Summary of the Biological Review Team's comments on Lower Yellowstone River Intake Dam Fish Passage and Screening Preliminary Design Report.

5 September 2006

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Approved for release by: Biological Review Team 01 September 2006

Executive Summary

The US Fish and Wildlife Service (Service) developed a team (Team) of pallid sturgeon experts (Appendix A) to review preliminary fish protection design options for the Lower Yellowstone River Irrigation Project. The Team met 17 and 18 August 2006 in Billings, Montana to review the Lower Yellowstone River Intake Dam Fish Passage and Screening Preliminary (10%) Design Final Report (US Army Corps of Engineers 2006). This report details design descriptions and cost estimates for an in-canal fish screen, and two fish passage options (rock ramp and dam removal). During the first day of the two day meeting, background data and an historical overview were provided by US Bureau of Reclamation (Bureau) employees, and passage and screening design and data were presented by staff from the US Army Corps of Engineers (USACE). The Team was provided an overview of the design options. Ample opportunity was provided to openly discuss all aspects of the designs and to ask questions to clarify areas of potential confusion. During the second day, the Team met by itself for several hours in the morning to record possible areas of concern and to identified methods to address design concerns that could limit pallid sturgeon passage. Subsequently, the Team, USACE, and Bureau staff convened and the Team's observations and recommendations were presented. The Team felt that the alternatives, as presented in the preliminary design report, were inadequate to prevent pallid sturgeon entrainment or provide pallid sturgeon passage, and as such are not likely to be successful if implemented according to current specifications. However, the team developed additional design considerations that, if implemented, would make both the upstream passage and screen facility viable options with a very high likelihood of success. The Team felt that the rock ramp and in-canal screening facility had the best potential for both upstream passage and entrainment prevention; however, several design modifications were necessary. The Team was not comfortable with the dam removal alternative as there was considerable uncertainty surrounding several design parameters and potential for failure to pass pallid sturgeon. The following report outlines the Team's suggested design changes and recommendations that, if implemented, will greatly improve the probability of successful pallid sturgeon passage at the lower Yellowstone River Intake Dam.

Background

Beginning in the late 1990's, the US Bureau of Reclamation (Bureau) entered into informal consultation with the US Fish and Wildlife Service (Service) concerning the potential effects of the Bureau's Lower Yellowstone Project (Project) on the federally-endangered pallid sturgeon *Scaphirhynchus albus* and designated critical habitat (US Bureau of Reclamation 2005a). In 2000, the Bureau proposed conservation measures included an in-canal fish screen in the main irrigation diversion canal (Main Canal) and a constructed bypass channel at the site of the irrigation diversion dam (Intake Dam) as protection measures to mitigate Project operation effects on pallid sturgeon (US Bureau of Reclamation 2000). During subsequent evaluation of these measures concerns were raised regarding the adequacy and efficiency of the proposed bypass channel. The development of additional alternatives was requested. Options presented by the USACE included nature-like fishways, baffled fishways, elevator fishways, dam removal and replacement with an infiltration gallery, and dam removal and replacement with a collapsible gate system (US Army Corps of Engineers 2002). In 2002, the Bureau conducted a value engineering study that implemented the Value Method decision making process to insure that all feasible passage alternatives were considered. This process included representatives from the USACE, Bureau, Lower Yellowstone Irrigation Project Board of Control, University of Idaho, and the Service. The study generated ten proposals/recommendations for consideration to improve fish passage (US Bureau of Reclamation 2002). On 8 July 2005, a Memorandum of Understanding (MOU) was developed to formalize the commitment among signatory partners on development of adequate fish passage alternatives for the Project. Signatory parties include: USACE, Bureau, Service, Montana Fish Wildlife and Parks (MFWP), and The Nature Conservancy (TNC). Following the signing of the MOU, a value study team (MOU Team) was developed with members representing the Bureau, USACE, TNC, and MFWP. This MOU Team implemented the Value Method decision making process to identify all possible fish passage options. This generated approximately 110 possible passage alternatives that were ultimately narrowed down to nine (US Bureau of Reclamation 2005b). During subsequent meetings of the MOU Team, the list of nine possible alternatives was narrowed down to three. The three options for passage included: (1) removing the dam and moving the canal intake upstream, (2) removing the dam and installing a large pump facility, and (3) developing a full channel width rock ramp. Later meetings of the MOU Team determined that option (2) was not a viable alternative since anticipated operation and maintenance of a pumping facility were considered too burdensome for irrigators. The MOU Team requested that the two remaining upstream passage alternatives, as well as the in-canal fish screen be developed to a ten percent design level so that they could be evaluated in greater detail. The USACE completed the ten percent design in July 2006 and produced the Lower Yellowstone River Intake Dam Fish Passage and Screening Preliminary Design Report-Final Report (US Army Corps of Engineers 2006).

Upon receipt of this report, the Service commissioned a group of pallid sturgeon experts (Appendix A) to review the fish passage and screening alternatives developed therein, and to evaluate the likelihood that these fish passage options would adequately pass and protect pallid sturgeon. The Biological Review Team (Team) was asked to provide suggestions or modifications, where appropriate, to improve the designs under consideration.

On 17 and 18 August 2006, the Biological Review Team (Team) (Appendix A) met with BOR and USACE representatives in Billings, Montana to review the design options presented. After review of the designs as presented, the Team expressed serious concerns with the current screen design and both of the proposed upstream passage alternatives. In response, the Team outlined a series of design considerations for incorporation into subsequent and final fish passage and screen designs. The Team believes that implementation of these modifications will result in passage solutions that are both protective and effective for sturgeon. Suggested modifications were made based upon our current understanding of sturgeon biology and behavior. When implemented these modifications are likely to result in significantly improved passage, decreased entrainment, and reduced probability of injury to sturgeon and other native fishes as compared to proposed designs as detailed in the Lower Yellowstone River Intake Dam Fish Passage and Screening Preliminary (10%) Design Final Report (US Army Corps of Engineers 2006).

Fish Screen

As presented, the fish screen consists of a "v-shape" screen located in the Main Canal approximately 500 feet from the diversion control structure. The screen material, as specified, is 0.069 inch (1.75 mm) stainless steel wedge-wire with screen panels resting on 12 inch concrete sills. The screen facility incorporates a trash barrier device at the screen entrance consisting of 8 inch bar spacing. This structure is planned to terminate two feet above the structure invert. To assist with cleaning the flat screen plates, a screen cleaning mechanism has also been incorporated. A more detailed description of the screen facility can be found in the Lower Yellowstone River Intake Dam Fish Passage and Screening Preliminary (10%) Design Final Report (US Army Corps of Engineers 2006).

The Team evaluated the screen facility for its ability to adequately prevent entrainment of pallid sturgeon. The Team recognized that the current standard of screen technology will not insure 100% survival of the earliest life stages, but felt that implementing multiple strategies that rely on behavior of pallid sturgeon could greatly improve the ability to protect all life stages. Given the paucity of data regarding pallid sturgeon and fish screen criteria, the Team felt that designing the fish screen facility to current National Marine Fisheries Service standards likely would afford adequate protection for all but the smallest life stages of pallid sturgeon. To improve design standards, the Team is recommending that project partners fund a study that would utilize larval and juvenile shovelnose sturgeon *Scaphirhynchus platorynchus* to compare impingement survival

differences on wedge wire screen at approach velocities of 0.3 and 0.4 fps. The Team is willing to develop a study design or proposal to evaluate screen approach velocities.

As designed, there is not an adequate mechanism to prevent initial entrainment of subadult and adult pallid sturgeon, i.e. fish entering the canal. This issue was one that the Team felt must be addressed. More emphasis should be placed on preventing pallid sturgeon from entering the ditch. Currently there is a grid system of large timbers on the riverward side of the canal inlet that serves as a trash screen. MFWP and Bureau data indicate that large bodied fishes can pass through this trash screen and thus become entrained (Heibert et al. 2000, M. Jaeger, MFWP, personal communication).

Team Recommendations:

- Install a removable 2 inch bar mesh "trash rack" and self cleaning mechanism on the riverward side of the canal intake to prevent initial entrainment. Design this trash rack system with water velocities below 4.0 fps to allow pallid sturgeon to escape the canal headworks.
- Install high flow water intakes at least 4 feet above the existing intakes. These would serve water delivery during periods of high flow (May-June). These high elevation intakes would reduce the likely hood of initial entrainment given the benthic nature of pallid sturgeon at all life stages greater than 14 days old.

The Team believes that implementation of an improved trash rack and high elevation water intakes will maximize the likelihood that the majority of pallid sturgeon life stages will not enter the ditch and the ones that do will likely be protected by the screen facility.

Rock Ramp

The rock ramp fish passage alternative generally consists of retrofitting an engineered structure to the existing dam structure that would afford geomorphic and hydraulic characteristics suitable for upstream migrating pallid sturgeon. The conceptual designs detailed in the Lower Yellowstone River Intake Dam Fish Passage and Screening Preliminary (10%) Design Final Report (US Army Corps of Engineers 2006) are based on an engineered "stair-step" design. Evaluated slopes were 5%, 3.33%, and 2% with drop heights of 0.5 ft and 1 ft. Detailed descriptions can be found in the report.

While these types of engineered steps have demonstrated some level of success for passage, there are no data indicating they will work for pallid sturgeon. As presented in the Lower Yellowstone River Intake Dam Fish Passage and Screening Preliminary (10%) Design Final Report (US Army Corps of Engineers 2006), the Team believes that these designs are unacceptable citing crest velocities that exceed 3-4 ft/s as recommended in White and Mefford (2002). The Team recommends a non-step design rock ramp with velocities in the 3-4 ft/s range (White and Mefford 2002). This style of ramp lacks engineered steps and excessively large boulder materials, but rather relies on mimicking natural geomorphic channel features to maintain stability.

Concerns about the step ramp were excessive turbulence documented to negatively affect upstream sturgeon movement White and Mefford (2002). Examples that should be considered are the Glenn-Colusa Irrigation District rock ramp on the Sacramento River and the Marble Bluff Dam gradient restoration facility on the Truckee River. Preliminary data indicate that the non-step gradient facility constructed at the Glenn-Colusa rock ramp was able to pass green sturgeon, *Acipenser medirostris*, (Vogel 2003) and the Team strongly believes that a suitably designed non-step ramp will work for pallid sturgeon and recommends the smooth ramp alternative be identified as the preferred alternative included in the NEPA process. The Team is willing to work with technical design specialists on the final design of the non-step ramp to incorporate features that provide a wide-range of flow conditions likely to be conducive to the passage of sturgeon and other native species.

If a non-step rock ramp is absolutely not feasible from an engineering or implementation standpoint, re-evaluating the step ramp with a maximum of 1% slope and step heights not to exceed 0.5 ft. may provide adequate velocities for passage. Concerns were also raised about the stability of a stair-step designed ramp. The stability and passability of a stair step ramp relies on the integrity of the steps. Should a step fail, the ramp could become unusable by pallid sturgeon and maintenance issues were also identified as a concern.

Team Recommendations:

- Model a non-step rock ramp with slopes of 0.5%, 0.75%, and 1.0% to evaluate feasibility of this type of structure.
- Crest velocities should not exceed 3-4 ft/s at flows of 77000 cfs (20% exceedance of June flows).
- Develop a physical model of a non-step ramp, and provide hydraulic models showing depths and velocities at various discharges for the 0.5%, 0.75%, and 1.0% slopes.
- A non-step ramp design should mimic natural channel morphology and incorporate a range of flow velocities throughout the entire structure averaging 3-4 ft/s. Suitable structures should be modeled after existing Yellowstone River riffles, known to pass pallid sturgeon, between Sidney, Mt and Intake dam. The non-step ramp should not be modeled after “slab” type riffles like the Buffalo Rapids area of the Yellowstone River.
- The smooth ramp should be designed in a fashion that would direct upstream migrating pallid sturgeon away from the canal headworks to reduce entrainment potential.

Relocate Diversion Upstream

This fish passage option consists of relocating the diversion point further upstream to a location that water could be diverted with out an accompanying dam. This option would require installing two miles of irrigation canal as well as in channel structures to insure water delivery. A more detailed description of the relocate diversion upstream option can be found the Lower Yellowstone River Intake Dam Fish Passage and Screening Preliminary (10%) Design Final Report (US Army Corps of Engineers 2006).

The Team agreed that the conceptual idea of removing Intake Dam and replacing it with a dam-less canal water intake point further upstream, effectively returning the river to a near natural condition, likely would have the greatest probability of allowing successful pallid sturgeon passage. However, after closer examination of the 10% design provided to the Team, it is clear that natural conditions would not be restored.

The design necessarily would be required to incorporate a series of floodplain protection berms, dike fields, and full channel grade control sills. These engineered features would not restore the river to near natural conditions. Instead, they would have a counter effect that is inconsistent with the desired condition of a naturally dynamic river corridor.

The proposed location of the new intake structure is in a river reach that is geomorphically prone to channel braiding and meandering (Boyd 2004). This raises concerns about long term successful water delivery with out additional construction of river channel training features. Also, the 10% design suggests the dam-less diversion should work at a minimum flow of 5,000 cfs. Flows in this area can drop below 5000 cfs and would limit the ability to deliver the required 1400 cfs to the irrigation district with out additional anthropogenic modification or in-channel disturbance. This could require temporary “push up” type weirs to divert water during low flow periods or more permanent diversion structures in the future if the river begins to meander.

Discussions among the Team and engineers suggested that portions of the dam may need to be left in place to maintain stability.

Team Recommendations:

- The Team recommends removing this option from the list of possible options for upstream fish passage as it does not meet earlier criteria of insuring adequate water delivery and adequate levels of fish passage.

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