Not Enough Space—Now What? Rehabilitation of the Krause Pumping Station in Tampa

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The City of Tampa's Krause Pumping Station (station) is located on South Ashley St. between the City of Tampa Convention Center and the Hillsborough River. As shown in Figure 1, the station is adjacent to the city's Riverwalk, immediately south of the Lee Roy Selman (Crosstown) Expressway, and across the street from the convention center parking building. The station has been active since construction was completed in 1952 and predates all facilities in the vicinity. Several modifications have been made to the station over the years; however, it was in need of its first major refurbishment.

The main focus of the city was to increase the capacity of the pump station to meet the future demands of the booming redevelopment of downtown Tampa. In addition, there was a focus to make this pump station more resilient. This station is a major collection system asset located directly adjacent to the Hillsborough River and subject to major flooding in the event of a major storm.

The goals of this project were to:

- Improve overall reliability
- Upgrade all equipment within the facility
- Protect the facility from the 100-year flood
- Meet all current building codes
- Meet all current permit conditions for wastewater pumping stations

There were several challenges presented during the course of the design, most of them related to the very compact layout of the facility and the lack of space within the pump station site to perform the necessary upgrades. As shown in Figures 2 and 3, the station falls within Flood Zone A of the Federal Emergency Management Agency (FEMA) flood insurance rate map (FIRM), and thus, all new equipment needs to be protected against a 100-year flood. This presented a significant challenge because it was to be accomplished without any major structural modifications to the building.

Another significant challenge included bypassing the station during the active construction period and the layout of bypass pumping equipment within the site constraints. Because of the proximity to the city's Riverwalk, the layout of temporary equipment, including bypass pumps and piping, needed to be clear of the Riverwalk so that the venue remained open during construction. Additional design constraints included improvements to the screening room to improve the convenience and efficiency of the debris removal from the screens, something that was very difficult to accomplish in the very compact structure.

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Design Approach

The interactive design process between the city staff and the consultant team was the basis for selection of the solutions imple-

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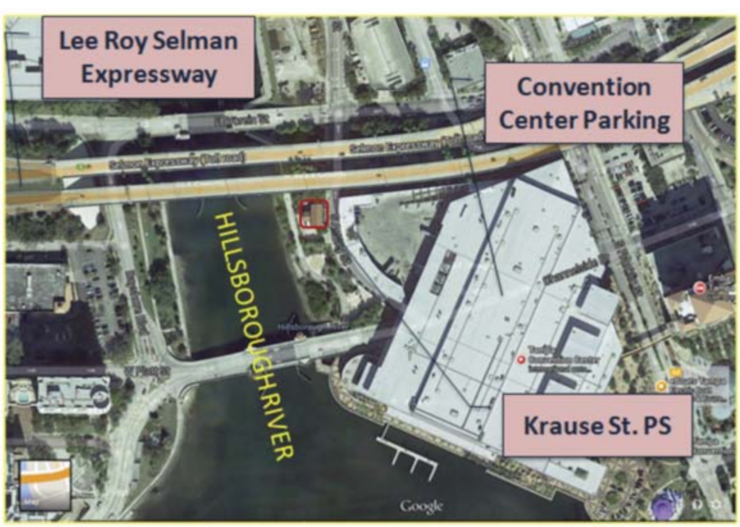

Figure 1. Location of Krause Pumping Station

Figure 2. Krause Pumping Station Location in Relation to Flood Zone

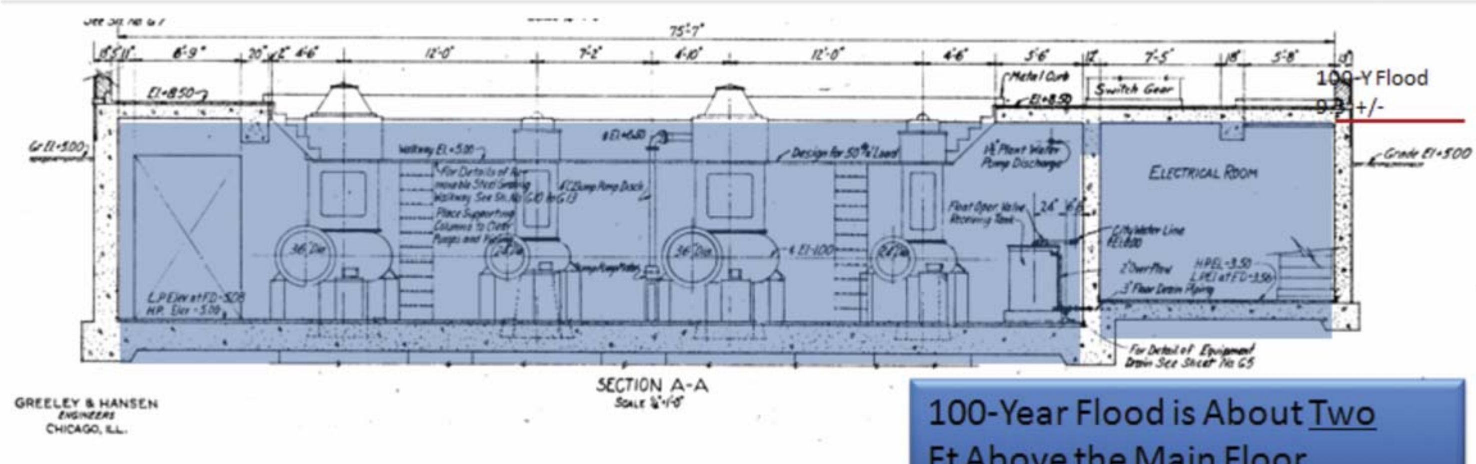

Figure 3. Existing Krause Pumping Station: Section View

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mented for this project. This article focuses on the following:

- Flood resiliency and equipment selection
- Bypass pumping considerations
- Improvements to screening debris handling

Flood Resiliency and Equipment Selection

The existing pump station had four pumps: two 100-horsepower (HP) jockey pumps with "MagneTek" adjustable frequency drives (AFDs), one 300-HP constant speed pump, and "Big Bertha," a 400-HP constant speed pump. All of these pumps have been in place since 1952.

Wastewater is received from interceptors that enter the screen area from the north and from the west (under the Hillsborough River through a siphon).

The design flows provided by the City of Tampa Wastewater Department were as follows:

- Low flow: 7,000 gal per minute (gpm) or 10 mil gal per day (mgd)
- Average flow: 17,000 gpm or 24.5 mgd
- Peak instantaneous flow: 45,000 gpm or 64.8 mgd

These flows need to be met under current and anticipated future operating conditions. The force main from the station to the Howard F. Curren Advanced Wastewater Treatment Plant (AWTP) was constructed along with the station in 1952, but includes some newer sections. The city plans to reroute a portion of this force main in the future, which will slightly increase the total pumping head. System curves were prepared to reflect both current and future operating conditions. Given the great differential between the low-flow condition and the peak condition, three operating pumps were selected to convey peak flow. Figure 4 shows the system curves, together with the pump curves, for the station. This figure shows that if the pump were installed with a smaller impeller, it could meet the initial conditions, with a nonoverloading (NOL) power requirement of 316 HP. This still necessitates a 400-HP motor.

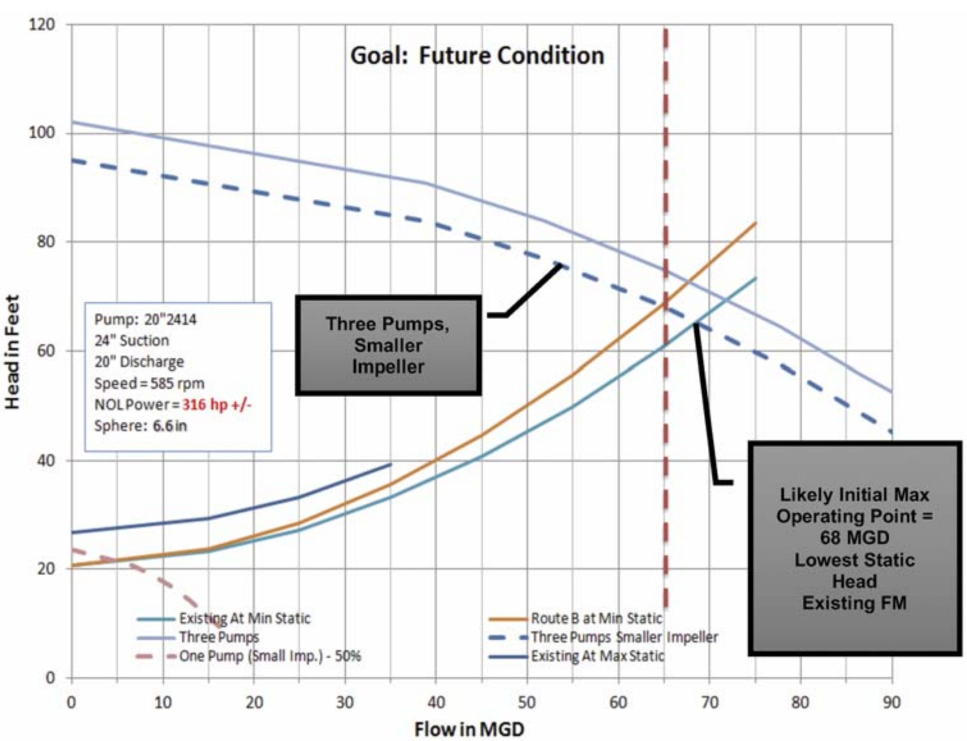

Figure 4. Krause Pumping Station Pump and System Curves

The existing pump station has limited space; thus, providing elevated motors with extended shafts was impractical for this application as it would have required significant structural changes within the facility, including removing the existing bridge crane, beams, and roof to elevate the ceiling of the structure. Other alternatives for flood-proofing were evaluated, including a perimeter flood wall, which was considered to be potentially visually disruptive to the area, and to flood-proof the station by means of replacing any potential entry and exit point with flood-resistance options, such as marine doors. These alternatives were rejected because of the possibility that flooding could occur within the building though the sewer and the wet well.

The recommended solution was to provide pumps with vertically coupled, blower-cooled, immersible motors to provide flood protection and locate critical electrical equipment above the 100-year flood level. These immersible motors can withstand up to 30 ft of submergence depth for a two-week period, which was deemed sufficient time for any localized flooding to subside and the city to take corrective measure to dewater the station lower level without compromising the equipment.

A disadvantage of using immersible motors is that they are uncommon for wastewater sewage applications in this area; however, Tampa Armature Works (TAW), one of the largest motor maintenance services providers in the area and commonly used by the city for its services, indicated that it is equipped and capable of providing maintenance and repairs of immersible motors from 3 HP to 7,000 HP. Considerations were given to installing submersible motors in a dry pit application; however, the conceptual analysis of this solution would have resulted in a significant cost impact to the city.

Figure 5 shows a section of the proposed design and Figure 6 shows a view of the installed pump and motors. In addition to protecting the pumping equipment, submersible, electrical, and pneumatic-rated actuators were required for the knife gate isolation valve and the discharge pump-check plug valves, respectively, which are permanently located in the pump room and below the 100-year flood elevation.

As indicated, the station was designed and constructed in the 1950s. As shown in Figure 7, the existing electrical equipment was located in the basement. Other electrical gear was located on the main floor, but still subject to impact of flooding. It operated over 60 years without major failures; however, it was imperative for the city to make this station flood-resilient.

Bypass Pumping Considerations

The station mainly conveys wastewater from two major interceptor systems: the West River intercepting system conveying flows from west central Tampa and the downtown intercepting system. Both interceptors converge in a chamber immediately west of the pumping station, between the station and the river.

There is a minor tributary sewer that is connected to the station downstream on this chamber and immediately upstream of the influent channels. A major design consideration for the bypass pumping arrangement was to be able to layout the bypass system without creating a raw sewage pool—with its potential odors—that could accommodate the suction piping for the high capacity bypass pumping equipment. As the station is next to the newly inaugurated Riverwalk, it is anticipated that there could be significant pedestrian traffic adjacent to the jobsite, particularly during events such as Gasparilla or the Downtown Arts Festival, among others.

Another major concern was that if the in-

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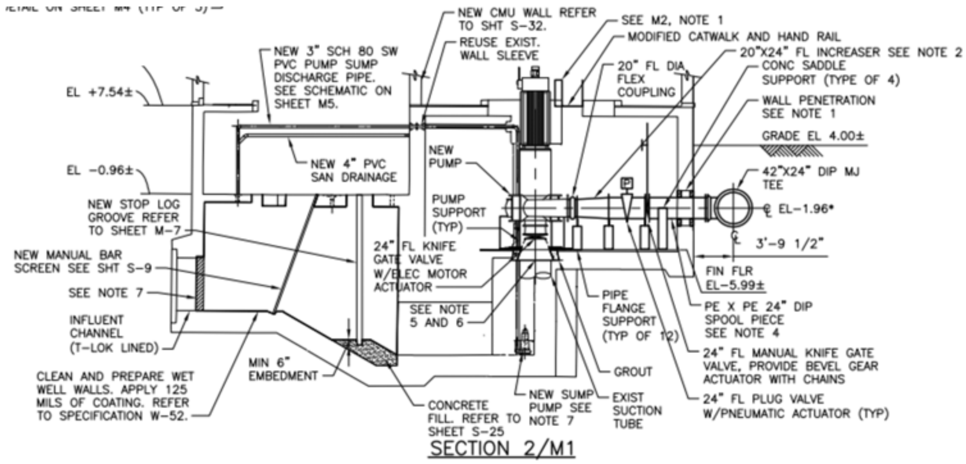

Figure 5. Section View Across Pump Station

Figure 6. New Pumps and Motors

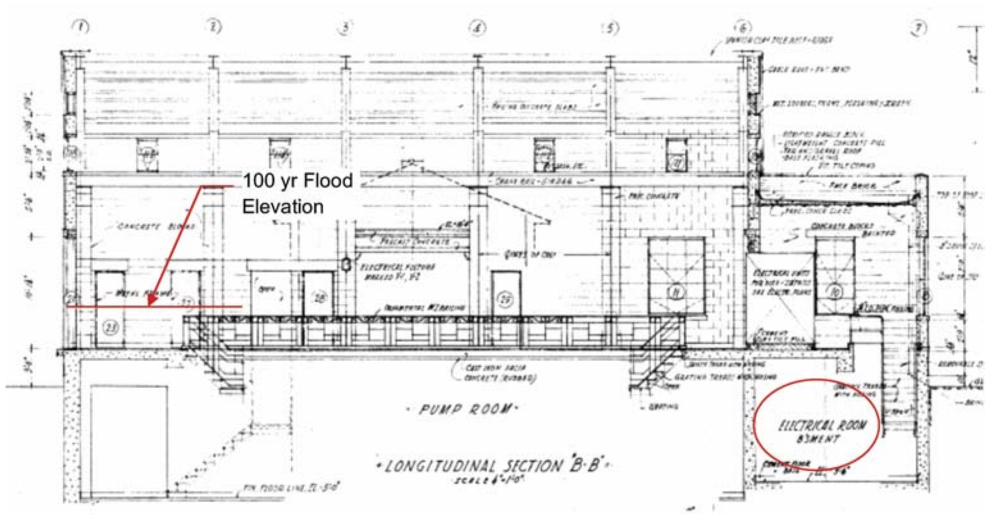

Figure 7. Longitudinal Section of Krause Pumping Station

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terceptor system was "backed up" to provide priming for the pumps, a wet weather event could surcharge the system and result in an overflow event, either in downtown Tampa or on the west side of the river. It is worth noting that the West River interceptor has a syphon crossing under the Hillsborough River.

The scope of the refurbishment for the station included the replacement of the manual bar screens, coating of the wet well, replacement of the pump suction tubes, and other modifications that required the wet well and influent channels to be offline for an extended period of time.

In addition to the major constraints identified, an evaluation of the implementation constraints for bypass of this station was performed. The constraints were identified as follows:

- The Riverwalk must be kept open to the public throughout the duration of construction activities.
- At least one lane along Ashley Street, south of Brorein Street, must remain open for exit of convention center parking. This required the development of a maintenance of traffic (MOT) plan during design.
- Any temporary bypass pumping pipe that crosses Ashley Street needed to be completely or at least partially buried, with steel plates on top to maintain traffic through the area.
- Use of parking spaces from the city's lot under the Crosstown Expressway for staging of materials or equipment required coordination with the city parking division. The city must meet the required parking agreement with the St. Pete Times Forum during events.
- Bypass pumping must be able to meet the expected peak flows of 65 mgd, with sufficient redundancy in the equipment in case of failures.
- The equipment must be protected and/or fenced to prevent unauthorized operation from unqualified personnel or pedestrians.

A conceptual layout of the bypass pumping configuration is represented in Figure 8. As noted in the drawing, a common discharge piping header of the pumps is required to be partially buried across the lane of traffic, which will remain open on Ashley Street as to not impede traffic exiting the convention center parking garage.

It was determined that the bypass configuration will likely consist of a combination of electrical pumps with AFDs to pace the low and average flows, and the use of diesel-engine-driven pumps for peak flows. A temporary power supply will be required for the operation of the electrically operated bypass pumps on AFDs. This will allow full access to the station by the contractor during construction.

As the city requires sufficient backup capabilities in case of failures, the system will consist of four electrical pumps of approximately 7,000 gpm, each with two equal-sized diesel backups. Peak flows are expected to be conveyed with the aid of a single large-capacity diesel pump and its respective backup.

The system layout required closure of a city parking lot and coordination with the Crosstown Expressway Authority, as it owned the right-of-way where the system was deployed.

The conceptual bypass also identified multiple entry points for the bypass suctions piping and/or any instruction or structure modification required to successfully implement the bypass operations. It is anticipated that at least two structures located in the through-lane of traffic on Ashley Street will be required, thus necessitating a temporary MOT plan. The conceptual MOT developed during design required the traffic to be moved toward the east side of Ashley Street and be reduced to a single lane, as noted in Figure 9.

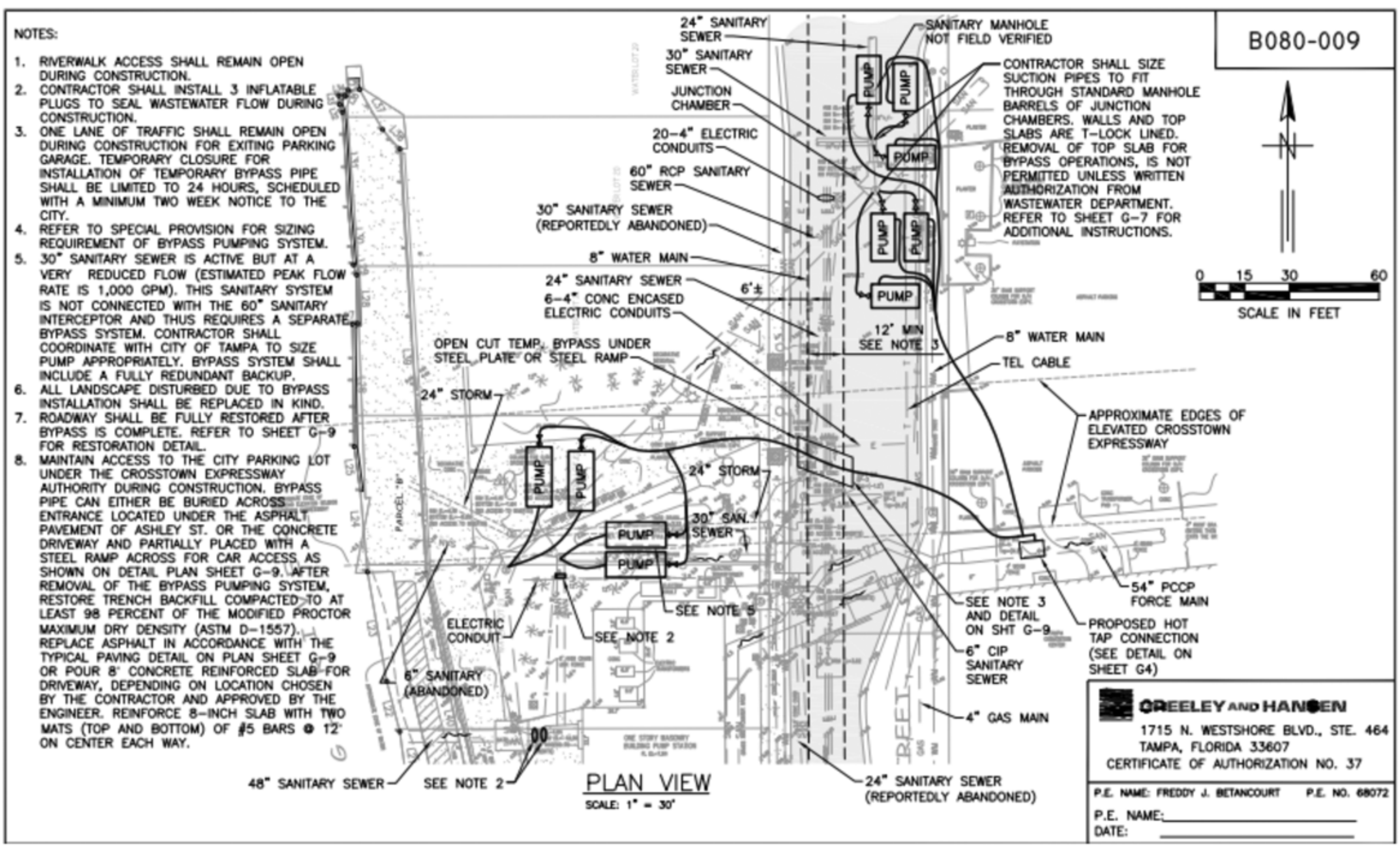

Figure 8. Conceptual Layout of Bypass Pumping Equipment

The anticipation of the list of constraints during the process was critical in implementing an acceptable bypass system. At the time of this study, the project was currently under construction, with the bypass system layout similar to the conceptual design. Figure 10 shows the hot tap on the 54-in. prestressed concrete cylinder pipe (PCCP) required for the bypass system. Figures 11 and 12 show views of the installed bypass system components.

Improvements to Screening Debris Handling

The city asked the consultant team to evaluate options for automated screening and/or other options for improvements to the current process for debris handling. Currently, the existing manual screens are manually raked at a lower level in the wet well room and loaded into 13-gal containers. The containers are manually carried up the stairs and placed in the back of a truck for transport to disposal.

Automated screens were evaluated to replace the existing manual screens. The goal was to reduce the amount of time necessary to handle screenings at the station. The consultant team and city staff discussed this project with manufacturers of mechanical screens, and the existing screens are at the influent to the pumping station. There are two screens, one to each side of the station wet well; the two halves of the wet well are not currently interconnected. To access the screens, operators need to go downstairs within the pumping station below grade to a platform, where a rake is used to collect the screenings and put them into a container.

The concept of mechanical screening was developed using information from one manufacturer; other manufacturers are available, but a single manufacturer was used to develop the concept. The concept was to provide one screen in-

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Figure 9. Conceptual Maintenance of Traffic Plan

Figure 10. 54-in. x 36-in. Hot Tap on Prestressed Concrete Cylinder Pipe

Figure 11. Installed Bypass System Components: Average-Flow Pumps and Enclosure

Figure 12. Installed Bypass System Components: Peak-Flow Pumps

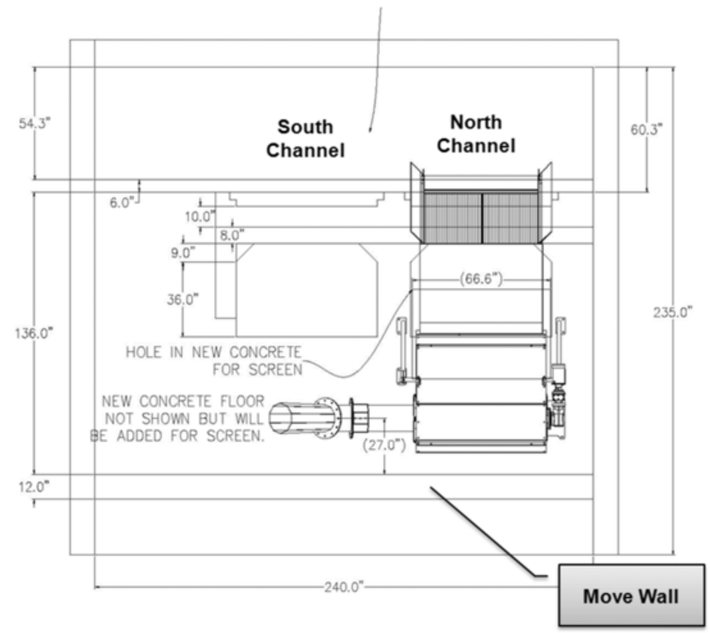

Figure 13. Inclined Mechanical Screen Concept: Plan View

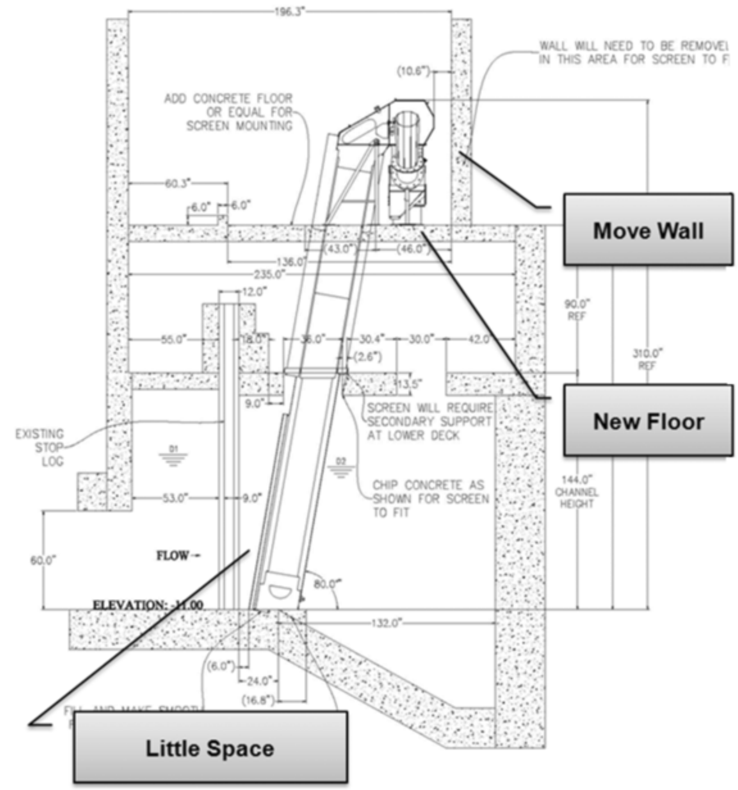

Figure 14. Inclined Mechanical Screen Concept: Section View 1

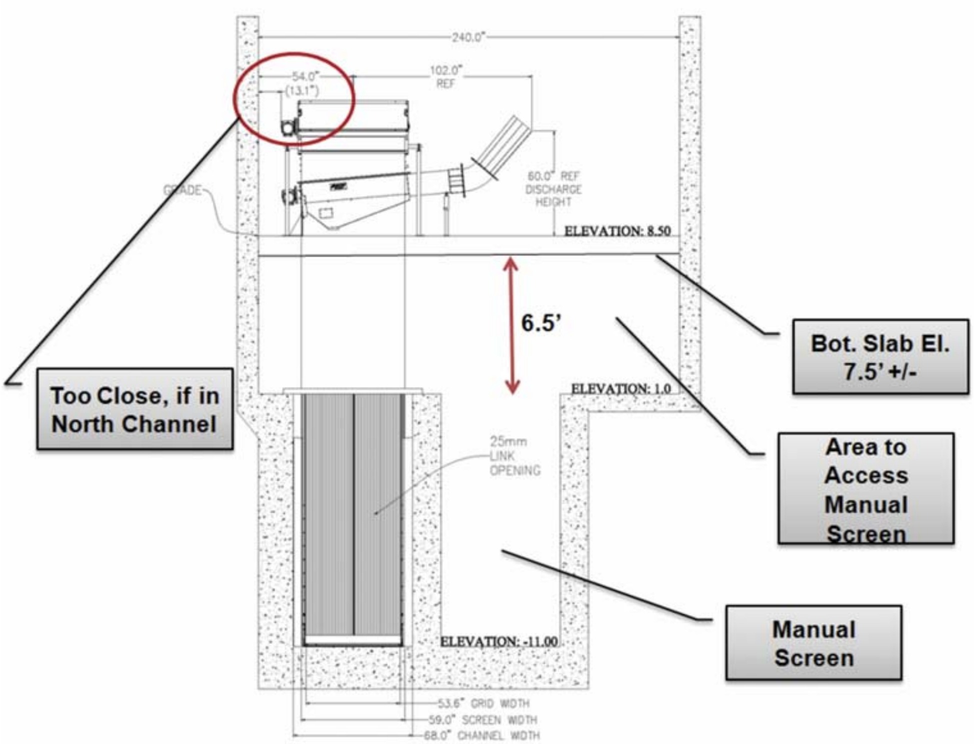

Figure 15. Inclined Mechanical Screen Concept: Section View 2

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stalled into one channel, which could handle the expected peak flow; if the mechanical screen failed, an overflow to the manual screen would be necessary. Sketches of the concept are shown in Figures 13 and 14; figure 13 shows the screen in the North Channel. The wall to the east is moveable to obtain additional space. Figure 14 shows the section view, with a new floor at the entrance level of the building, where the existing screen-room door is located. This arrangement would only allow for 6.5 ft of headroom to clean the manual screen.

Figure 15 is another section view, showing that the distance between the north (exterior) wall and the equipment would be just over 12 in. Figure 15 also shows that there would be little space between the base of the screen and the stop log groove. It also shows a screenings compactor and dewatering system, which would discharge to a container.

The automated inclined screening concept with the screen in the North Channel was not considered practical, since there is insufficient space to the north. The consulting team developed a concept for putting the screen in the South Channel, but the following disadvantages remain:

- Requires water for compactor: 65 gpm – 15 minutes/hour = 24,000 gal per day (gpd)
- Access to hauler needs to be provided
- Limited access to manual screen below

- Limited space available to provide an overflow to manual screen
- Cascade effect through the screen can lead to air entrapment and pump cavitation
- Construction cost of $1 million, plus additional annual costs
- Holding of screenings for longer periods could release odors
- Skilled labor associated with screen maintenance requires additional training, expertise level
- Less reliability than manual screens since periodic failure of mechanical screen is probable, reducing capacity

Another automated screen concept was also evaluated: a vertical screen, capable of being installed directly in manholes. This option addressed many of the disadvantages presented earlier. Figure 16 shows a representation of a dual-vertical screen concept for the station.

During the evaluation process, other mechanical options were analyzed and are summarized as follows:

- Channel grinders (Channel Monster and Task Master)
  - Largest model: 40 mgd

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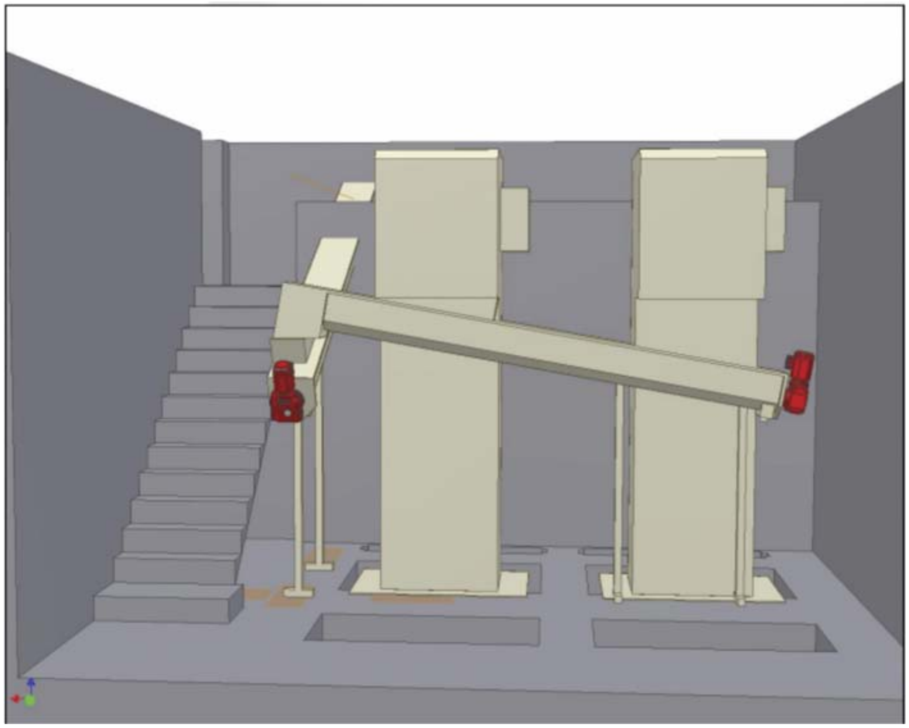

Figure 16. Vertical Screen Concept
(Visual representation of vertical screens for station provided by Aqualitec)

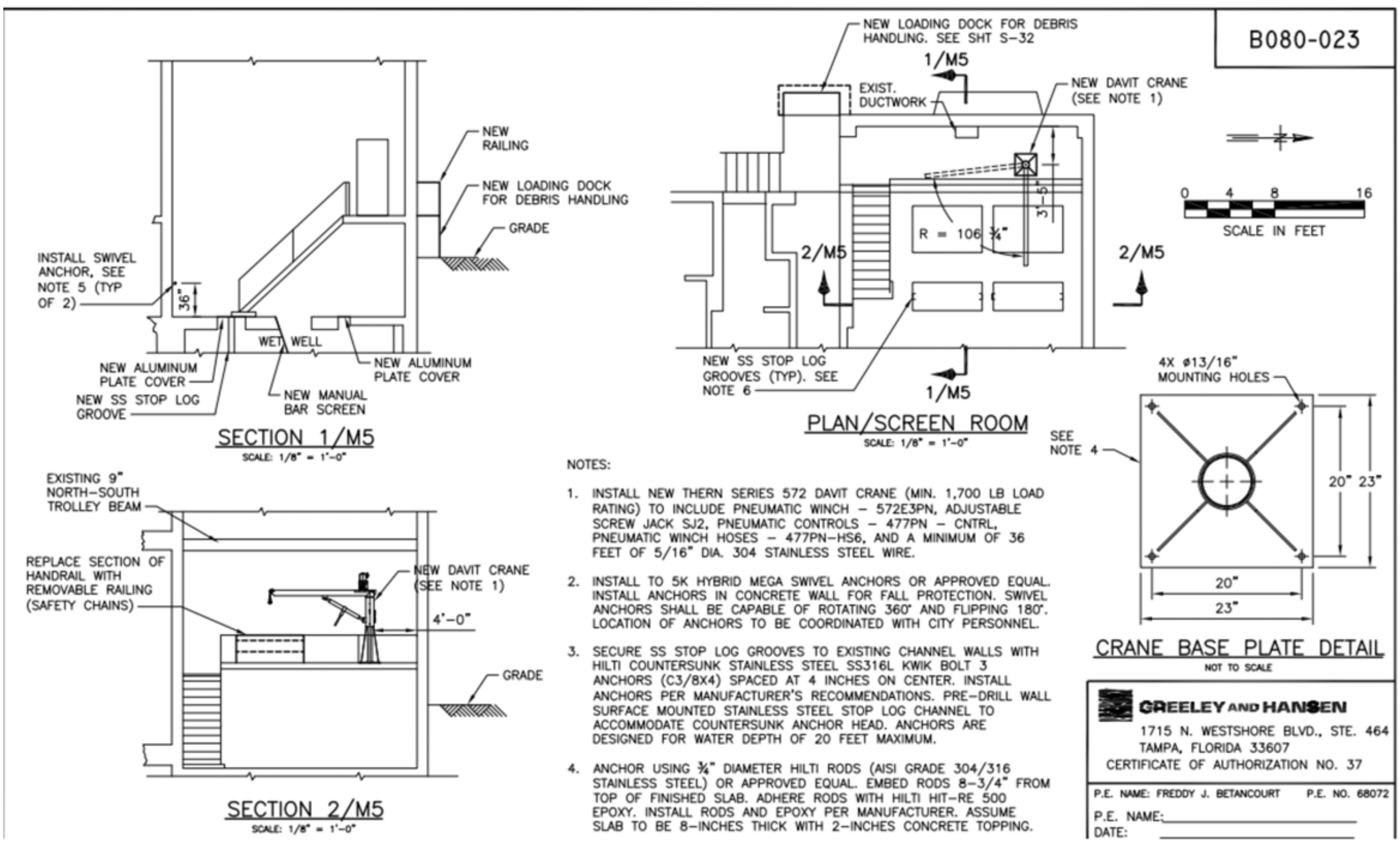

Figure 17. Improvements to Screening Room

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- Challenges on fitting side-by-side to meet peak flows
- Excessive headloss through system

- Inline shredder (Super Shredder)
  - Would require significant changes to pump intake
  - Maximum size: 24 in.
- Screen with submersible motor
  - Screenings still at lower level
- Other screens
  - Configuration largely the same

The conclusion of the evaluation was that the cost of installation of an automated system would not provide the desired return on investment to the city compared to manual debris handling. As consensus, the consultant team and city staff opted for performing improvements to mitigate the physical work of debris collecting and handling. As shown in Figure 17, the improvements to the screening room included providing a rotating davit crane with pneumatic winch, customized trolleys for the containers, and a nylon lifting sling. This will significantly improve the handling of the debris, eliminating the manual lifting of the container to the top of the stairs.

Conclusions

Infrastructure rehabilitation and flood resiliency may require innovative and out-of-the-box solutions, as the designs will need to be adapted to existing configurations that were not necessarily intended to include new equipment or components. To identify and evaluate solutions, it is imperative to have an environment that fosters creativity and openness; it also requires constant coordination between the design team and owner, including the operations and maintenance staff so that designs are not only constructible, but also operable and maintainable to the satisfaction of the owner.

In the case of the Krause Pumping Station, the City of Tampa staff, in combination with the selected consulting team, including Greeley and Hansen, Engineering Design Technologies (prime consultant also responsible for instrumentation and electrical), Biller Reinhart (structural), and Global Sanchez (heating, ventilation, and air conditioning), were able to solve unique challenges with careful planning and consideration.

Among the keys of success for this project were:

- Focus on a conceptual wastewater flow diversion plan.
- Protect the station against a 100-year flood.
- Proactive engagement of identified key stakeholders, such as the Tampa Convention Center and the Crosstown Expressway Authority.