

Proposed Code Change:

Supporting Statement (Reason for change should include an “authoritative source” and cost analysis where appropriate.):

Changes to the technical requirements in the standards must be based on recommended site improvement standards that are published by an academic or professional institution or organization, similar to those used in the original Rutgers Model Subdivision and Site Plan Ordinance.

New Rule, R.2001 d.352, effective October 1, 2001.
 See: 33 N.J.R. 1237(a), 33 N.J.R. 3427(a).

TABLE 4.1

AVERAGE DAILY MOTOR VEHICLE
 TRAFFIC TRIP GENERATION
 PER DWELLING UNIT¹

SUBCHAPTER 4. STREETS AND PARKING

Subchapter Historical Note

Administrative change.

See: 35 N.J.R. 609(b).

5:21-4.1 Street hierarchy

(a) Streets shall be classified in a hierarchy with design tailored to function. The street hierarchy definitions contained within this section are applicable only to local residential streets and are not to be considered related to the U.S. Department of Transportation, Federal Highway Administration's Functional Classification of Highways.

(b) The street hierarchy system shall be defined by road function and average daily traffic (ADT), calculated by trip generation rates from the current edition of "Trip Generation" by the Institute of Transportation Engineers, as indicated in Table 4.1 below. Trip generation rates from other sources may be used if the applicant demonstrates to the appropriate approving authority that these sources better reflect local conditions. In addition, the applicant shall investigate the opportunities for, and availability of, transit facilities and, if appropriate, consider their impact(s) on motor vehicle traffic trip generation rates per dwelling unit.

(c) Each residential street shall be classified and designed to meet the standards for one of the street types defined in Table 4.2 below. The entire length of the street need not be designed based on the highest ADT where the ADT varies along the street's length. However, each street segment between intersections shall be designed based on the highest ADT served in that segment.

(d) The municipality and the developer shall determine the highest order street required to be used in a given residential development, considering all of the following:

1. The size of the development (number and type of units). For example, using size to determine the highest order of street required, a development of up to 150 single-family detached units would not require any minor collectors or streets of a higher order;

2. The actual or potential development of adjacent sites (whether there is likely to be traffic passing through from neighboring developments). A "potential" development means a development having approvals granted, applications pending, or undergoing preliminary review; and

3. The streets proposed for that area, if any, as contained in the municipal master plan.

Land use ²	Peak rate
Single-family detached housing	10.1
Townhouse	5.9
Low-rise apartment	7.2
Mid-rise apartment	5.5
High-rise apartment	5.0
Mobile home park	5.0
Retirement community	2.8
Recreational homes (owner occupied)	3.2

Notes:

¹ The trip generation rates listed are guidelines only. The actual use of trip generation rates is derived by the use of regression analysis and should be computed only by professionals proficient in the use of the ITE Trip Generation manual. The "Land Use" definitions are based on the ITE manual with slight modifications to address inconsistencies contained within the ITE manual.

² For two-family dwellings (duplexes), apply the values for single-family dwellings to each unit.

Source: Institute of Transportation Engineers, Trip Generation (Washington, D.C.: ITE, 1982), 3rd Edition. The table was updated with data from the 6th Edition of the manual published by ITE in 1997. The peak ADT rates take into consideration Saturday and Sunday rates, as well as weekday rates.

DEFINITIONS

Land use	Definition
Single-family detached housing	Any single-family detached home on an individual lot.
Townhouse	Attached multiple-family dwelling units where the only separation between units is vertical.
Apartment	A dwelling unit located within the same building with at least three other dwelling units.
Low-rise apartment	Apartments in buildings that have one or two levels (floors).
Mid-rise apartment	Apartments in buildings that have more than two levels (floors) and less than ten levels.
High-rise apartment	Apartments in buildings with ten or more levels (floors).
Mobile home park	Generally trailers shipped, sited and installed on permanent foundations and in areas that typically have community facilities, such as recreation rooms, swimming pools, and laundry facilities.

<u>Land use</u>	<u>Definition</u>	<u>Land use</u>	<u>Definition</u>
Retirement community	Residential units similar to apartments and condominiums usually restricted to adults or senior citizens, and located in self-contained villages. Special services such as medical, dining, and retail facilities may be available.	Recreational home	Dwellings usually located in a resort containing local services and complete recreational facilities. These are often second homes used by the owner or rented on a seasonal basis.

TABLE 4.2
RESIDENTIAL STREET HIERARCHY DEFINITIONS

<u>Street type</u>	<u>Description</u>	<u>Average daily traffic (maximum)</u>
Residential Access [‡]	<p>Lowest order, other than rural street type, of residential streets Provides frontage for access to lots and carries traffic with destination or origin on the street itself. Designed to carry the least amount of traffic at the lowest speed. All, or the maximum number of housing units, shall front on this class of street.</p> <p>[†] Residential access streets of "loop" configuration, that is, two ways out, should be designed so no section conveys an ADT greater than 1500. Each half of a loop street may be classified as a single residential access street, but the total traffic volume generated on the loop street should not exceed 1500 ADT, nor should it exceed 750 ADT at any point of traffic concentration.</p>	1,500 [†]
Residential Neighborhood [‡]	<p>A type of residential access street conforming to traditional subdivision street design, and providing access to building lots fronting on a street and parking on both sides of street.</p> <p>[‡] Applicant may choose either the RESIDENTIAL ACCESS or the RESIDENTIAL NEIGHBORHOOD street type for new streets. See section 4.8(b) for specific right-of-way and cartway width requirements for new streets that are a continuation of an existing street.</p>	
Minor Collector	<p>Middle order of residential street. Provides frontage for access to lots and carries traffic of adjoining residential access streets. Designed to carry somewhat higher traffic volumes than lower-order streets such as rural and residential access streets, with traffic limited to motorists having origin or destination within the immediate neighborhood. Is not intended to carry regional traffic.</p> <p>Each half of a loop-configured minor collector may be classified as a single minor collector street, but the total traffic volume conveyed on the loop should not exceed 3,500 ADT, nor should it exceed 1750 ADT at any point of traffic concentration.</p>	3,500
Major Collector	<p>Highest order of residential streets. Conducts and distributes traffic between lower-order residential streets and higher-order streets—arterials and expressways. Carries the largest volume of traffic at higher speeds. Function is to promote free traffic flow; therefore, parking should be prohibited and direct access to homes from this level of street should be avoided. Collectors should be designed so they cannot be used as shortcuts by non-neighborhood traffic.</p>	7,500
Special Purpose Streets		
Rural	<p>A rural street is a street that serves dwellings on lots that are one acre or greater, AND primarily serves as access to abutting building lots, AND has no on-street parking, AND has lot-to-street access designed so vehicles do not back out of lots onto the street. Rural streets shall only connect to rural streets, rural residential lanes, or mixed-use collectors. However, a rural street shall not connect two mixed-use collectors.</p>	500
Rural residential lane	<p>A rural residential lane is a street that serves dwellings on lots that are two acres or greater, AND primarily serves as access to abutting building lots, AND has no on-street parking, AND has lot-to-street access designed so vehicles do not have to back out of lots onto the street. Rural residential lanes shall only connect to rural streets, rural residential lanes, or mixed-use collectors. However, a rural residential lane shall not connect two mixed-use collectors.</p>	200

Street type	Description	Average daily traffic (maximum)
Alley	A service road that provides a secondary means of access to lots. On same level as residential access street, but different standards apply. No parking shall be permitted; alleys should be designed to discourage through traffic. ADT level shall not exceed that of a residential access street.	500
Cul-de-sac ¹	A street with a single means of ingress and egress and having a turnaround, the design of which may vary. A divided-type entrance roadway to at least the first cross street, with median of sufficient width to ensure freedom of continued emergency access by lanes on one side, shall not be considered part of a cul-de-sac. Parking lots with a single means of ingress and egress shall not be included within the definition of cul-de-sac.	250
Marginal access street	A service street that runs parallel to a higher-order street and provides access to abutting properties and separation from through traffic. May be designed as residential access street or minor collector, according to anticipated daily traffic.	1,500 (residential access total) 3,500 (minor collector total)
Divided street	Municipalities may require streets to be divided to provide alternate emergency access, protect the environment, or avoid grade changes. Design standards should be applied to the combined dimensions of the two street segments, as required by the street class.	
Multifamily access cul-de-sac	A street with a single means of ingress and egress, which serves multifamily development, that provides a means for vehicles to turn around.	1,000
Multifamily court	A street with a single means of ingress and egress, which serves multifamily development, that does not provide a means for vehicles to turn around. The length of multifamily courts is limited to 300 feet.	Note ²

Notes:

¹ Streets serving multifamily developments with a single means of ingress and egress shall be classified as multifamily access cul-de-sacs.

² There is no ADT limit for multifamily courts specified because the length of the court will effectively limit the ADT to acceptable levels.

Administrative correction.
See: 29 N.J.R. 1296(a).
Amended by R.1999 d.374, effective November 1, 1999 (operative May 1, 2000).
See: 31 N.J.R. 477(a), 31 N.J.R. 3259(a).
In (c), added a second sentence; and in Table 4.2, added a third sentence in the Cul-de-sac Description, and substituted a reference to non-parallel parking for a reference to perpendicular parking in the Parking Loop Description.
Administrative correction.
See: 32 N.J.R. 684(b).
Amended by R.2000 d.480, effective December 4, 2000 (operative June 3, 2001).
See: 32 N.J.R. 2670(b), 32 N.J.R. 4277(a).
Rewrote Table 4.1 and in Table 4.2, rewrote the description of "Rural residential lane".
Amended by R.2002 d.399, effective December 16, 2002.
See: 34 N.J.R. 2615(a), 34 N.J.R. 4412(a).
In Table 4.1, inserted "Trip General" preceding "manual" in the second sentence of footnote 1, and added footnote 2; rewrote Table 4.2.
Public Notice: Notice regarding the Publication of two Notices of Adoption in the December 16, 2002 New Jersey Register.
See: 34 N.J.R. 4343(a), 4412(a), 35 N.J.R. 219(b).

5:21-4.2 Cartway width

(a) Cartway width for each street classification shall be determined by parking and curbing requirements that are based on intensity of development.

(b) Intensity of development shall be based on dwelling units per gross acre as follows:

Intensity	Dwelling Units per Gross Acre [†]
Low	Less than or equal to 4
Medium	More than 4 and less than or equal to 8
High	More than 8

Note: [†]In determining the intensity of development, the gross acreage shall not include dedicated common open space or other such areas restricted from future development.

(c) Cartway widths for each street classification are as shown in Table 4.3 below.

(d) Cartway width also shall consider possible limitations imposed by sight distances, climate, terrain, and maintenance needs.

(e) Municipalities may require additional cartway width for major or minor collectors which are part of a designated bike route as indicated in the bicycle circulation part of the municipal master plan to make them consistent with the AASHTO guidelines for bicycle-compatible streets.

TABLE 4.3
CARTWAY AND RIGHT-OF-WAY WIDTHS

Street type ^a	Total avg. daily traffic	Traveled way	No. of parking lanes ^b	Parking lane width	Cartway width	Curb or shoulder ^h	Sidewalk or graded area ^j	Right-of-way width ⁱ
Residential access	1,500 [†] (loop—750 each half)							
a. Parallel parking								
Low intensity		21 feet	1	7 feet	28 feet	None	1 SW GA	50 feet
Medium intensity		21 feet	1	7 feet	28 feet	Curb	2 SW	50 feet
High intensity (on-street parking)		21 feet	1	7 feet	28 feet	Curb	2 SW	50 feet
b. Nonparallel parking (all intensities)								
One-side parking		24 feet	1	18 feet		Curb	2 SW ⁿ	54 feet
Two-side parking		24 feet	2	36 feet		Curb	2 SW ⁿ	72 feet
c. No parking								
High intensity (off-street parking)		20 feet	0	0 feet	20 feet	None	2 SW	50 feet
Neighborhood (all intensities)	1,500	16 feet	2	14 feet	30 feet ^c	Curb	2 SW	50 feet
Minor Collector ^l	3,500							
Low intensity ^d with no parking		20 feet	0	0 feet	20 feet	None	1 SW 1 GA	50 feet
Low with one parking lane		21 feet	1	7 feet	28 feet	Curb	1 SW 1 GA	50 feet
Medium and High intensity								
With one parking lane		21 feet	1	7 feet	28 feet	Curb	2 SW	50 feet
With two parking lanes		22 feet	2	14 feet	36 feet	Curb	2 SW	60 feet
With off-street parking		22 feet	0	0 feet	22 feet	Curb or shoulder	2 SW	50 feet
Major Collector ^l	7,500							
Low intensity		24 feet	0	0 feet	24 feet	None	2 SW	50 feet
Medium and High		24 feet	0	0 feet	24 feet	Curb or shoulder	2 SW	50 feet if curb, 54 feet if shoulder
Multifamily access cul-de-sac ^m	1,000							
Multifamily court ^o	Note ^p							
Special Purpose Streets								
Rural street ^k	500	20 feet	0	0 feet	20 feet	None	2 GA	40 feet
Rural lane ^k	200	18 feet	0	0 feet	18 feet	None	2 GA	40 feet
Alley (one way)					9 feet			11 feet
Alley (two way)		18 feet	0	0 feet	18 feet	None	2 GA	22 feet
Cul-de-sac (stem) ^c	250							
Marginal access street ^f								
Divided street ^g								

NOTES:

^a See Table 4.2 for definitions of street hierarchy and N.J.A.C. 5:21-4.2 for definitions of low, medium, and high intensity of development.

^b Parking lane refers to parallel parking, except in the case of residential access streets with nonparallel parking, which have perpendicular parking.

^c The 30 foot cartway would accommodate two seven foot parking lanes and a 16 foot traveled way.

^d 20 foot minor collector cartways are permitted only when there is no direct building lot access to or from the street in question.

- e Cartway widths of cul-de-sac stems should conform to the applicable street type. Right-of-ways for cul-de-sac stems shall extend a minimum of eight feet beyond the cartway. Cul-de-sacs shall provide for a cartway turning radius of 40 feet and a right-of-way line eight feet beyond the edge of the cartway.
- f Cartway and right-of-way widths of marginal access streets and right-of-way requirements should conform to standards of either residential access or minor collector streets, as dictated by average daily traffic. If the classification is a minor collector requiring a 36 foot cartway, cartway width may be reduced to 28 feet, since frontage is restricted to one side of the street.
- g Cartway widths of divided streets should conform to standards of street classification, as dictated by anticipated average daily traffic, and be applied as aggregate dimensions of two street segments. Divided streets shall be provided with cut-throughs at a maximum of 1,200 feet intervals.
- h See N.J.A.C. 5:21-4.3(c) for additional requirements.
- i Right-of-way width applies only to streets proposed for dedication as shown on approved plans.
- j See N.J.A.C. 5:21-4.5(b) for additional requirements.
- k Rural streets and rural lanes are permitted only within developments which do not exceed an average daily traffic count of 500 and 200, respectively.
- l Municipalities may require additional width for major or minor collectors which are part of a designated bicycle route as indicated in the circulation part of the municipal master plan to make them consistent with the AASHTO guidelines for bicycle-compatible streets
- m Cartway widths of multifamily cul-de-sac stems should conform to the applicable residential access street type. Cul-de-sacs shall provide for a cartway turning radius of 40 feet or other suitable means for vehicles to turn around, such as hammerheads. Where not located on private property, a right-of-way line eight feet beyond the edge of the cartway shall be provided.
- n Sidewalks provided for streets with nonparallel parking shall be placed in accordance with N.J.A.C. 5:21-4.5(c).
- o Cartway and right-of-way widths for multifamily courts shall comply with the design criteria for residential access streets, based on the parking configuration. Multifamily courts need not be provided with a means of turning around; however, their length shall not exceed 300 feet.
- p There is no ADT limit for multifamily courts; however, the length of a multifamily court is limited to 300 feet.

Administrative correction.

See: 29 N.J.R. 1296(a).

Amended by R.1999 d.374, effective November 1, 1999 (operative May 1, 2000).

See: 31 N.J.R. 477(a), 31 N.J.R. 3259(a).

In Table 4.3, combined Medium and High Intensity Street Types, changed Parking Loop Right-of-Way Widths, rewrote Note e, added "as shown on approved plans" at the end of Note i, and added Note l. Amended by R.2000 d.480, effective December 4, 2000 (operative June 3, 2001).

See: 32 N.J.R. 2670(b), 32 N.J.R. 4277(a).

In (b), substituted "8" for "15" under Dwelling Units per Gross Acre; inserted (e); and in Table 4.3, inserted footnote "m" and all references thereto in the body of the table.

Public Notice: Special area standards.

See: 33 N.J.R. 897(a).

Amended by R.2002 d.399, effective December 16, 2002.

See: 34 N.J.R. 2615(a), 34 N.J.R. 4412(a).

Rewrote Table 4.3.

Public Notice: Notice regarding the Publication of two Notices of Adoption in the December 16, 2002 New Jersey Register.

See: 34 N.J.R. 4343(a), 4412(a), 35 N.J.R. 219(b).

Amended by R.2004 d.35, effective January 20, 2004.

See: 35 N.J.R. 3981(a), 36 N.J.R. 447(a).

Revised Table 4.3.

Administrative correction.

See: 36 N.J.R. 949(a).

5:21-4.3 Curbs or curbs and gutters

(a) Curbs or curbs and gutters shall be used for drainage purposes, safety, and delineation and protection of pavement edge. Where, based on stormwater management system design, there is determined to be a problem with runoff, curbs or curbs and gutters shall be used.

(b) Curb requirements shall vary according to street hierarchy and intensity of development, in accordance with the requirements set forth in Table 4.3 in N.J.A.C. 5:21-4.2. Generally, curbs shall be required on streets with on-street parking.

(c) Where curbing is not required, edge definition and stabilization shall be furnished for safety reasons, and to prevent pavement unraveling. Curbing may be required for: stormwater management, road stabilization, delineation of parking areas, 10 feet on each side of drainage inlets, intersections, corners, and tight radii.

(d) Curb requirements may be waived by the appropriate municipal approving agency, and shoulders and/or drainage swales used when it can be shown that: shoulders are required by CAFRA; soil and/or topography make the use of shoulders and/or drainage swales preferable; and/or the community desires to preserve its rural character by using shoulders and/or drainage swales instead of curbs. In cases of medium development intensity, the curbing requirement may be waived where front setbacks exceed 40 feet and it can be demonstrated that sufficient on-site parking exists.

(e) A municipality may designate a curb type by ordinance. Where curb type is not established by municipal ordinance, flexibility regarding curb type shall be permitted as long as the curb type accommodates the system of drainage proposed. Generally, curbs should be constructed of concrete or granite block. Curbing materials shall accommodate the purposes set forth in (c) above.

(f) Curbs shall be constructed according to the specifications set forth in N.J.A.C. 5:21-4.17.

(g) Curbing shall be designed to provide a curb ramp in compliance with the Americans with Disabilities Act or the Barrier Free Subcode of the New Jersey Uniform Construction Code (N.J.A.C. 5:23-7) at street intersections, as applicable.

(h) Where curbs and gutters are used and where the street is part of a designated bike route as indicated in the bicycle circulation part of the municipal master plan, the municipality may require that the cartway width be increased by one foot on each side of a street that uses a curb and gutter.

Amended by R.2000 d.480, effective December 4, 2000 (operative June 3, 2001).

See: 32 N.J.R. 2670(b), 32 N.J.R. 4277(a).

Added (h).

5:21-4.4 Shoulders

(a) Shoulders should be used instead of curbs when:

1. Shoulders are required by CAFRA;

Amended by R.2000 d.480, effective December 4, 2000 (operative June 3, 2001).

See: 32 N.J.R. 2670(b), 32 N.J.R. 4277(a).

In (c), rewrote 3, inserted last sentence of introductory paragraph to 6, rewrote 6ii(4) and (5), inserted reference to AWWA C909 and inserted last sentence in 8, and rewrote 11v; and amended Figure 6.1.

SUBCHAPTER 7. STORMWATER MANAGEMENT

5:21-7.1 Stormwater management: general system strategy

(a) Stormwater management systems prepared by design engineers shall emphasize a natural, as opposed to an engineered, drainage strategy.

(b) The applicability of a natural approach depends on such factors as site storage capacity, open channel hydraulic capacity, and maintenance needs and resources. N.J.A.C. 5:21-7.6(c)4 references authoritative sources on natural and nonstructural approaches. Applicability of a stormwater approach also can be limited by regulatory constraints that govern certain structures (for example, dams) or areas (for example, development in a floodplain or wetland). (See N.J.A.C. 5:21-7.5(c).)

(c) Where a municipal ordinance requires the control of runoff from a site that is the subject of a site plan or subdivision application, then the runoff shall be estimated in accordance with provisions of this subchapter. Any structures designed to control volume or rate of flow shall be designed and constructed in accordance with these provisions. Where this subchapter does not include provisions for a particular technique or method, then the design and construction shall be in accordance with best management practices listed in N.J.A.C. 5:21-7.6(b)4.

1. All stormwater collection and conveyance structures shall be designed in accordance with the provisions of this subchapter.

(d) Construction practices shall conform to Standards for Soil Erosion and Sediment Control in New Jersey, N.J.A.C. 2:90, as administered by the New Jersey Department of Agriculture.

(e) Design engineers shall determine hydraulic capacity for open-channel or closed-conduit flow based on the Manning equation, or charts/monographs based on this equation. The hydraulic capacity is termed Q and expressed as discharge in cubic feet per second as follows:

$$Q = (1.486/n) AR^{2/3}S^{1/2}$$

where

n = Mannings roughness coefficient

A = Cross-section area of flow in square feet

R = Hydraulic radius in feet, $R = A/P$ where P is equal to the wetted perimeter, measured in feet and

defined as the length of a line of contact between the flowing water and the channel.

S = Slope of energy grade line in feet per foot

The Manning roughness coefficients used by design engineers appear in Table 7.1 in N.J.A.C. 5:21-7.2.

1. A direct application of Manning's equation may be used for piped storm sewer systems. As an option, design engineers can use a standard step backwater calculation for storm sewer systems if the use of this approach is deemed appropriate by the designer. For other than pipe storm sewer systems, design engineers shall apply Manning's equation only when there is uniform flow, as defined by the following conditions: the bottom slope of the channel, energy grade line, and water surface (hydraulic grade line) are parallel; where the flow regime is in the turbulent range of Reynolds number; and where the boundaries of the cross section of the channel do not move.

(f) Velocities in open channels, excluding water quality swales, at design flow shall not be less than 0.5 of a foot per second and not greater than a velocity that will begin to cause erosion or scouring of the channel. Design engineers shall determine permissible velocities for swales, open channels, and ditches using methods presented in Standards for Soil Erosion and Sediment Control in New Jersey, N.J.A.C. 2:90, New Jersey State Soil Conservation Committee, Division of Rural Resources, New Jersey Department of Agriculture, revised to date.

(g) Velocities in closed conduits at design flow shall be at least two feet per second but not more than the velocity that will cause erosion damage to the conduit, as per the manufacturer's specifications. Minimum allowable pipe slopes shall produce velocity of at least three feet per second when the flow depth is full or half of the pipe diameter.

(h) Design engineers shall base culvert capacity on inlet/outlet analysis, as specified in *Hydraulic Design of Highway Culverts*, Hydraulic Design Series (HDS) No. 5, Report No. FHWA-IP-85-15, U.S. Department of Transportation, Federal Highway Administration, September 1985, incorporated here in by reference.

Amended by R.1999 d.374, effective November 1, 1999 (operative May 1, 2000).

See: 31 N.J.R. 477(a), 31 N.J.R. 3259(a).

Inserted a new (c); recodified former (c) through (g) as (d) through (h); in the new (e)1, inserted "there is a uniform flow, as defined by the following conditions:" following "only when" in the last sentence; and in the new (g), substituted a reference to three feet per second for a reference to two feet per second.

Administrative correction.

See: 32 N.J.R. 684(b).

5:21-7.2 Runoff estimation techniques

(a) Watershed stormwater management requires the determination of a watershed runoff hydrograph that displays and compares the peak discharge rate and volume. Both

parameters shall compare pre- and post-development conditions. The design engineer shall determine the status of the drainage area. All significant land features such as ponds, depressions, or hedgerows that increase ponding factors shall be considered by the design engineer to compute pre-development runoff. If the design engineer is able to verify that a given hydrologic condition has existed on the site for a period of at least five years prior to the time of computation, then this existing condition may be used by the design engineer to determine runoff coefficients. As an alternative, however, the design engineer should assume the drainage area in the pre-development condition to be in good hydrologic condition (if the lands are pastures, lawns, or parks), to have good cover (if the lands are woods), or to have had conservation treatment (if the lands are cultivated).

(b) Design engineers shall use the runoff hydrograph peak rate to determine the configuration and sizes of pipes, channels, and other routing or flow-control structures. They also shall use runoff volume calculations generated by the hydrograph to determine the size of detention and retention facilities.

(c) For the runoff peak rate of discharge calculation, design engineers shall have the option to choose the methodology to estimate peak rate of discharge. For relatively small drainage areas of up to one-half square mile (320 acres), the peak rate of runoff may be calculated by the Rational Method, its derivatives, or the referenced methods that follow:

1. For areas greater than 320 acres, design engineers shall calculate peak rate of runoff in accordance with the following procedures and methods, incorporated herein by reference.

i. *Urban Hydrology for Small Watersheds, Technical Release No. 55 (TR-55)*, U.S. Department of Agriculture, Soil Conservation Service, Engineering Division, as supplemented or amended to date;

ii. *Computer Program for Project Formulation—Hydrology, Technical Release No. 20 (TR-20)*, U.S. Department of Agriculture, Soil Conservation Service, Engineering Division, as supplemented or amended to date; or

iii. *The New HEC-1 Flood Hydrograph Package, Technical Paper No. 82*, Hydraulic Engineering Center, U.S. Army Corps of Engineers, used in appropriate conditions with appropriate values.

2. The equation for the Rational Method is:

$$Q_p = C I A$$

where

Q_p = the peak runoff rate in cubic feet per second

C = the runoff coefficient

I = the average rainfall intensity in inches per hour occurring at the time of concentration t_c

t_c = time of concentration in minutes

A = the size of the drainage area in acres

i. Typical C values for 100 year frequency storm events appear in Table 7.2 below. Coefficients for recurrence intervals more frequent than the 100-year storm should be reduced in accordance with Table 7.3 below. Impervious surfaces are not subject to adjustment.

ii. The Rational Method is most accurate when dealing with uniform drainage areas. Design engineers may divide nonuniform drainage areas into "uniform" sub-drainage areas and calculate the runoff from each of these areas separately, or they may use the weighted average technique for a composite drainage area. Design engineers also may use runoff coefficients from the following sources, incorporated herein by reference:

(1) *Design of Roadside Drainage Channels—Hydraulic Design Series No. 4, Report No. FHWA-EPD-86-103*, May 1965, U.S. Department of Transportation, Federal Highway Administration, as supplemented or amended to date; and

(2) *Airport Drainage, AC¹⁵⁰/₃₂₀-5B*, U.S. Department of Transportation, Federal Aviation Administration, July 1970, as supplemented or amended to date.

3. Design engineers may estimate time of concentration (t_c) with Figure 7.1, Time of Concentration nomograph from *Design Manual—Roadway*, New Jersey Department of Transportation, Division of Roadway Design, Bureau of Roadway Design Standards, May 1992, below. Use of this figure is limited to the design of storm sewer systems. For other purposes, design engineers shall use the procedures outlined in Chapter 3 of *Technical Release No. 55, Urban Hydrology for Small Watersheds (TR-55)*, U.S. Department of Agriculture, Soil Conservation Service, Engineering Division, as supplemented or amended to date.

FIGURE 7.1

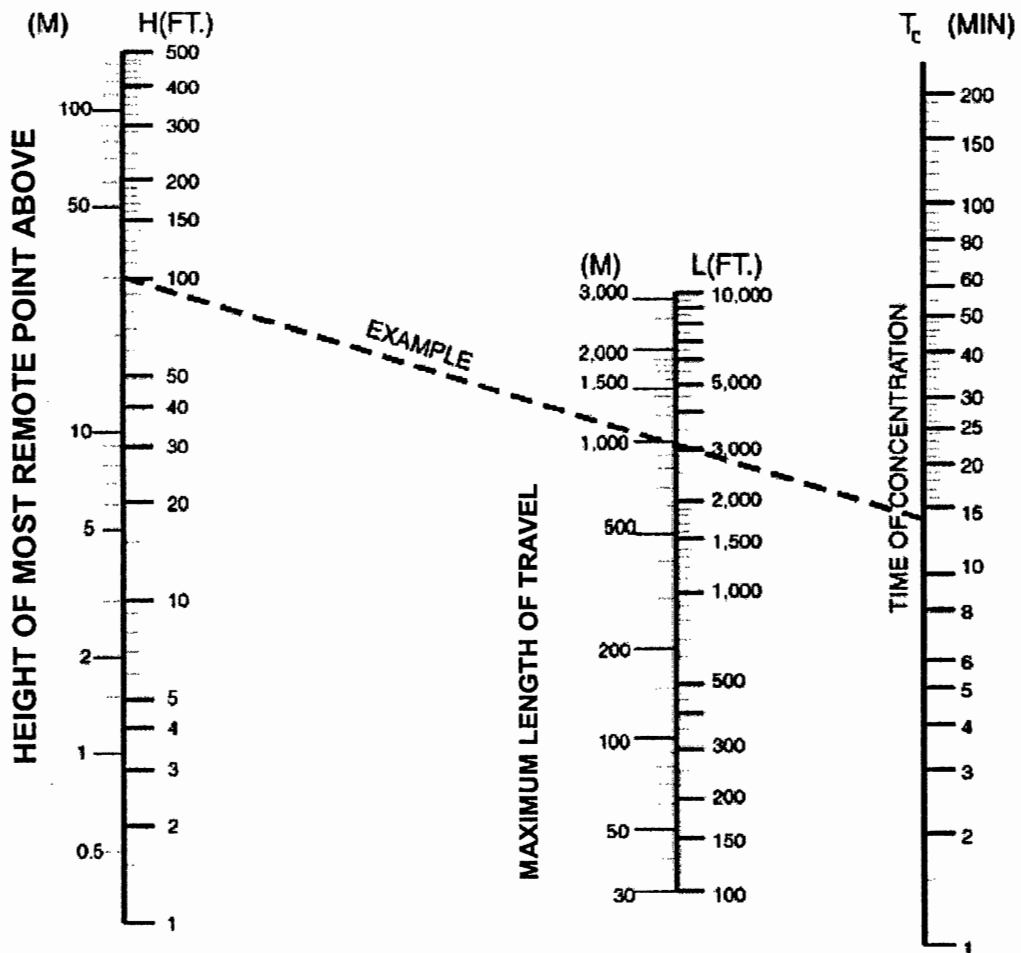
TIME OF CONCENTRATION

Example

Height = 100 ft.

Length = 3000 ft.

Time of Concentration = 14 Min.



Notes:

Use Nomograph T_c for natural basins with well-defined channels, for overland or bare earth, and for mowed grass roadside channels.

For overland flow, grassed surfaces, multiply T_c by 2.

For overland flow, concrete or asphalt surfaces, multiply T_c by 0.4.

For concrete channels, multiply T_c by 0.2.

Based on a study by P.Z. Kirpich, Civil Engineering, Vol.10, No.6, June 1940, p.362

TABLE 7.1
MANNING'S ROUGHNESS COEFFICIENTS

<u>Closed Conduits</u>	<u>Smooth</u>	<u>Normal</u>	<u>Rough</u>
Cast Iron			
Coated	0.010	0.013	0.014
Uncoated	0.011	0.014	0.016
Clay			
Vitrified Sewer	0.011	0.014	0.017
Vitrified sewer with manholes	0.013	0.015	0.017
Common drainage tile	0.011	0.013	0.017
Concrete			
Culvert strait and free of debris	0.010	0.011	0.013
Culvert with bends, connections	0.011	0.013	0.014
Finished	0.011	0.012	0.014
Sewer with manhole inlets	0.013	0.015	0.017
Unfinished steel form	0.012	0.013	0.014
Unfinished smooth wood form	0.012	0.014	0.016
Unfinished rough wood form	0.015	0.017	0.020
Metal, Corrugated			
Subdrain	0.017	0.019	0.021
Storm drain	0.021	0.024	0.030
Polyvinyl Chloride (PVC)	0.010	0.010	0.010
Polyethylene (PE)	0.008	0.009	0.011
Steel			
Lockbar and welded	0.010	0.012	0.014
Riveted and spiral	0.013	0.016	0.017
Wrought Iron			
Black	0.012	0.014	0.015
Galvanized	0.013	0.016	0.017
<u>Lined or Built-up Channels</u>	<u>Minimum</u>	<u>Normal</u>	<u>Maximum</u>
Asphalt			
Smooth	0.013	0.013	
Rough	0.016	0.016	
Brick			
Glazed	0.011	0.013	0.015
In cement mortar	0.012	0.015	0.018
Cement			
Neat surface	0.010	0.011	0.013
Mortar	0.011	0.013	0.015
Concrete			
Trowel finish	0.011	0.013	0.015
Float finish	0.013	0.015	0.016
Finished with gravel on bottom	0.015	0.017	0.020
Unfinished	0.014	0.017	0.020
Gunit (good section)	0.016	0.019	0.023
Gunit (wavy section)	0.018	0.022	0.025
On good excavated rock	0.017	0.020	
On irregular excavated rock	0.022	0.027	
Concrete Bottom Float Finished with sides of			
Dressed stone in mortar	0.015	0.017	0.020
Random stone in mortar	0.017	0.020	0.024
Cement rubble masonry, plastered	0.016	0.020	0.024
Cement rubble masonry	0.020	0.025	0.030
Dry rubble or rip rap	0.020	0.030	0.035
Dressed Ashlar	0.013	0.015	0.017
Gravel Bottom Sides of			
Formed concrete	0.017	0.020	0.025
Random stone in mortar	0.020	0.023	0.026
Dry rubble or rip rap	0.023	0.033	0.036
Masonry			
Cement rubble	0.017	0.025	0.030
Dry rubble	0.023	0.032	0.035
Metal, Corrugated	0.021	0.025	0.030
Steel, Smooth Surface			

<u>Closed Conduits</u>	<u>Smooth</u>	<u>Normal</u>	<u>Rough</u>
Unpainted	0.011	0.012	0.014
Painted	0.012	0.013	0.017
<u>Wood</u>			
Planed, untreated	0.010	0.012	0.014
Planed, treated	0.011	0.012	0.015
Unplaned	0.011	0.013	0.015
Plank with battens	0.012	0.015	0.018
Lined with roofing	0.010	0.014	0.017
Vegetal Lining	0.030		0.500
<u>Excavated, Dredged, or Natural Channels</u>	<u>Minimum</u>	<u>Normal</u>	<u>Maximum</u>
Channels Not Maintained and Brush Uncut			
Dense weeds, high flow depth	0.050	0.080	0.120
Clean bottom, brush on sides	0.040	0.050	0.080
Same, highest stage of flow	0.045	0.070	0.110
Dense brush, high stage	0.080	0.100	0.140
Drag Line—Excavated or Dredged			
No vegetation	0.025	0.028	0.033
Light brush or banks	0.035	0.050	0.060
Earth, Straight and Uniform			
Clean, recently completed	0.016	0.018	0.020
Clean, after weathering	0.018	0.022	0.025
Gravel, uniform section, clean	0.022	0.025	0.030
Short grass, few weeds	0.022	0.027	0.033
Earth, Winding and Sluggish			
No vegetation	0.023	0.025	0.030
Grass, some weeds	0.025	0.030	0.033
Dense weeds or aquatic plants	0.030	0.035	0.040
Earth bottom and rubble sides	0.028	0.030	0.035
Stony bottom and weedy banks	0.025	0.035	0.040
Cobble bottoms and clean sides	0.030	0.040	0.050
Rock Cuts			
Smooth and uniform	0.025	0.035	0.040
Jagged and irregular	0.035	0.040	0.050
Minor Streams (top width at flood stage < 100 ft)			
(a) Streams on plain			
1. Clean, straight, full stage, no rifts or deep pools	0.025	0.030	0.033
2. Same as above, but some stones and weeds	0.030	0.035	0.040
3. Clean, winding, some pools and shoals	0.033	0.040	0.045
4. Same as above, but some weeds and stones	0.035	0.045	0.050
5. Same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
6. Same as 4, but more stones	0.045	0.050	0.060
7. Sluggish reaches, weedy, deep pools	0.050	0.070	0.080
8. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.075	0.100	0.150
(b) Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages			
1. Bottom: gravels, cobbles, and few boulders	0.030	0.040	0.050
2. Bottom: cobbles with large boulders	0.040	0.050	0.070

TABLE 7.2
 RUNOFF COEFFICIENTS (ANTECEDENT MOISTURE CONDITION) AMCII

Land Use Description	Hydrologic Soil Group			
	A	B	C	D
Cultivated land:				
without conservation treatment	0.49	0.67	0.81	0.88
with conservation treatment	0.27	0.43	0.61	0.67
Pasture or range land:				
poor condition	0.38	0.63	0.78	0.84
good condition	NA	0.25	0.51	0.65
Meadow: good condition	NA	NA	0.44	0.61
Wood or forest land:				
thin stand, poor cover, no mulch	NA	NA	0.59	0.79
good cover	NA	NA	0.45	0.59
Open spaces, lawns, parks, golf courses, cemeteries:				
good condition, grass cover on 75% or more of area	NA	0.25	0.51	0.65
fair condition, grass cover on 50-75% of area	NA	0.45	0.63	0.74
Commercial and business areas (85% impervious)	0.84	0.90	0.93	0.96
Industrial districts (72% impervious)	0.67	0.81	0.88	0.92
Residential:				
Average lot size	Average impervious			
1/8 acre	65%	0.59	0.76	0.86
1/4 acre	38%	0.25	0.55	0.70
1/2 acre	30%	NA	0.49	0.67
3/4 acre	25%	NA	0.45	0.65
1 acre	20%	NA	0.41	0.63
Paved parking lots, roofs, driveways, etc.		0.99	0.99	0.99
Streets and roads:				
paved with curbs and storm sewers		0.99	0.99	0.99
gravel		0.57	0.76	0.84
dirt		0.49	0.69	0.80

Note: NA denotes information is not available; design engineers should rely on another authoritative source.
 Source: New Jersey Department of Environmental Protection, Technical Manual for Land Use Regulation Program, Bureaus of Inland and Coastal Regulations, Stream Encroachment Permits (Trenton, New Jersey: Department of Environmental Protection, Revised September 1995) p. 12.

TABLE 7.3
 ADJUSTMENT FACTORS FOR
 RUNOFF COEFFICIENTS

Frequency of Event (years)	Runoff Coefficient Adjustment Factor
2 to 10	0.80
25	0.88
50	0.96
100	1.00

Note: These adjustment factors are from a similar table presented on page 3-61 of *Design of Urban Highway Drainage, The State of the Art*, Report No. FHWA-TS-79-225, U.S. Department of Transportation, Federal Highway Administration, Offices of Research and Development, Implementation Division (HDV-21), August 1979. The values in this table are to be used with the Rational formula, where the runoff coefficient is taken from Table 7.2.

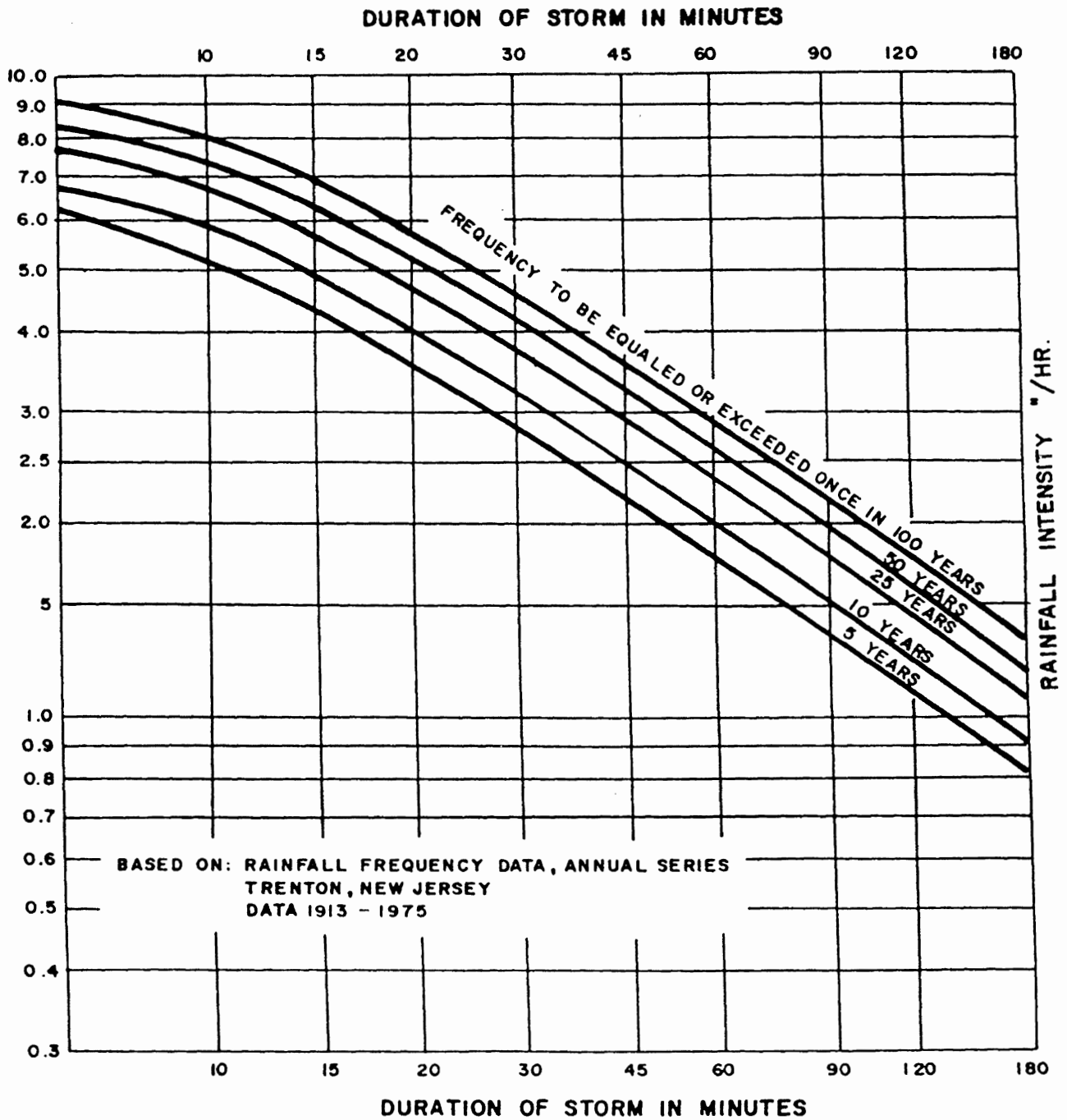
4. When using the Rational Method, rainfall intensity as a function of duration and storm frequency shall be based upon Figure 7.2 Rainfall Intensity Curves below and/or local rainfall frequency data, where available. A copy of Figure 7.2 also appears in the New Jersey Department of Transportation's *Design Manual—Roadway*, May 1992. Figure 7.2 shows rainfall intensity curves for Trenton, New Jersey. Design engineers may use this information for other parts of the State or they may substitute local rainfall frequency data, when available. In all instances, design engineers shall use a minimum time of concentration of 10 minutes. For storm sewer design, a 10-year to 25-year storm frequency consistent with localized circumstances should be considered as a minimum, unless special circumstances are involved such as inadequate downstream stormwater facilities, lack of positive overland relief, or evidence of local flooding. In such special circumstances, design engineers shall design facilities to accommodate, as a minimum, the following storm frequencies:

i. Ten-year storm for storm drain systems where excess flow can continue downgrade in the street and not exceed the gutter capacity. Also, ten-year storms shall be used at low points in storm drain systems with overland relief.

ii. Twenty-five-year storm where flow in a storm drain is totally carried by pipe when conditions under (c)4i above do not apply.

FIGURE 7.2

RAINFALL INTENSITY CURVES



iii. Twenty-five-year storm for culvert design where the culvert will be located in streams shown as a blue line on the New Jersey State Atlas or the United States Coast and Geodetic Survey maps. Culverts with an upstream drainage area of 50 acres or more shall be designed to accommodate a 100-year frequency storm in accordance with Flood Hazard Area Control Regulations, N.J.A.C. 7:13-2.16.

iv. Twenty-five-year storms for open channels where the upstream drainage area is less than 50 acres. When the upstream drainage area is 50 acres or more, design engineers shall design open channels to accommodate the 100-year storm, in accordance with Flood Hazard Area Control Regulations, N.J.A.C. 7:13-2.16.

5. The size of the drainage area shall include onsite and offsite lands contributing to the design point.

6. Computer software adaptations of the Rational Method or the S.C.S. TR-55 are acceptable, provided their data and graphic printout allow review and evaluation.

(d) Design engineers shall use a consistent method to calculate peak rate of runoff and volume when computing runoff hydrographs. If TR-55, TR-20 or HEC-1 is used to calculate peak rate of runoff, then the same method shall be used to determine volume. If the Rational Method is used for peak flow calculations, the design engineer shall use the Modified Rational Method to calculate peak volume to be used for basin routing. A maximum drainage area of 20 acres shall be used for the Modified Rational Method.

Administrative correction.
 See: 29 N.J.R. 1296(a).
 Amended by R.1999 d.374, effective November 1, 1999 (operative May 1, 2000).
 See: 31 N.J.R. 477(a), 31 N.J.R. 3259(a).
 In (b), substituted "size" for "necessity for, and sizing" in the second sentence; in (c), added a third sentence in 2i, and inserted new third and fourth sentences in the introductory paragraph of 4; in (d), inserted "when computing runoff hydrographs" at the end of the first sentence; and in Table 7.1, added a reference to Minor Streams.
 Administrative correction.
 See: 32 N.J.R. 684(b).
 Amended by R.2004 d.35, effective January 20, 2004.
 See: 35 N.J.R. 3981(a), 36 N.J.R. 447(a).
 In (c)3, amended Figure 7.1.

5:21-7.3 Runoff collection system design

(a) Design engineers shall determine pipe size based on design runoff, conduit entrance conditions, and hydraulic capacity.

(b) In general, no pipe size in the storm drainage system shall be less than 15 inches in diameter. Design engineers may use a 12-inch diameter pipe as a cross-drain to a single inlet. Design engineers shall use the Manning equation to determine hydraulic capacity of pipes.

(c) All discharge pipes shall terminate with an appropriate precast concrete or flared-end section or concrete head-wall with or without wingwalls, as conditions require. Design engineers shall consider such site conditions as slope, soil stability, vegetation, grade, and size of conduit to determine whether or not to use wingwalls.

(d) Materials used in the construction of storm sewers shall be constructed of reinforced concrete, ductile iron, or corrugated polyethylene, or, when approved by the municipal engineer, corrugated metal. The most cost-effective materials shall be permitted that conform to local site conditions and reflect the relevant operations, maintenance, and system character of the municipal stormwater system. Specifications referred to, such as ASTM or AWWA, shall be the latest revision in effect at the time of application.

1. The following apply to reinforced concrete pipe:
 - i. Circular reinforced concrete pipe and fittings shall meet the requirements of ASTM C76.
 - ii. Elliptical reinforced concrete pipe shall meet the requirements of ASTM C507.
 - iii. Joint design and joint material for circular pipe shall conform to ASTM C443.
 - iv. Joints for elliptical pipe shall be bell and spigot or tongue and groove sealed with butyl, rubber tape, rubber ring gaskets, or external sealing bands conforming to ASTM C877.
 - v. All pipe shall be Class III, minimum unless loading conditions call for stronger pipe (that is, higher class).
 - vi. The minimum depth of cover over the concrete pipe shall be as designated by the American Concrete Pipe Association in Table 7.4 below as follows.

TABLE 7.4

MINIMUM DEPTH OF COVERAGE OVER CONCRETE PIPE

Pipe Diameter (in inches)	ASTM Class Pipe	Minimum Cover (surface to top of pipe in inches)
12	III	17
	IV	12
	V	7
15	III	16
	IV	11
	V	7
18	III	16
	IV	10
	V	6
24	III	15
	IV	6
	V	6

Pipe Diameter (in inches)	ASTM Class Pipe	Minimum Cover (surface to top of pipe in inches)
30	III	10
	IV	6
	V	6
36 & above	III	6
	IV	6

Minimum depth of coverage as designated by the American Concrete Pipe Association.

vii. Minimum depth of cover standards for ductile iron and corrugated polyethylene pipe shall conform to manufacturer standards.

2. Ductile iron pipe shall conform to ANSI/AWWA C151/A21.51. Joints shall conform to ANSI/AWWA C111/A21.11 or ANSI/AWWA C115/A21.15 as appropriate. Pipe shall be designed in accordance with ANSI/AWWA C150/A21.50. The outside of the pipe shall be coated in accordance with ANSI/AWWA C151/A21.51, and the inside lined in accordance with ANSI/AWWA C104/A21.4. Ductile iron pipe shall be installed in accordance with AWWA C600.

3. Corrugated polyethylene pipe shall conform to AASHTO M252 for three through 10 inches and AASHTO M294 for sizes 12 inches and larger. All pipes greater than 12 inches in diameter shall be Type S, unless conditions dictate otherwise. Materials shall conform to ASTM D3350, "Standard Specification for Polyethylene Plastics Pipe and Fittings Materials." Pipe joints and fittings shall be compatible with the pipe material and shall conform to the same standards and specifications as the pipe material. Pipe couplers shall not cover less than one full corrugation on each section of pipe. Installation shall be in accordance with ASTM D2321, "Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications." Backfill material shall be placed in six-inch lifts and compacted to 95 percent minimum dry density, per AASHTO T99. In areas of high groundwater tables, design engineers shall check for flotation.

4. Corrugated metal pipe, when approved by the municipal engineer, shall meet the requirements and be installed in the manner specified in the subchapter appendix.

(e) Pipe bedding and backfill shall be provided as specified in *Design and Construction of Urban Stormwater Management Systems*, ASCE Manuals and Reports of Engineering Practice No. 77, 1993, incorporated herein by reference. Bedding and backfill for any pipe material not covered by this manual shall be installed in accordance with manufacturer's recommendations. The municipal engineer may require the developer to provide professional certification as to the suitability of backfill material and where such suitability does not exist, any modifications needed to use on-site

material and the appropriate methods to install this material. The municipal and/or utility engineer shall rely on this certification.

(f) No pipe shall be placed on private property unless the owner of the land is to own or operate the pipe, or an easement deeded to the municipality is obtained. All easements shall be a minimum of 20-foot wide unless depth of pipe, soil conditions, or additional utilities require wider. Where the easement is located adjacent to a right-of-way, the municipality may approve a narrower easement.

Amended by R.1999 d.374, effective November 1, 1999 (operative May 1, 2000).

See: 31 N.J.R. 477(a), 31 N.J.R. 3259(a).

In (d), inserted a reference to Table 7.4 in 1vi, rewrote 2, and rewrote the first sentence in 3.

Amended by R.2000 d.480, effective December 4, 2000 (operative June 3, 2001).

See: 32 N.J.R. 2670(b), 32 N.J.R. 4277(a).

Rewrote (f).

5:21-7.4 Inlets, catch basins, manholes, and outlets

(a) Design engineers shall design inlets, catch basins, and manholes in accordance with the New Jersey Department of Transportation's *Standard Specifications for Road and Bridge Construction* (1989). Design engineers shall use bicycle-safe grates. For Type A inlets, they should use a frame and single grate. Type B inlets require a frame, grate, and curb-type inlet with back piece. Type E inlets require a frame and double grate.

(b) Inlet spacing depends on the inlet capacity. Maximum gutter line flow is 400 feet. The maximum capacity of a curb inlet shall be six cubic feet per second. Area inlets in parking lots should be limited to three cubic feet per second.

(c) Manholes shall be precast concrete or concrete block coated with two coats of portland cement mortar outside the manhole. Masonry brick may be used to make vertical adjustment to rims, as long as the adjustments are 12 inches or less. In acidic soils, all manholes shall have two coats of black bitumastic waterproofing applied per manufacturer's instruction.

(d) If precast manhole barrels and cones are used, they shall conform to ASTM Specification C478, with round rubber gasketed joints, conforming to ASTM Specification C923. Both ASTM Specifications are incorporated herein by reference. Maximum absorption shall be eight percent in accordance with ASTM Specification C478, method A.

(e) If precast manholes are used, the top riser section shall terminate less than one foot below the finished grade, and the manhole cover shall be flush with the finished grade.

(f) Manhole frames and covers shall be of cast iron, conforming to ASTM Specification A48, Class 30, incorporated herein by reference, and be suitable for H-20 loading

(g) Outlet grates, fences, and other safety features for stormwater management facilities shall conform with New Jersey Department of Environmental Protection's Stormwater Management Rules, N.J.A.C. 7:8. Safety requirements for detention basin and other stormwater facilities are incorporated in N.J.A.C. 5:21-7.5(f)6.

(h) The channel should be, insofar as possible, a smooth continuation of the pipe. The pipe may be laid through the manhole and the top half removed by saw cut. The completed channel should be U-shaped. The channel height shall be three-fourths of the diameter of the pipe.

(i) The bench should provide good footing for a workman and a place where minor tools and equipment can be laid. It must have a slope of four to eight percent.

Administrative correction.

See: 29 N.J.R. 1296(a).

Amended by R.1999 d.374, effective November 1, 1999 (operative May 1, 2000).

See: 31 N.J.R. 477(a), 31 N.J.R. 3259(a).

Amended by R.2002 d.399, effective December 16, 2002.

See: 34 N.J.R. 2615(a), 34 N.J.R. 4412(a).

In (b), in second sentence substituted "gutter line flow" for "distance between inlets".

Public Notice: Notice regarding the Publication of two Notices of Adoption in the December 16, 2002 New Jersey Register.

See: 34 N.J.R. 4343(a), 4412(a), 35 N.J.R. 219(b).

5:21-7.5 Detention basins and other stormwater facilities

(a) Development shall use the best available technology to accommodate stormwater management by natural drainage strategies where possible and practicable. Detention facilities, when required or selected, shall be designed, constructed, and maintained according to the following standards.

(b) Design engineers shall coordinate structural detention requirements with nonstructural practices, such as cluster land-use development, open space acquisition, riparian buffers, and flood hazard controls.

(c) Detention and all other stormwater facilities shall conform to the New Jersey Department of Environmental Protection's Stormwater Management Rules, at N.J.A.C. 7:8-3.4. Design engineers shall also adhere to, when applicable, the stormwater design requirements in the following rules:

1. Coastal Zone Management Rules, N.J.A.C. 7:7E;
2. Dam Safety Standards, N.J.A.C. 7:20;
3. Soil Erosion and Sediment Control Standards, N.J.A.C. 2:90-1;
4. Flood Hazard Area Regulations, N.J.A.C. 7:13;
5. Pinelands Regulations, N.J.A.C. 7:50-6.81 through 6.88; and
6. Freshwater Wetlands Protection Act Rules, N.J.A.C. 7:7A.

(d) Where municipalities require the use of detention facilities, design engineers shall design the basins to accommodate site runoff generated from two-year, 10-year, and 100-year storms as routed to the basin, considered individually, unless the detention basin is classified as a dam, in which case the facility must comply with the Dam Safety Standards, N.J.A.C. 7:20.

1. These design storms shall be defined as either a 24-hour storm using Type III rainfall distribution when using U.S. Soil Conservation Service procedures (such as TR-20 or TR-55 tabular method), or the design storm resulting in the greatest storage volume to achieve the required outflow using a design method such as the Modified Rational Method. Runoff greater than that occurring from the 100-year, 24-hour storm will be passed over an emergency spillway.

i. A map of approximate geographic boundaries for S.C.S. rainfall distributions presented on page B-2 of the June 1986 edition of TR-55 shows all of New Jersey in the Type III region. Although the May 1982 version of TR-20 does not include a standard S.C.S. 24-hour, cumulative Type III distribution rainfall table like it does for Type I, IA, and II, there is a test version (Version 2.04TEST) of the program available from the S.C.S. which does. The Type III distribution also can be manually added to a TR-20 model by using a RAINFL table.

2. Detention facilities shall be designed to accommodate runoff from the development of the site for the two-, 10-, and 100-year storm events so that pre-development peak flow rates that impact on downstream properties, watercourses, and/or drainage systems are not increased.

3. Where there is not a regional stormwater plan, as specified below in (d)4, then the design engineer shall design detention facilities such that the post-project construction peak runoff for the two-year storm event is 50 percent of the pre-project construction peak runoff rate. The post-project construction peak runoff rates for the 10 and 100-year storm events shall be 75 and 80 percent, respectively, of the pre-project construction peak runoff rates. It should be noted that these percentages only apply to the portion of the post-project runoff from the site under development. Offsite runoff may be computed at 100 percent of the pre-project rate.

4. If a watershed stormwater management plan for the region or watershed exists, approved and adopted pursuant to the New Jersey Department of Environmental Protection rules at N.J.A.C. 7:8, then the design engineer shall design stormwater management systems to conform to that plan. For some parts of the watershed, this may mean a detention basin is unnecessary.

5. If the development site is not part of a watershed stormwater management plan, then the design engineer may model the watershed to be consistent with regulations administered by the Department of Environmental

Protection and shall design stormwater management facilities to conform to that model. This analysis shall include impacts of existing development and all potential future development in the drainage area. For some parts of the watershed, this may mean detention is unnecessary.

(e) Design engineers shall locate detention facilities (either "wet" or "dry") so as to not interfere with or adversely affect existing surface waters on the site or adjacent to the site. Excavation for detention facilities shall be designed to be the maximum practical distance above seasonally high groundwater elevation. In the case of "wet" detention facilities, storage may only be presumed to be available above the elevation of the seasonal high groundwater. If the facility is designed as an infiltration basin, the bottom of the basin shall be a minimum of two feet above the elevation of the seasonally high water table. The determination of the seasonal high water table shall be made by the applicant's engineer.

(f) The following list of general structural criteria shall be used to design stormwater detention basins.

1. Detention components: principal basin control structure (quantity control), as follows:

i. Principal basin control structures will consist of orifice and/or weir control devices. Design engineers shall design orifices based upon the following equation:

$$Q = C A (2gH)^{0.5}$$

where

Q = the flow rate in cubic feet per second
 C = 0.6 (The orifice flow coefficient "C" may vary, depending on entrance conditions. Design engineers may use other coefficients with appropriate references.)

A = cross-section area of flow in square feet
 H = the vertical distance in feet between the center of the orifice and the water surface
 2g = 64.4 feet per second²

To minimize the chance of clogging, orifices intended solely for runoff quantity control will be at least six inches in diameter (or its equivalent). All joints are to be watertight. In addition, trash racks and/or anti-vortex devices shall be required. When weirs are used alone or in conjunction with orifices, design engineers shall use the following equation:

$$Q = C_w L (h)^{3/2}$$

where

Q = the flow rate in cubic feet per second
 C_w = 3.2 (design engineers may use other coefficients with appropriate references)

L = length of the weir in feet
 h = the vertical distance in feet between water surface elevation and the crest of the weir.

All weirs shall be constructed as part of a reinforced concrete structure with appropriate grates.

ii. Eight-inch-thick, anti-seep collars are to be installed along outlet pipes when required by the municipal engineer. Reinforcement steel shall be No. 5 bars at 12 inches both ways, with two inches of cover on both faces (minimum).

iii. Where necessary for stability of the outlet pipe, a concrete cradle shall be provided.

iv. All principal basin control structures shall be precast or reinforced concrete. All joints are to be watertight.

v. Suitable lining shall be placed upstream and downstream of principal basin control structures, as necessary, to prevent scour and erosion. Such lining shall conform to Standards for Soil Erosion and Sediment Control in New Jersey, N.J.A.C. 2:90, promulgated by the N.J. State Soil Conservation Committee.

2. Detention components: emergency spillways, as follows:

i. Vegetated emergency spillways shall have side slopes not exceeding three horizontal to one vertical.

ii. Maximum velocities in emergency spillways shall be checked based on the velocity of the peak flow in the spillway resulting from the routed Emergency Spillway Hydrograph. The design of the emergency spillway will be based on the 100-year inflow to the basin, except for class IV dams, which shall comply with the Dam Safety Standards, N.J.A.C. 7:20. The design of the emergency spillway assumes the principal spillway is malfunctioning and will not allow any discharge or flow. Where maximum velocities exceed those contained in Table 7.5 below, suitable lining shall be provided.

iii. Where maximum velocities exceed the allowable velocities for soil stability as determined in the Standards for Soil Erosion and Sediment Control in New Jersey, N.J.A.C. 2:90, promulgated by the N.J. State Soil Conservation Committee, suitable lining should be provided. Design engineers also may check maximum velocities in emergency spillways based on the velocity of the peak flow in the spillway resulting from the routed Emergency Spillway Hydrograph. Where maximum velocities exceed those contained in Table 7.5 below, suitable lining shall be provided. Linings shall meet specifications required in Hydraulic Engineering Circular No. 15—Design of Stable Channels with Flexible Linings, published by the U.S. Department of Transportation, Federal Highway Administration or Standards for Soil Erosion and Sediment Control in New Jersey, N.J.A.C. 2:90, promulgated by the State Soil Conservation Committee, New Jersey Department of Agriculture.

TABLE 7.5

PERMISSIBLE VELOCITIES FOR EMERGENCY
SPILLWAYS WITH UNIFORM STANDS FOR VARIOUS
WELL-MAINTAINED GRASS COVERS

Ground Cover	Slope Percent	Permissible Velocities On:	
		Erosion- resistant soils (fps)	Easily eroded soils (fps)
Kentucky bluegrass	5-10	6	4
Lawn grass mixture	0-5	5	4
	5-10	4	3
Weeping lovegrass			
Alfalfa	0-5	3.5	2.5
Crabgrass			

Note: fps=feet per second

Designs are not limited to the ground covers shown above. Design engineers may use reinforced grass technologies and other types of ground cover in accordance with appropriate authoritative standards. Source: Soil Conservation Service, U.S. Department of Agriculture (Washington, DC: Government Printing Office, 1959). Cited in ULL-ASCE-NAHB, Residential Storm Water Management: Objectives, Principles, and Design Considerations (Washington, DC: Government Printing Office, 1975).

3. Detention components: dams, as follows:

i. Dam refers to any artificial dike, levee, or other barrier with appurtenant works that is constructed to impound water on a permanent or temporary basis and raises the water level five feet or more above the usual, mean, low-water height when measured from the downstream toe-of-dam to the emergency spillway crest, or, in the absence of an emergency spillway, the top of the dam.

ii. Design engineers shall design all dams in accordance with Dam Safety Standards, N.J.A.C. 7:20, administered by the New Jersey Department of Environmental Protection.

4. Detention basin berms and embankment ponds, as follows:

i. A detention basin berm is a water impoundment made by either constructing an embankment (a facility referred to as an embankment pond), or excavating a pit or dugout that does not qualify as a dam. Detention basin berms constructed by the second method are referred to as excavated ponds.

ii. Site conditions shall be such that runoff from the design storm can safely pass through: a natural or constructed emergency spillway designed to accept the entire 100-year flow; a combination of a principal spillway and the emergency spillway designed to ensure passage of the 100-year flow when either the principal spillway and/or the emergency spillway flows are impeded by debris; or a principal spillway designed so as to allow it to continue to function reliably, passing the 100-year flow, when impeded by debris.

(1) Drainage area of the pond shall be protected against erosion so that expected sediment does not shorten the planned effectiveness of the structure.

(2) When necessary, embankment ponds shall have foundation cutoff walls of relatively impervious

material under the berm. The cutoff walls shall extend up to abutments as required and be deep enough to extend into a relatively impervious layer, or provide for a stable structure when combined with seepage control. The cutoff trench shall have a bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations. Cutoff wall side slopes shall not be steeper than one horizontal to one vertical. The cutoff walls shall extend up to the normal water line and the minimum depth shall be at least three feet.

(3) Design engineers shall include seepage controls if pervious layers are not intercepted by the cutoff, seepage creates swamping downstream, such control is needed to insure a stable embankment, or special problems may require drainage for a stable berm. Seepage may be controlled by foundation, abutment, or embankment drains; reservoir blanketing; or a combination of these measures.

(4) The minimum top width for a berm shall be six feet. The minimum top width of dams should be 10 feet.

(5) All slopes must be designed to be stable. If needed to protect the slopes of the berm, special measures such as rock rip-rap, sand gravel, fabrics, geofabrics, geomembranes, or special vegetation shall be provided, as specified by the standards in: Guide for Design and Layout of Vegetative Wave Protection for Earth Dam Embankments, Technical Release No. 56, and Riprap for Slope Protection Against Wave Action, Technical Release No. 69. Both reports are published by the U.S. Department of Agriculture, Soil Conservation Service, and are incorporated herein by reference.

(6) The minimum elevation of the top of the settled embankment shall be one foot above the water surface in the detention basin, with the emergency spillway flowing at the design depth. The minimum difference in elevation between the crest of the emergency spillway and the settled top width of the structure shall be two feet for all berms having more than a 20-acre drainage area or more than 20 feet in effective height. Design engineers shall increase the design height of the structure by the amount needed to insure that after settlement the height of the berms equals or exceeds the design height. This increase shall not be less than five percent, except where detailed soil testing and laboratory analysis shows that a lesser amount is adequate.

(7) Design engineers shall place a pipe conduit with needed appurtenances under or through the berm except where rock, concrete, or other types of mechanical spillways are used or where the rate and duration of flow can be safely handled by a vegetated or earth spillway.

iii. The design elevation of the top of all embankments and berms shall be one foot or greater than the maximum water surface elevation in the basin, when stormwater from the 100-year flood passes over the emergency spillway. The design height, defined as the vertical distance from the top to the bottom of the deepest cut, shall be constructed to insure that the top elevation will be maintained following all settlement.

(1) When the design discharge of the principal spillway is considered in calculating peak outflow through the emergency spillway, the crest elevation of the inlet shall be such that the full flow will be generated in the conduit before there is discharge through the emergency spillway. The inlets and outlets of the principal spillway shall be designed to function satisfactorily for the full range of flow and hydraulic head anticipated. The capacity of the pipe conduit shall be adequate to discharge long-duration, continuous, or frequent flows without flow through the emergency spillways. The pipe diameter shall be no less than six inches. If the pipe conduit diameter is larger than 10 inches, its design discharge may be considered when calculating the peak outflow rate through the emergency spillway.

(2) Pipe conduits under or through the berm shall be capable of withstanding external loading without yielding, buckling, or cracking. Flexible pipe strength shall not be less than that necessary to support the design load with the maximum of five percent deflection. The inlets and outlets shall be structurally sound and made of materials compatible with those of pipe. All pipe joints shall be made watertight by the use of couplings, gaskets, or caulking.

iv. In earthen berms and embankment ponds, acceptable pipe materials are corrugated polyethylene, reinforced concrete, polyvinyl chloride, and ductile iron. When necessary for stability, concrete and ductile pipe shall be laid in a concrete bedding. Corrugated polyethylene pipe exposed to direct sunlight shall be made of ultraviolet-resistant materials and protected by coating or shielding, or provisions for replacement should be made as necessary. Connections of corrugated polyethylene pipe to less flexible pipe or structure must be designed to avoid stress concentrations that could rupture the plastic. Design engineers shall follow specifications in Table 7.6 below for polyvinyl chloride (PVC) pipe. Design engineers shall provide for seepage control if the conduit is of smooth pipe larger than eight inches in diameter.

Normal pipe size (inches)	Schedule for standard dimension ratio (SDR)	Maximum depth of fill over pipe (feet)
4 or smaller	schedule 40	15
	schedule 80	20
	SDR 26	10
6, 8, 10, 12	schedule 40	10
	schedule 80	15
	SDR 26	10

† Polyvinyl chloride pipe, PVC 1120 or PVC 1220, conforming to ASTM D1785 or ASTM D2241.

Design engineers shall provide for seepage control if the conduit is of smooth pipe larger than eight inches in diameter.

v. Seepage control along pipes extending through embankments shall be controlled by use of a filter and drainage diaphragm, unless it is determined that anti-seep collars will adequately serve the purpose.

(1) The drain is to consist of sand meeting fine concrete aggregate requirements (at least 15 percent passing through the No. 40 sieve, but no more than 10 percent passing through the No. 100 sieve). If unusual soil conditions exist, design engineers shall make a special design analysis. The drain shall be a minimum of two-feet thick and extend vertically upward and horizontally at least three times the pipe diameter, and vertically downward at least 18 inches beneath the conduit invert. The drain diaphragm shall be located approximately parallel to the centerline of the embankment. The drain shall be outletted at the embankment downstream toe, preferably using a drain backfill envelope continuously along the pipe where it exits in the embankment. Protecting drain fill from the surface erosion will be necessary.

(2) When antiseep collars are used in lieu of a drainage diaphragm, they shall have a watertight connection to the pipe. Maximum spacing shall be approximately 14 times the minimum projection of the collar measured perpendicular to the pipe. Collar material shall be compatible with the pipe materials. The antiseep collar(s) shall increase by 15 percent the seepage path along the pipe. When antiseep collars are used in lieu of a drainage diaphragm, the design engineers shall use the following criteria to determine the size and number of antiseep collars.

Let V = vertical projection and minimum horizontal projection of the antiseep collar in feet.

Let L = length in feet of the conduit within the zone of saturation, measured from the downstream side of the riser to the tow drain or point where the phreatic line intercepts the conduit, whichever is shorter.

Let n = number of antiseep collars.

The ratio $(L + 2nV)/L$ shall be at least 1.15. Antiseep collars should be equally spaced along part of the barrel within the saturated zone at distances of not more than 25 feet.

TABLE 7.6

ACCEPTABLE PVC PIPE FOR USE IN EARTH BERMS†

vi. Closed-circuit spillways designed for pressure flow must have adequate antivortex devices. To prevent clogging of the conduit, an appropriate trash guard shall be installed at the inlet or riser.

vii. Emergency spillways convey the design flow safely past earth embankments when the principal or auxiliary spillway is disabled. Design engineers shall provide for an emergency spillway for each basin.

(1) Emergency spillways shall provide for passage of the design flow at a safe velocity to a point downstream where the berm will not be endangered. The maximum permissible velocity in the exit channel shall be four feet per second, where only sparse vegetative cover can be expected; where excellent vegetative cover and a vigorous sod can be expected and maintained, the maximum permissible velocity is 6 feet per second.

(2) If chutes or drops are used for the principal or emergency spillways, they shall be designed according to standards in the U.S. Department of Agriculture, Soil Conservation Service's *Engineering Manual for Conservation Practices* (1984), or the U.S. Department of Agriculture's *National Engineering Handbook*, section 5, "Hydraulics;" section 11, "Drop Spillways;" and section 14, "Chute Spillways," incorporated herein by reference. The minimum capacity of a structural spillway shall be that required to pass the peak flow expected from the design storm.

viii. For excavated basins, provisions shall be made where needed for a principal spillway, emergency spillway, and embankment in accordance with the embankment and berm criteria described in this section.

(1) Where soil conditions and safe maintenance practices allow, side slopes of the excavated basin shall be stable and no steeper than three horizontal to one vertical.

ix. The material placed in the fill shall be free of detrimental amounts of sod, roots, frozen soil, stones more than six inches in diameter (except rock fills), and other objectionable material.

(1) Drainfill shall be kept from being contaminated by adjacent soil materials during placement by either placing it in a cleanly excavated trench, or by keeping the drain at least one foot above the adjacent earthfill.

(2) Selected drainfill and backfill material shall be placed around structures, pipe conduits, and antiseep collars at about the same rate on all sides to prevent damage from unequal loading. Fill material shall be placed and spread beginning at the lowest point in the foundation and then bringing it up in continuous horizontal layers thick enough that the required compaction can be obtained. The fill shall be constructed in continuous horizontal. If openings or section-

alized fills are required, the slope of the bonding surfaces between the embankment in place and the embankment to be placed shall not be steeper than the ratio of three horizontal to one vertical. The bonding surface shall be treated the same as that specified for the foundation to insure a good bond with the new fill.

(3) The distribution and gradation of materials shall be such that no lenses, pockets, streaks, or layers of material shall differ substantially in texture or gradation from the surrounding material. If it is necessary to use materials of varying texture and gradation, the more impervious material shall be placed in the center and upstream parts of the fill. If zoned fills of substantially differing materials are specified, the zones shall be placed according to lines and grades shown on the drawings. The complete work shall conform to the lines, grades, and elevations shown in the drawings or as staked in the field.

(4) The moisture content of the fill material shall be adequate for obtaining the required compaction. Material that is too wet shall be dried to meet this requirement, and material that is too dry shall be wetted and mixed until the requirement is met. Construction equipment shall be operated over each layer of fill to insure that the required compaction is obtained. Special equipment shall be used if needed to obtain the required compaction. If a minimum required density is specified, each layer of fill shall be compacted as necessary to obtain that density.

(5) Fill adjacent to structures, pipe conduits, and drainfill or antiseep collars shall be compacted to a density equivalent to that of the surrounding fill by hand tamping or by using manually directed power tampers or plate vibrators. Fill adjacent to concrete structures shall not be compacted until the concrete has had time to gain enough strength to support the load.

x. All permanent and temporary stabilization should be applied pursuant to the Standards for Soil Erosion and Sediment Control in New Jersey, N.J.A.C. 2:90.

xi. In a principal spillway, pipe materials shall conform to the appropriate specifications. Antiseep collars shall be made of materials compatible with that of the pipe and shall be installed according to the manufacturer's instructions. It may be firmly and uniformly bedded throughout its length, and shall be installed to the line and grade shown on the drawings.

xii. The mix, design, and testing of concrete shall be consistent with the size requirements of the job. Mix requirements or necessary strength shall be specified. The type of cement, air entrainment, slump, aggregate, or other properties shall be specified as necessary. All concrete is to consist of a workable mix that can be placed and finished in an acceptable manner. Necessary

curing shall be specified. Reinforcing steel shall be placed as indicated on the plans and shall be held securely in place during concrete placement. Subgrades and forms shall be installed to line and grade, and forms shall be mortar tight and unyielding as the concrete is placed.

xiii. Foundation and embankment drains, if required, shall be placed to the line and grade shown on the drawings. Detailed requirements for drain material and any required pipe shall be shown in the drawing and specifications for the job.

xiv. Concerning excavated basins, the compacted excavation shall conform to the lines, grades, and elevations shown on the drawings or as staked in the field.

xv. Concerning embankment and excavated berms, construction operations shall be carried out so that erosion and air and water pollution are minimized, and held within legal limits. All work shall be conducted in a skillful manner. The completed job shall present a workmanlike appearance.

(1) Measures and construction methods that enhance fish and wildlife values shall be incorporated as needed and practical. Ground cover to control erosion shall be established as needed and practical. Fencing shall be provided as needed.

5. Detention facilities in flood hazard areas, as follows:

i. Detention development must comply with all applicable regulations under the Flood Hazard Area Control Act, N.J.S.A. 58:16A-50 et seq.

6. The following safety provisions shall apply to stormwater management basins and parts thereof:

i. Trash racks shall be installed at the intake to the outlet from the stormwater management basin to ensure proper functioning of the basin outlets.

ii. Trash racks shall be designed to have parallel bars with no greater than six-inch spacing. The spacing shall be designed so as not to adversely affect the hydraulic performance of the outlet pipe or structure.

iii. The average velocity of flow through a clean trash rack is not to exceed 2.5 feet per second under the full range of stage and discharge. Velocity is to be computed on the basis of the net area of opening through the rack.

iv. Any outlet structure with an overflow grate must have the grate secured but removable for emergencies and maintenance. Grate spacing shall be no greater than two inches across the smallest dimension.

v. Trash racks and overflow grates shall be constructed and installed to be rigid, durable, and corrosion resistant and shall be designed to withstand a perpendicular live loading of 300 lbs/ft sq.

vi. Every outlet structure of a basin shall have escape provisions in or on the structure. Free-standing outlet structures may be excluded at the discretion of the approving authority.

vii. Safety ledges shall be constructed on the slopes of all new retention basins with a permanent pool of water deeper than two-and-one-half feet. Ledges shall be comprised of two steps, each four to six feet in width, one located approximately two-and-one-half feet below the permanent water surface, and the second located one to one-and-one-half feet above the permanent water surface.

viii. In new stormwater management basins, maximum interior slopes for earthen dams, embankments, or berms shall not exceed three horizontal to one vertical.

ix. Municipalities or other specified agencies may grant a variance or exception from these safety standards if they determine in writing that such variance or exception will not constitute a threat to the public safety.

7. Stormwater management facilities shall be regularly maintained to ensure that they function at design capacity and to prevent health hazards associated with debris buildup and stagnant water.

i. Maintenance and upkeep responsibility depend on the ownership of the facilities. If the drains, basins and/or other features of the stormwater system in the residential development are part of a public drainage system, then the municipality or an appropriate public entity is responsible for maintenance and upkeep. If part or all of the residential stormwater management system is privately owned, then the privately owned portion of the system must be privately maintained, unless the municipality or other appropriate public agency agrees to assume responsibility for the facilities. The terms of the agreement shall be in a form acceptable to the municipal attorney and may include but are not limited to maintenance easements, personal guarantees, deed restrictions, covenants, and bonds.

ii. In cases where there is common ownership of property that is not part of a publicly owned drainage system, a homeowner's association or similar permanent entity may be established as the agent responsible for upkeep, absent an agreement with the municipality or other appropriate public entity.

Administrative correction.

See: 29 N.J.R. 1296(a).

Administrative correction.

See: 29 N.J.R. 2816(a).

Public Notice: Egg Harbor Township special area standards.

See: 30 N.J.R. 3700(a).

Amended by R.1999 d.374, effective November 1, 1999 (operative May 1, 2000).

See: 31 N.J.R. 477(a), 31 N.J.R. 3259(a).

Rewrote the section.

Administrative correction.

See: 32 N.J.R. 684(b).

Amended by R.2000 d.480, effective December 4, 2000 (operative June 3, 2001).

See: 32 N.J.R. 2670(b), 32 N.J.R. 4277(a).

In (f)iii, inserted "when required by the municipal engineer" in the first sentence.

Amended by R.2004 d.35, effective January 20, 2004.

See: 35 N.J.R. 3981(a), 36 N.J.R. 447(a).

In (f)v(2), rewrote the fourth uncodified paragraph.

5:21-7.6 Stormwater management: water quality

(a) The water quality design storm shall be defined as the one-year frequency S.C.S. Type III, 24 hour storm or 1.25 inches of rainfall falling uniformly in two hours.

(b) Where detention basins, wet basins, ponds, constructed wetlands, infiltration structures, dry wells, or other devices are used to control the quantity or rate of post-development runoff, then they shall incorporate the measures required by this section in order to protect the quality of surface and subsurface waters. The water quality design storm shall be controlled by best management practices. These include, but are not limited to, the following:

1. In "dry" detention basins, provisions shall be made to ensure that the runoff from the water quality design storm is retained such that, 18 hours following the peak storage in the basin, no more than 90 percent of the volume stored will be evacuated. The 18-hour retention time shall be reduced in any case that would require an outlet size diameter of three inches or less. Therefore, three-inch-diameter orifices shall be the minimum allowed. This minimum is only for water quality outlets. If this minimum outlet size does not allow for the detention times required, then additional techniques shall be used to remove total suspended solids.

2. In permanent ponds or "wet" basins, the water quality requirements of this ordinance shall be satisfied where the volume of permanent water is at least three times the volume of runoff produced by the water quality design storm.

3. Infiltration practices such as dry wells, infiltration basins, infiltration trenches, and buffer strips may be used to satisfy this requirement provided they produce zero runoff from the water quality design storm and allow for complete infiltration within 72 hours. Infiltration strategies shall be limited to areas where the soils are suitable to allow infiltration.

4. Suitable best management practices can be found in the following documents:

i. Stormwater and Nonpoint Source Pollution Control, Best Management Practices Manual, State of New Jersey, Department of Environmental Protection, Office of Land and Water Planning.

ii. Technical Manual for Land Use Regulation Program, Bureaus of Inland and Coastal Regulations,

Stream Encroachment Permits, Revised September 1995, State of New Jersey, Department of Environmental Protection.

iii. Ocean County Demonstration Study, Stormwater Management Facilities Maintenance Manual, June 1989, State of New Jersey, Department of Environmental Protection, Office of Land and Water Planning.

iv. Any watershed stormwater management plan.

Amended by R.1999 d.374, effective November 1, 1999 (operative May 1, 2000).

See: 31 N.J.R. 477(a), 31 N.J.R. 3259(a).

Rewrote the section.

Amended by R.2002 d.399, effective December 16, 2002.

See: 34 N.J.R. 2615(a), 34 N.J.R. 4412(a).

Rewrote (b)1.

Public Notice: Notice regarding the Publication of two Notices of Adoption in the December 16, 2002 New Jersey Register.

See: 34 N.J.R. 4343(a), 4412(a), 35 N.J.R. 219(b).

APPENDIX

CORRUGATED METAL PIPE STANDARDS

Corrugated metal pipe, when approved by the municipal engineer, shall meet the requirements and be installed in the following manner. Corrugated metal pipe for drainage structures is allowed in accordance with the map below. In areas with acid waters (shaded area on the map), design engineers may use aluminum alloy, provided the environmental limitations below are met. In neutral/alkaline waters (unshaded on the map), aluminum, aluminum-coated steel type 2, and polymeric-coated steel may be used, provided the environmental limitations below are met. Water pH and resistivity values must fall within the ranges shown below. Samples should be measured in accordance with ASTM G51 and G57. Avoid sampling water during storm events or for two days following a storm to insure more typical readings. If there are severe corrosive conditions (pH <4), fiber-bonded steel pipe should be used.

ENVIRONMENTAL LIMITS FOR CORRUGATED METAL PIPE

Pipe type	pH	Resistivity values (ohm-cm)
aluminum	4-9	> 500
aluminum-coated type 2	5-9	>1500
polymeric coated	5-9	>1500
fiber bonded	<4	—

If the design velocity is greater than 10 feet per second, a one-half bituminous coating and paved invert in accordance with ASTM A849 (AASHTO M190) is required.

Minimum depth of coverage shall be as follows:

MINIMUM DEPTH OF COVERAGE FOR CORRUGATED METAL PIPE

Pipe diameter (inches)	Minimum cover (inches) from top of pipe to bottom of flexible payment or top of rigid pavement
12 inches to 48 inches	12 inches
54 inches of more	Per manufacturer's recommendations

Corrugated aluminum pipe shall conform to the requirements of ASTM B745 (AASHTO M196) for types I, II, IR, IIR, and III.

Corrugated aluminum-coated steel type 2 pipe shall conform to the requirements of ASTM A760 (AASHTO M36) for types I, II, IR, IIR, and III and have an aluminum-one ounce type 2 coating as specified in ASTM A929 (AASHTO M274).

Corrugated polymeric-coated steel pipe shall conform to the requirements of ASTM A762 (AASHTO M36) for types I and II and have a polymeric ¹⁰/₁₀ coating as specified in ASTM A743 (AASHTO M246).

Corrugated fiber-bonded steel pipe shall conform to the requirements of ASTM A760 (AASHTO M36) for types I and II and have an aramid fiber composite coating as specified in ASTM A885. In addition, the pipe shall be bituminous coated as specified in ASTM A849 (AASHTO M190).

Corrugated metal pipe shall be fabricated with annual corrugations by riveted lap joint construction or with helical corrugations and a continuous weld or lock seam extending from end to end of each length of pipe.

Connecting bands shall be manufactured in accordance with ASTM A760 (steel) or B745 (aluminum) and have the same base metal and coating as the corrugated metal pipe. All pipe ends shall be annularly reformed a minimum of two corrugations.

Fittings and end sections shall be of the same base metal and coating as the corrugated metal pipe.

Corrugated metal pipe shall be installed per ASTM A798 (steel) or ASTM B788.

Maximum cover and structural design of corrugated metal pipe shall be per ASTM A796 (steel) or ASTM B790.