	1	N/A	2 in.
E	Branch	73	N/A	4 in.
F	Circuit vent	66	16 m	3 in.
G	Additional circuit vent	N/A	N/A	2 in.
H	Branch vent	66	16 m	3 in.
I	Relief vent	N/A	N/A	2 in.
J	Continuous vent	7	4 m	1.5 in.
K	Branch vent	73	16 m	3 in.

3. Figure 2P-30

Table 3 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Trap arm — Fixture drain	4	N/A	3 in.
B	Branch	10	N/A	3 in.
C	Branch	20	N/A	4 in.
D	Branch — Acting as a relief vent	2	N/A	1.5 in.
E	Branch	26	N/A	4 in.
F	Circuit vent	24	13 m	2 in.
G	Dual and continuous vent — Acting as a relief vent	N/A	N/A	1.5 in.
H	Branch vent	26	13 m	2 in.

4. Figure 2P-31

Table 4 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Trap arm — Fixture drain	6	N/A	3 in.
B	Branch	18	N/A	4 in.
C	Fixture drain — Sized as a wet vent — Acting as an additional circuit vent	1	N/A	3 in.
D	Branch	30	N/A	4 in.
E	Branch	43	N/A	4 in.
F	Branch	67	N/A	4 in.
G	Branch	67	N/A	4 in.
H	Circuit vent	67	23 m	3 in.
I	Additional circuit vent	N/A	N/A	2 in.
J	Branch vent	67	23 m	3 in.
K	Relief vent	N/A	N/A	2 in.
L	Branch vent	67	23 m	3 in.

5. Figure 2P-32

Table 5 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Trap arm — Fixture drain	6	N/A	3 in.
B	Branch	18	N/A	4 in.
C	Branch	42	N/A	4 in.
D	Branch	54	N/A	4 in.
E	Fixture drain — Acting as a wet vent	1	N/A	2 in.
F	Branch	62	N/A	4 in.
G	Fixture drain — Acting as a relief vent	1	N/A	1.5 in.
H	Individual and continuous vent — Acting as a relief vent	N/A	N/A	1.5 in.
I	Circuit vent	54	13 m	2 in.
J	Branch vent	55	21 m	3 in.
K	Continuous vent	7	7 m	1.5 in.
L	Branch vent	62	21 m	3 in.

6. Figure 2P-33

Table 6 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Trap arm — Fixture drain	4	N/A	3 in.
B	Branch	12	N/A	4 in.
C	Branch	28	N/A	4 in.
D	Branch	36	N/A	4 in.
E	Branch	44	N/A	4 in.
F	Stack	169	N/A	4 in.
G	Circuit vent	44	30 m	3 in.
H	Additional circuit vent	N/A	N/A	2 in.
I	Branch vent	44	30 m	3 in.
J	Relief vent	N/A	N/A	2 in.
K	Branch vent	44	30 m	3 in.

7. Figure 2P-34

Table 7 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Fixture drain	4	N/A	3 in.
B	Branch	28	N/A	4 in.
C	Branch	40	N/A	4 in.
D	Branch	76	N/A	4 in.
E	Branch	88	N/A	4 in.
F	Stack	123	N/A	4 in.
G	Stack	35	N/A	4 in.
H	Circuit vent	88	31 m	3 in.
I	Additional circuit vent	N/A	N/A	2 in.
J	Branch vent	88	31 m	3 in.
K	Additional circuit vent	N/A	N/A	2 in.
L	Relief vent	N/A	N/A	2 in.
M	Branch vent	88	31 m	3 in.

8. Figure 2P-35

Table 8 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Branch	8	N/A	3 in.
B	Branch sized as a wet vent acting as a circuit vent	(2 – wv) 69	N/A	3 in.
C	Branch	20	N/A	4 in.
D	Branch sized as a wet vent acting as an additional relief vent	1	N/A	2 in.
E	Trap arm fixture drain	0.5	N/A	1.25 in.
F	Branch	45	N/A	4 in.
G	Branch	69	N/A	4 in.
H	Branch acting as a relief vent	3	N/A	2 in.
I	Branch	74	N/A	4 in.
J	Dual and continuous vent acting as an additional circuit vent	N/A	N/A	2 in.
K	Circuit vent	69	13 m	3 in.
L	Branch vent	69	16 m	3 in.
M	Dual and continuous vent acting as a relief vent	N/A	N/A	2 in.
N	Branch vent	77	16 m	3 in.

9. Figure 2P-36

Table 9 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Fixture drain	4	N/A	3 in.
B	Branch	8	N/A	3 in.
C	Branch	12	N/A	4 in.
D	Branch	20	N/A	4 in.
E	Branch	39	N/A	4 in.
F	Stack	39	N/A	4 in.
G	Stack	19	N/A	3 in.
H	Fixture drain	3	N/A	3 in.
I	Branch	15	N/A	3 in.
J	Stack	4	N/A	2 in.
K	Branch	1	N/A	2 in.
L	Branch	3	N/A	2 in.
M	Circuit vent	20	33 m	2 in.
N	Relief vent	N/A	N/A	1.5 in.
O	Circuit vent	15	26 mm	2 in.
P	Branch vent	20	33 m	2 in.
Q	Branch vent	35	33 m	3 in.
R	Circuit vent	4	10 m	1.5 in.
S	Branch vent	39	33 m	3 in.

10. Figure 2P-37

Table 10 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Fixture drain	4	N/A	3 in.
B	Branch	12	N/A	4 in.
C	Trap arm — Fixture drain	2	N/A	2 in.
D	Fixture drain	2	N/A	3 in.
E	Branch	18	N/A	4 in.
F	Trap arm — Fixture drain	1	N/A	1.25 in.
G	Fixture drain	1	N/A	2 in.
H	Branch	3	N/A	2 in.
I	Branch	21	N/A	4 in.
J	Trap arm — Fixture drain	1.5	N/A	1.5 in.
K	Branch	3	N/A	2 in.
L	Branch	25.5	N/A	4 in.
M	Stack	107	N/A	4 in.
N	Sanitary building drain	132.5	N/A	4 in.
O	Relief vent	N/A	N/A	1.25 in.
P	Circuit vent	4.5	30 m	1.5v
Q	Branch vent	4.5	31 m	2 in.
R	Branch vent	10.5	31 m	2 in.
S	Circuit vent	6	22 m	1.5 in.
T	Combined relief vent	N/A	N/A	1.5 in.
U	Circuit vent	12	21 m	2 in.
V	Branch bent	22.5	31 m	3 in.
W	Branch vent	25.5	31 m	3 in.
X	Branch vent	3	24 m	1.5 in.
Y	Relief vent	N/A	N/A	1.25 in.
Z	Circuit vent	3	24 m	1.5 in.

Self-Test D-1.9 Sizing Stack Vents, Vent Stacks, and Headers

Complete Self-Test D-1.9 and check your answers.

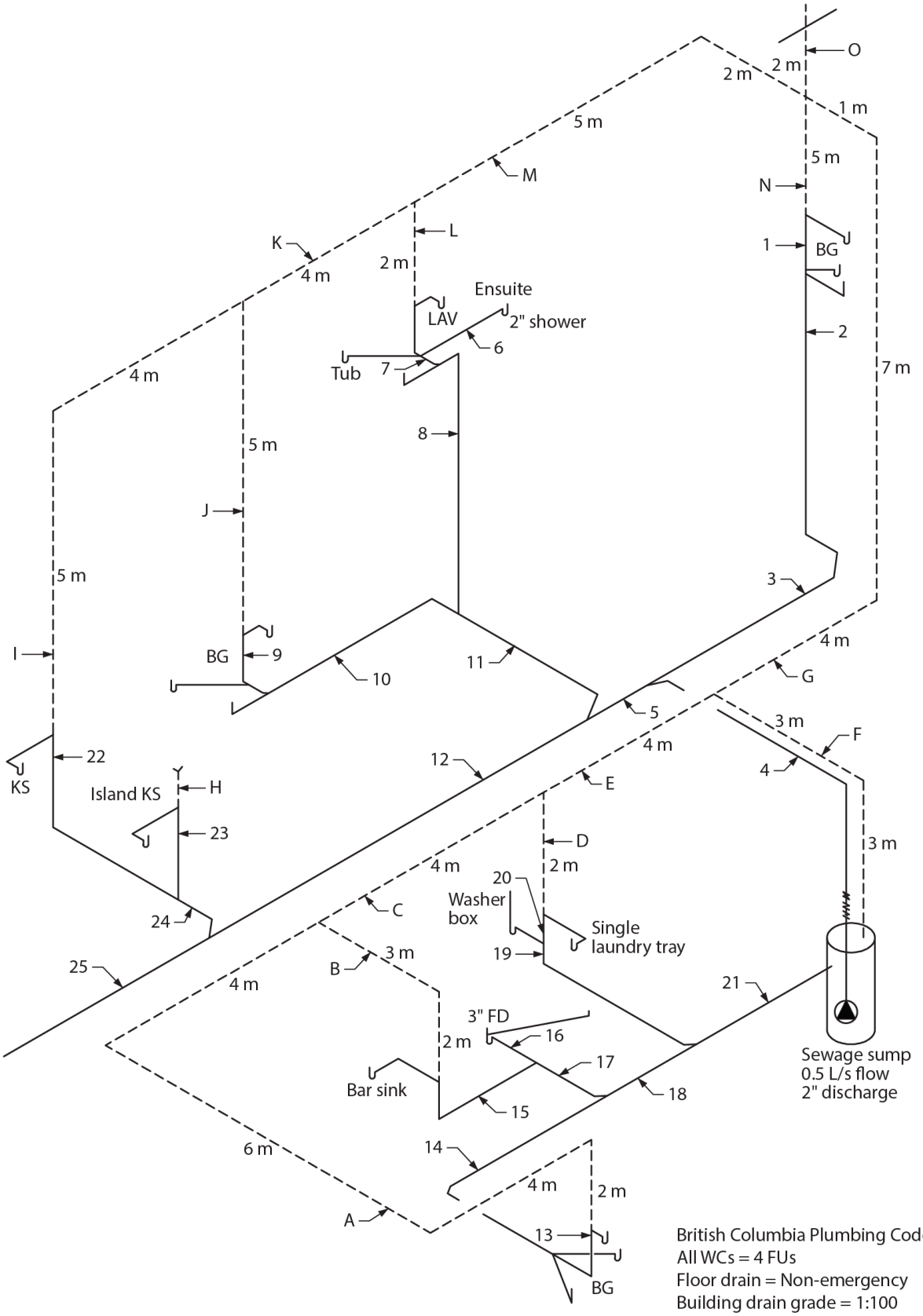

O
2 m
2 m
1 m
5 m
5 m
M
N
K
4 m
L
2 m
1
BG
Ensuite
LAV
2" shower
6
2
Tub
7
7 m
4 m
8
5 m
J
5 m
3
I
BG
9
10
11
4 m
G
5
3 m
F
4 m
22
KS
12
E
4
Island KS
H
23
D
3 m
4 m
2 m
20
Washer
box
C
Single
laundry tray
24
19
25
B
3 m
4 m
21
3" FD
16
2 m
17
Sewage sump
0.5 L/s flow
2" discharge
Bar sink
18
15
6 m
14
4 m
2 m
A
13
BG
British Columbia Plumbing Code
All WCs = 4 FUs
Floor drain = Non-emergency
Building drain grade = 1:100
2P-38

Figure 2P-38

1. Using Figure 2P-38, fill in Table 1 by identifying and sizing the DWV drainage installation indicated by the numbers.

Table 1

Number	Name	Hydraulic Load (FU)	Size
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			

2. Using Figure 2P-38, fill in Table 2 by identifying and sizing the DWV venting installation indicated by the letters.

Table 2

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				
N				
O				

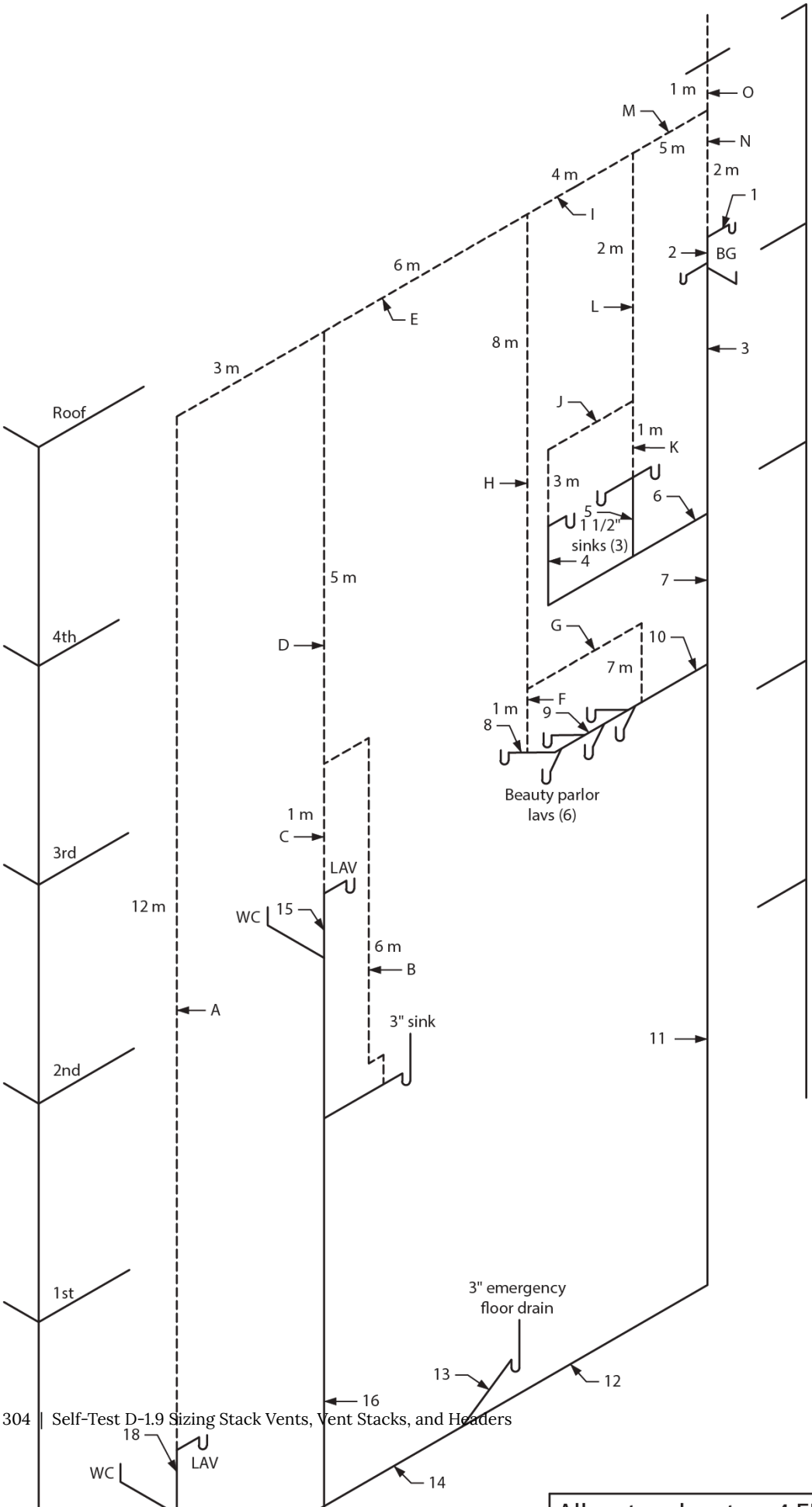

1 m
O
M
5 m
N
2 m
4 m
I
1
2 m
2
BG
6 m
E
L
8 m
3
3 m
Roof
J
1 m
K
H
3 m
6
5
1 1/2"
sinks (3)
4
7
5 m
4th
D
G
10
7 m
F
1 m
9
8
Beauty parlor
lavs (6)
1 m
C
3rd
LAV
12 m
WC
15
6 m
B
A
3" sink
11
2nd
1st
3" emergency
floor drain
13
12
16
18
LAV
WC
14

Figure 2P-39

3. Using Figure 2P-39, fill in Table 3 by identifying and sizing the DWV drainage installation indicated by the numbers.

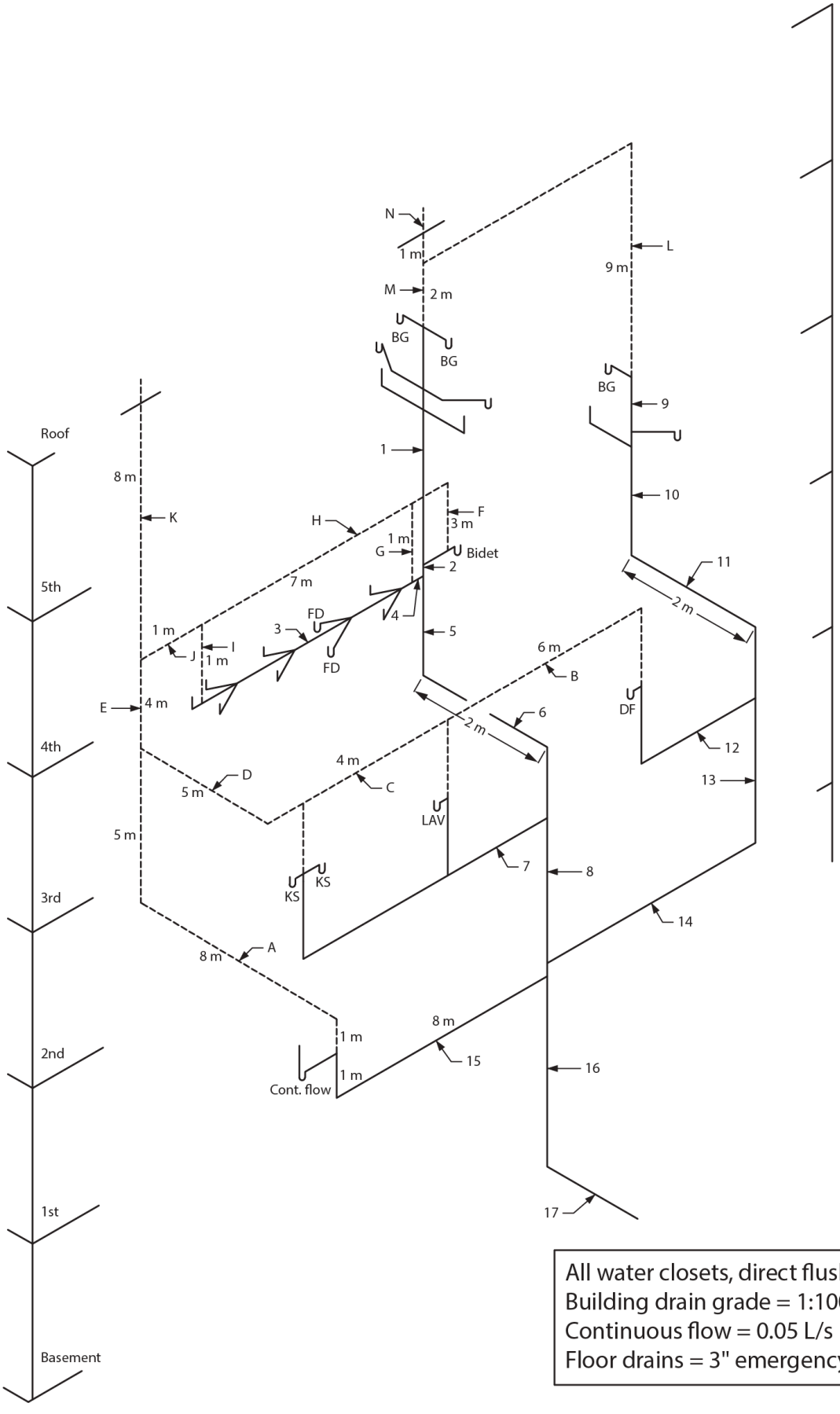
Table 3

Number	Name	Hydraulic Load (FU)	Size
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

4. Using Figure 2P-39, fill in Table 4 by identifying and sizing the DWV venting installation indicated by the letters.

Table 4

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				
N				
O				



All water closets, direct flush valve
Building drain grade = 1:100
Continuous flow = 0.05 L/s
Floor drains = 3" emergency

2P-40

Figure 2P-40

5. Using Figure 2P-40, fill in Table 5 by identifying and sizing the DWV drainage installation indicated by the numbers.

Table 5

Number	Name	Hydraulic Load (FU)	Size
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			

6. Using Figure 2P-40, fill in Table 6 by identifying and sizing the DWV venting installation indicated by the letters.

Table 6

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				
N				

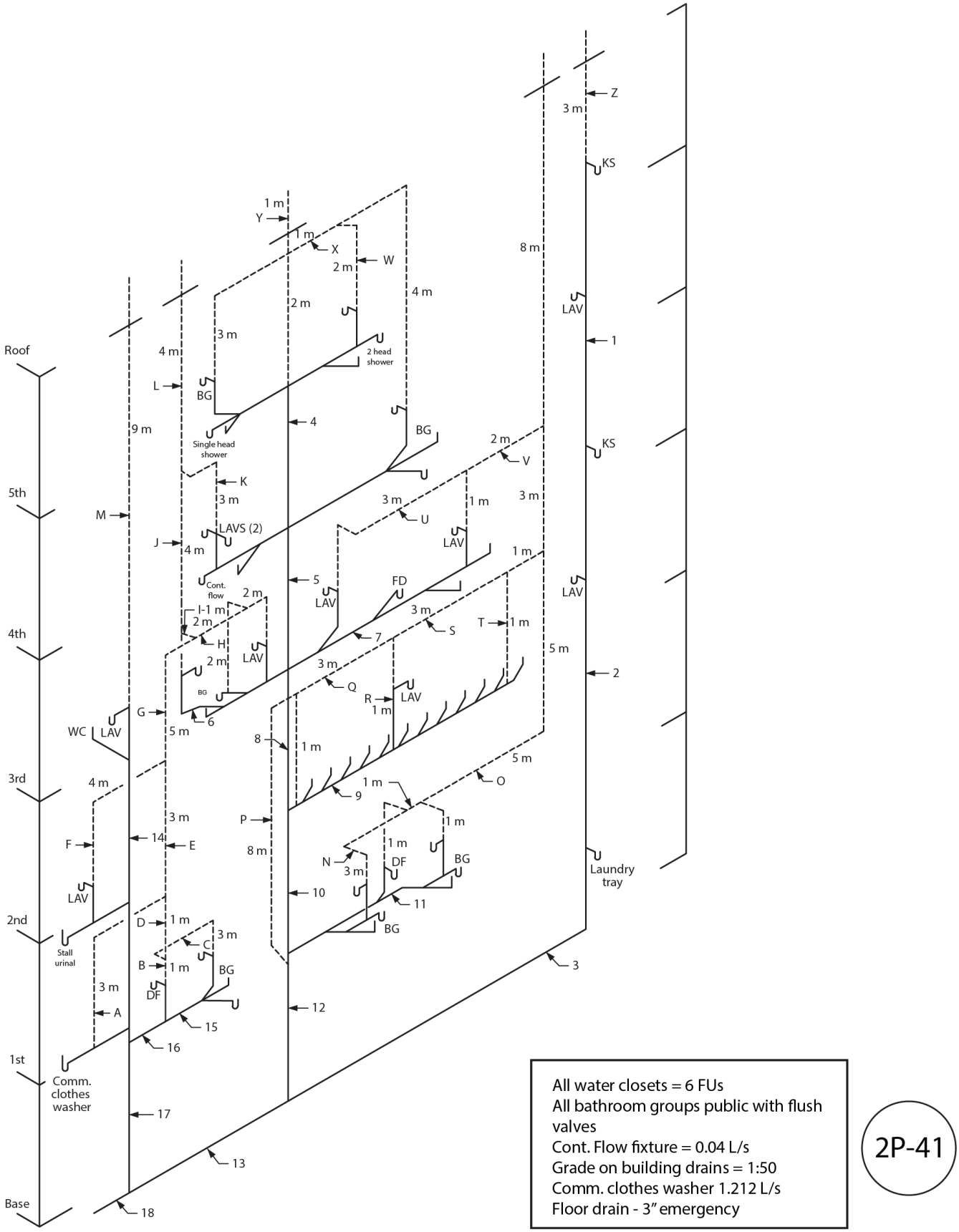

Roof
5th
4th
3rd
2nd
1st
Base
Comm. clothes washer
Stall urinal
WC
LAV
LAVS (2)
Cont. flow
Single head shower
2 head shower
BG
DF
FD
KS
Laundry tray
All water closets = 6 FUs
All bathroom groups public with flush valves
Cont. Flow fixture = 0.04 L/s
Grade on building drains = 1:50
Comm. clothes washer 1.212 L/s
Floor drain - 3" emergency
2P-41

***Figure* 2P-41**

7. Using Figure 2P-41, fill in Table 7 by identifying and sizing the DWV drainage installation indicated by the numbers.

Table 7

Number	Name	Hydraulic Load (FU)	Size
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			

8. Using Figure 2P-41, fill in Table 8 by identifying and sizing the DWV venting installation indicated by the letters.

Table 8

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				
N				
O				
P				
Q				
R				
S				
T				
U				
V				
W				
X				
Y				
Z				

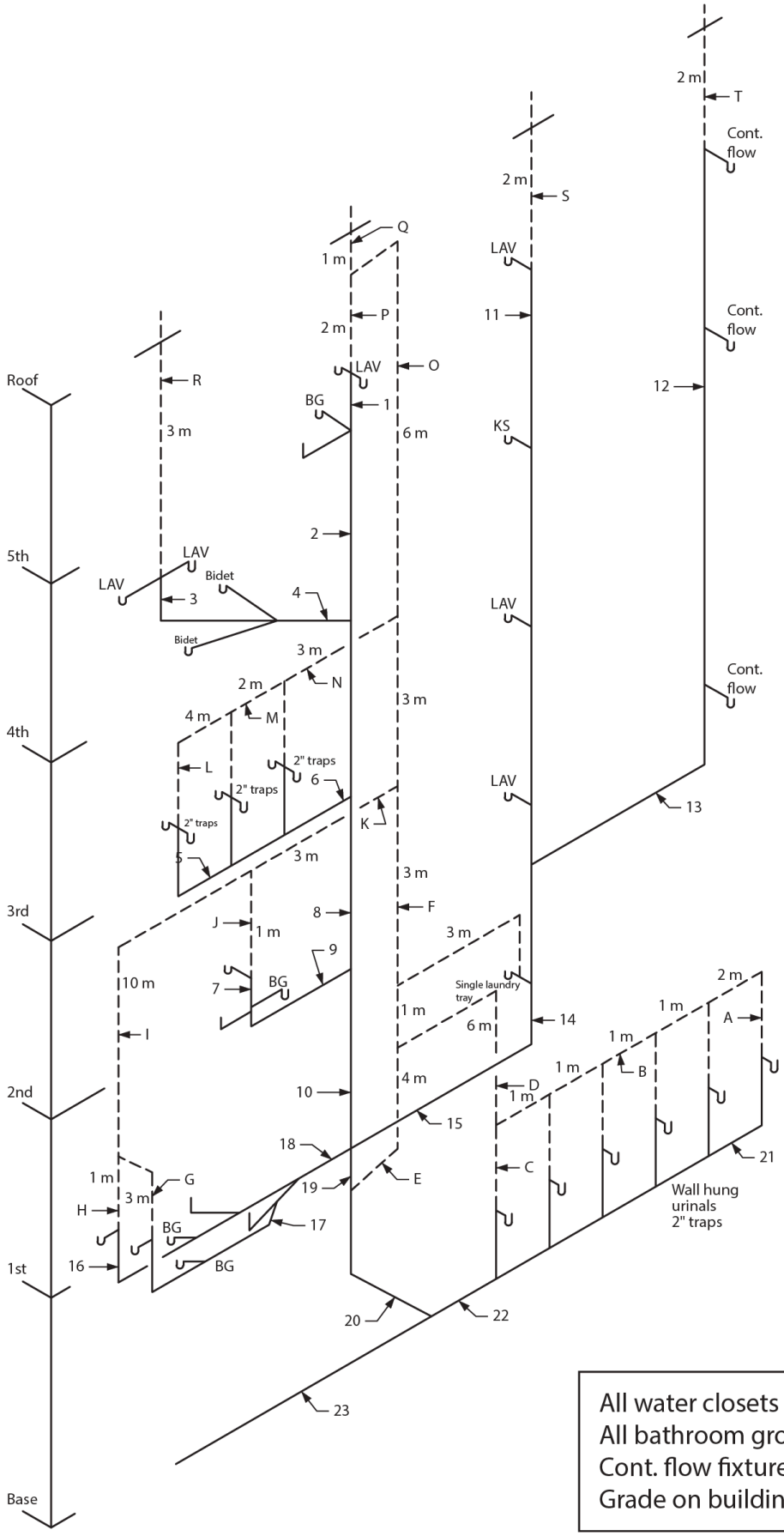

Roof
5th
4th
3rd
2nd
1st
Base
2 m
T
Cont. flow
2 m
S
LAV
11
Cont. flow
12
KS
Cont. flow
LAV
13
LAV
Q
1 m
2 m
P
LAV
O
BG
1
6 m
R
3 m
2
LAV
LAV
Bidet
3
4
Bidet
3 m
2 m
N
4 m
M
3 m
L
2" traps
2" traps
6
2" traps
K
5
3 m
3 m
J
1 m
8
F
3 m
9
10 m
7
BG
Single laundry tray
1 m
6 m
14
I
2 m
1 m
A
1 m
B
1 m
D
1 m
4 m
10
15
18
1 m
G
3 m
H
19
E
C
21
BG
17
Wall hung urinals 2" traps
16
BG
20
22
23
All water closets = 6 FU
All bathroom groups public
Cont. flow fixture = 0.07 L/s
Grade on building drains = 1:50
2P-42

Figure 2P-42

9. Using Figure 2P-42, fill in Table 9 by identifying and sizing the DWV drainage installation indicated by the numbers.

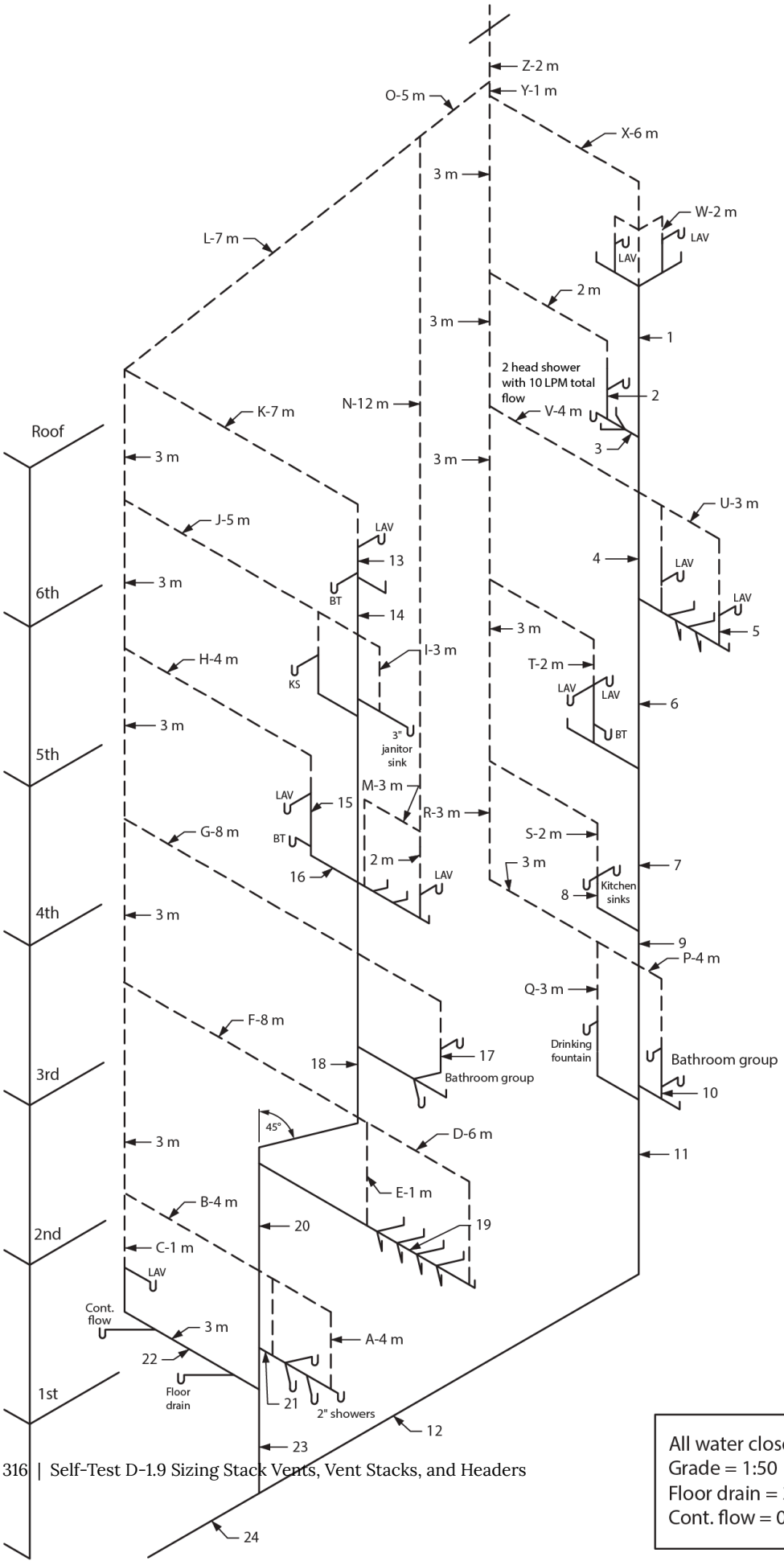
Table 9

Number	Name	Hydraulic Load (FU)	Size
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			

10. Using Figure 2P-42, fill in Table 10 by identifying and sizing the DWV venting installation indicated by the letters.

Table 10

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				
N				
O				
P				
Q				
R				
S				
T				



All water closets = 4 FUs
Grade = 1:50
Floor drain = 3" emergency
Cont. flow = 0.05 L/s

2P-43

Figure 2P-43

11. Using Figure 2P-43, fill in Table 11 by identifying and sizing the DWV drainage installation indicated by the numbers.

Table 11

Number	Name	Hydraulic Load (FU)	Size
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			

12. Using Figure 2P-43, fill in Table 12 by identifying and sizing the DWV venting installation indicated by the letters.

Table 12

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				
N				
O				
P				
Q				
R				
S				
T				
U				
V				
W				
X				
Y				
Z				

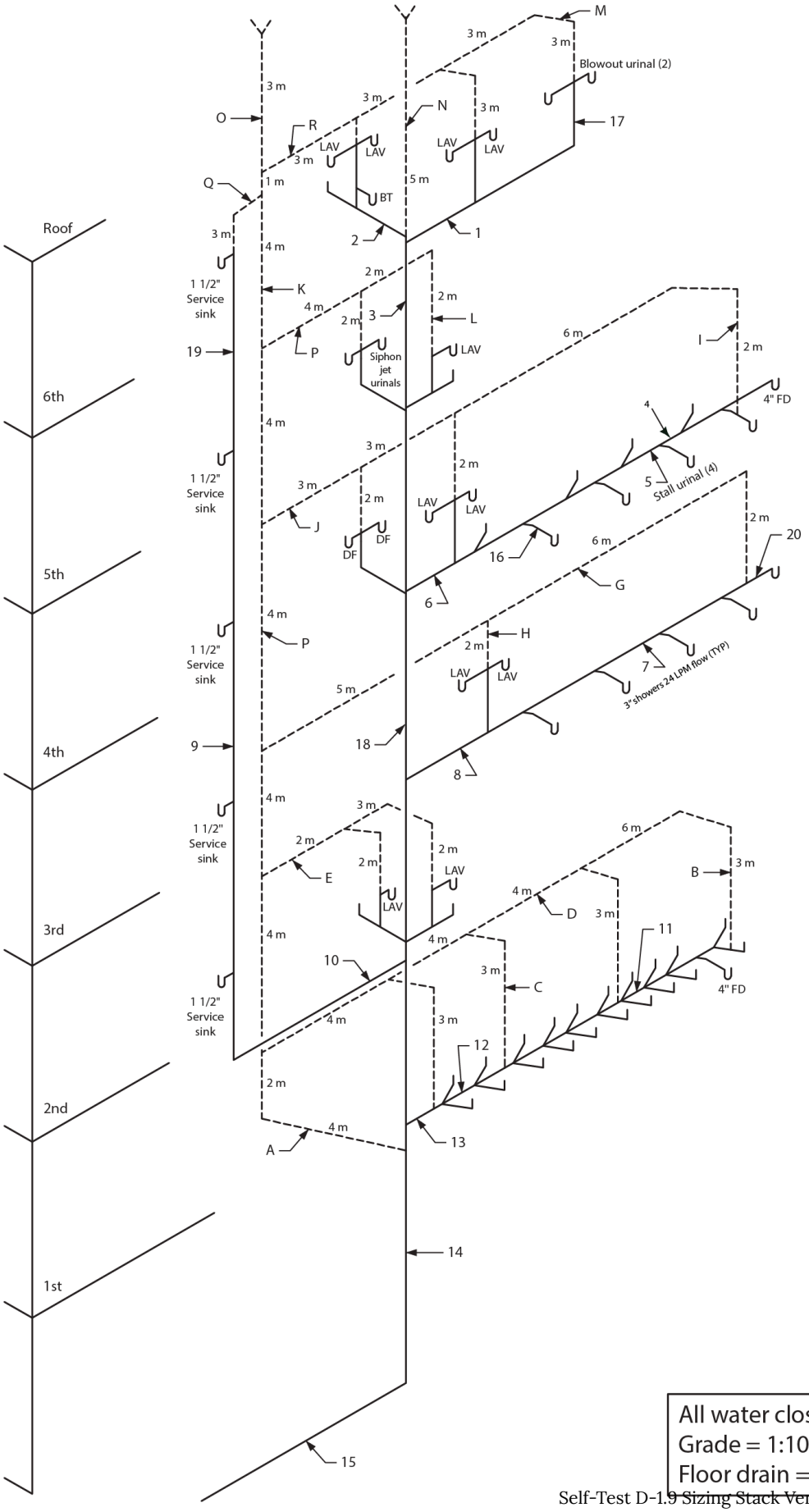

Roof
6th
5th
4th
3rd
2nd
1st
1 1/2" Service sink
Siphon jet urinals
Blowout urinal (2)
Stall urinal (4)
3" showers 24 LPM flow (TYP)
4" FD
LAV
BT
DF
All water closets = 6 FUs
Grade = 1:100
Floor drain = emergency

Figure 2P-44

13. Using Figure 2P-44, fill in Table 13 by identifying and sizing the DWV drainage installation indicated by the numbers.

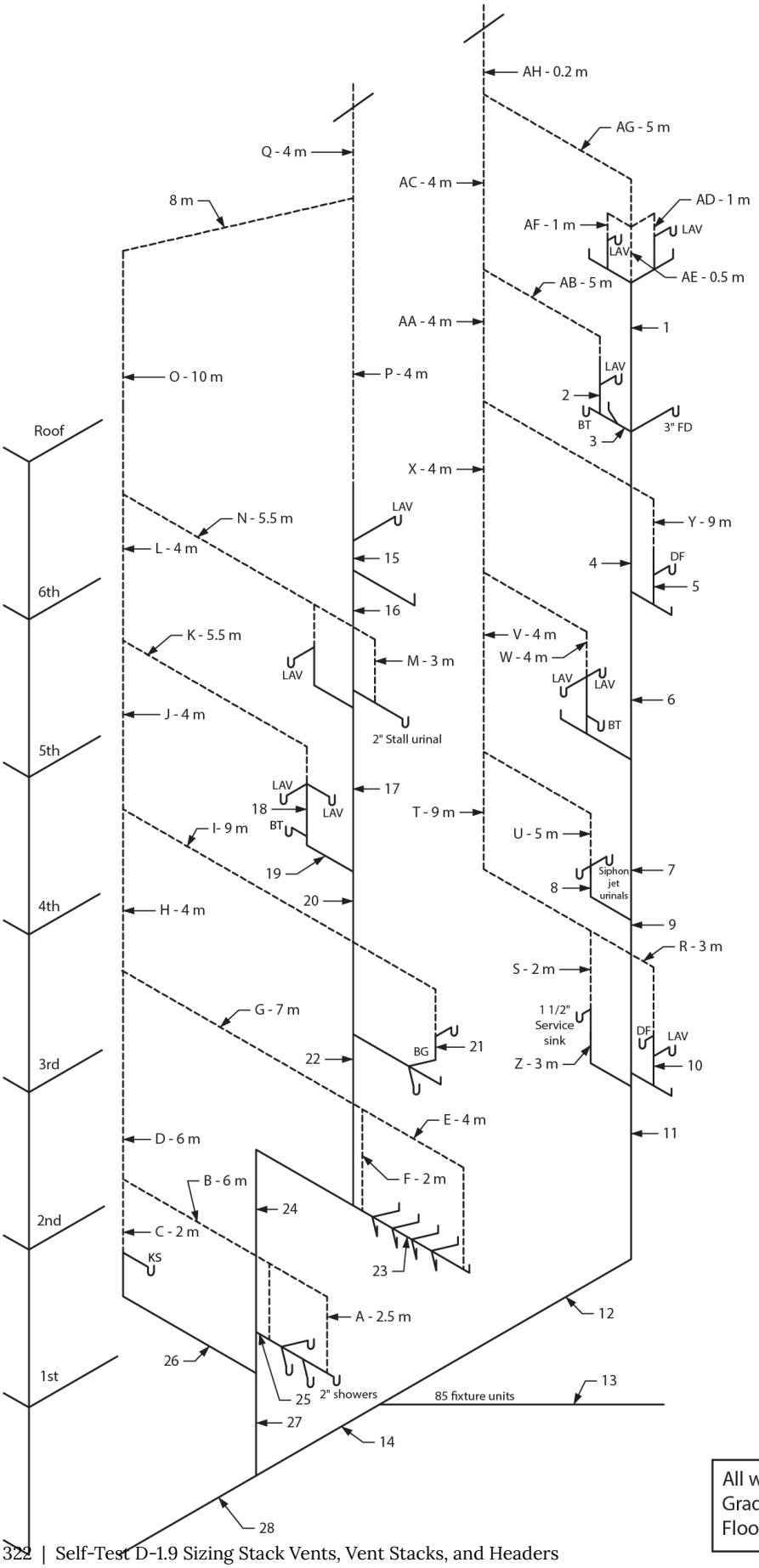
Table 13

Number	Name	Hydraulic Load (FU)	Size
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

14. Using Figure 2P-44, fill in Table 14 by identifying and sizing the DWV venting installation indicated by the letters.

Table 14

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				
N				
O				
P				
Q				
R				



All water closets = 4 FUs
Grade 1:100
Floor drain = non-emergency

2P-45

Figure 2P-45

15. Using Figure 2P-45, fill in Table 15 by identifying and sizing the DWV drainage installation indicated by the numbers.

Table 15

Number	Name	Hydraulic Load (FU)	Size
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			

16. Using Figure 2P-45, fill in Table 16 by identifying and sizing the DWV venting installation indicated by the letters.

Table 16

Letter	Name	Hydraulic Load (FU)	Length	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				
N				
O				
P				
Q				
R				
S				
T				
U				
V				
W				
X				
Y				
Z				
AA				
AB				
AC				
AD				
AE				
AF				
AG				
AH				

Answer Key: Self-Test D-1.9 (#chapter-answer-key-self-test-d-1-9) is on the next page.

Answer Key: Self-Test D-1.9

1. Drawing 2P-38 — Drainage

Table 1 Answers

Number	Name	Hydraulic Load (FU)	Size
1	Stack acting as a wet vent	2.5	3 in.
2	Stack	6	3 in.
3	Sanitary building drain	6	4 in. (preferred)
4	Sump discharge	15.85	2 in.
5	Sanitary building drain	21.85	4 in. (preferred)
6	Trap arm — Fixture drain	3	2 in.
7	Stack acting as a wet vent	5.5	3 in.
8	Stack	9	3 in.
9	Fixture drain — Acting as a wet vent	2.5	2 in.
10	Branch	6	3 in.
11	Branch	15	3 in.
12	Sanitary building drain	36.85	4 in. (preferred)
13	Fixture drain — Acting as a wet vent	1	2 in.
14	Branch	6	3 in.
15	Fixture drain	1.5	1.5 in.
16	Trap arm — Fixture drain	3	3 in.
17	Branch	4.5	3 in.
18	Branch	10.5	3 in.
19	Branch	3.5	2 in.
20	Fixture drain — Acting as a wet vent	1.5	1.5 in.
21	Branch	14	3 in.
22	Fixture drain	1.5	1.5 in.
23	Fixture drain	1.5	1.5 in.
24	Branch	3	1.5 in.
25	Sanitary building drain	39.85	4 in. (preferred)

2. Drawing 2P-38 — Venting

Table 2 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Continuous vent	6	36 m	2 in.
B	Individual and continuous vent	N/A	N/A	1.25 in.
C	Branch vent	7.5	36 m	2 in.
D	Continuous vent	3.5	18 m	1.5 in.
E	Branch vent	11	36 m	2 in.
F	Sump vent	N/A	N/A	2 in.
G	Branch vent	27	36 m	3 in.
H	Island vent (air admittance valve)	1.5	N/A	1.25 in.
I	Individual and continuous vent	N/A	N/A	1.25 in.
J	Continuous vent	6	9 m	1.5 in.
K	Branch vent	7.5	13 m	1.5 in.
L	Stack vent	9	11 m	1.5 in.
M	Stack vent	16.5	11 m	2 in.
N	Stack vent (Clause 2.5.8.4 (5))	6	7 m	3 in.
O	Vent header	49.5	38 m	3 in.

3. Drawing 2P-39 — Drainage

Table 3 Answers

Number	Name	Hydraulic Load (FU)	Size
1	Trap arm — Fixture drain	1	1.25 in.
2	Stack acting as a wet vent	2.5	3 in.
3	Stack	6	3 in.
4	Fixture drain	1.5	1.5 in.
5	Branch	3	1.5 in.
6	Branch	4.5	2 in.
7	Stack	10.5	3 in.
8	Trap arm — Fixture drain	1.5	1.5 in.
9	Branch	4.5	2 in.
10	Branch	9	2.5 in.
11	Stack	19.5	3 in.
12	Sanitary building drain	19.5	4 in. Preferred
13	Trap arm — Fixture drain	N/A	3 in.
14	Sanitary building drain	19.5	4 in. Preferred
15	Stack acting as a wet vent	1	2 in.
16	Stack	8	3 in.
17	Sanitary building drain	27.5	4 in.
18	Fixture drain acting as a wet vent	1	2 in.
19	Branch	5	3 in.
20	Sanitary building drain	32.5	4 in.

4. Drawing 2P-39 — Venting

Table 4 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Continuous vent	5	15 m	1.5 in.
B	Individual vent	N/A	N/A	1.5 in.
C	Stack vent	8	22 m	2 in.
D	Stack vent	8	22 m	2 in.
E	Stack vent	13	22 m	2 in.
F	Circuit vent	9	9 m	1.5 in.
G	Relief vent	N/A	N/A	1.25 in.
H	Branch vent	9	15 m	1.5 in.
I	Stack vent	22	22 m	2 in.
J	Individual and continuous vent	N/A	N/A	1.25 in.
K	Dual and continuous vent	N/A	N/A	1.25 in.
L	Branch vent	4.5	5 m	1.25 in.
M	Stack vent	26.5	22 m	2 in.
N	Stack vent	19.5	3 m	3 in.
O	Vent header	32.5	31 m	3 in.

5. Drawing 2P-40 — Drainage

Table 5 Answers

Number	Name	Hydraulic Load (FU)	Size
1	Stack	16	3 in.
2	Stack	17	3 in.
3	Branch	30	4 in.
4	Branch	42	4 in.
5	Stack	59	4 in.
6	Stack (Offset)	59	4 in.
7	Branch	4	2 in.
8	Stack	63	4 in.
9	Stack acting as a wet vent	2.5	2 in.
10	Stack	8	3 in.
11	Stack (Offset)	8	3 in.
12	Fixture drain	0.5	1.25 in.
13	Stack	8.5	3 in.
14	Branch	8.5	3 in.
15	Vent stack acting as a fixture drain sized as a wet vent	1.59	3 in.
16	Stack	73.09	4 in.
17	Sanitary building drain	73.09	4 in.

6. Drawing 2P-40 — Venting

Table 6 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Vent stack	73.09	35 m	3 in.
B	Individual and continuous vent	N/A	N/A	1.25 in.
C	Branch vent	1.5	15 m	1.5 in.
D	Branch vent	4.5	15 m	1.5 in.
E	Vent stack	73.09	35 m	3 in.
F	Individual vent	N/A	N/A	1.25 in.
G	Relief vent	N/A	N/A	1.5 in.
H	Branch vent	43	11 m	2 in.
I	Circuit vent	42	2 m	1.5 in.
J	Branch vent	43	11 m	2 in.
K	Vent stack	73.09	35 m	3 in.
L	Stack vent	8.5	10 m	1.5 in.
M	Stack vent	73.09	3 m	2 in.
N	Vent header	73.09	10 m	2 in.

7. Drawing 2P-41 —Drainage

Table 7 Answers

Number	Name	Hydraulic Load (FU)	Size
1	Stack acting as a wet vent	5	3 in.
2	Stack acting as a wet vent	5	3 in.
3	Branch	6.5	3 in.
4	Stack	18	3 in.
5	Stack	35.27	3 in.
6	Fixture drain acting as a wet vent	1	2 in.
7	Branch	13	3 in.
8	Stack	58.27	4 in.
9	Branch	61	4 in.
10	Stack	131.27	4 in.
11	Branch	8	3 in.
12	Stack	147.77	4 in.
13	Sanitary building drain	154.27	4 in.
14	Stack	7	3 in.
15	Branch	8	3 in.
16	Branch	8.5	3 in.
17	Stack	56.92	4 in.
18	Sanitary building drain	211.19	4 in.

8. Drawing 2P-41 — Venting

Table 8 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Individual vent	N/A	N/A	1.5 in.
B	Individual and continuous vent	N/A	N/A	1.25 in.
C	Continuous vent	8	21 m	1.5 in.
D	Branch vent	8.5	21 m	2 in.
E	Branch vent	46.92	21 m	3 in.
F	Continuous vent	3	18 m	1.5 in.
G	Branch vent	49.92	21 m	3 in.
H	Branch vent	2.5	13 m	1.5 in.
I	Branch vent	52.42	21 m	3 in.
J	Branch vent	58.92	21 m	3 in.
K	Continuous vent	9.27	7 m	1.5 in.
L	Branch vent	68.19	21 m	3 in.
M	Stack vent	56.92	9 m	3 in.
N	Continuous vent	8	14 m	1.5 in.
O	Branch vent	16.5	14 m	1.5 in.
P	Vent stack	147.77	26 m	3 in.
Q	Vent stack	147.77	26 m	3 in.
R	Fixture drain acting as an additional circuit vent sized as a wet vent	N/A	N/A	2 in.
S	Vent stack	148.77	26 m	3 in.
T	Circuit vent	73	1 m	2 in.
U	Individual and continuous vent acting as a relief vent	N/A	N/A	1.5 in.
V	Branch vent	14	5 m	1.5 in.
W	Continuous vent	10	3 m	1.5 in.
X	Branch vent	18	5 m	1.5 in.
Y	Stack vent	147.77	3 m	2 in.
Z	Stack vent	6.5	3 m	3 in.

9. Drawing 2P-42 — Drainage

Table 9 Answers

Number	Name	Hydraulic Load (FU)	Size
1	Stack acting as a wet vent	2	3 in.
2	Stack	9	3 in.
3	Branch	2	1.5 in.
4	Branch	4	2 in.
5	Branch	6	2 in.
6	Branch	18	3 in.
7	Fixture drain acting as a wet vent	2.5	2 in.
8	Stack	31	3 in.
9	Branch	8	3 in.
10	Stack	39	3 in.
11	Stack acting as a wet vent	3.5	2 in.
12	Stack acting as a wet vent	4.44	3 in.
13	Branch	6.66	3 in.
14	Stack	12.66	3 in.
15	Branch	12.66	3 in.
16	Fixture drain acting as a wet vent	2.5	2 in.
17	Branch — Wet vent	2.5	2 in.
18	Branch	16	3 in.
19	Stack	67.66	3 in.
20	Sanitary building drain	67.66	4 in.
21	Fixture drain	3	2 in.
22	Branch	18	3 in.
23	Sanitary building drain	85.66	4 in.

10. Drawing 2P-42 — Venting

Table 10 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Individual and continuous vent	N/A	N/A	1.5 in.
B	Branch vent	9	12 m	1.5 in.
C	Individual and continuous vent	N/A	N/A	1.5 in.
D	Branch vent	18	12 m	1.5 in.
E	Vent stack	67.66	18 m	2 in.
F	Vent stack	85.66	18 m	2 in.
G	Continuous vent	8	16 m	1.5 in.
H	Continuous vent	8	14 m	1.5 in.
I	Branch vent	16	16 m	2 in.
J	Continuous vent	8	4 m	1.5 in.
K	Branch vent	24	16 m	2 in.
L	Dual and continuous vent	N/A	N/A	1.5 in.
M	Branch vent	12	9 m	1.5 in.
N	Branch vent	18	9 m	1.5 in.
O	Vent stack	85.66	18 m	2 in.
P	Stack vent	67.66	3 m	3 in.
Q	Vent header	85.66	26 m	3 in.
R	Continuous vent	4	3 m	1.25 in.
S	Stack vent	12.66	2 m	1.5 in.
T	Stack vent	6.66	2 m	1.5 in.

11. Drawing 2P-43 — Drainage

Table 11 Answers

Number	Name	Hydraulic Load (FU)	Size
1	Stack	10	3 in.
2	Fixture drain acting as a wet vent	4	3 in.
3	Branch	12	3 in.
4	Stack	22	3 in.
5	Fixture drain acting as a circuit vent sized as a wet vent	1	2 in.
6	Stack	44	4 in.
7	Stack	51	4 in.
8	Branch	3	1.5 in.
9	Stack	54	4 in.
10	Branch — Wet vent	2.5	2 in.
11	Stack	60.5	4 in.
12	Sanitary building drain	60.5	4 in.
13	Stack acting as a wet vent	2.5	3 in.
14	Stack	6	3 in.
15	Fixture drain acting as a wet vent	1	1.5 in.
16	Branch	2.5	1.5 in.
17	Fixture drain acting as a wet vent	1	2 in.
18	Stack	32	4 in.
19	Branch	20	4 in.
20	Stack	68	4 in.
21	Branch	12	3 in.
22	Vent stack acting as a branch sized as a wet vent	2.59	3 in.
23	Stack	82.59	4 in.
24	Sanitary building drain	143.09	4 in.

12. Drawing 2P-43 — Venting

Table 12 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Circuit vent	12	8 m	1.5 in.
B	Branch vent	12	8 m	1.5 in.
C	Vent stack	82.59	33 m	3 in.
D	Circuit vent	36	14 m	2 in.
E	Relief vent	N/A	N/A	1.5 in.
F	Branch vent	36	14 m	2 in.
G	Continuous vent	6	8 m	1.5 in.
H	Continuous vent	2.5	4 m	1.25 in.
I	Individual vent	N/A	N/A	1.5 in.
J	Branch vent	4.5	8 m	1.5 in.
K	Stack vent	82.59	21 m	3 in.
L	Vent header	82.59	40 m	3 in.
M	Relief vent	N/A	N/A	1.5 in.
N	Branch vent	13	14 m	1.5 in.
O	Vent header	82.59	40 m	3 in.
P	Continuous vent	6	4 m	1.5 in.
Q	Vent stack	60.5	24 m	3 in.
R	Vent stack	60.5	24 m	3 in.
S	Dual and continuous vent	N/A	N/A	1.25 in.
T	Continuous vent	7	2 m	1.5 in.
U	Circuit vent	21	7 m	1.5 in.
V	Branch vent	22	7 m	1.5 in.
W	Continuous vent	5	2 m	1.5 in.
X	Stack vent	60.5	9 m	3 in.
Y	Vent header	60.5	25 m	3 in.
Z	Vent header	143.09	40 m	3 in.

13. Drawing 2P-44 — Drainage

Table 13 Answers

Number	Name	Hydraulic Load (FU)	Size
1	Branch	10	2.5 in.
2	Branch	9	3 in.
3	Stack	19	4 in.
4	Branch	8	2.5 in.
5	Branch	10	4 in.
6	Branch	34	4 in.
7	Branch	18	3 in.
8	Branch	32	4 in.
9	Stack acting as a wet vent	6	3 in.
10	Branch	7.5	3 in.
11	Branch	36	4 in.
12	Branch	108	4 in.
13	Branch	120	4 in.
14	Stack	242.5	5 in.
15	Sanitary building drain	242.5	5 in.
16	Trap arm — Fixture drain	2	2 in.
17	Branch	8	2.5 in.
18	Stack	69	4 in.
19	Stack acting as a wet vent	6	3 in.
20	Trap arm — Fixture drain	6	3 in.

14. Drawing 2P-44 — Venting

Table 14 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Vent stack	242.5	30 m	4 in.
B	Circuit vent	120	21 m	3 in.
C	Additional circuit vent	N/A	N/A	2 in.
D	Branch vent	120	21 m	3 in.
E	Branch vent	14	7 m	1.5 in.
F	Vent stack	242.5	30 m	4 in.
G	Circuit vent	30	13 m	2 in.
H	Dual and continuous vent acting as a relief cent	N/A	N/A	1.5 in.
I	Circuit vent	32	14 m	2 in.
J	Branch vent	35	14 m	2 in.
K	Vent stack	242.5	30 m	4 in.
L	Continuous vent	7	8 m	1.5 in.
M	Dual and continuous vent	N/A	N/A	1.5 in.
N	Stack vent	242.5	5 m	3 in.
O	Vent header	242.5	45 m	4 in.
P	Branch vent	15	8 m	1.5 in.
Q	Stack vent	7.5	7 m	3 in.
R	Branch vent	19	12 m	1.5 in.

15. Drawing 2P-45 — Drainage

Table 15 Answers

Number	Name	Hydraulic Load (FU)	Size
1	Stack	10	3 in.
2	Fixture drain acting as a wet vent	2.5	2 in.
3	Branch	6	3 in.
4	Stack	19	3 in.
5	Fixture drain acting as a wet vent	0.5	2 in.
6	Stack	23.5	3 in.
7	Stack	30.5	3 in.
8	Branch	8	2.5 in.
9	Stack	38.5	3 in.
10	Branch — Wet vent	1.5	2 in.
11	Stack	45.5	3 in.
12	Sanitary building drain	45.5	4 in.
13	Branch	85	4 in.
14	Sanitary building drain	130.5	4 in.
15	Stack acting as a wet vent	1	2 in.
16	Stack	5	3 in.
17	Stack	8	3 in.
18	Branch — Wet vent	2	1.5 in.
19	Branch	3.5	2 in.
20	Stack	11.5	3 in.
21	Fixture drain acting as a wet vent	1	2 in.
22	Stack	17.5	3 in.
23	Branch	20	4 in.
24	Stack	53.5	4 in.
25	Branch	12	3 in.
26	Vent stack acting as a fixture drain sized as a wet vent	1.5	3 in.
27	Stack	67	4 in.
28	Sanitary building drain	197.5	5 in.

16. Drawing 2P-45 — Venting

Table 16 Answers

Letter	Name	Hydraulic Load (FU)	Length	Size
A	Circuit vent	12	8.5 m	1.5 in.
B	Branch vent	12	8.5 m	1.5 in.
C	Vent stack	67	42 m	3 in.
D	Vent stack	67	42 m	3 in.
E	Circuit vent	36	11 m	2 in.
F	Relief vent	N/A	N/A	1.5 in.
G	Branch vent	36	11 m	2 in.
H	Vent stack	67	42 m	3 in.
I	Continuous vent	6	9 m	1.5 in.
J	Vent stack	67	42 m	3 in.
K	Continuous vent	3.5	5.5 m	1.25 in.
L	Vent stack	67	42 m	3 in.
M	Individual vent	N/A	N/A	1.5 in.
N	Branch vent	3	8.5 m	1.5 in.
O	Vent stack	67	42 m	3 in.
P	Stack vent	67	8 m	2 in.
Q	Vent header	67	48.5 m	3 in.
R	Continuous vent	5.5	3 m	1.5 in.
S	Vent stack	45.5	30.2 m	3 in.
T	Vent stack	45.5	30.2 m	3 in.
U	Dual and continuous vent	N/A	N/A	1.5 in.
V	Vent stack	45.5	30.2 m	3 in.
W	Continuous vent	7	4 m	1.5 in.
X	Vent stack	45.5	30.2 m	3 in.
Y	Continuous vent	4.5	9 m	1.5 in.
Z	Vent stack acting as a fixture sized as a wet vent	1.5	30.2 m	3 in.
AA	Vent stack	45.5	30.2 m	3 in.
AB	Continuous vent	6	5 m	1.5 in.
AC	Vent stack	45.5	30.2 m	3 in.
AD	Continuous vent	5	1 m	1.5 in.
AE	Stack vent	45.5	5.7 m	1.5 in.
AF	Continuous vent	5	1 m	1.5 in.
AG	Stack vent	45.5	5.7 m	1.5 in.
AH	Vent header	45.5	28.2 m	3 in.

Self-Test D-1.10 Requirements and Prohibitions for DWV Systems

Complete Self-Test D-1.10 and check your answers.

1. Piping, fittings and joints used in a pressure sewer, forcemain, or sump pump discharge applications shall be capable of withstanding at least _____ times the potential pressure.
   a. 1.5
   b. 2
   c. 2.5
   d. 3

2. What is the maximum number of showerheads that can be served by a single shower drain?
   a. 3
   b. 4
   c. 5
   d. 6

3. Except for column showers, what is the minimum dimension between two adjacent showerheads?
   a. 730 mm
   b. 690 mm
   c. 750 mm
   d. 800 mm

4. What type of fixture shall not have a concealed overflow?
   a. Lavatory
   b. Shampoo sink
   c. Food prep sink
   d. Shower

5. Where must copper tube not be used when connecting a flush valve–operated urinal?
   a. Branch drain serving the fixture
   b. Vent above the flood level rim
   c. Fixture drain
   d. Both b and c

6. What type of material may the cleanout plug be made of if serving a 2 in. trap standard made of cast-iron?
   a. Cast iron
   b. Galvanized steel
   c. Brass

d. Both b and c

7. What is the minimum trap seal depth for a lab sink that drains to an acid waste system?
   a. 25 mm
   b. 33 mm
   c. 38 mm
   d. 50 mm

8. According to the NPC, which of the following types of traps are prohibited?
   a. Bell traps
   b. Crown-vented trap
   c. All of the above

9. Transition solvent cement permitted by the NPC is used to join which type of pipe?
   a. ABS drainage to PE subsoil drainage
   b. PVC pressure to CPVC pressure
   c. PVC drainage to PE subsoil drainage
   d. PVC drainage to ABS drainage

10. Fasteners used to secure WC flanges to a building structure must have what quality?
    a. Corrosion resistant
    b. Coarse thread
    c. Expansion type
    d. Non-removable

11. If an indirectly connected 1.5 in. pipe forms an air break above a directly connected fixture, what is the minimum dimension of the air break?
    a. 1.25 in.
    b. 1.5 in.
    c. 2 in.
    d. 3 in.

12. What is the maximum pipe support spacing for a vertical three-storey stack?
    a. 6.5 m
    b. 7.0 m
    c. 7.5 m
    d. 8.0 m

13. When installing a hub and spigot pipe, at which end of the pipe shall the hub be installed?
    a. Upstream
    b. Downstream

14. What is the minimum depth of lead in a cold-caulked lead drainage joint?
    a. 15 mm
    b. 25 mm
    c. 50 mm
    d. 75 mm

15. When installing a caulked lead drainage joint, when is it acceptable to paint the pipe and caulking material?
    a. Immediately after installation
    b. Before testing the joint
    c. After testing the joint
    d. Never paint a lead joint; it will turn toxic.

16. What is the maximum hanger spacing for horizontal cast-iron soil pipe?
    a. 1 m
    b. 2 m
    c. 3 m
    d. 4 m

17. What is the maximum hanger spacing for horizontal PVC pipe?
    a. 1 m
    b. 1.2 m
    c. 1.3 m
    d. 1.4 m

18. When installing copper tube underground, the joints shall be joined by what method?
    a. Soldered or compression
    b. Soldered or brazed
    c. Brazed or screwed
    d. Brazed or flared

19. Cold-caulked joints shall only be used in which of the following bell and spigot piping systems?
    a. Water systems
    b. Drainage systems
    c. Venting systems
    d. Any of the above

20. When installing a lead stub during the rough-in of a WC, what type of floor flange shall be used when the toilet is set in place?
    a. ABS
    b. Cast-iron

c. Lead
d. Brass

21. Which fixture does not have to be directly connected to a sanitary drainage system?

a. Kitchen sink
b. Toilet c/w flush valve
c. Drinking fountain
d. Bar sink

22. What is the maximum permitted hydraulic load drained to a 12 in. sanitary building drain with a slope of 1:200?

a. 1,400 FU
b. 2,500 FU
c. 3,900 FU
d. 4,500 FU

23. You are sent to an existing house to rough-in a basement bathroom group. The building drain that you want to tie into serves a stack with 35 FU draining to it. What is the minimum distance from the base of the stack to the tie-in point that must be maintained in this situation?

a. 1 m
b. 1.5 m
c. 2 m
d. No restriction

24. You are sent to a business that provides bottled water for its customers. You are to provide a drainage system for six reverse osmosis (RO) water filtration units. You have decided to connect the drains to a common branch and then indirectly connect the branch to the sanitary drainage system. What is the minimum size of the common branch in this situation?

a. 0.75 in.
b. 1 in.
c. 1.25 in.
d. Twice the size of the largest drain (air gap)

25. Urinals shall not be installed in which of the following areas?

a. Residential occupancy buildings
b. Where the wall and floor surfaces are pervious to water
c. Where there is no emergency floor drain
d. All of the above

26. You are installing a domestic dishwasher and are going to drain the machine to the fixture outlet pipe of an adjacent kitchen sink. What type of fitting would you use to make the connection at the fixture outlet pipe?

a. Sanitary tee
b. Sanitary tee and a 90° ell

c. Wye fitting
d. Any of the above

27. A cleanout fitting serving a building trap shall be installed in which location(s) listed below?

a. Directly over the upstream side of the trap
b. Directly over the downstream side of the trap
c. As close as practicable to where the building drain leaves the building
d. Any of the above

28. When a building trap is installed, where does the NPC allow it to be located?

a. Upstream of the main building cleanout
b. Outside the building in a manhole
c. Inside the building as close as practicable to where the building drain leaves the building
d. Any of the above

29. Is the drain from an indirectly connected drinking fountain considered an acceptable method of maintaining the trap seal for a floor drain?

a. Yes
b. No
c. Yes, but only if the floor drain drains to a storm drainage system
d. No, only a manufactured trap seal primer is acceptable for this situation

30. There are certain requirements for the order in which valves and fittings are installed on a sump pump discharge. Listing the items in the direction of flow, what is the proper order?

a. Union, shut-off valve, check valve
b. Shut off-valve, union, check valve
c. Union, check valve, shut-off valve
d. Check valve, union, shut-off valve

31. When installed in a single-family dwelling building drain, a backwater valve shall meet which of the following requirements?

a. Normally closed
b. Normally open
c. Larger than 4 in. NPS
d. Not allowed by code on a building drain or building sewer

32. A floor drain subject to backflow may be protected in which manner?

a. Backwater valve only
b. Backwater valve or gate valve only
c. Backwater valve, gate valve, or removable screw cap on the upstream side of the trap
d. A floor drain subject to backflow cannot be installed.

33. A building sewer that serves a mobile home shall meet which of the following requirements?

    a. Minimum 4 in. NPS in size
    b. Terminated below ground in a frost-free vault
    c. Be of flexible construction to accommodate connection
    d. All of the above

34. What is the minimum size of cleanout fittings installed for pipes with diameters of 4 in. or less?

    a. Half the size of the drainage pipe being served
    b. The size of the drainage pipe being served
    c. The same size of the drainage pipe being served
    d. 4 in.

35. When installing a cleanout for a 4 in. building sewer using a wye fitting 6 ft below grade, what is the maximum length of pipe you can install before the next cleanout is required?

    a. 7.5 m
    b. 15 m
    c. 26 m
    d. 30 m

36. Every building drain shall be provided with a cleanout fitting located at which of the following locations?

    a. Upstream of the building trap
    b. At the base of the stack
    c. As close as practicable to where the building drain leaves the building
    d. Any of the above

37. When a manhole more than 1 m in depth is located in a building, which of the following features must it be provided with?

    a. Vent
    b. Corrosion-resistant ladder
    c. Cover with an airtight seal
    d. All of the above

38. What is the minimum horizontal dimension of a manhole at the bottom of the enclosure?

    a. 500 mm
    b. 600 mm
    c. 1,000 mm
    d. 1,500 mm

39. What is the minimum horizontal dimension of a manhole at the top of the enclosure?

    a. 500 mm

b. 600 mm
c. 1,000 mm
d. 1,500 mm

40. When roughing in an autopsy table at your neighbourhood mortuary, what is the minimum dimension above the flood level rim of the autopsy table that the cleanout could be installed?

a. 150 mm
b. 200 mm
c. 300 mm
d. 350 mm

41. When installing a grease interceptor to serve as a fixture trap for a commercial kitchen sink, what is the maximum developed length of the fixture outlet pipe between the sink and the interceptor?

a. 900 mm
b. 1 m
c. 1.2 m
d. 1.5 m

42. You are installing a triple-compartment kitchen sink equipped with 1.5 in. tailpieces. You are told to drain all compartments to a common trap. What is the minimum size trap that will suit this installation?

a. 1.5 in.
b. 2 in.
c. 3 in.
d. 4 in.

43. When installing a washer box in a single-family dwelling laundry room, what is the minimum distance of the drain standpipe measured from the trap weir to the top of the standpipe?

a. 400 mm
b. 600 mm
c. 800 mm
d. 1 m

44. When installing a washer box in a single-family dwelling laundry room, at what height above the floor shall the drain opening of the box be?

a. Below the flood level rim of the washing machine
b. Level with the flood level rim of the washing machine
c. Above the flood level rim of the washing machine
d. Any of the above

45. You are installing a stack through a building. You have to offset the stack 2 m horizontally to accommodate a change in wall location. The offset and lower section of stack shall be sized as which of the following?

a. Sanitary branch

b. Stack, but one size larger than it was prior to the offset
c. Sanitary building drain
d. Either a or c, whichever is less restrictive

46. What is the minimum size of a vent pipe that serves a manhole within a building?

a. 1.5 in.
b. 2 in.
c. 3 in.
d. 4 in.

47. What is the maximum length of a 3 in. wet vent?

a. 1.5 m
b. 2 m
c. 3 m
d. There is no limit to the length of a wet vent.

48. What is the minimum size of a vent pipe that serves a sewage sump?

a. 1.25 in.
b. 1.5 in.
c. 2 in.
d. 3 in.

49. What is the maximum change in direction that a basin trap arm may have before it is vented?

a. 115°
b. 125°
c. 135°
d. 225°

50. What is the minimum distance that a stack vent can terminate from an openable window or other air inlet?

a. 3.0 m
b. 3.5 m
c. 4.0 m
d. 4.5 m

51. If a sewage sump has a 6 in. pipe draining into it, what is the minimum size vent for the sump?

a. 3 in.
b. 4 in.
c. 5 in.
d. 6 in.

52. What is the minimum difference in elevation between the two vents serving an oil interceptor?

a. 150 mm
b. 200 mm
c. 250 mm
d. 300 mm

53. What is the minimum distance that a vent must terminate above the roof?

a. 25 mm
b. 50 mm
c. 100 mm
d. 150 mm

54. What is the maximum change in direction that a water closet trap arm may have before it is vented?

a. 115°
b. 125°
c. 135°
d. 225°

55. With regard to a multi-storey wet vent, what is the maximum load drained to the wet vent from any one storey above the first storey when the stack passes through more than one storey?

a. 4
b. 8
c. 16
d. No limit

56. What is the maximum number of fixture units that can be drained to the base of a vent stack?

a. 6
b. 8
c. No drainage can discharge on a vent stack.
d. No limit

57. A stack that serves as a multi-storey wet vent has restrictions regarding offsets. Choose the clause that best describes these restrictions for a wet-vented stack.

a. Cannot have offsets
b. May have one offset that does not exceed 2 m in length
c. May have two offsets that do not exceed 2.5 m in length
d. May have one offset that does not exceed 2.5 m in length

58. A wet-vented stack has fixtures draining into it from six storeys. The stack is serving two water closets located on the bottom floor. There are two kitchen sinks on each of the five floors above the bottom floor. What is the minimum size of the stack vent if it is 20 m in length?

a. 3 in.
b. 4 in.

c. 5 in.
d. 6 in.

59. What is the minimum size of a fresh air inlet?

a. 1.5 in.
b. 2 in.
c. 4 in.
d. 3 in.

60. Which of the following must a relief vent serving a circuit-vented branch be?

a. A sanitary drainage pipe with at least 6 FU draining to it
b. Connected downstream of the most downstream water closet
c. Connected to the trap arm of the most upstream fixture
d. Connected downstream of the most downstream circuit-vented fixture

61. A 12-storey building served by a 3 in. stack and a 2 in. vent stack may require a yoke vent. What would be the minimum size of the yoke vent in this situation?

a. 1.5 in.
b. 2 in.
c. 3 in.
d. 4 in.

62. A stack in a building has a nominally horizontal, 2-m long offset installed in it. The load above the offset is 143 FU draining from three floors. What is the additional venting requirement for this situation?

a. No additional venting required
b. One relief vent for the offset
c. Two relief vents for the offset
d. Three relief vents for the offset

63. If a combined relief vent is serving two circuit-vented branches, the combined relief vent must conform to which of the following requirements?

a. 2 in. minimum size
b. Sized as a wet vent
c. Symmetrically connected
d. Same size as the largest circuit vent

64. If an additional circuit vent is installed in conjunction with a circuit-vented branch and has a lavatory draining to it, the portion of the additional circuit vent that accepts the drainage shall conform to which of the following requirements?

a. Same size as the circuit vent
b. One size smaller than the circuit vent
c. Sized as a wet vent, maximum 2 in.

d. Sized as a wet vent, minimum 2 in.

65. If you are hired to install an acid dilution tank at a hospital lab, does the NPC allow you to connect the dilution tank vent to the existing plumbing venting system?

a. Yes, if the existing venting is cast iron
b. Yes, to a vent stack only, not to a branch vent
c. No, use an island vent configuration
d. No, it must be independent to open air

66. Which of the following fixtures would be considered when determining the hydraulic load on a continuous vent that serves a wet-vented branch?

a. All fixtures draining to the wet vent, including the water closets
b. All fixtures except 2 in. emergency floor drains
c. All wet-vented fixtures, except the water closets
d. All wet-vented fixtures

67. When circuit venting three drinking fountains, what would be the size of the fixture drain immediately downstream of the circuit vent connection?

a. 1.25 in.
b. 1.5 in.
c. 2 in.
d. 3 in.

68. When circuit venting four 2 in. showers, what would be the size of the fixture drain immediately downstream of the circuit vent connection?

a. 2 in.
b. 2.5 in.
c. 3 in.
d. 4 in.

69. What is the hydraulic load to be considered when sizing a circuit vent that serves a circuit-vented branch?

a. All fixtures draining to the circuit-vented branch
b. All fixtures draining to the circuit-vented branch, except separately vented fixtures
c. All circuit-vented fixtures and the fixtures attached to the relief vent
d. All circuit-vented fixtures

70. When circuit venting four drinking fountains, what is the size of the fixture drain immediately upstream of the circuit vent connection?

a. 1.25 in.
b. 1.5 in.
c. 2 in.
d. 3 in.

71. What is the code restriction for connecting fixtures to a circuit vent or an additional circuit vent?

    a. 1 fixture maximum; 2 in. trap size
    b. 2 fixtures maximum; 2 FU each
    c. 1 fixture maximum; 1.5 in. trap size
    d. 2 fixtures maximum; 1.5 FU each

72. What are the venting requirements for a secondary receiver installed in conjunction with an oil interceptor?

    a. 1.5 in. minimum size
    b. 2 in. minimum size
    c. 1 size smaller than the largest inlet
    d. It does not require a vent.

73. You have been hired to install the rough DVW piping in a single-family dwelling. You decide to stub a future vent into the basement. Due to no sewage sump in the basement, what would be the minimum size vent allowed by code?

    a. 1.25 in.
    b. 1.5 in.
    c. 2 in.
    d. 3 in.

74. What is the maximum horizontal distance a 3 in. trap arm serving a water closet may run before a vent connection is provided?

    a. 1.2 m
    b. 1.5 m
    c. 3 m
    d. 3.6 m

75. In areas where vents are subject to frost closure, the code allows for the installation of air admittance valves. Could all of the vents serving a single-family dwelling be air admittance valves?

    a. Yes, without any code restrictions
    b. No
    c. Yes, a maximum of four valves that must terminate where they will not freeze
    d. Yes, only if all the fixtures are individually vented and the valves terminate in an area where they will not freeze

76. When terminating an air admittance valve in an area where insulation materials are present, what is the minimum distance above the insulation that the valve can be installed?

    a. 100 mm
    b. 150 mm
    c. Cannot be installed in areas where insulation materials are present
    d. Should be covered by insulation so it will not freeze shut

77. You are installing an island vented kitchen sink. You decide to use an air admittance valve for your vent. What is the minimum distance above the trap arm of the sink that the valve may be installed?

    a. 100 mm
    b. 150 mm
    c. Above the flood level rim of the sink
    d. No minimum distance above the trap arm

Answer Key: Self-Test D-1.10 is on the next page.

Answer Key: Self-Test D-1.10

1. a. 1.5
2. d. 6
3. c. 750 mm
4. c. Food prep sink
5. c. Fixture drain
6. c. Brass
7. d. 50 mm
8. c. All of the above
9. d. PVC drainage to ABS drainage
10. a. Corrosion resistant
11. b. 1.5 in.
12. c. 7.5 m
13. a. Upstream
14. b. 25 mm
15. c. After testing the joint
16. c. 3 m
17. b. 1.2 m
18. d. Brazed or flare
19. d. Any of the above
20. d. Brass
21. c. Drinking fountain
22. c. 3900 FU
23. b. 1.5 m
24. c. 1.25 in.
25. b. Where the wall and floor surfaces are pervious to water
26. c. Wye fitting
27. a. Directly over the upstream side of the trap
28. d. Any of the above
29. a. Yes
30. c. Union, check valve, shut-off valve
31. b. Normally open
32. c. Backwater valve, gate valve, or removable screw cap on the upstream side of the trap
33. a. Minimum 4 in. NPS in size
34. c. Same size of the drainage pipe being served
35. b. 15 m
36. c. As close as practicable to where the building drain leaves the building
37. d. All of the above
38. c. 1,000 mm
39. b. 600 mm
40. a. 150 mm
41. c. 1.2 m
42. b. 2 in.
43. b. 600 mm
44. c. Above the flood level rim of the washing machine

45. d. Either a or c, whichever is less restrictive
46. b. 2 in.
47. d. There is no limit to the length of a wet vent.
48. c. 2 in.
49. c. 135°
50. b. 3.5 m
51. b. 4 in.
52. d. 300 mm
53. d. 150 mm
54. d. 225°
55. a. 4
56. b. 8
57. d. May have one offset that does not exceed 2.5 m in length
58. c. 5 in.
59. c. 4v
60. d. Connected downstream of the most downstream circuit vented fixture.
61. a. 1.5 in.
62. c. Two relief vents for the offset
63. c. Symmetrically connected
64. d. Sized as a wet vent, minimum 2 in.
65. d. No, it must be independent to open air.
66. a. All fixtures draining to the wet vent, including the water closets
67. c. 2 in.
68. c. 3 in.
69. a. All fixtures draining to the circuit-vented branch
70. a. 1.25 in.
71. d. 2 fixtures maximum 1.5 FU each
72. a. 1.5 in. minimum size
73. b. 1.5 in.
74. c. 3 m
75. b. No
76. b. 150 mm
77. a. 100 mm

Self-Test D-1.11 Trade Waste Systems

Complete Self-Test D-1.11 and check your answers.

1. Which classification of fixtures would generally not need to be drained to a trade waste system?
    a. Residential
    b. Commercial
    c. Industrial
    d. Institutional

2. What type of trade waste system is most commonly seen in a commercial setting?
    a. Clothes washer draining into a lint trap
    b. Toilet draining into a septic system
    c. Pot sink draining into a grease interceptor
    d. Basin draining into a septic tank

3. Complete the following statement: "The discharge draining into a grease interceptor should _____."
    a. Be as cool as possible
    b. Be as soapy as possible
    c. Be as hot as possible
    d. Move as fast as possible

4. How often should a grease interceptor be emptied?
    a. Yearly
    b. Monthly
    c. Daily
    d. When approximately 25% full

5. Approximately how much space in a pot sink's compartments is assumed to be taken up by pots and pans when sizing a grease interceptor?
    a. 10%
    b. 25%
    c. 40%
    d. 50%

6. As referenced in the 2007 BC Plumbing Code clauses, a 3-in. trap used in a trade waste system is assumed to be how many fixture units?
    a. 3
    b. 5
    c. 7
    d. 10

7. What should be the minimum size of vent used in the trade waste system referenced in the diagram from the 2007 BC Plumbing Code?

    a. 1.25 in.
    b. 1.5 in.
    c. 2 in.
    d. 3 in.

8. What is the principle by which an oil interceptor separates oil from drainage water?

    a. Venturi
    b. Conductivity
    c. Capillary action
    d. Flotation

9. What item inside an oil interceptor, when adjusted properly, allows oil to be drained off by gravity to a collection tank?

    a. Standpipe sleeve
    b. Float
    c. Inverted bell
    d. Baffle

10. Which one of the following pH ranges would generally not need to be adjusted for drainage to be allowed directly into a sanitary drainage system?

    a. 8 to 11
    b. 3 to 6.5
    c. 5.5 to 8.5
    d. 7.5 to 10.5

11. What is the minimum percentage of calcium carbonate ($CaCO_3$) content for limestone chips used in an acid neutralizer?

    a. 100%
    b. 90%
    c. 80%
    d. 70%

12. What is the name of the device found in a commercial pot sink that allows hot water to continually flow into a sink compartment without allowing it to spill over the flood level rim of the sink?

    a. Continuous waste
    b. Waste and overflow
    c. Standing waste
    d. Standpipe

13. What is installed either on the piping entering a grease interceptor or inside the interceptor near its inlet that slows the flow rate and reduces turbulence so that grease more easily separates from the water?

    a. Vent
    b. Strainer
    c. Escutcheon
    d. Flow control fitting

14. What type of grease interceptor has a mechanism that regularly skims the top layer of FOG into a separate collection chamber so that it can be disposed of on a daily basis without opening up the interceptor?

    a. Passive
    b. Aggressive
    c. Automatic
    d. Automatic mechanical

15. A three-compartment pot sink drains to a grease interceptor. Each compartment measures 15 in. by 15 in. by 10 in. If the drain-down time is one minute and 25% of the volume of the compartments is taken up by pots and pans, what is the minimum flow rate in USGPM and grease storage capacity in pounds for the grease interceptor?

    a. 7.3 USGPM and 14.6 pounds capacity
    b. 14.6 USGPM and 29.2 pounds capacity
    c. 21.9 USGPM and 43.8 pounds capacity
    d. 29.2 USGPM and 58.4 pounds capacity

Answer Key: Self-Test D-1.11 (#chapter-answer-key-self-test-d-1-11) is on the next page.

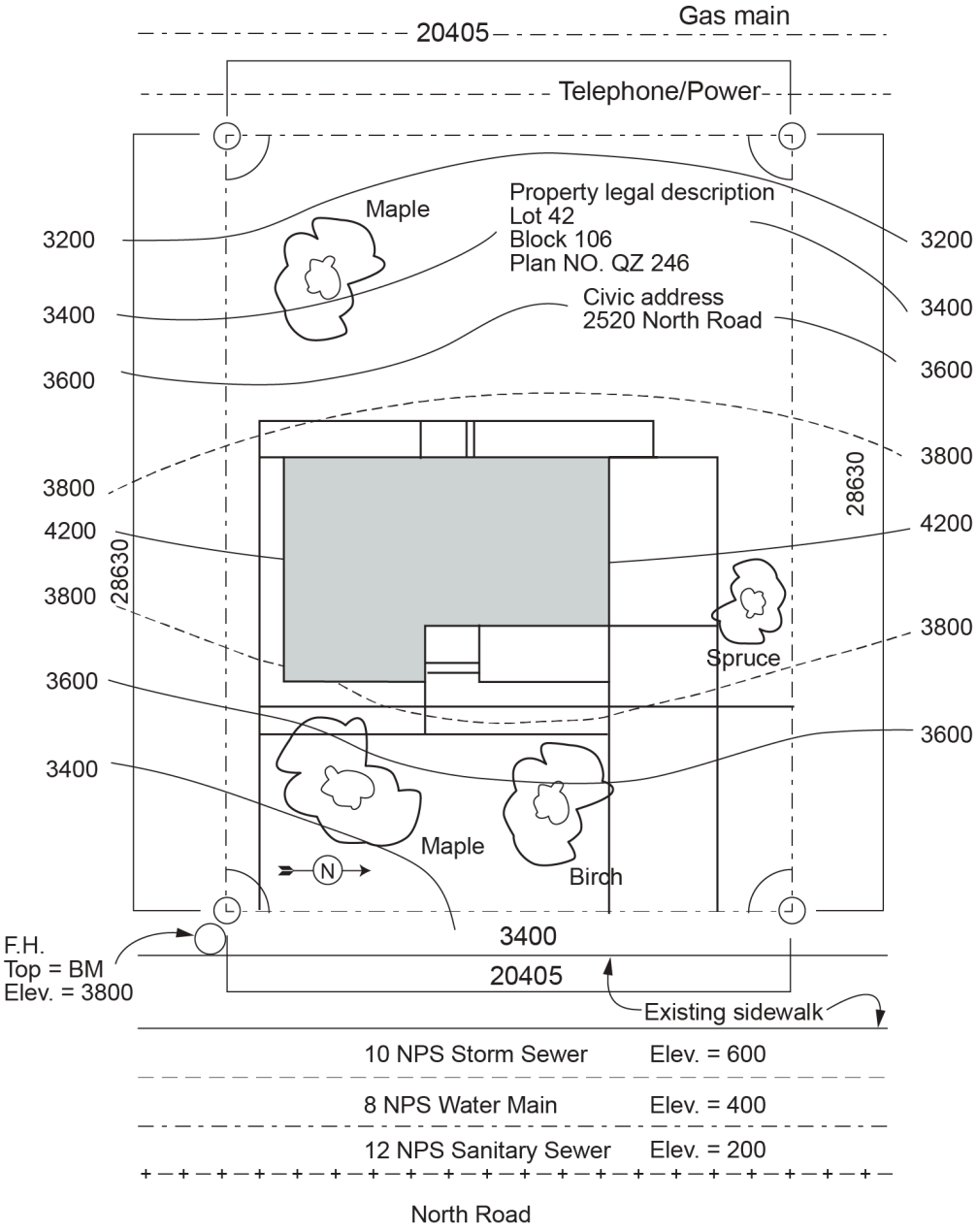
Answer Key: Self-Test D-1.11

1. a. Residential
2. c. Pot sink draining into a grease interceptor
3. c. Be as hot as possible
4. d. When approximately 25% full
5. b. 25%
6. a. 3
7. a. 1.25 in.
8. d. Flotation
9. a. Standpipe sleeve
10. c. 5.5 to 8.5
11. b. 90
12. c. Standing waste
13. d. Flow control fitting
14. d. Automatic mechanical
15. c. 21.9 USGPM and 43.8 pounds capacity

$$
\begin{aligned}
15 \times 15 \times 10 \times 3 \times 0.75 &= 5,062.5 \text{ in.}^3 \\
5062.5 \text{ in.}^3 \div 231 \text{ in.}^3/\text{USG} &= 21.9 \text{ USGPM flow rate} \\
21.9 \times 2 &= 43.8 \text{ pounds storage capacity}
\end{aligned}
$$

D-2 PLANNING AND INSTALLATION OF DWV SYSTEMS

Plumber Apprenticeship Program – Level 2



D-2 Planning and Installing DWV Systems Introduction

Communication between architects, homeowners, tradespeople, and inspectors is important when developing any project. While this could take place through extended conversations, the most efficient way to ensure success is by using drawings and diagrams.

Material organizational skills are essential for increasing job site productivity. Your blueprint reading and drafting skills will allow you to create installation drawings and organize your materials accordingly. Organizing materials in a list format eliminates material procurement errors and minimizes stock overruns. Knowing exact quantities and installation phases creates a systematic work atmosphere. Proper ordering techniques can decrease labour costs by minimizing material handling, thereby allowing more time for installation. By coordinating with other trades and organizing material, a plumber can expedite the installation of piping systems. This module will present proven methods for creating a productive job site.

Learning Objectives

After completing the chapters in this section, you should be able to:

- Describe the organization of a residential project.
- Describe considerations when handling plumbing materials.
- Describe the planning of interior DWV layouts.
- Create plan drawings of piping systems.
- Create isometric drawings of piping systems using the required lettering and line type.
- Describe the information to be contained in an isometric drawing of a piping system.
- Draw piping systems with the detail required.
- Use appropriate dimensioning and pipe sizing.
- Describe take-off procedures.
- Describe take-off materials from piping drawings.
- Describe the installation of DWV piping systems.

Resources

You will be required to reference the most current National Plumbing Code.

Terminology

The following terms will be used throughout this section. A complete list of terms for this section can be found in the **Glossary**.

- **architectural drawing:** the main plan of a building that shows its design, layout, materials, and finishes. It includes floor plans, elevations, sections, and detailed views to guide construction. These drawings are usually marked with an "A" followed by a page number (e.g., A-4). (Section D-2.1)
- **"As-built"**: The record drawings and documentation defining deviation to the designed information occurring during construction at the end of the project. (Section D-2.1)
- **bulkhead:** A barrier or wall built within a building that may require plumbing installation adjustments for the DWV system. (Section D-2.2)
- **consumables:** (Also known as consumable goods, non-durable goods, or soft goods); goods that can be consumed, dissipated, wasted, or spent. In plumbing construction projects, these may include materials such as solder, flux, sand cloth, fasteners, Teflon tape, and glue. (Section D-2.4)
- **dimensioning:** The process of adding measurements to a drawing. (Section D-2.3)
- **elevation drawings**: Vertical views of a building's outside, showing details like the roof slope and wall openings. It also displays the distance from the first floor to the basement. To find the basement elevation, subtract the space between floors from the first-floor elevation. (Section D-2.1)
- **fire-stop system:** A method used to seal penetrations in fire-rated walls or ceilings to prevent fire from spreading through the openings. (Section D-2.2)
- **fixture schedule:** A list detailing the location and specifications of plumbing fixtures. (Section D-2.4)
- **flashing:** A material used to create a watertight seal around vent pipes where they penetrate a roof, preventing water intrusion. (Section D-2.5)
- **floor plan:** A horizontal view of one floor of a building, showing room layout, dimensions, materials, and fixture locations, critical for determining piping routes. (Section D-2.1)
- **frost line:** The depth below the ground surface where the soil freezes in cold climates. Pipes must be installed below this line to avoid freezing. (Section D-2.2)
- **groundwork inspection:** Inspection of underground plumbing before covering pipes. (Section D-2.4)
- **hoisting and rigging:** The use of cranes, hoists, and rigging equipment to lift and position heavy materials safely on a construction site. (Section D-2.5)
- **isometric drawings:** 3-dimensional (3D) pictures that show how pipes in a building connect and work together. They help plumbers see where drain, waste, and vent pipes go and what size they should be. These drawings make it easier to plan and install plumbing systems correctly, whether in homes or larger buildings. (Section D-2.3)
- **key plan:** A small map on a drawing (usually near the title block) showing the location of the area depicted, especially if the drawing is of part of a larger structure. (Section D-2.1)
- **material handling:** The process of safely receiving, storing, moving, and disposing of plumbing materials to prevent damage and ensure efficiency. (Section D-2.5)
- **materials take-off:** (MTO) A list of materials required for a plumbing installation. (Section D-2.4)
- **orthographic drawing:** A 2D drawing that shows different views (top, front, side) of an object. (Section

D-2.3)

- **Personal Protective Equipment (PPE):** Safety gear, such as gloves, goggles, and respirators, required to protect plumbers from workplace hazards. (Section D-2.5)
- **pipe supports:** Structures or brackets that hold pipes in place, ensuring they are properly aligned, supported, and maintained at the correct slope for drainage. (Section D-2.2)
- **plumbing plan:** A two-dimensional plan view drawing showing the plumbing system. It is generated from the architectural floor plan showing the types and locations of the plumbing fixtures in the building. The plumbing plan describes the location, sizes, and types of all piping and fittings used in the system rough-in. The horizontal branches and fixture drains are drawn to scale, but due to the two-dimensional properties of the drawing, only the locations of all vertical pipes are shown. (Section D-2.3)
- **project scope:** The defined objectives, requirements, and limitations of a project. (Section D-2.4)
- **project specifications (specs):** Detailed documentation outlining materials, installation procedures, and performance requirements. (Section D-2.4)
- **Safety Data Sheet (SDS):** A document providing information on hazardous materials, including handling, storage, and emergency procedures. (Section D-2.5)
- **sectional view:** Drawing showing a cut-through of a building to provide detailed information about wall construction and other interior elements (exterior and interior wall finish). Check these drawings for potential obstructions or conflicts for all locations where piping must penetrate walls. (Section D-2.1)
- **seismic forces:** The forces exerted on structures during an earthquake, which plumbing systems must be designed to withstand. (Section D-2.2)
- **site plan:** A drawing that shows the layout of the building and how it fits on the land, including things like roads, utilities, and the property boundaries. It is a plot plan with a basic outline of the building superimposed on it, which helps understand the location and surroundings of the building. (Figure 2, Section D-2.1)
- **structure penetrations**: Openings made in a building's walls, floors, or beams to allow pipes, ducts, or wires. These must be carefully planned to avoid weakening the structure and must follow building codes and regulations, especially for load-bearing or fire-rated components. (Section D-2.2)

D-2.1 Types of DWV Drawings

A plumber should be competent in creating and interpreting drawings. Time and materials can be wasted if a project is not planned well. You may not always be provided with a set of piping drawings, so you must be able to extract all required information about the piping systems from general architectural drawings. This is usually the case on smaller jobs.

You must know how to read drawings in order to work efficiently with other trades. By clearly envisioning the location of structural members, wiring, and ductwork, you can spot possible conflicts in the piping system and solve problems before you start to install the piping.

Construction Drawing Types

To identify their purpose, drawings are divided into classifications. On very large projects, such as high-rise office towers, it would be impossible to place all the pertinent information on one drawing. So, several types of drawings are made, each with specific information. The types of drawings include:

- Plot
- Architectural
- Structural
- Mechanical
- Electrical
- Shop
- As-built

Plot Plan

Plot plans are usually shown on the first sheet of a set of drawings. The property line appearing on the plot plan shows the size and shape of the lot. Public utility mains, or at least the points of hookup to them, are usually shown on plot plans. Included among these utilities are potable water, gas, sanitary and storm sewer mains, and electrical and telephone lines.

Each contour line on the plot plan shows points of equal height or elevation on the lot. Every contour line is marked with a particular height, say 3.8 m or 44 ft, meaning that every point on that line is 3.8 m or 44 ft above a chosen point of reference. This point of reference may be sea level, an engineering elevation marker, or simply a convenient assumed elevation, such as 100 m or 100 ft. By comparing the heights between different contour lines, you can determine the slope of the lot at any given point. In addition to contours, plot plans show the heights of specific points on the lot, such as the corners of the lot or the locations of trees.

Figure 1 is a plot plan in metric.

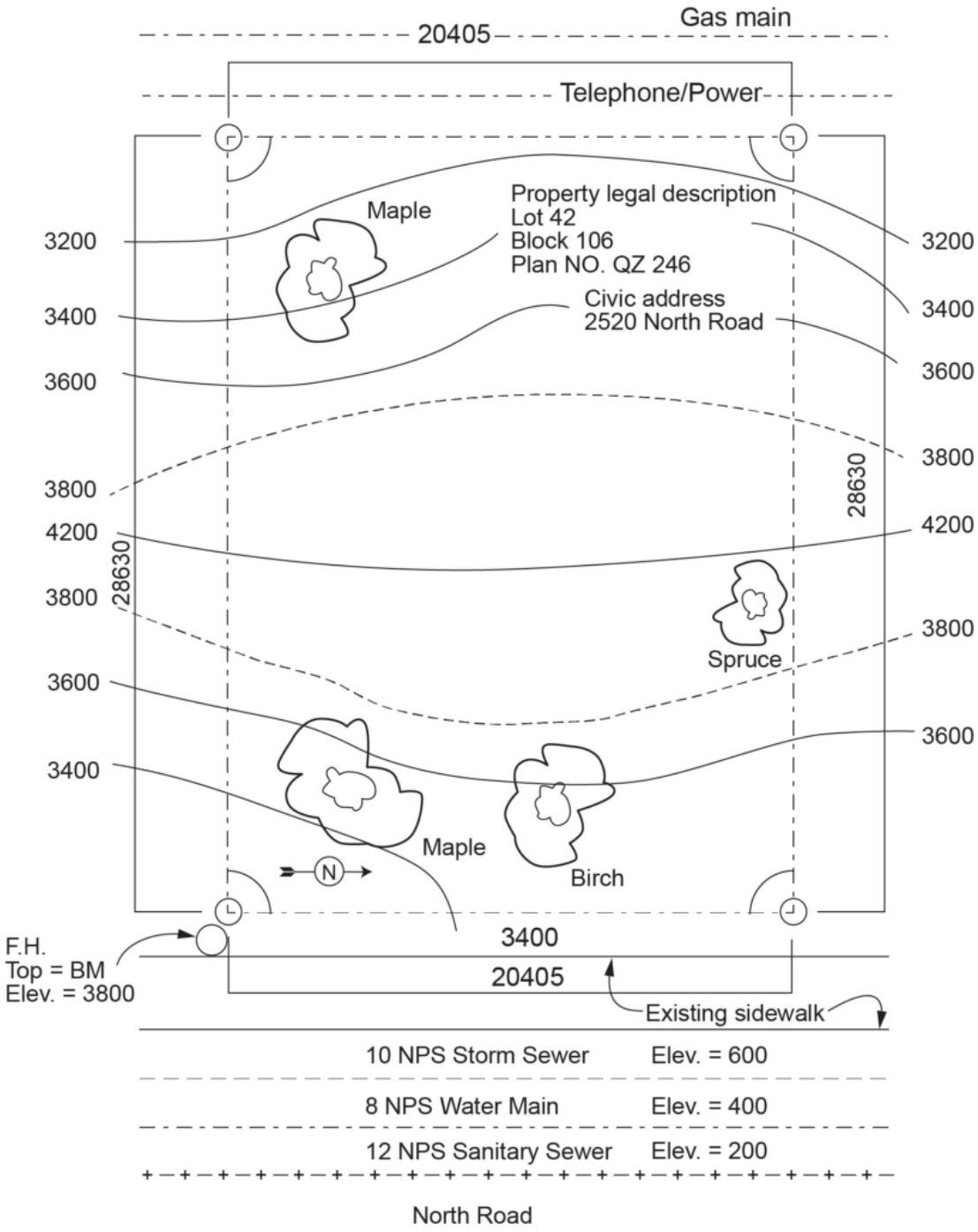


Figure 1 *Plot plan. (Skilled Trades BC, 2021) Used with permission.*

Site Plan

The **site plan** is a plot plan with a basic outline of the building superimposed on it. Figure 2 shows a site plan based on the plot plan of Figure 1. The site plan clearly shows the building's location and its services. The storm sewer, water main, and sanitary sewer are on the east side of the property. Their diameters are given in the legend as 10 NPS, 8 NPS, and 12 NPS, respectively.

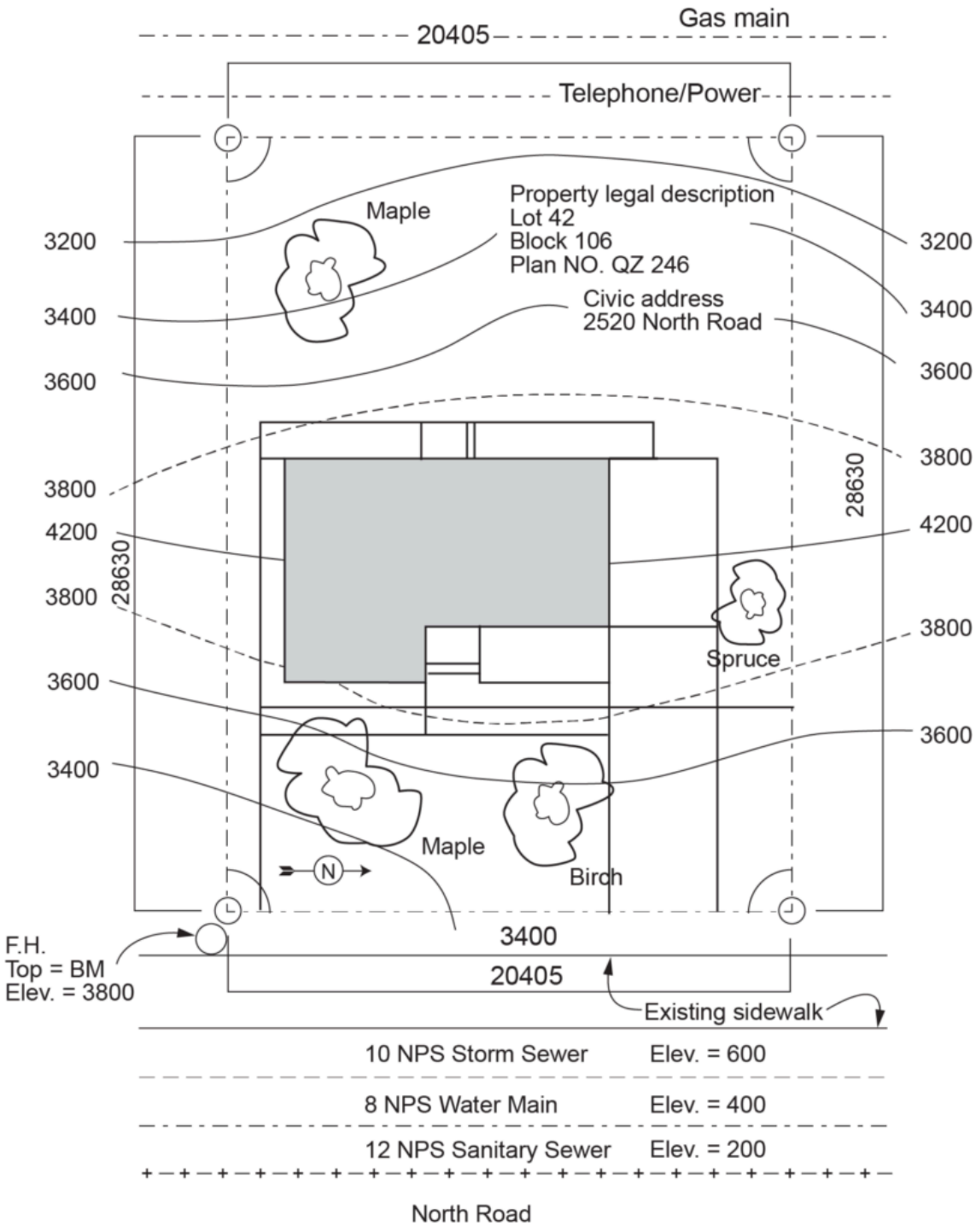


Figure 2 *Site plan. (Skilled Trades BC, 2021) Used with permission.*

The plot plan and site plan show the location of public utilities. This information will help us identify where building drains and supply pipes must be run to connect with municipal services (the storm sewer, sanitary sewer, water main, and gas main).

The site plan shows the horizontal distance of these utilities from the proposed building, and the elevation difference

between the public utilities and the basement. Finding the **elevations** of the utilities is a simple matter: the elevations of each utility are shown in the notes or written beside the utility on the drawing.

To determine whether the utilities can operate on gravity or if they require a pump, compare the elevations of the utilities to the basement elevation. To find the basement elevation, you will need to consult more than one drawing. The site plan shows the first-floor elevation, and an **elevation drawing** shows the distance between the first floor and the basement. To get the basement elevation, subtract the distance between floors from the first-floor elevation.

To calculate the amount of pipe you need, you need to know the horizontal and vertical distances of the utilities from the house. You also need to pay attention to the location of the property line. The city usually supplies pipe from the utilities to the property line, while the piping contractor supplies pipe from the building to the property line.

To install a septic tank, you need to check the location of the properly line because septic tanks and disposal field piping cannot be located within a certain distance from neighbouring properties. You also need to check the contour lines. Septic tanks should be installed where the grade is quite level.

Landscape Plan

The **landscape plan** may or may not be part of a building contract. The landscape plan is based on the site plan. A landscape architect may design the landscape and show all the recommended trees, shrubs, flowers, grass, and structures (fences, seating, walkways, etc.) on a landscape drawing. Landscaping is important for the final appearance of a building. If plumbers will be installing lawn sprinkler systems, the landscape plan will be used to design the layout of the system and the types of sprinklers used.

Architectural Drawings

The **architectural drawing** is the main drawing of a building. It presents the overall design of the building or structure to be built. It details all the finishing of the building and the materials used. The drawings include floor plans, elevations, sections, and details. An architectural drawing is usually indicated by an "A," which precedes the drawing page number (e.g., A-4).

When somebody wants a building built, they hire an architect (or designer) to design it. The architect finds out what type of building the customer has in mind and what the requirements are. The architect then makes a rough design for the customer's approval. When the details of the design have been agreed upon, the architect draws a complete set of plans for the building. If the building is fairly simple, like most houses, all information can be placed on one set of drawings, from which all tradespeople can work. Houses are often built from stock plans that the owner or contractor has purchased from a design company.

Floor Plan

The **floor plan** is a plan view of one floor. Architectural floor plans generally show the layout of rooms, dimensions, types of materials used, equipment, fixtures, and appliances. Figure 3 shows a typical floor plan.

Piping plans are always developed from floor plans by either the piping contractor or the engineer. There are several things to consider when you plot piping routes from a floor plan. The locations of plumbing fixtures, components, floor drains, and vertical drainage pipe stacks play a role in determining where a pipe is routed. You need to check the floor plan for doorways and windows because you need to install the pipe around these features.

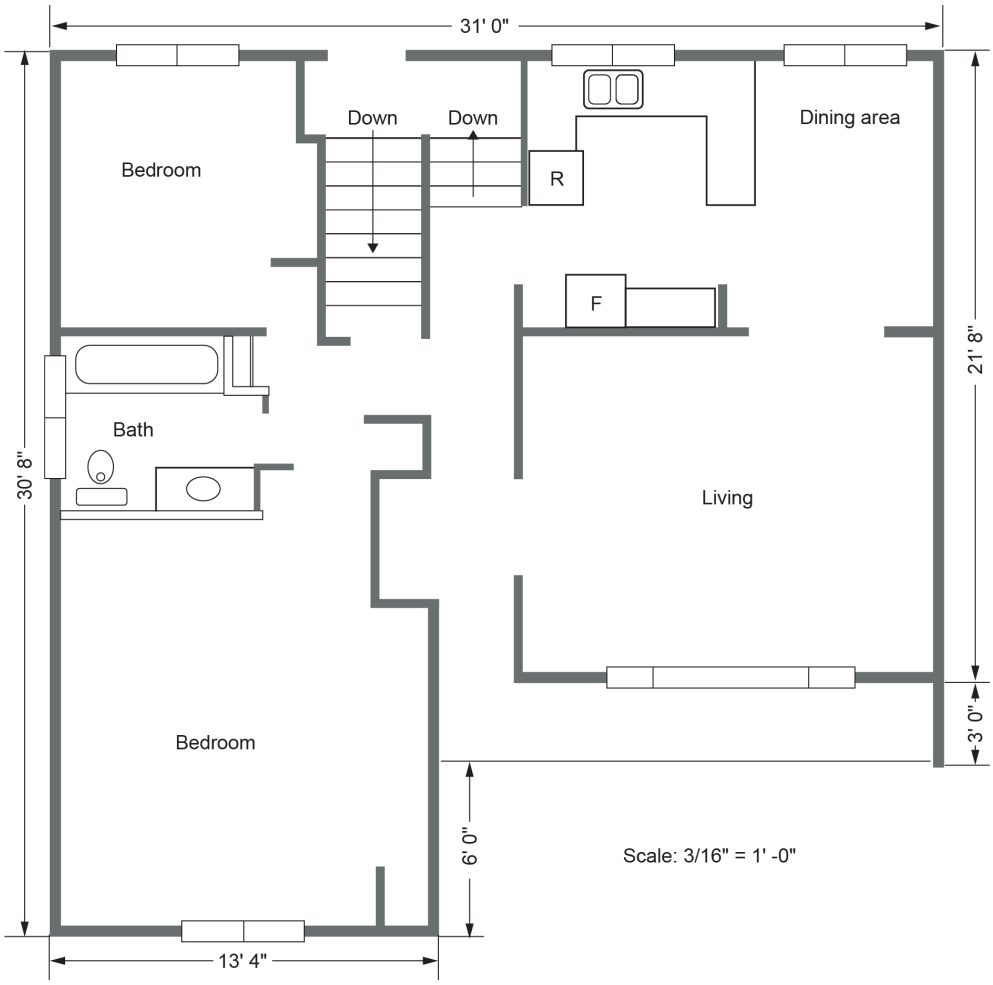


Figure 3 *Main (upper) floor plan. (Skilled Trades BC, 2021) Used with permission.*

Plumbing fixtures are shown as locations for drainage, waste, and vent (DWV) pipes, as well as for hot and cold water supply lines. Piping should be convenient to the fixture and concealed in walls, ceilings, floors, or in unused spaces where they do not conflict with other installations.

Figure 4 is the lower floor plan of the same house. It indicates the locations of the clothes washer, the floor drain, and the fixtures for the roughed-in half bath as well as the hot water tank and hose bibbs. You must coordinate the DWV and supply piping to these fixtures with those on the upper floor.

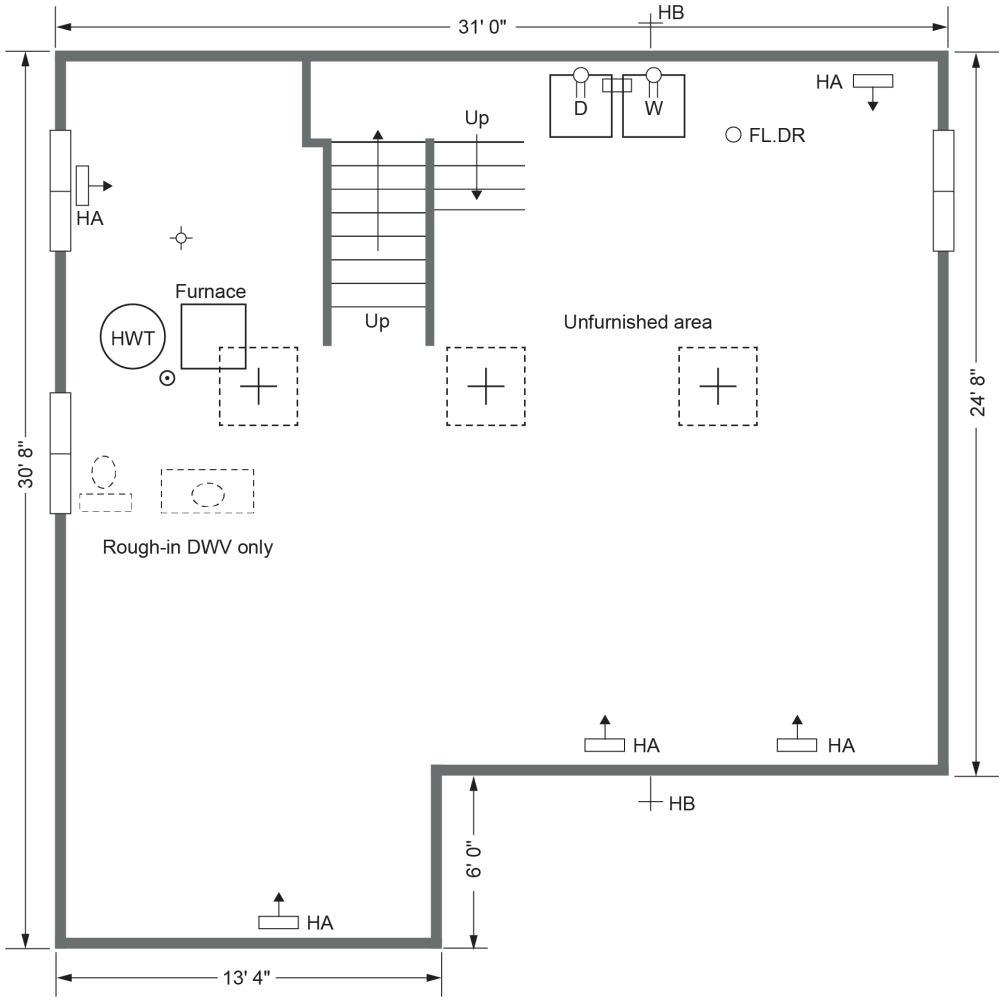


Figure 4 *Lower floor plan. (Skilled Trades BC, 2021) Used with permission.*

Reflected Ceiling Plan

A **reflected ceiling plan** shows an overhead plan view of a building ceiling, as if you were looking at it using a mirrored floor. These typically show tile ceiling layouts, light fixtures, speaker locations, diffuser locations, smoke detectors, and sprinkler locations, as related to the structural reference points and the floor plan. Figure 5 shows a corner portion of a reflected ceiling plan.

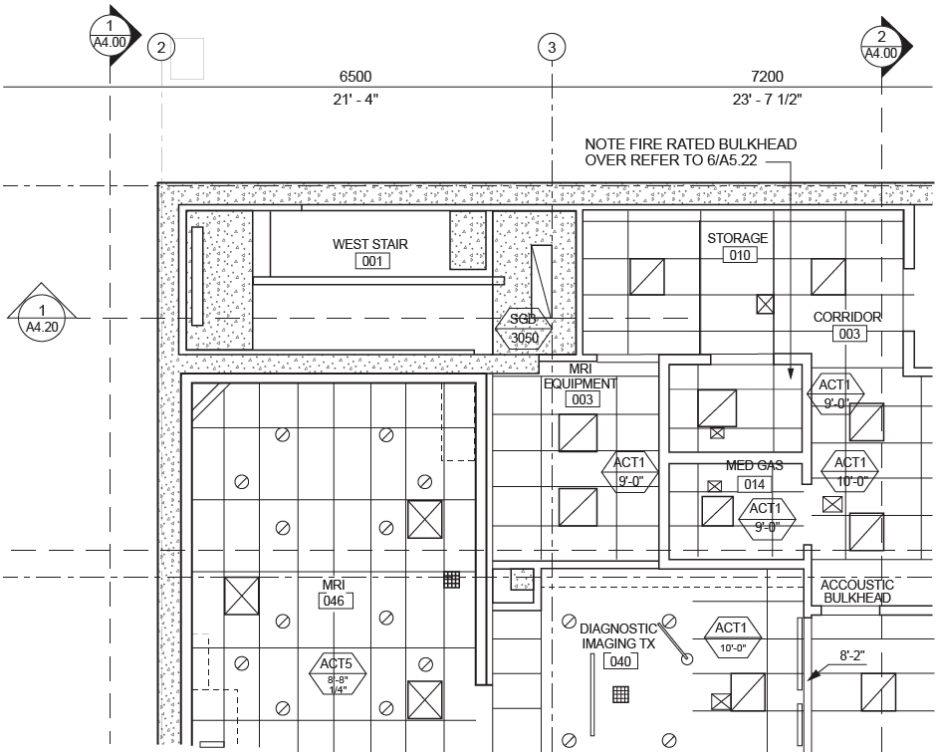


Figure 5 *Portion of reflected ceiling plan. (Skilled Trades BC, 2021) Used with permission.*

Elevations

Elevation drawings display the finished exterior view of the front, back, or side of a building. Together, the front, back, and two side elevation drawings give a clear idea of what the building will look like on completion. Locations and type of all wall openings and roof penetrations are shown on elevations. Elevation drawings also show the slope of the roof. A set of all four elevation drawings is shown in Figures 6 through 9. Consult the elevation drawings to calculate the total length of vertical piping needed to complete a job.

A floor plan will show a symbol for a vertical drainage stack. However, the floor plan does not indicate how long the drainage stack must be. Calculate the length of the drainage stack by checking the height of the building on the elevation drawing.

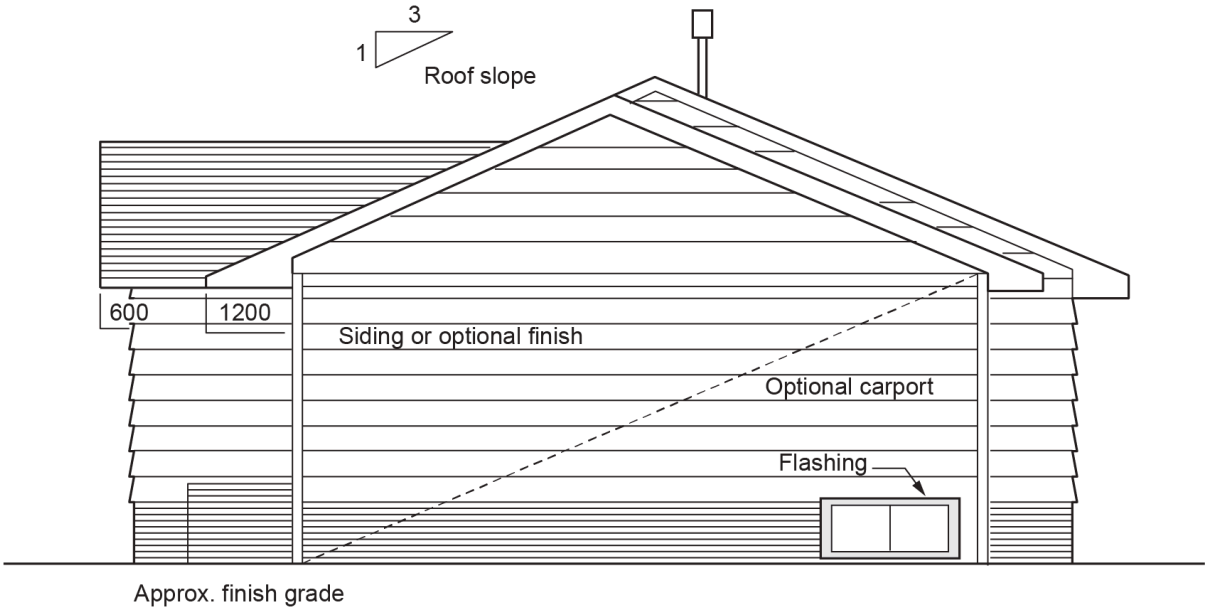


Figure 6 *Right elevation. (Skilled Trades BC, 2021) Used with permission.*

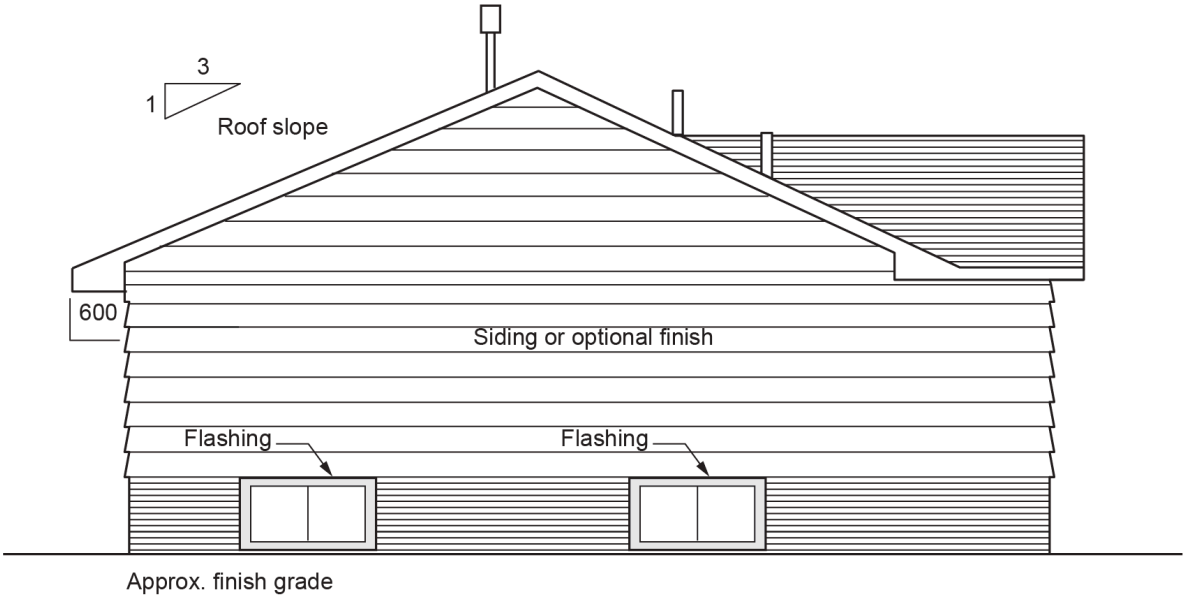


Figure 7 *Left elevation. (Skilled Trades BC, 2021) Used with permission.*

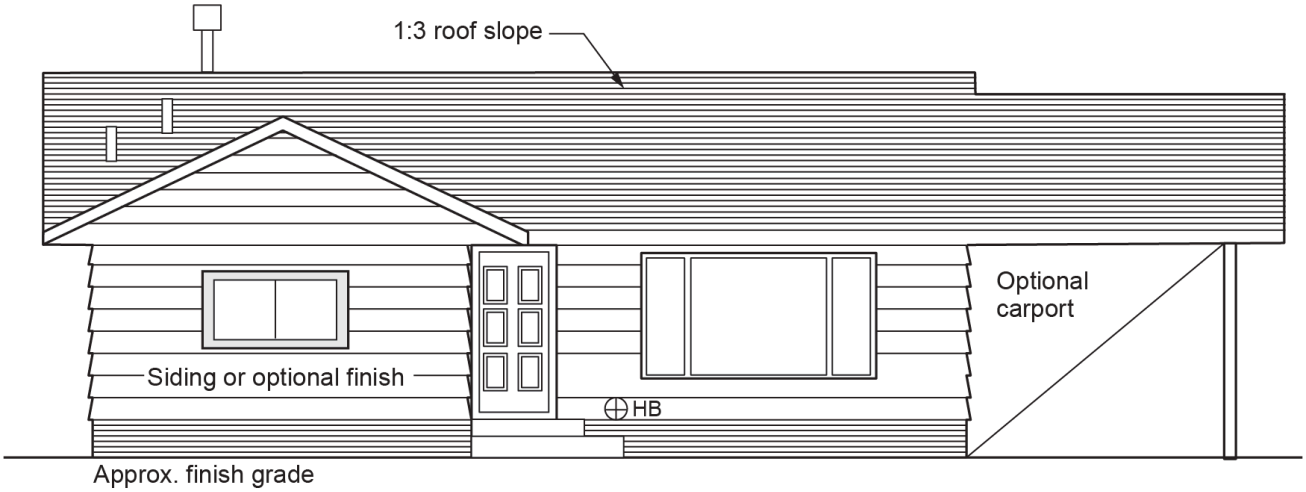


Figure 8 *Front elevation. (Skilled Trades BC, 2021) Used with permission.*

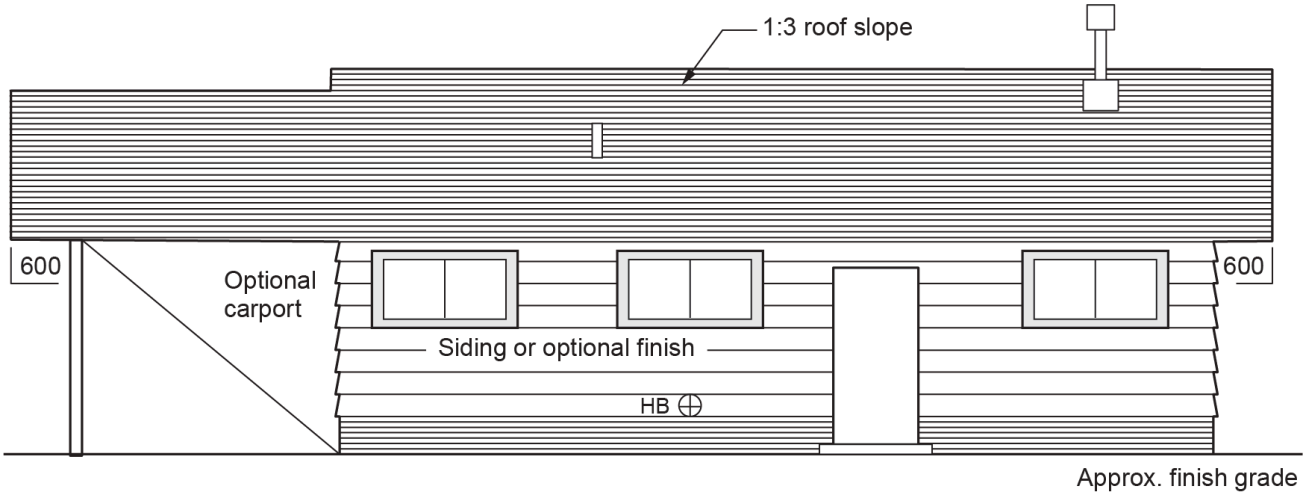


Figure 9 *Rear elevation. (Skilled Trades BC, 2021) Used with permission.*

Sectional Views

Sectional views give information about wall construction, the exterior wall finish, and the interior wall finish. Check these drawings for potential obstructions or conflicts for all locations where piping must penetrate walls.

Details

The details given on the floor plan give precise information on the location of sinks, showers, lavatories and other fixtures. The details on elevation drawings provide information on the heights of these fixtures. You need to know the heights of fixtures in order to correctly rough in the piping. Detailed drawing will take precedence over the regular drawings.

Structural Drawings

A **structural drawing** is required for buildings other than houses. It can be a simple one-page drawing or can include many pages of drawings. The structural drawing is usually indicated by an S, which precedes the drawing page number (e.g., S-3).

Most structural drawings are sectional views. The structural drawing gives information about the size of beams and girders, the reinforcing steel design, and the size and shape of structural members. It also details the materials to be used and the required strengths of concrete. This drawing is prepared by a structural engineer hired by the architect to design all the structural components of the building. Figures 10 and 11 show two typical structural drawings of wall cross-sections.

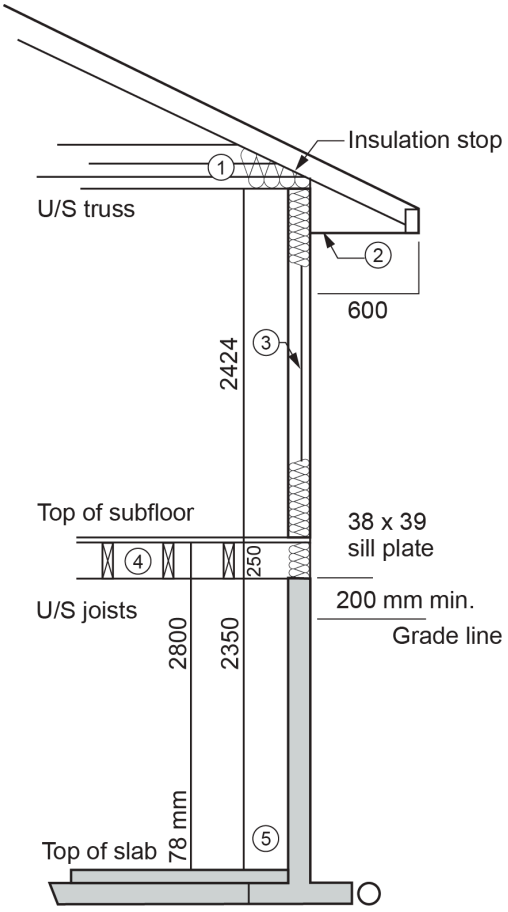


Figure 10 *Full concrete lower floor. (Skilled Trades BC, 2021) Used with permission.*

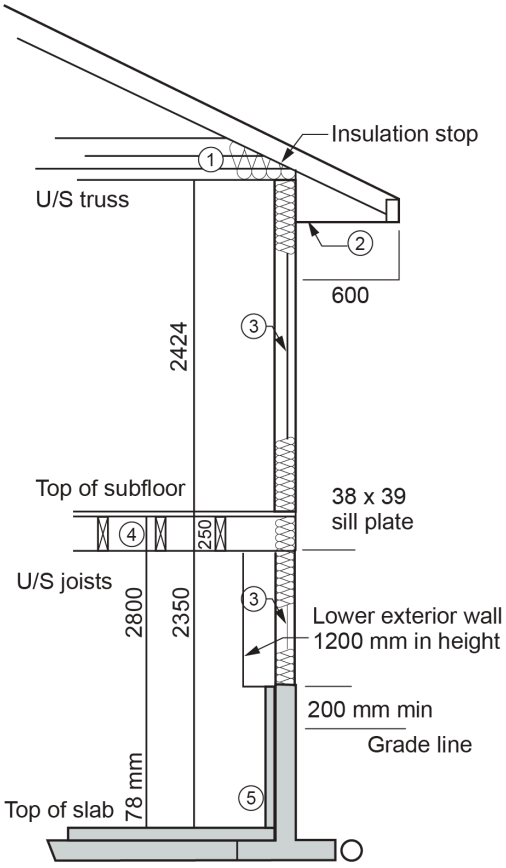


Figure 11 *Lower floor partial frame. (Skilled Trades BC, 2021) Used with permission.*

Mechanical Drawings

The **mechanical drawing** (or climate control plan) is used to identify and locate services for plumbing, heating, air conditioning, duct work, etc. The mechanical drawing is indicated by an M, which precedes the drawing page number (e.g., M-5).

The mechanical drawing is based on the floor plans of the architectural drawings. The architectural details are removed so that they do not interfere with the mechanical details. Sometimes, other drawings are required to complete the mechanical drawing. If there is a great deal of mechanical information, the drawing may be split into two drawings, with plumbing details on one and heating and air conditioning information on the other. In that case, the drawings are called plumbing plans and heating plans. They may also have a separate sprinkler drawing designated by F, FP, or SP.

For a small residential building, separate mechanical drawings are not usually included, and the main mechanical equipment locations will simply be shown on other drawings. For example, in the building drawing we have been looking at, the furnace location is shown in Figure 4 and the heating registers (hot air outlets) and cold air return are included on the electrical drawing in Figure 12.

Electrical Drawings

The **electrical drawing** identifies and locates services for the building's electrical system. The electrical plan is based on the floor plan. It shows the layout of wiring for lights, switches, outlets, and electrical panels. It also shows services for low-voltage systems, such as hydronic heating controls, telephone, cable television, and inter-communication network.

On large commercial buildings, factories, and high-rise office towers, the electrical services can be complicated. The electrical drawing is designed by an electrical engineer. It is indicated by an E, which precedes the drawing page number (e.g., E-2). A typical electrical plan is shown in Figure 12.

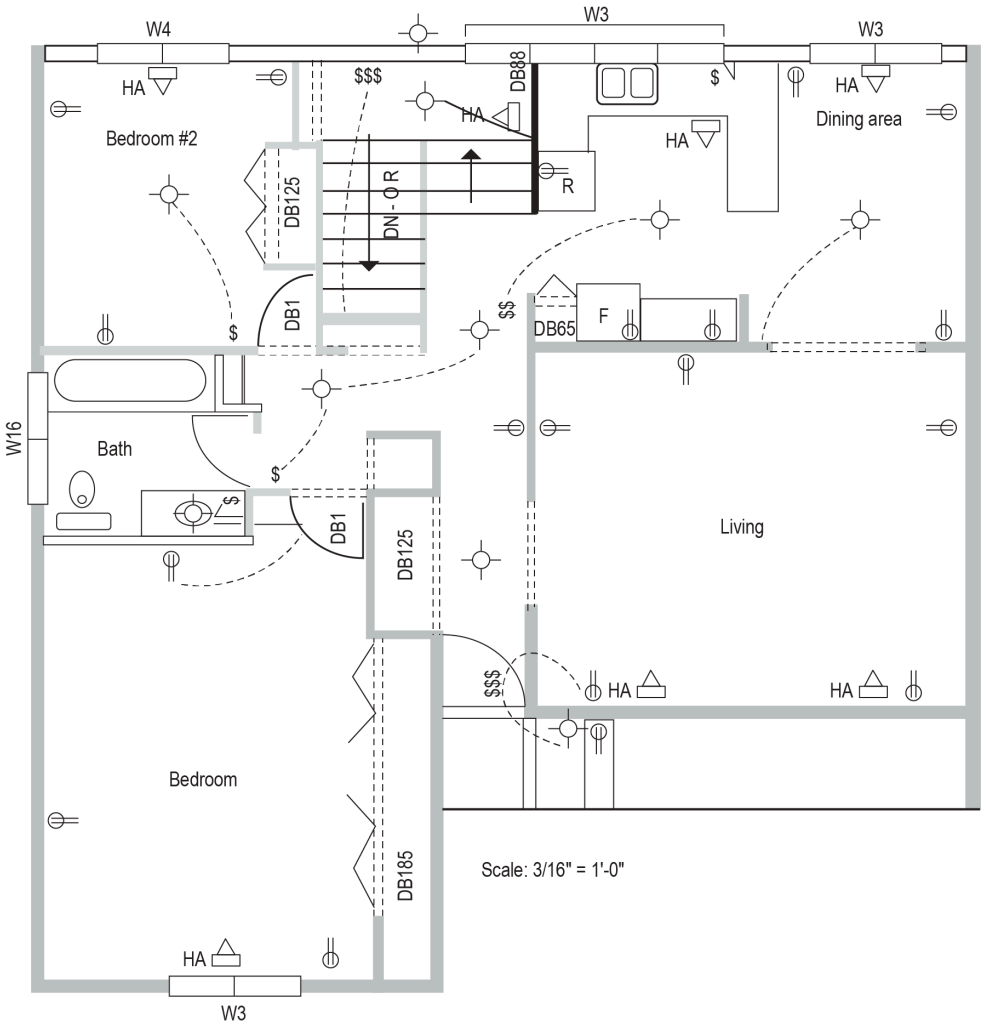


Figure 12 *A typical electrical plan. (Skilled Trades BC, 2021) Used with permission.*

The locations of all outlets, fixtures, and controls are shown on the electrical plan using electrical wiring symbols. A line of long dashes separated by dots indicates that a fixture and a switch will be connected by wiring. However, the dot-dash does not show the exact path of the wiring through the floor or ceiling. For example, the actual wiring from the dining area light switch to the lighting fixture might run along the wall and then perpendicular to the wall, instead of following the line shown. Plumbers can usually avoid the locations of electrical parts without any difficulty or inconvenience.

Shop Drawings

Shop drawings are used by prefabrication shops for making structural components. For example, a prefabrication shop producing steel columns for a building will take the information from the structural drawings and make detailed shop drawings that show the sizes and dimensions of all the columns. The shop drawings are then sent to the building contractor for approval of the sizes, dimensions, and quantities of each type of column. When the drawings have been approved, the fabricator starts production. Items such as beams, girders, trusses, and other fabricated members require that shop drawings be made before production starts.

As-Built or As-Constructed Drawings

In commercial buildings, changes are often made during construction to deal with conflicts discovered or changes made by the owner or architect as work proceeds. Any deviations from the original as-designed drawings must be documented on drawings. The terms **as-constructed** and **as-built** are often used interchangeably as they both refer to a drawing that indicates deviations from the as-designed drawings. These drawings are based on information provided by the installation contractor, therefore, the architect is not responsible for the information.

On some projects, the two terms might mean different things. For example:

- "**As-constructed":** the defect and deviation to the designed model occurring during construction.
- **"As-built"**: the record drawings and documentation defining deviation to the designed information occurring during construction at the end of the project.

Typically, the contractor is required to make red-line markings on the original construction drawings to indicate any changes as work progresses. For example, when services are buried under a concrete slab or hidden behind a wall, the owners of the building often ask the sub-trades, such as plumbers and electricians, to provide detailed drawings of the exact location of the services that have been buried. That way, if there is a problem with the services, the locations of the hidden services are quickly and correctly identified.

These red-line drawings are delivered to either the general contractor or the architect, who prepares the final as-built drawings. These drawings can be vital for the proper maintenance or repair of the building's systems.

Drawing Parts

To efficiently read drawings, you will need to be able to identify some of the common general parts of a drawing, including:

- Title block
- Scale
- Key plan
- North arrow
- References
- Schedules

- Notes
- Flow diagrams

Title Block

The **title block** contains:

- Job title (including the name and nature of the project, the name of the owner, and the site address)
- Name of the architectural or engineering firm
- Date of drawing and date of completion
- Job number
- Initials of drafter and checker
- Drawing number
- Scale of the drawing

The drawing number consists of a letter (either A, S, M or E) and a number. The letter refers to the type of drawing:

- A = Architectural
- S = Structural
- M = Mechanical
- E = Electrical

For example, the drawing number A1 of 4 would be the first sheet of the four architectural drawing sheets.

Figure 13 shows a piping drawing with a title block. The upper left portion of the drawing is a plan view, simply called a plan. This drawing sheet is numbered M3 of 5, which indicates it is the third sheet of the five mechanical drawings.

Scale

The **scale** included in the title block of Figure 13 means that all views on the sheet are drawn to a scale of $\frac{3}{8}$ of an inch equals one foot. ($\frac{3}{8}$ in. = 1 ft-0 in.).

Key Plan

If a plan drawing is not of an entire floor of a building, a **key plan** is usually placed near the title block to indicate which part of the floor is shown. The key plan is a miniature outline of the entire floor, with the plan view section hatch-marked or shaded in. A key plan is included in Figure 13.

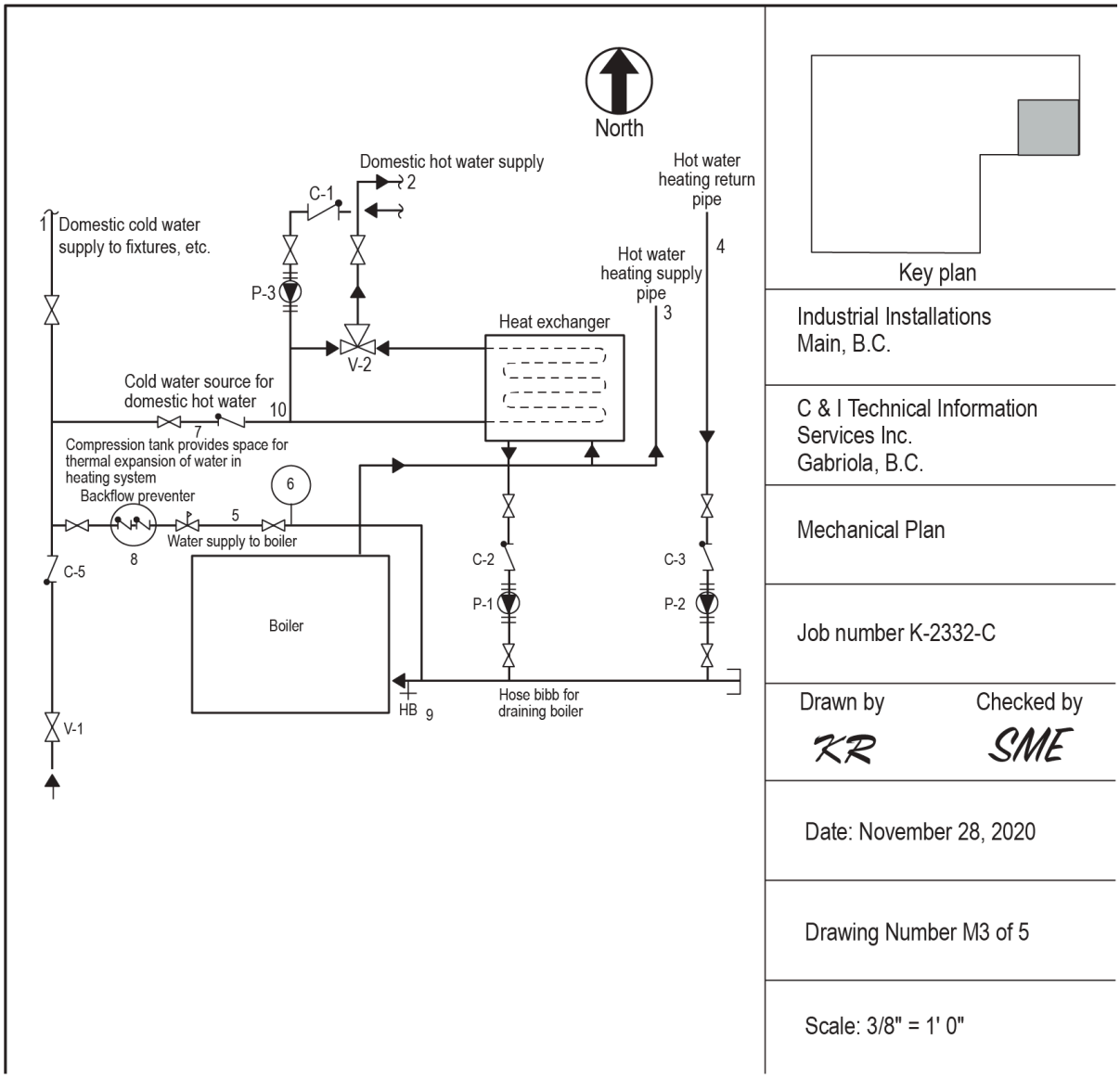


Figure 13 *Heating system plans including a key plan. (Skilled Trades BC, 2021) Used with permission.*

North Arrow

The arrow to the left of the key plan at the top right of Figure 13 shows which direction is north in relation to the building. This **north arrow symbol** is only used for plans on drawings. It is not used to orient any elevation or sectional views that may be on the same sheet. The direction symbol in Figure 14 is sometimes used in place of the north arrow symbol shown in Figure 13.

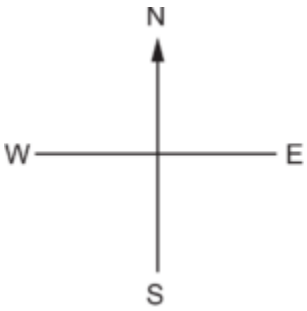


Figure 14 *Direction symbol. (Skilled Trades BC, 2021) Used with permission.*

References to Other Drawings

Other drawings may be produced for architect's drawings and show details of exterior walls or details of structural or mechanical drawings. To clarify and expand upon the information shown on a plan, it is common practice to include other drawings, such as a section or elevation drawing. These drawings show details or views of the system from other directions. Elevation drawings may be considered horizontal views of a system, while sections contain part of an elevation cut off at the reference markers.

Elevation References

The **elevation reference** symbol is shown on a plan view and indicates that an elevation drawing showing a vertical cross-section of the building at the point indicated by the symbol arrow has been prepared. The letter in the top half of the symbol identifies the elevation. The bottom half indicates the page on which the elevation drawing may be found. The symbol in Figure 15 indicates that Elevation C is shown on page A6 (one of the architectural drawings).

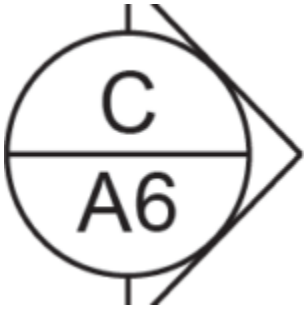


Figure 15 *Elevation reference symbol. (Skilled Trades BC, 2021) Used with permission.*

Section References

A **section reference symbol**, as in Figure 16, is used to indicate that a section drawing rather than an entire elevation has been prepared. The symbol appears beside any part of a building plan that is shown in sectional view on another drawing sheet. The letter in the top half of the section reference symbol identifies the section. The number in the bottom half shows the page on which the sectional view can be found. The long and short dashed lines indicate which part of the plan is shown in the sectional view, and the arrows show the direction of the view. The section drawing appears on a different page, as indicated by the bottom of the circle. The symbol in Figure 16 indicates that Section B may be found on page A5 and that the drawing presents the section you would view facing to the right.

Figure 16 *Section reference symbol. (Skilled Trades BC, 2021) Used with permission.*

Detail References

A **detail reference** symbol, as in Figure 17, appears beside a part of a building plan that is drawn in detail at a larger scale on another page. The number in the top half of the detail reference symbol is the detail number. The number in the bottom half is the page on which the detail drawing can be found. This page number is usually a letter and number combination.

Figure 17 *Detail reference symbol. (Skilled Trades BC, 2021) Used with permission.*

References to detail drawings shown on the same page use the symbol in Figure 18. The detail drawing will be labelled with the number shown in the top half, and the bottom half is left blank to indicate "this page."

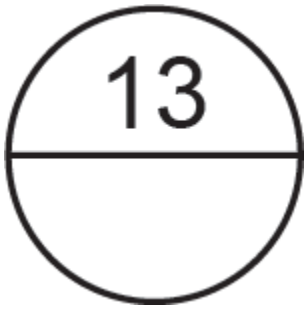


Figure 18 *Reference to detail drawing on same sheet. (Skilled Trades BC, 2021) Used with permission.*

Notice that the details are referenced by numbers, whereas sections and elevations are referenced by letters.

Schedules

A **schedule** is a convenient method of listing variable conditions on drawings so that similar information can be found in one handy location. For example, an architectural drawing may contain a door schedule that shows the type, size, style, drawing reference number, etc., of all the doors on a plan. Table 1 is a pump schedule that lists all circulation pumps used in the heating installation shown in Figure 13.

Table 1: Pump Schedule

Model No.	Flange Pipe Size (in.)	Face-to-Face Flange Length (in.)	HP	Volts	Phase
P3S25	0.75	6.5	0.08334	115	1
P1H32	1.25	8.5	0.1667	115	1
P2S34	1.5	8.5	0.1667	115	1

Notes

Notes are written descriptions of the materials, equipment, valves, instruments, etc., shown on a drawing. The notes can be placed beside the symbol being described, or they can be numbered and listed in a separate area to prevent crowding in the drawing.

Figure 19 is a flow diagram that contains notes. Some notes are listed with reference numbers, while others are inserted beside the objects described.

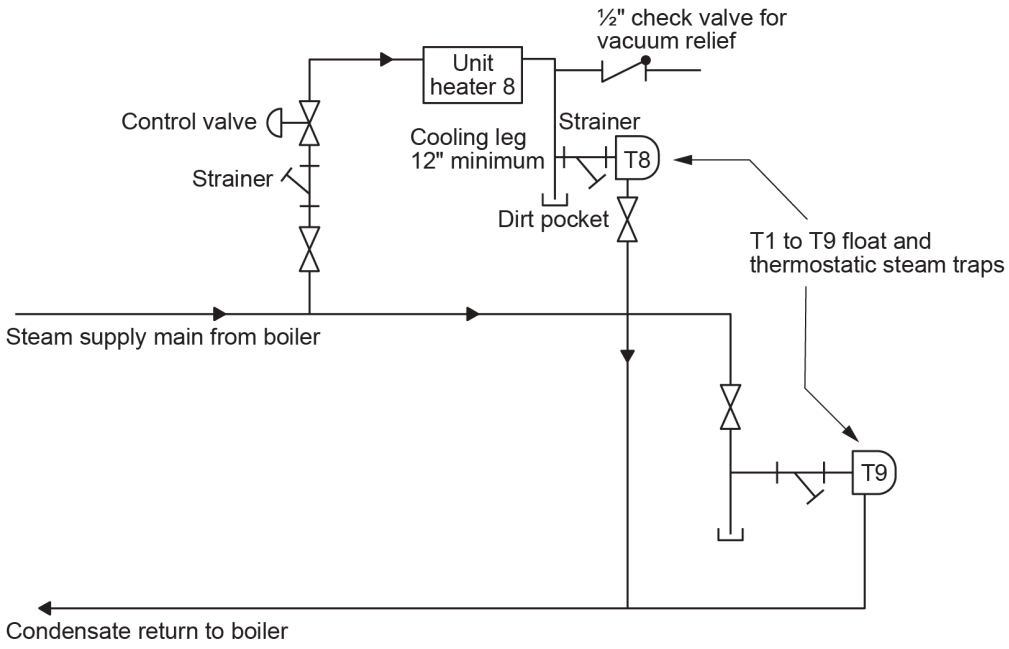


Figure 19 *Flow diagram (plan). (Skilled Trades BC, 2021) Used with permission.*

Self-Test D-2.1: Types of DWV Drawings

Complete Self-Test D-2.1 and check your answers.

If you are using a printed copy, please find Self-Test D-2.1 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=60#h5p-11 (https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=60#h5p-11)

References

Skilled Trades BC. (2021). *Book 2: Install fixtures and appliances, install sanitary and storm drainage systems.* Plumber apprenticeship program level 2 book 2 (Harmonized). Crown Publications: King's Printer for British Columbia.

Trades Training BC. (2021). D-2: Plan DWV systems. In: *Plumber Apprenticeship Program: Level 2.* Industry Training Authority, BC.

Media Attributions

All figures are used with permission from Skilled Trades BC (2021) unless otherwise noted.

D-2.2 Planning Interior DWV System Layouts

The layout process of a **DWV system** requires the plumber to consider all installation aspects of the system. Because each project is different, it is essential that the installer have a thorough understanding of applicable plumbing codes and the ability to visualize the completed DWV system.

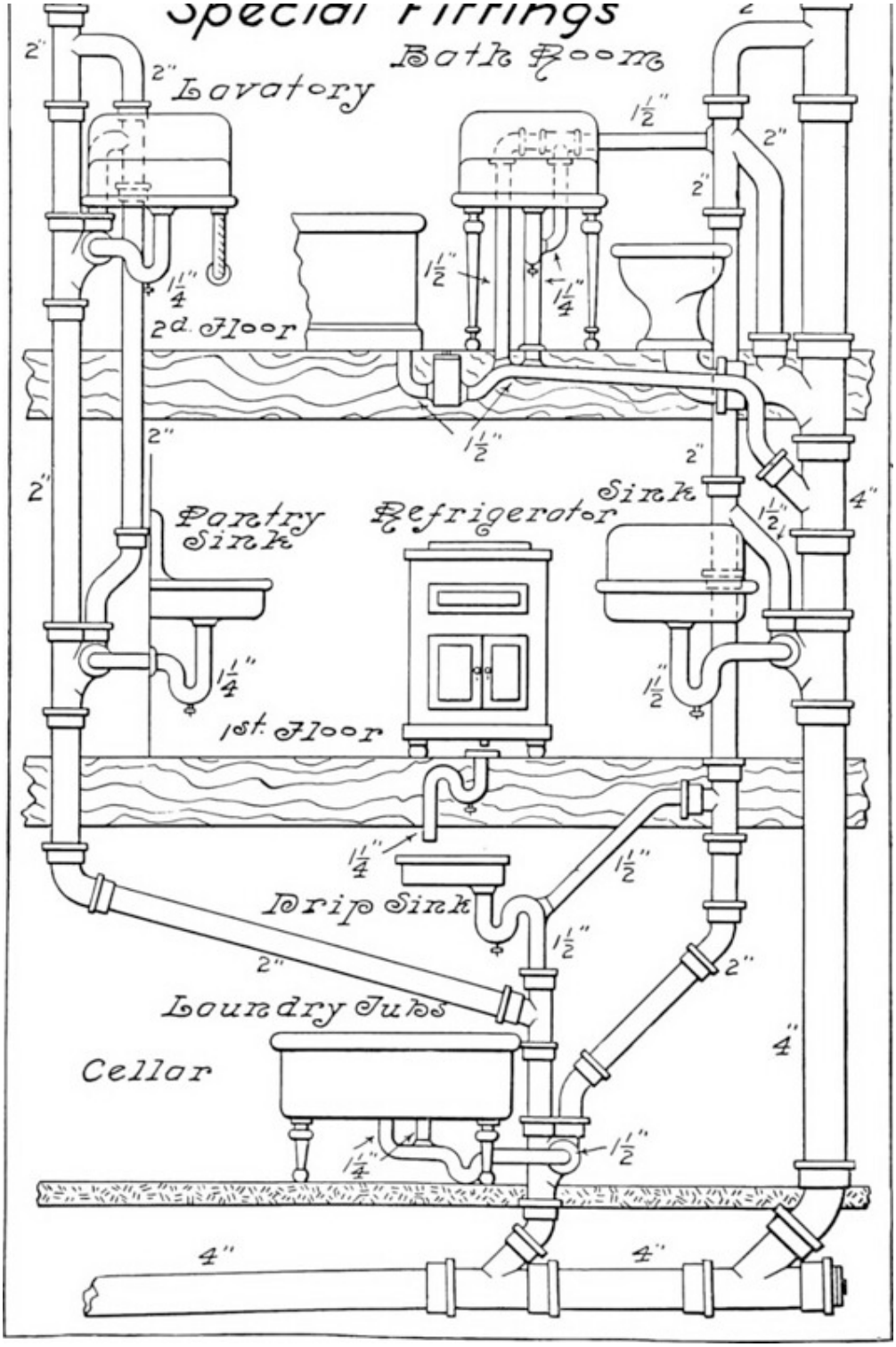


Figure 1 "*Modern*" *Plumbing in 1907.* (*Starbuck, Robert Macy, 1844-/ Flickr*) *Public Domain* (*https://creativecommons.org/publicdomain/zero/1.0/*)

Location of Structure Penetrations

In wood-frame buildings, keep the size and number of **penetration**s through structural members to a minimum. In a situation where a penetration is required, take care to not cut and notch wood joists and beams in a manner that reduces the strength and load-carrying ability of the structural member.

Regulations restrict the size and location of these penetrations, depending on the type of component. It is important to determine whether the wooden component is load bearing to correctly determine the allowable size penetration that can be drilled or notched. No penetration in the structure should be made until the entire project has been laid out.

When you are planning structural penetrations, note that commercial buildings equipped with fire separations require special considerations. Combustible DWV piping penetrations are permitted in a rated fire separation or a membrane that forms part of a rated fire separation as long as the penetration is sealed by a **fire-stop system**.

In some instances, sanitary building drains leave the building through a foundation wall due to the elevation of site services. The location and elevation of this penetration should be determined at the time of forming so that blocking or sleeves can be installed prior to the concrete pour, eliminating the need for coring expenses later.

Roof vent terminals should be located where they do not interfere with building aesthetics. In a residential installation, for example, locating the vent terminal on the back slope of the roof as opposed to the front will eliminate sighting from the street. Vent terminals should be located where they are provided with ample air supply and are not susceptible to adverse wind effects. The clearances that must be maintained from occupied spaces and building openings have already been discussed in Section D-1.1: Codes and Standards (#chapter-d-1-1-codes-and-standards).

Routing

The location of the major fixture groups determines the preferred location of stacks and branch drains. A thorough inspection of the proposed route is required to identify possible conflicts with structural components and space coordination with other trades. The **routing** should follow the lines of the building (parallel and perpendicular). This practice will limit **bulkhead** and **ceiling drop installations** to accommodate the DWV installation.

When a route is being planned, the plumber must be aware that current building codes do not allow plumbing drains and vents to be installed in the outside walls unless full insulation value can be achieved. This means the wall must be furred (built) out or the piping relocated to an interior space.

When routing drain lines in the ceiling space over sensitive areas, consideration must be given to the possibility of damage caused if there is a blockage that requires cleaning. Drains should be routed far enough away from walls and obstructions, so that the drain-cleaning machine can gain access if needed.

Pipe Supports

Underground piping from the municipal system into your home is installed in dug trenches to a depth below the **frost line** for your climate, which obviously could vary a great deal depending on your geographical location. The trench

should be constructed as narrow as is reasonable to allow proper joining of the pipes and to avoid having to dig below the depth required to support the pipe, as the undisturbed soil is naturally compacted and will not settle over time.

When laying the piping in the trench, the markings on the pipe that indicate the type and class of pipe should face up, and all the joints must be visible until an inspection by the local authority has been done.

Inside the building, the maximum distances between **pipe supports** are specified in the National Plumbing Code (NPC). The supports must be located to maintain a uniform slope that will not change with time. The pipe supports and structure connections must be able to resist forces due to hydraulic testing and the **seismic forces** imposed on them. The support locations must not introduce stresses in the piping caused by thermal expansion or contraction, and must isolate the piping from stresses caused by twisting, torsion, or lateral bending in the framing members.

Self-Test D-2.2: Planning Interior DWV System Layouts

Complete Self-Test D-2.2 and check your answers.

If you are using a printed copy, please find Self-Test D-2.2 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=62#h5p-10 (https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=62#h5p-10)

Media Attribution

- **Figure 1** "Modern" Plumbing in 1907 – **Identifier**: cu31924015368818 (https://www.flickr.com/photos/internetarchivebookimages/14591920039), at Flickr, is by Starbuck, Robert Macy, 1844-. This image is an excerpt from *Modern plumbing illustrated; a comprehensive and thoroughly practical work on the modern and most approved methods of plumbing construction* (https://archive.org/stream/cu31924015368818/cu31924015368818#page/n203/mode/1up), found on the Internet archive. It is in the public domain. (https://creativecommons.org/publicdomain/zero/1.0/)

D-2.3 Creating Plans and Isometric Drawings of DWV Systems

In this chapter, you will be asked to create plan and **isometric drawings** of residential piping systems.

The **plumbing plan** is a two-dimensional plan view drawing showing the plumbing system. It is generated from the architectural floor plan showing the types and locations of the plumbing fixtures in the building. The plumbing plan describes the location, sizes, and types of all piping and fittings used in the system rough-in. The horizontal branches and fixture drains are drawn to scale, but due to the two-dimensional properties of the drawing, only the locations of all vertical pipes are shown.

Sketching a Plan View of a Residential DWV System

The first step in creating an orthographic plumbing plan is to determine the locations of any fixtures and stacks in the basement level. The stack locations will depend on the locations of the fixtures on the floor(s) above. The exact stack locations can be added later once the upper floor piping has been designed. It is very important to note where the sanitary sewer service enters the building. This will be the design starting point, working back toward the fixture locations.

You can then tie in all of the fixtures and stacks, including all required fittings, such as the building drain cleanout and a normally open back water valve.

The stacks, branches, and fixture drains in the vertical plane are represented by open circles with a dot in the centre, while horizontal branches and fixture drains are shown as they would appear from above.

Sizing of the DWV system should be based on minimum code requirements for the fixture unit load being served. Once the sizing is complete, the next step is to determine the fittings required for the under-slab rough-in.

The DWV system for the floors above must be drawn on a separate drawing sheet using the same procedure (Figure 20). The stacks are represented by open circles without a dot in the centre that show the stacks dropping vertically to the lower floor, while horizontal branches and fixture drains are shown as they would appear from above. Ensure that the location where the stacks drop to the basement is the same location where the stack rises up through the basement floor. This will eliminate the need for an offset to connect the stack sections.

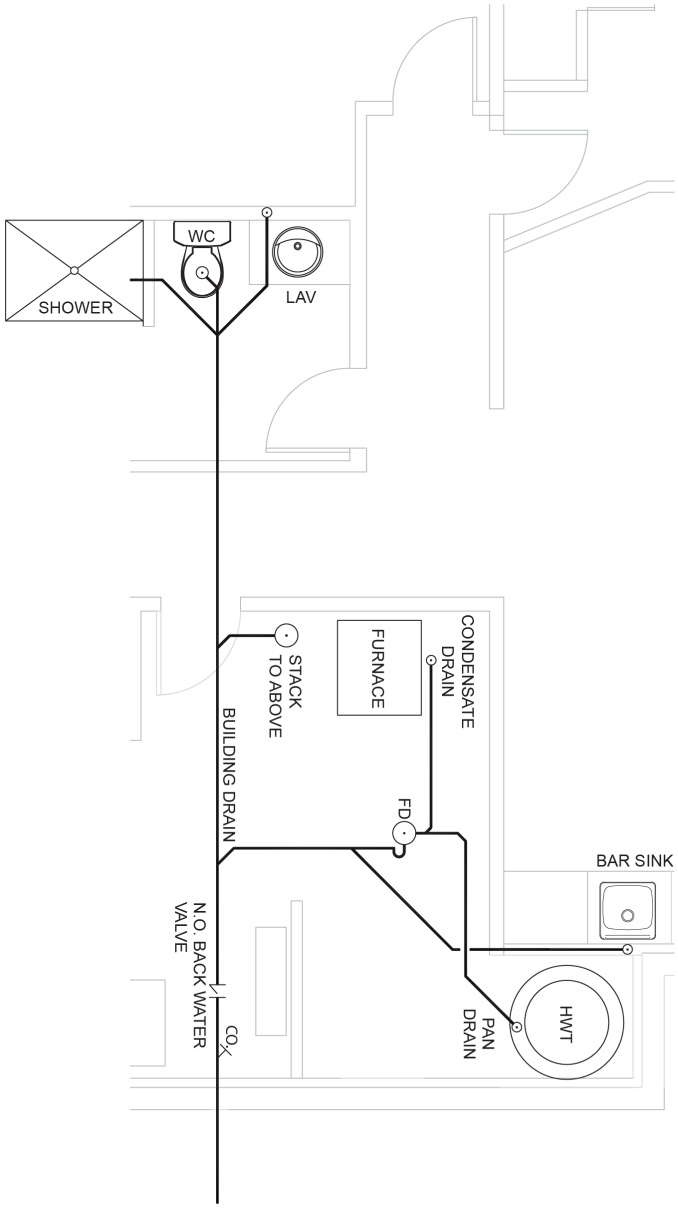


Figure 1 *Architectural floor plan showing under-slab DWV rough-in. (Skilled Trades BC, 2021) Used with permission.*

Choosing a Scale

You may choose to draw the orthographic plumbing plan on the house plan, or you may want to use a separate sheet of paper. When you draw an orthographic plan or isometric sketch on a drawing sheet, you must use an appropriate scale to ensure that the amount of information you need fits on your page. When choosing a scale, it is important to consider the size of paper you wish to use. The best way to determine the proper scale is to divide the longest length of your project by the longest dimension of your drawing page.

For example, if the floor plan measures 50 ft (or 600 in.) in length and the drawing sheet is 12 in., the scale would be:

$$600 \text{ in.} \div 12 \text{ in.} = 50$$

1:50 or approx. $\frac{1}{4}$ in. per foot

Sketching Residential Plumbing Groundwork Using Isometric Techniques

Isometric drawings are generated from the information found on the orthographic plan and elevation views when available. Unlike orthographic plumbing plans, isometrics allow the DWV system to be drawn in a manner by which the length, width, and height are shown in a single view. This allows for a more complete view of the groundwork system. Like the orthographic sketch, the isometric sketch is also drawn to scale so that the exact locations of fixtures and piping can be shown. Note that non-isometric lines, such as 45° elbows and Y-fitting branches, are not to scale. In this case, you must refer to an **orthographic drawing** for dimensions.

Usually, piping isometrics are drawn on sheets pre-printed with lines drawn vertically and at 30° to the horizontal (Figure 2). The symbols that represent fittings and valves are modified to adapt to the isometric grid. Isometrics are the most important drawings for mechanical contractors during the rough-in portion of a project.

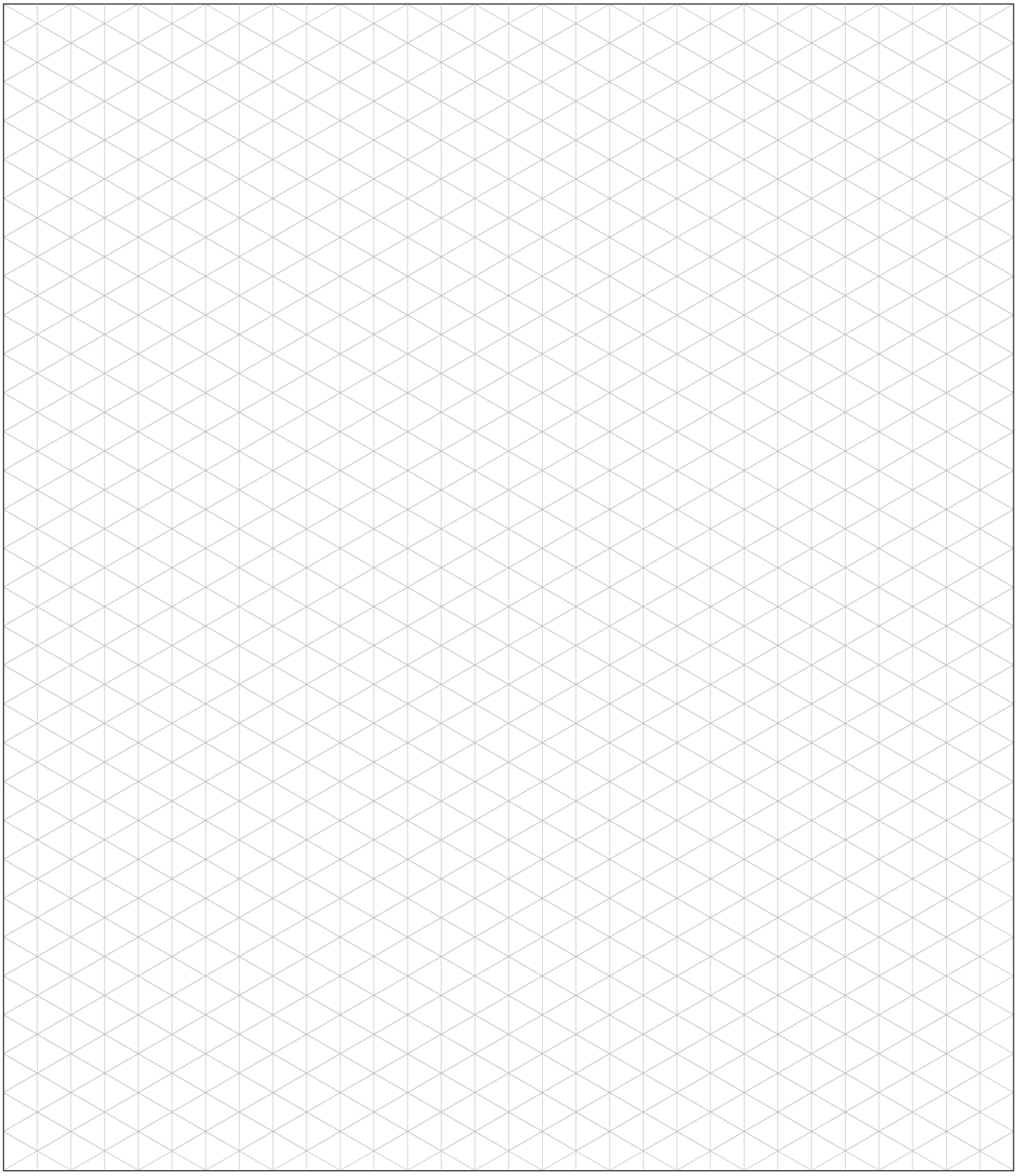


Figure 2 *Example of a pre-printed isometric drawing sheet. (Skilled Trades BC, 2021) Used with permission.*

As when creating an orthographic sketch, the first step in drawing an isometric sketch is to determine where the fixtures, stacks, and building sewer are to be located. This is an important step for laying out the groundwork and for deciding how to orient the sketch on the paper. The orientation on the drawing sheet is an important factor to consider because you want to avoid lines crossing one another or lines blocking the view of other piping or fittings.

Fixture Specifications

Once the fixture locations have been established on the drawing sheet, the next step is to determine the fixture manufacturer's specifications to determine the associated rough-in dimensions for the drain and water lines. This fixture model is provided in the specifications for the project, while the dimension information is available from a rough-in manual or the company website in both imperial and metric measurements (Figures 3 and 4).

The information typically found in the manufacturer's rough-in manual includes:

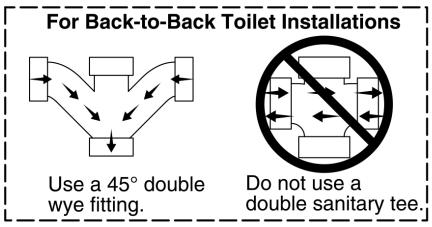
- Fixture dimensions
- Distance to the centre of the fixture's drain from the finished wall
- Height of the drain and water line connections from the floor
- Centre-to-centre dimensions of faucets
- Support backing for wall-hung fixtures

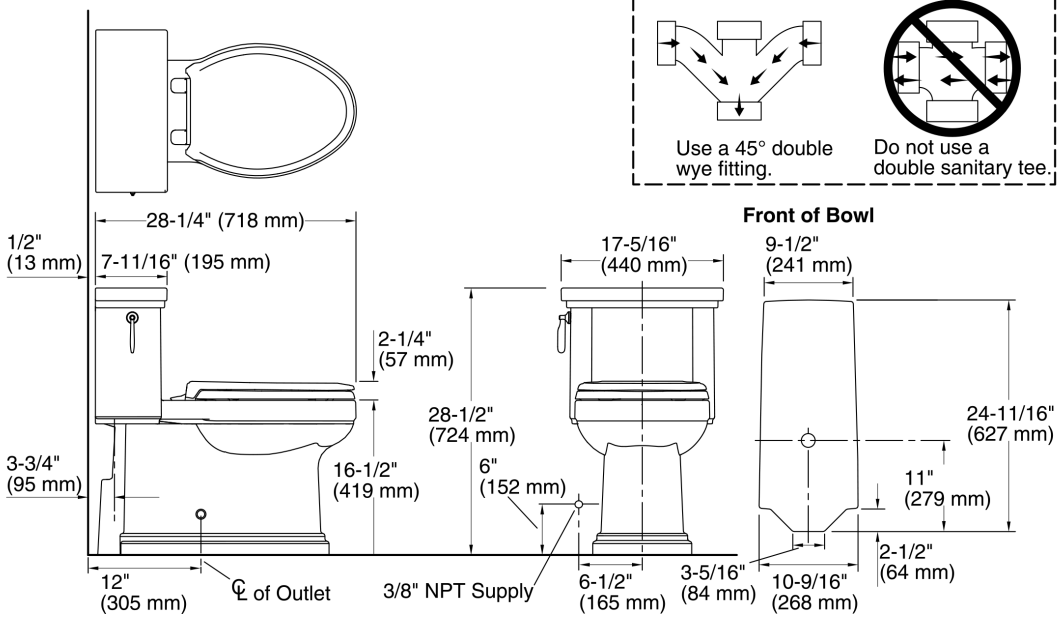
KOHLER®

Tresham®

Comfort Height® Toilet

K-3981





Technical Information

All product dimensions are nominal.

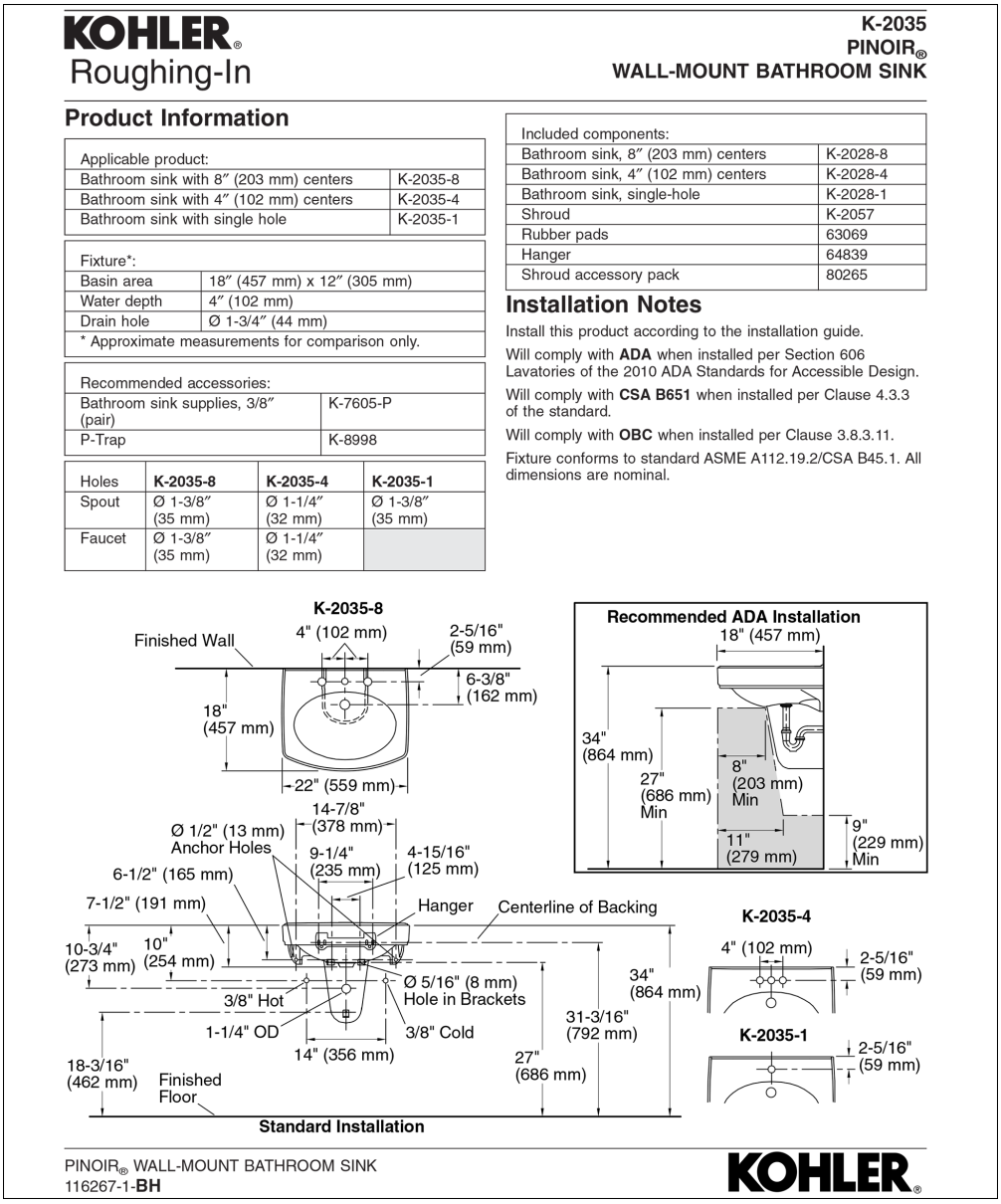
Toilet type:	One-piece
Bowl shape:	Compact Elongated front
Seat hinge type:	Quick-Attach®, Quiet-Close™, Quick-Release™
Trap passageway:	2-1/8" (54 mm)
Water Consumption Full:	1.28 gpf (4.8 lpf)
Water surface size:	9-5/8" x 6-7/8" (245 mm x 174 mm)
Rim to water surface:	5-3/8" (137 mm)
Rough-in:	12" (305 mm)
Seat-mounting holes:	5-1/2" (140 mm)

Notes

Install this product according to the installation guide.

For back-to-back toilet installations: Use only a 45° double wye fitting.

Figure 3 *Manufacturer's rough-in specification sheet for a residential toilet. (Image courtesy of Kohler Co.). Used with permission.*



KOHLER®
Roughing-In

K-2035
PINOIR®
WALL-MOUNT BATHROOM SINK

Product Information

Applicable product:	
Bathroom sink with 8″ (203 mm) centers	K-2035-8
Bathroom sink with 4″ (102 mm) centers	K-2035-4
Bathroom sink with single hole	K-2035-1

Fixture*:	
Basin area	18″ (457 mm) x 12″ (305 mm)
Water depth	4″ (102 mm)
Drain hole	Ø 1-3/4″ (44 mm)
* Approximate measurements for comparison only.	

Recommended accessories:	
Bathroom sink supplies, 3/8″ (pair)	K-7605-P
P-Trap	K-8998

Holes	K-2035-8	K-2035-4	K-2035-1
Spout	Ø 1-3/8″ (35 mm)	Ø 1-1/4″ (32 mm)	Ø 1-3/8″ (35 mm)
Faucet	Ø 1-3/8″ (35 mm)	Ø 1-1/4″ (32 mm)	

Included components:	
Bathroom sink, 8″ (203 mm) centers	K-2028-8
Bathroom sink, 4″ (102 mm) centers	K-2028-4
Bathroom sink, single-hole	K-2028-1
Shroud	K-2057
Rubber pads	63069
Hanger	64839
Shroud accessory pack	80265

Installation Notes

Install this product according to the installation guide.

Will comply with **ADA** when installed per Section 606 Lavatories of the 2010 ADA Standards for Accessible Design.

Will comply with **CSA B651** when installed per Clause 4.3.3 of the standard.

Will comply with **OBC** when installed per Clause 3.8.3.11.

Fixture conforms to standard ASME A112.19.2/CSA B45.1. All dimensions are nominal.

PINOIR® WALL-MOUNT BATHROOM SINK
116267-1-**BH**

KOHLER®

Figure 4 *Manufacturer's rough-in specification sheet for a wall-hung basin (Image courtesy of Kohler Co.). Used with permission.*

Plotting Fixtures

After you have obtained the rough-in dimensions for each fixture, you can begin to plot the location of the DWV slab **penetration points** on an isometric drawing. This would include the floor-mounted fixtures and any risers or waste stacks. These points should be marked with an isometric X on the drawing, as shown in Figure 5.

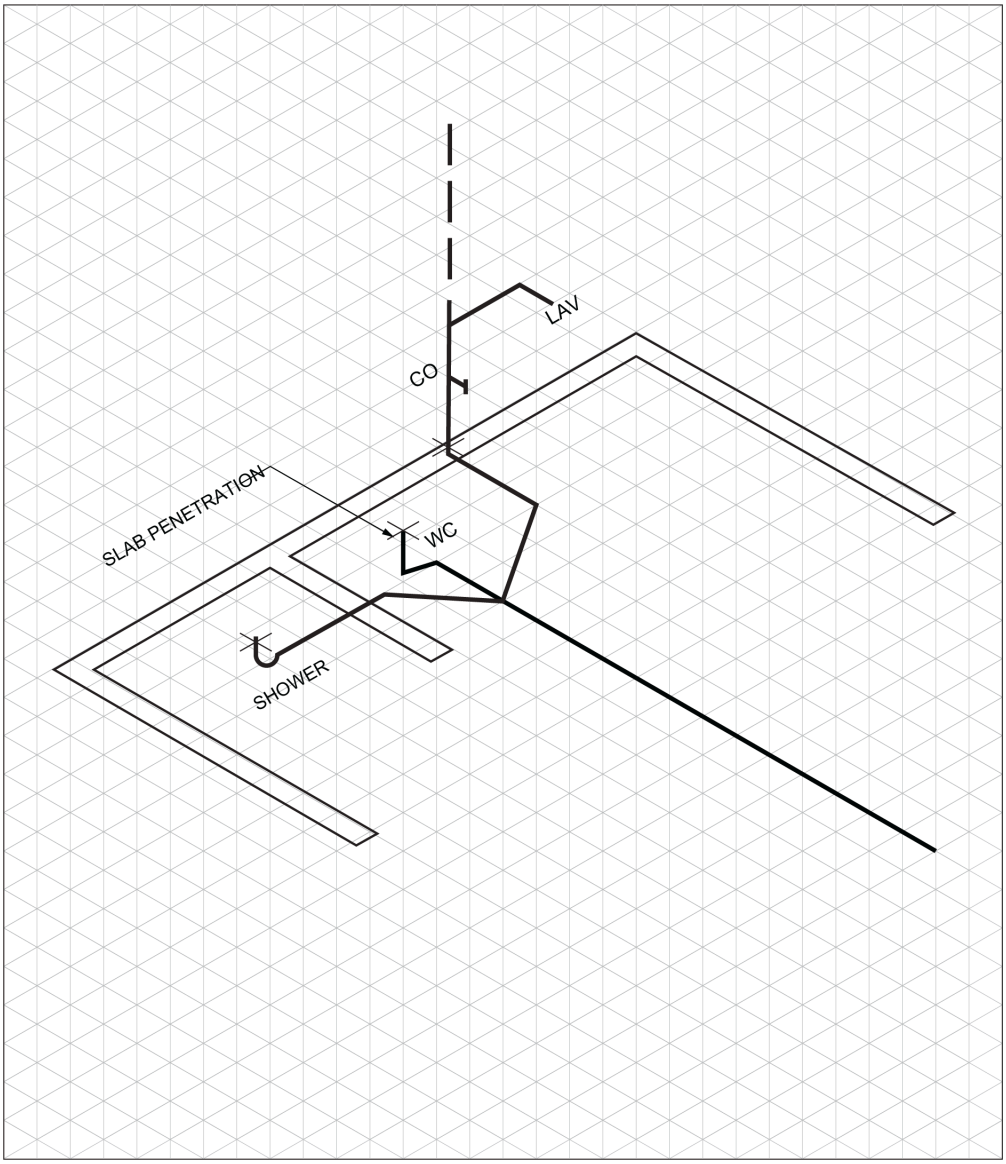


Figure 5 *Three-piece bathroom group showing the slab penetrations and DWV piping connected. (Skilled Trades BC, 2021) Used with permission.*

Once the slab penetration locations are plotted, it is time to connect them. Make sure that all connections are made to minimum code requirements. Take special care to use appropriate fittings for the layout with the cleanouts properly located and accessible for future use. When drawing the sketch, the plumbing vents should be indicated using dashed lines to differentiate them from the drains (Figure 6).

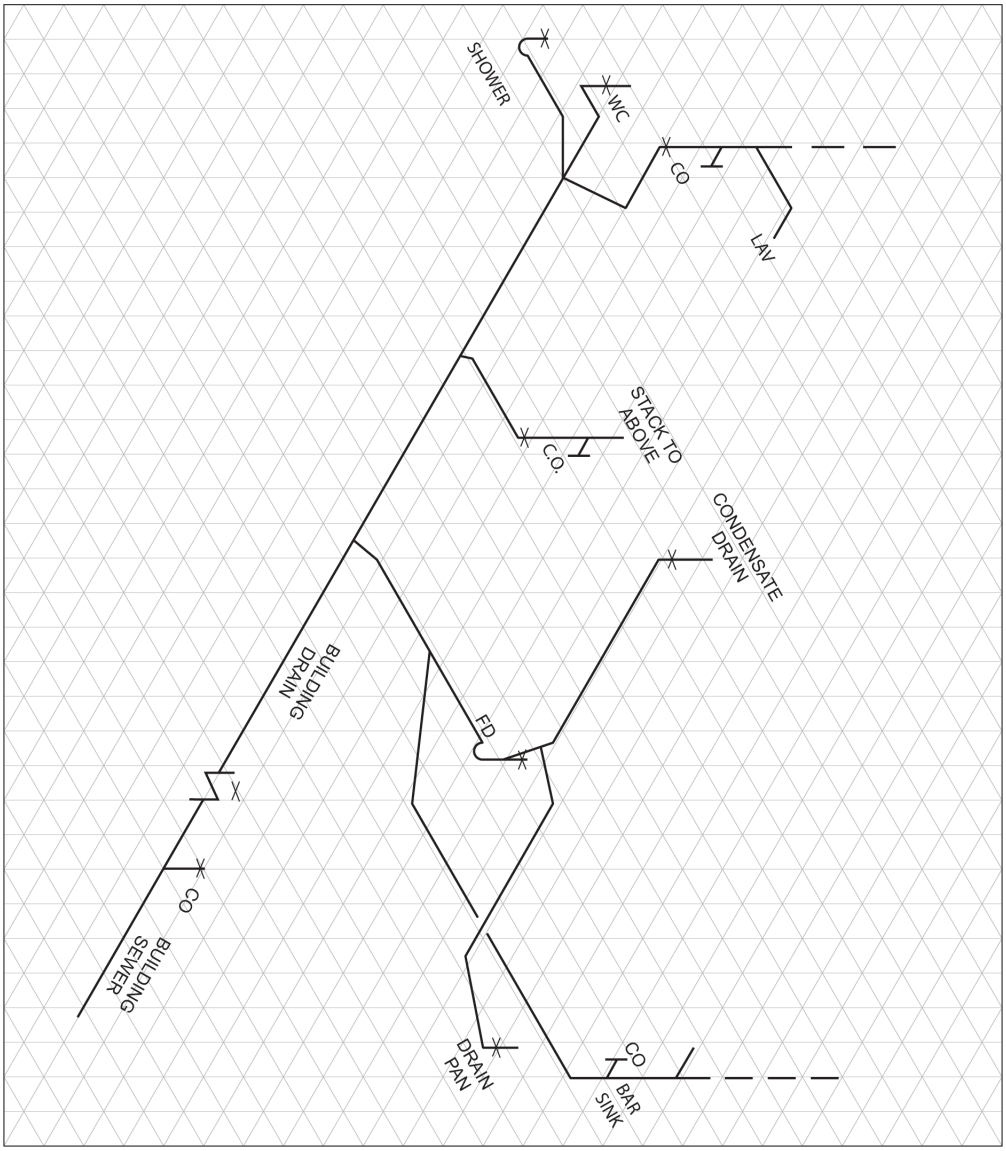


Figure 6 *Full three-dimensional isometric under-slab rough-in to match plan view sketch. (Skilled Trades BC, 2021) Used with permission.*

Upper Floors

As with groundwork, the DWV system drawn isometrically moving up through the structure provides a more complete three-dimensional view of the upper portion of the plumbing system (Figure 7). These sketches reveal connections to fixtures on upper floors, locations of stacks and vents within walls, and how the venting system terminates in open air.

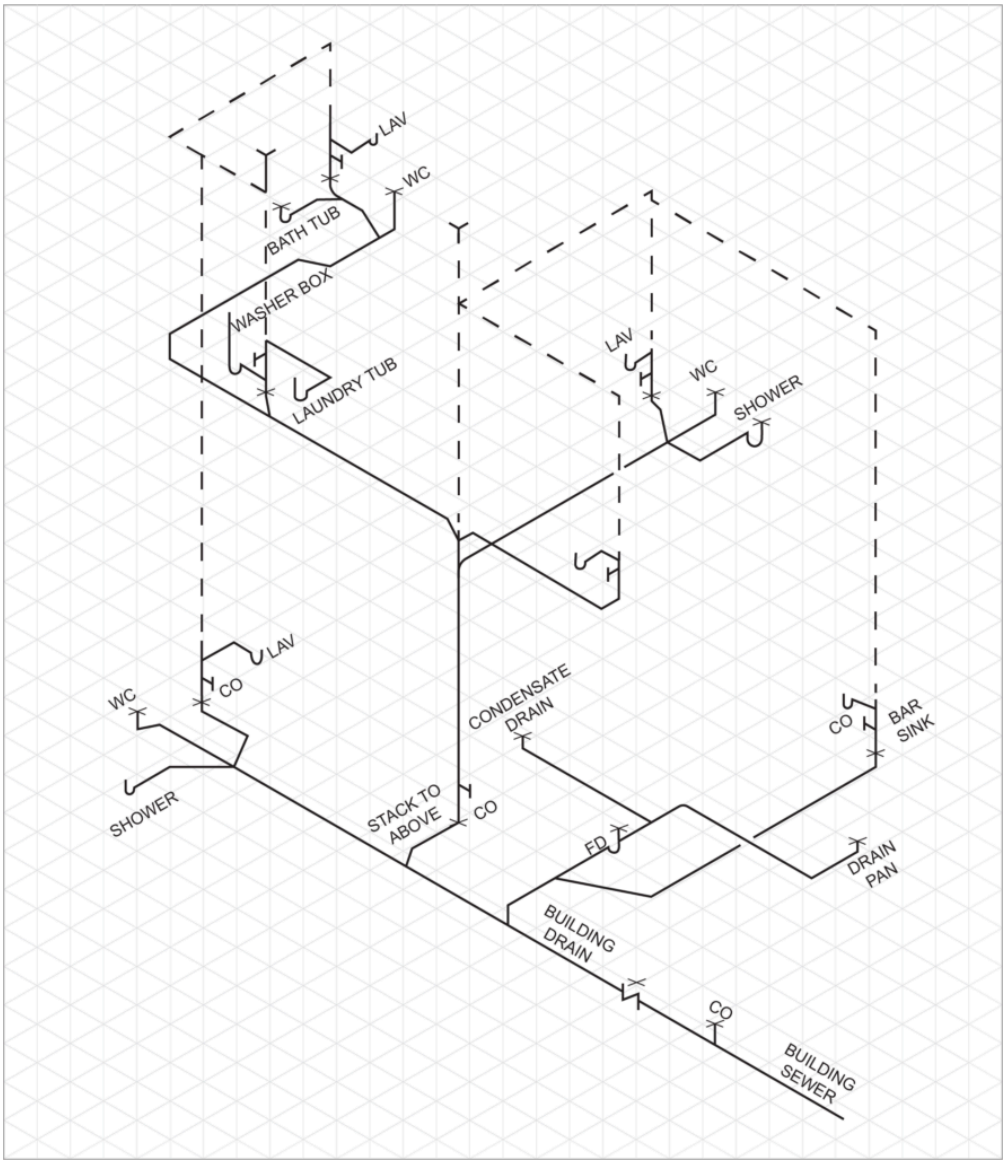


Figure 7 *Full three-dimensional isometric rough-in of a residential DWV system. (Skilled Trades BC, 2021) Used with permission.*

Vertical stacks, vents, and drainage branches are laid out in the same fashion as the groundwork plumbing. The floor penetrations are marked with an isometric X. The fixture connections to the DWV system must be installed to minimum code requirements.

Letters and Numbers

All drawings require some form of lettering and numbers, and these are as important as the lines. Scribbled, smudged, or badly written letters and numbers can be impossible to read. This may lead to time-consuming and costly errors.

Remember these principles when lettering and numbering:

- They should be legible and clear — especially numbers, as they often have to be read on their own.

- They should be of a suitable size and not less than 3 mm tall. Title blocks and relative information are usually larger (see Figure 8).
- All letters are written in capital (uppercase) letters.
- Letters should be correctly spaced and positioned.
- Notes and captions should be placed so that they can be read in the same direction as in the title block. In other words, it should not be necessary to turn a drawing on its side to read the information.
- Notes should be grouped together and not spread over the drawing.
- Underlining is not recommended.

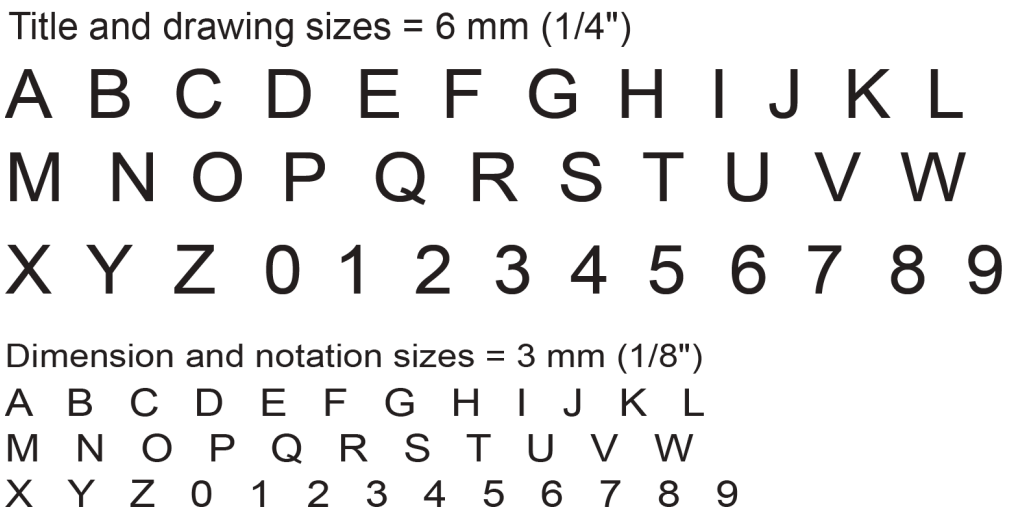


Figure 8 *Standard lettering for drawings. (Skilled Trades BC, 2021) Used with permission.*

Line Type

Standard lines have been developed so that every drawing or sketch conveys the same meaning to everyone. In order to convey that meaning, the lines used in technical drawings have both a definite pattern and a definite thickness (Figure 9). Some lines are complete and others are broken. Some lines are thick and others are thin.

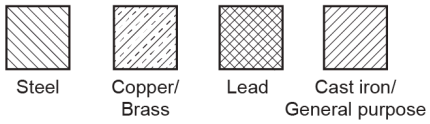
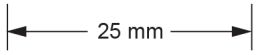
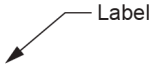
Object line Margin line	Heavy		Solid line to show visible shape, edges, and outlines.
Hidden body line	Medium		Broken line of long and short dashes to show hidden object lines not visible to the eye.
Phantom line	Light		Broken line of short dashes to show alternate positions or movement of a part.
Section line	Light		Unbroken lines arranged in a pattern, usually straight and at a 45º diagonal.
Projection line	Light		Unbroken line that extend away from the object or feature for emphasis.
Centre line	Light		Broken line of long and short dashes to show the centre of an object.
Extension line/ Dimension line	Light		Extension lines are small lines that extend outward from an object or feature. Dimension lines span between the extension lines with arrowheads and a given dimension.
Leader line	Light		Unbroken line usually drawn at an angle often with a “dogleg” and an arrowhead. A dot is used in place of an arrowhead where a surface is reference. Usually accompanied by a label.
Cutting plane line	Heavy		Broken line of one long and two short dashes to show an imaginary cross-section. The arrowheads show the direction from where the cross-section is viewed. A corresponding image will show the view of A.
Break lines for wood and metal	Heavy		Unbroken freehand or straight zig-zag lines to abbreviate longer spans of wood or metal.
Break lines for piping	Heavy		Curled lines to abbreviate a longer span of pipe.

Figure 9 *Standard lines. (Skilled Trades BC, 2021) Used with permission.*

Study the line thicknesses (line weights) shown in Figure 10 and practise making them. Use a sharp pencil when you draw, and try to maintain an even, consistent pressure to make it easier for you to produce acceptable lines.

In computer drafting, the line shape remains the same as in manually created drawings, but line thickness may not vary. Some lines, such as centrelines, may not cross in the same manner as in a manual drawing. For most computer drafting, line thickness is not important.

Figure 10 shows the nature of each line and explains how they are used in a technical drawing. You should be able to identify each line by name and describe its application.

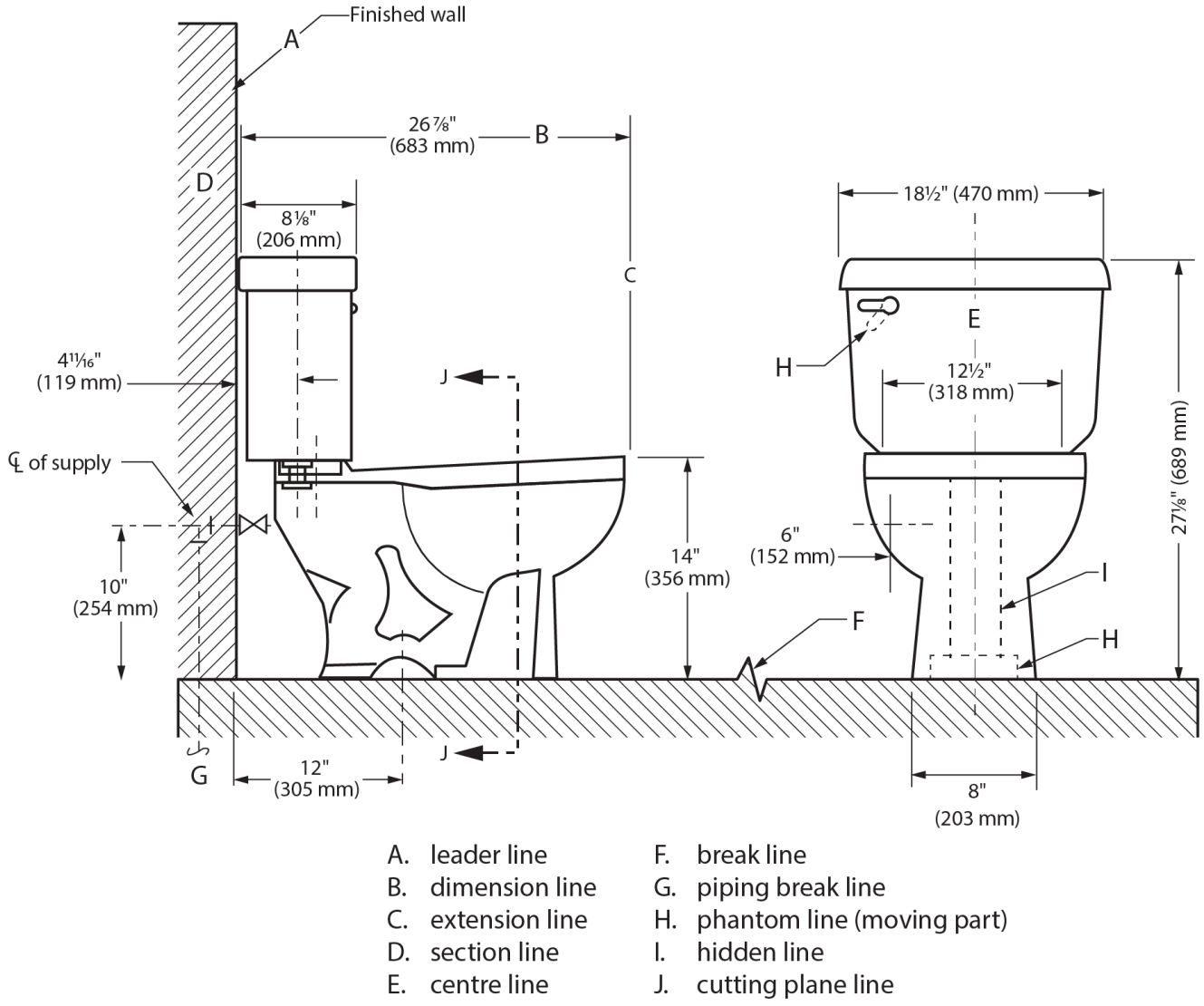


Figure 10 *Use of standard lines. (Skilled Trades BC, 2021) Used with permission.*

Information to be Contained in Drawings

Plan view DWV drawings and isometric DWV drawings are drawn to a specific scale and should show as much of the drainage and venting for a plumbing system as the view allows. Information such as rough-in heights, connection points to fixtures, floor penetrations, vent types, and vent locations should all be shown to enable the drawing to be as clear as possible while still fitting all information on the page.

Plumbing DWV drawings (isometric and orthographic plan) are really installation drawings. An installation drawing provides information for the proper positioning and installation of plumbing systems relative to the supporting structure and adjacent equipment, as applicable. This information may include:

- Dimensional data

- Piping configurations
- Piping materials
- Pipe sizes
- Fixture types
- General configuration information for the installation site

Dimensioning

Once the plan or isometric views of a piping assembly are created, they are not useful until they are completely and properly dimensioned. Dimensions show the length and size of DWV piping, as well as specific details that will determine how specific equipment is installed.

Dimensioning a drawing can be broken down into two steps:

1. Decide which dimensions are required.
2. Decide the best place on the drawing to place the selected dimensions.

A drawing that does not have all the required dimensions is said to be under-specified. This means that the person reading the drawing and installing the piping system does not have enough information to reproduce it. A drawing can also contain too many dimensions and, in that case, would be over-specified. Dimensions should NOT be duplicated, nor should the same information be given in two different ways.

Figures 11 and 12 show plan and isometric views of the same three-piece bathroom group. Note that the three-dimensional isometric drawing has the advantage of being able to show all of the information needed to install the rough-in. The isometric drawing is dimensioned with extension and dimension lines like a two-dimensional drawing. The extension lines extend from the drawing so the dimension lines are parallel to the object line.

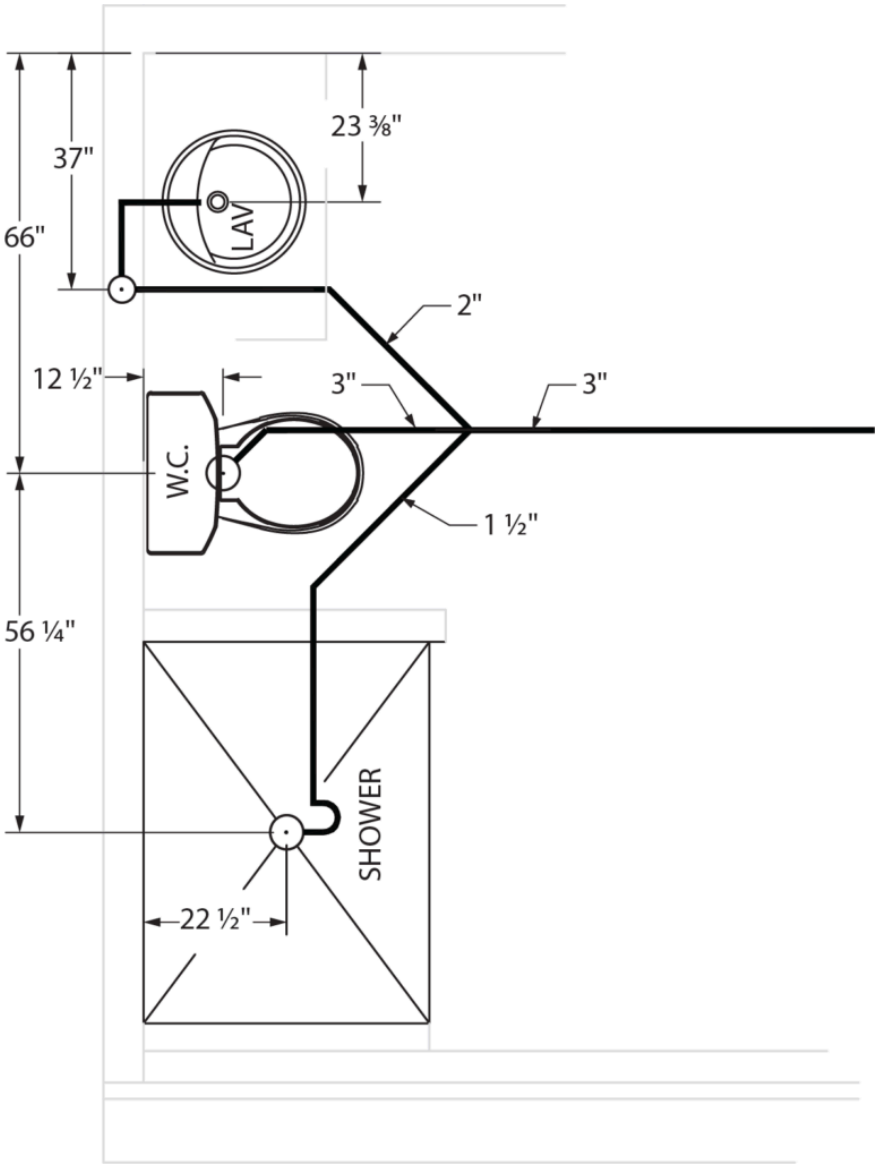


Figure 11 *Dimensioned plan view of three-piece bathroom group.* (*Skilled Trades BC*, 2021) *Used with permission.*

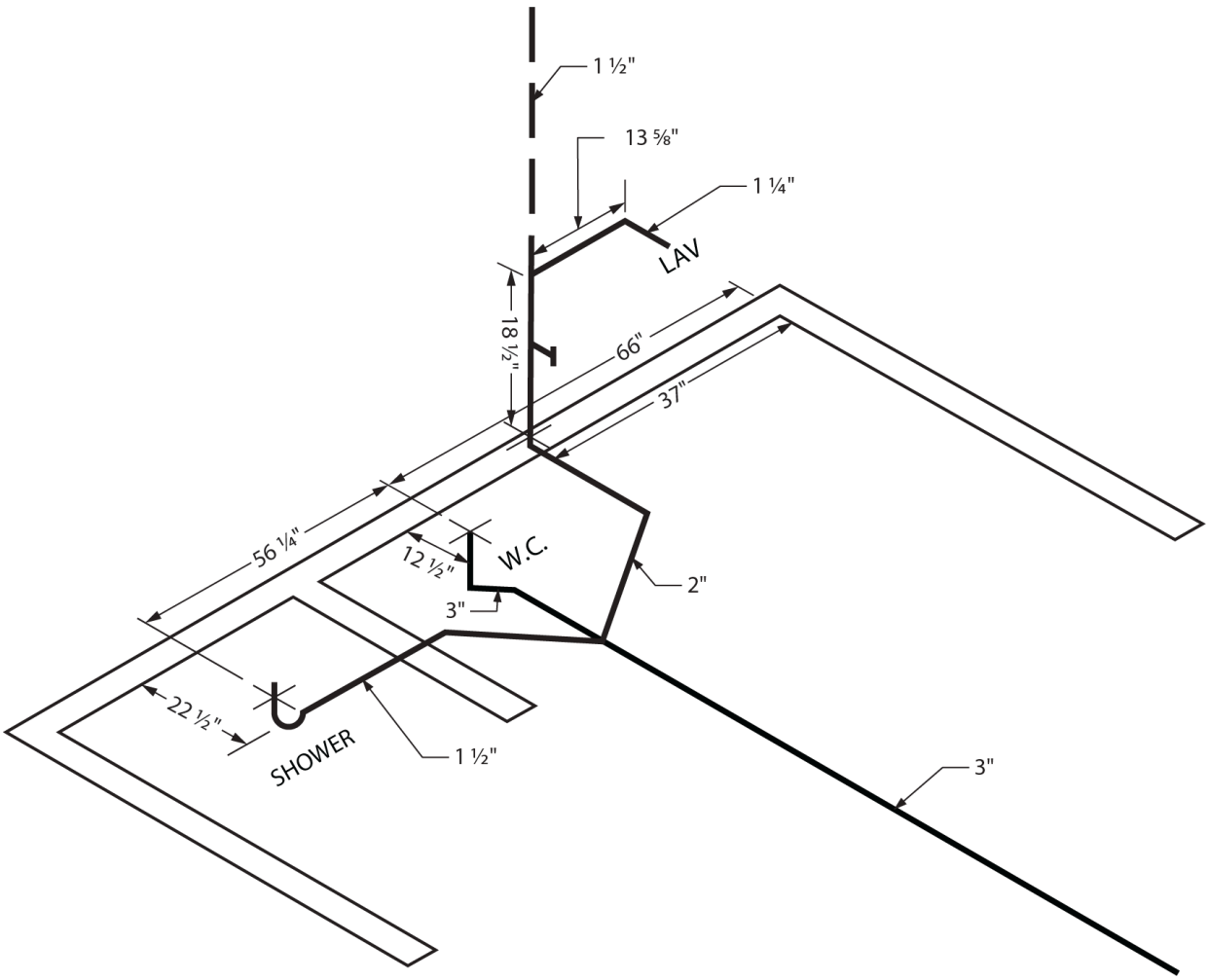


Figure 12 *Dimensioned isometric view of three-piece bathroom group. (Skilled Trades BC, 2021) Used with permission.*

Pipe Sizing

Sizing of the DWV system should be based on minimum code requirements. The drainage piping is only dependent on the connected load, while the size of vent piping is determined from its length and the total number of fixture units connected. Since the isometric drawing is to scale, the pipe lengths can be measured accurately with a scale rule.

Once every line is correctly sized, the next step is to determine the fittings required for the installation and the amount of piping required.

Self-Test D-2.3: Creating Plans and Isometric Drawings of DWV Systems

Complete Self-Test D-2.3 and check your answers.

If you are using a printed copy, please find Self-Test D-2.3 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=64#h5p-23 (https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=64#h5p-23)

References

Skilled Trades BC. (2021). *Book 2: Install fixtures and appliances, install sanitary and storm drainage systems.* Plumber apprenticeship program level 2 book 2 (Harmonized). Crown Publications: King's Printer for British Columbia.

Trades Training BC. (2021). D-2: Plan DWV systems. In: *Plumber Apprenticeship Program: Level 2.* Industry Training Authority, BC.

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- **Figure 3** Manufacturer's rough-in specification sheet for a residential toilet is courtesy of Kohler Co. and is used with permission. All rights reserved.
- **Figure 4** Manufacturer's rough-in specification sheet for a wall-hung basin is courtesy of Kohler Co. and is used with permission. All rights reserved.

D-2.4 Organizing a Plumbing Project

Project planning is crucial for successful plumbing projects, so it is important to take the time to carefully map out all aspects of the project. The first step in project planning is defining the **project scope**. This involves identifying what needs to be done, for whom, and why. Residential and commercial plumbing projects will differ in scale and complexity. Commercial projects often involve larger systems and more extensive planning and design. Once you have a clear understanding of the project scope, you can begin to develop a plan that addresses all aspects of the project.

The person responsible for managing the organization of the plumbing project could be a single plumber on site or, on larger projects, there could be a dedicated plumbing project manager.

In either case, the individual will be at the very least responsible, to varying degrees, for:

- Project specifications
- Sequence of operation
- Prioritization
- Coordination with other trades
- Material estimates
- Tools and equipment
- Materials deliveries
- Inventory requirements
- Cost efficiency

Project Specifications

Construction drawings focus on a building's shape, appearance, and dimensions, while the written construction specifications (or specs) focus on what materials will be used and how they should be installed. Which information goes into the notes on the drawings and which goes into the specs is up to the designer, but a good set of detailed specs goes far beyond what could possibly be put onto a drawing. It is acceptable for the same information to appear in both places, but if there is any contradiction, the specifications generally take priority from a legal standpoint.

Project specifications (specs) detail the performance requirements of the installations. The specification documents are the:

- Technical requirements for materials and equipment
- Standards of workmanship
- Requirements of testing and commissioning
- Requirements for document submissions for an installation

Sequence of Operation

Once the plumbing contract has been awarded, the **authority having jurisdiction (AHJ)** requires a plumbing permit to

be issued before installing or altering any plumbing work. The permit requires periodic inspections after each phase of the installation. A logical **sequence of operation** used by mechanical contractors is to divide the project into three distinct phases with an AHJ inspection showing the completion of the individual phases:

- **Groundwork inspection**: required immediately after all underground piping has been installed and before placing any material on or over the pipes. At this stage, an air or water test is required before being approved by the inspector.
- **Rough-in inspection**: required after rough-in plumbing has been completed and before installation of any wall covering that would conceal the piping. At this stage, an air or water test is conducted.
- **Final plumbing inspection**: required after the system has been completed and all fixtures have been installed and are fully functional.

Prioritization

The ability of a contractor to prioritize tasks and meet project deadlines is extremely important. A logical approach to this skill is to break the project into a list of activities that fall into each construction phase. The **prioritization** of activities in the list can use the following lettering system, which shows what must be done immediately and what can wait:

- Mark the activities that **MUST** be done today with an **A**.
- Mark the activities that you **SHOULD** be able to do today with a **B**.
- Mark the activities that you **HOPE** to be able to do today with a **C**.
- Mark the activities that **LIKELY WILL NOT** be accomplished today with a **D**.

This logical approach has a number of advantages for your company and the general contractor (GC) who has hired you. If you demonstrate a professional, organized approach to the project, the GC is more likely to hire you again. The advantages of a well-prioritized approach are:

- Reduced construction time
- Reduced costs for materials, labour, and overhead
- A more continuous work flow
- A goal for crews and subs to work toward
- Increased productivity

Coordination with Other Trades

The success of a construction project depends on proper site coordination. The general contractor is responsible for ensuring that this requirement is achieved through regular on-the-job meetings with the general contractor's authorized project representative and the onsite subcontractors.

Additional meetings may be required for subcontractors whose work might interfere with that of another at a given time during the project. The general contractor and each subcontractor should organize their own work so as not to deviate from the schedule nor to interfere with or otherwise adversely affect the work of others. The general contractor should monitor and coordinate the work of all parties to ensure compliance with the project schedule.

Estimate Materials

Installation estimates are based on the **materials take-off** (materials list). The materials list is used during two preliminary time periods of the project:

- **Job estimate:** the estimate or bid will only be as accurate as the take-off on which it is based. A properly made take-off shows everything necessary to enable a proper estimate for the installation. A full set of drawings and a set of specifications are needed for every materials list. If there are piping runs in three dimensions, begin by making an isometric drawing, which is the foundation for an accurate take-off. Another term used to describe a materials take-off is a **quantity survey**.
- **Materials acquisition:** the other function of the take-off is as the checklist for ordering materials. Any necessary materials overlooked by the take-off will not be on hand when you begin the installation. Time will be lost while you wait for the missing items. Therefore, it is very important that you can take-off materials accurately.

The isometric drawing is a valuable estimating tool because, from one drawing, you can estimate the required horizontal piping as well as the vertical risers, leaders, and stacks.

These vertical pipe sections are not represented to scale on a plan drawing. It is very important that the isometric drawing be to scale! Most isometric drawing sheets have $\frac{1}{4}$ in. isometric gridlines already printed on them, so if you scale the drawing to $\frac{1}{4}$ in. = 1 ft 0 in., then each grid box will represent one foot of pipe. If you construct the isometric drawing on paper without gridlines, use a scaling ruler to draw the system to scale. When scaling the lengths of piping, it is good practice to round up the lengths of pipe required to the nearest whole length. To stay organized when doing a DWV take-off, start at the top of the system and work toward the building sewer to avoid missing or duplicating material requirements.

Because there is so much material information that you take-off the drawings, it is best to use some kind of form to keep all of the information organized. A simple table, such as a DWV take-off worksheet (Figure 1), can be used as a starting point from which you create your own as your projects get more complex.

DWV System Piping Take-Off						
Length in ft. (m) for each pipe size						
1 ¼"	1 ½"	2"	3"	4"	Pipe Location	Misc. Items
					Under slab	
					Basement	
					Main floor	
					Second floor	
					Attic	
					Totals	

Figure 1 *DWV system piping take-off list. (Skilled Trades BC, 2021). Used with permission.*

The fittings should be arranged according to size and type (Figure 2). Most constructed DWV systems use more fittings than what was estimated in the take-off. These extra fittings are largely elbows used in getting around obstructions. An allowance should be made for extra fittings that are over and above the total in the estimate. The actual percentage will be refined as you become more experienced, but it will be around 5% of the total counted.

DWV System Fitting Take-Off			
Fitting Name	Size	Quantity	Installation Area
Total			

Figure 2 *DWV system take-off list. (Skilled Trades BC, 2021). Used with permission.*

A fixture and equipment take-off (Figure 3) is relatively straightforward because the location and required equipment will be shown on the plans or detailed in the specification. On larger projects, there would be a **fixture schedule** with

numbers that correspond to locations shown on the plans. These numbers would also correspond to the specification that would give details about each fixture.

Plumbing Fixture Take-Off				
Fixture Type	Location			Total
	Basement	1st	2nd	
Water Closets				
Lavatories				
Tubs/Showers				
Cabinet Sinks				
Floor Drains				
Total				

Figure 3 *Plumbing fixture take-off list. (Skilled Trades BC, 2021). Used with permission.*

Once the material quantities have been established, the next step is to take the material take-off sheets to all of your suppliers (not just one) and compare the prices each supplier offers.

Tools and Equipment

Whether constructing small residential or large commercial plumbing systems, every contractor has asked the same question at some point: "Do I rent or buy the equipment I need for the project?"

Buying Equipment

Buying equipment to use in your residential or commercial construction project can offer several benefits:

- Equipment you own is always on hand.
- You never have to worry about scheduling a time to use it.
- You also can gain a lot of experience using your own equipment so that you will be able to finish your job more quickly.

Renting Equipment

There are many benefits to renting equipment, whether it is something small like a chipping hammer or something large like an excavator:

- You will only need to pay for it when you need it, with no huge upfront cost and no worry that you may never use it again.
- You will also be able to access new equipment and never have to worry about having to pay for maintenance, repair, or even replacement.
- Renting equipment also means that you will have a better selection of tools to choose from.

Material Availability

Material availability may influence material selection decisions. Long delivery lead-in times must be allowed for, as delays may cause project holdups. Using locally available materials reduces **transportation costs**, labour costs, probability of damage to the materials, etc.

If the required material is not available at the desired time, an unavailability cost is incurred. Shortages may delay work, thereby wasting labour resources or delaying the completion of the entire project. It is difficult to forecast in advance exactly when an item may be required or when a shipment will be received. If items are unavailable when needed, it may be possible to assign workers to other activities, avoiding delays to the project.

Timing/Sequencing

The site delivery of materials at the right time is essential to an efficient material-handling system. The use of **just-in-time delivery** has reduced the time a contractor has to hold inventory from days, weeks, and months to minutes and hours. For many job sites working on a tight schedule, if materials cannot be delivered on time, it is better to have them not delivered at all until delivery can be rescheduled. Being late will cause scheduling problems, and the job site may incur associated cost overruns.

Transportation

The heavier or bulkier the materials are, the greater the transportation costs will be. Where possible, try to purchase locally, especially for heavy and bulky items. This will help to keep transportation costs to a minimum. Damage to materials occurs mainly during handling. The condition of the material when it arrives on site is highly dependent on the handling system and the distance it has travelled to the site.

Inventory Requirements

Once goods are purchased, they represent an inventory used during the construction process. **Inventory control** is an operational strategy that means stocking adequate numbers and kinds of materials so that the materials are available when and where they are needed. To accomplish this, many contractors employ an advance purchasing practice.

Advance purchasing of construction materials and equipment is a practical procedure that saves money and promotes the on-time completion of construction projects. Plumbing contractors gain the full benefit of advance purchasing by allowing progress payments to include payment for materials and equipment stored at the construction site. Early delivery of materials and equipment also guards against escalating costs, particularly in long-term contracts, and enables the contractor and subcontractors to make timely purchases when shortages may be a problem.

Secure Storage

When using an early purchase strategy on your construction site, the **secure storage** of materials is essential. For progress payment purposes, store as much material within the footprint of the new building as possible. Material storage trailers or containers should be used to store three types of things:

- Tools
- Equipment that can be carried off easily or damaged by exposure to the elements
- Materials that are targets for thieves, such as copper

Store as much material as will be used by your crews inside the work site. Keep stores secure, dry, and organized because bad storage procedures can cause considerable waste.

Unless the contract clearly assigns the responsibility for protecting equipment and materials on site solely to security personnel, the plumbing contractor is usually responsible for the safe storage of all materials and equipment that they have stored or installed.

"Just-In-Time" Delivery

When storage on the actual construction site is impractical, the only other solution is to employ a just-in-time delivery strategy. One of the challenges with a new-build project is logistics. Many different flows of materials need to come together in a precise sequence, creating a highly complex building schedule. A small delay at the start can have big effects on the timing later in the project. Ideally, one would like to have all required materials stored on site so that contractors can be called in to do their part exactly when they are needed and do not have to wait for materials to be manufactured or arrive on site. However, in practice, this is sometimes impractical, as sites need to be kept to minimal size, especially in urban areas. Scheduling materials deliveries to the job site can become critically important on some projects and requires close cooperation between the contractor and the supplier.

Many contractors now make arrangements with their suppliers for their materials to be delivered at the exact time that they are required at the job site. Many suppliers favour this process because it may reduce their inventory, storage, theft, and handling costs and also allows for planning their delivery operations.

Labelling Materials

A materials list provides a format for keeping track of the materials needed on the job site. Organizing those materials in a box or bag ensures that they will be available when needed.

Identifying the organized materials is crucial for locating the correct stored items. If a material is not available when the storing process begins, a note should be made to remind the plumber that the stock list is incomplete. Items such as washer boxes and tub and shower valves are installed in two different phases. Therefore, the trim plates must be stored, protected, or even removed from the site until required for the trim-out phase.

Consumables

Consumables (also known as consumable goods, non-durable goods, or soft goods) are goods that can be consumed, dissipated, wasted, or spent. In plumbing construction projects, these may include materials such as solder, flux, sand cloth, fasteners, Teflon tape, and glue.

Many estimators do not take the time to list the quantities of these types of goods on their estimate. Instead, they just give the whole category a fixed price and add it to the job quote. For example, a plumbing contractor may cover the cost by charging $100.00 for consumables for an average single-family dwelling or $10.00 per fixture on larger projects.

Cost Efficiency

The main goal of any contractor is to achieve a high-quality installation on time and on budget. Construction industry research has shown that material-handling tasks consume approximately 40% of a plumbing contractor's time — and time is money. Material handling is also recognized to be the single most common cause of unproductive time on the job. Any effort to significantly improve job-site productivity and profits can begin by addressing ways to reduce the lost time spent unnecessarily handling materials and equipment.

Plumbing project cost efficiency requires:

- Having adequate materials on hand when needed
- Paying the lowest possible prices, consistent with the requirement for quality and value for purchased materials
- Minimizing the inventory investment
- Operating efficiently

Post-job Efficiency Analysis

Project costs are measured and analyzed in many ways throughout a project — from planning, programming, and design to bidding, construction, turnover, and post-occupancy. First costs, cost-benefit ratios, and life-cycle costing are a few examples of how a project's cost-effectiveness can be evaluated. These cost-management processes start with establishing budgets based on actual estimates for the work performed. Comparing budgets to actual costs throughout the building process is critical to ensuring that the project is timely and cost effective.

Self-Test D-2.4: Organizing a Plumbing Project

Complete Self-Test D-2.4 and check your answers.

If you are using a printed copy, please find Self-Test D-2.4 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=66#h5p-9 (https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=66#h5p-9)

References

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D-2.5 Installing DWV Systems

This chapter covers the two primary aspects of the actual plumbing installation:

- Material-handling procedures
- Installation process factors

Procedures for Handling Plumbing Materials

A fundamental aspect of achieving successful plumbing installations is adhering to proper procedures for handling materials. This adherence is not merely a matter of operational efficiency but is vital for ensuring safety, job control, and overall project success.

There are many aspects related to proper handling plumbing materials, including:

- Safety procedures
- Handling
- Receiving and shipping materials
- Hazardous labels
- Storage
- Moving
- Product protection
- Disposal
- Recycling

Safety

Plumbers work in a variety of settings, some of which are hazardous. When installing a DWV system, the plumber must comply with Occupational Health and Safety (OHS) policies and procedures. These requirements include the following:

- Inspect equipment and tools for safety hazards before each use.
- Handle all hand and power tools in a safe manner.
- Wear proper **personal protective equipment (PPE)** at all times.
- Follow OHS lockout/tagout and confined space procedures.
- Know where the **Safety Data Sheets (SDS)** are kept and how to interpret an SDS.
- Take precautions to avoid inhaling dangerous vapours by using proper ventilation and/or properly fitted respirators.
- Use fall protection and other precautions when working at heights.
- Ensure that use of ladders complies with OHS guidelines.
- Keep work areas clear of clutter and equipment.
- Use safe lifting techniques.
- Report all incidents to your supervisor immediately.

Considerations When Handling Materials

In addition to instruction, training, and general safety principles, job site controls can help reduce workplace accidents involving the moving, handling, and storing of materials. Whether moving materials manually or mechanically, the tradesperson should know and understand the potential hazards associated with the task at hand and how to control their workplaces to minimize the danger.

Every employer must ensure that the safe work procedures for **material handling** and storage are followed. These procedures include the following:

- Facilitate and/or provide appropriate training as necessary to workers with respect to safe material handling and storage.
- Monitor and inspect material-handling and storage facilities to ensure hazard control in these areas.
- Ensure that, where appropriate, shelving is weight-rated as required by regulations.
- Identify and select materials for sorting, stacking, and stockpiling according to supervisor instructions or workplace requirements.
- Identify handling characteristics of materials and apply safe manual handling techniques.
- Apply specific handling requirements and protection for non-hazardous materials and chemicals.
- Ensure that materials are stored, stacked, stockpiled, protected, and clear of traffic ways for ease of identification, retrieval, and prevention of damage and cross-contamination in accordance with workplace requirements.
- Erect signage and barricades to isolate stored materials from workplace traffic or access.
- Identify hazardous material for separate handling by authorized persons.
- Use dust suppression procedures to minimize health risk to personnel in the workplace vicinity.
- Assess and control manual handling risks and provide instruction, training, and supervision for manual material handling. Risk controls may include:
    - Organizing the work to reduce the number of manual handling tasks involved.
    - Not working long periods of strenuous manual material handling.
    - Making sure the workplace layout allows enough space to move and work safely and comfortably.

Packaging/Shipping

Construction materials are received at and shipped from the job site on a regular basis. When receiving materials:

- Inspect the shipment for external damage and then remove the packaging and inspect the contents for any physical damage in the presence of the delivery driver.
- If there is any damage, you must indicate such on the delivery receipt. When you sign the delivery ticket and do not note any damage, the merchandise becomes your property, and the freight company will not allow a claim.
- Make sure hazardous products are identified for separate storage, transport, and handling by authorized persons, in line with workplace and safety procedures.
- On arrival, check for any spillage or leakage. Check to see that hazardous products are properly labelled. An SDS should be readily available.

When shipping materials:

- Determine the method of shipment and prepare bills, invoices, and other shipping documents.
- Assemble containers and crates, pack goods to be shipped, and prepare identifying information and shipping

instructions.

- Ensure that pallets are safe to use and loaded and transported safely:
  - Do not use pallets that are damaged or structurally inadequate for the load.
  - Do not overload pallets.
  - Secure unstable loads to the pallet where appropriate.
- Hazardous products should be transported and handled in accordance with regulatory requirements, including appropriate signage, markings, and safety precautions. WHMIS labels and SDS are mandatory in Canada.

Labelling

All hazardous products delivered to construction sites are labelled in accordance with the Hazardous Products Regulation (Canada). When working with this type of product, follow these guidelines:

- Never accept any container of hazardous goods unless it is properly labelled.
- Never remove, deface, modify, or alter any supplier label.
- When a hazardous product is used at a work site in a container other than the original supplier's container, a workplace label must be applied to the container immediately, except if transferred by a worker into a container for use during the same shift, provided that the worker maintains control of the new container and finishes use in that shift

Storage

Some materials deteriorate rapidly. Moisture can lead to damage from corrosion or growth of mould or fungi. It is essential that construction materials have the durability required for their area of use. Materials should be stored properly in accordance with the manufacturer's instructions to afford maximum protection against damage caused by weather, corrosion, mechanical force, and other causes before installation. Materials should be stored under a cover and on level, well-drained, and well-maintained hard-standing ground. Plastic pipes and fittings must be stored so that they are not exposed to sunlight, which can cause deformation or ultraviolet damage.

Securing

Construction materials that are stored on site must be secured correctly and safely according to workplace procedures. These procedures could include the following:

- Ensure that pallets used are safe to use and loaded and transported safely:
- Do not use pallets that are damaged or structurally inadequate for the load.
- Do not overload pallets.
- Secure unstable loads to the pallet where appropriate.
- Ensure that storage racks and shelves are secure and capable of handling the loads placed on them. If there is any evidence of potential failure, discuss the situation with the site supervisor.
- Report the following to the site supervisor:
  - Deformation of the structure (e.g., sagging shelves and upright supports that are leaning or otherwise

unstable)
    - Heavy weights (e.g., items that might exceed the safe load limit of the shelving)
    - Excessive materials (e.g., too much material on the shelf)
- Pile materials at work sites so they do not create tripping/slipping hazards.
- Do not pile other materials on pipe or behind pipe in a manner that requires a worker to walk over the pipe to reach them.
- Pile all materials clear of walkways and entrances.
- Pile higher rather than wider in order to allow a worker to approach all materials while walking on firm, unobstructed footing rather than having to weave through materials that create a tripping hazard or walking on materials that can create a tripping hazard or a potential for falls and property damage.
- If you are searching for something specific, clean up after yourself.

Moving

Materials that have arrived on site and been securely stored will eventually have to be moved and installed. Workers can be at risk of hazards when working around vehicles and mobile construction equipment at construction projects. These hazards can result in serious injuries or death. Incidents can be prevented by ensuring that:

- Trained signallers and competent equipment operators are in place.
- Construction projects are planned and organized to eliminate or reduce vehicles and construction equipment from operating in reverse.
- Workers wear personal protective equipment (PPE), including high-visibility clothing.

Hoisting and Rigging

Choosing the correct hoists, cranes, or rigging products for an application is always critically important due to the inherent risks involved in overhead lifting. Incorrectly specified overhead lifting equipment could fail, resulting in costly equipment damage, personal injury, and lost productivity. To prevent this, when **hoisting and rigging** on a construction site, follow these guidelines:

- Before starting hoisting, be aware of all possible unsafe conditions within the area in which the hoist will take place.
- Maintain safe clearances to overhead power lines, in keeping with regulations.
- Control traffic with flag persons, traffic cones, and/or barricades if lifting in areas of public travel.
- Use ropes or safety ribbons to secure the area and keep out anyone not involved in the hoisting procedure.
- Use only proper devices specifically designed and rated for lifting.
- Do not use frayed or torn cables or slings. If possible, obtain the weight of the piece being lifted to ensure that it is within the capacity of the lifting device. If the exact weight is unknown, test the lift in a safe location before lifting.
- Persons giving instructions to operators should know the proper hand signals.
- When hoisting equipment onto roofs, anyone closer to the roof edge than allowed by regulations must wear a proper safety harness secured to the building in such a manner as to prevent injury.

Work Platforms

Work platforms are often used to move materials around on a job site or to lift them into place for overhead installations. It is therefore important to consider them when planning a project.

The two basic types of elevating work platforms are boom lifts and scissor lifts. Both types come in on-slab models for use on smooth, hard surfaces — such as concrete or pavement — and rough-terrain models for use on firm, level surfaces — such as graded and compacted soil or gravel.

Both types share three major components: base, lifting mechanism, and platform assembly. The machines come with load charts that show safe operating configurations. Machines with booms long enough to cause overturning at low boom angles are required to have radius-limiting interlocks to prevent operation in unstable configurations.

Elevated work platforms are designed for different uses. It is essential to select the right machine for the job. Typical mistakes in platform selection include the following:

- Using an on-slab machine on rough terrain
- Using a unit undersized with respect to height, reach, and lifting capacity
- Extending the platform with planks, ladders, or other devices because the machine cannot reach the required height
- Failing to assess the job needs before starting and using the wrong machine or not ordering the right machine to do the job

When selecting an elevating work platform, keep in mind the following job site considerations:

- **Capacity**: does the machine have the lifting capacity, reach, and height to complete the task?
- **Surface conditions**: are the surface conditions hard or soft, sloped or level? Will the ground have an effect on the type of machine selected?
- **Platform size and configuration**: do you need a regular or extendable platform? Is rotation required? Are there space restrictions to consider?
- **Mobility**: is a boom type better suited to the task than a scissor lift?
- **Material to be lifted**: will the machine be able to lift the size and weight of material required for the job?
- **Access**: will the machine be able to travel around the workplace safely? Are there obstructions or depressions that would restrict the use of certain machines?
- **Operator skill or training**: are the people on site that can competently operate the machine? If a propane-powered engine is used, has the operator received propane training?
- **Work environment**: if the work is to be done indoors or in a poorly ventilated area, will an electrically powered machine be required

Product Protection

Builders and contractors alike have realized that protecting installed materials in the finishing stages of a project is 10 times more cost effective than spending time making repairs after completion. Interior protections are used on installed countertops, fixtures, walls, windows, cabinetry, floors, and stairs. When installed, materials are protected and end users report significantly fewer deficiencies upon completion, which increases their satisfaction with the contractor. This also increases the likelihood that the contractor will be employed on future projects.

Disposal

Construction site material management should aim to minimize waste, thereby reducing waste disposal and the release of pollutants. The initial step in a construction waste reduction strategy is good planning. The environmental impact of the disposal of materials at the end of their serviceable life must also be considered. Follow these guidelines:

- Reduce rejects by using high-quality materials, such as engineered products.
- Set aside construction and demolition materials that are in good condition.
- Sort your materials before disposal; you may find recycling or reuse opportunities. This may save you money and reduce environmental impacts at the same time.
- Think about the types of waste you produce and whether they need to be dealt with as hazardous waste.
- Make sure you recycle any waste because many plumbing materials contain recyclables, such as copper, steel, lead, cast iron, and aluminum.

Recycling

Some construction materials can be recycled directly into the same product for reuse. Others can be reconstituted into other usable products. The most important step for recycling construction waste is onsite separation. This will take some extra initial effort and training of construction personnel. Once separation habits are established, onsite separation can be done at little or no additional cost, increasing profitability and economy for the builder and customer.

Installation

Staying educated on relevant codes, materials, tools, and hazards is an important part of every plumbing professional's job. The practice of actually installing a DVW plumbing system requires the plumber to consider a number of factors during the installation process.

Tools and Equipment

On the job site, it has always been about having the right tools and equipment. Plumbers use a variety of tools and equipment to perform a DWV installation (power and hand tools, welding and soldering/brazing equipment, hoisting and lifting equipment, etc.). Specific certification may be required to perform some of those tasks or use some of that equipment. Too often, injuries occur because corners are cut when using the wrong tools and equipment for the job. The scope of the installation will dictate the tools required. For example, routing and securing pipes within house framing requires a variety of cutting and drilling tools, including reciprocating saws, power drills, and circular saws.

On larger projects, machinery and equipment such as scissor lifts and excavators may be used. In either instance, it is very important that tools be properly maintained in accordance with the manufacturer's specifications.

Determining Slopes

Horizontal drains are designated to flow at half to two-thirds full capacity under uniform flow conditions, which minimizes pressure fluctuations in the system. The NPC dictates minimum slopes according to the size and function of the pipe. All drainage pipes must be installed with a minimum slope of 1:50. In some situations, the slope of a building drain may be reduced to 1:100 if it is at least 100 mm (4 in.) in size. This reduction in slope will allow for less fall over a given length, which may be needed to match the invert of a previously installed municipal drainage connection.

Installing Components

The installation of components in a DWV system requires the plumber to possess specific knowledge and the ability to do the following:

- Interpret codes and regulations pertaining to DWV component installation.
- Interpret information pertaining to DWV components found on drawings and specifications.
- Identify types of DWV component supports and their applications.

Cleanout Locations

When designing and installing DWV systems, it is important for the plumber to consider how the drainage system will be maintained. The NPC has requirements for the location and size of **cleanout** fittings in the drainage pipes to allow drain-cleaning machines to have access to the drainage piping. Generally, a distance of about 900 mm (3 ft) from a cleanout to any obstruction or wall is required.

When planning the route for the drainage piping, the plumber must allow for cleanouts to be installed at appropriate intervals and in a manner that will allow access without causing excessive disruption to the building finishes. For example, a building drain installed below grade can be routed in corridors or aisles so that cleanouts are easily accessible.

When drains serving floors above grade require cleanouts, consider the spaces on the floor below where the drain piping changes direction. Try not to locate cleanouts in ceiling spaces over sensitive equipment. Cleanouts and drains should be routed to avoid being over food preparation areas, hospital operating rooms, computer rooms, or other critical areas.

Testing

DWV piping systems must be tested using methods determined by the NPC. The methods and requirements are detailed in Competency D-4: Test and Commission Sanitary and Storm Drainage Systems of this series. System testing is usually done after each phase of the rough-in by sealing off all trap arms and the building drain using plugs or inflatable balls. The most common test is the “water test,” in which the plumber fills the piping system with water and then visually inspects the system for integrity. In regions that experience extremely cold weather, the water test could be used if filled and inspected in the same day. Typically, in situations where the weather does not cooperate, an air test may be applied, requiring all openings to be sealed.

Other less frequently used methods are the ball test and the smoke test.

After the plumbing fixtures have been set and their traps filled with water, their connections shall be tested and proved gastight and/or watertight by filling each fixture to the overflow and performing a visual inspection.

Inspection

Plumbing inspections are carried out to ensure compliance with the requirements of the code, which contains the minimum health and safety requirements for plumbing installations.

Local municipal building bylaws dictate the frequency of inspections, which are typically required after the following construction phases.

1. **Plumbing underground:** All drain and vent installations are completed with all required tests applied and prior to covering.
2. **Rough-in:** All drain and vent installations are completed with all required tests applied and prior to covering.
3. **Final plumbing:** All above plumbing and drainage inspections are approved and all plumbing fixtures are installed and operating in final condition.

A certified building/plumbing inspector reviews the assembly of the DWV system components for compliance with the applicable code. Areas where the inspector will be focusing are:

- Materials and equipment
- Testing of drainage and venting systems
- Protection of piping
- Support of piping
- Trap installation
- Arrangement of drainage piping
- Cleanout installation
- Slope and length of drainage pipes
- Arrangement and size of venting pipes

Here is a bit of advice that will make your working life as a plumber easier: get to know your inspector. Communication is a major component of any good project. Knowing the inspectors in your area and what they expect will make jobs run more smoothly. Most inspectors are approachable and helpful as long as you do not convey a bad attitude.

Sealing Penetrations

Any exterior penetrations through a building structure must be made watertight. Roof penetrations around vent pipes must be made watertight using an approved **flashing** material and shall not restrict the internal cross-sectional area of the pipe. The roof slope and cladding material used typically dictate the type of flashing required. Always refer to the manufacturer's installation instructions when installing specialty flashings.

Sloped roofs require the flashing material to be interwoven with the roofing material (Figure 1).

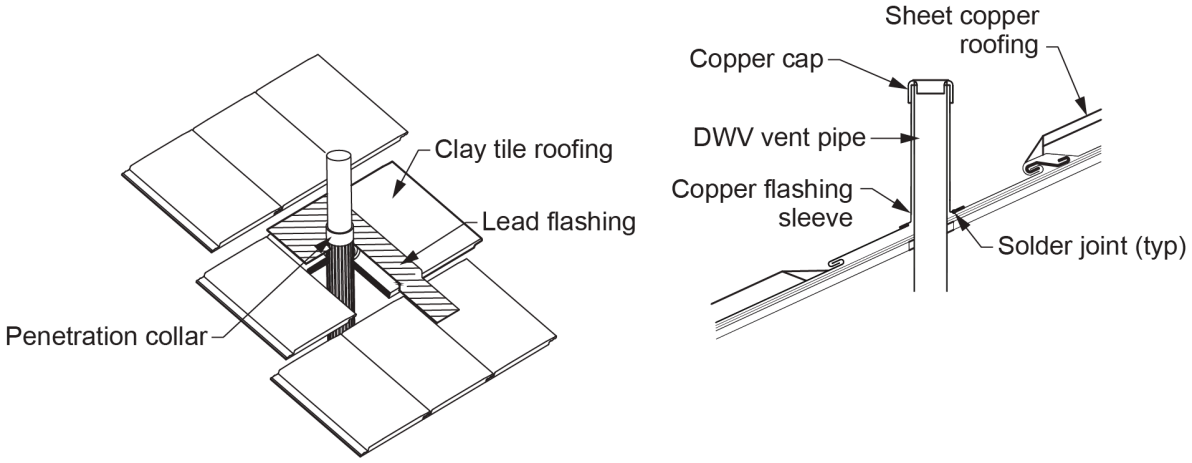

Figure 1 *Specialty sloped roof flashings. (Skilled Trades BC, 2021) Used with permission.*

Flat roofs, which are mostly found on commercial buildings, require the vent flashings to be "mopped" or "torched" into the roofing membrane to provide a watertight seal. Figure 2 illustrates a typical penetration through a flat roof.

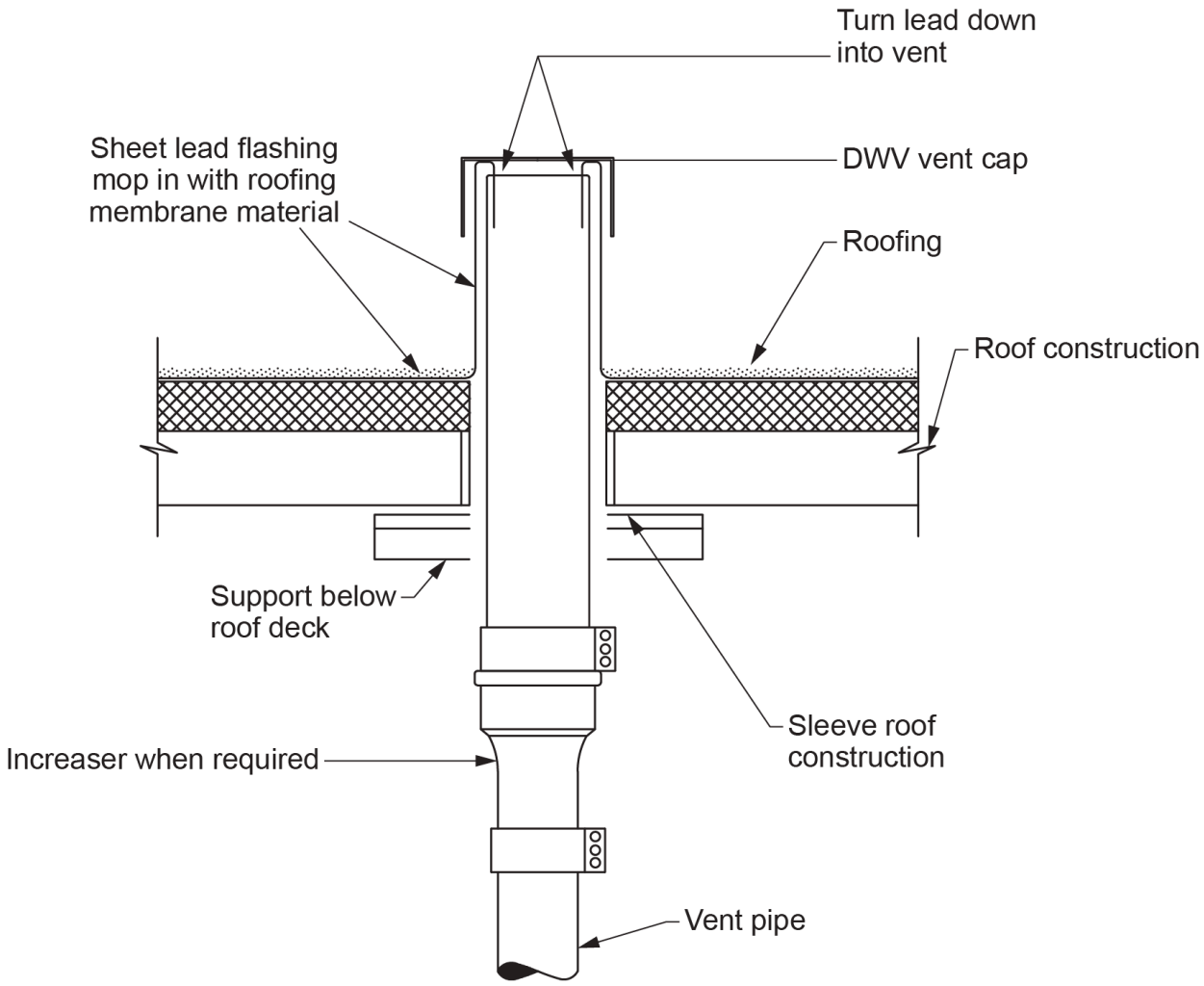

Figure 2 *Flat roof flashing incorporated into roof membrane material. (Skilled Trades BC, 2021) Used with permission.*

When drainage pipes are run through the foundation walls, the penetration must be sealed by one of two general methods:

1. Sleeve and caulking
2. Mechanical seals

The sleeve and caulking method can be accomplished using a non-corrosive sleeve poured in place during construction (Figure 3). The sleeve should be 50 mm (2 in.) larger than the DWV pipe passing through it. This will provide an annular space between the pipe wall and the sleeve. Caulking the gap around the pipe is typically done with high-viscosity polyurethane or another approved material. This caulking material can be used on both wet and dry installations. One advantage to this method is that the seal will be able to stretch and contract along with the natural fluctuations of the foundation walls.

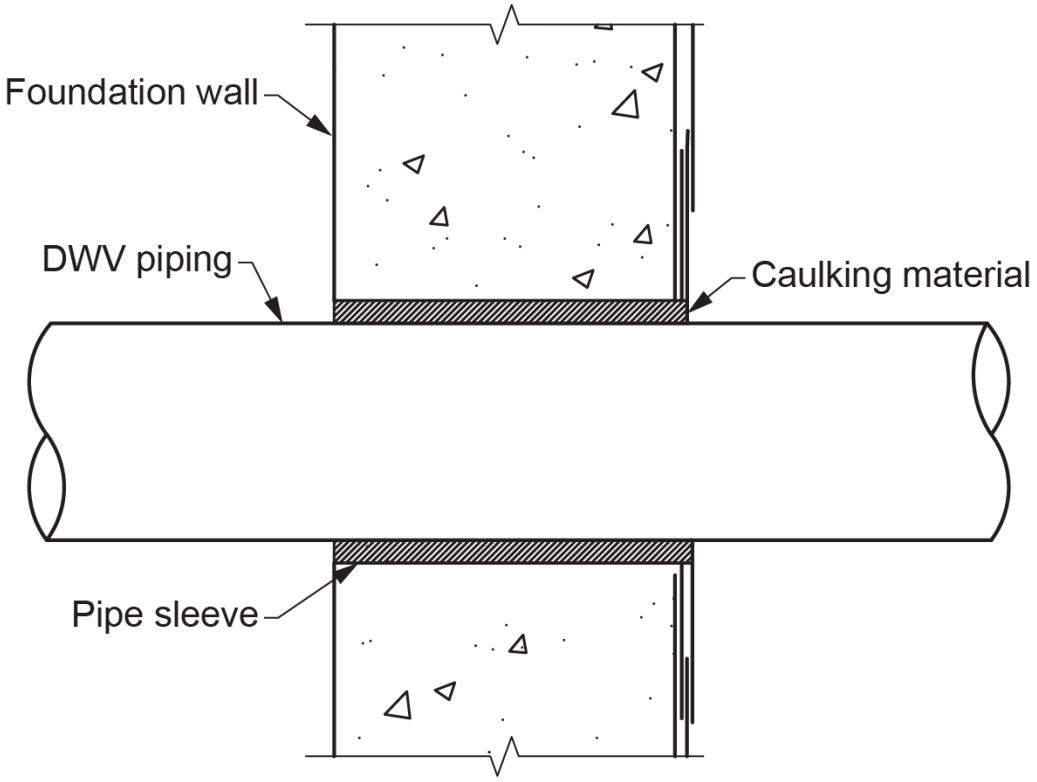

Figure 3 *Piping penetration sealed using a pipe sleeve and caulking compound. (Skilled Trades BC, 2021) Used with permission.*

Mechanical seals (Figure 4) form a watertight mechanical seal between the pipe and the hole through which it passes. These sleeves use elastomeric sealing elements and adjustable pressure plates to provide the seal around the pipe.

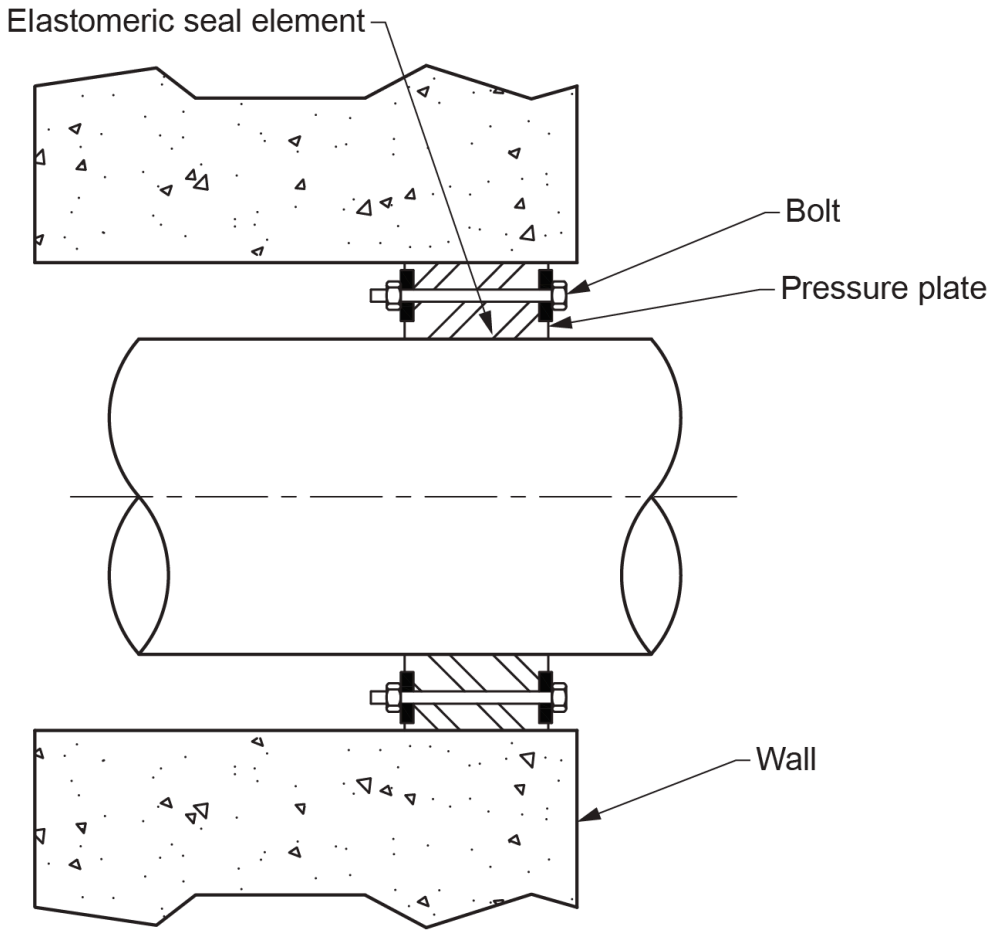

Figure 4 *Piping penetration sealed using a mechanical seal. (Skilled Trades BC, 2021) Used with permission.*

Fire-Stopping

Every time a fire-rated wall or floor/ceiling assembly is penetrated by DWV piping, the penetrations have to be protected by fire-rated fire-stop systems in order to maintain the assembly's intended fire rating. The size of the annular space to be filled and whether or not the pipe is combustible will dictate what type of fire-stopping system must be used.

When the annular space is relatively small — typically between 0.25 in. and 1.25 in. — the system could be special fire-rated insulation topped off with an intumescent caulking material (Figure 5). The term "intumescent" means that it swells when exposed to heat, closing off the opening.

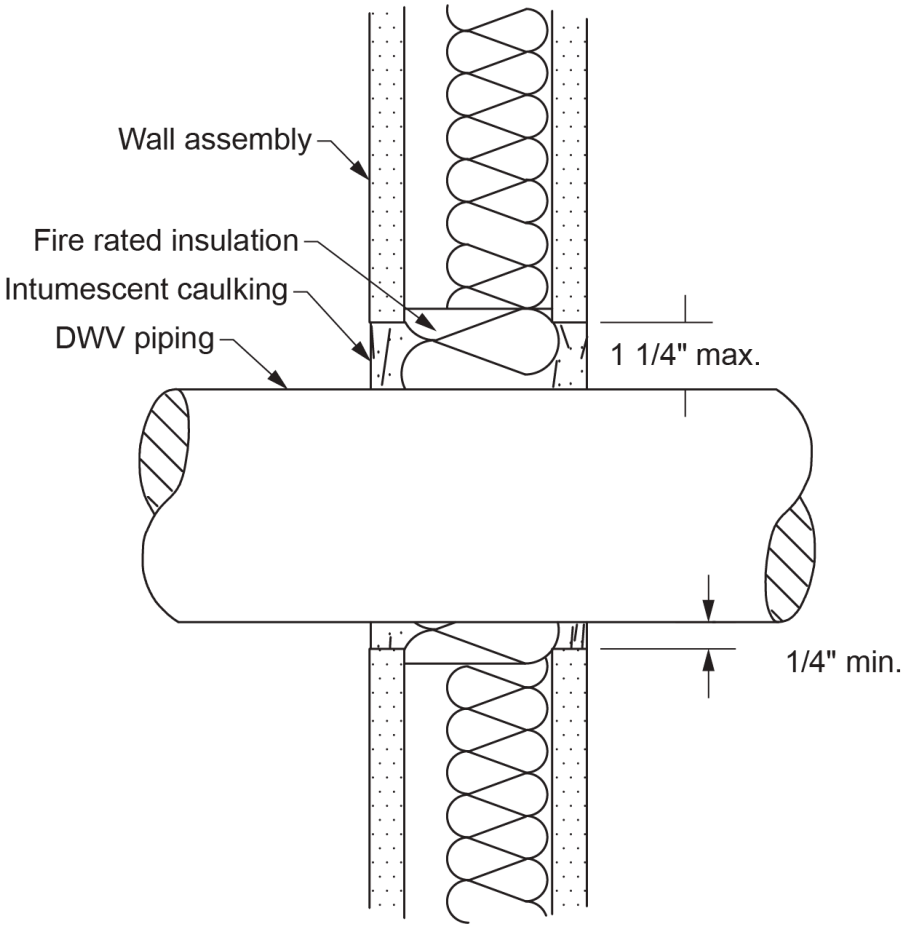

Figure 5 *Piping penetration fire-stopping using caulking and insulation. (Skilled Trades BC, 2021) Used with permission.*

On larger pipe penetrations resulting in a larger annular space ($\frac{3}{4}$ in. minimum), a restraining fire collar is sometimes used (Figure 6). The wrap strip on the collar uses a highly intumescent fire-stopping material. When exposed to fire, the wrap strip expands and forms a hard char to seal off the penetrating pipe and prevent the passage of fire and hot gases. The installation would be in conjunction with special fire-rated insulation and intumescent caulking of the annular space.

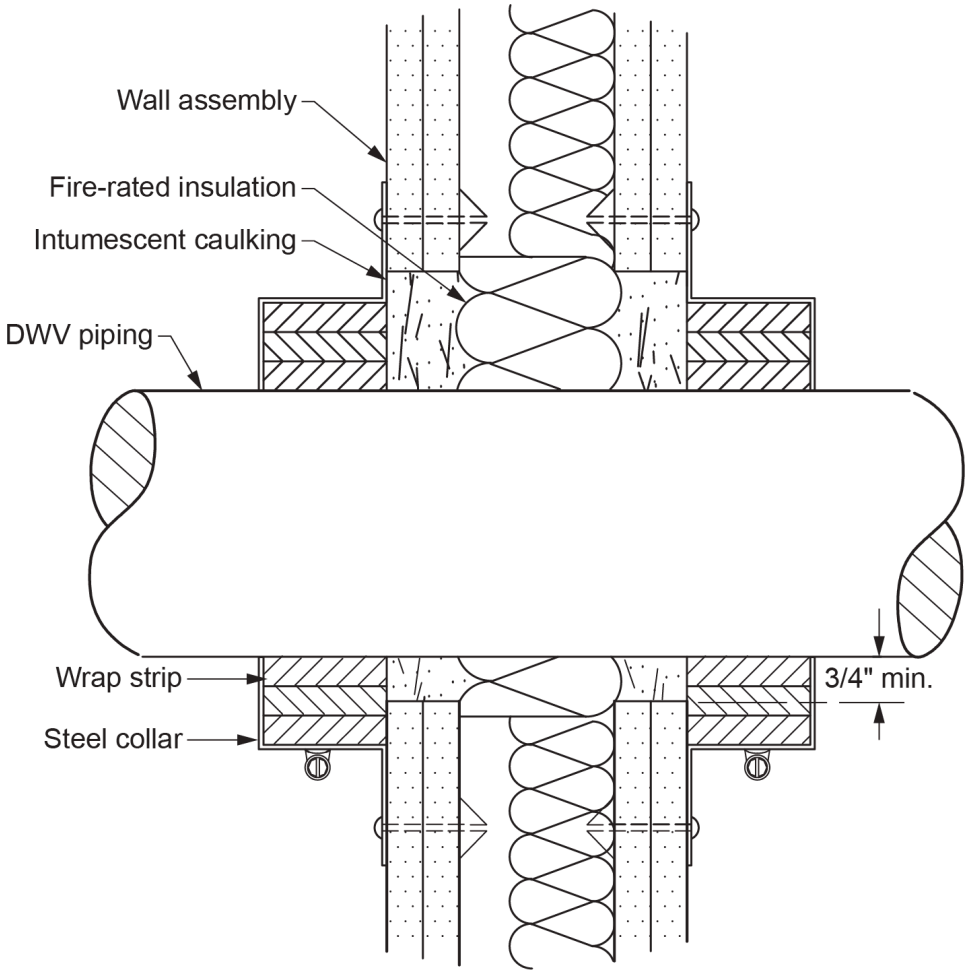

Figure 6 *Piping penetration fire-stopping using a fire collar. (Skilled Trades BC, 2021) Used with permission.*

Self-Test D-2.5: Installing DWV Systems

Complete Self-Test D-2.5 and check your answers.

If you are using a printed copy, please find Self-Test D-2.5 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=68#h5p-8 (https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=68#h5p-8)

References

Skilled Trades BC. (2021). *Book 2: Install fixtures and appliances, install sanitary and storm drainage systems.* Plumber apprenticeship program level 2 book 2 (Harmonized). Crown Publications: King's Printer for British Columbia.

Trades Training BC. (2021). D-2: Plan DWV systems. In: *Plumber Apprenticeship Program: Level 2.* Industry Training Authority, BC.

Media Attributions

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Self-Test D-2.1 Types of DWV Drawings

Complete Self-Test D-2.1 and check your answers.

1. Architectural drawings are used to show what details?
    a. Landscaping
    b. Structural
    c. Overall design and finishing
    d. Shop

2. Structural drawings show what details?
    a. Electrical
    b. Beam and girder
    c. Plumbing
    d. Mechanical

3. Telephone locations are shown on the electrical drawings.
    a. True
    b. False

4. Landscape drawings are always part of a building contract.
    a. True
    b. False

5. When a plumbing plan is combined with a heating plan, it is known as a(n) _____.
    a. Architectural drawing
    b. Mechanical drawing
    c. Site plan
    d. Structural drawing

6. A mechanical drawing is based on a _____.
    a. Sectional drawing
    b. Floor plan
    c. Site plan
    d. Climate control plan

7. The main drawing of a building is the _____.
    a. Plot plan
    b. Site plan
    c. Architectural drawing

d. Structural drawing

8. Public utilities are shown on which type of plan?
    a. Site plan
    b. Floor plan
    c. Landscaping plan
    d. Section plan

9. Which drawings show the distance from the building to the property line?
    a. Site plan
    b. Floor plan
    c. Mechanical plan
    d. Section plan

10. Before drawing a pipe route on a floor plan, you need to consult the electrical drawings, the mechanical drawings, and the _____ drawings.
    a. Architectural
    b. Elevation
    c. Section
    d. Structural

11. Which drawings would you consult to determine the exterior finish of walls that pipe must penetrate?
    a. Electrical
    b. Mechanical
    c. Elevation
    d. Structural

12. Which drawings would you consult to determine the amount of vertical pipe needed?
    a. Electrical
    b. Mechanical
    c. Elevation
    d. Structural

13. On which drawings can you find information on the heights of sinks or showers?
    a. Electrical
    b. Mechanical
    c. Elevation
    d. Structural

14. To determine whether the utilities can operate on gravity or whether they require a pump, you need to compare the elevations of the _____.

a. Utilities and basement elevation
b. Utilities and main floor elevation
c. Utilities and contour lines
d. Main floor elevation and contour lines

15. To decide on the placement of the septic tank, you need to check the _____.

a. Landscaping plans
b. Property line and contour lines
c. Septic tank and basement elevation
d. Utilities and contour lines

16. Where are descriptions written of the materials, components, and valves shown in symbol form on drawings?

a. Title block
b. Key plan
c. Notes
d. Specifications

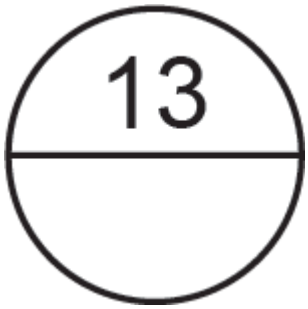
17. The scale usually appears in what part of the drawing?

a. Title block
b. Key plan
c. Notes
d. Specifications

18. What type of drawing does this symbol refer to?

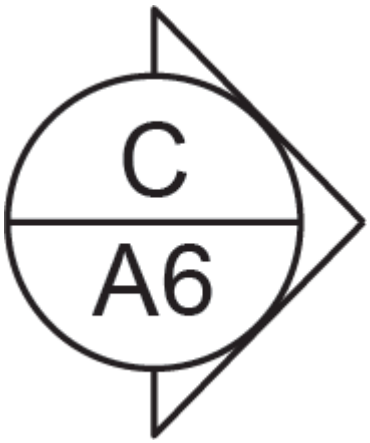
a. Oblique
b. Section
c. Elevation
d. Detail

19. What is the meaning of this symbol?



a. Section drawing appears on page 13.
b. Detail drawing appears on page 13.
c. Section drawing 13 appears on the same sheet.
d. Detail drawing 13 appears on the same sheet.

20. What type of drawing does this symbol refer to?



a. Oblique
b. Section
c. Elevation
d. Detail

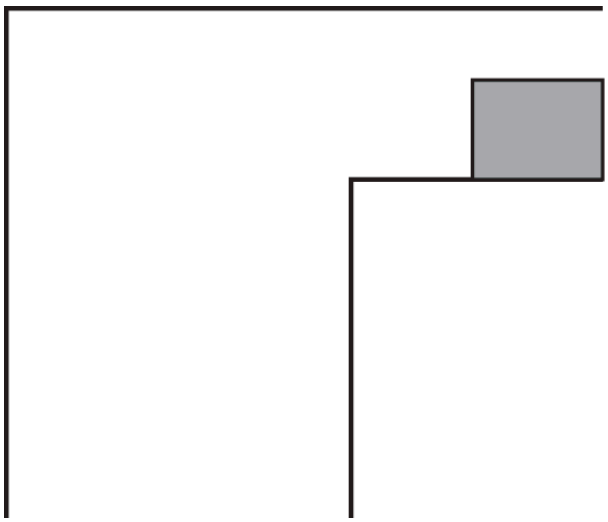
21. What type of drawing does this symbol refer to?

a. Oblique
b. Section
c. Elevation
d. Detail

22. What kind of drawing does E3 of 8 refer to?

a. Architectural
b. Structural
c. Mechanical
d. Electrical

23. The shaded part of the diagram indicates that _____.



a. Another drawing covers the shaded part
b. There is a sectional drawing of the shaded part

c. The portion of the building plan shown by the drawing
d. There is an elevation of the shaded part

Answer Key: Self-Test D-2.1 (#chapter-answer-key-self-test-d-2-1) is on the next page.

Answer Key: Self-Test D-2.1

1. c. Overall design and finishing details
2. b. Beam and girder details
3. a. True
4. b. False
5. b. Mechanical drawing
6. b. Floor plan
7. c. Architectural drawing
8. a. Site plan
9. a. Site plan
10. d. Structural
11. d. Structural
12. c. Elevation
13. c. Elevation
14. a. Utilities and basement elevation
15. b. Property line and contour lines
16. c. Notes
17. a. Title block
18. d. Detail
19. d. Detail drawing appears on the same sheet
20. c. Elevation
21. b. Section
22. d. Electrical
23. c. The portion of the building plan shown by the drawing

Self-Test D-2.2 Planning Interior DWV System Layouts

Complete Self-Test D-2.2 and check your answers.

1. When terminating a vent pipe through a roof structure, why is it a preferred practice to exit the building at a point that does not have sight lines from the adjoining street?
    a. Reduces frost closure
    b. Gives the building better aesthetics
    c. Improves sewer gas dissipation
    d. Usually requires a shorter vent length

2. If a building drain is to exit the building through a foundation wall, what is required during the forming stage in order to eliminate the need to core a hole in the cured concrete?
    a. Blocking or sleeves
    b. Flashing installation
    c. Approved caulking
    d. Nothing. A building drain is not allowed to penetrate a foundation wall.

3. What must be installed in conjunction with plastic DWV piping when it penetrates a fire-rated assembly?
    a. Silicone sealant
    b. Foam insulation
    c. Bitumen caulking
    d. Fire-stop system

4. Why is it important to limit the frequency and follow regulations when cutting and notching wooden framing components during a DWV Installation?
    a. Maintains the aesthetics of the building by eliminating the need for bulkheads
    b. Maintains the close clearances required from the pipe to the framing
    c. Maintains the strength and load-carrying capability of the framing

5. What force(s) should you consider when selecting and locating pipe supports to maintain pipe slope and alignment?
    a. Hydraulic testing
    b. Seismic forces
    c. Thermal expansion and contraction
    d. All of the above

Answer Key: Self-Test D-2.2 (#chapter-answer-key-self-test-d-2-2) is on the next page.

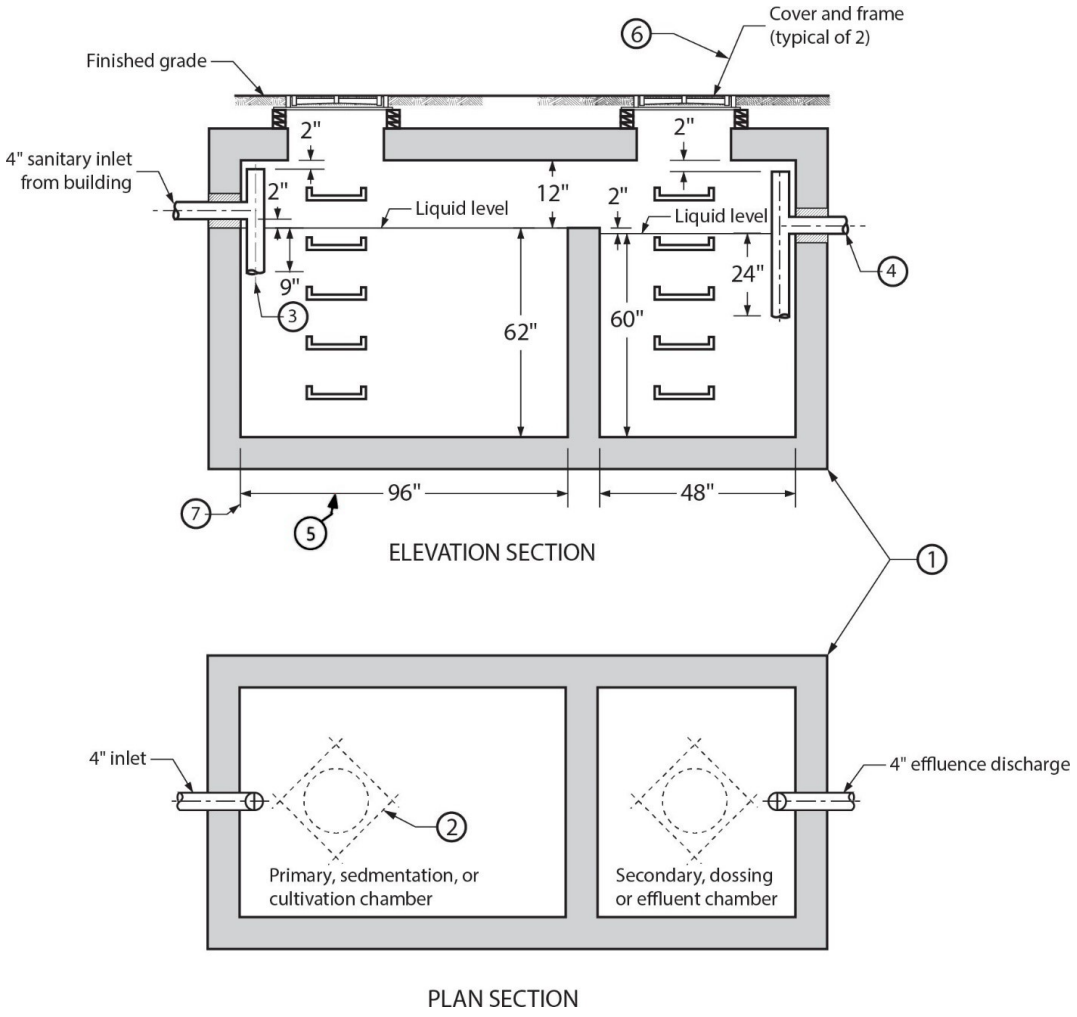
Answer Key: Self-Test D-2.2

1. b. Gives the building better aesthetics.
2. a. Blocking or sleeves
3. d. Fire-stop system
4. c. Maintains the strength and load-carrying capability of the framing
5. d. All of the above

Self-Test D-2.3 Creating Plans and Isometric Drawings of DWV Systems

Complete Self-Test D-2.3 and check your answers.

Figure 1



Using Figure 1, identify each type of line in Questions 1–7 by stating its:

A. Name (e.g., body line, hidden line, centreline, etc.)
B. Main use (e.g., shows object outline, shows centre of an object, shows the end of a dimension, etc.)

1. Line 1
   a.
   b.
2. Line 2
   a.
   b.
3. Line 3
   a.

b.

4. Line 4
   a.
   b.
5. Line 5
   a.
   b.
6. Line 6
   a.
   b.
7. Line 7
   a.
   b.

8. What is the purpose of a cutting plane line used in technical drawings?
   a. Indicates the centre of an object
   b. Shows alternate positions of a part
   c. Shows hidden object lines not visible to the eye
   d. Indicates where an imaginary cutting plane takes place

9. Which of the following lines should be drawn the thinnest?
   a. Body line
   b. Cutting plane line
   c. Hidden body line
   d. Leader line

10. What type of DWV plumbing drawing shows only horizontal two-dimensional details of the plumbing system on a single floor?
    a. DWV isometric drawing
    b. Plumbing detail drawing
    c. Plumbing rough-in drawing
    d. Orthographic plumbing plan

11. Most horizontal pipelines are drawn in what way on isometric drawings?
    a. Vertically
    b. 300° to the vertical
    c. 300° to the horizontal
    d. 450° to the horizontal

12. Why is it preferable to align the bottom floor stacks directly under the upper floor stack and/or stack vent?
    a. It is a plumbing code requirement
    b. Makes it easier to clean out the system
    c. Eliminates the need for an offset between floors

d. Reduces the hydraulic fixture unit load on the stack vent

13. When sketching an isometric plumbing layout, which plumbing fittings are not shown to scale?
    a. 45° ells
    b. P-traps
    c. Wye fitting branches
    d. All of the above

14. When preparing an orthographic drawing sheet, what would be the best scale to use when the project is 83 ft 4 in. long and the available drafting sheet is 10 in. long?
    a. 1:10
    b. 1:100
    c. 1:1000
    d. 0.25 in. per foot

Answer Key: Self-Test D-2.3 (#chapter-answer-key-self-test-d-2-3) is on the next page.

Answer Key: Self-Test D-2.3

1. a. Body line
   b. Shows the edges (outline) of an object
2. a. Hidden body line
   b. Represents hidden edges and boundaries
3. a. Centreline
   b. Locates the precise centre of a pipe or fixture
4. a. Break line
   b. Shows imaginary breaks in objects
5. a. Dimension line
   b. Shows the size or length of an object
6. a. Leader line
   b. Establishes a connection between a drawing feature or item and some text
7. a. Extension line
   b. Used in conjunction with a dimension line to show where the specific dimension starts and end
8. d. Indicates where an imaginary cutting plane takes place
9. d. Leader line
10. d. Orthographic plumbing plan
11. c. 300° to the horizontal
12. c. Eliminates the need for an offset between floors
13. d. All of the above
14. b. 1:100

Self-Test D-2.4 Organizing a Plumbing Project

Complete Self-Test D-2.4 and check your answers.

1. What is the first step in project planning for plumbing projects?
    a. Developing a schedule
    b. Defining the project scope
    c. Estimating costs
    d. Procuring materials

2. In addition to a building's shape and appearance, what do construction drawings focus on?
    a. Materials used
    b. Electrical layout
    c. Dimensions
    d. HVAC system

3. Which document generally takes priority if there is a contradiction between construction drawings and specifications?
    a. Construction drawings
    b. Specifications
    c. Inspection reports
    d. Contractor notes

4. The sequence of operation in plumbing projects typically requires how many phases of AHJ inspection?
    a. 1
    b. 2
    c. 3
    d. 4

5. In project prioritization, tasks that MUST be done today are marked with a(n) _____.
    a. A
    b. B
    c. C
    d. D

6. Who is responsible for proper site coordination in construction projects?
    a. Subcontractors
    b. General contractor
    c. Client
    d. Equipment suppliers

7. What is the materials take-off list used for?
    a. Scheduling work phases
    b. Ordering materials
    c. Assigning workers
    d. Conducting inspections

8. What is one advantage of renting equipment for a plumbing project?
    a. Lower long-term costs
    b. Immediate availability
    c. No maintenance responsibility
    d. Increased project speed

9. Which of the following is a strategy to minimize inventory investment?
    a. Buying all materials in bulk
    b. Just-in-time delivery
    c. Storing materials off-site
    d. Using only high-cost materials

Answer Key: Self-Test D-2.4 (#chapter-answer-key-self-test-d-2-4) is on the next page.

Answer Key: Self-Test D-2.4

1. b. Defining the project scope
2. c. Dimensions
3. d. Specifications
4. c. 3
5. a. A
6. b. General contractor
7. b. Ordering materials
8. c. No maintenance responsibility
9. b. Just-in-time delivery

Self-Test D-2.5 Installing DWV Systems

Complete Self-Test D-2.5 and check your answers.

1. What workplace safety requirements must a plumber comply with while working?
    a. CSA Standards
    b. National Plumbing Code
    c. Manufacturer's regulations
    d. OHS Regulation

2. When a job-site tool needs maintaining and servicing, what source of information would a plumber refer to in order to find the proper procedures?
    a. Project specifications
    b. Manufacturer's specifications
    c. Wholesaler's recommendations
    d. OHS Regulation

3. The NPC requires that all gravity drainage piping be graded at least 1:50 in the direction of flow. What gravity drainage piping section is an exception to this requirement?
    a. 3 in. branch
    b. 3 in. building drain
    c. 3 in. fixture drain
    d. 4 in. building drain

4. How much distance from an obstruction should be maintained from a C/O for adequate use of drain cleaning equipment?
    a. 1 ft (300 mm)
    b. 2 ft (600 mm)
    c. 3 ft (900 mm)
    d. 4 ft (1,200 mm)

5. When determining the location of a cleanout fitting serving above-grade drainage piping, why is it important to consider the process being performed on the floor below?
    a. Minimizes the damage caused to sensitive equipment in the event of a blockage
    b. Minimizes the noise generated by the drain-cleaning equipment during the cleaning process
    c. Eliminates the plumber having to work in occupied spaces during the cleaning process
    d. Reduces the disruption of the building processes due to the blockage

6. During a typical DWV installation, how many tests are performed on the system?
    a. 2
    b. 3

c. 4
d. 5

7. What factors usually determine the type of roof flashings used when installing a vent terminal?
   a. Snow loading
   b. Rainfall intensity
   c. Roof slope and cladding material
   d. Directional orientation

8. When placing a sleeve through a concrete wall for the future installation of a DWV piping section, how much larger should the ID of the sleeve be compared to the OD of the DWV piping?
   a. 1 in. (25 mm)
   b. 2 in. (50 mm)
   c. 3 in. (75 mm)
   d. 4 in. (100 mm)

9. When a fire-stopping material is said to be intumescent, what property does it have?
   a. Shrinks when cooled
   b. Expands when cooled
   c. Shrinks when heated
   d. Expands when heated

10. What type of device is used to fire-stop plastic DWV penetrations when a relatively large annular space is present?
    a. Mortar mix
    b. Fire collar
    c. Intumescent caulking
    d. Fire flashing

11. What is the most common test for DWV piping systems?
    a. Smoke test
    b. Ball test
    c. Air test
    d. Water test

12. What must be checked when receiving hazardous products?
    a. Quantity
    b. Colour
    c. Labels
    d. Price

13. What should be done with construction waste?

a. Sort before disposal
b. Label properly
c. Reduce quantity
d. Plan for recycling and reuse

Answer Key: Self-Test D-2.5 (#chapter-answer-key-self-test-d-2-5) is on the next page.

Answer Key: Self-Test D-2.5

1. d. OHS Regulation
2. b. Manufacturer's specifications
3. d. 4 in. building drain
4. c. 3 ft (900 mm)
5. a. Minimizes the damage caused to sensitive equipment in the event of a blockage
6. b. 3
7. c. Roof slope and cladding material
8. b. 2 in. (50 mm)
9. d. Expands when heated
10. b. Fire collar
11. d. Water test
12. c. Labels
13. d. Plan for recycling and reuse

D-3 INSTALL STORM DRAINAGE SYSTEMS

Plumber Apprenticeship Program – Level 2

D-3 Storm Drainage Systems Introduction

Storm drainage systems collect and transport rainwater to municipal or home collection locations for recycling or dispersing back into the water cycle.

Learning Objectives

After completing the chapters in this section, you should be able to:

- Describe the terminology and functions of a storm drainage system
- Describe code requirements for a storm drainage system
- Describe the planning of layouts for a storm drainage system
- Describe the installation of storm drainage systems

Resources

You will be required to reference the most current National Plumbing Code.

Terminology

The following terms will be used throughout this section. A complete list of terms for this section can be found in the **Glossary**.

Please also see the separate list of NPC Definitions for DWV Systems in Section D-3.1.

- **15-minute rain event:** A standard time frame used to express storm drainage load calculations, based on the volume of rainfall (in litres) expected over a 15-minute period. This metric helps determine appropriate pipe sizing. (Section D-3.3)
- **berm**: A raised area of soil that is typically built along the edge of a trench or drain to hold back water, directing it into the drain for proper collection and drainage. (Section D-3.7)
- **catch basin:** A ground-level stormwater collection point, often found in paved areas, that traps debris like

leaves before directing rainwater or stormwater into pipes for proper drainage. It has a grate on top to catch debris and prevent blockages, helping direct the water into storm sewers for discharge into natural water bodies. (Section D-3.2; Section D-3.6)

- **clamping collar**: A metal ring used to hold parts together, like a roof drain and the waterproof membrane, to make sure everything stays tightly in place and doesn't let water leak through. (Section D-3.5)
- **combined drainage piping system:** A system that carries both stormwater and wastewater in the same pipe. These systems can overflow during heavy precipitation, leading to direct discharge of untreated water into natural water bodies. (Section D-3.2)
- **corrugated steel galvanized pipe:** A type of durable, ribbed metal piping commonly used in stormwater systems such as culverts or detention systems. It must be joined with couplings that align pipes, resist separation, and prevent root or debris infiltration. (Section D-3.3)
- **curtain drain**: A French drain installed across a slope to intercept and drain water away from sensitive areas, such as septic disposal fields, reducing water accumulation and lowering the water table. (Section D-3.7)
- **deck drain:** A flat-strainer drain used in areas like walkways or patios, similar to a roof drain but intended for horizontal surfaces other than roofs. (Section D-3.2)
- **drainage trough:** A narrow channel or trench that collects and moves water away from areas like driveways or parking lots. Made of concrete or plastic, it has a grate on top for water to flow into, helping keep the area dry and safe. (Figure 4, Section D-3.6)
- **drain tile**: A type of pipe used in drainage systems, often made of clay, that helps collect and move water from the soil, typically used around foundations. (Section D-3.7)
- **duplex system:** Two pumps in a sump, each with its own pipes and valves. Float switches inside the sump detect water levels, and a control panel automatically turns the pumps on or off. This setup ensures the system works even if one pump fails. (Section D-3.6)
- **fixture unit (FU):** A unit of measure used in sanitary drainage systems to represent the load-producing effect of a plumbing fixture. In combined systems, 1 FU = 9.1 L/15 min when total load exceeds 260 FUs. (Section D-3.3)
- **float switch:** A device that controls water levels in tanks or pumps. It has a floating part that moves with the water level, and when the water gets too high or low, it sends a signal to turn the pump on or off to keep the water at the right level. (Section D-3.6)
- **flow-control roof drain:** A roof drain designed to limit the rate at which stormwater is released into the drainage system, reducing pipe size and minimizing strain on municipal sewers during peak rainfall. Design requirements include placement limits and overflow protection. (Section D-3.2)
- **French drain**: A drainage system consisting of a trench filled with perforated pipe and clean rock, designed to direct surface water away from an area. (Section D-3.7)
- **green roof:** A rooftop covered with vegetation that absorbs rainwater, reducing runoff and providing benefits like energy efficiency and improved air quality. (Figure 5, Section D-3.8)
- **greywater:** Water that comes from sinks, showers, and washing machines in your home. It's not dirty like sewage water, but it's not clean enough to drink either. Greywater can be reused for things like watering plants or flushing toilets to help save fresh water. (Section D-3.8)
- **hydrology**: The scientific study of the movement, distribution, and management of water, including the water cycle and water resources. (Section D-3.7)
- **litres per 15 minutes (L/15 min):** The unit used to express drainage loads in storm and combined systems, aligning volume with a 15-minute rainfall time frame. Helps convert area and rainfall depth into actionable flow data. (Section D-3.3)

- **local rainfall intensity:** The amount of rain, measured in millimetres, expected to fall over a 15-minute period in a specific geographic location. This data is obtained from the National Building Code and is critical to calculating drainage loads. (Section D-3.3)
- **minimum slope**: The smallest allowable incline for drainage pipes, typically 1:50 as per regulations like the NPC. In some cases, the slope may be reduced to 1:100 for building drains at least 100 mm (4 in.) in size to match other connected drainage systems. (Section D-3.5)
- **moling**: A process in agriculture where a torpedo-shaped mandrel creates tunnels or voids in the soil without leaving a visible trench, often used to improve drainage in waterlogged fields. (Section D-3.7)
- **rainwater leader (RWL):** A vertical pipe or tubing that conveys rainwater from roof drains or gutters to the ground or stormwater disposal system. Can be installed inside or outside a building. (Section D-3.2)
- **Roof scupper (or scupper):** An exterior, box-like device or opening in a parapet or wall that collects and drains stormwater from flat roofs. Scuppers serve as emergency overflow systems to prevent water buildup when primary roof drains are blocked. They are often used in combination with parapet walls and flow-control drains. Scuppers must be located no more than 30 m (100 ft) apart and be capable of handling up to 200% of local rainfall intensity when used with flow-control systems. (Section D-3.3)
- **sheet metal leader:** A vertical exterior pipe made of sheet metal that conveys rainwater from gutters to the ground. It is permitted for use only above ground and outside a building. (Section D-3.3)
- **siphonic roof drain:** A high-capacity roof drain that uses siphonic action to drain water more quickly than traditional gravity drains, reducing the number of required drains. (Section D-3.2)
- **sub-drainage system:** (subsoil drainage system); A network of pipes or drains placed underground to collect and carry away excess water from the soil. It helps prevent flooding or water buildup by directing water to safe areas, keeping the ground dry and stable. (Section D-3.6)
- **trenchless plow**: A type of equipment used in moling that creates a narrow void or tunnel in the soil without disturbing the surface or creating a visible trench. (Section D-3.7)
- **vitreous clay pipe**: A type of pipe made from baked clay that has a smooth, hard surface, like glass. It's used in plumbing and drainage systems because it's strong, durable, and resists wear and tear from water and chemicals. (Section D-3.7)

D-3.1 Storm Drainage Terminology

Terminology

This chapter introduces the terminology used when interpreting the code regulations for storm water drainage systems in buildings. Because the terminology and sizing techniques are quite different from sanitary drainage, the ability to interpret the National Plumbing Code (NPC) is vital.

NPC Definitions for DWV Systems

Much of the terminology associated with storm drainage systems is provided in the NPC.

authority having jurisdiction (AHJ): the governmental body responsible for enforcing any part of the British Columbia Plumbing Code.

clearwater waste: wastewater with impurity levels that will not be harmful to health and may include cooling water and condensate drainage from refrigeration and air-conditioning equipment and cooled condensate from steam heating systems but does not include storm water.

combined building drain: a building drain intended to conduct sewage and storm water.

combined building sewer: a building sewer intended to conduct sewage and storm water.

combined sewer: a sewer intended to conduct sewage and stormwater.

leader (rainwater leader or RWL): a pipe installed to carry stormwater from a roof to a storm building drain, sewer, or other place of disposal.

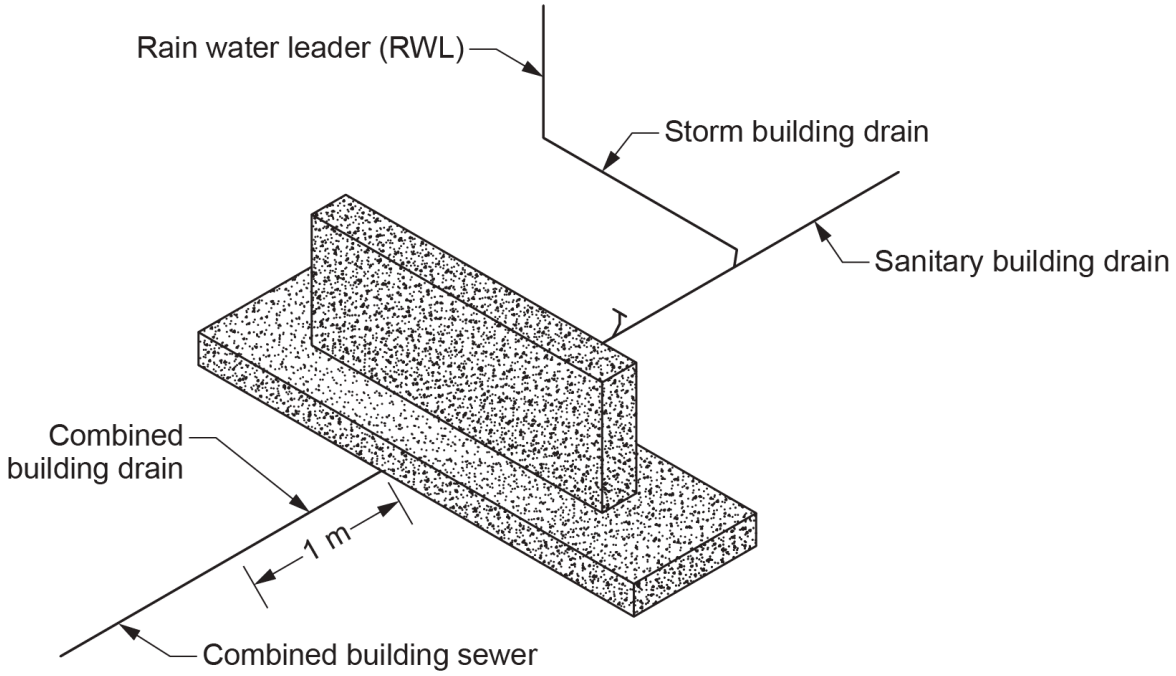


Figure 1 *Combined drainage terminology. (Skilled Trades BC, 2021) Used with permission.*

rainfall intensity: the quantity of rainfall related to a unit of time. For the purposes of the NPC, rainfall intensity is expressed in mm/15 min.

roof drain: a fitting or device installed in the roof to allow stormwater to discharge into a leader (Figure 2).

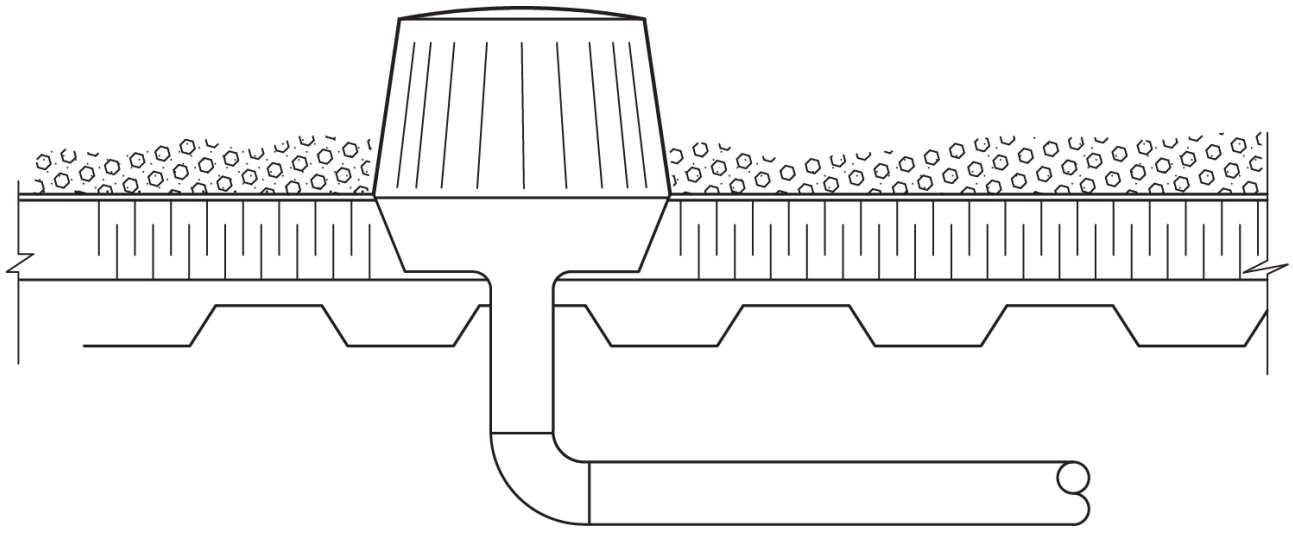


Figure 2 *Roof drain serving flat surface. (Skilled Trades BC, 2021) Used with permission.*

Roof gutter: an exterior channel installed at the base of a sloped roof to convey stormwater (Figure 3).

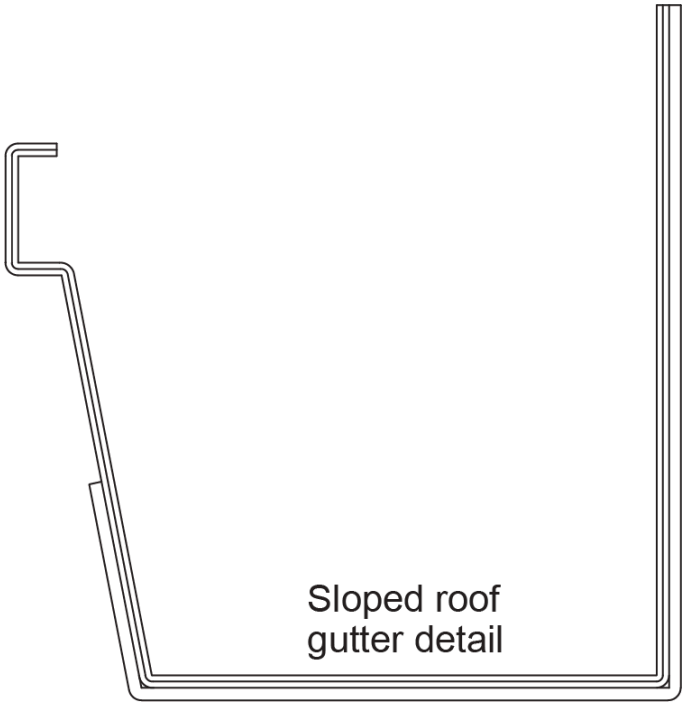


Figure 3 *Roof gutter serving sloped surface. (Skilled Trades BC, 2021) Used with permission.*

storm building drain: a building drain that conducts storm water and is connected at its upstream end to a leader, sump, or catch basin and at its downstream end to a building sewer or a designated stormwater disposal location.

storm building sewer: a building sewer that conveys stormwater.

storm drainage system: a drainage system that conveys stormwater.

storm sewer: a sewer that conveys stormwater.

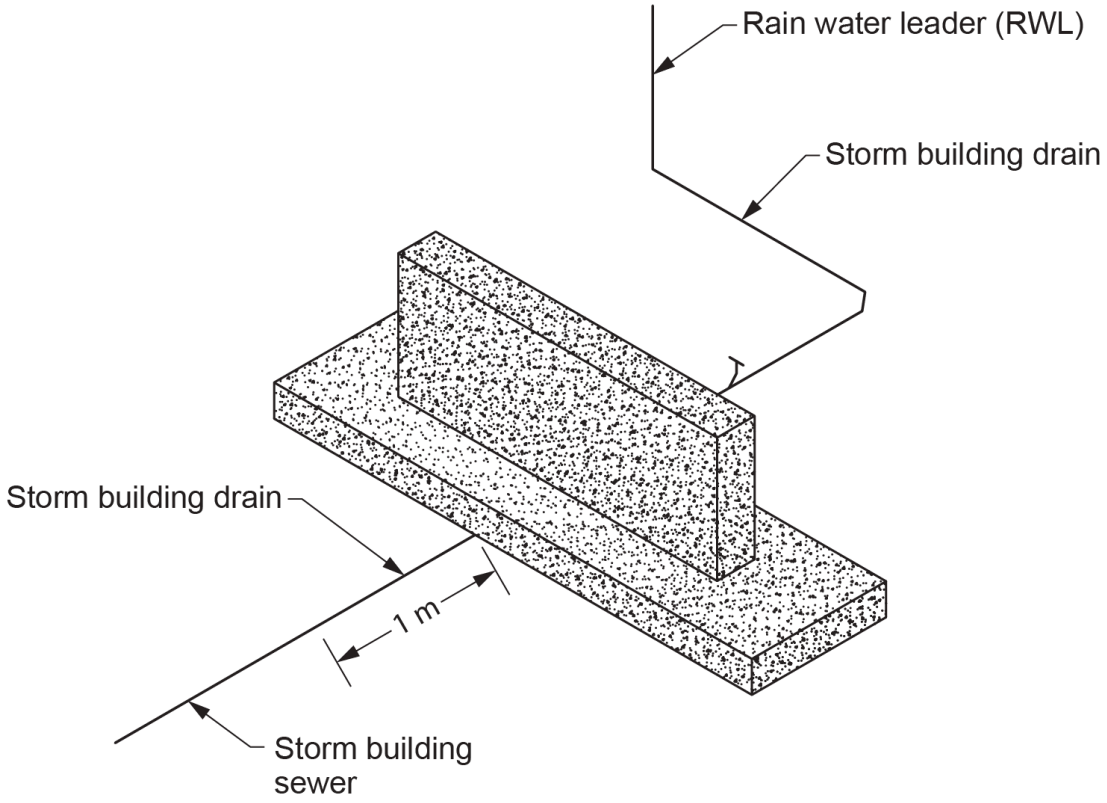


Figure 4 *Storm drainage terminology. (Skilled Trades BC, 2021) Used with permission.*

stormwater: water discharged from a surface as a result of rainfall or snowfall.

subsoil drainage pipe: a pipe installed underground to intercept and convey subsurface water (Figure 5).

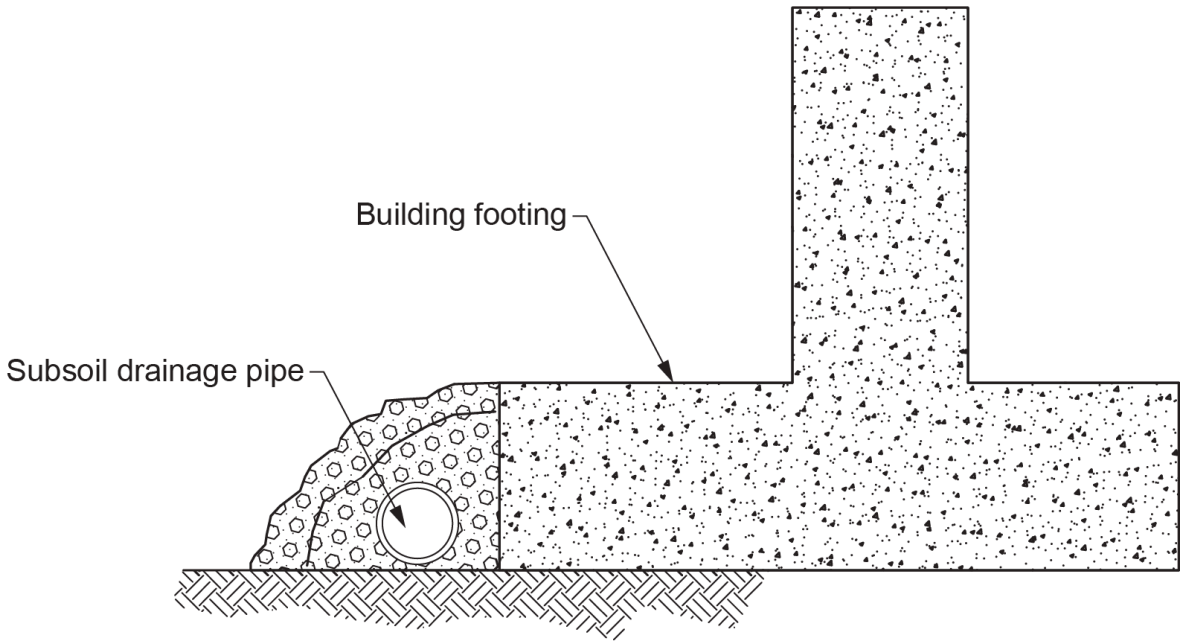


Figure 5 *Subsoil drainage pipe. (Skilled Trades BC, 2021) Used with permission.*

Self Test D-3.1: Storm Drainage Terminology

Complete Self Test D-3.1 and check your answers.

If you are using a printed copy, please find Self-Test D-3.1 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

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References

Skilled Trades BC. (2021). *Book 2: Install fixtures and appliances, install sanitary and storm drainage systems.* Plumber apprenticeship program level 2 book 2 (Harmonized). Crown Publications: King's Printer for British Columbia.

Trades Training BC. (2021). D-3: Install storm drainage systems. In: *Plumber Apprenticeship Program: Level 2.* Industry Training Authority, BC.

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D-3.2 Functions of Pipes in Storm Drainage Systems

A storm drainage system is composed of storm water collection devices and the associated piping connected to the collection devices that transport the stormwater to an approved disposal location. This chapter describes the array of stormwater collection devices utilized and their function in the system.

Parts and Function

Roof drain: a drain installed through the roof deck or slab. It is generally a circular body made of cast iron with a dome-type strainer that receives stormwater on all sides of the drain. Roof drains are also available in spun copper (Figure 1) or aluminum styles that may or may not be furnished with strainers. Whenever you install a flat roof drain, ensure that strainers or domes are in place to prevent debris and other potential obstruction elements from getting into the drainage system.

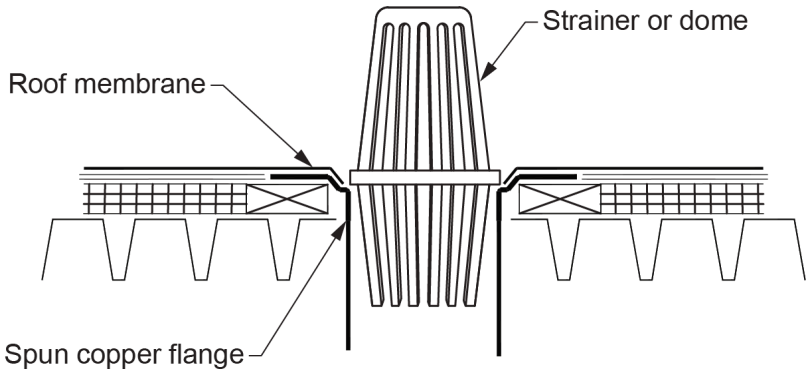

Figure 1 *Spun copper roof drain with stainer. (Skilled Trades BC, 2021) Used with permission.*

Flow-control roof drain: used to drain the roof at a controlled rate. Excess water is allowed to accumulate on the roof under controlled conditions. The water then drains off at a lower flow rate after a rain event. The roof must be structurally designed to temporarily store the maximum amount of water without overloading during periods of heavy rainfall.

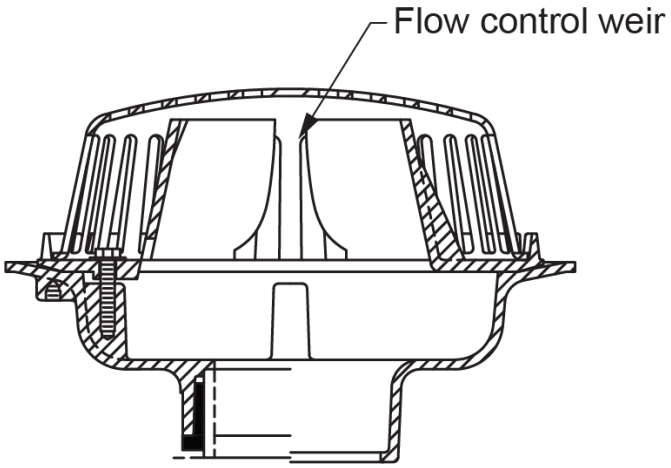

Figure 2 *Flow-control roof drain. (Skilled Trades BC, 2021) Used with permission.*

Siphonic roof drain: a drain designed to operate at full pipe capacity, which creates a siphonic condition. The siphonic condition allows water to drain faster than using conventional gravity roof drains. Because of the flow rates generated, a minimal number of roof drains are required, and they can be connected into a single rain leader.

Rainwater leaders (RWL): may be attached to the outside wall of a building or located within a building. They may be a sheet metal leader, a non-circular tubing material, or a pipe (Figure 3).

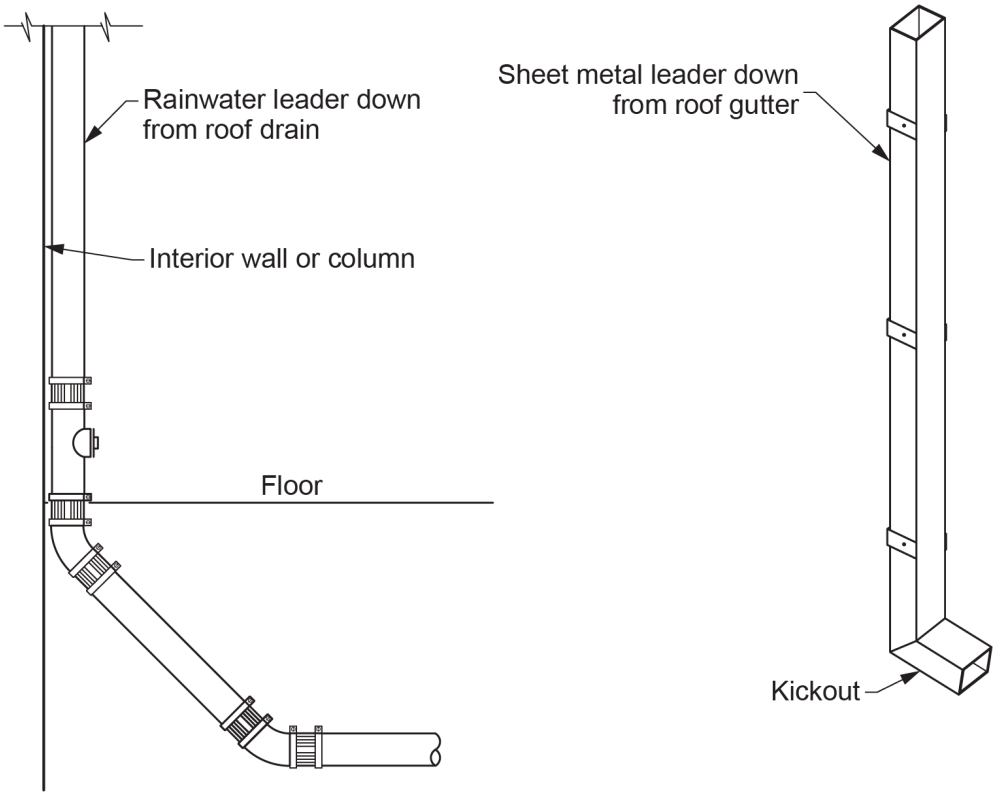

Figure 3 *Interior and exterior rainwater leaders. (Skilled Trades BC, 2021) Used with permission.*

Deck drain: a drain similar in all respects to a roof drain except that it generally has a flat strainer and is located in an area such as a walkway (Figure 4).

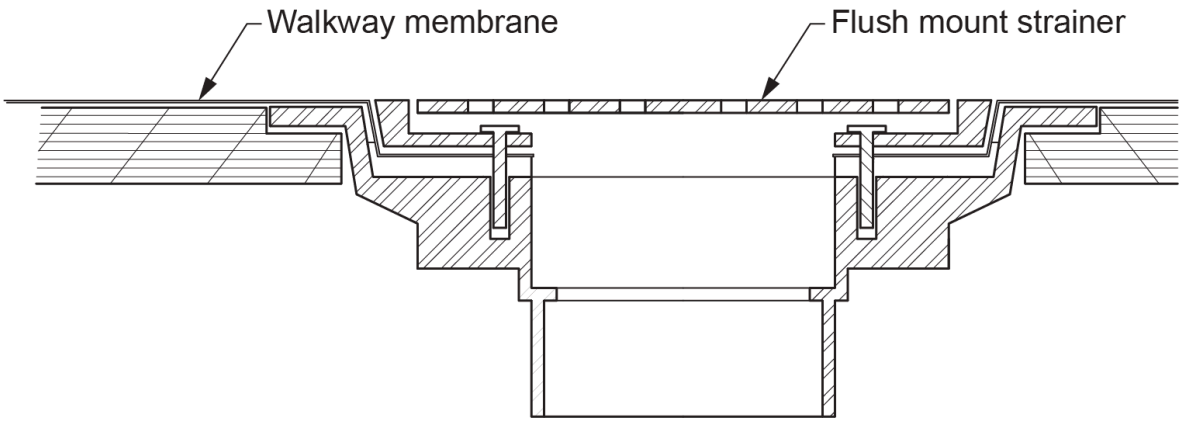

Figure 4 *Walkway deck drain. (Skilled Trades BC, 2021) Used with permission.*

Roof gutter: a collection device attached along the entire lower side of a pitched roof. Typically constructed of aluminum or steel with a corrosion-resistant coating and terminating at an external leader.

Roof scupper: a box-like collection device located on the exterior of a building and that receives stormwater on one side (Figure 5). Emergency scuppers are designed as overflow protection on flat roofs and are typically installed in conjunction with flow-control roof drains and parapet walls.

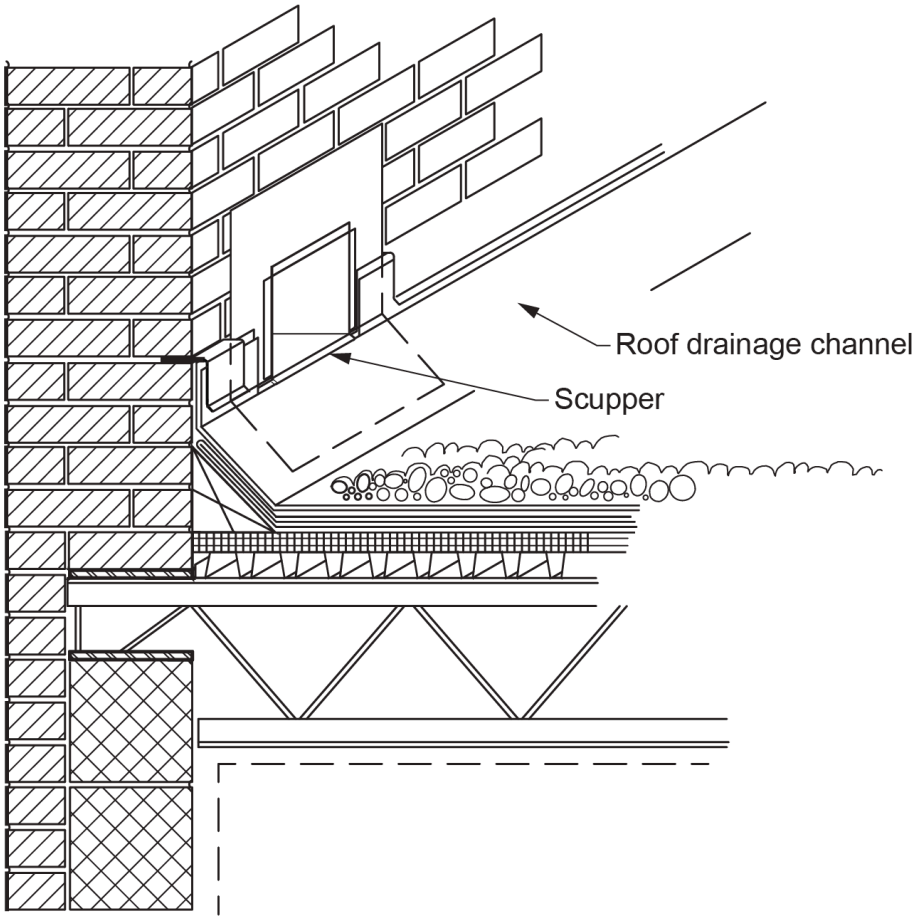

Figure 5 *Roof scupper. (Skilled Trades BC, 2021) Used with permission.*

Catch basin: a part of a storm drainage system used to drain paved areas, such as parking lots. Catch basins lead to storm sewers, which release the untreated water through outfalls directly into nearby streams or rivers. It is designed to trap debris to prevent it from entering the drainage pipes (Figure 6).

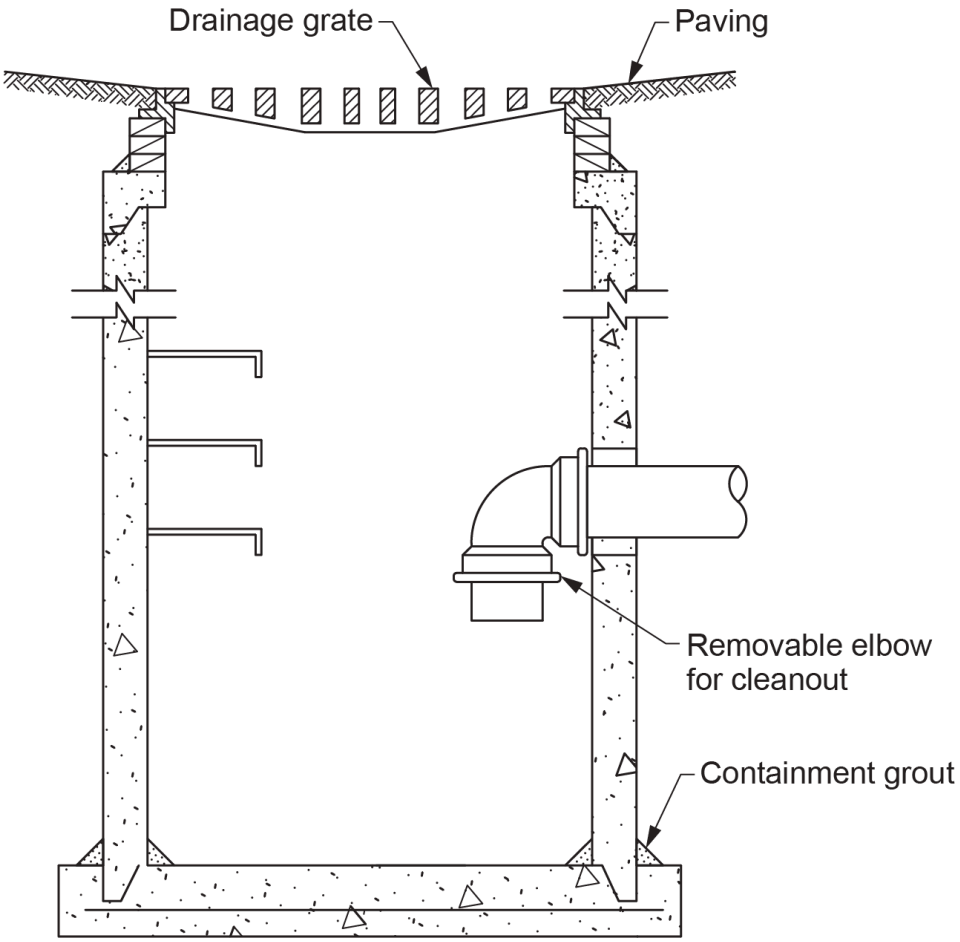

Figure 6 *Catch basin serving paved area. (Skilled Trades BC, 2021) Used with permission.*

Storm drainage piping systems: may be designed for gravity or pumped flow to a point of discharge. The AHJ regulates the discharge rate for stormwater systems according to a municipal stormwater management strategy.

Combined drainage piping systems: designed to collect both storm drainage (rainwater and snowmelt) and wastewater (sewage from homes and businesses) in the same pipe. These systems have serious drawbacks because during periods of heavy rainfall or snowmelt, the additional volume in a combined sewer system can exceed the capacity of the sewer system.

Although most jurisdictions have replaced or are replacing these systems with dedicated sewer systems for storm and sanitary drainage, there are existing systems that have not been converted. If this situation exists, some jurisdictions employ combined sewer overflows (CSOs). CSOs are designed to overflow and discharge the excess flow directly to a predetermined disposal area, such as a river, without reaching the sewage treatment plant.

Self-Test D-3.2: Functions of Pipes in Storm Drainage Systems

Complete Self-Test D-3.2 and check your answers.

If you are using a printed copy, please find Self-Test D-3.2 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

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References

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D-3.3 Storm Drainage Code Requirements

The National Plumbing Code (NPC) has established a minimum acceptable standard for the design and installation of storm and combined drainage systems. Because sanitary drainage systems were studied in Section E-1 of this series, this chapter will only focus on the sections of the NPC that deal with storm and combined drainage systems.

Piping Types

Piping materials used to construct an interior storm drainage system must be acceptable to the AHJ and the Code. Exposed leaders or downspouts should be capable of withstanding all anticipated abuses, corrosion, weather, and expected expansion and contraction. The piping may be the same material approved for sanitary drainage whether it is installed in any of the following ways:

- Above ground inside the building
- Underground under the building
- As a building sewer

The following are exceptions to the piping material approved for sanitary drainage.

Corrugated Steel Galvanized Pipe

Corrugated steel galvanized pipe is typically used in a variety of applications, such as culverts, stormwater detention systems, and storm sewers. Couplings for corrugated steel pipe shall be constructed so that, when installed, they:

- Maintain the pipe alignment
- Resist the separation of adjoining lengths of pipe
- Prevent root penetration
- Prevent the infiltration of surrounding material

Application

Table 1: Corrugated Steel Galvanized Pipe Application

Drainage System			Venting System	
Above Ground Inside Building	**Underground Under Building**	**Building Sewer**	**Above Ground**	**Underground**
N	N	P (only as a storm sewer)	N	N

Sheet Metal Leaders

A **sheet metal leader** shall not be used except above ground outside a building.

Piping Identification

The NPC requires that every length of pipe and every fitting have cast, stamped, or indelibly marked on it the maker's name or mark as well as the weight, class, or quality of the product. It must also be marked in accordance with the relevant standard. These **pipe markings** must be visible after installation.

Size

Rainwater leaders, storm and combined building drains, and storm and combined building sewers are all part of the storm drainage system. To size the above-mentioned piping sections, you must understand that the load to consider is measured in litres (L). For the load of litres to have any relationship to flow rate, there must be a time frame associated with it. The time frame used is a **15-minute rain event**. Even though the load on a pipe is expressed in litres, it really means it is litres per 15 minutes (L/15 min).

This 15-minute time frame is associated with climatic data listed in the National Building Code. This document lists different geographical locations and their **local rainfall intensity**. The rainfall intensity is the depth of water, in millimetres, received during a rain event over a 15 minute period, expressed as mm/15 min.

Determining the Drainage Load for a Flat Surface

To calculate the load in litres per 15 minutes from a roof or paved surface, we must know the area being drained. The area will be expressed in square metres (m^2). The question is, how do the area of a roof and the rainfall intensity relate to a load in litres per 15 minutes?

Figure 1 shows a roof surface with a roof drain in the centre. The area of the surface being served by the roof drain is 1 m^2.

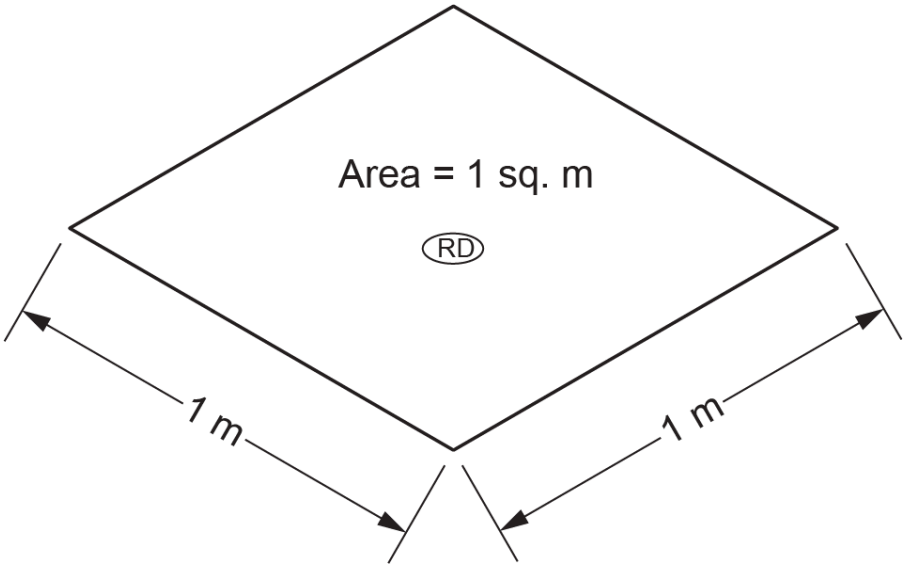

Figure 1 *1 m^2 roof surface. (Skilled Trades BC, 2021) Used with permission.*

If the surface had a water depth of one mm, the resulting volume would be one litre. Why is that? Well, we must know that:

- The area measurement, one square metre (m^2), contains one million mm^2:

$$1000\ \text{mm} \times 1000\ \text{mm} = 1000000\ \text{mm}^2$$

- The volumetric measurement, one litre, contains one million mm^3 of volume:

$$1000\ \text{mm} \times 1000\ \text{mm} \times 1\ \text{mm} = 1000000\ \text{mm}^3$$

If the depth were 2 mm, then the volume of water on the surface would be 2 L, and so on. If this roof were located in Burnaby, BC, which has a rainfall intensity of 10 mm/15 min, then it could be deduced that the 1 m^2 surface area and the associated roof drain would receive 10 L of flow in 15 minutes.

To find the load for any drained surface expressed in litres per 15 minutes, simply multiply the area in m^2 by the rainfall intensity in millimetres per 15 minutes.

Example

Figure 2 shows a $12\ \text{m} \times 12\ \text{m}$ roof

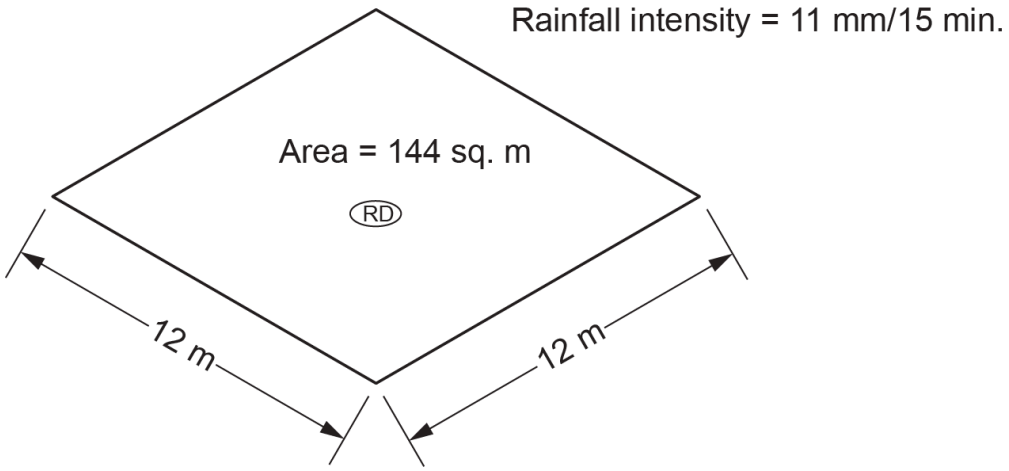

Figure 2 *Roof surface 12 m x 12 m. (Skilled Trades BC, 2021) Used with permission.*

Solution

1. Calculate the area of the roof surface:

$$12\ \text{m} \times 12\ \text{m} = 144\ \text{m}^2$$

2. Find the rainfall intensity given on the drawing:

$$11\ \text{mm}/15\ \text{min}$$

3. Determine the load on the roof drain:

$$144\ \text{m}^2 \times 11\ \text{mm}/15\ \text{min} = 1584\ \text{L}$$

Determining the Drainage Load for a Flat Surface With an Adjoining Wall

When determining the hydraulic load on the storm system from a roof with an adjoining wall, the calculation for the flat surface is the same as above (roof area x rainfall intensity). The NPC requires that the area of the wall be considered as well but not the whole wall; only one-half of the wall area must be considered when determining the effective area served by the roof drain.

Example

In Figure 3, a vertical adjoining wall has been added to our previous example. What is the load served by the roof drain?

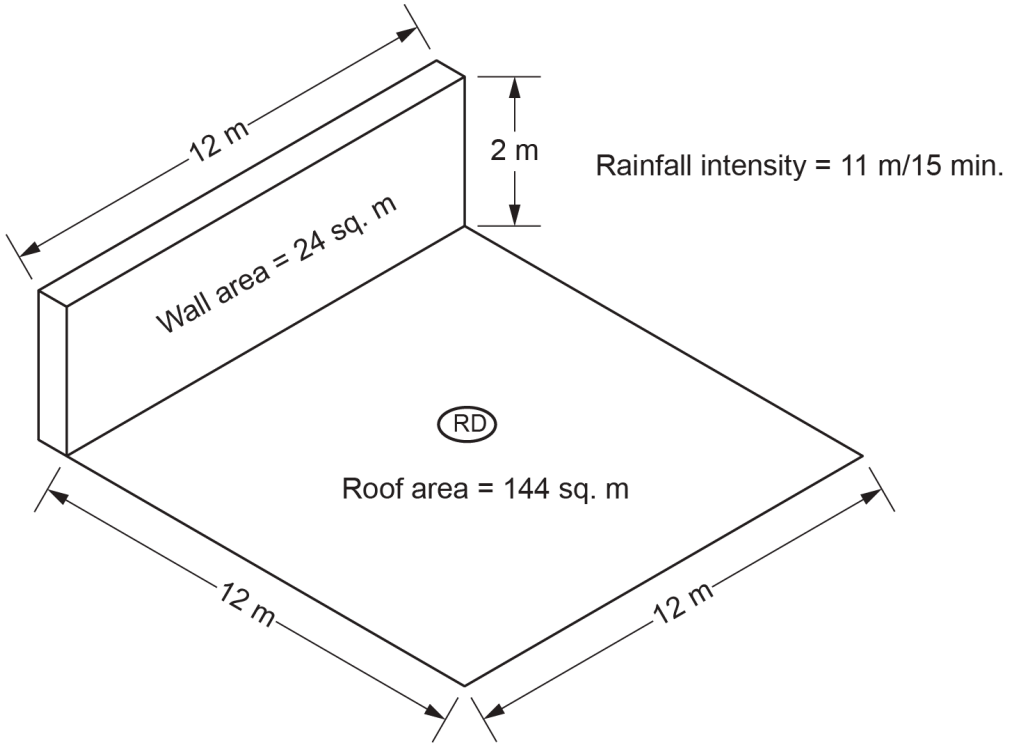

Figure 3 *Flat roof with vertical adjoining wall. (Skilled Trades BC, 2021) Used with permission.*

Solution

1. Calculate the area of the roof surface:

$$12\ \text{m} \times 12\ \text{m} = 144\ \text{m}^2$$

2. Calculate the area of the wall surface and divide by 2 (one-half):

$$12\ \text{m} \times 2\ \text{m} = 24\ \text{m}^2 \div 2 = 12\ \text{m}^2$$

3. Calculate the total effective area served by the roof drain:

$$144\ \text{m}^2\ (\text{roof}) + 12\ \text{m}^2\ (\text{wall}) = 156\ \text{m}^2$$

4. Find the rainfall intensity given on the drawing:

$$11\ \text{mm}/15\ \text{min}$$

5. Determine the load on the roof drain:

$$156\ \text{m}^2 \times 11\ \text{mm}/15\ \text{min} = 1716\ \text{L}$$

When determining the hydraulic load to the storm system from a roof with two or more adjoining walls, the NPC requires that only one-half of the largest adjoining wall area be considered.

Example

In Figure 4, a roof drain serves a flat roof surface and two vertical adjoining walls. Only half the area of the largest wall will be considered in our calculations, as the other wall will be ignored. The location of the installation has a rainfall intensity of 9 mm/15 min. What is the load served by the roof drain?

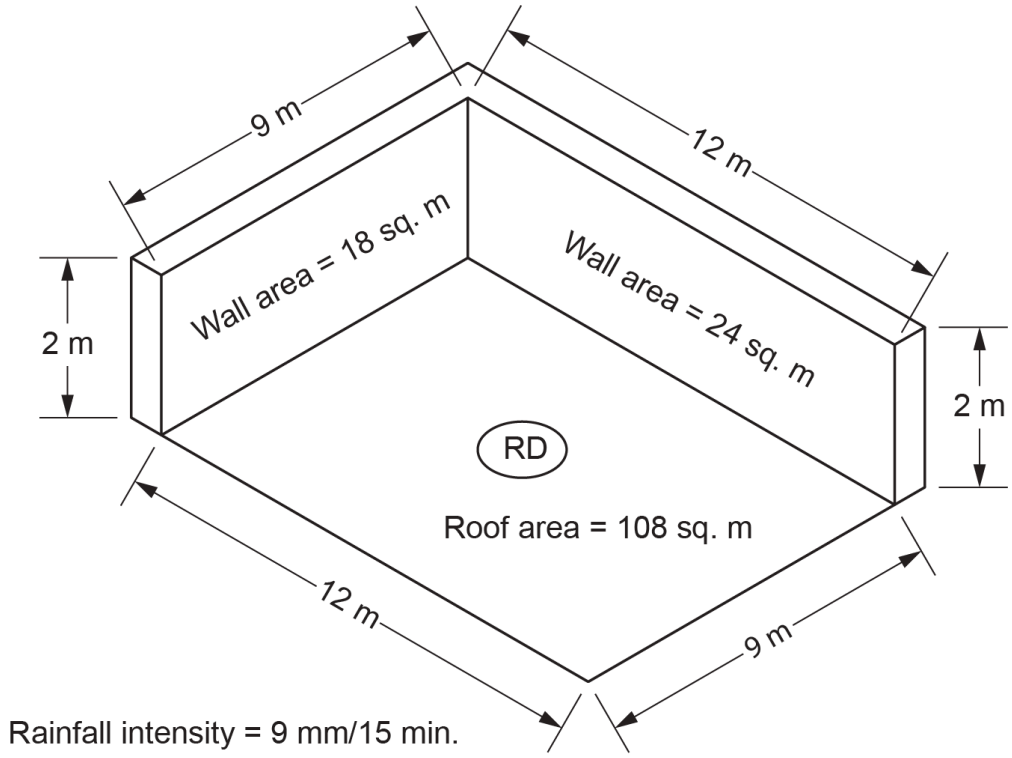

Figure 4 *Flat roof with two vertical adjoining walls. (Skilled Trades BC, 2021) Used with permission.*

Solution

1. Calculate the area of the roof surface:

$$9\ \text{m} \times 12\ \text{m} = 108\ \text{m}^2$$

2. Calculate the area of the largest wall surface and divide by 2 (one-half):

$$12\ \text{m} \times 2\ \text{m} = 24\ \text{m}^2 \div 2 = 12\ \text{m}^2$$

3. Calculate the total effective area served by the roof drain:

$$108\ \text{m}^2\ (\text{roof}) + 12\ \text{m}^2\ (\text{wall}) = 120\ \text{m}^2$$

4. Find the rainfall intensity given on the drawing:

$$9\ \text{mm}/15\ \text{min}$$

5. Determine the load on the roof drain:

$$120\ \text{m}^2 \times 9\ \text{mm}/15\ \text{min} = 1080\ \text{L}$$

Determining the Load From an Appliance That Produces Semi-continuous or Continuous Flow

Fixtures and appliances that discharge semi-continuous or continuous flow are allowed to drain to either sanitary or storm drainage systems. The one stipulation is that only fixtures or appliances that discharge clearwater waste may drain to a storm drainage system. Recall from Section D-1 that when a fixture with semi-continuous or continuous flow drains to a sanitary drainage system, the flow rate from that fixture is expressed in litres per second is multiplied by 31.7 to find the hydraulic load, expressed in **fixture units (FUs)**, imposed on the sanitary system by that fixture. Also, the size of the trap serving that flow was sized from Table 2.4.10.12. based on the flow rate, in litres per second, from that fixture. The reason we had to convert between a flow rate in litres per second to fixture units is that all sanitary drainage piping uses fixture units as the measurement for hydraulic load.

In storm and combined drainage systems, the unit of measure for hydraulic load is litres per 15 minutes. Because of this, when connecting a semi-continuous or continuous flow appliance with a flow rate expressed in litres per second to a storm or combined drainage system, another conversion must be used. To accomplish this, as stated in Clause 2.4.10.3.(2), simply multiply the flow rate (L/s) by 900 (number of seconds in 15 minutes) to get a hydraulic load in the proper format (L/15 min) for sizing the storm or combined system.

Example

What would be the hydraulic load imposed on a storm or combined drainage system when the flow rate from the fixture or appliance is 0.35 L/s?

Solution

Convert the flow rate in L/s to L/15 min:

$$0.35\ \text{L/ s} \times 900\ \text{s}/15\ \text{min} =\ \text{L}/15\ \text{min}\ 0.35 \times 900 = 315\ \text{L}/15\ \text{min}$$

Figure 5 compares the hydraulic loads when connecting an identical appliance to both a SOWS and an RWL. Pay special attention to the size of the RWL downstream of the appliance connection and why its size must be larger than required by the code tables.

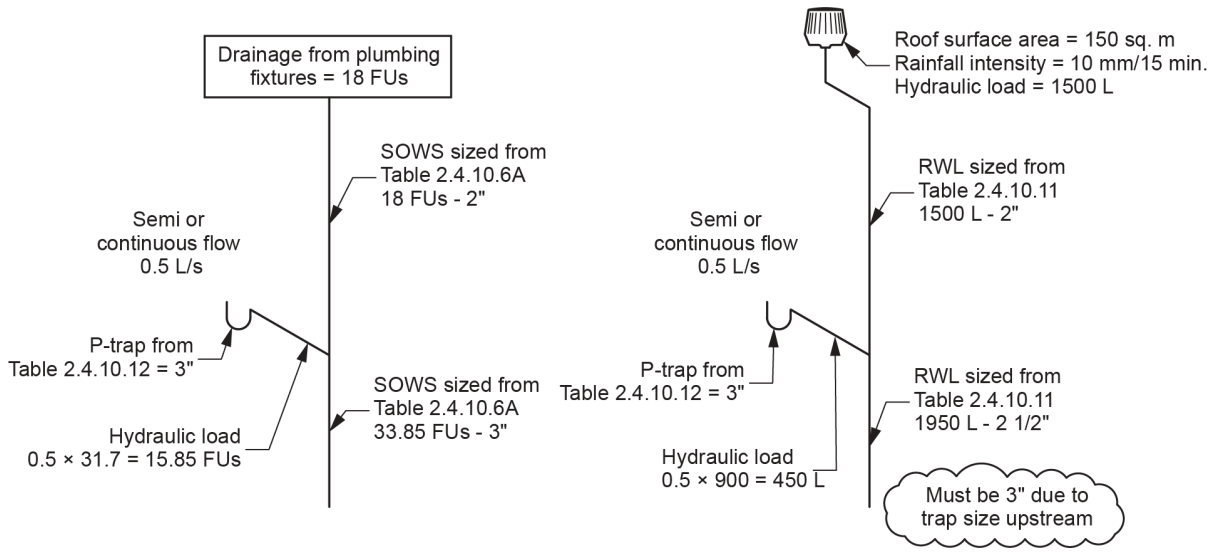

Figure 5 *A comparison of a semi-continuous or continuous fixture or appliance draining to storm and sanitary. (Skilled Trades BC, 2021) Used with permission.*

NPC Sizing Tables

Sizing pipe for a storm or combined drainage system is a relatively straightforward process once you are familiar with the tables provided in the NPC book. These tables provide the minimum size of all drainage pipes based on the load, in litres, it can carry for any particular size. Remember that the load on any pipe section is the load draining to it from upstream.

Because there are different tables for sizing leaders, gutters, and building drains/sewers, you must be able to properly identify the proper table for the pipe section you are sizing.

The following tables are the ones you will need to refer to.

Table 2.4.10.9. — Maximum Permitted Hydraulic Load Drained to a Storm Building Drain or Sewer or a Combined Building Sewer

The storm or combined building drain conducts flow from the furthest point upstream and terminates 1 m outside the foundation. At this point, the storm or combined building sewer is established and conducts the flow to an approved disposal system. To determine the size of any portion of the storm or combined building drain or the storm or combined building sewer, you must know the drainage load in litres (L) and the pipe grade. Notice that for any pipe size, the load-carrying capacity of the pipe increases as the grade is increased.

Table 2: (Table 2.4.10.9.) Maximum Permitted Hydraulic Load Drained to a Storm Building Drain or Sewer or a Combined Building Sewer

Size of Drain or Sewer (in.)	Maximum Hydraulic Load (L)						
	Slope						
	1 in 400	1 in 200	1 in 133	1 in 100	1 in 68	in 50	1 in 25
3	N/A	N/A	N/A	N/A	N/A	2,770	3,910
4	N/A	N/A	N/A	4,220	5,160	5,970	8,430
5	N/A	N/A	6,760	7,650	9,350	10,800	15,300
6	N/A	N/A	10,700	12,400	15,200	17,600	24,900
8	N/A	18,900	23,200	26,700	32,800	37,800	53,600
10	N/A	34,300	41,900	48,500	59,400	68,600	97,000
12	37,400	55,900	68,300	78,700	96,500	112,000	158,000
15	71,400	101,000	143,000	143,000	175,000	202,000	287,000

Table 2.4.10.10. — Maximum Permitted Hydraulic Load Drained to a Roof Gutter

To use this table, you need the load on the sloped roof as determined by its effective area and local rainfall intensity. Once the load has been determined, the slope of the gutter, in the direction of flow, becomes a determining factor. Once the slope ratio has been determined, the size of the gutter can be found in the column on the right side of the table. **Gutter sizing** and installation are not normally performed by plumbers. Gutter installation companies take care of gutters and external leaders.

Table 3: (Table 2.4.10.10.) Maximum Permitted Hydraulic Load Drained to a Roof Gutter

Size of Gutter (in.)	Area of Gutter (cm^2)	Maximum Hydraulic Load (L)			
		Slope			
		1 in 200	1 in 100	1 in 50	1 in 25
3	22.8	406	559	812	1,140
4	40.5	838	1,190	1,700	2,410
5	63.3	1,470	2,080	2,950	4,170
6	91.2	2,260	3,200	4,520	6,530
7	124.1	3,250	4,600	6,500	9,190
8	162.1	4,700	6,600	9,400	13,200
10	253.4	8,480	12,000	17,000	23,600

Table 2.4.10.11. — Maximum Permitted Hydraulic Load Drained to a Leader

To use this table, you need to calculate the load on the leader, as determined by the effective area drained and local rainfall intensity. Once the load has been determined, you have a leader material choice between circular (pipe) and non-circular (downspout). Now, follow the appropriate column down to the calculated load's range to determine the leader's size.

Table 4: (Table 2.4.10.11.) Maximum Permitted Hydraulic Load Drained to a Leader

Circular Leader		Non-Circular Leader	
Size of Leader (in.)	Maximum Hydraulic Load (L)	Area of Leader (cm^2)	Maximum Hydraulic Load (L)
2.5	3,070	31.6	2,770
3	5,000	45.6	4,500
4	10,800	81.1	9,700
5	19,500	126.6	17,600
6	31,800	182.4	28,700
8	68,300	324.3	61,500

Table 2.4.10.12. — Maximum Permitted Hydraulic Load From Fixtures With a Semi-continuous Flow

Sometimes, we need to size a trap serving a clearwater-waste–producing appliance that drains to a leader. When the flow is continuous or semi-continuous and expressed in litres per second (L/s), we can use that flow rate to find the minimum trap size in this table.

Table 5: (Table 2.4.10.12.) Maximum Permitted Hydraulic Load From Fixtures With a Semi-continuous Flow

Trap Size (in.)	Flow Rate (L/s)	Hydraulic Load (FUs)
1.5	0.00–0.090	3
2	0.091–0.190	6
3	0.191–0.850	27
4	0.851–5.700	180

Sizing Procedures

When sizing storm and combined drainage systems, there are three different hydraulic load that could contribute to the process:

- Sanitary drainage from plumbing fixtures, expressed in FUs
- Storm drainage from roofs and paved surfaces, expressed in **litres per 15 minutes**
- Combined storm and sanitary drainage, expressed in litres per 15 minutes

The sizing process is best described by examining the hydraulic load contributors individually.

Sizing Sanitary Drainage

This process was described in detail in Section E-1, so we will not dwell on this subject. It is important to note that

the hydraulic load generated by the sanitary system will become important later when we size the combined drainage system.

Sizing Storm Drainage

This process is relatively straightforward once the hydraulic load has been determined. The steps to follow are:

1. Determine the effective area in m^2 of roofs and paved surfaces.
2. Determine the local rainfall intensity (millimetres per 15 minutes of rainfall) found in the National Building Code.
3. Multiply the effective area by the rainfall intensity to obtain the hydraulic load in litres per 15 minutes.

Additional loads that may be considered when sizing a storm drainage system include:

- If a clearwater waste appliance or fixture discharges a continuous or semi-continuous flow to the storm system, multiply its load in litres per second by 900 to obtain the hydraulic load in litres per 15 minutes.
- If using flow-control roof drains, compute the discharge rate based on rain intensity, retention duration, accumulation height, and roof area from the roof drain manufacturer's data.

Add all contributing hydraulic loads listed above to obtain the total hydraulic load on the storm drainage pipe in litres per 15 minutes. Then, consult the appropriate table from among Tables 2.4.10.9., 2.4.10.10., and 2.4.10.11. to select the drain, leader, or gutter size.

Storm Drainage Sizing Example

You can refer to Figure 6 to see the hydraulic load calculations in Table 6 illustrated on a map of a storm drainage system. Because there is no such thing as storm branches, all horizontal storm drainage pipes will be sized as storm building drains using the given grade ratio.

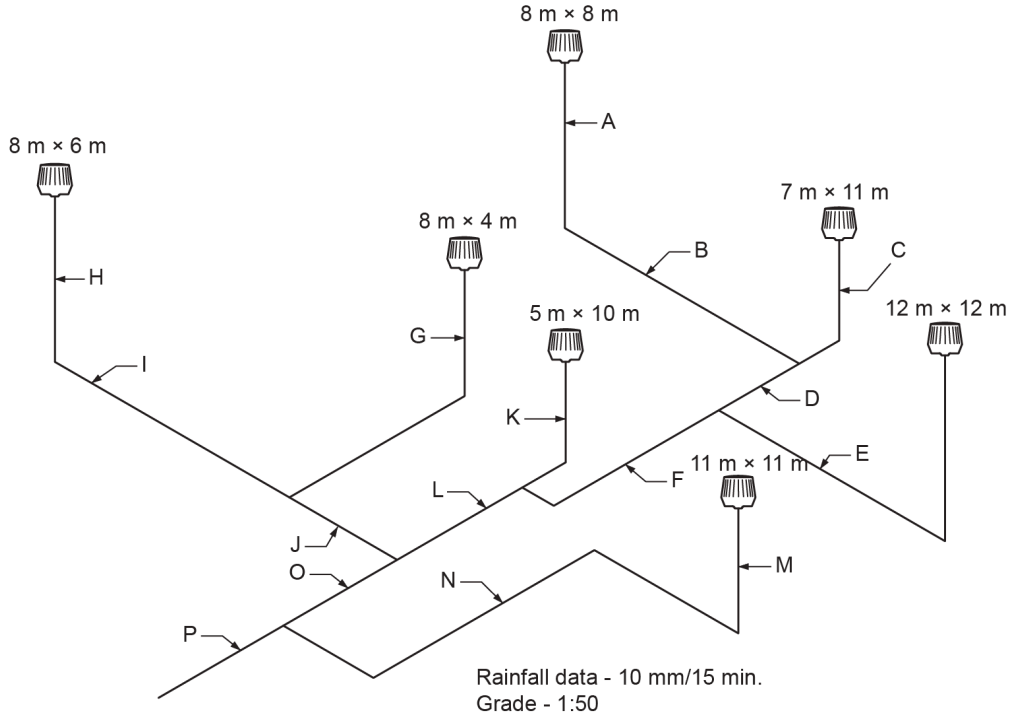

Figure 6 *Storm drainage system example. (Skilled Trades BC, 2021) Used with permission.*

Table 6: Hydraulic Load Calculations for Storm Drainage

Label	Name	Leader (m^2)	Load (L)	Size
A	RWL	64	640	2 in.
B	Storm building drain	–	640	3 in.
C	RWL	77	770	2 in.
D	Storm building drain	–	1,410	3 in.
E	Storm building drain	–	1,440	3 ft
F	Storm building drain	–	2,850	4 in.
G	RWL	32	320	2 in.
H	RWL	48	480	2 in.
I	Storm building drain	–	480	3 in.
J	–	–	800	3 in.
K	RWL	50	500	2 in.
L	Storm building drain	–	3,350	4 in.
M	RWL	121	1,210	2 in.
N	Storm building drain	–	1,210	3 in.
O	Storm building drain	–	4,150	4 in.
P	Storm building drain	–	5,360	4 in.

Sizing Combined Drainage

This process is more complex than the procedures we used in the above explanations. When sanitary drainage is connected to a combined drain or sewer, only the hydraulic load from the plumbing fixtures must be converted from fixture units to litres per 15 minutes or, in the case of continuous flow, from litres per second to litres per 15 minutes so that these loads can be added to the hydraulic loads from roofs and paved surfaces. Unfortunately, the relationship between fixture units and litres per second and, consequently, the relationship between fixture units and litres, is not easily calculated. To make the sizing process easier to navigate, the NPC has adopted an approximate conversion factor.

The conversion factor is detailed in Sentence 2.4.10.5.(1) of the NPC, which says to apply a hydraulic load of 9.1 L/15 min for each fixture unit drained to the combined drainage system. This holds true only when the total sanitary drainage load draining to any particular pipe section is greater than 260 FUs. When the load is 260 FUs or less, use a round figure of 2,360 L.

As stated earlier, when semi-continuous or continuous flow appliances or fixtures drain to combined sewers or storm sewers, the factor for converting flow of the fixture from litres per second to litres per 15 minutes is 900 (given in Sentence 2.4.10.3.[2]). This conversion factor is not an approximation but an exact calculation.

It is important to note that the conversion factors given in Sentences 2.4.10.3.(1) and 2.4.10.5.(1) are designed to convert in one direction only and must not be used to convert from fixture units to litres per second in the one instance nor from litres to fixture units in the other instance.

The sizing process for combined drainage systems requires you to determine the load on the section of pipe you are sizing and to find the pipe size from Table 2.4.10.9. in the NPC. Determining the load on any section of a combined drainage system requires the following four distinct steps.

Step 1

Determine the total load in fixture units from all upstream plumbing fixtures except semi-continuous or continuous flow appliances or fixtures draining to the sanitary system upstream. The load imposed by these fixtures or appliances will be accounted for in Step 2. If the fixture unit load exceeds 260, multiply it by 9.1 to determine the equivalent hydraulic load in litres per 15 minutes. If the fixture unit load is 260 or fewer fixture units, the hydraulic load is determined to be 2,360 L/15 min.

Note: When sizing a combined building drain, do NOT assume a 2,360 L load for each sanitary drainage load as it enters the combined drainage system. The total fixture unit load on any section must be calculated separately.

Step 2

Determine the hydraulic load in litres per second from any semi-continuous or continuous flow source connected to the sanitary or storm drainage system and multiply by 900 to get a hydraulic load in litres per 15 minutes; this is the same procedure used when sizing storm drainage pipes.

Step 3

Determine the hydraulic load (L/15 min) from roofs and paved surfaces using the same procedure employed when sizing storm drainage pipes (effective area [m^2] × rainfall intensity [mm/15 min]).

Step 4

Add the hydraulic loads calculated in Steps 1 through 3 to obtain the total hydraulic load on the combined drainage pipe in litres per 15 minutes, and then consult Table 2.4.10.9. to select the pipe size.

Storm and Combined Drainage Sizing Example

Refer to Figure 7 to see the hydraulic load calculations in Table 7 illustrated on a map of a combined drainage system. Size all horizontal pipe sections as storm, sanitary, or combined building drains using the given grade ratio.

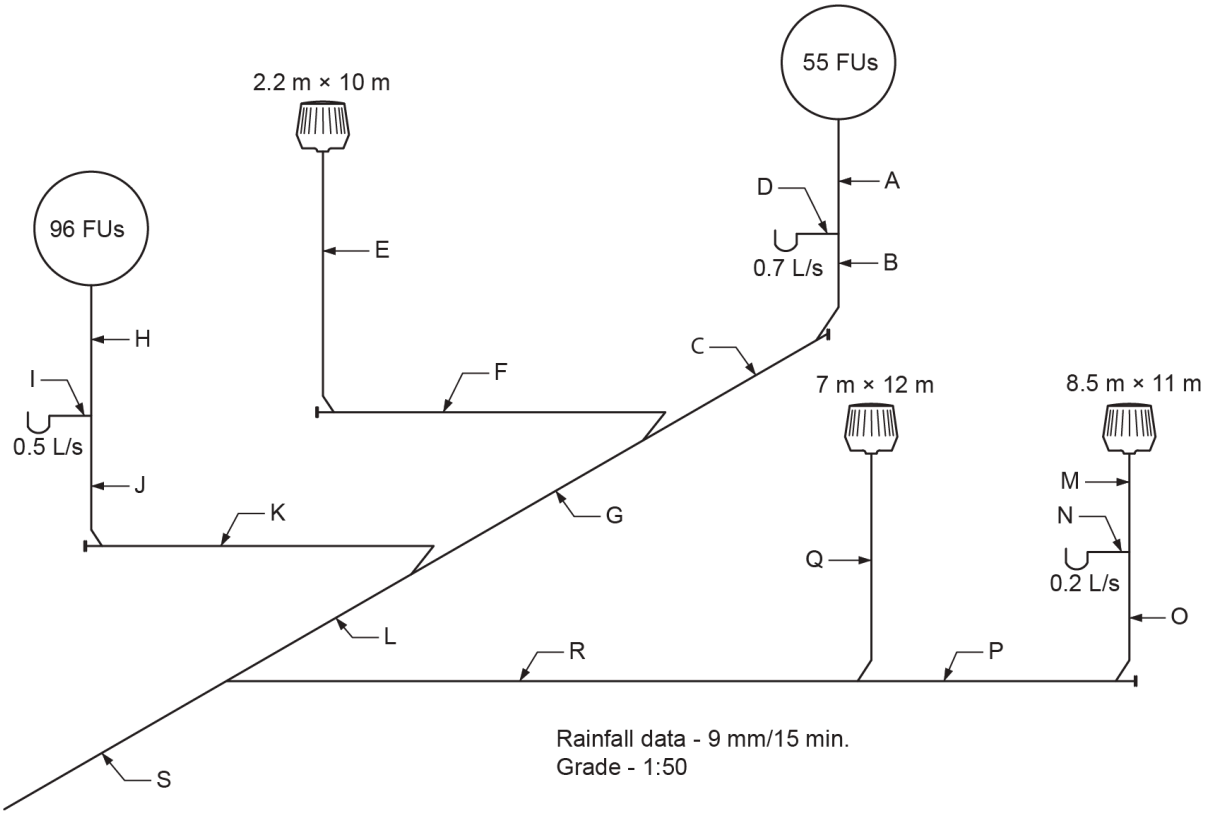

Figure 7 *Combined drainage system example. (Skilled Trades BC, 2021) Used with permission.*

Table 7: Hydraulic Load Calculations for Storm and Combined Drainage

Label	Name	Leader (m^2)	Load	Size (in.)
A	SOWS	–	55 FUs	3
B	SOWS	–	77.19 FUs	3
C	Sanitary building drain	–	77.19 FUs	4
D	Trap arm fixture drain	–	22.19 FUs	3
E	RWL	22	198 L	2
F	Storm building drain	–	198L	3
G	Combined building drain	–	3188 L Sanitary 55 FUs = 2360 L semi or cont. flow 0.7 L/s = 630 L Storm drainage = 198 L	4
H	SOWS	–	96 FUs	3
I	Trap arm fixture drain	–	15.85 FUs	3
J	SOWS	–	111.85 FUs	4
K	Sanitary building drain	–	111.85 FUs	4
L	Combined building drain	–	3638 L Sanitary 151 FUs = 2360 L semi or cont. flow 1.2 L/s = 1080 L Storm drainage = 198 L	4
M	RWL	93.5	841.5 L	2
N	Trap arm fixture drain	–	180 L	3
O	RWL	93.5	1021.5 L	3
P	Storm building drain	–	1,021.5 L	3
Q	RWL	84	756 L	2
R	Storm building drain	–	1,777.5 L	3
S	Combined building drain	–	5,415.5 L Sanitary 151 FUs = 2360 L Semi/Continous flow 1.4 L/s = 1260 L Storm drainage = 1795.5 L	4

Slopes

The slope ratio used with storm drainage systems must be steep enough to provide a flow velocity between 0.6 and 0.9 m/s to avoid excess water retention at the drain location. The NPC states that every drainage pipe with a size of 75 mm

(3 in.) or less shall have a downward slope in the direction of flow of at least one in 50 ($\frac{1}{3}$ in./ft.), with the exception of a storm and combined building drain or sewer larger than 75 mm. For example, a 100 mm (4 in.) storm building drain or storm building sewer is permitted to be sloped at 1:100 ($\frac{1}{8}$ in./ft.).

Fittings

The fittings used in storm drainage systems are the same DWV type used in sanitary drainage systems. However, expansion and contraction are a concern when a roof drain joins into a leader. The NPC requires that the roof drain be tightly connected to the leader and that provisions be made for expansion and contraction. You could accomplish this using an expansion joint or loop at the roof drain in the horizontal section of the leader to accommodate the leader's movement without affecting the roof drain.

Due to a possible surcharge condition during a high-flow event, vertical leaders should be connected to the building drain with single-wye fittings; the use of double-wye fittings should be avoided.

Orientation

Quite often, the roof drain and the leader location do not line up, and an offset is required. The NPC has certain requirements with regard to leader offsets, as stated in Clause 2.4.9.5.:

- There is no requirement to change the size of the leader with a nominally horizontal offset if the offset is located immediately under the roof and is not more than 6 m (19 ft 8 in.) long with a 1:50 minimum slope.
- If the horizontal offset is more than 6 m long, the leader shall be sized as a storm building drain using Table 2.4.10.9.

Appliance and Fixture Connections to a Storm Drainage System

In Clause 2.4.2.1.(1), the NPC states certain limitations on the type of appliances or fixtures that may drain into a storm drainage system. The items that may be connected are:

- A drinking fountain, provided that if it is subject to backflow, a **backwater valve** is installed in the drinking fountain waste pipe.
- Drainage pans from HVAC equipment, provided that if it is subject to backflow, a backwater valve is installed.
- A floor drain, provided that it is located where it can only receive clearwater waste or stormwater.

Fixture drains from the following appliances or fixtures may be directly connected to a common pipe:

- Fixtures used to display, store, prepare or process food and drinks
- Sterilizers

- Appliances that use water as heating or cooling mediums
- Water-operated devices
- Water-treatment devices
- Drains or overflows from a water or heating systems

Code states that the first two fixture types (the display case and the sterilizer) should drain into a sanitary drainage system because they are not considered clearwater waste. The following four types of fixtures could drain to either a sanitary or storm drainage system because they are considered to discharge clearwater waste.

This common pipe must be indirectly connected using an air break above the flood level rim of a fixture directly connected to a drainage system. When this provision is employed, the indirectly connected pipe must pass full-size through the roof if it receives discharge from three or more storeys.

Flow-Control Roof Drains

Controlled-flow systems collect rainwater on the roof and release the flow slowly to the drainage system. These systems can provide significant installation savings because they require smaller "flow-control" roof drains and smaller-diameter piping. These systems also reduce the impact on the sewage treatment plant from combined storm/sanitary sewer systems in locations where they are allowed.

In Clause 2.4.10.4.(2), the NPC states certain requirements when flow-control roof drains are employed and water is allowed to pond on the roof. Flow-control roof drains may be installed provided that:

- The maximum drain down time of the stored water does not exceed 24 hours.
- A structural engineer has deemed that the roof structure design is able to carry the weight of the stored water.
- The flow-control roof drains are located not more than 15 m (49 ft) from the edge of the roof and not more than 30 m (100 ft) from adjacent drains.
- There is at least one flow-control roof drain installed for every 900 m^2 (9,687 ft^2) of roof area.
- One or more overflow **scuppers** are installed along the perimetre of the building not more than 30 m (100 ft) apart. The overflow scuppers must provide protection so that up to 200% of the local 15-minute rainfall intensity can be drained, with the maximum depth of controlled water limited to 150 mm (6 in.).

Roof Drainage Emergency Overflow and Scuppers

Emergency overflow systems are referred to as secondary drainage systems and may be either scuppers, which allow the entrapped rainwater to overflow the roof, or a separately piped drainage system. The secondary piping system is installed separately from the primary system and discharged to an approved disposal point, preferably above grade, so building personnel can see that the primary drainage system is blocked.

In Clause 2.4.10.4.(2)(c), the NPC states certain regulations when installing these systems. When the height of the parapet wall is more than 150 mm (6 in.) or exceeds the height of the adjacent wall flashing, emergency roof overflows or scuppers shall be provided along with a minimum of two roof drains serving the roof. The requirements for the scupper locations and spacing are the same as the scupper requirements for flow-control roof drains, as mentioned earlier.

Prohibitions

The NPC has a number of prohibitions when installing storm drainage systems, including that it is prohibited to:

- Install a combined building drain unless it has been proven by past performance to be acceptable in some localities. If this is the case, then the installation of a combined building drain may be accepted.
- Install a sheet metal leader inside a building.
- Directly connect an overflow from a rainwater tank to a storm drainage system.
- Have a vertical soil or waste pipe conducting both sewage and stormwater.
- Have unused open ends in a drainage system, and when a dead end is provided, it must be graded so that it cannot retain water.

Traps

The NPC requires that where a storm drainage system connects to a combined building sewer or a public combined sewer, a trap, known as a building trap, shall be installed between any opening in the system and the drain or sewer. The one exception is that a trap is not required if the opening is the upper end of a leader that terminates at a roof used only for weather protection that is:

- Not less than 1 m (39 in.) above
- Not less than 3.5 m (11 ft $5\frac{4}{5}$ in.) in any other direction from any air inlet, openable window, or door
- Not less than 1.8 m (5 ft $10\frac{7}{8}$ in.) from a property line

A floor drain that drains to a storm drainage system shall be protected by a trap. The trap must be located between the floor drain and a leader, storm building drain, or storm building sewer. This single trap may serve all floor drains located in the same room and need not be protected by a vent pipe.

Where freezing conditions could cause storm drainage systems to freeze due to air circulation within the piping, a trap with a cleanout shall be installed in a heated location.

Cleanouts

The NPC has certain construction and location requirements for cleanouts serving DWV systems, as described in Section E-1. Those requirements apply to storm drainage systems as well.

As an example, every interior leader shall be provided with a cleanout fitting at the bottom of the leader, not more than 3 m (9 ft 10 in.) upstream of the bottom of the leader. This requirement is identical to the requirement for cleanouts at the base of a SOWS.

Venting

The NPC does not require venting in storm drainage systems, even if a trap is serving the system in some capacity.

Hangers and Supports

The hangers used must be compatible with the pipe they are supporting. You must use a hanger that will not be detrimental affected by corrosion on the piping. Due to the expansion and contraction effects experienced in storm drainage systems, the support system must always keep the pipe and fittings in proper alignment. A riser clamp should be provided at each floor line to support a leader. At the lower floors, all exterior leaders that may be damaged when installed in parking or truck-loading areas should be adequately supported and protected by sufficient guards.

Spacing

The NPC regulation states the maximum distance between supports and does not differentiate between storm and sanitary drainage piping. Depending upon the type of material you are using and whether the pipe is installed horizontally or vertically, the spacing between supports will vary.

Insulation

Low-temperature liquid flow in the storm interior drainage piping causes condensation to form on the outside of the piping, possibly causing stain damage to the ceilings or, where exposed, drip marks on the flooring. The NPC requires that an internal leader be insulated to protect the building interior from condensation. The insulation type and thermal properties may differ from job to job, so it is important to refer to the job specification requirements prior to installation.

Self-Test D-3.3: Storm Drainage Code Requirements

Complete Self-Test D-3.3 and check your answers.

If you are using a printed copy, please find Self-Test D-3.3 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=75#h5p-24 (https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=75#h5p-24)

References

Skilled Trades BC. (2021). *Book 2: Install fixtures and appliances, install sanitary and storm drainage systems.* Plumber apprenticeship program level 2 book 2 (Harmonized). Crown Publications: King's Printer for British Columbia.

Trades Training BC. (2021). D-3: Install storm drainage systems. In: *Plumber Apprenticeship Program: Level 2.* Industry Training Authority, BC.

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D-3.4 Planning the Storm System

Storm drain location must be coordinated with the architectural design of the building. The roof structure must be able to support the weight of **residual water** by design.

Location of Structure Penetrations

When planning the location of the roof drains, deck drains, scuppers, gutters, and rainwater leaders, consideration should be given to placing an overflow drain adjacent to each roof drain.

Scuppers are often used on flat roofs or on roofs with minimal slope for overflow protection. The amount of drainage provided by overflow drains or scuppers may be reduced on roofs that are flat or nearly flat. This is because under such circumstances, stormwater can flow to another drain before enough water can accumulate to cause damage to the structure. These overflow drains may be required by some local jurisdictions, so it is always good practice to check with the local plumbing officials. Even if the area served by a roof drain is relatively small, it is good practice to provide at least two drains in all individual roof areas.

Routing

The first step in planning a route for the storm drainage system is to find the locations of the drain outlets and their relation to interior walls and structural columns. This will help you determine the space available for installing the leaders. Locating the vertical leaders within the building as opposed to the building exterior has several advantages, such as convenience, safety, appearance, and freeze protection. However, leaders located on the exterior can be installed at a much lower cost and do not take up valuable floor space.

The piping layout must be coordinated with other trade disciplines that may be affected by the route, so to keep the number of leaders to a minimum, combine flows from more than one roof drain, clearwater wastes, or any combination thereof. If leaders are to be located at building columns, the column footing design must be coordinated with the structural engineer to take into consideration the leader location. Avoid running horizontal piping above the ceilings of computer rooms, kitchens, and food-preparation areas. A pipe rupture above one of these areas could cause major damage and contamination.

Pipe Supports

Expansion and contraction of the piping system installed without proper anchoring could cause roof drains to be pushed above the roof deck, destroying the integrity of the roof waterproofing by tearing the flashing and the waterproofing membrane. This problem can be more apparent in high-rise buildings and buildings where the exposed leader is subject to cold rainwater or melting snow and ice that enter piping at the ambient temperature of the building. Consider an expansion joint at the roof drain or a horizontal section of the branch line to accommodate the movement of the leader without affecting the roof drain.

Self Test D-3.4: Planning the Storm System

Complete Self Test D-3.4 and check your answers.

If you are using a printed copy, please find Self-Test D-3.4 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

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D-3.5 Installing Storm Drainage Systems

The storm drainage system installation has many of the same installation considerations as a sanitary drainage system; however, the roof penetrations will be connected to drains as opposed to vent terminations.

Safety

Construction sites are among the most dangerous and risky working environments. The installer must observe the **Occupational Health and Safety (OHS) Regulation** during all phases of a storm drainage system installation.

Pre-operational and safety checks are to be carried out on tools, equipment, and machinery according to manufacturer's specifications and site safety procedures. OHS hazards are identified, risks assessed, and risk controls implemented. The installation of storm drainage systems requires a worker to be aware when working at heights, in excavations, and in confined spaces, so always take appropriate safety precautions. The worker must also select, use, and maintain suitable personal protective equipment (PPE).

Tools and Equipment

Tools and equipment are selected according to the piping material used, the drainage system design requirements, and work site procedures.

Determining Slopes

The **minimum slopes** are dictated by the NPC depending on the size and function of the pipe. All drainage pipes must be installed with a minimum slope of 1:50. In some situations, the slope of the building drain may be reduced to 1:100 if it is at least 100 mm (4 in.) in size. This reduction in slope will allow for less fall over a given length, which may be needed to match the invert of a previously installed municipal drainage connection.

Installing Components

Installing and sealing a roof drain penetration where a waterproof roof membrane material is utilized requires knowledge of how the assembly is installed. The drain body is placed in the roof opening and held in place by an underdeck clamp. If a sump receiver is specified, it should be placed so that it is flush with the supporting edges of the drain body. The waterproof membrane will be installed over the sump receiver and drain body (Figure 1).

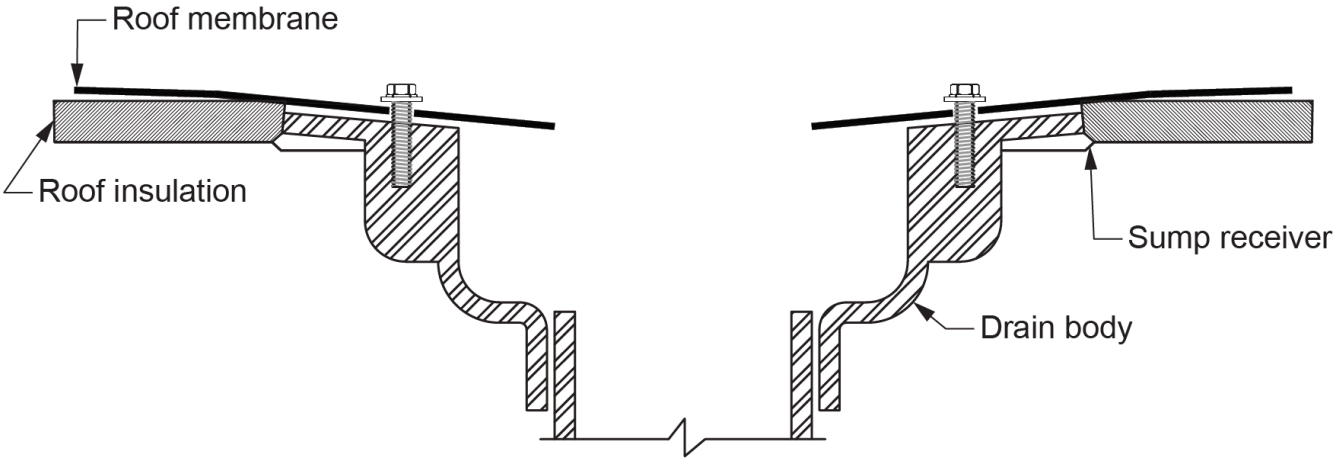

Figure 1 *Installation of a roof drain body. (Skilled Trades BC, 2021) Used with permission.*

The roof drain will be supplied with a **clamping collar** bolted through the drain body to clamp the roof membrane to the body, making a watertight seal. The dome is then placed into the clamping collar and twist-locked into retaining clips on the clamping collar (Figure 2).

Most commercial job sites will specify that a roofing contractor install the roof drain. The plumbing contractor's responsibility then is to supply and locate the drain. Always refer to the specific manufacturer's installation instructions when installing storm drainage components to ensure weather-tightness at the building penetrations.

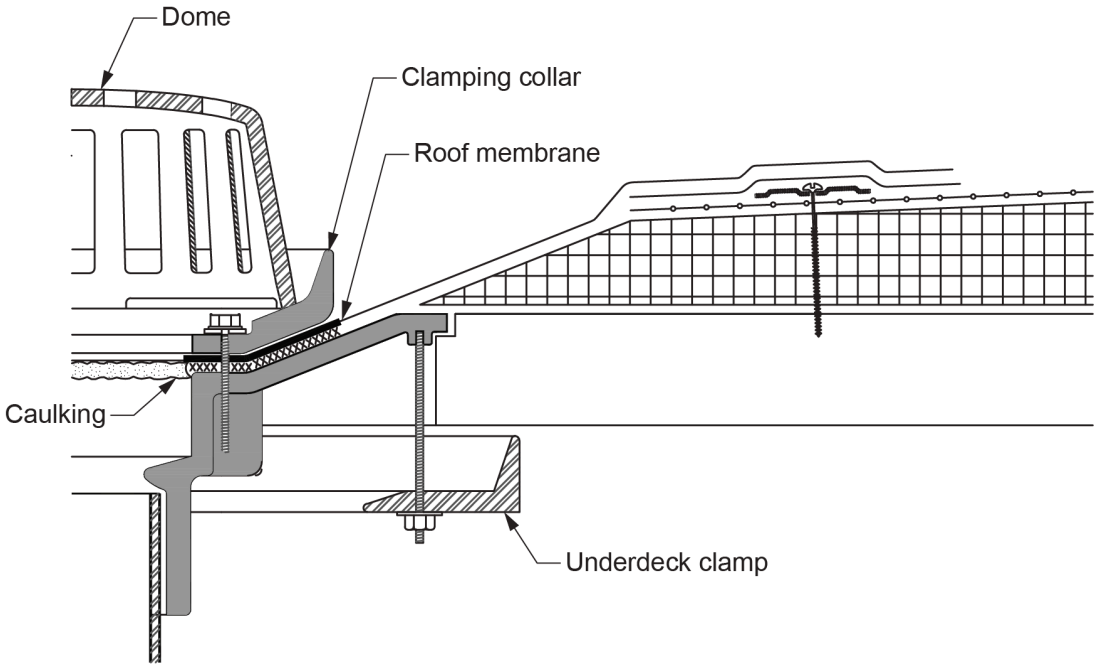

Figure 2 *Complete installation of a roof drain. (Skilled Trades BC, 2021) Used with permission.*

Self-Test D-3.5: Installing Storm Drainage Systems

Complete Self-Test D-3.5 and check your answers.

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References

Skilled Trades BC. (2021). *Book 2: Install fixtures and appliances, install sanitary and storm drainage systems.* Plumber apprenticeship program level 2 book 2 (Harmonized). Crown Publications: King's Printer for British Columbia.

Trades Training BC. (2021). D-3: Install storm drainage systems. In: *Plumber Apprenticeship Program: Level 2.* Industry Training Authority, BC.

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D-3.6 Sumps and Catch Basins

Storm water is often collecting in a catch basin or **sump** before being transfer to the public storm sewer of onsite storm water handing system.

Catch Basins

A **catch basin** is a type of **interceptor** that prevents debris, sand, grit, and other **contaminant**s from entering a drainage system. Catch basins can be found in curbs along the sides of roadways, in parking lots, along the edges of buildings, and in other low-lying areas. Smaller catch basins can be found as a part of landscaping and residential drainage systems, and sometimes, interior catch basins are used in parkades and other structures where outside water can make its way indoors.

A catch basin's purpose is to collect **surface water** (runoff from snow melt and rain) from low-lying areas on both public and private property. They are constructed to screen out, separate, and retain materials that would be detrimental to the operation of the storm systems that they drain into while allowing the water to drain away. Were it not for catch basins, water could be allowed to pool and present problems, such as flooding, street and property damage, and unsafe conditions for drivers and pedestrians.

Catch Basin Types

Catch basins are generally manufactured of concrete in round and rectangular configurations and in many different sizes to suit the application. Round catch basins (Figure 1) are designed to accept an eccentric concrete lid that may have one of various opening styles that suit the required casting. Grade or extension rings are used on top of the concrete lid to bring the drain grate assembly up vertically to match the grade of the surface being drained. Cylindrical catch basins are the more common variety used in the field.

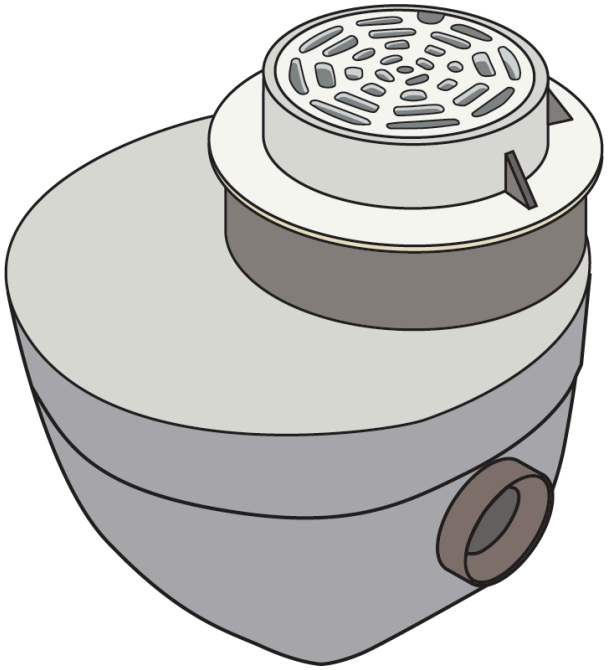

Figure 1 *Cylindrical concrete catch basin. (Skilled Trades BC, 2021) Used with permission.*

Rectangular catch basins are often designed to have the cast-iron frame and grate sit directly on top without needing a concrete lid (Figure 2).

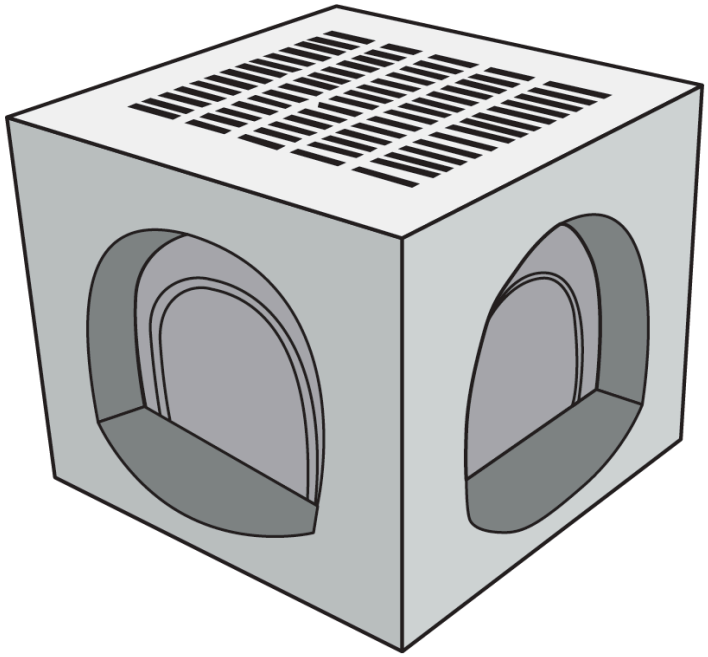

Figure 2 *Rectangular catch basin. (Skilled Trades BC, 2021) Used with permission.*

Reinforcing steel bars (rebar) and wire mesh are cast into high compressive strength concrete to ensure that the catch basin can withstand the loads imposed on them without fracturing. The catch basins may be constructed with bottoms,

or bottoms may be poured in place once the catch basin is located. Loops of rebar or wire rope are cast into the body so that they can be used as lifting eyes (attachment points) for placement using a crane or backhoe. Concrete basins may have pipe openings pre-cast into them; otherwise, the openings are cut into them after they have been set in place.

Smaller plastic catch basins, both round and square, (Figure 3), are available at most home improvement retail stores and plumbing wholesalers. They are of light duty construction and are widely used for residential landscaping in areas where there is no possibility of vehicular traffic on them.

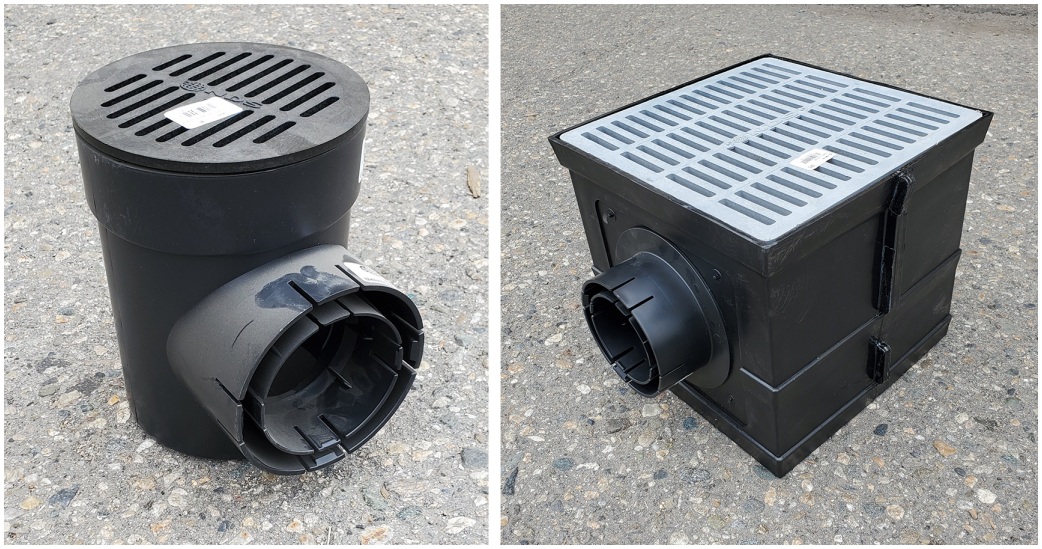

Figure 3 *Round plastic residential catch basin. (Skilled Trades BC, 2021) Used with permission.*

Drainage Troughs

Drainage troughs are another form of catch basin (Figure 4). They can be as long as needed and are fairly narrow. They are usually installed across driveways that are lower in elevation at the end nearest the building than at the street. They are preferred where water must be intercepted as it flows across a wide plane of sloped pavement or concrete rather than through a round or rectangular grate that has the area surrounding it graded to its central location. Water that would otherwise flow down the driveway and into the building is instead directed into the trough drain and carried away to the storm drainage system.

Figure 4 *Trough or trench drain in front of garage. (Skilled Trades BC, 2021) Used with permission.*

Trough or trench drains, as they are sometimes called, are constructed of either poured-in-place concrete or high strength plastic and have a narrow removable grate at the top where the runoff water enters. They are typically very shallow, and because of their limited depth, there is no downturned 90° elbow. Instead, the horizontal pipe outlet is located an inch or two above the bottom of the trench body (Figure 5). This allows a small amount of vertical space below the outlet's invert in which any sediment can be held back and accumulate. Accordingly, due to its limited sediment storage capacity, a trough or trench drain must be cleaned out more frequently than a catch basin.

Figure 5 *Plastic trough drain. (Skilled Trades BC, 2021) Used with permission.*

Catch Basin Operation

A catch basin's purpose is to allow surface runoff to drain while preventing sediment and debris from being carried out into the storm drainage system. This is accomplished by using a downturned 90° elbow and having some significant depth below it.

A cross-section of a typical heavy-duty concrete catch basin, such as what might be found in a parking lot, is shown in Figure 6. Notice that any sediment and debris carried through the drain grate with the runoff will settle and accumulate at the bottom of the basin. Once the depth of the sediment is sufficient, the drain grate is removed and the sediment can either be "mucked out" with hand tools or vacuumed out using a "jet vac" style of truck. Most catch basins are designed with at least a foot or more of liquid depth to allow sediment to accumulate while reducing the frequency of cleanings.

The liquid depth of a catch basin is measured between the bottom of the basin and the invert of the pipe leaving the basin. A key to trouble-free operation of catch basins is the use of a downturned 90° elbow with a short length of pipe extending into the liquid. This arrangement allows the water in the basin to drain while preventing anything that floats on the water's surface from being carried into the pipe. Some catch basins have a manufactured version of the elbow cast-in-place so that the installer only needs to connect the pipe to the outlet.

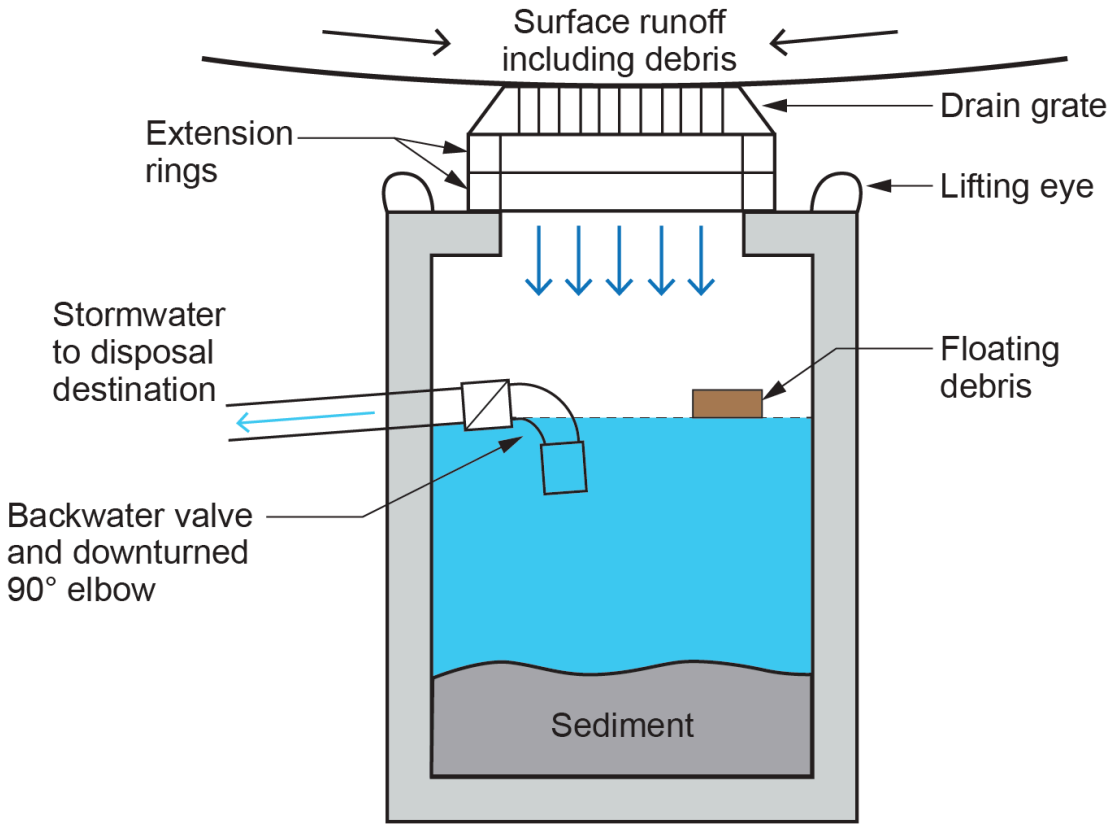

Figure 6 *Catch basin cross-section. (Skilled Trades BC, 2021) Used with permission.*

Catch basins may have a backwater valve installed downstream of the 90°. The intent of the backwater valve is to help prevent any surcharge (reverse flow) from coming back through the discharge piping into the catch basin and flooding the area. Backwater valves commonly have a rubber seal to allow them to close tight, but if the valve is not checked and maintained, it may not prevent reverse flow, and its installation may be ineffective.

In areas with dedicated storm sewers, the water from catch basins is carried through underground pipes to local streams, ditches, and other acceptable places of disposal instead of being taken to the sewage treatment plant along with household and industrial wastewater, as it is in a combined system. If the eventual discharge destination is a fish-bearing body of water, most AHJs will inform the public of the sensitivity to that environment by painting an icon of a fish on the concrete or paved surface adjacent to it. Some manufacturers now cast environmental warnings into their drain grates, as seen in Figure 7. These endeavours are meant to dissuade the public from allowing contaminants to enter the system and affect the environment.

Figure 7 *Catch basin grate with environmental info and fish icon. (Skilled Trades BC, 2021) Used with permission.*

Installation

When installing a concrete catch basin, a hole is dug and the ground beneath its intended location is levelled and compacted. The basin is set into place and levelled. The drain grate is set to elevation using extension rings of varying thickness grouted to the basin's top. The piping outlet elevation is determined and, if no pre-cast pipe opening has been provided, the wall of the concrete basin must be broken into using percussion tools and hammers. Any interior rebar or wire mesh is cut out of the way, the pipe is inserted into the new rough opening, and the penetration is sealed with grout.

Sumps

A sump differs from the definition of a catch basin in that a sump is usually a catch basin that cannot be drained by gravity because of its location and, therefore, needs to be pumped out. As well, sumps usually do not have an open drain grate on their top. They are sealed chambers with pipe inlets at either the top, sides, or both.

Sumps can be used for either stormwater or sanitary waste. An example of a storm sump would be one that is installed in the lowest level of an underground parkade in a large building. Discharge from all the floor drains for the parkade would be piped into the sump, and be pumped from there up into the storm building drain.

Using a sump for sewage is probably more common than for stormwater because there are many buildings where the

lowest plumbing fixtures cannot drain by gravity if the building drain leaves the building at a higher elevation than that of the fixture drains. As well, sometimes a fixture, such as a clothes washer, needs to be located in an area where there is no roughed-in drainage piping. Rather than omit any fixtures in these situations, sewage sumps allow for fixture placement without possibly having to jackhammer into concrete floors. Fixtures drain by gravity into the sump, and sump pumps lift the sewage and discharge it into the sanitary building drain.

Regulations

Regardless of the contents of the sump (storm or sanitary), the National and BC Plumbing Codes address the installation of sumps in Article 2.4.6.3. Listed below are those code clauses.

2.4.6.3. Sumps or Tanks (See Note A-2.4.6.3.):

1. Piping that is too low to drain into a building sewer by gravity shall be drained to a sump or receiving tank.
2. Where the sump or tank receives sewage, it shall be water- and airtight and shall be vented.
3. Equipment such as a pump or ejector that can lift the contents of the sump or tank and discharge it into the building drain or building sewer shall be installed.
4. Where the equipment does not operate automatically, the capacity of the sump shall be sufficient to hold at least a 24-hour accumulation of liquid.
5. Where there is a building trap, the discharge pipe from the equipment shall be connected to the building drain downstream of the trap.
6. The discharge pipe from every pumped sump shall be equipped with a union, a backwater valve and a shutoff valve installed in that sequence in the direction of discharge.
7. The discharge piping from a pump or ejector shall be sized for optimum flow velocities at pump design conditions.

Note: A-2.4.6.3. from the codes shows a typical sump piping configuration, as replicated in Figure 8.

Note: The sump is receiving discharge from a "**sub-drainage system**." Although no definition exists, a sub-drainage system is widely held to be any piping that carries liquid waste that is too low to drain by gravity to a building drain and, therefore, must be drained into a sump.

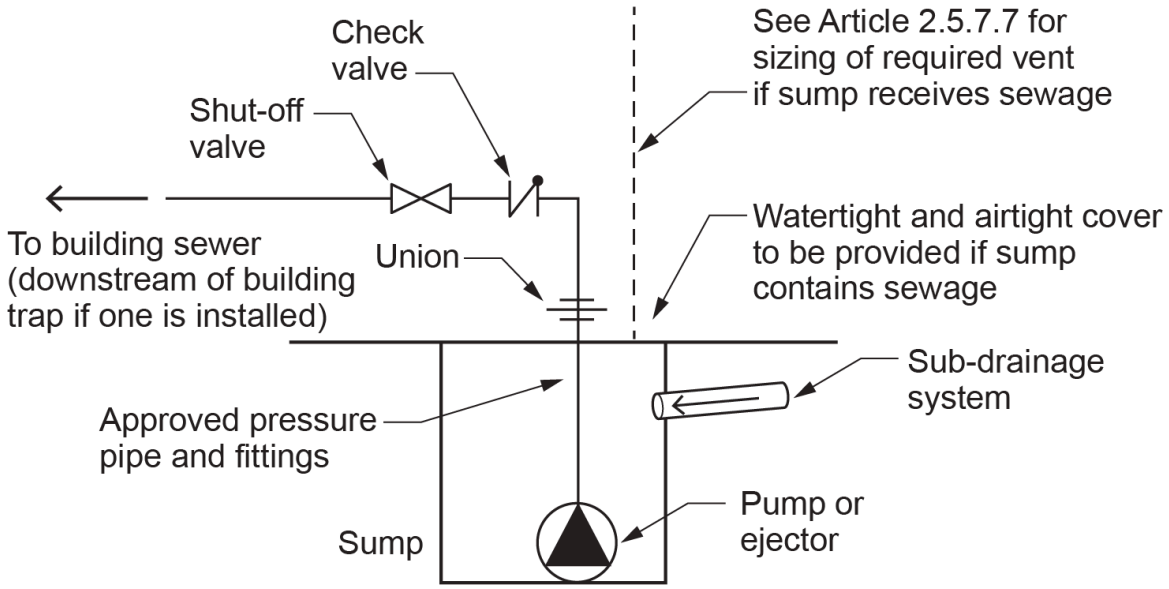

Figure 8 *Note A-2.4.6.3 arrangement of piping at sump. (Skilled Trades BC, 2021) Used with permission.*

In large commercial settings, sumps are either cast-in-place (formed and poured in concrete) or constructed of large sections (rings) of pre-cast concrete. The rings are stacked one onto another, with the seams grouted to make them watertight. A level floor is poured and made ready for pumps to be installed on them. Pre-cast sumps are also an option if of a smaller size.

The pumps and related controls and piping are installed so that the system works automatically. There is provision in the codes for a sump to have it be pumped out as part of a building operator's daily routine (see Subclause 4 above), but the sump would have to be sized to hold at least a 24-hour accumulation of liquid. This usually translates into a very large sump, and so the preference is for automatic control.

In large installations, the system is usually **duplex**, meaning that there are two pumps in the sump, each with its own union, check valve, and shutoff and piped in parallel. A series of **float switches** on electrical cord are suspended inside the sump. They are wired to a control panel that operates the pumps.

Sump Operation

Figure 9 shows four float switches, all at different levels, controlling two pumps. As the liquid level rises in the sump, the lowest switch starts to tip upward. A heavy lead weight is attached to the electrical cord just above each float to ensure that the float will be inverted vertically when the liquid level rises above it. At this point, the lowest float switch (#1) being inverted will not cause anything to occur.

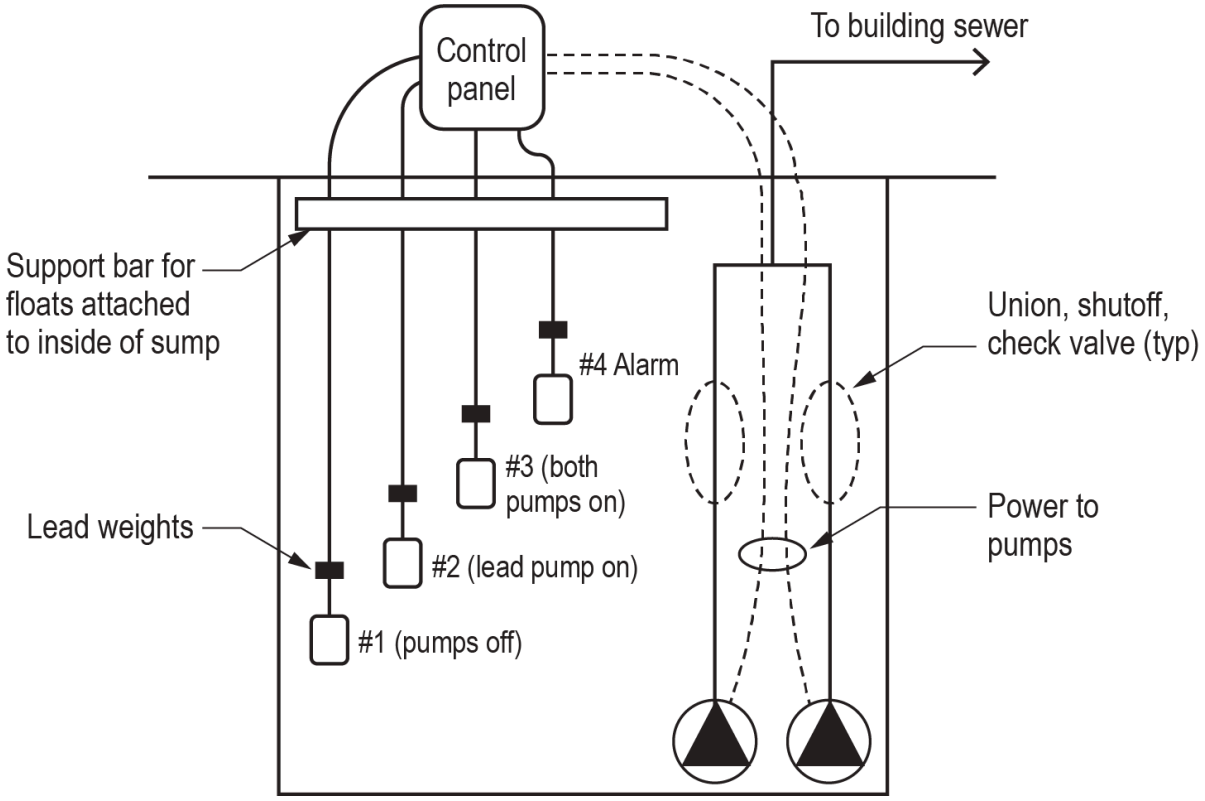

Figure 9 *Duplex sump pump system. (Skilled Trades BC, 2021) Used with permission.*

As the liquid level rises, float switch #2 tips upward. When the float is almost fully inverted, a switch inside it "makes" or closes, which sends a signal to the control panel. The control panel sends power to one of the two pumps, which turns on and starts to pump the liquid out through the piping to the building sewer. As the liquid level drops, float switch #2 hangs vertically again, but the pump continues to run. The pump will continue to operate until float switch #1 hangs vertically, at which point the switch contacts inside it "break" or open, and the pump shuts off.

Through normal operation, as the liquid level in the sump rises and falls, the control panel will operate the same pump on and off, while the other pump is on standby as a backup. This is known as "lead-lag" control. If desired, micro-switches inside the control panel can be configured so that the pumps take turns with normal operation. This is known as "alternating control."

Float switches #3 and #4 come into play in situations where, due to excessive inflow or possibly a pump that has malfunctioned, the liquid level continues to rise. If float switch #3 inverts, the control panel will power both pumps. In that way, if the lead pump has malfunctioned during normal inflows, the lag pump should be able to handle the flow and pump down the sump. If the lead pump cannot handle the excessive inflow, then both pumps should be able to pump down the sump. This is assuming, of course, that the pumps have been sized correctly.

If the liquid level gets to the point where float switch #4 is inverted, the control panel will sound a local alarm and possibly remote alarms as well.

Rather than have a horizontal support bar with a lead weight above each float, another option for installing the floats is to fix a small-diameter vertical pipe — made of galvanized iron, copper, or some other corrosion-resistant material — inside the sump (Figure 10). The cords of the float switches are taped or "zap-strapped" to the pipe a few inches above each float and one above the other. This negates the use of the lead weights while still allowing the float to tip upside down.

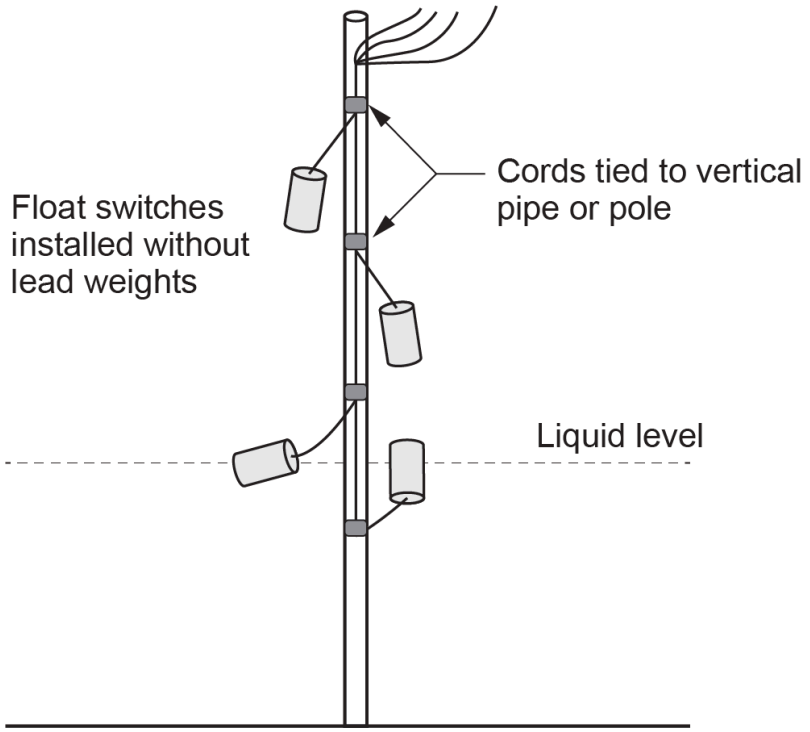

Figure 10 *Float tether pipe. (Skilled Trades BC, 2021) Used with permission.*

Cylindrical float switches will not "make" if the float does not invert. Without either a lead weight or the cord being tied off, the float switch will float in a horizontal orientation and will not engage the switch (Figure 11).

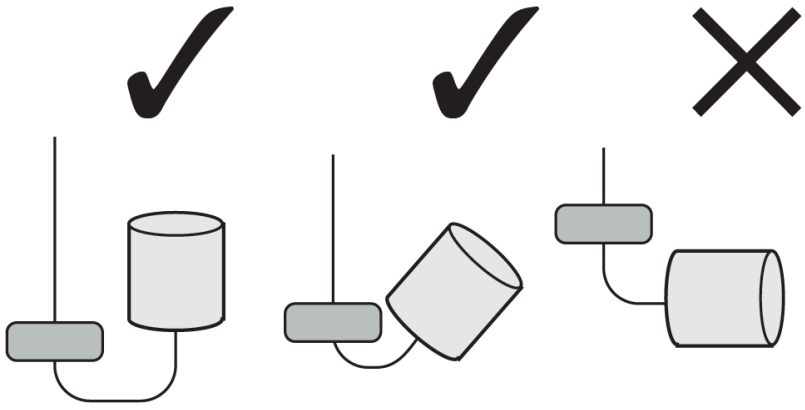

Figure 11 *Float switch orientation. (Skilled Trades BC, 2021) Used with permission.*

Sump Pump Installation

Small sump pumps, with outlet diameters two inches or less, are relatively easy to set into and pull from a sump. Cast-iron pumps three inches and larger are very heavy, and so there are support systems on guides and rails available to make installation, operation, and removal much easier.

Figure 12 shows a pump that only has to be winched in and out of the sump using lifting equipment. There are no electrical or piping connections in the bottom of the sump that need to be accessed to allow the pump to either be placed or removed. A cast-iron base with one or two vertical rails is bolted to the floor of the sump, and the rails are bolted to the inside of the sump near its top. The pump is mounted on a yoke that slides down the vertical rails to where it rests against the base. A hinged pipe connection, using rubber rings for sealing the yoke to the base, and flexible power supplies allow the pumps to be set in place or lifted out of the sump where they can more easily be worked on. Pumps used in large commercial installations are commonly high-voltage three-phase models.

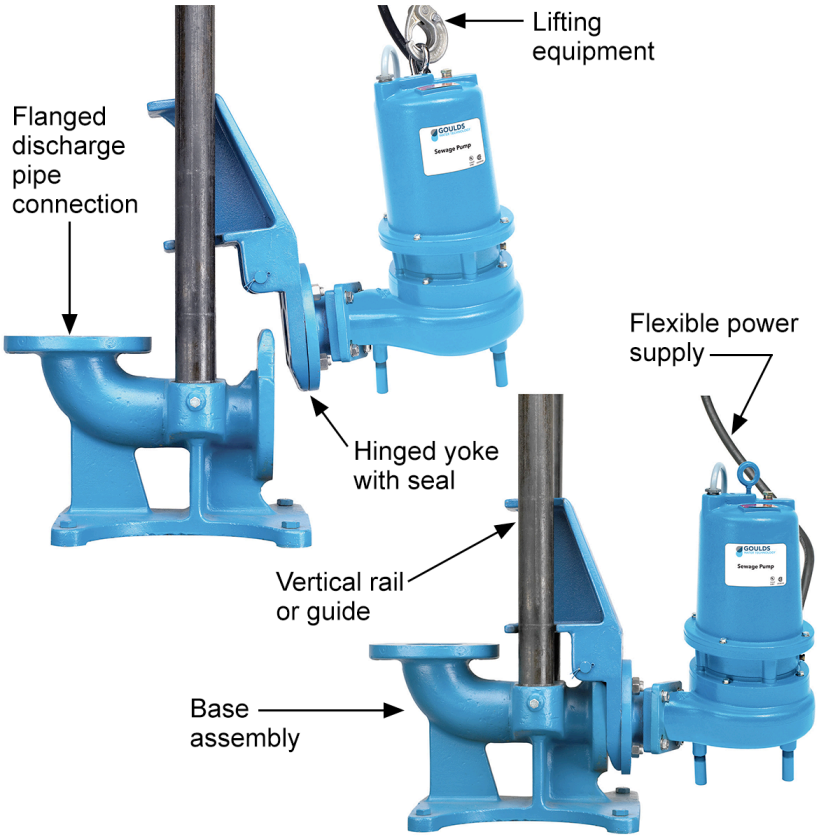

Figure 12 *Large-diameter sump pump installation on rails. (Skilled Trades BC, 2021; original from Xylem Canada, n.d.) Used with permission.*

Small packaged sump kits are commonly used in residential settings for basement bathrooms and laundries where the building drain is installed above the basement floor. A plastic tank with a sealed lid is furnished with a single submersible pump that is operated with a single float switch (Figure 13). The float switch is duplex in that it turns the pump on when inverted and off when back to its normal "hanging" position. There is a single inlet into the side of the tank, and the lid has openings for the discharge pipe, a vent, and a power cord.

Figure 13 *Plastic sumps. (Skilled Trades BC, 2021) Used with permission.*

The lid and all the openings have rubber seals to make the sump package water- and airtight. If the drainage piping is below floor elevation, the sump can be recessed and embedded (Figure 14).

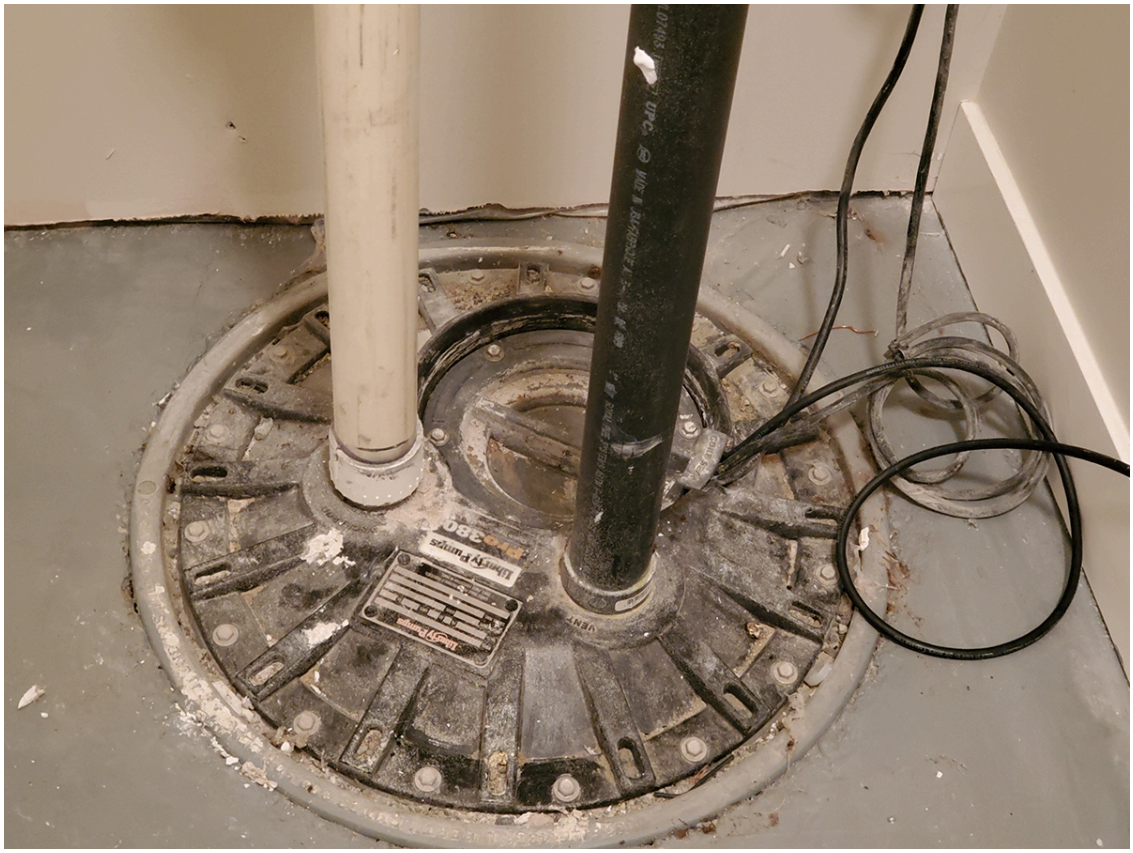

Figure 14 *Installed recessed and embedded sump. (Skilled Trades BC, 2021) Used with permission.*

If the fixture to be drained does not need to have buried piping, then an above-ground model of sump kit can be installed. In a laundry room, the clothes washer and laundry tub are drained through piping located above grade, so a plastic packaged sump can be installed on the floor near the fixtures. It will have either a side or top inlet, or sometimes both. Just like the recessed models, the removable lid will have openings with rubber seals for the discharge pipe, vent, and power cord (Figure 15).

Figure 15 *Above-grade sump kit for laundry fixtures. (Saniflo, 2021) Used with permission.*

Due to their limitations for placement, most above-ground sump kits have a capacity of only a few gallons, while below-ground models can be as large as desired. A common size for below-ground sump basins is 18 in. diameter by 32 in. deep, which would have a capacity of approximately 30 imp gal. Their pumps would have longer standby and run times than their smaller above-ground counterparts and should, therefore, have a longer life.

Any equipment that starts and stops frequently is more prone to wearing out and requiring service than that which operates less frequently and for a longer period. Access to above-ground sump pumps is normally easier than for below-ground units.

Some models of toilets are manufactured to be both a fixture and a sump (Figure 14). Known as "macerating toilets," they are rear-discharge to a sump that also has openings on either side to accept drainage pipes from bathtubs, showers, and basins. The upside to these styles of toilets is that they and the accompanying fixtures can be installed in basements without the need to break up concrete flooring.

Figure 16 *Above grade. (Saniflo, n.d.) Used with permission.*

The downside is that the drainage from the other fixtures is also above grade and may need to be exposed. As well, bathtubs and showers usually need to be installed on raised platforms in order to get their drainage piping high enough to connect to the macerating toilet's sump inlets. If aesthetics is a major consideration, then the installation of a below-ground sump is the better choice.

The electrical power needed for most above or below grade sump pumps is of the common household variety, which is single-phase, 120-volt alternating current supplied through a standard three-prong plug receptacle.

Self Test D-3.6: Sumps and Catch Basins

Complete Self Test D-3.6 and check your answers.

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References

Saniflo. (2021, May). Four affordable, value-adding home improvements real estate agents suggest! Blog 05/01/2021[Image]. Used with permission. Retrieved from https://www.saniflo.ca/us/blog/-four-affordable-value-adding-home-improvements-real-estate-agents-suggest-n292

Saniflo. (n.d.). *Saniaccess 3: Installing an additional bathroom* [Webpage]. Retrieved from https://www.sfasaniflo.com/us/installing-an-additional-bathroom/68-saniaccess-3.html

Skilled Trades BC. (2021). *Book 2: Install fixtures and appliances, install sanitary and storm drainage systems.* Plumber apprenticeship program level 2 book 2 (Harmonized). Crown Publications: King's Printer for British Columbia.

Trades Training BC. (2021). D-3: Install storm drainage systems. In: *Plumber Apprenticeship Program: Level 2.* Industry Training Authority, BC.

Xylem Inc. (n.d.). *Guide rails – 3" & 4"*. Xylem. https://www.xylem.com/en-us/products-services/pumps-packaged-pump-systems/pumping-accessories/goulds-water-technology-accessories/guide-rails-3-and-4/

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- **Figure 12:** Large-diameter sump pump installation on rails (https://www.xylem.com/en-ai/brands/goulds-water-technology/products/all-products/guide-rails-3-and-4/) from Xylem Inc. (n.d.) was adapted by Skilled Trades BC (2021) and used with permission from Xylem Canada, LLP. (https://www.xylem.com/en-ca/)
- **Figure 15:** Above-grade sump kit for laundry fixtures (https://www.saniflo.ca/us/blog/-four-affordable-value-adding-home-improvements-real-estate-agents-suggest-n292) from Saniflo was adapted by Skilled Trades BC (2021) and used with permission.
- **Figure 16:** Above grade (https://www.saniflo.com/us/installing-an-additional-bathroom/68-saniaccess-3.html) from Saniflo was adapted by Skilled Trades BC (2021) and is used with permission.

D-3.7 Sub-Soil Drainage Systems

Soil stability contributes to the integrity of building structures and public recreational areas as well as to slopes and landscapes that abut highways, subdivisions, septic systems, retaining walls, and the like. Natural soil conditions can vary greatly, and accordingly, their ability to hold or shed water will also vary greatly. The installation of subsoil drainage is often only considered after problems arise, and mitigating any such problems is usually far more expensive, disruptive, and time-consuming than if tackled as a process in the original planning of a project.

Hydrology – from Greek hýdōr meaning "water" and lógos meaning "study" — is the scientific study of the movement, distribution, and management of water on Earth and other planets, including the water cycle, water resources, and environmental watershed sustainability.

"Hydrologic" or "hydrological" engineers belong to a broad range of engineering technologies known as "**civil engineering.**" Their studies and findings have been widespread, well-documented, and full of terminologies that the average journeyperson may find hard to understand. Fortunately, most hydrologic-based information that the average plumber deals with is contained within jobsite blueprints, specifications, and applicable code books and is presented in a manner intended to be deciphered by non-engineers.

Purpose

Water contained within the soil can cause many problems, such as foundation collapse, sinkholes, mudslides, and other such catastrophes. While predicting such events may not be within the scope of a plumber's responsibilities, the use and application of sound industry principles and practices that an average plumber is expected to display in order to prevent them is.

Within the National Plumbing Code of Canada (NPC) and the BC Plumbing Code (BCPC), a "subsoil drainage pipe" is defined as "a pipe that is installed underground to intercept and convey subsurface water." Although no official definition exists in any of the model codes used in building in Canada, the most commonly held definition of "subsurface water" is "water that exists below the ground level."

Typical Locations for Subsoil Drainage

One of the most critical and common instances of having to deal with subsurface water is in the placing of footing drains for a building. The composition of soil can vary greatly, and although the practice of pouring concrete **footings** on rock or compacted granular fill may deter the retention of water below the footings, the act of installing a subsoil drainage system around the footings is widely accepted as the norm for all footing placements.

Regulations

The BC Building Code (BCBC), Sentence 9.15.3.2 (1) states, "Footings shall rest on undisturbed soil, rock or compacted granular fill."

Section 9.14 of the BCBC specifies requirements for surface and subsurface drainage. Sentence 9.14.1.2(1) states, "Drainage for crawl spaces shall conform to Section 9.18", and Sentence 9.14.1.3(1) specifies that "Drainage requirements beneath floors-on-ground shall conform to Section 9.16." The following points covered will be limited to those found in Sections 9.14.2 to 9.14.6, which focus on foundation wall drainage (9.14.2), drainage tile and pipe (9.14.3), drainage disposal (9.14.5), and surface drainage (9.14.6).

Subsoil Drainage for Building Footings

Subsoil drainage maintains the integrity of the ground under footings. By removing moisture, soil strength is stabilized, and the possibility of major foundation settlement is greatly reduced or eliminated entirely.

Sentence 9.14.2.1 (1) of the BCBC states "Unless it can be shown to be unnecessary, the bottom of every exterior foundation wall shall be drained by drainage tile or pipe laid around the exterior of the foundation in conformance with Subsection 9.14.3. or by a layer of gravel or crushed rock in conformance with Subsection 9.14.4."

BCBC Section 9.14.3.3 states that "**Drain tile** or pipe shall be laid on undisturbed or well-compacted soil so that the top of the tile or pipe is below the bottom of the floor slab or the ground cover of the crawl space." Figure 1 shows the standard installation for drainage systems around footings.

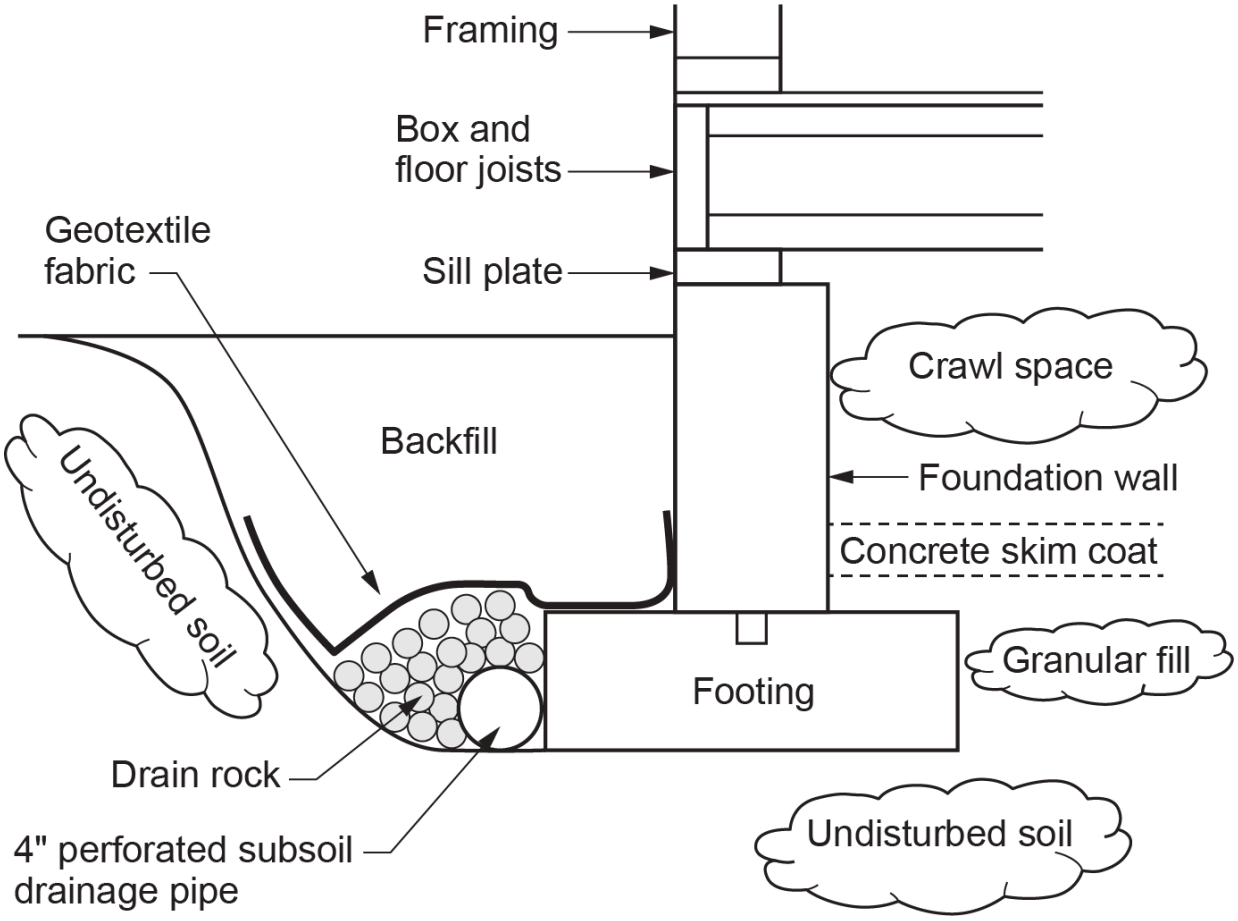

Figure 1 *Typical footing drain installation. (Skilled Trades BC, 2021) Used with permission.*

Although available in other sizes, 9.14.3.2. of the BCBC specifies "Drain tile or pipe used for foundation drainage shall be not less than 100 mm in diameter."

Although not specifically referenced in the codes, the backfill of a **perforated pipe** is protected from being plugged with fines and silt using a geotextile fabric (landscaping cloth or filter fabric) between the drain rock and backfill, as was shown in Figure 1. This practice is in use in virtually all instances where perforated pipe is installed underground.

Piping Materials

Subsection 9.14.3 of the BCBC lists the acceptable materials that can be used as drainage pipe — which are clay, concrete, plastic, and corrugated steel — and the standards that they must be certified to in order to be acceptable for installation. Of these, plastic is today's material of choice for most subsoil drainage applications.

Drain Tile

"**Drain tile**" refers to a type of pipe that, although still found in place, has been replaced by perforated plastic pipe. Subsequent to the use of wood stave piping but before the development of cast-iron pipe, clay was formed into pipe

lengths and fired in kilns to become vitrified (hard and glass-like) and, as such, was known as "**vitreous clay pipe**" (Figure 2). It was heavy, brittle, and very corrosion-resistant. Its main uses were in acid waste systems and in subsoil systems.

Figure 2 *Clay pipe. (Tesamoll/Wikimedia Commons) CC0 1.0 (https://creativecommons.org/publicdomain/zero/1.0/deed.en)*

For subsoil systems, 3 in. or 4 in. diameter clay pipe (Figure 3) was formed into short lengths (tiles) of between 8 in. and 12 in. in length that often had an octagonal outer profile.

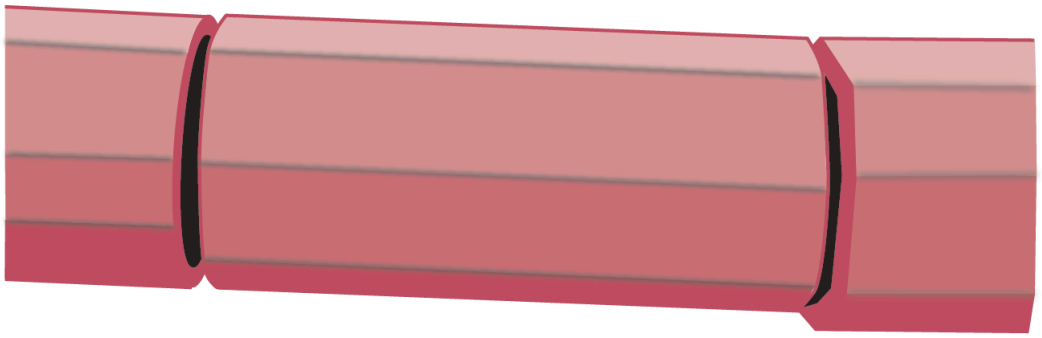

Figure 3 *Clay tile pipe for subsoil drainage. (Skilled Trades BC, 2021) Used with permission.*

The short lengths were laid end-to-end with a 0.25 in. to 0.50 in. space between them and covered with building paper or some other material to prevent the introduction of "**fines**" (small particles of dirt or silt) that would otherwise plug the openings. They were used extensively in sewage disposal fields and also to collect and channel away the water that might collect around footings until the advent of perforated plastic pipe. The terms "weeping tile" and "agriculture tile" were also given to this type of pipe because of the ways it was used.

Perforated Pipe

Clay tile pipe was replaced decades ago by **perforated PVC plastic pipe**. It is most commonly 3 in. or 4 in. in diameter and in lengths of either ten or thirteen feet. Although pipe is available that has perforations around its full circumference and length, the type most commonly used has two lines of 0.50 in. diameter holes spaced along the pipe's length 120° apart (Figure 4). The holes are positioned at the bottom of the pipe when being installed. The joints can be solvent-welded together, although leakage from the joints would be a redundant issue for most uses.

Figure 4 *Perforated PVC pipe. (Rod Lidstone) CC BY (https://creativecommons.org/licenses/by/4.0/deed.en)*

Corrugated Pipe

Another form of perforated plastic pipe is made of flexible corrugated polyethylene and is available in coils of 4 in. in diameter that are either 200 or 250 ft long (Figure 5). The perforations are quite small and so are more easily plugged by fines than PVC pipe. It is a common choice for agricultural applications where a constant even grade is not available.

Figure 5 *Four-inch corrugated perforated polyethylene pipe. (Greg Wirashowsky/Skilled Trades BC, 2021) CC BY (https://creativecommons.org/licenses/by/4.0/)*

Perforated polyethylene pipe is also available with the geotextile fabric pre-installed, as seen in Figure 6.

Figure 6 *Corrugated perforated pipe with fabric wrap. (Skilled Trades BC, 2021) Used with permission.*

Subsoil Drainage Discharge

Sentence 9.14.5.1 (1) of the BCBC specifies that "Foundation drains shall drain to a sewer, drainage ditch or dry well." Drainage to a sewer is expected to be accomplished by first dumping any footing drain discharge into a sump. In doing so, any debris is removed. The specifics of the sump construction for this application are found in Article 9.14.5.2 and are as follows:

1. Where a sump pit is provided it shall be:
    - Not less than 750 mm deep,
    - Not less than 0.25 m2 in area, and
    - Provided with a cover.
2. Covers for sump pits shall be designed:
    - To resist removal by children, and
    - To be airtight in accordance with Sentence 9.25.3.3.(7).
3. Where gravity drainage is not practical, an automatic sump pump shall be provided to discharge the water from the sump pit described in Sentence (1) into a sewer, drainage ditch or **dry well**.

A drainage ditch, as referenced in the code clauses above, is a common and acceptable termination point for most subsoil drainage systems. Many residential properties have ditches that abut the property line and are naturally used for such purposes.

In the absence of a drainage ditch, a dry well or rock pit can be used. It need not be anything more elaborate than an

excavated hole in the ground filled with drain rock, into which the drainage pipe is inserted. The dispersal of water from it is more localized than would occur if using a horizontal trench and drain rock. Any discharge from the pipe is expected to percolate (seep) into the soil within a relatively small area. Dry wells may have a perforated tank or drum that acts as a reservoir to provide more volume of initial fill (Figure 7). Regardless of the type of reservoir chosen, it would have to be capable of supporting the ground above it.

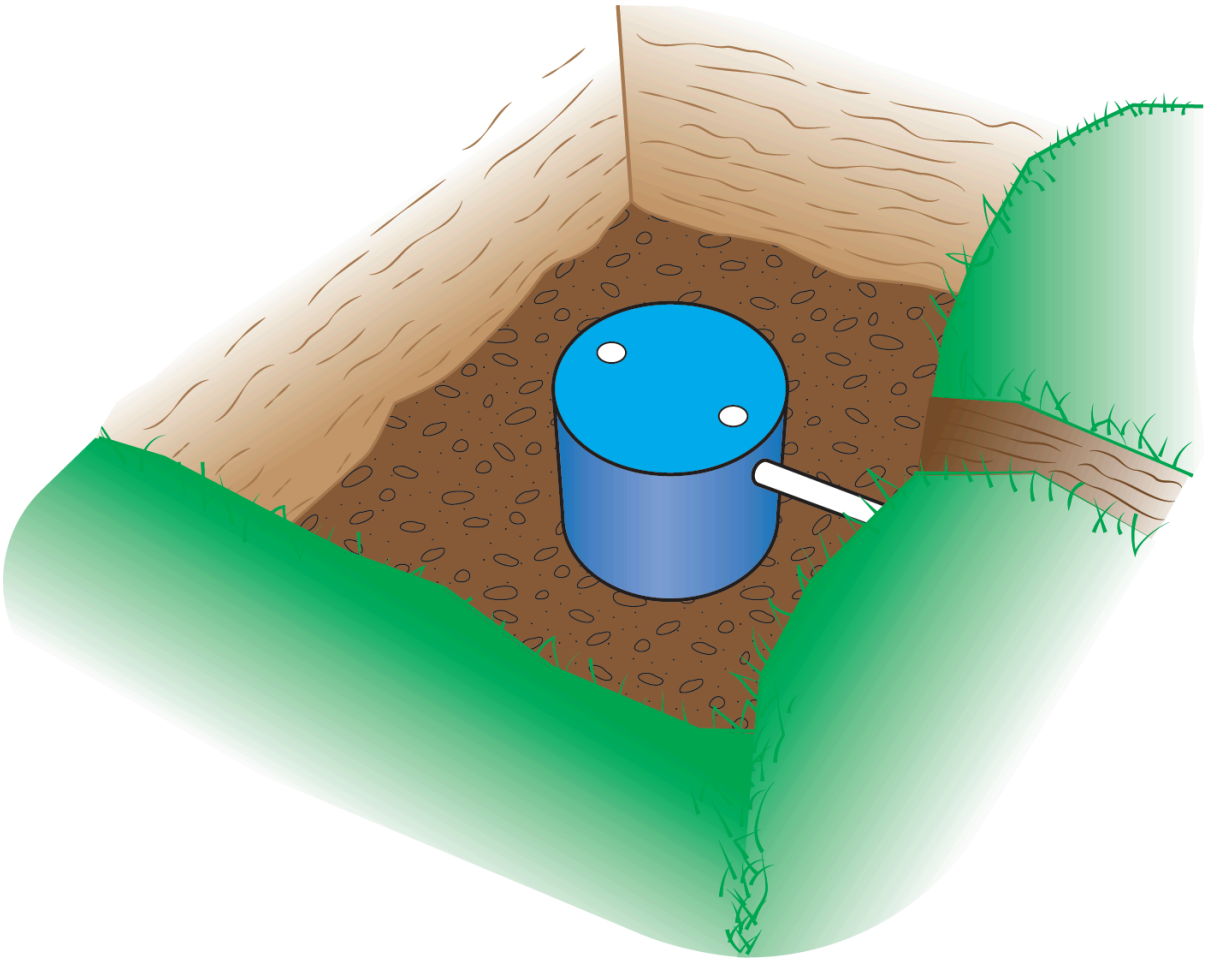

Figure 7 *Home-built dry well using perforated 45-gal plastic drum. (Skilled Trades BC, 2021) Used with permission.*

Many houses and buildings built in the latter half of the 20th century combined water from roof drains and eavestroughs with that from the footing drainage system. This was done primarily as a cost-saving measure. **Tees** were installed in the drain tile surrounding the footings at the locations where the vertical leaders or downspouts were to be located, and pipe was extended to just above ground level, where they connected to the bottom of the leaders. This method proved to be problematic, as the extra water from the leaders often found its way under the footing and into the building if the footing drainage system became restricted or plugged. This is no longer done. As seen in Figure 7, the roof drainage is directed into a separate system of watertight piping that encircles the building and usually discharges into the same termination point as the footing drain.

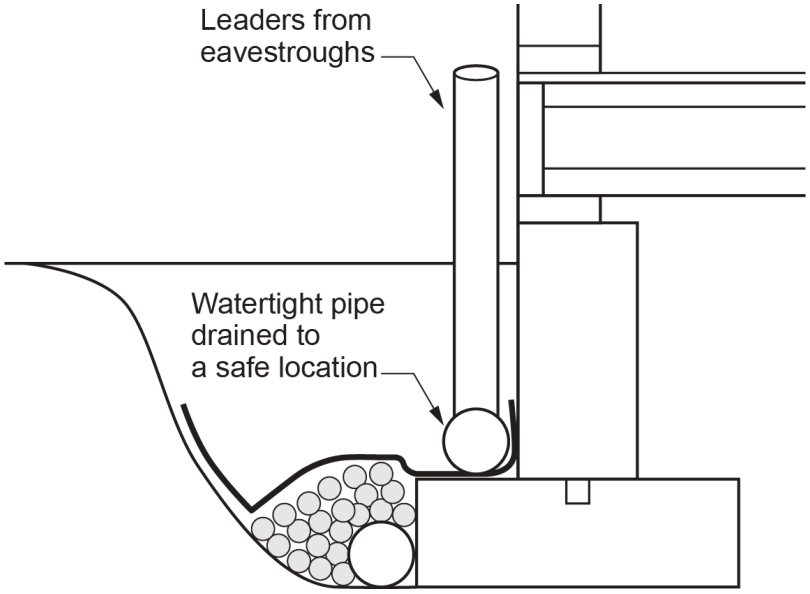

Figure 8 *Dedicated footing and roof drainage piping systems. (Skilled Trades BC, 2021) Used with permission.*

There are certain areas of the country where subsoil drains, such as from footings, are brought inside the building and tied into the sanitary drainage system. Sentence 2.4.6.4 (6) of the NPC and BCPC specify that the subsoil piping is to be protected from surcharge (backflow from the sanitary systems into the subsoil piping) by installing a gate valve or a backwater valve. This is illustrated in Note A-2.4.6.4 (6) of the code.

Other Subsoil Drains

There are many other types of subsoil drainage systems not covered in the building code because they are designed to control excess water on various landscapes, often for agricultural purposes, rather than for building protection.

French Drains

In 1859, in Concord, Massachusetts, a judge and farmer named Henry French developed an effective way to prevent surface water from ponding by collecting it and channelling it away. He published his concepts in a book with the exhaustive title of *Farm Drainage; The Principles, Processes, and Effects of Draining Land with Stones, Wood, Plows, and Open Ditches and Especially with Tiles; Including Tables of Rainfall, Evaporation, Filtration, Excavation, Capacity of Pipes, Cost and Number to the Acre, of Tiles, Etc., Etc.*

His concept was thereafter known as a "**French drain**" and is widely used to this day. There are numerous variations to his original idea, and modern materials have improved its functionality. In government publications in British Columbia, French drains are referred to as "blind inlets."

A French drain consists of a trench; perforated pipe; clean, washed rock; **geotextile fabric**; and backfill, as shown in Figure 9.

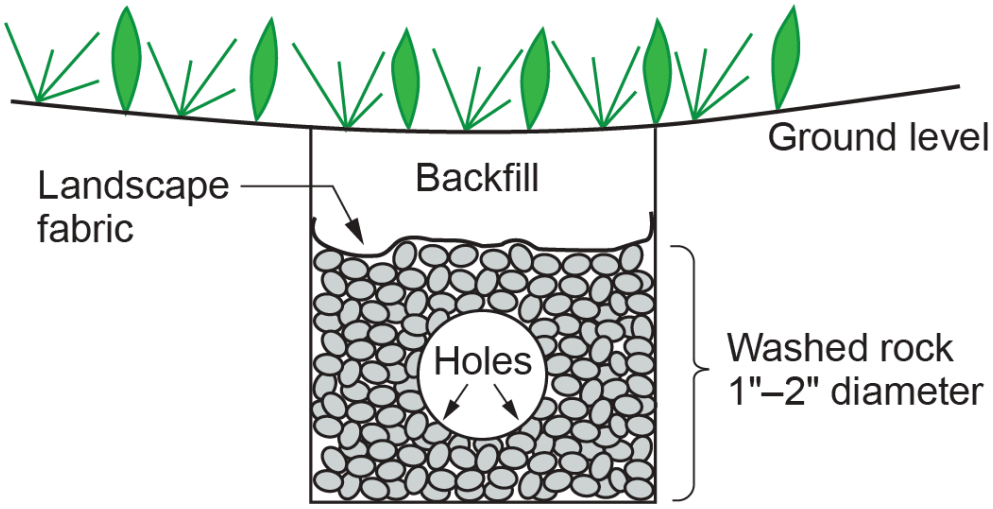

Figure 9 *Typical French drain. (Skilled Trades BC, 2021) Used with permission.*

A trench is dug approximately 8 in. (200 mm) wider than the width of the pipe and as deep as needed in order to have a reasonable amount of backfill above the landscape fabric separating the backfill from the rock. A minimum of 2 in. (50 mm) of washed rock is placed in the bottom of the trench below the pipe. The pipe is laid, and the trench is filled with washed rock to at least 2 in. (50 mm) above the pipe. Landscape fabric is laid on top of the washed rock, across the width of the trench, then the trench is backfilled. Note that the perforations (holes) are positioned at the bottom of the pipe.

A network of trenches can be installed in a few different configurations to provide coverage over large areas, as seen in Figures 10 and 11.

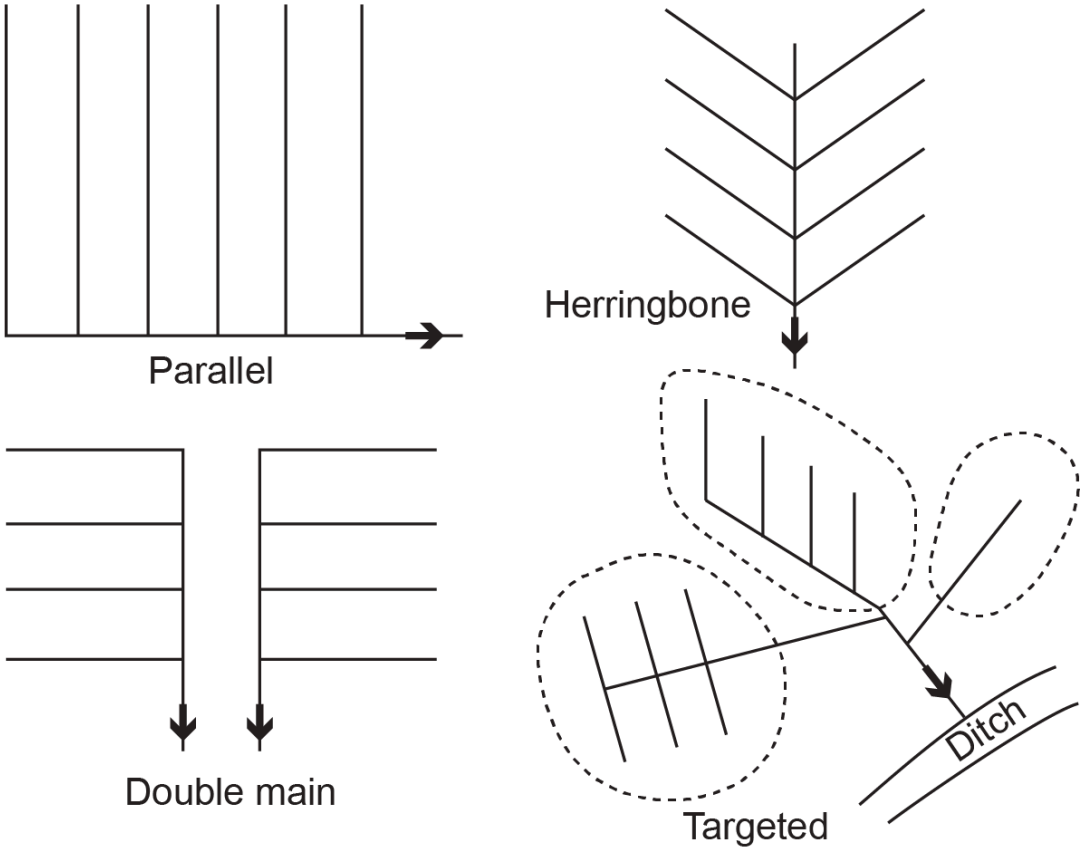

Figure 10 *Various drainage system layout alternatives. (Skilled Trades BC, 2021) Used with permission.*

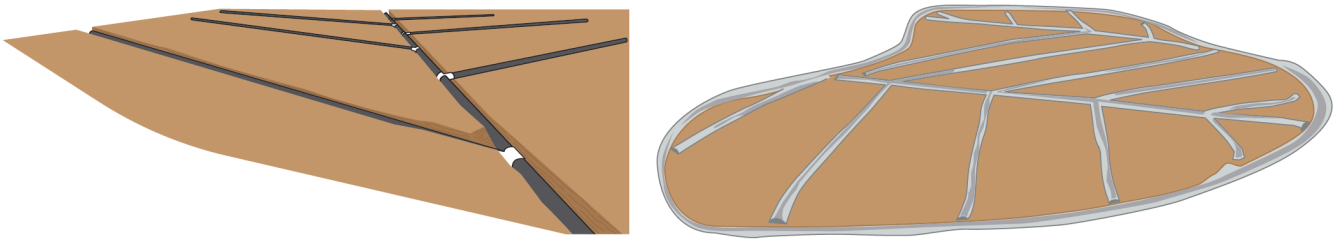

Figure 11 *Drainage trench examples. (Skilled Trades BC, 2021) Used with permission.*

Curtain Drain

Subsoil drains are typically installed at natural depressions in the ground, which is where ponding usually occurs. This minimizes the amount of sculpting that must be done to the surrounding area in order to direct surface water to desired locations for collection.

Curtain drains are French drains installed across a slope. Their purpose is to lessen the amount of water that might accumulate on a sensitive surface, such as the disposal field for a septic system, by intercepting and draining it away from the area. As seen in Figure 12, surface runoff is caught in a slight depression created by a buildup of soil on the downstream side of the trench. This is commonly called a **berm**. The berm holds back water that is allowed to percolate

through the thin layer of topsoil into the trench below and be drained away to a more suitable location. Curtain drains lower the water table of the original topography.

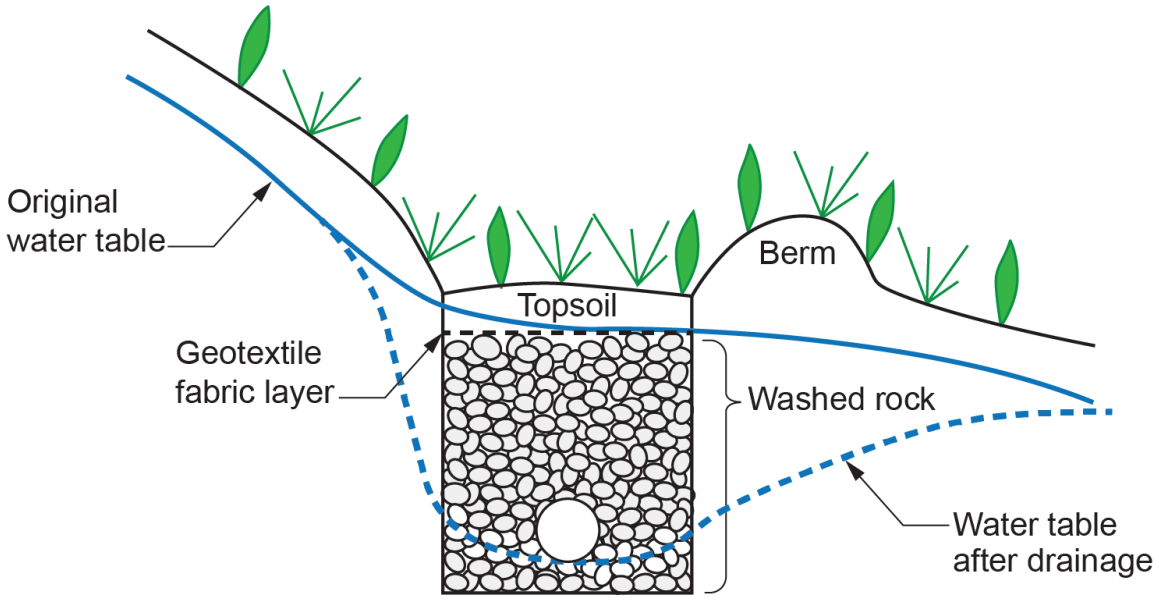

Figure 12 *Curtain drain. (Skilled Trades BC, 2021) Used with permission.*

Curtain drains are also beneficial when installed at the base of a slope of rock. Almost every drop of rain that contacts the rock face will make its way to the bottom of the slope, with virtually none of it being absorbed into the surface along the way. Ponding and flooding at the base of the slope could otherwise result. A curtain drain located near the slope's base can help mitigate any accumulation of water.

Mole Drains

"**Moling**" is a commonly used process in agriculture whereby a torpedo-shaped mandrel, with an expander/compacter behind it, is pulled through the soil behind a heavy tractor or bulldozer to create a void horizontal space or tunnel below ground. The mole assembly is at the bottom of a very narrow stem or beam that splits the ground cover without leaving a trench or depression. The equipment is often referred to as a "**trenchless plow**". Moling can be done with or without pipe being pulled simultaneously behind the expander/compacter into the trench.

Pipeless moling is most commonly used in farming. Soils with high clay content are problematic for farmers because they tend to hold water for great lengths of time once saturated (waterlogged) and have very slow percolation rates, which causes ponding of snow melt and rain in the shoulder seasons. Both situations are detrimental to crop production and can be alleviated by installing a pattern of "moled" channels that lead to a main French drain.

First, a main French or trench drain is installed through the field. Special equipment (Figure 13) is used to trench, install pipe, and drain rock all at the same time and to any chosen elevation below ground. These are normally installed at a recommended depth ranging from 900 mm (3 ft) to a maximum of 1.5 m (5 ft) with an average depth being 1.2 m (4 ft). These depths ensure the pipe will not be contacted by tillers or plows when the field is being cultivated.

Figure 13 *Installing a main French drain. (Skilled Trades BC, 2021; Western Australian Agriculture Authority) WAAA Copyright (https://www.agric.wa.gov.au/copyright)*

Next, a mole is pulled across the field in a grid pattern perpendicular to the main trench. The mole creates tunnels at an elevation that intersects the main trench just above the pipe (Figure 14). Groundwater enters the network or **mole drains** and follows them to the main trench drain. Discharge from the trench drain is directed to a natural waterway, such as a ditch or stream.

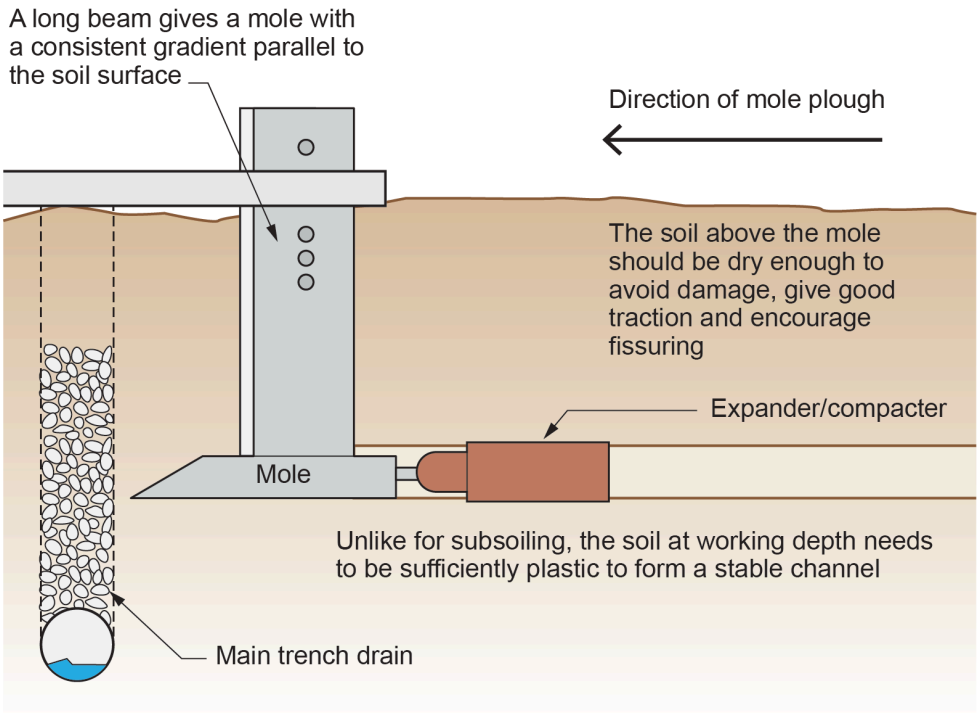

Figure 14 *Mole at work. (Skilled Trades BC, 2021) Used with permission.*

Self-Test D-3.7: Sub-Soil Drainage Systems

Complete Self-Test D-3.7 and check your answers.

If you are using a printed copy, please find Self-Test D-3.7 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=83#h5p-29 (https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=83#h5p-29)

References

Skilled Trades BC. (2021). *Book 2: Install fixtures and appliances, install sanitary and storm drainage systems.* Plumber apprenticeship program level 2 book 2 (Harmonized). Crown Publications: King's Printer for British Columbia.

Trades Training BC. (2021). D-3: Install storm drainage systems. In: *Plumber Apprenticeship Program: Level 2.* Industry Training Authority, BC.

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- **Figure 4:** Perforated PVC pipe by Rod Lidstone is used under a CC BY (https://creativecommons.org/licenses/by/4.0/deed.en) license.
- **Figure 13:** Installing a main French drain [Left image (https://www.agric.wa.gov.au/waterlogging/mole-drainage-western-australia), Right image (https://www.agric.wa.gov.au/sites/gateway/files/Bulletin%20-%204610%20Mole%20drainage%20for%20increased%20productivity%20in%20the%20south%20west%20irrigation%20area_0.pdf)] by the Western Australian Agriculture Authority was used by Skilled Trades BC ["for non-commerical educational purposes"] under WAAA Copyright (https://www.agric.wa.gov.au/copyright) terms and conditions.

D-3.8 Stormwater Site Retention Systems

Water evaporates from lakes, rivers, and oceans. It then becomes water vapour and forms clouds. It falls to the earth as precipitation and then evaporates again. This **hydrological cycle** never stops. Water keeps moving and changing phases from solid to liquid to gas, repeatedly. This process is described as the natural water balance. **Stormwater** is runoff generated by human development. It is created when land development alters the natural water balance and flow.

When vegetation and soils are replaced with roads and buildings, less rainfall infiltrates into the ground, less gets taken up by vegetation, and more becomes surface runoff. The biggest increments of change to the water balance in general — to the surface runoff component — occur when natural land is cleared and paved over. Environment Canada has estimated that urbanization of a natural drainage basin can increase stormwater **runoff** by 400% or more.

Until recently, the traditional approach to drainage has been to remove runoff as quickly as possible from developed areas. As a result, traditional urban design is very efficient in collecting, concentrating, conveying, and discharging stormwater to receiving waters. Runoff volume increases in proportion to impervious area (hard, non-absorbent surfaces). Traditional ditch and pipe systems have been designed to remove runoff from **impervious surfaces** as quickly as possible and deliver it to receiving waters. The resulting storm water arrives at the receiving waters much faster and in greater volumes than under natural conditions. This traditional grey infrastructure approach can cause flooding, loss of aquatic habitat, and water pollution in downstream receiving waters. Modern stormwater **source control** practices provide rainwater capture to reduce runoff volumes.

Stormwater Management Strategy

A stormwater management strategy seeks to mitigate the impacts of increased urban runoff and stormwater pollution by managing it as close to its source as possible.

The Local Government Act sets out specific provisions for planning, regulation, development approval, and servicing provisions applicable to storm water management, such as:

- Prohibition of pollution
- Soil deposit and removal (erosion control)
- Zoning
- Environmental policies
- Runoff control
- Landscaping
- Development permit areas
- Subdivision servicing requirements

In addition to the above, other municipal stormwater management powers can be found in provisions dealing with:

- Building regulations
- Contaminated sites
- Development cost charges
- Ditches and drainage
- Dikes
- Development works agreements
- Flood protection
- Farming
- Highways
- Improvement districts and specified areas
- Park land
- Regional district services
- Sewage systems
- Subdivision

- Temporary commercial and industrial use
- Tree cutting
- Utilities
- Water
- Waste management.

To achieve performance targets for rainfall capture, runoff control, and flood risk management, the targets must be translated into achievable design guidelines that developers and local government staff can understand and apply at the site level.

Reducing runoff volume is the key to achieving performance targets for rainfall capture. The following volume reduction strategies should be applied:

- Minimize the disturbance of natural soils and vegetation.
- Apply absorbent landscaping.
- Implement stormwater source control practices to capture runoff from impervious surfaces.

Minimize the Disturbance of Natural Soils and Vegetation

At the land use planning and site design levels, it is important to identify and preserve the natural areas that are most important to maintaining the natural water balance, such as wetlands, natural **infiltration** areas, and riparian forests. Low-impact site design practices that limit the creation of impervious area, the compaction of natural soils, and the clearing of natural vegetation should also be applied.

Apply Absorbent Landscaping

For landscaped areas, an absorbent surface soil layer should be provided. This absorbent soil layer should:

- Be deep enough to store the mean annual rainfall (24-hour duration).
- Meet the BC Landscape Standard for medium or better landscapes, which will ensure the type of hydrologic characteristics required for rainfall capture.

Stormwater Source Control Practices

Source control options include:

- Detention systems
- Retention/infiltration systems
- Green roofs
- Rainwater reuse

Detention or Retention

It is often difficult to identify the difference between the different types of stormwater control solutions because they use much of the same equipment, such as ponds, tanks, and infiltration chambers.

Detention systems are employed on a site to reduce the quantity of stormwater runoff leaving a site by temporarily storing the runoff that exceeds a site's allowable discharge rate and releasing or pumping it slowly over time, with little or no possibility of onsite infiltration.

The significant difference with a stormwater **retention system** is that it allows the water to slowly discharge into the soil instead of detaining it for a time before releasing it. This also helps to recharge the area's water table, which is something that runoff cannot do.

Underground stormwater retention and detention systems are a key component of reducing runoff in modern site development. Stormwater retention and detention systems are present in the industry as either above-ground ponds (Figure 1) or as subsurface storage and piping (Figure 2).

The use of ponds is the least expensive method, though it is the most inefficient use of developable land, is prone to siltation and clogging, and poses long-term aesthetic problems, such as insect breeding, weed growth, odour, and refuse issues. Whereas subsurface retention and detention systems use available land efficiently while introducing low maintenance costs and posing little or no aesthetic problems

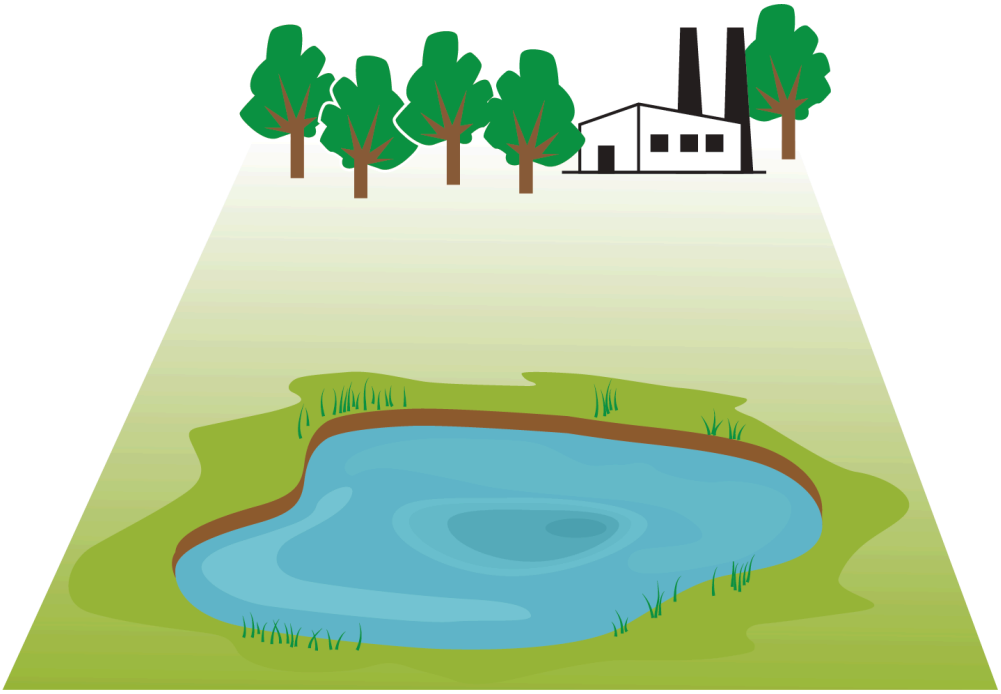

Figure 1 *Retention pond. (Skilled Trades BC, 2021) Used with permission.*

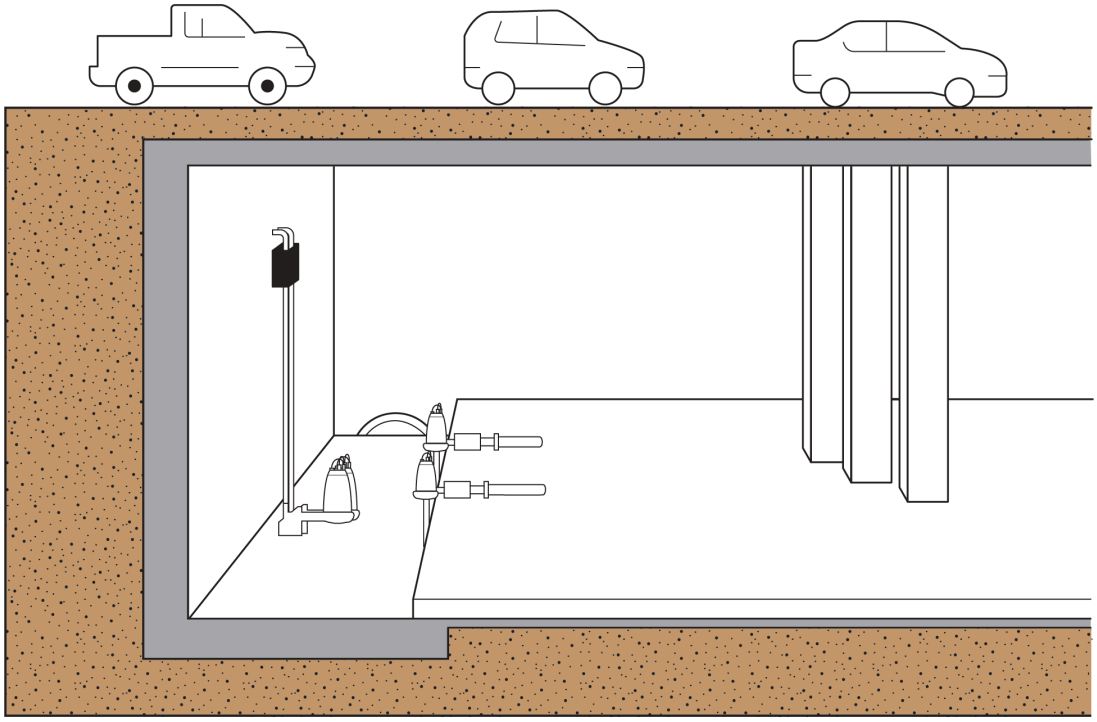

Figure 2 *Stormwater retention tank. (Skilled Trades BC, 2021) Used with permission.*

The components of these systems typically involve underground tanks, arches, or contained pipe systems in conjunction with geo-fabrics, filters, and aggregate layers. These systems are designed to help avoid the flooding and erosion that can be caused by excess runoff. With the integrated filtration elements, the discharged water will not have an adverse effect on streams, rivers, or wetlands and all the aquatic life they support.

Storage infiltration systems are incorporated into a retention solution to reduce the volume of stormwater runoff being discharged from a site. The infiltration system can consist of structurally reinforced chambers (Figure 3), vaults, crates, perforated pipes, or other void-forming structures embedded in coarse aggregate (https://wiki.sustainabletechnologies.ca/wiki/Reservoir_gravel).

Figure 3 *Arched infiltration chambers. (Arbitrarily0/Wikimedia Commons) CC BY-SA 3.0 (https://creativecommons.org/licenses/by-sa/3.0/deed.en)*

This runoff reduction strategy is a major part of a low-impact development design. Infiltration is likely the only way to achieve the target condition of restoring 90% of total rainfall volume to natural hydrologic pathways and is the most appropriate source control for single-family land uses, which is the dominant land use in most developed watersheds in most provinces. The level of reduction in the volume and rate of runoff achievable using infiltration depends on soil conditions, and therefore, soils information is key to the planning and design of infiltration facilities.

Because of the complexity of calculating target runoff discharge rates, site-retention systems for large developments (Figure 4) are typically designed by engineers and constructed by contractors to engineers' and local authorities' requirements. Design guidelines for systems serving single- family dwellings may be specified by local authorities due to their relatively low discharge rates. Rock pits and disposal fields, similar to those used in a septic disposal system, are most commonly used for small-scale runoff reduction. Using overflow piping to a discharge location ensures that the retention system does not back up and flood the property and equipment being served.

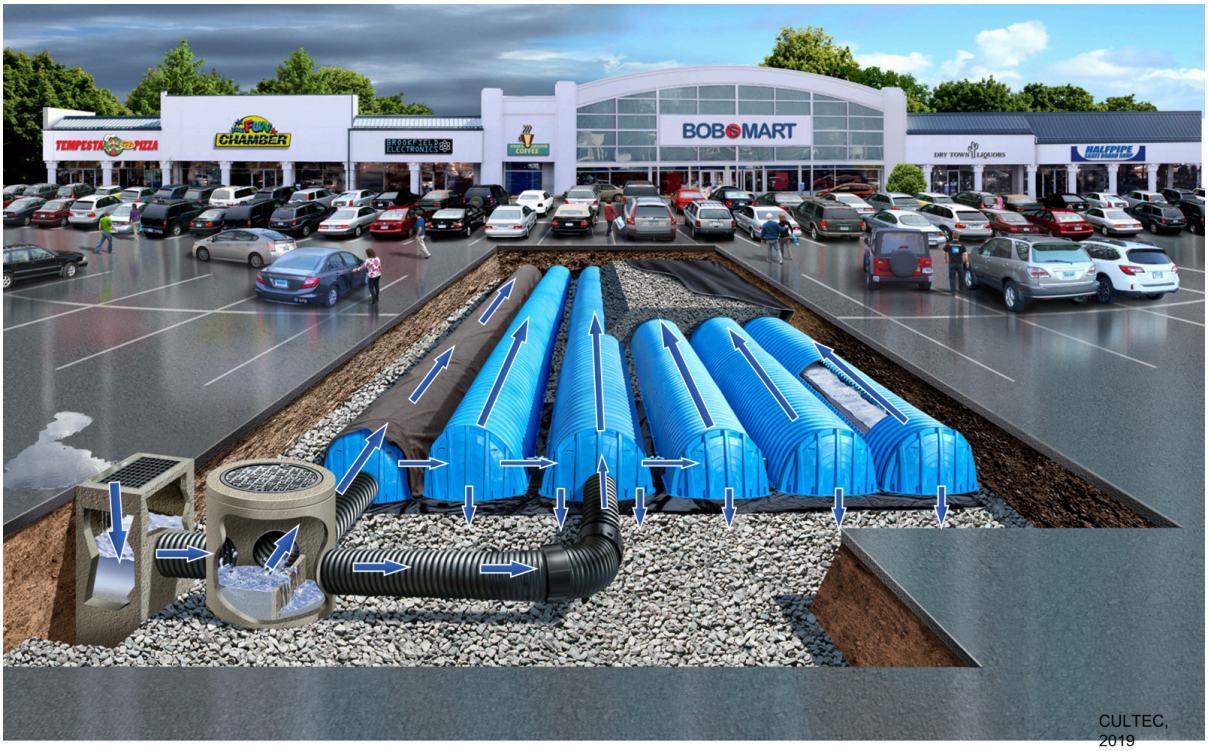

Figure 4 *Engineered stormwater retention system. (DanielFilippi/Sustainable Technologies Evaluation Program Wiki) CC BY 4.0 (https://creativecommons.org/licenses/by/4.0/)*

Green Roofs

The volume and rate of rooftop runoff can be reduced by installing absorbent landscaping on the rooftops of buildings or parkades. **Green roofs** (Figure 5) will store and provide evapotranspiration for rainfall from small events and will slow the rate of release of medium-sized events. Green roofs are most effective for land uses with high levels of rooftop coverage, such as multi-family and commercial land uses (especially with underground or structured parkades).

Figure 5 *Green roof. (Sky Garden Ltd/Wikimedia Commons) CC BY-SA 4.0 (https://creativecommons.org/licenses/by-sa/4.0/deed.en)*

A storage layer of perforated plastic or drain rock under the green roof soil can increase the effective rainfall capture and storage volume. The drainage outflow from the green roof should be connected to infiltration facilities in suitable areas of the site with an overflow to the storm drain system. Runoff from roof water should be kept separate from paved surfaces runoff, which can be polluted with hydrocarbons and heavy metals. Whereas paved surface runoff may require treatment, most green roof runoff will be clean enough to be released directly to storage and receiving waters.

Drain inlets from green roofs will require regular inspection. Watering may be required, using either surface standard watering devices or an automatic irrigation system.

Rainwater Reuse

Capturing and reusing rooftop runoff for **greywater** uses (e.g., toilets and laundry) or for irrigation can reduce runoff volume. The opportunities for runoff volume reduction through reuse are most significant for high-density residential and commercial land uses with high water usage.

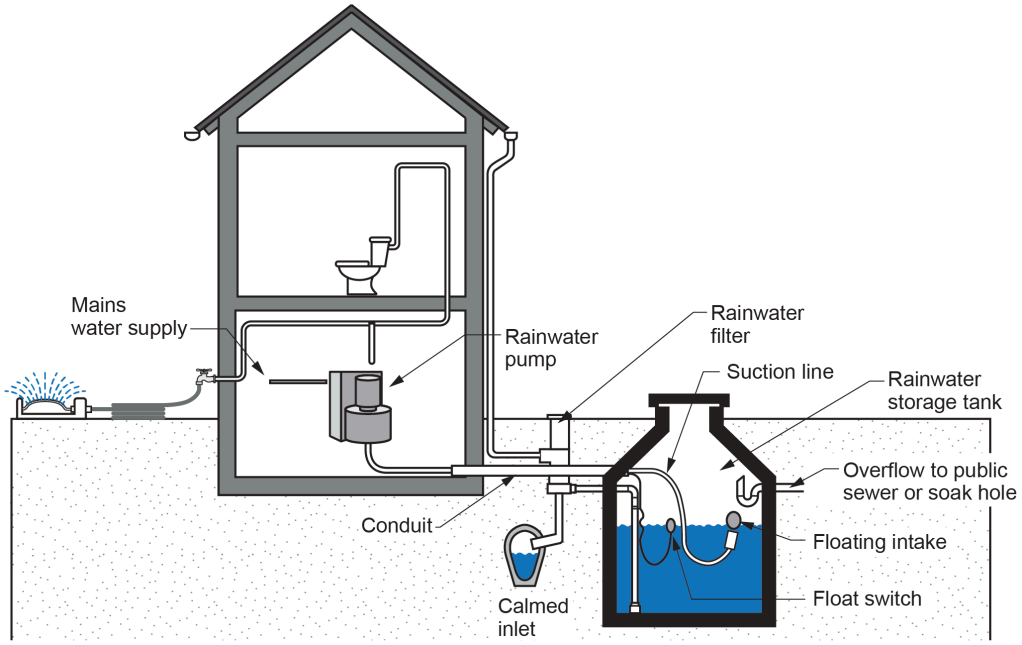

Figure 6 *Rainwater reuse system. (Skilled Trades BC, 2021) Used with permission.*

The benefits of **rainwater reuse** go beyond stormwater management in that reuse can also reduce the amount of water drawn from reservoirs and reduce the costs of water supply infrastructure.

Summary

Because there are many types of stormwater control solutions being applied in different regions, it is important to check with local building inspection departments for any regulations regarding site stormwater handling.

You can also find additional information in publications such as Storm Water Planning: A Guidebook for British Columbia (https://www2.gov.bc.ca/assets/gov/environment/waste-management/sewage/stormwater_planning_guidebook_for_bc.pdf).

Self-Test D-3.8: Stormwater Site Retention Systems

Complete Self-Test D-3.8 and check your answers.

If you are using a printed copy, please find Self-Test D-3.8 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=85#h5p-30 (https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=85#h5p-30)

References

Skilled Trades BC. (2021). *Book 2: Install fixtures and appliances, install sanitary and storm drainage systems.* Plumber apprenticeship program level 2 book 2 (Harmonized). Crown Publications: King's Printer for British Columbia.

Stephens, K. A., Graham, P., & Reid, D. (2002). *Stormwater planning: A guidebook for British Columba.* British Columbia Ministries of Community, Aboriginal and Women's Services and Water, Land and Air Protection. https://www2.gov.bc.ca/assets/gov/environment/waste-management/sewage/stormwater_planning_guidebook_for_bc.pdf

Trades Training BC. (2021). D-3: Install storm drainage systems. In: *Plumber Apprenticeship Program: Level 2.* Industry Training Authority, BC.

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- **Figure 3:** Arched infiltration chambers (https://commons.wikimedia.org/wiki/File:Parking_lot_stormwater_detention_system.jpg) by Arbitrarily0, via Wikimedia Commons, was used by Skilled Trades BC (2021) under a CC BY-SA 3.0 (https://creativecommons.org/licenses/by-sa/3.0/deed.en) license
- **Figure 4:** Engineered stormwater retention system (https://wiki.sustainabletechnologies.ca/wiki/

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- **Figure 5:** Green Roof (https://commons.wikimedia.org/wiki/File:British_Horse_Society_Head_Quarters_and_Green_Roof.jpg) by Sky Garden Ltd, via Wikimedia Commons was used by Skilled Trades BC (2021) under a CC BY-SA 4.0 (https://creativecommons.org/licenses/by-sa/4.0/deed.en) license.

Self-Test D-3.1 Storm Drainage Terminology

Complete Self-Test D-3.1 and check your answers.

1. What is the term given to wastewater with impurity levels that will not be harmful to health and may include HVAC condensate but does not include stormwater?
    a. Sewage
    b. Clearwater waste
    c. Effluent
    d. Potable water

2. What is the term given to a building drain that conducts stormwater and is connected at its upstream end to a leader, sump, or catch basin and at its downstream end to a building sewer or a designated stormwater disposal location?
    a. Sanitary building drain
    b. Storm branch
    c. Combined building drain
    d. Storm building drain

3. A roof drain, as defined by the NPC, is a drain installed to receive water collecting on the surface of a roof and to discharge the water into what location?
    a. Leader
    b. Storm building drain
    c. Combined building sewer
    d. Gutter

4. How far does a storm building drain continue outside the building wall before it can be considered a storm building sewer?
    a. 300 mm
    b. 1 m
    c. 3 m
    d. To the property line

5. What is the term given to a building drain that conducts stormwater and sewage?
    a. Sanitary building drain
    b. Storm branch
    c. Combined building drain
    d. Storm building drain

Answer Key: Self-Test D-3.1 (#chapter-answer-key-self-test-d-3-1) is on the next page.

Answer Key: Self-Test D-3.1

1. b. Clearwater waste
2. d. Storm building drain
3. a. Leader
4. b. 1 m
5. c. Combined building drain

Self-Test D-3.2 Functions of Pipes in Storm Drainage Systems

Complete Self-Test D-3.2 and check your answers.

1. What is the function of the dome installed over the drain opening in a flat roof drain?
    a. Acts as a warning device for a trip hazard for anyone on the roof
    b. Acts as a roof drain locating device when the roof is flooded due to a drain blockage
    c. Prevents debris from entering the drainage system from the roof
    d. Prevents winter ice and snow buildup on the drain inlet

2. A horizontal leader installed in conjunction with a siphonic roof drain is designed to flow at what capacity?
    a. 25% full
    b. 50% full
    c. 75% full
    d. 100% full

3. A flow-control roof drain system requires special building design considerations. Which of the following would be most important?
    a. Slope of the roof
    b. Structural design of the roof
    c. Height of the parapet wall
    d. Area of the roof

4. Other than acting as a stormwater collection device for a paved area, what other function does a catch basin serve for the storm drainage system?
    a. Traps debris that might otherwise enter the drainage system
    b. Discourages the entrance of rodents into the storm drainage system
    c. Allows all larger flows to be drained from the system without increasing the pipe size

5. What is the purpose of a CSO in regard to a municipal combined sewer system?
    a. Acts as a collection reservoir to detain untreated sewage until it can be properly treated at a sewage treatment plant
    b. Acts as a diverting device so the stormwater flow in the combined system is diverted around the sewage treatment plant without being treated
    c. Acts as an overflow mechanism so the combined drainage flow is allowed to flow to a discharge point in its raw form without treatment
    d. Acts as a metering chamber at the point of entry and allow only as much flow into the combined system as the sewage treatment plant can accommodate

Answer Key: Self-Test D-3.2 is on the next page.

Answer Key: Self-Test D-3.2

1. c. Prevents debris from entering the drainage system from the roof
2. d. 100% full
3. b. Structural design of the roof
4. a. Traps debris that might otherwise enter the drainage system
5. c. Acts as an overflow mechanism so the combined drainage flow is allowed to flow to a discharge point in its raw form without treatment

Self-Test 3.3 Storm Drainage Code Requirements

Complete Self-Test D-3.3 and check your answers.

1. Using Figure 2P-46, fill in Table 1 by identifying and sizing the storm drainage installation as per the NPC.

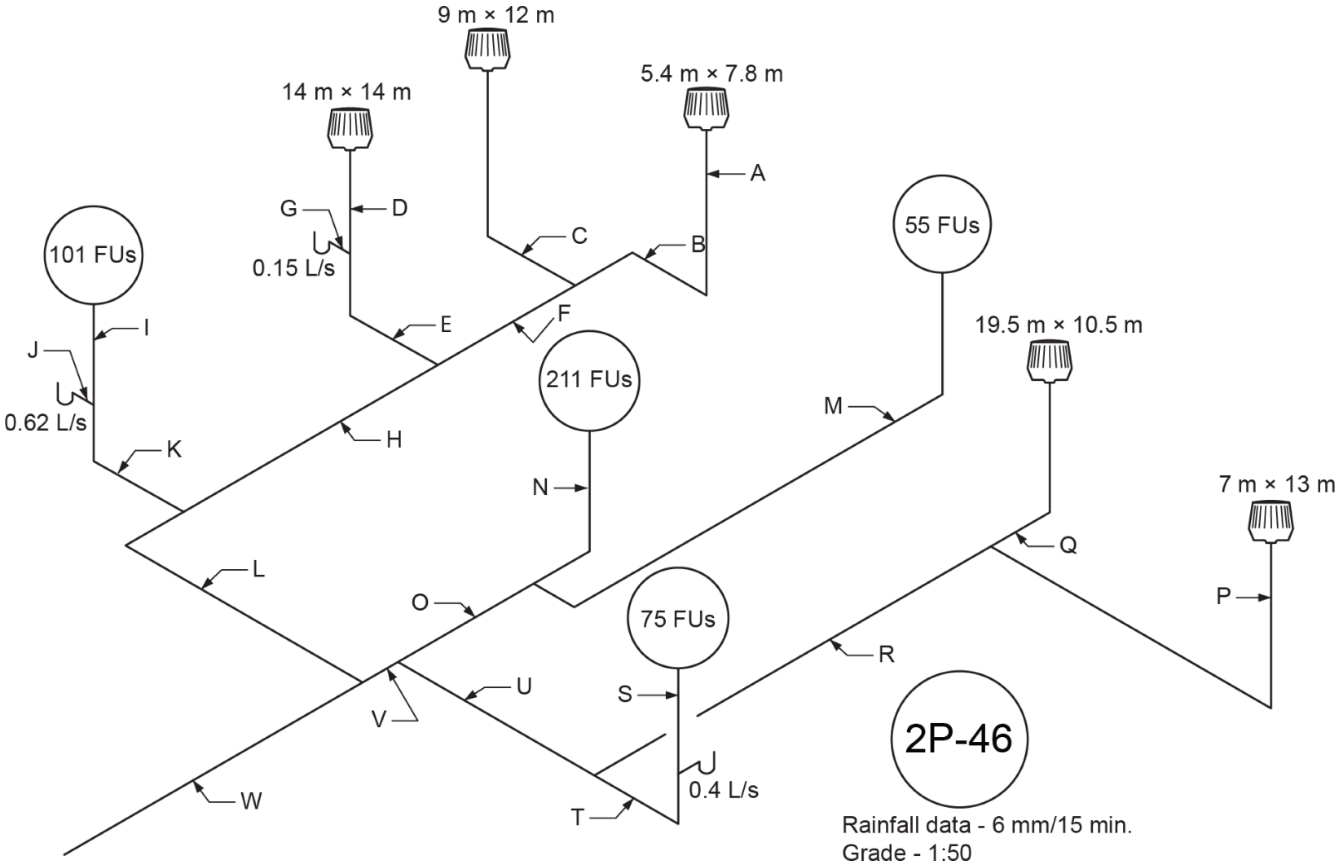


Figure 2P-46

Table 1

Letter	Name	Leader (m^2)	Load	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				
N				
O				
P				
Q				
R				
S				
T				
U				
V				
W				

2. Using Figure 2P-47, fill in Table 2 by identifying and sizing the storm drainage installation as per the NPC.

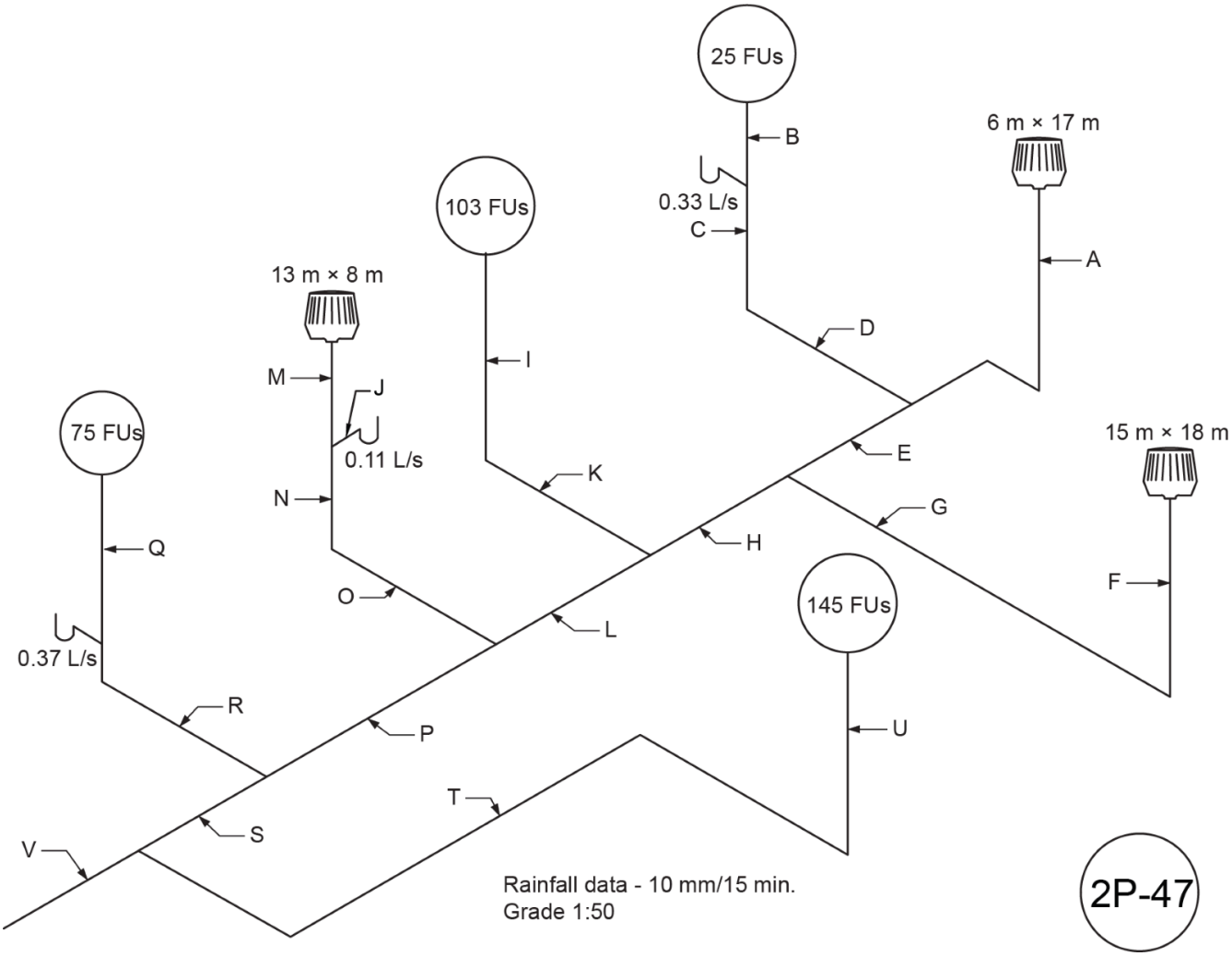

25 FUs
B
6 m × 17 m
0.33 L/s
C
103 FUs
A
13 m × 8 m
D
I
M
J
75 FUs
0.11 L/s
15 m × 18 m
E
K
N
G
Q
H
F
O
145 FUs
L
0.37 L/s
R
P
U
T
S
V
Rainfall data - 10 mm/15 min.
Grade 1:50
2P-47

Figure 2P-47

Table 2

Letter	Name	Leader (m^2)	Load	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				
N				
O				
P				
Q				
R				
S				
T				
U				
V				

3. Using Figure 2P-48, fill in Table 3 by identifying and sizing the storm drainage installation as per the NPC.

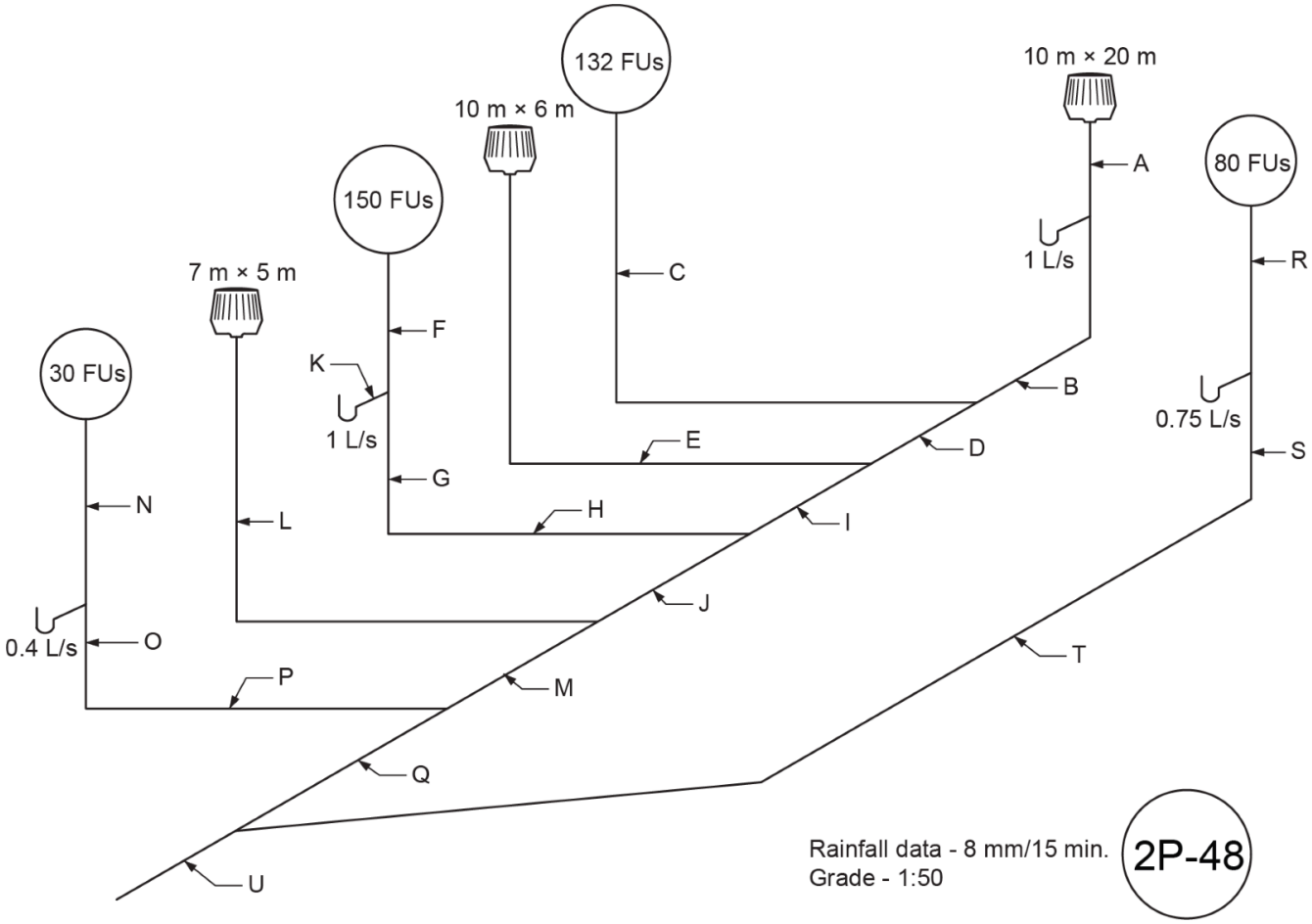

132 FUs
10 m × 6 m
10 m × 20 m
150 FUs
80 FUs
7 m × 5 m
A
R
1 L/s
C
F
K
30 FUs
B
0.75 L/s
1 L/s
E
D
S
G
N
H
L
I
J
0.4 L/s
O
T
P
M
Q
U
Rainfall data - 8 mm/15 min.
Grade - 1:50
2P-48

Figure 2P-48

Table 3

Letter	Name	Leader (m^2)	Load	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				
N				
O				
P				
Q				
R				
S				
T				
U				

4. Using Figure 2P-49, fill in Table 4 by identifying and sizing the storm drainage installation as per the NPC.

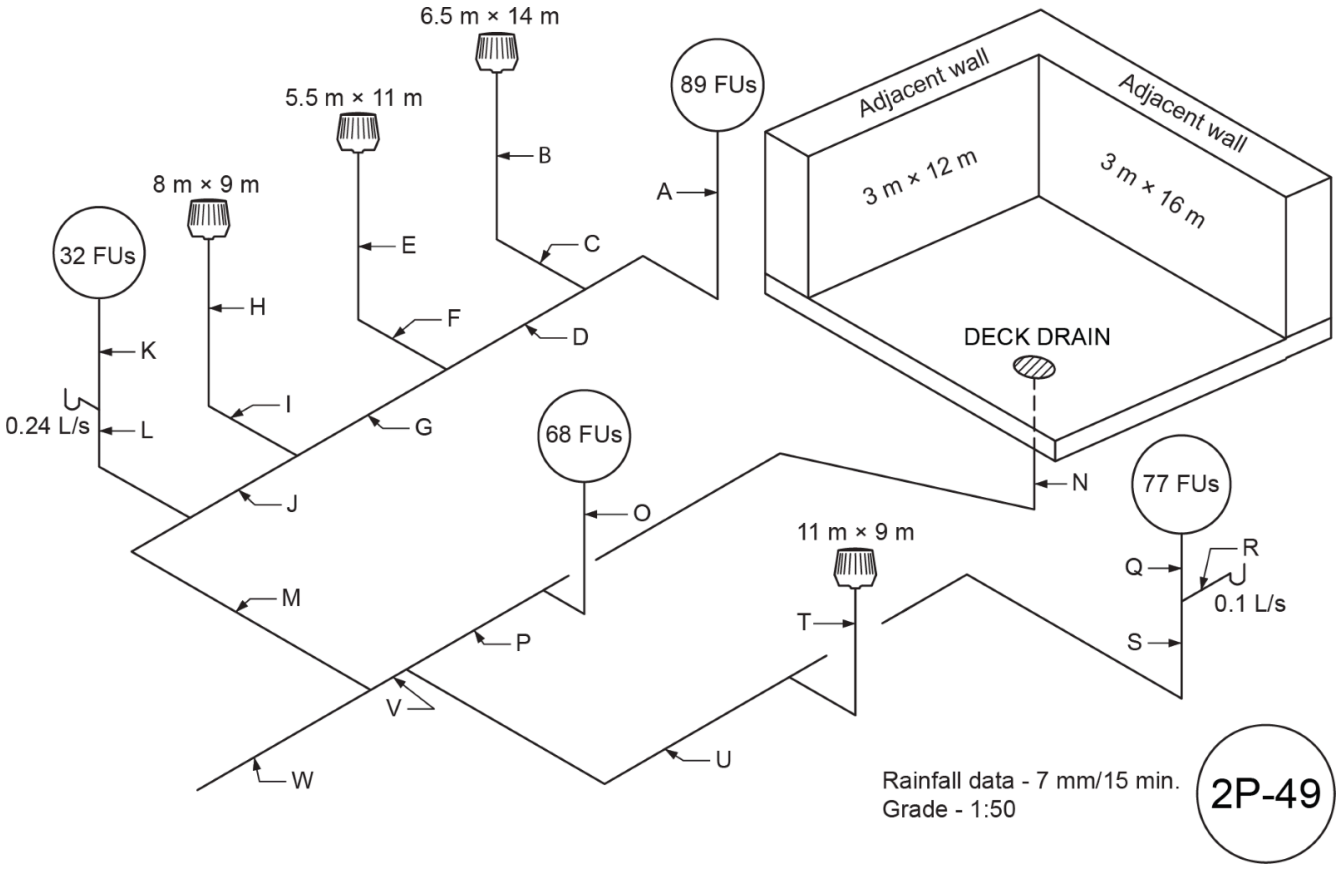

6.5 m × 14 m
5.5 m × 11 m
8 m × 9 m
89 FUs
32 FUs
Adjacent wall
Adjacent wall
3 m × 12 m
3 m × 16 m
DECK DRAIN
A
B
C
D
E
F
G
H
I
J
K
L
0.24 L/s
M
N
68 FUs
O
P
11 m × 9 m
T
77 FUs
Q
R
0.1 L/s
S
U
V
W
Rainfall data - 7 mm/15 min.
Grade - 1:50
2P-49

Figure 2P-49

Table 4

Letter	Name	Leader (m^2)	Load	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				
N				
O				
P				
Q				
R				
S				
T				
U				
V				
W				

5. Using Figure 2P-50, fill in Table 5 by identifying and sizing the storm drainage installation as per the NPC.

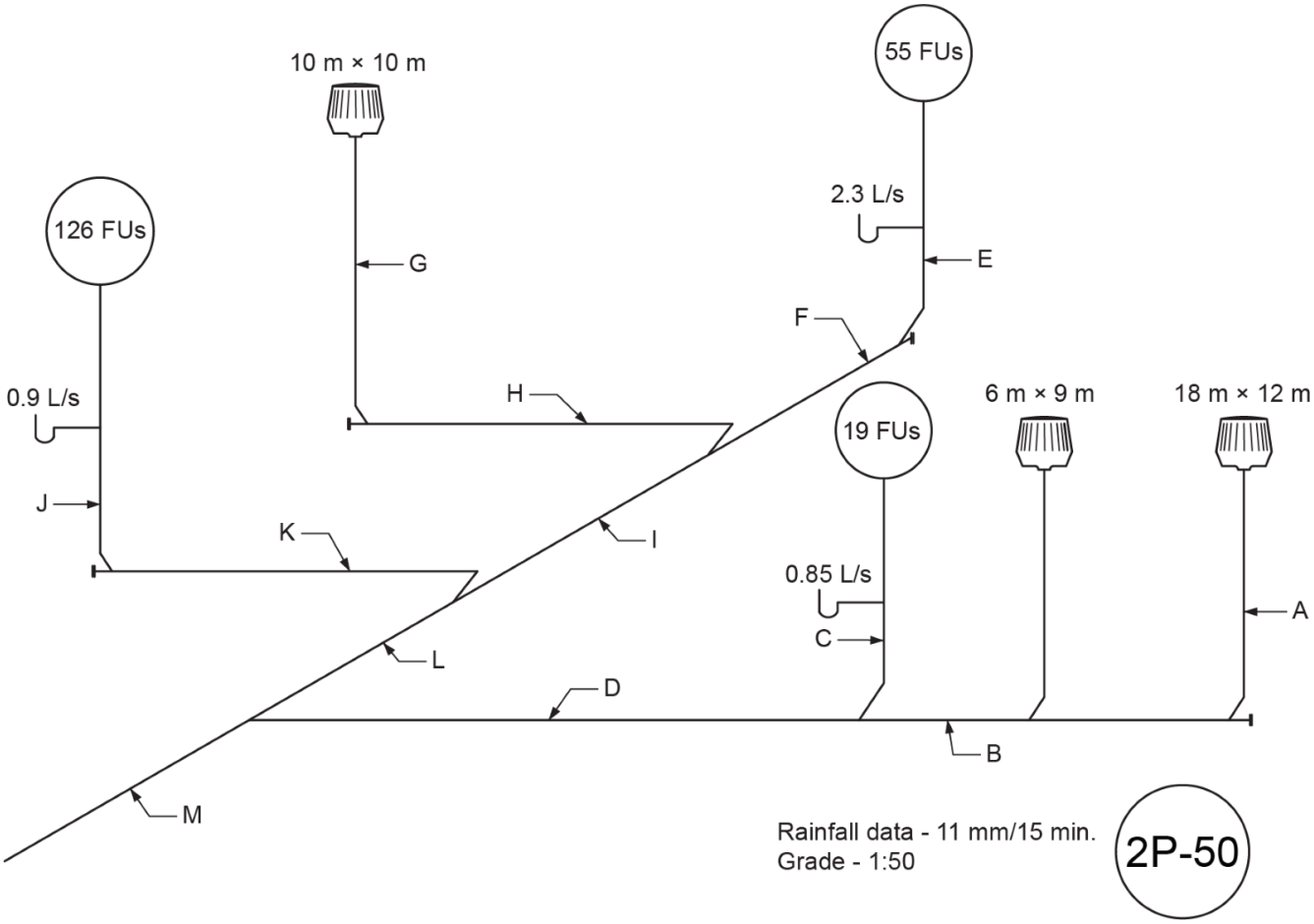


Figure 2P-50

Table 5

Letter	Name	Leader (m^2)	Load	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				

6. Using Figure 2P–51, fill in Table 6 by identifying and sizing the storm drainage installation as per the NPC.

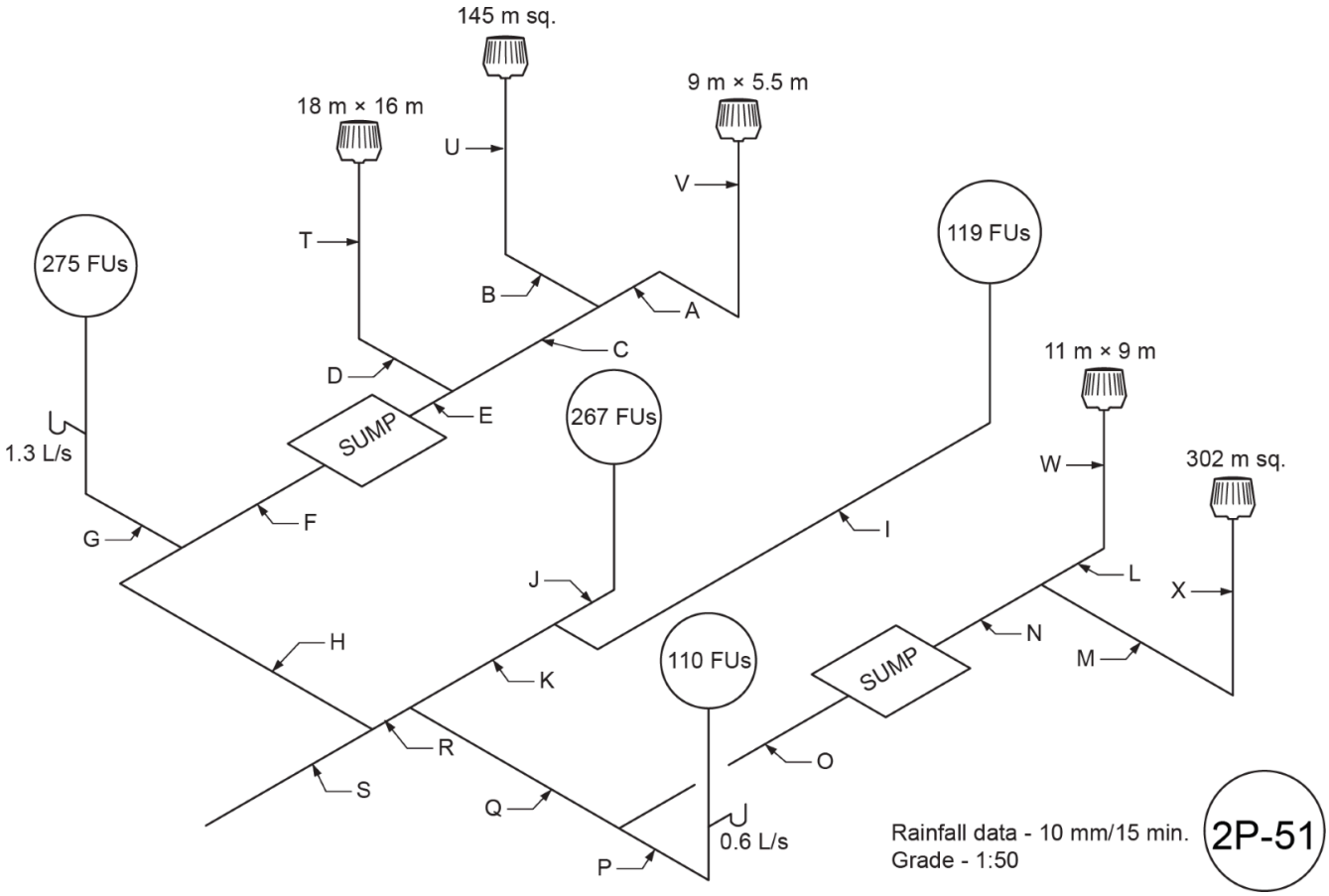

145 m sq.
18 m × 16 m
9 m × 5.5 m
U
V
T
275 FUs
119 FUs
B
A
C
D
11 m × 9 m
SUMP
E
267 FUs
W
302 m sq.
1.3 L/s
F
G
I
J
L
X
H
N
110 FUs
SUMP
M
K
R
O
S
Q
0.6 L/s
P
Rainfall data - 10 mm/15 min.
Grade - 1:50
2P-51

Figure 2P-51

Table 6

Letter	Name	Leader (m^2)	Load	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				
N				
O				
P				
Q				
R				
S				
T				
U				
V				
W				
X				

7. Using Figure 2P-52, fill in Table 7 by identifying and sizing the storm drainage installation as per the NPC.

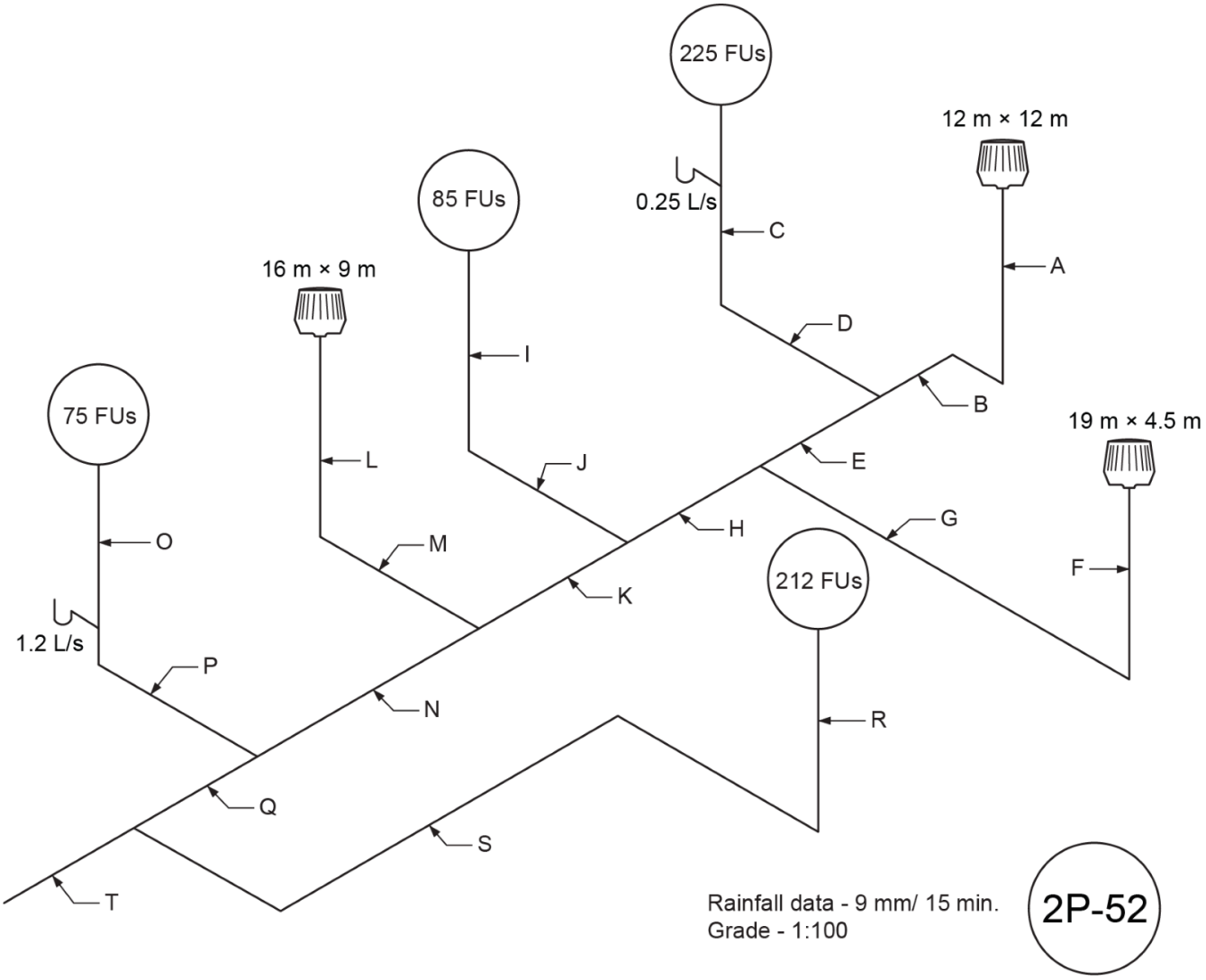

225 FUs
12 m × 12 m
85 FUs
0.25 L/s
C
A
16 m × 9 m
I
D
75 FUs
B
19 m × 4.5 m
L
J
E
O
M
H
G
F
212 FUs
K
1.2 L/s
P
N
R
Q
S
T
Rainfall data - 9 mm/ 15 min.
Grade - 1:100
2P-52

Figure 2P-52

Table 7

Letter	Name	Leader (m^2)	Load	Size
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				
N				
O				
P				
Q				
R				
S				
T				

8. What must be provided for when a roof drain is securely connected to a leader?

   a. Expansion
   b. Overflow
   c. Future loads
   d. Flow control

9. What feature must be installed when a drinking fountain is subject to backflow and directly connected to a storm drainage system?

   a. Air gap
   b. Air break
   c. Backwater valve
   d. Stop lift

10. If an indirectly connected 1.5 in. pipe forms an air break above a directly connected fixture to a storm drainage system, what is the minimum dimension of the air break?

    a. 1 in.
    b. 1.25 in.
    c. 1.5 in.

d. 2 in.

11. What is the maximum spacing of riser clamp supports for a vertical three-storey rainwater leader?

    a. 6.5 m
    b. 7.0 m
    c. 7.5 m
    d. 8.0 m

12. What is the maximum hanger spacing for horizontal cast-iron soil pipe?

    a. 1 m
    b. 2 m
    c. 3 m
    d. 4 m

13. A drainage pipe that conducts both sewage and storm water is prohibited to be installed in what plane?

    a. Vertical
    b. Horizontal

14. Which NPC table would be referred to when determining the maximum hydraulic load drained to a roof gutter?

    a. 2.4.10.6.C
    b. 2.4.10.9
    c. 2.4.10.10
    d. 2.4.10.11

15. Does the NPC allow drainage pans serving heating and cooling units to drain to a storm drainage system?

    a. Yes
    b. No

16. Does the NPC allow an overflow from a rainwater tank to be directly connected to a storm drainage system?

    a. Yes
    b. No

17. If a leader receives semi or continuous flow from an appliance, what is the minimum size of trap required if the flow rate is 2.2 L/s?

    a. 2 in.
    b. 3 in.
    c. 4 in.
    d. 6 in.

18. What is the minimum size of circular leader that receives a load of 30,000 L?

a. 2 in.
b. 3 in.
c. 4 in.
d. 6 in.

19. Does the NPC allow a food display compartment to be directly connected to a storm drainage system?

a. Yes
b. No

20. Does the NPC require a vent to protect a 2 in. floor drain connected to a storm drainage system?

a. Yes
b. No

21. A 16 m by 18 m flat roof is served by a roof drain with three adjacent walls. The dimensions of the walls are: 16 m by 3 m, 18 m by 1 m, and 18 m by 1.5 m. What would be the load on the roof drain if the rainfall intensity was 7 mm/15 min?

a. 2,016 L
b. 2,184 L
c. 2,205 L
d. 2,352 L

22. The RWL serving the roof drain in the previous question has an HVAC unit draining into it with a semi-continuous flow of 0.4 L/s. What load is to be considered at the base of the RWL?

a. 2,360 L
b. 2,544 L
c. 3,360 L
d. 4,376 L

23. A combined building drain receives discharges of 477 FU, 1.3 L/s of continuous flow, and 3,200 L/15 min of storm drainage. What would be the load to consider when sizing the combined building drain?

a. 2,360.5 L
b. 6,730.8 L
c. 7,810.4 L
d. 8,710.7 L

24. An outdoor restaurant patio is served by a storm drain that eventually connects to a combined building sewer. Does the storm drain require a trap?

a. Yes
b. No
c. Not if the patio is on the roof
d. Not if the storm drain is not subject to backflow

25. You are installing a rainwater leader through a building. You have to offset the leader horizontally to accommodate a change in wall location. The offset you install measures 7.2 m. According to NPC requirements, what must the leader be sized as?

    a. Storm branch
    b. Leader but one size larger than it was prior to the offset
    c. Sanitary building drain
    d. Storm building drain

26. You are asked to install flow-control roof drains on a flat roof that measures 90 m by 60 m. What is the minimum number of drains required for this installation?

    a. 2
    b. 4
    c. 6
    d. 8

27. Referring to the above-mentioned installation, what would be the minimum number of overflow scuppers installed in conjunction with flow-control roof drains?

    a. 4
    b. 6
    c. 8
    d. 10

Answer Key: Self-Test D-3.3 (#chapter-answer-key-self-test-d-3-3) is on the next page.

Answer Key: Self-Test D-3.3

1. Figure 2P-46

Table 1 Answers

Letter	Name	Leader (m^2)	Load	Size
A	RWL	42.12	252.72 L	2 in.
B	Storm building drain	N/A	252.72 L	3 in.
C	Storm building drain	N/A	648 L	3 in.
D	RWL	196	1,176 L	2 in.
E	Storm building drain	N/A	1,311 L	3 in.
F	Storm building drain	N/A	900.72 L	3 in.
G	Trap arm fixture drain	N/A	135 L	2 in.
H	Storm building drain	N/A	2211.72 L	3 in.
I	Stack	N/A	101 FU	3 in.
J	Trap arm fixture drain	N/A	19.65 FU	3 in.
K	Sanitary building drain	N/A	120.65 FU	4 in.
L	Combined building drain	N/A	5,129.72 L	4 in.
M	Sanitary building drain	N/A	55 FU	4 in.
N	Stack	N/A	211 FU	4 in.
O	Sanitary building drain	N/A	266 FU	5 in.
P	RWL	91	546 L	2 in.
Q	Storm building drain	N/A	1,228.5 L	3 in.
R	Storm building drain	N/A	1,774.5 L	3 in.
S	Stack	N/A	75 FU	3 in.
T	Sanitary building drain	N/A	87.68 FU	4 in.
U	Combined building drain	N/A	4,494.5 L	4 in.
V	Combined building drain	N/A	5,237.6 L	5 in.
W	Combined building drain	N/A	8,926.42	5 in.

2. Figure 2P-47

Table 2 Answers

Letter	Name	Leader (m^2)	Load	Size
A	RWL	102	1,020 L	2 in.
B	Stack	N/A	25 FU	3 in.
C	Stack	N/A	35.46 FU	3 in.
D	Sanitary building drain	N/A	35.46 FU	4 in.
E	Combined building drain	N/A	3,677 L	4 in.
F	RWL	270	2,700 L	2.5 in.
G	Storm building drain	N/A	2,700 L	3 in.
H	Combined building drain	N/A	6,377 L	5 in.
I	Stack	N/A	103 FU	4 in.
J	Trap arm fixture drain	N/A	99 L	2 in.
K	Sanitary building drain	N/A	103 FU	4 in.
L	Combined building drain	N/A	6,377 L	5 in.
M	RWL	104	1,040 L	2 in.
N	RWL	104	1,139 L	2 in.
O	Storm building drain	N/A	1,139 L	3 in.
P	Combined building drain	N/A	7,516 L	5 in.
Q	Stack	N/A	75 FU	3 in.
R	Sanitary building drain	N/A	86.73 FU	4 in.
S	Combined building drain	N/A	7,849 L	5 in.
T	Sanitary building drain	N/A	145 FU	4 in.
U	Stack	N/A	145 FU	4 in.
V	Combined building drain	N/A	8,655.8 L	5 in.

3. Figure 2P-48

Table 3 Answers

Letter	Name	Leader (m^2)	Load	Size
A	RWL	200	1,600 L	2 in.
B	Storm building drain	N/A	2,500 L	4 in.
C	Stack	N/A	132 FU	4 in.
D	Combined building drain	N/A	4,680 L	4 in.
E	Storm building drain	N/A	480 L	3 in.
F	Stack	N/A	150 FU	4 in.
G	Stack	N/A	181.7 FU	4 in.
H	Sanitary building drain	N/A	181.7 FU	4 in.
I	Combined building drain	N/A	5,340 L	4 in.
J	Combined building drain	N/A	6,446.2 L	5 in.
K	Trap arm fixture drain	N/A	31.7 FU	4 in.
L	RWL	35	280 L	2 in.
M	Combined building drain	N/A	6,726.2 L	5 in.
N	Stack	N/A	30 FU	3 in.
O	Stack	N/A	42.68 FU	3 in.
P	Sanitary building drain	N/A	42.68 FU	4 in.
Q	Combined building drain	N/A	7,359.2 L	5 in.
R	Stack	N/A	80 FU	3 in.
S	Stack	N/A	103.78 FU	4 in.
T	Sanitary building drain	N/A	103.78 FU	4 in.
U	Combined building drain	N/A	8,762.2 L	5 in.

4. Figure 2P-49

Table 4 Answers

Letter	Name	Leader (m^2)	Load	Size
A	Stack	N/A	89 FU	3 in.
B	RWL	91	637 L	2 in.
C	Storm building drain	N/A	637 L	3 in.
D	Combined building drain	N/A	2,997 L	4 in.
E	RWL	60.5	423.5 L	2 in.
F	Storm building drain	N/A	423.5 L	3 in.
G	Combined building drain	N/A	3,420.5 L	4 in.
H	RWL	72	504 L	2 in.
I	Storm building drain	N/A	504 L	3 in.
J	Combined building drain	N/A	3,924.5 L	4 in.
K	Stack	N/A	32 FU	3 in.
L	Stack	N/A	39.61 FU	3 in.
M	Combined building drain	N/A	4,140.5 L	4 in.
N	RWL	216	1,512 L	2 in.
O	Stack	N/A	68 FU	3 in.
P	Combined building drain	N/A	3,872 L	4 in.
Q	Stack	N/A	77 FU	3 in.
R	Trap arm fixture drain	N/A	3.17 FU	2 in.
S	Stack	N/A	80.17 FU	3 in.
T	RWL	99	693 L	2 in.
U	Combined building drain	N/A	3,143 L	4 in.
V	Combined building drain	N/A	4,655 L	4 in.
W	Combined building drain	N/A	6,496.1 L	5 in.

5. Figure 2P-50

Table 5 Answers

Letter	Name	Leader (m^2)	Load	Size
A	RWL	N/A	2,376 L	2.5 in.
B	Storm building drain	N/A	2,970 L	4 in.
C	Stack	N/A	45.95 FU	4 in. — 26.945 FU from one floor
D	Combined building drain	N/A	6,095 L	5 in.
E	Stack	N/A	127.91 FU	4 in.
F	Sanitary building drain	N/A	127.91 FU	4 in.
G	RWL	100	1,100 L	2 in.
H	Storm building drain	N/A	1,100 L	3 in.
I	Combined building drain	N/A	5,530 L	4 in.
J	Stack	N/A	154.53 FU	4 in.
K	Sanitary building drain	N/A	154.53 FU	4 in.
L	Combined building drain	N/A	6,340 L	5 in.
M	Combined building drain	N/A	10,075 L	5 in.

6. Figure 2P-51

Table 6 Answers

Letter	Name	Leader (m^2)	Load	Size
A	Storm building drain	N/A	495 L	3 in.
B	Storm building drain	N/A	1,450 L	3 in.
C	Storm building drain	N/A	1,945 L	3 in.
D	Storm building drain	N/A	2,880 L	4 in.
E	Storm building drain	N/A	4,825 L	4 in.
F	Storm building drain	N/A	4,825 L	4 in.
G	Sanitary building drain	N/A	216.21 FU	5 in.
H	Combined building drain	N/A	8,497.5 L	5 in.
I	Sanitary building drain	N/A	119 FU	4 in.
J	Sanitary building drain	N/A	267 FU	5 in.
K	Sanitary building drain	N/A	386 FU	5 in.
L	Storm building drain	N/A	990 L	3 in.
M	Storm building drain	N/A	3,020 L	4 in.
N	Storm building drain	N/A	4,010 L	4 in.
O	Storm building drain	N/A	4,010 L	4 in.
P	Sanitary building drain	N/A	129.02	4 in.
Q	Combined building drain	N/A	6,910 L	5 in.
R	Combined building drain	N/A	9,063.6 L	5 in.
S	Combined building drain	N/A	17,561.1 L	6 in.
T	RWL	288	2,280 L	2.5 in.
U	RWL	145	1,450 L	2 in.
V	RWL	49.5	495 L	2 in.
W	RWL	99	990 L	2 in.
X	RWL	302	3,020 L	2.5 in.

7. Drawing 2P-52

Table 7 Answers

Letter	Name	Leader (m^2)	Load	Size
A	RWL	144	1,296 L	2 in.
B	Storm building drain	N/A	1,296 L	4 in
C	Stack	N/A	232.93 FU	4 in.
D	Sanitary building drain	N/A	232.93 FU	5 in.
E	Combined building drain	N/A	3,881 L	5 in.
F	RWL	85.5	769.5 L	2 in.
G	Storm building drain	N/A	769.5 L	4 in.
H	Combined building drain	N/A	4,650 L	5 in.
I	Stack	N/A	85 FU	3 in.
J	Sanitary building drain	N/A	85 FU	4 in.
K	Combined building drain	N/A	5,111.5 L	5 in.
L	RWL	144	1,296 L	2 in.
M	Storm building drain	N/A	1,296 L	4 in.
N	Combined building drain	N/A	6,407.5 L	5 in.
O	Stack	N/A	75 FU	3 in.
P	Sanitary building drain	N/A	113.04 FU	4 in.
Q	Combined building drain	N/A	8,170 L	6 in.
R	Stack	N/A	212 FU	4 in.
S	Sanitary building drain	N/A	212 FU	5 in.
T	Combined building drain	N/A	10,099.2 L	6 in.

8. a. Expansion
9. c. Backwater valve
10. c. 1.5 in.
11. c. 7.5 m
12. c. 3 m
13. a. Vertical
14. c. 2.4.10.10
15. a. Yes
16. b. No
17. c. 4 in.
18. d. 6 in.
19. b. No
20. b. No
21. b. 2,184 L

22. b. 2,544 L
23. d. 8,710.7 L
24. a. Yes
25. d. Storm building drain
26. c. 6
27. d. 10

Self-Test D-3.4 Planning the Storm System

Complete Self-Test D-3.4 and check your answers.

1. What is the recommended minimum number of roof drains for any size individual roof?
    a. 1
    b. 2
    c. 3
    d. 4

2. Which of the following advantages is not associated with interior rainwater leaders?
    a. Lower cost
    b. Appearance
    c. Convenience
    d. Freeze protection

3. If the decision is made to install a leader at a building column location, what professional should be consulted prior to the installation?
    a. Mechanical engineer
    b. Electrical engineer
    c. Structural engineer
    d. Architect

4. What type of fitting is installed in a storm drainage piping system to accommodate pipe movement without affecting the placement of a roof drain?
    a. MJ clamp
    b. Expansion joint
    c. Fernco coupling
    d. Slip coupling

5. What part of the building envelope would be damaged if a proper pipe anchoring system were not in place when installing a rainwater leader to a roof drain?
    a. Piping material
    b. Roof truss system
    c. Expansion joint
    d. Waterproof membrane

Answer Key: Self-Test D-3.4 (#chapter-answer-key-self-test-d-3-4) is on the next page.

Answer Key: Self-Test D-3.4

1. b. 2
2. a. Lower cost
3. c. Structural engineer
4. b. Expansion joint
5. d. Waterproof membrane

Self-Test D-3.5 Installing Storm Drainage Systems

Complete Self-Test D-3.5 and check your answers.

1. What is the smallest size of storm drainage piping that is allowed to be installed at a slope of 1:100?
    a. 2 in.
    b. 3 in.
    c. 4 in.
    d. 5 in.

2. When installing a roof drain body on a flat roof, which device holds the drain body in place?
    a. Sump receiver
    b. Underdeck clamp
    c. Clamping collar
    d. Drain dome

3. When installing a roof drain body on a flat roof, which device clamps the waterproof membrane to the drain body?
    a. Sump receiver
    b. Underdeck clamp
    c. Clamping collar
    d. Drain dome

4. When installing a roof drain body on a flat roof, which device is the roof dome attached to?
    a. Sump receiver
    b. Underdeck clamp
    c. Clamping collar
    d. Drain body

Answer Key: Self-Test D-3.5 (#chapter-answer-key-self-test-d-3-5) is on the next page.

Answer Key: Self-Test D-3.5

1. c. 4 in.
2. b. Underdeck clamp
3. c. Clamping collar
4. c. Clamping collar

Self-Test D-3.6 Sumps and Catch Basins

Complete Self-Test D-3.6 and check your answers.

1. Complete the following statement: "A catch basin is a form of _____."
    a. Trap
    b. Fixture
    c. Interceptor
    d. Appurtenance

2. What is/are commonly used to bring the grate of a round concrete catch basin up to the desired final elevation?
    a. Extension rings
    b. Elevation fittings
    c. More grates
    d. Vertical pipe

3. What is commonly cast into concrete catch basins to be used as lifting eyes?
    a. Bolts
    b. Nuts
    c. Washers
    d. Wire rope

4. What is installed inside a catch basin that prevents floating debris from being carried into the outlet piping?
    a. Backwater valve
    b. Downturned 90
    c. Check valve
    d. Gate valve

5. What is often cast into a catch basin's grate to alert the public of environmental concerns downstream?
    a. Red flag
    b. Fish icon
    c. Skull and crossbones icon
    d. "Danger do not operate" warning

6. What might be installed in front of a garage that is below the elevation of the adjoining street?
    a. Trough drain
    b. Sewage sump
    c. French drain
    d. Subsoil drain

7. Which one of the following statements is correct?
    a. A catch basin has no piping outlet.
    b. A sump needs to be pumped out.
    c. A sewage sump has an open top.
    d. A catch basin needs a vent.

8. Where a sump does not operate automatically, its capacity shall be sufficient to hold at least how many hours of liquid accumulation.
    a. 1
    b. 6
    c. 12
    d. 24

9. What is the name of a piping system that is too low to drain by gravity to a building drain?
    a. Sub-drainage system
    b. Sub-soil drainage system
    c. Continuous waste system
    d. Combined building drainage system

10. What is commonly attached to the cord of a float switch in a sump to allow it to operate properly?
    a. Sensor
    b. Circuit breaker
    c. Lead weight
    d. Steel coupling

11. What happens if float switch #3 in a sump containing two pumps becomes inverted?
    a. Nothing
    b. Both pumps will shut off.
    c. Both pumps will come on.
    d. An alarm will sound.

12. What is sometimes used instead of a common support bar and lead weights to ensure that the float switches in a sump will operate properly?
    a. Individual support bars
    b. Vertical pipe or pole
    c. Individual alarm panels
    d. Submerged pressure switch

13. What is the result of a float switch that is turned upside down vertically?
    a. Reverses polarity
    b. Nothing happens.

c. “Breaks”
d. “Makes”

14. Which one of the following choices is not referenced as a component of a rail and yoke system for a sump?

a. Yoke
b. Base fitting
c. Ridged electrical conduit
d. Hinged connection with rubber seals

15. A sump with two pumps would be what type of system?

a. Duplex
b. Simplex
c. Cineplex
d. Complex

16. How many float switches are found in a residential packaged sump system?

a. 1
b. 2
c. 3
d. 4

17. How many openings are required in the lid of a packaged sump?

a. 1
b. 2
c. 3
d. 4

18. What are toilets that have a self-contained sump with a pump known as?

a. Washdown
b. Washout
c. Siphon jet
d. Macerating

19. What is the main installation consideration for installing bathtubs and showers that drain into an above-grade sump?

a. Must be white
b. Must be made of plastic
c. Must be elevated on platforms
d. Must not be used in any basement

20. What are the voltage and current values for the electrical circuit that powers a residential sump?

a. 120 volt, single-phase direct current
b. 208 volt, three-phase alternating current
c. 120 volt, single-phase alternating current
d. 240 volt, three-phase alternating current

Answer Key: Self-Test D-3.6 (#chapter-answer-key-self-test-d-3-6) is on the next page.

Answer Key: Self-Test D-3.6

1. c. Interceptor
2. a. Extension rings
3. d. Wire rope
4. b. Downturned 90
5. b. Fish icon
6. a. Trough drain
7. b. A sump needs to be pumped out.
8. d. 24
9. a. Subdrainage system
10. c. Lead weight
11. c. Both pumps will come on.
12. b. Vertical pipe or pole
13. d. “Makes.”
14. c. Ridged electrical conduit
15. a. Duplex
16. a. 1
17. c. 3
18. d. Macerating
19. c. Must be elevated on platforms.
20. c. 120-volt, single-phase, alternating current

Self-Test D-3.7 Sub-soil Drainage Systems

Complete Self-Test D-3.7 and check your answers.

1. What is the term given to the scientific study of the movement, distribution, and management of water on Earth?
    a. Hydrology
    b. Hydronomy
    c. Hydroscopy
    d. Hydroelectricity

2. Which one of the following is not a true statement when moisture is removed from the ground around footings by installing subsoil drains?
    a. Ponding is reduced.
    b. The water table is lowered.
    c. Soils become waterlogged.
    d. Soil strength is stabilized or increased.

3. What was often the shape or profile of the outside of short lengths of drain tile?
    a. Triangular
    b. Octagonal
    c. Hexagonal
    d. Pentagonal

4. How much space was there intended to be between lengths of vitrified tile drainage pipe?
    a. $\frac{1}{16}$ in. to $\frac{1}{8}$ in.
    b. $\frac{1}{8}$ in. to $\frac{1}{4}$ in.
    c. $\frac{1}{4}$ in. to $\frac{1}{2}$ in.
    d. $\frac{3}{4}$ in. to 1 in.

5. How many degrees apart are the perforations on common PVC perforated pipe?
    a. 45°
    b. 60°
    c. 90°
    d. 120°

6. According to the BC Building Code, where should the top of the pipe used for footing drains be located?
    a. Below the bottom of the floor slab or ground cover of the crawl space
    b. Above the bottom of the floor slab or ground cover of the crawl space

c. Below the bottom of the footing
d. Above the bottom of the footing

7. What type of layer protects the drain rock and perforated pipe from becoming plugged with fines from the soil?
   a. Plastic film
   b. Newspaper
   c. Linen
   d. Geotextile fabric

8. What is the term for an excavated hole in the ground that is filled with drain rock and used as a terminal for storm or subsurface water?
   a. Well
   b. Dry well
   c. Wet well
   d. Water well

9. What is the term that is sometimes used to describe a trench; perforated pipe; clean, washed rock; geotextile fabric; and backfill intended for subsurface drainage?
   a. Ditch drain
   b. French drain
   c. Canadian drain
   d. Below-surface drain

10. What is the name given to a drain that might be installed at the foot of a rock face and that is intended to intercept and channel away water that would pond at the base of the slope?
    a. Rockface drain
    b. Channel drain
    c. Curtain drain
    d. Slope drain

11. What is the term given to the process of creating horizontal holes underground that water can flow through to get to a trench drain?
    a. Moling
    b. Tunnelling
    c. Chambering
    d. Crosshatching

12. What is the average depth of the pipe in a trench drain used as the main drain associated with the question above?
    a. 300 mm (1 ft)
    b. 600 mm (2 ft)
    c. 1,200 mm (4 ft)
    d. 1,800 mm (6 ft)

Answer Key: Self-Test D-3.7 (#chapter-answer-key-self-test-d-3-7) is on the next page.

Answer Key: Self-Test D-3.7

1. a. Hydrology
2. c. Soils become waterlogged
3. b. Octagonal
4. c. $\frac{1}{4}$ in. to $\frac{1}{2}$ in.
5. d. 120
6. a. Below the bottom of the floor slab or groundcover of the crawl space
7. d. Geotextile fabric
8. b. Dry well
9. b. French drain
10. c. Curtain drain
11. a. Moling
12. c. 1,200 mm (4 ft)

Self-Test D-3.8 Stormwater Site-Retention Systems

Complete Self-Test D-3.8 and check your answers.

1. What is the term given to the natural flow of precipitation over land surfaces?
    a. Water table
    b. Run on
    c. Runoff
    d. Water cycle

2. What is the term given to the practice of holding runoff water on a site and releasing it slowly back into the water table?
    a. Stormwater detention
    b. Stormwater retention
    c. Drainage ditching
    d. Stormwater saving

3. What type of landscaping will promote stormwater entering the water table?
    a. Low-water
    b. Hard
    c. Soft
    d. Absorbent

4. What type of roof would be used in a source control stormwater practice?
    a. Blue
    b. Green
    c. Hard
    d. Soft

5. What is required when an onsite stormwater reuse system is constructed?
    a. Storage tank
    b. Expansion tank
    c. Storm valve
    d. Circuit vent

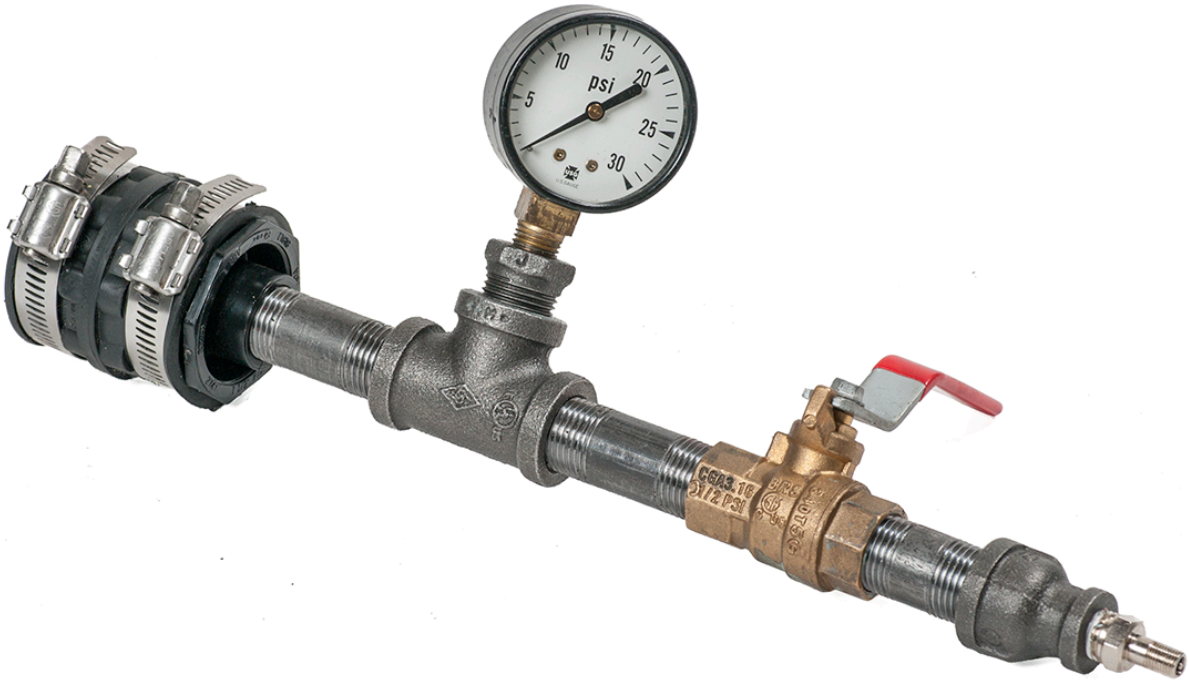
Answer Key: Self-Test D-3.8 (#chapter-answer-key-d-3-8-self-test) is on the next page.

Answer Key: D-3.8 Self-Test

1. c. Runoff
2. b. Stormwater retention
3. d. Absorbent
4. b. Green
5. a. Storage tank

D-4 TEST DRAINAGE SYSTEMS

Plumber Apprenticeship Program – Level 2



D-4 Testing Sanitary and Storm Drainage Systems Introduction

Code requires drain-waste-vent (DWV) pipes to be tested using an acceptable test method. The test must be present on the piping system during inspection. An improperly installed joint in a drainage pipe or vent could allow unsanitary conditions to occur inside a building and allow toxic gases to enter. If an alteration to the system occurs after the test and inspection, the piping system will have to be re-tested and inspected.

Learning Objectives

After completing the chapters in this section, you should be able to:

- Describe code and requirements used to test DWV systems.
- Describe methods used to test DWV systems.

Resources

You will be required to reference the most current National Plumbing Code.

Terminology

The following terms will be used throughout this section. A complete list of terms for this section can be found in the **Glossary**.

- **air pressure test:** A test that checks for leaks by filling pipes with pressurized air and observing if the pressure drops. (Section D-4.1)
- **ball test:** A test that checks for proper slope and obstructions in pipes by rolling a dense ball through the system. (Section D-4.1)
- **final test:** A test performed after fixtures are installed to make sure the whole plumbing system is

working properly and has no leaks. (Section D-4.1)

- **one-time-only test caps:** Disposable caps used to seal pipe openings during leak testing. they are designed for single-use applications and are typically removed and discarded after testing is complete. (Section D-4.2)
- **open centre test plug:** A type of test plug that is used to seal pipes during testing. It has a hole in the middle, so tools can be used to adjust or measure the pressure inside the pipe without taking the plug off. (Section D-4.2)
- **prefabricated system:** A plumbing system or part of a system that is built somewhere else (not at the building site) and then brought in and put into place. (Section D-4.1)
- **propeller-style blower:** A type of fan that blows air to test pipes or systems. The fan blades are connected directly to the motor, and it helps push air through the system to check for leaks. (Section D-4.2)
- **smoke testing:** A method used to detect leaks in a drainage system using thick smoke. The smoke is blown into the pipes, and if it escapes from any area other than the designated openings, it means there's a leak. (Section D-4.2)
- **smoke candle:** A small device that creates smoke when lit. It's used in smoke testing to help find leaks in pipes. When the candle is lit, the smoke is blown into the pipes to see if it escapes anywhere. (Section D-4.2)
- **smoke fluid system:** A machine that creates smoke by turning a special fluid into smoke. This is used in smoke testing to check for leaks in pipes, just like the smoke candle. (Section D-4.2)
- **squirrel-cage blower:** A type of blower that has a round fan inside it, kind of like a hamster wheel, to push air through a system. It can move a lot of air and is good for testing large pipes or systems.
- **test plug:** A device used to seal pipe openings during leak testing. Test plugs come in different types, including inflatable and expansion plugs, and help keep air or water sealed inside the system. (Section D-4.2)
- **water pressure test:** A test that checks for leaks by filling pipes with water and keeping them pressurized for a set amount of time. (Section D-4.1)
- **wye fitting:** A plumbing fitting shaped like a "y" that allows one pipe to join another at a 45-degree angle. it is commonly used to connect branch lines to a main drain line, helping to maintain smooth water flow and reduce clogs. (Section D-4.2)

D-4.1 Drainage System Testing Code Requirements

The regulations set out in the **National Plumbing Code (NPC)** are intended to ensure the quality and functionality of plumbing installations, protect the health of the occupants and the general public, and protect the building structure from damage caused by improper piping installation. As a result of this intent, drainage and venting pipes are required by code to be pressure-tested after the installation of each phase of the project.

The term "**authority having jurisdiction,**" commonly referred to as AHJ, covers a variety of regulating organizations. In the plumbing trade, the most common application is referencing the building official responsible for plumbing code and regulation enforcement.

For the building official, the limits may be the building and plumbing codes adopted by the jurisdiction. Quite often, local AHJ may require a DWV installation to meet bylaws or regulations that address local conditions before they will give approval. Some examples of local regulations could include using piping materials suitable for local soil conditions or burying piping at a certain depth to prevent freezing.

National Plumbing Code Testing Requirements

The NPC has certain requirements for testing DWV systems to ensure uniformity throughout its jurisdiction. Once the piping rough-in has been completed (ground work or above grade), the piping is required to be under a test while being inspected to confirm that there are no leaks as well as to confirm conformance with all other code requirements. The installer is required to notify the plumbing inspector or the administrative authority having jurisdiction over plumbing work before the test is applied.

Concealed work should remain uncovered until the required tests have been done and the work has been inspected. When testing, the system should be properly restrained at all bends, changes of direction, and the end of runs to prevent system failure due to applied test pressures. Follow proper safety procedures and use protective equipment during all testing procedures. Installers should always consider local conditions, codes, manufacturer installation instructions, and architect/engineer instructions in any installation.

The following are required by the NPC.

Testing Drainage Systems

- Except in the case of an external leader, after a section of a drainage system or a venting system has been roughed in, and before any fixture is installed or piping is covered, a water or air pressure test or air pressure test shall be conducted.
- After every fixture is installed and before any part of the drainage system or venting system is placed in operation, a final test shall be carried out when requested.
- Where a **prefabricated system** is assembled off the building site in such a manner that it cannot be inspected and tested on site, off-site inspections and tests shall be conducted.
- Where a prefabricated system is installed as part of a drainage or venting system, all other plumbing work shall be tested and inspected and a final test shall be carried out on the complete system when requested.

- When requested, a ball test shall be made to any pipe in a drainage system.
- Every pipe in a drainage system, except an external leader or fixture outlet pipe, shall be capable of withstanding without leakage a water pressure test, air pressure test, and final test.
- Every pipe in a drainage system shall be capable of meeting a ball test.

Testing Venting Systems

Every venting system shall be capable of withstanding without leakage a water pressure test, air pressure test, and final test.

DWV Tests Types

Testing of pipes in a DWV system is usually done after the rough-in phase by sealing off all trap arms and the building drain using plugs or inflatable balls. Four main tests may be performed on a DWV system:

- Water pressure tests
- Air pressure tests
- Final tests
- Ball tests

Water Pressure Tests

A **water pressure test** consists of applying a water column of at least 3 m (10 ft) to all joints. In making a water pressure test, every opening except the highest shall be tightly closed with a testing plug or screw cap, and the system or section shall be kept filled with water for at least 15 minutes.

Air Pressure Tests

Air pressure tests shall be conducted in accordance with the manufacturer's instructions for each piping material. Air shall be forced into the system until a pressure of 35 kPa (5 psig) is created, and this pressure shall be maintained for at least 15 minutes without a drop in pressure.

Final Tests

Where a **final test** is requested and made, every trap shall be filled with water, and the bottom of the system being tested shall terminate at a building trap, test plug, or cap. Smoke from smoke-generating machines shall be forced into the system, and when the smoke appears from all roof terminals, they shall be closed. A pressure equivalent to a 25 mm (1 in.) water column shall be maintained for 15 minutes without the addition of more smoke.

The smoke may be omitted, provided that the roof terminals are closed and the system is subjected to an air pressure equivalent to a 25 mm water column maintained for 15 minutes without the addition of more air.

Ball Tests

Where a **ball test** is conducted, a hard ball dense enough not to float shall be rolled through the pipe. The diameter of the ball shall be not less than 50 mm (2 in.) where the size of the pipe is 75 mm (3 in.) or more or 25 mm where the size of the pipe is less than 75 mm.

Self-Test D-4.1: Drainage System Testing Code Requirements

Complete Self-Test D-4.1 and check your answers.

If you are using a printed copy, please find Self-Test D-4.1 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=87#h5p-32 (https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=87#h5p-32)

References

Skilled Trades BC. (2021). *Book 2: Install fixtures and appliances, install sanitary and storm drainage systems.* Plumber apprenticeship program level 2 book 2 (Harmonized). Crown Publications: King's Printer for British Columbia.

Trades Training BC. (2021). D-4: Test sanitary and storm drainage systems. In: *Plumber Apprenticeship Program: Level 2.* Industry Training Authority, BC.

D-4.2 Testing Methods

Safety is of paramount importance when conducting leak tests. Even at relatively low internal pressures, leak testing can generate very high forces that can be dangerous if suddenly released by the failure of a joint, system component, or testing component. Air testing is inherently more dangerous than water testing, since air is highly compressible and expands quickly when pressure is released. If high air pressure is used, this expansion can be violent.

Always take safety precautions, such as the following, when conducting leak tests:

- Install all test plugs in a manner that prevents blowouts. Restrain pipe, components, and test equipment from moving in the event of a failure.
- Ensure that all air pressurizing equipment used for testing includes a regulator or relief valve set no higher than 63 kPa (9 psi) to avoid over-pressurizing.
- Keep people not involved in testing a safe distance away while testing.
- General safety instructions for inflatable test plug usage:
    - Read and understand the safety instruction sheet before using a test plug.
    - Always wear PPE.
    - Do not enter the safety zone when test plugs are under pressure.
    - Measure the pipe diameter accurately before selecting a test plug.
    - Never use a test plug in a pipe size different from the recommended usage range.
    - Always inflate the test plug to the recommended pressure shown on the plug.

Test Equipment

Different test equipment will be required depending on the type of DWV test that will be performed.

Test Plugs

Whether the test is by water, air, or smoke, all openings in the test section must be sealed. **Test plugs** are often used in the industry because they may be used repeatedly and are, therefore, cheaper than **one-time-only test caps**. Test plugs are available in a number of configurations, such as inflatable for use in a line cleanout or inflatable for use in a **wye fitting** (Figure 1).

Figure 1 *Left: Inflatable test plug for use in a line cleanout; Right: Inflatable test plug for use in wye cleanouts. (Skilled Trades BC, 2021) Used with permission.*

When sealing open pipe and fitting hubs for testing, you may use an expansion plug. These devices are not inflatable but use the expansion of a rubber sleeve to provide a seal. The expansion plug is inserted in the opening and tightened by hand or a smooth-faced wrench (Figure 2).

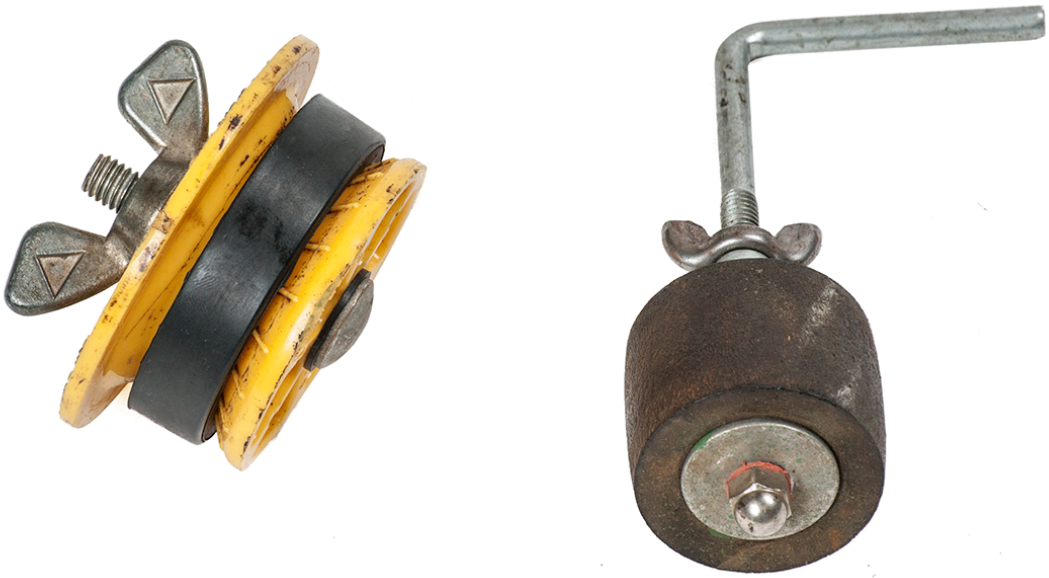


Figure 2 *Hand-tightened expansion-type test plug. (Skilled Trades BC, 2021) Used with permission.*

Water Pressure Tester

A **water pressure tester** allows you to introduce and measure the water pressure in a plumbing system. Used in conjunction with **open centre test plugs**, it allows access to the DWV system without cutting lines or creating leaky threaded joints (Figure 3).

Figure 3 *Open centre test plug. (Skilled Trades BC, 2021) Used with permission.*

Air Pressure Test Equipment

Another acceptable method for testing drainage and venting is an **air pressure test**. This is recommended if testing must be done in sub-zero temperatures or over water-sensitive areas, such as computer labs, hospital operating theatres, and rooms containing archives. Although these situations are rare to most installers, air tests have been employed when testing DWV systems in similar environments. As with a water test, the entire system or section you are testing must be completely sealed with airtight test plugs. The air pressure may be introduced into the system with a compressor, provided that a properly calibrated regulator is installed.

The air pressure may be introduced and recorded through a pressure gauge and Schrader valve combination (Figure 4).

A shop-built pressure testing assembly can be added to the drainage system. Pressure is applied through the Schrader valve, then the ball valve is closed. The system should hold pressure for 15 minutes at 5 psig when tested.

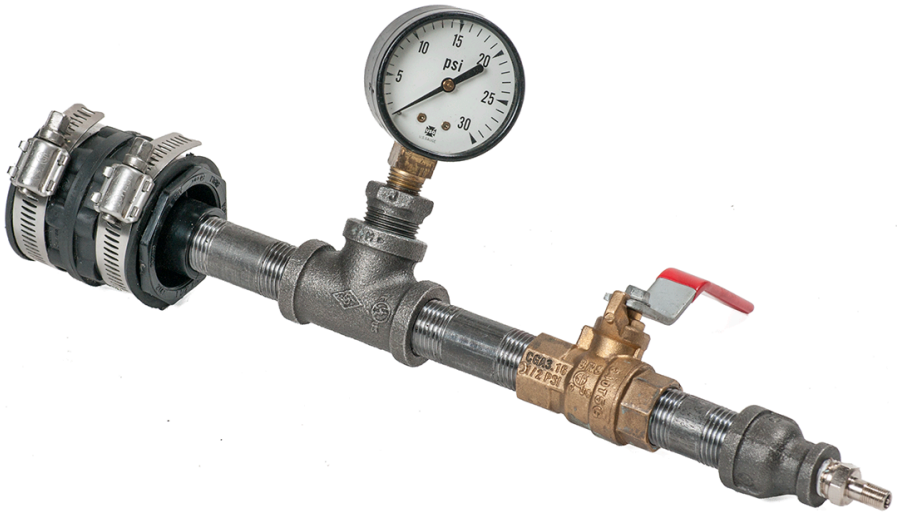


Figure 4 *Pressure testing assembly for DWV pipe. (Skilled Trades BC, 2021) Used with permission.*

Smoke Test Equipment

Smoke testing requires the use of a blower and a controlled smoke source.

Blowers

The NPC requirements for smoke testing identify a static pressure of a 25 mm (1 in.) water column. This requires the use of a blower capable of producing the test pressure. Two types of blowers are available for smoke testing DWV systems:

- Squirrel cage
- Direct-drive propeller

Squirrel-cage blowers are generally larger and can provide more static pressure in relation to CFM output. The output of the squirrel-cage type is usually adjustable by alternating pulleys and belts to meet the demands of the job.

Propeller-style blowers are usually more compact, and the output is not adjustable since the fan blade is attached directly to the engine shaft.

Smoke Sources

Two types of smoke sources are currently offered for smoke testing DWV systems:

- Smoke candles
- Smoke fluids

To use a **smoke candle**, simply place one on the fresh air intake side of the blower. Once the candle has been ignited, the exiting smoke is drawn in with the fresh air and blown down into the system. This type of smoke is formed by a chemical reaction and has a high atmospheric moisture content. It is very visible even at low concentrations and extremely effective at finding leaks.

A **smoke fluid system** involves injecting a smoke fluid (usually a petroleum-based product) into a heating chamber, such as the engine exhaust muffler of a portable blower engine (Figure 5). The smoke is then exhausted into the fresh air intake side of the blower. Smoke fluids do not consistently provide the same quality of smoke because as fluid is injected into the heating chamber, it immediately begins to cool the heating surface. The heating chamber will eventually reach a point where it is not hot enough to completely convert all the fluid to smoke, and it will then produce thin, wet smoke that is difficult to see. This can happen quickly, depending on the rate of fluid flow. Some manufacturers have taken steps to address this issue and now offer insulated heating chambers to help maintain necessary temperatures.

Figure 5 *Smoke testing machine for DWV pipe using liquefied smoke. (Kingscote Chemicals, n.d.). Used with permission.*

DWV Test Procedures

Test procedures vary with the type of test needed for the installation.

Water Test

A water or hydrostatic test is the most common test used to inspect a DWV installation. This is the recommended test in most plumbing codes, weather permitting. Before starting the test, all bends, changes of direction, and ends of runs should be properly restrained. Cap or plug all openings in the lower part of the section to be tested. Fill the system to be

tested with water at the highest point, if available. If this is not possible due to job-site conditions, use an open centre test plug.

Filling the system slowly should allow any air in the system to escape as the water rises in the vertical pipe. All air entrapped in the system should be expelled prior to beginning the test. Failure to remove entrapped air may give faulty test results. Once the piping has been filled to 3 m (10 ft) of head, the section being tested should be visually inspected for leaks. If leaks are found, drain the system, disassemble the joints, and check for proper installation. Once you have successfully tested the system, drain it and prepare the next section for testing.

In single-family houses, an adapter with a hose bib is commonly attached to a trap arm. Water is fed through a hose connected to the bibb, and the system is filled until water spills from the roof vent. This method eliminates the need to get a hose into the open vent on the roof, which would have created issues with fall arrest procedures.

Air Test

Prior to performing the air test, all threaded openings shall be sealed with a manufacturer's recommended sealant. All additional openings should be sealed using test plugs recommended for use in performing air testing. It is important to note that manufacturers of cast-iron soil pipe and fittings joined with rubber compression joints or MJ couplings expect to have a reduction in air pressure during a 15-minute test. This drop in air pressure does not indicate a failure of the system or that the system will leak water. The reduction occurs because air molecules are much smaller than water molecules and can escape through microscopic perforations in the pipe wall formed during the casting process.

However, a reduction of more than 7 kPa (1 psi) during the test period indicates a failure of the test. The system shall be pressurized to 35 kPa (5 psig) using a gauge graduated preferably to not more than three times the test pressure. Upon completion of the test, depressurize the system and remove the test plugs.

Smoke Test

When a system has been completely installed with some sections obscured from view, a smoke test may be required by engineers, architects, or plumbing codes to find leaks in the piping. The test is applied to all the parts of the drainage and venting system after all fixtures have been permanently connected and all traps have been filled with water. A thick, penetrating smoke produced by one or more smoke machines is introduced into the bottom of the system through a suitable opening. As the smoke appears at the stack opening on the roof, the opening is closed off and the introduction of smoke is continued until a pressure equal to 25 mm (1 in.) of water is built up and maintained for 15 minutes without the addition of more smoke. Under this pressure, smoke should not be visible at any point, connection, or fixture. To eliminate drafts, all windows in the building should be closed until the test has been completed.

Ball Test

A ball test does not check for leaks but instead ensures the drainage pipes have a proper grade. The local plumbing inspector may exercise discretion and insert a ball into a fitting to check for an adequate grade; if all is well, the ball will make it to the bottom point, which is normally a cleanout.

Duration

A DWV system undergoing pressure testing using an approved method and procedure shall withstand the test pressure for 15 minutes while the plumbing inspector is present.

Inspection

Upon completion of the roughed-in piping installation, the piping of plumbing drainage and venting systems shall be tested by water or air to prove it is watertight. The inspector's job is to make sure that the testing of the DWV system follows the plumbing code requirements. The inspector may require the removal of any cleanout plugs to determine if the pressure has reached all parts of the system.

During the construction of any project, large or small, the DWV test will be witnessed and signed off by the AHJ upon satisfactory completion of each phase. The plumbing contractor should record and maintain detailed inspection and testing data showing the date, time, and names of people participating in the inspection and testing.

Documentation

It is safe to say that the DWV system is an important part of the building design and function, which is why the final plumbing installation must be inspected before calling for the final building inspection. Once the plumbing and other individual disciplines have substantially completed their work, a certificate of occupancy may be issued.

A certificate of occupancy is a document issued by a local government agency or building department certifying a building's compliance with applicable building codes and other laws and indicating that it is in a condition suitable for occupancy. The procedure and requirements for the certificate vary widely from jurisdiction to jurisdiction and with the type of structure. Some projects may require certification from the installer that the plumbing system functions according to the approved design.

Self-Test D-4.2: Testing Methods

Complete Self-Test D-4.2 and check your answers.

If you are using a printed copy, please find Self-Test D-4.2 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=89#h5p-33 (https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=89#h5p-33)

References

Kingscote Chemicals. (n.d.). *M-45 plumbing kit*. Kingscote Chemicals [Division of Kingscote Industries]. https://www.kingscotechemicals.com/product/m-45-plumbing-kit/

Skilled Trades BC. (2021). *Book 2: Install fixtures and appliances, install sanitary and storm drainage systems.* Plumber apprenticeship program level 2 book 2 (Harmonized). Crown Publications: King's Printer for British Columbia.

Trades Training BC. (2021). D-4: Test sanitary and storm drainage systems. In: *Plumber Apprenticeship Program: Level 2.* Industry Training Authority, BC.

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- **Figure 5** M-45 Plumbing Kit from ©Kingscote Chemicals [A division of Kingscote Industries] (n.d.) is used with permission.

Self-Test D-4.1 Drainage System Testing Code Requirements

Complete Self-Test D-4.1 and check your answers.

1. For what period of time shall a drainage or venting system hold a water test before it is passed by the inspector?
    a. 15 min
    b. 20 min
    c. 25 min
    d. 30 min

2. What pressure shall drainage or venting systems hold during an air test?
    a. 15 kPa (2 psig)
    b. 21 kPa (3 psig)
    c. 35 kPa (5 psig)
    d. 56 kPa (8 psig)

3. During a ball test, what size ball shall a 3 in. drain be able to pass before the inspector accepts the installation?
    a. 75 mm
    b. 50 mm
    c. 38 mm
    d. 62 mm

4. The final test of a plumbing system is performed after all of the fixtures are installed and put into operation.
    a. True
    b. False

5. When testing drainage and venting installation for leaks with water (water pressure test), the pipe must be fitted with a standpipe for the introduction and observation of test water. What is the minimum height requirement for such a standpipe?
    a. 1.5 m
    b. 2 m
    c. 3 m
    d. 4 m

6. In certain instances, a code official may require a final test on the DWV system. The substance used will be either smoke or 25 mm air pressure.
    a. True
    b. False

Answer Key: Self-Test D-4.1 (#chapter-answer-key-self-test-d-4-1) is on the next page.

Answer Key: Self-Test D-4.1

1. a. 15 min
2. c. 35 kPa (5 psig)
3. b. 50 mm
4. b. False
5. c. 3 m
6. a. True

Self-Test D-4.2 Testing Methods

Complete Self-Test D-4.2 and check your answers.

1. Which of the following test methods for DWV piping is potentially more dangerous to the personnel conducting the test in the event of component failure?
    a. Air test
    b. Water test
    c. Smoke test
    d. Ball test

2. When conducting a 35 kPa (5 psig) air test on a DWV system, what is the maximum setpoint of the pressure regulator used to control test pressure?
    a. 35 kPa (5 psig)
    b. 49 kPa (7 psig)
    c. 63 kPa (9 psig)
    d. 77 kPa (11 psig)

3. What is the main advantage of using test plugs as opposed to glue- or solder-in-place test caps?
    a. The test plugs are less expensive.
    b. The test plugs can be used repeatedly.
    c. A single test plug will fit any size pipe.
    d. Test plugs will never leak once in place.

4. What is the most important test component that must be employed when conducting a DWV air test using compressed gas?
    a. Reliable hand pump as a backup
    b. Properly calibrated regulator
    c. High-pressure-rated test plugs
    d. Inert gas

5. Which testing component is typically employed when conducting a water test on a section of DWV piping where there is not an opening provided on the top of the system to introduce the water?
    a. Saddle fitting
    b. Test hub
    c. Open centre test plug
    d. Test spigot

6. When the AHJ requires a smoke test to be performed, how is the smoke introduced into the DWV system?
    a. Blower
    b. Compressed smoke cylinder

c. Gravity
d. Smoke bomb placed in the main sewer cleanout

7. In which of the two available styles of smoke test blowers is it easier to adjust the output in order to meet job conditions?
   a. Squirrel cage
   b. Direct-drive propeller

8. Where is a smoke candle placed in relation to the test blower when introducing the smoke into the system under test?
   a. At the blower exhaust
   b. At the blower intake
   c. Inside the blower housing
   d. In the piping cleanout

9. Which of the two types of smoke supplies used in DWV testing is more effective in producing a visible indicator of a system leak?
   a. Smoke candle
   b. Smoke fluid

10. Why do cast-iron soil pipe systems sometimes experience a drop in pressure when under an air test but do not show leakage when under a water test?
    a. MJ clamps are not meant to hold against static pressure above 1 in. wc.
    b. Water molecules bind together and seal pipe perforations.
    c. Air molecules are smaller than water molecules and sometimes escape through pipe perforations.
    d. Air molecules are lighter than water molecules and sometimes escape through the top of the system.

11. What is the maximum drop in air pressure expected by manufacturers of cast-iron soil pipe before they consider the piping system faulty?
    a. 7 kPa (1 psig)
    b. 14 kPa (2 psig)
    c. 21 kPa (3 psig)
    d. 28 kPa (4 psig)

12. What is the maximum preferred gauge scale for use when air testing a DWV system?
    a. Equal to test pressure
    b. Twice the test pressure
    c. Triple the test pressure
    d. Quadruple the test pressure

13. When performing a smoke test on a DWV system, what must the system traps be?

a. Not installed
b. Installed and inlets plugged
c. Installed and filled with water
d. Installed and inlets vented to atmosphere to verify the presence of test smoke

14. What does a ball test verify?

a. Pipe alignment
b. Pipe grade
c. That no concentric reducing fittings are used downstream
d. That no eccentric reducing fittings are used downstream

15. Which certificate does the local building department issue to indicate that a building is safe to inhabit?

a. Plumbing final inspection report
b. Electrical final inspection report
c. All trade disciplines' final inspection reports
d. Certificate of occupancy

Answer Key: Self-Test D-4.2 (#chapter-answer-key-self-test-d-4-2) is on the next page.

Answer Key: Self-Test D-4.2

1. a. Air test
2. c. 63 kPa (9 psig)
3. b. The test plugs can be used repeatedly.
4. b. Properly calibrated regulator
5. c. Open-centre test plug
6. a. Blower
7. a. Squirrel cage
8. b. At the blower intake
9. a. Smoke candle
10. c. Air molecules are smaller than water molecules and sometimes escape through pipe perforations.
11. a. 7 kPa (1 psig)
12. c. Triple the test pressure
13. c. Installed and filled with water.
14. b. Pipe grade
15. d. a certificate of occupancy

D-5 DRAINAGE SYSTEM MAINTENANCE AND REPAIRS

Plumber Apprenticeship Program – Level 2

Manhole Cover (https://unsplash.com/photos/drain-cover-with-the-word-drain-on-it-ZleoqT-LWsY) by Zoshua Colah on Unsplash (https://unsplash.com/license)

D-5 Maintaining and Repairing Sanitary and Storm Drainage Systems Introduction

Household, commercial, and industrial drains are subject to a variety of materials that can cause stoppages in the drainage system. Maintenance and repair of drainage systems is critical to proper flow of waste and rainwater.

Learning Objectives

After completing the chapters in this section, you should be able to:

- Explain the use of drain-cleaning equipment.

Resources

You will be required to reference the most current National Plumbing Code.

Terminology

The following terms will be used throughout this section. A complete list of terms for this section can be found in the **Glossary**.

- **auger head:** An attachment fitted to the end of a drill rod or casing, designed to bore into the ground and remove soil or sediment during well installation. (Section D-5.1)
- **closet auger:** A special tool, named after the water closet, used to unclog toilets. It has a long, flexible rod with a spiral end that you insert into the toilet drain. When you turn the handle, the spiral helps break up or remove the blockage. (Section D-5.1)
- **combustible gas indicator (CGI):** A tool that helps workers find dangerous gases in the air that could catch fire or explode. It keeps people safe by warning them when gas levels are too high. (Section D-5.1)
- **cross bore:** A cross bore happens when one underground pipe accidentally goes through another pipe.

For example, a new pipe might be drilled through a sewer pipe by mistake. This can be dangerous and cause clogs or leaks, so workers check carefully to make sure pipes don't cross like this. (Section D-5.1)

- **digital pipe locator:**
- **drain auger:**
- **hand auger:** A tool used to dig small holes in the ground. It has a long handle and a sharp, spiral bit at the end that you twist into the soil to make the hole. It's used for tasks like planting trees or installing posts. (Section D-5.1)
- **interface probe:** A portable electronic device used to detect the presence and thickness of non-aqueous phase liquids (NAPLs) such as oil floating on groundwater, by distinguishing between water and other fluids. (Section D-5.1)
- **lockable well cap:** A secure, often tamper-proof cap placed on top of a monitoring well casing to prevent contamination or unauthorized access. (Section D-5.1)
- **multi-parameter sonde:** A multi-sensor probe used for in situ water quality monitoring, capable of simultaneously measuring variables such as temperature, dissolved oxygen, pH, turbidity, and conductivity. (Section D-5.1)
- **piezometer:** A type of well designed specifically to measure groundwater pressure or hydraulic head at a specific depth within an aquifer. (Section D-5.1)
- **power drum auger:** A machine used to clear blockages in sewer pipes. It has a long, flexible metal cable stored in a drum (a round container) that spins to push the cable through the pipe. A cutting tool on the end helps break up clogs. Large diameter augers are used for big pipes, and small diameter augers are used for smaller household pipes. (Section D-5.1)
- **pressure transducer:** A device that converts pressure measurements (such as water level) into electrical signals, commonly used to monitor changes in groundwater elevation over time. (Section D-5.1)
- **radio transmitter:** A device that sends out signals through the air, like a radio station sending music or a walkie-talkie sending messages. It turns electrical signals into radio waves that can travel through the air to other devices, like radios or phones, that can receive and play the signals. (Section D-5.1)
- **riser pipe:** A vertical pipe that extends from the screened section of a well or piezometer to the surface, allowing access for sampling or measurement instruments. (Section D-5.1)
- **screen:** (well screen); A perforated section of a well casing that allows groundwater to enter the well while keeping out sediment. (Section D-5.1)
- **submersible pump:** An electric pump that operates while submerged in groundwater, commonly used to purge wells or collect samples during groundwater monitoring. (Section D-5.1)
- **top cap:** A protective cover placed on the top of a monitoring well casing, often used in addition to a lockable well cap. (Section D-5.1)
- **tubing:** Flexible plastic or rubber piping used to convey water from a well to sampling equipment, available in various diameters and materials depending on chemical compatibility. (Section D-5.1)
- **Waterloo APS:** The Waterloo Advanced Profiling System (APS), a high-resolution system used to collect groundwater samples and measure hydraulic conductivity at multiple depths within a single borehole. (Section D-5.1)
- **well casing:** A rigid pipe, usually made of PVC or stainless steel, that lines the borehole of a well to maintain its structure and isolate screened intervals. (Section D-5.1)
- **well development:** The process of cleaning and stabilizing a newly installed monitoring well by removing fine sediments and ensuring good hydraulic connection between the well screen and surrounding aquifer. (Section D-5.1)

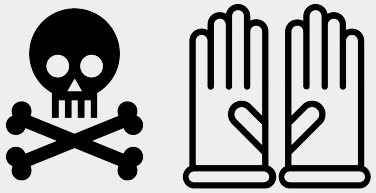
D-5.1 Drain Cleaning

Safety Precautions When Drain Cleaning

Using drain-cleaning equipment safely and effectively requires service personnel to wear personal protective equipment (PPE) while working on sewer or drain lines. Two important safety items essential to drain cleaning are:

- Safety glasses or goggles with side shields
- Gloves

Eye protection is an important safeguard against flying solid objects or pathogenic liquids, which can become airborne when, for instance, the tension on a cable is suddenly released. Gloves protect a technician's hands from sharp objects and are especially important for the hand that guides the cable into and out of the drain. The sudden release of a stoppage can cause the cable to spin rapidly enough to burn or cut bare hands.



Drains and sewers can carry bacteria and other infectious micro-organisms or materials that can cause death or severe illness. Avoid exposing eyes, nose, mouth, ears, hands, cuts, and abrasions to wastewater or other potentially infectious materials during drain and sewer cleaning operations.

Service personnel also need to be aware of the risks presented by ponding water from backed-up drains. One good safety practice is to stand on boards or a solid pallet to prevent electrical shock from grounding through water. As with any power tool, always check the safety features provided by the manufacturer before taking the equipment to the job site.

Since drain cleaners can suddenly hit blocks or stoppages, you should never force them through the blockage. The best practice is to use short forward and reverse movements of the cable to prevent jamming and breakage.

The cable drum should be cleaned before it is returned to storage because bacteria and pathogens can be transferred during handling, even after the job has been completed.

Cross Bores

To help minimize sidewalk and landscaping damage, new service lines — such as gas, electric, and cable TV — are usually installed by drilling holes horizontally beneath the ground. A "**cross bore**" is when the new pipe or cable accidentally goes through another underground pipe or cable (Figure 1).

A clogged sewer line may result from a cross bore with a gas line. Many explosions and deaths have occurred when a drain auger has ripped through a plastic gas line that has been drilled through a building sewer and caused a blockage.

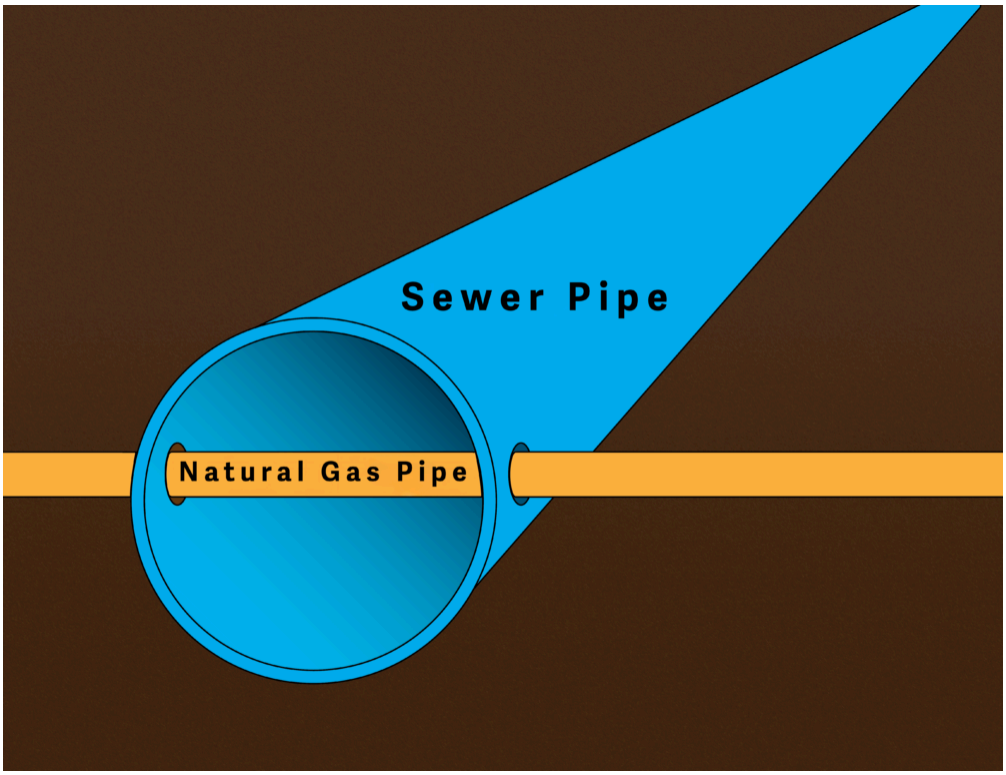


Figure 1 *Gas pipeline cross bore. (Skilled Trades BC, 2021) Used with permission.*

A drain auger — when sent down the sewer to clear a blockage often thought to have been caused by root penetration — will easily tear through the HDPE line, causing high-pressure gas to exit the sewer downstream of that point as well as upstream toward the auger's operator. Fires and explosions are the most common result, with property damage being the least of the outcomes.

Before clearing and underground drains, you should:

- Look for trees or landscaping that could possibly be causing an obstruction.
- Ask the resident if there has been any recent utility work in the area.
- Use an in-line video inspection device to better assess the blockage.

During the cleaning, you should:

- Clear without a cutting tool. Use minimally invasive equipment, such as a plumbing snake or water jet, to attempt to clear the blockage.
- Feel for obstructions that do not seem to resemble tree roots or other common obstructions as the tool moves through the sewer line.

After you finish, you should:

- Check the blades for yellow or orange plastic when it is withdrawn from the sewer line. Natural gas utility lines are typically made of these colours of plastic.

- Watch for bubbles caused by natural gas escaping from the toilet or other entry point of the cutting equipment. If bubbles or gas are found to be escaping from the entry point of the cutting equipment, IMMEDIATELY exit the structure. In such cases, warn all inhabitants as well.
- Inspect the area with a **Combustible Gas Indicator (CGI)** or other gas-detection equipment, if available.

Video Inspection Equipment

Video inspection equipment uses a remote video camera to inspect underground sewers and drains. If a stoppage is due to a suspected cross bore, video inspection should be attempted first; however, the video image is rarely of good quality when viewing through the sludge at a blockage. If determined to be safe to do so, the drain is typically cleared first using a cleaning auger before being visually inspected.

A video inspection provides an excellent way to detect and locate obstructions or damage that impedes or stops the flow of drainage lines. Video inspections can detect common problems such as:

- Root-bound drainage lines
- Pipe collapse and cracks
- Running inline traps
- Negative grade sloping
- Pipe sagging
- Offset joints
- Sludge buildup

The video camera equipped with LED lighting is “pushed” down the drain or sewer line from a reel on the surface that is connected to a recording monitor (Figure 2). The plumber receives the closed-circuit live picture and views it on a monitor as the video records to a flash drive or DVD archive for future reference.

Figure 2 *Left: Digital recording camera reel; Right: Digital recording monitor. (Skilled Trades BC, 2021) Used with permission.*

Pipe Locators

On some models of video inspection equipment, the camera is equipped with a **radio transmitter** (Figure 3). The camera/transmitter assembly sends a signal to a receiver on the ground surface indicating the camera location and depth of burial. This information can be vital if the line has to be excavated and repaired.

Figure 3 *Digital pipe locator used with a video inspection system. (Skilled Trades BC, 2021) Used with permission.*

Drain Augers

A drain auger is typically a long, flexible metal cable that rotates in a circular motion and is powered by an electric motor or by hand. On some models, the tool that attaches to the end can be changed to meet specific job requirements. The drain auger is inserted into a drain and rotated until it reaches the obstruction. The auger then breaks through and retrieves or reduces the obstruction so the drain can flow freely.

There are several different types of drain augers for home and commercial use:

- Hand auger
- Closet auger
- Power drum auger for small-diameter piping
- Power drum auger for large-diameter piping

Hand Auger

The **hand auger** uses a drum to contain the cable and keep it from tangling and kinking while being rotated by hand (Figure 4). These tools are useful for clearing small-diameter sink and bathtub drains (up to 2 in. NPS) when the obstruction has yet to solidify. Do not attempt to send this auger through toilet bowls because the exposed wire cable might damage the porcelain finish. Also, due to the large bowl passageway and the cable's small diameter, the cable can become tangled when rotated.

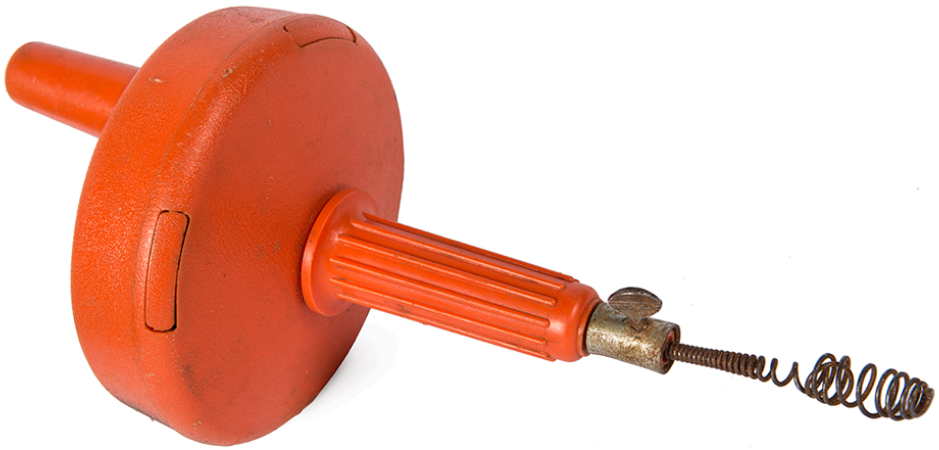


Figure 4 *Hand-operated drain auger. (Skilled Trades BC, 2021) Used with permission.*

Some hand augers can be attached to an electric drill, giving it more power to force it through the clog while also making it easier for the operator to use (Figure 5).

Figure 5 *Drain auger powered by an electric drill. (Skilled Trades BC, 2021) Used with permission.*

Closet Auger

The **closet auger**, named after the water closet, feeds a relatively short cable through a hook-shaped length of metal tubing (Figure 6). The hook shape makes it easier to feed the cable into a toilet. A plastic boot on the end of the cable protects the finish of the visible porcelain. Since most toilet clogs occur in the integral trap, the short cable is sufficient to break up or retrieve most clogs.

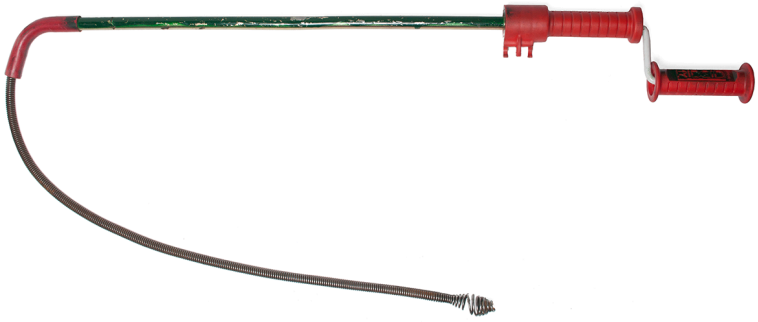


Figure 6 *Water closet drain auger. (Skilled Trades BC, 2021) Used with permission.*

Power Drum Augers (Small-Diametre Piping)

This power auger consists of a drum containing a length of cable (15 m/50 ft of $\frac{1}{4}$ in. or $\frac{5}{16}$ in. or 10 m/35 ft of $\frac{3}{8}$ in.) that is generally mounted on the end of a variable-speed electric drill. This hand-held drain cleaner can clear clogs in lines from 32 mm to 75 mm ($1\frac{1}{4}$ in.–3 in.) in diameter in awkward and tight spaces. The motor also has a quick-reversing switch to help release the cable should it get caught in a drain line.

The rotation of the drill unspools and drives the cable down a pipe. The cable is gripped by a chuck that must be loosened by hand for the cable to be loosened and manually fed into the drain and must again be hand-tightened to lock the cable in place. When the cable reaches the clog, the tip begins digging into and loosening the material.

This is where an electric power drum auger offers many benefits over a manual version. Using a hand auger, you are limited to the power you can generate and maintain with your hands alone. With a power auger, you can slowly ease up the pressure you are applying to a clogged drain in order to more effectively get rid of the obstruction.

Power Drum Augers (Large-Diametre Piping)

This power tool consists of a cable 30 m (100 ft) — or sometimes 15 m (50 ft) — long wrapped inside a metal drum or cage-like spool, which is turned by a reversible electric motor (Figure 7). Long lengths of cable contained within a cage or drum are not the only variety of cable available. Some models of drain augers use 8 ft (2.4 m) sections of cable in straight lengths that are fed through the machine and coupled using male and female ends before feeding again.

These tools are incredibly powerful, using low internal gear ratios to move slowly but with enough force to break apart or cut tough material. These machines are too heavy for one person to carry, so they are typically equipped with a frame with two wheels, allowing it to be rolled around like a dolly.

Figure 7 *Large-diameter power drum auger. (Skilled Trades BC, 2021) Used with permission.*

To use this type of tool, position the auger a few feet away from the cleanout and plug its power cord into a nearby grounded electrical outlet. Most augers have a foot pedal that allows the motor to be controlled hands-free. Set this down in a convenient location. Pull out the cable and feed it into the pipe a few feet, then press the pedal to start spinning the cable (and cutter head) in the normal (clockwise) rotation. While the auger is spinning, pull the cable off the spool and feed it into the drain a foot or so at a time. In addition to powering the cutting action, the rotation helps the cable work its way through bends in the drain pipe.

If the cable meets resistance, it could be an offset or obstruction. In either case, do not try to force the cable forward. Back off the cutter head by retracting the cable a bit, then feed it in again.

When the cutter encounters an obstruction, it may grab the material and stop turning while the cable keeps spinning. The cable is actually a tightly wound torsion spring, so you can let it wind up for a few rotations, but going too far can break it. Let the energy build up a little bit, then pull the cable back to free the cutter blade; the cable will instantly spin back to its normal position.

If the cutter gets stuck and you cannot get the cable unwound, stop the auger rotation, hit the reverse switch on the motor, and rotate the auger backward. Then, pull the cutter free before resuming in the clockwise rotation.

Once the cable returns to the normal position, start feeding it in again. Repeat the process until the drain is clear. Often, it is necessary to pull the cable all the way back out to check the cutter head for roots and other debris.

Advantages of electric drain cleaners include the ability to clean long sections of sewer drain and the ability to remove solid objects, such as tree roots. Machines using flexible attachments can easily negotiate multiple 90° bends while maintaining their effectiveness and without damaging the pipe.

Safety considerations for electric drain cleaners include the following:

- Wear work gloves and eye protection.
- Carefully control the cable during operation to avoid over-stressing it.
- Use appropriate caution when working around rotating machinery.
- Use properly grounded electrical outlets.

Auger Heads

Large-diameter machines typically have interchangeable heads that can be attached to the cable, each suited to a specific task. The most common types of **auger heads** are:

- Drop head auger
- Straight auger
- Funnel auger
- Hook auger
- Retrieving auger
- Spade cutter
- Four-blade sawtooth cutter
- Grease cutter
- Spiral sawtooth cutter
- Sawtooth cutter
- Spiral bar cutter
- Sharktooth cutter
- Grease C cutter
- Expanding finish cutter
- Chain knocker

Drop head auger: for cleaning the trap arms of fixtures mounted back-to-back (e.g., sinks where cable needs to be led into downpipe) (Figure 8).

Figure 8 *Drop head auger attachment.* (RIDGID, *n.d.*). *Used with permission.*

Straight auger: for use in exploring and breaking up stoppages or returning samples to the surface to determine the correct tool to use (Figure 9).

Figure 9 *Straight auger attachment. (RIDGID, n.d.). Used with permission.*

Funnel auger: for use as a second tool in line. It breaks up the stoppage remains left by a straight auger (Figure 10).

Figure 10 *Funnel auger attachment. (RIDGID, n.d.). Used with permission.*

Hook auger: for heavy and dense root stoppages in pipes that require hooking into and breaking up (Figure 11).

Figure 11 *Hook auger attachment. (RIDGID, n.d.). Used with permission.*

Retrieving auger: used for searching for cable that is broken or lost in a drain line (Figure 12).

Figure 12 *Retrieving auger attachment. (RIDGID, n.d.). Used with permission.*

Spade cutter: for following up after augers have been used and to open up floor drains (Figure 13).

Figure 13 *Spade cutter attachment. (RIDGID, n.d.). Used with permission.*

Four-blade sawtooth cutter: for blockages caused by hardened, glazed material, such as chemical deposits (Figure 14).

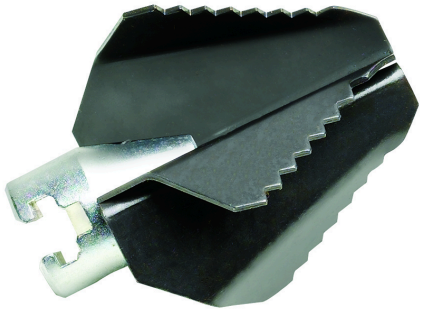


Figure 14 *Four-blade sawtooth cutter attachment. (RIDGID, n.d.). Used with permission.*

Grease cutter: for lines that have become badly clogged with grease or detergents and have to be opened (Figure 15).

Figure 15 *Grease cutter attachment. (RIDGID, n.d.). Used with permission.*

Spiral sawtooth cutter: for clearing any stoppage caused by roots, rags, sticks, etc. (Figure 16).

Figure 16 *Spiral sawtooth cutter attachment. (RIDGID, n.d.). Used with permission.*

Sawtooth cutter: for cleaning lines blocked heavily with roots. Its unique design permits the cutter to be removed from damaged pipe without locking (Figure 17).

Figure 17 *Sawtooth cutter attachment. (RIDGID, n.d.). Used with permission.*

Spiral bar cutter: for main sewers blocked by roots, leaf debris, sticks, sawdust, cloth, or sack material (Figure 18).

Figure 18 *Spiral bar cutter attachment. (RIDGID, n.d.). Used with permission.*

Sharktooth cutter: for use in cleaning pipes of general material clinging to pipe walls (Figure 19).

Figure 19 *Sharktooth cutter attachment. (RIDGID, n.d.). Used with permission.*

Grease C cutter: For grease blockages in lines leading from garbage disposal units or waste pipes (Figure 20).

Figure 20 *Grease C cutter attachment. (RIDGID, n.d.). Used with permission.*

Expanding finish cutters: for final removal of material adhering to walls and certain roots of fibrous nature (Figure 21).

Figure 21 *Expanding finish cutter attachment. (RIDGID, n.d.). Used with permission.*

Chain knocker: for use when vigorous action is required to clean scale in pipes and boiler tubes (Figure 22).

Figure 22 *Chain knocker attachment. (RIDGID, n.d.). Used with permission.*

Water jetting is a method of cleaning or unclogging drains and sewers using high-pressure water to remove debris. High-pressure water jetters usually operate with water pressures up to 28,000 kPa (4,000 psig), with flow rates of 9 to 113 L (2 to 25 gal.) of water per minute.

The pressure of the water jet propels a highly flexible hose through lines measuring 32 to 100 mm ($1\frac{1}{4}$ in. to 4 in.),

blasting through sludge, soap, and grease blockages. As you pull the hose back, it power-scrubs the line, flushing debris away and restoring drain lines to their free-flowing capacity. By introducing water into an already plugged line, the drainage pipe is ideally cleaned from the downstream end of the pipe, and the hose propels itself upstream.

When it is impossible to clean from the lower end of the pipe, the pipe must be water jetted several times to remove all the debris.

Water jetters can be truck-mounted and may carry up to 6,800 L (1,500 gal.) of water for large sewer cleaning jobs, or they can be mounted on a trailer and pulled by a large van or small truck. Smaller water jetters can be mounted on a cart for residential and light commercial applications (Figure 23).

When using this type of tool for a residential job, be aware of any cross-contamination issues. If a direct connection from the building's houseline is used, there must be an approved backflow preventer in the form of an RPBA (reduced pressure backflow assembly) installed between the houseline and the jetter.

Figure 23 *Water jetter machine. (RIDGID, n.d.). Used with permission.*

Air Blasters

Air blaster drain cleaners use accelerated carbon dioxide, air, or other gas to rupture the obstruction membrane. Accelerated gas creates a force on standing water that can dislodge clogs that accumulate close to drain openings but are too far away from the drain opening to be removed with a plunger. Unlike drain augers, air blasters do not pose any risk of scratching the surfaces of ceramic sinks, bathtubs, and toilets.

Disadvantages of air blaster drain cleaners include a limited cleaning range in pipes that do not contain standing water

and, in general, ineffectiveness for unclogging blocked main sewer drains. Air blasters can also force air and water back through the overflow of a basin if used improperly.

Safety considerations for air blaster drain cleaners include a requirement to wear eye protection and, when using an air-burst cleaner that uses compressed gas cartridges, careful handling of unused cartridges.

Steam Cleaning

Unlike air- and water jet systems, steam cleaning is an entirely different process. The steam cleaner (Figure 24) uses steam's expansion to accelerate water droplets, at the boiling point, to a high velocity. The closer the steam cleaner's nozzle is to the surface to be cleaned, the higher the temperature and velocity of the water/steam mixture, and the more rapid the cleaning action. The temperature of the water/steam mixture drops quickly as the distance between the nozzle and the surface to be cleaned increases.

Consequently, for drain-cleaning applications, the nozzle should be held close to the inner surfaces to achieve the best results.

Figure 24 *Steam-powered drain cleaner. (SIOUX Corporation, n.d.). Used with permission.*

Shop Vacuum

Most “shop vacs” have an output blower mode that should be powerful enough to clear small drain obstructions. Place the end of the vacuum hose firmly over the drain and seal the edges to maintain output pressure. Make sure any other drain openings are closed or tightly plugged.

In blower mode, quickly turn the power on and off repeatedly until you dislodge the clog from the drain. Continuously running the blower for a long period of time can damage your pipes (or the vacuum, if its air flow is restricted).

Self-Test D-5.1: Drain Cleaning

Complete Self-Test D-5.1 and check your answers.

If you are using a printed copy, please find Self-Test D-5.1 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=91#h5p-31 (https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/?p=91#h5p-31)

References

RIDGID. (n.d.). *Sectional cable tools* [Product images]. Retrieved March 18, 2025, from https://www.ridgid.com/ca/en/sectional-cable-tools

Skilled Trades BC. (2021). *Book 2: Install fixtures and appliances, install sanitary and storm drainage systems.* Plumber apprenticeship program level 2 book 2 (Harmonized). Crown Publications: King's Printer for British Columbia.

Sioux Corporation. (n.d.). *E-Series pressure washers* [Product image]. Retrieved March 18, 2025, from https://sioux.com/e-series-pressure-washers

Trades Training BC. (2021). D-5: Maintain and repair sanitary and storm drainage systems. In: *Plumber Apprenticeship Program: Level 2.* Industry Training Authority, BC.

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- **Figures 8-23** are from RIDGID/Emerson Electric Co. 's Sectional cable tools (https://www.ridgid.com/ca/en/sectional-cable-tools) webpage and they are used with permission.
- **Figure 24** Steam-powered drain cleaner (https://sioux.com/e-series-pressure-washers) [H4D2750 high pressure hot water washer] is from SIOUX Corporation and is used with permission.

Self-Test D-5.1 Drain Cleaning

Complete Self-Test D-5.1 and check your answers.

1. Using Table 1, match the following drain-cleaning applications with the appropriate drum cable attachment

Table 1

Question	Answer	Application	Attachment
1		Used in drain lines for final removal of ma- terial and roots adhering to pipe walls	A. Sharktooth cutter
2		Used on drain lines that have become badly greased with detergents and have to be opened	B. Four-blade sawtooth cutter
3		Used in drain lines leading from garbage disposal units and associated waste lines	C. Retrieving auger
4		Used on drain lines to recover a lost or broken drum cable	D. Funnel auger
5		Used in drain lines after a straight auger to break up remaining obstructions	E. Straight auger
6		Used in drain lines that are coated with hardened material such as chemical de- posits	F. Spiral sawtooth cutter
7		Used for easier entrance into drain lines from back-to-back fixtures	G. Drop head auger
8		Used in drain lines where heavy and dense roots require hooking to break them up	H. Grease C cutter
9		Used in drain lines to follow up after an auger has cleared a floor drain	I. Spiral bar cutter
10		Used in main sewers blocked by roots, leaf debris, sticks, sawdust, cloth, or sacking	J. Chain knocker
11		Used in drain lines blocked heavily with roots; has a feature that allows it to be removed from damaged pipe without locking	K. Spade cutter
12		Used in drain lines that require scale re- moval or even boiler tubes during service	L. Expanding finish cutter
13		Used in drain lines to clear general mate- rial that may be attached to the pipe walls	M. Hook auger
14		Used to retrieve a drain blockage sample that determines proper attachment	N. Grease cutter
15		Used in drain lines to clear multiple ob- structions such as roots, rags, and sticks	O. Sawtooth cutter

2. What two pieces of PPE are essential when undertaking a drain-cleaning procedure?
    a. Hard hat and safety glasses
    b. Rubber safety shoes and safety glasses with side shields
    c. Rubber safety shoes and gloves
    d. Gloves and safety glasses with side shields

3. What is the proper procedure to follow when sending a cutter attachment into a drain line and a blockage stops the cutter?
    a. Allow the cable to twist until the stoppage is cleared.
    b. Use short forward and reverse movements and allow the machine to work on the blockage.
    c. Force the attachment forward to break up the obstruction.
    d. Return the cable to the surface and attach a larger attachment.

4. What is the best tool to use when a building sewer is draining slowly and you suspect it has collapsed?

a. Drum auger with a retrieving attachment
b. Video inspection machine
c. Water jetter machine
d. Drum auger with a chain knocker attachment

5. What device does an on-surface pipe locator communicate with inside a drain line?
   a. Drain-cleaning attachment on the end of a cleaning cable
   b. Ball with an internal magnet
   c. Tracer wire
   d. Camera/transmitter on the end of the video inspection cable

6. Other than the location of a problem area inside a drain line, what other information is available to the operator at ground level when using a pipe locator?
   a. Depth of burial of the drain line
   b. Condition of the drain pipe
   c. Type of pipe material
   d. Drain pipe's proximity to the property line

7. Why is a hand-powered drum auger not meant to be sent down a toilet bowl to clear an obstruction?
   a. The cabling is too short and fragile and will snap inside the bowl.
   b. Toilets require more force than can be obtained from a hand-operated machine.
   c. The cable will mark the porcelain finish on the bowl surface.
   d. The cable is not flexible enough to navigate through the integral trap found in toilet bowls.

8. What feature does a closet auger have to help protect the finish on the inside of a closet bowl?
   a. Plastic cable
   b. Plastic boot on the hooked foot of the tool
   c. Re-usable rubber bowl liner

9. What loosens and tightens the chuck onto the cable when using a small pipe diameter power drum auger?
   a. A hex wrench
   b. The chuck is hand-tightened and loosened.
   c. The tool's motor automatically tightens and loosens the chuck.
   d. The cable is not tightened or loosened at the chuck.

10. What rotation direction is the normal forward feed position when using a large pipe diameter drum auger?
    a. Clockwise
    b. Counter-clockwise

11. If you are using a large pipe diameter drum auger and you encounter an obstruction that stops the rotation of the cutting attachment, what is the proper procedure to avoid snapping the cable?

a. Continue in the forward direction.
b. Continue in the forward direction, pull hard on the cable, and allow it to spin backward once released.
c. Place the machine in reverse to relax the tension on the cable.
d. Stop the machine and hand-feed the cable through the blockage.

12. What is typically the maximum water pressure used with drain-cleaning water jetter machines?

a. 7,000 kPa (1,000 psig)
b. 14,000 kPa (2,000 psig)
c. 21,000 kPa (3,000 psig)
d. 28,000 kPa (4,000 psig)

13. Which pipe location is best to introduce a water jetter hose into a clogged line?

a. Closest upstream cleanout above the obstruction
b. Closest downstream cleanout below the obstruction
c. Furthest upstream cleanout above the obstruction
d. Furthest downstream cleanout below the obstruction

14. What is the best tool to use when you suspect that a building sewer is frozen because it is not buried deep enough?

a. Drum auger with a root-cutting attachment
b. Steam cleaning machine
c. Water jetter machine
d. Drum auger with a chain knocker attachment

Answer Key: Self-Test D-5.1 (#chapter-answer-key-self-test-d-5-1) is on the next page.

Answer Key: Self-Test D-5.1

1. Table 1 Answers
    1. L. Expanding finish cutter
    2. N. Grease cutter
    3. H. Grease C cutter
    4. C. Retrieving auger
    5. D. Funnel auger
    6. B. Four-blade sawtooth cutter
    7. G. Drop head auger
    8. M. Hook auger
    9. K. Spade cutter
    10. I. Spital bar cutter
    11. O. Sawtooth cutter
    12. J. Chain knocker
    13. A. Sharktooth cutter
    14. E. Straight auger
    15. F. Spiral sawtooth cutter
2. d. Gloves and safety glasses with side shields
3. b. Use short forward and reverse movements and allow the machine to work on the blockage.
4. b. Video inspection machine
5. d. Camera/transmitter on the end of the video inspection cable
6. a. Depth of burial of the drain line
7. c. The cable will mark the porcelain finish on the bowl surface.
8. b. Plastic boot on the hooked foot of the tool
9. b. The chuck is hand-tightened and loosened.
10. a. Clockwise
11. c. Place the machine in reverse to relax the tension on the cable.
12. d. 28,000 kPa (4,000 psig)
13. b. Closest downstream cleanout below the obstruction
14. b. Stream cleaning machine

Glossary

“jet vac” trucks

A special truck that uses water and a strong vacuum to clean pipes and drains. It shoots high-pressure water to break up blockages, like dirt or grease, and then sucks up the waste to remove it. This helps keep pipes and drains clear and working properly. (Section D-1.11 (#chapter-d-1-11-trade-waste-systems))

15-minute rain event

A standard time frame used to express storm drainage load calculations, based on the volume of rainfall (in litres) expected over a 15-minute period. This metric helps determine appropriate pipe sizing. (Section D-3.3 (#chapter-d-3-3-storm-drainage-code-requirements))

90° elbow

A fitting used to change the direction of the pipe by 90 degrees. (Section D-1.10 (#chapter-d-1-10-requirements-and-prohibitions-for-dwv-systems))

acrylonitrile-butadiene-styrene (ABS) pipe

A type of plastic pipe that is lightweight, strong, and resistant to damage. It is often used in homes and buildings for carrying waste and venting air. However, because it can catch fire, it is usually only used in certain types of buildings. (Section D-1.4 (#chapter-d-1-4-acceptable-pipe-material-application))

adaptor plug

A fitting used to connect tubing of different sizes or types, ensuring a secure and leak-free transition between components in a water sampling system. (Section D-1.10 (#chapter-d-1-10-requirements-and-prohibitions-for-dwv-systems))

additional circuit vent

A vent pipe installed between a circuit vent and a relief vent to provide additional air circulation. (Figure 1, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

air admittance valves

Air admittance valves are mechanical devices that let air into the plumbing system to prevent siphoning while stopping air from escaping. They are used when traditional venting isn’t possible and should be installed in an accessible, ventilated area. (Figure 2, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

air break

An indirect connection between drainage pipes, created by a vertical gap of at least 25 mm (1 in.) to prevent contamination. It is commonly used for food prep sinks, drinking fountains, and ice makers. (Figure 3, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

Air pressure test

A test that checks for leaks by filling pipes with pressurized air and observing if the pressure drops. (Section D-4.1 (#chapter-d-4-1-drainage-system-testing-code-requirements))

Applied Science Technologists and Technicians of BC (ASTTBC)

The association for technology professionals and regulatory body that certifies wastewater professionals in BC. The ASTTBC registers practitioners once they have obtained the proper training. (Section D-1.1 (#chapter-d-1-1-codes-and-standards))

architectural drawing

the main plan of a building that shows its design, layout, materials, and finishes. It includes floor plans, elevations, sections, and detailed views to guide construction. These drawings are usually marked with an "A" followed by a page number (e.g., A-4). (Section D-2.1 (#chapter-d-2-1-types-of-dwv-drawings))

as-built

The record drawings and documentation defining deviation to the designed information occurring during construction at the end of the project. (Section D-2.1 (#chapter-d-2-1-types-of-dwv-drawings))

as-constructed

The defects and deviations from the original design that occur during the construction process. (Section D-2.1 (#chapter-d-2-1-types-of-dwv-drawings))

Association of Professional Engineers and Geoscientists of British Columbia (APEGBC)

The licensing body for professional engineers and geoscientists. Only professional engineers and geoscientists are permitted to construct and/or maintain a Type 3 sewerage system. (Section D-1.1 (#chapter-d-1-1-codes-and-standards))

auger head

An attachment fitted to the end of a drill rod or casing, designed to bore into the ground and remove soil or sediment during well installation. (Section D-5.1 (#chapter-d-5-1-drain-cleaning-equipment))

authority having jurisdiction (AHJ)

The governmental body responsible for enforcing any part of the NPC. (Section D-1.2; (#chapter-d-1-2-dwv-terminology)Section D-2.4 (#chapter-d-2-4-organizing-a-plumbing-project))

autoclave

A high-pressure, high-temperature chamber used to cure materials such as fibrocement pipe for strength and durability. (Section D-1.4 (#chapter-d-1-4-acceptable-pipe-material-application))

backflow

A reversal of the normal direction of the flow. (Section D-1.2 (#chapter-d-1-2-dwv-terminology))

backwater valve

A one-way flow control valve installed in a drainage system. Backwater valves are required to protect fixtures and drainage openings installed below grade, such as in a basement, where the possibility exists for the municipal sewage or stormwater systems to become overloaded and force wastewater back through your drains. Backwater valves are also required on
any subsoil drainage pipe that connects into the sanitary drain to protect it from sewage backups. Under normal

conditions, it allows the wastewater to drain out of the system, but if a reversal of flow should occur, the valve is forced closed and protects the interior of the building from sewage backup. (Figures 4 and 5, Section D-1.2; (#chapter-d-1-2-dwv-terminology)Section D-2.3 (#chapter-d-2-3-creating-plans-and-isometric-drawings-of-dwv-systems))

ball test

A test that checks for proper slope and obstructions in pipes by rolling a dense ball through the system. (Section D-4.1 (#chapter-d-4-1-drainage-system-testing-code-requirements))

BaroTROLL

A pressure sensor used to measure and record barometric pressure at a well site, allowing for accurate correction of water level data obtained from submersible pressure loggers.

bathroom group

A group of plumbing fixtures installed in the same room, consisting of one domestic lavatory, one water closet, and either one bathtub (with or without a shower) or one single-head shower. The intent is that these three fixtures are located in a room occupied by only one person, so they are not normally in simultaneous use. (Section D-1.2 (#chapter-d-1-2-dwv-terminology))

BC Onsite Sewage Association (BCOSSA) and Western Canada Onsite Wastewater Management Association (WCOWMA)

These organizations develop educational programs for onsite wastewater practitioners and provide technical information to industry stakeholders and practitioners. (Section D-1.1 (#chapter-d-1-1-codes-and-standards))

BC Plumbing Code (BCPC)

The plumbing standard for British Columbia, historically based on the National Plumbing Code of Canada. (Section D-1.1 (#chapter-d-1-1-codes-and-standards))

bell trap

A type of drain used in the past, often in floor drains. Installation is prohibited by the NPC because it can cause problems with draining. (Section D-1.10 (#chapter-d-1-10-requirements-and-prohibitions-for-dwv-systems))

bentonite chips

Small, pellet-like forms of bentonite clay used to seal the annular space in a monitoring well, preventing vertical water movement and protecting against contamination.

berm

A raised area of soil that is typically built along the edge of a trench or drain to hold back water, directing it into the drain for proper collection and drainage. (Section D-3.7 (#chapter-d-3-7-sub-soil-drainage-systems))

borehole

A cylindrical hole drilled into the ground to access groundwater, collect geological data, or install monitoring equipment such as wells or piezometers.

branch

A sanitary drainage pipe connected at its upstream end to the junction of two or more sanitary drainage pipes or to a stack and connected at its downstream end to another branch, a sump, a stack, or a building drain. (Figure 6, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

branch vent

A vent pipe connected at its lower end to the junction of two or more vent pipes. At its upper end, it either terminates in the open air or connects to another branch vent, stack vent, vent stack, or vent header. (Figure 7, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

building code

A set of rules that tell people how to build safe and strong buildings. These rules make sure houses, schools, and other buildings are built properly so they don't fall down, catch fire easily, or have other dangers. (Section D-1.1 (#chapter-d-1-1-codes-and-standards))

building drain

The lowest horizontal piping, including any vertical offset that conducts sewage, clear-water waste, or stormwater by gravity to a building sewer. (Figure 8, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

building permit

An official permission from the city or town that allows people to build or change a building. It makes sure the plans follow the building code and keeps everyone safe. (Section D-1.1 (#chapter-d-1-1-codes-and-standards))

building sewer

A pipe that connects to a building drain 1 m (39 in.) outside the wall of a building and connects to a public sewer or private sewage disposal system. (Figure 8, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

building trap

A trap installed in a building drain or building sewer to prevent the circulation of air between a drainage system and a public sewer. New buildings do not have building traps installed, but these traps still exist in older homes and buildings. (Figure 9, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

bulkhead

A barrier or wall built within a building that may require plumbing installation adjustments for the DWV system. (Section D-2.2 (#chapter-d-2-2-planning-interior-dwv-system-layouts))

Canadian Commission on Building and Fire Codes (CCBFC)

A national committee responsible for developing and maintaining Canada's model building, fire, plumbing, and energy codes. The CCBFC operates under the National Research Council of Canada (NRC) and collaborates with provincial, territorial, and industry stakeholders to ensure codes align with safety, health, and environmental standards. (Section D-1.1 (#chapter-d-1-1-codes-and-standards))

catch basin

A ground-level stormwater collection point, often found in paved areas, that traps debris like leaves before directing

rainwater or stormwater into pipes for proper drainage. It has a grate on top to catch debris and prevent blockages, helping direct the water into storm sewers for discharge into natural water bodies. (Section D-3.2; (#chapter-d-3-2-functions-of-pipes-in-storm-drainage-systems) Section D-3.6 (#chapter-d-3-6-sumps-and-catch-basins))

ceiling drop installations

A method of lowering pipes or ducts from the ceiling to accommodate plumbing or electrical systems. This is done when it's necessary to route systems through spaces where the ceiling is lower or obstructed. (Section D-2.2 (#chapter-d-2-2-planning-interior-dwv-system-layouts))

certification mark

A special symbol or label on a product (such as ASME) that shows it has been tested and approved to meet safety and quality standards. It proves that the product is safe to use and works properly.
Note about **ASME certification marks:** the **ASME "H" or "U" stamp** is used on pressure vessels, boilers, and piping systems to indicate compliance with ASME codes. In plumbing, ASME standards apply to products like pipes, fittings, and fixtures, but the products themselves often carry certification marks from testing organizations like **CSA, NSF, or UL**, which certify that they meet ASME standards. (Section D-1.1 (#chapter-d-1-1-codes-and-standards))

certified product (plumbing)

A plumbing part that has been tested and approved to be safe and work properly. These products have a special mark or label to show they meet important safety and quality rules. (Section D-1.1 (#chapter-d-1-1-codes-and-standards))

chemical-dosing neutralization systems

Systems that use controlled injection of acid or base into a waste stream to neutralize chemicals. The chemicals react to form a salt and water mixture, which is then discharged. (Section D-1.11 (#chapter-d-1-11-trade-waste-systems))

circuit vent

A type of vent that serves multiple fixtures on a horizontal drainage branch by utilizing the top portion of the pipe for ventilation. (Section D-1.8 (#chapter-d-1-8-sizing-branch-and-circuit-vents))

civil engineering

A branch of engineering that focuses on designing, building, and maintaining things like roads, bridges, buildings, and water systems. Civil engineers work to make sure these structures are safe, strong, and help people live and work better. (Section D-3.7 (#chapter-d-3-7-sub-soil-drainage-systems))

clamping collar

A metal ring used to hold parts together, like a roof drain and the waterproof membrane, to make sure everything stays tightly in place and doesn't let water leak through. (Figure 2, Section D-3.5 (#chapter-d-3-5-installing-storm-drainage-systems))

cleanout

An access point installed in drainage and venting systems for cleaning and inspection services. (Section D-1.2 (#chapter-d-2-3-creating-plans-and-isometric-drawings-of-dwv-systems); Section D-1.3 (#chapter-d-1-3-functions-of-different-parts-in-a-dwv-system); Section D-2.3 (#chapter-d-2-3-creating-plans-and-isometric-drawings-of-dwv-systems))

clear-water waste

Wastewater with impurity levels not harmful to health. It may include cooling water and condensate drainage from refrigeration and air-conditioning equipment and cooled condensate from steam heating systems, but it does not include stormwater. (Section D-1.2; (#chapter-d-1-2-dwv-terminology) Section D-3.1 (#chapter-d-3-1-storm-drainage-terminology))

clearwater waste

wastewater with impurity levels that will not be harmful to health and may include cooling water and condensate drainage from refrigeration and air-conditioning equipment and cooled condensate from steam heating systems but does not include storm water. (Section D-3.1)

closet auger

A special tool, named after the water closet, used to unclog toilets. It has a long, flexible rod with a spiral end that you insert into the toilet drain. When you turn the handle, the spiral helps break up or remove the blockage. (Section D-5.1)

cold-caulked joint

A type of joint sealed using a caulking compound, often used in bell and spigot pipe systems. The compound must be packed tightly to ensure a gas- and water-tight seal. (Section D-1.10 (#chapter-d-1-10-requirements-and-prohibitions-for-dwv-systems))

combined building drain

A building drain intended to conduct sewage and stormwater. (Figure 10, Section D-1.2 (#chapter-d-1-2-dwv-terminology); Section D-3.1 (#chapter-d-3-1-storm-drainage-terminology)) (#chapter-d-1-2-dwv-terminology)

combined building sewer

A building sewer intended to conduct sewage and storm water. (Section D-3.1 (#chapter-d-3-1-storm-drainage-terminology))

combined sewer

A sewer intended to conduct sewage and stormwater. (Section D-1.2; (#chapter-d-1-2-dwv-terminology) Section D-3.1 (#chapter-d-3-1-storm-drainage-terminology))

Combustible Gas Indicator (CGI)

A tool that helps workers find dangerous gases in the air that could catch fire or explode. It keeps people safe by warning them when gas levels are too high. (Section D-5.1)

combustible piping

Pipes made from materials that can burn, such as ABS and PVC, which have specific installation restrictions. (Section D-1.4 (#chapter-d-1-4-acceptable-pipe-material-application))

consumables

(Also known as consumable goods, non-durable goods, or soft goods); goods that can be consumed, dissipated, wasted, or spent. In plumbing construction projects, these may include materials such as solder, flux, sand cloth, fasteners, Teflon tape, and glue. (Section D-2.4 (#chapter-d-2-4-organizing-a-plumbing-project))

contaminant

Any solid, liquid, or gas that may impair the quality of the potable water. (Section D-3.3 (#chapter-d-3-3-storm-drainage-code-requirements))

continuous vent

A vent pipe that is an extension of a vertical section of a branch or fixture drain. (Section D-1.2 (#chapter-d-1-2-dwv-terminology))

conveying

The process of transporting effluent, waste, or water from one location to another through piping or other means. (Section D-3.3 (#chapter-d-3-3-storm-drainage-code-requirements))

coordination with other trades

The process of working with other construction professionals to ensure smooth project execution. (Section D-2.4 (#chapter-d-2-4-organizing-a-plumbing-project))

corrugated steel galvanized pipe

A type of durable, ribbed metal piping commonly used in stormwater systems such as culverts or detention systems. It must be joined with couplings that align pipes, resist separation, and prevent root or debris infiltration. (Section D-3.3 (#chapter-d-3-3-storm-drainage-code-requirements))

cross bore

A cross bore happens when one underground pipe accidentally goes through another pipe. For example, a new pipe might be drilled through a sewer pipe by mistake. This can be dangerous and cause clogs or leaks, so workers check carefully to make sure pipes don't cross like this. (Section D-5.1)

crown vented trap

A trap with a vent (small pipe) rising from the top of it. This design is prohibited by the NPC because the vent is too close to the trap, which can cause drainage problems. Clause 2.5.6.3.(1)(a) requires that the distance from the trap weir to the vent be not less than twice the size of the fixture drain.(Section D-1.10 (#chapter-d-1-10-requirements-and-prohibitions-for-dwv-systems))

curtain drain

A French drain installed across a slope to intercept and drain water away from sensitive areas, such as septic

disposal fields, reducing water accumulation and lowering the water table. (Section D-3.7 (#chapter-d-3-7-sub-soil-drainage-systems))

dead end

A pipe that terminates with a capped fitting. (Section D-1.2 (#chapter-d-1-2-dwv-terminology))

detail reference

Symbols that appear beside a part of a building plan that is drawn in detail at a larger scale on another page. The number in the top half of the detail reference symbol is the detail number. The number in the bottom half is the page on which the detail drawing can be found. This page number is usually a letter and number combination. (Figure 17, Section D-2.1 (#chapter-d-2-1-types-of-dwv-drawings))

detention system

A system that temporarily stores stormwater before releasing it slowly to reduce the risk of flooding and erosion. (Section D-3.8 (#chapter-d-3-8-storm-water-site-retention-systems))

developed length

The length along the centreline of the pipe and fittings. (Figure 12, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

dilution

The process of mixing chemical waste with water to reduce its concentration and stabilize it. This can be done through simple methods like flushing or using a dilution tank. (Section D-1.11 (#chapter-d-1-11-trade-waste-systems))

dimensioning

The process of adding measurements to a drawing. (Section D-2.3 (#chapter-d-2-3-creating-plans-and-isometric-drawings-of-dwv-systems))

directly connected

Implies that two pipes are physically connected in such a way that water or gas cannot escape from the connection. (Section D-1.2 (#chapter-d-1-2-dwv-terminology))

double sanitary tee

A plumbing fitting used to connect two fixtures at the same elevation to a vertical wet vent or drain stack. (Section D-1.7 (#chapter-d-1-7-multi-storey-wet-vents))

double wye

A special pipe fitting that looks like the letter "Y" with two branches. It helps connect two drain pipes to a main pipe at an angle, so water flows smoothly without clogging. (Section D-1.7 (#chapter-d-1-7-multi-storey-wet-vents))

double wye and 45° combination

A plumbing fitting that allows two fixture drains to connect at an angle to improve drainage efficiency. (Section D-1.7 (#chapter-d-1-7-multi-storey-wet-vents))

drain tile

A type of pipe used in drainage systems, often made of clay, that helps collect and move water from the soil, typically used around foundations. (Section D-3.7 (#chapter-d-3-7-sub-soil-drainage-systems))

drainage system

An assembly of pipes, fittings, fixtures, and traps used to convey sewage, clear-water waste, or stormwater to a public sewer or private sewage disposal system. It does not include subsoil drainage pipes. (Section D-1.1 (#chapter-d-1-1-codes-and-standards); Section D-1.2 (#chapter-d-1-2-dwv-terminology))

drainage troughs

A narrow channel or trench that collects and moves water away from areas like driveways or parking lots. Made of concrete or plastic, it has a grate on top for water to flow into, helping keep the area dry and safe. (Figure 4, Section D-3.6 (#chapter-d-3-6-sumps-and-catch-basins))

dry well

A large, deep hole filled with rocks or gravel where water can collect and slowly soak into the ground. It is used to manage excess rainwater and help prevent flooding by allowing the water to be absorbed instead of staying on the surface. (Section D-3.7 (#chapter-d-3-7-sub-soil-drainage-systems))

dual vent

A vent pipe that serves two fixtures and connects at the junction of the trap arms. (Figure 13, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

duplex system

Two pumps in a sump, each with its own pipes and valves. Float switches inside the sump detect water levels, and a control panel automatically turns the pumps on or off. This setup ensures the system works even if one pump fails. (Section D-3.6 (#chapter-d-3-6-sumps-and-catch-basins))

DWV system

Stands for Drain, Waste, and Vent system, which removes wastewater and vent gases from a building, ensuring proper drainage and pressure balance. (Section D-1.3; (#chapter-d-1-3-functions-of-different-parts-in-a-dwv-system)Section D-2.3 (#chapter-d-2-3-creating-plans-and-isometric-drawings-of-dwv-systems))

electrical drawing

Drawings that show the layout of the electrical system in a building, including lights, switches, outlets, and electrical panels. They also show systems for heating, phone lines, and cable TV. Based on the floor plan, these drawings are created by an electrical engineer and are marked with an "E" before the drawing number (e.g., E-2). (Section D-2.1 (#chapter-d-2-1-types-of-dwv-drawings))

elevation drawing

Vertical views of a building's outside, showing details like the roof slope and wall openings. It also displays the distance from the first floor to the basement. To find the basement elevation, subtract the space between floors from the first-floor elevation. (Section D-2.1 (#chapter-d-2-1-types-of-dwv-drawings))

elevation reference

Elevation preferences refer to the desired height levels for various parts of a building or site. These preferences are used to ensure that the building is properly positioned in relation to utilities, drainage, and other elements like the landscape, ensuring everything functions correctly and efficiently. The elevation reference symbol is shown on a plan view and indicates that an elevation drawing showing a vertical cross-section of the building at the point indicated by the symbol arrow has been prepared. (Figure 15, Section D-2.1 (#chapter-d-2-1-types-of-dwv-drawings))

elevations

Elevations show height differences between a building and nearby utilities, like water and sewer lines. They help determine if pipes will use gravity or need a pump to connect to municipal services. This information is found in drawings and notes, helping with the correct placement of pipes and septic tanks. (Section D-2.1 (#chapter-d-2-1-types-of-dwv-drawings))

emergency floor drain

A fixture used for overflow protection that does not receive regular discharge from other fixtures, other than from a trap primer. Any floor drain installed in a washroom is considered an emergency floor drain. (Section D-1.2 (#chapter-d-1-2-dwv-terminology))

emergency floor drains

A drainage fixture installed in areas prone to accidental water discharge, such as washrooms, mechanical rooms, laundry rooms, and commercial kitchens. Its purpose is to provide overflow protection by directing excess water to the drainage system, preventing flooding and water damage. Unlike regular floor drains, emergency floor drains are typically used as a backup and may remain dry under normal conditions. (Section D-1.5 (#chapter-d-1-5-sizing-sanitary-drainage-pipes))

Environmental Management Act

A law that helps protect the environment by making sure people and businesses follow rules about pollution, waste, and how they use natural resources. It helps keep the air, water, and land clean and safe for everyone.

fats, oils, and greases (FOGs)

A mixture of substances found in wastewater that can cause blockages and environmental damage if not properly treated and removed, often managed through grease interceptors. (Section D-1.11 (#chapter-d-1-11-trade-waste-systems))

fibrocement (DWV) pipe

A type of strong, lightweight pipe made from cement and fibers instead of metal or plastic. It is used in drain, waste, and vent (DWV) systems to move water and waste in buildings. This pipe was created to replace older pipes that contained harmful materials like asbestos. (Section D-1.4 (#chapter-d-1-4-acceptable-pipe-material-application))

final plumbing inspection

Inspection after all fixtures are installed and operational. (Section D-2.4 (#chapter-d-2-4-organizing-a-plumbing-project))

final test

A test performed after fixtures are installed to make sure the whole plumbing system is working properly and has no leaks. (Section D-4.1 (#chapter-d-4-1-drainage-system-testing-code-requirements))

fines

Small particles of dirt, sand, or silt that are tiny enough to pass through a sieve or filter. These particles can make soil harder to drain because they fill in the spaces between bigger particles. (Section D-3.7 (#chapter-d-3-7-sub-soil-drainage-systems))

fire-stop system

A method used to seal penetrations in fire-rated walls or ceilings to prevent fire from spreading through the openings. (Section D-2.2 (#chapter-d-2-2-planning-interior-dwv-system-layouts))

fitting

A piece that connects pipes together, like elbows and T-joints.

fixture

A receptacle, appliance, apparatus, or other device that discharges sewage or clear-water waste and includes a floor drain. (Section D-1.2; (#chapter-d-1-2-dwv-terminology)Section D-2.3 (#chapter-d-2-3-creating-plans-and-isometric-drawings-of-dwv-systems))

fixture drain

The pipe that connects a trap serving a fixture to another part of a drainage system. (Figure 14, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

fixture outlet pipe

A pipe that connects the waste opening of a fixture to the inlet of the trap serving the fixture. (Figure 15, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

fixture schedule

A list detailing the location and specifications of plumbing fixtures. (Section D-2.4 (#chapter-d-2-4-organizing-a-plumbing-project))

fixture unit (DWV)

The unit of measure based on the rate of discharge, time of operation, and frequency of use of a fixture that expresses the hydraulic load imposed by that fixture on the drainage system. (Section D-1.2 (#chapter-d-1-2-dwv-terminology))

fixture unit load

A way to measure how much water a plumbing fixture, like a sink or toilet, uses. It helps plumbers figure out how big the pipes need to be to handle the amount of water that flows through them. Each fixture has a specific number of fixture units based on how much water it uses. The higher the number of fixture units, the more water the fixture needs. (Section D-1.5 (#chapter-d-1-5-sizing-sanitary-drainage-pipes))

fixture units (FU)

A unit of measure used in sanitary drainage systems to represent the load-producing effect of a plumbing fixture. In combined systems, 1 FU = 9.1 L/15 min when total load exceeds 260 FUs. (Section D-3.3 (#chapter-d-3-3-storm-drainage-code-requirements))

flame spread rating (FSR)

A classification that indicates how quickly flames spread along a material's surface, relevant for building code compliance. (Section D-1.4 (#chapter-d-1-4-acceptable-pipe-material-application))

flashing

A material used to create a watertight seal around vent pipes where they penetrate a roof, preventing water intrusion. (Section D-2.5 (#chapter-d-2-5-installing-dwv-systems))

float switch

A device that controls water levels in tanks or pumps. It has a floating part that moves with the water level, and when the water gets too high or low, it sends a signal to turn the pump on or off to keep the water at the right level. (Section D-3.6 (#chapter-d-3-6-sumps-and-catch-basins))

flood level rim

The top edge at which water can overflow from a fixture or device. (Figure 16, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

floor plan

A horizontal view of one floor of a building, showing room layout, dimensions, materials, and fixture locations, critical for determining piping routes. (Section D-2.1 (#chapter-d-2-1-types-of-dwv-drawings))

footings

The strong, stable foundations or base structures that support the weight of a building or other construction. They help keep the building from sinking or shifting by spreading out the weight evenly onto the ground. Footings are usually made of concrete and are placed below the building to provide solid support, especially for heavy plumbing systems and pipes. (Section D-3.7 (#chapter-d-3-7-sub-soil-drainage-systems))

forcemain

A pressurized sewer system that transports wastewater using pumps when gravity flow is insufficient. (Section D-1.4 (#chapter-d-1-4-acceptable-pipe-material-application))

French drain

A drainage system consisting of a trench filled with perforated pipe and clean rock, designed to direct surface water away from an area. (Section D-3.7 (#chapter-d-3-7-sub-soil-drainage-systems))

fresh air inlet

A vent pipe installed in conjunction with a building trap and that terminates outdoors. It is used to prevent an air lock between the fixture traps and the building trap by allowing air circulation through the DWV system. (Figure 17, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

frost line

The depth below the ground surface where the soil freezes in cold climates. Pipes must be installed below this line to avoid freezing. (Section D-2.2 (#chapter-d-2-2-planning-interior-dwv-system-layouts))

geotextile fabric

A fabric material used in drainage systems to prevent the clogging of pipes by fine particles like silt while allowing water to pass through. (Section D-3.7 (#chapter-d-3-7-sub-soil-drainage-systems))

grease interceptor

A device used to trap fats, oils, or grease from wastewater before it enters the drainage system, often used in kitchens, restaurants, or care facilities. (Section D-1.10 (#chapter-d-1-10-requirements-and-prohibitions-for-dwv-systems))

green roof

A rooftop covered with vegetation that absorbs rainwater, reducing runoff and providing benefits like energy efficiency and improved air quality. (Figure 5, Section D-3.8 (#chapter-d-3-8-storm-water-site-retention-systems))

greywater

Water that comes from sinks, showers, and washing machines in your home. It's not dirty like sewage water, but it's not clean enough to drink either. Greywater can be reused for things like watering plants or flushing toilets to help save fresh water. (Section D-3.8 (#chapter-d-3-8-storm-water-site-retention-systems))

groundwork inspection

Inspection of underground plumbing before covering pipes. (Section D-2.4 (#chapter-d-2-4-organizing-a-plumbing-project))

gutter sizing

The process of determining the correct gutter dimensions based on roof area, local rainfall intensity, and gutter slope. Though sizing is influenced by plumbing code data, installation is typically performed by specialized gutter contractors. (Section D-3.3 (#chapter-d-3-3-storm-drainage-code-requirements))

hand auger

A tool used to dig small holes in the ground. It has a long handle and a sharp, spiral bit at the end that you twist into the soil to make the hole. It's used for tasks like planting trees or installing posts. (Section D-5.1)

hoisting and rigging

The use of cranes, hoists, and rigging equipment to lift and position heavy materials safely on a construction site. (Section D-2.5 (#chapter-d-2-5-installing-dwv-systems))

hydraulic load

The amount of water moving through a system, like pipes or drains, over a certain time. Imagine pouring water into a funnel—if you pour too much too fast, it overflows. In plumbing and wastewater systems, hydraulic load helps

us understand how much water a system can handle before it gets too full or backs up. (Section D-1.5 (#chapter-d-1-5-sizing-sanitary-drainage-pipes))

hydrological cycle

The continuous movement of water on, above, and below the surface of the Earth, including processes like evaporation, condensation, and precipitation. (Section D-3.7 (#chapter-d-3-7-sub-soil-drainage-systems))

hydrology

The scientific study of the movement, distribution, and management of water, including the water cycle and water resources. (Section D-3.7 (#chapter-d-3-7-sub-soil-drainage-systems))

impervious surfaces

Surfaces that do not absorb water, such as concrete, asphalt, and buildings, which increase the volume of runoff. (Section D-3.8 (#chapter-d-3-8-storm-water-site-retention-systems))

indirect connections

Plumbing connections where a fixture or device is not directly connected but instead terminates above the flood level rim of a directly connected fixture, forming an air break. This type of connection is designed to prevent backflow. (Section D-1.10 (#chapter-d-1-10-requirements-and-prohibitions-for-dwv-systems))

indirectly connected

A pipe that does not connect directly with the drainage system but conveys liquid wastes by discharging into a plumbing fixture, interceptor, or receptacle directly connected to the drainage system. An air break separates the two systems. The air break prevents the possibility of wastes backing up into a compartment or device and contaminating it. (Figure 18, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

individual vent

A vent pipe that serves one fixture. (Figure 19, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

inertial pump

A simple manual pump consisting of a foot valve and tubing, operated by a repetitive up-and-down motion to lift water to the surface.

infiltration

The process where stormwater is absorbed into the soil, reducing runoff and helping to restore the natural water balance. (Section D-3.8 (#chapter-d-3-8-storm-water-site-retention-systems))

interceptor

A receptacle installed to prevent unwanted materials from passing into a drainage system. There are three main types of interceptors: grease, oil, and solids. Each of them requires different considerations for sizing, operation, and maintenance. (Figure 20, Section D-1.2 (#chapter-d-1-2-dwv-terminology); Section D-1.11 (#chapter-d-1-11-trade-waste-systems))

interceptor venting

The process of venting systems like oil interceptors, sewage sumps, and dilution tanks to ensure proper airflow and compliance with plumbing codes. Specific venting requirements are outlined in plumbing codes. (Section D-1.11 (#chapter-d-1-11-trade-waste-systems))

inventory control

Managing materials to prevent shortages or delays in the project. (Section D-2.4 (#chapter-d-2-4-organizing-a-plumbing-project))

isometric drawings (plumbing)

3-dimensional (3D) pictures that show how pipes in a building connect and work together. They help plumbers see where drain, waste, and vent pipes go and what size they should be. These drawings make it easier to plan and install plumbing systems correctly, whether in homes or larger buildings. (Section D-2.3 (#chapter-d-2-3-creating-plans-and-isometric-drawings-of-dwv-systems))

just-in-time delivery

A logistics strategy that ensures materials arrive exactly when needed. (Section D-2.4 (#chapter-d-2-4-organizing-a-plumbing-project))

key plan

A small map on a drawing (usually near the title block) showing the location of the area depicted, especially if the drawing is of part of a larger structure. (Section D-2.1 (#chapter-d-2-1-types-of-dwv-drawings))

landscape plan

A drawing that shows the design and layout of the outdoor areas around a building, like gardens, walkways, and trees. It helps plan how the land will look and be used. (Section D-2.1 (#chapter-d-2-1-types-of-dwv-drawings))

leader (rainwater leader or RWL)

A pipe installed to carry stormwater from a roof to a storm building drain, sewer, or other place of disposal. (Section D-3.1 (#chapter-d-3-1-storm-drainage-terminology))

limestone chip neutralization

A method where acidic waste is neutralized by mixing it with limestone chips (calcium carbonate). The process produces a chemical reaction that neutralizes the acid, and the mixture is then discharged. (Section D-1.11 (#chapter-d-1-11-trade-waste-systems))

litres per 15 minutes (L/15 min)

The unit used to express drainage loads in storm and combined systems, aligning volume with a 15-minute rainfall time frame. Helps convert area and rainfall depth into actionable flow data. (Section D-3.3 (#chapter-d-3-3-storm-drainage-code-requirements))

local rainfall intensity

The amount of rain, measured in millimetres, expected to fall over a 15-minute period in a specific geographic

location. This data is obtained from the National Building Code and is critical to calculating drainage loads. (Section D-3.3 (#chapter-d-3-3-storm-drainage-code-requirements))

macerating toilet system

A type of plumbing system that uses a grinding or chopping mechanism to break down waste and toilet paper into a fine slurry before pumping it to the main sewer or septic line. It is commonly used in locations where traditional gravity drainage is not possible, such as basements or areas far from the main waste pipe. (Section D-1.9 (#chapter-d-1-9-stack-vents-vent-stacks-and-headers))

material availability

The impact of supply chain factors on project timelines. (Section D-2.4 (#chapter-d-2-4-organizing-a-plumbing-project))

material handling

The process of safely receiving, storing, moving, and disposing of plumbing materials to prevent damage and ensure efficiency. (Section D-2.5 (#chapter-d-2-5-installing-dwv-systems))

materials take-off

(MTO) A list of materials required for a plumbing installation. (Section D-2.4 (#chapter-d-2-4-organizing-a-plumbing-project))

mechanical drawing

(climate control plan); A type of drawing that shows the details of a building's heating, cooling, plumbing, and other mechanical systems. It helps understand how these systems are set up. (Section D-2.1 (#chapter-d-2-1-types-of-dwv-drawings))

minimum slopes

The smallest allowable incline for drainage pipes, typically 1:50 as per regulations like the NPC. In some cases, the slope may be reduced to 1:100 for building drains at least 100 mm (4 in.) in size to match other connected drainage systems. (Section D-3.5 (#chapter-d-3-5-installing-storm-drainage-systems))

Ministry of Environment and Climate Change Strategy

Regulates large community wastewater systems under the Environmental Management Act and the Municipal Wastewater Regulation. (Section D-1.1 (#chapter-d-1-1-codes-and-standards))

Ministry of Health

Regulates smaller, generally private, domestic sewerage systems, including on-site septic systems, under the Public Health Act and the Sewerage System Regulation. (Section D-1.1 (#chapter-d-1-1-codes-and-standards))

mole drain

A type of drain created using moling, where tunnels are formed in the soil to improve water drainage, commonly used in farming to address waterlogged soils with slow percolation rates. (Section D-3.7 (#chapter-d-3-7-sub-soil-drainage-systems))

moling

A process in agriculture where a torpedo-shaped mandrel creates tunnels or voids in the soil without leaving a visible trench, often used to improve drainage in waterlogged fields. (Section D-3.7 (#chapter-d-3-7-sub-soil-drainage-systems))

municipal bylaws

Rules made by a city or town to help keep things safe and organized, like where buildings can be built and how plumbing systems should be set up. (Section D-1.1 (#chapter-d-1-1-codes-and-standards))

municipality

A city or town that has its own local government to make decisions about things like roads, water, and public services. (Section D-1.1 (#chapter-d-1-1-codes-and-standards))

National Plumbing Code (NPC)

A model plumbing code developed by the National Research Council of Canada, updated every five years. (Section D-1.1 (#chapter-d-1-1-codes-and-standards))

neutralization

A chemical reaction between an acid and a base that produces a neutral solution of water and salt. This process can be achieved by dilution, limestone chips, or chemical dosing. (Section D-1.11 (#chapter-d-1-11-trade-waste-systems))

nominal pipe size (NPS)

The nominal diameter by which a pipe, fitting, trap, or other similar item is commercially designated. (Section D-1.2 (#chapter-d-1-2-dwv-terminology))

nominally horizontal

A DWV piping arrangement installed at an angle of less than 45° with the horizontal. (Figure 21, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

nominally vertical

A DWV piping arrangement installed at an angle of not more than 45° with the vertical. (Figure 21, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

non-combustible piping

Pipes made from materials like cast iron and copper that do not burn and are often required in fire-rated construction. (Section D-1.4 (#chapter-d-1-4-acceptable-pipe-material-application))

north arrow

A symbol on a map or drawing (to the left of the key plan) that shows which direction is north in relation to the building. It helps you understand how the map or drawing is oriented and which way things are facing. It is not used to orient any elevation or sectional views on the same sheet. (Section D-2.1 (#chapter-d-2-1-types-of-dwv-drawings))

Occupational Health and Safety (OHS) Regulation

A set of rules and guidelines designed to protect workers' health and safety during construction and other work activities. These regulations must be followed to minimize risks and hazards on job sites. (Section D-3.5 (#chapter-d-3-5-installing-storm-drainage-systems))

offset

The piping that connects the ends of two parallel pipes. (Figure 22, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

offset relief vent

A relief vent that provides additional air circulation upstream and downstream of an offset in a stack. (Figure 23, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

oil interceptor

A device installed to capture oil or gasoline in wastewater to prevent it from entering the drainage system. (Section D-1.10 (#chapter-d-1-10-requirements-and-prohibitions-for-dwv-systems))

one-time-only test caps

Disposable caps used to seal pipe openings during leak testing. they are designed for single-use applications and are typically removed and discarded after testing is complete. (Section D-4.2 (#chapter-d-4-2-testing-methods))

onsite sewage system

A decentralized sewage treatment system used in areas not connected to public sewer systems. (Section D-1.1 (#chapter-d-1-1-codes-and-standards))

open centre test plug

A type of test plug that is used to seal pipes during testing. It has a hole in the middle, so tools can be used to adjust or measure the pressure inside the pipe without taking the plug off. (Section D-4.2 (#chapter-d-4-2-testing-methods))

orthographic drawing

A 2D drawing that shows different views (top, front, side) of an object. (Section D-2.3 (#chapter-d-2-3-creating-plans-and-isometric-drawings-of-dwv-systems))

P-trap

A U-shaped pipe that prevents sewer gases, odors, and pests from entering a building by maintaining a water seal. (Section D-1.3 (#chapter-d-1-3-functions-of-different-parts-in-a-dwv-system))

penetration

A hole or opening made in a structural component, like a wall or floor, to allow for pipes, ducts, or other systems to pass through. (Section D-2.2 (#chapter-d-2-2-planning-interior-dwv-system-layouts))

penetration points

The location where a pipe passes through a floor or wall. (Section D-2.3 (#chapter-d-2-3-creating-plans-and-isometric-drawings-of-dwv-systems))

perforated pipe

A type of pipe with holes or slits along its length, used in drainage systems to allow water to enter the pipe from the surrounding soil. (Section D-3.7 (#chapter-d-3-7-sub-soil-drainage-systems))

permit application

A form people fill out to ask for permission from the city or government before starting work on things like plumbing or construction. (Section D-1.1 (#chapter-d-1-1-codes-and-standards))

personal protective equipment (PPE)

Safety gear, such as gloves, goggles, and respirators, required to protect plumbers from workplace hazards. (Section D-2.5 (#chapter-d-2-5-installing-dwv-systems))

pH

A measure of the hydrogen ion (H^+) concentration in a liquid that classifies liquids as acidic, alkaline, or neutral. The scale ranges from 0 to 14, where values below 7 are acidic, values above 7 are alkaline, and 7 is neutral. (Section D-1.11 (#chapter-d-1-11-trade-waste-systems))

pipe markings

Identifiers that must be cast, stamped, or permanently marked on each pipe or fitting, indicating the manufacturer, weight, class, or quality. These must remain visible after installation to comply with code. (Section D-3.3 (#chapter-d-3-3-storm-drainage-code-requirements))

pipe supports

Structures or brackets that hold pipes in place, ensuring they are properly aligned, supported, and maintained at the correct slope for drainage. (Section D-2.2 (#chapter-d-2-2-planning-interior-dwv-system-layouts))

plot plan

A drawing showing the size and shape of the property lot, including utilities and contour lines to determine the slope of the land. These are usually shown on the first sheet of a set of drawings. (Section D-2.1 (#chapter-d-2-1-types-of-dwv-drawings))

plumbing code

A set of regulations that establishes minimum standards for plumbing installations to ensure health and safety. (Section D-1.4 (#chapter-d-1-4-acceptable-pipe-material-application))

plumbing plan

A two-dimensional plan view drawing showing the plumbing system. It is generated from the architectural floor plan showing the types and locations of the plumbing fixtures in the building. The plumbing plan describes the location, sizes, and types of all piping and fittings used in the system rough-in. The horizontal branches and fixture

drains are drawn to scale, but due to the two-dimensional properties of the drawing, only the locations of all vertical pipes are shown. (Section D-2.3 (#chapter-d-2-3-creating-plans-and-isometric-drawings-of-dwv-systems))

polyethylene plastic (PE) piping

A type of flexible plastic pipe that can bend without breaking. It is often used in plumbing because it is lightweight, strong, and resistant to damage. (Section D-1.4 (#chapter-d-1-4-acceptable-pipe-material-application))

prefabricated system

A plumbing system or part of a system that is built somewhere else (not at the building site) and then brought in and put into place. (Section D-4.1 (#chapter-d-4-1-drainage-system-testing-code-requirements))

prioritization

The process of ranking tasks by urgency using a grading system (A, B, C, D). (Section D-2.4 (#chapter-d-2-4-organizing-a-plumbing-project))

private sewage disposal system

A privately owned plant for treating and disposing of sewage (e.g., a septic tank with an absorption field). (Section D-1.2 (#chapter-d-1-2-dwv-terminology))

private use (plumbing fixtures)

Fixtures in residences, apartments, or in private bathrooms of hotels or other buildings intended for use by one family or an individual. (Section D-1.2 (#chapter-d-1-2-dwv-terminology))

procedural standards

Rules that explain the correct steps to follow when doing important work, like installing plumbing or testing water quality. (Section D-1.1 (#chapter-d-1-1-codes-and-standards))

profile wall pipe

(profile polyethylene sewer pipe) A type of sewer pipe with a smooth interior and a ribbed or corrugated exterior for added structural strength. (Section D-1.4 (#chapter-d-1-4-acceptable-pipe-material-application))

project scope

The defined objectives, requirements, and limitations of a project. (Section D-2.4 (#chapter-d-2-4-organizing-a-plumbing-project))

project specifications (specs)

Detailed documentation outlining materials, installation procedures, and performance requirements. (Section D-2.4 (#chapter-d-2-4-organizing-a-plumbing-project))

propeller-style blowers

A type of fan that blows air to test pipes or systems. The fan blades are connected directly to the motor, and it helps push air through the system to check for leaks. (Section D-4.2)

public use (plumbing fixtures)

Fixtures that may be used by multiple users in a public setting, such as washrooms in schools, gymnasiums, hotels, bars, public comfort stations, and other installations where fixtures are installed so that their use is unrestricted. (Section D-1.2 (#chapter-d-1-2-dwv-terminology))

quantity survey

Another term for materials take-off, used in cost estimation. (Section D-2.4 (#chapter-d-2-4-organizing-a-plumbing-project))

radio transmitter

A device that sends out signals through the air, like a radio station sending music or a walkie-talkie sending messages. It turns electrical signals into radio waves that can travel through the air to other devices, like radios or phones, that can receive and play the signals. (Section D-5.1)

rainfall intensity

The quantity of rainfall related to a unit of time. For the purposes of the NPC, rainfall intensity is expressed in mm/15 min. (Section D-3.1 (#chapter-d-3-1-storm-drainage-terminology))

rainwater reuse

The practice of collecting rainwater, particularly from rooftops, for non-potable uses such as irrigation or toilet flushing, reducing the demand on municipal water supplies and stormwater runoff. (Section D-3.8 (#chapter-d-3-8-storm-water-site-retention-systems))

reflected ceiling plan

A plan showing the layout of the ceiling, including light fixtures, sprinklers, and diffusers, as if viewed from below. (Section D-2.1 (#chapter-d-2-1-types-of-dwv-drawings))

relief vent

A vent pipe used in conjunction with a circuit vent to provide additional air circulation within a circuit-vented system. (Figure 24, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

residual water

Water that remains in a place after most of it has drained or evaporated, like water left behind in a puddle or in soil after it rains. (Section D-3.4 (#chapter-d-3-4-planning-the-storm-system))

retention system

A stormwater management system that allows water to be held and absorbed into the ground, reducing runoff and helping to recharge the water table. (Section D-3.8 (#chapter-d-3-8-storm-water-site-retention-systems))

roof drain

A fitting or device installed in the roof to allow stormwater to discharge into a leader (Figure 2, Section D-3.1 (#chapter-d-3-1-storm-drainage-terminology))

roof gutter

An exterior channel installed at the base of a sloped roof to convey stormwater (Figure 3, Section D-3.1 (#chapter-d-3-1-storm-drainage-terminology))

roof vent terminal

The opening or vent located on the roof of a building, allowing gases and odors to escape from the plumbing system. (Section D-2.2 (#chapter-d-2-2-planning-interior-dwv-system-layouts))

rough-in inspection

Inspection before wall coverings are installed. (Section D-2.3; (#chapter-d-2-3-creating-plans-and-isometric-drawings-of-dwv-systems)Section D-2.4 (#chapter-d-2-4-organizing-a-plumbing-project))

routing

The planning and installation of plumbing pipes in a building, taking into account obstacles and the structure to ensure smooth, efficient plumbing connections. (Section D-2.2 (#chapter-d-2-2-planning-interior-dwv-system-layouts))

runoff

Water that flows over the ground after rainfall, often because it cannot infiltrate into the soil due to impervious surfaces like pavement. (Section D-3.8 (#chapter-d-3-8-storm-water-site-retention-systems))

S-trap

A drain shape that used to be common when pipes came up from the floor. It is now banned in most places because it can lose its water seal and cause bad smells to come back into the room. The s-trap shown in Figure 12 is prohibited by Clause 2.5.6.3.(1)(b), which limits the maximum fall on a trap arm fixture drain to not more than the inside diameter of the pipe. (Section D-1.10 (#chapter-d-1-10-requirements-and-prohibitions-for-dwv-systems))

Safety Data Sheets (SDS)

A document providing information on hazardous materials, including handling, storage, and emergency procedures. (Section D-2.5 (#chapter-d-2-5-installing-dwv-systems))

sanitary building drain

A building drain that conducts sewage to a building sewer from the most upstream stack, branch, or fixture drain serving a water closet. (Section D-1.2 (#chapter-d-1-2-dwv-terminology); Section D-1.3 (#chapter-d-1-3-functions-of-different-parts-in-a-dwv-system))

sanitary building sewer

A building sewer that conducts sewage. (Figure 25, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

sanitary drainage pipe

A pipe in a sanitary drainage system. (Section D-1.2 (#chapter-d-1-2-dwv-terminology))

sanitary drainage system

A drainage system that conducts sewage. (Section D-1.2 (#chapter-d-1-2-dwv-terminology))

sanitary sewage sump

A pit or basin that collects and temporarily holds wastewater before it is pumped to a sewer system or treatment facility, commonly used in low-lying areas where gravity drainage is not possible. (Section D-1.9 (#chapter-d-1-9-stack-vents-vent-stacks-and-headers))

sanitary sewer

The main underground pipe that carries wastewater out of a building. (Section D-1.2; (#chapter-d-1-2-dwv-terminology)Section D-2.3 (#chapter-d-2-3-creating-plans-and-isometric-drawings-of-dwv-systems))

sanitary tee

A plumbing fitting used to connect a vent pipe to a drain pipe while ensuring proper air circulation. (Section D-1.6 (#chapter-d-1-6-sizing-single-storey-vents))

scale

The ratio used to shrink or enlarge a drawing while keeping proportions accurate. (Section D-2.3 (#chapter-d-2-3-creating-plans-and-isometric-drawings-of-dwv-systems))

schedule

Lists that show important details about parts of the building project, such as the types of doors, windows, or materials. Schedules help keep track of what needs to be used or installed. (Section D-2.1 (#chapter-d-2-1-types-of-dwv-drawings))

scuppers

An exterior, box-like device or opening in a parapet or wall that collects and drains stormwater from flat roofs. Scuppers serve as emergency overflow systems to prevent water buildup when primary roof drains are blocked. They are often used in combination with parapet walls and flow-control drains. Scuppers must be located no more than 30 m (100 ft) apart and be capable of handling up to 200% of local rainfall intensity when used with flow-control systems. (Section D-3.3 (#chapter-d-3-3-storm-drainage-code-requirements))

section references

section references: These are symbols on a drawing that point to a section view, which shows what a part of the building looks like from the inside. It helps you understand the building's structure in more detail. (Figure 16, Section D-2.1 (#chapter-d-2-1-types-of-dwv-drawings))

sectional view

Drawing showing a cut-through of a building to provide detailed information about wall construction and other interior elements (exterior and interior wall finish). Check these drawings for potential obstructions or conflicts for all locations where piping must penetrate walls. (Section D-2.1 (#chapter-d-2-1-types-of-dwv-drawings))

secure storage

The practice of safeguarding plumbing materials and tools on-site. (Section D-2.4 (#chapter-d-2-4-organizing-a-plumbing-project))

seismic forces

The forces exerted on structures during an earthquake, which plumbing systems must be designed to withstand. (Section D-2.2 (#chapter-d-2-2-planning-interior-dwv-system-layouts))

seismic restraint

The components and systems installed to protect mechanical systems, including piping, from seismic forces, ensuring that the system can withstand the stresses of an earthquake. (Section D-1.10 (#chapter-d-1-10-requirements-and-prohibitions-for-dwv-systems))

semi-continuous flow

When something moves in a steady way but with small breaks. In water systems, semi-continuous flow means water or waste moves through pipes or tanks in regular amounts, but not nonstop. (Section D-1.5 (#chapter-d-1-5-sizing-sanitary-drainage-pipes))

sequence of operation

The logical order of steps in a plumbing project, including inspections and permitting. (Section D-2.4 (#chapter-d-2-4-organizing-a-plumbing-project))

sewage

Any liquid waste other than clear-water waste or stormwater. (Section D-1.2 (#chapter-d-1-2-dwv-terminology))

sewage disposal regulation

See "Sewerage System Regulation" (Section D-1.1 (#chapter-d-1-1-codes-and-standards))

sewerage system regulation (SSR)

BC regulation governing the design, installation, and maintenance of onsite sewage systems. (Section D-1.1 (#chapter-d-1-1-codes-and-standards))

sheet metal leader

A vertical exterior pipe made of sheet metal that conveys rainwater from gutters to the ground. It is permitted for use only above ground and outside a building. (Section D-3.3 (#chapter-d-3-3-storm-drainage-code-requirements))

shop drawing

A detailed drawing created by the builder or contractor and used by prefabrication shops that shows how a specific part of the building will be made or installed, like custom furniture or a special part of the building. (Section D-2.1 (#chapter-d-2-1-types-of-dwv-drawings))

siphonic

A type of system that uses the power of water moving through pipes to drain rainwater very quickly. It works like a siphon, where water is pulled through a pipe faster than normal, helping to drain a lot of water quickly from roofs or other areas. (Section D-3.2) (#chapter-d-3-2-functions-of-pipes-in-storm-drainage-systems)

site plan

A drawing that shows the layout of the building and how it fits on the land, including things like roads, utilities, and the property boundaries. It is a plot plan with a basic outline of the building superimposed on it, which helps understand the location and surroundings of the building. (Figure 2, Section D-2.1 (#chapter-d-2-1-types-of-dwv-drawings))

slope

(Grade); The angle or tilt of a pipe that helps waste flow in the right direction, usually downward. (Section D-1.10 (#chapter-d-1-10-requirements-and-prohibitions-for-dwv-systems))

smoke candle

A small device that creates smoke when lit. It's used in smoke testing to help find leaks in pipes. When the candle is lit, the smoke is blown into the pipes to see if it escapes anywhere. (Section D-4.2)

smoke fluid system

A machine that creates smoke by turning a special fluid into smoke. This is used in smoke testing to check for leaks in pipes, just like the smoke candle. (Section D-4.2)

smoke testing

A method used to detect leaks in a drainage system using thick smoke. The smoke is blown into the pipes, and if it escapes from any area other than the designated openings, it means there's a leak. (Section D-4.2 (#chapter-d-4-2-testing-methods))

soil stability

The ability of soil to remain intact and not shift or collapse, which is crucial for maintaining the integrity of structures and landscapes. (Section D-3.7 (#chapter-d-3-7-sub-soil-drainage-systems))

solids interceptors

Devices designed to trap solid materials, like food waste or precious metals, using gravity separation. These interceptors capture particles of various sizes and weights for disposal. (Section D-1.11 (#chapter-d-1-11-trade-waste-systems))

source control

Stormwater management techniques that focus on reducing runoff at its origin, such as using green roofs or rainwater capture systems. (Section D-3.8 (#chapter-d-3-8-storm-water-site-retention-systems))

squirrel-cage blower

A type of blower that has a round fan inside it, kind of like a hamster wheel, to push air through a system. It can move a lot of air and is good for testing large pipes or systems.

stack

A vertical sanitary drainage pipe that passes through one or more storeys and includes any offset in the stack.

Previously referred to as a soil-or-waste stack or SOWS. (Section D-1.2; (#chapter-d-1-2-dwv-terminology)Section D-2.3 (#chapter-d-2-3-creating-plans-and-isometric-drawings-of-dwv-systems))

stack vent

A vent pipe that connects the top of a stack to a vent header or terminates to outside air. (Figure 26, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

standard dimension ratio (SDR)

A measure of the wall thickness of plastic piping relative to its diameter, affecting flexibility and pressure resistance. (Section D-1.4 (#chapter-d-1-4-acceptable-pipe-material-application))

Standards Council of Canada (SCC)

A group that makes sure Canadian products, systems, and safety rules meet the right standards to protect people and the environment. (Section D-1.1 (#chapter-d-1-1-codes-and-standards))

storey (as applied to plumbing)

The interval between two successive floor levels, including mezzanine floors that contain plumbing fixtures, or between a floor level and roof. (Section D-1.2 (#chapter-d-1-2-dwv-terminology))

storm building drain

A building drain that conducts storm water and is connected at its upstream end to a leader, sump, or catch basin and at its downstream end to a building sewer or a designated stormwater disposal location. (Section D-3.1 (#chapter-d-3-1-storm-drainage-terminology))

storm building sewer

A building sewer that conveys stormwater. (Section D-3.1 (#chapter-d-3-1-storm-drainage-terminology))

storm drainage system

A drainage system that conveys stormwater. (Section D-3.1 (#chapter-d-3-1-storm-drainage-terminology))

storm sewer

A sewer that conveys stormwater. (Section D-3.1 (#chapter-d-3-1-storm-drainage-terminology))

stormwater

Water discharged from a surface as a result of rainfall or snowfall. (Section D-3.1 (#chapter-d-3-1-storm-drainage-terminology))

structural drawing

A drawing that shows the building's framework, including the foundation, beams, and columns. It helps builders know how to build the building to make it strong and safe. The structural drawing is usually indicated by an S, which precedes the drawing page number (e.g., S-3). (Section D-2.1 (#chapter-d-2-1-types-of-dwv-drawings))

structure penetrations

Openings made in a building's walls, floors, or beams to allow pipes, ducts, or wires. These must be carefully planned

to avoid weakening the structure and must follow building codes and regulations, especially for load-bearing or fire-rated components. (Section D-2.2 (#chapter-d-2-2-planning-interior-dwv-system-layouts))

sub-drainage system

A network of pipes or drains placed underground to collect and carry away excess water from the soil. It helps prevent flooding or water buildup by directing water to safe areas, keeping the ground dry and stable. (Section D-3.6 (#chapter-d-3-6-sumps-and-catch-basins))

subsoil drainage pipe

A pipe installed underground to intercept and convey subsurface water (Figure 5). (Section D-3.1 (#chapter-d-3-1-storm-drainage-terminology))

subsoil drainage pipe (drain tile/weeping tile)

A pipe installed underground to intercept and convey subsurface water. (Section D-1.2 (#chapter-d-1-2-dwv-terminology))

sump

A pit or tank used to collect waste water that can't flow by itself into the sewer. (Section D-1.10 (#chapter-d-1-10-requirements-and-prohibitions-for-dwv-systems))

surface water

Water that is found on the surface of the Earth, like in rivers, lakes, ponds, or oceans. It comes from rainfall, melting snow, or water flowing from other places. (Section D-3.6 (#chapter-d-3-6-sumps-and-catch-basins))

tees

A type of pipe fitting shaped like the letter "T" that is used to join three pipes together. It allows water or other liquids to flow in two different directions from one main pipe. (Section D-3.7 (#chapter-d-3-7-sub-soil-drainage-systems))

test or measurement standards

Rules that explain how to check if something is the right size, strength, or quality. These standards make sure that tests are done the same way every time so results can be trusted and compared. (Section D-1.1 (#chapter-d-1-1-codes-and-standards))

Test plug

A device used to seal pipe openings during leak testing. Test plugs come in different types, including inflatable and expansion plugs, and help keep air or water sealed inside the system. (Section D-4.2 (#chapter-d-4-2-testing-methods))

title block

The part of a drawing that contains the project title, drawing number, scale, date, and other key project details. (Section D-2.1 (#chapter-d-2-1-types-of-dwv-drawings))

trade waste system

A system designed to manage sewage that is more heavily contaminated than domestic waste, often requiring specialized treatment to prevent harm to the drainage system, environment, or public health. (Section D-1.11 (#chapter-d-1-11-trade-waste-systems))

transportation costs

The impact of distance and weight on material expenses. (Section D-2.4 (#chapter-d-2-4-organizing-a-plumbing-project))

trap

A fitting or device designed to hold a liquid seal that prevents the passage of gas while allowing the flow of liquid to continue without significant obstruction. (Section D-1.2 (#chapter-d-1-2-dwv-terminology))

trap arm

The portion of a fixture drain between the trap weir and the vent pipe connection. (Section D-1.2 (#chapter-d-1-2-dwv-terminology); Section D-1.3 (#chapter-d-1-3-functions-of-different-parts-in-a-dwv-system))

trap dip

The lowest part of the upper interior surface of a trap. (Section D-1.2 (#chapter-d-1-2-dwv-terminology))

trap seal depth

the vertical distance between the trap dip and the trap weir. (Section D-1.2 (#chapter-d-1-2-dwv-terminology))

trap standard

A trap for a fixture that is integral to the support for the fixture (Figure 28, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

trap weir

The highest part of the lower interior surface of a trap. (Figure 27, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

trenchless plow

A type of equipment used in moling that creates a narrow void or tunnel in the soil without disturbing the surface or creating a visible trench. (Section D-3.7 (#chapter-d-3-7-sub-soil-drainage-systems))

vent header

A vent pipe that connects any combination of stack vents or vent stacks and terminates to outside air. (Figure 29, Section D-1.2 (#chapter-d-1-2-dwv-terminology))

vent pipe

A pipe that is part of a venting system. (Section D-1.2 (#chapter-d-1-2-dwv-terminology))

vent stack

A vent pipe that is connected at its upper end to a vent header or that terminates to outside air. It connects at its

lower end to the stack at or below the lowest sanitary drainage pipe connection (Figure 30, Section D-1.2 (#chapter-d-1-2-dwv-terminology)).

venting system

An assembly of pipes and fittings that connects a drainage system with outside air to circulate air and protect trap seals in the drainage system. (Section D-1.1 (#chapter-d-1-1-codes-and-standards); Section D-1.2 (#chapter-d-1-2-dwv-terminology))

vitreous clay pipe

A type of pipe made from baked clay that has a smooth, hard surface, like glass. It's used in plumbing and drainage systems because it's strong, durable, and resists wear and tear from water and chemicals. (Section D-3.7 (#chapter-d-3-7-sub-soil-drainage-systems))

waste water treatment

The process of treating effluent to remove harmful chemicals, ensuring the wastewater is safe for discharge into the sewer system. (Section D-1.11 (#chapter-d-1-11-trade-waste-systems))

water pressure test

A test that checks for leaks by filling pipes with water and keeping them pressurized for a set amount of time. (Section D-4.1 (#chapter-d-4-1-drainage-system-testing-code-requirements))

welded joint

A type of piping joint where sections of pipe are fused together through heat, creating a strong, permanent bond. Specific standards, like ASME B31.9, govern their installation in building services. (Section D-1.10 (#chapter-d-1-10-requirements-and-prohibitions-for-dwv-systems))

wet vent

A sanitary drainage pipe that also serves as a vent pipe and extends from the most downstream wet-vent fixture connection to the most upstream fixture dry-vent connection (Figure 31). A wet vent is a function of a branch, fixture drain, or stack and should be identified as a BR/WV, FD/WV, or a Stack/WV. (Section D-1.2 (#chapter-d-1-2-dwv-terminology))

work platforms

Equipment such as scissor lifts and boom lifts used to elevate workers and materials to perform overhead installations. (Section D-2.5 (#chapter-d-2-5-installing-dwv-systems))

wye fitting

A plumbing fitting shaped like a "y" that allows one pipe to join another at a 45-degree angle. it is commonly used to connect branch lines to a main drain line, helping to maintain smooth water flow and reduce clogs. (Section D-4.2 (#chapter-d-4-2-testing-methods))

yoke vent

A vent pipe connected at its lower end to a stack and at its upper end to a vent stack or to a branch vent connected to a vent stack. A yoke vent is required when serving a stack receiving discharge from more than 11 storeys (Figure

32). A yoke vent provides extra air circulation for the operation of the stack. (Section D-1.2 (#chapter-d-1-2-dwv-terminology))

Plumbing Apprenticeship & Trade Resources in BC

A successful career in plumbing requires a strong foundation of skills, knowledge, and workplace safety awareness. Below are key resources to support plumbing apprentices in BC, including educational pathways, trade certifications, workplace safety guidelines, and mental health and wellness support.

Plumbing Apprenticeship & Certification Resources

- **SkilledTradesBC – Plumbing Apprenticeship (https://skilledtradesbc.ca/plumber)** — Overview of plumbing training, certification requirements, and apprenticeship pathways in British Columbia.
- **Red Seal Program – Plumber (https://www.red-seal.ca/eng/trades/plumbers/overview.shtml)** — National certification program with exam prep guides and trade mobility information.
- **BC Building Codes & Standards (https://www.bccodes.ca/)** — Official building and plumbing codes for British Columbia.

Workplace Safety & Regulations

- **WorkSafeBC (https://www.worksafebc.com/en)** — Essential safety resources for plumbers, including:
  - Health & Safety – WorkSafeBC (https://www.worksafebc.com/en/health-safety)
  - Report Unsafe Working Conditions (https://www.worksafebc.com/en/contact-us/departments-and-services/health-safety-prevention)
  - Report a Workplace Injury or Disease (https://www.worksafebc.com/en/claims/report-workplace-injury-illness)
  - Submit a Notice of Project Form (https://www.worksafebc.com/en/for-employers/just-for-you/submit-notice-project)
  - Get Health and Safety Resources (Videos, Posters, Publications, and More) (https://www.worksafebc.com/en/resources-health-safety)
  - Search the OHS Regulations (and Related Materials) (https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation)
  - Conduct an Incident Investigation (https://www.worksafebc.com/en/health-safety/create-manage/incident-investigations/conducting-employer-investigation)
- **CCOHS: OHS Answers Fact Sheets – Plumber (https://www.ccohs.ca/oshanswers/occup_workplace/plumber.html)** — Safety guidelines and best practices for plumbers in various work environments.

Financial Supports

- **Financial Support (SkilledTradesBC)** (https://skilledtradesbc.ca/financial-support) — Information about grants, tax credits, Canada apprentice loans, employment insurance, and the Indigenous Skills and Employment Training

(ISET) program.
- **StudentAidBC (https://studentaidbc.ca/)** — Complete post-secondary education through student loans, grants, and scholarships. There is also programs that help with loan repayment.
- **WorkBC (Government of BC)** (https://www.workbc.ca/find-loans-and-grants/students-and-adult-learners/services-apprentices-and-employers) — Services for apprentices and employers.

Mental Health & Wellness Support

- **HealthLink BC – Mental Health and Substance Use** (https://www.healthlinkbc.ca/mental-health-and-substance-use) — HealthLink BC resources for mental health and wellness support.
- **Here2Talk** (https://here2talk.ca/) — Free and confidential counseling services available to all post-secondary students registered at a BC school.
- **Help Starts Here** (https://helpstartshere.gov.bc.ca/) — A database with over 2,500 listings of services related to mental health and substance use supports.
- **Hope for Wellness Helpline** (https://www.hopeforwellness.ca/) — 24/7 online chat and phone line with experienced and culturally competent counselors available to all Indigenous people in Canada.
    - First Nations Health Authority Mental Health Supports Info Sheet [PDF] (https://www.fnha.ca/Documents/FNHA-mental-health-and-wellness-supports-for-indigenous-people.pdf) by First Nations health Authority — List of culturally safe services for Indigenous people.
- **HeretoHelp – BC** (https://www.heretohelp.bc.ca/) — Mental health resources, including videos, articles, and support services in BC.
- **BC Construction Industry Rehabilitation Plan** (https://www.constructionrehabplan.com/) — Mental health and substance use services for CLRA and BCBT members and their families.
- **Virtual Mental Health Supports (Government of BC)** (https://www2.gov.bc.ca/gov/content/health/managing-your-health/mental-health-substance-use/virtual-mental-health-supports) — Virtual services are available for British Columbians who are experiencing anxiety, depression, or other mental health challenges.

Crisis Support

- **Interior Crisis Line Network** — Call 1-888-353-2273 (tel:+1-888-353-2273) for 24/7 emotional support, crisis intervention, and community resource information.
- **Talk Suicide Chat Service** (https://talksuicide.ca/) — An alternative if calling is difficult; available for crisis intervention.
- **310Mental Health Support** — Call 250-310-6789 (tel:+1-250-310-6789) for emotional support, information, and resources specific to mental health.
- **1-800-SUICIDE** — Call 1-800-784-2433 (tel:+1-800-784-2433) if you are experiencing feelings of distress or despair, including thoughts of suicide.
- **Opioid Treatment Access Line** — Call 1-833-804-8111 (tel:+1-833-804-8111) between 9 am and 4 pm to connect with a doctor, nurse, or healthcare worker who can prescribe opioid treatment medication that same day.
- **KUU-US Crisis Response Service** — Call 1-800-588-8717 (tel:+1-800-588-8717) for culturally-aware crisis support for Indigenous peoples in BC.
- **Alcohol and Drug Information and Referral Service** — Call 1-800-663-1441 (tel:+1-800-663-1441) to find resources and support.

Emergency Services — For life-threatening situations, call 911 or visit your nearest emergency department.

Version History

This page provides a record of changes made to this learning resource, Plumbing Apprenticeship Level 2, Block D (https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/). Each update increases the version number by 0.1. The most recent version is reflected in the exported files for this resource.

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If you identify an error in this resource, please report it using the TRU Open Education Resource Error (#back-matter-tru-open-education-resource-error-form)Form.

Version	Date	Change	Details
1.0	September, 2025	Plumbing Apprenticeship Level 2 Block D learning resource from STBC content converted to open and freely accessible digital platform and published at TRU.	Published in September 2025; and released October 2025 by TRU Open Press.
1.01	November 24, 2025	Updates to Figures in D-1.10 and Figures and Answer key for Self-test D-1.8.	Figure 20 (D-1.10) – measurements removed; Figures 2P-28 and 2P-35 (Self-test D-1.8) – measurement and labels changed, Table 8 Answers key adjusted for H and I (Self-test D-1.8)