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MEMORANDUM

TO: Marty Melchior, Inter-Fluve, Inc.
FROM: Mark Mitsch, P.E.
DATE: May 29, 2009
SUBJECT: Shawsheen River Restoration Project
Geotechnical and Structural Engineering Project Review

Weston & Sampson Project No. 2090163

Introduction

The Shawsheen River Restoration Project is intended to restore fish passage at three dams on the Shawsheen River in Andover, Massachusetts. Inter-Fluve prepared a November 14, 2008 technical memorandum describing the conceptual design of removal for the three dams. This memorandum is intended to supplement the November 14, 2008 memorandum with our comments related to geotechnical engineering and structural engineering considerations for the three sites.

The project is aimed at river restoration and fish passage through dam removal or alternative fish passage methods at the Balmoral, Marland Place and Ballardvale Dams. During the course of conceptual design development, fish passage concerns were identified and added to the overall project for two breached dam locations; the Redman Cloth Dam (between the Ballardvale and Marland Place dams) and an unnamed dam downstream of Haverhill Street and the Balmoral Dam. Dam removal is the preferred alternative at all of the dams, but alternative fish passage may be considered for the Ballardvale Dam.

Inter-Fluve conducted field studies and developed conceptual design alternatives for the project during 2008. Weston and Sampson was engaged in April 2009 to assess geotechnical, structural and construction engineering issues related to the proposed modifications at each site. This letter report documents our review of available drawings of the three sites and our site reconnaissance observations. Included are recommendations for engineering studies to be conducted during final design at each of the sites.

Inter-Fluve has conducted a geomorphic review of the river and watershed, and completed topographic and bathymetric surveying at each site. The surveying included identifying and surveying topographic cross sections of the stream channel upstream and downstream of each dam for hydraulic modeling purposes, establishing local benchmarks, surveying channel bottom elevations, measuring sediment depths and sediment sampling and analyses for physical and chemical characterization.

Inter-Fluve collected and provided Weston & Sampson with historic drawings showing Shawsheen River dam and bridge geometry and construction, and accompanied Weston & Sampson during our site reconnaissance on May 5, 2009 to observe the three dam sites and discuss structural, geotechnical and construction engineering issues related to the proposed dam removals or modifications. Our observations and recommendations for each site are described in the following sections.

BALMORAL DAM

Existing Conditions

Balmoral Dam is a run-of-the-river dam. The spillway has a circular arch-shaped horizontal alignment and is formed of concrete. The weir has a stepped vertical configuration. The training walls are the vertical concrete and masonry river channel walls. The dam is approximately 170 feet downstream of the Balmoral Street Bridge and about 70 feet upstream of the Haverhill Street Bridge in Andover, MA. The National ID Number for Balmoral Dam is MA00179 and the name assigned to the dam in the Massachusetts Department of Conservation and Recreation (DCR) DamViewer database is Brothers of the Sacred Heart Dam. The dam is considered an Intermediate Size, Low Hazard dam.

The design of the dam is shown on the June 10, 1920 drawing titled “Shawsheen River Dam, American Woolen Company, Shawsheen Village, Mass.” According to this drawing, the crest of the spillway is approximately seven feet above the river bottom. The foundation level of the spillway extends between 1.5 and 2.5 feet below the river bottom. The tops of the concrete training walls are approximately 6.6 feet above the spillway weir crest.

The drawing indicates there is a bypass tunnel behind the right training wall extending from the upstream to the downstream sides of the spillway, and passing below the small gatehouse at the right abutment of the dam. The inside of the gatehouse could not be observed but the drawing indicates the gatehouse is fitted with a gate that was once used to divert water to a “Brush Factory” via a 24-inch cast iron pipe. The drawing shows that this pipe extends perpendicularly away from the river toward the Balmoral Building then turns 90 degrees downstream and parallel to the river toward Haverhill Street.

The drawing does not show the downstream end of the pipe. The drawing also indicates that the river channel/training walls at the dam and from the upstream to downstream ends of the tunnel are concrete gravity walls constructed integral with the stepped spillway weir.

Proposed Construction

The Balmoral Dam will be removed as part of the project. The extent of concrete spillway removal should be evaluated during final design. From the perspective of wall stability and cost, the spillway should be removed only to the extent that it is effective for both river hydraulics and fish passage. The drawings indicated the base of the dam is about 14 feet wide measured parallel to the direction of flow. Complete removal may not be prudent as the drawings indicate the spillway is locked into the channel walls. It is anticipated that the east wall (right wall looking downstream) will not be removed. The west wall may be maintained or as indicated above, may be removed and replaced with a bioengineered slope. For the walls that are maintained in their current configuration, consideration should be given to leaving portions of the spillway intact against the channel walls to act as buttresses to the walls. For practical purposes, the buttresses would be on the order of two to three feet wide at the top step of the weir, and would step out into the channel at a 1H:1V to 1.5H:1V inclination. The central portion of the spillway would be removed only down to the level that would be effective for fish passage. The need for the buttresses should be evaluated during final design and coordinated with decisions on the disposition of the gatehouse and the west wall of the channel. It may also be desirable from a historic perspective to leave buttress sections of the dam in place and include a historic marker describing what they are as part of the project.

Dam removal will require careful dismantling of the concrete spillway to limit vibrations that may adversely impact the adjacent gatehouse and other nearby buildings and site improvements. The contractor should be required to conduct the work so as not to damage adjacent features that will remain after the spillway is removed. Saw cutting the concrete spillway near the channel walls should be required to limit disturbance of the interface between the wall and spillway. Hoerammung or jackhammering the spillway should be limited to the extent practicable to minimize potential damage the integral river channel walls and adjacent gatehouse. Construction vibrations should be monitored at the Balmoral Building during construction and pre- and post-construction building surveys should be conducted to verify that dam removal activities have not damaged the building.

It is anticipated that an excavator will need to be placed in the river channel downstream of the dam for cutting and excavating sections of the dam. River flow will need to be managed during construction and sedimentation control measures will be required to limit downstream migration of demolition debris and sediment.

The impoundment level will be permanently lowered after dam removal, which will likely have an impact on flow velocity and shear stress ranges for storm events upstream of the dam. This may result in sediment scour from around the Balmoral Street Bridge foundations. Available drawings of the Balmoral Street Bridge suggest the bridge might be supported on pile foundations. If this is true, the subsurface conditions around the bridge abutments may consist of erodable fill soils over a compressible organic soil layer. Scour protection requirements as well as storm flow debris impact protection requirements should be established during final design. It is anticipated that some riprap scour/debris flow protection will be required around the bridge foundations. Some of the concrete removed from the dam could be used for bridge foundation protection.

A temporary working platform will need to be constructed in the river as well as a suitably graded ramp at the river edge to maneuver between the excavation site and the area where trucks will be loaded with demolition debris. One way to limit the impact of the working platform is to place suitably sized and load designed reinforced concrete box culvert sections side-by-side out into the river channel between the channel walls. The box culvert sections would be oriented so river flow can continue relatively unimpeded while the construction equipment operates on top of the sections. The culvert sections would be sized so the top surface is above the normal river level. Some bottom grading may be necessary to create a stable and level bearing surface for the culvert sections. The right channel wall would be cut down to the top of the culvert section and the area outside the channel graded and finished to create a suitable access ramp to the work site. This method is expected to have considerably fewer environmental impacts as compared to filling in the channel with rock or other earth materials.

The dam removal contractor will need to sequence the work and install, operate, maintain and remove appropriate water control procedures and sedimentation control measures during the work. The construction plans and specifications should communicate the allowable construction access and staging areas and the requirements for protecting and restoring adjacent site features as well as the sedimentation control measures for the project.

The quantities and types of materials to be removed from the site should be estimated during final design and an appropriate disposal site(s) identified and indicated in the contract documents.

Construction Access and Staging

Based on existing site constraints, it appears that site access and construction staging should be on the west side of the river channel. Ground surface to the east of the river channel is considerably higher and is steeply graded immediately adjacent to the river channel wall making site access from the east less feasible compared to the west. Further, the presence of the Balmoral Condominium Building immediately east of the site poses risks to public safety if the area between the building and the river channel were used for construction staging and site access.

It appears that site access from Balmoral Street through the parking lot adjacent to Main Street would have the least impact on local vehicular and pedestrian traffic during construction as compared to directly from Main Street or Haverhill Street. The capacity of the Balmoral Street Bridge will need to be evaluated for construction vehicle loading before determining construction traffic patterns at the site.

Consideration should be given during final design to protecting the historic Bowling Green left of the river channel. However, the current condition of the turf on the Green is not particularly good, which may be an opportunity to allow the use of the area for construction staging then have the area restored as part of the construction project.

A temporary construction access road will need to be constructed to access the river channel. For planning purposes, a 20 ft. wide top width access road is recommended. The road should be graded appropriately for the construction vehicles that will access the site. The actual width of the road corridor will need to consider any filled embankments required for grading.

In addition to the access road, the area within approximately 50 ft. to 80 ft. of the face of the channel wall should be designated as a staging area to allow storage of materials and equipment maneuvering on the site. Construction equipment loading should be avoided within 15 ft. of the stone masonry or concrete channel walls except as necessary to dismantle portions of the walls to be either temporarily or permanently removed. Locations of any utilities in the construction staging area should be identified so that the construction can be planned so as to protect the utilities. The stone masonry building and trees left and

downstream of the dam should be excluded from the construction access area so that they are not impacted by the project.

Construction equipment for dam removal will either need to be lowered into the river channel by a suitable crane positioned in the construction staging area, or a portion of the channel wall downstream of the dam will need to be cut down so a construction access ramp can be built for dam removal equipment to gain access to the river channel. Reinforced concrete box culvert sections could be temporarily placed in the river channel to support construction equipment and allow flow to continue in the river during the dam removal process. The layout and sizes of culvert sections and support requirements will need to be determined during final design. The intent of using culvert sections is to reduce earth material fill placement in the river channel to reduce wetland resource impacts of the project. Sedimentation control measures can be installed downstream of the culvert sections to limit migration of sediment downstream from the work site.

Planning the construction access and staging in accordance with these recommendations should reasonably limit the impacts of the dam removal on adjacent buildings, bridges and site features.

Data Gaps

The following additional issues should be assessed as part of final design to help assure that dam removal does not adversely impact existing features at the site:

1. Explore and document the configuration and condition of the tunnel at the right abutment below the gatehouse as well as the contents of the gatehouse. It is not known whether the tunnel has been permanently plugged and abandoned (i.e. filled with concrete or other material), or if the gate below the gatehouse is the only feature controlling flow through the tunnel and the cast iron pipe. A qualified diving contractor should be retained to conduct this evaluation. The tunnel and lower portion of the gatehouse should be permanently decommissioned by filling with concrete to assure stability of the channel walls and to adequately protect public safety at the gatehouse after dam removal. The diving evaluation will be used to determine the extent of construction required related to the tunnel and gatehouse during dam removal, and whether it might be possible to use the tunnel for water diversion during construction.

2. Available drawings of the Balmoral Street Bridge and anecdotal evidence relating to the foundations of the adjacent Balmoral Building suggest that these structures might be supported on pile foundations. This indicates that subsurface conditions adjacent to the river channel may consist of fill soils over a compressible organic soil layer. Drawings showing the Haverhill Street Bridge foundations were not available. It would be difficult to conduct test pits to observe the either of the bridge foundations. However, test borings conducted in the proposed construction staging area are recommended to better understand potential impacts of construction equipment working near the channel walls. There is a possibility that all or part of the west channel wall will be removed and a bioengineered slope constructed in its place. Test borings will also provide a basis for understanding the composition of the embankment soils for design of the bioengineered slope. At least two borings should be drilled behind the river channel walls; one near Balmoral Street Bridge and one near the dam. The borings should extend down into natural inorganic soils so the impacts of construction equipment loading and dam removal on the channel walls can be evaluated.
3. Bridge inspection reports should be available in the Andover public works or highway department offices for the Haverhill Street Bridge and the Balmoral Street Bridge (as well as the other bridges along the project alignment). We have contacted the Town to get copies of these reports without success. These reports should be reviewed as part of final design to help assure that potential impacts to the bridges and any existing utilities or other appurtenances are limited during the proposed construction.
4. A field evaluation of existing below-grade and overhead utilities should be conducted during final design so dam removal operations can be planned to assure continuity of utility service during construction.

MARLAND PLACE DAM

Existing Conditions

Marland Place Dam is an approximately 90 ft. long run-of-the-river dam with an uncontrolled stone masonry spillway spanning between concrete and stone masonry walls of adjacent structures approximately 120 ft. downstream of Stevens Street in Andover, MA. The height of the spillway is approximately 10 ft. from the weir crest to the downstream toe of the dam. The reported structural height of the dam (top of training walls to toe of dam) is 16 ft. The National ID Number for Marland Place Dam is MA01215 and the name assigned to the dam in the DCR DamViewer database is Shawsheen River Dam. Recent hydraulic modeling by Inter-Fluve indicates that at low flow the dam creates an approximately 2.4 acre impoundment that extends approximately 2,600 feet upstream to the base of the former Red Card Clothing dam site (National ID No. MA01504). The dam is considered a Large Size, Significant Hazard dam.

The downstream face of the spillway is sloped at approximately 1H:1V. There is a sluiceway at the right abutment of the spillway where the dam connects to a brick and stone masonry former mill building. It appears that this sluiceway could be made operational to lower the water level during low flow conditions. The left abutment of the spillway connects to a former waterpower intake race and an adjacent brick and stone masonry former mill building. The race and waterpower facilities are no longer functional. The former mill buildings on both sides of the dam extend downstream for about 120 ft. where the channel narrows to about 50 ft. and is bounded by vertical stone masonry channel walls. The channel extends approximately 200 ft. further downstream to where a bridge (steel beam and concrete/asphalt deck) spans the channel. The channel is approximately 40 ft. wide at the bridge crossing.

We reviewed two 2007 Fay Engineering reports in preparation of this report. The February 9, 2007 report was related to basement flooding in the Atria Senior Living, Marland Place facility. The primary relevant conclusion from this report was that basement flooding was not related to the Shawsheen River impoundment. Rather, it was caused by backwater from an inadequate drainage system in the basement floor. The July 25, 2007 report provided a summary of existing conditions of the Marland Place Dam and a discussion of dam removal versus dam repair or retrofitting for hydroelectric power. The report recommended to Atria Senior Living that dam removal would be in their best interest.

Proposed Construction

Marland Place Dam will be removed as part of the project. The current plan is to use many of the boulders removed from the dam to construct a riffle and pool feature extending upstream and downstream of the dam footprint.

Dam removal will require accessing the downstream side of the dam with an excavator to create the breach and to move excavated materials to designated locations or for disposal off the site. In this case, the breach would likely be formed by excavating the boulders forming the spillway, as well as any earth (and possibly timber) materials behind the stone masonry face of the dam. A temporary access road will need to be constructed along the edge of the river to the downstream side of the dam. The access road should be constructed of large angular rock fill and should be restricted to the edge of the river to the extent practicable, while being located so as not to damage the adjacent buildings. A surficial choking layer of crushed stone could be used on all or part of the access road if considered necessary for foot access to the work site.

River flow will need to be managed during construction and sedimentation control measures will be required to limit downstream migration of demolition debris and sediment. The sluice structure at the right abutment of the dam can likely be used to lower the impoundment water level prior to dam removal. The access road to the dam should include sufficient culvert width to handle flow from the sluice during construction.

Similar to the Balmoral Dam, a temporary working platform may need to be constructed in the river across the downstream face of the spillway. However, it may also be possible to operate equipment directly on what appears to be a boulder or possibly bedrock controlled river bottom. If considered necessary, suitably sized and load designed reinforced concrete box culvert sections could be used to form the working platform. The layout and sizes of culvert sections and support requirements would need to be determined during final design. Sedimentation control measures could be installed downstream of the culvert sections to limit migration of sediment and demolition debris downstream from the work site.

The lateral extent of dam removal should be determined during final design. It is recommended that portions of the dam against the adjacent buildings be allowed to remain to help buttress these structures, and to act as scour protection around the building foundations. In general, the full height of the stone masonry dam should remain against the building for a distance of 5 ft. The top of the structure can slope down and

away from the buildings at a 1.5H:1V slope until full depth removal is achieved. In addition, it is recommended that some of the boulders removed from the dam be placed upstream of the building walls, where exposed to the river at flood stage, to reduce the risk of debris flow impacts against the buildings during storm events. Details of this recommended design feature would be developed during final design.

The permanently lowered impoundment level after dam removal could have an impact on flow velocity and shear stress ranges for storm events upstream of the dam, which will tend to result in sediment scour from around the Stevens Street Bridge foundations. Scour protection requirements as well as storm flow debris impact protection requirements for any utilities hung from the bridge or buried below the bridge should be established during final design. It is anticipated that some riprap scour/debris flow protection will be required around the bridge foundations. Some of the boulders removed from the dam could be used for bridge foundation protection.

Excavated materials not used for riffle and pool construction will require transport from the site for disposal or placement as scour protection. The quantities of rock and earth materials to be used for the riffle and pool feature, for scour/debris flow impact protection, and requiring disposal should be estimated during final design and an appropriate disposal site(s) identified.

The dam removal contractor will need to sequence the work and install, operate, maintain and remove appropriate water control procedures and sedimentation control measures during the work. The construction plans and specifications should communicate the allowable work area, the requirements for protecting and restoring adjacent site features, and the sedimentation control requirements for the project.

Construction Access and Staging

At the Marland Place Dam site it appears that construction access and staging from the left side would likely be quite disruptive and may present public safety hazards to the Atria Marland Place senior living facility adjacent to the dam. There appears to be more room for access from the right side of the dam through the condominium complex at the corner of Stevens Street and North Main Street. There are substantial site improvements on this property including the concrete pavements and landscaping that will have to be protected during construction or restored the conditions existing prior to construction. We do not have access to plans that show how the property was developed that might give an indication of whether the pavement can support construction equipment traffic. This is an issue

that should be explored in detail during final design in coordination with the property owner. The process would likely include identifying preliminary site access road size and alignment, a construction staging area and provisions for site restoration for review and discussion with the property owners. Ultimately, these features and requirements will be included on the contract documents.

For planning purposes, a construction staging area measuring approximately 50 ft. by 100 ft. next to the channel wall should be identified to allow storage of materials and equipment maneuvering on the site. In general, construction equipment loading should be avoided within 15 ft. of the existing buildings near the site as well as the stone masonry channel wall (except as necessary to dismantle a portion of the wall for access to the temporary access road to the dam). Locations of any utilities in the construction staging area should be identified so that the construction can be planned so as to protect the utilities.

Construction equipment for dam removal will need to be driven from the construction staging area to the dam. A portion of the channel wall downstream of the dam will need to be cut down for the construction access road for dam removal equipment to gain access to the river channel. As indicated above, the road leading to the dam will need to be constructed using large rock fill that can later be removed or incorporated into the riffle and pool system to be constructed in the vicinity of the dam. Reinforced concrete box culvert sections could be temporarily placed in the river channel to support construction equipment and allow flow to continue in the river during the dam removal process.

The construction plans and specifications should communicate the allowable construction access road alignments and staging area. Planning the construction access and staging in accordance with these recommendations should reasonably limit the impacts of the dam removal on adjacent buildings, bridges and site features.

Data Gaps

1. As suggested in the Balmoral Dam discussion, above, bridge inspection reports should be available in the Andover public works or highway department offices for the Stevens Street Bridge. We have contacted the Town to get copies of these reports without success. These reports should be reviewed as part of final design to help assure that potential impacts to the bridges and any existing utilities or other appurtenances are limited during the proposed construction.
2. A field evaluation of existing below-grade and overhead utilities should be conducted during final

design so dam removal operations can be planned to assure continuity of utility service during construction.

BALLARDVALE DAM

Existing Conditions

Ballardvale Dam is an approximately 90 ft. long run-of-the-river dam with an uncontrolled concrete and stone masonry spillway spanning between concrete and stone masonry training walls. The vertical height of the spillway is approximately 9.5 ft. The reported structural height of the dam (top of training walls to toe of dam) is 14 ft. There is a 5 ft. wide low-level stone masonry sluiceway at the right abutment of the dam immediately adjacent to an occupied brick and stone masonry building. The National ID Number for Ballardvale Dam is MA00154. The dam is considered a Large Size, Significant Hazard dam.

Recent hydraulic modeling by Inter-Fluve indicates the dam impounds water to approximately 15,000 feet upstream of the dam at low flow. Accordingly, the impoundment extends upstream past Andover Street Bridge and along the railroad embankment along the left side of the river. The river channel downstream of the dam is contained within near vertical stone masonry walls. The floodplain downstream of the dam has been filled, with the left floodplain occupied by a building complex and parking lot and the right occupied by the Shawsheen Coating and Converting Building, which is adjacent to the sluiceway described above.

The downstream face of the spillway is formed by a relatively haphazard placement of stone riprap forming a variable grade downstream of the spillway crest. It appears that the sluiceway at the right abutment of the spillway could be made operational to lower the impoundment water level during low flow conditions.

Proposed Construction

Removal of the Ballardvale Dam is considered the preferred alternative for restoring fish passage, improving stream habitat, and reducing liability for the owners of the dam. However, there may be considerable local opposition to full height dam removal. Installation of a fish ladder may also be considered for this site.

An excavator would need to be positioned below the toe of the dam to remove the concrete, boulders, and stone masonry blocks forming the dam in the case of dam removal. Construction

equipment would also need to access this area for fish ladder construction. There will be considerable sediment and possibly timber remnants buried within the dam that would need to be removed as part of a dam removal project. A temporary access road will need to be constructed along the edge of the river to the downstream side of the dam. The access road should be constructed of large angular rock fill and should be restricted to the edge of the river to the extent practicable, while being located so as not to damage the adjacent buildings. A surficial choking layer of crushed stone could be used along all or part of the access road if considered necessary.

River flow will need to be managed during dam removal or fish ladder construction and sedimentation control measures will be required to limit downstream migration of demolition debris and sediment. The sluice structure at the right abutment of the dam can likely be used to lower the impoundment water level prior to dam removal. The access road to the dam should include sufficient culvert width to handle flow from the sluice during construction.

Similar to Marland Place Dam, it appears that boulders form the river bottom. It may be possible to operate excavators directly on the exposed boulders on river bottom after repositioning some of them to form a stable platform. If a temporary working platform is considered necessary across the downstream side of the dam (to keep the equipment above the river flow level and reduce environmental impacts during construction), suitably sized and load designed reinforced concrete box culvert sections placed in the river channel are recommended. As described above, this will allow relatively unimpeded river flow while the construction equipment operates on top of the culvert sections. Some bottom grading may be necessary to create a stable and level surface for supporting the culvert sections. The layout and sizes of culvert sections and support requirements will need to be determined during final design. Sedimentation control measures can be installed downstream of the culvert sections to limit migration of sediment and demolition debris downstream from the work site.

The lateral extent of dam removal should be determined during final design. It is recommended that portions of the dam against the adjacent Shawsheen Coating and Converting building and the stone masonry training at the left end of the spillway be allowed to remain to help buttress these structures, and help protect public safety at the ends of the dam (the channel is accessible by pedestrians at both ends of the dam). In general, the full height of the stone masonry dam should remain against the building for a distance of 5 ft. The top of the structure can slope down and away from the buildings at a 1.5H:1V slope until full depth removal is achieved. In addition, it is recommended that some of the boulders removed from the dam be

placed upstream of the building walls, where exposed to the river at flood stage, to reduce the risk of debris flow impacts against the Shawsheen Coating and Converting building during storm events. Details of this recommended design feature would be developed during final design.

The permanently lowered impoundment level after dam removal could have an impact on flow velocity and shear stress ranges for storm events upstream of the dam, which will tend to result in sediment scour from around the Andover Street Bridge foundations. Scour protection requirements as well as storm flow debris impact protection requirements should be established during final design. It is anticipated that some riprap scour/debris flow protection will be required around the bridge foundations. Some of the boulders removed from the dam could be used for bridge foundation protection.

Excavated rock materials not used for riffle and pool construction will require transport from the site for disposal or placement as scour protection. The quantities of rock and earth materials to be used for the riffle and pool feature, for scour/debris flow impact protection, and requiring disposal should be estimated during final design and an appropriate disposal site(s) identified.

The dam removal contractor will need to sequence the work and install, operate, maintain and remove appropriate water control procedures and sedimentation control measures during the work. The construction plans and specifications should communicate the allowable work area, the requirements for protecting and restoring adjacent site features, and the sedimentation control requirements for the project.

Construction Access and Staging

As with the Balmoral and Marland Place dams, construction access to the downstream side of the dam will be required for dam removal or for fish ladder construction. Both sides of the river channel appear to be suitable for construction access. There is likely more room for construction staging in the parking area at the left downstream side of the channel. However, potential impacts to public safety would likely be fewer if construction were staged from the Shawsheen Coating and Converting property to the right of the river channel. The access road size and alignment, the construction staging area and site restoration will need to be included on the contract plans and specifications during final design.

A construction staging area measuring approximately 50 ft. by 100 ft. next to the channel wall should be identified to allow storage of materials and equipment maneuvering on the site. In general, construction equipment loading should be avoided within 15 ft. of the existing buildings near the site as well as the stone masonry channel wall (except as necessary to dismantle a portion of the wall for access to the temporary access road to the dam). Locations of any utilities in the construction staging area should be identified so that the construction can be planned so as to protect the utilities.

Construction equipment for dam removal will need to be driven from the construction staging area to the dam. A portion of the channel wall downstream of the dam will need to be cut down for the construction access road for dam removal equipment to gain access to the river channel. As indicated above, the road leading to the dam will need to be constructed using large rock fill that can later be removed or incorporated into the riffle and pool system to be constructed in the vicinity of the dam. Reinforced concrete box culvert sections could be temporarily placed in the river channel to support construction equipment and allow flow to continue in the river during the dam removal process.

The construction plans and specifications should communicate the allowable construction access road alignments and staging area. Planning the construction access and staging in accordance with these recommendations should reasonably limit the impacts of the dam removal on adjacent buildings, bridges and site features.

Data Gaps

1. As suggested in the Balmoral Dam discussion, above, bridge inspection reports should be available in the Andover public works or highway department offices for the Andover Street Bridge. We have contacted the Town to get copies of these reports without success. These reports should be reviewed as part of final design to help assure that potential impacts to the bridges and any existing utilities or other appurtenances are limited during the proposed construction.
2. A field evaluation of existing below-grade and overhead utilities should be conducted during final design so dam removal operations can be planned to assure continuity of utility service during construction.