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Civil
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Kent County Water Authority
Distribution Storage Tank Hydraulic Evaluation

Technical Memorandum No. 3B
Existing and Future Water System Capabilities
March 2007

1.0 Purpose and Scope

The project has been divided into various sub tasks and each of which will be further detailed in a specific technical memorandum. The purpose of this technical memorandum is to describe the efforts and results associated with the task related to determining the existing (current) and future (20 year planning period) storage capacity of the distribution system. Also, each storage tank will be evaluated individually and a determination as to where additional storage might be needed will be made. It is intended that the information gathered as part of this task will be the basis for evaluation and analysis as part of this study and ultimately for development of recommendations in subsequent portions of this study. The following are the specific efforts associated with this task.

1. Perform the following hydraulic model simulations for both steady state and extended period for the water system with critical attention for each of the varied pressure zones in the system.

Current Water Demands (2006):

- Steady State Simulations
  - Average Day Demands
  - Maximum Day Demands
  - Peak Hour Demands (during Maximum Day)
  - Maximum Day Demand Plus Fire Flow

- Extended Period Simulations
  - Maximum Day Demands
    *48 hour simulation

Future Projected Water Demands (2026):

- Steady State Simulations
  - Average Day Demands
  - Maximum Day Demands
  - Peak Hour Demands (during Maximum Day)
  - Maximum Day Demand Plus Fire Flow

- Extended Period Simulations
  - Maximum Day Demands
    *48 hour simulation

Based on these model scenarios, specific water system improvements for the current (existing identified deficiencies) and future projected (20 year) planning horizons shall be identified. These improvements will be categorized by critical importance to water system operations. Any recommended improvements will also be included in the various modeling scenarios to demonstrate their effectiveness in meeting deficiencies and to assist in sizing of components.

2. The diurnal flow curves that were developed for each pressure zone as part of the original model have been reviewed and adjusted to conform to the current water demands in the hydraulic model. These diurnal flow curves were developed from hourly water production and tank level data that is representative of the maximum day water use patterns of the nine (9) pressures zones of the Kent County Water Authority (Authority) water system. The diurnal flow patterns were entered into the model and assigned to all of the junction node demands. The diurnal flow patterns will be used within the hydraulic model for extended period simulations (EPS). The EPS analysis is critical in gauging how the overall water system responds to periods of increased demands such as fire flows. An EPS analysis is important in evaluating the recovery rates of tanks as well as the existing pumping capability to adequately replenish distribution system storage tanks.

3. This analysis shall also include an operational assessment of the eight (8) existing storage tanks in order to determine their effectiveness in meeting the various system demands. Such determination would include specific analysis of each tank including fill and draw rates, system influences on tank operation including pump station set points and operation, etc.

    a. An assessment will be provided for potential solutions and alternatives for cycling those tanks, which are problematic. This may include retrofitting tanks with mixing systems, operation modifications such as off hour pumping systems, control valve sequencing or reconfiguration of underground infrastructure. This would all be performed in consideration of the critical nature of these tanks in providing fire protection in the general area of the tanks.

    b. A discussion will be provided on the overall effect on system operation for the removal of "locked up" or low turn over tanks and what affect they may have on fire flow capacity in the surrounding areas.

    c. For each existing storage tank, a determination shall be performed for the volumes of fire flow storage, emergency storage, equalization storage, as well as active and dead storage by service zone. These volumes will be compared to the standards that were previously developed as part of this study and appropriate recommendations shall be made.

4. Recommended improvements for the existing water system will be considered and shall include the following:

    a. Timeline and major milestones for each phase of any recommended project.

    b. Detailed Capital and Infrastructure improvement recommendations. These would include detailed justifications, anticipated results from completing the project and cost estimates that can be incorporated into future Capital and Infrastructure programs.

    c. All projects shall be prioritized and reflect projects that provide the best results for transmission and storage needs.

d. Cost estimates, the potential impacts on rates and future site development contribution funding strategies for un-serviced or poorly serviced areas for each project.

e. Costs for each project shall include design, construction and annual escalation. An explanation of the basis for computing the estimates shall be provided.

2.0 Steady State Analysis

The data previously developed in Technical Memorandum (TM) 2 regarding the development of water system evaluation criteria was utilized to determine the hydraulic model simulations necessary to identify areas of the Authority's water system that may need additional storage capacity.

It has been determined that four (4) steady state analysis simulations shall be conducted for the current planning period (year 2006) as well as four (4) steady state analysis simulations for the future planning period (year 2026) for a total of eight (8) steady state analysis simulations. These steady state analysis simulations include the following:

- Average Day Demands
- Maximum Day Demands
- Peak Hour Demands
- Maximum Day Demand Plus Fire Flow

The steady state analysis model simulations will help in identifying isolated areas of the distribution system that experience pressures below 35 psi on a routine basis as well as the hydraulic grade line (HGL) of the system. These areas will be evaluated on a case-by-case basis and may be overcome by individual booster pumps, as it may be cost prohibitive to increase a water system's HGL to address these isolated areas. The steady state model simulations will also identify areas of deficient storage, tanks that do not effectively cycle or are undersized, tanks that are problematic due to their location in the system, etc.

The Maximum Day Demand simulation will be utilized to determine the "effective" storage volume and the "total" storage volume of the storage tanks. The concept of "effective" versus "total" storage is used to provide a general overall assessment of the existing and potential new storage tanks. This concept applies to tanks that "float" on the system as do all of the existing tanks in the Authority's system as well as would any new storage tanks. The term "float" refers to the water level in the tank at any given time that will determine the pressure in the distribution system. Each individual tank will be examined and the "effective" storage volume to be located above the water elevation in the tank above which a minimum pressure of 20 psi can be maintained will be determined. This is defined as the minimum acceptable HGL for the tank. The "total" storage volume of the tank refers to the nominal capacity of the tank.

The Maximum Day Demand and Peak Hour Demand simulations will determine the equalization storage volume. Equalization storage volume is the volume in the tank that meets the water system demands that are in excess of the pumping capacity of the system. This storage volume is located at the top of the storage tank. Equalization storage is further broken down into operation storage, which is the upper portion of the equalization storage where the supply pumps are set to cycle on and off. The defining low water level point in the tank for equalization storage is that where 35 psi can be maintained within the distribution system.

The Maximum Day Demand Plus Fire Flow simulation as well as the Peak Hour Demand simulation will be utilized to determine the emergency and fire storage volumes of the storage tanks. The storage located beneath the equalization storage is referred to as emergency and fire storage and provides a minimum pressure of 20 psi to the system. This storage is typically for emergency purposes that would occur during a fire flow event. Below this water level is the ineffective or "dead" storage that cannot effectively supply the distribution system with adequate pressure. Emergency and fire storage provides water during emergency situations such as pipeline failures, fires, equipment failures, etc. at a minimum pressure of 20 psi.

3.0 Extended Period Analysis

There shall be one (1) extended period simulation conducted for the current planning period (year 2006) and one (1) extended period simulation conducted for the future planning period (year 2026) for a total of two (2) extended period simulations (EPS). The demand scenario for the EPS is as follows:

- Maximum Day Demands
  *48 hour simulations

The EPS shall be utilized to evaluate various storage alternatives as well as water main sizing associated with the storage facilities. It is critical to examine several of the Authority's water storage tanks (i.e. Fiskeville Reservoirs, West Street Standpipe and Wakefield Tank) that do not "float" on the system due to their proximity to the Clinton Avenue Pump Station. The EPS will evaluate options to optimize use of these tank facilities.

It is critical to use the EPS to examine the volumes and fill/draw rates that occur in a particular tank during the Maximum Day Demand condition. By examining the fill/draw rates, the equalization storage volume can be determined. The equalization storage at any given time (especially during a maximum day demand) will vary in the tank and may not be totally available as it is being consumed by the system demand. Once the peak demand subsides, the tank (the equalization portion) is refilled to its overflow elevation hence the need to examine fill/draw rates. Examining the fill/draw rates of the various storage facilities will also provide determination as to which tank(s) are most critical in meeting peak demands.

The EPS will also aide in determining the total storage capacity as well as the final tank sizing and location. The final tank size and location will be a function of various factors including volume of equalization storage, fire flow requirements, emergency storage, fill and draw cycles of the existing tank, hydraulics of the system, etc.