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AECOM File

Project name:
Piney Run Watershed Study

Project ref:
Contract 75-F-11-18/19

From:
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Date:
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DRAFT

Memo

Subject: Piney Run Dam (MD Dam No. 139) Pipe and Drain Camera Inspections

As part of the scope of work for the above-referenced contract, AECOM completed inspections of pipes and drains at the Piney Run Dam (Maryland Dam No. 139) using remotely operated vehicle (ROV) video inspection techniques. Inspections were made of the following locations:

- Principal spillway intake tower
- Principal spillway conduit
- Lake drain conduit
- Left (Northeast) internal drain conduit
- Right (Southwest) internal drain conduit
- Raw Water intake tower

1. Procedures

Inspections were completed December 19, 20, and 23, 2019 using a ROV camera system (Proteus Crawler). The crawler system provides the capability to complete remote inspections of pipe runs up to 500 feet in length. The system allows capturing real-time video to document the existing conditions of each conduit of interest. AECOM's field staff launched the camera system laterally from one end of each pipe to survey and document the pipe conditions efficiently and safely. Inspections were generally completed without the need for human entry into confined spaces.

To facilitate inspection of the lake drain conduit, AECOM subcontracted the installation of a temporary bulkhead by Marine Solutions, Inc. (MSI). MSI removed the two trash rack bars and installed a

bulkhead over the lake drain intake structure at the upstream end of the conduit. This allowed the lake drain sluice gate located inside of the principal spillway intake tower at the downstream end of the conduit to be open and the conduit dewatered. MSI also conducted a confined space entry, with self-contained breathing apparatus (SCBA), into the principal spillway intake tower to lift the ROV the seven inches from the tower floor into the lake drain conduit. Following the inspection of the lake drain conduit, the ROV was removed from the lake drain conduit by MSI and set back on the tower floor to be removed via the principal spillway conduit. The lake drain sluice gate was closed and MSI then removed the bulkhead and later reinstalled new trash rack bars provided by the County.

Inspection of the principal spillway and raw water intake towers was accomplished by using a hook system to lower the ROV down the tower.

Inspection of the foundation / toe drains was accomplished by hand placing the ROV between the bars of the animal guards inside the outfall pipe.

The County attempted to close all of the water intake valves to allow inspection of the water supply pipeline downstream of the raw water intake tower. However, they were not able to fully close all of the valves sufficiently to allow the ROV to be advanced up the pipeline. See additional details in the Section 2 below.

For the purposes of this report, references to the left and right internal drain conduits are made facing the downstream direction. All clock position references are taken looking in the direction of the camera lens, which is upstream.

2. Limitations

Inspection of the raw water intake tower was limited to the upper 30 feet of the 34.5-foot high tower due to the inability to fully close the gates in the tower. Because of this, water supply conduit and rate control piping could not be adequately dewatered and thus could not be inspected. The raw water intake tower was drained to 10 feet below the top of the tower which allowed inspection of the upper 30 feet of the tower to be completed (including 20 feet of submerged inspection). The remaining portion of the tower was not inspected due to poor visibility during the submerged portion of the tower that was inspected.

Inspection of the left (northeast) internal drain conduit could not be completed past a point approximately 80 feet from the outlet due to a build-up of sediment in the bottom of the conduit that prevented the ROV from gaining sufficient traction to continue to move forward. This is the approximate location of the “tee” connection from the left toe drain to the internal drain conduit.

Inspection of the right (southwest) internal drain conduit could not be completed past a point approximately 110 feet from the outlet due to a build-up of sediment in the bottom of the conduit that prevented the ROV from gaining sufficient traction to continue to move forward.

For the principal spillway conduit and lake drain conduit inspections, the cable spool, which is used by the system to measure distance from the outlet along the conduit, had to be positioned in such a way due to the baffles in the impact basin that obtaining an accurate measurement from the outlet was not possible (there were many instances where the cable had to be slacked in order to allow the ROV to pull it into the conduit without rubbing along the baffle walls). Therefore, findings for these conduits are reported relative to the joints in the conduit rather than the distance. Joints are reported with the distance noted in the video.

3. Inspection Findings Summary

Principal Spillway Conduit

The principal spillway conduit is a 36-inch reinforced concrete pipe, steel cylinder type. The conduit is approximately 303 feet long and extends from the principal spillway intake tower at the upstream end to a concrete impact basin at the downstream end. The slope of the conduit is approximately 0.25% and is bedded in a concrete cradle.

During inspection, there were approximately one to two inches of water flowing in the conduit invert. Inspection proceeded from downstream to upstream. The conduit appears to have well-seated joints. Minor pitting was observed along conduit walls below the spring line of the pipe (between three o'clock and nine o'clock) and minor spots of efflorescence above the spring line (between nine o'clock and three o'clock) along the entire length of the conduit.

Table 1. Principal Spillway Joint Summary

Joint Number (from Design Documents)	Video Location (feet)	Video Time	Description
1	263.75	0:13:27	Connection to Riser
2	249.58	0:12:46	
3	234.66	0:12:07	
4	220.41	0:11:10	
5	204.83	0:10:36	
6	190.91	0:10:00	
7	176.00	0:09:00	
8	161.16	0:07:30	
9	147.00	0:06:44	
10	131.75	0:05:46	
11	117.08	0:05:05	
12	102.91	0:04:30	
13	88.16	0:03:55	
14	73.50	0:03:30	
15	59.50	0:02:48	
16	46.16	0:02:15	
17	32.33	0:01:42	
18	19.25	0:01:10	
19	6.16	0:00:25	
20	-0.41	0:00:00	Connection to Impact Basin

Lake Drain Conduit

The lake drain conduit is a 24-inch reinforced concrete pipe, steel cylinder type. The conduit is approximately 123 feet long and extends from a head wall at the upstream end to the principal spillway intake tower at the downstream end. The conduit has a cast metal sluice gate at the downstream end

that is operated using a rising stem extension from the top of the principal spillway intake tower. The slope of the conduit is approximately 0.5% and is bedded in a concrete cradle.

During inspection, there were approximately one to two inches of water flowing in the conduit invert. Inspection proceeded from downstream to upstream. The inspection showed the conduit to have well-seated joints. Minor pitting was observed along conduit walls all around the conduit along its entire length. Discontinuities having the look of a scrape or indentation in the invert of the conduit wall were observed at locations 338.58 feet (six o'clock), 339.08 feet (six o'clock), 356.41 feet (between six o'clock and nine o'clock), and 363.16 feet (between seven o'clock and eight o'clock) along the pipe. No indications of leaks were identified at these locations. Minor hairline cracks with some efflorescence were observed at location 370.0 feet (between 10 o'clock and 12 o'clock).

Table 2. Lake Drain Joint Summary

Joint Number (from Design Documents)	Video Location (feet)	Video Time	Description
9	401.08	0:10:25	Connection to Head wall
8	387.41	0:09:35	
7	372.50	0:08:35	
6	357.66	0:06:50	
5	343.08	0:05:23	
4	329.33	0:03:26	
3	314.00	0:02:30	
2	299.41	0:00:52	
1	287.66	0:00:00	Connection to Riser

Principal Spillway Intake Tower

Inspection proceeded from top to bottom. The inspection showed that the safety ladder fall protection system running down the center of the ladder was misaligned toward the bottom of the ladder and that there was no ladder for the approximately 12 feet at the bottom of the tower. Therefore, the riser cannot currently be safely entered and descended to the bottom without an external fall protection system such as a tripod/winch system. The riser interior walls appeared to be in good condition with no major visible defects and the lake drain sluice gate rising stem extension and guides also appeared to be in operable condition.

The lake drain sluice gate was successfully operated several times during the inspections. The sluice gate itself was not completely sealed and there was a significant amount of water entering the riser from around the gate disc. A review previous inspections, particularly by Black and Veatch in 1994 and Walker Diving in 2009 showed that this has been a problem for many years with flow rates estimated as high as 100 gallons per minute (0.22 cubic feet per second). Black and Veatch concluded that the leaks were a source of hydrogen sulfide both in the air and in the water coming from decomposition processes taking place in the reservoir and delivered with the water leaking around the gate. Since the estimated leak rate is lower than the estimated inflow rate to the reservoir, there is not a concern about loss of water in the reservoir through the gate. In addition, there has been no historical documentation or anecdotal evidence to AECOM's knowledge pertaining the issue of maintaining the normal pool reservoir despite the leaking gate.

Left (Northeast) Internal Drain Conduit

According to the as-built design drawings, the left internal drain conduit is an eight-inch perforated corrugated metal circular pipe coated with a bitumen lining. The conduit is approximately 207 feet long extending from the chimney drain immediately downstream of the central core zone of the dam to the impact basin. The internal drain conduit has a tee connection approximately 80 feet upstream of the outlet in the impact basin. The slope of the conduit varies between 0.8 and 1.2%.

During inspection, there were approximately one to two inches of water standing/flowing in the conduit invert. Inspection proceeded from downstream to upstream. Loss of the conduit bitumen wall coating was observed along the entire conduit. Potential leaks were noted at locations 3.66 feet (two at four o'clock) and 48.58 feet (when pulling the camera out of the conduit in the downstream direction - two at seven o'clock) on the conduit. In all cases, these potential leaks appear to have some pressure forcing water up into the conduit above the standing water. At location 16.33 feet there was a large object noted at seven o'clock. Sediment deposits were also found in the invert of the conduit at location 15.0 feet. Significant buildup of material was observed between locations 61.16 feet and 70.91 feet and deeper flows and sediment were observed from locations 71.91 feet to the end of the inspection which is at the approximate location of the toe drain "tee" connection to the internal drain conduit. A characterization of these sediments could not be made from review of the video and therefore, it is not possible to determine a source at this time.

Right (Southwest) Internal Drain Conduit

According to the as-built design drawings, the right internal drain conduit is an eight-inch perforated corrugated metal circular pipe coated with a bitumen lining. The conduit is approximately 207 feet long extending from the chimney drain immediately downstream of the central core zone of the dam to the impact basin. The internal drain conduit has a "tee" connection approximately 80 feet upstream of the outlet in the impact basin. The slope of the conduit varies between 0.8 and 1.2%.

During inspection, there were approximately one to two inches of water standing/flowing in the conduit invert. Inspection proceeded from downstream to upstream. Loss of conduit wall bitumen coating was observed along the entire conduit. Potential leaks were noted at location 10.25 feet (when pulling the camera out of the conduit in the downstream direction - two at seven o'clock) on the conduit. These potential leaks appear to have some pressure forcing water up into the conduit above the standing water. At location 17.0 feet there was a large object noted at six o'clock. Significant buildup of material was observed between locations 52.91 feet and 76.33 feet and deeper flows and sediment were observed from locations 76.33 feet to just beyond the location of the toe drain "tee" connection to the internal drain conduit. A characterization of these sediments could not be made from review of the video and therefore, it is not possible to determine a source at this time.

A summary of the observations from the pipe and drain inspections is provided in Table 3.

4. Conclusions and Recommendations

Most of the findings made during the pipe and drain inspections of the subject structures and conduits at Piney Run Dam are minor in nature and warrant no additional follow-up. However, there are several findings that merit additional action.

General Recommendations

1. Re-inspect all conduits in five years and beyond that on a five-year cycle to identify any changes affecting performance or safety of the conduits.

2. Future inspection of the lake drain system will require temporary re-installation of a bulkhead over the upstream end of the lake drain at the intake structure by underwater diver to allow for dewatering of the conduit. The diver should also visually inspect the intake structure during this work.

Principal Spillway Conduit Recommendations

3. Findings identified in the conduit are minor and do not currently present a dam safety issue. Monitor these findings during future conduit inspections for changes in characterization. If changes are identified, consult a licensed engineer experienced in dams for further recommendations.

Lake Drain Conduit Recommendations

4. Findings identified in the conduit are minor and do not currently present a dam safety issue. Monitor these findings during future conduit inspections for changes in characterization. If changes are identified, consult a licensed engineer experienced in dams for further recommendations.

Principal Spillway Intake Tower Recommendations

5. The missing section of the access ladder and mis-aligned fall protection system do not currently present a dam safety issue but are critical to safely accessing the principal spillway intake tower without using an external fall protection system including tripod, winch, safety harness, etc. Replace the missing section of the access ladder at the bottom of the principal spillway intake tower and repair or replace the fall protection system before any further access using the ladder system is attempted. This work should be done with use of supplied air - see Recommendation 6. Complete these items within the next 12 months.
6. While the leaking lake drain sluice gate does not present an immediate dam safety concern, leaks should be minimized to facilitate inspection and maintenance of the principal spillway intake tower structure. Complete a detailed inspection and adjustment of the gate components including the wedges to improve the overall seal by a qualified technician within the next 12 months. Until that time, no entry to the principal spillway intake tower should be made without first testing the air at the bottom of the structure for oxygen and hydrogen sulfide levels and either venting the structure until levels are within the OSHA-compliant safe range or entering the structure using supplied air equipment such as a self-contained breathing apparatus or air lines.

Left and Right Internal Drain Conduit Recommendations

7. The loss of coating throughout the pipe does not currently present a dam safety issue. Monitor this finding during future conduit inspections for changes in characterization. If changes are identified, particularly loss of conduit wall (e.g. holes in the wall), consult a licensed engineer experienced in dams for further recommendations.
8. The obstructions identified (one in each internal drain conduit) although not ideal, do not currently present a dam safety issue as they do not appear to be inhibiting flow within the internal drain conduits. Monitor these findings during future inspections for changes in characterization. If changes are identified, particularly if additional obstructions are encountered and/or appear to be inhibiting flow, consult a licensed engineer experienced in dams for further recommendations.
9. The potential leaks identified in the internal drain conduits present some concern given that the conduit material (corrugated metal) has exceeded its known expected service life (approximately 30 years) and the leaks may be indications that the conduit walls are deteriorating. However, since

these conduits are bedded within a two-stage filter, the leaks into the pipe should allow it to continue to function and are not likely to affect performance or safety of the dam in the near future. Until permanent repairs are made as described in Recommendation 11, monitor leaks for changes to size, characterization and / or discharge rate. This may be done on an annual basis by using a push camera device to inspect the leaks which are all located in the downstream-most 20 feet of the internal drain conduits. If changes are identified, consult a licensed engineer experienced in dams for further recommendations.

10. The sediment deposits encountered could not be characterized through review of the video and thus a source could not be determined. Monitor the discharge from the internal drain outlets and sample to visually determine if soil fines are present in the discharge. This may be done by sampling the water and viewing through a clear container such as a glass jar. Soil fines may be an indication of loss of embankment material. If this finding is made, consult a licensed engineer experienced in dams for further recommendations.

11. As the conduit has reached its expected useful service life, modifications should be made to extend its service life within the next five years. These modifications will require an engineered design and permit from the Maryland Department of the Environment Dam Safety Division. Make the following modifications to the internal drain system on both conduits:

    a. Slip-line the existing conduits with a high-density polyethylene (HDPE) conduit up to six inches in diameter. The slip line limits should extend as far as possible into the dam but at minimum to the toe drain conduit "tee" connections.

    b. Re-align the downstream end of the drain system where the drain alignments run around the impact basin to their outlets. Install an access point such as a manhole or vault along the alignment of each internal drain conduit to allow for easier maintenance, camera inspections, discharge measurement, and discharge sampling and evaluation. The new internal drains should be aligned to reduce the number of bends for easier maintenance and inspection. All new conduit should be made of HDPE.

    c. The toe drain installation also includes a corrugated metal pipe conduit which cannot be repaired or replaced and it may experience reduced or non-existent functionality if the conduit fails in the future. A blanket drain which features a similar two-stage filter and drain with pipe conduit and an earthen buttress would provide a redundant internal drainage measure for the toe of the embankment should the existing toe drain become inoperable. Consider implementing this measure in conjunction with the components identified in sections a and b of this recommendation.

<u>Raw Water Intake Tower and Water Supply Conduit Recommendations</u>

12. As discussed in Section 2, the raw water intake tower and conduit were not able to be inspected completely due to malfunctioning gates in the tower that did not allow the tower and conduit to be dewatered. A previous inspection of the dewatered conduit performed by Progress Marine in November 2013 was reviewed and no major findings were identified. Inspect and repair the raw water intake tower gates to functional condition. Inspect the raw water intake tower and water supply conduit under dewatered conditions. Complete these items within the next six months.

Table 3. Observations Summary

Structure	File Name	Direction of Inspection	Date of Inspection	Video Inspection Completed	Observations		
					Video Time (H:MM:SS)	Distance from Outfall (feet)	Description (clock position references shown as HH:MM)
Principal Spillway Conduit	121919_Principal Spillway Conduit_Upstream.avi, 121919_Principal Spillway Conduit_Downstream.avi	Both (see File Names for direction)	12/19/2019	Complete	General	General	Minor pitting (3:00 to 9:00)
							Minor efflorescence (9:00 to 3:00)
Lake Drain Conduit	121919_Lake Drain_Upstream.avi, 121919_Lake Drain_Downstream.avi	Both (see File Names for direction)	12/19/2019	Complete	General	General	Minor pitting
					0:04:30	338.58	Scrape/Indentation (6:00)
					0:04:57	339.08	Scrape/Indentation (6:00)
					0:06:44	356.41	Scrape/Indentation (6:00 to 9:00)
					0:07:35	363.16	Scrape/Indentation (7:00 to 8:00)
					0:08:00	370.00	Hairline crack/efflorescence (10:00 to 12:00)
Principal Spillway Intake Tower	122319_Principal Spillway Intake Tower.avi	Top to Bottom of Tower	12/23/2019	Completed	0:10:16	27.08	No ladder within 12 feet of tower invert
					0:10:16	27.08	Safety guide mis-aligned toward the bottom of the safety ladder.
Raw Water Intake Tower	122319_Raw Water Intake Tower.avi	Top to Bottom of Tower	12/23/2019	Partial (to 30 feet below top)			Tower could not be drained, survey was canceled at 30' due to the rover's capabilities and the loss of stabilization
Left (Northeast) Internal Drain	121919_Left Internal Drain (to 80 feet)_Upstream.avi, 121919_Left Internal Drain (to 80 feet)_Downstream.avi	Both (see File Names for direction)	12/19/2019	Partial (to ~80 feet)	0:01:20	3.66	Potential Leak (4:00)
					0:05:30	15	Sediment buildup at elbow
					0:06:06	16.33	Large object (7:00)
					0:07:13	48.58	*Potential Leak (7:00)
					0:16:15	61.16	Sediment buildup
					0:19:29	70.91	Deeper flow and sediment accumulation
Right (Southwest) Internal Drain	122019_Right Internal Drain (to 110 feet)_Upstream.avi, 122019_Right Internal Drain (to 110 feet)_Downstream.avi	Both (see File Names for direction)	12/20/2019	Partial (to ~110 feet)	0:00:30	17.00	Large object (6:00)
					0:08:29	52.91	Sediment accumulation
					0:18:43	76.33	Deeper flow and sediment accumulation
					0:06:38	10.25	*Potential Leak (7:00)

**Denotes finding viewed on the downstream inspection.*