Лекція 2 **Water supply and sewage networks**

1. Water line network:

- water demand rates at districts, l/pers. day;
- daily **water consumption**, m^3/day;
- calculated discharges qmax, qmax +fire, qmin;
- draw a longitudinal piezometric profile from the 2nd lift pumping station to the dictionary point for all regimes (according of their design) with next datas: numbers of points; lands marks, m; lengths, m; d, mm; discharges, l/sec.

Water supply system, infrastructure for the **collection**, **transmission**, **treatment, storage, and distribution** of water for homes, commercial establishments, industry, and **irrigation**, as well as for such public needs as **firefighting** and **street flushing**. Of all municipal services, provision of **potable water** is perhaps the most vital. People depend on water for drinking, cooking, washing, carrying away wastes, and other domestic needs. In all cases, the water must fulfill both quality and quantity requirements.

Water systems typically have three classifications of pipe used to transport to demand points throughout a community. These are identified as follows:

1) **Primary feeders**: These are large pipes, usually with diameters ranging from 12 to 36 inches, based on the size of the population served. Primary feeders transport water form the water **treatment plant** to corporation line of the community and/or to major water storage locations within the community.

2) **Secondary feeders**: These are connected to the primary feeders to transport water along the major streets of the community. Secondary feeders need to be in place to supply all commercial property, public buildings, and private sector buildings that have a needed fire flow over 1,000 gpm. Secondary feeders typically are 10 to 16 inches in diameter.

3) **Distributor mains**: These are used to transport water from the secondary feeders to individual streets in the areas of the community that have small businesses like convenience stores and gas stations but, more importantly, along residential streets. The minimum pipe size should be 6 inches and, based on the system design, a possible dead- end pipe may need to be 8 or even 10 inches.

CHARACTERISTICS OF GRAVITY SEWERS

Slope of Sewer As stated before, the slope of the sewer should follow the lay of the land as closely as practical provided the slope is adequate to produce gravity flow and maintain the minimum velocity (2 fps= 0,61m/s). Some areas will be too **flat** to

permit exclusively gravity flow because the sewer lines would have to be buried excessively deep.

Design Flow Wastewater collection systems are designed to convey the **peak flow** from a service area when the area has reached its maximum **population density** and has been fully developed commercially and industrially. **Domestic wastewater flow** is often calculated by multiplying the estimated population in a service area by the per **capita flow**. In New Mexico the per capita flow ranges from 60 to 125 gallons per day per person (272 l/day – 568 l/day) . Businesses and industries will contribute varying flows and so must be accounted for differently. Also, because the actual flow of wastewater in the collection system will vary during a 24-hour period, (minimum flow during the early morning hours and maximum flow around 10:00 AM to 12:00 PM), a peaking factor must be used in order to ensure the **sewer** will handle the maximum **instantaneous** flow. Peaking factors of 2.5 – 3.5 times the total daily flow are often used to size wastewater collection systems.

Velocity The wastewater in a sewer line should move at a **speed** that will prevent the deposition and buildup of solids in the sewer; this is called a "**scouring velocity**". A minimum velocity of 2 fps has been shown by experience to provide this scouring or **self-cleaning velocity**. Not all lines will maintain a scouring velocity at all times throughout the day. However, the sewer should be designed to provide a scouring velocity at **average flows** or, at the very least, **during peak flows**.

Pipe Size A sewer line should be at least large enough to allow the use of the cleaning equipment available. When sized properly, a sewer line should flow one half full during average daily flows. The air space above the half full sewer line helps to maintain **aerobic conditions** in the wastewater and provides some **room** for error in determining design flow.

Water Distribution | System Design and Layout
https://www.youtube.com/watch?v=f2faanH0_Ww&ab_channel=AmericanWaterCollege

There are three basic design configurations for a distribution system. There's the **arterial loop system**, the **grid system** and the **tree system**.

An arterial loop system is a **distribution system** with a complete loop of arterial mains around the area being served to minimize dead ends. Features of an arterial loop system include large diameter mains around the service area. Water is supplied from four directions which means if you were to have a **fire hydrant** at an intersection and open that fire hydrant up water would be coming from four different directions to supply that hydrant and it has good flow throughout the system.

The next type of system is the grid system. The grid system is a distribution system layout in which all ends of the mains are connected to **eliminate dead ends**. And some features of the grid system include

- most of the water mains are interconnected.

- the mains are reinforced with larger arterial mains

- and flow is usually good if the mains are 6 inches or more.

- and you'll draw flow from 2 to 3 directions.

And the third type of system is the tree system. A tree system is a distribution system that centers around a single arterial main and branches are taken off at right angles and they have dead ends so the transmission line delivers water into an area.

The distribution main branches are not interconnected and this results in dead ends which ultimately results in poor water quality. Dead end mains that are longer than a thousand feet should be at least six inches in diameter.

Isolation valves are required to allow for system isolation for maintenance or repairs. These valves should be spaced periodically so that small sections of the system can be isolated if there is a problem requiring a shutdown lasting more than a few hours. Water mains less than or equal to 12 inches in diameter should have isolation valves within 1,000 feet of each other.

All branches off the arterial mains should have isolation valves as well. In situations where mains intersect in a grid at least two but preferably three isolation valves should be installed. A **relief valve** should be installed at the system high points to release air that's come out of solution. since this can reduce system flow. **Backflow prevention devices** should be installed to isolate the system from potential **contamination sources**.

The carrying capacity of a water main is determined by its size. Water mains must be sized to meet peak demands from domestic commercial industrial and fire protection uses. They must be able to deliver adequate quality, quantity, pressure and velocity.

One of the primary goals of distribution system operators is to maintain good water quality throughout the entire distribution system. The design of the system impacts the operation and maintenance procedures required to maintain good water quality. arterial loop systems are preferred to grid systems which are preferred to tree systems.

Domestic use requirements can be determined by either referring to pass usage records or from general usage figures for the area. Fire flow requirements are usually the determining factor for system size in communities with a population of 50,000 or less. Fire flow requirements are set by the Insurance Services office or the ISO. By your insurance underwriters recommend that no main and the distribution system

should be less than 6 inches in diameter. They also suggest the following minimum requirements. High-value districts such as libraries, shopping centers and the like should have 8 inch mains and larger. Residential mains of 6 inches are larger and mains smaller than 6 inches are only used to complete a grid.

35 psi at all fire hydrants is the minimum pressure able to meet fire flow requirements in areas requiring high fire flow capacity. The system should be able to ensure the pressure does not drop below 20 psi will used during firefighting operations. Residential pressure is typically kept in the 50 to 75 psi range. While commercial district pressure is in the seventy-five to a hundred psi range.

Systems that serve a community that has different elevations within it will find it necessary to have different pressure zones. Although customers want good water pressure when they turn on the faucet excessive pressure can damage fixtures and water appliances. High provider pressure will also contribute to more leaks in the distribution system.

Flow velocity should be limited to five feet per second in the distribution system to avoid friction losses during normal operations. Water velocities are reduced by increasing the diameter of the pipe for a given volume of flow. Systems are typically designed to provide a flow velocity of between two feet per second and four feet per second during maximum flows.

Wastewater Collection | Method of conveyance

https://www.youtube.com/watch?v=l53uHFQ2nIl&t=1s

The purpose of a **collection system** is to collect and convey the **wastewater** from homes and Industry at a flow rate greater than two feet per second to a wastewater treatment plant. So basically what we're saying here is we want the system to be designed so that flow is at least 2 feet per second and it's going to collect water from both residences and commercial and industrial customers.

Here we have a picture that shows industry contributing to the wastewater and then we also have residences that continue or contribute to the wastewater and they combine to provide all the flow that goes to the head works of the wastewater treatment plant. Now something else I want to point out on this picture. There are those lighter blue lines and those are showing it coming from the industrial and from the streets that's the **stormwater system** so that's a separate system from the **sanitary sewer** so we've got a **split system**.

Here and then also over on the far right of the screen the darker blue you can see there's a **combined sewer system** and that's a system in which both the sanitary

sewer and the stormwater flows into the same **conduit**. If there's an overflow of capacity, the excess then bypasses the wastewater treatment plant and goes on into the river. We're going to talk about the method of conveying this wastewater and what we're really talking about is what force is used to move the wastewater from the point of collection to the wastewater treatment plant. There's three main types that we'll look at. That's **gravity** so gravity is a force that can move the water. We also have **low pressure systems** where we use pumps to pressurize the force main to move the water. We also have **vacuum systems**. So we're going to briefly take a look at each of these types of systems in just a major components for each.

Here we have a gravity system and this is just typical system where you've got residences on a slightly sloping terrain. You can see as we start the wastewater flow it gets to a point to where we need to use a **lift station** to lift it to a higher elevation and then on to the sewer treatment plant. What's happening here is the depth of the **trench** is getting too deep so we need to raise that back up to a higher elevation so that the trenches don't need to be so deep. I'm going to insert a red line here that would be the depth that the sewer system would have to maintain without a lift station and that house on the hill would has a very deep trench just for the service connection. This case we're using gravity to allow the flow to go to the wastewater treatment plant but we've also used a lift station to assist with this gravity system.

The next system is a low pressure system so looking at that same terrain rather than having the lift station we just put the trenches at a constant depth below the surface level. We use pumps to pressurize the system so that the flow just continues due to pressure.

The last system is the vacuum system and in the vacuum system a couple things to point out we have a **vacuum station** which require or which provides the low pressure that's going to provide the motive force to draw the wastewater in one direction and then also near the residence we have the **vacuum interface unit** and what this does is that interfaces between the gravity portion of the building sewer and the vacuum system on the municipal side. So again in this case the vacuum station provides the force that's drawing the wastewater to the wastewater treatment plant.

We're going to talk about the different types of waste that's conveyed in the system and that dictates what the system is called. We have three basic types of systems. We have the sanitary sewer system, a stormwater system and then we have a combined system which combines both the sanitary and the stormwater systems.

In the sanitary sewer system you can see that we have it split out from any storm drain. So the only thing that goes in the sanitary sewer system is sanitary waste so that would be human waste as an example.

The stormwater system collects water from street runoff, surface runoff, from rain events. The storm water system sends all of its flow just directly to a natural waterway or a natural water course and does not receive any treatment at all.

Combined system we have a situation where you've got your household waste going into this pipe you also have roof drains or surface runoff going into the common pipe and you have storm drains or road runoff going into the pipe and as that fills the pipe up. It will overflow into the natural waterway so wondering normal conditions as long as this pipe is not overloaded. Or full the water both the runoff and the sanitary waste will run to the water treatment plant. But when it reaches full capacity that's when the overflow will go into the natural waterway and it'll be a combination of the surface runoff and the sanitary waste that goes into that waterway.