EVALUATION OF SELF CONSOLIDATING CONCRETE AND CLASS IV CONCRETE FLOW IN DRILLED SHAFTS – PART 1

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Task 2b Deliverable – Field Exploratory Evaluation of Existing Bridges with Drilled Shaft Foundations

Submitted to

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Preface

This deliverable is submitted in partial fulfillment of the requirements set forth and agreed upon at the onset of the project and indicates a degree of completion. It also serves as an interim report of the research progress and findings as they pertain to the individual task-based goals that comprise the overall project scope. Herein, the FDOT project manager's approval and guidance are sought regarding the applicability of the intermediate research findings and the subsequent research direction. The project tasks, as outlined in the scope of services, are presented below. The subject of the present report is highlighted in bold.

Task 1. Literature Review (pages 3-90)

Task 2a. Exploratory Evaluation of Previously Cast Lab Shaft Specimens (page 91-287)

Task 2b. Field Exploratory Evaluation of Existing Bridges with Drilled Shaft Foundations

Task 3. Corrosion Potential Evaluations

Task 4. Porosity and Hydration Products Determinations

Task 5. Rheology Modeling and Testing

Task 6. Effects of Construction Approach

Task 7. Reporting: Draft and Final Report

The proposed study will culminate with a comprehensive final report describing all aspects of the study. This interim report is also intended to serve as a living draft of what will ultimately be the final report. As such, all previously submitted interim reports to date will be included for completeness (in greyed-out font) but may contain changes based on any new findings; this is especially applicable to the *Literature Review* component.

Chapter Four: Field Exploratory Evaluation of Existing Bridges with Drilled Shaft Foundations (Task 2b Deliverable)

With extreme event loading states often controlling pier/foundation designs for overwater bridges, there has been an almost complete change from bridge bents to cap and column footings. The net effect was to make all foundation elements (piles or shafts) work in concert to resist vessel impact loads. As a result, most new bridge piers have fully submerged foundation elements. Figure 4-1 shows the two variants comprising the east and west bound bridges in the Gandy Bridge corridor of Tampa Bay.

Figure 4.1 Newer cap and column pier design (left); older pile bent piers (right).

Overwater shaft construction employs steel casing through the water and embedded in the soil that allows the shaft concrete to be poured up to the cut-off elevation, which is often near or below sea level. This casing is left in place until the concrete has cured sufficiently to proceed with footing construction, and at which time the casing can be removed (cut off) down to the level of the mudline. This Task targeted overwater bridges where the casing was fully or partially removed to assess the shaft surface conditions. This approach was adopted in lieu of partial excavation around on-land shafts that would also reveal the shaft surface but may have also required washing and been costly.

The approach was multi-faceted (1) identify an inventory/listing of bridges built on shafts, (2) obtain plan sets detailed enough to screen candidate bridges, (3) obtain biennial inspection reports complete with diver notes to focus on which shafts of which piers may be fruitful, and (4) conduct underwater evaluations of those bridges where the casing was in part removed, revealing the concrete surface. Ideally, candidate bridges would be constructed using all stabilization methods including: full length temporary casing (natural slurry), bentonite slurry, and attapulgite slurry. Recall from Chapter 3 (Task 2a), none of the 24 laboratory cast samples were tremie-placed in attapulgite.

4.1 Bridge Identification

Florida is home to more than 12,000 bridges (FHWA, 2016), many of which are over water. Close coordination with District maintenance engineers, past and present central office personnel, bridge inspectors and CEI consultants was required to draft a list of likely candidate bridges. Ongoing efforts to identify bridges that match the construction method in question have thus far produced a list of 14 bridges (Table 4.1, Figure 4.2).

Table 4.1 List of bridges reviewed to date.

Bridge Name	**Bridge Number**	**Location**	**Year Built**
Bridge of Lions	780074	St. Augustine, FL	1927
Clearwater Memorial Causeway	150244	Clearwater, FL	2005
Clearwater Pass Bridge	155522	Clearwater, FL	1995
Fuller Warren Bridge	720629*	Jacksonville, FL	1995
Gandy Bridge	100585	Tampa, FL	1924
John Ringling Causeway	170176	Sarasota, FL	1926
Overland Bridge	720627	Jacksonville, FL	2017
Santa Fe River Bridge	260112	Gainesville, FL	2002
SR2 Choctawhatchee Bridge	520145	Caryville, FL	1940
SR10 Choctawhatchee Bridge	520149	Caryville, FL	1927
SR20 Blountstown Bridge	470052	Blountstown, FL	1998
SR61 Lost Creek Bridge	590048	Wakulla, FL	1991
SR63 Ochlockonee Bridge	500124 - 500127	Ochlockonee River, FL	2001
Victory Bridge	530951	Chattahoochee, FL	1996

*Indicates main bridge span.

Not all necessary information could be obtained to warrant on-site investigations, but if any evidence suggested that exposed shaft concrete could be found, then those bridges were slated for underwater evaluation. A summary of each candidate bridge is provided for completeness.

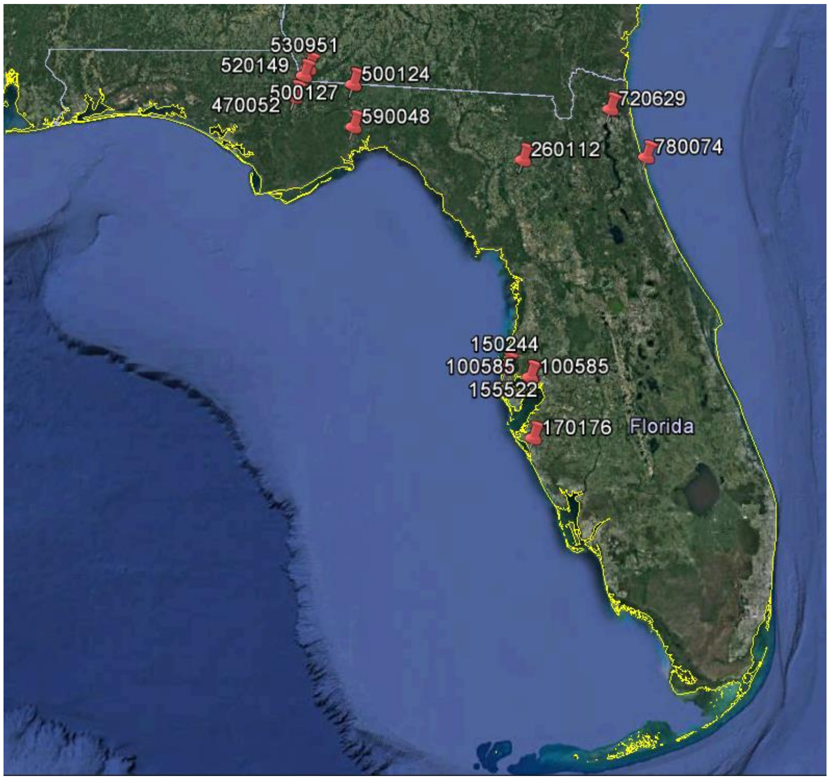


Figure 4.2 Bridge locations

4.1.1 Bridge of Lions

A part of State Road A1A, the Bridge of Lions spans the intracoastal waters of St. Augustine, connecting Anastasia Island with downtown St. Augustine. The bridge is iconically known for the two lions that have guarded the bridge since its construction in 1927. These lions are Carrara marble Medici Lions that are identical to those in Loggia dei Lanzi in Florence, Italy. Prior to the bridge of lions there was a wooden bridge, built in 1895, known as the "South Beach Railroad Bridge" or as "The Bridge to Anastasia Island". This bridge was renovated in 1904 and was able to accommodate a trolley. Known as the father of the Bridge of Lions, Henry Rodenbaugh initiated the construction of the bridge in 1925 through his funding efforts. Completed in 1927 with its extravagant art and style, the Bridge of Lions has been regarded as a symbol of the nation's oldest city. The Bridge of Lions underwent an 80 million dollar renovation in 2006. A temporary bridge was constructed and the lions were removed for the time being. After work was done on the bascule towers and the steel girders, the Bridge of Lions was reopened in March of 2010 and the Lions were brought back in March of 2011, marking the completion of a long renovation project.

Table 4.2 Bridge of Lions

Bridge Name	Bridge of Lions
Bridge Number	780074
Year Built	1927
Slurry Type	Mineral
Shaft Diameters	3 ft-8 ft

Bridge of Lions is a double leaf bascule bridge that stands on 25 piers (Figure 4.3). These piers are supported by drilled shafts ranging from 3 to 8 ft in diameter (Table 4.2). Inspection records show that the drilled shafts on piers 10 and 11 have steel casings extending up from the ground line to within 6 ft of the bottom of the footing. This is not a clear indicator that exposed concrete will be available for inspection. Inspection report photographs show delamination above the water line and minor damage to the fender system. The underwater photos do not indicate that any vegetation was removed for inspection and as such cannot be used to confirm or deny the presence of casing. Based on review of the information provided for this bridge, further on-site evaluation is warranted.

Figure 4.3 Bridge Number 780074 (Bridge of Lions) plan and elevation images.

4.1.2 Clearwater Memorial Causeway

Clearwater Memorial Causeway (Figure 4.4) is a fixed span structure that connects downtown Clearwater and Clearwater Beach, passing over the intracoastal waterway. It is a part of State Road 60, a road that goes from Clearwater Beach to Vero Beach. The first Memorial Causeway Bridge opened in the 1920s. It was a two-lane flat span concrete bridge. This bridge was used for approximately forty years before the second Memorial Causeway Bridge. The second was a bascule bridge, opened in the 1960s. A portion of the original bridge was then opened as a fishing pier. The third bridge became fully operational in 2005. This bridge is 2540 ft long and stands on 10 piers. These piers are supported by drilled shafts of 4 and 6 ft in diameter (Table 4.3).

Table 4.3 Clearwater Memorial Causeway

Bridge Name	Clearwater Memorial Causeway
Bridge Number	150244
Year Built	2002
Slurry Type	Natural
Shaft Diameters	4 ft, 5 ft

The underwater inspection report from 2016 indicates that the steel casing is still in place for all shafts. The report also indicates that the casings exhibit light pitting and minor corrosion. The presence of casings eliminates this bridge from the list of possible field inspections. Information provided for this bridge at this time was deemed insufficient or inappropriate to warrant further on-site evaluation.

Figure 4.4 Bridge Number 150244 (Clearwater Memorial Causeway) plan and elevation images.

4.1.3 Clearwater Pass Bridge

Clearwater Pass Bridge (Figure 4.5) is a fixed span structure that carries Gulf Blvd. across Clearwater pass from Clearwater Beach to Sand Key Public Park. The current bridge opened in 1995 and replaced a drawbridge that had been in service since the 1960s. The Clearwater Pass bridge has a vertical clearance of 74 ft and as such eliminates the need for drawbridge functionality. The bridge is 2520 ft long and stands on 22 piers. These piers are supported by drilled shafts of 3 and 6 ft in diameter (Table 4.4).

Table 4.4 Clearwater Pass Bridge

Bridge Name	Clearwater Pass Bridge
Bridge Number	155522
Year Built	1995
Slurry Type	Natural
Shaft Diameters	3 ft, 6 ft

The underwater inspection report from 2017 indicates that the scour has exposed the concrete surface below the casing on 12 shafts. The depth of exposure varies from 7 to 42 inches. The concrete is noted as "irregular with no exposed steel." This bridge was constructed using natural slurry, but the concrete irregularities may still warrant field verification. Based on review of the information provided for this bridge, further on-site evaluation is warranted.

Figure 4.5 Bridge Number 155522 (Clearwater Pass Bridge) plan and elevation images.

4.1.4 Fuller Warren Bridge

The Fuller Warren Bridge (Figure 4.6) is a prestressed concrete girder structure that carries interstate 95 across the St. Johns River. This bridge, which became fully operational in 2002, was built to replace the deteriorating steel bascule bridge that opened in 1954. The steel bridge remained in place, though out of service, until it was demolished with explosives in 2007. The new structure retains the namesake of former Florida Governor Fuller Warren, is eight lanes wide, 7,500 ft long, and has a 75-ft vertical clearance at midspan.

Table 4.5 Fuller Warren Bridge Sections

Bridge 1	720154
Detour over college street	720158
Bridge 2	720627
Ramp C Bridge	720628
Bridge 3	720629
Bridge 4	720630
Ramp F Bridge	720631
Ramp E Bridge	720632
Ramp D Bridge	720633
Ramp I Bridge	720645

Table 4.6 Fuller Warren Bridge

Bridge Name	Fuller Warren
Bridge Number	See Table 4.5
Year Built	2002
Slurry Type	Natural
Shaft Diameters	3 ft, 4 ft, 6 ft

The plans for the Fuller Warren Bridge were divided into 10 parts, each corresponding to a different bridge section. Each bridge section has a unique bridge ID number. The main span is labeled as Bridge #3 in the plans but corresponds to bridge ID 720629. The full list of bridge labels and numbers are given in Table 4.5. Based on initial information, the plans were only requested for bridges 720627, 720628 and 720633, which correspond to Bridge 2, Ramp C Bridge, and Ramp D Bridge, respectively. These three plan sets show a total of 44 drilled shafts in the water ranging from 3 to 6 ft in diameter (Table 4.6). The inspection reports indicate that these shafts are all fully cased. Information on the other seven bridges may provide further illumination regarding the drilled shafts in the main span; of particular interest is 720629, Bridge 3. Information provided for this bridge at this time was deemed insufficient or inappropriate to warrant further on-site evaluation.

Figure 4.6 Bridge Number 720629 (main) (Fuller Warren Bridge) plan and elevation images.

4.1.5 Gandy Bridge

The Gandy Bridge corridor is the first major water crossing between Hillsborough and Pinellas counties in Old Tampa Bay. The corridor, stretching 2.4 miles, has been the site for four bridges dating back to 1924 when the first two-lane low level draw bridge was built. In 1956, a second bridge, which carried westbound traffic, was built to the north of the original bridge, which carried two eastbound lanes. In 1975, the third Gandy Bridge was opened to the south of the 1924 bridge and took over east bound traffic. In 1996 the fourth bridge (Figure 4.7) was opened, which is the bridge of interest to this project. It was built on the original alignment of the 1924 bridge that had been fully removed. At that time, the 1956 bridge was converted to a pedestrian trail and all west bound traffic was routed over the newest bridge. The 1956, 1975 and 1996 bridges were all high level (45 ft clearance) with no moving components. Today, the bridge is still part of US 92.

The bridge is technically in FDOT District 7, but was built in 1996 under District 1 oversight prior to the creation of District 7. The bridge has 96 spans supported by 97 Piers, 94 of the piers are in the water. Each water pier has a cap-and-column design, where a single hammerhead-type pier cap, column, and footing are supported by four drilled shafts with shaft diameters ranging from 4 ft to 7 ft (Table 4.7), and with both single- and double-concentric steel reinforcing cage

Table 4.7 Gandy Bridge (Westbound)

Bridge Name	Gandy Bridge (Westbound)
Bridge Number	100585
Year Built	1997
Slurry Type	Natural
Shaft Diameters	4 ft, 6 ft, 7 ft

configurations. All shafts were constructed with natural slurry and a combination of temporary and permanent casings.

Inspection records for this bridge are highly detailed, and show which shafts had their casings removed and which have voids and/or honeycombing. This is one of the few bridges seen with casings removed. Based on review of the information provided for this bridge, further on-site evaluation is warranted.

Figure 4.7 Bridge Number 100585 (Gandy Bridge) plan and elevation images.

4.1.6 John Ringing Causeway

The original bridge was built in 1925 by John Ringling, who owned land on both Lido and Longboat keys. Wanting to develop the land in the future, Ringling connected the two keys with the mainland. Shortly after, the bridge was donated to the city in 1927. In 1951, the State Road Department started to build a four-lane drawbridge which opened in 1959, and the original bridge was demolished. The same thing occurred in 2000 and a fixed high-span bridge was completed in 2003 (Figure 4.8).

Table 4.8 John Ringling Causeway

Bridge Name	John Ringling Causeway
Bridge Number	170176
Year Built	2003
Slurry Type	Natural
Shaft Diameters	4 ft, 9 ft

John Ringling Causeway has 10 piers and two end bent systems. Each pier has two 9-ft drilled shafts (Table 4.8). Each end bent system has a total of four drilled shafts, each with a diameter of 4 ft. The drilled shafts for this bridge were cast using natural slurry. Review of the most recent inspection report indicated that all shafts are still fully cased. Information provided for this bridge at this time was deemed insufficient or inappropriate to warrant further on-site evaluation.

Figure 4.8 Bridge Number 170176 (John Ringling Causeway) plan and elevation images.

4.1.7 Overland Bridge

The Overland Bridge (Figure 4.9) is the elevated section of I-95 before the split into three bridges (the Fuller Warren Bridge, the Acosta Bridge and the Main St. Bridge). This bridge is currently under construction and as such, no as- built plans were available. However, as an over-land structure there will be no piers in the water, eliminating the possibility for underwater inspection. Basic bridge information can be found in Table 4.9. Information provided for this bridge at this time was deemed insufficient or inappropriate to warrant further on-site evaluation.

Table 4.9 Overland Bridge

Bridge Name	Overland Bridge
Bridge Number	720627
Year Built	2017
Slurry Type	Bentonite
Shaft Diameters	unknown

Figure 4.9 Bridge Number 720627 (Overland Bridge) plan and perspective images.

4.1.8 Santa Fe River Bridge

The Santa Fe River Bridge (Figure 4.10) is located in High Springs, FL on US41/441. Its purpose is to carry the highway over the Santa Fe River. The bridge has a length of 369 ft. While it does not have any historical significance, this bridge marks the start of a 26-mile paddle-boarding trail from High Springs to Bransford at the Suwannee River.

Table 4.10 Santa Fe River Bridge

Bridge Name	Santa Fe River Bridge
Bridge Number	260112
Year Built	2002
Slurry Type	Bentonite
Shaft Diameters	3 ft, 5 ft

This bridge has two end bent piers and three intermediate piers with shaft diameters of 3 and 5 ft, respectively (Table 4.10), and each pier is supported by two shafts. Inspection reports for this bridge note honeycombing on columns. Shafts were cast with bentonite slurry (contractor was given the choice of casing or bentonite). Based on the river depth profiles, the top of shafts can potentially be seen. Based on review of the information provided for this bridge, further on-site evaluation is warranted.

Figure 4.10 Bridge Number 260112 (Santa Fe River Bridge) plan and elevation images.

4.1.9 SR2 Choctawhatchee Bridge

This bridge carries SR 2 over the Choctawhatchee River (Figure 4.11). It is 2559 ft long and holds no historic significance. Review of the plans for this bridge indicate that there are 21 piers in the waterway or flood plain. Those piers are supported by 42 drilled shafts 5 ft in diameter (Table 4.11). Inspection reports show that this bridge is fully cased. Information provided for this bridge at this time was deemed insufficient or inappropriate to warrant further on-site evaluation.

Table 4.11 SR2 Choctawhatchee Bridge

Bridge Name	SR2 Choctawhatchee Bridge
Bridge Number	520145
Year Built	2001
Slurry Type	Natural
Shaft Diameters	5 ft

Figure 4.11 Bridge Number 520145 (SR2 Choctawhatchee Bridge) plan image.

4.1.10 SR10 Choctawhatchee Bridge

Known as the Caryville Bridge or the George L. Dickenson Bridge (Figure 4.12), this bridge was constructed in 1927 as an effort to connect Washington and Holmes County. The original bridge had four Warren deck trusses and a double leaf bascule section. Between 1944 and 1952, the bridge underwent a reconfiguration into a fixed deck design that had a wider roadway.

Review of the newer bridge plans indicates that there are 24 piers. Those piers are supported by 48 drilled shafts, 5 and 6 ft in diameter (Table 4.12). Permanent casing was used during installation. Information provided for this bridge at this time was deemed insufficient or inappropriate to warrant further on-site evaluation.

Table 4.12 SR10 Choctawhatchee Bridge

Bridge Name	SR10 Choctawhatchee Bridge
Bridge Number	520149
Year Built	2000
Slurry Type	Mineral Slurry
Shaft Diameters	5 ft, 6 ft

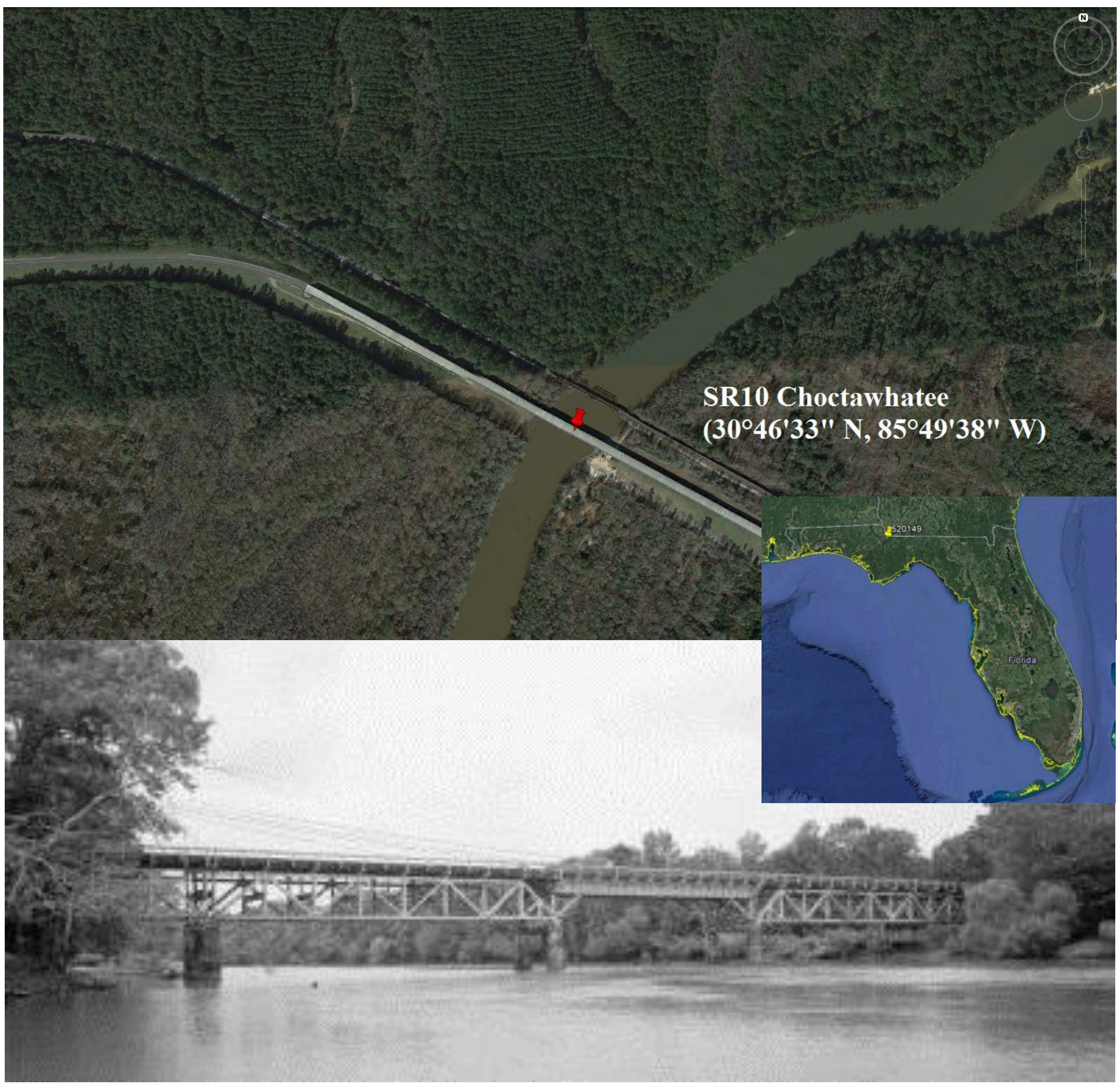


Figure 4.12 Bridge Number 520149 (SR10 Choctawhatchee Bridge) plan and elevation images.

4.1.11 SR20 Blountstown Bridge.

The bridge that carries SR20 over the Apalachicola river is commonly known as the Trammel Bridge (Figure 4.13), named after the three members of the Trammell family: (1) U.S Senator Park M. Trammel; (2) Member of the Florida Legislature John D. Trammell; and (3) Robert D. Trammel, a representative of the Blountstown area in the Florida legislature. These men helped either pass legislation that called for the construction of the bridge or were involved in securing funding. The original bridge was opened in 1938 and now carries westbound traffic whereas the eastbound span is a concrete high-rise bridge that was opened in 1998. Interestingly, the ends of the bridges do not share the same time zone. The east end is in the Eastern Time zone and the west end is in the Central Time Zone.

Table 4.13 SR20 Blountstown Bridge

Bridge Name	SR 20 Blountstown
Bridge Number	470052
Year Built	1998
Slurry Type	Bentonite
Shaft Diameters (ft)	5, 6, 7, 9

Review of the plans shows that there are 60 drilled shafts within the waterway or flood plain, four of which are in the Apalachicola River. Shafts range in diameter from 5 to 9 ft (Table 4.13). The inspection reports received to date do not include the underwater reports. However, the plans indicate casing should be removed down to an elevation 30 ft, and as such it is assumed that the casings were removed. Based on review of the information provided for this bridge, further on-site evaluation is warranted.

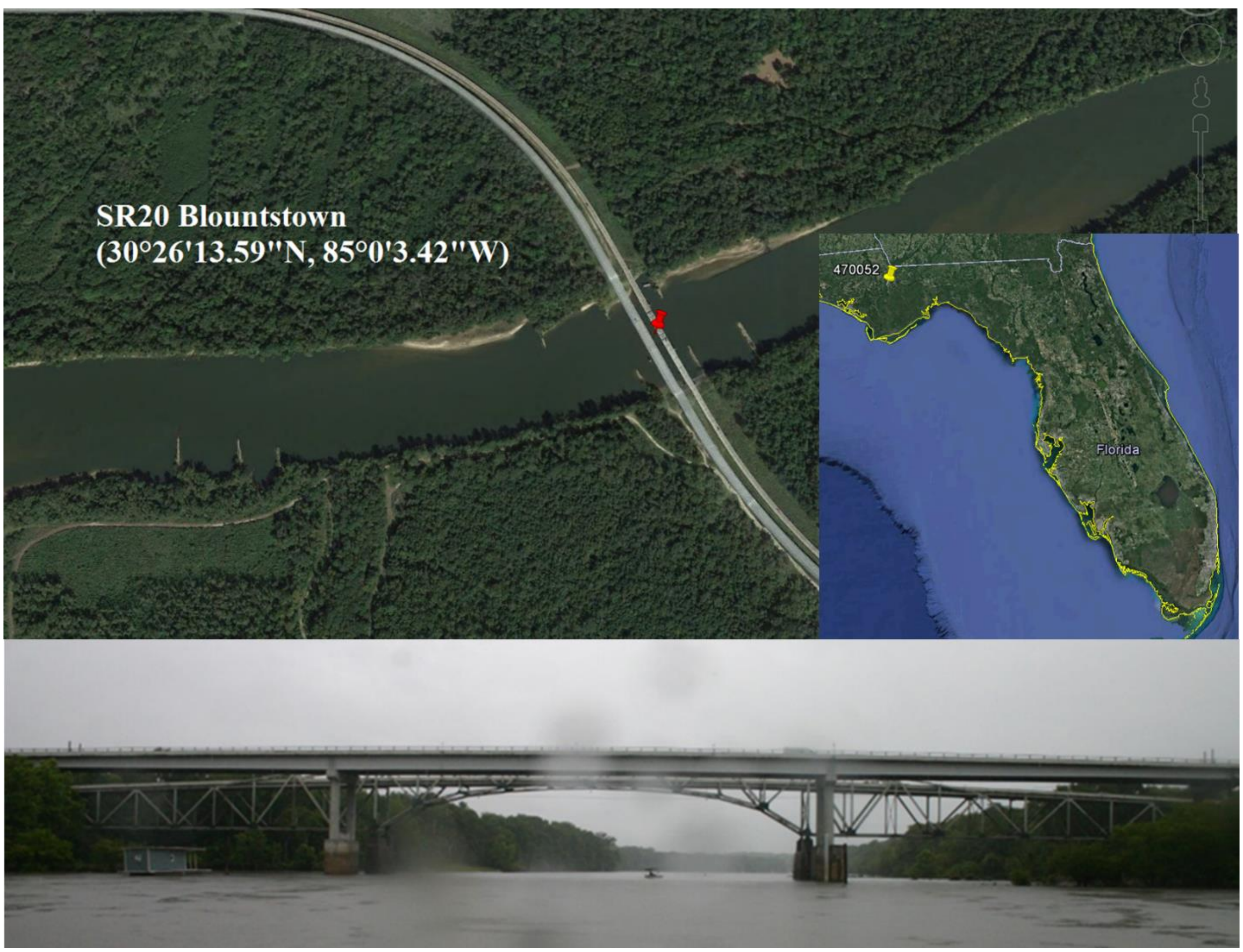


Figure 4.13 Bridge Number 470052 (SR20 Blountstown Bridge) plan and elevation images

4.1.12 SR61 Lost Creek Bridge

The Lost Creek Bridge (Figure 4.14) carries state road 61 over Lost Creek. This bridge is located 1.2 miles south of Crawfordville, FL. It has no historical significance.

Table 4.14 SR 61 Lost Creek Bridge

Bridge Name	SR61 Lost Creek Bridge
Bridge Number	590048
Year Built	1991
Slurry Type	Bentonite
Shaft Diameters	3 ft

There are 4 piers within the waterway with a total of 8 drilled shafts 3 ft in diameter (Table 4.14). Initial information indicated that the steel casings had been removed from the drilled shafts; however, there did not appear to be any water access to perform inspection. Thus, information provided for this bridge at this time was deemed insufficient or inappropriate to warrant further on-site evaluation.

Figure 4.14 Bridge Number 590048 (Lost Creek Bridge) plan image.

4.1.13 SR63 Ochlockonee Bridge

The Ochlockonee Bridge on US 27 (SR 63) and is located one half mile north of Leon County (Figure 4.15). This bridge connects the highway over the Ochlockonee River, hence the name. This bridge has no historical significance.

Table 4.15 SR63 Ochlockonee Bridge

Bridge Name	SR 63 Ochlocknee Bridge
Bridge Number	500124/500127
Year Built	2001
Slurry Type	Bentonite
Shaft Diameters	3 ft

The bridge is made up of four main sections each with their own bridge number. The northbound bridges are 500124 and 500126. The southbound bridges are 500125 and 500127. The portion of this bridge constructed using drilled shafts includes bridges 500124 and 500127. Review of the plans indicates that there are 20 piers within the waterway or flood plain. These piers are supported by 40 drilled shafts 3 ft diameter (Table 4.15). Inspection reports are unclear as to the presence of casing on the shafts. Information provided for this bridge at this time was deemed insufficient or inappropriate to warrant further on-site evaluation.

Figure 4.14 Bridge Numbers 500124/500127 (SR63 Ochlockonee Bridge) plan image.

4.1.14 Victory Bridge

The Victory Bridge carries US90 over the wetlands/flood plain west of the Apalachicola River, immediately downstream of the Jim Woodruff Dam. The original bridge was built in 1927 and is no longer used, having been replaced in 1996 by the high level bridge that is in service currently.

Review of the construction plans indicates that there are 22 piers, each supported by 2 drilled shafts 4 ft in diameter (Table 4.16). While inspection reports do not provide sufficient detail to determine what is visible, there is no access to the waterway to allow for inspection. Information provided for this bridge at this time was deemed insufficient or inappropriate to warrant further on-site evaluation.

Table 4.16 Victory Bridge

Bridge Name	Victory Bridge
Bridge Number	530111
Year Built	1996
Slurry Type	Natural
Shaft Diameters	4 ft

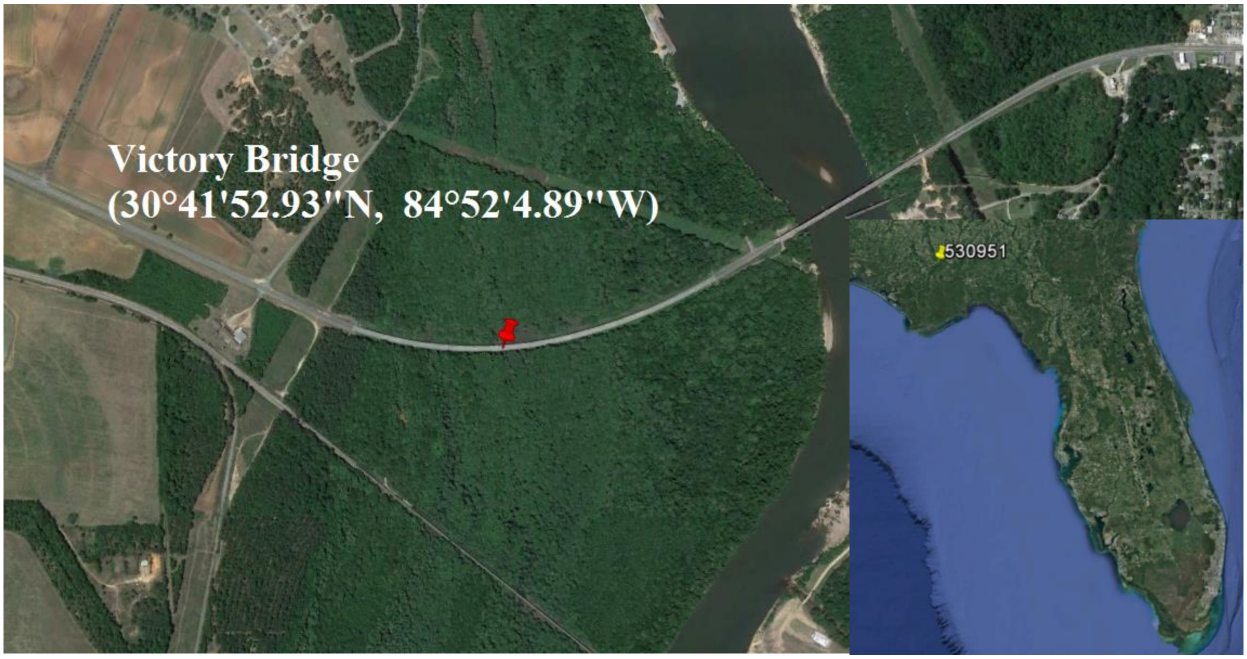


Figure 4.16 Bridge Number 530111 (Victory Bridge) plan image.

4.2 Underwater Evaluations

Of the 14 bridges screened and discussed earlier, four were selected for on-site, underwater evaluation. These bridges were selected to represent bridges constructed with bentonite, attapulgite and natural slurry types. To be appropriate for this stage, plans, and/or inspection or construction records had to indicate that the permanent casing (required for over water construction) had been removed at least in part allowing for direct access and visual evaluation.

4.2.1 Gandy Bridge 100585 (US-92 over Old Tampa Bay)

Drilled shaft construction records (logs) for the Gandy Bridge were not available through the normal information request protocol as that type of field record was not deemed important enough to store (hard copies). However, load testing reports from Statnamic tests provided the first real information about the construction process and were the only drilled shaft construction logs that could be found. These documents revealed that natural slurry was used for construction making this an ideal control site. Only a few shafts were included in the load testing report. Figure 4.17 shows both the eastbound (pile) and westbound (shaft) Gandy Bridges as well as the diving setup.

Figure 4.17 The current eastbound and westbound Gandy Bridge (looking west).

For dive inspections, shafts were selected based on the dive inspection reports provided by FDOT from Bolt Underwater Services. Uncased shaft locations were provided as well asif voids or honeycombing had been seen. Piers with voids and honeycombing were selected in addition to piers without deficiencies. Figure 4.18 shows the plan view of the eastern portion of the bridge and has the inspected piers circled. Figure 4.19(a) shows the drilled shaft numbering protocol, where shafts are labeled 1-4 with 1 being NW, 2 SW, 3 NE, and 4 SE. Figures 4.19 (b) to (d) show the shaft sizes and layouts of reinforcement cages used. More detail can be found in Appendix A. A summary of piers inspected along with their shaft sizes, reinforcement cages, and comments made by the dive inspectors can be found in Table 4.17.

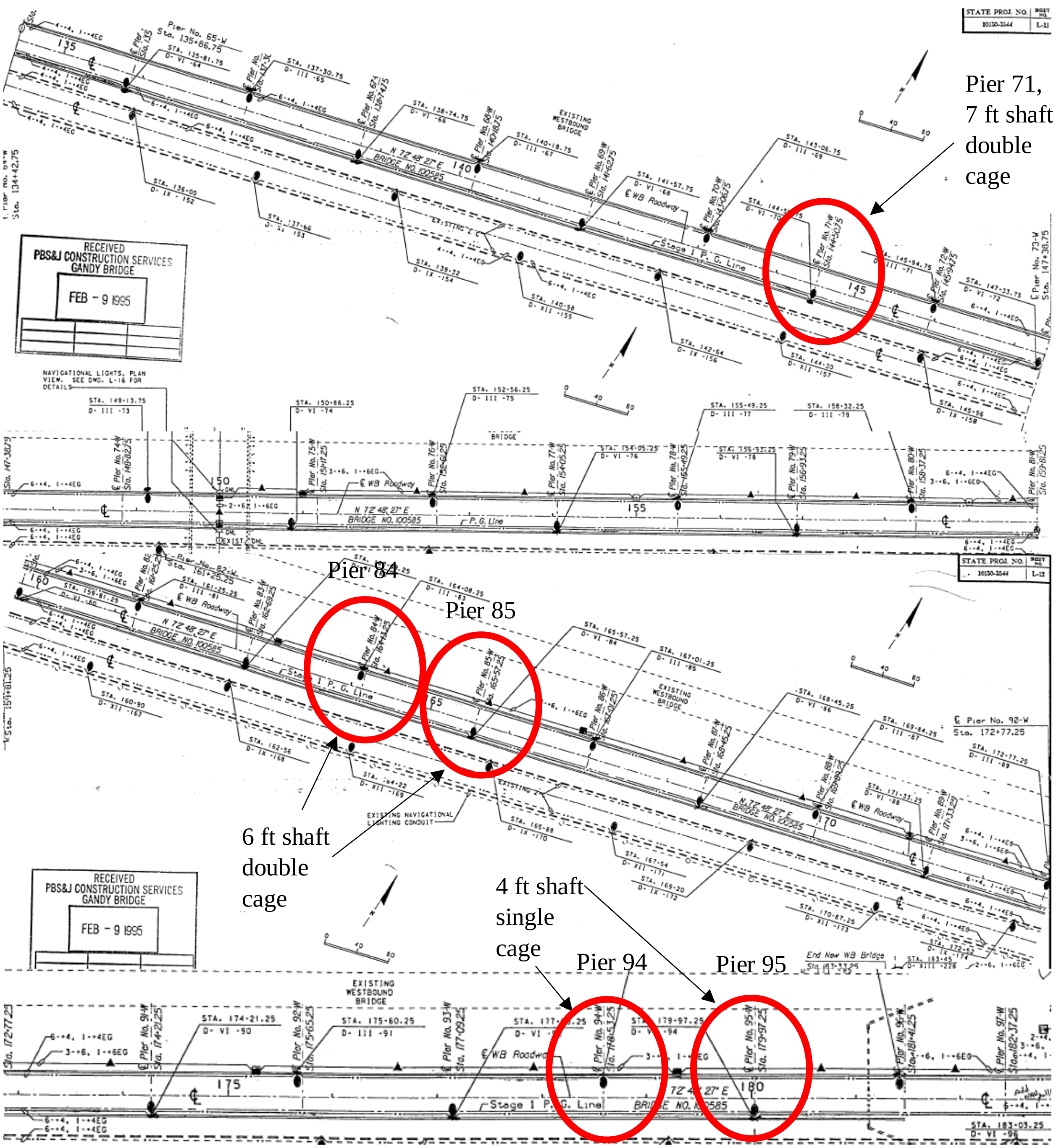


Figure 4.18 Plan view of eastern portion of Gandy Bridge. The piers that were inspected have been circled.

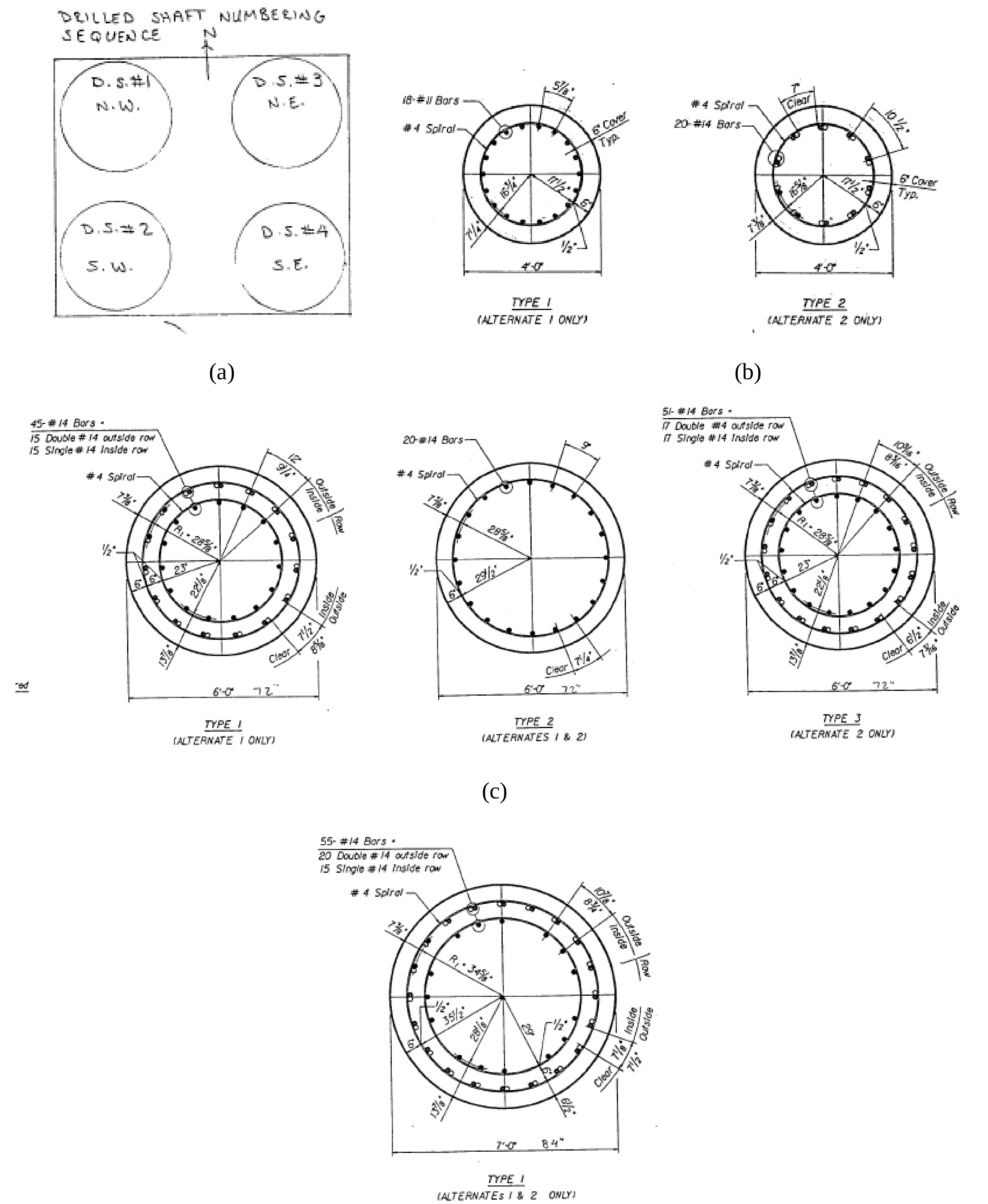


Figure 4.19 (a) Drilled shaft numbering sequence, (b) 4-ft diameter shaft reinforcement cage layouts, (c) 6-ft diameter shaft reinforcement cage layouts, (d) 7-ft diameter shaft reinforcement cage layout.

Table 4.17. Summary of shafts inspected at Gandy Bridge.

Shaft #	Shaft Diameter (ft)	Cage Type	Diver Comment
71-1	7	Double[a]	Void, 5 in. diameter x 3 in. deep
71-4	7	Double[a]	Void, 14 in. H x 14 in. W x 2 in. D
84-1	6	Double[b]	Void, 2 in. H x 9 in. W x 2 in. D
84-2	6	Double[b]	Void, 2 in. H x 9 in. W x 2 in. D
84-3	6	Double[b]	8 in. H x 3 in. W x 3 in. D
84-4	6	Double[b]	2 Voids, Up to 14 in. H x 5 in. W x 4 in. D
85 (all)	6	Double[b]	N/A
94 (all)	4	Single[c]	N/A
95-1	4	Single[c]	Void, 32 in. H x 12 in. W x 2 in. D
95-2	4	Single[c]	Void, 2 ft H x 18 in. W x 3 in. D

[a]See Figure 4.19(d)
[b]See Figure 4.19(c)- Type 1
[c]See Figure 4.19(b)- Type 1

Pier 95 (4 ft diameter, single cage)

Two shafts were chosen for inspection on Pier 95, 95-1 and 95-3 on the north side. Noted in the diver report, 95-1 had a void 12 in. below the footing/seal that is 32 in. H x 12 in. W x 2 in. D. 95-3 had no known deficiencies. All shafts at Pier 95 are 4 ft in diameter and have a Type 1 reinforcement cage (Figure 4.19b).

95-1 did have a void as noted, and it was noticeable even prior to cleaning (Figure 4.20). This void was substantial; Figure 4.21 shows the void before cleaning, which involved scraping barnacles, grinding and/or wire-brushing. A screwdriver was used for reference of void depth, which was about 2-3 in. (Figure 4.22). However, on the south (interior) side of the same shaft, the concrete was smooth (Figure 4.24). Figure 4.24 does demonstrate a crease, however this was noted to be from casing removal as it was a singular occurence. The north and south sides of the shaft can be seen in Figure 4.23 and 4.24 respectively. It should be noted that the sides of shafts appear to be concave; however, this is only from lens distortion.

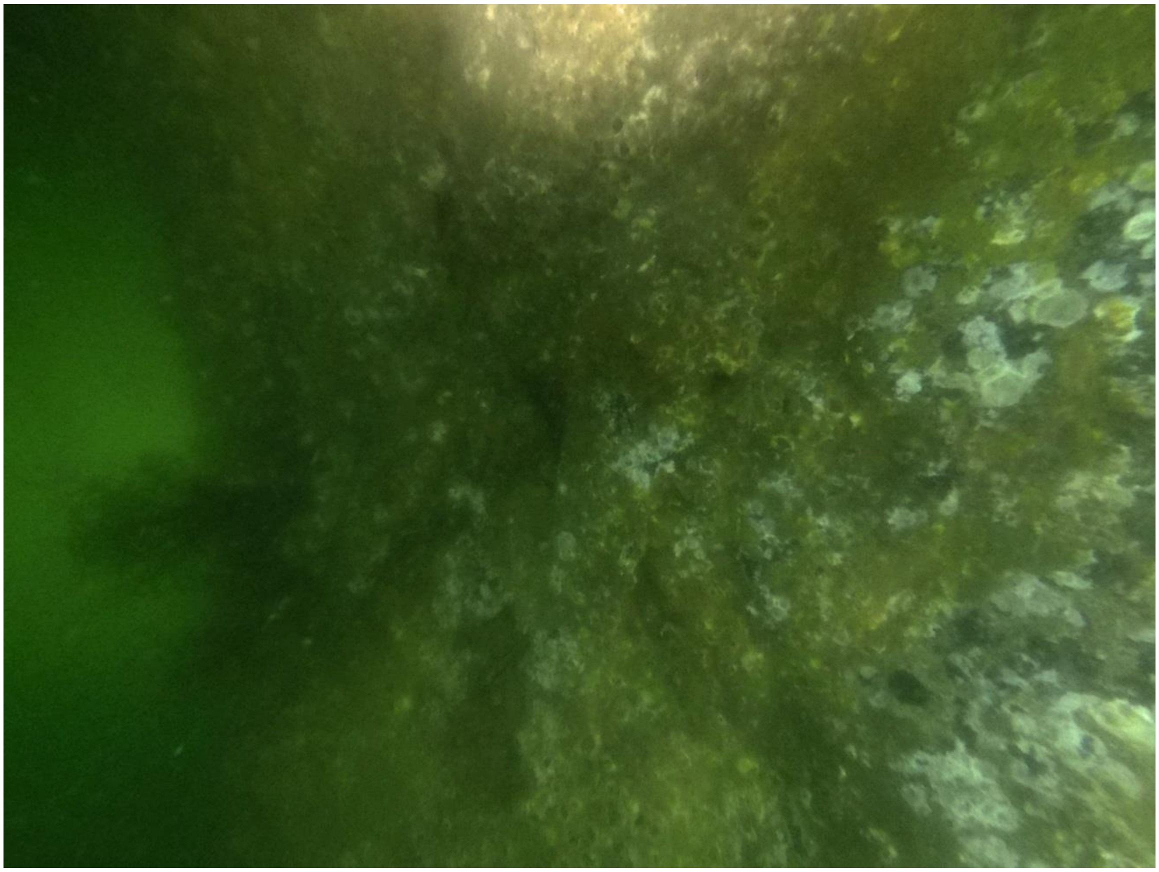


Figure 4.20 95-1 prior to cleaning.

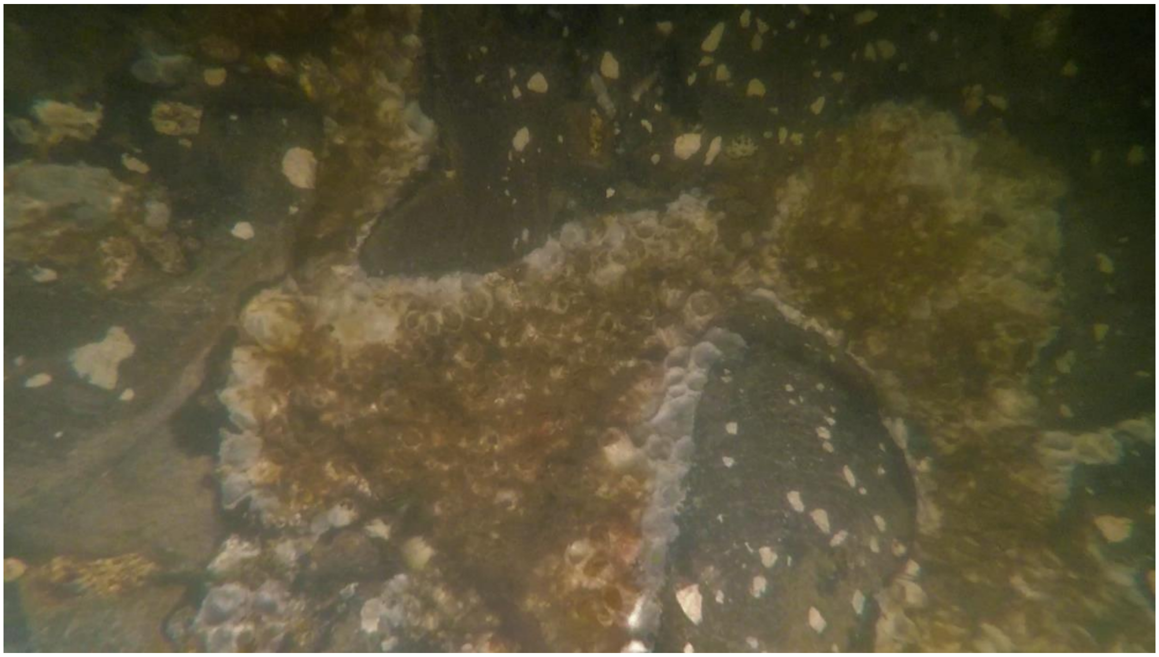


Figure 4.21 Void on 95-1, this was taken after grinding the shaft and before scraping out the barnacles residing in the voids.

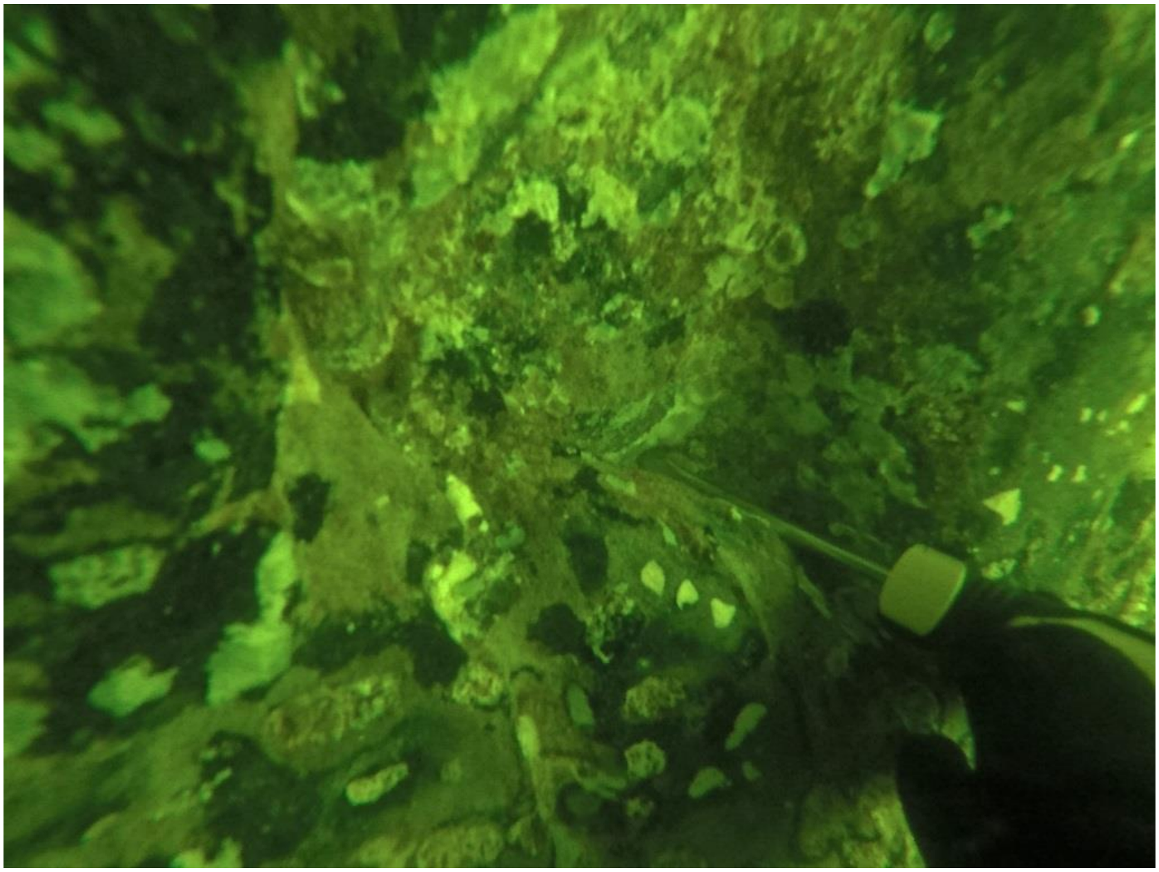
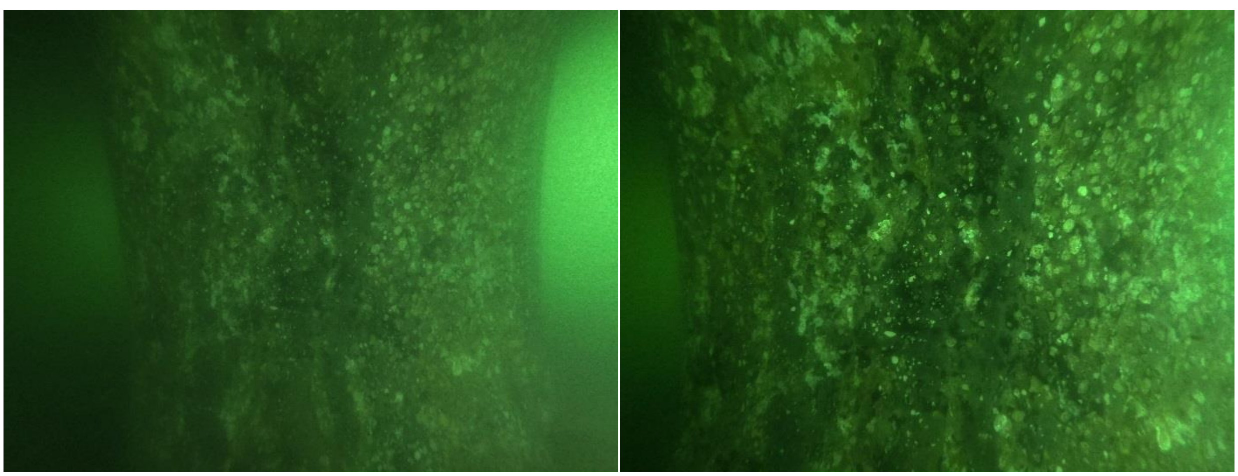


Figure 4.22 2-3in. void in Shaft 95-1 post-barnacle scraping



(a) (b)

Figure 4.23 (a) View of the north side of 95-1 post-cleaning, (b) zoomed in view of (a)

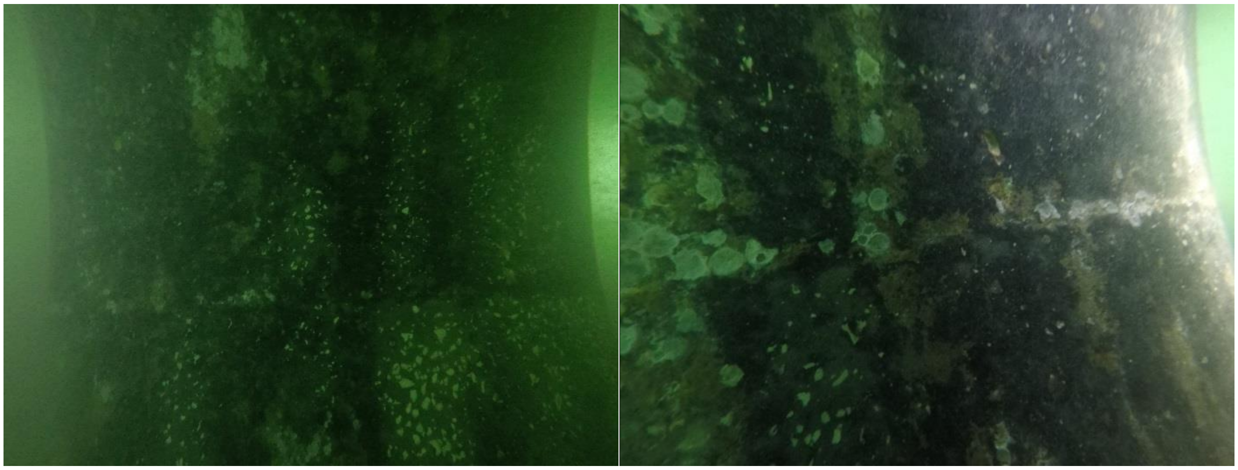


Figure 4.24 (a) South (interior) side of 95-1 post-cleaning, (b) zoomed in view of (a)

95-3 was cleaned for comparison as a shaft with no observed problems. Figure 4.25 shows 95-3 prior to cleaning. Due to the lack of water clarity on the day of inspection it was difficult to take a picture of the entire shaft, so sections are presented instead of an overall image. Figure 4.26 demonstrates a cleaned portion of the shaft. This shaft did not have any noticeable voids like 95-1. As seen from the cleaned portions the concrete surface was smooth.

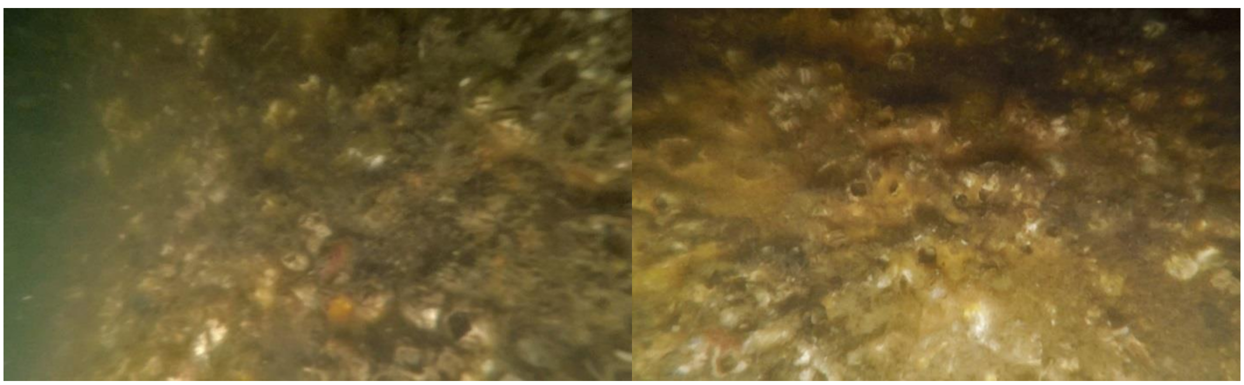


Figure 4.25 Shaft 95-3 pre-cleaning

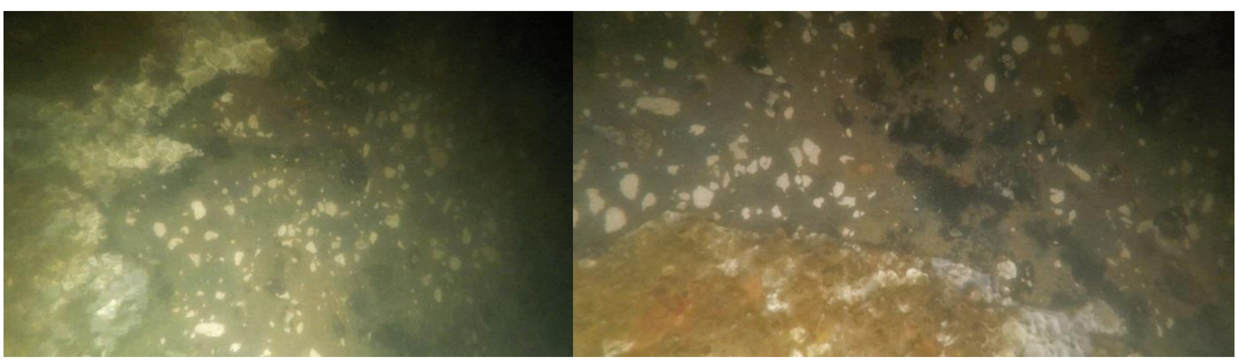


Figure 4.26 Shaft 95-3 sections post-cleaning

Pier 94 (4 ft diameter, single cage, cased)

Shaft 4 from Pier 94 was chosen for cleaning to demonstrate what a steel casing looks like versus the concrete. It can be difficult to tell if the shaft has a casing or not because of the thick layer of barnacles surrounding the shaft. Pier 94 was not mentioned in the diver report, and thus it was thought to be a good candidate to have a casing. Figure 4.27 shows 94-4 prior to cleaning and Figure 4.28 shows 94-4 during cleaning. In Figure 4.29 the steel from the casing is visible. As seen from Figure 4.29, there is a black layer underneath the encrustation and on top of the steel casing.

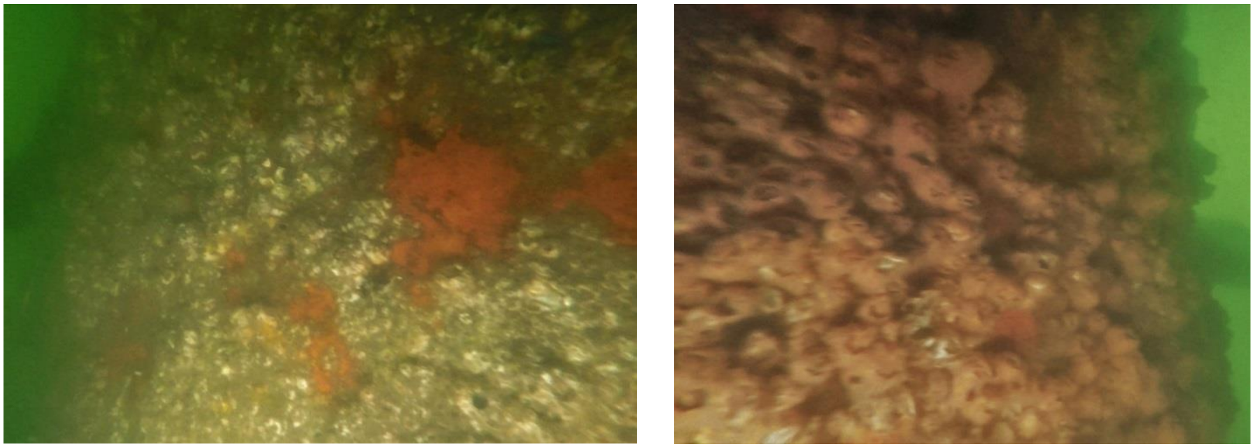


Figure 4.27 Shaft 94-4 pre-cleaning

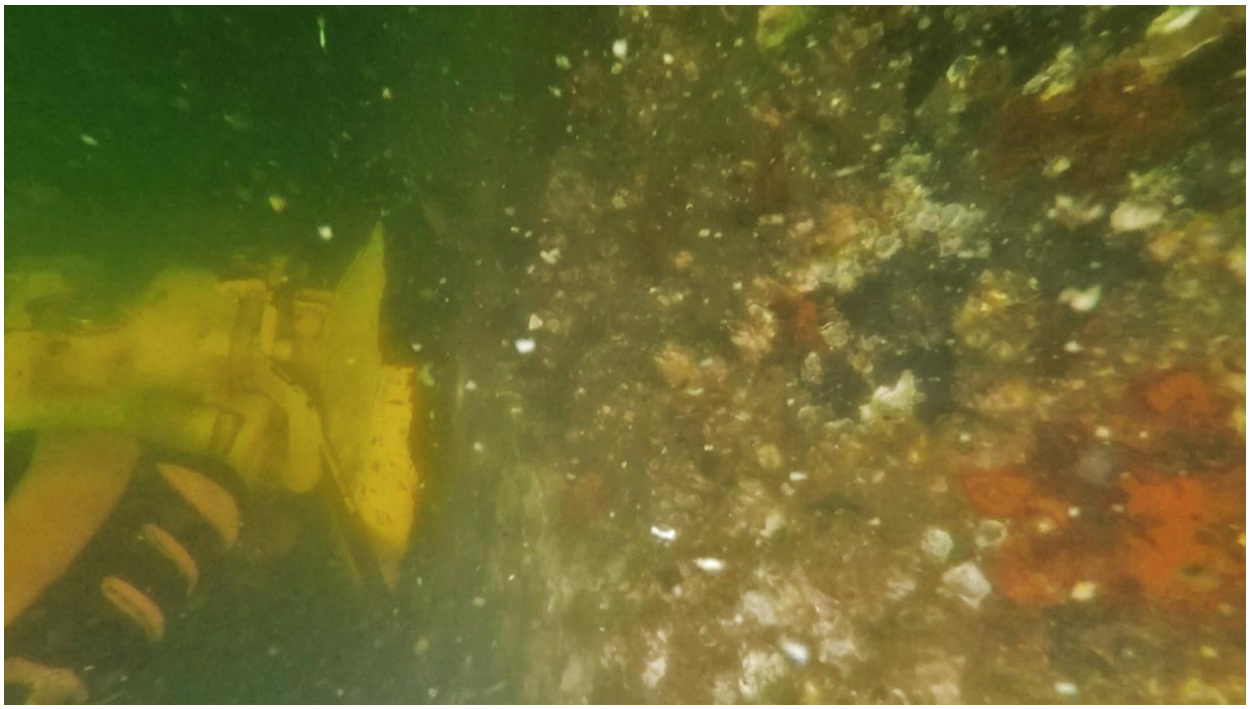


Figure 4.28 Shaft 94-4 during cleaning with the grinder

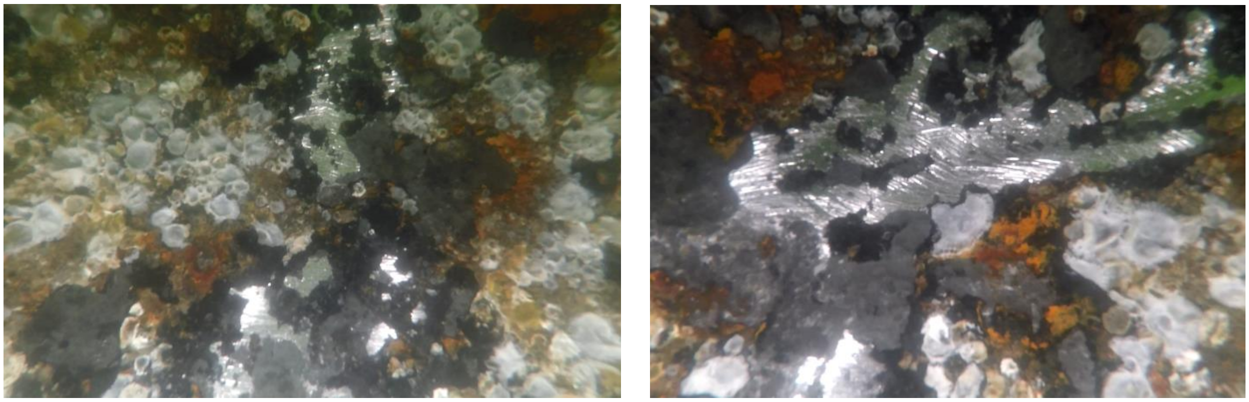


Figure 4.29 Shaft 94-4 after cleaning showing steel casing

Pier 85 (6 ft diameter, double cage)

Pier 85 was chosen as an example of a typical 6 ft Type 1 reinforcement cage (Figure 4.19(c)). The dive report does not mention this pier as having voids; however, it does state that two of the shafts, 85-2 and 85-3, do not have visible casings. Therefore, 85-2 was selected for inspection.

Unfortunately there is no image of 85-2 before cleaning; however, it looked similar to others covered in barnacles. While the cleaned section of the shaft overall shows a smooth surface (Figure 4.30), there are small crevices. As seen in Figures 4.31 and 4.32, barnacles and sea-life fill in these voids. The small voids/crevices are believed to have been caused by the double reinforcement cage, as this was not seen on the 4 ft diameter, single reinforcement cage shafts inspected at Pier 95.

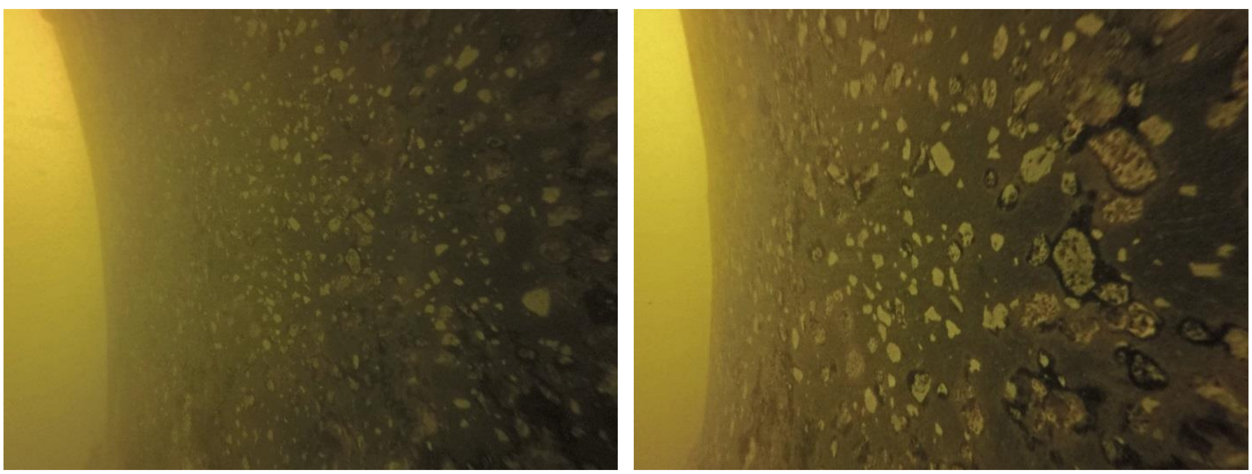


Figure 4.30 Shaft 85-2 after cleaning

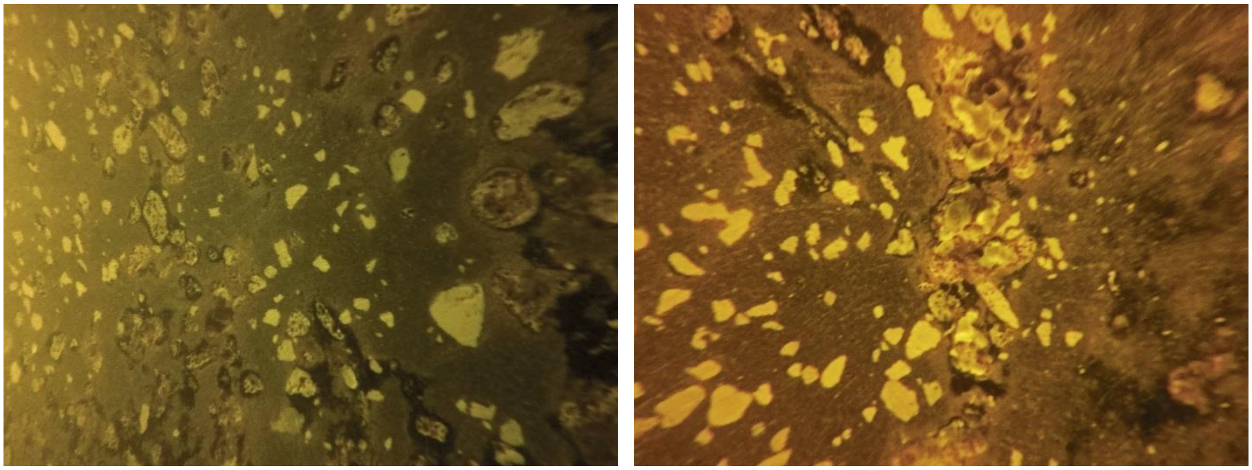


Figure 4.31 Crevices in 85-2 filled with barnacles

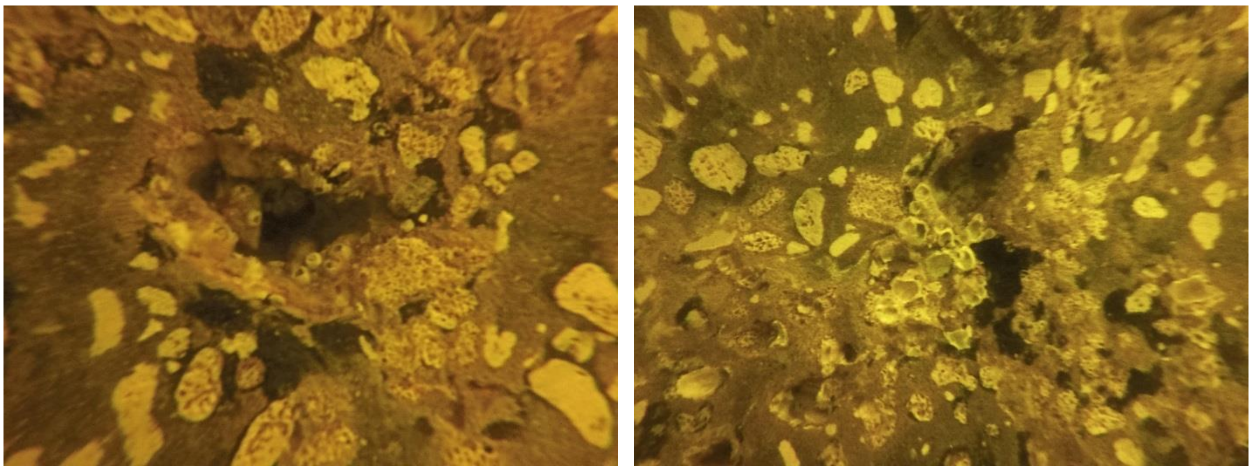


Figure 4.32 Small voids in 85-2 filled with sea-life and barnacles

Pier 84 (6 ft diameter, double cage)

In contrast to Pier 85, Pier 84 had voids on all four shafts. Pier 84 contains 6-ft diameter Type 1 reinforced shafts (Figure 4.19(c)). Shaft 84-4 was chosen for inspection as it is listed as having two voids. Figure 4.33 shows 84-4 with a thick layer of barnacles prior to cleaning. This layer is better viewed in Figure 4.34 where the cleaned concrete transitions into the barnacle layer. Figures 4.35 and 4.36 show the cleaned portions of the shaft from east and southeast sides. It can be seen in these figures that the concrete is not completely smooth like the 4-ft shaft. The circled red areas on Figure 4.35 represent areas of the cleaned concrete that are filled with barnacles. Therefore the 6-ft Type 1 shafts seem to experience at least small voids in the concrete. As mentioned for Pier 85, this is suspected to have been caused by the double reinforcement cage. Figure 4.37 shows the layers found when cleaning the concrete. Consistently throughout the examination of the Gandy shafts, encrustations were found consisting of barnacles and miscellaneous plant life/organisms. Upon initial cleaning, barnacles were knocked/scraped off and the remnants of the barnacle attachment were then removed. Below this layer, a thin black layer was encountered which was difficult to remove. In cases of smooth surfaces with no significant voiding, pristine concrete could clearly be seen. Rougher surfaces with voids retained the plant life, barnacles and black layer. Except for isolated instances, there was no attempt to dig into voids and determine the full depth.

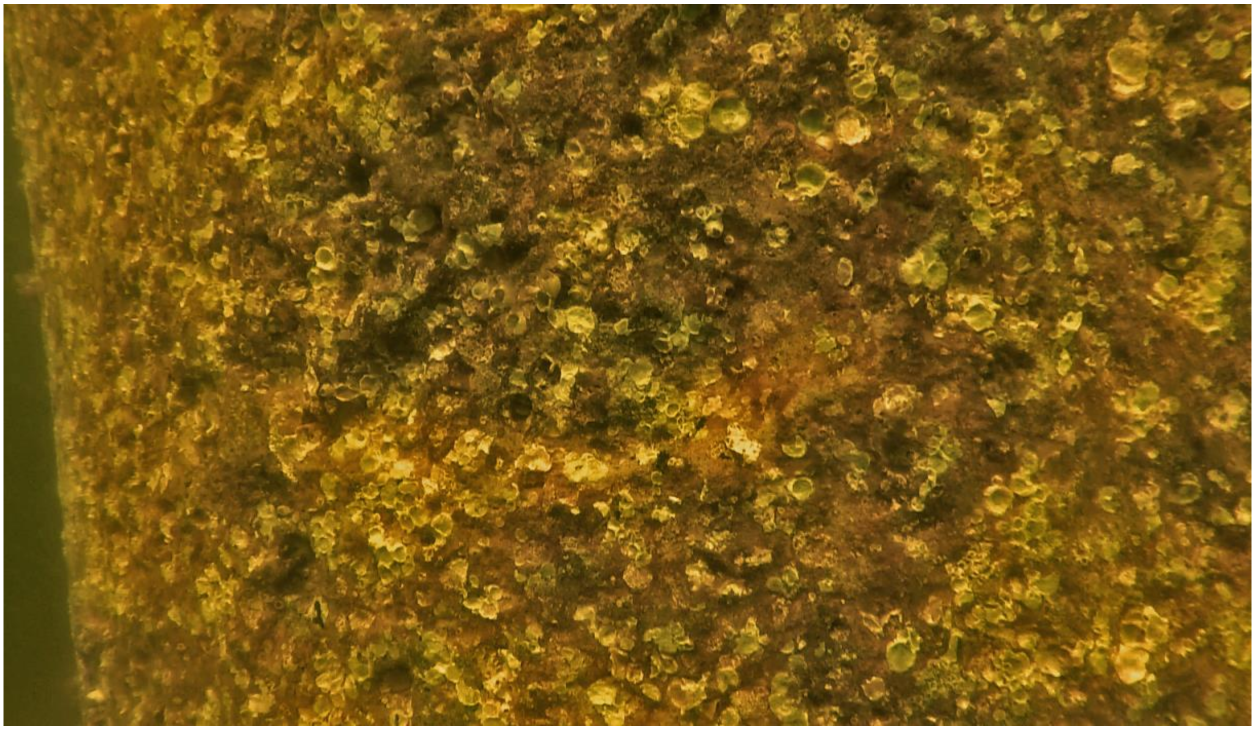


Figure 4.33 Shaft 84-4 prior to cleaning

Figure 4.34 Shaft 84-4 partially cleaned, note clean concrete going into layer of barnacles

Figure 4.35 Cleaned portion of 84-4 on the southeast side of the shaft, circled sections indicate small voids in concrete filled by barnacles

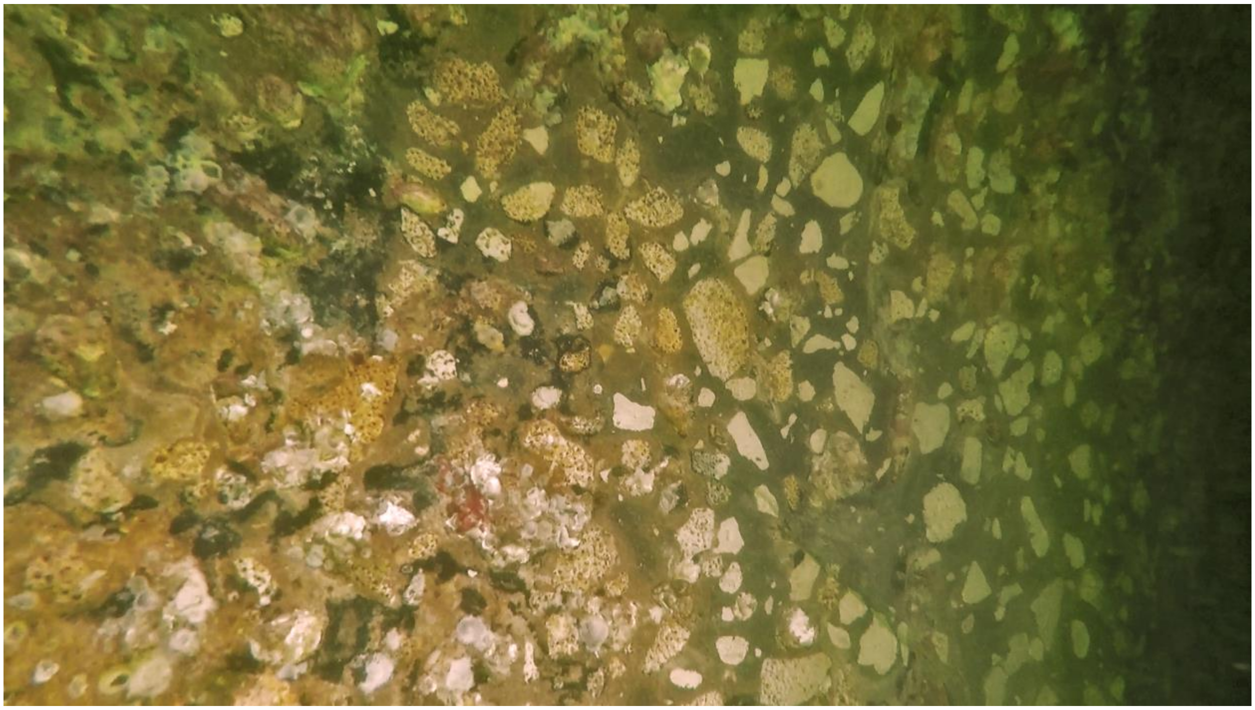


Figure 4.36. Cleaned portion of 84-4, east side of shaft

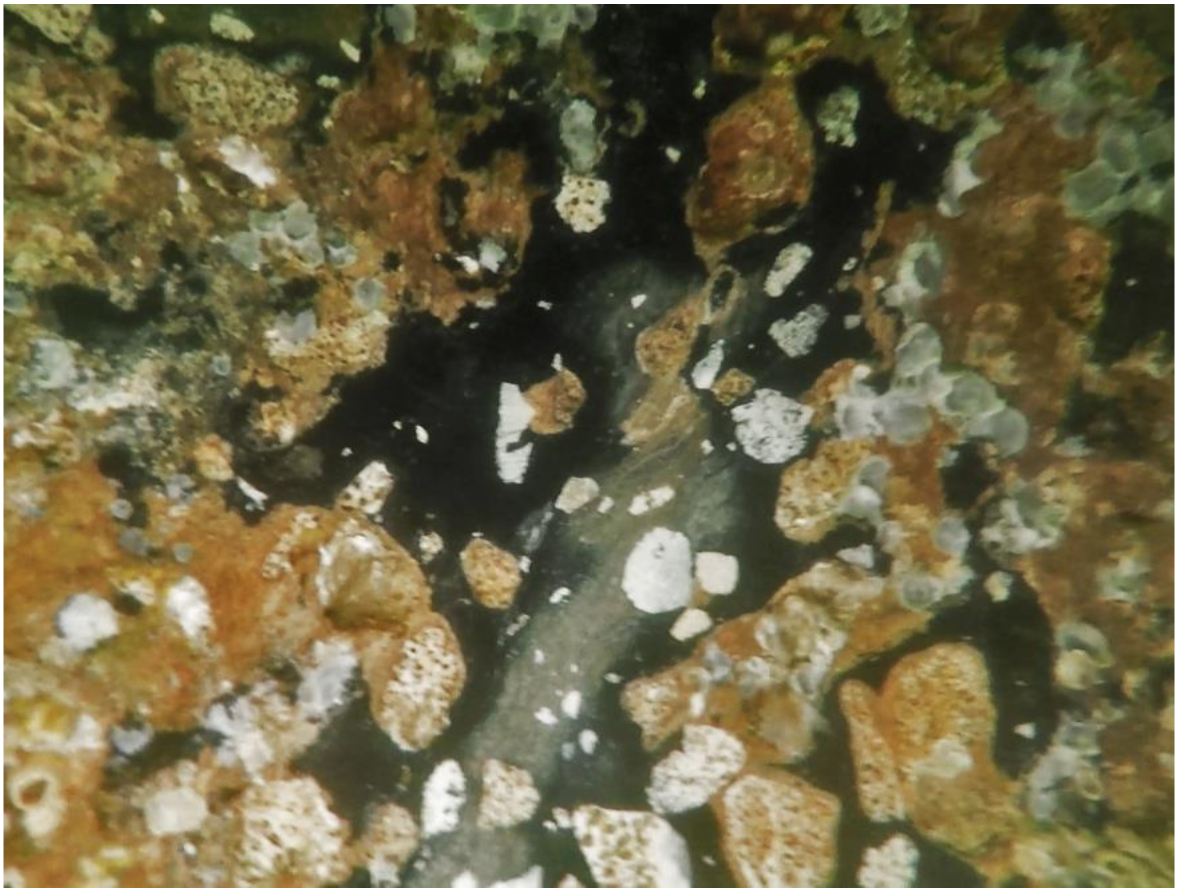


Figure 4.37 Layers from barnacles to black unknown layer to concrete

Pier 71 (7 ft diameter, double cage)

Pier 71 contains 7-ft diameter Type 1 shafts (Figure 4.19(d)). Two shafts 71-1 and 71-4 were listed as having voids in the dive report, and shaft 71-4 was chosen for inspection. Unfortunately, no images of the shaft were taken before cleaning; however, it looked similar to the shafts shown above, covered in a layer of barnacles. Figure 4.38 shows each side of the cleaned portion of the shaft. As noted for Piers 84 and 85, the 7-ft shafts also had small voids in the cleaned concrete surface (Figure 4.39). Sections of cleaned concrete can be seen up-close in Figure 4.40; note that this concrete was the roughest seen on this bridge. Figure 4.41 shows a long crevice in 71-4.

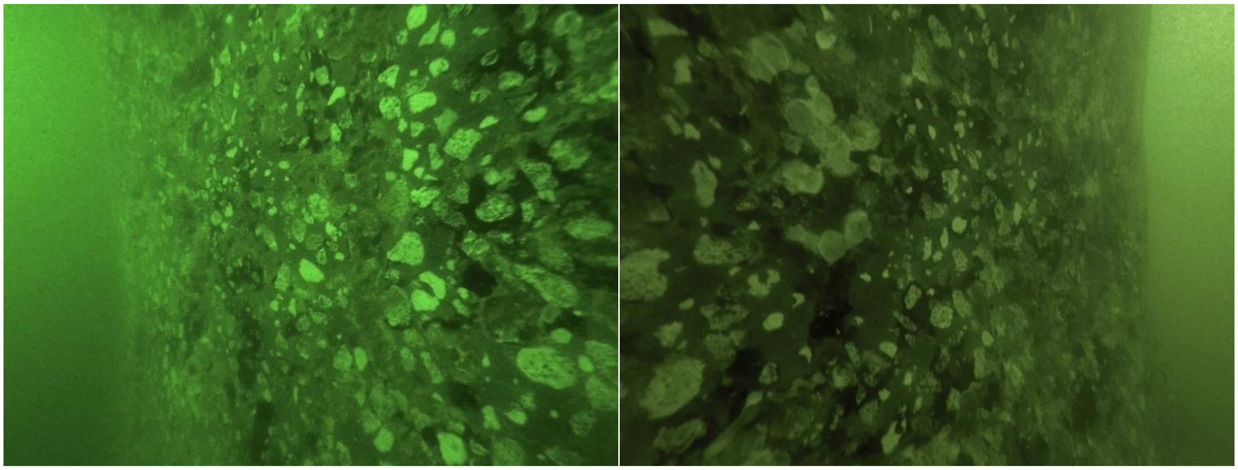


Figure 4.38 Shaft 71-4 post-cleaning

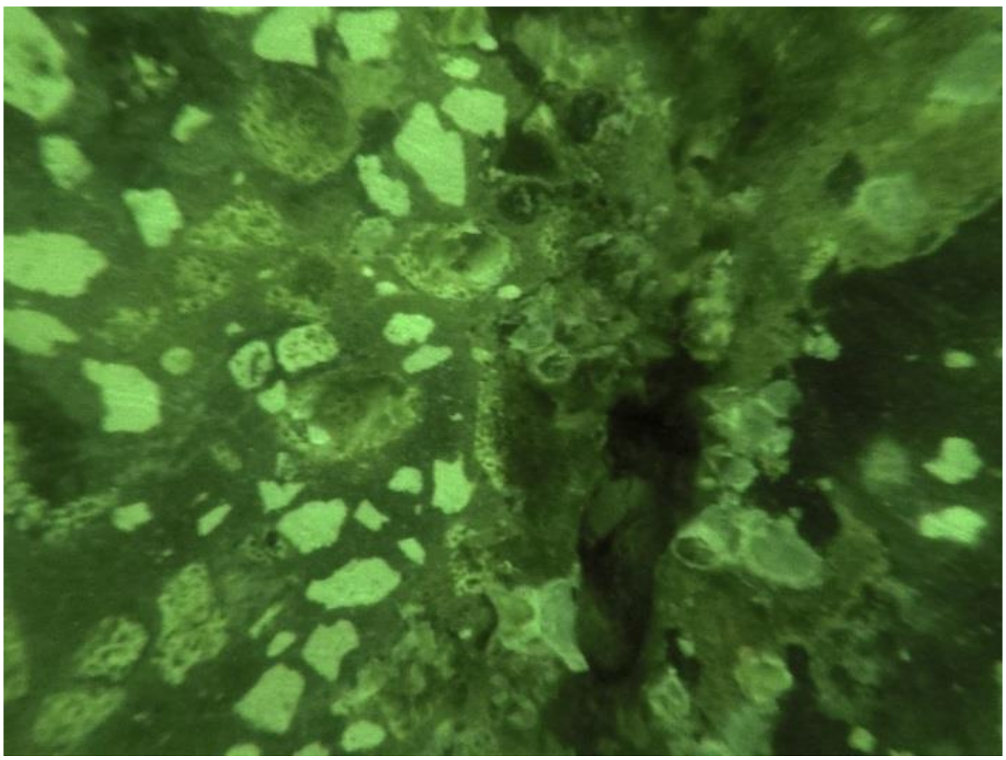


Figure 4.39 Close up of a small void on 71-4

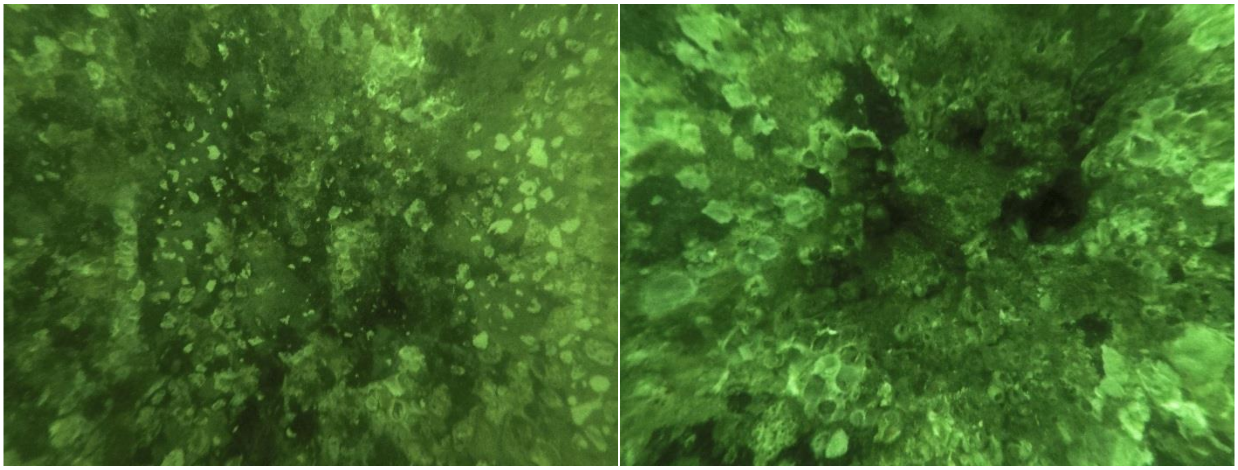


Figure 4.40 Cleaned concrete on 71-4, close pictures

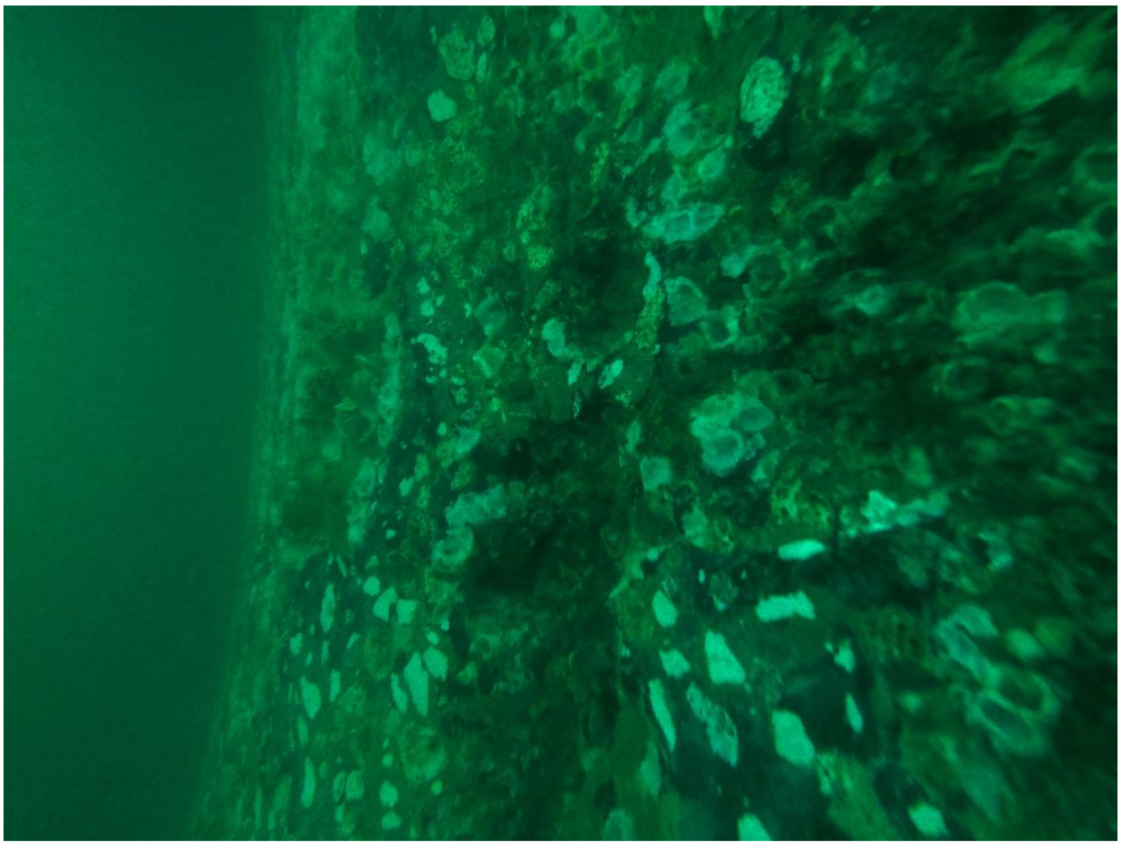


Figure 4.41 Large void found on the south side of 71-4

4.2.2 Santa Fe River Bridge 260112 (US 441 over the Santa Fe River)

The Santa Fe River Bridge has three intermediate piers (Figure 4.43), each on two 5-ft shafts (Figure 4.42). Two piers were in the river at the time of the on-site review (Figure 4.44). The shafts for this bridge were cast using bentonite slurry, making this bridge a good candidate for the study. According to the plans, shafts for this bridge terminate very close to the mudline and are mono-shaft column structures. However, considering river bottom depth changes after looking at the inspection report, it was decided that this bridge yielded potential for investigation. The piers were investigated first by ROV (Figure 4.45), then by divers (Figure 4.46). While it was expected that only the very top of the shaft would potentially be available, on-site inspection revealed depth changes due to scouring were not enough to expose the shafts. All four shaft/columns were investigated and only the smaller diameter 3-ft columns could be seen (Figure 4.47).

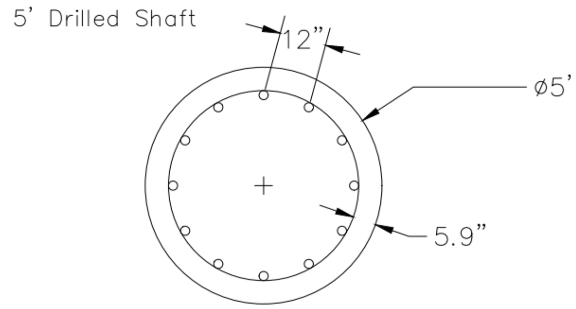


Figure 4.42 Intermediate drilled shaft layout

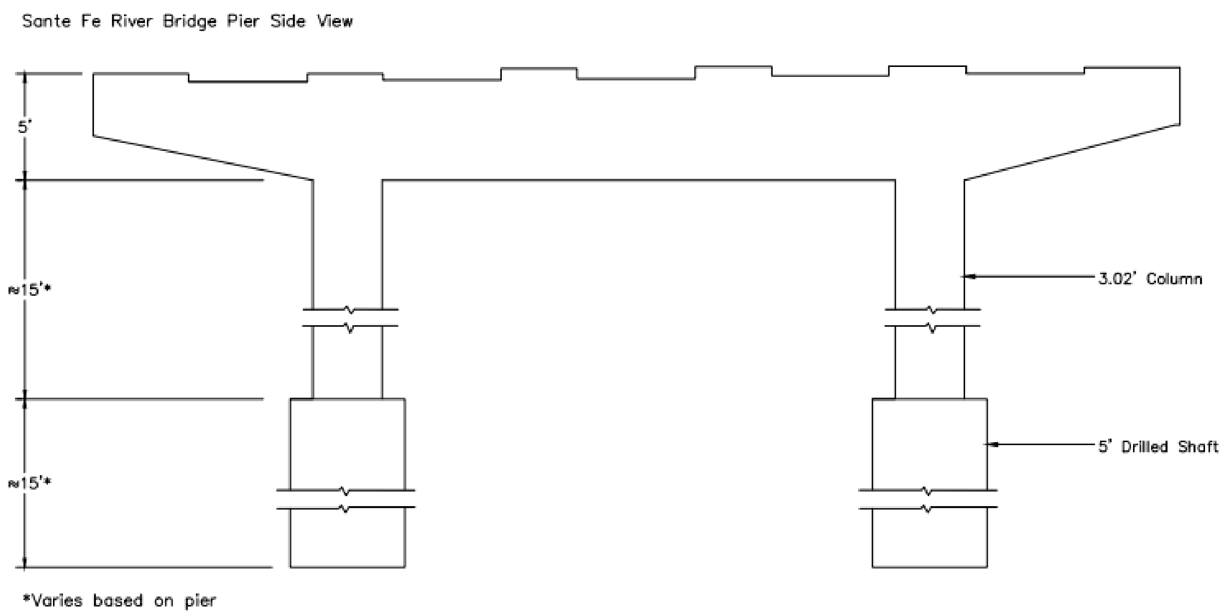


Figure 4.43 Layout for intermediate piers, height of column and shaft approximated as it varies by pier.

Figure 4.44 Four water column-to-shaft structures.

Figure 4.45 Remote operated vehicle system used to capture underwater images without divers.

Figure 4.46 Diver follow-up to further review column-to-shaft interface.

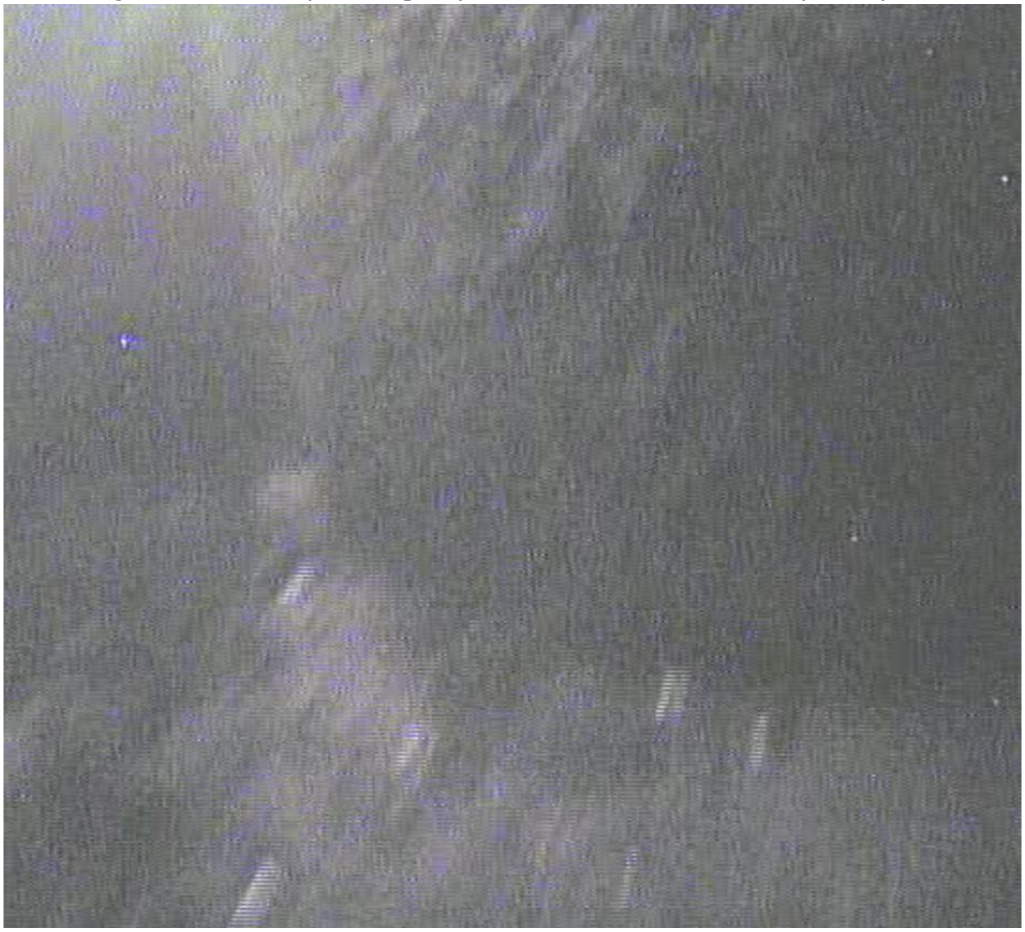


Figure 4.47 One of the columns at the mudline, no exposed shaft available for inspection

4.2.3 Blountstown Bridge 470052 (SR-20 over Apalachicola River)

The SR-20 bridge over the Apalachicola River (Figure 4.48), bridge number 470052 built in 1998 (Figure 4.49), was deemed to be a good inspection candidate as the 9-ft shafts were cast with bentonite slurry, and the plans noted the casing was to be burned off down to an elevation of 30 ft. That meant there should be at least a portion of exposed shaft for investigation. Figure 4.50 shows the plan view of Piers 58 and 59 as seen in the plans. Figure 4.51 highlights the strut in the top view and Figure 4.52 best demonstrates the column going into the shaft through the section view, as well as the reinforcement layout and where the casing was noted to be burned off. At the time of these pictures, clearance was 61 ft and water elevation was 35 ft, making the water 17.5 ft deep.

Figure 4.48 Main span of the Blountstown Bridge.

(a) (b)

Figure 4.49 (a) Date the bridge was built, (b) title of bridge and bridge number as seen on bridge.

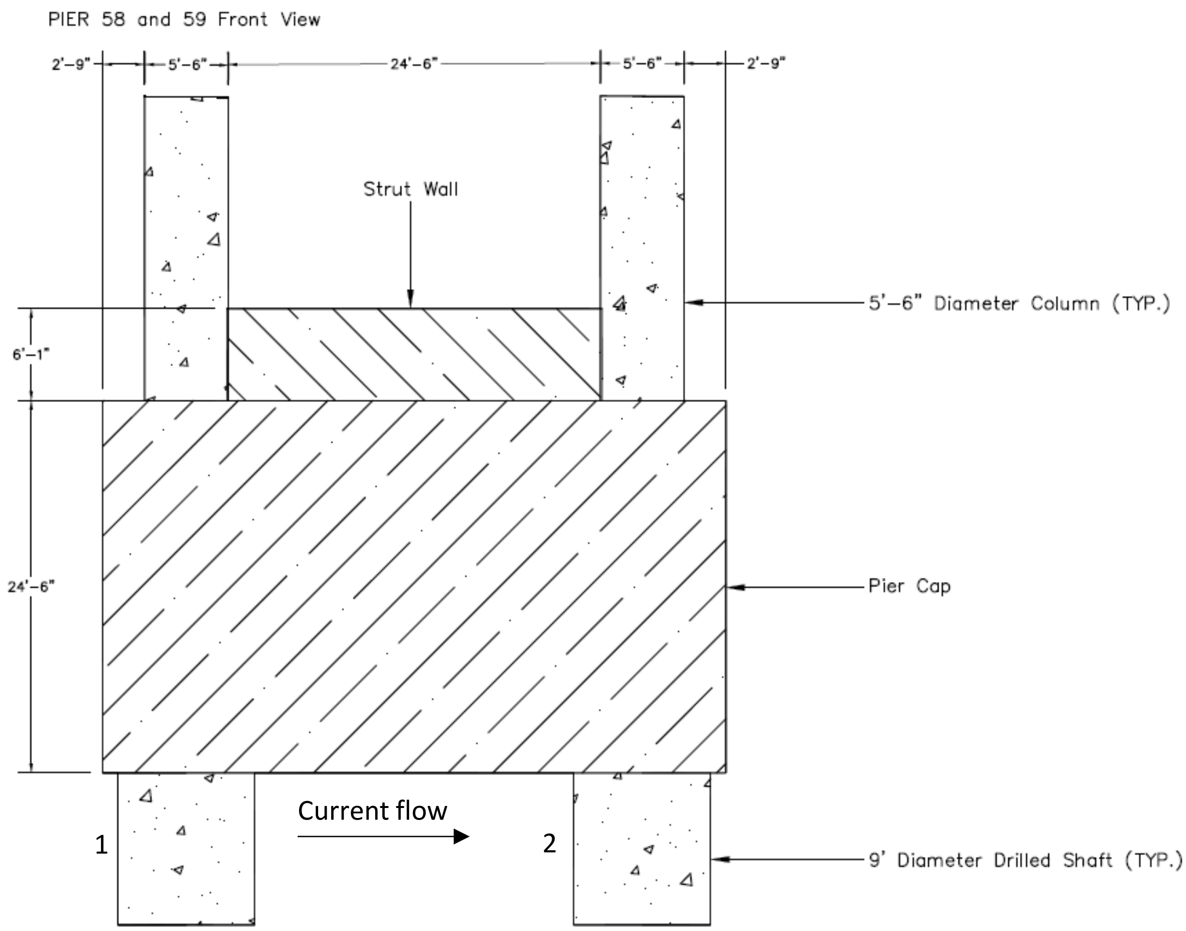


Figure 4.50 Elevation (front) view of Piers 58 and 59 looking east, river flow is to the right.

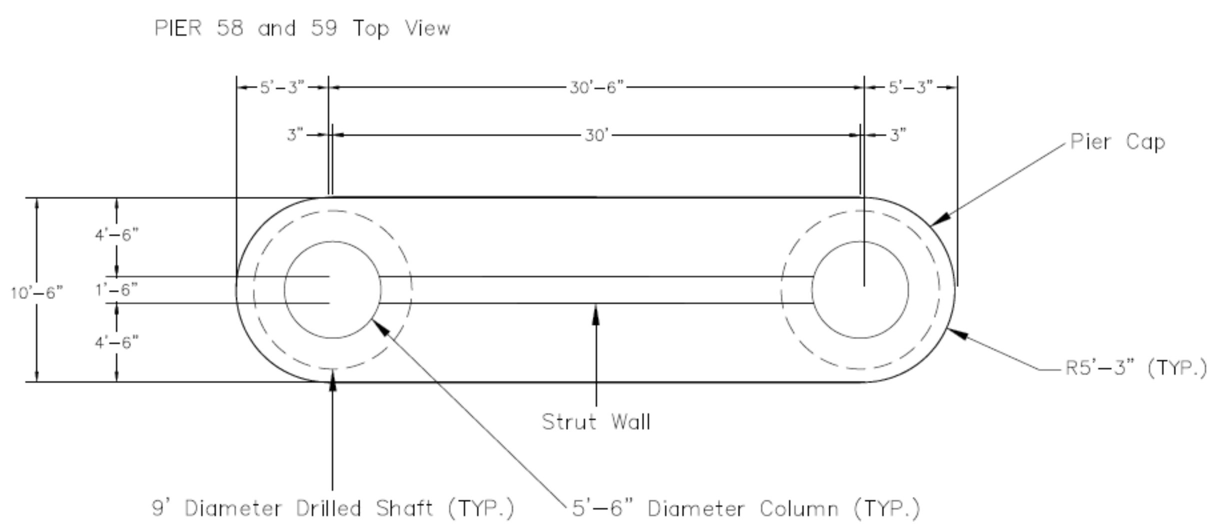


Figure 4.51 Top view of Piers 58 and 59.

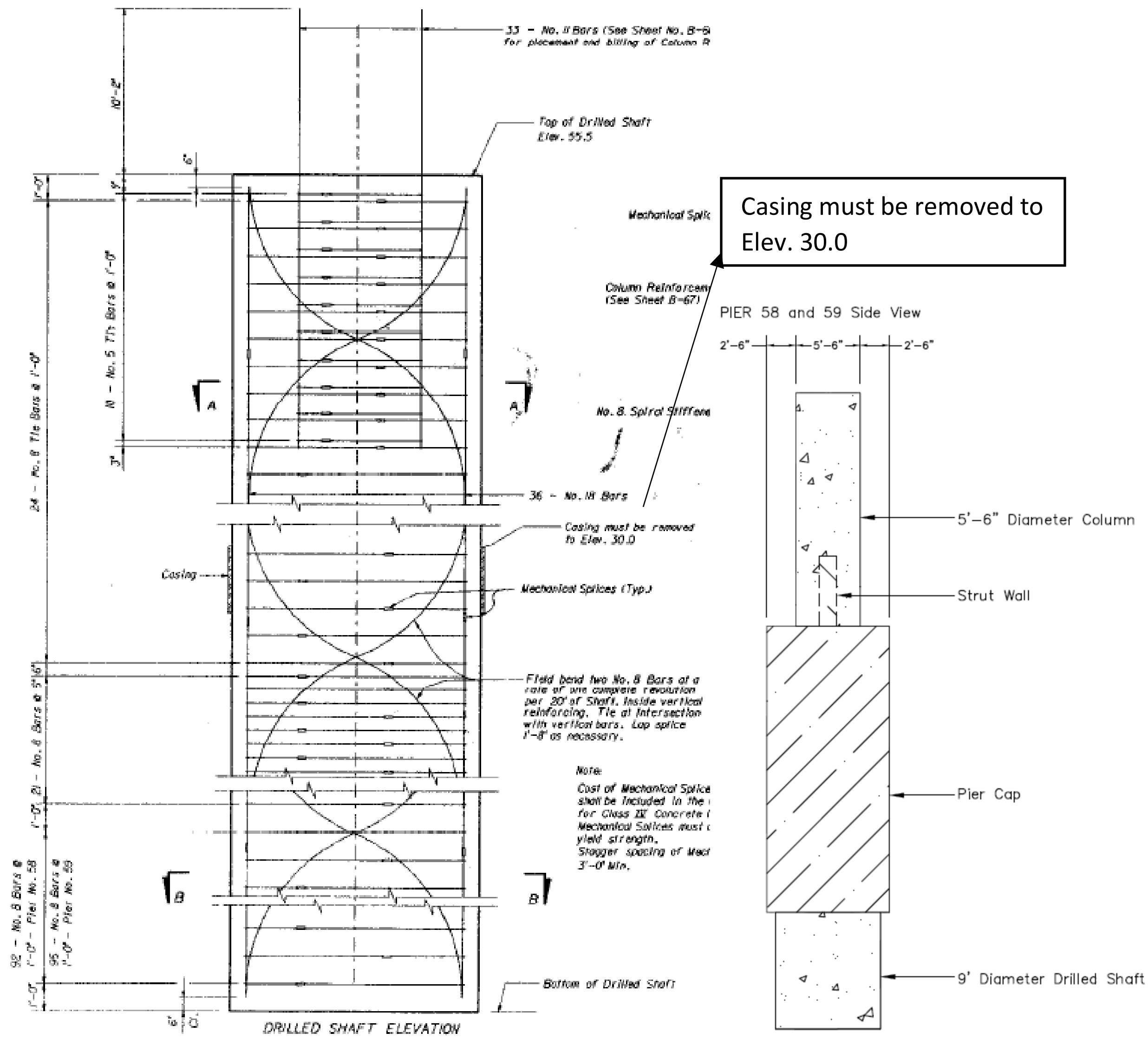


Figure 4.52 Section view of Piers 58 and 59.

While it was expected that there would be exposed shaft, after inspection it was realized that the only portion exposed was from what looked like a missing seal slab (Figure 4.53). Rubble on the bottom or river was likely to be remnants of the seal slab, and a steel collar was seen around shaft 2. Nevertheless, approximately 16-18 inches of uncased shaft was visible. Figure 4.54 is a picture of what the exposed portion of shaft looked like prior to cleaning shaft 58-1 (note shafts were labeled 1 and 2 based on river flow seen in Figure 4.50). Figure 4.55 shows the 58-1 shaft after cleaning. Figure 4.55 also shows four positions labeled 1-4 corresponding to close-up images taken at those locations. The water clarity was poor and made overview images unhelpful. In all four images of Figure 4.55, vertical or horizontal creases were found; image (2) shows both vertical and horizontal creases (camera slightly tilted) along with a white patching compound in the center of the squares that was not concrete.

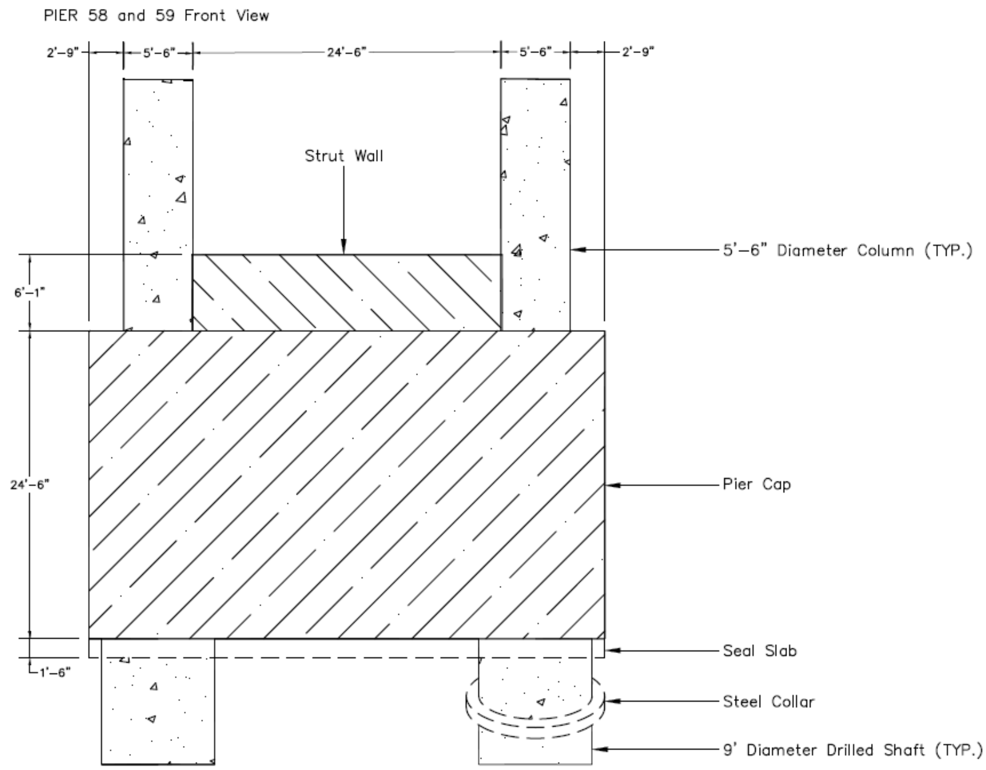


Figure 4.53 Front view of Pier 58 with expected seal slab and observed steel collar around shaft 2.

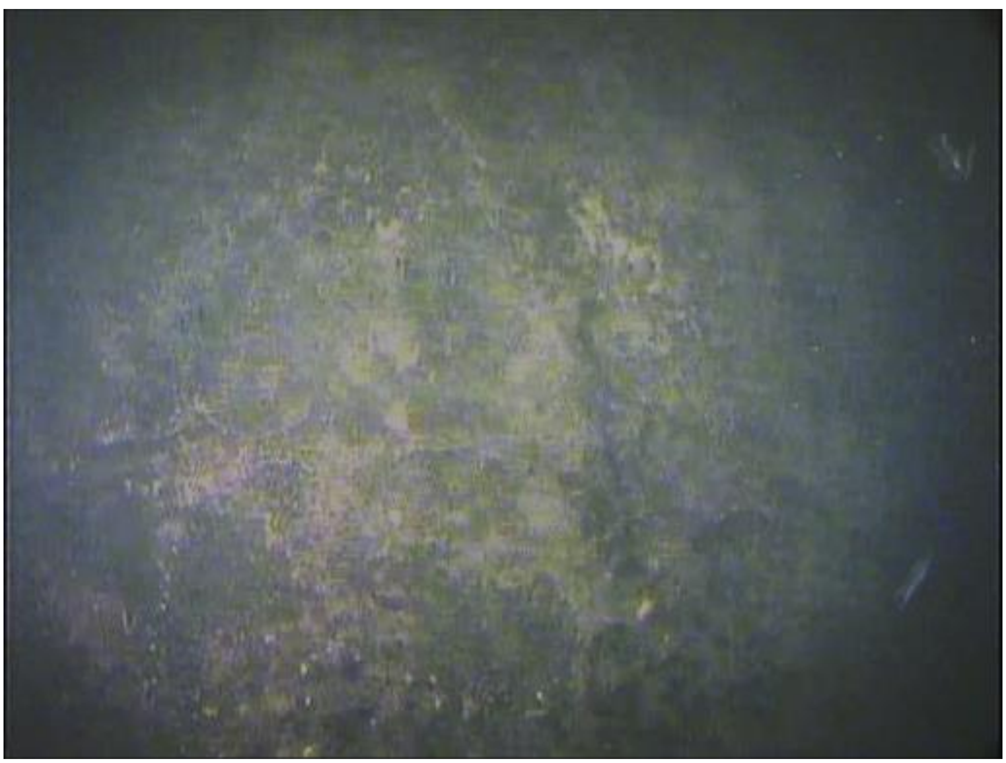


Figure 4.54 Shaft 58-1 prior to cleaning

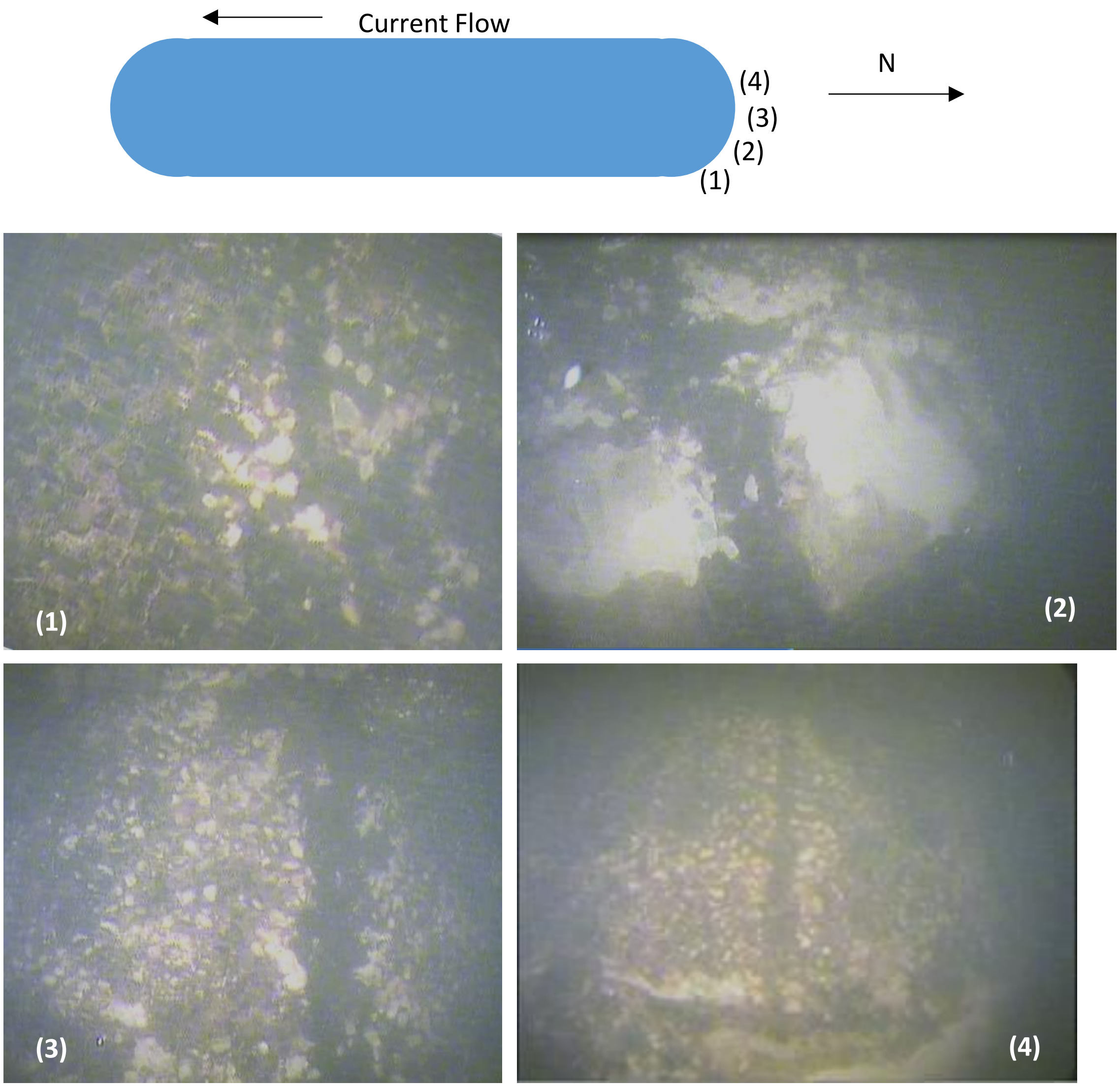


Figure 4.55 Images demonstrating quilting on Shaft 58-1. Images 1-4 correlate to positions 1-4 noted at the top of the figure.

Shaft 58-2 showed the same quilting as noted with shaft 58-1 prior to cleaning. This in part was based on experience from shaft 58-1. However, this shaft still had a portion of the collar (noted in the plans) partially dislodged and precariously leaning against the shaft on the south (downstream) side. The collar was seen as a safety hazard, and along with an increasing stream flow/current, conditions did not allow for a more thorough inspection.

Adjacent Pier 59, test shaft 8 (Figure 4.56) was also inspected. This is a 9-ft diameter out-of-position shaft south of pier 59 near the main channel. By visual inspection there was some light creasing along the vertical reinforcement (Figure 4.57). Figure 4.58 shows test shaft 8 before cleaning; Figure 4.59 shows after cleaning. Again, the creasing is light but it can be seen. Being a test shaft, construction sequencing is often not exactly the same as production shafts. This shaft had additional longitudinal instrumentation, which compounds concrete flow problems.

Figure 4.56 Test Pile adjacent (west) of Pier 59

Figure 4.57 West side of test shaft 8, light creases from vertical reinforcement

Figure 4.58 East side of test shaft 8 pre-cleaning.

Figure 4.59 East side of test shaft 8 post-cleaning.

4.2.4 Bridge of Lions 780074 (A1A over Matanzas River)

When Bridge of Lions was rehabilitated, shafts were constructed using attapulgite slurry around the existing piers and a below-water footing was cast to tie the existing caissons to the new sister shafts (Figure 4.60 and 4.61). Figure 4.60 shows the 8-ft diameter casing at the corners of the west bascule pier. These shafts were those indicated as possible locations for investigation. Figure 4.61 shows four 8-ft casings around each of the neighboring piers 13 and 14.

Figure 4.60 West Bascule (Pier 15 implied via plans / Pier 11 via inspection report) during rehabilitation; image taken from SE side looking NW.

Figure 4.61 West Bascule (Pier 15; right), Piers 14 and 13 moving to the left with four 8-ft shaft casings shown from south looking north during rehabilitation.

Based on dive/inspection reports this bridge was deemed a good candidate for inspection and comparison. Inspection note:

> *"the SW and NW drilled shafts on Pier 10, NE and SE on Pier 11 have larger round steel casings extending up from the groundline to within 6ft of the bottom of the footing"*

While the plan set never assigns a pier number to the bascule piers (only west or east bascule), the inspection report seemed to imply that the west bascule was pier 10 and the east was pier 11, but these inspection logs reference pier numbering from the east which is opposite the plan set. Nevertheless, this comment gave confidence that there may be two shafts on the bascule piers without casing. Unfortunately, upon arrival and combining the comment with the plan and profile view of the bridge, it was noticed that the diver was commenting on the shaft that transitioned from an 8-ft diameter shaft to a 5-ft diameter column. Much of the confusion stemmed from pier numbering differences. Nothing but steel casing was found upon dive investigation of these piers. Thus, no useful inspection came from the Bridge of Lions (Figure 4.62). However, discussions with the district maintenance engineer indicated there may be other piers without casing.

Figure 4.62. Existing main span bascule piers of Bridge of Lions (left); approach spans Pier 14 closest decreasing in number into the distance (per plan numbering).

Figures 4.63 and 4.64 show the discrepancy between pier numbering from inspection reports and original plan set, respectively.

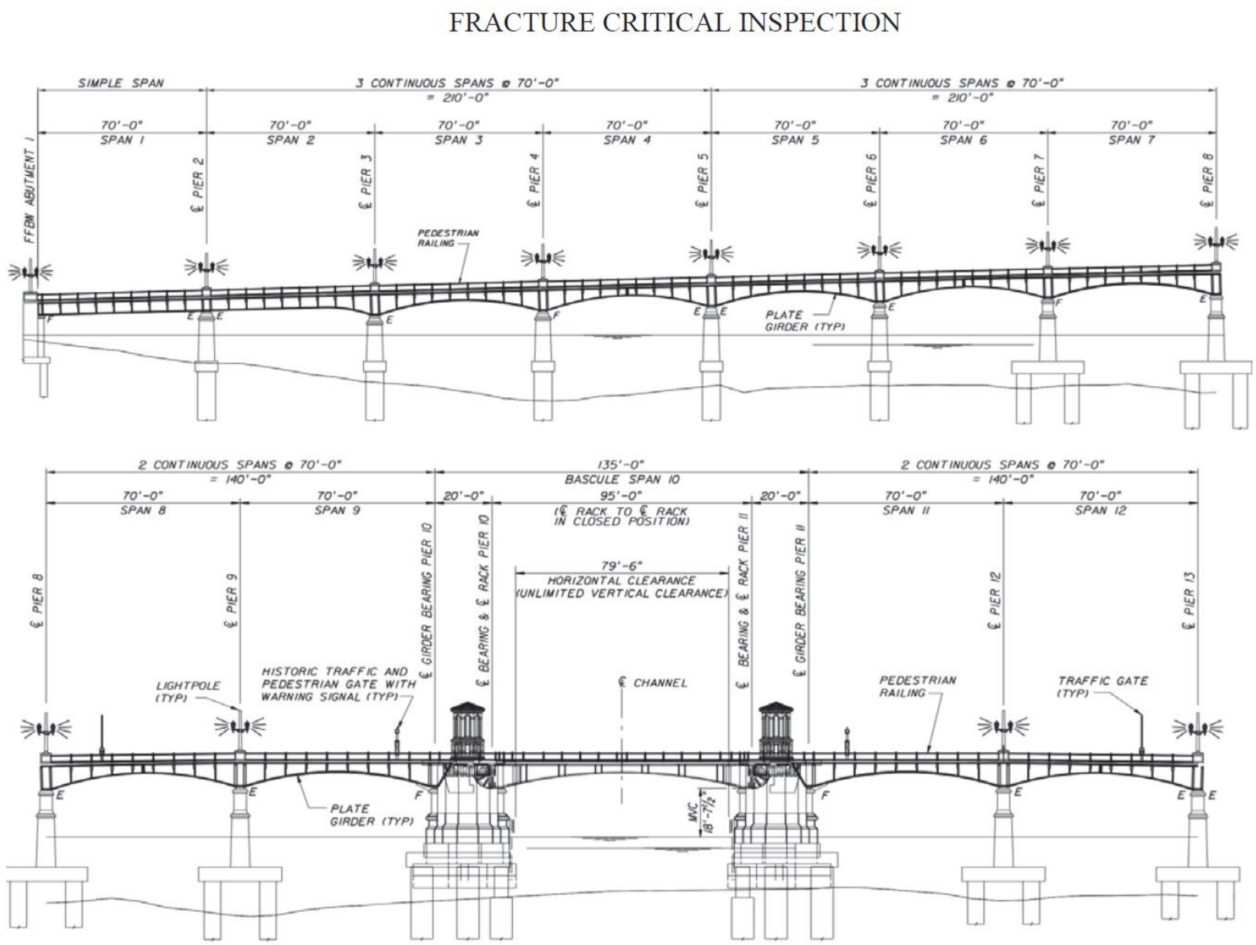


Figure 4.63 Plans from the inspection report noted as looking south which shows Pier 1 to be the east most end bent.

DRILLED SHAFT INSTALLATION TABLE										
INSTALLATION CRITERIA					DESIGN CRITERIA					
PIER OR BENT NO.	SHAFT SIZE Φ (IN)	TIP ELEV. (FT)	MIN. TIP ELEV. (FT)	MIN. ROCK SOCKET LENGTH (FT)	FACTORED DESIGN LOAD (TONS)	DOWN DRAG (TONS)	LONG-TERM SCOUR ELEV. (FT)	100 YR. SCOUR ELEV. (FT)	Φ	TOP OF SHAFT ELEV. (FT)
WEST ABUTMENT 1	36	-80	-80 ~~N/A~~	N/A	115	N/A	N/A	-41.2	0.55	-4.25
PIER 2	36	-88	-85 ~~N/A~~	N/A	163	N/A	N/A	-23.2	0.55	-7.75
PIER 3	36	-88	-85 ~~N/A~~	N/A	163	N/A	N/A	-25.0	0.55	-9.75
PIER 4	36	-88	-85 ~~N/A~~	AB N/A	163	N/A	N/A	-26.4	0.55	-9.75
PIER 5	36	-88	-85 ~~N/A~~	N/A	163	N/A	N/A	-26.9	0.55	-9.75
PIER 6	90	-101	-100	N/A	569	N/A	N/A	-34.4	0.55	-14.75
PIER 7	90	-108	-100	N/A	569	N/A	N/A	-37.3	0.55	-14.75
PIER 8	90	-100	-100	N/A	569	N/A	N/A	-36.8	0.55	-14.75
PIER 9	90	-100	-100	N/A	569	N/A	N/A	-37.9	0.55	-14.75
PIER 10	90	-109	-100	AB N/A	569	N/A	N/A	-39.2	0.55	-14.75
PIER 11	90	-110	-105 ~~-110~~	N/A	569	N/A	N/A	-43.9	0.55	-14.75
PIER 12	72	-109	-100 ~~-105~~	N/A	395	N/A	N/A	-48.5	0.55	-15.75
PIER 13	72	-105	-100 ~~-105~~	N/A	395	N/A	N/A	-47.8	0.55	-15.75
PIER 14	72	-106	-100 ~~-105~~	N/A	395	N/A	N/A	-50.3	0.55	-15.75
PIER 15 SHAFTS 1, 2, & 3	96	-135	-135	N/A	910	N/A	N/A	-46.1	0.55	-9.75
PIER 15 SHAFTS 4 & 5*	96	-135	-135	N/A	910	N/A	N/A	-46.1	0.55	-22.5
PIER 16 SHAFTS 1 & 2*	96	-135	-135	N/A	910	N/A	N/A	-50.3	0.55	-22.5
PIER 16 SHAFTS 3, 4, & 5	96	-135	-135	N/A	910	N/A	N/A	-50.3	0.55	-9.75
PIER 17	72	-105	-105	AB N/A	395	N/A	N/A	-56.9	0.55	-15.75
PIER 18	72	-105	-100 ~~-105~~	N/A	395	N/A	N/A	-50.5	0.55	-15.75
PIER 19	72	-105	-100 ~~-105~~	N/A	395	N/A	N/A	-48.3	0.55	-15.75
PIER 20	90	-110	-105 ~~-110~~	N/A	569	N/A	N/A	-45.2	0.55	-14.75
PIER 21	90	-110	-105 ~~-110~~	N/A	569	N/A	N/A	-44.8	0.55	-14.75
PIER 22	90	-110	-110	AB N/A	569	N/A	N/A	-51.6	0.55	-14.75
PIER 23	90	-110	-105 ~~-110~~	N/A	569	N/A	N/A	-42.0	0.55	-14.75
PIER 24	90	-103	-95 ~~-100~~	N/A	569	N/A	N/A	-32.3	0.55	-14.75
EAST ABUTMENT 25	36	-97	-97 ~~N/A~~	N/A	205	N/A	N/A	-37.8	0.55	-8.75
EAST SEAWALL	36	-75	-75 ~~N/A~~	N/A	135	N/A	N/A	-14.0	0.55	-8.75

4.64 List of piers as shown in plan set noting west most abutment to be Pier 1

4.3 Task Summary and Discussion

The goal of this Task was to identify the effects of slurry type on shaft surface roughness, void volume and/or cover quality. The premise of the approach was that overwater bridges supported by shafts will have some portion of the shaft between the mudline and footing that is exposed and therefore could be an easy way to reveal and assess the shaft surface. This type of investigation was performed in lieu of excavations beside on-land shafts or footings to expose the shaft side surface. To be a viable method/approach, the exposed underwater portion of a shaft must be free of casing, which is always used to provide formwork in the water up to the footing elevation.

Review of plan sets from fourteen overwater bridges known to have been constructed on shafts gave rise to four candidate bridges which coincidentally also incorporated three different slurry types (natural, bentonite and attapulgite). On-site investigations of these four bridges were conducted using both a remote operated vehicle that incorporated underwater video, and hands-on diving, which included surface cleaning and photography.

Of the four bridges visited, two provided valuable information; at the other two bridges exposed shaft concrete was not found. The Gandy Bridge provided a baseline for shafts cast with natural slurry, which was shown to have no detrimental effects in laboratory samples (Chapter 3). Additional information was obtained that included the effect of varying shaft sizes and reinforcement cage configurations. The SR-20 Blountstown Bridge provided information pertaining to the effects of bentonite slurry, even though there was not much shaft surface exposed and not all conditions were deemed safe. No usable information was obtained from the US 441 Santa Fe River Bridge or the Bridge of Lions in St. Augustine.

Gandy Bridge: Shafts constructed with simple single cage reinforcement with natural slurry exhibited pristine concrete surface conditions with virtually no surface voids. In isolated cases irregularities were found which appeared to be in no way associated with quilting. Shafts examined that were constructed with concentric double reinforcement cages yielded more frequent and pronounced voids, but again these voids seem to be more random and were not associated with the quilting pattern.

Blountstown Bridge: three out of five shafts in the river portion of the bridge were examined and all showed evidence of quilting. These shafts were all cast with bentonite. The quilting pattern was so pronounced the grinder was barely, if at all, able to make a smooth surface in any area.

A surprising discovery from diving both fresh and salt water bridges was that pitting in the steel casing was much worse in fresh water (Figure 4.65) when compared to salt water. The bridges compared, Gandy and Blountstown, were almost the same age, built in 1996 and 1998, respectively. Figure 4.65 shows pronounced pitting corrosion at Blountstown and very little visible pitting in the Gandy casings. When preparing the surface of the Gandy shafts, a thin black presumably organic layer was found that was difficult to remove (Figure 4.65 and 4.66). This layer was hypothesized to be a layer of anaerobic decay from the barnacles and sea-growth, which would be an oxygen barrier and may slow or prevent corrosion. Samples were taken and are currently under investigation. Discussions with the USF Department of Integrative Biology confirmed similar observations of a black layer under oyster and barnacle growth. Some consideration will be given to promoting encrusted surfaces that would be beneficial to both concrete and steel surfaces under these conditions. While the Bridge of Lions casing was heavily encrusted, no data or observations were collected which could have provided insight into the effect of east coast marine conditions on corrosion.

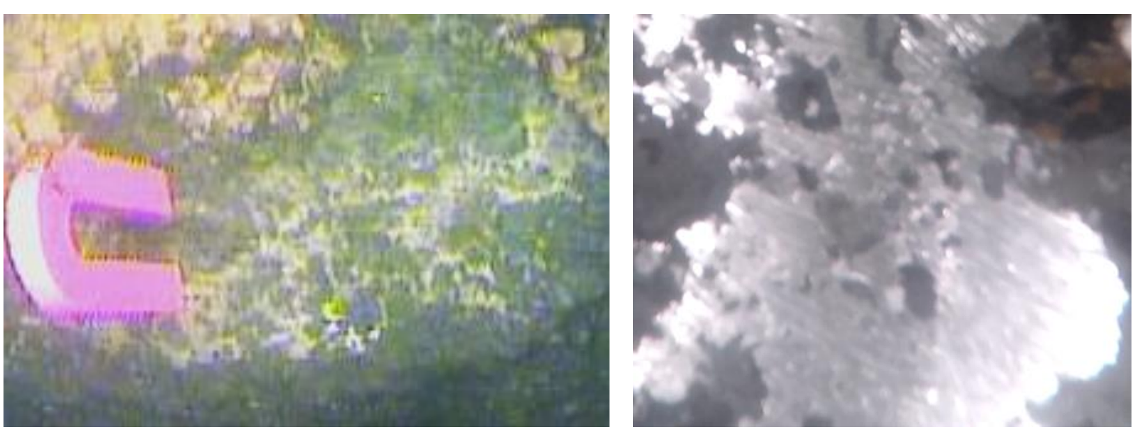


Figure 4.65. Pitting corrosion in freshwater (left); very little pitting in marine environment (right).

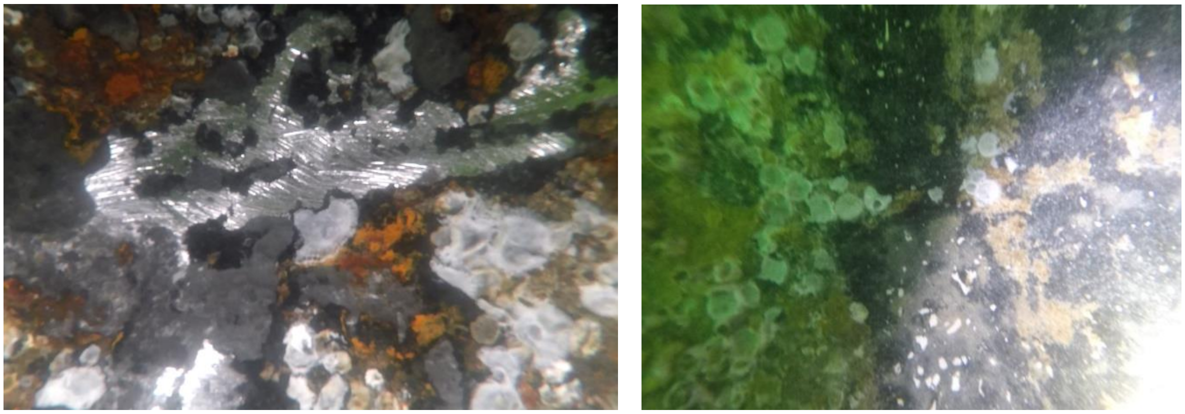


Figure 4.66 Black organic layer beneath barnacle growth: on steel casing (left), on concrete (right)

In summary, there are several observations that can be made from this task:

- While it would have been ideal to have more inspections for comparison, quilting was found as expected in bentonite-constructed shafts.
- Shafts constructed with natural slurry (water) were largely in pristine condition.
- Single reinforcement cages led to fewer voids and defects than double reinforcement cages.
- Pitting in steel casing was worse in fresh water without encrusted organism growth.
- While casing does not appear to have an adverse effect on shaft performance, it does not eliminate the presence of quilting within the casing. These areas are just as vulnerable to corrosion as those without the casing.
- Drilled shaft concrete surface quality was evaluated by examination of overwater bridges, but very few examples were found without casing. However, shafts without casing are in abundance for land piers, where cover quality is highly likely to be compromised.

4.4 Continued Efforts

Underwater evaluation of shaft concrete surface quality/roughness was performed using subjective visual methods. Original plans to use laser-based scanners and quantify surface texture was not possible as the technology slated for use was actually not "laser-based," and was limited by poor visibility (typical of site conditions encountered). An alternate technology/vendor is being reviewed. Review of plans and inquiries with state officials will continue with the aim of identifying more sites for inspection. Further, US Army Corps of Engineers (USACoE) recorded water levels for the Blountstown/Apalachicola river region show the water level was 6-7 ft above gage level elevation of 27 ft, which corresponds well with the observed water depth at the time of the site visit. Using the same data source and projecting forward, October or November is likely to produce fully exposed conditions and a more thorough investigation can be done at that time (Figure 4.67).

Personal observations from the PI. Despite overwhelming support and assistance from FDOT district maintenance personnel, the simple approach to review shafts underwater (without excavation) was frustrating from several aspects:

(1) The state bridge inventory database does not note the foundation element type (shaft or pile), which made personal recollections the only first round screening tool,
(2) Diver reports are scarce, and if included, are non-descriptive, inconsistent, and devoid of engineering terminology,

(3) Biennial inspection reports in today's era of databases and associated querying tools should be far more comprehensive and searchable. It is assumed that biennial inspections are privatized, performed by consultants that could change periodically. As a result, the continuity required to make decisions in-the-field pertaining to points of concern or interest is limited without a chronologically organized inspection list for each element, not just the overall reports.

(4) Construction logs/records were understandably more poorly archived 20 years ago when the Gandy and Blountstown bridges were built, but more recently constructed bridges like the Bridge of Lions (completed 2010) should have very accurate and highly accessible information/records.

(5) All inspection reports should be in the same format statewide, and it would be implicit that the dive reports would be appended to each overall inspection report, especially when there is something found of concern. For instance, the Blountstown bridge during the October, 2011 inspection would have had a water level elevation around 28 ft (based on USACoE records); this means that the underwater issues found between 30 and 31 ft in this report would have been exposed and easily visible, including the dislodged steel collar on shaft 58-2. Perhaps this information exists somewhere, but it was not made available to the researchers.

(6)

APALACHICOLA
BLOUNTSTOWN
Gage Zero 27.0 Flood Stage 15
NOTE: These readings are taken at approximately 12AM
2017 WATER YEAR

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.59	.44	.80	2.19		9.56	5.56	4.14	5.60	8.19		
2	.66	.45	.87	2.21		9.22	5.86	3.93	6.50	7.60		
3	.47	.47	.83	14.16		8.44	5.61	3.66	5.92	7.50		
4	.71	.48	.88	10.96		7.99	6.13	3.42	5.61	7.14		
5	.65	.51	.85	18.48		7.54	5.94	3.55	5.67	6.98		
6	1.04	.50	1.93	20.13		7.40	5.71	3.30	5.73			
7	.84	.48	8.42	20.37		7.39	11.23	3.17	5.88			
8	.67	.51	7.82	19.44	8.30	7.75	14.12	2.98	6.63			
9	.58	.47	8.19	18.08	10.93	8.29	15.23	2.83	8.68			
10	.50		7.41	17.24	12.30	7.94	14.81	2.75	9.26			
11	.46	.93	7.05	16.40	12.57	7.96	13.56	2.53	9.28			
12	.65	1.46	6.58	15.70	12.66		12.52	2.37	9.22			
13	.63	1.02	6.32	15.40	12.67	7.32	10.96	2.21	8.26			
14	.73	.53	5.96	14.94	11.20		9.71	1.81	7.94			
15	.66	.54	5.73	12.83	10.49	6.97	8.86	1.65	7.71			
16	.58	.49	5.37	11.14	9.60		7.76	1.33	7.56			
17	.49	.57	4.89	9.79	8.83		6.79	1.26	7.23			
18	.45	.56	4.70	8.96	8.42		6.70		7.02			
19	.42	.49	4.41	8.12	8.10		6.45		6.56			
20	.43	1.22	4.18	7.59			6.29	1.38	6.40			
21	.46	.85		7.63			6.29	1.35	7.30			
22	.52	.74	3.59	9.09	7.61	5.94	6.30	1.43	10.64			
23	.50	.73	3.26	-76.67	10.19	5.76	6.12	1.43	10.39			
24	.47	.72	2.97	18.95	13.65	5.89	6.08	7.47	9.46			
25	.46	.59	2.83	20.13	13.38	5.70	5.73	9.76	9.11			
26	.49	.52	2.82	19.73	12.86	5.63	5.35	8.87	9.71			
27	.52	.70	2.58	19.47	11.70	5.61	5.02	8.95	9.50			
28	.49	.84	2.57	18.72	10.78	5.56	4.74	8.15	9.34			
29	.51	.86	2.41	17.47		5.64	4.53	7.24	9.31			
30	.48	.84	2.25	16.34		5.62	4.38	7.20				
31	.44		2.22			5.51		6.26				
AVG	.57						7.81					
MAX	1.04						15.23					
MIN	.42						4.38					

Figure 4.67. Apalachicola River level at time of inspection (circled); historical values from last October boxed (http://water.sam.usace.army.mil/acfframe.htm)

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APPENDIX C

Photoshopped Images with Originals

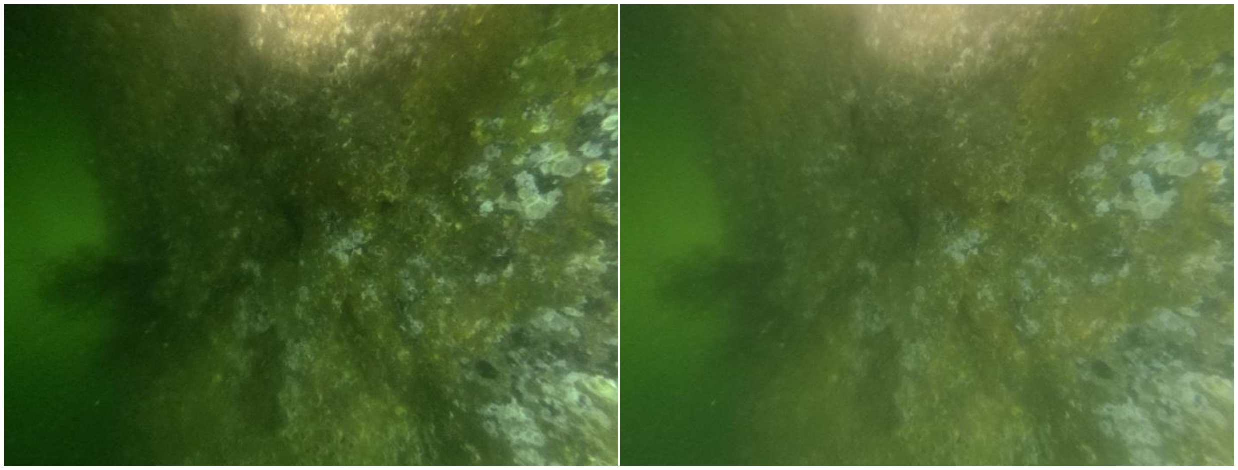
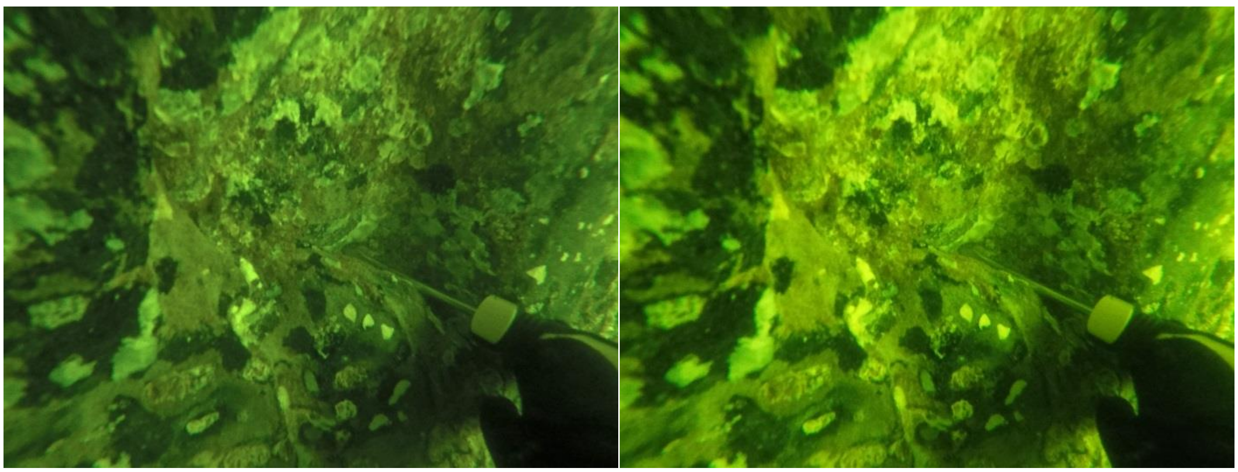


Figure C.1. Figure 4.20 Photoshopped (left), original (right)



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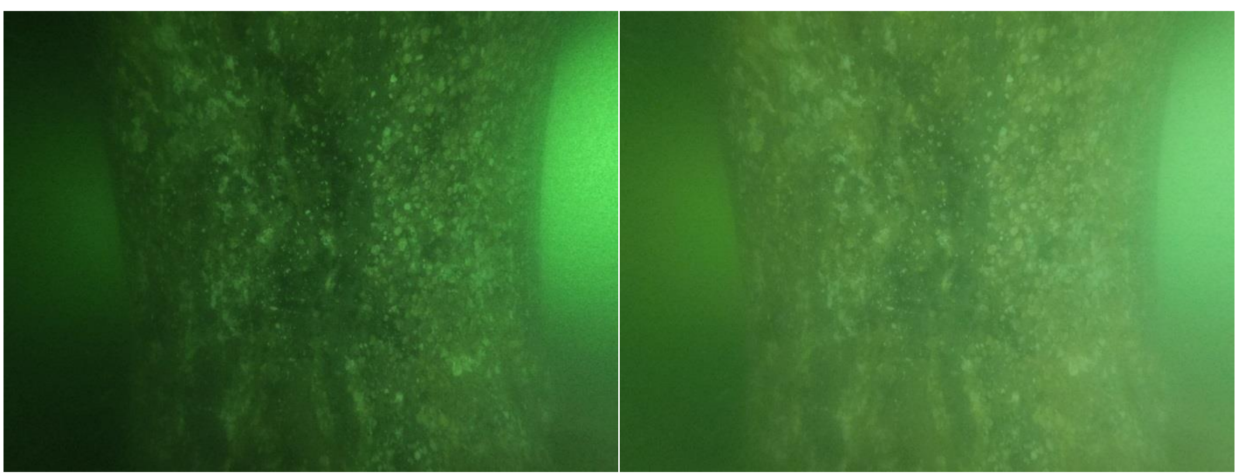

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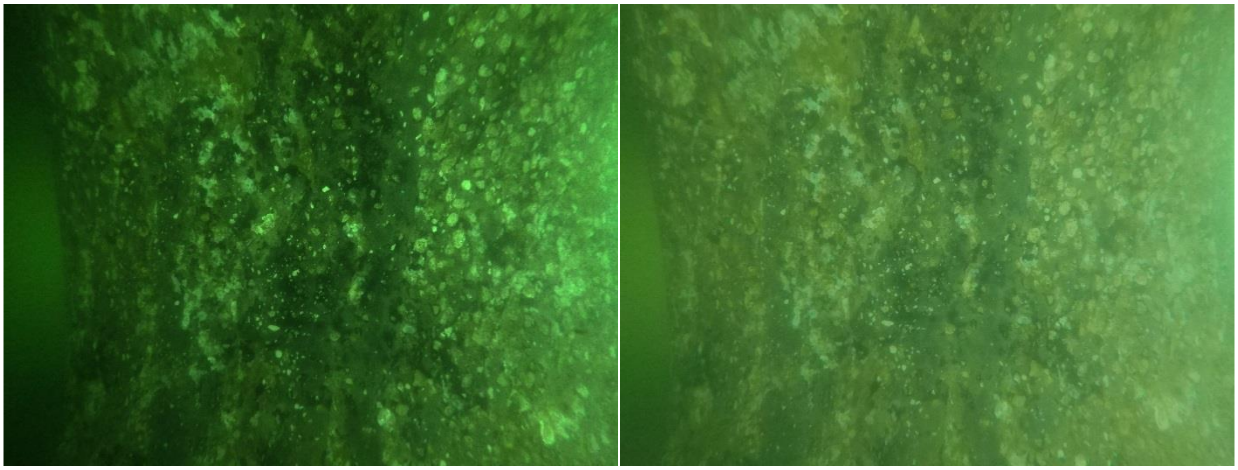

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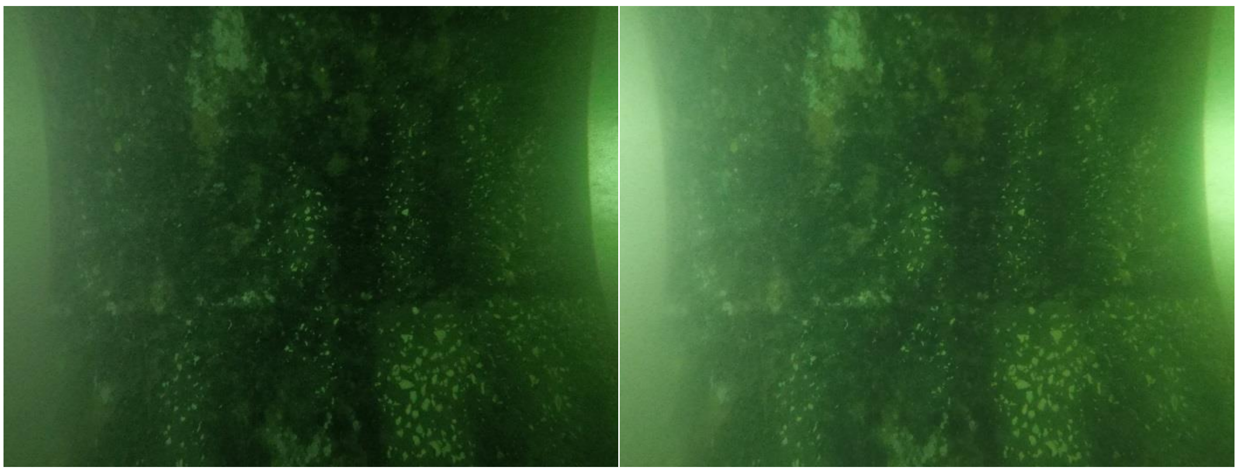

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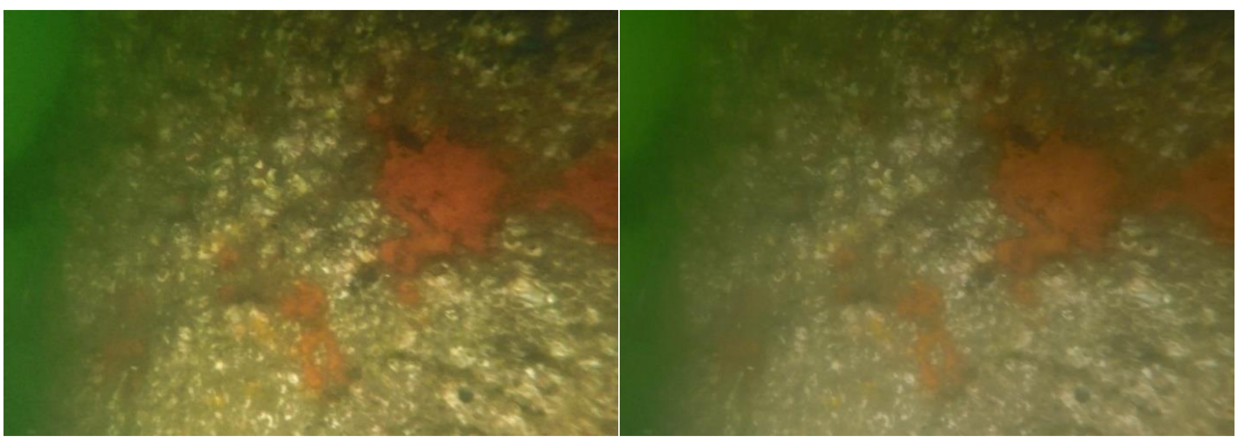
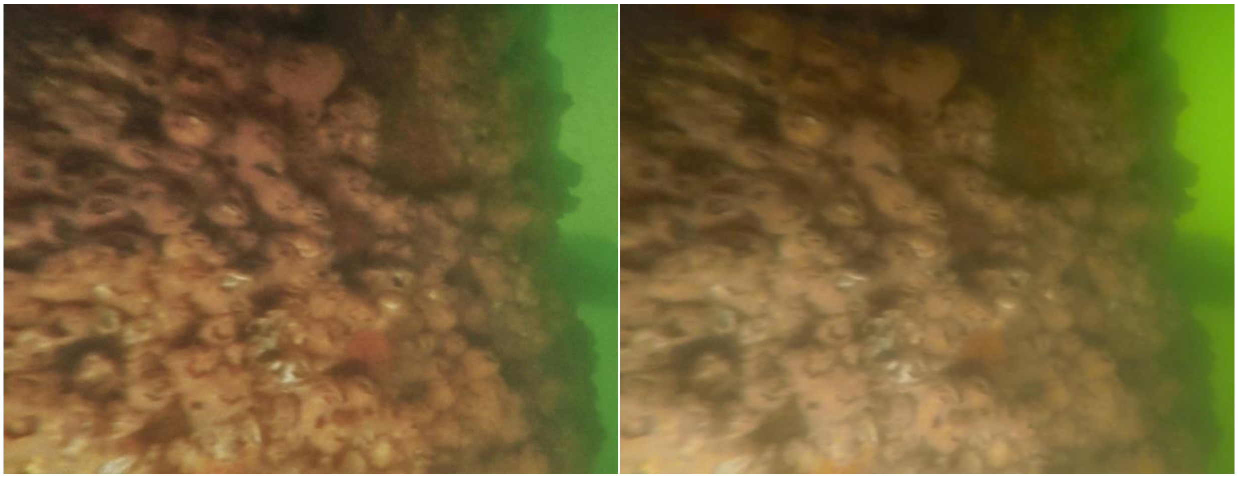


Figure C.6. Figure 4.27 (left image) Photoshopped (left), original (right)



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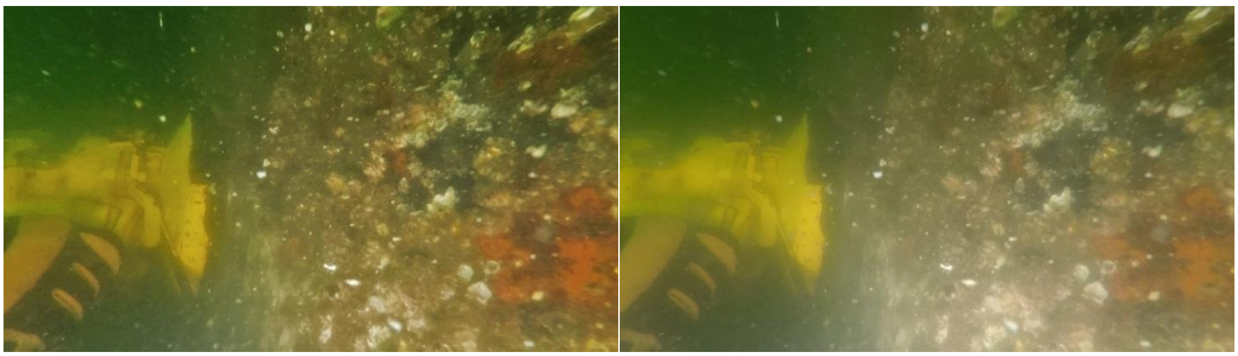

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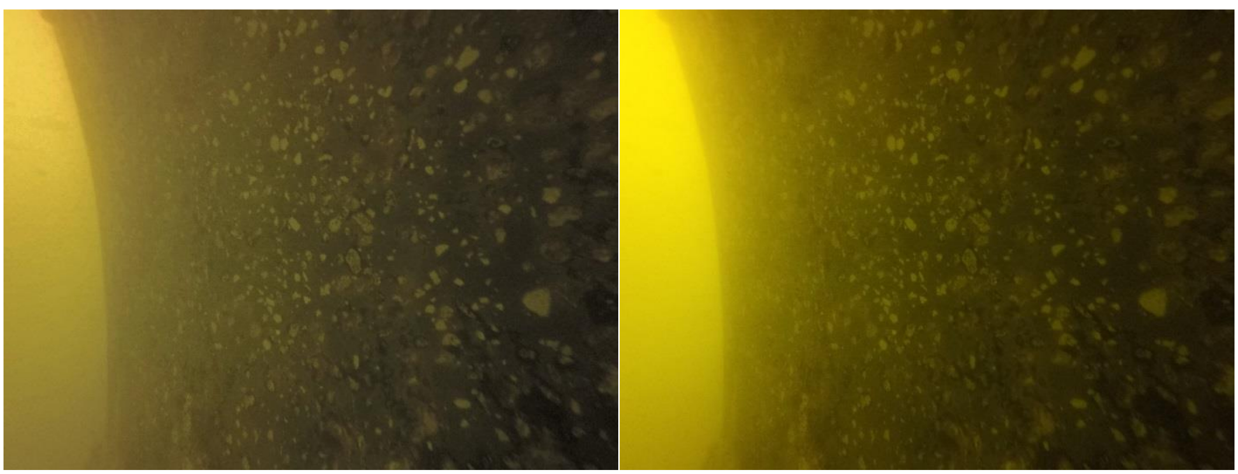
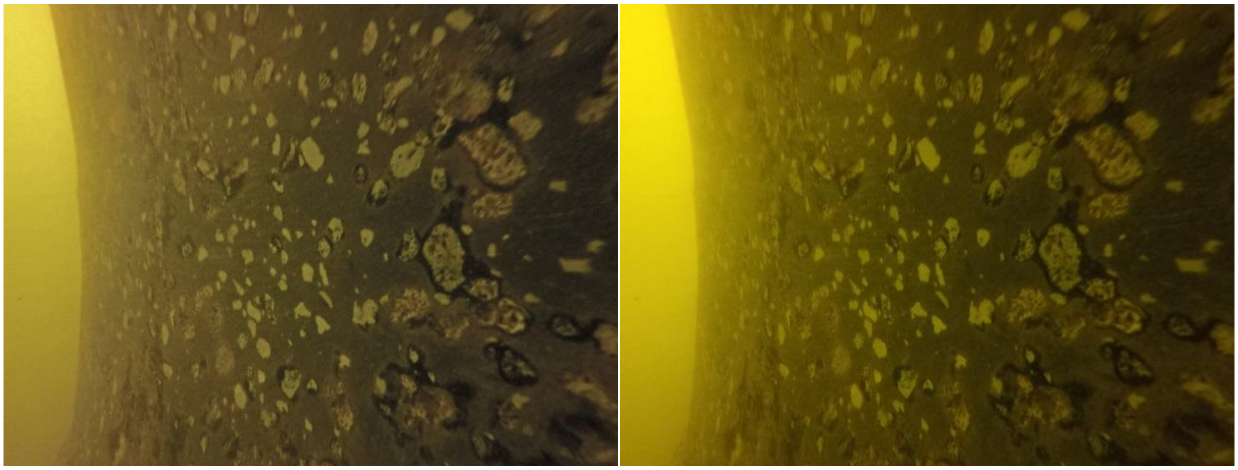


Figure C.9. Figure 4.30 (left image) Photoshopped (left), original (right)



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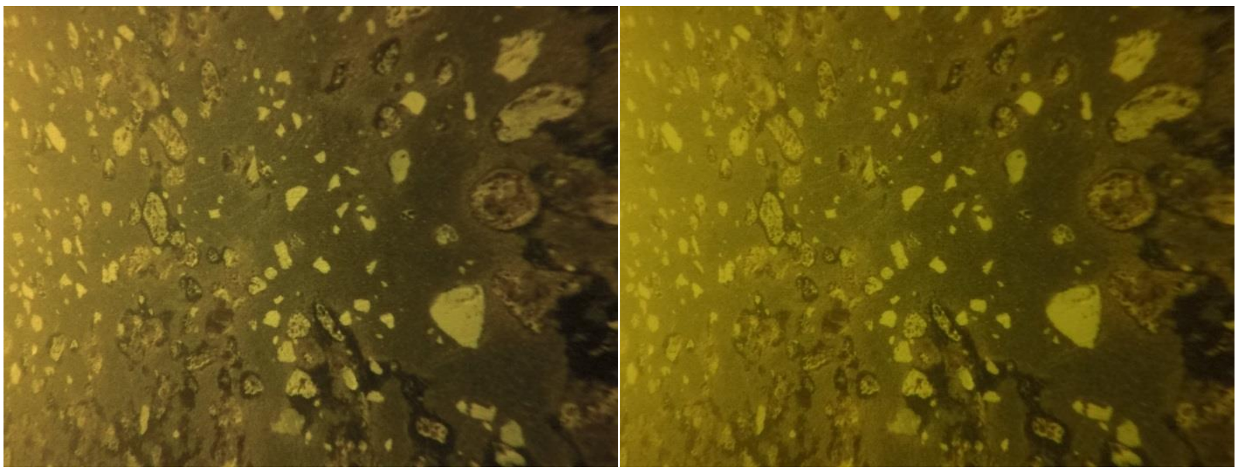

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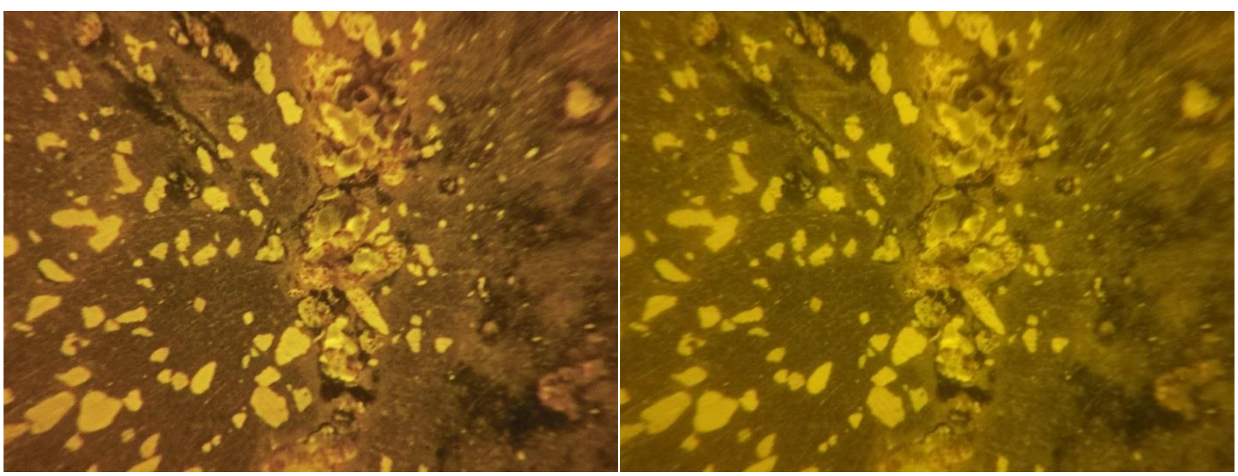

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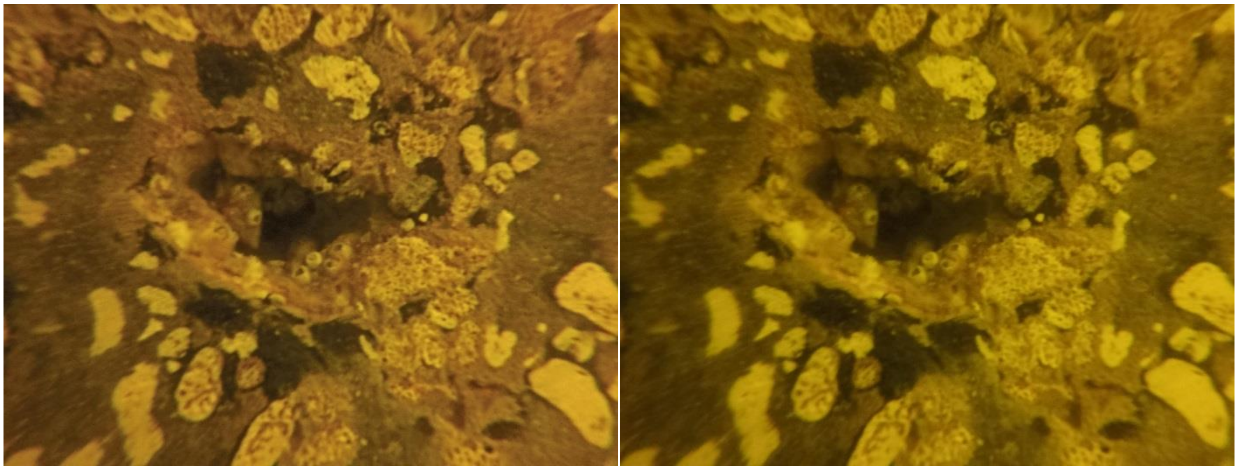

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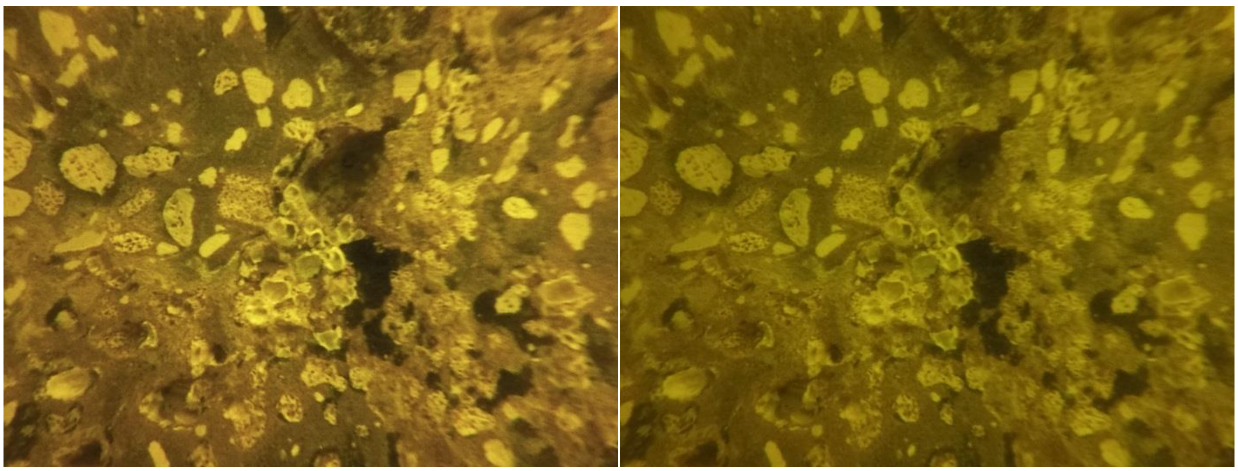

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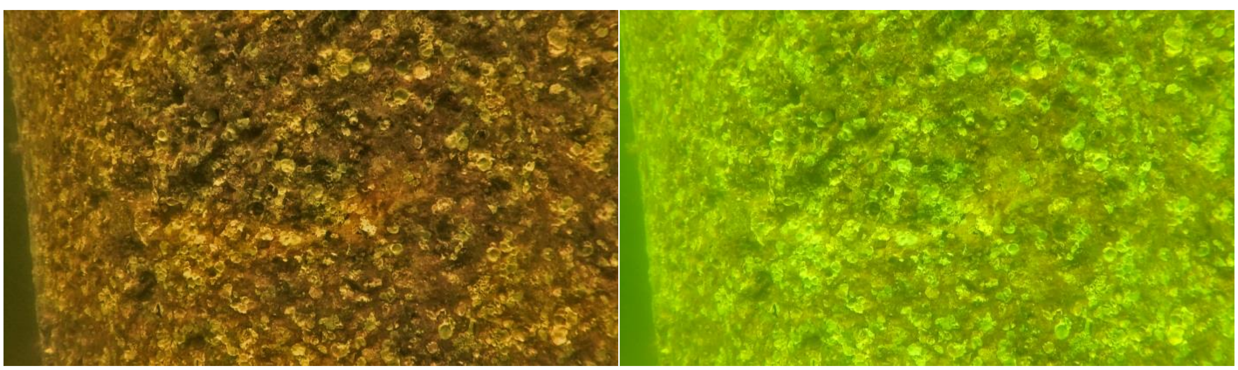

Figure C.15. Figure 4.33 Photoshopped (left), original (right)

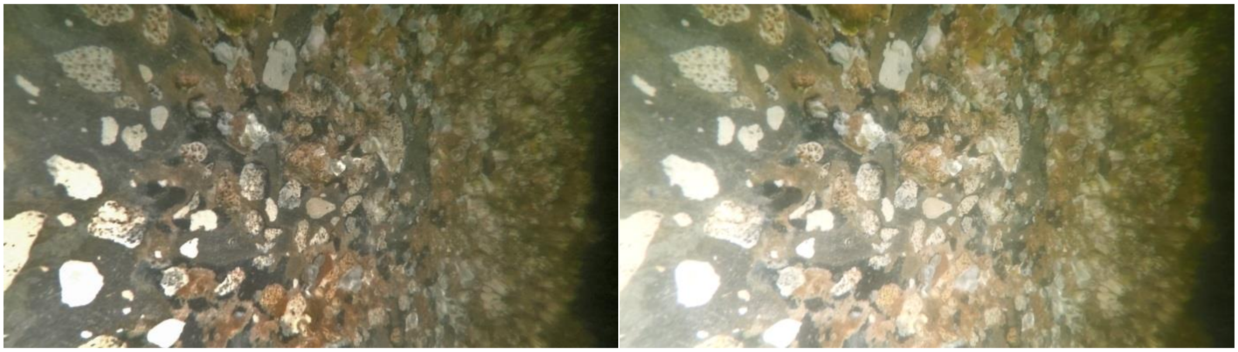
Figure C.16. Figure 4.34 Photoshopped (left), original (right)

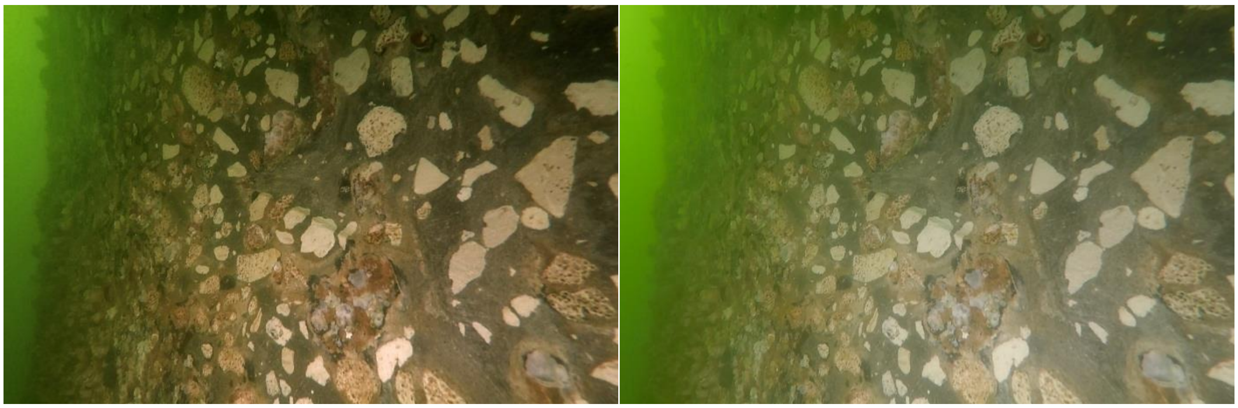
Figure C.17. Figure 4.35 Photoshopped (left), original (right)

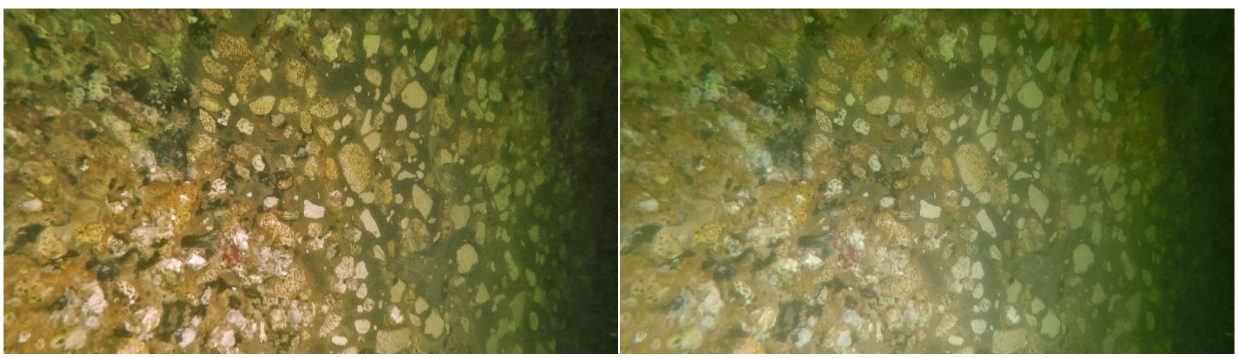
Figure C.18. Figure 4.36 Photoshopped (left), original (right)

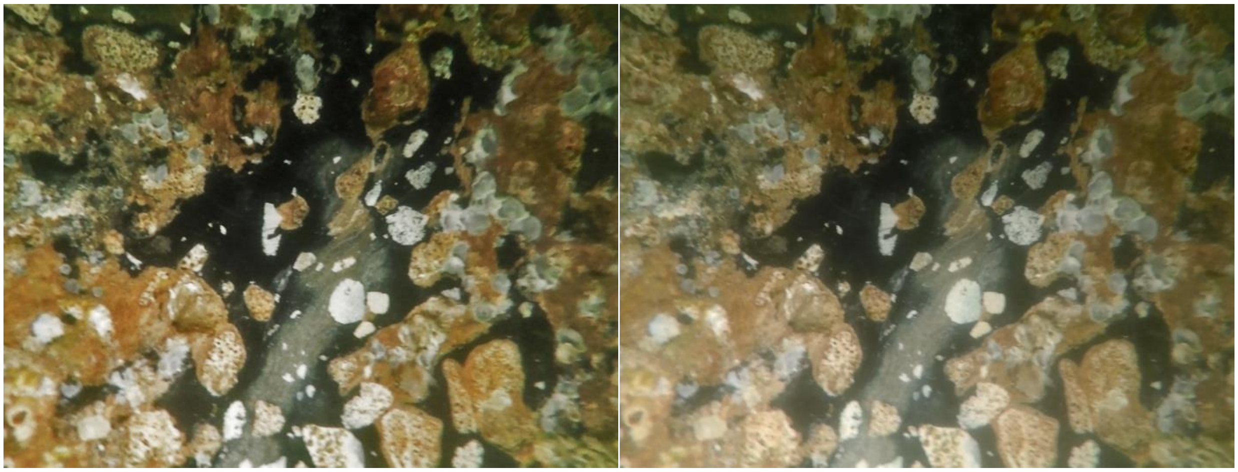
Figure C.19. Figure 4.37 Photoshopped (left), original (right)

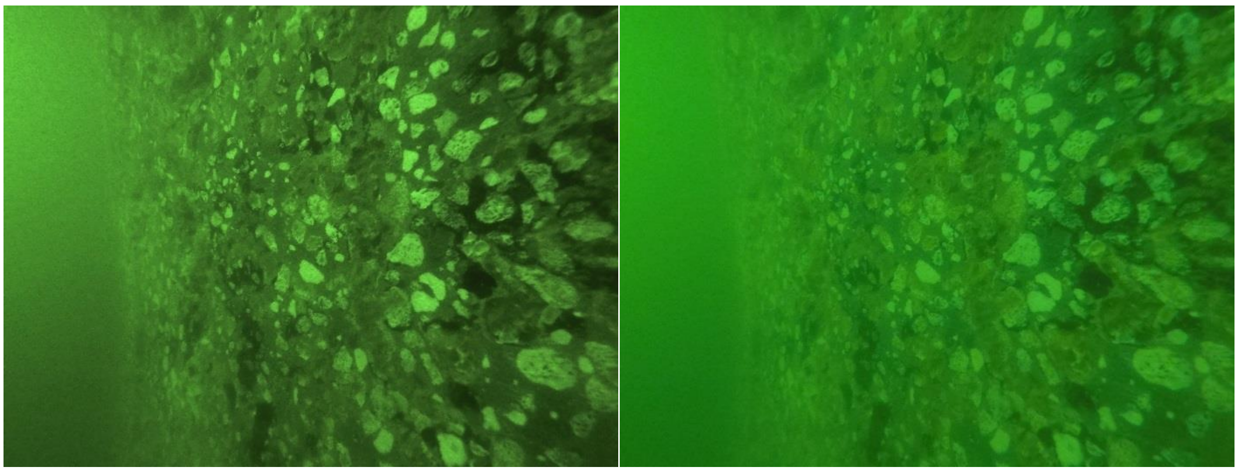
Figure C.20. Figure 4.38 (left image) Photoshopped (left), original (right)

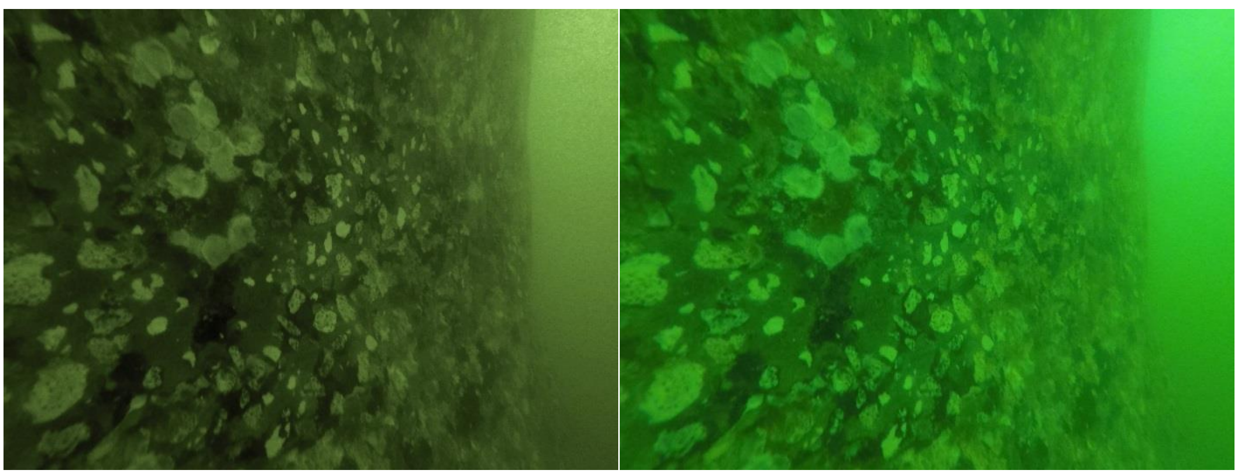
Figure C.21. Figure 4.38 (right image) Photoshopped (left), original (right)

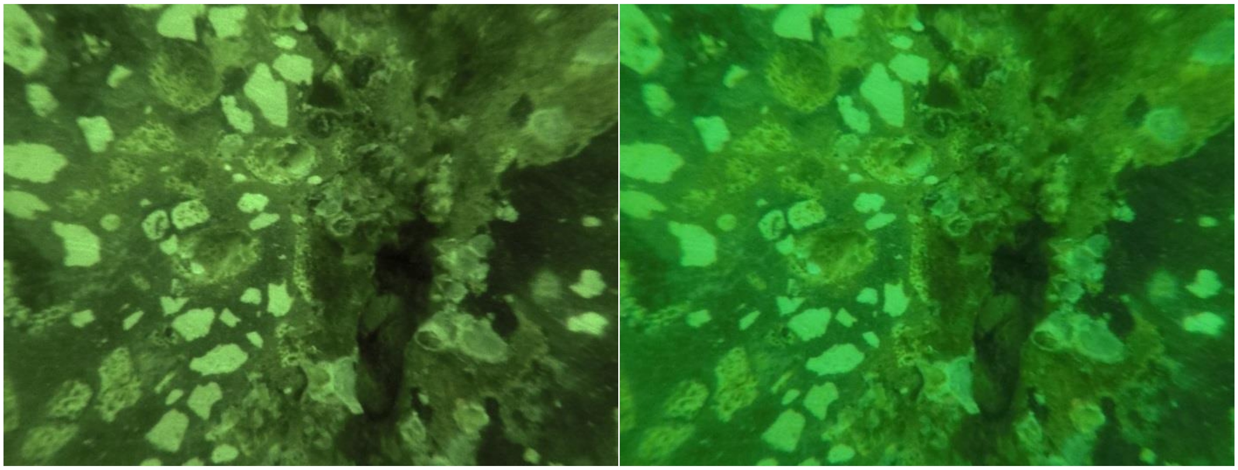

Figure C.22. Figure 4.39 Photoshopped (left), original (right)

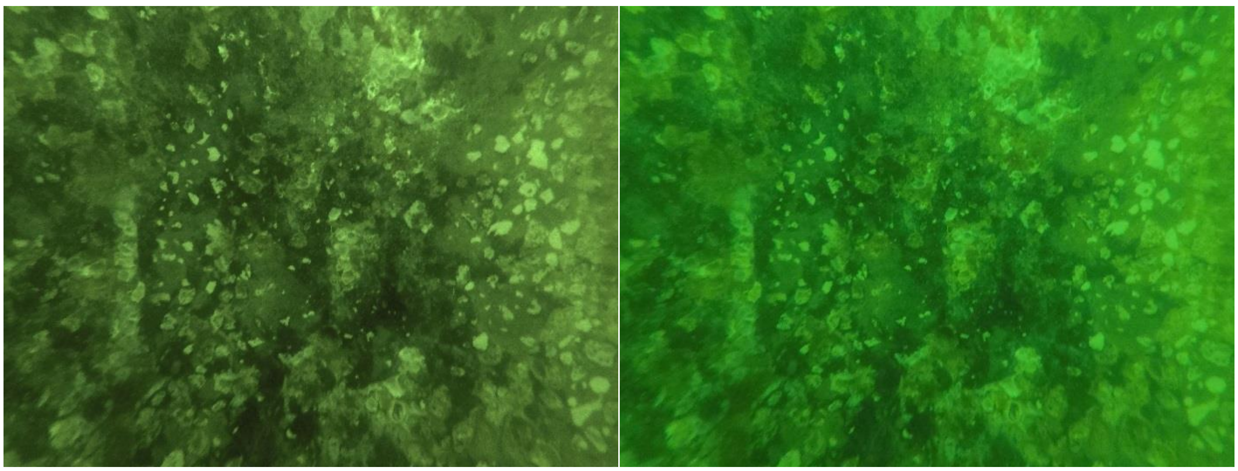

Figure C.23. Figure 4.40 (left image) Photoshopped (left), original (right)

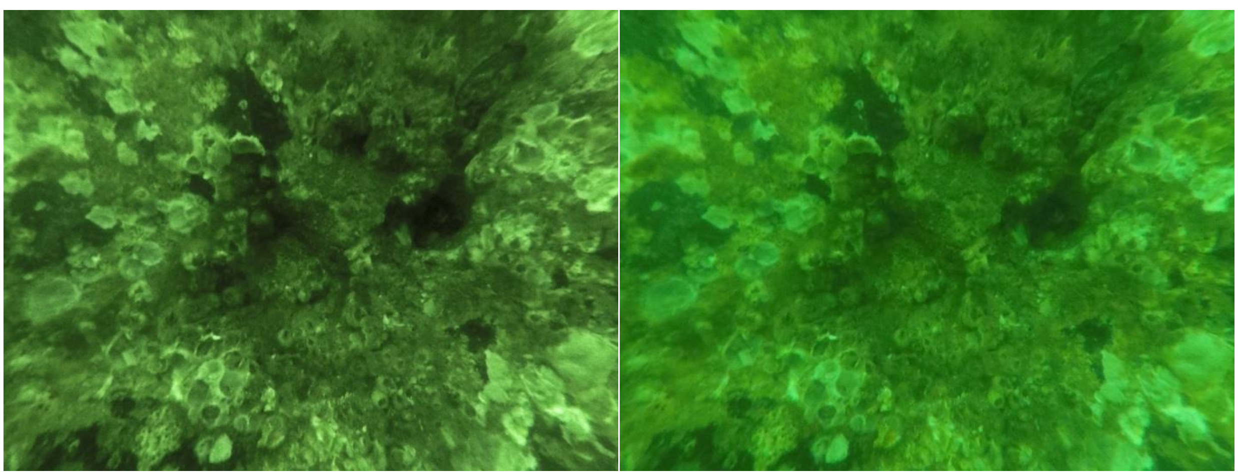

Figure C.24. Figure 4.40 (right image) Photoshopped (left), original (right)

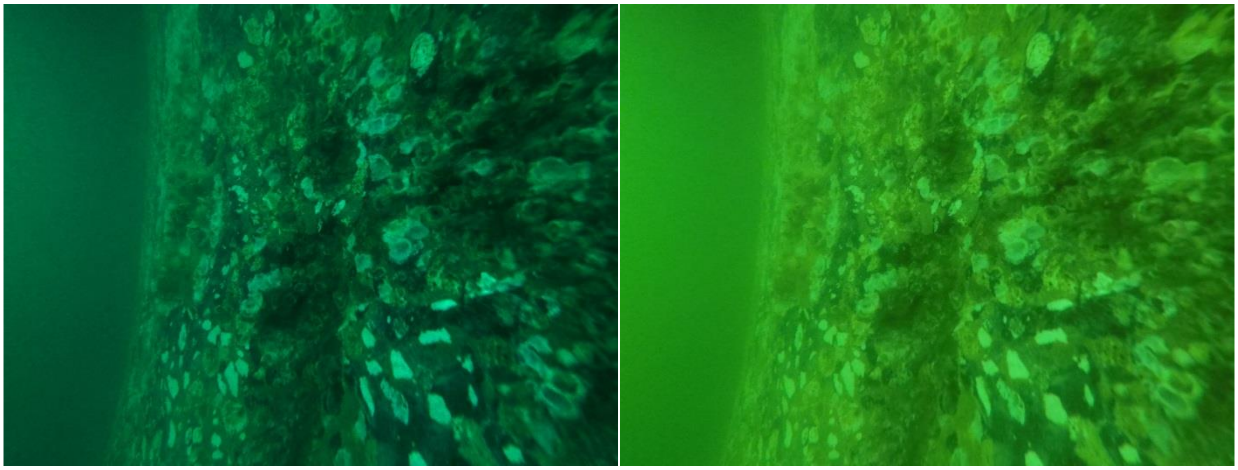

Figure C.25. Figure 4.41 Photoshopped (left), original (right)