BONNEVILLE POWER ADMINISTRATION

# Walla Walla River Basin Fish Screen Evaluations

## Nursery Bridge Fishway and Garden City/Lowden II Sites

Progress Report 2005 - 2006 June 2006 DOE/BP-00000652-34

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# Walla Walla River Basin Fish Screens Evaluations:

# Nursery Bridge Fishway and Garden City/Lowden II Sites

**Annual Report**

**January 2005 - May 2006**


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# Summary

Pacific Northwest National Laboratory (PNNL) evaluated two fish screen facilities in the Walla Walla River basin in 2005 and early 2006. The Garden City/Lowden screen site was evaluated in April and June 2005 to determine whether the fish screens met National Marine Fisheries Service criteria to provide safe passage for juvenile salmonids. Louvers behind the screens at the Nursery Bridge Fishway were modified in fall 2005 in an attempt to minimize high approach velocities. PNNL evaluated the effects of those modifications in March 2006.

Results of the Garden City/Lowden evaluations indicate the site performs well at varying river levels and canal flows. Approach velocities did not exceed 0.4 feet per second (fps) at any time. Sweep velocities increased toward the fish ladder in March but not in June. The air-burst mechanism appears to keep large debris off the screens, although it does not prevent algae and periphyton from growing on the screen face, especially near the bottom of the screens.

At Nursery Bridge, results indicate all the approach velocities were below 0.4 fps under the moderate river levels and operational conditions encountered on March 7, 2006. Sweep did not consistently increase toward the fish ladder, but the site generally met the criteria for safe passage of juvenile salmonids. Modifications to the louvers seem to allow more control over the amount of water moving through the screens. We will measure approach velocities when river levels are higher to determine whether the louver modifications can help correct excessive approach velocities under a range of river levels and auxiliary water supply flows.

# Acknowledgments

I am thankful for the support of Gary James and Preston Bronson, Confederated Tribes of the Umatilla Indian Reservation, and Sarah Branum, Bonneville Power Administration, in securing funding for this work. We also appreciate the assistance received from Stuart Durfee, Gardena Farms Irrigation District, and Jon Brough, Hudson Bay District Improvement Co., while conducting the field assessments. Abigail Capetillo, Brad Barfuss, and Scott Abernethy of Pacific Northwest National Laboratory assisted in the field work.

# Contents



# Figures

# 1.0 Introduction

Over the past 20 years, the Bonneville Power Administration (BPA) and the Northwest Power and Conservation Council (NPCC) have expanded screening efforts to protect and enhance fish populations. The evaluation of existing screen sites is important to ensure that the sites achieve the goals of protecting fish from entrainment and from harm within the screen facility itself (McMichael et al. 2004). The study reported here is focused on fish screen facilities at two sites in the Walla Walla River basin, one in southeastern Washington and the other in northeastern Oregon.

The Garden City/Lowden II site is located about 2 miles east of the town of Lowden off Highway 12 in Washington (Figure 1). The facility is an inclined plate screen with eight 6-ft-high × 4-ft-wide screen panels. The site was evaluated in April and again in June 2005 to look at effects of different river and irrigation flows on approach velocities, and whether those velocities were within criteria developed by the National Marine Fisheries Service (NMFS 1995).

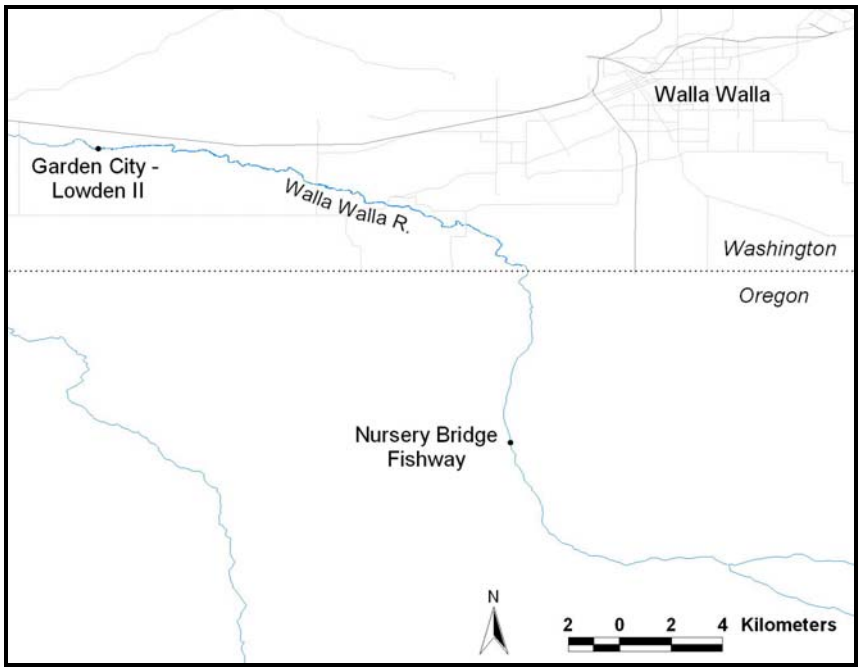


**Figure 1**. Locations of Fish Screen Sites in the Walla Walla Basin

The Nursery Bridge Fishway is located on the east bank (river right) of the Walla Walla River near the town of Milton-Freewater, Oregon (Figure 1). The fish screen is at the upstream end of the fish ladder and is used to draw water through the auxiliary water supply (AWS) to increase attraction flow at the fish ladder entrances. This facility consists of two horizontal-bar screens facing each other with a channel between. The screens at the Nursery Bridge Fishway were evaluated during spring 2004, and approach velocities were found to exceed NMFS criteria of 0.4 fps. Vucelick and McMichael (2003) recommended changes to the louvers (or tuning baffles) behind the screens. Those changes were made in September 2005, and the site was revisited on March 7, 2006, to measure approach velocities and set the modified louvers to minimize excessive approach values if necessary.

The methods currently used for evaluating screening facilities were developed while conducting similar studies at fish-screen facilities in the Yakima River Basin (Blanton et al. 1998, 1999, 2000; Chamness et al. 2001; Carter et al. 2002; McMichael et al. 2004). These evaluations addressed three main questions:

- Are screens designed, operated, and maintained to meet NMFS criteria standards over a wide range of conditions?
- Do velocities and flows meet NMFS criteria?
- Are screens effective at protecting fish from injury and from unnecessary migration delay?

# 2.0 Methods

We collected water-velocity measurements, underwater video recordings, and general operational data (e.g., screen submergence and fish presence) in 2005 at Garden City/Lowden and Nursery Bridge using equipment and techniques described in the following sections.

## 2.1 Water-Velocity Measurements

Water velocities were measured using a SonTek ADV[(a)] (acoustic Doppler velocimeter). The ADV emits sound at 10 kHz. The frequency of the returning sound waves increases or decreases depending on whether the water is flowing toward or away from the ADV receiver. The difference between the emitted frequency and the received frequency is used to calculate the velocity of the water. Return times to each of three receivers extending out at an angle from the transmitter are used calculate the three-dimensional water velocity at a point 3.9 in. below the probe. Velocities were typically recorded at each sampling point along the screen for 30 seconds at a rate of 2 Hz (two data points per second) and stored in a computer file.

Measurements of water velocity were taken at two to three evenly spaced points along the front of each screen panel. The probe was mounted on a cross arm attached to a vertical pole so that the probe sat about 3 in. from the screen face. At both sites, measurements were taken at 0.2% and 0.8% of the depth as measured from the surface. All measurements were taken with the axes of the probe oriented to measure water flowing parallel (sweep) and perpendicular (approach) to the screen face, regardless of the orientation of the screen.

Many flat plate screens are oriented vertically, with the screen face perpendicular to the forebay floor. At the Garden City/Lowden II site, however, the flat plate screen is oriented 45 degrees from vertical. At this site, the pole on which the probe was mounted was held parallel to the screen face (i.e., at a 45-degree angle) and measurements were taken parallel and perpendicular to the slanted screen face. A small brace was used to keep the probe approximately 2-3 in. from the screen.

(a) The SonTek ADV acoustic Doppler velocimeter is a trademark of SonTek/YSI, Inc., San Diego, California.

Multiple velocity measurements were taken in front of every screen or panel. Cleaning systems (brushes and air bursts) were turned off during velocity measurements. Average sweep and approach velocities and standard deviations were calculated for each position at each site.

## 2.2 Underwater Video

An underwater video system was used to investigate screen seal condition and to monitor debris buildup and fish presence. The video system consisted of a digital deep-sea camera (DeepSea Power and Light, Inc., Multi SeaCam 1050) connected to a digital video recorder (Sony Video Walkman Model GV-D800), which in turn was connected to a pair of video glasses (Olympus Eye-Trek Model FMD-200). The advantage of this system was that it allowed the person operating the camera to see what was being recorded while in the field, thus providing better video quality and a greater potential for problem identification. In addition, the end product of this system was digital video, which greatly improved the quality of still pictures captured from the video.

The camera was securely mounted on a vertical pole and adjusted as needed at each site. The camera was usually angled slightly downward to look for potential gaps between the screen and the bottom seal. The camera was usually moved from upstream to downstream, following the side and bottom seal/screen interfaces. The bypass also was inspected, looking both upstream and downstream for signs of excessive debris or fish presence.

Written observations were made in the field when something of interest was seen with the camera (i.e., debris, gaps, and fish). All videos were later reviewed in detail, and images of interest were digitally captured using Optimas image-enhancing software.

## 2.3 General Operational Data

Additional data collected during each evaluation included

- general site descriptions and photographs
- screen conditions
- screen submergence levels
- cleaning-system operation
- fish presence
- debris observed in the forebay.

Presence or absence of operator control aids, such as water gauges and drum submergence marks on screen frames, also were noted.

## 2.4 Data Analyses

National Marine Fisheries Service (NMFS) criteria for fish screens describe velocity and general operational conditions that would be expected to provide safe passage for juvenile salmonids (NMFS 1995). The criteria include

- maintaining a uniform flow distribution over the screen surface to minimize approach velocities
- keeping approach velocities at less than 0.4 fps
- achieving sweep velocities greater than approach velocities.

Normally, bypass flows would be evaluated, but neither site has a true bypass—water flows past the screens and into fish ladders at both sites. However, a gradual and efficient acceleration of flow across the screens will minimize delay by out-migrating salmonids. We compared our field measurements of water velocity and general data-collection results for each screen site to the NMFS criteria. The results of these comparisons for each site are discussed in Section 3.

# 3.0 Results and Discussion

## 3.1 Garden City/Lowden II Screens

The Garden City/Lowden II site was visited three times in 2005 to evaluate velocities during different river and irrigation canal flow conditions. There is no bypass structure at this site; water flows past the inclined flat plate screens into the fish ladder. Air bursts from behind the screens are used to prevent debris buildup by moving loose debris away from the screen face. Flow through the screens is controlled by baffles behind the screens. These are made of two overlapping metal sheets containing a series of 2-in.-diameter holes. Normally the holes in the metal sheets are aligned to allow maximum flow through the screens.

Velocity data and underwater video were collected on April 13, 2005, when river flow in the Walla Walla was about 170 cubic feet per second (cfs) and 14.5 cfs was flowing into the canal. We had hoped to evaluate the site when flow was even higher, but the dry winter and spring resulted in very small and brief spring runoff events. Two sets of measurements were collected at 0.2% and 0.8% of the water depth. The probe was positioned parallel to and approximately 2 to 3 in. above the screen face. Figure 2 shows sweep velocities in April increasing downstream, and approach velocities all below 0.4 fps.

Garden City/Lowden was visited again on June 2, 2005, at a time when river flow was lower (about 80 cfs) but canal flow was approximately the same as in April (approximately 15 cfs). Approach velocities were somewhat lower than in April, while sweep velocities were markedly lower than in April but still greater than the approach values. Sweep velocities did not increase downstream toward the fish ladder in June.

Video surveys indicated the screen and seals were in good condition, with some periphyton buildup increasing with depth visible in both evaluations. The air bursts do not remove this from the lowest 1 ft of screen material. Some sediment also builds up behind the screens and in the aftbay.

This site performed well at varying river levels and canal flows in 2005 and was operated in a way that should protect juvenile salmonids.

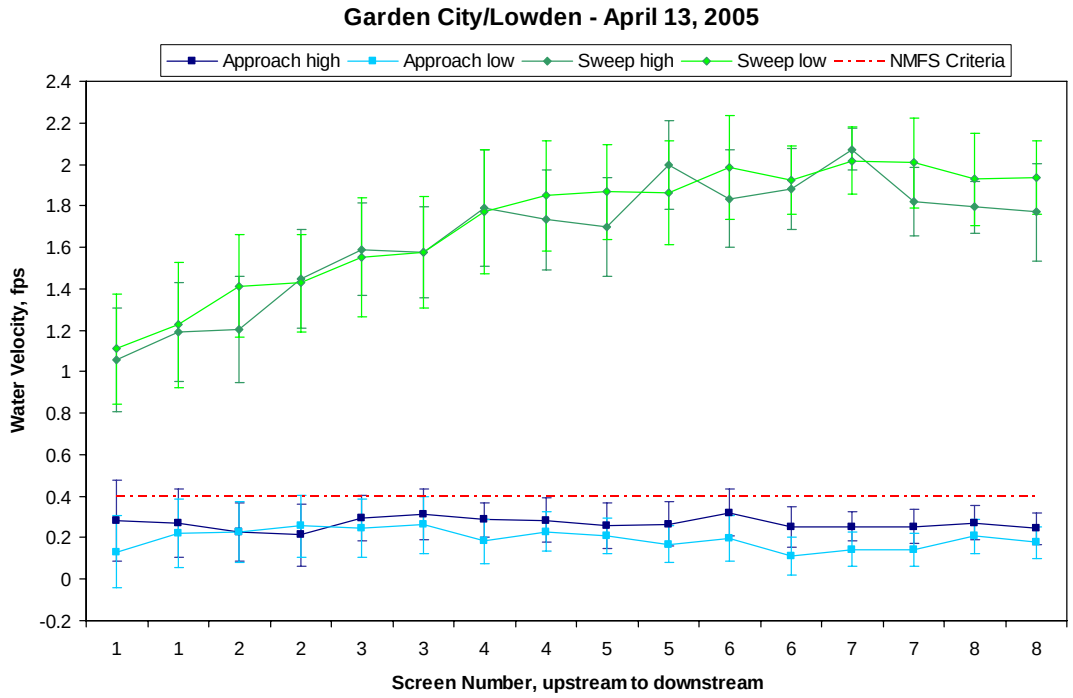


**Figure 2**. Garden City/Lowden Approach and Sweep Velocities in April 2005

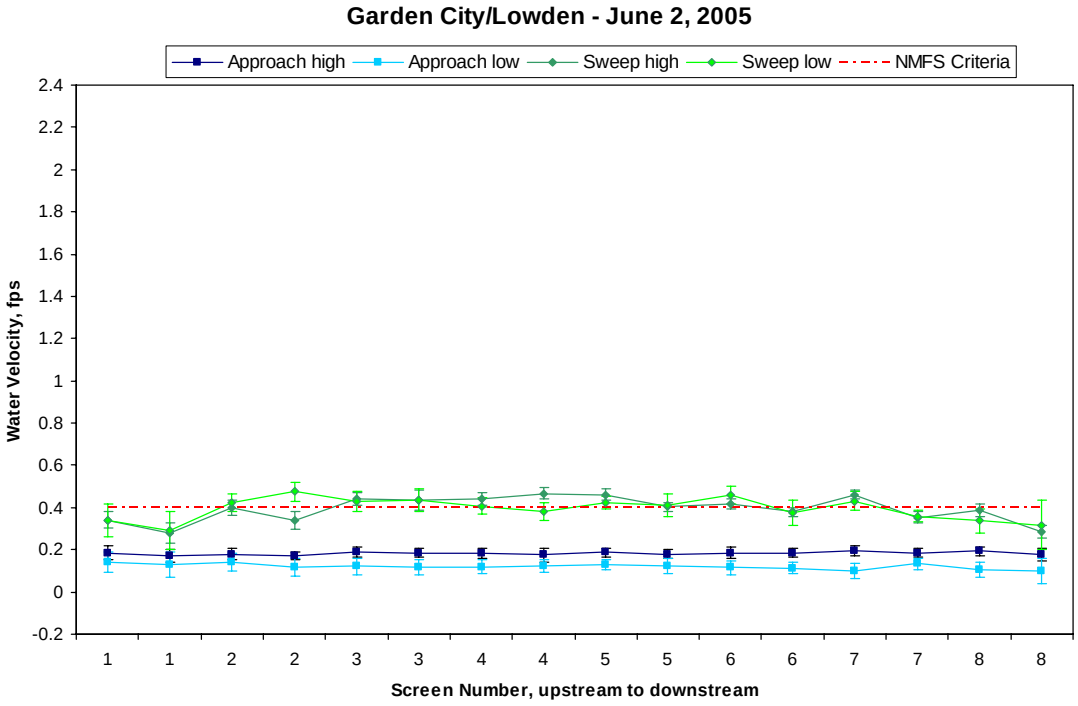


**Figure 3**. Garden City/Lowden Approach and Sweep Velocities in June 2005

## 3.2 Nursery Bridge Fishway

Although Nursery Bridge Fishway is designed to provide passage for adult salmonids on the east side of the Walla Walla River, juvenile salmonids also use the facility as they migrate out in the spring. Water enters the screens portion of the site through a tunnel under a bridge. As can be seen in Figure 4, the angle of the tunnel causes water to enter the screen facility at an angle, hitting the western panels more directly.

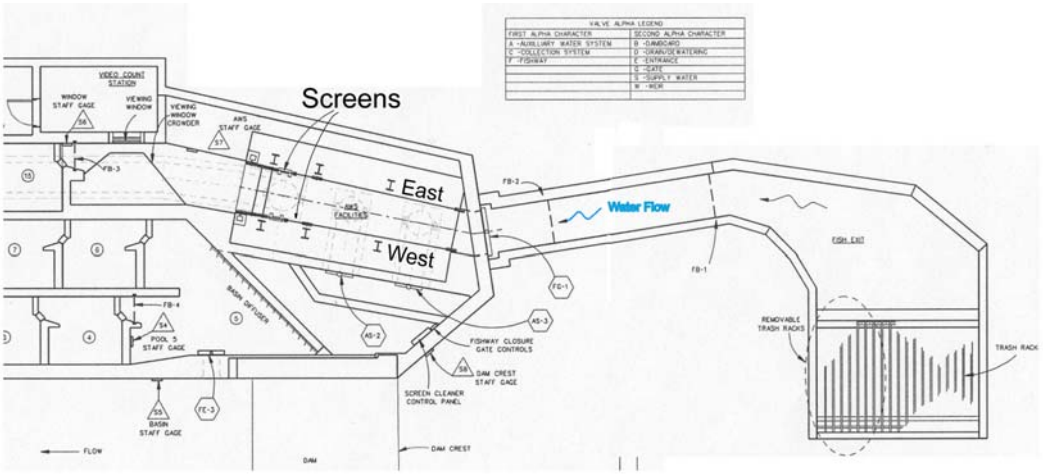


**Figure 4**. Plan View of Part of Nursery Bridge Fishway and Screens

In the past, approach velocities at the screening portion of the fishway have not always met NMFS criteria (Vucelick and McMichael 2003, 2004). Vucelick and McMichael noted the louvers used to control flow through the screens had gaps of up to 1 in. between individual louvers with even larger gaps where the louvers abut the cement walls of the structure. They were unable to adequately adjust flow through the screens using the louvers in this configuration and recommended extending the louvers so that they almost overlap and can be set to block more of the flow. These modifications were made in September 2005. Figure 5 shows a schematic of the screens and louvers and the width of the metal strips added to the louvers.

On March 7, 2006, we evaluated the site to see what approach velocities are like with the modified louvers under moderate river conditions. Flow in the Walla Walla River was 242 cfs at Pepper Bridge, about 10 miles downstream of Nursery Bridge. Gates controlling the auxiliary water supply to the fish ladder were set to allow typical flow through the screens. Louvers were almost closed, minimizing the amount of flow through the screens. Under these conditions, all approach velocities were below 0.4 fps (Figures 6 and 7). No adjustments were made to the louver positions.

We had hoped to evaluate the site at higher river flows, similar to those in March 2003 when almost all of the approach velocities exceeded 0.4 fps. River levels fluctuate rapidly this close to the Blue Mountains, and we have not yet been able to get to the site when river flows are above 400 cfs and the main channel is on the same side as the fishway. Until approach velocities can be evaluated over a range of river flows and operating conditions, no firm conclusions can be made as to the effectiveness of the louver modifications.

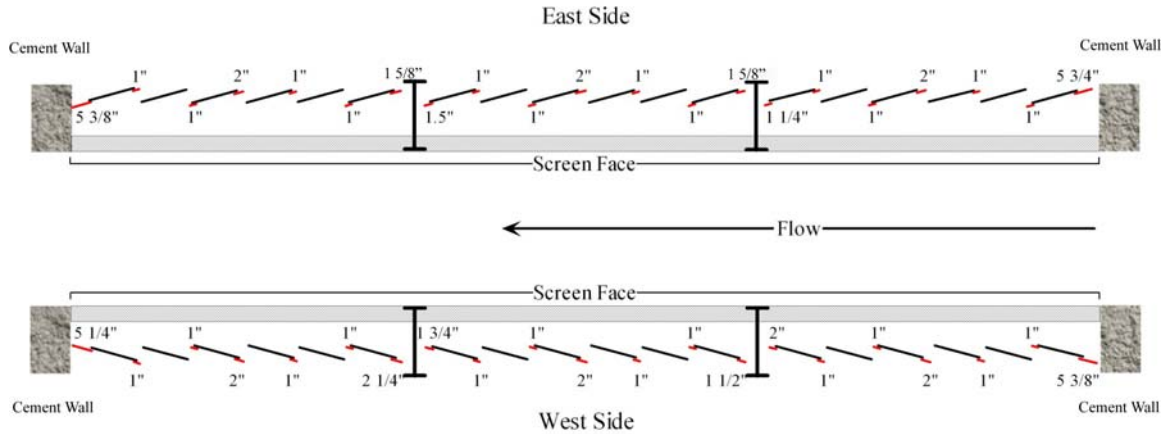


**Figure 5**. Modifications Made to Louvers at Nursery Bridge Fishway. Note that the louvers are in a partially open position and are not to scale in this sketch.

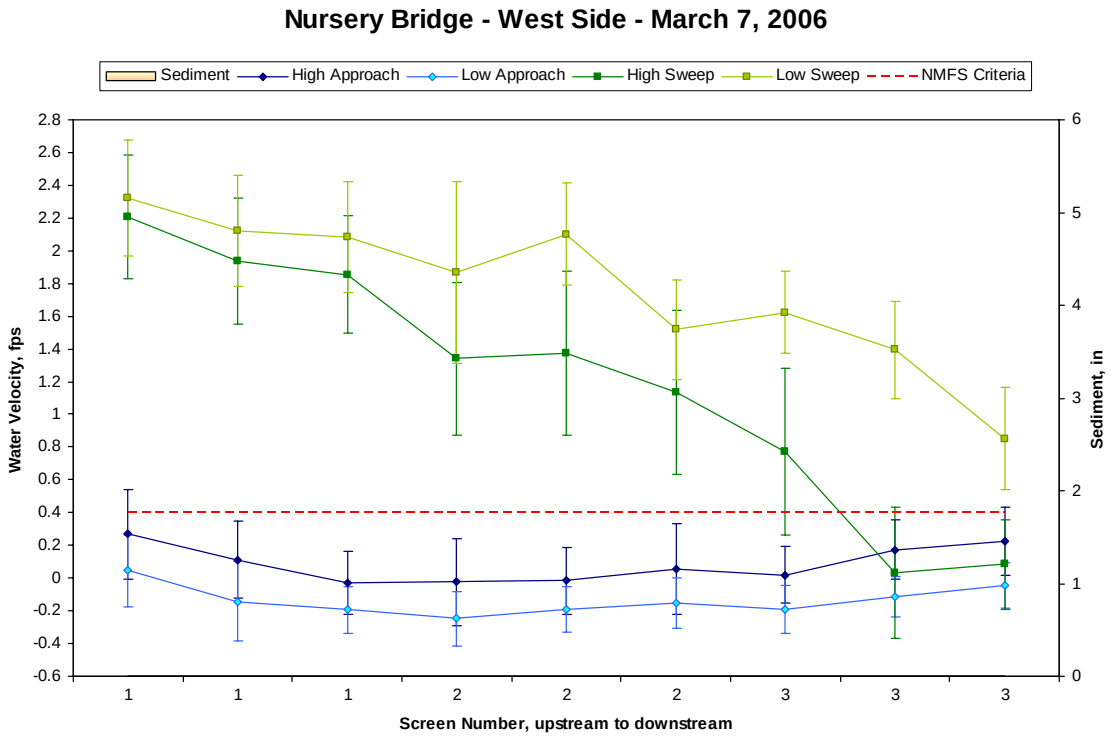


**Figure 6**. Approach and Sweep Velocities Along West Screens at Nursery Bridge Fishway. The error bars represent the turbulence (as root mean square) for each point. No sediment was found.

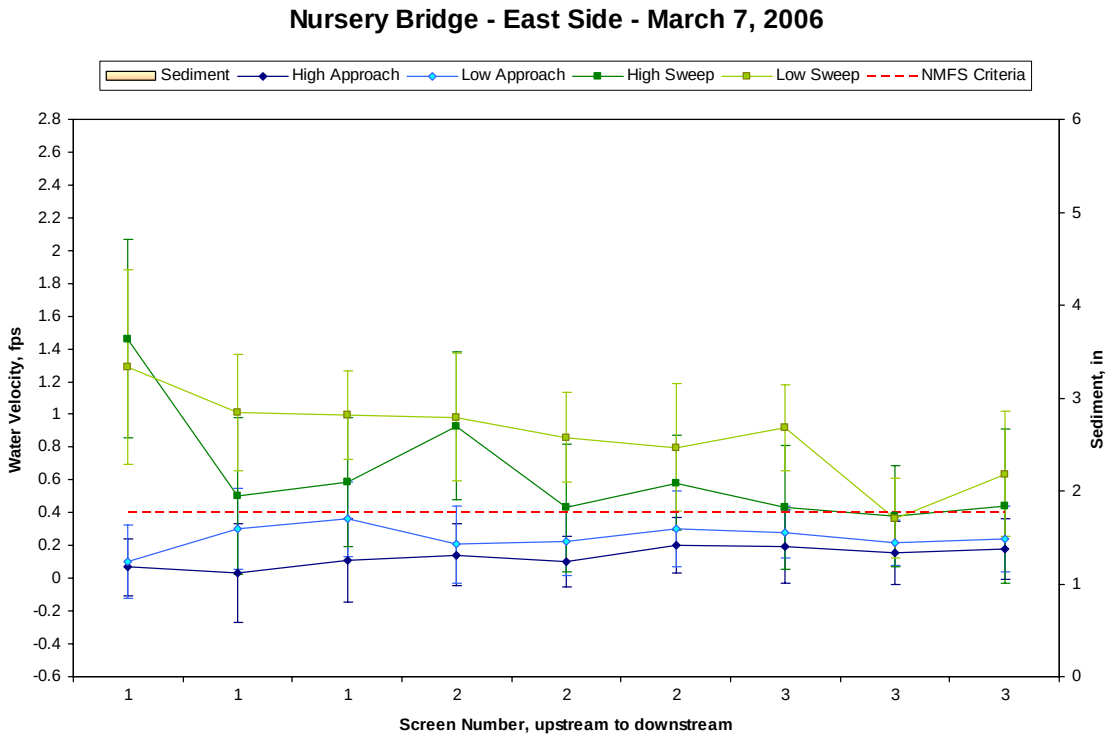


**Figure 7**. Approach and Sweep Velocities Along East Screens at Nursery Bridge Fishway. The error bars represent the turbulence (as root mean square) for each point. No sediment was found.

# 4.0 Conclusions

The 2005 evaluations of the Garden City/Lowden II site indicate it is being operated and maintained in a way that should effectively provide safe and efficient passage for juvenile fish. Approach velocities met NMFS criteria, and sweep velocities were higher than approach velocities during both visits. Sweep velocities also increased slightly toward the downstream end of the site in April, which should reduce delays near the site. Sweeps did not increase toward the fish ladder in June, but this is past the juvenile migration period and does not cause harm to juveniles.

Results of the Nursery Bridge Fishway evaluation in March 2006 also indicate the fish screens were operating to protect juvenile salmonids that day. Approach velocities met NMFS criteria under the moderate river flows and typical AWS settings found on March 7. Rapid fluctuations in river levels and channel location prevented us from evaluating the site under higher flow conditions. We recommend evaluations at both higher and lower river levels as well as at various AWS settings that might typically be in effect when juvenile salmonids are present. This information will help determine whether adjusting the louvers can effectively control excessive approach values under conditions prevalent when juvenile salmonids are present.

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