

- **Estimating Portable Toilet Counts Based on Event Attendance**

Estimating Portable Toilet Counts Based on Event Attendance Calculating Restroom Needs for Food and Beverage Events Mapping Portable Restroom Locations for Crowd Flow Accessibility Considerations in Event Restroom Placement Weather Factors that Influence Portable Toilet Positioning Portable Restroom Spacing Rules for Outdoor Festivals Integrating Hand Wash Stations with Restroom Layouts Using Technology to Track Portable Toilet Utilization at Events Reducing Line Times with Optimal Restroom Distribution Setup Timeline for Event Portable Restroom Delivery Coordination with Other Vendors During Restroom Placement Post Event Evaluation of Portable Toilet Placement Effectiveness

- **Measuring the Carbon Footprint of Portable Restrooms**

Measuring the Carbon Footprint of Portable Restrooms Benefits of Formaldehyde Free Deodorizer Solutions Recycling High Density Polyethylene from Retired Units Water Conservation Strategies in Portable Toilet Design Certification Pathways for Green Portable Sanitation Lifecycle Analysis of Standard and Deluxe Portable Toilets Partnering with Wastewater Plants for Sustainable Disposal Implementing Solar Lighting in Portable Restrooms Composting Options for Biodegradable Portable Toilet Waste Communicating Sustainability Initiatives to Event Organizers Selecting Vendors with ISO Environmental Management Systems Tracking Emission Reductions through Fleet

Optimization

- About Us



This shift not only addresses environmental concerns but also offers practical benefits in terms of maintenance and logistics.

Traditionally, portable toilets have relied on water for flushing mechanisms to transport waste away from the user and into holding tanks. However, with the advent of waterless technologies, this dependency is being rethought. One such innovation is the use of composting systems where organic material is broken down into compost over time through microbial activity. Virginia rental pricing varies by region with Northern Virginia typically commanding higher rates than rural areas **porta-potty rental** Pumphrey, Maryland. These systems require little to no water, significantly cutting down usage while simultaneously providing an eco-friendly disposal method for waste.

Another notable technology is vacuum-assisted toilets which use air pressure instead of water to move waste into storage areas. This method not only conserves water but also reduces the volume of waste by compacting it, thereby extending the service intervals between cleanings.

Additionally, urine-diverting toilets (UDTs) have gained traction. These designs separate liquid from solid waste at the source, allowing for different treatment processes that are more efficient without using additional water. Urine can be collected and potentially used as fertilizer after proper treatment, promoting a circular economy approach within sanitation.

The integration of these technologies into portable toilet design not only supports global efforts towards sustainable development goals related to water conservation but also enhances user experience by minimizing odors and reducing the frequency of waste removal operations due to less bulk from water-flushed systems.

Moreover, these innovations encourage public awareness about sustainable practices in everyday life. By choosing or designing portable toilets with waterless technologies, event organizers, construction sites, and outdoor festivals can demonstrate commitment to environmental stewardship while still providing necessary amenities.

In conclusion, embracing waterless technologies in portable toilet design is more than just an innovative choice; it's a strategic move towards sustainability. It reflects a broader understanding that even small changes in how we manage basic human needs like sanitation can contribute significantly to conserving our planet's resources. As these technologies continue to evolve and gain acceptance, they promise not only to redefine what we expect from portable sanitation but also pave the way for broader applications in fixed infrastructure where water conservation becomes paramount.

Optimizing flush systems for minimal water usage is a critical aspect of water conservation strategies in portable toilet design, addressing both environmental sustainability and practical efficiency. Portable toilets, often used in remote locations or at large events, must balance functionality with resource conservation. The challenge lies in designing a system that effectively removes waste while using as little water as possible.

One key approach to achieving this is through the use of vacuum-assisted flush technology. This system works by creating a vacuum that propels waste into a holding tank with minimal water. Traditional gravity-fed systems require a significant amount of water to move waste due to the reliance on the force of gravity alone. In contrast, vacuum systems can reduce water usage by up to 80%, making them highly efficient for portable applications where conserving water is paramount.

Another strategy involves incorporating dual-flush mechanisms, which provide users with the option of a small or large flush depending on the type of waste. This not only educates users about water conservation but also empowers them to participate actively in reducing water consumption. By offering choices, this system ensures that only the necessary amount of water is used for each flush, preventing wastage.

Moreover, sensor-based flushing technology can be integrated into portable toilet designs. These sensors detect when someone has finished using the facility and initiate a flush automatically, ensuring efficiency by avoiding unnecessary flushes while also preventing overuse by users who might forget or choose not to flush manually.

Design considerations also include the materials used in constructing these systems. Non-stick surfaces within the toilet bowl reduce the need for heavy flushing to clean residual waste, thereby saving additional water. Furthermore, choosing durable materials

extends the lifespan of these units, reducing environmental impact from frequent replacements and maintenance.

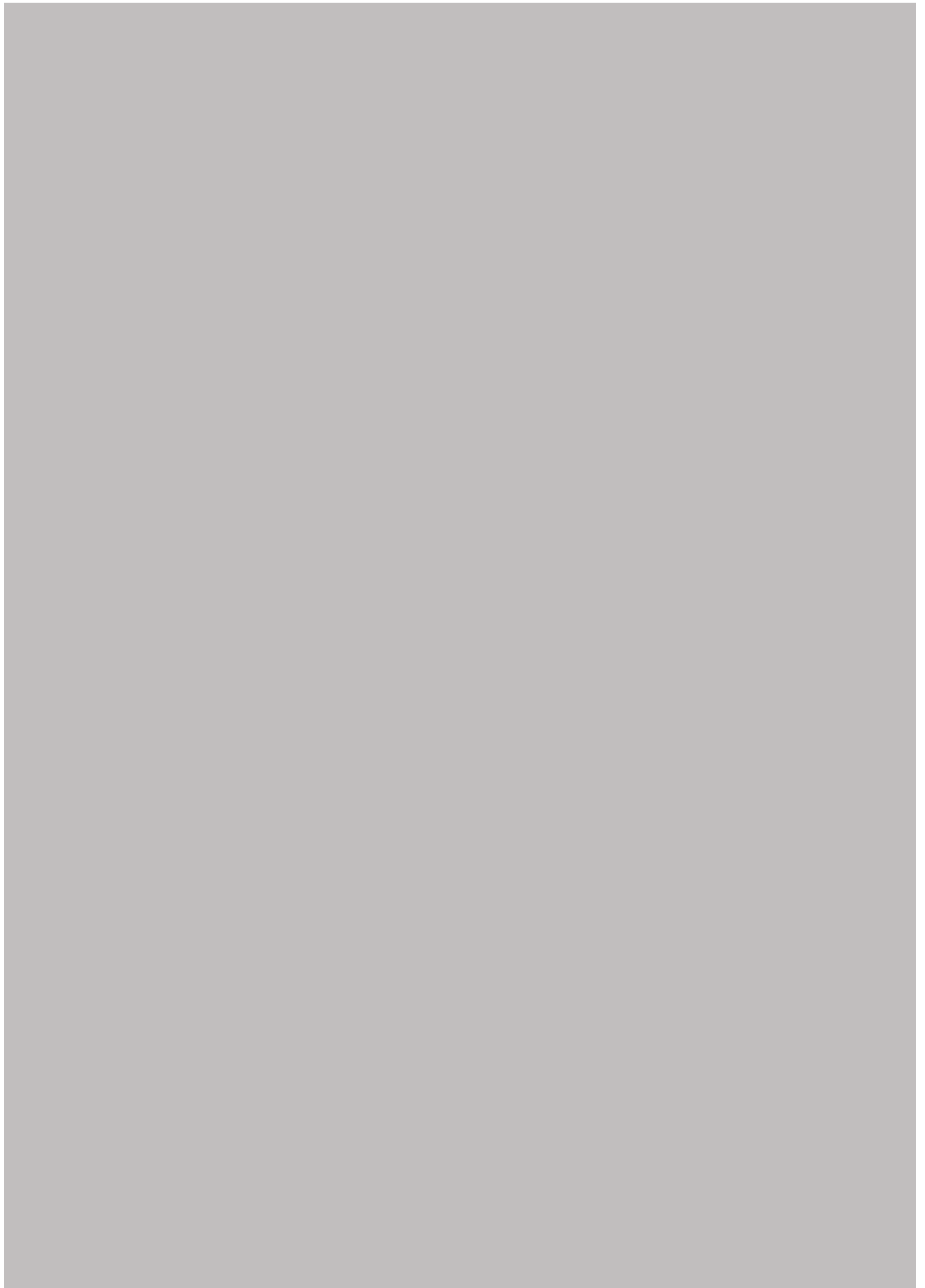
In practice, integrating these technologies requires careful planning to ensure they operate reliably under various conditions typical for portable toilets – from extreme temperatures to rough handling during transport. Regular maintenance checks are crucial to keep these systems functioning optimally without compromising on their eco-friendly benefits.

In conclusion, optimizing flush systems for minimal water usage in portable toilets involves innovative engineering solutions like vacuum technology and smart flushing options alongside user engagement through dual-flush mechanisms. By focusing on such strategies, we not only conserve vital freshwater resources but also set a standard for sustainable practices in temporary sanitation facilities worldwide.

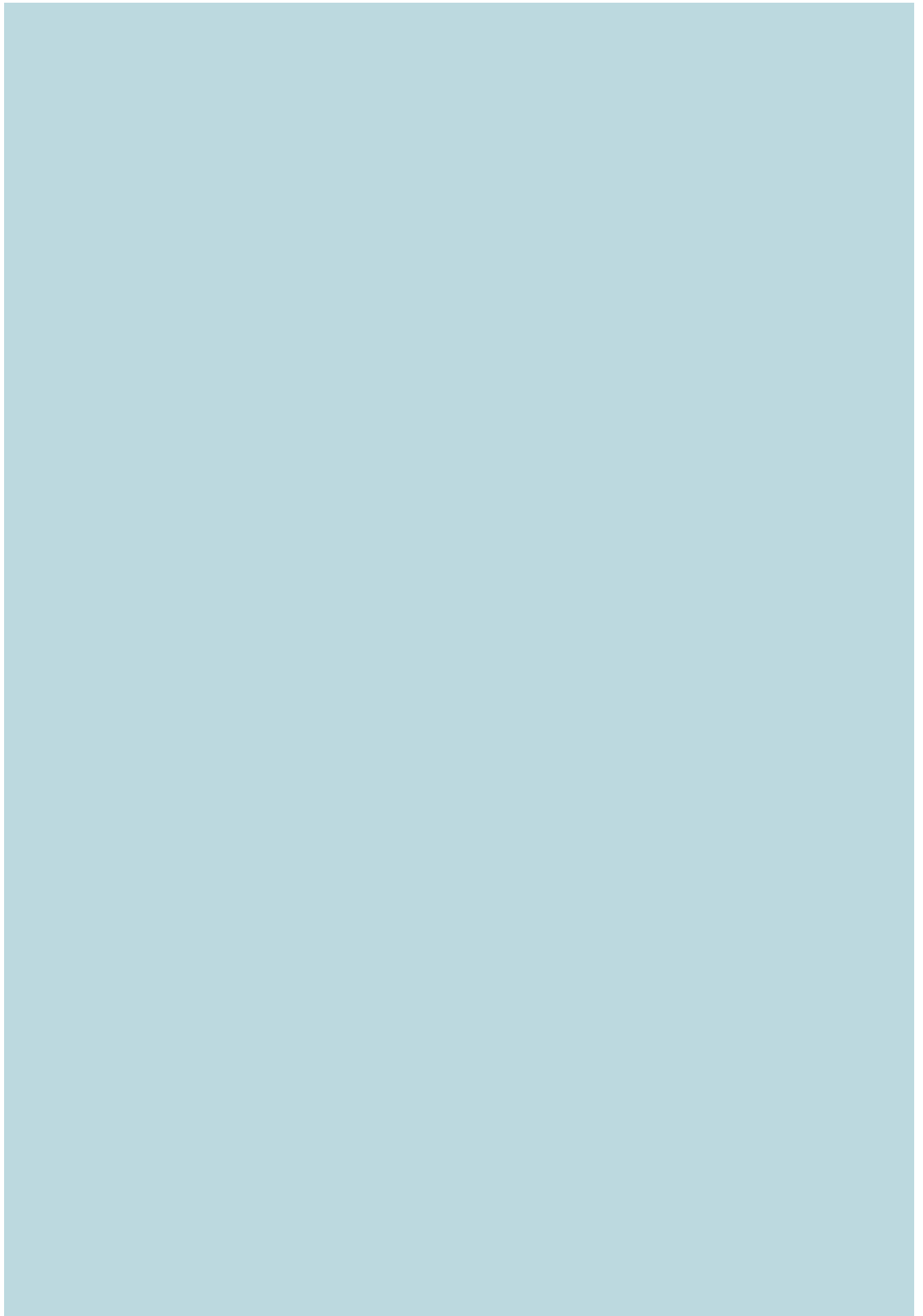
restroom rentals virginia

Social Signals:

Clear Restroom Social Signal:



How to reach us:



Duration of the Event and Toilet Needs

Lets talk about porta potties. Not exactly glamorous, right? But think about it: theyre a ubiquitous part of outdoor events, construction sites, and disaster relief efforts. And every flush, every handwash, uses precious water. Thats where greywater recycling comes in. Imagine a porta potty that doesnt just guzzle freshwater, but actually cleans and reuses the water already inside. Thats the promise of integrating greywater recycling into their design.

The basic idea is simple enough. "Greywater" is the relatively clean wastewater from handwashing. Instead of just dumping it, we could filter it, disinfect it, and then reuse it for flushing. This cuts down dramatically on the need for potable water refills, especially in areas where water is scarce or expensive to transport.

Of course, its not as easy as it sounds. Were talking about a self-contained system, so the filtration and disinfection need to be efficient, reliable, and compact. Think about the challenges: fluctuating usage, different types of soap, even the ambient temperature can affect the systems performance. Plus, people need to trust that the recycled water is safe and hygienic. Education and clear labeling are key.

But the potential benefits are huge. Reduced water consumption means lower operating costs for rental companies. It means a smaller environmental footprint for large events. And in emergency situations, it means more precious potable water available for drinking and other essential needs.

Integrating greywater recycling into porta potty design isn't just a futuristic pipe dream. It's a practical and increasingly necessary step towards more sustainable sanitation solutions. It's about looking at a humble necessity, and asking: how can we make this better? How can we make it greener? And how can we help conserve our planet's most precious resource, one flush at a time?



Special Considerations for Different Event Types

Okay, so when we were talking about making portable toilets more water-wise, a big piece of the puzzle is choosing the right materials. Think about it: the materials we use directly affect how much water gets absorbed and how much waste ends up sticking around, making it harder to clean.

Ideally, we want materials that are super non-porous. Things like certain high-density plastics or maybe even some advanced composites. The less porous a material, the less water it's going to soak up. And that's good news because less water absorption means less need for rinsing and flushing to get rid of lingering smells or stains. We're talking about potentially saving gallons per use, which adds up quickly at festivals, construction sites, or anywhere these units are deployed.

Beyond just water absorption, the surface texture matters too. A smooth, non-stick surface is a waste worker's worst nightmare. The easier it is to clean, the less water and cleaning chemicals you need to use. It also reduces the risk of waste buildup, which can be a breeding ground for bacteria and unpleasant odors.

But it's not just about performance; we also need to consider the environmental impact of the materials themselves. Are they recyclable? Are they durable enough to withstand years of use and abuse? Choosing more sustainable materials, even if they cost a bit more

upfront, can pay off in the long run by reducing waste and pollution. Think about materials with recycled content or those that are designed for easy disassembly and recycling at the end of their lifespan. It's all part of creating a more circular economy and minimizing the overall environmental footprint of portable toilet design. Basically, smart material selection is key to making these portable solutions not just convenient, but also responsible.

Okay, let's talk about how to get people to actually *use* water-saving portable toilets effectively. I mean, you can design the most ingenious low-flush system out there, but if users aren't on board, you're just wasting your time and engineering brilliance. That's where user education and behavioral strategies come in.

Think about it: most people aren't exactly thrilled to be using a portable toilet in the first place. It's not a luxurious experience! So, you're already fighting an uphill battle. The key is to make it as easy and intuitive as possible to do the right thing.

First, simple, clear signage is crucial. "Push Once to Flush" in big, bold letters, maybe with a little picture, is way more effective than some complicated instruction manual no one's going to read. Think about using icons that are universally understood, regardless of language. Keep it concise and placed right where people need it.

Beyond the signage, consider the overall "feel" of the portable toilet. A cleaner, more pleasant environment will naturally encourage more responsible behavior. Regular cleaning and maintenance are huge. Nobody wants to conserve water in a space that's already

gross – it sends the message that nobody cares, so why should they?

Then theres the psychological aspect. Subtly nudge users towards conservation. Maybe the flush mechanism is designed to require a conscious effort – a deliberate push rather than a light tap. This can make people think twice about whether they *really* need to flush. Even the color scheme could play a role; calming blues and greens might subconsciously encourage mindful water usage.

Finally, think about the context. If youre at a festival, you could have volunteers briefly demonstrating how to use the water-saving features. At a construction site, toolbox talks could include a quick reminder about responsible portable toilet usage. The point is to integrate the education into the existing environment, rather than relying on people to seek it out.

Ultimately, effective water conservation in portable toilet design isnt just about the technology; its about understanding human behavior and designing systems that make it easy and appealing for users to do their part. Its about making conservation the default, the obvious, and even the slightly more pleasant option.

Water conservation is a critical concern in todays world, and the design of portable toilets plays a significant role in this effort. The term "Regulatory Standards and Incentives for Water-Efficient Portable Toilets" encapsulates the importance of implementing guidelines and offering rewards to promote the use of water-efficient portable toilets. These

standards and incentives are essential in driving innovation and adoption of technologies that minimize water usage.

Regulatory standards for water-efficient portable toilets set the minimum requirements for water usage and performance. These standards ensure that portable toilets are designed to use water responsibly, reducing the overall demand on freshwater resources. By establishing clear benchmarks, regulatory bodies can guide manufacturers and designers to create products that meet these criteria, ultimately leading to a reduction in water waste.

Incentives for water-efficient portable toilets are equally important. Financial incentives, such as tax credits or subsidies, can encourage businesses and individuals to invest in these eco-friendly alternatives. Additionally, recognition programs and awards can highlight the achievements of companies that excel in water conservation, motivating others to follow suit. These incentives create a competitive environment where innovation thrives, and the best practices in water conservation are shared and adopted widely.

The integration of regulatory standards and incentives fosters a culture of sustainability. When regulations are in place, they provide a framework for accountability, ensuring that all portable toilets contribute to water conservation efforts. Incentives, on the other hand, provide the necessary push to make water-efficient options more attractive and accessible. Together, they create a synergistic effect that accelerates the transition towards a more sustainable future.

In conclusion, regulatory standards and incentives for water-efficient portable toilets are pivotal in advancing water conservation strategies. By setting clear guidelines and offering rewards, we can drive the adoption of technologies that save water and protect our precious resources for future generations.

Water conservation is a pressing concern in today's world, and even portable toilet rental fleets can play a significant role in this effort. Implementing water conservation features in porta potty rental fleets is not just an environmentally responsible choice; it can also lead to substantial cost savings over time. This essay explores the cost-benefit analysis of integrating water-saving technologies into portable toilet designs.

Firstly, the initial investment in water-efficient fixtures and systems might seem daunting. High-efficiency toilets, low-flow faucets, and smart water management systems require upfront costs. However, these expenses are often offset by the long-term savings in water usage and reduced maintenance costs. For instance, high-efficiency toilets can use up to 50% less water per flush compared to traditional models, leading to significant reductions in water bills.

Moreover, water conservation features can enhance the reputation of rental companies. In an era where consumers are increasingly conscious of environmental issues, businesses that adopt sustainable practices can attract more clients. This can lead to a competitive advantage and potentially higher revenue. Additionally, some municipalities offer incentives or tax breaks for businesses that implement water-saving measures, further reducing the financial burden.

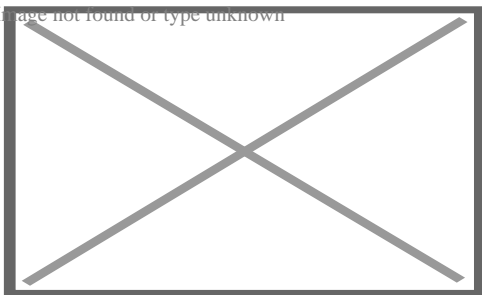
On the operational side, water conservation features can lead to lower utility costs and reduced environmental impact. Portable toilets that use less water mean fewer refills and less frequent maintenance, which translates to lower labor costs and fewer trips to refill the tanks. Furthermore, reducing water consumption helps conserve local water resources, which is particularly important in areas prone to drought or water scarcity.

In conclusion, while the initial investment in water conservation features for porta potty rental fleets may appear significant, the long-term benefits far outweigh the costs. From reduced utility expenses and enhanced corporate image to environmental stewardship and potential government incentives, the advantages of implementing water-saving technologies are clear. By prioritizing water conservation, rental companies can not only contribute to a sustainable future but also enjoy tangible financial and operational benefits.



About Ventilation (architecture)

Image not found or type unknown



An Ab anbar (water reservoir) with double domes and windcatchers (openings near the top of the towers) in the central desert city of Naen, Iran. Windcatchers are a form of natural ventilation.^[1]



This article's lead section **may need to be rewritten**. Please review the lead guide and help improve the lead of this article if you can. *(July 2025) (Learn how and when to remove this message)*

Ventilation is the intentional introduction of outdoor air into a space. Ventilation is mainly used to control indoor air quality by diluting and displacing indoor effluents and pollutants. It can also be used to control indoor temperature, humidity, and air motion to benefit thermal comfort, satisfaction with other aspects of the indoor environment, or other objectives.

The intentional introduction of outdoor air is usually categorized as either mechanical ventilation, natural ventilation, or mixed-mode ventilation.^[2]

- Mechanical ventilation is the intentional fan-driven flow of outdoor air into and/or out from a building. Mechanical ventilation systems may include supply fans (which push outdoor air into a building), exhaust^[3] fans (which draw air out of a building and thereby cause equal ventilation flow into a building), or a combination of both (called balanced ventilation if it neither pressurizes nor depressurizes the inside air,^[3] or only slightly depressurizes it). Mechanical ventilation is often provided by equipment that is also used to heat and cool a space.
- Natural ventilation is the intentional passive flow of outdoor air into a building through planned openings (such as louvers, doors, and windows). Natural ventilation does not require mechanical systems to move outdoor air. Instead, it relies entirely on passive physical phenomena, such as wind pressure, or the stack effect. Natural ventilation openings may be fixed, or adjustable. Adjustable openings may be controlled automatically (automated), owned by occupants (operable), or a combination of both. Cross ventilation is a phenomenon of natural ventilation.

- Mixed-mode ventilation systems use both mechanical and natural processes. The mechanical and natural components may be used at the same time, at different times of day, or in different seasons of the year.^[4] Since natural ventilation flow depends on environmental conditions, it may not always provide an appropriate amount of ventilation. In this case, mechanical systems may be used to supplement or regulate the naturally driven flow.

Ventilation is typically described as separate from infiltration.

- Infiltration is the circumstantial flow of air from outdoors to indoors through leaks (unplanned openings) in a building envelope. When a building design relies on infiltration to maintain indoor air quality, this flow has been referred to as adventitious ventilation.^[5]

The design of buildings that promote occupant health and well-being requires a clear understanding of the ways that ventilation airflow interacts with, dilutes, displaces, or introduces pollutants within the occupied space. Although ventilation is an integral component of maintaining good indoor air quality, it may not be satisfactory alone.^[6] A clear understanding of both indoor and outdoor air quality parameters is needed to improve the performance of ventilation in terms of occupant health and energy.^[7] In scenarios where outdoor pollution would deteriorate indoor air quality, other treatment devices such as filtration may also be necessary.^[8] In kitchen ventilation systems, or for laboratory fume hoods, the design of effective effluent capture can be more important than the bulk amount of ventilation in a space. More generally, the way that an air distribution system causes ventilation to flow into and out of a space impacts the ability of a particular ventilation rate to remove internally generated pollutants. The ability of a system to reduce pollution in space is described as its "ventilation effectiveness". However, the overall impacts of ventilation on indoor air quality can depend on more complex factors such as the sources of pollution, and the ways that activities and airflow interact to affect occupant exposure.

An array of factors related to the design and operation of ventilation systems are regulated by various codes and standards. Standards dealing with the design and

operation of ventilation systems to achieve acceptable indoor air quality include the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standards 62.1 and 62.2, the International Residential Code, the International Mechanical Code, and the United Kingdom Building Regulations Part F. Other standards that focus on energy conservation also impact the design and operation of ventilation systems, including ASHRAE Standard 90.1, and the International Energy Conservation Code.

When indoor and outdoor conditions are favorable, increasing ventilation beyond the minimum required for indoor air quality can significantly improve both indoor air quality and thermal comfort through ventilative cooling, which also helps reduce the energy demand of buildings.^[9]^[10] During these times, higher ventilation rates, achieved through passive or mechanical means (air-side economizer, ventilative pre-cooling), can be particularly beneficial for enhancing people's physical health.^[11] Conversely, when conditions are less favorable, maintaining or improving indoor air quality through ventilation may require increased use of mechanical heating or cooling, leading to higher energy consumption.

Ventilation should be considered for its relationship to "venting" for appliances and combustion equipment such as water heaters, furnaces, boilers, and wood stoves. Most importantly, building ventilation design must be careful to avoid the backdraft of combustion products from "naturally vented" appliances into the occupied space. This issue is of greater importance for buildings with more air-tight envelopes. To avoid the hazard, many modern combustion appliances utilize "direct venting" which draws combustion air directly from outdoors, instead of from the indoor environment.

Design of air flow in rooms

[edit]

The air in a room can be supplied and removed in several ways, for example via ceiling ventilation, cross ventilation, floor ventilation or displacement ventilation.^[citation needed]

Ceiling ventilation

○

Image not found or type unknown

Ceiling ventilation

Cross ventilation

○

Image not found or type unknown

Cross ventilation

Floor ventilation

○

Image not found or type unknown

Floor ventilation

Displacement ventilation

○

Image not found or type unknown

Displacement

ventilation

Furthermore, the air can be circulated in the room using vortexes which can be initiated in various ways:

Tangential flow vortices, initiated horizontally

○

Image not found or type unknown

Tangential flow
vortices, initiated
horizontally

Tangential flow vortices, initiated vertically

○

Image not found or type unknown

Tangential flow
vortices, initiated
vertically

Diffused flow vortices from air nozzles

○

Image not found or type unknown

Diffused flow
vortices from air
nozzles

Diffused flow vortices due to roof vortices

○

Image not found or type unknown

Diffused flow
vortices due to roof

vortices

Ventilation rates for indoor air quality

[edit]

The examples and perspective in this article **deal primarily with the United States and do not represent a worldwide view of the subject**. You may improve this article, discuss the issue on the talk page, or create a new article, as appropriate. *(April 2024) (Learn how and when to remove this message)*

The ventilation rate, for commercial, industrial, and institutional (CII) buildings, is normally expressed by the volumetric flow rate of outdoor air, introduced to the building. The typical units used are cubic feet per minute (CFM) in the imperial system, or liters per second (L/s) in the metric system (even though cubic meter per second is the preferred unit for volumetric flow rate in the SI system of units). The ventilation rate can also be expressed on a per person or per unit floor area basis, such as CFM/p or CFM/ft², or as air changes per hour (ACH).

Standards for residential buildings

[edit]

For residential buildings, which mostly rely on infiltration for meeting their ventilation needs, a common ventilation rate measure is the air change rate (or air changes per hour): the hourly ventilation rate divided by the volume of the space (*I* or *ACH*; units of 1/h). During the winter, ACH may range from 0.50 to 0.41 in a tightly air-sealed house to 1.11 to 1.47 in a loosely air-sealed house.^[12]

ASHRAE now recommends ventilation rates dependent upon floor area, as a revision to the 62-2001 standard, in which the minimum ACH was 0.35, but no less than 15 CFM/person (7.1 L/s/person). As of 2003, the standard has been changed to 3 CFM/100 sq. ft. (15 L/s/100 sq. m.) plus 7.5 CFM/person (3.5 L/s/person).^[13]

Standards for commercial buildings

[edit]

Ventilation rate procedure

[edit]

Ventilation Rate Procedure is rate based on standard and prescribes the rate at which ventilation air must be delivered to space and various means to the condition that air.^[14] Air quality is assessed (through CO₂ measurement) and ventilation rates are mathematically derived using constants. Indoor Air Quality Procedure uses one or more guidelines for the specification of acceptable concentrations of certain contaminants in indoor air but does not prescribe ventilation rates or air treatment methods.^[14] This addresses both quantitative and subjective evaluations and is based on the Ventilation Rate Procedure. It also accounts for potential contaminants that may have no measured limits, or for which no limits are not set (such as formaldehyde off-gassing from carpet and furniture).

Natural ventilation

[edit]

Main article: Natural ventilation

Natural ventilation harnesses naturally available forces to supply and remove air in an enclosed space. Poor ventilation in rooms is identified to significantly increase the localized moldy smell in specific places of the room including room corners.^[11] There are three types of natural ventilation occurring in buildings: wind-driven ventilation, pressure-driven flows, and stack ventilation.^[15] The pressures generated by 'the stack effect' rely upon the buoyancy of heated or rising air. Wind-driven ventilation relies upon the force of the prevailing wind to pull and push air through the enclosed space as well as through breaches in the building's envelope.

Almost all historic buildings were ventilated naturally.^[16] The technique was generally abandoned in larger US buildings during the late 20th century as the use of air conditioning became more widespread. However, with the advent of advanced Building Performance Simulation (BPS) software, improved Building Automation Systems (BAS), Leadership in Energy and Environmental Design (LEED) design requirements, and improved window manufacturing techniques; natural ventilation has made a resurgence in commercial buildings both globally and throughout the US.^[17]

The benefits of natural ventilation include:

- Improved indoor air quality (IAQ)
- Energy savings
- Reduction of greenhouse gas emissions
- Occupant control
- Reduction in occupant illness associated with sick building syndrome
- Increased worker productivity

Techniques and architectural features used to ventilate buildings and structures naturally include, but are not limited to:

- Operable windows
- Clerestory windows and vented skylights
- Lev/convection doors
- Night purge ventilation
- Building orientation
- Wind capture façades

Airborne diseases

[edit]

Natural ventilation is a key factor in reducing the spread of airborne illnesses such as tuberculosis, the common cold, influenza, meningitis or COVID-19.^[18] Opening doors and windows are good ways to maximize natural ventilation, which would make the risk

of airborne contagion much lower than with costly and maintenance-requiring mechanical systems. Old-fashioned clinical areas with high ceilings and large windows provide the greatest protection. Natural ventilation costs little and is maintenance-free, and is particularly suited to limited-resource settings and tropical climates, where the burden of TB and institutional TB transmission is highest. In settings where respiratory isolation is difficult and climate permits, windows and doors should be opened to reduce the risk of airborne contagion. Natural ventilation requires little maintenance and is inexpensive.^[19]

Natural ventilation is not practical in much of the infrastructure because of climate. This means that the facilities need to have effective mechanical ventilation systems and or use Ceiling Level UV or FAR UV ventilation systems.

Ventilation is measured in terms of air changes per hour (ACH). As of 2023, the CDC recommends that all spaces have a minimum of 5 ACH.^[20] For hospital rooms with airborne contagions the CDC recommends a minimum of 12 ACH.^[21] Challenges in facility ventilation are public unawareness,^[22]^[23] ineffective government oversight, poor building codes that are based on comfort levels, poor system operations, poor maintenance, and lack of transparency.^[24]

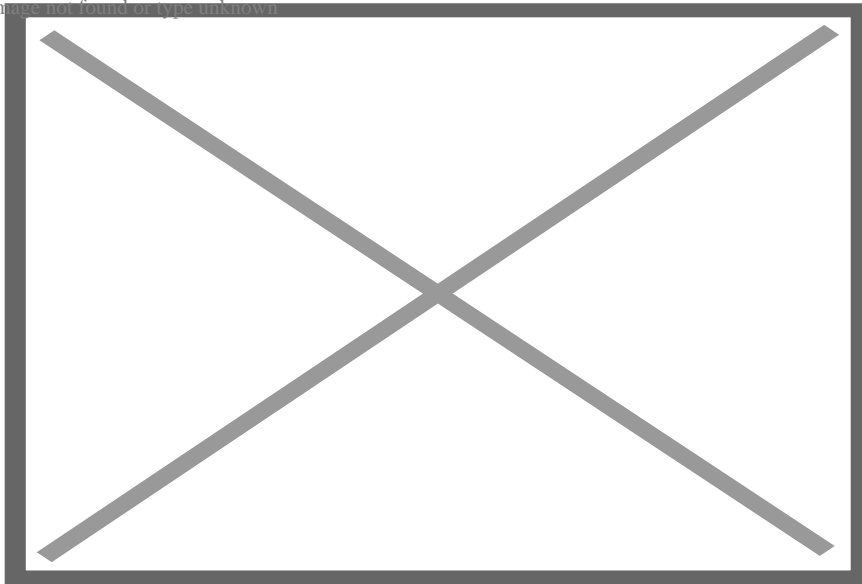
Pressure, both political and economic, to improve energy conservation has led to decreased ventilation rates. Heating, ventilation, and air conditioning rates have dropped since the energy crisis in the 1970s and the banning of cigarette smoke in the 1980s and 1990s.^[25]^[26]^[better source needed]

Mechanical ventilation

[edit]

Main article: HVAC

Image not found or type unknown



An axial belt-drive exhaust fan serving an underground car park. This exhaust fan's operation is interlocked with the concentration of contaminants emitted by internal combustion engines.

Mechanical ventilation of buildings and structures can be achieved by the use of the following techniques:

- Whole-house ventilation
- Mixing ventilation
- Displacement ventilation
- Dedicated subaerial air supply

Demand-controlled ventilation (DCV)

[edit]

Demand-controlled ventilation (**DCV**, also known as Demand Control Ventilation) makes it possible to maintain air quality while conserving energy.^[27]^[28] ASHRAE has determined that "It is consistent with the ventilation rate procedure that demand control be permitted for use to reduce the total outdoor air supply during periods of less occupancy."^[29] In a DCV system, CO₂ sensors control the amount of ventilation.^[30]^[31] During peak occupancy, CO₂ levels rise, and the system adjusts to deliver the same amount of outdoor air as would be used by the ventilation-rate procedure.^[32]

However, when spaces are less occupied, CO₂ levels reduce, and the system reduces ventilation to conserve energy. DCV is a well-established practice,^[33] and is required in high occupancy spaces by building energy standards such as ASHRAE 90.1.^[34]

Personalized ventilation

[edit]



This section needs to be **updated**. Please help update this article to reflect recent events or newly available information. (*September 2024*)

Personalized ventilation is an air distribution strategy that allows individuals to control the amount of ventilation received. The approach delivers fresh air more directly to the breathing zone and aims to improve the air quality of inhaled air. Personalized ventilation provides much higher ventilation effectiveness than conventional mixing ventilation systems by displacing pollution from the breathing zone with far less air volume. Beyond improved air quality benefits, the strategy can also improve occupants' thermal comfort, perceived air quality, and overall satisfaction with the indoor environment. Individuals' preferences for temperature and air movement are not equal, and so traditional approaches to homogeneous environmental control have failed to achieve high occupant satisfaction. Techniques such as personalized ventilation facilitate control of a more diverse thermal environment that can improve thermal satisfaction for most occupants.

Local exhaust ventilation

[edit]

See also: Power tool

Local exhaust ventilation addresses the issue of avoiding the contamination of indoor air by specific high-emission sources by capturing airborne contaminants before they are spread into the environment. This can include water vapor control, lavatory

effluent control, solvent vapors from industrial processes, and dust from wood- and metal-working machinery. Air can be exhausted through pressurized hoods or the use of fans and pressurizing a specific area.^[35]

A local exhaust system is composed of five basic parts:

1. A hood that captures the contaminant at its source
2. Ducts for transporting the air
3. An air-cleaning device that removes/minimizes the contaminant
4. A fan that moves the air through the system
5. An exhaust stack through which the contaminated air is discharged^[35]

In the UK, the use of LEV systems has regulations set out by the Health and Safety Executive (HSE) which are referred to as the Control of Substances Hazardous to Health (CoSHH). Under CoSHH, legislation is set to protect users of LEV systems by ensuring that all equipment is tested at least every fourteen months to ensure the LEV systems are performing adequately. All parts of the system must be visually inspected and thoroughly tested and where any parts are found to be defective, the inspector must issue a red label to identify the defective part and the issue.

The owner of the LEV system must then have the defective parts repaired or replaced before the system can be used.

Smart ventilation

[edit]

Smart ventilation is a process of continually adjusting the ventilation system in time, and optionally by location, to provide the desired IAQ benefits while minimizing energy consumption, utility bills, and other non-IAQ costs (such as thermal discomfort or noise). A smart ventilation system adjusts ventilation rates in time or by location in a building to be responsive to one or more of the following: occupancy, outdoor thermal and air quality conditions, electricity grid needs, direct sensing of contaminants, operation of other air moving and air cleaning systems. In addition, smart ventilation

systems can provide information to building owners, occupants, and managers on operational energy consumption and indoor air quality as well as a signal when systems need maintenance or repair. Being responsive to occupancy means that a smart ventilation system can adjust ventilation depending on demand such as reducing ventilation if the building is unoccupied. Smart ventilation can time-shift ventilation to periods when a) indoor-outdoor temperature differences are smaller (and away from peak outdoor temperatures and humidity), b) when indoor-outdoor temperatures are appropriate for ventilative cooling, or c) when outdoor air quality is acceptable. Being responsive to electricity grid needs means providing flexibility to electricity demand (including direct signals from utilities) and integration with electric grid control strategies. Smart ventilation systems can have sensors to detect airflow, systems pressures, or fan energy use in such a way that systems failures can be detected and repaired, as well as when system components need maintenance, such as filter replacement.^[36]

Ventilation and combustion

[edit]

Combustion (in a fireplace, gas heater, candle, oil lamp, etc.) consumes oxygen while producing carbon dioxide and other unhealthy gases and smoke, requiring ventilation air. An open chimney promotes infiltration (i.e. natural ventilation) because of the negative pressure change induced by the buoyant, warmer air leaving through the chimney. The warm air is typically replaced by heavier, cold air.

Ventilation in a structure is also needed for removing water vapor produced by respiration, burning, and cooking, and for removing odors. If water vapor is permitted to accumulate, it may damage the structure, insulation, or finishes. ^[citation needed] When operating, an air conditioner usually removes excess moisture from the air. A dehumidifier may also be appropriate for removing airborne moisture.

Calculation for acceptable ventilation rate

[edit]

Ventilation guidelines are based on the minimum ventilation rate required to maintain acceptable levels of effluents. Carbon dioxide is used as a reference point, as it is the gas of highest emission at a relatively constant value of 0.005 L/s. The mass balance equation is:

$$Q = G / (C_i - C_a)$$

- Q = ventilation rate (L/s)
- G = CO₂ generation rate
- C_i = acceptable indoor CO₂ concentration
- C_a = ambient CO₂ concentration^[37]

Smoking and ventilation

[edit]

ASHRAE standard 62 states that air removed from an area with environmental tobacco smoke shall not be recirculated into ETS-free air. A space with ETS requires more ventilation to achieve similar perceived air quality to that of a non-smoking environment.

The amount of ventilation in an ETS area is equal to the amount of an ETS-free area plus the amount V, where:

$$V = DSD \times VA \times A/60E$$

- V = recommended extra flow rate in CFM (L/s)
- DSD = design smoking density (estimated number of cigarettes smoked per hour per unit area)
- VA = volume of ventilation air per cigarette for the room being designed (ft³/cig)
- E = contaminant removal effectiveness^[38]

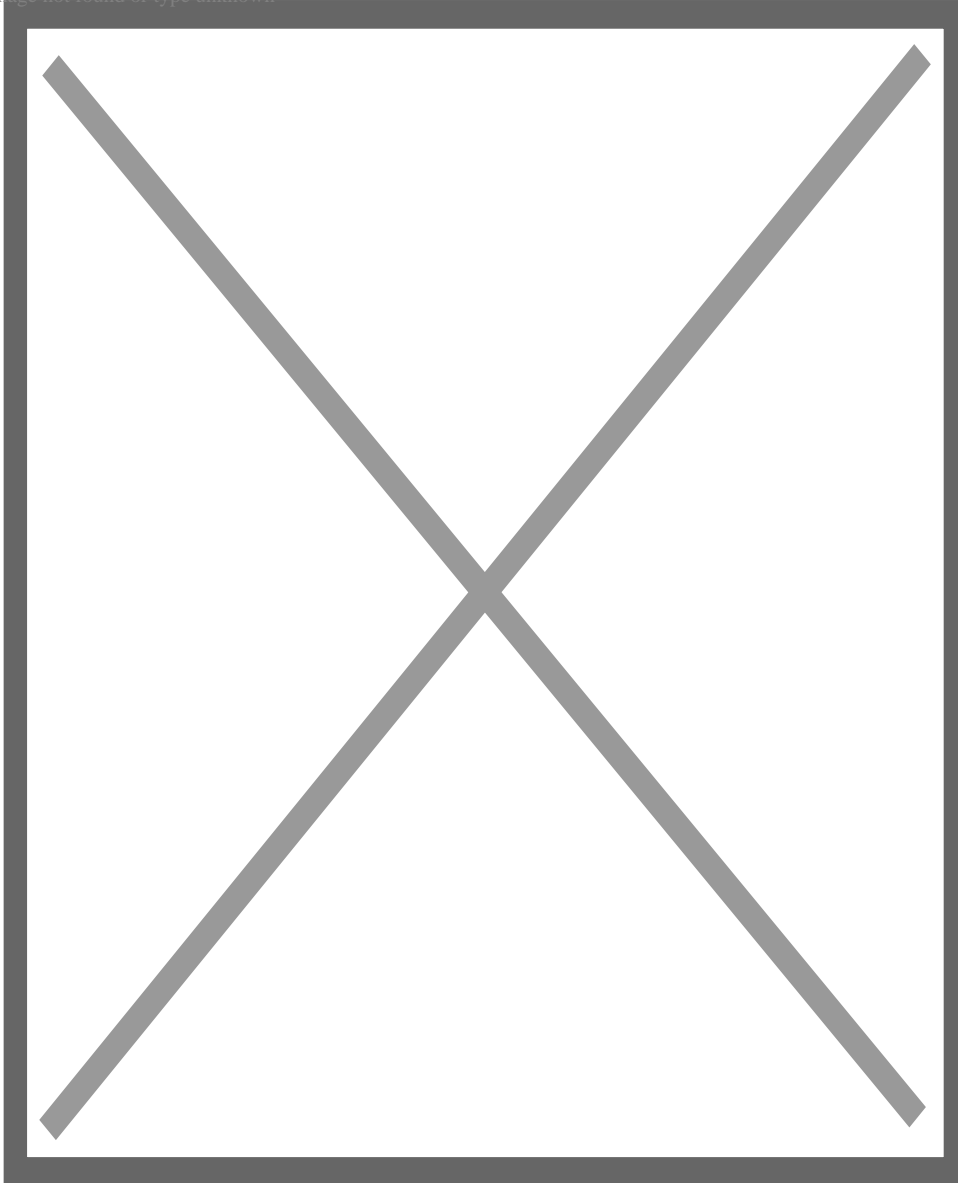
History

[edit]

This section needs expansion. You can help by adding to it. *(August 2020)*

[icon]

Image not found or type unknown



This ancient Roman house uses a variety of passive cooling and passive ventilation techniques. Heavy masonry walls, small exterior windows, and a narrow walled garden oriented N-S shade the house, preventing heat gain. The house opens onto a central atrium with an impluvium (open to the sky); the evaporative cooling of the water causes a cross-draft from atrium to garden.

Primitive ventilation systems were found at the Pločnik archeological site (belonging to the Vinča culture) in Serbia and were built into early copper smelting furnaces. The

furnace, built on the outside of the workshop, featured earthen pipe-like air vents with hundreds of tiny holes in them and a prototype chimney to ensure air goes into the furnace to feed the fire and smoke comes out safely.^[39]

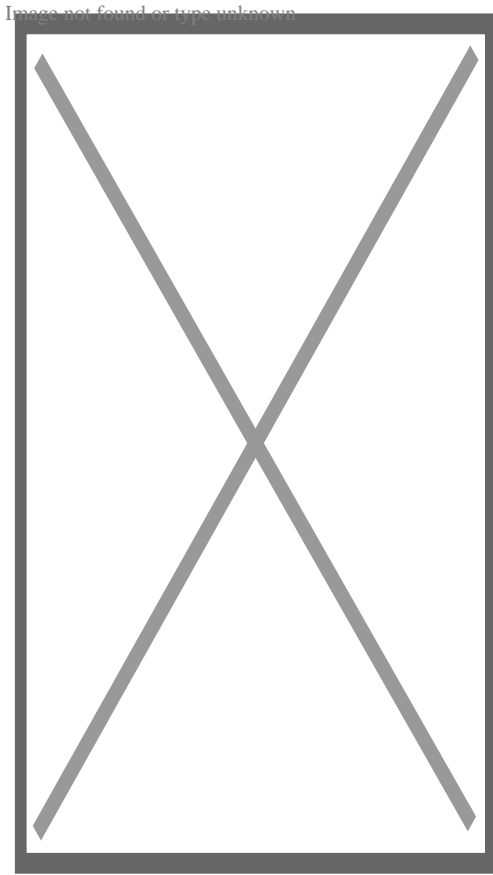
Passive ventilation and passive cooling systems were widely written about around the Mediterranean by Classical times. Both sources of heat and sources of cooling (such as fountains and subterranean heat reservoirs) were used to drive air circulation, and buildings were designed to encourage or exclude drafts, according to climate and function. Public bathhouses were often particularly sophisticated in their heating and cooling. Icehouses are some millennia old, and were part of a well-developed ice industry by classical times.

The development of forced ventilation was spurred by the common belief in the late 18th and early 19th century in the miasma theory of disease, where stagnant 'airs' were thought to spread illness. An early method of ventilation was the use of a ventilating fire near an air vent which would forcibly cause the air in the building to circulate. English engineer John Theophilus Desaguliers provided an early example of this when he installed ventilating fires in the air tubes on the roof of the House of Commons. Starting with the Covent Garden Theatre, gas burning chandeliers on the ceiling were often specially designed to perform a ventilating role.

Mechanical systems

[edit]

Further information: Heating, ventilation, and air conditioning § Mechanical or forced ventilation



The Central Tower of the Palace of Westminster. This octagonal spire was for ventilation purposes, in the more complex system imposed by Reid on Barry, in which it was to draw air out of the Palace. The design was for the aesthetic disguise of its function.^{[40][41]}

A more sophisticated system involving the use of mechanical equipment to circulate the air was developed in the mid-19th century. A basic system of bellows was put in place to ventilate Newgate Prison and outlying buildings, by the engineer Stephen Hales in the mid-1700s. The problem with these early devices was that they required constant human labor to operate. David Boswell Reid was called to testify before a Parliamentary committee on proposed architectural designs for the new House of Commons, after the old one burned down in a fire in 1834.^[40] In January 1840 Reid was appointed by the committee for the House of Lords dealing with the construction of the replacement for the Houses of Parliament. The post was in the capacity of ventilation engineer, in effect; and with its creation there began a long series of quarrels between Reid and Charles Barry, the architect.^[42]

Reid advocated the installation of a very advanced ventilation system in the new House. His design had air being drawn into an underground chamber, where it would undergo either heating or cooling. It would then ascend into the chamber through thousands of small holes drilled into the floor, and would be extracted through the ceiling by a special ventilation fire within a great stack.^[43]

Reid's reputation was made by his work in Westminster. He was commissioned for an air quality survey in 1837 by the Leeds and Selby Railway in their tunnel.^[44] The steam vessels built for the Niger expedition of 1841 were fitted with ventilation systems based on Reid's Westminster model.^[45] Air was dried, filtered and passed over charcoal.^[46]^[47] Reid's ventilation method was also applied more fully to St. George's Hall, Liverpool, where the architect, Harvey Lonsdale Elmes, requested that Reid should be involved in ventilation design.^[48] Reid considered this the only building in which his system was completely carried out.^[49]

Fans

[edit]

With the advent of practical steam power, ceiling fans could finally be used for ventilation. Reid installed four steam-powered fans in the ceiling of St George's Hospital in Liverpool, so that the pressure produced by the fans would force the incoming air upward and through vents in the ceiling. Reid's pioneering work provides the basis for ventilation systems to this day.^[43] He was remembered as "Dr. Reid the ventilator" in the twenty-first century in discussions of energy efficiency, by Lord Wade of Chorlton.^[50]

History and development of ventilation rate standards

[edit]

Ventilating a space with fresh air aims to avoid "bad air". The study of what constitutes bad air dates back to the 1600s when the scientist Mayow studied asphyxia of

animals in confined bottles.^[51] The poisonous component of air was later identified as carbon dioxide (CO₂), by Lavoisier in the very late 1700s, starting a debate as to the nature of "bad air" which humans perceive to be stuffy or unpleasant. Early hypotheses included excess concentrations of CO₂ and oxygen depletion. However, by the late 1800s, scientists thought biological contamination, not oxygen or CO₂, was the primary component of unacceptable indoor air. However, it was noted as early as 1872 that CO₂ concentration closely correlates to perceived air quality.

The first estimate of minimum ventilation rates was developed by Tredgold in 1836.^[52] This was followed by subsequent studies on the topic by Billings ^[53] in 1886 and Flugge in 1905. The recommendations of Billings and Flugge were incorporated into numerous building codes from 1900–the 1920s and published as an industry standard by ASHVE (the predecessor to ASHRAE) in 1914.^[51]

The study continued into the varied effects of thermal comfort, oxygen, carbon dioxide, and biological contaminants. The research was conducted with human subjects in controlled test chambers. Two studies, published between 1909 and 1911, showed that carbon dioxide was not the offending component. Subjects remained satisfied in chambers with high levels of CO₂, so long as the chamber remained cool.^[51] (Subsequently, it has been determined that CO₂ is, in fact, harmful at concentrations over 50,000ppm^[54])

ASHVE began a robust research effort in 1919. By 1935, ASHVE-funded research conducted by Lemberg, Brandt, and Morse – again using human subjects in test chambers – suggested the primary component of "bad air" was an odor, perceived by the human olfactory nerves.^[55] Human response to odor was found to be logarithmic to contaminant concentrations, and related to temperature. At lower, more comfortable temperatures, lower ventilation rates were satisfactory. A 1936 human test chamber study by Yaglou, Riley, and Coggins culminated much of this effort, considering odor, room volume, occupant age, cooling equipment effects, and recirculated air implications, which guided ventilation rates.^[56] The Yagle research has been validated, and adopted into industry standards, beginning with the ASA code

in 1946. From this research base, ASHRAE (having replaced ASHVE) developed space-by-space recommendations, and published them as ASHRAE Standard 62-1975: Ventilation for acceptable indoor air quality.

As more architecture incorporated mechanical ventilation, the cost of outdoor air ventilation came under some scrutiny. In 1973, in response to the 1973 oil crisis and conservation concerns, ASHRAE Standards 62-73 and 62-81) reduced required ventilation from 10 CFM (4.76 L/s) per person to 5 CFM (2.37 L/s) per person. In cold, warm, humid, or dusty climates, it is preferable to minimize ventilation with outdoor air to conserve energy, cost, or filtration. This critique (e.g. Tiller^[57]) led ASHRAE to reduce outdoor ventilation rates in 1981, particularly in non-smoking areas. However subsequent research by Fanger,^[58] W. Cain, and Janssen validated the Yagle model. The reduced ventilation rates were found to be a contributing factor to sick building syndrome.^[59]

The 1989 ASHRAE standard (Standard 62-89) states that appropriate ventilation guidelines are 20 CFM (9.2 L/s) per person in an office building, and 15 CFM (7.1 L/s) per person for schools, while 2004 Standard 62.1-2004 has lower recommendations again (see tables below). ANSI/ASHRAE (Standard 62-89) speculated that "comfort (odor) criteria are likely to be satisfied if the ventilation rate is set so that 1,000 ppm CO₂ is not exceeded"^[60] while OSHA has set a limit of 5000 ppm over 8 hours.^[61]

Historical ventilation rates

Author or source	Year	Ventilation rate (IP)	Ventilation rate (SI)	Basis or rationale
Tredgold	1836	4 CFM per person	2 L/s per person	Basic metabolic needs, breathing rate, and candle burning
Billings	1895	30 CFM per person	15 L/s per person	Indoor air hygiene, preventing spread of disease
Flugge	1905	30 CFM per person	15 L/s per person	Excessive temperature or unpleasant odor

ASHVE	1914	30 CFM per person	15 L/s per person	Based on Billings, Flugge and contemporaries
Early US Codes	1925	30 CFM per person	15 L/s per person	Same as above
Yaglou	1936	15 CFM per person	7.5 L/s per person	Odor control, outdoor air as a fraction of total air
ASA	1946	15 CFM per person	7.5 L/s per person	Based on Yaglou and contemporaries
ASHRAE	1975	15 CFM per person	7.5 L/s per person	Same as above
ASHRAE	1981	10 CFM per person	5 L/s per person	For non-smoking areas, reduced.
ASHRAE	1989	15 CFM per person	7.5 L/s per person	Based on Fanger, W. Cain, and Janssen

ASHRAE continues to publish space-by-space ventilation rate recommendations, which are decided by a consensus committee of industry experts. The modern descendants of ASHRAE standard 62-1975 are ASHRAE Standard 62.1, for non-residential spaces, and ASHRAE 62.2 for residences.

In 2004, the calculation method was revised to include both an occupant-based contamination component and an area-based contamination component.^[62] These two components are additive, to arrive at an overall ventilation rate. The change was made to recognize that densely populated areas were sometimes overventilated (leading to higher energy and cost) using a per-person methodology.

Occupant Based Ventilation Rates,^[62] ANSI/ASHRAE Standard 62.1-2004

IP Units	SI Units	Category	Examples
0 cfm/person	0 L/s/person	Spaces where ventilation requirements are primarily associated with building elements, not occupants.	Storage Rooms, Warehouses

5 cfm/person	2.5 L/s/person	Spaces occupied by adults, engaged in low levels of activity	Office space
7.5 cfm/person	3.5 L/s/person	Spaces where occupants are engaged in higher levels of activity, but not strenuous, or activities generating more contaminants	Retail spaces, lobbies
10 cfm/person	5 L/s/person	Spaces where occupants are engaged in more strenuous activity, but not exercise, or activities generating more contaminants	Classrooms, school settings
20 cfm/person	10 L/s/person	Spaces where occupants are engaged in exercise, or activities generating many contaminants	dance floors, exercise rooms

Area-based ventilation rates,^[62] ANSI/ASHRAE Standard 62.1-2004

IP Units	SI Units	Category	Examples
0.06 cfm/ft ²	0.30 L/s/m ²	Spaces where space contamination is normal, or similar to an office environment	Conference rooms, lobbies
0.12 cfm/ft ²	0.60 L/s/m ²	Spaces where space contamination is significantly higher than an office environment	Classrooms, museums
0.18 cfm/ft ²	0.90 L/s/m ²	Spaces where space contamination is even higher than the previous category	Laboratories, art classrooms
0.30 cfm/ft ²	1.5 L/s/m ²	Specific spaces in sports or entertainment where contaminants are released	Sports, entertainment
0.48 cfm/ft ²	2.4 L/s/m ²	Reserved for indoor swimming areas, where chemical concentrations are high	Indoor swimming areas

The addition of occupant- and area-based ventilation rates found in the tables above often results in significantly reduced rates compared to the former standard. This is compensated in other sections of the standard which require that this minimum amount of air is delivered to the breathing zone of the individual occupant at all times.

The total outdoor air intake of the ventilation system (in multiple-zone variable air volume (VAV) systems) might therefore be similar to the airflow required by the 1989 standard.

From 1999 to 2010, there was considerable development of the application protocol for ventilation rates. These advancements address occupant- and process-based ventilation rates, room ventilation effectiveness, and system ventilation effectiveness[63]

Problems

[edit]

- In hot, humid climates, unconditioned ventilation air can daily deliver approximately 260 milliliters of water for each cubic meters per hour (m^3/h) of outdoor air (or one pound of water each day for each cubic feet per minute of outdoor air per day), annual average.^[citation needed] This is a great deal of moisture and can create serious indoor moisture and mold problems. For example, given a 150 m^2 building with an airflow of $180 \text{ m}^3/\text{h}$ this could result in about 47 liters of water accumulated per day.
- Ventilation efficiency is determined by design and layout, and is dependent upon the placement and proximity of diffusers and return air outlets. If they are located closely together, supply air may mix with stale air, decreasing the efficiency of the HVAC system, and creating air quality problems.
- System imbalances occur when components of the HVAC system are improperly adjusted or installed and can create pressure differences (too much-circulating air creating a draft or too little circulating air creating stagnancy).
- Cross-contamination occurs when pressure differences arise, forcing potentially contaminated air from one zone to an uncontaminated zone. This often involves undesired odors or VOCs.
- Re-entry of exhaust air occurs when exhaust outlets and fresh air intakes are either too close, prevailing winds change exhaust patterns or infiltration between intake and exhaust air flows.

- Entrainment of contaminated outdoor air through intake flows will result in indoor air contamination. There are a variety of contaminated air sources, ranging from industrial effluent to VOCs put off by nearby construction work.^[64] A recent study revealed that in urban European buildings equipped with ventilation systems lacking outdoor air filtration, the exposure to outdoor-originating pollutants indoors resulted in more Disability-Adjusted Life Years (DALYs) than exposure to indoor-emitted pollutants.^[65]

See also

[edit]

- Architectural engineering
- Biological safety
- Cleanroom
- Environmental tobacco smoke
- Fume hood
- Head-end power
- Heating, ventilation, and air conditioning
- Heat recovery ventilation
- Mechanical engineering
- Room air distribution
- Sick building syndrome
- Siheyuan
- Solar chimney
- Tulou
- Windcatcher

References

[edit]

1. [^] Malone, Alanna. *"The Windcatcher House". Architectural Record: Building for Social Change*. McGraw-Hill. Archived from the original on 22 April 2012.
2. [^] ASHRAE (2021). *"Ventilation and Infiltration". ASHRAE Handbook—Fundamentals*. Peachtree Corners, GA: ASHRAE. ISBN 978-1-947192-90-4.

3. ^ **a b** Whole-House Ventilation | Department of Energy
4. ^ de Gids W.F., Jicha M., 2010. "Ventilation Information Paper 32: Hybrid Ventilation Archived 2015-11-17 at the Wayback Machine", Air Infiltration and Ventilation Centre (AIVC), 2010
5. ^ Schiavon, Stefano (2014). "Adventitious ventilation: a new definition for an old mode?". *Indoor Air*. **24** (6): 557–558. Bibcode:2014InAir..24..557S. doi: 10.1111/ina.12155. ISSN 1600-0668. PMID 25376521.
6. ^ ANSI/ASHRAE Standard 62.1, *Ventilation for Acceptable Indoor Air Quality*, ASHRAE, Inc., Atlanta, GA, US
7. ^ Belias, Evangelos; Licina, Dusan (2024). "European residential ventilation: Investigating the impact on health and energy demand". *Energy and Buildings*. **304** 113839. Bibcode:2024EneBu.30413839B. doi: 10.1016/j.enbuild.2023.113839.
8. ^ Belias, Evangelos; Licina, Dusan (2022). "Outdoor PM2. 5 air filtration: optimising indoor air quality and energy". *Buildings & Cities*. **3** (1): 186–203. doi:10.5334/bc.153 .
9. ^ Belias, Evangelos; Licina, Dusan (2024). "European residential ventilation: Investigating the impact on health and energy demand". *Energy and Buildings*. **304** 113839. Bibcode:2024EneBu.30413839B. doi: 10.1016/j.enbuild.2023.113839.
10. ^ Belias, Evangelos; Licina, Dusan (2023). "Influence of outdoor air pollution on European residential ventilative cooling potential". *Energy and Buildings*. **289** 113044. Bibcode:2023EneBu.28913044B. doi: 10.1016/j.enbuild.2023.113044.
11. ^ **a b** Sun, Y., Zhang, Y., Bao, L., Fan, Z. and Sundell, J., 2011. Ventilation and dampness in dorms and their associations with allergy among college students in China: a case-control study. *Indoor Air*, 21(4), pp.277–283.
12. ^ Kavanaugh, Steve. *Infiltration and Ventilation In Residential Structures*. February 2004
13. ^ M.H. Sherman. "ASHRAE's First Residential Ventilation Standard" (PDF). Lawrence Berkeley National Laboratory. Archived from the original (PDF) on 29 February 2012.
14. ^ **a b** ASHRAE Standard 62
15. ^ How Natural Ventilation Works by Steven J. Hoff and Jay D. Harmon. Ames, IA: Department of Agricultural and Biosystems Engineering, Iowa State University, November 1994.
16. ^ "Natural Ventilation – Whole Building Design Guide". Archived from the original on 21 July 2012.
17. ^ Shaqe, Erlet. *Sustainable Architectural Design*.

18. ^ "Natural Ventilation for Infection Control in Health-Care Settings" (PDF). World Health Organization (WHO), 2009. Retrieved 5 July 2021.
19. ^ Escombe, A. R.; Oeser, C. C.; Gilman, R. H.; et al. (2007). "Natural ventilation for the prevention of airborne contagion". *PLOS Med.* **4** (68): e68. doi: 10.1371/journal.pmed.0040068. PMC 1808096. PMID 17326709.
20. ^ Centers For Disease Control and Prevention (CDC) *"Improving Ventilation In Buildings"*. 11 February 2020.
21. ^ Centers For Disease Control and Prevention (CDC) *"Guidelines for Environmental Infection Control in Health-Care Facilities"*. 22 July 2019.
22. ^ Dr. Edward A. Nardell Professor of Global Health and Social Medicine, Harvard Medical School *"If We're Going to Live With COVID-19, It's Time to Clean Our Indoor Air Properly"*. *Time*. February 2022.
23. ^ *"A Paradigm Shift to Combat Indoor Respiratory Infection - 21st century"* (PDF). University of Leeds., Morawska, L, Allen, J, Bahnfleth, W et al. (36 more authors) (2021) A paradigm shift to combat indoor respiratory infection. *Science*, 372 (6543). pp. 689–691. ISSN 0036–8075
24. ^ Video *"Building Ventilation What Everyone Should Know"*. YouTube. 17 June 2022.
25. ^ Mudarri, David (January 2010). *Public Health Consequences and Cost of Climate Change Impacts on Indoor Environments (PDF) (Report)*. The Indoor Environments Division, Office of Radiation and Indoor Air, U.S. Environmental Protection Agency. pp. 38–39, 63.
26. ^ *"Climate Change a Systems Perspective"*. Cassbeth.
27. ^ Raatschen W. (ed.), 1990: "Demand Controlled Ventilation Systems: State of the Art Review Archived 2014-05-08 at the Wayback Machine", Swedish Council for Building Research, 1990
28. ^ Mansson L.G., Svennberg S.A., Liddament M.W., 1997: "Technical Synthesis Report. A Summary of IEA Annex 18. Demand Controlled Ventilating Systems Archived 2016-03-04 at the Wayback Machine", UK, Air Infiltration and Ventilation Centre (AIVC), 1997
29. ^ ASHRAE (2006). *"Interpretation IC 62.1-2004-06 Of ANSI/ASHRAE Standard 62.1-2004 Ventilation For Acceptable Indoor Air Quality"* (PDF). American Society of Heating, Refrigerating, and Air-Conditioning Engineers. p. 2. Archived from the original (PDF) on 12 August 2013. Retrieved 10 April 2013.
30. ^ Fahlen P., Andersson H., Ruud S., 1992: "Demand Controlled Ventilation Systems: Sensor Tests Archived 2016-03-04 at the Wayback Machine", Swedish National

Testing and Research Institute, Borås, 1992

31. ^ Raatschen W., 1992: "Demand Controlled Ventilation Systems: Sensor Market Survey Archived 2016-03-04 at the Wayback Machine", Swedish Council for Building Research, 1992
32. ^ Mansson L.G., Svennberg S.A., 1993: "Demand Controlled Ventilation Systems: Source Book Archived 2016-03-04 at the Wayback Machine", Swedish Council for Building Research, 1993
33. ^ Lin X, Lau J & Grenville KY. (2012). "Evaluation of the Validity of the Assumptions Underlying CO₂-Based Demand-Controlled Ventilation by a Literature review" (PDF). *ASHRAE Transactions NY-14-007 (RP-1547)*. Archived from the original (PDF) on 14 July 2014. Retrieved 10 July 2014.
34. ^ ASHRAE (2010). "ANSI/ASHRAE Standard 90.1-2010: Energy Standard for Buildings Except for Low-Rise Residential Buildings". American Society of Heating Ventilation and Air Conditioning Engineers, Atlanta, GA.
35. ^ **a b** "Ventilation. - 1926.57". *Osha.gov*. Archived from the original on 2 December 2012. Retrieved 10 November 2012.
36. ^ Air Infiltration and Ventilation Centre (AIVC). "What is smart ventilation?", AIVC, 2018
37. ^ "Home". *Wapa.gov*. Archived from the original on 26 July 2011. Retrieved 10 November 2012.
38. ^ ASHRAE, Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc, Atlanta, 2002.
39. ^ "Stone Pages Archaeo News: Neolithic Vinca was a metallurgical culture". *www.stonepages.com*. Archived from the original on 30 December 2016. Retrieved 11 August 2016.
40. ^ **a b** Porter, Dale H. (1998). *The Life and Times of Sir Goldsworthy Gurney: Gentleman scientist and inventor, 1793–1875*. Associated University Presses, Inc. pp. 177–79. ISBN 0-934223-50-5.
41. ^ "The Towers of Parliament". *www.parliament.UK*. Archived from the original on 17 January 2012.
42. ^ Alfred Barry (1867). "The life and works of Sir Charles Barry, R.A., F.R.S., &c. &c". Retrieved 29 December 2011.
43. ^ **a b** Robert Brueggemann. "Central Heating and Ventilation: Origins and Effects on Architectural Design" (PDF).
44. ^ Russell, Colin A; Hudson, John (2011). *Early Railway Chemistry and Its Legacy*. Royal Society of Chemistry. p. 67. ISBN 978-1-84973-326-7. Retrieved 29 December

2011.

45. ^ Milne, Lynn. "McWilliam, James Ormiston". *Oxford Dictionary of National Biography* (online ed.). Oxford University Press. doi:10.1093/ref:odnb/17747. (Subscription or UK public library membership required.)
46. ^ Philip D. Curtin (1973). *The image of Africa: British ideas and action, 1780–1850*. Vol. 2. University of Wisconsin Press. p. 350. ISBN 978-0-299-83026-7. Retrieved 29 December 2011.
47. ^ "William Loney RN – Background". Peter Davis. Archived from the original on 6 January 2012. Retrieved 7 January 2012.
48. ^ Sturrock, Neil; Lawsdon-Smith, Peter (10 June 2009). "David Boswell Reid's Ventilation of St. George's Hall, Liverpool". *The Victorian Web*. Archived from the original on 3 December 2011. Retrieved 7 January 2012.
49. ^ Lee, Sidney, ed. (1896). "Reid, David Boswell". *Dictionary of National Biography*. Vol. 47. London: Smith, Elder & Co.
50. ^ Great Britain: Parliament: House of Lords: Science and Technology Committee (15 July 2005). *Energy Efficiency: 2nd Report of Session 2005–06*. The Stationery Office. p. 224. ISBN 978-0-10-400724-2. Retrieved 29 December 2011.
51. ^ **a b c** Janssen, John (September 1999). "The History of Ventilation and Temperature Control" (PDF). *ASHRAE Journal*. American Society of Heating Refrigeration and Air Conditioning Engineers, Atlanta, GA. Archived (PDF) from the original on 14 July 2014. Retrieved 11 June 2014.
52. ^ Tredgold, T. 1836. "The Principles of Warming and Ventilation – Public Buildings". London: M. Taylor
53. ^ Billings, J.S. 1886. "The principles of ventilation and heating and their practical application 2d ed., with corrections" *Archived copy*. OL 22096429M.
54. ^ "Immediately Dangerous to Life or Health Concentrations (IDLH): Carbon dioxide – NIOSH Publications and Products". CDC. May 1994. Archived from the original on 20 April 2018. Retrieved 30 April 2018.
55. ^ Lemberg WH, Brandt AD, and Morse, K. 1935. "A laboratory study of minimum ventilation requirements: ventilation box experiments". *ASHVE Transactions*, V. 41
56. ^ Yaglou CPE, Riley C, and Coggins DI. 1936. "Ventilation Requirements" *ASHVE Transactions*, v.32
57. ^ Tiller, T.R. 1973. *ASHRAE Transactions*, v. 79
58. ^ Berg–Munch B, Clausen P, Fanger PO. 1984. "Ventilation requirements for the control of body odor in spaces occupied by women". *Proceedings of the 3rd Int.*

Conference on Indoor Air Quality, Stockholm, Sweden, V5




59. ^ Joshi, SM (2008). "The sick building syndrome". *Indian J Occup Environ Med.* **12** (2): 61–64. doi:10.4103/0019-5278.43262. PMC 2796751. PMID 20040980. in section 3 "Inadequate ventilation"
60. ^ "Standard 62.1–2004: Stricter or Not?" ASHRAE IAQ Applications, Spring 2006. "Archived copy" (PDF). Archived from the original (PDF) on 14 July 2014. Retrieved 12 June 2014.cite web: CS1 maint: archived copy as title (link) accessed 11 June 2014
61. ^ Apte, Michael G. Associations between indoor CO₂ concentrations and sick building syndrome symptoms in U.S. office buildings: an analysis of the 1994–1996 BASE study data." *Indoor Air*, Dec 2000: 246–58.
62. ^ **a b c** Stanke D. 2006. "Explaining Science Behind Standard 62.1–2004". ASHRAE IAQ Applications, V7, Summer 2006. "Archived copy" (PDF). Archived from the original (PDF) on 14 July 2014. Retrieved 12 June 2014.cite web: CS1 maint: archived copy as title (link) accessed 11 June 2014
63. ^ Stanke, DA. 2007. "Standard 62.1–2004: Stricter or Not?" ASHRAE IAQ Applications, Spring 2006. "Archived copy" (PDF). Archived from the original (PDF) on 14 July 2014. Retrieved 12 June 2014.cite web: CS1 maint: archived copy as title (link) accessed 11 June 2014
64. ^ US EPA. Section 2: Factors Affecting Indoor Air Quality. "Archived copy" (PDF). Archived from the original (PDF) on 24 October 2008. Retrieved 30 April 2009.cite web: CS1 maint: archived copy as title (link)
65. ^ Belias, Evangelos; Licina, Dusan (2024). "European residential ventilation: Investigating the impact on health and energy demand". *Energy and Buildings.* **304** 113839. Bibcode:2024EneBu.30413839B. doi:10.1016/j.enbuild.2023.113839.

External links

[edit]

Ventilation (architecture) at Wikipedia's sister projects

-  not found or type unknown Definitions from Wiktionary
-  not found or type unknown Media from Commons
-  not found or type unknown News from Wikinews
-  not found or type unknown Quotations from Wikiquote

-  not found or type unknown Texts from Wikisource
-  not found or type unknown Textbooks from Wikibooks
-  not found or type unknown Resources from Wikiversity

Air Infiltration & Ventilation Centre (AIVC)

[edit]

- Publications from the Air Infiltration & Ventilation Centre (AIVC)

International Energy Agency (IEA) Energy in Buildings and Communities Programme (EBC)

[edit]

- Publications from the International Energy Agency (IEA) Energy in Buildings and Communities Programme (EBC) ventilation-related research projects-annexes:
 - EBC Annex 9 Minimum Ventilation Rates
 - EBC Annex 18 Demand Controlled Ventilation Systems
 - EBC Annex 26 Energy Efficient Ventilation of Large Enclosures
 - EBC Annex 27 Evaluation and Demonstration of Domestic Ventilation Systems
 - EBC Annex 35 Control Strategies for Hybrid Ventilation in New and Retrofitted Office Buildings (HYBVENT)
 - EBC Annex 62 Ventilative Cooling

International Society of Indoor Air Quality and Climate

[edit]

- Indoor Air Journal
- Indoor Air Conference Proceedings

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

[edit]

- ASHRAE Standard 62.1 – Ventilation for Acceptable Indoor Air Quality

- ASHRAE Standard 62.2 – Ventilation for Acceptable Indoor Air Quality in Residential Buildings
- v
- t
- e

Heating, ventilation, and air conditioning

**Fundamental
concepts**

- Air changes per hour (ACH)
- Bake-out
- Building envelope
- Convection
- Dilution
- Domestic energy consumption
- Enthalpy
- Fluid dynamics
- Gas compressor
- Heat pump and refrigeration cycle
- Heat transfer
- Humidity
- Infiltration
- Latent heat
- Noise control
- Outgassing
- Particulates
- Psychrometrics
- Sensible heat
- Stack effect
- Thermal comfort
- Thermal destratification
- Thermal mass
- Thermodynamics
- Vapour pressure of water

- Absorption-compression heat pump
- Absorption refrigerator
- Air barrier
- Air conditioning
- Antifreeze
- Automobile air conditioning
- Autonomous building
- Building insulation materials
- Central heating
- Central solar heating
- Chilled beam
- Chilled water
- Constant air volume (CAV)
- Coolant
- Cross ventilation
- Dedicated outdoor air system (DOAS)
- Deep water source cooling
- Demand controlled ventilation (DCV)
- Displacement ventilation
- District cooling
- District heating
- Electric heating
- Energy recovery ventilation (ERV)
- Firestop
- Forced-air
- Forced-air gas
- Free cooling
- Heat recovery ventilation (HRV)
- Hybrid heat
- Hydronics
- Ice storage air conditioning
- Kitchen ventilation
- Mixed-mode ventilation
- Microgeneration
- Passive cooling

Technology

- Air conditioner inverter
- Air door
- Air filter
- Air handler
- Air ionizer
- Air-mixing plenum
- Air purifier
- Air source heat pump
- Attic fan
- Automatic balancing valve
- Back boiler
- Barrier pipe
- Blast damper
- Boiler
- Centrifugal fan
- Ceramic heater
- Chiller
- Condensate pump
- Condenser
- Condensing boiler
- Convection heater
- Compressor
- Cooling tower
- Damper
- Dehumidifier
- Duct
- Economizer
- Electrostatic precipitator
- Evaporative cooler
- Evaporator
- Exhaust hood
- Expansion tank
- Fan
- Fan coil unit
- Fan filter unit

**Measurement
and control**

- Air flow meter
- Aquastat
- BACnet
- Blower door
- Building automation
- Carbon dioxide sensor
- Clean air delivery rate (CADR)
- Control valve
- Gas detector
- Home energy monitor
- Humidistat
- HVAC control system
- Infrared thermometer
- Intelligent buildings
- LonWorks
- Minimum efficiency reporting value (MERV)
- Normal temperature and pressure (NTP)
- OpenTherm
- Programmable communicating thermostat
- Programmable thermostat
- Psychrometrics
- Room temperature
- Smart thermostat
- Standard temperature and pressure (STP)
- Thermographic camera
- Thermostat
- Thermostatic radiator valve

Professions, trades, and services	<ul style="list-style-type: none"> ○ Architectural acoustics ○ Architectural engineering ○ Architectural technologist ○ Building services engineering ○ Building information modeling (BIM) ○ Deep energy retrofit ○ Duct cleaning ○ Duct leakage testing ○ Environmental engineering ○ Hydronic balancing ○ Kitchen exhaust cleaning ○ Mechanical engineering ○ Mechanical, electrical, and plumbing ○ Mold growth, assessment, and remediation ○ Refrigerant reclamation ○ Testing, adjusting, balancing ○ AHRI ○ AMCA ○ ASHRAE ○ ASTM International ○ BRE
Industry organizations	<ul style="list-style-type: none"> ○ BSRIA ○ CIBSE ○ Institute of Refrigeration ○ IIR ○ LEED ○ SMACNA ○ UMC
Health and safety	<ul style="list-style-type: none"> ○ Indoor air quality (IAQ) ○ Passive smoking ○ Sick building syndrome (SBS) ○ Volatile organic compound (VOC)

- ASHRAE Handbook
- Building science
- Fireproofing
- Glossary of HVAC terms
- Warm Spaces
- World Refrigeration Day
- Template:Fire protection
- Template:Home automation
- Template:Solar energy

See also

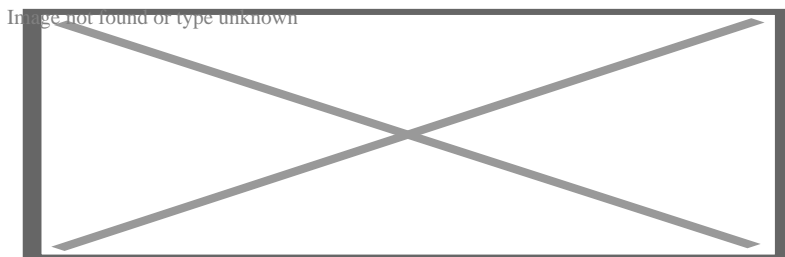
Authority control databases Image not found or type unknown
Edit this at Wikidata

National ○ Czech Republic

Other ○ NARA

About Sanitation

Not to be confused with Sanitization.

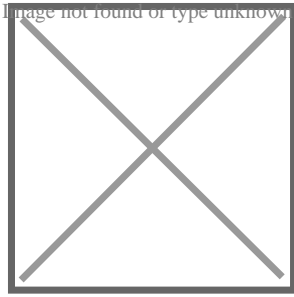


The sanitation system: collection, transport, treatment, disposal or reuse.

- v
- t
- e

Part of a series on

Public health



- Outline

Subfields

- Community health
- Dental public health
- Environmental health
- Epidemiology
- Health economics
- Health education
- Health promotion
- Health policy
- Health politics
- Mental health
- Occupational safety
- Rehabilitation (penology)
- Sexual and reproductive health
- Sanitation
- World health (Global health – International health)

Prevention

- Disease surveillance
- Harm reduction
- Health promotion (Behavior change)
- Health indicators
- Human right to water and sanitation
- Right to health
- Supervised injection site
- Universal health care

Lists and categories

- Terminology
- Journals
- National public health agencies

○  [Medicine portal](#) image/icon type unknown

○  [Society portal](#) image/icon type unknown

Sanitation refers to public health conditions related to clean drinking water and treatment and disposal of human excreta and sewage.^[1] Preventing human contact with feces is part of sanitation, as is hand washing with soap. Sanitation systems aim to protect human health by providing a clean environment that will stop the transmission of disease, especially through the fecal–oral route.^[2] For example, diarrhea, a main cause of malnutrition and stunted growth in children, can be reduced through adequate sanitation.^[3] There are many other diseases which are easily transmitted in communities that have low levels of sanitation, such as ascariasis (a type of intestinal worm infection or helminthiasis), cholera, hepatitis, polio, schistosomiasis, and trachoma, to name just a few.

A range of sanitation technologies and approaches exists. Some examples are community-led total sanitation, container-based sanitation, ecological sanitation, emergency sanitation, environmental sanitation, onsite sanitation and sustainable

sanitation. A sanitation system includes the capture, storage, transport, treatment and disposal or reuse of human excreta and wastewater.^[4] Reuse activities within the sanitation system may focus on the nutrients, water, energy or organic matter contained in excreta and wastewater. This is referred to as the "sanitation value chain" or "sanitation economy".^[5]^[6] The people responsible for cleaning, maintaining, operating, or emptying a sanitation technology at any step of the sanitation chain are called "sanitation workers".^[7]

Several sanitation "levels" are being used to compare sanitation service levels within countries or across countries.^[8] The sanitation ladder defined by the Joint Monitoring Programme in 2016 starts at open defecation and moves upwards using the terms "unimproved", "limited", "basic", with the highest level being "safely managed".^[8] This is particularly applicable to developing countries.

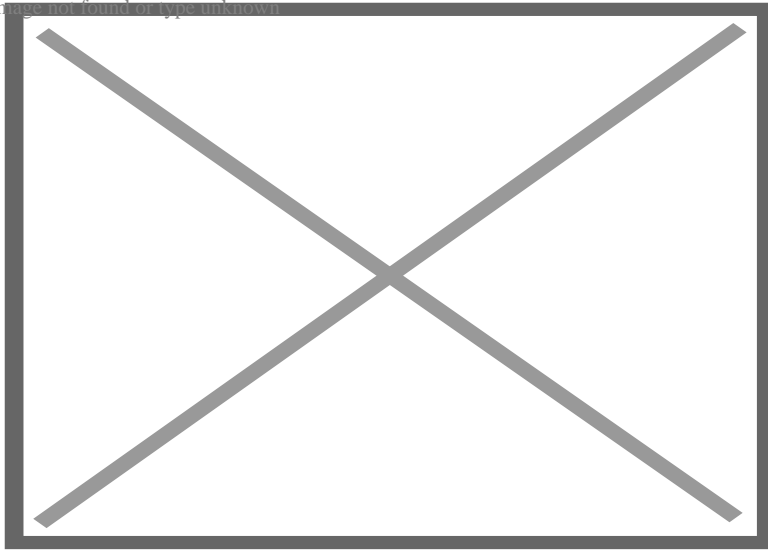
The Human right to water and sanitation was recognized by the United Nations General Assembly in 2010. Sanitation is a global development priority and the subject of Sustainable Development Goal 6.^[9] The estimate in 2017 by JMP states that 4.5 billion people currently do not have safely managed sanitation.^[9] Lack of access to sanitation has an impact not only on public health but also on human dignity and personal safety.

Definitions

[edit]

Animated video to underline the importance of sanitation (here with a focus on toilets) on public health in developing countries

Image not found or type unknown



Urban improved sanitation facilities versus rural improved sanitation facilities, 2015.^[10]

There are some variations on the use of the term "sanitation" between countries and organizations. The World Health Organization defines the term "sanitation" as follows:

"Sanitation generally refers to the provision of facilities and services for the safe disposal of human urine and faeces. The word 'sanitation' also refers to the maintenance of hygienic conditions, through services such as garbage collection and wastewater disposal."^[11]

Sanitation includes all four of these technical and non-technical systems: Excreta management systems, wastewater management systems (included here are wastewater treatment plants), solid waste management systems as well as drainage systems for rainwater, also called stormwater drainage.^[citation needed] However, many in the WASH sector only include excreta management in their definition of sanitation.

Another example of what is included in sanitation is found in the handbook by Sphere on "Humanitarian Charter and Minimum Standards in Humanitarian Response" which describes minimum standards in four "key response sectors" in humanitarian response situations. One of them is "Water Supply, Sanitation and Hygiene Promotion" (WASH) and it includes the following areas: Hygiene promotion, water supply, excreta

management, vector control, solid waste management and WASH in disease outbreaks and healthcare settings.^[12]

Hygiene promotion is seen by many as an integral part of sanitation. The Water Supply and Sanitation Collaborative Council defines sanitation as "The collection, transport, treatment and disposal or reuse of human excreta, domestic wastewater and solid waste, and associated hygiene promotion."^[13]

Despite the fact that sanitation includes wastewater treatment, the two terms are often used side by side as "sanitation and wastewater management".

Another definition is in the DFID guidance manual on water supply and sanitation programmes from 1998:^[14]

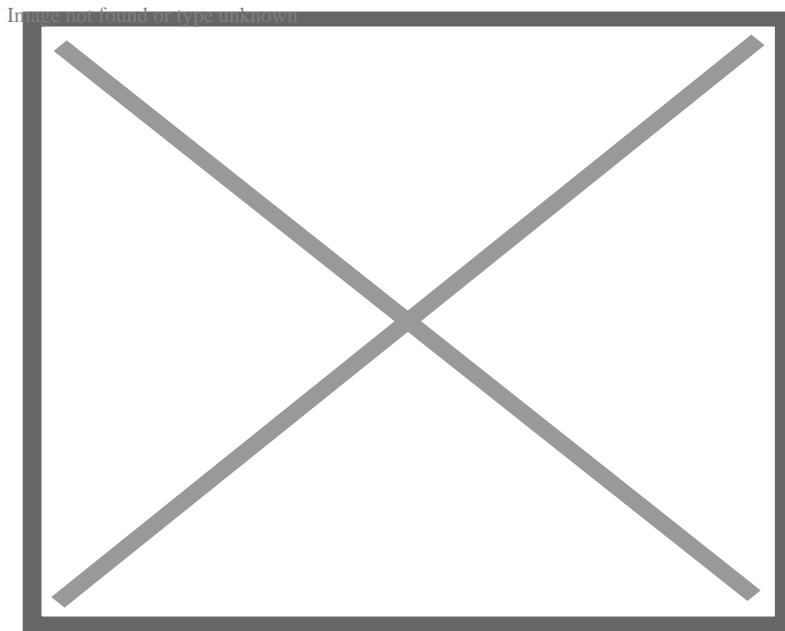
"For the purposes of this manual, the word 'sanitation' alone is taken to mean the safe management of human excreta. It therefore includes both the 'hardware' (e.g. latrines and sewers) and the 'software' (regulation, hygiene promotion) needed to reduce faecal-oral disease transmission. It encompasses too the re-use and ultimate disposal of human excreta. The term environmental sanitation is used to cover the wider concept of controlling all the factors in the physical environment which may have deleterious impacts on human health and well-being. In developing countries, it normally includes drainage, solid waste management, and vector control, in addition to the activities covered by the definition of sanitation."

Sanitation can include personal sanitation and public hygiene. Personal sanitation work can include handling menstrual waste, cleaning household toilets, and managing household garbage. Public sanitation work can involve garbage collection, transfer and treatment (municipal solid waste management), cleaning drains, streets, schools, trains, public spaces, community toilets and public toilets, sewers, operating sewage treatment plants, etc.^[15]

Workers who provide these services for other people are called sanitation workers.

Purposes

[edit]



Access to safe drinking water and sanitation (2016)

The overall purposes of sanitation are to provide a healthy living environment for everyone, to protect the natural resources (such as surface water, groundwater, soil), and to provide safety, security and dignity for people when they defecate or urinate.^[citation needed]

The Human Right to Water and Sanitation was recognized by the United Nations (UN) General Assembly in 2010.^{[16][17][18]} It has been recognized in international law through human rights treaties, declarations and other standards. It is derived from the human right to an adequate standard of living.^[19]

Effective sanitation systems provide barriers between excreta and humans in such a way as to break the disease transmission cycle (for example in the case of fecal-borne diseases).^[20] This aspect is visualised with the F-diagram where all major routes of fecal-oral disease transmission begin with the letter F: feces, fingers, flies, fields, fluids, food.^[21]

Sanitation infrastructure has to be adapted to several specific contexts including consumers' expectations and local resources available.^[citation needed]

Sanitation technologies may involve centralized civil engineering structures like sewer systems, sewage treatment, surface runoff treatment and solid waste landfills. These structures are designed to treat wastewater and municipal solid waste. Sanitation technologies may also take the form of relatively simple onsite sanitation systems. This can in some cases consist of a simple pit latrine or other type of non-flush toilet for the excreta management part.

Providing sanitation to people requires attention to the entire system, not just focusing on technical aspects such as the toilet, fecal sludge management or the wastewater treatment plant.^[22] The "sanitation chain" involves the experience of the user, excreta and wastewater collection methods, transporting and treatment of waste, and reuse or disposal. All need to be thoroughly considered.^[22]

Economic impacts

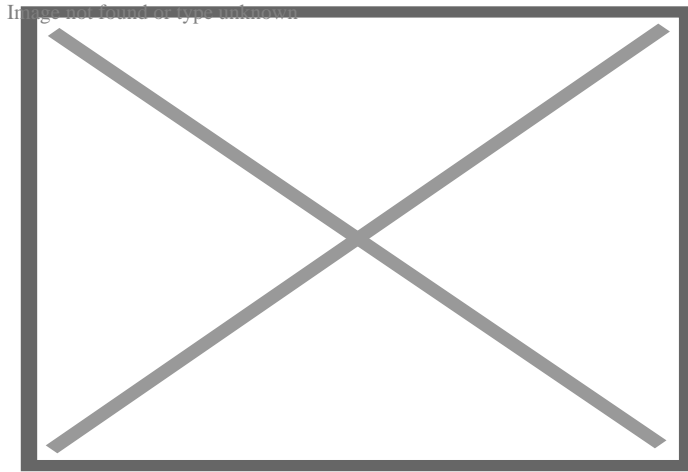
[edit]

The benefits to society of managing human excreta are considerable, for public health as well as for the environment. As a rough estimate: For every US\$1 spent on sanitation, the return to society is US\$5.50.^[23]

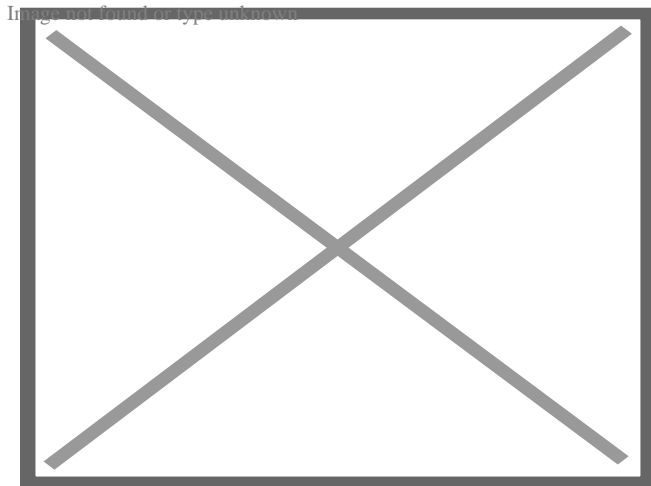
For developing countries, the economic costs of inadequate sanitation is a huge concern. For example, according to a World Bank study, economic losses due to inadequate sanitation to The Indian economy are equivalent to 6.4% of its GDP.^[24] Most of these are due to premature mortality, time lost in accessing, loss of productivity, additional costs for healthcare among others.^[24] Inadequate sanitation also leads to loss from potential tourism revenue.^[24] This study also found that impacts are disproportionately higher for the poor, women and children. Availability of toilet at home on the other hand, positively contributes to economic well-being of women as it leads to an increase in literacy and participation in labor force.^[25]

Types and concepts (for excreta management)

[edit]



Percentage of population served by different types of sanitation systems[26]



Example of sanitation infrastructure: Shower, double-vault urine-diverting dry toilet (UDDT) and waterless urinal in Lima, Peru

The term sanitation is connected with various descriptors or adjectives to signify certain types of sanitation systems (which may deal only with human excreta management or with the entire sanitation system, i.e. also greywater, stormwater and solid waste management) – in alphabetical order:

Basic sanitation

[edit]

In 2017, JMP defined a new term: "basic sanitation service". This is defined as the use of improved sanitation facilities that are not shared with other households. A lower level of service is now called "limited sanitation service" which refers to use of improved sanitation facilities that are shared between two or more households.^[9]

Container-based sanitation

[edit]

This section is an excerpt from Container-based sanitation.^[edit]

Container-based sanitation (abbreviated as CBS) refers to a sanitation system where toilets collect human excreta in sealable, removable containers (also called cartridges) that are transported to treatment facilities.^[27] This type of sanitation involves a commercial service which provides certain types of portable toilets, and delivers empty containers when picking up full ones. The service transports and safely disposes of or reuses collected excreta. The cost of collection of excreta is usually borne by the users. With suitable development, support and functioning partnerships, CBS can be used to provide low-income urban populations with safe collection, transport and treatment of excrement at a lower cost than installing and maintaining sewers.^[28] In most cases, CBS is based on the use of urine-diverting dry toilets.

Community-based sanitation

[edit]

Community-based sanitation is related to decentralized wastewater treatment (DEWATS).^[citation needed]

Community-led total sanitation

[edit]

This section is an excerpt from Community-led total sanitation.[edit]

Dry sanitation

[edit]

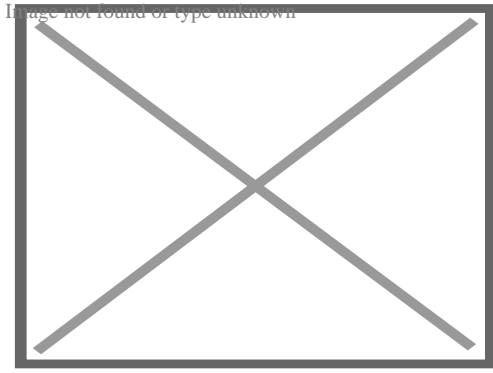
The term "dry sanitation" is not in widespread use and is not very well defined. It usually refers to a system that uses a type of dry toilet and no sewers to transport excreta. Often when people speak of "dry sanitation" they mean a sanitation system that uses urine-diverting dry toilet (UDDTs).[²⁹][³⁰]

Ecological sanitation

[edit]

This section is an excerpt from Ecological sanitation.[edit]

Ecological sanitation, commonly abbreviated as ecosan (also spelled eco-san or EcoSan), is an approach to sanitation provision which aims to safely reuse excreta in agriculture.[³¹] It is an approach, rather than a technology or a device which is characterized by a desire to "close the loop", mainly for the nutrients and organic matter between sanitation and agriculture in a safe manner. One of the aims is to minimise the use of non-renewable resources. When properly designed and operated, ecosan systems provide a hygienically safe system to convert human excreta into nutrients to be returned to the soil, and water to be returned to the land. Ecosan is also called resource-oriented sanitation.



Emergency pit lining kits by Evenproducts

Emergency sanitation

[edit]

This section is an excerpt from Emergency sanitation.[edit]

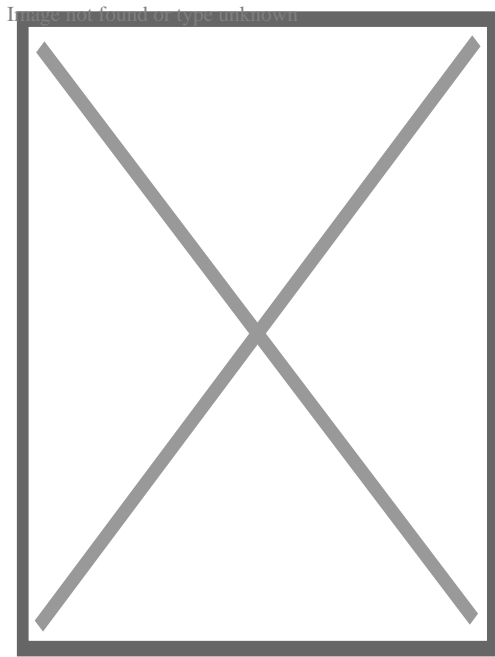
Emergency sanitation is the management and technical processes required to provide sanitation in emergency situations. Emergency sanitation is required during humanitarian relief operations for refugees, people affected by natural disasters and internally displaced persons.^[32] There are three phases of emergency response: Immediate, short term and long term.^[32] In the immediate phase, the focus is on managing open defecation, and toilet technologies might include very basic latrines, pit latrines, bucket toilets, container-based toilets, chemical toilets. The short term phase might also involve technologies such as urine-diverting dry toilets, septic tanks, decentralized wastewater systems. Providing handwashing facilities and management of fecal sludge are also part of emergency sanitation.

Environmental sanitation

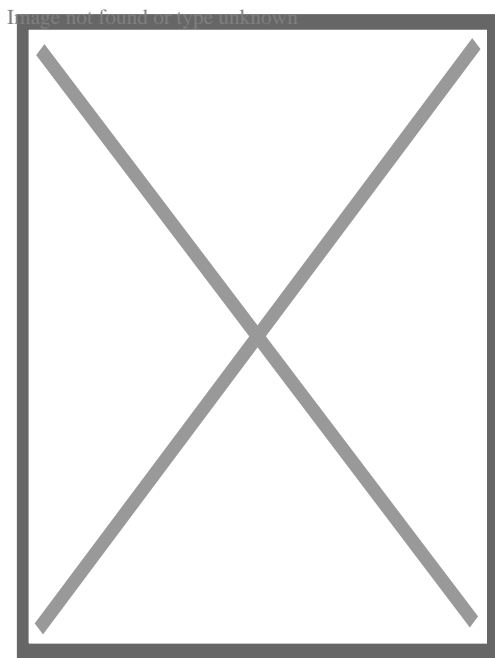
[edit]

Environmental sanitation encompasses the control of environmental factors that are connected to disease transmission. Subsets of this category are solid waste management, water and wastewater treatment, industrial waste treatment and noise pollution control. According to World health organization (WHO) Environmental

sanitation was defined as the control of all those factors in the physical environment which exercise a harmful effect on human being physical development, health and survival. One of the primary function of environmental sanitation is to protect public health.^[citation needed]



Environmental sanitation by an NGO member



A clean exercise organized by an NGO

Fecal sludge management

[edit]

This section is an excerpt from Fecal sludge management.[edit]

Fecal sludge management (FSM) (or faecal sludge management in British English) is the storage, collection, transport, treatment and safe end use or disposal of fecal sludge.^[33] Together, the collection, transport, treatment and end use of fecal sludge constitute the "value chain" or "service chain" of fecal sludge management. Fecal sludge is defined very broadly as what accumulates in onsite sanitation systems (e.g. pit latrines, septic tanks and container-based solutions) and specifically is not transported through a sewer. It is composed of human excreta, but also anything else that may go into an onsite containment technology, such as flushwater, cleansing materials (e.g. toilet paper and anal cleansing materials), menstrual hygiene products, grey water (i.e. bathing or kitchen water, including fats, oils and grease), and solid waste. Fecal sludge that is removed from septic tanks is called septage.

Improved and unimproved sanitation

[edit]

This section is an excerpt from Improved sanitation.[edit]

Improved sanitation (related to but distinct from a "safely managed sanitation service") is a term used to categorize types of sanitation for monitoring purposes. It refers to the management of human feces at the household level. The term was coined by the Joint Monitoring Program (JMP) for Water Supply and Sanitation of UNICEF and WHO in 2002 to help monitor the progress towards Goal Number 7 of the Millennium Development Goals (MDGs). The opposite of "improved sanitation" has been termed "unimproved sanitation" in the JMP definitions. The same terms are used to monitor progress towards Sustainable Development Goal 6 (Target 6.2, Indicator 6.2.1) from 2015 onwards.^[34] Here, they are a component of the definition for "safely managed sanitation service".

Lack of sanitation

[edit]

Lack of sanitation refers to the absence of sanitation. In practical terms it usually means lack of toilets or lack of hygienic toilets that anybody would want to use voluntarily. The result of lack of sanitation is usually open defecation (and open urination but this is of less concern) with associated serious public health issues.^[35] It is estimated that 2.4 billion people still lacked improved sanitation facilities including 660 million people who lack access to safe drinking water as of 2015.^{[36][37]}

Onsite sanitation or non-sewered sanitation system

[edit]

Onsite sanitation (or on-site sanitation) is defined as "a sanitation system in which excreta and wastewater are collected and stored or treated on the plot where they are generated".^[22] Another term that is used for the same system is non-sewered sanitation systems (NSSS), which are prevalent in many countries.^[38] NSSS play a vital role in the safe management of fecal sludge, accounting for approximately half of all existing sanitation provisions.^[38] The degree of treatment may be variable, from none to advanced. Examples are pit latrines (no treatment) and septic tanks (primary treatment of wastewater). On-site sanitation systems are often connected to fecal sludge management (FSM) systems where the fecal sludge that is generated onsite is treated at an offsite location. Wastewater (sewage) is only generated when piped water supply is available within the buildings or close to them.^[citation needed]

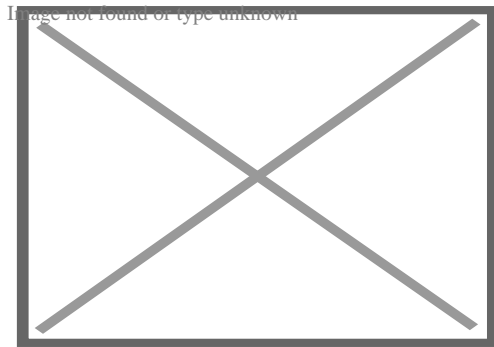
A related term is a decentralized wastewater system which refers in particular to the wastewater part of on-site sanitation. Similarly, an onsite sewage facility can treat the wastewater generated locally.^[citation needed]

The global methane emissions from NSSS in 2020 was estimated to as 377 Mt CO₂e per year or 4.7% of global anthropogenic methane emissions, which are comparable to

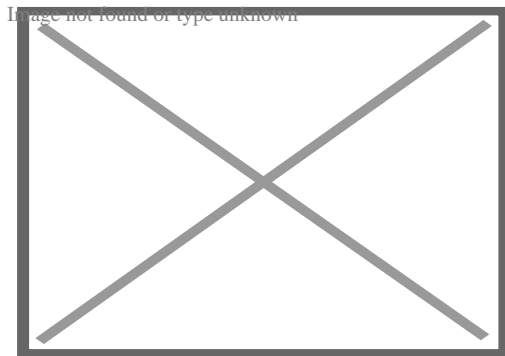
the greenhouse gas emissions from wastewater treatment plants.^[38] This means that the GHG emissions from the NSSS as a non-negligible source.^[38]

Safely managed sanitation

[edit]



Share of population using safely managed sanitation facilities in 2022^[39]



Number of handwashing facilities in the world, 2022

Safely managed sanitation is the highest level of household sanitation envisioned by the Sustainable Development Goal Number 6.^[40] It is measured under the Sustainable Development Goal 6.2, Indicator 6.2.1, as the "Proportion of population using (a) safely managed sanitation services and (b) a hand-washing facility with soap and water".^[41]^[9] The current value in the 2017 baseline estimate by JMP is that 4.5 billion people currently do not have safely managed sanitation.^[9]

Safely managed sanitation is defined as an improved sanitation facility which is not shared with other households, and where the excreta produced is either treated and disposed in situ, stored temporarily and then emptied and transported to treatment

off-site, or transported through a sewer with wastewater and then treated off-site.^[41]
In other words, safely managed sanitation is a basic sanitation service where in addition excreta are safely disposed of in situ or transported and treated offsite.^[9]

Sustainable sanitation

[edit]

This section is an excerpt from Sustainable sanitation.^[edit]

Sustainable sanitation is a sanitation system designed to meet certain criteria and to work well over the long-term. Sustainable sanitation systems consider the entire "sanitation value chain", from the experience of the user, excreta and wastewater collection methods, transportation or conveyance of waste, treatment, and reuse or disposal.^[42] The Sustainable Sanitation Alliance (SuSanA) includes five features (or criteria) in its definition of "sustainable sanitation": Systems need to be economically and socially acceptable, technically and institutionally appropriate and protect the environment and natural resources.^[43]

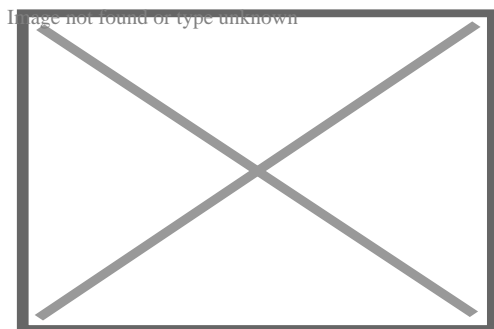
Other types, concepts and systems

[edit]

Wastewater management

[edit]

Main articles: Wastewater and Wastewater treatment



Sewage treatment plant, Australia.

Wastewater management consists of collection, wastewater treatment (be it municipal or industrial wastewater), disposal or reuse of treated wastewater. The latter is also referred to as water reclamation.^[*citation needed*]

Sanitation systems in urban areas of developed countries usually consist of the collection of wastewater in gravity driven sewers, its treatment in wastewater treatment plants for reuse or disposal in rivers, lakes or the sea.^[*citation needed*]

In developing countries most wastewater is still discharged untreated into the environment. Alternatives to centralized sewer systems include onsite sanitation, decentralized wastewater systems, dry toilets connected to fecal sludge management.

Stormwater drainage

[edit]

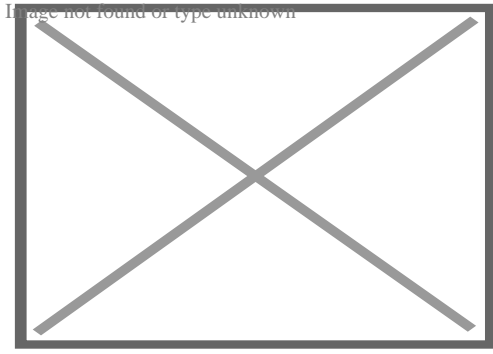
Main article: Storm drain

Sewers are either combined with storm drains or separated from them as sanitary sewers. Combined sewers are usually found in the central, older parts or urban areas. Heavy rainfall and inadequate maintenance can lead to combined sewer overflows or sanitary sewer overflows, i.e., more or less diluted raw sewage being discharged into the environment. Industries often discharge wastewater into municipal sewers, which can complicate wastewater treatment unless industries pre-treat their discharges.^[⁴⁴]

Solid waste disposal

[edit]

Main article: Waste management



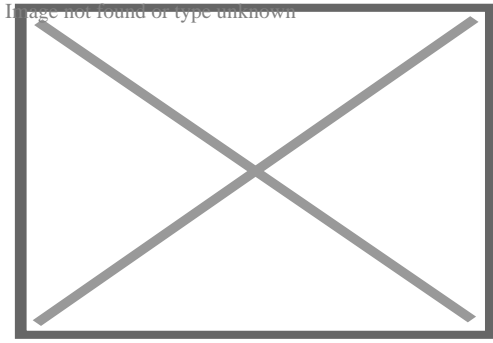
Hiriya Landfill, Israel.

Disposal of solid waste is most commonly conducted in landfills, but incineration, recycling, composting and conversion to biofuels are also avenues. In the case of landfills, advanced countries typically have rigid protocols for daily cover with topsoil, where underdeveloped countries customarily rely upon less stringent protocols.^[45] The importance of daily cover lies in the reduction of vector contact and spreading of pathogens. Daily cover also minimizes odor emissions and reduces windblown litter. Likewise, developed countries typically have requirements for perimeter sealing of the landfill with clay-type soils to minimize migration of leachate that could contaminate groundwater (and hence jeopardize some drinking water supplies).

For incineration options, the release of air pollutants, including certain toxic components is an attendant adverse outcome. Recycling and biofuel conversion are the sustainable options that generally have superior lifecycle costs, particularly when total ecological consequences are considered.^[46] Composting value will ultimately be limited by the market demand for compost product.^[citation needed]

Food safety

[edit]



Modern restaurant food preparation area.

Main article: Food safety

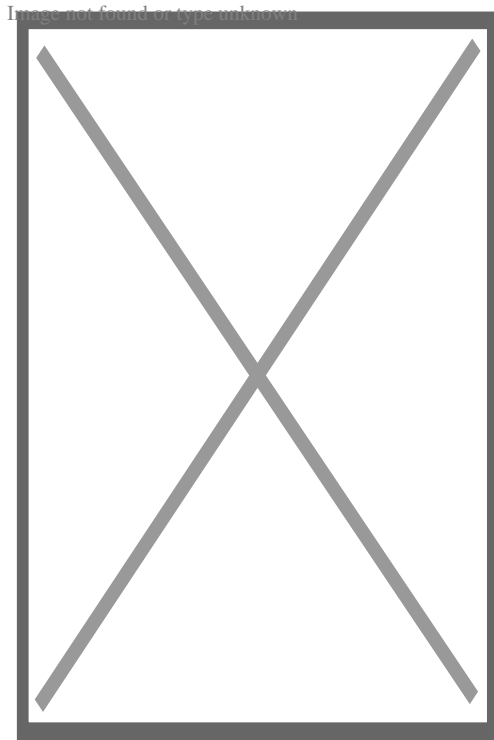
Sanitation within the food industry means the adequate treatment of food-contact surfaces by a process that is effective in destroying vegetative cells of microorganisms of public health significance, and in substantially reducing numbers of other undesirable microorganisms, but without adversely affecting the food or its safety for the consumer (U.S. Food and Drug Administration, Code of Federal Regulations, 21CFR110, USA). Sanitation Standard Operating Procedures are mandatory for food industries in United States. Similarly, in Japan, food hygiene has to be achieved through compliance with food sanitation law.^[47]

In the food and biopharmaceutical industries, the term "sanitary equipment" means equipment that is fully cleanable using clean-in-place (CIP) and sterilization-in-place (SIP) procedures: that is fully drainable from cleaning solutions and other liquids. The design should have a minimum amount of deadleg, or areas where the turbulence during cleaning is insufficient to remove product deposits.^[48] In general, to improve cleanability, this equipment is made from Stainless Steel 316L, (an alloy containing small amounts of molybdenum). The surface is usually electropolished to an effective surface roughness of less than 0.5 micrometre to reduce the possibility of bacterial adhesion.

Hygiene promotion

[edit]

Further information: Hygiene



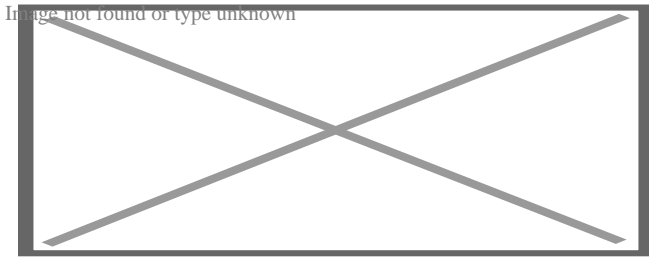
Hygiene education (on proper handwashing) in Afghanistan

In many settings, provision of sanitation facilities alone does not guarantee good health of the population. Studies have suggested that the impact of hygiene practices have as great an impact on sanitation related diseases as the actual provision of sanitation facilities. Hygiene promotion is therefore an important part of sanitation and is usually key in maintaining good health.^[49]

Hygiene promotion is a planned approach of enabling people to act and change their behavior in an order to reduce and/or prevent incidences of water, sanitation and hygiene (WASH)^[50] related diseases. It usually involves a participatory approach of engaging people to take responsibility of WASH services and infrastructure including its operation and maintenance. The three key elements of promoting hygiene are; mutual sharing of information and knowledge, the mobilization of affected communities and the provision of essential material and facilities.^[12]

Health aspects

[edit]



The "F-diagram" (feces, fingers, flies, fields, fluids, food), showing pathways of fecal-oral disease transmission. The vertical blue lines show barriers: toilets, safe water, hygiene and handwashing.

A video shedding light on the unsafe and undignified working conditions of many sanitation workers in India

Main article: WASH § Health aspects

This section is an excerpt from WASH § WASH-attributable burden of diseases and injuries.[edit]

The WHO has investigated which proportion of death and disease worldwide can be attributed to insufficient WASH services. In their analysis they focus on the following four health outcomes: diarrhea, acute respiratory infections, malnutrition, and soil-transmitted Helminthiasis (STHs).^[51] These health outcomes are also included as an indicator for achieving Sustainable Development Goal 3 ("Good Health and Well-being"): Indicator 3.9.2 reports on the "mortality rate attributed to unsafe water, sanitation, and lack of hygiene".

In 2023, WHO summarized the available data with the following key findings: "In 2019, use of safe WASH services could have prevented the loss of at least 1.4 million lives and 74 million disability-adjusted life years (DALYs) from four health outcomes. This represents 2.5% of all deaths and 2.9% of all DALYs globally."^[51] Of the four health outcomes studied, it was diarrheal disease that had the most striking correlation, namely the highest number of "attributable burden of disease": over 1 million deaths and 55 million DALYs from diarrheal diseases were linked with lack of WASH. Of these deaths, 564,000 deaths were linked to unsafe sanitation in particular.

Environmental aspects

[edit]

Indicator organisms

[edit]

When analyzing environmental samples, various types of indicator organisms are used to check for fecal pollution of the sample. Commonly used indicators for bacteriological water analysis include the bacterium *Escherichia coli* (abbreviated as *E. coli*) and non-specific fecal coliforms. With regards to samples of soil, sewage sludge, biosolids or fecal matter from dry toilets, helminth eggs are a commonly used indicator. With helminth egg analysis, eggs are extracted from the sample after which a viability test is done to distinguish between viable and non viable eggs. The viable fraction of the helminth eggs in the sample is then counted.

Climate change

[edit]

Main article: WASH § Climate change aspects

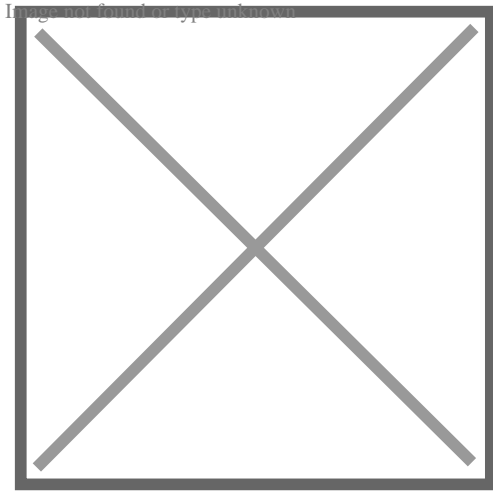
Global mechanisms

[edit]

Sustainable Development Goal Number 6

[edit]

Further information: Sustainable Development Goal 6



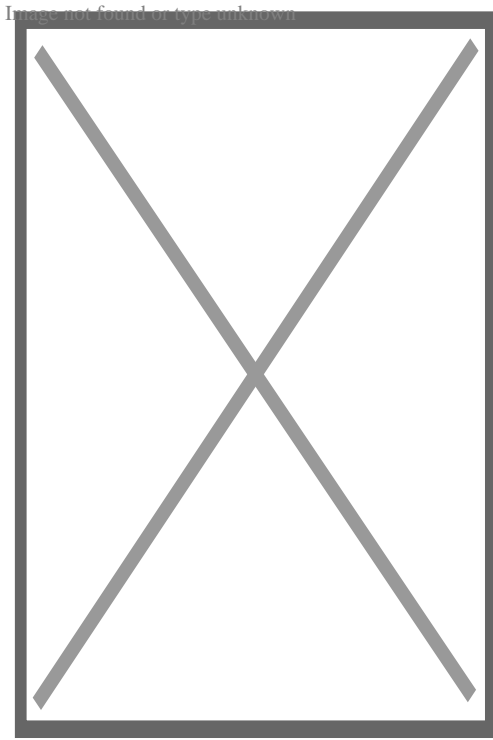
United Nations SDG 6 Logo

In the year 2016, the Sustainable Development Goals replaced the Millennium Development Goals. Sanitation is a global development priority and included Sustainable Development Goal 6 (SDG 6).^[9] The target is about "clean water and sanitation for all" by 2030.^[52] It is estimated that 660 million people still lacked access to safe drinking water as of 2015.^[36]^[37]

Since the COVID-19 pandemic in 2020, the fight for clean water and sanitation is more important than ever. Handwashing is one of the most common prevention methods for Coronavirus, yet two out of five people do not have access to a hand-washing station.^[53]

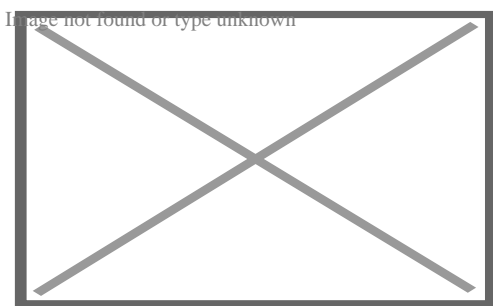
Millennium Development Goal Number 7 until 2015

[edit]



Example for lack of sanitation: Unhygienic pit latrine with ring slab in Kalibari community in Mymensingh, Bangladesh

The United Nations, during the Millennium Summit in New York in 2000 and the 2002 World Summit on Sustainable Development in Johannesburg, developed the Millennium Development Goals (MDGs) aimed at poverty eradication and sustainable development. The specific sanitation goal for the year 2015 was to reduce by half the number of people who had no access to potable water and sanitation in the baseline year of 1990. As the JMP and the United Nations Development Programme (UNDP) Human Development Report in 2006 has shown, progress meeting the MDG sanitation target is slow, with a large gap between the target coverage and the current reality.



Modified logo of International Year of Sanitation, used in the UN Drive to 2015 campaign logo

In December 2006, the United Nations General Assembly declared 2008 "The International Year of Sanitation", in recognition of the slow progress being made towards the MDGs sanitation target.^[54] The year aimed to develop awareness and more actions to meet the target.

There are numerous reasons for this gap. A major one is that sanitation is rarely given political attention received by other topics despite its key importance. Sanitation is not high on the international development agenda, and projects such as those relating to water supply projects are emphasised.^[55]

The Joint Monitoring Programme for Water Supply and Sanitation of WHO and UNICEF (JMP) has been publishing reports of updated estimates every two years on the use of various types of drinking-water sources and sanitation facilities at the national, regional and global levels. The JMP report for 2015 stated that:^[36]

- Between 1990 and 2015, open defecation rates have decreased from 38% to 25% globally. Just under one billion people (946 million) still practise open defecation worldwide in 2015.
- 82% of the global urban population, and 51% of the rural population is using improved sanitation facilities in 2015, as per the JMP definition of "improved sanitation".^[56]

Initiatives to promote sanitation

[edit]

In 2011 the Bill & Melinda Gates Foundation launched the "Reinvent the Toilet Challenge" to promote safer, more effective ways to treat human waste.^[57] The program is aimed at developing technologies that might help bridge the global sanitation gap (for example the Omni Processor, or technology for fecal sludge management). In 2015, the Bill & Melinda Gates Foundation published their "Water, sanitation, and hygiene strategy portfolio update and overview" called "Building demand for sanitation".^[58]

The latest innovations in the field of public health sanitation, currently in the testing phase, comprise – use of 'locally produced alcohol-based hand rub'; 'novel latrine improvement'; and 'container-based sanitation'. Centers for Disease Control and Prevention (CDC), the national public health agency of the United States has recognized the stated three initiatives.

Capacity development

[edit]

Capacity development is regarded as an important mechanism to achieve progress in the sanitation sector.^[59] For example, in India the Sanitation Capacity Building platform (SCBP) was designed to "support and build the capacity of town/cities to plan and implement decentralized sanitation solutions" with funding by the Bill & Melinda Gates Foundation from 2015 to 2022.^{[60][61]} Results from this project showed that capacity development best happens on the job and in a learning organization culture.^[62] In a government capacity development initiative, it is critical to have an enabling policy and program funding to translate capacity development input into program and infrastructure outputs. Capacity development aims to empower staff and institutions, develop a learning strategy, learning content and training modules, as well as strengthened partnerships and institutions of learning.^[62] The Capacity Development Effectiveness Ladder Framework (CDEL) identifies five critical steps for capacity development interventions: Developing original learning content, partnerships for learning and outreach, learning strategy, visioning change and designing solutions, contribution to capacity development discourse.^{[62][63]}

Costs

[edit]

A study was carried out in 2018 to compare the lifecycle costs of full sanitation chain systems in developing cities of Africa and Asia. It found that conventional sewer systems are in most cases the most expensive sanitation options, followed, in order of

cost, by sanitation systems comprising septic tanks, ventilated improved pit latrines (VIP), urine diversion dry toilets and pour-flush pit latrines.^[64] The main determinants of urban sanitation financial costs include: Type of technology, labour, material and utility cost, density, topography, level of service provided by the sanitation system, soil condition, energy cost and others (distance to wastewater treatment facility, climate, end-use of treatment products, business models, water table height).^[64]

Some grassroots organizations have trialled community-managed toilet blocks whose construction and maintenance costs can be covered by households. One study of Mumbai informal settlements found that US\$1.58 per adult would be sufficient for construction, and less than US\$1/household/month would be sufficient for maintenance.^[65]

History

[edit]

Further information: History of water supply and sanitation, Toilet § History, and History of waste management

Major human settlements could initially develop only where fresh surface water was plentiful, such as near rivers or natural springs. Throughout history people have devised systems to get water into their communities and households, and to dispose (and later also treat) wastewater.^[66] The focus of sewage treatment at that time was on conveying raw sewage to a natural body of water, e.g. a river or ocean, where it would be diluted and dissipated.

The Sanitation in the Indus Valley Civilization in Asia is an example of public water supply and sanitation during the Bronze Age (3300–1300 BCE). Sanitation in ancient Rome was quite extensive. These systems consisted of stone and wooden drains to collect and remove wastewater from populated areas—see for instance the Cloaca Maxima into the River Tiber in Rome. The first sewers of ancient Rome were built between 800 and 735 BCE.^[67]

By country

[edit]

- v
- t
- e

Water supply and sanitation by country

- Afghanistan
- Algeria
- Angola
- Argentina
- Australia
- Azerbaijan
- Bangladesh
- Belgium
- Belize
- Benin
- Bhutan
- Bolivia
- Bosnia and Herzegovina
- Brazil
- Burkina Faso
- Cambodia
- Canada
- Chile
- China
- Colombia
- Costa Rica
- Cuba
- Democratic Republic of the Congo
- Denmark
- Dominican Republic
- Ecuador
- Egypt
- El Salvador
- Ethiopia
- France
- Georgia
- Germany
- Ghana
- Greece
- Grenada

Society and culture

[edit]

There is a vast number of professions that are involved in the field of sanitation, for example on the technical and operations side: sanitation workers, waste collectors, sanitary engineers.

See also

[edit]

- List of abbreviations used in sanitation
- List of countries by proportion of the population using improved sanitation facilities
- List of water supply and sanitation by country
- Environmental health
- Water pollution
- Water security
- Self-supply of water and sanitation
- Sustainable Sanitation Alliance
- World Toilet Day

References


[edit]

1. [^] *"sanitation | Definition of sanitation in English by Oxford Dictionaries". Oxford Dictionaries | English. Archived from the original on November 17, 2017. Retrieved 2017-11-17.*
2. [^] SuSanA (2008). Towards more sustainable sanitation solutions Archived 2017-10-12 at the Wayback Machine. Sustainable Sanitation Alliance (SuSanA)
3. [^] *"Diarrhoeal disease". World Health Organization. Archived from the original on 2014-04-01. Retrieved 2017-11-17.*
4. [^] Gates Foundation (2010). *"Water Sanitation Hygiene Fact Sheet 2010" (PDF)*. Gates Foundation. Archived (PDF) from the original on 2020-10-21. Retrieved 2017-11-17.

5. ^ *Paranipe, Nitin (19 September 2017). "The rise of the sanitation economy: how business can help solve a global crisis". Thomson Reuters Foundation News. Archived from the original on 29 December 2019. Retrieved November 13, 2017.*
6. ^ *Introducing the Sanitation Economy (PDF). Toilet Board Coalition. 2017. Archived (PDF) from the original on 2018-07-31. Retrieved 2017-12-19.*
7. ^ World Bank, ILO, WaterAid, and WHO (2019). Health, Safety and Dignity of Sanitation Workers: An Initial Assessment Archived 2022-12-11 at the Wayback Machine. World Bank, Washington, DC.
8. ^ **a b** "Sanitation | JMP". *washdata.org*. Archived from the original on 2021-07-21. Retrieved 2017-11-17.
9. ^ **a b c d e f g** WHO and UNICEF (2017) Progress on Drinking Water, Sanitation and Hygiene: 2017 Update and SDG Baselines Archived 2019-07-25 at the Wayback Machine. Geneva: World Health Organization (WHO) and the United Nations Children's Fund (UNICEF), 2017
10. ^ *"Urban sanitation facilities vs. rural sanitation facilities". Our World in Data. Archived from the original on 19 September 2020. Retrieved 6 March 2020.*
11. ^ *"Sanitation". Health topics. World Health Organization. Archived from the original on 2020-06-06. Retrieved 2020-10-05.*
12. ^ **a b** Sphere Association (2018) The Sphere Handbook: Humanitarian Charter and Minimum Standards in Humanitarian Response Archived 2019-05-12 at the Wayback Machine, fourth edition, Geneva, Switzerland, 2018.
13. ^ Evans, B., van der Voorden, C., Peal, A. (2009). Public Funding for Sanitation – The many faces of sanitation subsidies Archived 2017-10-11 at the Wayback Machine. Water Supply and Sanitation Collaborative Council (WSSCC), Geneva, Switzerland, p. 35
14. ^ WELL (1998) DFID guidance manual on water supply and sanitation programmes Archived 2022-01-20 at the Wayback Machine WELL Loughborough University UK
15. ^ PRIA (2019): Lived Realities of Women Sanitation Workers in India: Insights from a Participatory Research Conducted in Three Cities of India Archived 2022-12-11 at the Wayback Machine. Participatory Research in Asia, New Delhi, India
16. ^ *"General Assembly" (PDF). Archived (PDF) from the original on 2017-03-19. Retrieved 2019-11-25.*

17. ^ Human Rights Council resolution 15/9, *Human rights and access to safe drinking water and sanitation*, (6 October 2010), available from <http://www.right2water.eu/sites/water/files/UNHRC%20Resolution%2015-9.pdf>
Archived 2017-05-17 at the Wayback Machine
18. ^ *"The human rights to safe drinking water and sanitation". Archived from the original (PDF) on 2017-08-25. Retrieved 2019-11-25.*
19. ^ Right to water and sanitation derive from the right to an adequate standard of living.
<http://www.ohchr.org/EN/NewsEvents/Pages/DisplayNews.aspx?NewsID=10403&LangID=>
Archived 2022-03-06 at the Wayback Machine
20. ^ Thor Axel Stenström (2005) Breaking the sanitation barriers; WHO Guidelines for excreta use as a baseline for environmental health Archived 2008-11-22 at the Wayback Machine, Ecosan Conference, Durban, South Africa
21. ^ Conant, Jeff (2005). *Sanitation and Cleanliness for a Healthy Environment (PDF)*. Berkeley, California, USA: The Hesperian Foundation in collaboration with the United Nations Development Programme (UNDP), Sida. p. 6. Archived from the original (PDF) on 2014-10-21.
22. ^ **a b c** Tilley, E., Ulrich, L., Lüthi, C., Reymond, Ph. and Zurbrügg, C. (2014). Compendium of Sanitation Systems and Technologies. 2nd Revised Edition Archived 2021-08-28 at the Wayback Machine. Swiss Federal Institute of Aquatic Science and Technology (Eawag), Duebendorf, Switzerland
23. ^ WWAP (United Nations World Water Assessment Programme) (2017). *The United Nations World Water Development Report 2017. Wastewater: The Untapped Resource*. Paris. ISBN 978-92-3-100201-4. Archived from the original on 2017-04-08.cite book: CS1 maint: location missing publisher (link)
24. ^ **a b c** WSP (2011). *The economic Impacts of Inadequate Sanitation in India*. Water and Sanitation Programme, The World Bank.
25. ^ Gius, Mark; Subramanian, Ramesh (2015). "The Relationship between Inadequate Sanitation Facilities and the Economic Well-Being of Women in India". *Journal of Economics and Development Studies*. **3** (1). doi:10.15640/jeds.v3n1a2 (inactive 12 July 2025). ISSN 2334-2382.cite journal: CS1 maint: DOI inactive as of July 2025 (link)
26. ^ WWAP (United Nations World Water Assessment Programme) (2017). *The United Nations World Water Development Report 2017. Wastewater: The Untapped Resource*. Paris. ISBN 978-92-3-100201-4. Archived from the original on 2017-04-

08.cite book: CS1 maint: location missing publisher (link)

27. ^ Tilmans, Sebastien; Russel, Kory; Sklar, Rachel; Page, Leah; Kramer, Sasha; Davis, Jennifer (2015-04-13). "Container-based sanitation: assessing costs and effectiveness of excreta management in Cap Haitien, Haiti". *Environment and Urbanization*. **27** (1): 89–104. Bibcode:2015EnUrb..27...89T. doi:10.1177/0956247815572746. PMC 4461065. PMID 26097288.
28. ^ Shepard, J.; Stevens, C.; Mikhael, G. (2017). *The world can't wait for sewers; Advancing container-based sanitation businesses as a viable answer to the global sanitation crisis*. EY, WSUP.
29. ^ Platzer, C., Hoffmann, H., Ticona, E. (2008). Alternatives to waterborne sanitation – a comparative study – limits and potentials Archived 2017-10-09 at the Wayback Machine. IRC Symposium: Sanitation for the urban poor – partnerships and governance, Delft, The Netherlands
30. ^ Flores, A. (2010). *Towards sustainable sanitation: evaluating the sustainability of resource-oriented sanitation* Archived 2017-06-29 at the Wayback Machine. PhD Thesis, University of Cambridge, UK
31. ^ GTZ, IWA (2003). *Ecosan - closing the loop - Proceedings of the 2nd international symposium, 7th–11th April 2003, Lübeck, Germany*. Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH and International Water Association (IWA).
32. ^ a b Harvey, Peter; et al. (2007). *Excreta disposal in emergencies a field manual: an inter-agency publication*. Loughborough: Loughborough university. Water, engineering and development centre (WEDC). p. 250. ISBN 978-1-84380-113-9.
33. ^ Velkushanova, Konstantina; Strande, Linda; Ronteltap, Mariska; Koottatep, Thammarat; Brdjanovic, Damir; Buckley, Chris, eds. (2021). *Methods for Faecal Sludge Analysis*. IWA Publishing. doi:10.2166/9781780409122. ISBN 978-1780409122.  Text was copied from this source, which is available under a Creative Commons Attribution 4.0 International License.
34. ^ WHO and UNICEF (2017) Progress on Drinking Water, Sanitation and Hygiene: 2017 Update and SDG Baselines. Geneva: World Health Organization (WHO) and the United Nations Children's Fund (UNICEF), 2017
35. ^ Mara, Duncan (2017). "The elimination of open defecation and its adverse health effects: a moral imperative for governments and development professionals". *Journal of Water Sanitation and Hygiene for Development*. **7** (1): 1–12. Bibcode:2017JWSHD...7....1M. doi:10.2166/washdev.2017.027. ISSN 2043-9083. Archived from the original on 2018-06-21. Retrieved 2017-08-17.

36. ^ **a b c** WHO and UNICEF *Progress on Sanitation and Drinking-water: 2015 Update Archived 2021-02-12 at the Wayback Machine*, WHO, Geneva and UNICEF, New York
37. ^ **a b** European Investment Bank (2019). *On Water*. Publications Office. doi:10.2867/509830. ISBN 9789286143199. Archived from the original on 2020-11-29. Retrieved 2020-12-07. cite book: |website= ignored (help)
38. ^ **a b c d** Cheng, Shikun; Long, Jinyun; Evans, Barbara; Zhan, Zhe; Li, Tianxin; Chen, Cong; Mang, Heinz-Peter; Li, Zifu (2022). "Non-negligible greenhouse gas emissions from non-sewered sanitation systems: A meta-analysis". *Environmental Research*. **212** (Pt D): 113468. Bibcode:2022ER....21213468C. doi:10.1016/j.envres.2022.113468. PMC 9227720. PMID 35597295.  Text was copied from this source, which is available under a Creative Commons Attribution 4.0 International License Archived 2017-10-16 at the Wayback Machine
39. ^ Ritchie, Roser, Mispy, Ortiz-Ospina (2018) "Measuring progress towards the Sustainable Development Goals." (SDG 6) Archived 2020-11-01 at the Wayback Machine *SDG-Tracker.org, website*
40. ^ "JMP - Sanitation". *washdata.org*. Joint Monitoring Programme of UNICEF and WHO. Archived from the original on 21 July 2021. Retrieved 25 February 2021.
41. ^ **a b** "Indicator 6.2.1 - Proportion of population using safely managed sanitation services, including a handwashing facility with soap and water". *sdg6monitoring.org*. UN Water. Archived from the original on 3 March 2021. Retrieved 25 February 2021.
42. ^ Tilley, E., Ulrich, L., Lüthi, C., Reymond, Ph. and Zurbrügg, C. (2014). *Compendium of Sanitation Systems and Technologies*. 2nd Revised Edition. Swiss Federal Institute of Aquatic Science and Technology (Eawag), Duebendorf, Switzerland
43. ^ SuSanA (2008). *Towards more sustainable sanitation solutions – SuSanA Vision Document*. Sustainable Sanitation Alliance (SuSanA)
44. ^ *Environmental Biotechnology: Advancement in Water And Wastewater Application*, edited by Z. Ujang, IWA Proceedings, Malaysia (2003)
45. ^ George Tchobanoglous and Frank Kreith *Handbook of Solid Waste Management*, McGraw Hill (2002)
46. ^ William D. Robinson, *The Solid Waste Handbook: A Practical Guide*, John Wiley and sons (1986)

47. ^ Japan External Trade Organization. "Food Sanitation Law in Japan" (PDF). Archived from the original (PDF) on 9 April 2008. Retrieved 1 March 2008.
48. ^ Treatment of deadleg plumbing areas
49. ^ Reed, Brian; Bevan, Jane (2014). *Managing hygiene promotion in WASH programmes*. Leicestershire, UK: Water, Engineering and Development Centre (WEDC), Loughborough University. ISBN 978-1-84380-168-9.
50. ^ "2021 water, sanitation and hygiene barometer" (PDF). SOLIDARITÉS INTERNATIONAL. 2021. Archived (PDF) from the original on 2021-03-25. Retrieved 2021-04-13.
51. ^ **a b** WHO (2023) Burden of disease attributable to unsafe drinking-water, sanitation and hygiene, 2019 update. Geneva: World Health Organization; 2023. Licence: CC BY-NC-SA 3.0 IGO.
52. ^ "Goal 6: Ensure access to water and sanitation for all". Archived from the original on 2019-04-16. Retrieved 2017-11-17.
53. ^ UN. "Water and Sanitation". United Nations Sustainable Development. Archived from the original on 2019-04-16. Retrieved 2021-01-04.
54. ^ Kurian, Mathew; McCarney, Patricia, eds. (2010). *Peri-urban Water and Sanitation Services*. Springer. doi:10.1007/978-90-481-9425-4. ISBN 978-90-481-9424-7. Archived from the original on 2022-12-11. Retrieved 2017-09-11.
55. ^ Abellán, Javier; Alonso, José Antonio (2022). "Promoting global access to water and sanitation: A supply and demand perspective". *Water Resources and Economics* . **38** 100194. Bibcode:2022WRE....3800194A. doi:10.1016/j.wre.2022.100194. S2CID 246261266.
56. ^ WHO and UNICEF types of improved drinking-water source on the JMP website, WHO, Geneva and UNICEF, New York, accessed on June 10, 2012
57. ^ BMGF (2012). Reinvent the Toilet Challenge Archived 2022-11-11 at the Wayback Machine (RTTC, Round 1 and 2), Grand Challenges Explorations (Round 6 and 7) – Request for proposals, grant conditions, Seattle exhibition fair program and exhibitor guide. Bill & Melinda Gates Foundation, Seattle, USA
58. ^ BMGF (2015). Building demand for sanitation – a 2015 portfolio update and overview – Water, sanitation, and hygiene strategy Archived 2022-11-12 at the Wayback Machine, June 2015. Bill & Melinda Gates Foundation, Seattle, Washington, USA
59. ^ Spuhler, D., McCreary, C., Fogde, M., Jenssen, P. D. (2012). Capacity development for sustainable sanitation – Factsheet of Working Group 1 Archived

- 2022-08-13 at the Wayback Machine. Sustainable Sanitation Alliance (SuSanA)
60. ^ "About SCBP | SCBP". *www.niua.org*. Archived from the original on 2021-08-03. Retrieved 2021-06-09.
 61. ^ Kapur, D. (2020) UNDERSTANDING EFFECTIVENESS OF CAPACITY DEVELOPMENT: Lessons from Sanitation Capacity Building Platform, Part 1: Journey of Urban Sanitation Capacity Development in India Archived 2022-01-19 at the Wayback Machine, National Institute of Urban Affairs (NIUA), India
 62. ^ **a b c** Kapur, D. (2021) UNDERSTANDING EFFECTIVENESS OF CAPACITY DEVELOPMENT : Lessons from Sanitation Capacity Building Platform (SCBP), Part III : Capacity Development Effectiveness Ladder (CDEL) Framework Archived 2022-01-20 at the Wayback Machine, NATIONAL INSTITUTE OF URBAN AFFAIRS, India
 63. ^ Jyoti Dash and Depinder Kapur (2021) UNDERSTANDING EFFECTIVENESS OF CAPACITY DEVELOPMENT : Lessons from Sanitation Capacity Building Platform (SCBP) Part II : Sanitation Capacity Building Platform: Understanding the Process and Effectiveness Archived 2021-09-20 at the Wayback Machine
 64. ^ **a b** Daudey, Loïc (2018). "The cost of urban sanitation solutions: a literature review". *Journal of Water Sanitation and Hygiene for Development*. **8** (2): 176–195. Bibcode:2018JWSHD...8..176D. doi:10.2166/washdev.2017.058. ISSN 2043-9083.
 65. ^ Patel, Sheela (2015-04-01). "The 20-year sanitation partnership of Mumbai and the Indian Alliance". *Environment and Urbanization*. **27** (1): 55–72. Bibcode:2015EnUrb..27...55P. doi:10.1177/0956247815569698. ISSN 0956-2478. S2CID 110444813.
 66. ^ "The Art of Plumbing as Recorded through History". *www.academia.edu*. Archived from the original on 2020-04-09. Retrieved 2016-03-10.
 67. ^ Farnsworth Gray, Harold. "Sewerage in Ancient and Mediaeval Times." *Sewage Works Journal* Vol.12.5 (1940): 939–46

External links

[edit]

 Image not found or type unknown

Look up ***sanitation*** in Wiktionary, the free dictionary.

-  Media related to Sanitation at Wikimedia Commons

- Sustainable Sanitation Alliance
- Sanitation and Wastewater Atlas of Africa
- Florence Nightingale (1863), *Sanitary Statistics of Native Colonial Schools and Hospitals*

- v
- t
- e

Public health

- Auxology
- Biological hazard
- Chief medical officer
- Cultural competence
- Deviance
- Environmental health
- Eugenics
 - History of
 - Liberal
- Euthenics
- Genomics
- Globalization and disease
- Harm reduction
- Health economics
- Health literacy
- Health policy
 - Health system
 - Health care reform
- Housing First
- Human right to water and sanitation
- Management of depression
 - Public health law
 - National public health institute
- Health politics
- Labor rights
- Maternal health
- Medical anthropology
- Medical sociology
- Mental health (Ministers)
- Occupational safety and health
- Pharmaceutical policy
- Pollution
 - Air
 - Water
 - Soil

General

**Preventive
healthcare**

- Behavior change
 - Theories
- Drug checking
- Family planning
- Harm reduction
- Health promotion
- Human nutrition
 - Healthy diet
 - Preventive nutrition
- Hygiene
 - Food safety
 - Hand washing
 - Infection control
 - Oral hygiene
- Needle and syringe programmes
- Occupational safety and health
 - Human factors and ergonomics
 - Hygiene
 - Controlled Drugs
 - Injury prevention
 - Medicine
 - Nursing
- Patient safety
 - Organization
- Pharmacovigilance
- Reagent testing
- Safe sex
- Sanitation
 - Emergency
 - Fecal–oral transmission
 - Open defecation
 - Sanitary sewer
 - Waterborne diseases
 - Worker
- School hygiene

- Biostatistics
 - Child mortality
 - Community health
 - Epidemiology
 - Global health
 - Health impact assessment
 - Health system
- Population health**
 - Infant mortality
 - Open-source healthcare software
 - Multimorbidity
 - Public health informatics
 - Social determinants of health
 - Commercial determinants of health
 - Health equity
 - Race and health
 - Social medicine
 - Case-control study
 - Randomized controlled trial
 - Relative risk
- Biological and epidemiological statistics**
 - Statistical hypothesis testing
 - Analysis of variance (ANOVA)
 - Regression analysis
 - ROC curve
 - Student's *t*-test
 - *Z*-test
 - Statistical software

**Infectious and
epidemic
disease
prevention**

- Asymptomatic carrier
- Epidemics
 - List
- Notifiable diseases
 - List
- Public health surveillance
 - Disease surveillance
- Quarantine
- Sexually transmitted infection
- Social distancing
- Tropical disease
- Vaccine trial
- WASH
- Food

**Food hygiene
and
safety
management**

- Additive
- Chemistry
- Engineering
- Microbiology
- Processing
- Safety
- Safety scandals
- Good agricultural practice
- Good manufacturing practice
 - HACCP
 - ISO 22000

**Health
behavioral
sciences**

- Diffusion of innovations
- Health belief model
- Health communication
- Health psychology
- Positive deviance
- PRECEDE–PROCEED model
- Social cognitive theory
- Social norms approach
- Theory of planned behavior
- Transtheoretical model

Organizations

- Caribbean
 - Caribbean Public Health Agency
- China
 - Center for Disease Control and Prevention
- Europe
 - Centre for Disease Prevention and Control
 - Committee on the Environment, Public Health and Food Safety
- Russia
 - Rospotrebnadzor
- India
 - Ministry of Health and Family Welfare
- Canada
 - Health Canada
 - Public Health Agency
- U.S.
 - Centers for Disease Control and Prevention
 - Health departments in the United States
 - Council on Education for Public Health
 - Public Health Service
- World Health Organization
- World Toilet Organization
- (Full list)
- Health education
- Higher education

Education

- Bachelor of Science in Public Health
- Doctor of Public Health
- Professional degrees of public health
- Schools of public health
- History of public health in the United Kingdom
- History of public health in the United States
- History of public health in Australia
- Sara Josephine Baker

**Organizations,
education
and history**

-  **Category**
-  **Commons**
-  **WikiProject**

Authority control databases  **Edit this at Wikidata**

- National**
 - Germany
 - United States
 - Israel
- Other**
 - NARA
 - Yale LUX

Clean Restroom Rentals

Phone : +18889350009

Email : info@cleanrestrooms.com

City : Manassas

State : VA

Zip : 20111

Address : Historic District, 8193-B Euclid Ct

Google Business Profile

Company Website : <https://restroomrentalsvirginia.com/product/porta-potty-rental/>

Sitemap

Privacy Policy

About Us

Follow us