



CITY OF VIRGINIA BEACH, VIRGINIA
DEPARTMENT OF PUBLIC WORKS
ENGINEERING GROUP

DESIGN STANDARDS

MANUAL

MARCH 2022





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FORWARD

This manual replaces all previous Department of Public Works Specifications and Standards, "Engineering Standards", and establishes a new Department of Public Works Design Standards Manual for development in the City of Virginia Beach, Virginia.

This manual is intended for the use in design and construction in existing and proposed public rights-of-way and easements and in the design and preparation of contract documents for all work in the City of Virginia Beach, Virginia. Sections 8 and 9 are to be used for all projects (private and public) in relation to stormwater management and erosion and sediment control. The Design Standards authority is established by the adopted resolutions of the City of Virginia Beach City Council and the ordinances of the City.

The use of the words "shall", "will", "must", "should", "may", and "can" within these design standards is meant to emphasize directions which will ensure the appropriate intended purpose is understood. To clarify the meanings intended in this manual by the use of these words, the following definitions shall apply:

SHALL, WILL, OR MUST

A mandatory condition. Where certain design criterion is described in a procedure or in the design of public improvements, it is mandatory that this condition be met.

SHOULD

An advisory condition. Where the word "should" is used, it is considered to be advisable usage, recommended but not mandatory at the review engineer's discretion.

MAY OR CAN

A permissive condition. Design or application for good engineering practice but is optional at the review engineer's discretion.

Questions or comments concerning this manual or the standards contained within, should be directed to the City of Virginia Beach, Department of Public Works, City Engineer's Office.



1.0 General

1.1 Intent

This manual provides the Public Works design standards for construction within proposed and existing City right-of-ways, easements, and other City owned property with the exception of Chapter 8, Stormwater Management and Chapter 9, Erosion, Sediment Control & Tree Protection where this manual is to be used for all projects (private and public) in relation to stormwater management and erosion and sediment control.

This manual is a supplement to other City ordinances (such as City Zoning, Site Plan, Subdivision, etc.) referenced within the sections and does not, in any way, waive specific requirements of such ordinances.

This manual provides flexibility for items such as design parameters, accepted engineering practices, and operational requirements as long as the goals of longevity, long term economy, functionality, reasonable maintenance, and other sound engineering practices of the system are met.

These design standards are also intended to be flexible and adaptable as new materials, equipment, and methods become available. The Department of Public Works will continue to review and research new materials and publications for applicability. Acceptance and approval of any of the above will be incorporated into the Standards as appropriate.

References to other manuals and publications are generic in nature and the designer shall refer to **Appendix G** for the latest edition approved by the City of Virginia Beach.

If there is a conflict between this manual and other publications the more stringent case shall apply.

These Design Standards herein are the minimum requirements on which the design professional shall base his/her design. Compliance with these design standards does not relieve the designer, including its agents, employees, subcontractors and sub-consultants from performing all work in accordance with all applicable professional standards consistent with sound engineering practice and principles and compliant with all applicable ordinances, codes, laws, and regulations.

1.2 Variances

1. The Director of Public Works or designee may authorize and approve, in specific cases, such variances or waivers from strict application of the terms of these design standards, as will not be contrary to serving the public interest, when a literal enforcement will result in unnecessary hardships, provided that the intent of the design standards will be observed. The following information and process will be adhered to, in order to request variances.
 - a. General
 - i. All publicly owned and maintained infrastructure, whether City or Developer built, shall adhere to these Design Standards, including any Special Provisions or Amendments.
 - ii. The Department of Public Works provides an opportunity for the Developer and/or design Engineer to request a variance from the Design Standards where appropriate and justifiable to the individual situation. For consideration, the design Engineer must submit the written variance request with complete documentation and justification to the Public Works Project Manager or the Development Service Center (DSC) Project Manager during plan review. Variances after plan approval will not be considered.



- iii. The Department will consider each request on an individual case-by-case basis. Thus, an approved variance of the Design Standards for one project may not be applied to another project. The Department's divisions of Engineering, Operations, and Business will, as appropriate, consider the variance request and the potential impacts before approval or denial by the Director of Public Works or designee.
 - iv. In the case of a City entity applying for a variance, for projects not involved with the DSC review process, the request will be processed through Public Works, not DSC.
- b. Process
- i. To request a variance during the design process, the Developer or design Engineer must submit a letter to the Public Works Project Manager or the Development Service Center (DSC) Project Manager with the following:
 - 1) State and reference the section of the Design Standards for which the variance is requested.
 - 2) State the change to the Design Standards being sought.
 - 3) Discuss the reason the variance is being requested.
 - 4) Indicate any examples where a similar variance has been granted.
 - 5) Discuss other alternatives to granting the variance or complying with the Design Standards.
 - 6) Include any calculations, model analysis results, drawings, or site plans, supporting and explaining the request.
 - 7) Discuss any costs considerations relating to the alternatives.
 - ii. The Public Works Project Manager or the DSC Project Manager will compile the required information and provide a written recommendation with concerns, comments and considerations regarding the request and forward it to the Department of Public Works, Engineering Division, for processing within Public Works. The review process within Public Works generally requires 20 working days.
 - iii. All appeals shall be received within 45 days of denial and follow the same process as the initial variance request. All appeals shall be decided by the Director of Public Works or designee within 15 working days.
2. All requests for variances or waivers and documents relating thereto will be open to the public for inspection in the Department of Public Works.

1.3 Separability

Should any section or provision of this publication be declared by the courts to be unconstitutional or invalid, such decision will not affect the validity of the publication as a whole, other than the part so declared to be unconstitutional or invalid. Any errors contained within this publication will not relieve the user from the responsibility of adhering to and complying with all established City ordinances, policies and guidelines. All plans must be designed using sound engineering practices. This publication will not be used as the only reference for engineering practices. Other references should be sought out and used as applicable.

1.4 Effective Date

This Public Works Design Standards Manual was adopted by the City Council of Virginia Beach, Virginia on June 16, 2020.

An amendment will become effective as of the date it is adopted by City Council.



1.5 Interim Amendments to the Department of Public Works Design Standards Manual

1. After adoption of this publication by the Virginia Beach City Council, the Design Standards Manual may be updated with interim amendments by the Director of Public Works subject to the following criteria:
 - a. The interim amendment must be necessary to comply with changes in state or federal law and regulations, or must be deemed necessary to protect the general public interest, safety, welfare and environment.
 - b. The Director of Public Works will present to City Council all interim amendments made to the Design Standards Manual for formal adoption on an as needed basis.

1.6 Transition Provisions

1. All provision of these Design Standards shall be applicable to all projects located within the City of Virginia Beach, after its adoption by the City Council of Virginia Beach or revisions by Public Works. The following transition rules are provided to govern cases in which plans for development, subject to the provisions of these Design Standards, were not approved prior to the most recent adoption date of these Design Standards:
 - a. Eligibility: Plans of development, including site plans and subdivision construction plans, and request for variances which were accepted for review, but not approved, prior to or within thirty (30) days of the adoption date of the Design Standards;
 - b. Plans of development described in a) above must obtain approval from the City within 180 days of the adoption date of these Design Standards; and
 - c. No extensions of approved plans designed under previous Editions of the Public Works Specifications and Standards will be granted unless they meet the criteria found in the Code of Virginia Sections 15.202209.1 or 15.2-2261 or the Virginia Stormwater Management program regulations.



2.0 Plats & Easements

2.1. General

All plats and easements must be recorded in the Clerk's Office of the Circuit Court for the City of Virginia Beach, Virginia. (The Public Works Real Estate Office may also require that encroachment agreements be recorded.)

All surveys and plats shall be based on the following datums:

Horizontal Control: All surveys shall be on the Virginia State Plane Coordinate System, South Zone, NAD 1983/93 (HARN) all measurements expressed in U.S. Survey Feet.

Vertical Control: All surveys requiring elevations shall be based on North American Vertical Datum (NAVD), 1988.

Appropriate environmental site assessments and title reports are required for acquisition and/or dedication of land to the City for easements, right-of-ways, or fee simple ownership.

2.2. Plans - State Plane Coordinate Requirements

Each plan set shall include a survey control sheet which will include a minimum of two (2) survey control points tied to the Virginia State Plane Coordinate System (South Zone), North American Datum (NAD) 1983/1993 (HARN). The points will be labeled on the face of the plan sheet and the measurements (coordinate values) expressed in U.S. Survey feet. The survey control points will be placed in an area where their location will not be disturbed by construction.

2.3. Plat/Plan Requirements

1. The following requirements must be met for all plats submitted to the Department of Public Works. Refer to **Appendix I** of this manual for more specific requirements for developing plats.
 - a. **Surveyor's Seal and Signatures** - All plats and exhibits will be signed, sealed by a Land Surveyor licensed in The Commonwealth of Virginia. The seal shall contain the signature and date of the professional. Exhibits can alternatively be sealed, signed and dated by a Professional Engineer or Architect.
 - b. **Verification Statement** - A statement is required specifying that the plat is based on a current field survey or the result of a compilation from deeds and/or plats of record.
 - c. **Approval Signature** - A place on the face of the plat of each sheet will be prepared to receive the signature and date of the Director of Public Works. If the plat is for Public Utilities, a signature line and date for the Director of Public Utilities must be provided in addition to the Director of Public Works.
 - d. **Material** - Mylar film must be used for all plats, with India ink or equivalent ink type or by computer plotting systems (electrostatic).
 - e. **Plat Sizes** - All original plats are to be prepared using one of the following sheet sizes: 8½" x 11", 11" x 17", and 18" x 24"



- f. **Margin** - Margins will be at least $\frac{1}{4}$ inch on all sides. All drawings shall have centering marks on each side, adjacent and outside the margins. If the plat requires more than one (1) sheet, all sheets will be the same size.
- g. **Plat Scale** - For the area surveyed, the plat must be drawn to the largest scale possible (no less than one [1] inch equals 100 feet) that will fit a reasonable size sheet and meet the individual requirements contained herein. A graphic and written bar scale shall be shown for each scale of drawing shown on the sheet.
- h. **Inscriptions** - Lettering will be no less than one-tenth (1/10) inch or 2.54 mm in height. Lettering and line weight will be no less than 0.013 inches or 0.3302 mm. All shading and screening will meet standards established herein. Line Conventions and Lettering (ANSI Y14.2M-1987), Drawing Sheet Size and Format (ANSI Y14.1-1980), and Modern Drafting Techniques for Quality Microreproduction (NMA reference series No. 3) will be consulted as guidelines.
- i. **Recordation** - Plats and deeds of conveyance will be recorded in the Clerk's Office of the Circuit Court of the City of Virginia Beach, Virginia.
- j. **Meridian** - All plats shall be based on the meridian of the Virginia State Plane Coordinate System, South Zone, NAD 1983/1993 (HARN). All measurements and coordinate values shall be expressed in U.S. Survey Feet. The north arrow shall contain the meridian reference.
- k. **Accuracy** - All distances are to be expressed in feet and hundredth of a foot. Bearings are to be expressed in degrees, minutes, and seconds and shall run in a clockwise direction. As a minimum, curve data will include the delta, length of arc, radius, tangent, chord and chord bearing. Where curves are not tangent, a tangent bearing or radial bearing will be provided. Lines which are radial to curves shall be indicated as such on the plat.
- l. **Closures** - Closures must balance and close within one (1) to twenty thousand (20,000).
- m. **Fee Simple Acquisitions**
 - i. **Portion of Parcel** - When a portion of a parcel is being acquired as fee simple (e.g., right-of-way acquisition), the survey may be limited to the acquisition area; however, sufficient information is required to establish the boundary lines. The residue area of the parcel must be shown.
 - ii. **Entire Parcel** - If an entire parcel is being acquired as fee simple, a boundary survey, including monumentation, is required for the entire parcel in compliance with the Department of Professional and Occupational Regulations (DPOR) current regulation.
 - iii. Large area of fee simple acquisitions for stormwater should be acquired as City proprietary property not as right-of-way and should be labeled as "Property to be acquired in fee simple for stormwater purposes."
- n. On plats with more than one sheet, sheet numbers must be shown at or near the bottom right corner of each sheet in the following form: "Sheet 1 of 2", "Sheet 2 of 2". Match lines must be shown if the tract is divided onto more than one sheet with identifiers noted on each match line denoting the sheet that it matches.



- o. Proper qualifying notes are to be shown on the plats as required for the plat type or by project requirements.
- p. For streets and roads that have been in public use for 20 years or more and for which there are no known deed, dedication or other transfer of title, the “Byrd Road Act of 1932” (Section 33.2-105 of the Code of Virginia) shall be shown under the name of the street.
- q. Title Requirements - The title should specify what is being acquired (e.g.; right-of-way, easements, or right-of-way and easements.). The title block will include the following:
 - i. Project name with CIP number (if applicable)
 - ii. Parcel number
 - iii. Date prepared
 - iv. Scale with graphic scale shown elsewhere on the plat
 - v. Name and address of firm preparing the plat
- r. Current Ownership
 - i. The current owner's name, title reference (deed book, will book, instrument no., and map book) must be shown on the plat. The Geographical Property Identification Number (GPIN) must also be shown.
 - ii. When applicable, project parcel numbers, subdivision's name and section, as well as block and lot numbers will be shown.
 - iii. When the parcel abuts or contains any natural or artificial bodies of water, lines will be drawn representing approximate high water, bulkheads, pierheads, (if officially established). Where such lines are intersected by lot or block lines, measurements locating such intersections will be given along such lot or block lines.
- s. Adjacent Ownership
 - i. The abutting property owners' names, with their appropriate deed book, instrument no., GPIN, and map book number references, will be shown.
 - ii. When applicable, project parcel numbers, subdivision's name and section, as well as block and lot numbers will be shown.
- t. Adjacent Right-of-Ways
 - i. Widths and names of abutting or adjoining roads, streets, and alleys; map book deed book or instrument no. reference for the existing right-of-way, as well as existing and proposed right-of-way widths will be shown. Provide appropriate recording data references of the vesting documents (deed book, instrument no. and map book).
 - ii. A distance tie is required to the nearest street intersection.



u. Existing Easements

- i. All known existing easements, rights-of-way, and right-of-way reservations, will be shown and identified along with their appropriate deed book, instrument number and map book references.
- ii. Existing one (1) foot ingress/egress easements that will be relocated to a new right-of-way line (but not otherwise changed) will be labelled as "Relocated 1' no ingress/egress easement" and a note should be added "Relocation of existing 1' no ingress/egress easement to new right-of-way line to occur simultaneously with acquisition of property being acquired for right-of-way purposes."

v. Monuments

- i. Natural or permanent monuments must be shown to allow reproduction of the survey on the ground. Plats will indicate each monument type found (e.g., pin [F]) and each monument type set (e.g., pin [s]) by the Land Surveyor. A legend must be provided on the plat showing the symbols used.
- ii. At least one (1) bearing and distance tie is required to an existing permanent monument at a property corner which is outside the acquisition area.
- iii. A minimum of two (2) points on each sheet must be identified with their coordinate values based on the Virginia State Plane Coordinate System, South Zone, NAD 1983/93 (HARN). Coordinate values shall be expressed in U.S. Survey feet to a minimum of two (2) decimal places.

w. Acquisition Area

- i. The area of each type of easement or fee simple acquisition and any parcel residue area will be shown on the face of the plat and shown in the area table. The area should be expressed in square feet, rounded to the foot and its equivalent acreage to a minimum of three (3) decimal places.
- ii. When the total and residue areas shown are not the result of a boundary survey they should be noted as being approximate and the source from which the areas were derived.
- iii. The acquisition area must be identified by shading, hatching, cross hatching or other symbol on the face of the plat and identified within a legend. A different shading style is required for each type of acquisition which may appear on the same plat. Solid color or solid shading is not acceptable.
- iv. The exact dimensions, to include bearings and distances, are required for all proposed rights-of-way, easements, and/or acquisition areas.
- v. All easements are presumed indefinite unless otherwise noted as temporary. Do not include "permanent" in any easement identifier.
- vi. Bearings and distances must be legible for each line, with complete data given for each curve. All bearings shall run in a clockwise direction.



- vii. **Flood Zone** - All Plats shall be required to provide a note stating the flood zone designation. "THE PROPERTY SHOWN HEREON APPEARS TO LIE WITHIN FLOOD ZONE " " ACCORDING TO THE FEMA COMMUNITY PANEL NUMBER "XXXXX-XXXXX", DATED "CURRENT PUBLISHED VERSION DATE". Additionally, if a hazardous zone appears within the subject parcel, the line must be delineated on the body of the plat and labeled.
- x. Additional Requirements for Capital Improvement Program (CIP) Projects
Refer to **Appendix I** of this Manual for more specific requirements.
 - i. Acquisition plats being prepared in conjunction with CIP projects have the additional requirement to be tied to the construction centerline. Station and offset data is required and identified within a legend.

Virginia State Plane Grid Coordinate values are required on all control points of the construction centerline (P.C., P.T., P.I., etc.).

These ties will include, but not be limited to, ties to each corner of the parcel, changes in direction, beginning of curves, and ending of curves.

All ties are to be at right angles or radial to the construction centerline and shall indicate the station and offset distance from the construction centerline.

Note: There will be a minimum of two (2) points on the construction centerline on each plan sheet of street/highway CIP projects tied to the Virginia State Plane Coordinate System, South Zone NAD 1983/1993 (HARN), U.S. Survey Feet. This requirement also applies to private development plans for all streets/highways.
 - ii. Station plus and offset distances will be shown to the existing and proposed rights-of-way, proposed temporary construction easements, and temporary or permanent drainage easements or utility easements.
 - iii. The construction centerline shall be shown on each plat with its appropriate stationing and will include construction centerline bearings, radius, length of arc etc., and a tie to the nearest control point. A unique bracket symbol shall be used for each different type of station and offset distance and shall be identified within a legend.

2.4. Drainage and Maintenance Easements

Drainage Easements - Where required, drainage easements and/or right-of-ways for public surface and subsurface drainage will be dedicated to the City of Virginia Beach. Surface and subsurface drainage easement will be a minimum of 20 feet wide. The easement will be the greater of 20 feet or as determined by the following: Outside diameter of the pipe plus two times the depth, then rounded up to the nearest five foot increment. For side lot swales, private easements having a minimum width of 10 feet will be required, five (5) feet on each lot. Final easement widths will be verified by the City review engineer.

2.5. Southeastern Expressway

When a project is adjacent to, or falls within the alignment of the Southeastern Expressway, the following document shall be executed, notarized and recorded in the Circuit Court of the City of



Virginia Beach prior to project approval:

Southeastern Expressway Disclosure Statement

This certifies that the Buyer/Owner has been informed that the property which the Buyer/Owner proposes to develop, located at _____ (address), is adjacent to or within the alignment for the Southeastern Expressway and that they have been fully informed regarding noise and other impacts.

The Buyer/Owner has been given the opportunity to fully investigate impacts the Southeastern Expressway will have on the property which they propose to acquire/develop, as well as on surrounding properties.

The Buyer/Owner has evaluated the effect of the Southeastern Expressway on their use and enjoyment of the property, are satisfied, and have voluntarily elected to purchase the property after having been fully informed concerning noise and other impacts.

This document will be recorded and run with the land to serve as legal notice of the alignment and impact of the Southeastern Expressway for future owners.

OWNER

NOTARY SEAL

State of Virginia

City of Virginia Beach, to wit:

I _____ a notary public within and for the City of Virginia Beach, State of Virginia hereby certify that _____ whose name is signed to the foregoing, has acknowledged the same before me in my City aforesaid.

Given under my hand this _____ day of _____, 20

Notary Public

My Commission expires on the _____ day of _____, 20

Registration No. _____



3.0 Roadway Geometric Alignment & Design

3.1. General

Unless otherwise noted in these design standards, geometric design criteria for all roadways will conform to the applicable provisions in **Appendix G**.

3.2. Corner Right-of-Ways

Instead of the rounded right-of-way lines at street intersections, referred to in Section 4.1 (j) of the City of Virginia Beach Subdivision regulations, truncated corners with short distances of 20 feet or more connecting the tangent points of the required radius circles may be required by the City.

Right-of-ways should be parallel with the face of the curb, except where right-of-ways for traffic signal equipment, etc., are needed.

3.3. Right-of-Way for Shoulders and Drainage

Where curbs and gutters are not required, additional right-of-way and/or easement width may be required for adequate shoulder and drainage facilities as deemed necessary.

3.4. Typical Sections

See **Appendix A** of this manual for typical sections. The Strategic Growth Areas may have specific typical sections not included in **Appendix A**. Please contact the Strategic Growth Area Office.

3.5. Minor Streets and Intersection Radii

A. Minor Street Centerline Radii

The minimum street centerline radius for minor streets will be 125 feet. There shall be a 100 foot minimum straight tangent section at intersections and between reverse curves.

Streets with short cul-de-sacs may use a minimum 75 foot radius where the distance from the nearest intersecting street to the end of the cul-de-sac is less than 200 feet.

B. Intersection Minimum Corner Radii

Table III- 1 identifies the minimum corner radius for various intersecting streets. The various street types are classified as follows:

Minor Streets – Used primarily for access to abutting properties, often referred to as local streets. Typical right-of-way widths include 40 foot R/W, 50 foot R/W, or 60 foot R/W.

Collector Streets – Used primarily to carry traffic from minor streets to major streets. Typical right-of-way widths include 70 foot R/W and larger.

Major Streets (or Arterial) – Designated primarily for fast or heavy traffic, and shall be considered to be as shown in any comprehensive plan or element thereof designating such major streets. Typical right-of-way widths include 110 foot R/W and larger.



TABLE III - 1 Intersection Minimum Corner Radii			
	Minor Streets	Collector Streets	Major Streets
Minor Streets	25'	25'	35'
Collector Streets	25'	35'	35'
Major Streets	35'	35'	50'
Note: 1. The radii dimensions are measured at the face of the curb. 2. If collector streets intersect in an industrial or office park, the minimum corner radius shall be 50 feet at the face of the curb			

3.6. Traffic Impact Studies

Refer to **Appendix H** of this manual for Traffic Impact Study guidelines for commercial and residential development.

3.7. Streets and Alleys

A. General

All curbs and gutters in the City of Virginia Beach right-of-ways will have a minimum longitudinal slope of 0.3% or 0.003 ft/ft.

The lowest elevation in the roadway shall be no less than the 100 year base flood elevation shown AE, AH, AO, or AR as determined from the current Flood Insurance Rate Map, (FIRM) and by the Floodplain Ordinance.

All alleys, streets, roads, collectors, and arterials, etc., within the City of Virginia Beach right-of-ways, will be minimally designed to be passable for the 100-year storm event (refer to *Additional Design and Construction Criteria for SWMFs/BMPs* in Section 8.5.C).

B. Vertical Curves and Minor Intersecting Streets

All proposed streets and roads with a centerline vertical profile grade difference of one (1) % or greater, must be designed with vertical curves of at least 100 feet in length. The length of a vertical curve will be determined based on sight distance (and other criteria) in accordance with Virginia Department of Transportation Road and Bridge Standards, Section 600 and the Virginia Department of Transportation Road Design Manual for roads with posted speed limits more than 25 m.p.h., or a length appropriate for the design speed of the facility.

Minor street intersections must have negative grade lines, falling away from the major through streets and have vertical curves at the approaches of the minor street to the major through street.



C. Open Cuts

Open cutting of existing roadways will not be allowed unless there are extenuating circumstances. Open cuts may be allowed, subject to approval, on site plans and subdivisions for all minor and residential streets, except where conditions would logically warrant boring or jacking of the proposed crossing. All open cut requests must be made in writing to the review engineer, with substantial justification, that may include the dig-up information, verifying the conflicts. Should an open cut request be approved, a Traffic Control Plan must be included on the plans and approved by Traffic Engineering or the City's Traffic Engineer.

Open cut pavement replacement must meet the minimum pavement replacement criteria set forth in **Chapter 5** and **Appendix C, Standard Drawings C-3A, C-3B or C-4**, of this manual wherever applicable.

When reviewing requests for open cuts, designers, DSC and Public Works engineers will consider the following:

1. Roadway Classification.
2. Traffic volumes.
3. Ease of installation.
4. Inconvenience to the public.
5. Age of the existing pavement.
6. Condition of existing pavement.
7. Is the existing pavement scheduled for an overlay in the near future?

Temporary pavement patch material must be available on-site prior to the commencement of any open cut activity.

D. Site Plan Right-of-Way Dedication and Improvements

Right-of-way dedications and improvements will be required when the development of the property generates the need for the dedication and/or improvements. The need for the dedication and/or improvements will be determined by the Department of Public Works/Engineering Group and DSC in accordance with Section 3.7.F or a warranted Traffic Impact Study.

E. Right-of-Way Improvements - Stub Streets

Stub streets will be required only where future development is likely to occur and access is determined to be necessary. If the stub street serves more than four (4) lots or is more than 150 feet in length, an acceptable temporary turnaround must be provided. Where future development is unlikely, a permanent cul-de-sac will be required.

F. Development Plans for Right-of-Way Improvements

The purpose of this section is to provide guidelines for the establishment of off-site right-of-way improvements that are associated with proposed developments. This regulation will cover all proposals that are to be developed according to the Site Plan and Subdivision Ordinances.

1. Right-of-way improvements will be defined as follows, but not limited to:
 - a. Sidewalks.
 - b. Curbs and gutters.
 - c. New Pavement and Pavement widening.



- d. Street lighting.
 - e. Storm drainage facilities, including Stormwater Management Facilities (SWMF and other BMPs).
2. Sidewalks, curbs and gutters, storm drainage facilities, pavement widening, and street lighting must comply with the Department of Public Works Design Standards, in conjunction with the planned development. Lane widths (as referenced in **Appendix A**) will not include the gutter pan width.
3. Pavements will be widened on one side of the roadway along the front of the parcel being developed using the following guidelines:
- a. Pavement widening and full right-of-way improvements will be required when necessary.
 - b. Right-of-way improvements, including sidewalks, storm drainage facilities, and street lighting will be required and evaluated independent of pavement widening and curb and gutter requirements, as determined after review, by the DSC and the Department of Public Works/Engineering Group.
 - c. Right-of-way improvements will be required based upon the following categories as defined in the City of Virginia Beach Comprehensive Plan. Urban subdivisions are those located north of the Green Line where the city provides public facilities to support urban development. The Transition Area of the city between the Green Line and the Rural Service Area is where limited development may occur above the rural level but less than densities typical of more urban areas to the north and will be evaluated on a case by case basis by the DSC. Rural subdivisions are located in the area of the city south of the Transition Area where the city recommends only agricultural, rural residential and other comparable uses:
 - i. **Commercial developments, multi-family apartments and condominiums**
 - 1) Requires a traffic impact study if it meets the guidelines in **Appendix H**, Traffic Impact Studies of this Manual.
 - 2) Curbs and gutters are required.
 - 3) Sidewalks are required.
 - 4) Vacant property in the area that could be improved must be considered.
 - 5) Width of the existing pavement must be considered.
 - 6) Street lighting will be installed or upgraded to meet current City standards
 - ii. **Construction of Urban Subdivisions**
 - 1) Requires a traffic impact study if it meets the guidelines in **Appendix H**, Traffic Impact Studies of this Manual.
 - 2) The number and size of lots must be considered.
 - 3) Pavement widening and new streets will be required to



provide a lane width as shown in **Appendix A**. This excludes residual parcels of greater than 15 acres.

- 4) A curb and gutter will be required with the development if the area is largely developed and future installation of a curb, gutter, and/or sidewalk is anticipated or if curb and gutter exists on adjacent parcels.
- 5) Sidewalks are required.
- 6) The lane width must be taken from the centerline and must include a four (4) feet wide by four (4) inches deep gravel shoulder if curb & gutter is not required.
- 7) Street lighting will be installed or upgraded to meet current City standards.

iii. **Construction of Rural Subdivisions**

- 1) Requires a traffic impact study if it meets the guidelines in **Appendix H**, Traffic Impact Studies.
- 2) Rural or agricultural zoned properties will require a gravel shoulder on the approach side of the driveway. The 30 foot gravel shoulder will be four (4) feet wide and four (4) inches in depth, on approach side of driveway on existing roads excluding residual parcels of greater than 15 acres. The gravel will be VDOT Type I or II, # 21A or 21B aggregate.
- 3) Subdivisions with lot sizes of one (1) acre or more are required to install a minimal right-of-way improvement, such as shoulder widening. If the pavement is less than 18 feet wide, then the pavement must be widened to 12 feet from the centerline of the existing pavement.
- 4) Street lighting will be installed or upgraded to meet current City standards.
- 5) If no curb and gutter exists, the existing and/or proposed ditch that parallels the roadway in front of the development will be moved back to provide a minimum eight (8) feet wide shoulder (four (4) feet gravel and four (4) feet earth). New ditches will have a minimum horizontal-to vertical-ratio of 3:1 side slope and a temporary or permanent drainage easement provided to the City if outside the right-of-way. The adequacy of the downstream drainage system will be confirmed.

iv. **Duplexes**

- 1) Right-of-way improvements (curbs, gutters and sidewalks) are required for duplexes, especially when they exist in front of adjoining or nearby properties. However, when there are no improvements in the area, including the adjacent property, right-of-way improvements may not be required.



- 2) Street lighting will be installed or upgraded to current City standards.
- 3) If no curb and gutter exists, the existing and/or proposed ditch that parallels the roadway in front of the development will be moved back to provide a minimum eight (8) feet wide shoulder (four (4) feet gravel and four (4) feet earth). New ditches will have a minimum horizontal-to vertical-ratio of 3:1 side slope and a temporary or permanent drainage easement provided to the City if outside the right-of-way. The adequacy of the downstream drainage system will be confirmed.

v. **Single Family**

- 1) If the adjacent roadway pavement width is less than 20', then rural residential or agriculturally zoned properties will require a gravel shoulder on the approach side of the concrete or asphalt driveway apron. The gravel shoulder will be 30 feet long by four (4) feet wide and have a depth of four (4) inches. The gravel will be VDOT Type I # 21A aggregate.
- 2) For rural properties roadway lighting will be installed or upgraded in accordance with current City standards to adequately light the driveway apron.

3.8. Roadway and Street Right-of-Way and Alignment

A. Master Transportation Plan Right-of-Way Widths

See **Appendix A** of this manual for typical sections. The Strategic Growth Areas may have specific typical sections not included in **Appendix A**. Please contact the Strategic Growth Area Office.

B. Roadway Alignment

For specific information concerning certain existing or proposed roadway alignments, contact the Department of Public Works/Engineering Group.

Roadway alignments will be in accordance with good engineering practice and publications in **Appendix G**.

3.9. Entrances

A. General

Entrances will be constructed according to the applicable provisions of the Virginia Department of Transportation Road and Bridge Specifications, the Virginia Department of Transportation Road and Bridge Standards, the Virginia Department of Transportation Road Design Manual, and the City of Virginia Beach Subdivision Ordinance (Section 4.4). These specifications are intended to outline the geometric design standards for entrances in the City of Virginia Beach. The specifications contained within this section will apply to all entrances in the City of Virginia Beach. The following additional criteria apply to



entrances:

1. Entrances will not be steeper than eight (8) percent.
2. It will be noted on the plans that the existing curb and gutter will be completely removed before installing the entrance, where curb cuts are allowed.
3. When approved by the Departments of Planning and Public Works, temporary asphalt entrances for minor development sites will be noted on the plans and installed using the following guidelines:
 - a. The absolute minimum entrance thickness will be two (2) inches of surface course asphalt, over eight (8) inches of aggregate base material (minimum), over compacted subgrade.
 - b. Temporary entrances and connections will be designed with a pavement thickness based on the methods and soil testing procedures described in **Chapter 5** of this manual for large sites, all subdivisions, developments with high volumes of vehicular traffic, and developments with small to moderate volumes of truck traffic.
 - c. These temporary asphalt entrances and connections are only authorized when there is a reasonable prediction that the entrance will be torn out within six (6) years because of a future connection to a roadway listed in the City Capital Improvement Program (CIP). The temporary entrance and connection will require posting escrow to the CIP financial account.
 - d. Temporary entrances and connections are not to be substituted for or confused with Erosion and Sediment Control (E&S) Temporary Construction Entrances.
4. Entrances shall not extend beyond the property line as extended to the edge of pavement unless it is a shared entrance with established ingress/egress or cross access easement internal to the site.
5. A minimum 1.5 foot separation must be provided between any part of the entrance and a light pole, power pole, or other fixed structure (including trees).

B. Industrial Entrance Geometrics

The following criteria shall be followed when designing industrial entrances:

1. Industrial entrances are generally intended for use on sites with significant amounts of large sized vehicle traffic.
2. Undivided entrances will have a minimum width of 36 feet and a maximum width of 40 feet, measured at the point of tangent in the entrance.
3. The radii for entrances will be 25 feet unless the design vehicle necessitates larger radii.
4. Industrial entrances will be located no closer than 100 feet from the curb return of the adjacent intersection (point of tangent), to the nearest return at the entrance (also, point of tangent).



C. Commercial Entrances

1. All commercial entrances will be installed in accordance with Virginia Department of Transportation standard entrance (CG-9D, CG-11 or CG-13).
2. Commercial entrances will have a **width** of 30 feet at the point of tangent in the entrance. A **maximum width** of 40 feet at the point of tangent will be allowed when there are three (3) lanes (two (2) exiting and one (1) entering) or where there are a significant number of large vehicles accessing the site (using Minimum Turning Path of WB-40, WB-50, SU, etc). Refer to **Standard Drawing D-3** "Commercial Entrances".
3. One-way entrances will have a minimum width of 18 feet and a maximum width of 22 feet, measured at the point of tangent in the entrance. One-way entrances will be evaluated and approved on a case-by-case basis.
4. All commercial entrances will have a radius of 15 feet. Commercial entrances within industrial zoned districts, or at sites where it is anticipated that there will be a significant number of large vehicles accessing the site, a radius of 25 feet will be used unless the design vehicle necessitates larger radii.
5. All commercial entrances shall be designed such that there will be a minimum distance of 30 feet from the right-of-way line in the entrance to the beginning of the first internal aisle way or parking space. This entrance throat length must be sufficient to accommodate site traffic waiting to park or exit without interfering in any way with traffic within the adjacent public roadway.
6. Corner sites that generate a large volume of traffic will be allowed only one (1) curb cut on each street. Right turn lanes leading to each entrance are required and will be placed according to **Appendix D, Standard Drawing D-4** "Geometrics for Minimum Dimensioned Corner Sites".

D. Commercial Entrances on Connector Parks East of Atlantic Avenue

The following is an amendment initiated and adopted by the City Council on May 5, 2015. The City Council is the sole authority to allow an entrance to a commercial use from a connector street east of Atlantic Avenue from Rudee Inlet to 42nd Street. Any request for the City Council to consider such an entrance must be coordinated through the Planning Department in conjunction with development review or other such similar administrative process.

1. No lot or zoning lot located on Atlantic Avenue between Rudee Inlet and 42nd Street on which any commercial use is located shall have a vehicular entrance from any numbered street east of Atlantic Avenue unless (i) there is an existing curb cut onto such a street as of April 21, 2015, or (ii) such entrance is approved by the City Council. For purposes of this section, "commercial use" shall be deemed to include any building other than one containing dwelling units, as defined by Section 111 of the City Zoning Ordinance.
2. The provisions of this section shall not be varied by the Director of Public Works pursuant to Section 1.4 of these standards or by the City Manager or his designee pursuant to Chapter 5 of the Site Plan Ordinance, or any successor specification, standard or ordinance.



E. Residential Entrances in the North Beach Area

In an effort to balance the functional need for residential driveways, protect public property, and to maximize on-street public parking in the North Beach area, the following driveway standards will be adhered to for all single family, duplex and multi-family site plans on the west side of Atlantic Avenue and in the 100/200 blocks of 41st Street to 89th Street:

1. Each single-residential unit requires two parking spaces. Where on-site parking meets or exceeds the requirements of the City's zoning ordinance and can be reasonably accommodated or is required by the approved site plan, one 12-foot wide driveway will be designed so as to tie into that parking area. Where on-site parking does not meet the minimum requirements of the City's zoning ordinance or does not exist or where the minimum requirements for onsite parking cannot be reasonably accommodated a 20-foot wide driveway apron for two cars will be designed within the right-of-way extending as much as practical onto the site.
2. For duplex and multi-family units, each individual unit requires two parking spaces. Where on-site parking meets or exceeds the requirements of the City's zoning ordinance and can be reasonably accommodated or is required by the approved site plan, one 12-foot wide driveway will be designed so as to tie into that parking area. In unusual cases where on-site parking does not exist and cannot be reasonably accommodated on-site, driveway aprons may be designed within the right-of-way to the following maximum width;

4 cars = 36 feet

6 cars = 48 feet

8 cars = 64 feet

The width of the driveway apron will not exceed the lot width. Any existing entrances and driveway aprons within the right-of-way will be modified to meet the criteria set above. Every effort will be made to have these driveway aprons extended onto the private property.

F. Residential Entrances for Duplex and Single Family Developments

This section establishes residential driveway specifications and standards for duplex and single family developments. For all single family and duplex developments on the west side of Atlantic Avenue and in the 100/200 blocks of 41st Street to 89th Street, Section 3.9.E supersedes this section in regards to driveway widths.

1. Residential driveway entrances will be constructed of Class A-3 concrete, seven (7) inches in depth, extending from the paved roadway to the right-of-way line. Concrete pavers may also be used in lieu of the required Class-3 concrete with a City approved Encroachment Agreement. If approved, the concrete pavers must be constructed per **Standard Drawing D-7**. However, if a sidewalk exists, the full depth concrete sidewalk must continue across the entrance apron for ADA accessibility.
2. The use of exposed aggregate concrete on driveways, parking areas, entrance aprons, and curbs and gutters will not be allowed in the right-of-way.
3. All driveway aprons on roadways with speed limits of 35 m.p.h. or greater will be installed according to the Virginia Department of Transportation standard entrance (CG-9D). VDOT standard PE-1 Type II can be used if no curb and gutter exists. These driveways shall have radial curbs on each side of the entrance that are a minimum of 15 feet. The driveway shall have a minimum width of 12 feet at the



right-of-way line and 42 feet at the curb line.

4. All driveway aprons on any street where the speed limit is less than 35 m.p.h. will be installed according to the City of Virginia Beach Standard Residential Entrance with two (2) foot minimum flares on each side of the apron per **Standard Drawing D-5**. The flares must extend from the curb line to the right-of-way line or ten (10) feet, whichever is less.
5. For duplex developments, each individual unit requires two parking spaces. Where on-site parking meets or exceeds the requirements of the City's zoning ordinance and on-site maneuvering can be reasonably accommodated, a 20-foot maximum driveway width, measured at the right-of-way line, will be designed so as to tie into the parking area. In cases where on-site maneuvering cannot be reasonably accommodated on-site, driveway aprons will be designed to meet the needs of the zoning ordinance up to a total maximum width of 36 feet measured at the right-of-way line.
6. Driveway aprons that are installed along interior subdivision streets will have a minimum width of 13 feet at the curb line and nine (9) feet at the right-of-way line.
7. Single family driveway aprons will have a maximum width of 20 feet at the right-of-way line. Exceptions will be allowed for homes with three-car (or more) garages where on-street parking is prohibited. In such cases, the maximum may go up to, but not exceed, 30 feet at the right-of-way line if reasonable maneuvering cannot be made on site.
8. Asphalt may be used for driveways south of the Transition Zone.
9. In order to prevent damage to the historical brick sidewalks in the Cavalier Shores subdivision, on lots west of Atlantic Avenue driveways to 43rd or 44th Street or to the south side of 45th Street shall not be permitted.
10. For corner lots, entrances must be a minimum 25 feet from intersection, as measured from tangent point to radius return.
11. For corner lots that front an arterial or major collector street, entrances will only be allowed on the minor street frontage.
12. The following criteria must be met for multiple entrances:
 - a. Lot width less than 100 feet wide, maximum one entrance allowed meeting Section 3.9.F.7.
 - b. Lot width 100 feet to 150 feet wide, up to two entrances allowed, with total entrance width not to exceed 30 feet, as measured at the property line.
 - c. Lot width greater than 150 feet wide, up to two entrances allowed, with a total entrance width not to exceed 40 feet, as measured at the property line.
 - d. For corner lots, the above applies however, an additional driveway entrance may be allowed along the side except on an arterial or major collector street.

G. Multi-Family Entrances

This section establishes driveway specifications and standards for all multi-family,



residential driveway aprons installed in Virginia Beach, including apartments, townhouses, and condominiums. For all multi-family developments on the west side of Atlantic Avenue and in the 100/200 blocks of 41st Street to 89th Street, Section 3.9.E supersedes this section in regards to driveway widths.

1. On multi-family developments where each home is on a separate parcel and fronts a public street, then the residential driveway aprons will follow the same criteria as in Section 3.9.F “Residential Entrances for Duplex and Single Family Developments.”
2. On multi-family developments where all homes utilize a common entrance to a public street, then the residential driveway apron will follow the same criteria as in Section 3.9.C “Commercial Entrances.”

3.10. Turn Lanes

A. General

The following criteria are provided to help determine the requirements for constructing right and left turn lanes. These standards were developed to help expedite the movement of through traffic, control the movement of turning traffic, increase the capacity of intersections, and to improve safety on roadways.

B. Right Turn Lane Justification

When a location generates 35 or more vehicle trips per any hour, making a right turn into a single entrance, a right turn lane will be required.

Other factors, such as accident history and analysis of the area, pedestrian conflicts, and the existing highway capacity and volume, must be considered when evaluating the need for the installation of a right turn lane. A determination will be made by the City Traffic Engineer.

C. Right Turn Lane Geometrics

1. **Storage Length** - Storage length of a right turn lane at an unsignalized intersection is determined by the posted speed limit as outlined in the following chart:

TABLE III - 2 Right Turn Lane Minimum Storage Length / Bay Taper Length Based on M.P.H.	
Speed	Storage/Taper
25 m.p.h.	50'/50'
30 to 35 m.p.h.	100'/100'
Greater or equal to 40 m.p.h.	150'/150'



At signalized intersections, storage length should be based on two (2) times the average number of vehicles that would store per signal cycle, using 20 feet per vehicle (peak hour), depending on the cycle length, signal phasing, and vehicle arrival/departure rate. The storage lane length will not be less than the minimum, based on the posted speed limit of the roadway.

2. **Bay Taper** - A straight taper along the right edge of the road is used to guide vehicles into the turn lane. A short radius will be used at the beginning and end of the bay taper.
3. **Width** - A 12-foot turn lane width is required for right turn lanes on new road projects or developments. The width of the turn lane will **not** include the gutter pan. If the turn lane is incorporated into and is a part of the widening of the road and serves as an outside travel lane, then the right turn lane will be 13 feet wide with an added 2 foot wide gutter pan. All other aspects of the turn lane will be designed to match future expansions, such as drainage, pavement thickness, and landscaping.

D. Entrances Located Within the Right Turn Lane

Entrances are allowed in the turn lane **only** when there is no alternative access available. The end of the entrance radial curb to the end of the bay taper will have a tangential distance of no less than 50 feet. This distance should be as long as possible.

Continuous right turn lanes should be avoided whenever possible.

E. Right Turn Lanes on Corner Sites

The City Subdivision Ordinance, Section 4.4.B, outlines the specifications for right turn lanes leading to corner sites. The standard parameters in this ordinance will also be used to determine high traffic generators on corner lots when designing site plans. For the geometrics involved, see **Appendix D, Standard Drawing D-4**, of this manual.

F. Right-of-Way Dedication for Right Turn Lanes

Right-of-way dedication for turn lanes is required when justified and required by the City.

G. Left Turn Lane Justification

When the location generates 30 or more vehicle trips per any hour making a left turn into a single entrance, a left turn lane will be required.

However, other factors, such as analysis of accident history for the area, pedestrian conflicts, and the existing highway capacity must be considered to evaluate the need for and the installation of a left turn lane. These factors will be considered by the City Traffic Engineer in determining whether the left turn lane will be required.

Dual left turn lanes shall be considered when the left turn demand exceeds 300 vehicles per hour, and are desirable where peak left turn movements exceed 350 vehicles per hour.

H. Single Left Turn Lane Geometrics

1. **Storage Length** - Storage length of a left turn lane at unsignalized intersections is determined by **the greater of** either a critical gap analysis using a length double



the average number of vehicles stored at 20 feet per vehicle, or the following table using the proposed or posted speed limit:

TABLE III- 3 Left Turn Lane Minimum Storage Length/ Minimum Bay Taper Length	
Storage Length: Rural - Design Speed $\geq$ 50 m.p.h. Design Speed $<$ 50 m.p.h. Urban- All Design Speeds	200 ft minimum ⁽¹⁾ - for 240 or fewer left turning vehicles during the peak hour 100 ft minimum ⁽¹⁾ - for 60 or fewer left turning vehicles during the peak hour 150 ft minimum ⁽¹⁾ ⁽¹⁾ Minimum storage lengths above are to be adjusted upward as determined by left turn lane capacity analysis.
Urban - Left turn storage length to be determined by capacity analysis	
Taper Length: Urban and Rural - Design Speed $\geq$ 35 m.p.h. Design Speed $<$ 35 m.p.h.	150 ft minimum ⁽²⁾ 100 ft minimum ⁽²⁾ ⁽²⁾ In congested areas taper length may be reduced to increase storage length.

The storage lane length will not be less than the minimum.

- Bay Taper** - A straight taper along the left edge of the traveled way is used to guide vehicles into the turn lane. A short radius should be used at the beginning and end of the bay taper.
- Width** - A 12-foot width is required for left turn lanes with any new road projects or developments. The width of the turn lane will **not** include the gutter pan. Where CG-2 or CG-3 curb is used along the side of the turn lane, the minimum width for striping shall be 13 feet.

The dimensions will be reviewed on a case-by-case basis where the site frontage is limited, or when the existing right-of-way is not sufficient.

I. Dual Left Turn Lane Geometrics

- General** – Construction of dual left turn lanes require a protected signal phase, a 28' minimum median width, and a width of at least 30' of the acceptance lanes.
- Storage Length** - The length of storage shall be based on a capacity analysis and shall be no less than 150 feet.
- Bay Taper** - For design speeds greater than or equal to 35 mph, use four-hundred feet (400') minimum. For design speeds less than 35 mph, use two-hundred feet



(200') minimum.

4. **Width** - A 12 foot width is required with any new road projects or developments. The width of the turn lane will not include the gutter pan. For a travel lane adjacent to CG-2 or CG-3 curb, an additional one foot should be provided to the width of the travel lane for the appropriated clear zone distance. The minimum width of the lane at the mid-point of the turning radius shall be fifteen feet (15').
5. **Acceptance Lanes** - Each acceptance lane (receiving lane) installed with any new road project or development shall be fifteen feet (15') wide. The lane shall then be tapered to twelve feet (12') using the following transition ratios. (Refer to **Appendix D, Standard Drawing D-2**, for the Standard Drawing).

<u>Design speed</u>	<u>Taper Ratio</u>
55 mph	16 to 1
50 mph	14 to 1
45 mph	13 to 1
40 mph	11 to 1

J. Left Turn Lane Approach Transition Formulas

When a left turn lane is required in an area where there is no median, an approach taper must be installed. The length of the approach will be determined by using the following formulas. (Refer to **Appendix D, Standard Drawing D-1**, for the Standard Drawing.)

1. For speeds of 45 m.p.h. or more: $L = S \times W$
2. For speeds of 40 m.p.h. or less: $L = (W)(S)^2 \div 60$

Where: L = Length of taper in feet
S = 85th percentile or posted speed
W = Offset in feet

3.11. Median Crossover Spacing

A. Spacing Criteria

The following table lists the desirable and minimum median crossover spacing for divided roadways, based on design speeds and minimum sight distances. This table is based on the VDOT Road Design Manual.



TABLE III - 4 Crossover Spacing Criteria			
Design Speed of Roadway (M.P.H.)	Crossing Spacing		Minimum Sight Distance* (Feet)
	Desirable (Feet)	Minimum**(Feet)	
70	1250	1000	825
60	1100	900	700
55	1000	800	650
50	900	700	600
45	800	650	525
40	700	600	475
35	600	500	400
* The minimum sight distance requirement must be met at all crossover locations.			
** These minimum dimensions are not to be reduced unless exceptions are specifically approved by the City Traffic Engineer.			

B. Reduction of Minimum Spacing Standards

Installation of crossovers for private streets or commercial entrances will be considered on a case-by-case basis, following the evaluation of an individual traffic safety and operation study. This study will be submitted by the design consultant and evaluated by Public Works. Operating speeds, volume of traffic for the crossover and associated through street, signal operation/progression, accident rates with and without the crossover, number of U-turn violations, observations of weaving maneuvers, alternative solutions, capacity analysis, and type of vehicles involved are just some of the factors that will be included in the study.

Final approval or waiver for reduction in median spacing will be made by the City Traffic Engineer.

3.12. Sight Distance

A. General

These criteria have been established to help ensure that roads are designed to allow sufficient horizontal and vertical sight distance to the driver, promoting safe maneuvers across or onto an intersecting road.



B. Visibility Triangle

The visibility triangle is defined as the area needed to ensure safe maneuvering across or onto an intersecting roadway. A visibility triangle is formed by using the speed limit (preferably the 85th percentile, if available) in Table III - 5 to determine the sight distance from the edge of the traveled roadway. By placing the driver on the controlled minor approach, 14.5 feet back from the intersecting major roadway, a "line-of-sight" is formed (see **Appendix D, Standard Drawing D-9** "Visibility Triangle"). The intersection of two (2) line-of-sights forms the visibility triangle. In this triangle, nothing will be erected, placed, parked, planted, or allowed to grow in such a way that impedes the driver's vision for a height of three and one-half (3½') feet above the centerline of the intersecting roadway.

C. Sight Distance at Intersections

At a non-signalized intersection, where a minor road meets a major road or two (2) major roads intersect, a commercial entrance and crossover are required to have sufficient sight distance to permit a safe departure from a stopped position.

Sight distance requirements may be reduced at signalized intersections for protected movements when the traffic signal assigns the right-of-way, thereby reducing the required visibility needs. **However, unprotected right and left hand turning movements still need to meet the sight distance criteria.**

Table III - 5 provides the required sight distance, based on the speed limit of a non-controlled (approaching) leg of the intersection. The 85th percentile speed should be used, if available, for improved accuracy.

TABLE III - 5				
Sight Distance at Intersections				
	M.P.H.			
	25	35	45	55
Residential / local streets	250'	350'	450'	550'
Residential collectors, minor arterial, rural roads	350'	500'	600'	750'
Major arterial, interchanges, etc.	500'	600'	775'	950'

D. Stopping Sight Distance

The stopping sight distance is the minimum sight distance allowed at a corner intersection and will only be considered when the proper sight distance (Table III -5) cannot physically be obtained because of existing conditions or monetary limitations.

TABLE III - 6				
Stopping Sight Distance				
	M.P.H.			
	25	35	45	55
Stopping Sight Distance	150'	250'	345'	470'



3.13. Bus Turnouts

Bus turnouts will be installed at bus stops on major road arteries. The turnouts will be 12 feet wide (not including the curb and gutter) and a minimum tangent length of 80 feet, with a 50-foot pavement transition. A "BUSES ONLY" sign will be placed adjacent to the turnout near the bus loading point. See **Standard Drawing D-54** for details and pavement section.

3.14. Guardrail

A. General

The installations of guardrails in the City of Virginia Beach will follow the design criteria as established in the Roadside Design Guide published by the American Association of State Highway and Transportation Officials (AASHTO) or the most current edition of VDOT Road Design Manual and VDOT Instructional and Informational Memoranda (IIM).

B. Guardrail Type

The City of Virginia Beach uses a standard GR-2 or GR-2A (strong post) guardrail with standard GR-7 (wood post) breakaway cable end-treatment as the basic standard for guardrail selection. The design engineer must justify any change from this standard to the City Traffic Engineer. The justifications will be considered for approval on a case-by-case basis. Self oxidizing guardrail shall be considered when aesthetics are an issue of concern.

C. Guardrail Placement

A guardrail installation will be considered at all locations where clear zone requirements are not met for fixed objects, embankments or bodies of water.

On curbed sections of roadway, the face of the GR-2 or GR-2A guardrail will be aligned vertically with the face of the curb.

3.15. Drive-up or Pick-up Windows

For sites with drive-up or pick-up windows, such as fast food restaurants, pharmacies, banks, ATM machines, dry cleaners, etc., a minimum 10 vehicle stacking lane is required from the pick-up window. Each vehicle space shall measure 22 feet from front bumper to front bumper which includes length of vehicle and separation between vehicles. Additional drive-up lanes will not be counted towards meeting this requirement. The stacking lane must ensure adequate on-site stacking that prevents vehicles from obstructing the right-of-way and does not block any required parking spaces.



4.0 Geotechnical Information & Design

4.1 General

This chapter provides guidance for performing geotechnical engineering studies, public or private, which shall include, but not be limited to, geotechnical investigations for roadway, stormwater management and structure projects in the City of Virginia Beach. At a minimum, geotechnical studies shall be performed in accordance with The Manual of Instruction (MOI) of the Virginia Department of Transportation Chapter III – Geotechnical Engineering.

4.2 Minimum Depth of Investigation for Pavement Subgrade

For cuts and fill less than 25 feet, each exploration shall be advanced to at least ten (10) feet below proposed subgrade. In fill areas, the exploration shall be advanced to a depth equal to the height of fill but not less than ten (10) feet below the existing grade.

4.3 CBR Values

All CBR values shall be determined in accordance with “The Virginia Method of Conducting California Bearing Ratio Tests” (Designation VTM-8).

Soil sampling frequency and CBR tests for design of subdivision streets and secondary roads shall be performed in accordance with the VDOT Pavement Design Guide for Subdivisions and Secondary Roads in Virginia (Revised 2018).

A minimum of one soil sample is required for streets and parking lots less than 200 feet in length.

Resilient Modulus (M_R) = 1,500 x CBR value if no resilient modulus test are performed this may be used as an approximation.

4.4 Atterberg Limits

Atterberg limits will be performed for each applicable soil type. Atterberg limits for subbase and aggregate base material will conform to the Virginia Department of Transportation Road and Bridge Specifications, Section 208.

4.5 Density

The density of the subbase and aggregate base material shall conform to the Virginia Department of Transportation Road and Bridge Specifications, Sections 308 and 309.

4.6 Optimum Moisture Content

The optimum moisture content for subbase and aggregate base material shall conform to the Virginia Department of Transportation Road and Bridge Specifications, Section 208.

4.7 Sieve Analysis

The sieve analysis for dense graded aggregates for subbase and aggregate base material shall conform to the Virginia Department of Transportation Road and Bridge Specifications, Section 208.



4.8 pH Value

The soil and/or ground water pH value shall be included in the soil report. The pH value should be between 3 and 9. Where the pH value is outside this range, the designer shall provide remedies to prevent chemical attack on metal pipes and geotextile fabrics.

4.9 Groundwater Elevation

The existing groundwater elevation at time of boring and the 24-hour stabilized groundwater elevation must be shown in the soil report along with the seasonal high groundwater elevation.

Pavement and foundation designs must take into consideration the seasonal high ground water elevation and fluctuation.

4.10 Soil Reports for Pavement Design

Soil reports for pavement designs must be performed according to VDOT, Materials Division, Manual of Instruction (MOI) Chapter III – Geotechnical Engineering.

4.11 Soils Report Recommendations

A professional engineer with a geotechnical specialty licensed in the Commonwealth of Virginia remarks and recommendations shall be provided in the sealed, signed and dated soils report. All tests included in the analysis shall comply with appropriate ASTM, AASHTO, and VTM designation.

4.12 Embankments and Fill

All embankments shall consider underdrains and reinforcement with geotextiles or geogrids unless adjacent to a lake, canal, or pond steeper than 3.0 (horizontal): 1.0 (vertical) and higher than five (5) feet. The design engineer shall evaluate this issue.

Whenever a subdivision or site plan is proposed where fill has been previously placed under a proposed pavement, dwellings, or other structures, the design engineer shall have a professional engineer with a geotechnical specialty licensed in the Commonwealth of Virginia make recommendations to avoid settlement.



5.0 Pavement Design & Pavement Patching

5.1 Disclaimer

This guide provides a comprehensive set of procedures and recommendations which can be used for the design and rehabilitation of pavements both rigid (Portland cement concrete) and flexible (asphalt concrete). It is intended to aid the professional engineers knowledgeable in the field of pavement design. This guide is not intended to address pavement distress mechanisms, structural inadequacy of the pavement, existing pavement defects, or other types of pavement deficiencies. It is the responsibility of the user to conduct an analysis/evaluation of the existing or expected pavement conditions prior to using this guide. Failure to do so could significantly affect the performance and service life of the materials and mixes selected. The City and individuals associated with the development of this guide cannot be held responsible for improper use or application.

Pavement design is the process of selecting a practical and economical combination of materials of known strength and adequate thickness to support anticipated traffic under the prevailing environmental conditions. All pavement designs will be certified by a professional engineer licensed to practice in the Commonwealth of Virginia.

This Chapter also provides information for pavement reconstruction and patching as shown on the approved plans.

5.2 Materials

All materials will conform to the specifications provided in Division II of the Virginia Department of Transportation (VDOT) Road and Bridge Specifications, unless otherwise specified herein.

5.3 Method of Determining Traffic Volumes

For the purpose of determining Annual Average Daily Traffic (AADT), in residential subdivision streets, a formula based on average vehicle trips per dwelling unit per day on the build-out design will be used. An estimate of traffic generation will be determined by multiplying twelve vehicle trips by the number of single family detached units to be served by the street under design. For all other land uses, the trip generation should be calculated using the latest edition of the Institute of Transportation Engineers (ITE) "Trip Generation". A collector or arterial street volume will be determined by either using the sum of traffic generated by local or intersecting streets or by referring to the City's Interactive Traffic Control Database System for Traffic Count Data.—Percentage of trucks and truck classifications will be provided by Public Works, Traffic Engineering. Whichever is greater, the actual percentage truck traffic or 5% minimum trucks should be used to determine the AADT.

A. Growth Rates

The growth rates for the projected traffic volumes will be adjusted in accordance to **Table V-1** unless different growth factors are provided by Public Works, Traffic Engineering:



TABLE V – 1 Growth Rates G.R.		
Major Collector and Arterial Streets	2%	0.02
Minor Collector Streets (two lanes)	1%	0.01
Subdivision or Residential Through Streets *	0.5%	0.005
Subdivision or Residential Loop Streets **	0.1%	0.001
Subdivision or Residential Cul-de-sacs	0.1%	0.001
* Subdivision through streets are generally streets that connect through from one side of a subdivision or neighborhood to the other side, or such streets that are mainly used by motorists passing through and not stopping in a neighborhood.		
** Loop streets are such streets that loop back and connect at two separate locations to the same road within a particular subdivision, development, or neighborhood.		

B. Projected Traffic Volume

For Subdivisions and Secondary Roads, the Design AADT shall be determined and calculated by using the design equations in VDOT's Pavement Design Guide for Subdivision and Secondary Roads in Virginia

For Primarily Roads, traffic information is determined and calculated by the design equations in AASHTO Guide for the Design of Pavements Structures (1993) and AASHTO Guide for Design of Pavement Structures, Supplement (1998) that includes axle loads, axle configuration and number of applications.

These guides convert a mixed traffic stream of different axle loads and axle configurations into a design traffic number by converting each expected axle loads into an equivalent number of 18-kip Equivalent Single Axle Loads (EASLs) and to sum these ESALs over the design performance period. The determination of design EASLs is a very important consideration for the design of the pavement structure.

C. Lane Distribution

The design AADT assumes the traffic volumes are equally distributed in both directions. In most cases, a 50/50 directional split is assumed unless information from Public Works, Traffic Engineering or other sources are provided.

For multi-lane facilities, the lane distribution factor should be made to the projected AADT in accordance with **Table V-2**.



TABLE V-2 Lane Distribution Factors		
Number of lanes/roadway	Number of lanes/direction	Lane Distribution Factor
2	1	1.0
4	2	0.9
6	3	0.7
8 or more	4 or more	0.6

5.4 Pavement Design Methods and Pavement Design Life

A. Pavement Design

Pavement structures are designed and calculated by using the following publications and/or software:

1. AASHTO Guide for Design of Pavement Structures (1993),
2. AASHTO Pavement Design Guide, Supplement (1998), Guide for Design of Pavement Structures, 4th Edition, Supplement
3. VDOT, Material Division, Manual of Instructions, Chapter VI,
4. 2016 VDOT's Road and Bridge Specifications,
5. Virginia Test Methods Manual,
6. 2018 VDOT Pavement Design Guide for Subdivision and Secondary Roads in Virginia,
7. software developed by VDOT for Subdivision and Secondary Roads pavement design at www.virginiadot.org/business/materials-download-docs.asp or
8. PaveXpress (www.paveexpressdesign.com)
9. Equivalent software which meets all AASHTO and VDOT requirements and is pre-approved for use by the City's Engineer

For primary roadways, the Mechanistic-Empirical Pavement Design Guide (MEPDG) shall be used for projects consisting of new construction, new alignment, pavement widening (lane addition) and rehabilitation. Rehabilitation encompasses the activities and extends the service life of an existing pavement through the principles of resurfacing, restoration, and reconstruction.

For secondary and subdivision roadways, the VDOT's Pavement Design Guide for Subdivision and Secondary Roads in Virginia will be used for new construction and reconstruction with traffic volumes equal to or less than 10,000 AADT. If the traffic volumes of the Secondary Roadway exceeds 10,000 AADT, the actual truck count and classifications need to be determined and serious consideration shall be given to the design using MEPDG for new construction and reconstruction.

Other alternative pavement design procedures, such as "WinPAS", "AASHTOWare Pavement ME Design", "Streetpave" or "pavementdesign.org" may be used in specific applications when approved by the City's Engineer.



B. Pavement Design Life

Pavement design life is 30 years for both primary, secondary and subdivision roadways within the geographical boundaries of the City of Virginia Beach.

5.5 Soil and Subgrade Requirements

All soil and subgrade information will be evaluated by the design engineer prior to design of pavements. Soil and Subgrade Information; as specified in **Chapter 4, “Geotechnical Information & Design”** will be submitted to the City in accordance with these criteria to substantiate the pavement design prior to plan approval.

Soil samples for California Bearing Ratio (CBR) tests shall be taken from the top 12 inches of proposed subgrade by a qualified soils technician or engineer. If the subgrade soil has been identified as fine grained, more than 35% passing the 200 sieve according to AASHTO Classification System, Atterberg tests (Liquid and Plastic limits) shall be run in addition to the normal sieve analysis, laboratory compaction and CBR tests, so that an assessment of the potential need for the subgrade stabilization or undercut can be made. If indications of unstable conditions for construction equipment are present, natural moisture content determinations should also be made to aid in determining the appropriate method of stabilization/undercut by comparison with the Atterberg Limits of the soils.

The design CBR determination process assumes that the properly compacted subgrade soil will produce a stable platform for pavement construction. If an unstable subgrade is encountered, it should be stabilized or undercut to a firm foundation. Stabilization would use lime or cement depending on PI of the soil. Undercut material would be replaced with adequately compacted soil or aggregate materials. The use of a geosynthetic to produce a stable platform for construction equipment is acceptable.

A minimum soaked CBR value of nine (9) will be required for subgrade support soils (except private property). Where subgrade support soils indicate a CBR value of less than nine (9), the design will include a method for stabilization and proper support through the use of subgrade improvements. Where field conditions indicate further selective areas of poor or yielding subgrade upon exposure of the subgrade, these substandard areas will be undercut to provide for additional subbase, base, or select material as directed by the City. The stabilization of subgrade will be to a depth as established by VDOT publications Virginia's Method of Conducting CBR Test and VDOT Material Division, Manual of Instructions, or some other mutually acceptable method.

When using the VDOT Pavement Design Guide for Subdivision and Secondary Roads in Virginia, the Resiliency Factor (RF) shall not be assumed for the City of Virginia Beach. Instead, the Resiliency Factor should be determined by the following three primary factors from the soil borings (see **Table V-3**):

1. Soil Classification (based on AASHTO Designation M-145)
2. Sand Content (percent retained on #200 mesh sieve)
3. Mica Content (Determination should be based on an engineer with a geotechnical specialty licensed in the Commonwealth of Virginia).



TABLE V - 3 Evaluation of Soil Resiliency Factors		
Classification	Soil Type	Resiliency Factor⁽²⁾
Soils Without Mica Content		
Very Low Resilient Soils	a) A-1 and A-3 soils b) A-4, A-5, and A-7 soils with sand content 60 percent or more.	3.0
Low Resilient Soils	A-2, A-4, A-5, A-6, and A-7 soils with sand content more than 40 and less than 60 percent.	2.5
Medium Low Resilient Soils	A-2, A-4, A-5, A-6, and A-7 soils with sand content 40 percent or less.	2.0
Soils With Mica Content		
Medium Low Resilient Soils	a) A-7-5 soil b) Soil with low (including traces) mica content ⁽¹⁾ and with an average group index (G.I.) Below 5. c) A-2, A-5, A-6, and A-7-6 soils with low (including traces) mica content	1.5
High Resilient Soils	Soils which do not come within the category of "Medium Low Resilient Soils" and also contain mica	1.0
Notes: 1. In this table, soil classifications based on AASHTO Designation M-145-66, sand content (retained #200 sieve) and mica content have been adopted. Determination of the mica content will be done by an engineer with a geotechnical specialty licensed in the Commonwealth of Virginia. 2. To determine the Soil Resiliency Factor, proceed from the top to the bottom of the table and obtain the correct resiliency factor by the process of elimination.		

The Design CBR is two-thirds ($\frac{2}{3}$) of the average soaked CBR value, not the average CBR value.

The design CBR determination process assumes that properly compacted subgrade soil will produce a stable platform for pavement construction. If an unstable subgrade is encountered, it should be undercut to a firm foundation and be replaced with adequately compacted soil or



aggregate materials or otherwise be stabilized by lime, cement, or the use of a geotextile to produce a stable platform for construction equipment.

All CBR values are to be determined in accordance with "The Virginia Test Method for Conducting California Ratio Test" (Designation VTM-8). The Soil Sample Frequency and CBR test for pavement design shall be in compliance with the VDOT Pavement Design Guide for Subdivision and Secondary Roads in Virginia. CBR test locations and procedures must be performed in accordance with **Section 4.3 "CBR Values"** of this manual.

A soaked CBR of less than 9 will require subgrade improvements that may include, but not limited to, the removal of subgrade stabilization or geosynthetics. Any other proposed means to resolve a particularly unsuitable soil and/or subgrade situation will require approval of the City. The AASHTO Construction Manual for Highway Construction can be used as a guide.

The preparation of the subgrade should be accordance with the VDOT's Road and Bridge Specifications. Subgrade compaction should be verified every 1000 feet before placement of the subbase/base layer, with a minimum of two compaction tests per roadway. The compaction shall be 98 percent in compliance with the VTM Test Methods, Standard Proctor (VTM-1) for all but gravelly soils. Refer to Sections 304 and 305 of VDOT Road and Bridge Specifications for compaction requirement.

Even if not listed in each individual design and/or plan, compaction and proofroll of subgrade and aggregate layer is required with a fully loaded tandem dump truck on streets, roadways and on parking lots, etc.

Soils with large percentages of fines must be protected from traffic, disturbance, and water. Otherwise, removal will be required when they become unstable.

As directed by the appropriate City inspector, root material one-half ($\frac{1}{2}$) inch and larger in diameter, as well as root mat (organic material), will be removed from the subgrade.

A. Chemical Subgrade Stabilization

1. General Guidelines for Soil Cement and Soil Lime

- a. Each situation is required to be evaluated by the design engineer on a case-by-case basis.
- b. In all cases, driving on stabilized subgrade is not permitted.
- c. Representative samples of the soil to be stabilized should be tested in accordance with Virginia Test Method (VTM) VTM-72 for Cement and VTM-11 for Lime to determine the optimal percentage to stabilize the soils.
- d. Soil cement and lime stabilization will not be used on soils with greater than 20% silt, or 40% clay, or where organic material is present, and when the plasticity index is less than 12. For silts, use a 10% to 20% fly ash and 80% to 90% lime mixture. Use of lime stabilization is recommended for type A-4 or A-7 soils. Tests for unconfined compressive strength, or CBR tests for soil stabilized with lime and cement must be reviewed by the design engineer prior to preparing specifications. Unconfined compressive strength must be equal to or greater than 500 p.s.i. and/or CBR values must be equal to or greater than 15 after the material has been stabilized with lime or cement.



- e. Soil stabilization should be completed before the ambient air temperature drops below 40 degrees Fahrenheit and, for best results, covered immediately with an untreated aggregate course provided that construction equipment does not damage the stabilized course or an asphalt seal.

TABLE V-4 Soil Cement Guidelines ¹		
AASHTO Soil	Cement % By Volume	Cement % By Weight
A1A	5 - 7	3 - 5
A1B	7 - 9	5 - 8
A-2	7 - 10	5 - 9
A-3	8 - 10	7 - 11
Note: 1. A proper design and testing protocol should be performed using VTM test method. 2. When cement stabilized aggregate is used over very weak soils ($SSV \leq 2$), it should be placed over a minimum of 4 inches of untreated aggregate.		

TABLE V-5 Soil Lime Guidelines ²		
ASSHTO Soil	Lime % By Volume	Lime % By Weight
A-4	8 - 10	8 - 10
A-5	7 – 8	7 - 9
A-6	6 - 7	6 - 8
A-7	5 - 6	5 – 8
Note: 1. The pH of material after lime stabilization should be approximately 12.5. 2. A proper design and testing protocol should be performed using VTM test and methods.		



Hydrated lime must be used with a dust control plan and cannot be used adjacent to residential areas or in windy weather conditions. Notes will be added to the plans addressing these issues. Water trucks must be on site for soil cement and lime stabilization prior to placement, even if soil is wet and saturated. Soil cement and lime may take more water than is naturally available, even in wet conditions.

Lime soil mixtures should be mixed and cured for 48 hours before final mixing and compacting. Care should be taken during winter months so that the freeze/thaw cycle may not negatively affect the soil cement application before hydration has occurred. Curing times for soil cement and lime stabilization will be in accordance with VDOT's Road and Bridge Specifications Section 306, or as determined by the appropriate City's Inspector. It will be noted that lime may take up to 30 days to fully stabilize.

Stabilized subgrades will be designed to provide pavement system performance equivalent to a pavement system according to the licensed geotechnical engineer

B. Geosynthetics (Geotextile and Geogrid)

Geosynthetics may be considered for subgrade stabilization, when the area in question represents a relatively small amount of the subgrade soils. This may prove more economically feasible in isolated cases. Refer to VDOT Road and Bridge Specifications regarding geosynthetics for subgrades stabilization to select the proper strength requirements

A woven geotextile may be used when undercutting is utilized to remove unsuitable subgrade soil. The woven geotextile should be placed at the bottom of the undercut zone to separate the select backfill from the subgrade. Geotextile will not be required if it is demonstrated that the following criteria are met:

$$\frac{D_{15} BF}{D_{85} SG} \leq 5, \& \quad \frac{D_{50} BF}{D_{50} SG} \leq 25$$

Where: D_{15} , D_{50} , and D_{85} = The diameter for which only 15%, 50%, or 85% of the particles are finer by weight than the entire sample.

BF = Base, Fines

SG = Subbase,

The geotextile will meet the criteria for medium survivability and separation per AASHTO M288.

As determined by the design engineer on a case-by-case basis, geosynthetics may be utilized to stabilize subgrades. Geosynthetics will meet the criteria noted in Section 245 of VDOT's Road and Bridge specifications.

5.6 Pavement Design Criteria

A. Conventional Rigid Pavement Design

Rigid pavements are classified into jointed and continuously reinforced. A Jointed Plain



Concrete Pavement (JPCP) is an unreinforced pavement structure with joints at certain design intervals to compensate for expansion and contraction forces and thermally induced stresses. Jointed Reinforced Concrete Pavement (JRCP) is reinforced pavement structure with joints at certain design intervals. Continuously Reinforced Concrete Pavements (CRCP) have been designed with sufficient reinforcement to eliminate the need for joints.

Rigid pavements generally consist of a prepared roadbed underlying a layer of subbase. The subbase may be stabilized or unstabilized. A drainage layer can be included in rigid pavement design. Stabilized aggregate material or stabilized soil should be used under plain jointed concrete pavement when the support soils are weak and truck traffic exceeds 5% of the total traffic. In case of very weak or highly resilient soil, the soil in place should be stabilized for a depth of six (6) inches with 10-12% cement by volume.

In case of very weak or very low resiliency soils having CBR values less than 2, the soil should be stabilized for a depth of six (6) inches with soil cement, 10% - 12% by volume, or in accordance with the approved and detailed geotechnical design.

The rigid pavement shall be Class A-3 paving concrete according to VDOT's Road and Bridge Specifications and City's Amendments to VDOT's Road and Bridge Specifications or appropriate supplemental specifications. The thickness shall be rounded up to the nearest 0.5 inches. The concrete pavement shall be Jointed Plain Concrete Pavement shall be designed with transverse joint spacing not to exceed 15 feet (the joint spacing in feet shall not exceed 2 times the pavement thickness in inches) of 20 feet (recommended joint spacing: 15 feet). Non-dowelled pavement of 6 inches or less in thickness, shall have at least 3 longitudinal joints (no joint along the wheel path), shall have maximum aspect ratio of 1:1 (length to width) and shall have a maximum panel size of 8 feet by 8 feet. Typical joint detail examples are provided in the VDOT's Pavement Design for Subdivision and Secondary Roads in Virginia.

B. Flexible Pavement Design (Asphalt Concrete)

Flexible pavement generally consists of a prepared roadbed underlying layers of subbase, base and surface courses. In some cases, the subbase will be stabilized to maximize the use of local materials.

The following guide provides a set of procedures and recommendation in determining the flexible pavement design:

1. For MEPDG method, the material's substitution ratios shall be in accordance with AASHTO Value/Structural layer coefficient as noted in **Table V-6**, unless otherwise specified by the pavement design method used:



Table V-6 Structural Layer Coefficients (New Design and Overlay)	
Material	VDOT Value for Pavement Design (a_i)
SM-9.5	0.44
SM-12.5	0.44
IM-19.0	0.44
BM-25.0	0.40
BM-37.5	0.37
SMA 9.5, SMA 12.5, SMA 19.0	0.54
Graded Aggregate Base – 21A or 21B	0.12
Cement Treated Aggregate Base	0.20
Rubblized Concrete	0.18
Break and Seat/Crack and Seat	0.25
Soil Cement	0.18
Lime Treated Soil	0.18
Gravel	0.10
Open Graded Drainage Layer – Bound	0.10 Open
Graded Drainage Layer – Unbound	0.0-0.10
All other soils and subgrade improvements	No Layer Coefficient

2. Asphalt Mix Types shall be in accordance with VDOT's Road and Bridge Specifications and the City's Amendments to VDOT's Road and Bridge Specifications and as shown in **Table V-7** below, unless otherwise specified by the pavement design method used. These mixes are designed to perform different functions within the pavement structure. Mixes vary based on nominal maximum aggregate sizes, aggregate graduation, asphalt binder content and other variables.
 - a. Surface mixes serve as both function and structural layers of the pavement structure. Surface mixes are directly exposed to traffic and the environment. They must provide a smooth, stable, safe (i.e. skid resistance) riding surface, and promote surface water drainage. They serve to prevent the entrance of excessive quantities of water into the underlying hot mix asphalt layers, bases, and subgrades. The surface layer normally contains the highest quality materials. Typically, only one surface mix lift will be placed on a project. Surface mixes are given SM-XY.Z designation in the specifications where SM stands for surface mix and XY.Z denotes the nominal maximum aggregate size.
 - b. The intermediate mix, sometimes called binder course, consist of one or



more lifts of structural asphalt concrete placed below the surface layer. Its purpose is to distribute traffic loads so that stresses transmitted to the pavement foundation will not result in permanent deformation of the layer. It facilitates the construction of the surface layer. Designed with larger aggregates, the intermediates layer is intended to provide resistance to rutting and to intercept top-down fatigue cracking. Intermediate mixes are given IM-XY.Z designation in the specifications where IM stands for intermediate mix and XY.Z denote the nominal maximum aggregate size.

- c. The base mix is the base asphalt layer for the pavement structure. Its major function is to provide the principal support of the pavement structure. The base mix uses the largest aggregate to provide resistance to rutting and to bottom-up fatigue cracking. More than one lift of base mix may be placed to obtain the designed base layer thickness. Base mixes are given the BM-XY.Z designation in the specifications where BM stands for base mix and XY.Z denotes the nominal maximum aggregate size.
- d. Gap graded mixes are asphalt mixes with a non-uniform distribution of aggregate sizes. These mixes contain aggregates retained on the upper and lower sieves, but with little aggregate retained on the middle sieves. Gap grade mixes are given the SMA-XY.Z designation in specifications where SMA stands for Stone Matrix Asphalt and XY.Z denoted the nominal maximum aggregate size. SMA gap-graded aggregate maximizes rutting resistance and durability with a stable stone skeleton held together by a rich mixture of asphalt binder, filler and stabilizing agents such a fibers. This mix is for use on heavy to extreme heavy traffic volumes routes where the expected higher cost can be justified with improved performance over other mixes.



Table V-7 Asphalt Mix Types			
	Equivalent Single-Axle	Minimum Asphalt	Aggregate Nominal
Mix Type	Load (ESAL) Range	Performance Grade	Maximum Size₂
	(millions)	(PG)¹	(inch)
SM-9.0A	0 to 3	64S-16	$\frac{3}{8}$
SM-9.0D	3 to 10	64H-16	$\frac{3}{8}$
SM-9.0E	Above 10	64E-22	$\frac{3}{8}$
SM-9.5A	0 to 3	64S-16	$\frac{3}{8}$
SM-9.5D	3 to 10	64H-16	$\frac{3}{8}$
SM-9.5E	Above 10	64E-22	$\frac{1}{2}$
SM-12.5A	0 to 3	64S-16	$\frac{1}{2}$
SM-12.5D	3 to 10	64H-16	$\frac{1}{2}$
SM-12.5E	Above 10	64E-22	$\frac{3}{4}$
IM-19.0A	Less than 10	64S-16	$\frac{3}{4}$
IM-19.0D	10 to 20	64H-16	$\frac{3}{4}$
IM-19.0E	20 and above	64E-22	1
BM-25.0A	All range	64S-16	1
BM-25.0D	Above 10	64H-16	1
¹ Minimum Asphalt Performance Grade (PG) is defined as the minimum binder performance grade for the job mixes as determined by AASHTO T170 or AASHTO M332.			
² Aggregate Nominal Maximum Size is defined as one sieve size larger than the first sieve to retain more than 10 percent aggregate			
Note: SM= Surface Mixture; IM = Intermediate Mix; BM= Base Mixture			

3. Asphalt binders use VDOT typical letters to designate asphalt binders in contracts and specifications just like the asphalt mixes. For dense graded mixes, asphalt binder designations A, D, E are used. Mix stiffness generally increases from “A” to “E”, with “A” being the softest. For gap graded asphalt concrete, no letter designation is used in contracts, specifications and special provisions. In the specifications and special provisions for specialty mixes, the asphalt binder is declared. The following sections define each asphalt binder.

a. Dense Graded Mix Binder Letter Designations

“A” – The “A” designation corresponds with a Performance Graded (PG) asphalt binder of PG 64S-22 (formerly PG 64-22). This designation should perform well in low to medium traffic loading situations.



“D” – The “D” designation corresponds with a Performance Graded (PG) asphalt binder of PG 64H-22 (formerly PG 70-22). This designation should perform well in medium to high traffic loading situation.

“E” – The “E” designation corresponds with a Performance Graded (PG) asphalt binder of PG 64E-22 (formerly PG 76-22). Mixes with this binder designation should perform well in high to extremely high traffic loading situation. The stiffness of mixes using this binder should not be used as a substitute for deficient pavement structure (high deflections under traffic loadings will destroy any pavement structure). In general applications, the “E” binder designation is not used in a base mix.

b. Gap Graded and Specialty HMA Binders

PG 64H-22 – Like the “D” designation for dense graded mixes, this binder is the Performance Graded (PG) 64H-22 (formerly PG 70-22). This designation should perform well in medium to high traffic loading situations and over jointed continuously reinforced concrete pavement.

PG 64E-22 – Like the “E” designation for dense graded mixes, this binder is the Performance Graded (PG) 64E-22 (formerly PG 76-22). This designation should perform well in high to extremely high traffic loading situations and over continuously reinforced concrete pavement. The stiffness of mix should not be used as a substitute for deficient pavement structure (high deflections under traffic loadings will destroy any pavement structure).

PG 64V-28 – This binder is a polymer modified Performance Graded (PG) 64V-28 (formerly PG 70-28). The purpose of this binder is to resist thermal cracking and minimize reflective cracking over jointed concrete pavement.

4. The recommended minimum and maximum limits for thickness of pavement layer are shown in **Table V-8**. However, not less than 4 ½ inches of asphalt concrete must be placed over cement treated base/subbase material as the surface/intermediate/base layer(s).

Maximum thickness of an asphalt concrete surface shall be 2 inches, except as follows:

- a. When staged surfacing is required, a maximum of 2 ½ inches of surface is allowable, provided the thickness of the final is not less than one inch and at least one year’s time elapse between the placement of the initial and final surfaces.
- b. A maximum thickness of 3 inches is allowable when using Type. IM-19.0A.
- c. Six inches of full-depth asphalt concrete pavement is the minimum recommended allowable thickness (Surface mix and base mix) when placed directly on the prepared subgrade, except as may be permitted by **Tables A and B in Appendix IV** of the VDOT Pavement Design Guide for Subdivision and Secondary Roads in Virginia.



The maximum thickness of aggregate material used as the base layer shall be 8 inches before considering any additional thickness as a subbase material.

Maximum combined thickness of the base and subbase aggregate layers is 12 inches.

Table V-8 Asphalt Concrete Material Layer Thickness		
Material	Min Thickness (in./lift)	Max. Thickness (in./lift)
SM-9.5	1	1.5
SMA-9.5	1	1.5
SM-12.5	1.5	2
SMA-12.5	1.5	2
SMA 19.0	2	3
IM-19.0	2	3
BM-25.0	2.5	4
BM-37.5	3	6

5. Porous pavement is not allowed in the City's right-of-ways or in any City's easements because of maintenance cost and design parameter considerations.

5.7 Minimum Pavement Design Standards

Installed pavement thickness must be not less than 90% of each layer specified in a design. Otherwise, installed pavement will be either removed or added, to bring the total thickness up to 100% of that specified in the design.

In all cases the pavement section will be based on pavement design however, the following pavement sections or their equivalent is the minimum acceptable.

A. Concrete

1. On-Site (Outside of the Public Right-of-Way):
 - a. Five (5) inches of plain Portland cement concrete, over
 - b. Compacted subgrade.
2. Within the Public Right-of-Way or a City Easement:
 - a. Eight (8) inches of plain Portland cement concrete, over
 - b. Compacted subgrade.

B. Full Depth Asphalt

Total asphalt pavement placed directly on subgrade is not allowed due to poor results.



C. Flexible Pavement Recommendations (Outside of the Public Right-of-Way)

1. Two (2) inches of bituminous concrete surface, over
2. Eight (8) inches of VDOT Type I or Type II aggregate base, over
3. Compacted subgrade.

One and one-half (1½) inches of surface asphalt course may be used if supported by the flexible pavement design.

D. Flexible Pavement Recommendations (Inside of the Public Right-of-Way)

All flexible pavements must be designed based on the existing subgrade and the projected traffic volumes or projected truck volumes.

5.8 Materials for Design

All materials, including their handling, treatment, and placement will conform to the 2016 VDOT's Road and Bridge Specifications, the City's Amendments to 2016 VDOT's Road and Bridge Specifications and VDOT, Material Division, Manual of Instructions, Chapter VI.

5.9 Prime Coat and Tack Coat

Prime coat and tack coat shall be applied according to the VDOT's Road and Bridge Specifications.

5.10 Pavement Replacement and Patching

Without an approved plan, no pavement is to be cut without a written request and permission from the DSC and/or Public Works. Pipe or conduit must be jacked, driven or otherwise pushed under the roadway whenever possible. Pavement replacement and/or pavement patching will be required after the roadway surface has been disturbed by road construction, underground installation or repairs of sewer, water, storm sewer, telephone, power, cable television, gas, or any other underground utility or service lines. The design engineers shall use sound engineering judgment in determining whether the roadway work involved constitutes a roadway reconstruction or a roadway patch as defined below. Any pavement replacement or patching will require a surety posted in the DSC or as part of the Public Works construction bond. See **Standard Drawings C-3A, C-3B and C-4**.

If the existing roadway has been resurfaced within the last 2 years, then the existing roadway is in a moratorium status of "No Open Cuts" permitted without the approval from the Director of Public Works. If approved, then an additional 25-foot area before and after the trenched area will have to be milled and resurfaced with an appropriate surface asphalt course mix to provide a smooth transition.

Definitions - The following definitions are provided to clearly delineate the types of pavement replacement:

A. Roadway Reconstruction

Reconstruction is defined as removal or manipulation of all bound layers and/or manipulation of bound and unbound base and subgrade exceeding the removed or



damaged area defined in **Section 5.10.B, Roadway Patch**

During roadway reconstruction, the existing asphalt surface course should be milled and overlaid within the project limits of the open cut.

Roadway reconstruction of any streets, cul-de-sacs, collectors, or major arterials, etc., will be considered as the placement of a new pavement, requiring the submittal of a pavement design based on at least one CBR test in accordance with City Standards and will be reviewed by the Departments of Public Works/Operations and the Department of Planning.

The CBR test will be made on the material actually used in the roadway reconstruction. This material (CBR ≥ 15) may be either:

1. Select fill (with Unified Soil Classification of SC, SW, S, SP or SM), or
2. The original trench material (only if it can be made to achieve a CBR ≥ 15).

The material will then be compacted back into the area of excavation.

B. Roadway Patch

Roadway Patch is defined as a repair of removed or damaged pavement that has been cut no more than five (5) feet wide, at an angle between 45 degrees and 90 degrees to the length of the roadway, or a ten (10) foot by ten (10) foot square cut, maximum. Anything greater shall be defined as roadway reconstruction.

1. For Local and Collector streets, the roadway patch shall be in accordance to the **Standard Drawings, C-3A**. The roadway patch is to either match the existing pavement section in depth and type of materials or will be in accordance with the following, whichever is greater:
 - a. One and one-half (1½) inch of SM-9.5A surface asphalt concrete over,
 - b. Three (3) inches of BM-25.0A base mix asphalt concrete over,
 - c. Six (6) inches of Aggregate Base Material, Type I, No. 21A, over,
 - d. Compacted subgrade.
 - i. For excavation below the base material, all existing materials will be removed and replaced with select fill having a CBR ≥ 15 to a minimum depth of 12" or as determined by the City's inspector.
 - ii. Subgrade will be compacted in 12 inch layers to three (3) feet below the base material to 95% of the ASTM D-698 (Standard Proctor) maximum theoretical density, and
 - iii. Compacted in six (6) inch layers to 95% of the ASTM D-698 (Standard Proctor) maximum theoretical density, from three (3)



feet below the base material to the base material.

2. For Major and Minor Arterials, the roadway patch shall be in accordance with **Standard Drawing C-3B**. The roadway patch is to either match the existing pavement section in depth and type of materials or will be in accordance with the following, whichever is greater:
 - a. Two (2) inches of SM-9.5 D surface asphalt concrete, over
 - b. Four (4) inches of BM-25.0 A base mix asphalt concrete, over
 - c. Eight (8) inches of Aggregate Base Material, Type I, No. 21A, over
 - d. Compacted subgrade.
 - i. For excavation under the base material, all existing materials will be removed and replaced with select fill having a CBR ≥ 15 to a minimum depth of 12" or as determined by the City's inspector.
 - ii. Subgrade will be compacted in 12 inch layers to three (3) feet below the base material to 95% of the ASTM D-698 (Standard Proctor) maximum theoretical density, and
 - iii. Compacted in six (6) inch layers to 95% of the ASTM D-698 (Standard Proctor) maximum theoretical density, from three (3) feet below the base material to the base material.
 - iv. The appropriate choice of soil cement stabilization or lime stabilization will be designed and installed for the pavement patch.
3. Other pavement patching requirements;

Temporary pavement patching materials shall be approved prior to cutting the roadway. All cuts made in the roadway will be temporarily patched the same day the cut is made. The temporary pavement will be maintained and kept free of potholes until final paving is complete.

A load test is required to determine the degrees of deflection and will be coordinated through the Department of Planning, Civil Inspections and/or Department of Public Works. Prior to placement of pavement, a density test may be required to be performed by the developer/contractor upon request by the City's Inspector.

Temporary pavement will be placed over all cuts through sidewalks or paved areas. No more than 500 feet of longitudinal trench will be cut before a temporary patch is installed.

 - a. Concrete will be completely removed to its nearest construction and/or control joints. Replace expansion materials and reinforcements to match the existing design as required. A minimum



of Class A-3, 3,000 psi concrete will be placed in all concrete paved areas. High early strength concrete may be used to reduce the required curing period in order to restore traffic expeditiously.

- b. When pavement is removed, the replacement normally will be of a similar type, i.e., a concrete pavement section should be replaced with a concrete pavement section and an asphalt pavement section should be replaced with an asphalt section. Exceptions must be specifically approved by the Departments of Public Works and Planning.
- c. When a road has been open cut and the final pavement cannot be placed on either the same workday or the trench backfilled and a temporary patch placed then, at the direction of the City inspector, the trench will be backfilled and a temporary steel bridge plate placed over the trench. Unless special approval is given by the City due to extenuating circumstances, all travel lanes will be reopened to traffic at the end of each workday.

If approval is obtained from the City to have the trench remain open overnight, the trench must be barricaded by appropriate work area protection, as required by VDOT standards.

Note: See **Section 10.4.K “General Temporary Traffic Control Notes and Time Restrictions”** of this manual for restrictions on any work within the public right-of-way that is within ten (10) feet of the travel lane. This includes any work such as (but not limited to) obstructions hindering the motoring public, pavement drop offs, open cuts, utility work, paving, pavement reconstruction, temporary traffic control, construction, or any other issue considered to be a hazard or an inconvenience to the traveling public.

5.11 Testing Requirements

The purpose of this section is to provide guidelines for the performance of field density testing for new roadways and roadway reconstruction. (Also see **Chapter 4 “Geotechnical Information & Design”**.)

- 1. All developers will be responsible for contracting (at their cost) with a private firm to do density field testing.
- 2. Before scheduling density tests, the developer will be required to call the City Inspector to inspect proof rolling, depth checks and the grading.
- 3. When the field density tests are to be performed, the City Inspector shall be notified of the time. The Inspector must receive a copy of the test results before the next phase of construction can begin. A field copy is sufficient. The Inspector will ensure that the test results are representative of the field conditions before authorization is given to proceed with construction with a field observation.
- 4. If the tested surface has been disturbed by traffic or has been adversely affected by weather, the density test will have to be repeated.



5. If the test results are acceptable and the City Inspector authorizes the next phase of construction, work on the next layer may begin. If the test results are unacceptable the contractor may re-compact and re-test.



6.0 Incidental Construction Items

6.1 General

All incidental concrete construction will conform to Virginia Department of Transportation Road and Bridge Specifications, Division V "Incidental Construction." All concrete work performed within the public right-of-ways and City easements will be inspected by the appropriate inspection staff.

6.2 Curb and Combination Curb & Gutter

All curbs and combination curb & gutters will be Class A-3 concrete and constructed according to specifications provided in section 502.02 (a, c, & d) and 502.03 (a) of the Virginia Department of Transportation Road and Bridge Specifications, the standard drawings included in the Virginia Department of Transportation Road and Bridge Standards, and **Detail B-15** "Combination Curb and Gutter, VBCG-1" included in **Appendix B** of this manual.

The minimum fall around standard curb returns will 0.5 percent or two-tenths (0.2) feet whichever is greater.

Valley gutters will be considered on a case-by-case basis when deemed necessary and only within the shoulder areas of minor streets. In no case shall a valley gutter be installed perpendicular to the direction of traffic or between a through lane and turn lane.

1. If the design CBR value of the subgrade is 10 or greater and is not clay or silt then the curb and gutter can be placed on the compacted subgrade [except as noted in 6.2.1 (c) and 6.2.1 (e)]. In this case a minimum of 1 CBR test per street shall be taken and the CBR test must be taken every 500' as measured along the streets.
2. If the design CBR value of the subgrade is less than 10, then a minimum of 6 inches of aggregate base material (Type 1, No. 21B) must be placed under the curb & gutter to a distance 1 foot behind the curb and compacted to 95% standard proctor.
3. Curb & gutter will not be placed directly on clay, silt or other unsuitable type material.
4. If the design CBR values in or adjacent to a project are generally 10 or greater, but some of the CBRs are less than 10, then those areas less than 10 must have 4 inches of aggregate placed under the curb. If any areas are then found in the field to be soft or not suitable, aggregate must be placed under the curb as described in 6.2.1 (b).
5. If the pavement design is of such a depth that the aggregate base or subbase is below the bottom of the curb, then aggregate must be placed under the curb as described in 6.2.1 (b), regardless of the CBR value of the subgrade.
6. Curb and combination curb & gutter on right-of-way for streets and roads with design speeds 45 m.p.h. or less will be VDOT CG-2 curb and CG-6 curb & gutter. Right-of-way for arterials with design speeds 50 m.p.h. and above will be VDOT CG-3 curb and CG-7 curb & gutter.



6.3 Sidewalks and Bikeways

A. Sidewalks

All concrete sidewalks must be in compliance with the latest Americans with Disabilities Act (ADA) and will be a minimum of five (5) feet wide. All concrete sidewalks will be a minimum of four (4) inches thick, conforming to the specifications provided in Section 504.02 (a, c, d, f), Section 504.03 and Section 217 of the Virginia Department of Transportation Road and Bridge Specifications. Standard sidewalk widths are indicated in **Appendix F** of this manual, and general locations for sidewalks are shown in the Standard Drawings included in **Appendix A** of this manual. Variations from the standard location of the sidewalks may be allowed or required by the Department of Public Works due to topographical or other physical features.

B. Bikeways

Right-of-way for and construction of bikeways included in the City of Virginia Beach Bikeways and Trails Plan shall be required based on policies set forth in the City's Master Transportation Plan as well as Standard Drawings included in **Appendix A** of this manual. These bikeways shall be designed in accordance with **Appendix F**, "Bicycle Facility Standards PW/Engineering Technical Report." Variations from the standard locations may be allowed or required by the Department of Public Works due to topographical or other physical features. Pavement designs for asphalt bikeways shall be determined for each project following the methods in **Chapter 5**, "Pavement Design and Pavement Patching."

C. Monolithic Curbing and Sidewalks

Where monolithic sidewalk and curbing is required:

1. It may be constructed and the concrete poured monolithically, or
2. May be constructed using No. 3 reinforcing steel dowels which structurally connect the sidewalk and concrete curb and/or drainage structures. The steel dowels will be placed 16" on center, or a curb ledge will be provided to receive the sidewalk in accordance with **Standard Drawing C-5** "Sidewalk Connection to Curb Alternative" in **Appendix C** of this manual or as allowed by VDOT.

D. Curb Ramps

1. All curb ramps will be designed in accordance with the Code of Virginia (Section 15.2-2021), the latest Americans with Disabilities Act (ADA) guidelines, and the latest VDOT detail.
2. VDOT CG-12 curb ramps will be located at all:
 - a. Intersections where both curbs and sidewalks, or curbs and vegetated accessible spaces exist, where sidewalk is existing or is planned, and
 - b. At other major points of pedestrian flow between intersections where sidewalk exists or is planned for the future.
 - c. Curb ramps are required according to ADA guidelines.



- d. Curb ramps are not required where there is insufficient right-of-way (minimum 3') or where there are obstructions such as walls or ditches.
- e. Where a Standard VDOT CG-12 curb ramp is required:
 - i. The entire curb ramp must be installed. No wipe downs in the curb line will be allowed in "anticipation" of future construction.
 - ii. Prefer two ramps for each corner. Ramps will be installed at both ends of each radius at the tangent, or as close as practical to the point of tangency within the radius as feasible, the curb ramp should align with the existing crosswalk and be at least 4' in front of its associated STOP BAR. The use of 1 wide CG-12 ramp, centered in the radius, is typically not permitted so as to preserve curbing for use by the visually impaired at the crosswalk, on all high speed and/or high traffic volume roadways.
 - iii. CG-12 ramps should be constructed on the opposite side of the roadway, directly across from each other where possible, to avoid "trapping" users who rely on the presence of curb ramps. Medians will have protected wipe down spaces at the location of the crosswalk. Do not install CG-12's without ensuring median wipe downs and opposing CG-12's are installed.
 - iv. When determining proper corner or entrance radii, use of accepted large vehicle turning templates is strongly encouraged. The guidelines listed in this manual are minimum radii. Sound engineering judgment should be used in determining the proper radius in each case and its impact on positioning of the CG-12 curb ramps.
 - v. **CG-12 Curb Ramp Construction Details**
 - 1) CG-12 ramps, including flares, will be 7" thick. This thickness will extend to the second construction joint on either side of curb ramp (which will be a minimum distance equal to the width of the sidewalk/path) to provide sufficient structural support for vehicles which may ride over these areas. Subgrade below CG-12's as well as sidewalks and bikeways shall be firm and compacted, with no unsuitable, soft or yielding material for the subgrade.
 - 2) Flares of the CG-12 curb ramps will have a standard broom finish and will not have the aggregate exposed.

6.4 Permanent Monuments

Monuments will be constructed of precast Class A-3 concrete, thirty (30) inches in depth and either six (6) inches square or six (6) inches in diameter, having a number five (5) deformed reinforcing bar imbedded therein; or the monument may be a number five (5) deformed reinforcing bar a minimum of thirty (30) inches long with Class A-3 concrete poured in place around the bar twenty-four (24) inches deep, and a minimum of six (6) inches in diameter, marking the point represented in the final plat. See **Appendix C, Standard Drawing C-8**, Permanent Survey Monument.



7.0 Utilities Within the Right-of-Way

7.1 General

Utilities are defined as publicly and privately owned cable television, telephone, electrical, gas, petroleum, sanitary sewer, water, and similar underground infrastructure.

PRIOR TO ANY WORK UNDERGROUND, THE CONTRACTOR WILL CONTACT MISS UTILITIES AT 811 AT LEAST 48 HOURS BEFORE WORK IS TO COMMENCE. THE CONTRACTOR WILL ALSO COMPLY WITH ALL REQUIREMENTS OF THE VIRGINIA UNDERGROUND UTILITY DAMAGE PREVENTION ACT, CHAPTER 10.3, SECTION 56-265, ALL PARTS.

The contractor will contact the Landscape Management Division, Department of Parks and Recreation at 385-4461 at least three (3) days prior to removing trees or other vegetation in the right-of-way for utility installation and again immediately after completion of work. If a tree is damaged during utility installation contact the Landscape Management Division immediately.

7.2 Minimizing Impacts to Pavement with Utility Installation

It is the standard practice of Public Works that the cutting of pavement be minimized. In the case of unavoidable cuts coordination with Section 5.10 will be required. Also, if the existing roadway has been resurfaced within the previous two (2) years then it is in a moratorium status of "NO OPEN CUTS PERMITTED WITHOUT APPROVAL FROM THE DIRECTOR OF PUBLIC WORKS". If approved, then an additional 25-foot area before and after the trench area will have to be milled and resurfaced with an appropriate surface asphalt course mix to provide a smooth transition. Refer to ***Standard Drawings C-3A, C-3B, and C-4*** for additional details.

1. Prior to installing utilities in any active roadway or pedestrian sidewalk/path, a traffic control plan approved by the City's Traffic Engineering Division is required.



8.0 Stormwater Management

8.1 General

In addition to the factors that must be considered and evaluated in the design of any drainage system, drainage systems in coastal areas must account for the unique characteristics of coastal flooding, including the impacts of tides, sea level rise and rainfall due to climate change, low ground elevations, and high groundwater tables.

This Chapter of the Public Works Design Standards identifies the specific minimum design standards that must be met by all proposed drainage systems within the City of Virginia Beach. However, conformance to these standards does not relieve the licensed design professional or the firm for which the licensed design professional is performing the design, from performing all work in accordance with all applicable professional standards. The design professional must also ensure the design is consistent with sound engineering practice and principles and in accordance and compliance with all applicable codes, laws, and regulations. The licensed design professional and the firm for which the licensed design professional is performing the work are responsible for the design and for assuring that the design meets all applicable requirements and, for the required design storm/tide frequency pairs and the check storm, results in no flooding on-site and no increase in flooding upstream and downstream of the site.

All proposed drainage systems within the City of Virginia Beach shall be designed and constructed in accordance with this Chapter, as well as the criteria and provisions contained in the below listed references. Analysis of existing conditions shall be required to the same level of detail and extent as the proposed drainage system design, using the same methodologies as used for the proposed drainage system and as required by these Design Standards.

Virginia Department of Transportation Drainage Manual (VDOT DM) Chapters 3 through 9 and 12, inclusive of appendices and computation forms

Virginia Erosion and Sediment Control Handbook (VESCH)

Virginia Stormwater BMP Clearinghouse, Draft 2013 version, website
(<https://www.swbmp.vwrrc.vt.edu>)

Virginia Stormwater Management Handbook (VSMH), website
(<https://swbmp.vwrrc.vt.edu/references-tools/2013-draft-handbook/>)

The designer shall become familiar with these references and the documents they reference. Consider the latest amendments and updates to the above listed references to be incorporated into these Design Standards.

Stormwater quantity and quality control measures shall be provided within the project limits or on land specifically acquired, usually in conjunction with the project, for SWM purposes in accordance with the SWMO and other applicable requirements of the City Code, state laws and regulations, or federal code, laws, and regulations. The use of off-site stormwater management facilities (SWMFs/BMPs) shall be limited to off-site compliance options contained within the SWMO.

The use of water bodies not specifically designed and constructed as SWMFs/BMPs must be avoided. In all cases where offsite compliance options are being considered, the designer must provide the legal proof the project is allowed to use the offsite facility for SWM control as well as documentation demonstrating the adequacy of the SWMF/BMP for stormwater quality control. Development must also ensure adequate downstream capacity and provide easements to the extent required.

Prior to beginning a project and throughout design development, designers are encouraged to



meet with the City to discuss advanced design coordination. This coordination is especially important when complex drainage systems and tailwater conditions are involved.

1. For capital improvement or other City projects, the Public Works Stormwater Engineering Center is available for consultation, or
2. For private development projects, the designer is encouraged to meet with Planning/Development Services Center (Planning/DSC).

Updates to the City Stormwater Management Master Plan (SWMM files and reports) and the Comprehensive Sea Level Rise and Recurrent Flooding Study (Sea Level Wise Study) are under development. These plans and reports, and other studies are available from the Public Works Stormwater Engineering Center. Private developers and their designers should request these documents and files through Planning/DSC.

8.2 Definitions

The definitions provided herein establish the nomenclature utilized in this section.

1. Check Storm – The check storm shall be defined as the 100-year design storm event.
2. Culvert (References: VDOT DM, VDOT Road and Bridge Specifications, and VSMH, modified for clarification.)- A short closed conduit (box culvert, pipe, or other manufactured culvert), not classified as a bridge, which provides an opening through an area filled with soil for highway, roadway, or site development. Also, one or more cross drainpipes connected by one or more drainage structures (inlets, junction boxes, or manholes) hydraulically designed to function as a culvert that is not connected to a storm sewer system.
3. Drainage Area - A land area, water area, or both from which all runoff flows to a common point.
4. Drainage System- Includes all those components, manmade and natural, that convey and/or store stormwater runoff or other surface flows.
5. Energy Grade Line (EGL)- The line that represents the total energy of flow at a given location. It is the sum of the elevation head (z), pressure head ($p/\rho g$), and velocity head ($v^2/2g$).
6. Flooding- A general or temporary condition of partial or complete inundation of normally dry land areas from:
 - a. The overflow of inland or tidal waters, or
 - b. The unusual and rapid accumulation runoff of surface waters from any source, or
 - c. Mudflows, which are akin to a river of liquid and flowing mud on the surfaces of normally dry land areas, as when earth is carried by a current of water and deposited along a path of the current,
 - d. The collapse or subsidence of land along the shore of a lake or other body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels or suddenly caused by an unusually high water level in a natural body of water, accompanied by a severe storm, or by an unanticipated force of nature such as a flash flood an abnormal tidal surge, some similarly unusual and unforeseeable event that results in flooding as defined above.



7. Hydraulic Grade Line (HGL)- A line coinciding with the level of flowing water in an open channel. In a closed conduit flowing under pressure, the HGL is the level to which water would rise in a vertical tube at any point along the pipe. It is equal to the energy grade line elevation minus the velocity head ($V^2/2g$).
8. Impoundment (Reference: VSMH)- A collection or storage of water, such as a pond, reservoir, pit, dugout, sump etc.
9. Lake (Reference: VSMH)- A water-filled basin with a restricted outlet or no outlet; includes reservoirs and tidal ponds.
10. Localized Flooding- Smaller scale flooding that may occur outside of a stormwater conveyance system. This may include high water, ponding, or standing water from stormwater runoff, which is likely to cause property damage or unsafe conditions.
11. Major Water Body- A public bay, creek, lake, stream, river, ocean, or other large body of water that receives stormwater runoff and has a base flood elevation determined by the current Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS), the City Stormwater Master Plan, or other study available from the Public Works Stormwater Engineering Center. For tailwater computations the major (receiving) water bodies in the City of Virginia Beach are listed in **Table J-12** in **Appendix J**. When the project does not discharge directly into one of the water bodies listed above and the drainage system is tidally influenced, the designer shall determine the hydraulic grade line (HGL) and/or water surface profile (WSP) between the project discharge point and the mapped edge of the water body listed to provide an accurate tailwater control for design purposes.
12. Private Stormwater Drainage- Surface flow, channelized flow through collection methods such as pipes and ditches, storage, treatment and discharge of rainfall generated exclusively on private property and not defined as public stormwater drainage.
13. Proposed (Increased) Impervious Area- The total increase in impervious area from existing conditions to proposed conditions within the limits of disturbance associated with the entire project. This includes improvements made both onsite and offsite,
 - a. It will be considered an increase in impervious area if drainage area boundaries are modified as part of a project and directs additional existing impervious area into a different stormwater conveyance system.
 - b. It will not be considered an increase in impervious area if the project site has been included in a separately approved master planned development, and the total site impervious does not exceed that included in the master planned development.
14. Public Stormwater Drainage- The collection, conveyance, storage, and/ or treatment and discharge of stormwater runoff draining the public right-of-ways, public drainage easements, and City owned property.
15. Stormwater Conveyance System (Reference: SWMO)- A combination of drainage components that are used to convey stormwater discharge, either within or downstream of the land-disturbing activity. This includes:
 - a. “Manmade stormwater conveyance system” means a pipe, ditch, vegetated swale, or other stormwater conveyance system constructed by man except for restored stormwater conveyance systems,
 - b. “Natural stormwater conveyance system” means the main channel of a natural stream and the flood-prone area adjacent to the main channel, or



- c. “Restored stormwater conveyance system” means a stormwater conveyance system that has been designed and constructed using natural channel design concepts. Restored stormwater conveyance systems include the main channel and the flood-prone area adjacent to the main channel.
16. Storm Sewer System (Reference: VDOT DM)- A drainage system (pre-developed and/or proposed) consisting of a series of at least two interconnecting pipes and two structures (drop inlets, manholes, junction boxes, etc.), initially designed to intercept and convey stormwater runoff from a specific storm event without surcharge. A storm sewer system is one of several different types of manmade conveyance systems and is used interchangeably with the term “storm drain.”
17. Stormwater Management Facility (Reference: SWMO)- A control measure that controls stormwater runoff and changes the characteristics of the runoff including, but not limited to, the quantity and quality, the period of release or the velocity of flow. Hereafter this will be referred to as SWMF/BMP. (This term includes stormwater management facilities, post-construction best management practices, stormwater treatment measures, and stormwater control measures. SWMFs/BMPs include, but are not limited to, grass channels, swales, rainwater harvesting systems, permeable pavement, infiltration systems, bioretention systems, filtering practices, constructed wetlands, wet ponds, detention ponds, and manufactured storage and/or treatment devices.)

8.3 Design Requirements Applicable To All Drainage System Components

Positive surface drainage and positive stormwater conveyance systems shall be provided for all projects. See Section 3.7 *Streets and Alleys* and Chapters 7 and 9 of the VDOT DM for minimum longitudinal slope requirements.

A. Design Storms – Minimum Frequency Criteria

The following design storms are required (based on drainage area contributing to each project site outfall, or disturbed area of the project):

Table VIII-1 Design Storm Frequency	
Contributing Drainage Area	Design Storm Frequency
< 300 Acres	10-year
≥ 300 Acres and < 500 Acres	25-year
≥ 500 Acres	50-year
Critical Infrastructure Projects*	100-year
* Emergency Management Centers, Evacuation Routes, Hospitals, Fire and Rescue Stations, Police Stations, Shelters, Principal Highways and Major Roadways, Public Works, Public Utilities, Emergency Operations Centers, Etc. Consult with the City Department of Emergency Management to determine if the project contains critical infrastructure.	

(Note: This requirement is more stringent than the VSMP Regulation and was applicable



prior to January 1, 2013.)

See Chapter 6 of the VDOT DM for explanations of design storms and return periods.

Critical infrastructure projects shall be designed using a 100-year design storm (Consult with the City Department of Emergency Management to determine if the project contains critical infrastructure).

If lower frequency design storm criteria is stated in the referenced documents (VDOT DM, Virginia Erosion and Sediment Control Handbook, Virginia Stormwater BMP Clearinghouse, or Virginia Stormwater Management Handbook) for drainage system components (channels, culverts, storm sewer systems, and SWMFs/BMPs), these Design Standards shall govern; however, the lower frequency design storm criteria cited in the reference documents shall also be analyzed and used for design. Applicable laws, ordinances, and regulations may require analyses using additional storm frequencies, such as a 1-year, 2-year, or 25-year storm for channel protection or erosion control.

B. Storm Depth-Duration and Rainfall Distribution Criteria

Storm rainfall depths are generally taken from NOAA Atlas 14 precipitation frequency data. However, precipitation frequency studies undertaken by the City indicate that actual rainfall frequency depths in Virginia Beach are approximately 10% greater than those specified in NOAA Atlas 14. In order to address the need for more accurate design rainfall data and to consider projected increases in rainfall frequency depths over the next 30 years, rainfall depth-duration values were increased by 20% over NOAA Atlas 14 values. These updated design rainfall depths are presented in Table VIII-2. Refer to the City of Virginia Beach study titled "Analysis of Historical and Future Heavy Precipitation," dated July 24, 2017 (CIP 7-030, PWCN-15-0014, Work Order 9A) for additional information.

Table VIII-2 Rainfall Depths for City of Virginia Beach (Inches)	
Storm Frequency	Rainfall Depths (NOAA Atlas 14 + 20%)
1-YR	3.60
2-YR	4.38
10-YR	6.77
25-YR	8.39
50-YR	9.79
100-YR	11.34

The storm depth, duration, and rainfall distribution criteria (1-year through 100- year storm frequency) are dependent upon the analysis and design methodology to be used (See **Section 8.4.A Methodologies for Stormwater Conveyance System Design** and **Section 8.5.A Methodologies for Design of SWMFs/BMPs**). PC-SWMM® files containing approved rainfall distribution data are available from the Public Works Stormwater Engineering Center.



C. Sea Level Rise/ Recurrent Flooding Analyses

Base tidal elevations are generally taken from the FEMA Flood Insurance Study (FIS) for Virginia Beach and from studies undertaken by the City to assess tidal elevation frequencies particular to the City's southern receiving water bodies.

1. For development of Non-Critical Infrastructure within the City of Virginia Beach, design storm tidal elevations in the City shall be increased by 1.5 feet over the respective base (existing condition) values in order to address the impacts of minimum projected sea level rise on tidal tailwater levels. Sea level rise increases are not required for the check storm except as noted in 3 below.
2. For development of Critical Infrastructure within the City of Virginia Beach, design storm tidal elevations in the City shall be increased by 3.0 feet over the respective base (existing condition) values in order to address the impacts of maximum projected sea level rise on tidal tailwater levels. Sea level rise increases are not required for the check storm except as noted in 3 below.
3. The following drainage basins do not have long-range tidal protections included in the City's Sea Level Wise Adaptation Strategy plan. The design storm tidal elevations for the drainage basins below should apply the increased tidal elevations, shown in sections 1 and 2 above, to the check storm tidal elevations.
 - a. Upper North Landing River
 - b. Little Creek
 - c. All areas south of Beggar's Bridge Creek
4. Consult with the City Department of Emergency Management to determine if the project contains critical infrastructure.

Refer to **Table J-12 Design Tidal Elevations for Virginia Beach** in **Appendix J** for design tidal elevations described in this section.

D. Hydraulic Grade Line and Tailwater Criteria

The Hydraulic Grade Line (HGL) must be calculated for all components of the proposed (post-development) conveyance and routed system, including any existing drainage system elements that contribute to or receive drainage from the proposed (post-development) conveyance and routed systems.

The step-backwater method (HEC-RAS or WSPRO) is used to compute the HGL (called "water surface profile" in the VDOT DM) in a waterway reach. This calculation is used to evaluate the unrestricted water surface elevations for bridge hydraulic design or to analyze and design channels with gradually varied flow (See **Chapters 7 and 12** of the VDOT DM).

The HGL calculations shall begin at the limits of analysis in the downstream receiving stormwater conveyance or at the receiving water body, whichever is necessary to establish an accurate tailwater elevation (beginning water surface level) for the HGL calculations. The limits of analysis shall be as determined using these Design Standards.

To address the combination of rain and receiving water surface elevation, each project shall be designed and analyzed using the following criteria:

1. Tailwater Criteria for Projects Draining to Tidally Influenced Waters
 - a. When the project point of discharge drains directly into one of the water



bodies listed in **Table J-12 Design Tidal Elevations for Virginia Beach in Appendix J**, the licensed design professional shall design and analyze the drainage system, starting at the mapped or surveyed edge of the water body, using tailwater design criteria with corresponding design storm/tide joint probability pairs.

- b. The required design storm frequency for a project shall be determined from **Table VIII-1 Design Storm Frequency**. The corresponding design storm/tide joint probability pairs are provided in **Table VIII-3 Design Storm/Tide Joint Probability Pairs for Determining Controlling Tailwater Elevation**.

Table VIII-3 Design Storm/Tide Joint Probability Pairs for Determining Controlling Tailwater Elevation				
Design	10-YR	25-YR	50-YR	100-YR
Tide	1-YR	2-YR	2-YR	3-YR
Rain	10-YR	25-YR	50-YR	100-YR
Note: Refer to Table J-12 Design Tidal Elevations for Virginia Beach in Appendix J for corresponding tide elevations. Note: Joint probability pairs represent the highest-frequency rainfall with the lowest-frequency tide for each design frequency, as informed by joint probability studies undertaken by the City.				

- c. When the project discharge point is not directly adjacent to a major water body, as defined herein, the designer shall determine the HGL between the project discharge point and the major water body to provide an accurate tailwater control for design purposes. The HGL analysis shall start at the mapped or surveyed edge of the major water body. If the HGL is determined using the Environmental Protection Agency Stormwater Management Model (EPA SWMM) or City-accepted value enhanced versions of SWMM, static tides, not diurnal tides, shall be used in the analyses. In no case can starting tailwater elevations be lower than the associated tidal elevation listed in **Table J-12 in Appendix J**. City Stormwater Master Plans and City SWMM files may be used for analysis, if available.
2. Tailwater Criteria for Projects Draining to Impoundments, Lakes, SWMFs/BMPs (with no tidal influence), or Non-Tidal Waterways
- a. For drainage systems which discharge into existing impoundments, lakes, SWMFs/BMPs, and non- tidal waterways, the designer shall use the higher value of:
- i. 0.8 times the pipe diameter plus the invert of the system discharge pipe, or



- ii. The design year (10, 25, 50, or 100 based on contributing drainage area to each project or site outfall or critical infrastructure as per **Table VIII-1 Design Storm Frequency**) peak water surface elevation (WSE) in the receiving water body or waterway at the pipe discharge location. (Use a 10-year controlling WSE if the design storm frequency is 10-year; use a 25-year controlling WSE if the design storm frequency is 25-year; use a 50-year controlling WSE if the design storm frequency is 50-year; and use a 100-year controlling WSE if the design storm frequency is 100-year.)
 - b. For drainage systems designed using EPA SWMM or City-accepted value enhanced versions of SWMM the design year peak water surface elevation at each node in the system shall be determined using dynamic routing (by modeling) of all contributing storm hydrographs through the storm drainage systems and receiving impoundments, lakes, SWMFs/BMPs, or waterways to the downstream limits of analysis (See **Sections 8.4 and 8.5** for additional SWMM analysis and design requirements). City Stormwater Master Plans and SWMM files may be used for analysis, if available **.and 8.5** for additional SWMM analysis and design requirements.
3. Tailwater Criteria for Projects with new (increased) impervious area less than 20,000 square feet
- a. When design methodology outlined in sections 8.4.A.2.a and 8.5.A.2.a are used, Designer has the option to use 0.8 times the pipe diameter plus the invert of the system discharge pipe as the starting tailwater for HGL calculations in all storm events.
 - b. When design methodology outlined in sections 8.4.A.2.a and 8.5.A.2.b are used, Designer has the option to use a variable tailwater provided from the City Master Drainage study.
 - c. For drainage systems designed using tailwater elevations provided from the City Master Drainage Study, the provided tie-in location can be considered as the limit of analysis.

Tailwater elevation data is available upon request from the Stormwater Engineering Center for public projects, and from the Development Services Center for private projects.

E. Check Storm Requirements for All Projects

All drainage system designs including SWMFs/BMPs and conveyance systems shall be checked using the check storm HGL analysis (incorporating the tailwater criteria stated in Section 8.3.D flooding of buildings and streets. In cases where off-site structure and street flooding are determined to occur under pre-developed (existing) 100-year design storm drainage conditions, the HGL shall not increase over the pre-developed condition as noted in Section 8.3.G.3 below.

F. Compensation for Seasonal High Groundwater

All developments and projects shall include a seasonal high baseflow in all channel, lake, wetland, pond and other waterway and waterbody design calculations and routings. The designer shall include the minimum allowable baseflow rate using the seasonal high baseflow shown in **Table VIII-4** for each drainage area. The seasonal high baseflow shall be added to the most upstream node, waterway, or water body in the drainage area or



areas in which the development or project is situated. For example, if the drainage area to one outfall in a development is 60 acres, the seasonal high baseflow to be added to the most upstream node in the drainage area equals 0.5 c.f.s., because the on-site drainage area to each site outfall is between 50 and 100 acres.

If the seasonal high groundwater table does not influence the development or project drainage, then the designer shall submit hydro-geotechnical or soil science data and reports that substantiate that claim.

Table VIII-4 Groundwater Baseflows According To Drainage Area	
Drainage Area within Development or Project to Each Outfall (Acres)*	Seasonal High Baseflow (c.f.s.)
<50	0.2
≥ 50 and < 100	0.5
≥ 100 and < 250	1.2
≥ 250 and < 500	2.3
≥ 500 and < 1000	4.7
≥ 1000	Consult with Public Works Stormwater Engineering Center

* Exclude drainage areas upstream of the project.

G. Upstream and Downstream Drainage Analyses

This section provides guidelines for consideration of upstream and downstream stormwater runoff and downstream improvements and easements associated with all development and redevelopment in the City of Virginia Beach.

Drainage systems shall be of adequate design for the type of proposed improvements and must sufficiently handle the existing and projected contributing upstream stormwater runoff. There must be no detrimental impacts, such as on-site flooding of buildings and streets and an increase in the frequency or level of off-site flooding of upstream or downstream properties, public right-of-ways, or drainage systems.

Adequacy of the downstream system must be demonstrated for all of the following:

1. The downstream system must adequately convey the design storm to the limits of analysis, using freeboard heights and headwater depths stipulated herein and in the referenced documents. In calculations, flooding shall be considered when:
 - a. HGL exceeds the rim of a drop inlet or manhole structure or the flowline of a curb inlet structure, or the top of bank of a channel during a design storm.
 - b. HGL exceeds the top of curb, centerline of roadway, or finished floor elevation of a building during the check storm.
2. When flooding does not exist upstream or downstream of the proposed project,



the post-developed HGL may increase provided it does not create a new area of flooding.

3. When flooding exists upstream or downstream of the proposed project, the post-development design year HGL shall not increase over the pre-development design year HGL in any receiving channels and water bodies. In conformance with Army Corps of Engineers standards, 'increase in HGL' shall be defined as any design that calculates 0.05' or greater increase in HGL (per ACOE EM 1110-2-1607 Appendix B).

(Note: This requirement is more stringent than the VSMP Regulation and was applicable prior to January 1, 2013.)

If the development drains directly via overland runoff or a stormwater conveyance system into a major water body, the development may continue to discharge into the major water body, at its present undeveloped rate of runoff without having an easement of record. This is provided that there is neither an increase in stormwater discharge or volume nor any more than a one minute change in the timing of the peak discharge.

The need for drainage easements and the type of drainage easement required (private or public) will be evaluated on a case-by-case basis. Whether the drainage easement is designated as private or public depends upon the source of the stormwater. The developer must obtain a drainage easement to drain any stormwater through man-made portions (such as a canal, ditch, or pipe) of the downstream system that are not within existing drainage easements or right-of-way. Such drainage easements shall be dedicated along the entire conveyance system downstream to the closest of the following:

1. A major water body (See *Definitions*),
2. A City of Virginia Beach right-of-way, or
3. A City of Virginia Beach public drainage easement.

See **Chapter 2 Plats and Easements** for detailed requirements

If downstream improvements are proposed to provide conformance with the SWMO, then public drainage easements shall be provided for the downstream improvements, to include the full extent of the improvements.

H. Projects Adjacent to or Discharging onto Property in Other Cities

When there is potential for stormwater runoff to discharge into adjacent Cities or onto property in other Cities, the designer must consult with the agencies of that City and the property owner to determine any additional requirements.

8.4 Stormwater Conveyance System Design Requirements

This section provides design requirements that are applicable to all conveyance systems (storm sewers, culverts, channels, ditches, swales, etc.). The VDOT DM is the primary reference for conveyance system design. Because SWMF/BMP design requirements are predominantly dictated by the SWMO and BMP Clearinghouse, SWMF/BMP design requirements are presented in **Section 8.5 SWMF/BMP Design Requirements**, separate from stormwater conveyance system design requirements.

The design of complex conveyance systems, such as bridges, restored streams, rivers, stormwater pumping stations, or drainage systems in coastal zones, requires additional analysis. The use of applicable design standards and specifications are recommended.



A. Methodologies for Stormwater Conveyance System Design

1. Proposed (Increased) Impervious Area $\geq$ 20,000 square feet
 - a. The City requires drainage system analyses, pre-developed and proposed (post-developed) discharge hydrographs, and designs using EPA SWMM. Alternatively, designers can use a computer program that includes an EPA SWMM engine with Dynamic Routing that can be automatically uploaded into EPA SWMM.
 - 1) Pipes 15" and larger shall be included in SWMM models. Smaller pipes and open ditches can be modeled using methodology discussed below in section 2.
 - 2) Conduit lengths in SWMM models will be checked for accuracy to the nearest foot.
 - b. The modeler shall use Green-Ampt infiltration method and parallel pipe/ overland flow dual links rather than flood storage nodes. City Stormwater Master Plan models use Green-Ampt Infiltration parameters. The Green-Ampt parameters shown in **Table J-13** in **Appendix J** shall be used for the Green-Ampt infiltration method.
 - c. When EPA SWMM-based models are used, runoff flow times are computed using the catchment runoff widths.
2. Proposed (Increased) Impervious Area $<$ 20,000 square feet
 - a. Designer may use any design program that utilizes the 24-hour design storm.
 - b. Designer has the option to use methodology described above in item 1.
3. Time of Concentration for NRCS (SCS) Win TR-55 Methods
 - a. The longest Time of Concentration (**T_c**) to each inlet shall be used for most catchments (See the Section **6.4.4.1.8 Common Errors** of the VDOT DM for overland flow conditions that require adjustments to the **T_c** calculation).
 - b. Manning's Kinematic Solution is an acceptable manual method for determining the flow time for the first 100 feet of sheet flow (flow depths less than 0.1 feet). FHWA or NRCS overland flow charts, equations, or software should then be used to determine times for shallow concentrated flow (flow depths between 0.1 and 0.5 feet). For flow depths deeper than 0.5 feet, channel or pipe flow times should be determined.
 - c. The total time of concentration (**T_c**) to an inlet or other point of analysis equals the sum of sheet flow time plus shallow concentrated flow time plus channel/pipe flow time. See **Chapter 5 Tabular Hydrograph** Method of NRCS TR-55 for development of travel times for stream reach routing.

B. Additional Requirements for Stormwater Conveyance Systems

This subsection provides additional requirements for specific components of stormwater conveyance systems, including storm sewer systems, storm drain inlets, channels, ditches, swales, canals, and lakes.



1. Manning's "n" Roughness Coefficients for Storm Sewer Pipe and Culverts are provided in **Table J-4** in **Appendix J**.
2. Design Methods for Storm Drain Inlets

Storm drain inlets on public highways and streets shall be designed in accordance with **Chapter 9** of the VDOT DM, except rainfall intensity values shall be increased by 20%.
3. Drainage Structure Standards and Dimensions
 - a. Standard drawings for City of Virginia Beach drainage structures are shown in **Appendix B**.
 - b. Dimensions for City of Virginia Beach and VDOT drainage structures are provided in **Tables J-5, J-6, and J-7** in **Appendix J**.
4. Design Methods for Channels and Culverts

Channels and culverts shall be designed in accordance with **Chapters 7 and 8**, respectively, of the VDOT DM.

Manning's "n" Roughness Coefficients for Channels, Streams, and Floodplains are listed in Table J-8 in Appendix J.
5. Ditches greater than 18 inches in depth shall be piped within City of Virginia Beach. Open drainage systems and channels are allowed where culvert requirements exceed a 72-inch diameter of reinforced concrete pipe (or equivalent).
6. Swale systems may be utilized up to 18 inches in depth, as measured from the invert of the swale to the "top of (excavated) cut." Swale side slopes must be no steeper than 3:1 H:V (horizontal to vertical); however, flatter slopes are encouraged. The minimum longitudinal slope of swales shall be 0.5% or 0.005 ft./ft.
7. Public drainage systems should not be allowed in rear yards of residential properties. Storm drain piping, conveying private drainage, shall be on a single lot.
8. Shorelines and side slopes for canals with a normal pool surface area of one acre or more shall be at a minimum designed and constructed in accordance with the following standard drawings (See **Appendix B**):
 - a. B-23 Rip Rap Shoreline Protection for Lakes, Ponds, and Canals without Benching
 - b. B-24 Acceptable Slope Alternative for Lakes, Ponds, and Canals without Benching
 - c. B-25 Rip Rap Shoreline Protection for Lakes, Ponds, and Canals with Benching
9. Whenever the canal top-of-bank to top-of-bank width is 30 feet or greater, public maintenance easements (as per the above standard drawings) shall be provided on both sides of the canal beyond the top of bank. All public maintenance easements shall be free and clear of trees and structures but shall be sloped to



facilitate drainage. Maintenance easement cross slopes shall not be more than 6%. The requirement for public maintenance easements along both sides of canals will not be waived, since crews cannot maintain wider canals from only one (1) side.

10. The designer shall inspect and classify the soil on all bank slopes graded steeper than 7:1 H:V and recommend appropriate stabilization and wave protection measures. In no case shall side slopes be steeper than 3:1 H:V.
11. Bank slope protection for canals with a normal pool surface area of one acre or more shall be installed adjacent to all water bodies with bank slopes steeper than 7:1 H:V in accordance with the standard drawings. Bank slopes that are steeper than 7:1 H:V require riprap or other appropriate long-term hardened revetment design for stabilization at the waterline, as shown on the standard drawings. This minimizes escarpments and damage from wave action at the normal waterline.
12. Channels, canals, and lakes shall only be excavated from previously undisturbed soil. Box cutting (vertical excavation) followed by establishment of conforming bank slopes by placement of fill material is strictly prohibited.
13. Whenever open channel drainage systems or swales are installed, adequate bank stabilization and erosion control measures shall be carried out according to the Virginia Erosion and Sediment Control Law and Regulations, the Virginia Erosion and Sediment Control Handbook, the City Code, Chapter 30, Article III "Erosion and Sediment Control," and **Chapter 9** of these Design Standards.

8.5 SWMF/BMP Design Requirements

This section provides design requirements for SWMFs/BMPs within the City of Virginia Beach. The SWMO provides specific water quality and quantity design and compliance requirements and references the VSMH, Virginia Stormwater BMP Clearinghouse website, VSMP Regulation, and these Design Standards.

A. Methodologies for Design of SWMFs/BMPs

The design methodology selection process for SWMFs/BMPs is as follows:

1. When a project proposes more than 20,000 square feet of new (increased) impervious area, or designer elects to use this methodology for any development project, designer shall use the following computer programs for hydrologic and hydraulic calculations pertaining to SWMFs/BMPs:
 - a. EPA SWMM, or
 - b. Value enhanced SWMM programs that can directly exchange input data with EPA SWMM.

These computer programs are preferred by the City for use in all hydrologic and hydraulic analyses, no matter what size the drainage area is.
2. When a project proposes less than 20,000 square feet of new (increased) impervious area, designer has the option to use any of the following methodologies:
 - a. Any design program that utilizes the 24-hour design storm with a tailwater based on 0.8d of the receiving pipe: When using this alternate



methodology, the following minimum storage requirements shall each be met (as a cumulative storage volume):

- 1) Provide stormwater storage to account for 100% of increased volume generated pre-development to post-development for the design storm, and
 - 2) If the provided tailwater from the City Master Drainage Study (the higher of either 10-year+SLR or 100-year without SLR) shows existing flooding onsite, provide 1:1 stormwater storage for any fill added below existing peak tailwater elevation.
- b. Any design program that utilizes the 24-hour design storm. When using this alternate methodology, the designer will use a variable tailwater as described in the tailwater section.
- c. Same as described above in item 1, except for these smaller projects the modeling updates can be limited. If drainage patterns stay the same, the model updates can be limited to impervious cover changes without changing subcatchment delineations.

B. Additional Design and Construction Criteria for SWMFs/BMPs

1. Stormwater detention and retention facilities must be designed to return to a water surface elevation that will provide 90% of the design event storage capacity within 48 hours of the end of the City's 24 hour 10-year storm. This requirement is in addition to the drawdown requirements of the Virginia Stormwater BMP Clearinghouse.
2. The elevation of the normal dry weather water level will not be less than the 10-year design storm tidal elevation (See 1-year tidal elevation, with 1.5-feet SLR, in **Table J-12 Design Tidal Elevations for Virginia Beach**) of the downstream major water body. (Note: This requirement is more stringent than the Virginia Stormwater BMP Clearinghouse Design Specifications and was applicable prior to January 1, 2013.) This dry weather water level minimizes the destruction of vegetation due to saltwater inundation and will help mitigate the high flood stage or tide impact on the available storage within the SWMF/BMP.
3. For SWMF/BMP design, the seasonal high groundwater (SHGW) level shall be determined and certified by a Virginia licensed professional engineer, hydrogeologist, or soil scientist with training and experience in advanced soil morphology. The certification of the SHGW elevation shall be included with the drainage calculations for each proposed SWMF/BMP.
4. Underdrains shall be required for all SWMFs that utilize percolation, regardless of the infiltration rate. These underdrains shall be perforated and run horizontally along the entire length of the SWMF and shall be connected to a surface drainage structure (at least 1 surface drainage structure for every 100 linear feet of pipe). The underdrains are only required within the horizontal limits of the SWMF to aid in infiltration and are not required to have a designed outfall.
5. See the Virginia Stormwater BMP Clearinghouse Design Specifications for minimum vertical separation distances between SWMFs/BMPs and the seasonal high groundwater table and for additional SWMF/BMP design requirements. Requirements related to freeboard, setbacks, and maintenance access for extended detention basins shall also apply to all surface detention facilities with at least 18" depth.



6. Outlet control structures shall be designed to discourage clogging. Washed gravel can be piled around small diameter perforated pipes or orifices to discourage clogging due to sediments in the stormwater. The minimum on-site storm sewer pipe diameter used to restrict stormwater runoff flows shall be six (6) inches. See Appendix B *Principal Spillways* of the Virginia Stormwater BMP Clearinghouse Design Specifications for outlet control structure design guidance.
7. SWMFs/BMPs shall only be excavated from previously undisturbed soil. Box cutting (vertical excavation) followed by establishment of conforming bank slopes by placement of fill material is not allowed.
8. All wet SWMF/BMP retention basins shall conform to the following Standard Drawings:
 - a. **B-23** Rip Rap Shoreline Protection for Lakes, Ponds, and Canals without Benching
 - b. **B-24** Acceptable Slope Alternative for Lakes, Ponds, and Canals Without Benching
 - c. **B-25** Rip Rap Shoreline Protection for Lakes, Ponds, and Canals with Benching

Bank slopes steeper than 7:1 H:V shall have riprap or other appropriate long-term hardened revetment design for stabilization at the waterline to prevent erosion from wave action. (Note: The requirement for riprap stabilization at the waterline is more stringent than the Virginia Stormwater BMP Clearinghouse Design Specifications and was applicable prior to January 1, 2013). In no case shall side slopes be steeper than 3:1 H:V.

For lakes and ponds with a normal pool surface area of less than one acre, the minimum required side slope is 4:1

9. Impermeable liners shall not be used for BMP facilities unless:
 - a. HGL soil group A or B soils exist that will not allow the normal water elevation of a wet pond to be maintained; or,
 - b. Liners are required to prevent groundwater contamination.
10. All facilities that account for infiltration in routing calculations shall use the following maximum rates in design:
 - a. 1 or 2-year storm: $\frac{1}{2}$ field measured rate
 - b. Design storm: $\frac{1}{4}$ field measured rate
 - c. Check storm: $\frac{1}{8}$ field measured rate
11. All underground SWMFs/BMPs must be marked with a 5" x 5" x $\frac{1}{4}$ " or larger steel plate at each corner or marked with white metallic marking tape, three (3) inches wide, placed on top of the SWMF/BMP, not to exceed one (1) foot below the ground surface level. In certain cases, at the option of the City Inspector, it may be appropriate to use both.
12. Outlet control structures shall be person-accessible and shall be of sufficient size to accommodate a 12-inch diameter vacuum hose. Maintenance ports, for underground storage, shall be of sufficient size to accommodate a 12-inch diameter vacuum hose.



13. Plastic (HDPE, PE, etc.) and corrugated (aluminum or steel) metal manufactured treatment devices (MTDs) are not allowed within City right-of-way.
14. Privately owned SWMFs/BMPs should not be placed behind residential structures in rear yards and shall not be placed in the public right of way.
15. City maintained wet ponds require that the main cell be a minimum of five (5) feet deep.
16. City maintained SWMFs shall not install check valves as part of the discharge system.

C. Additional Safety Considerations for SWMFs/BMPs

Even the most carefully designed outlet systems are susceptible to clogging. Outlet structures shall be equipped with an emergency overflow design or an emergency overland flow path to an adequate receiving channel or water body, thereby preventing buildings and parking lots from flooding.

D. Maintenance Requirements

SWMFs/BMPs require regular maintenance. All private SWMFs are required to meet all minimum maintenance and access standards outlined in the DEQ BMP Clearinghouse. The owner shall execute a "SWMF Maintenance Agreement" for storm and surface water facility and system maintenance for all SWMFs/BMPs, with the exception of single family site developments. The final plats and completed SWMF Maintenance Agreement must be submitted to Planning/DSC for review and recordation in the office of the Clerk, Circuit Court in the City of Virginia Beach. The latest agreement form and plat requirements are available from Planning/DSC.

Public SWMFs are required to meet the additional standards listed below. Accessible 20-foot wide public entrance access easements from public streets to SWMFs/BMPs and a maintenance and inspection access easement around SWMFs/BMPs shall be set aside so maintenance equipment can access all SWMFs/BMPs. These easements shall be dedicated to the City. SWMFs/BMPs may need public easements for staging of maintenance equipment, drying of dredge spoils, or stockpiling of excavated material. Additionally, 20-foot wide public lake entrance access easements (one (1) for every five (5) acres of lake) shall be dedicated to the City. SWMFs/BMPs greater than $\frac{1}{4}$ acre shall provide adequate space near them for spoil or stockpile facilities (needed for maintenance) **or** provide a public easement on a park site with a minimum of two public access pumping easements along the appropriate lot lines. The pump-hose easements must have a minimum width of 10 feet. (Note: These requirements are more stringent than the Virginia Stormwater BMP Clearinghouse Design Specifications and were applicable prior to January 1, 2013.)

City site development projects (fire stations, libraries, police stations, recreation centers, schools, etc.) with ponds on City property that are not within City right-of-way must provide all required City of Virginia Beach drainage impoundment easements on the site drawings and any recorded subdivision plats. These easements shall be labeled as proposed drainage easements on the drawings and subdivision plats. A note shall be provided on the subdivision plat stating: **"All easements shall be established by a legal document prior to transferring the property to private ownership."**

Within each public access and maintenance easement, a paved driveway shall be installed from the street to the 20-foot wide maintenance easement that encircles the impoundment easement of each SWMF/BMP site. The paved driveway access shall be constructed with either asphalt or concrete, designed to support an AASHTO HS-20 live



load, have a minimum width of 15 feet, and have a City of Virginia Beach standard residential entrance with a width to match the paved driveway and contain two 2-foot wide flares located at the roadway. Each of the paved driveways shall be maintained by the City as necessary. These access easements shall be dedicated to the City of Virginia Beach by deed in order to allow the City staff to inspect all SWMF/BMP sites. Access to each SWMF/BMP shall be available at all times and property owners found impeding this paved driveway shall be given 24 hours' notice to remove the impediment or the City will remove the obstruction at the property owner's expense. No permanent structures or obstructions are permitted in the easement and the driveway surface shall not be altered by private entities and/or property owners without prior approval from the City of Virginia Beach.

Outlet devices and other structures for public facilities must be constructed of reinforced concrete. Bolting appurtenances in place discourages vandalism. All components of outlet devices and other structures shall be accessible for maintenance.

E. Impoundment Easements

A City drainage and impoundment easement must be recorded, by plat, over the entire lake, pond, drainage system, retention basin, detention basin, or other SWMF/BMP where public water is routed, when such facilities are not within a public right-of-way. The following notes must be shown on the plat where City or public waters or stormwater runoff flows through or into such a facility.

Note 1. "The variable width Impoundment, Drainage, Access, and Maintenance Easement shall be available for all of the following, but not limited to, conveyance, collection, storage, drainage, impoundment, treatment, and other related uses of surface water and/or groundwater and maintenance of and access to and over the stormwater management facility. No alterations whatsoever of the stormwater management facility and its bank side slopes within the limits of the impoundment, drainage, access, and maintenance easement is permitted without the approval of the Department of Public Works. City maintenance shall be limited to that as described in the recorded Deed of Easement, see Note 2."

Note 2. "Variable width impoundment, drainage, access, and maintenance easement to be dedicated to the City of Virginia Beach by deed recorded Instrument Number__in the Office of the Clerk of Circuit Court in the City of Virginia Beach."

Note 3. "Twenty-foot (20') wide access and maintenance easement to be dedicated to the City of Virginia Beach by deed recorded as Instrument Number_____in the Office of the Clerk of Circuit Court in the City of Virginia Beach."

Note 4. if storm water pipes are located in the access way and for use in dedicating public drainage easements: "____-foot (____') wide drainage, access, and maintenance easement hereby dedicated to the City of Virginia Beach."

All required drainage and impoundment easements shall be platted and dedicated to the City of Virginia Beach.



F. Stormwater Management Facility (SWMF/BMP) Maintenance Schedule

SWMF/BMP maintenance and maintenance schedules shall be in accordance with the Virginia Beach Stormwater Management Facility Inspection and Maintenance Manual.

8.6 Materials

All storm sewer systems, culverts and open drainage systems/ways shall be constructed in accordance with the applicable provisions of Divisions II through VI of the VDOT Road and Bridge Specifications, the VDOT Road and Bridge Standards, City of Virginia Beach Standard Amendments to the VDOT Road and Bridge Specifications, City of Virginia Beach Amendments to the VDOT Road and Bridge Standards, and these Design Standards, including the Standard Drawings in **Appendices A, B, and C**.

A. Drainage Structures

1. VDOT Drainage Structures

VDOT storm drainage inlets and curbs and gutters (CG-6 or CG-7) shall be used in all right-of-ways greater than 60 feet, unless otherwise directed or approved by the Department of Public Works. All other drainage structures, including catch basins, storm inlets, junction boxes, and manholes, shall be standard precast or cast-in-place concrete structures, unless otherwise approved by the Department of Public Works. Use of brick or non-standard drainage structures requires Department of Public Works approval. Hollow masonry block structures are not permitted within the City right-of-ways, public easements, or City property.

2. Inlet Shaping

All storm structures (drop inlets, catch basins, and manholes, etc.) shall have full diameter invert shaping in accordance with VDOT Standard IS-1.

3. Weep Holes

All storm drainage inlet structures in the right-of-way shall have a note or detail indicating that the drainage structures have permanent weep holes installed at the aggregate/subgrade interface. These weep holes will remain open after completion of the construction by using hardware cloth (or an acceptable alternative as approved by the City's Inspector) to prevent gravel intrusion into the drainage structure. Weep holes shall be constructed in accordance with City Standard Drawings as specified in **Appendix B** or in accordance with the VDOT Road and Bridge Standards.

4. Pipe Connections to Drainage Structures

When storm sewer pipes are within City right-of-way or public easements, all connections shall be with a standard drainage structure, as referenced herein. Appropriate flexible, sealed connections in accordance with manufacturers' recommendations shall be used when pipes and structures of dissimilar materials are joined.

5. Requirements for Modified or Non-Standard Drainage Structures

Detailed drawings and supporting structural design computations must be included in the design documents when storm drainage structures are designed using other than City of Virginia Beach or VDOT standards or when standard



drawings are modified. The drawings and structural design computations shall be prepared, signed, dated, and sealed by a structural engineer licensed by the Commonwealth of Virginia, Board of APELSCIDLA.

6. Minimum Interior Dimensions

Where the depth of the modified or special design drainage structure is less than four (4) feet, the length and width shall each be a minimum of three (3) feet or the outside diameter of the largest connecting pipe, whichever is greater, along each wall pair. Where the depth of the modified or special design drainage structure is equal to or greater than four (4) feet, the length and width shall each be a minimum of four (4) feet or the outside diameter of the largest connecting pipe, whichever is greater, along each wall pair. See **Tables J-5, J-6, and J-7** in **Appendix J** for suggested minimum drainage structure dimensions.

B. Pipes

1. Minimum Allowable Pipe Diameter for Pipes within City Right-of-ways or Public Easements

The minimum storm sewer pipe diameter that is permitted in the City right-of-way or public drainage easement shall be 15 inches. When conditions adjacent to a paved street or parking lot dictate, such as at the shallow end of the system or where conflicts exist, a 12-inch, 10-inch or 8-inch pipe with a reach length not to exceed 50 feet may be used as an exception. This is intended for situations involving connections or extensions to existing systems with established geometric constraints. This exception to the minimum pipe size criteria shall not be considered for new storm sewer systems.

2. Allowable Pipes

- a. All pipes in public easements, City right-of-ways, and City owned property shall be reinforced concrete pipe, conforming to the specifications for concrete storm sewer pipe (AASHTO designation M-170) with the modification that all reinforced concrete pipes shall be manufactured with concrete having a minimum compressive strength of 4,000-psi. All pipe joints shall be sealed in accordance with the VDOT Road and Bridge Specifications.
- b. Pipes from the following list may be used in installations that are not subject to paragraph 1, above:
 - a) Concrete, Class III, IV, or V (only Class V reinforced concrete pipe shall be used under railroad tracks).
 - b) Polyvinyl chloride (PVC) ribbed or corrugated storm sewer pipe (smooth interior).
 - c) Polyethylene (PE) double-wall pipe (smooth interior).
 - d) Ductile Iron.
- c. Corrugated aluminum alloy pipe and pipe arches; aluminum-coated, asphalt-coated, galvanized, polymer-coated, and plain corrugated steel pipe and pipe arches; and coated, galvanized, and plain aluminum alloy and steel structural plate pipe, pipe arches, and bottomless arches are not allowed in Public or Private projects.



3. Allowable Culvert Types

In addition to any of the types of pipes listed in **Section 8.6.B.2**, above, VDOT standard reinforced concrete box culverts may be used when conveyances cross fields, roadways or parking lots.

4. Minimum Pipe Slope and Velocity

All storm drainage pipes and culverts must meet one of the following 2 criteria:

- a. Minimum slope of 0.3% or 0.003ft/ft or
- b. Minimum full flow velocity of 3 feet per second, based on the design storm.

5. Maximum Pipe Velocity: Maximum pipe velocity, for concrete pipe, shall not exceed 10 feet per second to prevent scouring.

6. Pipe Joints

All pipe joints within City right-of-ways, public easements, or City property, shall be sealed in accordance with the VDOT Road and Bridge Specifications. Non-gasket joints shall be sealed using a VDOT approved method and wrapped with approved filter fabric. For 12-inch to 36-inch storm pipes, a minimum 24-inch wide filter fabric shall be used; for 48-inch and larger pipes, a minimum 36-inch wide filter fabric shall be used. Each joint shall be completely wrapped with approved filter fabric cut to the required width and secured in place with the ends overlapping at least two (2) feet prior to backfilling.

- a. Tie-in locations between pipes and drainage structures shall be grouted and sealed with a material that conforms to the VDOT Road and Bridge Specifications and covered with a three (3) foot wide filter fabric which is secured in place as stated above. No lift holes allowed.

- b. Proposals for alternate joint systems that provide soil-tight joints must be submitted to the Department of Public Works for approval of work within the City right-of-way, public easements or City property. For development plans on private property, proposals must be sent to Planning/ DSC for approval.

- c. Where significant groundwater flow is anticipated, avoid placing coarse, open-graded materials, such as Virginia Class A1 riprap, above, below, or adjacent to finer materials, unless methods are employed to impede migration (fines may migrate into the coarser materials due to the action of hydraulic gradient from groundwater flow). A filter fabric shall be used to separate the materials to prevent migration.

7. Marking Non-Concrete and Non-Metal Pipe

All pipes not made of concrete or metal shall have three (3) inch white metallic marking tape placed above the pipe at an elevation no less than one (1) foot below the ground surface.

8. Backfilling of Pipes and Culverts

All pipes and culverts installed in the City right-of-way, public easements, or City-owned property that are subject to traffic loadings shall be:



- a. Backfilled with Select Borrow for Trench Backfill, Minimum CBR-15 (in accordance with the City of Virginia Beach Amendments to the VDOT Road and Bridge Specifications) or granular material (as defined by AASHTO M 145 "Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes"),
 - b. Placed in six (6) inch lifts, and
 - c. Compacted to 95 percent of standard density based on AASHTO Specifications T-99 (ASTM D698).
9. Pipe Cover
- a. Concrete Pipe – To protect pipe during construction, minimum height of cover prior to allowing any traffic to cross the installed pipe, shall be the diameter or span (for elliptical pipe) divided by 2 or 3 feet, whichever is greater. Minimum finished height of cover is to be the diameter or span (for elliptical pipe) divided by 2 or 2 feet, whichever is greater, in accordance with the VDOT Road and Bridge Standards. In accordance with VDOT Drainage Manual Section 9.4.8.4, a minimum cover of 12-inches will be allowed provided all possible means have been exhausted by the design engineer and the use is approved by Public Works or DSC.
 - b. Plastic Pipe – Plastic pipe and fittings shall be installed in accordance with VDOT Road and Bridge Standards, PB-1 and ASTM D2321 "Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications." Furthermore, underground installation of plastic pipe for sewers and other gravity flow applications shall be made with embedment materials conforming to VDOT Road and Bridge Specifications, AASHTO M 145 "Classification of Soils and Soil- Aggregate Mixtures for Highway Construction Purposes" or ASTM D2487 "Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)." Embedment materials shall be chosen from the following:
 - a) VDOT Class I Backfill (Crusher Run Aggregate, Size No. 25 or 26 or Aggregate Base Material, Size No. 21A only),
 - b) AASHTO M 145 group A-1, or
 - c) ASTM D2487classification GW.
 - c. Ductile iron pipe, Thickness Class 52, shall have a minimum cover, per manufacturer recommendations, of 30-inches.
10. Flowable Backfill

Flowable fill may be used on a case-by-case basis, after receiving approval from the Department of Public Works.

C. Culvert and Pipe Durability

1. Polyvinyl Chloride (PVC) Pipe (Smooth Interior)

Polyvinyl Chloride (PVC) pipe and fittings shall be manufactured and tested in accordance with AASHTO M304 with a minimum pipe stiffness of 46 psi at five percent deflection when tested in accordance with ASTM D2412. PVC pipe shall



be certified by the compounder as meeting the requirements of ASTM D1784, cell class 12454B. PVC pipe shall be joined with two gaskets and/or a water tight sleeve in accordance with the manufacturer's recommendations for their system to result in soil tight performance (no soil infiltration into pipe) as defined in AASHTO M294-94. Otherwise, all joints and other infiltration points must be wrapped in accordance with **Section 8.6.B.5**, above.

2. Polyethylene (PE) Double Wall Pipe (Smooth Interior)

Corrugated Polyethylene (PE) pipe, AASHTO M294, shall be produced and certified by the resin producer's professional engineer as meeting the requirements of ASTM D3350. Cell class 335420C PE pipe shall be joined with two gaskets and/or a watertight sleeve as recommended by the licensed design professional and by the pipe manufacturer for their system to result in soil-tight performance (no soil infiltration into the pipe) as defined in AASHTO M294. Otherwise, all pipe joints and all other points of potential soil infiltration shall be wrapped with geotextile fabric in accordance with **Section 8.6. B.5**, above.

D. Standard Inspections

The developer, contractor or permittee shall, at their expense, inspect all constructed storm sewer pipes and culverts with a cumulative total more than 200 linear feet of storm sewer pipe and/or culverts located within City rights-of-way and public easements utilizing a closed circuit television (CCTV) camera. Inspection shall include, but not be limited to, initial cleaning, dewatering and CCTV inspection. All data gathered to describe the conditions within the pipe system shall be collected and coded accurately and consistently utilizing standards established in Nassco's Pipeline Assessment Certification Program (PACP). For subdivision projects, the CCTV inspection shall be completed, submitted, reviewed, and approved by the Department of Planning prior to approval of the Certificate of Completion or start of defect period. For site plan projects, the CCTV inspection shall be completed, submitted, reviewed, and approved prior to surety reduction or start of defect period. Any substandard construction work, defects or damage shall be corrected by the developer, contractor or permittee at their expense to the satisfaction of the City. The corrective action must take place under the observation of Department of Planning/Civil Inspections or by providing an updated CCTV inspection to be reviewed and approved prior to approval of Certificate of Completion, start of defect, or surety reduction, whichever is applicable. Prior to the release of a Subdivision and/or Right of Way defect surety, a final visual inspection will be performed by Civil Inspections. If any deficiencies are noted, an additional CCTV inspection of the defective section may be required at the Civil Inspectors discretion.

8.7 Stormwater Utility-Fee Adjustment Program

All developed sites discharging stormwater runoff into the City storm sewer system or into bodies of water within the City, either directly or indirectly, will be charged a fee in accordance with Chapter 32.5 of the Code of Virginia Beach as it pertains to the Stormwater Management Utility. Any existing developed site may request a fee adjustment by submitting a Stormwater Utility Adjustment Application provided in **Appendix K**.



9.0 Erosion, Sediment Control, & Tree Protection

9.1 General

All construction and land disturbing activity in the City of Virginia Beach must conform to the Virginia Erosion and Sediment Control Law and Regulations, the minimum standards of the Virginia Department of Environmental Quality (DEQ), the Virginia Erosion and Sediment Control Handbook, the Code of the City of Virginia Beach Chapter 30, Appendix D (Stormwater Management Ordinance), Appendix E (Tree Planting, Preservation and Replacement), Appendix F (Chesapeake Bay Preservation Area Ordinance), Appendix G (Southern Rivers Watershed Management Ordinance), and the City Landscaping Guide.

1. Erosion and sediment control submitted for review and approval shall meet the standards contained in the Virginia Erosion and Sediment Control Regulations, Virginia Erosion and Sediment Control Handbook, and City Code.
2. All construction related activities will limit land disturbance to the amount necessary to accommodate the desired improvements.
3. Avoid work in the tree drip line area and comply with the Virginia Erosion and Sediment Control Handbook and ANSI A300 Standards for Tree Care Operations with respect to tree preservation and protection.
4. Straw Bales for erosion and sediment control are not allowed on construction sites within the City right-of-way.



10.0 Traffic Control

10.1 Traffic Signals

A. General

This chapter provides with the specific information and direction needed to prepare plans and specifications for construction of active traffic control devices in accordance with the requirements of the City of Virginia Beach. These devices include traffic signals, intersection caution beacons, emergency signals for fire stations, school zone caution lights, and warning beacons. The design guidelines are provided as a supplement and are not to supersede the Federal Manual of Uniform Traffic Control Devices (MUTCD), latest edition. In addition to City guidelines and the MUTCD, some recommended design references include the Manual of Traffic Signal Design, Traffic Signal Installation and Maintenance Manual (Institute of Transportation Engineer's publications), and the Federal Highway Administration Traffic Control Devices Handbook, Part IV, Signals.

B. Traffic Signal Plan Sheet Information

The following information will be shown on each traffic control device plan sheet:

1. **Base Plan** – A base plan prepared from an accurate field survey will be used for the traffic control device plan sheet. The base plan will be prepared so that the full traffic control device installation appears on one plan sheet.
2. **A North Arrow.**
3. **Scale** – A written and graphic scale will be 1 inch = 25 feet. Scale variations or changes must be approved by Traffic Engineering.
4. **Legend** – The same legend symbols will be used consistently throughout the traffic control plan sheets in the plan set. Where the project only includes traffic signalization, and is not a part of a road construction project, the legend will also be shown on the Title Sheet of the plan set. Symbols will be the same as those used by the Virginia Department of Transportation. Contact Traffic Engineering for a list of these symbols and a list of unique items not identified by VDOT.
5. **Title Block** – Each traffic control device plan sheet will include a title block. It will be located in the bottom right or bottom center of the sheet and will contain, as a minimum, the following information: the full name of the intersection, the type of plan sheet, date, intersection control number, and the CIP project number or DSC file number when applicable. The following is an example of this requirement:

Intersection of Holland Road and Dam Neck Road
Traffic Signal Plan
January 22, 1997 Control Number 268 CIP 2-816

6. **Phase Sequence Diagram.**
7. **Signal Display and Wiring Diagram** - The diagram will conform to one (1) of the typical diagrams included in **Appendix D** of this manual.



8. **Signal Head Display Detail.**
9. **Location/Vicinity Map** - Where the project only includes traffic signalization, the map may be placed either on the traffic signal plan sheet or the Title Sheet. The map may be omitted where the traffic control device plans are part of a larger road construction project.
10. **Right-of-way** - All traffic control devices, including signing and pavement markings will be located in the right-of-way or in traffic control easements.
11. **Traffic Control Easements** - If traffic control easements are required, they will be shown on the plan with dimensions, along with the name of the property owner.
12. **Detector System Diagram** - Either a Vehicle Loop Detector Diagram or Camera Detection Zone Chart, as applicable, will be shown on the plan, and will conform to the typical diagram and chart in **Appendix D** of this manual. For additional information, or questions concerning the preparation of a loop detector diagram or camera detection zone chart, contact Traffic Engineering.
13. **Underground and Overhead Utilities** - The Design Engineer will identify and show all utilities in the vicinity of construction on the plan. **IMPORTANT NOTE:** The Design Engineer must try to ensure that the construction of the traffic control devices does not conflict with any existing or proposed utilities and is responsible for obtaining and incorporating clearances required by utility owners.
14. **Existing Traffic Control Devices** - All existing traffic signalization and interconnect cable facilities will be shown and identified on the plan. The plans will provide sufficient detail identifying all existing equipment and modifications so that the plans can be used as the record set.
15. **Signs** - All regulatory and warning signing, necessary for the operation of the traffic control device, will be shown on the plan sheet and identified on the Legend. The signing to be shown on a typical traffic signalization plan would include the following: Metro or Internally Illuminated Street Name signs, City Standards LTYOFYA or MUTCD R10-12 LTYOCG signs, MUTCD W3-3 Signal Ahead signs; Pedestrian Push-button signs, and NO TURN ON RED signs. The plan will also identify existing signing to be removed, such as STOP signs and post mounted Street Name signs. For additional information regarding signing materials refer to Chapter 10.2 "Signs" of this manual.
16. **Plan Notes** - Traffic Engineering has compiled a list of plan notes that cover a variety of information that must be included on the plans. Many notes have instructions for the Design Engineer. A Master List of Traffic Signalization Plan Notes is included in **Appendix E.2** of this manual. The Design Engineer will select the applicable notes from this list and prepare additional notes, as necessary, for the specific traffic control device plan sheets under design. They will be placed on the plan using the following guidelines:
 - a. Plan notes applicable to a specific plan sheet will be placed on that plan sheet.
 - b. Plan notes applying to all traffic control device sheets may either be placed on each sheet, if space permits, or may be placed on a single plan sheet elsewhere in the plan set. When the general notes are placed elsewhere, each traffic control device plan sheet will have a note referencing where these other general notes are found.



17. **Color Sequence Diagram** - Unless otherwise directed by Traffic Engineering, a color sequence diagram is required only for emergency traffic signal plans and linear Phase Sequence Diagrams.
18. **Foundation Design**- The Design Engineer shall provide a foundation design for all poles, signed and sealed by a Professional Engineer licensed in Virginia.

C. Traffic Signal Phasing

All vehicle and pedestrian traffic movements will be identified in accordance with the National Electrical Manufacturer's Association (NEMA) standards. The City uses a phase numbering scheme that depends on whether the major street runs north-south or east-west. Phase assignments for full eight phase operation, with either protected or protected/permitted left turn movements, are made as follows:

1. Major Streets that run East-West

Phase 1 - Vehicle Westbound Left Turn Movement.
Phase 2 - Vehicle Eastbound Through Movement.
Phase 2P - Pedestrian Movement Across South Leg of Intersection.
Phase 3 - Vehicle Northbound Left Turn Movement.
Phase 4 - Vehicle Southbound Through Movement.
Phase 4P - Pedestrian Movement Across West Leg of Intersection.
Phase 5 - Vehicle Eastbound Left Turn Movement.
Phase 6 - Vehicle Westbound Through Movement.
Phase 6P - Pedestrian Movement Across North Leg of Intersection.
Phase 7 - Vehicle Southbound Left Turn Movement.
Phase 8 - Vehicle Northbound Through Movement.
Phase 8P - Pedestrian Movement Across East Leg of Intersection.

2. Major Street runs North-South

Phase 1 - Vehicle Northbound Left Turn Movement.
Phase 2 - Vehicle Southbound Through Movement.
Phase 2P - Pedestrian Movement Across West Leg of Intersection.
Phase 3 - Vehicle Eastbound Left Turn Movement.
Phase 4 - Vehicle Westbound Through Movement.
Phase 4P - Pedestrian Movement Across North Leg of Intersection.
Phase 5 - Vehicle Southbound Left Turn Movement.
Phase 6 - Vehicle Northbound Through Movement.
Phase 6P - Pedestrian Movement Across East Leg of Intersection.
Phase 7 - Vehicle Westbound Left Turn Movement.
Phase 8 - Vehicle Eastbound Through Movement.
Phase 8P - Pedestrian Movement Across South Leg of Intersection.

When the left turn movement is permissive only, the phase number is not used. Here the left turn movement has the same phase number as the adjacent through movement. For example, on a major street running north-south, if the northbound left turn movement is permissive only, then the northbound left turn and northbound through movement will both be identified as Phase 6.

Pedestrian movements are not numbered, unless there are pedestrian signals.



Where a side street is to be operated in a "split phase" mode, the movement that is to be served in the sequence first will be assigned as Phase 3. The movement immediately following will be assigned as Phase 4.

The Designer Engineer should contact Traffic Engineering if there are questions concerning the orientation or designation of the major street, or if any unique intersection geometrics or phasing requirements exist.

D. Traffic Signal Display Selection

All vehicle displays will be 12 inch LED displays, except for special applications noted elsewhere in this chapter.

All protected left turn signals will have green arrow, amber arrow, and red arrow displays.

All protected/permitted signals will have a four (4) section flashing yellow arrow signal display unless otherwise directed by Traffic Engineering.

All traffic signals shall have a durable, flat black finish with backplates. Backplates shall consist of the retroreflective high visibility signal backplates.

At sharply skewed intersections, the designer should consider specifying either standard signals with angle or louvered visors, or selective view signals to shield the displays from conflicting movements.

E. Traffic Signal Head Wiring

Unless otherwise specified by Traffic Engineering, all cable used for wiring vehicle signals will be 14AWG/5 or 7 conductor cables conforming to IMSA Specification 20-1. The design engineer will confirm the plan notes or specifications as appropriate to satisfy this requirement.

A five (5) conductor cable will be specified for a circuit serving a three (3) section signal head. This applies to through phases and exclusive left turn phases. A seven (7) conductor cable is to be specified for circuits operating a four (4) or five (5) section signal head.

A seven (7) conductor cable shall be used when wiring a three (3) section signal head controlling a "protected only" left turn movement. This will simplify any future modification to convert the movement to a protected/permitted operation.

Cable runs will be continuous from the controller cabinet to the first signal head on each circuit. The design engineer will not specify the splicing of signal cables in hand holes or junction boxes, without prior written approval of the Traffic Management Center (TMC). Wiring from the first signal head to subsequent signals will be accomplished by jumpering conductor cables between the signal heads. Running a separate conductor cable from the cabinet to each signal head on the same phase is typically not necessary. However, when the number of signals on the same phase or circuit is three (3) or more, the load should be reviewed to decide whether the wiring requirements should be modified, requiring a larger gauge conductor, or to add an additional conductor cable to divide the load.



F. Vehicle Detection

Standard practice is to design all traffic signal installations to operate in a fully actuated vehicle detection mode. Traffic Engineering must be contacted for a decision to use exclusive right turn lane detection.

1. Types of Detection Zones

- a. **Presence** - Presence detection is shown for major street left turn movements and minor street through and left turn movements. Presence detection zones will be 6 x 50 foot rectangles.

The presence detection in each lane shall extend a minimum of thirty feet behind the stop bar and extend forward of the stop bar a sufficient distance to detect a single vehicle that might pull forward of the stop bar. This placement should provide detection to within 15 feet of the nearest cross street through lane. Where a left turn lane is next to a raised median, placing the head of the zone even with the nose of the median is usually sufficient.

- b. **Pulse** - Pulse, or call type detection is typically shown for a major street through movements. Pulse detection zones should be 6 x 6 foot squares. A pulse detection zone is placed in each through lane ahead of the intersection. The number of zones and zone setbacks from the stop bar is determined by the posted approach speed limit and will be as follows:

TABLE X - 1 Speed - Detector Setback	
Speed Limit (mph)	Detector Setback (ft.)
25	105
30	140
35	185
40	230
45	140, 285 *
50	110, 220, 340 *
55	100, 250, 400 *
* On approaches with posted speed limits of 45 mph or greater, multiple sets of detection zones are required and may necessitate two cameras.	

Each detection zone will be numbered on the plan, in accordance with the Traffic Engineering Standard Drawings in **Appendix D** of this Manual.

2. Video Detection

- a. Unless otherwise directed by Traffic Engineering, only video detection will be provided in new traffic signal installations.

A video imaging vehicle detection system will consist of one or more cameras on each approach to the intersection. The number of cameras depends on the location and accuracy of detection zones. Equipment is as specified in Division



VII of the City of Virginia Beach Amendments to the VDOT Road and Bridge Specifications.

Video detection cameras shall be mounted a minimum of twenty feet above the roadway.

Following the initial video imaging setup, return visits will be scheduled to inspect the operation of the system during sunrise and sunset as well as after dark. Depending upon the location, additional inspections may also be necessary based upon the time of year.

3. Loop Detectors

Loop detection shall only be used by direction of Traffic Engineering. If Traffic Engineering directs the use of loop detection, the following shall apply:

Presence loop detectors will typically be a VDOT Standard TD-1C, 6 x 50 foot quadrapole type loop.

Pulse loop detectors are to be a VDOT Standard TD-1B, six (6) foot by six (6) foot loops.

Loop detector lead-in cables are to be used to connect the vehicle loop detector to the control equipment in the controller cabinet. The type and number of cables are as follows:

- a. **Type** – The designer will designate all loop detector lead-in cable(s) as 14AWG/2C(S) on the plans and specify that the cable(s) will conform to IMSA Specification 50-2.
- b. **Number of Cables** – A separate loop detector lead-in cable will be shown for each presence loop detector. A separate loop detector lead-in cable **will be shown for each set** of pulse loop detectors. Exceptions to the above design practice may be necessary and allowed with prior approval by Traffic Engineering and/or the TMC. Where traffic computer system sampling detectors are specified, a separate lead-in cable will be shown for each sampling loop.

The designer must be familiar with the following:

- a. The City's Specification for Measurement and Payment of loop detectors is different from the Virginia Department of Transportation requirement. VDOT breaks down separate pay items for loop detector wire and saw cut. The City has combined these charges into a single pay item titled "Vehicle Loop Detector" which is the unit of payment based on linear feet of pavement saw cut. There is no separate measurement or payment for the loop detector wire. The cost is all inclusive.
- b. Unless otherwise directed by Traffic Engineering, the designer is to specify a 12AWG loop detector wire, loosely encased in tubing that conforms to IMSA Specification 51-5. A note to this effect must be placed on the plans.
- c. A one (1) inch conduit is to be shown between the pavement edge and the adjacent junction box, where the loop wires are spliced to the loop detector lead-in cables(s), for each loop detector saw slot. Further detail is depicted in VDOT Road and Bridge Standards, Standard TD-1, A, B, C, Loop Detector Installation Details.



- d. The designer must inspect the existing pavement conditions to decide whether special installation procedures or materials are necessary where vehicle loop detectors are to be installed in existing pavements. Loops must not be designed so as to cross pavement patches, open cuts, pavement expansion joints, or asphalt to concrete pavement joints.

Loop detectors will be installed before finishing the final pavement and shall be set 4 inches below final finish grade.

G. Pedestrian Signal Display Selection

All new intersection design and construction will include LED pedestrian signals and pushbuttons across all legs of the intersection. Exceptions may be made to this requirement when the intersection geometry or other conditions make a pedestrian crossing undesirable. The pedestrian movement will typically be concurrent with a vehicle movement, but in certain cases may have to be served as an exclusive pedestrian movement. Consult Traffic Engineering on this matter.

Pedestrian signals will be VDOT Standard SP-8 unless otherwise specified by Traffic Engineering.

H. Pedestrian Signal Head Wiring

Unless otherwise specified by Traffic Engineering, all cable for wiring pedestrian signals will be 14AWG/3 conductor cable conforming to IMSA Spec 20-1. The designer will confirm the plan notes or specifications as appropriate to satisfy this requirement.

Cable runs will be continuous from the controller cabinet to the pedestrian signal head. The designer will not specify splicing of pedestrian signal wiring in hand holes or junction boxes without prior written approval of Traffic Engineering and/or the TMC. Depending on the conditions, wiring may either be jumpered from the first pedestrian signal head to additional pedestrian signals on the same circuit, or separate cables may be run to each pedestrian signal. Traffic Engineering and/or the TMC will work with the designer to decide which arrangement is most advantageous.

I. Pedestrian Pushbuttons, Signs, and Wiring

Unless otherwise specified by Traffic Engineering, all cable for wiring pedestrian pushbuttons will be 14AWG/3 conductor cable conforming to IMSA Spec 20-1. The designer will confirm that this requirement is included as a plan note or is in the specifications.

The Designer will include a pedestrian pushbutton on each corner of a pedestrian crossing that has pedestrian signals. Additionally, if the pedestrian crosswalk passes through the median, a pushbutton will also be located in the median. When pedestrian displays are provided, the designer will specify a pushbutton sign conforming to the Virginia Beach **Standard Drawing D-46** "Pedestrian Pushbutton Sign".

The designer will make sure that each pushbutton location on the plans is clearly delineated so that it is obvious to the Contractor where the pushbutton is to be located on the traffic pole. If the location cannot be clearly depicted, then a plan note must be added that either describes the pushbutton position or directs the Contractor to request guidance from the Design Engineer on placement of the pushbutton. The designer will



locate the pushbutton on the signal pole or pedestrian pedestal pole in the position closest to its corresponding crosswalk.

Pedestrian pushbutton cable will be continuous from the controller cabinet to the pushbutton. The designer will not specify splicing of this cable in hand holes or junction boxes without prior approval from Traffic Engineering and/or the TMC. Depending upon the circumstances, wiring may be jumped from the first pushbutton to additional pushbuttons on the same circuit or separate cables may be run to each pushbutton. Traffic Engineering and/or the TMC will work with the designer to decide which arrangement is the most advantageous. Pushbuttons will be accessible from the sidewalk, or vegetated access. Where sidewalk is existing or is part of the design, the sidewalk will be designed or extended so the pushbuttons are accessible.

J. Junction Boxes

City practice dictates that all junction boxes will be constructed from fiberglass reinforced polymer with a Class A-3 concrete collar. The junction boxes are to be the VDOT Standard, JB-S1 through JB-S3. For specific information, refer to the VDOT Road and Bridge Standards and the City's Amendments to the 2016 VDOT Road and Bridge Specifications.

The design will include placing junction boxes at appropriate locations, providing access to the underground conduit/cable system. The locations will include, but will not be limited to, the points where loop detector splices are made, the intermediate locations in conduit runs greater than 300 ft., and at conduit terminal points.

Junction boxes are required at each end of a road crossing. This does not apply to driveway entrances or where the cable is a direct buried interconnect cable passing through the conduit.

Junction boxes will be placed next to the interconnect cable terminal enclosure. This junction box is to be placed in-line with the interconnect conduit/ cable system and will be connected to the enclosure with a single conduit of the appropriate size for the incoming and outgoing interconnect cables.

Junction boxes will not be located in the roadway, driveway entrances or in handicapped pedestrian facilities. It is recommended that junction boxes not be placed in a utility strip between the curb and sidewalk unless the utility strip is at least six (6) feet wide. Avoid placement of junction boxes on sloping grades or directly behind a curb. Junction boxes may be placed in a sidewalk area, except in handicapped facilities as noted above.

When conduit "stub outs" from junction boxes are necessary, the designer must consider the intended use of these conduits, ensuring that their future access will not be hampered. The plans must provide clear direction to the Contractor regarding length and location of the conduit stub(s).

Selecting the proper sized junction box is important to ensure that there is an adequate area for entry of conduits and cables as well as for the splicing of vehicle loop detectors. The chart on the next page is provided to assist in selecting junction box size.



TABLE X - 2 Junction Box Size		
VDOT St'd	Conduits Entering the Box	Comments
JB - S1	A single 2" or 3" conduit plus 1 or more 1" conduits	A conduit termination point where loop detectors are spliced
	A single 2" conduit and a 3" stub out	Electrical service point of connection
	A maximum of two conduits up to 3 inches in diameter each or	Interconnect cable
	A maximum of two conduits up to 3" in diameter each plus 1 or more 1" conduits	Loop detection system
JB - S2	Three conduits up to 3" in diameter plus one or more 1" conduits	Junction boxes in the median and on corners of intersections
JB - S3	Four or more conduits up to 4" in diameter	Typically used as the first junction box next to the control cabinet when all the cables are routed to it in a mast arm installation

K. Conduit

All signal, detector, and electrical service conductors and cables that are installed underground will be placed in conduits. Direct burial will be permitted for interconnect cable only, when directed by the TMC.

Conduit is specified as either Galvanized Rigid Steel (GRS), High Density Polyethylene (HDPE) or Polyvinyl Chloride (PVC). The applications of each are as follows:

1. GRS conduit will be specified for:
 - a. Conduit for risers placed on the surface of wood or steel poles.
 - b. Conduit between the edge of pavement and junction box for loop wires. Conduit for loop wires will be one (1) inch in diameter.
 - c. Conduit for electrical service conductors between the controller cabinet and the point of connection. Conduit placed for electrical service conductors will be 1¼ inch diameter GRS, with the following exception: Conduit placed under roadway pavement for roadway service conductors will be GRS conduit a minimum of two (2) inches in diameter.
2. HDPE Schedule 80 conduit will be specified under all roadway pavement and under driveway entrances. Conduit placed under roadway pavement will be a minimum of three (3) inches in diameter, regardless of the cable fill area.



3. PVC Schedule 40 or HDPE Schedule 80 conduit will be specified for all other non pavement areas, unless otherwise directed by Traffic Engineering. The minimum conduit diameter will be three (3) inches.

NOTE: There is a commonly used fitting that couples PVC conduit directly to galvanized, rigid steel conduit. Consequently, when it is necessary to make this type of transition, a junction box is not required. It is not required that the Contractor use this type of coupling for these transitions.

4. Conduit installation is placed into one of the three following categories:
 - a. TRENCHED Conduit installed in an earth area.
 - b. OPEN CUT Conduit installed in existing pavement area and the pavement structure is to be open cut.
 - c. JACK/BORE Conduit installed underneath existing pavement area without disturbing the existing pavement structure.



L. Conductor Cable

The designer will ensure that the plans provide the types of conductor cable for wiring the items listed below:

TABLE X - 3 Conductor Cable	
Item	Conductor Cable Type
Vehicle Signals, 12"	14 AWG with 5 or 7 conductors, conforming to IMSA Spec 20-1
Vehicle Signals, 8"	14 AWG/5 conductor, conforming to IMSA Spec 20-1
Pedestrian Signals	14 AWG/3 conductor, conforming to IMSA Spec 20-1
Vehicle Loop Detector	12 AWG/1 conductor, conforming to IMSA Spec 51-5
Loop Detector Lead-In	14 AWG/2 conductor (shielded), conforming to IMSA Spec 50-2
Pedestrian Pushbutton	14 AWG/3 conductor, conforming to IMSA Spec 20-1
Internally Illuminated Traffic Control Signs and Street Name Signs	12 AWG/3 conductor, conforming to IMSA Spec 20-1
Flashing Warning Beacons	14 AWG/3 conductor, conforming to IMSA Spec 20-1
Bonding/Grounding	10 AWG/1 conductor, conforming THHN, Green
Preemption Cable	20 AWG (7 x 28)/4 conductor, Opticom 138 Compatible
Video Detection	18 AWG/6 conductor RG59U, conforming to IMSA Spec 20-1
Service Cable	In accordance with National Electrical Code, currently 3-8 AWG/1 conductor



M. Controller Cabinet and Equipment

Traffic signal controllers shall be NAZTEC TS2 Type 1 Controllers. Traffic signal controller cabinets shall be NAZTEC TS2 Type 1 Virginia Beach Cabinet Assembly. All furnished control equipment must completely interface and be compatible with the Department of Public Works Traffic Management Center's NAZTEC ATMS (Advanced Traffic Management Systems) computer system.

Traffic signal installations are typically designed to house the control equipment in a ground mounted cabinet. However, where there is a limited right-of-way and signal phasing will permit, a pole-mounted cabinet may be necessary. A VDOT Standard CF-1, as found in the VDOT Road and Bridge Standards, controller cabinet foundation will be specified on the plans for ground mounted cabinets.

Pole-mounted cabinets are typically specified for intersection flashing beacons, school zone caution lights, emergency traffic signals, and warning beacon installations. When the designer considers a pole mounted cabinet for a full traffic signal installation, Traffic Engineering must be contacted for review and approval. The designer will specify the appropriate VDOT Standards for pole mounted cabinets on the plans.

The designer must take into consideration the following criteria when deciding where to locate the controller cabinet:

1. The cabinet is to be located near an available electrical service source.
2. The cabinet is to be located in a position where it is not vulnerable to traffic.
3. Traffic movements must be visible to a service technician performing timing adjustments or maintenance of the cabinet control equipment.
4. The cabinet door is to be located on the side away from traffic and open away from traffic.
5. It must not be placed in a traffic island or where the approach is unpaved.
6. It must not be located in an area subject to flooding.
7. Parking a maintenance vehicle near the cabinet should be possible.

N. Communications Media

The City has a NAZTEC ATMS computer system. The master computer is found at the Dam Neck Road Highway Maintenance Yard and is linked by a City owned interconnect system to the majority of signalized intersections throughout the City. Some existing interconnect is twisted pair of various count and is installed both aerially and underground. The Aerial cable conforms to REA Specification PE38 and the Underground cable conforms to REA Specification PE-39. The City also utilizes a network of fiber optic cable. There are also a limited number utilizing radio communications. The designer must check with the TMC for interconnect type and communication equipment needed for all new work.

1. Underground interconnect shall be installed in a conduit system. In fully developed areas where there are mostly concrete or asphalt conditions, a conduit system should be provided for the interconnect. The designer must consult with the TMC before making a decision regarding whether to design for



aerial, or a conduit interconnect system.

2. Conduit systems for interconnect shall have junction boxes not more than 250 feet apart. The junction boxes must not be smaller than JB-S2 when installed in line with the conduit run and JB-S3 when the conduit and cable are turned at a 90° angle and at each intersection for fiber splice enclosure on the cabinet corner if possible.

The TMC will specify the number of fibers required for the particular installation.

3. Interconnect that is larger than a drop is not to be taken into the controller cabinet. Cable larger than a drop is to be terminated in an above ground cable terminal enclosure and linked to the controller cabinet by a "drop". This "drop" cable may be routed to the controller cabinet through conduits having signal cables or other electrical current carrying cables. All other interconnect will not be routed through conduits having signal cables or other electrical current carrying cables. The only exception to this is that the interconnect cables may share a conduit with loop detector lead-in cables.
4. The splicing of interconnect installed in conduit systems will only be permitted in above ground splice enclosures.

Splicing of aerial interconnect will only be permitted in approved aerial splice enclosures.

5. Where the designer is dealing with modifying, relocating, or connecting into the existing interconnect system, the plans must specify the following information:
 - a. No splicing will be permitted unless a Public Works/Traffic Operations representative is present.
 - b. Splicing of active interconnect will only be permitted during periods when the affected sections of the ATMS computerized traffic signal system are in scheduled non-coordinated standby operation, unless otherwise approved by the TMC.
 - c. The Contractor will notify the TMC 72 hours prior to commencing work on planned interconnect splicing.
 - d. The Contractor will perform appropriate diagnostic tests on the section of spliced interconnect before it is placed into service. These tests will be made from the nearest access points on either side of the splice(s).
 - e. The designer will not show above ground splice enclosures between the curb and sidewalk, or in any location where they are susceptible to damage.

O. Traffic Signal Poles and Foundations

Traffic signal poles are to be located where an applicable clear zone criterion is satisfied. The structure will be protected by a guardrail where the required clear zone setback cannot be provided.

The designer will make every effort to place signal poles behind and clear of the sidewalk area.



On road construction projects, the location of signal poles will be identified with a Station and Offset. If there is more than one baseline noted in the plans close to the signal pole, the Station and Offset must identify the respective baseline.

During the design phase test pits shall be dug to verify the location of existing utilities in relation to signal pole placement. This will ensure adequate placement of any signal poles and guard against insufficient mast arm lengths due to the adjustment of foundations to avoid utilities. Test pits shall be sufficient depth to ensure there are no conflicts with existing utilities. Photos shall be provided to Traffic Engineering to illustrate and document findings.

Wherever possible, the designer should consider the use of combination signalization/streetlight poles, otherwise known as joint use poles. When joint use poles are specified, the signal plans will show the streetlighting electrical conduit(s) that are necessary for the lighting conductors. When joint use poles are planned, the designer will follow the direction given in **Standard Drawing D-28**, "Joint Use Traffic Signal Pole," included in **Appendix D** of this manual. This detail must be included in the plans.

Lighting, signal, pedestal poles, sign posts, and overhead and bridge-mounted sign structures will be designed according to The VDOT Road and Bridge Specifications and the City's Amendments to the VDOT Road and Bridge Specifications. For joint use traffic signal/lighting poles, the design analysis will use luminary ratings of 1.65 square feet effective projected area (Cd 1.0) and 60 pounds of weight per luminaire.

The following criterion is used when selecting, designing, and placing signal poles:

1. **Mast Arm Poles**

- a. All traffic signal installations will use Mast Arm Poles unless in temporary situations or otherwise prohibited by geometrics.
- b. Specify mast arms in 5 ft. increments.
- c. Show luminary arm(s) on traffic signal plans.
- d. The outboard signal head on a mast arm should be shown mounted at least two (2) feet from the end of the arm.
- e. Specified mast arm mounted signals are to be installed in accordance with VDOT Standard SM-3.

2. **Steel Strain Poles**

- a. Only to be used if the geometrics prohibit the use of mast arm poles.
- b. Specify the length of pole in two (2) foot increments. Select a length using the following criteria:
 - i. 16 feet of clearance from the pavement to the tether wire/ bottom of signal heads.
 - ii. Five (5) foot signal head height.
 - iii. 5% span sag.



- iv. Span attachment to be a minimum of 18 inches below the top of the pole (see VDOT Standard WD-1).
- c. Specify that the wiring and rigging are to conform to VDOT Standard WD-1.

3. **Wooden Poles**

- a. **Wooden poles are used for temporary installations only.**
- b. Plans must show the down guy wires.
- c. Specified length of pole in five (5) foot increments. Select a length using the following information:
 - i. One (1) foot in the ground for every six (6) feet above ground.
 - ii. 16 foot clearance from the pavement to tether wire/bottom of signal heads.
 - iii. 5 foot signal head height.
 - iv. 5% span sag.
 - v. Span attachment is to be minimum of 18 inches below the top of the pole (see VDOT Standard WD-2).
- d. Select a class of pole using engineering calculations that substantiate proper loading and allowable stress of the material.
- e. Specify that the wiring and rigging conform to VDOT Standard WD-2.

4. **Span Wire Installations**

- a. Specify one-half ($\frac{1}{2}$) inch diameter span wire for all span wire installations.
- b. Specify a one-quarter ($\frac{1}{4}$) inch diameter tether wire for all span wire installations and that the tether rigging will conform to VDOT Standard TA-1.
- c. For temporary span wire installations, specify that the cable rings are to be used by the Contractor to attach the cables to the span. Also, specify that an amount of extra cable will be coiled either at each signal or at the pole when adjustments in the locations of the signals will be needed due to construction. The Design Engineer must specify the length of cable to be coiled.
- d. Specify that the span wire mounted signal heads will conform to VDOT Standard SW-1.
- e. All five (5)-section signal heads are to be shown on the plans as one-way mounted. Two, three (3) section signal heads may be shown as a two-way mount. **Do not design a three (3) or four (4) way mounting configuration.**



The Design Engineer will provide foundation designs for each traffic signal pole. The design will be based on the soil data collected from the soil boring done at each foundation location. All designs will be for drilled foundations. Spread footings will not be accepted.

P. Electrical Service

The electrical service source, point of connection and VDOT Standard Service type will be identified on the plans. This will include the conduits, cables, risers, junction box(es), meter, and disconnect/safety switch. The meter and disconnect/safety switch must be located on the same corner as the traffic signal controller cabinet.

The Design Engineer will be responsible for meeting with Dominion Energy representatives to determine the appropriate service locations. This will include determining and showing on the plans all additional conduits and junction boxes needed by Dominion Energy to install the service.

Q. Signing for Traffic Signals

All flashing yellow arrow signals shall have the Virginia Beach **Standard Drawing D-57** "Left Turn Yield on Flashing Yellow Arrow Sign" on the mast arm or span wire next to each 4-section, protected/permitted left turn signal. Any 5-section, protected/permitted left turn signal shall have the MUTCD R10-12 sign on the mast arm or span wire next to each signal head. **Do not use these signs for permitted only left turn movements.**

Street Name signs will be shown mounted either on the mast arms or pole shafts. When a mast arm is not positioned perpendicular to a street, it may be necessary to show the Metro or Internally Illuminated street name sign as being pole shaft mounted.

Mast arm mounted, Metro Street Name signs and Internally Illuminated Street Name signs should generally be shown in a position where they are centered over the curb return. Metro Street Name signs will generally be provided by the City for installation by the Contractor on site and subdivision plan developments.

Each Internally Illuminated Street Name sign is to have a 12AWG/3C conductor cable run from the sign to the controller cabinet. This cable is to be routed through the same conduit system as the signal cable. A separate conduit is not necessary.

When an exclusive pedestrian movement is included in the signal phasing or pedestrian activity is regularly anticipated, a MUTCD R10-15 sign using Fluorescent Yellow-Green should be shown to mitigate conflict with right turn movements during the pedestrian phase.

Show the New Signal Ahead Advance Warning signs (W3-3 signs with warning flags and light) on each approach of all new signal installations. The detail of this sign assembly, included in **Appendix D**, will be placed on the plans. On approaches with two or more lanes and a divided median, place a sign in the median and on the shoulder of the approach. The signs typically are placed at a distance, in feet, prior to the intersection, calculated by multiplying the speed limit by 10, (i.e., 25 MPH x 10 = 250 feet). It may be necessary to adjust this setback due to approach geometrics.



R. Pavement Markings for Traffic Signals

Pavement markings may be shown on traffic signal plans. It is generally suggested to prepare a separate pavement marking plan sheet. Contact Traffic Engineering for guidance regarding this matter.

When the permanent pavement markings are not shown on the signal plans, the plans will show the following information:

1. Stop bar locations.
2. Crosswalks.
3. Lane lines, arrows and legends identifying lane usage.

S. Emergency Traffic Signals

Emergency traffic signals are generally limited to fire station entrances. The same design criteria for traffic signals are also applicable to these installations, with the following special considerations and guidelines.

The signal displays will be as follows:

1. Facing the Fire Station entrance - Two (2), three (3) section signal heads with displays from top to bottom of 12 inch circular red, 12 inch circular amber, and 12 inch circular green lights. During the non-preempted periods, these signals will display a flashing circular red light.
2. Facing each of the main street approaches - two (2), three (3) section signal heads (minimum) with displays from top to bottom of 12 inch circular red, 12 inch circular amber, and eight (8) inch circular amber lights. During the non-preempted mode, the main street signals will display an eight (8) inch flashing circular amber light. If the Fire Station entrance is on a multi-lane roadway and the approaches have three (3) or more lanes where more than two (2) signals are needed, then this signal should be centered over the approach lanes.
3. Facing a Minor Intersecting Street - When a fire station entrance is located directly across from a Cross Street Approach, controlled by a red stop light, two (2), two (2) section signal heads with 12 inch circular red displays in each section will face the Cross Street. In the non-preempted mode, a flashing red display will be activated in the bottom section of each head. During the preempted mode, the bottom flashing displays will be extinguished and the top sections will be activated to display a solid red indication.

A blank-out sign with the message NO TURN ON RED should be considered for the side street. This sign would be activated during the preemption interval.

The signal will be activated to the preempt mode by means of one (1) or more pushbuttons, located in the fire station. A 14AWG/3C conductor cable will be installed between the controller cabinet on the pole and the pushbuttons in the fire station. The plan will contain sufficient information and detail identifying the location of all pushbuttons in the building and a schematic, depicting the conduit routing location and wiring within the building for each pushbutton. No vehicle detection is required.



Emergency signals will operate in a flashing mode during non-preempted periods.

A sign, bearing the legend EMERGENCY SIGNAL (R10-13), shall be placed next to the traffic signals on each approach to the emergency signal. Other advance signage shall be placed in accordance with the MUTCD.

A pole mounted controller cabinet will be designed for Emergency Traffic Signals.

When the Fire Station is located within 500 feet of a traffic signal, the design should include a three (3) inch conduit with a 14AWG/3C conductor cable routed to the controller cabinet of that traffic signal. This will allow that signal to be preempted. Most signalized intersections have controller units with an integral preemption capability. All that will be needed, usually, is to relay the pushbutton preempt signal to the control equipment.

T. School Zone Caution Lights

The proper placement and operation of warranted school zone caution lights will maximize the ability to increase levels of safety for both pedestrians and motorists.

The installation of school zone caution lights on a roadway with an unsignalized ingress and/or egress to a school site, and a posted speed limit greater than 25 mph, may be justified when one (1) or more of the following warrants are satisfied:

- Warrant #1 -** That a minimum of 20, school-oriented pedestrians cross the road adjacent to the school during a two (2)-hour period of a typical school day.
- Warrant #2 -** The vehicular volume on the road from which school buses access the school exceeds 200 vehicles per hour in urban areas or 140 vehicles per hour in rural areas during the hours that school is opening or closing.
- Warrant #3 -** A school crossing guard is present and next to the roadway in front of the school.
- Warrant #4 -** Existing safety hazards are present as established by previous accident data.
- Warrant #5 -** The approach visibility does not satisfy the Virginia Department of Transportation or local jurisdiction stopping.

These warrants represent minimum conditions that should exist for the installation of school zone caution lights. Sound engineering judgment is to be exercised in conjunction with the requirements listed above when determining if conditions justify the use of school zone caution lights.

The placement and operation of warranted school zone caution lights will be governed by the following criteria:

1. Virginia Department of Transportation "Clear Zone" criteria (Refer to VDOT's Road Design Manual) will be satisfied when relating to the lateral placement of signs with respect to the road. In an urban area where design speeds are 45 MPH or less, normally signs should be 7.5 feet desirable and 6 feet minimum beyond the face of the curb. In urban areas, where these distances are not



practical, a lateral clearance of not less than three (3) feet from the face of a curb is permissible.

2. The installation of caution lights shall not be less than 200 feet nor more than 600 feet ahead of the school grounds or school crossing. If the distance exceeds 600 feet, then a supplemental fixed message sign assembly will be posted midway between the caution light and school grounds. The clear delineation of the beginning of a school zone must promote effective motorist reaction time and speed reduction, ensuring acceptable vehicle-to-pedestrian clearance distances.
3. The length of the school zone between the beacons will not be less than 600 feet.
4. Caution lights will consist of two (2) 12 inch amber LED traffic signal head warning beacons at right angles to the existing roadway, facing the approaching vehicular traffic. They are to be oriented so that they are clearly visible and do not impede vehicle or pedestrian flow.
5. At locations where the defined school zone includes side streets, a sign assembly containing a black on white supplemental street name sign (identifying the main street affected by the school zone caution lights), a S4-3 "SCHOOL" panel, an R2-1 "SPEED LIMIT 25" sign and a S4-1 panel should be installed depicting the time of day and/or day of the week the reduced speed is in effect. This sign assembly will be placed on the side street at the approach to the main street. At locations where the side street contains a significant volume of traffic or the posted speed limit is greater than 25 mph, a supplemental flashing caution light may be necessary. The decision to install an additional caution light is to be based on an engineering study of prevailing conditions.
6. The end of an authorized and posted school speed zone will be marked with a standard "END SCHOOL ZONE" sign. This sign shall be located opposite the beacon for opposing traffic or 200 - 600 feet beyond the school zone on one-way streets. A speed limit sign, showing the speed limit for the upcoming roadway section, shall be placed beyond the "END SCHOOL ZONE" sign.
7. Sign installations will conform to the MUTCD.
8. The caution lights will be in operation as required, typically thirty minutes prior to the beginning of school to fifteen minutes after the beginning of school in the morning, and fifteen minutes before the closure of school to thirty minutes after school is dismissed.
9. All flashing signals will be fully automated with programmable capabilities. The units will have the ability to skip predefined weekends and holidays.
10. At each caution light location, a "SCHOOL" pavement marking message will be placed in each approach lane. The message will be a minimum of eight (8) feet in height.

U. Warning Beacons

Contact Traffic Engineering for specific information concerning warning beacons.



V. Overhead Sign Structures

The Designer will contact Traffic Engineering for direction regarding overhead signing requirements, including lighting fixtures.

The Designer will contact Traffic Engineering to help determine whether metered or unmetered service is required. The requirements of Chapter 10.1.P “Electrical Service” are applicable to this chapter.

The Designer should ensure that the message of the overhead sign is not obstructed by other structures and that the sign does not limit the visibility of any traffic signals or other active traffic control devices.

W. Temporary Signalization

Temporary signalization installed for work zone traffic control will use span wire configurations conforming to Chapter 10.1.O.

X. Utility Clearances

The designer will be responsible for ensuring that the design for all new, modified, or temporary traffic control devices meet the National Electrical Safety Code overhead and underground clearances as well as overhead and underground clearances required by public and private utilities.

Y. Future Signalization

Contact Traffic Engineering for specific information concerning future signalization.

Z. Project Title Sheet

The Public Works Engineering standard title sheet shall be used for all projects, unless otherwise directed by Traffic Engineering.

AA. Project Summary Sheet

The Project Summary Sheet(s) must include all Traffic Control Device Pay Items. The description and quantity of each item in the summary must correspond with the Bid Item List in the Contract Document Proposal.

The City of Virginia Beach Amendments to the VDOT Road and Bridge Specifications contain many revisions to the Measurement and Payment subsection of the VDOT Road and Bridge Specifications for Sections 700, 701, 703, and 704. The Design Engineer should be completely familiar with these amendments before attempting to prepare the Summary Sheet and Bid Item List.

The reason for City amendments to the VDOT Measurement and Payment may be categorized into one (1) of three (3) groups:

1. To reduce the number of items that the construction representative has to measure. For example, the City has established a Vehicle Loop Detector pay item. Whereas the VDOT pay items for saw cut and conductor cables would



normally be individual pay items, the City incorporates them into a single pay item.

2. To incorporate VDOT Special Provisions.
3. To establish pay items for work not covered in the VDOT Specifications.

Plan Notes which provide information regarding City furnished equipment or materials must be placed on the Summary Sheet. Each affected item in the Summary is to be tagged with an asterisk or another symbol that alerts the Contractor's attention to the note(s).

AB. Project Detail Sheet

The plans must include all typical traffic control device details applicable to the project. These Standard Drawings are included in **Appendix D**.

AC. Traffic Control Right-of-Way and Easements

Typically, the boundaries of right-of-way or traffic control easements require a five (5) foot area around the facility. Contact Traffic Engineering for specific information and direction concerning traffic control right-of-ways and easements.

AD. Internally Illuminated Street Name Signs

Internally illuminated street name signs shall be installed when one of the following criteria is met:

1. Internally illuminated street name signs are to be installed on major arterial highways of divided four (4) or greater lane capacities that satisfy the following criteria:
 - a. Traffic volume on the main arterial highway is a minimum of 30,000 vehicles per day; and,
 - b. The cross street is to be of major significance, with a traffic volume of at least 15,000 vehicles per day; and,
 - c. The speed limit on the main arterial highway is to be at least 45 miles per hour; and,
 - d. These signs will only be installed at signalized intersections with mast arm poles.
2. These signs may be installed at signalized intersections with mast arm poles on major arterial highways of four (4) lanes, divided or greater, with a speed limit of 55 miles per hour.
3. When geometric or other conditions that restrict visibility make it inherently difficult for motorists to readily detect the name of the street intersection at a signalized location, there may be justification to install an internally illuminated street name sign. An example of this would be an extremely wide roadway such as those that are eight (8) lane divided facilities.



4. When an enhancement project is undertaken or at “Gateway” locations where the major objective is to enhance the aesthetics and upgrade the streetscape, there may be justification to include internally illuminated street name signs at signalized intersections.

The City will provide sign panels for internally illuminated street name signs. All other equipment, including mounting hardware and electronic components, is to be provided by the contractor.

AE. Pedestrian Crosswalks Across Multi-Lane Roadways

Halfway crossings are to be used for six (6) and eight (8) lane roadways and may be used on four (4) lane roadways. A refuge island, with a minimum six (6) foot width, will be installed to accommodate pedestrians safely that are crossing halfway. A pedestrian pushbutton shall be installed in the refuge island.

AF. Audible Pedestrian Signals

Audible pedestrian signals are retrofitted upon request at existing traffic signals where warranted and technically feasible. Contact Traffic Engineering and the TMC for information regarding audible pedestrian signals.

AG. Emergency Preemption Equipment

Each new traffic signal installation will be designed and equipped with emergency vehicle preemption equipment that detects emergency vehicles on all approaches to the intersection. The equipment will be optically activated and will completely interface with and have the same features and functions of existing City of Virginia Beach emergency preemption systems. The existing system consists of the GTT, Model 700 Series Detectors, 4 Channel System Chassis, and Multimode Phase Selectors.

The location and type of each optical detector and corresponding conductor cable and the controller cabinet will be shown on the Traffic Signal Plan. In addition, the Traffic Signal Plan **Phase Sequence** diagram will include a sequence for each emergency vehicle preemption plan.

AH. Traffic Signal New Construction and Modifications for Site Development

The Developer will provide qualified construction administration engineering services for the following:

1. Schedule and conduct a preconstruction meeting between the City and the Developer’s contractor.
2. The Developer’s Engineer will provide the contractor with the City standard specifications for all traffic signal and related traffic construction items.
3. Review the Contractor’s shop drawings, and equipment and materials submittals. This will include coordination of City review comments.
4. Provide all necessary support during the construction phase, including responding to questions and comments from either the City or the developer’s contractor.



5. Make a final inspection of the contractor's work, and review punch list comments with the City and the contractor.
6. Prepare "as-built" plans of the signal installation and furnish the City with one (1) reproducible mylar, two (2) prints, and one (1) electronic file of the plans.
7. The Developer will furnish all necessary traffic signal timings for isolated and coordinated signal operation.

10.2 Signs

A. General

1. All traffic control devices will conform to the applicable provisions of the U.S. Department of Transportation Federal Highway Administration Manual on Uniform Traffic Control Devices.
2. The fabrication and installation of permanent traffic control devices, including signs and posts, will be in accordance with Division VII, of the Virginia Department of Transportation Road and Bridge Specifications, and as amended by the City of Virginia Beach Amendments to the VDOT Road and Bridge Specifications.
3. The fabrication and installation of temporary construction warning signs furnished in conjunction with the maintenance and protection of traffic through areas of construction and detours will be in accordance with Section 512 of the Virginia Department of Transportation Road and Bridge Specifications and as amended by the City of Virginia Beach Amendments to the VDOT Road and Bridge Specifications.
4. Recycled plastic decorative sign posts will not be approved for use.

B. Installation of Street Name Signs

1. General

Street name sign dimensions, lettering, and fabrication will conform with the Virginia Department of Transportation Road and Bridge Specifications and Section 701 of the City of Virginia Beach Amendments to the VDOT Road and Bridge Specifications.

2. Nine (9) inch signs

Street name signs will go above the regulatory sign. The street name and regulatory sign will be installed on the same pole, when applicable.

3. Twelve inch signs

The Contractor will install all twelve inch street name signs on traffic signal strain poles. The signs will be staggered at a height of seventeen feet from the bottom edge of the sign to the ground.



4. **Eighteen inch signs**

The Contractor will install all eighteen inch street name signs on traffic signal mast arms. The signs will be installed in a way that they will be centered over the curb return.

C. Color of Street Name Signs

1. The Developer or Contractor will verify if the installation of a new street name sign will be on a City or private street. The street name sign will be white lettering on a green background if the City accepts the street name and maintains it in the system. If the City does not accept a street or road into the public system, the street signs will have black lettering on a white background, signifying a private street.
2. Private street name blades will follow the same provisions as the ones used for public street name signs.

D. Spelling/Block Numbers of Street Name Signs

It will be the responsibility of the Developer or Contractor to coordinate with the Planning Department to determine the correct spelling and block numbers for the street name signs. No sign will be accepted with incorrect spelling or block numbers.

E. Placement of Traffic Control Devices

1. All intersections will have some form of a regulatory traffic control device.
 - a. Four (4) legged intersections shall be controlled by STOP signs. These signs should control or stop traffic flow from a minor street where it intersects a major street.
 - b. "Tee" intersections shall be controlled by either STOP signs or YIELD signs, depending on driver visibility. At "tee" intersections, the stem of the tee is normally the street to be controlled.
 - c. Small cul-de-sacs (five (5) units or less) are not usually controlled with a traffic control device except when they intersect a major street.
 - d. Speed Limit signs are normally installed on roads entering subdivisions and not usually on interior streets.
 - e. Other traffic control devices (e.g., curve warning signs, pedestrian crossing signs, delineators, pavement markings, etc.) are used where necessary to convey information to motorists.
 - f. Street name signs are installed at all intersections and other locations where a change in a street name occurs.
2. End-of-roadway markers (OM4-2) with public notice of street extension signs are required at the termination of streets, as directed by Public Works/Traffic Engineering.



F. KEEP RIGHT Signs

The following criteria will be used to establish the need for a KEEP RIGHT (type R4-7) sign installation.

1. KEEP RIGHT sign installations will be required at all median noses of traffic signalized intersections where other signs do not clearly mark the need for motorists to keep to the right.
2. KEEP RIGHT signs will be required where the median opening is found in a curved section of the roadway, or the through lanes do not align with the median opening.
3. KEEP RIGHT signs will be required at median islands where unusual or unexpected traffic patterns have been established.
4. KEEP RIGHT signs will be required and mounted on the face of, or just in front of, any existing obstruction in the center of the roadway.
5. KEEP RIGHT signs may be required in an area that historically has a high accident rate or because an engineering study shows the existence of a hazardous traffic condition that could be improved.
6. KEEP RIGHT signs will not be required at intermediate ends of divisional islands or medians that are found in straight sections of roadway.
7. KEEP RIGHT signs will not be used at locations where other signs clearly show that the motorist must pass on the right.

G. Directional Signage

1. Directional signs are intended to direct motorists to important landmarks, educational, historical, recreational, cultural, or government sites. The color, shape, and placement will always conform to the Manual on Uniform Traffic Control Devices. All directional signs installed in the City of Virginia Beach will conform to the following policies.
 - a. Public or private transportation facilities justify directional signs in certain cases. Whenever possible, a sign will display the appropriate symbol (e.g., bus symbol for bus station). If two (2) similar facilities are found in close proximity of each other, then a supplementary name plate should be added for distinction between sites. The directional signs will be used only to delineate the route from nearby major arterial or interstate highways to the sight. Signs will be installed not more than one (1) mile from the site.
 - b. Off-street municipal parking facilities, open to the public, may have directional signs. Signs are to be used to direct motorists to municipal parking facilities in order to reduce “on-street” parking congestion. Signs will be installed within a reasonable proximity to the parking facility as determined by Traffic Engineering.
 - c. Municipal services may have directional signs in certain cases. Signs may be used to help motorists find remote municipal facilities dedicated to serve a small area of the City. They will be placed from the nearest



arterial street only when the site is difficult to find. The signs will not be used for facilities where the public does not regularly pay a visit. For example, remote highway storage yards, equipment storage or municipal garages do not justify signs. However, precinct police and fire stations are justification for using signs if they are located off a major artery or are in hard to find locations.

- d. Centralized municipal facilities, such as the Municipal Center, may have signs within a larger radius. The Municipal Center is a central, Citywide facility that generates considerable citizen traffic. Such directional signs will only be installed on major arterial highways.
 - e. Public Schools and libraries do not justify directional signs unless the facility is found in a remote area. In this instance, directional signs will be used, only to direct motorists from the nearest residential collector street.
 - f. Accredited colleges and universities including extension campuses may have directional signs. Proof of accreditation must be submitted with any request. The directional signs will only be used to delineate the route to the site from a nearby arterial or interstate highway.
 - g. City, State, and National Parks occasionally merit directional signs. Neighborhood City parks do not justify directional signs. Citywide or regional parks may have signs, only when the site is remotely located and difficult to find. Sign placement should be limited to nearby arterial streets.
 - h. Other regional recreational facilities such as camping, golf, recreation areas, fishing services, and theme parks may have directional signs. **The signs will not have individual names that delineate specific facilities.** Placement of directional signs will be limited to a reasonable distance from the site as determined by Traffic Engineering. The recreational facilities that merit signs will be major generators of regional traffic.
 - i. Any request for this type of guide sign will be reviewed by Traffic Engineering for compliance to this policy and the appropriateness of the proposed location. If such signing is deemed appropriate, it will be installed by Traffic Engineering personnel and the requestor will bear the associated expense.
2. Directional signs for both publicly and privately owned destinations and attractions, not specifically addressed in Chapter 10.2.G a) of this manual shall not be permitted, except as allowed in City Zoning Ordinance 211.1.

10.3 Pavement Markings and Markers

All guidelines and requirements for pavement markings and markers are provided in **Appendix D, Standard Drawings D-55** "Pavement Marking Standards & Details". For additional information on temporary construction pavement markings, refer to Chapter 10.4 "Construction – Maintenance" of this manual.

All pavement markings and markers shall be shown on the plan sheets. Pavement markings will be identified by line width, color, and type in accordance with **Appendix D, Standard Drawing D-**



55 "Pavement Marking Standards & Details". Pavement markers will be identified by color in accordance with **Standard Drawing D-55**.

All pavement markings in the right-of-way shall be of thermoplastic material conforming to Division VII of the Virginia Department of Transportation Road and Bridge Specifications and as amended by the City of Virginia Beach Amendments to the VDOT Road and Bridge Specifications. VDOT Type A pavement markings (paint) shall not be used in public streets.

10.4 Construction - Maintenance

A. Description

This chapter provides basic transportation principals and standards needed to design and/or maintain a temporary traffic control work zone area. When construction, maintenance operations, incident management areas, and/or special events will encroach into or adjacent to any public street, a traffic control work zone area will be established.

The purpose of this chapter is to provide you with the minimum requirements needed to warn, control, guide and protect vehicular traffic, pedestrians, and workers and equipment within the work zones. It will prepare you with the minimum standards on how to provide a safe and effective work zone area.

This chapter is set forth to be observed by all agencies public or private. This chapter is in no way exempt from private contractors or agencies who perform any work on behalf of or for the City of Virginia Beach.

B. General Information

1. All traffic maintenance and control devices, methods and applications will conform to the following publications and reports including all current editions and revisions:
 - a. Virginia Department of Transportation Work Area Protection Manual (Virginia WAPM).
 - b. Manual on Uniform Traffic Control Devices for Street and Highways issued by the U.S. Department of Transportation,
 - c. Federal Highway Administration.(MUTCD)
 - d. Virginia Department of Transportation Road and Bridge Standards Vol. II.
 - e. Virginia Department of Transportation Road and Bridge Specifications.
 - f. City of Virginia Beach, Public Works Design Standards.
 - g. National Cooperative Highway Research Program (NCHRP) Report #350 on crash worthy test requirements.
2. Proper traffic control techniques used effectively will:
 - a. Reduce accidents.
 - b. Reduce motorist confusion.



- c. Expedite traffic flow.
 - d. Prevent injury to both workers and the public.
 - e. Prevent damage to private and public property, including damage to the construction project and construction equipment.
 - f. Minimize the possibility of claims and litigation arising from work area accidents.
 - g. Improve public relations.
3. Standardization of traffic control devices and methods of application are very important when dealing with temporary conditions. Unexpected conditions due to temporary construction or maintenance are generally more hazardous. A familiar sign in a familiar pattern greatly enhances the driver's decision-making process.
4. Due to the possible variety of conditions that could potentially be encountered, not one standard or sequence of signs or other devices can be set up as an arrangement for all situations. An attempt has been made to eliminate unreasonable restrictions, and to incorporate sufficient rules to assure adequate safety and traffic flow.
5. All people or agencies working on public streets or within public right-of-ways are responsible for obtaining all necessary permits. They must coordinate the work to the satisfaction of all affected agencies, and the public, and will inform the occupants of adjoining properties that access limitations may be encountered due to the work area.
6. Construction, repairs of streets, special events or incident management areas can create hazardous conditions that may result in traffic accidents if proper precautions are not taken. Public and private agencies can be liable for such accidents through gross negligence. Proper signing, barricading, and channelization on all approaches into and throughout the work zone areas on public streets should deter such accidents.
7. Responsibility for the installation of adequate safety devices for the protection of both the traveling public and workers, as well as safeguarding the area in general, rests with the Contractor, utility company, or public department doing the work.

C. General Requirements

1. Street space is at a premium, so no more space should be used for construction or maintenance work than is absolutely necessary.
2. Traffic maintenance and control devices will be set up before the beginning of construction, maintenance operations, or special events and will be removed or moved when the work is finished or work conditions change.
3. The agency responsible for doing the work will patrol the work site and will check all traffic maintenance and control devices and work zones before, during, and after each work day to ensure proper operation. On weekends, holidays, or any non-working day, the agency responsible for the work will be responsible for checking the traffic maintenance and control devices daily for proper operation.
4. When construction or special event equipment is not being used during working hours or at night, the construction or special event equipment will not be parked



in a way that blocks the motorists' view of traffic signs and signals, or in a way that blocks a motorist's or pedestrian's access.

5. During construction, maintenance and special event operations, the minimum width for a lane of traffic opened to public travel is 10 feet; however, a 12 foot lane is advisable and should be used wherever possible. Public traffic will not be permitted on any lanes of traffic under 10 feet in width. If a 10 foot travel lane cannot be maintained, alternate routes or bypasses must be used to reroute traffic around the work zone area.
6. Whenever traffic must be temporarily routed across the centerline, the two (2) directions of traffic flow must be physically separated by approved traffic maintenance and control barricades or channelizing devices.
7. The peak flow of traffic in Virginia Beach occurs between the hours of 7:00-9:00 a.m. and 4:00-6:00 p.m. During these hours, construction or maintenance work will not be allowed on streets except for emergency conditions or with approval from Traffic Engineering. Unless otherwise noted and under normal conditions, all work will be done on streets during the standard hours of 9:00 a.m. – 4:00 p.m. Traffic Engineering maintains a list of roads with exceptions to the standard work hours and will inform the Design Engineer if an exception applies.
8. The entity responsible for doing the work will be required to provide flagmen and/or Police control when required. When traffic flagging is required at a signalized intersection, it will be accomplished by a City of Virginia Beach Police Officer (either on-duty or off-duty).
9. Every attempt will be made to schedule and expedite the work to reduce any inconvenience to the traveling public.
10. The protection of the traveling public and workers on the site will be of the utmost priority and consistent with the general principles in this Manual.
11. The City Traffic Engineer or his designee are authorized to stop any construction or maintenance activity that is not properly signed and barricaded until such requirements are met as required by this chapter.

D. Planning

1. All work will be planned, well in advance, to keep traffic obstructions, public inconvenience, and lost working time to a minimum.
2. Those responsible for planning should visit the job site before starting the work to consider the following:
 - a. Traffic conditions.
 - b. Existing traffic controls.
 - c. Traffic lane requirements.
 - d. Physical features.
 - e. Visibility restrictions.
 - f. Access to private or business properties.
 - g. The type, number, and location of signs, barricades, lights, and other traffic control devices.
 - h. Safety of pedestrians, including the blind or other physically disabled people.



E. Approval Procedure for Work in City Right-of-Way

1. A right-of-way permit is required from the Department of Planning for any work performed within the City right-of-way. Right-of-way Permits are issued by the Permits and Inspection Division and the Development Services Center.
2. During the permit process, any public or private agency completing work within the right-of-way will be responsible for providing or selecting the appropriate traffic maintenance and control plan to best suit conditions at each work site. All traffic maintenance and control plans must be approved by Traffic Engineering before the permit is issued.
3. The agency must submit any changes to the traffic maintenance and control plan a minimum of 14 days prior to the start of work.
4. The City reserves the right to modify the traffic maintenance and control plan as necessary in the interest of public safety or convenience.

F. Temporary Road and Street Closures

Please contact the Traffic Engineering Division for specific requirements concerning temporary road and street closures.

G. Temporary Construction Pavement Markings

All guidelines and requirements for temporary construction pavement markings will be in accordance with Section 512 of the Virginia Department of Transportation Road and Bridge Specifications and as amended by the City of Virginia Beach Amendments to the VDOT Road and Bridge Specifications.

H. Eradicating Pavement Markings

All guidelines for pavement marking eradication will be in accordance with Section 512 of the Virginia Department of Transportation Road and Bridge Specifications and as amended by the City of Virginia Beach Amendments to the VDOT Road and Bridge Specifications.

I. Bridging of Excavation and Trenches

1. Whenever trenches and excavations will be bridged to permit an unobstructed flow of traffic, trench walls, and adjacent soils will be sufficiently stable before using steel plates.
2. Bridging must be secured and prevent displacement by using adjustable cleats, angles, bolts, or other devices that prevent movement due to traffic.
3. The trench must be adequately shored to support the bridging and traffic.
4. Excavations are to be backfilled with select fill and compacted to 95% in maximum one (1) foot lifts.



5. Clean, washed VDOT No. 57 stone is to be placed in the excavation a minimum of eight (8) inches and a temporary asphalt patch is to be placed before any use by vehicular traffic
6. Steel plates used for bridging must extend at least one (1) foot beyond the edges of the trench. Temporary paving materials, such as "premix," will be used to feather the edges of the plate to minimize wheel impact damage. Installation of steel plates shall be in accordance with Section 6G.15 of the latest Virginia Work Area Protection Manual.

J. Pedestrian Traffic

1. When the work area encroaches upon a sidewalk, walkway or crosswalk, special consideration must be given to pedestrian safety. Since the pedestrian moves at a slow rate, an effort must be made to separate pedestrians from the work area.
2. Protective barricades, fencing, handrails, and bridges, with warning and guidance devices and signs, must be used so that the passageway for pedestrians (especially the blind and other physically disabled pedestrians) is safe and well defined.
3. Walkways in construction areas will be maintained at least four feet in width and free from abrupt changes in grade. Obstructions within the walkway will be illuminated during the hours of darkness. A minimum vertical clearance to any obstruction within the walkway will be seven feet.
4. If sidewalks are closed by construction, an alternate walkway will be provided. When it is necessary to divert pedestrians into the parking lane of a street, approved barricades will be used to separate the pedestrian walkway from the adjacent traffic lane. At no time will pedestrians be diverted into a part of the street that is used for vehicular traffic. Whenever a sidewalk must be closed due to construction and/or maintenance activities, the agency responsible for the work must obtain a permit from Permits and Inspections.
5. At locations where alternate walkways cannot be provided, appropriate signs and barricades must be installed at the limits of the work area and ahead of the closure at the nearest crosswalk or intersection to divert pedestrians across the street.

K. General Temporary Traffic Control Notes and Time Restrictions

Temporary Traffic Control Notes will be included on all projects. The general notes can be found in **Appendix E**.

If a contractual relationship exists between the City and the Contractor, then the contract, along with the plan specifications, will dictate the time restriction. The City Traffic Engineer or his designee may specify or authorize extensions on these time restrictions if appropriate justification has been shown, and the work by the Contractor progresses in a reasonable manner. Appropriate justification to specify or authorize extensions on these time restrictions for projects may include, but are not limited to:

1. The extensiveness of the work, such as travel lane reconstruction.



2. If there are unknown utilities or extensive utility relocations that are required. This is justified only if prior location “dig-ups” have been performed by the design consultant during the design phase.
3. If there are unknown poor subgrades that require drying out. This is appropriate as justification only if the design consultant has obtained soil tests during the design phase.
4. Adverse weather prevents completion of the work.
5. If there were no road or travel lanes initially in existence at the location causing no inconvenience to the public.

Large projects in the right-of-ways will not be abandoned simply because the Contractor did not meet the required timeline. The design consultant will show appropriate time restrictions on the plans. If a Contractor ceases or abandons a construction or work project in the City right-of-way for more than the time allowed, then the City may file on the bond and immediately shut down the entire project, including work outside the right-of-way. The City may proceed to take any other appropriate action as necessary to complete the work within the City right-of-way. Abandonment means the ceasing of work, ceasing of reasonable competent progress, unreasonable removal of necessary machinery, equipment, supplies, personnel, etc., from the work area or other actions that appropriately show the City that the work is abandoned.

L. Summary

1. The standards presented in this chapter are the minimum required. Additional signs, cones, barricades, and warning devices may be used, but at no time will less than what is specified to be acceptable. Due to public safety considerations, a high degree of conformity to the presented standards is required.
2. In all cases, the guidelines in this chapter and the traffic control plan shall conform to, or be of a higher standard than, the Virginia WAPM and the Manual on Uniform Traffic Control Devices, (MUTCD). Adequate protection of the traveling public, workers, and pedestrians will dictate the measure to be taken, consistent with the information presented here, the Virginia WAMP, and in the MUTCD.
3. Other traffic control devices or applications may be used, but only with the approval of the City Traffic Engineer.

10.5 Sequence of Construction

All roadway plans designed for (or by) the City of Virginia Beach will include a suggested Sequence of Construction Section for the project. In this chapter, the designer will address each phase and stage of construction in a step by step sequence. A written narrative of each phase and stage will be included as part of the plans.

The construction project will be depicted on a 1 inch = 50 feet maximum scale map for each stage. Phases and areas of construction will be identified by shading, cross hatching, or by using other appropriate symbology.

Each phase or stage of construction will include a Maintenance of Traffic Plan complete with the following:



1. Temporary striping with temporary raised pavement markers included in the transition and merge tapers.
2. The locations and identification of all channelizing devices.
3. All temporary traffic control and warning signs for construction will be located and identified with type and size in accordance with the Virginia WAPM and MUTCD.
4. All pertinent traffic control notes will be included as part of the traffic maintenance plans.
5. Dimensions for merge tapers, transition lengths, and sign spacings will be depicted.
6. Temporary street lighting locations (if warranted by construction sequencing, traffic volumes, and/or roadway geometries) will be depicted.
7. Any temporary signalization installations or modifications of existing signals must be addressed on the Maintenance of Traffic plans. A separate, more detailed sheet may be necessary for this work.
8. Any street closures or detours necessary for construction of the roadway project will be included in the Sequence of Construction plans. Any street closures included in the plan will be approved in advance by the City Traffic Engineer. The designer must provide written justification for the street closure.
9. If warranted, concrete barrier service may be required on a roadway project. If required, the barrier service will be depicted on the Sequence of Construction plans, with all openings and end treatments found and identified.

All geometries of channelized device placements, temporary striping layouts, and construction signing sequences will be according to the current edition of the Manual on Uniform Traffic Control Devices or the Virginia Work Area Protection Manual.

10.6 Construction Haul Routes

A. General

The intent and purpose of this chapter is to provide specific information and direction needed to prepare Construction Haul Route plans and specifications for roadway, utility, and other development projects according to the requirements of the City of Virginia Beach. A hauling permit may be required by DSC or Permits and Inspections. The guidelines in the chapter are supplemented by the current edition of the Virginia Department of Transportation Road and Bridge Specifications.

B. Requirements

Haul routes will be established between the project area and material source(s) that will reduce disturbance to the community and will, always, use arterial and collector roadways instead of residential streets in compliance with VDOT-Section 104.04-(k). However, if a project is found within a residential area, special approval may be granted by Traffic Engineering. Haul route plans will include the following information:

1. A map outlining the direction of hauling to and from the work site (Map must be an appropriate City map with a scale of 1 inch = 3200 feet).



2. A listing of all bridges and culverts within City limits that will be traveled upon during the hauling procedure.
3. Haul route entrance points on the project site and material site(s) are to be used.
4. A traffic control plan showing placement of "Trucks Entering Highway" signs and other advance warning signs to be installed on the approaches of the access point. All traffic control signs and devices will conform to the Manual on Uniform Traffic Control Devices.
5. If flagmen are needed to warn or direct traffic at established access point entrances, a traffic control plan will be included in the plan showing the proper placement and selection of advance warning signs.
6. All traffic control signs will be removed or covered when haul routes are not in effect.
7. Include traffic control notes on the plans and in the specifications.
8. Indicate number of cubic yards to be excavated.

C. Time Restrictions

Traffic Engineering will determine the time of day that trucks are to haul on the streets or highways. Traffic Engineering reserves the right to restrict the hauling hours. This may be done to regulate traffic volumes during peak hours or special events.

D. Approval

All proposed Haul Routes will be submitted and reviewed for approval to Traffic Engineering. A response will be made within five (5) working days after receipt. Haul Route activity **will not** begin until the approved Haul Route plan has been returned to the Contractor, and when all traffic control devices have been installed according to the approved plan.



11.0 Roadway Lighting

11.1 Introduction

There are two roadway lighting systems used in Virginia Beach, one of light emitting diode (LED) lights owned and maintained by the City and one of high pressure sodium vapor (HPSV) lights owned by Dominion Energy (Dominion). A project's nature determines the type of roadway lights to be used; the type of roadway lights in turn determines the scope of the designer's responsibilities. In all cases, however, every designer must keep in mind that increased visibility from roadway lighting combines to safeguard, facilitate and encourage vehicular and pedestrian traffic. Roadway lighting, when activated, should provide near instantaneous illumination, be accurately placed, and provide for comfortable visibility at night.

The standards in this Chapter apply only to roadway lights within the public right-of-way, including fixed lighting for roadways and adjacent sidewalks and shared use paths.

11.2 General Standards

1. Roadway light poles shall be installed as per the typical sections shown in **Appendix A**, and as per VDOT Road Design Manual for clear zone criteria (*Section A-2 "Clear Zone Guidelines"*). Exceptions to these criteria may be authorized by the City Traffic Engineer.
2. To the extent that setbacks and maximum arm lengths allow, a 2 foot fixture overhang from edge of traveled roadway will be provided.
3. Where guardrail is provided, roadway light poles will be located behind the guardrail, outside of the dynamic deflection distance. For GR-2 guardrail, setback is six (6) feet. City of Virginia Beach setback policy for GR-2A guardrail is a minimum three (3) feet. See VDOT Road and Bridge Standards.
4. Luminaire arms shall be perpendicular to the centerline of the roadway. For joint-use traffic signal poles on street corners with only one luminaire arm, the luminaire may be perpendicular to either roadway's centerline.
5. Roadway light poles and luminaires shall be a minimum of ten (10) feet from tree trunks. Additional spacing will be provided as needed to ensure that the mature tree canopy does not pass between the luminaire and roadway.
6. Capital Improvement Program (CIP) projects will have roadway lighting shown on the roadway signing and marking plan sheets, landscaping plan sheets, and construction plan sheets at a scale of one (1) inch equals twenty-five feet (1" = 25'). When stand-alone roadway lighting plans are prepared, other scales may be used if approved by the City Traffic Engineer.
7. For subdivision and site plans, roadway lighting will be shown on an overall landscape plan as well as on the construction plan sheets.
8. Both existing and proposed roadway light poles will be shown on the plans to include: pole number for existing lights, pole location, light wattage and style of fixture, luminaire mounting height, orientation, and bracket arm length. Both the existing and proposed locations for relocated roadway lights should be clearly marked on the plans.
9. On lighting plans, underground and overhead utility lines will be shown. Every effort shall be made to provide the minimum clearances required by the utility owners between existing utilities and proposed lighting poles.



10. Where joint-use traffic signal/roadway light poles are used, conduit, cable, and junction boxes for the roadway light power shall be shown on the plans. These conduits and junction boxes shall be separate from the traffic signal conduit and junction boxes.

11.3 Roadway Lighting System Selection

1. City-owned LED roadway lighting shall be provided as the standard lighting for new or replacement roadway light systems on all non-residential roadways.
2. Residential subdivisions shall have the option of either Dominion HPSV or City-owned LED roadway lights.
3. Special Cases:
 - a. Joint-use traffic signal/roadway light poles shall use City-owned LED roadway lights.
 - b. Fill-in roadway lights of three or less shall use the same fixture as the surrounding system. Four or more roadway lights located contiguously along non-residential roadways shall use City-owned LED roadway lights.

11.4 City-Owned LED Roadway Lighting

A. LED Equipment

The LED roadway light design shall use the LED fixtures and poles provided for in the City of Virginia Beach Annual Renewable Indefinite Quantity Construction Contract for LED Street Lighting Installation/Maintenance and Repairs in effect at the time of design.

B. Prepare Full Electrical Plans

Plans for city-owned LED roadway lights shall include all electrical distribution and control systems, facilities, and circuits required for their operation. Refer to the Virginia Beach Installation/Maintenance and Repairs for specifications and details.

C. Design to RP-8

All LED lighting will be designed using the Illuminance Method of Analysis of ANSI/IESNA RP-8-00 American National Standard Practice for Roadway Lighting. Point calculations will be provided for each typical section and all intersections. The average level of illumination and the uniformity ratio for each calculation area will be reported on the plans.

1. **Illumination levels will be calculated for the full width of the pavement and shoulders or curb and gutter.** For medians with curb and gutter, only the eight (8) feet of median adjacent to the travel lanes in each direction (maximum 16' total) may be included in the calculation area. For medians without curb and gutter, only the twelve (12) feet of median adjacent to the travel lanes in each direction (maximum 24' total) may be included in the calculation area.
2. **All lighting calculations will use a Total Light Loss Factor (LLF) of 0.85.** Pavement classification will be R1 for concrete pavement and R2/R3 for asphalt pavement.



11.5 Design of Dominion Roadway Lighting

A. Equipment Availability

Equipment is furnished, owned and maintained by Dominion Energy. The City pays Dominion the actual cost of purchasing and installing roadway lighting equipment, less a credit equal to four (4) years operating charges. Dominion furnishes a variety of poles and equipment, although availability may be changed without notice. For numerous reasons including cost, performance, and aesthetics, the City uses only the Dominion lighting options described below.

1. Fixtures

- a. Flat Lens Enclosed unit (“cobrahead”) Type III Medium, Full Cutoff - available in 70, 100, 150, 250, and 400 watt.
- b.
- c. Traditional Colonial unit, Type III Medium, Semi Cutoff - available in 70, 100, and 150 watt.

All lamps will be High Pressure Sodium Vapor. The light output is described in **Table XI-1**.

TABLE XI - 1	
Dominion Energy Lumen Ratings	
Watts	Lumens
70	5,000
100	8,000
150	14,000
250	23,000
400	42,000

2. Poles, Luminaire Arms, Junction Boxes and Conduit

- a. Use of aluminum poles will be required when roadway lights are installed on median barriers and bridges. All other roadway lighting poles shall be direct bury fiberglass, except where roadway lights are installed on poles supporting overhead utilities.
- b. Standard luminaire arm lengths for fiberglass poles are: 6', 8', 10' and 12'. Dual arm fiberglass poles cannot accommodate 12' arms.
- c. Standard luminaire arm lengths for bridge mounted aluminum poles are: 6' and 8'.
- d. Standard luminaire arm lengths for wood poles are: 6', 8', 10', 12', 14' and 16'. Typically, arm lengths 12' and greater will require guying of the pole.
- e. Conduit and junction boxes required for roadway lighting conductors will



be specified by Dominion. Junction boxes shall have minimum of one (1) - 2" PVC conduit stub out. Junction boxes shall have "ELECTRIC" on the cover.

B. Design Criteria

1. **Continue existing lighting patterns.** Match the mounting height, spacing, and wattage of existing lights surrounding the project if they are comparable roads in terms of design, traffic pattern, and surrounding land-use. If the project's roadway lighting is not an obvious continuation of a surrounding light pattern or there is no acceptable surrounding light pattern, use the standard spacing, mounting heights, and wattages in **Table XI-2**.

Table XI-2 Standard HPSV Cobrahead Roadway light Characteristics			
Roadway Classification	Spacing	Mounting Height	Wattage
Major Arterials	200 feet -250 feet	35 feet	250 W
Minor Arterials	220 feet – 250 feet	35 feet	250 W
Local & Collector Streets	170 feet – 240 feet	30 feet	100 W or 150 W

On rural roads, roadway lights are provided as needed for specific roadway features such as driveways, intersections, dead-end streets, sharp curves, and high accident areas. Where lighting is adjacent to crops, shielding will be used.

When approved by Traffic Engineering, typical spacing for colonial fixtures on local streets is 80 feet – 120 feet at a mounting height of 14 feet.

Mounting height is measured from the surface of the roadway to the lens of the luminaire. Where the elevation at the pole location varies significantly from that of the roadway due to slope changes, ditches, etc., poles will be either longer or shorter, as necessary, to obtain the specified mounting height.

2. **Light all intersections.** A minimum of two roadway lights is required at each intersection, and these required roadway lights shall be on diagonal corners. More roadway lights may be needed for larger intersections. Roadway lights for intersections may be part of a regular sequence of lights according to the **Table XI-2** spacing requirements or may be between the lights of such a sequence.
3. **Place roadway light poles on property lines.** This will prevent interference with future driveways and limit view obstruction from residential homes. The typical roadway light spacings given within §11.5.2(1) provide the flexibility needed for property line placement. If roadway light poles are not placed on property lines, then the following note will be required on the plans:

"Every effort has been made to develop the lighting shown on these plans so roadway lights are located on or near as practical to property lines. However, as a result of the subdivision layout, lot size, roadway light fixture chosen by the developer and the spacing required between the lights to achieve the required lighting levels, not all roadway lights may fall on lot lines. Requests by builders,



property owners or others to adjust the location of these lights must be approved by the Department of Public Works/Traffic Engineering. All costs associated with the relocation must be borne by either the developer or the party requesting the roadway light relocation.”

4. **Keep roadway light poles out of cul-de-sacs.** This will help prevent light spillage into residential homes. However due to certain types of light fixtures, it may be necessary to install roadway lights in cul-de-sacs to achieve the desired lighting levels.



12.0 As-Built Drawings

12.1 General

The purpose of this Chapter is to set forth procedures for providing As-built construction drawings required by the City of Virginia Beach, Department of Public Works. The guidance outlines the minimum required information and the method for providing this information on all drawings submitted as a record of improvements to public infrastructure constructed in the City of Virginia Beach. An As-Built Drawing is generally defined as an accurate representation of the final results of a construction activity.

The following procedures will be followed when submitting As-built drawings for approval by Public Works:

1. It will be the responsibility of the project engineer to ensure that the As-built drawings are in compliance with this Chapter upon the completion of the project and prior to acceptance by the City. As-builts must be in compliance with these requirements prior to final payment, payment for the As-built survey.
2. This Chapter applies to any major project that requires public infrastructure to be installed through a CIP project including a lane of pavement, right turn lane, median break and left turn lane, storm drain/structures, sewer and water, SWMF and other post-construction BMP and signal poles/control boxes. An As-built would not be required for a minor improvement project such as driveway aprons, moving a fire hydrant, less than 100 square feet of new pavement, curb and gutter, sidewalk, landscaping or lane lines. The requirement for As-builts will be determined by the Public Works Project Manager.
3. This Chapter does not apply to private and public infrastructure improvements reviewed and approved by the City of Virginia Beach Planning Department. As-built drawings for these improvements must follow the requirements of the Planning Department, Development Services Center (DSC). Refer to the DSC webpage for as-built drawing requirements, including submittal form and checklist.

12.2 Procedure

As-built drawings are to be provided in an acceptable format to the City of Virginia Beach Public Works. The following process will be followed for the submittal:

1. All As-built Plan Drawings are to be sealed, signed, and dated, by a licensed Professional Engineer or Land Surveyor in the Commonwealth of Virginia certifying to the accuracy as defined herein.

A statement is required at or near the professional seal or within the Notes section as follows:

"This As-built Drawing of _____ (provide description of the project) was completed under the direct and responsible charge of _____ (Name of Professional Engineer or Land Surveyor) from an actual ground survey made under my supervision. The imagery and/or original data was obtained on _____ (Date). This As-built Drawing, including metadata, meets minimum accuracy standards unless otherwise noted."



2. One (1) PDF format of the As-built drawings will be submitted to the City's Project Manager, Public Works, for review and approval, plus paper copies as directed by the City's Project Manager.
3. The City's Project Manager will provide copies of the drawings to the appropriate reviewing agencies. A review comment letter will be provided to the submitter with directions for resubmittal, if required.
4. Upon approval of the drawings, one (1) PDF format original print and an electronic digital file, outlined in Section 12.4, of the drawings will be provided to the City's Project Manager sealed, signed and dated by a licensed Professional Engineer or Land Surveyor in the Commonwealth of Virginia.
5. The original As-built project drawings of public infrastructure will be filed in the Public Works File Room system and recorded with the City's records management office.

12.3 Technical Requirements

This section is not intended to address either construction tolerances or survey practices (e.g., where and how often to take a survey elevation and/or survey horizontal location shot). Usually, the frequency and location of survey shots will match the proposed grade elevations, normally shown on and required by construction plans.

The As-built drawings shall include the following minimum information including the specified measurement of survey precision. A checklist is included with this section to aid in an accurate and complete drawing submittal.

1. The construction centerline shall be shown on the As-built drawings with its appropriate stationing and will include centerline bearing, radius, length of arc, etc. All ties are to be at right angles or radial to the construction centerline and shall indicate the plus stationing and offset distance from the centerline. In the absence of a construction centerline, the stationing can be from the existing sewer manholes.
2. The accuracy of both surface and sub-surface gravity-fed systems will be measured in a survey and recorded to within 0.01 foot vertically and one foot horizontally at the structure location.
3. The accuracy of curb/curb and gutter and pavements measurements will be 0.01 foot vertically and one foot horizontally at high points, low points, curb returns, and various other positions following good engineering, construction, and surveying practices.
4. Storm Water Management Facility (SWMF) and other post-construction BMP measurements will be accurate to 0.1 foot vertically and one foot horizontally, including the top of the bank, bottom of the bank, edge of the water, and setback distances to right-of-way lines and any unusual feature of each SWMF and other post-construction BMP. Structures and pipes will be accurate to within 0.01 foot vertically and one foot horizontally.
5. The SWMF As-Built drawing shall include the following:
 - a. The SWMF As-Built Chart: The SWMF as-built drawings shall include the SWMF As-Built Chart that provides data needed for inspection and maintenance, MS4 permit compliance, and facility details. The SWMF As-Built Chart is in a spreadsheet format and shall be obtained from Public Works Engineering for inclusion in the construction plans and As-Built drawings.



- b. Certification by a licensed Professional Engineer registered in the Commonwealth of Virginia that the SWMF was constructed and installed in accordance with the approved plans and manufacturer's specification. A copy of the Engineer's certification statement form can be obtained from the Project Manager.
 - c. A digital polygon of the drainage area to the SWMF shall be submitted for review in addition to the SWMF as-built drawing.
 - d. The City reserves the right to require revision of the project design, construction, and as-built documents to meet the design standards (See Section 8 Stormwater Management) for the constructed SWMF as applicable.
- 6. The project title and names must correspond with the approved construction documents, except that the drawing shall be titled "As-Built Survey Drawing of..."
 - 7. Profiles of As-built work shall be a part of the drawing set if profiles were provided in the approved project design drawing set.
 - 8. All public easements acquired by the project shall be shown on the drawings along with notation of public record recordation data.
 - 9. All dimensions and working units will be expressed to the nearest hundredth of a foot. All elevations will be expressed to the nearest hundredth of a foot on solid surfaces and to the nearest tenth of a foot on ground/grass surfaces.
 - 10. The horizontal and vertical elements of the As-built drawing will be referenced to the current HORIZONTAL and VERTICAL datums recognized by the City of Virginia Beach Survey Bureau.
 - 11. The As-built drawings shall show all elements that are shown on the project design plans that lie within public lands, rights-of-way and public easements.

12.4 Submittal of Digital As-Built Drawing Files

Upon acceptance and approval of an As-built drawing a digital copy must be submitted in .DWG format and compatible with AutoCAD. This section provides guidance in order to standardize digital submittals of As-built drawings to the City of Virginia Beach, Department of Public Works. This section applies to all engineering designs and project plan drawings for public projects. The following information is provided for digital submittals:

- 1. **Contract Digital Submittals** - Digital files will be submitted according to the project's contract for all design and project plan record drawing contracts with the City of Virginia Beach. In addition, City Project As-built plans will be submitted in the AutoCAD digital design format.
- 2. Submittals shall be provided on portal digital media in .DWG format. All electronic files necessary to reproduce a hard copy of the submitted As-built drawing set shall be provided on the digital media. This may include any externally referenced drawings and images necessary for a complete drawing set that must be bound to the drawing or provided with the electronic file. This will also include any non-standard or custom settings (e.g. plot styles, fonts, or line types) that will be needed to reproduce a hard copy of the plans.



12.5 As-Built Drawing Checklist

A checklist is provided for use when submitting As-built drawings for City approval. This check list is not to be considered a complete specification, but rather as a guideline. This checklist cannot reflect all conditions for all types of As-built drawings, but shall provide guidance in their preparation.

As-built drawings shall not be submitted for City review until all construction items are in place, inspected and accepted by the City.

The As-built drawings are to be a true representation of elements that exist as a result of a completed construction project. Therefore, all references to PROPOSED or CONTRACTOR SHALL or any other similar type statements that refers future work must not be included on the submitted As-built drawings.

Questions regarding As-built drawings, reviews, comments, etc. should be directed to the Department of Public Works.



AS-BUILT DRAWING CHECKLIST

ROADWAYS

PAVEMENT:

- ☐ Centerline of roadway
- ☐ Entrances, Curbs or Curb and Gutters with top of curb elevations
- ☐ Finished pavement elevations along edge of pavement
- ☐ Finished pavement elevations along centerline of roadway pavement
- ☐ Finished ground elevations along the centerline of grass medians
- ☐ Crosswalks, type and detail

TRAFFIC CONTROL:

- ☐ Lane paint lines and centerline paint lines
- ☐ Painted Turn lane arrows and messages
- ☐ Traffic control signage (Stop, Yield, Street Name, Speed, ETC.)
- ☐ Traffic Signal Poles, control boxes, etc.

MISCELLANEOUS:

- ☐ Open space access improvements
- ☐ Street Light Poles with Pole Numbers
- ☐ Right-of-Way monuments found during survey
- ☐ Sidewalks and multi-use paths with elevations
- ☐ Handicap ramps

STORM DRAINAGE SYSTEM

STRUCTURES:

- ☐ Type of structure is clearly defined in LEGEND and in PLAN view
- ☐ Rim and invert of structure
- ☐ Inlet shaping noted if in place
- ☐ Invert elevation of each pipe in structure
- ☐ End wall or flared end sections clearly noted and shown
- ☐ Riprap limits outlined
- ☐ Roadside swale elevations
- ☐ Monitoring well location, material, size, type, rim and invert elevation
- ☐ Virginia State Plane Coordinate System, South Zone, NAD 83/93 HARN Coordinate (U.S. Survey Feet), Coordinate shown for each storm drainage structures

SWMF or OTHER STRUCTURAL POST-CONSTRUCTION BMP:

- ☐ Location of facility outer marking plates for underground SWMF
- ☐ Location and depth of flow control structures for the SWMF or other post-construction BMP
- ☐ All items on SWMF As-Built Chart based on SWMF type
- ☐ SWMF certification statement signed in accordance with Section 1-7(C) of the City's Stormwater Management Ordinance
- ☐ Letter from manufacturer of proprietary manufactured treatment devices acknowledging final inspection and warranty information for product
- ☐ As-built elevations of each design element in the system (top and bottom of stone, filter media, pavers, benches, etc.)
- ☐ Water surface elevations from approved design for the 1, 2, 10, and 100 year storm events as applicable
- ☐ Seasonal high groundwater elevation



PIPES:

- ☐ Size and type of pipe
- ☐ Invert of both ends of each pipe
- ☐ Slope of pipe based on actual invert elevations

PONDS / MAJOR CANALS / SWMFs

- ☐ Contours or cross section elevations of entire pond, basin, or canal and embankments
- ☐ Top of water level at time of survey
- ☐ Inflow and Outlet structures located, shown and elevation information for all openings, rims and inverts
- ☐ Aeration devices located and shown
- ☐ Shoreline treatments located and shown
- ☐ Maintenance or land easements

LANDSCAPING

- ☐ All Landscape items required on construction plan are field located
- ☐ Street trees located with size and type
- ☐ Landscape beds
- ☐ Private signage structures within the Public rights-of-way or City parcels
- ☐ Decorative subdivision fencing, etc. within the Public rights-of-way or City parcels

PUBLIC UTILITIES

For Public Utilities information refer to: https://www.vbgov.com/government/departments/public-utilities/Engineering-Construction/Standards-Forms/Documents/2014-07-01_DSM.pdf

WATER:

- ☐ Valves, tees, hydrants, air release structures, etc.
- ☐ Waterline with size and type of pipe
- ☐ Reflector in street pavement opposite hydrants
- ☐ Water meters with station and offset data
- ☐ Bends, tees, reducers, etc.

SANITARY SEWER:

- ☐ Pump station site improvements
- ☐ Force main location with appurtenances
- ☐ Sewer manholes with rim and invert elevations
- ☐ Street main cleanouts with rim elevations
- ☐ Street main pipe sizes, types and slopes
- ☐ Lateral lines
- ☐ Lateral Cleanouts with Station and offset data
- ☐ Vacuum sewer system improvements completely shown
- ☐ Manhole structures, force mains and vacuum systems station and offsets



DRAWINGS

GENERAL:

- ☐ Survey and Drawing prepared by Professional Engineer or a licensed Land Surveyor
- ☐ Professional Seal on all sheets, signed and dated
- ☐ Name and address of Professional Engineer or Surveyor
- ☐ Certification Note giving date(s) of survey
- ☐ Horizontal Control Datum Note
- ☐ Vertical Control Datum Note with Bench mark reference
- ☐ Site / Project Bench mark
- ☐ Legend depicting all items on survey drawing
- ☐ Graphic Scales
- ☐ Vicinity Map
- ☐ Cover Sheet with Sheet Index if more than two drawing sheets
- ☐ Drawing sheets numbered in sequence
- ☐ All easements shown and labeled

PLAN SHEETS:

- ☐ 24" X 36" Sheets
- ☐ Title states **AS-BUILT DRAWING**
- ☐ Match Lines with sheet match data
- ☐ Profile sheets showing grades and utility data
- ☐ Note on Profile Sheets depicting source of pressure pipe data

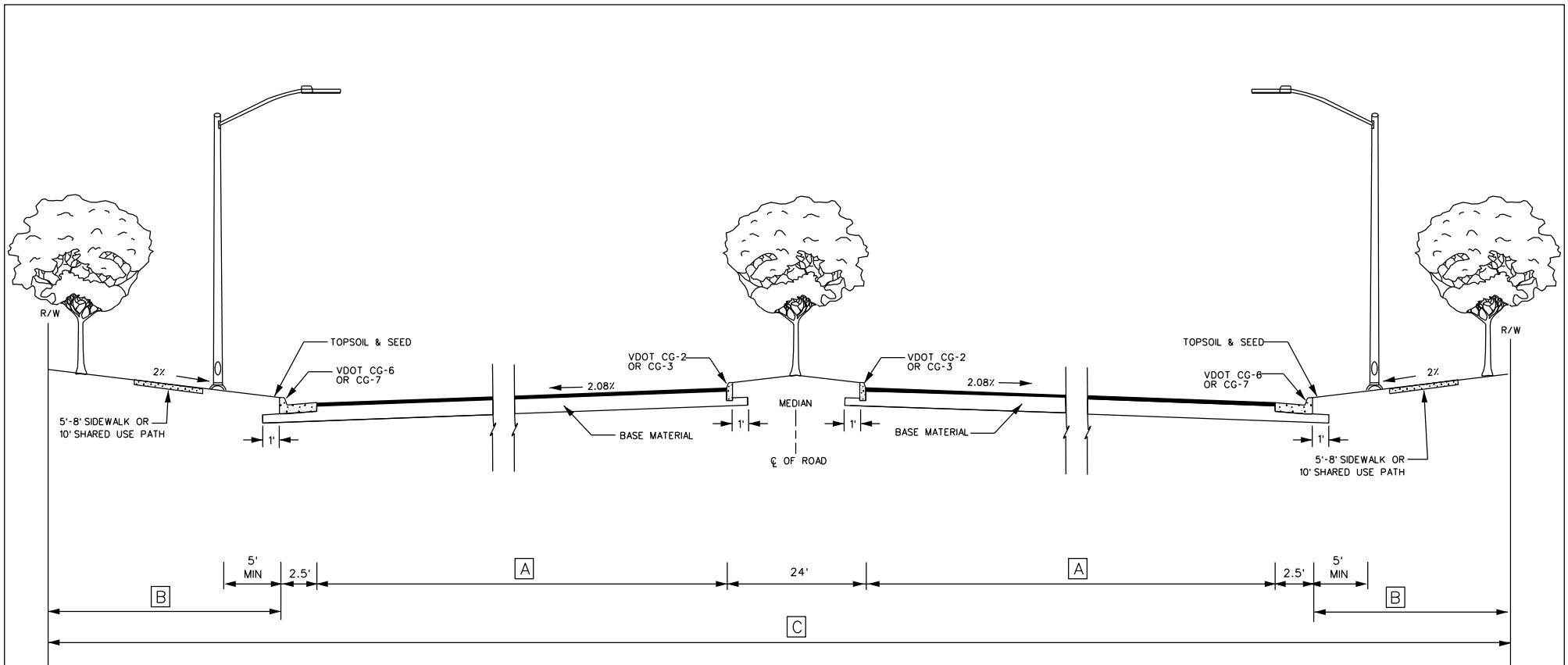


Appendix A

Right-of-Way Typical Section Standard Drawings

A.1 Intent

The following typical sections are intended to be complimentary to the Master Transportation Plan of the City Comprehensive Plan.



NOTES:

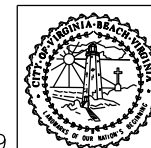
- 1) DIMENSION **A** BASED ON 12' TRAVEL LANE AND 4' BIKE LANE.
- 2) STREETLIGHT DESIGN IS REQUIRED TO DETERMINE POLE LOCATION, HEIGHT, ARM LENGTH, LIGHT TYPE, AND WATTAGE.
- 3) LOCATION OF SIDEWALK & PATH MAY VARY IN RELATION TO STREETLIGHTS, TREES, AND OTHER GREEN INFRASTRUCTURE.
- 4) FOR BICYCLE FACILITIES REFER TO APPENDIX F.

	A	B	C

4 LANE DIVIDED	29'	29'	145'
6 LANE DIVIDED	41'	27'	165'
8 LANE DIVIDED	53'	27.5'	190'

Intersection Typical Sections and Designs will be required with projects showing the placement and locations of right turn lanes, left turn lanes (possibly dual), sidewalks, landscaping and all utilities, including : streetlights, traffic control, water, sewer, gas, power, telephone, television, storm drainage, etc.

(N.T.S.)
REV. 03/19

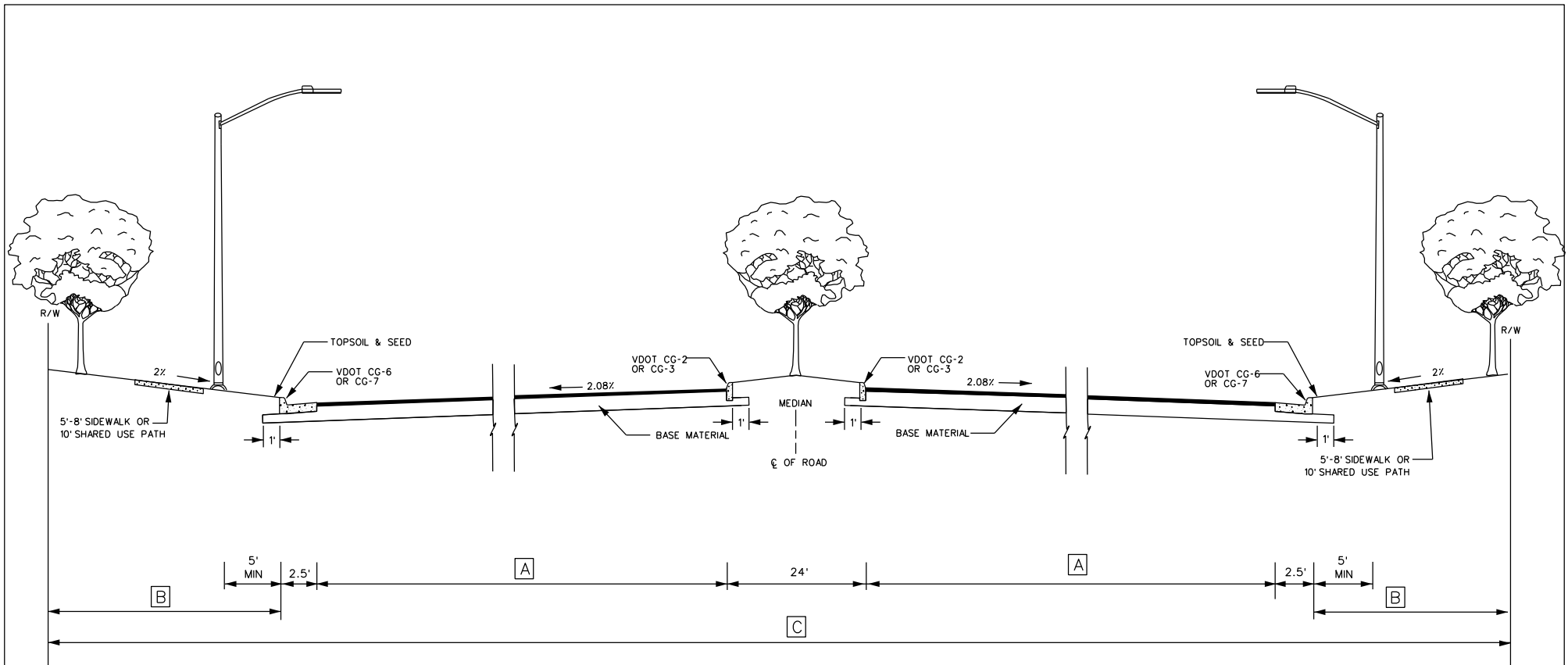


CITY OF VIRGINIA BEACH
STANDARD

TYPICAL SECTION FOR
ARTERIAL DIVIDED

PUBLIC WORKS

A-1



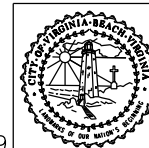
NOTES:

- 1) DIMENSION **A** BASED ON 12' TRAVEL LANE AND 4' BIKE LANE.
- 2) STREETLIGHT DESIGN IS REQUIRED TO DETERMINE POLE LOCATION, HEIGHT, ARM LENGTH, LIGHT TYPE, AND WATTAGE.
- 3) LOCATION OF SIDEWALK & PATH MAY VARY IN RELATION TO STREETLIGHTS, TREES, AND OTHER GREEN INFRASTRUCTURE.
- 4) FOR BICYCLE FACILITIES REFER TO APPENDIX F.

	A	B	C
4 LANE DIVIDED	29'	19'	125'
6 LANE DIVIDED	41'	19.5'	150'
8 LANE DIVIDED	53'	17.5'	170'

Intersection Typical Sections and Designs will be required with projects showing the placement and locations of right turn lanes, left turn lanes (possibly dual), sidewalks, landscaping and all utilities, including : streetlights, traffic control, water, sewer, gas, power, telephone, television, storm drainage, etc.

(N.T.S.)
REV. 03/19

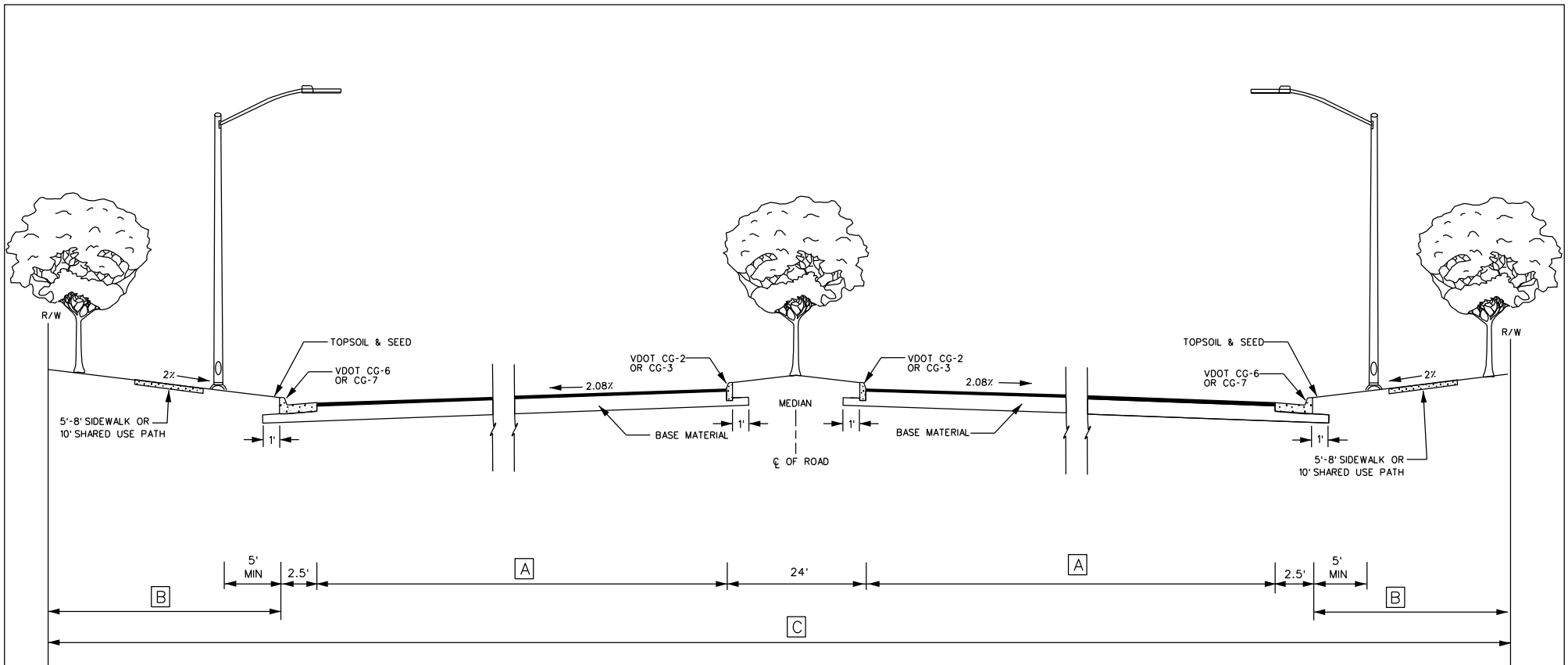


CITY OF VIRGINIA BEACH
STANDARD

TYPICAL SECTION FOR
ARTERIAL DIVIDED -
MODERATELY CONSTRAINED

PUBLIC WORKS

A-2



NOTES:

- 1) DIMENSION [A] BASED ON 11' TRAVEL LANE AND 4' BIKE LANE.
- 2) STREETLIGHT DESIGN IS REQUIRED TO DETERMINE POLE LOCATION, HEIGHT, ARM LENGTH, LIGHT TYPE, AND WATTAGE.
- 3) LOCATION OF SIDEWALK & PATH MAY VARY IN RELATION TO STREETLIGHTS, TREES, AND OTHER GREEN INFRASTRUCTURE.
- 4) FOR BICYCLE FACILITIES REFER TO APPENDIX F.

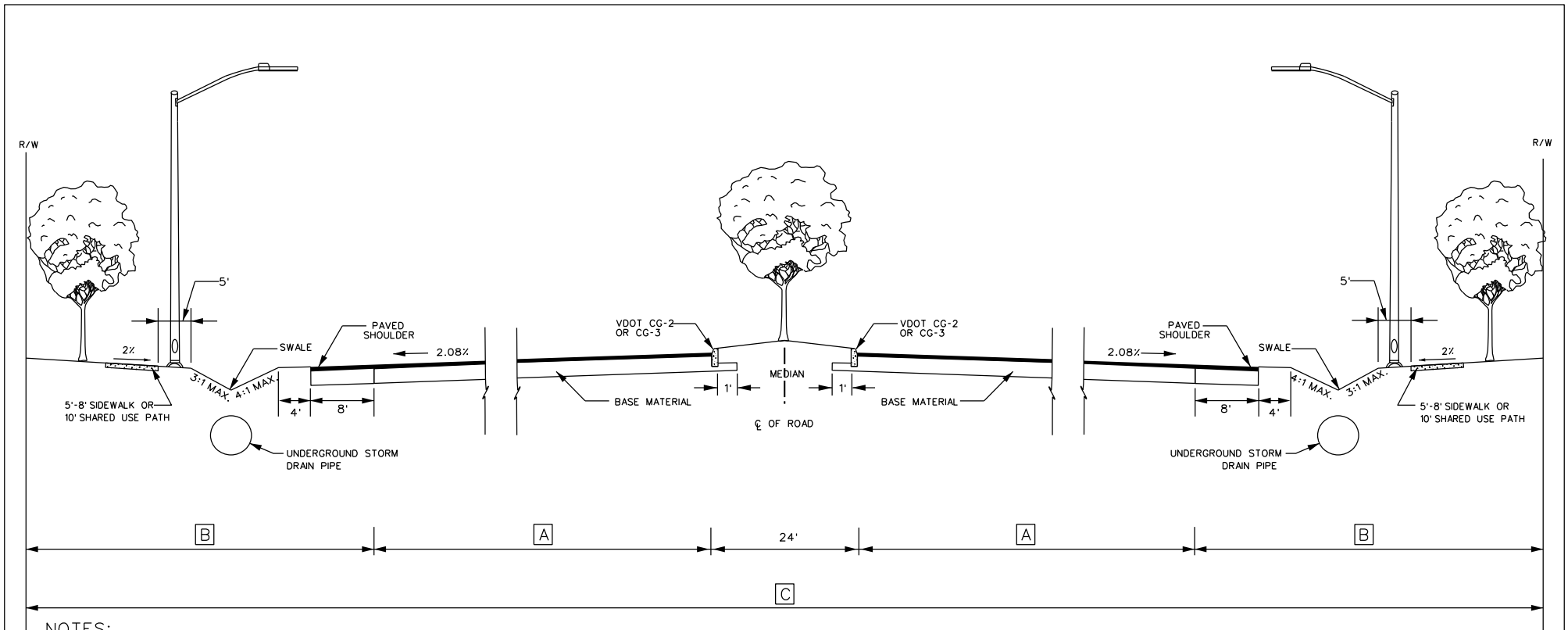
	A	B	C
4 LANE DIVIDED	27'	13.5'	110'
6 LANE DIVIDED	38'	12.5'	130'
8 LANE DIVIDED	49'	14'	155'

Intersection Typical Sections and Designs will be required with projects showing the placement and locations of right turn lanes, left turn lanes (possibly dual), sidewalks, landscaping and all utilities, including : streetlights, traffic control, water, sewer, gas, power, telephone, television, storm drainage, etc.

(N.T.S.)
REV. 03/19



CITY OF VIRGINIA BEACH STANDARD	
TYPICAL SECTION FOR ARTERIAL DIVIDED CONSTRAINED	
PUBLIC WORKS	A-3



NOTES:

- 1) DIMENSION [A] BASED ON 12' TRAVEL LANE AND 4' BIKE LANE.
- 2) STREETLIGHT DESIGN IS REQUIRED TO DETERMINE POLE LOCATION, HEIGHT, ARM LENGTH, LIGHT TYPE, AND WATTAGE.
- 3) LOCATION OF SIDEWALK & PATH MAY VARY IN RELATION TO TREES AND OTHER GREEN INFRASTRUCTURE.
- 4) SWALES SHALL BE LESS THAN 18" IN DEPTH WITH 3:1 (H:V) OR FLATTER SIDE SLOPES.
- 5) ON-ROAD BIKE LANE REQUIREMENTS SHALL BE FACILITATED WITHIN THE PAVED SHOULDER AREA, SEE APPENDIX F.

	A	B	C
4 LANE DIVIDED	25'	58'	190'
6 LANE DIVIDED	37'	58.5'	215'
8 LANE DIVIDED	49'	59'	240'

Intersection Typical Sections and Designs will be required with projects showing the placement and locations of right turn lanes, left turn lanes (possibly dual), sidewalks, landscaping and all utilities, including : streetlights, traffic control, water, sewer, gas, power, telephone, television, storm drainage, etc.

(N.T.S.)
REV. 03/19

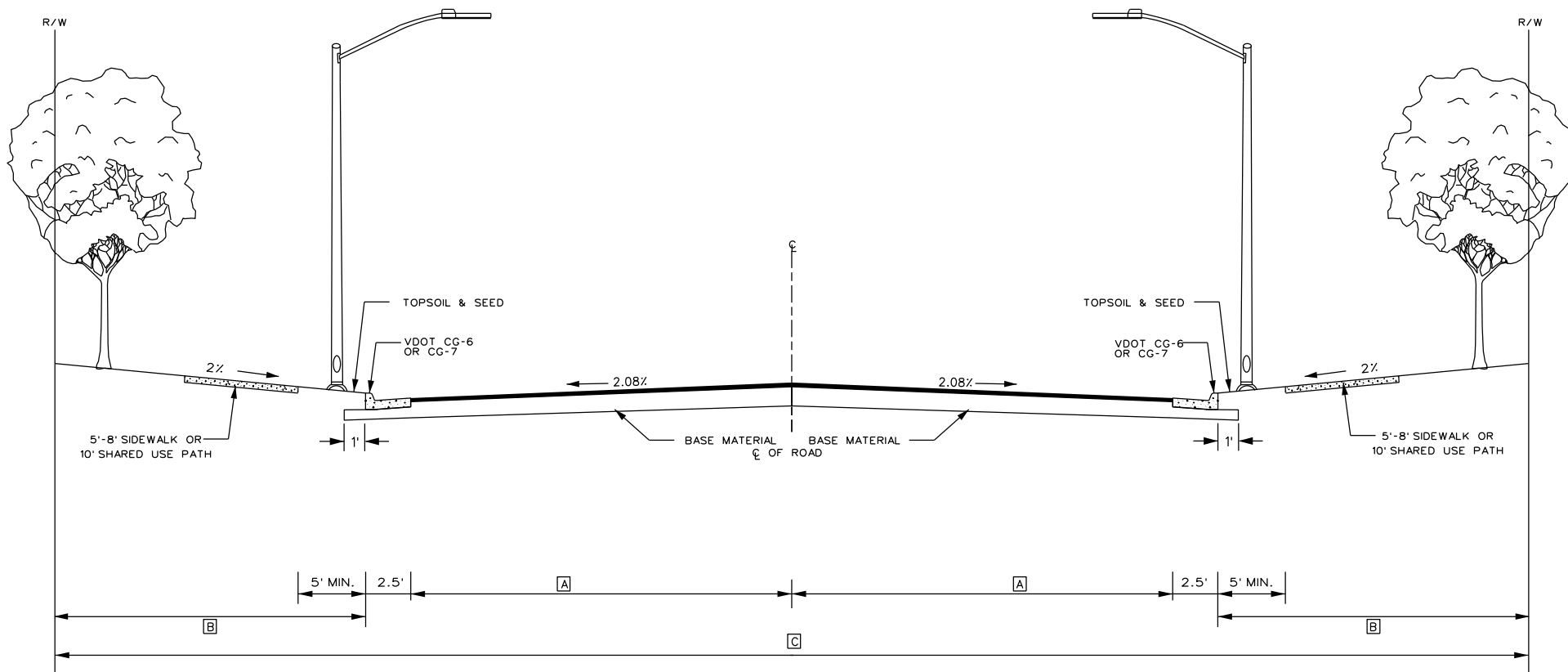


CITY OF VIRGINIA BEACH
STANDARD

TYPICAL SECTION FOR
PARKWAY

PUBLIC WORKS

A-4



NOTES:

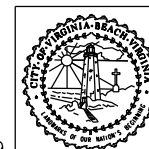
- 1) DIMENSION [A] BASED ON 12' TRAVEL LANE AND 4' BIKE LANE.
- 2) STREETLIGHT DESIGN IS REQUIRED TO DETERMINE POLE LOCATION, HEIGHT, ARM LENGTH, LIGHT TYPE, AND WATTAGE.
- 3) FOR BICYCLE FACILITIES REFER TO APPENDIX F.

4 LANE UNDIVIDED

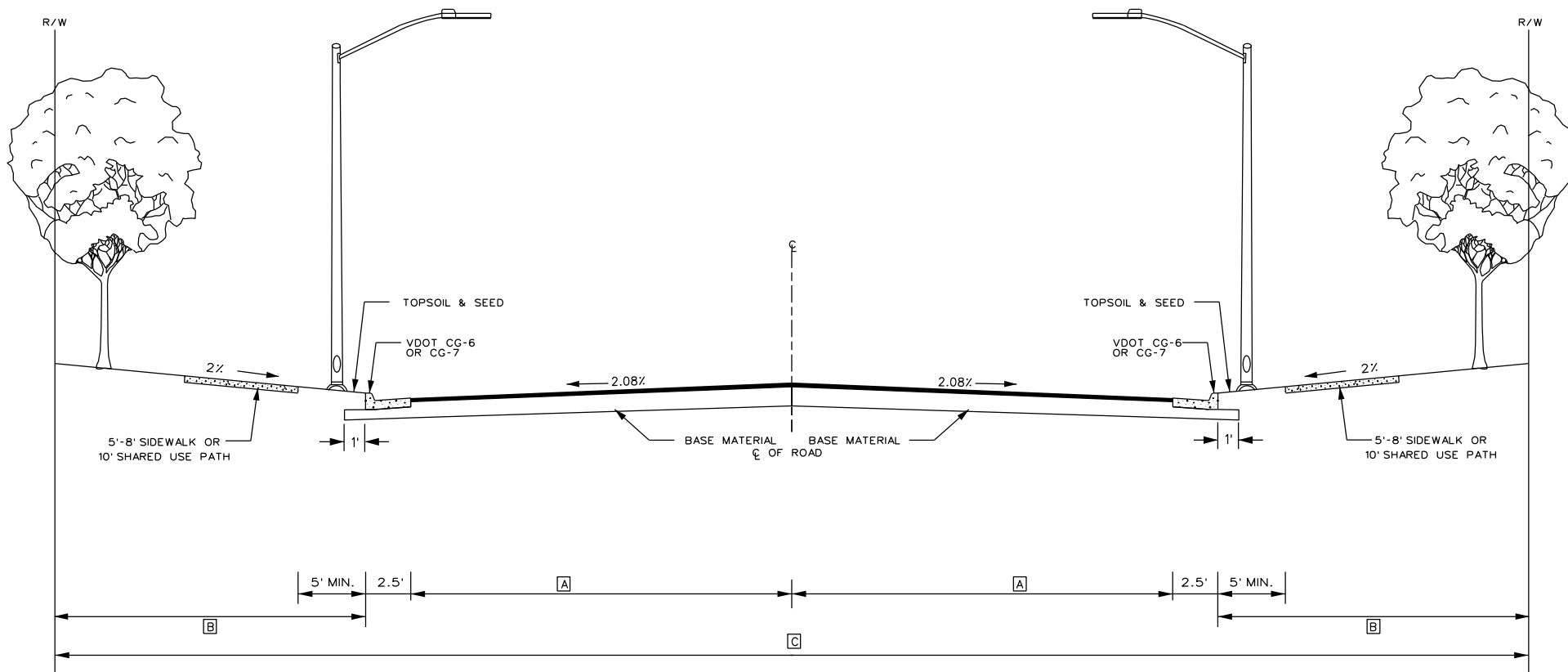
A	B	C
28'	19.5'	115'

Intersection Typical Sections and Designs will be required with projects showing the placement and locations of right turn lanes, left turn lanes (possibly dual), sidewalks, landscaping and all utilities, including : streetlights, traffic control, water, sewer, gas, power, telephone, television, storm drainage, etc.

(N.T.S.)
REV. 03/19



CITY OF VIRGINIA BEACH STANDARD	
TYPICAL SECTION FOR MAJOR COLLECTOR- 4 LANE UNDIVIDED STANDARD	
PUBLIC WORKS	A-5



NOTES:

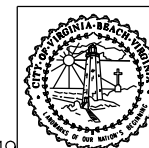
- 1) DIMENSION [A] BASED ON 12' TRAVEL LANE AND 4' BIKE LANE.
- 2) STREETLIGHT DESIGN IS REQUIRED TO DETERMINE POLE LOCATION, HEIGHT, ARM LENGTH, LIGHT TYPE, AND WATTAGE.
- 3) FOR BICYCLE FACILITIES REFER TO APPENDIX F.

A	B	C

4 LANE UNDIVIDED

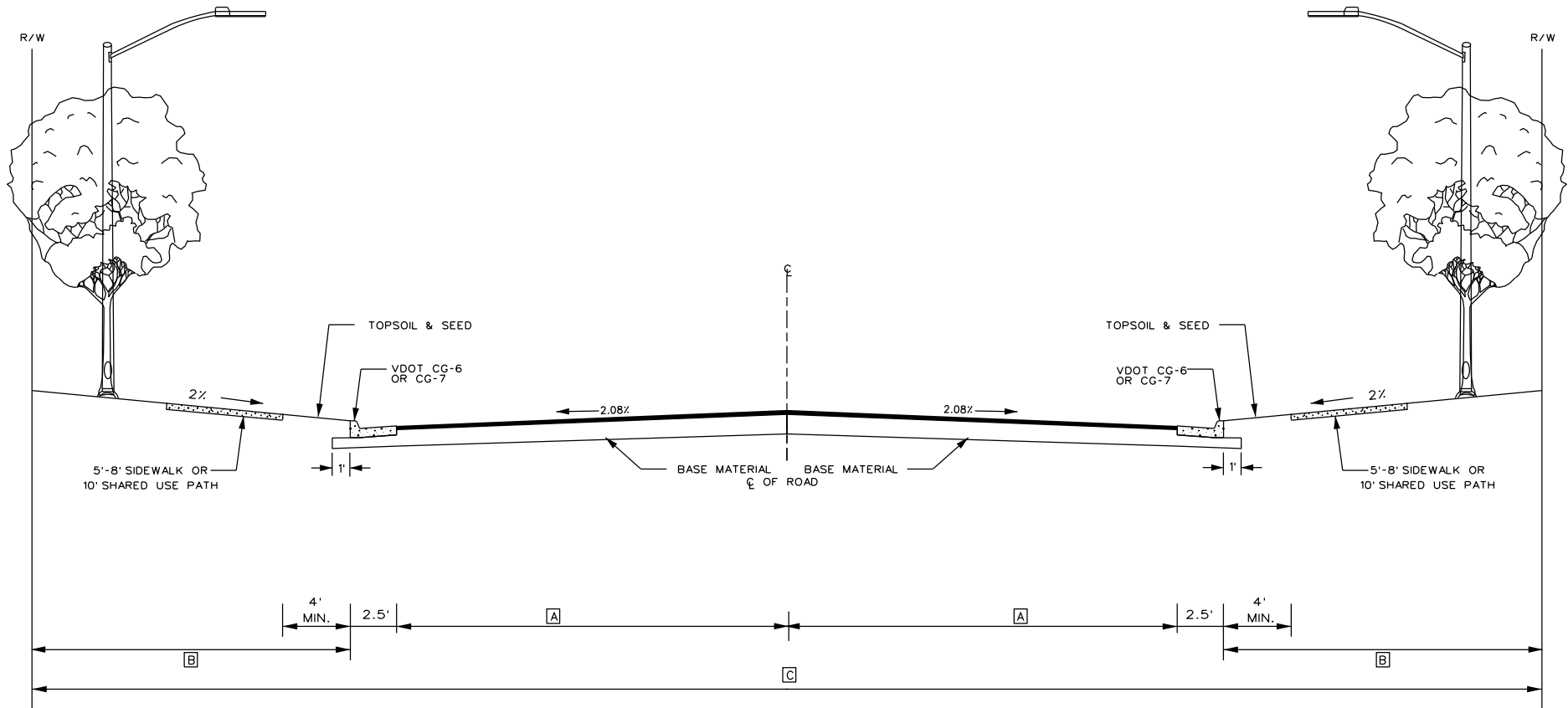
28' 19.5' 100'

Intersection Typical Sections and Designs will be required with projects showing the placement and locations of right turn lanes, left turn lanes (possibly dual), sidewalks, landscaping and all utilities, including : streetlights, traffic control, water, sewer, gas, power, telephone, television, storm drainage, etc.



CITY OF VIRGINIA BEACH STANDARD	
TYPICAL SECTION FOR MAJOR COLLECTOR- 4 LANE UNDIVIDED- MODERATELY CONSTRAINED	
PUBLIC WORKS	A-6

(N.T.S.)
REV. 03/19



NOTES:

- 1) DIMENSION [A] BASED ON 11' TRAVEL LANE.
- 2) STREETLIGHT DESIGN IS REQUIRED TO DETERMINE POLE LOCATION, HEIGHT, ARM LENGTH, LIGHT TYPE, AND WATTAGE.
- 3) FOR BICYCLE FACILITIES REFER TO APPENDIX F.

A	B	C

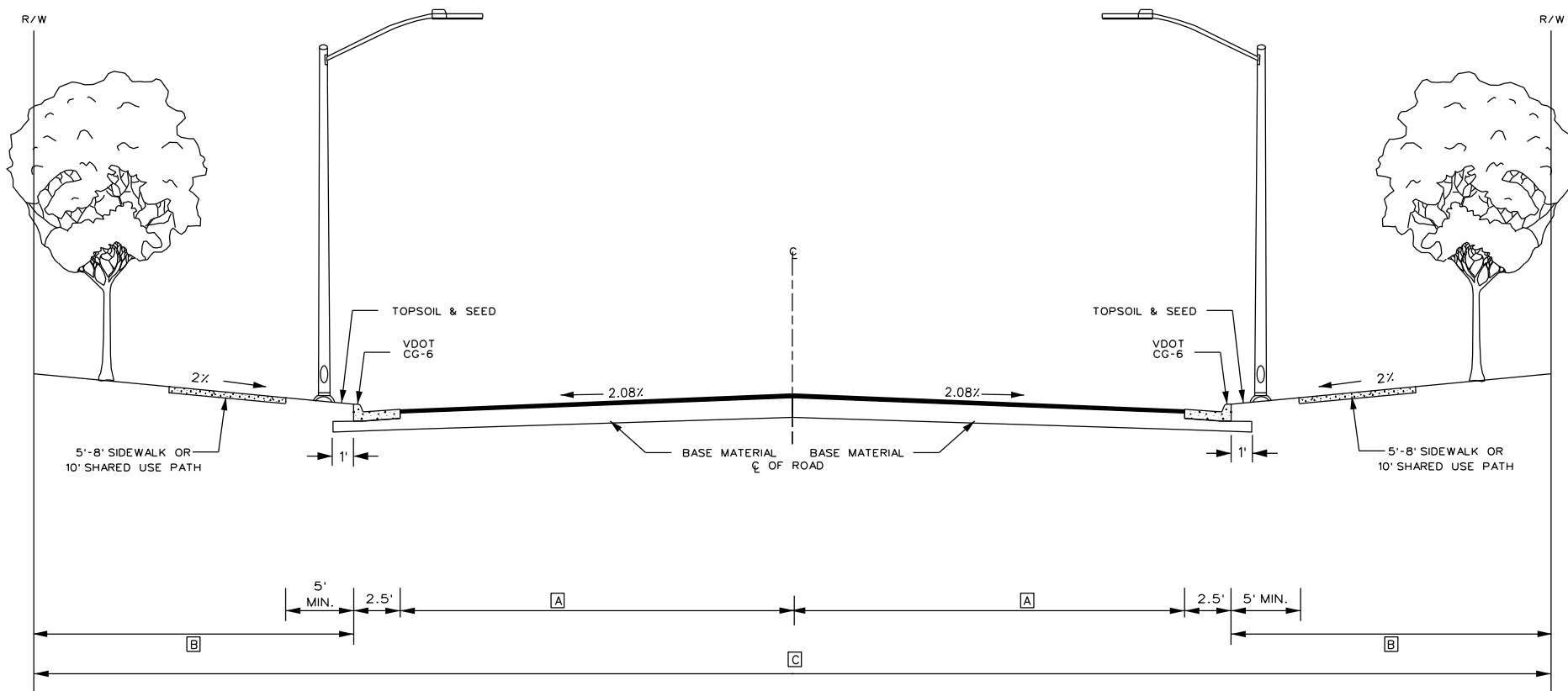
4 LANE UNDIVIDED 22' 15.5' 80'

Intersection Typical Sections and Designs will be required with projects showing the placement and locations of right turn lanes, left turn lanes (possibly dual), sidewalks, landscaping and all utilities, including : streetlights, traffic control, water, sewer, gas, power, telephone, television, storm drainage, etc.

(N.T.S.)
REV. 03/19



CITY OF VIRGINIA BEACH STANDARD	
TYPICAL SECTION FOR MAJOR COLLECTOR- 4 LANE UNDIVIDED- CONSTRAINED	
PUBLIC WORKS	A-7



NOTE:

1) STREETLIGHT DESIGN IS REQUIRED TO DETERMINE POLE LOCATION, HEIGHT, ARM LENGTH, LIGHT TYPE, AND WATTAGE.

2) FOR BICYCLE FACILITIES REFER TO APPENDIX F.

Intersection Typical Sections and Designs will be required with projects showing the placement and locations of right turn lanes, left turn lanes (possibly dual), sidewalks, landscaping and all utilities, including : streetlights, traffic control, water, sewer, gas, power, telephone, television, storm drainage, etc.

2 LANE UNDIVIDED

A	B	C

13' 19.5' 70'



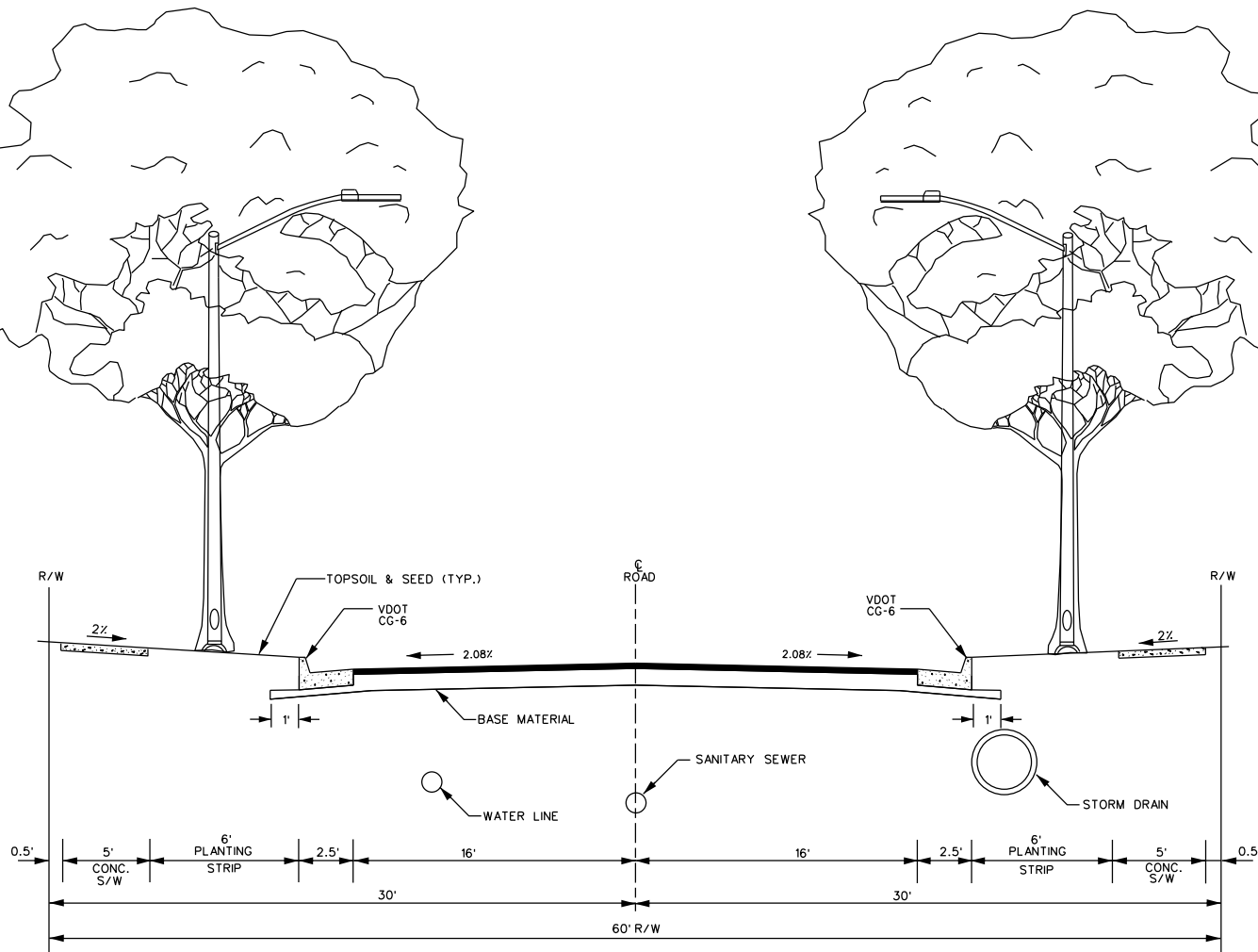
CITY OF VIRGINIA BEACH
STANDARD

TYPICAL SECTION FOR
MINOR COLLECTOR
2-LANE UNDIVIDED

PUBLIC WORKS

A-8

(N.T.S.)
REV. 03/19



NOTES:

- 1) STREETLIGHT DESIGN IS REQUIRED TO DETERMINE POLE LOCATION, HEIGHT, ARM LENGTH, LIGHT TYPE, AND WATTAGE.
- 2) LOCATIONS OF STORM DRAINS, WATERLINES, SEWERLINES, GAS LINES, AND OTHER UNDERGROUND UTILITIES ARE SHOWN IN THEIR APPROXIMATE LOCATIONS
- 3) FOR BICYCLE FACILITIES REFER TO APPENDIX F.
- 4) ON STREET PARKING IS ALLOWED ON BOTH SIDES.

Intersection Typical Sections and Designs will be required with projects showing the placement and locations of right turn lanes, left turn lanes (possibly dual), sidewalks, landscaping and all utilities, including : streetlights, traffic control, water, sewer, gas, power, telephone, television, storm drainage, etc.

(N.T.S.)
REV. 03/19



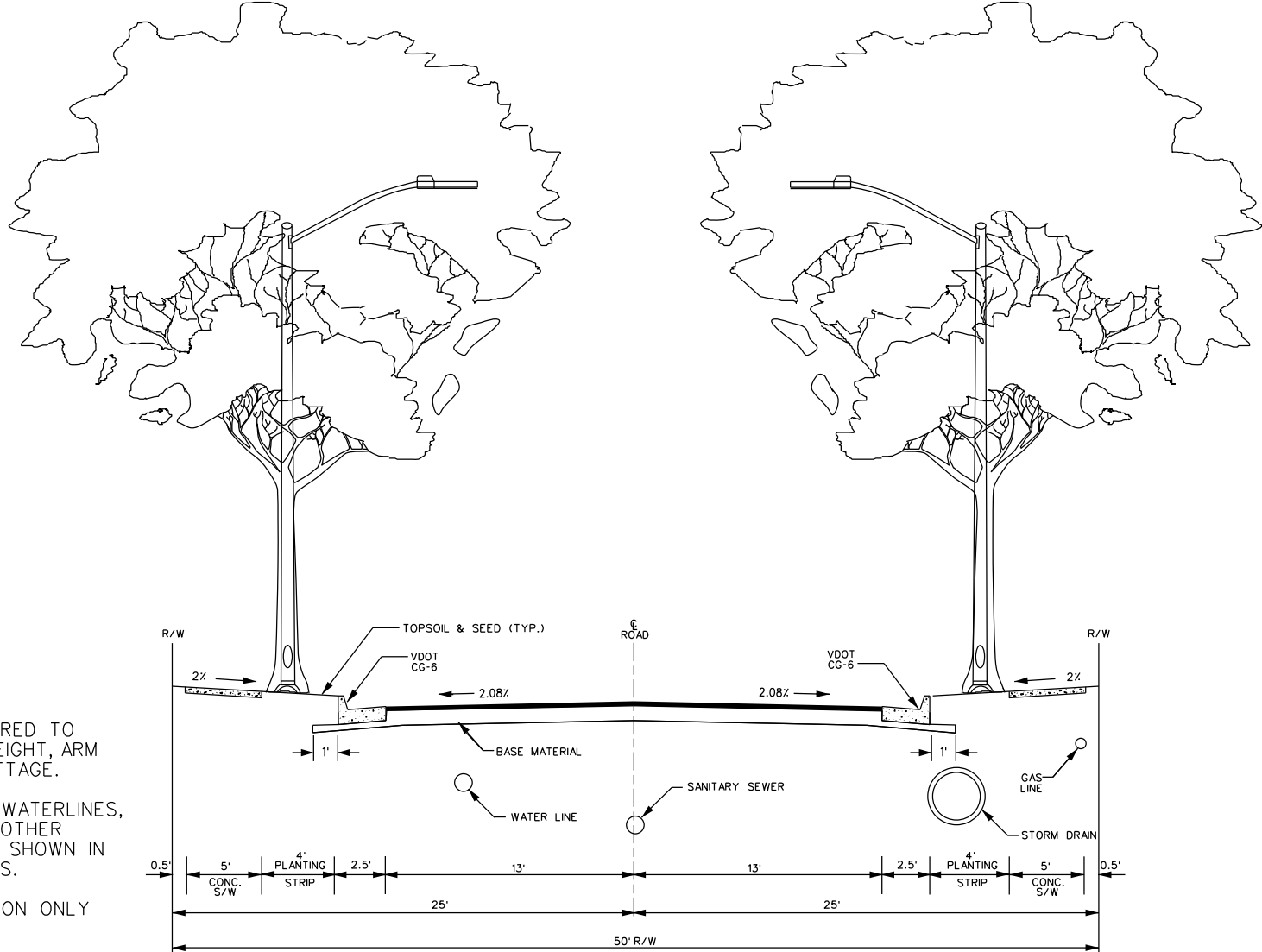
SHOWN WITH TREES (40' TALL)

CITY OF VIRGINIA BEACH
STANDARD

TYPICAL SECTION FOR
NEW STREET IMPROVEMENTS IN
60' R/W

PUBLIC WORKS

A-9

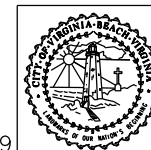


NOTES:

- 1) STREETLIGHT DESIGN IS REQUIRED TO DETERMINE POLE LOCATION, HEIGHT, ARM LENGTH, LIGHT TYPE, AND WATTAGE.
- 2) LOCATIONS OF STORMDRAINS, WATERLINES, SEWERLINES, GAS LINES, AND OTHER UNDERGROUND UTILITIES ARE SHOWN IN THEIR APPROXIMATE LOCATIONS.
- 3) SIDEWALK MAY BE REQUIRED ON ONLY ONE SIDE.
- 4) FOR BICYCLE FACILITIES REFER TO APPENDIX F.
- 5) ON-STREET PARKING IS RESTRICTED TO ONE SIDE OF THE ROAD ONLY. ADD CITY STANDARD "NO PARKING-FIRE LANE" SIGNS TO OPPOSING SIDE. CONTACT FIRE MARSHAL'S OFFICE FOR DETAIL.

Intersection Typical Sections and Designs will be required with projects showing the placement and locations of right turn lanes, left turn lanes (possibly dual), sidewalks, landscaping and all utilities, including : streetlights, traffic control, water, sewer, gas, power, telephone, television, storm drainage, etc.

(N.T.S.)
REV. 03/19



SHOWN WITH TREES (40' TALL)

CITY OF VIRGINIA BEACH
STANDARD

30' TYPICAL SECTION FOR
NEW STREET IMPROVEMENTS IN
50' R/W

PUBLIC WORKS

A-10

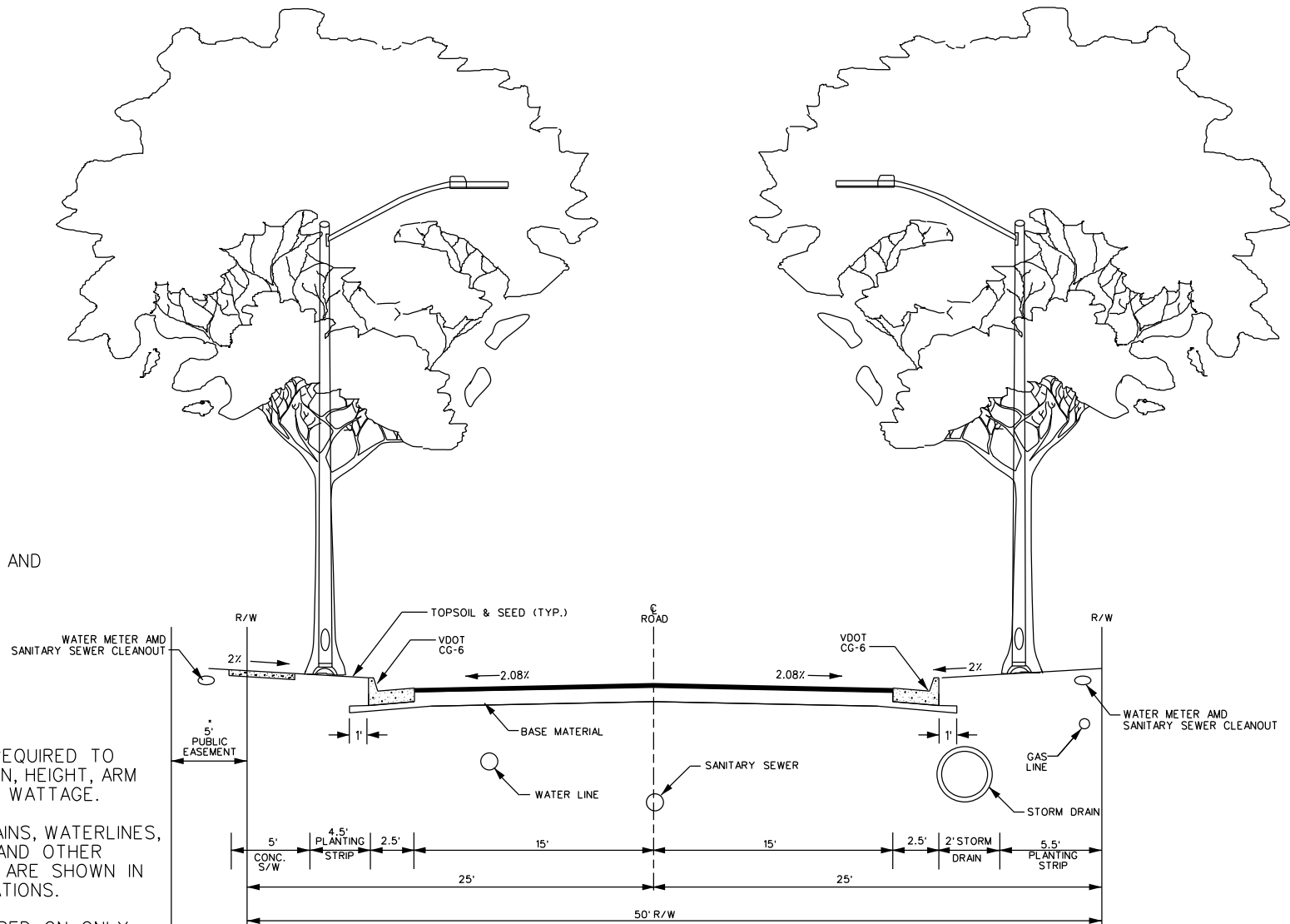
* DENOTES PUBLIC UTILITY AND PEDESTRIAN EASEMENT

NOTES:

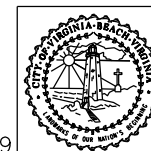
- 1) STREETLIGHT DESIGN IS REQUIRED TO DETERMINE POLE LOCATION, HEIGHT, ARM LENGTH, LIGHT TYPE, AND WATTAGE.
- 2) LOCATIONS OF STORMDRAINS, WATERLINES, SEWERLINES, GAS LINES, AND OTHER UNDERGROUND UTILITIES ARE SHOWN IN THEIR APPROXIMATE LOCATIONS.
- 3) SIDEWALK MAY BE REQUIRED ON ONLY ONE SIDE.
- 4) FOR BICYCLE FACILITIES REFER TO APPENDIX F.
- 5) ON-STREET PARKING IS ALLOWED ON BOTH SIDES OF THE ROAD.

Intersection Typical Sections and Designs will be required with projects showing the placement and locations of right turn lanes, left turn lanes (possibly dual), sidewalks, landscaping and all utilities, including : streetlights, traffic control, water, sewer, gas, power, telephone, television, storm drainage, etc.

(N.T.S.)
REV. 03/19



SHOWN WITH TREES (40' TALL)

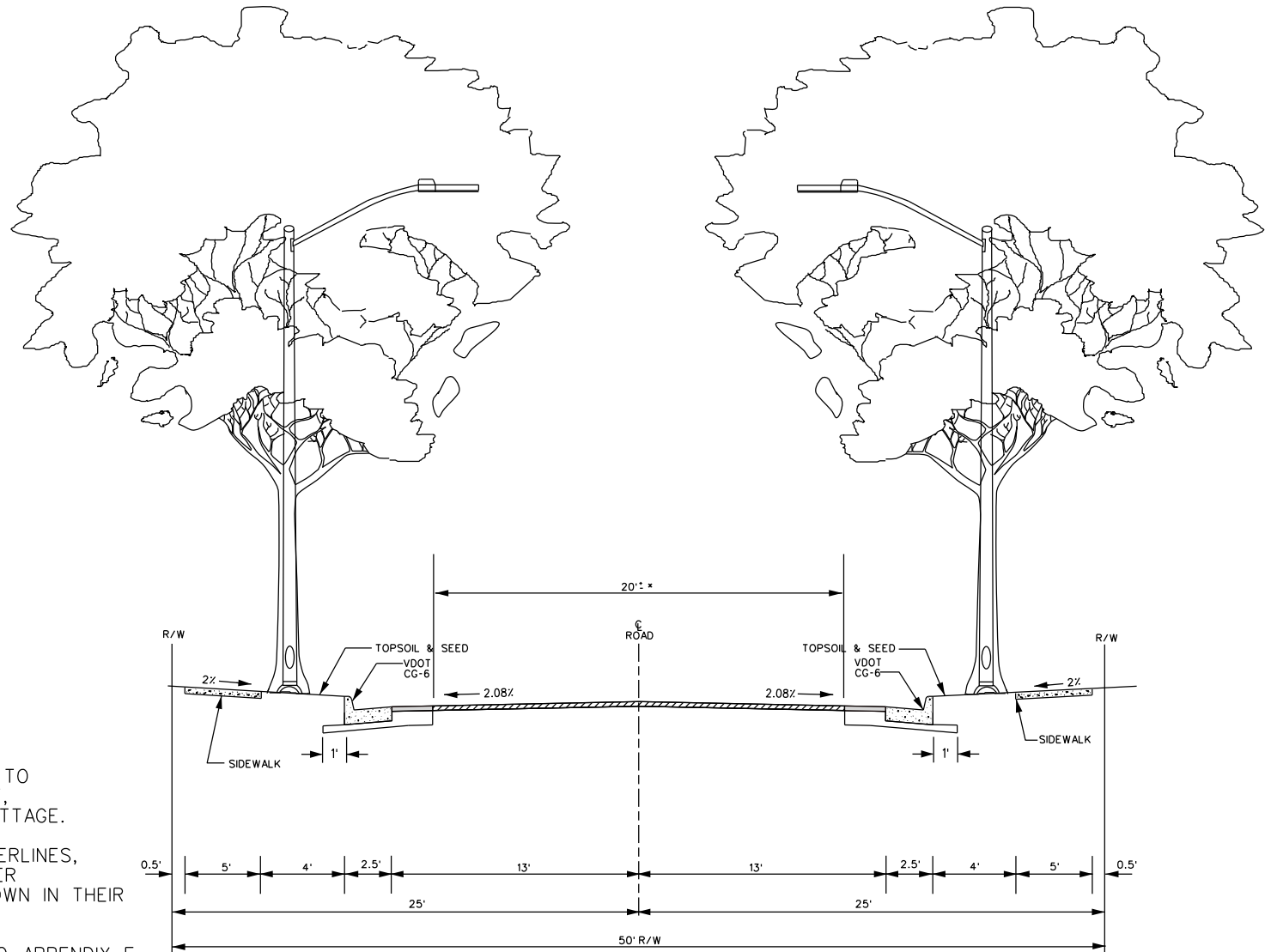


CITY OF VIRGINIA BEACH
STANDARD

34' TYPICAL SECTION FOR
NEW STREET IMPROVEMENTS IN
50' R/W

PUBLIC WORKS

A-II



NOTES:

- 1) STREETLIGHT DESIGN IS REQUIRED TO DETERMINE POLE LOCATION, HEIGHT, ARM LENGTH, LIGHT TYPE, AND WATTAGE.
- 2) LOCATIONS OF STORMDRAINS, WATERLINES, SEWERLINES, GAS LINES, AND OTHER UNDERGROUND UTILITIES ARE SHOWN IN THEIR APPROXIMATE LOCATIONS.
- 3) FOR BICYCLE FACILITIES REFER TO APPENDIX F.
- 4) ON-STREET PARKING IS RESTRICTED TO ONE SIDE OF THE ROAD ONLY. ADD CITY STANDARD "NO PARKING-FIRE LANE. CONTACT FIRE MARSHAL FOR DETAIL.

* HATCHED AREA DENOTES EXISTING PAVEMENT

Intersection Typical Sections and Designs will be required with projects showing the placement and locations of right turn lanes, left turn lanes (possibly dual), sidewalks, landscaping and all utilities, including : streetlights, traffic control, water, sewer, gas, power, telephone, television, storm drainage, etc.

(N.T.S.)
REV. 03/19



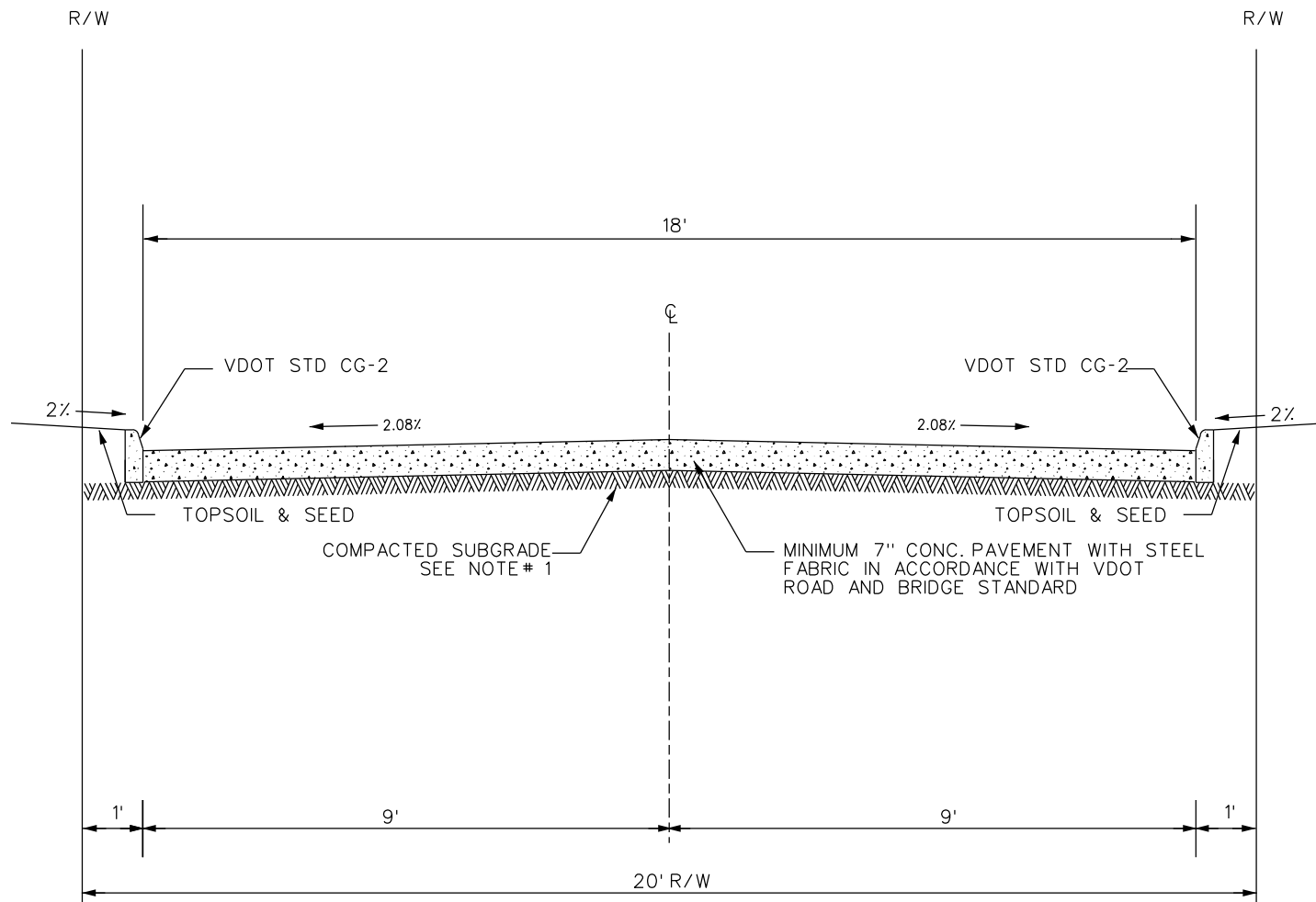
SHOWN WITH TREES (40' TALL)

CITY OF VIRGINIA BEACH
STANDARD

TYPICAL SECTION FOR
WIDENING EXISTING STREET
IN 50' R/W

PUBLIC WORKS

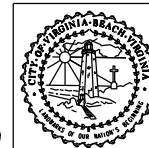
A-12



NOTE: 1. MIN. CBR VALUE 10 REQUIRED ON SUBGRADE

2. A PAVEMENT DESIGN IS REQUIRED IN ACCORDANCE
WITH CHAPTER 5 OF THE PUBLIC WORKS
DESIGN STANDARDS MANUAL.

(N.T.S.)
REV. 03/19

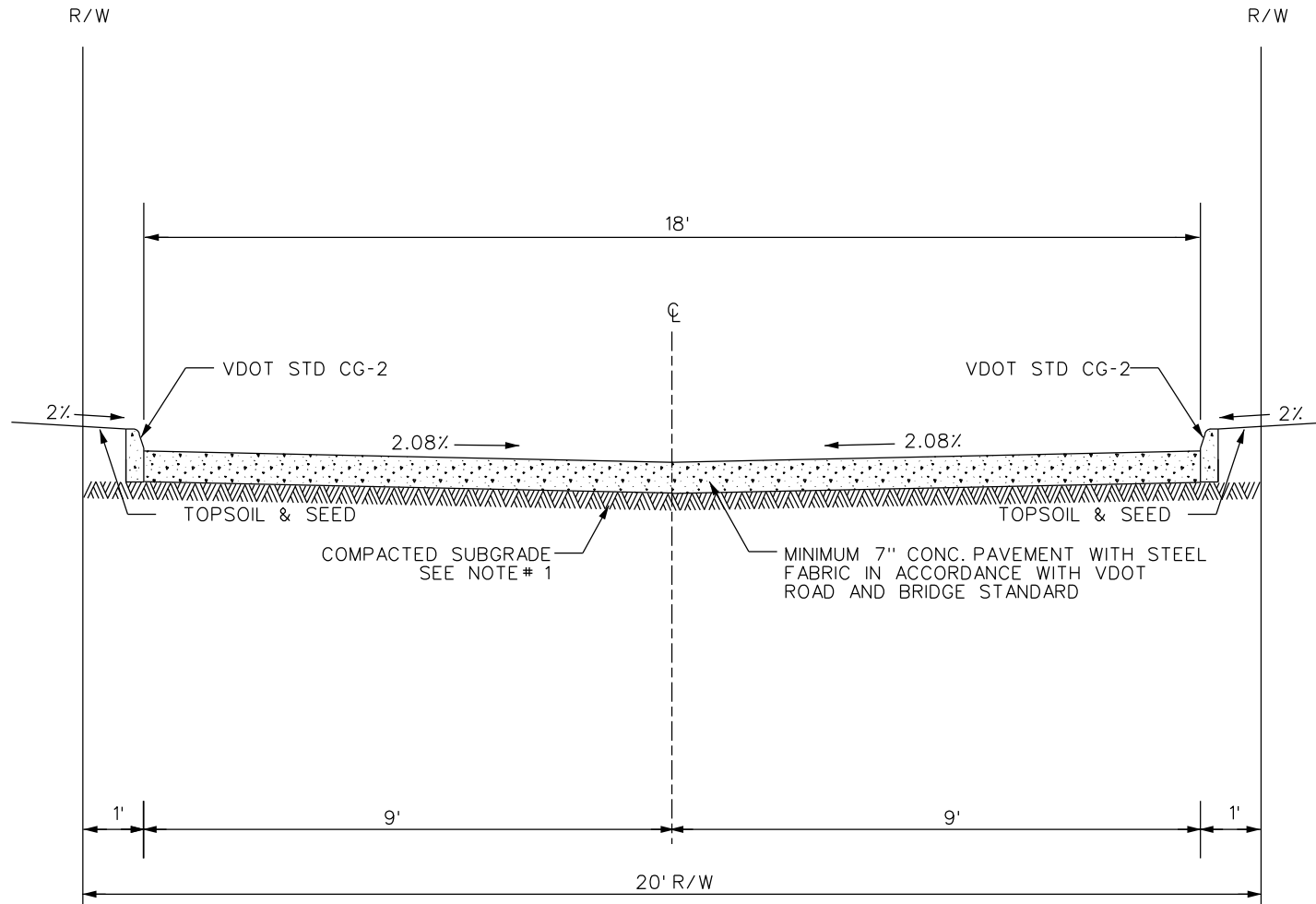


CITY OF VIRGINIA BEACH
STANDARD

TYPICAL SECTION FOR
ALLEY IN
20' R/W

PUBLIC WORKS

A-13



NOTE: 1. MIN. CBR VALUE 10 REQUIRED ON SUBGRADE

2. A PAVEMENT DESIGN IS REQUIRED IN ACCORDANCE WITH CHAPTER 5 OF THE PUBLIC WORKS DESIGN STANDARDS MANUAL.

(N.T.S.)
REV. 03/19

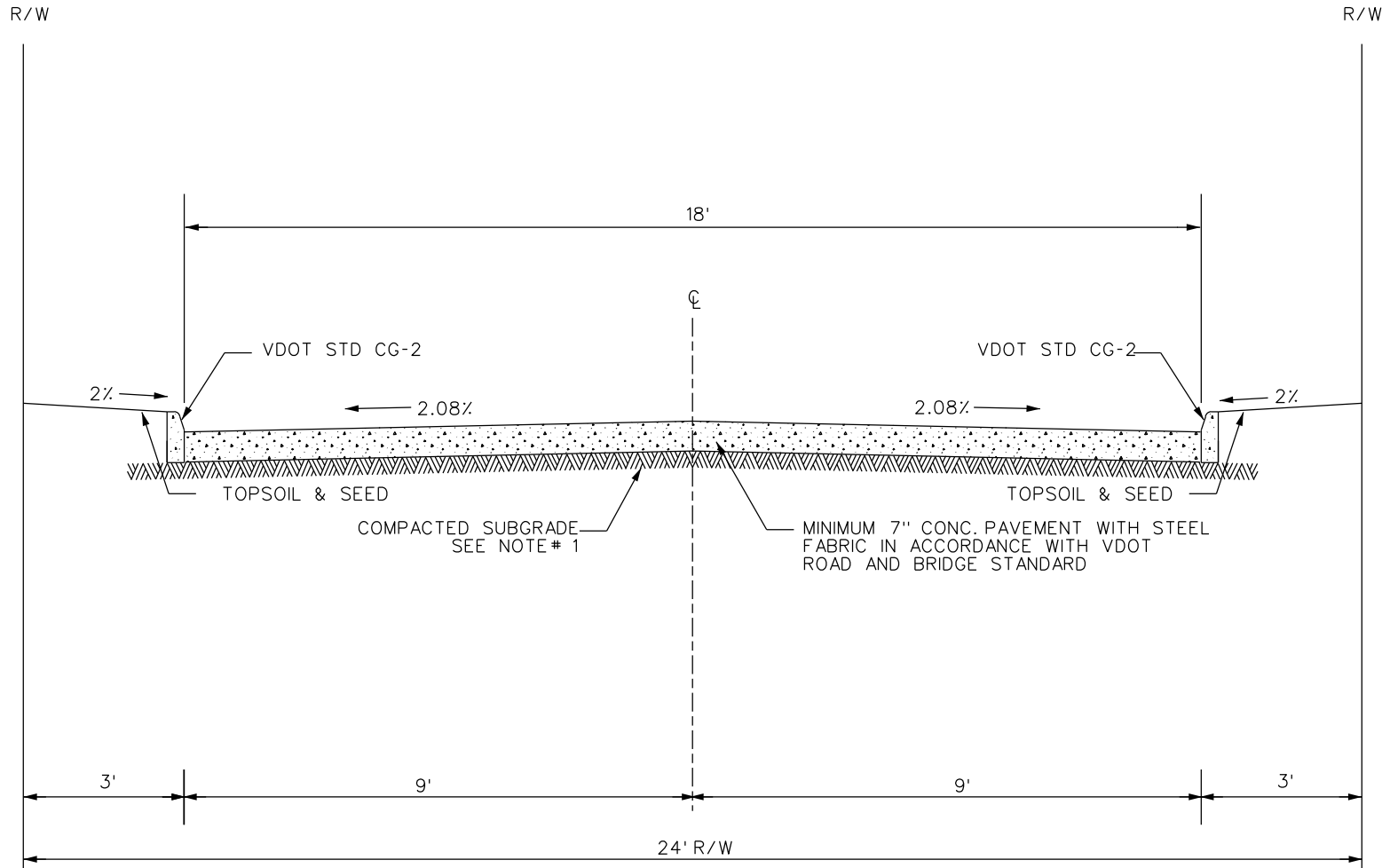


CITY OF VIRGINIA BEACH
STANDARD

TYPICAL SECTION FOR
ALLEY IN 20' R/W
INVERTED CROWN

PUBLIC WORKS

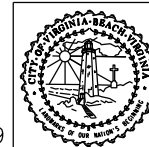
A-14



NOTE: 1. MIN. CBR VALUE 10 REQUIRED ON SUBGRADE

2. A PAVEMENT DESIGN IS REQUIRED IN ACCORDANCE
WITH CHAPTER 5 OF THE PUBLIC WORKS
DESIGN STANDARDS MANUAL.

(N.T.S.)
REV. 03/19

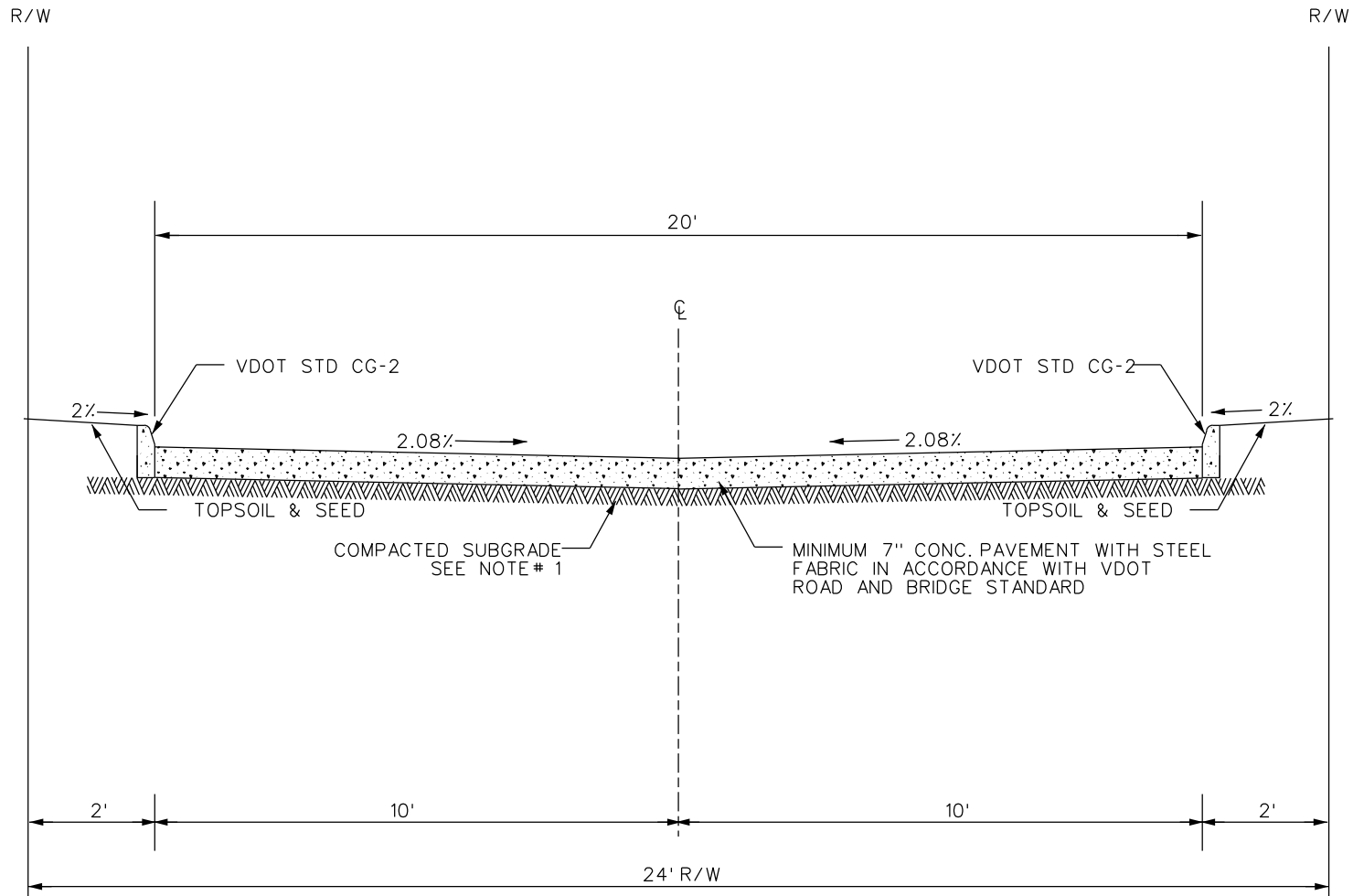


CITY OF VIRGINIA BEACH
STANDARD

TYPICAL SECTION FOR
ALLEY IN
24' R/W

PUBLIC WORKS

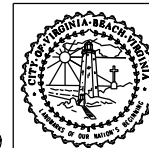
A-15



NOTE: 1. MIN. CBR VALUE 10 REQUIRED ON SUBGRADE

2. A PAVEMENT DESIGN IS REQUIRED IN ACCORDANCE WITH CHAPTER 5 OF THE PUBLIC WORKS DESIGN STANDARDS MANUAL.

(N.T.S.)
REV. 03/19

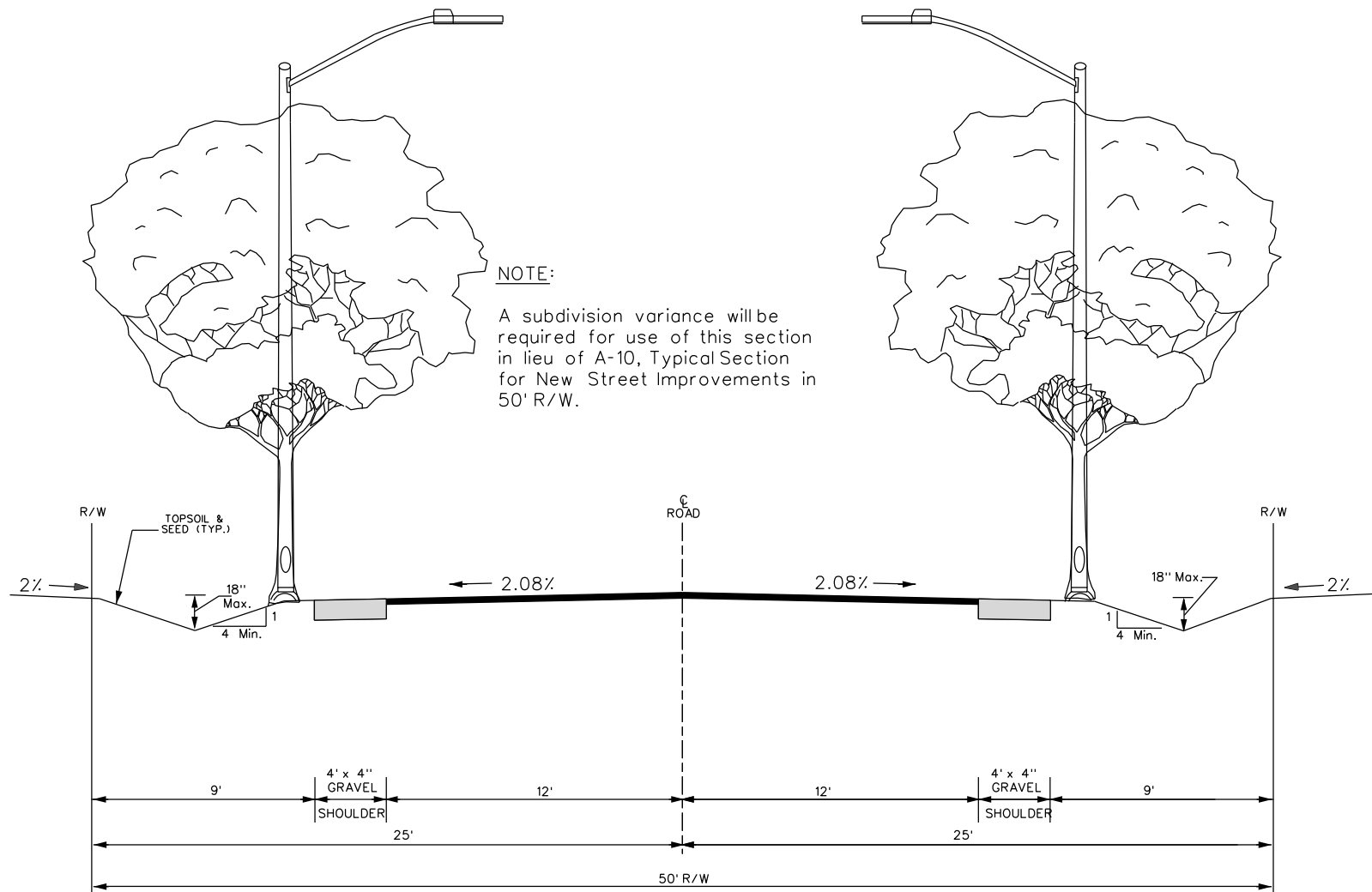


CITY OF VIRGINIA BEACH
STANDARD

TYPICAL SECTION FOR
ALLEY IN 24' R/W
INVERTED CROWN

PUBLIC WORKS

A-16



NOTES:

- 1) FOR BICYCLE FACILITIES REFER TO APPENDIX F.
- 2) DISTANCE FROM ROADWAY TO STREETLIGHTS, LANDSCAPING, DITCH, AND OTHER FIXED OBJECTS MUST MEET CLEAR ZONE REQUIREMENTS.

Intersection Typical Sections and Designs will be required with projects showing the placement and locations of right turn lanes, left turn lanes (possibly dual), sidewalks, landscaping and all utilities, including : streetlights, traffic control, water, sewer, gas, power, telephone, television, storm drainage, etc.

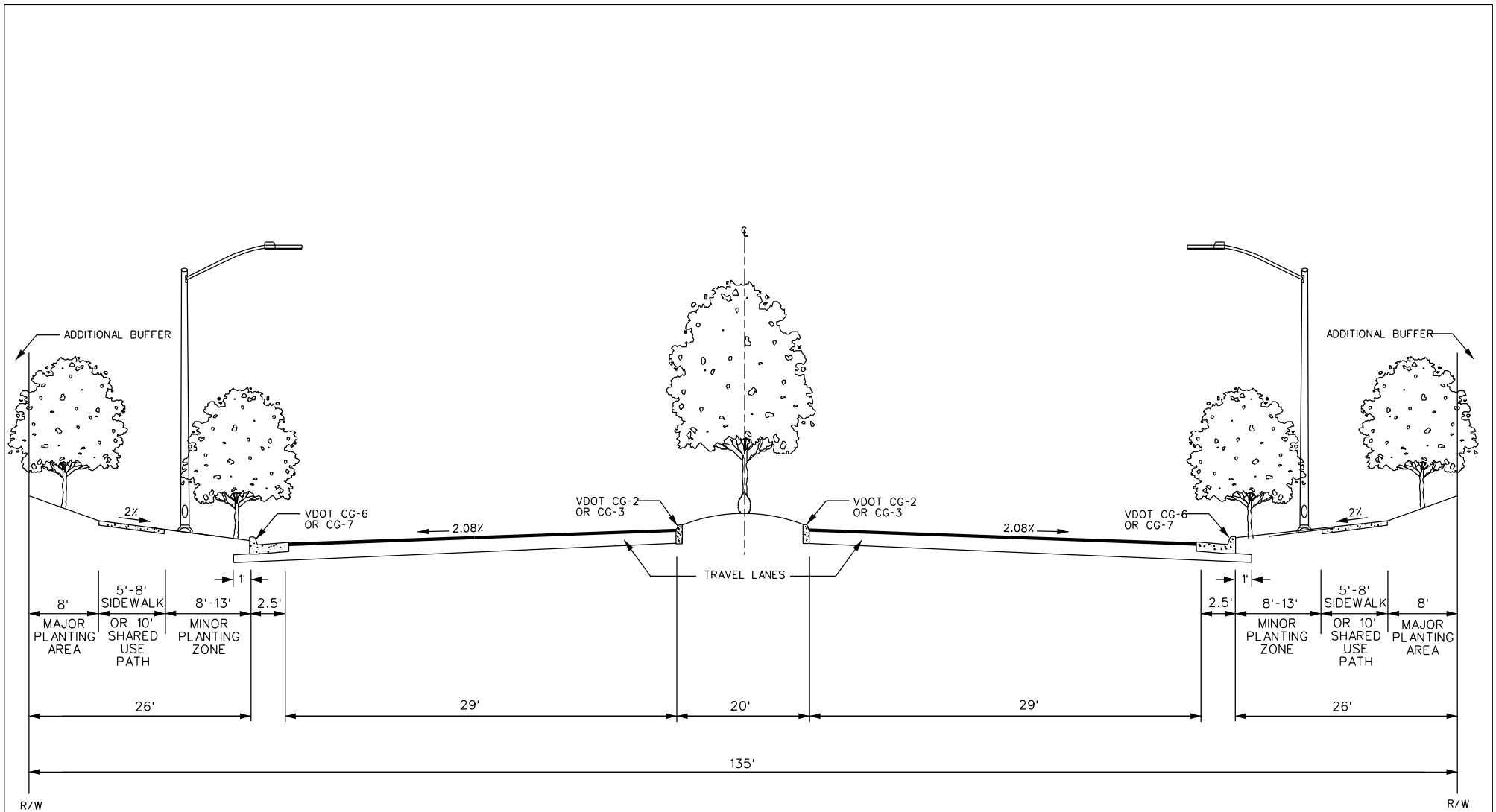
(N.T.S.)
REV. 03/19



CITY OF VIRGINIA BEACH
STANDARD
REDUCED TYPICAL SECTION FOR
50' RURAL NEW RESIDENTIAL
MINOR STREET

PUBLIC WORKS

A-17



NOTES:

- 1) ROADWAY DIMENSION BASED ON 12' TRAVEL LANES AND 4' BIKE LANE.
- 2) FOR BICYCLE FACILITIES REFER TO APPENDIX F.

(N.T.S.)
REV. 03/19

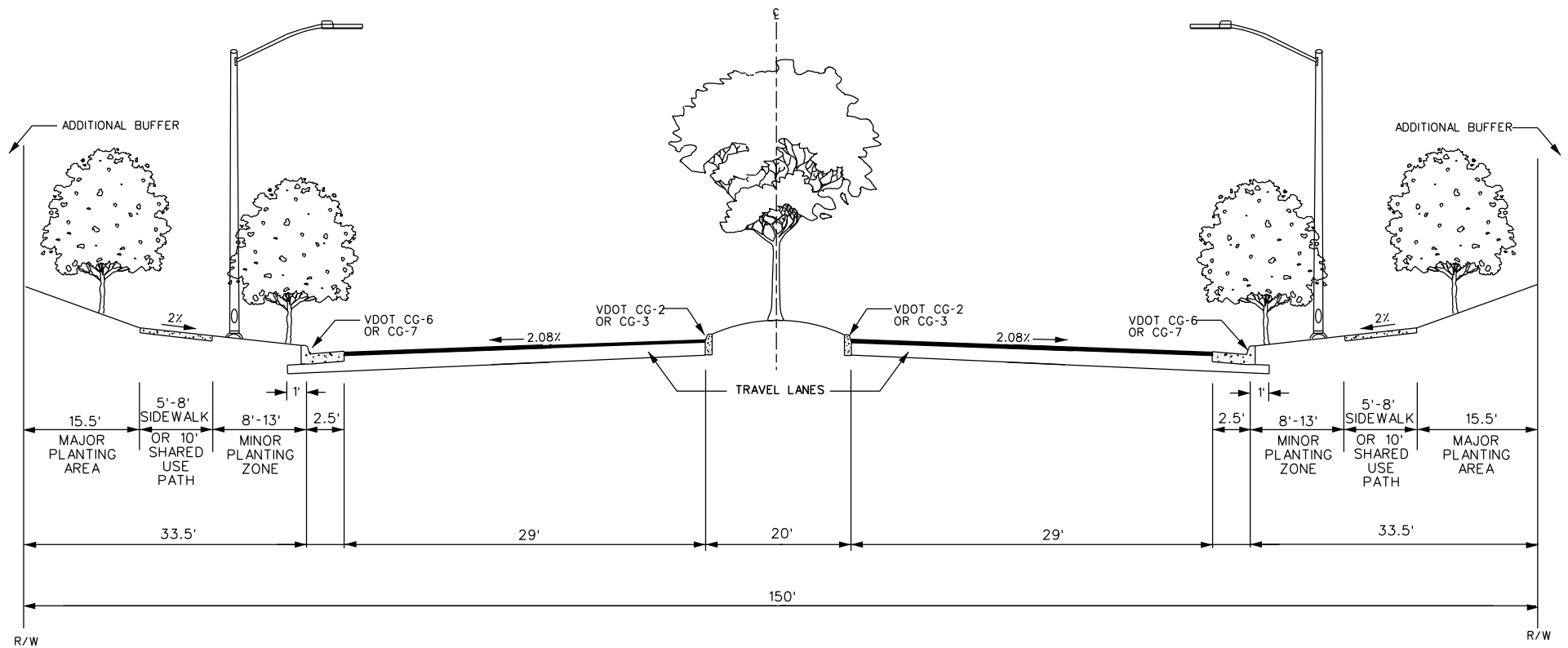


CITY OF VIRGINIA BEACH
STANDARD

TYPICAL SECTION FOR
FOUR-LANE PARKWAY (135' R/W)
IN TRANSITION AREA

PUBLIC WORKS

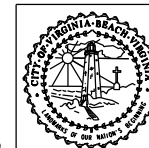
A-18



NOTES:

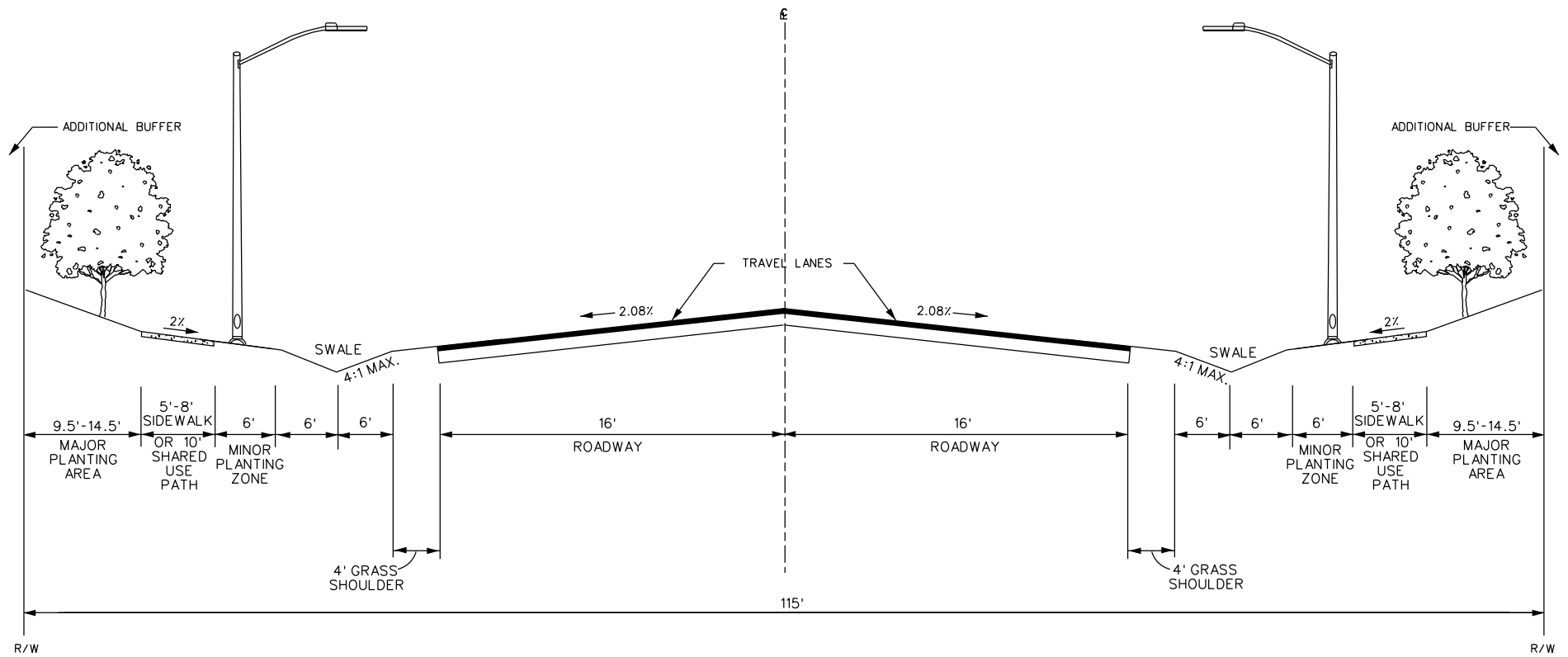
- 1) ROADWAY DIMENSION BASED ON 12' TRAVEL LANES AND 4' BIKE LANE.
- 2) FOR BICYCLE FACILITIES REFER TO APPENDIX F.

(N.T.S.)
REV. 03/19



CITY OF VIRGINIA BEACH
STANDARD
TYPICAL SECTION FOR
FOUR-LANE PARKWAY (150' R/W)
IN TRANSITION AREA
PUBLIC WORKS

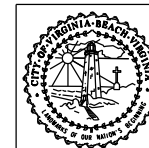
A-19



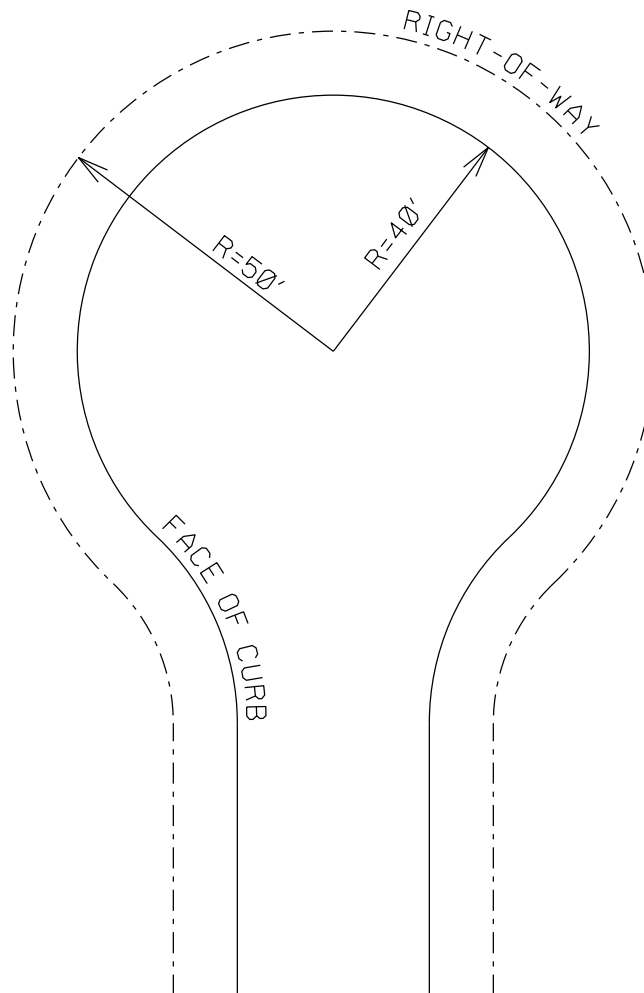
NOTES:

- 1) ROADWAY DIMENSION BASED ON 12' TRAVEL LANES AND 4' BIKE LANE.
- 2) FOR BICYCLE FACILITIES REFER TO APPENDIX F.

(N.T.S.)
REV. 03/19



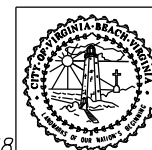
CITY OF VIRGINIA BEACH
STANDARD
TYPICAL SECTION FOR
TWO-LANE ROADWAY
IN TRANSITION AREA
PUBLIC WORKS A-20



NOTE:

ISLANDS WILL NOT BE ALLOWED
WITHIN A 40' RADIUS OR SMALLER
CUL-DE-SAC.

(N.T.S.)
REV. 07/18



CITY OF VIRGINIA BEACH
STANDARD

STANDARD CUL-DE-SAC

PUBLIC WORKS

A-21

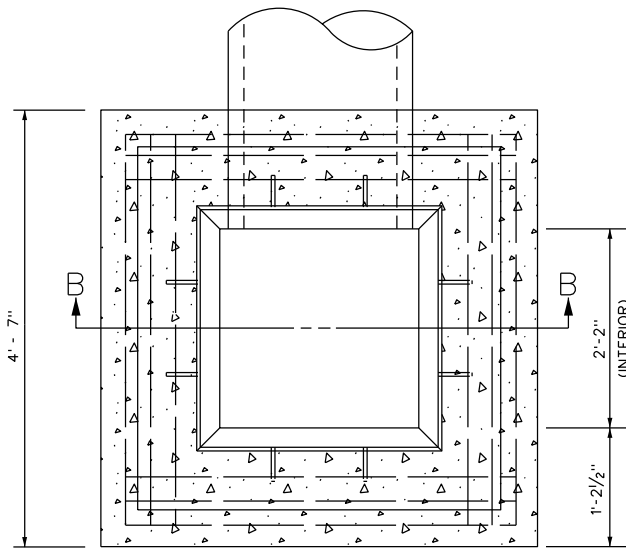


Appendix B

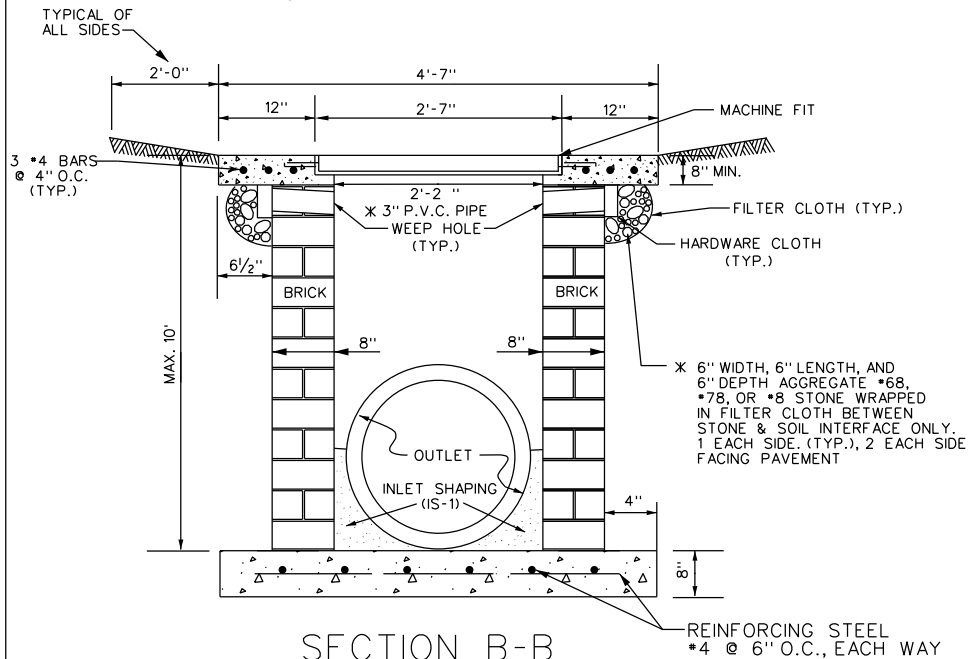
Storm Drainage Standard Drawings

B.1 Intent

The following standard drawings are intended to be an integral part of these standards. Any deviation from the standard must be reviewed by the City's engineer and approved prior to the installation of any modified section, structure, or standard.



PLAN
(GRATE REMOVED)



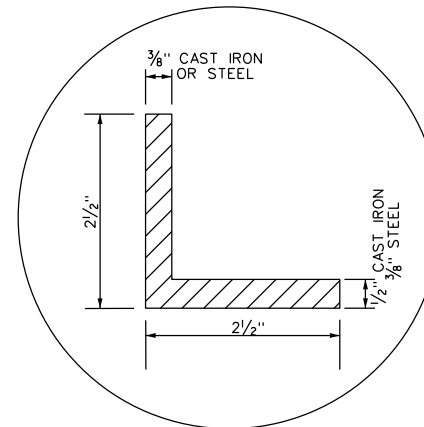
SECTION B-B

GENERAL SPECIFICATIONS

1. GRATE CASTINGS SHALL BE A GOOD GRADE OF GRAY IRON.
2. WALLS SHALL BE BRICK OR SOLID CONCRETE BLOCK. BRICK AND CONCRETE BLOCK SHALL CONFORM TO VDOT ROAD AND BRIDGE SPECIFICATIONS.
3. MORTAR SHALL BE MIXED, 1 PT. PORTLAND CEMENT TO 3 PT. CLEAN GRADED SAND. JOINTS SHALL BE FLUSHED FULL. INSIDE AND OUTSIDE OF ALL WALLS SHALL BE FULLY PLASTERED, 1/2" THICK (MIN.)
- * 4. WEEP HOLE WITH 12" X 12" PLASTIC HARDWARE CLOTH 1/4" MESH OR GALVANIZED STEEL WIRE, MINIMUM WIRE DIAMETER 0.03 INCH, NUMBER 4 MESH HARDWARE CLOTH ANCHORED FIRMLY.
5. TOP AND FRAMES SHALL BE SUFFICIENTLY TRUE TO A PLANE SURFACE SO THAT TOPS WILL NOT ROCK.
6. ALL REBAR SHALL HAVE A MINIMUM 1 1/2" COVER.
7. THIS ITEM MAY BE USED INSTEAD OF V.D.O.T. INLETS. SEE 8.6.1 "DRAINAGE STRUCTURES" IN SECTION 8 OF PUBLIC WORKS DESIGN STANDARDS MANUAL.
8. ALL DRAINAGE STRUCTURES WITHIN THE CITY RIGHT-OF-WAYS AND EASEMENTS OR ON CITY PROPERTY SHALL BE PRECAST OR CAST-IN-PLACE, UNLESS OTHERWISE APPROVED BY THE DEPARTMENT OF PUBLIC WORKS.

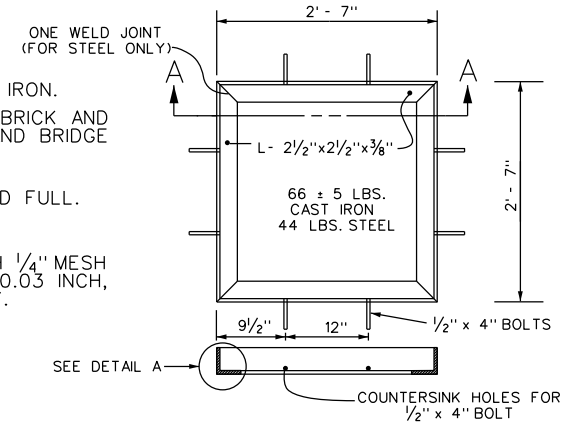
APPROX. QUANTITIES

0.505 CU. YDS. CONC.
171 BRICKS PER FT. IN HEIGHT, ABOVE PIPE.
155 BRICKS PER FT. IN HEIGHT, AT PIPE LEVEL

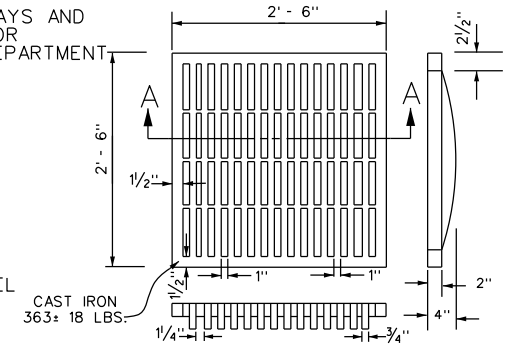


DETAIL A

(N.T.S.)
REV. 11/16



SECTION A-A COLLAR



SECTION A-A GRATE

GENERAL SPECIFICATION

1. CASTINGS SHALL CONFORM TO VDOT ROAD AND BRIDGE SPECIFICATIONS.
2. TEST BARS SHALL BE PROVIDED.
3. WEIGHT SHALL BE PAINTED ON FRAME AND COVER.
4. WEIGHT : FRAME-66 ± 5 LBS. CAST IRON
COVER-363 ± 18 LBS. CAST IRON
TOTAL-429 ± 23 LBS. CAST IRON



CITY OF VIRGINIA BEACH
STANDARD

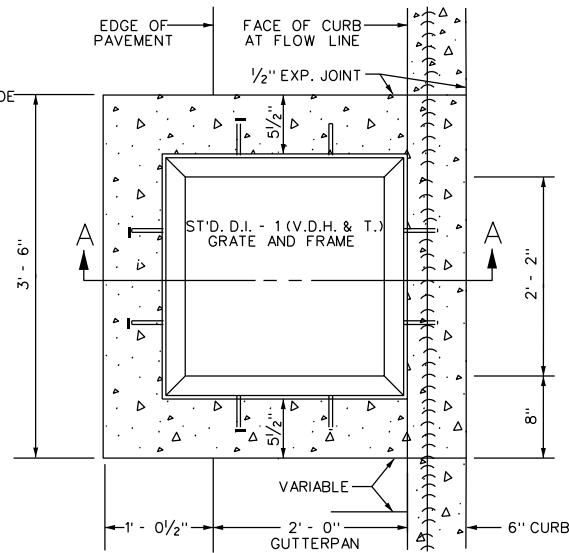
DROP INLET FOR PIPE
SIZES UP TO 24"

PUBLIC WORKS

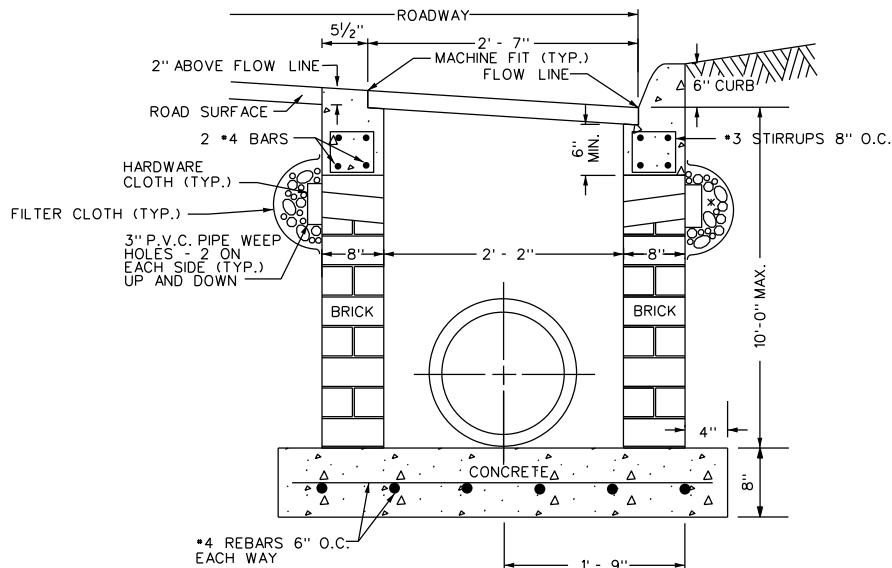
B-2

NOTE:

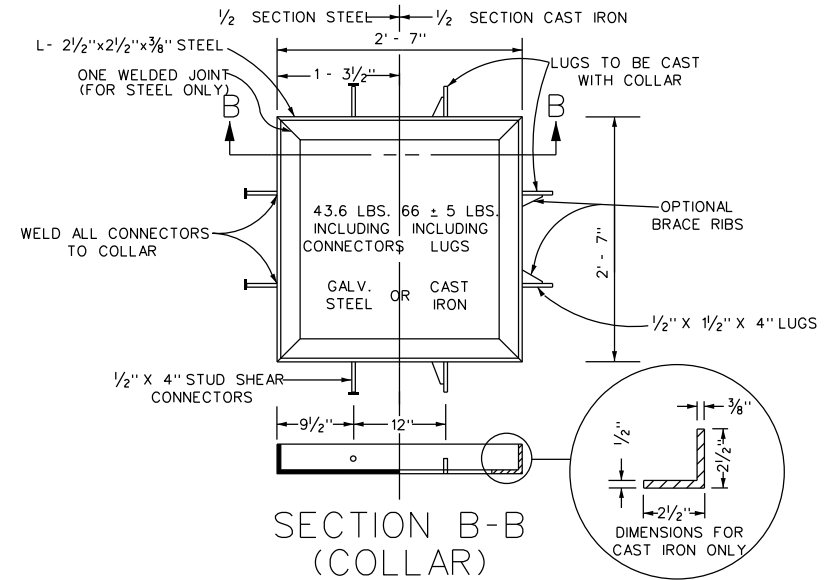
1. ALL REBAR SHALL HAVE A MINIMUM $\frac{1}{2}$ " COVER.
2. WEEP HOLES MADE OF 3" P.V.C. PIPE LOCATED AT THE TOP OF THE SUBGRADE AND ONE ON THE BOTTOM FACE OF THE STRUCTURE (EXCEPT FOR ANY WHICH HAS A PIPE) SHALL BE PROVIDED AS FOLLOWS: ONE ON THE TOP FACE OF THE STRUCTURE AND TWO ON ALL SIDES. WEEP HOLE WITH 12" X 12" PLASTIC HARDWARE CLOTH $\frac{1}{4}$ " MESH OR GALVANIZED STEEL WIRE, MINIMUM WIRE DIAMETER 0.03 INCH, #4 MESH HARDWARE CLOTH ANCHORED FIRMLY TO OUTSIDE OF STRUCTURE.
3. THIS ITEM MAY BE USED INSTEAD OF V.D.O.T. INLETS. SEE 8.6.1 "DRAINAGE STRUCTURES" IN SECTION 8 OF PUBLIC WORKS DESIGN STANDARDS MANUAL.



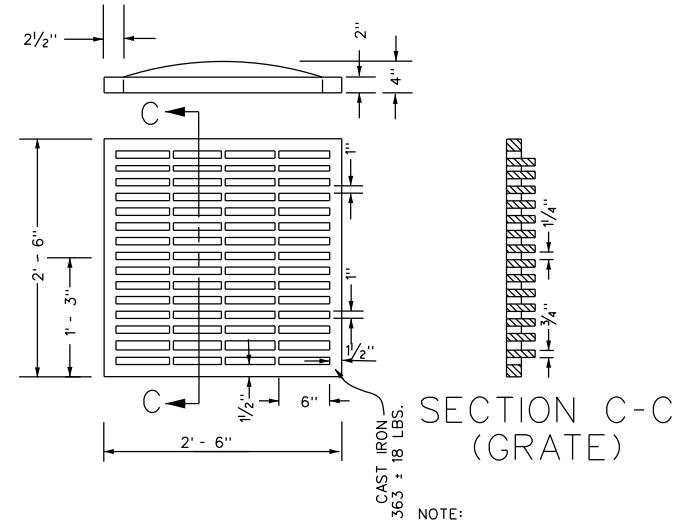
PLAN
(GRATE REMOVED)



SECTION A-A



SECTION B-B
(COLLAR)



SECTION C-C
(GRATE)

NOTE:

6" GRATE SLOTS TO BE PLACED PERPENDICULAR TO FACE OF CURB.



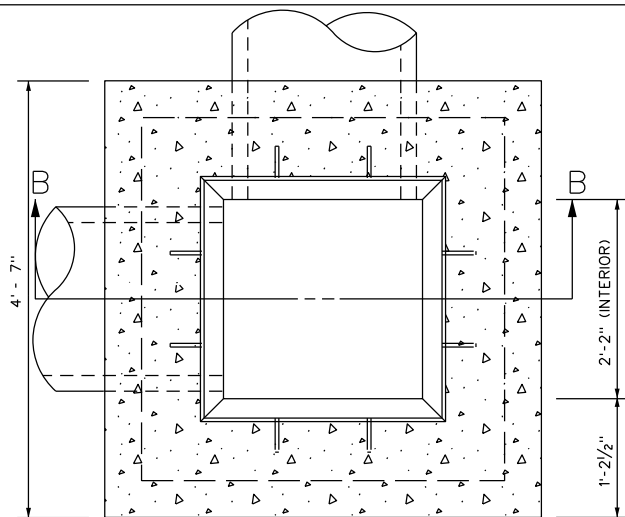
CITY OF VIRGINIA BEACH
STANDARD

GUTTER DROP INLET

PUBLIC WORKS

B-4

(N.T.S.)
REV. 11/16

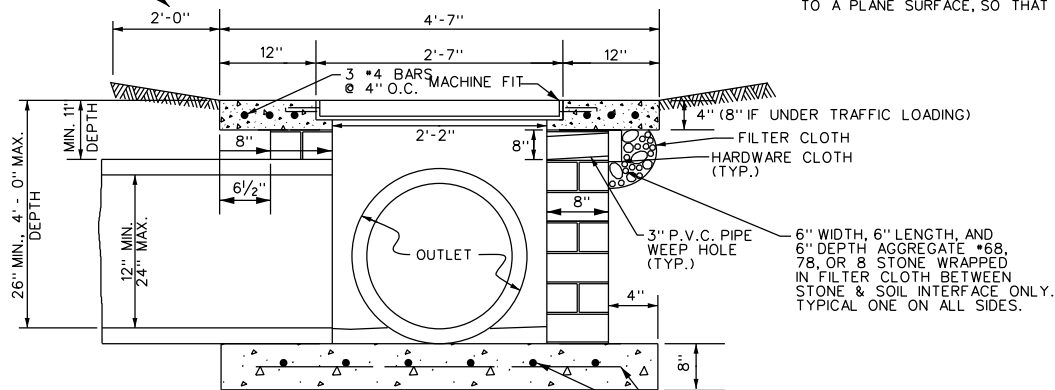


PLAN (GRATE REMOVED)

NOTES:

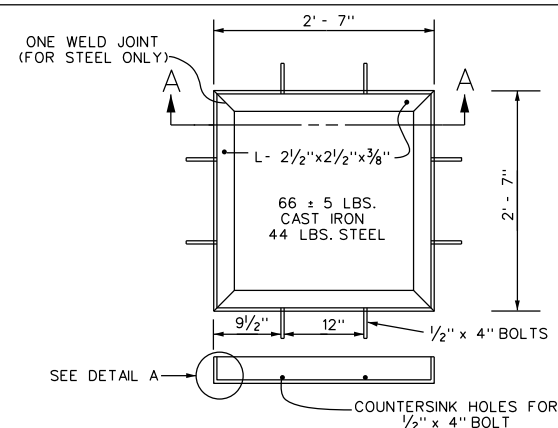
1. MAXIMUM DEPTH (H) TO BE 4'.
2. THE "H" DIMENSIONS SPECIFIED ON THE PLANS WILL BE MEASURED FROM THE INVERT OF THE OUTFALL PIPE TO THE TOP OF THE STRUCTURE. PLAN "H" DIMENSIONS ARE APPROXIMATE ONLY FOR ESTIMATING PURPOSES. THE ACTUAL DIMENSIONS SHALL BE DETERMINED BY THE CONTRACTOR FROM FIELD CONDITIONS.
3. WHEN SPECIFIED ON PLANS THE INVERT IS TO BE SHAPED IN ACCORDANCE WITH STANDARD PLAN V.D.O.T. IS-1. THE COST OF FURNISHING AND PLACING ALL MATERIALS INCIDENTAL TO THE SHAPING IS TO BE INCLUDED IN THE PRICE BID FOR THE DROP INLET COMPLETE.
4. ALL DRAINAGE STRUCTURES WITHIN THE CITY RIGHT-OF-WAYS AND EASEMENTS AND ON CITY PROPERTY SHALL BE PRECAST OR CAST-IN-PLACE, UNLESS OTHERWISE APPROVED BY THE DEPARTMENT OF PUBLIC WORKS.

TYPICAL OF ALL SIDES

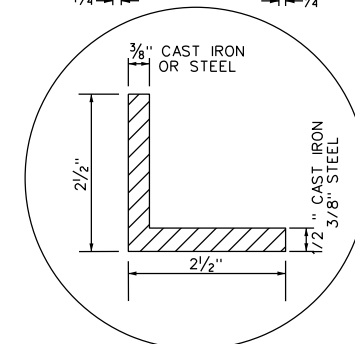
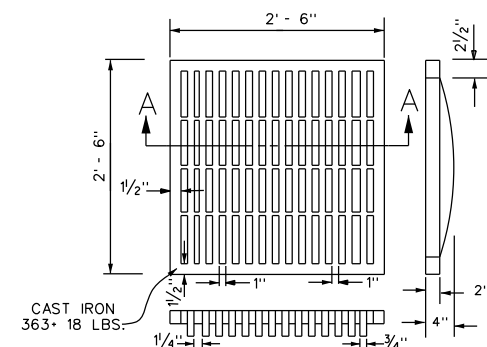


SECTION B-B

5. ALL CAST IN PLACE CONCRETE TO BE CLASS A3 3,000 P.S.I., CONCRETE WITH REBAR. PRECAST CONCRETE SHALL BE 4000 P.S.I. WITH REBAR.
6. #4 X 8" SMOOTH DOWELS @ APPROX. 12" C-C TO BE PLACED IN ALL AREAS ADJACENT TO ABUTING CONCRETE. KEYWAYS OR OTHER MEANS OF PREVENTING SETTLEMENT MAY BE SUBSTITUTED WHEN APPROVED BY THE ENGINEER.
7. WEEP HOLE WITH 12" X 12" PLASTIC HARDWARE CLOTH 1/4" MESH OR GALVANIZED STEEL WIRE, MINIMUM WIRE DIAMETER 0.03 INCH, NUMBER 4 MESH HARDWARE CLOTH ANCHORED FIRMLY TO OUTSIDE OF STRUCTURE. AT LEAST ONE WEEP HOLE SHALL BE PROVIDED ON ALL FOUR SIDES, AND TWO ON ANY SIDE FACING A PAVEMENT SECTION. THE NUMBER, THE DIMENSIONS AND THE LOCATIONS OF THE WEEP HOLES MAY BE MODIFIED TO COINCIDE WITH STANDARD V.D.O.T. PRECAST STRUCTURE SPECIFICATIONS. HOWEVER, WEEP HOLES SHALL BE PROVIDED IN ANY CASE ON ALL DRAINAGE STRUCTURES.
8. ANY ALTERNATE METHODS OF ANCHORAGE, MEETING THE APPROVAL OF THE ENGINEER, MAY BE SUBSTITUTED FOR THE CAST IRON LUGS AS SHOWN HEREON.
9. THIS ITEM MAY BE USED INSTEAD OF V.D.O.T. INLETS. SEE 8.6.1 "DRAINAGE STRUCTURES" IN SECTION 8 OF PUBLIC WORKS DESIGN STANDARDS MANUAL.
10. GENERAL SPECIFICATIONS:
 - A. CASTINGS SHALL CONFORM TO VDOT ROAD AND BRIDGE SPECIFICATIONS.
 - B. TEST BARS SHALL BE PROVIDED.
 - C. WEIGHT SHALL BE PAINTED ON FRAME AND COVER.
 - D. WEIGHT : FRAME-66 ± 5 LBS. CAST IRON
COVER-363 ± 18 LBS. CAST IRON
TOTAL-429 ± 23 LBS. CAST IRON
11. GRATE CASTINGS SHALL BE A GOOD GRADE OF GRAY IRON.
12. FOR PRIVATE DEVELOPMENT WALLS MAY BE BRICK, SOLID CONCRETE BLOCK, OR CLASS A-3 (3,000 P.S.I.) CONCRETE WITH REINFORCING STEEL. THIS ITEM MAY BE CAST IN PLACE OR PRECAST FOR PRIVATE DEVELOPMENT. MATERIAL SHALL CONFORM TO VDOT ROAD AND BRIDGE SPECIFICATIONS.
13. MORTAR SHALL BE MIXED, 1 OF PORTLAND CEMENT TO 3 OF CLEAN GRADED SAND. JOINTS SHALL BE FLUSHED FULL. INSIDE AND OUTSIDE OF ALL WALLS SHALL BE FULLY PLASTERED, 1/2" THICK (MIN.) OF 1:3 MORTAR.
14. TOPS AND FRAMES SHALL BE SUFFICIENTLY TRUE TO A PLANE SURFACE, SO THAT TOPS WILL NOT ROCK.



SECTION A-A COLLAR



DETAIL A



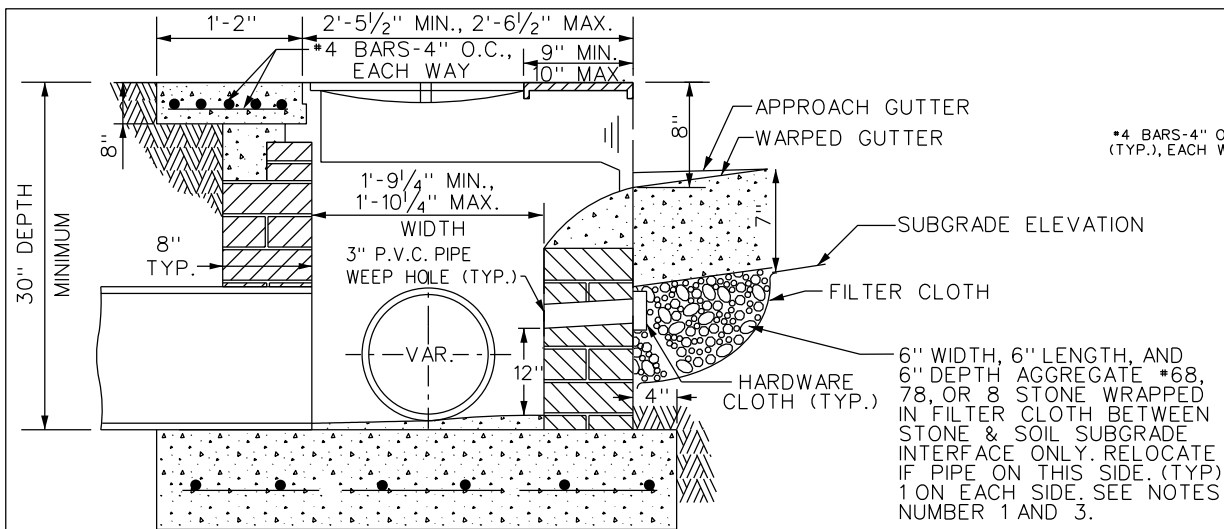
CITY OF VIRGINIA BEACH
STANDARD

STANDARD SHALLOW
DROP INLET

PUBLIC WORKS

B-5

(N.T.S.)
REV. 11/16



SECTION A-A

NOTES:

1. MAXIMUM DEPTH (H) TO BE 4'.
2. THE "H" DIMENSIONS SPECIFIED ON THE PLANS WILL BE MEASURED FROM THE INVERT OF THE OUTFALL PIPE TO THE TOP OF THE STRUCTURE. PLAN "H" DIMENSIONS ARE APPROXIMATE ONLY FOR ESTIMATING PURPOSES. THE ACTUAL DIMENSIONS SHALL BE DETERMINED BY THE CONTRACTOR FROM FIELD CONDITIONS.
3. WHEN SPECIFIED ON PLANS THE INVERT IS TO BE SHAPED IN ACCORDANCE WITH STANDARD PLAN V.D.O.T. IS-1. THE COST OF FURNISHING AND PLACING ALL MATERIALS INCIDENTAL TO THE SHAPING IS TO BE INCLUDED IN THE PRICE BID FOR THE DROP INLET COMPLETE.

4. ALL DRAINAGE STRUCTURES WITHIN THE CITY RIGHT-OF-WAYS AND EASEMENTS AND ON CITY PROPERTY SHALL BE PRECAST OR CAST-IN-PLACE, UNLESS OTHERWISE APPROVED BY THE DEPARTMENT OF PUBLIC WORKS.

5. ALL CAST IN PLACE CONCRETE TO BE CLASS A3 3,000 P.S.I., CONCRETE WITH REBAR. PRECAST CONCRETE SHALL BE 4000 P.S.I. WITH REBAR.

6. *4 X 8" SMOOTH DOWELS @ APPROX. 12" C-C TO BE PLACED IN ALL AREAS ADJACENT TO ABUTING CONCRETE. KEYWAYS OR OTHER MEANS OF PREVENTING SETTLEMENT MAY BE SUBSTITUTED WHEN APPROVED BY THE ENGINEER.

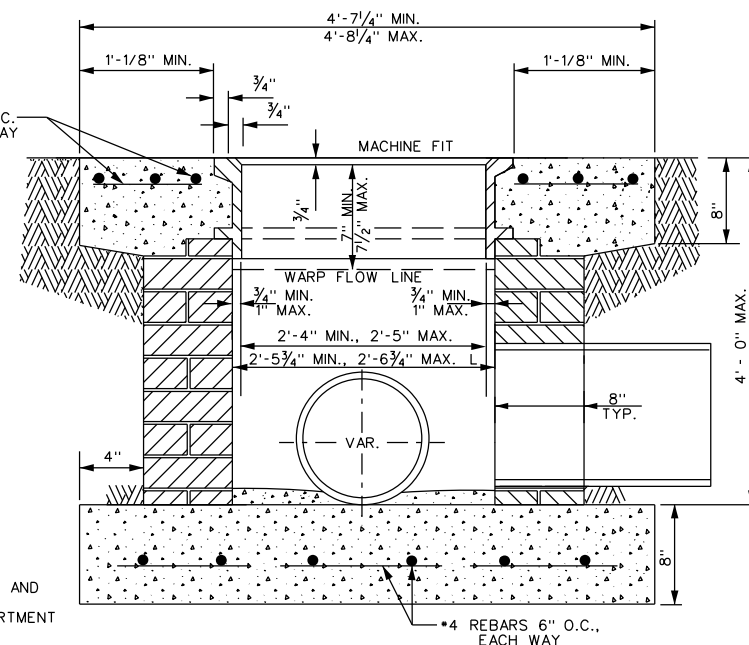
7. WEEP HOLE WITH 12" X 12" PLASTIC HARDWARE CLOTH 1/4" MESH OR GALVANIZED STEEL WIRE, MINIMUM WIRE DIAMETER 0.03 INCH, NUMBER 4 MESH. HARDWARE CLOTH ANCHORED FIRMLY TO OUTSIDE OF STRUCTURE. AT LEAST ONE WEEP HOLE SHALL BE PROVIDED ON ALL FOUR SIDES, AND TWO ON ANY SIDE FACING A PAVEMENT SECTION. THE NUMBER, THE DIMENSIONS AND THE LOCATIONS OF THE WEEP HOLES MAY BE MODIFIED TO COINCIDE WITH STANDARD V.D.O.T. PRECAST STRUCTURE SPECIFICATIONS, HOWEVER, WEEP HOLES SHALL BE PROVIDED IN ANY CASE ON ALL DRAINAGE STRUCTURES.

8. ANY ALTERNATE METHODS OF ANCHORAGE, MEETING THE APPROVAL OF THE ENGINEER, MAY BE SUBSTITUTED FOR THE CAST IRON LUGS AS SHOWN HEREON.

9. THIS ITEM MAY BE USED INSTEAD OF V.D.O.T. INLETS. SEE 8.6.1 "DRAINAGE STRUCTURES" IN SECTION 8 OF PUBLIC WORKS DESIGN STANDARDS MANUAL.

10. GENERAL SPECIFICATIONS:

- A. GRAY IRON CASTINGS SHALL CONFORM TO VDOT ROAD AND BRIDGE SPECIFICATIONS
- B. TEST BARS SHALL BE PROVIDED
- C. WEIGHT SHALL BE PAINTED ON FRAME AND COVER
- D. WEIGHT: FRAME - 210 +/- 20 LBS.
COVER - 110 +/- 10 LBS.
TOTAL - 320 +/- 30 LBS.



SECTION B-B

11. CASTINGS SHALL BE A GOOD GRADE OF GRAY IRON.

12. FOR PRIVATE DEVELOPMENT WALLS MAY BE BRICK, SOLID CONCRETE BLOCK, OR CLASS A-3 (3,000 P.S.I.) CONCRETE WITH REINFORCING STEEL. THIS ITEM MAY BE CAST IN PLACE OR PRECAST FOR PRIVATE DEVELOPMENT. MATERIAL SHALL CONFORM TO VDOT ROAD AND BRIDGE SPECIFICATIONS.

13. MORTAR SHALL BE MIXED, 1 OF PORTLAND CEMENT TO 3 OF CLEAN GRADED SAND. JOINTS SHALL BE FLUSHED FULL. INSIDE AND OUTSIDE OF ALL WALLS SHALL BE FULLY PLASTERED, 1/2" THICK (MIN.) OF 1:3 MORTAR.

14. CAST IRON TOPS AND FRAMES SHALL BE SUFFICIENTLY TRUE TO A PLANE SURFACE, SO THAT TOPS WILL NOT ROCK.

THIS DETAIL TO BE USED WHEN ST'D CITY OR V.D.O.T. INLETS CANNOT BE USED.



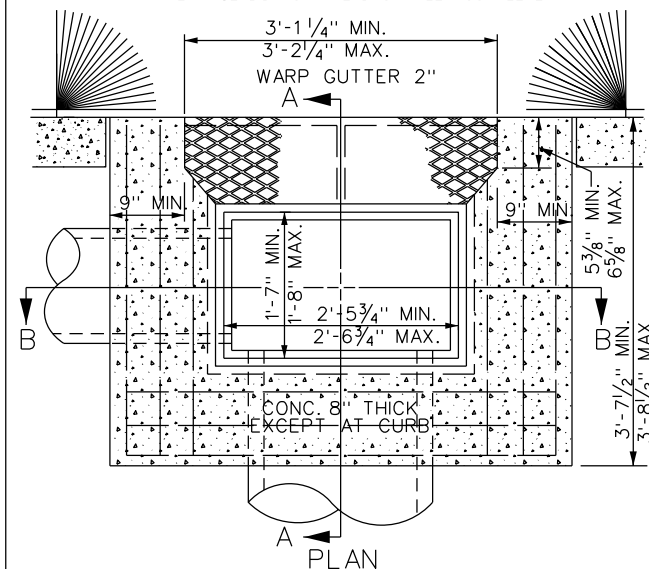
CITY OF VIRGINIA BEACH
STANDARD

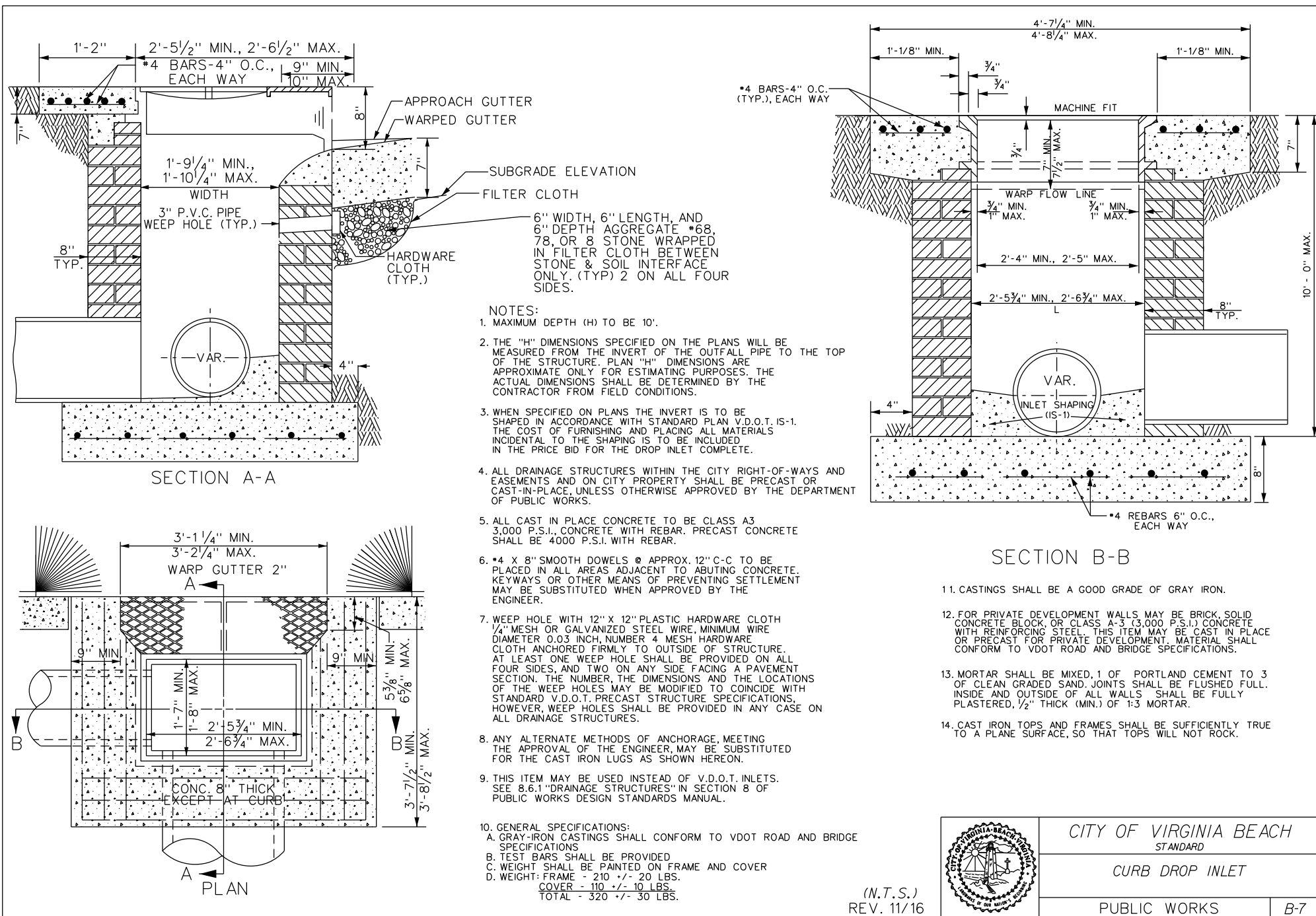
STANDARD SHALLOW
CURB DROP INLET

PUBLIC WORKS

B-6

(N.T.S.)
REV. 11/16



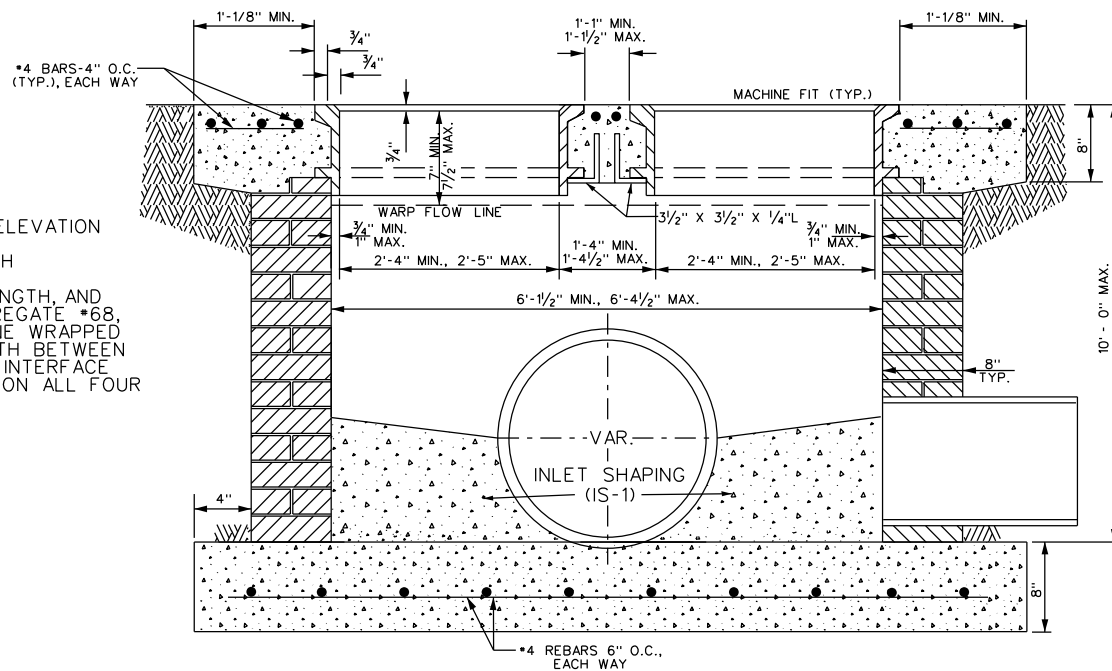
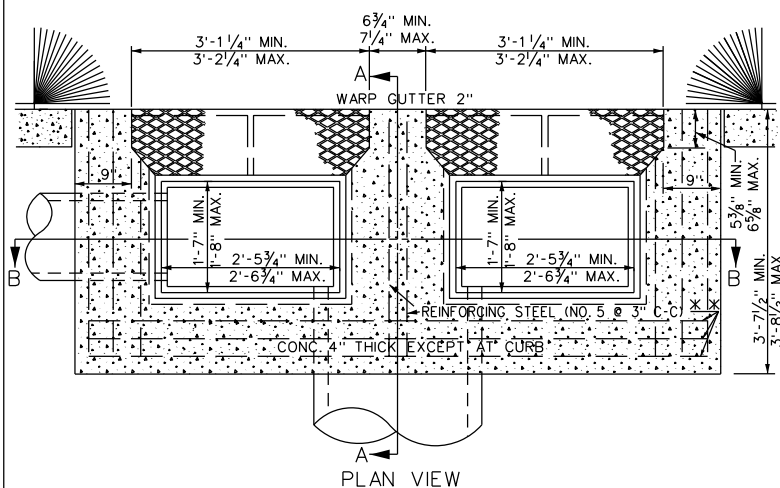




SECTION A-A

NOTES:

1. MAXIMUM DEPTH (H) TO BE 10'.
2. THE "H" DIMENSIONS SPECIFIED ON THE PLANS WILL BE MEASURED FROM THE INVERT OF THE OUTFALL PIPE TO THE TOP OF THE STRUCTURE. PLAN "H" DIMENSIONS ARE APPROXIMATE ONLY FOR ESTIMATING PURPOSES. THE ACTUAL DIMENSIONS SHALL BE DETERMINED BY THE CONTRACTOR FROM FIELD CONDITIONS.



SECTION B-B

5. WHEN SPECIFIED ON PLANS THE INVERT IS TO BE SHAPED IN ACCORDANCE WITH STANDARD PLAN V.D.O.T. IS-1. THE COST OF FURNISHING AND PLACING ALL MATERIALS INCIDENTAL TO THE SHAPING IS TO BE INCLUDED IN THE PRICE BID FOR THE DROP INLET COMPLETE.
4. ALL DRAINAGE STRUCTURES WITHIN THE CITY RIGHT-OF-WAYS AND EASEMENTS AND ON CITY PROPERTY SHALL BE PRECAST OR CAST-IN-PLACE, UNLESS OTHERWISE APPROVED BY THE DEPARTMENT OF PUBLIC WORKS.
5. ALL CAST IN PLACE CONCRETE TO BE CLASS A3 3,000 P.S.I., CONCRETE WITH REBAR. PRECAST CONCRETE SHALL BE 4000 P.S.I. WITH REBAR.
6. *4" X 8" SMOOTH DOWELS @ APPROX. 12" C-C TO BE PLACED IN ALL AREAS ADJACENT TO ABUTING CONCRETE. KEYWAYS OR OTHER MEANS OF PREVENTING SETTLEMENT MAY BE SUBSTITUTED WHEN APPROVED BY THE ENGINEER.
7. WEEP HOLE WITH 12" X 12" PLASTIC HARDWARE CLOTH 1/4" MESH OR GALVANIZED STEEL WIRE, MINIMUM WIRE DIAMETER 0.03 INCH, NUMBER 4 MESH HARDWARE CLOTH ANCHORED FIRMLY TO OUTSIDE OF STRUCTURE. AT LEAST ONE WEEP HOLE SHALL BE PROVIDED ON ALL FOUR SIDES, AND TWO ON ANY SIDE FACING A PAVEMENT SECTION. THE NUMBER, THE DIMENSIONS AND THE LOCATIONS OF THE WEEP HOLES MAY BE MODIFIED TO COINCIDE WITH STANDARD V.D.O.T. PRECAST STRUCTURE SPECIFICATIONS. HOWEVER, WEEP HOLES SHALL BE PROVIDED IN ANY CASE ON ALL DRAINAGE STRUCTURES.
8. ANY ALTERNATE METHODS OF ANCHORAGE, MEETING THE APPROVAL OF THE ENGINEER, MAY BE SUBSTITUTED FOR THE CAST IRON LUGS AS SHOWN HEREON.
9. THIS ITEM MAY BE USED INSTEAD OF V.D.O.T. INLETS. SEE 8.6.1 "DRAINAGE STRUCTURES" IN SECTION 8 OF PUBLIC WORKS DESIGN STANDARDS MANUAL.

* * A COMMON WALL WITH A BUILT-IN ARCH
OR A SHORT PIECE OF PIPE BUILT INTO THE
WALL IS ALSO ACCEPTABLE.

(N.T.S.)
REV. 11/16

10. GENERAL SPECIFICATIONS:
- A. GRAY-IRON CASTINGS SHALL CONFORM TO VDOT ROAD AND BRIDGE SPECIFICATIONS
 - B. TEST BARS SHALL BE PROVIDED
 - C. WEIGHT SHALL BE PAINTED ON FRAME AND COVER
 - D. WEIGHT: FRAME - 210 +/- 20 LBS.
COVER - 110 +/- 10 LBS.
TOTAL - 320 +/- 30 LBS.
11. CASTINGS SHALL BE A GOOD GRADE OF GRAY IRON.
12. FOR PRIVATE DEVELOPMENT WALLS MAY BE BRICK, SOLID CONCRETE BLOCK, OR CLASS A-3 (3,000 P.S.I.) CONCRETE WITH REINFORCING STEEL. THIS ITEM MAY BE CAST IN PLACE OR PRECAST FOR PRIVATE DEVELOPMENT. MATERIAL SHALL CONFORM TO VDOT ROAD AND BRIDGE SPECIFICATIONS.
13. MORTAR SHALL BE MIXED, 1 OF PORTLAND CEMENT TO 3 OF CLEAN GRADED SAND. JOINTS SHALL BE FLUSHED FULL. INSIDE AND OUTSIDE OF ALL WALLS SHALL BE FULLY PLASTERED, 1/2" THICK (MIN.) OF 1:3 MORTAR.
14. CAST IRON TOPS AND FRAMES SHALL BE SUFFICIENTLY TRUE TO A PLANE SURFACE, SO THAT TOPS WILL NOT ROCK.
15. FOR TRIPLE AND QUADRUPLE CURB DROP INLETS APPLY DIMENSION DIFFERENCES BETWEEN SINGLE AND DOUBLE CURB DROP INLETS. A CONSTRUCTION DETAIL SHALL BE INCLUDED IN THE PLANS SUBMITTED FOR REVIEW.



CITY OF VIRGINIA BEACH
STANDARD

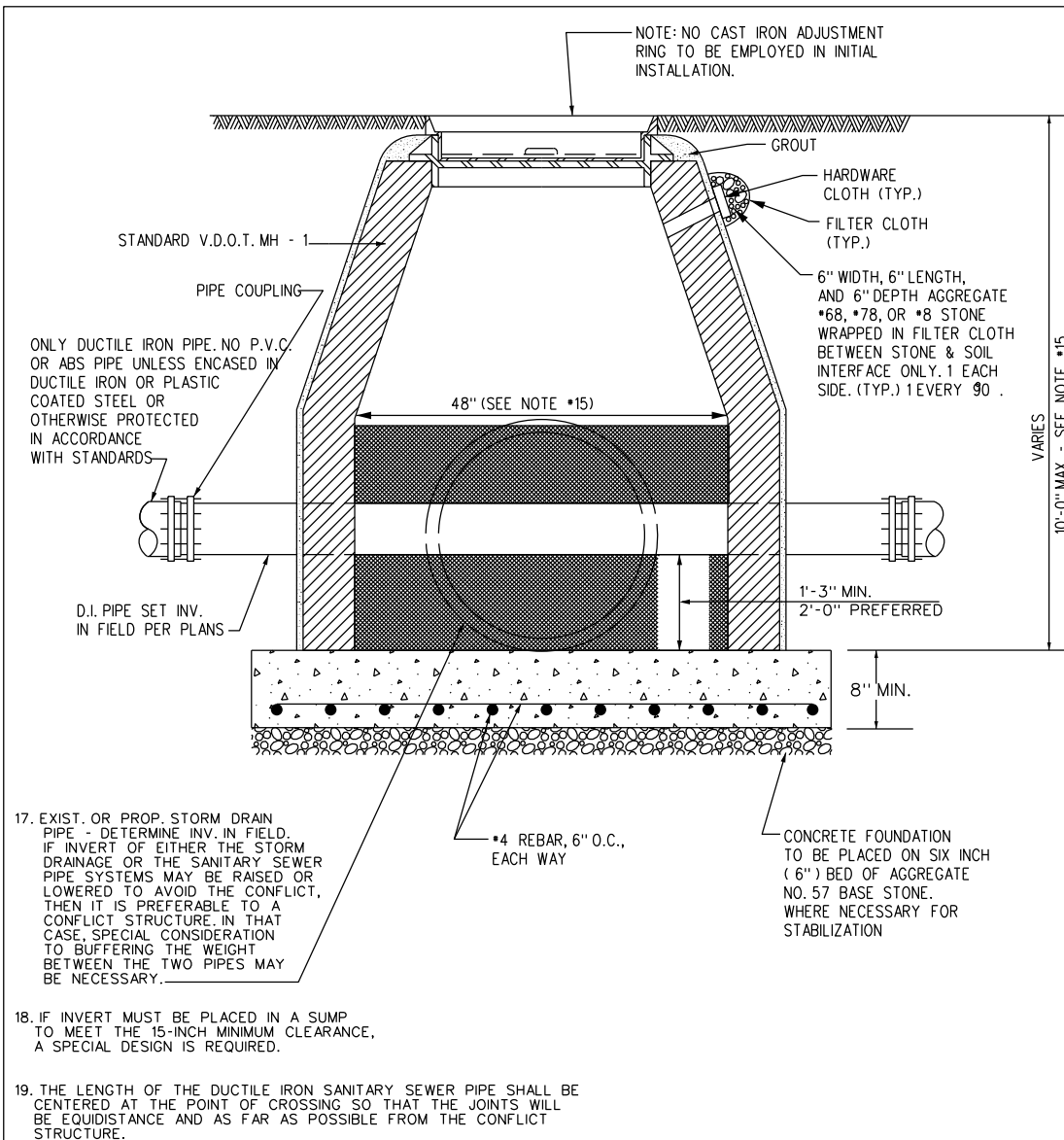
DOUBLE CURB DROP INLET

PUBLIC WORKS

B-8



(N.T.S.)
REV. 11/16



NOTES:

1. MAXIMUM DEPTH (H) TO BE 10'.
2. THE "H" DIMENSIONS SHOWN ON THE STANDARDS AND SPECIFIED ON THE PLANS WILL BE MEASURED FROM THE INVERT OF THE OUTFALL PIPE. PLAN "H" DIMENSIONS ARE APPROXIMATE ONLY FOR ESTIMATING PURPOSES AND THE ACTUAL DIMENSIONS SHALL BE DETERMINED BY THE CONTRACTOR FROM FIELD CONDITIONS.
3. WHEN SPECIFIED ON PLANS THE INVERT IS TO BE SHAPED IN ACCORDANCE WITH STANDARD PLAN V.D.O.T. IS-1. THE COST OF FURNISHING AND PLACING ALL MATERIALS INCIDENTAL TO THE SHAPING IS TO BE INCLUDED IN THE PRICE BID FOR THE DROP INLET COMPLETE.
4. ALL DRAINAGE STRUCTURES WITHIN THE CITY RIGHT-OF-WAYS AND EASEMENTS AND ON CITY PROPERTY SHALL BE PRECAST OR CAST-IN-PLACE, UNLESS OTHERWISE APPROVED BY THE DEPARTMENT OF PUBLIC WORKS.
5. ALL CAST IN PLACE CONCRETE TO BE CLASS A3 3,000 P.S.I., CONCRETE WITH REBAR. PRECAST CONCRETE SHALL BE 4000 P.S.I. WITH REBAR.
6. *4 X 8" SMOOTH DOWELS @ APPROX. 12" C-C TO BE PLACED IN ALL AREAS ADJACENT TO ABUTTING CONCRETE. KEYWAYS OR OTHER MEANS OF PREVENTING SETTLEMENT MAY BE SUBSTITUTED WHEN APPROVED BY THE ENGINEER.
7. WEEP HOLE WITH 12" X 12" PLASTIC HARDWARE CLOTH 1/4" MESH OR GALVANIZED STEEL WIRE, MINIMUM WIRE DIAMETER 0.03 INCH, NUMBER 4 MESH HARDWARE CLOTH ANCHORED FIRMLY TO OUTSIDE OF STRUCTURE. AT LEAST ONE WEEP HOLE SHALL BE PROVIDED ON ALL FOUR SIDES, AND TWO ON ANY SIDE FACING A PAVEMENT SECTION. THE NUMBER, THE DIMENSIONS AND THE LOCATIONS OF THE WEEP HOLES MAY BE MODIFIED TO COINCIDE WITH STANDARD V.D.O.T. PRECAST STRUCTURE SPECIFICATIONS, HOWEVER, WEEP HOLES SHALL BE PROVIDED IN ANY CASE ON ALL DRAINAGE STRUCTURES.
8. ANY ALTERNATE METHODS OF ANCHORAGE, MEETING THE APPROVAL OF THE ENGINEER, MAY BE SUBSTITUTED FOR THE CAST IRON LUGS AS SHOWN HEREON.
9. THIS ITEM MAY BE USED INSTEAD OF V.D.O.T. INLETS. SEE 8.6.1 "DRAINAGE STRUCTURES" IN SECTION 8 OF PUBLIC WORKS DESIGN STANDARDS MANUAL.
10. GENERAL SPECIFICATIONS:
 - A. CAST IRON SHALL CONFORM TO VDOT ROAD AND BRIDGE SPECIFICATIONS
 - B. TEST BARS SHALL BE PROVIDED
 - C. WEIGHT SHALL BE PAINTED ON FRAME AND COVER
 - D. WEIGHT: FRAME - 66 LBS.
COVER - 354 LBS.
TOTAL - 415 LBS.
11. CASTINGS SHALL BE A GOOD GRADE OF GREY IRON.
12. FOR PRIVATE DEVELOPMENT WALLS MAY BE BRICK, SOLID CONCRETE BLOCK, OR CLASS A-3 (3,000 P.S.I.) CONCRETE WITH REINFORCING STEEL. THIS ITEM MAY BE CAST IN PLACE OR PRECAST FOR PRIVATE DEVELOPMENT. MATERIAL SHALL CONFORM TO VDOT ROAD AND BRIDGE SPECIFICATIONS.
13. MORTAR SHALL BE MIXED, 1 OF PORTLAND CEMENT TO 3 OF CLEAN GRADED SAND. JOINTS SHALL BE FLUSHED FULL. INSIDE AND OUTSIDE OF ALL WALLS SHALL BE FULLY PLASTERED, 1/2" THICK (MIN.) OF 1:3 MORTAR.
14. CAST IRON TOPS AND FRAMES SHALL BE SUFFICIENTLY TRUE TO A PLANE SURFACE, SO THAT TOPS WILL NOT ROCK.
15. IF THE INSIDE DIAMETER OF THE STRUCTURE EXCEEDS 48", AND/OR IF THE MAXIMUM ALLOWED DEPTH EXCEEDS THAT AS SHOWN, THEN USE VDOT STANDARDS AS NECESSARY.
16. SHADED AREAS MUST EQUAL (MIN.) 1.5 TIMES THE CROSS-SECTIONAL AREA OF THE STORM DRAIN

(N.T.S.)
REV. 11/16

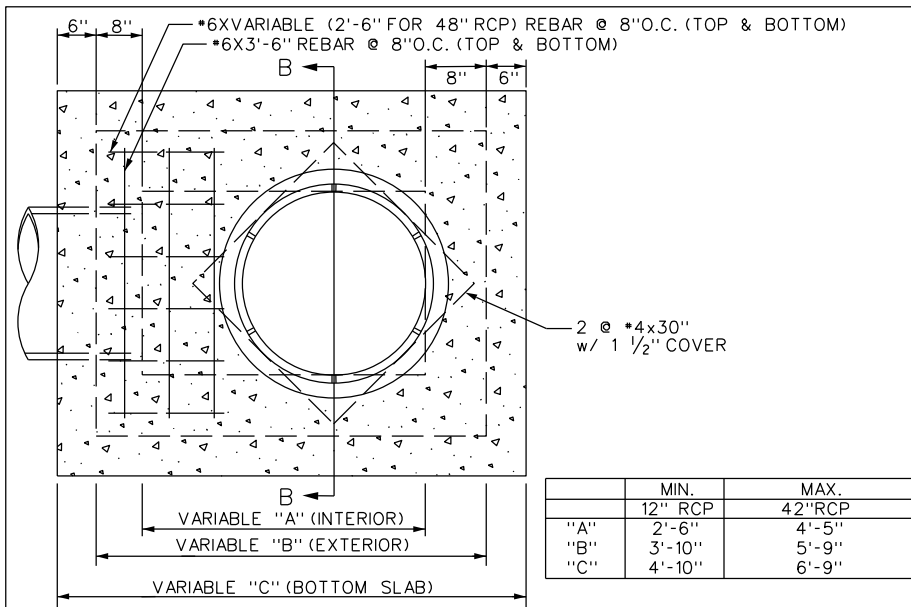


CITY OF VIRGINIA BEACH
STANDARD

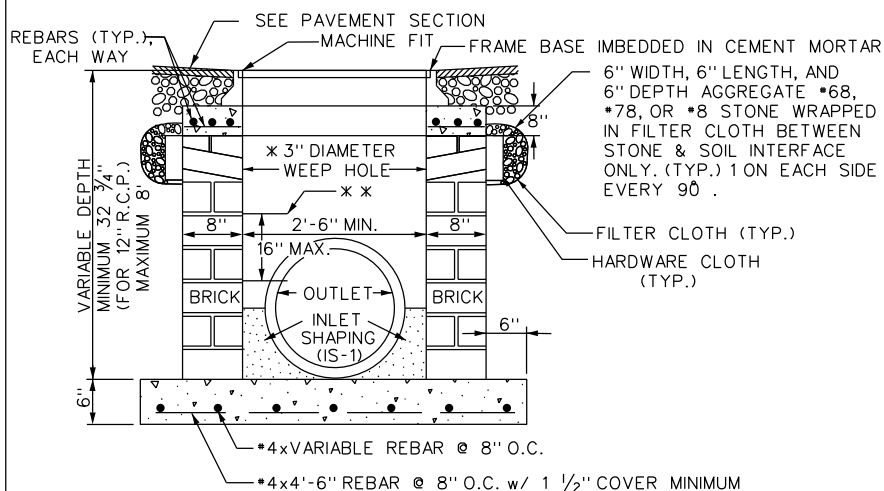
SPECIAL MANHOLE SHOWING D.I.
SAN. SEWER PASSING THROUGH

PUBLIC WORKS

B-10



PLAN



SECTION B-B

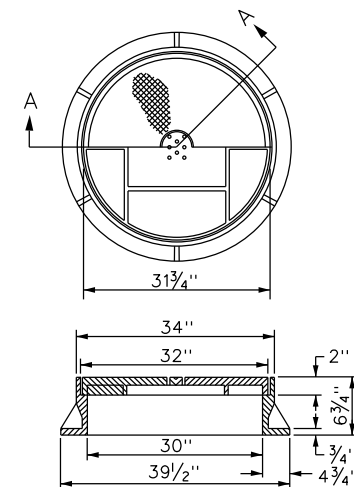
XX STEPS REQUIRED IF M.H. EXCEEDS 4 FEET IN DEPTH. STEPS SHALL BE IN ACCORDANCE WITH V.D.O.T. STANDARD ST-1 STANDARD STEP.

NOTES:

1. MAXIMUM DEPTH (H) TO BE 8'.
2. THE "H" DIMENSIONS SPECIFIED ON THE PLANS WILL BE MEASURED FROM THE INVERT OF THE OUTFALL PIPE TO THE TOP OF THE STRUCTURE. PLAN "H" DIMENSIONS ARE APPROXIMATE ONLY FOR ESTIMATING PURPOSES AND THE ACTUAL DIMENSIONS SHALL BE DETERMINED BY THE CONTRACTOR FROM FIELD CONDITIONS.
3. WHEN SPECIFIED ON PLANS THE INVERT IS TO BE SHAPED IN ACCORDANCE WITH STANDARD PLAN V.D.O.T. IS-1. THE COST OF FURNISHING AND PLACING ALL MATERIALS INCIDENTAL TO THE SHAPING IS TO BE INCLUDED IN THE PRICE BID FOR THE DROP INLET COMPLETE.
4. ALL DRAINAGE STRUCTURES WITHIN THE CITY RIGHT-OF-WAYS AND EASEMENTS AND ON CITY PROPERTY SHALL BE PRECAST OR CAST-IN-PLACE, UNLESS OTHERWISE APPROVED BY THE DEPARTMENT OF PUBLIC WORKS.
5. ALL CAST IN PLACE CONCRETE TO BE CLASS A3 3,000 P.S.I., CONCRETE WITH REBAR. PRECAST CONCRETE SHALL BE 4000 P.S.I. WITH REBAR.
6. #4 X 8" SMOOTH DOWELS @ APPROX. 12" C-C TO BE PLACED IN ALL AREAS ADJACENT TO ABUTING CONCRETE. KEYWAYS OR OTHER MEANS OF PREVENTING SETTLEMENT MAY BE SUBSTITUTED WHEN APPROVED BY THE ENGINEER.
7. WEEP HOLE WITH 12" X 12" PLASTIC HARDWARE CLOTH 1/4" MESH OR GALVANIZED STEEL WIRE, MINIMUM WIRE DIAMETER 0.03 INCH, NUMBER 4 MESH HARDWARE CLOTH ANCHORED FIRMLY TO OUTSIDE OF STRUCTURE. AT LEAST ONE WEEP HOLE SHALL BE PROVIDED ON ALL FOUR SIDES, AND TWO ON ANY SIDE FACING A PAVEMENT SECTION. THE NUMBER, THE DIMENSIONS AND THE LOCATIONS OF THE WEEP HOLES MAY BE MODIFIED TO COINCIDE WITH STANDARD V.D.O.T. PRECAST STRUCTURE SPECIFICATIONS, HOWEVER, WEEP HOLES SHALL BE PROVIDED IN ANY CASE ON ALL DRAINAGE STRUCTURES.
8. ANY ALTERNATE METHODS OF ANCHORAGE, MEETING THE APPROVAL OF THE ENGINEER, MAY BE SUBSTITUTED FOR THE CAST IRON LUGS AS SHOWN HEREON.
9. THIS ITEM MAY BE USED INSTEAD OF V.D.O.T. INLETS. SEE 8.6.1 "DRAINAGE STRUCTURES" IN SECTION 8 OF PUBLIC WORKS DESIGN STANDARDS MANUAL.
10. GENERAL SPECIFICATIONS:
 - A. CASTINGS SHALL CONFORM TO VDOT ROAD AND BRIDGE SPECIFICATIONS
 - B. TEST BARS SHALL BE PROVIDED
 - C. WEIGHT SHALL BE PAINTED ON FRAME AND COVER
 - D. WEIGHT: FRAME - 287 ± 15 LBS.
COVER - 234 ± 15 LBS.
TOTAL - 521 ± 30 LBS.
11. MANHOLE COVER CASTINGS SHALL BE A GOOD GRADE OF GRAY IRON.
12. FOR PRIVATE DEVELOPMENT WALLS MAY BE BRICK, SOLID CONCRETE BLOCK, OR CLASS A-3 (3,000 P.S.I.) CONCRETE WITH REINFORCING STEEL. THIS ITEM MAY BE CAST IN PLACE OR PRECAST FOR PRIVATE DEVELOPMENT. MATERIAL SHALL CONFORM TO VDOT ROAD AND BRIDGE SPECIFICATIONS.
13. MORTAR SHALL BE MIXED, 1 OF PORTLAND CEMENT TO 3 OF CLEAN GRADED SAND. JOINTS SHALL BE FLUSHED FULL. INSIDE AND OUTSIDE OF ALL WALLS SHALL BE FULLY PLASTERED, 1/2" THICK (MIN.) OF 1:3 MORTAR.
14. TOPS AND FRAMES SHALL BE SUFFICIENTLY TRUE TO A PLANE SURFACE, SO THAT TOPS WILL NOT ROCK.
15. NON-REINFORCED CONCRETE WALLS AND FLOOR MAY BE USED FOR STRUCTURES LESS THAN 6' DEEP AND PIPE SIZE LESS THAN OR EQUAL TO 42". FOR LARGER SIZES A CONSTRUCTION DETAIL SHALL BE INCLUDED IN THE PLANS SUBMITTED FOR REVIEW.

APPROXIMATE QUANTITIES

0.951 CU. YDS. CONCRETE NOT INCLUDING IS-1
193 BRICKS/FT. IN HEIGHT, ABOVE PIPE
177 BRICKS/FT. IN HEIGHT, AT PIPE LEVEL



SECTION A-A

CITY STANDARD 30" STORM DRAIN MANHOLE FRAME & COVER



CITY OF VIRGINIA BEACH
STANDARD

SHALLOW CITY MANHOLE
MODIFIED FROM STANDARD

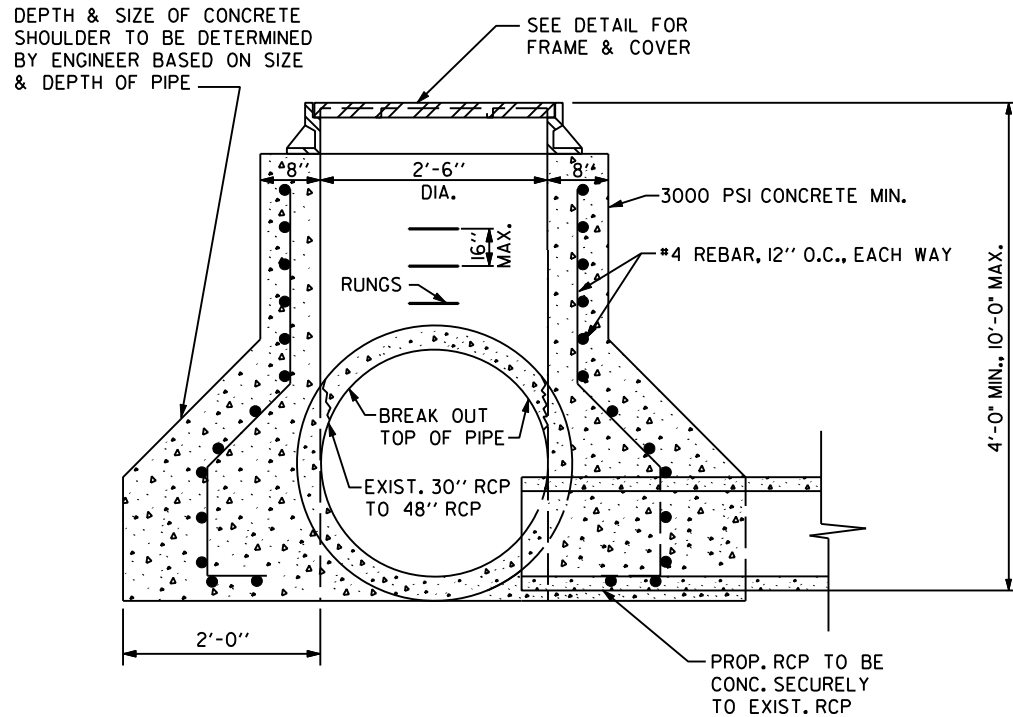
PUBLIC WORKS

B-II

(N.T.S.)
REV. 11/16

NOTES:

1. THIS DETAIL IS FOR REPRESENTATION. THIS MANHOLE IS NOT PREFERRED AND SHOULD ONLY BE USED IN UNIQUE SITUATIONS. SEE STANDARD MANHOLE DETAILS.
2. CAST IRON TOP & FRAME SHALL BE SUFFICIENTLY TRUE TO A PLANE SURFACE SO THAT TOPS WILL NOT ROCK.
3. ALL REBAR SHALL HAVE A MINIMUM $1\frac{1}{2}$ " COVER.
4. ALL CONCRETE SHALL BE CLASS A-3 3000 PSI CONCRETE WITH REBAR CAST IN PLACE.
5. THIS DETAIL IS TO BE USED ONLY WITH CONCRETE PIPE MEETING STANDARDS.
6. STEPS SHALL BE IN ACCORDANCE WITH V.D.O.T. STANDARD ST-1 STANDARD STEP.



SADDLE MANHOLE DETAIL

(N.T.S.)
REV. 3/18/15

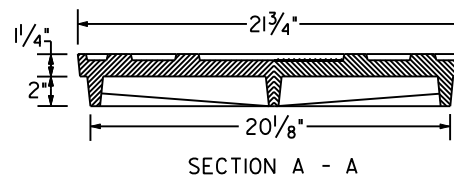
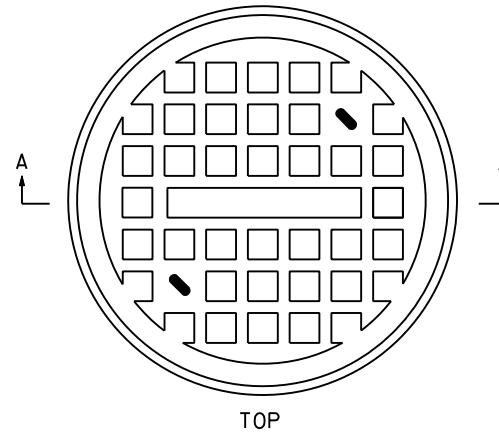
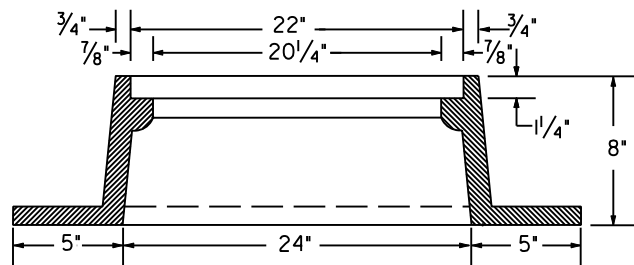
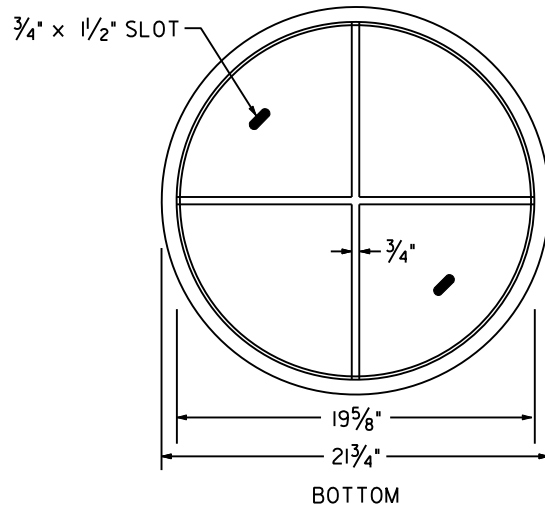


CITY OF VIRGINIA BEACH
STANDARD

SADDLE MANHOLE DETAIL FOR
NON-TRAFFIC LOADING AREAS

PUBLIC WORKS

B-12



NOTES:

RUNGS SHALL BE ALUMINUM OR OTHER APPROVED MATERIAL.

FOR STORM WATER COVER, THE WORD "STORM" SHALL BE CASTED IN THE CENTER OF THE COVER. CAST IRON SHALL BE 35,000 P.S.I., A.S.T.M. SPECS. A-48-60. WEIGHT SHALL BE PAINTED ON FRAME & TOP. MANHOLE STEP SHALL BE 10" x 14". TEST BARS SHALL BE PROVIDED FOR M.H. CASTINGS.

CAST IRON TOP AND FRAMES SHALL BE SUFFICIENTLY TRUE TO A PLANE SURFACE SO THAT TOPS WILL NOT ROCK.

GENERAL SPECIFICATIONS:

1. CASTINGS SHALL BE A GOOD GRADE OF GREY IRON.
2. CAST IRON TOPS AND FRAMES SHALL BE SUFFICIENTLY TRUE TO A PLANE SURFACE, SO THAT TOPS WILL NOT ROCK.
3. GENERAL SPECIFICATIONS:
 - A. CAST IRON SHALL CONFORM TO VDOT ROAD AND BRIDGE SPECIFICATIONS
 - B. TEST BARS SHALL BE PROVIDED
 - C. WEIGHT SHALL BE PAINTED ON FRAME AND COVER
 - D. WEIGHT: FRAME - 66 LBS.
COVER - 354 LBS.
TOTAL - 415 LBS.

THIS WILL BE USED ONLY WHERE THE LARGER 30" FRAME & COVER CANNOT BE USED AND ONLY WITH THE APPROVAL OF THE CITY REVIEW ENGINEER

(N.T.S.)
REV. 5/14

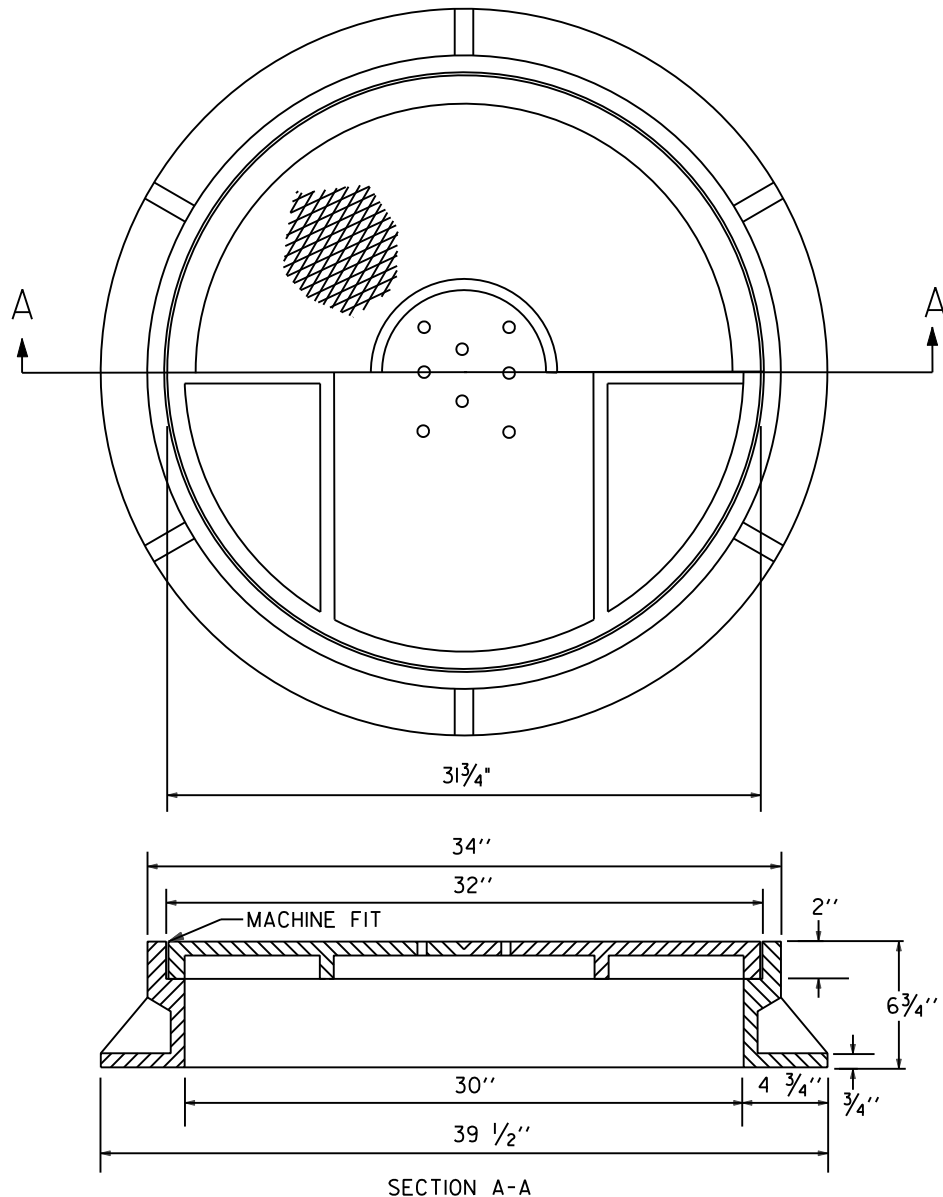


CITY OF VIRGINIA BEACH
STANDARD

24" STORM DRAIN MANHOLE
FRAME & COVER

PUBLIC WORKS

B-13



NOTES:

RUNGS TO BE ALUMINUM OR OTHER APPROVED MATERIAL.

FOR STORM WATER COVER, THE WORD "STORM" SHALL BE CASTED IN THE CENTER OF THE COVER. CAST IRON SHALL BE 35,000 P.S.I., A.S.T.M. SPECS. A-48-60. WEIGHT SHALL BE PAINTED ON FRAME & TOP. MANHOLE STEP SHALL BE 10" x 14". TEST BARS SHALL BE PROVIDED FOR M.H. CASTINGS.

TOP AND FRAMES SHALL BE SUFFICIENTLY TRUE TO A PLANE SURFACE SO THAT TOPS WILL NOT ROCK.

GENERAL SPECIFICATIONS:

1. MANHOLE COVER CASTINGS SHALL BE A GOOD GRADE OF GRAY IRON.
2. CAST IRON TOPS AND FRAMES SHALL BE SUFFICIENTLY TRUE TO A PLANE SURFACE, SO THAT TOPS WILL NOT ROCK.
3. GENERAL SPECIFICATIONS:
 - A. CASTINGS SHALL CONFORM TO VDOT ROAD AND BRIDGE SPECIFICATIONS
 - B. TEST BARS SHALL BE PROVIDED
 - C. WEIGHT SHALL BE PAINTED ON FRAME AND COVER
 - D. WEIGHT: FRAME - 287 ± .15 LBS.
COVER - 234 ± .15 LBS.
TOTAL - 521 ± .30 LBS.

(N.T.S.)
REV. 5/14

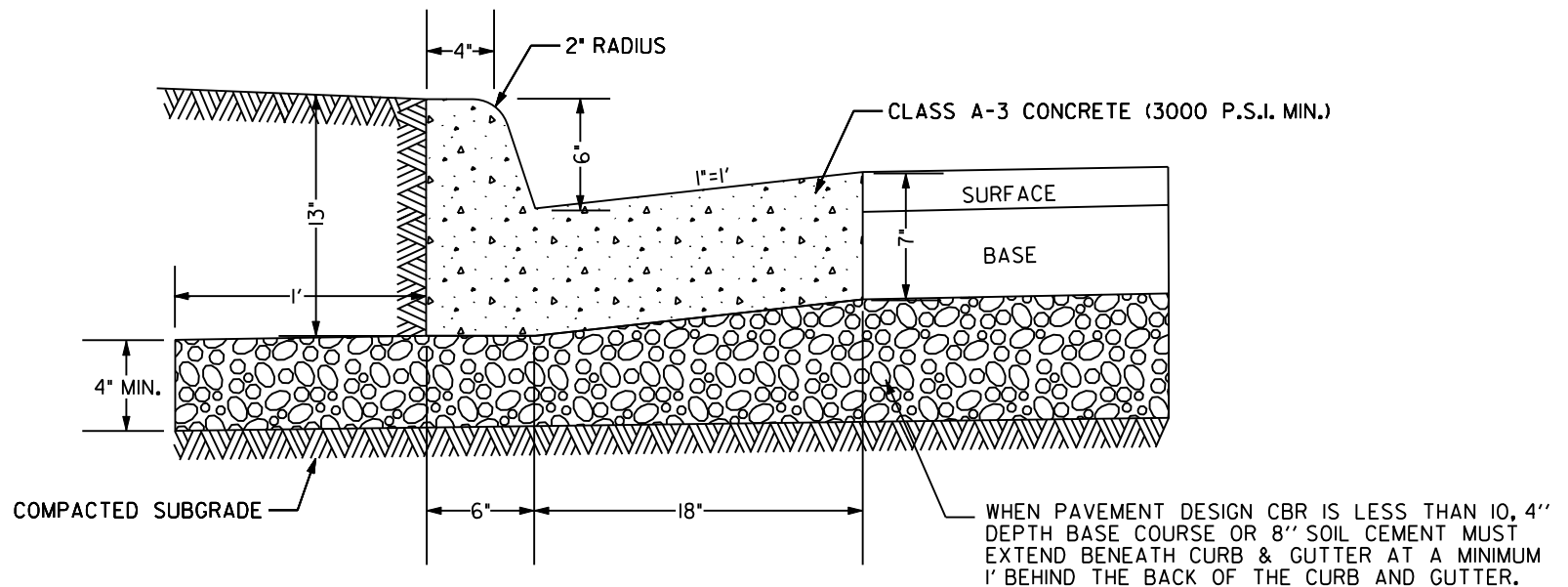


CITY OF VIRGINIA BEACH
STANDARD

30" STORM DRAIN MANHOLE
FRAME & COVER

PUBLIC WORKS

B-14



NOTES:

1. VDOT CG-7 AND CG-3 ARE REQUIRED FOR USE IN CITY RIGHT-OF-WAY, OR OTHER VDOT STANDARD CURB AND GUTTER WHERE POSTED SPEED OF VEHICLES WILL BE ≥ 45 MPH.
2. VDOT CG-2 OR CITY VBCG-1 NOT REQUIRED, BUT PERMITTED TO BE USED AS THE REQUIRED PERIMETER CURB AROUND PARKING ON PRIVATE PROPERTY.
3. ALL STREETS IN R.O.W. MUST USE CG-6 OR CG-2 OR OTHER APPROPRIATE VDOT STANDARD CURBS AND GUTTERS. VBCG-1 AND OTHER SPECIAL DESIGNS MUST BE APPROVED BY THE CITY REVIEW ENGINEER.

(N.T.S.)
REV. 5/14



CITY OF VIRGINIA BEACH
STANDARD

COMBINATION
CURB & GUTTER VBCG-1

PUBLIC WORKS

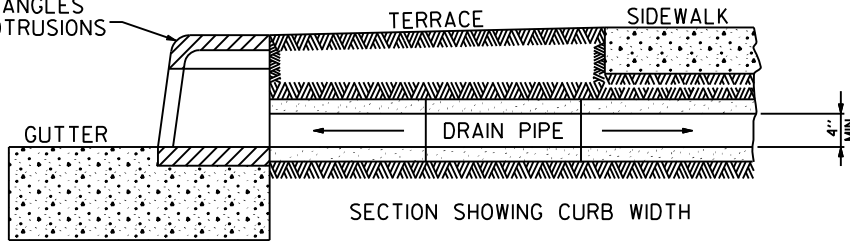
B-15

NOTES:

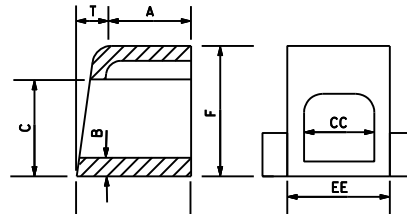
1. CURB MUST BE SAW CUT FOR A CLEAN, NEAT FINAL PRODUCT. CURB CASTING TO BE EXPOXIED IN PLACE.
2. OTHER SIMILAR CAST IRON CASTINGS FROM OTHER MANUFACTURERS MAY BE SUBSTITUTED DEPENDING UPON AVAILABILITY.
3. CASTINGS SHALL BE A GOOD GRADE OF GREY IRON.
4. CAST IRON TOPS AND FRAMES SHALL BE SUFFICIENTLY TRUE TO A PLANE SURFACE, SO THAT TOPS WILL NOT ROCK.
5. GENERAL SPECIFICATIONS:
 1. CAST IRON SHALL BE 35,000 P.S.I.
 2. TEST BARS SHALL BE PROVIDED
 3. A.S.T.M. SPECIFICATIONS A-48-60
 4. WEIGHT SHALL BE PAINTED ON FRAME AND COVER

THE USE OF THIS DETAIL SHALL BE LIMITED TO THE ELIMINATION OF EXISTING OFFSITE DRAINAGE ISSUES OR SITUATIONS WHERE POSITIVE DRAINAGE CANNOT BE ACHIEVED THROUGH ON-SITE LOT GRADING.

CURB CASTING TO MATCH FACE OF CURB WITH NO SHARP ANGLES OR PROTRUSIONS

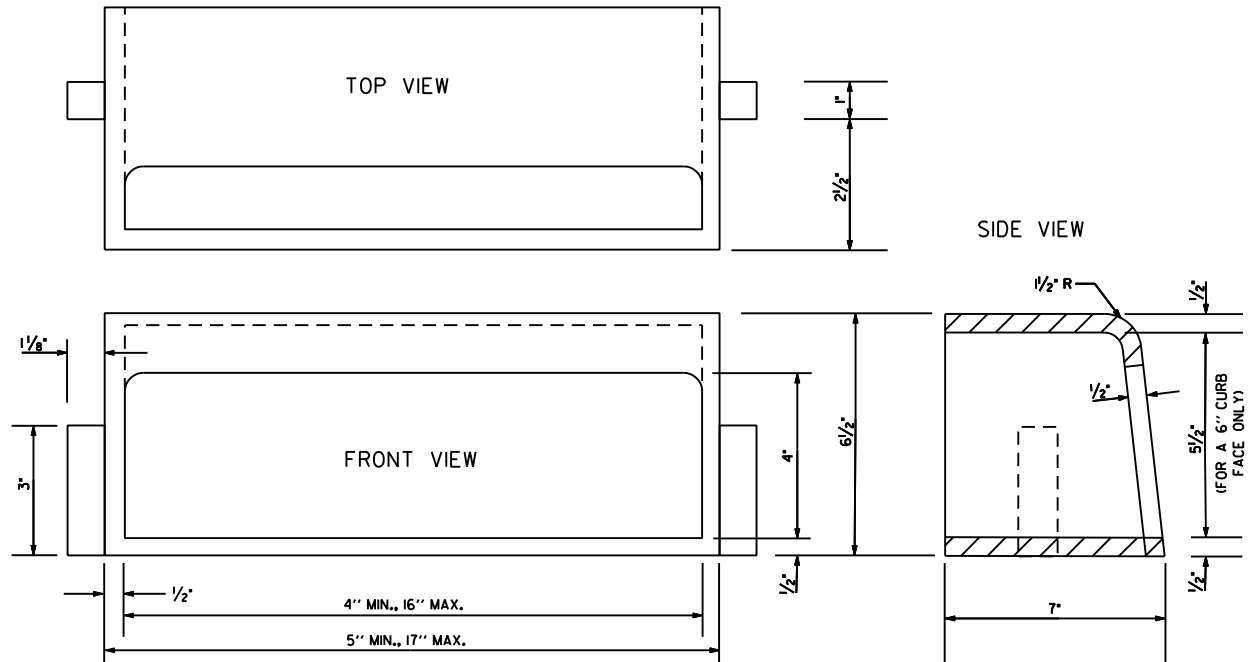


SECTION SHOWING CURB WIDTH



SIDE VIEW

FRONT VIEW



NEENA OR EQUIVALENT (SEE NOTE #2)

CATALOG NO	A	B	C	C-C	E	E-E	F	T	WT. LBS.
R-3262-1	5	1/2	4	4	6	5	7	1	20
* R-3262-2	6	1/2	4	4	8 1/4	5	6	2 1/4	20
R-3262-3	5	1/2	4	5 1/2	6	6 1/2	6 1/2	1	20
R-3262-4	5	1/2	4	16	7	17	6 3/8	2	45
R-3262-6	6	1/2	6	6	8	7 1/4	9	2	30

* RECOMMENDED, NOTE THAT THE "F" DIMENSION VARIES. A CASTING MUST MATCH THE EXACT FACE OF CURB THAT IT IS TO BE WITHIN OR ADJACENT TO

(N.T.S.)
REV. 5/14

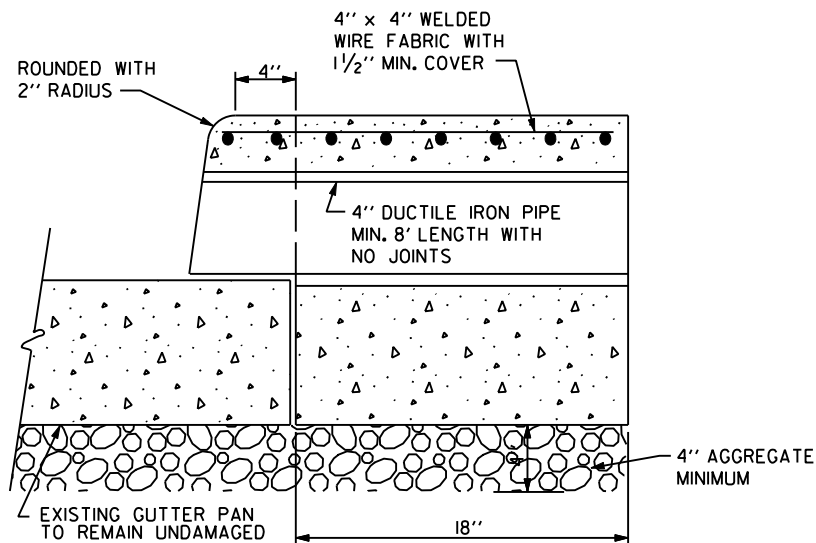


CITY OF VIRGINIA BEACH
STANDARD

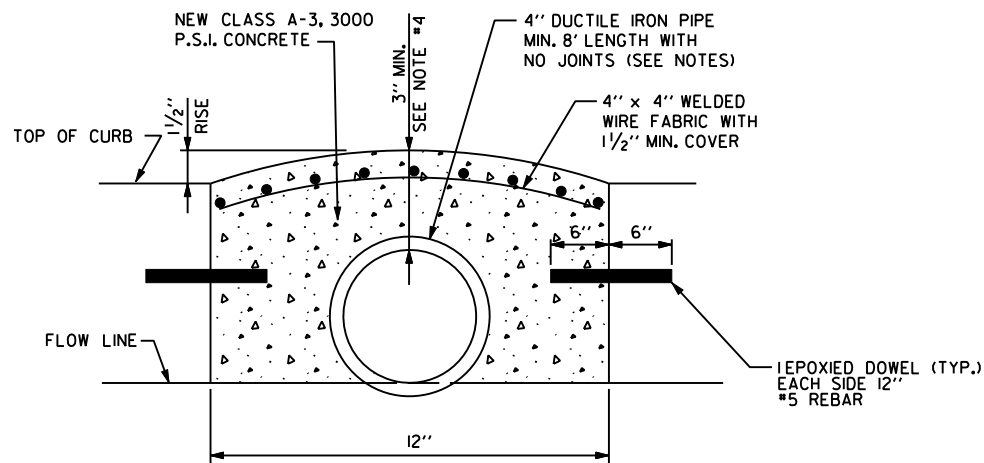
STORM WATER CURB OPENING
(CAST IRON)

PUBLIC WORKS

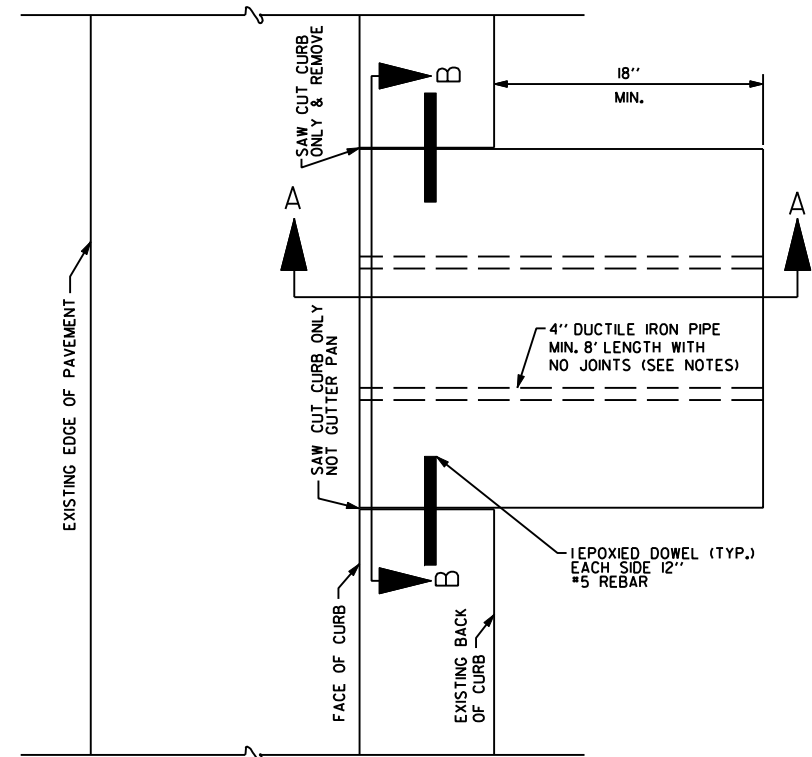
B-16



SECTION A-A



SECTION B-B

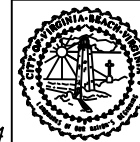


NOTES:

1. FACE AND TOP OF NEW CONCRETE TO MATCH AND BE FLUSH WITH EXISTING CURB TO EACH SIDE
2. FOR STORM DRAINAGE PIPES ONLY
3. IF 4" OR 6" DRAINAGE PIPE IS OF PVC OR OTHER APPROVED MATERIAL, THEN THAT PORTION OF PIPE WITHIN CITY R/W SHALL BE DUCTILE IRON AND THE JOINTS SEALED AS NECESSARY
4. THIS 3" MIN. RISE CANNOT BE EXTENDING INTO PEDESTRIAN SIDEWALKS

THE USE OF THIS DETAIL SHALL BE LIMITED TO THE ELIMINATION OF EXISTING OFFSITE DRAINAGE ISSUES OR SITUATIONS WHERE POSITIVE DRAINAGE CANNOT BE ACHIEVED THROUGH ON-SITE LOT GRADING.

(N.T.S.)
REV. 5/14



CITY OF VIRGINIA BEACH
STANDARD

ALTERNATE PIPE THROUGH
FACE OF CURB

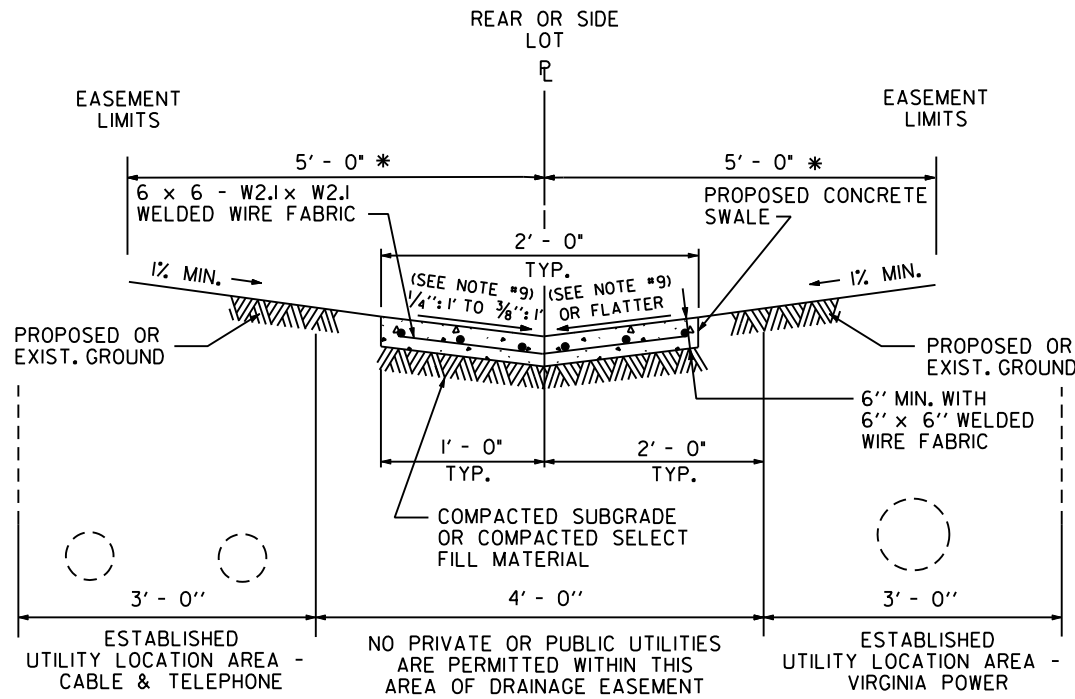
PUBLIC WORKS

B-17

* TOTAL 10' DRAINAGE, PEDESTRIAN & UTILITY EASEMENT REQUIRED IN CONJUNCTION WITH DEVELOPMENT PLAN & ORDINANCES.

NOTE:

IF GREATER THAN 3'-0" IN WIDTH, THEN
*4 REBAR, 12" O.C. IS TO BE SUBSTITUTED
FOR THE WELDED WIRE FABRIC



GENERAL NOTES

- 1.) NO ENCROACHMENTS WILL BE PERMITTED WITHIN THE 10' DRAINAGE, PEDESTRIAN, AND UTILITY EASEMENTS UNLESS APPROVED BY THE DEPARTMENT OF PUBLIC WORKS.
- 2.) UTILITIES WILL BE PERMITTED IN THE LOCATIONS AS SHOWN HEREON.
- 3.) THE 4' o.c. AREA OF THE SIDE AND REAR PROPERTY LINES IS EXCLUSIVELY FOR DRAINAGE USE ONLY.
- 4.) ANY / ALL UTILITIES THAT ARE PLACED WITHIN THE EXCLUSIVE DRAINAGE AREA MUST BE REMOVED AT THE EXPENSE OF UTILITY COMPANY OR DEVELOPER. IT IS THE RESPONSIBILITY OF THE OWNER/DEVELOPER TO ENSURE THAT THE UTILITIES DO NOT CONFLICT WITH THE CONCRETE SWALE, WHICH MUST BE INSTALLED PRIOR TO BUILDING
- 5.) FEEDER LINES MAY BE BORED UNDER CONCRETE SWALE. THE CONCRETE SWALE MAY NOT BE OPEN CUT.
- 6.) UTILITIES ARE RECOMMENDED TO BE INSTALLED PRIOR TO THE INSTALLATION OF THE CONCRETE SWALE.
- 7.) ADDITIONAL PRIVATE UTILITY EASEMENTS MAY BE REQUIRED FOR THE PLACEMENT OF UTILITY PEDESTALS & PADS.
- 8.) A MINIMUM LONGITUDINAL SLOPE OF 1.0% IS RECOMMENDED. ABSOLUTE MINIMUM LONGITUDINAL SLOPE ALLOWED SHALL BE 0.3% FOR POURED IN PLACE (AND 0.5% FOR PRE-CAST.)
- 9.) CROSS SLOPE IS TO BE BETWEEN 1/4" : 1' AND 3/8" : 1' OR FLATTER TO ACCOMMODATE PEDESTRIAN TRAFFIC. IF WIDTH IS GREATER THAN 3'-0", THEN *4 REBAR, 12" O.C. (BOTH WAYS) IS TO BE SUBSTITUTED FOR THE 6" x 6" WELDED WIRE FABRIC.
- 10.) TOWNHOUSES ARE REQUIRED TO INSTALL THESE CONCRETE SWALES IN THE REAR AND SIDE YARDS WITH CROSS SLOPES OF 1/4" : 1' (MIN.) TO 3/8" : 1' (MAX.)

SHEET 1 OF 2

(N.T.S.)
REV. 5/14



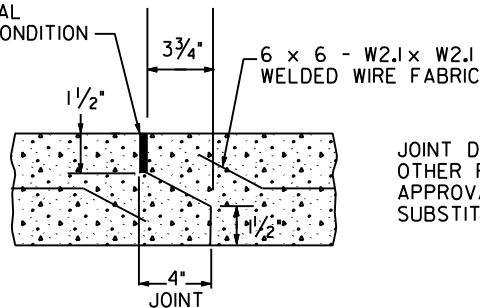
CITY OF VIRGINIA BEACH
STANDARD

CONCRETE SWALE, EASEMENT &
UTILITY LOCATION SECTION FOR
REAR YARDS

PUBLIC WORKS

B-19A

JOINT TO BE SEALED WITH MORTAR
OR OTHER SUITABLE MATERIAL
TO INSURE A WATERTIGHT CONDITION



JOINT DETAIL SHOWN IS SUGGESTED ONLY.
OTHER FABRICATOR'S DESIGN MEETING THE
APPROVAL OF THE ENGINEER MAY BE
SUBSTITUTED.

GENERAL NOTES (CONT'D.)

11.) ALL CONCRETE TO BE CLASS
A3-3,000 P.S.I.

12.) LIFTING DEVICES OF THE
FABRICATOR'S DESIGN ARE TO
BE FURNISHED WHEN REQUIRED.

13.) THE PRIMARY USE OF THESE
CONCRETE SWALES ARE FOR REAR YARD
AND SIDE YARD DRAINAGE IN
ASSOCIATION WITH TOWNHOUSE
DEVELOPMENT.

14.) STRICT COMPLIANCE WITH SECTION
502 OF THE V.D.O.T. ROAD & BRIDGE
SPECIFICATIONS IS REQUIRED.

15.) JOINT FILLER MUST COMPLY WITH
SECTION 212 OF THE V.D.O.T. ROAD
& BRIDGE SPECIFICATION.

16.) A MINIMUM LONGITUDINAL SLOPE
OF 1% IS RECOMMENDED FOR ALL PAVED
SWALES. .5% IS THE ABSOLUTE
MINIMUM LONGITUDINAL SLOPE FOR
PRECAST.

17.) PRECAST LENGTH TO BE
DETERMINED BY FABRICATOR,
HOWEVER, SHALL NOT EXCEED 20 FEET
IN LENGTH.

18.) WELDED WIRE FABRIC SHALL HAVE
A MINIMUM 1 1/2\"

SHEET 2 OF 2

(N.T.S.)
REV. 5/14



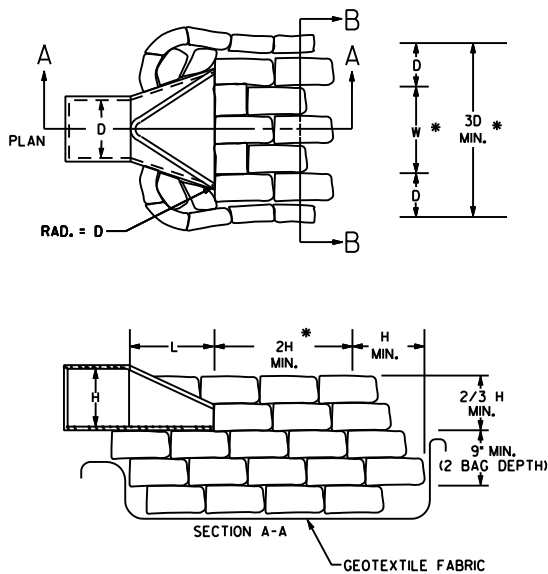
CITY OF VIRGINIA BEACH
STANDARD

CONCRETE SWALE, EASEMENT &
UTILITY LOCATION SECTION FOR
REAR YARDS

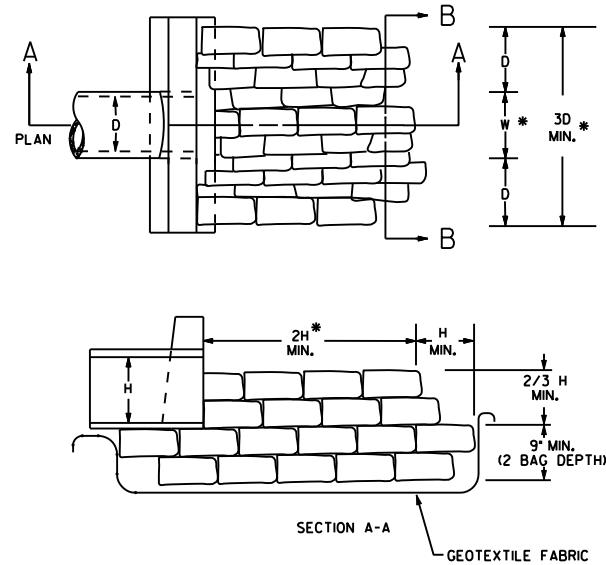
PUBLIC WORKS

B-19B

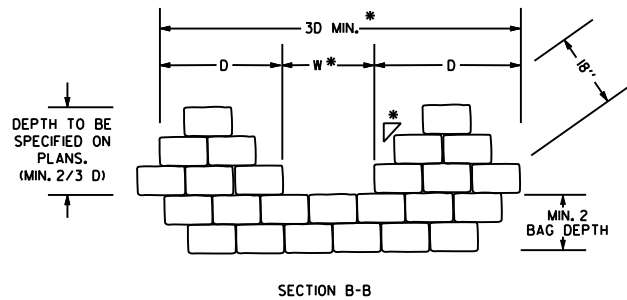
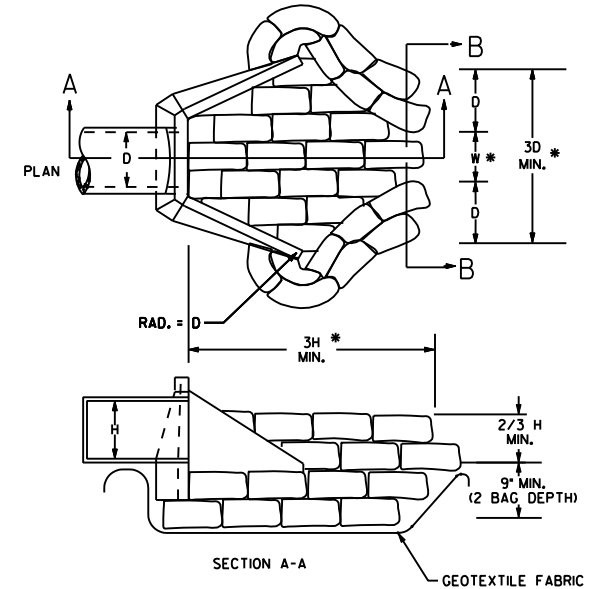
DETAIL 1



DETAIL 2



DETAIL 3



NOTES

1. FOR MULTIPLE LINE INSTALLATIONS DIMENSION (D) IS TO GOVERN THE PROTECTION OUTSIDE THE CHANNEL WIDTH (W).
2. ON ANY SECONDARY ROADS INSTALLATION REQUIRING EROSION TREATMENT WHERE NO ENDWALL OR ENDSECTION IS SPECIFIED ON PLANS, CONSTRUCTION IS TO BE ACCORDANCE WITH DETAIL 2 SHOWN ABOVE.
3. * D REPRESENTS SPAN FOR BOX CULVERT INSTALLATION
4. H = DIAMETER FOR ROUND PIPE, RISE FOR PIPE ARCH AND BOX CULVERT HEIGHT.
5. * USE TYPICAL SECTION SHOWN ON PLANS OR NORMAL SIDE SLOPE, BOTTOM WIDTH, AND DEPTH OF CHANNEL, DITCH OR NATURAL GROUND

6. FOR LOW FLOW ($Q \leq 9$ cfs) AND LOW VELOCITY ($V \leq 3$ fps) ONLY. SEE NOTE #7

7. * FOR HIGHER FLOWS, RIP RAP IS STILL REQUIRED BUT DIMENSIONS OF RIP RAP TO BE SIZED BY THE ENGINEER DEPENDING UPON SIZE OF PIPE, QUANTITY AND VELOCITY OF WATER FLOWS, VEGETATION AND SOIL TYPES.

8. ALL RIP RAP SHALL BE UNDERLAIN WITH APPROPRIATE GEOTEXTILE FABRIC MATERIAL.

9. EROSION DOWNSTREAM MUST BE CHECKED AND THE USE OF ENERGY DISSIPATORS CONSIDERED

10. BAGS TO BE BURLAP FILLED WITH CONCRETE & PLACED BEFORE CONCRETE SETS HARD. IF PAPER (COMMERCIAL) CONCRETE BAGS USED, THEN PAPER TO BE TORN OPEN & REBAR PER BAG DRIVEN VERTICALLY THROUGH EACH TO BOTTOM BAG

(N.T.S.)
REV. 5/14



CITY OF VIRGINIA BEACH
STANDARD

LOW FLOW / VELOCITY
STORM DRAIN OUTFALL

PUBLIC WORKS

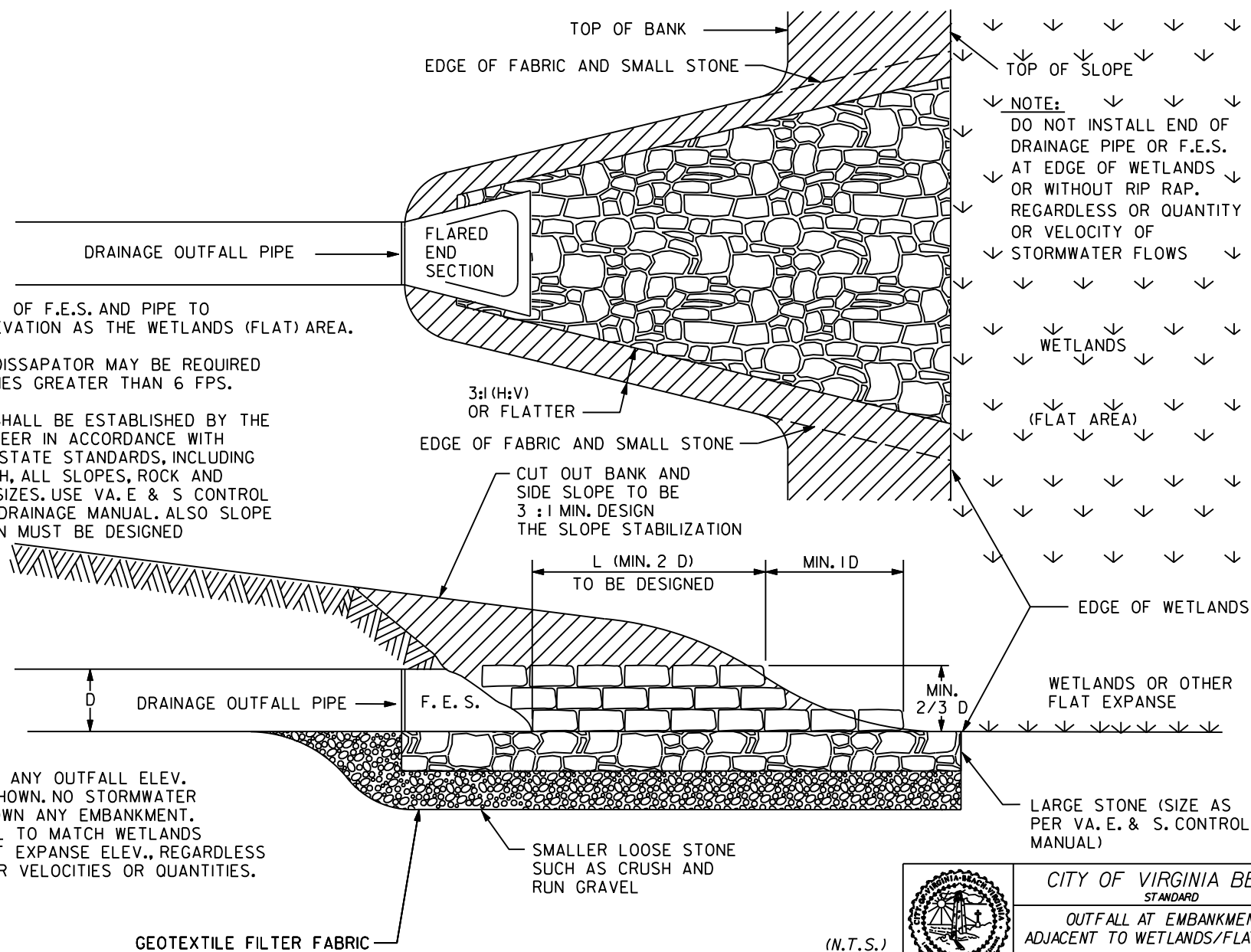
B-20

NOTES :

- 1) LOWER INVERT OF F.E.S. AND PIPE TO THE SAME ELEVATION AS THE WETLANDS (FLAT) AREA.
- 2) AN ENERGY DISSIPATOR MAY BE REQUIRED FOR VELOCITIES GREATER THAN 6 FPS.
- 3) DIMENSIONS SHALL BE ESTABLISHED BY THE DESIGN ENGINEER IN ACCORDANCE WITH ALL CITY / STATE STANDARDS, INCLUDING LENGTH, WIDTH, ALL SLOPES, ROCK AND AGGREGATE SIZES. USE VA. E & S CONTROL MANUAL, VA. DRAINAGE MANUAL. ALSO SLOPE STABILIZATION MUST BE DESIGNED

NOTE

DO NOT DESIGN ANY OUTFALL ELEV. HIGHER THAN SHOWN. NO STORMWATER IS TO FLOW DOWN ANY EMBANKMENT. LOWER OUTFALL TO MATCH WETLANDS OR OTHER FLAT EXPANSE ELEV., REGARDLESS OF STORMWATER VELOCITIES OR QUANTITIES.



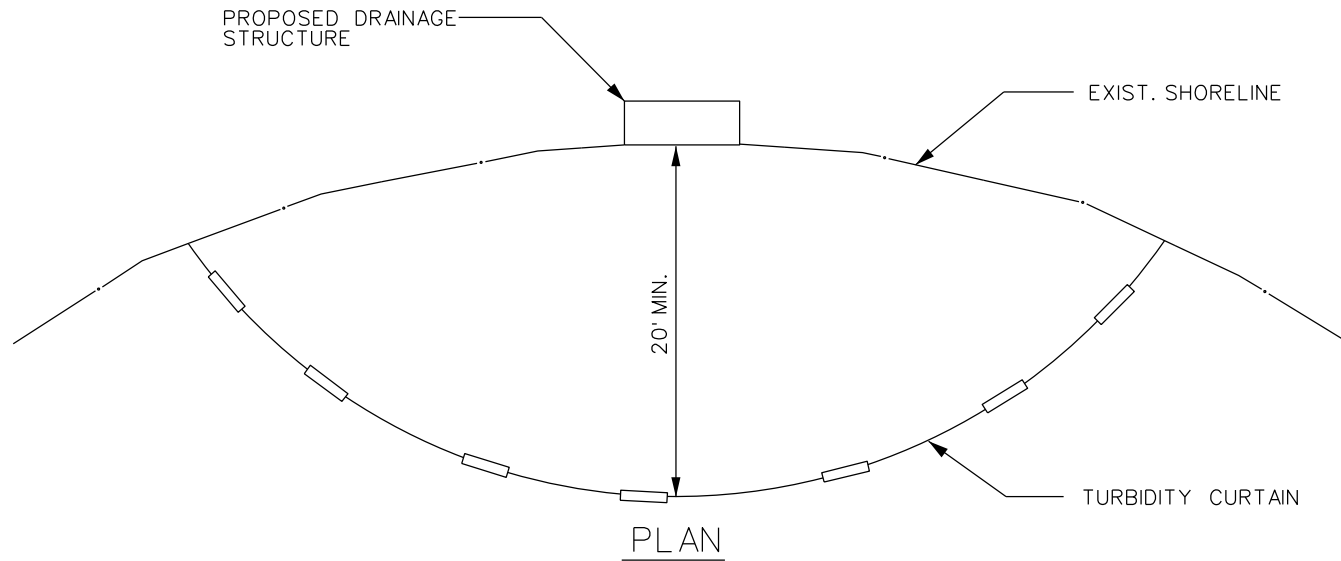
CITY OF VIRGINIA BEACH
STANDARD

**OUTFALL AT EMBANKMENTS
ADJACENT TO WETLANDS/FLAT AREAS**

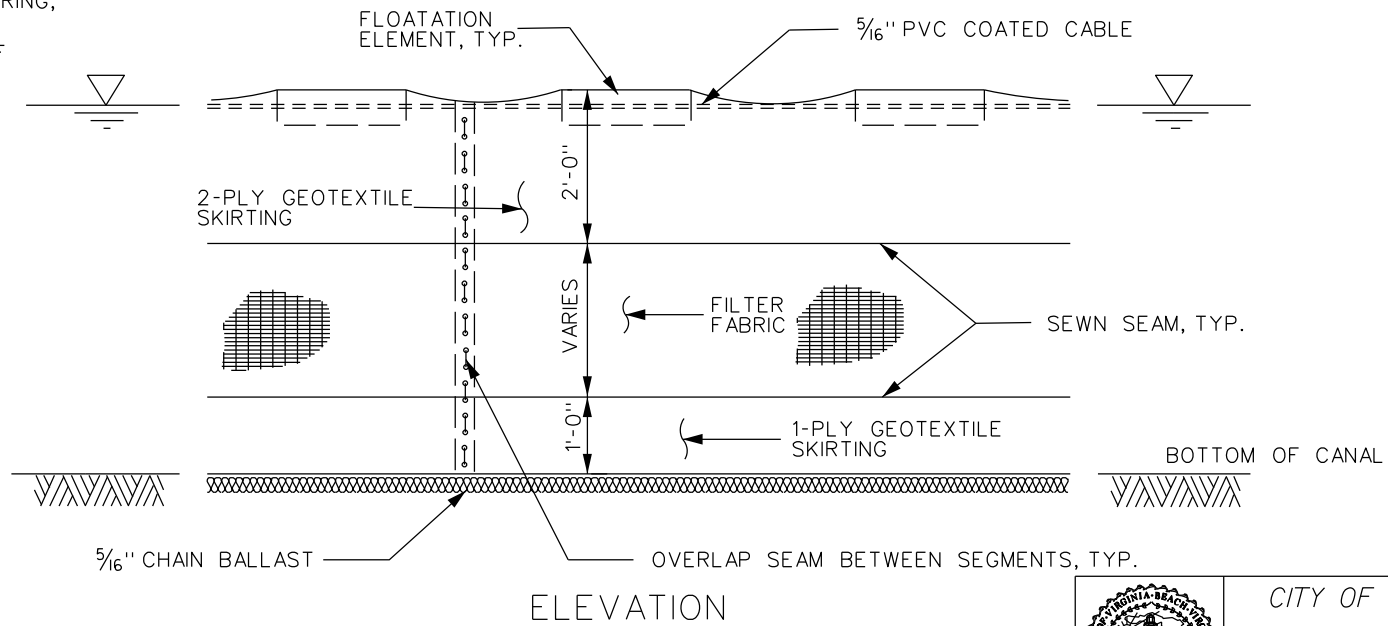
PUBLIC WORKS

B-2/

(N.T.S.)
REV. 5/14



NOTE:
FOR COMPLETE REQUIREMENTS
OF CURTAIN AND ITS ANCHORING,
SEE TABLE J-10 "TURBIDITY
CURTAINS" IN APPENDIX J OF
THESE DESIGN STANDARDS.



(N.T.S.)
REV. 11/16



CITY OF VIRGINIA BEACH
STANDARD

TURBIDITY CURTAIN

PUBLIC WORKS

B-22

1. FOR ALL WET PONDS, LAKES AND CANALS
WITHIN CITY IMPOUNDMENT OR DRAINAGE EASEMENT.
TOE, EDGE OF WATER REVETMENT REQUIRED
2. ALTERNATIVE FOR WET PONDS, LAKES, AND
CANALS CITY OR PRIVATE AND COMMERCIAL, AS WELL
AS RESIDENTIAL
3. MIN. = OR GREATER THAN, OR FLATTER THAN

TIDAL MEAN HIGH WATER (IF TIDAL)
 MEAN OR NORMAL WATER ELEVATION
 TIDAL MEAN LOW WATER (IF TIDAL)
 18" MIN. IF TIDAL OR IF SUBJECT TO SUBSTANTIAL WAVE ACTION. 6" IF NOT TIDAL AND NO SUBSTANTIAL WAVE ACTION.
 12" MIN. IF TIDAL OR IF SUBJECT TO SUBSTANTIAL WAVE ACTION. 6" IF NOT TIDAL AND NO SUBSTANTIAL WAVE ACTION
 6' MIN.
 4 MIN. OR FLATTER
 3 MIN. OR FLATTER (2:1 MAY BE APPROVED BELOW 6' WATER DEPTH WITH SOILS ENGINEER'S RECOMMENDATION)
 4:1 FLATTER
 FILTER CLOTH
 CLASS "A-1" RIP RAP PREFERRED. SMALLER RIP RAP ALLOWED EXCEPT ON CITY PROPERTY AND IF NOT SUBJECT TO SUBSTANTIAL WAVE AND TIDAL ACTION. SIZE MAY BE DESIGNED
 36" IF NOT TIDAL AND NO SUBSTANTIAL WAVE ACTION. SEE NOTE *6
 4" MIN. DEPTH AGGREGATE: *357 OR *68 VDOT STONE OR SIMILAR
 50" MIN. AND TO BE DESIGNED, ONLY IF TIDAL (LUNAR OR WIND DRIVEN TIDES), OR IF SUBJECT TO SUBSTANTIAL WAVE ACTION. ZERO IF THERE IS NO MEAN LOW WATER AND NO SUBSTANTIAL WAVE ACTION. SEE NOTE *6
 90"
 12" MIN.

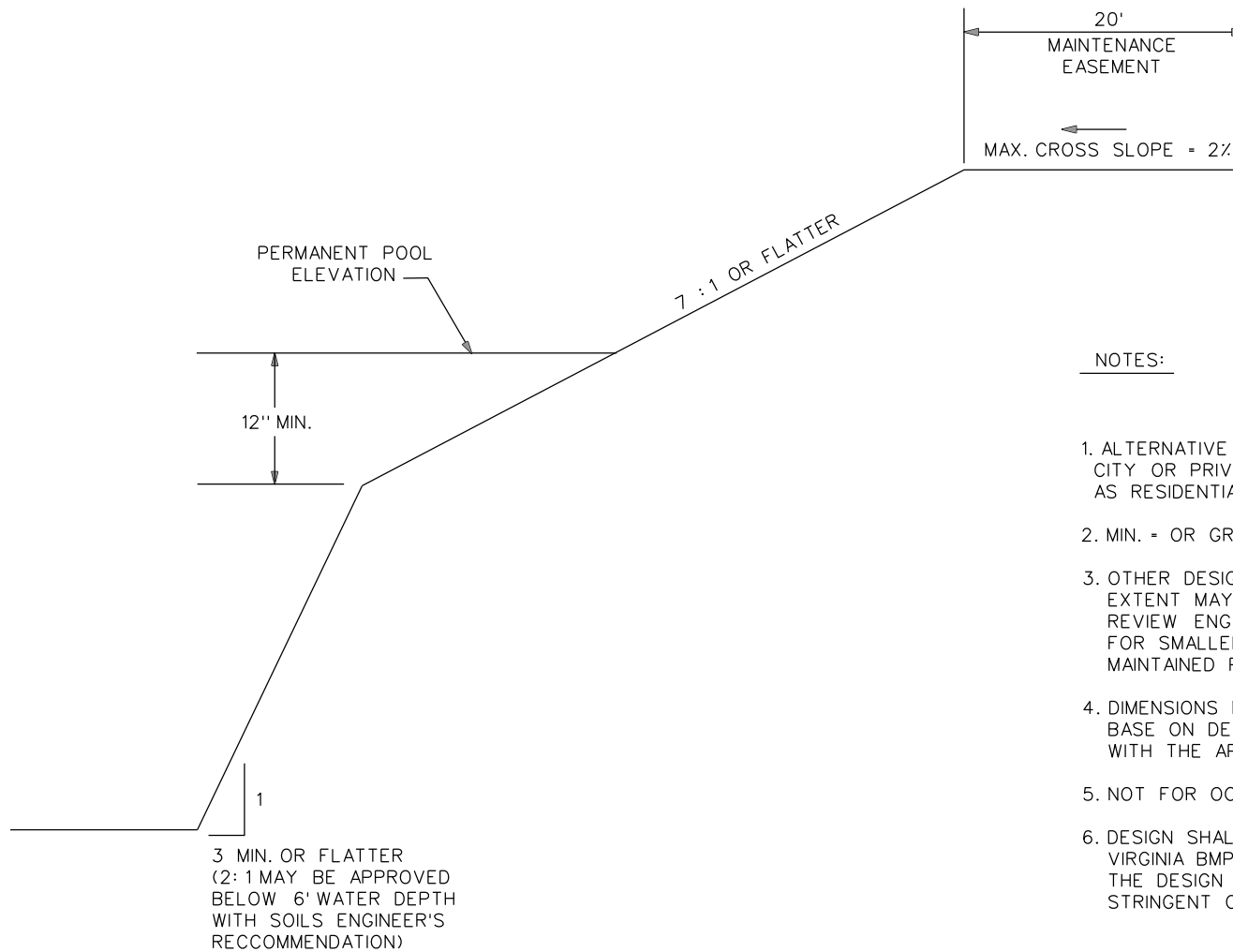
5. OTHER DESIGNS OF LESSER STRENGTH AND EXTENT MAY BE APPROVED BY THE CITY'S REVIEW ENGINEER ON A CASE BY CASE BASIS, FOR SMALLER PRIVATELY OWNED AND MAINTAINED PONDS AND SWMF'S.
6. DIMENSIONS MAY BE LESSENNED AS RECOMMENDED BASE ON DESIGN BY THE CONSULTING ENGINEER, AND WITH THE APPROVAL OF THE CITY REVIEW ENGINEER.
7. NOT FOR OCEANFRONT OR BAYFRONT.
8. DESIGN SHALL MEET THE MINIMUM CRITERIA OF THE VIRGINIA BMP CLEARINGHOUSE FOR WET PONDS. WHERE THE DESIGN CRITERIA DIFFER FROM THIS DETAIL, THE MORE STRINGENT CRITERIA SHALL BE USED.

WITHOUT BENCHING

(N.T.S.)
REV. 08/18



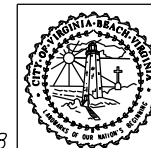
CITY OF VIRGINIA BEACH	
STANDARD	
RIP RAP SHORELINE PROTECTION FOR LAKES, PONDS, AND CANALS WITHOUT BENCHING	
PUBLIC WORKS	B-23



NOTES:

1. ALTERNATIVE FOR WET PONDS, LAKES, AND CANALS CITY OR PRIVATE AND COMMERCIAL, AS WELL AS RESIDENTIAL
2. MIN. - OR GREATER THAN, OR FLATTER THAN
3. OTHER DESIGNS OF LESSER STRENGTH AND EXTENT MAY BE APPROVED BY THE CITY'S REVIEW ENGINEER ON A CASE BY CASE BASIS, FOR SMALLER PRIVATELY OWNED AND MAINTAINED PONDS AND SWMF'S.
4. DIMENSIONS MAY BE LESSENED AS RECOMMENDED BASE ON DESIGN BY THE CONSULTING ENGINEER, AND WITH THE APPROVAL OF THE CITY REVIEW ENGINEER.
5. NOT FOR OCEANFRONT OR BAYFRONT.
6. DESIGN SHALL MEET THE MINIMUM CRITERIA OF THE VIRGINIA BMP CLEARINGHOUSE FOR WET PONDS. WHERE THE DESIGN CRITERIA DIFFER FROM THIS DETAIL, THE MORE STRINGENT CRITERIA SHALL BE USED.

(N.T.S.)
REV.08/18

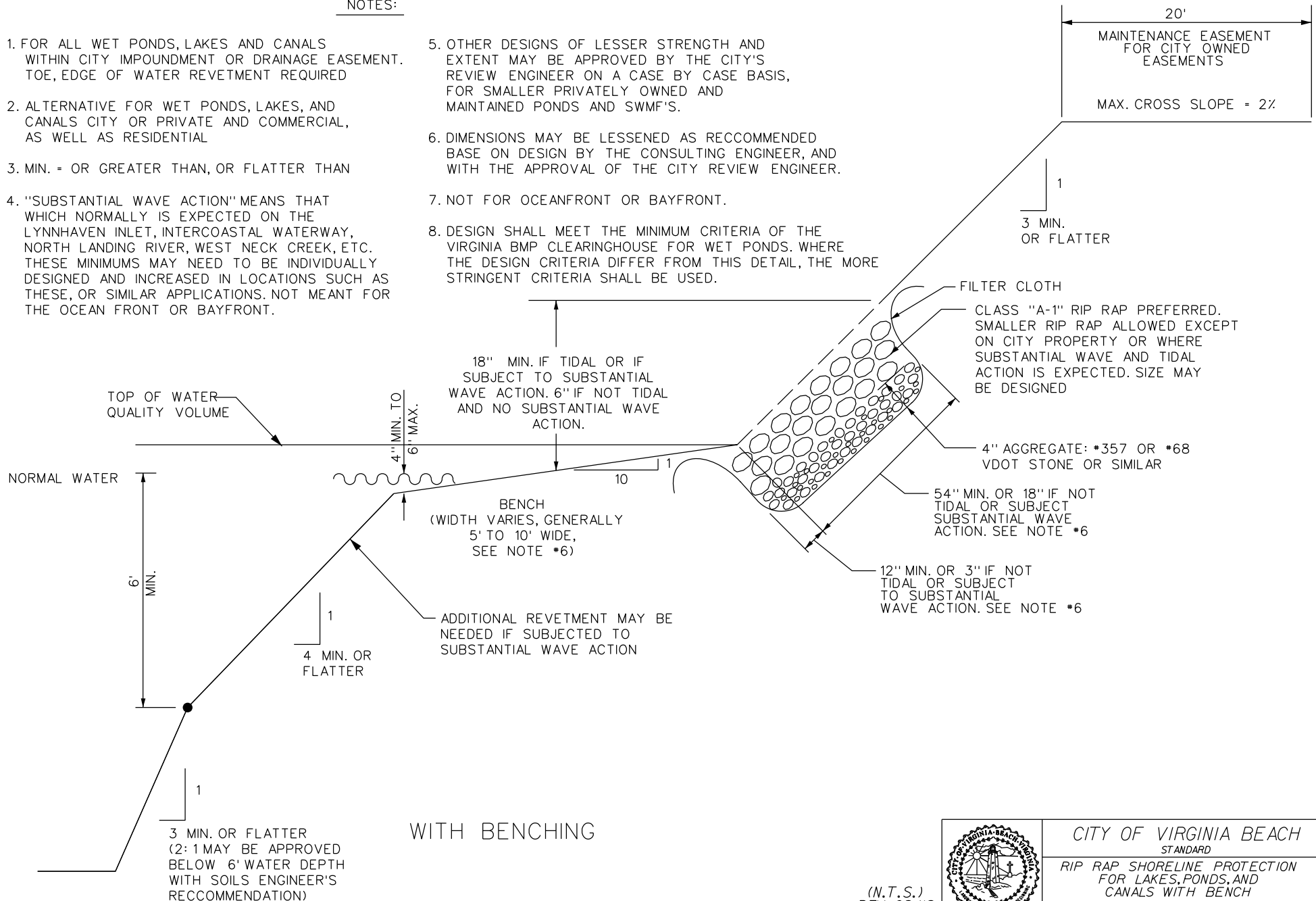


CITY OF VIRGINIA BEACH	
STANDARD	
ACCEPTABLE SLOPE ALTERNATIVE FOR LAKES, PONDS, AND CANALS WITHOUT BENCHING	
PUBLIC WORKS	B-24

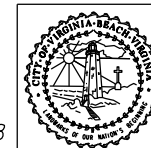
NOTES:

1. FOR ALL WET PONDS, LAKES AND CANALS WITHIN CITY IMPOUNDMENT OR DRAINAGE EASEMENT. TOE, EDGE OF WATER REVETMENT REQUIRED
2. ALTERNATIVE FOR WET PONDS, LAKES, AND CANALS CITY OR PRIVATE AND COMMERCIAL, AS WELL AS RESIDENTIAL
3. MIN. = OR GREATER THAN, OR FLATTER THAN
4. "SUBSTANTIAL WAVE ACTION" MEANS THAT WHICH NORMALLY IS EXPECTED ON THE LYNNHAVEN INLET, INTERCOASTAL WATERWAY, NORTH LANDING RIVER, WEST NECK CREEK, ETC. THESE MINIMUMS MAY NEED TO BE INDIVIDUALLY DESIGNED AND INCREASED IN LOCATIONS SUCH AS THESE, OR SIMILAR APPLICATIONS. NOT MEANT FOR THE OCEAN FRONT OR BAYFRONT.

5. OTHER DESIGNS OF LESSER STRENGTH AND EXTENT MAY BE APPROVED BY THE CITY'S REVIEW ENGINEER ON A CASE BY CASE BASIS, FOR SMALLER PRIVATELY OWNED AND MAINTAINED PONDS AND SWMF'S.
6. DIMENSIONS MAY BE LESSENED AS RECOMMENDED BASE ON DESIGN BY THE CONSULTING ENGINEER, AND WITH THE APPROVAL OF THE CITY REVIEW ENGINEER.
7. NOT FOR OCEANFRONT OR BAYFRONT.
8. DESIGN SHALL MEET THE MINIMUM CRITERIA OF THE VIRGINIA BMP CLEARINGHOUSE FOR WET PONDS. WHERE THE DESIGN CRITERIA DIFFER FROM THIS DETAIL, THE MORE STRINGENT CRITERIA SHALL BE USED.



(N.T.S.)
REV. 08/18



CITY OF VIRGINIA BEACH
STANDARD

RIP RAP SHORELINE PROTECTION
FOR LAKES, PONDS, AND
CANALS WITH BENCH

PUBLIC WORKS B-25

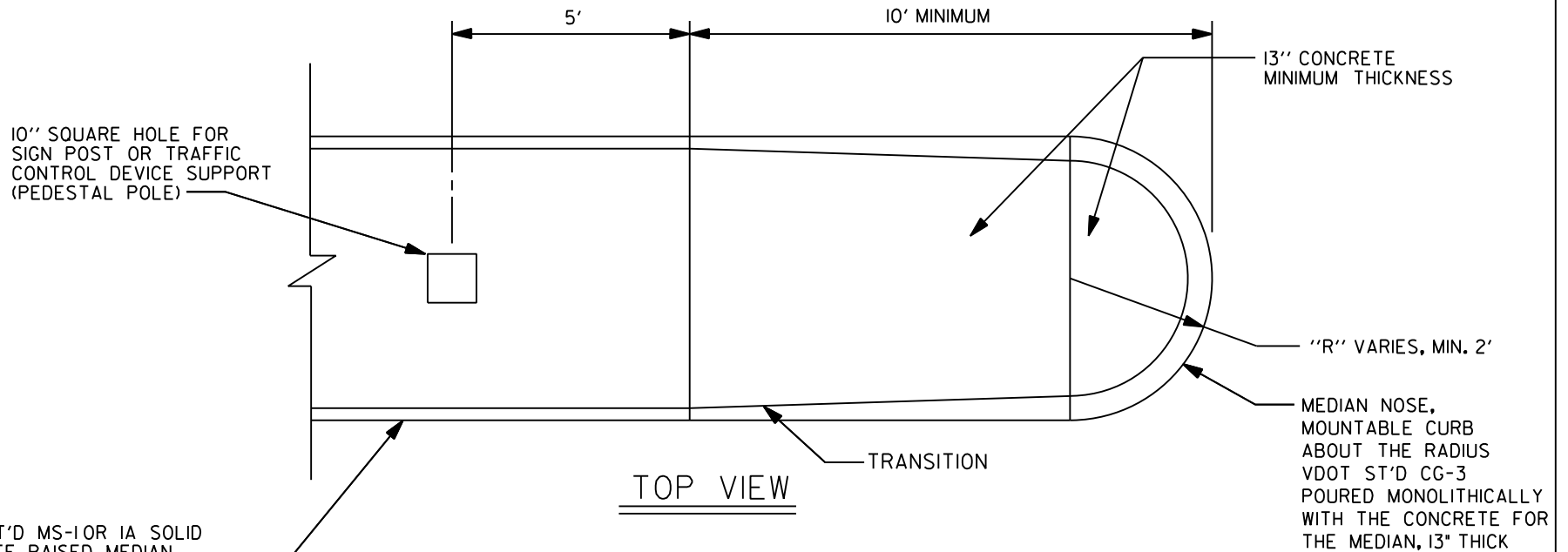


Appendix C

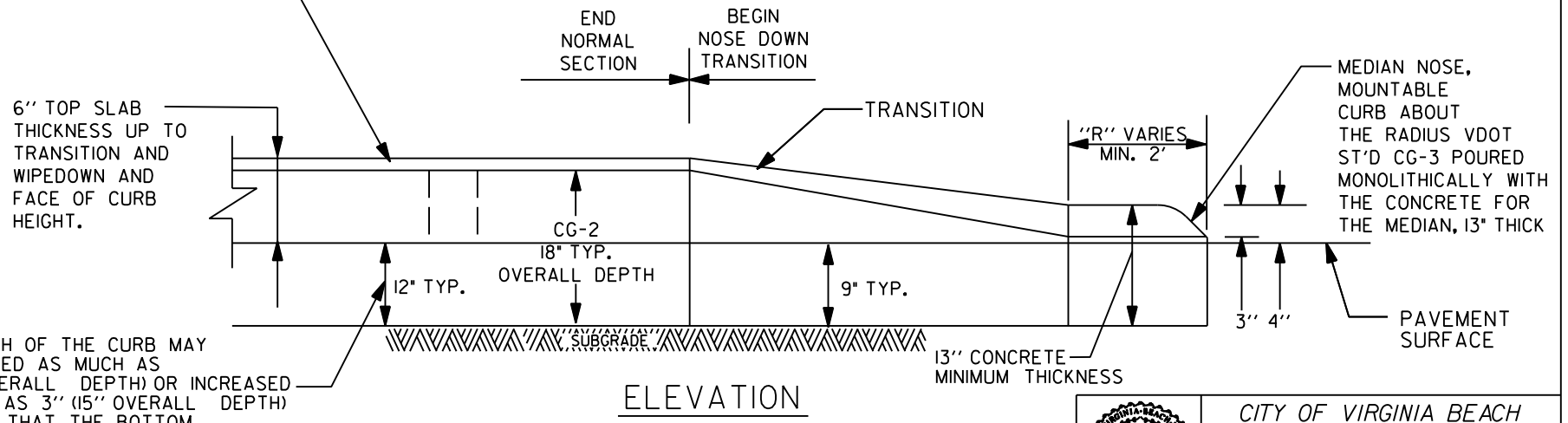
Incidental Concrete Standard Details and other Miscellaneous Standard Drawings

C.1 Intent

The following standard drawings are intended to be an integral part of these standards. Any deviation from the standard must be reviewed by the City's engineer and approved prior to the installation of any modified section, structure, or standard.



VDOT ST'D MS-10R 1A SOLID CONCRETE RAISED MEDIAN (6" BARRIER TYPE CURB FACE)



NOTE:
THE DEPTH OF THE CURB MAY BE REDUCED AS MUCH AS 3" (9" OVERALL DEPTH) OR INCREASED AS MUCH AS 3" (15" OVERALL DEPTH) IN ORDER THAT THE BOTTOM OF CURB WILL COINCIDE WITH THE BOTTOM OF PROPOSED SUBGRADE. SEE VDOT STD. MS-10R 1A FOR DETAILS

(N.T.S.)
REV. 5/14



CITY OF VIRGINIA BEACH
STANDARD

NOSE DOWN AT APPROACH
END OF MEDIAN AND ISLAND

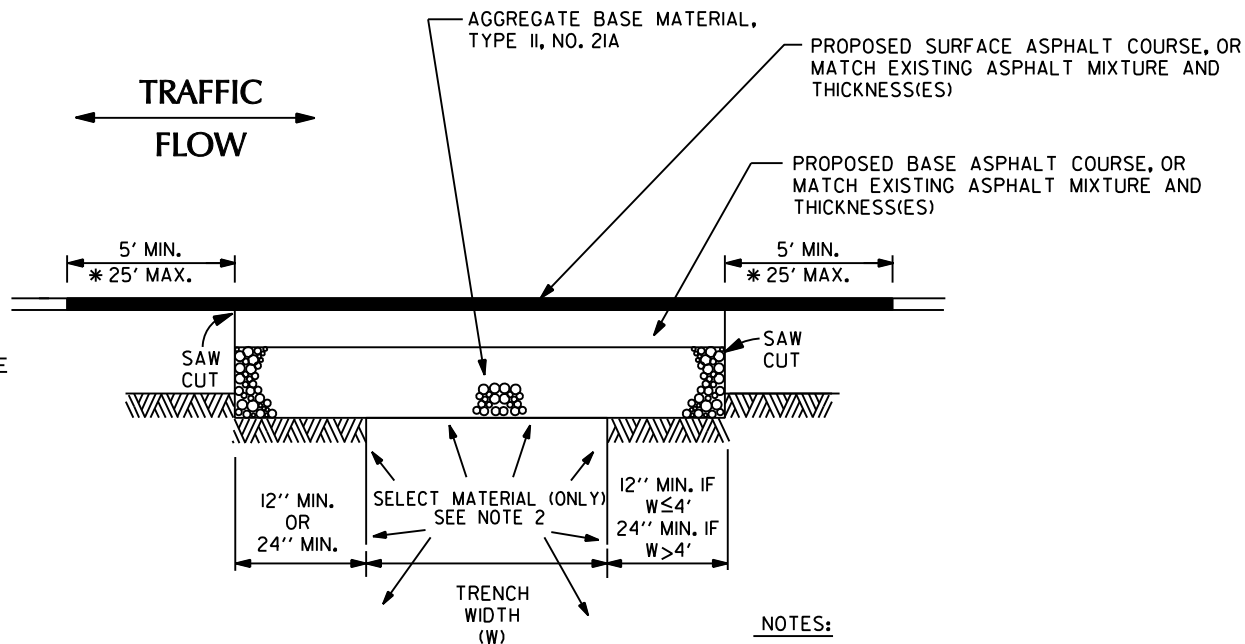
PUBLIC WORKS

C-2

● **ROADWAY RECONSTRUCTION** - IS DEFINED AS A RECONSTRUCTION OF PAVEMENT THAT HAS BEEN REMOVED TO SUCH EXTENT THAT THIS PAVEMENT PATCH CANNOT BE USED. IN THE CASE OF ROADWAY RECONSTRUCTION, THE CONSULTING ENGINEER SHALL DESIGN THE PAVEMENT THICKNESS BASED ON THE CBR, ETC. OF THE SOIL TO GO BACK IN THE TRENCH. SEE SECTION 5.11 OF PUBLIC WORKS DESIGN STANDARDS, AND ROADWAY PATCH DEFINITION.

● **ROADWAY PATCH** - IS DEFINED AS A REPAIR OF A PAVEMENT CUT THAT DOES NOT EXCEED APPROX. 5' WIDE, AT AN ANGLE BETWEEN 45 DEGREES AND 90 DEGREES TO THE LENGTH OF THE ROADWAY, OR UP TO A 10' x 10' SQUARE. MORE EXTENSIVE PAVEMENT CUTS ARE CONSIDERED ROADWAY RECONSTRUCTION.

* IF THE EXISTING STREET HAS BEEN RESURFACED WITHIN THE LAST 2 YEARS THEN IT IS IN A MORATORIUM STATUS OF "NO OPEN CUTS" PERMITTED WITHOUT PUBLIC WORKS APPROVAL. IF APPROVED THEN AN ADDITIONAL 25-FOOT AREA BEFORE AND AFTER THE TRENCH AREA WILL HAVE TO BE MILLED AND RESURFACED WITH AN APPROPRIATE SURFACE ASPHALT COURSE MIX TO PROVIDE A SMOOTH TRANSITION.



NOTES:

- 1) SEE SECTION 5 IN PUBLIC WORKS DESIGN STANDARDS. IN ALL CASES, IT IS ALWAYS PREFERABLE TO ACTUALLY DESIGN ANY PAVEMENT PATCH AND REPAIRS BASED ON GOOD ENGINEERING PRACTICES.
- 2) BACKFILL TO BE SELECT MATERIAL (CBR $\geq$ 15) COMPACTED IN 12" LAYERS TO 3' BELOW PAVEMENT AND THEN IN 6" LAYERS THEREAFTER TO 95% OF THE ASTM D-698 MAXIMUM THEORETICAL DENSITY.
- 3) USE OF TEMPORARY STEEL BRIDGE PLATE FOR TRAFFIC PRIOR TO PLACEMENT OF ASPHALT MUST BE APPROVED BY CITY INSPECTOR.

ROADWAY PATCH FOR ASPHALT (ONLY) STREETS WITH THE CLASSIFICATION OF LOCAL OR COLLECTOR SHALL BE THE GREATER OF:

- MATCH THE EXISTING PAVEMENT, OR
- 1 1/2" SM-9.5A SURFACE ASPHALT CONCRETE, OVER 3" BM-25.0A BASE MIX ASPHALT CONCRETE, OVER 6" AGGREGATE BASE MATERIAL, TYPE I NO. 21A, OVER COMPACTED SUBGRADE IF SUBGRADE IS A MINIMUM CBR OF 15. OTHERWISE SELECT MATERIAL WITH CBR $\geq$ 15 TO BE USED AS BACKFILL. IF CONCRETE IS UNDER ASPHALT, THEN CONCRETE MUST BE USED AND MATCH EXISTING PAVEMENT. SEE NOTE #1.

(N.T.S.)
REV. 5/14



CITY OF VIRGINIA BEACH
STANDARD

FLEXIBLE PAVEMENT PATCH FOR
LOCAL & COLLECTOR STREETS

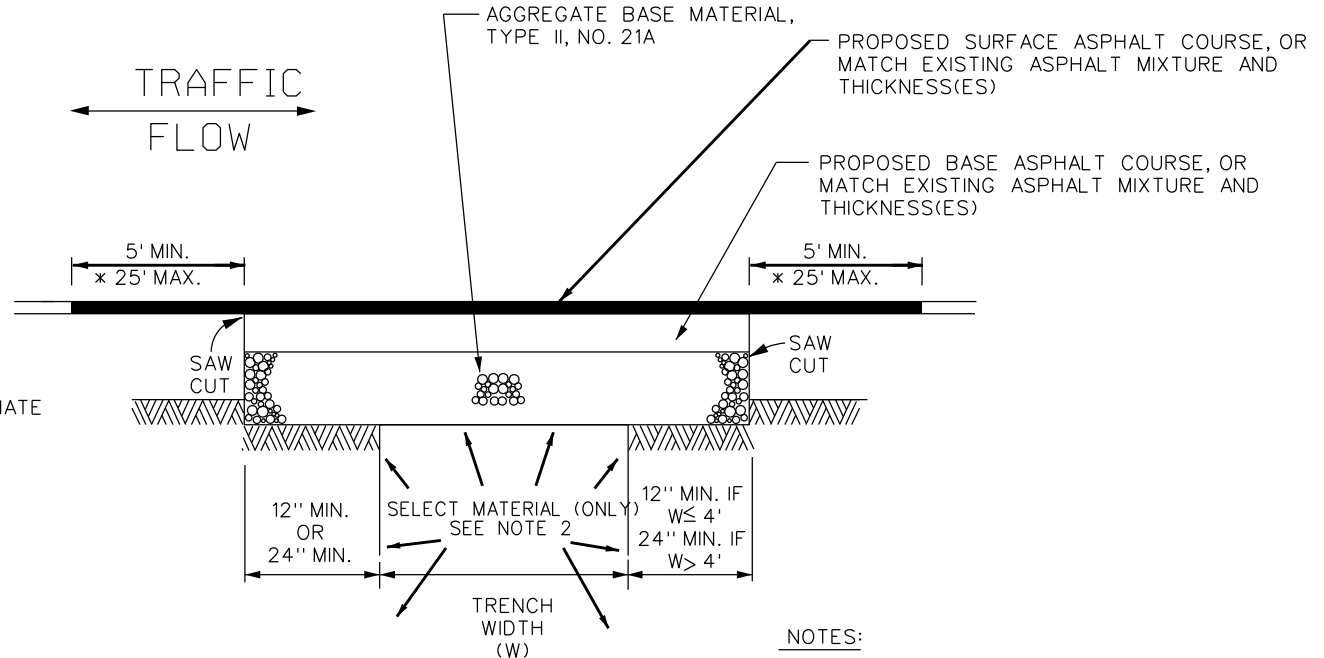
PUBLIC WORKS

C-3A

● ROADWAY RECONSTRUCTION IS DEFINED AS A RECONSTRUCTION OF PAVEMENT THAT HAS BEEN REMOVED TO SUCH EXTENT THAT THIS PAVEMENT PATCH CANNOT BE USED. IN THE CASE OF ROADWAY RECONSTRUCTION, THE CONSULTING ENGINEER SHALL DESIGN THE PAVEMENT THICKNESS BASED ON THE CBR, ETC. OF THE SOIL TO GO BACK IN THE TRENCH. SEE SECTION 5.11 OF PUBLIC WORKS DESIGN STANDARDS, AND ROADWAY PATCH DEFINITION.

● ROADWAY PATCH- IS DEFINED AS A REPAIR OF A PAVEMENT CUT THAT DOES NOT EXCEED APPROX. 5' WIDE, AT AN ANGLE BETWEEN 45 DEGREES AND 90 DEGREES TO THE LENGTH OF THE ROADWAY, OR UP TO A 10' x 10' SQUARE. MORE EXTENSIVE PAVEMENT CUTS ARE CONSIDERED ROADWAY RECONSTRUCTION.

* IF THE EXISTING STREET HAS BEEN RESURFACED WITHIN THE LAST 2 YEARS THEN IT IS IN A MORATORIUM STATUS OF "NO OPEN CUTS" PERMITTED WITHOUT PUBLIC WORKS APPROVAL. IF APPROVED THEN AN ADDITIONAL 25-FOOT AREA BEFORE AND AFTER THE TRENCH AREA WILL HAVE TO BE MILLED AND RESURFACED WITH AN APPROPRIATE SURFACE ASPHALT COURSE MIX TO PROVIDE A SMOOTH TRANSITION.



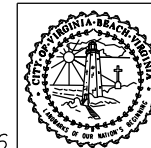
NOTES:

- 1) SEE SECTION 5 IN PUBLIC WORKS DESIGN STANDARDS. IN ALL CASES, IT IS ALWAYS PREFERABLE TO ACTUALLY DESIGN ANY PAVEMENT PATCH AND REPAIRS BASED ON GOOD ENGINEERING PRACTICES.
- 2) BACKFILL TO BE SELECT MATERIAL (CBR 15) COMPACTED IN 12" LAYERS TO 3' BELOW PAVEMENT AND THEN IN 6" LAYERS THEREAFTER TO 95% OF THE ASTM D-698 MAXIMUM THEORETICAL DENSITY.
- 3) USE OF TEMPORARY STEEL BRIDGE PLATE FOR TRAFFIC PRIOR TO PLACEMENT OF ASPHALT MUST BE APPROVED BY CITY INSPECTOR.

ROADWAY PATCH FOR ASPHALT (ONLY) STREETS WITH THE CLASSIFICATION OF MAJOR OR MINOR ARTERIALS SHALL BE THE GREATER OF:

- MATCH THE EXISTING PAVEMENT SECTION, OR
- 2" SM-9.5A SURFACE ASPHALT CONCRETE, OVER 4" BM-25.0D BASE MIX ASPHALT CONCRETE, OVER 8" AGGREGATE BASE MATERIAL, TYPE I NO. 21A, OVER COMPACTED SUBGRADE IF SUBGRADE IS A MINIMUM CBR OF 15. OTHERWISE, SELECT GRANULAR MATERIAL WITH CBR 15 AND USE AS BACKFILL. IF CONCRETE IS UNDER ASPHALT, THEN CONCRETE MUST BE USED AND MATCH EXISTING PAVEMENT. SEE NOTE *1.

(N.T.S.)
REV. 04/16



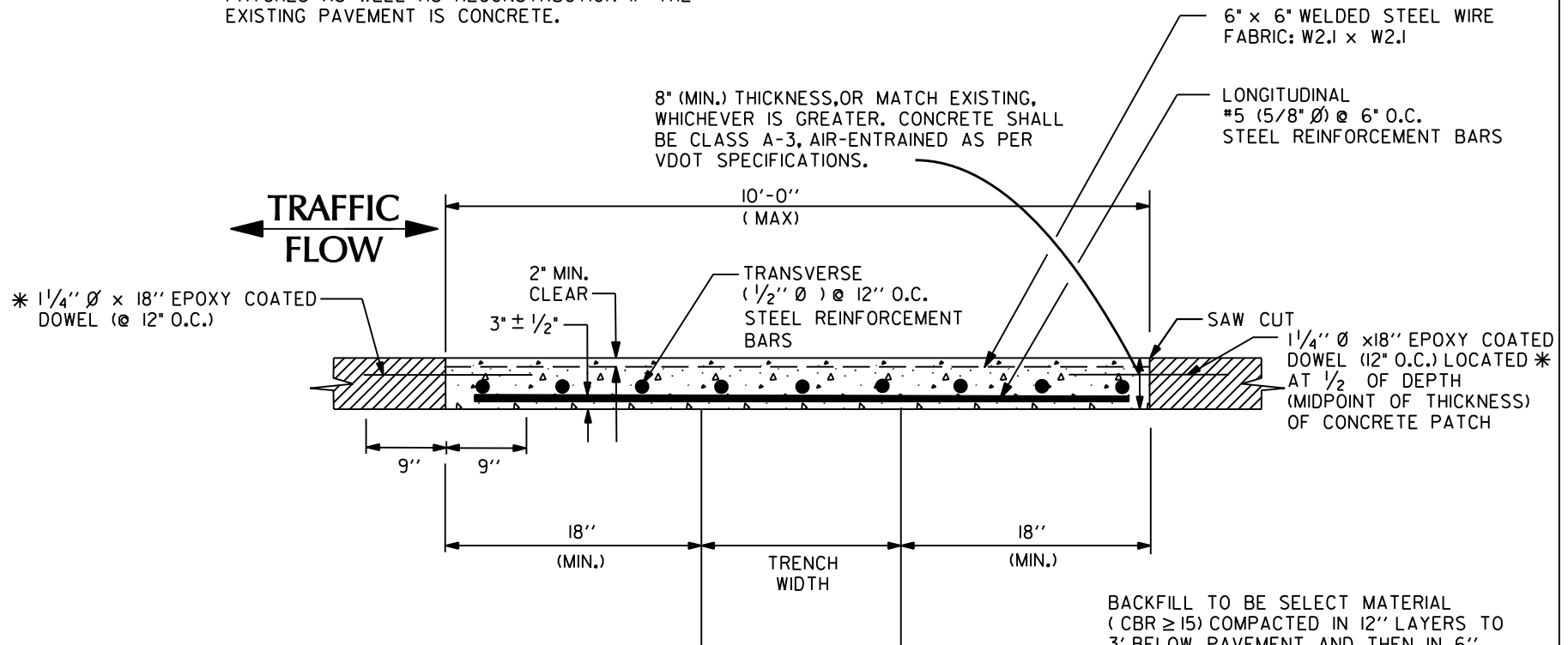
CITY OF VIRGINIA BEACH
STANDARD

FLEXIBLE PAVEMENT PATCH
FOR MAJOR & MINOR ARTERIALS

PUBLIC WORKS C-3B

● **ROADWAY RECONSTRUCTION** - IS DEFINED AS A RECONSTRUCTION OF PAVEMENT THAT HAS BEEN REMOVED TO SUCH EXTENT THAT THIS PAVEMENT PATCH CAN'T BE USED. IN THE CASE OF ROADWAY RECONSTRUCTION, THE CONSULTING ENGINEER SHALL DESIGN THE PAVEMENT THICKNESS BASED ON THE CBR, ETC. OF THE SOIL TO GO BACK IN THE TRENCH. SEE SECTION 5.11 OF PUBLIC WORKS DESIGN STANDARDS. HOWEVER, ONLY CONCRETE IS TO BE USED FOR PATCHES AS WELL AS RECONSTRUCTION IF THE EXISTING PAVEMENT IS CONCRETE.

● **ROADWAY PATCH** - IS DEFINED AS A REPAIR OF A PAVEMENT CUT HAS NOT BEEN CUT NO MORE THAN 5' WIDE, AT AN ANGLE BETWEEN 45 AND 90 DEGREES TO THE LENGTH OF THE ROADWAY, OR UP TO A 10' x 10' SQUARE. MORE EXTENSIVE PAVEMENT CUTS ARE CONSIDERED ROADWAY RECONSTRUCTION.



NOTES:

- 1) ASPHALT PATCHES AND ASPHALT PAVEMENT WIDENING SHALL NOT BE UTILIZED ON CONCRETE, OR ASPHALT ROAD OVER CONCRETE PAVEMENTS UNLESS APPROVED BY CITY INSPECTOR.
- 2) ONLY CONCRETE IS TO BE USED ON ROADWAY PATCHES AND RECONSTRUCTION WHERE THE EXISTING PAVEMENT IS CONCRETE.
- 3) IF THE EXISTING PAVEMENT HAS ASPHALT OVERLAY ON CONCRETE, THEN A SPECIAL PAVEMENT PATCH SECTION SHALL BE DESIGNED BY THE DESIGN ENGINEER.

BACKFILL TO BE SELECT MATERIAL (CBR ≥ 15) COMPACTED IN 12" LAYERS TO 3' BELOW PAVEMENT AND THEN IN 6" LAYERS THEREAFTER TO 95% OF THE ASTM D-698 MAXIMUM THEORETICAL DENSITY.

* THE 1 1/4" DIAMETER x 18" DOWEL MAY BE OMITTED IF AT LEAST 9" OF EXISTING REINFORCING STEEL STRAIGHTENED, EPOXY APPLIED, AND LEFT IN PLACE, IS IN EXCELLENT SHAPE.

(N.T.S.)
REV. 5/14



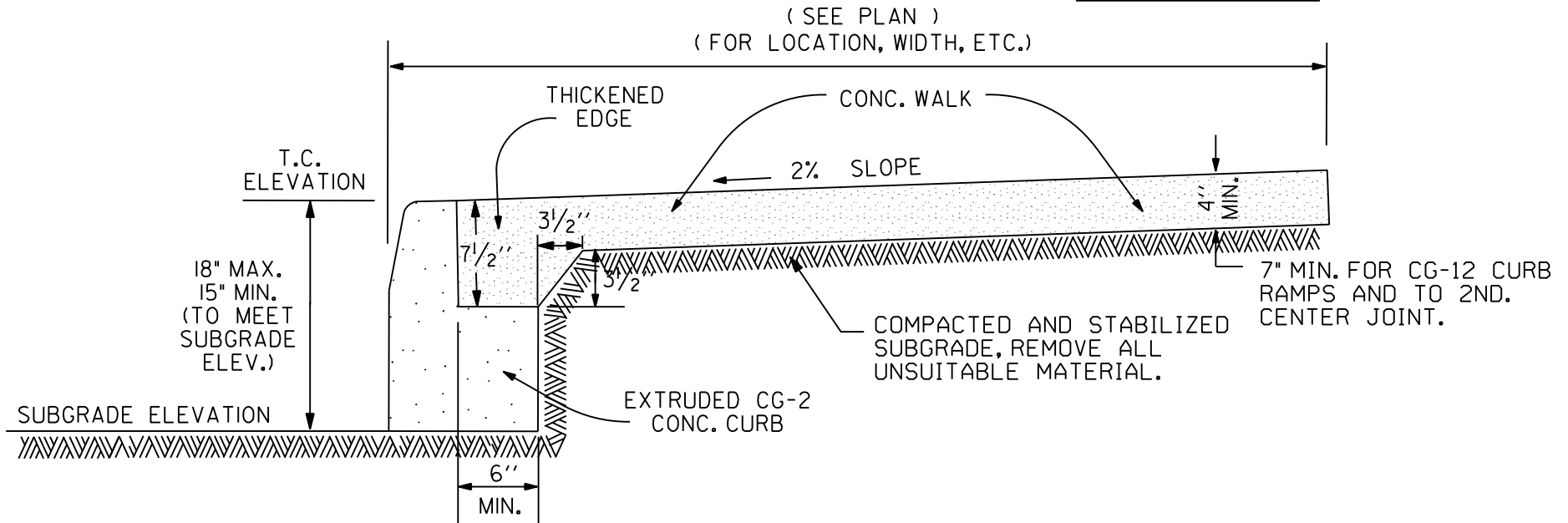
CITY OF VIRGINIA BEACH
STANDARD

RIGID PAVEMENT PATCHING

PUBLIC WORKS

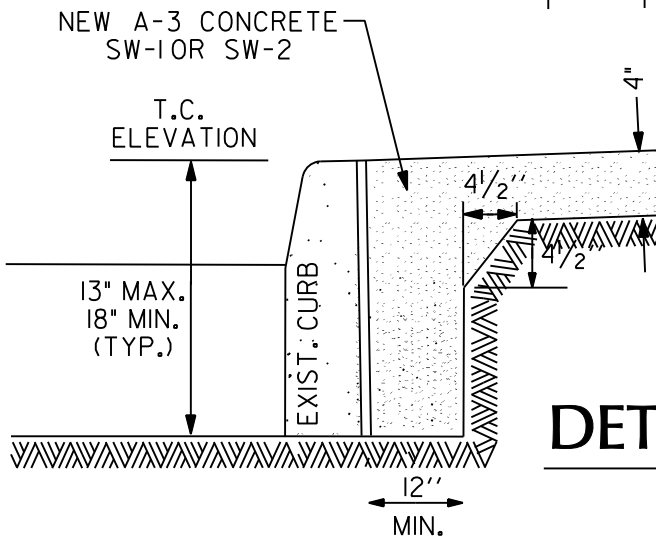
C-4

DETAIL A:



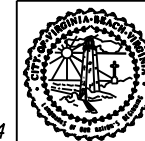
NOTES :

- (1.) IF THIS CURB IS NOT EXTRUDED THEN CONC. WALK SHALL BE POURED MONOLITHIC WITH CURB. IF CURB IS EXISTING THEN DOWELLING OR OTHER MEANS SUCH AS DETAIL B SHALL BE UTILIZED.
- (2.) IF THE FACE OF CURB IS TO MATCH CG-3, OR CG-7, THEN THE OVERALL HEIGHT DIMENSIONS SHALL BE ADJUSTED ACCORDINGLY (2" LESS.)



DETAIL B:

(N.T.S.)
REV. 5/14

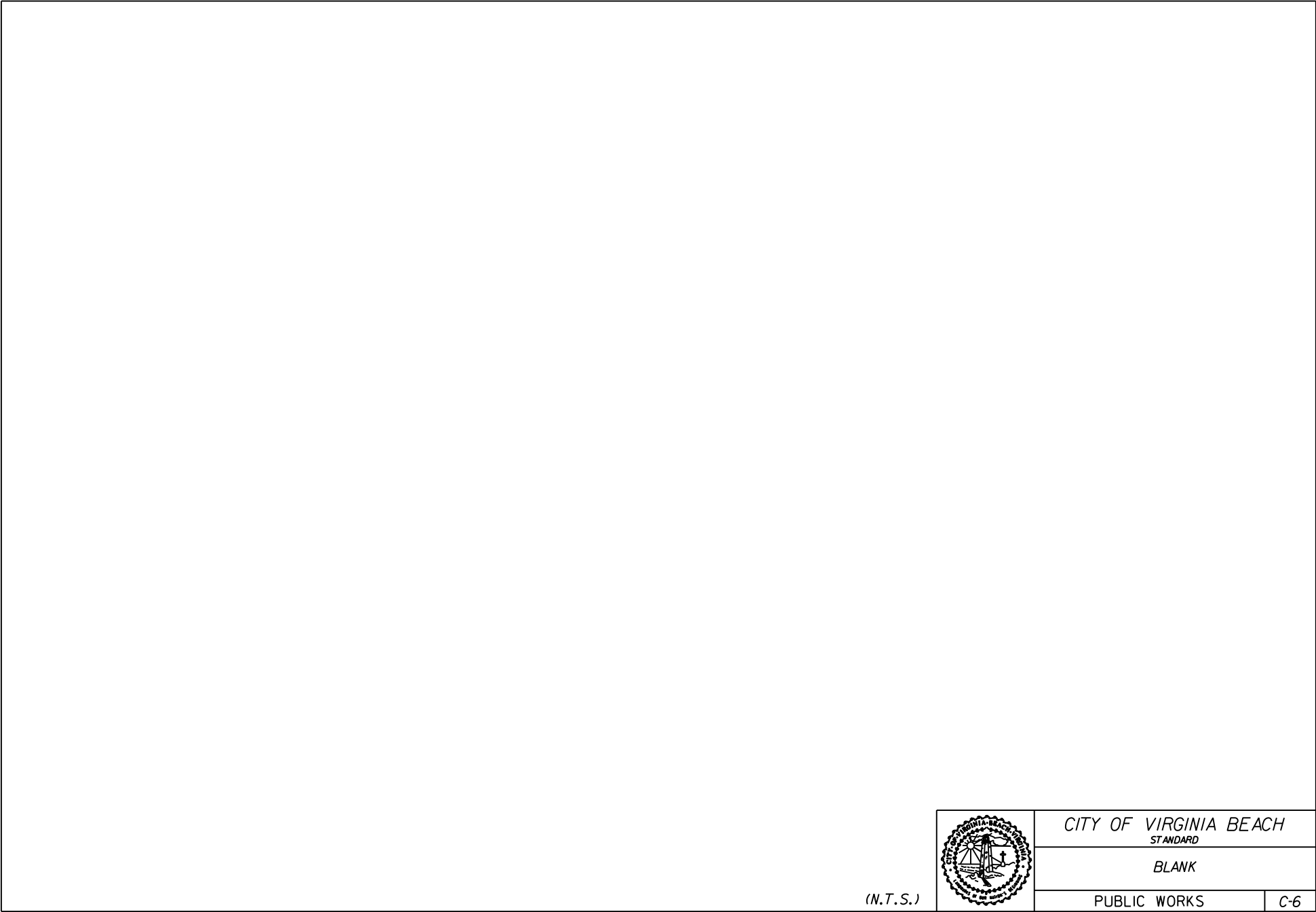


CITY OF VIRGINIA BEACH
STANDARD

SIDEWALK CONNECTION TO
CURB ALTERNATE

PUBLIC WORKS

C-5



(N.T.S.)



CITY OF VIRGINIA BEACH	
STANDARD	
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PUBLIC WORKS	C-6

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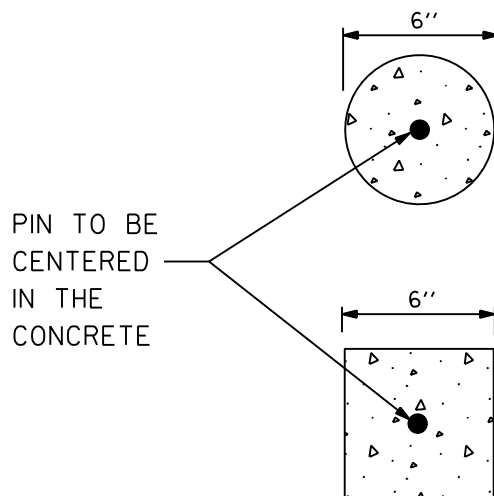


CITY OF VIRGINIA BEACH
STANDARD

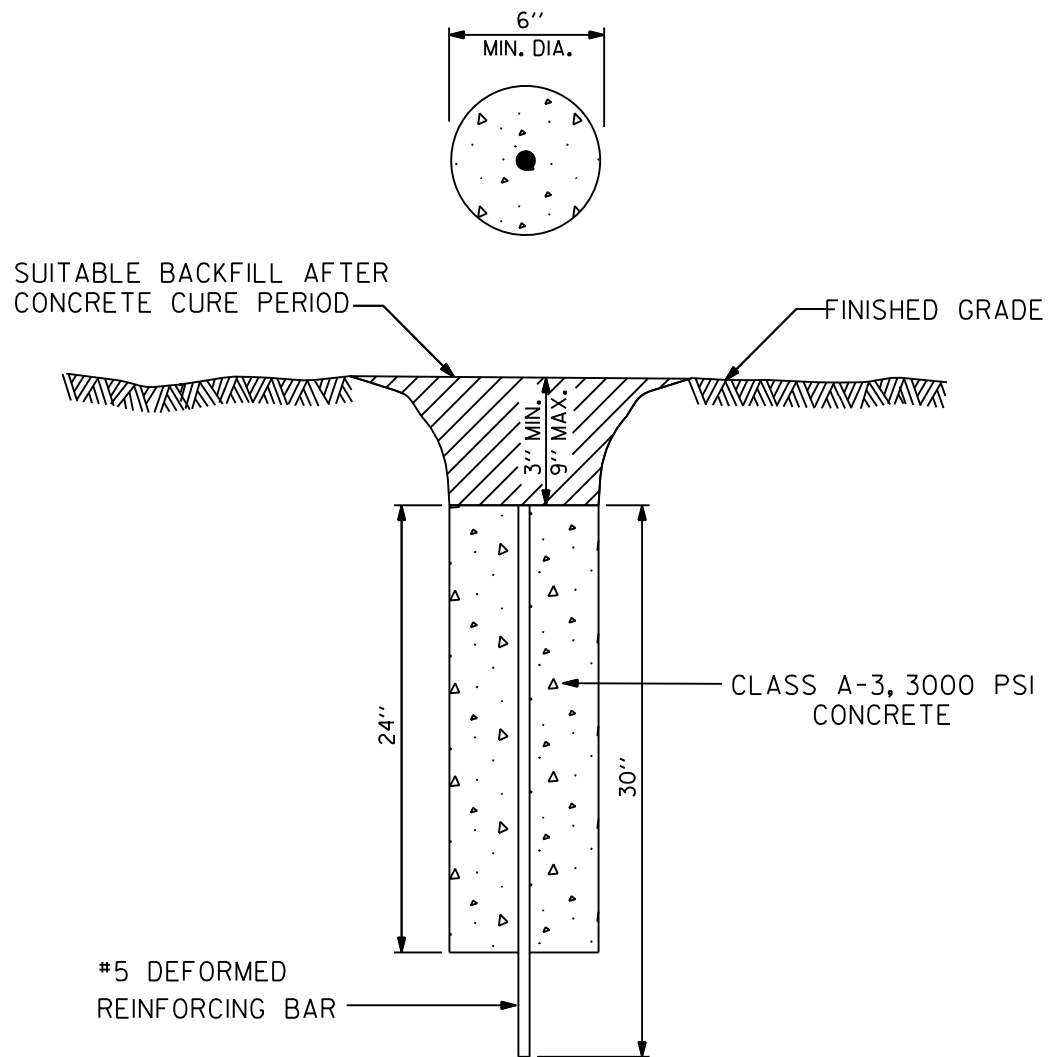
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PUBLIC WORKS

C-7



MONUMENT MAY BE
PRECAST OR POURED
IN PLACE



(N.T.S.)
REV. 5/14

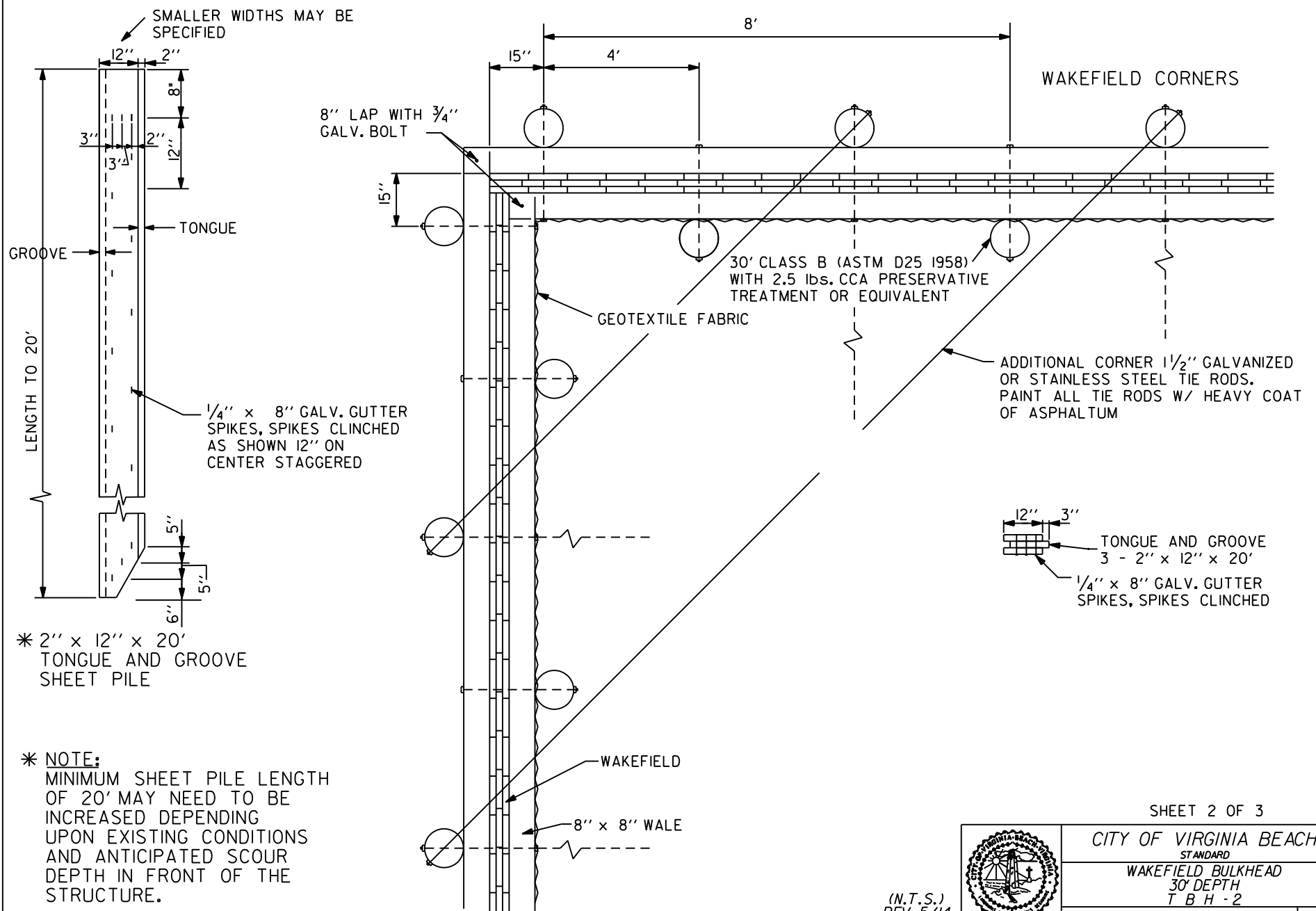


CITY OF VIRGINIA BEACH
STANDARD

PERMANENT SURVEY MONUMENT

PUBLIC WORKS

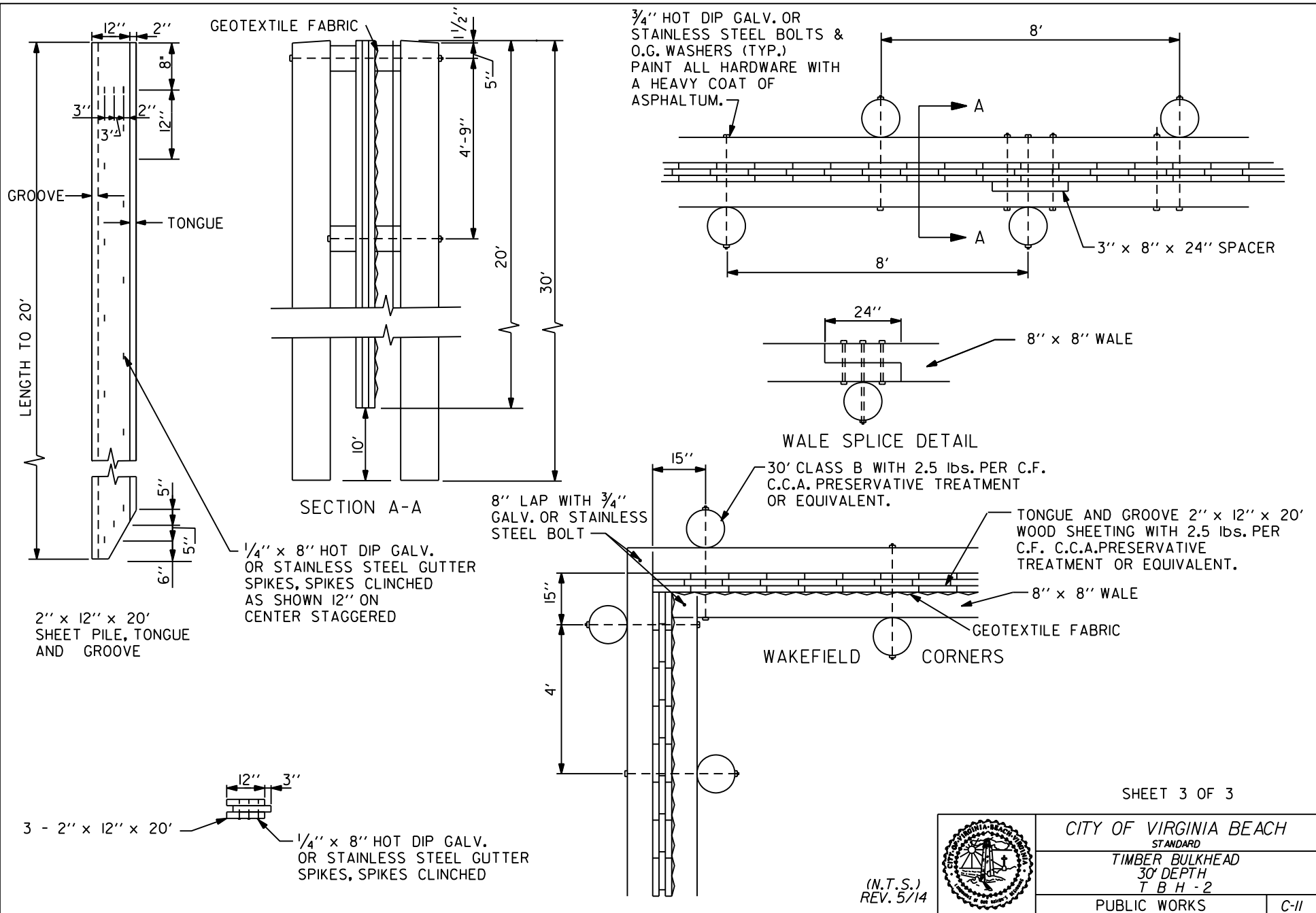
C-8

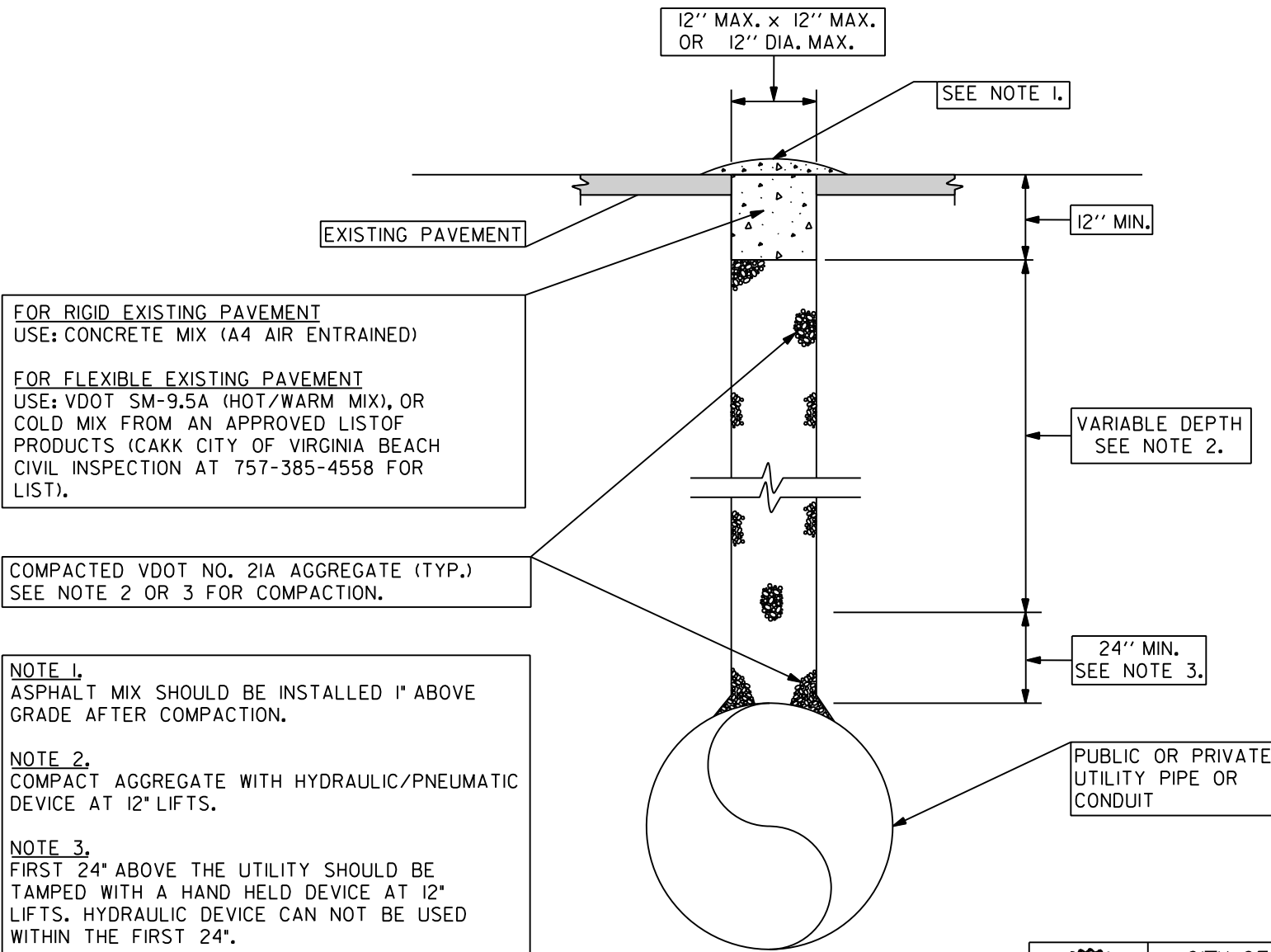


(N.T.S.)
REV. 5/14



SHEET 2 OF 3	
CITY OF VIRGINIA BEACH	
STANDARD	
WAKEFIELD BULKHEAD	
30' DEPTH	
T B H - 2	
PUBLIC WORKS	C-10





(N.T.S.)
REV. 5/14



CITY OF VIRGINIA BEACH
STANDARD

UTILITY TEST HOLE BACKFILL

PUBLIC WORKS

C-12



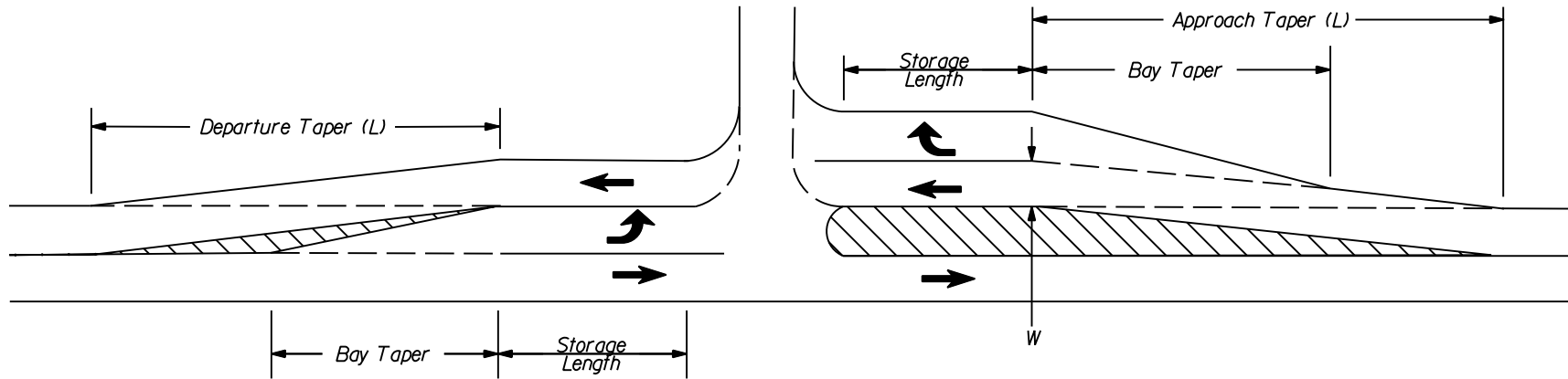
Appendix D

Traffic Engineering Standard Drawings

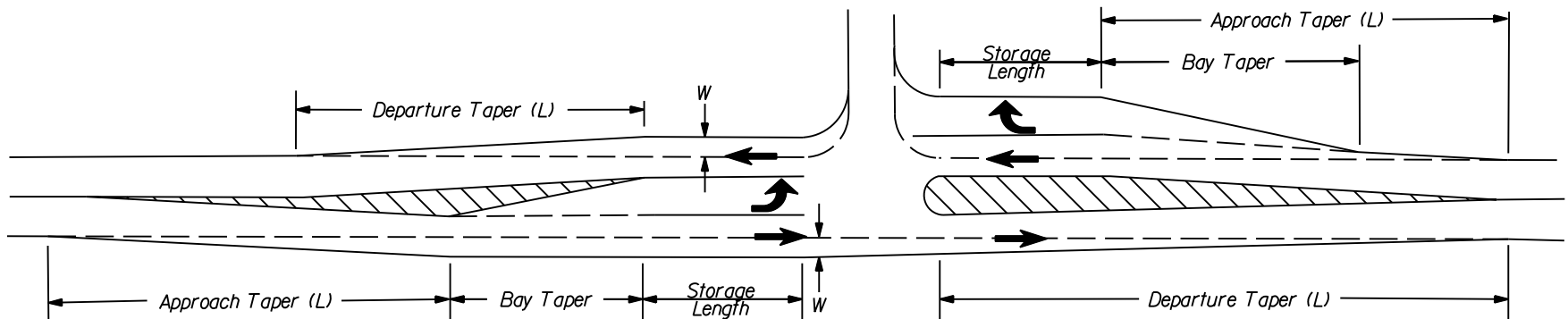
D.1 Intent

The following standard drawings are intended to be an integral part of these standards. Any deviation from the standard must be reviewed by the City's engineer and approved prior to the installation of any modified section, structure, or standard.

Near Side Widening



Symmetrical Widening



Approach and Departure Taper Length Formulas

$$S \leq 40 \text{ mph, } L = \frac{WS^2}{60}$$

$$S > 40 \text{ mph, } L = WS$$

L = length of taper
 W = offset distance in feet
 S = posted speed limit

For Storage Length And Bay Taper Dimensions
 Refer to section 3J0
 "Turn Lanes" of this manual

(N.T.S.)
 REV. 5/14

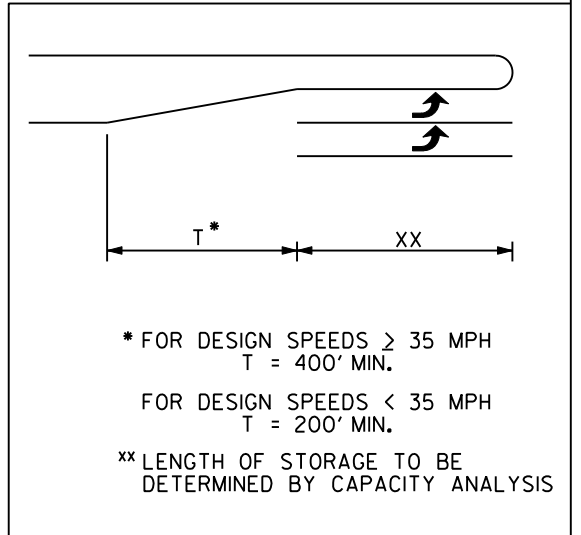
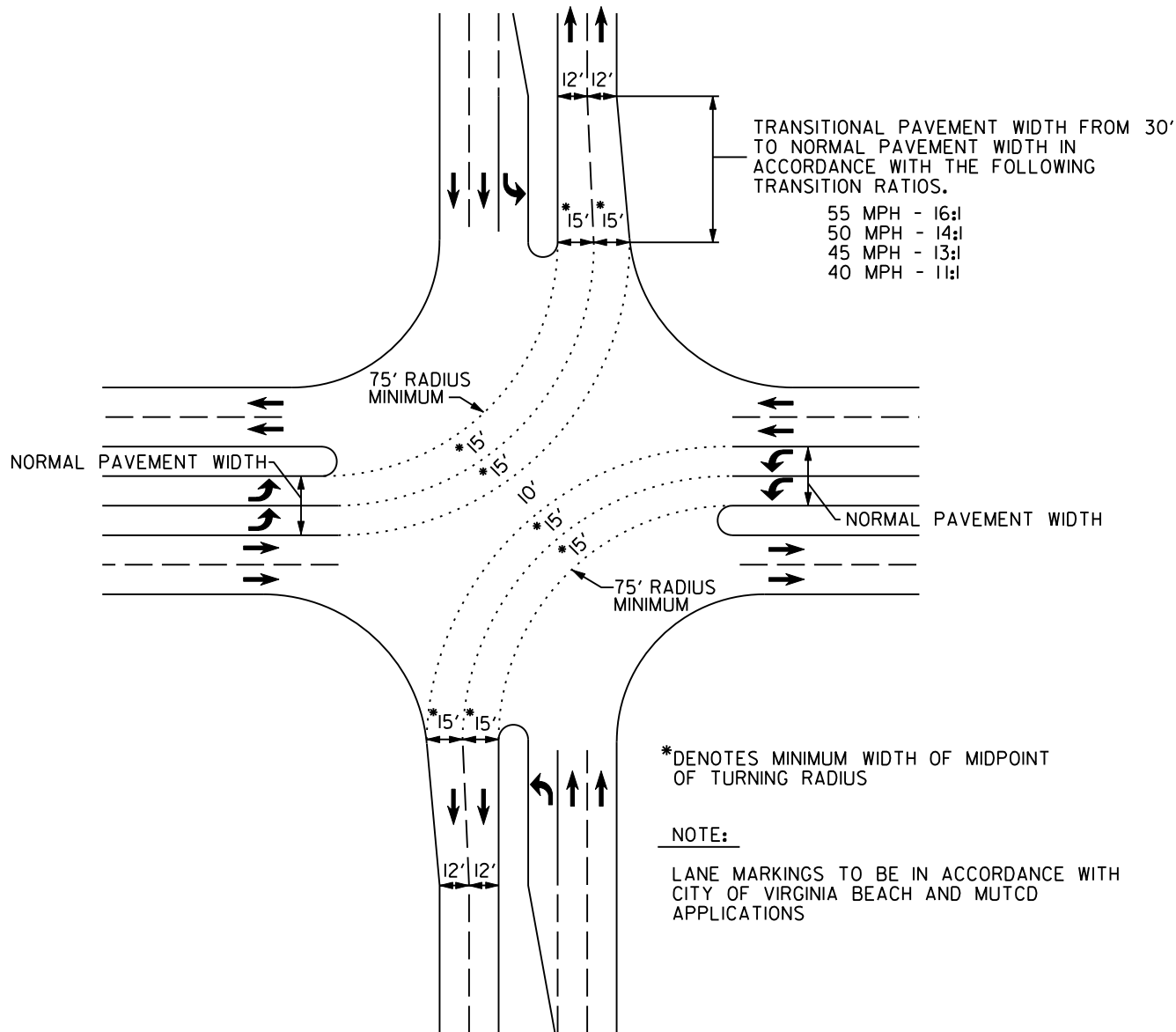


CITY OF VIRGINIA BEACH
 STANDARD

TURN LANE WIDENING

PUBLIC WORKS

D-1



(N.T.S.)
REV. 10/15

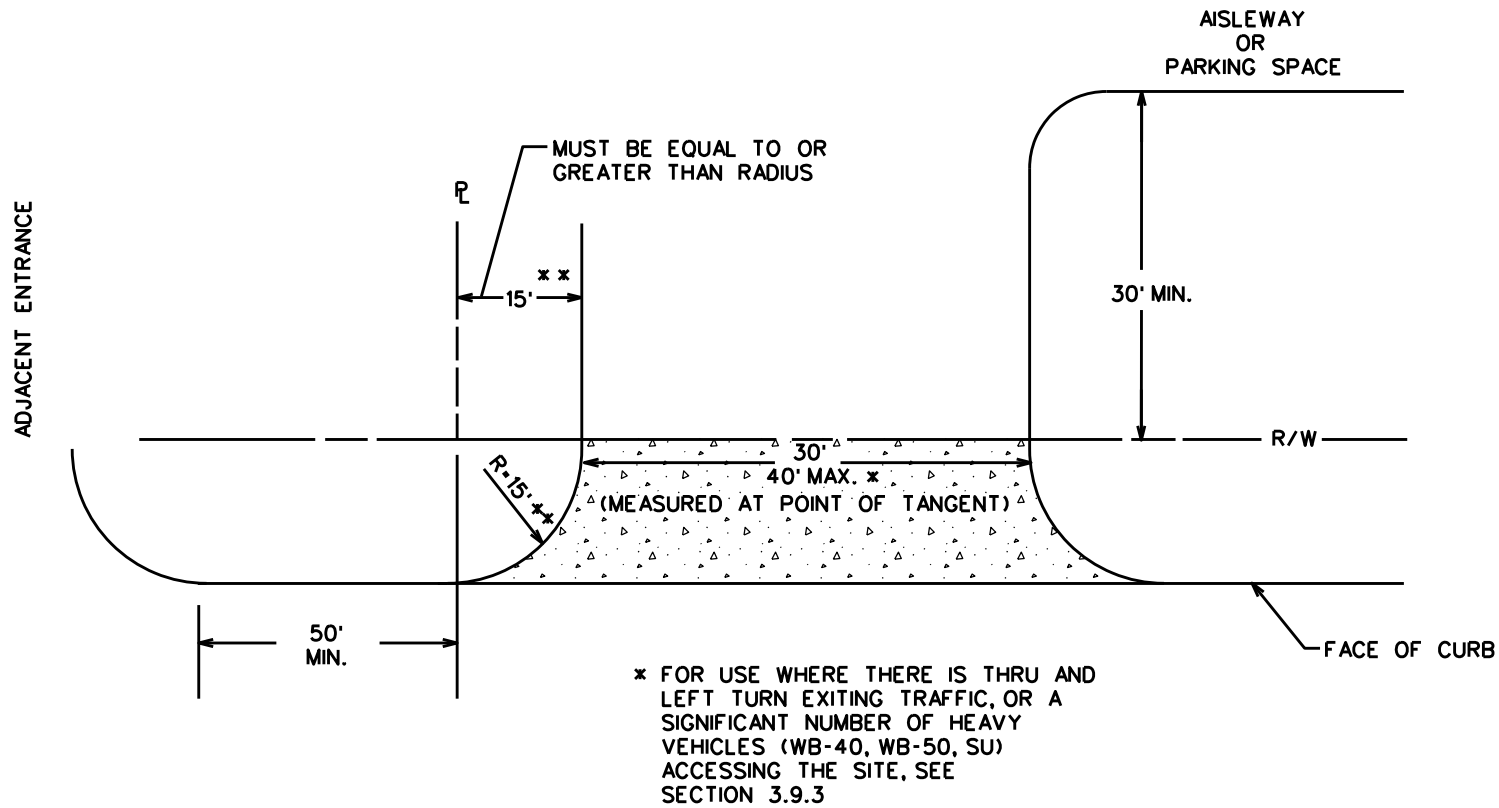


CITY OF VIRGINIA BEACH
STANDARD

DOUBLE LEFT TURN LANE
GEOMETRICS

PUBLIC WORKS

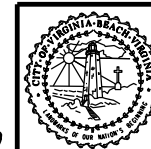
D-2



NOTES:

1. FOR TWO-WAY (ENTERING AND EXITING) TRAFFIC
2. NOT FOR DIVIDED COMMERCIAL ENTRANCES
3. ENTRANCE TO BE 7" THICK CONCRETE, TO THE PROPERTY LINE
4. ENTRANCES TO BE VDOT STANDARD, INCORPORATING NOTE #3 ABOVE
5. CG-11 CONCRETE ENTRANCES REQUIRE THE USE OF CG-12 RAMPS ON BOTH SIDES, AND GRADES MUST BE SHOWN TO PREVENT STORMWATER FLOWING ONTO PRIVATE PROPERTY

(N.T.S.)
REV.02/19

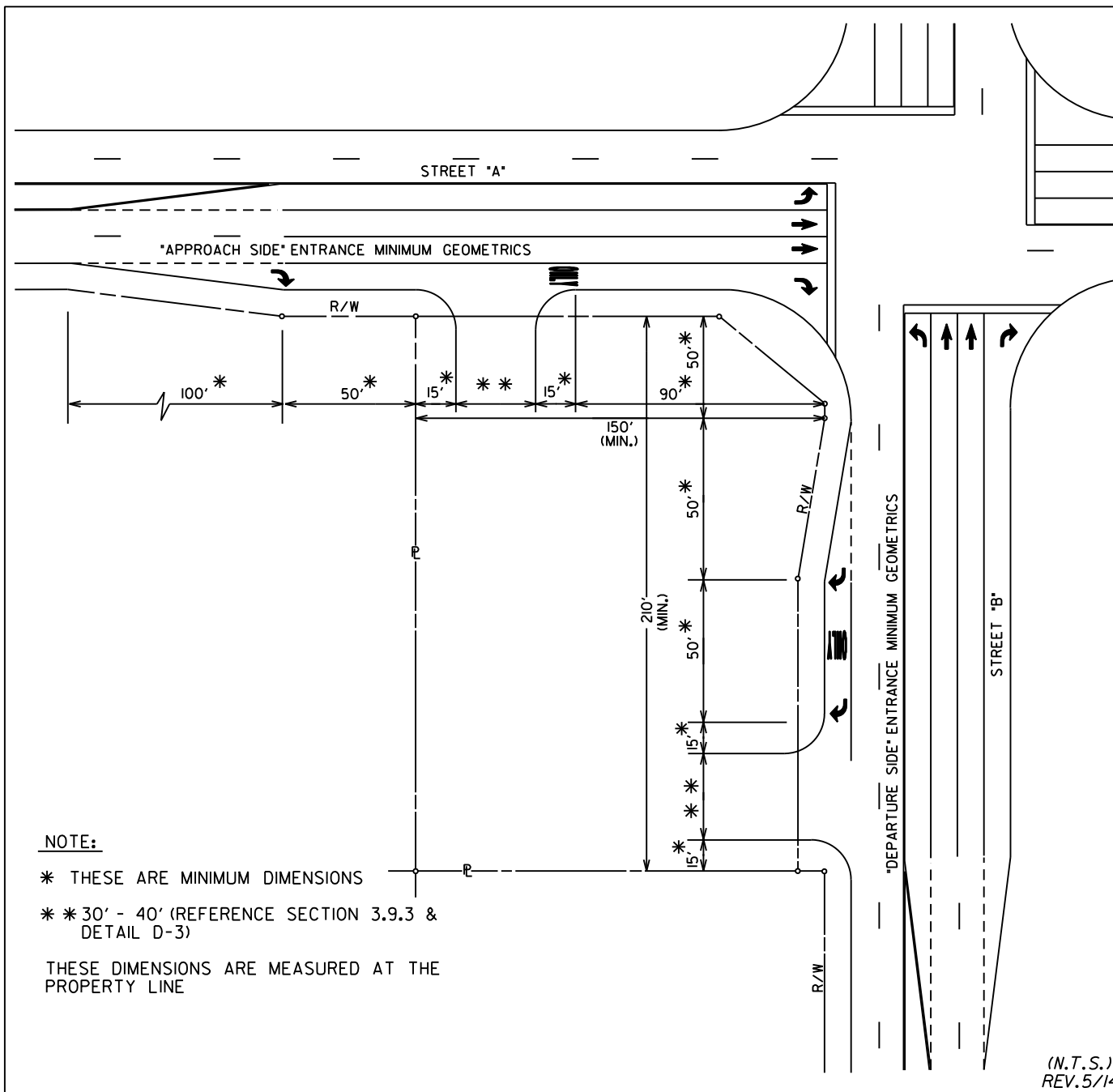


CITY OF VIRGINIA BEACH
STANDARD

COMMERCIAL ENTRANCES

PUBLIC WORKS

D-3



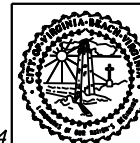
NOTES:

1. SEE DRAWING D-3 AND OTHER DRAWINGS IN APPENDICES "A" AND "C" FOR MORE DETAIL. REFER TO 3.9.3 FOR TEXT.
2. IF MINIMUM DIMENSIONS CANNOT BE MET THEN ENTRANCES IN RIGHT TURN LANES SHOULD NOT BE BUILT
3. ENTRANCES SHALL NOT BE CONSTRUCTED IN TAPER SECTIONS

NOTE:

- * THESE ARE MINIMUM DIMENSIONS
 - ** 30' - 40' (REFERENCE SECTION 3.9.3 & DETAIL D-3)
- THESE DIMENSIONS ARE MEASURED AT THE PROPERTY LINE

(N.T.S.)
REV. 5/14



CITY OF VIRGINIA BEACH
STANDARD

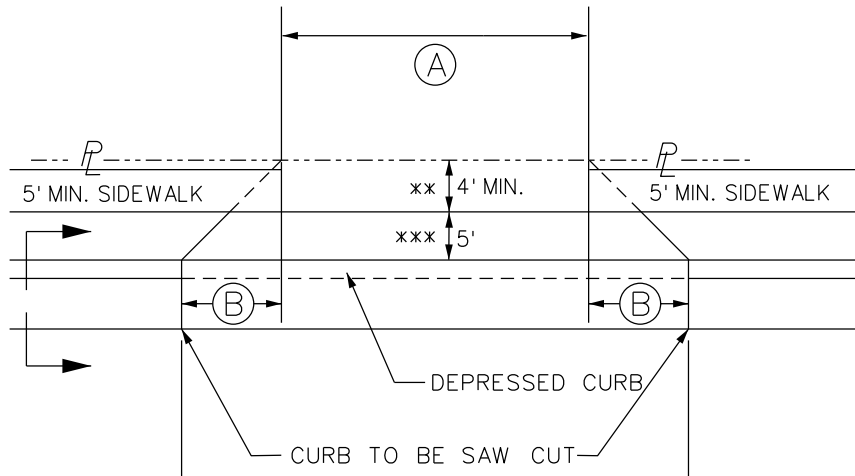
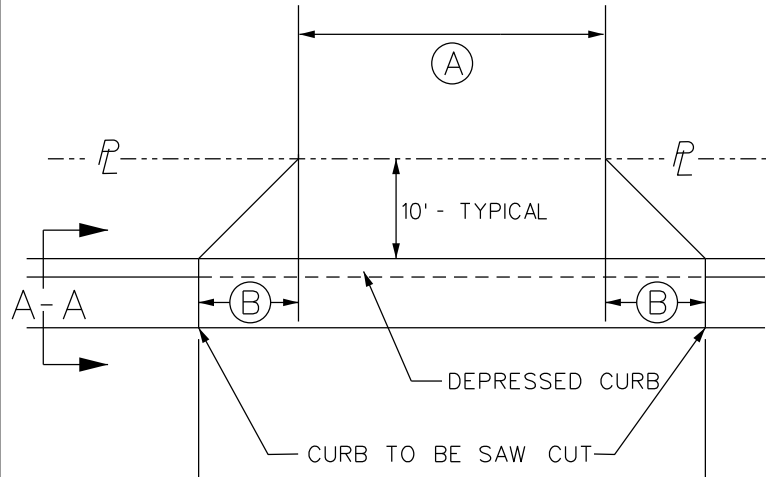
GEOMETRICS FOR MINIMUM
DIMENSIONED CORNER SITES

PUBLIC WORKS

D-4

CONSTRUCTION NOTES

1. SAW CUT TO BE COATED WITH AN APPLICATION OF A TWO (2) COMPONENT EPOXY BONDING COMPOUND IN ACCORDANCE WITH THE V.D.O.T. SPECIFICATIONS.
2. ENTRANCE SHALL NOT BE STEEPER THAN EIGHT (8) PERCENT.



** PEDESTRIAN ACCESS ROUTE WITH 4' MINIMUM TRAVERSABLE WIDTH AND 2% MAX. CROSS SLOPE.

*** NON-TRANVERSABLE SLOPE

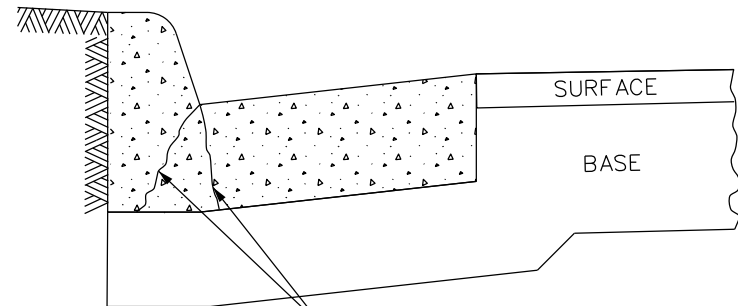
ENTRANCE REQUIREMENTS

	A (Driveway Width) See Note 1 Below	B (Flare Width)
LOCAL STREET WITHOUT CENTERLINE MARKING	9' OR GREATER	2'
LOCAL STREET WITH CENTERLINE MARKING AND A ROADWAY WIDTH OF 22 FEET OR LESS	9'	6'*
	10'	5'*
	11'	4'
	12'	3'
	13' OR GREATER	2'
LOCAL STREET WITH CENTERLINE MARKING AND A ROADWAY WIDTH GREATER THAN 22 FEET	9'	4'
	10' - 11'	3'
	12' OR GREATER	2'
ROADWAY WITH SPEED LIMIT OF 35 MPH OR GREATER	12' OR GREATER	SEE NOTE 2 BELOW

NOTES:

1. FOR NEW RESIDENTIAL ENTRANCES STANDARDS, SEE SECTION 3.9 OF THIS MANUAL.
2. INSTALL THE ENTRANCE IN ACCORDANCE WITH THE VIRGINIA DEPARTMENT OF TRANSPORTATION (VDOT) STANDARD CG-9D ENTRANCE REQUIREMENTS. THE ENTRANCE SHALL HAVE A RADIAL CURB ON EACH SIDE OF THE ENTRANCE WITH A MINIMUM RADIUS OF 15 FEET. A VDOT STANDARD PE-1, TYPE 2 ENTRANCE MAY BE USED IF NO CURB OR GUTTER EXISTS. SEE SECTION 600 OF THE VDOT ROAD AND BRIDGE STANDARDS FOR PE-1 DETAIL.

*AT THE HOMEOWNERS OPTION, THE FLARES MAY BE REDUCED TO NO LESS THAN 4'.



SAW CUT TO BE NO LESS THAN 60° NOR MORE THAN 90° FROM HORIZONTAL

SECTION A-A



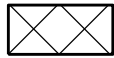
CITY OF VIRGINIA BEACH
STANDARD

RESIDENTIAL ENTRANCES

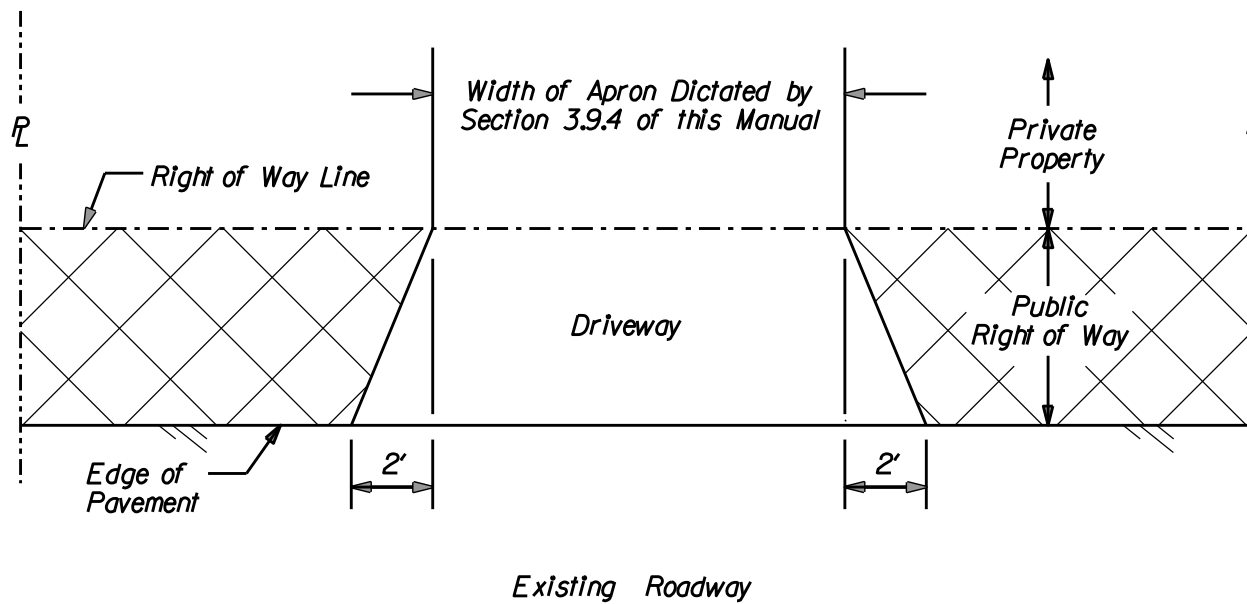
PUBLIC WORKS

D-5

(N.T.S.)
REV.07/18



Area adjacent to apron, in the right of way, shall be free of obstructions including fencing, landscaping, etc. Area shall be topsoil and seeded. Gravel and pavement is not allowed.



Note: Entrance shall not be steeper than eight (8) percent.

(N.T.S.)
REV. 02/19

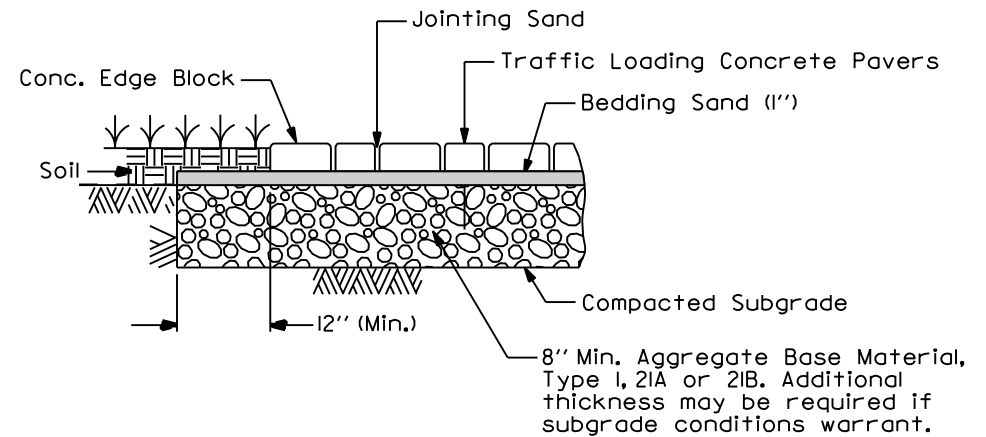
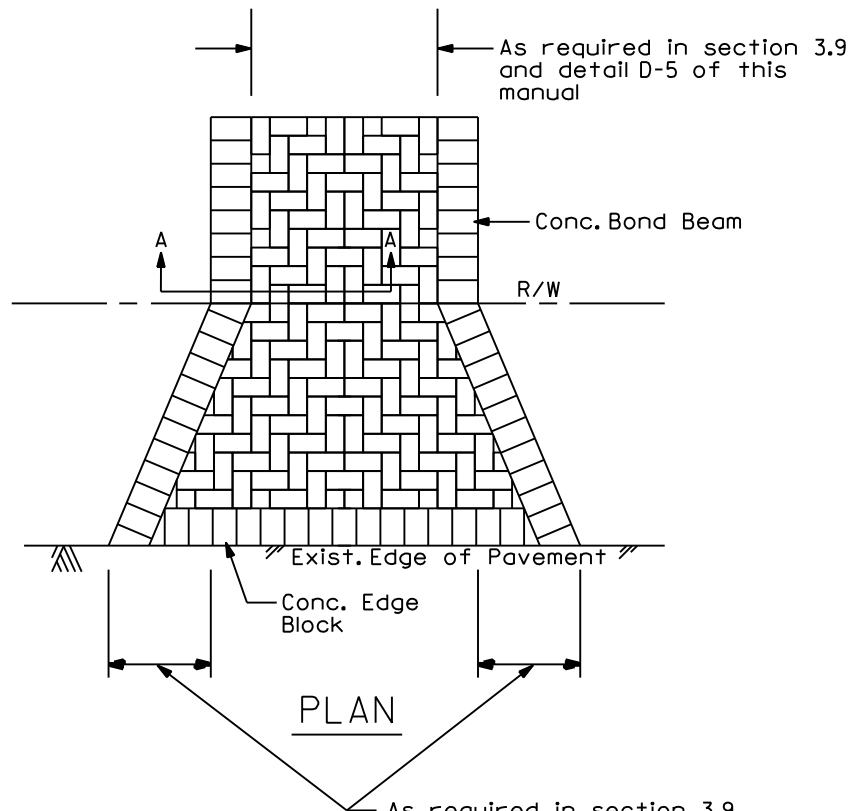


CITY OF VIRGINIA BEACH
STANDARD

NORTH BEACH STREETS
RESIDENTIAL DRIVEWAY
APRON DETAIL

PUBLIC WORKS

D-6



SECTION A-A

NOTES:

1. REFER TO SECTION 3.9 FOR OTHER ENTRANCE DESIGN REQUIREMENTS.
2. PLASTIC, STEEL, ALUMINUM OR PRECAST CONCRETE EDGING MAY BE USED IN LIEU OF CONCRETE BOND BEAM.
3. CONCRETE PAVERS SHALL MEET THE MINIMUM STANDARDS AS STATED IN THE ICPI (INTERLOCKING CONCRETE PAVING INSTITUTE) GUIDE SPECIFICATIONS.
4. CITY IS NOT RESPONSIBLE FOR MAINTENANCE OF RESIDENTIAL ENTRANCE.
5. WATER METERS AND SEWER CLEANOUTS ARE NOT TO BE LOCATED IN PAVER ENTRANCE.
6. ENTRANCE SHALL NOT BE STEEPER THAN EIGHT (8) PERCENT.

(N.T.S.)
REV. 5/14



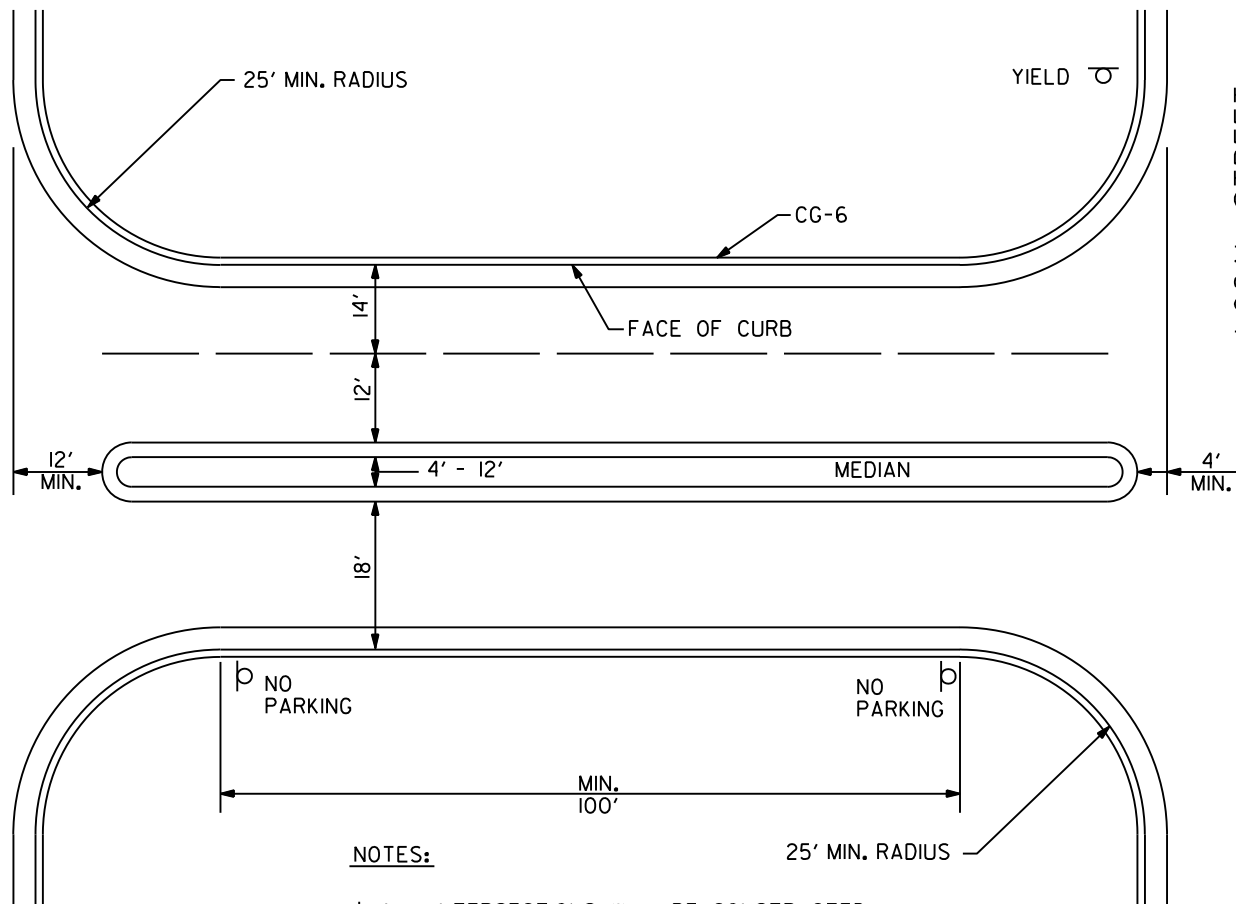
CITY OF VIRGINIA BEACH
STANDARD

RESIDENTIAL ENTRANCE
CONCRETE PAVER DETAIL

PUBLIC WORKS

D-7

ENTRANCE INTO
SUBDIVISION



LOCAL STREET
(SUBDIVISION)

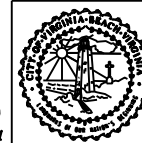
SEE NOTE 2

YIELD

NOTES:

1. ALL INTERSECTIONS WILL BE CONSTRUCTED SUCH TO CONFORM TO THE PROPER SIGHT DISTANCES AS DESCRIBED IN SECTION 3.12
2. FOUR-WAY INTERSECTIONS WILL BE CONTROLLED BY STOP SIGNS ON THE INTERNAL ROADS (IN PLACE OF THE YIELD SIGNS).

(N.T.S.)
REV. 5/14

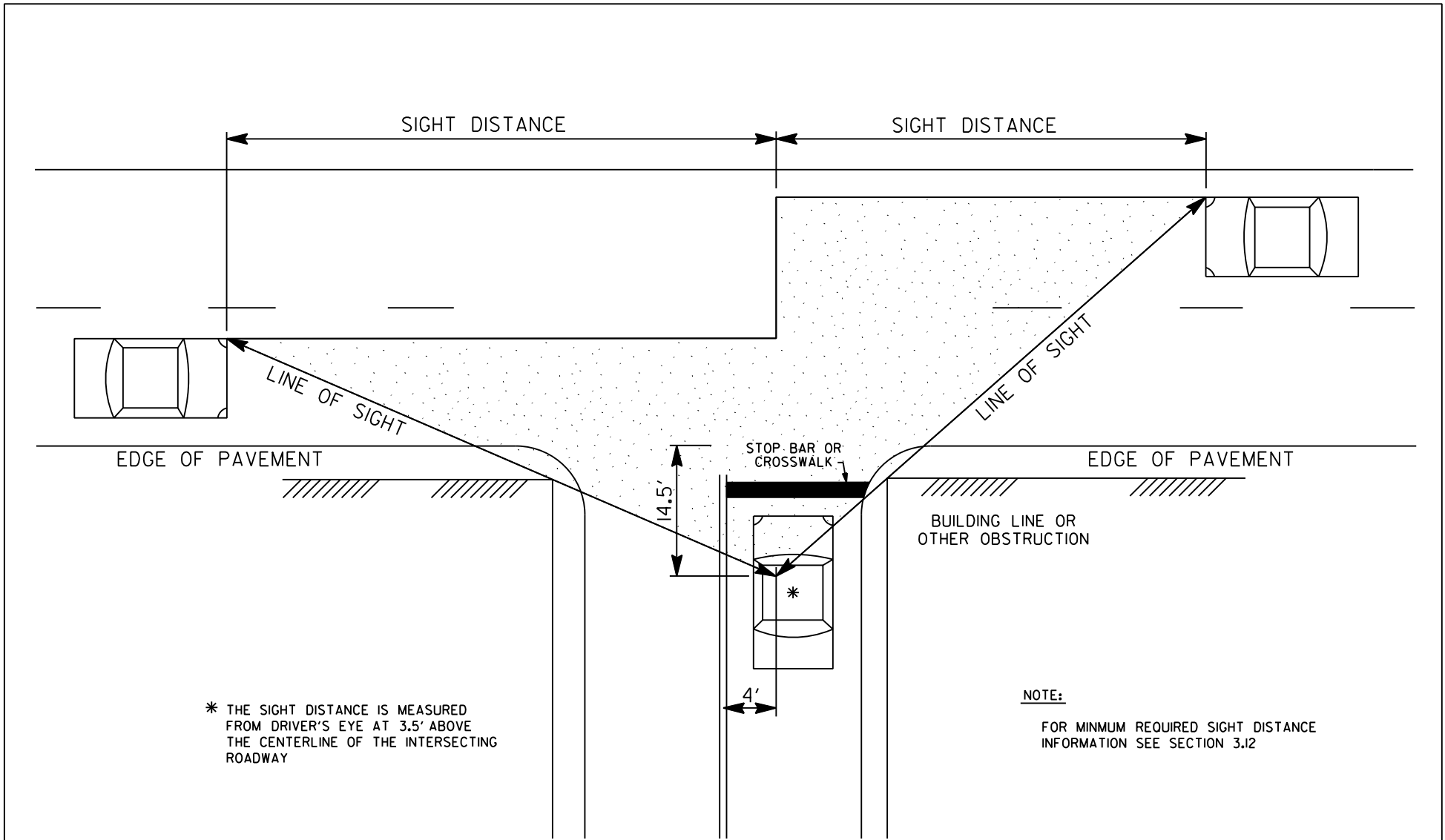


CITY OF VIRGINIA BEACH
STANDARD

SUBDIVISION ENTRANCE
WITH MEDIAN

PUBLIC WORKS

D-8



(N.T.S.)
REV.5/14



CITY OF VIRGINIA BEACH
STANDARD

VISIBILITY TRIANGLE

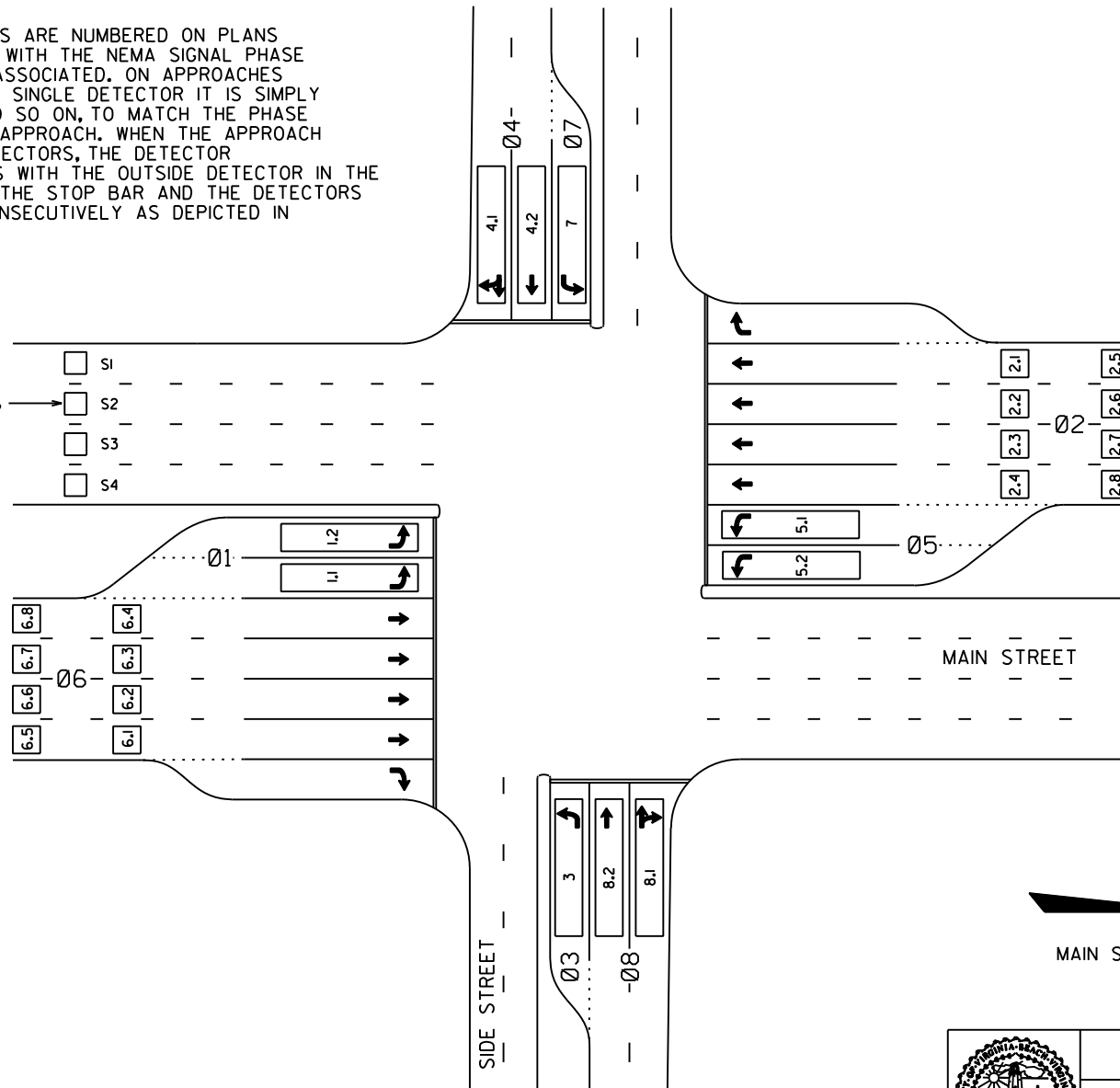
PUBLIC WORKS

D-9

VEHICLE DETECTORS ARE NUMBERED ON PLANS TO IDENTIFY EACH WITH THE NEMA SIGNAL PHASE WITH WHICH IT IS ASSOCIATED. ON APPROACHES WHERE THERE IS A SINGLE DETECTOR IT IS SIMPLY NUMBERED 1, 2, AND SO ON, TO MATCH THE PHASE NUMBER OF THAT APPROACH. WHEN THE APPROACH HAS MULTIPLE DETECTORS, THE DETECTOR NUMBERING STARTS WITH THE OUTSIDE DETECTOR IN THE SET CLOSEST TO THE STOP BAR AND THE DETECTORS ARE NUMBERED CONSECUTIVELY AS DEPICTED IN THE DIAGRAM.

SYSTEM
SAMPLING
DETECTORS

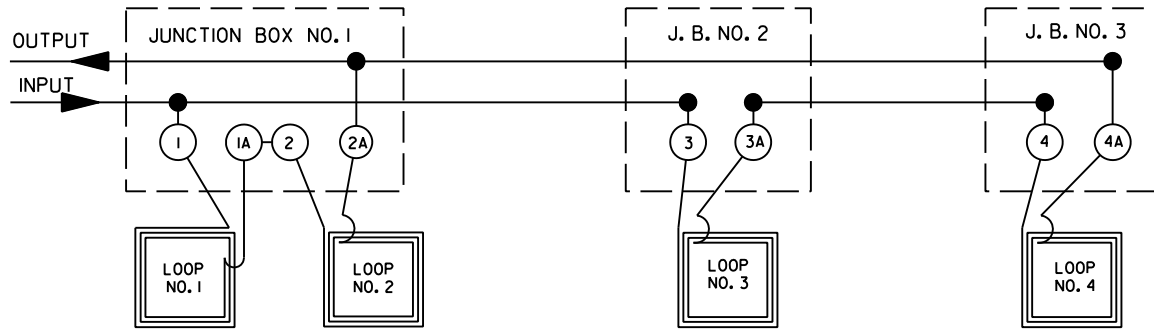
☐ S1
☐ S2
☐ S3
☐ S4



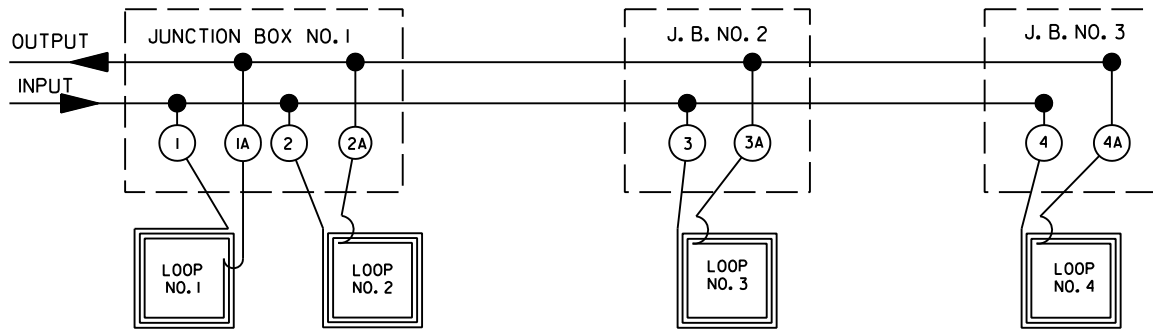
(N.T.S.)
REV. 5/14



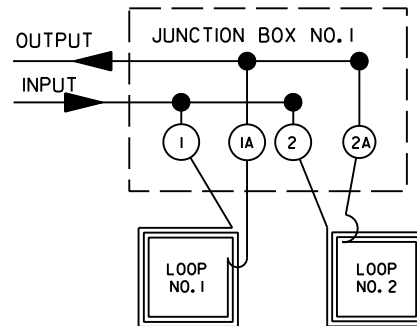
CITY OF VIRGINIA BEACH STANDARD	
VEHICLES DETECTOR NUMBERING GUIDELINES	
PUBLIC WORKS	D-10



4 LOOPS, SERIES/PARALLEL CONNECTED

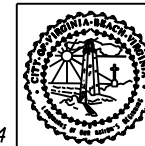


4 LOOPS, PARALLEL CONNECTED



2 LOOPS, PARALLEL CONNECTED

(N.T.S.)
REV. 5/14

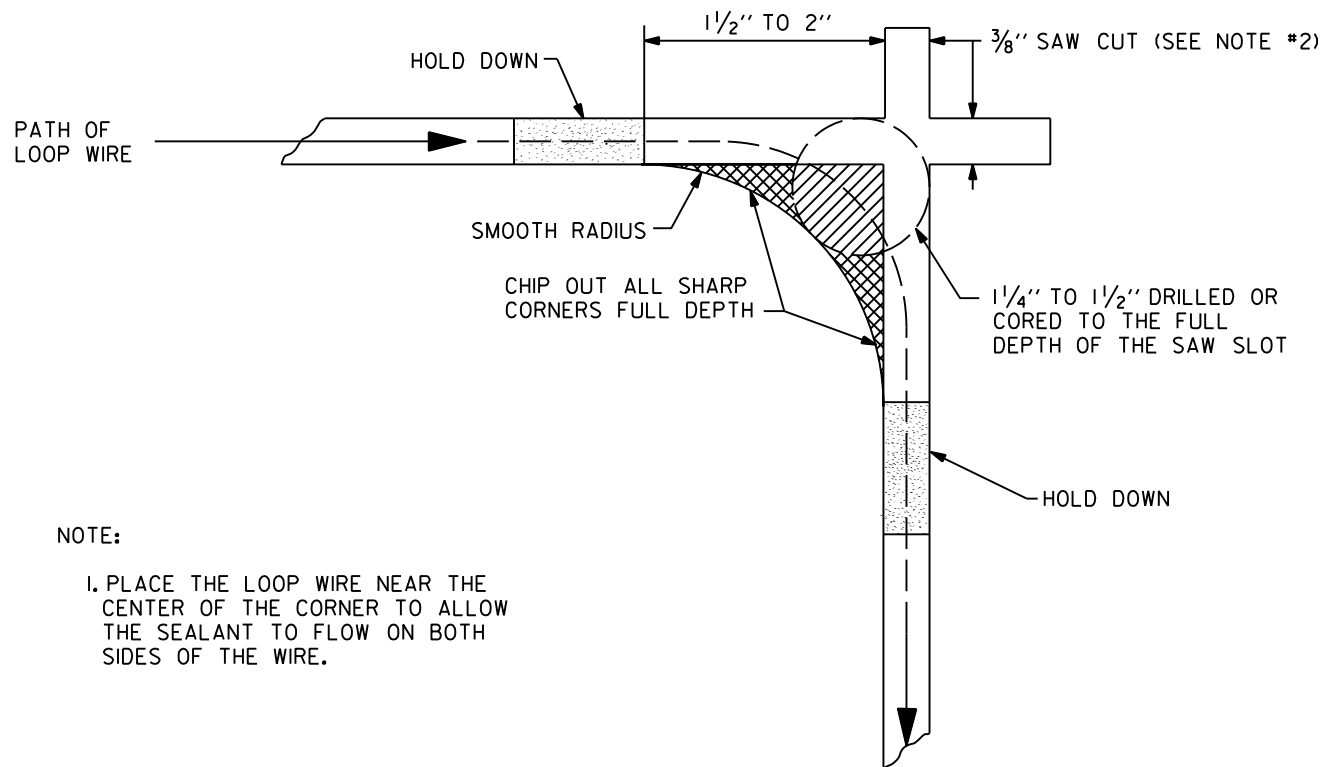


CITY OF VIRGINIA BEACH
STANDARD

VEHICLE LOOP DETECTOR
AND PARALLEL WIRING DIAGRAM

PUBLIC WORKS

D-12



NOTE:

- I. PLACE THE LOOP WIRE NEAR THE CENTER OF THE CORNER TO ALLOW THE SEALANT TO FLOW ON BOTH SIDES OF THE WIRE.

(N.T.S.)
REV. 5/14

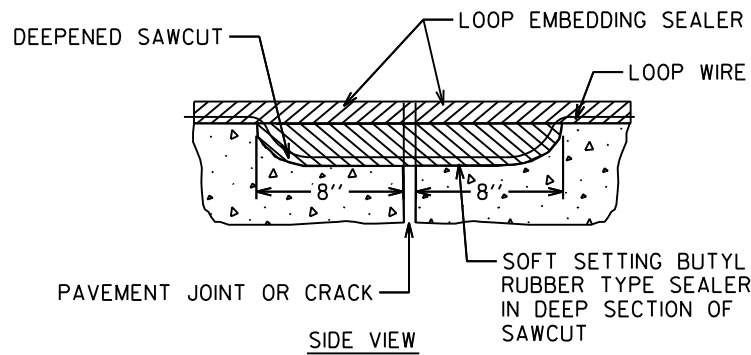


CITY OF VIRGINIA BEACH
STANDARD

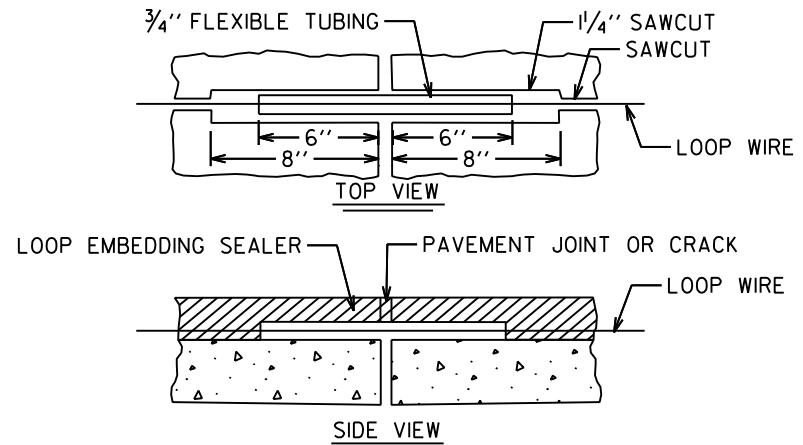
VEHICLE LOOP DETECTOR
CORED/DRILLED CORNER

PUBLIC WORKS

D-13



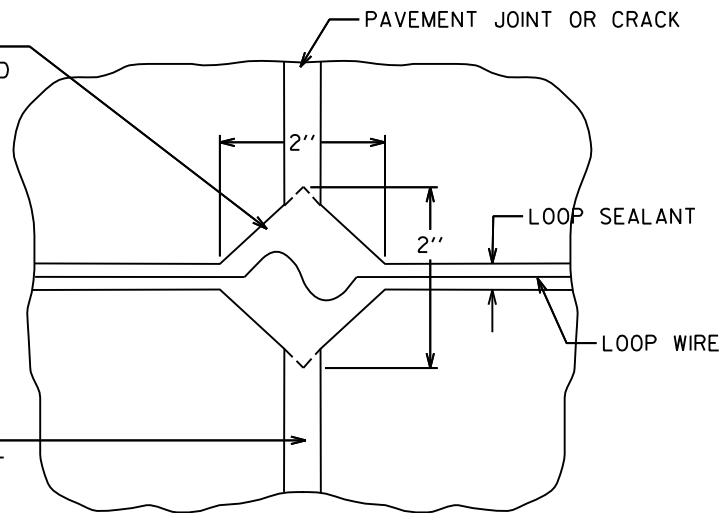
METHOD 1



METHOD 2

THIS AREA REMOVED SHALL BE THE SAME DEPTH AS THE WIRE SLOT AND SHALL BE BACKFILLED WITH COLD APPLIED RUBERIZED ASPHALT JOINT SEALING COMPOUND

IF NECESSARY RE-SEAL WITH COLD APPLIED RUBBERIZED ASPHALT JOINT SEALING COMPOUND



METHOD 3

NOTE:

ONE OF THE ABOVE METHODS SHALL BE USED WHERE LOOP WIRES CROSS PAVEMENT JOINTS, EXPANSION JOINTS, PAVEMENT IRREGULARITIES, FROM CONCRETE TO ASPHALT PAVEMENT SECTIONS, OR FROM OLD ASPHALT TO NEW ASPHALT PAVEMENT SECTIONS.

(N.T.S.)
REV. 5/14

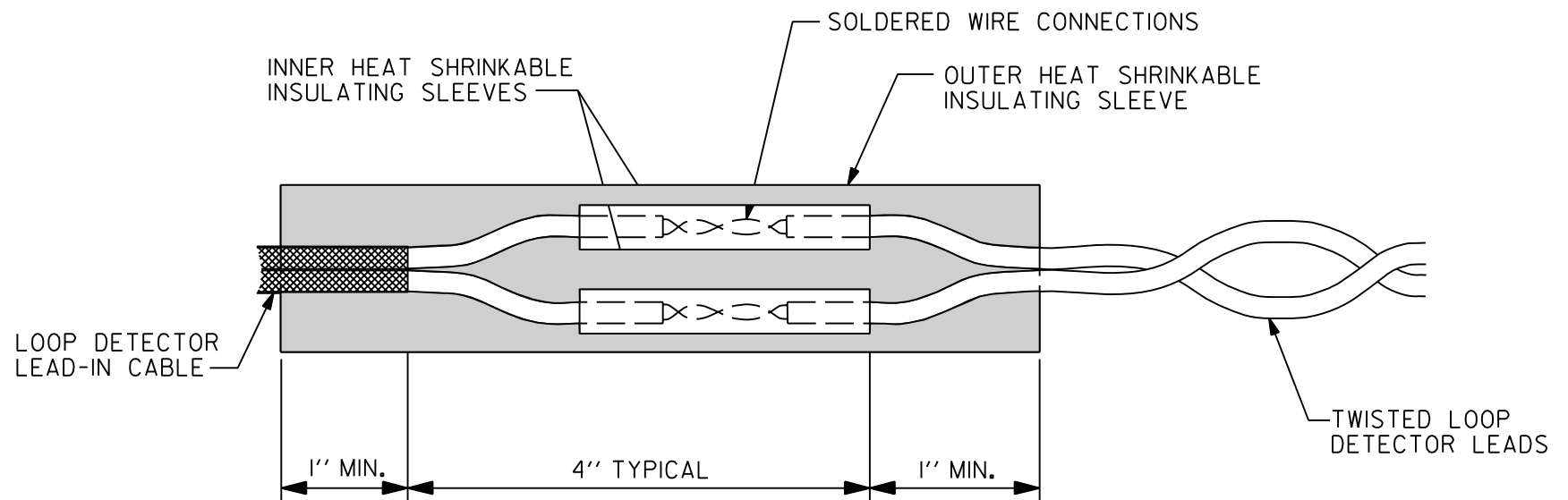


CITY OF VIRGINIA BEACH
STANDARD

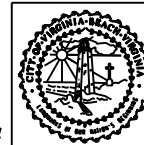
METHOD OF CROSSING PAVEMENT
JOINTS WITH LOOP DETECTOR WIRES

PUBLIC WORKS

D-14



(N.T.S.)
REV. 5/14



CITY OF VIRGINIA BEACH
STANDARD

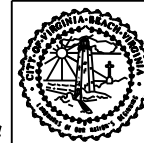
VEHICLE LOOP DETECTOR
SPlice

PUBLIC WORKS

D-15

DIRECTION / ROADWAY	DETECTION ZONE	CAMERA NUMBER	PHASE NUMBER
EB - LASKIN RD.	2.1 - 2.4	1	Ø2
EB LT - LASKIN RD.	5	1	Ø5
WB - LASKIN RD.	6.1 - 6.4	2	Ø6
WB LT - LASKIN RD.	1	2	Ø1
NB - BAL TIC AVE.	4	3	Ø4
SB - BAL TIC AVE.	8	4	Ø8

(N.T.S.)
REV. 5/14

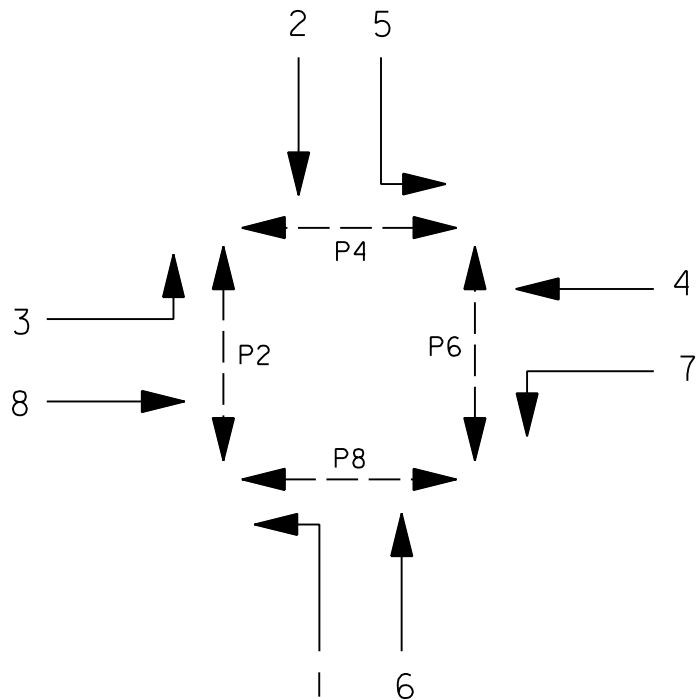


CITY OF VIRGINIA BEACH
STANDARD

SAMPLE CAMERA
DETECTION ZONE CHART

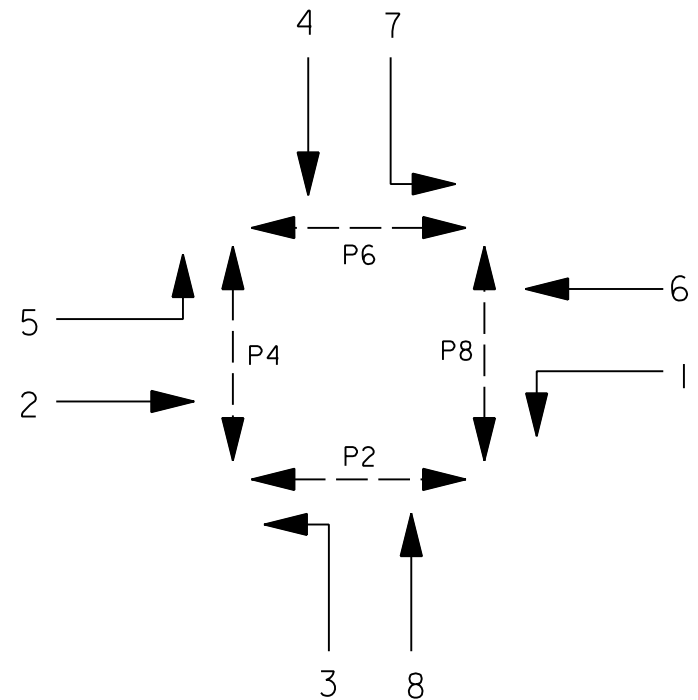
PUBLIC WORKS

D-16



CASE I:

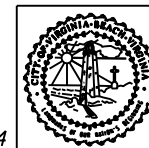
MAJOR ARTERIAL - NORTH / SOUTH
MINOR ARTERIAL - EAST / WEST



CASE II:

MAJOR ARTERIAL - EAST / WEST
MINOR ARTERIAL - NORTH / SOUTH

(N.T.S.)
REV. 5/14

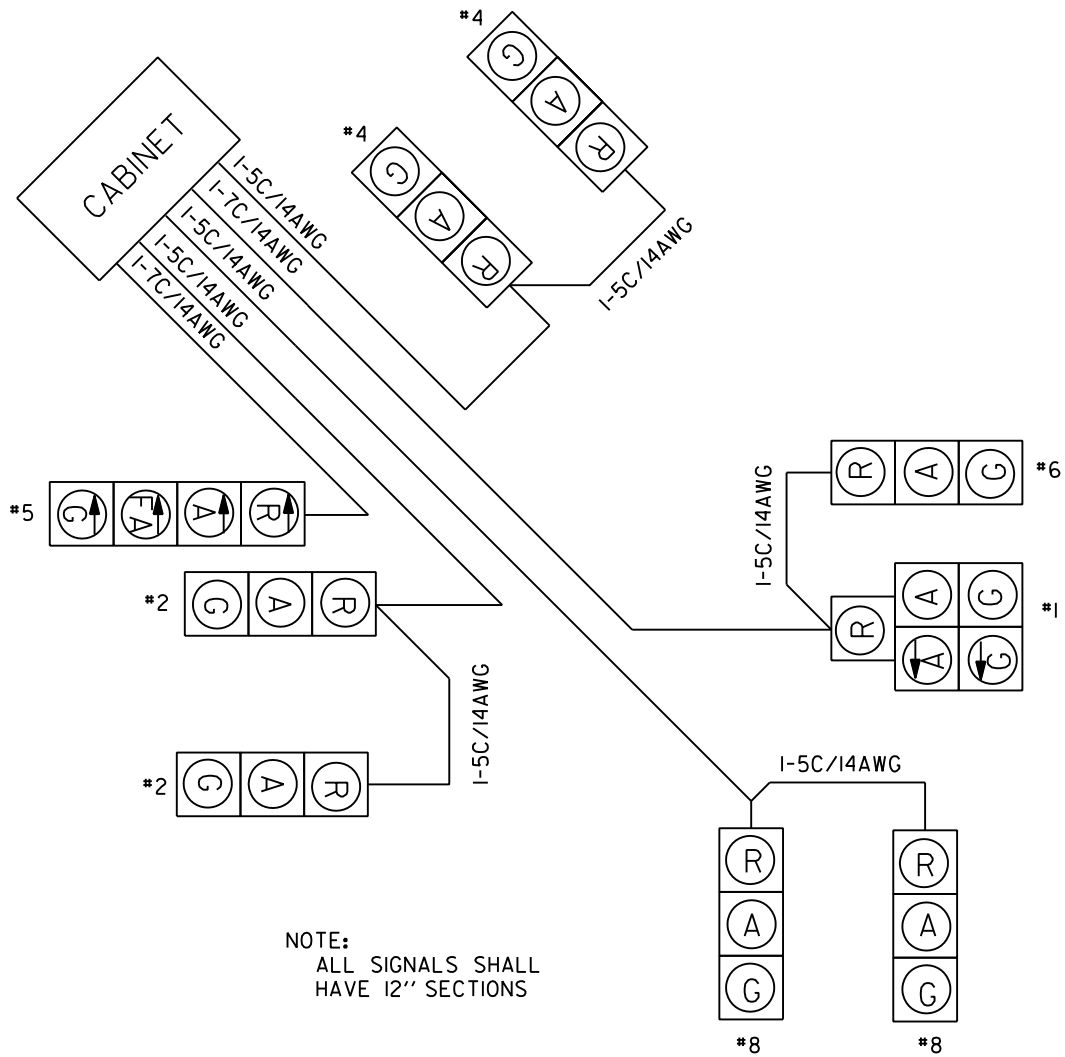


CITY OF VIRGINIA BEACH
STANDARD

TRAFFIC SIGNAL PHASE ORIENTATION

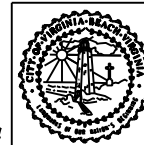
PUBLIC WORKS

D-17



NOTE:
ALL SIGNALS SHALL
HAVE 12" SECTIONS

(N.T.S.)
REV. 5/14

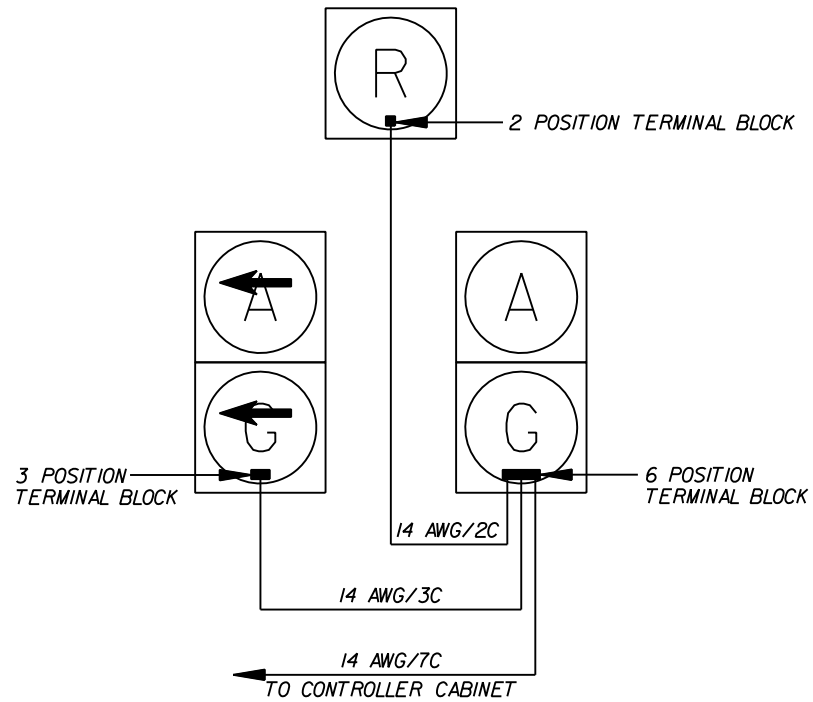


CITY OF VIRGINIA BEACH
STANDARD

SAMPLE SIGNAL HEAD
WIRING DIAGRAM

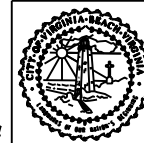
PUBLIC WORKS

D-19



DISPLAY	7C	3C	2C
NEUTRAL	WHITE	WHITE	WHITE
RED	RED	—	BLACK
AMBER	ORANGE	—	—
GREEN	GREEN	—	—
AMBER ←	BLACK	BLACK	—
GREEN ←	BLUE	RED	—
SPARE	WHITE / BLACK	—	—

(N.T.S.)
REV. 5/14

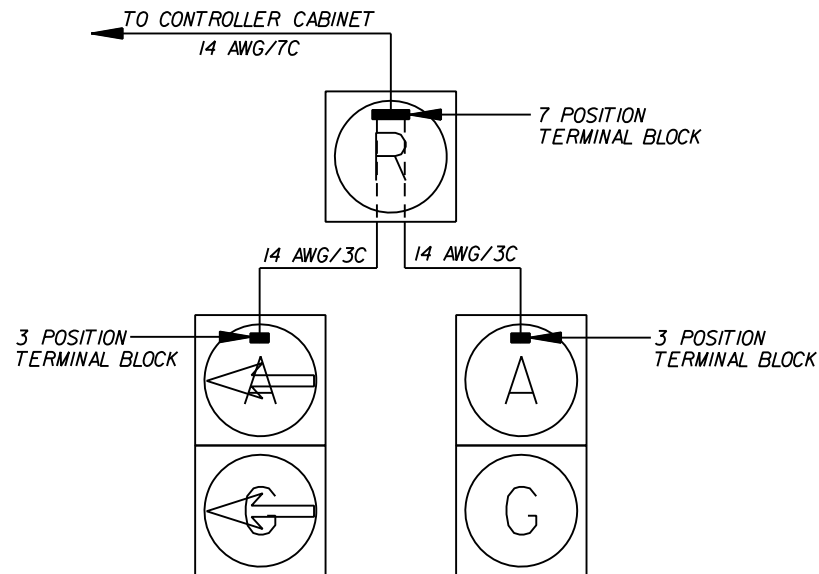


CITY OF VIRGINIA BEACH
STANDARD

WIRING DETAIL FOR MAST ARM
MOUNTED FIVE SECTION SIGNAL

PUBLIC WORKS

D-20



DISPLAY	7C	3C	3C
NEUTRAL	WHITE	WHITE	WHITE
RED	RED	—	—
AMBER	ORANGE	—	BLACK
GREEN	GREEN	—	RED
AMBER ←	BLACK	BLACK	—
GREEN ←	BLUE	RED	—
SPARE	WHITE / BLACK	—	—

(N.T.S.)
REV. 5/14

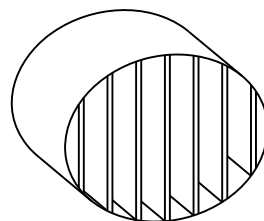


CITY OF VIRGINIA BEACH
STANDARD

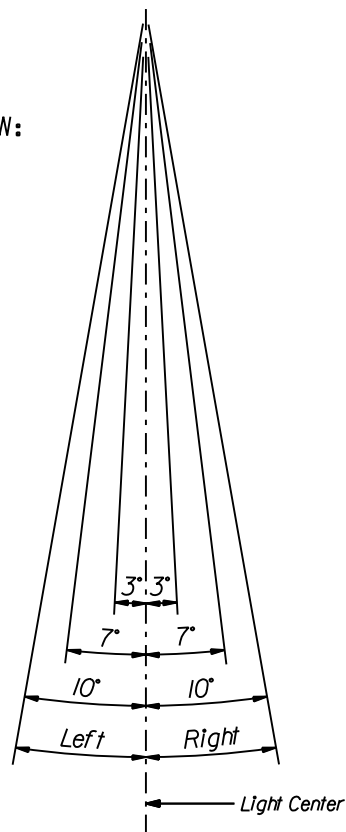
WIRING DETAIL FOR SPAN WIRE
MOUNTED FIVE SECTION SIGNAL

PUBLIC WORKS

D-21



FIELD OF VIEW:



NOTES:

1. LOUVER TO PROVIDE CUT-OFF REQUIRED.
2. UNLESS OTHERWISE SPECIFIED, LOUVERED VISORS SHALL HAVE SEVEN (7) VANES.
3. USED WHERE SIGNALIZED INTERSECTIONS' CROSS STREETS ARE LESS THAN 90° TO EACH OTHER. USED AT THE DISCRETION OF THE REVIEW ENGINEER.

(N.T.S.)
REV. 5/14



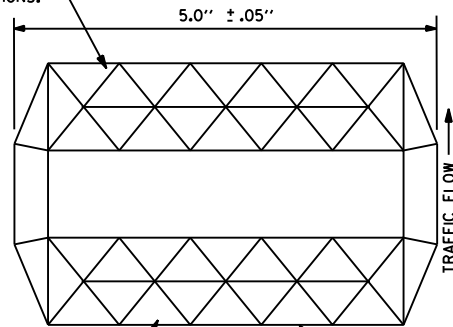
CITY OF VIRGINIA BEACH
STANDARD

TRAFFIC SIGNAL LOUVERED VISOR

PUBLIC WORKS

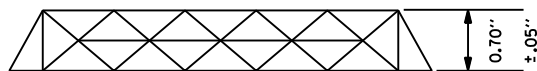
D-22

FOR ONE-WAY TRAFFIC AT INTERSECTIONS, REFLECTORS SHALL BE RED FOR DIRECTION OPPOSITE OF TRAFFIC FLOW FOR ENTIRE LENGTH OF FULL WIDTH OF TURN LANES & TRANSITIONS.

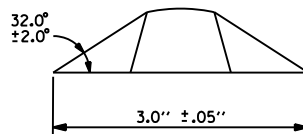


REFLECTORS SHALL BE WHITE OR YELLOW IN THE DIRECTION OF TRAFFIC FLOW. REFLECTIVE AREA = 4.0 ± 0.05 SQ. INCHES

TOP VIEW



FRONT VIEW

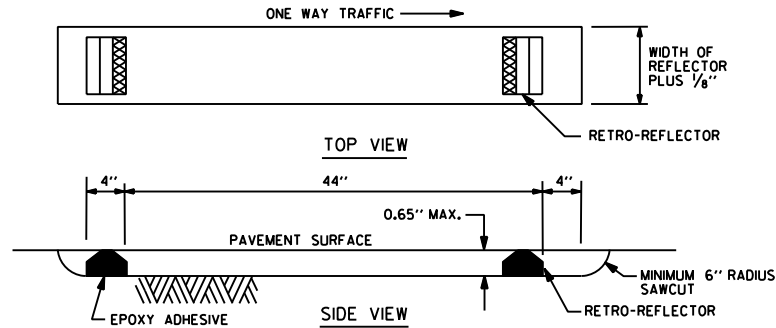


SIDE VIEW

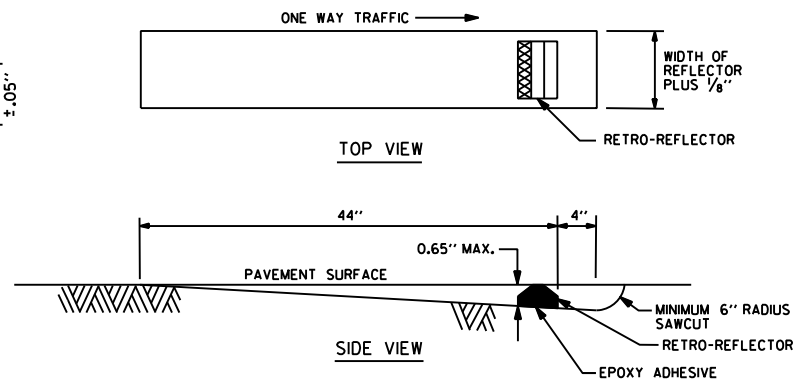
RAISED REFLECTIVE PAVEMENT MARKER

NOTES:

1. RAISED PAVEMENT MARKERS SHALL BE INSTALLED IN ACCORDANCE WITH PROJECT SPECIFICATIONS.
2. RECESSED PAVEMENT MARKERS MAY BE USED IN LIEU OF RAISED MARKERS IF APPROVED BY THE CITY ENGINEER.

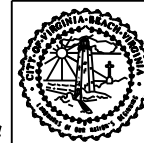


TWO WAY PAVEMENT MARKERS



INSTALLATION OF RECESSED REFLECTIVE PAVEMENT MARKERS

(N.T.S.)
REV. 5/14

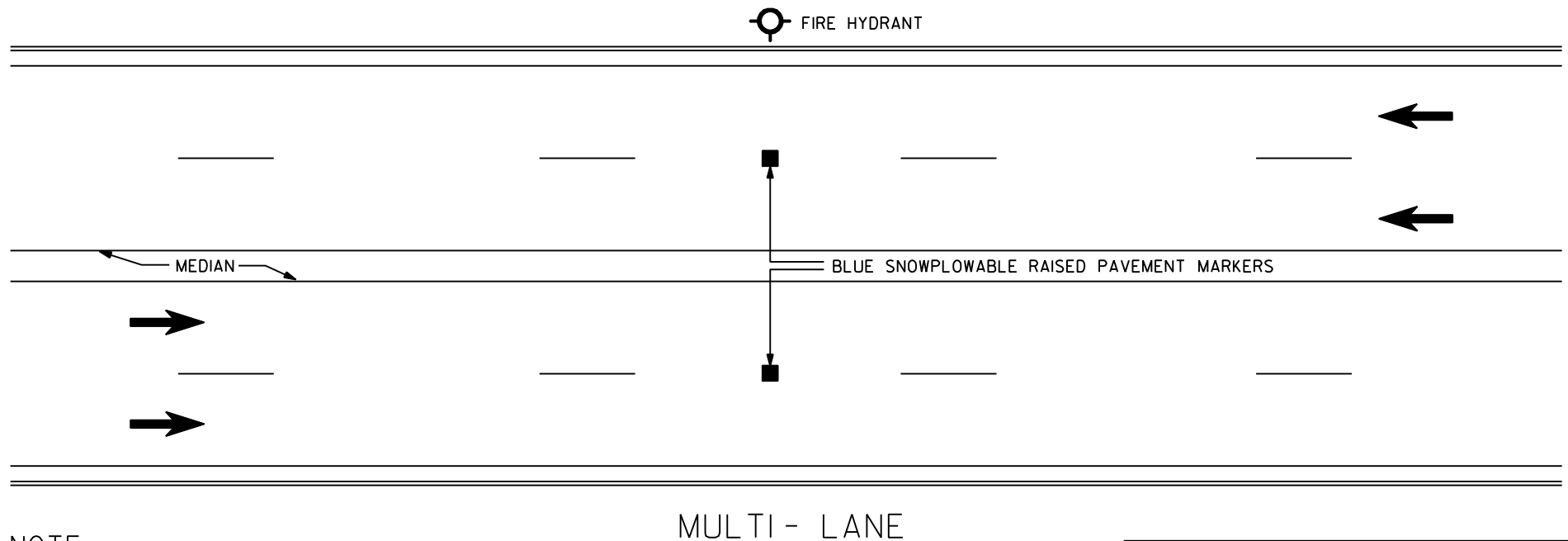
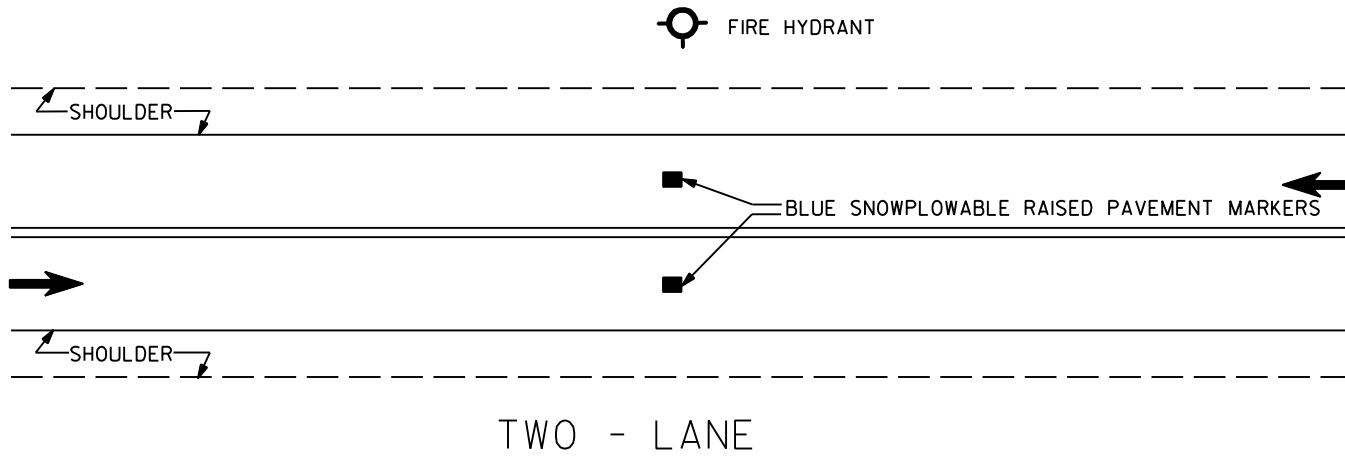


CITY OF VIRGINIA BEACH
STANDARD

RECESSED AND RAISED RETRO-REFLECTIVE PAVEMENT MARKERS

PUBLIC WORKS

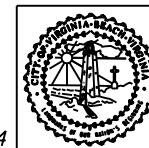
D-23



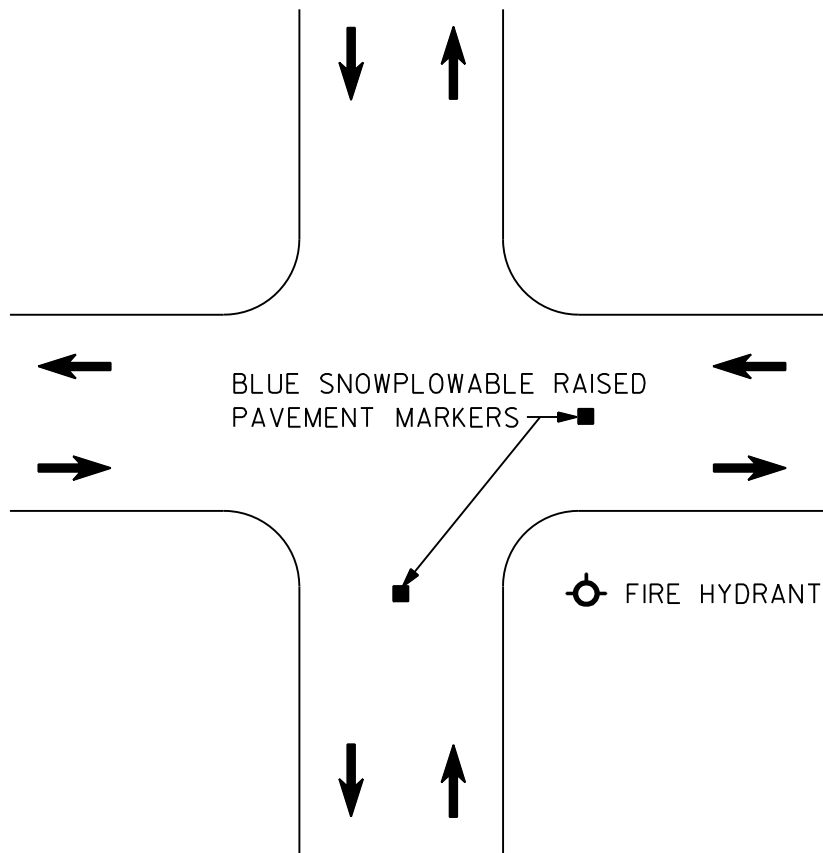
NOTE:

1) IF THERE ARE ADDITIONAL LANES, MARKERS SHALL BE PLACED ON EACH ADDITIONAL LANE LINE.

(N.T.S.)
REV. 5/14



CITY OF VIRGINIA BEACH STANDARD	
BLUE PAVEMENT MARKER LOCATIONS FOR FIRE HYDRANT ON TWO-LANE AND MULTI-LANE ROADWAYS	
PUBLIC WORKS	D-24

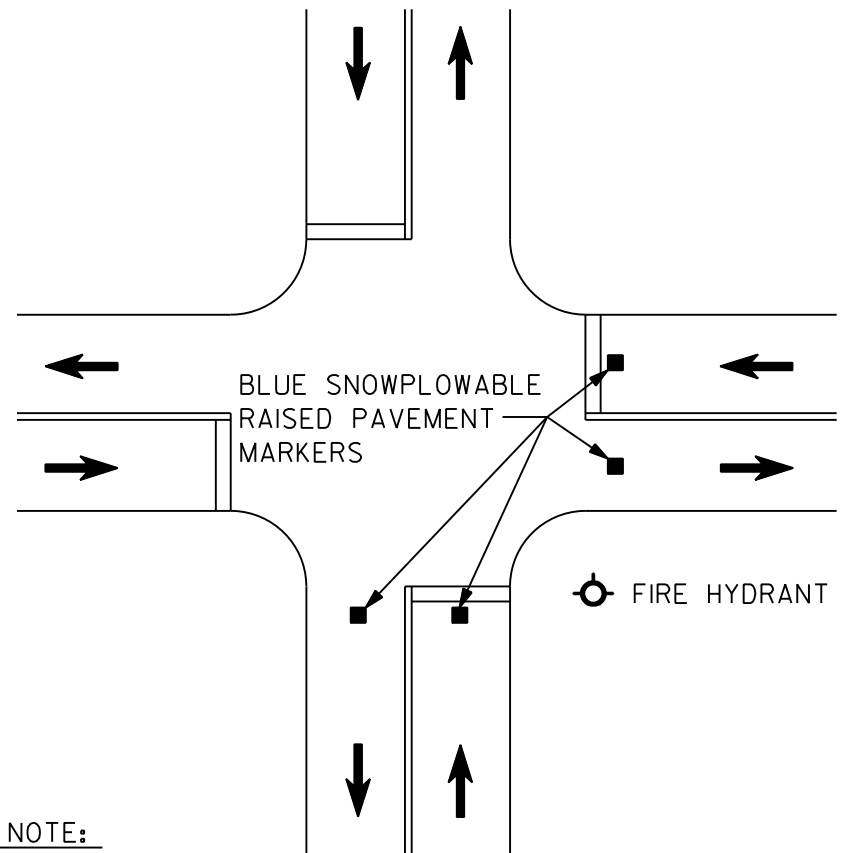


BLUE SNOWPLOWABLE RAISED
PAVEMENT MARKERS

FIRE HYDRANT

NOTE:

PLACE MARKER ON
CENTERLINE OF STREET



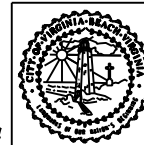
BLUE SNOWPLOWABLE
RAISED PAVEMENT
MARKERS

FIRE HYDRANT

NOTE:

PLACE MARKER IN CENTER OF
TRAVEL LANES

(N.T.S.)
REV. 5/14



CITY OF VIRGINIA BEACH
STANDARD

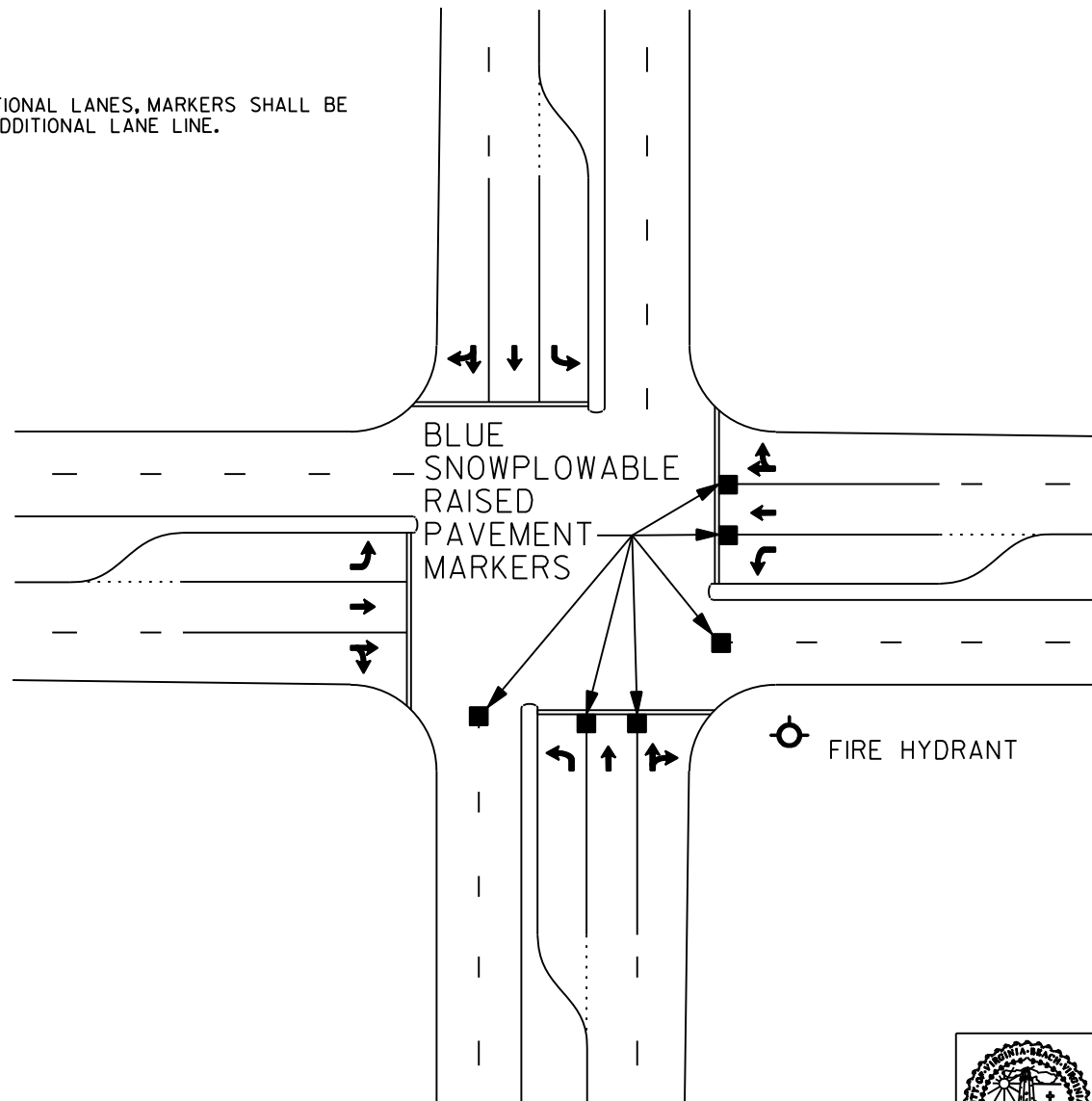
BLUE PAVEMENT MARKER
LOCATIONS FOR FIRE HYDRANTS ON
CORNERS OF URBAN ROADWAYS

PUBLIC WORKS

D-25

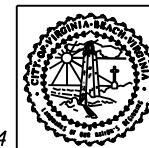
NOTE:

1) IF THERE ARE ADDITIONAL LANES, MARKERS SHALL BE PLACED ON EACH ADDITIONAL LANE LINE.



FIRE HYDRANT

(N.T.S.)
REV. 5/14



CITY OF VIRGINIA BEACH	
STANDARD	
BLUE PAVEMENT MARKER	
LOCATIONS FOR FIRE HYDRANT ON	
CORNER OF MULTI-LANE ROADWAYS	
PUBLIC WORKS	D-26

GREEN
SHEETING

6"

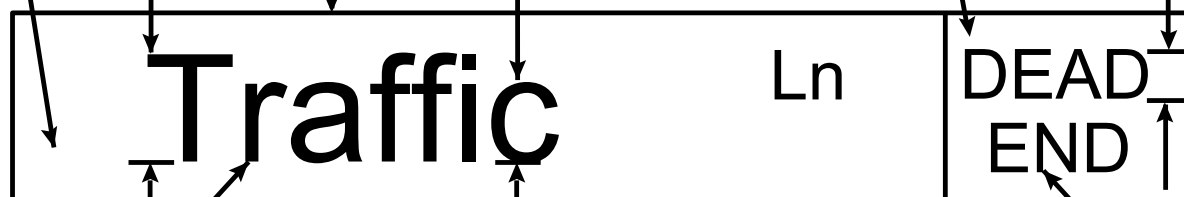
9"

4.5"

YELLOW
SHEETING

2.5"

1"



WHITE

BLACK

VARIES PER
LENGTH OF WORDS

OPTIONAL
EXTENSION



(N.T.S.)
REV.1/18

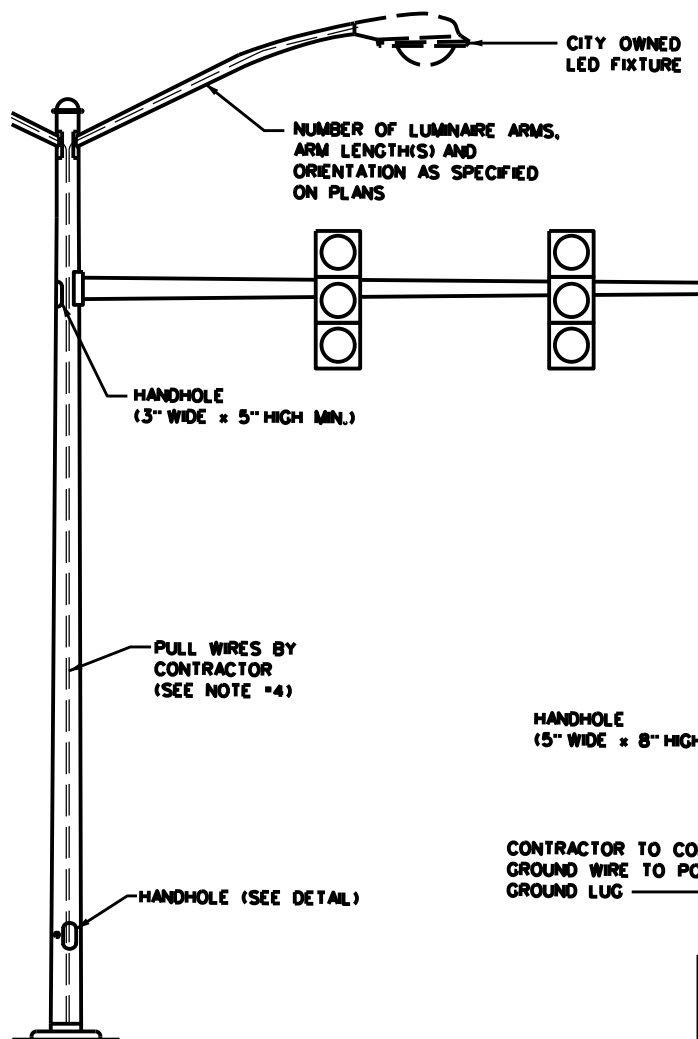


CITY OF VIRGINIA BEACH
STANDARD

FLAT/DEAD END/NO OUTLET
GROUND MOUNTED STREET NAME SIGN

PUBLIC WORKS

D-27

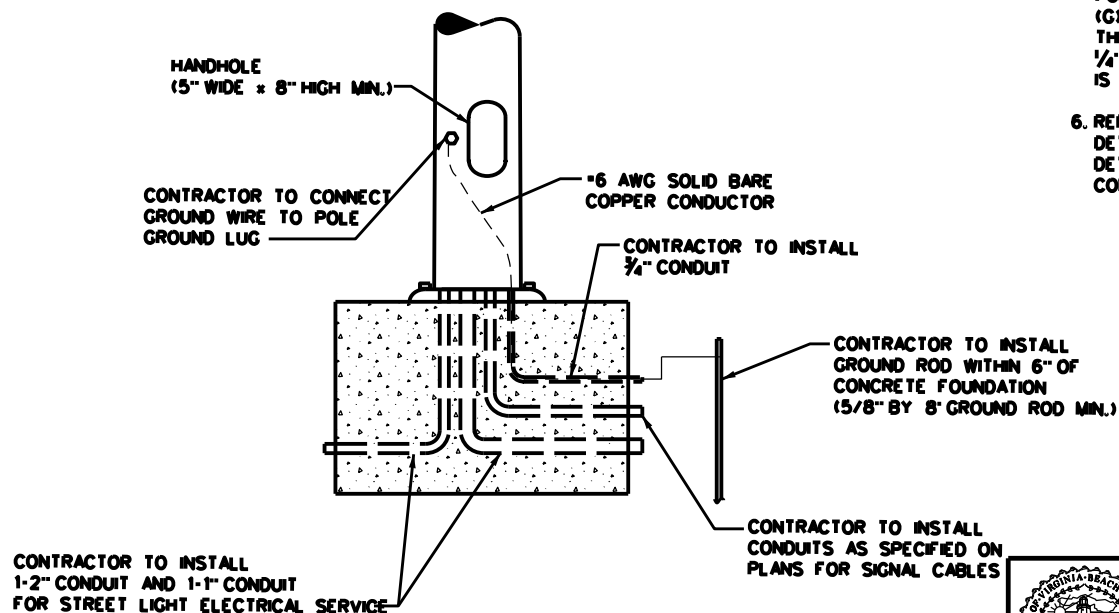


NOTES:

1. DOMINION ENERGY WILL NOT CONNECT SERVICE TO TRAFFIC CONTROLLER IN POLE HANDHOLE. VIRGINIA POWER WILL RUN A SEPERATE SERVICE TO TRAFFIC CONTROLLER AT A SEPERATE LOCATION.
2. JOINT USE POLE SHALL CONFORM TO VIRGINIA DEPT. OF TRANSPORTATION ROAD AND BRIDGE SPECIFICATIONS, AS AMENDED BY THE CITY OF VIRGINIA BEACH TECHNICAL SPECIFICATIONS AND PLANS.

INSTALLATION NOTES:

1. THE FOUNDATION, POLE, MAST ARM AND LUMINAIRE MUST BE DESIGNED FOR EACH LOCATION
2. 1 - 2" CONDUIT AND 1 - 1" CONDUIT FOR STREETLIGHT ELECTRICAL SERVICE SHALL BE CAST IN THE FOUNDATION IN OPPOSITE DIRECTIONS.
3. INSTALL GROUND ROD AND GROUND WIRE THRU 3/4" CONDUIT AND CONNECT GROUND WIRE TO POLE GROUND LUG.
4. FURNISH AND INSTALL POLYOLEFIN, 500 LB. STRESS PULL LINES (OR EQUIVALENT) FROM POLE HANDHOLE, UP POLE AND THRU LUMINAIRE ARMS.
5. THE CONTRACTOR SHALL PERMANENTLY MARK EACH POLE FOUNDATION TO INDICATE THE LOCATIONS OF ALL CONDUITS CAST IN THE FOUNDATION. THE MARKINGS SHALL CONSIST OF AN ARROW, 4 TO 6 INCHES LONG, AND A LETTER DESIGNATION AS FOLLOWS: (S)-SPARE CONDUIT, (T)-CONDUIT WITH SIGNAL DETECTOR CABLES, (E)-CONDUIT WITH ELECTRICAL SERVICE CONDUCTORS FOR THE TRAFFIC SIGNAL, (L)-CONDUITS INSTALLED FOR LUMINAIRE CONDUCTORS ON JOINT USE POLES, (G)-CONDUITS INSTALLED FOR GROUND WIRE(S). THE MARKINGS SHALL BE ETCHED WITH A TROWEL 1/4" DEEP IN THE CONCRETE WHILE THE CONCRETE IS BEING FINISHED.
6. REFERENCE VDOT ROAD AND BRIDGE STANDARDS DETAIL PF-8, SIGNAL POLE FOUNDATION INSTALLATION DETAILS, FOR ADDITIONAL REQUIREMENT REGARDING CONDUITS CAST IN FOUNDATION.



(N.T.S.)
REV.1/18

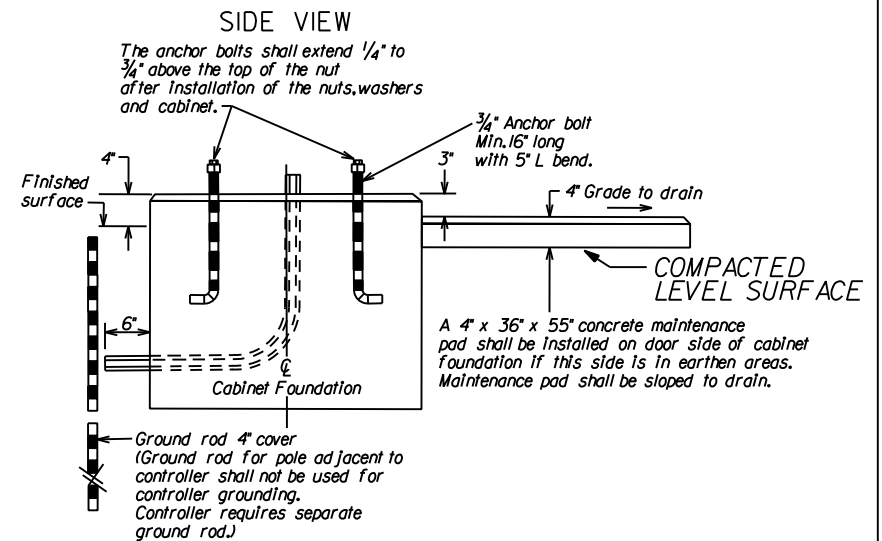
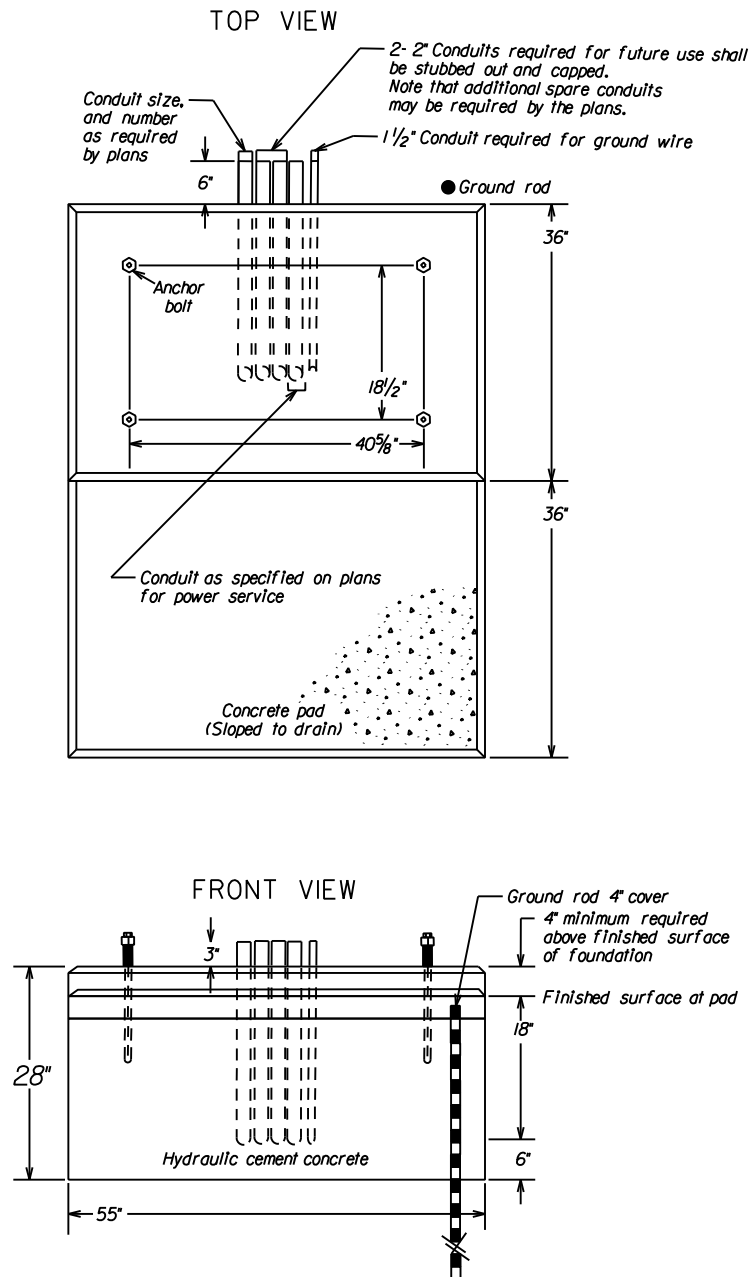


CITY OF VIRGINIA BEACH
STANDARD

**JOINT USE TRAFFIC SIGNAL /
STREET LIGHTING POLE**

PUBLIC WORKS

D-28



Notes:

All exposed concrete surface edges shall be chamfered 3/4".

Anchor bolts and bolt circle template shall be furnished with cabinet. Cabinet shall be centered on foundation.

Each foundation shall be permanently marked to indicate all sides from which conduits pass. This mark shall be made with a trowel when finishing the concrete and shall be 1/4" deep and 4" to 6" long. Locations of empty conduits shall have an additional 2" long mark made perpendicular to and centered on this marking.

The controller cabinet at the inside and outside foundation joints shall be sealed with a silicone sealant.

Bell ends shall be installed on each end of PVC conduits. Empty conduits shall be plugged to prevent moisture and rodent entry.

Grounding bushings shall be installed on each end of metal conduits. Empty conduits shall be plugged to prevent moisture and rodent entry.

Two - 1/2" diameter weepholes shall be provided in the foundation and located 2" inside of the back or side edges of the controller cabinet. Weepholes shall be sloped to allow outlet to be 3" below top of foundation. Two inches of the outlet end shall be fiber filled.

Voids remaining after conduits exit or enter bell ends or bushings of conduits shall be sealed with silicone to prevent moisture or rodent entry.

(N.T.S.)
REV. 5/14

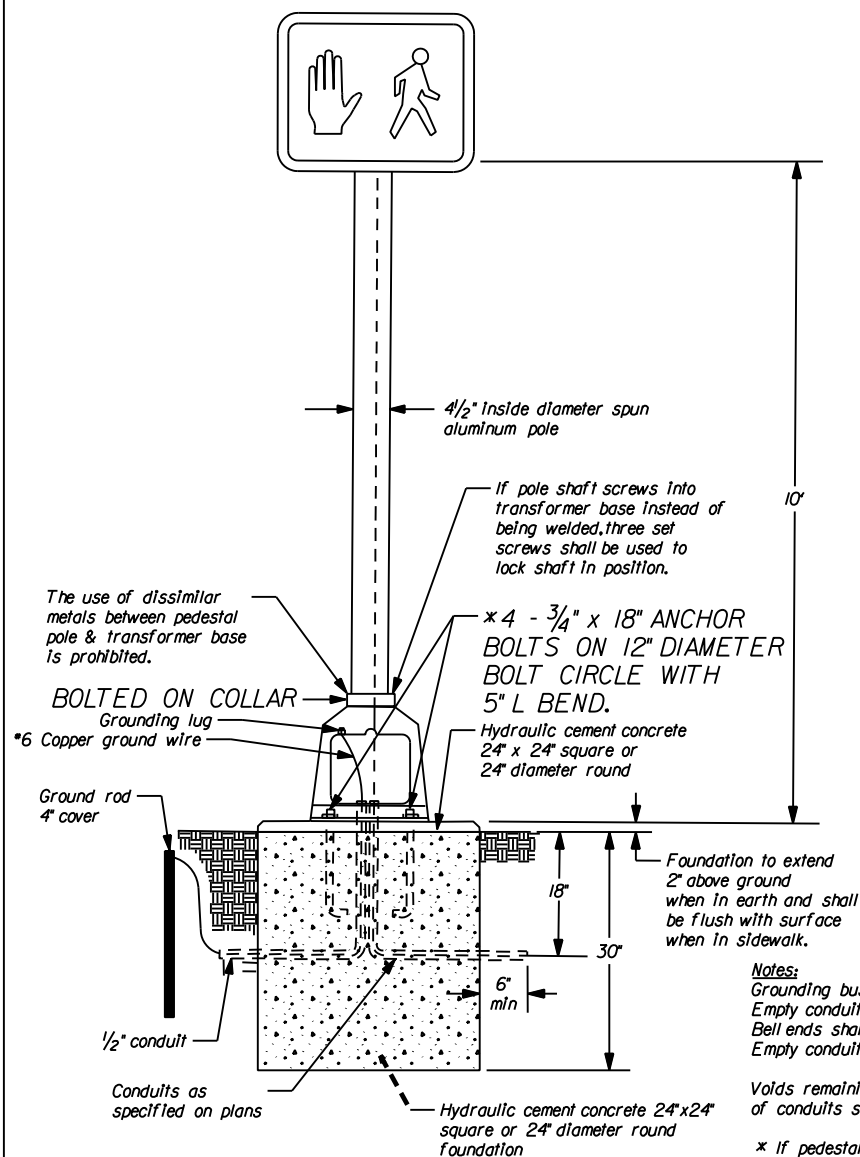


CITY OF VIRGINIA BEACH
STANDARD

CONTROLLER CABINET FOUNDATION
AND CONDUIT PLACEMENT DETAILS

PUBLIC WORKS

D-29



PEDESTRIAN SIGNAL POLE

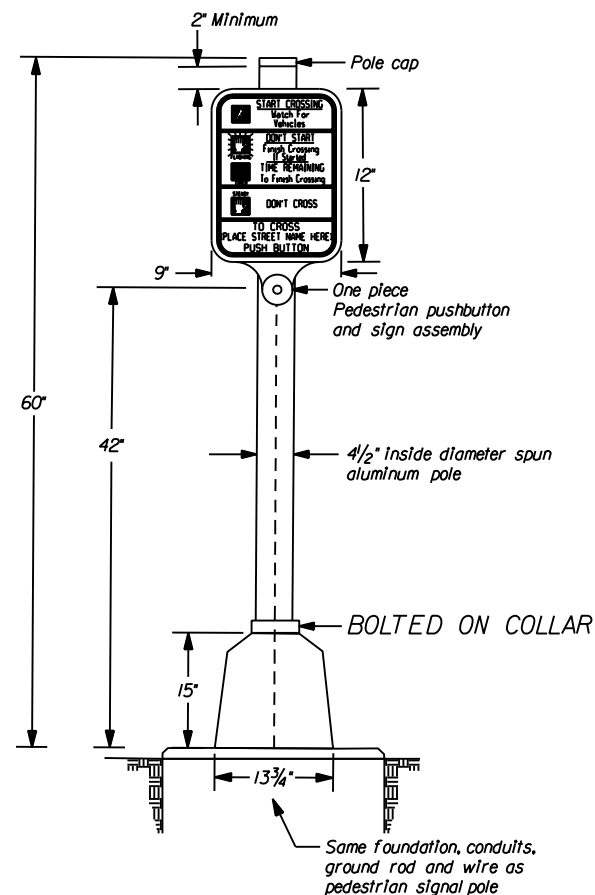
Notes:

Grounding bushings shall be installed on each end of metal conduits. Empty conduits shall be plugged to prevent moisture and rodent entry. Bell ends shall be installed on each end of PVC conduits. Empty conduits shall be plugged to prevent moisture and rodent entry.

Voids remaining after conductors exit or enter bell ends or bushings of conduits shall be sealed with silicone to prevent moisture and rodent entry.

* If pedestal pole and foundation are utilized for a SE-5 service, the foundation and pole shall be designed to accommodate on 8" bolt circle. Breakaway devices shall not be utilized.

Pedestal pole shall have a breakaway base, either slip base or frangible transformer type 3" x 5" minimum curved handhole with frame and cover required in pole when slip base supplied. Distance from bottom of pole to center of handhole shall be 12".

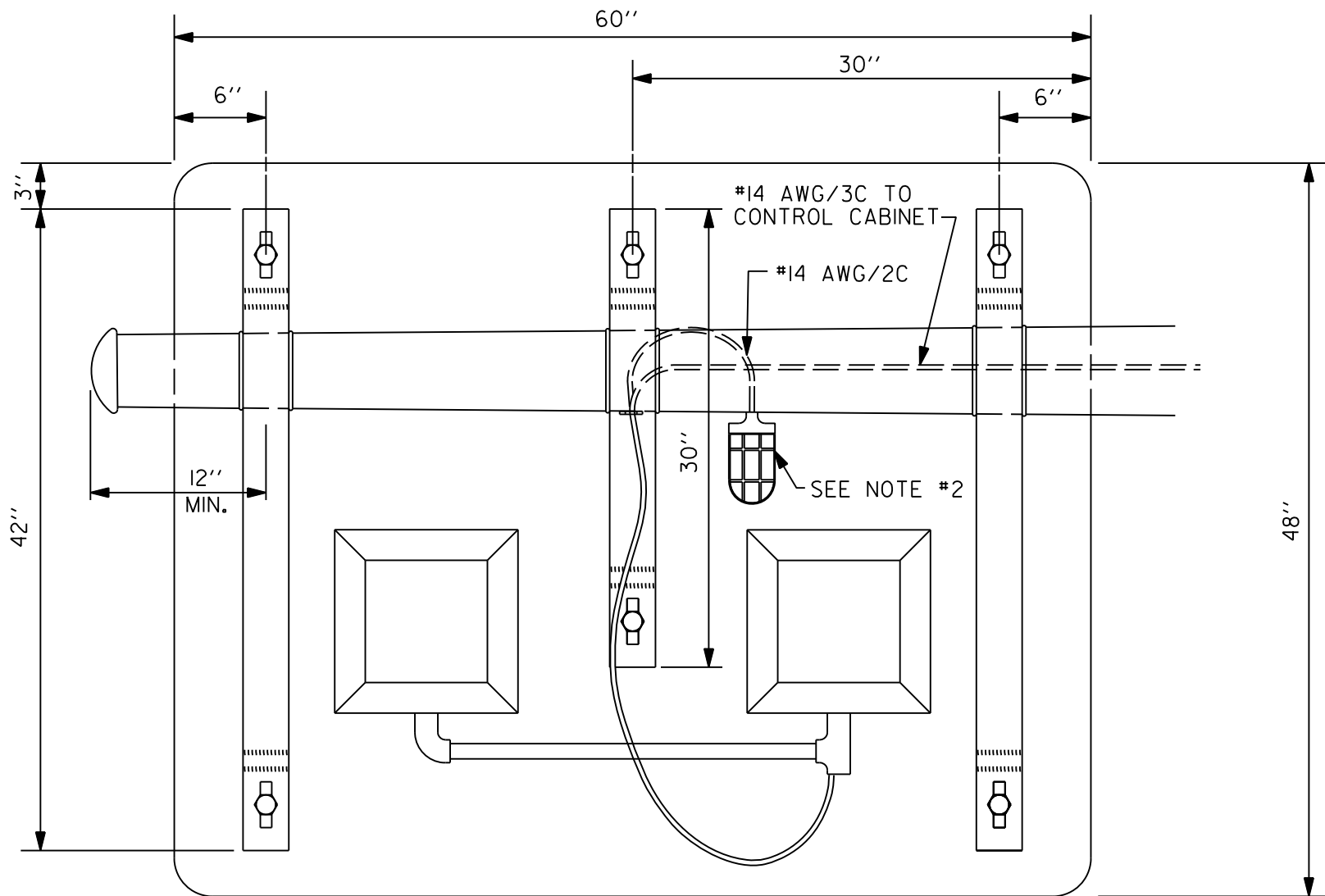


PEDESTRIAN PUSHBUTTON POLE

(N.T.S.)
REV. 5/14



CITY OF VIRGINIA BEACH STANDARD	
MODIFIED PEDESTRIAN SIGNAL POLE AND PEDESTRIAN PUSHBUTTON POLE	
PUBLIC WORKS	D-30



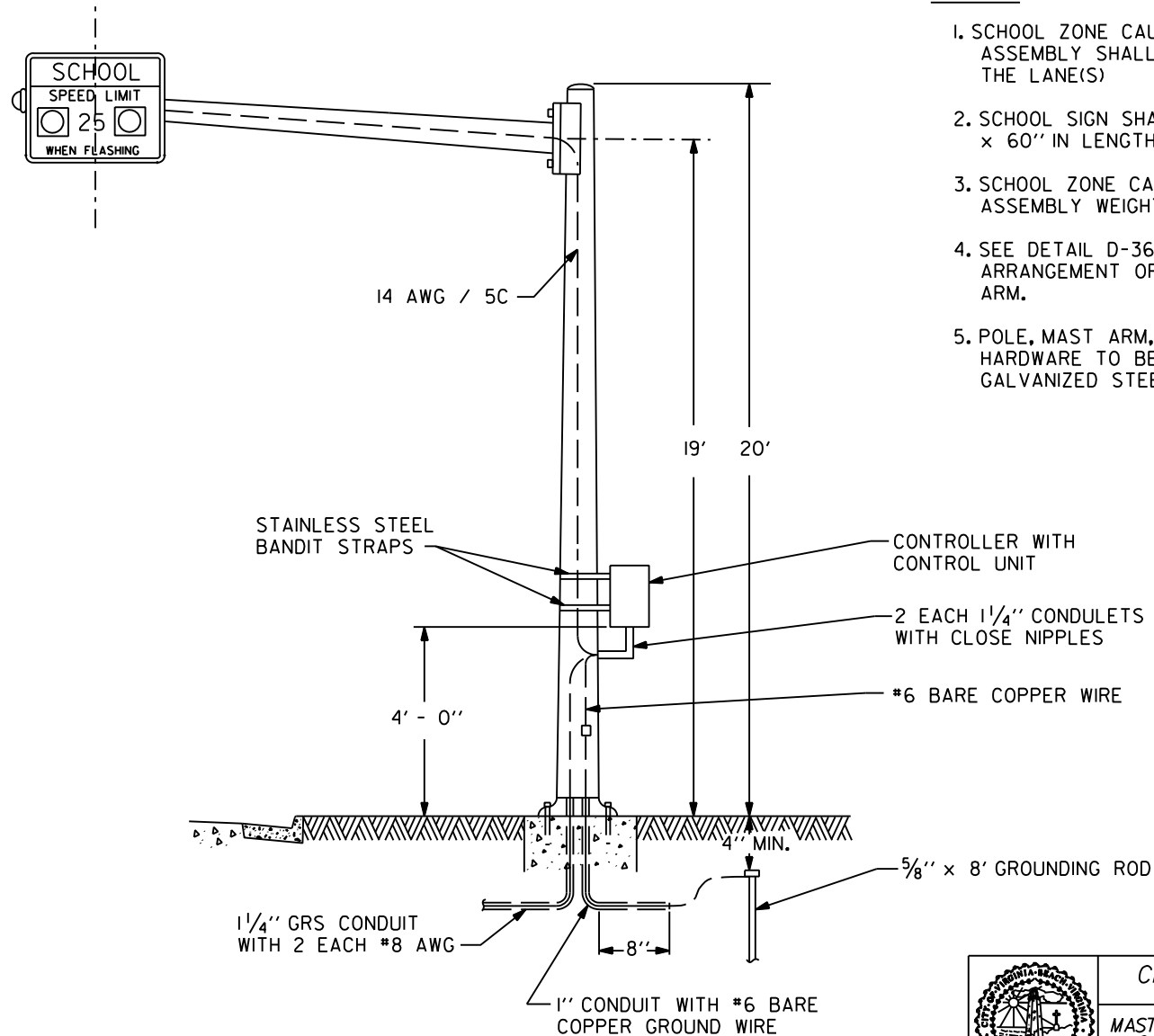
NOTE:

- 1) PELCO ASTRO-SIGN-BRACKETS (OR EQUIVALENT) SHALL BE USED FOR ATTACHING SIGN TO MAST ARM
- 2) INDICATOR BEACON SHALL FLASH SIMULTANEOUSLY WITH AMBER SCHOOL ZONE CAUTION LIGHTS

(N.T.S.)
REV. 5/14



CITY OF VIRGINIA BEACH STANDARD	
MAST ARM MOUNTED SCHOOL ZONE CAUTION LIGHT SIGN ASSEMBLY (REAR VIEW)	
PUBLIC WORKS	D-31



NOTES:

1. SCHOOL ZONE CAUTION LIGHT SIGN ASSEMBLY SHALL BE CENTERED OVER THE LANE(S)
2. SCHOOL SIGN SHALL BE 48" IN HEIGHT x 60" IN LENGTH.
3. SCHOOL ZONE CAUTION LIGHT SIGN ASSEMBLY WEIGHT = 140 LBS.
4. SEE DETAIL D-36 FOR MOUNTING ARRANGEMENT OF ASSEMBLY TO MAST ARM.
5. POLE, MAST ARM, AND ALL ASSOCIATED HARDWARE TO BE DOUBLE HOT DIPPED GALVANIZED STEEL.

(N.T.S.)
REV. 5/14



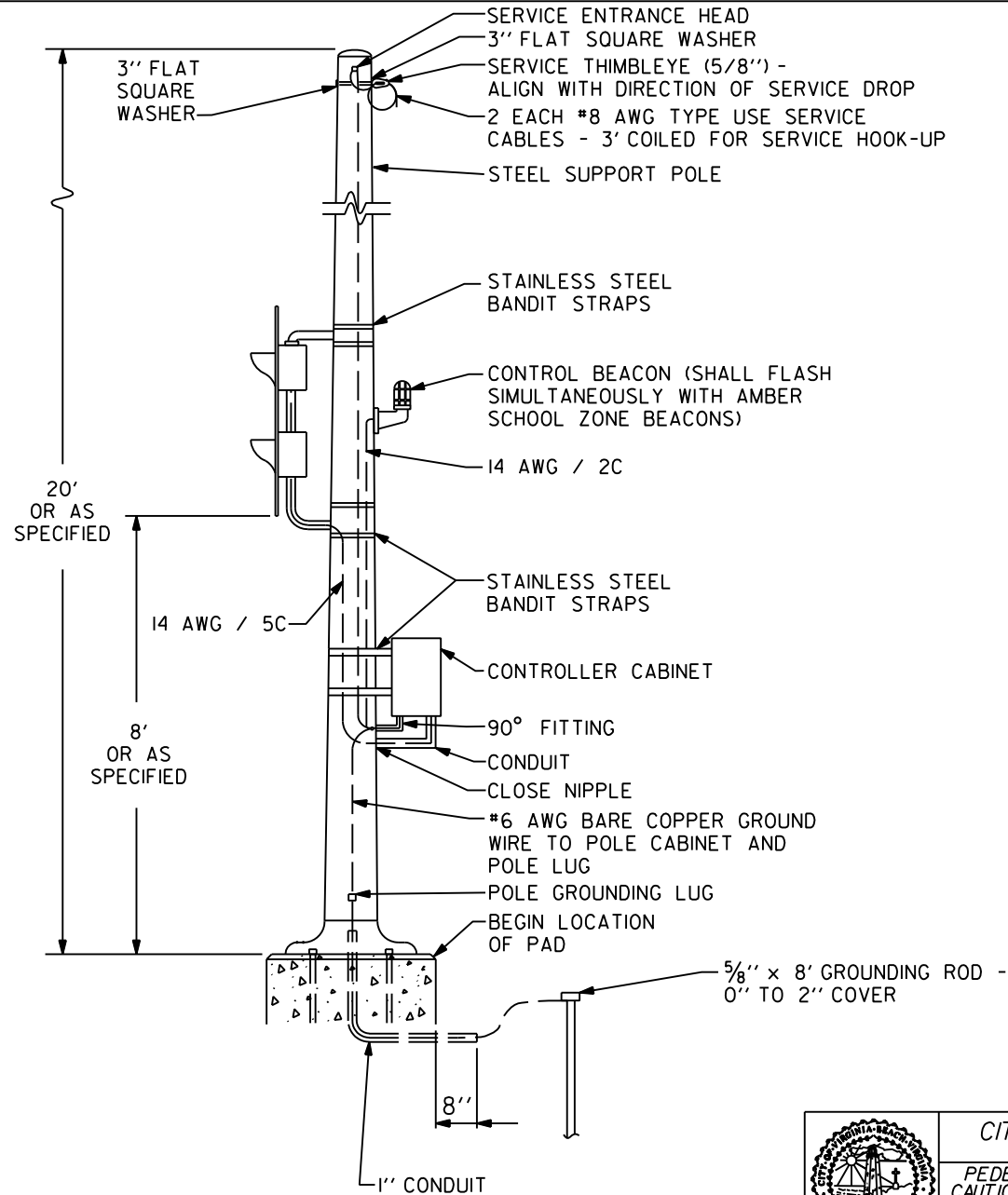
CITY OF VIRGINIA BEACH
STANDARD

MAST ARM MOUNTED SCHOOL ZONE
CAUTION LIGHT SIGN ASSEMBLY

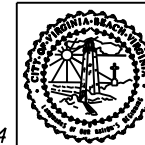
PUBLIC WORKS

D-32

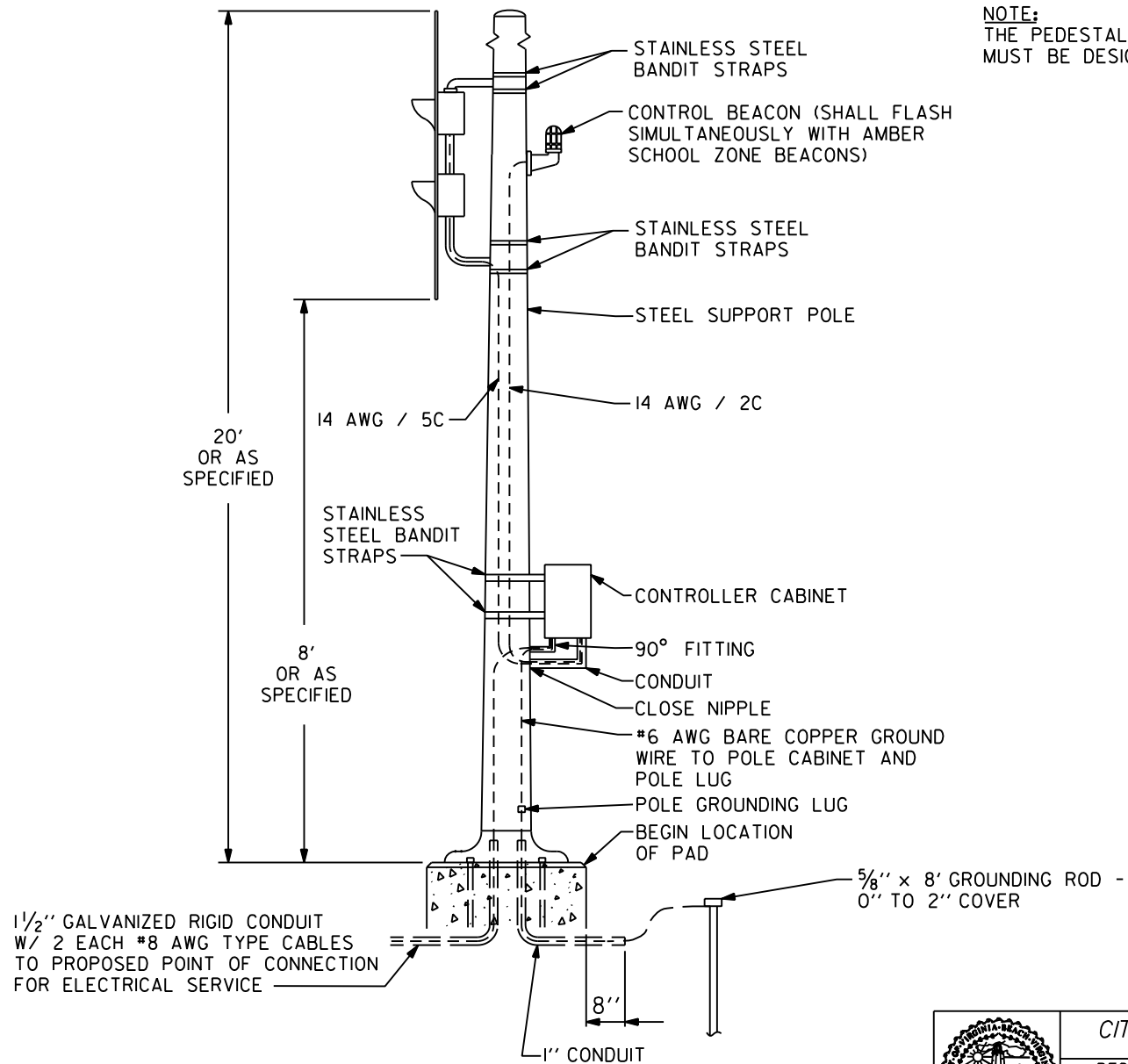
NOTE:
THE PEDESTAL POLE AND FOUNDATION
MUST BE DESIGNED FOR EACH LOCATION.



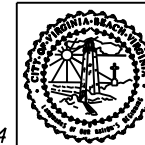
(N.T.S.)
REV. 5/14



CITY OF VIRGINIA BEACH STANDARD	
PEDESTAL MOUNTED SCHOOL ZONE CAUTION LIGHT SIGN ASSEMBLY, SINGLE UNIT WITH OVERHEAD SERVICE	
PUBLIC WORKS	D-33



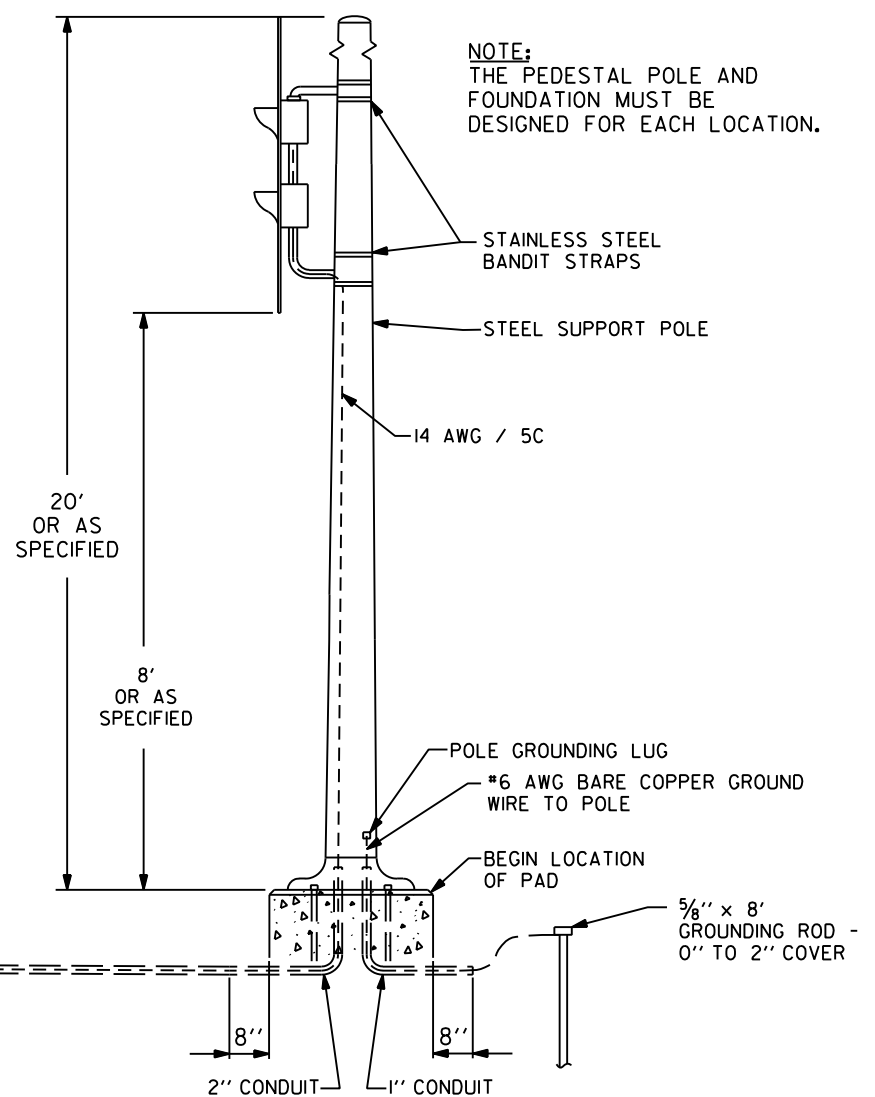
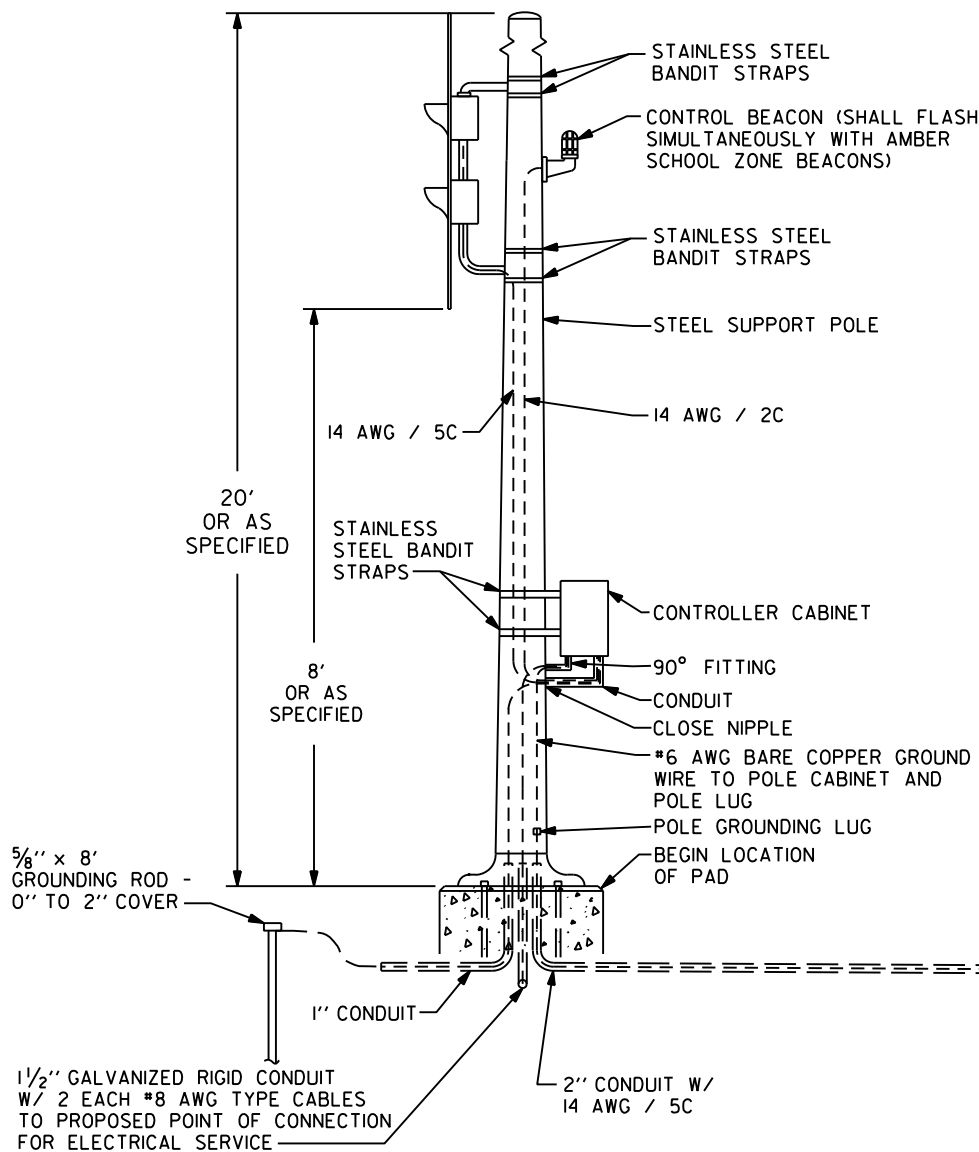
(N.T.S.)
REV. 5/14



CITY OF VIRGINIA BEACH
STANDARD
PEDESTAL MOUNTED SCHOOL ZONE
CAUTION LIGHT SIGN ASSEMBLY, SINGLE
UNIT WITH UNDERGROUND SERVICE

PUBLIC WORKS

D-34



ON DIVIDED HIGHWAYS WITH FOUR OR MORE LANES,
TWO PEDESTAL MOUNTED CAUTIONS MAY BE PLACED
ON EACH SIDE OF THE APPROACH, ONE IN THE MEDIAN
AND ONE ON THE OUTSIDE OF THE ROADWAY

(N.T.S.)
REV. 5/14

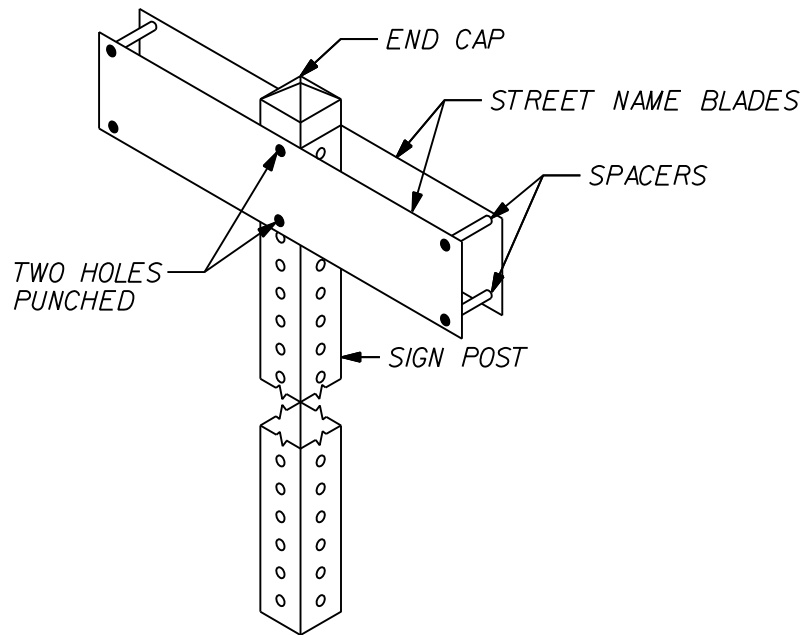


CITY OF VIRGINIA BEACH
STANDARD

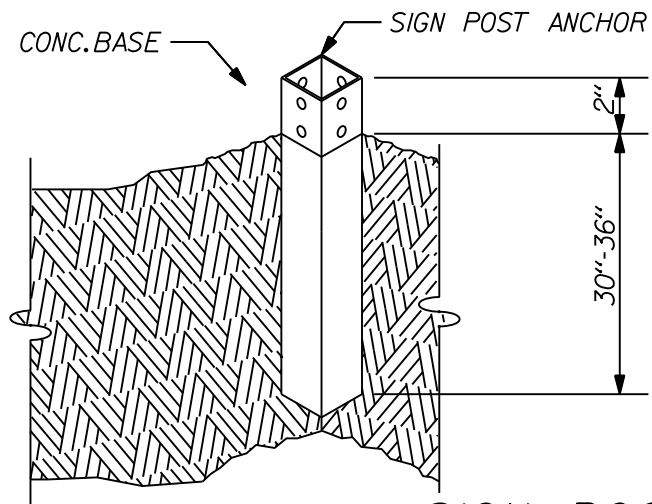
PEDESTAL MOUNTED SCHOOL ZONE
CAUTION LIGHT SIGN ASSEMBLY, DUAL
INDICATED WITH UNDERGROUND SERVICE

PUBLIC WORKS

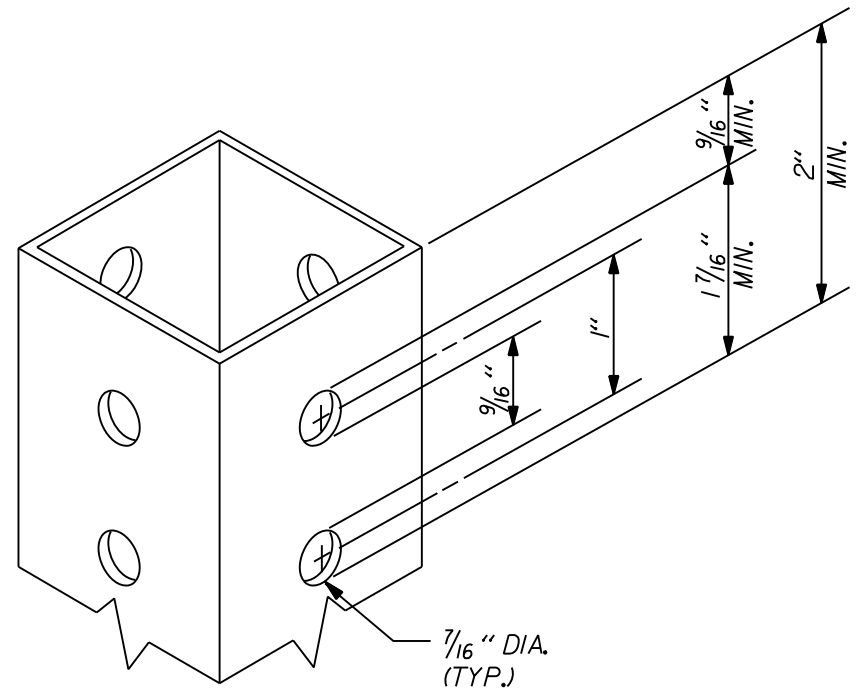
D-35



SIGN POST



SIGN POST ANCHOR

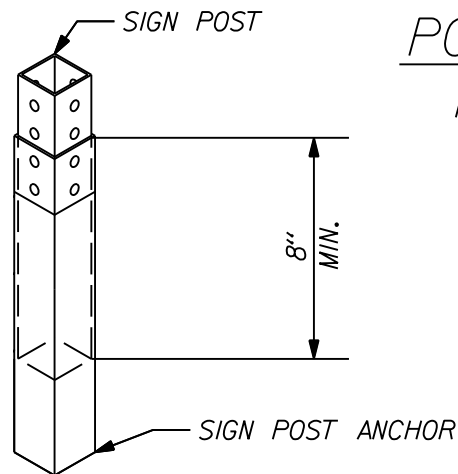


POST DETAIL

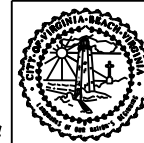
NOTES:

1. REFER TO THE CITY OF VIRGINIA BEACH AMENDMENTS TO THE VDOT ROAD AND BRIDGE SPECIFICATIONS FOR EXACT SPECIFICATIONS.

2. IF POOR SOIL CONDITIONS EXIST, THEN A 3' DEEP CONCRETE POST FOUNDATION IS RECOMMENDED



(N.T.S.)
REV. 5/14

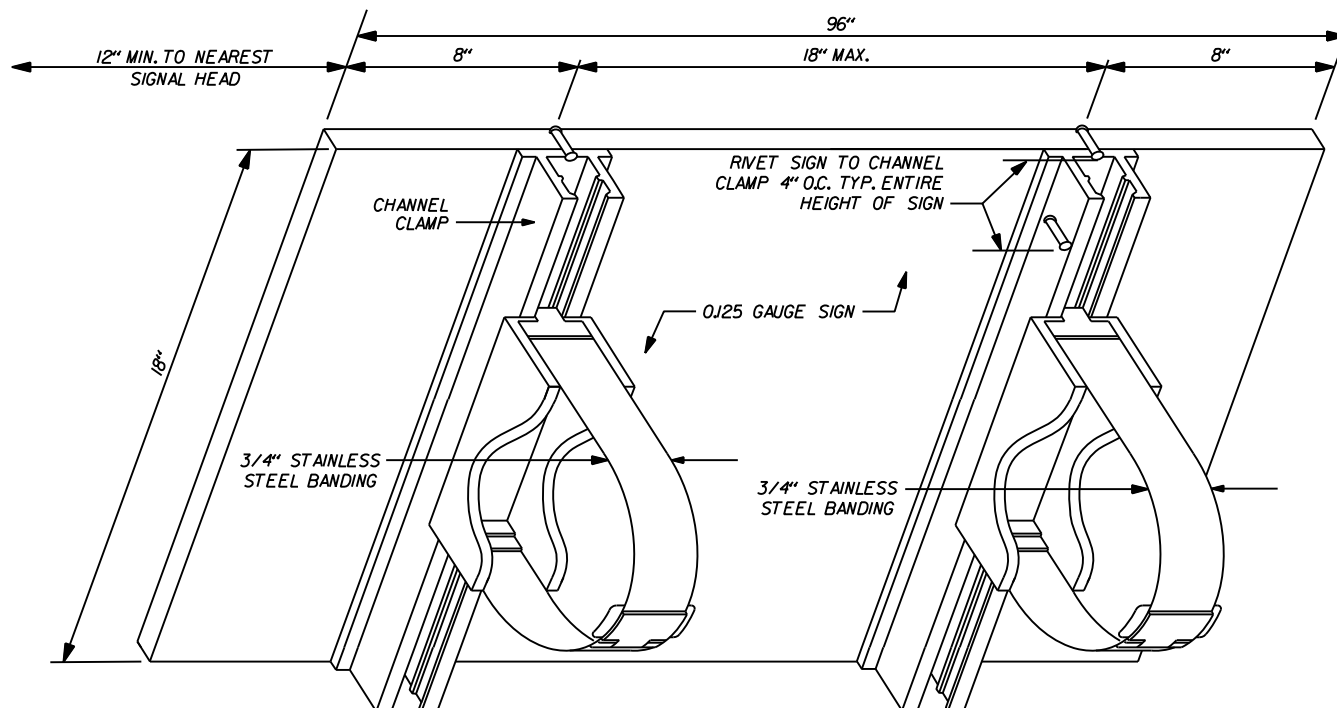


CITY OF VIRGINIA BEACH
STANDARD

TELESCOPING STEEL SIGN POST
AND ANCHORS

PUBLIC WORKS

D-36



(N.T.S.)
REV. 5/14

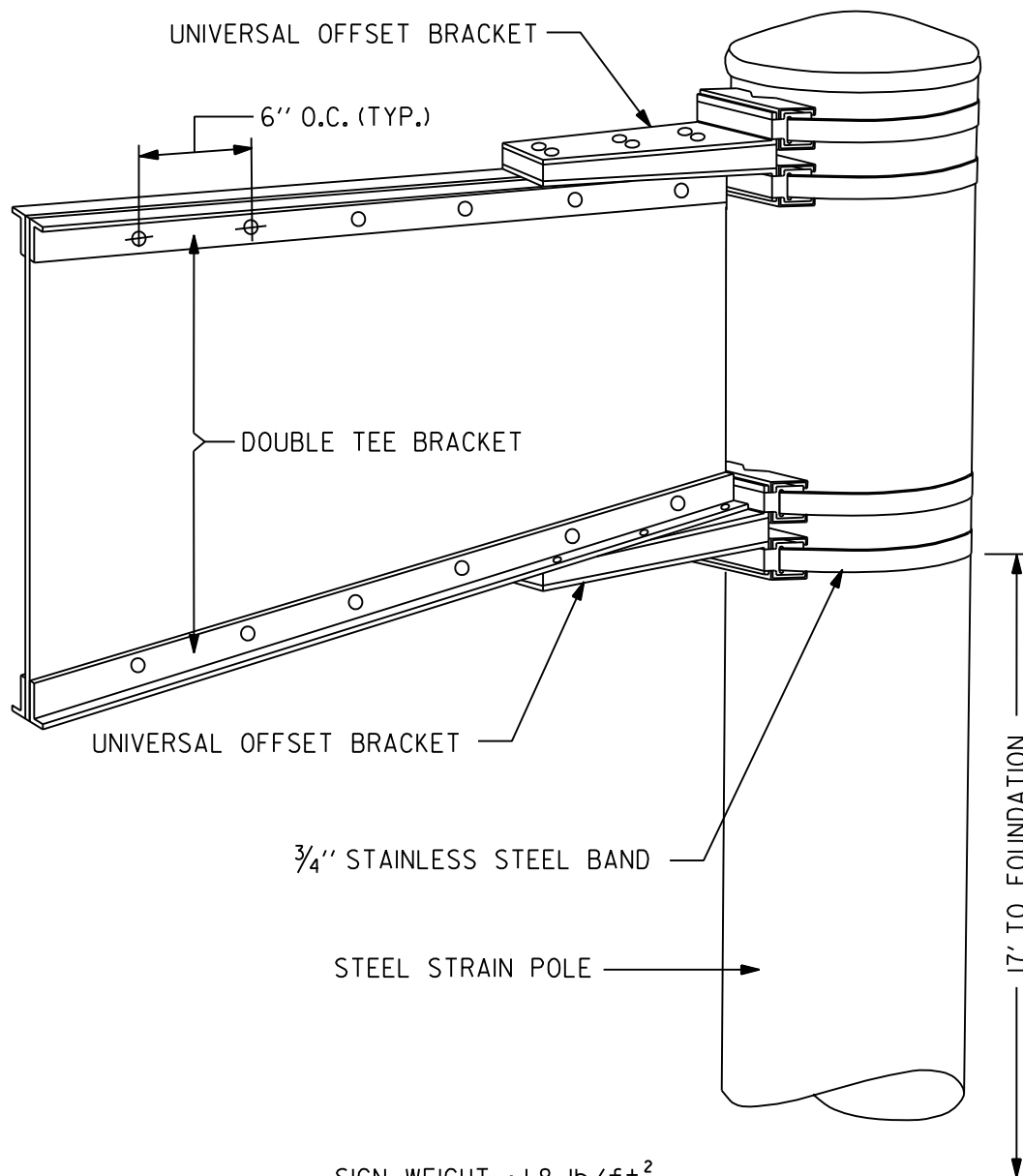


CITY OF VIRGINIA BEACH
STANDARD

METRO STREET NAME
SIGN MOUNTING
(MAST ARM MOUNT)

PUBLIC WORKS

D-37



SIGN WEIGHT : 1.8 lb/ft²
GAUGE : .125"

(N.T.S.)
REV. 5/14

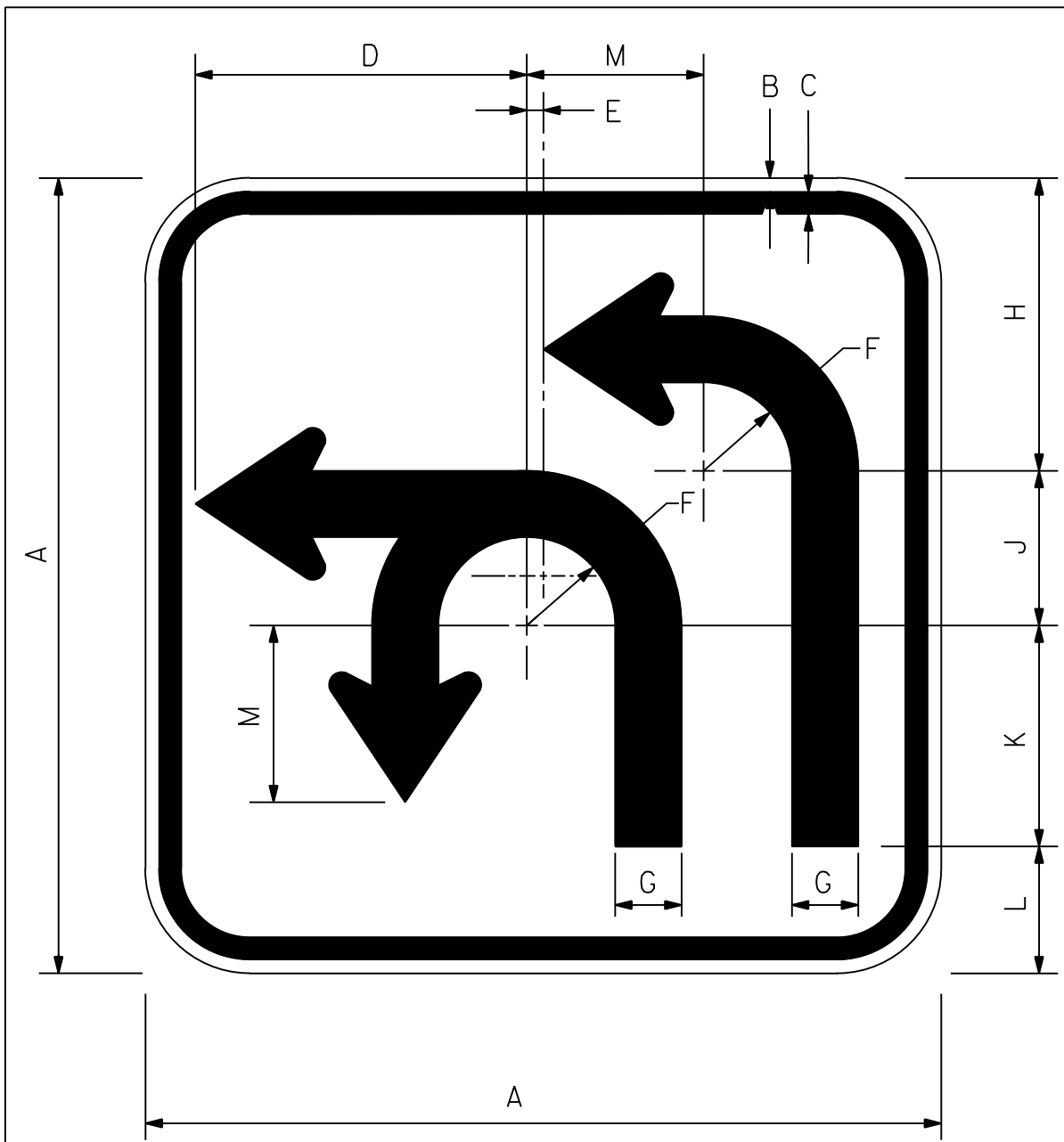


CITY OF VIRGINIA BEACH
STANDARD

METRO STREET NAME SIGN
MOUNTING (STRAIN POLE MOUNT)

PUBLIC WORKS

D-38



SIGN	DIMENSIONS (INCHES)												
	A	B	C	D	E	F	G	H	J	K	L	M	
MINIMUM	24	$\frac{3}{8}$	$\frac{5}{8}$	10	$\frac{1}{2}$	$2\frac{5}{8}$	2	$8\frac{5}{16}$	$4\frac{3}{4}$	$6\frac{11}{16}$	$3\frac{5}{8}$	$5\frac{15}{16}$	
STANDARD	36	$\frac{5}{8}$	1	15	$\frac{3}{4}$	4	3	$13\frac{1}{4}$	7	10	$5\frac{3}{4}$	8	

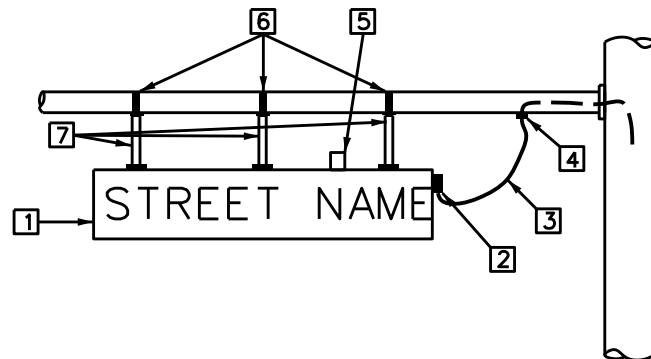
COLORS:

ARROWS AND BORDER - BLACK
BACKGROUND - WHITE (REFL)

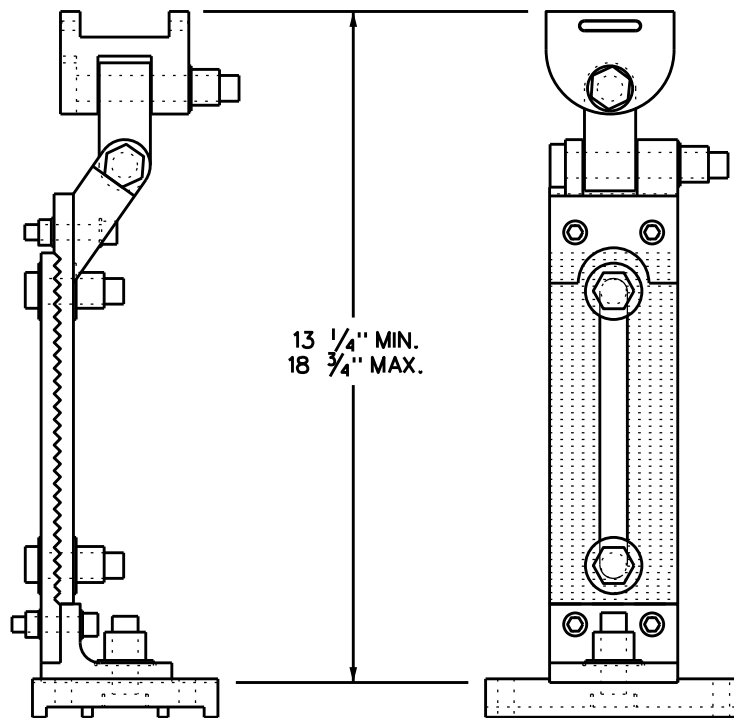
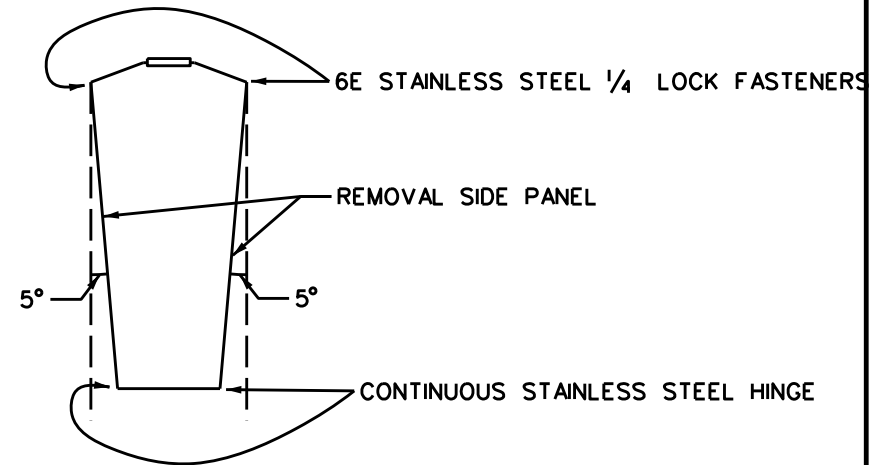
(N.T.S.)
REV. 5/14



CITY OF VIRGINIA BEACH STANDARD	
DUAL LEFT TURN WITH PERMITTED U-TURN SIGN	
PUBLIC WORKS	D-39



SIGN MOUNTING



ADJUSTABLE LENGTH SIGN HANGER ASSEMBLIES

- 1 - SIGN HOUSING, 6 FT. OR 8 FT. LENGTH
- 2 - WIRING OUTLET BOX (EITHER INTERNAL OR EXTERNAL) WITH STRAIN RELIEF
- 3 - 12 AWG/3C CABLE, CONTINUOUS FROM WIRING OUTLET BOX TO CONTROLLER CABINET
- 4 - 1" BLIND HALF COUPLING ON BOTTOM OF MAST ARM, FOR CABLE ENTRY
- 5 - PHOTOELECTRICAL CONTROL
- 6 - 1" HEAVY DUTY BAND-IT STAINLESS STEEL STRAP.
- 7 - SIGN HANGER ASSEMBLY - 2 EACH FOR 6 FT. SIGNS AND 3 EACH FOR 8 FT. SIGNS
 - ALL MATERIAL 6061-T6 ALUMINUM OR BETTER
 - ALL HARDWARE STAINLESS STEEL
 - ALL NYLOCK NUTS
 - SELF LUBRICATING BUSHINGS AT ALL HINGES

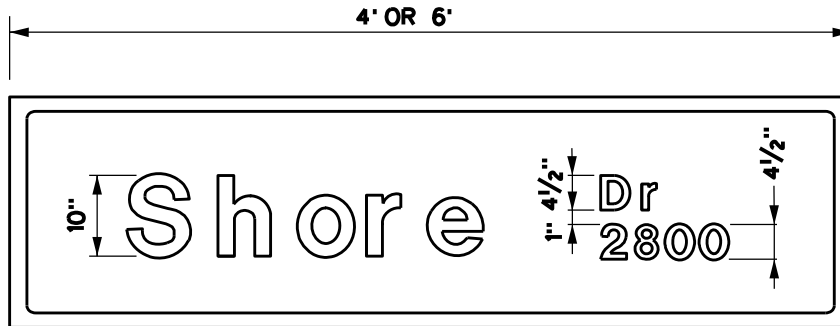
(N.T.S.)
REV.1/18



CITY OF VIRGINIA BEACH	
STANDARD	
DOUBLE FACED INTERNALLY ILLUMINATED	
STREET NAME	
SIGN DETAIL	
PUBLIC WORKS	D-40

MESSAGE

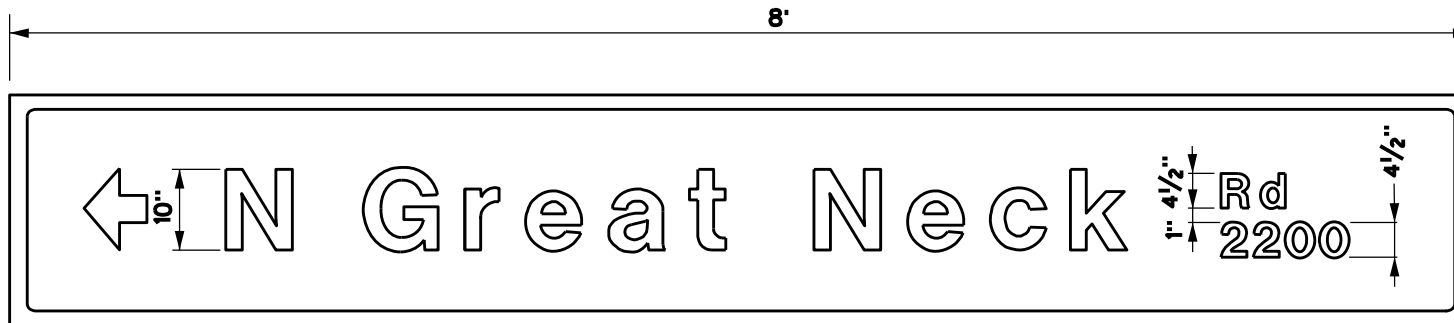
①



T2000 HIGHWAY SERIES C

MESSAGE

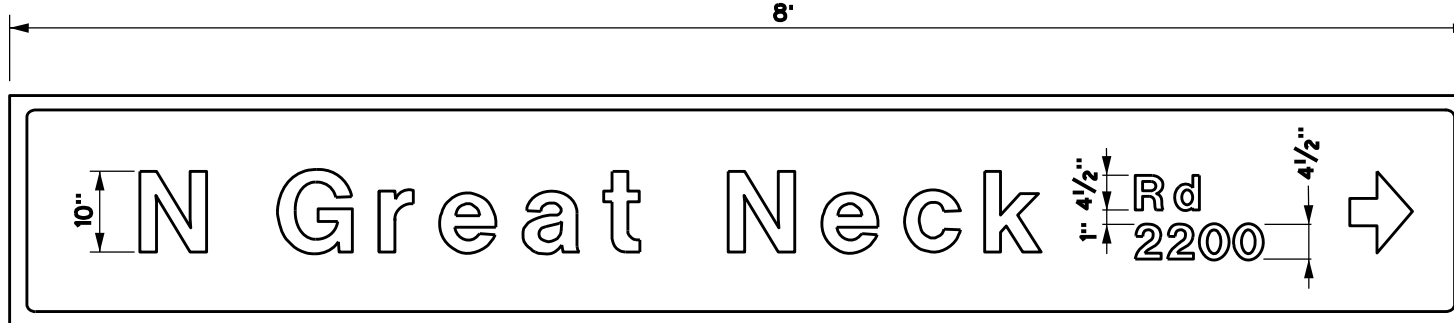
②



T2000 HIGHWAY SERIES C
or D

MESSAGE

③



T2000 HIGHWAY SERIES C
or D

COLORS:
BACKGROUND - GREEN
LETTERING - WHITE
BORDER - WHITE

(N.T.S.)
REV. 1/18

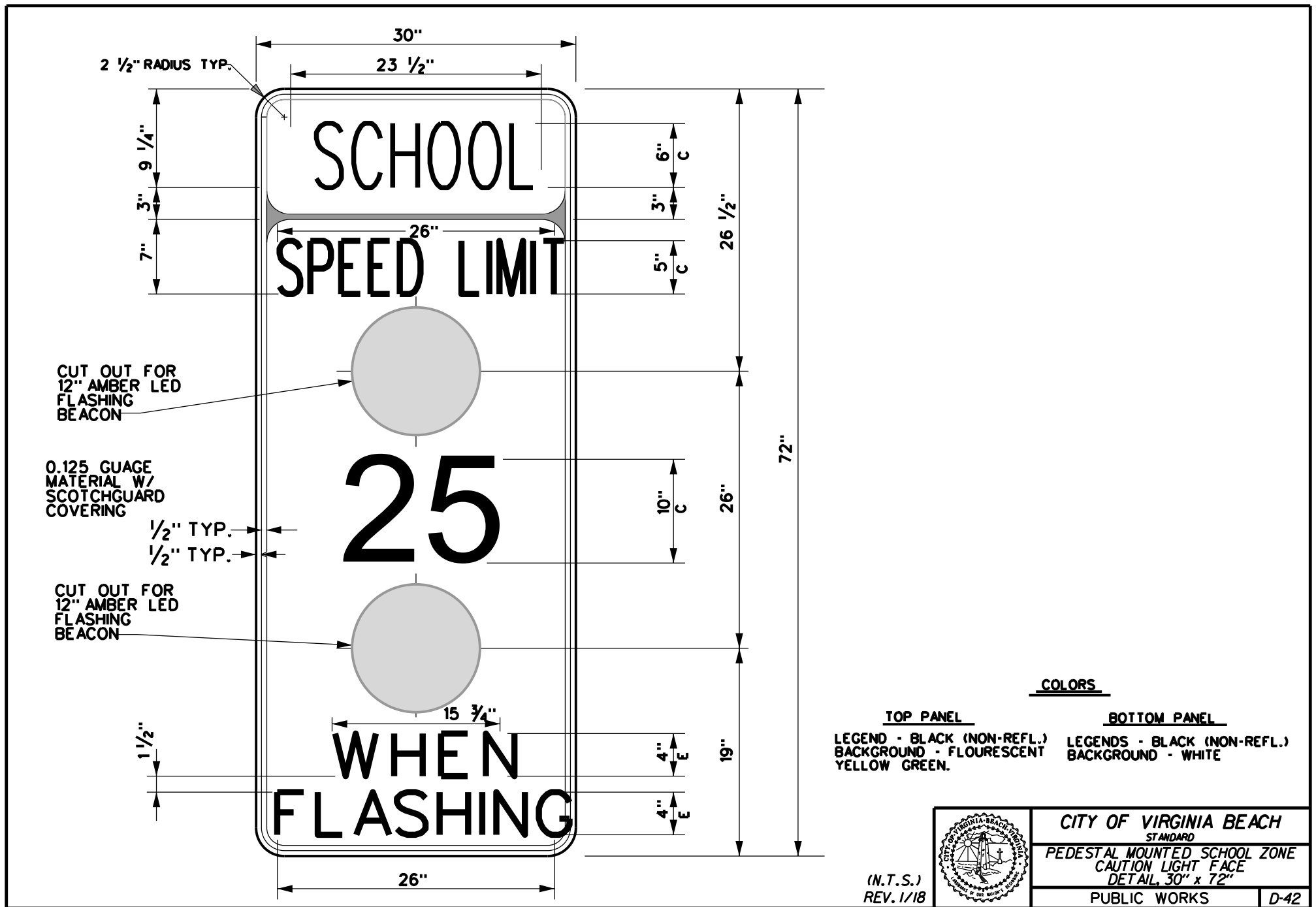


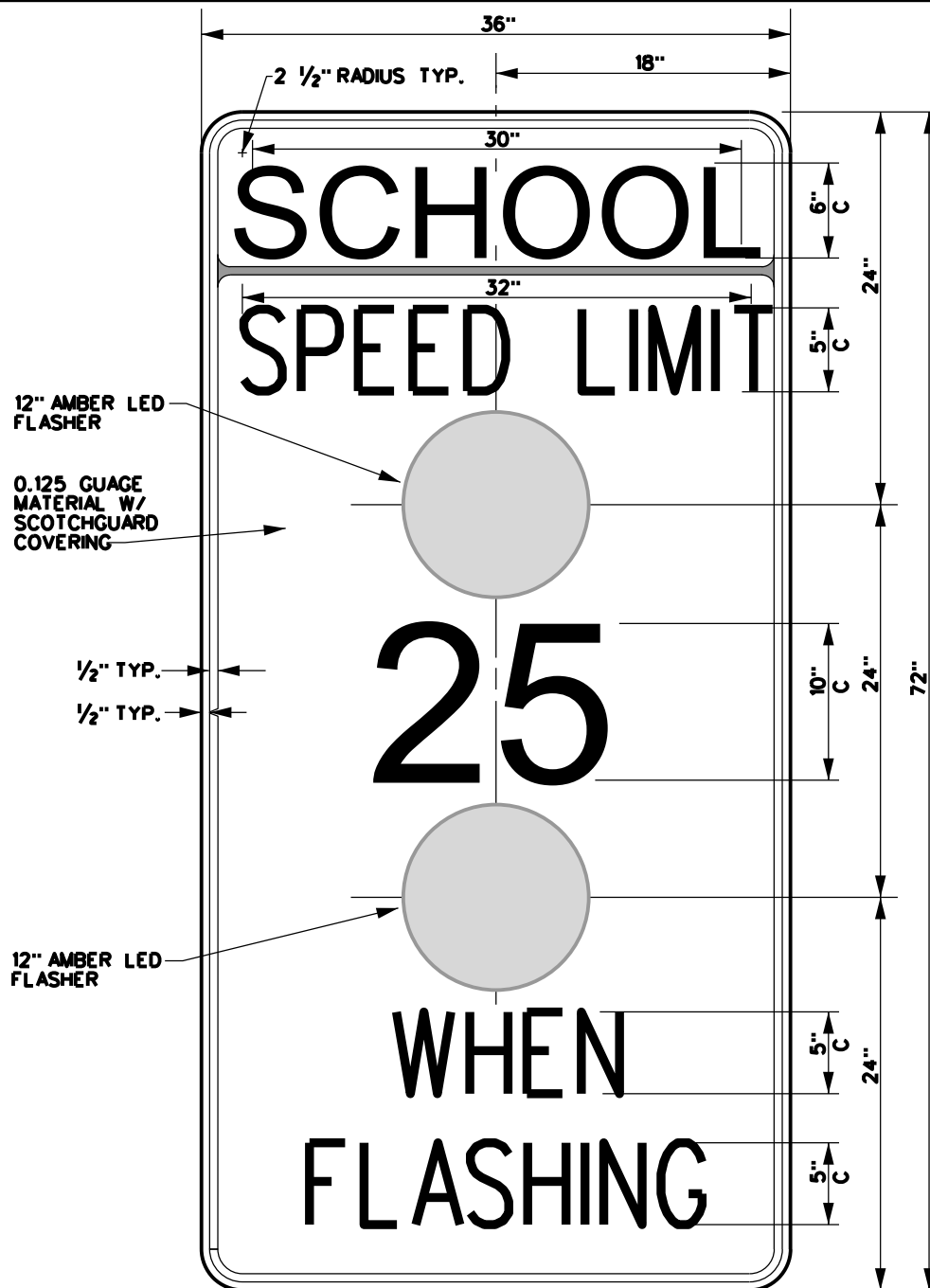
CITY OF VIRGINIA BEACH
STANDARD

INTERNALLY ILLUMINATED
STREET NAME SIGN PANEL
MESSAGE LAYOUT

PUBLIC WORKS

D-41





COLORS

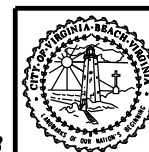
TOP PANEL

LEGEND - BLACK (NON-REFL.)
BACKGROUND - FLOURESCENT
YELLOW GREEN.

BOTTOM PANEL

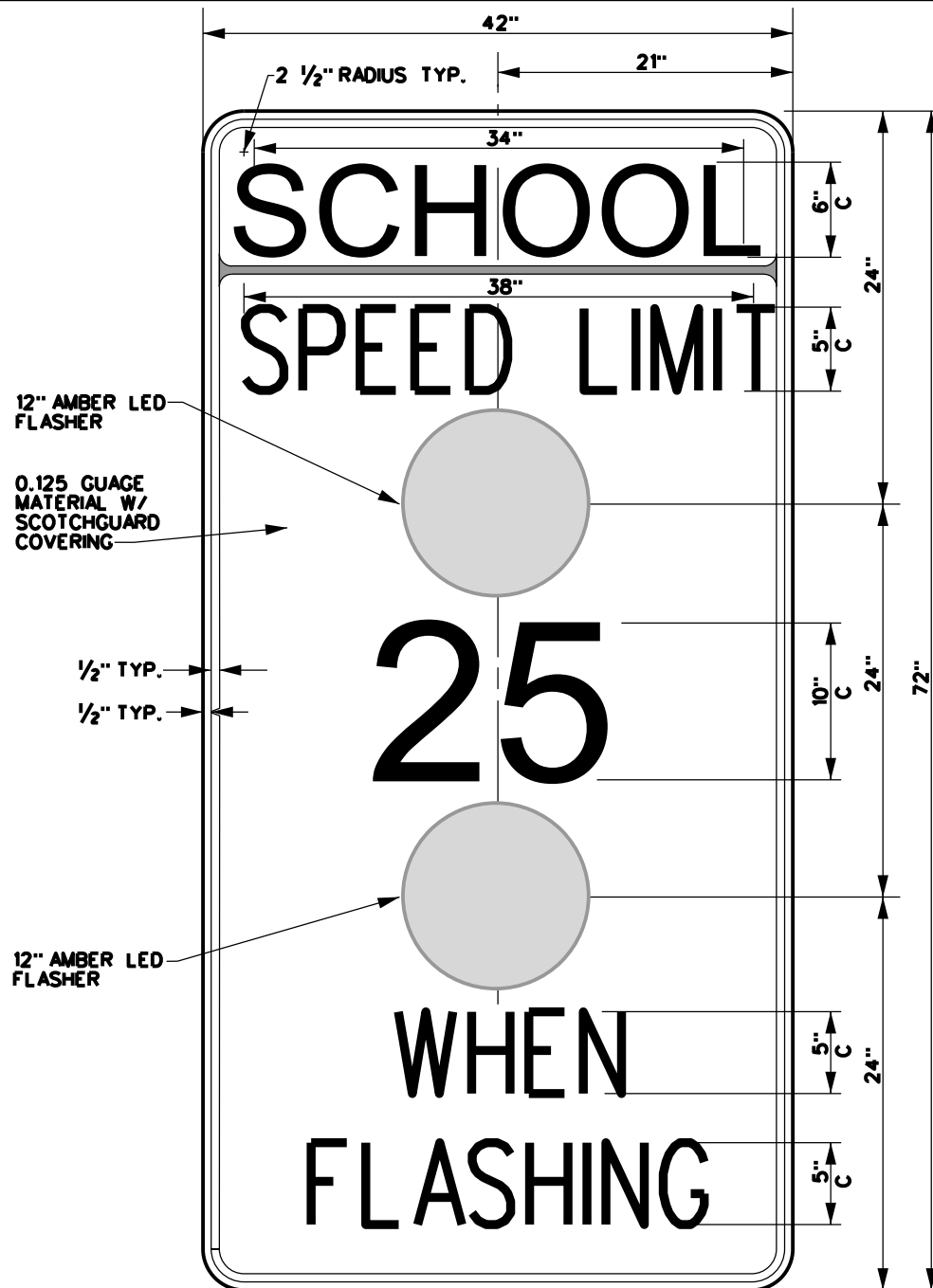
LEGENDS - BLACK (NON-REFL.)
BACKGROUND - WHITE

(N.T.S.)
REV. 1/18



CITY OF VIRGINIA BEACH
STANDARD
PEDESTAL MOUNTED SCHOOL ZONE
CAUTION LIGHT FACE
DETAIL, 36" x 72"
PUBLIC WORKS

D-43



COLORS

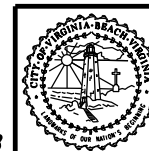
TOP PANEL

LEGEND - BLACK (NON-REFL.)
BACKGROUND - FLOURESCENT
YELLOW GREEN.

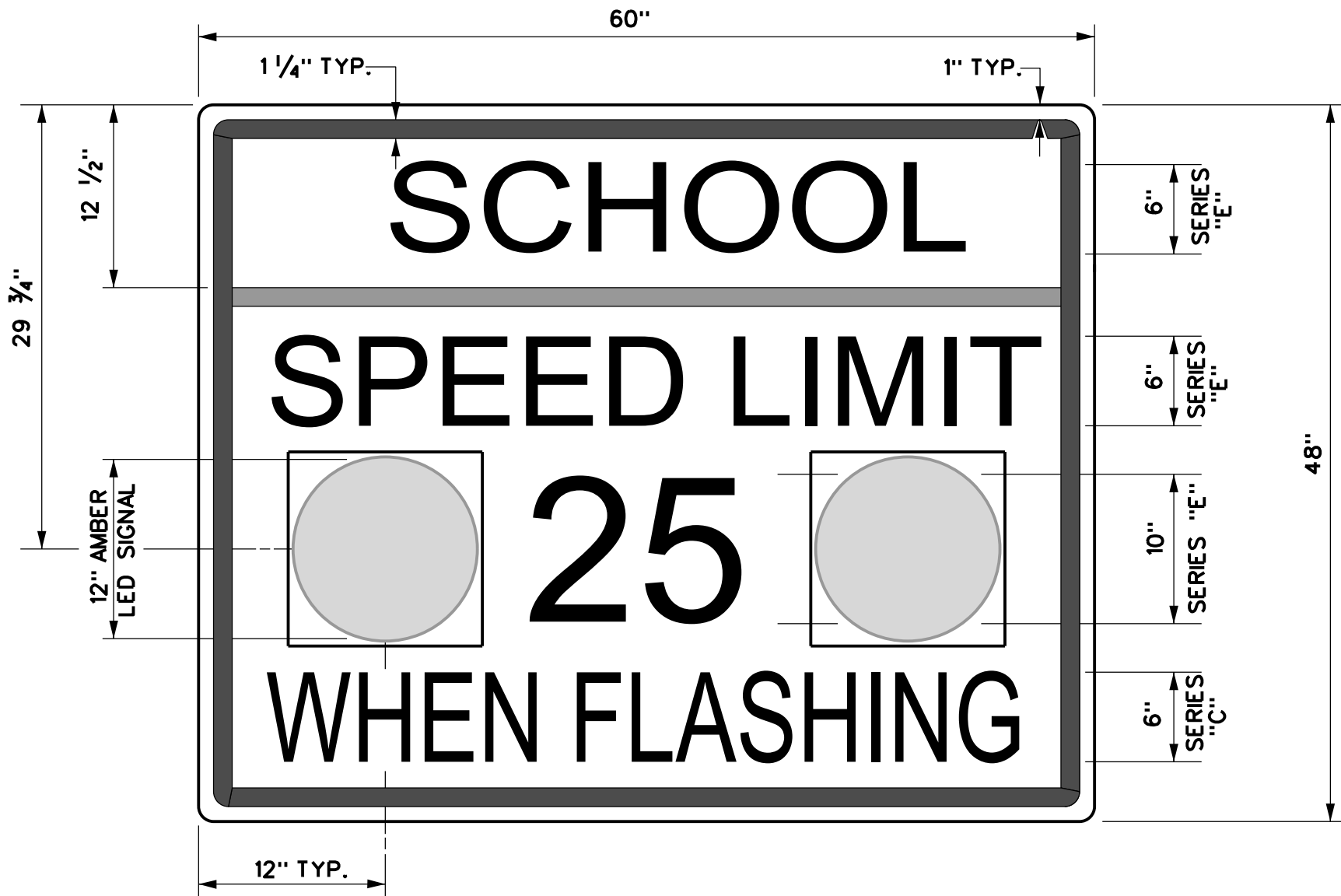
BOTTOM PANEL

LEGENDS - BLACK (NON-REFL.)
BACKGROUND - WHITE

(N.T.S.)
REV. 1/18



CITY OF VIRGINIA BEACH STANDARD	
PEDESTAL MOUNTED SCHOOL ZONE CAUTION LIGHT FACE DETAIL, 42" x 72"	
PUBLIC WORKS	D-44



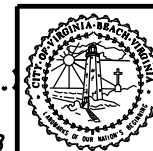
COLORS

TOP PANEL

LEGEND - BLACK (NON-REFL.)
BACKGROUND - FLOURESCENT
YELLOW GREEN.

BOTTOM PANEL

LEGENDS - BLACK (NON-REFL.)
BACKGROUND - WHITE
(N.T.S.)
REV. 1/18

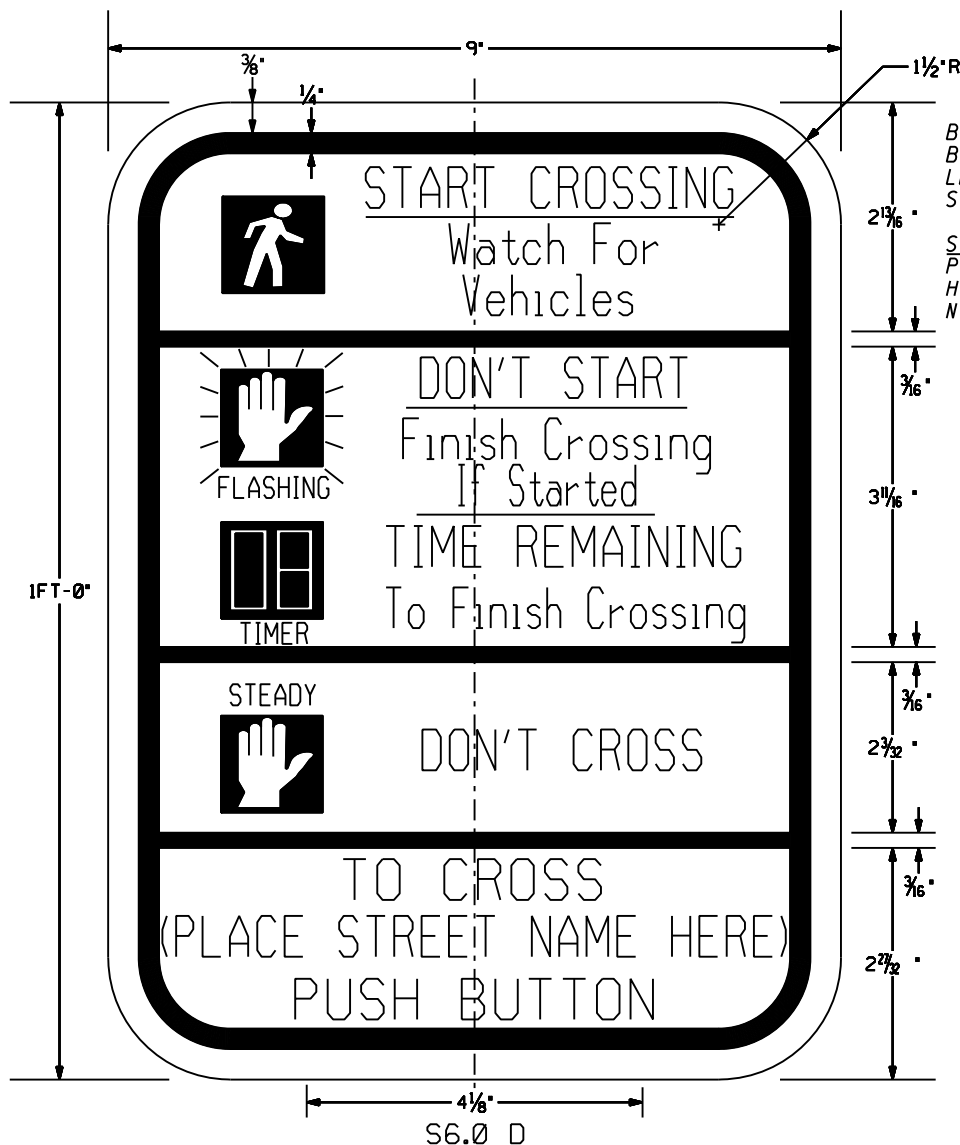


CITY OF VIRGINIA BEACH
STANDARD

MAST ARM MOUNTED SCHOOL ZONE
CAUTION LIGHT FACE DETAIL.
48" x 60"

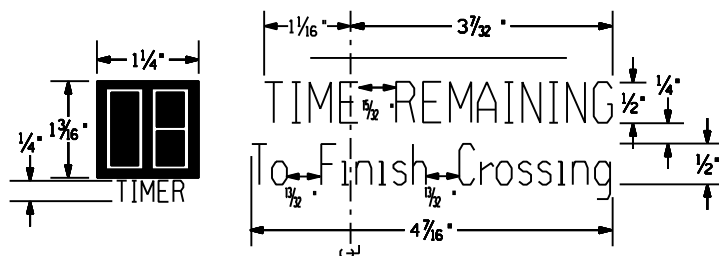
PUBLIC WORKS

D-45



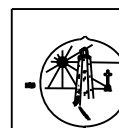
BACKGROUND-WHITE
BORDERS-BLACK
LETTERING-BLACK
SQUARES CONTAINING SYMBOLS-BLACK

SYMBOLS
PEDESTRIAN-WHITE
HAND-RED
NUMBER-RED



NOTE: ALL LETTERING
SHALL BE HIGHWAY
GOTHIC "C"

(N.T.S.)
REV.5/14

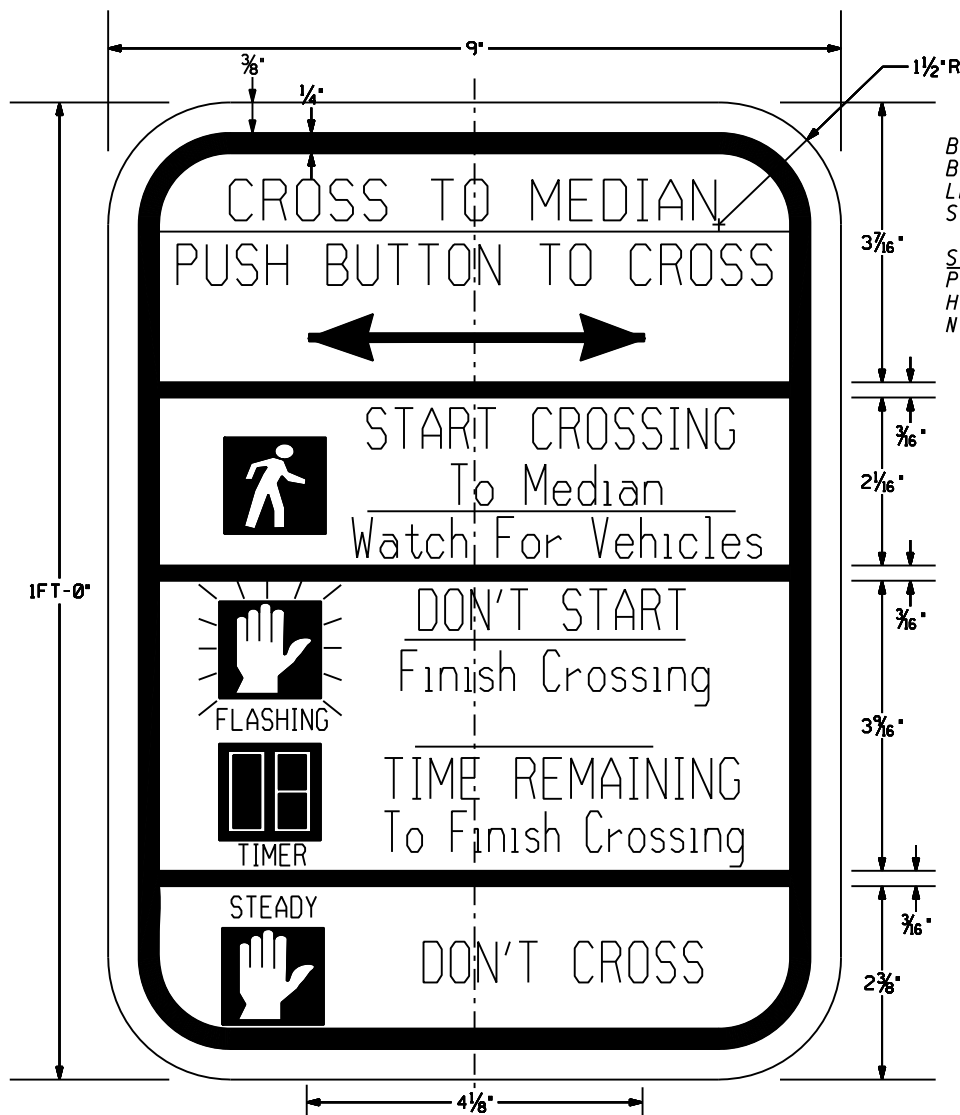


CITY OF VIRGINIA BEACH
STANDARD

PEDESTRIAN PUSHBUTTON
SIGN LAYOUT

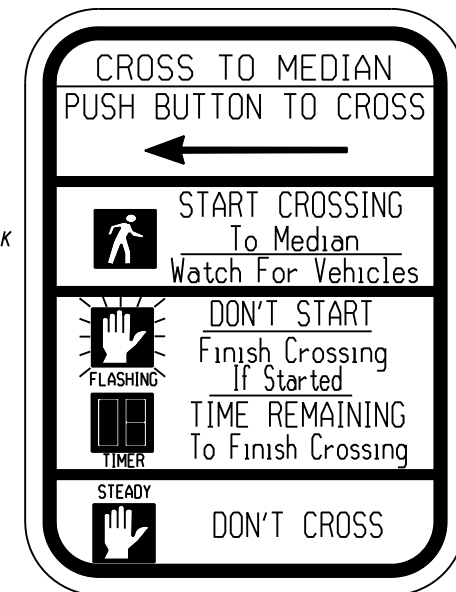
PUBLIC WORKS

D-46

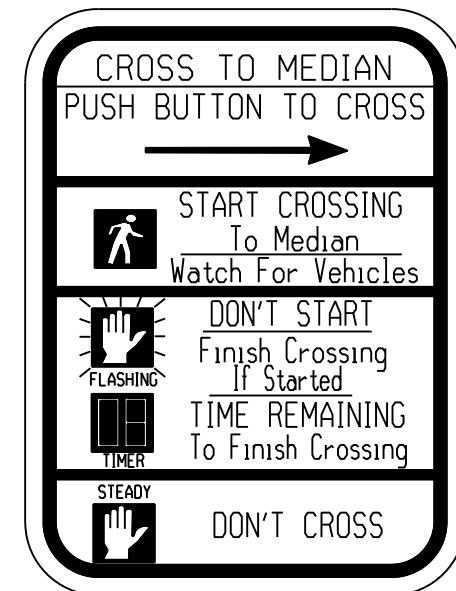


BACKGROUND-WHITE
BORDERS-BLACK
LETTERING-BLACK
SQUARES CONTAINING SYMBOLS-BLACK

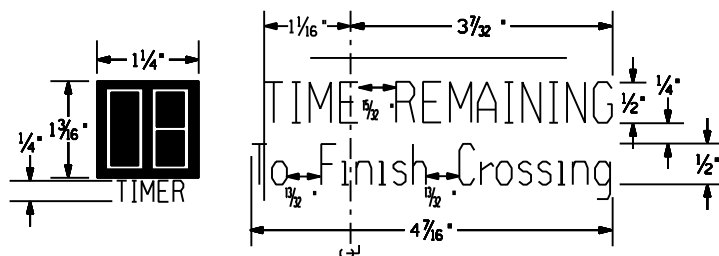
SYMBOLS
PEDESTRIAN-WHITE
HAND-RED
NUMBER-RED



S6.0 L

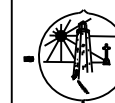


S6.0 R



NOTE: ALL LETTERING
SHALL BE HIGHWAY
GOTHIC "C"

(N.T.S.)
REV. 5/14



CITY OF VIRGINIA BEACH
STANDARD

PEDESTRIAN PUSHBUTTON
SIGN LAYOUT
(FOR USE IN MEDIANS)

PUBLIC WORKS

D-47



NOTE: ALL LETTERING
SHALL BE HIGHWAY
GOTHIC "C"

(N.T.S.)
REV. 5/14

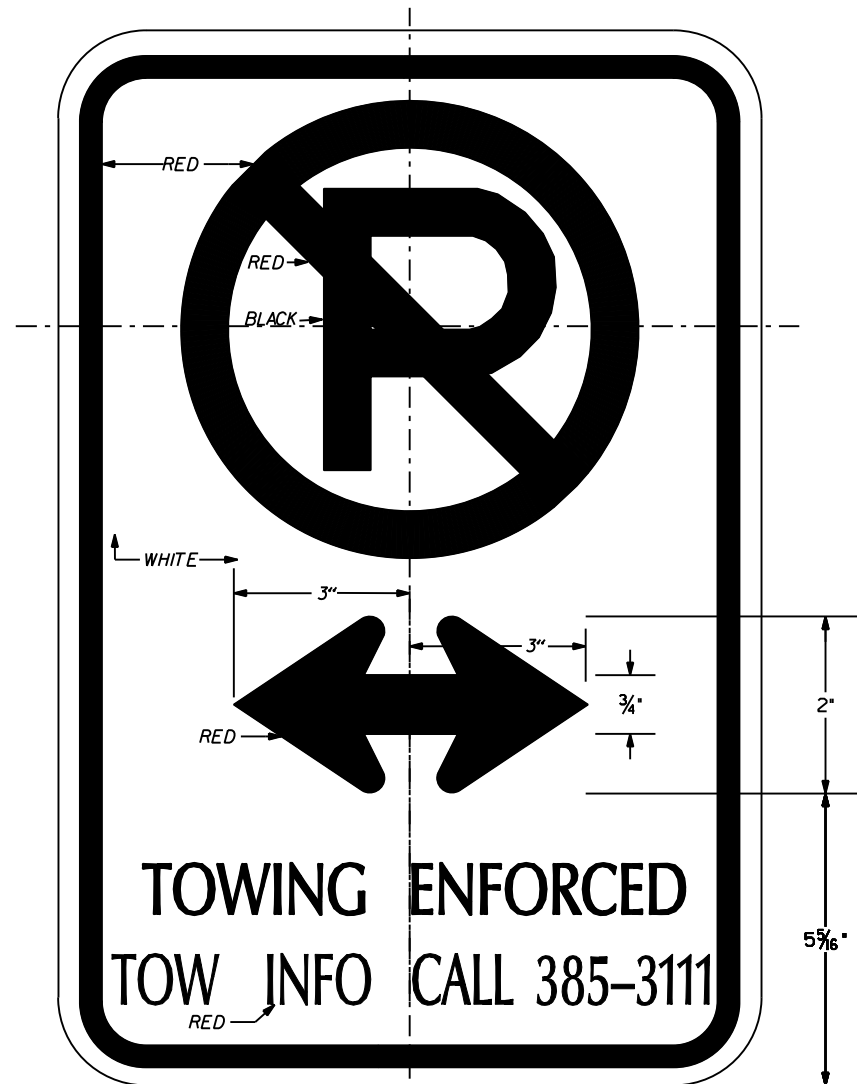


CITY OF VIRGINIA BEACH
STANDARD

NO PARKING ON PAVEMENT
SIGN LAYOUT
(TOWING ENFORCED)

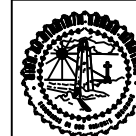
PUBLIC WORKS

D-48



NOTE: ALL LETTERING
SHALL BE HIGHWAY
GOTHIC "C"

(N.T.S.)
REV. 5/14

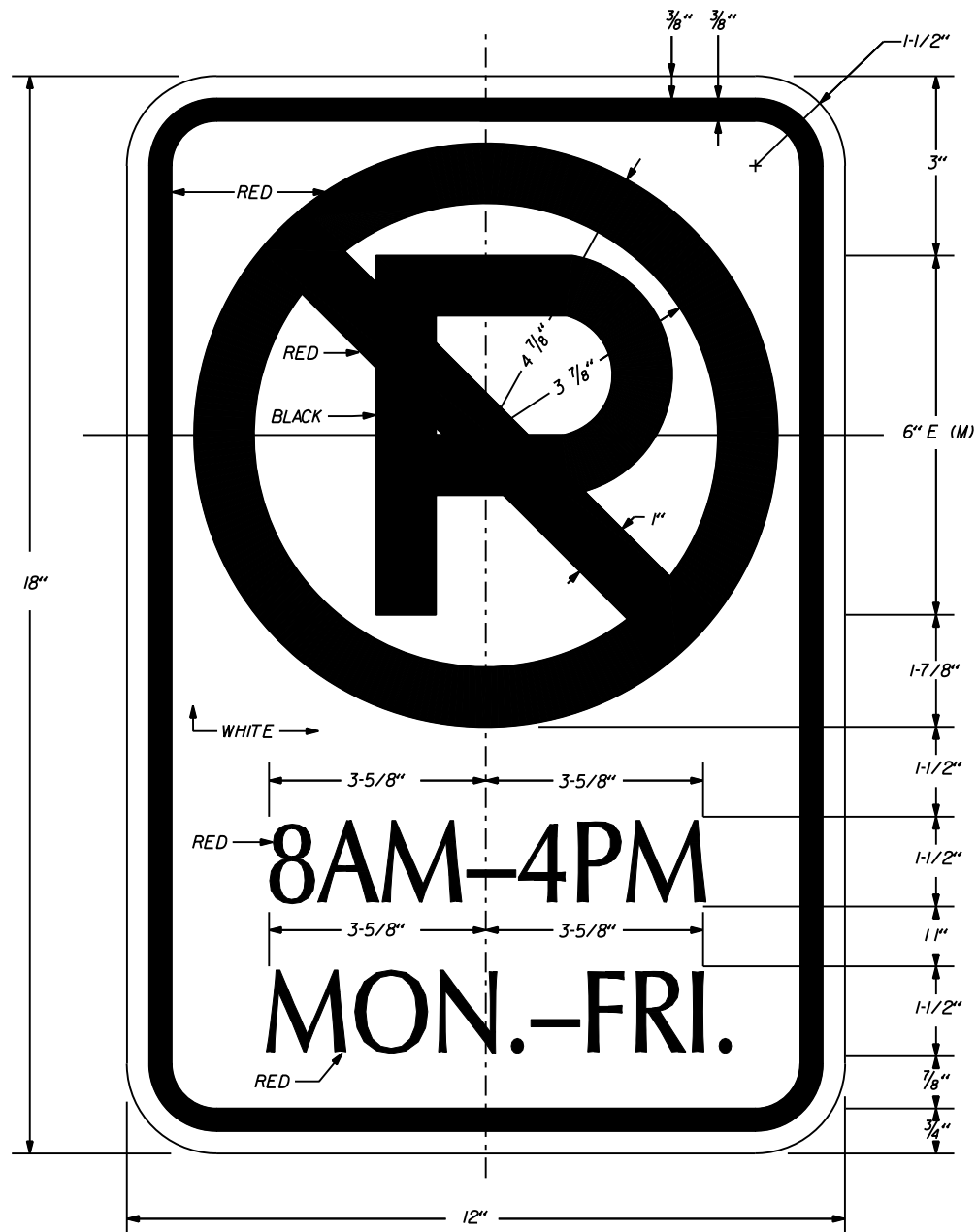


CITY OF VIRGINIA BEACH
STANDARD

NO PARKING SIGN LAYOUT
WITH ARROWS
(TOWING ENFORCED)

PUBLIC WORKS

D-49



(N.T.S.)
REV. 5/14

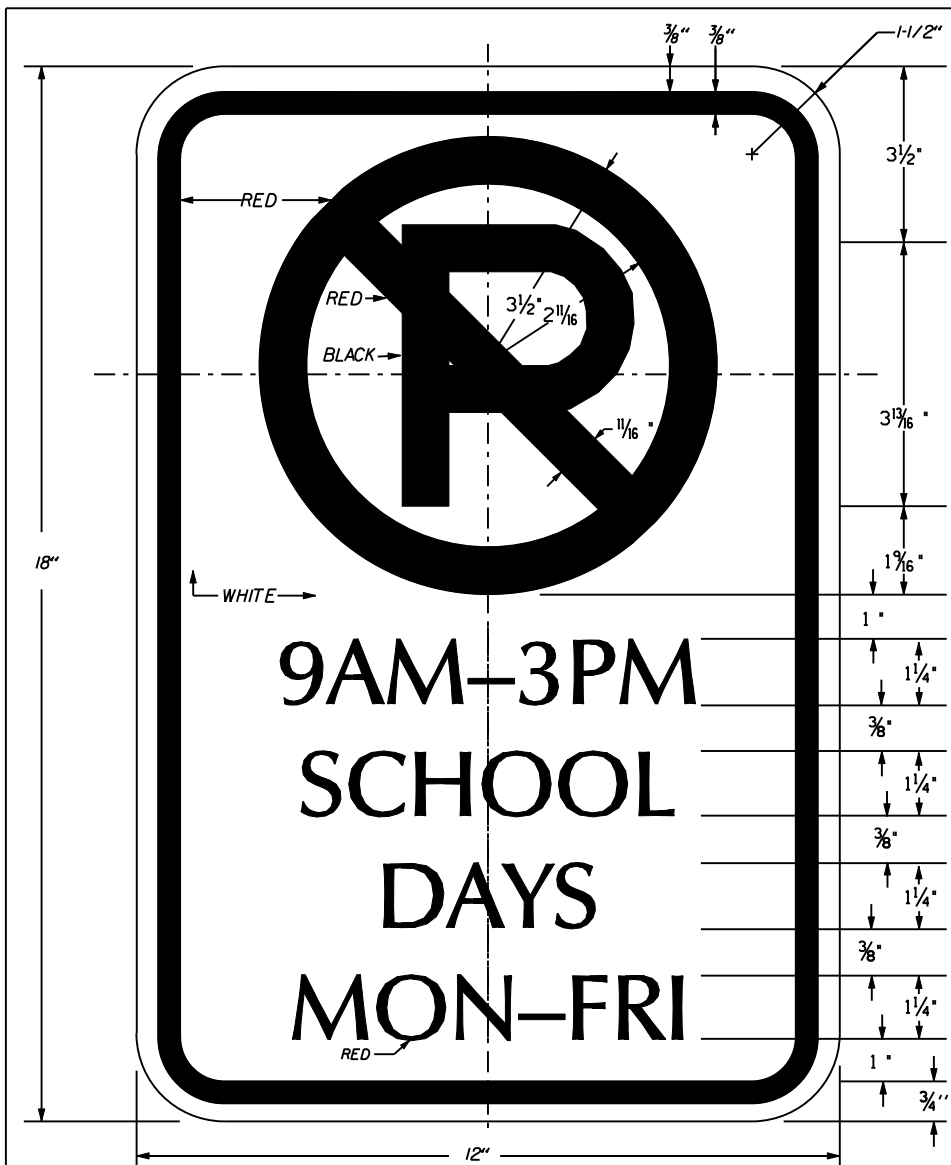


CITY OF VIRGINIA BEACH
STANDARD

NO PARKING SIGN LAYOUT
(RESTRICTED HOURS), MON.-FRI.

PUBLIC WORKS

D-50



NOTE: ALL LETTERING
SHALL BE HIGHWAY
GOTHIC "C"

(N.T.S.)
REV.6/15

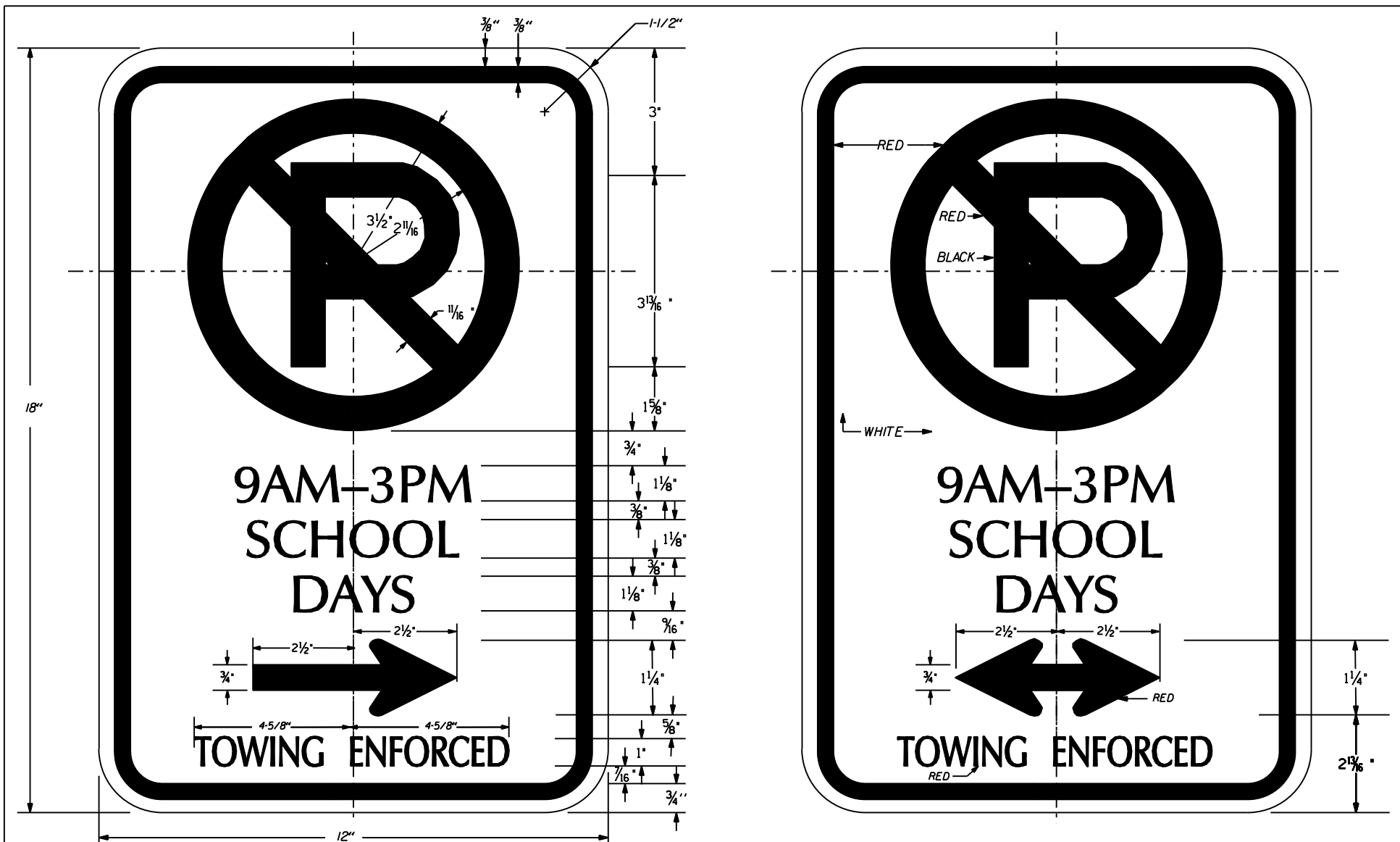


CITY OF VIRGINIA BEACH
STANDARD

NO PARKING 9PM-3PM SIGN LAYOUT
SCHOOL DAYS MON-FRI

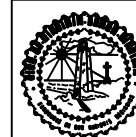
PUBLIC WORKS

D-51



NOTE: ALL LETTERING
SHALL BE HIGHWAY
GOTHIC "C"

(N.T.S.)
REV. 5/14

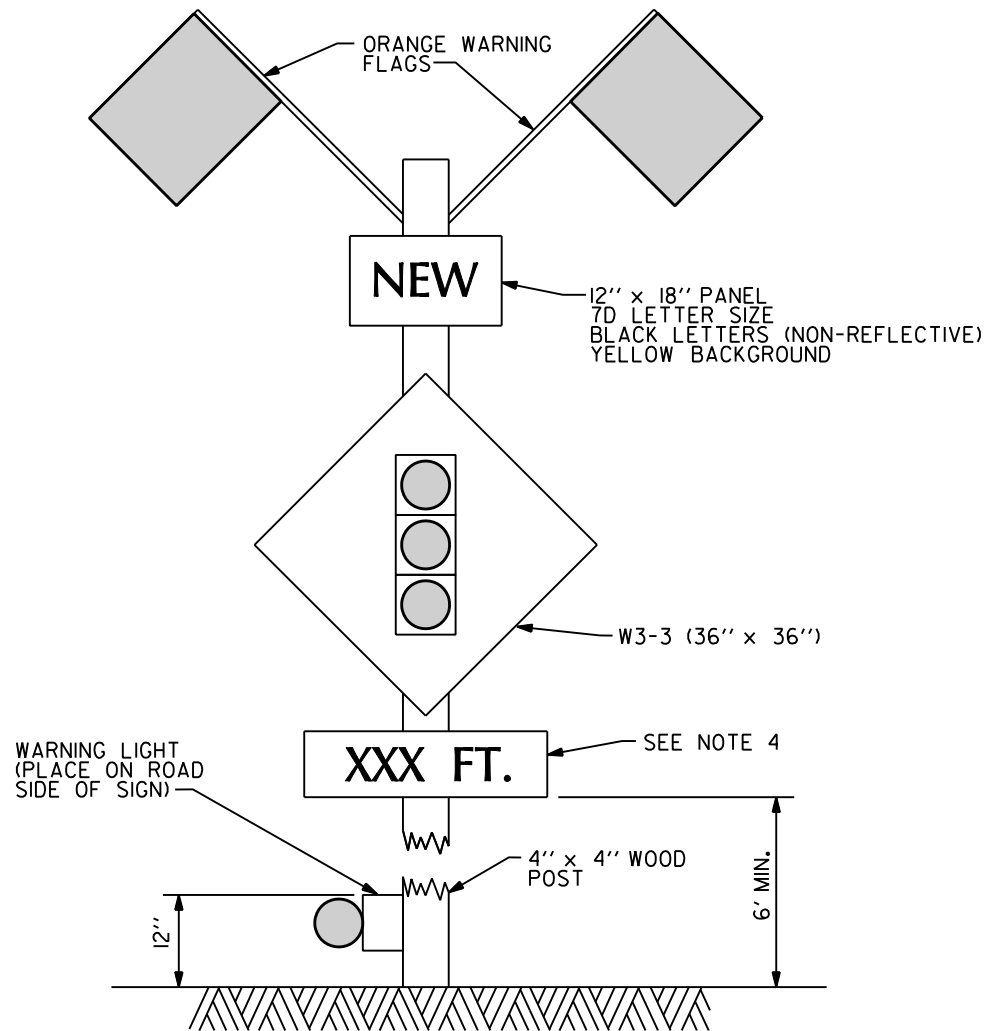


CITY OF VIRGINIA BEACH
STANDARD

NO PARKING 9AM-3PM SIGN LAYOUT
WITH ARROWS
(TOWING ENFORCED)

PUBLIC WORKS

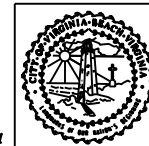
D-52



NOTES:

1. SIGNS TYPICALLY SHOULD BE SET BACK A DISTANCE FROM THE STOP BAR EQUAL TO TEN TIMES THE SPEED LIMIT.
2. SIGNS WILL BE COVERED UNTIL SIGNAL IS PLACED IN SERVICE.
3. SIGNS WILL BE REMOVED 30 DAYS AFTER SIGNAL IS PLACED IN SERVICE, UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
4. WHERE THE NEW SIGNAL IS NOT VISIBLE FROM THE SIGN LOCATION, A SUPPLEMENTAL PLATE WITH THE DISTANCE TO THE INTERSECTION WILL BE INSTALLED.

(N.T.S.)
REV. 5/14

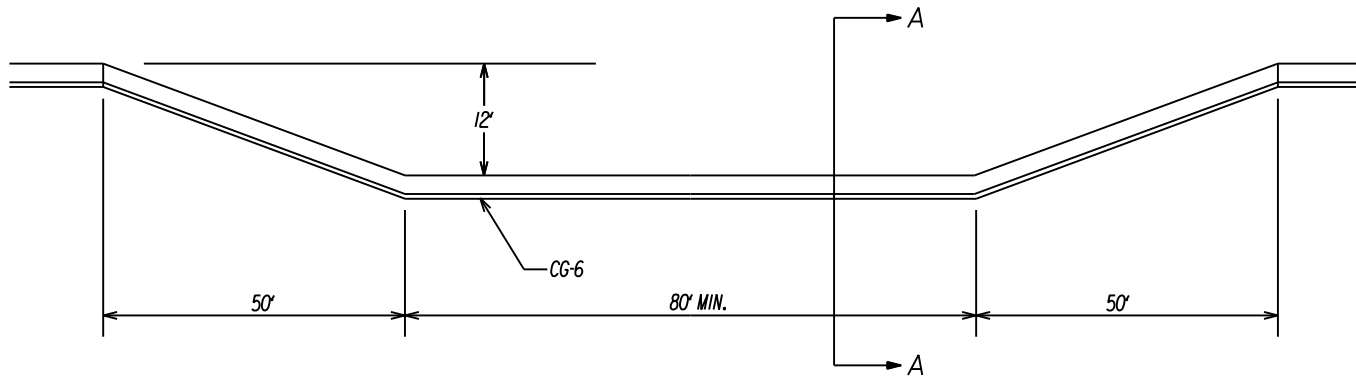


CITY OF VIRGINIA BEACH
STANDARD

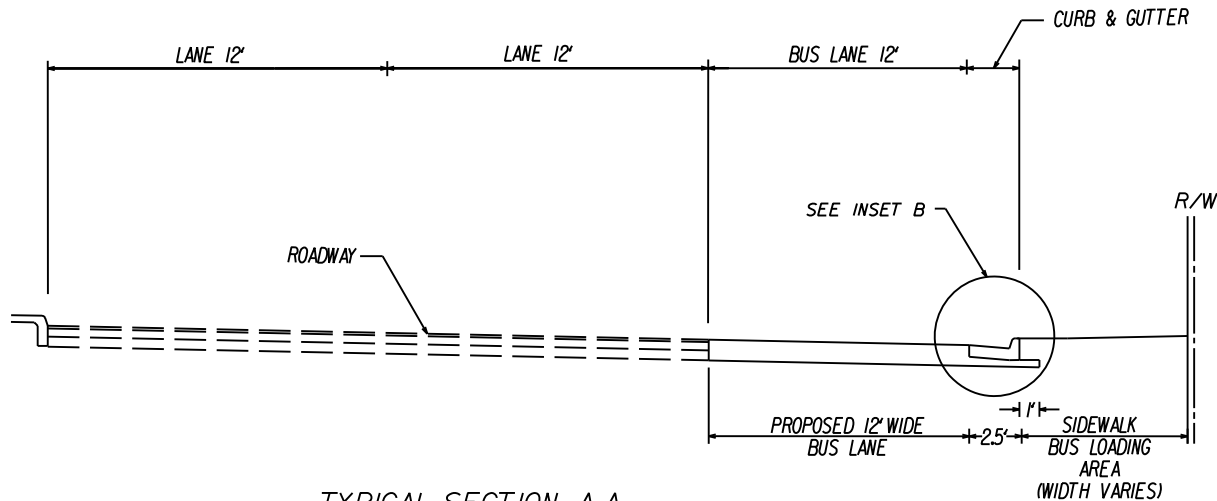
NEW SIGNAL ADVANCE WARNING SIGN

PUBLIC WORKS

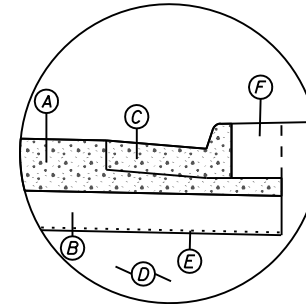
D-53



BUS TURNOUT
N.T.S.



TYPICAL SECTION A-A
N.T.S.



- (A) 8" THICK 3000 P.S.I. (MIN.) CONTINUOUSLY REINFORCED (WIRE MESH) CONCRETE PAVEMENT AS PER V.D.O.T. ROAD & BRIDGE STD. PR-3
- (B) 12" STD. V.D.O.T. AGGREGATE BASE MATERIAL TYPE 1, 2IB
- (C) STD. V.D.O.T. CG-6 CURB & GUTTER
- (D) SELECT BORROW (DEPTH VARIES, 6" MIN.) C.B.R.:15 MIN.
- (E) GEOTEXTILE FABRIC - TENSAR TRIAX TX-160 OR APPROVED EQUIVALENT
- (F) SIDEWALK - TO BE UNDERCUT BY 1' MIN.

INSET B

(N.T.S.)
REV. 5/14

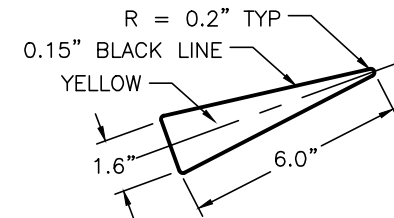
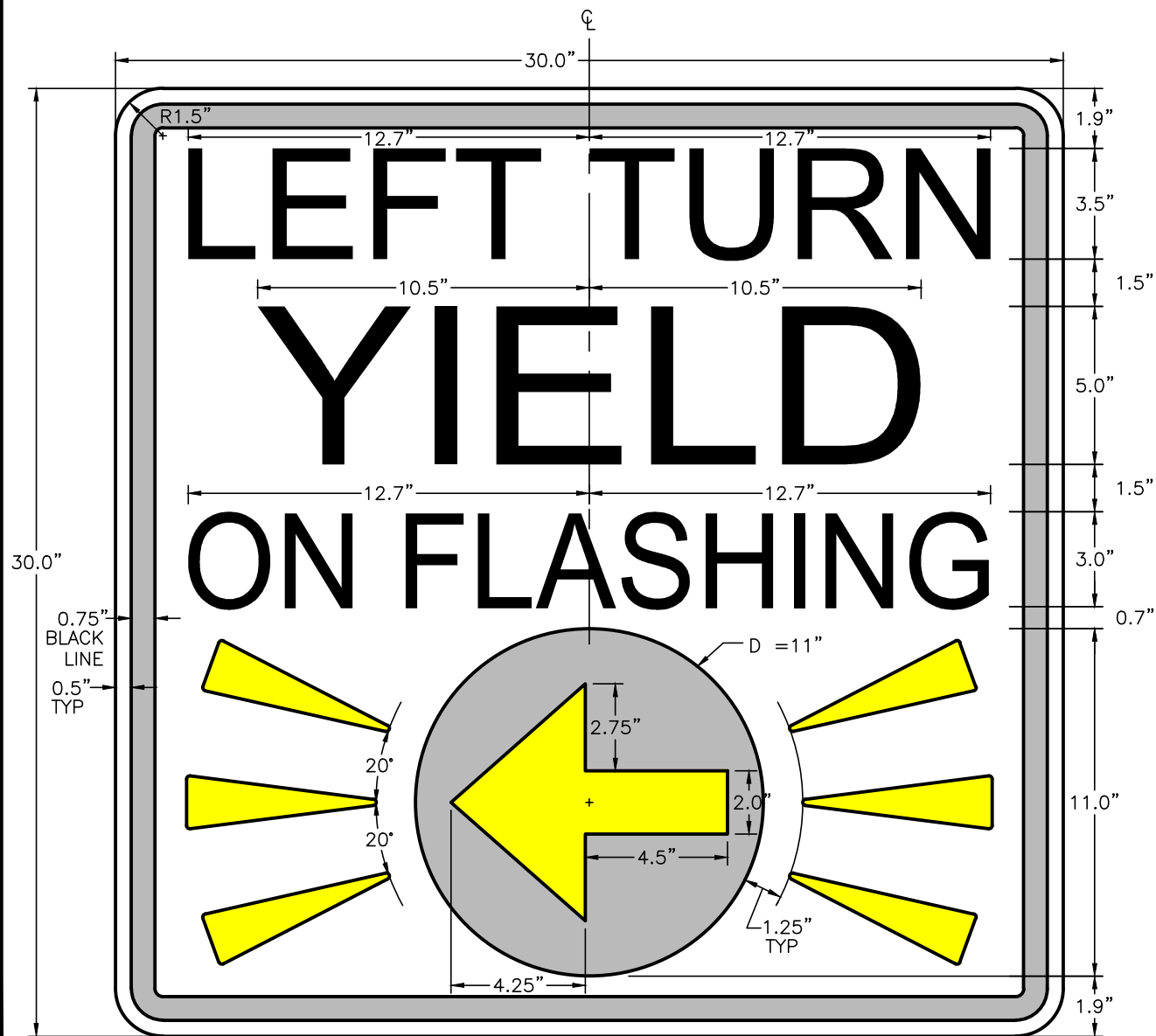


CITY OF VIRGINIA BEACH
STANDARD

BUS TURNOUT

PUBLIC WORKS

D-54



ALL LETTERING IS
T2000 HIGHWAY "C"

CIRCLE CONTAINING ARROW, BORDER, TEXT,
AND LINES - BLACK
BACKGROUND - WHITE (RETROREFLECTIVE)
ARROW AND FLASHING SYMBOLS - YELLOW
(RETROREFLECTIVE)



CITY OF VIRGINIA BEACH
STANDARD

LEFT TURN YIELD ON FLASHING
YELLOW ARROW SIGN

NTS

Public Works

D-57



Appendix E

Temporary Traffic Control and Master List of Traffic Signalization Plan Notes

E.1 Temporary Traffic Control Notes

1. The City of Virginia Beach, Traffic Engineering Division is responsible for reviewing and approving all temporary traffic control plans and reviewing the sequence of construction plans essential to complete this project.
2. All temporary traffic control devices, methods and applications will conform to the following publications including all current editions and revisions:
 - a. Manual on Uniform Traffic Control Devices for Street and Highways issued by the U.S. Department of Transportation, Federal Highway Administration (MUTCD).
 - b. Virginia Department of Transportation Road and Bridge Standards Vol. II.
 - c. Virginia Department of Transportation Road and Bridge Specifications.
 - d. Virginia Department of Transportation Work Area Protection Manual.
 - e. City of Virginia Beach, Public Works Design Standards Manual.
3. Work Hours in Roadway Open to Traffic and/or Pedestrian area:
 - a. Monday through Saturday: Work will be completed between the hours of 9:00 a.m. and 4:00 p.m. only.
 - b. Sundays and Holidays: No work may be completed in the roadway or pedestrian areas unless otherwise noted or approved in writing by the Owner.
 - c. Additional restrictions may apply based on traffic conditions.
 - d. Extended work hours and workdays may be requested with a written request to the Owner. This request must be submitted at least five (5) working days prior to the extended work periods. (Please note that if work is to be conducted in the resort area, certain restrictions apply from May through September. Please contact Traffic Engineering for these restrictions).
4. Traffic Control Plans:

Traffic control plans are included in the construction plans for the referenced project; however, field conditions may require modifications. If the contractor feels that the traffic control plan(s) included with this project does not suit conditions at a work site, then the contractor shall submit to the Owner a revised plan to maintain traffic. The revised plan shall include site-specific traffic details and shall identify the sequence of construction. The contractor will submit the revised traffic control plan(s) a minimum 10 calendar days prior to the start of work. The contractor will not disrupt traffic patterns until the Owner has approved



the revised traffic control plan. The Owner reserves the right to modify any traffic control plan(s) as necessary in the interest of public safety or traffic efficiency. Prior to beginning work, it is the contractor's responsibility to insure that all requirements have been met and that all traffic control devices have been installed according to the approved traffic control plan(s).

5. The contractor shall check all temporary traffic control devices and work zones before, during, and after each workday to ensure proper operation. On weekends, holidays, or any non-working day, the contractor shall be responsible for checking the temporary traffic control devices daily for proper operation.
6. Two-way traffic will be maintained at all times during construction unless Traffic Engineering has approved another alternative for traffic control, such as a lane closure or a temporary street closure. Resident and emergency access will be maintained at all times during construction regardless if a street closure is in effect or not.
7. If there is an approval from Traffic Engineering for a lane closure or a temporary street closure, all lanes of traffic will be reopened to traffic at the conclusion of each construction day, unless a 24-hour temporary street closure is approved and in effect.
8. In all cases in which existing or established traffic patterns will be disrupted, the contractor will notify all affected residents and/or businesses a minimum of 48 hours in advance of the anticipated disruption by distributing door-to-door notices. A copy of the notice shall be forwarded to Traffic Engineering for review and approval prior to beginning work.
9. At night or during non-construction hours, all excavated areas are to be backfilled or secured and protected by using approved safety devices or materials.
10. For construction operations lasting more than 14 days, the contractor will install "ROAD WORK AHEAD" (W21-4, 48" x 48") and "END ROAD WORK" (G20-2a, 48" x 24") warning signs on 4" x 4" wooden ground mounted posts. These signs must be installed prior to beginning construction work and will be removed after completion of all construction activities.
11. For all approved construction/truck entrances, the contractor will install "TRUCKS ENTERING HIGHWAY" (48" x 48" orange and black) warning signs on 4" x 4" wooden ground mounted posts. These signs will be installed 500 feet in advance of all approved construction access/entrance points.
12. Any traffic control devices including but not limited to pavement markings, signs, and traffic control signal equipment damaged or destroyed by the contractor must be replaced at the contractor's expense unless their removal or destruction is called for by the plans.
13. No construction materials shall be stockpiled within the "Clear Zone" as defined in the Federal Highway Administration (FHWA) "Roadside Design Guide". Also, no equipment or machinery shall be left parked or unattended within the Clear Zone while work is not being performed.



14. For any further information on temporary traffic control requirements, please contact the Traffic Engineering Division, 2405 Courthouse Drive, Virginia Beach, Virginia 23456-9031, (757) 385-4131 Fax: (757) 385-4913.

E.2 Master List of Traffic Signalization Plan Notes

1. The Contractor will contact "Miss Utility of Virginia" (811) prior to beginning work in order to determine the extent and location of all underground utilities within the project limits. Utility companies will be notified through "Miss Utility of Virginia" 48 hours prior to any excavation within the proximity of their utilities. The Contractor will be responsible for repairing or replacing, at his own expense, any existing utilities, pavement, concrete items, pipes, etc., that are damaged during construction.
2. The Contractor will contact the City of Virginia Beach Traffic Signal Supervisor at the Traffic Management Operations Group (TMO) (385-1470) 72 hours prior to beginning work.
3. Install legends, stop bars, crosswalks and lane lines as shown on the pavement marking plan sheet(s). The Contractor will eradicate any existing markings that interfere with the new markings.
4. All traffic control items will be constructed and installed in accordance with the Virginia Department of Transportation Road and Bridge Standards, the Virginia Department of Transportation Road and Bridge Specifications, the City of Virginia Beach Amendments to the Virginia Department of Transportation Road and Bridge Specifications and the Public Works Design Standards.
5. The Contractor is responsible for all work zone signing, delineation, pavement markings, and any other traffic control devices necessary to perform the work. Upon completion of the project, the Contractor will immediately remove all such temporary devices.
6. Replacement/reconstruction of damaged sidewalks, entrances, curb and gutter, landscaping and other items is the responsibility of the Contractor, including areas where proposed construction is shown.
7. The City will provide the Contractor with signal timings for the controller when the traffic signal installation is ready to be placed into service. The Contractor will notify TMO in writing 10 working days in advance of the final signal timing requirement.
8. Unless otherwise specified on the plans, backplates will be installed on all signal heads. Backplates shall consist of the retroreflective high visibility signal backplate.
9. The City will furnish the following equipment: **(see note)**. The Contractor will furnish all other equipment. All equipment specified as furnished by the City will be picked up by the Contractor at the location assigned by the Traffic Management Operations Group. Pick-up of items will be by appointment only Monday through Thursday between the hours of 7:00 AM and 3:00 PM. The Contractor will call the traffic control shop two working days in advance to schedule an appointment. To pick up materials, the contractor will report to the designated location at the scheduled time and will sign a receipt for all equipment



and materials received. The above requirements will also apply to all equipment and materials specified on the plans to be returned to the City by the Contractor.

(Note to the Engineer- revise this note to include only those items that the City has chosen to furnish for this particular project. No equipment will be provided by the City on any project with state or federal funding.).

10. Existing street name blades will be maintained by the contractor throughout the duration of the project or until the new Street Name Blades have been installed. The Contractor will furnish and install all other signing as required by the plans.
11. The Contractor will install all items necessary for electrical service as specified on the plans, to the point of connection shown on the plans. The electrical service will be installed in accordance with VDOT standard **(see note)**. A meter base (will/will not) be required. The Contractor will notify Traffic Engineering and Traffic Management Operations in writing 90 days prior to the date when the new signal installation is to be placed into service.

(Note to the Engineer - this note is to be placed on each signalization plan sheet and edited to specify the VDOT standard service required, e.g.: SE-1 thru SE-5. Meter bases are required for all new signals. For modification of existing signals no meter base is required.).

12. The contractor will stub and cap two (2) ea. 2 inch PVC conduits for future use from each strain pole, mast arm pole, and controller cabinet foundation. In addition, the contractor will also stub out and cap a 2 inch PVC conduit and a 1 inch PVC conduit from the foundations of joint use signalization/street lighting poles for joint use streetlights.
13. New traffic signal installations will be placed into flashing operation for 48 hours before being placed into full operation.
14. Unless otherwise specified on the plans, all junction boxes will be fiberglass reinforced polymer concrete and conform to VDOT standard JB-S1 – JB-S3 (size as specified on the plans).
15. Unless otherwise specified on the plans, all mast arm signal mountings will be in accordance with VDOT standard SM-3.
16. Unless otherwise specified on the plans, all span wire signal mountings will be in accordance with VDOT standard SW-1, except that balance adjusters are not required.
17. Prior to installing the pedestrian pushbuttons on the pole, the contractor shall have the engineer field verify the location and orientation for each pushbutton. On each corner, the pushbutton and sign shall be oriented to face the crosswalk to which it applies, so as to be visible to a pedestrian standing on the sidewalk at the beginning of the crosswalk. The message on these signs shall include the name of the street crossing. Pushbutton signs located in the median shall be oriented parallel with the median crosswalk and have a double-headed arrow in lieu of the street name.
18. Unless otherwise specified on the plans, span wire mounted signal heads will be tethered in accordance with VDOT standard TA-1.



19. The Contractor will furnish and install a Polyolefin, 500 lb. stress pull line, or an approved equal on joint use signalization/street lighting poles, from the pole handhole up the pole interior and through the luminaire arm. This will be incidental to the installation of the joint use pole and separate payment will not be made for this work.
 20. The Contractor will verify the elevations of all underground utilities to be crossed, prior to jacking or boring conduits.
 21. The Contractor will **hand dig** when crossing water lines and sewer force mains.
 22. Each cabinet and pole foundation will be permanently marked, indicating the locations of all conduits that are cast in the foundation. The markings will consist of an arrow, four (4) to six (6) inches long, with a letter designation as follows: **(S)**- spare conduit; **(T)**-conduit with signal or detector cables; **(E)**- conduit with electrical service conductors for the traffic signal; **(L)**- conduits installed for luminaire conductors on joint use poles; **(G)**- conduit for grounding conductor(s). The markings will be etched with a trowel 1/4 inches deep into the concrete while the concrete is being finished.
 23. The Contractor will furnish and install new signal ahead warning sign assemblies, conforming to DPW **Standard Drawing, D-53** "New Signal Advance Warning Sign", on each approach to a new signal installation. The signs must be covered until the signal is placed into operation. The contractor will remove these signs 30 days after the signal has been placed into service and the signs and posts are delivered to the traffic operations shop.
 24. Unless otherwise specified, mast arm mounted signs will be rigidly mounted to the mast arm.
 25. All 6 x 6 foot call loops will be VDOT standard TD-1B and all presence loops will be VDOT standard TD-1C. The corner drilling or coring method, as depicted in DPW **Standard Drawing, D-13** "Vehicle Loop Detector Cored/Drilled Corner" of this Manual, will be used on all loop detector installations.
 26. Various equipment and materials will be furnished by the City to the Contractor for installation. For a description of these items see sheet ____, note____.
- (Note to the Engineer- include this note on the quantity summary sheet and reference the plan sheet and note(s) which list these items.).**
27. Test pits, silt fence, sediment barrier and temporary removable preformed plastic tape are contingency items and will be utilized at the discretion and direction of the Engineer. **(Note to the Engineer- include this note on the quantity summary sheet and revise as necessary to include those items designated as contingency items.).**
 28. Loop detector cable will be 12 AWG stranded copper enclosed in tubing and will conform to IMSA specification 51-5.

(Note to the Engineer- include this note on the quantity summary sheet when encased loop wire is required.).



29. Loop detector cable will be 12 AWG stranded copper, enclosed in tubing and will conform to IMSA specification 51-5. Traffic loop sealant will be a one part elastomeric compound designed specifically to meet the physical properties for sealing traffic loop pavement cuts. The sealant will bond to either Portland cement concrete or bituminous concrete, and must be unaffected by environmental conditions. It also will have a dielectric strength sufficient to allow the traffic loop to operate as intended. The sealant must have been tested and accepted for use by the VDOT. Epoxy or polyester sealants will not be allowed.

(Note to the Engineer- include this note on the quantity summary sheet when encased loop wire and one part loop sealant is required.).

30. Unless otherwise approved by the Traffic Management Operations, splicing of active interconnect cable will only be permitted during periods when the affected sections of the VMS computerized traffic signal system are in scheduled non-coordinated standby operation.
31. The contractor will notify Traffic Engineering (385-4131) and Traffic Management Operations (385-1470) 72 hours prior to planned interconnect cable splicing work.
32. The Contractor will furnish Traffic Management Operations (3) copies of the drawings, detailing the exact location(s) of any direct buried splice.
33. Splicing will not be permitted, unless a Traffic Management Operations representative is present.
34. Buried splices to direct burial interconnect cable will be constructed using approved telephone and communications industry materials and methods. Individual conductors will use spliced with sealed moisture resistant connectors. A heat shrinkable wrap around splice sleeve must enclose the splice. The Contractor will submit three (3) copies of material specifications to Traffic Management Operations for review and approval.
35. The Contractor will perform megger and fault tests on the section of spliced cable before it is placed into service. These tests will be made from the nearest access points on either side of the splice(s). Tests will be made in the presence of the Traffic Management Operations representative.
36. For private development, relocation, repair, or replacement of any existing traffic control facilities, whether identified on the site plan or not, will be at the Developer's expense and will be completed with the site work by the Developer's contractor.
37. The Contractor will contact the City of Virginia Beach Traffic Management Operations 72 hours prior to any work that will affect existing traffic control facilities.
38. Unless otherwise specified on the plans, all 12 inch signal head sections will have tunnel visors.
39. Post top signal head mountings will be in accordance with VDOT Standard (see note).



(Note to the Engineer- specify whether VDOT Standard SMB-1, SMB-2 or SMB-3 mounting is required.).

- 40. Unless otherwise specified on the plans, all pedestal poles will be 10 feet in height measured from top of foundation to top of pole.
- 41. Conductor cable for internally illuminated street name signs will conform to IMSA specification 20-1.
- 42. Conductor cable for pedestrian pushbuttons must conform to IMSA specification 20-1.
- 43. All existing traffic control equipment, including signalization and signing, which is removed by the Contractor and not to be reused with the project must be returned to the City of Virginia Beach and coordinated with Traffic Management Operations.
- 44. Cable rings will be utilized to attach the signal and detector lead-in cables to the span.
- 45. The Contractor will position the signal heads and video detection cameras as directed by the City's Engineer or Traffic Management Operations representative and make final adjustments to the alignment and location of each signal.
- 46. Rigid mount hanger assemblies for traffic signals and signs must have a 42 inch stainless steel strap or equivalent length cable that ensures adequate length for attachment to City furnished mast arm poles.

(Note to the Engineer - this note will be placed on the quantity summary sheet on all projects where it is specified that the City is furnishing the mast arm support poles for signals and signs.).

- 47. All conduits stubbed from junction boxes and foundations must extend a minimum of six (6) inches beyond the box, collar, or foundation and must be capped.
- 48. For private development, the Developer will be responsible for furnishing all labor, equipment, materials and costs associated with this signal installation, including traffic signal controller, cabinet and traffic signal poles. The controller unit must be a NAZTEC TS-2 Type 1 980 Secondary Controller with a TS-2 Type 1 Virginia Beach P Cabinet with Ethernet capability to ensure compatibility with the City of Virginia Beach traffic computer system.
- 49. For private development, the Developer and his Engineer will provide all necessary construction services during the course of the traffic signal installation. These services include (but are not limited to) the following:
 - a. Schedule and conduct a preconstruction meeting between the City, the Developer's Contractor, and Dominion Virginia Power.
 - b. Review all Contractor shop drawings, and equipment/material submittals for conformance to the plans and specifications. This must be coordinated with City Review. Two (2) sets of foundation designs, shop drawings and equipment and material submittals for all traffic signalization, signing and



pavement marking items will be provided to the City for review. Approval of anything will not be given until all comments from the City have been satisfactory addressed.

- c. Provide all necessary support during the construction phase of the signal installation, including plan modifications, resolving conflicts between the proposed installation and existing facilities, respond to questions and comments from either the City or the Developer's Contractor as well as all others issues that may arise during construction.
 - d. Final inspection of the Contractor's work to insure compliance with the plans and specifications. Review with the City and the Contractor any punch list items for completion by the Contractor.
 - e. Prepare "as built" plans of the signal installation and furnish the City with one (1) reproducible Mylar, two (2) prints of the plan and a digital copy.
 - f. Furnish the traffic signal pole foundation designs in accordance with the requirements set forth in the plan and specifications. These foundations are to be drilled type designs only. Spread footing designs are not acceptable.
 - g. Develop all traffic signal timing necessary for operation of the signal in both isolated and coordinated modes. This will include all revisions to the coordinated system timings that are necessary as a result of the addition of this signal. The first submittal of timings will be made to the City for review not less than 90 days before the scheduled activation of the signal. No timings will be implemented until approved by the City of Virginia Beach Traffic Management Operations.
50. The Engineer will be responsible for contacting Dominion Energy to verify that electrical service can be furnished to the traffic signal from the source that is shown on the signal plan. For private development, the Developer will be responsible for all costs associated with having the service connected.
51. Any of the existing conduit and cable shown to be used in conjunction with this signal modification will be replaced by the Developer with new conduit and cable, if it is determined by either the City Traffic Engineering or Traffic Management Operations to be unsuitable for use. A determination will be made during construction as the existing facilities are uncovered by the Contractor. For private development, the Developer will be responsible for all costs associated with the conduit and cable replacement.
52. A 10 inch square hole must be saw cut into the concrete median for each relocated sign post.
53. PRIOR TO BEGINNING ANY TRAFFIC SIGNAL CONSTRUCTION WORK, THE CONTRACTOR WILL CONTACT THE CITY TRAFFIC MANAGEMENT OPERATIONS GROUP (385-1470) AND THE CITY TRAFFIC ENGINEERING GROUP (385-4131) AND SCHEDULE A PRECONSTRUCTION MEETING. THE CONTRACTOR WILL CONTACT THE CITY STAFF A MINIMUM OF 10 WORKING DAYS PRIOR TO THE BEGINNING OF ANY PLANNED SIGNAL CONSTRUCTION.



54. For mast arm and span wire installations/removals over roadways open to traffic, a minimum of two weeks' notice must be provided to Public Works/ Traffic Maintenance Operations and Public Works/Traffic Engineering. Work shall take place on a Sunday starting at 7:00 am unless otherwise approved by Traffic Engineering, with an off duty City of Virginia Beach police officer until the mast arm installation is complete. No work shall take place over traffic. Message Boards must be put out 10 days in advance of the scheduled work.
55. Contractor will deliver and pickup the controller, cabinet, and control equipment at the Traffic Management Operations Maintenance Yard, 3556 Dam Neck Road, for inspection and testing procedures.
56. All signal heads, mounting hardware for pedestrian signal heads, and one-piece pushbutton assemblies shall be colored black.



Appendix F

Bicycle Facility Standards Public Works Engineering Technical Report

F.1 Intent

The following Design Standards are intended to compliment the City of Virginia Beach Bikeways and Trails Plan, a component of the Comprehensive Plan. Standard Drawings included in this appendix are intended to supplement the Typical Section Standard Drawings in **Appendix A** and the Traffic Engineering Standard Drawings in **Appendix D**.



Bicycle Facility Standards

PW/Engineering

Technical Report

March 2022

I. BACKGROUND

This Technical Report has been prepared in response to the need for Bicycle Facility Standards for the City of Virginia Beach.

A new Bikeways and Trails Plan (BTP) was approved by City Council in April 2011. The BTP describes the types and location of bicycle facilities in the City of Virginia Beach. The Bikeways and Trail plan is a component of the Department of Planning, Comprehensive Plan.

The details included in these standards are intended primarily for use on new projects, and to the degree possible, when retrofitting existing roadways with bicycle facilities. Retrofitting existing roadway corridors with bicycle facilities and signage will need to be evaluated and constructed on a case by case basis where right-of-way is available and funding is approved in the budget.

Based on the 2011 Bikeways and Trails Plan, there are four types of on-road bicycle facilities: Bike Lanes, Paved Shoulders, Wide Outside Lanes, and Signed Shared Roadways (by state code all roadways in Virginia, other than limited access facilities, are shared roadways, therefore only signed shared roadways will be addressed in these standard), and three types of off-road facilities: Shared Use Paths, Sidewalks, and Wide Sidewalks. Descriptions of these facilities are located in the BTP. It is the intent of this report to address each type of facility in the plan and provide standards for each type of facility. These standards include plan drawings which provide locations and dimensions of bicycle facilities; and typical sections which provide horizontal widths and clearances, pavement markings, and signage.

II. CONSIDERATIONS

A review of existing guidelines and standards was conducted to determine the state of the practice regarding bicycle facilities. The following are standards and guidelines governing the design and operation of bicycle facilities.

- a) American Association of State Highways and Transportation Officials (AASHTO) – A Policy on Geometric Design of Highways and Streets
- b) American Association of State Highways and Transportation Officials (AASHTO) – Guide for Development of Bicycle Facilities
- c) Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways
- d) Virginia Department of Transportation (VDOT) – Road and Bridge Standards
- e) VDOT – Virginia Supplement to the Manual on Uniform Traffic Control Devices
- f) VDOT – Road Design Manual

The City of Virginia Beach Bicycle Facility Standards has been developed to supplement the VDOT standards and guidelines. Where a City standard has not been developed, VDOT standards, and if not available, guidelines shall be used. Where VDOT standards and guidelines have not been

developed, AASHTO guidelines shall be used.

While drainage structures are not specifically addressed in the Bicycle Standards section, all drainage covers, grates or any other drainage facility within close proximity to a bicycle facility shall be designed to accommodate bicycle travel.

III. STANDARD FACILITIES

The Standard Facilities part of this report is divided into three main sections a) Roadway Geometrics and Materials, b) Signage and Pavement Markings, and c) Standard Drawings. The Roadway Geometrics and Materials section describes the width of facilities and how they relate to other geometric features. The section also includes descriptions for off-road facilities, as well as construction materials. The Signage and Pavement Markings section provides the details regarding how bicycle facilities are to be signed and marked. The Standard Drawings show cross sections and standard pavement marking details.

a) Roadway Geometrics and Materials

Bicycle facilities are grouped into two categories: "On-Road" facilities and "Off-Road" facilities. The four types of on-road bicycle facilities are:

- Bike Lane,
- Paved Shoulder,
- Wide Outside Lane, and
- Signed Shared Roadway

On-road bicycle facilities are designed as one-way facilities and carry bicycle traffic in the same direction as the adjacent motor vehicle traffic.

The three types of off-road facilities are:

- Shared Use Path,
- Wide Sidewalk, and
- Sidewalk

Typically, additional right-of-way (ROW) will be needed beyond the standard cross section at intersections to accommodate turn lanes and bicycle facilities.

Specific details for each of these facilities are listed below.

- 1) **Bike Lane** - A Bike Lane is a paved portion of the roadway for preferential use by bicyclists, between the right edge line and the edge of gutter pan or barrier curb if there is no gutter pan. If there is no curb or gutter it is a paved area to the right of the right edge line.

The minimum width for a bike lane adjacent to a vehicular traveled lane is four (4) feet. This width shall be increased to a minimum of five (5) feet when the bike lane is approaching an intersection between lanes, or adjacent to barrier curb, and six (6) feet when the bike lane is located adjacent to parallel parking. When a Bike Lane is adjacent to curb and gutter or a valley gutter, the gutter pan is not included in the overall width of the Bike Lane.

- 2) **Paved Shoulder** - A Paved Shoulder is a paved area to the right of the edge line on which bicycles may ride. The minimum width for a paved shoulder to be considered a bicycle facility is four (4) feet. A minimum shoulder width of five (5) feet shall be used from the face of a guardrail, curb, or other roadside barrier. Additional shoulder width should also be considered if the posted speed is greater than fifty (50) MPH, or if the percentage of trucks is higher than average or if lateral obstructions exist.

- 3) **Wide Outside Lane** - A Wide Outside Lane is the right travel lane which is shared by both motorized vehicles and bicycles. The minimum width for a wide outside lane is fourteen (14) feet. Additional width is allowable within the constraints of right-of-way as needed but not to exceed fifteen (15) feet. Fifteen feet is desirable when the wide outside lane is adjacent to on street parking that effectively reduces the lane width, there are steep grades, or where there is high traffic volume and speed.
- 4) **Signed Shared Roadway** - A Signed Shared Roadway is a roadway that is signed as a bike route that has travel lanes shared by both motorized vehicles and bicycles. A Signed Shared Roadway will follow the standard details and dimensions specified in the Public Works Design Standards for typical roadway sections.
- 5) **Shared Use Path** - A Shared Use Path is a facility located outside of the roadway but typically within the right-of-way to be shared by bicycles, pedestrians, and other non-motorized forms of transportation as permitted by City and State code. Shared use paths are typically designated for two-way travel but may be designated for one-way travel. The minimum width for a shared use path is ten (10) feet. A buffer and clear zone as noted on the standard drawing entitled "Shared Use Paths within the Roadway-Right-of-Way" are required. The surface material for a Shared Use Path should be asphalt, however concrete may be used. The width of any curb ramps will be the same as the width of the Shared Use Path.
- 6) **Wide Sidewalk** - A Wide Sidewalk is a facility located outside of the roadway but within the right-of-way. The minimum width of a wide sidewalk is eight (8) feet. A Wide Sidewalk is designed to be used by bicycles and pedestrians and other non-motorized forms of transportation as permitted by City and State code. It is most commonly designed for two-way travel. The surface material for a Wide Sidewalk should be asphalt, however concrete, or if approved by the Director of Public Works or his designee, pavers may be used in urbanized areas.
- 7) **Sidewalk** - A Sidewalk is a facility located outside the roadway but within the right-of-way. Sidewalks are designed primarily for pedestrians however consideration must be given to other users such as bicyclist and other non-motorized use as permitted by City and State code. The minimum width of a sidewalk is five (5) feet. The surface material for a Sidewalk should be concrete or, if approved by the Director of Public Works or his designee, pavers.

b) **Signage and Pavement Markings**

Signs and pavement markings are necessary to delineate regulatory and warning information as well as to identify intended exclusive and shared space for motor vehicles and bicycles. Facilities that do not meet the standards should not be signed or marked with pavement markings. This will foster an understanding and expectation among users of the facilities and provide for a safe transportation system for all users. Existing facilities that meet the City standards, as laid out in this report, may be signed and marked with pavement markings according to their specific facility type. In addition to the signs and markings noted below, additional regulatory or warning signs may be required.

All signs and pavement markings shall be in accordance with the most current approved version of the Virginia Supplement to the MUTCD.

Any signs for the exclusive use of bicyclists must be located so as to avoid confusing other road users.

Bicycle Warning signs (W11-1) and SHARE THE ROAD supplemental plaque assembly may be considered where all of the following conditions exist:

- A bike lane ends,

- The speed limit is 40 MPH or greater, and
- A hazard exists, such as a narrow bridge or overpass, narrow lane, parallel parked vehicles, or a downstream intersection with many turning vehicles. (The end of a bike lane, by itself, is not a hazard.)

- 1) **Bike Lanes** - Bike Lane signs and Bike Lane pavement markings which include the bicyclist symbol shall use the helmeted bicycle symbol as noted in the Virginia Supplement to the MUTCD. A six inch edge line shall be used to designate the left edge of Bicycle Lanes. Bike route signs may be posted where there is a designated bike route.
- 2) **Paved Shoulder** - The only pavement marking associated with a Paved Shoulder is a four (4) inch white edge line adjacent to the travel lane. No signage will be required, however if the facility is a designated bike route, bike route signage may be used.
- 3) **Wide Outside Lane** - Bike route signage may be posted to alert drivers to the presence of bicyclists and to provide direction for bicyclists where there is a designated bike route.
- 4) **Signed Shared Roadway** - A Signed Shared Roadway may have bike route signs posted where there is a designated bike route. No additional pavement marking is necessary.
- 5) **Shared Use Path** – Bicycle related signs and pavement markings are generally not utilized for a Shared Use Path. However, a Shared Use Path *may* have pavement marking to designate the two directions of travel particularly where it intersects with streets where heavy use or other safety issues are identified. Bike route signs may be posted where there is a designated bike route.
- 6) **Wide Sidewalk** - Bicycle related signs and pavement markings are generally not utilized for a Wide Sidewalk.
- 7) **Sidewalk** - Bicycle related signs and pavement markings are generally not utilized for a Sidewalk.

c) Standard Drawings

These Standard Drawings are intended to supplement the Typical Section Standard Drawings found in the Public Works Design Standards **Appendix A**. Additional related details can be found in the Virginia Supplement to the MUTCD.

- F-1 Bike Lanes/Paved Shoulder with Separate Right Turn Lane
- F-2 Wide Outside Lane with Separate Right Turn lane
- F-3 Bike Lanes/Paved Shoulder with No Separate Right Turn Lane and Bus Bay
- F-4 Bike Lanes with On Street Parking, Curb and Gutter
- F-5 Bike Lanes with Right Turn Drop Lane, Curb and Gutter
- F-6 Bike Lanes at Interchange Ramps
- F-8 Shared Use Paths within the Roadway-Right-of-Way
- F-9 Bike Lanes with Curb and Gutter and Graded Shoulders
- F-10 Bike Lanes with On-street Parking

IV. NONSTANDARD FACILITIES

Under certain circumstances it may not be possible to meet the requirements in section III, Standard Facilities, such as when retrofitting bicycle facilities to an existing roadway. This may be due to constrained ROW, physical obstructions or other reasons. When this is the case, an exception to the standard may be granted by the Director of Public Works or his designee. If a non-standard facility is constructed, it should not be signed or marked as if it were a standard facility. For non-standard

facilities the following considerations should apply.

1) Bike Lane

The minimum width for a bike lane is four (4) to six (6) feet as noted in section III Standard Facilities.

- If less than the standard width is available, it shall not be considered a bike lane. If the total pavement width including the outside lane is between fourteen (14) and fifteen (15) feet, it can be considered a wide outside lane. Signing and marking would be commensurate with a wide outside lane.
- If the total pavement width including the outside lane is between twelve (12) and fourteen (14) feet, it can be considered a wider outside lane or paved shoulder and standard lane markings would be adjusted to accommodate the wider outside lane or Paved Shoulder. Bike route signs may be installed if it is a designated bike route.

2) Paved Shoulder

The minimum width for a Paved Shoulder is four (4) or five (5) feet as noted in section III Standard Facilities.

- If less than the standard width is available and a Paved Shoulder is required, it would be considered a non-standard paved shoulder. A four (4) inch white edge line would be installed adjacent to the right through lane.
- If a Paved Shoulder is not required and If the total pavement width including the outside lane is between fourteen (14) and fifteen (15) feet, it can be considered a wide outside lane. Signing and marking would be commensurate with a Wide Outside Lane. If the total pavement width including the outside lane is between twelve (12) and fourteen (14) feet, it can be considered a wider outside lane and standard lane markings would be adjusted to accommodate the wider outside lane. Bike route signs may be installed if it is a designated bike route.

3) Wide Outside Lane

The minimum width for a Wide Outside Lane is fourteen (14) feet as noted in section III Standard Facilities.

- If the total pavement width including the outside lane is between twelve (12) and fourteen (14) feet, it can be considered a wider outside lane and would be striped as a traveled lane with adjustment to accommodate the wider outside lane. Bike route signs may be installed if it is a designated bike route.

4) Signed Shared Roadway

A Signed Shared Roadway will follow the details and dimensions in the Public Works Design Standards.

- If a roadway has less than the standard pavement width, it shall not be designated as a Signed Shared Roadway and shall not be signed as a bike route unless it is determined to be the preferable route for cyclists to traverse a corridor.

5) Shared Use Path

The minimum width for a Shared Use Path is ten (10) feet as noted under section III Standard Facilities.

- If at least eight (8) feet of pavement is available, it can be considered a Wide Sidewalk.
- If less than eight (8) feet of pavement is available, it would be considered a Sidewalk.

Bicycle related signs or markings are typically not utilized for a Sidewalk or Wide Sidewalk.

6) **Wide Sidewalk**

- The minimum width for a Wide Sidewalk is eight (8) feet.
- If less than eight (8) feet of pavement is available, it will be considered a Sidewalk. Bicycle related signs and pavement markings are generally not utilized for a Sidewalk.

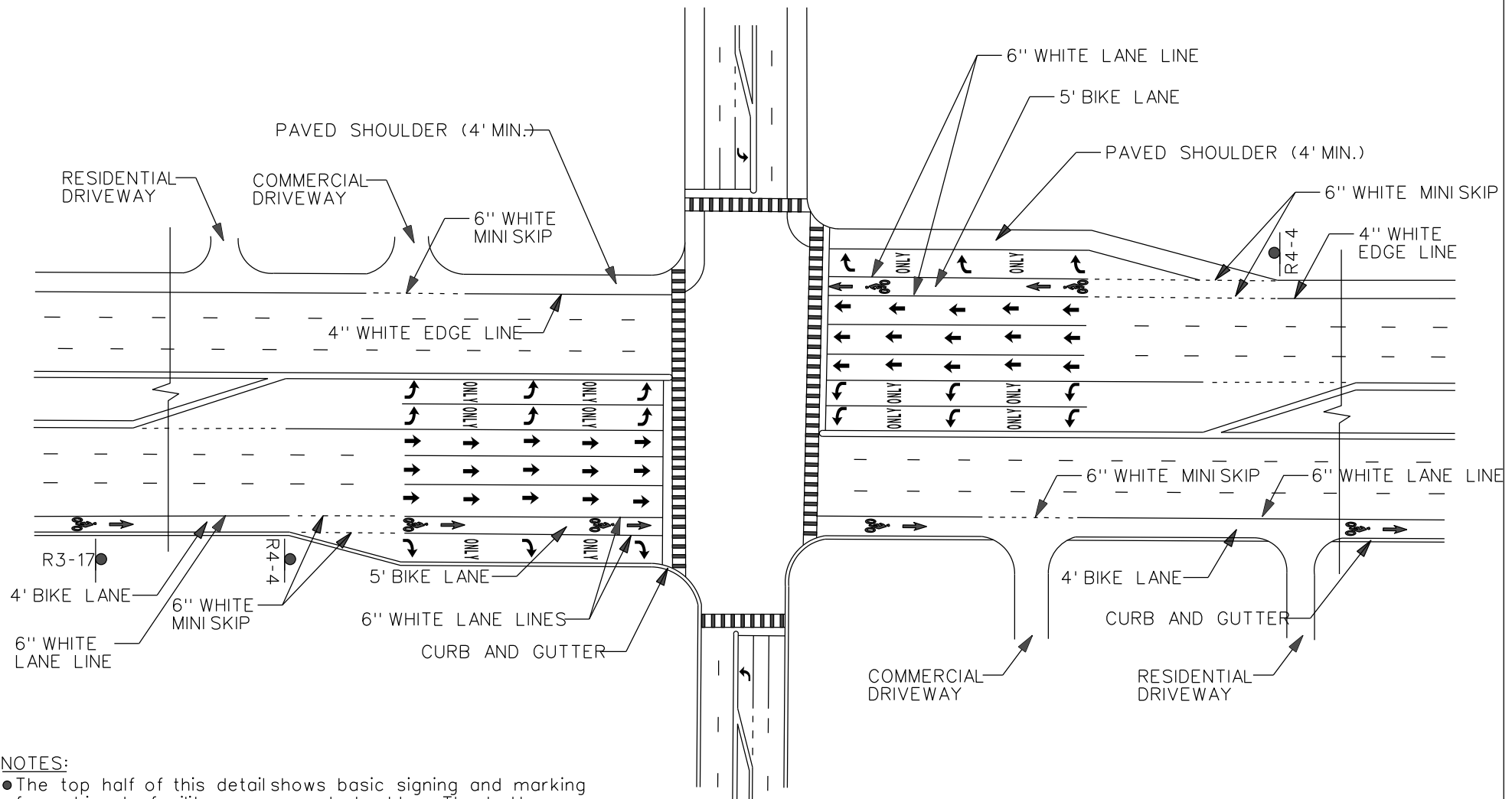
7) **Sidewalk**

The minimum width for a Sidewalk is five (5) feet.

- A sidewalk narrower than five (5) feet must be approved by the Director of Public Works or his designee.
- Bicycle related signs and pavement markings are generally not utilized for a Sidewalk.

Note that in addition to the signs and markings noted above; warning or regulatory signs may be required in accordance with the Virginia Supplement to the MUTCD.

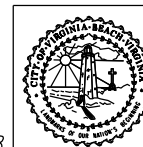
From the MUTCO:
R3-17: Bike Lane
R4-4: Begin Right Turn Lane
Yield to Bikes



NOTES:

- The top half of this detail shows basic signing and marking for a bicycle facility on a paved shoulder. The bottom half of this detail shows basic signing and marking for a bicycle facility along curb & gutter.
- On a signalized intersection approach, bicycle lane markings (symbol & arrow) shall be placed at the beginning of the solid lane line and at the stop bar only.
- If a side street has a bicycle facility, it shall have the same signing and pavement markings as a main street from the appropriate bicycle lane detail.

(N.T.S.)
REV. 07/18

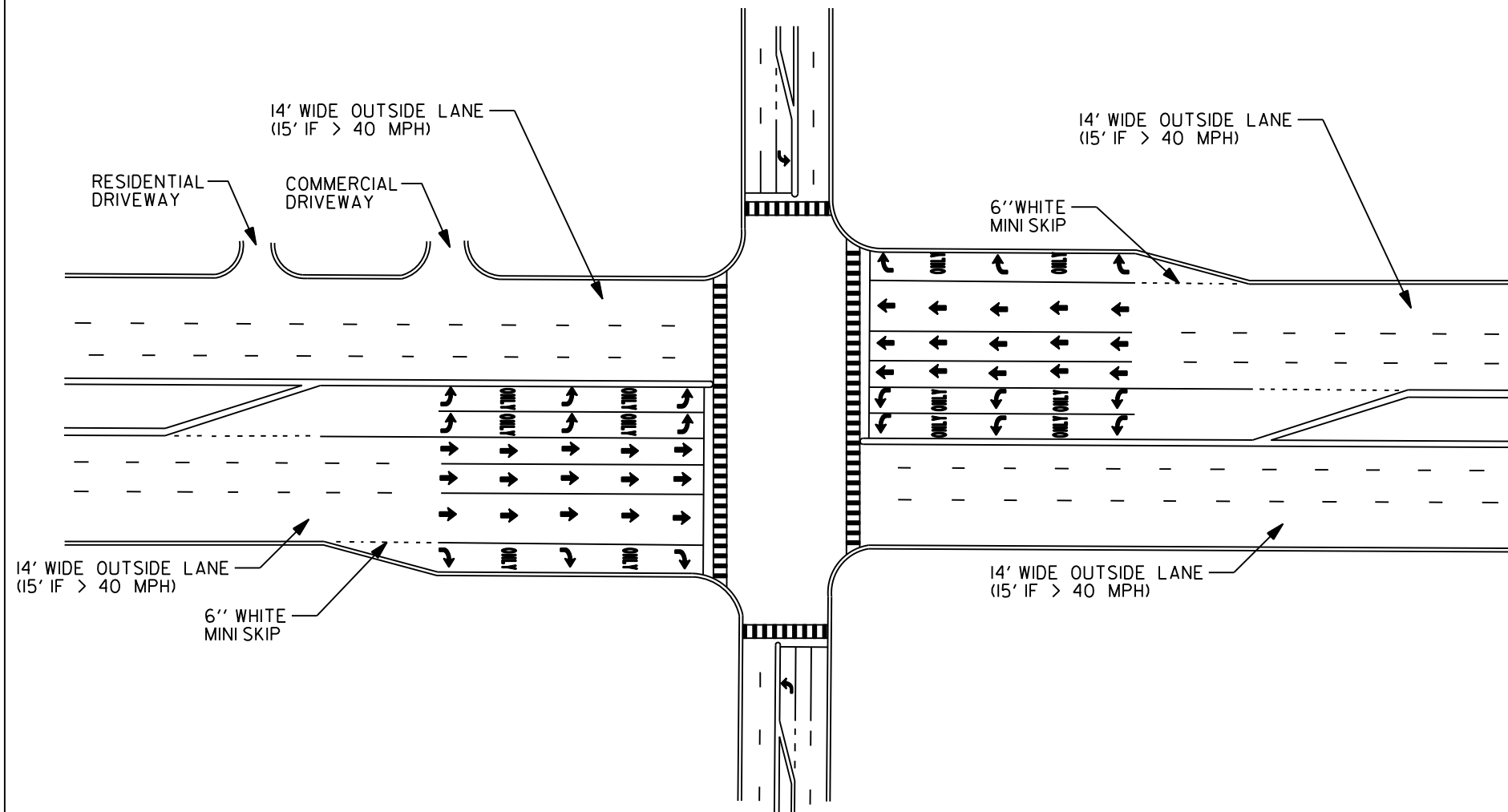


CITY OF VIRGINIA BEACH
STANDARD

BIKE LANES/PAVED SHOULDERS WITH
SEPARATE RIGHT TURN LANE

PUBLIC WORKS

F-1



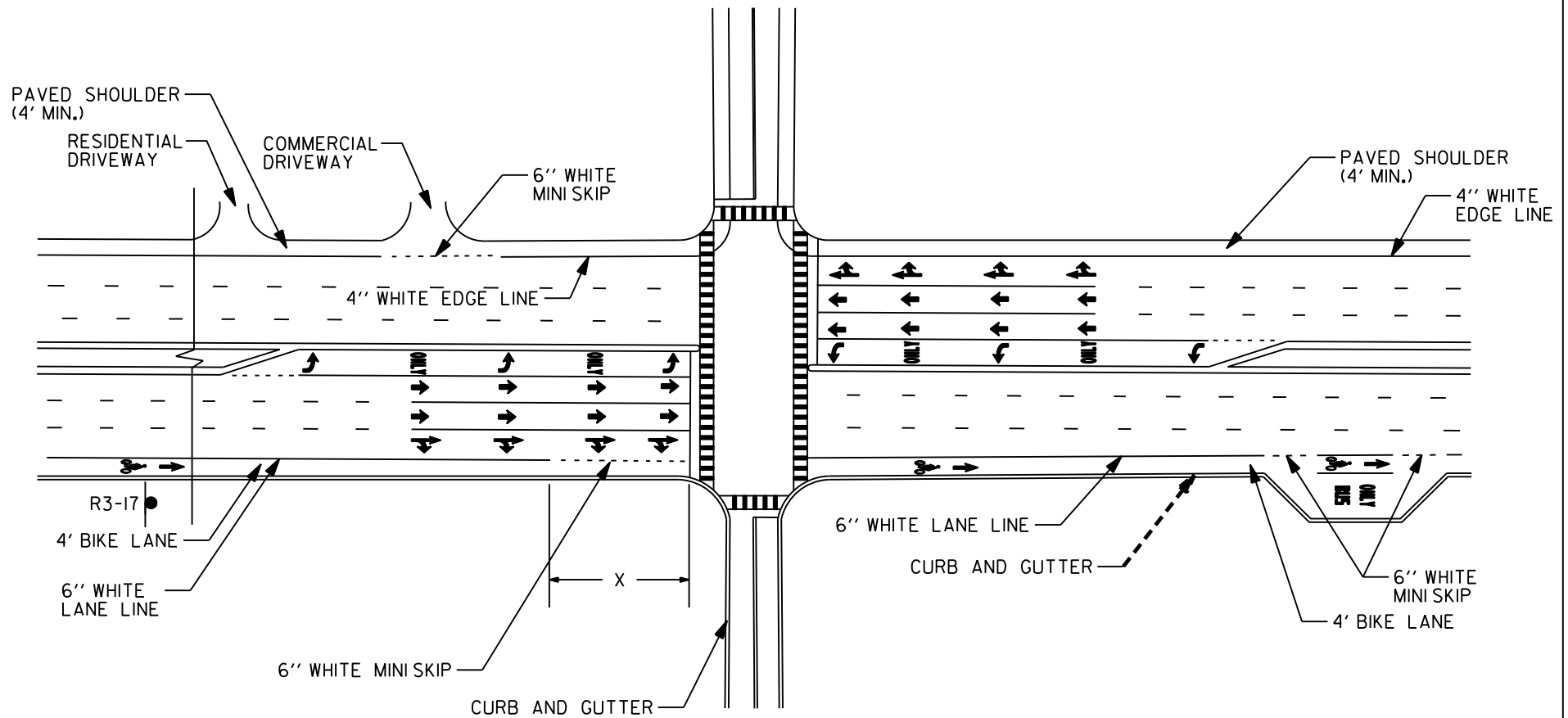
(N.T.S.)
REV.5/14



CITY OF VIRGINIA BEACH
STANDARD

WIDE OUTSIDE LANE WITH
SEPARATE RIGHT TURN LANE.

PUBLIC WORKS F-2



NOTES:

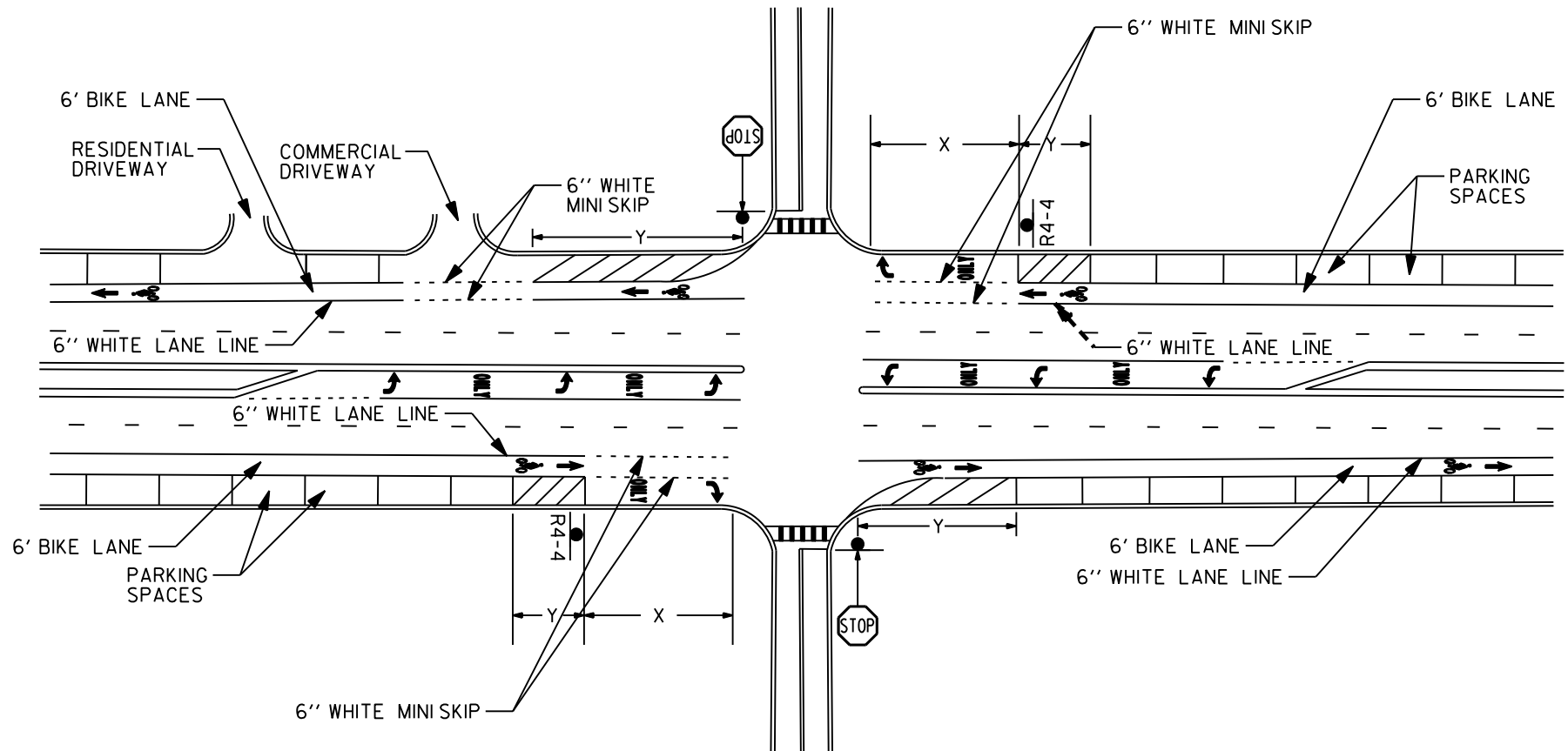
- The top of this detail shows signing and marking for a bicycle facility for a paved shoulder. The bottom of this detail shows signing and marking for a bicycle facility for a bike lane.

- X = 100' IF ≤ 35 MPH
150' IF > 35 MPH

(N.T.S.)
REV.5/14



CITY OF VIRGINIA BEACH	
STANDARD	
BIKE LANES/PAVED SHOULDERS WITH NO SEPARATE RIGHT TURN LANE AND BUS BAY	
PUBLIC WORKS	F-3



NOTES:

- X = 100' IF ≤ 35 MPH
150' IF > 35 MPH

- Y-Dimension as needed for sight distance
Refer to section 3.12 for sight distance.

(N.T.S.)
REV.5/14



CITY OF VIRGINIA BEACH
STANDARD

BIKE LANES WITH ON STREET
PARKING, CURB AND GUTTER

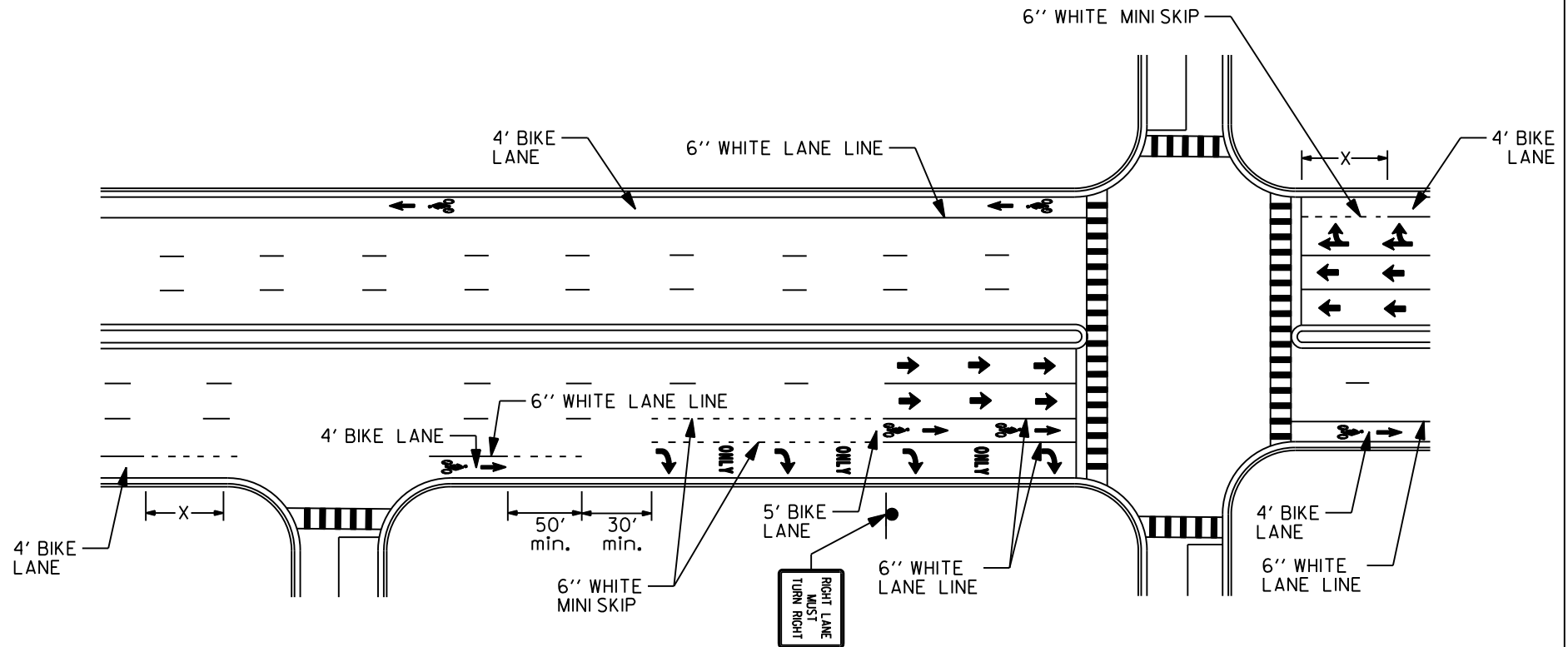
PUBLIC WORKS

F-4

NOTES:

- X = 100' IF ≤ 35 MPH
150' IF > 35 MPH

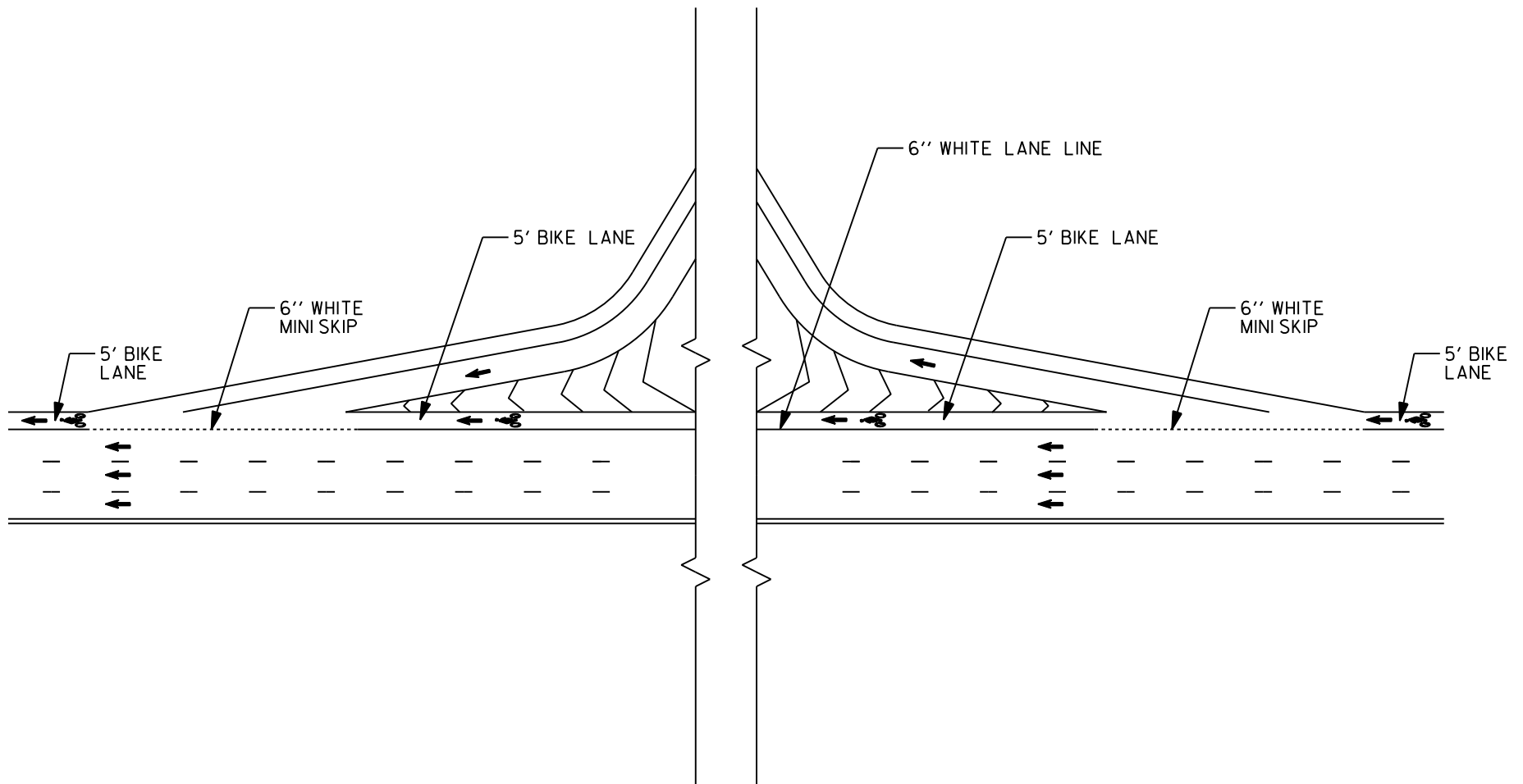
- On a signalized intersection approach, bike lane markings (symbol & arrow) shall be placed at the beginning of the solid lane line and at the stop bar only.



(N.T.S.)
REV. 5/14



CITY OF VIRGINIA BEACH STANDARD	
BIKE LANES WITH RIGHT TURN DROP LANE, CURB AND GUTTER	
PUBLIC WORKS	F-5



NOTES:

- Bike lanes shall transition from 5 feet in width at interchanges to the standard 4 feet in width on adjacent roadways over a minimum distance of 25 feet.

(N.T.S.)
REV. 5/14

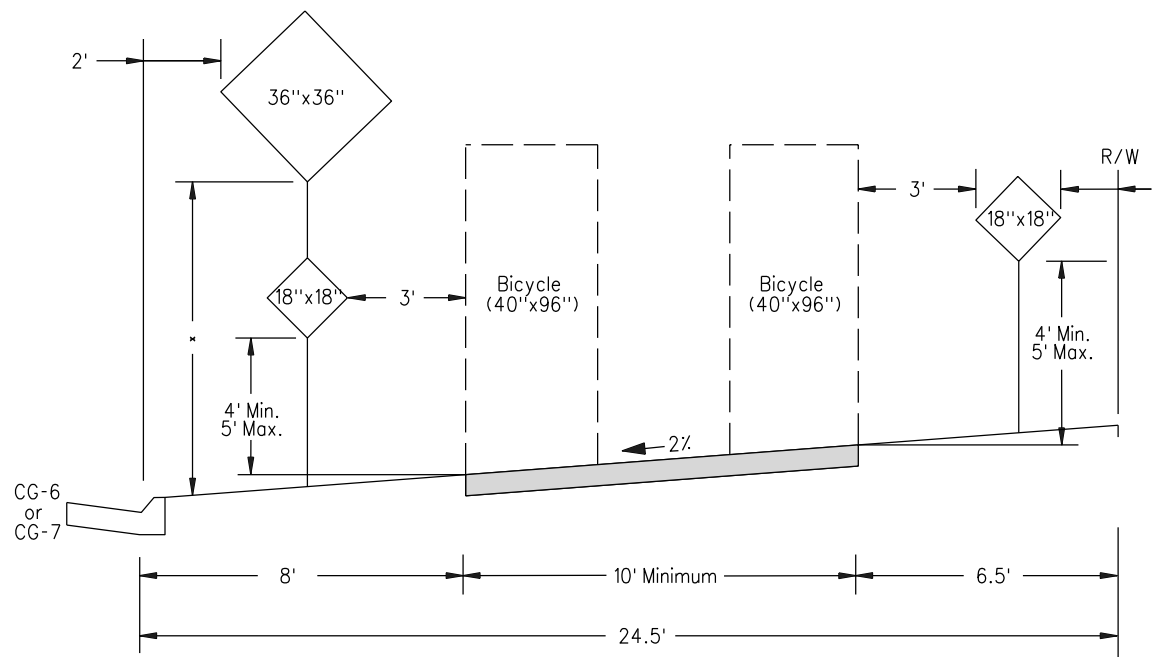
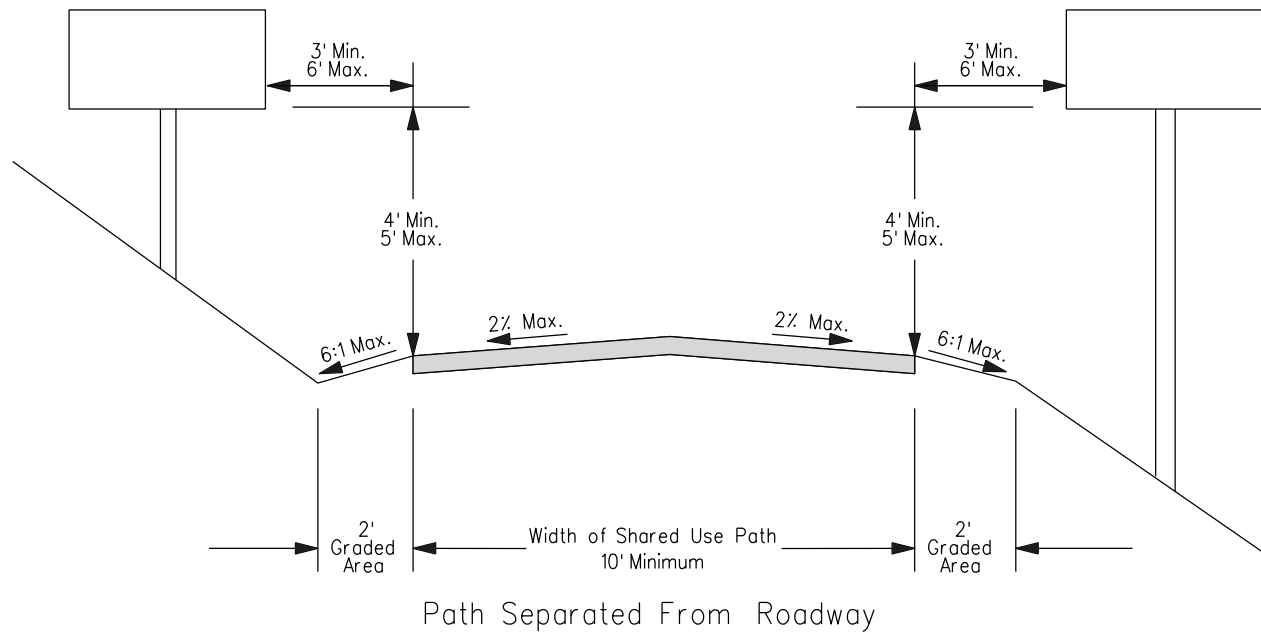


CITY OF VIRGINIA BEACH
STANDARD

BIKE LANES AT
INTERCHANGE RAMPs

PUBLIC WORKS

F-6



Notes:

- * For roadway signs 30" in width or less, use 7' minimum mounting height.
- * For roadway signs greater than 30", use 8' minimum mounting height.

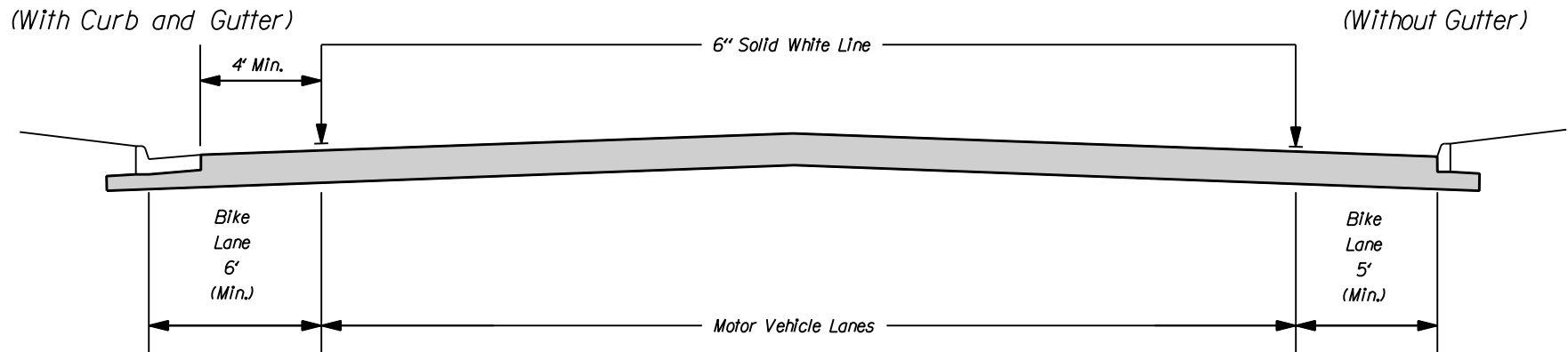
Path Adjacent To Roadway

(N.T.S.)
REV. 07/18

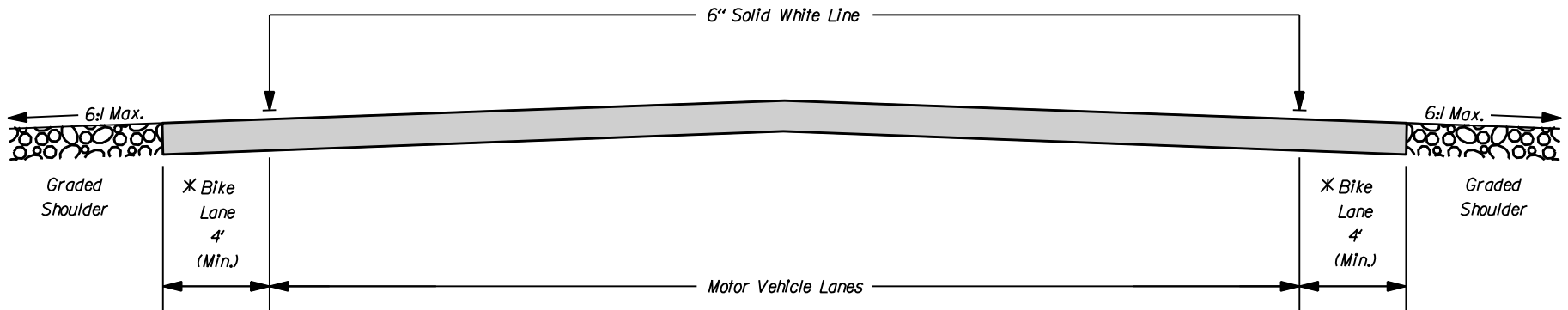


CITY OF VIRGINIA BEACH STANDARD	
SHARED USE PATHS WITHIN THE ROADWAY RIGHT-OF-WAY	
PUBLIC WORKS	F-8

BIKE LANES WITH CURBING



BIKE LANES WITH GRADED SHOULDERS



* Delineating bike lanes within the limits of a required paved shoulder area is not permitted.

(N.T.S.)
REV. 5/14



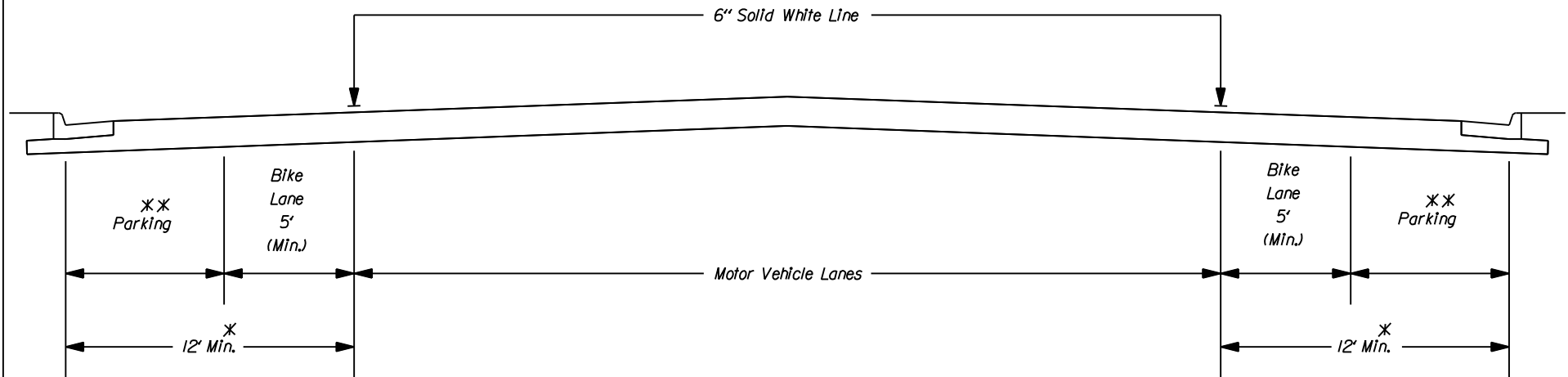
CITY OF VIRGINIA BEACH
STANDARD

BIKE LANES WITH
CURB AND GUTTER
AND GRADED SHOULDERS

PUBLIC WORKS

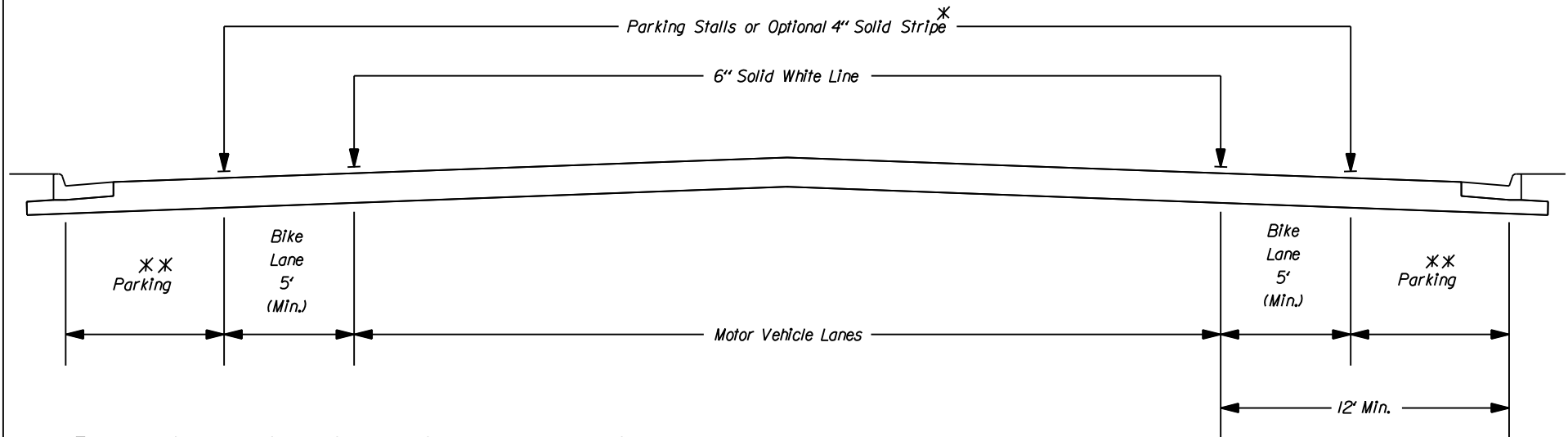
F-9

PARKING PERMITTED WITHOUT PARKING STRIPE OR STALL (Bike lane not designated or marked)



* 13 feet is recommended where there is substantial parking or turn over of parked cars is high (e.g. commercial areas)
 ** 7 feet for Residential Streets and 8 feet for Commercial and mix use Streets.

BIKE LANES WITH ON-STREET PARKING



* The optional solid white stripe may be advisable where stalls are unnecessary (because parking is light).

** 7 feet for Residential Streets and 8 feet for Commercial and mix use Streets.

(N.T.S.)
 REV.5/14



CITY OF VIRGINIA BEACH
 STANDARD

BIKE LANES WITH
 ON-STREET PARKING

PUBLIC WORKS

F-10



Appendix G

Manuals & Publications

G.1 General

The following manuals and publications are hereby adopted, and made an integral part of these design standards. However when required, other design standards published by Federal and State agencies may be considered if reviewed and approved by the City's Engineer.

Virginia Department of Transportation Road and Bridge Specifications, (2016)*

Virginia Department of Transportation Road and Bridge Standards, (2016)*

Virginia Department of Transportation Virginia Work Area Protection Manual, (2011 Edition, Revision 1 - April 1, 2015)*

Virginia Supplement to the 2009 MUTCD, (2011 Edition, Revision 1 September 30, 2013)*

Virginia Department of Transportation Drainage Manual, (Issued April 2002, Revision July 2017)*

Virginia Department of Transportation Road Design Manual, (Issued January 2005, Revision January 2019)*

Virginia Department of Transportation Manual of the Structure and Bridge Division, (October 2018)*

Virginia Department of Transportation Instructional and Informational Memoranda, (Latest Revisions)

Virginia Department of Transportation, Pavement Design Guide for Subdivision and Secondary Roads in Virginia (2018)*

Manual on Uniform Traffic Control Devices, U. S. Department of Transportation Federal Highway Administration (FHWA), (2009 with Revisions 1 and 2, May 2012)*

American National Standard Practice for Roadway Lighting, (I.E.S.N.A. RP-8-00)*

FHWA Lighting Handbook, U.S. Department of Transportation FHWA, (August 2012)*

AASHTO Roadway Lighting Design Guide, (2005)*

Manual of Traffic Signal Design, Institute of Transportation Engineers (ITE), (1998)*

Standard Specification for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, AASHTO, (2015)*

Standard Highway Signs Manual U.S. Department of Transportation, FHWA, (2004 Edition with 2012 Supplement)*

- Code for Gas Transmission and Distribution Piping System, ASME B31.8, (2016)*
- Standard Specifications for Highway Bridges 16th Edition, American Association of State Highway Transportation Officials (AASHTO), (2002)*
- AASHTO Guide for Design of Pavement Structures, (1993)*
- AASHTO A Policy on Geometric Design of Highways and Streets, 7th Edition (2018)*
- AASHTO Guidelines for the Geometric Design of Very Low Volume Local Roads, (2001)*
- AASHTO A Guide for Achieving Flexibility in Highway Design, (2004)*
- AASHTO LRFD Bridge Design Specifications, 8th Edition, (2017)*
- AASHTO LRFD Guide specifications for the Design of Pedestrian Bridges, 2nd Edition (2014 with 2015 Interim Revisions)*
- AASHTO Guide for the Development of Bicycle Facilities, (2012)*
- AASHTO Guide for Planning, Design and Operation of Pedestrian Facilities, 1st Edition (2004)*
- AASHTO Roadside Design Guide, 4th Edition (2011)*
- AASHTO Guide for Geometric Design of Transit Facilities on Highways and Streets, 1st Edition (2014)*
- AASHTO Mechanistic – Empirical Pavement Design Guide: A Manual of Practice, 2nd Edition (2015)*
- Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way, United States Access Board (July 26, 2011)*
- Virginia Erosion and Sediment Control Handbook, Latest Edition*
- HRPDC Regional Construction Standards, Sixth Edition, (June 2016)*
- Virginia Test Methods Manual, Virginia Department of Transportation
- City of Virginia Beach Bikeways and Trails Plan, A Component of the Comprehensive Plan, Department of Parks and Recreation, (April 26, 2011)*
- City of Virginia Beach Department of Public Utilities Design Standards Manual, (Revised July 2014)*
- City of Virginia Beach Amendments to VDOT Road and Bridge Specifications, (2016)*
- FEMA Flood Insurance Study, City of Virginia Beach, Virginia, Latest Edition
- Virginia Stormwater BMP Clearinghouse, website, (2013)*
- Virginia Stormwater Management Handbook (VSMH), website, (2013)*
- Storm Water Management Model User's Manual, Version 5.1, Environmental



Protection Agency (EPA), EPA/600/R-14/413b, (Revised September 2015)*

Storm Water Management Model Reference Manual, Volume I – Hydrology (Revised), EPA/600/R-15/162A, (Revised January 2016)*

Analysis of Historical and Future Precipitation, Dewberry, CIP7-030, PWCN-15-0014, Work Order 9A submitted to City of Virginia Beach, (July 24, 2017)

Joint Occurrence and Probabilities of Tides and Rainfall, Dewberry, CIP 7-030, PWCN-15-0014, Work Orders 2 and 5A submitted to City of Virginia Beach, (October 9, 2017)

Southern Watershed Storm Surge Elevation Review, Dewberry, CIP 7-030, PWCN-15-0014, Work Order 2A submitted to City of Virginia Beach, (January 31, 2017)

NOAA Atlas 14 – Precipitation-Frequency Atlas of the United States, Volume 2 Version 3.0: Delaware, District of Columbia, Illinois, Indiana, Kentucky, Maryland, New Jersey, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, West Virginia, Geoffrey M. Bonnin, Deborah Martin, Bingzhang Line, Tye Parzybok, Michael Yekta, David Riley, U.S Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, (2004, revised 2006)*

Recurrent Flooding Study for Tidewater Virginia, William & Mary Virginia Institute of Marine Science, Center for Coastal Resources Management, Report submitted to the Virginia General Assembly, (January 2013)

*Stated edition or most recent edition utilized by the City.



Appendix H

Policy Governing Traffic Impact Studies

H.1 Purpose

The purpose of this policy is to set forth guidelines concerning the content, procedures and method of technical analysis for traffic impact studies (TIS). The purpose of a traffic impact study is to identify the nature and magnitude of traffic impacts created by certain proposed land uses and/or development as compared to the traffic impacts under existing conditions, and to identify ways that the applicant can mitigate those differential impacts upon the roadway system.

H.2 Applicability

This policy will have applicability whenever a TIS is done in conjunction with a proposed development. It will have particular applicability when the TIS is done on a voluntary basis as part of a conditional zoning application filed in conformance with the City's Comprehensive Plan.

A. Need For a Traffic Impact Study

A TIS will be required where any of the following apply:

1. Under circumstances where the Comprehensive Plan prescribes the use of a traffic impact study before a rezoning is granted;
2. Any development that would potentially generate 150 or more trips during the peak period of the generator, according to the rates or equations published in the latest edition of the Institute of Transportation Engineers (ITE) Trip Generation Manual and Trip Generation Handbook, an ITE Proposed Recommended Practice;
3. Any rezoning request, whether conditioned or otherwise, that does not conform to the Comprehensive Plan.
4. When required by City Code for a conditional zoning.
5. At the discretion of the City of Virginia Beach Traffic Engineer.

B. Multi-Development

The City of Virginia Beach may require a group of developers to jointly perform a traffic impact study on a section of roadway where many independent developments are planned. The results of this study will be the basis for determining improvements and levels of participation by each developer.



C. Exceptions

When a proposed developments traffic impact to City roadway facilities can be clearly anticipated without a study and the City and the developer are able to negotiate appropriate roadway improvements to be proffered by the developer, the TIS may be waived by the City Traffic Engineer.

D. Updating an Existing TIS

A TIS that has been previously submitted and approved by the City is required to be updated by the developer when the amount and/or character of traffic on the existing study area roadway facilities is significantly different from an earlier study. Generally a TIS requires updating every two years, however, the City Traffic Engineer may require an update prior to the two-year date at his/her discretion.

H.3 Conduct of the Study

If a TIS is required, the developer will be responsible for performing and submitting a formal TIS. The applicant shall choose a consultant qualified by professional credentials, including registration as a Professional Engineer in Virginia, and experience to conduct the study in a satisfactory manner. The applicant shall contract directly with that consultant to perform the TIS.

The TIS must be prepared in accordance with the guidance included in this Traffic Impact Studies Policy document. A general outline for information to be included in a TIS and format for the report is included as Section H.6 of this Policy. This outline includes minimum requirements for a TIS and additional information and analyses may be required, as determined by the City Traffic Engineer.

It shall be the consultant's responsibility to arrange a pre-study meeting with representatives of the City's Traffic Engineering Division and the Department of Planning to identify the necessary background information, assumptions, forecast year(s), time periods to be analyzed and the radius of influence that needs to be studied.

Following the pre-study meeting, the design consultant shall submit a memorandum of understanding confirming the scope of the TIS, to include the following:

- 1) Study area boundaries.
- 2) Issues to be addressed in the study.
- 3) Assumptions including time period(s) to be studied, forecast year(s), and methods of analysis.
- 4) Data sources - both existing data and data to be collected, to include counts and the current signal timings at existing signals.
- 5) Report contents.
- 6) Other pertinent issues discussed in the initial meeting.

The City will evaluate the memorandum of understanding and once approved by the City Traffic Engineer, the applicant may proceed with the TIS per the approved scope.



H.4 Purpose of the Study

The TIS shall identify those improvements to the roadway system (including but not limited to turn lanes, through lanes, signal operation and signalization) necessary to maintain the functioning of the road system to the same level of service prior to development. Where it is not possible to maintain the existing level of service (LOS), a design LOS of “C” shall be used. The Planning Department and Traffic Engineering staff shall review the study. The City Traffic Engineer shall grant final acceptance of the study. For a conditional zoning application, in order to be deemed in conformance with the City’s Comprehensive Plan, it should include proffers of those improvements identified by the study.

H.5 Detailed Study Criteria

A. Boundaries of the Traffic Impact Study

The study area for a TIS shall include, within reason, all roadway segments and intersections that will be significantly affected by the traffic volumes generated by the proposed development. As a minimum, the TIS will include all site access point intersections with public roadways, all public roadway segments adjacent to the site and the first signalized intersection on the roadways serving the site. Beyond this minimum, the City and the developer will jointly determine any additional areas to be included in the study based upon site-specific issues. The City Traffic Engineer will give final approval of the TIS study area boundaries.

B. Traffic Counts

Existing traffic counts, both average daily trips (ADT) for roadway segments and turning movement counts conducted at study area intersections, shall be based on data from counts collected or secured by the consultant that are no older than twelve (12) months. If such counts are unavailable, counts shall be performed by the consultant and prepared under the direction of a professional engineer registered in Virginia with expertise in traffic engineering. The following issues apply to the collection of traffic counts for use in the preparation of a TIS:

1. ADT counts are to be collected in one-hour increments or smaller and be directional.
2. Peak hour turn movement counts are to be collected on a Tuesday, Wednesday, or Thursday in a non-holiday week, unless otherwise directed by the City’s Traffic Engineering Division, and collected in fair weather conditions. All peak period turn movement counts are to be collected and tabulated in 15-minute increments.
3. Turning movement counts at study area intersections must be conducted in the AM peak period (7 a.m.- 9 a.m.) and PM peak period (4 p.m.- 6 p.m.) Other turning movement counts may be required, as is discussed in the Peak Hours section below.
4. All traffic counts shall be collected simultaneously.
5. All raw traffic data must be included in the Appendix of the report. Electronic traffic count files shall also be included with the TIS submittal.
6. Seasonal adjustment factors are to be applied if available from the City.



7. Existing peak hour factors are to be determined by approach for each peak period studied.

C. Peak Period Hours

In general, the TIS must include an AM peak period analysis (7 am to 9 am) and PM peak period analysis (4 pm to 6 pm). Other peak periods (11:30 a.m.- 1:30 p.m., weekend, and specific development peak hours) may also be required to be analyzed to determine the magnitude of the traffic impacts generated by a proposed development. A determination of required peak periods to be included in each TIS will be made at the pre-study meeting.

D. Traffic Analysis Scenarios

The following scenarios must be analyzed as part of a TIS. These scenarios represent the minimum and additional scenarios may be required for specific developments depending on the type of development and roadway specific issues, such as development phasing and roadway improvement projects in the study area. Future year will generally be ten years or the buildout year for the project. For large developments generating more than 250 peak hour trips, the design year will be determined at the pre-study meeting.

1. Existing Conditions – Use existing traffic volumes and roadway configurations.
2. Future Conditions Without Development – Use forecasted future year traffic volumes, including any approved developments that may affect study area roadways, and roadway configurations with any programmed roadway Capital Improvements Projects.
3. Future Conditions With Development – Use forecasted future year background traffic volumes and traffic generated by the development and assigned to study area roadways and intersections.
4. Future Conditions With Development and Proposed Improvements – Use forecasted future conditions with development traffic and any proposed roadway improvements.

E. Background Traffic Growth

The background growth in traffic is to be established in consultation with City staff through one of the following methods:

1. Roadway growth factors from the regional travel demand forecast model.
2. Historic traffic growth.
3. Corridor transportation studies, if available.

Development of historic traffic growth trends are to be based on traffic counts obtained over a number of years, with any unusual data removed from the analysis. Historic growth trends may be available through the City's traffic count program.

Sound engineering judgment is to be used when determining the most appropriate method to be used to establish a background growth rate for study area roadways. Often



straight lined growth from the travel demand model is not appropriate since volumes on certain roadways may rise, fall, and rise again as roads are widened and new facilities are added. Therefore, the timing of such planned improvements must also be considered when determining a growth rate over a given time period.

The TIS report must clearly indicate the methods and assumptions used to develop the background growth rate and the future year background traffic volumes.

F. Trip Generation

Total traffic generated by the proposed development shall be computed using the best available equations or rates published in the latest edition of the Institute of Transportation Engineers (ITE) Trip Generation Manual, unless documentation is supplied and approved by the City Traffic Engineer justifying the use of different rates. If a rezoning is proposed without detailed understanding of the proposed land use(s), the highest possible traffic generation situation shall be analyzed.

1. Trip Generation Rates - The methodologies described in the ITE Trip Generation Handbook are to be used to determine the most applicable rates or equations. When the land use has a limited number of studies to support the trip generation rates, the consultant is to use sound engineering judgment in the use of the rates and must indicate in the report how these rates were used or modified.
2. Multi-Use Developments/Internal Trips- According to the latest edition of Trip Generation Handbook, an ITE Proposed Recommended Practice, a multi-use development is typically a single real-estate project that consists of two or more ITE land use classifications between which trips can be made without using the off-site road system. Note that any major street running through the development is not considered off-site. Determination of internal trip reduction for multi-use developments should be consistent with the methodologies described in Chapter 7 of the above document.
3. Pass-By Trips- Determination of pass-by trips is to be consistent with the methodology presented in the latest edition of Trip Generation Handbook, an ITE Proposed Recommended Practice. It is important to note that pass-by trip reductions are only applicable to evaluation of traffic operations at intersections remote from the site; pass-by trips must be included in the analysis of access point/public roadway intersections.

G. Trip Distribution

Trip distribution refers to the direction a vehicle will take to enter or exit the proposed development site and can vary depending on:

1. Type of proposed development
2. Similar land uses in the vicinity
3. Size of the proposed development
4. Conditions on the roadway network in the vicinity of the site.
5. Demographics of the area



All these items and any other relevant information must be considered when developing trip distribution for each of the time periods. As with all technical analysis steps, the basic method and assumptions used in this work must be clearly stated in order that the reviewer can replicate the results reported.

H. Evaluation of Impacts of Site Generated Traffic

For all traffic analysis scenarios required for a TIS, peak hour LOS and volume/capacity analyses are required as a minimum level of traffic analysis. Summaries of these analyses are to be reported in a tabular format.

Under the City's policy, if the proposed development is shown to not change the LOS of study area intersections or roadway segments, no roadway improvements will be required. However, if the LOS is affected by the addition of proposed development traffic, the developer will be responsible for proposing roadway improvements that will restore study area intersections and roadways to the existing LOS. These improvements may include the addition or extension of traffic lanes, turn lanes, acceleration and deceleration lanes, traffic signal improvements, access controls, turn restrictions and new traffic signals.

Additional traffic analyses may be required to be included in a TIS to assess the impacts of the proposed development. A queue length analysis is required to be performed when intersection turn or thru movement LOS are adversely affected by the impacts of site traffic. Also, the queue analysis is required when the possibility exists that queues will block thru lanes or upstream intersections. Roadway improvements will be required to mitigate any negative queuing effects caused by the proposed development.

I. Analysis Methodologies

The traffic analysis methodologies listed below for the different facility types are used by the City in its analyses and are acceptable for use in a TIS prepared for the City. Other analysis methods may be accepted, however the consultant preparing the TIS must receive prior approval of the proposed alternate methodologies.

1. Two-lane roadways- HCM*, operational analysis
2. Multi-lane roadways- HCM*, operational analysis
3. Signalized intersections- HCM*, Highway Capacity Software, Synchro**, operational analysis
4. Unsignalized intersections- HCM*, Highway Capacity Software, Synchro**, operational analysis
5. Signal warrants- Manual on Uniform Traffic Control Devices (MUTCD), latest edition.
6. Signal progression- Transyt-7F, Synchro
7. Pedestrian Facilities- HCM, MUTCD
8. Turn lane warrants- City of Virginia Beach Standards and Specifications, latest revision.

* Highway Capacity Manual, latest edition.

** Use the HCM analysis report option if Synchro is used.



The following additional guidance is provided for use in signalized and unsignalized intersection analysis:

1. Existing signal timings and phasing shall be used for existing conditions analysis. The City will provide this information on request.
2. Modifications to existing timings and phasing may be proposed in the TIS as a proposed improvement, however the modifications must include an analysis of the effects of these modifications on the applicable traffic signal system.
3. Existing field measured peak hour factors are to be used. The use of modified peak hour factors must be justified in the TIS.
4. A minimum green time of 10 seconds must be used for individual movements.
5. Synchro produces unrealistic queue lengths when volume to capacity ratios exceeds 0.95. In these instances, other methods will be required to determine queue lengths.

H.6 Traffic Impact Study Outline

1. Executive Summary
2. Introduction
 - a. Description of Existing Area
 - b. Project Description - including proposed site plan if available
3. Existing Conditions
 - a. Existing Developments
 - b. Approved Developments in the Study Area
 - c. Existing Roadway Conditions
 - (1) Geometric
 - (2) Traffic Control
 - (3) Traffic Volumes
 - (4) Relevant Access Issues
 - d. Existing Intersection Level of Service Analysis
4. Future Year No Build Conditions
 - a. Historic Growth Trend Analysis
 - b. Additional Growth related to item C2 above
 - c. Total Background Traffic



- d. Planned Roadway Improvements
- e. Buildout Year No Build Level of Service Analysis
- 5. Future Year Build Condition
 - a. Site Generated Traffic
 - (1) Proposed Access Conditions
 - (2) Trip Generation
 - (3) Trip Distribution
 - (4) Trip Assignment
 - (5) Phasing of Project
 - b. Total Future Year Traffic
 - c. Planned Roadway Improvements with Project
 - d. Future Year Build Level of Service Analysis
- 6. Special Analyses as Appropriate
 - a. Traffic Signal Warrants Analysis - to include any proposed new signals or intersections where signals may be warranted.
 - b. Queuing/Turn Lane Length Analysis
 - c. Evaluation of Signal spacing for all proposed signals
 - d. Internal Roadway System Analysis
- 7. Mitigation Measures/Recommendations
 - a. Off Site Improvement Needs
 - b. Site Access Issues
- 8. Conclusions
- 9. Appendix
 - a. 24-hour Traffic Count Data
 - b. Peak Hour Turning Movement Count Data
 - c. All Capacity Analysis Sheets - use form that contains all timing data and queuing analysis
 - d. Signal Warrant Analysis Documentation



Appendix I

Acquisition Plat Standards

I.1 General

Plats being prepared for the acquisition process by the City of Virginia Beach must meet the requirements outlined herein. They must further meet the standards set forth as Standards in Section 18 VAC 10-20-370 of the Department of Professional and Occupational Regulation (DPOR).

All plats prepared for acquisition purposes must be recorded in the Office of the Clerk of the Circuit Court in the City of Virginia Beach, Virginia and therefore must meet the requirements imposed by that office for the recordation process.

All plats shall be based on the most current horizontal and vertical control datum utilized or specified by the Department of Public Works. All plats must clearly specify the datum used with a note placed on the plat.

A. Plat Requirements

This section provides minimum standard requirements for preparation of plats for acquisition by the City of Virginia Beach. These plats are not considered as “Subdivision Plats” and therefore are not subject to the requirements contained within the “Subdivision Ordinance” of the City of Virginia Beach.

1. **Land Surveyor’s Seal** must be placed on each sheet of all plats and exhibits to be considered for the recordation process. The Land Surveyor must be licensed within the Commonwealth of Virginia to perform such work. The seal shall contain the Land Surveyor’s signature and the date of the signing.
2. **Land Surveyor’s Company Name and Address** must be clearly shown on all sheets of all plats with the address of the office responsible for the preparation thereof. The telephone number of that office must be shown.
3. **Approval Signature** space must be provided on each sheet to receive the signature of the appropriate official(s) of the City of Virginia Beach. Plats prepared for the Department of Public Works must contain a signature space and date for the Director of Public Works. Plats prepared for the Department of Public Utilities must contain a signature space and date for the Director of Public Utilities. Plats prepared for joint department projects must contain a signature line and date for each Director.
4. **Plat Material** shall be “mylar film” with the use of India black ink or equivalent or composition material (if prepared on electronic plotters). The density of the ink or composition must be suitable for the photographic processes within the Office of the Clerk of the Circuit Court recordation processes.
5. **Plat Dimensions** shall be either 11” x 17” or 18” x 24”, trim line to trim line. All plats requiring more than one sheet shall be prepared on the same size sheets. The sheets shall have an exterior border of a minimum of 1/4” on all sides.



6. **Plat Scale** shall be the largest scale possible to accomplish the requirements of the project within a clear, legible and complete fashion. No plat shall be on a scale of less than one inch (1") equals 100 feet (100') unless otherwise approved by the Department of Public Works. A written and graphic scale shall be shown on each plat sheet containing property drawing or details. All plats containing match lines shall be of the same scale.
7. **Inscriptions** on all plats shall be of no less than one-tenth (1/10) inch or 2.54 mm in height. All lettering and line weights will be no less than 0.013 inch or 0.3302 mm.
8. A 2-inch by 3-inch box shall be placed at the top right corner of the first sheet for the instrument identification number.
9. **Shading, Screening or Hatching** or other convention used to designate areas within the plat shall meet the standards of the Clerk of the Circuit Court for recordation purposes or as defined herein. All lettering shall be free of all shading, screening or hatching. The purpose of all shading, screening or hatching shall be clearly outlined in a Legend on the plat. All shading, screening or hatching conventions shall meet the guidelines of Conventions and Lettering (ANSI Y14.2M-1987 or latest version). All shading, screening or hatching used shall be uniform throughout all plats prepared for that project.
10. **Meridian** of all plats shall be based on the current datum utilized and approved by the Department of Public Works. The north arrow shall contain the meridian reference. The plat shall contain a note which clearly describes the meridian. The note shall read as follows:
 - a. "The meridian of this plat is based on the Virginia State Plane Coordinate System, South Zone, NAD 1983/1993 (HARN). All measurements and coordinate values are expressed in U.S. Survey Foot."
11. **Accuracy** – All distances are to be expressed in feet and hundredths of a foot. All bearings are to be expressed in degrees, minutes and seconds and shall run in a clockwise direction. All curve data shall be provided in a table and shall contain curve number, delta, radius, arc length, tangent, chord and chord bearing (clockwise). Where curves are not tangent, a tangent bearing or radial bearing must be provided.
12. **Closure** of all plats shall conform to the regulations of the Virginia Department of Professional and Occupational Regulation (DPOR) APELSCIDLA Board, but shall have a maximum permissible error of closure of no less than one part in 20,000. The maximum permissible positional uncertainty, based on the 95% confidence level of any independent boundary, property corner, right-of-way or control line points established by utilizing a GPS system shall not exceed the positional tolerance of 0.07 feet (20mm or 50ppm).
13. **Areas** shall be shown in an area table on the plat. The table shall contain areas in both square feet and acres (0.000 A.C., minimum). The areas of each parcel, portion of parcel or easement shall be provided. The residue of the subject parcel or tract after the subtraction of all fee simple land areas to be acquired shall be shown. If the parcel total area is not based on a boundary survey by the Land Surveyor preparing the plat, the source of the area shall be noted on the plat.
14. **Monumentation** of all property and right-of-way corner points shall be clearly shown on the plat. For roadway projects, concrete monuments are required for all right-of-way angle points including points of curve and tangency. The type of



concrete monument shall be approved by the Department of Public Works prior to preparation of the plat. All intersecting property lines shall be provided with an iron pin marker. On plats of total take acquisitions, approved monuments shall be provided at all boundary points.

- a. Monuments of all types are to be set by the Land Surveyor preparing the plat OR shall be specified on the project plans to be set at the last stages of construction of the project. The determination of the method of monument placement shall be determined at the beginning stages of the project. If the monuments are to be set by the Land Surveyor preparing the plat, all symbols of property or right-of-way points found or set must be clearly detailed in a legend on the face of the plat. If the points are to be set within the construction project, a note must be provided on the plat to state the procedure utilized.
15. **Match Lines** of the plats requiring more than one sheet shall be shown on all sheets with the appropriate identifiers noted thereon. Sheet numbers, at or near the bottom right corner of each plat must be shown denoting “Sheet 1 of 2”, “Sheet 2 of 2”, etc.
16. **Title** of each plat shall define the purpose of the plat. The title format shall be in accordance with the “Plat Title Standard” attached to this chapter.
17. **Source of Title** for the subject parcel or tract shall be clearly noted on the plat. The Source of Title shall include the Deed Book and Page, Will Book and Page, Instrument Number, Map Book and Page and the Geographic Property Identification Number (GPIN). If the plat contains more than one parcel (GPIN), a source of title for each parcel shall be shown.
18. **Water Bodies** that abut or are within the subject parcel, whether natural or artificial, shall be shown. The plat shall show the high water line, bulkheads, and piers of all water bodies.
19. **Adjacent right-of-ways** shall be shown with the roadway name, width and the full source of title shall be shown. At least one distance tie from the subject parcel to the nearest street line intersection shall be provided on the plat.
20. **Coordinate Values** shall be shown for a minimum of two (2) points on the subject parcel, preferably on existing monuments, on each plat sheet containing property details. Provide two (2) coordinate values on the project baseline or construction centerline control. If existing monuments are not available, provide coordinate values on two (2) points of the subject parcel. Coordinate values are to be expressed in U.S. Survey feet to a minimum of two (2) decimal places.
21. **Construction Baseline**, if provided within the project, shall be shown with stationing provided. The bearings and curve data must be shown. A minimum of two (2) coordinate value must be shown on the baseline with appropriate stationing.
22. **Station and Offset** values must be shown for all points of angle for existing and proposed rights-of-way and proposed easements. A unique bracket symbol for each type of easement, rights-of-way and/or acquisition area shall be required and identified with a legend.
23. **Existing Easements** shall be shown for all known easements with their Map Book, Deed Book and Instrument Numbers references. Easement information for



all easements outlined within a title report, furnished to the Land Surveyor, shall be shown.

24. **Area Descriptors** for each area shall be labeled. All descriptors must be consistent in wording in all areas of the plat including all charts.
25. **Existing Structures** may be required to be located and shown on the plat. Permanent structures within thirty feet (30') of a new right-of-way line are to be considered. Structures are defined as buildings, dwellings, in-ground pools, and permanent accessory structures. These will be considered at the time of the project establishment along with an estimated number defined at that time. This requirement will be considered on a case by case basis and is not to be considered as a standard project requirement. This requirement shall be pre-approved by the City Project Manager when the approved project funding is available and the project need is identified.

B. Research

This section shall define the level of responsibility for the Land Surveyor and the City of Virginia Beach for the necessary research prior to the commencement of the plat preparation.

1. Land Surveyor

Land Surveyor performing the plat preparation shall meet the minimum research requirements outlined by the Virginia DPOR, APELSCIDLA Board statutes, and shall

- a. Obtain a copy of the last recorded deed in the title of the parcel for which the plat is prepared.
- b. Obtain a copy of the deed for each parcel of land that is contiguous to the parcel for which the plat is prepared. If the adjacent land is a part of a recorded subdivision of land for which a plat is available, the recorded plat shall be considered as sufficient source.
- c. Research of available records within the Departments of Public Works and Public Utilities must be performed. Data obtained from this research may require that the Land Surveyor obtain copies of additional recorded documents.
- d. If records necessitate, the Land Surveyor must research available records of the office of the Real Estate Assessor to obtain the source of title.

C. Quality Control

This section shall define the minimum quality control duties to be exercised by the Land Surveyor preparing the plat.

1. Plat / Plan Coordination

Plat / Plan Coordination - The Land Surveyor shall carefully review the proposed features on the project plans to assure that all required acquisitions outlined by the plans are achieved. The review shall include all items relevant to the plat



preparation. All items not clearly understood by the Land Surveyor shall be discussed with the project designer prior to plat preparation and / or completion.

2. Plat Review

The plat shall be thoroughly reviewed by the Land Surveyor prior to submission for the review by the City.

The plat shall be reviewed by various City agencies after submission by the Land Surveyor. Review comments will be provided, however, **it must be understood that the review by the City agencies does not replace nor diminish that which must be performed by the Land Surveyor.**

3. Plat Submittals

The initial plat submittal shall consist of an electronic version, to scale, (PDF format) for review by the City.

After review of comments the second plat submittal will be submitted along with a letter of response to each comment.

After receipt of written approval from the City, the final submission shall consist of two original sealed and signed mylar tracings.

4. Plat Checklist

Plat Checklist – A plat review checklist is attached to this Chapter. This checklist shall be used by the Land Surveyor to aid in a quality review. This checklist must not be considered to be the only review requirement. It is provided as a review aid only.



Department of Public Works Acquisition Plat Checklist

This check list shall be used prior to the submittal of any plat, regardless of its stage of completeness.

- ☐ Title of Drawing
- ☐ Name of the Survey Firm, Address, City, State, Zip Code and Telephone Number
- ☐ Reference Deed Book and Page, Instrument Number and Map Book/Page for the Subject Parcel
- ☐ North Arrow and See Note # (Meridian note)
- ☐ Lot Dimensions
- ☐ Bearings Around Areas to be Acquired (clockwise)
- ☐ Curve Information in a Table Containing: Radius, Delta, Arc Length, Tangent, Chord and Chord Bearing (clockwise)
- ☐ Existing Easements, Size, Reference to Recordation Source
- ☐ Street Name(s), Width of Right of Way and Reference to Recordation Source
- ☐ Distance Tie to the Nearest Street Intersection from a Property Corner
- ☐ Scale: Graphic and Written
- ☐ Legend Including a Legend Box(s) for Fee Simple Acquisition Areas and Easements
- ☐ Bracket legend matching the brackets used in plans
- ☐ Adjacent Lot Owners, Lot Number, Subdivision Name, GPIN, Deed and Plat Reference
- ☐ Instrument Box (2" X 3") at the top right corner of the plat



- ☐ Land Surveyor's Seal, Signature and date on each sheet
- ☐ Director of Public Works or Appropriate Director Signature Line with the Date (blank) on each sheet
- ☐ Location Map with North Arrow and Scale
- ☐ Survey/ Construction Base Line with Two (2) Reference Coordinates
- ☐ Two (2) Reference Coordinates on the Subject Parcel(s)
- ☐ Area Table. Area in Square Feet (to the nearest foot) and Acreage to a minimum of 3 decimal places
- ☐ All Wording for the Acquisition Area must be identical in the: Area Table, Legend, Title, Body of the Plat and any other Reference shown to the Acquired Parcel
- ☐ Notes:
 1. Meridian Note
 2. Basis of Survey (Plat, field survey, etc.)
 3. Title Report Reference Note
 4. This plat is intended for acquisition purposes only and does not constitute a subdivision of land. See "Notes for Acquisition Plats" document in this chapter.
- ☐ Monuments and corner pins, both set and found. Provide Symbols and Descriptions in a Legend
- ☐ Provide a station/offset for each corner of: existing R/W, proposed R/W, proposed easement(s) and control points. The station/offsets on the plat must match the station offsets on the plans.



Notes for Acquisition Plats

1. THE MERIDIAN SOURCE OF THIS PLAT IS BASED ON THE VIRGINIA STATE PLANE COORDINATE SYSTEM, SOUTH ZONE, N.A.D. 1983/ 1993 (HARN). COORDINATE VALUES ARE EXPRESSED IN U.S. SURVEY FEET.
2. THIS PLAT IS INTENDED FOR ACQUISITION PURPOSES ONLY AND DOES NOT CONSTITUTE A BOUNDARY SURVEY OR SUBDIVISION OF LAND.
3. THIS PLAT WAS PREPARED UTILIZING A TITLE REPORT PREPARED BY (TITLE CO. NAME) DATED (DATE OF REPORT).
- 3a. THIS PLAT WAS PREPARED WITHOUT THE BENEFIT OF A TITLE REPORT AND DOES NOT SHOW PHYSICAL IMPROVEMENTS. ALL EASEMENTS AND RESTRICTIONS THAT MAY AFFECT THE PROPERTY MAY NOT BE SHOWN.
4. PROPERTY LINE AND RIGHT-OF-WAY INFORMATION IS BASED ON VARIOUS PLATS, DEEDS OF RECORD AND FIELD MEASUREMENTS.
5. PROPERTY/EASEMENTS TO BE ACQUIRED BY DEED.
6. CIP OR PROJECT:

RIGHT-OF-WAY AND PROPERTY MONUMENTATION SHALL BE INSTALLED WITHIN THE PROJECT CONSTRUCTION CONTRACT. ALL MONUMENTS SHALL BE INSTALLED BY A LAND SURVEYOR LICENSED WITHIN THE COMMONWEALTH OF VIRGINIA AND WILL NOT BE INSTALLED BY THIS SURVEYOR.

ALL EXISTING PROPERTY AND RIGHTS-OF-WAY MONUMENTS SHOWN HEREON ARE TO BE PROTECTED FROM DAMAGE OR DISPLACED DURING CONSTRUCTION. ANY MONUMENT DAMAGED OR DISPLACED SHALL BE REPLACED AT THE FINAL STAGES OF CONSTRUCTION BY A LAND SURVEYOR LICENSED IN THE COMMONWEALTH OF VIRGINIA. THE COST FOR REPLACEMENT WILL BE AT THE CONTRACTOR'S EXPENSE, UNLESS OTHERWISE NOTED. THE LAND SURVEYOR SHALL CERTIFY TO THE OWNER, IN WRITING, THAT THE MONUMENTS ARE IN PLACE.

DIRECTOR'S DISCLAIMER AND SIGNATURE LINE

BY APPROVAL, THE UNDERSIGNED DOES NOT CERTIFY AS TO THE CORRECTNESS OF THE BOUNDARY, STREETS OR OTHER LINES ON THIS PLAT. EXISTING PUBLIC RIGHTS-OF-WAY, EASEMENTS, OR OTHER PUBLIC



**INTERESTS NOT SHOWN ON THIS PLAT REMAIN INTACT AND ARE NOT
TERMINATED OR EXTINGUISHED BY OMISSION FROM THIS PLAT.**

APPROVED: _____
DIRECTOR OF PUBLIC WORKS **DATE**



“PLAT TITLE STANDARD”

PLAT SHOWING
PROPERTY (AND EASEMENTS) TO BE ACQUIRED
FROM

OWNER’S NAME(S)

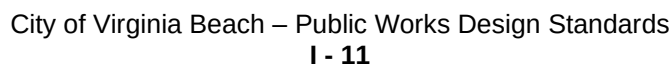
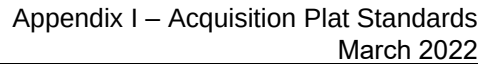
BY
THE CITY OF VIRGINIA BEACH
FOR

PROJECT NAME
PARCEL NUMBER
CIP NUMBER

VIRGINIA BEACH, VIRGINIA

SCALE: 1” = (___ __')

DATE: (PLAT DATE)





Appendix J

Stormwater Management Design Checklists and Tables

J.1 Storm Sewer System Design Outline

The below outline is for designing closed storm sewer systems, including drainage structures, with contributing drainage areas less than 20 acres and times of concentration (T_c) between 5 and 30 minutes. Use SWMM for analysis and design when T_c is ≥ 30 minutes.

A. Rainfall Intensity

1. IDF Equation

a.
$$i_f = \frac{B}{(T_c + D)^E}$$

Where:

i_f = Rainfall intensity for a given recurrence interval “f” (2 yr., 10 yr., 25 yr., etc.), in inches/hour.

T_c = Drainage area time of concentration (assumed equal to the storm duration), in minutes.

$E = 1.0$ for all sites in Virginia Beach

- b. Use for drainage areas less than 20 acres and times of concentration between 5 and 30 minutes.
- c. Use the latest B and D coefficients for Virginia Beach (city) for determining rainfall intensity in the Rational and Modified Rational Methods as shown in Table J-1 below. Consistent with the discussion in **Section 8.3.B Design Storm Depth-Duration and Rainfall Distribution Criteria**, these coefficients include the requisite 20% increase to obtain the design intensity for Rational Method computations.

TABLE J – 1 Steel Equation Coefficients					
Coefficient	2-Year	10-Year	25-Year	50-Year	100-Year
B	158.7	238.1	285.	333.3	370.4
D	18.5	22.8	25.1	27.1	24.4

2. **Time of Concentration (T_c)**- Includes sheet flow plus overland flow plus channel flow. Use a minimum of five and a maximum of 30 minutes.

- a. **Kinematic Wave Formulation** (See chart in VDOT Drainage Manual (VDOT DM), but ignore impervious area restriction).

i.
$$T_t = \frac{0.93(nL)^{0.6}}{i^{0.4}S^{0.6}}$$



Where:

T_t – sheet flow travel time,

minutes,

n = Manning's roughness coefficient for overland sheet flow,

L = flow length, feet,

i = rainfall intensity, inches/hour, and

S = average surface slope (feet/feet).

ii. Sheet flow (flow depth is 0.1 feet or less) - maximum length is 100 feet.

iii. Minimum slope is 0.1% - maximum slope is 6.0%.

iv. See **Table J-3 Manning's Roughness Coefficients for Kinematic Wave Formulation**.

b. **FHWA/NRCS Overland Flow** (See charts in VDOT DM).

- i. $V_{\text{forest with heavy ground litter}} = 2.516 S^{0.5}$
 $V_{\text{fallow or woodland}} = 5.032 S^{0.5}$
 $V_{\text{cultivated-straight row}} = 8.762 S^{0.5}$
 $V_{\text{nearly bare or untilled}} = 9.965 S^{0.5}$
 $V_{\text{grassed waterway or unpaved}} = 16.135 S^{0.5}$
 $V_{\text{paved}} = 20.328 S^{0.5}$

Where:

V = the average velocity in feet per second, and

S = the average surface slope in feet per feet.

- i. For overland flow on grass use methods approved by Virginia DCR or DEQ, as appropriate.
- ii. Use with the Rational Method or SCS (NRCS) Unit Hydrograph Method (Do not use in SWMM analyses).
- iii. Shallow concentrated flow (flow depths of 0.1 to 0.5 feet) – minimum length is 50 feet; maximum length is 10,000 feet, but not beyond interception by natural or man-made channels or pipes.
- iv. Minimum slope is 0.1% - maximum slope is 50.0%.

c. **Open Channel Flow and Closed Conduits**

- i. Use Manning's Equation for design storm flow. Apply Bernoulli Theorem (hydraulic grade line) to closed conduits. Divide length by average velocity to obtain travel time for each segment. See VDOT DM Chapters 8 and 9 for additional requirements.



B. Rational Method - Use for drainage areas less than 20 acres.

1. **Runoff Coefficient (C)**– Site specific formulation required. See **Table J-2 Rational Method Runoff Coefficients**. See VDOT DM, VESCH, or VSMH for additional values and ranges.
2. **Time of Concentration - Inlet Time**
 - a. See subsection J.1.1.2 above.
 - b. The minimum allowable time of concentration is 5 minutes.
3. **Intensity (Rainfall)** - Use a 10-year storm event for Virginia Beach from VDOT DM or Hydraulic Design Advisory, whichever is most current. Consistent with the discussion in **Section 8.3.B Design Storm Depth-Duration and Rainfall Distribution Criteria**, the designer shall utilize the Steel Equation Coefficients in **Table J-1** to obtain the design intensity for Rational Method computations.
4. **Flowrate (Runoff) - Q** = (CiA).

Where:

Q = maximum rate of runoff (cfs)

C = dimensionless runoff coefficient, dependent upon land use

i = design rainfall intensity (in./hr.), for a duration equal to the time of concentration of the drainage area

A = drainage area (acres)

C. Storm Drain Conduit Design – See VDOT DM

1. **Pipe Length Between Structures**
 - a. For 12 inch pipe, the length should not exceed 50 feet.
 - b. For 15 to 42 inch pipe, the length should not exceed 300 feet.
 - c. For 48 inch or larger pipe, the length should not exceed 800 feet.
2. **Slope** - Should be given in either in ft./ft. or sometimes in percent. (Use **Table J-5 Drainage Structure Minimum Depth** of this manual to verify that the depth is adequate at the drainage structures). The minimum and maximum pipe slopes required by the VDOT DM shall be used.
3. **Capacity** = $[S^{1/2} \times K]$, in c.f.s.

Where:

S = Slope of the energy grade line (assumed to be parallel to the bottom slope for uniform flow,

K = Conveyance = $(1.486/n) \times A \times (Rh)^{2/3}$

n = Manning's 'n' for storm sewer pipe (See **Table J-4 Manning's "n" Roughness Coefficients for Storm Sewer Pipe and Culverts**)

A = Flow area, in square feet

Rh = Hydraulic Radius, in feet = A/P

P = Wetted Perimeter, in feet

For initial pipe sizing, the flow rate should not exceed the pipes capacity.



4. **Velocity (V)**

- a. If a pipe is flowing full ($V=Q/A$), then **A** equals the area of the pipe in S.F. and **Q** = rate of flow, in c.f.s.
- b. If a pipe is in open channel flow, uses the Hydraulic Element chart (The depth of flow should be greater than 25% of the pipe diameter).
- c. The only way to tell if the pipe is in open channel or full flow is to calculate the hydraulic grade line. **Assume the pipe is flowing full.**

5. **Flow Time** = $L/(V \times 60)$ Flow time is given in seconds, where **V** equals the actual velocity for each conduit and **L** = conduit length.

D. Hydraulic Grade Line - See VDOT DM.

1. **Outlet Water Surface Elevation (Tailwater (TW))** – See **Section 8.3.D Hydraulic Grade Line and Tailwater Criteria** and VDOT DM Chapters 7, 8, and 9
2. HGL at each drainage structure that is adjacent to or within pavement must not be above the rim elevation or gutter flow line, whichever is lower.
3. Conform to minimum freeboard requirements.
4. The designer shall consider the effects of groundwater in all storm drainage system designs. Seasonal high groundwater baseflows shall be included in all open channel water surface profile analyses. See **Section 8.3.E Compensation for Seasonal Groundwater** for baseflow addition requirements.

E. Spread Calculations for Curb Drop Inlets or Catch Basins

1. Combination grate and curb inlets or gutter basins are discouraged.
2. See **Chapter 9** of the VDOT DM for inlet design criteria and procedures, except rainfall intensities shall be increased by 20%.
3. All storm drain inlet designs for public highways and streets shall comply with the requirements of **Section 8.4.D.4**.

a. Drainage Areas

- i. Low Point (sump or sag condition) – Use two drainage areas, one left (down station) and one right (up station) of the drainage structure. Provide flanker inlets on each side of the sag inlet, sized to pick up drainage when the sag inlet is clogged.
- ii. On Grade – Use the total drainage area.

b. Rainfall Intensity (I)

See VDOT Drainage Manual. Add 20% to required rainfall intensity values.



J.2 Rational Method Runoff Coefficients

The Runoff Coefficients shall be based upon site specific criteria. The following values are for reference only:

TABLE J - 2 Rational Method Runoff Coefficients	
Area Classification	Runoff Coefficient
Building Roofs, Gravel, Pavement, and Other Impervious Surfaces	0.90
Forested and Dry Marsh Areas	0.20
Managed Turf	0.30
Lakes, Ponds, and Other Water Bodies	1.00

J.3 Manning's Roughness Coefficients for Kinematic Wave Formulation

The following Manning's 'n' roughness coefficients shall be used for overland flow in the Kinematic Wave formula in the City of Virginia Beach:

TABLE J - 3 Manning's Roughness Coefficients for Kinematic Wave Formulation	
Surface	"n"
Dense shrubbery/Woods with light underbrush	0.40
Woods with dense underbrush	0.80
Fallow – no residue (non-compacted bare, plowed soil)	0.05
Cultivated soils – residue cover $\leq$ 20%	0.06
Cultivated soils – residue cover $>$ 20%	0.17
Pasture	0.35
Lawns (Use Virginia DCR or DEQ approved methods)	-----
Sparse vegetation	0.15
Bare clay-loam soil (eroded)	0.02
Gravel surface	0.012
Concrete/asphalt/bare, compacted soil	0.011



J.4 Manning's "n" Roughness Coefficients for Storm Sewer Pipe and Culverts

The following table represents the accepted Manning "n" factors for storm sewer pipes and culverts allowed in the City of Virginia Beach.

TABLE J – 4 Manning's "n" Roughness Coefficients for Storm Sewer Pipe and Culverts	
Concrete	0.013
PVC ribbed or corrugated sewer pipe (smooth interior)	0.011
Polyethylene double wall pipe (smooth interior)	0.013
Aluminum spiral rib pipe	0.014

Note: Obtain "n" values for pipe not listed above from each manufacturer.

J.5 Drainage Structure - Minimum Depth

The Drainage Structure Minimum Depth information was compiled from the VDOT Road and Bridge Standards, City of Virginia Beach Department of Public Works Amendments to the VDOT Road and Bridge Standards, the standard drawings in **Appendix B** of these Design Standards, and actual field practices of the Department of Public Works. Designers shall confirm that the information is correct. See the next page for **Table J-5 Drainage Structure Minimum Depth**.

See below for **Table J-5** footnotes.

- † Minimum depths for City standard drainage structures are based on AASHTO M170 / ASTM C 76 Wall C. VDOT 'H' is per VDOT Road and Bridge Standards.
- †† The "H" dimension for this item is measured from the invert of the outfall pipe to the top of the drainage structure. All other 'H' dimensions shown on the table are total height from inside bottom of structure to top of structure slab or casting, whichever is higher.
- * If the drainage pipe does not cross under the curb or curb and gutter, subtract 0.64 feet to the minimum height.
- ** Safety Slabs are to be provided at approximately 10' vertical intervals and are to be spaced so as not to conflict with the pipe openings. See VDOT Road and Bridge Standards, Volume I, SL-1 "TYPICAL CONCRETE SAFETY SLAB FOR DROP INLETS, MANHOLES AND JUNCTION BOXES" for more information.
- *** The maximum depth does not correspond to this combination of precast units but to the depth of the maximum number of precast units assembled into a drainage structure. See VDOT Road and Bridge Standards, Volume I, JB-1 "JUNCTION BOX CHAMBER DETAILS FOR 48" – 72" PIPE CULVERTS MAX. DEPTH (H) = 20'" for more information.
- **** The maximum depth does not correspond to this combination of precast units but to the depth of the maximum number of precast units assembled into a drainage structure. See the 103 section (PRECAST UNITS) of the VDOT Road and Bridge Standards, Volume I for more information.



TABLE J-5 Drainage Structure Minimum Depth

Drainage Structures	Max.** Height	Minimum Height of the Standard Drainage Structures in feet (H)													
		12	15	18	21	24	27	30	36	42	48	54	60	66	72
Pipe Diameter (inches)		2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.75	5.25	5.75	6.25	6.75	7.25	7.75
Pipe Wall Thickness (inches)†															
City St'd. Drop Inlet (B-2/B-5)††	10'	2.15	2.42	2.69	2.96	3.23									
City St'd. Double D.I. (B-3)	10'	2.67	2.96	3.25	3.55	3.84	4.13	4.42	5.00	5.59	6.17				
City St'd. Single Curb DI (B-6/7)*	10'	2.92	3.21	3.50	3.80	4.09									
City St'd. Double to Quad Curb DI*	10'	2.92	3.21	3.50	3.80	4.09	4.38	4.67	5.25	5.84	6.42				
City St'd. Manhole (B-9)	10'6-3/4"	3.53	3.82	4.11	4.41	4.70	5.07	5.61	6.69						
Shallow CITY M.H - Mod. (B-11)	8'	2.73	3.03	3.32	3.61	3.90	4.19	4.48	5.07	5.65					
DI-1	10'	2.17	2.42	2.67	2.98	3.25									
DI-1A	20'	10.00	10.00	10.00	10.00	10.00									
DI-2A,B,C	9'	3.50	3.75	4.00	4.25	4.50									
DI-2AA,BB,CC	20'	9.00	9.00	9.00	9.00	9.00									
DI-2D,E,F	9'						4.75	5.00	5.50	6.00	6.50				
DI-2DD,EE,FF	20'						9.00	9.00	9.00	9.00	9.00				
DI-3A,B,C	8'	3.67	3.92	4.17	4.42	4.67	4.92	5.17							
DI-3AA,BB,CC	20'	8.00	8.00	8.00	8.00	8.00	8.00	8.00							
DI-3D,E,F	8'	3.67	3.92	4.17	4.42	4.67	4.92	5.17							
DI-3DD,EE,FF	20'	8.00	8.00	8.00	8.00	8.00	8.00	8.00							
DI-4A,B,C	8'								5.83	6.33	6.83				
DI-4AA,BB,CC	20'								8.00	8.00	8.00				
DI-4D,E,F	8'								5.83	6.33	6.83				
DI-4DD,EE,FF	16'								8.00	8.00	8.00				
DI-5	12'8"	2.75	3.00	3.33		3.83		4.42	5.00	5.50					
DI-7 Cast in Place	12'8"	2.50	2.77	3.04	3.58	3.85	4.13	4.40	4.67	5.21					
MH-1 Cast in Place or Brick	25'	1.94	2.21	2.53	3.05	3.48	4.09	4.73	5.94	6.61	7.15				
JB-1, Type A Tower	20'***										9.33	9.83	10.33	10.83	12.33
JB-1, Type B Tower	20'***										7.17	7.67	8.17	8.67	10.17
JB-1, Type C Tower	20'***										6.33	6.83	7.33	7.83	9.33
B-1, T-MH-2, MH-1 frame	50'****	3.96	4.25	4.54	4.83	5.13	5.42	6.71	7.29	7.88	9.46	10.04	11.63	12.21	13.79
B-1, R-2 & T-DI-1, 48" to 96" Base	25'****	2.50	2.77	3.04	3.31	3.58	4.88	5.17	5.75	6.34	6.92	7.50	8.08	8.67	9.25
B-1 & T-DI-2A-C, 36" Base	4'	4.67	4.94	5.21											
B-1, R-2 & T-DI-2A-C, 48" Base	25'****	5.50	5.77	6.04	6.31	6.58									
B-1, R-2 & T-DI-2A-C, 60" Base	25'****	5.50	5.77	6.04	6.31	6.58	6.86	7.38							
B-1, R-2 & T-DI-2A-C, 72" Base	25'****	5.50	5.77	6.04	6.31	6.58	6.86	7.38	7.92	8.46	9.00				
B-1, R-2 & T-DI-2A-C, 84" Base	25'****	5.50	5.77	6.04	6.31	6.58	6.86	7.38	7.92	8.46	9.00	9.55	10.09		
B-1, R-2 & T-DI-2A-C, 96" Base	25'****	5.50	5.77	6.04	6.31	6.58	6.86	7.38	7.92	8.46	9.00	9.55	10.09	10.63	11.17
B-1 & T-DI-3A-C, 36" Base	4'	3.50	3.77	4.04											
B-1, R-2 & T-DI-3A-F, 48" Base	25'****	4.34	4.61	4.88	5.15	5.42									
B-1, R-2 & T-DI-3A-F, 60" Base	25'****	4.34	4.61	4.88	5.15	5.42	5.69	6.23							
B-1, R-2 & T-DI-3A-F, 72" Base	25'****	4.34	4.61	4.88	5.15	5.42	5.69	6.23	6.75	7.30	7.84				
B-1, R-2 & T-DI-3A-F, 84" Base	25'****	4.34	4.61	4.88	5.15	5.42	5.69	6.23	6.75	7.30	7.84	8.38	8.92		
B-1, R-2 & T-DI-3A-F, 96" Base	25'****	4.34	4.61	4.88	5.15	5.42	5.69	6.23	6.75	7.30	7.84	8.38	8.92	9.46	10.00
B-1, R-2 & T-DI-4A-F, 60" Base	25'****	4.34	4.61	4.88	5.15	5.42	5.69	6.23	6.75						
B-1, R-2 & T-DI-4A-F, 72" Base	25'****	4.34	4.61	4.88	5.15	5.42	5.69	6.23	6.75	7.30	7.84				
B-1, R-2 & T-DI-4A-F, 84" Base	25'****	4.34	4.61	4.88	5.15	5.42	5.69	6.23	6.75	7.30	7.84	8.38	8.92		
B-1, R-2 & T-DI-4A-F, 96" Base	25'****	4.34	4.61	4.88	5.15	5.42	5.69	6.23	6.75	7.30	7.84	8.38	8.92	9.46	10.00
B-1, R-2 & T-DI-7, 48" to 96" Base	25'****	2.67	2.94	3.21	3.48	3.75	5.05	5.34	5.92	6.51	7.09	7.67	8.25	8.84	9.42

There are many conditions where the minimum height referenced above cannot be used due to conflicts or restriction with pre-development or post-development utilities, drainage items and pavement section. Engineering judgment is required in the design of any drainage structure.

SEE PREVIOUS PAGE FOR FOOTNOTE TEXT.



J.6 Standard Interior Dimensions for Drainage Structures

The information for the Standard Interior Dimensions for Drainage Structures was compiled from: VDOT Road and Bridge Standards, City of Virginia Beach Department of Public Works Amendments to the VDOT Road and Bridge Standards, the Standard Drawings in **Appendix B** of these Design Standards, and actual field conditions experience by the Department of Public Works staff. Designers shall confirm that the information is correct. See the next page for **Table J-6** *Standard Interior Dimensions for Drainage Structures*.

See below for **Table J-6** footnotes.

- * The maximum pipe size can increase by one pipe size only if there is one pipe entering the drainage structure.
- ** "Ht." is the tower that connects to the top of the junction box. See page 106.12 of the VDOT "Road and Bridge Standards, Volume I" for more information.



TABLE J-6 Standard Interior Dimensions for Drainage Structures

Drainage Structures	Pipe Sizes		Interior Dimensions (Deflection Angle of Pipe if laid Parallel to the Road)						
	Min.	Max.	Sides (0 to 45 degrees)				Front and Back (45 to 90 Degrees)		
CITY ST'D. Single D.I.	12"	24"	Outer Pipe Diameter (Min. 2' 2")				Outer Pipe Diameter (Min. 2' 2")		
CITY ST'D. Double D.I..	12"	48"	Outer Pipe Diameter (Min. 2' 2")				Outer Pipe Diameter (Min. 5' 2")		
CITY ST'D. Single C.D.I.	12"	24"	Outer Pipe Diameter (Min. 1' 9.75")				Outer Pipe Diameter (Min. 2' 6.25")		
CITY ST'D. Double C.D.I..	12"	48"	Outer Pipe Diameter (Min. 1' 9.75")				Outer Pipe Diameter (Min. 6' 4.5")		
CITY ST'D. Triple C.D.I.	12"	48"	Outer Pipe Diameter (Min. 1' 9.75")				Outer Pipe Diameter (Min. 10' 0")		
DI-1 or 1A	12"	24"	2' 2"				2' 2"		
DI-2A,2B,2C,2AA,2BB,2CC	12"	24"	2' 3"				2' 2"		
DI-2D,2E,2F,2DD,2EE,2FF	30"	48"	6' 8"				4' 8"		
DI-3A,3B,3C,3AA,3BB,3CC	12"	30"	2' 8"				2' 6"		
DI-3D,3E,3F,3DD,3EE,3FF	12"	30"	5' 0"				2' 6"		
DI-4A,4B,4C,4AA,4BB,4CC	36"	48"	4' 6"				4' 0"		
DI-4D,4E,4F,4DD,4EE,4FF	36"	48"	6' 2"				4' 0"		
DI-7,7A,7B	12"	36"	3' 0"				3' 0"		
DI-7,7A,7B	42"	42"	3' 6"				3' 6"		
DI-10A	12"	36"	3' 0"				3' 0"		
VDOT Shoulder Slot Inlet	15" CMP	15" CMP	0' 6"				10' 0" or 20' 0"		
VDOT Shallow MH-1 (Brick)	12"	18"	Concentric Cone (Top 2' 0",Bottom 3' 0")				Concentric Cone (Top 2' 0",Bottom 3' 0")		
MH-1 Cast in place or Brick	12"	48"	4' 0"				4' 0"		
B-1 or B-2 Base	12"	18"*	3' 0"				3' 0"		
B-1 or B-2 Base	12"	24"*	4' 0"				4' 0"		
B-1 or B-2 Base	12"	36"*	5' 0"				5' 0"		
B-1 or B-2 Base	12"	48"*	6' 0"				6' 0"		
B-1 or B-2 Base	12"	60"*	7' 0"				7' 0"		
B-1 or B-2 Base	12"	66"*	8' 0"				8' 0"		
Junction Boxes	Pipe Sizes		Interior Dimensions						
	Min.	Max.	Sides (Deflection Angle of the Pipes)				Front and Back**		
			0 degree	1-30 degree	31-60 degree	61-90 degree	Type A Tower	Type B Tower	Type C Tower
							Ht. >3'8"	Ht. 1'6"-3'8"	Ht. 0'8"-1'6"
JB-1	12"	48"	4' 0"	4' 2"	4' 8"	5' 8"	4'	3'	2'
JB-1	12"	54"	4' 6"	4' 8"	5' 3"	6' 5"	4'	3'	2'
JB-1	12"	60"	5' 0"	5' 3"	5' 10"	7' 1"	4'	3'	2'
JB-1	12"	66"	5' 6"	5' 9"	6' 5"	7' 10"	4'	3'	2'
JB-1	12"	72"	6' 0"	6' 3"	7' 0"	8' 6"	4'	3'	2'

SEE PREVIOUS PAGE FOR FOOTNOTE TEXT.



J.7 Standard Throat Lengths for Drainage Structures

The Standard Throat Lengths for Drainage Structures information was compiled from the following sources: VDOT Road and Bridge Standards, Volume I, City of Virginia Beach Department of Public Works Amendments to the VDOT Road and Bridge Standards, and the Standard Drawings in **Appendix B** of these Design Standards.

TABLE J-7 Standard Throat Lengths for Drainage Structures

Drainage Structures	Pipe Sizes		Length of Drainage Structure Throats																
	Min.	Max.	2'2"	2'6"	2'7"	3'	4'	4'8"	5'	6'	8'	9'	10'	12'	14'	16'	18'	20'	
CITY ST'D. Single D.I.*	12"	48"																	
CITY ST'D. Double D.I.*	12"	48"																	
CITY ST'D Single C.D.I..	12"	48"																	
CITY ST'D. Dbl. C.D.I.	12"	48"																	
CITY ST'D. Triple C.D.I.	12"	48"																	
VDOT DI-1 or 1A*	12"	24"																	
VDOT DI-2A or 2AA**	12"	24"																	
VDOT DI-2B or 2BB**	12"	24"																	
VDOT DI-2C or 2CC**	12"	24"																	
VDOT DI-2D or 2DD**	30"	48"																	
VDOT DI-2E or 2EE**	30"	48"																	
VDOT DI-2F or 2FF**	30"	48"																	
VDOT DI-3A or 3AA	12"	30"																	
VDOT DI-3B or 3BB	12"	30"																	
VDOT DI-3C or 3CC	12"	30"																	
VDOT DI-3D or 3DD	12"	30"																	
VDOT DI-3E or 3EE	12"	30"																	
VDOT DI-3F or 3FF	12"	30"																	
VDOT DI-4A or 4AA	36"	48"																	
VDOT DI-4B or 4BB	36"	48"																	
VDOT DI-4C or 4CC	36"	48"																	
VDOT DI-4D or 4DD	36"	48"																	
VDOT DI-4E or 4EE	36"	48"																	
VDOT DI-4F or 4FF	36"	48"																	
VDOT DI-7*	12"	42"																	
VDOT DI-7A*	12"	42"																	
VDOT DI-7B*	12"	42"																	
VDOT DI-10A**	12"	36"																	
VDOT DI-10B**	12"	36"																	
VDOT DI-10C**	12"	36"																	
VDOT Shoulder Slot Inlet	15" CMP	15" CMP																	

* Width of the grate(s)

** Width of the throat only. This drainage structure has a throat opening and a grate. The grate dimensions are 2' 6" by 1' 8" with the grate slots at a 45 degree angle from the face of curb. See VDOT Road and Bridge Standards, Volume 1, DI-2 "STANDARD CURB DROP INLET 12" – 24" PIPE: MAXIMUM DEPTH (h)=9" for more information.



J.8 Manning’s “n” Roughness Coefficients for Channels, Streams, and Floodplains

Table J-8 Manning’s “n” Roughness Coefficients for Channels, Streams and Floodplains		
Type of Channel and Description	Normal	Maximum
LINED CHANNELS (Selected linings)		
a. Concrete		
1. Trowel finish	0.013	0.015
2. Float finish	0.015	0.016
3. Gunite, good section	0.019	0.023
b. Asphalt		
1. Smooth	0.013	-
2. Rough	0.016	-
c. Riprap (St’d VDOT sizes)		
1. Class 1A	0.038	-
2. Class 1	0.040	-
3. Class 2	0.042	-
4. Class 3	0.045	-
5. Type I	0.047	-
6. Type II	0.050	-
EXCAVATED OR DREDGED		
a. Earth, straight and uniform		
1. Clean, recently completed	0.018	0.020
2. Clean, after weathering	0.022	0.025
3. Gravel, uniform section, clean	0.025	0.030
4. With short grass, few weeds	0.027	0.033
b. Earth, winding and sluggish		
1. No vegetation	0.025	0.030
2. Grass, some weeds	0.030	0.033
3. Dense weeds or aquatic plants in deep channels	0.035	0.040
4. Earth bottom and rubble sides	0.030	0.035
5. Stony bottom and weedy sides	0.035	0.045
6. Cobble bottom and clean sides	0.040	0.050
c. Dragline excavated or dredged		
1. No vegetation	0.028	0.033
2. Light brush on banks	0.050	0.060
d. Channels not maintained, weeds and brush uncut		
1. Dense weeds, high as flow depth	0.080	0.120
2. Clean bottom, brush on sides	0.050	0.080
3. Same, highest stage of flow	0.070	0.110
4. Dense brush, high stage	0.100	0.140
NATURAL STREAMS		
1. Minor streams (top width at flood stage <100 ft)		
a. Streams on Plain		
1. Clean, straight, full stage, no rifts or deep pools	0.030	0.033
2. Same as above, but more stones/weeds	0.035	0.040
3. Clean, winding, some pools/shoals	0.040	0.045
4. Same as above, but some weeds/stones	0.045	0.050
5. Same as above, lower stages, more ineffective slopes and sections	0.048	0.055
6. Same as 4, but more stones	0.050	0.060
7. Sluggish reaches, weedy, deep pools	0.070	0.080



Table J-8 (Cont'd) Manning's "n" Roughness Coefficients for Channels, Streams and Floodplains

Type of Channel and Description	Normal	Maximum
8. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.100	0.150
2. Floodplains		
a. Pasture, no brush		
1. Short grass	0.030	0.035
2. High grass	0.035	0.050
b. Cultivated area		
1. No crop	0.030	0.040
2. Mature row crops	0.035	0.045
3. Mature field crops	0.040	0.050
c. Brush		
1. Scattered brush, heavy weeds	0.050	0.070
2. Light brush and trees, in winter	0.050	0.060
3. Light brush and trees, in summer	0.060	0.080
4. Medium to dense brush, in winter	0.070	0.110
5. Medium to dense brush, in summer	0.100	0.160
d. Trees		
1. Dense Willows, summer, straight	0.150	0.200
2. Cleared land with tree stumps, no sprouts	0.040	0.050
3. Same as above, but with heavy growth of sprouts	0.060	0.080
4. Heavy stand of timber, a few down trees, little undergrowth, flood stage below branches	0.100	0.120
5. Same as above, but with flood stage reaching branches	0.120	0.160
3. Major Streams (top width at flood stage > 100 ft)		
The n-value is less than that for minor streams of similar description, because banks offer less effective resistance		
a. Regular section with no boulders or brush	-	0.060
b. Irregular and rough section	-	0.100

Sources: (1) VDOT DM, May 2017
(2) Chow, V.T., Open Channel Hydraulics, McGraw-Hill, 1959
(3) FHWA, River Engineering for Highway Encroachments, HDS No. 6, 2001



J.9 SWMF Stone Permeability Characteristics

TABLE J - 9 SWMF Stone Permeability Characteristics		
Aggregate type	"k" (inches/hr)	CFS per 2'x 2' section
#1	7100*	0.656
#57 (washed)	580	0.054
#8 (washed)	670	0.062
#50 sand (Tarmac)	48	0.0045
Manufactured sand (Vulcan)	1.42	0.00013
* Approximate value		



J.10 Turbidity Curtains

TABLE J-10 Turbidity Curtains	
Product	Description
Type 1 Silt Curtain	For Small Lakes & Ponds. Light Wt. 100'l.12" Draft Ballast 1/4"Chain Wt. Per Ft.1.7#
Type 1A Silt Curtain	For Lakes & Ponds Light Wt. 100'l.6" Draft Ballast 3/8"Chain Wt. Per Ft.1.8#
Type 2 Silt Curtain	For Rivers & Streams of Light Current. Also Open Lakes & Bays. 100'l. Ballast 5/16"Chain
Type 3 Heavy Duty Containment Boom	Channels, Harbors, Larger Bodies of Water. 50'l.24" Draft Tension 3/8"Chain Wt. Per Ft.2.9#
Containment Systems. Flatwater Barrier	Calm Protected Waters (Lakes, Ponds, Canals) Ballast: 1/4" Chain Floatation: 4" Expanded Polystyrene Over 9#/Ft Buoyancy
Lightweight Barrier	Waters W/Little Current (Lakes, Ponds, Canals) Ballast: 1/4" Chain Floatation: 6" Expanded Polystyrene Over 9#/Ft Buoyancy
Middle Weight Barrier	Rivers, Open Lakes, Exposed Shorelines. Ballast: 5/16" Chain Floatation: 8" Expanded Polystyrene Over 19#/Ft Buoyancy



J.11 List of More Stringent Items

TABLE J-11 List of More Stringent Items

Item	Requirement Subject	VSMP Regulation Code/BMP Specification		Virginia Beach Public Works Design Standards (PWDS)		Justification for More Stringent Requirement
		Reference	Code/Spec	Reference	Standard/Spec	
1	Channel Protection – Limits of Analysis	9VAC25-870-66.B. Channel Protection, Item 4	Unless subdivision 3 of this subsection is utilized to show compliance with the channel protection criteria, stormwater conveyance systems shall be analyzed for compliance with channel protection criteria to a point where either: a or b (1% rule).	PWDS 8.3.D.1.d, PWDS 8.3.D.2.b and 8.2	8.3.D.1.d Tailwater Criteria for Projects Draining to Tidally Influenced Waters - When the project discharge point is not directly adjacent to a major water body, as defined herein, the designer shall determine the HGL between the project discharge point and the major water body to provide an accurate tailwater control for design purposes. The HGL analysis shall start at the mapped or surveyed edge of the major water body. If the HGL is determined using the Environmental Protection Agency Stormwater Management Model (EPA SWMM) or City-accepted value enhanced versions of SWMM, static tides, not diurnal tides, shall be used in the analyses. In no case can starting tailwater elevations be lower than the associated tidal elevation listed in Table J-12 in Appendix J. City Stormwater Master Plans and City SWMM files may be used for analysis, if available. 8.3.D.2.b Tailwater Criteria for Projects Draining to Impoundments, Lakes, SWMFs/BMPs (with no tidal influence), or Non-Tidal Waterways – For drainage systems designed using EPA SWMM or City-accepted value enhanced versions of SWMM, the design year peak water surface elevation at each node in the system shall be determined using dynamic routing (by modeling) of all contributing storm hydrographs through the storm drainage systems and receiving impoundments, lakes, SWMFs/BMPs, or waterways to the downstream point of adequacy (See Sections 8.4 and 8.5 for additional SWMM analysis and design requirements). City Stormwater Master Plans and SWMM files may be used for analysis, if available. 8.2 Point of Adequacy (Reference: VDOT DM, see “adequate channel”) - A point in the downstream receiving stormwater conveyance system where it has adequate capacity to convey the design storm discharge under proposed (post--development) conditions to a major water body. Major Water Body- A public bay, creek, lake, stream, river, ocean, or other large body of water that receives stormwater runoff and has a base flood elevation determined by the current <u>Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS)</u>, the City Stormwater Master Plan, or other study available from the Stormwater Engineering Center. For tailwater computations the following are considered major (receiving) water bodies in the City of Virginia Beach are listed in Table J-12 in Appendix J. When the project does not discharge directly into one of the water bodies listed above and the drainage system is tidally influenced, the designer shall determine the hydraulic grade line (HGL) and/or water surface profile (WSP) between the project discharge	9VAC25-870-66 does not address the large, flat watersheds (<2% slope) with tidally influenced waters that are within the City of Virginia Beach. The more stringent requirement (Analysis to the point of adequacy) prevents further degradation of water resources and addresses localized flooding within the watershed (VA Code 62.1-44.15:33).



TABLE J-11 (Cont'd) List of More Stringent Items

Item	Requirement Subject	VSMP Regulation Code/BMP Specification		Virginia Beach Public Works Design Standards (PWDS)		Justification for More Stringent Requirement
		Reference	Code/Spec	Reference	Standard/Spec	
1 Cont'd	Channel Protection – Limits of Analysis				point and the mapped edge of the water body listed to provide an accurate tailwater control for design purposes.	
2	Water Quantity - Flood Protection	9VAC25-870-66.C Flood Protection	Concentrated stormwater flow shall be released into a stormwater conveyance system and shall meet one of the following criteria as demonstrated by use of acceptable hydrologic and hydraulic methodologies: 1. Concentrated stormwater flow to stormwater conveyance systems that currently do not experience localized flooding during the 10-year 24-hour storm event: The point of discharge releases stormwater into a stormwater conveyance system that, following the land-disturbing activity, confines the post-development peak flow rate from the 10-year 24-hour storm event within the stormwater conveyance system. Detention of stormwater or downstream improvements may be incorporated into the approved land-disturbing activity to meet this criterion, at the discretion of the VSMP authority. 2. Concentrated stormwater flow to stormwater conveyance systems that currently experience localized flooding during the 10-year 24-hour storm event: The point of discharge either: a. Confines the post-development peak flow rate from the 10-year 24-hour storm event within the stormwater conveyance system to avoid the localized flooding. Detention of stormwater or downstream improvements may be incorporated into the approved land disturbing activity to meet this criterion, at the discretion of the VSMP authority; or	PWDS 8.3.A, PWDS 8.3.D, PWDS 8.3.F, PWDS 8.5.C.1 4, and PWDS 8.2	8.3.1 For each drainage area (contributing to the project or site outfall) less than 300 acres use a 10-year design storm event for capacity design; for a drainage area (contributing to a project or site outfall) equal to or greater than 300 acres but less than 500 acres use a 25-year design storm event; for a drainage area (contributing to a project or site outfall) equal to or greater than 500 acres use a 50-year design storm event. (Note: This requirement is more stringent than the <u>VSMP Regulation</u> and was applicable prior to January 1, 2013). 8.3.D The Hydraulic Grade Line (HGL) must be calculated for all components of the proposed (post-development) conveyance and routed system, including any existing drainage system elements that contribute to or receive drainage from the proposed conveyance and routed system. . . . The HGL calculations shall begin at the point of adequacy in the downstream receiving stormwater conveyance or at the receiving water body, whichever is necessary to establish an accurate tailwater elevation (beginning water surface level) for the HGL calculations. The point of adequacy shall be as determined using these <u>Design Standards</u>. 8.3.F All drainage system designs including SWMFs/BMPs and conveyance systems shall be checked using HGL analysis for flooding of buildings and streets within the project limits, upstream or up-pipe to the upper limits of each drainage area that drains to the project, and downstream or down-pipe of the project limits to the point of adequacy. This analysis must use the 100-year design storm to the downstream point of adequacy, incorporating the tailwater criteria stated in Section 8.3.D Hydraulic Grade Line and Tailwater Criteria. The modeling of flow down streets using dual links is recommended. The lowest floor (as defined in the current <u>Floodplain Ordinance</u>) of a newly constructed building or manufactured home shall be set the minimum distance above the base flood elevation established in the City's Floodplain Ordinance or the same distance above the highest 100-year design storm HGL elevation within the drainage sub-catchment of the building (incorporating the tailwater criteria stated in Section 8.3.D.1 Tailwater Criteria for Projects Draining to Tidally Influenced Waters or Section 8.3.D.2 Tailwater Criteria for Projects Draining to Impoundments, Lakes, SWMFs/BMPs (with no tidal influence), or Non-Tidal Waterways), whichever elevation is higher.	9VAC25-870-66 does not address flat watershed (<2% slope) with tidally influenced waters. In cases where the drainage area for the proposed SWMF or receiving conveyance system is 300 acres or more, the 10-year storm event requirement in 9VAC25-870-66 does not address the larger watersheds within the City. The Stormwater Management Plan for the City of Virginia Beach divides the City into 25 watersheds ranging from 0.60 square miles (384 acres) to 20.11 square miles (12,870 acres), which were evaluated under a 50-year rainfall event coupled with an annual mean high tide. The more stringent requirement to convey the 25- or 50- year storm for larger contributing watersheds prevents further degradation of water resources and addresses localized flooding within the watershed (VA Code 62.1-44.15:33). These more stringent provisions were applicable prior to January 1, 2013.



TABLE J-11 (Cont'd) List of More Stringent Items

Item	Requirement Subject	VSMP Regulation Code/BMP Specification		Virginia Beach Public Works Design Standards (PWDS)		Justification for More Stringent Requirement
		Reference	Code/Spec	Reference	Standard/Spec	
2 Cont'd	Water Quantity - Flood Protection		b. Releases a post-development peak flow rate for the 10-year 24-hour storm event that is less than the predevelopment peak flow rate from the 10-year 24-hour storm event. Downstream stormwater conveyance systems do not require any additional analysis to show compliance with flood protection criteria if this option is utilized. 3. Limits of analysis. Unless subdivision 2 b of this subsection is utilized to comply with the flood protection criteria, stormwater conveyance systems shall be analyzed for compliance with flood protection criteria to a point where: a. The site's contributing drainage area is less than or equal to 1.0% of the total watershed area draining to a point of analysis in the downstream stormwater conveyance system; b. Based on peak flow rate, the site's peak flow rate from the 10-year 24-hour storm event is less than or equal to 1.0% of the existing peak flow rate from the 10-year 24-hour storm event prior to the implementation of any stormwater quantity control measures; or c. The stormwater conveyance system enters a mapped floodplain or other flood-prone area, adopted by ordinance, of any locality.		Adequacy of the downstream system must be demonstrated for all of the following: 1. The downstream system must adequately convey the design storm to the point of adequacy, using freeboard heights and headwater depths stipulated herein and in the referenced documents. The design storm shall either be the 10-year, 25-year, 50-year, or 100-year design storm, whichever corresponds to the each drainage area contributing to its respective project or site outfall, served by the downstream system or type of facility (Critical or non-critical, See Section 8.3.A Design Storms – Minimum Frequency Criteria). 2. When flooding does not exist upstream or downstream of the proposed project, the post-developed HGL may increase provided it does not exceed the rim of structures or top of bank of open conveyance systems. When flooding exists upstream or downstream of the proposed project, the post-development design year HGL (10, 25, 50, or 100 per Section 8.3.A) shall not increase over the pre-development design year HGL (10, 25, 50, or 100 per Section 8.3.A) in all receiving channels and water bodies, as determined using methods described in the <u>VDOT DM</u> and the <u>VSMH</u>. 3. All requirements of the <u>Floodplain Ordinance</u>, <u>SWMO</u>, <u>VDOT DM</u>, and applicable state and federal codes, laws, and regulations shall be met. 8.5.C.14 Positive drainage shall be provided for all SWMF/BMP discharges. Except where there are downstream flow constraints and the proposed (post-development) discharge must be reduced to the capacity of the downstream channel, discharge from a properly designed system shall not exceed the pre-development rate for all storm frequencies up to and including the required design storms. The downstream system from a SWMF/BMP must always be considered in the design process. 8.2 Point of Adequacy (Reference: <u>VDOT DM</u>, see “adequate channel”) - A point in the downstream receiving stormwater conveyance system where it has adequate capacity to convey the design storm discharge under proposed (post-development) conditions to a major water body. Major Water Body- A bay, creek, lake, stream, river, ocean, or other large body of water that receives stormwater runoff and has a base flood elevation determined by the current <u>Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS)</u>, the City Stormwater Master Plan, or other study available from the Storm Water Engineering Center. For tailwater computations the following are	



TABLE J-11 (Cont'd) List of More Stringent Items

Item	Requirement Subject	VSMP Regulation Code/BMP Specification		Virginia Beach Public Works Design Standards (PWDS)		Justification for More Stringent Requirement
		Reference	Code/Spec	Reference	Standard/Spec	
2 Cont'd	Water Quantity - Flood Protection				considered major (receiving) water bodies in the City of Virginia Beach are listing in Table J-12 in Appendix J . When the project does not discharge directly into one of the water bodies listed above and the drainage system is tidally influenced, the designer shall determine the hydraulic grade line (HGL) and/or water surface profile (WSP) between the project discharge point and the mapped edge of the water body listed to provide an accurate tailwater control for design purposes.	
3	Design Storms-Rainfall Precipitation Frequency Data	9VAC25-870-72.A.	Unless otherwise specified, the prescribed design storms are the one-year, two-year, and 10-year 24-hour storms using the site-specific rainfall precipitation frequency data recommended by the U.S. National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Partial duration time series shall be used for the precipitation data.	PWDS 8.3.A, PWDS 8.3.B	8.3.A For each drainage area (contributing to a project or site outfall) less than 300 acres use a 10-year design storm event for capacity design; for a drainage area *contributing to a project or site outfall) equal to or greater than 300 acres but less than or equal to 500 acres use a 25-year design storm event; for a drainage area (contributing to a project or site outfall) greater than 500 acres use a 50-year design storm event. 8.3.B Design storm rainfall depths are generally taken from NOAA Atlas 14 precipitation frequency data. However, precipitation frequency studies undertaken by the City indicate that actual rainfall frequency depths in Virginia Beach are approximately 10% greater than those specified in NOAA Atlas 14. In order to address the need for more accurate design rainfall data and to consider projected increases in rainfall frequency depths over the next 30 years, rainfall depth-duration values were increased by 20% over NOAA Atlas 14 values. These updated design rainfall depths are presented in Table VIII-1 . Refer to the City of Virginia Beach study titled "Analysis of Historical and Future Heavy Precipitation", dated July 24, 2017 (CIP 7-030, PWCN-15-0014, Work Order 9A) for additional information.	Please refer to the City of Virginia Beach study titled "Analysis of Historical and Future Heavy Precipitation," dated July 24, 2017 (CIP 7-030, PWCN-15-0014, Work Order 9A).
4	Design Storms - 24-Hour Rainfall Distribution	9VAC25-870-72.C.	The U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) synthetic 24-hour rainfall distribution and models, including, but not limited to TR-55 and TR-20; hydrologic and hydraulic methods developed by the U.S. Army Corps of Engineers; or other standard hydrologic and hydraulic methods, shall be used to conduct the analyses described in this part.	PWDS 8.3.B, PWDS 8.4.B, PWDS 8.4.C.1, PWDS 8.5.A and PWDS 8.5.B	8.3.B Design storm rainfall depths are generally taken from NOAA Atlas 14 precipitation frequency data. However, precipitation frequency studies undertaken by the City indicate that actual rainfall frequency depths in Virginia Beach are approximately 10% greater than those specified in NOAA Atlas 14. In order to address the need for more accurate design rainfall data and to consider projected increases in rainfall frequency depths over the next 30 years, rainfall depth-duration values were increased by 20% over NOAA Atlas 14 values. These updated design rainfall depths are presented in Table VIII-1 . Refer to the City of Virginia Beach study titled "Analysis of Historical and Future Heavy Precipitation", dated July 24, 2017 (CIP 7-030, PWCN-15-0014, Work Order 9A) for additional	Please refer to the City of Virginia Beach study titled "Analysis of Historical and Future Heavy Precipitation," dated July 24, 2017 (CIP 7-030, PWCN-15-0014, Work Order 9A).



TABLE J-11 (Cont'd) List of More Stringent Items

Item	Requirement Subject	VSMP Regulation Code/BMP Specification		Virginia Beach Public Works Design Standards (PWDS)		Justification for More Stringent Requirement
		Reference	Code/Spec	Reference	Standard/Spec	
4 Cont'd	Design Storms - 24-Hour Rainfall Distribution				information. The design storm depth, duration, and rainfall distribution criteria (1-year through 100-year design storm frequency) are dependent upon the analysis and design methodology to be used. (See Section 8.4.C Methodologies for Stormwater Conveyance System Design and Section 8.5.B Methodologies for Design of SWMMs/BMPs). PC-SWMM® files containing approved rainfall distribution data are available from the Public Works Stormwater Engineering Center. 8.4.B Except for the design of conveyance systems (storm sewers, culverts, channels, ditches, and swales) serving less than 20 acres, where the use of the Rational Method is permissible, design storm rainfall distributions shall be based on the City-modified NOAA Type "C" 24-hour, 25-year rainfall distribution (See Section 8.3.B Design Storm Depth-Duration and Rainfall Distribution Criteria). The shape of the NOAA Type-C 25-year rainfall distribution curve is used to generate all other rainfall distribution curves. PC-SWMM® files that contain the rainfall distribution data are available from the Public Works Stormwater Engineering Center. 8.4.C.1 Drainage Area (Contributing to Each Site Outfall) < 20 acres – The "Rational Method" or allowable methods stated in paragraph b) below, may be used to determine the peak stormwater runoff from each drainage area with less than 20 acres contributing to each project or site outfall. Otherwise, EPA SWMM-based models shall be used for storm sewer system design. a) To obtain rainfall intensities for use with the Rational Method, designers shall refer to the latest rainfall duration-intensity-frequency information for the City of Virginia Beach provided in the <u>VDOT DM</u>, which is based on National Oceanic and Atmospheric Administration (NOAA) Atlas 14 rainfall data. Consistent with the requirements in Section 8.3.B Design Storm Depth-Duration and Rainfall Distribution Criteria, the designer shall utilize the Steel Formula coefficients found in Table J-1 in Appendix J to calculate rainfall intensity.	



TABLE J-11 (Cont'd) List of More Stringent Items

Item	Requirement Subject	VSMP Regulation Code/BMP Specification		Virginia Beach Public Works Design Standards (PWDS)		Justification for More Stringent Requirement
		Reference	Code/Spec	Reference	Standard/Spec	
4 Cont'd	Design Storms - 24-Hour Rainfall Distribution				8.4.C.2 Drainage Area (Contributing to Each Site Outfall) ≥ 20 Acres a. For stormwater conveyance systems receiving ≥ 20 acres of drainage area to each project or site outfall, the City requires drainage system analyses, pre-developed and proposed (post-developed) discharge hydrographs, and designs using EPA SWMM. Alternatively, designers can use a computer program that includes an EPA SWMM engine with Dynamic Routing that can be automatically uploaded into EPA SWMM. 8.5.A (SWMF/BMP Design)- For SWMF/BMP and conveyance system analysis and design, the design storm rainfall distributions (based upon 120% of the City-modified Type "C" 24-hour, 25-year rainfall distribution available from the Public Works Stormwater Engineering Center) shall be used for stormwater conveyance system and routing analysis and design. The shape of the 25-year rainfall distribution curve is used to generate all other rainfall distribution curves. PC-SWMM® files containing the approved rainfall distribution data are available from the Public Works Stormwater Engineering Center. 8.5.B The design methodology selection process for SWMFs/BMPs is as follows: 1. When total land disturbance is less than 20,000 square feet or the proposed impervious area is at least 10% less than the existing impervious area: Designer may use any computer design software that utilizes the 24-hour design storm hyetograph with increased precipitation and the static tailwater provided by the Development Services Center or the Public Works Stormwater Engineering Center. Under these conditions, the requirement to evaluate flooding impacts, upstream and downstream or the proposed project, is waived. 2. All other development projects not included in Paragraph 1 above shall use the following computer programs for hydrologic and hydraulic calculations pertaining to SWMFs/BMPs: a. EPA SWMM, or b. Value enhanced SWMM programs that can directly exchange input data with EPA SWMM. These computer programs are preferred by the City for use in all hydrologic and hydraulic analyses, no matter what size the drainage area is	



TABLE J-11 (Cont'd) List of More Stringent Items

Item	Requirement Subject	VSMP Regulation Code/BMP Specification		Virginia Beach Public Works Design Standards (PWDS)		Justification for More Stringent Requirement
		Reference	Code/Spec	Reference	Standard/Spec	
4 Cont'd	Design Storms - 24-Hour Rainfall Distribution				impacts, upstream and downstream of the proposed project, is waived. 2. All other development projects not included in Paragraph 1 above shall use the following computer programs for hydrologic and hydraulic calculations pertaining to SWMFs/BMPs: a. EPA SWMM, or b. Value enhanced SWMM programs that can directly exchange input data with EPA SWMM. These computer programs are preferred by the City for use in all hydrologic and hydraulic analyses, no matter what size the drainage area is.	
5	Drainage Area Limit for Use of Rational Method for Evaluating Peak Discharges	9VAC25-870-72. Design storms and hydrologic methods, paragraph D.	For drainage areas of 200 acres or less, the VSMP authority may allow for the use of the Rational Method for evaluating peak discharges.	PWDS 8.4.C.1	8.4.C.1 Drainage Area (Contributing to Each Site Outfall) < 20 acres - The "Rational Method" or the allowable methods stated in paragraph b) below, may be used to determine the peak storm water runoff from each drainage area less than 20 acres contributing to each project or site outfall. Otherwise, EPA SWMM-based models shall be used for storm sewer system design.	Use of the NRCS 24-hour hyetograph for areas equal to or greater than 20 acres, instead of the Rational Method, is a more stringent requirement that addresses localized flooding within the watershed. (VA Code 62.1-44.15:33)
6	Drainage Area Limit for Use of Modified Rational Method for Evaluating Volumetric Flows to Stormwater Conveyances	9VAC25-870-72. Design Storms and Hydrologic Methods, paragraph E	For drainage areas of 200 acres or less, the VSMP authority may allow for the use of the Modified Rational Method for evaluating volumetric flows to stormwater conveyances.	PWDS 8.5.B.1, and PWDS 8.5.B.2	The design methodology selection process for SWMFs/BMPs is as follows: 1. When total land disturbance is less than 20,000 square feet or the proposed impervious area is at least 10% less than the existing impervious area: Designer may use any computer design software that utilizes the 24-hour design storm hyetograph with increased precipitation and the static tailwater provided by the Development Services Center or the Public Works Stormwater Engineering Center. Under these conditions, the requirement to evaluate flooding impacts, upstream and downstream of the proposed project, is waived. 2. All other development projects not in Paragraph 1 above shall use the following computer programs for hydrologic and hydraulic calculations pertaining to SWMFs/BMPs: a. EPA SWMM, or b. Value enhanced SWMM programs that can directly exchange input data with EPA SWMM. These computer programs are preferred by the City for use in all hydrologic and hydraulic analyses, no matter the size the drainage area is.	The 24-hour hydrograph provides a more accurate, realistic representation of stormwater runoff patterns for longer duration rainfall events in drainage areas greater than 2 acres. This more stringent provision was applicable prior to January 1, 2013.



TABLE J-11 (Cont'd) List of More Stringent Items

Item	Requirement Subject	VSMP Regulation Code/BMP Specification		Virginia Beach Public Works Design Standards (PWDS)		Justification for More Stringent Requirement
		Reference	Code/Spec	Reference	Standard/Spec	
7	Residential Subdivision Retention and Detention SWMF/BMP Design	BMP Clearing-house Appendix A: Earthen Embank-ment, Section A-7 Embank-ment Geometry	Height: The height of an earthen embankment is based upon the freeboard requirements relative to the maximum water surface elevation during the 100-year frequency storm event.	PWDS 8.5.C.1	All residential subdivision retention and detention SWMF/BMP basins must be designed in such a way that the 100-year storm event rise does not exceed the based flood elevation shown for Zones AE, AH, AO, or AR on the FEMA FIRM maps. To be excluded from this requirement, the ground of the affected residential subdivision must be set a minimum of one (1) foot above the FEMA FIRM base flood elevation.	This more stringent requirement will prevent any further degradation to water resources and address localized flooding within the watershed. (VA Code 62.1-44.15:33) This more stringent provision was applicable prior to January 1, 2013.
8	Principal Spillways	BMP Clearing-house Appendix B: Principal Spillway	Appendix B does not describe how to address tailwater conditions when determining the hydraulic performance of a principal spillway	PWDS 8.5.C.2	Tailwater conditions must always be considered when analyzing the hydraulic performance of an outlet device. Many factors, such as annual high tides, seasonal high groundwater, and flood elevations, will affect tailwater elevations. (Note: This requirement is more stringent than the <u>Virginia Stormwater BMP Clearinghouse Design Specifications</u> and was applicable prior to January 1, 2013.) A backwater check shall be calculated to determine the correct orifice and outlet sizes. See Section 8.3.D Hydraulic Grade Line and Tailwater Criteria for additional guidance.	Most of this city is flat, low-lying and subject to flooding. This more stringent requirement will prevent any further degradation to water resources, reduce excessive stream channel erosion and address localized flooding within the watershed. (VA Code 62.1-44.15:33)) This more stringent provision was applicable prior to January 1, 2013.
9	Wet Pond Minimum Design Depth	BMP Clearing-house Spec No.14 Wet Ponds, Section 5 Physical Feasibility & Design Applications	The depth of a wet pond is usually determined by the hydraulic head available on the site. The bottom elevation is normally the invert of the existing downstream conveyance system to which the wet pond discharges. Typically, a minimum of 6 to 8 feet of head are needed for a wet pond to function.	PWDS 8.5.C.8	The elevation of the normal dry weather water level will not be less than the 10-year design tidal elevation (See Table J-12 Design Tidal Elevations for Virginia Beach) of the downstream major water body. (Note: This requirement is more stringent than the <u>Virginia Stormwater BMP Clearinghouse Design Specifications</u> and was applicable prior to January 1, 2013). This dry weather water level minimizes the destruction of vegetation due to saltwater inundation and will help mitigate the high flood stage or tide impact on the available storage within the SWMF/BMP.	This prevents backflow of saltwater into the proposed retention system that can kill vegetation acclimated to the freshwater environment. This more stringent requirement will prevent any further degradation to water resources. (VA Code 62.1-44.15:33) These more stringent provisions were applicable prior to January 1, 2013.
10	Embankment Slope and Material	BMP Clearinghouse Spec. No. 14 Wet Pond, Section 6.6 Internal Design Geometry	Side slopes for wet ponds should generally have a gradient of 4H:1V to 5H:1V. The mild slopes promote better establishment and growth of vegetation and provide for easier maintenance and a more natural appearance.	PWDS 8.5.C.17 and Standard Drawings B-23, B-24, and B-25	All wet SWMF/BMP retention basins shall conform to the Standard Drawings: 1) B-23 RIP RAP SHORELINE PROTECTION FOR LAKES, PONDS, AND CANALS WITHOUT BENCHING 2) B-24 ACCEPTABLE SLOPE ALTERNATIVE FOR LAKES, PONDS, AND CANALS WITHOUT BENCHING 3) B-25 RIP RAP SHORELINE PROTECTION FOR LAKES,	With high winds in this city the fetch ends of lakes and ponds tend to erode heavily if not protected by riprap stone. This more stringent requirement will prevent any further degradation to water resources (VA Code 62.1-44.15:33). This more stringent provision was applicable to canals, wet ponds and lakes prior to January 1, 2013.



TABLE J-11 (Cont'd) List of More Stringent Items

Item	Requirement Subject	VSMP Regulation Code/BMP Specification		Virginia Beach Public Works Design Standards (PWDS)		Justification for More Stringent Requirement
		Reference	Code/Spec	Reference	Standard/Spec	
10 Cont'd	Embankment Slope and Material				PONDS, AND CANALS WITH BENCHING Bank slopes steeper than 7:1 H:V shall have riprap or other appropriate long-term hardened revetment design for stabilization at the waterline to prevent erosion from wave action. (Note: The requirement for riprap stabilization at the waterline is more stringent than the <u>Virginia Stormwater BMP Clearinghouse Design Specifications</u> and was applicable prior to January 1, 2013). In no case shall side slopes be steeper than 3:1 H:V.	
11		Removal; BMP Clearinghouse Spec. No. 15 Extended Detention Pond Section 6.8 Maintenance Features and Section 9.3 Common Ongoing Maintenance Issues	from the forebay is essential to maintain the function and performance of a pond. ... The designer should also check to see whether removed sediments can be spoiled on-site or must be hauled away.		the City. SWMFs/BMPs may need public easements for staging of maintenance equipment, drying of dredge spoils, or stockpiling of excavated materials. Additionally, 20-foot wide public lake access easements (one (1) for every five (5) acres of lake) shall be dedicated to the City. SWMFs/BMPs greater than 1/4 acre shall provide adequate space near them for spoil or stockpile facilities (needed for maintenance) or provide a public easement on a park site with a minimum of two access pumping easements along the appropriate lot lines. The pump-hose easements must have a minimum width of 10 feet.	sediment loadings and address localized flooding within the watershed (VA Code 62.1-44.15:33). This more stringent provision was applicable prior to January 1, 2013.



J.12 Design Tidal Elevations for Virginia Beach

TABLE J-12 Design Tidal Elevations for Virginia Beach All Elevations in feet relative to the North American Vertical Datum (NAVD) of 1988										
Location	Design Level	1-YR	2-YR	3-YR	5-YR	10-YR	25-YR	50-YR	100-YR	500-YR
Lynnhaven Bay & River, Eastern Branch	Existing Condition	3.1	3.6	4.0	4.4	5.2	5.8	6.2	6.7	8.5
	1.5 ft SLR	4.6	5.1	5.5	5.9	6.7	7.3	7.7	8.2	10.0
	3.0 ft SLR	6.3	6.9	7.3	7.7	8.5	9.2	9.6	10.1	12.0
Lynnhaven Bay & River, Incl. all areas other than Eastern Branch (Western Branch, Broad Bay, Linkhorn Bay, Little Neck Creek)	Existing Condition	3.2	3.9	4.3	4.8	5.5	6.3	6.9	7.4	9.3
	1.5 ft SLR	4.7	5.4	5.8	6.3	7.0	7.8	8.4	8.9	10.8
	3.0 ft SLR	6.4	7.2	7.6	8.1	8.8	9.7	10.3	10.8	12.8
Chesapeake Bay	Existing Condition	3.2	3.8	4.1	4.5	5.2	5.9	6.5	7.1	8.5
	1.5 ft SLR	4.7	5.3	5.6	6.0	6.7	7.4	8.0	8.6	10.0
	3.0 ft SLR	6.4	7.1	7.4	7.8	8.5	9.3	9.9	10.5	12.0
Atlantic Ocean & Rudee Inlet	Existing Condition	3.6	4.1	4.5	4.9	5.4	6.3	6.8	7.3	8.7
	1.5 ft SLR	5.1	5.6	6.0	6.4	6.9	7.8	8.3	8.8	10.2
	3.0 ft SLR	7.2	7.7	8.2	8.6	9.2	10.1	10.7	11.2	12.8
Back Bay, North of Beggars Bridge Creek	Existing Condition	-	-	-	-	2.4	3.4	4.2	4.9	6.4
	1.5 ft SLR	-	-	-	-	3.9	4.9	5.7	6.4	7.9
	3.0 ft SLR	-	-	-	-	7.6	9.0	10.1	11.1	13.2
Back Bay, South of Beggars Bridge Creek	Existing Condition	-	-	-	-	-	2.4	2.8	3.3	4.2
	1.5 ft SLR	-	-	-	-	-	3.9	4.3	4.8	5.7
	3.0 ft SLR	-	-	-	-	-	7.6	8.1	8.8	10.1
North Landing River	Existing Condition	-	-	-	-	-	2.8	3.4	3.9	4.9
	1.5 ft SLR	-	-	-	-	-	4.3	4.9	5.4	6.4
	3.0 ft SLR	-	-	-	-	-	6.3	6.9	7.5	8.5
West Neck Creek at Indian River Road	Existing Condition	-	-	-	-	-	3.0	3.6	4.1	5.1
	1.5 ft SLR	-	-	-	-	-	4.5	5.1	5.6	6.6
	3.0 SLR	-	-	-	-	-	6.5	7.2	7.7	8.8
Elizabeth River	Existing Condition	2.8	3.6	4.1	4.7	5.8	6.5	7.1	7.9	10.3
	1.5 ft SLR	4.3	5.1	5.6	6.2	7.3	8.0	8.6	9.4	11.8
	3.0 ft SLR	5.9	6.7	7.2	7.8	8.9	9.6	10.2	11.0	13.4
Notes:										
1. All elevations sourced from direct sampling and statistical analysis of the distribution of water elevations in each watershed										
2. Lynnhaven, Elizabeth River, and Atlantic Ocean elevations were sourced from the 2015 FEMA Flood Insurance Study										
3. Back Bay and North Landing River elevations were sourced from CIP 7-030, PWCN-15-0014, WO2A										
4. The values do not represent potential wind-driven water levels in the Back Bay and North Landing River										



5. Back Bay, North Landing River and West Neck Creek at Indian River Road tailwater values have been limited to return periods where tailwater elevations are above recurring wind tides. The designer shall use 25-year design tidal elevations for 1-year to 10-year return periods in Back Bay – South North Landing River, and West Neck Creek at Indian River Road.
6. Conditions related to a 3-ft rise in sea level include non-linear increases derived from numerical modeling completed by the U.S. Army Corps of Engineers and the North Carolina Floodplain Mapping Program

J.13 Green-Ampt Infiltration Parameters for City of Virginia Beach

TABLE J-13
Green-Ampt Infiltration Parameters

Soil Texture	Hydraulic Conductivity (in/hr)	Initial Moisture Deficit (fraction)	Suction Head (inches)
Sand	4.74	0.34	1.9
Loamy Sand	1.18	0.33	2.4
Sandy Loam	0.43	0.33	4.3
Loam	0.13	0.31	3.5
Silt Loam	0.26	0.32	6.7
Sandy Clay Loam	0.06	0.26	8.7
Clay Loam	0.04	0.24	8.3
Silty Clay Loam	0.04	0.26	10.6
Sandy Clay	0.02	0.22	9.5
Silty Clay	0.02	0.22	11.4
Clay	0.01	0.21	12.6

Note: Table values developed from Rawls, Brakensiek, and Miller, "Green-Ampt Infiltration Parameters from Soil Data", Journal of Hydraulic Engineering, 109:1316 (1983).



Appendix K

Stormwater Utility Fee Adjustment Program

K.1 Applicability

The Stormwater Utility Fee Adjustment Program provides for a reduction in the fees assessed in accordance with Virginia Beach City Code Chapter 32.5. The adjustment program is applicable to non-residential properties that have functional on-site stormwater management facilities designed, constructed and maintained in accordance with the City of Virginia Beach Public Works Standards. To be eligible for a fee reduction, property owners must enter into a stormwater management facility maintenance agreement with the City of Virginia Beach. A non-residential property may be eligible for a reduction in the stormwater management utility fee assessed for the property based on the following:

Developed non-residential properties employing on-site stormwater management facilities (SWMFs) to provide water quality pollution reductions may be eligible for up to a 30% reduction in the fee.

Additionally, or separately, developed non-residential properties employing on-site SWMFs to provide water quantity reductions may be eligible for up to a 20% reduction in the fee.

Partial fee adjustments; i.e., less than the maximum adjustment, may be made where a SWMF serves less than the total developed area of the property or serves an off-site developed area. In such case the partial adjustment (percent), if allowed, will be equal to the ratio of partial area served by the functional SWMF.

Developed non-residential properties employing off-site SWMFs that serve the non-residential property may be eligible for a reduction under one of the above conditions provided the SWMF is functional, adequately maintained, and legal documentation exists to define maintenance responsibilities of the property owner requesting the adjustment.

No additional fee adjustments will be allowed for SWM facilities that exceed the design criteria, either individually or cumulatively, for design, construction, and maintenance.

Continuation of fee adjustments requires that the SWMF maintains its functionality and a SWMF Maintenance Agreement be recorded.



K.2 Application Procedures

A completed application form and required documents for an adjustment to the stormwater management utility fee must accompany each request. Applications for stormwater management utility fee adjustments are to be submitted to Public Works Engineering:

Department of Public Works Engineering Division
Stormwater Management Regulatory
2405 Courthouse Drive
Virginia Beach, VA 23456

The City will review the application within 60 days, unless extensive modification to the application or extenuating circumstances require additional time. If the application is approved, an approval letter documenting the amount of adjustment approved will be sent to the applicant. If the application is rejected, reasons for rejection will be identified in a response letter to the applicant.

The Stormwater Utility Fee Adjustment Application identifies the minimum information that is required to review an adjustment request. Information provided with the application for stormwater management utility fee adjustments must substantiate that the stormwater management facilities were designed in accordance with Department of Public Works Design Standards, were constructed in accordance with the design, and are maintained in proper working order. Information needed for the on-site SWMFs includes as-built survey information, city-approved engineering design calculations, inspection and maintenance records, and plans and schedules for the continued inspection and maintenance of the SWMFs.

CITY OF VIRGINIA BEACH

APPLICATION FOR STORMWATER MANAGEMENT UTILITY FEE ADJUSTMENT



APPLICANT INFORMATION

Applicant Name:	_____	_____	_____
	Last	First	M.I.
Name of Property:	_____		
Property Address:	_____		
	Street Address		Apartment/Unit #

	City	State	Zip Code
Phone:	() _____		
Email Address:	_____		
Mailing Address:	_____		
Property Parcel ID Number (G-PIN):	_____		
Stormwater Utility Account Number:	_____		

APPLICATION PROCEDURE

Please fill out all sections of this application and mail the application and all attachments to:

City of Virginia Beach Department of Public
Works Stormwater Management Regulatory
Division 3556 Dam Neck Road
Virginia Beach, Virginia 23453

Or email a copy of this application and the attachments to: vbstormwater@vbgov.com

Additional information about the adjustment program can be found in the City of Virginia Beach Public Works Design Standards Manual. For additional support contact the City Engineers Office at (757) 385-4131

APPLICANT CHECKLIST

Please indicate the basis for the application for Stormwater Management Utility Fee Adjustment. **THE APPLICANT MUST INCLUDE ALL OF THE ATTACHMENTS LISTED (CHECK OFF).** If any information is missing from the application package, you will be asked to complete the request and re-submit. Please note that the City reserves the right to request additional information if necessary.

- ☐ **IMPERVIOUS AREA CORRECTION**
 - ☐ Revised impervious area calculations.
 - ☐ Overall Site Map depicting impervious area.
 - ☐ Any other information to substantiate revised impervious area.
- ☐ **NO STORMWATER DISCHARGED TO CITY MS4 OR OTHER WATER BODIES WITHIN THE CITY**
 - ☐ Detailed hydrologic and hydraulic calculations by a licensed engineer substantiating no stormwater discharge.
 - ☐ Current topographic survey of the property.
 - ☐ Any other information to substantiate no stormwater discharge.

APPLICANT CHECKLIST (CONTINUED)☐ **Stormwater Management Facility On-site**

Type of SWMF utilized (check all that apply)

- ☐ Wet Pond
- ☐ Extended Detention Pond
- ☐ Infiltration
- ☐ Bioretention
- ☐ Manufactured BMP
- ☐ Other (Describe) _____
- ☐ Approved Site Plans or as-built construction drawings (signed and sealed by a licensed surveyor or engineer) depicting the site, topographic details, overland flow paths, sizing and specifications of all on-site stormwater management facilities, and all on-site stormwater conveyance features.
- ☐ Detailed hydrologic and hydraulic calculations by a licensed engineer depicting the design and sizing of the on-site Stormwater Management Facilities.
- ☐ Drainage Area map depicting the location and the contributing drainage area of the on-site Stormwater Management Facilities.
- ☐ A copy of a 'Stormwater Management Facilities Maintenance Agreement' between the owner and the City of Virginia Beach. If one has not been filed with the City of Virginia Beach, then one will be required in order to obtain an adjustment to the Stormwater Management Utility Fee.

CERTIFICATION STATEMENTS

Please initial the following statements certifying that you have read and understand each one.

- _____ I hereby certify that the information in this application is truthful and accurate.
- _____ I hereby certify that the credited Stormwater Management Facility will be inspected and maintained and will continuously meet all City standards.
- _____ I hereby certify that the owner is obligated to pay the full Stormwater Management Utility Fee during the application and review process.
- _____ I hereby certify that the City of Virginia Beach must be notified should any destruction or damage occur to any facilities referenced in this application that prevents it from performing as credited.

OWNER OR OWNER REPRESENTATIVE SIGNATURERepresentative Name: _____
Last First M.I.

Signature: _____ Date: _____

OFFICE USE ONLY

Received By: _____ Date: _____

Reviewed By: _____ Date: _____

Approval: ☐ No
☐ Yes

Fee Reduction Percentage: _____