July 2010

SITE UTILITY DESIGN MANUAL

Including Sanitary

For:

- New Hospitals
- Replacement Hospitals
- Ambulatory Care
- Clinical Additions
- Energy Centers
- Outpatient Clinics
- Animal Research Facilities
- Laboratory Buildings

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CHAPTER 1: BASIC REQUIREMENTS

1.1 PERTINENT STANDARDS

The Site Utility Design Manual replaces an older Site Sanitary Design Manual produced by the Department of Veterans Affairs, Office of Construction and Facilities Management. This new site utility design manual aims to create a composite site utility plan that coordinates those utilities that normally fall under the responsibility of the civil engineer and other site utilities such as steam distribution, site power distribution, and telecommunications.

The site utility design must be compatible with the site development plan and coordinate with the requirements in the Site Development Design Manual. The Site Development Design Manuals deals with issues such as development density, parking capacity, pedestrian and vehicular circulation, storm water management and design, hardscape design, and other related issues.

The site utility plan coordinates the design activities of the steam distribution system, electrical power and site lighting, telecommunications and other work that fall outside of building boundaries. While reviewing the site utility design requirements, the civil engineer must also review the electrical, steam distribution, site development, fire protection, and telecommunications design manuals for additional site requirements.

Note: The A/E shall submit to the VA a list of all applicable documents, posted in the TIL, listed below along with the dates that were in effect on date of contract award.

Major standards are described in this section.

1.1.1 DESIGN MANUALS (PG-18-10)

Located in Technical Information Library (TIL)
http://www.cfm.va.gov/til/

Purpose
Conveys the general and specific VA design philosophy for medical and support facilities.

The manuals accomplish this by:

- Explaining specific design methodologies.
- Listing acceptable system types.
- Codifying certain code interpretations.
- Listing values for design parameters.
- Referencing certain sections of the Master Specification and Standard Details.
- Containing examples of certain design elements.

1.1.2 DESIGN SUBMISSION REQUIREMENTS (PG-18-15)

Located in Architect/Engineer Information
http://www.cfm.va.gov/til/

Purpose
Provides a staged list of tasks in various design categories to define the A/E scope and assure thorough and timely completion of the final design package and bid documents.

The instructions accomplish this by:

- Progressively listing tasks at Schematic, Design Development, and Construction Documents stages.
- Requiring task completion and submission for each stage according to a Critical Path Method (CPM) calendar.
- Requiring implementation of a QA/QC process to assure a quality design product.
- Requiring life-cycle analysis of alternatives in order to optimize the design/cost tradeoff.
- Listing and detailing all the drawings, calculations, and specifications required for a complete design package.
- Indicating the final distribution of bid documents.

Note: The A/E shall submit specifications at the Construction Documents (CD1) submittal to include an electronic version of the VA Master Specifications with tracked changes or modifications displayed.

1.1.3 MASTER SPECIFICATIONS (PG-18-1)

Located in Technical Information Library (TIL)
http://www.cfm.va.gov/til/

Purpose
Defines a standardized method for the A/E to assure that the contractors provide equipment and systems that meet the design intent in terms of performance, quality, and cost.

The specifications accomplish this by:

- Providing specific narrative descriptions of required equipment, salient elements, and system construction.
- Listing applicable standards and codes and references.
- Requiring individual submittal of equipment and systems for review and approval prior to contractor purchase.
- Defining specific installation methods to be used.

1.1.4 ARCHITECT ENGINEER REVIEW CHECKLIST

Located in Technical Information Library (TIL)
http://www.cfm.va.gov/til/

Purpose
Provides the VA Peer Reviewer with a minimum list of critical items which must be included in each A/E submission.

The checklist accomplishes this by:

- Referring to all VA design tools which pertain to the specific project.
- Detailing certain life safety and coordination requirements.

1.1.5 DESIGN ALERTS

Located in Technical Information Library (TIL)
http://www.cfm.va.gov/til/

Purpose
Communicates current design issues and solutions.

The design alerts accomplish this by:

- Publishing periodic alert memos.
- Summarizing design solutions.

1.1.6 QUALITY ALERTS

Located in Technical Information Library (TIL)
http://www.cfm.va.gov/til/

Purpose
Communicates quality deficiencies from recent A/E design submissions.

The quality alerts accomplish this by:

- Publishing checklists of design details often missed.
- Including references to technical resources.

1.1.7 DESIGN GUIDES (PG-18-12)

Located in Technical Information Library (TIL)
http://www.cfm.va.gov/til/

Purpose
Provides the designer with specific layout templates and medical equipment lists for all types of spaces/uses and specific design parameters for structural, electrical and mechanical service.

The design guides accomplish this by:

- Publishing design information.
- Including functional diagrams and layout plates.
- Listing standards.

1.1.8 DESIGN AND CONSTRUCTION PROCEDURES (PG-18-3)

Located in Technical Information Library (TIL)
http://www.cfm.va.gov/til/

Purpose
Establishes minimum consistent design/construction practices.

The procedures section accomplishes this by:

- Referencing applicable codes and policies.
- Describing standard drawing formats.
- Listing security strategies.

- Including miscellaneous design details.

1.1.9 NATIONAL CAD STANDARDS (NCS) AND DETAILS (PG-18-4) AND CAD DELIVERABLES GUIDELINES (PG-18-4)

Located in Technical Information Library (TIL)
http://www.cfm.va.gov/til/

Purpose
Promotes standardization of CAD documents submitted to the VA Authorities.

The standards section accomplishes this by:

- Providing downloadable equipment schedules.
- Listing symbols and abbreviations.
- Providing downloadable standard details in .dwg or .dwf format.
- Providing guidelines for preparing CAD drawings.

NOTE: The A/E shall utilize the VA Standard Details to the fullest extent possible. A modification to a Standard Detail requires the approval of the VA Authorities.

1.1.10 PHYSICAL SECURITY DESIGN MANUAL FOR VA FACILITIES – MISSION CRITICAL FACILITIES AND LIFE SAFETY PROTECTED FACILITIES (FORMERLY CD-54)

http://www.cfm.va.gov/til/

Purpose
Sets physical security standards required for facilities to continue operation during a natural or man-made extreme event and for facilities that are required to protect the life safety of patients and staff in an emergency.

The manuals accomplish this by:

- Setting objectives for physical security.
- Providing strategies for use in design and construction to provide protection to VA facilities.
- Providing cost-effective design criteria.

1.1.11 COST ESTIMATING MANUAL

Located in Cost Estimating
http://www.cfm.va.gov/til/

Purpose
Conveys the general and specific VA cost estimating philosophy for medical facilities.

The manual accomplishes this by:

- Explaining specific estimating methodologies.
- Providing examples of certain design elements.

1.1.12 SUSTAINABLE DESIGN FOR DESIGN AND CONSTRUCTION OF VHA FACILITIES, VBA FACILITIES, AND NCA FACILITIES

Purpose
Incorporates sustainable design practices to improve the building environment and to provide cost savings for long-term building operations and maintenance.

The manual accomplishes this by:

- Prescribing the use of integrated design practices.
- Providing strategies for optimization of energy performance.
- Providing strategies for protection and conservation of water resources.
- Providing strategies for enhancement of indoor environmental quality.
- Providing strategies for reduction of environmental impact of materials.

1.1.13 SEISMIC DESIGN REQUIREMENTS (H-18-8)

Located in Technical Information Library (TIL)
http://www.cfm.va.gov/til/

Purpose
Sets the requirements for seismic design in new facilities and for rehabilitation of existing facilities.

The manual accomplishes this by:

- Defining critical and essential facilities.
- Prescribing code compliance with modifications.
- Prescribing occupancy categories.

1.1.14 FIRE PROTECTION DESIGN MANUAL

Located in Technical Information Library (TIL)
http://www.cfm.va.gov/til/

Purpose
Provides the fire protection engineering design criteria for all categories of VA construction and renovation projects.

The manual accomplishes this by:

- Mandating code and standard compliance.
- Defining water supply requirements.
- Defining fire extinguishing and fire alarm system requirements.

1.2 COMPUTER AIDED FACILITIES MANAGEMENT REQUIREMENTS (CAFM)

The VA intends to implement Computer Aided Facility Management (CAFM) systems in all new and replacement hospital construction, and as feasible in all existing hospitals. The CAFM concept requires that all pertinent data regarding a facility be contained in a master digital database, accessible by facilities personnel at their workstations for use in operations,

energy/cost management, and maintenance and for planning modifications in facility infrastructure due to space utilization changes.

In Appendix 1-A, additional information about format, utilization, and calculations is given.

APPENDIX 1-A: COMPUTER AIDED FACILITIES MANAGEMENT

1-A.1 CAFM AND EQUIPMENT SCHEDULE UTILIZATION

1-A.1.1 INTRODUCTION

The requirement for access to a master digital database necessitates the compilation all architectural/engineering design data (plans, specifications, calculations, equipment selections, equipment submittal, commissioning/balance reports, and both hard copy and electronic job-related communications) in a digital, electronic format throughout the project. This need for digital data will affect the requirements for submission (see Design Submission Requirements).

1-A.1.1 SUBMISSION REQUIREMENTS

Although the VA is still finalizing software requirements for the ultimate CAFM configuration, the A/E shall begin the digital submission process now.

1-A.1.2 SCHEDULES

(a) The equipment and other schedules, which previously appeared in the VA TIL under the National CAD Standards as either .dwf or .dwg files, have been converted into Excel spreadsheet files (.xls), and are still located in the CAD section of the TIL. The schedules shall be downloaded for use.

(b) The schedules are similarly arranged to promote consistent data presentation. Notes for special requirements are listed below the schedules. Roll the cursor over column headings to display pop-up notes containing recommended methodologies for determining how to populate the columns. Several columns are initially hidden for use later in the design/construction and maintenance process.

(c) Use the schedules initially for equipment selection and listing. Completed schedules can then be inserted into project CAD drawings. Copies of the Excel files will be given to the successful contractor to fill in data from approved submittals, equipment suppliers, or bills of material. These modified schedules will then be inserted into the final as-built CAD drawings, to become part of the ultimate CAFM database. The facilities management group can then reveal the hidden columns for their purposes.

(d) The A/E Submission Requirements include full calculation sets for equipment selections. These calculations will also appear in the pop-up data boxes to provide easy access when used later in the CAFM system.

CHAPTER 2: SCOPE OF SITE UTILITY DESIGN

2.1 BASIC DESIGN PARAMETERS

2.1.1 EXISTING AND NEW SITE UTILITIES

Show all existing and new site utilities on all utility plans. For clarity of the design of the specific utility systems, the engineer may elect to indicate the specific design for the utility system on separate plan sheets. However, each plan sheet shall indicate the appropriate horizontal and vertical relationship between all utilities. The following underground systems will be included, and shown on the site utility drawings:

- Site utility tunnels and vaults
- Potable water distribution, pumping and storage
- Fire protection water distribution, pumping and storage
- Sanitary sewer system
- Storm drainage system
- Reclaimed/reuse water distribution, pumping and storage
- Chilled water distribution
- Irrigation water distribution, pumping and storage
- Natural gas distribution system
- Oil and fuel systems
- Duct banks, vaults and conduit systems
- Hot water distribution (for horizontal alignment information only)
- Steam system distribution (for horizontal alignment information only)
- Street lighting, area lighting and traffic signal systems
- Aerial power and communications systems

2.1.2 ESTIMATED QUANTITY OF ROCK EXCAVATION

Where rock excavation is anticipated, indicate estimated quantity, in cubic yards (cubic meters), of rock excavation for each new utility on drawings. This shall be based on the geotechnical report and the required trench configuration. Allowance shall be provided for installation requirements and trench safety, and shoring. Only rock as defined in Master Specification 31 20 00, EARTH MOVING (02200, EARTHWORK), paragraph, Measurement and Payment for Rock Excavation, shall be included in the calculations.

2.1.3 OWNER OF UTILITY SYSTEM

Indicate on the drawings the owner of all utility systems that are not owned and operated by the VA. Provide contact information for all non-VA utilities.

2.1.4 MINIMUM DEPTH OF COVER

Indicate by notes on drawings or detail section, the minimum depth of cover required over each specific utility system. Minimum cover for all utilities under traffic areas shall be 3 feet (915 mm). Top of potable water, chilled water, fuel and gas lines and appurtenances shall be at least 1 foot (300 mm) below frost penetration. The minimum depth of sanitary sewer lines at the terminus point shall be 4 feet (1.22 meter). Where practical, top of sewers shall be at least 1 foot (300 mm) below frost penetration. Where such depth below is not practical, provide freeze protection and/or supporting foundations to a depth below the frost line and securely fasten sewer to foundation.

2.1.5 JOINT TRENCHES

Generally, do not install more than one utility system in the same trench. However, do to site constraints and value engineering concepts, joint trenches will be evaluated by the government on a per case basis. Prior to approving any joint trench, the engineer shall document that the use of the joint trench will not negatively impact the utility system, adequate clearances are provided for the operation and maintenance of the systems, and that the joint trench will not pose any constructability constraints.

2.1.6 TRENCHLESS TECHNIQUES

When specific site conditions warrant, the engineer shall consider trenchless techniques for the installation of new utilities and the rehabilitation of existing utilities. Trenchless techniques included directional boring, jack and bore, micro-tunneling, pipe bursting, and cured in-place pipe. Such techniques shall be evaluated on a cost-benefit basis, including the initial construction costs, mitigation of interruptions of service, negative impacts of other site functions, and longevity of the system. Trenchless construction will be evaluated by the government on a per case basis. Prior to approving any trenchless technique, the engineer shall document that the use such techniques will not negatively impact the utility service life or capacity. The carrier conduit (pipe conveying the fluid or cabling system) shall be meet or exceed the parameters for the piping system as specified in the Master Specifications.

2.1.7 HORIZONTAL CLEARANCE

Maintain a horizontal clearance between potable water mains and gravity flow sanitary sewer/sanitary sewer force mains of at least 10 feet (3.05 meters). The horizontal clearance between potable water mains and sanitary sewer mains may be reduced to 6 feet (1.83 meters) when: local conditions prevent a horizontal clearance of 10 feet (3.05 meters), the water main invert is a minimum of 18 inches (450 mm) above the crown of the sewer, and the water main is in a trench, separated by undisturbed soil.

When the specified horizontal clearance cannot be met, the water main shall be constructed with mechanical joint ductile iron pipe per Specification 33 10 00 – Water Utilities, and the sanitary sewer shall be constructed with mechanical joint pressure rated ductile iron pipe per Specification 33 30 00 – Sanitary Sewage Utilities. Horizontal clearances shall comply with the requirements of the State Health Department, Department of Environmental Quality, or agency governing the installation of potable water mains and systems.

Maintain a horizontal clearance of at least 6 feet (1.83 meters) between potable water mains and reclaimed/reuse and chilled water mains.

Maintain a horizontal clearance of at least 5 feet (1.52 meters) between potable water mains and storm sewers.

Maintain a horizontal clearance of at least 3 feet (920 mm) between duct banks and piped utilities.

The horizontal clearance shall be measured between the outside dimension of the pipe, duct bank, or structure.

VERTICAL CLEARANCE

Maintain a minimum vertical clearance of at least 1 feet (305 mm) between all utilities at crossings. At crossings of potable water mains and sanitary sewers, storm sewers, force mains, reclaimed/reuse mains, or chilled water mains, where the potable water main crosses above the other utility, the minimum vertical separation shall be 2 feet (610 mm), or as required by the State Health Department, Department of Environmental Quality, or agency governing the installation of potable water, whichever is greater.

Where 2 feet (610 mm) cannot be maintained or where potable water lines cross under gravity sewers, reclaimed/reuse mains, or chilled water mains, additional protection shall be provided as required by the agency governing the installation of potable water. Additional protection shall consist of constructing both piping systems with ductile iron pipe with restrained mechanical joints or use of concrete encasement. The additional protection shall extend a minimum distance of 10 feet (3.05 meters) outside the limits of the crossing.

Sanitary sewer force mains shall only cross under potable water mains with a minimum vertical clearance of 2 feet (305 mm). When the vertical clearance between the potable water main and the force main is fewer than 6 feet, both the water main and the force main shall be constructed or restrained mechanical joint ductile iron pipe as indicated above for additional protection.

The preferred vertical clearance between duct banks and piped utilities shall be 2 feet (305 mm) and the minimum vertical clearance shall be 18 inches (460 mm).

The minimum vertical clearance to all steam, pumped condensate, and hot water, and other utilities shall be at least 2 feet (1.83 meters). When this vertical clearance cannot be maintained, the insulation thickness on the steam, condensate, or hot water main shall be increased by 50%.

The vertical clearance shall be measured between the outside dimension of the pipe, duct bank, or structure. For insulated piping, the clearance shall be measured to the outside of the insulation.

At utility crossing where adequate compaction of the shading and bedding material cannot be obtained, use flowable fill in the zones were compaction is impossible or impractical.

2.2 CONTRACT DRAWINGS

2.2.1 GENERAL REQUIREMENTS

All existing and new utilities shall be indicated on "CU-Series" drawings (see VA Design and Construction Procedures, “Drawings,” and the VHA National CAD Standard Application Guide). The “CU-Series” drawings shall be utilized to evaluate potential utility conflicts between various existing and new utility systems.

All site utility design, potable and fire protection water distribution, water storage, water pumping, groundwater wells, sanitary sewer collection, force mains and pumping, storm drainage, reclaimed/reuse water distribution and storage, chilled water distribution, irrigation water distribution and storage, gas distribution, oil and fuel systems, and duct banks shall be indicated on the “CU-Series” drawings.

Design of steam and hot water distribution systems shall be indicated on the “MS-Series” drawings. The horizontal alignment of the steam and hot water distribution systems shall also be shown on the “CU-Series” drawings. At crossings of new and existing utilities, the inverts and/or the vertical clearance between the utilities shall be indicated on the plan view or the vertical profile of the utility system.

Design of duct banks for power and telecommunications shall be indicated on the “CU-Series” drawings.” Cabling and hardware for the power and telecommunications distribution systems shall be indicated on the “ES-Series” and “T-Series” drawings, respectively.

Design of building foundation drains shall be shown on the “A-Series” drawings and details for the foundation drains shall not be shown on Site Utility ("CU-Series") drawings. However, the design of all lift stations and piping from the low point of the foundation drainage system to the storm sewage system or point of discharge shall be indicated on the “CU-Series” drawings.

2.2.2 HORIZONTAL SCALE

Provide all utility plan drawings, plan profile drawings, at the same horizontal scale as the site plans (“C-Series”) landscape and irrigation plans ("LI- and L -Series") drawings. Details for the utility plans may be indicated at a larger scale. The minimum scale shall be 1” = 40’.

2.3 CALCULATIONS AND REVIEW SUBMITTALS

Submit calculations required under the contract to include the following systems:

Cathodic Protection	Storm Drainage
Water	Gas
Irrigation	Pumps
Sanitary Sewage	Oil and Gasoline Supply

CHAPTER 3: SITE UTILITY SYSTEMS AND EQUIPMENT

3.1 CATHODIC PROTECTION

3.1.1 CATHODIC PROTECTION ANALYSIS

Submit a cathodic protection analysis (see section 3.1.3) with recommendations at the first review when ferrous piping, tanks, conduits, and appurtenances are to be installed in direct contact with the soil. The design team should coordinate the requirements to establish the existing soil parameters with the project geotechnical investigation.

Cathodic protection for ferrous piping, tanks, conduits, and appurtenances shall be designed in accordance with NACE International Standards. The analysis shall consider coating, lining, passive and induced current systems. The evaluation of the systems shall consider the initial and long-term operational cost, risk of damage during installation, and in-situ verification of the system. Cathodic protection systems for underground storage tanks (UST) containing fuels or other regulated substances shall comply with all federal and state Environmental Protection Agency (EPA) rules and regulations.

3.1.2 CORROSION PROTECTION

Corrosion protection of ductile iron piping, fittings, and appurtenances shall be designed in accordance with the Ductile Iron Pipe Research Association (DIPRA) publication, “The Design Decision Model for Corrosion Control of Ductile Iron Pipe.”

3.1.3 EXISTING CATHODIC PROTECTION

Contact the VA Medical Center's engineering personnel, and conduct site surveys to determine the type and extent of existing cathodic protection systems. For a new site, contact the previous owner, owners of adjacent property, and local utility companies for information of cathodic protection systems in operation that could affect the project design.

The site survey shall review the configuration of adjacent overhead power lines, light rail transportation systems, and other conditions that could generate stray currents.

When modifying or rerouting existing utility systems equipped with cathodic protection system, the analysis and design shall include the impact on the overall existing system. Insertion of sections of non-metallic piping sections within a ferrous piping system can have profound impacts on the existing system.

3.2 WATER SUPPLY

3.2.1 POTABLE WATER DEMANDS (Average Daily Demand)

If meter readings are not available for similar functions, average daily water demands, under normal operating conditions, shall be determined using the following:

(a) Hospitals: 300 gallons (1140 liters) per day per bed.

(b) Laundry: Daily flow shall be based on 2.5 gallons (21 liters/kg) per pound of laundry.

(c) Ambulatory Care and Clinical Additions: Daily flow shall be based on 0.40 gallons per day per square foot (19.57 liters per day per square meter).

(d) Energy Centers: Based on the ultimate cooling and heating capacity plus a 10% contingency for other plant activities. The average daily demand shall be the larger of the average daily demand during the peak cooling month or the average daily demand during the peak heating month.

(e) Existing Irrigation Systems: For existing irrigation systems, the demands shall be based on established irrigation controller operation, or flow metering. If such data is unavailable, the demand shall be based on a Blaney-Criddle consumptive use water balance model or other acceptable technique.

(f) Fire: The minimum fire demand shall not be less than 120,000 gallons (450 kL). The total fire demand shall be as determined by NFPA 1, Uniform Fire Code. Refer to Article 3.3.2 for unfavorable conditions that may increase the fire demands.

3.2.2 POTABLE WATER FLOW (DESIGN FLOW RATES)

If flow rate metering and data is not available for similar functions at the facility, the following flow rates shall be utilized:

Average daily domestic flow rate for hospitals, ambulatory care, clinical additions, and outpatient clinics in gpm (liters/second) shall be determined by assuming 80% of the average domestic daily demand occurs in 16 hours (divide average domestic daily demand, in gallons, by 1200).

Peak hourly domestic flow rate for hospitals, ambulatory care, clinical additions, and outpatient clinics shall be three times the average daily domestic flow rate.

Fire flow for existing facilities shall be based on the established fire requirement for the facility with the largest fire demand. For new facilities, the fire flow shall be based on the design of the building sprinkler system with the acceptable hose stream requirement. The minimum flow to hydrants connected to the distribution system, for non-sprinkled facilities shall be 1,500 GPM. The total fire flow rate shall be as determined by NFPA 1, Uniform Fire Code. Refer to Article 3.3.2 for unfavorable conditions that may increase the fire flow requirements.

Average daily flow rates for energy centers shall be determined based on the average daily demand during the peak month (total heating, cooling, and energy production), assuming that 90% of the demand occurs over a period of 20 hours. The peak hourly flow rate for energy center shall be two times the average daily flow rate.

Average daily flow rate for irrigation systems shall be determined based on the average daily demand during the peak month, assuming that 90% of the demand occurs over a period of 10 hours. The peak hourly flow rate for irrigation systems shall be two times the average daily flow rate.

3.2.3 NON-POTABLE WATER DEMANDS

The water quality of reclaimed/reuse water and surface waters varies significantly between communities. The variations in the water quality can significantly affect the cycles, blow-down ratios, and water treatment programs for cooling towers and nitrate loading of landscape areas. Prior to utilizing non potable water sources, the engineer shall obtain and analyze the anticipated water quality, seasonal variations, and recommend specific demand and flow rates in keeping with the parameters set forth for potable water. If a non-potable water source is

utilized, the demands and flow rates discussed for potable water shall be adjusted for the anticipated water quality and utilized for the basis of design.

3.2.4 POTABLE WATER SOURCES

Connections to an adequate public water system for the site is preferred. A minimum of two connections to the public water system are required. Each connection shall be configured with adequate valving to isolate the water source so that in the event of line failure or operational shutdowns in off-site or on-site portions of the water distribution system, the second source will be available. Each connection shall be sized for the total design flow.

Based on an assessment of the public water system, the selection of the supply points/connections to the public water system for the site shall be based on the hydraulic capacity of the public system and shall provide the best redundancy for the on-site water system. The engineer shall contact the public water system operators and consider planned expansions/upgrades of the public water system in the assessment.

The connection to the public water system, metering, backflow/cross connection protection, and off-site main extensions shall be in accordance with the rules and regulations of the public water company. At connections where backflow prevention is required, the backflow assemblies shall be reduced pressure devices. At each point of connection two backflow assemblies shall be installed in parallel to facilitate annual testing and maintenance of the assemblies while not interrupting the water supply.

If an adequate public water supply is not possible, an alternate water source shall be developed. Alternative water sources include groundwater wells, augmentation of the off-site public water system, and/or on-site storage. In the evaluation of ground water wells, the analysis shall include the anticipated water quality, required water treatment to comply with current and projected standards of Safe Drinking Water Act, water rights, geo-hydrologic impacts, and potential migration of known pollution within the aquifer.

The engineer shall submit documentation for the public water company stating that the potable water system has the capacity to provide for the projected demands and flow rates. The documentation shall include the anticipated static and residual pressure (high water elevation (HWE) of the specific pressure zone) at the point of connection for the range of anticipated flows.

3.2.5 NON-POTABLE WATER SOURCES

The engineer shall evaluate the potential for non-potable water for industrial water and irrigation. This evaluation shall review the life-cycle costs of available reclaimed/reuse water and surface waters.

3.3 WATER STORAGE

3.3.1 ON-SITE STORAGE

Provide on-site water storage and/or pumping system if the water source (public water system, alternative water source including groundwater wells, etc.) cannot meet the following requirements:

Fire Protection: On-site water system shall provide for the design fire flow at the design pressure based on the provisions of NFPA 1, Uniform Fire Code, and the requirements of this design manual.

Potable Water Uses: On-site water system shall provide for the peak daily demand and peak hourly flow rate at a minimum residual pressure of 50 PSI (345 kPa). However, if adequate pressure to serve the user at the highest point is not possible or would result is excessive pressures in the distribution system, building booster pumps may be used in lieu of pumping the entire distribution system (See Article 3.5, Domestic Water Pumping System).

3.3.2 UNFAVORABLE CONDITIONS

When any of the following unfavorable conditions occur, the minimum calculated fire demand shall not be less than 180,000 gallons (680 kL) and on-site water distribution system shall provide 3000 GPM at 20 PSI (11340 L/min at 138 kPa) residual pressure for fire protection:

(a) Buildings housing patients are not completely sprinklered.

(b) Combustible construction.

(c) Moderate or serious fire exposures.

(d) Hindrance to fire department apparatus access to building site.

(e) Delayed response by inadequately staffed fire department.

3.3.3 MISSION CRITICAL FACILITIES

When the facility is classified as a mission critical facility, the following minimum on-site storage shall be provided to facilitate the operation of the facility during natural disasters or other events that would preclude the normal delivery of water: all storage volumes shall be based on the usable volume within the storage facility and the demand calculations contained in the Physical Security Design Manual for VA Facilities (Mission Critical Facilities).

(a) Four (4) days storage of potable water.

(b) Seven (7) days storage of industrial water, including energy centers.

(c) Total fire protection demand.

(d) If the configuration of the storage facility will not provide for the gravity distribution meeting the design pressures and flow rates, booster pumps shall be installed as indicated in this manual. All such booster pumps and control systems shall be furnished with emergency power.

(e) If calculations of the water storage volume excludes non-essential water demands (utilize the demand rates set forth in the Physical Security Design Manual), the system shall be configured to readily isolate all non-essential demands from withdrawing from the storage facility during critical events. If isolation of non-essential demands are not integrated in the design, the demands set forth in this manual shall be utilized.

(f) Locate water storage facilities as close as practical to the mission critical facility.

3.3.4 DESIGN OF ON-SITE WATER STORAGE FACILITIES

The design of on-site water storage facilities shall conform to the American Water Works Association guidelines, and NSF Standard 61, Drinking Water System Components – Health Effects. The storage facilities shall be design to permit the maintenance of the tanks without interruption to the water supply to the buildings and fire protection systems.

The design of water storage facilities shall preclude un-authorized access to the storage facility.

The design of the on-site water storage tank shall include an assessment of the water quality impacts, including bacteriological growth, chlorination residuals, water temperature, and including the primary and secondary water quality standards of the Safe Drinking Water Act. The storage facility shall be sited and configured to minimize the potential for airborne particles, acidic rain, spores, and other contaminants from entering the tanks.

The design shall evaluate the turnover of the tanks during normal operation and during minimum flow conditions. To prevent stagnation, the design of storage tanks for normal operations and for mission critical facilities, shall be continuously on-line with continuous flow-through. Should the anticipated chlorine residual fall below acceptable limits (1 ppm), pre-chlorination and/or post chlorination equipment shall be provided.

Where temperatures of the water being discharged from the tank into the potable water distribution system are expected to exceed 85 F (29.4 C), provisions shall be installed to cool the water and/or prevent the temperature rise within the tank.

All water storage facilities shall be designed to facilitate visual inspection of the facility. In regions where ice may form in the tank, provisions shall be installed to prevent adverse ice buildup within the tank, at control locations, and other areas that would impact the operation or structure of the facility. All tanks shall be provided with level gauges and isolation valves.

3.4 WATER DISTRIBUTION SYSTEMS

3.4.1 DESIGN OF SYSTEM

Design the water distribution system to provide adequate water service to all facilities under the following flow scenarios:

- Peak hourly domestic and non-domestic flow rate at the design residual pressure, with the largest water source closed.
- Average daily domestic and non-domestic plus fire flow at the design residual pressure with one water source closed.

Layout the water system in a looped configuration/grid to the maximum practical extent. Buildings that house patients, energy centers, and facilities that have critical fire demands shall be looped by a water main. No water main shall be smaller than 8 inches (300 mm) in diameter and no fire hydrant branch less than 6 inches (150 mm) in diameter.

The alignment of the water distribution system shall facilitate maintenance of the system and allow for system expansion. Do not locate water mains and appurtenances where exposing of the pipe would damage adjacent structures. Locate new water mains a minimum of 10 feet (3.05 meters) outside of new buildings, and outside of engineered fill zones for structures. Fire hydrants shall be installed in the distribution systems as site conditions warrant.

3.4.2 ISOLATION VALVES

Place isolation valves to provide control over reasonably sized area. In general, a segment of the water distribution system can be isolated without impacting more than one service line and one fire hydrant. Install valves on all fire hydrant branches and at all building service lines. Locate service line valves as close as possible to their connections to the distribution mains. Valves with post indicators shall be set in non-traffic areas. Post indicator valves that could be potentially damaged by vehicular traffic shall be protected by post bollards.

Locate valves in areas where they can readily be located and service equipment can access their location. In congested vehicular corridors, locate the valve so it can be accessed with minimum interruption of traffic flow. To the extent possible, avoid locating valves in areas that may become flooded, or under snow removal pipes.

On campuses that contain both public and VA water systems, the valve boxes shall clearly indicate the owner of the valve.

3.4.3 FIRE HYDRANTS

Typically, place fire hydrants at a nominal 300 feet spacing (91 meters) and within 150 feet (46 meters) of all fire department connections. The locations shall be along approved fire access lanes or adequate roadways. The location of the hydrants shall comply with NFPA 1, Uniform Fire Code, Annex 1.

Coordinate hydrant locations and hose thread with the fire department responding to the facility. Set hydrants on the right side of the roadway panned to be the initial access route to the site for responders. Hydrants shall be offset from roadways an minimum of 2.5 feet (760 mm), and not more than 7.5 feet (2.2 m) behind the face of the curb. Areas were the hydrant may be damaged by vehicular traffic shall be protected by post bollards located a minimum of 3 feet (610 mm) away from the hydrant and configured to avoid restricting access to the hydrant.

In regions where hydrants could be subject to freeze damage, protect hydrant per local water system standards. All freeze protection materials shall be safe for potable water systems.

3.4.4 HYDRAULIC NETWORK MODELING

The design of the water system shall include hydraulic network modeling of the system. The model utilizing a program or procedure based on the basic parameters of the Hazen Williams heat loss equation and at minimum the flow scenarios indicated above. The maximum Hazen Williams roughness coefficient (C_{HW}) shall not exceed 140. Minor losses shall be based on accepted engineering values. The modeling shall reflect the dynamic nature of the system.

Flow velocity shall not exceed 7.5 feet/second (2.3 meters/second) during fire flows and 5 feet/second (1.5 meters/second) during peak hourly domestic/non-domestic flows.

The model shall include the characteristics of the water supply, including the approximation of the system curve for the off-site public water system and the specific pump curves for on-site pumping facilities. The approximation of the offsite public water system curve shall be based on data furnished by the water company, the system HWE for the specific zone, and the results from flow testing of hydrants.

For systems that are being modified or realigned, the model shall include sufficient data on the existing system to evaluate the impact on the existing system and the ability of the new system to meet the projected demands. Additionally, for modifications to existing systems, the analysis shall consider the quality of the existing piping. Submit hydraulic model in electronic format according to the requirements of Article 1.4, Computer Aided Facilities Management Requirements.

3.4.5 WATER DISTRIBUTION DESIGN PLANS

The design of all water mains 8 inches (200 mm) in diameter and smaller may be designed based on a plan view only. Clearances between the water main and other new and existing

utilities shall be noted on the drawings. However, in areas where there is utility congestion or tight clearances, a profile is strongly suggested. All water mains larger than 8 inches (200 mm) in diameter shall include a plan profile of the design.

In the event that the design utilizes standard details of the local public water company, all referenced details shall be indicated on the drawings.

Due to the inherent flexibility of joint restraint system compared to traditional thrust block systems, it is recommended that the use of thrust blocks be minimized. Thrust blocking may be required at the connections to existing systems that were not constructed with joint restrain systems. The engineer shall evaluate the use of thrust blocks at the point of connection or restraining the existing water mains. The design shall include a joint restraint schedule indicating the section of the system to be restrained based on the horizontal and vertical alignment of the water mains.

3.4.6 WATER SERVICE LINES AND METERS

All building potable and industrial water services shall be equipped with meters. The meter shall be "line-size" rated for the total range of flows anticipated. To accommodate large variations in flow rates, parallel meters may be required. Coordinate remote reporting and status parameters with the facility's Energy Monitoring and Control System (EMCS) system.

All building potable water services shall be equipped with backflow assemblies. The backflow assemblies shall operate based on the reduced pressure principal and shall be "line-size" rated for the total range of flows anticipated. Locate the assembly in locations were they are protected for damage, freezing, and un-authorized operations. The location shall provide adequate access for testing and maintenance of the device.

On service lines that the system pressure is 85 psi or greater, the service line shall be equipped with a pressure reducing valve (PRV) unless this design documents that the building system piping and plumbing fixtures are designed for a higher pressure and that the higher pressure benefits the facility.

3.5 DOMESTIC WATER PUMPING SYSTEM

3.5.1 PUMP SYSTEM

Typically for smaller facilities, design pumping systems utilizing a three pump system. Size one pump for approximately one-third of the design peak hourly water demand. Each of the other pumps shall be sized for approximately two-thirds of the design peak hourly demand. The smaller pump will operate until water demand exceeds the pump's capacity, at which point it will stop and one of the other larger pumps will start. When the demand exceeds the capacity of this larger pump, the smaller pump will restart and both pumps will operate together. The other large pump will be a standby and alternate with the first large pump.

For larger facilities, based on the demand profile and the system curve, the analysis of the pumping system shall consider alternative pump configurations. All pumping configurations must be capable of meeting the peak hourly design flow and pressure with the largest pump out of service. The maximum cycles per hour for each pump shall not exceed 6 for all flow scenarios with any pump out of service.

3.5.2 VARIABLE FREQUENCY DRIVES (VFD)

Provide variable frequency drives (VFD) or a hydro-pneumatic tank to maintain the pumps operation near the best efficiency point.

3.5.3 CONTROL SYSTEM

All pumping facilities shall be provided with a control system to control the pump operation based on the water distribution system pressure. The location of the pressure transmitters shall be remote from the pumping station to adequately monitor the system pressures and provide redundancy should one transmitter fail. The logic of the control system shall provide for the selection of the most efficient pump operation based on the trending of the system demands. The system shall facilitate remote monitoring of the system operation and alarm conditions. The system shall be compatible with the facility's EMCS system. The system shall provide for manual overrides on the control system for the operation of all pumps.

The control system alarms shall include low pressure, high pressure, failure to start alarms, and "NO-FLOW" shut-down controls.

System equipped with hydro-pneumatic tanks shall also be equipped with an automatic air charging systems. All air charging systems shall have oil free compressors and maintain the volume of air within the tank in accordance with the design.

Control systems in systems that include alternative water sources (groundwater wells) and on-site storage shall be fully intergraded with the well operation and storage facilities.

3.5.4 EMERGENCY POWER

All water pumps and associated control systems shall be on emergency power.

3.5.5 PUMPING SYSTEM HYDRAULIC MODELING

The design of the pumping system shall be integrated with the hydraulic modeling of the water distribution system. The system curve developed for the distribution system shall be the basis for the design. The modeling of the pumping system shall include the cycles and operating point of all pumps simulated over the full range of anticipated flows and pump status conditions. Submit hydraulic model in electronic format according to the requirements of Article 1.4, Computer Aided Facilities Management Requirements.

3.6 IRRIGATION DISTRIBUTION SYSTEM

3.6.1 IRRIGATION

The intent of this system is to address the major main lines and site distribution system of the irrigation system. Specifics regarding the heads, drip zones, etc., shall be designed and constructed per the VA irrigation design requirements.

The VA Site Design Manual and the project scope of work will indicate if an automatic irrigation system is required for the project and the extents of the irrigation system. The system shall be designed based on consumptive demands for the existing and new vegetation to be irrigated and local conditions. The frequency of irrigation cycles shall be established in the programming phase.

Irrigation systems installed above the frost line shall be equipped with appurtenances and drain ports capable of evacuating all mainlines and laterals.

Systems that utilizes reclaimed/reuse water shall be designed to minimize the potential of the general public coming in contact with the irrigation water. All reclaimed/reuse irrigation piping, valve boxes, and appurtenances shall be labeled as “non-potable water” and identified with purple coloration.

Distribution piping shall be non-metallic to the greatest extent possible and sized for a maximum velocity of 5 feet/second (1.5 meters/second). A hydraulic model shall be developed for the distribution system as described in Article 3.4.4, Hydraulic Network Modeling. Vertical clearances between the irrigation mainlines shall comply with Article 2.1, Basic Design Parameters.

3.6.2 AUTOMATIC IRRIGATION

All irrigation systems shall be provided with an automatic irrigation control system in accordance with the Master Specifications. The design of the system shall permit all irrigation to be completed between the hours of 10:00pm to 6:00am.

At mission critical facilities, the controller(s) shall be interfaced with the facility’s EMCS system. The controls shall not permit irrigation (non-critical water consumption) to occur during period when water usage is curtailed.

3.6.3 IRRIGATION SYSTEM CONNECTIONS

Keep the number of irrigation system connections to the potable system to a minimum. Equip all connections with a reduced pressure-type backflow assembly and meter. Limit maximum flow from any connection to the potable water distribution system to 180 gpm (11 liters/second).

Connections to reclaimed/reuse systems are not limited to the 180 gpm (11 liters/second) criterion, but rated on the hydraulics of the reclaimed/reuse distribution system and source. Prior to connecting any existing irrigation system to a reclaimed/reuse water source, the existing irrigation system shall be dye-tested and investigated for potential cross connections to the potable water system or devices. The dye-testing shall continue for an adequate duration to ensure its detection at all sources. All connections and cross-connections to the potable water system shall be eliminated prior to making the tie-over to the reclaimed/reuse system.

3.7 SANITARY SEWER SYSTEMS

3.7.1 UNDERGROUND SANITARY SYSTEM

Design an underground sanitary system, including building connections, manholes, clean-outs, cooling tower waste lines, etc., and all appurtenances.

3.7.2 DESIGN FLOWS

If meter readings are not available, average daily sewage flow and peak flow shall be projected to be 95% of water demand indicated in Article 3.2, Water Supply.

3.7.3 OFF-SITE SANITARY SEWER SYSTEM REQUIREMENTS

Comply with the requirements for off-site sanitary sewer systems. Confirm the acceptable discharge rates, effluent limitations, and permitting requirements with the public sewer system.

3.7.4 STORM DRAINAGE SYSTEMS

Do not connect sanitary sewer systems to storm drainage systems.

3.7.5 SEWER PIPES AND MANHOLES

To extent feasible, do not locate sewer pipes and manholes under pavement. Provide manholes at junctions, changes in direction, changes in slope, and changes in invert elevations of sewers 8 inches (200 mm) and above. Clean-outs are required for 4 and 6 inch (100 and 150 mm) sewers. Limit spacing between manholes to 300 feet (90 meters), except in straight runs of long out-fall sewers, where feet (150 meters) of spacing is permitted.

3.7.6 EXTRA STRENGTH PIPE

Indicate on drawings where extra strength pipe is required to support anticipated trench and superimposed loads. Include adequate pipe bedding and, if necessary, provide structural supports for sewer pipes, manholes, inlets, and other appurtenances.

3.7.7 SANITARY SEWERS

Limit sanitary sewers to not fewer than 8 inches (200 mm) in diameter and sanitary sewer building connections to not fewer than 4 inches (100 mm) in diameter. Establish sanitary sewer slopes to provide minimum velocity of 2.5 feet/second (0.75 mm/ second) when pipe is flowing full; maximum slope shall be 9%.

3.7.8 DISCHARGE

Discharge cooling tower drains, overflows, and blow-down piping systems to the sanitary sewage system. Provide air gaps to prevent cross connections between sewage and water systems.

3.7.9 LOCAL STANDARD DETAILS

Use state or local standard details for manholes, and pipe cradles. Adjust master specifications as necessary.

3.7.10 HYDRAULIC CALCULATIONS

Provide hydraulic calculations for the sanitary sewer system. The maximum depth of flow at peak flow shall not exceed 0.75D. Submit hydraulic calculations in electronic format according to the requirements of Article 1.4, Computer Aided Facilities Management Requirements.

3.7.11 MISSION CRITICAL FACILITIES

When the facility is classified as a mission critical facility, the following minimum on-site sanitary sewage storage shall be provided to facilitate the operation of the facility during natural disasters or other events that would preclude the normal disposal of wastewater. All storage volumes shall be based on the usable volume within the storage facility and the demand calculations contained in the Physical Security Design Manual for VA Facilities (Mission Critical Facilities).

(a) Four (4) days storage for domestic wastewater.

(b) Seven (7) days for discharges for industrial water blowdown from cooling towers and boilers.

(c) Allowance for infiltration in the collection system. This allowance shall be based on regional accepted values and the size of the collection system.

The sanitary sewage storage shall be configured to be “off-line” (no through flow) during normal operation. The sanitary sewer collection system shall be configured to divert wastewater to the storage tank during emergency events. This diversion shall be readily accomplished without entering manholes or confined spaces.

If the sanitary sewer collection system, upstream of the sanitary sewage storage tank, conveys wastewater from non-mission critical facilities (non-essential) uses, the anticipated flow from such non-essential uses shall be added to the tank capacity.

Locate holding facilities to provide gravity flow from the mission critical facilities to the fullest extent possible. Should lift stations be required, the pumping shall be designed with 100% redundancy and all pumps and controls shall be supplied with emergency power.

Locate the storage tank to facilitate access to the tank for removal of wastewater after the re-establishment of normal sanitary sewer conveyance systems.

The tank design shall provide access points, ventilation, and aeration of the wastewater. The facility shall also provide for a system to remove the wastewater from the tank. The disposal system shall be compatible with the requirements of the downstream public sanitary sewer collection system and wastewater treatment plant.

3.8 STORM SEWER SYSTEMS

3.8.1 SEPARATE UNDERGROUND STORM SEWAGE SYSTEMS

Design separate underground storm sewage systems, including building roof leader connections, manholes, clean-outs, drainage inlets (yard and curb), open drainage channels, dry wells, etc., and all appurtenances. Storm drainage system shall serve all areas under construction or affected by construction.

3.8.2 HYDROLOGIC AND HYDRAULIC EVALUATION

Provide a hydrologic and hydraulic evaluation for the drainage and storm sewer system. The hydrologic assessment shall be based on state or local standards and shall evaluate the 2, 5, 10, 50, and 100 year storm event.

3.8.3 COMPONENTS OF STORM SEWAGE SYSTEM

Design all components of storm sewage system on basis of not less than 10-year storm frequency for one hour.

3.8.4 OFF-SITE RECEPTOR OF STORM WATER REQUIREMENTS

Comply with the requirements of off-site receptor of storm water. Retention may be required. Roof storage of storm water is not allowed.

3.8.5 SANITARY SEWAGE SYSTEMS

Do not connect storm drainage system to sanitary sewage systems.

3.8.6 SEWER PIPES AND MANHOLES UNDER PAVEMENT

To the extent feasible, do not locate sewer pipes and manholes under pavement. Provide manholes at junctions, changes in direction and changes in slope. Limit spacing between manholes to 300 feet (90 meters), except in straight runs of long out-fall sewers, where 500 feet (150 meters) of spacing is permitted.

3.8.7 EXTRA STRENGTH PIPE

Indicate on drawings where extra strength pipe is required to support anticipated trench and superimposed loads.

3.8.8 STORM SEWERS SERVING DRAINAGE INLETS

Limit storm sewers serving drainage inlets to not fewer than 12 inches (300 mm) in diameter and roof leader connections to not fewer than 4 inches (100 mm) in diameter. Establish storm sewer slopes to provide minimum velocity of 2 feet/second (0.6 mm/second) when pipe is flowing full. Maximum storm sewer design velocity shall be in non-erosive range for specified pipe material.

3.8.9 STATE OR LOCAL STANDARD DETAILS

Use state or local standard details for manholes, inlets, endwalls, and pipe cradles. Adjust master specifications as necessary.

3.9 SEWAGE PUMPING EQUIPMENT (OUTSIDE)

3.9.1 PUMPING SYSTEM TO DISCHARGE AT MAXIMUM SEWAGE FLOW RATE

Design pumping system to discharge at maximum sewage flow rate with largest pump not operating. Connect pumping system to emergency power.

3.9.2 WET WELL

Wet well shall be large enough to allow an interval of at least 6 minutes between successive starts of same pump motor throughout entire range of estimated flow rates. Include high water level alarm system in wet well, and place warning bell in boiler plant (energy center), operator's office, or other appropriate location.

3.10 GAS DISTRIBUTION SYSTEM

Coordinate with gas company concerning housing and/or fencing for gas metering and regulating equipment. Provide gas filter upstream of meter.

Provide cathodic protection system for all ferrous piping systems.

3.11 OIL AND GASOLINE SUPPLY SYSTEMS

Provide to serve emergency generators, vehicles, and equipment requiring fuel. Show tank, piping (from tank to building or tank to fuel dispensers), tank and piping monitoring, pumps, and dispensers on "W-Series" drawings. Tanks, piping, pumps, and monitoring are described in Master Specification 23 10 00, FACILITY FUEL SYSTEMS. Interior requirements for emergency generators shall be shown on electrical drawings and are described in Master Specification 26 32 13, ENGINE GENERATORS.

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