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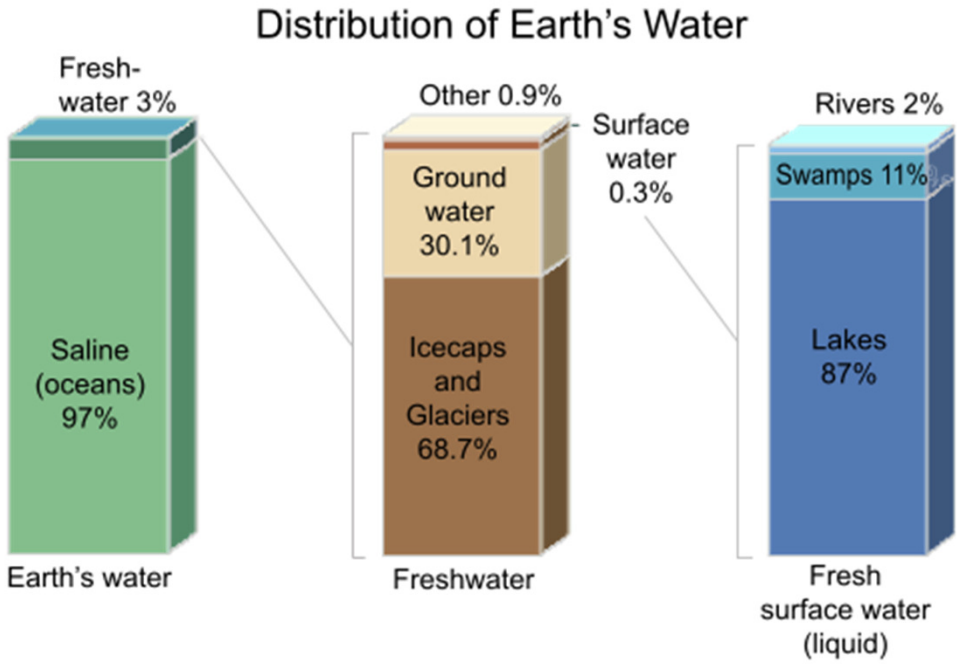
Water and Waste Water processes.

- Water – from Source to Sink
- Waste Water – from Sink to Soil
- Typical Municipal loss scenarios

Water Sources
Considered Raw Water or Non Potable



Potable Water

- Drinking water is water that is of sufficiently high quality so that it can be consumed or used without risk of immediate or long term harm. Such water is commonly called **potable water.**

- Basic household water requirements have been estimated at around 100 gallons per person per day, excluding water for gardens.

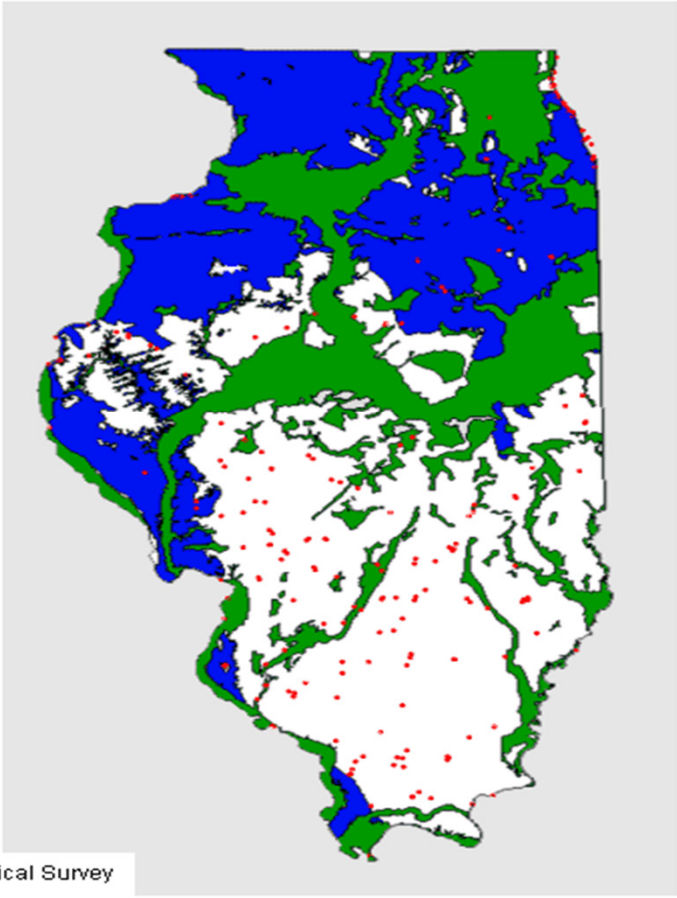
Sources of Illinois Potable Water

Water Resources

Surface Water Intakes
(public water supply)

Sand/gravel aquifers

Bedrock aquifers within 300 feet of land surface



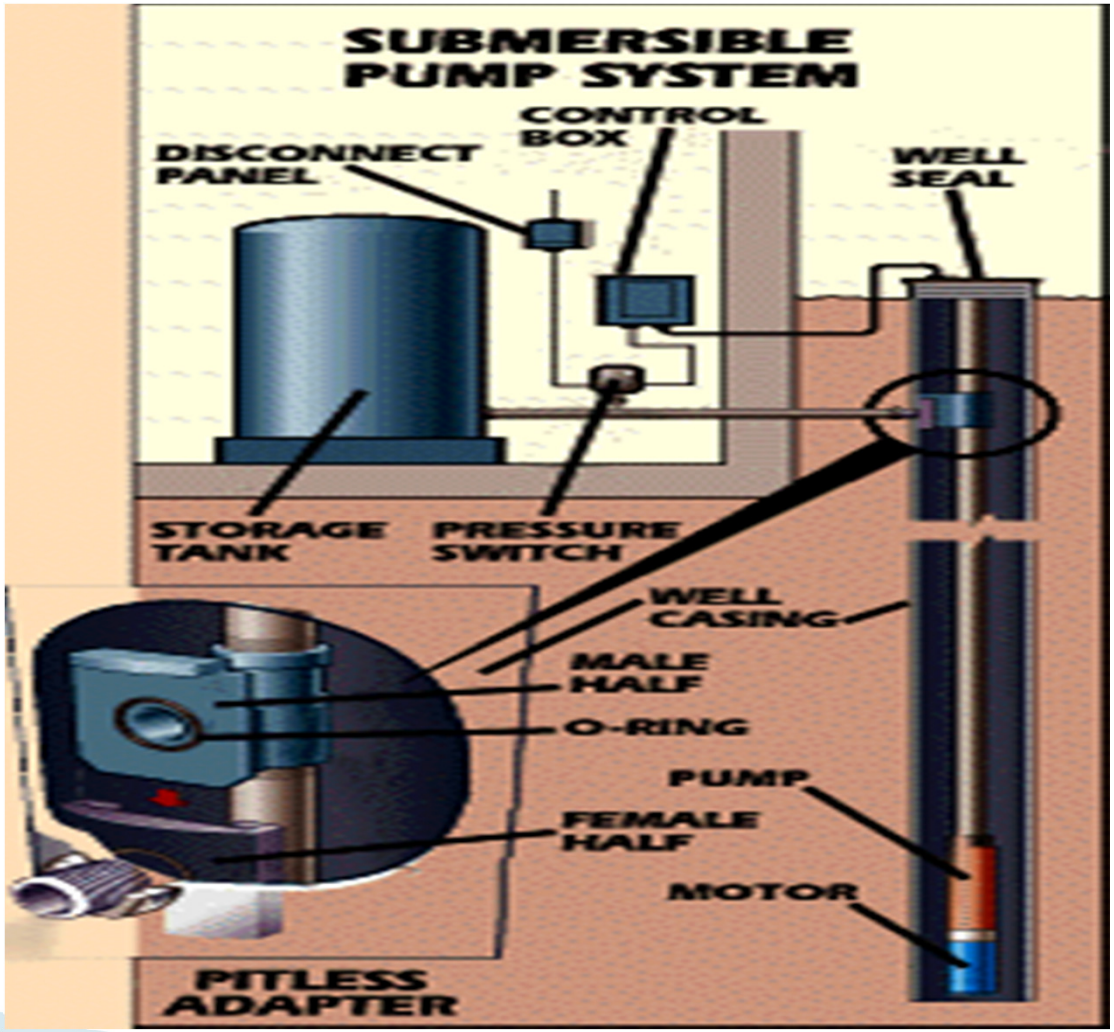
Source for aquifer boundaries, Illinois State Geological Survey

Accessing water from Wells

- **Jet Pumps**
- Jet pumps work on suction mechanism and as a general rule can only elevate water 25 feet and therefore are often referred to as shallow well pumps. External jet pumps are:
  - more energy efficient.
  - more user friendly, maintainable (as it is fixed outside)
  - and cost effective option for water pumps for wells.

- **Submersible Pumps**
- Submersible pumps are better choice for deep wells.
  - No risk of cavitations (sucking air)
  - Typically more expensive to purchase, install and maintain.

Submersible Pump



Submersible Pump Parts

SUBMERSIBLE

Applications

Features

1 Discharge Pipe
Properly sized for optimum water velocities to insure peak hydraulic performance.

2 Discharge Bowl
Several discharge sizes available for NPT or flanged pipe.

3 Discharge Bearing
Extra long top protected bronze bearing insures positive shaft alignment and stabilization for extended life.

4 Intermediate Bowl
Glass lined cast iron standard 6" through 15" size for maximum efficiency and abrasion resistance.

5 Impellers
Designed for maximum efficiency with wide range hydraulic coverage. Precision balanced for smooth operation.

6 Upthrust Washer
Designed for extra margin of safety against possible momentary upthrust occurring at startup.

7 Intermediate Bowl Bearings
Reliable long life bronze or rubber bearing.

8 Taper Lock
Accurately machined to insure positive locking of impeller to pump shaft.

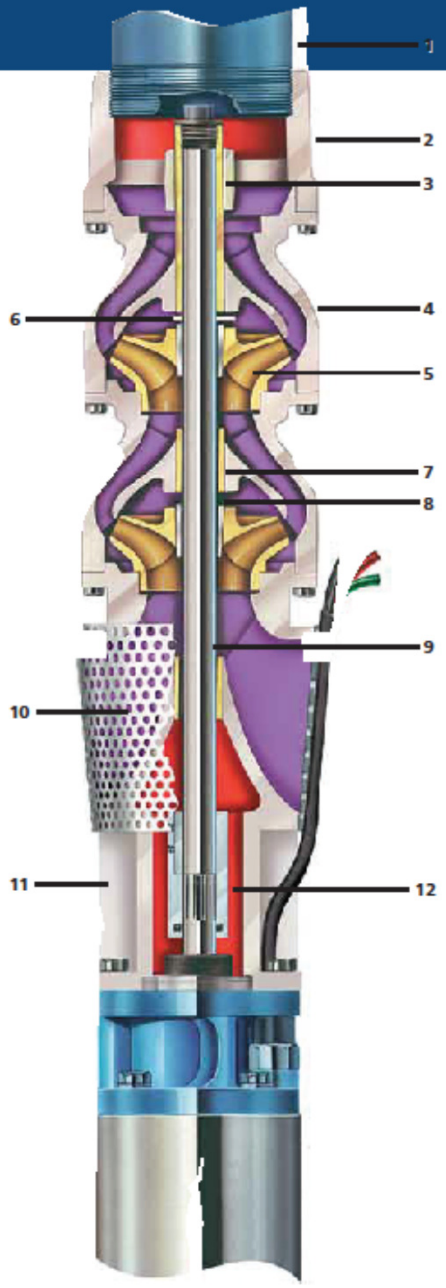
9 Pump Shaft
100,000 PSI high tensile stainless steel provides strength and excellent corrosion resistance. Ground and polished for smooth bearing surface.

10 Suction Inlet
Contoured for smooth flow entrance. Protected by an oversized stainless steel strainer to prevent entrance of damaging solids.

11 Suction Adapter
Ductile iron provides for increased strength and positive motor alignment. Open area permits easy access to pump/motor coupling.

12 Pump/Motor Coupling
Large stainless steel coupling accurately machined for perfect alignment, balance and power transmission.

Submersible pumps and motors provide an extensive list of options versus other deep well pumping equipment systems. Advanced engineering designs and experience assure units for long term pumping service. Water well applications provide the perfect opportunity to evaluate features and benefits of submersible equipment.



Accessing Water from Surface Source

from lake, rivers and reservoirs

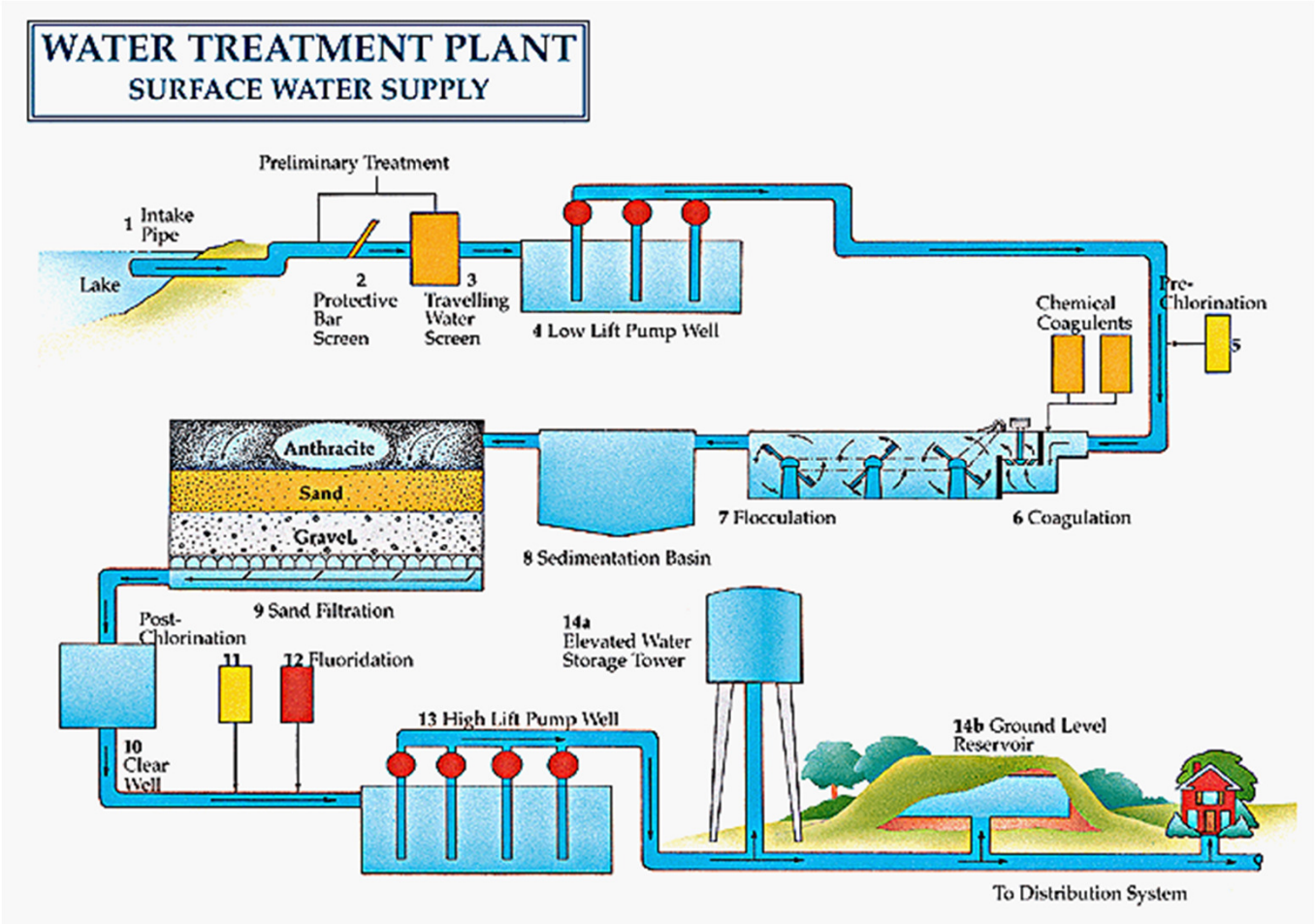
- Surface system are designed based on the distance volume and terrain between the source and treatment plant.
- Untreated drinking water may be transferred using uncovered ground-level aqueducts, covered tunnels or underground water pipes flowing in conjunction with pumps and/or gravity.

Water Treatment Process

The process of converting raw water to drinking water
Water supply providers can be either public, private, mixed or cooperative.

- Coagulation – the addition of chemicals to add weight to particulates in the water.
- Flocculation – the grouping of solids in the water
- Filter – removing the solids
- Disinfection – Destruction of pathogens in water
- Storage – water towers
- Supply

Water Treatment Process



Pressurized Delivery

- Water pressures vary in different locations of a distribution system.
- Water mains below the street may operate at higher pressures, with a pressure reducer located at each point where the water enters a building or a house.
- In poorly managed systems, water pressure can be so low as to result only in a trickle of water or so high that it leads to damage to plumbing fixtures and waste of water.
- Pressure in an urban water system is typically maintained either by a pressurized water tank serving an urban area, by pumping the water up into a tower and relying on gravity to maintain a constant pressure in the system or solely by pumps at the water treatment plant and repeater pumping stations.

Water Towers

Create Pressure and Allow for Storage

Water towers are tall to provide pressure. Each foot of height provides 0.43 PSI (pounds per square Inch) of pressure. A typical municipal water supply runs at between 50 and 100 PSI (major appliances require at least 20 to 30 PSI).

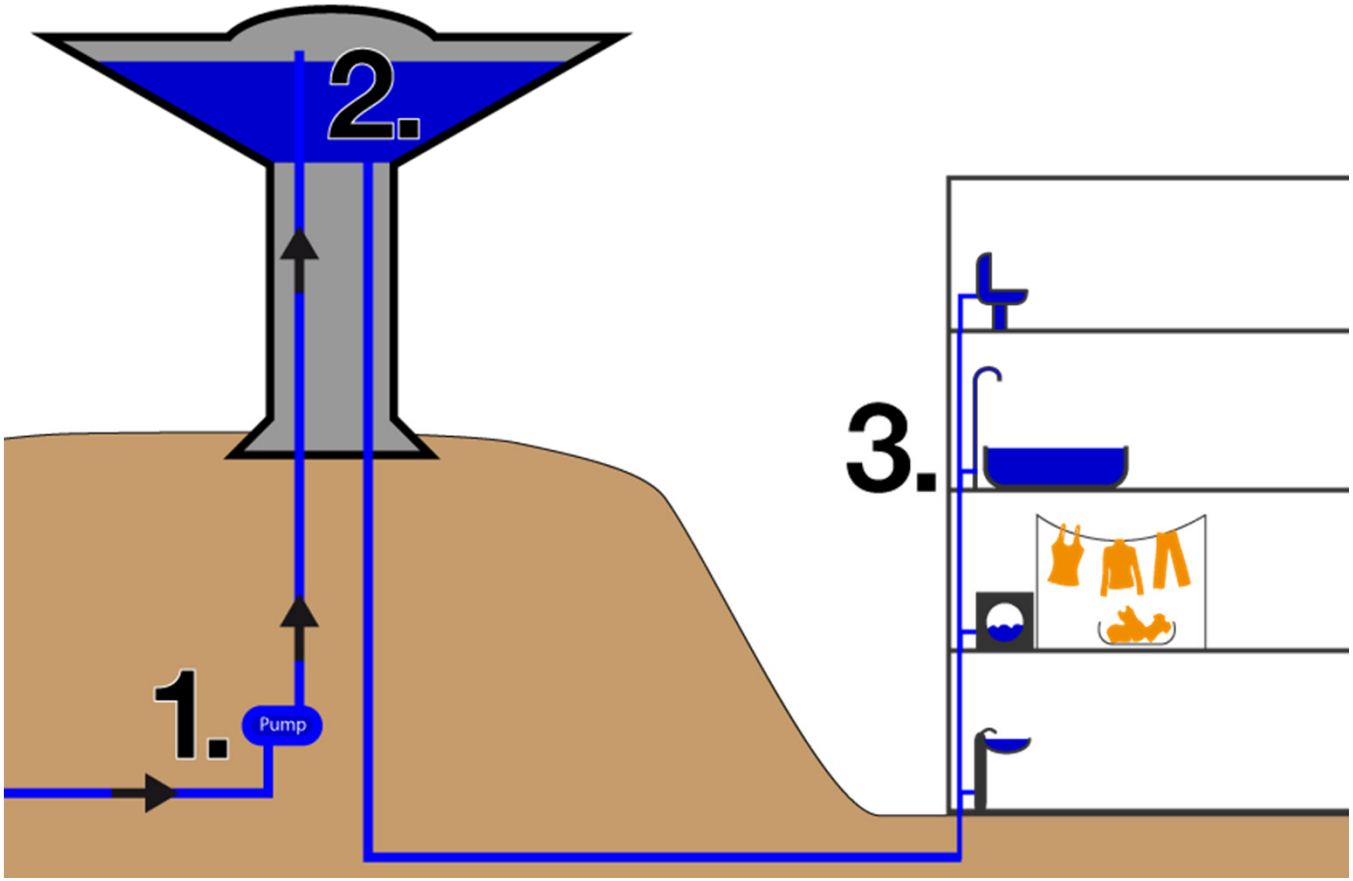
Multiple Column Tank

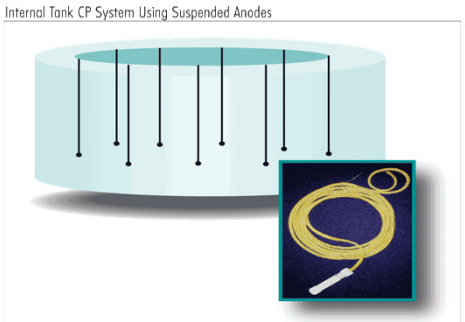
Single Pedestal Tank

Reservoir Tank

- Types of Towers – reservoir or pedestal tank.
- Types of material –
  - 1.)Steel welded tanks replaced riveted tanks by 1950(s) – greater design options.
  - 2.) Factory Bolted tanks – limited designs

How Water Towers Operate





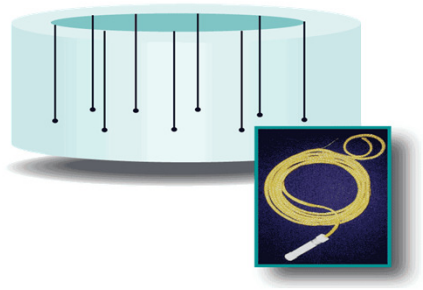
Cathodic Protection

- As with any steel structure, corrosion is an ever present concern. The effects of corrosion on storage tanks include premature failures and disruptions in service during repairs. Cathodic protection (CP), however, stops the corrosion reaction when properly applied.

- Steel naturally reacts with water and oxygen releasing energy and returning to its more stable chemical state, iron oxide. When this oxidation/reduction reaction occurs to steel we call it corrosion. To understand and prevent corrosion, it is important to understand the reaction process.

- The rate of the corrosion reaction is a function of current flow with one amp of current consuming approximately 20 pounds of steel in one year. Thus milliamps of electrical current over several years can have a devastating impact on the tank bottoms, side walls and the roof of steel storage tanks. Left unprotected, storage tanks can fail quickly as the result of these corrosion reactions.

Internal Tank CP System Using Suspended Anodes



Cathodic Protection cont.

- Tank designers use coatings as a primary defense against corrosion on the internal wetted surfaces of water storage tanks. Coating systems, however, are less than perfect and they degrade over time. Corrosion is a pervasive phenomenon and wherever there are voids or coating failures--the galvanic corrosion cell will rush into action and continue unabated unless addressed. The common means of supplementing the coating system is to install a cathodic protection system inside the storage tank.

- Cathodic protection provides electrical current to those areas not isolated from the environment by virtue of being coated, and therefore stops the corrosion cycle. Therefore, the combination of coating and CP work in concert to arrest the corrosion reaction when properly applied and maintained.

- There are two basic types of cathodic protection systems – the first type is the galvanic system, which relies on anodes made from metals that are inherently more electronegative than steel. Zinc and Magnesium are common anode materials used in water storage tanks. The second type is an impressed current system where longer-lasting anode materials can be used in conjunction with an external power supply, or rectifier, which converts AC power to DC current. Alternative energy sources are also available including solar power panels connected to DC batteries, which then supply current to the anode system.

SCADA

SCADA (**supervisory control and data acquisition**) generally refers to computer systems that monitor and control water treatment and distribution, wastewater collection and treatment, oil and gas pipelines and electrical power transmission.

A **SCADA** system usually consists of the following subsystems:

- A human–machine interface or **HMI** is the apparatus which presents process data to a human operator, and through this, the human operator monitors and controls the process.
- A supervisory (computer) system, gathering (acquiring) data on the process and sending commands (control) to the process.
- **Remote terminal units** (RTUs) connecting to sensors in the process, converting sensor signals to digital data and sending digital data to the supervisory system.
- **Programmable logic controller** (PLCs) used as field devices because they are more economical, versatile, flexible, and configurable than special–purpose RTUs.

Plant Piping

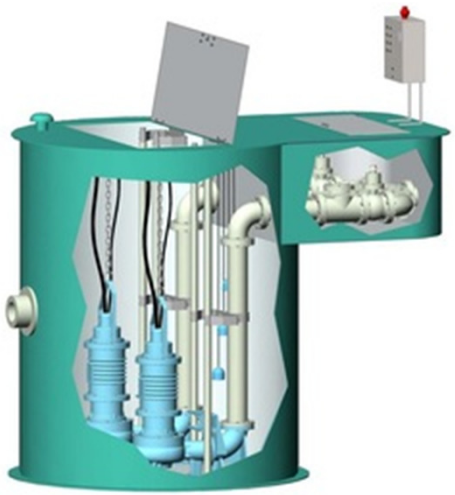
To facilitate identification of piping in plants and pumping stations it is recommended that the following color scheme be utilized:

Water Lines	Color
Raw or Recycle	Olive Green
Settled or Clarified	Aqua
Finished or Potable	Dark Blue

Waste Line	Color
Backwash Waste	Light Brown
Sludge	Dark Brown
Sewer (Sanitary or Other)	Dark Gray

Chemical Lines	Color
Alum or Primary Coagulant	Orange
Ammonia	White
Carbon Slurry	Black
Caustic	Yellow with Green Band
Chlorine (Gas and Solution)	Yellow
Chlorine Dioxide	Yellow with Violet Band
Fluoride	Light Blue with Red Band
Lime Slurry	Light Green
Ozone	Yellow with Orange Band
Phosphate Compounds	Light Green with Red Band
Polymers or Coagulant Aids	Orange with Green Band
Potassium Permanganate	Violet
Soda Ash	Light Green with Orange Band
Sulfuric Acid	Yellow With Red Band
Sulfur Dioxide	Light Green with Yellow Band

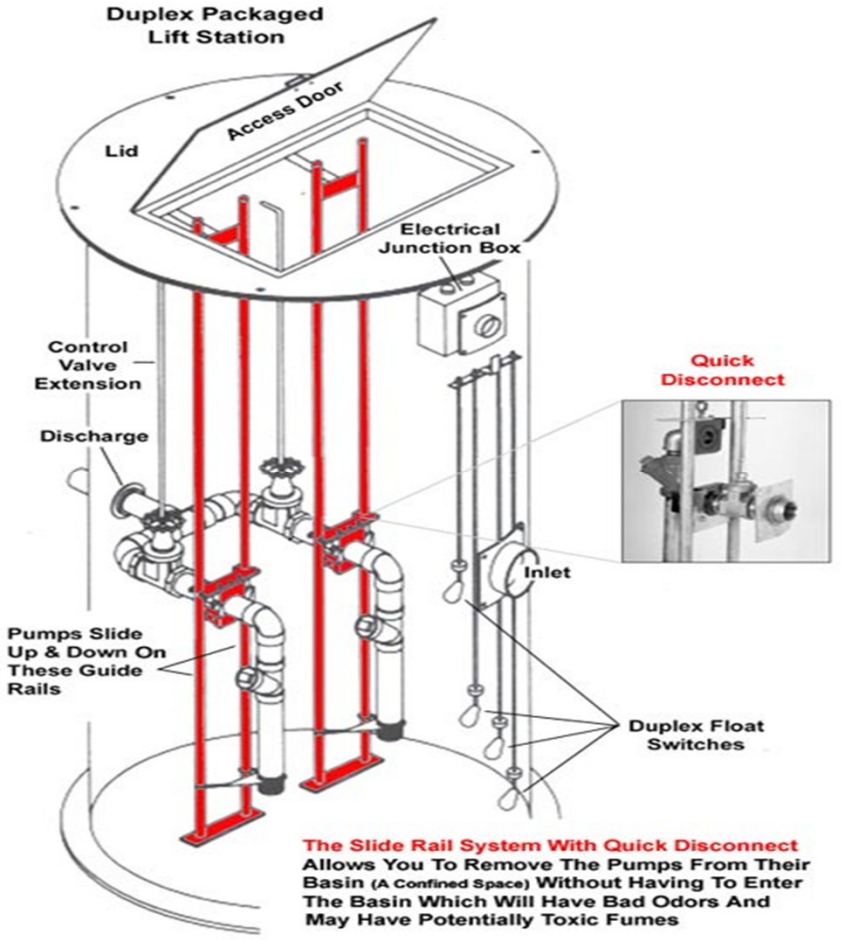
Lift Stations



- Lift stations contain pumps, valves, and electrical equipment necessary to pump water or wastewater from a low elevation to a high elevation. For example, a sewage lift station is used to pump sewage or wastewater uphill from a low-lying neighborhood to a collection system of pipes.

- A lift station typically comprises a concrete well that is fitted with several submersible pumps. Lift station design also include incorporating level-sensing probes, valves and pressure sensors, and may also include a stand-by generator. Large storm water treatment facilities may have generator back-up for a pump station to ensure the proper drainage of water during a storm or power outage. Lift stations must function in harsh and corrosive environments and are typically made of precast concrete with the pumps and valves accessible through a hatch for cleaning and maintenance.

Duplex Lift Station



Flow Meters

The most common principals for fluid flow metering are:

- Differential Pressure Flow meters
- Velocity Flow meters
- Positive Displacement Flow meters
- Mass Flow meters
- Open Channel Flow meters

Differential Pressure Flow meters

- In a differential pressure drop device the flow is calculated by measuring the pressure drop over an obstructions inserted in the flow. The differential pressure flow meter is based on the Bernoullis Equation, where the pressure drop and the further measured signal is a function of the square flow speed.

Velocity Flow meters

- In a velocity flow meter the flow is calculated by measuring the speed in one or more points in the flow, and integrating the flow speed over the flow area.

Positive Displacement Flow meter

- The positive displacement flow meter measures process fluid flow by precision-fitted rotors as flow measuring elements. Known and fixed volumes are displaced between the rotors. The rotation of the rotors are proportional to the volume of the fluid being displaced.
- The number of rotations of the rotor is counted by an integral electronic pulse transmitter and converted to volume and flow rate.

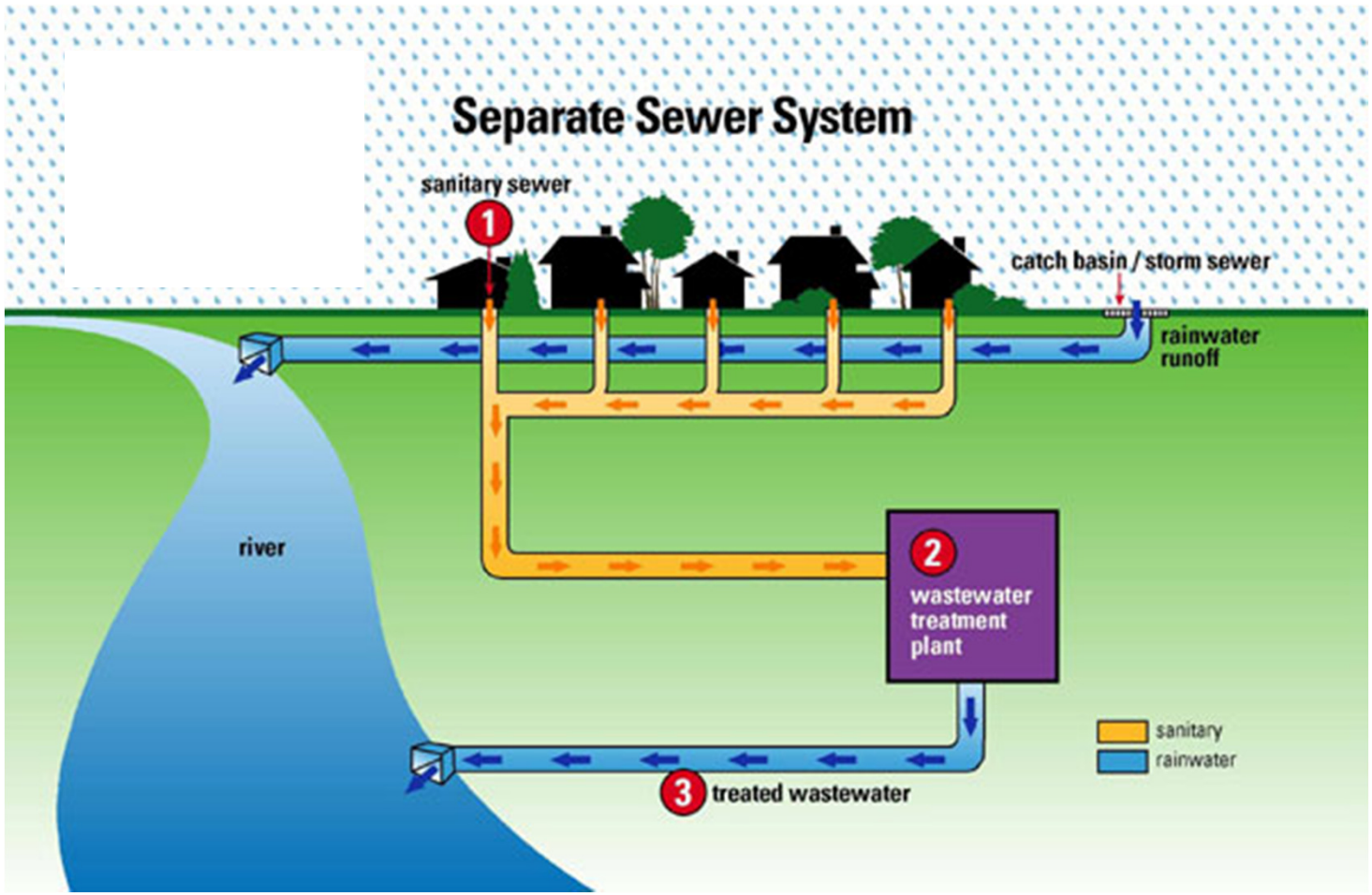
Mass Flow meters

- Mass meters measure the mass flow rate directly.

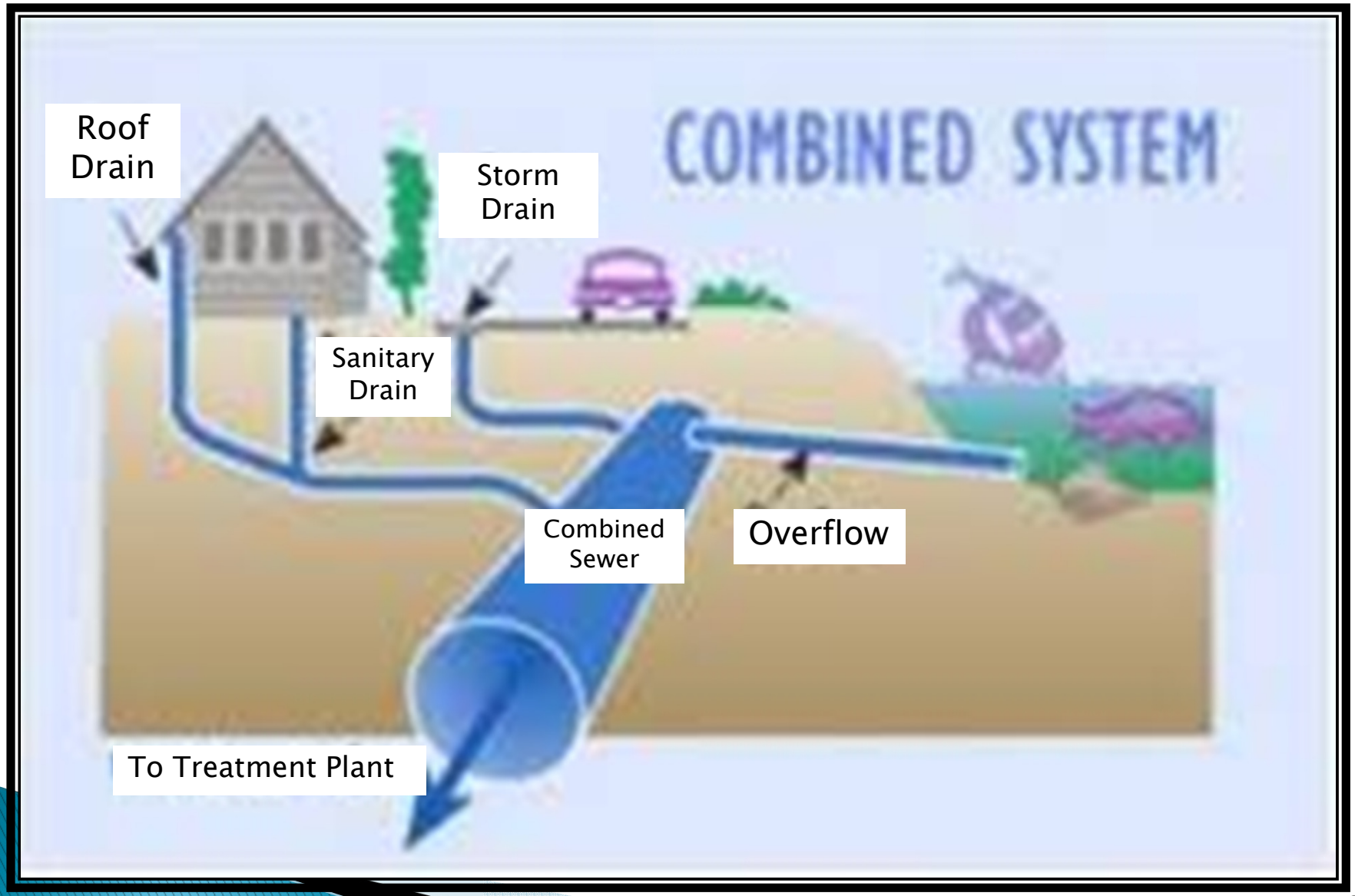
Open Channel Flow meters

- A common method of measuring flow through an open channel is to measure the height of the liquid as it passes over an obstruction.

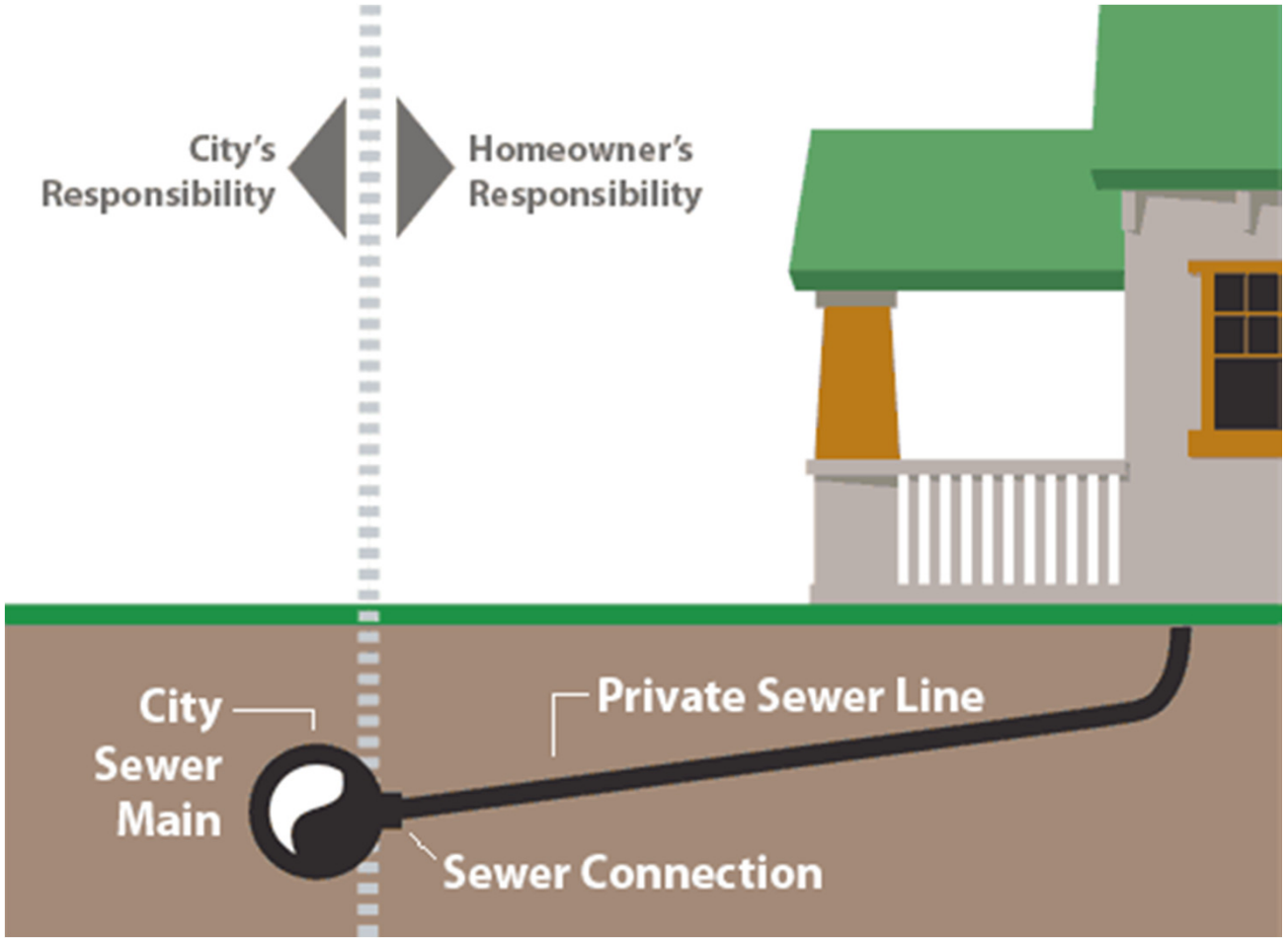
Separate Sewer System



Combined Sewer System



Typical Sewer System Ownership



Sewer Pipe Material

Ductile iron

- Ductile iron (DI) pipe is utilized for sewers requiring a high resistance to external loading, a high degree of toughness and ductility .. Pipe is available in diameters 3-inch through 54-inch, and in 18 or 20 foot laying lengths .

Cast iron soil

- Cast iron soil (CIS) pipe will normally be allowed only as an option for building connections . CIS pipe is used primarily for building interior drainage, waste and vent piping . CIS pipe is available in 2-inch through 15-inch diameters, in 5 and 10 foot laying lengths.

Vitrified clay

- Vitrified clay (VC) pipe is products to form an ideal material resistance to corrosion from acids and erosion well . VC pipe is available in nominal diameters 4-inch through 42-inch, and laying lengths of 1 to 10 feet .

Concrete

- Concrete sewer pipe is appropriate for applications requiring large diameter sizes or high strength characteristics . The advantages of RC pipe include a wide range of diameters,
- 12-inch through 108-inch, and laying lengths, 4 feet to 24 feet, which are available . A disadvantage is the lack of corrosion resistance to acids, especially critical where hydrogen sulfide is generated in substantial quantities .

Asbestos-cement

- Asbestos-cement (AC) pipe is made from a. mixture of asbestos fibers and portland cement . AC pipe matches the durability of concrete pipe but weighs less and is manufactured in a wide variety of strength classifications and laying lengths . AC pipe will deteriorate in a corrosive environment of hydrogen sulfide, acid wastes or aggressive soils ; however some degree of protection can be provided with plastic linings .

Sewer Pipe Material cont.

Polyvinyl chloride plastic

- Polyvinyl chloride (PVC) pipe is chemically inert to most acidic and alkaline wastes, and is totally resistant to biological attack . Since it is a nonconductor, PVC pipe is immune to nearly all types of underground corrosion caused by galvanic or electrochemical reactions, in addition to aggressive soils . Durability, light weight, a high strength-to-weight ratio, long laying lengths, watertight joints and smooth interior surfaces are characteristics which make PVC pipe an attractive alternative for use in sewer systems . Disadvantages include possible chemical instability due to long-term exposure to sunlight, excessive pipe deflection under trench loadings when installed improperly or subjected to high temperature wastes, and brittleness when exposed to very cold temperatures .

Acrylonitrile-butadiene-styrene plastic

- Acrylonitrile-butadiene-styrene (ABS) composite pipe consists of two concentric thermoplastic tubes integrally connected across the annulus by a truss-like bracing . The annular void space is filled with portland cement concrete, or other suitable material, to form a bond between the inner and outer tubes. ABS composite pipe is termed a "semi-rigid" pipe because it resists deflection better than most other plastics . The pipe is light in weight and resists attack by acids, alkalies, and biological growths .

Reinforced plastic mortar

- Reinforced plastic mortar pipe (RPMP) is composed of a siliceous sand aggregate reinforced with glass fibers, and embedded in a thermosetting polyester resin . RPMP is ideally suited for large diameter applications, and performs extremely well in resisting pipe wall deflection and internal/external corrosion

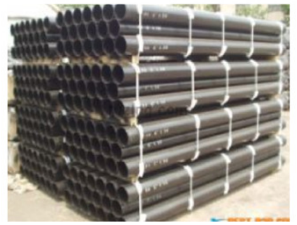
Images of Sewer Pipe Types

Vitrified Clay Pipe

Ductile Pipe

Concrete Pipe

Cast Iron Pipe



Acrylonitrile butadiene styrene (ABS)

Asbestos Cement Pipe

Polyvinyl chloride (PVC)

Reinforced Plastic Mortar (RPM)

Check Valves

- A **check valve**, **clack valve**, **non-return valve** or **one-way valve** is a mechanical device, a valve, which normally allows fluid (liquid or gas) to flow through it in only one direction. As opposed to a Gate Valve which is an on/off valve regardless of flow direction.

- Check valves are two-port valves, meaning they have two openings in the body, one for fluid to enter and the other for fluid to leave. There are various types of check valves used in a wide variety of applications. Check valves are often part of common household items. Although they are available in a wide range of sizes and costs, check valves generally are very small, simple, and/or inexpensive. Check valves work automatically and most are not controlled by a person or any external control; accordingly, most do not have any valve handle or stem. The bodies (external shells) of most check valves are made of plastic or metal.

- **Backwater valve** (for sanitary drainage system) protects lower located rooms against flooding caused by return flow of sewage waters. Such risk occurs most often in sanitary drainage systems connected to combined sewerage systems and in rainwater drainage systems. It may be caused by intense rainfall, thaw or flood. Backwater valve prevents rats and other rodents entering the sanitary and rainwater drainage systems and, consequently, the building interiors. It protects also against unpleasant smells in case of longer breaks in system use.

- A **ball check valve** is a check valve in which the closing member, the movable part to block the flow, is a spherical ball. In some ball check valves, the ball is spring-loaded to help keep it shut. For those designs without a spring, reverse flow is required to move the ball toward the seat and create a seal. The interior surface of the main seats of ball check valves are more or less conically-tapered to guide the ball into the seat and form a positive seal when stopping reverse flow.

- A **diaphragm check valve** uses a flexing rubber diaphragm positioned to create a normally-closed valve. Pressure on the upstream side must be greater than the pressure on the downstream side by a certain amount, known as the pressure differential, for the check valve to open allowing flow. Once positive pressure stops, the diaphragm automatically flexes back to its original closed position.

Check Valves cont.

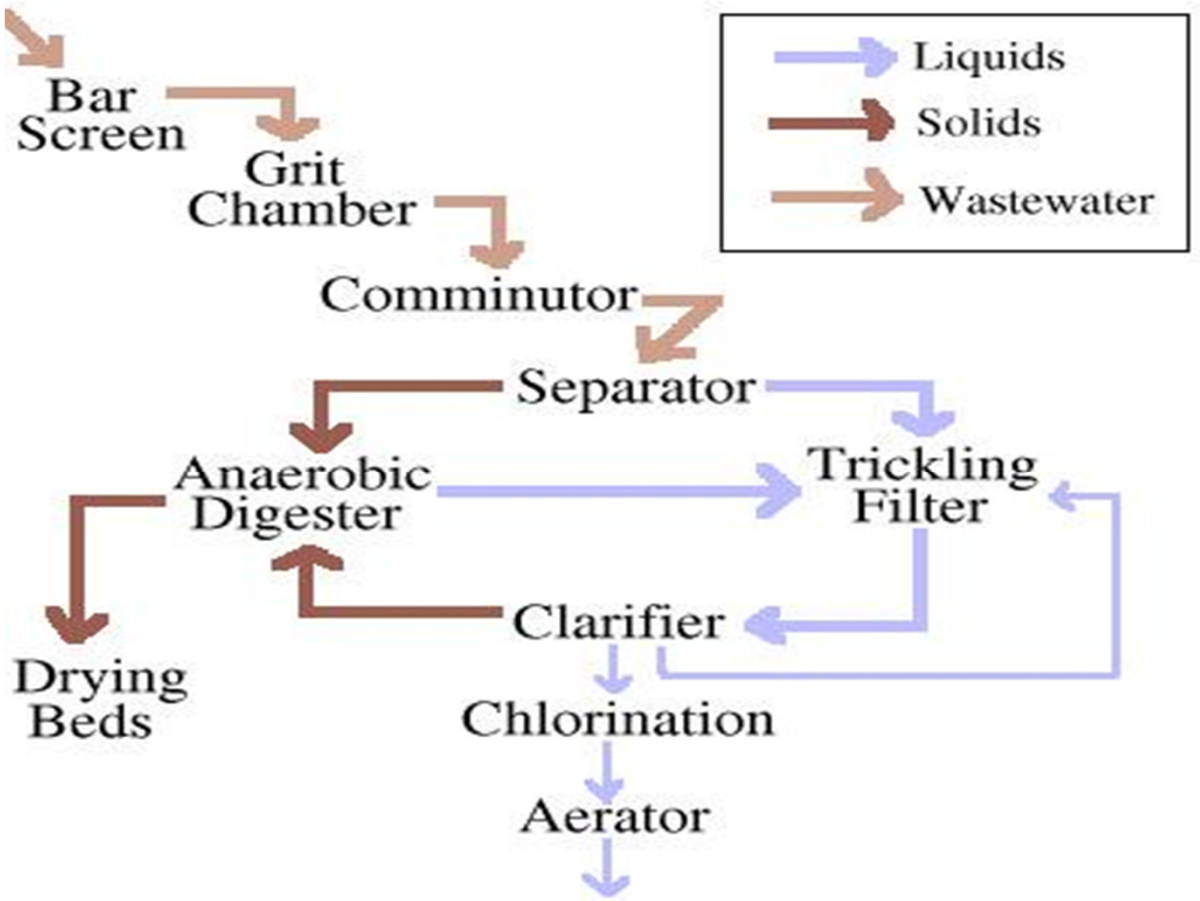
- A **swing check valve** or **tilting disc check valve** is check valve in which the disc, the movable part to block the flow, swings on a hinge either onto the seat to block reverse flow or off the seat to allow forward flow. The seat opening cross-section may be perpendicular to the centerline between the two ports or at an angle.

- A **stop-check valve** is a check valve with override control to stop flow regardless of flow direction or pressure. In addition to closing in response to backflow or insufficient forward pressure (normal check-valve behavior), it can also be deliberately shut by an external mechanism, thereby preventing any flow regardless of forward pressure.

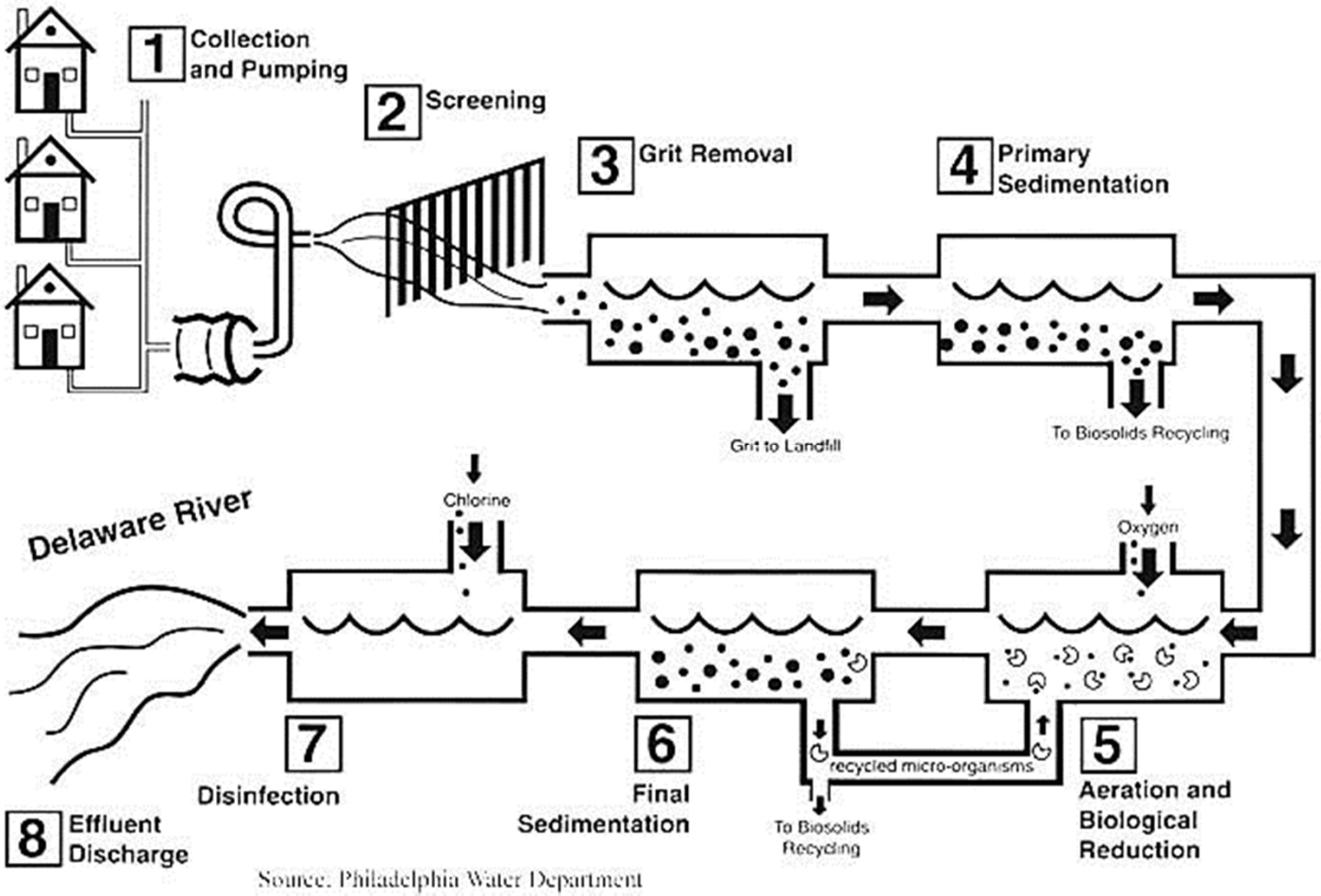
- A **lift-check valve** is a check valve in which the disc, sometimes called a *lift*, can be lifted up off its seat by higher pressure of inlet or upstream fluid to allow flow to the outlet or downstream side. A guide keeps motion of the disc on a vertical line, so the valve can later reseat properly. When the pressure is no longer higher, gravity or higher downstream pressure will cause the disc to lower onto its seat, shutting the valve to stop reverse flow.

- A **duckbill valve** is a check valve in which flow proceeds through a soft tube that protrudes into the downstream side. Back-pressure collapses this tube, cutting off flow.

Sewage Process – Liquid versus Solids



Sewer Treatment Process



Source: Philadelphia Water Department

Primary Treatment Process

1. Screening:

- Wastewater entering the treatment plant includes items like wood, rocks, and even dead animals. Unless they are removed, they could cause problems later in the treatment process. Most of these materials are sent to a landfill.

2. Pumping:

- The wastewater system relies on the force of gravity to move sewage from your home to the treatment plant. So wastewater-treatment plants are located on low ground, often near a river into which treated water can be released. If the plant is built above the ground level, the wastewater has to be pumped up to the aeration tanks (item 3). From here on, gravity takes over to move the wastewater through the treatment process.

3. Aerating:

- One of the first steps that a water treatment facility can do is to just shake up the sewage and expose it to air. This causes some of the dissolved gases (such as hydrogen sulfide, which smells like rotten eggs) that taste and smell bad to be released from the water. Wastewater enters a series of long, parallel concrete tanks. Each tank is divided into two sections. In the first section, air is pumped through the water.
- As organic matter decays, it uses up oxygen. Aeration replenishes the oxygen. Bubbling oxygen through the water also keeps the organic material suspended while it forces 'grit' (coffee grounds, sand and other small, dense particles) to settle out. Grit is pumped out of the tanks and taken to landfills.

4. Removing sludge

- Wastewater then enters the second section or sedimentation tanks. Here, the sludge (the organic portion of the sewage) settles out of the wastewater and is pumped out of the tanks. Some of the water is removed in a step called thickening and then the sludge is processed in large tanks called digesters.

Primary Treatment Process cont.

5. Removing scum:

- As sludge is settling to the bottom of the sedimentation tanks, lighter materials are floating to the surface. This 'scum' includes grease, oils, plastics, and soap. Slow-moving rakes skim the scum off the surface of the wastewater. Scum is thickened and pumped to the digesters along with the sludge.
- Many cities also use filtration in sewage treatment. After the solids are removed, the liquid sewage is filtered through a substance, usually sand, by the action of gravity. This method gets rid of almost all bacteria, reduces turbidity and color, removes odors, reduces the amount of iron, and removes most other solid particles that remained in the water. Water is sometimes filtered through carbon particles, which removes organic particles. This method is used in some homes, too.

6. Killing bacteria:

- Finally, the wastewater flows into a 'chlorine contact' tank, where the chemical chlorine is added to kill bacteria, which could pose a health risk, just as is done in swimming pools. The chlorine is mostly eliminated as the bacteria are destroyed, but sometimes it must be neutralized by adding other chemicals. This protects fish and other marine organisms, which can be harmed by the smallest amounts of chlorine.
- The treated water (called effluent) is then discharged to a local river or the ocean

7. Wastewater Residuals:

- Another part of treating wastewater is dealing with the solid-waste material. These solids are kept for 20 to 30 days in large, heated and enclosed tanks called 'digesters.' Here, bacteria break down (digest) the material, reducing its volume, odors, and getting rid of organisms that can cause disease. The finished product is mainly sent to landfills, but sometimes can be used as fertilizer.

Images of Treatment Process

Screen Systems

Clarifier

Digester

Aeration

Trickling Filter

Master Control Centers (MCC)

Motor Control Centers consists of six [6] Soft Start Starter buckets, six [6] Variable Frequency Drives [VFD's], and an Auto-sensory and Control section. Additionally there is modem/router to communicate with SCADA.

Inspection process

- Identify Cause of Loss:
  - Document Cause of loss with photograph
  - Address Concurrent Causes (determine moving efficient cause) and document with photograph
  - Acknowledge contributing factors and document with photograph
  - Secure/preserve evidence (subrogation)
- Obtain scope of damages:
  - Communicate Scope with Member or Contractor
  - Include Make/Model when available
  - Attain clear dimensions and accurate quantities
  - Consider Repair options
  - Address Salvage
  - Document all damaged items with a photograph
  - Acquire receipts/invoices for costs incurred prior to inspection.

Prevailing Wage

The Prevailing Wage Act requires contractors and subcontractors to pay laborers, workers and mechanics employed on PUBLIC WORKS construction projects no less than the general prevailing rate of wages (consisting of hourly cash wages plus fringe benefits) for work of a similar character in the county where the work is performed

Trade Name	TYP	C Base	FRMAN	M-F>8	OSA	OSH	H/W	Pensn	Vac	Trng
CARPENTER	All	40.770	42.770	1.5	1.5	2.0	12.34	11.25	0.000	0.530

Legend:

M-F>8 (Overtime is required for any hour greater than 8 worked each day, Monday through Friday. OSA (Overtime is required for every hour worked on Saturday)

OSH (Overtime is required for every hour worked on Sunday and Holidays)

H/W (Health & Welfare Insurance)

Pensn (Pension)

Vac (Vacation)

Trng (Training)

Prevailing Wage - Carpenter in Cook County $64.89 cost to employer

Xactimate - Labor Wage for Cook County $68.49

Integri - Labor Wage for Cook County $69.64

Aaberg Claim Professionals, Inc

- 1.) Determine/document the cause of loss
- 2.) Establish/document the scope of damages
- 3.) Estimate the cost of repairs and/or replacement
- 4.) Identifying/document Subrogation
- 5.) Recognize/document salvage potential.