Appendix B:
Geotechnical and Structural Analyses

APPENDIX B
GEOTECHNICAL AND STRUCTURAL

1.0 General

On December 2-3, 2013, Robert Wheeler (ED-T-G), Tim Wessel (ED-DS), Dale Polston (ED-M-C), Leslie Williams (RE), Drew Russell (PM-P-E), Michael Turner (PM-P), and Nathan Moulder (PM-P) were accompanied by Sherri Alderson (Green River Area Lockmaster) and Sean Bennett (Green River Area Maintenance) to Green River Locks and Dams 3, 4, 5, 6, and Barren River Lock and Dam 1. The purpose of these site visits was to assess the condition of the structures, compare the condition of the structures to previous study, and identify actions or repairs which would be necessary to dispose of these projects. These assessments focused on any actions deemed necessary to maintain pool where required; and to provide adequate public safety at each structure. Restoration of operational capability or other work outside the minimum required to ensure stability was not considered. Currently the projects are not operational and have been placed in "caretaker" status. A discussion of the assessment of each of the structures follows.

2.0 Green River Lock and Dam 3.

This structure was originally constructed in 1833-1836 and consists of a 35.8 feet x 137.5 feet lock and about 353 feet of timber cribbing and rock fill dam. Photographs of the project are shown in Figures GR3-1 through GR3-12.

Since routine maintenance was no longer performed on the project, significant siltation has continued to occur around the miter gates and in the lock approaches. Considerable debris had accumulated in the area downstream of the lower miter gates, and the upstream approach has heavy siltation (Figure GR3-5).

2.1 Geotechnical Assessment

From a stability standpoint, the majority of the project appeared to be in satisfactory condition. The exception to this observation is the rock filled timber cribbing portion of the downstream guide wall, which is in a condition of failure (Figure GR3-6). This wall appears to have deteriorated more since the last inspection in 1998. It has continued to settle and rotate riverward significantly, and it appears a portion of the wall has fallen down or been eroded away completely.

The walls of the lock, constructed of cut stone masonry, show signs of significant surficial weathering; however, the walls do not show evidence of settlement or movement which would cause concern from a stability standpoint. No change was noted from the 1998 inspection.

The miter gates appear to be in the same condition as the 1998 inspection. The gates remain clogged with debris / sediment and not fully closed. Additional trees and under growth have increased around the gates and along the land wall of the lock.

The dam appears intact, stone fill was observed for the entire length of the dam. Historical records indicate an old mill race was located along the left bank, and more flow was observed through this area at the time of the site visit (same as previous inspection in 1998).

2.2 Structural Assessment

The lockmaster's house and one maintenance shed are still in existence. The primary maintenance/office building has burned down since the previous inspection in 1998. The house roof is in poor condition and is in a state of failure. The brick walls are still intact and are not in any danger of imminent collapse (Figure GR3-7). The esplanade, although cracked, can still adequately support vehicular traffic (Figure GR3-8).

The lock walls are in good condition. They are constructed of cut stone masonry. Their alignments are straight and there appears to be no signs of settlement. There are some root intrusions under the first layer of limestone blocks on the riverside (Figures GR3-3 & GR3-4). The downstream bullnose is losing some of its limestone blocks on the downstream end of the wall. This loss is far enough away from the downstream miter gates that it should not have an effect on the gate's structural integrity (Figure GR3-9).

The portions of the miter gates that are visible appear to be in good condition overall. Structural members look sound. Connections and welds appear to be intact, however there are some visible signs of rusting and pitting of the steel (Figure GR3-10). The gates were not mitered completely due to some debris stuck between them but the pool was not compromised due to the heavy siltation build up and woody vegetation growth in front of the upstream and especially the downstream gates.

The upstream guard wall is made of timber piling and appears to be in good condition (Figure GR3-11). The downstream guide wall is made of timber cribbing and has failed. It is not impacting the rest of the project.

The dam consists of large derrick stones placed on timber cribbing. It appears to be stable (Figure GR3-12).

2.3 Recommendations

Structurally, the lock and dam system looks sound and, except for the downstream guide wall, does not appear to be in any danger of immanent failure.

The site investigation did not reveal any conditions at this structure which would result in the loss of pool in the near future. However, during the time of the inspection the upstream miter gates were not fully mitered and pool was being held by the downstream miter gates. This is acceptable and repair actions are not considered necessary prior to disposition. However,

to maintaining pool for long term consideration, a concrete plug could be placed against the upstream face of the upstream miter gates. This same fix was proposed in a recent study conducted at Green River Lock and Dam #3 and can be found in the Engineering Documentation Report, Remedial Suite No. 2 provided by Stantec Consulting Services dated April 13, 2011.

To keep people off the dam side lock wall, the upstream and downstream miter gates could be gated off with fan fencing barricades on the land side miter gates. The siltation and vegetation of the chamber is substantial enough to act as egress (Figures GR3-3 & GR3-4). It is expected for the sediment to continue to collect in the lock camber provided the upstream and downstream miter gates remain closed / mitered.

3.0 Green River Lock and Dam 4.

This structure was originally constructed in 1834-1839 and consists of a 35.8 feet x 138 feet lock and about 409 feet of timber cribbing and rock fill dam. In May of 1965 the dam was breached and navigation upstream of this lock was suspended. Photographs of the project are shown in Figures GR4-1 through GR4-10.

Due to the breach of the dam, there was no pool differential, and the upstream approach to the lock was completely silted in, with significant tree growth (Figure GR4-5). A major section of the dam was gone due to the breach (Figure GR4-6). Significant siltation had occurred downstream of the right bank abutment of the dam.

3.1 Geotechnical Assessment

From a stability standpoint, the majority of the project with the exception of the upstream guard wall appeared to be in satisfactory condition (same as previous inspection in 1998). There is no water impounded by this project so loss of pool is not a consideration here. The upstream guard wall has settled and rotated landward, and is in a condition of total failure, being held up by heavy tree growth (Figure GR4-7). This appears to be in the same condition as it was in the previous inspection. The walls of the lock, constructed of cut stone masonry, show signs of significant surficial weathering with weeds and brush growing through the walls in several places; however, the walls do not show evidence of settlement or movement and appear to be in the same condition as noted in the previous inspection in 1998.

3.2 Structural Assessment

The esplanade appears to be in good condition and can still support vehicular loads (Figure GR4-8). The lock wall alignments are straight and there appears to be no settlement. There is some root intrusion in some of the limestone block joints. Also, there are some limestone block faces that have spalled off due to freeze-thawing. But overall, the lock walls are considered to be structurally sound (Figures GR4-3 & GR4-4).

Due to the breach in the dam, the upstream approach channel is completely silted in, with significant tree growth. This tree growth has caused the upstream approach wall, which is constructed of wood cribbing, to fail by rotating landward. It appears the wall rotation has been stabilized by the tree growth and silt on either side.

The upstream miter gates are holding back a significant amount of silt and tree growth. All visible structural member connections look sound (Figures GR4-10). The downstream miter gate is missing its members at and below the waterline, and there is some visible rusting and pitting of the rest of the gates (Figures GR4-9).

The downstream guide wall has good alignment and does not show any signs of settlement. The condition of the concrete appears satisfactory (Figures GR4-1).

3.3 Recommendations

No actions are recommended for the section of the upstream guard wall which has failed. Should the wall continue to rotate, it will not cause any damage.

Structurally the lock and downstream guide wall do not appear to be in any danger of failure. No conditions were observed at the site which would further impair the stability of this structure. In the long term, it is recommended that the brush growing through the lock walls be killed and cut off to prevent the brush growth from causing damage to the walls.

To keep people off the river side lock wall, the upstream and downstream miter gates could be gated off with fan fencing barricades on the land side miter gates. The siltation and vegetation of the chamber is substantial enough to acts as egress (Figures GR4-3 & GR4-4) along with the deterioration of the lower downstream miter gates (Figure GR4-9). It is expected for the sediment to continue to collect in the lock camber provided the upstream and downstream miter gates remain closed / mitered.

4.0 Green River Lock and Dam 5.

This structure was originally put in operation in 1900. A new lock was built in 1933-1934, when the old structure was removed. The new structure consists of a 56 feet x 360 feet lock and approximately 300 feet of concrete dam. Photographs of the Project are shown in Figures GR5-1 through GR5-8.

A significant amount of siltation is occurring around both the upstream and downstream gates, inside and outside of the lock chamber as also noted in the 1998 inspection. Trees are observed growing in the channel immediately upstream and downstream of the chamber. Both land and

river walls are covered with minor amounts of weeds and brush with some growing through the lock land wall, and a few small damp spots on the land wall indicated some minor seepage through the wall.

4.1 Geotechnical Assessment

From a stability standpoint, the majority of the project appeared to be in same satisfactory condition as reported during the previous inspection in 1998. Leakage was observed around the upstream riverward gate leaf during the previous inspection and appears to be unchanged. The lock walls, and dam, which are concrete, appeared to remain stable and in good condition. Some minor weathering and spalling of surficial concrete was again observed, but the lock walls do not show evidence of settlement or movement which would cause concern from a stability standpoint.

4.2 Structural Assessment

As previously stated, the Green River Lock and Dam 5 project site actually contains generations of project sites. All that is left of the original 1900 lock is the landside lock and guide walls (Figure GR5-7). At the newer lock site, the esplanade has been removed and vegetation has replaced it. The only remains from the Lockmaster's houses are the building foundations, some filled in cisterns, and steps that lead up to the yard area.

The concrete lock walls have good alignment and show no signs of settlement. There are some visible cracks, but the overall conditions of the lock walls are good. The upper and lower guide walls have excellent alignment, show no signs of settlement, and look in very good condition (Figures GR5-2 through GR5-4). This lock system also used two sheet pile cells as part of the river side upstream guard walls. These cells, which are linked together by walkway planks, appear to be in good condition (Figure GR5-8).

The miter gates are holding back a significant amount of silt and tree growth. At least 3/4 of the upper gate and half of the lower gates are covered by silt (Figures GR5-2 & GR5-3). The structural member connections that are visible look sound. There is some visible rusting and pitting of the steel. The concrete dam, though underwater at the time of the visit, appears to be in good condition. Since the dam is underwater, any potential undermining, underseepage, or other structural deterioration is unknown (Figure GR 5-6). The only way to fully assess the condition of the dam would be when the flow was sufficiently low that water was not passing over the dam. This flow condition is very rare.

The two story control tower is missing window panes but otherwise appears in good condition (Figure GR5-4). There is no exposed reinforcing and the condition of the concrete is good. The spiral stairs are still intact that provides access to the second level. The balcony at the second level is still structurally sound and is in good condition. Additionally, a lifting beam was observed on site that could be salvaged.

4.3 Recommendations

No conditions were observed at this site which would result in the loss of pool in the near future. The condition of the miter gates appear to be satisfactory. If the upper set of miter gates were to fail, the lower set would provide the redundancy needed to maintain the pool until a fix (rock plug, sheet pile cut off, etc.) could be reestablished on the upstream end of the lock.

To keep people off the dam side lock wall, the upstream and downstream miter gates could be gated off with fan fencing barricades on the land side miter gates and insure the land side valve pits and bulkhead slots grates are bolted securely. The siltation and vegetation of the chamber is substantial enough to acts as egress (Figures GR5-2 & GR5-3). It is expected for the sediment to continue to collect in the lock camber provided the upstream and downstream miter gates remain closed / mitered.

5.0 Green River Lock and Dam 6.

This structure was built in 1904-1905 and consists of a 36 feet x 145 feet lock and approximately 220 feet of concrete and stone dam. In 1989, repairs were made to the structure by placing a sheet pile cutoff upstream of the upper gates and into the right bank. The upper gates were also partially encased in concrete. This work was performed as the result of major seepage through the lock chamber, and end-around seepage occurring through the right bank. Photographs of the project are shown in Figures GR6-1 through GR6-9.

Since the downstream gates have been removed siltation has not occurred around the upstream and downstream gates, inside and outside of the lock chamber. However, debris has accumulated in the upper approach area, and between the sheet pile cutoff and the upper gates (Figure GR6-7). Some spalling was evident on the lock walls (Figure GR6-3).

5.1 Geotechnical Assessment

From a stability standpoint, there are still some items of concern related to this project. Most notably are the seepage conditions still evident through and around the lock wall cutoff, right bank and land lock wall. Low areas/Sinkholes were still evident in the right bank indicating seepage was still occurring but no changes were noted from the previous inspection in 1998. Clear water was observed seeping under the land wall into the lock chamber. The flow into the chamber is not caused by a culvert failure because the lock chamber utilized valves located in the miter gates. At the end of the lower approach wall, where the wall runs into the bank, the wall appears to have settled and rotated outward at the top but does not look different than what was observed during the 1998 inspection (Figures GR6-6 and GR6-8). Upstream, the upper approach wall directly above the sheet pile cutoff wall remains in a state of failure (Figure GR6-7).

5.2 Structural Assessment

The concrete in the lock walls appear to be undergoing some deterioration but are in satisfactory condition overall. The alignment still appears to be good with no visible signs of settlement (Figure GR6-4).

Most of the upper guide and guard walls are made of timber pilings and timber rails. These have been taken over by trees growing through the rails (Figures GR6-5, GR6-9). The complete failure of this wall section will not affect the river flow, or pool. The portion of the upper landside guide wall next to the upper gates is made up of concrete monoliths and is rotating with the growth of trees. A section of this wall was removed for the placement of the sheet pile cutoff wall. The approach channel has become blocked by silt, debris, and vegetation.

The concrete dam, though underwater at the time of the visit, appears to be in good condition. Since the dam is underwater, any potential undermining, underseepage, or other structural deterioration is unknown (Figure GR6-1). The only way to fully assess the condition of the dam would be when the flow was sufficiently low that water was not passing over the dam. This flow condition is very rare.

The lower landside guide wall is constructed of approximately 150 feet of concrete monoliths. The end of the wall cuts back into the bank approximately 30 feet. It has good alignment, and shows no signs of settlement, except for the tie-back portion of the wall. There is an approximate 2 inch gap in the joint between the second and third monolith. This has not changed since the 1998 inspection (Figure GR6-1). There are concrete steps on the outside of these monoliths that provide access from the bank to the water's edge utilized by area fishermen. They descend about 30 vertical feet. The major portion of these steps has rotated away from the monoliths approximately 3 inches. This has not changed significantly since the 1998 inspection (Figure GR6-6). This rotation appears to be independent of the gap between the monoliths described above. Any failure of the steps or cut back portion of the wall will not adversely affect river flow.

The downstream miter gates have been cut off and are lying in the chamber. The upper gates were encased in concrete to a height equal to that of the dam.

5.3 Recommendations

It appears that the guide and guard wall sections will not cause damage or concern should they continue to move. Therefore, no repair action is recommended. Lock walls appear stable with no repair action recommended.

The agency requesting this property is the National park Service. They would like the dam removed. Therefore, the dam material could be placed in the lock chamber and along the lower approach walls and the associated steps to help minimize disposal costs and environmental impacts

(roads, fuel, offsite disposal, etc.) and reduce safety concerns. Also, egress for this structure is not an issue since the downstream gates have been removed.

6.0 Barren River Lock and Dam 1.

This structure was originally constructed in 1841. The new lock was built between 1933-1934 and incorporated into the old one. The new lock is a 56 feet x 360 feet lock. A concrete cutoff wall was placed across the upstream sill of the old lock (Figure BR1-7). The dam is approximately 276 feet long, and consists of a concrete covered timber cribbing structure. Photographs of the project are shown in Figures BR1-1 through BR1-12.

A significant amount of siltation has occurred upstream of the lock, and trees were observed growing in the upstream approach channel. Trees were also observed growing through holes in the old lock walls (Figure BR1-10). Wet spots on the lock land wall indicated water was seeping through cracks in the wall. No changes were noted from the previous inspection in 1998.

6.1 Geotechnical Assessment

From a stability standpoint, the majority of the project appeared to be in satisfactory condition. The lock walls, which are concrete, appeared to be in good condition, with the exception of minor weathering (no change from previous inspection in 1998). The downstream side of the dam appeared to have some surficial damage, as indicated by zones of turbulent water flow (Figure BR1-8). The dam appeared to be in the same condition as the previous inspection with the exception of the left most portion of the dam. At the time of inspection the left most portion of the dam appeared to be slightly shifted/tilted toward the opposite bank (see red circle in Figure BR1-8). However, it was difficult to determine with additional water flowing over the dam during this inspection. The lock walls still do not show evidence of settlement or movement which would cause concern from a stability standpoint. The miter gates appear to be in good condition. No changes noted on the lock structure since the previous inspection in 1998.

6.2 Structural Assessment

The overall structural condition of Barren River Lock and Dam 1 project appears to be good. The two story control tower is missing window panes and has evidence of bullet holes, but there is no exposed reinforcing and the overall condition of the concrete is good (Figure BR1-2). The esplanade, although cracked, can still adequately support vehicular loads (Figure BR1-9).

The portions of the miter gates that are visible appear to be in good condition. Approximately 1/3 of the gates have silt against them (Figure BR1-6). All structural members look sound, and all connections and welds appear to be intact.

The lock, guide, and guard walls are in good condition (Figures BR1-1 & BR1-5). Their

alignments are straight and the condition of the concrete is good. Some of the bulkhead slots, piping, and valve pits are missing their gratings. These have been removed in order to place rock in them, thereby reducing an entrapment hazard.

The old lock chamber was put out of service by placing a concrete cutoff wall across the upstream sill, and putting rock fill in the rest of the chamber. This concrete cutoff wall appears to be in good condition (Figure BR1-7). There was not much evidence of the rock fill in the chamber on this visit due to high water. Some of the rock or fill may have settled or washed away (Figure BR1-7).

Additionally, two dewatering beams were observed on site that appeared to be in good condition. These could be scrapped, or salvaged and reused at another project site (FigureBR1-12).

The concrete dam, though underwater at the time of the visit, appears to be in about the same condition as the 1998 inspection. There appears to be some indication of through seepage. Since the dam is underwater, any potential undermining (through seepage or other structural deterioration) is unknown (Figure BR 1-8). The only way to fully assess the condition of the dam would be when the flow is sufficiently low and water is not passing over the dam. This flow condition is very rare.

6.3 Recommendations

At the time of this report, no work is recommended for improving the stability of this project. However, there is some concern about the stability of the dam. To eliminate this concern, a cutoff would need to be established upstream of the dam. The most effective means of cutoff would be a single row of sheet piling driven immediately upstream of the upstream face of the dam. The area between the sheet pile wall and sloping face of the dam would then be filled with large-size stone. This is similar to a repair technique used on the Kentucky River Locks but would prove to be very expensive and not even known to be warranted at this time.

No conditions were observed at this site which would result in the loss of pool in the near future. The conditions of the miter gates appear to be satisfactory. If the upper set of miter gates were to fail, the lower set would provide the redundancy needed to maintain the pool until a fix (rock plug, sheet file cut off, etc) could be reestablished on the upstream end of the lock.

To keep people off the dam side lock wall, the upstream and downstream miter gates could be gated off with fan fencing barricades on the land side miter gates. Egress is provided at this structure through the following ways: ladders located on the lock walls (Figure BR1-2), vegetation and concrete berm just downstream of upstream miter gates (Figure BR1-3 & BR1-4), and the accumulated siltation located near the miter gates (though hard to see this in the photographs from this inspection due to high water during the time of inspection).

Figure GR3-1: Downstream River Wall and Dam of Green River Lock and Dam #3 (Dec. 2013)

Figure GR3-2: Over grown area around Lock Master's house at Green River Lock and Dam #3 (Dec. 2013)

Figure GR3-3: Lock chamber looking upstream from river wall at Green River Lock and Dam #3 (Dec. 2013)

Figure GR3-4: Lock chamber looking downstream from river wall at Green River Lock and Dam #3 (Dec. 2013)

Figure GR3-5: Upstream approach channel from river wall at Green River Lock and Dam #3 (Dec. 2013)

Figure GR3-6: Downstream land side approach wall failure at Green River Lock and Dam #3 (Dec. 2013)

Figure GR3-7: Lock Master's House at Green River Lock and Dam #3 (Dec. 2013)

Figure GR3-8: Esplanade at Green River Lock and Dam #3 (Dec. 2013)

Figure GR3-9: Downstream bullnose and miter gates at Green River Lock and Dam #3 (Dec. 2013)

Figure GR3-10: Downstream miter gates at Green River Lock and Dam #3 (Dec. 2013)

Figure GR3-11: Downstream miter gates at Green River Lock and Dam #3 (Dec. 2013)

Figure GR3-12: Dam at Green River Lock and Dam #3 (Dec. 2013)

Figure GR4-1: Green River Lock and Dam #4 from Lock Master's House (Dec. 2013)

Figure GR4-2: Lock Master's house at Green River Lock and Dam #4 (Dec. 2013)

Figure GR4-3: Lock chamber looking upstream from river wall at Green River Lock and Dam #4 (Dec. 2013)

Figure GR4-4: Lock chamber looking downstream from upstream miter gates at Green River Lock and Dam #4 (Dec. 2013)

Figure GR4-5: Upstream approach channel from upstream miter gates at Green River Lock and Dam #4 (Dec. 2013)

Figure GR4-6: Section of dam missing due to breach at Green River Lock and Dam #4 (Dec. 2013)

Figure GR4-7: Upstream river side approach wall failure at Green River Lock and Dam #4 (Dec. 2013)

Figure GR4-8: Esplanade at Green River Lock and Dam #4 (Dec. 2013)

Figure GR4-9: Missing structural members at and below the water line, Green River Lock and Dam #4 (Dec. 2013)

Figure GR4-10: Upstream miter gates holding back a significant amount of silt and tree growth, Green River Lock and Dam #4 (Dec. 2013)

Figure GR5-1: View of Green River Lock and Dam #5 from downstream land wall (Dec. 2013)

Figure GR5-2: Siltation of lock chamber and vegetation at Green River Lock and Dam #5 looking upstream from downstream miter gates (Dec. 2013)

Figure GR5-3: Siltation of lock chamber and vegetation at Green River Lock and Dam #5 looking downstream from upstream miter gates (Dec. 2013)

Figure GR5-4: Power House located on the land side wall at Green River Lock and Dam #5 (Dec. 2013)

Figure GR5-5: Upstream approach channel from river wall at Green River Lock and Dam #5 (Dec. 2013)

Figure GR5-6: Dam from river wall at Green River Lock and Dam #5 (Dec. 2013)

Figure GR5-7: View of the original 1900 Green River Lock and Dam #5 site as viewed from the newer 1934 Green River Lock and Dam #5, river wall (Dec. 2013)

Figure GR5-8: Upstream guard cells with walkway planks looking downstream (Dec. 2013)

Figure GR6-1: Lock chamber and dam from downstream land wall at Green River Lock and Dam #6 (Dec. 2013)

Figure GR6-2: Downstream miter gates have fallen into lock chamber at Green River Lock and Dam #6 (Dec. 2013)

Figure GR6-3: Lock chamber looking downstream from river wall at Green River Lock and Dam #6 – note seepage under lock wall at ladder (Dec. 2013)

Figure GR6-4: Lock chamber looking upstream from river wall at Green River Lock and Dam #6 (Dec. 2013)

Figure GR6-5: Upstream approach channel from right river bank just upstream of Green River Lock and Dam #6 (Dec. 2013)

Figure GR6-6: Downstream land wall stairs failure at Green River Lock and Dam #6 (Dec. 2013)

Figure GR6-7: Upstream sheet pile wall in front of miter gates at Green River Lock and Dam #6 (Dec. 2013)

Figure GR6-8: Gap in monolith joint on end of downstream lock wall at Green River Lock and Dam #6 (Dec. 2013)

Figure GR6-9: Upstream approach channel Guard wall at Green River Lock and Dam #6 (Dec. 2013)

Figure BR1-1: Downstream River Wall and Dam of Barren River Lock and Dam #1 (Dec. 2013)

Figure BR1-2: Over grown area around Power House on river wall at Barren River Lock and Dam #1 (Dec. 2013)

Figure BR1-3: Lock chamber looking upstream from downstream miter gates at Barren River Lock and Dam #1 (Dec. 2013)

Figure BR1-4: Lock chamber looking downstream from upstream miter gates at Barren River Lock and Dam #1 (Dec. 2013)

Figure BR1-5: Upstream approach channel from river wall at Barren River Lock and Dam #1 (Dec. 2013)

Figure BR1-6: Siltation downstream of downstream miter gates at Barren River Lock and Dam #1 (Dec. 2013)

Figure BR1-7: Concrete cutoff placed across upstream sill of the old lock chamber at Barren River Lock and Dam #1 (Dec. 2013)

Figure BR1-8: Dam with old lock chamber in the foreground at Barren River Lock and Dam #1. Circled area is of turbulent water flow noted during inspection (Dec. 2013)

Figure BR1-9: Esplanade with control tower in the background at Barren River Lock and Dam #1 (Dec. 2013)

Figure BR1-10: Old lock chamber at Barren River Lock and Dam #1 (Dec. 2013)

Figure BR1-11: Old lock chamber with rock fill at Barren River Lock and Dam #1 (Dec. 2013)

Figure BR1-12: dewatering beams at Barren River Lock and Dam #1 (Dec. 2013)