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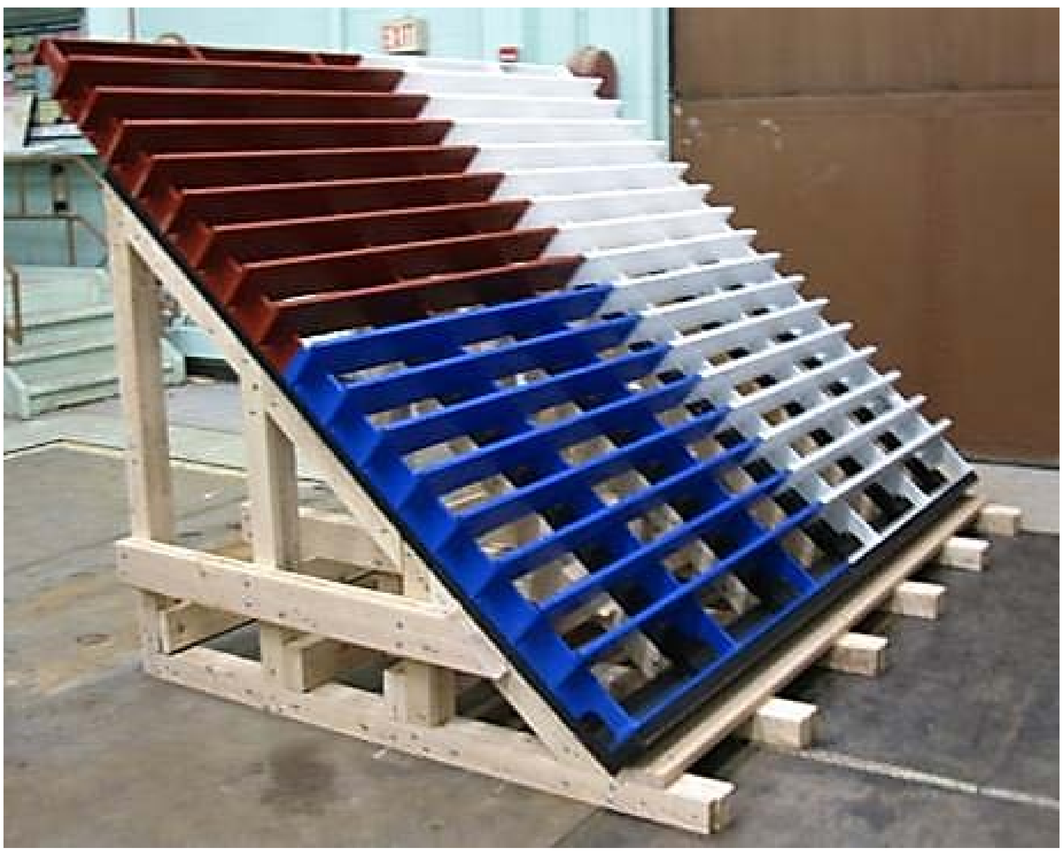
Managing Water in the West

Foul-Release Coatings Scale-Up Testing—Parker Dam Trashrack: FY 2015 Final Report

Research and Development Office
Final Report ST-2015-5270-1 / MERL-2015-75



U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Denver, Colorado

September 2015

Mission Statements

The U.S. Department of the Interior protects America's natural resources and heritage, honors our cultures and tribal communities, and supplies the energy to power our future.

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14. ABSTRACT *(Maximum 200 words)*

In 2012, a full-sized trashrack panel was fabricated and coated with four (4) foul-release coating systems. The project goal was to scale-up several of the most promising foul-release systems to assess their performance and durability characteristics in field conditions. Fabrication and coating work was performed by Reclamation staff in the Materials Engineering Research Lab (MERL). The panel was shipped to the selected field test site, Parker Dam, on the lower Colorado River and installation was completed in December 2013. Inspections were performed May 20, 2014, December 1, 2014, and May 19, 2015. Damage occurred on the front facing surfaces of the trashrack where the trash rake guides scraped the surface. After 18 months of exposure, the silicone foul-release coatings had less damage than the hard epoxy siloxane hybrid. The inner surfaces of the trashrack panel bars were in good condition. No mussels appear to be attaching to the silicone foul-release coatings. However, a few mussels were found colonizing on the epoxy siloxane hybrid coating. The front surfaces of the original trashrack panels, coated with the coal tar enamel, and the new galvanized steel racks were damaged exposing bare steel due to the mechanical damage from the trash rake guides.

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Acronyms

ADV	acoustic doppler velocimeter
ft^3/s	cubic feet per second
MERL	Materials Engineering Research Lab
LC	Bureau of Reclamation Lower Colorado Region
R&D	Research and Development Office
Reclamation	Bureau of Reclamation
S&T	Science and Technology

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EXECUTIVE SUMMARY

In 2012, a full-sized trashrack panel was fabricated and coated with four (4) foul-release coating systems. The goal of the project was to scale-up several of the most promising foul-release systems in order to assess their performance and durability characteristics while testing under field conditions. Fabrication and coating work was performed by the Bureau of Reclamation's (Reclamation) Technical Service Center staff in the Materials Engineering Research Lab (MERL), in Denver, Colorado. Fabrication and welding presented technical challenges that required corrective action to achieve resolution. The panel was shipped to the selected field test site, Parker Dam, at Lake Havasu Reservoir on the lower Colorado River, between the States of Arizona and California.

Initial attempts to install the structure failed after the hired crane operator was unable to dislodge and remove the existing panels to allow for the new installation.

In December 2013, a contractor was onsite to replace the top row of trashrack panels at Parker Dam. A small contract modification was issued to allow the contractor to replace one of the panels in the second row down with the foulrelease coated test panel. The installation was completed with no further complications in December 2013.

To inspect the trashrack panel coating condition, a waterproof portable stand-alone video recording device was affixed to the trashrack cleaning system. The inspection technique was successful in documenting the condition and performance of the coatings. Scheduled inspections were performed May 20, 2014, December 1, 2014, and May 19, 2015. As expected, damage occurred on the front facing surfaces of the trashrack where the trash rake guides scraped the surface. Surprisingly, after 18 months of exposure the silicone foul-release coatings had less damage than the hard epoxy siloxane hybrid. The inner surfaces of the trashrack panel bars still appeared to be in good condition. No mussels appear to be attaching to the silicone foul-release coatings. However, a few mussels were found colonizing on the epoxy siloxane hybrid coating. The front surfaces of the original trashrack panels, coated with the coal tar enamel, and the new galvanized steel racks were damaged to bare steel due to the mechanical damage from the trash rake guides.

INTRODUCTION

Zebra mussels were first discovered in the United States in the 1980's in the Great Lakes; the mussels spread rapidly across the United States into different water bodies. In January 2007, quagga mussels were found in Lake Mead (Hoover Dam). Since then, the mussels have been discovered elsewhere in the Colorado River as well as the Central Arizona Project and Metropolitan Water Districts Colorado Aqueduct. There have been confirmed detections of zebra and quagga mussels in many other reservoirs in the Western United States. Due to the warm climate of the southwest mussels are able to reproduce at greater rates than in the Great Lakes Region and Upper Mississippi River Basin.

Mussels have the potential to not only disrupt water delivery and hydropower generation functions, they create long-term economic impacts as well. Mussels attach to underwater surfaces and can clog small-diameter piping (i.e., cooling water, HVAC, and domestic water piping), reduce flow in larger diameter piping, clog fish screens, and impact intake structures.

Due to the potential impacts mussels can have at Bureau of Reclamation (Reclamation) facilities, a coatings research project was initiated in 2008 to identify or develop solutions to mitigate problems caused by mussels. The coatings field study at Parker Dam identified several foul-release coating products that effectively prevent fouling, but lack abrasion resistance. Hence, facility managers were skeptical that these coatings would withstand a severe service environment that included abrasion, impact, and scouring from entrained solids. The goal of the scale-up project was to evaluate foul-release coating performance in a real-world severe service application. As such, a full size trashrack panel was fabricated and coated with four (4) candidate foul-release coating systems. The panel was split into four (4) quadrants and coatings were applied in accordance with manufacturers recommendations as shown in table 1.

Table 1.—Foul-Release Coated Trashrack Panel

Topcoat	Generic Coating Type	Topcoat Color	Location
International Intersleek 970	Fluorinated silicone foul-release	White	Upper left
Sherwin Williams Sher-Release	Silicone foul-release	White	Upper right
PPG Sigmaglide 890	Silicone foul-release	Red	Lower left
Seacoat Seaspeed V5	Epoxy silicone hybrid	Blue	Lower right

Commercial systems with the following topcoats were selected: PPG Sigmaglide 890, Sherwin Williams Sher-Release, International Paint Intersleek 970, and Seacoat Seaspeed V5. Two of the four coating systems are silicone elastomers, and one is a silicone fluoropolymer; these require care when handling due to low resistance to abrasion damage. The fourth system (Seaspeed V5) is an epoxy silicone hybrid system, which is a hard coating. However, Seaspeed V5 is more prone to fouling. This system was tested to investigate whether the coating would self-clean on larger, in-service infrastructure. The panel was installed at Parker Dam in December 2014. Further details regarding the field test site, fabrication, and coating of the scale-up panel can be found in MERL-2013-19 [1].

INSTALLATION

Installation was attempted in fiscal year 2013 by plant staff using a locally hired crane and operator, as noted in MERL-2013-19 [1]. The initial attempts failed, and the installation was rescheduled for December 2013 when a contractor was to replace the top row of trashrack panels.

The experimental trashrack installation was completed on December 19, 2013. It was installed in Bay 9 right side (facing downstream). There were no problems extracting the existing trashrack, and it appeared to be in good condition, with no major rusting. Significant mussel buildup was present on the existing panel (figures 1–3). Figures 4–6 show the foul-release coated trashrack panel being installed in Bay 9.

Figure 1.—Existing trashrack heavily fouled with quagga mussels.

Figure 2.—Existing trashrack, view looking east.

Figure 3.—Existing trashrack, view looking south on trashrack structure.

Figure 4.—Installation of the new trashrack panel.

Figure 5.—Installation of the new foul-release coated panel.

Figure 6.—Installation of the new trashrack panel.

SERVICE CONDITIONS

Velocity Measurements

In January and June, 2010, water velocity measurements were acquired along the trashrack structure. The velocity measurements were collected under a different project, but are applicable for this study.

During this time, measurements were obtained near the foul-release coated trashrack panel at flow rates of 4,700, 9,800, and 15,000 cubic feet per second (ft^3/s). Unfortunately, measurements were not collected when the plant was operating at maximum capacity (22,000ft^3/s). The trashrack structure has 13 bays, with the bays numbered from south to north. In general, velocities varied with depth and across the trashrack structure with the lower velocities occurring at locations further from the penstocks. The velocity measurements were made with an acoustic doppler velocimeter (ADV).

The top of the foul-release coated trashrack panel is approximately 3 to 5 ft below the water surface at elevation 445 ft, and is 10-ft-long. Figure 7 shows measured velocities during the lowest flow rate of 4,700 ft^3/s, figure 8 shows velocities at 9,800 ft^3/s, and figure 9 shows velocities at 15,000 ft^3/sec. The variability in measurement elevation was caused by strong currents moving the probe downstream and upward in the water column. At 4,700 ft^3/s the velocities were 0.2 to 0.3 ft/s. At 9,800 ft^3/s the velocities were 0.6 to 0.7 ft/s. At 15,000 ft^3/s, the velocities were 1.2 to 1.3 ft/s.

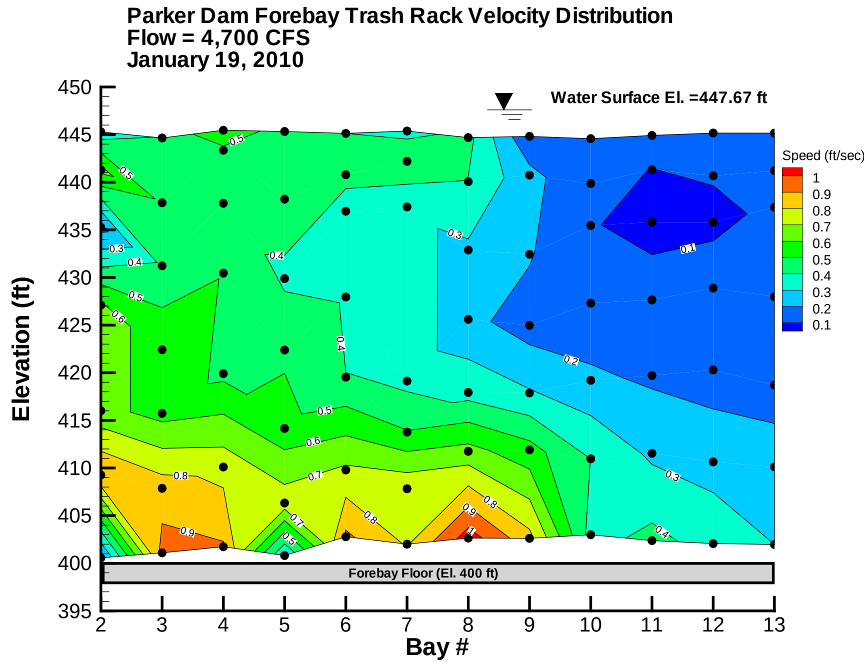

Figure 7.—Isovel plot of the velocity magnitudes passing through trashrack bays 2 to 13. The foul-release coated panel is located at 435-445 ft.

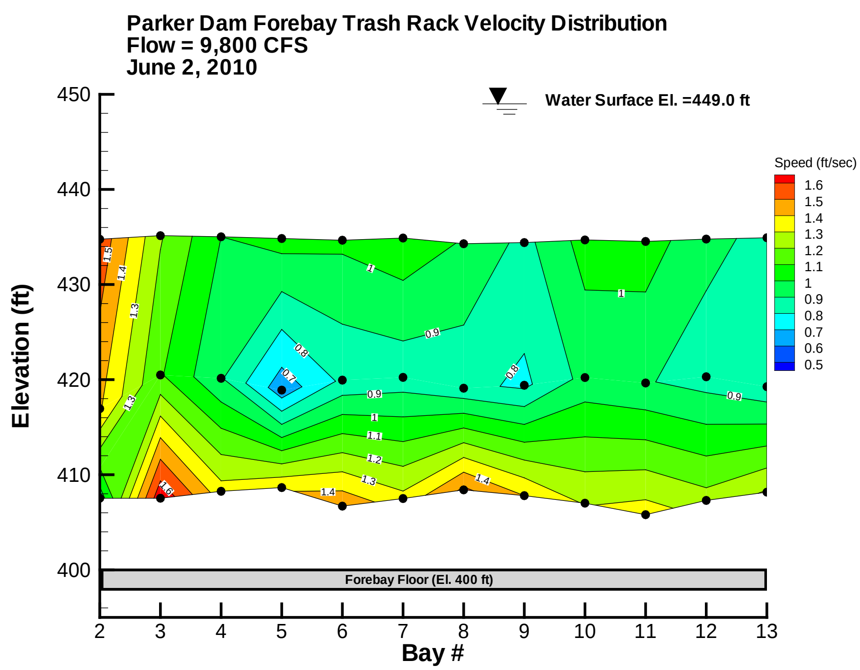

Figure 8—Isovel plot of the velocity magnitude passing through trashrack bays 2 to 13. The foul-release coated panel is located at 435-445 ft.

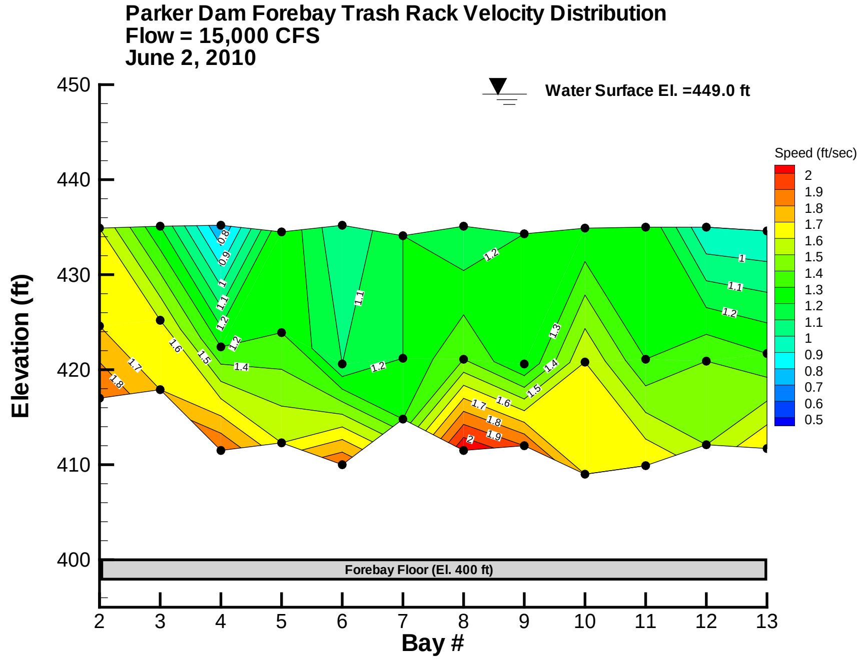

Figure 9.—Isovel plot of the velocity magnitude passing through trashrack bays 2 to 13. The foul-release coated panel is located at 435-445 ft.

Water Temperature

Water temperature data were recorded between October 20, 2009, through December 2012, at 15-minute intervals. Figure 10 shows temperature data at elevation 410 ft, 40 ft below the water surface. Quagga mussels are capable of reproducing as low as 48°F. Temperature data shows that at this facility the water temperatures would allow mussels to reproduce year round.

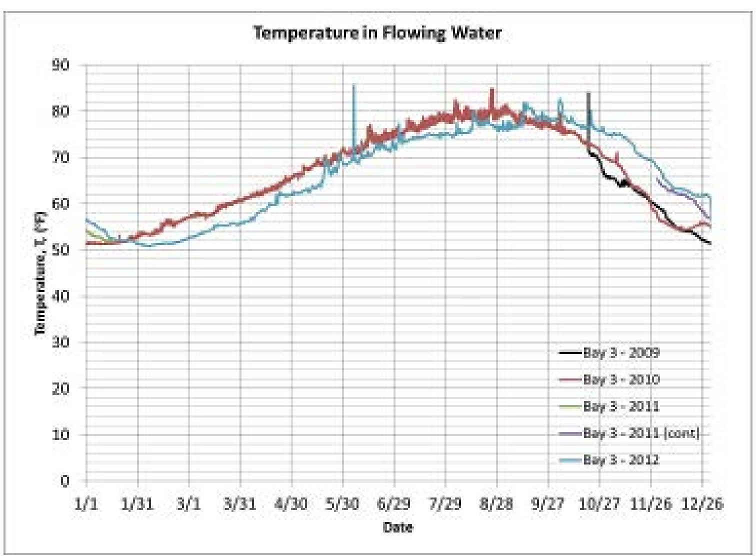

Figure 10.—Temperature data from 2009-2012 in bay 3 of trashrack, 40 ft below the water surface.

INSPECTION RESULTS

Scheduled inspections were performed May 20, 2014, December 1, 2014, and May 19, 2015. A submersible camera was deployed to document the degree of fouling and damage on the existing structure. This was accomplished by attaching a GoPro camera to the bars of the trashrack cleaner (see figure 11 for the mounting location for May and December 2014 inspections). Opening the trash rake jaws tilted the camera downward and gave a broad perspective of the fouling conditions. Closing the jaws produced a closer picture, revealing the coating condition with 3 visible bars. During the May 2015 inspection, the camera was mounted further to one side initially and then shifted to the other side for a more complete inspection.

Figure 11.—Trashrack cleaner with GoPro camera mounted.

The trash rake has three points of contact, the bottom has two guides that are in contact with the trash bars (figure 11) and a roller at the top (figure 12).

Figure 12.—Trash rake has a roller in the back and two guides on the bottom of the rake.

Observations for Traditional Panels

Figure 13 is a still image captured from the GoPro video recording taken during the May 2015 inspection. As of May 2015, there was no mussel settlement on the new galvanized trashrack panel above the foul-release panel, but these panels are typically only partially immersed. The trash rake guides caused damage to the metal coatings and the old coal tar enamel. One bar of the galvanized rack had scraping damage. All bars had damage on the existing trashrack panel coated with coal tar enamel.

Figure 13.—New galvanized trashrack panel shows corrosion on leading edge where trash rake guide scrapes the surface (third bar from right).

Figure 14.—Existing coal tar enamel coated trashrack.

Observations for Foul-Release Panel

It was expected that there would be some localized damage due to the automated trash rake. The trash rake runs every 7 days during normal operations, and it runs every day during the late summer (August- September) when large volumes of aquatic weeds impact the structure. Ideally, trash rake damage would be contained to rake contact areas. Regular cleaning by the rake was expected to keep these damaged areas mussel-free.

Figure 15 is an overview of the coated area of the Intersleek 970, the trash rake guide scrapes the coating on the third bar from the left, and there was very little damage on the Intersleek 970. Figure 16 is a close-up view of the coating, and no damage was observed. There were algae on the coating, but no mussels were present.

Figure 15.—International Paint Intersleek 970 after 18 months exposure—
the dashed line demarcates the end of the Intersleek coating.

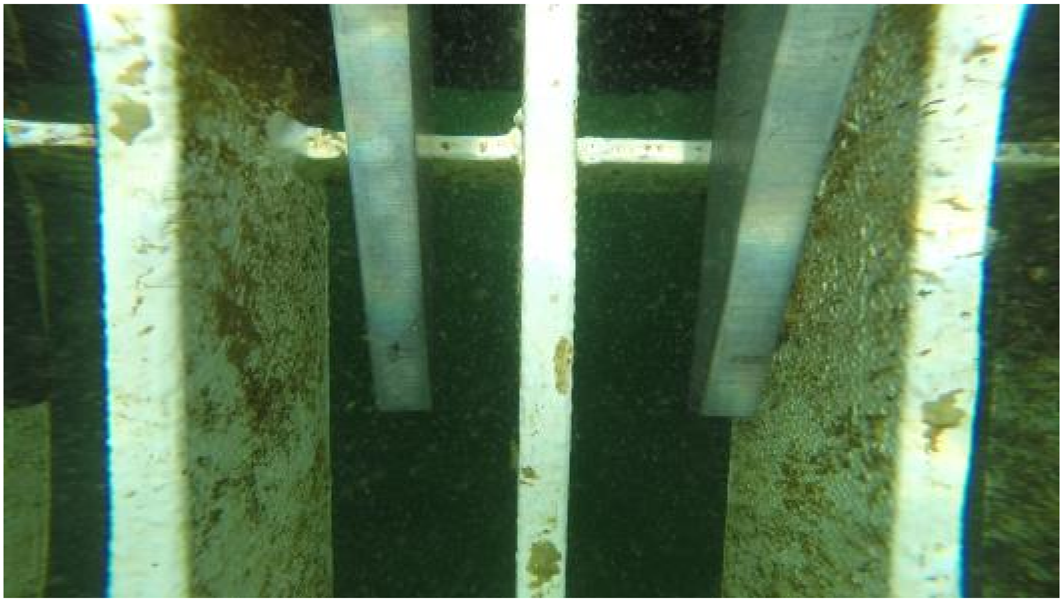

Figure 16.—International Paint Intersleek 970 after 18 months exposure.

Figure 17 is an overview of PPG Sigmaglide 890. There appeared to be some scrape marks on the front face where the guide scrapes the coating (third bar from left). Figure 18 is a close-up view of the coating and shows no damage. There were some algae on the bars, but no mussels were present.

Figure 17.—PPG Sigmaglide 890 after 18 months exposure.

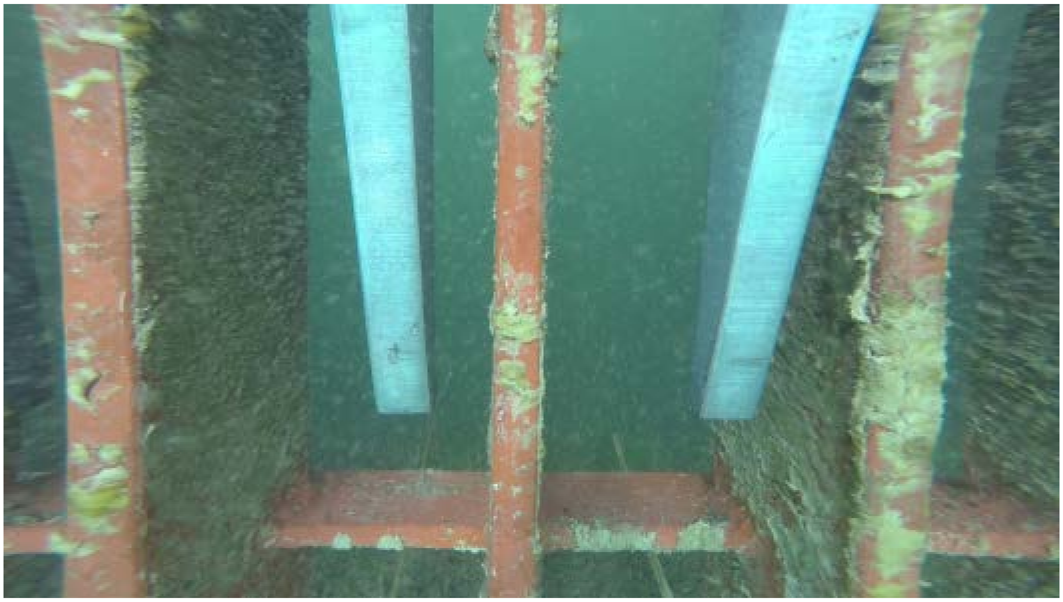

Figure 18.—PPG Sigmaglide 890 after 18 months exposure.

Figure 19 is an overview of the coated area of the Sherwin Williams Sher-Release. The trash rake guide scraped the coating on a few bars, and there is moderate damage on the front face. Figure 20 is a close-up view of the coating with some damage apparent. There were some algae on the coating, but no mussels are present.

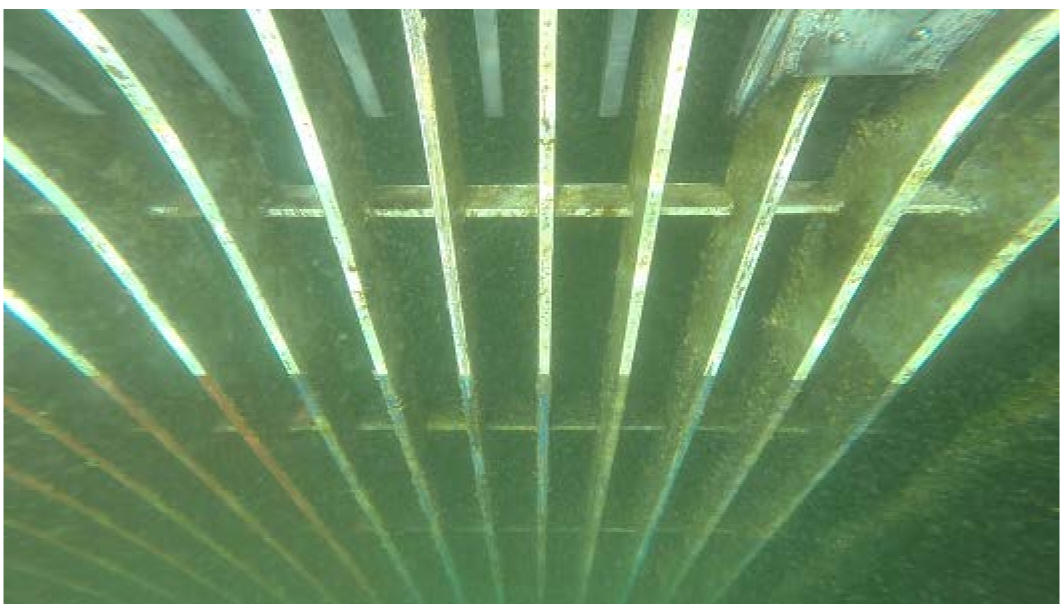

Figure 19.—Sherwin Williams Sher-Release after 18 months exposure.

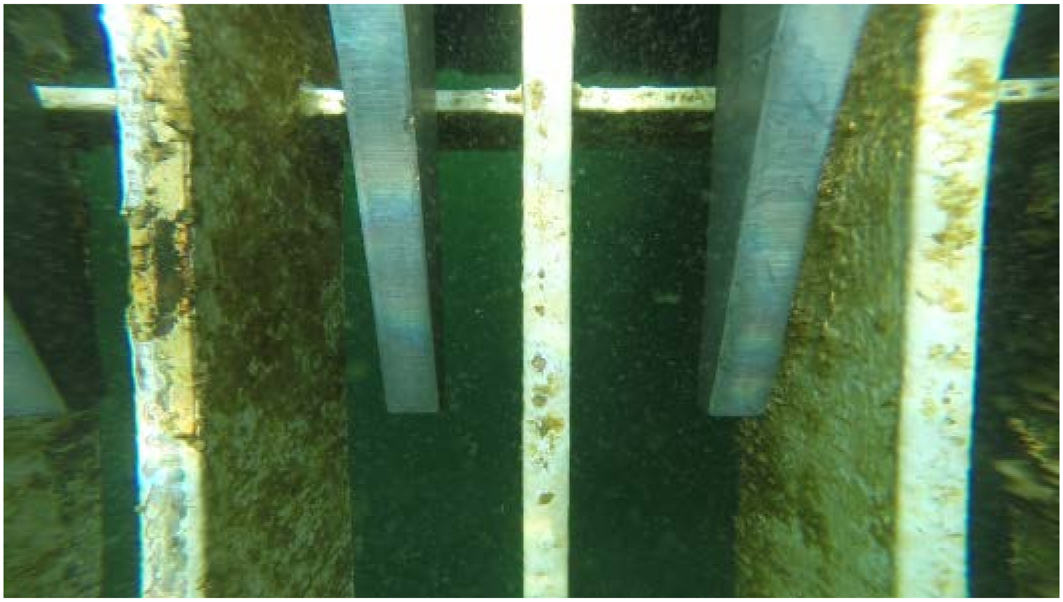

Figure 20.—Sherwin Williams Sher-Release after 18 months exposure.
Small damaged area on left bar.

Figure 21 is an overview of the coated area of the Seacoat Seaspeed V5 coatings. The trash rake guide scraped the coating, and there was moderate damage on the front face. Figure 22 is a close-up view of this damage. There was also algae and mussels present of the coating.

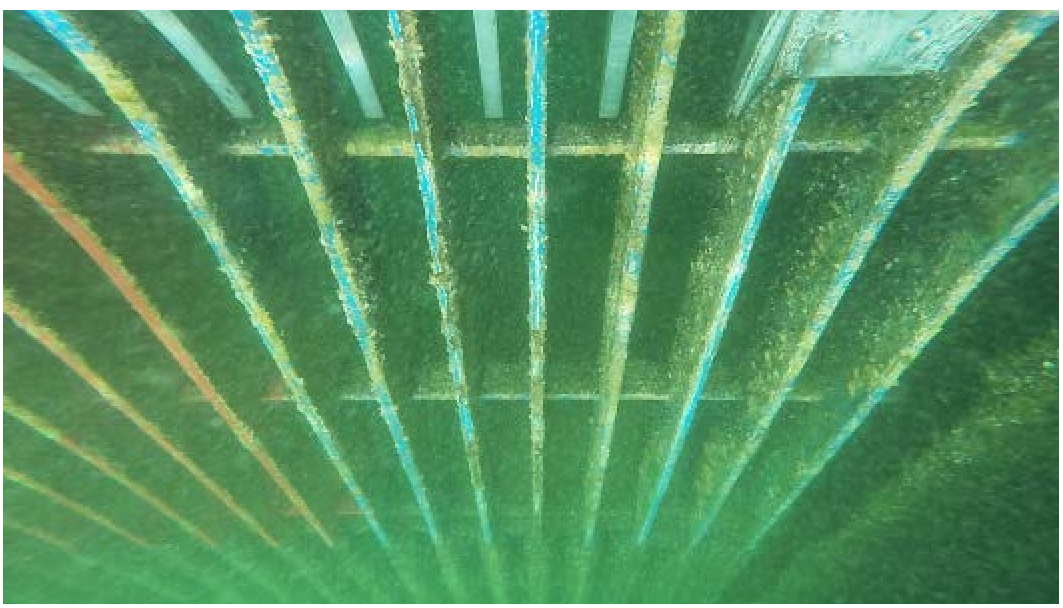

Figure 21.—Seacoat Seaspeed V5 after 18 months exposure.

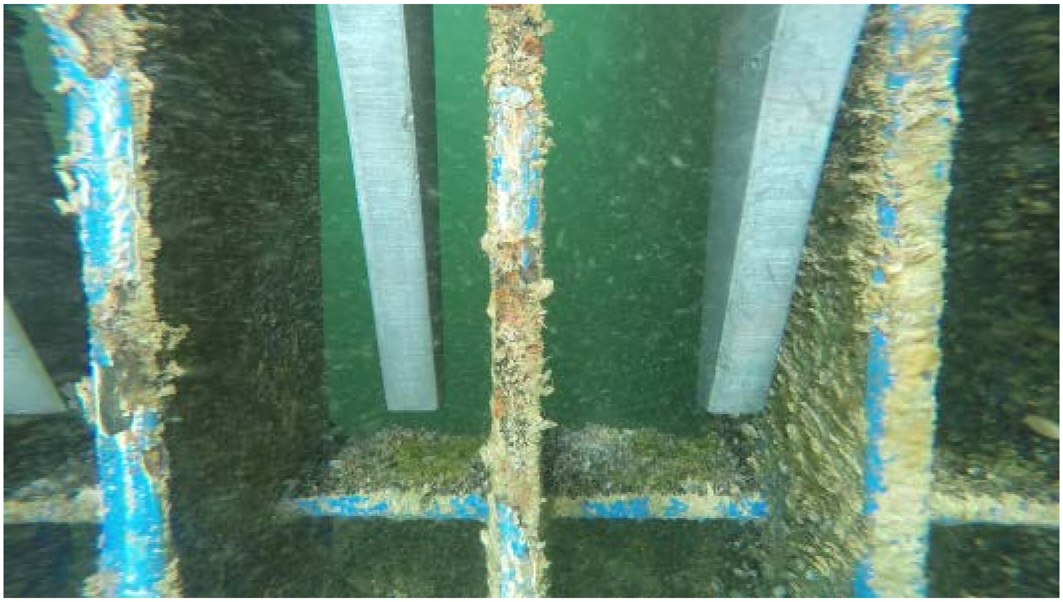

Figure 22.—Seacoat Seaspeed V5 after 18 months exposure.

DISCUSSION

The results showed less damage on the soft silicone foul-release coatings than the hard epoxy silicone hybrid. The contrary was expected. While the softer silicone foul-release systems are more prone to mechanical damage from gouging, abrasion, and impact, the sliding of the trash rake across the surface caused less damage compared to the epoxy silicone hybrid [2]. It was observed that a majority of the damage was on the bars that make contact with the trash rake guides. The silicones may provide a lubricating effect to help the rake glide across the coating rather than scrap the coating. Furthermore, the elastomeric nature may assist the coating in absorbing the load stresses.

The epoxy silicone hybrid had damage on a number of bars. This includes damage on bars that contact the trash rake guides as well as those that contact the trash rake roller. The hard epoxy silicone hybrid, may not withstand the high loading stress (compression stress) of a trash rake. The coating may crack and be scraped from the surface.

For now, all the damage appears to be on the front face of the trash rack bars. There does not appear to be damage in between the bars. However, undercutting corrosion may eventually creep around the edges of the bars.

CONCLUSION

The trash rake guide caused some damage to all coatings shown here: coal tar enamel, galvanized steel, epoxy silicone hybrid, and silicone foul-release coatings. The silicone foul-release coatings had less damage than the epoxy silicone hybrid coating. Mechanical shear by scraping and compression stresses due to weight caused greater damage to the hard coating than the soft elastomeric foul-release coatings. The silicones may provide a lubricating effect to help the trash rake roller glide across the coating rather than damage the coating. However, the epoxy silicone hybrid had damage on bars caused by the rollers. It is believed that the hard epoxy silicone coating cracks under this compression stress, resulting in greater amount of damage and subsequent corrosion.

REFERENCES

[1] Bureau of Reclamation. March 2013. Foul-Release Coatings Scale-Up Testing: Parker Dam Trashrack, Technical Memorandum No. MERL-2013-19. Materials Engineering Research Lab, Denver, Colorado.

[2] Bureau of Reclamation. 2012. Coatings for Mussel Control — Three Years of Laboratory and Field Testing. Technical Memorandum No. MERL-2012-11. https://www.usbr.gov/mussels/research/docs/20120821-MusselCoatings.pdf. Materials Engineering Research Lab, Denver, Colorado.

Data Sets that support the final Report

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Shared Drive contains photo and video documentation of fabrication, installation, and inspections. The following reports are also stored at this location:

MERL-2013-19: Technical Memorandum for FY2013
MERL-2014-67: Technical Memorandum for FY2014
MERL-2015-75: Technical Memorandum for FY2015