

Report No. CDOT-DTD-R-93-13

Type "T" Manholes

Experimental Feature

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Technical Report Documentation Page

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16. Abstract <p>At present the Colorado Department of Transportation requires a concrete box base at the location of each manhole in the Colorado Standard Plans (CDOT Standard M-604-20). These manholes are used for inspection of the drainage lines and periodic maintenance. The standard construction is a box base design that can be either cast in place or precast. In an area with heavy traffic a design which allows for the lanes of traffic to be closed for a minimum amount of time would be of considerable benefit.</p> <p>A new design for mainline manholes that can ease installation and reduce the time taken and thereby reducing traffic congestion, and also may reduce overall construction costs is the Type "T" manhole. Type "T" manholes are fabricated by the concrete pipe manufacturer and are constructed to be part of the pipe. This type of manhole is a pre-cast design that is delivered to the site and set in place rather quickly.</p> <p>This manhole was monitored during construction on a major street in Denver for problems and observed annually for two years looking for fatigue.</p> <p>Implementation: This design should be considered on all roadways with high traffic counts that can not be closed for extended periods during construction.</p>					
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I. Introduction

At present the Colorado Department of Transportation calls for a concrete box base at the location of each manhole in the Colorado Standard Plans (CDOT Standard M-604-20). These manholes are used for inspection of the drainage lines and periodic maintenance. These manholes can be a cast in place or precast design.

A new design for mainline manholes has recently been considered that should ease installation and reduce installation costs. This design is called a type "T" manhole. Type "T" manholes are fabricated by the concrete pipe manufacturers and are constructed to be part of the pipe. This type of manhole is a pre-cast design that is delivered to the site and set in place. An advantage to the type "T" manhole is a much more efficient hydraulic design than that of the Colorado Standard Design and construction time is reduced over the standard design.

A Type "T" manhole is a precast steel reinforced concrete manhole. The advantages of a Type "T" manhole are that they can be delivered to the site and set in place more easily than the standard box base, saving construction time thus using less time for lane closure when this is an important factor and they are more efficient hydraulically than the box base manhole being that the manhole is a part of the pipe itself.

However, even with the believed ease of construction, improved hydraulic efficiency, and reduced cost the actual structural performance of the finished manhole in place must be evaluated.

II. Construction

Construction of the Type "T" manhole began on the evening of October 11, 1989 at approximately 8:00 pm. The manhole was placed on project CXFCU (GF) 10-0085-10, located on eastbound Hampden Avenue approximately 100 feet east of the Santa Fe to eastbound Hampden ramp. The plans originally called for two type "T" manholes to be placed on the project. However, the manhole fabricator had concerns that one of the Type "T" manholes was not economical, constructable or practical because intersecting pipes at the Type "T" manhole have different invert elevations, caused the necessary reinforcement in the pipe to be complex. To correct the problem the future trunk line and the lateral drainage pipe was redesigned so that connecting invert elevations would be reasonably similar. Figure 1 shows original design of manhole and figure 2 shows new design. At this time it was decided to place only one manhole on this project. The one that was placed was used in a location where the most benefit could be achieved. In order to place a CDOT standard cast-in-place box-base manhole the location for the manhole must be closed to all traffic for a period of time to allow the concrete box to obtain minimum strength for traffic loads. However, the precast design is similar to the type "t" manhole construction. It can take several days for the concrete to meet minimum strength requirements before backfilling on the cast in place design. The attached diagram (figure 3) shows a type "T" manhole. This type is a pre-cast manhole that needs only the time required to assemble in place before back filling and allowing the roadway to be open to traffic.

On this project the Type "T" manhole was placed on a 48" storm drain in the middle

of eastbound Hampden Ave. Traffic in this area is 48200 ADT which makes closing the roadway during daytime hours undesirable. The standard box base manhole would have required a detour during the daytime hours. At 8:00 pm the roadway was closed down with a detour running over Santa Fe Dr. and around the work area. This detour would have greatly disrupted traffic during the day. The Contractor for this job was Lawrence Construction Company, but this work was subcontracted to Winslow Construction, with the Type "T" manhole being manufactured by Carter Concrete Company in Denver. Excavation of the existing storm drain began with the removal of pavement and surrounding fill with a backhoe. After the storm drain was uncovered, a concrete saw was used to cut the existing pipe to the dimensions of the new Type "T" manhole. A backhoe was then used to break out this section of cut pipe. A filter material was placed below where the manhole was to be placed to help with drainage of any fluids leaking from the new manhole. The material used was a filter material described in section 703.09 of the Colorado Highway Specifications Manual. The next step was to slowly lower the new manhole into place between the two open pipes. A backhoe was used at this time to help with positioning the manhole into the proper alignment. Sandbags were then placed around the two joints connecting the pipe to the manhole in a manner to make a form for concrete placement around the pipe, which would seal the existing pipe to the new manhole. The concrete placed around this area had a 1-inch slump. A class 2 backfill material was placed around the manhole, finishing the installation. The entire job was completed and the roadway open to traffic early the following morning before the traffic rush hour began. This proved to be one of the main advantages to this type of manhole.

Type "T" Design Change

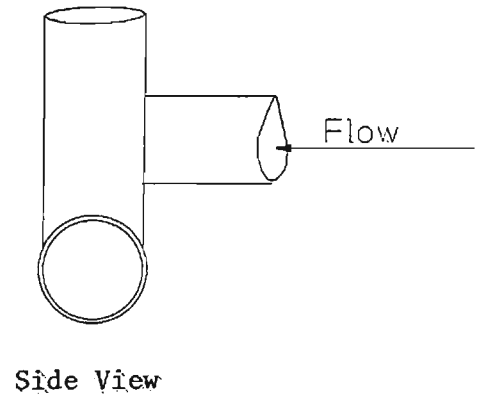
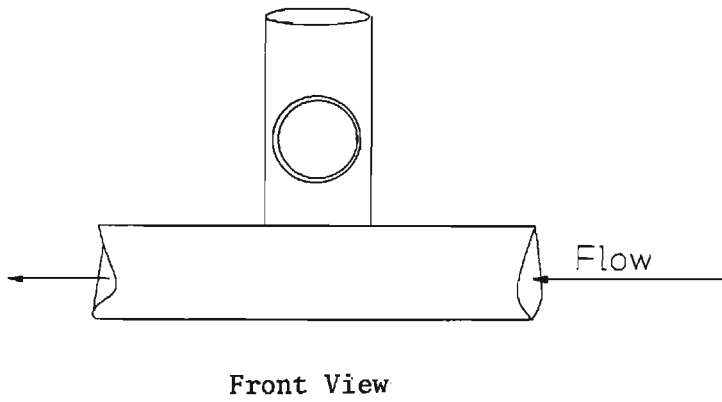


Figure 1

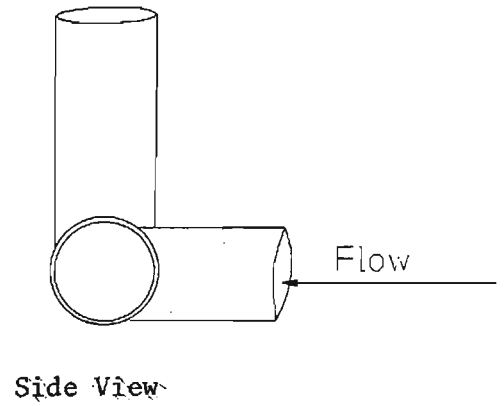
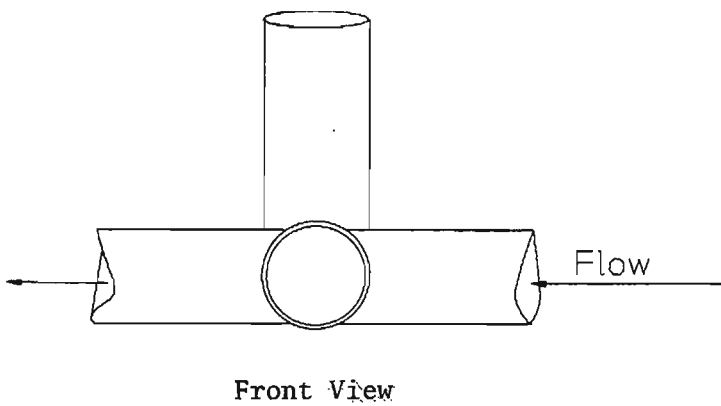
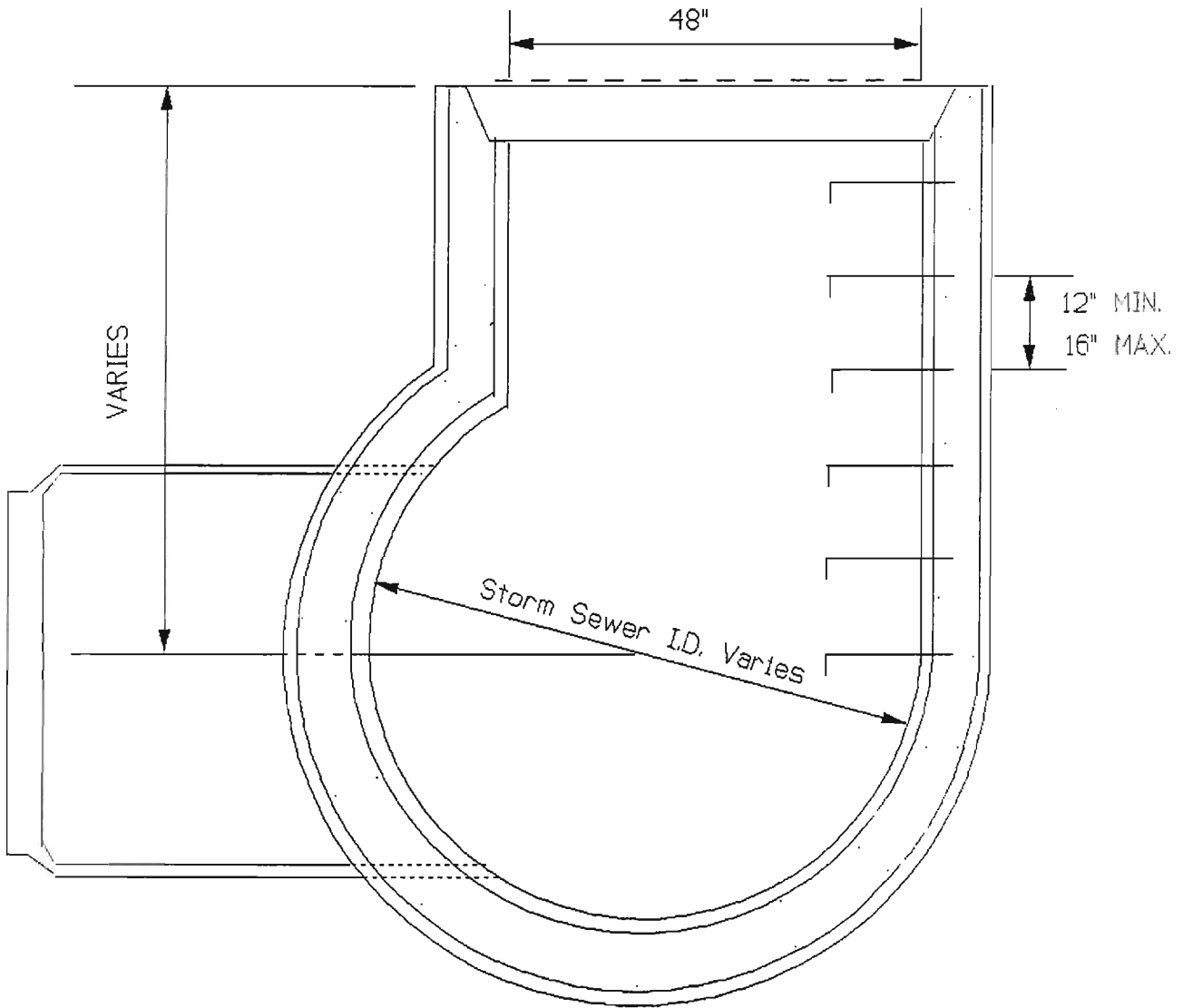


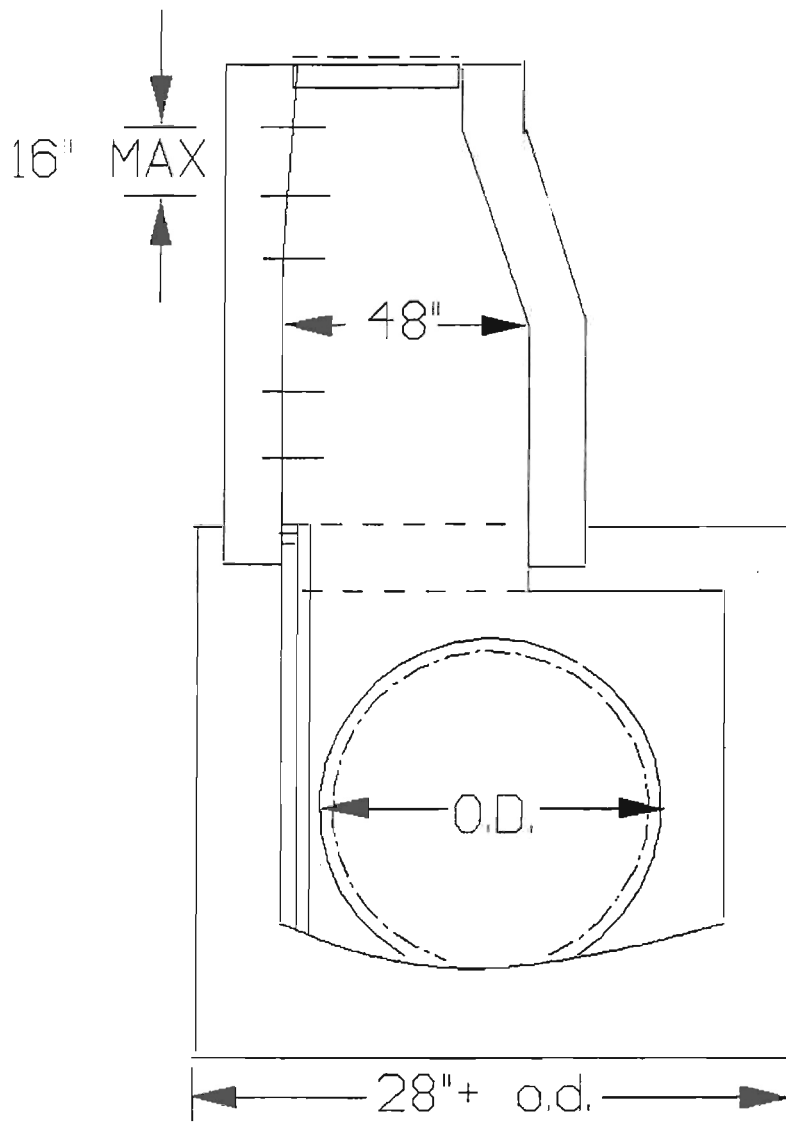
Figure 2



MANHOLE SPECIAL (10 FOOT)

-NO SCALE

Figure 3



CONCRETE MANHOLE AND BOX BASE
(Typical for Conduit 36" I.D. and Larger)

Figure 4

The installation sequence can be seen in accompanying photos in appendix A. Figure 3 shows the Type "T" design and figure 4 shows standard box base design.

III. Cost

The engineers estimate on Type "T" manholes was \$1500 each; however, Lawrence Construction bid \$6000 each. This is 62% higher than the price of standard box base manhole (bid at \$3700 each). These prices can vary due to the availability of the item. The cost is also high due to the extremely specialized and difficult casting of this particular manhole. If the Type "T" manhole were to be used more frequently, this cost should be reduced. But, if only for convenience to the public, the cost may be justified in areas with high traffic counts require the roadway to be closed for as short a period as possible.

IV. Evaluation

On October 2, 1990 the center lane of S.H. 285 at the Santa Fe intersection was closed to traffic by District 6 maintenance. At this time, the manhole cover was removed and the structure was inspected for cracking and any other type of distress that could be noted.

Approximately one year after installation, no cracking could be seen in the area of the riser or was any other type of structural distress noted. No blockages were noticed and hydraulic flow appeared to be normal or better than that of a normal box type manhole due to the smooth edges within the Type "T" manhole. In October of 1991, two years after placement the manhole was again inspected for distress. Visual observations were noted

to be the same as the evaluation from the previous year. No cracking or fatigue within the manhole could be seen and again the fluid flow through the manhole was normal with no blockages.

At this time, the experimental manhole is functioning as expected and appears to be a good alternative to the box-type manhole (Colorado Standard M-604-20) in locations where the roadway must be reopened to traffic as soon as possible.

V. CONCLUSIONS

The Type "T" manhole was placed on Hampden Ave. with little difficulty in construction and minimal disruption to traffic flow. The two main advantages to a Type "T" manhole is the ease of placement allowing quicker installation and thereby causing less traffic congestion and increasing overall safety on heavily traveled roadways. The other advantage is the fact that the manhole is basically part of the pipe, allowing good hydraulic flow with minimal restrictions caused by the manhole. A box base manhole has an area at its base that can collect trash and thereby over a period of time must be cleaned out to reduce the restrictions to hydraulic flow. The Type "T" manhole does not have this possible problem being that it resembles and acts like part of the existing pipe.

The Type "T" manhole on this project had a 62% higher cost possibly due to the fact that it was a different design than standard thereby causing a lot of work to be accomplished in the design and prefabricated construction. This cost should drop somewhat as this design sees more use. Even with higher costs, the fact that construction can be

completed in such reasonably short time, thereby reducing traffic congestion the use of this manhole is justified in high traffic areas.

Evaluations over a two year period showed the manhole to be performing as expected with no problems with fatigue or hydraulic flow.

In 1992 the Type "T" manhole design was added to the CDOT Standard Plans. The two types of manholes discussed are shown in appendix B from the M&S Standards M-604-20.

APPENDIX A
PHOTOGRAPHS

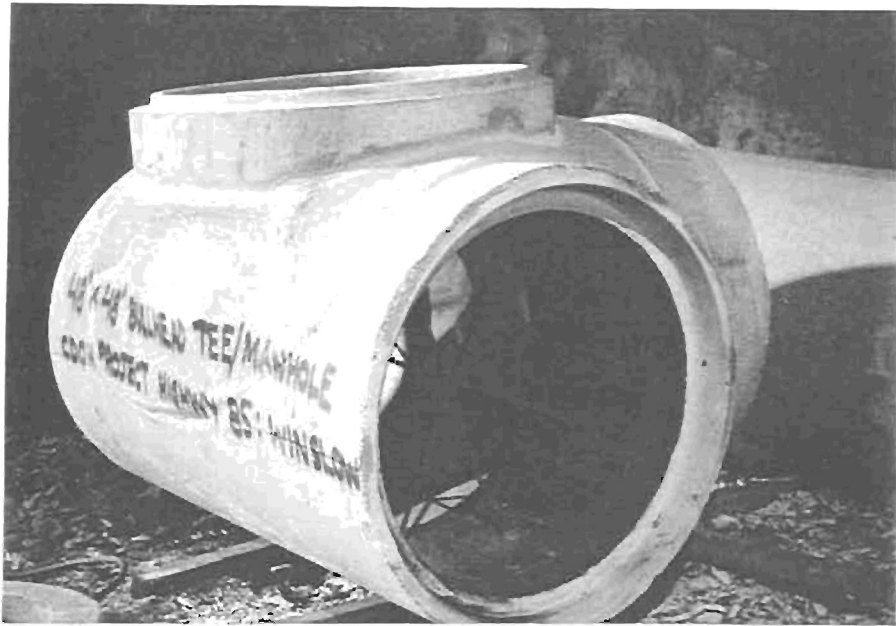


Photo 1 - Type "T" manhole to be placed on eastbound Hampden Ave. approximately 100 ft. east of the Santa Fe to eastbound Hampden ramp.

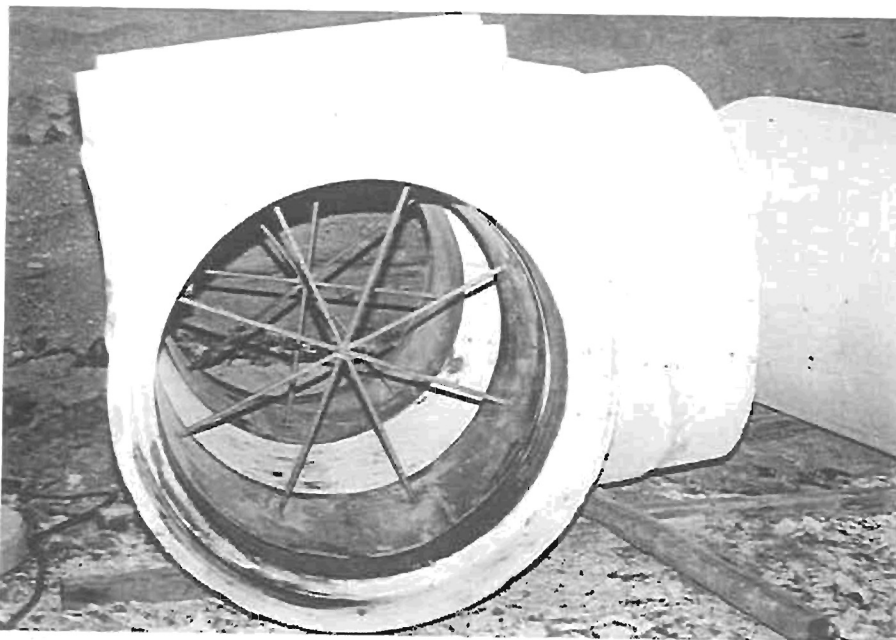


Photo 2 - This particular Type "T" manhole is a three way design. The rebar in the center is used for support during transit, and is removed after installation.



Photo 3 - Eastbound lanes on Hampden Blvd. were closed due to place the manhole. Excavation of existing storm drain required the entire width of roadway.



Photo 4 - A concrete saw was used to cut existing pipe allowing area for placement of new manhole.

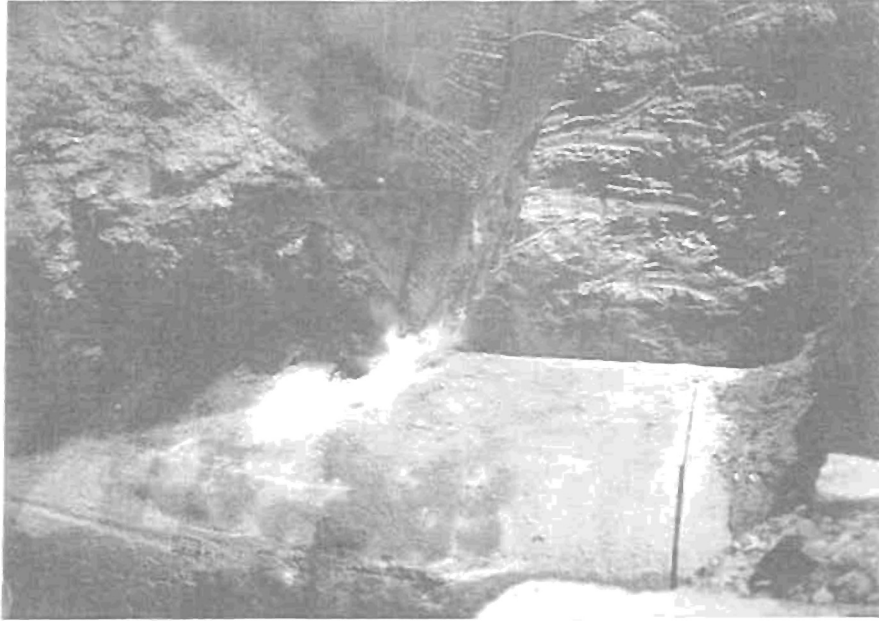


Photo 5 - After cutting pipe a back-hoe was used to break out a section of pipe where the manhole was to be placed.



Photo 6 - Same as above.

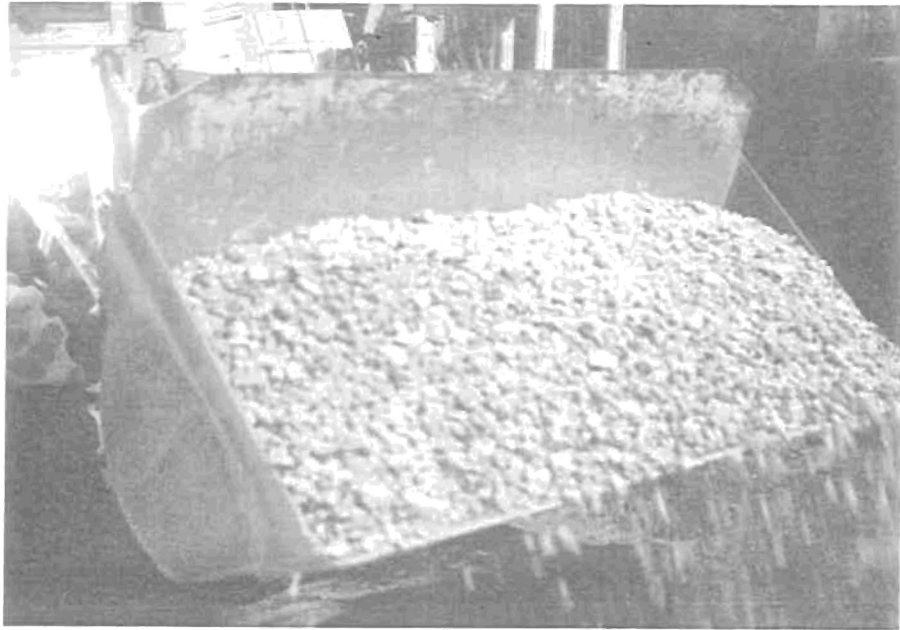


Photo 7 - A granular filter material was placed in the excavated area for a base before placing the manhole.



Photo 8 - The granular material placed.



Photo 9 - Same as photo 8.



Photo 10 - Type "T" manhole wa lifted with a crane and placed in the excavated area.

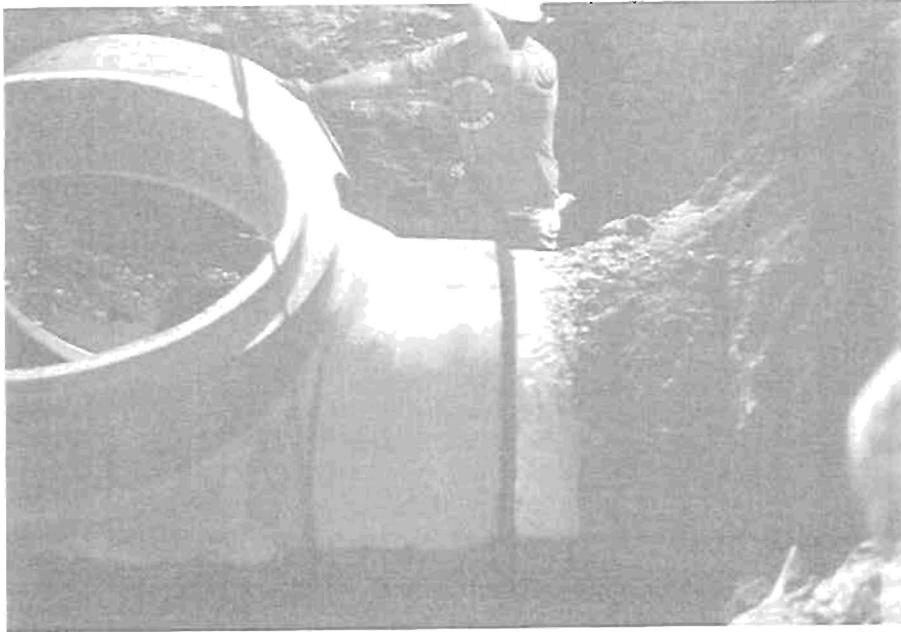


Photo 11 - The manhole was slowly lowered and fitted into position.



Photo 12 - After setting the manhole down a back-hoe was used to shift it vertically into position.

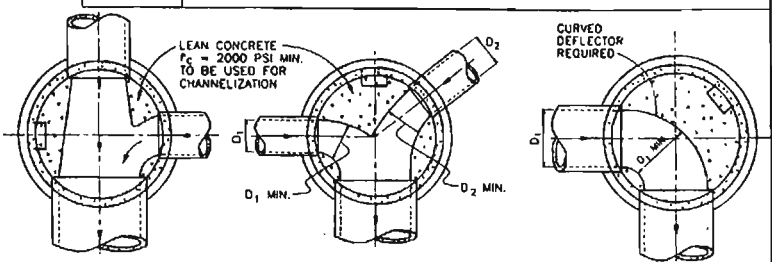
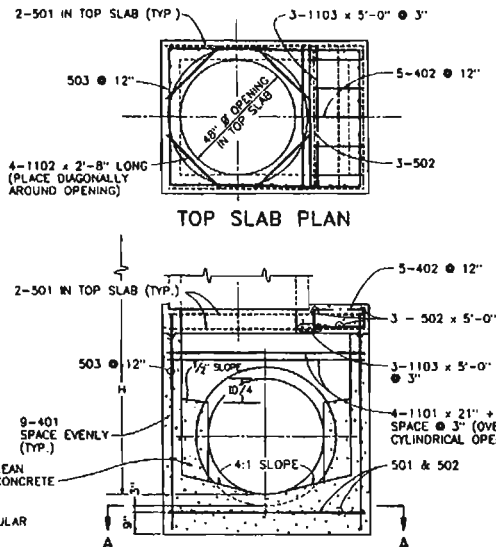
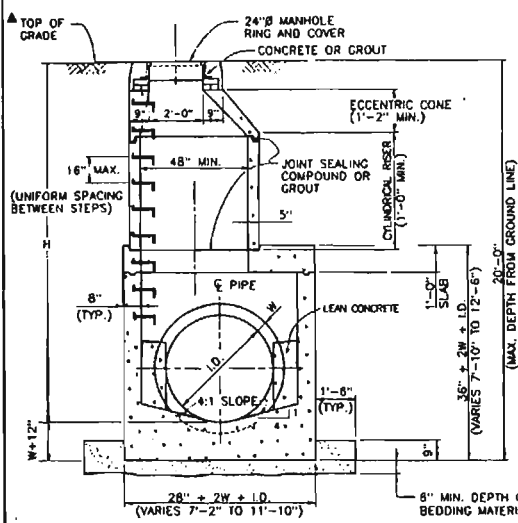


Photo 13 - Concrete with a 1-inch slump was used around the joint as a seal.



Photo 14 - The contractor used a class 2 backfill material around the manhole. By using this material the contractor was not required to use any devices for compaction.

APPENDIX B
CDOT MANHOLE STANDARDS



TYPICAL CHANNELIZATION DETAILS

GENERAL NOTES

SINCE ALL PIPE ENTRIES INTO THE BASE ARE VARIABLE, THE DIMENSIONS SHOWN ARE TYPICAL. ACTUAL DIMENSIONS AND QUANTITIES FOR CONCRETE AND REINFORCEMENT SHALL BE AS REQUIRED IN THE WORK.

THE PRECAST FLAT TOP MAY BE USED ON ANY MANHOLE. THE ECCENTRIC CONE MAY BE USED WHEN THE MANHOLE "H" HEIGHT IS AT LEAST 8'.

THE MH RING (FRAME) SHALL BE SET IN A BED OF GROUT. THE FRAME SHALL BE SURROUNDED WITH A CEMENT GROUT IN UNPAVED AREA, OR A CONCRETE COLLAR IN PAVED AREA. SEE DETAILS ON SHEETS 2 AND 3.

DESIGN OF BOX BASE IS BASED ON STRAIGHT RUNS OF CONDUIT OR CHANGE IN DIRECTION OF LESS THAN 45°. SPECIAL DESIGN IS REQUIRED FOR 45° OR GREATER.

PRECAST MANHOLES AND REINFORCEMENT SHALL CONFORM TO ASTM C 478 (AASHTO M 199).

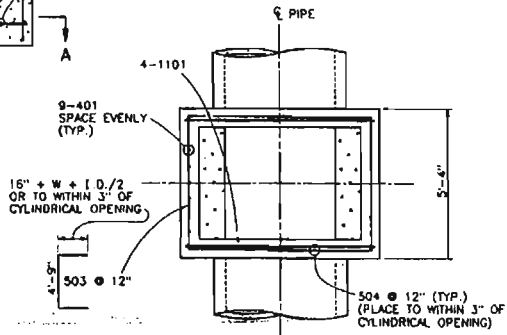
CAST-IN-PLACE MANHOLES SHALL BE CLASS A OR B CONCRETE. STEPS SHALL BE REQUIRED WHEN THE MANHOLE DEPTH EXCEEDS 3'-6" AND SHALL BE IN ACCORDANCE WITH AASHTO M 199.

ALL REINFORCING STEEL SHALL HAVE A MINIMUM YIELD STRENGTH OF 60,000 PSI. VERTICAL STEEL SHALL BE PLACED AT $\frac{1}{4}$ OF WALL. ALL BARS SHALL HAVE A 2" MINIMUM CLEARANCE.

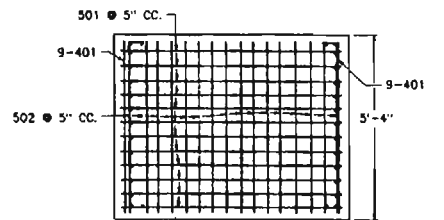
ALL PIPE ENTRIES INTO THE BASE OF MANHOLE SHALL BE CONNECTED BY OPEN CHANNELIZATION ADJUSTED FOR PIPE SIZE, SHAPE, SLOPE, AND DIRECTION OF FLOW. DETAILS SHOWN ARE TYPICAL FOR INSTALLATIONS WITH ALL INVERTS OF SAME RELATIVE ELEVATION. FOR EXCESSIVE ELEVATION DIFFERENCE BETWEEN INVERTS, SPECIAL BASE/CHANNEL DETAILS WILL BE SHOWN ON THE PLANS.

FLOW CHANNELS AND INVERTS SHALL BE FORMED BY SHAPING WITH LEAN CONCRETE ($F_c = 2000$ PSI MIN.).

STUB-OUTS SHALL EXTEND 2" MINIMUM BEYOND OUTSIDE WALL SURFACE OF MANHOLE AND BE SATISFACTORILY PLUGGED.



PLAN



SECTION A-A (STEEL IN BOTTOM OF BASE)

QUANTITIES FOR CONCRETE MANHOLE BOX BASE

MARK	SIZE	TYPE	WT. #/FT.	BARS	I.D.						FORMULAS
					54"	60"	66"	72"	84"	96"	
401	4	I	0.668	{ NO. REQ'D. LENGTH WEIGHT •	18 8'-1" 97.2	18 8'-8" 104.2	18 9'-3" 111.2	18 9'-10" 118.2	18 11'-0" 125.2	18 12'-2" 132.3	401 BAR LENGTH = 32'+2W+1.0.
402	4	III	0.668	{ NO. REQ'D. LENGTH WEIGHT •	5 9'-5" 18.1	5 8'-0" 20.0	5 8'-7" 22.0	5 7'-2" 23.9	5 8'-4" 27.8	5 9'-6" 31.7	402 BAR LENGTH = I.D. + 2W
501	5	I	1.043	{ NO. REQ'D. LENGTH WEIGHT •	17 7'-5" 131.5	17 8'-0" 141.2	17 8'-7" 152.2	17 9'-2" 162.5	17 10'-4" 183.2	17 11'-6" 203.9	501 BAR LENGTH = 24" + I.D. + 2W
502	5	I	1.043	{ NO. REQ'D. LENGTH WEIGHT •	22 5'-0" 114.7	23 5'-0" 119.9	25 5'-0" 130.4	26 5'-0" 135.6	28 5'-0" 151.2	32 5'-0" 166.9	502 NUMBER BARS REQ'D. = $J + \left(\frac{24 + I.D. + 2W}{5} + 1 \right)$
503	5	II	1.043	{ NO. REQ'D. LENGTH WEIGHT •	18 12'-10" 214.2	18 13'-5" 223.9	18 14'-0" 232.8	18 14'-7" 242.8	20 15'-9" 258.5	24 16'-11" 273.5	503 NUMBER BARS REQ'D. = $2 \left(\frac{13 + I.D. + 2W}{12} + 1 \right)$ BAR LENGTH = 4'-9" + 2(16" + W + I.D./2)
504	5	I	1.043	{ NO. REQ'D. LENGTH WEIGHT •	12 8'-1" 101.2	14 8'-8" 126.6	14 9'-3" 135.1	16 9'-10" 164.1	18 11'-0" 206.5	20 12'-2" 253.8	504 NUMBER BARS REQ'D. = $2 \left(\frac{2W + I.D. - d}{12} + 1 \right)$ BAR LENGTH = 32" + 2W + I.D.
1101	11	I	5.313	{ NO. REQ'D. LENGTH WEIGHT •	4 7'-2" 152.3	4 7'-9" 164.7	4 8'-4" 177.1	4 8'-11" 189.5	4 10'-1" 214.3	4 11'-3" 239.1	1101 BAR LENGTH = 21" + I.D. + 2W
1102	11	I	5.313	{ NO. REQ'D. LENGTH WEIGHT •	4 2'-8" 56.7	4 2'-8" 56.7	4 2'-8" 56.7	4 2'-8" 56.7	4 2'-8" 56.7	4 2'-8" 56.7	TYPE I
1103	11	I	5.313	{ NO. REQ'D. LENGTH WEIGHT •	3 5'-0" 79.7	3 5'-0" 79.7	3 5'-0" 79.7	3 5'-0" 79.7	3 5'-0" 79.7	3 5'-0" 79.7	TYPE II
REINFORCING STEEL TOTAL *					965.8	1,037.5	1,127.2	1,204.0	1,380.2	1,601.6	
CONCRETE - CUBIC YARDS - TOTAL					6.0	6.6	7.3	8.0	9.3	11.1	

NOTE: QUANTITIES ARE BASED ON SAME SIZE PIPE ENTRANCE TO AND EXIT FROM BASE AND A 4 FT. MANHOLE ENTRANCE INTO TOP SLAB OF BASE.

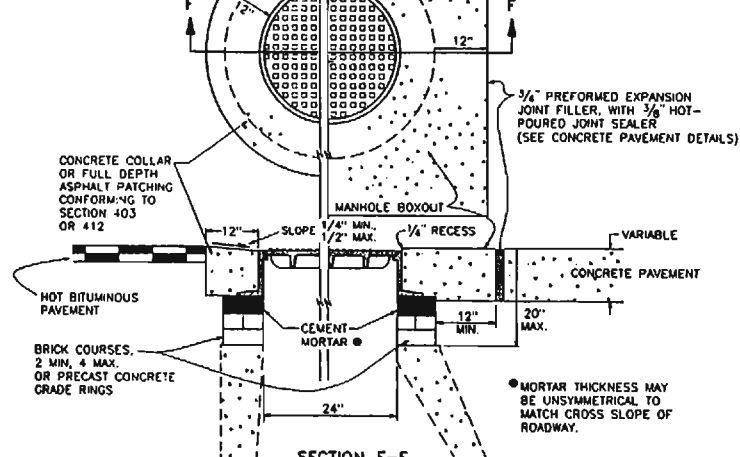
COLORADO
DEPARTMENT OF TRANSPORTATION

MANHOLES

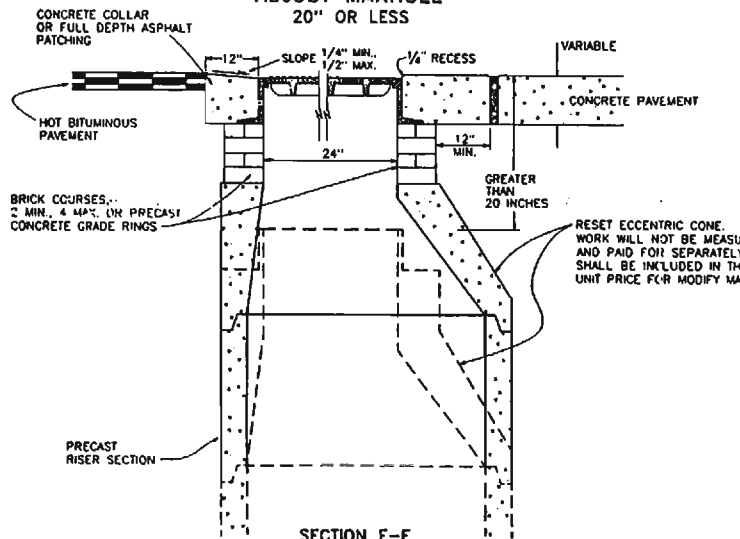
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DATE: NOV. 1, 1992

STANDARD PLAN NO.
M-604-20
SHEET 1 OF 3

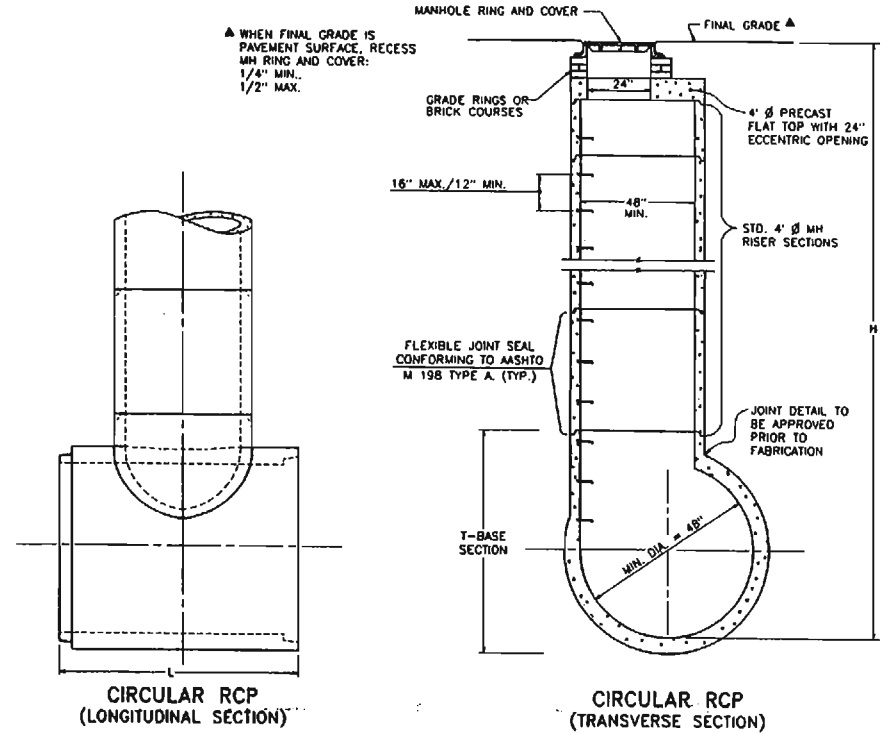
WHEN ADJUSTMENT HEIGHT IS 3" OR LESS, METAL ADJUSTMENT RINGS COMPATIBLE WITH THE EXISTING UN RING AND COVER MAY BE USED IF APPROVED BY THE ENGINEER.



SECTION F-F
ADJUST MANHOLE
20" OR LESS



SECTION F-F
MODIFY MANHOLE
GREATER THAN 20"



CIRCULAR RCP
(LONGITUDINAL SECTION)

CIRCULAR RCP
(TRANSVERSE SECTION)

MANHOLE T-BASE

T-BASE MANHOLES:
THE T-BASE SECTION SHALL BE SHOP-FABRICATED FOR DELIVERY TO THE CONSTRUCTION SITE AS A COMPLETE UNIT.
THESE DETAILS SHALL ONLY BE CONSTRUED TO SHOW CONCEPTUAL AND STANDARD DIMENSIONAL REQUIREMENTS FOR TYPE T-BASE MANHOLES. THE CONTRACTOR SHALL FURNISH DETAILED SHOP DRAWINGS FOR APPROVAL PRIOR TO FABRICATION. THE DETAILS SHOWN HEREIN APPLY ONLY TO 48-INCH DIAMETER PIPE AND LARGER.
EXCEPT FOR CLASS OF PIPE, SPECIFICATIONS TO BE MET FOR THE MANHOLE SHALL BE THE SAME AS THOSE REQUIRED FOR THE ADJOINING PIPE CULVERT OR SEWER.
THE T-BASE SECTION SHALL MAINTAIN ITS INTERNAL SHAPE AND FLOW AREA WITH ANY GROUTING, ETC. APPLIED SO AS TO NOT DISTURB THE NORMAL FLOW OR REDUCE THE AREA.

COLORADO DEPARTMENT OF TRANSPORTATION	
MANHOLES	
ISSUED BY STAFF DESIGN BRANCH	STANDARD PLAN NO. M-604-20
DATE REVISED	DATE: NOV. 1, 1992 SHEET 3 OF 3