

State-of-the-Art Tools and Techniques for Multidisciplinary Condition Assessments

Tyler Smith Semago, Larry Elliott, Marti Martin, and Seung Park

The City of Tampa owns and operates the David L. Tippin Water Treatment Facility (facility). The facility processes surface water from the Hillsborough River and is permitted to withdraw an average annual daily flow of 82 mil gal per day (mgd), with a permitted maximum-day capacity of 120 mgd. Originally built in the 1920s, the facility has undergone expansions and upgrades and houses thousands of assets that are currently in service. The facility's major systems include mechanical bar screens, Actiflo™ systems, conventional coagulation systems, ozone, biofilters, chemical feed systems, gravity thickeners, pump stations, and clearwells. Since a majority of the existing assets

range from 15 to 40 years in service, a comprehensive master plan was undertaken to determine the remaining useful life and functionality of those assets considering, among other factors, their size, age, efficiency, reliability, and process complexity.

The following disciplines and respective scopes of work were required to complete the assessment:

- ◆ Mechanical - Inspection of process and non-process mechanical equipment, chemical feed and storage systems, and pumping systems.
- ◆ Structural - Inspection of water-bearing structures, building superstructures, and structural components of mechanical equipment.

Tyler Smith is with Carollo Engineers in Tampa and Larry Elliott is senior vice president with Carollo Engineers in Orlando. Marti Martin is lead programmer and Seung Park is chief engineer with City of Tampa Water Department.

- ◆ Architectural - Inspection of each building interior and exterior; roofing; lighting; lavatories; heating, ventilation, and air conditioning (HVAC); and fire suppression systems.
- ◆ Electrical - Inspection of electric power supply and distribution systems, building electrical systems, and electrical components of mechanical equipment.
- ◆ Civil - Inspection of onsite paving, roadways, drainage, and easily accessible lift stations and manholes.

Instrumentation and controls, and assets under \$5,000 in value and not critical to plant operations, were not evaluated under this project. In order to complete this task in the most efficient manner, the AWWA Research Foundation "Water Treatment Plant Infrastructure Assessment Manager" (Manager) software was utilized in conjunction with a newly developed android tablet software and field tablets.

Methodology

The Manager desktop software, originally developed in the early 2000s, utilizes a tree structure hierarchy to aid in organization and management of systems ranging in complexity from simple pump stations to complex multi-process systems (i.e., ozone). The software's main purpose is to assist in organizing and recording results of the physical and operating characteristics of any system within a water treatment plant and help identify assets most critical and in need of attention (Elliott and Stecklein, 2002). The desktop software is free to download for any American Water Works Association (AWWA) or Water Environment Federation (WEF) member via the Water Research Foundation (WRF) website under the "Resources" section.

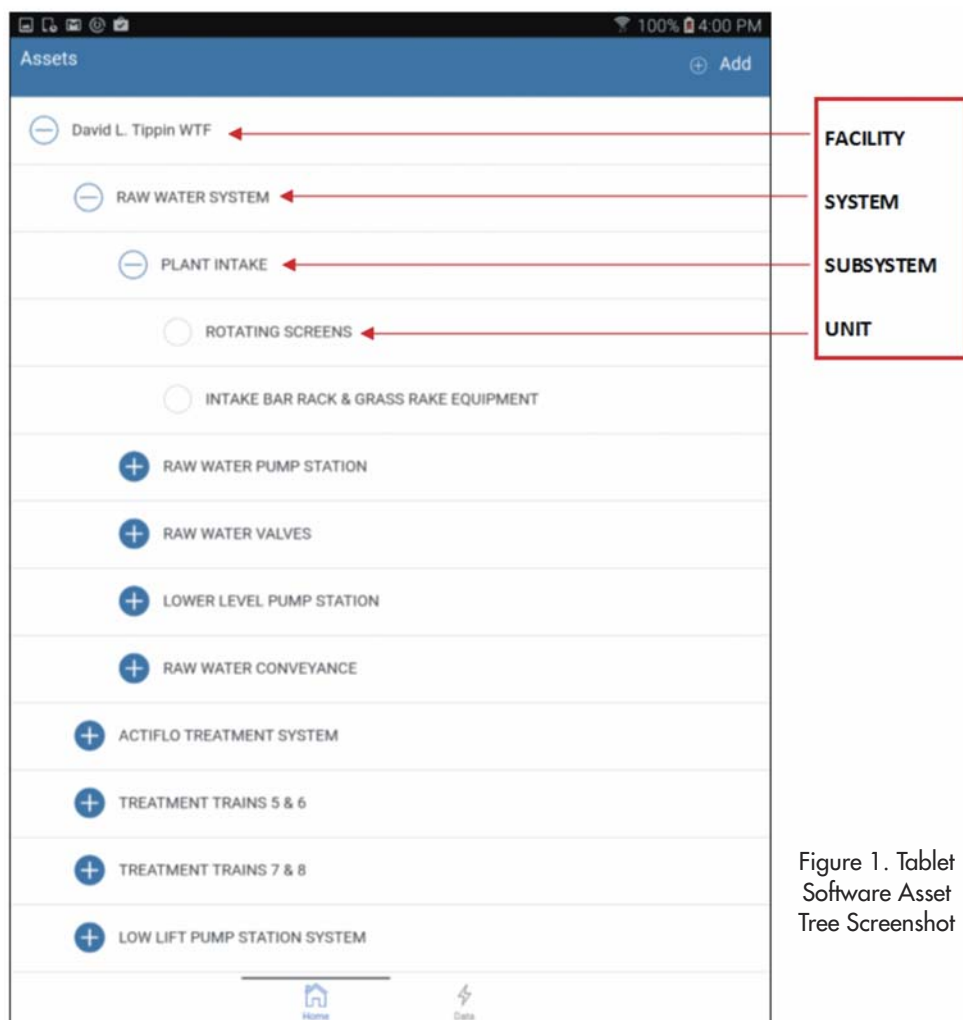


Figure 1. Tablet Software Asset Tree Screenshot

Tablet Software Application

Additional programming and modifications were needed in order to fully utilize the benefits of this software in the field. A software application was created to allow for the use of specific aspects of the Manager desktop software on an android platform tablet. These specific aspects included the ability to:

1. Define applicable unit discipline(s), unit type, and estimated useful life.
2. Ability to add systems, subsystems, and units while in the field.
3. Ability to add questions/components under the physical condition, assessment, and/or supplemental information tabs for any unit.
4. Assign a percent weight (or importance) to a unit within a subsystem.
5. Assess units and assign scores for overall condition, criticality, estimated replacement value, and safety impact.
6. Automatically calculate overall score of a subsystem, system, and facility.
7. Provide comments for physical, operational, and supplementary aspects of a unit.

The tablet also provides the ability to use “talk-to-text” for taking notes and is able to cap-

ture photos for each unit. This helps save time in the field, while also minimizing confusion when trying to recall any particular asset evaluated under any particular subsystem (i.e., a specific pump in a pump station). Another difference between the desktop and tablet software was the desire to use a different condition-naming convention. The tablet software was programmed to utilize the International Infrastructure Management Manual (IIMM) condition scoring nomenclature.

Pre-Data and Post-Data Management

Extensive preparation was required before use of the tablets in the field for the condition assessment due to the number of assets and major treatment processes. The City of Tampa provided a comprehensive asset inventory list based on the terminology and nomenclature in its existing computerized maintenance management system (CMMS), which, after consolidation and/or elimination of some assets, resulted in the manual input of 16 systems, 96 subsystems, and 771 units into the Manager desktop software. If formatted properly, there is the ability to convert an Excel file with the listed assets to a Microsoft Access database file, which can

then be imported into the software, thereby eliminating this manual step.

After creation of the organized tree in the desktop software, the data were then exported as a database file (.dbf) and imported into the tablet software utilizing a desktop program coded by the programmer. Figure 1 shows a screenshot from the tablet software illustrating the tree structure organization: Facility > System > Subsystem > Unit.

The systems and subsystems were organized by engineering discipline (mechanical, structural, electrical, and architectural) and uploaded to four tablets for each discipline team, respectively; for example, the electrical engineers received a tablet that only contained electrical assets to be evaluated. This helped expedite the assessment process by eliminating extraneous assets that were not pertinent to that assessment team. Laminated field guides were also created for each discipline team to help facilitate the use of the tablet and condition assessment process.

After the field assessments were completed, the scored units and data were exported and copied from the tablets, compiled, and imported

Continued on page 40

Continued from page 39

back into the Manager desktop software using Microsoft Access database files and manually written queries by the programmer. Additionally, a script was written and programmed so that the photos could be labeled and imported with their appropriate assets.

Results

The Manager desktop software has the ability to generate a number of reports, including a unit data report that comprehensively contains all the scoring and comments related to the physical, operational, and supplemental information aspects for all units within an entire facility. An example of this report is shown in Figure 2.

The unit data report was used to verify assessment completeness, aid in quality control, and provide a foundation for a chapter in the master plan document as described:

- Assessment Completeness Verification

- Asset units without rating or comments were identified to be verified with the inspection discipline team to check whether the assessment was erroneously missed or unit actually didn't exist in the field
- Asset units with missing component scores were identified and scoring determined based on accompanying photos
- Quality assurance/quality control tailored reports for each discipline created and sent to each team for thorough review
 - Teams could comment on reports and edit scores or add notes or clarifications if needed
- Chapter in the master plan document
 - Comments on physical aspects used to justify condition scoring
 - Operational information used to justify criticality scoring
 - Supplemental information used to develop background and/or historical information on asset

Due to the preferred IIMM method of condition assessment scoring (i.e., condition score ranging from 1 to 5, risk, evaluated remaining useful life, etc.), the desktop software was not utilized for overall weighting and scoring calculations. Therefore, the database was exported from the desktop software to a workable Excel file that organized the assets by facility, system, subsystem, unit, and discipline, allowing for easy management and calculation of condition fractions, evaluated remaining useful life, vulnerability, and risk.

Discussion

Facility and condition assessment can be a major effort, especially at larger facilities with complex treatment processes. The utilization of field tablets and the Manager tablet software can help eliminate the need for excessive paperwork and field materials, allow for easy discipline separation, provide ease of note-taking and documentation through talk-to-text and camera features, allow for quick navigation from one asset to another, and more.

Like conventional condition assessments, preparation and post-data management is required and can be extensive given the number of assets; however, such efforts can be significantly reduced through the use of the desktop software. Clients have the option to utilize the software's built-in scoring and weighting system or can manage and analyze the data themselves via an exported Microsoft Excel file and/or reports with the same goal of prioritizing the units in most need of rehabilitation, repair, or replacement. Additionally, the exported Microsoft Excel files, when formatted properly, can be imported to a utility's existing CMMS.

Due to the recent creation and development of the tablet application, a number of data importing and exporting efforts (between the desktop and tablet) were manually completed by an experienced programmer, and automation of functionalities that were helpful for the end user required additional programming efforts; however, the Manager desktop software is free and readily available, unlike expensive proprietary software out on the market. This efficient approach to facilities evaluations, condition assessments, and benchmarking could significantly reduce data collection error and provide valuable information for report writing and presentation of results.

References

- Elliott, L.E., Stecklein, M. "Infrastructure Manager Software Provides Comprehensive, Multidiscipline Plant Assessment." *Journal AWWA*, 94:1:60. 2002. ◊

Unit Data Report			
DLTWTF UNIT			
Sort Order : Data Tree Order			
Current Year: 2016			
Facility Name: David L. Tippin WTF			
System Name: RAW WATER SYSTEM			
Subsystem Name: PLANT INTAKE			
Unit	Rotating Screens	Criticality Moderate	Condition 2 - Satisfactory
Weight 0 %			
Unit Type: Screening			
Discipline Type(s): Electrical Mechanical			
Safety Impact: N/A or Unknown		Safety Comments:	
Item	Observation	Comment	
Assessment Consideration	Overall Reliability = Good		
Assessment Consideration	Overall Functionality = Good	Functionality improved if channel is reversed and dumpster placed at end to collect debris	
Assessment Consideration	Spare Parts Availability =		
Assessment Consideration	Corrosion = Severe		
Assessment Consideration	Equipment Vibration = Minimal		
Physical Assessment	Bars/ Screen = Good		
Physical Assessment	Drive/ Chain = Unsatisfactory	#2 and 3 need replacement	
Physical Assessment	Flushing Connections = Unknown		
Physical Assessment	Frame = Inoperable	Structural members poor condition	
Physical Assessment	ROTATING SCREEN MOTORS = Good	Spare parts available	
Physical Assessment	ROTATING SCREEN GEARBOXES = Unknown		
Physical Assessment	Misc piping = Satisfactory		
Supplemental Info	Identification / Tag Number		
Supplemental Info	Manufacturer name		
Supplemental Info	Number of redundant units	1	
Supplemental Info	Screen Type	Traveling Water Screen	
Supplemental Info	Screen/ Rack Materials	Fiberglass	

Figure 2. Unit Data Report From Manager Desktop Software