Heat Impacts on Infrastructure & Personnel: A Miami-Dade Water and Sewer Case Study

Final Report

Resilient Analytics

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Executive Summary

Miami-Dade Water and Sewer Department (WASD) will experience several vulnerabilities due to future increases in extreme heat events as a result of projected changes in climate. Resilient Analytics (RA) is using a climate stressor methodology to analyze the impact of such extreme temperature events on critical WASD physical infrastructure assets and personnel. The methodology focuses on examining the effects of extreme temperatures on personnel and facilities in the years 2030, 2050 and 2070, compared to a 1990 to 2009 baseline. Note that projected costs do not account for inflation.

Increases in daily heat index and daily maximum temperatures will put additional stress on the outdoor workers. This could lead to additional workplace accidents resulting in additional costs for WASD.

- By 2030, it is projected that the WASD service area will see an additional:
  - eight weeks of temperatures over 90°F
  - six days of temperatures over 95°F each year.
- By 2070, it is projected that the WASD service area will see an additional:
  - 13 weeks of temperatures over 90°F
  - 4.5 weeks of temperatures over 95°F each year
  - one day of temperatures over 100°F every three years.
- If WASD does nothing, the risk of workplace accidents and injuries is estimated to increase by as much as 5% by 2070 for RCP 8.5.
- The number of **High Heat Index** (Heat Index of 103°F to 124°F)[1] days is estimated to increase from 13 days to:
  - 27 days by 2030
  - 54 days by 2070.
- The number of **Extreme Heat Index** (Heat Index of 125°F or higher) days is estimated to increase from 17 days to:
  - 20 days by 2030
  - 28 days by 2070.
- A national heat stress standard could be put into place, which would require WASD to follow a regulated work/rest cycle. Implementing a standard work/rest cycle will help to avoid additional worker accidents and fatalities from increased heat.
- To offset losses in productivity associated with increases in work/rest cycles, **WASD should implement scheduling related adaptation strategies to reduce exposure to mid-day heat.** One example would be to flex outdoor worker schedules to earlier in the morning. Under this scenario, WASD would see savings from increased productivity. Annual savings range from $32,000 to $241,000 in 2030 and $76,000 to $869,000 in 2070 depending on the heat standard.

The facilities and assets owned and operated by WASD will also experience additional stress due to increases in temperature. Cooling operating costs are projected to increase and the increase in outdoor temperature is projected to reduce the lifespan of critical assets.

- Cooling costs are projected to increase by:
  - 11% to 12% by 2030
  - 16% to 22% by 2050
  - 24% to 31% by 2070.

- From 2021 to 2080, the average increase in cooling cost the facilities included in this study is projected to be between $3.0 million and $3.8 million.
- We recommend these additional costs to be considered in near- and long-term budget planning.
- **We recommend that WASD upgrade aging and inefficient cooling equipment, including chillers and air handling units, to equipment with progressive efficiency ratings which will help to offset additional cost of cooling. Emphasis should be placed on equipment that is near the end of its useful life with efficiencies worse than modern energy codes and design guidelines.**
- **We recommend that the South District Wastewater Treatment Plant cooling system be prioritized.** The facility has a large cooling demand, so a replacement will yield more savings. Further analysis will need to be done internally by WASD to prioritize which system should be upgraded/replaced. We recommend the prioritization be based on efficiency, size, and time to end of life.
- Equipment that operates in spaces with high ambient operating temperature (unconditioned spaces, confined spaces, actively cooled spaces with undersized cooling systems, etc.) will have shorter lifespans. For such spaces **we recommend investigating the cost/benefit of installing, or upgrading in the case of an undersized system, a cooling system to control the indoor temperature and limit equipment lifespan degradation due to high temperature operation.**
- Confined space temperature is heavily influenced by outdoor air temperature and is projected to increase significantly (see Figure 10). **Additional safety measures/protocols need to be considered for workers in these spaces due to the increase in temperature.**
- **We recommend that indoor temperature be monitored in unconditioned spaces to determine the actual annual indoor space temperature profile.** This information can better inform motor lifespan reduction analyses, motor replacement cost analyses and cost benefit analysis of installing active cooling in unconditioned spaces.
- **We recommend that indoor temperatures be monitored in actively cooled spaces** to determine whether the cooling system is providing the necessary and expected cooling effect. If elevated temperatures are seen, or temperatures show a trend of increasing, we recommend investigating the cost/benefit of installation of additional cooling capacity as mentioned above. Additionally, the installation of extra cooling capacity can be evaluated now in anticipation of increasing outdoor air temperatures.
- The susceptibility of an indoor facility's temperature to change in response to changing outdoor air temperature can be reduced using various building improvements. These include **increased envelope insulation, tighter air sealing to prevent infiltration of outdoor air, and pre-conditioning ventilation air that is brought into the space**. We recommend for WASD to evaluate the cost/benefit of retrofitting existing facilities with such features to minimize the heat load inside of any given facility due to outdoor air temperature. We also recommend that WASD reviews its engineering specifications for new construction with the intent of minimizing heat gain from the outdoors in new facilities.
- **In addition, to prolong motor lifespan as ambient operating temperature increases WSAD can investigate the installation of motors with higher NEMA ratings.** Motors with higher NEMA ratings will cost more but can also withstand higher operating temperatures. However, a higher NEMA rating doesn't directly equate to the motor being able to withstand higher ambient temperatures without loss of life because motors with higher temperature ratings may also have a higher temperature delta between when the motor is off and when it is at full capacity

operation, negating any increase in allowable ambient temperature[21]. When replacing or rewinding motors in the future, we recommend to evaluate the potential for extending the life of the motor by determining the allowable ambient operating temperature of the motor and then weighing the upfront cost versus the cost savings from any increase in the motor lifespan due to the increased allowable ambient operating temperature.

- Besides ambient operating temperature, motors overheat and prematurely fail due to several other factors that should be mitigated. These factors include dirt, improper and/or imbalanced voltage, frequent start/stop cycles, and others. **We recommend closely monitoring the operation and maintenance schedules of each motor to optimize the motor lifespan.**
- At times when the space temperature setpoint (temperature for which the cooling system is sized and set to maintain) is higher than the outdoor air temperature **an airside economizer can be used to circulate untreated outdoor air to help cool the space.** This strategy is commonly used to save energy in a comfort cooling application where the space would be maintained at the cooling setpoint during airside economizer operation. However, in spaces where comfort is not a priority (mechanical spaces, pump rooms, etc.), an airside economizer may be able to be used to achieve indoor space temperature lower than the cooling setpoint during periods where the outdoor air temperature is some temperature below the cooling setpoint (depending on fan capacity). However, the system's fan airflow capacity may need to be increased to achieve this effect. Theoretically, according to the 10-degree rule, this would extend motor lifespan. However, economizer use would affect other factors that impact motor lifespan such as humidity, temperature fluctuation, and others as noted above. For this reason, investigation with the motor manufacturer, building engineers, and local code authorities should be undertaken along with a cost/benefit analysis prior to initiating such airside economizer operation.
- This report is only able to present incremental replacement-per-motor and $/hp values due to the absence of motor quantity and motor value information for each building and site. We recommend that Miami WASD collect this information and apply the incremental values presented int his study to calculate the magnitude of increased replacement quantities and costs that face each building and site due to the projected increase in outdoor air temperature.