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ENGINEERING INSTRUCTION

NEW YORK STATE DEPARTMENT OF TRANSPORTATION

SUBJECT: STANDARD DRAINAGE STRUCTURES

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Supersedes: EI 79-38

We have established a standard for drainage structures. To implement it we are now issuing a revised section 8.04.06 to the Highway Design Manual, a revised Section 604 to the Standard Specifications, a revised subsection 706-04 to the Standard Specifications and the following new standard sheets:

604-5 DRAINAGE STRUCTURE DETAILS
604-6 DRAINAGE STRUCTURE DETAILS FOR TOP SLABS
604-7 DRAINAGE STRUCTURE DETAILS - TOP SLAB REINFORCEMENT LAYOUT TABLES
604-8 DRAINAGE STRUCTURE DETAILS

The design manual revisions, specification revisions, and new standard sheets provide suitable drainage structures for most project drainage requirements, and it is anticipated that their use will provide both design and construction economies.

EI 79-38 STANDARD DRAINAGE GRATES is superseded. Standard frames and grates will now be those contained and/or listed on the new drainage structure standard sheets accompanying this EI. Special drainage structure designs should use these same frames and grates whenever possible.

The revised specifications and new standard sheets allow the designer the following options:

1. Selection of small rectangular drainage structures with no top slab. (By pay item). See Standard Sheet 604-8 for details.
2. Selection of round precast manholes 48" through 96" diameter. (By pay item). See Standard Sheet 604-8 for details.
3. Selection of rectangular drainage structures (36 x 36 through 80 x 80) with top slab. (By pay item). See Standard Sheets 604-5, 6 & 7, for details.

4. Selection of rectangular drainage structures (36 x 36 through 80 x 80) with top slab and contractor option of providing round alternate drainage structures. (By pay item). See Standard Sheets 604-5, 6 & 7 for details.

The revised specifications and standard sheets allow the Contractor the following options:

1. Unless prohibited in the contract documents the Contractor may propose the reduction of the size of the riser above the highest pipe entry by using flat slab reducers or corbeled (conical) riser sections. The use of flat slab reducers will be subject to the review and approval of the Engineer.

2. When the optional pay item is in the proposal the Contractor has the option of substituting round precast drainage structures for rectangular drainage structures. This substitution will be in accordance with the requirements of § 604-3.02 of the revised specifications and Standard Sheet 604-5.

3. The Contractor may provide cast-in-place or precast concrete rectangular drainage structures.

The new standard sheets show details for both rectangular and round drainage structures. Standard Sheets 604-5, 604-6, and 604-7 include details and requirements for rectangular drainage structures with top slabs and alternate round precast drainage structures. The top slab reinforcement tables of standard sheet 604-7 indicate the various frame types that can be utilized with the various rectangular top slabs. Minimum reinforcement embedment length in the top slabs limit the combinations of grates and top slabs. Note 15 on standard sheet 604-6 shows the pay item coding that will be used to describe a drainage structure by type (size) and what frame is utilized. Standard sheet 604-8 includes details and requirements for rectangular drainage structures without top slabs and for round precast manholes.

§ 604 and § 706-04 of the Standard Specifications have been rewritten to better describe the drainage structures, clarify the material requirements, construction details, method of measurement and basis of payments; and add the necessary pay items for the drainage structures.

§ 706-04 no longer is associated with the extensive quality assurance procedures for concrete pipe. Under § 604, shop drawings are required only for changes to drainage

units shown on the standard sheets or plans; for precast round units being substituted for rectangular units; and for contractor proposed flat slab reducers. The payment items for the various drainage structures have been coded to reflect the structure type (size) and the type of frame utilized.

Item 604.07XXYY Altering Drainage Structures, Leaching Basins, and Manholes has been serialized to provide the designer with additional items when the work differs appreciably between drainage structures.

Item 604.50XXYY Special Drainage Structure is a new serialized item intended to handle special Regional designs and to reduce the need for special specifications.

Section 8.04.06 of the Highway Design Manual has been rewritten and includes two (2) new design tables used to determine the internal wall dimensions based on the various pipe entries. These tables are used to select the appropriate structure size, (Types A through P). Section 8.04.06 also has two (2) new tables showing the maximum pipe size and skew for the type Q thru U drainage structures. Also included is a table showing the sizes of the standard drainage structures.

Designers please note the following:

1. The standard sheets and specifications do not refer to drop inlets, field inlets, and catch basins as in the past. The designer will indicate in the drainage or culvert tables what drainage structures are to receive sumps, drains, scoops, and formed inverts. See Note 5 on the standard sheets.

2. The standard sheet for Parallel Bar Type Grates and Frames has been revised and renumbered 655-8R5. There are now 6 sizes of Parallel Bar grates; 3 of them are new sizes to accommodate the rectangular drainage structures without top slabs. Sizes 6PCB, 7PCB, and 8PCB are only used in the F1, F2, and F3 cast iron frames with curb boxes. These grates have been increased in depth from 31/2" to 4" to accommodate the cast iron frames without shimming and to more easily utilize cam locking devices. New sizes 10PCB through 12PCB are utilized in drainage structures with and without top slabs.

3. Designers will have to indicate in their drainage tables the type of grate and curb box utilized when F1, F2 and F3 cast iron frames are specified.

4. The designer has been provided with pay items allowing the contractor to substitute round precast drainage units for rectangular units. If the shape is unimportant in the design and construction of the drainage system, the round units should be a viable alternative. However placement of round units in lieu of rectangular units may shift the centerline of the drainage structure as well as the centerline of pipe entries. If the shifting of pipe or drainage unit centerline presents any design or construction problems, or results in additional work or disruption of adjacent existing sections, the designer should refrain from using the item.

   The round units may be best suited to field inlet type installations or manhole type units that are not associated with curbs. Because the Department has limited experience with the use of round units for inlet type applications, designers should proceed with caution when considering the round alternate items.

The new standard sheets, design manual revisions and revised standard specifications are attached and shall become effective with the letting date of February 14,1991. The M.O. will insert the new § 604 and § 706-04 into proposals with 604 items.

In the interim, each Region should determine which Regional special specifications in the 604 series are to be retained. Those to be retained that require no modifications because of the new § 604 and § 706-04 specifications should be listed by memo to M. Tegza of the Final Plan Review Bureau. Special specifications requiring revision should be revised and submitted for approval and incorporation into the Engineer's Estimate Handling System. As of February 14,1991 all § 604 special specifications that have not been listed by memo for retention or revised and submitted for approval will be disapproved.

If any questions arise regarding this instruction you may contact Bruce Zeh at (518)457-4090 or William Hopkins at (518)457-4092.

8.04.06 SELECTION OF DRAINAGE STRUCTURE TYPES

An inlet structure consists of the drainage structure (riser, floor slab, and top slab) and surface inlet (frame and grate). Drainage structures up to 80" x 80", inside dimension, are detailed on the standard sheets and listed below in Table 8-1A "Table of Structure Sizes". When selecting a drainage structure the designer should note that the surface flow is always parallel to the length of the structure.

TABLE 8-1A
Table of Structure Sizes

Type	Internal Width	Internal Length	Type	Internal Width	Internal Length
A	36"	36"	L	80"	60"
B	48"	36"	M	36"	80"
C	60"	36"	N	48"	80"
D	80"	36"	O	60"	80"
E	36"	48"	P	80"	80"
F	48"	48"	Q	33"	36½"
G	60"	48"	R	33"	46½"
H	80"	48"	S	24"	32½"
I	36"	60"	T	26 1/2"	42½"
J	48"	60"	U	34"	37½"
K	60"	60"			

Note: Structures larger than 80" x 80", when required, shall be designed individually on a case by case basis.

Drainage structure types A through P utilize top slabs and accommodate a wide range of pipe sizes. Structure types Q through U do not utilize top slabs, are more economical to install and are limited to the smaller pipe sizes.

The smallest structure that will accommodate the pipe sizes and surface inlet should be specified. The standard sheets show what surface inlets (frames and grates) can be utilized with various structure types (sizes). Tables 8-1B and 8-1C provide the wall dimensions for Type A through P drainage structures based on the various concrete and corrugated pipe sizes, and the entry skew. Using the standard sheets and tables 8-1B and 8-1C, the designer should determine the drainage structure type that will accommodate the pipes and surface inlets selected.

Type Q through U drainage structure should be selected by the frames shown in Table 8-1D and the maximum allowable pipe sizes shown in Tables 8-1E and 8-1F.

TABLE 8-1B

**********CONCRETE DRAINAGE STRUCTURE INTERNAL WALL DIMENSIONS FOR TYPE A THRU P STRUCTURES USING CONCRETE PIPE**********

	ROUND PIPES											HORIZONTAL ELLIPTICAL PIPES						
PIPE ID	12	15	18	21	24	30	36	42	48	54	60	19x30	22x34	24x38	27x42	29x45	32x49	34x53
SKEW																		
0°	36	36	36	36	36	48	60	60	80	80	80	48	48	60	60	60	80	80
7.5°	36	36	36	36	48	48	60	60	80	80	80	48	48	60	60	80	80	80
15°	36	36	36	36	48	48	60	80	80	80		48	60	60	60	80	80	80
22.5°	36	36	36	48	48	60	60	80	80	80		60	60	60	80	80	80	80
30°	36	36	48	48	48	60	80	80	80			60	60	80	80	80	80	
37.5°	36	48	48	48	60	60	80	80		SPECIAL		60	80	80	80			
45°	48	48	60	60	60	80	80			DESIGN		80	80			SPECIAL DESIGN		

Computations were made for the internal wall dimensions using a reinforced concrete pipe with wall "B" as listed in § 706-02, a 3" clearance around the pipe for the knockout, and an 8" thick structure wall. Pipes with wall "C" as listed in § 706-02 will fit in all cases. However, a few of the pipes with wall "C" will have less than the a 3" knockout clearance but will always have more than the 2" minimum. For Vertical Elliptical Pipe use the horizontal dimension and pick a round pipe with the next larger diameter. Example, 45"x29" VE use a 30" round pipe to enter the table.

TABLE 8-1C

**********CONCRETE DRAINAGE STRUCTURE INTERNAL WALL DIMENSIONS FOR TYPE A THRU P STRUCTURES USING METAL OR PLASTIC PIPE**********

	ROUND PIPES											CORRUGATED METAL PIPE ARCH							
PIPE ID	12	15	18	21	24	30	36	42	48	54	60	17x13	21x15	24x18	28x20	35x24	42x29	49x33	57x38	60x46
SKEW																				
0°	36	36	36	36	36	48	48	60	60	80	80	36	36	36	36	48	60	60	80	80
7.5°	36	36	36	36	36	48	48	60	60	80	80	36	36	36	48	48	60	60	80	80
15°	36	36	36	36	36	48	48	60	60	80	80	36	36	36	48	48	60	80	80	80
22.5°	36	36	36	36	48	48	60	60	80	80	80	36	36	48	48	60	60	80	80	80
30°	36	36	36	48	48	48	60	80	80	80		36	48	48	48	60	80	80	80	
37.5°	36	36	48	48	48	60	80	80	80			48	48	48	60	60	80	80		
45°	36	48	48	60	60	80	80	80		SPECIAL DESIGN		48	60	60	60	80	80		SPEC.DESIGN	

Computations were made for the internal wall dimensions using 3x1 corrugations regardless of pipe size or material.

TABLE 8-1E

MAXIMUM PIPE SIZE AND SKEW FOR TYPE Q THRU U DRAINAGE STRUCTURES
ROUND CONCRETE PIPES

STRUCTURE TYPE WALL WIDTH & LENGTH	Q 33" WIDTH	Q 36½" LENGTH	R 33" WIDTH	R 46½" LENGTH	S 24" WIDTH	S 32½" LENGTH	T 26½" WIDTH	T 42½" LENGTH	U 34" WIDTH	U 37½ LENGTH
SKEW										
0°	21	24	21	30	12	21	15	30	21	24
7.5°	18	24	18	30	12	18	12	24	21	24
15°	18	21	18	30	**	18	12	24	18	21
22.5°	15	18	15	24	**	15	**	24	15	18
30°	12	15	12	24	**	12	**	21	15	15
37.5°	**	12	**	21	**	**	**	21	15	15
45°	**	**	**	15	**	**	**	12	**	**

Computations to determine the maximum pipe size were made using reinforced concrete pipe with wall "B" as listed in § 706-02, a 3" clearance around the pipe for the knockout, and an 8" thick structure wall. Pipes with wall "C" as listed in § 706-02 will fit in all cases with a few pipes having less than a 3" knockout clearance but at least the 2" minimum.

TABLE 8-1F

MAXIMUM PIPE SIZE AND SKEW FOR TYPE Q THRU U DRAINAGE STRUCTURES
ROUND CORRUGATED METAL OR PLASTIC PIPE

STRUCTURE TYPE WALL WIDTH & LENGTH	Q 33" WIDTH	Q 36½" LENGTH	R 33" WIDTH	R 46½" LENGTH	S 24" WIDTH	S 32½" LENGTH	T 26½" WIDTH	T 42½" LENGTH	U 34" WIDTH	U 37½ LENGTH
SKEW										
0°	24	24	24	36	15	24	18	30	24	24
7.5°	24	24	24	36	15	21	15	30	24	24
15°	21	24	21	30	12	21	15	30	21	24
22.5°	18	21	18	30	**	18	12	24	18	21
30°	15	18	15	24	**	15	**	24	15	18
37.5°	12	15	12	24	**	12	**	18	12	15
45°	**	12	**	18	**	**	**	15	**	12

Computations were made using 3x1 corrugations regardless of pipe size or material.

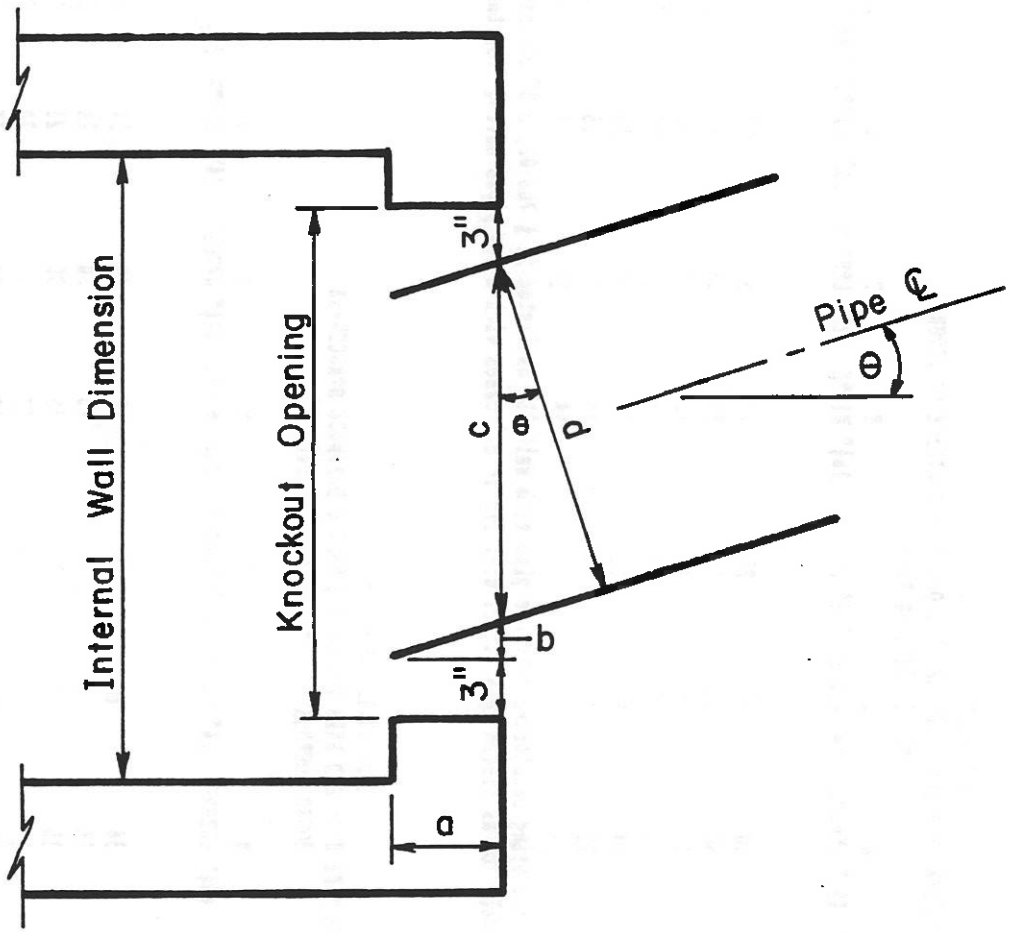

FIGURE 8-P

Method used to determine Knock-out Openings, minimum internal wall dimensions and maximum pipe sizes.

θ = Pipe skew angle
a = Wall thickness of drainage structure (inches)
d = Outside diameter of pipe (inches)
Knock-out clearance = 3" (specification is 2" min., 3" max.)
b = a(tan θ)
c = d/cos θ
Knock-out opening (inches) = b+c+6 = a(tan θ) + d/cos θ + 6
Knock-out opening $\leq$ Internal wall dimension.

TABLE 8-1D

RECTANGULAR DRAINAGE STRUCTURES
TYPE Q THROUGH U

TYPE	STRUCTURE WIDTH	STRUCTURE LENGTH	FRAME*
Q	33	36-1/2	F2
R	33	46-1/2	F3
S	24	32-1/2	11 and 10PCB
T	26-1/2	42-1/2	16 and 11PCB
U	34	37-1/2	22 and 12PCB

* For details of frames and grates see the current standard sheets in the 655 series.

Tables 8-1B, 8-1C, 8-1E and 8-1F were constructed using the relationships shown in Figure 8-P.

On deep structures with large pipes, the designer should consider designing special flat slab reducers or corbeling to reduce the size of the riser above the level of the pipe entries. As the use of flat slab reducers or corbeling is not always economical, the designer should analyze the cost factors in deep structures to determine if there is a cost savings. The flat slab reducers may be used on either rectangular or round structures, and corbeling is for use on round structures only.

Formed inverts and scoops (see Section 8.04.09) should be used to reduce head losses (Section 8.04.08) and to encourage self-cleaning.

Inlets should be selected to be hydraulically efficient under normal and debris conditions, bicycle safe and structurally durable. The "Bicycle-Safe Grate Inlet Study", Volumes 1 to 3, by FHWA (Ref. 34) discusses the hydraulic efficiencies under normal and debris conditions, as well as discussing bicycle safety.

The efficiency of inlets can be increased, and the number of inlets decreased, if the designer considers the economics of drainage when developing typical sections. The capacity of an inlet depends not only on its size but on the depth of the water over the grating. The depth of water can be increased without an excessive spread on the traffic lane by pitching the pavement as steep as the geometric criteria permits. The inlet efficiency is directly proportional to the depth and amount of water that runs across the inlet. Consequently, pavements with ¼"/ft. cross slopes and very flat (less than 1%) longitudinal slopes require an excessive number of inlets. Where even flatter slopes are encountered, non-draining low points can occur and might be best addressed through the use of pipe interceptor drains.

Inlets recessed back from the normal curb line will not be allowed due to the potential hazard they present. Inlets in or adjacent to the travel lane should be flush with the pavement but can have a total depression up to 1/2 inch.

Studies have shown that curb openings are not generally efficient unless they are extremely long. However, combination inlets (curb opening plus grate) are very valuable when debris is a problem and at low points where water velocities are low. Whenever inlets are placed along curbs, the combination grate should be used to gain this advantage.

The Standard Sheets show details for reticuline and parallel bar type grates with various type frames. These are reliable inlets that have proven to be efficient and durable. The hydraulic efficiencies under clean conditions are very close when comparing these two styles, but the reticuline is superior on bicycle safety and the parallel bar type is superior under debris conditions. However, reticuline grates can get plugged under some conditions particularly where small stones and sand are present.

As previously mentioned, pipe interceptor drain inlets provide an answer to draining very flat areas. A gutter line must still be formed, but the use of these inlets will address conditions where little or no longitudinal slope occurs. Pipe interceptor drains also have the advantage of reducing conflicts with underground utilities. The "Bicycle-Safe Grate Inlet Study", Volume 4, "Hydraulic Characteristics of Slotted Drain Inlets" (Ref. 34) includes procedures, charts and tables on how to determine capacities.

SECTION 604 - DRAINAGE STRUCTURES

604-1 DESCRIPTION

604-1 General. This work shall consist of the construction or alteration of drainage structures, manholes, leaching basins and transverse drainage interceptors in accordance with these specifications, the contract plans and the standard sheets.

604-1.01 Adjustment Rings and Frames for Drainage Structures and Manholes. The Contractor shall furnish and install prefabricated adjustment rings and frames for drainage structures and manholes. The extensions shall elevate and support drainage structure grates or manhole covers without the necessity of removing the original drainage structure frame or manhole casting, when the roadway is resurfaced.

604-2 MATERIALS

604-2.01 Drainage Structures and Manholes. Materials used for the construction of drainage structures and manholes shall be as indicated on the plans, and/or Standard Sheets, and shall conform to the requirements of the following:

Cast-in-Place Concrete - Class A	501
Frames and Grates	655
Concrete Repair Material	701-04
Concrete Grouting Material	701-05
Precast Concrete Pavers	704-13
Premolded Resilient Joint Filler	705-07
Mortar for Concrete Masonry	705-21
Reinforced Concrete Pipe	706-02
Precast Concrete Drainage Units	706-04
Bar Reinforcement, Grade 60	709-01
Wire Fabric for Concrete Reinforcement	709-02
Cold Drawn Wire for Concrete Reinforcement	709-09
Steps for Manholes	725-02

604-2.02 Transverse Drainage Interceptors. Materials used for the construction of transverse drainage interceptors shall meet the requirements of §604-2.01, except that bar reinforcement shall meet the requirements of §709-04, Epoxy Coated Bar Reinforcement Grade 60.

Transverse drainage interceptors, if precast, shall meet the requirements of §706-04, Precast Concrete Drainage Units.

Dowels shall be fabricated from epoxy coated bar reinforcement conforming to §709-04.

604-2.03 Leaching Basins. Materials used for the construction of leaching basins shall conform to the requirements of §604-2.01 and shall be as indicated on the plans. Concrete for precast units shall conform to the requirements of §706-04, Precast Concrete Drainage Units.

604-2.04 Adjustment Rings and Frames for Drainage Structures and Manholes. Materials for prefabricated adjustment rings and frames for drainage structures and manholes shall conform to the following:

Prefabricated Adjustment Rings and Frames for Drainage Units and Manholes	715-13

604-2.05 Altering Drainage Structures, Leaching Basins and Manholes. Materials for the repair and alteration of existing structures shall meet the requirements of §604-2.01 and shall be as indicated on the contract plans. Structures originally constructed with concrete block, common brick or concrete brick shall be altered with Precast Concrete Pavers, §704-13, unless indicated otherwise on the contract plans.

604-3 CONSTRUCTION DETAILS

604-3.01 Excavation. Excavation shall be in conformance with the Construction Details of §206-3 - Trench, Culvert and Structure Excavation.

604-3.02 Concrete Drainage Structures and Manholes. Concrete drainage structures and manholes shall be constructed in accordance with the requirements of these specifications, the Standard Sheets and plans. The Contractor shall have the option of erecting either cast-in-place or precast drainage structures unless specified otherwise. Cast-in-place drainage structures shall be constructed of Class A concrete and to the requirements of §555, Structural Concrete.

The Contractor shall have the option of constructing either a rectangular or circular drainage structure when such option is specified and allowed in the contract documents. When the circular structure is selected, it shall conform to the requirements of §706-04 and will require submission of complete working drawings to the Engineer for his review and approval.

Contractor proposed changes to drainage structures shown on the Standard Sheets or on the plans, other than minor changes approved by the Engineer, shall require submission of complete working drawings to the Engineer for his review and approval.

Unless prohibited in the contract documents, the Contractor shall have the option of reducing the size of the drainage structure riser above the uppermost pipe entry in accordance with the requirements of the Standard Sheets. Flat slab reducer designs proposed by the Contractor shall be subject to the review and approval of the Engineer and shall be accompanied by the following:

1. Working drawings prepared by a Professional Engineer licensed to practice in New York State.

2. The design calculations used in the preparation of the working drawings.

Acceptance of flat slab tops or platforms for flat slab reducer designs will be on the Basis of Proof-of-Design Test or on the Basis of Rational Design as required by ASTM C478.

604-3.03 Masonry Construction. Masonry construction, when indicated on the plans or standard sheets, shall consist of concrete pavers laid in full mortar beds. All joints shall be full mortar joints not greater than ½ inch wide. When specified, the outside of the masonry construction shall be plastered with ½ inch thick mortar coat.

604-3.04 Leaching Basins. Leaching basins shall be constructed in accordance with these specifications and the contract plans.

604-3.05 Pipe Entries. All pipe(s) built into the wall(s) of a drainage structure shall be flush with the inside face of the drainage structure wall and shall project outside a sufficient distance to allow connection with the adjoining section. The wall knockouts and sealing the space around the pipe shall be in accordance with the Standard Sheets. The bell of concrete pipe shall be cut off at every pipe entry where the bell enters the drainage structure.

604-3.06 Steps. Drainage structure steps may be cast or bolted in place during construction, mortared with a concrete grouting material after the structure is completed or attached by friction locking into preformed or drilled holes. The steps shall clear all pipes. Steps in risers and conical top sections shall be aligned to form a continuous ladder with rungs equally spaced vertically in the completed structure at a maximum distance of 16 inches. Steps shall be embedded into the walls of the riser or conical top section a minimum of 3 inches. The rung shall project a minimum clear distance of 4 inches from the walls of the riser or conical sections measured from the point of embedment.

604-3.07 Frames and Grates. Frames and grates shall be as specified in the contract documents. Frames located in the top slab or top of the uppermost riser shall be secured and held in place by a minimum of 4 stirrups or studs per frame, welded to the frame near the corners. Parallel bar frames shall contain shear stud anchors, for the purpose of transferring loads, as required and detailed on the standard sheet for parallel bar grates and frames. Shear stud anchors, when required, shall replace the frame securing stirrups or studs.

604-3.08 Altering Drainage Structures, Leaching Basins and Manholes. Reconstruction and adjustment of existing drainage structures shall be as detailed and specified on the contract plans. Construction with cast-in-place concrete shall conform to the requirements of §555, Structural Concrete.

Frames, grates and covers to be reused shall be removed, cleaned and reset at the required elevations. New frames, grates and manhole covers shall be installed when specified.

Upon completion, each structure shall be cleaned of any accumulation of silt, debris or foreign matter of any kind and shall be kept clear of such accumulation until final acceptance of the work.

604-3.09 Adjustment Rings and Frames for Drainage Structures and Manholes. Prior to the placement of the surface course and after the placement of the binder course, when required, the Contractor shall install adjustment rings and frames for manholes and drainage units. The adjustment ring or frame shall be placed so the manhole cover or drainage unit grate will not protrude above the finished surface of the pavement. When adjustment rings or frames having incremental height adjustments are installed and the increment cannot produce a height which will result in the cover being flush with the pavement surfaces they shall be installed so the cover or grate is no more than one increment below the finished grade of the pavement.

To assure a firm and secure fit with the adjustment ring or frame, the seat of the existing manhole casting or drainage unit frame shall be free of all foreign material at the time of installation. The entire assembly shall be set on the seat of the existing manhole casting or drainage unit frame and the locking devices shall be tightened evenly. The manhole cover or drainage unit grate shall then be set upon the seat of the adjustment ring or frame.

The contractor shall be responsible for insuring that the adjustment rings and frames are compatible with the existing manhole castings and covers or drainage frames and grates.

All rings or frames shall be protected from displacment caused by traffic maintained on the roadway or equipment used in the paving operation.

The Contractor shall have the option of removing and resetting the existing manhole casting or drainage unit frames to the required grade where shown on the plans or approved by the Engineer.

604-3.10 Transverse Drainage Interceptors. This work shall consist of the construction of reinforced concrete transverse drainage interceptors with frames and grates, and dowels as shown on the plans or Standard Sheets. Unless specifically designated on the plans and/or in the proposal, the Contractor shall have the option of constructing cast-in-place or precast transverse drainage interceptors.

A. **Cast-in-Place.** Cast-in-place transverse drainage interceptors shall conform to the requirements of Section 555, Structural Concrete. The cast-in-place interceptors shall be constructed so that they have construction joints at a maximum spacing of 24 feet, unless the Engineer gives written directions otherwise or a longer length is specified on the plans.

B. **Precast Interceptors.** Precast interceptors shall be laid in reasonably close conformity to line and grade and shall have a full, firm and even bearing at each joint and along their entire length.

They shall be handled and assembled in accordance with the manufacturer's instructions, except as modified on the plans or by the Engineer's written directions. One-quarter inch thick Premoulded Resilient Joint Filler shall be placed in the joint between the units, and the lifting hole and dowels shall be grouted with material conforming to §701-04 or §701-05.

Underdrain and Underdrain Filter shall be installed when shown on the plans or directed by the Engineer.

The underdrain pipe shall be installed in accordance with §605-3.01, and the underdrain filter shall be placed in accordance with §605-3.02 except when the details of either or both are modified on the plans or by the Engineer's written order.

604-3.11 Backfill. No structure shall be backfilled until all the mortar has completely set. The requirements of §203-3.15, Fill and Backfill at Structures, Culverts, Pipes, Conduits and Direct Burial Cable, shall apply.

604-4 METHOD OF MEASUREMENT

604-4.01 Drainage Structures, Leaching Basins and Manholes. Drainage structures, leaching basins and manholes will be measured for payment by the number of linear feet of height measured to the nearest tenth of a foot from the bottom of the base to the top of the masonry, including the top slab.

604-4.02 Transverse Drainage Interceptors

A. **Cast-In-Place.** Cast-in-place transverse drainage interceptors will be measured by the actual length of interceptor placed.

B. **Precast.** Precast transverse drainage interceptors will be measured by multiplying the number of whole units by the nominal length of each unit and adding thereto the length of any fractional units incorporated in the work. The nominal length of the units shall be indicated on the Standard Sheet.

604-4.03 Altering Drainage Structures, Leaching Basins and Manholes. Altering drainage structures, leaching basins and manholes will be measured by the number of structures altered.

604-4.04 Adjustment Rings and Frames for Drainage Structures and Manholes. This work will be measured by the number of prefabricated adjustment rings or frames furnished and installed.

604-5 BASIS OF PAYMENT

604-5.01 Drainage Structures, Leaching Basins and Manholes. The unit price bid per linear foot shall include the cost of all labor, equipment and materials, including bar reinforcement and welded wire fabric, necessary to complete the work, except the following:

A. Excavation will be paid for under Trench and Culvert Excavation.

B. Backfill of drainage structures and leaching basins will be paid for under the item(s) shown in the contract documents.

C. Frames, covers and grates will be paid for under the appropriate payment items for Frames and Grates in §655.

604-5.02 Contractor Options. When the specifications allow the contractor to substitute a precast circular drainage unit in lieu of a rectangular drainage unit or the contractor constructs a flat slab reducer design under the provisions of §604-3.02, the following basis of payment provisions will apply.

1. §604-5.01 will apply.

2. Payment for excavation and backfill will be for those quantities determined for the original structure.

3. No adjustments will be made to the unit price bid for the original structure.

604-5.03 Altering Drainage Structures, Leaching Basins and Manholes. The unit price bid for each shall include the cost of all material, labor and equipment necessary to satisfactorily complete the work including all necessary cleaning, excavation, backfill, and replacment of any pavement, shoulder and sidewalk courses, subcourses, curbs, drives, lawns and any other surface. Frames, covers or grates to be reused that are broken by the Contractor's operations shall be replaced at the Contractor's expense.New frames, covers and grates will be paid for under the appropriate payment items for Frames and Grates in §655.

604-5.04 Adjustment Rings and Frames for Drainage Structures and Manholes. The unit price bid for each adjustment ring or frame shall include the cost of all material, labor and equipment necessary to satisfactorily install the adjustment rings and frames. If the Contractor elects to reset the existing casting or frames, the costs of the work involved in the removal and replacement of existing disturbed pavement shall be included in the price bid for the adjustment rings and frames.

604-5.05 Transverse Drainage Interceptors. The price per linear foot bid for this work shall included the cost of furnishing all labor, materials and equipment necessary to complete the work, except the excavation will be paid for under Trench and Culvert Excavation, and the Underdrain and Underdrain Filter will be paid for under their respective items.

Payment will be made under:

Item No.	Item	Pay Unit
604.01	Leaching Basins	Linear Foot
604.06	Transverse Drainage Interceptors	Linear Foot
604.07XXYY	Altering Drainage Structures, Leaching Basins and Manholes 604.07XXYY YY — Serialized 01 to 99* XX — Region (01 through 11)	Each
604.10	Prefabricated Adjustment Rings for Manholes	Each
604.11	Prefabricated Adjustment Frames for Drainage Structures	Each
604.30XXYY	Rectangular Drainage Structure 604.30XXYY YY — Frame No. ** XX — Structure Type **	Linear Foot
604.31XXYY	Rectangular Drainage Structure with Round Option 604.31XXYY YY — Frame No. ** XX — Structure Type **	Linear Foot
604.40XX	Round Precast Manhole 604.40XX XX — Diameter (inches)	Linear Foot
604.50XXYY	Special Drainage Structure 604.50XXYY YY — Serialized (01 to 99) * XX — Region (01 through 11)	Linear Foot

* Serialized number identifies structure detailed on the plans.

** Structure type and frame number are as defined on the Drainage Structure Details Standard Sheets and the Grate and Frame Standard Sheets.

706-04 PRECAST CONCRETE DRAINAGE UNITS

SCOPE

This specification covers the material and fabrication requirements for precast concrete drainage units including transverse drainage interceptors.

GENERAL

Precast concrete drainage units shall be machine made or cast at a manufacturers yard in conformance with these specifications and to the size, shape and requirements shown on the standard sheets or plans. Drainage units shall be manufactured under inspection procedures stipulated by the directives of the Materials Bureau.

A. Machine made units are those made by the following methods:

1. Packerhead
2. Roller suspension
3. Centrifugal
4. Machine tamped
5. Machine vibrated
6. Other methods as defined by the Materials Bureau

These methods use very low slump concrete and the methods of consolidation produce a dense product with low permeability and good resistance to freeze-thaw damage.

B. Cast units are those made from concrete placed and consolidated by conventional equipment. These units develop resistance to freeze-thaw damage through the use of entrained air in the concrete.

MATERIAL REQUIREMENTS

General. All materials used in the manufacture of precast concrete drainage units shall conform to the requirements of the specifications listed below:

Frames and Grates	655
Portland Cement (Types 1,2, or 3)	701-01
Concrete Repair Material	701-04
Coarse Aggregates	703-02
Concrete Sand	703-07
Reinforcement	
Bar Reinforcement, Grade 60	709-01
Wire Fabric for Concrete Reinforcement	709-02
Cold Drawn Wire for Concrete Reinforcement	709-09
Admixtures	711-08
Fly Ash	711-10
Water	712-01
Steps for Manholes	725-02
Elastomeric Gaskets	NYSDOT Approved List
Pipe Joint Sealing Compound	NYSDOT Approved List

Bar reinforcement for transverse drainage interceptors shall meet the requirements of SS709-04 Epoxy Coated Bar Reinforcement, Grade 60.

The ends of chairs or spacers, used to support or locate reinforcing steel, that may come in contact with the faces of the form shall be made or coated with non-corrosive material.

The manufacturer shall maintain at the manufacturing site a record of materials used and their sources, and a copy of the concrete mix design for a minimum of 3 years following the final payment of the project.

Fabrication Requirements

1. Drawings. When working drawings are necessary for the manufacture of precast drainage units, five prints of each drawing shall be submitted to the Engineer for his review and approval. Unless otherwise shown on the plans, the tolerances of all dimensions, including the reinforcing shall be $\pm$ 1/4 inch.

2. Round Units. Precast bases, floors, risers, conical top sections, grade rings and flat slab tops shall conform to the design, dimension and reinforcement requirements of ASTM C478. The C478 requirements for splices, laps and welds shall not apply. All bar reinforcement steel shall be tied as specified under (a) Tying below. Tack welding or any other welding of specified bar reinforcement will not be allowed. Welding for cage stability will be permitted provided that redundant steel is added in each direction and tied to the cage. The redundant steel shall be thirty (30) bar diameters, minimum, in length and shall be positioned so that the midpoint is located at the weld.

   Wire fabric splices shall be secured by one of the following methods:

   (a) Tying: Under this method the ends shall lap to a length of not less than thirty (30) diameters of the reinforcement and the lap shall contain a longitudinal member. A sufficient number of laps shall be tied to maintain continuity of the cage through the period of placement and curing of the concrete.

   (b) Welding: Each circular member shall be lapped a minimum of two (2") inches and welded by one of the following methods:

      a. Electric arc welding
      b. Resistance spot welding
      c. Fusion welding
      d. Oxyacetylene torch welding