Leveraging Technology for a Comprehensive Water Study at Guantanamo Bay

Moderator:

- Lara Zuzak, AICP, PMP; AtkinsRéalis

Speakers:

- Jim Kapinos, P.E., CCM; Director of Civil Engineering, AtkinsRéalis
- John Woods, P.E., Senior Civil Engineer; AtkinsRéalis

May 14, 2024, 1:30 p.m.

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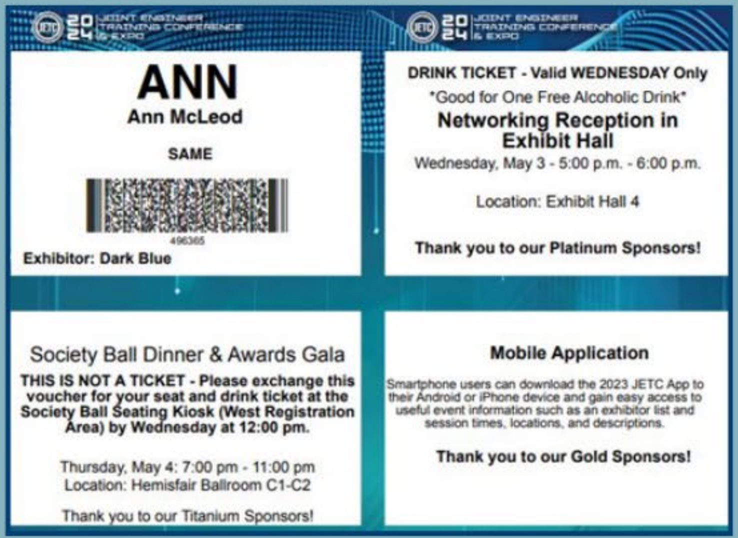

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MODERATOR

Lara Zuzak, AICP, PMP

AtkinsRéalis
Senior Project Director

Fun Facts

- Dream Vacation Spots: Hawaii, Florida Keys, Switzerland
- Did you know? I competed in a televised quiz bowl show in high school
- Hobbies: Gardening and cooking

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SPEAKER

Jim Kapinos, P.E., CCM
AtkinsRéalis
Director of Civil Engineering

Fun Facts

- Favorite Sports Teams: All Boston teams
- Dream Vacation Spots: Lake Tahoe, Hawaii
- Hobbies: Classic Pinballs

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SPEAKER

John Woods, P.E.

AtkinsRéalis
Senior Civil Engineer

Fun Facts

- Favorite Football Teams: Pittsburgh Steelers and the University of Central Florida Knights
- Love to vacation in Europe
- Hobbies: Photography

Live Content Slide

Poll: How much is the annual lease for NSGB? (Choose all that apply.)

Agenda

Agenda

- Introductions
- Project Overview
- Field Technology
- Modeling Technology
- Analysis
- Recommendations

Project Overview

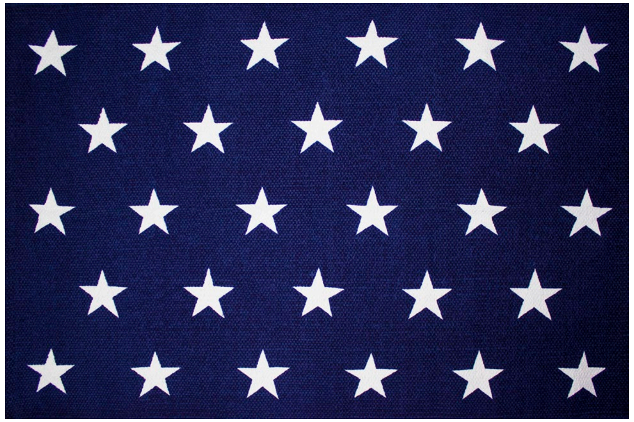
NSGB At a Glance

- U.S. military base on the shore of Guantánamo Bay
- **Oldest overseas U.S. Naval Base**
- **45 square miles of land and water** at Guantánamo Bay, at the southeastern region of Cuba
- Current population is approximately 5,500 people

NSGB Uses and Mission

Historical Uses

- Fleet training
- Ship repair
- Refueling and resupply
- Migrant operations
- Regional humanitarian relief and disaster assistance
- Search and rescue support
- Detention operations



Today, it remains the **forward, ready, and irreplaceable U.S. sea power platform in the Caribbean**, giving decision makers unique options across the range of military and interagency operations

Purpose of Study

- **Purpose: Determine if limitations and deficiencies exist in the water system.**
- The most comprehensive base-wide water study in decades was recently undertaken at Naval Station Guantanamo Bay (NSGB).
- Joint effort of the Navy (NAVFAC SE) and USACE (Mobile District).

Water System Overview

- Reverse osmosis (RO) plant
- Treatment plant
- 13 Storage tanks (13.4M Gal)
- 6 Pump stations

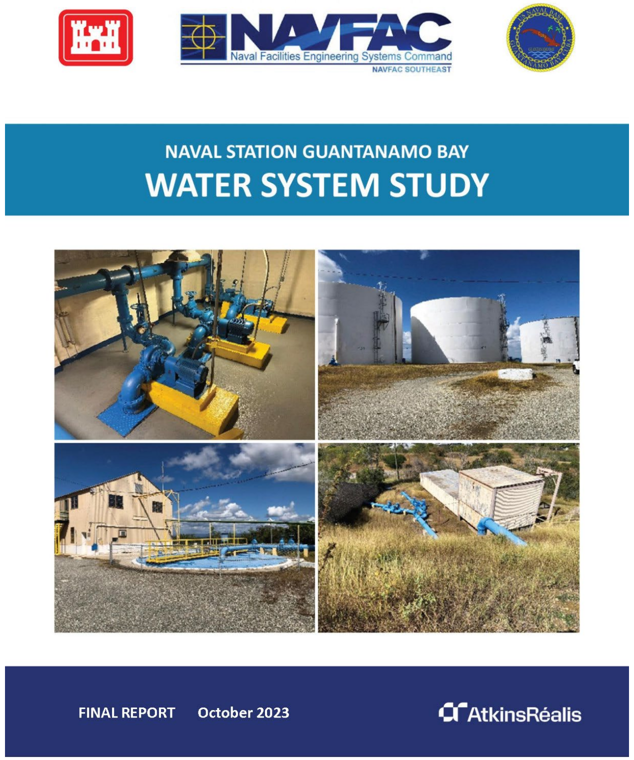
Distribution system

- 104 miles of pipe up to 16-inch Diameter
- 2,250 isolation valves
- 506 fire hydrants
- 135 backflow preventers

Average daily water consumption is 1 MGD

Scope

- Objective - Provide a **very detailed, accurate and comprehensive assessment** going well beyond the typical
  - Typical includes flow tests; assumptions for boundary conditions
- Required an **exhaustive field data collection effort**, **extensive hydraulic modeling**, and **system-wide analysis** using the latest technology



Scope

- Using field assessments and a model, **analyze numerous water system components to determine if limitations and deficiencies exist in the water system**
- **Recommend** improvements with cost estimates where appropriate
- Provide **condition scores** according to the Utility Infrastructure Condition Assessment Program (U-ICAP) rating system

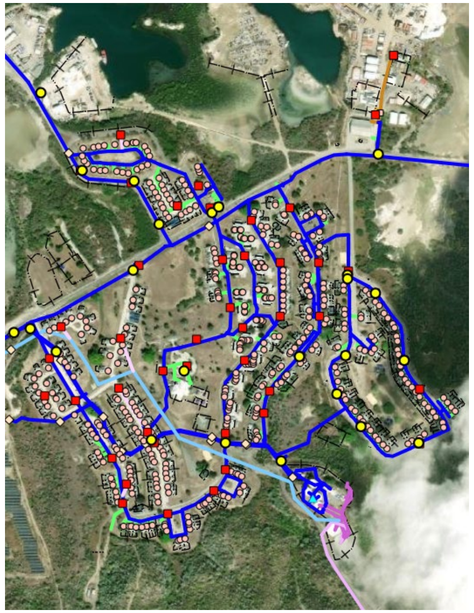
	Likelihood Category	Degradation Index
Fully Functional	Negligible = 1	No noticeable defects. Some aging or wear may be visible. Fully functional.
	Not Likely = 2	Only minor deterioration or defects are evident. Noticeable wear or aging is visible. Fully functional. Minor maintenance may be required.
	Possible = 3	Deterioration or defects are evident. Function is not significantly affected. Minor repairs are required.
Function Affected	Likely = 4	Serious deterioration or defects in at least some portion of the asset. Function is significantly affected. Extensive repairs or replacement are required.
	Very Likely = 5	Extensive deterioration or defects in the asset. Not functional, barely functional, or beyond repair.

Field Technology

ArcGIS Water System Map

Field Work

- An ArcGIS map showing cloud accessible water system maps, including aerial features, system components and ground elevations was created **using ArcGIS Field Map (proprietary GIS system).**
- Field crews accessed the water system map on their mobile devices.
- Water system maps **tracked the field personnel locations, allowing field crews to follow the water system and locate system components.**
- Data entry forms were added, allowing users to enter data and photos for any system component, streamlining data collection.



Data Collection

- Pressure logging
- Tracer monitoring
- Flow testing
- Disinfectant decay coefficient sampling
- Chlorine testing
- Pump station testing
- Acoustical leak detection testing
- TOC sampling
- Timelapse photography of meter readings and tank levels

Pressure Logging

<u>Field Work</u>

- Installed 13 pressure loggers throughout the base.
- Loggers were installed on fire hydrants.
- Several loggers were left in place to record over 30 days worth of data.
- Loggers recorded pressure readings every 5 minutes.
- Data was then downloaded from the logger and loggers removed.

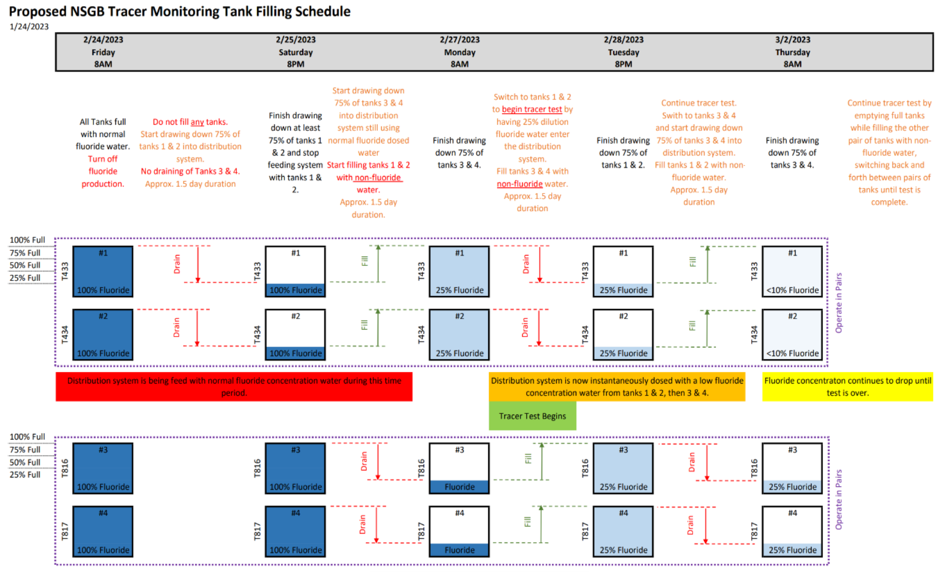
<u>Modeling of Field Data</u>

- **Recorded pressures were compared to modeling pressures and calibration adjustments were made.**
- 10% calibration target. All pressure logger readings were **under 4% with a 2% average calibration**.

Tracer Monitoring (1 of 2)

Field Work

- The four finished water tanks were drained to approx. 25% and non-fluoride water added. This brought the fluoride levels down from 0.5 mg/L to 0.2 mg/L.
- Once the low fluoride water was ready, plant operators released this water into the distribution system and the test start date and time was recorded.
- **Twelve locations** were chosen to pull water samples and test the fluoride levels.



Tracer Monitoring (2 of 2)

Field Work

- Once the fluoride level reached 0.2 mg/L, the testing at that location ended and the date and time recorded.

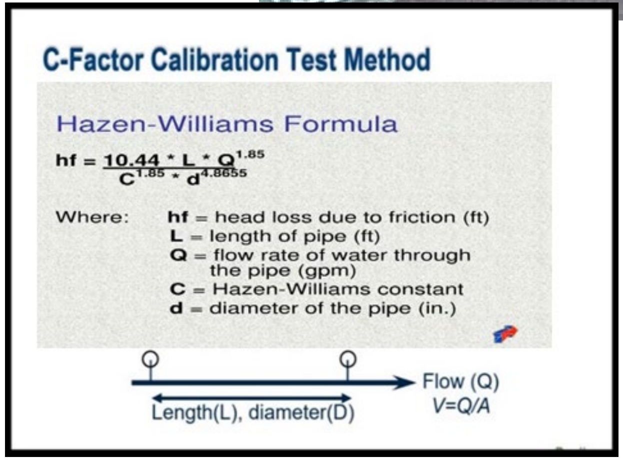
Modeling of Field Data

- **Water age travel times were then compared to hydraulic model water age times and calibration adjustments were made.**
- Times for all the test locations ***ranged from 10 hours to 243 hours.***
- **10% calibration target. All tracer times were under 8%.**

C-Factor Flow Testing (1 of 2)

Field Work

- **20 triple fire hydrant test** were performed throughout the base **to "spot-check" water pipe roughness coefficients "C"**, also referred to the C-factor.
- The **Hazen-Williams formula** is used for this test to solve for "C".
- Flow must be in one direction with flow passing the two static hydrants and discharging out the flowing hydrant.
- This test can be extremely sensitive with the inputs. It is recommended to have a headloss greater than 5 PSI between the static hydrants and maximizing the distance between them.



C-Factor Flow Testing (2 of 2)

Modeling of Field Data

- Roughness coefficients were compiled and compared to the known water distribution pipe ages and pipe material.
- **C-Factors were then assigned to all water distribution piping in the hydraulic model.**
- Secondary information such as pressure readings can also be used to help calibrate the model.

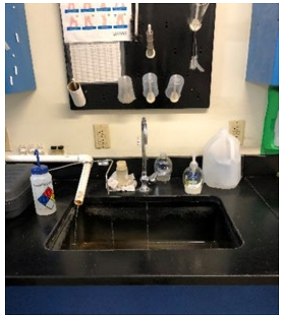
Disinfectant Decay Coefficient Sampling

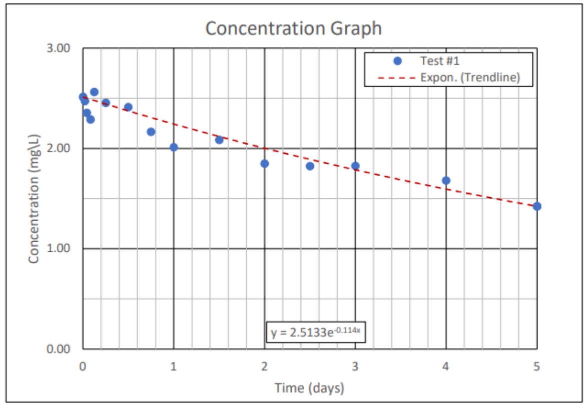
<u>Field Work</u>

- A **“bottle test”** was performed to record the **chlorine decay rate** within the water distribution system.
- Individual bottles were filled with water from the water treatment plant.
- Bottles were then stored in an environment to mimic that of the water treatment plant.
- **Bottles were opened at specified time intervals and chlorine levels measured and recorded.**

<u>Modeling of Field Data</u>

- The chlorine concentrations were plotted over time.
- **The slope of the line was calculated to obtain the bulk decay rate coefficient (kb)** and was entered into the hydraulic modeling software.





Chlorine Testing

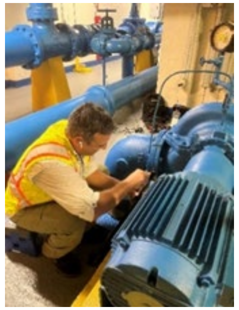
Field Work

- **50+ locations** were chosen throughout the base and chlorine samples were pulled from the water distribution system.
- Two samples were pulled at each location, averaged and recorded.

Modeling of Field Data

- Chlorine samples from the field were compared to chlorine residuals in the hydraulic model and calibration adjustments were made.
- Results from the tracer test, bulk decay bottle test and these chlorine residual readings helped calibrate the water age model.

Pump Station Testing



Field Work

- **9 water pumps** were performance tested to determine if they were operating per the manufacturer's specifications. These tests included:
  - **Pressure (Head) Tests (pressure and flow rates)**
  - **Power (Amps) Tests**
  - **Bearing Vibration and Temperature**
  - **Sound Pressure (Noise)**
- **Pump performance curves** were created and compared to the manufacturer's curves.
- **Recommendations for pump maintenance or replacement were provided**.

Modeling of Field Data

- **Pump curves from the field testing were used in the hydraulic model.**

Acoustical Leak Detection Testing

Field Work

- Acoustical leak detection was performed on the **most critical watermains** which consisted of distribution mains, important service lines, pipes with frequent breaks and pipe age.
- This resulted in approx. **20 miles of water main testing**.
- Small loggers were magnetically placed on hydrants, valve nuts, or any pipeline appurtenance.
- Correlating loggers were programmed using a tablet and communication link to simultaneously listen for leaks over a specific period of time.
- The loggers listened for distinct frequency noises for a short period of time (15 to 30 seconds) which are indicative of a leak.
- Logger data was downloaded and algorithms were used to determine if there were leaks.

Modeling of Field Data

- Pipe repair recommendations were provided within the final deliverable for all leaks found.

Timelapse Photography of Meters and Tanks

Field Work

- **Water meter readings and finished water storage tank water levels were recorded using time lapse photography.**
- Cameras were mounted nearby and programmed to take photos at 5 min. intervals. Cameras were equipped with flashed for nighttime photos.
- Water usage at each meter was obtained and water fill and discharge at the tanks was obtained.
- Photos were downloaded and the data recorded.
- Pump run times were obtained from field logbooks.

Modeling of Field Data

- **Water meter demand over time and tank discharge data was used to generate a diurnal curve, which was applied to the hydraulic model.**
- Field log books and water tank fill times were used to calibrate the model and assist with establishing pump controls within the hydraulic model.

Modeling Technology

Comprehensive and Calibrated Model

ArcGIS Desktop

- **Build the water model network** and **import into WaterGEMS**

Autodesk Civil 3D

- **Analyze as-built information** and **import construction documents** into the hydraulic model
- **Generate a LandXML surface file** and import into the model

WaterGEMS

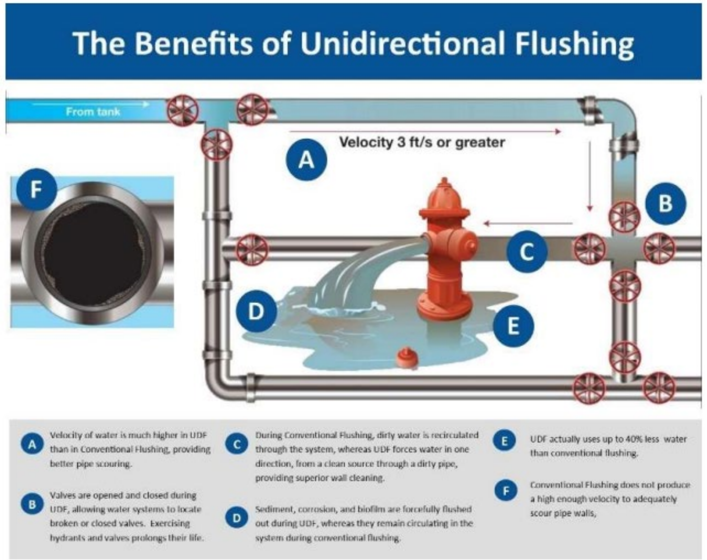
- **Used the TRex tool to establish elevations** at water system nodes
- **Used for hydraulic modeling** of the base's water system

Model Build

Advanced WaterGEMS Modeling Tools:

- GIS Integration
- Pump Controls
- Unidirectional Flushing (UDF)
- Fire Flow Analysis
- Water Quality Analysis
- Selection Sets
- Flex Tables
- Custom Reports
- ModelBuilder

  Tool used to map tabular information



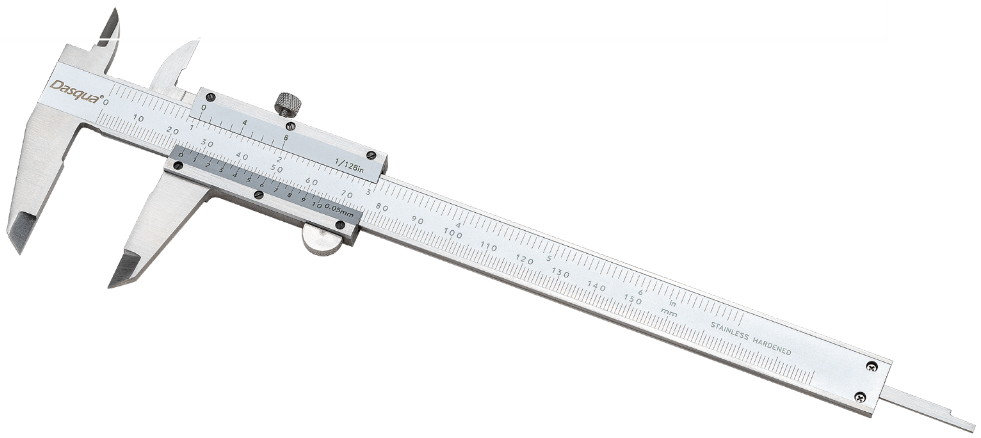
HAMMER was used to do the following:

- Generated a **transient model to analyze severe pressure conditions** observed for a portion of the base.

Benefits of Model Calibration with Field Data

Resulting model more accurately represented actual field conditions.

- Tracer Monitoring
- Pressure Logger Data
- C-Factors obtained from hydrant testing
- Chlorine residual concentrations
- Chlorine decay rate
- Pump run times
- Water storage tank levels
- Existing pump performance curves
- Flow meter readings



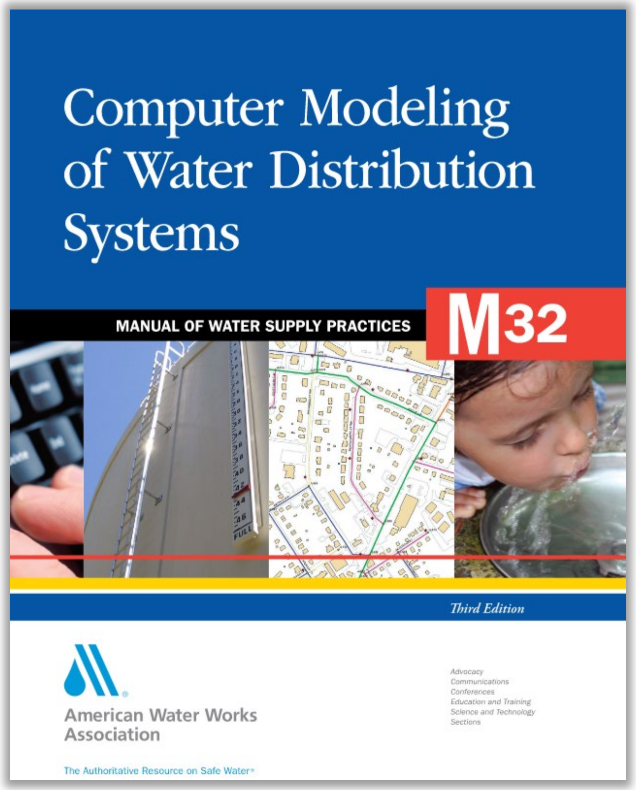
Model Scenarios

Existing Conditions (Real World)

1) Finished Water System Scenario
2) Finished Water Fire Flow Scenario
3) Finished Water Quality Scenarios
   a) Free Chlorine Scenario
   b) Water Age Scenario
4) Raw Water System Scenario

Proposed Conditions

1) Finished Water System Scenario
2) Finished Water Fire Flow Scenario
3) Finished Water Quality Scenarios
   a) Free Chlorine Scenario
   b) Water Age Scenario



Analysis

What animal is this?

Answer choices:

a) Capybara
b) Banana Rat
c) Woolly Rat
d) Leak Detector

Live Content Slide

Poll: Choose which animal you think it was:

Analysis

- **The Reverse Osmosis Plant Intake Well and Lime Bed**
- **Water Treatment Plant 3**
- **TTHMs**
- **Aggressive water reduction**
- *Water storage tanks*
- ***Sherman Ave optimization***
- *Waterline pigging*
- *Finished water pumps*
- *Leak detection*
- *Resiliency and redundancy*
- *Automation*
- *Unidirectional flushing*
- *Antiterrorism/force protection*

Blue represents water quality elements.

Black italics required hydraulic modeling.

Recommendations

Recommendations

Basis for Recommendations

- ➢ Proposed modeling scenario results
- ➢ Stakeholder interviews
- ➢ Records research
- ➢ Field assessments

Recommendations

- Prioritized Modernization and/or restoration recommendations (high, mid and low level)
- Thirteen projects with a total constructed value of approximately **$86M**

Prioritization Factors

- **Meet Federal and Navy Regulatory requirements for safe drinking water**
- **Potential environmental, safety, or health hazards requiring immediate attention**
- **Improvements to ATFP as it applies to the water infrastructure.**
- **Compliance with Navy Regulations and Directives**
- **Correcting deficiencies found in Navy Drinking Water Sanitary Surveys**
- **Reduction of system maintenance**
- **Ability to reduce response time for unscheduled outages**
- **Results from Field Survey/Recommendations**

Representative, Recommended Projects

- RO Plant Lime Bed Modifications and Aggressive Water Reduction (**High**)
- Water Treatment Modernization and Decommissioning of WTP 3 (**High**)
- Finished Water Pumps (**Medium**)
- Water Storage Tanks Recommendations (**Medium**)
- Resiliency and Redundancy (**Low**)
- Water System Automation (**Low**)
- ATFP (**Low**)

THANK YOU

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Q&A

- Jim Kapinos, james.kapinos@atkinsrealis.com
- John Woods, john.woods@atkinsrealis.com
- Lara Zuzak, lara.zuzak@atkinsrealis.com