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Technical Memorandum

Date: June 8, 2007

To: Mick Noland, P.E., Fayetteville Public Works Commission

From: James G. Pimblett, P.E., NEW

Re: U.S. Army Corps of Engineers General Reevaluation Report for the Wilmington Harbor Deepening Project

Review of the Corps' Water Supply Intake Evaluation

Project No.: 3141-001

This Technical Memorandum (TM) provides technical review comments on a portion of the U.S. Army Corps of Engineers (Corps) General Reevaluation Report (GRR) under preparation as part of the Wilmington Harbor Deepening Project. Specifically, this TM provides technical review comments on the contents of the Corps' March 2007 Wilmington Harbor GRR Lock and Dam Study Intake Evaluation. Our focus was on aspects of the Corps' study that are applicable to the Fayetteville Public Works Commission's two Cape Fear River water supply intakes in the event that Lock & Dam No. 3 is either removed or the managed water level is otherwise lowered.

The Public Works Commission operates two separate intake and pump station systems on the Cape Fear River, the Glenville Pump Station and the Hoffer Pump Station. The stations are located next to each other on the west bank of the river near the Hoffer Water Treatment Facility. The pump stations are addressed separately in the Corps' evaluation so we have provided comments separately for each, although many of the comments are similar.

Glenville Pump Station

After reviewing the text and figures applicable to the Glenville Pump Station in the Corps' Wilmington Harbor GRR Lock and Dam Study Intake Evaluation document, we have the following observations, comments and questions:

Design Capacity

- The analysis must consider the station's existing design capacity and/or proposed ultimate capacity. Consideration of only the current average usage rates is not acceptable. Our understanding is that the Glenville Pump Station currently has the capability to pump up to 18 mgd to the Glenville Lake Water Treatment Facility or up 40 mgd to the P.O. Hoffer Water Treatment Facility. Therefore, the analysis should address withdrawals through the pump station up to at least 40 mgd.

Screening

- Based on the Corps description of proposed changes to accommodate alternatives 1 and 3, it appears that the existing traveling water screen would be permanently removed and replaced with new air backwashed intake screens located in the river. However, the proposed screening ability and maximum opening size of the proposed screens compared to the existing traveling water screen has not been addressed.
- Intake screen design criteria are not addressed. Will the existing screen size criteria be acceptable to state permitting authorities having jurisdiction or will more stringent criteria be required by those authorities to protect the eggs, larvae and fry of anadromous fish species which will have access to this portion of the river in the event that Lock & Dam No. 3 is either removed or the managed water level is otherwise lowered?
- Screening requirements for the intake screens proposed for alternatives 1 and 3 must be addressed. At a minimum, the width of slot and maximum through screen velocity assumed for the alternatives should be noted in the report. Has it been assumed that the design criteria (maximum slot/opening size and maximum through screen velocity) of the existing Hoffer traveling water screen will apply to the new screens? Ideally, the assumed screen design criteria for the in-river submerged screens should be confirmed to be in accordance with all applicable State standards or consistent with similar projects within the State that might have created precedents.
- Projected water surface elevations (WSELs) for alternatives 1 and 3 are provided, but corresponding water depths at the intake are not given. What depth of water is expected? This will have a major impact on the design of cylindrical wedge wire screens, which require certain minimum clearances to the water surface and the river bed in order to achieve the intended even distribution of flow around the full circumference screen.
- Assuming the depth of water is 4-feet under low water level conditions (similar to that noted for the Hoffer intake) a cylindrical wedge-wire screen up to 2-feet in diameter could be utilized. Based on best case assumptions of an allowable maximum slot width of 2 mm and a maximum allowable through slot velocity of 0.5 feet per second, twelve standard 2 foot diameter tee screens would be required to provide a total intake capacity of 40 mgd. If more restrictive screening criteria were required, such as a narrower slot or lower velocity, even more screens would be needed.

Sediment

- The Corps sketch of the revised intake shows new screens installed in the river with a centerline Elevation of 20.0. However, the existing bottom of the river is shown at approximately Elevation 19.5. The Corps description of the proposed intake modifications acknowledges that there is a sediment problem at the site that will impact their recommended solution and notes that dredging and/or diversion of flow to the right bank needs to be investigated. However, their description of the recommended solution does not address how the existing bottom, which

consists of some depth of accumulated sediments overlaying original river bottom, will be deepened in the area of the screens to accommodate the proposed centerline elevation and how the bottom will be maintained at this lower level in the future. The cost of initially dredging the intake area to achieve the desired depth, the cost to maintain this depth with future maintenance dredging, and the potential for flood flows to rapidly fill the dredged area and impact withdrawal capabilities are not addressed. Until the impact of the river depth and sediment situation on long term operation and reliability of the intake are thoroughly addressed, the true feasibility of the recommended intake modifications for alternatives 1 and 3 cannot be evaluated

- It appears possible that an intake design could be developed that would accommodate the expected variation over time of the river water surface elevation, sediment depth and bottom elevation, and resulting water depth. One possible approach would be to construct a long intake chamber along the river bank, long enough to accommodate the required number of intake screens placed end to end, and with several screen connections at different depths for each screen. For example, the uppermost screen flange could be set with a centerline elevation of 25.0, a middle flange could be set at elevation 22.5, and a lower flange set at 20.0. As the river bottom elevation and corresponding water surface elevation dropped in the future, the screens would be progressively moved from their initial installation on the uppermost flanges to their long term permanent installation on the lowermost flanges. For twelve 24-inch diameter tee screens, the length of this structure along the river bank would likely need to be approximately 100 feet.
- Another possible intake design would place the screens within a deep intake chamber set into the river shoreline and provide a row of openings along the face of the structure. The structure and these openings would be designed deep enough to accommodate the expected future water levels and bottom elevation of the river, but initially stop planks would be installed in the lower part of the openings to prevent sediment from entering the deeper intake chamber. As the sediment level and river WSEL dropped, the stop planks would be progressively removed to maintain the free flow of water into the screen chamber. This design would be similar to the intake recently constructed by Harnett County on the Cape Fear River upstream of Fayetteville.

Pumping

- The projected WSEL in the pump wetwell is shown as equal to that of the river above the intake, with no allowance for headloss through the proposed intake screens or inlet piping. The headloss under maximum withdrawal conditions must be determined and included in the assessment of available minimum pump submergence and minimum Net Positive Suction Head Available ($NPSH_a$).
- Apparently, no check of the capability of the existing pumps to operate acceptably (e.g., no cavitation) with less submergence has been performed. The available submergence and $NPSH_a$ within the wetwell must be determined for each alternative and compared to the required submergence and Net Positive Suction

Head Required ($NPSH_r$) for each existing vertical turbine pump in the station. Each pump must be checked as there can be significant variations in these parameters between pumps, even for pumps with identical design points and pumps from the same manufacturer.

- The impact of a lower WSEL in the pump wetwell on pump output has not been considered. Assuming that the required submergence and $NPSH_r$ are satisfied and with all else being equal, a drop in the water level in the pump wetwell will lead to some amount of reduction in pump output (either head or flow).

Constructability

- The time required to complete the modifications as described has not been defined. Based on the limited description of work and sequence of construction provided, it appears possible that from 6 to 12 months would be required to complete the work as described.
- The feasibility of taking the station completely out of service for an extended time period has not been addressed.
- An alternative that allows for construction of a new intake while the existing intake and pump station remain in service should be considered. A short shutdown to allow the new intake pipe to be connected to the existing pump station would still be required.
- Sequencing of work activities at this station and the adjacent Hoffer Pump Station has not been considered. The limits of excavation required to construct the lower intake lines as described may overlap or interfere with the Hoffer Pump Station.

Cost

- The cost estimate presented by the Corps does not appear to be realistic for the recommended project. Several of the individual unit prices do not appear to be adequate for the line items as described, for example, the dewatering cost is clearly too low.
- As noted in previous comments, the recommended project is not a feasible solution when the actual pump station capacity and sediment issues are considered. A more realistic total project cost for a 40 mgd intake with an allowance for limited sediment dredging is likely to be in the $4,000,000 range.
- For comparison, a new intake was recently constructed on the Cape Fear River by the Public Utilities Department of Harnett County, North Carolina. The intake is located upstream of the Route 401 bridge over the Cape Fear River. This intake's bid price was approximately $795,000 in June 2004. The final completed cost is expected to be slightly higher due to pending change orders. The construction market has changed considerably in the last three years so it would be reasonable to expect 2007 bid prices for this type of work to be appreciably higher. In comparing this actual project construction cost to the Corps' estimate, it should be noted that this cost represents only the construction cost and that the three tee screen assemblies installed in the Harnett County intake structure have 5/32-inch (4 mm) wide slot openings and were designed for a maximum through slot velocity of approximately 0.28 feet per second. There is a potential for more

restrictive screen design criteria to be applied to the Glenville intake if the dams are removed or fish passages installed, which would open up the river to anadromous fish.

Hoffer Pump Station

After reviewing the text and figures applicable to the Hoffer Pump Station in the Corps Wilmington Harbor GRR Lock and Dam Study Intake Evaluation document, we have the following observations, comments and questions:

Design Capacity

- The analysis must consider the station's existing design capacity and/or proposed ultimate capacity. Consideration of only the current average usage rates is not acceptable. Our understanding is that the Hoffer Pump Station currently has a firm capacity of 44 mgd and is capable of pumping only to the P.O.Hoffer Water Treatment Facility. Pumping modifications are currently being considered that would increase the firm capacity of the station to 52 mgd. Therefore, the analysis should address flows through the pump station up to at least 52 mgd.

Screening

- Based on the description of changes provided, for alternatives 1 and 3 the existing 3-foot diameter cylindrical water screens would be permanently removed and replaced with new, smaller diameter air backwashed intake screens set at a lower elevation to accommodate the lower water surface elevation and shallower water depth. However, the proposed screening ability and maximum opening size of the proposed screens compared to the existing screens has not been addressed.
- Intake screen design requirements are not addressed. Will the existing screen size criteria be acceptable to state permitting authorities having jurisdiction or will more stringent criteria be required by those authorities to protect the eggs, larvae and fry of anadromous fish species which will have access to this portion of the river in the event that Lock & Dam No. 3 is either removed or the managed water level is otherwise lowered?
- Screening requirements for the intake screens proposed for alternatives 1 and 3 must be addressed. At a minimum, the width of slot and maximum through screen velocity assumed for the alternatives should be noted in the report. Has it been assumed that the design criteria (maximum slot/opening size and maximum through screen velocity) of the existing Hoffer traveling water screen will apply to the new screens? Ideally, the assumed screen design criteria for the in-river submerged screens should be confirmed to be in accordance with all applicable State standards or consistent with similar projects within the State that might have created precedents.

- Based on the 3 to 4-foot depth of water expected at the intake in the future as noted in the Corps description, a cylindrical wedge-wire screen up to 2-feet in diameter could be utilized. Based on best case assumptions of an allowable maximum slot width of 2 mm and a maximum allowable through slot velocity of 0.5 feet per second, fifteen standard 2 foot diameter tee screens would be required to provide a total intake capacity of 52 mgd. If more restrictive screening criteria were required, such as a narrower slot or lower velocity, even more screens would be needed.

Sediment

- The Corps sketch of the revised intake shows new screens installed in the river with a centerline Elevation of 21.0 while the text notes that a centerline elevation of 20.0 would be preferred. However, the existing bottom of the river is shown at approximately Elevation 19.5 in the Corps sketch. Also, the most recent inspection of the screens by Intercoastal Diving, Inc. revealed that the river bottom was only inches below the existing screens, which would suggest that the bottom is actually at approximately Elevation 23.0. The Corps description of the proposed intake modifications acknowledges that there is a sediment problem at the site that will impact their recommended solution and notes that dredging and/or diversion of flow to the right bank needs to be investigated. However, their description of the recommended solution does not address how the existing bottom, which consists of some depth of accumulated sediments overlaying original river bottom, will be deepened in the area of the screens to accommodate the proposed centerline elevation and how the bottom will be maintained at this lower level in the future. The cost of initially dredging the intake area to achieve the desired depth, the cost to maintain this depth with future maintenance dredging, and the potential for flood flows to rapidly fill the dredged area and impact withdrawal capabilities are not addressed. Until the impact of the river depth and sediment situation on long term operation and reliability of the intake are thoroughly addressed, the true feasibility of the recommended intake modifications for alternatives 1 and 3 cannot be evaluated
- As noted in the comments for the Glenville Pump Station, it appears possible that an intake design could be developed that would accommodate the expected variation over time of the river water surface elevation, sediment depth and bottom elevation, and resulting water depth. For fifteen 24-inch diameter tee screens, the length of this structure along the river bank would likely need to be approximately 120 feet.

Pumping

- The projected WSEL in the pump wetwell is shown as equal to that of the river above the intake, with no allowance for headloss through the proposed intake screens or inlet piping. The headloss under maximum withdrawal conditions must be determined and included in the assessment of available minimum pump submergence and minimum Net Positive Suction Head Available ($NPSH_a$).

- Apparently, no check of the capability of the existing pumps to operate acceptably (e.g., no cavitation) with less submergence has been performed. The available submergence and $NPSH_a$ within the wetwell must be determined for each alternative and compared to the required submergence and Net Positive Suction Head Required ($NPSH_r$) for each existing vertical turbine pump in the station. Each pump must be checked as there can be significant variations in these parameters between pumps, even for pumps with identical design points and pumps from the same manufacturer.
- The impact of a lower WSEL in the pump wetwell on pump output has not been considered. Assuming that the required submergence and $NPSH_r$ are satisfied and with all else being equal, a drop in the water level in the pump wetwell will lead to some amount of reduction in pump output (either head or flow).

Constructability

- The time required to complete the modifications as described has not been defined. Based on the limited description of work and sequence of construction provided, it appears possible that from 6 to 12 months would be required to complete the work.
- The feasibility of taking the station completely out of service for an extended time period has not been addressed.
- An alternative that allows for construction of a new intake while the existing intake and pump station remain in service should be considered. A short shutdown to allow the new intake pipe to be connected to the existing pump station would still be required.
- Sequencing of work activities at this station and the adjacent Glenville Pump Station has not been considered. Limits of excavation to construct the lower intake lines as described may overlap.

Cost

- The cost estimate presented by the Corps does not appear to be realistic for the recommended project. Several of the individual unit prices do not appear to be adequate for the line items as described, for example, the dewatering cost is clearly too low for an excavation at the edge of a river.
- As noted in previous comments, the recommended project is not a feasible solution when the actual pump station capacity and sediment issues are considered. A more realistic total project cost for a 52 mgd intake with an allowance for limited sediment dredging is likely to be in the $5,000,000 range.
- For comparison, a new intake was recently constructed on the Cape Fear River by the Public Utilities Department of Harnett County North Carolina. The intake is located upstream of the Route 401 bridge over the Cape Fear River. This intake's bid price was approximately $795,000 in June 2004. The final completed cost is expected to be slightly higher due to pending change orders. The construction market has changed considerably in the last three years so it would be reasonable to expect 2007 bid prices for this type of work to be appreciably higher. In comparing this actual project cost to the Corps' estimate, it should be noted that

the three tee screen assemblies installed in the Harnett County intake structure have 5/32-inch (4 mm) wide slot openings and were designed for a maximum through slot velocity of approximately 0.28 feet per second. There is a potential for more restrictive screen design criteria to be applied to the Hoffer intake if the dams are removed or fish passages installed, which would open up the river to anadromous fish.

Conclusion

As noted in the preceding comments, the Corps' recommended projects for modification of the Glenville and Hoffer intakes, as described in the Corps' March 2007 Wilmington Harbor GRR Lock and Dam Study Intake Evaluation, do not adequately address a number of issues which have the potential to significantly increase the complexity and cost of a modification project. The capacity of the replacement intakes must be properly coordinated so that the capacity of the pump stations is not decreased and the potential for a reduction of capacity from the existing pumps must be addressed.

The issue of sediment levels in the river at the intakes is noted in the Corps' report, but not addressed. This is a significant issue that must be addressed as part of the evaluation of modifications needed at these intakes.

The recently constructed intake project in Harnett County, which has a capacity of 36 mgd, can be used as a starting point for assessing the possible cost of new intakes for the Glenville and Hoffer Pump Stations. Accounting only for the difference in total required capacity and allowing for 3 years of inflation at 4 percent per year, the corresponding cost only for construction of a single 92 mgd intake would be approximately $2,250,000.

Accounting for the possibility that the screening criteria for new intakes at Fayetteville would be more restrictive (due to the river being open to migratory anadromous fish) would further increase the cost. For example, changing the screen design criteria from 4 mm slots at 0.28 feet per second maximum through screen velocity to 2 mm slots at 0.25 feet per second maximum through screen velocity would increase the required screen area by approximately 50 percent. Assuming this increased screen area results in a proportional increase in the overall construction cost, the construction cost estimate for a 92 mgd intake would be $3,400,000.

In order to construct a new Fayetteville intake while the existing intakes remain in service, the new intake would have to be located either upstream or downstream of the existing intakes. This would require that multiple new intake pipes be installed to connect the new intake to the existing pump stations. These pipes would have to be installed along the sloping river bank and would have to be placed at an elevation below the river's minimum water surface, resulting in a deep excavation. Construction of these pipes could cost on the order of $1,000,000, depending on the required distance between the new intake and the existing pump stations.

It should be recognized that the sediment issues that have been noted to exist at the Fayetteville intakes must be addressed if a new intake is to function reliably. If dredging of sediment is determined to be necessary, the cost is likely to be significant. For example, if it were determined that three feet of sediment should be dredged from the river over a distance of 3,000 feet, then a total of approximately 75,000 cubic yards of material would need to be dredged. The cost for this work would likely be in the range of $3,750,000. However, the cost for this type of dredging would be very dependent on how and where the dredge spoils could be dewatered and disposed.

While these cost estimates are conceptual, they clearly illustrate that the cost to replace the Fayetteville intakes would be greater than the costs estimated by the Corps and could be significantly greater. Taking into account the need to maintain the actual intake capacities, the need to maintain operation of the existing intakes during construction, the potential for more restrictive screening requirements, and the potential that dredging would be required to address the sediment issue, a conceptual estimate for possible total construction costs associated with a new intake is on the order of $8,000,000 to $9,000,000 dollars. This value is substantially higher than the combined $1,380,000 predicted by the Corps for construction cost of both projects.

jgp