OPERATION, SITING, AND DESIGN CRITERIA FOR FARMER'S SCREEN

I. INTRODUCTION

The Farmer's Screen was created to fulfill the need for a reliable device that simultaneously diverts water, protects fish, removes debris, and requires no moving parts and little maintenance. The result is a passive, substantially self-cleaning, horizontal flat plate overshot screen device. Both NMFS and ODFW have determined that additional installations of The Farmer's Screen technology at other sites may be approved on a case-by-case basis. With the support of many natural resource groups, this technology was developed, tested and patented by Farmer's Irrigation District, which is located in Hood River, Oregon.

II. OPERATION

The intended operation of the overshot horizontal fish screen (The Farmer's Screen) is to safely pass fish and effectively manage debris and sediment. Fish and debris are passed over the screen and off the end to the bypass channel. Diverted water passes through the screen and then flows from a sub-screen chamber over a uniform control weir to the attenuation chamber and then to the inlet of a water conveyance facility. The attenuation chamber functions to create separation between the weir and the water conduit such that any vertical flow at the water conduit entrance does not disrupt the flow dynamics at the weir or screen plane.

Water is introduced to the screen through an inlet transition section. Water flowing through the screen develops the following three velocity components:

- Sweeping velocity (V_S) is the average velocity of water moving directly across (parallel to) the screen from input to bypass output
- Boundary layer velocity (V_B) is the velocity of water in the non-diverted (bypass) flow at or very near the screen (as opposed to V_S, which is the velocity of water **above** the water layer traveling at (V_B)
- Normal velocity (V_N) is the velocity of water passing through the screen approximately perpendicular to the plane of the screen material.

When constant inflow is available to submerge the control weir and screen, an elevated grade line is achieved, and steady-state operation begins. Water entering the screen either sweeps above the screen at V_S (substantially unaffected by the hydraulic condition at the screen) or becomes part of the near-screen hydraulic condition. Water in the near screen hydraulic condition is diverted between a slower moving boundary layer component, V_B, and a component that passes through the screen at V_N. The V_N flow is the diverted water flow. Water traveling at V_S preferably achieves a relatively uniform fluid flow over water closer to the screen. To the extent that propagating waveforms appear at the water surface elevation over the screen, the V_N oscillates along the vertical axis. This phenomenon enhances screen self-cleaning.

The velocity of the water passing down through the screen, V_N, is relatively uniform across the entire plane of the screen due to the uniform control weir. This uniform velocity ensures that the screen operates without "hot spots," which are non-uniform areas of velocities greater than the acceptable V_N. The uniform control weir also ensures the screen is sufficiently submerged so that fish and debris pass over the screen with adequate water depth. The screen is typically designed with a taper wall to ensure that V_S remains sufficiently high throughout the length of the screen. Correct V_S also reduces the likelihood of trapping debris or delaying fish along the screen. The V_S is typically at least fifteen times greater than V_N. Site-specific adjustments in design and operation are required to optimize system performance over a range of flow levels and site conditions.

II. SITING

The Farmer's Screen requires proper site conditions in order to function correctly and efficiently. The following information provides the minimum conditions required in order to reliably install the Farmer's Screen at a given site.

These criteria must be met in order for the Farmer's Screen to perform reliably:.

- Bypass water: Generally, for screens 100 cfs and smaller, a minimum of 15% of the total diverted flow must be maintained for transporting fish and debris across the plane of the screen. For screens 100 to 500 cfs, a minimum of 10% of the total diverted flow must be available for proper operation.
- Sediment type and load: Site sediment—suspended and bed load—must be characterized. If sediment is present, then sediment management facilities must be included as an integral component of the screen project.
- Backwater profile: The influence of backwater from the water conveyance system must be taken into account when designing the screen system.
- Debris type and load: Generally, The Farmers Screen manages even large volumes of debris in a highly effective manner. In instances where aquatic plants are present, lower V_N values, covers to block UV light, and upstream, fish-safe antifouling treatment might be required.
- Footprint area: Adequate area must be available to accommodate the screen structure.

III. DESIGN

The Farmer's Screen requires proper flow parameters in order to function correctly and efficiently. The following information provides the minimum conditions required in order to realize optimum cleaning dynamics and fish protection from the Farmer's Screen.

The following criteria must be met in order for the Farmer's Screen to perform reliably:

- Normal velocity (V_N): The velocity of flow throughout the entire plane of the screen (generally perpendicular to the plane of the screen), at any given point, should not exceed 0.25 ft/s after correcting for net open area.
- Sweeping velocity (V_S): The water traveling parallel to the plane of the screen should have a sustained velocity throughout the entire length of the screen, averaging about 4 to 8 ft/s in order to achieve the maximum cleaning dynamics and fish protection. A taper wall is usually required to maintain correct velocity parameters.
- Depth of water over screen: The depth of water over the entire screen area should be maintained at a uniform level between one and two feet. The actual depth will vary as a function of screen size and overall hydraulic conditions. A taper wall is usually required to maintain a uniform water surface elevation over the plane of the screen.
- Screen area: The total screen area must be large enough to achieve the correct V_N after correcting for net free area.
- Screen hole size: Screen hole size, material, and open area should be in compliance with NMFS standards and allow for an appropriate footprint size and approach velocity.

- Length to width ratio: The length to width ratio must be correctly determined to avoid disruptive hydraulic conditions across the entire plane of the screen.

Features:

A. Inlet transition (from canal to screen)
B. Sweeping channel
C. Bypass (output) channel
D. Sub-screen chamber
E. Uniform control weir
F. Attenuation chamber
G. Water conveyance facility
H. Bypass step pools