23. Relief Sewer Design.

a. Interaction of Relief Sewer with Existing Sewer.

1) Relief sewer design. Determine how the design flow will be routed. The topography, available outlets, and available head may dictate which alternative is selected. Three (3) alternatives for relief sewer design are as follows:

   a) Flow is divided between the existing and relief sewer;

   b) Flows in excess of a predetermined quantity are diverted to the relief sewer;

   c) A predetermined flow from the upper end of the system is diverted to the relief sewer.

2) An examination of the flow quantities in the existing and relief sewer may determine the method of relief. If on the other hand, the relief sewer is designed to take flows in excess of a fixed quantity, the relief sewer itself will stand idle much of the time, and solid deposits are likely. Judgment is required in deciding which relief alternative is most appropriate. In some cases, the best alternative may be to make the new sewer large enough to carry the total flow and abandon the old one.

3) Diverting the flows.

   a) If the flows are divided according to a predetermined ratio, the inlet structure to the relief sewer must be designed to divide the flow.

   b) If the relief sewer is to take all the flows in excess of a predetermined quantity, the excess flow may be discharged over a weir to the relief sewer.

   c) If a predetermined quantity is to be diverted in the upper reaches of the system, the entire flow at the point of diversion may be sent to the relief sewer or the flow may be divided in a diversion structure.

4) The design of the relief sewer must maintain a self-cleansing velocity of a minimum of two and one half (2.5 fps) feet per second, see Hydraulic Design of Relief Sewers, in this section. Determine the flow ratio between the relief sewer and the existing sewer and indicate this information on the drawings.

5) The extent of the existing sewer line to be relieved will be determined by WSSC.

b. Flow Distributions.

1) Determine how the initial flows will be distributed and what changes are needed to redistribute the ultimate flows. The flow quantity for both the initial and ultimate flow must be noted on the drawings.

2) Devices to regulate flow.

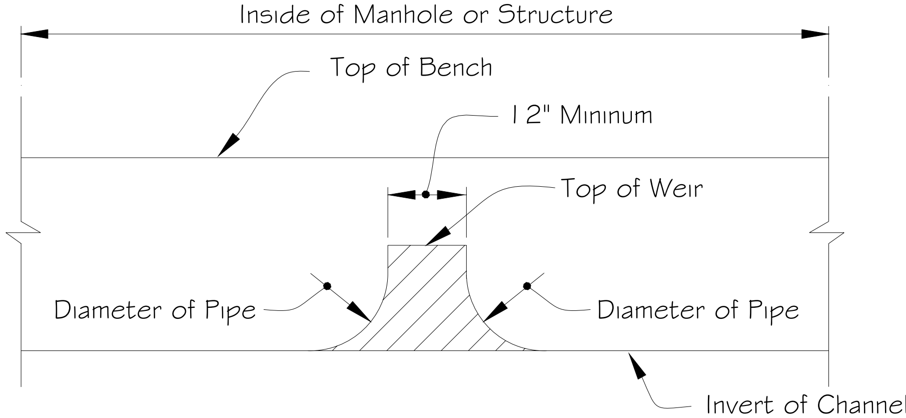
   a) A weir can be designed to divert flows in excess of predetermined flow or ratio of flow. Weirs can be either a permanent weir or temporary/adjustable weir.

(1) Permanent weir.

(a) Design a brick or concrete weir (same material as the channel).

(b) Minimum of 12" wide at the top of weir, with a side radius slope to the channel invert the same as the diameter of the relief sewer piping and channel, see Sketch "Y".

(c) Indicate on the drawings the elevation of the top of the weir and the weir material.



SKETCH "Y"

Relief Sewer - Flow Control Device (Weir)

(2) Temporary/adjustable weir.

(a) Design a weir plate, using an aluminum plate with lifting handles.

(b) The channel at the weir plate must be designed to suit the guide frame of the weir plates. Typically the weir plates are non-circular and the channel must be designed to transition from a circular channel to a flat bottom channel at the weir.

(c) Indicate on the drawings, the elevation at the top of the weir.

(d) If the design requires the weir to have adjustable height for flow control, provide the capacities for each weir plate.

(e) Provide storage hooks on the manhole or structure wall to store the plates when they are not in use.

(f) Lifting hooks above the weir plate location at the channels must be designed and provided on the underside of the top slab.

b) To divert all the flows from the existing sewer to the relief sewer, design the diversion structure with a slide gate.

(1) Design the slide gates and their frame to suit the channel. Typically the slide gate is non-circular and the channel must be designed to transition from a circular channel to a flat bottom channel at the weir.

(2) Provide all manufacturer's catalog material for slide gates and frames.

c. Junction Chambers, Structures or Manholes.

1) For the design guidelines for junction chambers, structures or manholes, see Part Two, Section 11 (Design of Structures).

2) In addition to the above requirements, provide the following:

a) Removable grating platform with access openings for the devices to regulate flows. The platform must be above the top of the bench and a minimum of 6" above the hydraulic gradient of the design flow of the sewers.

b) Minimum of six and one half (6-1/2) feet of head room.

c) Channel design with all dimensions, sizes, shapes, slopes, etc.

d. Horizontal Alignment.

1) For general horizontal alignment requirements, see Part Two, Section 5 (General Horizontal Alignment).

2) For most cases, the location of the relief sewer is designed parallel to the existing sewer. Determine the spacing requirements between the two pipelines and the total working area required, (right of way and construction strips). Consider the following to determine the required construction area:

a) The construction area over the existing sewer must not impose any additional loading on the pipe which includes heavy construction equipment, trench excavation, etc., unless calculations are submitted showing the existing sewer will not be damaged by the additional loading.

b) Area required for stockpiling materials along the alignment. Items that are considered to be stockpile materials include storing the pipe along the trench, storing stone and gravel, and storing excavated trench material, etc.

c) Contractor access road. This area must be left open at all times.

d) Trench width.

e) Area for construction equipment on the side of the trench.

f) Minimum spacing requirements between relief sewer and original sewer pipelines, see Part Three, Section 3 (Pipeline Crossings and Clearances).

g) Minimum work area on the side of the relief sewer, opposite of the existing sewer, is twenty-five (25) feet. This area can be a combination of the right of way and construction strip.

e. Vertical Alignment.

1) For vertical alignment and profiles, see requirements under Part Two, Section 8 (Vertical Alignment-Profiles).

f. Design Flows for Both Systems.

1) Show the design flows (Q) on the profile at all connecting sewer manholes, changes in pipe sizes, changes in pipe slopes, and any other locations that will change the capacities will occur. These flows are ultimate design flow.

a) Design flows for both pipelines.

(1) $Q^{\text{Design Relief}}$ = the design flow for the relief sewer

(2) $Q^{\text{Existing Sewer}}$ = the design flow for the existing sewer

b) Design capacities of both the pipelines.

(1) $Q^{\text{Pipe Relief}}$ = the design capacity of the pipe for the size and slope of the relief sewer

(2) $Q^{\text{Pipe Existing}}$ = the design capacity of the pipe for the size and slope of the existing sewer

c) See Hydraulic Design of Relief Sewers, in this section.

g. Hydraulic Design of Relief Sewers.

1) Flow rates.

a) Determine the flow rate using the existing range of flow rates (existing average, existing peak) and future flow rates (ultimate [future] minimum, ultimate [future] average, ultimate [future] peak), consult WSSC.

b) Evaluate hydraulic limitations of the existing sewer. This will include an evaluation of the existing sewer capacity, flow velocities, downstream controls/outfall conditions, and overflow points.

2) Preliminary hydraulic analyses include:

a) <u>Relief sewer design alternatives.</u> Specify the extent of the relief sewer and the locations of tie in with the existing sewer at the upstream and downstream ends of the relief sewer. Evaluate the method of providing relief capacity for the existing sewer. The choice of the method of relief can depend on several factors such as peak and minimum flows, velocities in the existing and proposed sewers, topography, available head, and downstream control/outfall conditions. Consider the following alternatives:

(1) The proposed relief sewer is designed to divert part of the total flow from the upper reaches of the system. This may require more than one point of flow diversion/distribution.

(2) The proposed relief sewer is designed to divert all flows in excess of a certain quantity, which may be determined by the capacity of the existing sewer, or the flow at which the minimum flushing velocity is attained.

(3) The proposed relief sewer is designed to accommodate all rates of flow in combination with the existing sewer. This may require the design of an inlet structure at the upstream end or more than one interconnecting junction structure for the system to divide the flows.

b) Estimate flows (minimum/maximum) to be conveyed by each sewer line. These flows may vary along the length of the sewer lines.

c) Provide preliminary sizing of the relief sewer based on available head and proposed flows.

(1) Size the relief sewer flow for open channel flow conditions, using Manning's equation.

(2) A surcharged flow condition is not desirable for a gravity sewer. Use Manning's friction factor of 0.013 (minimum) for new pipes, and reflect the type of pipe material and increase of friction factor due to aging of the sewer pipes.

d) Provide preliminary HGL profiles for each sewer line for the range of flow rates. Include backwater effects from the downstream control location and significant headlosses at manholes and interconnecting structures.

e) Estimate the minimum/maximum flow velocities in each sewer line for the range of flow rates considered. The minimum velocity of two and one half (2.5) fps for gravity sewers to be achieved daily.

f) Determine the method of flow diversion and distribution. The use of transverse weirs, side-overflow weirs, orifices, baffles, sluice gates, proportioning flow channels, etc., may be considered. Adjustable devices may be required to allow for flow adjustment.

g) Provide hydraulic design of flow diversion/distribution structures. For preliminary design, the flow diversion/distribution devices may be sized assuming open channel flow conditions prevail in the downstream sewer segments. Estimate headlosses and the HGL elevations of the merging flow streams should match inside the interconnecting structure. The total number of such structures should be minimized.

3) <u>Detailed hydraulic analysis.</u> Complete by the final design a detailed hydraulic analysis. Incorporate any changes and modifications made to the preliminary design. Consider the following guidelines:

a) Base the final calculations of backwater profiles/HGL profiles for the sewer system on the step backwater profile calculation methods to account for any backwater effects due to down stream control and energy losses at manholes, interconnecting structures and pipe friction. Calculation of energy losses at manholes or interconnecting structures must be done individually for each structure. The purpose of these calculations is to ensure that the sewer pipeline would be operating under open channel flow conditions at design flows. The starting location and hydraulic grade in the existing downstream sewer for the backwater profile analysis will be provided by WSSC. Provide references for the method employed for energy loss calculation at the manholes and structures. If a computer program is used, provide adequate information to show that the program computes the backwater profile accurately.

b) Headlosses at manholes and interconnecting structures should be minimized. These losses can be caused by abrupt flow expansion and contraction due to improper channel design, changes in flow direction, changes in flow velocities due to differences in upstream and downstream pipe size/slope, changes in flow quantity and losses at flow control devices. It may be necessary to compensate for these losses in order to avoid surcharge flow conditions.

c) Check the design of the flow diversion or distribution devices by incorporating any backwater effects from the downstream sewer segment, based on the HGL profiles developed.

d) If surcharged flow conditions cannot be avoided, plot the HGL profile associated with the maximum design flow on the pipeline profile.

e) High velocity transitions in interconnecting structures should be avoided so as to minimize excessive turbulence and headlosses, especially for structures where there are flow diversions or distribution devices.

f) If more than one pipe enters an interconnecting structure, it is necessary to design the transition such that flow streams from individual influent sewers can blend together without abrupt changes in water surface elevations. It is desirable to keep the velocities of the incoming flows approximately the same.

4) Identify and shown on the drawings, for each sewer pipeline that discharges into a downstream wastewater pumping station, the location and elevation of the wastewater overflow point, as a result of an inoperative wastewater pumping station.

5) Submit the drawings and detailed final hydraulic calculations in support of the relief sewer design.