BELL SYSTEM PRACTICES
Outside Plant Construction
and Maintenance

SECTION G43.118.1
Issue 1, June, 1946
AT&T Co Standard

MANHOLES
EXCAVATING

1. GENERAL

1.01 Excavation in public streets and highways involves hazards due to the nature of the work and also to the movement of traffic and the occupancy of the public ways by other services. By the observation of proper precautions, the normal hazards incidental to such activity may be minimized, and the application of certain well established safety rules may be relied upon to reduce the hazards from other sources. The exercise of proper precautions for the safety of the workmen will, in general, increase the protection afforded the public. Workmen are expected to familiarize themselves with the safety practices discussed in this section and also with the general recommendations of G40.090.1 on "Precautions."

1.02 The disposition of materials, equipment, and spoil should be arranged in an orderly manner while keeping in mind the requirements of traffic, both vehicular and pedestrian. Where the work may be of several days' duration, suitable barricades and flags supplemented by warning lights at night should be used to outline the area under excavation. If the street is narrow it may be necessary to have "No Parking" signs placed along

the clear side in order to leave the space free for two-way traffic and to avoid the hazards due to confining two-way traffic to a narrow lane. The work may be of such a nature that the street should be closed entirely and traffic detoured elsewhere. Such matters involve the municipal authorities and arrangements should be made with them before any conduit work is done.

1.03 In many situations there will be only a constriction of traffic for a brief period. In such cases a flagman, supplemented by warning signs, will be found useful in guiding traffic around the restricted area.

1.04 Accessibility to fire hydrants, fire alarm boxes and private driveways should be maintained. The necessary gutters to carry storm water away from the work should be provided and kept free of obstructions.

1.05 Where construction vehicles and other equipment such as pumps and compressors are employed in connection with the work, care should be exercised in their use to avoid creating hazards. Such equipment should be located with respect to the work so that it causes a minimum obstruction to the movement of traffic. Where indicated, flagmen, barricades and detour signs should be used to control traffic approaching and passing the point at which the equipment is operating.

1.06 **Permits** which are required to do work in accordance with the detail plans should be secured before starting the job. All permits, or a record of all permits, should be retained by the supervisor or inspector, ready for immediate reference, during the progress of the job. Operations for which specific permits may be required are listed in G40.090.1.

2. LOCATION OF MANHOLES

2.01 It is desired that the manholes be located as shown on the construction prints. Obstructions in the excavation or other field conditions, however, may make it advisable to shift the manhole locations, in which case the inspector or supervisor should always be consulted.

2.02 In built-up areas where the possibility of undisclosed subsurface conditions exist, test holes may be required to verify that the construction can be carried out as planned and to avoid useless excavation. The test holes should extend diagonally across the manholes and should be dug one foot deeper than the depth of the proposed manhole excavations.

2.03 If foreign pipes or other structures are encountered in the test holes, immediate steps should be taken to determine their ownership. Frequently in congested streets, it will be found that there are abandoned or idle structures which can

be removed with permission of the owners at little or no extra expense. If the structure cannot be removed readily, a decision must be made as to the practicability of (a) shifting the manhole, (b) arranging with the owning company for a change in the route of their plant or (c) including the structure in the manhole. The penalties or costs associated with each of these alternatives should be carefully considered before a decision is reached.

2.04 Springs or underground streams may increase construction costs and should be avoided, if practicable. Occasionally, bad water conditions may be traced to leaking water pipes or sewers, in which case arrangements should be made for their repair, if possible, before the construction work proceeds.

2.05 Manhole openings should be located so as to avoid unnecessary hazards and also so that future work in the manhole will cause minimum interference with the normal flow of vehicular traffic. In streets where there are street railway tracks, the manhole openings should be located so as to provide sufficient clearance from the overhang of the street car.

3. WATER CONTENT OF SOIL

3.01 The strength required for manhole walls and floors depends greatly upon the characteristics of the soil in which the manhole is to be constructed. Manholes built in quicksand, swampy ground or other soils with high water content require heavier wall and floor construction than manholes built in firm soils because of the greater pressure exerted on the walls and floors by fluid types of soils.

3.02 Usually, specific information concerning soil conditions at a particular location is not readily available at the time the detail plans are prepared. Therefore, at the first opportunity, such as at the time of digging test holes, particular attention should be paid to the type of soil, having in mind that the manhole construction for this location should conform to the requirements of firm or fluid soil as defined below.

3.03 In these sections the term **firm soil** denotes any soil which is normally self-supporting except where deep excavation and the possibility of caving due to vibration make it advisable to sheet the walls of the excavation. This classification shall also be considered to include dry to moist sand of medium grain or larger.

3.04 **Fluid soils** are defined as soils which are normally in a semi-fluid condition to the extent that they are not self-supporting and generally must be confined by tight sheet-

ing. Quicksands, marshes, soft clay and boggy ground fall in this group.

3.05 Fluid soil is sometimes encountered at a depth of several feet below a more or less well defined stratum of firm soil. Where this condition is found in excavating for a new manhole, fluid soil construction shall be employed if more than 1/4 of the depth of the excavation is in the fluid soil.

4. EXCAVATION DIMENSIONS

Length and Width of Excavation

4.01 The length and width of the excavation for concrete manholes shall be such that the manhole can be constructed with the interior dimensions as specified on the detail plans and with walls of the necessary thickness at the point of minimum dimension. Where sheeting is required to prevent caving, the excavation shall be enlarged accordingly to account for the sheeting. If wooden stringers are to be left in place when the walls are poured similar adjustment should be made to allow for the thickness of these members.

4.02 The length and width of the excavation for manholes with brick walls shall be such that the manhole can be constructed with the interior dimensions as specified on the detail plans and with walls of the necessary thickness, plus 3 inches clear space between the outside brick and the walls of the excavation or sheeting. This space is to be carefully backfilled with earth as the walls are built up. Where sheeting is required to prevent caving, the excavation shall be correspondingly larger to provide space for the sheeting.

4.03 If the excavation is to be made in water bearing soil, an increase in the length of part of the excavation may be required, depending on the need for a construction sump as discussed in 8.03.

4.04 The following table may be used for determining the length and width of the excavation for most manholes.

LENGTH AND WIDTH OF EXCAVATION
FOR MANHOLES

(A) Concrete Manhole without Sheeting-Use Figure in Table.
(B) Concrete Manhole with 2 in. Sheeting-Add 4 in. to Figure in table.
(C) Brick Manhole without Sheeting – Add 6 in. to Figure in table.
(D) Brick Manhole with 2 in. Sheeting – Add 10 in. to Figure in table.

Length or Width of Inside of Manhole	Thickness of Manhole Wall in Inches																	
	6		7		8		9		10		11		12		13		14		15	
	Length or Width of Excavation																	
	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.
3 ft.-6 in.	4	6	4	8	4	10	5	0	5	2	5	4	5	6	5	8	5	10	6	0
4 ft.-0 in.	5	0	5	2	5	4	5	6	5	8	5	10	6	0	6	2	6	4	6	6
4 ft.-6 in.	5	6	5	8	5	10	6	0	6	2	6	4	6	6	6	8	6	10	7	0
5 ft.-0 in.	6	0	6	2	6	4	6	6	6	8	6	10	7	0	7	2	7	4	7	6
5 ft.-6 in.	6	6	6	8	6	10	7	0	7	2	7	4	7	6	7	8	7	10	8	0
6 ft.-0 in.	7	0	7	2	7	4	7	6	7	8	7	10	8	0	8	2	8	4	8	6
6 ft.-6 in.	7	6	7	8	7	10	8	0	8	2	8	4	8	6	8	8	8	10	9	0
7 ft.-0 in.	8	0	8	2	8	4	8	6	8	8	8	10	9	0	9	2	9	4	9	6
7 ft.-6 in.	8	6	8	8	8	10	9	0	9	2	9	4	9	6	9	8	9	10	10	0
8 ft.-0 in.	9	0	9	2	9	4	9	6	9	8	9	10	10	0	10	2	10	4	10	6
8 ft.-6 in.	9	6	9	8	9	10	10	0	10	2	10	4	10	6	10	8	10	10	11	0
9 ft.-0 in.	10	0	10	2	10	4	10	6	10	8	10	10	11	0	11	2	11	4	11	6
9 ft.-6 in.	10	6	10	8	10	10	11	0	11	2	11	4	11	6	11	8	11	10	12	0
10 ft.-0 in.	11	0	11	2	11	4	11	6	11	8	11	10	12	0	12	2	12	4	12	6
10 ft.-6 in.	11	6	11	8	11	10	12	0	12	2	12	4	12	6	12	8	12	10	13	0
11 ft.-0 in.	12	0	12	2	12	4	12	6	12	8	12	10	13	0	13	2	13	4	13	6
11 ft.-6 in.	12	6	12	8	12	10	13	0	13	2	13	4	13	6	13	8	13	10	14	0
12 ft.-0 in.	13	0	13	2	13	4	13	6	13	8	13	10	14	0	14	2	14	4	14	6

Depth of Excavation

4.05 The depth of the excavation for manholes shall be sufficient to allow a floor of the required thickness to be placed and still provide the necessary headroom, etc. The following measurements should be totaled to determine the depth of the excavation:

(a) Depth of manhole frame.

(b) Depth of brick collar for manhole frame.

(c) Thickness of roof.

(d) Headroom of manhole.

(e) Thickness of floor.

(f) Plus 4 inches for layer of crushed stone if necessary to provide drainage during construction in wet locations.

4.06 If highway regrading operations are expected at a later date, provision for lowering the manhole frame shall be made if necessary by a corresponding increase in the height of the brick collar over the normal 4 inches.

4.07 Where the manhole is constructed in a grass plot and the Type R frame is employed, the roof should be located not less than 12 inches below the ground surface in order to afford sufficient cover of soil to permit the sod to re-establish itself. This will require that a collar at least 2 bricks high be constructed to support the ring type frame at the proper level.

4.08 The following table may be used for determining the depth of excavation for most manholes.

DEPTH OF EXCAVATION
FOR MANHOLES
Normal Construction-4 in. Collar

If the combined thickness of the Roof and Floor is	Add this dimension to the Headroom of the Manhole to obtain the required depth of the excavation.			
	Type of Frame			
	A	B	SA or SB	R
10 inches	2 ft.-1 in.	2 ft.-0 in.	1 ft.-8 in.	1 ft.-4 in.
11 inches	2 ft.-2 in.	2 ft.-1 in.	1 ft.-9 in.	1 ft.-5 in.
12 inches	2 ft.-3 in.	2 ft.-2 in.	1 ft.-10 in.	1 ft.-6 in.
13 inches	2 ft.-4 in.	2 ft.-3 in.	1 ft.-11 in.	1 ft.-7 in.
14 inches	2 ft.-5 in.	2 ft.-4 in.	2 ft.-0 in.	1 ft.-8 in.
15 inches	2 ft.-6 in.	2 ft.-5 in.	2 ft.-1 in.	1 ft.-9 in.
16 inches	2 ft.-7 in.	2 ft.-6 in.	2 ft.-2 in.	1 ft.-10 in.
17 inches	2 ft.-8 in.	2 ft.-7 in.	2 ft.-3 in.	1 ft.-11 in.
18 inches	2 ft.-9 in.	2 ft.-8 in.	2 ft.-4 in.	2 ft.-0 in.
19 inches	2 ft.-10 in.	2 ft.-9 in.	2 ft.-5 in.	2 ft.-1 in.
20 inches	2 ft.-11 in.	2 ft.-10 in.	2 ft.-6 in.	2 ft.-2 in.

The following adjustment may be necessary:

(A) If layer of crushed stone is required for drainage-add 4 inches.

(B) If future grading operations will require lowering of frame-add the amount that frame will be lowered.

(C) Lack of space in street may require reduction of the normal height of collar.

(D) If Type R Cover is used and manhole is located in grass plot-add 6 in.

5. REMOVING PAVEMENT

5.01 The line of excavation should be clearly marked before starting to excavate. This should be done by stretching a line (1/4-inch rope or heavy chalk line) and marking along the line with crayon or a pick. The marking of the excavation line should be carefully done so that no more pavement will be disturbed than is necessary. If it is known in advance that sheeting will be required, the outline of the excavation will be established by the plank framing, as illustrated in 7.02.

5.02 In removing the pavement surface, save as much of the paving material as practicable for temporary reuse. The paving material should be kept separated from the other excavated material. If asphalt or similar paving material is removed, strips approximately 12 inches long and 18 inches wide should, so far as practicable, be removed in one piece.

5.03 In parkways and lawns, keep the sod and top soil separated from other excavated material so that it can be replaced properly. Place excavated earth on tarpaulins or burlap where necessary so as not to damage the grass. This work should be done with care and completed to the satisfaction of the authorities or property owners.

5.04 Asphalt or similar paving should be removed with an asphalt cutter or flat, chisel pointed tool. An air compressor and approved tools can be used to advantage in removing pavement, rock and other hard packed materials or soils where a considerable amount of this work is to be done.

5.05 Pavement base material should be separated from other excavated material so that it may be used for restoration of the base, if desirable.

6. EXCAVATING

6.01 In general, the excavation for manholes is done manually. In order to facilitate the removal of earth from the excavation, staging should be used as required.

6.02 In deep excavations or in excavation in filled ground which may contain waste material in a state of partial decomposition, there is a possibility of oxygen deficiency or the presence of harmful gases. Likewise, even in shallow excavations in proximity to natural or manufactured gas mains there is a remote possibility of seepage of gas without its presence being detected by odor. Where there is any question as to the safety of the working conditions in such excavations, a check of the atmosphere should be made in accordance with G10.212, G10.214 or G10.216 for testing manhole atmosphere.

6.03 Where rock is encountered in the excavation, consult the inspector or supervisor relative to the possibilities of avoiding the rock excavation by either shifting the manhole or reducing the headroom by the provision for double racking in the manhole. If rock excavation is unavoidable, the rock should be chipped out where present in small quantities or blasted if large amounts must be removed, whichever is more economical or practicable.

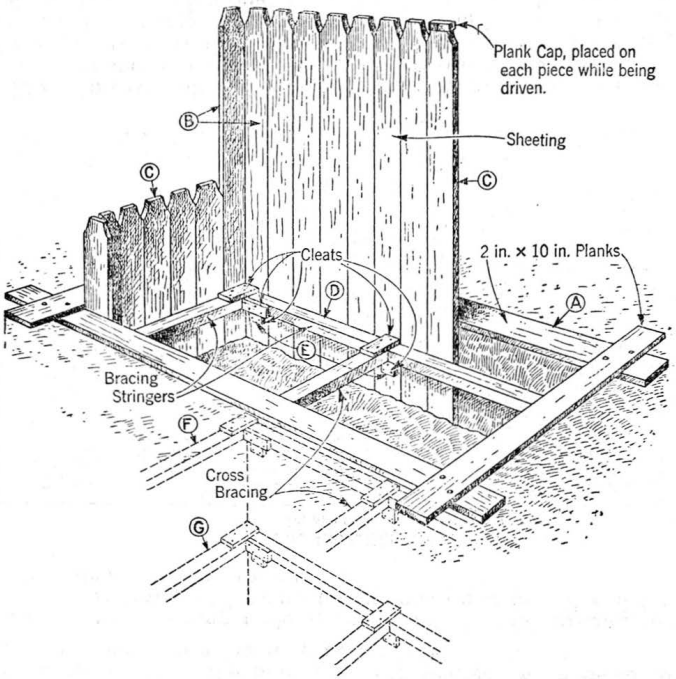
Caution: Blasting shall be done by an authorized powder man as outlined in the instructions covering "Use of Dynamite," G.10.320 to G10.323, inclusive, and only at the direction of the supervisor.

6.04 Where the spoil pile is located on the street side of the excavation, care should be taken to prevent loose stones and rock from rolling out into the driving area where they might be struck and hurled by the wheels of passing vehicles, with possible injury to persons or damage to property. Do not place excavated material nearer than 18 inches to the edge of the opening, and keep the shoulders clear of all loose objects that might fall on men in the excavation.

7. SHEETING AND BRACING

7.01 The type and amount of sheeting and bracing required for manhole excavation varies according to the stability of the soil and to the depth of the excavation. For example, a shallow manhole to be built in firm soil may require shoring only, while the same manhole in fluid soil would require tight sheeting and heavy bracing.

7.02 The method generally used for placing sheeting and bracing is shown in the following illustration. Depending upon the stability of the soil, the sheeting should be driven 12 to 18 inches below the bottom of the excavation.



1. - Construct frame A and place at manhole location.
2. - Start excavation, then drive planks B at each corner of frame.
3. - Place bracing D about 1 foot from top.
4. - Place cleats E to support bracing and adjust cleats as sheeting is driven.
5. - Partly drive planks C at sides and ends.
6. - As excavation progresses, drive planks B and C further in and place the bracing F and G about 4 feet apart.
7. At completion of excavation, drive all planks B and C until the ends are below bottom of excavation.

7.03 In placing the top bracing make certain that there is sufficient clearance between the top of the form and the bracing to permit pouring the roof without disturbing the bracing.

7.04 Where monolithic construction is to be employed, a minimum clearance of 30 inches should be maintained between the bottom bracing and the top level of the floor in order to allow one tier of the sectional steel forms to be placed under the bracing. At locations having very fluid soil, it may be necessary to provide a row of bracing below the bottom level of the floor. This bracing will remain in place after the floor and walls are poured.

7.05 Where the floor is to be poured some time in advance of the walls, a minimum clearance of 4 inches should be maintained between the bottom bracing and the top level of the floor. After the floor has been poured and allowed to set, this row of bracing may be removed.

7.06 The following table specifies the size and spacing for sheeting and bracing for various types of soil and for various depths of excavation.

BRACING AND SHEETING
For Manholes

Depth of Excavation in Feet	Sheet Piling		Stringers		Cross-Bracing	
	Size in Inches	Horizontal Spacing in Feet	Size in Inches	Vertical Spacing in Feet	Size in Inches	Horizontal Spacing in Feet
	(A) Hard and Solid Soil					
5 to 10	2 × 6	6	4 × 6	4	4 × 6	6
10 to 20	2 × 6	Tight	6 × 6	4	6 × 6	6
More than 20	2 × 6	Tight	6 × 8	4	6 × 8	6
	(B) Soil Likely to Crack or Crumble					
5 to 10	2 × 6	3	4 × 6	4	4 × 6	6
10 to 20	2 × 6	Tight	6 × 6	4	6 × 6	6
More than 20	3 × 6	Tight	6 × 8	4	6 × 8	6
	(C) Soft ,Sandy, Filled-in or Loose Soil					
5 to 10	2 × 6	Tight	6 × 6	4	6 × 6	6
10 to 20	2 × 6	Tight	8 × 8	4	6 × 6	6
More than 20	3 × 6	Tight	8 × 8	4	6 × 8	6
	(D) Where Hydrostatic Pressure Exists					
To 10	2 × 6	Tight	6 × 8	4	6 × 8	6
More than 10	3 × 6	Tight	8 × 10	4	6 × 10	6

7.07 In cases where it would be impracticable to remove one or more of the stringers due to foreign obstructions or for other reasons at the time the concrete walls are being poured, the stringers should preferably consist of steel channels with such additional cross bracing as may be necessary

to prevent excessive deflection of the channels. Otherwise, if wooden stringers are employed the wall thickness should be increased by an amount equivalent to the thickness of the stringers.

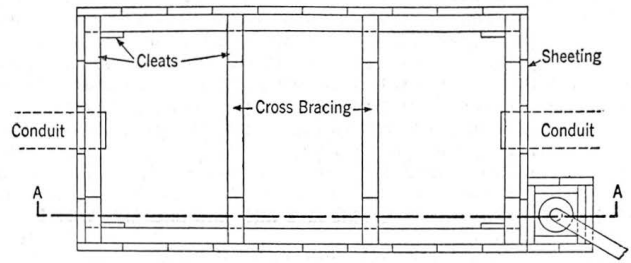
8. HANDLING WATER DURING EXCAVATION

8.01 In all cases where there is a continuing accumulation of water, the excavation should be kept free of water during the construction. After the concrete or brickwork has been completed, water should not be allowed to flow across or along the concrete or mortar until it has thoroughly set, in order to prevent washing away the cement. Water pressure should not be allowed to build up under the floor or around the walls until the concrete or brickwork has attained sufficient strength to withstand the pressure and to avoid water percolating through the fresh concrete or mortar and causing porosity.

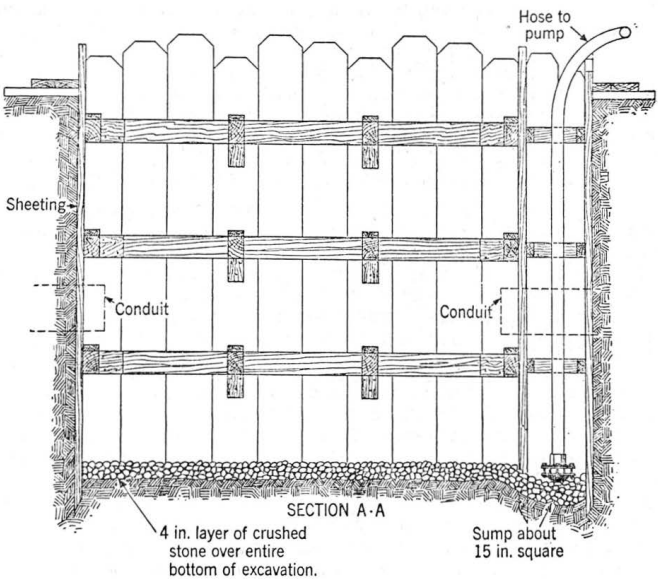
8.02 There are 3 methods generally used to handle water during manhole construction, as follows: (A) the provision of a construction sump outside of the manhole, (B) the provision of a construction sump within the manhole and (C) the installation of well points. Each of the methods has advantages, disadvantages and limitations which should be considered before the choice is made.

8.03 Method (A) as shown in the following illustration requires the excavation of a pit about 15 inches square immediately adjacent to the line of sheeting for the manhole and about 9 inches deeper than the manhole excavation. A 4-inch layer of crushed stone is placed on the bottom of the manhole excavation below the floor level. By pumping from the sump, the water level in the excavation can be kept below the top of the layer of crushed stone, thereby allowing the floor and the walls to be placed without water difficulties. If monolithic construction is employed for the manhole, this method for handling water requires continual pumping until the floor has attained sufficient strength to withstand the water pressure. The period of pumping time required is one day for concrete made with high early strength cement and three days for concrete made with normal cement. The period of time required for pumping, however, can be reduced by allowing water to enter the manhole after the concrete has set in order to relieve the pressure. Water can be admitted to the manhole by providing several weep holes through the walls just above the floor level consisting of lengths of steel pipe 1 to 2 inches in diameter. These pipes can later be capped or plugged at the time the manhole is pumped for the removal of the forms. As an alternative to the weep holes, the manhole can be filled with water to the ground water level by pumping directly into the manhole through the opening in the roof.

METHOD "A"
CONSTRUCTION SUMP OUTSIDE OF MANHOLE



PLAN VIEW

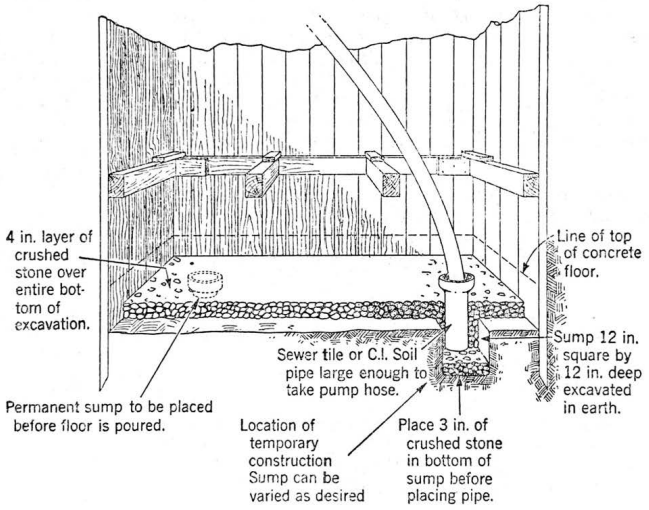


SECTION A-A

8.04 **Method (B) as shown in the following illustration is similar to method (A) except that a temporary construction** sump is provided within the manhole in addition to the permanent sump described in G43.122.1. The main dis-

advantage of this method is that the hose is somewhat in the way of construction activities and must be carried through the opening in the roof form so pumping can be continued when concrete walls are poured. When this method is used, pumping need not be continued after the concrete in the walls and floor is set because water will enter the manhole through the construction sump and thus relieve the pressure. Later when the manhole is pumped, the construction sump should be sealed off and filled to the floor level, as described for replacement of floors, G43.410.1.

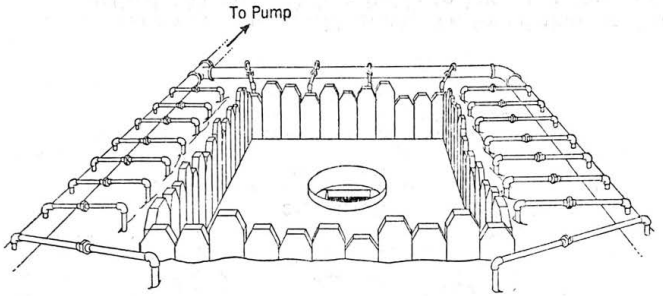
METHOD "B"
CONSTRUCTION SUMP WITHIN MANHOLE



8.05 In very wet sand it will usually be found that neither method (A) nor (B) is suitable to keep the work dry and still retain the walls of the excavation, even with extra heavy sheeting and bracing. In such cases the use of the well point pumping system is indicated. The system consists of placing a line of pipe about 3 inches in diameter around the outside edge of the excavation and tapping into it at intervals of about 18 inches a series of smaller pipes equipped with well points and extending vertically in the sand to a point a little below the bottom of the proposed excavation. By connecting a pump

to the 3-inch pipe, the water can be removed from the sand within the area of excavation, thus allowing work to proceed. Tight sheeting and proper bracing should, of course, be provided. A well point system of pumping, designated as method (C) is shown in the following illustration:

METHOD "C"
WELL POINT SYSTEM FOR PUMPING



9. FOREIGN STRUCTURES ENCOUNTERED

9.01 Where foreign structures are encountered in the excavation, the procedures outlined in 2.03 and 2.04 should be followed.

9.02 Gas and oil mains should be given special attention and precautions should be taken to guard against the fire hazards they present. Excavations in public streets should always be checked for gas leakage, even though gas mains or sewers are not directly encountered. Uncovering gas mains or working in the vicinity of such mains always involves the possibility of encountering gas leaks, with the resulting hazard of accumulated gas in the excavation. No open flame of any sort should be permitted in or near excavations when the odor of gas is detected. Workmen should not be permitted to smoke and precautions should be taken to prevent pedestrians from throwing lighted cigars, cigarettes or burning matches into such excavations. Where practicable, it is advisable to notify the owning company when excavation involving such structures is undertaken so that a representative may be present if desired.

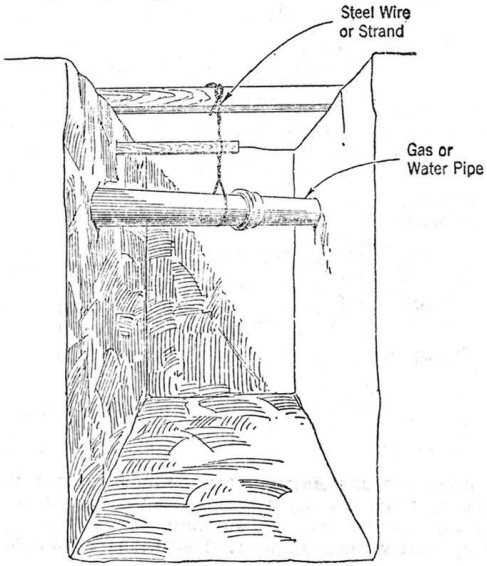
9.03 The minimum desirable separations between foreign structures and telephone manholes are as follows:

(a) Electric light, power, or other conduits—at least 3 inches of clearance from the outside surface of the manhole wall or roof.

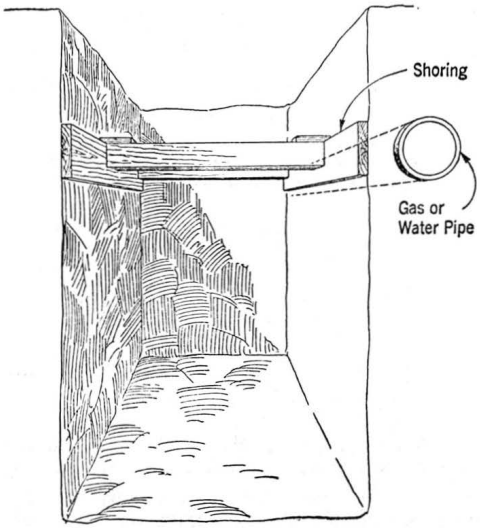
(b) Other foreign pipes such as gas, water, oil mains, etc.—separations of at least 6 inches when crossing and 12 inches when paralleling, as measured from the nearest exterior surface of the manhole. These clearances are provided to facilitate maintenance of the foreign structure and are subject to adjustment to meet particular conditions. In the event a question arises as to the practicability of the clearances given, consult with the owning company.

(c) It is preferable that manholes not be constructed directly above sewers or other deeply placed foreign structures. Where it is impracticable to avoid this condition at least one foot of clearance should be maintained between the bottom of the manhole floor and the top of the foreign structure. The inspector or supervisor should consider the advisability of taking precautionary measures to protect the structure or workmen against future excavating operations within the manhole. Such protection may consist of embedding 1/4-inch boiler plate in the manhole floor directly over the foreign structure.

9.04 Foreign structures which cross the excavation shall be adequately supported as shown in the following figure.

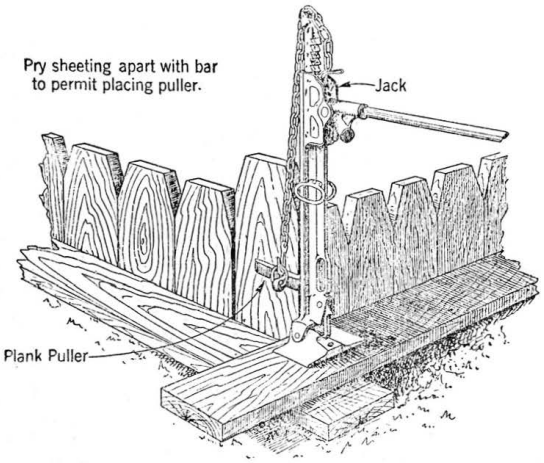


9.05 Foreign structures paralleling and within 12 inches of the excavation shall be braced laterally by shoring as shown, except when the necessity for sheeting to support the excavation furnishes adequate bracing for the structure.



10. SHEETING REMOVAL

10.01 Where conditions permit and recovery can be made intact, remove all sheeting after the time specified for curing the concrete has elapsed. A plank puller as illustrated may be used to grip the sheeting. The sheeting may be lifted by a lever or jack, although on larger jobs the substitution of a tripod and chain blocks will facilitate the work of sheeting removal. After the sheeting is removed, backfill the remaining space and tamp thoroughly.



10.02 If the sheeting is not to be removed cut it off at a point as near the top of the manhole roof as practicable.