Partnering with the US Navy: Water Storage Tank Maintenance on a Global Scale

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Water Tank Inspection Program

Naval Facilities Engineering and Expeditionary Warfare Center (NAVFAC EXWC)

TIC's Naval Deployment

15 Countries

19 States

92 Bases

577 Tanks

753 Projects

TIC/Navy Partnership

- TIC began evaluating tanks for the Navy in 1987
- Indefinite Delivery/Indefinite Quantities contract since 2001

Challenges

- Mobilization of Equipment and Crews
  - Resolve issues “on the fly”
    - Japan - Tramped through jungles to locate the tanks
    - Bahrain – Inspection equipment took five months to be returned
    - Island facilities - Barges and private planes
    - Armed escorts
    - Local civilian “officials”
    - Local laws and regulations

Locating Tanks in Japan

Endangered Wildlife

Coconut Crab

Near Hurricane in Australia

Travel Restrictions


CAUTION
WATCH FOR SEALS
ON ROADWAY

Challenges

- Myriad of Types of Structures
  - Steel – welded, bolted, and riveted
  - Concrete
  - Stainless Steel
  - Fiber-Reinforced Plastic (FRP)
  - High-Density Polyethylene (HDPE)
  - Earthen
  - Square Tanks with Concave Contour

Challenges

Safe Working Practices over and above standard OSHA requirements

- Site-specific HASPs
- Certificates of third-party training for all climbing personnel
  - Tower climbing
  - Self rescue
  - Rope access
  - High-angle rescue

High Angle Rescue Training


Successful Tank Management Program!
Tank Rating & Ranking
Comprehensive Tank Evaluation

Comprehensive Tank Evaluation

- Identify Deficiencies
  - Sanitary
  - Safety
  - Security
- Coatings Evaluation
- Structural Evaluation
- Certified Professional Engineering Report

Inspection Standards and Guidelines

- AWWA D101 Inspection of Water Tanks and Related Facilities (currently being rewritten)
- AWWA M42 Steel Water-Storage Tanks
- AWWA Steel Water Storage Tanks Handbook
- NFPA 25 Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems

Selecting a Tank Engineering and Inspection Company

- Registered Professional Engineer
- Extensive Knowledge of:
  - Industry standards
  - Traditional engineering disciplines
  - Specialized training
  - Tank construction practices
  - Surface cleaning and cleanliness standards
  - Familiar with tank design and maintenance

Selecting a Tank Engineering and Inspection Company

- Effective Communications Skills to:
  - Interpret specifications
  - Resolve potential issues
- Climbing Abilities and Knowledge of:
  - Proper rigging
  - Safety practices
  - Respect for heights

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Tank Evaluation Methods

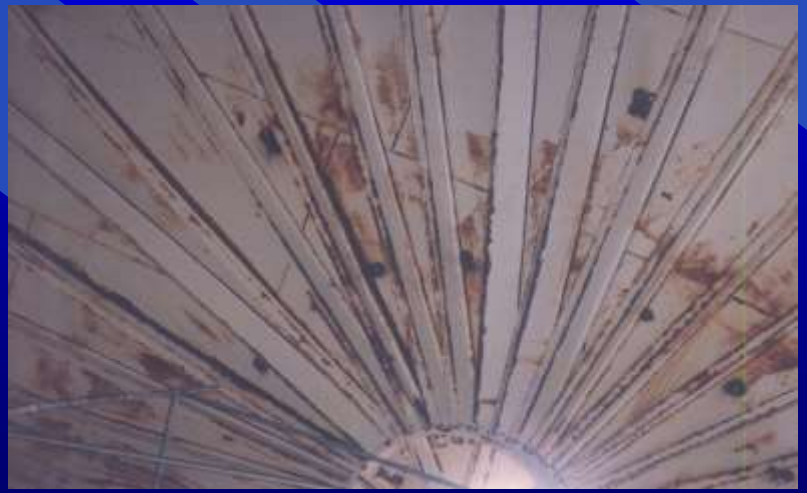
- Drained
- ROV
- Dive

Drained Evaluation Benefits

- Tank has been drained and silt removed
- Thoroughly evaluate surfaces that are adjacent to ladders and that can be accessed by rigging
- Measure metal loss in water-bearing surfaces

Drained Evaluation Disadvantages

- Tank must be removed from service
- Condition of roof structure require further evaluation



ROV Evaluation

ROV Evaluation Benefits

- Tank not removed from service
- Easy to combine with a “raft” evaluation
- Get a general idea of coating condition

ROV Evaluation Disadvantages

- Measurements limited
- Extensive silt can reduce visibility
- Does not remove silt
- Cannot be performed if ice caps in tank

Diving Evaluations

Dive Evaluation Benefits

- Removed from service for minimal time period
- Easy to combine with a “raft” evaluation
- Get a general idea of coating condition
- Can measure metal loss found in water-bearing surfaces, piping, column bases

Dive Evaluation Disadvantages

- Tank must be removed from service briefly
- Extensive silt can reduce visibility
- Cannot be performed if ice caps in tank

OSHA 29 CFR Part 1910, Subpart T – Commercial Diving Operations

- Valid Commercial Diving Certification
  - Association of Diving Contractors
  - International (ADCI)
  - Diver Certification Board of Canada (DCBC) Company Field Records. This includes the company's dive logs and the diver's personal dive logs.

Commercial Diving Certification

- 434 Hour Program of Classroom and Dive Time
- Approx. $40,000 per diver

OSHA 29 CFR Part 1910, Subpart T – Commercial Diving Operations

- Company Training Programs Completion Statements or Equivalent Proof of Competency
- Safe Practices Manual

Navy EM385-1-1

Navy HASP

- Dive Operations Plan
- Activity Hazard Analysis (AHA)
- Site-Specific Risk Assessment
- Emergency Management Plan
- Dive Personnel Qualifications
- US Navy Dive Tables

Activity Hazard Analysis (AHA)

Activity/Work Task: Diving	Overall Risk Assessment Code (RAC) (Use highest code) **M**
Project Location: 2 tanks at the Naval Air Station Corpus Christi, TX	**Risk Assessment Code (RAC) Matrix**
Contract Number: N62583-10-D-0340	
Date Prepared: 11/25/2013	
Prepared by (Name/Title): Jennifer Coon, CHMM, CET Safety Director	
Reviewed by (Name/Title):	
Notes: (Field Notes, Review Comments, etc.)	

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each "Hazard" with identified safety "Controls" and determine RAC (See above)

"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom or Unlikely

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

- E = Extremely High Risk
- H = High Risk
- M = Moderate Risk
- L = Low Risk

Job Steps	Hazards	Controls	RAC
1. Spread tarp on roof adjacent to manhole 2. Disinfect wetsuit (see Disinfection AHA) 3. Enter tank (see Confined Space Entry AHA) 4. Perform evaluation while diving 5. Exit tank	Oxygen deficiency Engulfment Fatigue	Use air monitor continuously; diver must have back-up air bottle Lockout/tagout of all valves for filling/emptying the tank as well as electrical controls Maintain communications between diver and crew Review emergency response procedures prior to each dive Inspect all dive and safety equipment prior to each use	M M M

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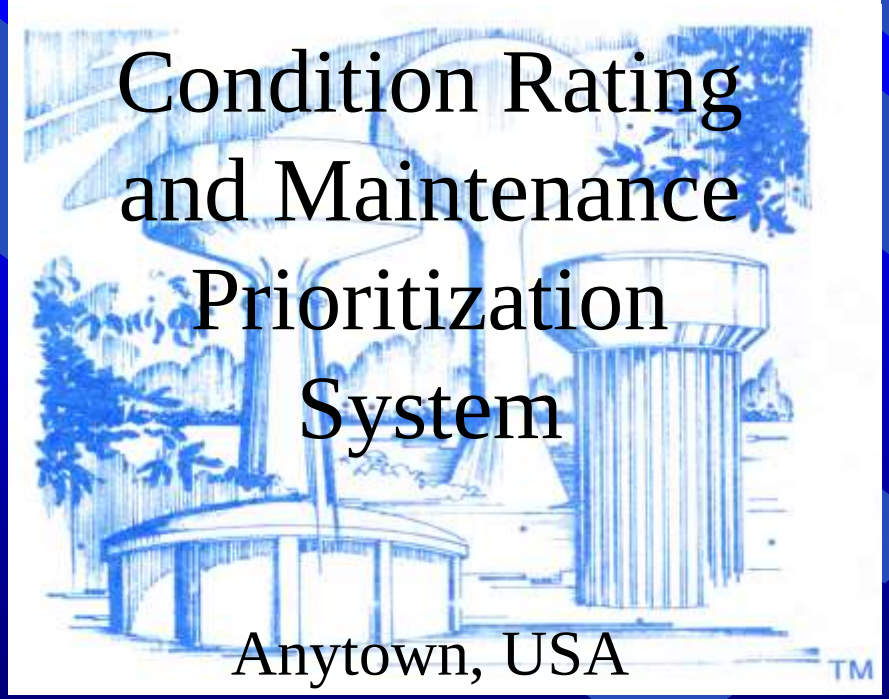

Condition Rating and Maintenance Prioritization System

Anytown, USA

What is it?

- A computerized management tool for comparing the relative overall condition of the infrastructure within the same water system in order to simplify long-term maintenance prioritization.

Why use it?

- To estimate the cost of the forecasted maintenance schedule and better manage maintenance priorities and funds.
- Baseline for smaller systems to develop maintenance program

Baseline to Establish Tank Management Program or Inventory

Owner	State	Start	Finish	# Tanks
Harrisonburg	VA	2011	2015	13
New Jersey American	NJ	2008	current	142
West Virginia American	WV	2005	current	180
Virginia American	VA	2008	current	47
Annapolis	MD	2015	2015	8
MUA Westmoreland	PA	2014	2014	62
Chesapeake	VA	2001	2007	12
Pennsylvania American	PA	1998	current	424
Greater Cincinnati Water Works	OH	2003	2003	12
Ohio American	OH	2011	2011	123
Montgomery County	OH	2016	current	14
City of Johnson City	TN	2010	2010	20
Nashville METRO	TN	2012	current	42
Indiana American	IN	2016	current	104
Illinois American	IL	2017	current	117
St. Paul	MN	2013	2013	16
Kentucky American	KY	2012	2012	24
Rio Rancho	NM	2016	2016	15
New Mexico American	NM	2007	2007	9
City of Orange	CA	2008	2008	18
Arizona American	AZ	2007	2007	11
California American - Village District	CA	2007	2007	22
Navy	Various	1990	current	577

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System Size

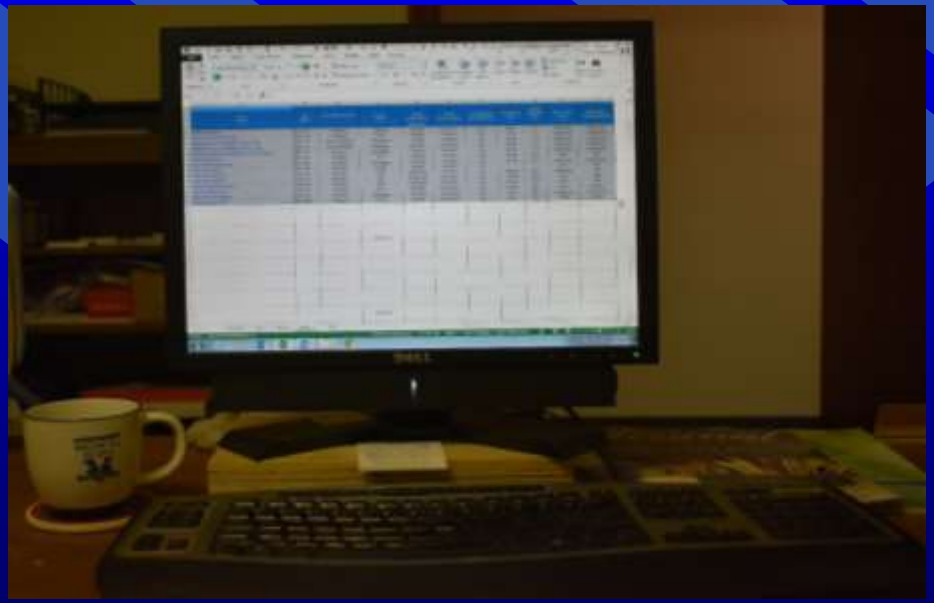
Less than 10 to more than 500

Elements of System

- Field and Engineering Evaluation
  - Numerical ratings for various aspects of the tank including:
    - Structural Condition
    - Sanitary Condition
    - Safety Condition
    - Coating Condition
    - Corrosion Protection
    - Seismic Analysis
    - Tank and Site Security

Elements of System

- Transfer Data into Program



Elements of System

- Program performs multiple logical and mathematical functions to determine, among other things:
  - Style of tank
  - Condition of the exterior coatings
  - Condition of the interior coatings
  - Presence of regulated heavy metals in the coatings
  - Seismic rating (if applicable)
  - Structural rating
  - Safety rating
  - Sanitary rating
  - Overall comparative rating tanks within the system.

Elements of System

- Economic Factors
  - Based on the determined scope of work

Spreadsheet

Maintenance Prioritization Template

A	B	C

- Data entry from field evaluation

Maintenance Prioritization Template

A	B	C

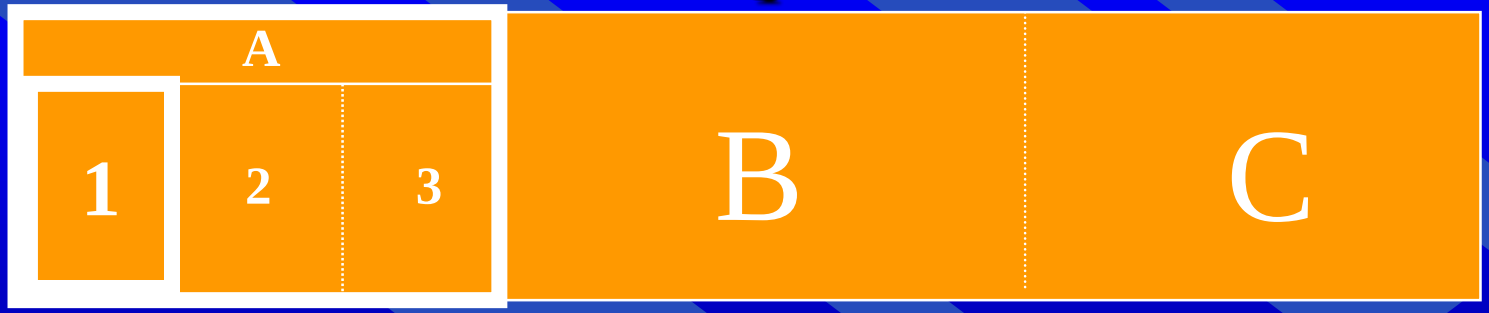
- Mathematical Calculations and Logic

Maintenance Prioritization Template

A	B	C

- Tank Data
- Rankings & Characteristics
- Budgets

Maintenance Prioritization Template



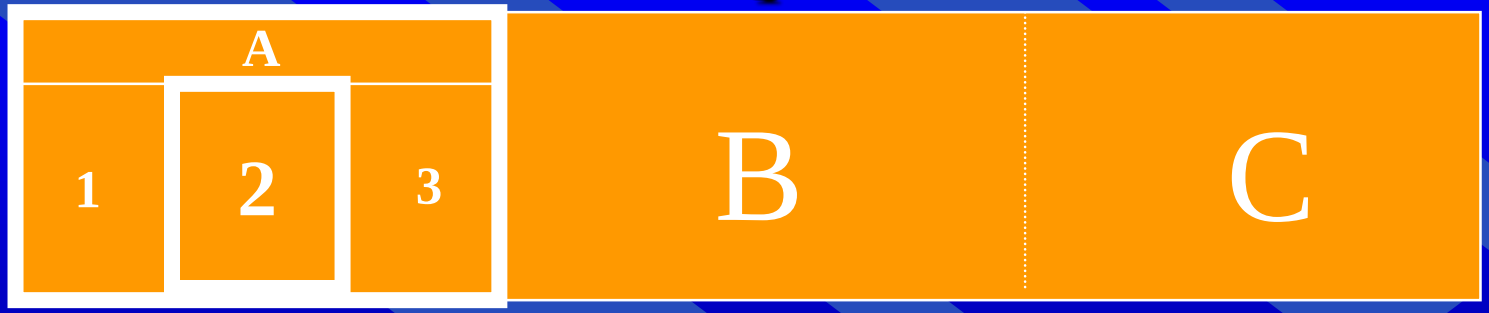
A. Rankings

1. Tank Data

- Name
- Pressure Zone
- HWL
- Heavy Metals
- Tank Style
- etc...

TANK NAME	TIC JOB #	CONSTRUCTION	TANK TYPE	TANK CAPACITY (gallons)	DATE EVALUATED	CATHODIC PROTECTION	DIAMETER (FT)	SHELL HEIGHT (FT)	ERECTION DATE	ERECTION CONTRACTOR
Aldrich Unit #1	E012.165	Welded	Aldrich	500,000	2/13/2017	No	86.50	12.5	Unknown	Unknown
Roosevelt Avenue Tank	E012.124	Welded	EWT	750,000	3/9/2017	No	70.0	7.1	Unknown	Unknown
Highland Ave. Standpipe, East Tank	E012.175	Riveted Shell	Standpipe	175,000	3/28/2017	No	20.00	75.6	Unknown	Unknown
Highland Ave. Standpipe, West Tank	E012.176	Riveted Shell	Standpipe	400,000	3/29/2017	No	30.00	75.5	Unknown	Unknown
Haddon Heights Standpipe #1, West Tank	E012.177	Riveted	Standpipe	63,000	4/4/2017	No	11.80	75.0	Unknown	Unknown
Hutton Hill Tank	E012.170	Welded	GST	2,500,000	5/4/2017	No	83.00	60.0	1969	CBI
Crest Drive Reservoir	E012.184	Welded	Standpipe	1,500,000	5/5/2017	No	65.50	79.0	Unknown	Unknown
Newstead Tank	E012.185	Welded	Single	200,000	5/6/2017	No			1952	CBI
Oak Tree Tank #2	E012.173	Welded	GST	10,000,000	6/7/2017	No	169.00	60.0	Unknown	CBI
Oak Tree Tank #1	E012.172	Welded	GST	10,000,000	9/21/2017	No	170.00	60.0	1963	CBI
Fellowship Road Tank	E012.182	Welded	GST	2,000,000	9/27/2017	No	92.00	41.0	1967	CBI
Sunset Road Tank	E012.171	Welded	GST	460,000	10/16/2017	No	65.00	16.5	1972	Fisher
Gibbsboro Standpipe	E012.138	Welded	Standpipe	1,500,000	10/19/2017	No	51.0	98.2	Unknown	Unknown
Walnut Glen Tank	E012.098	Welded	GST	200,000	11/30/2017	No	40.0	24.0	1988	Fisher

Maintenance Prioritization Template



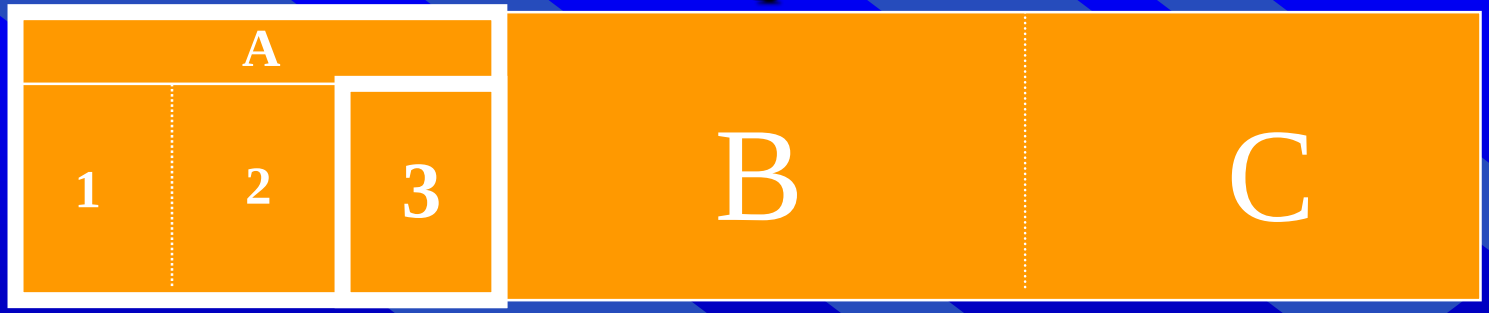
A. Rankings

2. Tank Rating

- **Structural**
- **Safety**
- **Sanitary**
- **Security**
- **P/C/M**
- **Seismic**
- **Weighted Combination**

TANK NAME	TIC JOB #	TANK TYPE	TANK CAPACITY (gallons)	SAFETY RATING	SANIT. RATING	STRUCT. RATING	EXT. PCM RATING	INT. PCM RATING	OVERALL RATING
Aldrich Unit #1	E012.165	Aldrich	500,000	92	100	89	60	53	79
Roosevelt Avenue Tank	E012.124	EWT	750,000	62	65	69	52	20	54
Hummocks Spheroid	E012.96	Spheroid	250,000	64	0	95	85		49
Highland Ave. Standpipe, East Tank	E012.175	Standpipe	175,000	68	0	60	27	13	34
Highland Ave. Standpipe, West Tank	E012.176	Standpipe	400,000	75	0	0	27	22	25
Haddon Heights Standpipe #1, West Tank	E012.177	Standpipe	63,000	86	0	67	27	24	41
Hutton Hill Tank	E012.170	GST	2,500,000	72	0	70	53	53	50
Crest Drive Reservoir	E012.184	Standpipe	1,500,000	71	0	56	8	18	31
Newstead Tank	E012.185	Single	200,000	0	0	79	29	23	26
Oak Tree Tank #2	E012.173	GST	10,000,000	78	0	57	60	60	51
Oak Tree Tank #1	E012.172	GST	10,000,000	78	0	79	70	44	54
Fellowship Road Tank	E012.182	GST	2,000,000	89	95	80	70	24	72
Sunset Road Tank	E012.171	GST	460,000	92	0	0	80	13	37
Gibbsboro Standpipe	E012.138	Standpipe	1,500,000	100	100	100	100	100	100
Walnut Glen Tank	E012.098	GST	200,000	92	0	100	95	93	76

Maintenance Prioritization Template



A. Rankings

3. Budget Factors

- **Historical**
- **Forecasted**

TANK NAME	TIC JOB #	2018 ESTIMATED FUNDING	2019 ESTIMATED FUNDING	COMMENTS
Aldrich Unit #1	E012.165		$600,000	Metal loss and missing bolts/nuts on interior surfaces and rake arms.
Roosevelt Avenue Tank	E012.124	$902,000		2017 - Inadequate balcony safety railing dimensions, lack of balcony access, and no interior safe-climbing device
Hummocks Spheroid	E012.96		$721,000	2017 - No overflow screen, no clog-resistant vent, safe-climbing device not located on bottom 12 ft of access tube ladder, no interior wet ladder safe-climbing device.
Highland Ave. Standpipe, East Tank	E012.175	$495,000		Unlocked roof manhole, no safe-climbing device on roof ladder and holes in the top shell ring.
Highland Ave. Standpipe, West Tank	E012.176	$728,000		Gap at vent pallet, unlocked roof manhole, no safe-climbing device on roof ladder, and holes in top shell ring.
Haddon Heights Standpipe #1, West Tank	E012.177	$476,000		No roof vent, no overflow pipe, unlocked vandal deterrent, holes in top shell ring, and ineffective screening at shell-to-roof gap.
Hutton Hill Tank	E012.170		$1,636,000	Warped roof vent pallet and lack of self-closing gate at roof access platform.
Crest Drive Reservoir	E012.184	$1,374,000		No exterior safe-climbing device, holes in roof plates, uncovered cathodic protection anode hand holes, roof vent not of clog-resistant design, and roof manhole unlocked.
Newstead Tank	E012.185	$571,000		3 holes in roof cap plate, inadequate top platform safety railing, no dedicated means of interior wet ventilation, unlocked roof manholes, no access tube ladder safe-climbing device, no interio
Oak Tree Tank #2	E012.173		$3,554,000	Gap at roof vent pallet, and no safety railing on the roof.
Oak Tree Tank #1	E012.172		$3,671,000	Gaps at roof vent pallet and no roof safety railing.
Fellowship Road Tank	E012.182	$1,043,000		Roof exterior could not be accessed at the time of the field evaluation, and no roof safety railing.
Sunset Road Tank	E012.171	$615,000		Holes corroded through the roof plates, gaps at roof vent screening, and no self-closing gate at roof access railing.
Gibbsboro Standpipe	E012.138			2014 - Exterior shell ladder safe-climbing device not installed properly, open roof coupling and flanged and bolted roof manhole not locked. 2015 - Tank rehabilitated. 2017 - First Anniversa
Walnut Glen Tank	E012.098	$61,500		Overflow pipe discharge was not adequatley screened, roof vent was not clog-resistant, no closure chains across roof safety railing opening, and nearly all of the interior roof rafters had twiste

Benefits

- Ease of scheduling and budgeting for tank maintenance.
- Easy-to-understand comparison of all tanks within system
- Allows **PROACTIVE** response to future needs.

Consistent Detailed Evaluations based on Sound Engineering Practices

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Method for Tracking and Rating Maintenance Requirement

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Successful Tank Management Program

Questions?

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