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Submerged Jump Remediation at Low-Head Dams: The Multiple Staggered Deflector Design

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Master of Science

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ABSTRACT

Submerged Jump Remediation at Low-Head Dams:
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Master of Science

Low-head dams are capable of creating dangerous counter-currents just downstream from the structure. These dangerous counter-currents are known as submerged hydraulic jumps and are responsible for hundreds of fatalities at numerous low-head dams across the United States. The counter-current creates high upstream-directed surface velocities across the width of the channel, making it nearly impossible for an individual to escape. This submerged jump can occur during a range of upstream and downstream conditions.

Effective, safe and low-cost remediation options must be explored in order to prevent further fatalities at these structures. This document explores such a remediation option: the Multiple Staggered Deflector Design. This remediation option will disrupt uniform upstream-directed surface velocities across the channel within a submerged jump for nearly all downstream conditions that create a submerged jump for a range of upstream conditions. The dam modification is designed such that an individual will escape the submerged jump without severe injury or harm, while being relatively inexpensive and simple to install.

Keywords: low-head dam, remediation, submerged jump, deflectors

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1 INTRODUCTION

Low-head dams are defined as hydraulic structures, spanning the width of a natural channel, that are “built to pass inflows from upstream over the entire width of the dam crest on a continual and uncontrolled basis” (USACE, 2015). The most common crests are flat-topped and ogee-crested (Tschantz and Wright, 2011). These dams were and are constructed to set a reliable upstream water depth to provide “additional water supply, [produce] hydropower, and [divert] irrigation water,” for municipal, industrial and agricultural demands (Tschantz, 2014).

While low-head dams provide benefits to local cities, businesses, and agriculture, they often the present a very dangerous downstream condition known as a submerged hydraulic jump. During certain hydraulic conditions, the momentum of the plunging nappe is drowned by a high downstream tailwater elevation, creating a hydraulic vortex at the base of the dam with strong upstream-directed currents along the surface of the water. Entrained air within the jump adds to the danger by changing buoyant conditions in the jump, making it harder for objects to remain afloat. This hydraulic condition is commonly referred to as a “drowning machine” or “hydraulic” to the public (Minnesota DNR, 2012).

Figure 1: Typical Low-Head Dam, (NIOSH, 2010)

When a water recreationalist goes over the top of the dam during these conditions, the individual is typically caught in this “hydraulic.” The individual plunges underwater and resurfaces just downstream from the dam, only to be pulled back to the plunging nappe, which pounds the individual back under the water surface (Fig. 2). This entrapment process usually results in drowning. According to the Low-Head Dams Fatalities Database at Brigham Young University, there have been over 450 fatalities over the past 60 years (Brigham Young University, 2014).

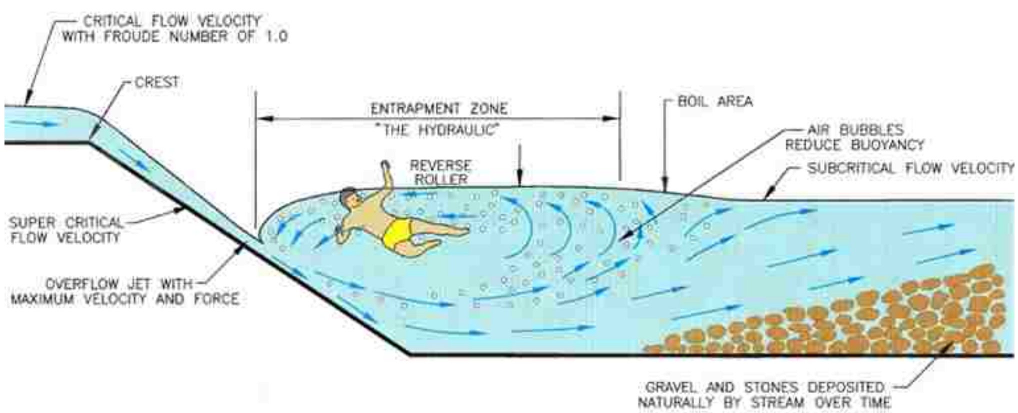

Figure 2: Entrapment Process at Low-Head Dams, (Wright et. al 1995)

Engineers, state legislatures, boat safety organizations, and various other parties have begun to explore possible preventive measures in order to reduce the risk of drowning at low-head dams (Tschantz and Wright, 2011). Among these measures, various structural modification designs have been proposed. The purpose of a structural modification is to disrupt the submerged jump or completely eliminate it, while maintaining the original functionality of the dam. A structural modification is usually presented as an option when the current function of the dam is desired to be maintained or when the removal of the dam is prohibitive. The purpose of this article is to promote safety at these structures by determining a simple and low cost low-head dam structural modification that will disrupt or eliminate the submerged hydraulic jump condition.

2 BACKGROUND

2.1 Hydraulics of the Submerged Jump

As described by Chow (1959), and later expounded upon by Leutheusser and Birk (1991), four types of hydraulic jumps can occur at the base of a low-head dam: a swept-out jump, an optimal jump, a submerged jump, or a washed-out jump. All of these jump conditions are dependent on the downstream tailwater elevation (*TW*). A submerged jump occurs when the tailwater elevation is slightly, but not significantly, greater than the sequent depth (y_s) (see Case C in Fig. 3). As the tailwater elevation rises, this jump persists until a "flip point" (y_{f2}) is reached and the submerged jump becomes a washed-out jump (Leutheusser and Fan 2001). As the tailwater elevation decreases from a washed out jump, the submerged jump reappears when the tailwater elevation reaches the "flop" point (y_{f1}). Typically, the flip point is higher than the flop point. The reason for this discrepancy is described as "incomplete ventilation of the nappe when the tailwater decreases" (Leutheusser and Fan 2001). Therefore, a submerged jump will always be present when the tailwater elevation is between the sequent depth and the flop point and may be present between the flip and flop point. To give full consideration to when a submerged jump may occur in further discussion, the interval of tailwater elevations between the sequent depth and the flip point is referred to as the Submergence Interval (*SI*). The sequent depth and flip/flop points of the *SI* are a function of discharge.

$$SI = y_{f2} - y_s$$

Equation 1: Submergence Interval

Where

y_{f2} = Flip Point [ft]

y_s = Sequent Depth [ft]

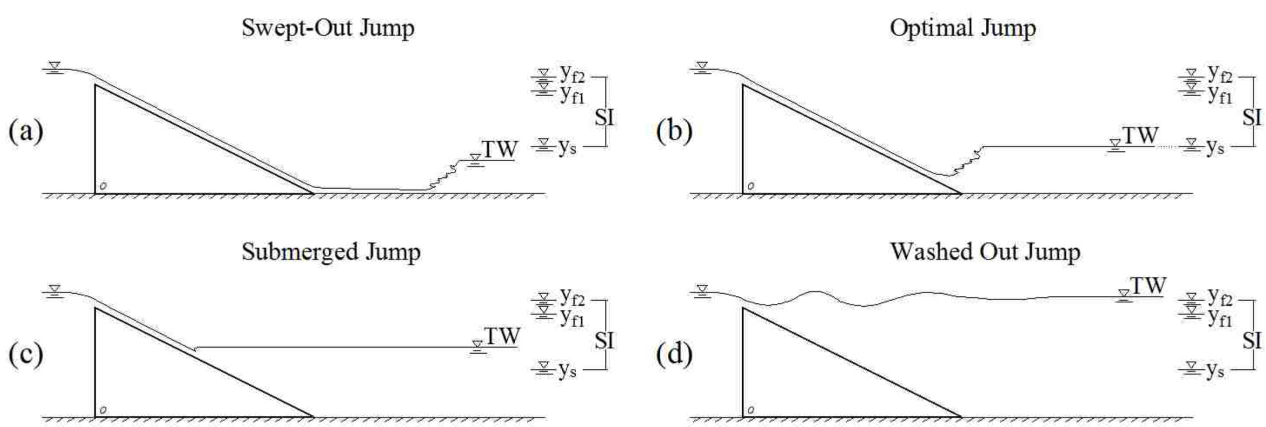

Figure 3: Standard Hydraulic Jumps

When a C jump is present, the strong momentum of the nappe plunges below the surface of the downstream pool towards the bottom of the channel, entraining air and surface water due to high turbulence (Olsen 2013). This strong current is then directed downstream along the bottom of the channel until, due to decreased density from air entrainment, it rises to the surface at an elevated location known as the "boil point" (Wright 1995). The boil point is higher than the depression at the point of the nappe impact, directing flow upstream towards the dam (Wright 1995). These counter-current velocities can reach magnitudes up to 4 feet per second (Robinson and Houghtalen 2007), "[challenging] even the most highly trained swimmers to escape the pull towards the overflowing nappe" (Tschantz and Wright 2011). This plunging nappe can have an impact force of up to 1.5 times the weight of a mature adult (Leutheusser 1988).

The magnitude of these upstream-directed surface velocities are directly related to the tailwater elevation. Once a submerged jump is formed, the magnitude of upstream-directed surface velocities increase to a maximum magnitude at a degree of submergence (*S*) of approximately 25-30% (Fig. 4, Leutheusser and Fan 2001). Govinda Rao and Rajarantnam (1963) defines the degree of submergence as

$$S = (TW - y_s)/y_s$$

Equation 2: Degree of Submergence

Where

S = degree of submergence

TW = tailwater elevation [ft]

y_s = sequent depth [ft]

From Fig. 4, as the degree of submergence (or *TW*) continues to increase from the maximum magnitude, the upstream surface velocities (V_s/V_1) will decrease until the flip point is reached. As the degree of submergence decreases from the flop point, the upstream-directed surface velocities follow the same trend as when the tailwater elevations were increasing, maintaining the same magnitude. This trend is true for a range of Froude numbers at the spillway crest (Fig. 4).

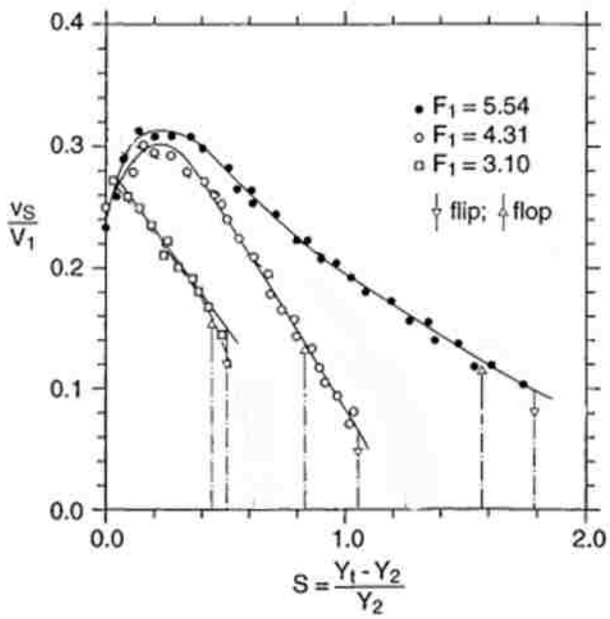

Figure 4: Upstream-directed Velocities in a Submerged Jump, (Leutheusser and Fan 2001)

2.2 Important Aspects of Structural Modifications

The most important aspect to consider for a low-head dam structural modification is the effectiveness of the design in eliminating or disrupting the submerged hydraulic jump. In conjunction with his work on determining the hydraulic characteristics of a submerged jump, Leutheusser suggested “baffled chute spillways” as a structural modification to a low head dam, (Leutheusser and Birk 1991). These spillways typically include rows of baffle blocks on the face of the dam or at the toe of the dam in a specified alignment. This is a common design used by many engineers to dissipate the energy in the overflow of a hydraulic structure, such as a spillway, and theoretically would be effective at eliminating the submerged jump downstream of a dam. However, when considering human passage the design introduces another potential safety hazard to the public. A water recreationalist that goes over a spillway equipped with this modification would likely be seriously injured by coming into contact with the baffle blocks (Hotchkiss and Comstock 1992).

A safe and effective design was previously demonstrated by various parties by using boulder sloped spillways (or rock ramps), which were also intended to provide safe fish passage for a wide range of fish species (Schwieger 2011). The design includes adding rocks and large boulders from the top of the dam to the bottom of the channel at a shallow slope, such as 20H:1V to 6H:1V. At specified distances along the shallow slope, rock weirs are implemented in order to disrupt the momentum of the plunging nappe and presents a more natural-looking modification. These designs have proven to be very effective in dissipating the hydraulics of a submerged jump and in providing safe conditions for the public. However, the application of these designs can be limited by cost of construction and materials (Schwieger 2011).

Based on the structural modifications previously exemplified, the purpose of this paper is to explore a structural modification design that is not only effective at disrupting or eliminating a submerged jump, but also gives special considerations to safety and cost.

2.3 USACE Spillway Modification

A “flip lip” spillway modification, explored by the U.S. Army Corps of Engineers, proved to be very effective at eliminating the beginning stages of the submerged jump formation (USACE 1984). A “flip lip”, or horizontal deflector, is defined as a rectangular baffle block on a dam’s spillway with a specified tread (t), parallel to the tailwater surface, and a corresponding rise (r). The original purpose of the modification was to promote safe fish passage by reducing nitrogen supersaturation of dam discharges in stilling basins in the Pacific Northwest (USACE 1984).

According to the design, the vertical momentum of the plunging nappe over the spillway will be deflected horizontally downstream, preventing air entrainment and eliminating the beginning of the submerged hydraulic jump. Instead, downstream-directed surface velocities are created in the form of a standing wave (Fig. 5).

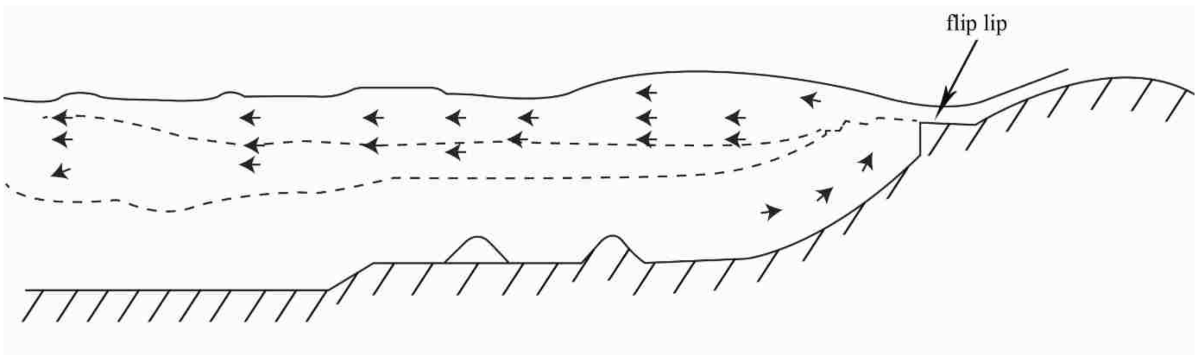

Figure 5: Elevation View of USACE Model Spillway Observations, Redrawn (USACE 1984)

3 MULTIPLE DEFLECTOR DESIGN METHODOLOGY

A modification of the USACE “flip lip” spillway design holds promise as a simple and inexpensive structural retrofit for low-head dams to potentially eliminate or disrupt submerged hydraulic jumps. It will theoretically prevent a submerged jump from forming and allow safe passage downstream to any individual who goes over the spillway. The deflectors themselves are also relatively safe because an individual who goes over the modified spillway would be deflected downstream without serious injury. The cost to add these deflectors to a spillway would be relatively inexpensive, because the deflector does not require extensive renovations to the dam, such as extending the length of the spillway.

Laboratory experiments of this modification were conducted in two stages. The first stage was exploratory and tested a single deflector spanning the width of the low-head dam (single deflector hydraulics simulations) and a configuration of multiple partial-width deflectors at 12 locations on the face of the dam that spanned a portion of the dam height (multiple staggered deflector simulations). Details about these exploratory tests can be found in Kern, 2014. The second set of experiments was based on a theory and design procedure derived from the results of the exploratory tests and examined placing multiple deflectors more systematically. This second set of experiments is explained in this document along with the accompanying theory and design procedure.

3.1 Theory

From the results of the single deflector hydraulics simulations (Table 3, Appendix A), a standing wave will occur with corresponding downstream-directed velocities at a portion of the channel width, approximately equal to the width of the deflector, when the tailwater elevation is within a certain range of tailwater elevations with respect to the deflector. This interval of tailwater elevations is known as the Standing Wave Interval (*SWI*). Since the deflector jump transition depths vary, depending on whether the tailwater elevation is increasing or decreasing, the proceeding design will be conservative by defining the *SWI* as the smallest interval between these values, namely the interval between y_{ds1} and y_{df2} according to Eqn. 2 and Fig. 6. This *SWI* is a function of deflector tread/rise and flowrate. As both flow and deflector size increase, the *SWI* increases as well.

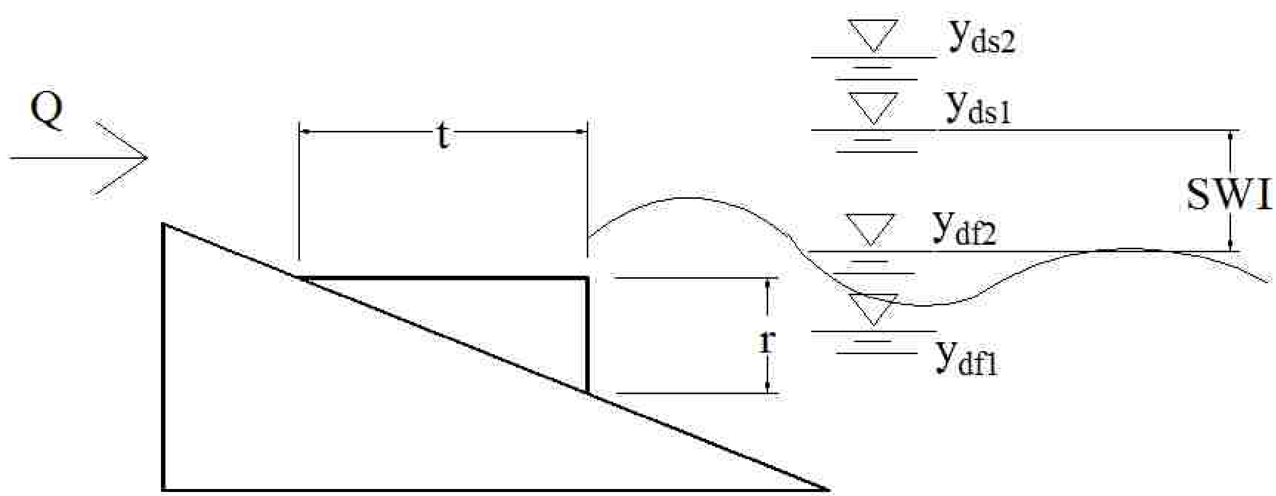

Figure 6: Single Deflector Parameters, Elevation View

$$SWI_d = y_{ds1} - y_{df2}$$

Equation 3: Design Standing Wave Interval [ft]

Where

y_{ds1} = First Deflector Sequent Depth [ft]

y_{df2} = Deflector Flip Point [ft]

A specified accumulation of deflectors on the spillway should create a cumulative *SWI* ($\sum SWI$) that will encompass the entire *SI* of one or more flows, allowing regions of standing waves, or regions of downstream-directed surface velocities in the form of a standing wave, to be present throughout the width of the channel during any downstream condition when a submerged jump may be present (Fig. 7). For this Multiple Deflector Design, whenever the tailwater elevation is within the *SWI* of a particular deflector, that deflector becomes active because it is performing its function by deflecting the plunging nappe in the form of a standing wave. Hence, it is termed an active deflector (d_a). All other deflectors not deflecting the plunging nappe in the form of a standing wave are termed inactive (d_{in}).

Any deflector installation will need to accommodate the *SI*'s of a range of flows. Therefore, the *SI*'s of a previously determined maximum flow (Q_{max}) and a design (or minimum) flow (Q_d) will be used to define this range. These flows will be determined according to the best judgements of the engineer and may be best approximated by hydrologic and/or hydraulic studies and design standards (Mays, 1994). The "flip" point of the maximum flow and the sequent depth of the design flow will be used to define a Design Submergence Interval (SI_d) according to Eqn. 3, which will be used to determine the least amount of deflectors needed on the spillway to accrue a sufficient

$\sum SWI$ to encompass all possible conditions that will allow a submerged jump to form for the pre-determined range of flows.

$$SI_d = y_{f2.max} - y_{s0}$$

Equation 4: Design Submergence Interval [ft]

Where

$y_{f2.max}$ = Maximum Flip Point [ft]

y_{s0} = Design Sequent Depth [ft]

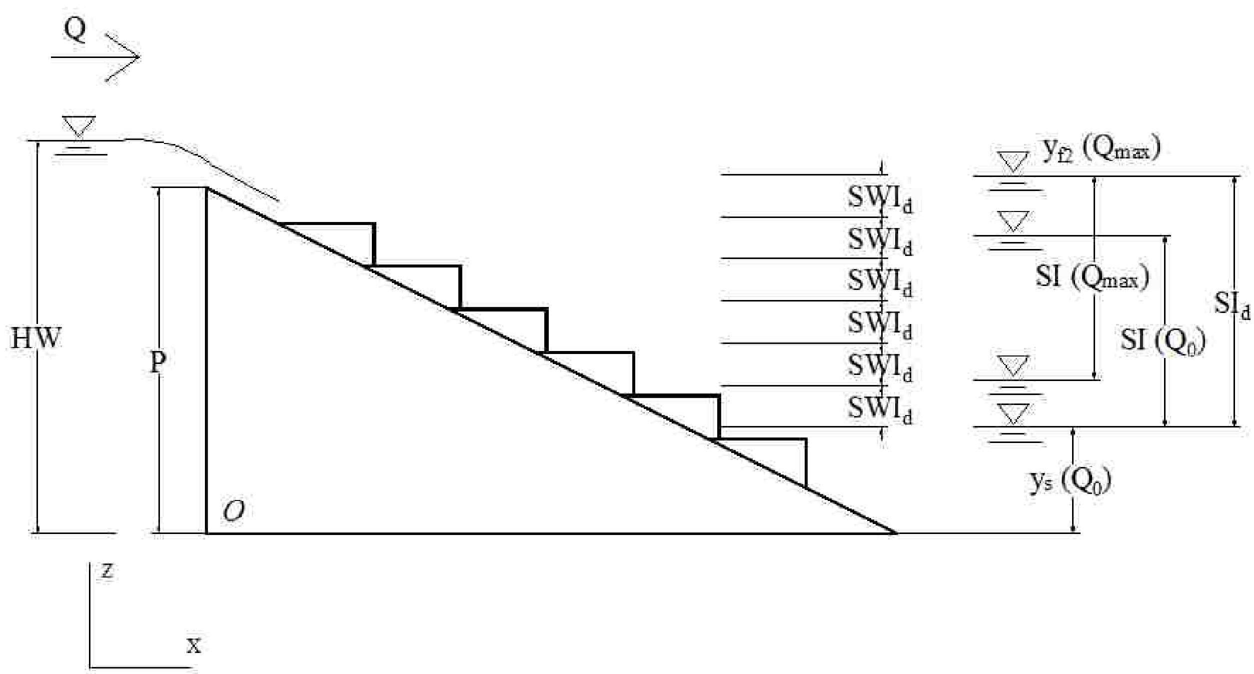

Figure 7: $\sum$SWI vs. SI$_d$ Theory, Elevation View

The smallest *SWI* of each deflector, or the *SWI* associated with the design discharge, will be used to form the ∑*SWI* and will be referred to as the Design Standing Wave Interval (SWI_d). While this is the most conservative value to use for the *SWI* of each deflector, as flow increases, the *SWI* of each deflector will grow larger, overlapping in some areas along the Design Submergence Interval (SI_d) (Fig. 8). Therefore, certain tailwater elevations will be encompassed by the *SWI* of two or more deflectors. This indicates that for higher flows there will be multiple active deflectors creating regions of standing waves across the width of the channel for various tailwater elevations. Since the danger of entrapment is greater at higher flows due to greater upstream surface velocities, it is appropriate that more regions of standing waves be available for various downstream conditions at these higher flows.

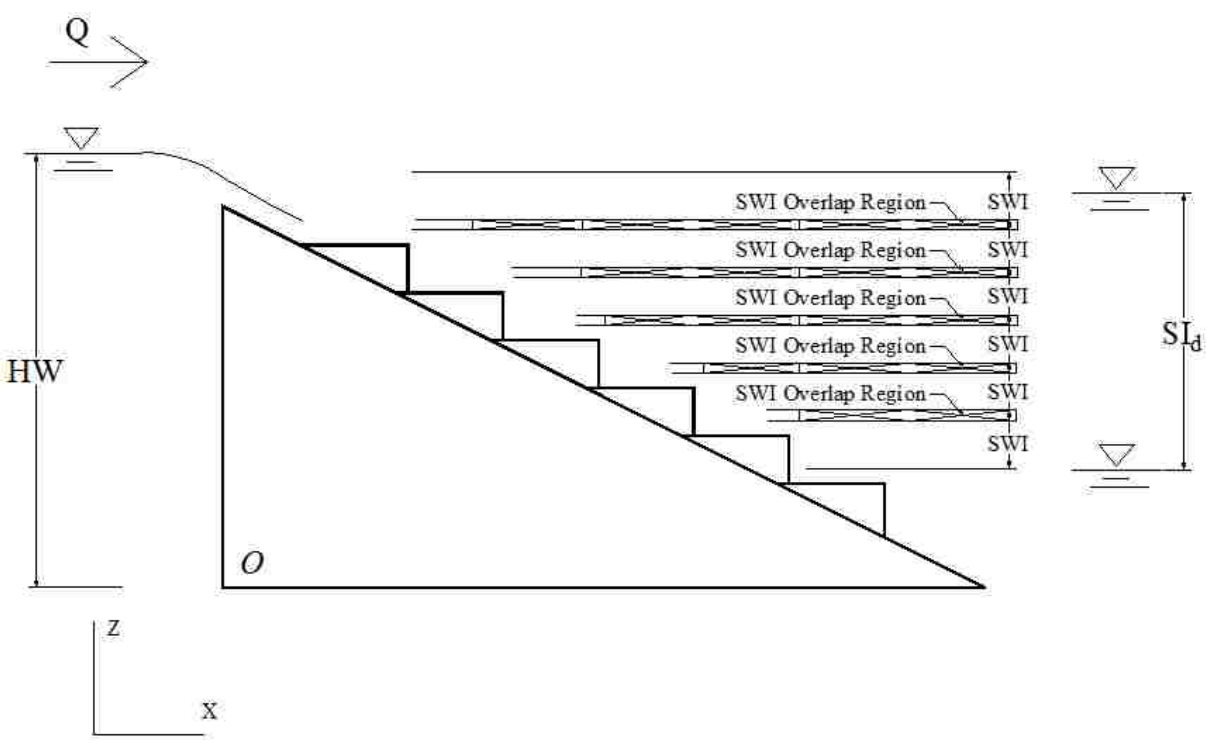

Figure 8: Overlapping SWI vs. SI_d, Elevation View

3.2 **Design Procedure**

3.2.1 Multiple Deflector Design

The proposed design uses the following axis orientations as shown in Figs. 7 & 10. The point of origin (*O*) in the design is defined at the bottom of the upstream side of the dam, looking river-right. The following basic procedure is used for the design modification:

I. Deflectors of a specified tread, *t*, will be placed on the spillway, along the Z-axis, beginning at the bottom of a previously determined SI_d such that the bottom of its SWI_d is at the bottom of SI_d (Eqn. 2).

$$d_{11z} = y_{s0} - y_{df2}$$

Equation 5: Elevation of First Deflector [ft]

Where

y_{s0} = Design Sequent Depth [ft]

y_{df2} = Deflector Flip Point [ft]

After the first deflector is placed, another deflector is placed such that the bottom of its SWI_d is set to the top of the previous deflector's SWI_d, according to Eqn. 6. This process is repeated until the last deflector's SWI_d is greater than the maximum flip point, or until the last deflector is placed at the very top of the dam.

$$d_{zn} = d_{zm} + (y_{dmf2} - y_{dnf2}) + SWI_{dm}$$

Equation 6: Elevation of Proceeding Deflector [ft]

Where

d_{zm} = Elevation of Current Deflector [ft]

y_{dmf2} = Flip Point of Current Deflector [ft]

y_{dnf2} = Flip Point of Next Deflector [ft]

SWI_{dm} = SWI_d of Current Deflector

The amount of cumulative deflectors placed on the spillway along the Z-axis in this manner are the least amount of deflectors needed in order to produce a standing wave throughout the channel width for all of SI_d.

II. Deflectors are to be placed directly above lower deflectors such that the maximum nappe projectile distance of the higher deflector is equal to or greater than the position of the lower deflector along the Z- and X-axis (Fig. 9, Case b).

If Part II is not followed, the projectile nappe of the higher deflector will exceed the position of the lower deflector and, "since a deflector cannot deflect flow that it does not come into contact with," the function of the lower deflector is incapacitated (Kern, 2014). This would mean that there is an interval of tailwater elevations within SI_d that will not have a standing wave present (Fig. 9).

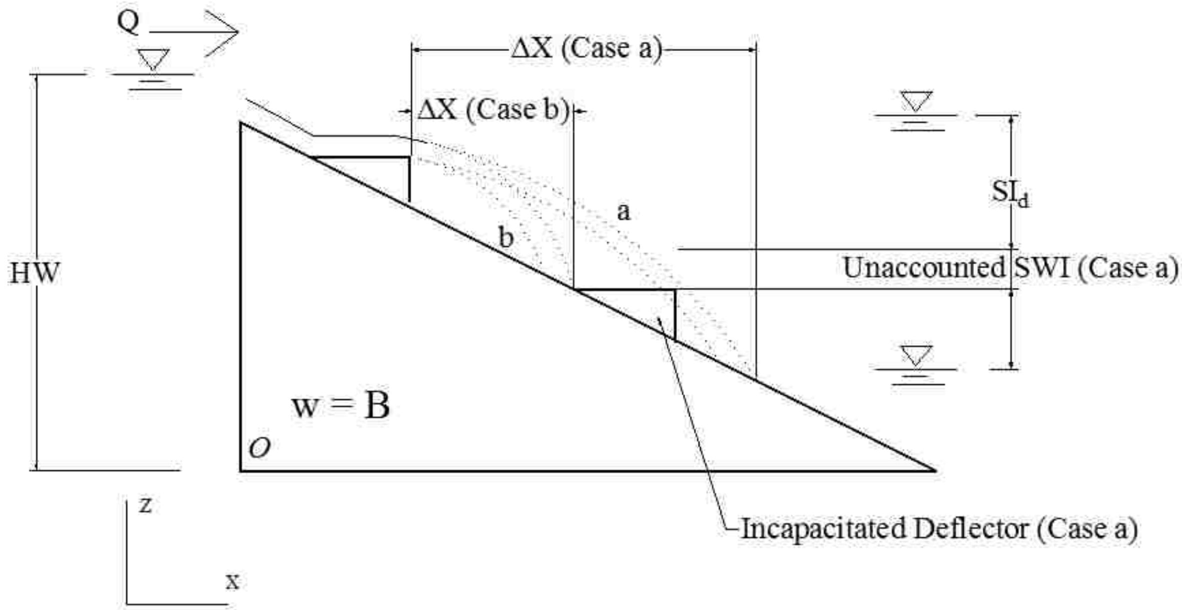

Figure 9: Projectile Nappe(s) of Higher Deflector, Elevation View

3.2.2 Multiple Staggered Deflector Design

From the results of the Single Deflector Hydraulics Simulations, it is evident that the maximum nappe projectile distance of a higher deflector will often exceed the distance to the next lowest deflector needed along the Z-axis. Therefore, a $\sum SWI$ composed of multiple full dam-width deflectors according to Part I of the design procedure will not be effective throughout SI_d due to multiple incapacitated deflectors. In order to ensure that each deflector width (w) is maximized and that the entire SI_d is addressed, deflectors are to be reduced to a percentage of the full width of the dam and are staggered across the spillway as they are placed along the Z-axis (Kern 2014). While this will eliminate the option of having very wide deflectors with corresponding wide regions of standing waves, it allows all partial dam-width deflectors to be fully functional throughout the entire SI_d with corresponding partial dam-width regions of standing waves as well as the introduction of lateral velocities.

This staggered approach includes placing all deflectors in levels (*i*) and columns (*j*) along the spillway (Fig. 10). It should be noted that all deflector columns are of equal length (*b*) and designate the stagger of the deflectors along the Y-axis. All deflectors are placed within deflector columns with their width equal to *b*. Each deflector placed in a column does not cross over the column lines. Each column is numbered along the positive Y-axis, beginning at the origin. Deflector levels are composed of one deflector from each column, beginning with the first column and ending with the last column. They are numbered along the positive Z-axis, beginning at the origin.

Therefore, three additional parts of the previously described procedure are necessary for partial-width deflectors:

III. Each deflector is placed along the Y-axis in a separate deflector column from previous deflectors until Part II is possible. Once this occurs, a deflector may be placed in a previous deflector column that allows for this condition, ending the first deflector level.

IV. Once the first level is placed, the number of deflectors in this level are equal to the number of deflector columns needed for the entire design. The width of each deflector (*w*), and the width of each deflector column (*b*), is then determined to be the number of deflector columns divided by the dam width, *B* (Eqn. 2).

$$w = b = \frac{B}{\sum j}$$

Equation 7: Deflector/Column Width [ft]

Where:

j = deflector column

B = dam width [ft]

V. Once the value of w and b are determined, the remaining deflectors will be placed according to Parts I – III in the established deflector columns.

VI. According to the numbering of each level and column, each placed deflector will be numbered based on its corresponding level and column (e.g. the deflector in the second level, third column, is $d_{ij} = d_{23}$).

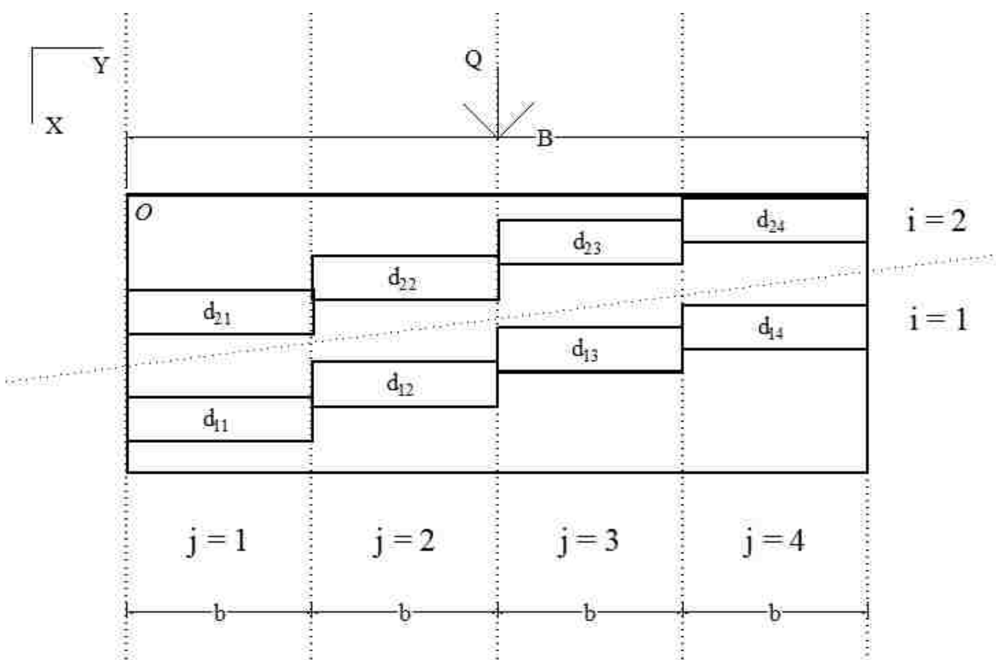

Figure 10: Deflector Rows and Columns of Staggered Deflectors, Plan View

Varying deflector dimensions along the Z-axis, by deflector level, is recommended during the design procedure. By varying the dimensions of the deflectors, the nappe projectile distances and *SWI*'s of the deflectors may be manipulated to allow for fewer deflector columns, creating wider regions of standing waves. Slight alterations may also be made after the basic design is completed, if desired, such as switching deflector columns along the Y-axis and/or doubling the amount of deflector columns and corresponding deflectors while dividing the width of all deflector columns and deflectors (Appendix C). These design alterations will alter the regions of standing waves for certain tailwater elevations or divide these regions across the width of the channel. The compiled basic design procedure and the corresponding detailed design procedure are provided in Appendix B & C, respectively.

4 MULTIPLE STAGGERED DEFLECTOR DESIGN EXPERIMENTS

The design procedure was tested in the same environment using the same methods as the exploratory experiments: a non-specific physical model of a 1V:2H sloped low-head dam in a level laboratory flume for various upstream and downstream conditions (Fig. 11). The model dam was approximately 4 feet wide (*B*) with a crest height (*P*) of approximately 1 foot. Headwater (*HW*) and tailwater elevations (*TW*) represented the upstream and downstream conditions. These elevations were measured with graduated scales 3*P* upstream and 6*P* downstream, respectively, in order to eliminate the effects of drawdown and amplitudes of standing waves (Olsen et al, 2013). All tailwater elevations were adjusted using a tailgate at the downstream end of the flume. Flows corresponding to each headwater elevation were measured using a Venturi meter.

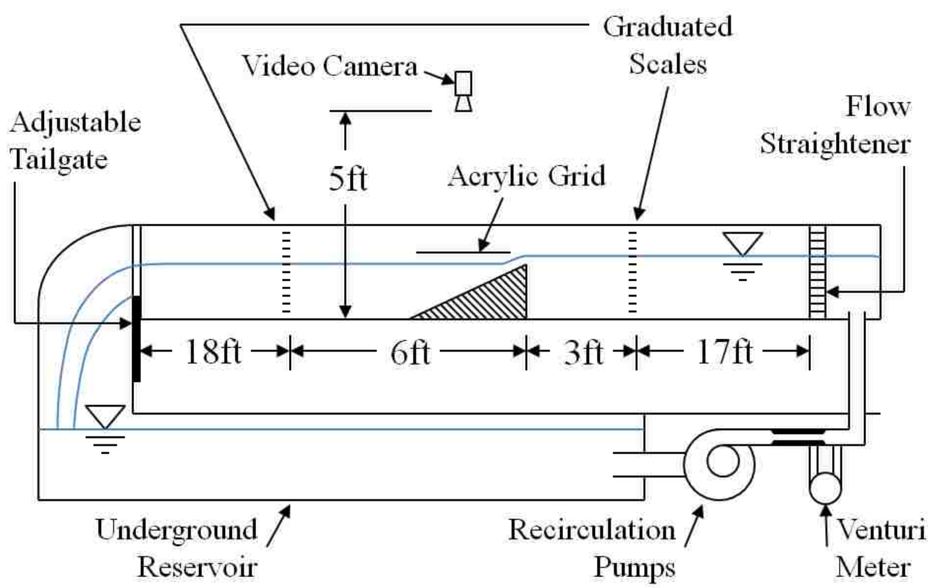

Figure 11: Design Simulation Experimental Setup (Kern, 2014)

Two sets of simulations were conducted: Submergence Characteristic Simulations and Design Simulations. Both sets of simulations were tested for the same upstream conditions (*HW* 1.25*P*, *HW* 1.2*P*, *HW* 1.15*P* and *HW* 1.1*P*). In accordance with the design procedure, *HW* 1.25*P* is considered to be the *HW* associated with Q_{max} and *HW* 1.1*P* is considered to be the *HW* associated with Q_0.

4.1 Submergence Simulations

4.1.1 Experiment

To ensure that the design was tested throughout SI_d and when the surface velocities are greatest, the first set of simulations was conducted in order to determine SI_d and the most appropriate downstream conditions to test for the design simulations. This set of simulations was tested with the unmodified spillway configuration in order to determine the submerged jump characteristics of the previously determined upstream conditions. The parameters measured for these simulations included the tailwater elevations associated with the flip/flop points, sequent depths and supercritical depths associated with each upstream condition. The *SI* for each upstream condition, SI_d, and the degrees of submergence correlating to each desired tailwater elevation were then calculated from these measurements. The degrees of submergence for each *HW/TW* condition were determined using Rajarantnam's equation previously mentioned (Eqn. 1).

4.1.2 Results

The following results were used to determine the four most appropriate tailwater elevations to test for each upstream condition in the subsequent Design Simulations (Table 1). The lowest tailwater elevation to be tested is when the surface velocities are greatest, or when the degree of submergence is 30% (Leutheusser and Fan 2001). The highest tailwater elevation to be tested is at 90% of the degree of submergence when the jump "flips," (90% S_{f2}). The two intermediate tailwater elevations to be tested are equally spaced in between the degrees of submergence of the lowest and highest tailwater elevations. The resulting SI_d was calculated to be 1.11P, beginning at the sequent depth of HW 1.1P (y_s = 0.121P) and ending at the flip depth of HW 1.25P (y_{f1} = 1.23P).

Typically, the intermediate tailwater elevations correlate to approximately 35% and 63% of S_{f2} for all upstream conditions. The degrees of submergence for the lowest tailwater elevations for all upstream conditions had a wider range of variability when compared to S_{f2} (from 4% - 13%). This is appropriate because the degree of submergence for the lowest tailwater elevation is fixed at 30% for all upstream conditions, whereas S_{f2} for all upstream conditions increases as the headwater elevation decreases.

Table 1: Submergence Simulations Results

(1) HW/P	(2) Fr_1	(3) y_s/P	(4) y_{f1}/P	(5) y_{f2}/P	(6) SI/P	(7) S_{f1}	(8) S_{f2}	(9) S	(10) % S_{f2}	(11) TW/P
1.25	5.20	0.379	1.14	1.23	0.843	2.01	2.23	0.30	13%	0.49
								0.87	39%	0.71
								1.44	64%	0.92
								2.01	90%	1.14
1.2	5.75	0.312	1.11	1.17	0.863	2.55	2.75	0.30	11%	0.41
								1.03	37%	0.63
								1.75	64%	0.86
								2.48	90%	1.09
1.15	6.56	0.232	1.08	1.13	0.892	3.63	3.85	0.30	8%	0.30
								1.35	35%	0.55
								2.41	63%	0.79
								3.46	90%	1.04
1.1	8.62	0.121	1.03	1.05	0.931	7.56	7.76	0.30	4%	0.16
								2.53	33%	0.42
								4.76	61%	0.69
								6.99	90%	0.96

Notes:

(1) dimensionless headwater elevation
(2) incoming froude number
(3) sequent depth
(4) flop point
(5) flip point
(6) submergence interval
(7) degree of submergence at flop point
(8) degree of submergence at flip point
(9) degree of submergence for determined tailwater elevation
(10) percent of degree of submergence at flip point for determined tailwater elevation
(11) dimensionless tailwater elevation

4.1.3 Discussion

These results seem very reasonable when compared to Leutheusser's work (Fig. 4). As the incoming Froude number increases, the degree of submergence when the jump flips increases as well. The calculated tailwater depths to test for subsequent simulations also appears reasonable as they are evenly spaced throughout the *SI* of each upstream condition. Therefore, these tailwater elevations will be used as the downstream conditions in the Design Simulations.

4.2 Design Simulations

4.2.1 Experiment

This set of simulations is composed of two parts: the Unmodified Design Simulations and the Multiple Staggered Deflector Design Simulations. Both spillway configurations were tested in order to determine the hydraulic state of the submerged jump before and after the installation of the Multiple Staggered Deflector Design configuration. This design, as depicted in Figs. 11 & 12, was configured from the previously specified design procedure (Appendix B) and the results of the exploratory Single Deflector Hydraulics simulations (Table 3 in Appendix A). The exact dimensions, positions, and coordinates of each deflector are tabulated in Table 4 in Appendix D.

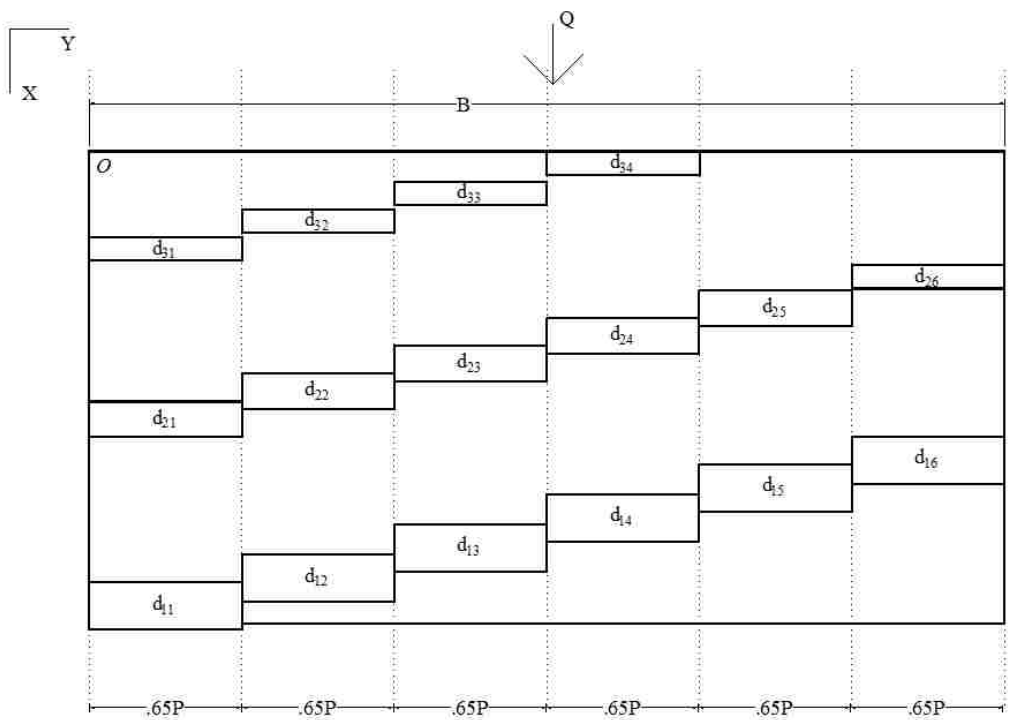

Figure 12: Model Multiple Staggered Deflector Design Configuration, Plan View

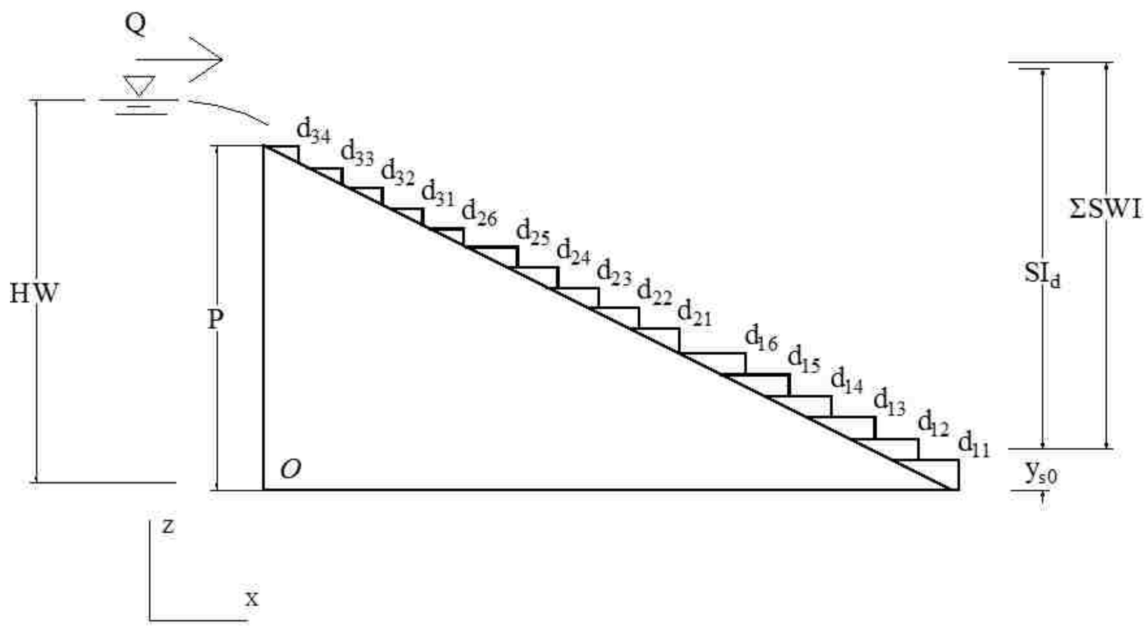

Figure 13: Model Multiple Staggered Deflector Design Configuration, Elevation View

The hydraulic state of the submerged jump was determined for all upstream and downstream conditions by measuring the surface velocities within the jump across the width of the channel. The surface velocities were measured by tracking 0.025 feet diameter floating beads on the surface of the water. A horizontal grid, with spacing at 0.1 feet, was suspended approximately 0.3 feet above the water surface in the area of the submerged jump directly downstream of the dam. The x- and y-axis of the grid follow the same axes previously specified in the design procedure. The grid was aligned such that the y-axis represented the point where the plunging nappe meets the tailwater. A downward facing camera was positioned 5 ft above the bottom of the channel, directly above the grid, where it filmed each simulation at a resolution of 720P at 60 frames per second (Fig. 13). Surface velocities in the submerged jump were measured manually from video footage of each simulation. Downstream velocities, or velocities in the X-direction (V_x), and lateral velocities, or velocities in the Y-direction (V_y), were measured by tracking the amount of frames it took a bead to travel a given distance in the x and y directions (Fig. 14). These velocities were calculated at a corresponding average position along the Y-axis (y_{ave}). These calculations were determined from the starting and ending position of a bead within the jump using Eqns. 7 and 8 below. To make these results dimensionless, the velocity in the X-direction is divided by the critical velocity, V_c, and the average Y-position is divided by the dam height, *P*. Results from both simulation sets will be compared in order to determine the effectiveness of the design.

$$V_{x/y}/V_c = \frac{x_2 - x_1}{(t_2 - t_1) * V_c}$$

Equation 8: Dimensionless Velocity in X-direction

Where

x = position of bead along X-axis [ft]

y = position of bead along Y-axis [ft]

t = time at which bead is at x-position [frames]

V_c = critical velocity [ft/s]

$$y_{ave}/P = \frac{y_2 + y_1}{2P}$$

Equation 9: Dimensionless Average Y - Position

Where

y = position of bead along Y-axis [ft]

P = dam height [ft]

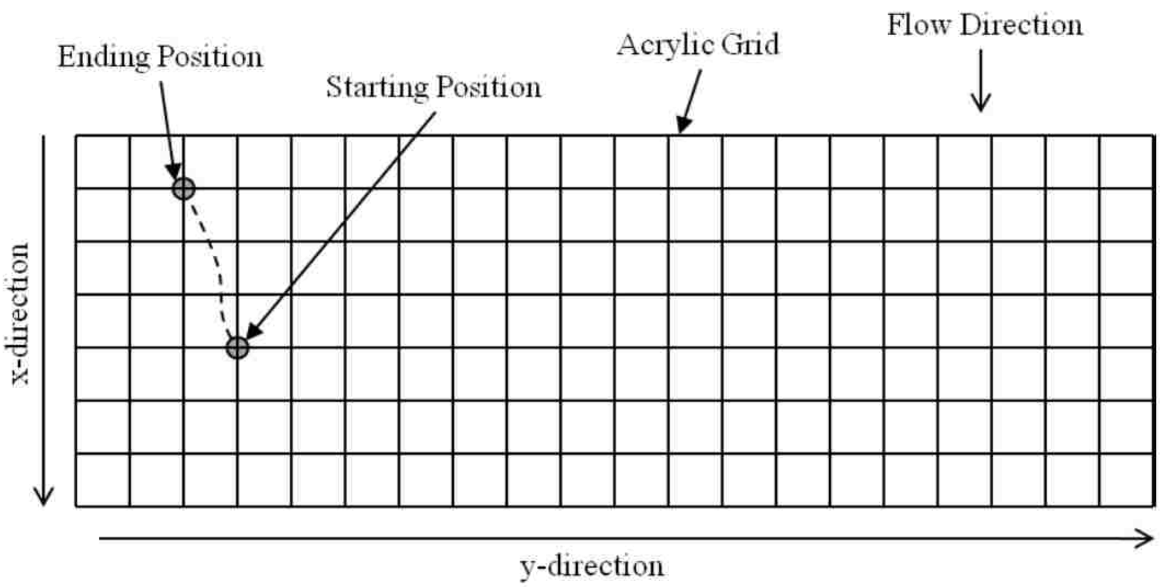

Figure 14: Sample Velocity Measurement on Suspended Grid, Plan View (Kern, 2014)

For each Multiple Staggered Deflector Design simulations, the activity of all deflector columns were pre-determined from the resulting deflector *SWI*'s of the Single Deflector Hydraulics experiment (Appendix A) in correlation with the final deflector positions (Appendix D). A deflector column is considered to be active (j_a) if it contains an active deflector (d_a) and is considered to be inactive (j_{in}) if it does not contain an active deflector. These pre-determined active and inactive deflector columns are tabulated by the sign of the magnitude of the surface velocities (+/-) within each deflector column in Appendix E and are to be used in the analysis of the Multiple Staggered Deflector Design Simulations in order to determine the viability of the design theory.

4.2.2 Results

The results indicate that the proposed Multiple Staggered Deflector Design modification was effective for all but two simulations. Figures 15 & 16 indicate the regions of standing waves across the channel width, *B*. The magnitude of velocities vary greatly within each deflector column for each simulation. Therefore, only the extent of the regions of positive velocity magnitudes across the channel width are indicated in the figures. In Fig. 16, all of the plotted simulations have the same degree of submergence and are offset for illustrative purposes only.

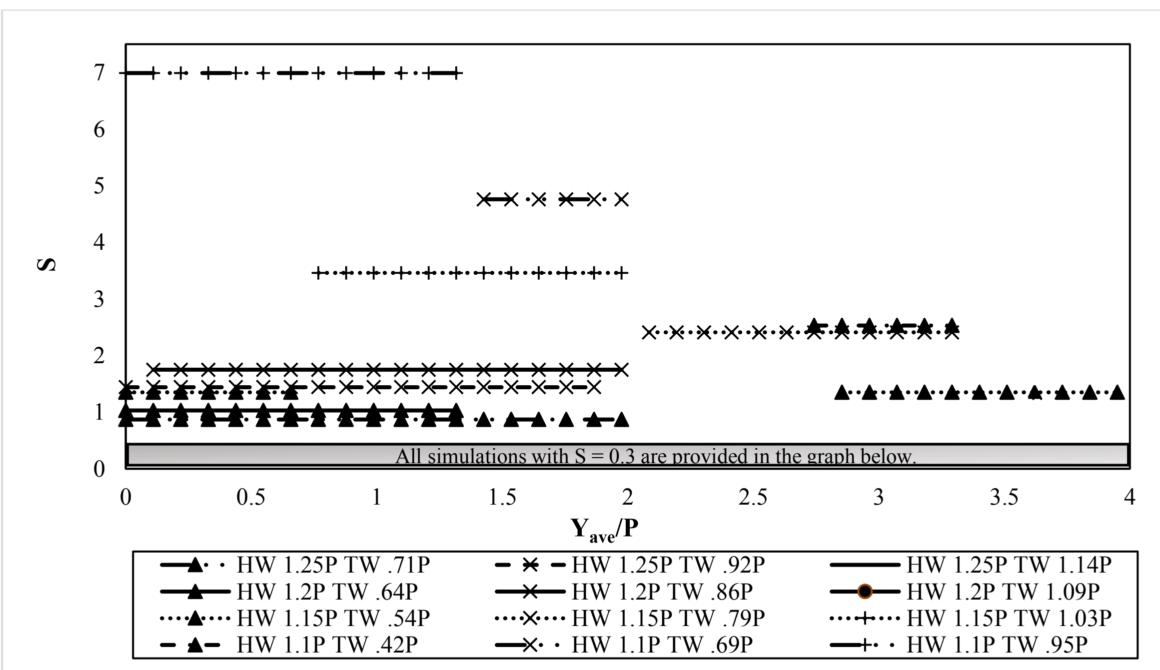

Figure 15: Location and Amount of Channel Width with Standing Waves

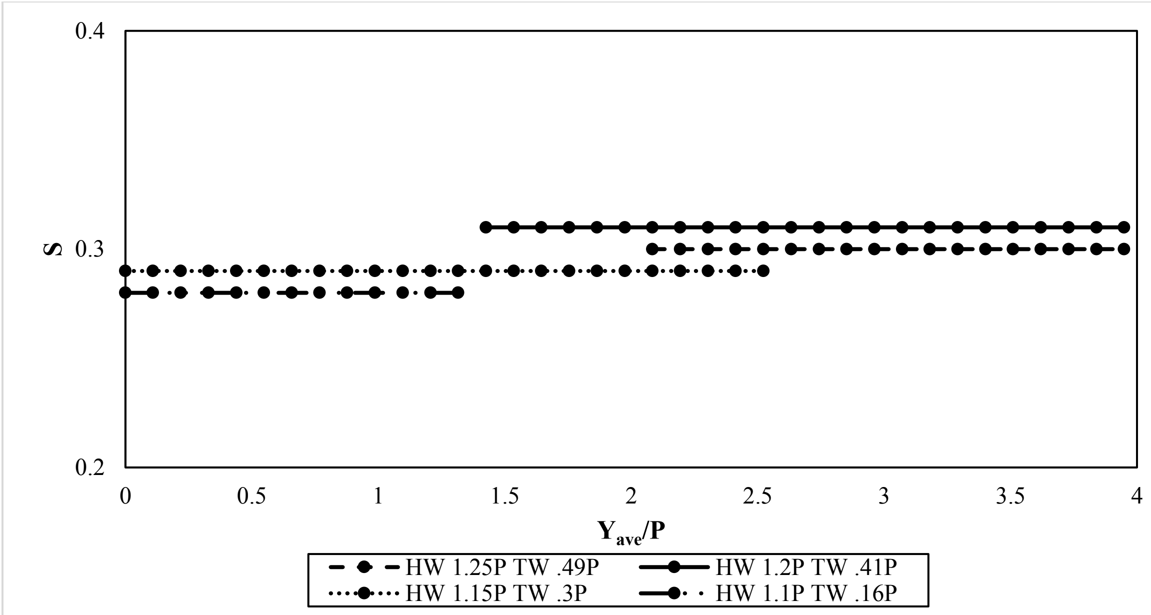

Figure 16: Location and Amount of Channel Width with Standing Waves for S = 0.3

These conclusions are tabulated in Table 6 in Appendix F by deflector column and were determined from the results of each of the Multiple Staggered Deflector Design Simulations, which are exemplified in the figure of the *HW* 1.1*P* *TW* 0.69*P* simulation (Fig. 17). Deflector columns are depicted in order to indicate the effects of the deflector in each deflector column that is closest to the tailwater elevation. For this particular simulation, it is clear that the third deflector column is correctly performing its function by creating a region of downstream-directed velocities (positive V_x/V_c values) approximately as wide as b (or w) in the form of standing waves. All inactive deflector columns in this configuration created upstream-directed velocities (negative V_x/V_c values) in the form of a submerged jump. Similar results were found in the remaining simulations in Appendix H.

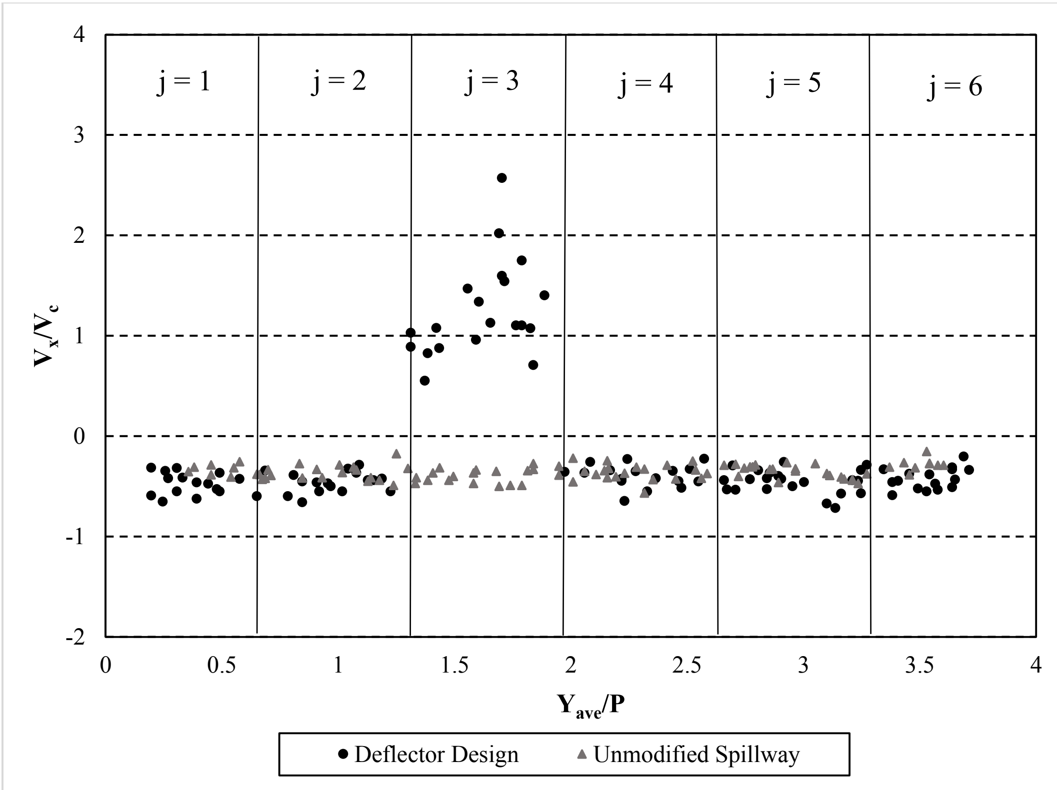

Figure 17: HW 1.1P TW 0.69P Design Simulations Results, V_x/V_c vs. Y_{ave}/P

The Unmodified Spillway Simulation results for this and all other simulations yielded uniform upstream-directed velocities across the width of channel. These results are expected and are provided in each simulation results graph in order to indicate the change in surface velocities due to the Multiple Staggered Deflector Design modification. All raw data obtained from both sets of simulations for the purpose of determining these results is found in Appendix H with corresponding figures.

The j_a and j_{in} for each Design Simulation was determined from Table 6 and compared to the pre-determined j_a and j_{in} from Table 5 and are indicated in Table 2 below. All j_a and j_{in} that were accurately anticipated are marked by a ✓ and all j_a and j_{in} that was inaccurately anticipated are marked by the sign of the actual velocity magnitude (+/-) from the Multiple Staggered Deflector Design Simulations. The two deflector columns marked "ND" indicates there was no data available from the simulation results. Consequently, these deflector columns were not use in subsequent calculations. The last column of the table indicates the percentage of accuracy of the predicted activity of each deflector column for each simulation. According to Table 2, an overall average of 80% of the deflector columns were accurately predicted for all simulations. Of the 20% that were inaccurately predicted, 15% included additional regions of standing waves that were not originally anticipated. The remaining 5% were unexpected inactive deflector columns that mainly occurred for the two highest tailwater simulations, *HW* 1.25*P* *TW* 1.14*P* and *HW* 1.2*P* *TW* 1.09*P*.

Table 2: Anticipated Column Velocity Activity

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
HW/P	**TW/P**	**S**	**V_x/V_c**						**% B Accurately Anticipated**
			j = 1	**j = 2**	**j = 3**	**j = 4**	**j = 5**	**j = 6**	
1.25	0.49	0.30	✓	✓	✓	✓	✓	+	83%
	0.71	0.87	✓	✓	+	✓	✓	✓	83%
	0.92	1.44	✓	✓	✓	+	✓	✓	83%
	1.14	2.01	✓	✓	-	-	✓	✓	67%
1.2	0.41	0.30	✓	✓	✓	✓	+	+	67%
	0.64	1.03	✓	✓	✓	✓	✓	+	83%
	0.86	1.75	✓	✓	✓	✓	✓	+	83%
	1.09	2.48	✓	-	-	✓	✓	✓	67%
1.15	0.30	0.30	+	✓	✓	+	✓	ND	50%
	0.54	1.35	✓	✓	✓	✓	+	✓	83%
	0.79	2.41	✓	✓	✓	✓	✓	✓	100%
	1.03	3.46	✓	✓	+	✓	✓	✓	83%

1.1	0.16	0.30	✓	+	✓	✓	✓	✓	83%
	0.42	2.53	✓	✓	✓	✓	✓	ND	83%
	0.69	4.76	✓	✓	-	+	✓	✓	67%
	0.95	6.99	+	✓	✓	✓	✓	✓	83%

(11)	
Overall %B Accurately Anticipated	
✓	80%
+	15%
-	5%

Notes:

(1) dimensionless headwater elevation

(2) dimensionless tailwater elevation

(3) degree of submergence

(4) - (9) dimensionless velocity in x-direction within each deflector column

(10) percent of channel width accurately anticipated according to recorded data

(11) overall average percent of channel width accurately anticipated and sign of channel width that actually occurred for those not accurately anticipated

4.2.3 Discussion

The Multiple Staggered Deflector Design modification has proven to be a very effective method at dissipating significant portions of a channel-wide submerged jump for almost all conditions that may present a submerged hydraulic jump. Active deflectors performed their proper function in the majority of the upstream and downstream conditions tested by producing regions of downstream-directed velocities in the form of a standing wave. The amount of channel width encompassed by standing waves appear to increase as the degree of submergence increases (Fig. 15), making it more likely to be washed out of the jump when surface velocities are greater, or when the jump becomes more dangerous.

These regions of standing waves were well-anticipated according to the design theory. However, unanticipated active deflectors were observed for many of the conditions tested, resulting in larger portions of the channel width having regions of standing waves. This indicates that not only is the design theory and subsequent design procedure viable, but it performs better than anticipated, making it more likely for an individual to be washed downstream through the jump in various upstream and downstream conditions.

The two highest tailwater simulations that did not produce standing waves in the Multiple Staggered Deflector Design simulations indicate that the anticipated active deflectors did not perform correctly. This discrepancy may be attributed to an assumption taken from the results of the Single Deflector Hydraulics simulations. The *SWI* values for each deflector, calculated from these simulation results, are based on the deflectors' height (d_z) of 0.7P on the dam for all simulations. Due to the amount of unanticipated active deflectors in various Multiple Staggered Deflector Design simulations and the failed active deflectors for the two highest tailwater simulations, it is possible that the *SWI* of a deflector is also dependent on the height of the deflector on the dam with respect to the incoming velocity of the overflow nappe.

Further research on the implementation of this design is recommended, particularly in regards to economic feasibility, regulation efforts, and further improving the safety of the design, while not altering their downstream hydraulic effects.

5 CONCLUSION

The danger of a submerged jump at low-head dams is very real and has claimed hundreds of lives in the past 60 years. Effective and safe remediation options need to be implemented in order to prevent further fatalities at these hydraulic structures, preferably at low cost. According to this study, the Multiple Staggered Deflector Design modification is a promising effective, safe, and low cost remediation option. This design includes installing multiple horizontal deflectors in a staggered pattern on the spillway of these structures, according to a prescribed design procedure. This study shows that this design is a very effective method at eliminating uniform upstream-directed surface velocities across the channel within the submerged jump for numerous upstream and downstream conditions. Regions of downstream-directed surface velocities in the form of a standing wave are presented throughout the width of the channel in the form of a standing wave, which should allow the opportunity for to any individual who is swept over the head of the dam to pass through a submerged jump with no severe threat to injury or death.

LIST OF VARIABLES

Variable		Definition
SI	=	Submergence Interval [ft]
SWI	=	Standing Wave Interval [ft]
SI_d	=	Design Submergence Interval [ft]
SWI_d	=	Design Standing Wave Interval [ft]
y_{f1}	=	Flop Point [ft]
y_{f2}	=	Flip Point [ft]
$y_{f2.max}$	=	Flip Point of Maximum Discharge [ft]
y_{df1}	=	Design Deflector Flop Point [ft]
y_{df2}	=	Design Deflector Flip Point [ft]
y_s	=	Sequent Depth [ft]
y_{s0}	=	Sequent Depth of Design Discharge [ft]
y_{ds1}	=	1st Deflector Sequent Depth [ft]
y_{ds2}	=	2nd Deflector Sequent Depth [ft]
x_{ave}	=	Average X-Position [ft]
y_{ave}	=	Average Y-Position [ft]
P	=	Dam Height [ft]
B	=	Dam Width [ft]
b	=	Column Width [ft]
i	=	Deflector Level
j	=	Deflector Column
j_a	=	Active Deflector Column
j_{in}	=	Inactive Deflector Column

k	=	Multiple
t	=	Deflector Tread [ft]
r	=	Deflector Rise [ft]
w	=	Deflector Width [ft]
d_{ij}	=	Named Deflector
d_x	=	Deflector X-Coordinate [ft]
d_y	=	Deflector Y-Coordinate [ft]
d_z	=	Deflector Z-Coordinate [ft]
d_{pz}	=	Possible Deflector Elevation [ft]
d_m	=	Current Deflector
d_n	=	Proceeding Deflector
d_a	=	Active Deflector
d_{in}	=	Inactive Deflector
HW	=	Headwater Elevation [ft]
TW	=	Tailwater Elevation [ft]
S	=	Degree of Submergence
S_{f2}	=	Degree of Submergence at Flip Point
S_{f1}	=	Degree of Submergence at Flop Point
Fr_1	=	Incoming Froude Number
Δx	=	Nappe Projectile Distance in X-direction, [ft]
Δz	=	Nappe Projectile Distance in Z-direction, [ft]
Q_0	=	Design Discharge [cfs]
Q_{max}	=	Maximum Discharge [cfs]
V_x	=	Velocity in X-direction [ft/s]
V_y	=	Velocity in Y-direction [ft/s]
V_c	=	Critical Velocity [ft/s]

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APPENDIX A. SINGLE DEFLECTOR HYDRAULICS RESULTS

Table 3: Single Deflector Hydraulics Results

d_t = 0.1P						
(1)	(2)	(3)	(4)	(5)	(6)	(7)
HW/P	**TW/P**				**Δz/P**	**SWI/P**
	y_{ds1} (a to b)	**y_{ds2} (b to a)**	**y_{df1} (b to c)**	**y_{df2} (c to b)**		
1.1	0.81	0.815	0.725	0.75	0.25	0.06
1.15	0.88	0.885	0.735	0.795	0.29	0.08
1.2	0.92	0.93	0.77	0.83	0.2	0.09
1.25	0.97	0.98	0.81	0.87	0.21	0.10

d_t = 0.15P						
(1)	(2)	(3)	(4)	(5)	(6)	(7)
HW/P	**TW/P**				**Δz/P**	**SWI/P**
	y_{ds1} (a to b)	**y_{ds2} (b to a)**	**y_{df1} (b to c)**	**y_{df2} (c to b)**		
1.1	0.81	0.81	0.72	0.75	0.32	0.06
1.15	0.87	0.88	0.74	0.79	0.45	0.08
1.2	0.93	0.93	0.76	0.82	0.46	0.11
1.25	0.97	0.98	0.8	0.86	0.5	0.11

d_t = 0.2P						
(1)	(2)	(3)	(4)	(5)	(6)	(7)
HW/P	**TW/P**				**Δz/P**	**SWI/P**
	y_{ds1} (a to b)	**y_{ds2} (b to a)**	**y_{df1} (b to c)**	**y_{df2} (c to b)**		
1.1	0.8	0.81	0.7	0.735	0.28	0.06
1.15	0.86	0.87	0.71	0.76	0.36	0.10
1.2	0.9	0.93	0.73	0.8	0.39	0.10
1.25	0.96	0.97	0.77	0.83	0.42	0.13

Notes:

(1) Dimensionless Headwater Elevation
(2) 1st Deflector Sequent Depth [ft]
(3) 2nd Deflector Sequent Depth [ft]
(4) Deflector Flop Point [ft]
(5) Deflector Flip Point [ft]
(6) Nappe Projectile Distance in Z-direction
(7) Standing Wave Interval

APPENDIX B. BASIC DESIGN PROCEDURE

I. Deflectors of a specified tread (*t*) will be placed on the spillway, along the Z-axis, beginning at the bottom of a previously determined SI_d such that the bottom of its SWI_d is at the bottom of SI_d (Eqn. 4).

$$d_{11z} = y_{s0} - y_{df2}$$

Equation 5: Elevation of First Deflector [ft]

Where

y_{s0} = Design Sequent Depth [ft]

y_{df2} = Deflector Flip Point [ft]

After the first deflector is placed, another deflector is placed such that the bottom of its SWI_d is set to the top of the previous deflector's SWI_d, according to Eqn. 6. This process is repeated until the last deflector's SWI_d is greater than the maximum flip point, or until the last deflector is placed at the very top of the dam.

$$d_{zn} = d_{zm} + (y_{dmf2} - y_{dnf2}) + SWI_{dm}$$

Equation 6: Elevation of Proceeding Deflector [ft]

Where

d_{zm} = Elevation of Current Deflector [ft]

y_{dmf2} = Flip Point of Current Deflector [ft]

y_{dnf2} = Flip Point of Next Deflector [ft]

SWI_{dm} = SWI_d of Next Deflector

This process will continue along the Z-axis of the dam until the $\sum SWI$ is equal to or greater than the top of SI_d or the top of the dam is reached (Fig. 7).

II. Deflectors are to be placed directly above lower deflectors such that the maximum nappe projectile distance of the higher deflector is equal to or greater than the position of the lower deflector along the Z- and X-axis (Fig. 9, Case b).

III. Each deflector is placed along the Y-axis in a separate deflector column from previous deflectors until Part II is possible. Once this occurs, a deflector may be placed in a previous deflector column that allows for this condition, ending the first deflector level.

IV. Once the first level is placed, the number of deflectors in this level are equal to the number of deflector columns needed for the entire design. The width of each deflector (w), and the width of each deflector column (b), is then determined to be the number of deflector columns divided by the dam width, B (Eqn. 2).

$$w = b = \frac{\sum j}{B}$$

Equation 7: Deflector/Column Width

Where:

j = deflector column

B = dam width [ft]

V. Once the value of w and b are determined, the remaining deflectors will be placed according to Parts I – III in the established deflector columns.

VI. According to the numbering of each level and column, each placed deflector will be numbered based on its corresponding level and column (e.g. the deflector in the second level, third column, is $d_{ij} = d_{23}$).

APPENDIX C. DETAILED DESIGN PROCEDURE

The design procedure is as follows:

I. Determine Input Parameters.

II. Design Deflectors along the Z- and Y-axis.

III. Design Modification

The first two steps of this design are an iterative procedure that will yield a basic design with the least amount of deflectors needed and the location of every deflector. The last step includes suggestive modifications to the basic design that may yield more efficient and desired results, pending on the specific project. An illustrative example of this procedure is provided using a 2:1 sloped low-head dam.

I. <u>Determine Input Parameters</u>

The design considers the effects of a design flow (Q_0) and a maximum flow (Q_{max}), which will be determined according to the best judgements of the engineer. Therefore, parameters involving both flows will need to be determined. All flows in between will be considered indirectly.

From field measurements, determine all necessary dam parameters: dam height (P), dam width (B), and design and maximum discharges (Q_d and Q_{max}) going over the dam. Then, determine all necessary flow parameters for both the design and maximum discharges: headwater elevation (*HW*), design sequent depth (or sequent depth corresponding to the design discharge) (y_{s0}), and maximum "flip" point (or the flip point corresponding to the maximum discharge) ($y_{f2.max}$). A headwater elevation may be determined before the corresponding discharge, which can be then be determined from this *HW* value through hydraulic relationships such as a weir equation. Determine the Design Submergence Interval from flow parameters (Eqn. 3). Intermediate flows and corresponding submergence intervals may be desired for measurements in order to produce a more efficient design.

$$SI_d = y_{f2.max} - y_{s0}$$

Equation 4: Design Submergence Interval

Where

$y_{f2.max}$ = Maximum Flip Point [ft]

y_{s0} = Design Sequent Depth [ft]

Single deflector parameters are also necessary in order to adhere to the design procedure. These parameters include the maximum nappe projectile distances (Δx, Δz) and deflector sequent and flip depths (y_{ds1} and y_{df2}) of all deflector dimensions that are considered. These parameters will also need to be determined in relation to the design and maximum discharge. Then determine the Design Standing Wave Interval (SWI_d) according to Eqn. 3 using the design deflector sequent and flip depths. Intermediate flow deflector parameters may be desired measurements in order to produce a more efficient design.

$$SWI_d = y_{ds1} - y_{df2}$$

Equation 3: Design Standign Wave Interval

Where

y_{ds1} = First Deflector Sequent Depth [ft]

y_{df2} = Deflector Flip Point [ft]

II. Design deflectors along the Z- and Y-axis:

A. The design will begin by establishing the first level of deflectors along the dam, beginning in the first deflector column. This level will not have any lower deflectors, so the projectile distance of these deflectors will not be considered and a larger deflector tread (*t*) may be considered. Deflectors are placed in each level according to SWI_d. It should be noted that once the submergence interval of the design flow has been exceeded, then the SWI_d adjusts to the *SWI* of the next highest flow measured. As each deflector is placed in this level, or any level, the position of the next level of deflectors will be considered simultaneously until the next deflector level within a deflector column exceeds the Design Submergence Interval or the height of the dam. This consideration calculates two possible deflector locations according to the maximum nappe projectile distance of the higher deflector, according to both Δx_{max} and Δz_{max}. The higher location is the location at which the next level deflector may be placed in the specified deflector column. Obviously, deflectors may be placed higher according to the required position along the Z-axis.

1. Place the first deflector in the first deflector column along the Z-axis such that the bottom of the SWI interval of the deflector is at the design sequent depth, $SWI_{11.bottom} = y_{s0}$ (Fig. 19). The elevation of this deflector is:

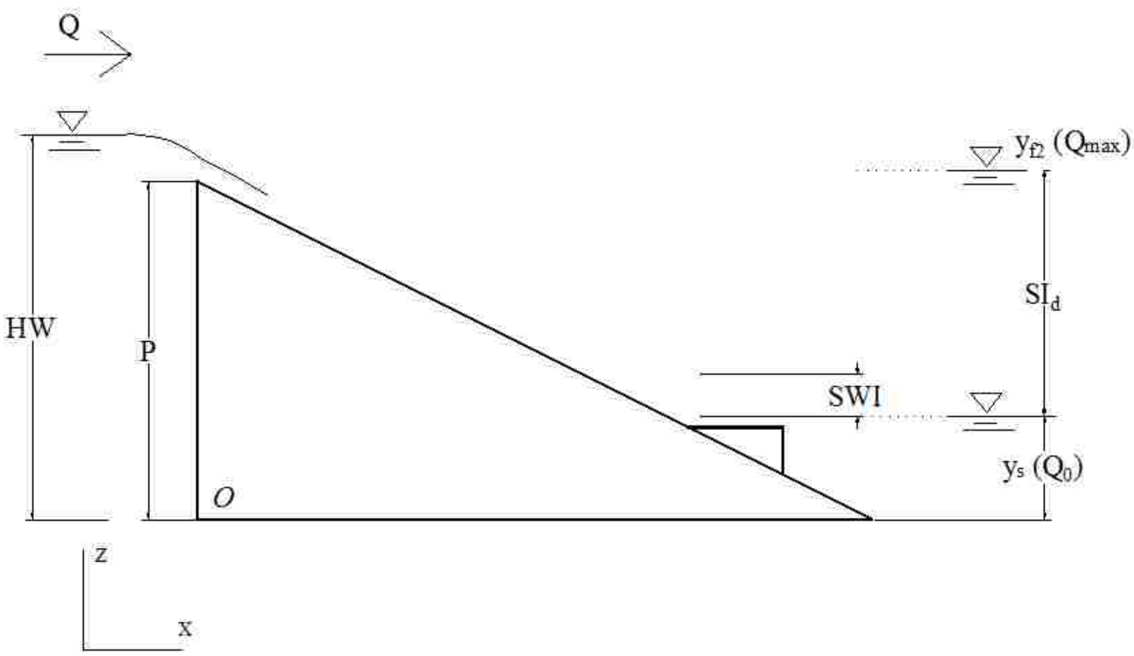

Figure 18: Placing First Deflector Along SI_d, Elevation View

$$d_{11z} = y_{s0} - y_{df2}$$

Equation 5: Elevation of First Deflector [ft]

Where

y_{s0} = Design Sequent Depth [ft]

y_{df2} = Deflector Flip Point [ft]

2. As the first deflector is placed, the possible Z location of a higher level deflector will be calculated according to the maximum nappe projectile distance of the higher level deflector dimension (Eqn. 9).

$$d_{i+1,j\,pz} = d_{ijz} + \Delta z / x_{max}$$

Equation 10: Possible Elevation of Higher Deflector [ft]

Where

d_{ijz} = Elevation of Recently Placed Deflector [ft]

$\Delta z/x_{max}$ = Maximum Nappe projectile distance in X- and Z- direction [ft]

3. Record the z- and corresponding x-coordinate of this first deflector (d_{11x}, d_{11z}) and the possible z- and x-coordinate of the higher deflector (d_{11px}, d_{11pz}). Repeat for each deflector as it is placed.

4. The next deflector should be placed such that the bottom of its SWI_d is equal to the top of the SWI_d of the previous deflector, $SWI_{bottom.d12} = SWI_{top.d11}$. This process will continue as deflectors are placed along the Z-axis according to Eqn. 6.

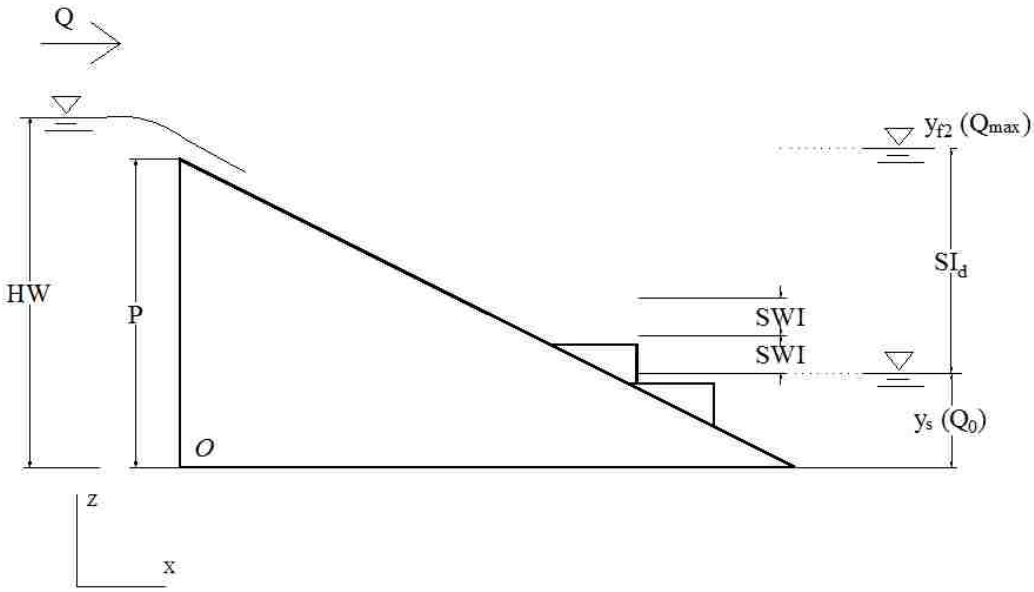

Figure 19: Second Placed Deflector Along SI_d, Elevation View

$$d_{zn} = d_{zm} + (y_{dmf2} - y_{dnf2}) + SWI_{dm}$$

Equation 6: Elevation of Proceeding Deflector [ft]

Where

d_{zm} = Elevation of Current Deflector [ft]

y_{dmf2} = Flip Point of Current Deflector [ft]

y_{dnf2} = Flip Point of Next Deflector [ft]

SWI_{dm} = SWI_d of Next Deflector

5. Possible deflector locations will continue to be calculated as each deflector is placed.

6. Continue placing deflectors along the Z-axis according to Eqn. 5 until the SWI_{top} of a possible deflector exceeds the top of the Design Submergence Interval, $SWI_{n.top} > SI_{top}$ (see Fig. 20). Once the top deflector is placed, the flows associated with the SWI_{top} of the deflector should be compared to the associated SI_{top} for each corresponding measured flow to ensure that the *SWI* of the deflector exceeds each submergence interval.

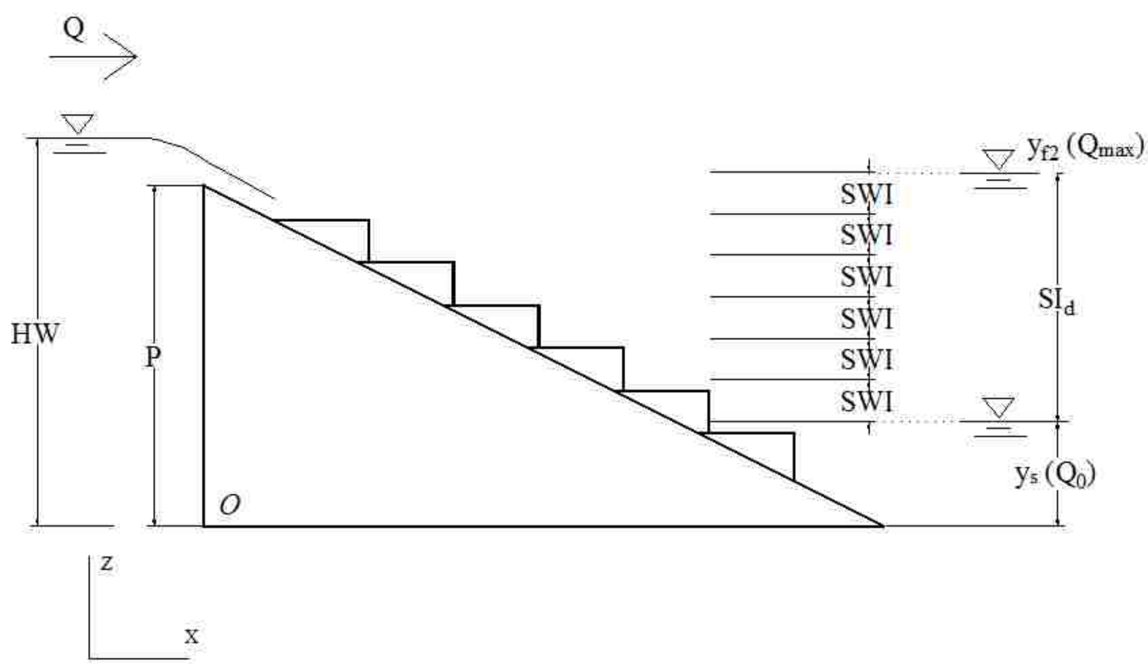

Figure 20: ∑SWI > SI_d, Elevation View

B. Design along the Y-axis will be considered simultaneously with the design along the Z-axis, however the 1st step of the design along the Z-axis will be considered first.

1. As deflectors are placed in the first level, along the Z-axis, and possible deflector locations are determined, once a deflector's elevation is greater than or equal to the first calculated possible deflector location ($d_{nz} \geq d_{21pz}$), the second deflector level begins in the first column at the required deflector elevation, d_{nz}.

2. All subsequent deflectors must be placed in proceeding columns such that its elevation is greater than the previously calculated possible deflector elevation within the deflector column ($d_{nz} \geq d_{pz}$).

Once the second level begins, the amount of deflector columns ($\sum j$) is defined as the amount of deflectors in the first level. This value must now be adhered to throughout the rest of the procedure. If at any point, Step 2 of this section is not met, altering the Z-dimension of one or two deflectors may be conducted in order to satisfy this condition. However, if this minor alteration cannot satisfy Eqn. 6, the deflector columns will need to be re-evaluated, beginning with Step 1 of this section. This will include adding deflector column(s) such that Step 2 of this section is met throughout the entire design.

3. Calculate the width of the deflectors (w) with the following equation:

$$w = \frac{B}{\sum j}$$

Equation 7: Deflector/Column Width [ft]

Where:

j = deflector column

B = dam width [ft]

4. Now that the deflector columns and corresponding deflector width (w) has been determined, go back and record the y-coordinate of each deflector in the first level. As deflectors are continuing to be placed, record the y-coordinate (d_{ijy}) of each deflector.

5. Continue placing deflectors along the second level and calculating higher possible deflector locations until the deflector within the last column is placed.

6. Repeat this procedure for all higher levels until the last deflector is placed at the top of the dam or its SWI_{top} exceeds the design submergence interval, $SWI_{top.n} > SI_{top}$ (see Fig. 20).

III. Design Modifications:

Now that the basic design has been created, minor modifications can be made in order to yield more desired results. It is recommended that step a be made before step b, but these steps may be conducted out of order.

a. The location(s) of the regions of standing waves at certain tailwater elevations may be desired at other locations within the channel. For example, the deflector column(s) that yield standing waves at the depth of the highest degree of submergence may be desired in the center of the channel. Therefore, the deflector columns are interchangeable along the width of dam. Deflector columns may be rearranged, so long as the Z- and X- coordinates of the deflectors within that column(s) are maintained upon rearrangement. This is exemplified in Figs. 21 & 22 below.

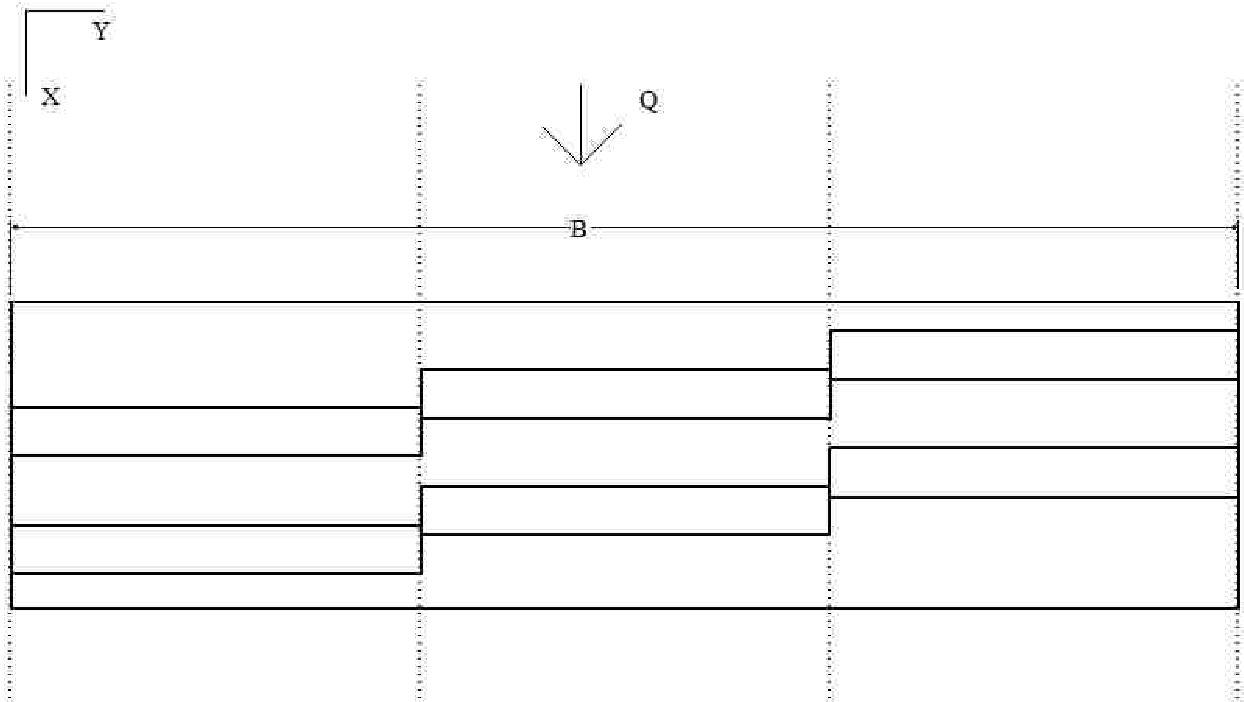

Figure 21: Basic Multiple Staggered Deflector Design, Plan View

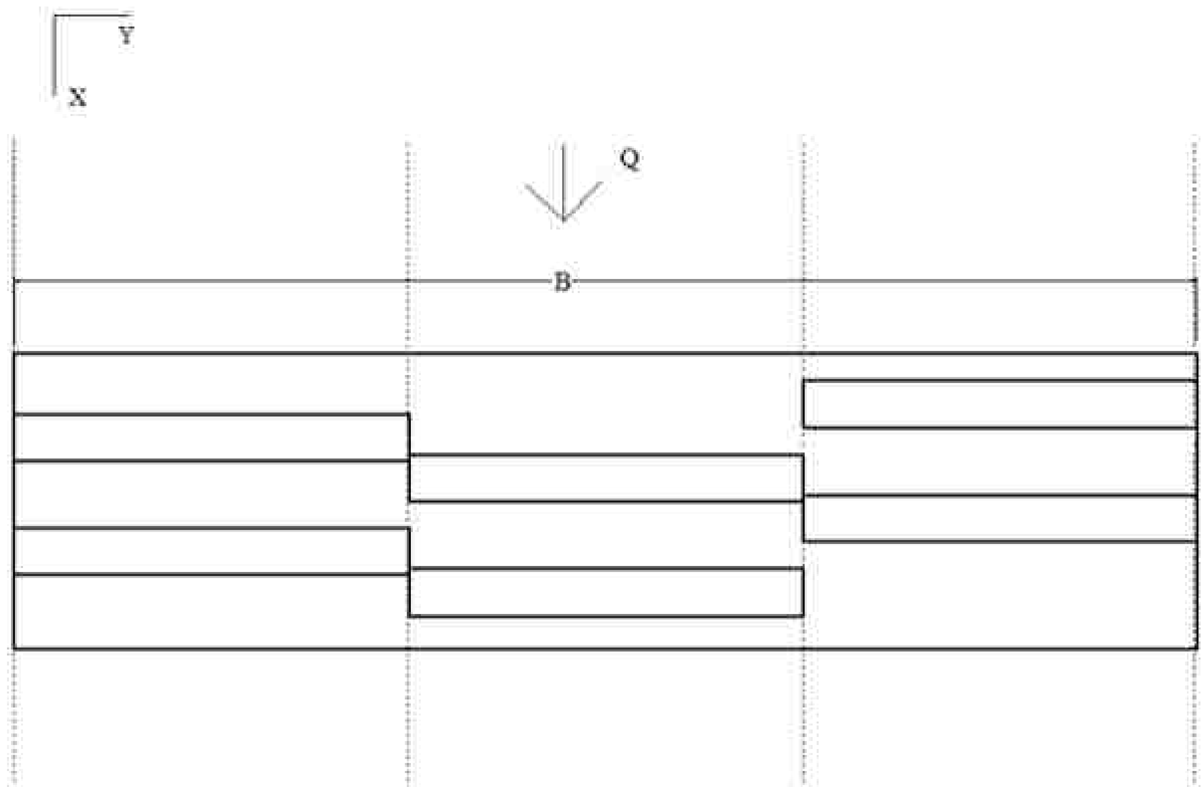

Figure 22: Modified Multiple Staggered Deflector Design A, Plan View

b. In order to yield further safety in the event that an individual does not fall in the channel near the vicinity of the region of standing waves, this area may be divided across the channel. This can be accomplished by increasing the amount of deflectors, at their assigned Z- and X-coordinates, by a multiple (k) of the total number of deflectors (Eqn. 10), while dividing the width of the deflectors by the same multiple (Eqn. 11). This will create multiple regions of standing waves at a new y-dimension, which will maintain the total amount of downstream-directed velocities within the channel. It should be noted that the y-coordinate of each deflector will need to be re-evaluated. The new columns can then be rearranged as stated in step a.

$$\sum d_n = k \sum d_m$$

Equation 11: Modified Number of Deflectors

Where

$\sum d_m$ = Total Number of Current Deflectors

k = multiple

$$w_n = \frac{w_m}{k}$$

Equation 12: Modified Deflector Width [ft]

Where

w_m = current deflector width [ft]

k = multiple

It should be noted that as you increase the amount of divided areas across the channel the width of these regions decrease, possibly making it more difficult for safe passage through the jump. Therefore, increasing the total amount of deflectors by 2 or 3 times is considered sufficient.

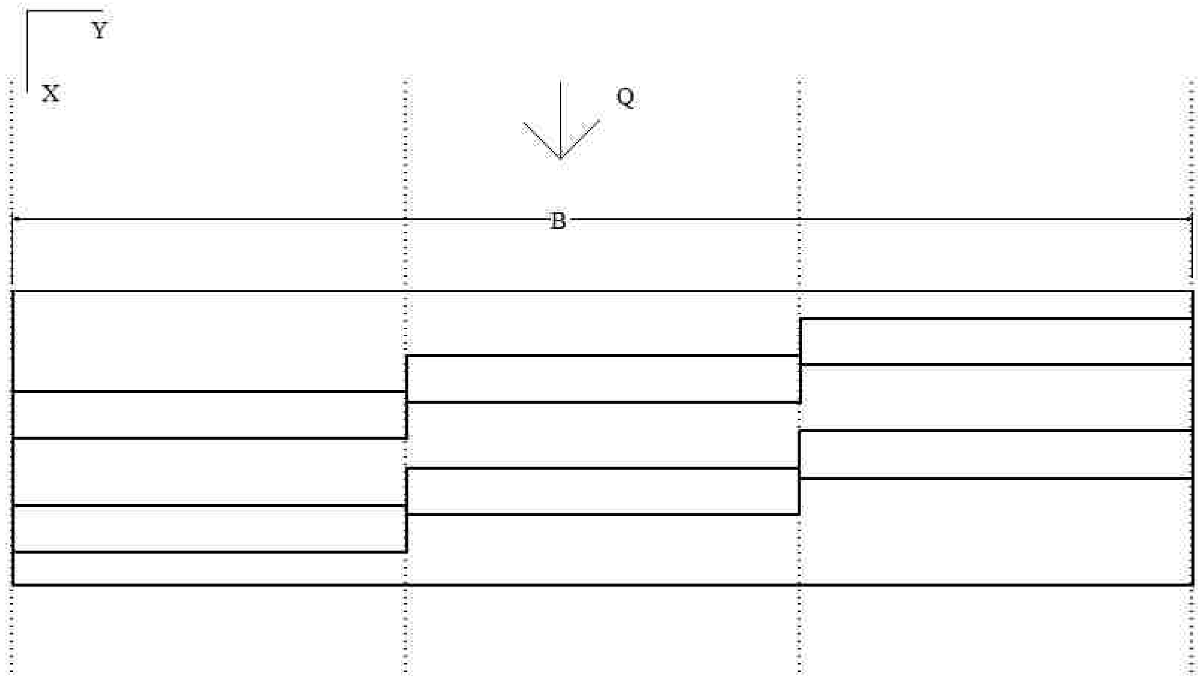

Figure 23: Basic Multiple Staggered Deflector Design, Plan View

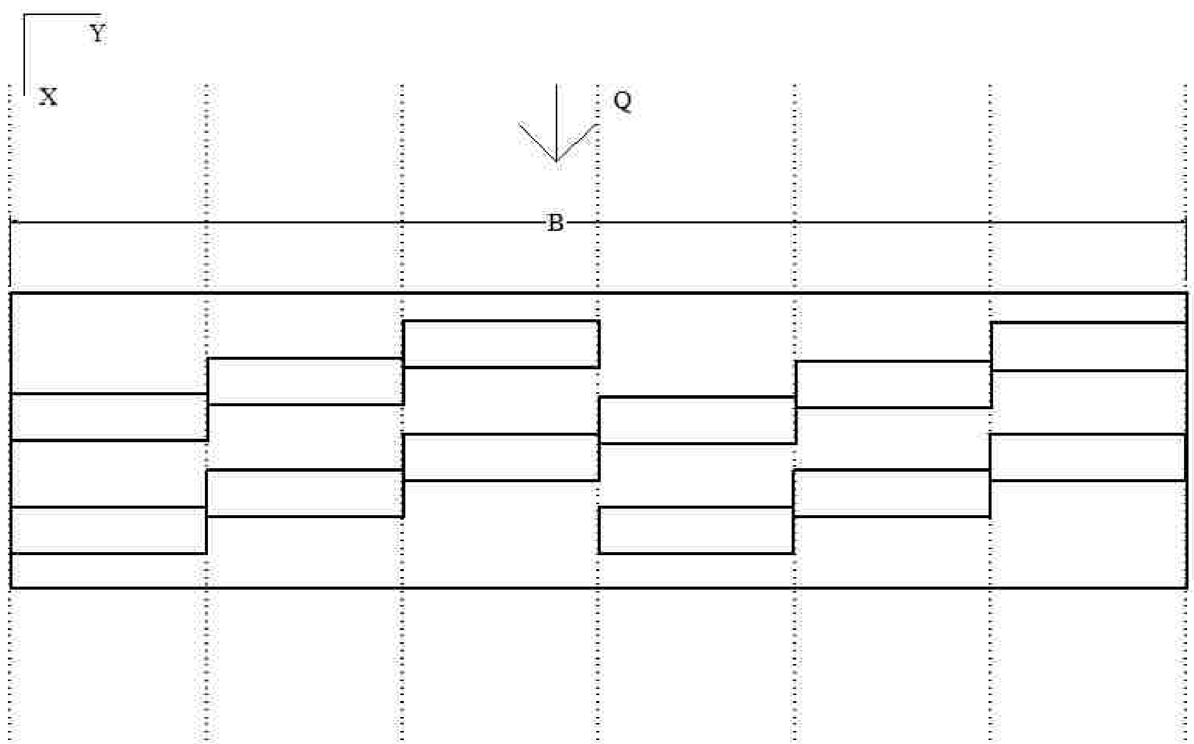

Figure 24: Altered Multiple Staggered Deflector Design B, Plan View

APPENDIX D. MODEL DEFLECTOR COORDINATES AND DIMENSIONS

Table 4: Model Deflector Coordinates and Dimensions

(1)	(2)	(3)	(4)	(5)	(6)
d	**d_x/P**	**d_y/P**	**d_z/P**	**d_t/P**	**d_r/P**
11	1.83	0.32	0.09	0.20	0.10
12	1.70	0.97	0.15	0.20	0.10
13	1.58	1.61	0.21	0.20	0.10
14	1.45	2.26	0.27	0.20	0.10
15	1.33	2.90	0.34	0.20	0.10
16	1.20	3.55	0.40	0.20	0.10
21	1.06	0.32	0.47	0.15	0.08
22	0.94	0.97	0.53	0.15	0.08
23	0.82	1.61	0.59	0.15	0.08
24	0.71	2.26	0.65	0.15	0.08
25	0.59	2.90	0.71	0.15	0.08
26	0.48	3.55	0.76	0.10	0.05
31	0.36	0.32	0.82	0.10	0.05
32	0.25	0.97	0.88	0.10	0.05
33	0.13	1.61	0.94	0.10	0.05
34	0.00	2.26	1.00	0.10	0.05

(7)	**$\sum d$**	16
(8)	**d_w/P**	0.65
(9)	**$\sum d_c$**	6
(10)	**$\sum d_l$**	3

Notes:
- (1) deflector number
- (2) deflector x-coordinate
- (3) deflector y-coordinate
- (4) deflector z-coordinate
- (5) deflector tread
- (6) deflector rise

(7) cumulative amount of deflectors
(8) deflector width
(9) total number of columns
(10) total number of levels

APPENDIX E. ANTICIPATED AND ACTUAL ACTIVE DEFLECTOR COLUMNS FOR MODEL DESIGN

Table 5: Anticipated Active Deflector Columns for Model Design

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
HW/P	**TW/P**	**S**	**V_x/V_c**						**% B w/ Standing Waves**
			j = 1	**j = 2**	**j = 3**	**j = 4**	**j = 5**	**j = 6**	
1.25	0.49	0.30	-	-	-	+	+	-	33%
	0.71	0.87	+	+	-	-	-	-	33%
	0.92	1.44	-	-	-	-	+	+	33%
	1.14	2.01	-	-	+	+	-	-	33%
1.2	0.41	0.30	-	-	+	+	-	-	33%
	0.64	1.03	+	+	-	-	-	-	33%
	0.86	1.75	-	-	-	+	+	-	33%
	1.09	2.48	-	+	+	-	-	-	33%
1.15	0.30	0.30	-	+	+	-	-	-	33%
	0.54	1.35	+	-	-	-	-	+	33%
	0.79	2.41	-	-	-	+	+	-	33%
	1.03	3.46	-	+	-	-	-	-	17%
1.1	0.16	0.30	+	-	-	-	-	-	17%
	0.42	2.53	-	-	-	-	+	-	17%
	0.69	4.76	-	-	-	+	-	-	17%
	0.95	6.99	-	+	-	-	-	-	17%

Notes:
(1) dimensionless headwater elevation
(2) dimensionless tailwater elevation

(3) degree of submergence
(4) - (9) dimensionless velocity in x-direction within each deflector column
(10) percent of channel width with regions of standing waves ($+V_x/V_c$)

Table 6: Actual Active Deflector Columns for Model Design

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
HW/P	**TW/P**	**S**	**V_x/V_c**						**% B w/ Standing Waves**
			j = 1	**j = 2**	**j = 3**	**j = 4**	**j = 5**	**j = 6**	
1.25	0.49	0.30	-	-	-	+	+	+	50%
	0.71	0.87	+	+	+	-	-	-	50%
	0.92	1.44	-	-	-	+	+	+	50%
	1.14	2.01	-	-	-	-	-	-	0%
1.2	0.41	0.30	-	-	+	+	+	+	67%
	0.64	1.03	+	+	-	-	-	+	50%
	0.86	1.75	-	-	-	+	+	+	50%
	1.09	2.48	-	-	-	-	-	-	0%
1.15	0.30	0.30	+	+	+	+	-	ND	67%
	0.54	1.35	+	-	-	-	+	+	50%
	0.79	2.41	-	-	-	+	+	-	33%
	1.03	3.46	-	+	+	-	-	-	33%
1.1	0.16	0.30	+	+	-	-	-	-	33%
	0.42	2.53	-	-	-	-	+	ND	17%
	0.69	4.76	-	-	+	-	-	-	17%
	0.95	6.99	+	+	-	-	-	-	33%

Notes: (1) dimensionless headwater elevation
(2) dimensionless tailwater elevation
(3) degree of submergence
(4) - (9) dimensionless velocity in x-direction within each deflector column
(10) percent of channel width with regions of standing waves ($+V_x/V_c$)

APPENDIX F. DESIGN SIMULATIONS RAW DATA AND CALCULATIONS

Table 7: HW 1.25P TW 0.49P, Multiple Staggered Deflector Design Simulation*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	0.7	0.175	52199	0.475	0.15	52225	-0.229	-0.025	0.576	0.159
2	0.6	0.275	39974	0.225	0.2	40003	-0.342	-0.068	0.404	0.233
3	0.65	0.55	40686	0.3	0.6	40729	-0.215	0.031	0.466	0.564
4	0.675	0.625	50077	0.225	0.825	50124	-0.253	0.113	0.441	0.711
5	0.75	0.65	18010	0.2	0.875	18064	-0.270	0.110	0.466	0.748
6	0.7	0.75	87504	0.3	0.775	87529	-0.423	0.026	0.490	0.748
7	0.575	0.75	6267	0.3	0.75	6290	-0.316	0.000	0.429	0.735
8	0.65	0.8	87541	0.175	1	87596	-0.229	0.096	0.404	0.882
9	0.6	0.825	93058	0.125	0.95	93091	-0.381	0.100	0.355	0.870
10	0.7	0.9	60617	0.15	0.925	60659	-0.347	0.016	0.417	0.895
11	0.7	0.925	45213	0.2	0.85	45237	-0.551	-0.083	0.441	0.870
12	0.625	0.95	39536	0.175	0.95	39598	-0.192	0.000	0.392	0.931
13	0.675	1.025	45268	0.275	0.925	45310	-0.252	-0.063	0.466	0.956
14	0.525	1.025	34966	0.175	0.95	34997	-0.299	-0.064	0.343	0.968
15	0.7	1.025	39708	0.125	1.125	39758	-0.304	0.053	0.404	1.054
16	0.7	1.075	24387	0.325	1.225	24416	-0.342	0.137	0.502	1.127
17	0.625	1.075	33478	0.25	1.25	33516	-0.261	0.122	0.429	1.140
18	0.7	1.15	39797	0.2	0.95	39837	-0.331	-0.132	0.441	1.029
19	0.6	1.175	34118	0.1	1.125	34153	-0.378	-0.038	0.343	1.127
20	0.675	1.2	34615	0.35	0.975	34653	-0.226	-0.157	0.502	1.066
21	0.7	1.25	49883	0.15	1.175	49913	-0.485	-0.066	0.417	1.189
22	0.6	1.275	34099	0.2	1.4	34130	-0.341	0.107	0.392	1.311
23	0.7	1.275	49904	0.2	1.35	49932	-0.473	0.071	0.441	1.287
24	0.7	1.35	34356	0.25	1.2	34408	-0.229	-0.076	0.466	1.250
25	0.7	1.375	5664	0.175	1.425	5701	-0.375	0.036	0.429	1.373
26	0.725	1.375	24342	0.2	1.75	24401	-0.235	0.168	0.453	1.532
27	0.7	1.4	24734	0.125	1.575	24782	-0.317	0.096	0.404	1.458
28	0.7	1.475	34262	0.075	1.55	34298	-0.459	0.055	0.380	1.483
29	0.7	1.525	81695	0.15	1.475	81729	-0.428	-0.039	0.417	1.471
30	0.7	1.55	6753	0.125	1.675	6780	-0.564	0.123	0.404	1.581
31	0.7	1.625	27298	0.15	1.65	27327	-0.502	0.023	0.417	1.605

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
32	0.65	1.625	39236	0.275	1.775	39256	-0.496	0.198	0.453	1.667
33	0.65	1.65	6255	0.375	1.825	6268	-0.560	0.356	0.502	1.703
34	0.6	1.7	12322	0.35	1.95	12352	-0.221	0.221	0.466	1.789
35	0.6	1.725	54724	0.275	1.95	54748	-0.358	0.248	0.429	1.801
36	0.7	1.75	76808	0.3	2.15	76842	-0.311	0.311	0.490	1.912
37	0.6	1.825	65697	0.3	1.95	65720	-0.345	0.144	0.441	1.850
38	0.675	1.85	65755	0.3	1.925	65777	-0.451	0.090	0.478	1.850
39	0	1.85	81131	0.75	2.325	81158	0.735	0.466	0.368	2.047
40	0.7	1.9	60454	0.1	1.825	60514	-0.265	-0.033	0.392	1.826
41	0	1.95	65532	1.05	2.1	65550	1.544	0.221	0.515	1.985
42	0	1.95	6122	1	2.1	6147	1.058	0.159	0.490	1.985
43	0	1.975	81129	1.075	2.375	81159	0.948	0.353	0.527	2.132
44	0.7	1.975	81840	0.4	2.075	81854	-0.567	0.189	0.539	1.985
45	0.075	2.075	6000	1.05	2.35	6048	0.538	-0.152	0.478	1.703
46	0	2.15	62738	1.1	2.35	62851	0.258	-0.047	0.539	1.667
47	0.2	2.2	33197	0.7	2.2	33202	2.646	0.000	0.245	1.716
48	0.075	2.225	33193	1.1	2.2	33204	2.466	0.060	0.502	1.703
49	0.025	2.225	33194	1	2.225	33205	2.345	0.000	0.478	1.691
50	0.025	2.275	57763	1.1	2.3	57778	1.896	-0.044	0.527	1.630
51	0.1	2.3	11995	1.1	2.55	12055	0.441	-0.110	0.490	1.495
52	0	2.35	59959	1.125	2.4	59980	1.418	0.063	0.551	2.328
53	0.4	2.45	76609	1.125	2.35	76619	1.918	-0.265	0.748	2.353
54	0	2.45	35261	1	2.45	35274	2.036	0.000	0.490	2.402
55	0.1	2.45	51677	1.025	2.45	51693	1.530	0.000	0.551	2.402
56	0.025	2.525	6659	1	2.6	6671	2.150	0.165	0.502	2.512
57	0	2.525	33182	1.1	2.6	33197	1.941	0.132	0.539	2.512
58	0	2.55	9944	1.05	2.55	9958	1.985	0.000	0.515	2.500
59	0	2.575	39254	0.7	2.6	39262	2.315	0.083	0.343	2.537
60	0	2.575	76466	1.075	2.925	76480	2.032	0.662	0.527	2.696
61	0.1	2.65	49532	0.825	2.575	49543	1.744	-0.180	0.453	2.561
62	0	2.675	44752	1.05	2.625	44764	2.315	-0.110	0.515	2.598
63	0.025	2.675	49493	1.075	2.55	49506	2.137	-0.254	0.539	2.561
64	0.025	2.75	13766	0.65	2.6	13777	1.504	-0.361	0.331	2.623
65	0	2.775	4653	1.025	2.65	4670	1.595	-0.195	0.502	2.659
66	0	2.825	33045	0.7	2.825	33052	2.646	0.000	0.343	2.770
67	0.075	2.85	6558	0.95	2.8	6573	1.544	-0.088	0.502	2.770
68	0	2.9	9978	1.025	3.025	9995	1.595	0.195	0.502	2.904
69	0.1	2.925	4542	1.1	2.85	4554	2.205	-0.165	0.588	2.831
70	0.05	2.95	6491	0.9	3.05	6504	1.730	0.204	0.466	2.941
71	0.05	2.975	13862	1.1	2.95	13877	1.852	-0.044	0.564	2.904

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
72	0	2.975	19526	0.925	2.825	19541	1.632	-0.265	0.453	2.843
73	0	3.025	6590	1.1	2.875	6602	2.426	-0.331	0.539	2.892
74	0.125	3.1	4560	0.75	3.075	4568	2.067	-0.083	0.429	3.027
75	0	3.1	6480	0.7	3.15	6489	2.058	0.147	0.343	3.064
76	0	3.125	4513	0.8	3.15	4529	1.323	0.041	0.392	3.076
77	0.1	3.175	10014	1.025	3.275	10028	1.748	0.189	0.551	3.162
78	0	3.2	4629	0.9	3.275	4642	1.832	0.153	0.441	3.174
79	0.025	3.225	10085	0.65	3.15	10096	1.504	-0.180	0.331	3.125
80	0.025	3.275	19558	1.025	3.275	19574	1.654	0.000	0.515	3.211
81	0.075	3.275	32833	0.85	3.125	32842	2.279	-0.441	0.453	3.137
82	0	3.3	4601	0.7	3.15	4611	1.852	-0.397	0.343	3.162
83	0.1	3.425	19723	1.025	3.525	19745	1.113	0.120	0.551	3.407
84	0	3.45	9966	1	3.475	9980	1.890	0.047	0.490	3.395
85	0.1	3.45	19672	1.025	3.45	19686	1.748	0.000	0.551	3.382
86	0.075	3.475	9998	1.1	3.55	10010	2.260	0.165	0.576	3.444
87	0.025	3.525	19611	1.025	3.625	19625	1.890	0.189	0.515	3.505
88	0	3.55	19541	1.1	3.675	19555	2.079	0.236	0.539	3.542
89	0.25	3.575	65262	1	3.675	65283	0.945	0.126	0.613	3.554

Notes:
(1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

*All subsequent raw data tables follow the same format as shown here.

Table 8: HW 1.25P TW 0.49P, Unmodified Spillway Simulation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	0.7	0.175	33092	0.15	0.025	33114	-0.662	-0.180	0.417	0.098
2	0.6	0.275	29807	0.2	0.25	29826	-0.557	-0.035	0.392	0.257
3	0.7	0.3	30415	0.1	0.675	30456	-0.387	0.242	0.392	0.478
4	0.7	0.35	19125	0.25	0.3	19141	-0.744	-0.083	0.466	0.319
5	0.7	0.425	19455	0.2	0.475	19480	-0.529	0.053	0.441	0.441
6	0.6	0.425	30068	0.2	0.35	30085	-0.623	-0.117	0.392	0.380
7	0.7	0.45	34214	0.1	0.475	34243	-0.547	0.023	0.392	0.453
8	0.7	0.55	21388	0.1	0.55	21415	-0.588	0.000	0.392	0.539
9	0.75	0.55	21840	0.15	0.35	21861	-0.756	-0.252	0.441	0.441
10	0.7	0.55	26821	0.1	0.175	26846	-0.635	-0.397	0.392	0.355
11	0.675	0.6	29304	0.1	0.6	29330	-0.585	0.000	0.380	0.588
12	0.7	0.6	29322	0.075	0.5	29347	-0.662	-0.106	0.380	0.539
13	0.7	0.65	19816	0.05	0.725	19843	-0.637	0.074	0.368	0.674
14	0.7	0.7	21599	0.1	0.85	21619	-0.794	0.198	0.392	0.760
15	0.7	0.75	18124	0.225	0.75	18149	-0.503	0.000	0.453	0.735
16	0.7	0.75	20655	0.1	0.65	20678	-0.690	-0.115	0.392	0.686
17	0.7	0.8	17831	0.1	0.8	17865	-0.467	0.000	0.392	0.784
18	0.7	0.825	18213	0.1	0.975	18240	-0.588	0.147	0.392	0.882
19	0.7	0.85	19484	0.1	0.975	19510	-0.611	0.127	0.392	0.895
20	0.7	0.925	19545	0.1	0.9	19571	-0.611	-0.025	0.392	0.895
21	0.7	0.95	17532	0.1	1.075	17553	-0.756	0.158	0.392	0.993
22	0.65	0.95	17639	0.225	0.925	17658	-0.592	-0.035	0.429	0.919
23	0.675	1.025	19301	0.15	0.75	19323	-0.631	-0.331	0.404	0.870
24	0.675	1.05	17618	0.1	1.05	17643	-0.609	0.000	0.380	1.029
25	0.7	1.05	17913	0.2	1	17952	-0.339	-0.034	0.441	1.005
26	0.6	1.15	14360	0.1	1.325	14382	-0.601	0.210	0.343	1.213
27	0.7	1.15	16369	0.075	1.2	16398	-0.570	0.046	0.380	1.152
28	0.7	1.15	19799	0.1	1.5	19841	-0.378	0.221	0.392	1.299
29	0.7	1.175	14496	0.1	1.35	14525	-0.547	0.160	0.392	1.238
30	0.675	1.175	16724	0.125	1.175	16747	-0.633	0.000	0.392	1.152
31	0.7	1.225	16341	0.1	1.325	16367	-0.611	0.102	0.392	1.250
32	0.7	1.275	15992	0.2	1.45	16014	-0.601	0.210	0.441	1.336
33	0.7	1.35	16614	0.1	1.15	16640	-0.611	-0.204	0.392	1.225
34	0.7	1.35	17550	0.1	1.35	17580	-0.529	0.000	0.392	1.324
35	0.7	1.375	14626	0.225	1.475	14650	-0.524	0.110	0.453	1.397
36	0.7	1.375	16320	0.075	1.325	16342	-0.752	-0.060	0.380	1.324
37	0.7	1.45	17115	0.225	1.525	17139	-0.524	0.083	0.453	1.458
38	0.7	1.5	16052	0.1	1.65	16074	-0.722	0.180	0.392	1.544
39	0.7	1.55	13800	0.1	1.525	13821	-0.756	-0.032	0.392	1.507

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.7	1.55	16278	0.1	1.6	16313	-0.454	0.038	0.392	1.544
41	0.7	1.6	13181	0.05	1.65	13204	-0.748	0.058	0.368	1.593
42	0.7	1.625	13101	0.15	1.475	13128	-0.539	-0.147	0.417	1.520
43	0.7	1.65	13251	0.1	1.55	13277	-0.611	-0.102	0.392	1.569
44	0.7	1.725	14707	0.05	1.9	14745	-0.453	0.122	0.368	1.777
45	0.7	1.75	16075	0.1	1.775	16094	-0.836	0.035	0.392	1.728
46	0.7	1.75	16285	0.1	1.65	16316	-0.512	-0.085	0.392	1.667
47	0.7	1.825	10732	0.1	1.75	10759	-0.588	-0.074	0.392	1.752
48	0.7	1.825	16077	0.1	1.825	16096	-0.836	0.000	0.392	1.789
49	0.7	1.85	17232	0.2	1.925	17260	-0.473	0.071	0.441	1.850
50	0.675	1.875	13916	0.1	1.925	13945	-0.525	0.046	0.380	1.863
51	0.7	1.925	12809	0.15	1.9	12831	-0.662	-0.030	0.417	1.875
52	0.7	1.95	10309	0.2	1.975	10328	-0.696	0.035	0.441	1.924
53	0.6	2	10663	0.1	2	10683	-0.662	0.000	0.343	1.961
54	0.7	2.025	12267	0.1	2.1	12295	-0.567	0.071	0.392	2.022
55	0.7	2.05	11169	0.1	1.9	11196	-0.588	-0.147	0.392	1.936
56	0.7	2.075	10076	0.15	2.35	10106	-0.485	0.243	0.417	2.169
57	0.7	2.1	10624	0.1	1.8	10658	-0.467	-0.233	0.392	1.912
58	0.75	2.15	10372	0.075	2.075	10404	-0.558	-0.062	0.404	2.071
59	0.7	2.2	10170	0.15	2.2	10193	-0.633	0.000	0.417	2.157
60	0.7	2.2	10308	0.175	2.15	10330	-0.631	-0.060	0.429	2.132
61	0.725	2.225	14865	0.15	2.25	14886	-0.725	0.032	0.429	2.194
62	0.7	2.3	9838	0.1	2.3	9866	-0.567	0.000	0.392	2.255
63	0.7	2.3	10546	0.1	2.4	10572	-0.611	0.102	0.392	2.304
64	0.7	2.3	10946	0.1	2.325	10973	-0.588	0.025	0.392	2.267
65	0.7	2.4	9692	0.1	2.45	9730	-0.418	0.035	0.392	2.377
66	0.7	2.425	6304	0.1	2.625	6334	-0.529	0.176	0.392	2.475
67	0.6	2.45	6860	0.1	2.55	6878	-0.735	0.147	0.343	2.451
68	0.7	2.475	6304	0.1	2.65	6333	-0.547	0.160	0.392	2.512
69	0.7	2.525	6640	0.1	2.475	6661	-0.756	-0.063	0.392	2.451
70	0.7	2.55	7270	0.1	2.525	7296	-0.611	-0.025	0.392	2.488
71	0.7	2.575	10339	0.1	2.6	10360	-0.756	0.032	0.392	2.537
72	0.7	2.6	6289	0.1	2.525	6309	-0.794	-0.099	0.392	2.512
73	0.6	2.65	9921	0.1	2.75	9942	-0.630	0.126	0.343	2.647
74	0.675	2.7	6298	0.1	2.65	6322	-0.634	-0.055	0.380	2.623
75	0.7	2.725	6628	0.2	2.85	6645	-0.778	0.195	0.441	2.733
76	0.7	2.75	4210	0.1	2.8	4231	-0.756	0.063	0.392	2.721
77	0.7	2.8	5803	0.1	2.85	5828	-0.635	0.053	0.392	2.770
78	0.65	2.8	6201	0.1	2.65	6229	-0.520	-0.142	0.368	2.672
79	0.7	2.85	6349	0.1	2.575	6384	-0.454	-0.208	0.392	2.659

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.7	2.875	4092	0.05	2.85	4119	-0.637	-0.025	0.368	2.806
81	0.7	2.925	8395	0.1	3.075	8416	-0.756	0.189	0.392	2.941
82	0.6	2.95	6864	0.1	2.95	6894	-0.441	0.000	0.343	2.892
83	0.6	2.975	4344	0.1	2.975	4361	-0.778	0.000	0.343	2.917
84	0.7	3.025	4988	0.1	2.95	5011	-0.690	-0.086	0.392	2.929
85	0.7	3.05	3943	0.15	3	3964	-0.693	-0.063	0.417	2.966
86	0.7	3.125	5755	0.1	3.25	5776	-0.756	0.158	0.392	3.125
87	0.675	3.15	4915	0.05	3.05	4946	-0.534	-0.085	0.355	3.039
88	0.675	3.15	5850	0.1	3.15	5869	-0.801	0.000	0.380	3.088
89	0.6	3.175	4311	0.125	3.225	4328	-0.739	0.078	0.355	3.137
90	0.675	3.225	4299	0.15	3.15	4322	-0.604	-0.086	0.404	3.125
91	0.65	3.25	5033	0.1	3.25	5055	-0.662	0.000	0.368	3.186
92	0.7	3.275	4441	0.1	3.5	4465	-0.662	0.248	0.392	3.321
93	0.6	3.3	4440	0.1	3.15	4459	-0.696	-0.209	0.343	3.162
94	0.7	3.35	4351	0.1	3.45	4384	-0.481	0.080	0.392	3.333
95	0.6	3.375	4640	0.1	3.45	4665	-0.529	0.079	0.343	3.346
96	0.6	3.4	4713	0.05	3.5	4737	-0.606	0.110	0.319	3.382
97	0.7	3.4	4263	0.125	3.3	4283	-0.761	-0.132	0.404	3.284
98	0.7	3.5	4054	0.2	3.475	4075	-0.630	-0.032	0.441	3.419
99	0.6	3.525	4219	0.125	3.45	4246	-0.466	-0.074	0.355	3.419
100	0.7	3.55	3829	0.2	3.65	3851	-0.601	0.120	0.441	3.529
101	0.7	3.575	6011	0.075	3.45	6054	-0.385	-0.077	0.380	3.444
102	0.6	3.625	5852	0.1	3.65	5881	-0.456	0.023	0.343	3.566
103	0.7	3.65	4636	0.125	3.65	4658	-0.692	0.000	0.404	3.578
104	0.7	3.675	5741	0.1	3.65	5782	-0.387	-0.016	0.392	3.591
105	0.7	3.7	5135	0.1	3.55	5166	-0.512	-0.128	0.392	3.554
106	0.55	3.7	5574	0.1	3.625	5591	-0.700	-0.117	0.319	3.591

Notes:
(1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

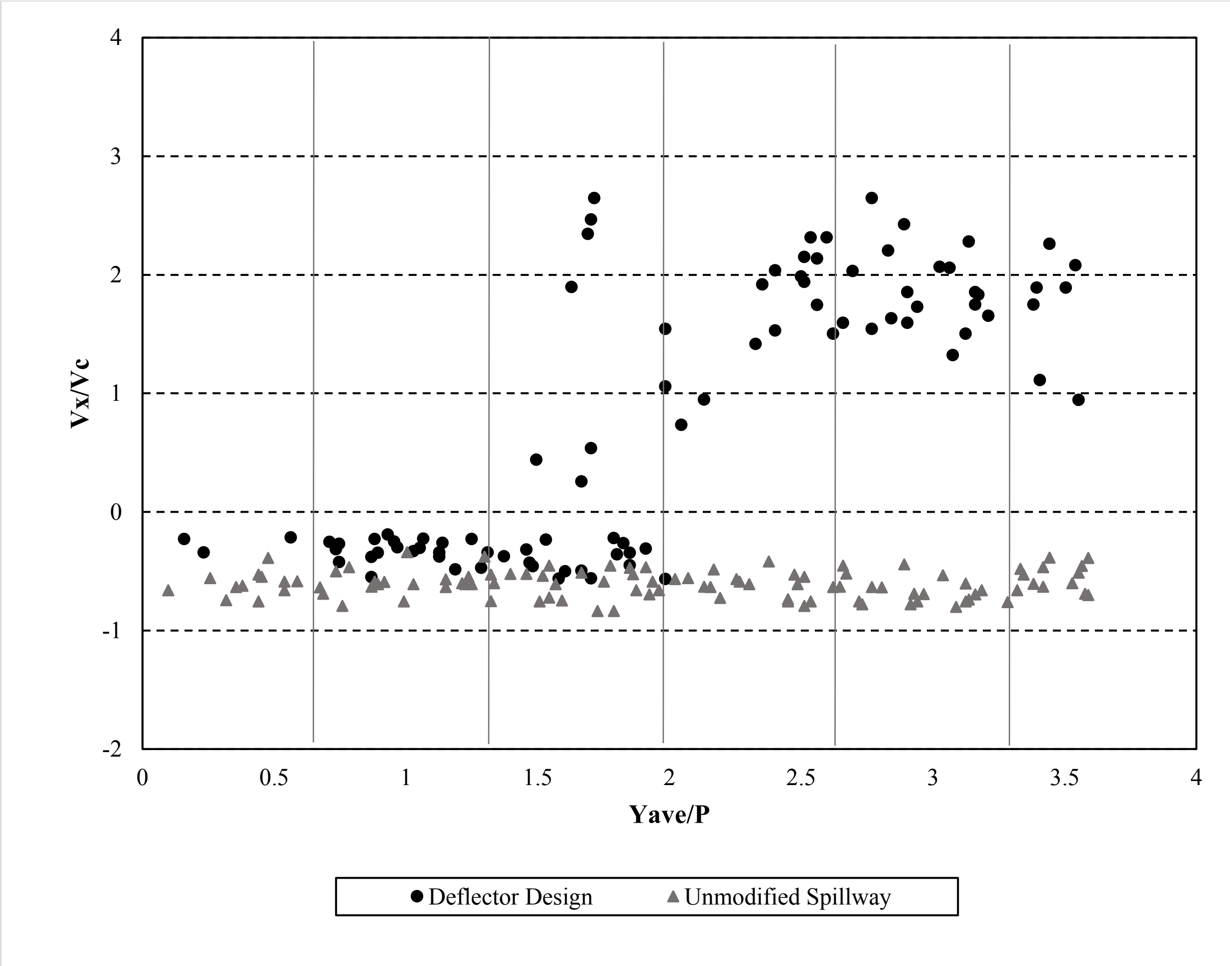

Figure 25: HW 1.25P TW 0.49P Design Simulations Results

Table 9: HW 1.25P TW 0.71P, Multiple Staggered Deflector Design Simulation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	0.6	0.45	39089	1.1	0.55	39100	1.203	0.241	0.833	0.490
2	0	0.5	31985	0.8	0.45	31997	1.764	-0.110	0.392	0.466
3	0	0.55	15677	0.8	0.45	15689	1.764	-0.221	0.392	0.490
4	0.475	0.55	31898	1.1	0.675	31911	1.272	0.254	0.772	0.600
5	0.025	0.625	15737	0.9	0	15749	1.930	-1.378	0.453	0.306
6	0	0.65	11274	1.1	0.7	11290	1.819	0.083	0.539	0.662
7	0.175	0.65	20854	1	0.55	20868	1.559	-0.189	0.576	0.588
8	0.025	0.725	11202	0.9	0.575	11213	2.105	-0.361	0.453	0.637
9	0.1	0.75	3124	1.1	0.725	3137	2.036	-0.051	0.588	0.723
10	0	0.75	12664	1.025	0.375	12679	1.808	-0.662	0.502	0.551
11	0	0.8	10830	0.8	0.65	10842	1.764	-0.331	0.392	0.711
12	0	0.8	19439	0.825	0.65	19454	1.455	-0.265	0.404	0.711
13	0.025	0.85	23836	1.1	0.85	23851	1.896	0.000	0.551	0.833
14	0.025	0.9	11355	0.825	0.75	11367	1.764	-0.331	0.417	0.809
15	0	0.9	27838	1.1	0.975	27858	1.455	0.099	0.539	0.919
16	0.05	0.925	3080	1.025	0.825	3093	1.985	-0.204	0.527	0.858
17	0	1	20153	1.075	0.925	20168	1.896	-0.132	0.527	0.944
18	0	1.05	10865	1	1.2	10883	1.470	0.221	0.490	1.103
19	0	1.05	12758	0.9	1.025	12770	1.985	-0.055	0.441	1.017
20	0.025	1.075	23814	1.075	1	23828	1.985	-0.142	0.539	1.017
21	0	1.125	16958	1	1.125	16971	2.036	0.000	0.490	1.103
22	0.05	1.15	3101	1.025	1.175	3115	1.843	0.047	0.527	1.140
23	0	1.2	21284	0.6	1.275	21296	1.323	0.165	0.294	1.213
24	0	1.225	16814	1.1	1.35	16827	2.239	0.254	0.539	1.262
25	0	1.225	16961	0.9	1.3	16972	2.165	0.180	0.441	1.238
26	0	1.275	16834	1	1.375	16847	2.036	0.204	0.490	1.299
27	0.025	1.3	3123	0.7	1.55	3135	1.488	0.551	0.355	1.397
28	0	1.3	20124	1.075	1.35	20138	2.032	0.095	0.527	1.299
29	0	1.375	24819	0.75	1.6	24829	1.985	0.595	0.368	1.458
30	0	1.4	23784	0.8	1.425	23799	1.411	0.044	0.392	1.385
31	0.025	1.425	3204	0.725	1.475	3216	1.544	0.110	0.368	1.422
32	0.075	1.475	16864	1	1.775	16882	1.360	0.441	0.527	1.593
33	0	1.475	43202	1	1.575	43231	0.912	0.091	0.490	1.495
34	0	1.525	48391	1	1.75	48410	1.393	0.313	0.490	1.605
35	0	1.575	34607	0.6	1.7	34620	1.221	0.254	0.294	1.605
36	0	1.625	25927	1.1	1.65	25945	1.617	0.037	0.539	1.605
37	0	1.65	27776	0.825	1.85	27801	0.873	0.212	0.404	1.716
38	0	1.7	62226	0.8	1.75	62241	1.411	0.088	0.392	1.691
39	0.05	1.7	32560	1	1.8	32580	1.257	0.132	0.515	1.716

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.6	1.85	38853	0.425	1.85	38864	-0.421	0.000	0.502	1.814
41	0.6	1.85	46484	0.4	2.05	46505	-0.252	0.252	0.490	1.912
42	0.6	1.9	23658	0.1	2.05	23700	-0.315	0.095	0.343	1.936
43	0.6	1.9	28015	0.15	1.875	28053	-0.313	-0.017	0.368	1.850
44	0.75	1.95	36586	0.025	2.175	36642	-0.343	0.106	0.380	2.022
45	0.6	2.05	12572	0.2	2.1	12604	-0.331	0.041	0.392	2.034
46	0.55	2.05	15321	0	2.25	15354	-0.441	0.160	0.270	2.108
47	0.7	2.05	21274	0.25	1.875	21305	-0.384	-0.149	0.466	1.924
48	0.7	2.1	3041	0.1	2.3	3074	-0.481	0.160	0.392	2.157
49	0.6	2.1	23603	0.175	2.075	23621	-0.625	-0.037	0.380	2.047
50	0.6	2.15	16576	0.15	1.95	16600	-0.496	-0.221	0.368	2.010
51	0.7	2.175	3189	0.275	1.95	3213	-0.469	-0.248	0.478	2.022
52	0.7	2.2	13909	0.05	2.125	13953	-0.391	-0.045	0.368	2.120
53	0.6	2.225	16568	0.05	2.075	16602	-0.428	-0.117	0.319	2.108
54	0.675	2.325	25665	0.1	2.125	25695	-0.507	-0.176	0.380	2.181
55	0.575	2.35	19938	0.1	2.1	19969	-0.405	-0.213	0.331	2.181
56	0.725	2.35	38568	0.1	1.875	38629	-0.271	-0.206	0.404	2.071
57	0.7	2.425	3038	0.2	2.425	3074	-0.368	0.000	0.441	2.377
58	0.7	2.45	3113	0.3	2.4	3145	-0.331	-0.041	0.490	2.377
59	0.45	2.45	20034	0.1	2.3	20057	-0.403	-0.173	0.270	2.328
60	0.525	2.55	38655	0.3	2.375	38667	-0.496	-0.386	0.404	2.414
61	0.6	2.55	48021	0.125	2.15	48048	-0.466	-0.392	0.355	2.304
62	0.5	2.55	50882	0.1	2.25	50903	-0.504	-0.378	0.294	2.353
63	0.6	2.575	20005	0.25	2.3	20043	-0.244	-0.191	0.417	2.390
64	0.7	2.6	16565	0.35	2.375	16588	-0.403	-0.259	0.515	2.439
65	0.6	2.6	2908	0.2	2.45	2929	-0.504	-0.189	0.392	2.475
66	0.625	2.7	12253	0.2	2.35	12278	-0.450	-0.370	0.404	2.475
67	0.6	2.7	15323	0.25	2.3	15347	-0.386	-0.441	0.417	2.451
68	0.55	2.75	18841	0.125	2.425	18860	-0.592	-0.453	0.331	2.537
69	0.4	2.85	10476	0.3	2.65	10484	-0.331	-0.662	0.343	2.696
70	0.5	2.85	27499	0.175	2.65	27518	-0.453	-0.279	0.331	2.696
71	0.6	2.85	27518	0.4	2.7	27532	-0.378	-0.284	0.490	2.721
72	0.425	2.875	25638	0.1	2.5	25675	-0.232	-0.268	0.257	2.635
73	0.625	2.875	32251	0.275	3.35	32273	-0.421	0.571	0.441	3.051
74	0.45	2.95	13521	0.15	2.625	13547	-0.305	-0.331	0.294	2.733
75	0.4	2.975	62064	0.2	2.85	62077	-0.407	-0.254	0.294	2.855
76	0.55	3	27540	0.125	2.75	27557	-0.662	-0.389	0.331	2.819
77	0.475	3	46186	0.05	2.725	46209	-0.489	-0.316	0.257	2.806
78	0.45	3.075	27597	0.2	2.85	27614	-0.389	-0.350	0.319	2.904
79	0.45	3.15	32307	0.25	2.95	32321	-0.378	-0.378	0.343	2.990

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.4	3.15	12717	0.2	2.975	12734	-0.311	-0.272	0.294	3.002
81	0.45	3.2	41251	0.275	3.05	41278	-0.172	-0.147	0.355	3.064
82	0.5	3.225	59224	0.275	2.95	59237	-0.458	-0.560	0.380	3.027
83	0.45	3.25	27543	0.3	3.15	27556	-0.305	-0.204	0.368	3.137
84	0.4	3.275	7604	0.225	3.3	7611	-0.662	0.095	0.306	3.223
85	0.225	3.35	32257	0.1	3.275	32269	-0.276	-0.165	0.159	3.248
86	0.425	3.375	25595	0.15	3.225	25613	-0.404	-0.221	0.282	3.235
87	0.4	3.45	25493	0.1	3.25	25509	-0.496	-0.331	0.245	3.284
88	0.4	3.45	68898	0.225	3.375	68910	-0.386	-0.165	0.306	3.346
89	0.4	3.475	86383	0.05	3.3	86397	-0.662	-0.331	0.221	3.321
90	0.45	3.525	27741	0.1	3.6	27761	-0.463	0.099	0.270	3.493
91	0.45	3.55	25574	0.075	3.575	25591	-0.584	0.039	0.257	3.493
92	0.525	3.575	33471	0.25	3.4	33490	-0.383	-0.244	0.380	3.419
93	0.5	3.625	13582	0.2	3.5	13603	-0.378	-0.158	0.343	3.493

Notes:
(1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

Table 10: HW 1.25P TW 0.71P, Unmodified Spillway Simulation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	0.7	0.225	28724	0.2	0.3	28752	-0.473	0.071	0.441	0.257
2	0.7	0.25	26280	0.15	0.275	26317	-0.393	0.018	0.417	0.257
3	0.7	0.25	27950	0.2	0.2	28012	-0.213	-0.021	0.441	0.221
4	0.7	0.275	27336	0.1	0.25	27382	-0.345	-0.014	0.392	0.257
5	0.7	0.3	27472	0.1	0.275	27500	-0.567	-0.024	0.392	0.282
6	0.7	0.35	28527	0.1	0.35	28562	-0.454	0.000	0.392	0.343
7	0.7	0.45	24030	0.1	0.6	24074	-0.361	0.090	0.392	0.515
8	0.7	0.45	25391	0.1	0.375	25435	-0.361	-0.045	0.392	0.404
9	0.7	0.45	25429	0.1	0.45	25464	-0.454	0.000	0.392	0.441
10	0.6	0.525	24766	0.175	0.375	24810	-0.256	-0.090	0.380	0.441
11	0.5	0.55	11709	0.3	0.65	11781	-0.074	0.037	0.392	0.588
12	0.7	0.55	26131	0.15	0.55	26166	-0.416	0.000	0.417	0.539
13	0.5	0.6	12034	0.3	0.45	12068	-0.156	-0.117	0.392	0.515
14	0.63	0.65	11623	0.2	0.6	11647	-0.474	-0.055	0.407	0.613
15	1.1	0.65	12412	0.3	0.45	12453	-0.516	-0.129	0.686	0.539
16	0.6	0.675	22387	0.15	0.625	22426	-0.305	-0.034	0.368	0.637
17	1	0.7	167	0.3	1.875	214	-0.394	0.662	0.637	1.262
18	0.7	0.725	24954	0.15	0.55	24985	-0.469	-0.149	0.417	0.625
19	0.9	0.83	11520	0.1	0.86	11564	-0.481	0.018	0.490	0.828
20	0.6	0.85	21482	0.1	0.85	21515	-0.401	0.000	0.343	0.833
21	0.675	0.85	24359	0.025	0.975	24395	-0.478	0.092	0.343	0.895
22	0.6	0.875	21388	0.1	0.95	21427	-0.339	0.051	0.343	0.895
23	0.7	0.95	10625	0.2	1	10663	-0.348	0.035	0.441	0.956
24	0.75	0.95	11029	0.1	0.76	11085	-0.307	-0.090	0.417	0.838
25	0.7	1.025	21686	0.1	0.925	21716	-0.529	-0.088	0.392	0.956
26	0.7	1.025	24096	0.05	1.225	24141	-0.382	0.118	0.368	1.103
27	0.7	1.05	22075	0.175	0.775	22127	-0.267	-0.140	0.429	0.895
28	0.7	1.075	23056	0.15	1.125	23085	-0.502	0.046	0.417	1.078
29	0.65	1.1	23008	0.15	0.95	23037	-0.456	-0.137	0.392	1.005
30	0.6	1.15	10147	0.3	1	10174	-0.294	-0.147	0.441	1.054
31	0.7	1.16	9793	0.125	1.16	9874	-0.188	0.000	0.404	1.137
32	0.5	1.22	10771	0.1	1.2	10799	-0.378	-0.019	0.294	1.186
33	1	1.25	10890	0.1	1.25	10947	-0.418	0.000	0.539	1.225
34	0.7	1.3	20560	0.1	1.375	20591	-0.512	0.064	0.392	1.311
35	0.7	1.3	20742	0.1	1.45	20777	-0.454	0.113	0.392	1.348
36	0.7	1.35	22498	0.1	1.525	22535	-0.429	0.125	0.392	1.409
37	1	1.375	9274	0.4	1.475	9316	-0.378	0.063	0.686	1.397
38	0.7	1.4	20817	0.225	1.575	20844	-0.466	0.172	0.453	1.458
39	0.8	1.45	9667	0.3	1.55	9734	-0.197	0.039	0.539	1.471

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.7	1.475	20556	0.15	1.625	20597	-0.355	0.097	0.417	1.520
41	0.7	1.525	22977	0.075	1.45	23018	-0.403	-0.048	0.380	1.458
42	0.65	1.55	23261	0	1.625	23304	-0.400	0.046	0.319	1.556
43	0.7	1.575	19633	0.1	1.575	19661	-0.567	0.000	0.392	1.544
44	0.7	1.625	20599	0.2	1.675	20632	-0.401	0.040	0.441	1.618
45	0.7	1.65	20996	0.1	1.9	21048	-0.305	0.127	0.392	1.740
46	0.7	1.725	17200	0.1	1.775	17246	-0.345	0.029	0.392	1.716
47	0.6	1.75	18322	0.2	1.95	18354	-0.331	0.165	0.392	1.814
48	0.6	1.75	19006	0.2	1.85	19035	-0.365	0.091	0.392	1.765
49	0.6	1.8	18442	0.1	1.875	18472	-0.441	0.066	0.343	1.801
50	0.6	1.85	10047	0.05	1.8	10098	-0.285	-0.026	0.319	1.789
51	0.7	1.85	16917	0.1	1.8	16963	-0.345	-0.029	0.392	1.789
52	0.7	1.9	16417	0.1	1.8	16457	-0.397	-0.066	0.392	1.814
53	0.6	1.925	17062	0.1	1.85	17087	-0.529	-0.079	0.343	1.850
54	0.7	1.95	17633	0.1	1.925	17671	-0.418	-0.017	0.392	1.900
55	0.625	1.975	18798	0.1	1.85	18826	-0.496	-0.118	0.355	1.875
56	0.6	2	19368	0.075	2.05	19416	-0.289	0.028	0.331	1.985
57	0.7	2.05	16984	0.05	1.925	17029	-0.382	-0.074	0.368	1.949
58	0.6	2.125	16824	0.1	2	16848	-0.551	-0.138	0.343	2.022
59	0.7	2.15	14172	0.1	2.325	14220	-0.331	0.096	0.392	2.194
60	0.6	2.15	14359	0.2	1.975	14385	-0.407	-0.178	0.392	2.022
61	0.6	2.2	13786	0.025	2.175	13816	-0.507	-0.022	0.306	2.145
62	0.7	2.225	18205	0.15	2.1	18240	-0.416	-0.095	0.417	2.120
63	0.7	2.225	18713	0.1	2.325	18755	-0.378	0.063	0.392	2.230
64	0.6	2.275	13784	0.1	2.35	13809	-0.529	0.079	0.343	2.267
65	0.6	2.35	11396	0.25	2.45	11420	-0.386	0.110	0.417	2.353
66	0.7	2.35	12941	0.1	2.45	12972	-0.512	0.085	0.392	2.353
67	0.6	2.375	13998	0.1	2.45	14024	-0.509	0.076	0.343	2.365
68	0.6	2.45	9367	0.2	2.425	9397	-0.353	-0.022	0.392	2.390
69	0.7	2.45	11664	0.1	2.575	11705	-0.387	0.081	0.392	2.463
70	0.6	2.5	9269	0.1	2.3	9311	-0.315	-0.126	0.343	2.353
71	0.7	2.55	11647	0.2	2.75	11682	-0.378	0.151	0.441	2.598
72	0.7	2.55	9619	0.1	2.325	9652	-0.481	-0.180	0.392	2.390
73	0.7	2.575	9399	0.1	2.6	9432	-0.481	0.020	0.392	2.537
74	0.65	2.575	11529	0.1	2.75	11569	-0.364	0.116	0.368	2.610
75	0.6	2.65	13012	0.1	2.625	13049	-0.358	-0.018	0.343	2.586
76	0.7	2.7	8791	0.2	2.65	8840	-0.270	-0.027	0.441	2.623
77	0.7	2.7	10096	0.1	2.5	10126	-0.529	-0.176	0.392	2.549
78	0.6	2.75	8869	0.075	2.5	8915	-0.302	-0.144	0.331	2.574
79	1	2.8	9230	0.2	2.8	9288	-0.365	0.000	0.588	2.745

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.6	2.85	9739	0	2.6	9781	-0.378	-0.158	0.294	2.672
81	0.7	2.85	13383	0.1	2.75	13423	-0.397	-0.066	0.392	2.745
82	0.6	2.92	10799	0.1	2.9	10832	-0.401	-0.016	0.343	2.853
83	1.1	2.95	11111	0.2	2.75	11171	-0.397	-0.088	0.637	2.794
84	1.1	2.95	14145	0.1	2.92	14231	-0.308	-0.009	0.588	2.877
85	0.6	3.05	7136	0.2	3	7167	-0.341	-0.043	0.392	2.966
86	0.68	3.05	11299	0.1	2.98	11320	-0.731	-0.088	0.382	2.956
87	1	3.05	12208	0.2	2.95	12256	-0.441	-0.055	0.588	2.941
88	0.9	3.1	11477	0.2	3.1	11520	-0.431	0.000	0.539	3.039
89	0.65	3.15	12335	0.4	3.35	12404	-0.096	0.077	0.515	3.186
90	0.8	3.15	12372	0.6	3.52	12400	-0.189	0.350	0.686	3.270
91	0.7	3.25	9460	0.4	3.16	9478	-0.441	-0.132	0.539	3.142
92	0.63	3.25	11207	0.2	3.45	11258	-0.223	0.104	0.407	3.284
93	0.6	3.25	11682	0.1	3.25	11709	-0.490	0.000	0.343	3.186
94	0.7	3.35	11173	0.1	3.55	11207	-0.467	0.156	0.392	3.382
95	0.6	3.35	7312	0.1	3.3	7340	-0.473	-0.047	0.343	3.260
96	0.7	3.35	7366	0.1	3.175	7401	-0.454	-0.132	0.392	3.199
97	0.9	3.45	10242	0.1	3.46	10296	-0.392	0.005	0.490	3.387
98	0.93	3.45	12186	0.3	3.4	12241	-0.303	-0.024	0.603	3.358
99	1	3.45	13542	0.05	3.45	13595	-0.474	0.000	0.515	3.382
100	0.6	3.525	7820	0.2	3.75	7847	-0.392	0.221	0.392	3.566
101	0.6	3.525	7712	0.1	3.55	7742	-0.441	0.022	0.343	3.468
102	0.7	3.55	11564	0.1	3.55	11608	-0.361	0.000	0.392	3.480
103	1	3.57	9594	0.1	3.3	9666	-0.331	-0.099	0.539	3.368
104	0.6	3.6	8126	0.1	3.525	8157	-0.427	-0.064	0.343	3.493
105	0.6	3.6	8316	0.2	3.575	8347	-0.341	-0.021	0.392	3.517
106	1.1	3.75	10496	0.2	3.55	10548	-0.458	-0.102	0.637	3.578
107	0.9	3.75	10947	0.1	3.4	11029	-0.258	-0.113	0.490	3.505
108	0.7	3.75	14110	0.1	3.7	14163	-0.300	-0.025	0.392	3.652

Notes: (1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

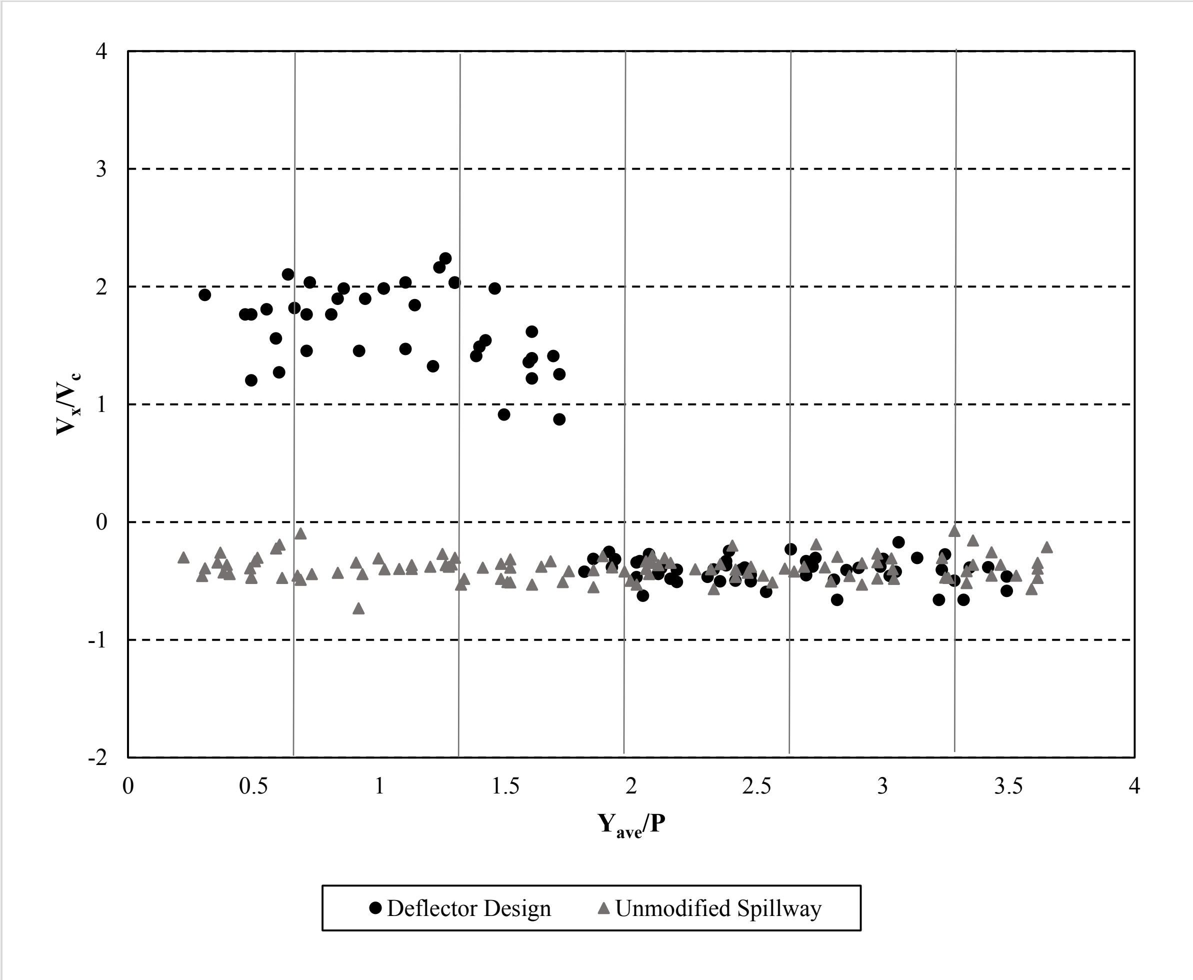

Figure 26: HW 1.25P TW 0.71P Design Simulations Results

Table 11: HW 1.25P 0.92P, Multiple Staggered Deflector Design Simulation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	0.65	0.4	10542	0.3	0.45	10568	-0.356	0.051	0.466	0.417
2	0.6	0.45	25991	0.1	0.525	26036	-0.294	0.044	0.343	0.478
3	0.4	0.55	25917	0.025	1.5	25942	-0.397	1.006	0.208	1.005
4	0.575	0.55	28240	0.15	0.4	28279	-0.288	-0.102	0.355	0.466
5	0.6	0.55	33212	0.1	0.625	33269	-0.232	0.035	0.343	0.576
6	0.6	0.625	11250	0.2	0.575	11293	-0.246	-0.031	0.392	0.588
7	0.65	0.65	16136	0.1	0.575	16185	-0.297	-0.041	0.368	0.600
8	0.575	0.65	25266	0.125	0.475	25303	-0.322	-0.125	0.343	0.551
9	0.6	0.675	12875	0.075	0.675	12906	-0.448	0.000	0.331	0.662
10	0.6	0.725	15707	0.1	0.75	15745	-0.348	0.017	0.343	0.723
11	0.6	0.75	12936	0.1	0.6	12974	-0.348	-0.104	0.343	0.662
12	0.6	0.775	23297	0.275	0.65	23320	-0.374	-0.144	0.429	0.699
13	0.6	0.825	15382	0.1	0.575	15419	-0.358	-0.179	0.343	0.686
14	0.675	0.85	15998	0.05	0.825	16037	-0.424	-0.017	0.355	0.821
15	0.4	0.925	10325	0.05	0.9	10360	-0.265	-0.019	0.221	0.895
16	0.4	0.95	12877	0.05	0.825	12899	-0.421	-0.150	0.221	0.870
17	0.4	0.95	15778	0	0.875	15823	-0.235	-0.044	0.196	0.895
18	0.6	0.975	10183	0.1	0.75	10223	-0.331	-0.149	0.343	0.846
19	0.5	1.025	10248	0.05	0.825	10293	-0.265	-0.118	0.270	0.907
20	0.6	1.025	10263	0.175	0.875	10289	-0.433	-0.153	0.380	0.931
21	0.6	1.075	15512	0.125	0.925	15551	-0.322	-0.102	0.355	0.980
22	0.6	1.125	12864	0.1	1.05	12890	-0.509	-0.076	0.343	1.066
23	0.6	1.15	22902	0.1	0.85	22936	-0.389	-0.233	0.343	0.980
24	0.675	1.225	15303	0.125	1.1	15330	-0.539	-0.123	0.392	1.140
25	0.6	1.225	17821	0.05	0.9	17859	-0.383	-0.226	0.319	1.042
26	0.5	1.225	20098	0.1	1.2	20127	-0.365	-0.023	0.294	1.189
27	0.6	1.3	10179	0.2	1.125	10205	-0.407	-0.178	0.392	1.189
28	0.6	1.3	15321	0.075	1.05	15354	-0.421	-0.200	0.331	1.152
29	0.55	1.3	19992	0.25	1	20016	-0.331	-0.331	0.392	1.127
30	0.575	1.45	12956	0.125	1.225	12980	-0.496	-0.248	0.343	1.311
31	0.6	1.45	18010	0.1	1.35	18048	-0.348	-0.070	0.343	1.373
32	0.4	1.475	25197	0.1	1.45	25216	-0.418	-0.035	0.245	1.434
33	0.425	1.525	10054	0.15	1.55	10069	-0.485	0.044	0.282	1.507
34	0.475	1.55	25217	0.125	1.325	25238	-0.441	-0.284	0.294	1.409
35	0.425	1.6	15222	0.1	1.55	15243	-0.410	-0.063	0.257	1.544
36	0.6	1.625	18060	0.1	1.475	18083	-0.575	-0.173	0.343	1.520
37	0.575	1.65	25070	0.075	1.425	25102	-0.413	-0.186	0.319	1.507
38	0.475	1.675	17635	0.2	1.625	17654	-0.383	-0.070	0.331	1.618
39	0.6	1.725	17904	0.2	1.5	17928	-0.441	-0.248	0.392	1.581

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.45	1.75	10049	0.2	1.6	10063	-0.473	-0.284	0.319	1.642
41	0.4	1.775	10158	0.125	1.65	10175	-0.428	-0.195	0.257	1.679
42	0.45	1.775	12954	0.1	1.675	12973	-0.487	-0.139	0.270	1.691
43	0.525	1.8	23025	0.15	1.725	23048	-0.431	-0.086	0.331	1.728
44	0.35	1.9	12713	0.05	1.95	12738	-0.318	0.053	0.196	1.887
45	0.425	1.9	15209	0.1	1.775	15236	-0.319	-0.123	0.257	1.801
46	0.35	1.95	10130	0.15	2.075	10157	-0.196	0.123	0.245	1.973
47	0.3	1.975	37252	0.075	2.025	37273	-0.284	0.063	0.184	1.961
48	0.425	1.975	37386	0.1	1.85	37406	-0.430	-0.165	0.257	1.875
49	0.45	1.975	51492	0.3	1.95	51508	-0.248	-0.041	0.368	1.924
50	0.025	2.125	64730	0.9	2.05	64752	1.052	-0.090	0.453	2.047
51	0.5	2.15	27650	0.3	2.075	27665	-0.353	-0.132	0.392	2.071
52	0.025	2.2	42034	0.9	2.125	42054	1.158	-0.099	0.453	2.120
53	0	2.225	37331	0.9	2.25	37362	0.768	0.021	0.441	2.194
54	0.05	2.225	41859	0.85	2.325	41879	1.058	0.132	0.441	2.230
55	0.025	2.275	17741	0.8	2.2	17767	0.789	-0.076	0.404	2.194
56	0	2.3	52996	0.9	2.45	53021	0.953	0.159	0.441	2.328
57	0.05	2.35	46772	0.925	2.325	46787	1.544	-0.044	0.478	2.292
58	0.075	2.375	27693	0.925	2.3	27731	0.592	-0.052	0.490	2.292
59	0	2.4	27744	0.9	2.325	27768	0.992	-0.083	0.441	2.316
60	0.05	2.45	9924	0.925	2.45	9942	1.286	0.000	0.478	2.402
61	0	2.475	27596	0.8	2.475	27619	0.920	0.000	0.392	2.426
62	0	2.5	12520	1.025	2.35	12541	1.292	-0.189	0.502	2.377
63	0.05	2.55	9825	1	2.375	9845	1.257	-0.232	0.515	2.414
64	0.025	2.575	12755	0.8	2.375	12770	1.367	-0.353	0.404	2.426
65	0.025	2.575	22800	0.9	2.425	22823	1.007	-0.173	0.453	2.451
66	0	2.6	22592	0.9	2.45	22613	1.134	-0.189	0.441	2.475
67	0.025	2.675	17744	0.975	2.625	17760	1.571	-0.083	0.490	2.598
68	0	2.675	22641	0.9	2.65	22657	1.488	-0.041	0.441	2.610
69	0.025	2.75	12761	0.8	2.85	12775	1.465	0.189	0.404	2.745
70	0.075	2.775	17551	0.95	2.75	17566	1.544	-0.044	0.502	2.708
71	0	2.775	17732	0.9	2.775	17746	1.701	0.000	0.441	2.721
72	0	2.85	24827	0.925	2.725	24843	1.530	-0.207	0.453	2.733
73	0.05	2.875	9754	0.875	2.85	9768	1.559	-0.047	0.453	2.806
74	0	2.875	12599	0.9	2.875	12613	1.701	0.000	0.441	2.819
75	0	2.95	12536	1.025	2.825	12554	1.507	-0.184	0.502	2.831
76	0	2.975	9683	0.9	2.925	9696	1.832	-0.102	0.441	2.892
77	0.025	3.025	9722	0.925	2.975	9736	1.701	-0.095	0.466	2.941
78	0.05	3.05	17497	0.8	2.825	17512	1.323	-0.397	0.417	2.880
79	0.05	3.075	12551	0.9	2.825	12568	1.323	-0.389	0.466	2.892

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.05	3.075	22610	0.95	2.875	22627	1.401	-0.311	0.490	2.917
81	0	3.1	12491	0.9	3	12506	1.588	-0.176	0.441	2.990
82	0	3.175	12490	0.925	3.05	12505	1.632	-0.221	0.453	3.051
83	0.05	3.225	17526	0.975	3.15	17540	1.748	-0.142	0.502	3.125
84	0	3.25	9909	0.9	3.225	9925	1.488	-0.041	0.441	3.174
85	0	3.275	12581	0.875	3.225	12596	1.544	-0.088	0.429	3.186
86	0.05	3.3	19886	0.825	3.25	19899	1.578	-0.102	0.429	3.211
87	0.05	3.35	31349	0.825	3.35	31361	1.709	0.000	0.429	3.284
88	0.025	3.375	12587	1	3.4	12602	1.720	0.044	0.502	3.321
89	0	3.375	19903	0.9	3.425	19917	1.701	0.095	0.441	3.333
90	0	3.375	27600	0.9	3.375	27615	1.588	0.000	0.441	3.309
91	0.35	3.475	46740	0.95	3.475	46749	1.764	0.000	0.637	3.407
92	0.025	3.525	19979	0.9	3.575	19993	1.654	0.095	0.453	3.480
93	0	3.575	12466	0.95	3.55	12480	1.796	-0.047	0.466	3.493
94	0.6	3.625	28355	0.175	3.65	28390	-0.321	0.019	0.380	3.566
95	0.7	3.65	25627	0.15	3.625	25671	-0.331	-0.015	0.417	3.566
96	0.575	3.675	15650	0.2	3.625	15677	-0.368	-0.049	0.380	3.578
97	0.7	3.75	13116	0.1	3.725	13166	-0.318	-0.013	0.392	3.664
98	0.7	3.75	15455	0.1	3.75	15503	-0.331	0.000	0.392	3.676

Notes:
(1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

Table 12: HW 1.25P TW 0.92P, Unmodified Spillway Simulation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	0.5	0.2	36632	0.1	0.25	36676	-0.241	0.030	-0.196	0.221
2	0.55	0.25	38152	0.3	0.35	38260	-0.061	0.025	-0.123	0.294
3	1	0.25	39300	0.05	0.55	39416	-0.217	0.068	-0.466	0.392
4	0.7	0.25	40109	0.1	0.75	40211	-0.156	0.130	-0.294	0.490
5	0.7	0.3	38449	0.1	0.25	38599	-0.106	-0.009	-0.294	0.270
6	0.5	0.35	37392	0.1	0.35	37445	-0.200	0.000	-0.196	0.343
7	0.6	0.35	37502	0.1	0.35	37561	-0.224	0.000	-0.245	0.343
8	0.8	0.4	36850	0.25	0.25	36932	-0.177	-0.048	-0.270	0.319
9	0.65	0.45	36521	0.2	0.25	36593	-0.165	-0.074	-0.221	0.343
10	0.7	0.45	36528	0.05	0.45	36613	-0.202	0.000	-0.319	0.441
11	0.65	0.475	35354	0.2	0.2	35408	-0.221	-0.135	-0.221	0.331
12	0.7	0.5	36065	0.1	0.35	36113	-0.331	-0.083	-0.294	0.417
13	0.6	0.55	35931	0.2	0.45	35979	-0.221	-0.055	-0.196	0.490
14	0.6	0.6	35031	0.25	0.45	35079	-0.193	-0.083	-0.172	0.515
15	0.8	0.65	34481	0.1	0.4	34572	-0.204	-0.073	-0.343	0.515
16	0.6	0.65	35079	0.05	0.65	35131	-0.280	0.000	-0.270	0.637
17	0.7	0.75	33846	0.3	0.45	33894	-0.221	-0.165	-0.196	0.588
18	0.7	0.75	34801	0.1	0.55	34863	-0.256	-0.085	-0.294	0.637
19	0.8	0.75	35282	0.1	0.45	35340	-0.319	-0.137	-0.343	0.588
20	0.8	0.775	35888	0.3	0.65	35931	-0.308	-0.077	-0.245	0.699
21	1	0.8	35670	0.1	1.1	35760	-0.265	0.088	-0.441	0.931
22	0.6	0.85	35556	0.175	0.65	35606	-0.225	-0.106	-0.208	0.735
23	0.7	0.95	4611	0.1	0.95	4681	-0.227	0.000	-0.294	0.931
24	1.1	0.95	33002	0.15	0.4	33193	-0.132	-0.076	-0.466	0.662
25	0.875	0.95	34725	0.1	0.45	34801	-0.270	-0.174	-0.380	0.686
26	0.8	1.05	33597	0.15	0.85	33656	-0.292	-0.090	-0.319	0.931
27	1	1.05	33681	0.1	0.65	33770	-0.268	-0.119	-0.441	0.833
28	0.7	1.05	34201	0.1	0.75	34242	-0.387	-0.194	-0.294	0.882
29	0.8	1.075	33256	0.1	0.85	33303	-0.394	-0.127	-0.343	0.944
30	0.8	1.125	32628	0.05	1.125	32700	-0.276	0.000	-0.368	1.103
31	1.1	1.15	34275	0.1	0.55	34411	-0.195	-0.117	-0.490	0.833
32	0.6	1.2	31401	0.2	1.15	31442	-0.258	-0.032	-0.196	1.152
33	1	1.25	29946	0.1	1.05	30027	-0.294	-0.065	-0.441	1.127
34	0.9	1.25	32347	0	1.05	32420	-0.326	-0.072	-0.441	1.127
35	0.7	1.3	30635	0.15	1.15	30681	-0.316	-0.086	-0.270	1.201
36	0.9	1.35	32110	0.05	1.35	32179	-0.326	0.000	-0.417	1.324
37	0.6	1.35	33197	0.05	0.8	33250	-0.275	-0.275	-0.270	1.054
38	1.1	1.375	31627	0.1	1.05	31701	-0.358	-0.116	-0.490	1.189
39	1	1.45	30547	0.1	1.45	30633	-0.277	0.000	-0.441	1.422

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.6	1.45	30739	0.1	1.25	30780	-0.323	-0.129	-0.245	1.324
41	1.1	1.55	27857	0.05	1.6	27970	-0.246	0.012	-0.515	1.544
42	1	1.55	31122	0.05	1.45	31192	-0.359	-0.038	-0.466	1.471
43	0.7	1.55	32541	0	1.45	32590	-0.378	-0.054	-0.343	1.471
44	1.1	1.575	32187	0.1	1.85	32298	-0.238	0.066	-0.490	1.679
45	0.8	1.6	30690	0.1	1.55	30739	-0.378	-0.027	-0.343	1.544
46	0.8	1.65	31785	0.075	1.7	31854	-0.278	0.019	-0.355	1.642
47	0.8	1.675	27593	0.2	1.25	27658	-0.244	-0.173	-0.294	1.434
48	1.1	1.75	32832	0.025	1.7	32895	-0.452	-0.021	-0.527	1.691
49	0.8	1.75	39003	0.15	1.55	39056	-0.325	-0.100	-0.319	1.618
50	0.6	1.85	29303	0	1.85	29350	-0.338	0.000	-0.294	1.814
51	1.1	1.85	33303	0.1	1.55	33435	-0.200	-0.060	-0.490	1.667
52	0.8	1.85	34580	0.1	1.75	34651	-0.261	-0.037	-0.343	1.765
53	0.9	1.95	24042	0.05	2.05	24099	-0.395	0.046	-0.417	1.961
54	0.9	1.95	29628	0.1	2.35	29709	-0.261	0.131	-0.392	2.108
55	0.9	1.95	33794	0.1	1.9	33846	-0.407	-0.025	-0.392	1.887
56	0.9	2.05	25805	0.1	1.65	25865	-0.353	-0.176	-0.392	1.814
57	1	2.05	25892	0.2	1.7	25959	-0.316	-0.138	-0.392	1.838
58	1.1	2.05	32442	0.1	2.2	32533	-0.291	0.044	-0.490	2.083
59	1.1	2.125	25721	0.075	2.25	25796	-0.362	0.044	-0.502	2.145
60	0.5	2.15	26464	0.05	2.35	26511	-0.253	0.113	-0.221	2.206
61	0.6	2.15	27956	0.05	2.1	27993	-0.393	-0.036	-0.270	2.083
62	0.7	2.25	20787	0.025	2.25	20827	-0.447	0.000	-0.331	2.206
63	0.7	2.25	24604	0.025	2.35	24652	-0.372	0.055	-0.331	2.255
64	0.7	2.35	20933	0.05	2.2	20981	-0.358	-0.083	-0.319	2.230
65	0.7	2.35	21203	0.03	2.65	21259	-0.317	0.142	-0.328	2.451
66	0.6	2.35	22836	0.1	2.45	22868	-0.413	0.083	-0.245	2.353
67	1	2.4	17621	0.1	2.35	17675	-0.441	-0.025	-0.441	2.328
68	0.9	2.45	19583	0.1	2.35	19639	-0.378	-0.047	-0.392	2.353
69	0.8	2.45	20451	0.1	2.7	20523	-0.257	0.092	-0.343	2.525
70	1.1	2.5	16884	0	2.25	16972	-0.331	-0.075	-0.539	2.328
71	1	2.525	16500	0	2.4	16599	-0.267	-0.033	-0.490	2.414
72	0.7	2.55	16810	0.15	2.7	16856	-0.316	0.086	-0.270	2.574
73	0.9	2.575	18353	0.1	2.65	18424	-0.298	0.028	-0.392	2.561
74	0.7	2.65	15955	0.05	2.65	15991	-0.478	0.000	-0.319	2.598
75	0.6	2.65	16121	0.15	2.95	16179	-0.205	0.137	-0.221	2.745
76	1.1	2.75	15860	0.125	2.825	15931	-0.363	0.028	-0.478	2.733
77	0.7	2.75	16188	0.15	3.15	16231	-0.338	0.246	-0.270	2.892
78	0.6	2.75	16231	0.15	2.9	16270	-0.305	0.102	-0.221	2.770
79	0.8	2.85	15226	0.1	3.35	15299	-0.254	0.181	-0.343	3.039

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.8	2.85	15542	0.05	3.15	15610	-0.292	0.117	-0.368	2.941
81	1.1	2.85	15727	0.1	3.2	15840	-0.234	0.082	-0.490	2.966
82	0.8	2.9	13771	0.1	3.15	13831	-0.309	0.110	-0.343	2.966
83	0.8	2.9	14316	0	3.25	14380	-0.331	0.145	-0.392	3.015
84	0.8	2.95	14655	0.1	3.2	14705	-0.370	0.132	-0.343	3.015
85	0.9	3	12082	0.2	3.25	12197	-0.161	0.058	-0.343	3.064
86	0.6	3.025	11567	0.15	3.15	11613	-0.259	0.072	-0.221	3.027
87	0.7	3.05	11382	0.1	3.35	11422	-0.397	0.198	-0.294	3.137
88	0.6	3.1	11894	0.05	3.4	11944	-0.291	0.159	-0.270	3.186
89	0.6	3.15	10842	0.05	3.65	10888	-0.316	0.288	-0.270	3.333
90	0.6	3.15	11842	0.25	3.25	11891	-0.189	0.054	-0.172	3.137
91	0.7	3.2	10980	0.05	3.5	11043	-0.273	0.126	-0.319	3.284
92	0.6	3.2	11098	0.05	3.5	11142	-0.331	0.180	-0.270	3.284
93	0.9	3.25	10899	0.2	3.4	10956	-0.325	0.070	-0.343	3.260
94	0.6	3.3	10446	0.1	3.4	10491	-0.294	0.059	-0.245	3.284
95	0.7	3.3	10498	0.1	3.55	10548	-0.318	0.132	-0.294	3.358
96	0.9	3.325	10568	0.025	3.425	10679	-0.209	0.024	-0.429	3.309
97	1.1	3.4	6807	0.1	3.25	6898	-0.291	-0.044	-0.490	3.260
98	0.625	3.4	10155	0.1	3.75	10240	-0.163	0.109	-0.257	3.505
99	0.7	3.4	10367	0.05	3.5	10423	-0.307	0.047	-0.319	3.382
100	0.6	3.475	8747	0.1	3.575	8788	-0.323	0.065	-0.245	3.456
101	0.5	3.5	9889	0.1	3.65	9929	-0.265	0.099	-0.196	3.505
102	1.1	3.55	7445	0.05	3.45	7505	-0.463	-0.044	-0.515	3.431
103	0.7	3.6	6501	0.1	3.6	6569	-0.233	0.000	-0.294	3.529
104	0.65	3.65	6003	0.1	3.75	6110	-0.136	0.025	-0.270	3.627
105	1.1	3.65	6216	0.1	3.55	6384	-0.158	-0.016	-0.490	3.529
106	0.6	3.7	5416	0	3.65	5520	-0.153	-0.013	-0.294	3.603
107	0.5	3.725	6934	0	3.625	6987	-0.250	-0.050	-0.245	3.603
108	1.1	3.75	4931	0.2	3.75	5162	-0.103	0.000	-0.441	3.676

Notes:
(1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

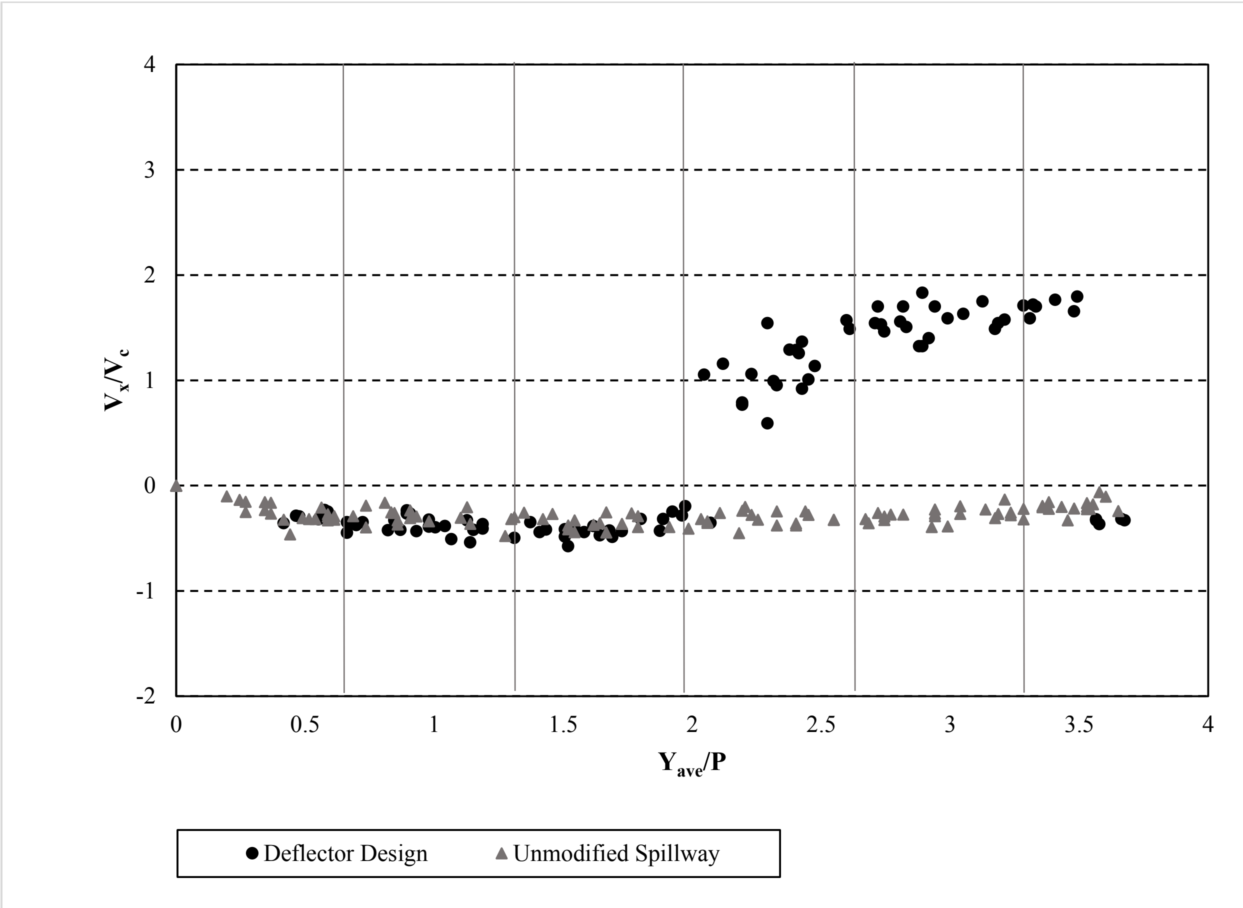

Figure 27: HW 1.25P TW 0.92P, Design Simulation Results

Table 13: HW 1.25P TW 1.14P, Multiple Staggered Deflector Design

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	0.475	0.45	91132	0.1	0.25	91218	-0.115	-0.062	0.282	0.343
2	0.575	0.45	902	0.15	0.2	1054	-0.074	-0.044	0.355	0.319
3	0.6	0.525	52204	0.15	0.275	52338	-0.089	-0.049	0.368	0.392
4	0.6	0.525	75106	0.075	0.55	75226	-0.116	0.006	0.331	0.527
5	0.475	0.55	85703	0.125	0.25	85803	-0.093	-0.079	0.294	0.392
6	0.475	0.65	68376	0.1	0.35	68460	-0.118	-0.095	0.282	0.490
7	0.7	0.65	80771	0.25	0.475	80856	-0.140	-0.054	0.466	0.551
8	0.425	0.65	83209	0.1	0.7	83268	-0.146	0.022	0.257	0.662
9	0.7	0.7	66622	0.2	0.525	66726	-0.127	-0.045	0.441	0.600
10	0.7	0.725	31088	0.2	0.5	31179	-0.145	-0.065	0.441	0.600
11	0.5	0.75	66333	0.1	0.45	66428	-0.111	-0.084	0.294	0.588
12	0.65	0.825	30485	0.2	0.675	30559	-0.161	-0.054	0.417	0.735
13	0.7	0.85	31855	0.275	0.575	31921	-0.170	-0.110	0.478	0.699
14	0.6	0.9	65036	0.1	0.55	65143	-0.124	-0.087	0.343	0.711
15	0.55	0.925	60054	0.1	0.725	60173	-0.100	-0.044	0.319	0.809
16	0.7	0.95	65420	0.1	0.875	65523	-0.154	-0.019	0.392	0.895
17	0.7	1	39190	0.2	0.725	39284	-0.141	-0.077	0.441	0.846
18	0.7	1.025	48896	0.25	0.775	48968	-0.165	-0.092	0.466	0.882
19	0.7	1.05	32062	0.1	0.975	32177	-0.138	-0.017	0.392	0.993
20	0.7	1.075	52787	0.1	0.9	52891	-0.153	-0.045	0.392	0.968
21	0.7	1.1	48233	0.3	0.925	48370	-0.077	-0.034	0.490	0.993
22	0.525	1.15	58903	0.125	0.85	58989	-0.123	-0.092	0.319	0.980
23	0.65	1.2	52512	0.1	1.1	52670	-0.092	-0.017	0.368	1.127
24	0.75	1.225	50756	0.3	0.75	50903	-0.081	-0.086	0.515	0.968
25	0.6	1.25	53340	0.1	1.425	53471	-0.101	0.035	0.343	1.311
26	0.675	1.275	64753	0.075	1.225	64917	-0.097	-0.008	0.368	1.225
27	0.625	1.35	29485	0.15	1.05	29608	-0.102	-0.065	0.380	1.176
28	0.6	1.35	57625	0.25	1.025	57690	-0.142	-0.132	0.417	1.164
29	0.7	1.375	39228	0.1	1.125	39459	-0.069	-0.029	0.392	1.225
30	0.625	1.45	45794	0.225	1.2	45890	-0.110	-0.069	0.417	1.299
31	0.575	1.45	47137	0.125	1.175	47229	-0.129	-0.079	0.343	1.287
32	0.7	1.475	33158	0.1	1.325	33285	-0.125	-0.031	0.392	1.373
33	0.575	1.475	44201	0.125	1.175	44322	-0.098	-0.066	0.343	1.299
34	0.7	1.5	38026	0.1	1.55	38231	-0.077	0.006	0.392	1.495
35	0.7	1.6	48236	0.1	1.375	48357	-0.131	-0.049	0.392	1.458
36	0.7	1.625	38022	0.075	2	38261	-0.069	0.042	0.380	1.777
37	0.7	1.625	45171	0.125	1.425	45340	-0.090	-0.031	0.404	1.495
38	0.7	1.725	44115	0.175	1.55	44228	-0.123	-0.041	0.429	1.605
39	0.7	1.725	56797	0.2	1.475	56890	-0.142	-0.071	0.441	1.569

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.6	1.75	36704	0.1	1.725	36935	-0.057	-0.003	0.343	1.703
41	0.6	1.8	33346	0.1	1.775	33441	-0.139	-0.007	0.343	1.752
42	0.7	1.8	42493	0.1	1.775	42591	-0.162	-0.007	0.392	1.752
43	0.7	1.8	49992	0.075	1.475	50177	-0.089	-0.046	0.380	1.605
44	0.525	1.875	15385	0.1	1.725	15502	-0.096	-0.034	0.306	1.765
45	0.625	1.9	29809	0.075	1.9	29896	-0.167	0.000	0.343	1.863
46	0.6	1.925	29788	0.1	2.25	29936	-0.089	0.058	0.343	2.047
47	0.525	1.975	37160	0.15	2.35	37244	-0.118	0.118	0.331	2.120
48	0.6	2.025	32895	0.225	1.825	33039	-0.069	-0.037	0.404	1.887
49	0.6	2.05	42844	0.075	2.15	42984	-0.099	0.019	0.331	2.059
50	0.6	2.1	14839	0.1	2.225	14922	-0.159	0.040	0.343	2.120
51	0.6	2.125	32821	0.1	2.075	32923	-0.130	-0.013	0.343	2.059
52	0.65	2.125	38806	0.1	2.2	38913	-0.136	0.019	0.368	2.120
53	0.625	2.175	36010	0.1	1.975	36145	-0.103	-0.039	0.355	2.034
54	0.575	2.175	42333	0.125	2.475	42458	-0.095	0.064	0.343	2.279
55	0.7	2.225	39603	0.075	2.475	39858	-0.065	0.026	0.380	2.304
56	0.6	2.275	15611	0.2	2.325	15683	-0.147	0.018	0.392	2.255
57	0.6	2.275	16035	0.175	2.5	16139	-0.108	0.057	0.380	2.341
58	0.6	2.35	39598	0.1	2.575	39853	-0.052	0.023	0.343	2.414
59	0.6	2.425	15962	0.1	2.75	16074	-0.118	0.077	0.343	2.537
60	0.65	2.425	43614	0.1	2.175	43739	-0.116	-0.053	0.368	2.255
61	0.7	2.45	39330	0.1	2.3	39446	-0.137	-0.034	0.392	2.328
62	0.525	2.475	12097	0.1	2.725	12162	-0.173	0.102	0.306	2.549
63	0.6	2.475	37310	0.1	2.35	37412	-0.130	-0.032	0.343	2.365
64	0.7	2.525	28589	0.3	2.65	28759	-0.062	0.019	0.490	2.537
65	0.575	2.575	42600	0.1	2.625	42686	-0.146	0.015	0.331	2.549
66	0.65	2.575	43923	0.1	2.475	44140	-0.067	-0.012	0.368	2.475
67	0.7	2.625	39639	0.125	2.875	39791	-0.100	0.044	0.404	2.696
68	0.6	2.675	19029	0.175	2.575	19128	-0.114	-0.027	0.380	2.574
69	0.6	2.725	17195	0.1	2.875	17347	-0.087	0.026	0.343	2.745
70	0.6	2.75	34122	0.15	2.475	34250	-0.093	-0.057	0.368	2.561
71	0.76	2.775	19482	0.1	3.225	19630	-0.118	0.080	0.422	2.941
72	0.6	2.775	13285	0.1	2.825	13363	-0.170	0.017	0.343	2.745
73	0.6	2.8	13235	0.075	3.35	13322	-0.160	0.167	0.331	3.015
74	0.65	2.875	14319	0.25	3.075	14406	-0.122	0.061	0.441	2.917
75	0.65	2.875	18820	0.1	3.05	18975	-0.094	0.030	0.368	2.904
76	0.6	2.925	13564	0.125	3.175	13670	-0.119	0.062	0.355	2.990
77	0.6	3	13173	0.25	3.475	13265	-0.101	0.137	0.417	3.174
78	0.6	3.025	17080	0.1	3.15	17250	-0.078	0.019	0.343	3.027
79	0.6	3.05	13881	0.1	3.475	13966	-0.156	0.132	0.343	3.199

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.7	3.075	11563	0.1	3.4	11707	-0.110	0.060	0.392	3.174
81	0.625	3.1	11959	0.1	3.575	12093	-0.104	0.094	0.355	3.272
82	0.6	3.125	15757	0.1	3.3	15895	-0.096	0.034	0.343	3.150
83	0.65	3.175	24714	0.125	3.35	24828	-0.122	0.041	0.380	3.199
84	0.625	3.2	20192	0.1	3.275	20334	-0.098	0.014	0.355	3.174
85	0.675	3.25	17803	0.175	3.55	17874	-0.186	0.112	0.417	3.333
86	0.7	3.275	19472	0.2	3.425	19580	-0.123	0.037	0.441	3.284
87	0.6	3.275	25594	0.15	3.45	25788	-0.061	0.024	0.368	3.297
88	0.625	3.3	19191	0.2	3.475	19301	-0.102	0.042	0.404	3.321
89	0.6	3.375	16657	0.15	3.575	16780	-0.097	0.043	0.368	3.407
90	0.625	3.425	17941	0.15	3.425	18038	-0.130	0.000	0.380	3.358
91	0.65	3.45	17339	0.2	3.525	17469	-0.092	0.015	0.417	3.419
92	0.6	3.475	16997	0.1	3.675	17162	-0.080	0.032	0.343	3.505
93	0.6	3.525	27618	0.125	3.75	27751	-0.095	0.045	0.355	3.566

Notes:
(1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

Table 14: HW 1.25P TW 1.14P, Unmodified Spillway Simulation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	0.3	0.25	47029	0.1	0.25	47116	-0.061	0.000	0.196	0.245
2	0.3	0.25	47868	0.1	0.25	47923	-0.096	0.000	0.196	0.245
3	0.3	0.25	48240	0.1	0.15	48302	-0.085	-0.043	0.196	0.196
4	0.4	0.35	45594	0.1	0.55	45685	-0.087	0.058	0.245	0.441
5	0.5	0.35	45710	0.4	0.25	45822	-0.024	-0.024	0.441	0.294
6	0.5	0.45	44921	0.3	0.25	45057	-0.039	-0.039	0.392	0.343
7	0.5	0.45	45308	0.4	0.35	45449	-0.019	-0.019	0.441	0.392
8	0.5	0.45	45451	0.4	0.25	45561	-0.024	-0.048	0.441	0.343
9	0.5	0.55	44276	0.4	0.25	44383	-0.025	-0.074	0.441	0.392
10	0.6	0.55	44397	0.4	0.35	44489	-0.058	-0.058	0.490	0.441
11	0.8	0.6	43436	0.5	0.25	43624	-0.042	-0.049	0.637	0.417
12	0.6	0.65	43129	0.1	0.25	43304	-0.076	-0.060	0.343	0.441
13	0.6	0.65	43332	0.5	0.35	43416	-0.032	-0.095	0.539	0.490
14	0.85	0.75	41700	0.5	0.35	41852	-0.061	-0.070	0.662	0.539
15	0.7	0.75	42304	0.5	0.35	42520	-0.025	-0.049	0.588	0.539
16	0.8	0.75	42663	0.5	0.25	42807	-0.055	-0.092	0.637	0.490
17	1	0.85	40361	0.4	0.25	40653	-0.054	-0.054	0.686	0.539
18	0.9	0.85	40988	0.1	0.25	41275	-0.074	-0.055	0.490	0.539
19	0.7	0.85	41292	0.2	0.25	41482	-0.070	-0.084	0.441	0.539
20	0.6	0.9	39289	0.1	0.25	39422	-0.099	-0.129	0.343	0.564
21	0.9	0.9	39657	0.3	0.35	39960	-0.052	-0.048	0.588	0.613
22	0.6	0.95	39423	0.1	0.45	39639	-0.061	-0.061	0.343	0.686
23	0.7	1.05	37905	0.1	0.6	38035	-0.122	-0.092	0.392	0.809
24	0.5	1.05	38063	0.1	0.25	38207	-0.074	-0.147	0.294	0.637
25	0.6	1.05	38224	0.1	0.25	38380	-0.085	-0.136	0.343	0.637
26	0.6	1.15	36610	0.1	0.25	36772	-0.082	-0.147	0.343	0.686
27	0.5	1.15	37736	0.1	0.45	37806	-0.151	-0.265	0.294	0.784
28	0.6	1.15	37812	0.1	0.45	37901	-0.149	-0.208	0.343	0.784
29	0.7	1.2	35707	0.1	0.65	35838	-0.121	-0.111	0.392	0.907
30	0.45	1.25	36299	0.2	0.25	36404	-0.063	-0.252	0.319	0.735
31	0.5	1.25	36438	0.1	0.55	36561	-0.086	-0.151	0.294	0.882
32	1	1.35	34910	0.1	0.25	35186	-0.086	-0.105	0.539	0.784
33	0.6	1.35	35285	0.1	0.65	35376	-0.145	-0.204	0.343	0.980
34	0.9	1.35	35406	0.1	0.75	35631	-0.094	-0.071	0.490	1.029
35	0.4	1.45	33669	0.1	1.75	33754	-0.093	0.093	0.245	1.569
36	1	1.45	33708	0.1	0.45	33884	-0.135	-0.150	0.539	0.931
37	0.6	1.45	34272	0.1	0.75	34420	-0.089	-0.125	0.343	1.078
38	0.7	1.55	32996	0.1	1.55	33121	-0.127	0.000	0.392	1.520
39	1	1.55	33188	0.1	0.65	33418	-0.104	-0.104	0.539	1.078

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.6	1.55	33487	0.1	1.75	33619	-0.100	0.040	0.343	1.618
41	0.4	1.65	30263	0.1	1.65	30330	-0.118	0.000	0.245	1.618
42	1	1.65	30916	0.1	1.5	31169	-0.094	-0.016	0.539	1.544
43	1	1.65	31171	0.1	0.45	31450	-0.085	-0.114	0.539	1.029
44	0.5	1.75	29516	0.1	2.05	29724	-0.051	0.038	0.294	1.863
45	0.8	1.75	29988	0.3	1.05	30176	-0.070	-0.099	0.539	1.373
46	0.5	1.75	30092	0.1	1.7	30263	-0.062	-0.008	0.294	1.691
47	0.6	1.85	28286	0.1	1.45	28460	-0.076	-0.061	0.343	1.618
48	0.9	1.85	28647	0.1	1.35	28872	-0.094	-0.059	0.490	1.569
49	0.9	1.85	28694	0.1	1.65	28822	-0.165	-0.041	0.490	1.716
50	0.5	1.9	26465	0.1	1.9	26534	-0.153	0.000	0.294	1.863
51	0.7	1.95	27140	0.1	1.75	27266	-0.126	-0.042	0.392	1.814
52	0.8	1.95	28246	0.1	1.45	28460	-0.087	-0.062	0.441	1.667
53	0.7	2.05	24917	0.1	2.75	25159	-0.066	0.077	0.392	2.353
54	0.7	2.05	24945	0.1	2.7	25182	-0.067	0.073	0.392	2.328
55	0.5	2.05	25672	0.1	1.85	25762	-0.118	-0.059	0.294	1.912
56	0.5	2.15	24732	0.3	2.95	24907	-0.030	0.121	0.392	2.500
57	0.3	2.15	24909	0.1	2.55	24967	-0.091	0.182	0.196	2.304
58	0.4	2.25	23637	0.1	2.35	23726	-0.089	0.030	0.245	2.255
59	0.6	2.25	23867	0.1	2.25	24102	-0.056	0.000	0.343	2.206
60	0.5	2.25	24257	0.1	3.45	24421	-0.065	0.194	0.294	2.794
61	0.8	2.3	20918	0.1	1.2	21122	-0.091	-0.143	0.441	1.716
62	0.2	2.35	21378	0.05	2.35	21453	-0.053	0.000	0.123	2.304
63	0.6	2.35	23436	0.05	2.85	23540	-0.140	0.127	0.319	2.549
64	0.4	2.45	19268	0.1	2.35	19396	-0.062	-0.021	0.245	2.353
65	0.4	2.45	19432	0.1	2.95	19551	-0.067	0.111	0.245	2.647
66	0.7	2.45	20510	0.1	2.2	20673	-0.097	-0.041	0.392	2.279
67	0.7	2.55	17834	0.1	3.55	17976	-0.112	0.186	0.392	2.990
68	0.7	2.55	17981	0.1	2.85	18079	-0.162	0.081	0.392	2.647
69	0.7	2.55	18079	0.1	3.05	18188	-0.146	0.121	0.392	2.745
70	0.6	2.65	16122	0.3	3.35	16233	-0.072	0.167	0.441	2.941
71	1	2.65	16122	0.1	3.25	16388	-0.090	0.060	0.539	2.892
72	0.9	2.65	17173	0.1	3	17369	-0.108	0.047	0.490	2.770
73	0.8	2.75	14230	0.3	3.65	14449	-0.060	0.109	0.539	3.137
74	0.6	2.75	14703	0.1	3.35	14837	-0.099	0.118	0.343	2.990
75	0.9	2.75	14703	0.2	3.55	14899	-0.095	0.108	0.539	3.088
76	0.4	2.85	13096	0.1	3.45	13163	-0.118	0.237	0.245	3.088
77	0.9	2.85	13549	0.2	3.75	13809	-0.071	0.092	0.539	3.235
78	0.8	2.85	13961	0.1	3.35	14193	-0.080	0.057	0.441	3.039
79	0.8	2.95	12420	0.1	2.95	12563	-0.130	0.000	0.441	2.892

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.8	2.95	12491	0.1	3.05	12668	-0.105	0.015	0.441	2.941
81	1	2.95	12829	0.1	3.25	13028	-0.120	0.040	0.539	3.039
82	0.6	3.05	11837	0.3	3.75	11930	-0.085	0.199	0.441	3.333
83	0.7	3.05	11837	0.4	3.75	11930	-0.085	0.199	0.539	3.333
84	0.8	3.05	11941	0.1	2.85	12072	-0.141	-0.040	0.441	2.892
85	0.6	3.15	10743	0.1	3.75	10893	-0.088	0.106	0.343	3.382
86	1	3.15	10900	0.4	3.35	11185	-0.056	0.019	0.686	3.186
87	1.1	3.15	11677	0.6	3.45	11806	-0.103	0.062	0.833	3.235
88	0.7	3.25	10055	0.2	3.75	10240	-0.072	0.072	0.441	3.431
89	1	3.25	10055	0.1	3.75	10220	-0.144	0.080	0.539	3.431
90	0.8	3.25	10346	0.2	3.35	10459	-0.141	0.023	0.490	3.235
91	0.7	3.35	9667	0.2	3.65	9849	-0.073	0.044	0.441	3.431
92	0.8	3.35	9683	0.2	3.65	9849	-0.096	0.048	0.490	3.431
93	1	3.35	10093	0.2	3.35	10240	-0.144	0.000	0.588	3.284
94	0.5	3.45	9189	0.1	3.75	9374	-0.057	0.043	0.294	3.529
95	0.8	3.45	9190	0.1	3.75	9430	-0.077	0.033	0.441	3.529
96	0.8	3.45	9379	0.4	3.75	9641	-0.040	0.030	0.588	3.529
97	0.6	3.5	8546	0.2	3.65	8702	-0.068	0.025	0.392	3.505
98	0.6	3.55	8711	0.1	3.5	8898	-0.071	-0.007	0.343	3.456
99	0.6	3.55	8791	0.1	3.4	8898	-0.124	-0.037	0.343	3.407
100	0.6	3.65	7970	0.1	3.5	8140	-0.078	-0.023	0.343	3.505
101	0.7	3.65	7996	0.1	3.45	8216	-0.072	-0.024	0.392	3.480
102	0.4	3.65	8243	0.1	3.75	8345	-0.078	0.026	0.245	3.627
103	0.2	3.7	7846	0.1	3.75	7930	-0.032	0.016	0.147	3.652
104	0.5	3.75	7045	0.1	3.85	7153	-0.098	0.025	0.294	3.725
105	0.5	3.75	7383	0.1	3.85	7547	-0.065	0.016	0.294	3.725

Notes:
(1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

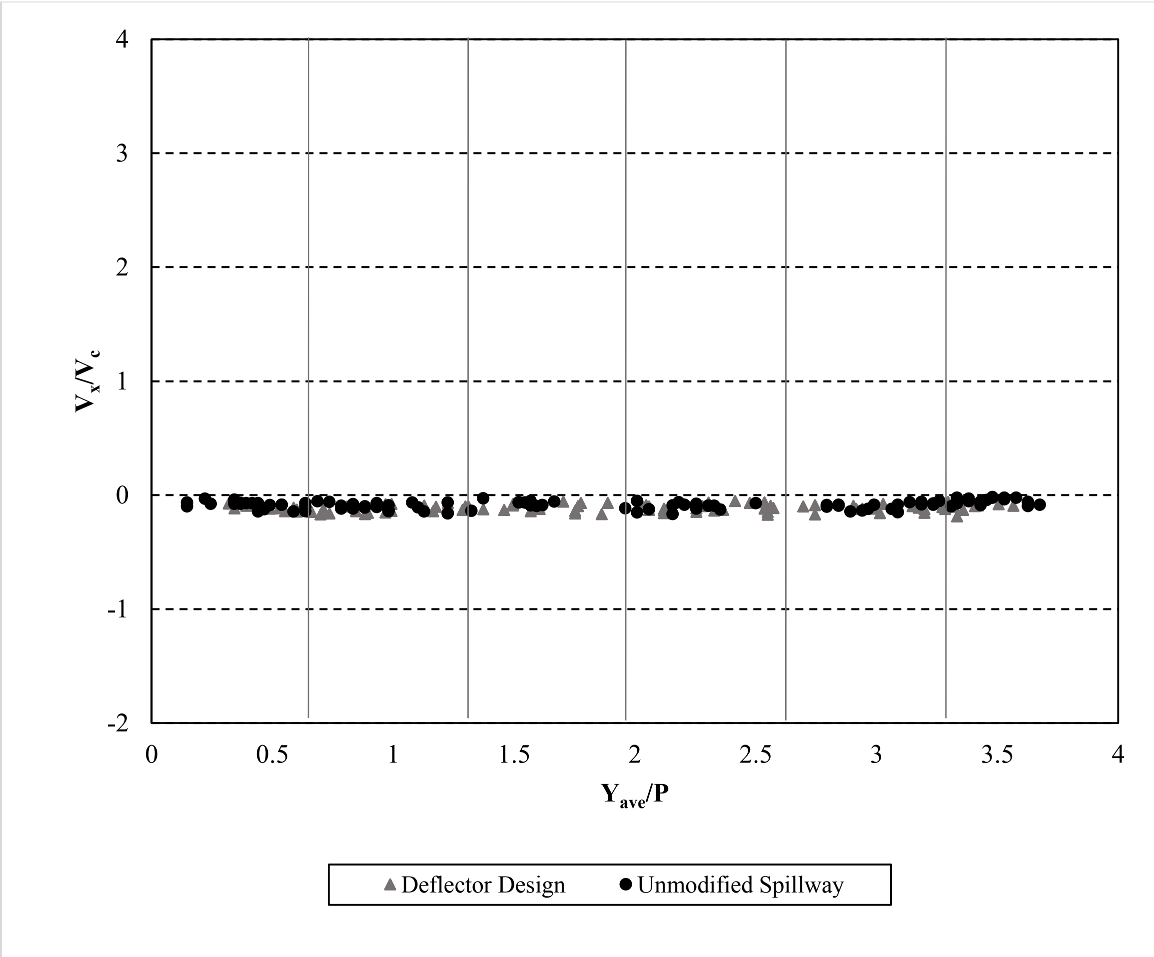

Figure 28: HW 1.25P TW 1.14P, Design Simulation Results

Table 15: HW 1.20P HW 0.41P, Multiple Staggered Deflector Design Simulation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	0.6	0.15	19651	0.2	0.35	19669	-0.667	0.333	0.392	0.245
2	0.6	0.15	29838	0.1	0.15	29874	-0.417	0.000	0.343	0.147
3	0.6	0.15	41734	0.1	0.25	41758	-0.625	0.125	0.343	0.196
4	1	0.25	13879	0.3	0.15	13939	-0.350	-0.050	0.637	0.196
5	0.5	0.25	19479	0.2	0.15	19517	-0.237	-0.079	0.343	0.196
6	1	0.25	28024	0.3	0.45	28106	-0.256	0.073	0.637	0.343
7	0.8	0.35	14814	0.5	0.45	14841	-0.333	0.111	0.637	0.392
8	0.9	0.35	18982	0.4	0.25	19017	-0.429	-0.086	0.637	0.294
9	0.8	0.35	19824	0.1	0.55	19857	-0.637	0.182	0.441	0.441
10	0.9	0.4	15190	0.5	0.25	15253	-0.191	-0.071	0.686	0.319
11	1	0.45	13748	0.6	0.25	13767	-0.632	-0.316	0.784	0.343
12	0.9	0.45	30013	0.1	0.25	30058	-0.534	-0.133	0.490	0.343
13	0.9	0.55	15051	0.1	0.45	15187	-0.177	-0.022	0.490	0.490
14	1	0.55	36333	0.3	0.15	36479	-0.144	-0.082	0.637	0.343
15	0.6	0.55	48648	0.4	0.45	48723	-0.080	-0.040	0.490	0.490
16	0.375	0.65	63430	0.275	0.75	63439	-0.333	0.333	0.319	0.686
17	0.7	0.675	28057	0.5	0.9	28092	-0.172	0.193	0.588	0.772
18	0.6	0.75	47293	0.1	0.95	47345	-0.289	0.115	0.343	0.833
19	0.325	0.75	66030	0	0.975	66067	-0.264	0.183	0.159	0.846
20	0.7	0.85	30949	0.3	0.95	30978	-0.414	0.103	0.490	0.882
21	0.7	0.85	46629	0.2	0.95	46736	-0.140	0.028	0.441	0.882
22	0.575	0.85	18650	0.175	0.975	18675	-0.480	0.150	0.368	0.895
23	0.6	0.95	47222	0.1	1.15	47245	-0.652	0.261	0.343	1.029
24	0.45	0.95	58855	0.15	1.05	58871	-0.563	0.188	0.294	0.980
25	0.45	1.05	52317	0.05	1.2	52370	-0.227	0.085	0.245	1.103
26	0.7	1.05	30149	0.3	1.15	30197	-0.250	0.063	0.490	1.078
27	1.1	1.05	48792	0.5	0.95	48892	-0.180	-0.030	0.784	0.980
28	0.9	1.15	14932	0.5	1.15	15040	-0.111	0.000	0.686	1.127
29	0.6	1.15	41269	0.1	1.05	41352	-0.181	-0.036	0.343	1.078
30	0.5	1.25	37311	0.2	1.25	37331	-0.450	0.000	0.343	1.225
31	0.2	1.25	47736	0.7	1.45	47767	0.484	0.194	0.441	1.324
32	0	1.35	35890	0.9	1.25	35942	0.519	-0.058	0.441	1.275
33	0.1	1.35	35892	1	1.35	35921	0.931	0.000	0.539	1.324
34	0.1	1.35	14472	1.1	1.525	14538	0.455	0.080	0.588	1.409
35	0	1.45	36542	1	1.55	36564	1.364	0.136	0.490	1.471
36	0	1.45	37164	1.1	1.35	37186	1.501	-0.136	0.539	1.373
37	0	1.45	42743	0.9	1.95	42756	2.078	1.154	0.441	1.667
38	0	1.475	58318	0.8	1.45	58336	1.334	-0.042	0.392	1.434
39	0	1.55	52151	0.9	1.55	52171	1.351	0.000	0.441	1.520

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0	1.55	58154	0.9	1.55	58166	2.251	0.000	0.441	1.520
41	0	1.65	36670	0.9	1.65	36687	1.589	0.000	0.441	1.618
42	0	1.65	47490	0.9	1.45	47517	1.000	-0.222	0.441	1.520
43	0	1.65	58064	0.9	1.55	58083	1.422	-0.158	0.441	1.569
44	0	1.75	27931	0.9	1.65	27944	2.078	-0.231	0.441	1.667
45	0	1.75	42332	1	1.75	42348	1.876	0.000	0.490	1.716
46	0	1.75	58062	0.9	1.75	58084	1.228	0.000	0.441	1.716
47	0	1.85	36781	0.9	1.75	36796	1.801	-0.200	0.441	1.765
48	0	1.85	42293	0.9	1.75	42305	2.251	-0.250	0.441	1.765
49	0	1.85	42558	0.9	1.8	42579	1.286	-0.071	0.441	1.789
50	0	1.9	36613	0.9	1.95	36650	0.730	0.041	0.441	1.887
51	0	1.95	18724	1	2.05	18738	2.144	0.214	0.490	1.961
52	0	1.95	32733	0.9	1.65	32746	2.078	-0.693	0.441	1.765
53	0	2.05	18683	0.9	2.05	18699	1.688	0.000	0.441	2.010
54	0	2.05	47401	1	1.95	47421	1.501	-0.150	0.490	1.961
55	0	2.05	52214	1	2.15	52227	2.309	0.231	0.490	2.059
56	0	2.1	6680	0.9	2.05	6711	0.871	-0.048	0.441	2.034
57	0	2.15	3920	0.8	2.35	3942	1.091	0.273	0.392	2.206
58	0	2.15	27731	1	2.15	27754	1.305	0.000	0.490	2.108
59	0	2.25	14553	1	2.25	14564	2.729	0.000	0.490	2.206
60	0	2.25	14608	1	2.25	14621	2.309	0.000	0.490	2.206
61	0	2.25	14608	1	2.95	14626	1.667	1.167	0.490	2.549
62	0	2.25	14686	0.9	2.25	14700	1.929	0.000	0.441	2.206
63	0	2.35	4053	0.9	2.25	4071	1.501	-0.167	0.441	2.255
64	0	2.35	27795	0.9	2.15	27808	2.078	-0.462	0.441	2.206
65	0	2.35	36527	0.9	2.25	36539	2.251	-0.250	0.441	2.255
66	0	2.45	6140	0.9	2.35	6153	2.078	-0.231	0.441	2.353
67	0	2.45	14286	0.9	2.45	14302	1.688	0.000	0.441	2.402
68	0	2.45	22393	0.9	2.65	22408	1.801	0.400	0.441	2.500
69	0.1	2.55	3961	0.9	2.65	3981	1.201	0.150	0.490	2.549
70	0	2.55	14269	0.9	2.55	14283	1.929	0.000	0.441	2.500
71	0.1	2.55	14269	1	2.55	14283	1.929	0.000	0.539	2.500
72	0	2.65	6342	1	2.55	6360	1.667	-0.167	0.490	2.549
73	0	2.65	27710	1	2.75	27730	1.501	0.150	0.490	2.647
74	0	2.65	27765	0.9	2.85	27777	2.251	0.500	0.441	2.696
75	0	2.75	3766	1	2.75	3785	1.580	0.000	0.490	2.696
76	0	2.75	6381	0.9	2.75	6402	1.286	0.000	0.441	2.696
77	0	2.75	22436	0.9	2.85	22456	1.351	0.150	0.441	2.745
78	0	2.85	18753	0.9	3.05	18764	2.456	0.546	0.441	2.892
79	0	2.85	22501	1	2.85	22513	2.501	0.000	0.490	2.794

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0	2.85	27551	0.9	2.85	27560	3.001	0.000	0.441	2.794
81	0	2.9	3789	1	3.15	3799	3.001	0.750	0.490	2.966
82	0	2.95	18561	0.9	3.05	18576	1.801	0.200	0.441	2.941
83	0	2.95	18561	0.9	3.15	18576	1.801	0.400	0.441	2.990
84	0	3.05	18617	1	3.15	18629	2.501	0.250	0.490	3.039
85	0	3.05	22419	0.9	3.05	22436	1.589	0.000	0.441	2.990
86	0	3.05	36715	1	2.85	36724	3.335	-0.667	0.490	2.892
87	0	3.1	4009	0.9	3.05	4018	3.001	-0.167	0.441	3.015
88	0	3.15	3889	1.1	3.35	3913	1.376	0.250	0.539	3.186
89	0	3.15	14582	0.9	3.25	14543	-0.693	-0.077	0.441	3.137
90	0	3.15	22456	0.9	3.25	22474	1.501	0.167	0.441	3.137
91	0	3.175	36593	0.9	3.25	36615	1.228	0.102	0.441	3.150
92	0	3.25	6159	1	3.25	6176	1.766	0.000	0.490	3.186
93	0	3.25	32668	0.9	3.15	32682	1.929	-0.214	0.441	3.137
94	0	3.275	79976	0.9	3.25	79987	2.456	-0.068	0.441	3.199
95	0	3.35	36870	0.9	3.45	36881	2.456	0.273	0.441	3.333
96	0	3.35	42478	0.9	3.45	42494	1.688	0.188	0.441	3.333
97	0	3.45	14494	1	3.55	14521	1.112	0.111	0.490	3.431
98	0	3.45	69206	1	3.35	69215	3.335	-0.333	0.490	3.333
99	0	3.5	42391	0.9	3.55	42405	1.929	0.107	0.441	3.456
100	0	3.5	69039	0.9	3.65	69046	3.859	0.643	0.441	3.505
101	0	3.55	18881	1	3.45	18897	1.876	-0.188	0.490	3.431
102	0	3.575	7710	0.9	3.45	7726	1.688	-0.234	0.441	3.444
103	0	3.65	47520	0.9	3.65	47548	0.965	0.000	0.441	3.578
104	0	3.65	47665	1	3.75	47689	1.251	0.125	0.490	3.627

Notes: (1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

Table 16: HW 1.20P HW 0.41P, Unmodified Spillway Design

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	0.6	0.25	29508	0.15	0.25	29544	-0.375	0.000	-0.221	0.245
2	0.6	0.25	33495	0.1	0.25	33526	-0.484	0.000	-0.245	0.245
3	0.6	0.25	34540	0.1	0.25	34571	-0.484	0.000	-0.245	0.245
4	0.9	0.35	31298	0.1	0.45	31329	-0.775	0.097	-0.392	0.392
5	0.8	0.35	33882	0.1	0.45	33915	-0.637	0.091	-0.343	0.392
6	0.6	0.35	34478	0.1	0.95	34500	-0.682	0.819	-0.245	0.637
7	0.8	0.45	29429	0.1	0.45	29463	-0.618	0.000	-0.343	0.441
8	0.9	0.45	31133	0.1	0.55	31174	-0.586	0.073	-0.392	0.490
9	1	0.45	33819	0.2	0.65	33882	-0.381	0.095	-0.392	0.539
10	0.7	0.55	30957	0.1	0.55	30992	-0.515	0.000	-0.294	0.539
11	1	0.55	31146	0.1	0.55	31188	-0.643	0.000	-0.441	0.539
12	0.6	0.55	31366	0.1	0.65	31392	-0.577	0.115	-0.245	0.588
13	0.6	0.65	30757	0.1	0.85	30792	-0.429	0.172	-0.245	0.735
14	1	0.65	30863	0.1	0.55	30912	-0.551	-0.061	-0.441	0.588
15	0.9	0.65	33174	0.1	0.65	33206	-0.750	0.000	-0.392	0.637
16	1	0.75	28468	0.1	0.85	28505	-0.730	0.081	-0.441	0.784
17	0.9	0.75	30128	0.1	0.8	30164	-0.667	0.042	-0.392	0.760
18	0.5	0.75	30402	0.1	0.85	30419	-0.706	0.177	-0.196	0.784
19	0.6	0.85	28546	0.1	0.95	28577	-0.484	0.097	-0.245	0.882
20	0.7	0.85	29309	0.1	0.65	29334	-0.720	-0.240	-0.294	0.735
21	0.6	0.85	29847	0.1	0.85	29867	-0.750	0.000	-0.245	0.833
22	1	0.95	27500	0.15	0.95	27536	-0.709	0.000	-0.417	0.931
23	0.6	0.95	28658	0.05	0.925	28683	-0.660	-0.030	-0.270	0.919
24	0.5	0.95	28710	0.1	1.05	28722	-1.000	0.250	-0.196	0.980
25	1.1	1.05	20465	0.1	0.95	20499	-0.883	-0.088	-0.490	0.980
26	1	1.05	20689	0.05	0.85	20752	-0.453	-0.095	-0.466	0.931
27	0.6	1.05	25070	0.05	1.05	25095	-0.660	0.000	-0.270	1.029
28	1	1.15	22762	0.1	1.05	22816	-0.500	-0.056	-0.441	1.078
29	0.8	1.15	23660	0.1	1.05	23688	-0.750	-0.107	-0.343	1.078
30	0.8	1.15	27806	0.1	1.15	27840	-0.618	0.000	-0.343	1.127
31	1	1.175	27927	0.1	1.55	27988	-0.443	0.185	-0.441	1.336
32	1	1.25	21890	0.1	1.3	21939	-0.551	0.031	-0.441	1.250
33	0.6	1.25	28286	0.05	1.25	28315	-0.569	0.000	-0.270	1.225
34	0.7	1.35	19506	0.1	1.25	19530	-0.750	-0.125	-0.294	1.275
35	1	1.35	20161	0.1	1.55	20193	-0.844	0.188	-0.441	1.422
36	0.7	1.35	21708	0.1	1.35	21728	-0.900	0.000	-0.294	1.324
37	0.6	1.45	19409	0.1	1.5	19438	-0.517	0.052	-0.245	1.446
38	0.8	1.45	21288	0.2	1.35	21338	-0.360	-0.060	-0.294	1.373
39	0.5	1.45	21637	0.1	1.3	21658	-0.572	-0.214	-0.196	1.348

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.6	1.5	27696	0.1	1.55	27716	-0.750	0.075	-0.245	1.495
41	0.7	1.55	24230	0.1	1.65	24258	-0.643	0.107	-0.294	1.569
42	0.9	1.55	28053	0.1	1.35	28082	-0.828	-0.207	-0.392	1.422
43	0.6	1.65	19683	0.1	1.85	19744	-0.246	0.098	-0.245	1.716
44	1	1.65	24023	0.2	1.75	24063	-0.600	0.075	-0.392	1.667
45	0.8	1.65	27517	0.1	1.65	27541	-0.875	0.000	-0.343	1.618
46	1	1.75	19135	0.1	1.65	19176	-0.659	-0.073	-0.441	1.667
47	1	1.75	20259	0.1	1.55	20295	-0.750	-0.167	-0.441	1.618
48	1	1.75	24295	0.1	2.05	24339	-0.614	0.205	-0.441	1.863
49	1	1.85	23853	0.1	1.85	23895	-0.643	0.000	-0.441	1.814
50	0.8	1.85	23959	0.1	2.05	23997	-0.553	0.158	-0.343	1.912
51	0.7	1.85	24112	0.1	1.85	24144	-0.563	0.000	-0.294	1.814
52	0.6	1.95	19792	0.1	1.95	19819	-0.556	0.000	-0.245	1.912
53	1	1.95	21208	0.1	1.75	21246	-0.711	-0.158	-0.441	1.814
54	1	1.95	21491	0.1	1.85	21528	-0.730	-0.081	-0.441	1.863
55	1.1	2	18475	0.2	1.85	18524	-0.551	-0.092	-0.441	1.887
56	1	2.05	18262	0.1	2.25	18294	-0.844	0.188	-0.441	2.108
57	0.6	2.05	18388	0.05	2.15	18412	-0.688	0.125	-0.270	2.059
58	0.7	2.15	14933	0.1	2.05	14964	-0.581	-0.097	-0.294	2.059
59	0.6	2.15	15693	0.1	2.35	15720	-0.556	0.222	-0.245	2.206
60	0.7	2.15	15983	0.1	1.95	16093	-0.164	-0.055	-0.294	2.010
61	1.1	2.2	15731	0.1	2.2	15765	-0.883	0.000	-0.490	2.157
62	1.1	2.25	15445	0.1	2.5	15506	-0.492	0.123	-0.490	2.328
63	0.8	2.25	15922	0.2	2.05	15951	-0.621	-0.207	-0.294	2.108
64	1.1	2.35	13485	0.1	2.1	13532	-0.639	-0.160	-0.490	2.181
65	0.9	2.35	13510	0.1	2.05	13543	-0.728	-0.273	-0.392	2.157
66	0.5	2.35	15240	0.1	2.35	15262	-0.546	0.000	-0.196	2.304
67	1	2.45	15052	0.2	2.45	15086	-0.706	0.000	-0.392	2.402
68	1.1	2.45	15107	0.2	2.25	15163	-0.482	-0.107	-0.441	2.304
69	1	2.45	15186	0.1	2.25	15222	-0.750	-0.167	-0.441	2.304
70	0.8	2.5	12969	0.1	2.55	13003	-0.618	0.044	-0.343	2.475
71	1.1	2.55	13236	0.1	2.5	13283	-0.639	-0.032	-0.490	2.475
72	1	2.55	13328	0.1	2.9	13397	-0.391	0.152	-0.441	2.672
73	1.1	2.65	11037	0.05	2.5	11082	-0.700	-0.100	-0.515	2.525
74	0.3	2.65	11238	0.1	2.55	11249	-0.546	-0.273	-0.098	2.549
75	1.1	2.65	11516	0.1	2.55	11556	-0.750	-0.075	-0.490	2.549
76	0.8	2.75	11152	0.1	2.65	11185	-0.637	-0.091	-0.343	2.647
77	0.9	2.75	11312	0.1	2.65	11343	-0.775	-0.097	-0.392	2.647
78	0.9	2.75	11689	0.05	2.75	11717	-0.911	0.000	-0.417	2.696
79	0.6	2.85	10117	0.1	2.88	10138	-0.715	0.043	-0.245	2.809

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.6	2.85	10138	0	2.85	10164	-0.693	0.000	-0.294	2.794
81	0.6	2.875	10375	0.1	2.8	10395	-0.750	-0.113	-0.245	2.782
82	0.8	2.95	9779	0.1	2.8	9827	-0.438	-0.094	-0.343	2.819
83	0.9	2.95	10593	0.05	2.8	10630	-0.690	-0.122	-0.417	2.819
84	0.8	3.05	8434	0.2	3.05	8462	-0.643	0.000	-0.294	2.990
85	0.7	3.05	10295	0.1	3	10317	-0.819	-0.068	-0.294	2.966
86	1.1	3.05	11738	0.1	3.05	11786	-0.625	0.000	-0.490	2.990
87	0.9	3.15	8225	0.025	3.05	8267	-0.625	-0.071	-0.429	3.039
88	0.7	3.15	9717	0.1	3.05	9751	-0.530	-0.088	-0.294	3.039
89	0.6	3.15	10320	0.05	3.15	10340	-0.825	0.000	-0.270	3.088
90	1.1	3.25	8269	0.1	2.95	8331	-0.484	-0.145	-0.490	3.039
91	0.7	3.25	8637	0.2	3.35	8659	-0.682	0.136	-0.245	3.235
92	1.1	3.25	9222	0.1	3.15	9281	-0.509	-0.051	-0.490	3.137
93	1	3.35	8464	0.4	3.35	8529	-0.277	0.000	-0.294	3.284
94	1	3.35	8790	0	3.25	8834	-0.682	-0.068	-0.490	3.235
95	1	3.35	8820	0.1	3.25	8853	-0.819	-0.091	-0.441	3.235
96	0.6	3.45	8616	0.1	3.55	8637	-0.715	0.143	-0.245	3.431
97	0.8	3.45	8755	0.1	3.35	8787	-0.657	-0.094	-0.343	3.333
98	1	3.45	8866	0.2	3.2	8905	-0.616	-0.192	-0.392	3.260
99	0.6	3.5	8464	0.1	3.55	8487	-0.652	0.065	-0.245	3.456
100	0.6	3.55	8346	0.1	3.55	8371	-0.600	0.000	-0.245	3.480
101	0.8	3.55	8693	0.05	3.55	8725	-0.703	0.000	-0.368	3.480
102	0.8	3.6	9427	0.1	3.45	9468	-0.512	-0.110	-0.343	3.456
103	0.9	3.65	8977	0.1	3.35	9014	-0.649	-0.243	-0.392	3.431
104	0.4	3.65	10702	0.1	3.75	10718	-0.563	0.188	-0.147	3.627
105	0.6	3.675	10843	0.05	3.65	10870	-0.611	-0.028	-0.270	3.591
106	0.5	3.7	11011	0.1	3.7	11028	-0.706	0.000	-0.196	3.627
107	1	3.75	8551	0.6	3.85	8614	-0.191	0.048	-0.196	3.725

Notes:
(1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

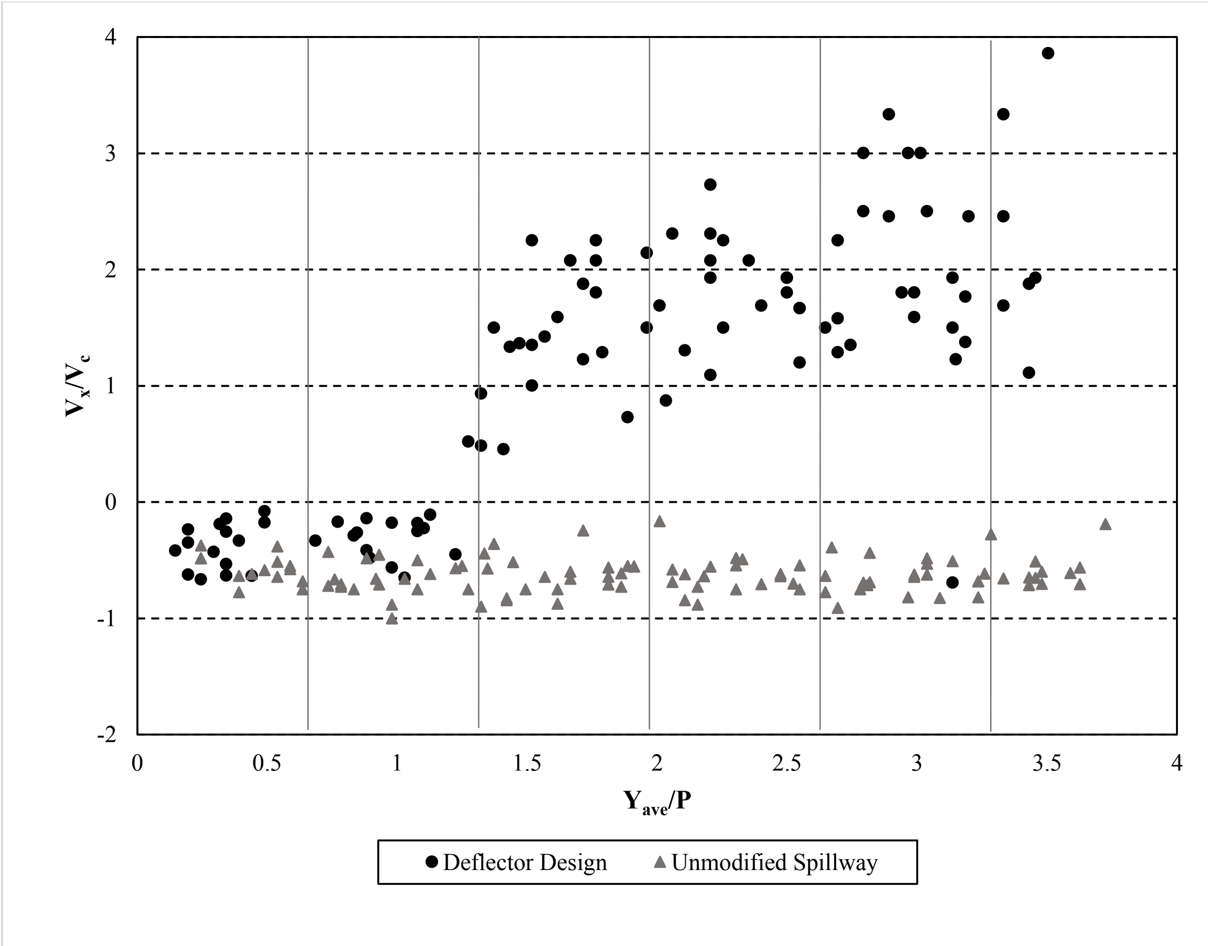

Figure 29: HW 1.20P TW 0.41P, Design Simulation Results

Table 17: HW 1.20P TW 0.65P, Multiple Staggered Design Deflector Simulation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	0	0.325	76236	0.7	0.225	76249	1.616	-0.231	0.343	0.270
2	0	0.425	21567	0.9	0.325	21578	2.456	-0.273	0.441	0.368
3	0	0.45	76232	0.8	0.5	76245	1.847	0.115	0.392	0.466
4	0.05	0.45	30741	0.9	0.375	30754	1.962	-0.173	0.466	0.404
5	0	0.55	21349	1.1	0.65	21364	2.201	0.200	0.539	0.588
6	0.075	0.55	26596	0.8	0.625	26610	1.554	0.161	0.429	0.576
7	0.4	0.55	75932	1.1	0.85	75947	1.401	0.600	0.735	0.686
8	0	0.65	21217	0.9	0.65	21232	1.801	0.000	0.441	0.637
9	0.05	0.65	21324	0.9	0.75	21338	1.822	0.214	0.466	0.686
10	0.05	0.65	26258	0.8	0.65	26268	2.251	0.000	0.417	0.637
11	0	0.675	21318	0.9	0.625	21331	2.078	-0.115	0.441	0.637
12	0.075	0.75	14341	0.925	0.825	14352	2.319	0.205	0.490	0.772
13	0	0.75	25994	0.9	0.675	26006	2.251	-0.188	0.441	0.699
14	0.2	0.775	36531	0.9	0.9	36545	1.501	0.268	0.539	0.821
15	0	0.8	21220	0.975	0.975	21249	1.009	0.181	0.478	0.870
16	0	0.8	21424	0.8	0.85	21434	2.401	0.150	0.392	0.809
17	0	0.9	26518	0.9	0.875	26540	1.228	-0.034	0.441	0.870
18	0.45	0.9	58385	0.8	1.25	58399	0.750	0.750	0.613	1.054
19	0.025	0.95	45483	0.675	0.95	45513	0.650	0.000	0.343	0.931
20	0	1	58791	0.5	1.025	58800	1.667	0.083	0.245	0.993
21	0.1	1.05	42890	0.825	1.05	42916	0.837	0.000	0.453	1.029
22	0.05	1.075	36841	0.825	1.05	36857	1.454	-0.047	0.429	1.042
23	0.05	1.1	21088	0.9	1.075	21104	1.594	-0.047	0.466	1.066
24	0	1.15	80763	0.625	1.25	80770	2.680	0.429	0.306	1.176
25	0	1.175	36418	0.85	1.2	36442	1.063	0.031	0.417	1.164
26	0	1.2	16403	1.1	2.425	16431	1.179	1.313	0.539	1.777
27	0.025	1.3	13917	0.6	1.375	13933	1.079	0.141	0.306	1.311
28	0.025	1.3	76149	0.7	1.375	76165	1.266	0.141	0.355	1.311
29	0.35	1.35	53341	1	1.375	53371	0.650	0.025	0.662	1.336
30	0.425	1.375	45826	0.25	1.325	45846	-0.263	-0.075	0.331	1.324
31	0.7	1.4	43016	0.425	1.375	43041	-0.330	-0.030	0.551	1.360
32	0.7	1.425	21193	0.425	1.325	21213	-0.413	-0.150	0.551	1.348
33	0.7	1.475	36643	0.3	1.275	36677	-0.353	-0.177	0.490	1.348
34	0.675	1.5	26037	0.4	1.4	26080	-0.192	-0.070	0.527	1.422
35	0.6	1.525	36561	0.35	1.5	36576	-0.500	-0.050	0.466	1.483
36	0.7	1.575	13983	0.2	1.45	14022	-0.385	-0.096	0.441	1.483
37	0.325	1.6	14062	0.175	1.4	14082	-0.225	-0.300	0.245	1.471
38	0.6	1.65	16175	0.2	1.325	16213	-0.316	-0.257	0.392	1.458
39	0.7	1.7	31532	0.2	1.5	31568	-0.417	-0.167	0.441	1.569

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.5	1.75	14014	0.15	1.625	14052	-0.276	-0.099	0.319	1.654
41	0.6	1.75	16147	0.4	1.65	16161	-0.429	-0.214	0.490	1.667
42	0.55	1.775	13894	0.3	1.75	13903	-0.834	-0.083	0.417	1.728
43	0.7	1.775	21017	0.375	1.575	21042	-0.390	-0.240	0.527	1.642
44	0.65	1.775	26302	0.375	1.475	26320	-0.459	-0.500	0.502	1.593
45	0.6	1.95	52969	0.425	1.85	52988	-0.276	-0.158	0.502	1.863
46	0.65	2	58580	0.4	1.975	58599	-0.395	-0.039	0.515	1.949
47	0.4	2.05	42868	0.275	2.05	42880	-0.313	0.000	0.331	2.010
48	0.65	2.125	36561	0.4	2.125	36580	-0.395	0.000	0.515	2.083
49	0.575	2.125	45558	0.4	2.2	45569	-0.477	0.205	0.478	2.120
50	0.6	2.15	50840	0.125	1.975	50871	-0.460	-0.169	0.355	2.022
51	0.6	2.2	36420	0.3	2.1	36436	-0.563	-0.188	0.441	2.108
52	0.675	2.2	36504	0.475	2.15	36518	-0.429	-0.107	0.564	2.132
53	0.7	2.2	47918	0.4	1.95	47936	-0.500	-0.417	0.539	2.034
54	0.6	2.275	45807	0.175	1.975	45843	-0.354	-0.250	0.380	2.083
55	0.625	2.275	45379	0.4	2.125	45395	-0.422	-0.281	0.502	2.157
56	0.6	2.35	42679	0.2	2.075	42703	-0.500	-0.344	0.392	2.169
57	0.6	2.4	31422	0.075	1.975	31465	-0.366	-0.297	0.331	2.145
58	0.45	2.425	45429	0.225	2.25	45445	-0.422	-0.328	0.331	2.292
59	0.525	2.45	13862	0.225	2.175	13880	-0.500	-0.459	0.368	2.267
60	0.575	2.475	80105	0.4	2.475	80118	-0.404	0.000	0.478	2.426
61	0.5	2.525	42774	0.35	2.4	42786	-0.375	-0.313	0.417	2.414
62	0.575	2.525	55810	0.4	2.25	55825	-0.350	-0.550	0.478	2.341
63	0.425	2.625	36407	0.3	2.55	36419	-0.313	-0.188	0.355	2.537
64	0.6	2.65	50650	0.35	2.575	50674	-0.313	-0.094	0.466	2.561
65	0.6	2.75	80208	0.375	2.575	80230	-0.307	-0.239	0.478	2.610
66	0.45	2.75	89933	0.2	2.8	89953	-0.375	0.075	0.319	2.721
67	0.45	2.75	42728	0.3	2.675	42737	-0.500	-0.250	0.368	2.659
68	0.5	2.775	47775	0.25	2.75	47788	-0.577	-0.058	0.368	2.708
69	0.425	2.825	16118	0.15	2.725	16134	-0.516	-0.188	0.282	2.721
70	0.575	2.825	42739	0.375	2.75	42749	-0.600	-0.225	0.466	2.733
71	0.475	2.875	45514	0.325	2.725	45525	-0.409	-0.409	0.392	2.745
72	0.575	2.9	13828	0.35	2.65	13851	-0.294	-0.326	0.453	2.721
73	0.4	2.95	47679	0.25	2.875	47688	-0.500	-0.250	0.319	2.855
74	0.45	3	47676	0.275	2.875	47686	-0.525	-0.375	0.355	2.880
75	0.35	3	17419	0.225	2.85	17425	-0.625	-0.750	0.282	2.868
76	0.525	3.025	84667	0.1	2.675	84690	-0.555	-0.457	0.306	2.794
77	0.3	3.075	84540	0.2	2.975	84546	-0.500	-0.500	0.245	2.966
78	0.3	3.1	36668	0.175	3	36677	-0.417	-0.333	0.233	2.990
79	0	3.1	93245	0.9	3.175	93264	1.422	0.118	0.441	3.076

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.375	3.225	58328	1.1	3	58351	0.946	-0.294	0.723	3.051
81	0.025	3.25	49026	0.9	3.225	49054	0.938	-0.027	0.453	3.174
82	0	3.275	42615	0.925	3.275	42642	1.028	0.000	0.453	3.211
83	0	3.3	36453	1.1	3.225	36502	0.674	-0.046	0.539	3.199
84	0.175	3.325	38663	0.05	3.275	38670	-0.536	-0.214	0.110	3.235
85	0.025	3.425	21047	0.7	3.45	21062	1.351	0.050	0.355	3.370
86	0	3.425	25958	0.9	3.45	25980	1.228	0.034	0.441	3.370
87	0.025	3.45	25979	0.9	3.375	26013	0.772	-0.066	0.453	3.346
88	0.025	3.475	26021	0.9	3.525	26059	0.691	0.039	0.453	3.431
89	0	3.575	26001	1.05	3.525	26019	1.751	-0.083	0.515	3.480
90	0	3.575	45086	0.9	3.725	45105	1.422	0.237	0.441	3.578

Notes:
(1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

Table 18: HW 1.20P TW 0.65P, Unmodified Spillway Simulation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	1	0.2	19296	0.2	0.45	19343	-0.511	0.160	-0.392	0.319
2	1.1	0.25	18828	0.15	0.35	18934	-0.269	0.028	-0.466	0.294
3	1	0.25	19047	0.2	0.15	19138	-0.264	-0.033	-0.392	0.196
4	1	0.25	19143	0.2	0.45	19240	-0.248	0.062	-0.392	0.343
5	0.6	0.35	18936	0.05	0.3	18968	-0.516	-0.047	-0.270	0.319
6	1	0.35	19047	0.15	0.2	19134	-0.293	-0.052	-0.417	0.270
7	1.1	0.35	19498	0.05	0.9	19596	-0.322	0.168	-0.515	0.613
8	0.9	0.45	18245	0.1	0.45	18308	-0.381	0.000	-0.392	0.441
9	0.7	0.45	18370	0.1	0.4	18425	-0.327	-0.027	-0.294	0.417
10	1.1	0.45	18513	0.1	0.5	18599	-0.349	0.017	-0.490	0.466
11	0.9	0.55	17560	0.1	0.55	17623	-0.381	0.000	-0.392	0.539
12	0.7	0.55	17656	0.05	0.4	17702	-0.424	-0.098	-0.319	0.466
13	0.9	0.55	17672	0.1	0.7	17717	-0.534	0.100	-0.392	0.613
14	1	0.6	18072	0.1	0.45	18193	-0.223	-0.037	-0.441	0.515
15	0.8	0.65	17130	0.1	0.35	17200	-0.300	-0.129	-0.343	0.490
16	0.9	0.65	17914	0.1	0.85	17955	-0.586	0.146	-0.392	0.735
17	0.9	0.7	17114	0.05	0.85	17187	-0.349	0.062	-0.417	0.760
18	0.8	0.75	17219	0.05	0.8	17255	-0.625	0.042	-0.368	0.760
19	0.7	0.75	17245	0.1	0.65	17273	-0.643	-0.107	-0.294	0.686
20	0.7	0.775	15842	0.05	0.85	15880	-0.513	0.059	-0.319	0.797
21	0.7	0.85	16193	0.015	0.7	16237	-0.467	-0.102	-0.336	0.760
22	0.7	0.85	16443	0.1	0.75	16479	-0.500	-0.083	-0.294	0.784
23	0.9	0.9	15904	0.05	0.7	15955	-0.500	-0.118	-0.417	0.784
24	0.7	0.95	13370	0.1	0.85	13405	-0.515	-0.086	-0.294	0.882
25	1	0.95	15955	0.075	0.85	16009	-0.514	-0.056	-0.453	0.882
26	1.1	1	16055	0.1	0.85	16119	-0.469	-0.070	-0.490	0.907
27	0.5	1	16301	0.1	1.05	16329	-0.429	0.054	-0.196	1.005
28	0.8	1.05	15773	0.1	0.95	15828	-0.382	-0.055	-0.343	0.980
29	0.8	1.15	15399	0.1	1	15434	-0.600	-0.129	-0.343	1.054
30	0.6	1.15	16389	0.1	1.075	16420	-0.484	-0.073	-0.245	1.091
31	1.1	1.15	16518	0.05	1.1	16565	-0.671	-0.032	-0.515	1.103
32	0.9	1.25	13260	0.1	1.25	13311	-0.471	0.000	-0.392	1.225
33	0.8	1.25	15355	0.1	1.15	15396	-0.512	-0.073	-0.343	1.176
34	1.1	1.25	16703	0.1	1.4	16790	-0.345	0.052	-0.490	1.299
35	0.6	1.35	9299	0.05	1.2	9330	-0.533	-0.145	-0.270	1.250
36	0.6	1.35	10740	0.05	1.4	10774	-0.486	0.044	-0.270	1.348
37	0.8	1.35	13493	0.1	1.45	13540	-0.447	0.064	-0.343	1.373
38	1.1	1.4	12331	0.1	1.25	12409	-0.385	-0.058	-0.490	1.299
39	0.5	1.4	13699	0.1	1.5	13729	-0.400	0.100	-0.196	1.422

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.6	1.45	13062	0.1	1.45	13094	-0.469	0.000	-0.245	1.422
41	0.9	1.5	14154	0.1	1.45	14234	-0.300	-0.019	-0.392	1.446
42	1	1.55	14107	0.1	0.75	14187	-0.338	-0.300	-0.441	1.127
43	0.8	1.55	14569	0.05	1.6	14630	-0.369	0.025	-0.368	1.544
44	0.9	1.65	12063	0.1	1.6	12107	-0.546	-0.034	-0.392	1.593
45	1.1	1.65	12649	0.1	1.55	12718	-0.435	-0.043	-0.490	1.569
46	1	1.65	13103	0.1	1.65	13170	-0.403	0.000	-0.441	1.618
47	1	1.7	9560	0.1	1.65	9623	-0.429	-0.024	-0.441	1.642
48	0.9	1.75	10373	0.05	1.85	10413	-0.638	0.075	-0.417	1.765
49	0.8	1.75	10979	0.05	1.65	11031	-0.433	-0.058	-0.368	1.667
50	1	1.85	9363	0.1	1.95	9421	-0.466	0.052	-0.441	1.863
51	0.7	1.85	11864	0.05	1.85	11900	-0.542	0.000	-0.319	1.814
52	0.8	1.85	12014	0.15	2.15	12048	-0.574	0.265	-0.319	1.961
53	1	1.95	8358	0.05	1.85	8423	-0.439	-0.046	-0.466	1.863
54	0.6	1.95	9060	0.03	1.95	9106	-0.372	0.000	-0.279	1.912
55	1	1.95	11459	0.3	1.95	11523	-0.328	0.000	-0.343	1.912
56	0.9	2.05	8688	0.1	2.25	8745	-0.421	0.105	-0.392	2.108
57	1	2.05	9864	0.1	1.95	9909	-0.600	-0.067	-0.441	1.961
58	1	2.05	10683	0.1	2.45	10731	-0.563	0.250	-0.441	2.206
59	1	2.1	8824	0.08	2	8876	-0.531	-0.058	-0.451	2.010
60	0.8	2.15	7821	0.03	2.2	7876	-0.420	0.027	-0.377	2.132
61	0.6	2.15	9765	0.1	2	9799	-0.441	-0.132	-0.245	2.034
62	0.8	2.2	8882	0.1	2.15	8930	-0.438	-0.031	-0.343	2.132
63	1	2.2	9211	0.07	2.45	9294	-0.336	0.090	-0.456	2.279
64	0.5	2.25	8982	0.05	2.25	9014	-0.422	0.000	-0.221	2.206
65	0.6	2.35	7666	0.075	2.1	7744	-0.202	-0.096	-0.257	2.181
66	0.7	2.35	7876	0.1	2.4	7926	-0.360	0.030	-0.294	2.328
67	0.6	2.35	8062	0.1	2.55	8107	-0.333	0.133	-0.245	2.402
68	0.8	2.45	6324	0.1	2.65	6380	-0.375	0.107	-0.343	2.500
69	0.5	2.45	7569	0.1	2.35	7592	-0.522	-0.130	-0.196	2.353
70	1.1	2.45	7748	0.05	2.25	7810	-0.508	-0.097	-0.515	2.304
71	0.6	2.475	7325	0.1	2.25	7375	-0.300	-0.135	-0.245	2.316
72	1.1	2.55	6539	0.05	2.05	6617	-0.404	-0.192	-0.515	2.255
73	0.7	2.55	6997	0.1	2.25	7050	-0.340	-0.170	-0.294	2.353
74	1	2.575	7151	0.05	2.45	7216	-0.439	-0.058	-0.466	2.463
75	0.6	2.65	7497	0.1	2.55	7525	-0.536	-0.107	-0.245	2.549
76	0.8	2.65	7525	0.05	2.45	7562	-0.608	-0.162	-0.368	2.500
77	0.8	2.7	7059	0.1	2.65	7150	-0.231	-0.016	-0.343	2.623
78	0.6	2.75	6960	0.05	2.9	6995	-0.472	0.129	-0.270	2.770
79	0.6	2.75	7059	0.1	2.75	7123	-0.234	0.000	-0.245	2.696

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	1.1	2.82	6460	0.015	2.75	6525	-0.501	-0.032	-0.532	2.730
81	1.1	2.85	6655	0.1	2.75	6712	-0.527	-0.053	-0.490	2.745
82	0.8	2.85	6891	0.1	3.15	6950	-0.356	0.153	-0.343	2.941
83	1	2.95	6074	0.1	2.975	6129	-0.491	0.014	-0.441	2.904
84	1	2.95	6720	0.15	3.15	6777	-0.448	0.105	-0.417	2.990
85	0.8	2.95	6806	0.2	3.05	6844	-0.474	0.079	-0.294	2.941
86	0.6	2.975	6410	0.1	3.15	6444	-0.441	0.154	-0.245	3.002
87	0.9	3.05	5992	0.075	3.25	6048	-0.442	0.107	-0.404	3.088
88	0.7	3.05	6242	0.1	3	6284	-0.429	-0.036	-0.294	2.966
89	1.1	3.1	6149	0.1	3.25	6193	-0.682	0.102	-0.490	3.113
90	1.1	3.12	5892	0.05	3.15	5947	-0.573	0.016	-0.515	3.074
91	0.7	3.15	6138	0.1	3.2	6176	-0.474	0.039	-0.294	3.113
92	0.7	3.2	5650	0.1	3.65	5694	-0.409	0.307	-0.294	3.358
93	1	3.2	5721	0.1	3.25	5774	-0.510	0.028	-0.441	3.162
94	0.9	3.25	5788	0.1	3.5	5831	-0.558	0.174	-0.392	3.309
95	0.5	3.325	5124	0.1	3.4	5151	-0.445	0.083	-0.196	3.297
96	0.5	3.35	5250	0.1	3.55	5278	-0.429	0.214	-0.196	3.382
97	0.9	3.35	5518	0.1	3.45	5568	-0.480	0.060	-0.392	3.333
98	0.8	3.4	5324	0.1	3.4	5412	-0.239	0.000	-0.343	3.333
99	0.9	3.42	3976	0.1	3.55	4024	-0.500	0.081	-0.392	3.417
100	0.9	3.45	3677	0.1	3.55	3743	-0.364	0.045	-0.392	3.431
101	1	3.475	4657	0.1	3.45	4702	-0.600	-0.017	-0.441	3.395
102	0.7	3.55	4583	0.05	3.65	4644	-0.320	0.049	-0.319	3.529
103	0.6	3.55	4868	0.1	3.6	4911	-0.349	0.035	-0.245	3.505
104	0.9	3.625	3861	0.1	3.65	3937	-0.316	0.010	-0.392	3.566
105	0.6	3.65	3796	0.1	3.65	3844	-0.313	0.000	-0.245	3.578
106	1	3.65	4429	0.075	3.65	4492	-0.441	0.000	-0.453	3.578
107	0.7	3.675	4705	0.1	3.65	4743	-0.474	-0.020	-0.294	3.591
108	0.6	3.72	4233	0.1	3.6	4362	-0.116	-0.028	-0.245	3.588
109	0.9	3.75	5029	0.2	3.65	5094	-0.323	-0.046	-0.343	3.627

Notes: (1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

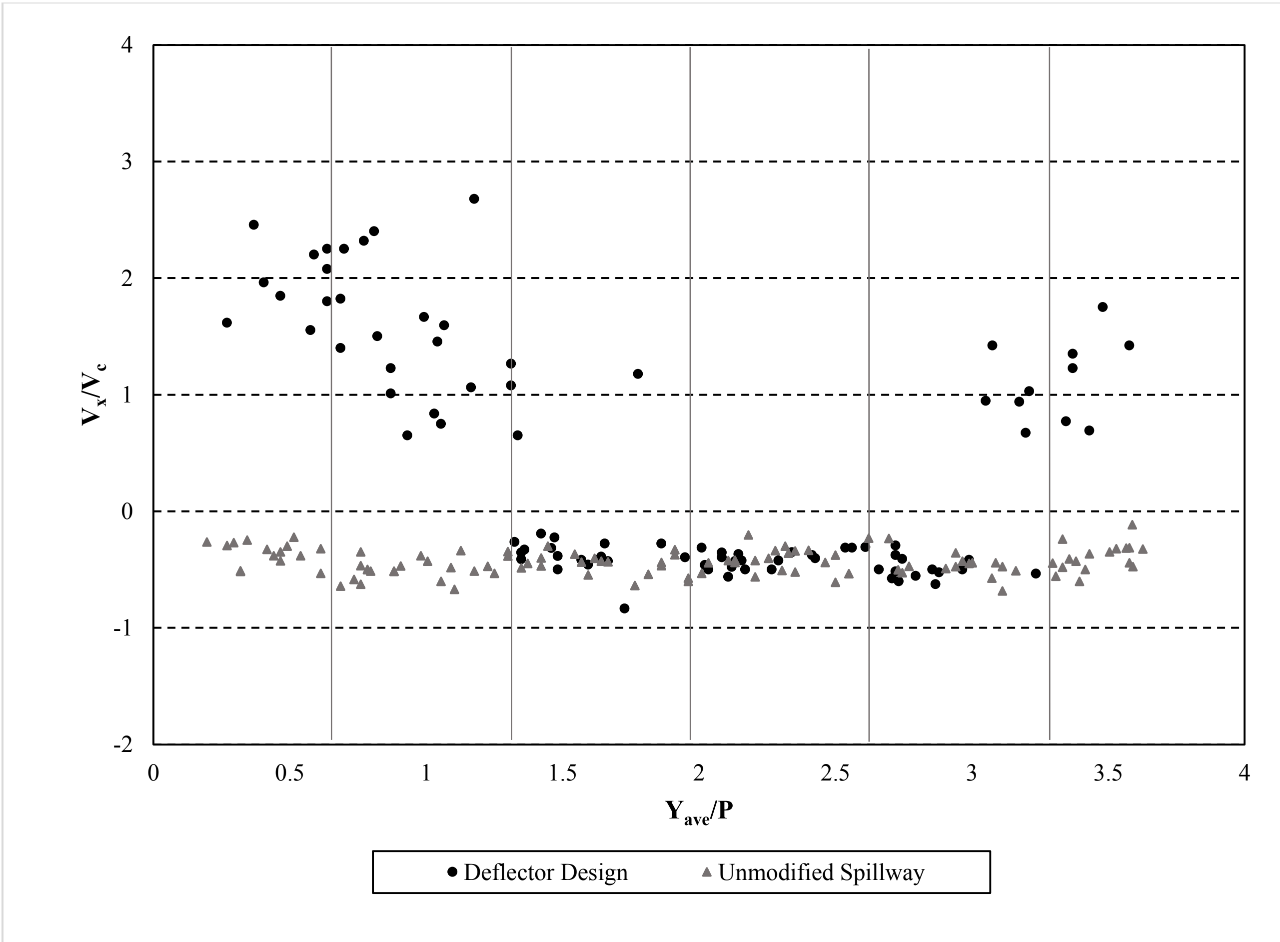

Figure 30: HW 1.20P TW 0.65P, Design Simulation Results

Table 19: HW 1.20P TW 0.86P, Multiple Staggered Deflector Design Simulation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	0.525	0.175	11740	0.2	0.225	11778	-0.257	0.039	0.355	0.196
2	0.6	0.25	11422	0.2	0.25	11449	-0.445	0.000	0.392	0.245
3	0.675	0.25	11663	0.2	0.25	11709	-0.310	0.000	0.429	0.245
4	0.75	0.3	12180	0.1	0.325	12235	-0.355	0.014	0.417	0.306
5	0.7	0.35	11182	0.175	0.3	11224	-0.375	-0.036	0.429	0.319
6	0.7	0.35	11273	0.125	0.25	11329	-0.308	-0.054	0.404	0.294
7	0.675	0.375	12584	0.1	0.25	12622	-0.454	-0.099	0.380	0.306
8	0.5	0.4	11077	0.125	0.45	11133	-0.201	0.027	0.306	0.417
9	0.625	0.45	10821	0.125	0.325	10855	-0.441	-0.110	0.368	0.380
10	0.6	0.5	13136	0.075	0.275	13180	-0.358	-0.153	0.331	0.380
11	0.625	0.55	10821	0.125	0.375	10855	-0.441	-0.154	0.368	0.453
12	0.5	0.55	12355	0.175	0.475	12399	-0.222	-0.051	0.331	0.502
13	0.55	0.6	11494	0.15	0.4	11523	-0.414	-0.207	0.343	0.490
14	0.6	0.65	11000	0.1	0.4	11042	-0.357	-0.179	0.343	0.515
15	0.5	0.65	11161	0.175	0.55	11194	-0.296	-0.091	0.331	0.588
16	0.55	0.7	11434	0.1	0.625	11462	-0.482	-0.080	0.319	0.650
17	0.5	0.75	11232	0.2	0.6	11254	-0.409	-0.205	0.343	0.662
18	0.55	0.75	11370	0.025	0.725	11406	-0.438	-0.021	0.282	0.723
19	0.525	0.85	18504	0.15	0.8	18530	-0.433	-0.058	0.331	0.809
20	0.65	0.85	18649	0.175	0.55	18688	-0.366	-0.231	0.404	0.686
21	0.35	0.85	25675	0.025	0.85	25705	-0.325	0.000	0.184	0.833
22	0.35	0.925	18374	0.075	0.65	18402	-0.295	-0.295	0.208	0.772
23	0.575	0.925	18432	0.1	0.9	18472	-0.356	-0.019	0.331	0.895
24	0.6	0.95	11019	0.1	0.725	11070	-0.294	-0.132	0.343	0.821
25	0.5	1.025	32142	0.1	0.9	32170	-0.429	-0.134	0.294	0.944
26	0.525	1.05	18309	0.125	0.875	18342	-0.364	-0.159	0.319	0.944
27	0.5	1.05	18311	0.125	0.875	18341	-0.375	-0.175	0.306	0.944
28	0.375	1.15	18212	0.1	1.075	18228	-0.516	-0.141	0.233	1.091
29	0.55	1.15	25817	0.05	1.9	25851	-0.441	0.662	0.294	1.495
30	0.45	1.15	32341	0.1	1.05	32367	-0.404	-0.115	0.270	1.078
31	0.425	1.225	18206	0.1	1.075	18226	-0.488	-0.225	0.257	1.127
32	0.4	1.25	10381	0.025	1.1	10415	-0.331	-0.132	0.208	1.152
33	0.45	1.25	11037	0.175	1.25	11057	-0.413	0.000	0.306	1.225
34	0.4	1.3	31468	0.175	0.95	31483	-0.450	-0.700	0.282	1.103
35	0.525	1.325	18071	0.1	1.35	18094	-0.555	0.033	0.306	1.311
36	0.575	1.35	10310	0.075	1.2	10362	-0.289	-0.087	0.319	1.250
37	0.575	1.4	18062	0.1	1.225	18095	-0.432	-0.159	0.331	1.287
38	0.425	1.425	10897	0.1	1.6	10927	-0.325	0.175	0.257	1.483
39	0.5	1.45	10249	0.1	1.3	10291	-0.286	-0.107	0.294	1.348

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.5	1.475	18327	0.2	1.4	18346	-0.474	-0.118	0.343	1.409
41	0.475	1.5	18197	0.05	1.425	18218	-0.607	-0.107	0.257	1.434
42	0.4	1.525	10871	0.1	1.4	10887	-0.563	-0.234	0.245	1.434
43	0.35	1.575	31795	0.1	1.4	31813	-0.417	-0.292	0.221	1.458
44	0.45	1.625	18126	0.2	1.45	18143	-0.441	-0.309	0.319	1.507
45	0.45	1.625	18129	0.2	1.45	18144	-0.500	-0.350	0.319	1.507
46	0.4	1.675	17999	0.175	1.55	18019	-0.338	-0.188	0.282	1.581
47	0.275	1.7	17807	0.075	1.675	17824	-0.353	-0.044	0.172	1.654
48	0.475	1.75	11070	0.1	1.675	11090	-0.563	-0.113	0.282	1.679
49	0.475	1.85	18142	0.25	1.5	18162	-0.338	-0.525	0.355	1.642
50	0.35	1.85	18177	0.2	1.85	18189	-0.375	0.000	0.270	1.814
51	0.35	1.85	18200	0.2	1.725	18210	-0.450	-0.375	0.270	1.752
52	0	1.875	38288	1	1.85	38325	0.811	-0.020	0.490	1.826
53	0.35	1.9	18175	0.175	1.85	18192	-0.309	-0.088	0.257	1.838
54	0.35	1.95	18129	0.2	1.775	18142	-0.346	-0.404	0.270	1.826
55	0	2	44487	0.9	2.125	44520	0.819	0.114	0.441	2.022
56	0	2.025	38228	1.025	2.275	38256	1.099	0.268	0.502	2.108
57	0.025	2.05	24842	0.8	2.125	24878	0.646	0.063	0.404	2.047
58	0.05	2.1	31992	0.9	2.125	32010	1.417	0.042	0.466	2.071
59	0	2.1	38028	0.9	2.1	38052	1.126	0.000	0.441	2.059
60	0	2.125	24953	0.75	2.175	24969	1.407	0.094	0.368	2.108
61	0.025	2.175	17767	0.8	2.225	17786	1.224	0.079	0.404	2.157
62	0	2.2	17663	0.8	2.1	17679	1.501	-0.188	0.392	2.108
63	0	2.25	17654	0.6	2.275	17667	1.385	0.058	0.294	2.218
64	0.025	2.275	25466	0.9	2.3	25485	1.382	0.039	0.453	2.243
65	0.075	2.3	10751	0.6	2.2	10765	1.126	-0.214	0.331	2.206
66	0	2.35	10079	0.8	2.15	10096	1.412	-0.353	0.392	2.206
67	0	2.4	17865	0.8	2.325	17881	1.501	-0.141	0.392	2.316
68	0	2.4	31418	0.9	2.3	31433	1.801	-0.200	0.441	2.304
69	0	2.425	10115	0.9	2.275	10134	1.422	-0.237	0.441	2.304
70	0.025	2.5	24866	0.7	2.225	24882	1.266	-0.516	0.355	2.316
71	0.1	2.525	17881	0.8	2.25	17899	1.167	-0.459	0.441	2.341
72	0.05	2.55	10188	0.6	2.35	10201	1.270	-0.462	0.319	2.402
73	0.05	2.575	17665	0.7	2.2	17677	1.626	-0.938	0.368	2.341
74	0	2.65	10213	0.825	2.55	10228	1.651	-0.200	0.404	2.549
75	0	2.65	10662	0.8	2.6	10679	1.412	-0.088	0.392	2.574
76	0	2.675	17641	0.9	2.6	17656	1.801	-0.150	0.441	2.586
77	0	2.75	10034	0.925	2.75	10046	2.314	0.000	0.453	2.696
78	0	2.75	10125	0.9	2.75	10140	1.801	0.000	0.441	2.696
79	0.025	2.775	17866	0.95	2.775	17880	1.983	0.000	0.478	2.721

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.05	2.775	18080	0.9	2.775	18092	2.126	0.000	0.466	2.721
81	0	2.8	10307	0.925	2.8	10321	1.983	0.000	0.453	2.745
82	0	2.875	9939	1	2.875	9954	2.001	0.000	0.490	2.819
83	0	2.925	9873	0.8	2.95	9885	2.001	0.063	0.392	2.880
84	0	2.925	9934	0.95	3.025	9948	2.037	0.214	0.466	2.917
85	0	2.975	10028	0.925	2.975	10042	1.983	0.000	0.453	2.917
86	0	2.975	10162	0.925	2.95	10176	1.983	-0.054	0.453	2.904
87	0	3.05	9794	0.8	3.05	9805	2.183	0.000	0.392	2.990
88	0.025	3.075	24672	1	2.975	24686	2.090	-0.214	0.502	2.966
89	0	3.1	9944	1	2.9	9959	2.001	-0.400	0.490	2.941
90	0	3.1	10089	0.925	2.975	10103	1.983	-0.268	0.453	2.978
91	0	3.175	37993	0.925	3.075	38006	2.136	-0.231	0.453	3.064
92	0	3.2	25478	0.975	3.125	25495	1.721	-0.132	0.478	3.100
93	0	3.25	17544	0.925	3.225	17558	1.983	-0.054	0.453	3.174
94	0	3.275	25127	1	3.25	25141	2.144	-0.054	0.490	3.199
95	0.025	3.35	9979	0.9	3.325	9992	2.020	-0.058	0.453	3.272
96	0	3.35	17586	0.9	3.375	17601	1.801	0.050	0.441	3.297
97	0.025	3.375	31971	0.8	3.4	31983	1.938	0.063	0.404	3.321
98	0	3.375	38298	1.025	3.3	38315	1.810	-0.132	0.502	3.272
99	0.025	3.425	25473	0.925	3.4	25487	1.929	-0.054	0.466	3.346
100	0	3.475	38250	1.1	3.475	38268	1.834	0.000	0.539	3.407
101	0.025	3.5	17740	0.95	3.5	17753	2.136	0.000	0.478	3.431
102	0	3.525	10094	1	3.55	10108	2.144	0.054	0.490	3.468
103	0.025	3.6	50603	1.1	3.55	50619	2.017	-0.094	0.551	3.505
104	0	3.625	44823	0.9	3.6	44836	2.078	-0.058	0.441	3.542
105	0.05	3.65	17796	0.9	3.55	17808	2.126	-0.250	0.466	3.529

Notes:
(1) Measurement Number
(2) 1st X-Position
(3) 1st Y-Position
(4) 1st Frame
(5) 2nd X-Position
(6) 2nd Y-Position
(7) 2nd Frame
(8) Velocity in X-direction
(9) Velocity in Y-direction
(10) Average X-Position
(11) Average Y-Position

Table 20: HW 1.20P TW 0.86P, Unmodified Spillway Simulation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	0.6	0.275	28390	0.1	0.25	28455	-0.231	-0.012	-0.245	0.257
2	0.6	0.325	28523	0.1	0.35	28580	-0.263	0.013	-0.245	0.331
3	0.6	0.35	29375	0.1	0.4	29463	-0.171	0.017	-0.245	0.368
4	0.6	0.375	27688	0.1	0.3	27737	-0.306	-0.046	-0.245	0.331
5	0.6	0.4	27773	0.1	0.3	27817	-0.341	-0.068	-0.245	0.343
6	0.6	0.45	27701	0.1	0.45	27740	-0.385	0.000	-0.245	0.441
7	0.6	0.5	26905	0.1	0.45	26951	-0.326	-0.033	-0.245	0.466
8	0.6	0.5	27081	0.15	0.35	27112	-0.436	-0.145	-0.221	0.417
9	0.6	0.55	27328	0.15	0.4	27365	-0.365	-0.122	-0.221	0.466
10	0.6	0.6	26525	0.075	0.375	26579	-0.292	-0.125	-0.257	0.478
11	0.6	0.65	26529	0.1	0.425	26574	-0.333	-0.150	-0.245	0.527
12	0.6	0.65	27437	0.1	0.75	27483	-0.326	0.065	-0.245	0.686
13	0.6	0.675	26569	0.1	0.725	26614	-0.333	0.033	-0.245	0.686
14	0.6	0.725	26717	0.1	0.75	26751	-0.441	0.022	-0.245	0.723
15	0.6	0.75	26380	0.1	0.8	26423	-0.349	0.035	-0.245	0.760
16	0.6	0.8	26259	0.1	0.525	26331	-0.208	-0.115	-0.245	0.650
17	0.6	0.825	26347	0.1	0.85	26391	-0.341	0.017	-0.245	0.821
18	0.6	0.85	26018	0.1	0.675	26070	-0.289	-0.101	-0.245	0.748
19	0.6	0.875	26040	0.15	0.65	26075	-0.386	-0.193	-0.221	0.748
20	0.6	0.875	25775	0.15	0.8	25816	-0.329	-0.055	-0.221	0.821
21	0.6	0.9	25887	0.1	0.85	25950	-0.238	-0.024	-0.245	0.858
22	0.6	0.975	25707	0.125	0.65	25751	-0.324	-0.222	-0.233	0.797
23	0.6	1	25370	0.05	0.7	25408	-0.434	-0.237	-0.270	0.833
24	0.6	1.025	25839	0.075	0.9	25880	-0.384	-0.092	-0.257	0.944
25	0.6	1.075	25149	0.075	1.025	25193	-0.358	-0.034	-0.257	1.029
26	0.6	1.1	24118	0.1	1.025	24159	-0.366	-0.055	-0.245	1.042
27	0.6	1.15	24202	0.15	0.9	24244	-0.322	-0.179	-0.221	1.005
28	0.6	1.175	25452	0.075	1.15	25487	-0.450	-0.021	-0.257	1.140
29	0.6	1.2	25060	0.1	1.1	25099	-0.385	-0.077	-0.245	1.127
30	0.6	1.225	25568	0.1	1.1	25608	-0.375	-0.094	-0.245	1.140
31	0.6	1.325	24074	0.05	1.375	24114	-0.413	0.038	-0.270	1.324
32	0.6	1.325	25201	0.1	1.35	25282	-0.185	0.009	-0.245	1.311
33	0.6	1.35	25573	0.1	1.175	25608	-0.429	-0.150	-0.245	1.238
34	0.6	1.375	24596	0.05	1.225	24635	-0.423	-0.115	-0.270	1.275
35	0.6	1.4	24601	0.075	1.375	24650	-0.322	-0.015	-0.257	1.360
36	0.7	1.425	11905	0.1	1.35	11953	-0.375	-0.047	-0.294	1.360
37	0.6	1.5	24931	0.15	1.675	24973	-0.322	0.125	-0.221	1.556
38	0.825	1.55	11837	0.1	1.55	11904	-0.325	0.000	-0.355	1.520
39	0.6	1.55	24371	0.2	1.525	24396	-0.480	-0.030	-0.196	1.507

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	x_1 [ft]	y_1 [ft]	$Frame_1$	x_2 [ft]	y_2 [ft]	$Frame_2$	V_x/V_c	V_y/V_c	x_{ave}/P	y_{ave}/P
40	0.6	1.575	22899	0.1	1.5	22931	-0.469	-0.070	-0.245	1.507
41	0.6	1.6	21440	0.1	1.525	21483	-0.349	-0.052	-0.245	1.532
42	0.6	1.65	21436	0.1	1.45	21485	-0.306	-0.123	-0.245	1.520
43	0.6	1.675	23765	0.1	1.65	23822	-0.263	-0.013	-0.245	1.630
44	0.6	1.75	21587	0.1	1.675	21629	-0.357	-0.054	-0.245	1.679
45	0.6	1.75	21798	0.15	1.75	21838	-0.338	0.000	-0.221	1.716
46	0.6	1.8	23380	0.125	1.75	23417	-0.385	-0.041	-0.233	1.740
47	0.6	1.825	23947	0.1	1.85	23987	-0.375	0.019	-0.245	1.801
48	0.6	1.85	22606	0.2	1.9	22646	-0.300	0.038	-0.196	1.838
49	0.75	1.9	8865	0.1	1.95	8927	-0.315	0.024	-0.319	1.887
50	0.6	1.925	20066	0.1	1.9	20102	-0.417	-0.021	-0.245	1.875
51	0.8	1.95	9579	0.075	2.825	9642	-0.345	0.417	-0.355	2.341
52	0.6	1.975	19975	0.1	1.9	20015	-0.375	-0.056	-0.245	1.900
53	0.825	2	12285	0.075	1.825	12352	-0.336	-0.078	-0.368	1.875
54	0.8	2.05	9803	0.075	2.1	9871	-0.320	0.022	-0.355	2.034
55	0.825	2.075	13541	0.1	2.15	13593	-0.418	0.043	-0.355	2.071
56	0.6	2.125	19980	0.1	2.1	20017	-0.406	-0.020	-0.245	2.071
57	0.6	2.15	20799	0.025	2.175	20840	-0.421	0.018	-0.282	2.120
58	0.75	2.25	10576	0.075	2.25	10631	-0.368	0.000	-0.331	2.206
59	0.6	2.25	21220	0.075	2.2	21256	-0.438	-0.042	-0.257	2.181
60	0.65	2.25	21358	0.075	2.35	21399	-0.421	0.073	-0.282	2.255
61	0.6	2.275	18200	0.125	2.475	18250	-0.285	0.120	-0.233	2.328
62	0.7	2.35	12803	0.125	2.425	12847	-0.392	0.051	-0.282	2.341
63	0.625	2.35	19807	0.1	2.25	19845	-0.415	-0.079	-0.257	2.255
64	0.6	2.425	20213	0.1	2.4	20252	-0.385	-0.019	-0.245	2.365
65	0.6	2.425	20219	0.075	2.375	20259	-0.394	-0.038	-0.257	2.353
66	0.6	2.45	17755	0.1	2.6	17790	-0.429	0.129	-0.245	2.475
67	0.825	2.475	9928	0.05	2.6	9982	-0.431	0.069	-0.380	2.488
68	0.6	2.5	17848	0.15	2.65	17879	-0.436	0.145	-0.221	2.525
69	0.7	2.55	18441	0.1	2.65	18488	-0.383	0.064	-0.294	2.549
70	0.6	2.575	9674	0.1	2.075	9719	-0.333	-0.333	-0.245	2.279
71	0.8	2.6	13674	0.1	2.8	13728	-0.389	0.111	-0.343	2.647
72	0.75	2.65	17953	0.1	2.85	18016	-0.310	0.095	-0.319	2.696
73	0.65	2.7	8700	0.075	2.875	8754	-0.320	0.097	-0.282	2.733
74	0.775	2.75	9741	0.1	3.1	9799	-0.349	0.181	-0.331	2.868
75	0.6	2.75	17247	0.075	2.95	17281	-0.463	0.177	-0.257	2.794
76	0.85	2.8	9195	0.075	2.95	9266	-0.328	0.063	-0.380	2.819
77	0.75	2.825	9000	0.1	2.65	9043	-0.454	-0.122	-0.319	2.684
78	0.725	2.85	9436	0.1	2.9	9494	-0.323	0.026	-0.306	2.819
79	0.8	2.875	10050	0.05	3.1	10104	-0.417	0.125	-0.368	2.929

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.675	2.9	9646	0.075	2.9	9699	-0.340	0.000	-0.294	2.843
81	0.875	2.95	9503	0.15	2.875	9559	-0.389	-0.040	-0.355	2.855
82	0.725	3.05	10343	0.075	3.35	10391	-0.406	0.188	-0.319	3.137
83	0.6	3.05	17055	0.1	3.325	17101	-0.326	0.179	-0.245	3.125
84	0.6	3.05	17134	0.125	3.25	17184	-0.285	0.120	-0.233	3.088
85	0.6	3.1	16694	0.1	3.35	16753	-0.254	0.127	-0.245	3.162
86	0.75	3.125	10950	0.1	3.45	11001	-0.383	0.191	-0.319	3.223
87	0.675	3.15	8921	0.15	3.25	8973	-0.303	0.058	-0.257	3.137
88	0.6	3.175	14892	0.1	3.1	14942	-0.300	-0.045	-0.245	3.076
89	0.8	3.2	9275	0.05	3.275	9358	-0.271	0.027	-0.368	3.174
90	0.775	3.225	9990	0.2	3.2	10056	-0.261	-0.011	-0.282	3.150
91	0.775	3.325	11131	0.1	3.45	11196	-0.312	0.058	-0.331	3.321
92	0.6	3.325	16086	0.15	3.5	16113	-0.500	0.195	-0.221	3.346
93	0.6	3.325	16608	0.15	3.4	16653	-0.300	0.050	-0.221	3.297
94	0.6	3.35	15622	0.1	3.45	15663	-0.366	0.073	-0.245	3.333
95	0.6	3.4	14800	0.1	3.45	14863	-0.238	0.024	-0.245	3.358
96	0.6	3.425	15861	0.175	3.5	15890	-0.440	0.078	-0.208	3.395
97	0.6	3.45	15470	0.1	3.4	15517	-0.319	-0.032	-0.245	3.358
98	0.6	3.525	15051	0.075	3.475	15090	-0.404	-0.038	-0.257	3.431
99	0.6	3.55	14627	0.15	3.6	14662	-0.386	0.043	-0.221	3.505
100	0.6	3.55	15753	0.15	3.775	15845	-0.147	0.073	-0.221	3.591
101	0.6	3.575	15232	0.1	3.775	15315	-0.181	0.072	-0.245	3.603
102	0.6	3.65	14976	0.15	3.6	15034	-0.233	-0.026	-0.221	3.554
103	0.6	3.65	15158	0.1	3.6	15211	-0.283	-0.028	-0.245	3.554

Notes:
(1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

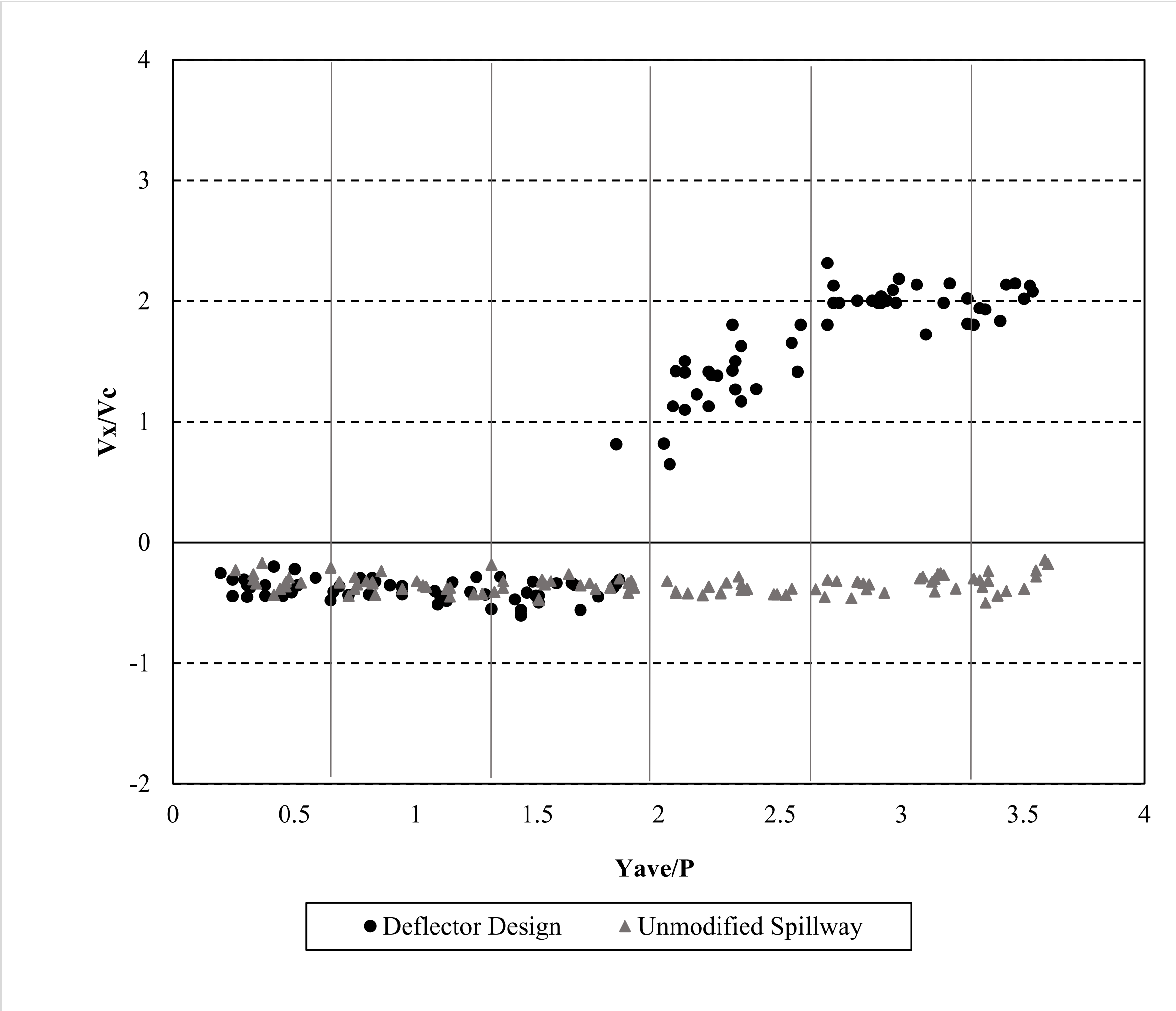

Figure 31: HW 1.20P TW 0.86P, Design Simulation Results

Table 21: HW 1.20P TW 1.09P, Multiple Staggered Deflector Design Simulation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	0.85	0.525	28093	0.15	0.2	28253	-0.131	-0.061	0.490	0.355
2	0.775	0.6	30429	0.1	0.675	30591	-0.125	0.014	0.429	0.625
3	1	0.625	3291	0.5	0.45	3374	-0.181	-0.063	0.735	0.527
4	1.125	0.65	31917	0.1	0.725	32054	-0.225	0.016	0.600	0.674
5	1	0.7	1294	0.225	0.55	1434	-0.166	-0.032	0.600	0.613
6	0.95	0.7	30587	0.15	0.275	30730	-0.168	-0.089	0.539	0.478
7	0.775	0.75	26965	0.125	0.85	27047	-0.238	0.037	0.441	0.784
8	0.975	0.8	997	0.125	0.475	1166	-0.151	-0.058	0.539	0.625
9	0.975	0.85	4286	0.5	0.85	4413	-0.112	0.000	0.723	0.833
10	0.9	0.85	9640	0.2	0.35	9788	-0.142	-0.101	0.539	0.588
11	0.75	0.9	27535	0.15	0.4	27651	-0.155	-0.129	0.441	0.637
12	0.475	0.9	28368	0.1	0.9	28436	-0.166	0.000	0.282	0.882
13	0.8	0.95	30143	0.1	0.4	30346	-0.103	-0.081	0.441	0.662
14	0.7	1.025	30550	0.25	0.975	30667	-0.115	-0.013	0.466	0.980
15	0.85	1.025	29434	0.1	0.525	29748	-0.072	-0.048	0.466	0.760
16	1.05	1.05	3903	0.425	0.875	3975	-0.261	-0.073	0.723	0.944
17	0.65	1.075	9940	0.1	1.175	10066	-0.131	0.024	0.368	1.103
18	0.525	1.1	28546	0.1	0.9	28621	-0.170	-0.080	0.306	0.980
19	0.95	1.1	29307	0.1	0.75	29409	-0.250	-0.103	0.515	0.907
20	0.625	1.175	10136	0.1	0.675	10224	-0.179	-0.171	0.355	0.907
21	0.95	1.2	508	0.1	1	630	-0.209	-0.049	0.515	1.078
22	1	1.25	2868	0.4	0.85	2971	-0.175	-0.117	0.686	1.029
23	0.675	1.275	34865	0.1	0.65	34966	-0.171	-0.186	0.380	0.944
24	1.1	1.275	1843	0.5	0.65	1943	-0.180	-0.188	0.784	0.944
25	0.975	1.3	29115	0.475	1.15	29197	-0.183	-0.055	0.711	1.201
26	0.975	1.4	30856	0.1	1.1	30997	-0.186	-0.064	0.527	1.225
27	0.875	1.425	12972	0.275	1.05	13038	-0.273	-0.171	0.564	1.213
28	0.675	1.45	34987	0.075	1.4	35097	-0.164	-0.014	0.368	1.397
29	1.1	1.475	1574	0.1	1.125	1718	-0.208	-0.073	0.588	1.275
30	0.675	1.525	12813	0.1	1.225	12931	-0.146	-0.076	0.380	1.348
31	0.85	1.525	13673	0.075	1.55	13793	-0.194	0.006	0.453	1.507
32	0.85	1.575	3172	0.1	1	3299	-0.177	-0.136	0.466	1.262
33	0.775	1.6	20909	0.275	1.225	20994	-0.177	-0.132	0.515	1.385
34	1.05	1.65	8274	0.1	1.675	8392	-0.242	0.006	0.564	1.630
35	0.825	1.675	17640	0.15	1.435	17779	-0.146	-0.052	0.478	1.525
36	0.775	1.75	18029	0.2	1.05	18168	-0.124	-0.151	0.478	1.373
37	0.625	1.75	24873	0.1	1.825	24972	-0.159	0.023	0.355	1.752
38	0.6	1.775	24881	0.1	1.825	24969	-0.171	0.017	0.343	1.765
39	1.05	1.775	21048	0.1	1.35	21166	-0.242	-0.108	0.564	1.532

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.775	1.85	4488	0.1	1.65	4550	-0.327	-0.097	0.429	1.716
41	0.9	1.9	16994	0.1	1.6	17100	-0.227	-0.085	0.490	1.716
42	0.825	1.925	20695	0.1	1.45	20787	-0.237	-0.155	0.453	1.654
43	0.6	1.95	10097	0.2	1.875	10164	-0.179	-0.034	0.392	1.875
44	0.975	1.975	14408	0.1	1.85	14481	-0.360	-0.051	0.527	1.875
45	0.65	2	12700	0.1	1.975	12809	-0.151	-0.007	0.368	1.949
46	0.75	2.05	1446	0.15	1.65	1522	-0.237	-0.158	0.441	1.814
47	0.8	2.125	24224	0.15	1.9	24299	-0.260	-0.090	0.466	1.973
48	0.8	2.15	12578	0.3	1.7	12647	-0.217	-0.196	0.539	1.887
49	0.725	2.2	17418	0.1	1.7	17546	-0.147	-0.117	0.404	1.912
50	0.85	2.225	34591	0.1	1.375	34716	-0.180	-0.204	0.466	1.765
51	0.9	2.25	28409	0.1	1.75	28531	-0.197	-0.123	0.490	1.961
52	0.675	2.3	15260	0.1	2.05	15347	-0.198	-0.086	0.380	2.132
53	0.8	2.35	16748	0.125	2.65	16832	-0.241	0.107	0.453	2.451
54	0.625	2.35	27918	0.1	1.9	27996	-0.202	-0.173	0.355	2.083
55	0.725	2.4	20475	0.25	1.95	20552	-0.185	-0.175	0.478	2.132
56	0.8	2.4	25409	0.1	1.775	25516	-0.196	-0.175	0.441	2.047
57	0.95	2.45	14245	0.125	1.9	14343	-0.253	-0.168	0.527	2.132
58	0.675	2.5	20771	0.1	2.275	20835	-0.270	-0.106	0.380	2.341
59	0.7	2.525	13714	0.125	2.425	13830	-0.149	-0.026	0.404	2.426
60	0.825	2.525	17152	0.2	2.275	17218	-0.284	-0.114	0.502	2.353
61	0.725	2.6	8534	0.075	2	8652	-0.165	-0.153	0.392	2.255
62	0.7	2.65	11897	0.1	2.425	11963	-0.273	-0.102	0.392	2.488
63	0.775	2.65	35984	0.075	2.325	36046	-0.339	-0.157	0.417	2.439
64	0.65	2.7	35321	0.25	2.4	35377	-0.214	-0.161	0.441	2.500
65	0.625	2.75	13567	0.15	2.775	13652	-0.168	0.009	0.380	2.708
66	0.65	2.775	38717	0.075	2.3	38820	-0.168	-0.138	0.355	2.488
67	0.725	2.775	12239	0.1	2.45	12292	-0.354	-0.184	0.404	2.561
68	0.675	2.8	35111	0.075	2.075	35163	-0.346	-0.418	0.368	2.390
69	0.7	2.875	13077	0.175	2.55	13128	-0.309	-0.191	0.429	2.659
70	0.75	2.95	23556	0.2	2.4	23624	-0.243	-0.243	0.466	2.623
71	0.725	2.95	35243	0.275	2.575	35286	-0.314	-0.262	0.490	2.708
72	0.575	3.025	13368	0.1	2.85	13438	-0.204	-0.075	0.331	2.880
73	0.65	3.025	23873	0.1	2.75	23925	-0.317	-0.159	0.368	2.831
74	0.825	3.05	13762	0.3	2.625	13825	-0.250	-0.202	0.551	2.782
75	0.55	3.1	19269	0.075	3.1	19320	-0.280	0.000	0.306	3.039
76	0.775	3.125	22292	0.225	2.9	22332	-0.413	-0.169	0.490	2.953
77	0.725	3.125	18304	0.075	3.05	18421	-0.167	-0.019	0.392	3.027
78	0.6	3.175	18942	0.075	3	19027	-0.185	-0.062	0.331	3.027
79	0.6	3.2	11572	0.075	3	11634	-0.254	-0.097	0.331	3.039

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.725	3.25	17493	0.35	3.05	17526	-0.341	-0.182	0.527	3.088
81	0.725	3.325	17245	0.125	3.15	17323	-0.231	-0.067	0.417	3.174
82	0.475	3.325	21474	0.15	2.9	21556	-0.119	-0.156	0.306	3.051
83	0.475	3.325	36166	0.1	3.375	36222	-0.201	0.027	0.282	3.284
84	0.6	3.35	21855	0.2	3.15	21896	-0.293	-0.146	0.392	3.186
85	0.675	3.4	34195	0.1	3.725	34283	-0.196	0.111	0.380	3.493
86	0.625	3.4	21355	0.1	3.125	21398	-0.366	-0.192	0.355	3.199
87	0.575	3.425	14111	0.2	3.3	14158	-0.239	-0.080	0.380	3.297
88	0.7	3.45	21763	0.1	3.4	21823	-0.300	-0.025	0.392	3.358
89	0.9	3.45	33969	0.1	3.475	34065	-0.250	0.008	0.490	3.395
90	0.7	3.5	38953	0.2	3.6	39039	-0.174	0.035	0.441	3.480
91	0.8	3.5	39310	0.1	3.45	39455	-0.145	-0.010	0.441	3.407
92	0.575	3.55	8145	0.1	3.35	8192	-0.303	-0.128	0.331	3.382
93	0.575	3.55	20470	0.075	3.375	20518	-0.313	-0.109	0.319	3.395
94	0.625	3.55	22318	0.125	3.55	22419	-0.149	0.000	0.368	3.480
95	0.9	3.575	32024	0.1	3.675	32201	-0.136	0.017	0.490	3.554
96	0.9	3.6	33519	0.15	3.725	33675	-0.144	0.024	0.515	3.591
97	0.425	3.625	56581	0.075	3.375	56669	-0.119	-0.085	0.245	3.431
98	0.425	3.625	56893	0.075	3.675	56920	-0.389	0.056	0.245	3.578
99	0.775	3.65	44174	0.15	3.5	44270	-0.195	-0.047	0.453	3.505
100	0.4	3.65	44857	0.075	3.905	44891	-0.287	0.225	0.233	3.703
101	0.8	3.675	43848	0.15	3.75	43970	-0.160	0.018	0.466	3.640

Notes:
(1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

Table 22: HW 1.20P TW 1.09P, Unmodified Design Spillway Simulation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	0.7	0.325	23095	0.2	0.35	23195	-0.150	0.008	-0.245	0.331
2	0.525	0.35	11654	0.1	0.225	11822	-0.076	-0.022	-0.208	0.282
3	0.65	0.35	22028	0.1	0.35	22153	-0.132	0.000	-0.270	0.343
4	0.7	0.4	29949	0.275	0.3	30021	-0.177	-0.042	-0.208	0.343
5	0.75	0.45	29291	0.15	0.35	29512	-0.081	-0.014	-0.294	0.392
6	0.75	0.45	29999	0.1	0.3	30173	-0.112	-0.026	-0.319	0.368
7	0.725	0.5	21677	0.3	0.4	21842	-0.077	-0.018	-0.208	0.441
8	0.7	0.5	22459	0.1	0.425	22598	-0.130	-0.016	-0.294	0.453
9	0.7	0.55	17771	0.1	0.225	18025	-0.071	-0.038	-0.294	0.380
10	0.7	0.625	22411	0.1	0.4	22568	-0.115	-0.043	-0.294	0.502
11	0.7	0.65	22374	0.1	0.35	22560	-0.097	-0.048	-0.294	0.490
12	0.75	0.65	22444	0.1	0.525	22598	-0.127	-0.024	-0.319	0.576
13	0.7	0.675	11982	0.2	0.45	12187	-0.073	-0.033	-0.245	0.551
14	0.7	0.75	7181	0.2	0.55	7341	-0.094	-0.038	-0.245	0.637
15	0.7	0.75	22417	0.1	0.925	22623	-0.087	0.025	-0.294	0.821
16	0.7	0.825	11341	0.2	0.575	11456	-0.130	-0.065	-0.245	0.686
17	0.7	0.825	15491	0.2	0.475	15600	-0.138	-0.096	-0.245	0.637
18	0.65	0.85	6640	0.1	1	6846	-0.080	0.022	-0.270	0.907
19	0.7	0.95	81777	0.1	1.2	81947	-0.106	0.044	-0.294	1.054
20	0.7	1	74431	0.075	0.9	74570	-0.135	-0.022	-0.306	0.931
21	0.7	1	87172	0.1	1.025	87316	-0.125	0.005	-0.294	0.993
22	0.7	1.05	77924	0.1	1.075	78086	-0.111	0.005	-0.294	1.042
23	0.7	1.1	79585	0.2	0.825	79713	-0.117	-0.064	-0.245	0.944
24	0.7	1.15	74240	0.25	1.45	74429	-0.071	0.048	-0.221	1.275
25	0.7	1.15	77931	0.1	1.325	78091	-0.113	0.033	-0.294	1.213
26	0.7	1.175	80079	0.1	1.125	80220	-0.128	-0.011	-0.294	1.127
27	0.7	1.225	74121	0.1	1.35	74280	-0.113	0.024	-0.294	1.262
28	0.65	1.25	79470	0.075	1.175	79625	-0.111	-0.015	-0.282	1.189
29	0.7	1.3	80129	0.15	1.2	80300	-0.097	-0.018	-0.270	1.225
30	0.7	1.3	91896	0.2	0.9	92015	-0.126	-0.101	-0.245	1.078
31	0.7	1.325	91270	0.1	1.175	91436	-0.108	-0.027	-0.294	1.225
32	0.7	1.4	12421	0.1	1.4	12537	-0.155	0.000	-0.294	1.373
33	0.7	1.425	91297	0.1	1.05	91445	-0.122	-0.076	-0.294	1.213
34	0.6	1.45	8253	0.2	1.15	8339	-0.140	-0.105	-0.196	1.275
35	0.7	1.475	84950	0.1	1.25	85163	-0.085	-0.032	-0.294	1.336
36	0.7	1.475	3653	0.2	1.725	3831	-0.084	0.042	-0.245	1.569
37	0.7	1.55	91419	0.1	1.15	91522	-0.175	-0.117	-0.294	1.324
38	0.7	1.6	14982	0.1	1.65	15123	-0.128	0.011	-0.294	1.593
39	0.7	1.65	59692	0.2	1.85	59856	-0.092	0.037	-0.245	1.716

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.7	1.65	76422	0.1	1.725	76594	-0.105	0.013	-0.294	1.654
41	0.7	1.675	84436	0.2	1.425	84545	-0.138	-0.069	-0.245	1.520
42	0.7	1.725	85643	0.1	1.675	85773	-0.139	-0.012	-0.294	1.667
43	0.6	1.75	60709	0.1	1.825	60915	-0.073	0.011	-0.245	1.752
44	0.7	1.825	57906	0.1	2.1	58086	-0.100	0.046	-0.294	1.924
45	0.7	1.85	66733	0.1	1.7	66871	-0.130	-0.033	-0.294	1.740
46	0.6	1.85	68987	0.1	2.075	69144	-0.096	0.043	-0.245	1.924
47	0.6	1.875	58480	0.125	2.15	58648	-0.085	0.049	-0.233	1.973
48	0.7	1.9	66736	0.15	2.05	66921	-0.089	0.024	-0.270	1.936
49	0.6	1.95	64489	0.15	2.15	64623	-0.101	0.045	-0.221	2.010
50	0.7	2	47545	0.1	1.975	47719	-0.103	-0.004	-0.294	1.949
51	0.7	2.025	43959	0.1	1.925	44122	-0.110	-0.018	-0.294	1.936
52	0.7	2.05	44208	0.15	2.1	44318	-0.150	0.014	-0.270	2.034
53	0.7	2.1	55864	0.2	2.35	55977	-0.133	0.066	-0.245	2.181
54	0.7	2.1	71338	0.1	2.3	71503	-0.109	0.036	-0.294	2.157
55	0.6	2.15	63870	0.1	1.975	63957	-0.172	-0.060	-0.245	2.022
56	0.7	2.2	51962	0.2	2.425	52205	-0.062	0.028	-0.245	2.267
57	0.7	2.25	67314	0.2	2.575	67411	-0.155	0.101	-0.245	2.365
58	0.65	2.25	70165	0.1	2.15	70355	-0.087	-0.016	-0.270	2.157
59	0.7	2.325	13578	0.1	2.05	13753	-0.103	-0.047	-0.294	2.145
60	0.7	2.325	43563	0.1	2.425	43715	-0.118	0.020	-0.294	2.328
61	0.6	2.35	37712	0.1	2.35	37817	-0.143	0.000	-0.245	2.304
62	0.6	2.4	33471	0.1	2.425	33618	-0.102	0.005	-0.245	2.365
63	0.7	2.4	35946	0.1	2.55	36191	-0.074	0.018	-0.294	2.426
64	0.7	2.45	15462	0.1	2.525	15613	-0.119	0.015	-0.294	2.439
65	0.6	2.5	81514	0.1	2.775	81610	-0.156	0.086	-0.245	2.586
66	0.7	2.55	35760	0.1	2.65	35875	-0.157	0.026	-0.294	2.549
67	0.65	2.55	62655	0.15	2.275	62881	-0.066	-0.037	-0.245	2.365
68	0.7	2.6	38219	0.1	2.5	38378	-0.113	-0.019	-0.294	2.500
69	0.6	2.65	43051	0.1	2.45	43281	-0.065	-0.026	-0.245	2.500
70	0.7	2.65	52306	0.2	2.475	52399	-0.161	-0.056	-0.245	2.512
71	0.7	2.7	31003	0.1	2.85	31225	-0.081	0.020	-0.294	2.721
72	0.7	2.7	31880	0.1	2.775	32096	-0.083	0.010	-0.294	2.684
73	0.7	2.725	16001	0.1	2.55	16267	-0.068	-0.020	-0.294	2.586
74	0.7	2.8	28972	0.1	2.9	29123	-0.119	0.020	-0.294	2.794
75	0.7	2.825	26393	0.1	3.225	26542	-0.121	0.081	-0.294	2.966
76	0.7	2.85	29232	0.25	2.975	29378	-0.093	0.026	-0.221	2.855
77	0.6	2.875	9643	0.1	3.025	9753	-0.136	0.041	-0.441	2.892
78	0.7	2.9	19421	0.1	3.35	19600	-0.101	0.075	-0.294	3.064
79	0.7	2.925	28998	0.075	3	29174	-0.107	0.013	-0.306	2.904

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.7	2.975	19053	0.125	3.15	19234	-0.095	0.029	-0.282	3.002
81	0.6	3	10169	0.1	3	10332	-0.092	0.000	-0.245	2.941
82	0.7	3.05	21330	0.1	3.15	21475	-0.124	0.021	-0.294	3.039
83	0.7	3.125	7025	0.1	3.1	7169	-0.125	-0.005	-0.294	3.051
84	0.7	3.15	6808	0.2	3.325	6942	-0.112	0.039	-0.245	3.174
85	0.7	3.15	18003	0.125	3.55	18153	-0.115	0.080	-0.282	3.284
86	0.7	3.175	20356	0.2	3.35	20524	-0.089	0.031	-0.245	3.199
87	0.6	3.225	4200	0.1	3.3	4310	-0.136	0.020	-0.245	3.199
88	0.7	3.25	23136	0.1	3.45	23292	-0.115	0.038	-0.294	3.284
89	0.6	3.275	4001	0.175	3.65	4164	-0.078	0.069	-0.208	3.395
90	0.7	3.3	10878	0.1	3.225	10972	-0.192	-0.024	-0.294	3.199
91	0.6	3.35	20007	0.1	3.25	20144	-0.110	-0.022	-0.245	3.235
92	0.6	3.4	4472	0.15	3.5	4577	-0.129	0.029	-0.221	3.382
93	0.6	3.45	4276	0.1	3.55	4348	-0.208	0.042	-0.245	3.431
94	0.6	3.45	7599	0.125	3.6	7785	-0.077	0.024	-0.233	3.456
95	0.6	3.475	7236	0.1	3.55	7355	-0.126	0.019	-0.245	3.444
96	0.6	3.5	6829	0.1	3.675	6930	-0.149	0.052	-0.245	3.517
97	0.6	3.5	7074	0.1	3.5	7181	-0.140	0.000	-0.245	3.431
98	0.7	3.575	7047	0.225	3.775	7260	-0.067	0.028	-0.233	3.603
99	0.7	3.625	34259	0.225	3.675	34415	-0.091	0.010	-0.233	3.578
100	0.6	3.625	3048	0.1	3.475	3213	-0.091	-0.027	-0.245	3.480

Notes:
(1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

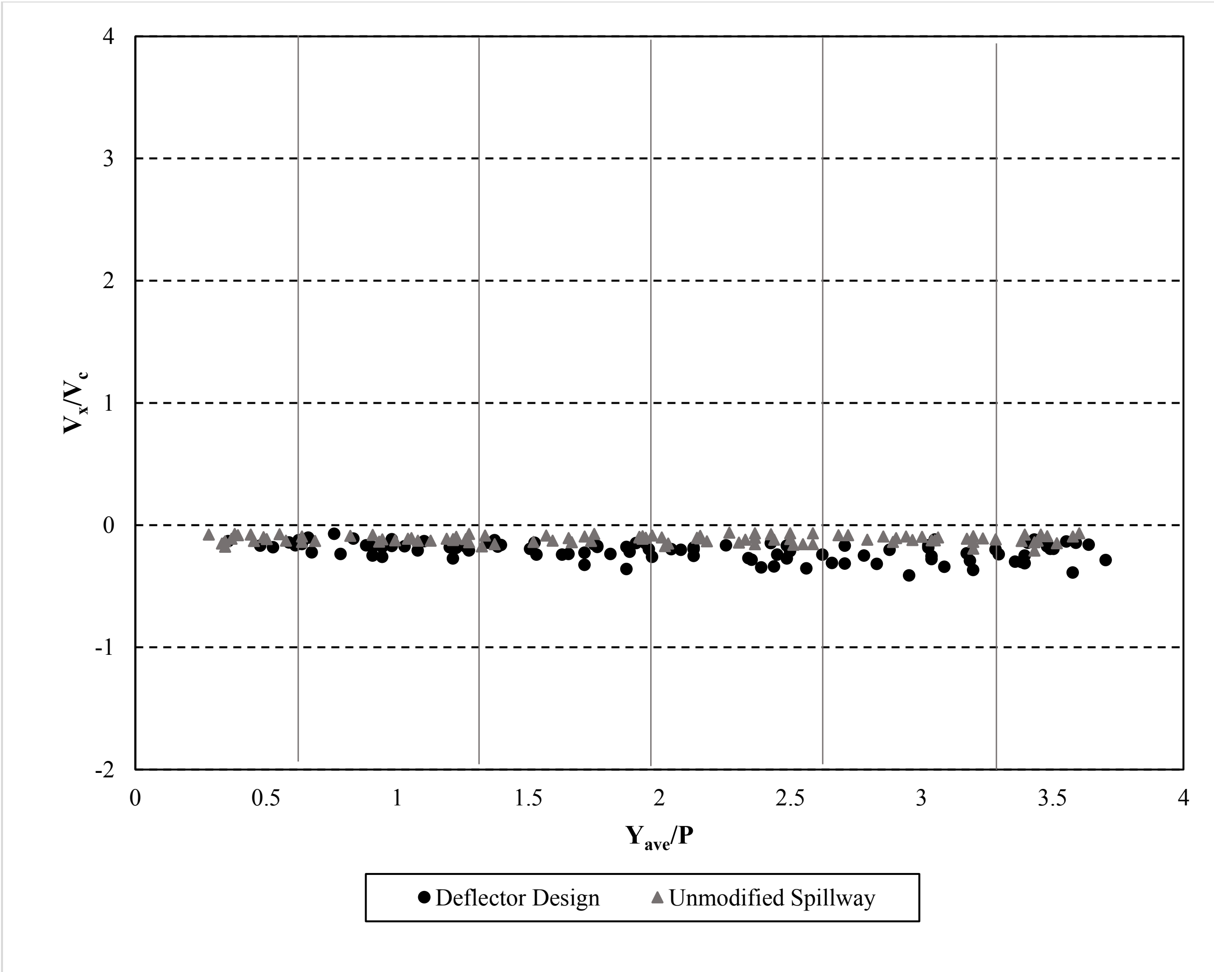

Figure 32: HW 1.20P TW 1.09P, Design Simulation Results

Table 23: HW 1.15P TW 0.30P, Multiple Staggered Deflector Design Simulation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	x_1 [ft]	y_1 [ft]	$Frame_1$	x_2 [ft]	y_2 [ft]	$Frame_2$	V_x/V_c	V_y/V_c	x_{ave}/P	y_{ave}/P
1	0	0.3	9904	0.9	0.15	10006	0.305	-0.051	0.441	0.221
2	0	0.425	17132	0.8	0.45	17162	0.923	0.029	0.392	0.429
3	0	0.475	17636	0.825	0.275	17671	0.815	-0.198	0.404	0.368
4	0	0.5	90582	0.9	0.45	90647	0.479	-0.027	0.441	0.466
5	0	0.55	65903	0.85	0.25	65945	0.700	-0.247	0.417	0.392
6	0	0.575	20539	1.1	0.425	20595	0.680	-0.093	0.539	0.490
7	0	0.6	31575	1.05	0.525	31641	0.550	-0.039	0.515	0.551
8	0	0.65	48060	0.9	0.6	48123	0.494	-0.027	0.441	0.613
9	0.025	0.675	23561	1.025	0.225	23615	0.641	-0.288	0.515	0.441
10	0	0.75	20497	0.85	0.575	20524	1.089	-0.224	0.417	0.650
11	0	0.75	84037	1.1	0.55	84070	1.153	-0.210	0.539	0.637
12	0.1	0.85	77967	0.9	0.7	78013	0.602	-0.113	0.490	0.760
13	0	0.85	4055	0.65	0.5	4121	0.341	-0.183	0.319	0.662
14	0	0.85	16353	0.9	0.75	16394	0.759	-0.084	0.441	0.784
15	0	0.875	84108	0.9	0.85	84129	1.483	-0.041	0.441	0.846
16	0	0.9	42605	1.05	0.825	42633	1.297	-0.093	0.515	0.846
17	0	0.95	41553	1	0.95	41591	0.910	0.000	0.490	0.931
18	0.1	1	53254	1.05	1.25	53289	0.939	0.247	0.564	1.103
19	0	1.025	84911	0.8	0.95	84934	1.203	-0.113	0.392	0.968
20	0	1.05	78313	1.1	0.65	78367	0.705	-0.256	0.539	0.833
21	0.025	1.075	64933	0.7	0.95	64947	1.668	-0.309	0.355	0.993
22	0.025	1.125	83775	0.8	0.9	83811	0.745	-0.216	0.404	0.993
23	0.025	1.15	25859	0.925	1.1	25884	1.245	-0.069	0.466	1.103
24	0	1.2	20190	0.7	1.1	20210	1.211	-0.173	0.343	1.127
25	0	1.225	71275	0.7	1.25	71289	1.730	0.062	0.343	1.213
26	0	1.225	3550	0.9	1.25	3580	1.038	0.029	0.441	1.213
27	0	1.3	53218	0.675	1	53249	0.753	-0.335	0.331	1.127
28	0	1.325	9030	1	0.975	9053	1.504	-0.526	0.490	1.127
29	0	1.35	40632	1.1	1.625	40700	0.560	0.140	0.539	1.458
30	0	1.375	64949	1.1	1.15	65000	0.746	-0.153	0.539	1.238
31	0	1.475	35852	1.05	1.575	35876	1.514	0.144	0.515	1.495
32	0	1.5	35388	1.025	1.625	35412	1.477	0.180	0.502	1.532
33	0	1.6	30097	0.8	1.625	30131	0.814	0.025	0.392	1.581
34	0	1.6	42618	1.05	1.95	42646	1.297	0.432	0.515	1.740
35	0	1.65	40507	1.025	1.625	40534	1.313	-0.032	0.502	1.605
36	0	1.675	3129	0.7	1.75	3154	0.969	0.104	0.343	1.679
37	0	1.7	41083	1	1.725	41130	0.736	0.018	0.490	1.679
38	0.25	1.75	47356	1.1	1.675	47372	1.838	-0.162	0.662	1.679
39	0.025	1.85	35206	0.925	2	35251	0.692	0.115	0.466	1.887

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0	1.85	46901	1.025	1.75	46923	1.612	-0.157	0.502	1.765
41	0.025	1.85	83591	1.05	1.625	83608	2.086	-0.458	0.527	1.703
42	0.05	1.875	9571	0.825	1.675	9607	0.745	-0.192	0.429	1.740
43	0	1.875	23158	0.775	1.825	23204	0.583	-0.038	0.380	1.814
44	0	1.95	42414	0.675	2.15	42450	0.649	0.192	0.331	2.010
45	0	1.975	90003	0.875	1.95	90056	0.571	-0.016	0.429	1.924
46	0.05	2.05	35428	1.025	2.175	35491	0.535	0.069	0.527	2.071
47	0	2.05	9489	0.6	2.2	9503	1.483	0.371	0.294	2.083
48	0	2.1	48823	1.625	2.85	48869	1.222	0.564	0.797	2.426
49	0	2.15	35537	0.9	2.025	35572	0.890	-0.124	0.441	2.047
50	0.025	2.15	41650	0.9	2.275	41672	1.376	0.197	0.453	2.169
51	0.125	2.25	83149	1.1	2.05	83176	1.249	-0.256	0.600	2.108
52	0	2.3	49133	1.075	2.125	49151	2.066	-0.336	0.527	2.169
53	0.05	2.3	55419	0.85	2.275	55435	1.730	-0.054	0.441	2.243
54	0	2.325	42245	1.1	2.25	42275	1.268	-0.086	0.539	2.243
55	0	2.4	90979	1.1	2.275	91008	1.312	-0.149	0.539	2.292
56	0.025	2.425	48820	1.1	2.45	48886	0.563	0.013	0.551	2.390
57	0.025	2.425	55790	0.9	2.325	55819	1.044	-0.119	0.453	2.328
58	0.025	2.5	90957	0.8	2.475	91004	0.570	-0.018	0.404	2.439
59	0.025	2.5	49143	0.9	2.225	49177	0.890	-0.280	0.453	2.316
60	0	2.525	55451	1.1	2.375	55511	0.634	-0.086	0.539	2.402
61	0.025	2.6	69755	0.775	2.5	69801	0.564	-0.075	0.392	2.500
62	0.05	2.675	69415	1.1	2.625	69473	0.626	-0.030	0.564	2.598
63	0	2.675	8010	0.8	2.65	8040	0.923	-0.029	0.392	2.610
64	0.05	2.8	10128	0.8	2.75	10156	0.927	-0.062	0.417	2.721
65	0.2	2.85	53613	1.05	2.725	53637	1.225	-0.180	0.613	2.733
66	0.025	2.95	82884	1.1	2.7	82931	0.791	-0.184	0.551	2.770
67	0.6	2.95	23947	0.35	2.9	23995	-0.180	-0.036	0.466	2.868
68	0.6	2.95	30710	0.1	3.25	30795	-0.203	0.122	0.343	3.039
69	0.55	3	35367	0.175	3.15	35418	-0.254	0.102	0.355	3.015
70	0.4	3.025	59698	0.15	3.2	59750	-0.166	0.116	0.270	3.051
71	0.625	3.05	46767	0.1	3.25	46848	-0.224	0.085	0.355	3.088
72	0.6	3.075	14450	0.15	3.25	14501	-0.305	0.119	0.368	3.100
73	0.5	3.125	35427	0.15	3.1	35489	-0.195	-0.014	0.319	3.051
74	0.7	3.15	36657	0.225	3.175	36697	-0.411	0.022	0.453	3.100
75	0.65	3.25	14045	0.25	3.25	14102	-0.243	0.000	0.441	3.186
76	0.7	3.25	25467	0.2	2.9	25507	-0.432	-0.303	0.441	3.015
77	0.6	3.25	35629	0.225	3.2	35665	-0.360	-0.048	0.404	3.162
78	0.675	3.275	37637	0.225	3.175	37676	-0.399	-0.089	0.441	3.162
79	0.6	3.325	14591	0.225	3.125	14625	-0.382	-0.203	0.404	3.162

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.6	3.325	35421	0.3	3.05	35494	-0.142	-0.130	0.441	3.125
81	0.425	3.375	90974	0.15	3.15	91018	-0.216	-0.177	0.282	3.199
82	0.475	3.525	30634	0.375	3.325	30667	-0.105	-0.210	0.417	3.358

Notes:
(1) Measurement Number
(2) 1st X-Position
(3) 1st Y-Position
(4) 1st Frame
(5) 2nd X-Position
(6) 2nd Y-Position
(7) 2nd Frame
(8) Velocity in X-direction
(9) Velocity in Y-direction
(10) Average X-Position
(11) Average Y-Position

Table 24: HW 1.15P TW 0.30P, Unmodified Spillway Simulation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	x_1 [ft]	y_1 [ft]	$Frame_1$	x_2 [ft]	y_2 [ft]	$Frame_2$	V_x/V_c	V_y/V_c	x_{ave}/P	y_{ave}/P
1	0.7	0.425	39477	0.2	0.5	39503	-0.665	0.033	-0.245	0.429
2	0.675	0.45	34430	0.1	0.4	34452	-0.904	-0.157	-0.282	0.392
3	0.7	0.45	37010	0.2	0.4	37034	-0.793	-0.072	-0.270	0.417
4	0.7	0.5	29850	0.1	0.5	29875	-0.830	-0.069	-0.294	0.466
5	0.6	0.5	38612	0.2	0.5	38627	-1.038	-0.115	-0.221	0.466
6	0.7	0.55	31398	0.1	0.6	31420	-0.943	0.079	-0.294	0.564
7	0.7	0.6	45450	0.1	0.5	45475	-0.830	-0.104	-0.294	0.551
8	0.7	0.625	29703	0.1	0.7	29731	-0.741	0.031	-0.294	0.625
9	0.7	0.65	41450	0.1	0.6	41469	-1.047	-0.046	-0.282	0.625
10	0.7	0.7	29495	0.1	0.6	29520	-0.830	-0.208	-0.294	0.613
11	0.7	0.7	29677	0.2	0.6	29699	-0.826	-0.236	-0.257	0.613
12	0.65	0.75	34717	0.2	0.7	34740	-0.677	-0.150	-0.221	0.686
13	0.6	0.775	39166	0.1	0.7	39187	-0.824	-0.124	-0.245	0.723
14	0.7	0.8	34230	0.2	0.7	34257	-0.705	-0.192	-0.270	0.711
15	0.6	0.85	32679	0.1	0.9	32699	-0.865	0.086	-0.245	0.858
16	0.7	0.95	27727	0.2	0.9	27751	-0.721	-0.072	-0.245	0.907
17	0.7	0.95	29617	0.1	0.9	29642	-0.830	-0.069	-0.294	0.907
18	0.7	0.95	37904	0.1	0.9	37929	-0.830	-0.035	-0.294	0.919
19	0.6	0.975	27595	0.1	1.0	27624	-0.596	0.030	-0.245	0.968
20	0.6	0.975	37964	0.2	1.0	37980	-0.973	-0.054	-0.221	0.944
21	0.6	1	33341	0.1	0.9	33359	-0.961	-0.240	-0.245	0.919
22	0.7	1.15	30249	0.1	1.1	30274	-0.830	-0.035	-0.294	1.115
23	0.7	1.15	32866	0.1	1.2	32891	-0.830	0.104	-0.294	1.164
24	0.7	1.15	35236	0.2	1.1	35258	-0.747	-0.157	-0.233	1.078
25	0.7	1.225	32365	0.2	1.7	32386	-0.865	0.782	-0.257	1.434
26	0.7	1.25	36791	0.1	1.4	36813	-0.943	0.197	-0.294	1.287
27	0.6	1.25	37903	0.1	1.2	37922	-0.910	-0.182	-0.245	1.176
28	0.7	1.3	32571	0.1	1.2	32592	-0.947	-0.206	-0.282	1.213
29	0.7	1.35	38098	0.1	1.2	38124	-0.798	-0.233	-0.294	1.238
30	0.7	1.35	38385	0.2	1.3	38410	-0.761	-0.035	-0.270	1.311
31	0.7	1.375	28210	0.1	1.4	28233	-0.902	-0.038	-0.294	1.336
32	0.6	1.4	28039	0.1	1.3	28058	-0.910	-0.182	-0.245	1.324
33	0.7	1.425	28318	0.2	1.4	28341	-0.752	0.000	-0.245	1.397
34	0.7	1.475	25144	0.2	1.5	25165	-0.824	0.041	-0.245	1.458
35	0.7	1.5	27853	0.2	1.6	27875	-0.786	0.157	-0.245	1.520
36	0.6	1.5	27990	0.1	1.4	28012	-0.786	-0.236	-0.245	1.397
37	0.7	1.6	28121	0.1	1.6	28146	-0.830	-0.069	-0.294	1.544
38	0.7	1.65	26434	0.2	1.7	26450	-1.081	0.162	-0.245	1.654
39	0.575	1.65	30088	0.1	1.6	30106	-0.913	-0.192	-0.233	1.569

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.7	1.675	28597	0.2	1.9	28620	-0.790	0.263	-0.257	1.728
41	0.6	1.75	16549	0.1	1.8	16566	-0.967	0.153	-0.233	1.752
42	0.7	1.775	15593	0.1	1.8	15616	-0.902	0.038	-0.294	1.752
43	0.6	1.775	26438	0.2	1.7	26452	-0.988	-0.124	-0.196	1.716
44	0.6	1.8	16489	0.1	1.9	16511	-0.786	0.079	-0.245	1.789
45	0.7	1.825	28254	0.1	1.9	28280	-0.798	0.100	-0.294	1.826
46	0.675	1.875	24272	0.1	1.9	24292	-1.038	0.086	-0.294	1.863
47	0.6	1.95	19075	0.1	2.0	19095	-0.865	0.000	-0.245	1.912
48	0.7	1.95	24522	0.2	1.9	24544	-0.865	-0.039	-0.270	1.900
49	0.7	1.975	24580	0.1	1.9	24603	-0.865	-0.188	-0.282	1.875
50	0.6	1.975	25846	0.1	2.0	25863	-1.068	-0.051	-0.257	1.924
51	0.6	2.05	25751	0.1	2.1	25771	-0.865	0.000	-0.245	2.010
52	0.6	2.1	14980	0.1	2.1	15013	-0.524	-0.052	-0.245	2.034
53	0.6	2.125	21467	0.1	2.1	21481	-1.236	-0.062	-0.245	2.071
54	0.6	2.15	16384	0.1	2.3	16412	-0.618	0.124	-0.245	2.157
55	0.6	2.175	19390	0.1	2.3	19409	-0.865	0.137	-0.233	2.169
56	0.7	2.25	16206	0.2	2.3	16225	-1.001	0.137	-0.270	2.243
57	0.7	2.25	25972	0.2	2.3	25996	-0.721	0.000	-0.245	2.206
58	0.6	2.275	8714	0.1	2.3	8739	-0.692	-0.035	-0.245	2.218
59	0.6	2.3	8157	0.1	2.4	8180	-0.752	0.075	-0.245	2.279
60	0.6	2.35	8295	0.1	2.4	8320	-0.692	0.000	-0.245	2.304
61	0.6	2.425	8781	0.1	2.5	8800	-0.910	0.046	-0.245	2.390
62	0.6	2.45	12590	0.1	2.5	12612	-0.786	0.000	-0.245	2.402
63	0.6	2.45	16260	0.1	2.4	16282	-0.786	-0.079	-0.245	2.377
64	0.6	2.525	15439	0.2	2.6	15468	-0.537	0.119	-0.221	2.525
65	0.7	2.525	15991	0.1	2.5	16017	-0.798	0.000	-0.294	2.475
66	0.7	2.525	16964	0.1	2.6	16986	-0.943	0.079	-0.294	2.500
67	0.6	2.625	18063	0.1	2.7	18088	-0.692	0.069	-0.245	2.598
68	0.7	2.65	8564	0.1	2.7	8587	-0.902	0.000	-0.294	2.598
69	0.6	2.65	15712	0.1	2.7	15735	-0.752	0.000	-0.245	2.598
70	0.6	2.7	19485	0.1	2.7	19506	-0.824	0.041	-0.245	2.659
71	0.6	2.75	14877	0.1	2.9	14901	-0.721	0.144	-0.245	2.745
72	0.6	2.75	15220	0.1	2.7	15239	-0.910	-0.182	-0.245	2.647
73	0.7	2.775	6808	0.2	2.7	6825	-0.967	-0.102	-0.233	2.696
74	0.6	2.8	10822	0.1	2.8	10849	-0.641	0.000	-0.245	2.745
75	0.7	2.85	7116	0.1	2.9	7139	-0.902	0.000	-0.294	2.794
76	0.6	2.9	13067	0.1	2.9	13083	-1.081	-0.108	-0.245	2.819
77	0.6	2.95	11309	0.2	3.0	11326	-0.916	0.000	-0.221	2.892
78	0.6	2.95	13022	0.2	3.0	13040	-0.817	0.048	-0.208	2.904
79	0.7	3	5179	0.1	3.2	5206	-0.769	0.256	-0.294	3.039

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.7	3.05	4574	0.3	3.1	4593	-0.819	0.000	-0.221	2.990
81	0.7	3.05	6574	0.1	3.1	6598	-0.865	0.072	-0.294	3.015
82	0.65	3.1	4932	0.2	3.2	4954	-0.786	0.079	-0.245	3.064
83	0.6	3.1	8847	0.1	3.1	8869	-0.786	-0.079	-0.245	3.015
84	0.6	3.125	8270	0.2	3.1	8290	-0.778	-0.086	-0.221	3.039
85	0.6	3.175	5535	0.1	3.3	5556	-0.824	0.124	-0.245	3.150
86	0.7	3.175	5685	0.1	3.2	5712	-0.769	0.032	-0.294	3.125
87	0.6	3.25	10189	0.1	3.3	10211	-0.786	0.039	-0.245	3.199
88	0.7	3.275	4709	0.1	3.4	4732	-0.865	0.113	-0.282	3.248
89	0.6	3.3	5763	0.1	3.4	5786	-0.752	0.113	-0.245	3.272
90	0.6	3.35	5438	0.2	3.4	5456	-0.865	0.000	-0.221	3.284
91	0.6	3.375	5560	0.1	3.4	5585	-0.692	0.035	-0.245	3.321
92	0.65	3.4	5296	0.2	3.4	5328	-0.541	0.000	-0.245	3.333
93	0.6	3.45	7250	0.1	3.4	7272	-0.786	-0.039	-0.245	3.370
94	0.7	3.525	4908	0.0	3.5	4931	-1.015	-0.075	-0.331	3.431
95	0.7	3.55	5839	0.1	3.6	5863	-0.829	0.000	-0.282	3.480
96	0.7	3.55	6746	0.1	3.4	6776	-0.692	-0.144	-0.294	3.419

Notes:
(1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

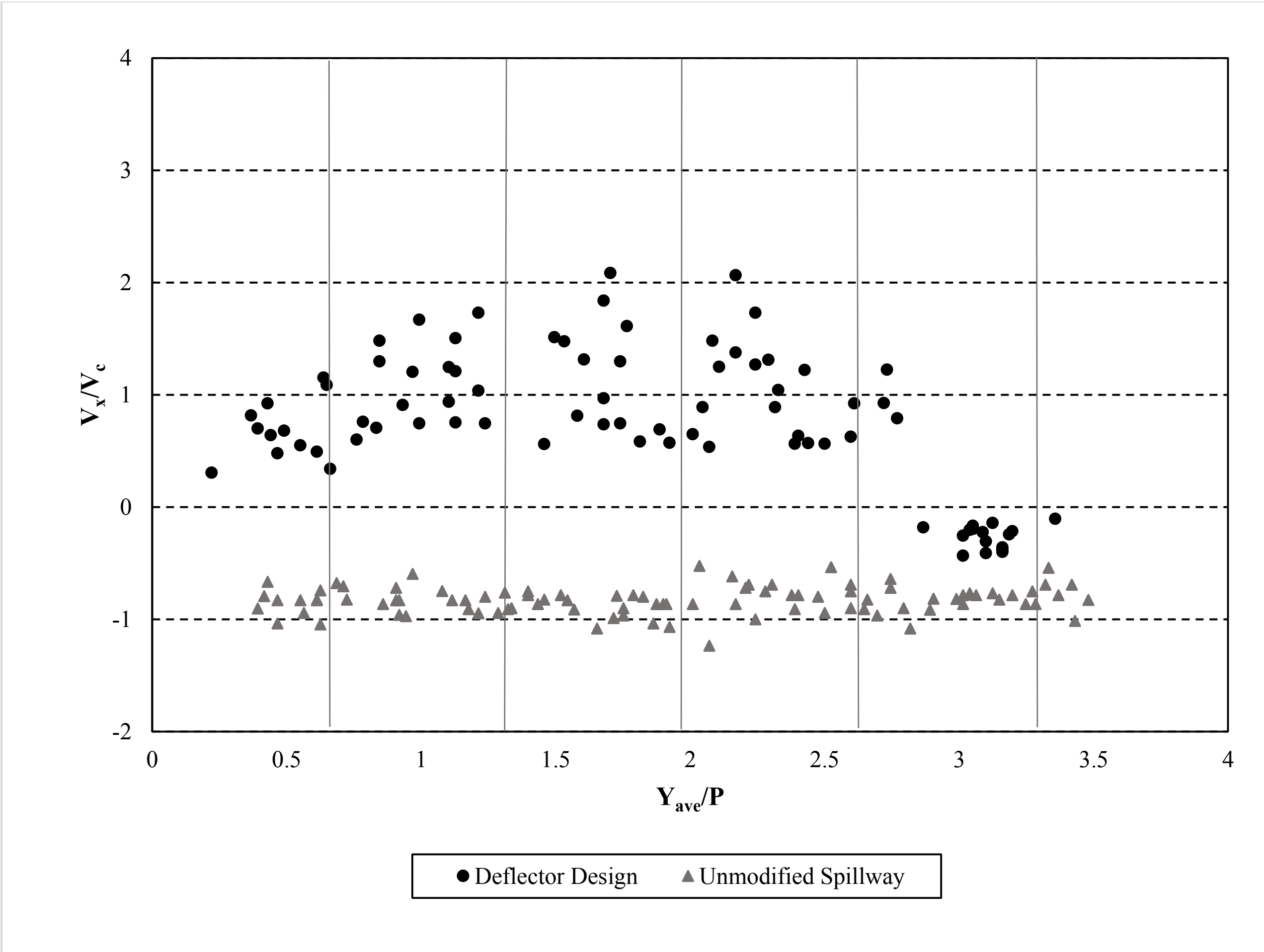

Figure 33: HW 1.15P TW 0.30P, Design Simulations Results

Table 25: HW 1.15P TW 0.56P, Multiple Staggered Deflector Design Simulation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	0.15	0.25	33626	0.8	0.15	33646	1.124	-0.173	0.466	0.196
2	0.35	0.25	54584	1.075	0.275	54611	0.929	0.032	0.699	0.257
3	0.5	0.275	71430	1.1	0.325	71465	0.593	0.049	0.784	0.294
4	0.55	0.425	54641	1.025	0.325	54660	0.865	-0.182	0.772	0.368
5	0.625	0.45	19232	1.1	0.275	19256	0.685	-0.252	0.846	0.355
6	0	0.475	33347	1.1	0.35	33385	1.001	-0.114	0.539	0.404
7	0.5	0.55	87636	1.1	0.375	87661	0.830	-0.242	0.784	0.453
8	0	0.55	33589	1.1	0.4	33611	1.730	-0.236	0.539	0.466
9	0.1	0.625	8104	1	0.475	8131	1.153	-0.192	0.539	0.539
10	0.3	0.625	43646	0.925	0.3	43669	0.940	-0.489	0.600	0.453
11	0.325	0.65	62600	0.875	0.4	62621	0.906	-0.412	0.588	0.515
12	0.05	0.675	33066	0.975	0.475	33096	1.067	-0.231	0.502	0.564
13	0.5	0.75	28585	0.3	0.65	28611	-0.266	-0.133	0.392	0.686
14	0.525	0.75	43623	0.275	0.675	43644	-0.412	-0.124	0.392	0.699
15	0.55	0.775	25731	0.25	0.7	25762	-0.335	-0.084	0.392	0.723
16	0.65	0.8	33246	0.4	0.65	33272	-0.333	-0.200	0.515	0.711
17	0.55	0.85	8205	0.375	0.85	8218	-0.466	0.000	0.453	0.833
18	0.625	0.875	54520	0.225	0.65	54556	-0.384	-0.216	0.417	0.748
19	0.6	0.9	43910	0.35	0.725	43930	-0.432	-0.303	0.466	0.797
20	0.5	0.95	70938	0.325	0.775	70955	-0.356	-0.356	0.404	0.846
21	0.625	1	62609	0.5	0.825	62621	-0.360	-0.505	0.551	0.895
22	0.55	1.05	87449	0.4	0.85	87464	-0.346	-0.461	0.466	0.931
23	0.575	1.05	33183	0.325	0.675	33209	-0.333	-0.499	0.441	0.846
24	0.625	1.075	48740	0.2	0.9	48770	-0.490	-0.202	0.404	0.968
25	0.55	1.1	16523	0.3	0.95	16540	-0.509	-0.305	0.417	1.005
26	0.475	1.1	62668	0.225	1	62690	-0.393	-0.157	0.343	1.029
27	0.575	1.175	25731	0.35	1.925	25753	-0.354	1.179	0.453	1.520
28	0.55	1.25	68935	0.25	1.75	68957	-0.472	0.786	0.392	1.471
29	0.425	1.25	43554	0.3	1.15	43565	-0.393	-0.314	0.355	1.176
30	0.475	1.275	28534	0.2	1.1	28545	-0.865	-0.550	0.331	1.164
31	0.5	1.3	42859	0.15	1.15	42887	-0.432	-0.185	0.319	1.201
32	0.475	1.35	59896	0.3	3.275	59907	-0.550	6.054	0.380	2.267
33	0.45	1.375	20270	0	1.375	20305	-0.445	0.000	0.221	1.348
34	0.4	1.4	24951	0.175	1.375	24974	-0.338	-0.038	0.282	1.360
35	0.5	1.425	3832	0.125	1.325	3861	-0.447	-0.119	0.306	1.348
36	0.475	1.475	11397	0.125	1.475	11429	-0.378	0.000	0.294	1.446
37	0.475	1.475	54088	0.1	1.475	54112	-0.541	0.000	0.282	1.446
38	0.5	1.5	76836	0.3	1.45	76848	-0.577	-0.144	0.392	1.446
39	0.375	1.575	42662	0.15	1.6	42680	-0.432	0.048	0.257	1.556

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.4	1.6	3297	0.1	1.475	3325	-0.371	-0.154	0.245	1.507
41	0.35	1.65	42584	0.2	1.65	42596	-0.432	0.000	0.270	1.618
42	0.4	1.725	48575	0.075	1.65	48609	-0.331	-0.076	0.233	1.654
43	0.475	1.75	42566	0.125	1.75	42594	-0.432	0.000	0.294	1.716
44	0.475	1.75	80122	0.3	1.875	80136	-0.432	0.309	0.380	1.777
45	0.475	1.775	42353	0.125	1.75	42384	-0.391	-0.028	0.294	1.728
46	0.5	1.8	42681	0.125	1.85	42704	-0.564	0.075	0.306	1.789
47	0.5	1.85	59548	0.325	1.875	59563	-0.404	0.058	0.404	1.826
48	0.575	1.9	24610	0.2	1.85	24645	-0.371	-0.049	0.380	1.838
49	0.475	1.9	42293	0.2	1.875	42315	-0.432	-0.039	0.331	1.850
50	0.525	1.95	42470	0.075	1.825	42499	-0.537	-0.149	0.294	1.850
51	0.5	2.05	778	0.25	1.9	798	-0.432	-0.259	0.368	1.936
52	0.4	2.075	59601	0.05	1.975	59635	-0.356	-0.102	0.221	1.985
53	0.35	2.1	70731	0.025	2.05	70751	-0.562	-0.086	0.184	2.034
54	0.35	2.15	3420	0.125	2.075	3434	-0.556	-0.185	0.233	2.071
55	0.475	2.175	34006	0.05	2.075	34042	-0.408	-0.096	0.257	2.083
56	0.4	2.175	89201	0.05	1.95	89223	-0.550	-0.354	0.221	2.022
57	0.35	2.225	89616	0.2	2.15	89626	-0.519	-0.259	0.270	2.145
58	0.675	2.35	42279	0.2	2.15	42297	-0.913	-0.384	0.429	2.206
59	0.45	2.35	68824	0.2	2.25	68840	-0.541	-0.216	0.319	2.255
60	0.35	2.35	89257	0.15	2.275	89269	-0.577	-0.216	0.245	2.267
61	0.4	2.45	52621	0.15	2.375	52640	-0.455	-0.137	0.270	2.365
62	0.3	2.45	68791	0.125	0.35	68814	-0.263	-3.159	0.208	1.373
63	0.25	2.45	728	0.1	2.275	739	-0.472	-0.550	0.172	2.316
64	0.375	2.5	34127	0.2	2.175	34147	-0.303	-0.562	0.282	2.292
65	0.5	2.55	24764	1.1	2.5	24789	0.830	-0.069	0.784	2.475
66	0.325	2.55	33597	0.1	2.325	33618	-0.371	-0.371	0.208	2.390
67	0.5	2.625	24520	1.1	2.375	24551	0.670	-0.279	0.784	2.451
68	0.3	2.65	24689	1.1	2.425	24737	0.577	-0.162	0.686	2.488
69	0.475	2.65	24963	1	2.675	24982	0.956	0.046	0.723	2.610
70	0.35	2.75	11532	1.1	2.2	11602	0.371	-0.272	0.711	2.426
71	0.3	2.75	27971	0.15	2.6	27980	-0.577	-0.577	0.221	2.623
72	0	2.8	16591	1.1	2.575	16652	0.624	-0.128	0.539	2.635
73	0	2.8	47962	1	2.85	47997	0.988	0.049	0.490	2.770
74	0	2.85	28723	1.1	2.825	28745	1.730	-0.039	0.539	2.782
75	0	2.9	16532	1.1	2.85	16558	1.464	-0.067	0.539	2.819
76	0.5	2.9	16573	1.1	2.85	16590	1.221	-0.102	0.784	2.819
77	0	2.925	2706	0.85	2.9	2733	1.089	-0.032	0.417	2.855
78	0	3.025	28365	0.975	3.15	28394	1.163	0.149	0.478	3.027
79	0	3.05	28422	0.95	3.15	28447	1.315	0.138	0.466	3.039

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0	3.075	28342	1	3.175	28371	1.193	0.119	0.490	3.064
81	0	3.075	33872	0.95	3.05	33898	1.264	-0.033	0.466	3.002
82	0	3.075	33984	1.05	3.125	34010	1.397	0.067	0.515	3.039
83	0	3.2	7818	1	2.825	7863	0.769	-0.288	0.490	2.953
84	0	3.225	59647	1	3.35	59676	1.193	0.149	0.490	3.223
85	0.625	3.225	89077	0.925	3.225	89108	0.335	0.000	0.760	3.162
86	0	3.275	19594	1	3.175	19616	1.572	-0.157	0.490	3.162
87	0	3.3	19596	0.6	3.325	19611	1.384	0.058	0.294	3.248
88	0	3.3	19729	1.1	3.25	19756	1.409	-0.064	0.539	3.211
89	0	3.325	19864	0.95	3.225	19889	1.315	-0.138	0.466	3.211
90	0	3.425	3914	0.9	3.525	3928	2.224	0.247	0.441	3.407
91	0	3.45	59160	1	3.5	59182	1.572	0.079	0.490	3.407
92	0	3.45	59318	1.05	3.55	59337	1.912	0.182	0.515	3.431
93	0	3.5	59850	1.025	3.45	59866	2.216	-0.108	0.502	3.407
94	0	3.575	59275	1.025	3.7	59289	2.533	0.309	0.502	3.566
95	0	3.6	59272	0.6	3.65	59281	2.306	0.192	0.294	3.554

Notes: (1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

Table 26: HW 1.15P TW 0.56P, Unmodified Spillway Simulation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	1	0.15	35083	0.1	0.25	35207	-0.251	0.028	-0.441	0.196
2	0.7	0.25	34182	0.1	0.35	34263	-0.256	0.043	-0.294	0.294
3	0.7	0.25	34453	0.1	0.45	34550	-0.214	0.071	-0.294	0.343
4	0.8	0.25	34961	0.1	0.45	35033	-0.336	0.096	-0.343	0.343
5	0.4	0.35	33716	0.1	0.3	33739	-0.451	-0.075	-0.147	0.319
6	0.8	0.35	33844	0.1	0.35	33874	-0.807	0.000	-0.343	0.343
7	1	0.35	33913	0.1	0.25	33997	-0.371	-0.041	-0.441	0.294
8	0.5	0.45	33358	0.1	0.25	33390	-0.432	-0.216	-0.196	0.343
9	0.8	0.45	33392	0.1	0.35	33448	-0.432	-0.062	-0.343	0.392
10	1.1	0.45	33617	0.1	0.45	33716	-0.349	0.000	-0.490	0.441
11	0.9	0.55	32854	0.1	0.35	32896	-0.659	-0.165	-0.392	0.441
12	0.5	0.55	33154	0.1	0.35	33185	-0.446	-0.223	-0.196	0.441
13	0.9	0.55	33190	0.1	0.75	33238	-0.577	0.144	-0.392	0.637
14	0.6	0.65	32310	0.1	0.45	32337	-0.641	-0.256	-0.245	0.539
15	0.8	0.65	32710	0.1	0.55	32757	-0.515	-0.074	-0.343	0.588
16	0.7	0.65	33061	0.1	0.55	33092	-0.670	-0.112	-0.294	0.588
17	0.6	0.75	31832	0.1	0.35	31883	-0.339	-0.271	-0.245	0.539
18	0.9	0.75	32086	0.1	0.75	32139	-0.522	0.000	-0.392	0.735
19	0.4	0.75	32155	0.1	0.65	32169	-0.741	-0.247	-0.147	0.686
20	0.5	0.85	31640	0.1	0.75	31664	-0.577	-0.144	-0.196	0.784
21	1.1	0.85	31699	0.1	0.65	31759	-0.577	-0.115	-0.490	0.735
22	0.5	0.85	31911	0.1	0.85	31939	-0.494	0.000	-0.196	0.833
23	0.5	0.95	31303	0.1	1.05	31332	-0.477	0.119	-0.196	0.980
24	1	0.95	31321	0.1	1.15	31379	-0.537	0.119	-0.441	1.029
25	0.9	0.95	31391	0.1	1.4	31450	-0.469	0.264	-0.392	1.152
26	0.8	1.05	30140	0.1	0.75	30214	-0.327	-0.140	-0.343	0.882
27	0.9	1.05	30185	0.1	0.85	30233	-0.577	-0.144	-0.392	0.931
28	0.9	1.05	30365	0.1	0.85	30410	-0.615	-0.154	-0.392	0.931
29	1	1.15	30638	0.1	1.15	30687	-0.635	0.000	-0.441	1.127
30	0.8	1.15	30676	0.1	1.15	30702	-0.931	0.000	-0.343	1.127
31	0.3	1.15	30687	0.1	1.05	30729	-0.165	-0.082	-0.098	1.078
32	0.6	1.25	29683	0.1	1.05	29728	-0.384	-0.154	-0.245	1.127
33	1	1.25	29705	0.1	1.05	29763	-0.537	-0.119	-0.441	1.127
34	0.6	1.25	29912	0.1	1.35	29944	-0.541	0.108	-0.245	1.275
35	0.6	1.35	28387	0.1	1.35	28421	-0.509	0.000	-0.245	1.324
36	0.8	1.35	28554	0.1	1.45	28604	-0.484	0.069	-0.343	1.373
37	0.85	1.35	28622	0.1	1.95	28727	-0.247	0.198	-0.368	1.618
38	0.6	1.45	27769	0.1	1.45	27804	-0.494	0.000	-0.245	1.422
39	1	1.45	27788	0.1	1.15	27866	-0.399	-0.133	-0.441	1.275

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.8	1.45	28143	0.1	1.25	28182	-0.621	-0.177	-0.343	1.324
41	0.5	1.55	27150	0.05	1.55	27178	-0.556	0.000	-0.221	1.520
42	0.9	1.55	27315	0.1	1.55	27379	-0.432	0.000	-0.392	1.520
43	1.1	1.55	27476	0.1	1.05	27551	-0.461	-0.231	-0.490	1.275
44	0.8	1.65	25716	0.1	1.55	25765	-0.494	-0.071	-0.343	1.569
45	1	1.65	25897	0.1	1.7	25967	-0.445	0.025	-0.441	1.642
46	0.6	1.65	25906	0.1	1.55	25953	-0.368	-0.074	-0.245	1.569
47	0.9	1.75	21767	0.1	1.75	21829	-0.446	0.000	-0.392	1.716
48	0.9	1.75	21998	0.1	1.85	22059	-0.454	0.057	-0.392	1.765
49	0.7	1.75	22133	0.1	1.65	22173	-0.519	-0.086	-0.294	1.667
50	0.9	1.85	23375	0.1	2.15	23436	-0.454	0.170	-0.392	1.961
51	0.4	1.85	23673	0.1	1.85	23693	-0.519	0.000	-0.147	1.814
52	0.5	1.85	24979	0.1	1.85	25003	-0.577	0.000	-0.196	1.814
53	0.9	1.95	20729	0.1	1.85	20794	-0.426	-0.053	-0.392	1.863
54	0.3	1.95	20912	0.1	1.95	20925	-0.532	0.000	-0.098	1.912
55	0.8	1.95	21034	0.1	2.05	21080	-0.526	0.075	-0.343	1.961
56	1.1	2.05	19866	0.1	2.45	19927	-0.567	0.227	-0.490	2.206
57	0.4	2.05	20012	0.1	2.05	20040	-0.371	0.000	-0.147	2.010
58	0.8	2.05	20630	0.05	2.45	20686	-0.463	0.247	-0.368	2.206
59	0.7	2.15	16914	0.1	2.05	16955	-0.506	-0.084	-0.294	2.059
60	0.5	2.15	17206	0.1	2.15	17234	-0.494	0.000	-0.196	2.108
61	0.7	2.15	17836	0.1	2.15	17883	-0.442	0.000	-0.294	2.108
62	0.7	2.25	18753	0.1	1.95	18817	-0.324	-0.162	-0.294	2.059
63	0.9	2.25	18788	0.1	2.05	18832	-0.629	-0.157	-0.392	2.108
64	0.5	2.25	18817	0.1	2.05	18837	-0.692	-0.346	-0.196	2.108
65	0.6	2.35	16081	0.1	2.45	16126	-0.384	0.077	-0.245	2.353
66	0.8	2.35	16938	0.1	2.3	16976	-0.637	-0.046	-0.343	2.279
67	1	2.35	17124	0.1	2.45	17206	-0.380	0.042	-0.441	2.353
68	0.95	2.45	15513	0.1	2.05	15588	-0.392	-0.185	-0.417	2.206
69	1	2.45	15949	0.1	2.25	16036	-0.358	-0.080	-0.441	2.304
70	1	2.45	16258	0.1	2.6	16318	-0.519	0.086	-0.441	2.475
71	1.1	2.5	14313	0.1	2.65	14407	-0.368	0.055	-0.490	2.525
72	0.6	2.55	14037	0.1	2.55	14056	-0.910	0.000	-0.245	2.500
73	0.3	2.55	14037	0.1	2.65	14085	-0.144	0.072	-0.098	2.549
74	0.7	2.6	13524	0.1	1.95	13564	-0.519	-0.562	-0.294	2.230
75	0.5	2.65	13497	0.1	2.55	13522	-0.554	-0.138	-0.196	2.549
76	1.1	2.65	13796	0.1	2.6	13854	-0.596	-0.030	-0.490	2.574
77	0.6	2.75	13156	0.1	2.65	13189	-0.524	-0.105	-0.245	2.647
78	0.9	2.75	13190	0.1	2.65	13270	-0.346	-0.043	-0.392	2.647
79	1.1	2.75	13190	0.1	2.75	13250	-0.577	0.000	-0.490	2.696

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.7	2.8	13323	0.1	3.05	13361	-0.546	0.228	-0.294	2.868
81	0.8	2.85	12903	0.1	2.75	12952	-0.494	-0.071	-0.343	2.745
82	0.5	2.85	13270	0.1	3.1	13323	-0.261	0.163	-0.196	2.917
83	0.9	2.9	12434	0.1	2.85	12485	-0.543	-0.034	-0.392	2.819
84	0.9	2.95	11987	0.1	2.85	12033	-0.602	-0.075	-0.392	2.843
85	0.6	2.95	12268	0.1	2.85	12304	-0.480	-0.096	-0.245	2.843
86	0.5	3.05	10585	0.1	3	10624	-0.355	-0.044	-0.196	2.966
87	1	3.05	10683	0.1	3.15	10756	-0.427	0.047	-0.441	3.039
88	0.9	3.05	10987	0.1	3.15	11054	-0.413	0.052	-0.392	3.039
89	1	3.15	9216	0.1	3.15	9281	-0.479	0.000	-0.441	3.088
90	0.65	3.15	9602	0.05	3.3	9662	-0.346	0.086	-0.294	3.162
91	0.6	3.15	9677	0.1	3.075	9706	-0.596	-0.089	-0.245	3.051
92	0.9	3.2	8911	0.1	3.25	8955	-0.629	0.039	-0.392	3.162
93	1	3.25	8955	0.1	3.35	9017	-0.502	0.056	-0.441	3.235
94	0.7	3.25	9076	0.1	3.35	9114	-0.546	0.091	-0.294	3.235
95	0.8	3.35	6550	0.1	3.35	6615	-0.373	0.000	-0.343	3.284
96	0.3	3.35	6639	0.05	3.35	6652	-0.665	0.000	-0.123	3.284
97	0.8	3.35	6816	0.1	3.75	6863	-0.515	0.294	-0.343	3.480
98	0.7	3.45	6998	0.1	3.75	7038	-0.519	0.259	-0.294	3.529
99	0.8	3.45	7178	0.1	3.65	7249	-0.341	0.097	-0.343	3.480
100	1	3.45	7178	0.1	3.25	7240	-0.502	-0.112	-0.441	3.284
101	0.6	3.55	7093	0.2	3.75	7175	-0.169	0.084	-0.196	3.578
102	0.8	3.55	7478	0.1	3.65	7541	-0.384	0.055	-0.343	3.529
103	0.5	3.55	7776	0.1	3.65	7802	-0.532	0.133	-0.196	3.529
104	0.7	3.65	6910	0.1	3.65	6995	-0.244	0.000	-0.294	3.578
105	0.6	3.65	7331	0.1	3.65	7372	-0.422	0.000	-0.245	3.578
106	0.6	3.65	7590	0.1	3.75	7627	-0.467	0.093	-0.245	3.627
107	1	3.75	8319	0.1	3.75	8398	-0.394	0.000	-0.441	3.676
108	0.8	3.75	8321	0.1	3.65	8398	-0.314	-0.045	-0.343	3.627
109	0.4	3.75	8435	0.1	3.65	8471	-0.288	-0.096	-0.147	3.627
110	1.1	3.85	8146	0.1	3.45	8240	-0.368	-0.147	-0.490	3.578
111	1.1	3.85	8146	0.1	3.45	8231	-0.407	-0.163	-0.490	3.578

Notes: (1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

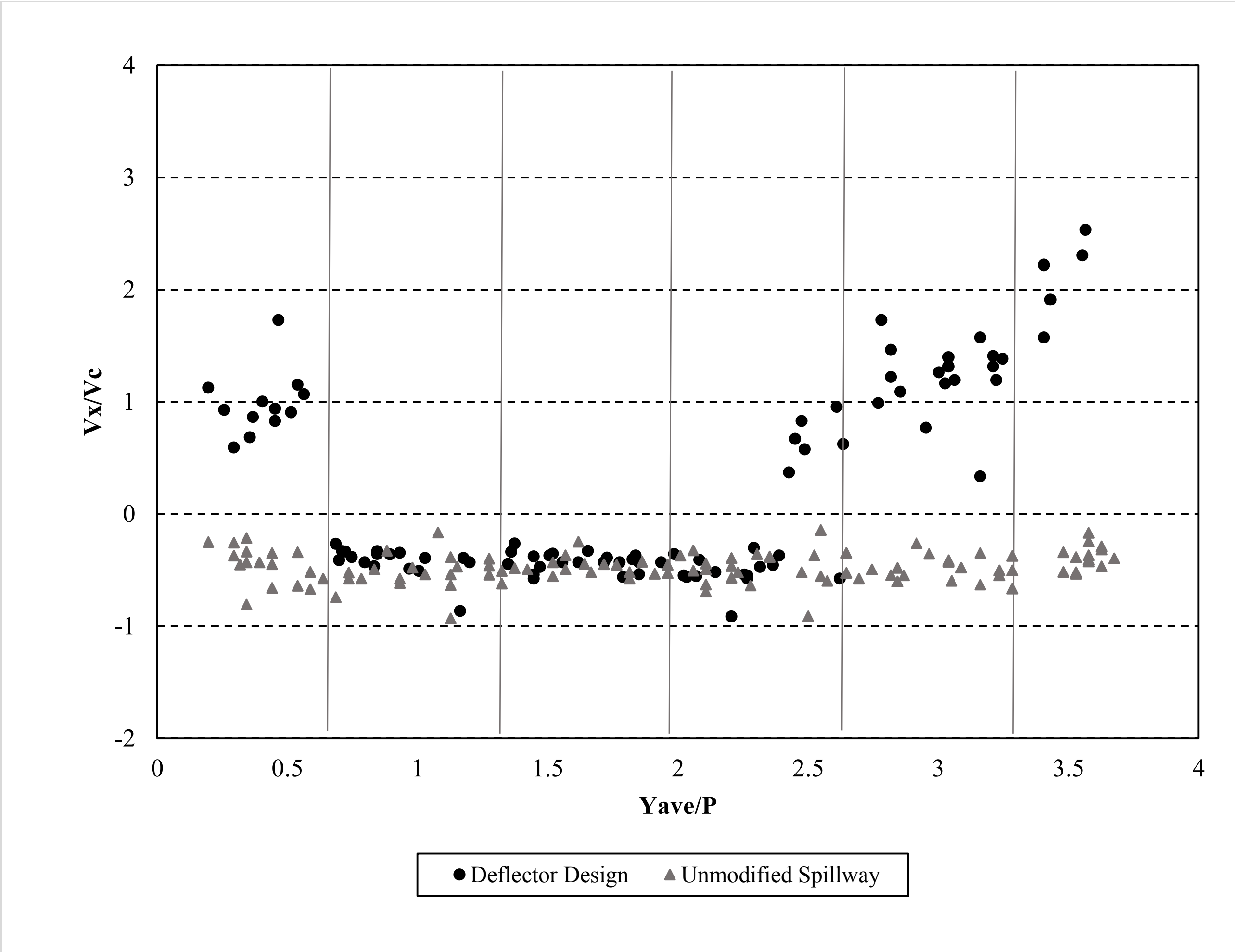

Figure 34: HW 1.15P TW 0.56P, Design Simulations Results

Table 27: HW 1.15P TW 0.79P, Multiple Staggered Deflector Design

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	x_1 [ft]	y_1 [ft]	$Frame_1$	x_2 [ft]	y_2 [ft]	$Frame_2$	V_x/V_c	V_y/V_c	x_{ave}/P	y_{ave}/P
1	0.6	0.15	8080	0.075	0.175	8143	-0.288	0.014	0.331	0.159
2	0.5	0.175	7254	0.1	0.175	7294	-0.346	0.000	0.294	0.172
3	0.75	0.25	8334	0.2	0.15	8386	-0.366	-0.067	0.466	0.196
4	0.65	0.25	9141	0.2	0.2	9176	-0.445	-0.049	0.417	0.221
5	0.7	0.275	8218	0.1	0.175	8266	-0.432	-0.072	0.392	0.221
6	0.6	0.35	8286	0.1	0.25	8330	-0.393	-0.079	0.343	0.294
7	0.6	0.35	8364	0.1	0.15	8412	-0.360	-0.144	0.343	0.245
8	0.6	0.4	7273	0.125	0.2	7349	-0.216	-0.091	0.355	0.294
9	0.6	0.425	7307	0.2	0.2	7357	-0.277	-0.156	0.392	0.306
10	0.6	0.425	8738	0.1	0.15	8796	-0.298	-0.164	0.343	0.282
11	0.55	0.55	10984	0.1	0.25	11049	-0.239	-0.160	0.319	0.392
12	0.575	0.55	36515	0.1	0.15	36593	-0.211	-0.177	0.331	0.343
13	0.55	0.55	65853	0.25	0.2	65879	-0.399	-0.466	0.392	0.368
14	0.425	0.575	7175	0.175	0.475	7190	-0.577	-0.231	0.294	0.515
15	0.625	0.625	805	0.1	0.6	829	-0.757	-0.036	0.355	0.600
16	0.5	0.65	83849	0.2	0.525	83885	-0.288	-0.120	0.343	0.576
17	0.55	0.675	64735	0.15	0.525	64769	-0.407	-0.153	0.343	0.588
18	0.5	0.725	84176	0.1	0.55	84204	-0.494	-0.216	0.294	0.625
19	0.6	0.75	26285	0.1	0.55	26335	-0.346	-0.138	0.343	0.637
20	0.475	0.8	7978	0.1	0.7	8013	-0.371	-0.099	0.282	0.735
21	0.55	0.825	7280	0.1	0.75	7318	-0.410	-0.068	0.319	0.772
22	0.55	0.875	7297	0.1	0.6	7335	-0.410	-0.250	0.319	0.723
23	0.6	0.925	64552	0.1	0.775	64597	-0.384	-0.115	0.343	0.833
24	0.5	0.95	65800	0.1	0.7	65828	-0.494	-0.309	0.294	0.809
25	0.5	1.05	6665	0.2	0.95	6690	-0.415	-0.138	0.343	0.980
26	0.5	1.05	47267	0.2	0.75	47294	-0.384	-0.384	0.343	0.882
27	0.5	1.05	55505	0.1	0.675	55745	-0.058	-0.054	0.294	0.846
28	0.55	1.075	7363	0.1	0.725	7402	-0.399	-0.310	0.319	0.882
29	0.35	1.1	6706	0.1	0.95	6726	-0.432	-0.259	0.221	1.005
30	0.5	1.1	24935	0.125	0.925	24973	-0.341	-0.159	0.306	0.993
31	0.525	1.175	7884	0.1	0.8	7936	-0.283	-0.249	0.306	0.968
32	0.45	1.175	55914	0.1	1.025	55935	-0.577	-0.247	0.270	1.078
33	0.425	1.25	55434	0.1	0.925	55457	-0.489	-0.489	0.257	1.066
34	0.4	1.3	84102	0.15	1.175	84123	-0.412	-0.206	0.270	1.213
35	0.425	1.35	47192	0.1	1.275	47213	-0.535	-0.124	0.257	1.287
36	0.275	1.35	55168	0.1	1.25	55183	-0.404	-0.231	0.184	1.275
37	0.425	1.375	64425	0.2	1.225	64448	-0.338	-0.226	0.306	1.275
38	0.35	1.4	46725	0.15	1.325	46748	-0.301	-0.113	0.245	1.336
39	0.425	1.4	84763	0.2	1.325	84724	0.200	0.067	0.306	1.336

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.35	1.5	11024	0.15	1.375	11041	-0.407	-0.254	0.245	1.409
41	0.4	1.5	21171	0.25	1.375	21187	-0.324	-0.270	0.319	1.409
42	0.3	1.55	65535	0.125	1.6	65549	-0.432	0.124	0.208	1.544
43	0.375	1.6	26134	0.225	1.55	26147	-0.399	-0.133	0.294	1.544
44	0.425	1.625	64858	0.1	1.55	64882	-0.468	-0.108	0.257	1.556
45	0.35	1.65	65560	0.15	1.625	65574	-0.494	-0.062	0.245	1.605
46	0.4	1.75	64537	0.1	1.7	64555	-0.577	-0.096	0.245	1.691
47	0.4	1.75	65506	0.1	1.65	65528	-0.472	-0.157	0.245	1.667
48	0.3	1.75	84237	0.075	1.7	84248	-0.708	-0.157	0.184	1.691
49	0.35	1.775	6486	0.1	1.725	6501	-0.577	-0.115	0.221	1.716
50	0.35	1.825	6547	0.1	1.75	6560	-0.665	-0.200	0.221	1.752
51	0.275	1.825	65079	0.125	1.875	65088	-0.577	0.192	0.196	1.814
52	0.05	1.925	6578	0.8	1.975	6598	1.297	0.086	0.417	1.912
53	0	1.95	74164	1	2.175	74189	1.384	0.311	0.490	2.022
54	0.325	1.95	415	1	2.15	441	0.898	0.266	0.650	2.010
55	0.05	1.975	24751	1.1	1.9	24781	1.211	-0.086	0.564	1.900
56	0	2	17712	1.1	2.1	17757	0.846	0.077	0.539	2.010
57	0	2.025	17784	1.1	2.025	17821	1.028	0.000	0.539	1.985
58	0	2.125	6223	1.1	2.15	6253	1.268	0.029	0.539	2.096
59	0.025	2.15	337	0.7	2.15	350	1.796	0.000	0.355	2.108
60	0	2.15	11140	0.9	2.1	11155	2.076	-0.115	0.441	2.083
61	0	2.175	46607	1.1	2.275	46646	0.976	0.089	0.539	2.181
62	0	2.2	25009	0.6	2.25	25022	1.597	0.133	0.294	2.181
63	0	2.2	64308	1.1	2.225	64336	1.359	0.031	0.539	2.169
64	0	2.3	25778	1.1	2.35	25802	1.586	0.072	0.539	2.279
65	0	2.325	36088	1.1	2.35	36108	1.903	0.043	0.539	2.292
66	0.025	2.325	11174	1.1	2.3	11194	1.859	-0.043	0.551	2.267
67	0.025	2.425	17432	1.1	2.35	17459	1.377	-0.096	0.551	2.341
68	0	2.45	17830	0.7	2.35	17847	1.424	-0.203	0.343	2.353
69	0	2.45	35286	1.1	2.45	35309	1.655	0.000	0.539	2.402
70	0	2.5	25212	1.1	2.5	25238	1.464	0.000	0.539	2.451
71	0	2.525	6762	0.6	2.45	6776	1.483	-0.185	0.294	2.439
72	0.025	2.55	25457	1.1	2.475	25483	1.430	-0.100	0.551	2.463
73	0	2.575	17565	1.1	2.4	17599	1.119	-0.178	0.539	2.439
74	0	2.6	6263	1.1	2.55	6289	1.464	-0.067	0.539	2.525
75	0	2.6	25498	0.8	2.5	25520	1.258	-0.157	0.392	2.500
76	0.1	2.675	6693	0.75	2.675	6705	1.874	0.000	0.417	2.623
77	0	2.7	17493	1.1	2.725	17518	1.522	0.035	0.539	2.659
78	0.025	2.75	17685	1.1	2.9	17707	1.690	0.236	0.551	2.770
79	0	2.8	25231	1.1	3.05	25251	1.903	0.432	0.539	2.868

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0	2.85	17569	1.1	2.8	17591	1.730	-0.079	0.539	2.770
81	0	2.85	25586	1.1	2.925	25606	1.903	0.130	0.539	2.831
82	0	2.875	6658	1.1	2.9	6676	2.114	0.048	0.539	2.831
83	0	2.875	35689	1.1	2.875	35706	2.238	0.000	0.539	2.819
84	0	2.95	6867	1	3.1	6887	1.730	0.259	0.490	2.966
85	0	2.975	45887	1.1	3.05	45906	2.003	0.137	0.539	2.953
86	0	3.05	25151	1.1	3.175	25172	1.812	0.206	0.539	3.051
87	0	3.05	35425	1.1	3.1	35450	1.522	0.069	0.539	3.015
88	0	3.075	35439	1.1	3.25	35463	1.586	0.252	0.539	3.100
89	0	3.075	35546	1.1	3.3	35568	1.730	0.354	0.539	3.125
90	0.05	3.1	16848	1.1	3.3	16868	1.816	0.346	0.564	3.137
91	0	3.175	25284	0.8	3.15	25302	1.538	-0.048	0.392	3.100
92	0	3.175	25529	1.1	3.225	25554	1.522	0.069	0.539	3.137
93	0	3.175	55034	0.8	3.275	55050	1.730	0.216	0.392	3.162
94	0	3.275	16897	0.7	3.375	16917	1.211	0.173	0.343	3.260
95	0	3.275	17217	0.6	3.275	17229	1.730	0.000	0.294	3.211
96	0.275	3.425	55472	0.1	3.55	55516	-0.138	0.098	0.184	3.419
97	0.3	3.5	16139	0.075	3.525	16172	-0.236	0.026	0.184	3.444
98	0.825	3.55	19884	0.175	3.75	19968	-0.268	0.082	0.490	3.578
99	0.5	3.55	25663	0.1	3.85	25745	-0.169	0.127	0.294	3.627
100	0.7	3.6	17339	0.15	3.7	17444	-0.181	0.033	0.417	3.578
101	0.7	3.6	17369	0.1	3.675	17438	-0.301	0.038	0.392	3.566
102	0.575	3.625	18272	0.1	3.65	18320	-0.342	0.018	0.331	3.566
103	0.5	3.7	13357	0.1	3.825	13447	-0.154	0.048	0.294	3.689
104	0.55	3.725	10988	0.1	3.825	11056	-0.229	0.051	0.319	3.701
105	0.7	3.725	17014	0.05	3.8	17124	-0.204	0.024	0.368	3.689
106	0.8	3.775	11258	0.3	3.825	11318	-0.288	0.029	0.539	3.725
107	0.5	3.825	7348	0.1	3.8	7460	-0.124	-0.008	0.294	3.738
108	0.5	3.825	12557	0.1	3.825	12643	-0.161	0.000	0.294	3.750

Notes:
(1) Measurement Number
(2) 1st X-Position
(3) 1st Y-Position
(4) 1st Frame
(5) 2nd X-Position
(6) 2nd Y-Position
(7) 2nd Frame
(8) Velocity in X-direction
(9) Velocity in Y-direction
(10) Average X-Position
(11) Average Y-Position

Table 28: HW 1.15P TW 0.79P, Unmodified Simulation Spillway

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	0.7	0.15	44993	0.15	0.35	45088	-0.200	0.073	-0.270	0.245
2	0.7	0.15	45914	0.1	0.2	46003	-0.233	0.019	-0.294	0.172
3	0.475	0.15	49486	0.075	0.25	49554	-0.203	0.051	-0.196	0.196
4	0.6	0.2	42250	0.12	0.15	42305	-0.302	-0.031	-0.235	0.172
5	0.5	0.25	41948	0.075	0.375	41984	-0.408	0.120	-0.208	0.306
6	0.6	0.25	42606	0.1	0.3	42685	-0.219	0.022	-0.245	0.270
7	0.6	0.275	43004	0.075	0.375	43072	-0.267	0.051	-0.257	0.319
8	0.6	0.3	43689	0.15	0.35	43750	-0.255	0.028	-0.221	0.319
9	0.6	0.35	39931	0.125	0.25	39976	-0.365	-0.077	-0.233	0.294
10	0.7	0.425	37683	0.05	0.4	37736	-0.424	-0.016	-0.319	0.404
11	0.7	0.425	39917	0.075	0.25	39971	-0.400	-0.112	-0.306	0.331
12	0.7	0.45	39001	0.15	0.45	39053	-0.366	0.000	-0.270	0.441
13	0.7	0.5	38712	0.075	0.5	38767	-0.393	0.000	-0.306	0.490
14	0.675	0.55	38534	0.05	0.525	38581	-0.460	-0.018	-0.306	0.527
15	0.6	0.55	40912	0.05	0.325	40967	-0.346	-0.142	-0.270	0.429
16	0.6	0.575	38022	0.1	0.4	38082	-0.288	-0.101	-0.245	0.478
17	0.7	0.6	37835	0.05	0.425	37896	-0.369	-0.099	-0.319	0.502
18	0.7	0.6	38013	0.1	0.4	38080	-0.310	-0.103	-0.294	0.490
19	0.7	0.7	38368	0.075	0.425	38427	-0.366	-0.161	-0.306	0.551
20	0.8	0.75	37521	0.05	0.725	37595	-0.351	-0.012	-0.368	0.723
21	0.6	0.75	38214	0.1	0.5	38257	-0.402	-0.201	-0.245	0.613
22	0.6	0.8	37924	0.05	0.675	37971	-0.405	-0.092	-0.270	0.723
23	0.7	0.825	39717	0.05	0.7	39777	-0.375	-0.072	-0.319	0.748
24	0.8	0.85	37521	0.05	0.65	37585	-0.405	-0.108	-0.368	0.735
25	0.7	0.925	28232	0.075	0.725	28282	-0.432	-0.138	-0.306	0.809
26	0.7	0.925	30149	0.05	0.8	30204	-0.409	-0.079	-0.319	0.846
27	0.7	0.95	28055	0.125	0.75	28117	-0.321	-0.112	-0.282	0.833
28	0.7	1.025	27919	0.075	0.95	27968	-0.441	-0.053	-0.306	0.968
29	0.6	1.05	29420	0.05	1.05	29473	-0.359	0.000	-0.270	1.029
30	0.65	1.05	29927	0.05	0.95	29978	-0.407	-0.068	-0.294	0.980
31	0.7	1.075	29568	0.1	1.05	29608	-0.519	-0.022	-0.294	1.042
32	0.7	1.15	29134	0.05	1.05	29181	-0.478	-0.074	-0.319	1.078
33	0.6	1.15	30380	0.1	1.05	30430	-0.346	-0.069	-0.245	1.078
34	0.6	1.175	27500	0.1	1	27548	-0.360	-0.126	-0.245	1.066
35	0.7	1.225	26859	0.05	1	26919	-0.375	-0.130	-0.319	1.091
36	0.6	1.225	28960	0.1	0.95	28993	-0.524	-0.288	-0.245	1.066
37	0.65	1.275	27806	0.05	1.175	27857	-0.407	-0.068	-0.294	1.201
38	0.675	1.35	27351	0.075	1.275	27391	-0.519	-0.065	-0.294	1.287
39	0.65	1.35	28934	0.075	1.025	28976	-0.474	-0.268	-0.282	1.164

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.7	1.4	27631	0.075	1.25	27684	-0.408	-0.098	-0.306	1.299
41	0.7	1.45	28572	0.05	1.4	28616	-0.511	-0.039	-0.319	1.397
42	0.6	1.45	29262	0.05	1.4	29301	-0.488	-0.044	-0.270	1.397
43	0.7	1.5	26556	0.1	1.3	26618	-0.335	-0.112	-0.294	1.373
44	0.675	1.525	26805	0.1	1.3	26855	-0.398	-0.156	-0.282	1.385
45	0.6	1.55	39395	0.1	1.5	39434	-0.444	-0.044	-0.245	1.495
46	0.7	1.6	38279	0.075	1.5	38324	-0.480	-0.077	-0.306	1.520
47	0.6	1.625	39053	0.05	1.675	39092	-0.488	0.044	-0.270	1.618
48	0.6	1.625	39243	0.05	1.675	39281	-0.501	0.046	-0.270	1.618
49	0.7	1.675	26175	0.05	1.675	26232	-0.394	0.000	-0.319	1.642
50	0.7	1.7	25992	0.05	1.7	26066	-0.304	0.000	-0.319	1.667
51	0.7	1.75	26163	0.05	1.775	26212	-0.459	0.018	-0.319	1.728
52	0.7	1.8	19406	0.05	1.675	19463	-0.394	-0.076	-0.319	1.703
53	0.8	1.8	25171	0.05	1.65	25243	-0.360	-0.072	-0.368	1.691
54	0.7	1.85	25623	0.1	1.9	25673	-0.415	0.035	-0.294	1.838
55	0.7	1.9	25738	0.05	2	25790	-0.432	0.067	-0.319	1.912
56	0.725	1.925	25765	0.1	2.05	25826	-0.354	0.071	-0.306	1.949
57	0.6	1.95	25118	0.05	2.05	25164	-0.414	0.075	-0.270	1.961
58	0.775	1.975	26995	0.075	1.875	27078	-0.292	-0.042	-0.343	1.887
59	0.6	2	14191	0.075	2	14249	-0.313	0.000	-0.257	1.961
60	0.7	2.05	13464	0.1	2.025	13509	-0.461	-0.019	-0.294	1.998
61	0.6	2.1	14423	0.05	2	14471	-0.396	-0.072	-0.270	2.010
62	0.7	2.1	19095	0.05	1.9	19148	-0.424	-0.131	-0.319	1.961
63	0.6	2.15	14530	0	2.25	14584	-0.384	0.064	-0.294	2.157
64	0.7	2.225	20087	0.05	2.325	20148	-0.369	0.057	-0.319	2.230
65	0.6	2.25	13660	0.1	2.2	13709	-0.353	-0.035	-0.245	2.181
66	0.6	2.25	14007	0.05	2.15	14058	-0.373	-0.068	-0.270	2.157
67	0.6	2.325	15675	0.1	2.35	15713	-0.455	0.023	-0.245	2.292
68	0.6	2.325	15726	0.05	2.3	15772	-0.414	-0.019	-0.270	2.267
69	0.6	2.35	13663	0.05	2.4	13702	-0.488	0.044	-0.270	2.328
70	0.6	2.4	16012	0.1	2.4	16058	-0.376	0.000	-0.245	2.353
71	0.6	2.45	15740	0.075	2.5	15782	-0.432	0.041	-0.257	2.426
72	0.675	2.45	15837	0.05	2.275	15878	-0.527	-0.148	-0.306	2.316
73	0.7	2.475	11695	0.025	2.625	11744	-0.477	0.106	-0.331	2.500
74	0.65	2.5	16073	0.075	2.575	16117	-0.452	0.059	-0.282	2.488
75	0.6	2.55	15874	0.05	2.45	15912	-0.501	-0.091	-0.270	2.451
76	0.7	2.575	16178	0.025	2.8	16244	-0.354	0.118	-0.331	2.635
77	0.8	2.575	16914	0.05	2.9	16980	-0.393	0.170	-0.368	2.684
78	0.4	2.625	13280	0.1	2.675	13306	-0.399	0.067	-0.147	2.598
79	0.65	2.675	15833	0.05	2.725	15867	-0.610	0.051	-0.294	2.647

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.7	2.75	11533	0.075	2.875	11596	-0.343	0.069	-0.306	2.757
81	0.7	2.75	16143	0.05	3.25	16209	-0.341	0.262	-0.319	2.941
82	0.8	2.775	11944	0	3.05	12013	-0.401	0.138	-0.392	2.855
83	0.5	2.825	5153	0.05	2.8	5188	-0.445	-0.025	-0.221	2.757
84	0.7	2.85	11867	0.05	3.075	11930	-0.357	0.124	-0.319	2.904
85	0.7	2.9	8947	0.1	3.15	9001	-0.384	0.160	-0.294	2.966
86	0.6	2.95	7749	0.05	3.175	7790	-0.464	0.190	-0.270	3.002
87	0.7	2.95	8762	0.075	3.3	8825	-0.343	0.192	-0.306	3.064
88	0.7	2.975	5530	0.05	3	5596	-0.341	0.013	-0.319	2.929
89	0.8	3	7803	0.1	3.225	7857	-0.448	0.144	-0.343	3.051
90	0.6	3.025	7759	0.05	3.2	7799	-0.476	0.151	-0.270	3.051
91	0.7	3.15	6990	0.05	3.35	7047	-0.394	0.121	-0.319	3.186
92	0.65	3.15	7147	0.075	3.55	7215	-0.293	0.203	-0.282	3.284
93	0.7	3.15	7257	0.05	3.425	7321	-0.351	0.149	-0.319	3.223
94	0.75	3.225	5871	0.05	3.15	5939	-0.356	-0.038	-0.343	3.125
95	0.6	3.25	6557	0.05	3.375	6613	-0.340	0.077	-0.270	3.248
96	0.675	3.25	6696	0.05	3.4	6755	-0.366	0.088	-0.306	3.260
97	0.75	3.3	5873	0.025	3.3	5937	-0.392	0.000	-0.355	3.235
98	0.7	3.325	5862	0.025	3.4	5927	-0.359	0.040	-0.331	3.297
99	0.4	3.35	5681	0.05	3.5	5704	-0.526	0.226	-0.172	3.358
100	0.6	3.45	5989	0	3.55	6043	-0.384	0.064	-0.294	3.431
101	0.75	3.45	6097	0.05	3.65	6183	-0.282	0.080	-0.343	3.480
102	0.775	3.45	6543	0.05	3.35	6625	-0.306	-0.042	-0.355	3.333
103	0.6	3.55	6125	0.05	3.575	6203	-0.244	0.011	-0.270	3.493
104	0.5	3.55	5939	0.025	3.55	5979	-0.411	0.000	-0.233	3.480
105	0.75	3.55	6619	0.025	3.5	6680	-0.411	-0.028	-0.355	3.456
106	0.75	3.65	6309	0	3.55	6383	-0.351	-0.047	-0.368	3.529
107	0.75	3.65	6616	0.075	3.6	6680	-0.365	-0.027	-0.331	3.554
108	0.725	3.65	7439	0.1	3.55	7529	-0.240	-0.038	-0.306	3.529
109	0.9	3.675	6168	0.05	3.65	6291	-0.239	-0.007	-0.417	3.591
110	0.55	3.7	5776	0.15	3.75	5844	-0.203	0.025	-0.196	3.652
111	0.825	3.7	6085	0.05	3.575	6204	-0.225	-0.036	-0.380	3.566

Notes: (1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

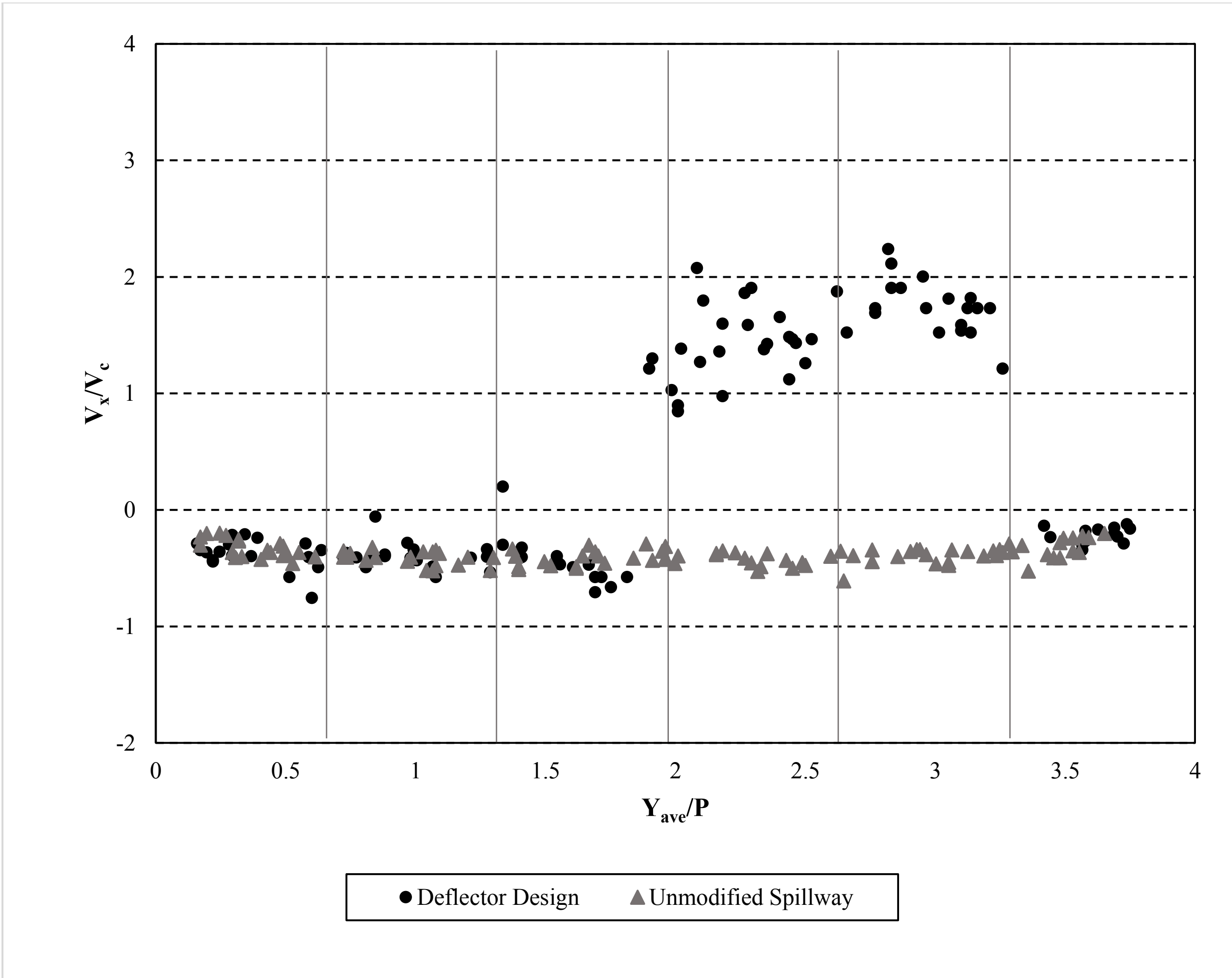

Figure 35: HW 1.15P TW 0.79P, Design Simulations Results

Table 29: HW 1.15P TW 1.03P, Multiple Staggered Deflector Design

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	0.4	0.2	63622	0.1	0.275	63659	-0.280	0.070	0.245	0.233
2	0.1	0.25	78194	0.6	0.3	78231	0.467	0.047	0.343	0.270
3	0.1	0.3	79581	0	0.325	79599	-0.192	0.048	0.049	0.306
4	0.4	0.325	70450	0.05	0.25	70478	-0.432	-0.093	0.221	0.282
5	0.3	0.35	41884	0.05	0.25	41912	-0.309	-0.124	0.172	0.294
6	0.3	0.45	82128	0.1	0.35	82141	-0.532	-0.266	0.196	0.392
7	0.35	0.55	57496	0.05	0.4	57532	-0.288	-0.144	0.196	0.466
8	0.15	0.55	81697	0.025	0.525	81715	-0.240	-0.048	0.086	0.527
9	0.3	0.575	57817	0.1	0.45	57832	-0.461	-0.288	0.196	0.502
10	0.125	0.625	55452	0.025	0.7	55470	-0.192	0.144	0.074	0.650
11	0.275	0.65	1458	0.05	0.55	1488	-0.259	-0.115	0.159	0.588
12	0.2	0.725	72830	0.05	0.6	72851	-0.247	-0.206	0.123	0.650
13	0.2	0.75	57276	0.1	0.2	57300	-0.144	-0.793	0.147	0.466
14	0.15	0.775	19425	0.075	0.775	19461	-0.072	0.000	0.110	0.760
15	0.15	0.8	13297	0.05	0.7	13321	-0.144	-0.144	0.098	0.735
16	0.175	0.8	61649	0.05	0.575	61677	-0.154	-0.278	0.110	0.674
17	0.1	0.925	1068	0.8	0.8	1109	0.591	-0.105	0.441	0.846
18	0.15	0.95	27911	0.6	0.925	27942	0.502	-0.028	0.368	0.919
19	0.15	0.95	28047	0.05	0.925	28071	-0.144	-0.036	0.098	0.919
20	0.05	1	65367	0.55	0.8	65393	0.665	-0.266	0.294	0.882
21	0.075	1.05	49507	0.6	0.975	49538	0.586	-0.084	0.331	0.993
22	0.1	1.125	64709	0.6	1	64742	0.524	-0.131	0.343	1.042
23	0.15	1.15	57070	0.6	0.525	57109	0.399	-0.554	0.368	0.821
24	0.1	1.15	57376	0.7	1	57419	0.483	-0.121	0.392	1.054
25	0.2	1.175	3745	1.1	0.925	3785	0.778	-0.216	0.637	1.029
26	0.175	1.2	27193	0.6	1.1	27210	0.865	-0.203	0.380	1.127
27	0.2	1.25	19424	0.6	1.45	19434	1.384	0.692	0.392	1.324
28	0.1	1.325	27757	0.6	1.05	27776	0.910	-0.501	0.343	1.164
29	0.075	1.35	33751	0.6	1.025	33779	0.649	-0.402	0.331	1.164
30	0.1	1.375	19076	0.6	1.25	19099	0.752	-0.188	0.343	1.287
31	0.2	1.45	41796	0.7	0.325	41814	0.961	-2.162	0.441	0.870
32	0.1	1.475	4893	0.6	1.425	4910	1.017	-0.102	0.343	1.422
33	0.1	1.475	5357	0.7	1.5	5377	1.038	0.043	0.392	1.458
34	0.15	1.65	11093	0.725	1.65	11108	1.326	0.000	0.429	1.618
35	0.1	1.65	16665	0.6	1.675	16680	1.153	0.058	0.343	1.630
36	0.1	1.7	1177	0.6	1.75	1209	0.541	0.054	0.343	1.691
37	0.1	1.75	16483	0.7	1.75	16499	1.297	0.000	0.392	1.716
38	0.125	1.825	5410	0.825	1.8	5428	1.345	-0.048	0.466	1.777
39	0.15	1.825	885	0.7	1.85	899	1.359	0.062	0.417	1.801

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.1	1.875	12820	0.7	1.875	12833	1.597	0.000	0.392	1.838
41	0.225	1.925	4901	0.8	1.95	4921	0.995	0.043	0.502	1.900
42	0.05	1.95	4757	0.6	2	4773	1.189	0.108	0.319	1.936
43	0.05	2.05	40960	0.3	2.55	40986	0.333	0.665	0.172	2.255
44	0.025	2.05	44844	0.5	2.4	44878	0.483	0.356	0.257	2.181
45	0.2	2.1	26272	0.05	2.525	26308	-0.144	0.408	0.123	2.267
46	0.175	2.15	8589	0.05	2.5	8613	-0.180	0.505	0.110	2.279
47	0.25	2.15	10792	0.075	2.7	10848	-0.108	0.340	0.159	2.377
48	0.2	2.175	16242	0.075	2.45	16261	-0.228	0.501	0.135	2.267
49	0.275	2.25	80797	0.075	2.75	80854	-0.121	0.303	0.172	2.451
50	0.25	2.25	81121	0.05	2.9	81168	-0.147	0.478	0.147	2.525
51	0.2	2.25	10524	0.05	3.15	10550	-0.200	1.197	0.123	2.647
52	0.25	2.35	77708	0.075	2.725	77742	-0.178	0.382	0.159	2.488
53	0.225	2.45	71979	0.05	2.575	72011	-0.189	0.135	0.135	2.463
54	0.2	2.45	72354	0.075	2.85	72385	-0.139	0.446	0.135	2.598
55	0.575	2.475	70307	0.05	2.9	70354	-0.386	0.313	0.306	2.635
56	0.325	2.55	47050	0.1	2.95	47089	-0.200	0.355	0.208	2.696
57	0.2	2.55	57894	0.025	2.525	57912	-0.336	-0.048	0.110	2.488
58	0.275	2.55	65078	0.05	2.9	65115	-0.210	0.327	0.159	2.672
59	0.325	2.6	44908	0.025	2.875	44946	-0.273	0.250	0.172	2.684
60	0.325	2.625	59208	0.075	3.025	59252	-0.197	0.314	0.196	2.770
61	0.275	2.65	58869	0.05	3.25	58919	-0.156	0.415	0.159	2.892
62	0.45	2.725	63592	0.1	3.3	63698	-0.114	0.188	0.270	2.953
63	0.175	2.75	3501	0.025	3.075	3544	-0.121	0.261	0.098	2.855
64	0.25	2.75	45033	0.075	2.975	45070	-0.164	0.210	0.159	2.806
65	0.425	2.85	65720	0.125	3.225	65778	-0.179	0.224	0.270	2.978
66	0.325	2.875	53616	0.05	3.2	53662	-0.207	0.244	0.184	2.978
67	0.325	2.9	26090	0.1	3.25	26129	-0.200	0.310	0.208	3.015
68	0.225	2.95	26320	0.025	3.1	26352	-0.216	0.162	0.123	2.966
69	0.3	3.025	26083	0.05	3.375	26149	-0.131	0.183	0.172	3.137
70	0.3	3.05	3318	0.25	3.45	3388	-0.025	0.198	0.270	3.186
71	0.225	3.05	41054	0.025	3.175	41082	-0.247	0.154	0.123	3.051
72	0.225	3.075	25816	0.125	3.175	25839	-0.150	0.150	0.172	3.064
73	0.275	3.1	26076	0.075	3.4	26131	-0.126	0.189	0.172	3.186
74	0.475	3.15	26266	0.1	3.375	26322	-0.232	0.139	0.282	3.199
75	0.475	3.2	40681	0.075	3.45	40778	-0.143	0.089	0.270	3.260
76	0.3	3.25	30689	0.05	3.375	30757	-0.127	0.064	0.172	3.248
77	0.2	3.25	40928	0.5	-1.8	40961	0.314	-5.294	0.343	0.711
78	0.5	3.3	19494	0.1	3.5	19607	-0.122	0.061	0.294	3.333
79	0.275	3.325	26293	0.05	3.425	26334	-0.190	0.084	0.159	3.309

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.35	3.35	15304	0.05	3.55	15360	-0.185	0.124	0.196	3.382
81	0.375	3.35	30612	0.075	3.6	30720	-0.096	0.080	0.221	3.407
82	0.525	3.425	3368	0.1	3.55	3468	-0.147	0.043	0.306	3.419
83	0.4	3.45	12880	0.15	3.6	12944	-0.135	0.081	0.270	3.456
84	0.3	3.475	10519	0.025	3.55	10563	-0.216	0.059	0.159	3.444
85	0.8	3.525	3790	0.1	3.7	3932	-0.171	0.043	0.441	3.542
86	0.375	3.55	4195	0.1	3.625	4256	-0.156	0.043	0.233	3.517
87	0.4	3.575	4609	0.15	3.65	4662	-0.163	0.049	0.270	3.542
88	0.375	3.625	5163	0.1	3.725	5237	-0.129	0.047	0.233	3.603
89	0.4	3.65	4663	0.05	3.55	4710	-0.258	-0.074	0.221	3.529
90	0.4	3.675	3653	0.1	3.625	3735	-0.127	-0.021	0.245	3.578
91	0.5	3.725	3487	0.1	3.65	3565	-0.177	-0.033	0.294	3.615
92	0.5	3.725	6111	0.075	3.675	6180	-0.213	-0.025	0.282	3.627
93	0.275	3.725	4437	0.075	3.725	4494	-0.121	0.000	0.172	3.652

Notes: (1) Measurement Number
(2) 1st X-Position
(3) 1st Y-Position
(4) 1st Frame
(5) 2nd X-Position
(6) 2nd Y-Position
(7) 2nd Frame
(8) Velocity in X-direction
(9) Velocity in Y-direction
(10) Average X-Position
(11) Average Y-Position

Table 30: HW 1.15P TW 1.03P, Unmodified Spillway Design

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	x_1 [ft]	y_1 [ft]	$Frame_1$	x_2 [ft]	y_2 [ft]	$Frame_2$	V_x/V_c	V_y/V_c	x_{ave}/P	y_{ave}/P
1	0.8	0.35	39036	0.3	0.25	39307	-0.064	-0.013	-0.245	0.294
2	0.6	0.35	39036	0.1	0.65	39554	-0.033	0.020	-0.245	0.490
3	0.4	0.35	40839	0.1	0.2	40954	-0.090	-0.045	-0.147	0.270
4	0.4	0.35	41064	0.1	0.25	41151	-0.119	-0.040	-0.147	0.294
5	0.6	0.45	36499	0.1	0.25	36658	-0.109	-0.044	-0.245	0.343
6	0.7	0.45	37934	0.1	0.3	38144	-0.099	-0.025	-0.294	0.368
7	0.4	0.45	38224	0.1	0.35	38285	-0.170	-0.057	-0.147	0.392
8	1	0.45	39036	0.1	0.45	39554	-0.060	0.000	-0.441	0.441
9	0.8	0.45	39575	0.2	0.35	40083	-0.041	-0.007	-0.294	0.392
10	0.7	0.55	36175	0.1	0.25	36396	-0.094	-0.047	-0.294	0.392
11	0.8	0.55	37046	0.1	0.35	37271	-0.108	-0.031	-0.343	0.441
12	0.7	0.55	37593	0.1	0.45	37703	-0.189	-0.031	-0.294	0.490
13	0.4	0.55	37828	0.1	0.45	37909	-0.128	-0.043	-0.147	0.490
14	1	0.55	37927	0.1	0.35	38134	-0.150	-0.033	-0.441	0.441
15	0.6	0.65	29182	0.5	0.45	29258	-0.046	-0.091	-0.049	0.539
16	0.9	0.65	35203	0.1	0.25	35500	-0.093	-0.047	-0.392	0.441
17	1.1	0.65	37323	0.1	0.75	37547	-0.154	0.015	-0.490	0.686
18	0.4	0.65	37593	0.1	0.45	37703	-0.094	-0.063	-0.147	0.539
19	1.1	0.65	38285	0.1	0.35	38482	-0.176	-0.053	-0.490	0.490
20	0.9	0.75	29331	0.3	0.35	29558	-0.091	-0.061	-0.294	0.539
21	1	0.75	37320	0.1	0.75	37536	-0.144	0.000	-0.441	0.735
22	0.6	0.75	37828	0.1	0.7	37909	-0.214	-0.021	-0.245	0.711
23	0.9	0.85	34896	0.1	0.45	35055	-0.174	-0.087	-0.392	0.637
24	0.7	0.85	36727	0.1	0.85	36938	-0.098	0.000	-0.294	0.833
25	0.7	0.85	36727	0.1	0.75	36938	-0.098	-0.016	-0.294	0.784
26	0.6	0.95	28975	0.1	0.75	29140	-0.105	-0.042	-0.245	0.833
27	0.65	0.95	28975	0.1	0.75	29140	-0.115	-0.042	-0.270	0.833
28	1.1	0.95	30214	0.1	0.25	30514	-0.115	-0.081	-0.490	0.588
29	0.8	1	31327	0.3	0.25	31548	-0.078	-0.117	-0.245	0.613
30	1.1	1.05	29377	0.1	0.65	29692	-0.110	-0.044	-0.490	0.833
31	0.5	1.05	38667	0.1	1.15	38755	-0.157	0.039	-0.196	1.078
32	0.6	1.15	22925	0.1	1	23090	-0.105	-0.031	-0.245	1.054
33	1	1.15	23090	0.1	1.15	23261	-0.182	0.000	-0.441	1.127
34	1.1	1.15	30275	0.1	0.35	30561	-0.121	-0.097	-0.490	0.735
35	0.5	1.25	22618	0.1	1.15	22746	-0.108	-0.027	-0.196	1.176
36	0.5	1.25	27293	0.1	0.75	27423	-0.106	-0.133	-0.196	0.980
37	1	1.25	28095	0.1	0.25	28243	-0.210	-0.234	-0.441	0.735
38	0.6	1.35	22746	0.1	1.25	22925	-0.097	-0.019	-0.245	1.275
39	0.8	1.35	27822	0.1	1.45	27990	-0.144	0.021	-0.343	1.373

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.6	1.35	34410	0.1	1.45	34561	-0.115	0.023	-0.245	1.373
41	0.6	1.45	27152	0.1	1.35	27258	-0.163	-0.033	-0.245	1.373
42	0.8	1.45	29922	0.1	1.15	30117	-0.124	-0.053	-0.343	1.275
43	0.8	1.45	34609	0.1	1.65	34764	-0.156	0.045	-0.343	1.520
44	0.8	1.5	29558	0.3	1.65	29692	-0.129	0.039	-0.245	1.544
45	0.7	1.55	22238	0.1	1.3	22431	-0.108	-0.045	-0.294	1.397
46	1	1.55	31095	0.1	1.3	31243	-0.210	-0.058	-0.441	1.397
47	0.45	1.65	22441	0.1	1.35	22610	-0.072	-0.061	-0.172	1.471
48	0.6	1.65	26947	0.1	1.45	27081	-0.129	-0.052	-0.245	1.520
49	0.6	1.65	26948	0.1	1.55	27114	-0.104	-0.021	-0.245	1.569
50	0.7	1.75	26870	0.1	1.65	27081	-0.098	-0.016	-0.294	1.667
51	0.7	1.75	28769	0.1	1.15	28904	-0.154	-0.154	-0.294	1.422
52	1	1.75	29748	0.1	1.15	29917	-0.184	-0.123	-0.441	1.422
53	0.5	1.8	6544	0.1	1.65	6609	-0.213	-0.080	-0.196	1.691
54	0.8	1.85	5871	0.1	2	6190	-0.076	0.016	-0.343	1.887
55	0.7	1.85	6340	0.1	1.95	6537	-0.105	0.018	-0.294	1.863
56	0.2	1.95	5798	0.05	1.95	5818	-0.259	0.000	-0.074	1.912
57	1	1.95	23104	0.1	2.25	23284	-0.173	0.058	-0.441	2.059
58	0.7	1.95	26323	0.1	2.15	26454	-0.158	0.053	-0.294	2.010
59	0.6	2.05	26462	0.1	1.75	26611	-0.116	-0.070	-0.245	1.863
60	0.8	2.05	26462	0.1	1.85	26696	-0.103	-0.030	-0.343	1.912
61	1	2.05	26462	0.1	1.75	26739	-0.112	-0.037	-0.441	1.863
62	0.8	2.15	26054	0.1	1.95	26239	-0.131	-0.037	-0.343	2.010
63	1	2.15	26054	0.1	2	26313	-0.120	-0.020	-0.441	2.034
64	0.8	2.15	26054	0.1	1.95	26278	-0.108	-0.031	-0.343	2.010
65	0.7	2.25	15985	0.1	2.15	16165	-0.115	-0.019	-0.294	2.157
66	0.8	2.25	24244	0.1	2.25	24548	-0.080	0.000	-0.343	2.206
67	0.7	2.25	25932	0.1	2.3	26024	-0.226	0.019	-0.294	2.230
68	0.8	2.3	25450	0.1	2.35	25712	-0.092	0.007	-0.343	2.279
69	0.4	2.35	24638	0.1	2.35	24707	-0.150	0.000	-0.147	2.304
70	0.7	2.35	25290	0.1	2.3	25427	-0.152	-0.013	-0.294	2.279
71	0.7	2.45	14460	0.1	2.65	14643	-0.113	0.038	-0.294	2.500
72	1	2.45	16135	0.1	2.05	16408	-0.114	-0.051	-0.441	2.206
73	0.4	2.45	24748	0.1	2.35	24810	-0.167	-0.056	-0.147	2.353
74	1	2.5	7919	0.05	3.25	8202	-0.116	0.092	-0.466	2.819
75	0.2	2.55	5700	0.05	2.65	5736	-0.144	0.096	-0.074	2.549
76	0.3	2.55	6207	0.05	2.7	6335	-0.068	0.041	-0.123	2.574
77	0.65	2.6	5864	0.1	2.55	6005	-0.135	-0.012	-0.270	2.525
78	0.6	2.65	18129	0.1	2.95	18340	-0.082	0.049	-0.245	2.745
79	1.05	2.65	19688	0.1	2.55	19927	-0.138	-0.014	-0.466	2.549

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.45	2.7	5680	0.1	2.95	5776	-0.126	0.090	-0.172	2.770
81	1	2.7	23915	0.1	2.25	24225	-0.100	-0.050	-0.441	2.426
82	0.4	2.75	23513	0.1	2.85	23609	-0.108	0.036	-0.147	2.745
83	0.4	2.85	16408	0.1	2.75	16468	-0.173	-0.058	-0.147	2.745
84	1	2.85	18653	0.3	3.65	18955	-0.080	0.092	-0.343	3.186
85	0.3	2.85	20002	0.1	2.95	20028	-0.266	0.133	-0.098	2.843
86	1.1	2.9	14840	0.5	2.8	15041	-0.103	-0.017	-0.294	2.794
87	0.5	2.9	15623	0.1	2.85	15721	-0.141	-0.018	-0.196	2.819
88	0.4	2.95	14840	0.1	3	14893	-0.196	0.033	-0.147	2.917
89	0.3	3.05	6612	0.1	3.65	6705	-0.074	0.223	-0.098	3.284
90	0.6	3.05	7159	0.1	3.75	7337	-0.097	0.136	-0.245	3.333
91	0.4	3.05	14108	0.1	3	14224	-0.089	-0.015	-0.147	2.966
92	0.8	3.15	11874	0.1	3.4	12035	-0.150	0.054	-0.343	3.211
93	0.8	3.15	13149	0.1	2.65	13267	-0.205	-0.147	-0.343	2.843
94	0.6	3.15	13470	0.1	2.95	13600	-0.133	-0.053	-0.245	2.990
95	0.6	3.25	9054	0.05	3.2	9185	-0.145	-0.013	-0.270	3.162
96	0.4	3.25	9054	0.1	0.45	9172	-0.088	-0.821	-0.147	1.814
97	0.7	3.25	9228	0.1	3.35	9359	-0.158	0.026	-0.294	3.235
98	0.8	3.3	11631	0.1	3.75	11863	-0.104	0.067	-0.343	3.456
99	0.9	3.35	11631	0.05	3.65	11863	-0.127	0.045	-0.417	3.431
100	0.25	3.35	12086	0.1	3.55	12132	-0.113	0.150	-0.074	3.382
101	0.8	3.45	6791	0.3	3.35	7150	-0.048	-0.010	-0.245	3.333
102	0.6	3.45	8239	0.1	3.55	8395	-0.111	0.022	-0.245	3.431
103	0.6	3.45	10796	0.3	3.65	10922	-0.082	0.055	-0.147	3.480
104	0.35	3.5	8642	0.1	3.75	8730	-0.098	0.098	-0.123	3.554
105	0.5	3.55	8484	0.1	3.75	8608	-0.112	0.056	-0.196	3.578
106	0.6	3.55	9373	0.1	3.75	9705	-0.052	0.021	-0.245	3.578
107	0.6	3.6	8761	0.2	3.75	9046	-0.049	0.018	-0.196	3.603
108	0.6	3.65	7355	0.1	3.75	7581	-0.077	0.015	-0.245	3.627
109	0.45	3.65	10145	0.2	3.65	10352	-0.042	0.000	-0.123	3.578
110	0.4	0.35	41169	0.1	0.25	41249	-0.130	-0.043	-0.147	0.294

Notes: (1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

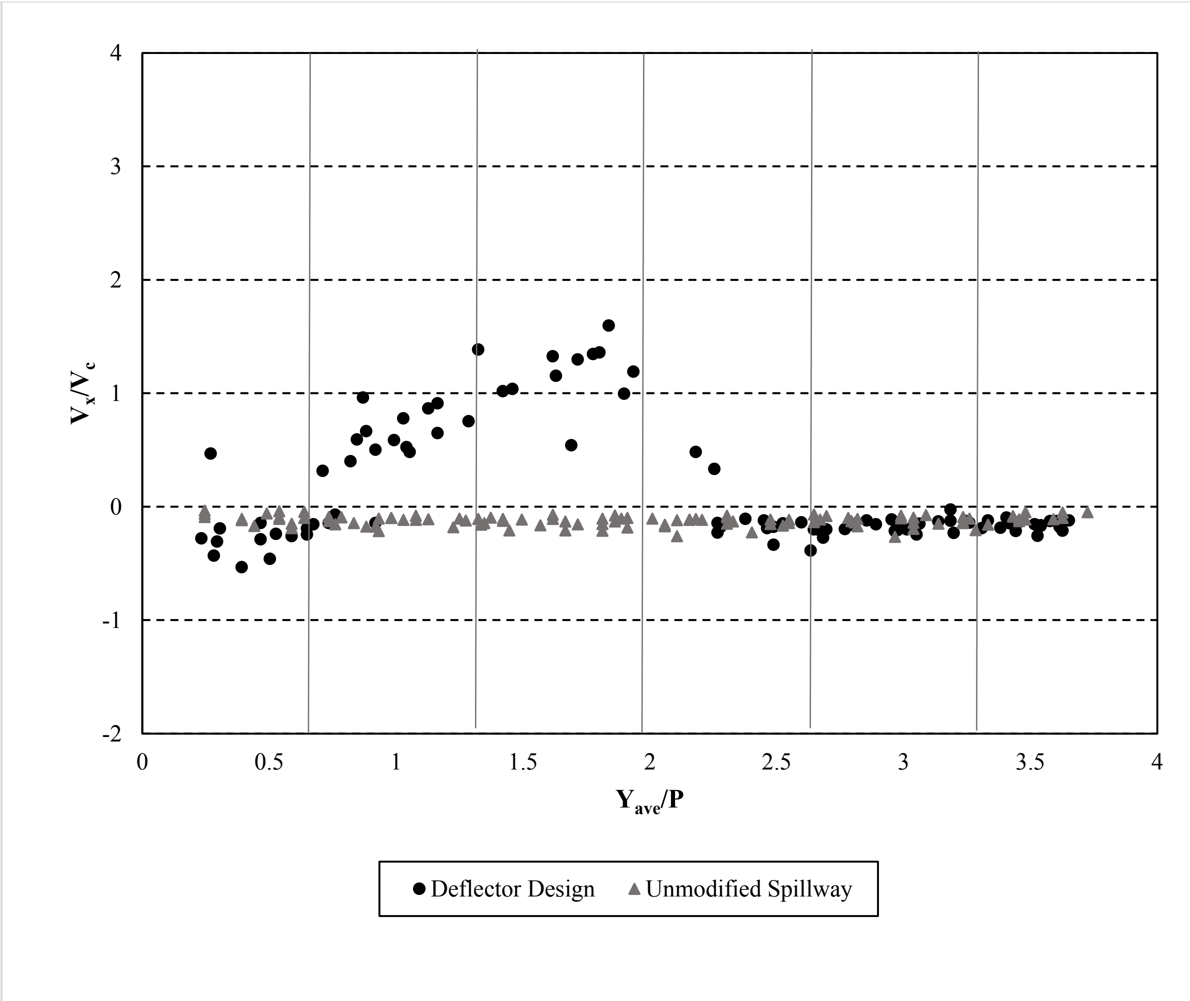

Figure 36: HW 1.15P TW 1.03P, Design Simulation Results

Table 31: HW 1.10P TW 0.16P, Multiple Staggered Deflector Design Simulation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	0.1	0.4	15929	0.9	0.4	15958	1.215	0.000	0.490	0.343
2	0.1	0.5	9546	1.0	0.5	9584	1.072	0.000	0.527	0.441
3	0.0	0.5	15068	1.1	0.2	15185	0.414	-0.104	0.539	0.306
4	0.0	0.5	62031	1.0	0.5	62058	1.631	0.000	0.490	0.441
5	0.0	0.5	62024	1.0	0.6	62058	1.231	0.130	0.466	0.515
6	0.0	0.5	10821	1.0	0.5	10878	0.773	-0.039	0.490	0.466
7	0.0	0.5	55935	1.0	0.3	55963	1.455	-0.354	0.478	0.380
8	0.0	0.6	2341	1.0	0.4	2380	1.129	-0.226	0.490	0.490
9	0.0	0.6	77189	1.0	0.3	77247	0.759	-0.247	0.490	0.429
10	0.0	0.7	62027	0.9	0.6	62082	0.721	-0.020	0.441	0.625
11	0.0	0.7	55943	1.0	0.9	55985	1.049	0.157	0.490	0.760
12	0.0	0.7	2338	1.1	0.3	2400	0.764	-0.337	0.551	0.478
13	0.0	0.7	54435	1.1	0.7	54489	0.877	-0.061	0.527	0.674
14	0.0	0.8	36615	1.0	0.8	36714	0.445	0.000	0.490	0.760
15	0.0	0.9	15595	0.9	0.7	15629	1.101	-0.162	0.441	0.772
16	0.0	0.9	36883	0.9	0.7	36927	0.901	-0.125	0.441	0.772
17	0.0	0.9	36278	0.8	0.9	36336	0.589	-0.019	0.404	0.895
18	0.0	1.0	10329	0.9	0.9	10369	0.991	-0.083	0.441	0.895
19	0.0	1.0	14292	0.9	0.9	14344	0.741	-0.064	0.429	0.895
20	0.0	1.0	37012	0.9	0.7	37065	0.706	-0.270	0.417	0.797
21	0.0	1.1	14190	0.9	0.7	14255	0.610	-0.220	0.441	0.870
22	0.0	1.1	36273	0.9	0.7	36336	0.577	-0.229	0.429	0.869
23	0.0	1.1	75150	1.0	0.8	75208	0.759	-0.209	0.490	0.919
24	0.5	1.2	27748	0.2	1.2	27786	-0.348	0.029	0.294	1.140
25	0.5	1.2	58790	0.2	1.1	58815	-0.529	-0.088	0.294	1.103
26	0.3	1.2	13977	0.1	1.3	14006	-0.266	0.228	0.184	1.225
27	0.5	1.2	84243	0.3	1.2	84293	-0.198	-0.044	0.380	1.152
28	0.0	1.2	9594	0.9	0.8	9657	0.612	-0.280	0.453	1.005
29	0.3	1.2	48295	0.1	3.3	48317	-0.400	4.205	0.221	2.230
30	0.4	1.3	62590	0.1	2.2	62621	-0.391	1.350	0.233	1.716
31	0.4	1.3	54226	0.1	1.3	54254	-0.393	0.000	0.221	1.250
32	0.0	1.3	24046	0.9	0.8	24132	0.448	-0.269	0.453	1.042
33	0.5	1.4	83535	0.3	1.1	83573	-0.290	-0.290	0.368	1.225
34	0.4	1.5	66462	0.1	1.3	66497	-0.378	-0.220	0.245	1.336
35	0.5	1.5	31663	0.5	1.1	31693	-0.073	-0.514	0.466	1.275
36	0.5	1.5	48414	0.3	1.1	48457	-0.205	-0.359	0.392	1.275
37	0.5	1.5	3421	0.2	1.2	3465	-0.300	-0.350	0.343	1.299
38	0.6	1.7	42722	0.4	1.1	42795	-0.106	-0.362	0.453	1.324
39	0.7	1.7	43588	0.3	1.9	43724	-0.130	0.065	0.441	1.716

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.4	1.7	47630	0.3	1.4	47660	-0.184	-0.404	0.355	1.483
41	0.4	1.8	2507	0.1	1.9	2551	-0.275	0.175	0.257	1.801
42	0.6	1.8	31489	0.5	1.7	31511	-0.200	-0.200	0.515	1.667
43	0.5	1.8	32730	0.2	2.1	32776	-0.287	0.311	0.343	1.875
44	0.6	1.8	51678	0.1	2.0	51764	-0.256	0.128	0.343	1.863
45	0.4	1.9	15663	0.0	1.9	15697	-0.518	0.000	0.196	1.814
46	0.6	1.9	42418	0.1	2.1	42507	-0.247	0.111	0.343	1.924
47	0.4	1.9	15328	0.1	1.8	15348	-0.606	-0.110	0.257	1.814
48	0.6	1.9	15894	0.1	2.2	15961	-0.312	0.197	0.331	2.010
49	0.6	2.0	15484	0.1	1.9	15555	-0.295	-0.016	0.331	1.900
50	0.6	2.0	23271	0.2	2.2	23306	-0.440	0.220	0.368	2.022
51	0.5	2.0	28549	0.2	2.0	28593	-0.350	0.025	0.319	1.949
52	0.6	2.0	55508	0.1	2.2	55557	-0.449	0.180	0.343	2.034
53	0.5	2.1	11875	0.1	2.0	11930	-0.340	-0.080	0.306	2.010
54	0.6	2.1	17020	0.1	2.4	17076	-0.393	0.177	0.343	2.194
55	0.5	2.2	68887	0.1	2.2	68936	-0.315	0.000	0.270	2.108
56	0.5	2.3	7801	0.2	2.5	7842	-0.349	0.242	0.355	2.316
57	0.4	2.3	15263	0.1	2.4	15305	-0.315	0.105	0.245	2.255
58	0.4	2.3	26743	0.1	2.3	26767	-0.551	0.092	0.270	2.230
59	0.5	2.3	67176	0.1	2.9	67240	-0.293	0.396	0.306	2.512
60	0.6	2.3	35096	0.2	2.2	35157	-0.307	-0.090	0.380	2.218
61	0.5	2.4	26603	0.1	2.5	26645	-0.393	0.105	0.282	2.353
62	0.5	2.4	21894	0.1	2.6	21932	-0.464	0.203	0.294	2.463
63	0.5	2.5	87429	0.1	2.7	87489	-0.294	0.147	0.270	2.500
64	0.5	2.5	41489	0.1	2.7	41548	-0.317	0.187	0.282	2.549
65	0.4	2.5	67622	0.0	2.7	67668	-0.335	0.168	0.172	2.537
66	0.5	2.6	69271	0.1	2.5	69322	-0.345	-0.065	0.294	2.463
67	0.6	2.6	16104	0.1	2.7	16171	-0.362	0.049	0.319	2.610
68	0.4	2.6	56884	0.2	2.8	56907	-0.479	0.287	0.270	2.647
69	0.6	2.6	67272	0.1	2.9	67321	-0.427	0.202	0.331	2.684
70	0.5	2.7	67809	0.1	2.8	67845	-0.489	0.184	0.245	2.696
71	0.4	2.7	14659	0.1	2.9	14689	-0.440	0.220	0.245	2.721
72	0.6	2.7	42555	0.1	2.9	42653	-0.236	0.090	0.355	2.770
73	0.6	2.8	34764	0.1	2.7	34822	-0.380	-0.038	0.343	2.696
74	0.6	2.8	14686	0.3	3.0	14722	-0.336	0.184	0.404	2.819
75	0.5	2.9	8505	0.1	3.1	8546	-0.430	0.269	0.294	2.917
76	0.5	3.0	49051	0.1	3.4	49100	-0.405	0.360	0.294	3.088
77	0.5	3.0	73561	0.2	3.0	73619	-0.266	0.057	0.319	2.929
78	0.4	3.0	35903	0.1	2.8	35942	-0.367	-0.198	0.233	2.806
79	0.5	3.0	27394	0.2	3.0	27452	-0.228	-0.057	0.319	2.929

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.6	3.0	93232	0.1	3.4	93318	-0.256	0.166	0.343	3.125
81	0.5	3.1	35448	0.1	2.9	35545	-0.170	-0.091	0.282	2.892
82	0.6	3.2	9258	0.2	3.2	9297	-0.508	0.085	0.392	3.125
83	0.6	3.2	14969	0.2	3.1	15008	-0.452	-0.028	0.392	3.076
84	0.6	3.2	21203	0.2	3.1	21246	-0.461	-0.026	0.368	3.076
85	0.6	3.2	9173	0.1	3.1	9228	-0.400	-0.040	0.343	3.088
86	0.6	3.3	18090	0.2	3.3	18132	-0.420	0.052	0.392	3.211
87	0.5	3.3	26739	0.1	3.4	26772	-0.534	0.133	0.294	3.235
88	0.6	3.3	8628	0.2	3.4	8684	-0.315	0.059	0.392	3.248
89	0.5	3.3	57228	0.2	3.5	57261	-0.467	0.234	0.319	3.297
90	0.5	3.3	68336	0.2	3.5	68376	-0.358	0.193	0.355	3.297
91	0.3	3.4	63140	0.0	3.5	63183	-0.333	0.077	0.159	3.346
92	0.3	3.4	24162	0.0	3.5	24184	-0.451	0.250	0.135	3.370
93	0.4	3.4	35624	0.2	3.5	35644	-0.496	0.330	0.282	3.382
94	0.6	3.5	89572	0.2	3.6	89619	-0.398	0.070	0.355	3.493
95	0.5	3.6	8304	0.2	3.5	8375	-0.202	-0.062	0.306	3.431

Notes:
(1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

Table 32: HW 1.10P TW 0.16P, Unmodified Spillway Simulation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	x_1 [ft]	y_1 [ft]	$Frame_1$	x_2 [ft]	y_2 [ft]	$Frame_2$	V_x/V_c	V_y/V_c	x_{ave}/P	y_{ave}/P
1	0.55	0.15	846	0.1	0.225	877	-0.639	0.107	-0.221	0.184
2	0.6	0.15	29735	0.1	0.25	29770	-0.629	0.126	-0.245	0.196
3	0.5	0.15	48611	0.1	0.175	48647	-0.489	0.031	-0.196	0.159
4	0.6	0.25	68450	0.075	0.225	68494	-0.526	-0.025	-0.257	0.233
5	0.5	0.25	68865	0.1	0.25	68882	-1.036	0.000	-0.196	0.245
6	0.6	0.25	68984	0.1	0.25	69015	-0.710	0.000	-0.245	0.245
7	0.45	0.325	82078	0.15	0.25	82098	-0.661	-0.165	-0.147	0.282
8	0.5	0.35	13874	0.075	0.2	13903	-0.646	-0.228	-0.208	0.270
9	0.4	0.35	65494	0.1	0.3	65510	-0.826	-0.138	-0.147	0.319
10	0.4	0.45	66018	0.15	0.375	66035	-0.648	-0.194	-0.123	0.404
11	0.4	0.45	7174	0.125	0.375	7200	-0.466	-0.127	-0.135	0.404
12	0.5	0.45	64468	0.125	0.375	64492	-0.688	-0.138	-0.184	0.404
13	0.475	0.5	71605	0.2	0.45	71627	-0.551	-0.100	-0.135	0.466
14	0.525	0.55	67703	0.2	0.425	67726	-0.622	-0.239	-0.159	0.478
15	0.4	0.55	5902	0.125	0.55	5923	-0.577	0.000	-0.135	0.539
16	0.5	0.6	49611	0.075	0.45	49636	-0.749	-0.264	-0.208	0.515
17	0.45	0.6	53207	0.1	0.45	53233	-0.593	-0.254	-0.172	0.515
18	0.6	0.65	14446	0.15	0.65	14472	-0.762	0.000	-0.221	0.637
19	0.6	0.7	66898	0.125	0.5	66936	-0.551	-0.232	-0.233	0.588
20	0.4	0.7	25523	0.05	0.45	25553	-0.514	-0.367	-0.172	0.564
21	0.55	0.725	26747	0.1	0.5	26779	-0.619	-0.310	-0.221	0.600
22	0.55	0.75	32311	0.2	0.6	32341	-0.514	-0.220	-0.172	0.662
23	0.475	0.825	85274	0.1	0.75	85296	-0.751	-0.150	-0.184	0.772
24	0.4	0.85	32644	0.15	0.85	32663	-0.580	0.000	-0.123	0.833
25	0.425	0.85	25071	0.125	0.75	25093	-0.601	-0.200	-0.147	0.784
26	0.5	0.925	86964	0.075	0.775	86989	-0.749	-0.264	-0.208	0.833
27	0.45	0.925	88843	0.125	0.75	88873	-0.477	-0.257	-0.159	0.821
28	0.6	0.95	29028	0.1	0.675	29066	-0.580	-0.319	-0.245	0.797
29	0.45	1	78335	0.125	1.875	78362	-0.530	1.428	-0.159	1.409
30	0.475	1	11346	0.075	0.8	11371	-0.705	-0.352	-0.196	0.882
31	0.55	1.025	32588	0.1	0.95	32612	-0.826	-0.138	-0.221	0.968
32	0.475	1.1	64892	0.2	1	64916	-0.505	-0.184	-0.135	1.029
33	0.4	1.1	25478	0.2	0.95	25490	-0.734	-0.551	-0.098	1.005
34	0.375	1.2	68689	0.175	1.125	68702	-0.678	-0.254	-0.098	1.140
35	0.5	1.25	76371	0.1	1.3	76400	-0.608	0.076	-0.196	1.250
36	0.45	1.25	87950	0.1	1.375	87977	-0.571	0.204	-0.172	1.287
37	0.4	1.3	28762	0.1	1.25	28783	-0.629	-0.105	-0.147	1.250
38	0.425	1.325	68517	0.125	1.325	68538	-0.629	0.000	-0.147	1.299
39	0.55	1.35	87577	0.15	1.4	87607	-0.587	0.073	-0.196	1.348

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.55	1.4	76017	0.05	2.425	76046	-0.759	1.557	-0.245	1.875
41	0.4	1.4	48221	0.175	1.45	48235	-0.708	0.157	-0.110	1.397
42	0.525	1.4	50043	0.175	1.45	50064	-0.734	0.105	-0.172	1.397
43	0.425	1.5	83463	0.1	1.475	83490	-0.530	-0.041	-0.159	1.458
44	0.575	1.55	57128	0.15	1.75	57161	-0.567	0.267	-0.208	1.618
45	0.55	1.55	65896	0.1	1.85	65930	-0.583	0.389	-0.221	1.667
46	0.4	1.6	47324	0.1	1.675	47347	-0.575	0.144	-0.147	1.605
47	0.5	1.65	87199	0.075	1.75	87223	-0.780	0.184	-0.208	1.667
48	0.375	1.65	50148	0.125	1.775	50169	-0.524	0.262	-0.123	1.679
49	0.55	1.7	28595	0.2	1.8	28614	-0.811	0.232	-0.172	1.716
50	0.425	1.75	26277	0.125	1.9	26292	-0.881	0.440	-0.147	1.789
51	0.55	1.75	76549	0.125	1.95	76578	-0.646	0.304	-0.208	1.814
52	0.3	1.8	28354	0.15	1.85	28366	-0.551	0.184	-0.074	1.789
53	0.4	1.85	63735	0.1	1.875	63752	-0.777	0.065	-0.147	1.826
54	0.6	1.85	26292	0.15	1.95	26327	-0.566	0.126	-0.221	1.863
55	0.45	1.9	29168	0.1	1.975	29191	-0.670	0.144	-0.172	1.900
56	0.35	1.9	31797	0.1	1.95	31811	-0.787	0.157	-0.123	1.887
57	0.5	1.95	65682	0.15	2.2	65730	-0.321	0.229	-0.172	2.034
58	0.5	2	45389	0.1	2.15	45412	-0.766	0.287	-0.196	2.034
59	0.425	2.05	64211	0.125	2.15	64234	-0.575	0.192	-0.147	2.059
60	0.4	2.05	76391	0.1	2.15	76408	-0.777	0.259	-0.147	2.059
61	0.45	2.1	26316	0.075	2.2	26354	-0.435	0.116	-0.184	2.108
62	0.4	2.1	13402	0.15	2.25	13425	-0.479	0.287	-0.123	2.132
63	0.45	2.125	78872	0.1	2.3	78905	-0.467	0.234	-0.172	2.169
64	0.6	2.225	27535	0.125	2.35	27560	-0.837	0.220	-0.233	2.243
65	0.6	2.25	28262	0.3	2.35	28288	-0.508	0.169	-0.147	2.255
66	0.575	2.25	41386	0.1	2.25	41422	-0.581	0.000	-0.233	2.206
67	0.6	2.3	55188	0.1	2.45	55227	-0.565	0.169	-0.245	2.328
68	0.7	2.3	79266	0.1	2.425	79312	-0.575	0.120	-0.294	2.316
69	0.575	2.325	89916	0.2	2.35	89946	-0.551	0.037	-0.184	2.292
70	0.525	2.4	56552	0.075	2.35	56578	-0.762	-0.085	-0.221	2.328
71	0.6	2.45	28670	0.1	2.45	28709	-0.565	0.000	-0.245	2.402
72	0.6	2.45	39260	0.125	2.55	39300	-0.523	0.110	-0.233	2.451
73	0.55	2.5	54257	0.2	2.55	54283	-0.593	0.085	-0.172	2.475
74	0.6	2.525	28318	0.1575	2.5	28353	-0.557	-0.031	-0.217	2.463
75	0.6	2.525	29221	0.15	2.55	29252	-0.639	0.036	-0.221	2.488
76	0.6	2.6	41043	0.15	2.725	41083	-0.496	0.138	-0.221	2.610
77	0.6	2.65	27330	0.3	2.65	27356	-0.508	0.000	-0.147	2.598
78	0.55	2.65	46114	0.1	2.75	46141	-0.734	0.163	-0.221	2.647
79	0.35	2.7	31359	0.1	2.75	31374	-0.734	0.147	-0.123	2.672

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.5	2.725	39700	0.15	2.7	39717	-0.907	-0.065	-0.172	2.659
81	0.6	2.75	11378	0.125	2.75	11415	-0.566	0.000	-0.233	2.696
82	0.6	2.85	10216	0.125	2.8	10250	-0.615	-0.065	-0.233	2.770
83	0.55	2.85	12511	0.05	2.9	12543	-0.688	0.069	-0.245	2.819
84	0.6	2.85	39605	0.2	2.85	39631	-0.678	0.000	-0.196	2.794
85	0.5	2.9	10552	0.1	2.825	10577	-0.705	-0.132	-0.196	2.806
86	0.475	2.9	26797	0.1	3	26826	-0.570	0.152	-0.184	2.892
87	0.5	2.925	10649	0.075	3.025	10685	-0.520	0.122	-0.208	2.917
88	0.525	3	47110	0.175	2.925	47135	-0.617	-0.132	-0.172	2.904
89	0.5	3	47691	0.1	3.025	47723	-0.551	0.034	-0.196	2.953
90	0.4	3.05	9798	0.125	3.025	9814	-0.757	-0.069	-0.135	2.978
91	0.45	3.125	10717	0.125	3.175	10738	-0.682	0.105	-0.159	3.088
92	0.475	3.15	9865	0.1	3.1	9886	-0.787	-0.105	-0.184	3.064
93	0.6	3.15	28690	0.1	3.15	28723	-0.667	0.000	-0.245	3.088
94	0.475	3.2	45936	0.1	3.25	45975	-0.424	0.056	-0.184	3.162
95	0.65	3.225	28403	0.1	3.15	28440	-0.655	-0.089	-0.270	3.125
96	0.6	3.25	11050	0.125	3.275	11076	-0.805	0.042	-0.233	3.199
97	0.4	3.3	49725	0.175	3.3	49749	-0.413	0.000	-0.110	3.235
98	0.375	3.325	15364	0.075	3.45	15383	-0.696	0.290	-0.147	3.321
99	0.5	3.35	45201	0.05	3.475	45239	-0.522	0.145	-0.221	3.346
100	0.6	3.4	10397	0.1	3.375	10431	-0.648	-0.032	-0.245	3.321
101	0.5	3.4	11214	0.15	3.425	11238	-0.642	0.046	-0.172	3.346
102	0.725	3.45	30398	0.125	3.55	30452	-0.489	0.082	-0.294	3.431
103	0.6	3.5	12793	0.125	3.55	12824	-0.675	0.071	-0.233	3.456
104	0.6	3.525	10253	0.05	3.45	10301	-0.505	-0.069	-0.270	3.419
105	0.6	3.525	10974	0.125	3.5	11007	-0.634	-0.033	-0.233	3.444
106	0.55	3.6	12442	0.15	3.65	12475	-0.534	0.067	-0.196	3.554
107	0.6	3.6	13777	0.2	3.65	13816	-0.452	0.056	-0.196	3.554
108	0.6	3.65	12697	0.15	3.7	12745	-0.413	0.046	-0.221	3.603

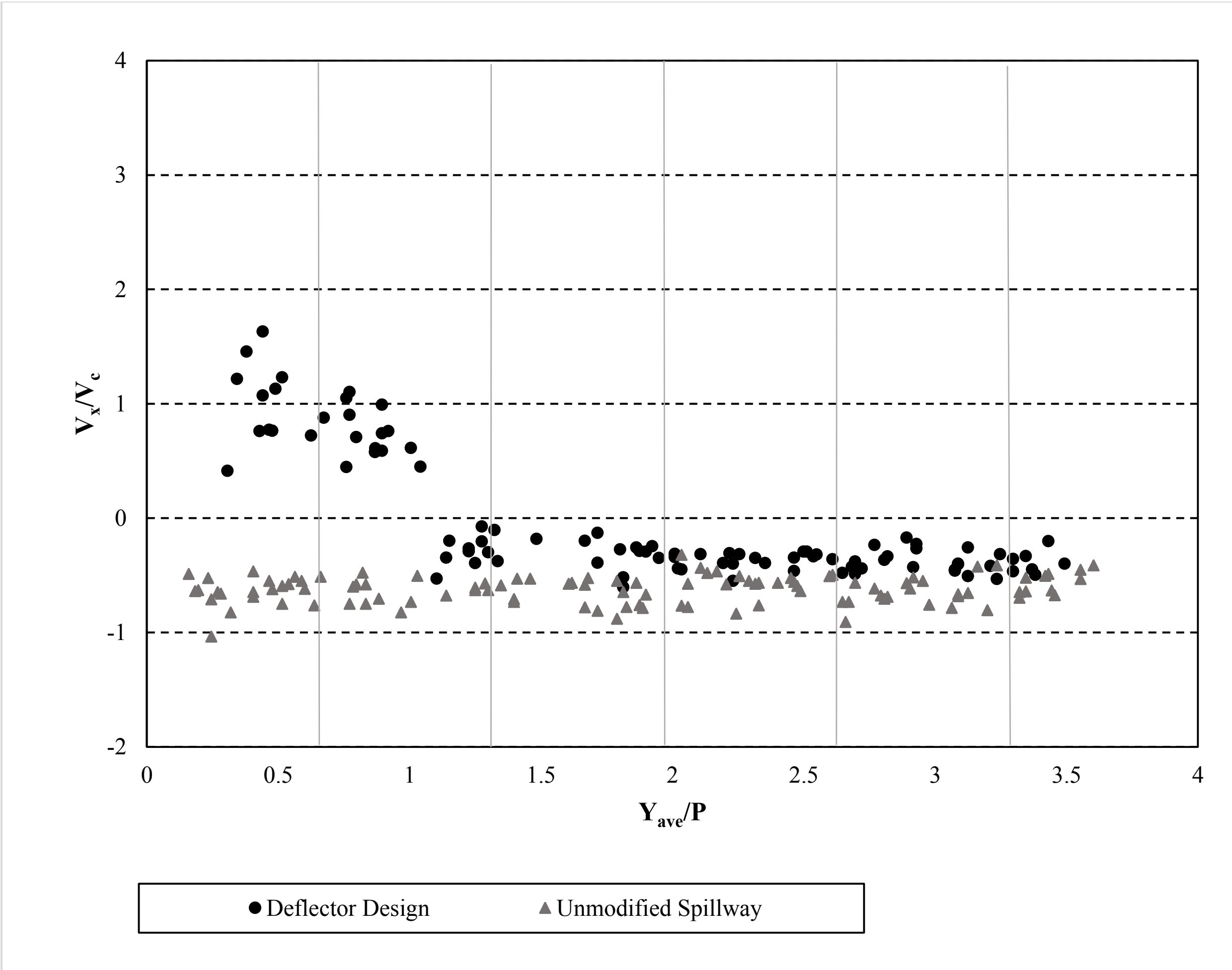

Figure 37: HW 1.10P TW 0.16P, Design Simulations Results

Table 33: HW 1.10P HW 0.42P, Multiple Staggered Deflector Design Simulation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	0.625	0.6	12036	0.425	0.525	12090	-0.16	-0.061	0.515	0.55
2	0.575	0.6	62728	0.325	0.425	62772	-0.25	-0.175	0.441	0.50
3	0.65	0.65	31400	0.325	0.5	31452	-0.28	-0.127	0.478	0.56
4	0.65	0.75	61289	0.3	0.575	61337	-0.32	-0.161	0.466	0.65
5	0.675	0.75	62591	0.375	0.575	62639	-0.28	-0.161	0.515	0.65
6	0.6	0.775	10378	0.375	0.625	10405	-0.37	-0.245	0.478	0.69
7	0.5	0.85	32767	0.375	0.75	32782	-0.37	-0.294	0.429	0.78
8	0.425	0.85	45243	0.225	0.725	45262	-0.46	-0.290	0.319	0.77
9	0.6	0.875	9278	0.4	0.675	9295	-0.52	-0.518	0.490	0.76
10	0.6	0.9	24139	0.125	0.6	24179	-0.52	-0.330	0.355	0.74
11	0.4	0.95	12338	0.175	0.85	12360	-0.45	-0.200	0.282	0.88
12	0.6	1.025	32974	0.375	0.75	33000	-0.38	-0.466	0.478	0.87
13	0.575	1.05	13654	0.4	0.7	13687	-0.23	-0.467	0.478	0.86
14	0.525	1.05	23197	0.175	0.775	23234	-0.42	-0.327	0.343	0.89
15	0.6	1.1	22452	0.3	0.85	22484	-0.41	-0.344	0.441	0.96
16	0.525	1.125	8520	0.3	0.775	8561	-0.24	-0.376	0.404	0.93
17	0.45	1.15	31355	0.2	0.85	31380	-0.44	-0.529	0.319	0.98
18	0.475	1.175	12393	0.225	1.05	12409	-0.69	-0.344	0.343	1.09
19	0.5	1.2	11903	0.3	0.9	11928	-0.35	-0.529	0.392	1.03
20	0.4	1.225	21764	0.225	1.125	21775	-0.70	-0.400	0.306	1.15
21	0.35	1.325	11970	0.2	1.25	11981	-0.60	-0.300	0.270	1.26
22	0.4	1.325	33335	0.225	1.25	33352	-0.45	-0.194	0.306	1.26
23	0.4	1.35	32430	0.1	1.35	32453	-0.57	0.000	0.245	1.32
24	0.35	1.425	46074	0.025	1.3	46110	-0.40	-0.153	0.184	1.34
25	0.475	1.45	33248	0	1.35	33290	-0.50	-0.105	0.233	1.37
26	0.45	1.525	8125	0.175	1.425	8146	-0.58	-0.210	0.306	1.45
27	0.425	1.525	32886	0.05	1.35	32911	-0.66	-0.308	0.233	1.41
28	0.475	1.55	23567	0.2	1.45	23587	-0.61	-0.220	0.331	1.47
29	0.475	1.575	9198	0.175	1.475	9215	-0.78	-0.259	0.319	1.50
30	0.45	1.575	31106	0.05	1.35	31137	-0.57	-0.320	0.245	1.43
31	0.325	1.625	9150	0.15	1.525	9162	-0.64	-0.367	0.233	1.54
32	0.45	1.675	33079	0	1.4	33107	-0.71	-0.433	0.221	1.51
33	0.4	1.7	31184	0.2	1.55	31199	-0.59	-0.440	0.294	1.59
34	0.425	1.725	10266	0.175	1.55	10283	-0.65	-0.453	0.294	1.61
35	0.3	1.775	47549	0.1	1.525	47572	-0.38	-0.479	0.196	1.62
36	0.35	1.825	23532	0.175	1.65	23547	-0.51	-0.514	0.257	1.70
37	0.35	1.85	75698	0.125	1.525	75723	-0.40	-0.573	0.233	1.65
38	0.325	1.875	62041	0.15	1.775	62059	-0.43	-0.245	0.233	1.79
39	0.275	1.925	23503	0.125	1.85	23518	-0.44	-0.220	0.196	1.85

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.325	1.925	47104	0.125	1.9	47125	-0.42	-0.052	0.221	1.88
41	0.175	2.05	55717	0.025	2.075	55744	-0.24	0.041	0.098	2.02
42	0.25	2.05	71151	0.1	1.975	71164	-0.51	-0.254	0.172	1.97
43	0.275	2.075	10848	0.05	2.075	10873	-0.40	0.000	0.159	2.03
44	0.175	2.125	9812	0.025	2.05	9827	-0.44	-0.220	0.098	2.05
45	0.275	2.15	76720	0	2.025	76748	-0.43	-0.197	0.135	2.05
46	0.2	2.175	61566	0.05	2.2	61574	-0.83	0.138	0.123	2.14
47	0.225	2.25	21679	0.05	2.3	21693	-0.55	0.157	0.135	2.23
48	0.2	2.25	32831	0.025	2.2	32841	-0.77	-0.220	0.110	2.18
49	0.3	2.325	21704	0.075	2.2	21720	-0.62	-0.344	0.184	2.22
50	0.3	2.325	32476	0.075	2.175	32492	-0.62	-0.413	0.184	2.21
51	0.275	2.325	75969	0.025	2.175	75988	-0.58	-0.348	0.147	2.21
52	0.225	2.375	32233	0.05	2.225	32249	-0.48	-0.413	0.135	2.25
53	0.275	2.4	89524	0.075	2.4	89536	-0.73	0.000	0.172	2.35
54	0.2	2.425	10984	0.075	2.395	10996	-0.46	-0.110	0.135	2.36
55	0	2.525	77031	1	2.55	77071	1.10	0.028	0.490	2.49
56	0.275	2.55	11020	0.9	2.55	11051	0.89	0.000	0.576	2.50
57	0.375	2.55	41580	1.1	2.65	41629	0.65	0.090	0.723	2.55
58	0	2.575	46004	0.9	2.55	46040	1.10	-0.031	0.441	2.51
59	0.025	2.6	56115	1	2.55	56167	0.83	-0.042	0.502	2.52
60	0	2.65	45990	0.9	2.825	46047	0.70	0.135	0.441	2.68
61	0	2.7	22314	0.8	2.6	22357	0.82	-0.102	0.392	2.60
62	0	2.725	89440	0.9	2.75	89481	0.97	0.027	0.441	2.68
63	0.025	2.75	62356	0.9	2.85	62388	1.20	0.138	0.453	2.75
64	0	2.775	45513	0.9	2.875	45553	0.99	0.110	0.441	2.77
65	0	2.8	23235	1	2.925	23266	1.42	0.178	0.490	2.81
66	0	2.8	31185	0.9	2.925	31211	1.52	0.212	0.441	2.81
67	0	2.875	31540	0.825	3.075	31566	1.40	0.339	0.404	2.92
68	0.025	2.875	40521	1	3.075	40561	1.07	0.220	0.502	2.92
69	0	2.9	87932	0.9	3.025	87962	1.32	0.184	0.441	2.90
70	0	2.975	22037	1.025	2.95	22061	1.88	-0.046	0.502	2.90
71	0	2.975	71594	0.725	3	71614	1.60	0.055	0.355	2.93
72	0	3.05	76609	0.925	3.05	76646	1.10	0.000	0.453	2.99
73	0	3.375	22319	0.9	3.425	22354	1.13	0.063	0.441	3.33

Notes: (1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position

(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

Table 34: HW 1.10P TW 0.42P, Unmodified Spillway Simulation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	x_1 [ft]	y_1 [ft]	$Frame_1$	x_2 [ft]	y_2 [ft]	$Frame_2$	V_x/V_c	V_y/V_c	x_{ave}/P	y_{ave}/P
1	0.6	0.3	827	0.1	0.3	872	-0.489	0.000	-0.245	0.294
2	0.6	0.3	830	0.1	0.3	879	-0.449	0.000	-0.245	0.294
3	0.55	0.35	1230	0.1	0.45	1276	-0.431	0.096	-0.221	0.392
4	0.575	0.4	1256	0.075	0.45	1311	-0.400	0.040	-0.245	0.417
5	0.5	0.45	831	0.1	0.55	868	-0.476	0.119	-0.196	0.490
6	0.4	0.45	898	0.1	0.3	923	-0.529	-0.264	-0.147	0.368
7	0.5	0.475	1428	0.05	0.4	1457	-0.684	-0.114	-0.221	0.429
8	0.6	0.525	762	0.075	0.4	804	-0.551	-0.131	-0.257	0.453
9	0.5	0.525	1430	0.075	0.525	1459	-0.646	0.000	-0.208	0.515
10	0.6	0.6	1749	0.1	0.65	1796	-0.469	0.047	-0.245	0.613
11	0.5	0.65	1993	0.05	0.625	2025	-0.619	-0.034	-0.221	0.625
12	0.6	0.65	1458	0.075	0.475	1501	-0.538	-0.179	-0.257	0.551
13	0.5	0.675	1912	0.1	0.675	1953	-0.430	0.000	-0.196	0.662
14	0.6	0.7	1912	0.1	0.575	1960	-0.459	-0.115	-0.245	0.625
15	0.6	0.75	2116	0.1	0.575	2180	-0.344	-0.120	-0.245	0.650
16	0.5	0.8	3662	0.1	0.89	3692	-0.587	0.132	-0.196	0.828
17	0.3	0.8	5461	0.1	0.75	5479	-0.489	-0.122	-0.098	0.760
18	0.2	0.85	5678	0.1	0.9	5691	-0.339	0.169	-0.049	0.858
19	0.4	0.9	5816	0.1	0.925	5845	-0.456	0.038	-0.147	0.895
20	0.45	0.95	4698	0.1	1.075	4741	-0.359	0.128	-0.172	0.993
21	0.275	0.95	5377	0.1	0.95	5400	-0.335	0.000	-0.086	0.931
22	0.325	1.05	3022	0.1	0.85	3051	-0.342	-0.304	-0.110	0.931
23	0.2	1.05	4852	0.1	1.05	4864	-0.367	0.000	-0.049	1.029
24	0.2	1.05	5289	0.1	1.025	5309	-0.220	-0.055	-0.049	1.017
25	0.15	1.1	4749	0.1	1.15	4763	-0.157	0.157	-0.025	1.103
26	0.4	1.1	4912	0.1	1.12	4937	-0.529	0.035	-0.147	1.088
27	0.6	1.1	5160	0.1	1.225	5212	-0.424	0.106	-0.245	1.140
28	0.25	1.225	5053	0.1	1.175	5073	-0.330	-0.110	-0.074	1.176
29	0.6	1.25	3091	0.1	1.35	3151	-0.367	0.073	-0.245	1.275
30	0.5	1.25	5007	0.1	1.25	5041	-0.518	0.000	-0.196	1.225
31	0.6	1.275	10165	0.1	1.175	10221	-0.393	-0.079	-0.245	1.201
32	0.5	1.35	9932	0.1	1.2	9960	-0.629	-0.236	-0.196	1.250
33	0.2	1.35	10372	0.1	1.45	10399	-0.163	0.163	-0.049	1.373
34	0.6	1.4	12478	0.1	1.35	12528	-0.440	-0.044	-0.245	1.348
35	0.15	1.4	12949	0.06	1.4	12958	-0.440	0.000	-0.044	1.373
36	0.4	1.45	12889	0.1	1.35	12918	-0.456	-0.152	-0.147	1.373
37	0.5	1.5	2815	0.1	1.45	2859	-0.400	-0.050	-0.196	1.446
38	0.6	1.55	2927	0.1	1.45	2973	-0.479	-0.096	-0.245	1.471
39	0.5	1.55	4844	0.1	1.775	4887	-0.410	0.230	-0.196	1.630

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.6	1.6	11487	0.1	1.6	11523	-0.612	0.000	-0.245	1.569
41	0.6	1.65	1057	0.1	1.65	1090	-0.667	0.000	-0.245	1.618
42	0.2	1.65	9615	0.1	1.67	9625	-0.440	0.088	-0.049	1.627
43	0.6	1.7	3740	0.1	1.8	3783	-0.512	0.102	-0.245	1.716
44	0.5	1.75	2894	0.075	1.775	2923	-0.646	0.038	-0.208	1.728
45	0.6	1.75	3534	0.1	1.65	3577	-0.512	-0.102	-0.245	1.667
46	0.6	1.8	2585	0.05	1.95	2657	-0.336	0.092	-0.270	1.838
47	0.6	1.825	2356	0.075	1.825	2415	-0.392	0.000	-0.257	1.789
48	0.5	1.85	2491	0.1	1.9	2524	-0.534	0.067	-0.196	1.838
49	0.6	1.9	2728	0.1	1.85	2768	-0.551	-0.055	-0.245	1.838
50	0.6	1.925	3073	0.1	2.025	3116	-0.512	0.102	-0.245	1.936
51	0.4	1.95	4309	0.1	1.95	4343	-0.389	0.000	-0.147	1.912
52	0.5	2	3037	0.1	2.05	3070	-0.534	0.067	-0.196	1.985
53	0.6	2.05	2704	0.05	2.025	2757	-0.457	-0.021	-0.270	1.998
54	0.4	2.05	3619	0.1	2.1	3655	-0.367	0.061	-0.147	2.034
55	0.6	2.1	2859	0.075	2.175	2896	-0.625	0.089	-0.257	2.096
56	0.5	2.125	2581	0.1	2.025	2611	-0.587	-0.147	-0.196	2.034
57	0.4	2.15	3246	0.1	2.15	3272	-0.508	0.000	-0.147	2.108
58	0.6	2.25	3926	0.1	2.375	3976	-0.440	0.110	-0.245	2.267
59	0.6	2.25	4008	0.1	2.225	4049	-0.537	-0.027	-0.245	2.194
60	0.6	2.25	8532	0.05	2.45	8583	-0.475	0.173	-0.270	2.304
61	0.6	2.35	3533	0.075	2.4	3581	-0.482	0.046	-0.257	2.328
62	0.6	2.35	3950	0.125	2.325	3999	-0.427	-0.022	-0.233	2.292
63	0.5	2.35	4492	0.125	2.25	4541	-0.337	-0.090	-0.184	2.255
64	0.6	2.4	4436	0.1	2.525	4480	-0.501	0.125	-0.245	2.414
65	0.6	2.45	3431	0.1	2.55	3476	-0.489	0.098	-0.245	2.451
66	0.5	2.45	3614	0.05	2.475	3650	-0.551	0.031	-0.221	2.414
67	0.6	2.5	3998	0.1	2.55	4047	-0.449	0.045	-0.245	2.475
68	0.5	2.55	3673	0.25	2.6	3695	-0.501	0.100	-0.123	2.525
69	0.6	2.55	3747	0.1	2.75	3800	-0.416	0.166	-0.245	2.598
70	0.5	2.575	3363	0.1	2.575	3428	-0.271	0.000	-0.196	2.525
71	0.6	2.6	3419	0.05	2.6	3468	-0.494	0.000	-0.270	2.549
72	0.45	2.65	3511	0.075	2.625	3539	-0.590	-0.039	-0.184	2.586
73	0.5	2.7	4824	0.1	2.75	4874	-0.352	0.044	-0.196	2.672
74	0.6	2.75	3211	0.075	2.75	3268	-0.406	0.000	-0.257	2.696
75	0.6	2.75	7890	0.1	2.675	7928	-0.580	-0.087	-0.245	2.659
76	0.6	2.775	6274	0.05	2.69	6317	-0.563	-0.087	-0.270	2.679
77	0.5	2.85	4783	0.05	2.95	4826	-0.461	0.102	-0.221	2.843
78	0.6	2.85	4910	0.1	3	4969	-0.373	0.112	-0.245	2.868
79	0.6	2.95	4073	0.05	3.075	4117	-0.551	0.125	-0.270	2.953

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.5	2.95	7074	0.1	2.95	7099	-0.705	0.000	-0.196	2.892
81	0.5	2.95	7297	0.1	2.925	7340	-0.410	-0.026	-0.196	2.880
82	0.6	3	5013	0.075	2.925	5075	-0.373	-0.053	-0.257	2.904
83	0.4	3.05	4151	0.1	3.025	4170	-0.696	-0.058	-0.147	2.978
84	0.5	3.05	5023	0.1	3.075	5069	-0.383	0.024	-0.196	3.002
85	0.6	3.07	5082	0.1	3.075	5137	-0.400	0.004	-0.245	3.012
86	0.6	3.075	4945	0.1	3.175	5013	-0.324	0.065	-0.245	3.064
87	0.6	3.15	5425	0.05	3.225	5470	-0.538	0.073	-0.270	3.125
88	0.175	3.225	2892	0.05	3.25	2906	-0.393	0.079	-0.061	3.174
89	0.6	3.225	4334	0.075	3.15	4386	-0.445	-0.064	-0.257	3.125
90	0.6	3.25	1410	0.075	3.4	1458	-0.482	0.138	-0.257	3.260
91	0.2	3.25	2911	0.1	3.35	2935	-0.184	0.184	-0.049	3.235
92	0.6	3.35	1524	0.05	3.25	1565	-0.591	-0.107	-0.270	3.235
93	0.25	3.35	2859	0.1	3.25	2885	-0.254	-0.169	-0.074	3.235
94	0.7	3.35	3254	0.05	3.35	3308	-0.530	0.000	-0.319	3.284
95	0.6	3.4	1328	0.1	3.45	1384	-0.393	0.039	-0.245	3.358
96	0.5	3.425	1340	0.05	3.5	1392	-0.381	0.064	-0.221	3.395
97	0.65	3.45	1219	0.07	3.3	1273	-0.473	-0.122	-0.284	3.309
98	0.7	3.5	1077	0.05	3.6	1150	-0.392	0.060	-0.319	3.480
99	0.7	3.55	1077	0.1	3.7	1139	-0.426	0.107	-0.294	3.554
100	0.6	3.55	1219	0.05	3.5	1273	-0.449	-0.041	-0.270	3.456
101	0.5	3.625	1275	0.1	3.7	1310	-0.503	0.094	-0.196	3.591
102	0.6	3.65	1196	0.1	3.65	1248	-0.424	0.000	-0.245	3.578
103	0.625	3.65	1306	0.1	3.55	1358	-0.445	-0.085	-0.257	3.529

Notes:
(1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

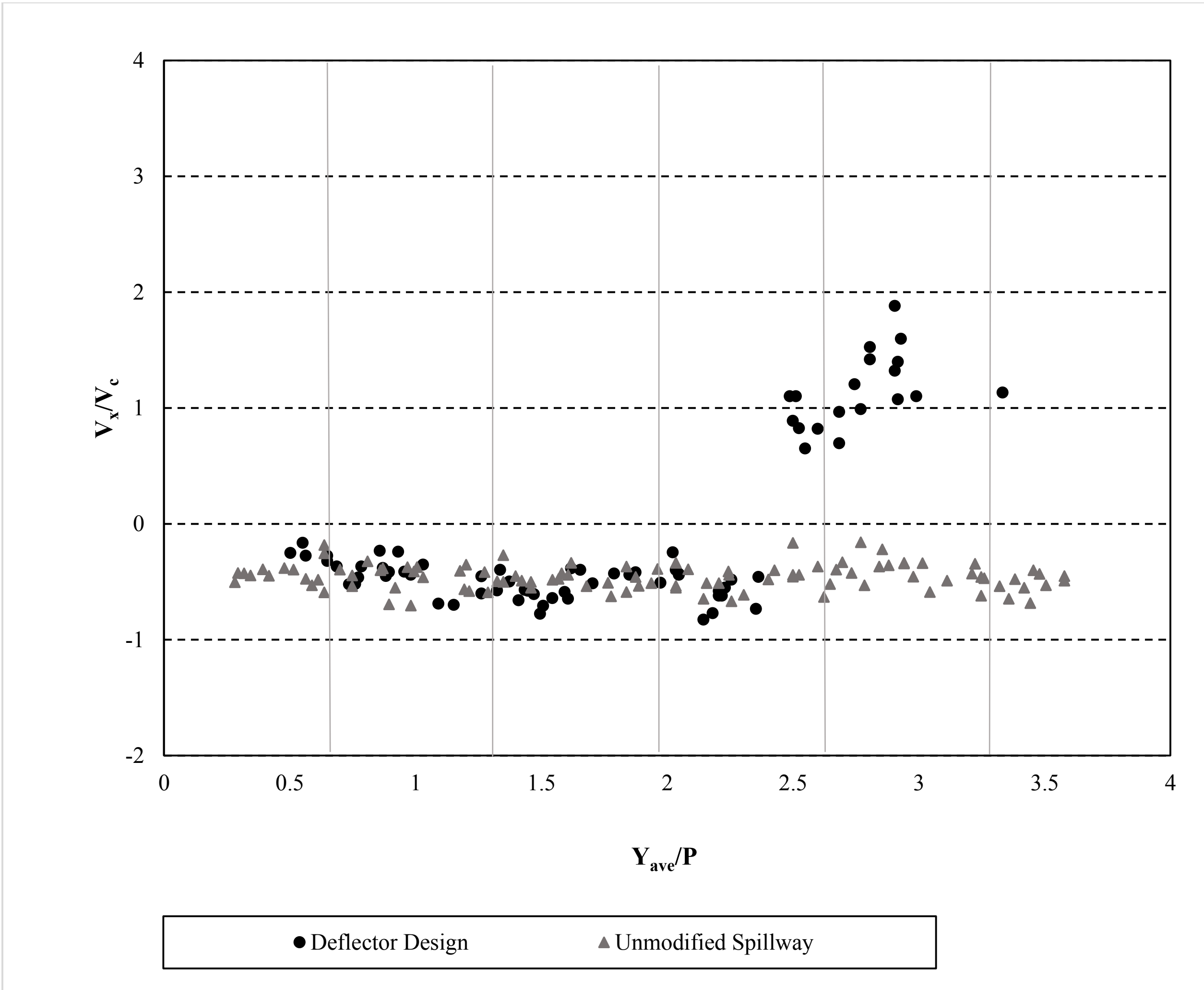

Figure 38: HW 1.10P TW 0.42P, Design Simulations Results

Table 35: HW 1.10P TW 0.69P, Multiple Staggered Deflector Simulation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	0.4	0.2	11775	0.1	0.2	11817	-0.315	0.000	0.245	0.196
2	0.45	0.225	11132	0.1	0.175	11158	-0.593	-0.085	0.270	0.196
3	0.425	0.25	11012	0.1	0.3	11046	-0.421	0.065	0.257	0.270
4	0.5	0.3	10571	0.1	0.2	10598	-0.653	-0.163	0.294	0.245
5	0.5	0.35	10503	0.1	0.275	10535	-0.551	-0.103	0.294	0.306
6	0.525	0.35	10835	0.1	0.175	10889	-0.347	-0.143	0.306	0.257
7	0.425	0.375	20143	0.1	0.25	20188	-0.318	-0.122	0.257	0.306
8	0.5	0.425	10776	0.1	0.375	10814	-0.464	-0.058	0.294	0.392
9	0.475	0.475	72098	0.1	0.2	72138	-0.413	-0.303	0.282	0.331
10	0.425	0.55	41811	0.1	0.425	41838	-0.530	-0.204	0.257	0.478
11	0.525	0.55	87482	0.1	0.25	87512	-0.624	-0.440	0.306	0.392
12	0.5	0.575	18364	0.1	0.325	18401	-0.476	-0.298	0.294	0.441
13	0.4	0.65	88596	0.15	0.35	88626	-0.367	-0.440	0.270	0.490
14	0.45	0.65	20426	0.1	0.35	20454	-0.551	-0.472	0.270	0.490
15	0.35	0.675	20043	0.05	0.5	20074	-0.426	-0.249	0.196	0.576
16	0.275	0.675	41870	0.125	0.65	41881	-0.601	-0.100	0.196	0.650
17	0.25	0.725	41769	0.125	0.675	41785	-0.344	-0.138	0.184	0.686
18	0.375	0.825	72990	0.225	0.825	73007	-0.389	0.000	0.294	0.809
19	0.35	0.85	31227	0.2	0.75	31238	-0.601	-0.400	0.270	0.784
20	0.375	0.925	31052	0.2	0.8	31069	-0.453	-0.324	0.282	0.846
21	0.4	0.95	6346	0.2	0.9	6365	-0.464	-0.116	0.294	0.907
22	0.425	0.95	72969	0.125	0.775	72989	-0.661	-0.385	0.270	0.846
23	0.425	1	40346	0.225	0.875	40362	-0.551	-0.344	0.319	0.919
24	0.375	1.025	71978	0.15	0.925	71999	-0.472	-0.210	0.257	0.956
25	0.275	1.05	40316	0.125	1.025	40328	-0.551	-0.092	0.196	1.017
26	0.225	1.075	6296	0.1	1.05	6313	-0.324	-0.065	0.159	1.042
27	0.4	1.075	31372	0.15	0.9	31394	-0.501	-0.350	0.270	0.968
28	0.3	1.15	18504	0.2	1.05	18516	-0.367	-0.367	0.245	1.078
29	0.35	1.175	18927	0.2	1.05	18950	-0.287	-0.239	0.270	1.091
30	0.275	1.175	71946	0.125	1.125	71961	-0.440	-0.147	0.196	1.127
31	0.35	1.25	86498	0.2	1.1	86513	-0.440	-0.440	0.270	1.152
32	0.275	1.275	18922	0.15	1.15	18935	-0.424	-0.424	0.208	1.189
33	0.325	1.3	41068	0.125	1.2	41084	-0.551	-0.275	0.221	1.225
34	0	1.375	53255	1.075	1.3	53301	1.029	-0.072	0.527	1.311
35	0.2	1.45	54268	0.725	1.35	54310	0.551	-0.105	0.453	1.373
36	0.275	1.45	86017	0.8	1.225	86043	0.889	-0.381	0.527	1.311
37	0.025	1.475	39789	0.7	1.45	39823	0.875	-0.032	0.355	1.434
38	0.025	1.475	53257	1.1	1.425	53301	1.076	-0.050	0.551	1.422
39	0	1.525	6196	0.9	1.3	6244	0.826	-0.206	0.441	1.385

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.025	1.6	53724	0.625	1.575	53742	1.468	-0.061	0.319	1.556
41	0	1.625	6177	1	1.625	6223	0.958	0.000	0.490	1.593
42	0.025	1.625	41058	1.1	1.75	41100	1.127	0.131	0.551	1.654
43	0.05	1.7	19107	0.9	1.575	19135	1.337	-0.197	0.466	1.605
44	0	1.725	18182	1.1	1.725	18206	2.019	0.000	0.539	1.691
45	0	1.75	29452	0.7	1.725	29464	2.570	-0.092	0.343	1.703
46	0	1.825	6150	0.675	1.825	6167	1.749	0.000	0.331	1.789
47	0.025	1.85	17772	1.075	1.65	17802	1.542	-0.294	0.539	1.716
48	0.025	1.85	18230	1.075	1.625	18259	1.595	-0.342	0.539	1.703
49	0.1	1.925	17726	0.625	1.725	17747	1.101	-0.420	0.355	1.789
50	0	1.925	30178	0.7	1.925	30200	1.402	0.000	0.343	1.887
51	0.15	1.95	29290	1	1.65	29324	1.101	-0.389	0.564	1.765
52	0	1.975	17725	1	1.75	17766	1.074	-0.242	0.490	1.826
53	0	1.975	40029	1.075	1.775	40096	0.707	-0.131	0.527	1.838
54	0.45	2.05	85520	0.15	1.975	85557	-0.357	-0.089	0.294	1.973
55	0.55	2.075	19033	0.2	2.175	19093	-0.257	0.073	0.368	2.083
56	0.55	2.15	5990	0.2	2.275	6035	-0.343	0.122	0.368	2.169
57	0.525	2.15	30550	0.3	2.05	30577	-0.367	-0.163	0.404	2.059
58	0.6	2.175	19192	0.25	2.4	19259	-0.230	0.148	0.417	2.243
59	0.625	2.225	6022	0.2	2.3	6064	-0.446	0.079	0.404	2.218
60	0.4	2.25	6920	0.225	2.275	6938	-0.428	0.061	0.306	2.218
61	0.45	2.275	6867	0.2	2.275	6884	-0.648	0.000	0.319	2.230
62	0.7	2.325	17689	0.15	2.325	17758	-0.351	0.000	0.417	2.279
63	0.45	2.325	18976	0.2	2.425	18996	-0.551	0.220	0.319	2.328
64	0.525	2.375	5440	0.2	2.45	5474	-0.421	0.097	0.355	2.365
65	0.7	2.425	17788	0.2	2.6	17837	-0.449	0.157	0.441	2.463
66	0.6	2.45	17789	0.225	2.6	17821	-0.516	0.206	0.404	2.475
67	0.625	2.475	17474	0.2	2.5	17528	-0.347	0.020	0.404	2.439
68	0.675	2.525	17764	0.25	2.6	17821	-0.328	0.058	0.453	2.512
69	0.55	2.6	9471	0.25	2.65	9529	-0.228	0.038	0.392	2.574
70	0.575	2.625	17399	0.225	2.575	17433	-0.453	-0.065	0.392	2.549
71	0.6	2.65	6573	0.225	2.8	6604	-0.533	0.213	0.404	2.672
72	0.575	2.675	6119	0.275	2.825	6164	-0.294	0.147	0.417	2.696
73	0.7	2.7	6740	0.25	2.725	6785	-0.440	0.024	0.466	2.659
74	0.7	2.75	6181	0.225	2.775	6220	-0.537	0.028	0.453	2.708
75	0.7	2.775	6214	0.25	2.875	6260	-0.431	0.096	0.466	2.770
76	0.75	2.825	5826	0.225	2.975	5881	-0.420	0.120	0.478	2.843
77	0.7	2.85	5595	0.25	2.875	5653	-0.342	0.019	0.466	2.806
78	0.55	2.875	6313	0.25	3.05	6344	-0.426	0.249	0.392	2.904
79	0.575	2.875	6646	0.25	2.925	6673	-0.530	0.082	0.404	2.843

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.7	2.925	6455	0.275	2.975	6502	-0.398	0.047	0.478	2.892
81	0.675	3.025	7745	0.3	3	7778	-0.501	-0.033	0.478	2.953
82	0.575	3.05	5700	0.225	2.9	5760	-0.257	-0.110	0.392	2.917
83	0.6	3.05	7350	0.225	3.075	7386	-0.459	0.031	0.404	3.002
84	0.75	3.1	9361	0.25	2.725	9421	-0.367	-0.275	0.490	2.855
85	0.5	3.15	9873	0.225	3.175	9891	-0.673	0.061	0.355	3.100
86	0.425	3.15	9922	0.1	3.25	9942	-0.716	0.220	0.257	3.137
87	0.4	3.175	7922	0.1	3.275	7945	-0.575	0.192	0.245	3.162
88	0.575	3.25	7142	0.2	3.35	7179	-0.446	0.119	0.380	3.235
89	0.425	3.25	9204	0.05	3.375	9253	-0.337	0.112	0.233	3.248
90	0.375	3.275	9133	0.025	3.275	9168	-0.440	0.000	0.196	3.211
91	0.45	3.3	7223	0.075	3.325	7252	-0.570	0.038	0.257	3.248
92	0.425	3.3	9037	0.15	3.375	9079	-0.288	0.079	0.282	3.272
93	0.525	3.35	7324	0.15	3.475	7374	-0.330	0.110	0.331	3.346
94	0.475	3.375	7436	0.15	3.575	7468	-0.447	0.275	0.306	3.407
95	0.5	3.45	6822	0.1	3.6	6869	-0.375	0.141	0.294	3.456
96	0.675	3.45	7114	0.1	3.45	7157	-0.589	0.000	0.380	3.382
97	0.6	3.475	7016	0.1	3.425	7064	-0.459	-0.046	0.343	3.382
98	0.5	3.525	6940	0.1	3.75	6977	-0.476	0.268	0.294	3.566
99	0.575	3.55	6839	0.1	3.575	6879	-0.523	0.028	0.331	3.493
100	0.575	3.575	7099	0.2	3.65	7142	-0.384	0.077	0.380	3.542
101	0.575	3.65	7359	0.1	3.65	7398	-0.537	0.000	0.331	3.578
102	0.55	3.65	7505	0.075	3.55	7543	-0.551	-0.116	0.306	3.529
103	0.425	3.675	8115	0.1	3.75	8158	-0.333	0.077	0.257	3.640
104	0.425	3.7	7773	0.1	3.725	7801	-0.511	0.039	0.257	3.640
105	0.425	3.75	8019	0.1	3.7	8052	-0.434	-0.067	0.257	3.652
106	0.475	3.775	7046	0.1	3.65	7099	-0.312	-0.104	0.282	3.640
107	0.5	3.775	7237	0.1	3.8	7289	-0.339	0.021	0.294	3.713
108	0.4	3.775	8418	0.1	3.75	8483	-0.203	-0.017	0.245	3.689

Notes:
(1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

Table 36: HW 1.10P TW 0.69P, Unmodified Deflector Simulation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	0.5	0.3	10639	0.1	0.25	10700	-0.289	-0.036	0.294	0.270
2	0.5	0.35	10603	0.1	0.325	10668	-0.271	-0.017	0.294	0.331
3	0.6	0.35	11024	0.2	0.25	11085	-0.289	-0.072	0.392	0.294
4	0.5	0.4	10507	0.1	0.275	10571	-0.275	-0.086	0.294	0.331
5	0.6	0.425	10434	0.125	0.275	10570	-0.154	-0.049	0.355	0.343
6	0.6	0.45	10423	0.1	0.35	10493	-0.315	-0.063	0.343	0.392
7	0.6	0.5	10382	0.12	0.35	10437	-0.384	-0.120	0.353	0.417
8	0.6	0.55	10307	0.1	0.475	10378	-0.310	-0.047	0.343	0.502
9	0.4	0.55	10427	0.1	0.35	10477	-0.264	-0.176	0.245	0.441
10	0.4	0.625	11067	0.1	0.6	11102	-0.378	-0.031	0.245	0.600
11	0.4	0.65	10219	0.1	0.65	10247	-0.472	0.000	0.245	0.637
12	0.375	0.65	11127	0.1	0.7	11155	-0.433	0.079	0.233	0.662
13	0.6	0.7	10223	0.1	0.65	10273	-0.440	-0.044	0.343	0.662
14	0.45	0.75	10239	0.1	0.675	10275	-0.428	-0.092	0.270	0.699
15	0.6	0.75	10266	0.1	0.7	10320	-0.408	-0.041	0.343	0.711
16	0.6	0.8	10216	0.1	0.775	10275	-0.373	-0.019	0.343	0.772
17	0.4	0.8	10283	0.125	0.75	10314	-0.391	-0.071	0.257	0.760
18	0.4	0.825	10170	0.125	0.85	10214	-0.275	0.025	0.257	0.821
19	0.4	0.95	10070	0.1	0.9	10108	-0.348	-0.058	0.245	0.907
20	0.4	0.95	10109	0.125	0.975	10155	-0.263	0.024	0.257	0.944
21	0.35	0.95	12859	0.1	0.9	12893	-0.324	-0.065	0.221	0.907
22	0.3	1	12822	0.1	1	12841	-0.464	0.000	0.196	0.980
23	0.35	1.05	12852	0.125	1.025	12882	-0.330	-0.037	0.233	1.017
24	0.4	1.05	13000	0.125	1	13037	-0.327	-0.060	0.257	1.005
25	0.225	1.125	9932	0.1	1.1	9950	-0.306	-0.061	0.159	1.091
26	0.5	1.15	10073	0.15	1.05	10127	-0.286	-0.082	0.319	1.078
27	0.6	1.15	9847	0.125	1.1	9915	-0.308	-0.032	0.355	1.103
28	0.5	1.2	10007	0.1	1.15	10051	-0.400	-0.050	0.294	1.152
29	0.6	1.25	10115	0.1	1.05	10184	-0.319	-0.128	0.343	1.127
30	0.4	1.25	9971	0.1	1.125	10018	-0.281	-0.117	0.245	1.164
31	0.6	1.3	11632	0.125	1.175	11704	-0.291	-0.076	0.355	1.213
32	0.5	1.35	11449	0.125	1.375	11498	-0.337	0.022	0.306	1.336
33	0.6	1.35	11635	0.1	1.275	11694	-0.373	-0.056	0.343	1.287
34	0.5	1.375	9988	0.1	1.3	10030	-0.420	-0.079	0.294	1.311
35	0.4	1.45	9864	0.1	1.45	9895	-0.426	0.000	0.245	1.422
36	0.6	1.45	12061	0.125	1.3	12145	-0.249	-0.079	0.355	1.348
37	0.5	1.5	11008	0.125	1.6	11046	-0.435	0.116	0.306	1.520
38	0.225	1.5	9948	0.1	1.475	9967	-0.290	-0.058	0.159	1.458
39	0.6	1.55	11529	0.12	1.8	11586	-0.371	0.193	0.353	1.642

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.4	1.6	9804	0.1	1.575	9835	-0.568	-0.036	0.245	1.556
41	0.6	1.625	9705	0.1	1.55	9772	-0.329	-0.049	0.343	1.556
42	0.3	1.625	9754	0.125	1.62	9779	-0.308	-0.009	0.208	1.591
43	0.4	1.725	11075	0.125	1.7	11105	-0.404	-0.037	0.257	1.679
44	0.25	1.75	9576	0.15	1.75	9594	-0.245	0.000	0.196	1.716
45	0.25	1.75	11115	0.125	1.775	11131	-0.344	0.069	0.184	1.728
46	0.5	1.775	11272	0.1	1.825	11318	-0.383	0.048	0.294	1.765
47	0.6	1.8	9661	0.1	1.7	9714	-0.416	-0.083	0.343	1.716
48	0.3	1.8	9704	0.125	1.69	9728	-0.321	-0.202	0.208	1.711
49	0.4	1.9	11410	0.1	1.9	11439	-0.456	0.000	0.245	1.863
50	0.2	1.95	9518	0.1	1.85	9538	-0.220	-0.220	0.147	1.863
51	0.5	1.95	9894	0.1	1.75	9944	-0.352	-0.176	0.294	1.814
52	0.25	1.975	9494	0.1	1.95	9511	-0.389	-0.065	0.172	1.924
53	0.175	1.975	10939	0.1	1.95	10950	-0.300	-0.100	0.135	1.924
54	0.425	2.05	11439	0.15	2.1	11483	-0.275	0.050	0.282	2.034
55	0.5	2.1	10049	0.1	2.15	10085	-0.489	0.061	0.294	2.083
56	0.5	2.1	10858	0.1	2.05	10911	-0.332	-0.042	0.294	2.034
57	0.35	2.15	9447	0.1	2.05	9479	-0.344	-0.138	0.221	2.059
58	0.2	2.175	9516	0.1	2.175	9525	-0.489	0.000	0.147	2.132
59	0.475	2.25	9354	0.1	2.225	9401	-0.351	-0.023	0.282	2.194
60	0.35	2.25	9994	0.1	2.2	10016	-0.501	-0.100	0.221	2.181
61	0.2	2.325	9195	0.125	2.35	9204	-0.367	0.122	0.159	2.292
62	0.175	2.35	9311	0.1	2.325	9318	-0.472	-0.157	0.135	2.292
63	0.2	2.35	9943	0.1	2.3	9956	-0.339	-0.169	0.147	2.279
64	0.4	2.4	10129	0.1	2.49	10159	-0.440	0.132	0.245	2.397
65	0.2	2.425	9936	0.1	2.425	9947	-0.400	0.000	0.147	2.377
66	0.2	2.5	9877	0.1	2.47	9891	-0.315	-0.094	0.147	2.436
67	0.2	2.51	9884	0.1	2.52	9896	-0.367	0.037	0.147	2.466
68	0.2	2.55	9841	0.08	2.525	9853	-0.440	-0.092	0.137	2.488
69	0.2	2.6	9828	0.125	2.585	9835	-0.472	-0.094	0.159	2.542
70	0.25	2.6	9900	0.1	2.575	9916	-0.413	-0.069	0.172	2.537
71	0.4	2.65	10402	0.1	2.6	10443	-0.322	-0.054	0.245	2.574
72	0.175	2.675	9729	0.075	2.7	9738	-0.489	0.122	0.123	2.635
73	0.2	2.675	9753	0.12	2.675	9773	-0.176	0.000	0.157	2.623
74	0.2	2.75	10242	0.1	2.75	10252	-0.440	0.000	0.147	2.696
75	0.175	2.775	10264	0.09	2.8	10273	-0.416	0.122	0.130	2.733
76	0.6	2.8	20668	0.1	2.8	20717	-0.449	0.000	0.343	2.745
77	0.2	2.85	10307	0.1	2.85	10320	-0.339	0.000	0.147	2.794
78	0.7	2.9	14823	0.1	2.925	14896	-0.362	0.015	0.392	2.855
79	0.25	2.95	10255	0.1	2.9	10278	-0.287	-0.096	0.172	2.868

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.55	2.95	19098	0.1	2.775	19162	-0.310	-0.120	0.319	2.806
81	0.7	3	10779	0.1	3.2	10875	-0.275	0.092	0.392	3.039
82	0.7	3	12365	0.1	3	12429	-0.413	0.000	0.392	2.941
83	0.7	3.025	14019	0.125	3.025	14095	-0.333	0.000	0.404	2.966
84	0.575	3.1	10461	0.1	3.075	10511	-0.418	-0.022	0.331	3.027
85	0.65	3.15	12100	0.1	3.3	12162	-0.391	0.107	0.368	3.162
86	0.675	3.15	14179	0.1	3.425	14246	-0.378	0.181	0.380	3.223
87	0.7	3.2	10707	0.1	3.3	10770	-0.420	0.070	0.392	3.186
88	0.6	3.2	13407	0.1	3.275	13473	-0.334	0.050	0.343	3.174
89	0.6	3.25	14423	0.1	3.275	14474	-0.432	0.022	0.343	3.199
90	0.7	3.3	11902	0.1	3.25	11971	-0.383	-0.032	0.392	3.211
91	0.7	3.35	12332	0.1	3.375	12436	-0.254	0.011	0.392	3.297
92	0.65	3.35	14659	0.1	3.625	14743	-0.288	0.144	0.368	3.419
93	0.7	3.375	12645	0.1	3.425	12710	-0.407	0.034	0.392	3.333
94	0.7	3.4	12919	0.1	3.375	13003	-0.315	-0.013	0.392	3.321
95	0.6	3.425	14474	0.075	3.55	14534	-0.385	0.092	0.331	3.419
96	0.6	3.475	11273	0.1	3.525	11334	-0.361	0.036	0.343	3.431
97	0.6	3.475	12496	0.1	3.65	12567	-0.310	0.109	0.343	3.493
98	0.6	3.525	14601	0.1	3.65	14663	-0.355	0.089	0.343	3.517
99	0.7	3.625	11461	0.1	3.625	11566	-0.252	0.000	0.392	3.554
100	0.65	3.625	13067	0.1	3.7	13155	-0.275	0.038	0.368	3.591
101	0.65	3.65	11892	0.1	3.55	11979	-0.278	-0.051	0.368	3.529

Notes:
(1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

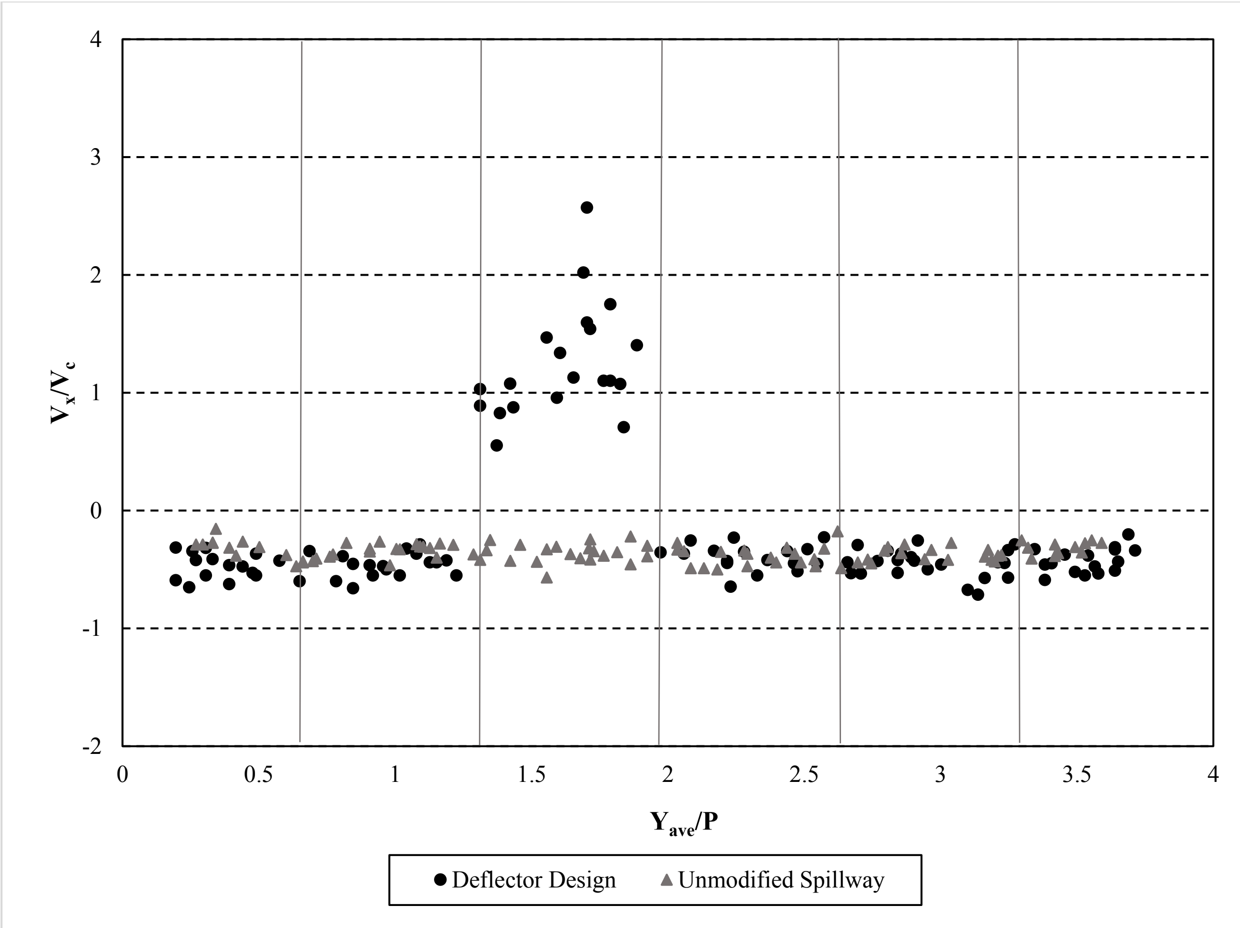

Figure 39: HW 1.10P TW 0.69P, Design Simulations Results

Table 37: HW 1.10P TW 0.95P, Multiple Staggered Deflector Design Simulation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	0.3	0.15	30115	0.05	0.2	30141	-0.424	0.085	0.172	0.172
2	0.15	0.15	56194	0.6	0.25	56251	0.348	0.077	0.368	0.196
3	0.2	0.2	30223	0.6	0.25	30275	0.508	0.042	0.392	0.221
4	0.15	0.25	37337	0.6	0.15	37367	0.661	-0.147	0.368	0.196
5	0.2	0.25	56077	0.1	0.2	56107	-0.147	-0.073	0.147	0.221
6	0.3	0.35	37302	0.075	0.275	37331	-0.342	-0.114	0.184	0.306
7	0.075	0.35	55682	0.6	0.475	55718	0.642	0.153	0.331	0.404
8	0.1	0.35	19684	0.6	0.5	55718	0.001	0.000	0.343	0.417
9	0.375	0.35	56013	0.1	0.25	20049	0.000	0.000	0.233	0.294
10	0.1	0.4	30006	0.6	0.425	30038	0.688	0.034	0.343	0.404
11	0.1	0.4	55996	0.375	0.35	56014	0.673	-0.122	0.233	0.368
12	0.3	0.45	29976	0.1	0.25	30010	-0.259	-0.259	0.196	0.343
13	0.3	0.55	37242	0.075	0.375	37270	-0.354	-0.275	0.184	0.453
14	0.225	0.55	47269	0.6	0.45	47289	0.826	-0.220	0.404	0.490
15	0.15	0.55	55404	0.675	0.475	55437	0.701	-0.100	0.404	0.502
16	0.2	0.6	55374	0.1	0.5	55394	-0.220	-0.220	0.147	0.539
17	0.1	0.625	55353	0.6	0.575	55391	0.580	-0.058	0.343	0.588
18	0.1	0.625	55367	0.2	0.6	55373	0.734	-0.184	0.147	0.600
19	0.1	0.675	29956	0.3	0.55	29967	0.801	-0.501	0.196	0.600
20	0.05	0.675	37227	0.3	0.6	37238	1.001	-0.300	0.172	0.625
21	0.1	0.7	67033	0.6	0.8	67059	0.847	0.169	0.343	0.735
22	0.15	0.8	65632	0.65	0.775	65656	0.918	-0.046	0.392	0.772
23	0.1	0.8	29904	0.6	0.75	29922	1.224	-0.122	0.343	0.760
24	0.1	0.825	21754	0.6	0.7	21775	1.049	-0.262	0.343	0.748
25	0.1	0.875	66235	0.4	0.85	66244	1.468	-0.122	0.245	0.846
26	0.1	0.9	66575	0.65	0.875	66591	1.514	-0.069	0.368	0.870
27	0.1	0.95	67050	0.6	0.925	67063	1.694	-0.085	0.343	0.919
28	0.2	1.05	7430	0.7	1.05	7444	1.573	0.000	0.441	1.029
29	0.1	1.05	65399	0.6	1.05	65411	1.835	0.000	0.343	1.029
30	0.1	1.05	65602	0.6	1.05	65615	1.694	0.000	0.343	1.029
31	0.1	1.1	12303	0.6	1.125	12317	1.573	0.079	0.343	1.091
32	0.1	1.15	9827	0.6	1.2	9841	1.573	0.157	0.343	1.152
33	0.1	1.15	7595	0.6	1.15	7607	1.835	0.000	0.343	1.127
34	0.1	1.25	7967	0.7	1.2	7981	1.888	-0.157	0.392	1.201
35	0.1	1.25	20218	0.7	1.15	20235	1.555	-0.259	0.392	1.176
36	0.1	1.25	65369	0.65	1.15	65384	1.615	-0.294	0.368	1.176
37	0.1	1.3	9562	0.6	1.275	9574	1.835	-0.092	0.343	1.262
38	0.1	1.325	7949	0.7	1.25	7979	0.881	-0.110	0.392	1.262
39	0.1	1.35	10004	0.6	1.4	10042	0.580	0.058	0.343	1.348

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.25	1.4	7925	0.1	1.45	7965	-0.165	0.055	0.172	1.397
41	0.375	1.45	7997	0.1	1.4	8046	-0.247	-0.045	0.233	1.397
42	0.3	1.45	10951	0.125	1.5	11003	-0.148	0.042	0.208	1.446
43	0.3	1.5	8907	0.125	1.5	8937	-0.257	0.000	0.208	1.471
44	0.25	1.55	8215	0.15	1.6	7650	0.008	-0.004	0.196	1.544
45	0.6	1.55	8251	0.25	1.7	8379	-0.120	0.052	0.417	1.593
46	0.5	1.65	8009	0.1	1.65	7458	0.032	0.000	0.294	1.618
47	0.4	1.65	8519	0.2	1.8	8561	-0.210	0.157	0.294	1.691
48	0.6	1.65	8865	0.2	1.75	8927	-0.284	0.071	0.392	1.667
49	0.4	1.7	8287	0.15	1.75	8319	-0.344	0.069	0.270	1.691
50	0.45	1.75	7838	0.15	1.7	7890	-0.254	-0.042	0.294	1.691
51	0.4	1.75	8110	0.25	1.7	8145	-0.189	-0.063	0.319	1.691
52	0.5	1.8	8656	0.15	1.7	8712	-0.275	-0.079	0.319	1.716
53	0.25	1.85	7482	0.15	1.85	7501	-0.232	0.000	0.196	1.814
54	0.55	1.85	7828	0.2	1.7	7895	-0.230	-0.099	0.368	1.740
55	0.4	1.875	7686	0.15	1.8	7735	-0.225	-0.067	0.270	1.801
56	0.5	1.95	7558	0.15	1.85	7660	-0.151	-0.043	0.319	1.863
57	0.325	1.95	8421	0.125	1.85	7501	0.008	0.005	0.221	1.863
58	0.4	1.975	10928	0.125	1.975	10960	-0.379	0.000	0.257	1.936
59	0.25	2	7466	0.05	2	7501	-0.252	0.000	0.147	1.961
60	0.4	2.025	9745	0.15	2	9774	-0.380	-0.038	0.270	1.973
61	0.15	2.075	13210	0.025	2.125	13236	-0.212	0.085	0.086	2.059
62	0.325	2.15	14457	0.025	2.225	14495	-0.348	0.087	0.172	2.145
63	0.225	2.15	14656	0.05	2.15	14679	-0.335	0.000	0.135	2.108
64	0.5	2.25	45698	0.1	2.35	45747	-0.360	0.090	0.294	2.255
65	0.4	2.25	45929	0.1	2.25	45973	-0.300	0.000	0.245	2.206
66	0.175	2.275	19310	0.05	2.35	19331	-0.262	0.157	0.110	2.267
67	0.5	2.3	14574	0.1	2.25	14620	-0.383	-0.048	0.294	2.230
68	0.175	2.3	45768	0.05	2.375	45800	-0.172	0.103	0.110	2.292
69	0.4	2.4	46278	0.025	2.425	46321	-0.384	0.026	0.208	2.365
70	0.5	2.425	67928	0.025	2.45	67975	-0.445	0.023	0.257	2.390
71	0.15	2.45	19377	0.025	2.55	18196	0.005	-0.004	0.086	2.451
72	0.3	2.55	19819	0.05	2.5	19880	-0.181	-0.036	0.172	2.475
73	0.175	2.55	36947	0.05	2.65	36997	-0.110	0.088	0.110	2.549
74	0.5	2.55	45858	0.1	2.85	45939	-0.218	0.163	0.294	2.647
75	0.25	2.6	33796	0.05	2.625	33821	-0.352	0.044	0.147	2.561
76	0.25	2.625	19754	0.05	2.6	19787	-0.267	-0.033	0.147	2.561
77	0.4	2.65	45881	0.1	2.85	45939	-0.228	0.152	0.245	2.696
78	0.2	2.7	19401	0.05	2.725	19432	-0.213	0.036	0.123	2.659
79	0.15	2.7	19506	0.05	2.75	19526	-0.220	0.110	0.098	2.672

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.4	2.75	19590	0.1	2.75	19621	-0.426	0.000	0.245	2.696
81	0.4	2.775	19521	0.05	2.8	19561	-0.385	0.028	0.221	2.733
82	0.3	2.85	19613	0.1	2.9	19644	-0.284	0.071	0.196	2.819
83	0.35	2.875	20358	0.05	2.95	20385	-0.489	0.122	0.196	2.855
84	0.45	2.9	19689	0.025	2.9	19752	-0.297	0.000	0.233	2.843
85	0.5	2.95	19685	0.025	2.925	19754	-0.303	-0.016	0.257	2.880
86	0.475	2.95	22471	0.1	2.975	22510	-0.424	0.028	0.282	2.904
87	0.45	3.05	19900	0.05	3.05	19934	-0.518	0.000	0.245	2.990
88	0.4	3.05	20038	0.05	2.975	20077	-0.395	-0.085	0.221	2.953
89	0.3	3.05	20142	0.05	3.05	20175	-0.334	0.000	0.172	2.990
90	0.2	3.1	19732	0.05	3.15	19759	-0.245	0.082	0.123	3.064
91	0.4	3.15	19792	0.1	2.95	19833	-0.322	-0.215	0.245	2.990
92	0.3	3.2	20332	0.075	3.275	20365	-0.300	0.100	0.184	3.174
93	0.2	3.2	20499	0.05	3.25	20524	-0.264	0.088	0.123	3.162
94	0.35	3.25	20660	0.1	3.125	20694	-0.324	-0.162	0.221	3.125
95	0.275	3.275	20399	0.1	3.35	20438	-0.198	0.085	0.184	3.248
96	0.4	3.3	20087	0.05	3.3	20144	-0.270	0.000	0.221	3.235
97	0.275	3.35	20210	0.05	3.35	20259	-0.202	0.000	0.159	3.284
98	0.2	3.375	20852	0.05	3.4	20877	-0.264	0.044	0.123	3.321
99	0.4	3.4	20287	0.05	3.375	20322	-0.440	-0.031	0.221	3.321
100	0.3	3.4	20904	0.05	3.45	20932	-0.393	0.079	0.172	3.358
101	0.2	3.55	21058	0.05	3.575	21071	-0.508	0.085	0.123	3.493
102	0.3	3.55	21751	0.025	3.675	21809	-0.209	0.095	0.159	3.542
103	0.3	3.55	21805	0.025	3.475	21839	-0.356	-0.097	0.159	3.444
104	0.2	3.6	21003	0.025	3.625	21039	-0.214	0.031	0.110	3.542
105	0.25	3.6	21685	0.025	3.575	21723	-0.261	-0.029	0.135	3.517
106	0.3	3.65	21114	0.025	3.675	21162	-0.252	0.023	0.159	3.591
107	0.175	3.7	21179	0.05	3.675	21197	-0.306	-0.061	0.110	3.615
108	0.3	3.725	21518	0.05	3.6	21569	-0.216	-0.108	0.172	3.591
109	0.25	3.725	21275	0.05	3.725	21299	-0.367	0.000	0.147	3.652
110	0.2	3.775	21600	0.05	3.775	21635	-0.189	0.000	0.123	3.701
111	0.3	3.8	21357	0.05	3.775	21394	-0.298	-0.030	0.172	3.713

Notes: (1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

Table 38: HW 1.10P TW 0.95P, Unmodified Spillway Simulation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
1	0.65	0.35	32102	0.1	0.25	32546	-0.055	-0.010	0.368	0.294
2	0.725	0.35	35143	0.1	0.55	35711	-0.048	0.016	0.404	0.441
3	0.55	0.35	36102	0.1	0.2	36500	-0.050	-0.017	0.319	0.270
4	0.6	0.375	22219	0.1	0.3	22515	-0.074	-0.011	0.343	0.331
5	0.6	0.425	93034	0.125	0.3	93190	-0.134	-0.035	0.355	0.355
6	0.675	0.45	22227	0.1	0.425	22433	-0.123	-0.005	0.380	0.429
7	0.6	0.55	79949	0.1	0.225	80227	-0.079	-0.051	0.343	0.380
8	0.6	0.55	89934	0.1	0.65	90110	-0.125	0.025	0.343	0.588
9	0.7	0.55	4833	0.075	0.875	5145	-0.088	0.046	0.380	0.699
10	0.6	0.575	90878	0.1	0.5	91138	-0.085	-0.013	0.343	0.527
11	0.6	0.625	6352	0.075	0.725	6660	-0.075	0.014	0.331	0.662
12	0.7	0.65	82527	0.075	0.275	82802	-0.100	-0.060	0.380	0.453
13	0.7	0.75	80311	0.1	0.425	80687	-0.070	-0.038	0.392	0.576
14	0.7	0.75	4855	0.075	0.925	5200	-0.080	0.022	0.380	0.821
15	0.6	0.75	4930	0.1	0.95	5229	-0.074	0.029	0.343	0.833
16	0.6	0.775	91020	0.1	0.2	91400	-0.058	-0.067	0.343	0.478
17	0.7	0.825	4930	0.1	0.775	5376	-0.059	-0.005	0.392	0.784
18	0.7	0.85	80923	0.1	0.35	81238	-0.084	-0.070	0.392	0.588
19	0.6	0.875	2295	0.075	0.675	2451	-0.148	-0.056	0.331	0.760
20	0.6	0.925	17017	0.1	0.875	17246	-0.096	-0.010	0.343	0.882
21	0.6	0.925	17018	0.1	0.975	17239	-0.100	0.010	0.343	0.931
22	0.7	1	20611	0.1	0.9	20992	-0.069	-0.012	0.392	0.931
23	0.75	1.05	89026	0.1	1.425	89371	-0.083	0.048	0.417	1.213
24	0.7	1.075	77856	0.1	0.9	78129	-0.097	-0.028	0.392	0.968
25	0.6	1.125	60910	0.1	0.975	61074	-0.134	-0.040	0.343	1.029
26	0.7	1.15	49250	0.1	1.05	49625	-0.070	-0.012	0.392	1.078
27	0.7	1.225	48873	0.1	1.325	49314	-0.060	0.010	0.392	1.250
28	0.6	1.225	77849	0.1	1.05	78045	-0.112	-0.039	0.343	1.115
29	0.75	1.25	88978	0.1	1.55	89331	-0.081	0.037	0.417	1.373
30	0.5	1.3	88224	0.1	1.35	88373	-0.118	0.015	0.294	1.299
31	0.525	1.325	75913	0.1	0.85	76062	-0.126	-0.140	0.306	1.066
32	0.6	1.35	86780	0.1	1.2	87114	-0.066	-0.020	0.343	1.250
33	0.6	1.375	49420	0.1	1.4	49674	-0.087	0.004	0.343	1.360
34	0.6	1.4	49051	0.1	1.325	49298	-0.089	-0.013	0.343	1.336
35	0.6	1.45	49498	0.1	1.5	49703	-0.107	0.011	0.343	1.446
36	0.6	1.5	49951	0.125	1.75	50247	-0.071	0.037	0.355	1.593
37	0.55	1.55	51393	0.1	1.575	51556	-0.122	0.007	0.319	1.532
38	0.575	1.55	51420	0.1	1.65	51691	-0.077	0.016	0.331	1.569
39	0.6	1.575	53964	0.1	1.25	54226	-0.084	-0.055	0.343	1.385

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
40	0.55	1.575	51160	0.1	1.675	51348	-0.105	0.023	0.319	1.593
41	0.6	1.65	51257	0.1	1.65	51457	-0.110	0.000	0.343	1.618
42	0.6	1.7	48916	0.1	1.55	49122	-0.107	-0.032	0.343	1.593
43	0.6	1.7	50352	0.125	1.75	50511	-0.132	0.014	0.355	1.691
44	0.6	1.75	50317	0.1	1.8	50562	-0.090	0.009	0.343	1.740
45	0.7	1.8	57317	0.1	1.825	57599	-0.094	0.004	0.392	1.777
46	0.6	1.85	51753	0.1	2.075	51927	-0.127	0.057	0.343	1.924
47	0.65	1.85	51753	0.1	2.2	51992	-0.101	0.065	0.368	1.985
48	0.6	1.9	48536	0.075	1.325	48807	-0.085	-0.093	0.331	1.581
49	0.5	1.95	51111	0.075	2	51282	-0.109	0.013	0.282	1.936
50	0.7	1.95	51816	0.1	2.225	52123	-0.086	0.039	0.392	2.047
51	0.575	1.975	51435	0.1	1.9	51721	-0.073	-0.012	0.331	1.900
52	0.5	2.025	50779	0.075	2.075	50958	-0.105	0.012	0.282	2.010
53	0.55	2.05	50361	0.1	2.05	50483	-0.162	0.000	0.319	2.010
54	0.6	2.075	52028	0.075	2.2	52264	-0.098	0.023	0.331	2.096
55	0.65	2.1	51575	0.1	2.275	51990	-0.058	0.019	0.368	2.145
56	0.5	2.15	49776	0.1	2.05	49950	-0.101	-0.025	0.294	2.059
57	0.575	2.175	52136	0.1	2.175	52310	-0.120	0.000	0.331	2.132
58	0.7	2.225	47969	0.1	2.05	48259	-0.091	-0.027	0.392	2.096
59	0.6	2.225	52242	0.1	2.3	52458	-0.102	0.015	0.343	2.218
60	0.625	2.3	52750	0.075	2.325	52907	-0.154	0.007	0.343	2.267
61	0.525	2.325	50433	0.1	2.35	50602	-0.111	0.007	0.306	2.292
62	0.6	2.35	52192	0.1	2.55	52492	-0.073	0.029	0.343	2.402
63	0.6	2.4	27317	0.1	2.75	27534	-0.101	0.071	0.343	2.525
64	0.6	2.4	52465	0.1	2.5	52657	-0.115	0.023	0.343	2.402
65	0.55	2.45	48847	0.1	2.375	49018	-0.116	-0.019	0.319	2.365
66	0.6	2.55	8415	0.1	2.825	8633	-0.101	0.056	0.343	2.635
67	0.7	2.55	26717	0.2	3.5	27072	-0.062	0.118	0.441	2.966
68	0.75	2.55	41952	0.1	2.975	42296	-0.083	0.054	0.417	2.708
69	0.575	2.575	7768	0.1	2.725	7988	-0.095	0.030	0.331	2.598
70	0.5	2.6	7542	0.1	2.65	7680	-0.128	0.016	0.294	2.574
71	0.7	2.65	7432	0.075	2.6	7726	-0.094	-0.007	0.380	2.574
72	0.7	2.725	20489	0.25	3.25	20716	-0.087	0.102	0.466	2.929
73	0.7	2.75	20254	0.075	3.15	20470	-0.127	0.082	0.380	2.892
74	0.7	2.75	20384	0.1	3.35	20666	-0.094	0.094	0.392	2.990
75	0.7	2.825	37921	0.1	2.975	38155	-0.113	0.028	0.392	2.843
76	0.7	2.825	41457	0.1	3.275	41694	-0.112	0.084	0.392	2.990
77	0.7	2.85	42249	0.1	3.375	42643	-0.067	0.059	0.392	3.051
78	0.5	2.95	7686	0.075	3.125	7811	-0.150	0.062	0.282	2.978
79	0.7	2.95	15122	0.075	2.85	15450	-0.084	-0.013	0.380	2.843

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
#	**x_1 [ft]**	**y_1 [ft]**	**$Frame_1$**	**x_2 [ft]**	**y_2 [ft]**	**$Frame_2$**	**V_x/V_c**	**V_y/V_c**	**x_{ave}/P**	**y_{ave}/P**
80	0.7	2.95	15162	0.1	3.05	15487	-0.081	0.014	0.392	2.941
81	0.725	2.975	32439	0.1	3.075	32954	-0.053	0.009	0.404	2.966
82	0.525	2.975	33374	0.1	3.1	33624	-0.075	0.022	0.306	2.978
83	0.7	3.025	14977	0.1	2.75	15308	-0.080	-0.037	0.392	2.831
84	0.7	3.075	33049	0.125	3.125	33237	-0.135	0.012	0.404	3.039
85	0.7	3.125	38122	0.2	3.6	38489	-0.060	0.057	0.441	3.297
86	0.7	3.15	11608	0.225	3.4	11803	-0.107	0.056	0.453	3.211
87	0.7	3.175	12629	0.225	3.55	12824	-0.107	0.085	0.453	3.297
88	0.7	3.175	13365	0.1	3.45	13580	-0.123	0.056	0.392	3.248
89	0.5	3.2	7259	0.075	3.175	7409	-0.125	-0.007	0.282	3.125
90	0.7	3.275	12958	0.2	3.7	13334	-0.059	0.050	0.441	3.419
91	0.7	3.325	15033	0.1	3.1	15308	-0.096	-0.036	0.392	3.150
92	0.7	3.325	28435	0.2	3.75	28639	-0.108	0.092	0.441	3.468
93	0.7	3.4	11057	0.2	3.525	11181	-0.178	0.044	0.441	3.395
94	0.7	3.4	13660	0.1	3.5	14031	-0.071	0.012	0.392	3.382
95	0.6	3.45	13583	0.1	3.55	13870	-0.077	0.015	0.343	3.431
96	0.7	3.475	13795	0.1	3.7	14142	-0.076	0.029	0.392	3.517
97	0.65	3.5	13660	0.1	3.675	13957	-0.082	0.026	0.368	3.517
98	0.6	3.525	14014	0.1	3.725	14305	-0.076	0.030	0.343	3.554
99	0.55	3.6	13605	0.15	3.85	13877	-0.065	0.040	0.343	3.652
100	0.6	3.6	16432	0.1	3.7	16788	-0.062	0.012	0.343	3.578
101	0.55	3.65	16043	0.1	3.825	16340	-0.067	0.026	0.319	3.664

Notes:
(1) measurement number
(2) 1st x-position
(3) 1st y-position
(4) 1st frame
(5) 2nd x-position
(6) 2nd y-position
(7) 2nd frame
(8) velocity in x-direction
(9) velocity in y-direction
(10) average x-position
(11) average y-position

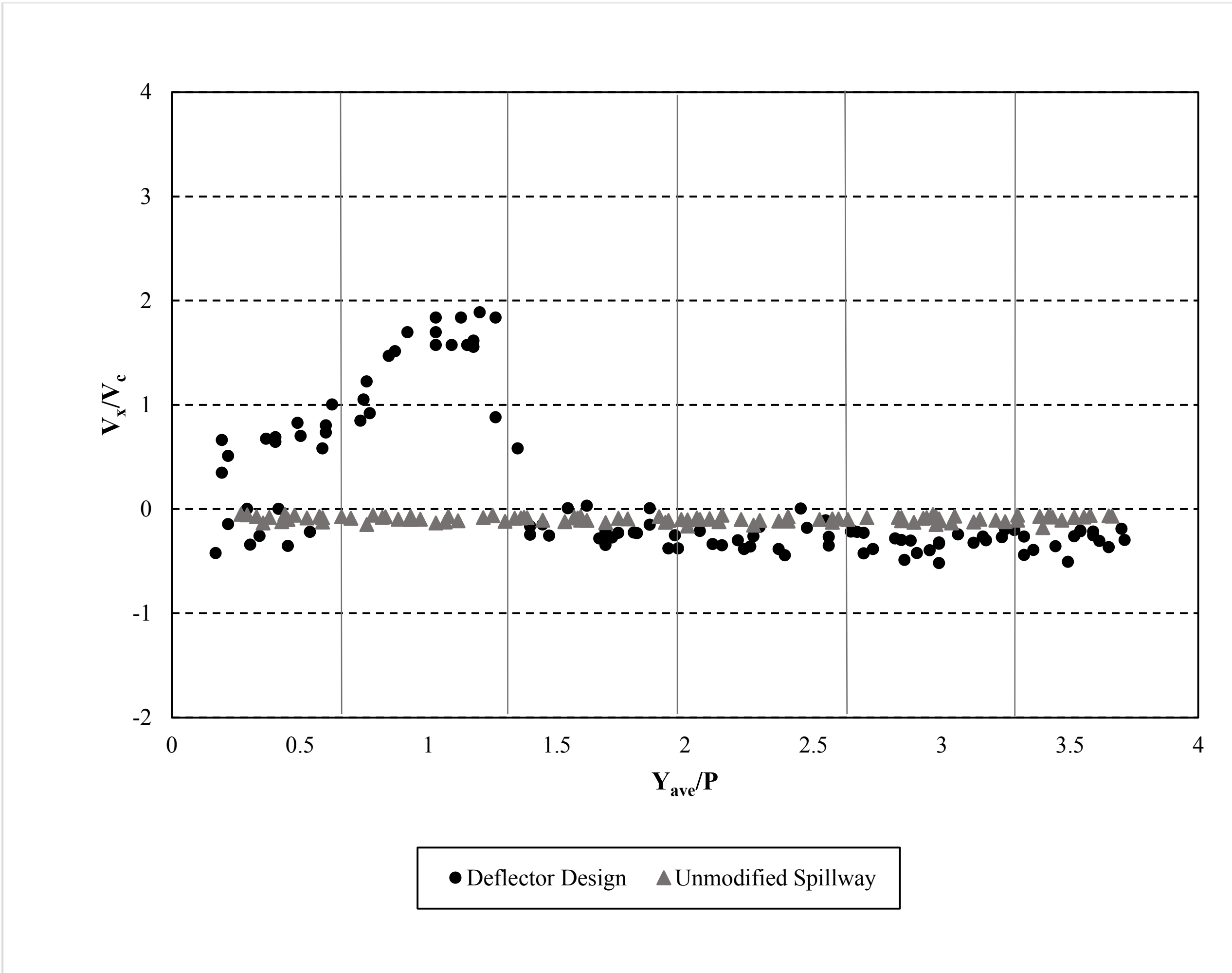

Figure 40: HW 1.10P TW 0.95P, Design Simulations Results