City of Pompano Beach
Water Treatment Plant Building
Hurricane Hardening Study –
Final Technical Memorandum

June 30, 2016

Prepared for:
City of Pompano Beach
Utilities Department
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I. EXECUTIVE SUMMARY

Tetra Tech was retained by the City of Pompano Beach to evaluate specific buildings at the Water Treatment Plant (WTP) with respect to the current wind codes. The study includes the following buildings, as shown in Figure 1: Filter [High Service Pumps (HSP) 1-4, Office, Filter Operation Gallery], HSP 5-6/Electrical Equipment, Chemical, and Sludge Dewatering. For each building, the doors, windows, louvers, structural components, and lateral load resisting systems were evaluated to determine if they meet the current wind design criteria of the Florida Building Code (FBC) 2014, 5th ed. (Risk Category 3, 180 mph, Exposure C, and Wind Borne Debris Region). The goal of this study is to identify systems and components of the buildings that do not meet the current wind code and provide a cost estimate to retrofit or replace them. The City may choose to accept all or any combination of these retrofit/replacement upgrades depending on the importance of each building and budget constraints. Based upon our prioritization meeting with the City, the City of Pompano Beach has prioritized the buildings that need hurricane hardening from greatest to least as follows: Filter-HSP 1-4, HSP 5-6/Electrical Equipment, Chemical, Sludge Dewatering, Filter-Office, and Filter-Operation Gallery Building.

On April 20th and 21st, 2016, Jason Burkett and Chris Zavatsky, two professional engineers from Tetra Tech, performed the field investigation at the WTP. Using destructive and nondestructive methods, the as-built conditions of the buildings were identified and documented to the level needed for this study. The field investigation concluded that the building structures were generally constructed as indicated on the available record drawings with the exception of recent interior renovations in the administration area of the Filter Building. Findings and recommendations for each building are summarized below:

A. FILTER BUILDING

Only the building structures (non-water bearing) associated with the Filter Building are being considered for hurricane hardening. Those buildings are the HSP 1-4 Building, Office Building (formerly Lab and Control), and Filter Operation Gallery. Most of the buildings are constructed with reinforced concrete tie-columns and tie-beams with load bearing 8" unreinforced CMU infill. Roof members for the concrete/CMU buildings are precast double tees. The Filter Operation Gallery addition was constructed as a steel frame with metal stud walls and steel roof deck. The structural members and components of the Filter Buildings were observed to be in good condition overall, with the exception of some stucco and CMU cracking. The structural deficiencies found for potential retrofitting are the exterior unreinforced CMU walls, metal stud walls, and steel roof deck attachment. The most significant finding was in the Filter Operation Gallery addition where the metal stud wall assembly does not meet the current code requirements and it would be best to replace the entire wall system. Some architectural openings in the building envelope are currently in process to be or have recently been replaced with High Velocity Hurricane Zone (HVHZ) compliant glazing and frames as result of renovation projects. There are still several original windows with shutters. Almost all the man-doors and frames have been replaced over the years

but do not meet current requirements for anchoring, impact, or sealing to prevent compromising the building envelope in high winds. There is one overhead door in the HSP 1-4 Building that appears to be original and should be replaced for hurricane hardening. The rough order of magnitude (ROM) costs for implementing all hardening options on the HSP 1-4 Building, Office Building, and Filter Operation Gallery are $223,000, $205,000, and $375,000, respectively.

B. HSP 5-6/ELECTRICAL EQUIPMENT BUILDING

The HSP 5-6/Electrical Building is a one story concrete frame building with unreinforced CMU infill. The roof structure is comprised of precast concrete double tees. The structural members and components were observed to be in good condition overall, with the exception of some minor cracking and water damage around the windows of the HSP room. The only structural deficiencies found for potential retrofitting are the exterior unreinforced CMU walls. All but one architectural opening in the building envelope are original to the construction of the building. Existing windows, doors, overhead doors, and louvers are not in compliance with the current HVHZ requirements of the FBC. The focus of hurricane hardening efforts should be on the unreinforced CMU infill, doors, windows, and louvers to protect the building envelope. The ROM cost for implementing all hardening options on this building is $250,000.

C. CHEMICAL BUILDING

The Chemical Building is a two story and high-bay, steel frame building with a metal deck roof and precast concrete cladding. Most structural members and components were observed to be in good condition overall, with the exception of some steel framing that has started corroding due to loss of sprayed-on fire protection. No structural deficiencies were found in the structural framing or concrete panels that warrant retrofitting. Structural deficiencies were found in the metal roof deck attachment to the steel framing. Most architectural openings in the building envelope, with the exception of two doors, are original to the construction of the building. None of the existing windows, doors, overhead doors, and louvers appear to be in compliance with the current HVHZ requirements of the FBC. The focus of hurricane hardening efforts should be on the roof deck attachment, doors, and louvers to protect the building envelope. The ROM cost for implementing all hardening options on this building is approximately $299,000.

D. SLUDGE DEWATERING BUILDING

The Sludge Dewatering Building is a two story steel frame building with metal roof deck and precast concrete cladding. Most structural members and components were observed to be in good condition overall, with the exception of some second floor and roof steel framing that has started corroding due to loss of sprayed-on fire protection. No structural deficiencies were found in the structural frame or concrete panels that warrant retrofitting. Structural deficiencies were found in the metal roof deck attachment to the steel framing. All but one architectural opening in the

building envelope are original to the construction of the building. Existing windows, doors, overhead doors, and louvers are not in compliance with the current HVHZ requirements of the FBC. The focus of hurricane hardening efforts should be on the roof deck attachment, doors, and louvers to protect the building envelope. The ROM cost for implementing all hardening options on this building is approximately $195,000.

II. BACKGROUND AND SCOPE

The City of Pompano Beach requested that Tetra Tech perform a study on four buildings at the Pompano Beach WTP to identify components, cladding, and structural members that need to be retrofitted or replaced for hurricane hardening. The four buildings studied, as shown in Figure 1, are the: Filter, HSP 5-6/Electrical Equipment, Chemical, and Sludge Dewatering Buildings. For each building, the doors, windows, louvers, vents, structural components, and lateral load resisting systems were evaluated to determine if they meet the current building code for wind and missile impact. Based on the FBC 2014, 5th ed., the following wind design criteria was used for this study: Risk Category 3, 180 mph Basic Wind Speed, Exposure C, and wind borne debris region). By comparison, the approximate relationship between the current FBC wind code and Saffir/Simpson Hurricane Category, per ASCE 7-10 Table C26.5-2, is a Category 5 hurricane.

Figure 1: Aerial View of Pompano Beach WTP (Looking West)

Since the WTP is located in Broward County, the High Velocity Hurricane Zone requirements of the FBC are also applicable. Replacement of any glazing or part thereof must be designed and constructed in accordance with FBC Chapter 34 Existing Building Provisions for HVHZ. Exterior wall cladding, surfacing and glazing in HVHZ shall be of sufficient strength to resist large and small missile impacts. An exception is provided that allows glazing to be protected by fixed, operable or portable shutters, or screens which have a product approval to resist full pressurization from wind loads as well as large and small missile impacts (FBC 2014, 5th edition). It is our recommendation that the exception rule is not sought for this case.

III. SITE INVESTIGATION AND FINDINGS

Tetra Tech visited the Pompano Beach WTP site at 1205 NE 5th Ave., Pompano Beach, FL 33060, on April 20th and 21st, 2016. Tetra Tech personnel were accompanied on site by a WTP maintenance employee who provided access throughout each building and provided additional information regarding the history and use of each building.

Data collected during the site visit was obtained by various methods including: select masonry and concrete demolition, select removal of drywall where already damaged, visual observation of exposed surfaces and ceiling spaces, roof access, measuring building element dimensions, and photographic documentation. Comparing the record drawings with the field investigation data, it is Tetra Tech's opinion that all four building structures were generally constructed as indicated on the as-built drawings, with the exception of a few alterations and items that will be discussed in the following sections.

A. FILTER BUILDING

Record drawings titled, "WATER TREATMENT PLANT FOR CITY OF POMPANO BEACH, FLORIDA", indicate that the original water treatment structures and buildings design was completed in September 1959. The original structure consisted of 6 filters, a clearwell, pipe gallery, filter operation gallery, lab and control building (now offices), and high service pump building. In 1975 an approximately 27ft x 26ft room was added to the west side of the High Service Pump Building on top of the clearwell structure. Then, in 1983, under City Project 81-375, a major expansion occurred where 8 new filters were added which extended the filter operation gallery. For the purposes of this study, only the building structures (non-water bearing) associated with the Filter Building are being considered for hurricane hardening. Those buildings are the High Service Pump 1-4 Building, Office Building, and Filter Operation Gallery.

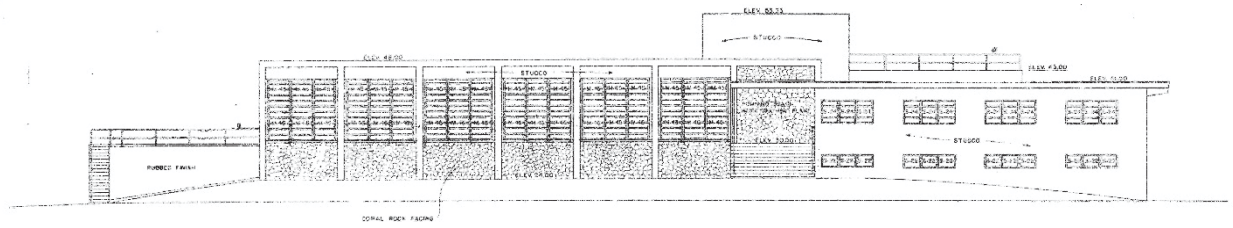

Figure 2: Filter Building - South Elevation

The original 1959 building construction is reinforced concrete tie-columns and tie-beams with load bearing 8" unreinforced CMU infill. Roof members are 12" or 14" deep x 4'-0" wide precast double tees, without composite concrete topping. The concrete foundations are a combination of continuous wall footings, isolated column footings, and grade beams. The structural members and components were observed to be in good condition overall, with the exception of some stucco and CMU cracking.

It is not indicated on the record drawings which building code the Filter Building was designed to, but it is likely they used the early versions of the South Florida Building Code. For this investigation and structural study, wind loads were calculated using methods found in the FBC 2014, 5th ed. Both the Lateral Load Resisting Systems and various structural component and cladding elements were checked using the FBC 2014, 5th ed., wind pressures. Structural calculations were performed for cold-formed steel framing, structural steel framing, concrete columns, concrete beams, double tees, roof diaphragm, and CMU infill.

The Filter Building consists of multiple architectural opening and enclosure components (i.e. doors, windows, louvers, overhead doors). Most windows and louvers appear to be original from 1959 construction, while most doors and several windows appear to have been replaced since then. In addition to replacing doors, an additional alteration to the doors and frames has taken place to install magnetic locks. It was verbally confirmed by site staff that the windows replaced most recently are impact resistant and comply with the HVHZ requirements of the FBC 2014, 5th ed.

HSP 1-4

Structural framing for the HSP room is robust with concrete beams and columns between windows and precast double tee roof members. The only structural deficiency found that warrants retrofitting is the exterior unreinforced CMU walls. The focus of hurricane hardening should be on the CMU infill and architectural components and cladding that protect the building envelope.

Exterior openings in the HSP 1-4 section of the Filter Building are grouped by type and consist of the following:

1. Six (6) approximately 12’ x 12’ operable window assemblies that are protected by manually operated roll down shutters doors mounted to the exterior of the building. The opening enclosures are original to the construction of the facility and provided ventilation to the HSP room.

2. One (1) 12’ x 14’ manually operated overhead coil door. The door appears to be original to the construction of the facility. The door provides the only exterior access to the HSP room at grade level, limiting emergency egress path from the bay. The overhead door is utilized to provide intake air in addition to the windows.

3. One (1) double passage door is located on elevation 30.22 ft and provides exterior access to an Electrical Room that is an addition to the west side of the HSP mezzanine level. The doors where installed in a 1988 renovation project to the Filter Building.

4. One (1) 8’x8’ exterior exhaust fan louver is located on the west elevation.

Office Building

Structural framing of the office building is typical reinforced concrete tie-columns and tie-beams with load bearing 8” unreinforced CMU infill. Roof members are 14” deep precast double tee roof members. The only structural deficiency found that warrants retrofitting is the exterior unreinforced CMU walls. The focus of hurricane hardening should be on the CMU infill and Architectural components and cladding that protect the building envelope.

Exterior openings in the Office section of the Filter Building are grouped by type and consist of the following:

1. Fifteen (15) windows of various sizes and configurations. Five (5) of the original windows have been replaced with HVHZ rated windows and glazing. Ten (10) of the windows are original to the construction of the facility and are protected by bi-fold accordion shutters mounted to the exterior of the building. Some of the existing windows provide ventilation and if replaced an alternate means of ventilation will be required.

2. Two (2) single passage door and two (2) double door provide personnel access and supply access to the chemical feed room and the reception room. The current door configuration is two doors that were replaced in the 1988 renovation that are a bronze color and one door that has been replaced after that time frame in an aluminum color. It is unclear if there is a site wide color coding for the door function or if there is another reason for the variation in door finish.

3. A small air louver is located in the ammonia room and appears to be sound and operational. It is located just below the air intake fan and should be analyzed for meeting the air exchange requirements of the ammonia room.

Filter Operation Gallery

Structural framing of the Filter Operation Gallery is mixed. The original construction of the south side is typical reinforced concrete tie-columns and tie-beams with load bearing 8" unreinforced CMU infill. The only structural deficiency found that warrants retrofitting is the exterior unreinforced CMU walls. However, since the south portion is connected to the north expansion without a demising wall, findings for the building expansion should also be considered when considering how the building will be used during a hurricane event.

When the plant was expanded in 1983, the operation gallery was extended to the north but built with steel framing and metal stud cladding. Roof members are 8" deep wide flange beams with 1 ½" metal deck. Wall construction is 6" cold formed steel studs with stucco on metal lath over gypsum board. When analyzed for current wind loads, the structural framing and typical metal studs were verified as adequate. However, there are several deficiencies, including: metal roof deck attachment, metal stud construction/strength around large openings, lack of structural sheathing on the metal studs, and gypsum board attachment and wind/impact rating. Information regarding all three of these items is based on the record drawings and limited observation by removing sections of drywall from the building interior.

Hurricane hardening of this building as a whole will be difficult and costly. The focus would be on the CMU infill, metal stud wall construction, metal stud details around large window openings, impact resistant wall sheathing, metal deck attachment, and doors that protect the building envelope.

Exterior openings in the Filter Operation Gallery are grouped by type and consist of the following:

1. Sixteen (16) windows ranging from approximately 6'-0"W x 2'-0"H to 15'-5"W x 4'-0"H have been recently upgraded to HVHZ resistant frames and glazing. There will be no work with respect to these openings to harden the building. There is one (1) 3'-0"W x 2'-0"H window in the pipe gallery compressor room. This window is shielded by other structures and an accordion style shutter therefore poses little rick to the building in a hurricane event.

2. Eight (8) single passage doors located in the operations gallery as well as four (4) more doors located on the first and second level of the pipe gallery were replaced around 1988 with aluminum doors and frames. The doors do not have weather-stripping nor do they fit tightly in their frames. Various issues including weather seals, thresholds, strikers and installation of new magnetic locks have negatively impacted the operation of the doors.

B. HSP 5-6/ELECTRICAL EQUIPMENT BUILDING

Record drawings titled, "WATER TREATMENT PLANT EXPANSION – ELECTRICAL EQUIPMENT AND PUMP BUILDING – PROJECT NO. 76-248", indicate that the building design was completed in December 1977. The HSP 5-6/Electrical Equipment Building's overall dimensions are approximately 131ft x 34ft with an 8ft offset in the west wall. The building is subdivided into four spaces by load bearing CMU walls as shown in Figure 3. Those four spaces are the transformer, generator, electrical equipment, and pump rooms.

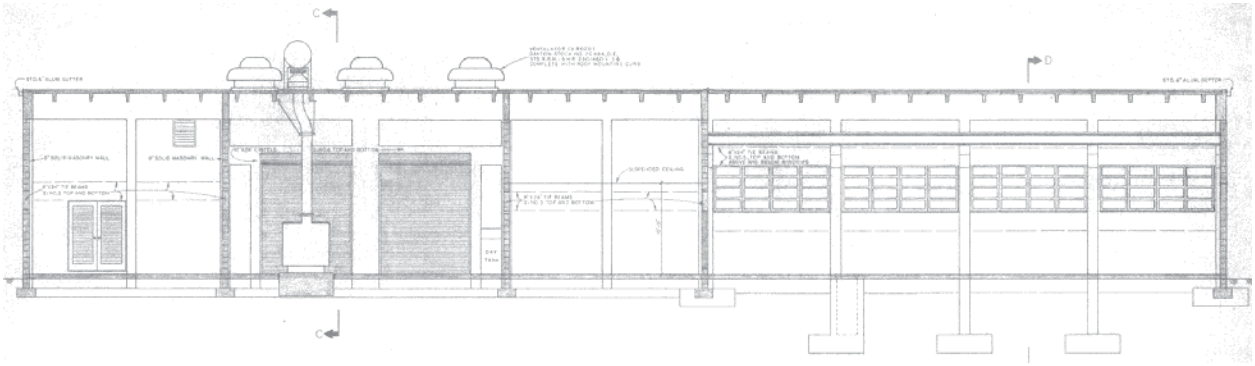

Figure 3: HSP/Electrical Equipment Building - Cross Section

Building construction is reinforced concrete tie-columns and tie-beams with load bearing 8" unreinforced CMU infill. Roof members are 14" deep x 8'-0" wide precast double tees, without composite concrete topping. The concrete foundations are a combination of continuous wall footings, isolated column footings, and grade beams. The structural members and components were observed to be in good condition overall, with the exception of some minor cracking and water damage around the windows of the HSP room, as shown in the Appendix photos.

It is not indicated on the record drawings which building code the HSP 5-6/Electrical Equipment Building was designed to, but it is likely they used the early versions of the South Florida Building Code. For this structural study, wind loads were calculated using the FBC 2014, 5th ed. Both the Lateral Load Resisting Systems and various structural component and cladding elements were checked using the 2014 FBC, 5th ed., wind pressures. Structural calculations were performed for concrete columns, beams, double tees, roof diaphragm, and CMU infill. The only structural deficiencies found that warrant retrofitting are the exterior unreinforced CMU walls. The focus of hurricane hardening should be on the CMU infill and architectural components and cladding that are part of and protect the building envelope.

The HSP 5-6/Electrical Equipment Building has several architectural opening and enclosure components (i.e. doors, windows, louvers, overhead doors) which appear to be original to the 1977 plans. These components are grouped by type and consist of the following:

1. Seven (7) approximately 13’ x 5’ operable window assemblies that are protected by manually operated roll down shutters doors mounted to the exterior of the building. The openings are original to the construction of the facility and provide ventilation to the High Service Pump room. The windows are not currently operable, and water damage is evident where windows are stuck in the open position.

2. Three (3) 10’ x 12’ manually operated overhead coil doors. The doors appear to have replaced at some time since construction of the building, but not in the last 10 years. The doors provide the exterior service access to the HSP and the generator rooms at grade level.

3. Three (3) double passage doors provide exterior access to the transformer, generator and HSP rooms. Two (2) single passage doors provide exterior access to the Electrical Equipment Room. All doors appear to be original, with the exception of one single-leaf door on the West side of the Electrical Equipment Room, which was likely replaced in the last 5-8 years. The original doors are steel and exhibit signs of wear and deterioration expected for their age, type, use, and environment. Various issues including weather seals, thresholds, strikers and installation of new magnetic locks have negatively impacted the operation of the doors. The doors on the west side of the building are very exposed and located close to electrical equipment inside the building, therefore posing a severe risk should they be compromised during a hurricane.

4. Seven (7) louvers of various sizes on the exterior walls appear to be original. The louvers do not do not comply with current HVHZ requirements and some existing damage was observed.

C. CHEMICAL BUILDING

Record drawings titled, “WATER TREATMENT PLANT IMPROVEMENTS – CITY PROJECT NO. 81-375”, indicate that the Chemical Building design was completed in May 1981. The Chemical Building is two levels with overall dimensions of approximately 192ft x 33ft. A maintenance shop, control room, equipment rooms, and chemical tanks are on first floor. The second floor is mostly used for storage and equipment, but also provides access to the grit unloading area. Two lime storage silos extend up through the roof deck on the south end of the building. An elevation view from the west is shown in Figure 4.

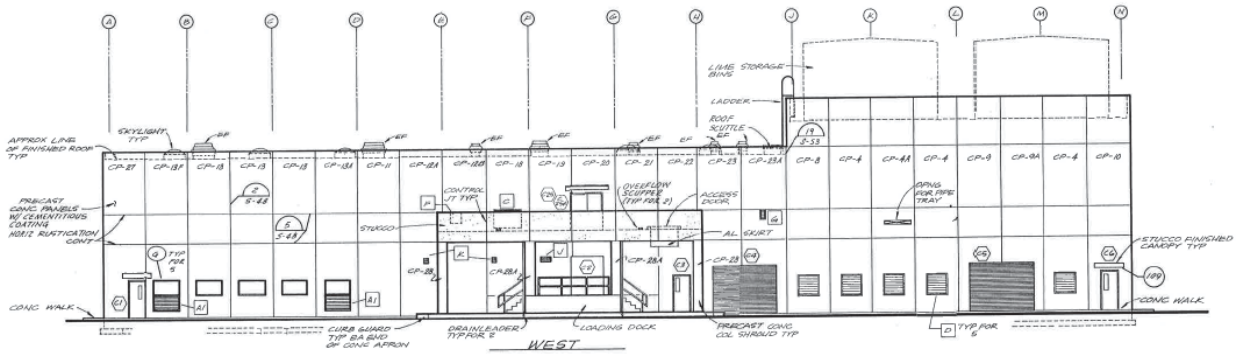

Figure 4: Chemical Building - West Elevation

Building construction is primarily steel framing and exterior precast concrete wall panels that rest on top of the floor slab. The precast wall panel connections are detailed to transfer out-of-plane and in-plane loads only. Gravity loads from the roof and floor are carried by the steel framing. Roof framing over the shop and second floor is a combination of W-shape steel beams and H-series bar joists that support metal roof deck. The roof framing around the Lime silos is W-shape steel beams that act compositely with a 6" concrete slab. The second floor is a 6½" composite metal deck slab that that is supported by a combination of CMU walls and W-shape beams. The concrete foundations are comprised of piers and stem walls on monolithically poured column and wall footings. Most structural members and components were observed to be in good condition overall, with the exception of some of the steel framing that has started corroding due to loss of sprayed-on fire protection.

Sheet S-32 of the record drawings indicates that the Chemical Building was designed for wind loads in accordance with the 1979 Broward County edition of the South Florida Building Code. After comparing the 1979 design wind loads with the FBC 2014, 5th ed., it was determined that wind pressures for design of the lateral load resisting systems are very similar. The major difference in design wind loads between the 1979 and 2014 wind codes is in how component and cladding pressures are calculated. Various structural component and cladding elements were checked with the 2014 FBC, 5th ed., components and cladding pressures including the roof deck and attachment, roof diaphragm, and precast panel reinforcement. Despite the discrepancies in wind loads between the building codes, no structural deficiencies were found in the structural frame or concrete panels that warrant retrofitting. However, structural deficiencies were found in the metal roof deck attachment that are not adequate for the uplift and diaphragm shear near the perimeter of the roof. The focus of hurricane hardening should be on the roof deck attachment and architectural components and cladding to protect the building envelope.

The Chemical Building has several architectural openings and enclosure components (i.e. doors, windows, louvers, skylights and overhead doors) which appear to be original to the 1981 plans. These components are grouped by type and consist of the following:

1. Ten (10) approximately 5’ x 3’ operable window assemblies that are not protected by exterior shutters and do not appear to have HVHZ rated frames or glazing. Four (4) of the window units are combination window and louver openings. The openings appear to be original to the construction of the building and provide ventilation to the interior space.

2. One (1) 10’ x 14’ and two (2) 12’ x 9’ manually operated overhead coil door provide service access to the Shop Area and the Lime Feed areas. The doors appears to be original to the construction of the facility and are showing advanced corrosion around the base of the tracks.

3. Three (3) single passage doors and one (1) double door provide exterior access to the facility at grade level. An additional one (1) double door at the second level provides access to the canopy roof from the freight elevator. All the doors appear to be original, with the exception of one single and double door at the Southeast corner of the Lime Feed room, which were replaced in the last 5-8 years. The original doors exhibit signs of wear and deterioration expected for their age, type, use, and environment. Various issues including weather seals, thresholds, strikers and installation of new magnetic locks have negatively impacted the operation of the doors.

4. Seventeen (17) louvers of various sizes on the exterior walls appear to be original to the facility. The louvers do not appear to comply with current HVHZ requirements.

5. Eight (8) skylights provide natural daylighting into the Shop Area and the Flocculation Aid Feed. The skylights are original to the construction of the facility and do not appear to comply with current HVHZ design requirements for openings in the roof of the building.

D. SLUDGE DEWATERING BUILDING

Record drawings titled, “WATER TREATMENT PLANT IMPROVEMENTS – CITY PROJECT NO. 81-375”, indicate that the building design was completed in May 1981. The Sludge Dewatering Building is two stories with overall dimensions of 96ft x 36ft. The first floor has three drive thru loading bays and an equipment room. The second floor has a small electrical room with the remaining space dedicated to three sludge dewatering units. An elevation view from south is shown in Figure 5.

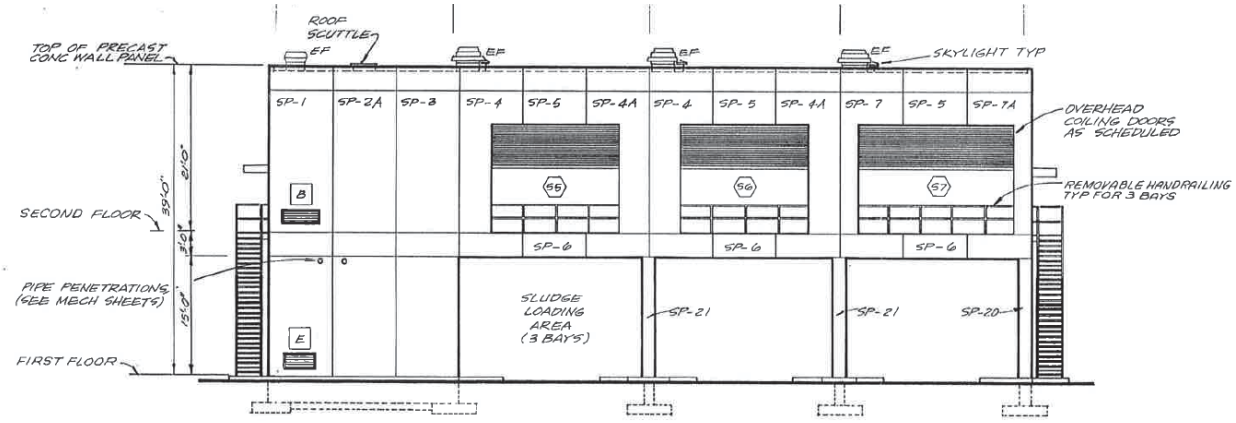

Figure 5: Sludge Dewatering Building - South Elevation

Building construction is steel framing with precast concrete wall panels. The precast wall panel connections are detailed to transfer out-of-plane and in-plane loads only. Gravity loads from the roof and floor are carried by the steel framing. Roof framing is a combination of W-shape steel beams and H-series bar joists that support metal roof deck. The second floor is an 8" concrete slab that acts compositely with the W-shape floor framing. The concrete foundations are mostly isolated column footings with some continuous wall footings to the support the precast panels that extend to the ground level. Most structural members and components were observed to be in good condition overall, with the exception of some of the second floor steel framing that has started corroding due to loss of sprayed-on fire protection.

Sheet S-43 of the record drawings indicates that the Sludge Dewatering Building was designed for wind loads in accordance with the 1979 Broward County edition of the South Florida Building Code. After comparing the design wind loads with the FBC 2014, 5th ed., it was determined that wind pressures for design of the lateral load resisting systems are very similar. The major difference in wind loads between the 1979 and 2014 wind codes is in how component and cladding pressures are calculated. Various structural component and cladding elements were checked with the 2014 FBC components and cladding pressures including the roof deck and attachment, roof diaphragm, and precast panel reinforcement. Despite the discrepancies in wind loads between the building codes, no structural deficiencies were found in the structural frame or concrete panels that warrant retrofitting. However, structural deficiencies were found in the metal roof deck attachment that are not adequate for the uplift and diaphragm shear near the perimeter of the roof. The focus of hurricane hardening should be on the roof deck attachment and Architectural components and cladding to protect the building envelope.

The Sludge Dewatering Building has multiple architectural opening and enclosure components (i.e. doors, louvers, skylights and overhead doors) which mostly appear to be original to the 1981 plans. These components are grouped by type and consist of the following:

1. Two (2) 16’ x 14’ and one (1) 20’ x 14’ manually operated overhead coil door are located on the south side of the building on the second level. These three doors appears to be original to the construction of the facility. One overhead door on the West side of the building appears to have replaced a pair of original double doors. Its size is approximately 9’-0”W x 7’-4”H and bolted to the wall with ½” diameter anchors at 10” o.c.

2. Three (3) single passage doors provide exterior access to the facility. The doors appear to be original to the 1981 construction of the facility and exhibit signs of wear expected of their age and use environment. Various issues including weather seals, thresholds, strikers and installation of new magnetic locks have negatively impacted the operation of the doors.

3. Eight (8) louvers of various sizes on the exterior walls appear to be original to the facility. The louvers do not appear to be rated for current HVHZ requirements.

4. Six (6) skylights provide natural daylighting into the Vacuum Filter Room. The skylights are original to the construction of the facility and do not appear to comply with current HVHZ design requirements for openings in the roof of the building.

IV. RECOMMENDATIONS AND COST

Based on our evaluation of the four buildings, using the as-built drawings and data collected from this site investigation, Tetra Tech recommends that it is feasible to move forward with a design phase for construction documents according to the City’s priority and budget. Construction documents would provide all the retrofit details and specifications to harden the four buildings and bring them in compliance with the wind design provisions of the FBC 2014, 5th ed.

The Rough Order of Magnitude (ROM) costs associated with hurricane hardening improvements to the buildings, including design fees and contingency, can be found in the following sections, summarized in Table 1, and tabulated in APPENDIX B. This represents a Class 4 cost estimate based on a feasibility study, which has an expected accuracy range of from -30% to +50%. Assumptions for door and glazing replacements take into consideration removal of existing and installation of new components. The costs associated with each opening is rounded up to the nearest $1,000 and are based on past contract data for similar scope and R.S. Means Cost Estimating Manuals. All replacement components are based on and required to have a Miami-Dade County Notice of Acceptance (NOA) or Florida Approval Number. The following recommendations and prices are summarized per building.

A. FILTER BUILDING

HSP 1-4

1. Add #5 vertical reinforcement in grout filled cells at 48" o.c. to unreinforced CMU. ROM $43,000.

2. Replace five (5) of six (6) approximately 12' x 12' operable window assemblies with HVHZ reinforced aluminum window frames and glazing rated for small and large missile impact and wind loads. Replace northern most 12'x12' window with HVHZ rated air intake fan and louver designed to meet code required for make-up air intake requirements and provide controlled ventilation of the HSP room. ROM $60,000.

3. Add one (1) 3'-0" x 7'-0" passage door with panic hardware for emergency egress and access. The current doors do not provide adequate life safety egress in the event of an emergency nor a safe path of ingress and egress for plant operators. Ideally, the new door would be located on the ground floor near the overhead door on the West end of the pump room. The potential locations of this new door are limited due to the existing stairs on the West end of the building and earth backfill on the South side. The best location should be decided during detailed design, but will likely require additional work besides cutting the opening in the wall. ROM $20,000

4. Replace one (1) 12' x 14' manually operated overhead coil door with a new steel overhead coil door with motorized operator and controls. ROM $10,000.

5. Replace one (1) 8'x8' exterior exhaust fan louver located on the west elevation. The size and type of the exhaust fan should be evaluated to ensure the new intake and exhaust system is adequately sized for the building needs and code requirements. ROM $3,000.

6. Replace one (1) double passage door. Typical of all new doors recommended to be replaced, the new door shall be rated for HVHZ and include weather-stripping, thresholds, closers, and hardware. Doors with lites shall have glazing rated for impact per FBC and local code requirements. ROM $12,000

Office Building

1. Add #5 vertical reinforcement in grout filled cells at 48" o.c. to unreinforced CMU. ROM $62,000.

2. Replace two (2) single passage doors and two (2) double doors that provide personnel and supply access to the office building. Typical of all doors recommended to be replaced, the

new door shall be rated for HVHZ and include weather-stripping, thresholds, closers, and hardware. Doors with lites shall have glazing rated for impact per current FBC and local code requirements. ROM $38,000.

3. A small air louver is located in the ammonium room just below the air intake fan and appears to be sound and operational. As part of any future hardening project, it should be analyzed for meeting the air exchange requirements of the ammonium room. ROM $1,000

4. Replace ten (10) of the windows that are original to the building construction with code compliant windows similar to the windows that have already been replaced. ROM $35,000.

Filter Operation Gallery

1. Remove and replace metal stud wall assembly on Filter Operation Gallery addition with code compliant, engineered metal stud wall assembly. It is assumed that the recently replaced HVHZ rated windows can be reused. ROM $75,000.

2. Retrofit metal deck attachment by adding mechanical fasteners over Filter Operation Gallery addition. Roofing replacement would be required for this retrofit. ROM $25,000

3. Add #5 vertical reinforcement in grout filled cells at 48" o.c. to unreinforced CMU. ROM $54,000.

4. Sixteen (16) windows in the operations gallery have been recently upgraded to HVHZ resistant frames and glazing. There will be no work required at this location to provide code compliant windows.

5. Replace eight (8) single passage doors located in the operations gallery as well as four (4) single and one (1) double door located on the first and second level of the pipe gallery. New doors shall be rated for HVHZ and include weather-stripping, thresholds, closers, and hardware. Doors with lites shall have glazing rated for impact per current FBC and local code requirements. ROM $96,000.

B. <u>HSP 5-6/ELECTRICAL EQUIPMENT BUILDING</u>

1. Add #5 vertical reinforcement in grout filled cells at 48" o.c. to unreinforced CMU. ROM $56,000.

2. Replace seven (7) approximately 13' x 5' operable window assemblies with HVHZ reinforced aluminum window frames and glazing rated for small and large missile impact and wind loads. Install louvers as required by mechanical for ventilation compliance. Remove roll shutters and repair exterior wall. ROM $50,000.

3. Replace three (3) 10' x 12' manually operated overhead coil door with new steel overhead coil doors with motorized operator and controls. ROM $30,000.

4. Replace two (2) single passage doors as well as three (3) double doors. Typical of all doors recommended to be replaced, the new door shall be rated for HVHZ and include weather-stripping, thresholds, closers, and hardware. Doors with lights shall have glazing rated for impact per FBC and local code requirements. ROM $36,000.

5. Replace seven (7) louvers. The size and type of the exhaust fan should be evaluated to ensure the new intake and exhaust system is adequately sized for the building needs and code requirements. ROM $9,000.

C. CHEMICAL BUILDING

1. Clean steel framing that is corroded and respray with fire protection. ROM $8,000.

2. Retrofit metal deck attachment over shop area and 2nd floor by adding mechanical fasteners. Roofing replacement would be required for this retrofit. ROM $50,000.

3. Replace ten (10) approximately 5' x 3' operable window assemblies with HVHZ reinforced aluminum window frames and glazing rated for small and large missile impact and wind loads. Install louvers as required by mechanical for ventilation compliance. Remove roll shutters and repair exterior wall. ROM $30,000.

4. One (1) 10' x 14' and two (2) 12' x 9' manually operated overhead coil door with new steel overhead coil doors with motorized operator and controls. ROM $30,000.

5. Replace three (3) single passage doors and two (2) double doors with new doors to provide personnel access and supply access to the facility. Typical of all new doors recommended to be replaced, the new doors shall be rated for HVHZ and include weather-stripping, thresholds, closers, and hardware. Doors with lites shall have glazing rated for impact per FBC and local code requirements. ROM $44,000.

6. Replace seventeen (17) louvers of various sizes. The size and type of the louvers should be evaluated to ensure the intake and exhaust system is adequately sized for the building needs and code requirements. ROM $22,000.

7. Replace eight (8) skylights with compliant units. ROM $16,000.

D. SLUDGE DEWATERING BUILDING

1. Clean steel framing that is corroded and respray with fire protection. ROM $8,000.

2. Retrofit metal deck attachment by adding mechanical fasteners. Roofing replacement would be required for this retrofit. ROM $42,000.

3. Replace all manually operated overhead coil door with new steel overhead coil doors with motorized operator and controls. ROM $42,000.

4. Replace two (2) single passage doors and one (1) double door with new doors to provide personnel and supply access to the facility. Typical of all doors recommended to be replaced, the new doors shall be rated for HVHZ and include weather-stripping, thresholds, closers, and hardware. Doors with lites shall have glazing rated for impact per current FBC and local code requirements. ROM $18,000.

5. Replace eight (8) louvers of various sizes rated for current HVHZ requirements. ROM $8,000.

6. Replace six (6) skylights that provide natural daylight into the Vacuum Filter Room with skylights that comply with current HVHZ design requirements for openings in the roof of the building. ROM $12,000.

E. SUMMARY

This memorandum has identified systems and components of the buildings that do not meet the current wind code and provides a cost estimate to retrofit or replace them, see Table 1. Based upon our prioritization meeting with the City, the City of Pompano Beach has prioritized the buildings that need hurricane hardening from greatest to least as follows and shown in Table 2: Filter-HSP 1-4, HSP 5-6/Electrical Equipment, Chemical, Sludge Dewatering, Filter-Office, and Filter-Operation Gallery Building. The City may choose to pursue these retrofit/replacement upgrades for all or any combination of these buildings to meet their needs.

Table 1: Cost Summary

HURRICANE HARDENING COST SUMMARY	
Filter Building - HSP 1-4	
Structural Retrofits - CMU Grouted Cells	$43,000
Architectural Opening Replacement - Doors, Windows, Louvers	$105,000
Subtotal	$148,000
30% Contingency	$45,000
Design Fees	$30,000
Total	$223,000
Filter Building - Offices	
Structural Retrofits - CMU Grouted Cells	$62,000
Architectural Opening Replacement - Doors, Windows, Louvers	$74,000
Subtotal	$136,000
30% Contingency	$41,000
Design Fees	$28,000
Total	$205,000
Filter Building - Filter Operation Gallery	
Structural Retrofits - CMU Grouted Cells	$54,000
Structural Retrofits - Metal Deck Attachment and Reroof	$25,000
Structural Retrofits - Metal Stud Wall Demo and Rebuild	$75,000
Architectural Opening Replacement - Doors	$96,000
Subtotal	$250,000
30% Contingency	$75,000
Design Fees	$50,000
Total	$375,000
HSP 5-6/Electrical Equipment Building	
Structural Retrofits - CMU Grouted Cells	$56,000
Architectural Opening Replacement - Doors, Windows, Louvers	$110,000
Subtotal	$166,000
30% Contingency	$50,000
Design Fees	$34,000
Total	$250,000
Chemical Building	
Structural Retrofits - Clean Steel Framing and Fireproof	$8,000
Structural Retrofits - Metal Deck Attachment and Reroof	$50,000
Architectural Opening Replacement - Doors, Windows, Louvers	$141,000
Subtotal	$199,000
30% Contingency	$60,000
Design Fees	$40,000
Total	$299,000
Sludge Dewatering Building	
Structural Retrofits - Clean Steel Framing and Fireproof	$8,000
Structural Retrofits - Metal Deck Attachment and Reroof	$42,000
Architectural Opening Replacement - Doors, Windows, Louvers	$80,000
Subtotal	$130,000
30% Contingency	$39,000
Design Fees	$26,000
Total	$195,000
Retrofit Total	$1,029,000
Contingency Total	$310,000
Design Fees Total	$208,000
TOTAL CONSTRUCTION COST	**$1,547,000**

Table 2: Priority Summary

HURRICANE HARDENING PRIORITY SUMMARY				
PRIORITY[a] RANK	BUILDING NAME	RETROFIT COST	VULNERABILITY[a,c] RATING (1-5)	CONDITION[b,d] RATING (1-10)
1	Filter-HSP 1-4	$223,000	5	5
2	HSP 5-6/Elect	$250,000	4	5
3	Chemical	$299,000	3	8
4	Sludge Dewatering	$195,000	3	8
5	Filter-Office	$205,000	1	7
6	Filter-Operation Gallery	$375,000	2	4

a. Established by City of Pompano Beach

b. Condition assessment relative to current wind code requirements

c. Vulnerability Scale: 1 = Not Vulnerable, 3 = Moderately Vulnerable, 5 = Very Vulnerable

d. Condition Scale: 1 = Does not meet any code reqt's, 5 = Meets some code reqt's, 10 = Meets all code reqt's

V. DISCLAIMER

Tetra Tech's recommendations are based only on representative findings and limited visual observation. Tetra Tech's assumption is that the structural members and connections were constructed per our observations in a typical manner throughout the building. Tetra Tech does not imply or guarantee in any way that the construction of the building is precisely according to the Record Documents.

APPENDIX A - PHOTOS

Filter Building – HSP 1-4

Photo 1: South View

Photo 2: West View

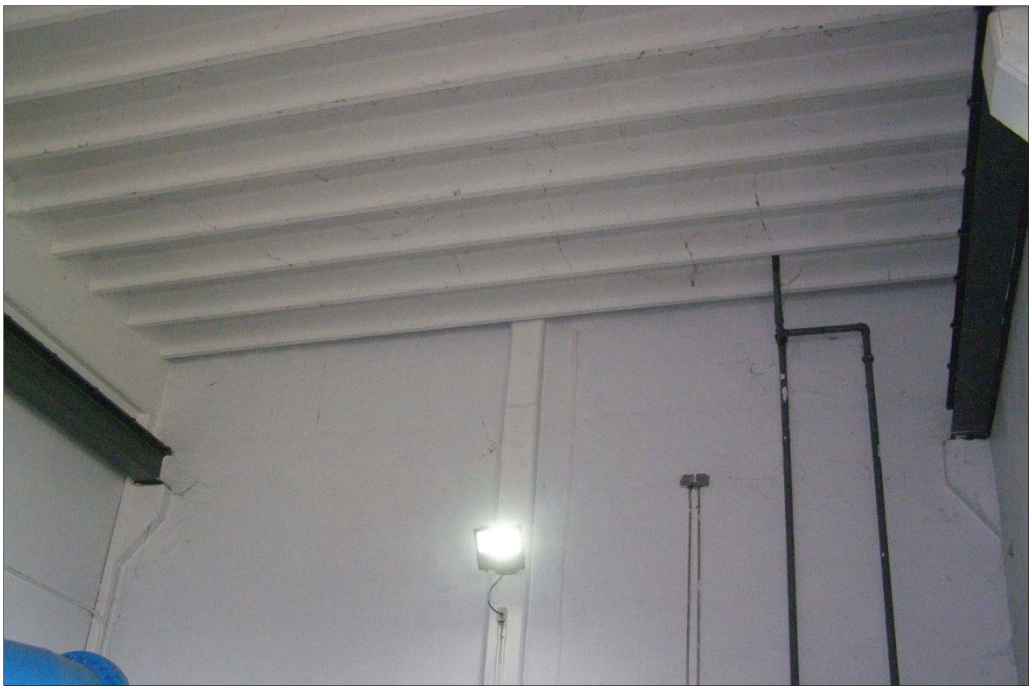

Photo 3: Typical Double Tee Roof Structure

Photo 4: Interior View of Windows

Photo 5: Exterior View of Window and Shutter

Filter Building – Office

Photo 6: South View

Photo 7: East View

Filter Building – Filter Operation Gallery

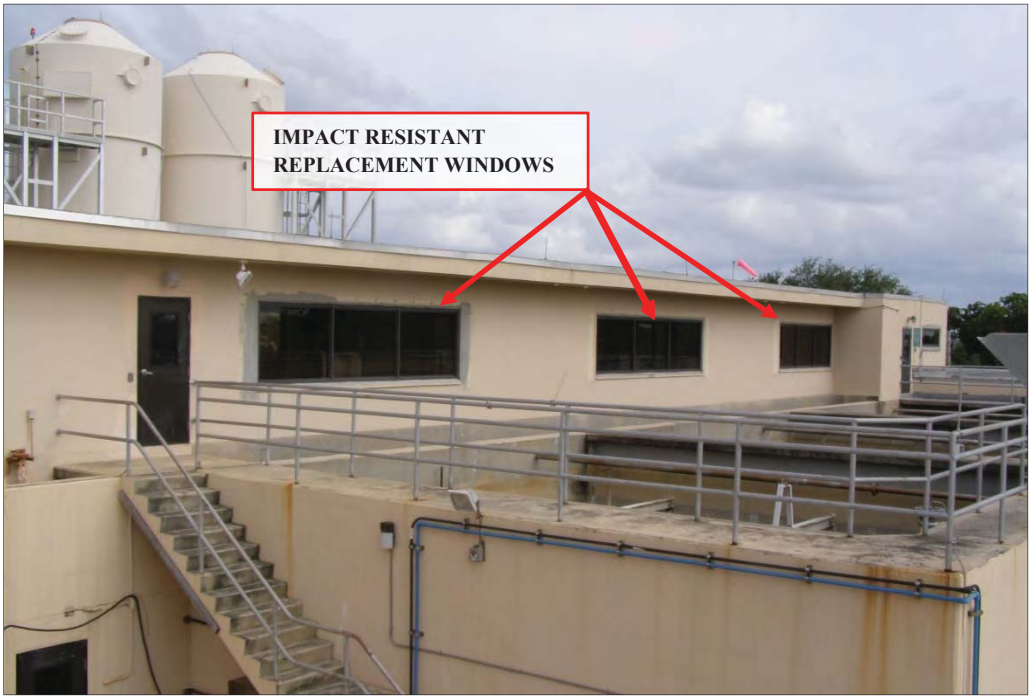

Photo 8: Original Filter Operation Gallery – West View

Photo 9: Filter Operation Gallery Expansion – West View

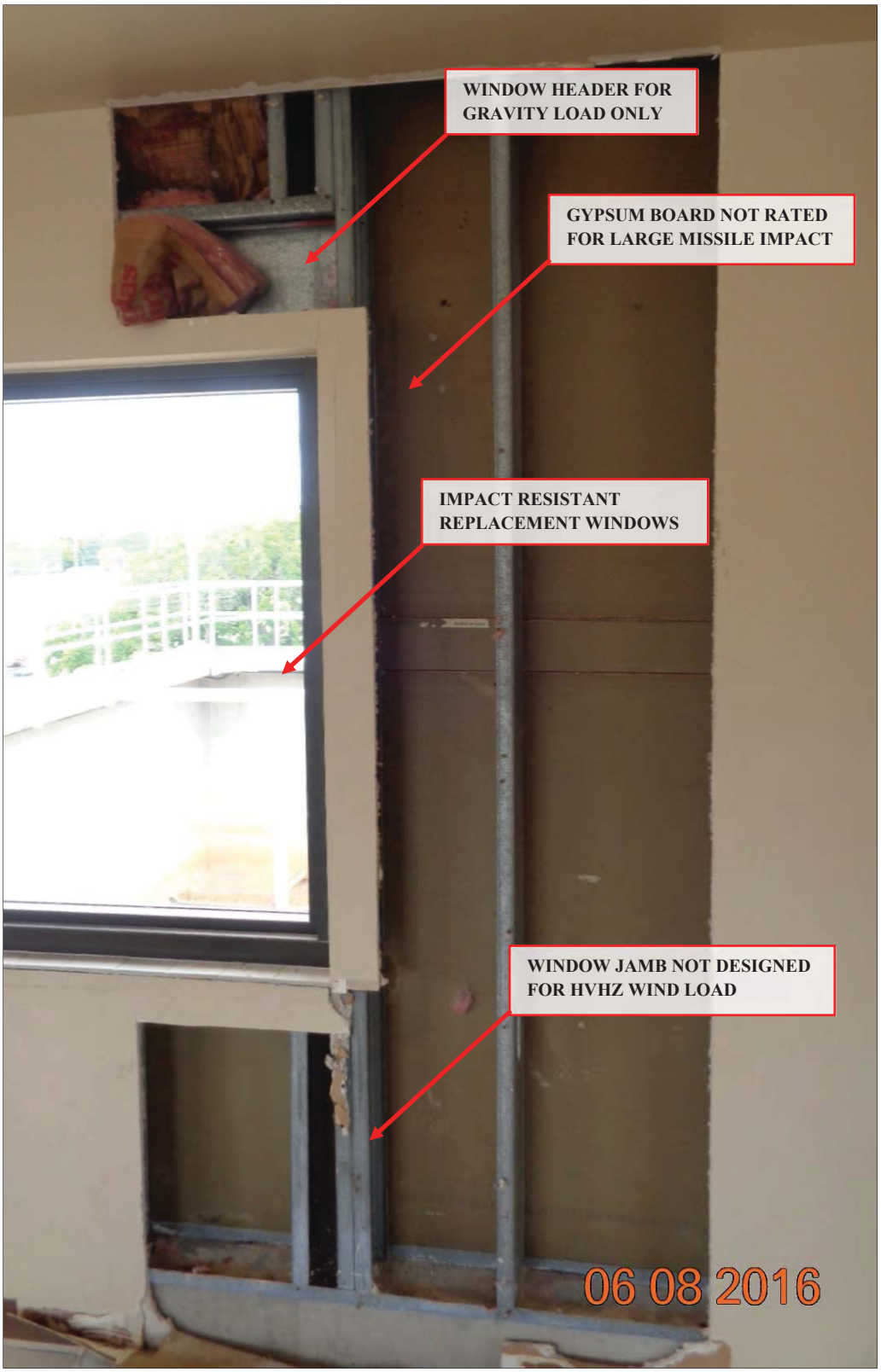

Photo 10: Filter Gallery Expansion - Stud Wall Assembly

Photo 11: Filter Gallery Expansion - Window Sill Framing

Photo 12: Replacement Window Information

HSP 5-6/Electrical Equipment Building

Photo 13: Northeast View

Photo 14: North View

Photo 15: Northwest View

Photo 16: Southwest View

Photo 17: Southeast View

Photo 18: Window Sill Deterioration in Pump Room

Photo 19: Column Damage in Generator Room

Chemical Building

Photo 20: South View

Photo 21: Southwest View

Photo 22: Northwest View

Photo 23: North View

Photo 24: East View

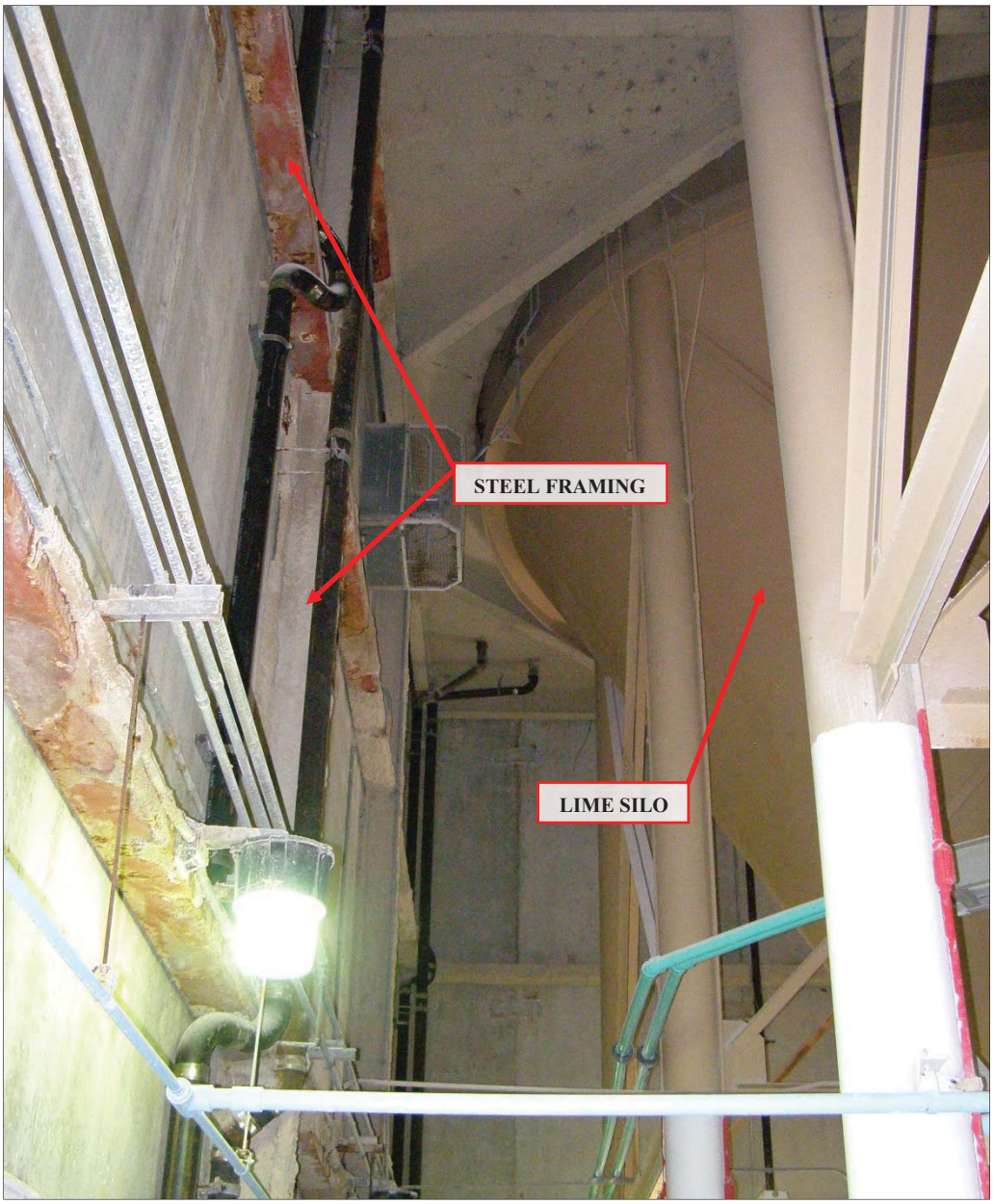

Photo 25: Steel Framing with Corrosion and Loss of Fire Protection

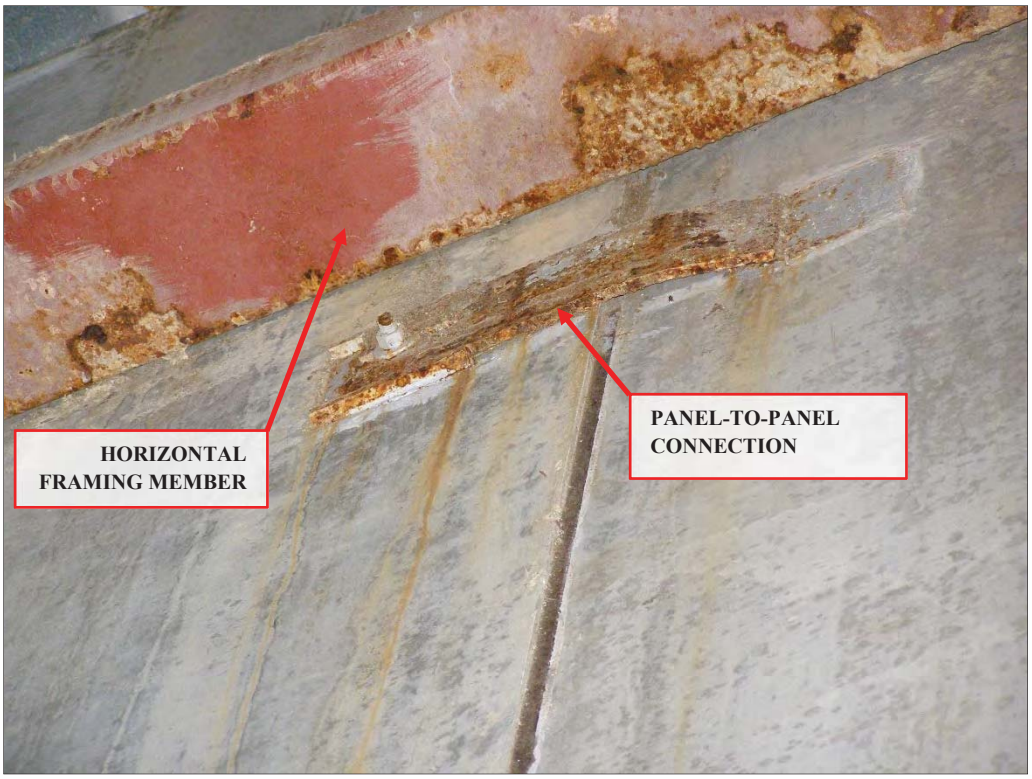

Photo 26: Steel Framing and Connection Corrosion

Photo 27: Overhead Door Frame Corrosion

Sludge Dewatering Building

Photo 28: South View

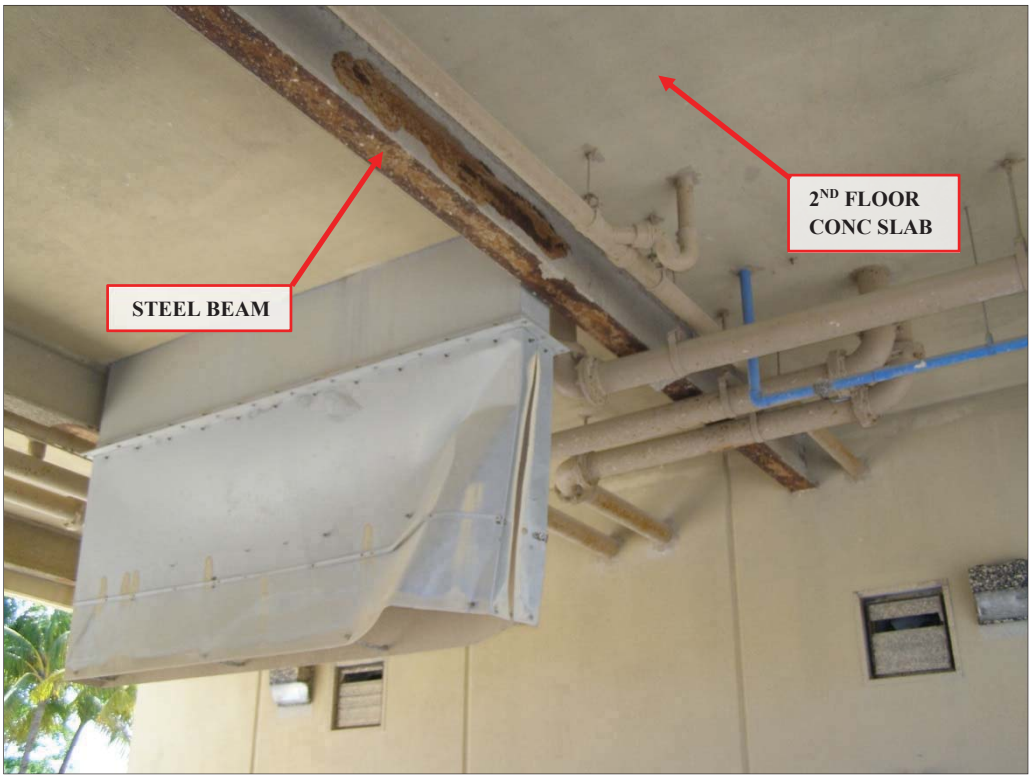

Photo 29: 2nd Floor Framing Corrosion

Photo 30: Typical Roof Framing

APPENDIX B – ROM COST TABLES

FILTER BUILDING

FILTER BUILDING ARCHITECTURAL OPENINGS - WINDOWS, DOORS, LOUVERS					
ELEV	**LEVEL / LOCATION**	**TYPE**	**SIZE (WxH)**	**QTY**	**ROM**
		HSP 1-4			
SOUTH	L2 / HSP PUMP	WINDOW	12'-0" X 12'-0"	6	$60,000
WEST	L1 / HSP PUMP	OVERHEAD DOOR	12'-0" X 14'-0"	1	$10,000
WEST	L1 / HSP PUMP	NEW SINGLE DOOR	3'-0" X 7'-0"	1	$20,000
WEST	L2 / HSP PUMP	LOUVER	8'-0" X 8'-0"	1	$3,000
WEST	L2 / HSP PUMP	DOUBLE DOOR	6'-0" x 7'-0"	1	$12,000
				SUBTOTAL	**$105,000**
		OFFICE			
NORTH	L2 / OFFICE	WINDOW	3'-0" X 1'-4"	1	$2,000
EAST	L1 / OFFICE	SINGLE DOOR	2'-8" X 7'-0" & 6'-8"	2	$14,000
EAST	L1 / OFFICE	DOUBLE DOOR	6'-0" X 7'-0"	1	$12,000
EAST	L1 / OFFICE	LOUVER	1'-4" X 1'-4"	1	$1,000
EAST	L1 / OFFICE	WINDOW	3'-0" X 4'-0"	1	$2,000
EAST	L1 / OFFICE	WINDOW	6'-0" X 4'-0"	1	$4,000
EAST	L2 / OFFICE	WINDOW	3'-0" X 4'-0"	2	$4,000
EAST	L2 / OFFICE	WINDOW	3'-0" X 4'-0"	2	-
SOUTH	L1 / OFFICE	WINDOW	3'-0" X 4'-0"	2	-
SOUTH	L1 / OFFICE	WINDOW	9'-0" X 2'-4"	3	$11,000
SOUTH	L2 / OFFICE	WINDOW	9'-0" X 4'-0"	2	$12,000
SOUTH	L2 / OFFICE	WINDOW	6'-0" X 4'-0"	1	-
SOUTH	L2 / OFFICE	DOUBLE DOOR	6'-0" X 7'-0"	1	$12,000
				SUBTOTAL	**$74,000**
		FILTER OPERATION GALLERY			
NORTH	L1 / FILTER GALLERY	DOUBLE DOOR	6'-0" X 7'-0"	1	$12,000
NORTH	L2 / FILTER GALLERY	WINDOW	3'-0" X 3'-0"	1	-
EAST	L1 / FILTER GALLERY	SINGLE DOOR	3'-0" X 7'-0"	1	$7,000
EAST	L2 / FILTER GALLERY	SINGLE DOOR	2'-8" X 6'-8"	1	$7,000
EAST	L3 / FILTER GALLERY	SINGLE DOOR	3'-0" X 7'-0"	4	$28,000
EAST	L3 / FILTER GALLERY	WINDOW	12'-0" X 4'-0"	1	-
EAST	L3 / FILTER GALLERY	WINDOW	15'-4" X 4'-0"	6	-
WEST	L3 / FILTER GALLERY	WINDOW	6'-0" X 2'-0"	1	-
WEST	L1 / FILTER GALLERY	SINGLE DOOR	3'-0" X 7'-0"	1	$7,000
WEST	L2 / FILTER GALLERY	SINGLE DOOR	3'-0" X 7'-0"	1	$7,000
WEST	L3 / FILTER GALLERY	SINGLE DOOR	2'-8" X 6'-8"	4	$28,000
WEST	L3 / FILTER GALLERY	WINDOW	12'-0" X 4'-0"	1	-
WEST	L3 / FILTER GALLERY	WINDOW	15'-4" X 4'-0"	6	-
WEST	L3 / FILTER GALLERY	WINDOW	6'-0" X 2'-0"	1	-
				SUBTOTAL	**$96,000**
				TOTAL	**$275,000**

HSP 5-6/ELECTRICAL EQUIPMENT BUILDING

HSP PUMP/ELECT EQUIP BLDG ARCH OPNGS - WINDOWS, DOORS, LOUVERS				
ELEVATION	**TYPE**	**SIZE (WxH)**	**QTY**	**ROM**
NORTH	LOUVER	5'-3" X 5'-8"	1	$2,000
NORTH	OH DOOR	10'-0" x 12'-0"	1	$10,000
EAST	LOUVER	2'-6" X 3'-0"	4	$3,000
EAST	LOUVER	8'-0" X 5'-6"	2	$4,000
EAST	DOUBLE DOOR	6'-0" X 7'-0"	2	$24,000
EAST	SINGLE DOOR	3'-0" X 7'-0"	1	$7,000
EAST	WINDOW	13'-0" X 5'-0"	3	$9,000
WEST	WINDOW	13'-0" X 5'-0"	4	$12,000
WEST	SINGLE DOOR	3'-0" X 7'-0"	1	$7,000
WEST	OH DOOR	10'-0" x 12'-0"	2	$20,000
WEST	DOUBLE DOOR	6'-0" X 7'-0"	1	$12,000
			Total	**$110,000**

CHEMICAL BUILDING

CHEMICAL BLDG ARCH OPENINGS - WINDOWS, DOORS, LOUVERS				
ELEVATION	**TYPE**	**SIZE (WxH)**	**QUANTITY**	**ROM**
WEST	SINGLE DOOR	3'-0" X 7'-0"	3	$20,000
WEST	ELEVATOR OPENING	5'-10" X 6'-10"	1	-
WEST / L2	DOUBLE DOOR	6'-0" X 7'-0"	1	$12,000
WEST	LOUVER	5'-0" X 3'-0"	2	$2,000
WEST	WINDOW	5'-0" X 3'-0"	5	$15,000
WEST	LOUVER	2'-0" X 2'-0"	1	$1,000
WEST	LOUVER	5'-0" X 3'-6"	1	$1,000
WEST	LOUVER	1'-0" X 1'-0"	2	$1,000
WEST	LOUVER	2'-0" X 1'-0"	1	$1,000
WEST	LOUVER	1'-0" X 2'-0"	1	$1,000
WEST	LOUVER	4'-0" X 4'-0"	5	$3,000
WEST	OH DOOR	12'-0" X 9'-0"	2	$20,000
NORTH	OH DOOR	10'-0" X 13'-9"	1	$10,000
EAST	LOUVER	5'-0" X 2'-0"	2	$2,000
EAST	LOUVER	5'-0" X 3'-0"	4	$4,000
EAST	LOUVER	4'-0" X 2'-0"	2	$2,000
EAST	LOUVER	5'-0" X 3'-6"	1	$1,000
EAST	LOUVER	2'-0" X 2'-0"	1	$1,000
EAST	LOUVER	2'-4" X 2'-4"	1	$1,000
EAST	WINDOW	5'-0" X 3'-0"	5	$15,000
SOUTH	DOUBLE DOOR	6'-0" X 7'-0"	1	$12,000
ROOF	SKYLIGHT	5'-0" x 5'-0"	8	$16,000
			Total	**$141,000**

SLUDGE DEWATERING BUILDING

SLUDGE DEWATERING BLDG ARCH OPNGS - WINDOWS, DOORS, LOUVERS				
ELEVATION	**TYPE**	**SIZE (WxH)**	**QUANTITY**	**ROM**
SOUTH	LOUVER	5'-0" X 2'-0"	1	$1,000
SOUTH	LOUVER	4'-0" X 2'-0"	1	$1,000
SOUTH L2	OH DOOR	16'-0" X 14'-0"	2	$22,000
SOUTH L2	OH DOOR	19'-6" X 14'-0"	1	$20,000
WEST L2	SINGLE DOOR	3'-0" X 7'-0"	1	$3,000
WEST	DOUBLE DOOR	6'-0" X 7'-4"	1	$12,000
WEST	LOUVER	5'-0" X 3'-0"	1	$1,000
NORTH	LOUVER	4'-0" X 2'-0"	5	$3,000
EAST	LOUVER	2'-0" X 2'-0"	2	$2,000
EAST L2	SINGLE DOOR	3'-0" X 7'-0"	1	$3,000
ROOF	SKYLIGHT	5'-0" X 5'-0"	6	$12,000
			Total	**$80,000**