STRUCTURAL DESIGN STANDARDS

I. GENERAL DESIGN CRITERIA

A. OBJECT

The object of these standards is to offer a guide to Engineers doing work for Baltimore County. Only general methods and suggestions are offered to assist the Engineer in establishing proper criteria and methods used. They are not, however, intended to restrict the Engineer in exercising proper engineering judgment in his work. Alternate methods are acceptable, but should be discussed with the Bureau of Engineering and Construction before being used. Proposed design criteria must be submitted to the Bureau of Engineering and Construction for approval prior to commencing the final design.

B. SPECIFICATIONS

In general, the following specifications should be used to establish design criteria.

1. AASHTO *Standard Specifications for Highway Bridges*, Latest Edition.
2. *ACI Building Code Requirements for Reinforced Concrete*, Latest Edition.
3. Baltimore County *Building Code*.
4. AISC *Manual of Steel Construction for the Design, Fabrication and Erection of Structural Steel for Buildings*, Latest Edition.
5. Maryland SHA Division of Bridge Development, *Policy and Procedure Manual* (*PPM*).

C. MATERIALS

All materials used shall be properly noted and applicable specifications cited in general notes on contract drawings or by means of special provisions in specifications. The Bureau of Engineering will approve the use of the appropriate materials specification prior to commencing the final design. Approval will usually be given at the preliminary stage of the project. Sole source materials should be avoided. Specify a minimum of three sources of material for materials not on the approved source of supply list.

D. MATERIAL SPECIFICATIONS

1. **County Projects**: Baltimore County Department of Public Works *Standard Specifications to Construction and Materials*, as amended and updated.

2. **Federal Aid Projects**: Maryland Department of Transportation, State Highway Administration *Standard Specifications for Construction and Materials*, latest edition.

E. DESIGN METHODS AND CONSIDERATIONS

1. Loading and Combination of Loadings to be in conformance with the applicable design specification.

2. Generally, Working Stress design shall be used for Design, and Load Factor Design shall be used for Bridge Inspection Ratings, where this gives a more conservative design. Load Resistance Factor Design (LRFD) will be required for Federal Aid Projects, when the Maryland State Highway Administration requires LRFD for Federal Aid Projects. LRFD will only be accepted for County projects after previous approval of the County for specific projects, usually of longer span bridges.

3. Our preference is to "over-design" sufficiently that a nominal amount of deterioration can be withstood without having to "post" a bridge (reduce the allowable bridge loading). This procedure yields a better life cycle cost and reduces public inconvenience.

4. Live Load for structures along and adjacent to public roads to be **HS25/27** in conformance with SHA Policy and Procedure Memorandum.

5. Allow for a two-inch future-wearing surface.

6. Maryland State Highway Administration Office of Bridge Development Policy and Procedure Memorandums are hereby referenced, where applicable, as part of this Design Manual. Maryland State Highway Administration Office of Bridge Development Structural Standards may be used, but since these are not specifically adopted by Baltimore County, these must be reproduced on the contract drawings, if used, and as permitted by the Maryland State Highway Administration.

F. BRIDGE WIDTH

Minimum bridge roadway width shall be in accordance with AASHTO Standards, but in no case shall be less than 24 feet, unless otherwise approved by the Director of Public Works.

G. BRIDGE HYDRAULIC CONSIDERATIONS

Reference is made to **Storm Drainage Design Section IV B** for bridge hydraulic considerations, including geometric layout, size, and protection of embankments, footings, and scour.

II. TYPES OF STRUCTURES

A. GENERAL

Before any particular type of structure is chosen for a specific job, the engineer must make a careful study of the economic and aesthetic considerations governing the final selection of a design. All of the factors must be studied and alternatives considered in the preliminary design stages. In the preliminary

submission the engineer should cite reasons for his final recommendation with all supporting data.

B. FOUNDATIONS AND RETAINING WALLS

1. Subsurface Investigations – See applicable SHA *Policy and Procedure Manual* (*PPM*). A foundation report based on borings is usually to be required after the **Type, Size, and Location** (**TS&L**) of the Structure are approved.

2. General Design Features

   a. Bearing Capacity – Bearing Capacity shall be obtained from actual boring blow counts as shown in the SHA *PPM*. Boring locations shall be per SHA *PPM*. A presumptive bearing capacity without borings shall only be used for small walls of less than four feet of reveal that are also less than 50 feet in length. The presumptive bearing capacity shall not exceed 2500psf.

   b. Scour- Scour shall be considered in accordance with SHA *PPM*. Bottom of footing elevations and/or pile tip elevations shall take scour in to account.

   c. Piling – Piling or Drilled Shafts shall be considered where required by lack of bearing capacity for spread footings or scour considerations. A cost comparison between a spread footing and pile-supported structure may be required.

   d. Earth Pressure – Earth pressure acting on walls and underground structures shall be computed using Rankine's formula. The unit weight and friction angle of earth are recited in the applicable specifications. In the absence of more exact investigation these should be used. The surcharge and drainage provisions must be considered when selecting coefficients and weights of earth for Rankine's Formula. Weep holes and a drainage system shall be provided when the length of wall exceeds 15 feet.

   e. Stability - **Factor of Safety for Overturning** shall be a minimum of 2.0 and the **Factor of Safety for Sliding** shall be a minimum of 1.5. The Resultant Force shall be within the middle third of the footing. Backfill in front of toe shall be ignored for sliding. Additionally, **Global Slope Stability** shall be computed by the designer, and found acceptable by the Bureau of Engineering and Construction (F.S.=1.5 preferably), if the slope continues above and/or below the proposed wall, if there are stepped walls, if there is a building or other source of vertical load or surcharge horizontally closer to the wall face than the height of the wall, or if there is reason to have saturated earth in the vicinity such as a stream or pond.

   f. Proprietary Walls – Proprietary Walls (walls constructed of proprietary components using proprietary procedures) in non-stream locations will be considered in accordance with SHA *PPM*'s. Proprietary Walls near

stream locations or ponds will generally not be considered because scour, or fines washing through wall openings, or saturated ground may undermine the integrity of component type walls, especially those with shallow foundations. Proprietary walls shall also be avoided in cases where tiebacks, geogrids, etc., may interfere with existing or future utility trenches. Upon completion of construction of a proprietary wall, the designer shall prepare a written field investigation report with photographs, signed and sealed by a registered Maryland Professional Engineer, stating that the wall has been constructed according to the approved plans and in his view is acceptable. The report shall be submitted to the Bureau of Engineering for approval before the wall is accepted.

g. Retaining Walls for Development purposes, done at a Developer's expense, shall be constructed wholly outside County Right-of-Way. No part of the wall shall be closer to County Right-of-Way than the height of the wall unless specifically approved by the Bureau of Engineering and Construction.

h. A safety rail or guard for pedestrians may be required in conformance with the Baltimore County Building Code.

C. PRECAST CONCRETE BOX CULVERTS

1. Precast box culverts may be used where there is a time restraint on construction, a desire to minimize detour time, or other valid reason.

2. Headwalls and wing walls shall be cast in place unless approved otherwise by the Bureau of Engineering and Construction.

3. Longitudinal tie rods, or other approved devices, shall be provided to maintain the integrity of the box culvert system unless approved otherwise by the Bureau of Engineering and Construction.

D. BOTTOMLESS ARCHES

1. Corrugated metal bottomless arches are not permitted unless with the specific permission of the Director of Public Works.

2. Precast Concrete Bottomless Arches such as those by Conspan, BEBO, or HySpan may be used provided all design criteria for scour is addressed per SHA *PPM* D-91-42 (4), and headwalls and wing walls are cast in place.

E. PUMPING STATIONS AND PIPES

1. Buildings

a. The exterior appearance of pumping station buildings should be architecturally compatible with the surrounding dwellings and structures.

b. The operating floor level should be at least two feet above flood level.

c. Buildings shall be designed with the necessity of installing and removing equipment borne in mind.

d. Standard grating and non-skid plates should be used wherever necessary.

e. Suitable handrails must be provided around openings, elevated platforms and stairways.

2. Substructure

a. Basements and tanks must be designed to withstand the pressure exerted on them by earth on one side and water on the other. It is important to note that these forces are not necessarily coincident and the structure must be designed to withstand all combinations of loading. When computing earth pressure on the outside walls, bear in mind that there is no drainage through the wall and it must withstand the full hydrostatic pressure of impounded water.

b. When tanks are designed, consideration must be given to the various types of restraint at the top and bottom of the tank so that the most economical design can be made.

c. All underground tanks and structures must be checked for flotation. When making this check, assume that the tank is empty and check its equilibrium against rising. The upward force would be equal to the volume multiplied by the weight of water per unit volume. The forces resisting this upward force would be the dead load of the structure plus the weight of the wedge of earth included in a plane 15 degrees away from the vertical around the base slab.

d. All base slabs shall be extended past the walls by a minimum of six inches whether cast in place or precast. A factor of safety of 1.25 should be assumed for safe design against flotation. Proper investigation should be made to determine the high water level when checking stability of the structure against flotation. If the high water level data is not available then it can be assumed that the high water level is at the elevation of existing grade at the operating floor level.

e. Since a pumping station and other underground structures are designed to resist flotation only when the complete superstructure and backfill is in place, some provision should be made to prevent flotation during construction.

F. BRIDGES

1. As previously stated, the County generally follows the MD DOT SHA *Policy and Procedure Manual* for structural design. With regard to Formal Review Stages of Projects, the County may combine some of the review stages for

smaller projects. The Consultant shall respond on a point-by-point written response basis to all comments.

2. The County will consider Concrete, Prestressed Concrete, and Steel Bridges. The selection of structural material shall consider cost, esthetics, and ease of construction. Material shall be as maintenance free as possible. The use of Weathering Steel may be considered in non-splash zones or in areas not known to be detrimental to Weathering Steel. If prestressed concrete box beams are recommended, they shall have a membrane waterproofing system over them, or equivalent waterproofing, and be connected with tie rods, or other approved means.

3. The Consultant shall provide all required environmental permits, historical surveys, hydraulics and hydrology, right-of-way mosaics and/or plats, geotechnical studies, etc.

4. CADD Standards shall also be per County (See **CADD Section**) and SHA (for Federal Aid projects) guidelines as applicable for the project. Please note, however, that electronic submittals to the County shall be in AutoCad rather than MicroStation format in all cases. County-provided background shall be used. A disk for the background shall be supplied to the Consultant with CADD information in AutoCAD format.

5. Structural Design and/or Analysis Computer Programs – STRUDL and STADD are accepted. Other programs must receive prior written approval before use, have a list of assumptions made, and documentation for the program provided to this office.

6. Where SHA Standard Details are used, they must be reproduced as part of provided contract drawings. In this way, our inspectors will have these Details available during construction.

7. Soil Borings shall be shown on the contract drawings.

8. Esthetics shall be considered. Use of form liners and other esthetic treatments is encouraged if compatible with the area and the expense can be justified.

9. Rehabilitation of existing bridges – This item RESERVED for future use.

G. BRIDGES ON SCENIC OR HISTORIC ROADS

This item RESERVED for future use.