US Army Corps of Engineers®

Portland District

Letter Report

The Dalles Lock and Dam
Spillway Redistribution
Vortex Suppression Device (VSD)

Columbia River, Oregon-Washington

September 2006

COMPLETION OF INDEPENDENT TECHNICAL REVIEW:

The District has completed the100% Review of The Dalles Spillway Redistribution – Vortex Suppression Device (VSD) Letter Report. Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project, as defined in the Quality Control Plan. During the independent technical review, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of assumptions; methods, procedures, and material used in analyses; alternatives evaluated; the appropriateness of data used, and level of data obtained; and reasonableness of the results including whether the product meets the customer's needs consistent with law and existing Corps policy.

Technical Review Team Leader — 9/22/2006 (Date)

CERTIFICATION OF INDEPENDENT TECHNICAL REVIEW:

Significant concerns and the explanation of the resolutions are as follows:

A dynamic analysis of the VSDs should be performed during Plans & Specifications development to ensure the stability of the structure under flowing water conditions.

As noted above, all concerns resulting from independent technical review of the project have been considered. The report and all associated documents required by the National Environmental Policy Act, have been fully reviewed.

Chief, Engineering and Construction Division — 9/27/06 (Date)

For Chief, Operations Division — 9/28/06 (Date)

Chief, Real Estate Division — 9/29/2006 (Date)

CERTIFICATION OF LEGAL REVIEW:

The Letter Report for The Dalles Spillway Redistribution – Vortex Suppression Device (VSD) including all associated documents required by the National Environmental Policy Act, has been fully reviewed by the Office of Counsel, Portland District, and is approved as legally sufficient.

District Counsel — 10-2-2006 (Date)

TECHNICAL DOCUMENTATION APPROVAL:

The Letter Report for The Dalles Spillway Redistribution – Vortex Suppression Device (VSD) is approved.

District Commander — 3 OCT '06 (Date)

EXECUTIVE SUMMARY

This letter report covers the design, construction, operation, and maintenance of the proposed Spillway Redistribution – Vortex Suppression Device (VSD) at The Dalles Lock and Dam (TDA). This report describes the background of the project, outlines the technical aspects of the design, and describes operations, maintenance, and construction concerns. The working cost estimate and records of coordination between CENWP and other agencies and customers is also included.

Based on a construction midpoint of January 2007, the cost of constructing VSDs for Bays 6 and 7 is $1,750,800 with a 20 percent contingency. Planning, Engineering, and Design costs are estimated at $410,000 with 20 percent contingency. Construction Management costs are estimated at $121,300 with a 20 percent contingency. Total project costs of construction, design, management, escalation and contingency is $2,282,100.

After spillwall construction, the juvenile spill pattern shifted to a concentrated flow of water between Bays from 1 to 6 (from North to South). As water flow wraps laterally to the North around the Southern Bay 6 spillway pier a large vortex forms. Hydraulic modeling and forebay fish passage distribution studies suggest that this vortex creates a large surface zone of influence that proves attractive to passing fish. For example, in a post construction spillwall evaluation in 2004 the majority of fish passing Bay 6 navigated through the Southern portion of the Bay (Cash et al. 2005). Similarly, in a 2005 post construction spillwall evaluation, roughly 66 percent of the fish typically passed spill through Bays 5 and 6, whereas, roughly 33 percent of the fish passed through Bays from 1 to 4 (John Beeman, Fishery Biologist, personal communication). These data indicate that in 2005 over 50% of fish passing the project passed through Bays 5 and 6. Spillway fish survival studies since the spillwall was constructed have shown that juvenile fish survival for Bays 5 and 6 was 89 percent to 92 percent, whereas, the survival of fish passing in Bays from 1 to 4 was estimated at roughly 97 percent (Counihan et al 2006a, 2006b).. Therefore it is thought that suppressing the vortex could provide a more even distribution of juvenile salmon passing the spillway.

The lower estimated survival rates through Bays 5 and 6 are believed related to predation in proximity to the hydraulic edge of turbulent water that occurs on the stilling basin shelf, just beyond the end sill. Predators hold in the relatively slack water waiting for juvenile salmonids, disoriented from passage, to become available in this area. In an effort to diminish the amount of predator holding habitats in proximity to fish passing Bay 5 and 6 it is proposed that a training spill out of Bay 7 (i.e., from 3 to 5 thousand cubic feet per second (KCFS)) be tested. Results from tests on the 1:80 scale general model, and CFD models suggest that training spill from Bay 7 should act to flush predators from such optimal foraging areas. As such, a test of providing training spill from Bay 7 will be conducted to determine it's effectiveness at providing a buffer zone between passing juveniles and foraging predators. Testing at the dam indicates that even the small openings being proposed for the Bay 7 training spill will cause a vortex to form in Bay7. Therefore Bay 7 will also be outfitted with a VSD to ensure no vortex forms in this bay, and provide juvenile guidance to the northern bays. Such guidance to the north should encourage passage in areas with lower probabilities of predator prey encounter, thereby, enhancing the overall survival rates of fish passing via spill.

Results from tests on the 1:25 scale sectional spillway model, the 1:80 scale general model, and CFD models indicate to achieve maximum vortex suppression along with lateral guidance, a vortex suppression device with an 8 foot nominal draft would be required on the pier nose in combination with a 12 foot nominal draft vortex suppression device in the stoplog slot. Both devices would be similar to typical stoplog/bulkhead devices with solid skin plates on the upstream face and bolt-on solid polyethylene panels on the downstream face to keep juvenile fish that might be caught in the back roller between devices from being trapped into the structure.

It is recommended that the proposed VSDs be constructed and tested in Bays 6 and 7 as documented in this report.

THE DALLES LOCK AND DAM
SPILLWAY DISTRIBUTION
VORTEX SUPPRESSION DEVICE

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THE DALLES LOCK AND DAM

VORTEX SUPPRESSION DEVICES

1. PURPOSE AND SCOPE

This Letter Report presents the technical details of the main features of the proposed Spillway Redistribution Project, Bays 6 and 7 Vortex Suppression Devices at The Dalles Lock and Dam (TDA). The overall implementation plan for fish passage improvements can be found in The Dalles Configuration and Operation Plan (COP) Document.

October 2006. U.S. Army Engineer Portland District, 90 percent Draft Configuration and Operation Plan (COP), The Dalles Lock and Dam, Behavior Guidance System (BGS), Columbia River, Oregon and Washington.

2. PROJECT AUTHORIZATION

a. General Information. The Dalles Lock and Dam Project was authorized by the River and Harbor Act of May 17, 1950. The multi-purpose project is part of the Columbia River navigation system and provides recreational, hydropower, and navigation benefits.

b. Authorization. The Energy and Water Development Appropriation Bill, 1995, directed the Corps to use additional appropriations to aggressively improve effectiveness and efficiency of the bypass systems, reduce mortality by predators, and enhance passage conditions.

c. Objectives. The NMFS 2004 Biological Opinion on Remand for Operation of the Columbia River Power System (BiOp) states that through 2007 the Corps will focus on actions that were initiated under the 2000 BiOp and are continuing based on the need to improve passage survival rates at main stem projects. Action plans are underway to guide specific actions at each of the Lower Snake and Columbia River projects and to determine the optimal combination of adult and juvenile passage actions to meet the system performance standards. The Updated Proposed Actions (UPA) provided by the Action Agencies identifies a targeted goal of achieving 98 percent TDA spillway passage survival. The UPA further identifies key post-spillwall alternatives under development for TDA; including, spillway improvements, a forebay behavioral guidance structure (BGS), sluiceway guidance efficiency modifications, sluiceway outfall relocation, and turbine survival improvements. Because spillway passage survival estimates from 2004 and 2005 indicate that survival is less than 98 percent, the UPA further directs the Action Agencies to continue to pursue additional improvements to achieve the targeted 98 percent spillway passage survival.

3. PROJECT LOCATION

The Dalles Lock and Dam is located at the head of Lake Bonneville, approximately 192 miles upstream of the mouth of the Columbia River. Construction of TDA began in 1952, and water was first impounded in 1957.

4. PROJECT FEATURES

The project includes a navigation lock, spillway, powerhouse, fish passage facilities, ice and trash sluiceway, and the non-overflow dam, see Plate 1. The fish passage facilities for the migration of adult anadromous fish consist of two fish ladders, powerhouse fish collection systems and a transportation channel. The powerhouse has 22 main turbine units, two fish turbine units and two station service units. The fish turbine units provide the attraction flow water for the fish ladders. The powerhouse and the non-overflow dam are at right angles to the main river flow. The spillway contains 23 spillway bays. Each 50-foot wide bay is controlled with a tainter gate (47-foot radius) and is separated from adjoining bays with a 10-foot wide pier. The spillwall was constructed in 2003/2004 and extends from the spillway pier between spillway bays 6 and 7 to the stilling basin end sill.

5. PROBLEM

After spillwall construction, the juvenile spill pattern shifted to a concentrated flow of water between Bays from 1 to 6 (from north to south). As water flow wraps laterally to the north around the Southern Bay 6 spillway pier a large vortex forms, see figures 5.1 and 5.2. Physical observations, computational fluid dynamic (CFD), and hydraulic model studies at the Engineer Research and Development Center - Waterways Experimentation Station (ERDC-WES) indicate the vortex creates a large surface zone of influence that proves attractive to passing fish. Data indicate many fish that bypass the powerhouse, travel downstream until encountering the southern portion of the spillway. Subsequently, fish predominately migrate from South to North along the Spillway, until discovering a potential route of dam passage. Typically, the first potential route of passage fish discover is associated with the large surface draw created by the vortex at Bay 6. For example, in a 2004 post construction spillwall evaluation roughly 66 percent of fish passing via the spillway passed through spillbays 5 and 6, whereas, roughly 33 percent passed through spillbays 1 through 4 (Hansel et al. 2005). These data indicate that in 2004 over 50% of fish passing the project passed through Bays 5 and 6. Post-spillwall fish survival studies have shown that juvenile fish survival for Bays 5 and 6 is roughly 92 percent, whereas, the survival of fish passing in Bays from 1 to 4 was estimated at roughly 97 percent (Counihan et al 2006). In a study evaluating the behaviors of juvenile salmon using three dimensional radio-telemetry the majority of fish passing Bay 6 navigated through the Southern portion of the Bay (Cash et al. 2005). Fish passing the Southern portion of Bay 6 enter the tailrace at the spill's hydraulic edge. Such placement of fish could diminish their probability of successfully navigating away from documented predator holding areas (e.g., Southern tailrace shelf, Basin Islands, BRZ Island) by encouraging predator prey encounters in these areas (Duran et al. 2003). A depiction of these areas demonstrating described spillway passage, along with downstream predator zones is shown below (Figure 5-3). Physical general scale model studies at ERDC (1:80 scale) and CFD results both demonstrate that structural devices used to suppress the vortex encourage lateral flow of surface water to the North, which should guide fish to redistribute to the north. Such redistribution to the north should increase overall spillway survival rates. As such, suppressing the vortex is considered to be a cost effective solution to redistributing juvenile fish to Bays to the North, thereby, encouraging better tailrace egress and bolstering fish survival rates.

Spillway fish survival numbers, since the spillwall was installed, have shown that survival in Bays 5 and 6 are less than the survival in Bays 1 through 4. Four hypothesis exist as to why the survival is different: 1) increased predation at the edge between a spilling bay and a non-spilling bay, 2) the fate of the juvenile fish in Bays 5 and 6 after they leave the spillway shelf and enter the main thalweg has higher predation than those in Bays 1 through 4, 3) passing through the vortex impacts the juvenile fish ability to avoid predators and 4) a combination of hypothesis 1 and 2. Vortex suppression will address hypothesis 3. The 1:80 general physical model at ERDC-WES supports hypothesis 1 and 2 when dye is released in Bays 1-6. There is an edge effect for dye released in Bays 5 and 6 and poorer egress conditions for Bays 5 and 6. The edge effect was minimized in the general physical model by using training spill in Bay 7. The goal of the training spill was to minimize juvenile migration through Bay 7 and to minimize the edge effect between Bay 6 and Bay 7. Model test suggested that a gate opening of 2 to 3 feet depending on the gate opening of Bays 1-6 would meet the requirement. The evaluation was based on moving dye released in Bays 5 and 6 to the thalweg and not to re-circulate on the spillway shelf. Training spill is considered a way to reduce edge effects and increase survival. The COP identifies this as an interim measure for improving spillway survival.

Figure 5-1   Vortex in Bay 6

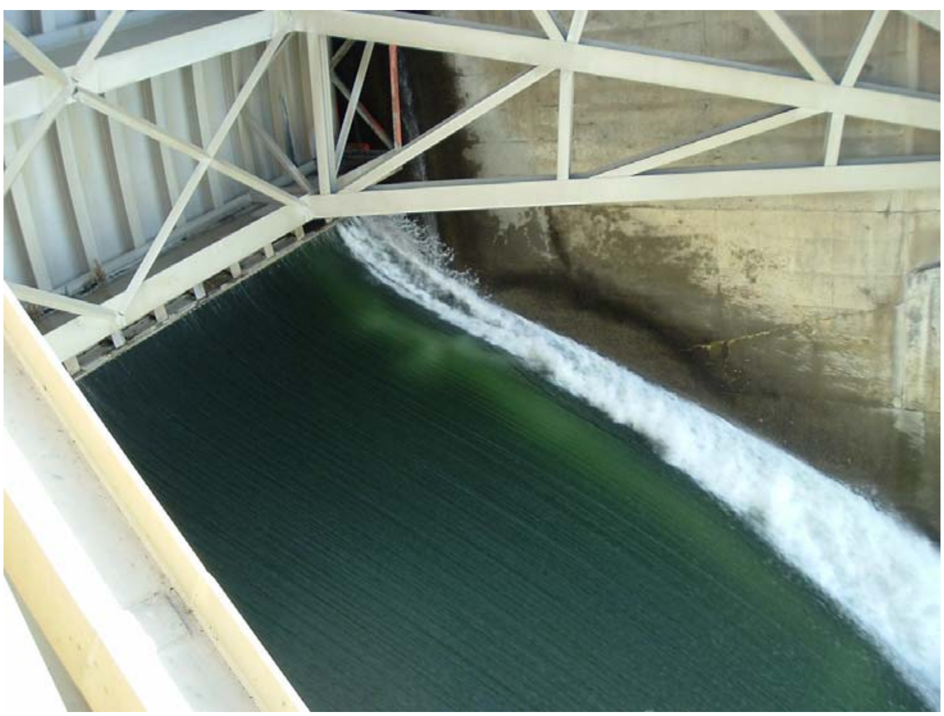

Figure 5-2 Vortex tail under tainter gate and down the ogee

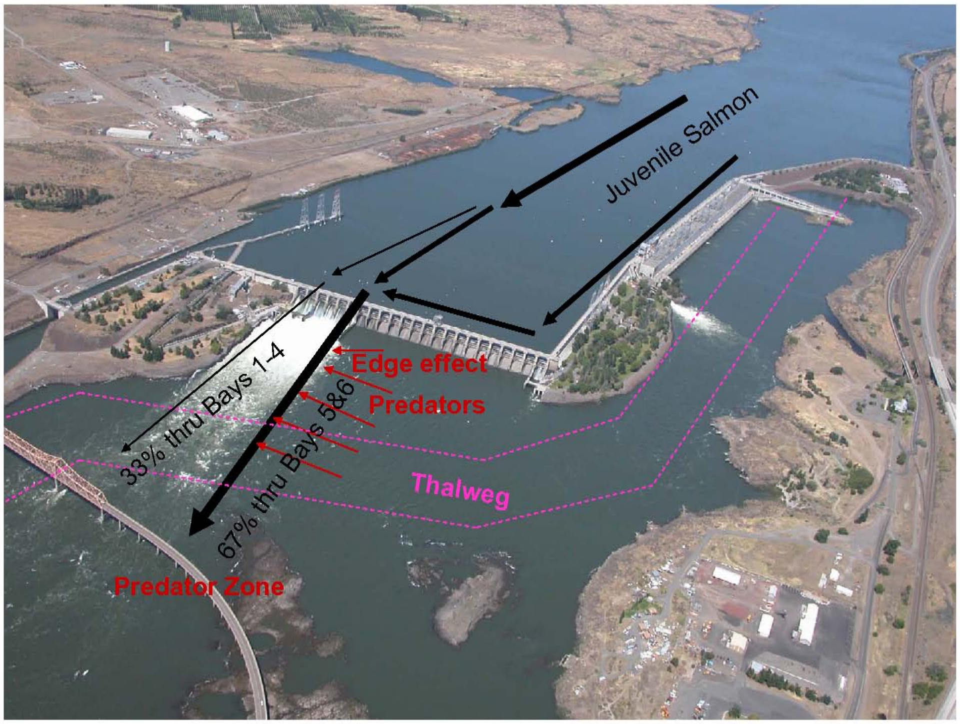

Figure 5-3 Juvenile passage interaction with predators

6. ALTERNATIVES EVALUATION

Physical and numerical hydraulic models were used in the hydraulic design and evaluation of vortex suppression devices considered. A 1:25 sectional model representing 2 ½ spillway bays was used to determine vortex suppression device configurations. A 1:80 general model was used to investigate far field approach flow conditions to the vortex suppression device and egress conditions in the tailrace. Computational fluid dynamics models were used to investigate alternatives and determine flow velocities.

The following design options were considered as vortex suppression devices.

a. Forebay Pier Modification. Reshaping the pier between Bays 6 and 7 could not only suppress the vortex, but could eliminate it. However, the schedule for implementing this suppression device does not allow enough time for hydraulic modeling to accomplish this work. In addition the needed projection into the forebay might have caused some unexpected fish behavior.

b. Floating Vortex Suppression Device in Stoplog Slot. Designing the vortex suppression device to float in the stoplog slot could work, and was tested, at ERDC, and at TDA using a spillway stoplog. The TDA test was limited, due to the 3-foot draft that the stoplog provides, and only suppressed the vortex up to a 10-foot gate opening; however, this test did prove that a vertical barrier plate in this general location could function to suppress the vortex. However, further testing at ERDC found that at the larger, 14-foot, gate openings the vortex was never suppressed, no matter what the draft of the device in the stoplog slot.

c. Vortex Suppression Device on Spillway Pier. This alternative involves mounting a track on the piers and installing the vortex suppression device on the upstream face of the spillway piers. In model testing this appeared to provide a faster movement of confetti and dye to the northern bays than if the device is in the stoplog slot, which reduces that chance that juvenile fish might sound and go through the bay. However, model testing at ERDC determined the following:

(1) A device with a 3-5-foot draft suppressed the vortex in the forebay, but a rather large vortex still existed between the device and the tainter gate.

(2) A device with a 5- to 10-foot draft suppressed all vortices, but created an oscillation between the device and the tainter gate. This oscillation wave is created by the device and the tainter gate each attempting to establish control of the flow, and had a maximum head differential of 5 to 10 feet at a constant period. This condition created unfavorable conditions for the existing tainter gates.

(3) A device with a 13- to 18-foot draft suppressed all vortices, but was so deep that the device controlled flow at very small tainter gate openings and had very large head differentials acting on it.

d. Vortex Suppression Devices in Stoplog Slot and on Spillway Pier. During lab testing at ERDC, it was discovered that placing a device in both locations, stopped the downstream vortex in the 3-5 foot pier nose device, and stopped the oscillation in the 5- to 10-foot pier nose device.

7. SELECTED PLAN

7.1 DESCRIPTION OF PLAN FEATURES

Results from tests on the 1:25 scale sectional spillway model, the 1:80 scale general model, and CFD models indicate to achieve maximum vortex suppression along with lateral guidance, a vortex suppression device with an 8 foot nominal draft would be required on the pier nose in combination with a 12-foot nominal draft vortex suppression device in the stoplog slot. Both devices would be fixed, with bottom elevations of 150 feet on the pier device and 146 feet on the stoplog slot device, therefore the actual draft will vary based on forebay elevations. Both devices would be similar to typical stoplog/bulkhead devices with solid skin plates on the upstream face, and bolt-on solid polyethylene panels to keep juvenile fish that might be caught in the back roller between device from being trapped into the structure.

7.2 DESIGN RATIONAL

a. <u>Biological Considerations</u>. The UPA provided by the Action Agencies identifies a targeted goal of achieving 98 percent TDA spillway passage survival. Post-spillwall fish survival studies have estimated juvenile fish survival rates for Bays 5 and 6 were approximately 92 percent, whereas, the survival of fish passing in Bays from 1 to 4 was estimated at roughly 97 percent (Counihan et al 2006). A causal mechanism associated with the lower survival rates through Bays 5 and 6, in relation to Bays from 1 to 4, has been hypothesized to be predation associated with the 'edge effect' in the tailrace. This edge occurs downstream at the interface of spill from Bay 6, and non-spill from Bay 7, and is believed to result in poor tailrace egress conditions and high predation in this area (i.e., indirect mortality). Data supporting this premise are provided by balloon tag survival studies which showed little physical evidence of mortality from shear and or strike (Normandeau et al. 2005). Juvenile salmonids are particularly vulnerable to predation by avian and piscine predators due to disorientation and stunning induced by pressure changes, turbulence, and shear forces associated with dam-passage events (ISG 2000; Budy et al. 2002). Studies of avian predation show that gull tailrace feeding activity primarily occurs downstream in the turbulent interface created at the hydraulic edge from the intersection of rapidly moving and slack water between Bays 6 and 7 (Madsen et al. 2006).

Moreover, studies of predator prey interactions indicate that the Southern portion of the tailrace; including, the BRZ Island, Bridge Islands, and shelf in the south tailrace provides optimal piscine predator foraging areas (Duran et al. 2003). Taken together, these studies indicate bolstering passage rates through Bays from 1 to 4 would increase overall spillway survival rates. In addition, results from the physical hydraulic model (1:80 scale) suggest providing training spill from Bay 7 should act to flush predators from holding areas beyond Bay 7 within the tailrace, ultimately reducing indirect effects on juvenile salmon.

The physical hydraulic model (1:80) and computational fluid dynamic (CFD) model results both suggest that a vortex suppression device (VSD) at Bay 6, in concert with a VSD at Bay 7 (recall, training spill will require a VSD at Bay 7) to suppress the vortex that will form will act to guide fish to the Northern Spillway and improve egress and survival rates. As such, providing a more benign passage environment in concert with redistribution of fish to the Northern bays should enhance overall spillway survival rates by reducing predator prey encounters.

Potential Effects of VSD(s). Potential effects of VSD(s) on fish survival and guidance include:

(1) Direct and Indirect Effects on Juvenile Salmonid Survival. It is anticipated that providing a more benign passage environment through vortex suppression will improve direct survival and injury rates and reduce indirect affects (i.e., predation) through redistributing fish to the north. However, the amount of improvement that will be attained is unclear. Because spillway redistribution is designed to enhance survival rates for fish passing spill; it will be necessary to compare the survival rates from bays with lower documented survival (5 & 6) to bays with higher survival rates (1 to 4) to verify where mortalities are occurring. These data can then be used to determine, if spillway survival goals are not being met, where additional improvements can be attained.

(2) Spillway Redistribution (Guidance). Like evaluating causal mechanisms affecting survival rates, there is a need to evaluate the effects of VSD(s) on redistributing fish to the more Northern spillbays. Redistributing fish to what are deemed the optimal passage locations should provide for more dispersed spillway passage, potentially increasing overall spillway survival for juvenile salmonids. Because spill is now typically concentrated through bays from 1 to 6, dispersed passage among these six bays should help spread the risk(s) associated with concentrated passage distributions (e.g., predators). Indirect survival improvements are expected to be realized through dispersed fish passage and enhanced egress as a result of VSD guidance to the Northern bays.

Prototype Test. The Prototype VSD(s) in Bays 6 and 7, in concert with water flow releases (i.e., training spill) from Bay 7 (~ 3 to 5 thousand cubic feet per second (Kft^3/s)) will be evaluated with radio telemetry survival studies. These studies will be designed to estimate survival and compare survival rates from yearling and subyearling Chinook salmon passing Bays 5 and 6, in relation to survival rates in Bays from 1 to 4. The survival rates and behavior of yearling Chinook salmon will be used as a proxy for survival rates and behavior of juvenile steelhead.

To better understand the effect of migration pathways through the tailrace; stilling basin residence times, post-passage travel paths, and downstream egress times will be ascertained. To determine VSD and training spill affects on spillway redistribution, fixed location hydro-acoustics will be used to assess fish passage distributions through Bays 1 through 7. Because providing training spill from Bay 7 has the potential to pass fish to areas of high predation, in-season monitoring (i.e., hydro-acoustics) will be necessary to ensure few fish are passed via this route.

The goal of these studies is to determine whether VSDs in concert with training spill achieve the targeted goal of 98 percent TDA spillway passage survival. Tertiary goals include reducing direct injury and mortality, and too maintain rapid and effective upstream passage for adult salmon and steelhead. The execution of these studies will be instrumental in providing the information necessary at critical decision points that are defined in The Dalles Configuration and Operation Plan (COP). The TDA COP details the strategic direction of fish passage improvements at TDA, with vortex suppression being one alternative to enhance the survival of fish passing via spill at TDA. A more detailed rationale for vortex suppression; including, detailed descriptions of past assessed fish passage alternatives and the results of subsequent biological evaluations can be observed in the TDA COP.

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b. Hydraulic Design.

(1) General. The selected configuration is to install VSDs in Bays 6 and 7 at the pier face and stoplog slots. See paragraphs 6 and 7.2a for background. As mentioned in paragraph 7.2a, biological studies suggest providing training spill from Bay 7 may act to flush predators on the spillway shelf and improve egress conditions for Bay 5 and Bay 6. Results from the general physical model and computational fluid dynamics models indicate that a VSD at Bay 6 and with

training spill in Bay 7 of 3 to 5 kft^3/s can provide fish guidance to the northern spillway and improve spillway egress resulting in improved survival rates.

(2) Hydraulic Models. Physical and numerical hydraulic models were used in the hydraulic design and evaluation of the various vortex suppression devices considered. A 1:25 scale sectional model representing 2 ½ spillway bays was used to determine vortex suppression device configurations. Different VSDs were tried at different gate openings and forebay elevations. A 1:80 scale general model was used to investigate far field approach flow conditions to the vortex suppression device and egress conditions in the tailrace. CFD models were used to investigate alternatives and determine detailed flow characteristics. The models are briefly described below, but all three of the models have strength and weaknesses and needed to be used in combination to develop a design that would meet the objective. The 1:25 spillway model provides the best scale for evaluating the vortex but does not include lateral flow generated by spilling out of the northern spillbays. The 1:80 general model allows for the evaluation of the lateral flow and egress conditions but the scale is insufficient to capture the nuisances of the flow in and around the VSDs and the gate well slot. The CFD model provides the ability to look at particle traces and document the potential guiding characteristics of the VSD. It also allows for detail velocity information to be mapped around the VSD to compute hydraulic loads. See Appendix C for hydraulic model data and trip reports for details.

(a) The 1:25 scale section model representing 2 ½ spillway bays is a rectangular flume with flow enter the upstream end of the model and exiting over a tailgate approximately 300 feet prototype downstream of the end sill. The flow is re-circulated with a pump. Flow through the spillway is controlled by opening the tainter gates the desired amount and then tweaking the pump such that the forebay elevation is stable. The 1:25 model has a hydraulic capacity of 5 kft^3/s to 100 kft^3/s prototype.

(b) The existing 1:80 scale model of The Dalles Dam consists of the powerhouse, spillway, and navigation lock. The model covers a 2.4-mile stretch of the river, approximately 1.4 miles upstream and 1 mile downstream of the spillway. Flow is pumped into the forebay at the upstream extent of the model and transitions from the forebay to the tailrace through the powerhouse and spillway. Each turbine unit is represented with an intake and a draft tube but no operating turbine unit. Each spillway bay is controlled by a tainter gate. The inflow into the model is adjusted until a stable forebay and tailrace elevation is obtained.

(c) The CFD model and model runs is documented in an MFR from PNNL, Rakowski et al,2006. The CFD model used in this evaluation started with the CFD model used to look at various BGS in the forebay and documented in DDR No 34. The CFD model was refined in the area of the spillway (Bays 1-8) to easily allow for VSDs to be incorporated in the bulkhead slot and at the pier nose to different elevations. The CFD model is a rigid lid model with the upstream boundary being defined as a pressure boundary. All flow outlets are modeled as inlets with flow exiting the model (operating units, ice and trash sluiceway and spillway). The inlet boundary is set as a velocity boundary.

(3) Hydraulic Design Considerations.

Oscillation. For VSD in the stoplog slot at elevation 150 feet and VSD at the pier nose at elevation 146 feet, oscillations appear not to exist at tainter gate openings up to 25 feet (largest gate opening investigated in the 1:25 sectional model). The forebay elevation was varied from 155 feet to 160 feet (normal forebay fluctuation) and gate openings were varied from 2 feet to 25 feet.

Upwelling. When compared with VSDs in Bay 6 only, operating Bay 6 and 7 with VSDs in the stoplog slot at elevation 146 feet and elevation 150 feet at the pier face reduces the upwelling (velocities) in Bay 6 in between the VSDs as well as in between the stoplog slot VSD and tainter gate. The training spill in Bay 7 eases some of the lateral flow that impacts Bay 6 when the first operating bay is Bay 6.

VSD Lip Geometry. Flow from a square edge lip VSD is highly turbulent and separates. To minimize vibration and cavitation potential, the bottom lip of the VSDs should not be square. An angled or chamfered lip should be used. Angled or chamfered VSD lips may also reduce upwelling between the devices and between the stoplog slot device and the tainter gate. The pier nose device will have a knife edge and the gate slot VSD will have chamfers on both sides.

Forebay Spillway Drawdown. Previous hydraulic model studies for The Dalles Dam indicate a 6 foot difference in water surface elevation between the forebay and the pier nose and a 7 foot difference between the forebay and the stoplog slot for Probable Maximum Flood (PMF) level flows. For the VSDs to clear the regulated PMF forebay elevation of 178.4 feet, the pier nose VSD bottom should be set no lower than 172.5 feet to clear the water surface, and the stoplog slot VSD bottom be set no lower than 171.5 feet.

Tainter Gate Control. Hydraulic control shifts from the tainter gate to the vortex suppression device at approximately 20 to 22 feet of tainter gate opening. Hydraulic loads on the VSDs are less when the tainter gate maintains hydraulic control.

Prototype Testing. Scaled physical models can underestimate vortices thus two "prototype" test will be conducted during the initial start up of the VSDs. The first prototype will be conducted while the contractor is still on site and will involve opening Bays 6 and 7 to 14 feet and making detailed observations of the hydraulic conditions that occur, see section 7.3. The second prototype test will be after spill has been initiated and will be to exercise the gates to their maximum gate opening and verify acceptable performance. The second test will generate maximum lateral flow since Bays 1 through 7 will be exercised.

(4) Flow Characteristics. A CFD model of the forebay was used to document the flow characteristics with and without the VSDs installed, the CFD code used for this part of the analysis is Star-CD. Figure 7.2.b-1 shows the extent of the CFD model. Table 7.2.b-1 shows the model runs that were generated. Figure 7.2.b-2 demonstrates the vortex that forms for a 315 Kcfs total river. Figures 7.2.b-3, 7.2.b-4, 7.2.b-5 shows the fate of water particles released at the same location at different elevations for a clean forebay, VSDs in Bay 6 and VSDs in Bays 6 and 7, respectively. The flow condition is 315 Kcfs except for Figure 7.2.b-5 which has training spill in Bay 7 thus a total river of 320 Kcfs. For the particles released in the upper 10 feet the VSDs push the water particles to the north. The other thing to note is the lack of concentration of particles in the south end of Bay 6, Figure 7.2.b-3.

Hydraulic Loads. There are two major hydraulic loads to be considered in the design of the VSDs. The first is the load caused by velocity acting on the VSDs. There are two components of this load – drag and skin friction. The second hydraulic load is due to head differentials on the VSDs. The head differentials were measured in the 1:25 scale sectional model.

Hydraulic force due to velocity:

The hydraulic force is computed using the following form drag equation:

$$F_D = (\tfrac{1}{2}) C_D A \rho V^2$$

Where: F_D = Force
C_D = Coefficient
A = projected area

ρ = density of water
V = the Velocity

Depending upon which force is being computed, perpendicular to the VSD or parallel to the VSD, different coefficients would be used. The coefficient for force perpendicular to the VSD is assumed to be 2.0 and parallel to the VSD is conservatively assumed to be 0.01 (see TDA BGS DDR, Glosten White Paper on Upper and Lower Limits of Hydraulic Loads). There is also a component of the vertical velocity acting on the web of the VSD (if skin plate is not applied to the back face). The load (web force) uses the vertical component of velocity on the back face and a C_D of 2.0. The velocities used to estimate the hydraulic force were determined in the CFD models shown in table 7.2.b-1. Two configurations are shown in table 7.2.b-1, VSDs in Bay 6 only and VSDs in Bays 6 and 7. Both configurations were ran because if training spill causes significant numbers of juveniles to pass through Bay 7 training spill could be stopped and the devices removed. Thus hydraulic loads had to be computed from the configuration that would provide the velocities velocities. Four total rivers were evaluated, 135 kft^3/s, 225 kft^3/s, 315 kft^3/s and 987 kft^3/s. The highest velocities on the pier nose VSD occurred at a total river of 987 kft^3/s. The highest velocities on the bulk head VSD occurred at a total river of 315 kft^3/s on bay 6 without a VSDs installed on Bay 7. The velocities and resultant hydraulic forces are summarized in table 7.2.b-2. The CFD model runs presented are based on a maximum gate opening of 14 feet for Bays 1-7, which could restrict spill operations for juvenile fish passage. To provide additional capacity the goal is to design the devices for a maximum gate opening of 16 feet for Bays 1-6 and training spill in Bay 7. The velocities for this design were estimated from other model runs and a hydraulic force computed. The CFD model run for this operations is being ran and will be incorporated into the final design for Plans and Specs.

The hydraulic forces due to head differential are computed by calculating the hydrostratic pressure on both sides of the device, see figure 7.2.b-6. The largest head differential measured in the 1:25 scale sectional model was 1.2 on the bulkhead VSD, for design a 1.5 foot head differential was assumed

During the initial model work done to identify a single VSD device per bay the data from the 1:25 model showed that the VSD if deep enough had an impact on the capacity of the spillbay. This was detected because the forebay elevation was dropping implying that the VSD made the spillbay more efficient at passing flow. The two device VSDs per bay did not show this same characteristics, the forebay elevation was stable during the evaluation up to gate openings of 22 to 25 feet.

Environmental Loads

The environmental load information from the DDR for the Behavior Guidance Device is being used to provide the environmental loads on the VSD. For details on the computations please see the DDR. The wind information is:

Return period of wind speed at KDLS, The Dalles, OR

	Return interval, *R*			
The Dalles, OR (KDLS)	**2-yr**	**10-yr**	**50-yr**	**100-yr**
U, Wind speed (mph)	56.4	71.2	89.1	98.6
90% confidence interval (±*U*, mph)	3.8	12.4	22.8	28.3

The computed wind driven wave information is:

Calculated return intervals for wave height and period at KDLS

	H_{2yr} (ft)	T_{2yr} (s)	H_{50yr} (ft)	T_{50yr} (s)	H_{100yr} (ft)	T_{100yr} (s)
NE	2.3	2.7	3.7	3.2	4.1	3.3
S-SW	1.1	1.6	1.8	1.9	1.9	2.0

The vessel wave height information is:

Predicted wave data from various vessel types at $Y = 350$ ft

Vessel-type	F_d	H_{ship} (ft)	T_{ship} (s)	θ_{ship} (deg)
Tug/barge	0.47	0.6	1.6	35.2
Cruise ship	0.47	0.5	1.6	35.2
Cabin cruiser	0.94	0.6	5.3	17.7

A hydraulic load associated with the wind driven wave is in paragraph 7.2.b-2.

References

November 1964. U.S. Army Engineer Division, North Pacific, Technical Report No. 55-1, Spillway and Stilling Basin for The Dalles Dam, Columbia River, Oregon and Washington.

June 1965. U.S. Army Engineer Division, North Pacific, Technical Report No. 52-1, The Dalles Dam, Columbia River, Oregon and Washington.

May 2006. U.S. Army Engineer Portland District, Design Development Report (DDR) No. 34, The Dalles Lock and Dam, Behavior Guidance System (BGS), Columbia River, Oregon and Washington.

October 2006. Rakowski, C.L., Richmond, M.C. and Serkowski, J.A, “Forebay Computational Fluid Dynamics Modeling for The Dalles Dam to Support Vortex Suppress Device Studies”, Pacific Northwest National Laboratory, Richland, Washington.

c. Structural Design. The VSDs for Bay 6 and 7 will consist of two devices in each bay, one installed at the pier nose spanning approximately 60 feet across the bay and 12 feet high with a bottom elevation of 150 feet, and one installed in the stoplog slot spanning 53 feet across and 16 feet high with a bottom elevation of 146 feet. The VSDs, pier nose guide slot and the stoplog slot dogging brackets will all be new construction utilizing structural steel.

Design Criteria and Material Properties.

Design Water Elevations. Forebay pool elevations to be used for structural design of the VSD are shown in table 7.2.c – 1.

Table 7.2.b - 1 Full Forebay CFD Model Runs

				Pier Nose		Bulkhead Slot		Spillbay Gate Opening							
Model #	Forebay Elevation	Total River Q	Spill Q	Device Bay 6	Device Bay 7	Device Bay 6	Device Bay 7	1	2	3	4	5	6	7	8 - 23
	ft	Kcfs	Kcfs	ft	ft	ft	ft	ft	ft	ft	ft	ft	ft	ft	ft
Clean	158.6	315	126	0	0	0	0	14	14	14	14	14	14		
Bay6_150_146	158.6	315	126	150	0	146	0	14	14	14	14	14	14		
Bay6_150_146	158.6	225	90	150	0	146	0	10	10	10	10	10	10		
Bay6_150_146	158.6	135	54	150	0	146	0	6	6	6	6	6	6		
Bay6+7_150_146	158.6	326	130.5	150	150	146	146	14	14	14	14	14	14	3	
Bay6+7_150_146	158.6	236	94.5	150	150	146	146	10	10	10	10	10	10	3	
Bay6+7_150_146	158.6	143	57	150	150	146	146	6	6	6	6	6	6	2	
Bay6+7_150_146	158.6	987	987	150	150	146	146	30	30	30	30	30	14	14	30

Table 7.2.b-2 Hydraulic Loads

Total River	Elevation	Velocity Magnitude																									
		Pier Nose Device - Elevation 150						Stop Log Device - Elevation 146						Pier Nose Device - Elevation 150							Stop Log Device - Elevation 146						
Total River	Elevation	us south	us middle	us north	ds south	ds middle	ds north	us south	us middle	us north	ds south	ds middle	ds north	Perpendicular Velocity	Horizontal Drag Force	Vertical Velocity	Down Drag Force	Web Force	Differential Head	Force	Perpendicular Velocity	Horizontal Drag Force	Vertical Velocity	Down Drag Force	Web Force	Differential Head	Force
Kcfs	ft	fps	fps	fps	fps	fps	fps	fps	fps	fps	fps	fps	fps	fps	lbs/ft	fps	lbs/ft	lbs/ft	ft	lbs/ft	fps	lbs/ft	fps	lbs/ft	lbs/ft	ft	lbs/ft
135	157.5	2.2	1.7	1.7	0.4	2.3	1.2	1	1.5	1.6	0.7	2.1	1.2	1.6		1.6		10.3			0		1.6		10.3		
135	151	2.9	2.8	2.1	1.2	1.9	1	1.36	0.7	2.5	0.6	2.1	2	2.1		2.1		16.3			0		2.1		16.3		
135	149.5	3.2	3.2	2.3	2.2	1.5	2.1	1.5	0.7	2.5	2.1	2.5	1.9	2.3	76.0	2.3	0.8	19.9			2.5		2.3		19.9		
135	145.5	3.9	3.8	2.5	5	4.2	3.5	2.8	3	3.4	2.6	2	2.1								3.4	67.5	3.5	0.4	48.5		
225	157.5	3.3	2.6	2.7	1.6	3.7	2.1	1	2.1	2.5	1.3	3.8	3	2.6		2.6		26.6			0		2.7		28.0		
225	151	5	4.8	3.4	1.6	2.6	4.4	5.7	5.5	3.8	2.1	1.2	3.7	3.5		3.5		48.5			0		4.0		63.0		
225	149.5	5.7	5.5	3.8	3.2	2.5	5.7	2.1	1.2	3.7	3.4	3.7	2.8	4.0	223.5	4.0	2.2	63.0			3.7		4.0		63.0		
225	145.5	6.9	6.5	4.1	4.7	4.7	5.5	4.7	4.7	5.5	4.4	3.4	3.5								5.5	164.2	4.9	1.0	92.4		
315	157.5	6.2	4.5	5.4	1.7	6.2	3.3	2	4.2	3.9	1.8	6.1	4.1	4.4		4.4		74.6			0		4.4		74.6		
315	151	8	7.4	5.7	3.3	5.4	2.7	3	2.2	6.9	5.2	7.3	5.3	5.7		5.7		124.2			0		5.7		124.2		
315	149.5	9.1	8.4	6	5.9	3.9	6.3	3.6	2.1	6.5	5.8	6.9	5.1	6.4	585.1	6.4	5.9	160.7			6.9		6.4		160.7		
315	145.5	10.4	9.8	6.2	12.7	10.9	8	7.4	7.6	8.7	7.3	5.5	5.4								8.7	472.1	9.0	2.7	312.9		
987	157.5	1.8	2.8	8.7	1	4.2	2.5	1.5	2.3	3.2	1.3	3.2	2.9	6.2		6.2		146.8			0		6.2		146.8		
987	151	5.1	6.3	8.7	1.4	3.1	2.5	1.8	1.2	6.5	2.1	2.9	3.3	6.2		6.2		146.8			0		6.2		146.8		
987	149.5	6.1	7.5	8.9	4.2	2.7	5.6	3.7	1.2	6.3	2.3	2.8	3.1	6.3	745.5	6.3	7.5	153.7			6.3		6.3		153.7		
987	145.5	7.4	9.3	9	10.6	9.5	7.4	9	5.6	8.2	2.9	2.6	4.6								9	454.1	7.5	2.9	218.0		
																			2.05	1412							
Maximum differential on Pier Nose VSD due to wind driven wave - wave height is 4.1 feet differential head is 2.05 feet																											
Maxiumum differential on Stop log VSD due to hydraulics and is assumed to be 1.5 feet, larger than measured in 1:25 model.																										1.5	1382

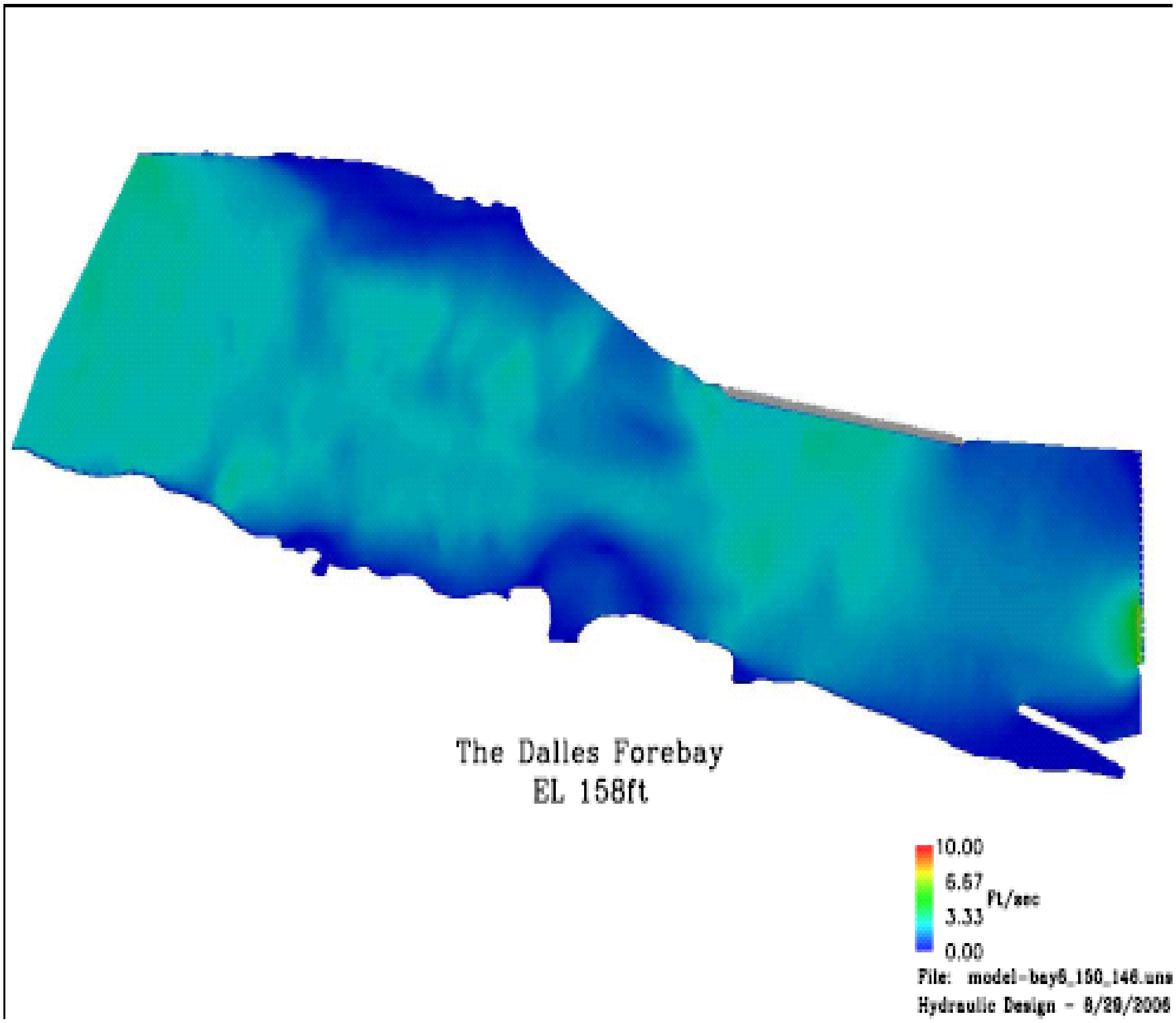


Figure 7.2.b-1 Domain of the forebay model (CFD)

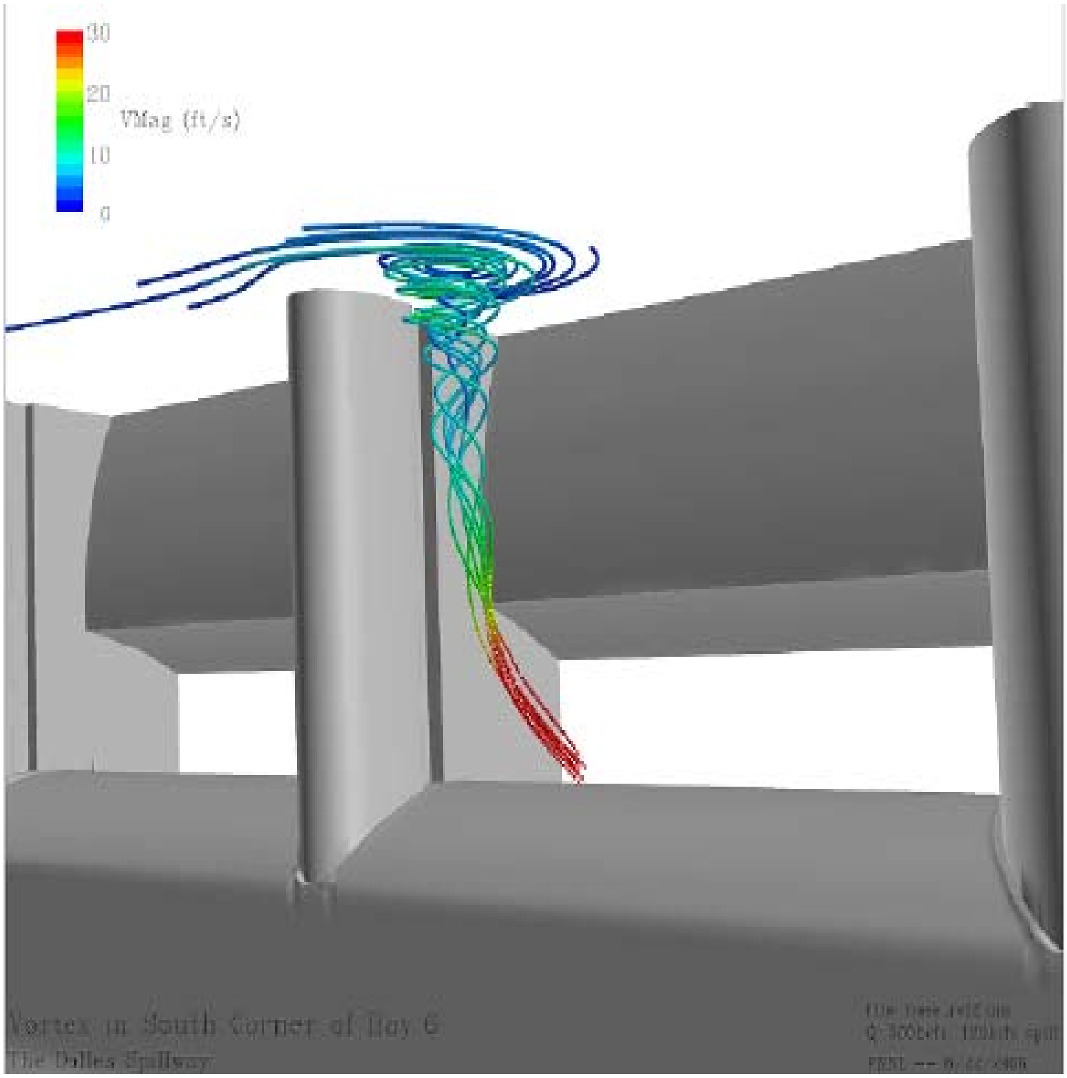


Figure 7.2.b-2 Development of Vortex in Bay 6 – 315 Kcfs total river

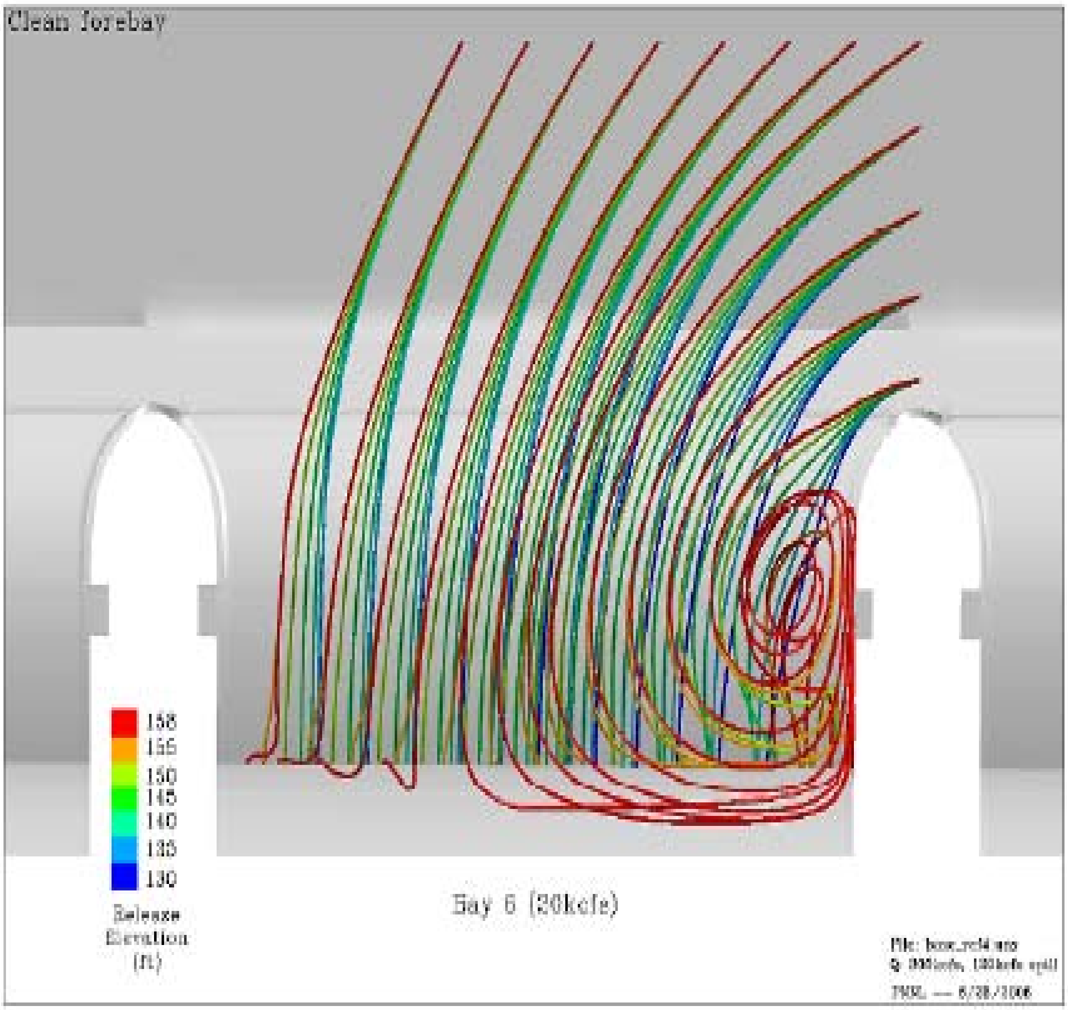


Figure 7.2.b-3 Water Particles Released at Different Elevations, 315 Kcfs total river – Clean

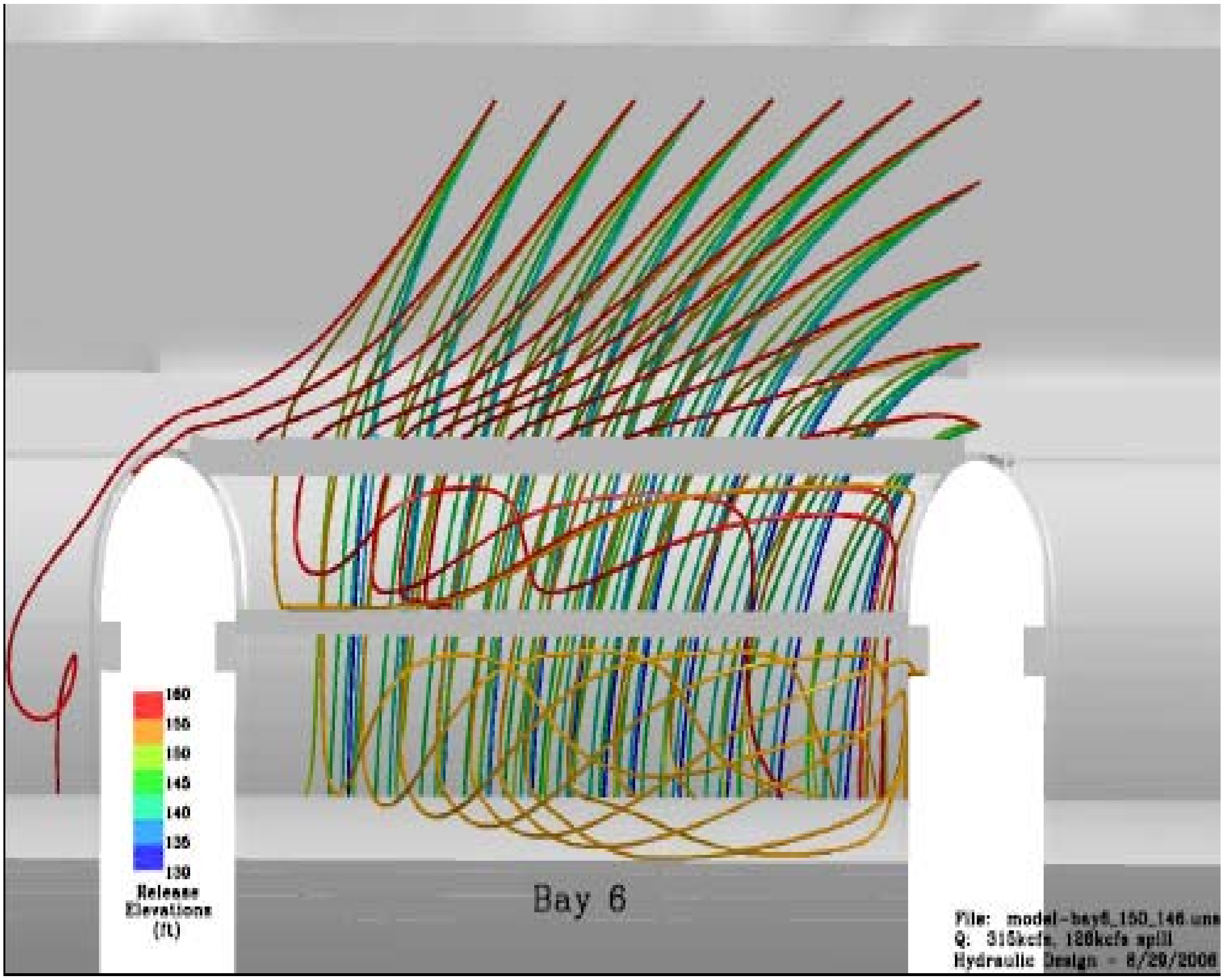


Figure 7.2.b-4 Water Particles Released at Different Elevations, 315 Kcfs total river, VSDs in Bay 6

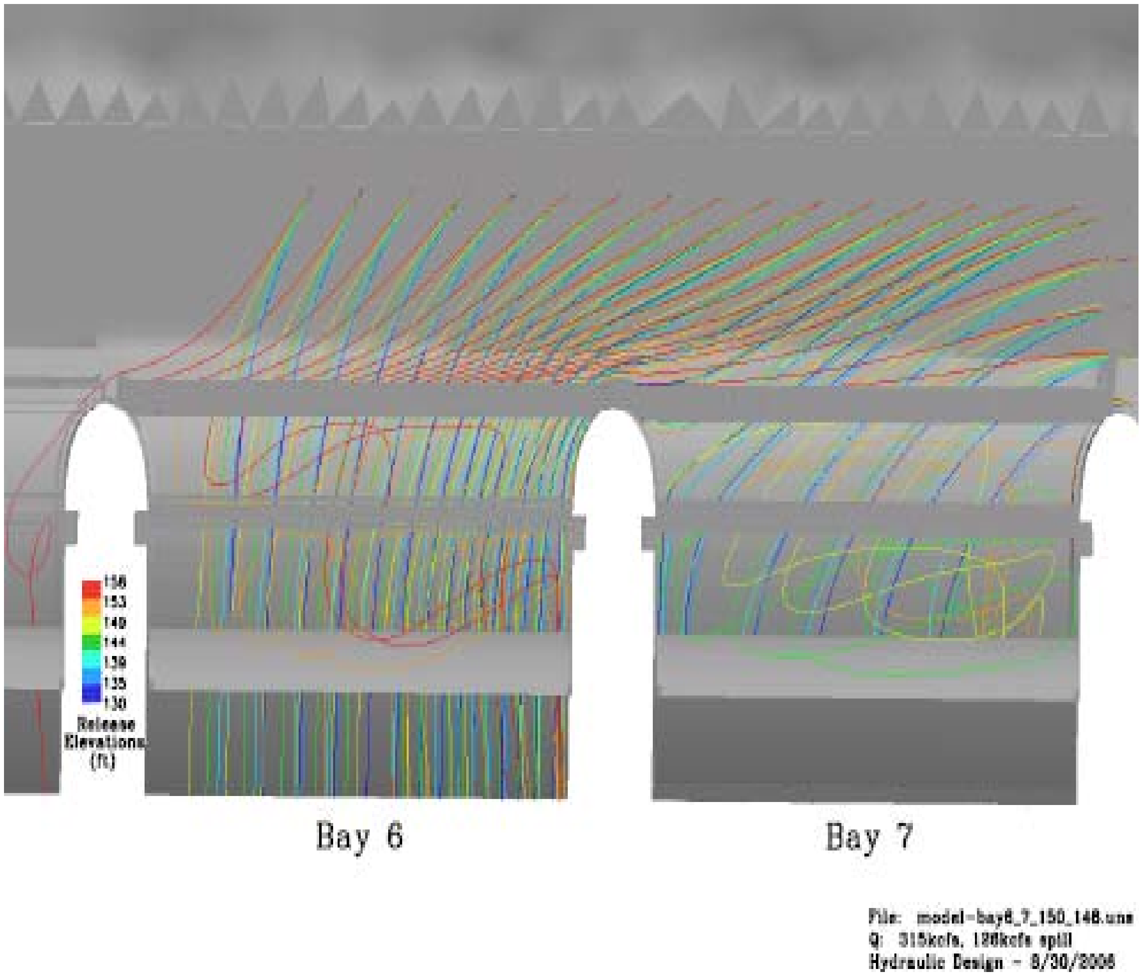


Figure 7.2.b-5 Water Particles Released at Different Elevations, 315 Kcfs total river,

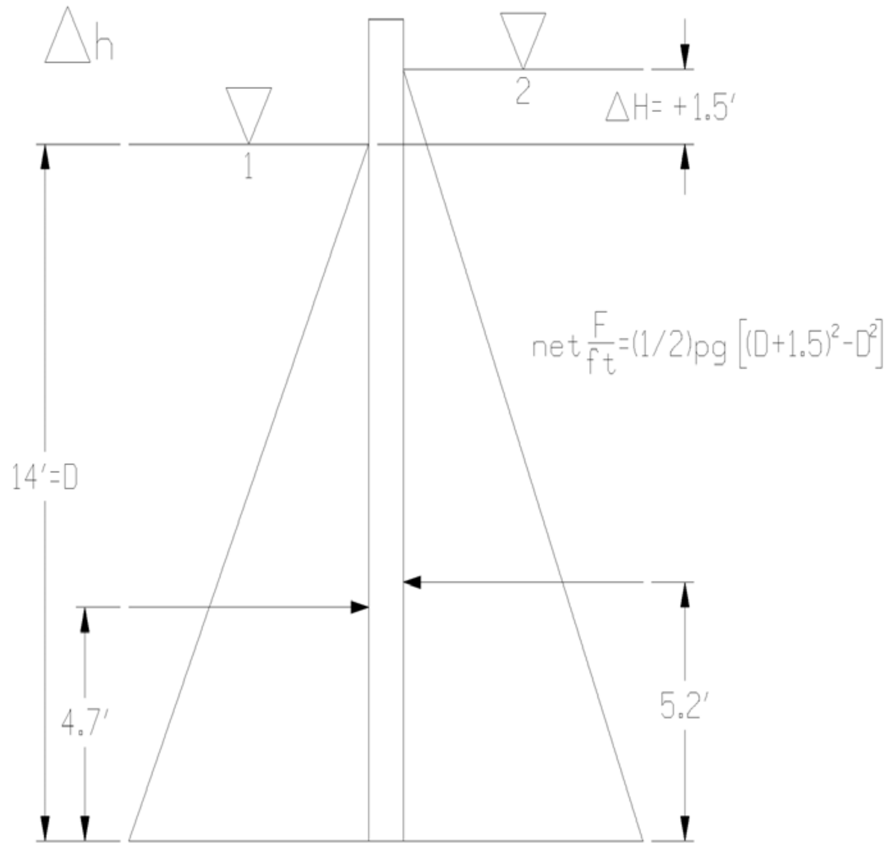


Figure 7.2.b-6 Hydraulic Force due to Head Differential

Design Loads and Load Combinations.

(1) General. All structural features shall be designed using the following general loading criteria as applicable unless stated otherwise. All structural features shall be designed to resist combinations of loads as described in the appropriate manual, code, or standard. Loads are summarized in Table 7.2.c – 2, and their application to the design is shown in the calculations included in Appendix D - Structural

(2) Dead Loads. Dead loads consist of the weight of the steel and all fixed equipment. The unit weight of steel is assumed to be 490 lb/ft^3.

(3) Live Loads. Since no personnel access will be available on the VSDs there are no live loads anticipated to act on the structure.

(4) Hydraulic Loads. Hydraulic loads consist of lateral and longitudinal forces from hydrostatic pressure and hydrodynamic forces due to flow of water under the structure with a maximum16 foot tainter gate opening. The hydraulic loads acting on the VSD were developed utilizing the CFD modeling and are listed in Paragraph 7.2.b. Effects of water induced vibrations will be considered in the design of different VSD features. All hydraulic loads will be in accordance with EM 1110-2-2105 for steel components. The unit weight of water shall be taken as 62.4 lb/ft^3.c. Structural Design. The VSDs for Bay 6 and 7 will consist of two devices in each bay, one installed at the pier nose spanning approximately 60 feet across the bay and 12 feet high with a bottom elevation of 150 feet, and one installed in the stoplog slot spanning 53 feet across and 16 feet high with a bottom elevation of 146 feet. The VSDs, pier nose guide slot and the stoplog slot dogging brackets will all be new construction utilizing structural steel.

Design Criteria and Material Properties.

Design Water Elevations. Forebay pool elevations to be used for structural design of the VSD are shown in table 7.2.c – 1.

Design Loads and Load Combinations.

(1) General. All structural features shall be designed using the following general loading criteria as applicable unless stated otherwise. All structural features shall be designed to resist combinations of loads as described in the appropriate manual, code, or standard. Loads are summarized in Table 7.2.c – 2, and their application to the design is shown in the calculations included in Appendix D - Structural

(2) Dead Loads. Dead loads consist of the weight of the steel and all fixed equipment. The unit weight of steel is assumed to be 490 lb/ft^3.

(3) Live Loads. Since no personnel access will be available on the VSDs there are no live loads anticipated to act on the structure.

(4) Hydraulic Loads. Hydraulic loads consist of lateral and longitudinal forces from hydrostatic pressure and hydrodynamic forces due to flow of water under the structure with a maximum16 foot tainter gate opening. The hydraulic loads acting on the VSD were developed utilizing the CFD modeling and are listed in Paragraph 7.2.b. Effects of water induced vibrations will be considered in the design of different VSD features. All hydraulic loads will be in accordance with EM 1110-2-2105 for steel components. The unit weight of water shall be taken as 62.4 lb/ft^3.

(5) Wind Load. The wind load used for design shall be 50 psf, in accordance with the criteria established for The Dalles lock and Dam Juvenile Bypass Features, Design Memorandum No. 29.

(6) Wave Load. The wave load used for design shall be from a wind generated event corresponding to an equivalent 2.05 foot hydrostatic load. This load only applies to the pier nose device, as this device protects the stoplog slot device from all waves.

(7) Debris and Impact. The VSD will be designed for the following debris and impact loads:

(a) Log Impact force is computed using a 2 feet diameter, 40-foot-long design log with a density of 60 lb/ft^3 moving at a velocity of 3 ft/s, and assuming a deceleration time of 1 second. Using the kinetic energy equation F=ma, we develop a log impact force of 18.8 kips on the 2-foot diameter area.

(b) Barge Impact forces are not considered in the design of the VSD. EM-1110-2-2702, "Design of Spillway Tainter Gates", Paragraph 3-4b1(d), indicates that the ice impact load for tainter gates provides a margin of safety against structural collapse of the tainter gate due to barge impact. "Barge impact is an accidental event that is not practical to design for and is not specifically considered in design." Unlike the training wall of a navigation lock or a lock miter gate, where barge impact is a guaranteed occurrence, the VSD will only be struck by a barge in an extreme accident. Either the barge will veer off course due to driver error or a loss of power. Therefore, the probability of barge impact occurring to the VSD is extremely lower than that of a lock wall or miter gate. EM-1110-2-2703, "Lock Gates and Operating Equipment", Paragraph 1-9b. indicates "The force of impact usually is limited by local failure in the region of impact." Therefore, the likely failure to the VSD would be either localized failure, or catastrophic, such that the VSD would deflect enough that it would disengage from the guide slot and drop to the ogee or river bottom.

(8) Ice and Snow Loads. In accordance with criteria established for The Dalles Lock and Dam Juvenile Bypass Features, Design Memorandum No. 29, the ice loads to structures may be gravity loads or short-duration lateral loads. Gravity loads due to wave action and spray when the VSD is deployed shall be assumed to accumulate to a thickness of 6 inches which applies a vertical load of 30 psf on exposed surfaces of the VSD. When the VSD is in the storage location, dogged off out of the water, the ice build up will be from freezing rain events and shall be assumed to accumulate to a thickness of 1 inch which applies a vertical load of 5.2 psf on exposed surfaces of the VSD. Formation of Frazile ice is not expected to occur and will not be considered in the design of any project features. The short-duration lateral ice loads will not occur since the operational period of these devices is April through August. The snow load used for design where applicable will be 50 psf.

(9) Seismic Design Criteria. Seismic design will conform to the applicable requirements of ER 1110-2-6050, EM 1110-2-2104, EC 1110-2-291, and ETL 1110-2-342. The Maximum Design Earthquake (MDE) and Operation Basis Earthquake (OBE) will be used for the analysis and design of the new facilities.

(a) The MDE is the maximum level of ground motion for which the structure is designed or evaluated. For critical structures, the MDE is the same as the MCE. Since project features are classified as non-critical structures per ER 1110-2-1806, the MDE will be selected as the 5 percent probability of exceedence in 50 years event (return period of about 950 years). Spectral response accelerations are shown in Table 7.2.c - 3

(b) Design response spectra curves for the OBE and MDE were developed in accordance with FEMA 302 provisions using Site Class B (rock with shear wave velocity between 2,500 and 5,000 ft/sec). Spectral ordinates S_{DS} and S_{D1} for the OBE and MDE were based on the 1997 NEHRP maps.

Since the NEHRP maps provide spectral accelerations for recurrence intervals of 475 years and 2475 years, the values for the 144-year return period of the OBE were obtained using the procedure indicated in FEMA 356, Section 1.6.1.3.2. The PGA for the 144–year return period was determined using the COE program DEQAS-R.

Spectral ordinates S_{DS} and S_{D1} for the MDE could be determined using FEMA 356, Section 1.6.1.3. Alternatively, the MDE values may be determined directly using the USGS Earthquake Hazards Program web site (http:/earthquakes.usgs.gov) and the latitude-longitude coordinates for the site. The following latitude-longitude values were used for the project site.

Latitude = 45.6150
Longitude = -121.1383

The USGS Earthquake Hazards Program values are as follows. The interpolated probabilistic ground motion values are given in percent.

	10%PE in 50 yr	5%PE in 50 yr	2%PE in 50 yr
PGA	9.39	13.16	19.65
0.2 SA	21.84	29.72	45.33
0.3 SA	19.17	27.44	41.31
1.0 SA	8.29	11.54	17.05

(c) Dynamic earthquake-induced forces produced by water acting on walls or other stationary structures(sloshing) will be calculated according to TM 5-809-10.

(Load Combinations. The load combinations to be used for all features of this project are as follows.

Group I Loads:

1. Case #1
    a. Dead load
    b. Hydrostatic load
    c. Hydrodynamic load
    d. Down drag
    e. Average wave height

2. Case #2
    a. Dead load
    b. Average wave height
    c. Ice Loading – deployed

Group II Loads:

3. Case #3
    a. Dead load
    b. Hydrostatic load
    c. Hydrodynamic load
    d. Down drag
    e. Max wave height

4. Case #4
    a. Dead load
    b. Hydrostatic load
    c. Hydrodynamic load
    d. Down drag
    e. Earthquake OBE

5. Case # #5
    a. Dead load
    b. Hydrostatic load
    c. Hydrodynamic load
    d. Down drag
    e. Wind loading

6. Case #6
    a. Dead load
    b. Hydrostatic load
    c. Hydrodynamic load
    d. Down drag
    e. Debris log impact

7. Case #7 (case for gate dogged off in the top of the slot)
    a. Dead load
    b. Wind load
    c. Ice loading – storage location

Structural Materials. The material properties of structural materials anticipated for use are summarized in table 7.2.c – 4.

-Steel Design Parameters. Steel will be designed by Allowable Stress Design (ASD) ethod in accordance with the AISC Manual of Steel construction and EM 1110-2-2105 "Design of Hydraulic Steel Structures" as applicable. In accordance with EM 1110-2-2105, and due to the possibility of unknown dynamic loading the VSD will be considered a Type A Hydraulic Steel Structure. As such, the allowable stress of the steel will be limited to 75 percent of the recommended AISC value. Furthermore, when the load combination includes any Group II loads as defined in EM1110-2-2105 (typically dynamic, short duration loads) the allowable stress can be increased by 1/3. All structural steel will be painted, galvanized, or stainless steel as indicated by feature or shown on the drawings. High strength bolted steel connections will be bearing type, or friction type with or without direction tension indicators, as determined appropriate on a case-by-case basis depending on the application.

Pier Nose VSD Design. The Pier Nose VSD will consist of a steel bulkhead type structure, with horizontal girders spanning approximately 60 feet, between centerlines of the piers minus the guide slot width, by 12 feet high, by 2 feet deep, see Plate 2 and 3 for more information. The solid skin plate will be on the upstream face, with the T-girders on the back but covered with bolt-on solid polyethylene panels to keep juvenile fish that might be caught in the back roller between devices from being trapped into the structure, while eliminating sediment buildup on the structure and allowing access for inspection. The VSD is too large for galvanizing, and would tend to warp too much during the galvanizing process, therefore the best corrosion protection will be to paint the structure. Since the VSD does not have to move under flowing water rollers are not needed, instead low friction plastic rub strips will be provided.

In the deployed position the device will have a bottom elevation of 150 feet, with all of the VSD's weight resting on the bottom of the guide slot. This provides 5 to 10 feet of draft, depending on forebay elevations, with a minimum of 2 feet of freeboard. Anytime the tainter gates in Bay 6 or 7 need to be opened beyond 14-16 feet, or anytime the stoplog slot VSD will be pulled and the tainter gate opened, the pier nose VSD will need to be lifted and dogged off at the top of the guide, with the top of the VSD a foot or two above the parapet wall. In the dogged off position the bay can pass water up to a forebay elevation of 182.0 feet. Any forebay elevations above 182.0 feet the pier nose VSD will need to be removed completely out of the spillbay and stored elsewhere.

Since there is no existing guide slot at the pier nose a new one will be designed and constructed as part of this work. The guide will be one piece welded steel assembly with bent saddle plates that are attached to the face of the pier with grouted in galvanized anchors. Wedge anchors can be used for erection purposes, but due to the high probability of vibration the permanent anchors shall be grouted. Since these anchors will penetrate beyond the existing reinforcement line the amount of reinforcement cut during installation of this guide slot should be minimized, no prestressing reinforcement exists in this area. Due to expected variances in the pier shape the saddle plates will be grouted after installation. The guide assembly will be galvanized, if a large enough tank exists, otherwise it will be painted to match the VSDs.

Stoplog Slot VSD Design. The stoplog slot VSD will consist of a steel bulkhead type structure, with horizontal girders spanning approximately 53 feet, between the existing stoplog slots on the piers, by 16 feet high, by 2 feet deep, see Plate 2 and 4 for more information. The solid skin plate will be on the upstream face, with the T-girders exposed on the back but covered with bolt-on solid polyethylene panels attached to keep juvenile fish that might be caught in the back roller between device and the tainter gate from being trapped into the structure, while greatly reducing sediment buildup on the structure and allowing access for inspection. The VSD is too large for galvanizing, and would tend to warp too much during the galvanizing process, therefore the best corrosion protection will be to paint the structure. Since the VSD does not have to move under flowing water rollers are not needed, instead low friction plastic rub strips will be provided.

In the deployed position the device will have a bottom elevation of 146 feet, and dogged off as shown in figure 7.2.c – 1 on to stiffened steel ledges installed on the sides of the piers, see Figure 7.2.c – 2. This provides 9 to 14 feet of draft, depending on forebay elevations, with a minimum of 2 feet of freeboard. Anytime the tainter gates in Bay 6 or 7 need to be opened beyond 14-16 feet, the stoplog slot VSD will need to be lifted and dogged off at the top of the slot, in the stoplog storage location so that the deck panels can be reinstalled, see Figure 7.2.c – 3. Anytime the stoplogs need to be deployed the stoplog slot VSD will need to be moved and dogged in another bay. For a flood event with a forebay elevation above 172 feet the stoplog slot VSD will need to be removed completely out of the spillway bay and stored elsewhere.

The stiffened steel ledges shall be galvanized , and held by galvanized grouted anchors. No prestressing steel exists at the location of the ledges, however the bolting mechanism for the embedded steel of the stoplog slot should not be cut during installation.

Table 7.2.c - 1

Design Water Elevations

Pool	**Elevation, feet (msl)**
Minimum Operating Forebay Pool Elevation	El. 155.00
Maximum Operating Forebay Pool Elevation	El. 160.00
100 Year Flood Forebay Elevation	El. 160.00
Regulated Probable Maximum Flood Forebay Elevation	El. 178.40
Unregulated Probable Maximum Flood Forebay Elevation	El. 188.10

Table 7.2.c - 2 Summary of Design Loads

Loads on Pier Nose VSD

Max Pressure from Static Head	0.328	ksf	(Either Direction)
Max Pressure due to Velocity	0.134	ksf	Acting U/S to D/S
Increase pressure due to Hydro-dynamic OBE	0.0795	ksf	Acting U/S to D/S
Increase pressure due to Hydro-dynamic MDE	0.189	ksf	Acting U/S to D/S
Down Drag Force	10	lbs/ft	increase to Gravity
Log Impact	18.8	kips	Acting U/S to D/S
Average Height Wave Load	0.0312	ksf	Acting U/S to D/S
Maximum Height Wave Load	0.141	ksf	Acting U/S to D/S

Loads on Slot VSD

Max Pressure from Static Head	0.094	ksf	(Either Direction)
Max Pressure due to Velocity	0.168	ksf	Acting U/S to D/S
Increase pressure due to Hydro-dynamic OBE	0.085	ksf	Acting U/S to D/S
Increase pressure due to Hydro-dynamic MDE	0.224	ksf	Acting U/S to D/S
Down Drag Force	3.5	lbs/ft	increase to Gravity
Log Impact	0	ksf	No force due to Pier Device
Wave Load	0	kips	No force due to Pier Device

Loads on Pier Nose Guide

All loads from Pier Nose VSD			
Max Pressure due to velocity	50	psf	Normal to guide slot

NOTE: All loads are rounded up or max velocity was used for computation. Equations for Hydraulic forces were give by EC-HD.

Table 7.2.c - 3 **Site-Specific Design Earthquake** **Data for OBE and MDE**		
	Operation Basis Earthquake (OBE)	Maximum Design Earthquake (MDE)
Probability of Exceedence	50% in 100 years	5% in 50 years
Return Period	144 years	1000 years
Peak Ground Acceleration	0.055 g	0.1316 g
Spectral Acceleration S_{DS} (at 0.2 second)	0.115 g	0.2972 g
Spectral Acceleration S_{D1} (at 1.0 second)	0.042 g	0.1154 g
$T_0 = 0.2\ S_{D1}/S_{DS}$	0.073 second	0.078 second
$T_S = S_{D1}/S_{DS}$	0.365 second	0.388 second

Table 7.2.c - 4

Structural Materials and Properties

Feature and Material	Property	
Concrete Grout	f'c =	4000 psi at 7 days
Reinforcing Steel - ASTM A615, Grade 60	f_y =	60 ksi
High Strength Bar - ASTM A722 Grade 150	f_y =	150 ksi
Structural Steel		
Plates, Shapes, and Bars - ASTM A572 Gr. 50 or ASTM A36 as appropriate	f_y =	36 ksi or 50 ksi
Square Structura Tube (HHS) - ASTM A500 Grade B	f_y =	46 ksi
Round Pipe - ASTM A53 Grade B, Type E or S	f_y =	35 ksi
Corrosion Resisting Steel (CRES) - Stainless Steel -		
Bars and Shapes - ASTM A276, Type 316	f_y =	25ksi
Plate - ASTM A167, Type 316	f_y =	25 ksi
High Strength Bolts		ASTM A325, Type 3
Anchor Bolts		ASTM A307 unless otherwise shown
Stainless Steel Bolts		ASTM A193, Type 316

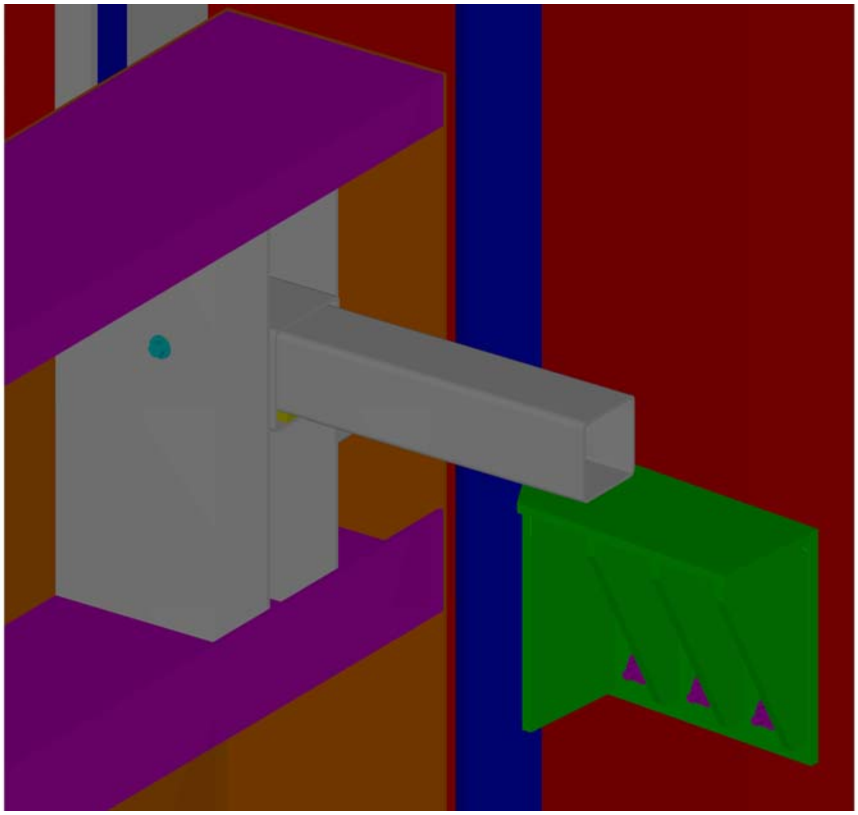


Figure 7.2.c – 1 Stoplog Slot Device Dogged in Deployed Position

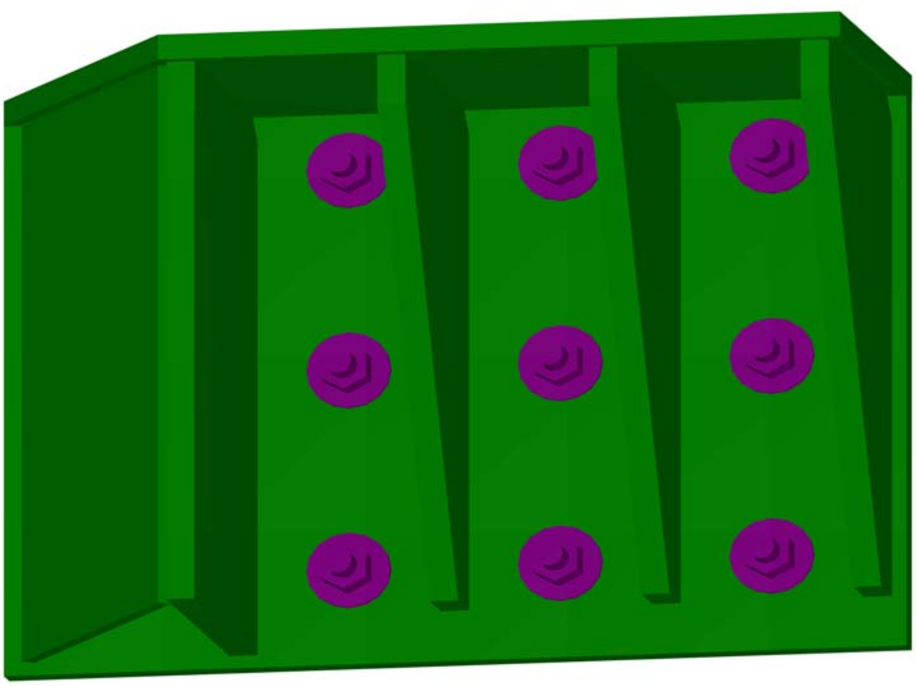


Figure 7.2.c – 2 Stoplog Slot Device Stiffened Steel Ledge – with upstream angled deflector

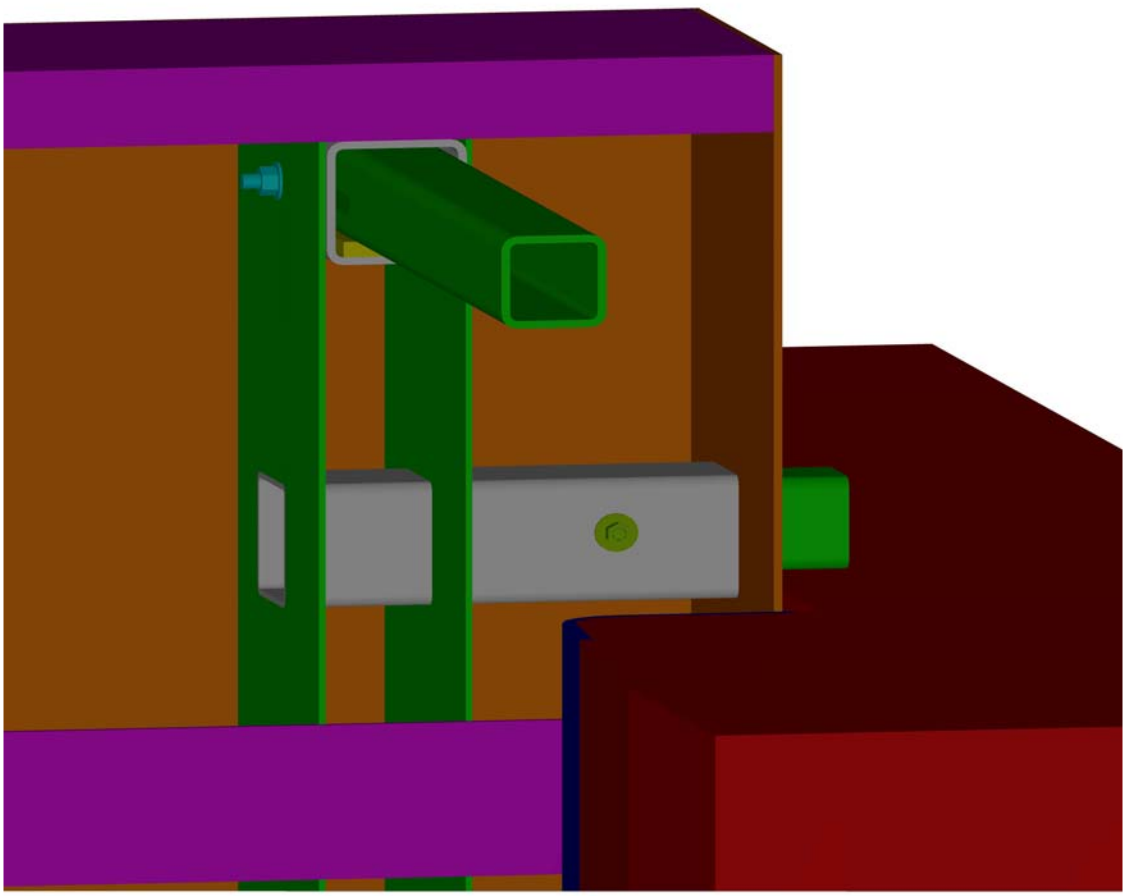


Figure 7.2.c – 3 Stoplog Slot VSD Dogged at Stoplog Storage Location

7.3 CONSTRUCTION METHODS AND MATERIALS

7.3.1 GENERAL

a. General. This section presents the basic construction considerations, restrictions, and coordination of the major feature construction for TDA Spillway Bay 6 and Bay 7 Vortex Suppression Devices (VSD). There is a construction schedule in Paragraph 11, Schedule (table 11-1).

b. Construction Constraints. Construction activities will be constrained by several parameters.

(1) In-Water-Work Periods (IWW). For The Dalles the IWW is 01 December through 28 February, annually. All work within, adjacent to, or over the river is usually required to be performed during the IWW.

(2) Long Lead Items. Pier nose and bulkhead slot suppression device shop fabrication represent the only long lead items and is the sole critical path work for this project. The contract must allow sufficient time for fabrication of suppression device elements and for site delivery during IWW for deployment. Deployment of the suppression devices will simply entail placing the devices in both the existing bulkhead slots and the new pier nose slots at Bays 6 and 7. Suppression device installation is presumed to occur (see schedule, table 11-1) just prior to the spill season to provide the maximum fabrication duration. Deployment is construed to be usual project operating activity and therefore is not considered to be restricted to the IWW.

(3) Pier Nose Guide Installation. Pier nose guide installation will require off-site fabrication followed by on-site diver installation. Guide fabrication is not construed to be a critical path but and must be completed in sufficient time to allow installation well in advance of VSD delivery and deployment. Guide installation will require diver services. Guide installation must be conducted during IWW.

(4) Project Operations. Powerhouse (PH) operations will be able to continue unaltered during construction activities at the distant location of Spillway Bays 6 and 7. The spillway should not be in operation during the IWW. Pier nose guide installation must be completed during this IWW however, deployment of the suppression devices could occur outside of the IWW duration, although the target date for deployment is prior to the spill season in early April. Should deployment occur after spill season begins the tainter gate of the bay being worked on and the tainter gates in adjacent bays on either side would be required to be closed during the short time needed for deployment, probably one day or less per VSD pair (stoplog slot and pier nose VSD at one bay). Coordination with the Project will be required throughout the on-site construction duration.

All vortex suppression on-site project work will be performed from the spillway deck or from floating plant in the pool U/S of the spillway. This work will not impact river traffic.

(5) Acquisition Strategy. The PDT chose IFB as the acquisition strategy for this project. 8a construction contracting was the initial preferred procurement method and a review of potential regional contractors was conducted. The team research indicates that there are no 8a contractors within the region that have an in-house capability to handle the size and number of devices in the time frame required. It was determined that all potential 8a contractors would be forced to subcontract most or all of the work. An unrestricted IFB procurement method, open to all, has therefore been selected as the best means for contracting this work and the best means for obtaining a fair and reasonable price in timely fashion for this fast paced project.

7.3.2 CONSTRUCTION

a. Pier Nose Guide Fabrication and Installation.

(1) Off-Site Fabrication.

(a) Fabrication. Fabrication of the guide elements will be one piece welded steel assembly with bent saddle plates that are attached to the face of the pier with grouted in galvanized anchors; conventional steel welding and fabrication methods will be used. The guides shall be constructed so they can be shimmed and grouted on-site to accommodate irregularities in the existing concrete pier surfaces.

(b) Corrosion Protection. The guides will be galvanized if a large enough tank exists; otherwise they will be shop painted prior to delivery to the site. The paint system used will be a three coat epoxy system that will require sand blasting the item prior to undercoating and applying final layers.

(2) On-Site Installation. Installation of the pier nose guides will be accomplished by grouting drilled bolts in the existing concrete pier and attaching fabricated guides to the face of the pier nose. Core drilling will be required because existing steel reinforcement will be encountered during the drilling of the approximate 18 inch ± holes. The portion of the guide projecting above the forebay pool elevation will be installed by conventional construction means from a skiff, barge, or suspended work platform, while the lower portion of the guides will be completed by diver operations. Paint touch up will be required after guide delivery and prior to installation.

Stoplog slot VSDs will utilize the existing slots and will not require on-site work beyond simple deployment except for installing dogging brackets.

(3) Dogging Brackets. Dogging Brackets for both the Pier Nose VSD and for the Slot VST will be stiffened galvanized steel ledges held by galvanized grouted anchors installed concurrently with the Pier Nose Guide installation. This work will be above water and will require crane support with a man basket to accomplish.

(4) Diving. Pier nose VSDs will project nominally 8 feet below the forebay surface which will require bolt and guide installation by diver. Standard dive safety protocols will be coordinated with the Safety Office, Office of Dive Safety, and TDA Project.

b. Vortex Suppression Device (VSD) Fabrication and Deployment.

(1) Off-Site Fabrication.

(a) Welding. Conventional shop welding will be required to fabricate individual elements of the VSD system. Typical welds will be ¼ inch filet welds, however some full pen welds will be required if skin plates not supplied in one piece and will require additional testing.. Dogging devices will be fabricated as integral attributes of the VSD.

(b) Painting. The VSDs will be shop painted prior to delivery to the site. The paint system used will be a three coat epoxy system that will require sand blasting the item prior to undercoating and applying final layers. Paint touch up will be required after delivery and prior to deployment.

(2) On-Site Deployment. Deployment will consist of delivery of the fully fabricated VSDs, either by truck to the spillway deck or by barge to the forebay. Setting of the VSDs will

be by Contractor barge crane if delivery is by water and by either Contractor supplied mobile crane or Contractor barge crane if delivered is to the spillway deck. Deployment entails rigging the VSDs for lifting, placing them in prepared guides, and removing or stowing the rigging. Barge support of any work delayed to after spill begins will not be allowed, all such work must be accomplished from the spillway deck. The project route and spillway deck are rated HS-20 and possesses sharp turns which will complicate both access for delivery and crane setup for deployment if performed from the deck. Due to the complications of load ratings, deck beam spacing, curve radii, and other factors, it is preferred that the Contractor deliver the VSDs by water and deploy them from a barge mounted crane. Pier nose guide slot and the stoplog slot dogging brackets will all be new construction utilizing structural steel and will be bolted to the existing concrete structure.

(3) Testing. Each gate pair shall be tested after deployment at both bays. Testing shall be through the full fish passage operating range of gate openings. Testing shall be completed prior to Contractor equipment demobilization. Team members will visually observe the behavior of the system and will make physical measurements as deemed necessary. Full coordination with the Reservoir Control Center (RCC) and The Dalles Project will be required for conducting the tests..

Contractor deployment of VSDs is required to be in the order as shown:

- Bay 6 – both the slot VSD and the pier nose VSD must be deployed before the gate can be opened.

- Bay 7 - both the slot VSD and the pier nose VSD must be deployed before the gate can be opened.

8. COST ESTIMATE

8.1 GENERAL

This section presents the cost estimate for The Dalles Vortex Suppression Device at Bays 6 and 7 of the Spillway. Two steel bulkhead type devices with a draft of 8 and 12 feet in front of each spillway gate will be installed to minimize the vortex. Appendix E contains the detailed printout of the cost estimate.

8.2 CRITERIA

ER 1110-2-1302, Engineering and Design Civil Works Cost Engineering, provides policy, guidance, and procedures for cost engineering for all Civil Works projects in the US Army Corps of Engineers. For a project at this phase the cost estimates are to include construction features, lands and damages, relocations, environmental compliance, mitigation, engineering and design, construction management, and contingencies. The cost estimating methods used are to establish reasonable costs to support a planning evaluation process. The design is at a preliminary level and the cost estimate is at a similar level.

8.3 BASIS OF COST ESTIMATE

The cost estimate is based on preliminary engineering calculations from the design team and data presented in this letter report. The estimate is a MCACES MII Version 2.21, using labor and equipment crews, quantities, production rates, and material prices.

8.4 COST ITEMS

a. Research. Research costs are not included in the cost estimate.

b. Construction Features. The construction cost is detailed below.

c. Lands and Damages. Not applicable. All structures and features are within the existing boundaries of The Dalles Lock and Dam.

d. Relocations. Not applicable. All new features are assumed not to interfere with existing features. Existing spillway stoplogs are stored below the spillway deck. There are sufficient remaining bays to store the stoplogs with Spillway Bays 6 and 7 used for the Vortex Suppression Devices in the stoplog slots.

e. Environmental Compliance. Not applicable as a separate cost item. Construction methods and costs include environmental compliance costs.

f. Hazardous, Toxic, and Radioactive Waste (HTRW) Remedial Cost. The work is on existing project features. The embedded steel angles in the existing stoplog slots may have lead based paint, but disturbance will be minor if at all. Cost for disturbing this paint is incidental to the work, and no assessable costs are anticipated for HTRW.

g. Cultural Resources. No costs are assumed for cultural resources, since work involves modifications to the existing structures.

h. Mitigation. Not applicable as a separate cost item.

i. Engineering and Design. Engineering and Design costs are determined from an estimate of the expected design and engineering effort. These costs include engineering costs for design and development of a contract package (Plans and Specifications), District review, contract advertisement, award activities, and engineering during construction. This effort is estimated to be $340,000 plus a 20 percent contingency.

j. Construction Management. Construction management costs are estimated from historical data and an expected effort required for supervision and administration of the construction work. Cost for a Dive Safety Officer is included for the diving during construction. This is estimated at $100,000 plus a 20 percent contingency.

k. Contingencies. Contingencies are based on a percentage to assure that unforeseen items of work or level of details that may be needed later are covered. Since model testing has established the required geometry, design changes for the project are expected to be minor. However, material and construction costs have been unstable and increasing, therefore a 20 percent contingency is assumed.

l. Escalation. Escalation to account for inflation is applied according to EM 1110-2-1307 Civil Works Construction Cost Index System, Tables Revised as of 31 March 2006, using the Composite Index weighted average. Prices are effective Aug 2006. Design costs have a mid point of October 2006, for an escalation factor of 0.5 percent. Construction costs have a mid point of Jan 2007 for an escalation factor of 1.1 percent.

8.5 CONSTRUCTION SCHEDULE

a. Overtime. Because of the In-water-work-period and the expense of having divers on site, overtime is assumed at 10 hour days, 5 days a week.

b. Construction Windows. Site construction is limited to the in-water work period. The construction window is December 1, 2006 to March 31, 2007.

c. Acquisition Plan. The cost estimate assumes competitive pricing will be obtained by invitation for seal bidding for the construction contract. \

8.6 SUBCONTRACTING PLAN

The cost estimate is based on the work being accomplished by a general construction contractor being the prime contractor. Subcontractors are expected to be a dive company to perform work requiring divers, a steel fabrication shop to fabricate the steel pieces with a subcontractor to paint the finished product, and a marine company to provide floating work platforms, floating cranes, and other boat related equipment.

8.7 PROJECT CONSTRUCTION.

a. Site Access. Personnel access is assumed by project roads from the north shore via Washington Highway 197. Due to the size of the bulkheads, 52 feet long 16 feet high 2 feet thick, and 60 feet long 12 feet high and 2 feet thick, highway transport is probably possible with special oversized permits, however the estimate assumes delivery of the bulkheads by barge. The work requires floating equipment to access work areas.

b. Materials. Steel and concrete quantities required for the project are readily available by commercial sources.

c. Government Furnished Property. None.

d. Construction Methodology. Divers and marine based equipment will be used during site construction. Steel fabrications are typical of large plates and welding and will be done in the shop, delivered to the site ready for installation.

f. Unusual Conditions (Soil, Water, Weather). The site work is during the winter and subject to reduced worker production due to cold, wet weather, shorter daylight hours. Water visibility can be restricted and hinder the diving work. Water visibility is expected to be 0 to 4 feet.

g. Unique Construction Techniques. Construction by divers for installation of brackets and guides to support the bulkheads.

h. Equipment/Labor Availability and Distance Traveled. Labor and equipment is available within a 250 mile radius of the project and includes the areas of Portland/Vancouver (90 miles), Pasco / TriCities area (135 miles), and Seattle/Puget Sound area, (240 miles). Mobilization and demobilization is based on 250 mile travel distance.

i. Overhead, Profit and Bond. Rule of Thumb markups are assumed for the estimate. For the Prime contractor Job Office Overhead is 14 percent, Home Office Overhead is 6 percent, Profit of 8 percent, and Bond Table B, about 1 percent. For the Subcontractors on site, Job Office Overhead is assumed as 15 percent, Home Office Overhead is 10 percent, Profit is 10 percent, and no bond since the prime contractor carries that. Higher markups are assume for the subcontractors due to the highly specialized nature of diving and marine based work, small company size, and additional safety requirements compared to general construction. Since this is marine based and work over water Longshoreman, and Harbors Insurance of 40 percent is assumed in addition to typical workmen's compensation rates. Markups for the Steel fabrication a subcontractor is include in the shop rate assumed to be $65 per hour. The location of the work site is in the state of Washington, which has a sales tax on materials of 7.0 percent and a "Business and Occupational Tax of 1.5 percent on the contact amount.

8.8 ENVIRONMENTAL CONCERNS

The proximity of the water requires additional attention to eliminate all spills and to control / cleanup debris to prevent it from entering the water.

8.9 EFFECTIVE DATES FOR LABOR, EQUIPMENT, MATERIAL PRICING

Effective date for all pricing is August 2006. The most recent Davis-Bacon labor rates were used. The Region 8 2005 Equipment database was employed, as was the 2004 Cost Book Database of MII, which are the most recent MII databases available.

8.10 OPERATIONAL AND MAINTENANCE COSTS

Use of the equipment is experimental and final configuration is not determined and subject to change. Therefore, O&M costs can not be estimated, but are likely to be less than the existing spillway stoplogs.

8.11 SUMMARY OF COSTS.

Table 8-1 summarizes the total estimated project cost at $2,282,100. This is the expected cost from this point onward. Feasibility study costs are not shown since they are in the past. The total estimated project cost of the project includes construction costs of , engineering and design costs, supervision, administration and inspections costs, engineering during design costs, contingency costs, and escalations costs.

******* TOTAL PROJECT COST SUMMARY *******

PAGE 1 OF 1

THIS COST IS BASED ON THE LETTER REPORT DATED AUGUST 2006

PROJECT: THE DALLES DAM - SPILLWAY BAY 6 & 7 VORTEX SUPPRESSION DEVICE — DISTRICT: PORTLAND — DATE: 29-AUG-2006

LOCATION: THE DALLES DAM — P.O.C.: PAT JONES, CHIEF, CONSTRUCTION AND COST ENGINEERING

ACCOUNT NUMBER	FEATURE DESCRIPTION	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	OMB (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FEATURE MID PT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)
	CURRENT COST ESTIMATE PREPARED:	Aug-06				AUTHORIZ./BUDGET YEAR: 2006								
	EFFECTIVE PRICING LEVEL:	Aug-06												
05---	DAMS AND LOCKS	1,443.1	288.6	20%	1,731.7	0%	1,443.1	288.6	1,731.7	Jan-07	1.1%	1,459.0	291.8	1,750.8
06---	FISH AND WILDLIFE FACILITIES	-	-	20%	-	0%	-	-	-	Jan-07	1.1%	-	-	-
	TOTAL CONSTRUCTION COSTS ===>	1,443.1	288.6	20%	1,731.7	0%	1,443.1	288.6	1,731.7			1,459.0	291.8	1,750.8
22---	FEASIBILITY STUDIES	-	-	20%	-	0%	-	-	-	Jul-06	0.0%	-	-	-
30---	PLANNING, ENGINEERING AND DESIGN	340.0	68.0	20%	408.0	0%	340.0	68.0	408.0	Oct-06	0.5%	341.7	68.3	410.0
31---	CONSTRUCTION MANAGEMENT	100.0	20.0	20%	120.0	0%	100.0	20.0	120.0	Jan-07	1.1%	101.1	20.2	121.3
	TOTAL PROJECT COSTS ======>	1,883.1	376.6	20%	2,259.7		1,883.1	376.6	2,259.7			1,901.8	380.3	2,282.1

Note 1: Account 05--- includes construction cost for the project.
Note 2: Account 22--- has already been funded and expended, therefore not included here.
Note 3: Account 30--- includes engineering for Plans and Specifications, review, contract advertisement, award activities and engineering during construction.
Note 4: Account 31--- includes administration of the construction contract for S&A (supervision and administration) and inspections costs.

TABLE 8-1

9. OPERATIONS

9.1 GENERAL

The proposed VSDs will be located at the pier nose and in the stoplog slot for each suppressed bay with each location having unique operational characteristics. This section is broken into three discussion areas, general for items affecting both devices, pier nose device, and stoplog slot device.

a <u>Maximum Tainter Gate Opening.</u> Physical hydraulic model testing indicates at tainter gate openings between 16 and 18 feet a side to side surging in the water surface develops between the stoplog VSD and the tainter gate. This results in an unbalanced load on the tainter gate. At tainter gate openings between 20 and 22 feet the hydraulic control switches from the tainter gate to the VSD. Therefore, in a bay outfitted with VSDs, the tainter gate opening should be electrically limited to 14-16 feet.

b <u>VSD Removal.</u> VSDs should only need to be removed in the following circumstances.

(1) <u>Stoplog Deployment.</u> Since one of the VSD pairs is located in the stoplog slot, anytime the stoplogs need to be deployed, the stoplog VSD needs to be removed. If while the stoplog VSD is removed, there is any reason to open the tainter gate, and allow water to flow out the bay, the pier nose VSD also needs to be removed, see paragraph 9.1.c VSD Pairs.

(2) <u>Tainter Gate Opening Limitation.</u> Any river event that will require the suppressed bay's tainter gate to open greater than 14-16 feet, the VSDs shall be removed, see Paragraph 9.1.a.

(3) <u>Tainter Gate Failure.</u> There currently is no emergency plan for this occurrence at any USACE projects outfitted with tainter gates. The stoplogs are for routine maintenance and are not designed to be deployed through flowing water individually or in their stacked configuration. Therefore no specific design features are being incorporated into the VSD to facilitate removal due to a tainter gate failure.

(4) <u>Movement During Spill Events.</u> Since there are no scenarios that require the VSDs to be removed under flowing water, and that there are larger hydraulic forces acting during this situation, the VSDs are not designed to be removed with flowing water in the suppressed bay. For added safety and if possible, the adjacent bays on either side should also be closed during these operations.

c <u>VSD Pairs.</u> Model testing revealed that the hydraulic forces acting on these devices when used in pairs (pier nose and stoplog slot), were less than if only one device was used by itself in either location. Therefore neither the pier nose device nor the stoplog slot device shall be used alone in a bay with flowing water. In addition, model testing revealed that a pier nose device acting alone with a draft of 5-10 feet, creates an oscillation in the water between the device and the tainter gate that should be avoided.

d <u>Inspection.</u> These devices are not used for dewatering purposes, or personnel access and therefore are not subject to the full hydraulic steel structures (HSS) inspection regime. Although these structures are painted steel weldments subject to cyclic loading and should be inspected for corrosion and structural integrity, typically fatigue cracking, every year for the first five years, then at 5 year intervals after that. However, if any significant structural problems are found during the first five annual inspections, the inspection interval shall remain yearly. Any deficiencies noted during the inspections shall be reported to engineering for formulation of a repair plan, then repaired as necessary.

e Maintenance. The maintenance of the VSDs should be similar to that of any typical steel stoplog or bulkhead. This will include repairing deficiencies found in the inspections, see paragraph 9.1.d, such as damaged paint, cracked structural members and welds, and damaged rollers. It is anticipated that the paint and rollers will have at least 20 year life, upon which a major rehabilitation effort will be required.

9.2 PIER NOSE VSD

a Deployment. The pier nose VSD is designed to be lifted with the project's 55 ton mobile crane, utilizing rigging and spread bar supplied with the pier nose VSD. However, due to limitations on the spillway bridge the mobile crane can not be used to transport the VSD horizontally along the spillway. To move the device to another bay or to storage will require that the device be loaded onto a truck, then unloaded at the new location. Due to this limitation, the pier nose VSD can be dogged off at the top of its guide slot, with a few feet projecting above the guide.

b Flood Passage. The dogged off position, in combination with the spillway draw-down, see Paragraph 7.2.b, will provide enough clearance under the device to pass a river with a forebay elevation of 182.0 feet. Passage of any river above a forebay of 182.0 feet will require removal of the pier nose VSD.

c VSD Pairs. The pier nose device shall never be deployed without a stoplog slot device being deployed. See Paragraph 9.1.c for additional information.

9.3 STOPLOG SLOT VSD

a Deployment. The stoplog slot device is designed to be lifted with the project's spillway gantry crane. A self actuating lifting beam will be required. However, since this is a prototype design, and due to schedule concerns, the lifting beam will not initially be provided, but instead the stoplog slot VSD will be lifted utilizing slings, pendants and a contractor crane. The project's 55 ton mobile crane does not have the capacity at this pick angle and boom height to accomplish this, but the likelihood of the VSD needing to be removed is remote. If the VSD's are successful, a lifting beam should be provided. The stoplog VSDs will be able to dog off at the stoplog storage level right under the spillway bridge deck. If the device needs to be moved out of the suppressed bay to allow maintenance of the tainter gate, the VSD in question can be moved to another bay for storage. Stoplogs are normally stored at this location. There are 23 bays and 20 stoplogs, therefore, 3 bays are available and upon completion of this contract, the project operations should keep the one free bay near Bay 6 and Bay 7, for easy storage of the VSDs. Any additional bays outfitted with VSDs will require a storage solution for VSDs and stoplogs.

b Flood Passage. The dogged off location, in combination with the spillway draw-down, see Paragraph 7.2.b, will provide enough clearance under the device to pass a river with a forebay elevation of 172.0 feet. Passage of any river above a forebay elevation of 172.0 feet will require removal of the stoplog slot VSD.

c VSD Pairs. The stoplog slot device shall never be deployed without a pier nose device deployed. See Paragraph 9.1.c for additional information.

10. CULTURAL/ENVIRONMENTAL REQUIREMENTS

10.1 ENVIRONMENTAL COMPLIANCE

All actions that are federally funded, permitted, or constructed must satisfy the requirements of the National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. 4321 et seq.). The installation of the vortex suppression devices (VSDs) at The Dalles Dam is considered an activity occurring at a completed Corps project which will carry out authorize purposes. This action qualifies as a Categorical Exclusion under NEPA and ER 200-2-2 (9) (a). An Environmental Assessment (EA) is not required.

The installation of the VSDs will not involve any fill or excavation in waters of the United States. This project will not require a Section 404 (b) (1) Evaluation under the Clean Water Act of 1977. The installation will occur during an agency approved in-water work window. The proposed project is in compliance with the Clean Water Act.

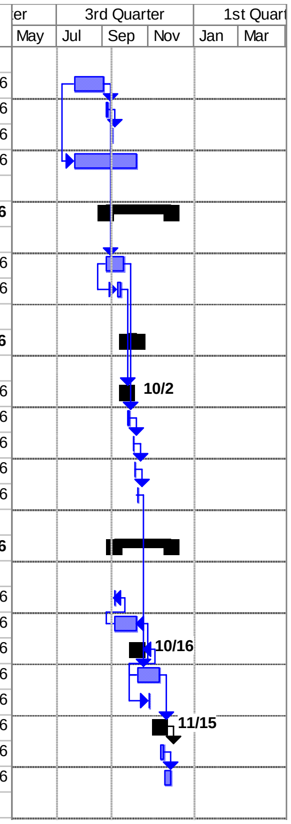
In accordance with Paragraph 7(a) (2) of the Endangered Species Act of 1973, as amended, federally funded, constructed, permitted, or licensed projects must take into consideration impacts to federally listed or proposed species. A species list was received from the US Fish and Wildlife Service (USFWS) on August 13, 2006. Based upon the proposal, we have determined that the project will have *no effect* on any federally listed or proposed species or critical habitat. The project is in compliance with the Endangered Species Act.

Essential Fish Habitat (EFH) exists in the project vicinity for Chinook and coho salmon. However, the installation of the VSDs will have no adverse effect on any freshwater habitats or any of the primary constituent elements essential for the conservation of these species. The proposed project is not expected to affect EFH used by Chinook or coho salmon in the project vicinity. The project is in compliance with the Magnuson-Stevens Fishery Conservation and Management Act (MSA).

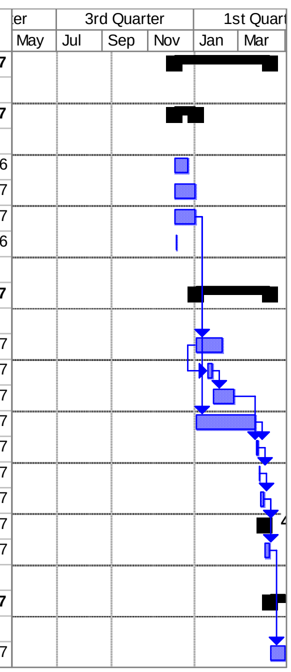
Section 106 of the National Historic Preservation Act (NHPA) requires that federally assisted or federally permitted undertakings account for the potential effects on sites, districts, buildings, structures, or objects that are included in or eligible for inclusion in the National Register of Historic Places. The proposed project will have no adverse effect on any cultural, historic, or archaeological resource. The project is in compliance with the NHPA.

11. SCHEDULE

ID		Task Name	Duration	Start	Finish
1					
2		Letter Report	30 days	Mon 7/24/06	Fri 9/1/06
3		100% Review Letter Report	4 days	Tue 9/5/06	Fri 9/8/06
4		Incorporate Letter Report Review Comments	3 days	Mon 9/11/06	Wed 9/13/06
5		Develop Environmental Documents	59 days	Mon 7/24/06	Mon 10/16/06
6					
7		**Plans and Specifications**	**61 days**	**Tue 9/5/06**	**Fri 12/1/06**
8					
9		Compile P&S	19 days	Tue 9/5/06	Fri 9/29/06
10		60%	5 days	Tue 9/19/06	Mon 9/25/06
11					
12		**BCOE**	**10 days**	**Mon 10/2/06**	**Mon 10/16/06**
13					
14		Design Quantity, Cost Estimate, Construction Schedule	0 days	Mon 10/2/06	Mon 10/2/06
15		BCOE Review , ITR Review	5 days	Mon 10/2/06	Fri 10/6/06
16		Incorporate BCOE Comments	2 days	Tue 10/10/06	Wed 10/11/06
17		Backcheck Review Comments	2 days	Thu 10/12/06	Fri 10/13/06
18		CT Package	1 day	Mon 10/16/06	Mon 10/16/06
19					
20		**Procurement**	**53 days**	**Fri 9/15/06**	**Fri 12/1/06**
21					
22		Synopysize	1 day	Fri 9/15/06	Fri 9/15/06
23		Advance Notice	31 edays	Fri 9/15/06	Mon 10/16/06
24		Final EA and Signed FONSI NLT Aw ard	0 days	Mon 10/16/06	Mon 10/16/06
25		Solicitation	30 edays	Mon 10/16/06	Wed 11/15/06
26		Site Tour	1 day	Tue 10/31/06	Tue 10/31/06
27		Bid Opening	0 days	Wed 11/15/06	Wed 11/15/06
28		Aw ard	3 days	Thu 11/16/06	Mon 11/20/06
29		NTP	8 days	Tue 11/21/06	Fri 12/1/06
30					



ID		Task Name	Duration	Start	Finish
31		**Construction**	**88 days**	**Mon 12/4/06**	**Tue 4/10/07**
32					
33		**Preparation Phase**	**20 days**	**Mon 12/4/06**	**Tue 1/2/07**
34					
35		Project Specific Management Plan	15 days	Mon 12/4/06	Fri 12/22/06
36		Submittals	20 days	Mon 12/4/06	Tue 1/2/07
37		Shop Draw ings	20 days	Mon 12/4/06	Tue 1/2/07
38		Pre-Con	1 day	Wed 12/6/06	Wed 12/6/06
39					
40		**Construction Phase**	**68 days**	**Wed 1/3/07**	**Tue 4/10/07**
41					
42		Pier Nose Guide Fabrication and Delivery	25 days	Wed 1/3/07	Wed 2/7/07
43		Mobilize	5 days	Thu 1/18/07	Wed 1/24/07
44		Pier Nose Guide Installation & Dogging Bracket Installation	20 days	Thu 1/25/07	Thu 2/22/07
45		Suppression Device Fabrication and Delivery	11 w ks	Wed 1/3/07	Thu 3/22/07
46		Suppression Device Installation	2 days	Fri 3/23/07	Mon 3/26/07
47		Test Devices - suppressed gates thru full fish passage range	2 days	Tue 3/27/07	Wed 3/28/07
48		Float/Weather	4 days	Thu 3/29/07	Tue 4/3/07
49		Construction Completion	0 days	Tue 4/3/07	Tue 4/3/07
50		Demobilization	5 days	Wed 4/4/07	Tue 4/10/07
51					
52		**Closeout Phase**	**20 days**	**Wed 4/11/07**	**Tue 5/8/07**
53					
54		Closeout	20 days	Wed 4/11/07	Tue 5/8/07



SCHEDULE NOTES:

LINE 44: MOBILIZE

- Dogging brackets can be installed at any time during the IWW and should be done before installation of the guide brackets to alleviate schedule impacts
- Guides should be delivered on a staggered schedule, installed as delivered
- Bolts for guide installation to the pier nose concrete can be installed in advance of guide delivery to facilitate and alleviate schedule complications

LINE 45: PIER NOSE GUIDE INSTALLATION

- Crew composition
  - Project manager/superintendent
  - Crane Operator
  - 2 deck hands
  - Skiff operator
  - Tug operator
    - 2 deck hands
  - 1 dive crew for 2 underwater attachments at 4 locations
  - 3-4 hands for 6 plus attachments above water at 4 locations and dogging brackets
- No lifting beam – may need a spreader bar if simple sling lift height is too much for crane configuration

12. LOCAL COOPERATION REQUIREMENTS

This project entails modifications to the spillway at The Dalles Project, which is owned by the Federal Government. There is no expected impact on other entities, including the WASCO PUD, or navigation users.

Coordination on the project has taken place with many agencies. Fish passage improvement coordination with the agencies and tribes has occurred and will continue through the Anadromous Fish Evaluation Program's (AFEP) work groups and teams.

13. FUNDING

Plans and Specifications are being developed concurrently with the development of this Letter Report. Funding should continue being provided to complete the Plans and Specifications throughout FY06 and into the beginning of FY07. Funds for construction, engineering during construction, and construction supervision and administration will be required at the beginning of FY07 for completion of this project.

14. REAL ESTATE REQUIREMENTS

There are no additional Real Estate requirements for this facility as it is entirely within the limits of The Dalles Project.

15. DAM SAFETY CONCERNS

There are a few Dam Safety Concerns with the implementation of the VSDs.

a. VSD Deployed. Tainter Gate opening for the suppressed bays is electrically limited to 14-16 feet. This limits the flow that can pass through these bays.

b. VSD Dogged. This allows the suppressed bays tainter gates to be opened to what ever amount is required. However, due to the rising forebay in these events, the piernose VSD will need to be removed when forebay elevations exceed 182.0 feet, and the stoplog slot VSD will need to removed when forebay elevations exceed 172.0 feet. For any river elevations above these the VSDs will need to be removed and stored off the spillway.

c. Tainter Gate Failure. The VSDs are not designed to be lifted with flowing water in the bay. The only condition that could create the need for this would be if a tainter gate is open and can not close. There currently is no emergency plan for this occurrence at any USACE projects outfitted with tainter gates. The stoplogs are for routine maintenance and are not designed to be deployed through flowing water individually or in their stacked configuration. Therefore no specific design features are being incorporated into the VSD to facilitate removal due to a tainter gate failure.

16. RECOMMENDATIONS AND FOLLOW-ON ACTIONS

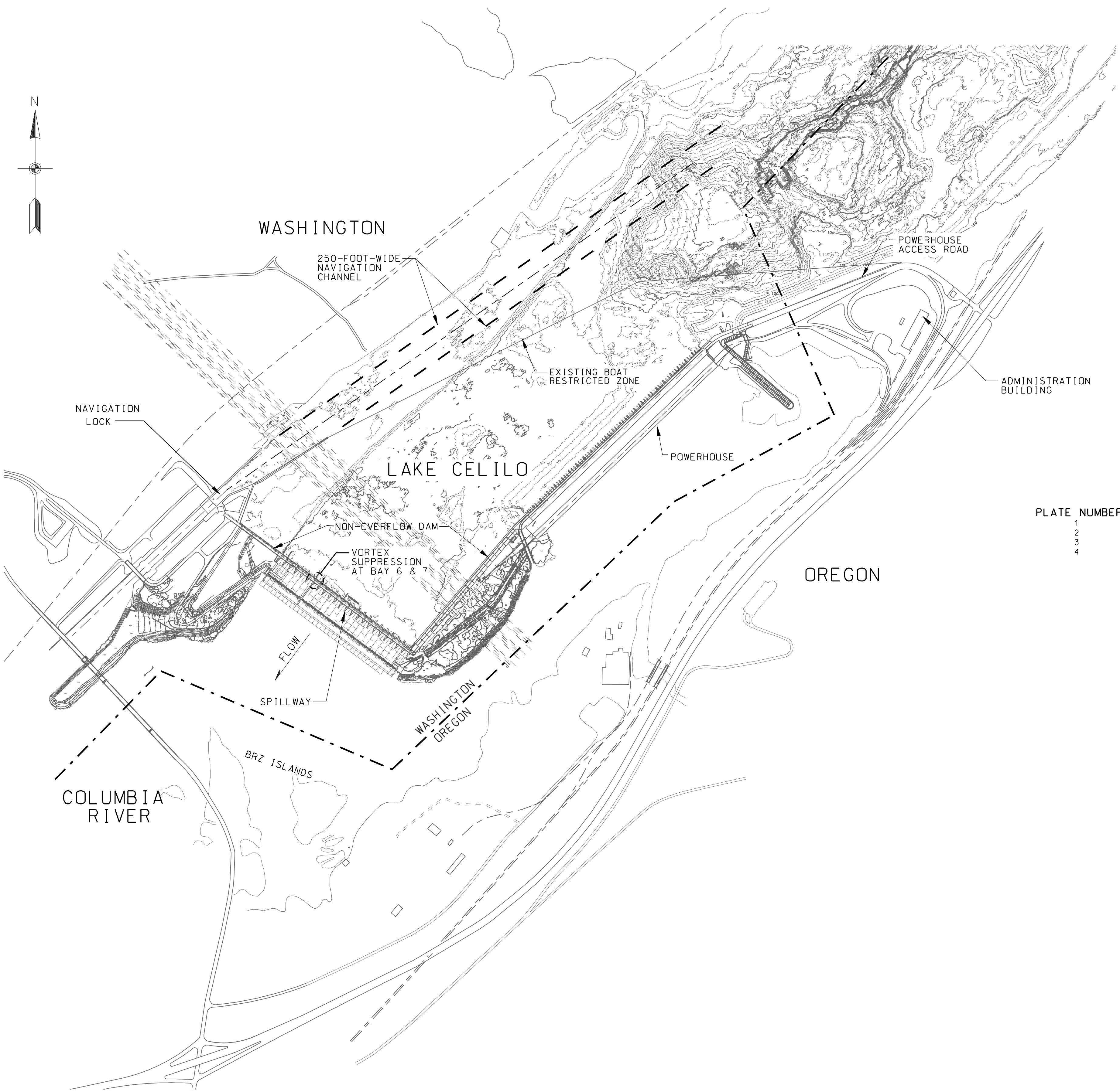
It is recommended that the proposed VSDs, as described in this Letter Report, be approved. The Plans and Specifications that have been under development concurrently should be complete, and then VSDs should be constructed for Bays 6 and 7.

During the initial design work for the Letter Report a maximum gate opening of 14 feet was assumed for Bays 6 and 7. But to provide additional flexibility to meet 40% spill during the spill season the maximum gate opening for Bay 6 could be 16 feet. The velocities for this design were estimated from other model runs and a hydraulic force computed. The CFD model run for this operations is being ran and will be incorporated into the final design for Plans and Specs.

Two prototype test will be conducted during the initial start up of the VSDs. The first prototype will be conducted while the contractor is still on site and will involve opening Bays 6 and 7 to 14 feet and making detailed observations of the hydraulic conditions that occur, see section 7.3. The second prototype test will be after spill has been initiated and will be to exercise the gates to their maximum gate opening (16 feet) and verify acceptable performance. The second test will generate maximum lateral flow since Bays 1 through 7 will be exercised.

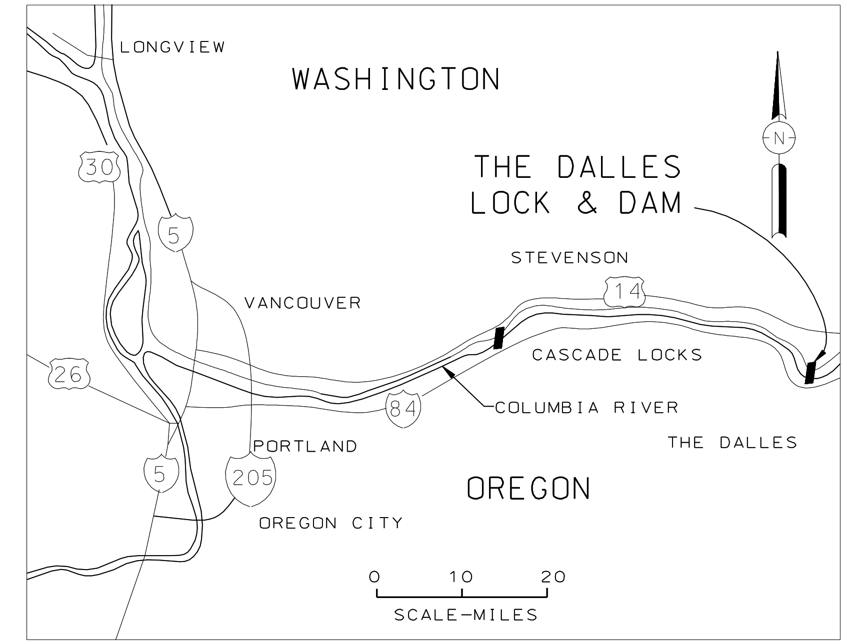
If biological testing indicates that the VSDs are successful, design and construction of a lifting beam and a storage rack, if required, should be initiated.

After the fish passage season, the VSD and guides should be inspected.



PROJECT LOCATION MAP

NTS



VICINITY MAP

INDEX

PLATE NUMBER	TITLE
1	PROJECT LOCATION MAP AND VICINITY MAP AND INDEX
2	SPILLWAY BAYS 6 AND 7 PLAN AND SECTION
3	PIER NOSE VSD ELEVATION AND SECTION VIEWS
4	STOPLOG SLOT VSD ELEVATION AND SECTION VIEWS

US Army Corps of Engineers
Portland District

Symbol | Description | Date | Appr.

DESIGNED BY:
DRAWN BY: J.CHASE
CHECKED BY:
FILE NAME: Plate 01.dgn
SUBMITTED BY:
DATE: October 22, 2006
SOLICITATION NO. DACW-
CONTRACT NO. DACW-

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
Portland, Oregon

COLUMBIA RIVER OREGON/WASHINGTON
THE DALLES DAM AND RESERVOIR
PROTOTYPE VORTEX SUPPRESSION DEVICE
PROJECT LOCATION MAP AND VICINITY MAP AND INDEX

Drawing Number

Plate Number:
1

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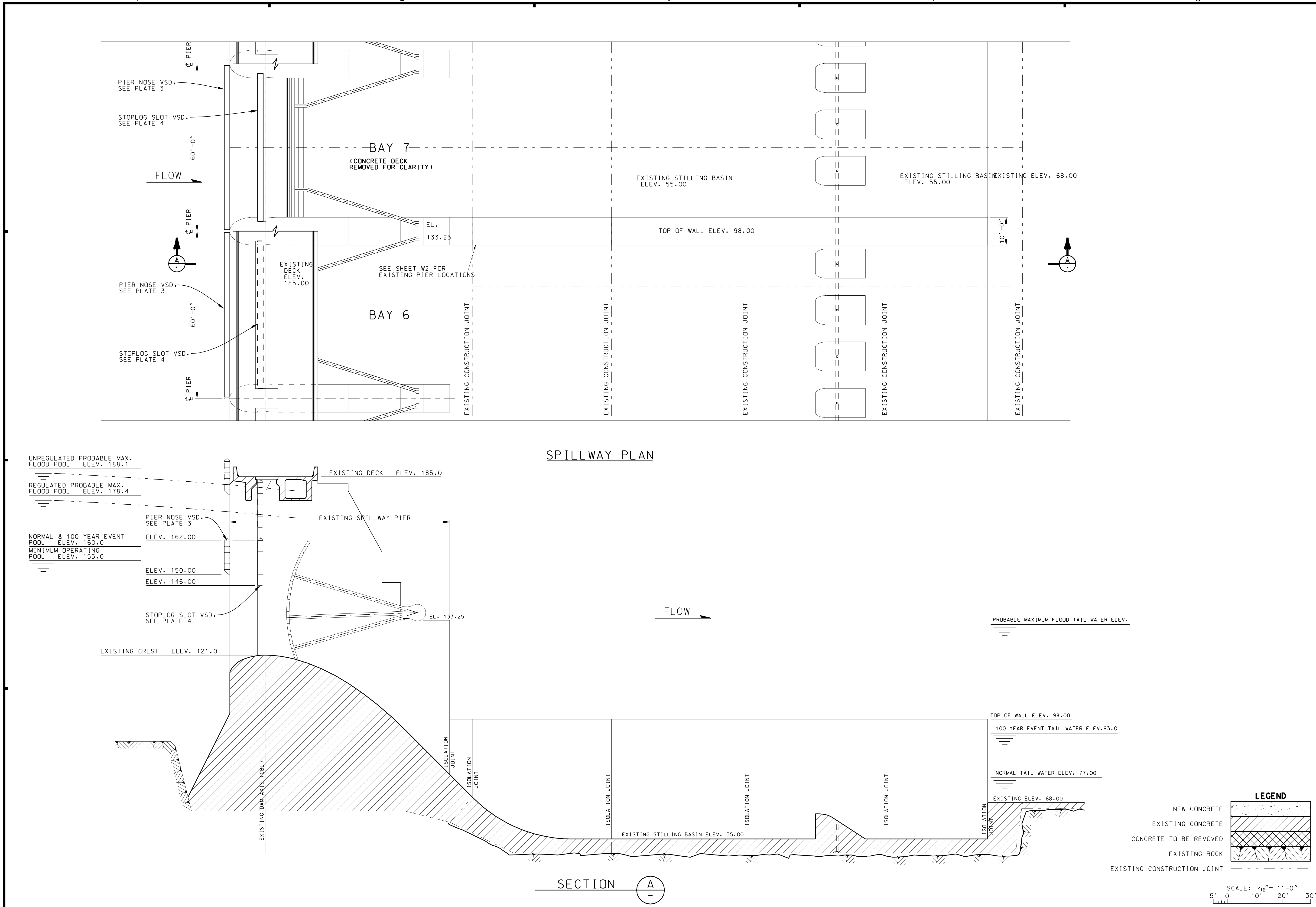
SHEET NAME: PLATE 1



US Army Corps of Engineers
Portland District

Symbol	Description	Date	Appr.

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CHECKED BY: G2EC#XXX
DATE: October 22, 2006
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CONTRACT NO. DACW-
FILE NAME: Plate 02.dgn
SUBMITTED BY: SUBMITTER NAME SUBMITTER TITLE

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
Portland, Oregon

COLUMBIA RIVER — OREGON/WASHINGTON
THE DALLES DAM AND RESERVOIR
PROTOTYPE VORTEX SUPPRESSION DEVICE

SPILLWAY BAYS 6 AND 7
PLAN AND SECTION

Drawing Number

Plate Number:
2

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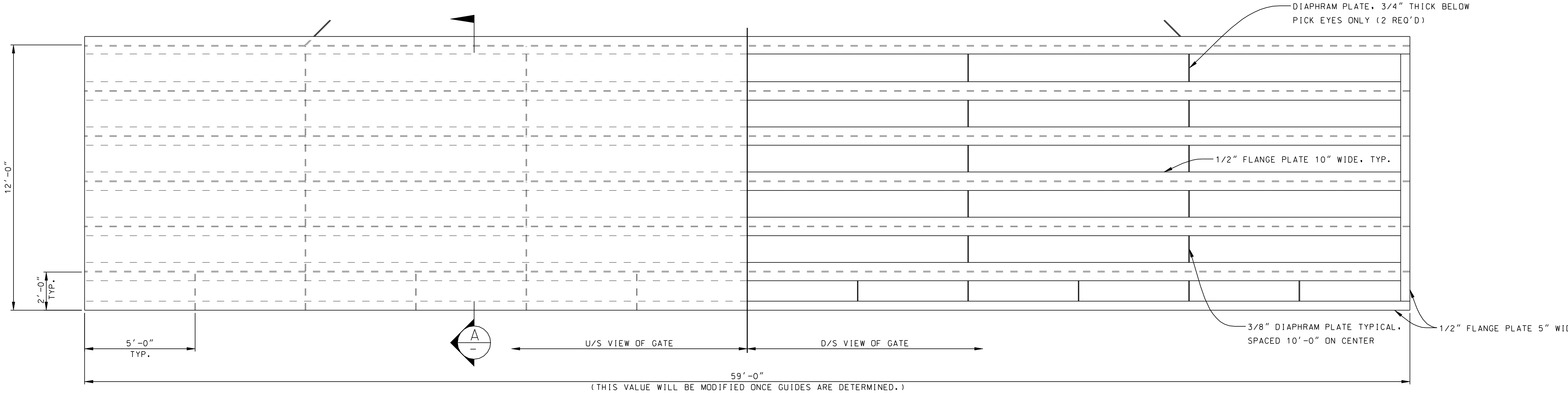
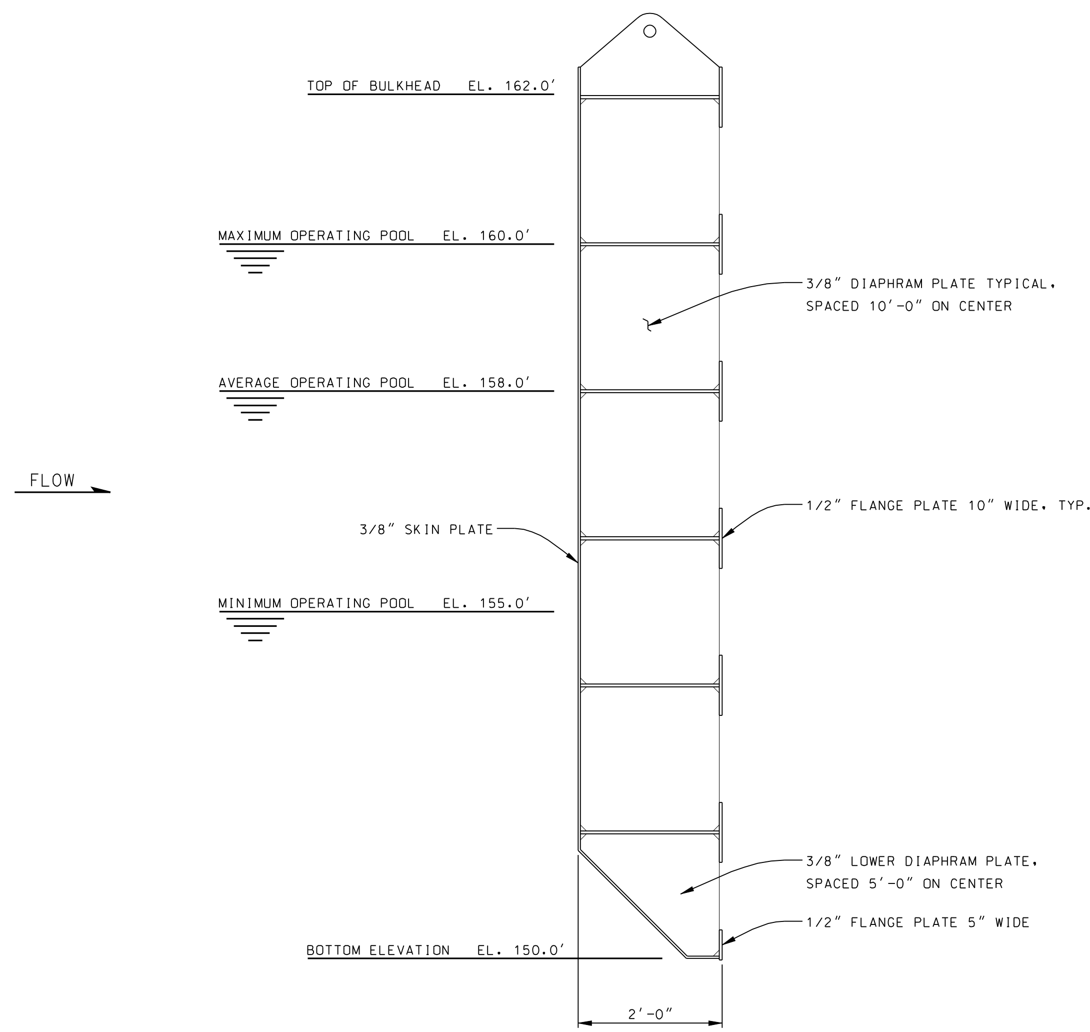


PIER NOSE VSD

SCALE: 3/8" = 1'-0"



SECTION THRU PIER NOSE VSD (A)

SCALE: 3/4" = 1'-0"

US Army Corps of Engineers
Portland District

DATE: October 22, 2006
DESIGNED BY: P. DUYCK
CHECKED BY:
SOLICITATION NO. DACW-
DRAWN BY: G2ECDJRC
CONTRACT NO. DACW-
FILE NAME: Plate 03.dgn
SUBMITTED BY:

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
Portland, Oregon

COLUMBIA RIVER OREGON/WASHINGTON
THE DALLES DAM AND RESERVOIR
PROTOTYPE VORTEX SUPPRESSION DEVICE
PIER NOSE VSD
ELEVATION AND SECTION VIEWS

Drawing Number

Plate Number: 3

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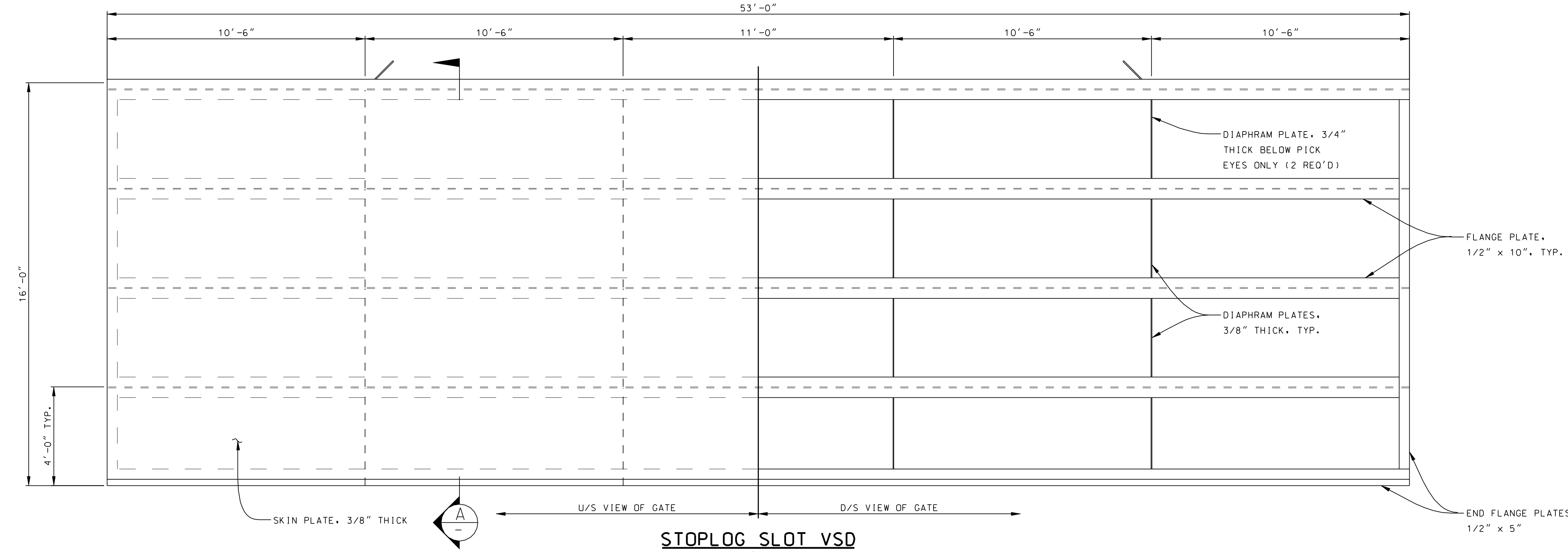

STOPLOG SLOT VSD

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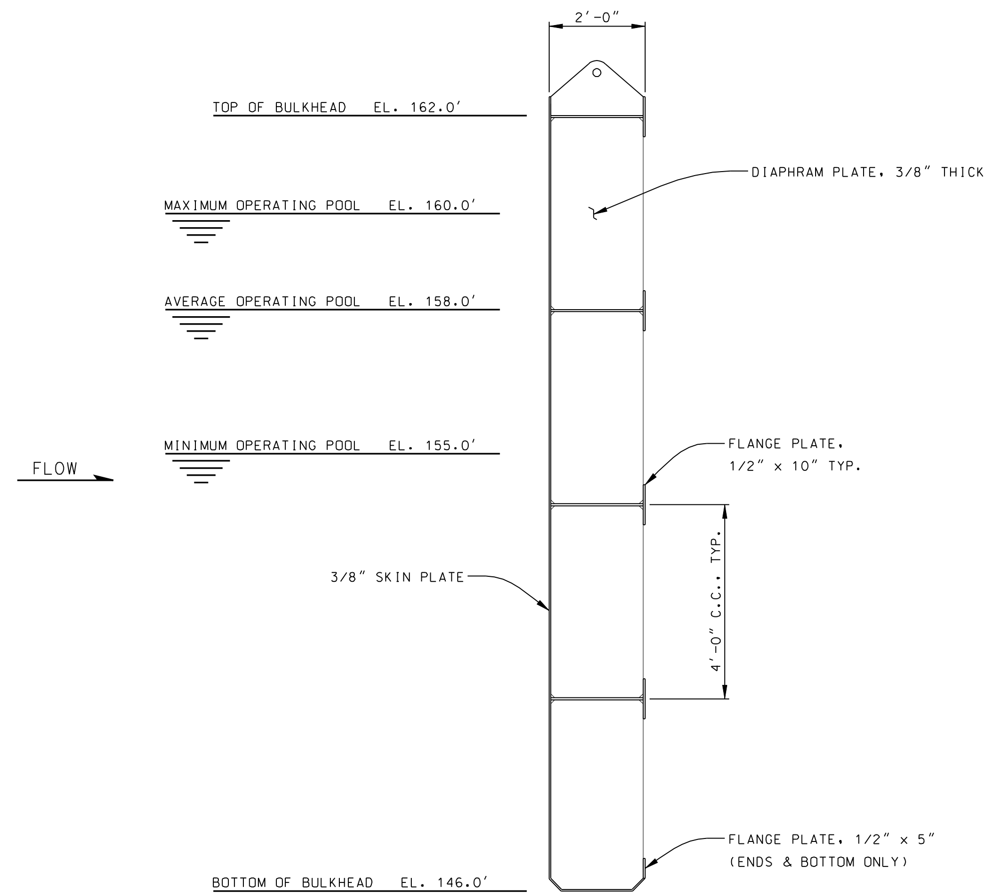

SECTION THRU STOPLOG SLOT VSD (A)

SCALE: 1/2" = 1'-0"

US Army Corps of Engineers
Portland District

DESIGNED BY: P. DUYCK
DRAWN BY: G2ECDJRC
CHECKED BY:
DATE: October 22, 2006
SOLICITATION NO. DACW-
CONTRACT NO. DACW-
FILE NAME: Plate 04.dgn
SUBMITTED BY:

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CORPS OF ENGINEERS
Portland, Oregon

COLUMBIA RIVER OREGON/WASHINGTON
THE DALLES DAM AND RESERVOIR
PROTOTYPE VORTEX SUPPRESSION DEVICE
STOPLOG SLOT VSD
ELEVATION AND SECTION VIEWS

Drawing Number

Plate Number: 4

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APPENDIX A - AGENCY COORDINATION

APPENDIX A

Trip Report – ERDC – July 17 – 21, 2006 Gary Fredricks and Ed Meyer

The primary purpose of the trip was to evaluate vortex suppression devices for the Dalles Dam spillway, other tasks included preliminary looks at surface spill options and spillway egress improvement options with the newly modified general model. We used a 1:25 scale sectional model of the spillway to evaluate vortex suppression capabilities of several vortex suppression devices or VSD's and we used the 1:80 general model to evaluate how well the most promising VSD's altered forebay flows. We also used the general model to evaluate forebay response to surface spill and tailrace egress conditions for each option.

Using the 1:25 sectional model we assessed several variations of vortex suppression devices which consisted of different lengths of bulkheads either attached to the pier noses or positioned in a bulkhead slot in front of the spillway tainter gate or both. The length of the various bulkheads refers to the depth of submergence beneath the forebay water surface. Bulkheads of lengths from 4' to 18' were modeled singly or in tandem. When two devices were used they could be either the same length or different lengths. It turned out that a device in both positions was necessary to adequately suppress a vortex at a 14' gate opening. We found that equal length devices of 8' suppressed the vortex well at the 14' gate opening but did cause a large amount of turbulence and surging in the space between the devices and the gate. A dual length option with the pier nose gate shorter than the slot gate turned out to do slightly better job of vortex suppression and a very good job of reducing the integrate turbulence and surging. After looking at various lengths and configurations of the VSD's we settled on evaluating tandem gate lengths of 8'and 8' (pier nose and bulkhead slot lengths, respectively), 5' and 8' and 8' and 12'in the general model. Later in the week the preferred option of 8 and 12' VSD's were again evaluated under different spill gate settings working down from the maximum of 14' to make sure there were no unexpected hydraulic conditions at the lower gate settings. None arose.

The 1:80 scale general model was used at river flows of 315, 250 and 150 kcfs. The 315 kcfs flow level corresponds to the level at which 40% of the river flow can be passed thorough bays 1-6. We also looked at both 40 and 30% spill levels. VSD's were placed in spillbays 6 and 7 individually and together. We had initially thought that suppression devices would be needed in bay 6 and maybe bay 5 but after working with the model a bit we decided that some training spill from bay 7 would improve egress conditions for fish passing through bay 6. Flow from bay 7 would be limited by only opening the gate 2 or 3 feet. By placing suppressing devices in bays 6 and 7 we were able to limit entrainment of surface confetti, beads and dye into those bays substantially, particularly bay 7. Surface indicators showed that the upper level flow was stalling somewhat in front of these bays and moving slowly laterally to the north. When we included surface spill from bay 5, this stagnation disappeared and the surface flow moved strongly laterally to the open surface spill bay.

We also were able to look at some initial spillway improvement study options in the general model. The model had been recently modified to allow removal of large sections of the spillway tailrace shelf from the stilling basin to the deep thalweg downstream. The upper surface of these sections included greatly improved bathymetry detail obtained from recent more detailed surveys. It became apparent to those who have used this model in the past that this new bathymetry made a significant change in egress conditions, particularly for flow passing through bays 5 and 6 under the lower river flow levels. This flow now moves much more readily to the south and a large portion of the flow (60%+) from both bays eventually moves south along the bridge shelf and into the Oregon channel or over the shelf and into the predator laden shallows beyond.

The ability to remove spillway shelf sections will allow investigation of changes in bathymetry that could improve this egress issue. The more downstream sections of the new spill shelf were actually stacked. Complete removal and subsequent placement of sandbags allowed evaluation of different depths and configurations of excavation. Our very preliminary look at various amounts and configurations of rock excavation in the tailrace didn't show much promise until we decided to use the sandbags to emulate a wall extension which would extend the existing spillwall about three times its current length of about 200 feet. The wall was also curved to the north a bit towards the end. We also simulated removal and shaping of some of the north spill shelf shoreline. These combinations made a dramatic improvement in the egress conditions allowing all the flow from the bays inside the wall to egress swiftly into the thalweg. Some of the participants made the observation that this option might make the VSD's unnecessary, although they would still be useful in reducing fish passage through bays south of the spillwall area when use of those bays was necessary.

Conclusions: The vortex suppression concept shows a lot of promise for reducing passage of fish into problematic spill gates, particularly when used in combination with nearby surface spill. The combination of these devices in gates 6 and 7 and surface spill in gates 3-5 is an alternative that should be pursued at least through the design phase as soon as possible with the idea of implementing the vortex suppression devices in 2007. Spillway improvement study options should be investigated concurrent with this schedule with the idea of implementation of some combination of options in 2008 or 2009. Study results evaluating the fish distribution benefits of the 2007 VSD installation will be useful in defining the next steps. The implementation options fall out something like this, none of these are mutually exclusive but they are in order of how they can or should be completed:

1. Install VSD's in bays 6 and 7 and test effect on passage distribution.
2. Install VSD's in bays 6 and 7 and surface spill in bays 3, 4 and/or 5 and test for full effect.
3. Install VSD's in bays 6 and 7 and pursue SIS options such as extending and shaping the spillwall, bathymetry mods and shoreline mods and evaluate the full effect.
4. Install forebay guidance devices (if needed) and test for changes in distribution.

Several of the Corps personnel stayed in Mississippi an additional week to work with the spillway improvement options. The results of this and subsequent work will be presented to the agencies in future FFDRWG meetings and will be the subject of another ERDC trip later this fall or winter.

APPENDIX B - ENVIRONMENTAL COMPLIANCE

CENWP-PM-E

MEMORANDUM FOR RECORD
SUBJECT: RECORD OF ENVIRONMENTAL CLEARANCES-THE DALLES VORTEX PROJECT
DATE: AUGUST 15, 2006

Categorical Exclusion Determination
The proposed project is the installation of a vortex suppression device (VSD) for Bays 6 and 7 at The Dalles Dam in Klickitat County, WA. The VSD is a structural device installed in the stop log slot and on the spillway pier to reduce a large vortex flow. Suppressing the vortex is considered to be a cost effective solution to redistributing juvenile fish to bays to the north, thus encouraging better tailrace egress and fish passage survival. Installing the VSDs and suppressing the vortex will increase juvenile fish passage survival at The Dalles Dam.

The VSDs will be pre-fabricated offsite and installed on the spillway bays at The Dalles Dam. The installation does not require any fill or excavation in waters of the United States. There will be no river substrate disturbance. Installation will take place by cranes from the dam and/or floating plants. The work will be accomplished during an agency approved in-water work window.

In consideration of the above, and since the development is considered an activity occurring at a completed Corps project which will carry out authorized project purposes, the proposed action qualifies as a Categorical Exclusion under the National Environmental Policy Act (NEPA) and ER 200-2-2, (9) (a). An Environmental Assessment (EA) is not required.

Other Environmental Compliance
Other environmental laws or requirements, such as cultural resources acts, Endangered Species Act, Clean Water Act, etc. still apply, and are being coordinated through PM-E.

Clean Water Act: The proposed action does not involve any fill or excavation in waters of the United States. A Section 404 (b) (1) Evaluation will not be required for this project. The proposed action is in compliance with this Act.

Endangered Species Act: The Klickitat County species list was downloaded from the US Fish and Wildlife Service website on August 13, 2006. The list was reviewed for listed species that may occur in the project vicinity. It was determined that the installation of the VSDs would have *no effect* on any listed species or critical habitat. There are no proposed species in Klickitat County, WA.

Magnuson-Stevens Fishery Conservation and Management Act (MSA): The Pacific Fisheries Management Council (PFMC) has designated essential fish habitat (EFH) for three species of Pacific salmon including Chinook (*Onchorynchus tshawytscha*), coho (*O. kisutch*), and Puget Sound pink salmon (*O. gorbuscha)* (PFMC 1999). Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds, wetlands, and other water bodies currently, or historically accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable barriers.

Essential Fish Habitat for both Chinook and coho salmon exists in the vicinity of the proposed project. No EFH for Puget Sound pink salmon is present.

The proposed action is to install VSDs on spillway piers at The Dalles Dam to ultimately improve juvenile fish passage survival. The installation will not require the manipulation of any habitats or any of the primary constituent elements essential for the conservation of the species. There will be only construction activities associated with the installation of the VSD at two bays on the existing structure. There will be no fill or excavations associated with the installation of the VSDs for this project. The installation of the VSDs will have no adverse effect on any freshwater habitats or any of the primary constituent elements essential for the conservation of these species.

The proposed project is not expected to adversely affect EFH used by Chinook or coho salmon in the project vicinity.

Cultural Resources: Section 106 of the National Historic Preservation Act (NHPA) requires that federally assisted or federally permitted undertakings account for the potential effects on sites, districts, buildings, structures, or objects that are included in or eligible for inclusion in the National Register of Historic Places. The proposed action will take place on The Dalles Dam on existing spillway piers. The proposed project will have no adverse effect on any cultural, historic, or archaeological resource. The project is in compliance with the NHPA.

James B. Stengle
Environmental Resources Specialist

APPENDIX C – HYDRAULICS

CENWP-EC-HD 15 June 2006

MEMORANDUM FOR RECORD

SUBJECT: The Dalles Vortex Suppression (VSD) – 1:25 Sectional Model Trip

1. This MFR documents the subject trip made to ERDC on 5-9 June 2006 to determine a prototype VSD configuration to design and construct for the 2007 juvenile fish outmigration at The Dalles Dam spillway. Attending were: Jeff Ament EC-DS, Randy Lee EC-HD, Glenn Davis and Bobby Fuller ERDC.

2. Background. After construction of the spillwall, the juvenile spill pattern shifted to a concentrated flow between Bays 1-6. This concentrated flow creates a rather large vortex at the edges of spill due to lateral flow as the spill wraps around the piers. Forebay fish tracking studies have indicated that 66% of the fish pass through Bays 5 and 6, while only 33% of the fish pass through Bays 1-4. It appears that many fish that bypass the powerhouse, travel downstream to Spillbay 23 then head north to Bay 6, where the first thing fish encounter is the large surface draw from this vortex. Based on this and hydraulic model studies at ERDC it appears that the vortex has a large surface influence. Spillway fish studies have shown that juvenile fish survival along the southern edge of Bay 6 is less than the juvenile fish survival Bays 1-4. This is due to the edge effect in the tailrace caused by poor egress and high predation in this area. Therefore suppressing the vortex is considered to be a cost effective solution to redistributing juvenile fish to Bays, to the north, that have higher survival.

3. For this trip, the original intent was to investigate the draft required for a VSD to suppress the vortex at the bulkhead slot and on the front face of the spillway pier. In addition, to improve hydraulics, three VSD bottom shapes were constructed to investigate: a knife edge, half round shape and a quarter round shape. See attached agenda.

   Prior to testing the constructed shapes a VSD with a square edge bottom shape (one of the constructed shapes turned upside down) was installed. We did this preliminary step to get a "feel" for the model. However, when a deep draft (12-15 foot submerged) square edged VSD was installed at the front face of the pier nose with the tainter gate 14 foot open (preferred position for fish passage) the forebay in the model lowered dramatically. This indicated an increase in efficiency that results in an increase in tainter gate discharge for the given opening. One possible reason for the increase in discharge is that the streamlines generated by the VSD at this depth and farther out into the forebay are close to streamlines generated by the tainter gate. A smoother transition occurs resulting in an increase in efficiency. The group determined that it was not necessary to investigate the knife edge, half round and quarter round shapes since improving hydraulic efficiency was not an issue. All investigations conducted for the week were with a squared edged VSD.

4. Summary of Observations. See attached notes for detailed observations of scenarios viewed. In addition, a shallow draft (3-4 foot submerged) VSD and variations to this were briefly viewed.

No VSD (Base Condition)

A vortex forms on the left side (looking downstream) in the area of the bulkhead slot. A deep core is formed that travels under the tainter gate. See Photo1.

VSD in Stoplog Slot

A VSD in the stoplog slot alone does not suppress the vortex through all fish passage flows, no matter how deep the draft. Therefore placing a VSD in this slot alone was eliminated from further consideration.

VSD on Upstream end of Forebay Piers

3-4 foot Draft VSD – Suppresses the vortex at a 5 foot and 10 foot gate opening, but at a 12, 14 and 20 foot gate opening a sizable vortex forms between the VSD and the tainter gate, but does not appear to have any attraction affect on the dye or beads. This VSD had minimal head differential and could be made into a floating structure to accommodate the varying forebay elevations.

Additional changes to the 3-4 foot draft VSD were briefly tested.

Slot Closure – Filling in the stoplog slot had minimal affect if any on the vortex between the VSD and the tainter gate.

Floating Dock – Placing a large horizontal floating dock type structure between the VSD and the tainter gate changed the vortex shape, but did not suppress it, and added structure that would cause damage if oscillation started.

Secondary VSD in Stoplog Slot – This seemed to work when at the same 3-4 foot submergence as the forebay pier VSD. A very small and very occasional vortex formed between the slot VSD and the tainter gate.

5-10 foot Draft VSD – Causes a rather large oscillation in the forebay and between the VSD and the tainter gate at the 12-14 foot gate openings. Should never go into this condition!

13 foot Draft VSD – Suppresses the vortex, but causes smaller traveling vortices to form up to 25 foot upstream of the VSD. If this is chosen and it is at a fixed elevation, this VSD will need to be a 13 foot draft at forebay elevation 155 ft, which equates to an 18 foot + draft VSD at forebay elevation 160 ft. This configuration will have to withstand very large head differentials (up to the maximum draft of the VSD),

will be quite heavy and will require operations personnel to remove it to pass flows above standard fish flows.

5. Conclusions and Recommendations.

From an engineering and operations standpoint, the shallow draft floating structure appears to be the better solution. However, recognizing that the vortex still exists behind the forebay shallow structure, and that part of the goal of this VSD is to move the fish laterally along it to the north, the biologists need to weigh in on:

- Will the vortex behind the single forebay, shallow structure still create a surface attraction for the fish?
- Will the 2 shallow VSDs (forebay pier and stoplog slot) suppress the vortex sufficiently?
- Will the shallow VSD/s provide the lateral guidance to the north?
- If the shallow VSD is not sufficient, is there any gain in performance with the deep draft VSD?
- Is there any concern with the vortices in the forebay with the deep draft VSD?

Conduct CFD modeling using TDA forebay model with shallow VSD at the pier face and bulkhead slot and a deep draft VSD at the pier face. Particle tracking and stream traces should be used to determine possible fish travel.

Due to the apparent increase in efficiency of the deep draft VSD at the pier nose face, spillway gate rating curves will need to be revised if a deep draft VSD is implemented.

Randy Lee, EC-HD
Hydraulic Engineer

Jeff Ament, EC-DS
Structural Engineer

CF: Glenn Davis, CEERD-HN-HI
Lance Helwig, CENWP-PM

Agenda

The Dalles Dam - Vortex Suppression VSD
1:25 Scale Model Trip 5-9 June 2006

Objective(s):

1. To determine the draft of the bulkhead to suppress the vortex and to not impact the flow through the spillway. This will be determined for bulkheads installed in the stoplog slot and on the upstream face of the pier noses.

Steps for the 1:25 spillway sectional model:

1. Three VSD bottom shapes will be investigated: knife edge, half round and quarter round.

2. Each VSD will be placed and investigated in the stoplog slot and on the upstream face of the pier noses.

3. Scenarios of operation are shown on the attached table.

4. Identify depth of submergences at which flow through the spillway bay is impacted. It is anticipated that the middle bay will be operating and the full bay and ½ bay will be closed.

- Open the spillway bay X feet (see attached table).
- Establish an equilibrium condition where the forebay elevation is stable.
- Does the vortex exist in these flow conditions
- Insert the bulkhead in the stoplog slot and identify the depth where the vortex is suppressed
- Insert the bulkhead in the stoplog slot to the depth where flow through the spillway is impacted. Anticipated that this is identified by a raising forebay elevation.
- Insert the bulkhead in the upstream guides and identify the depth where the vortex is suppressed
- Insert the bulkhead in the upstream guides to the depth where flow through the spillway is impacted. Anticipated that this is identified by a raising forebay elevation.

Identify submergences for bulkhead installed in stoplog slot and submergences for bulkhead installed in guides to suppress the vortex up to 14 feet gate opening. The submergences depth will most likely be larger than that determined by the 1:25 model since the lateral flow in the model is less than that in the prototype.

Monday – June 5

Travel to Vicksburg

Tuesday – June 6

8:00 am – 8:30 am Meet with Glen Davis

8:30 am – 9:30 am Gate Opening 14 ft., forebay 160 ft., bulkhead slot (3 types)

9:30 am – 10:30 am Gate Opening 14 ft., forebay 160 ft., front face pier nose (3 types)

10:30 am – 11:30 am Gate Opening 14 ft., forebay 155 ft., front face pier nose (3 types)

11:30 am – 12:30 pm Lunch

12:30 pm – 1:30 pm Gate Opening 14 ft., forebay 155 ft. bulkhead slot (3 types)

1:30 pm – 2:00 pm Model flow change

2:00 pm – 3:00 pm Gate Opening 20 ft., forebay 160 ft., bulkhead slot (3 types)

3:00 pm – 4:00 pm Gate Opening 20 ft., forebay 160 ft., front face pier nose (3 types)

4:00 pm – 5:00 pm Gate Opening 20 ft., forebay 155 ft., front face pier nose (3 types)

5:00 pm – 6:00 pm Gate Opening 20 ft., forebay 155 ft., bulkhead slot (3 types)

Wednesday – June 7

8:00 am – 9:00 am Gate Opening 10 ft., forebay 160 ft., bulkhead slot (3 types)

9:00 am – 9:30 am Gate Opening 10 ft., forebay 160 ft., front face pier nose (3 types)

9:30 am – 10:30 am Gate Opening 10 ft., forebay 155 ft. front face pier nose (3 types)

10:30 am – 11:30 am Gate Opening 10 ft., forebay 155 ft. front face pier nose (3 types)

11:30 am – 12:30 pm Lunch and model flow change
12:30 pm – 1:30 pm Gate Opening 5 ft., forebay 160 ft., bulkhead slot (3 types)

1:30 pm – 2:30 pm Gate Opening 5 ft. forebay 160 ft., front face pier nose (3 types)

2:30 pm – 3:00 pm Gate Opening 5 ft., forebay 155 ft., front face pier nose (3 types)

3:00 pm – 4:00 pm Gate Opening 5 ft., forebay 155 ft., bulkhead slot (3 types)

4:00 pm – 5:00 pm Meet to discuss the day's effort and set up for Thursday.

Thursday – June 8

Determine VSD Depth That Impacts Gate Capacity Only

8:00 am – 8:30 am Gate Opening 25 ft, forebay 160 ft. bulkhead slot (3 types), **Depth to Impact Gate Capacity Only.**

9:00 am – 10:00 am Gate Opening 25 ft, forebay 160 ft. front face pier nose (3 types), **Depth to Impact Gate Capacity Only.**

10:00 am – 10:30 am Gate Opening 25 ft. forebay 155 ft., front face pier nose (3 types) **Depth to Impact Gate Capacity Only.**

10:30 am – 11:00 am Gate Opening 25 ft., forebay 155 ft., bulkhead slot (3 types) **Depth to Impact Gate Capacity Only.**

11:00 am – 11:30 am Model Flow Change

11:30 am – 12 noon Gate Opening 30 ft., forebay 160, bulkhead slot (3 types), **Depth to Impact Gate Capacity Only.**

12 noon – 1:00 pm Lunch and NWP TDA Team Meeting Conference Call to NWP. **Depth to Impact Gate Capacity Only.**

1:00 pm – 1:30 pm Gate Opening 30 ft., forebay 160, front face pier nose (3 types), **Depth to Impact Gate Capacity Only.**

1:30 pm – 2:00 pm Gate Opening 30 ft., forebay 155, front face pier nose (3 types), **Depth to Impact Gate Capacity Only.**

2:00 pm – 2:30 pm Gate Opening 30 ft., forebay 155, bulkhead slot, **Depth to Impact Gate Capacity Only.**

2:30 pm – 3:00 pm Model flow change
3:00 pm – 3:30 pm Gate Opening 35 ft., forebay 160, bulkhead slot, **Depth to Impact Gate Capacity Only.**

3:30 pm – 4:00 pm Gate Opening 35 ft., forebay 160, pier nose face, **Depth to Impact Gate Capacity Only.**

4:00 pm – 4:30 pm Model flow change

4:30 pm – 5:00 pm Uncontrolled, forebay 182, pier nose face, **Depth to Impact Gate Capacity Only.**

5:00 pm – 5:30 pm Uncontrolled, forebay 182, bulkhead slot, **Depth to Impact Gate Capacity Only.**

5:30 pm – 6:00 pm Exit meeting.

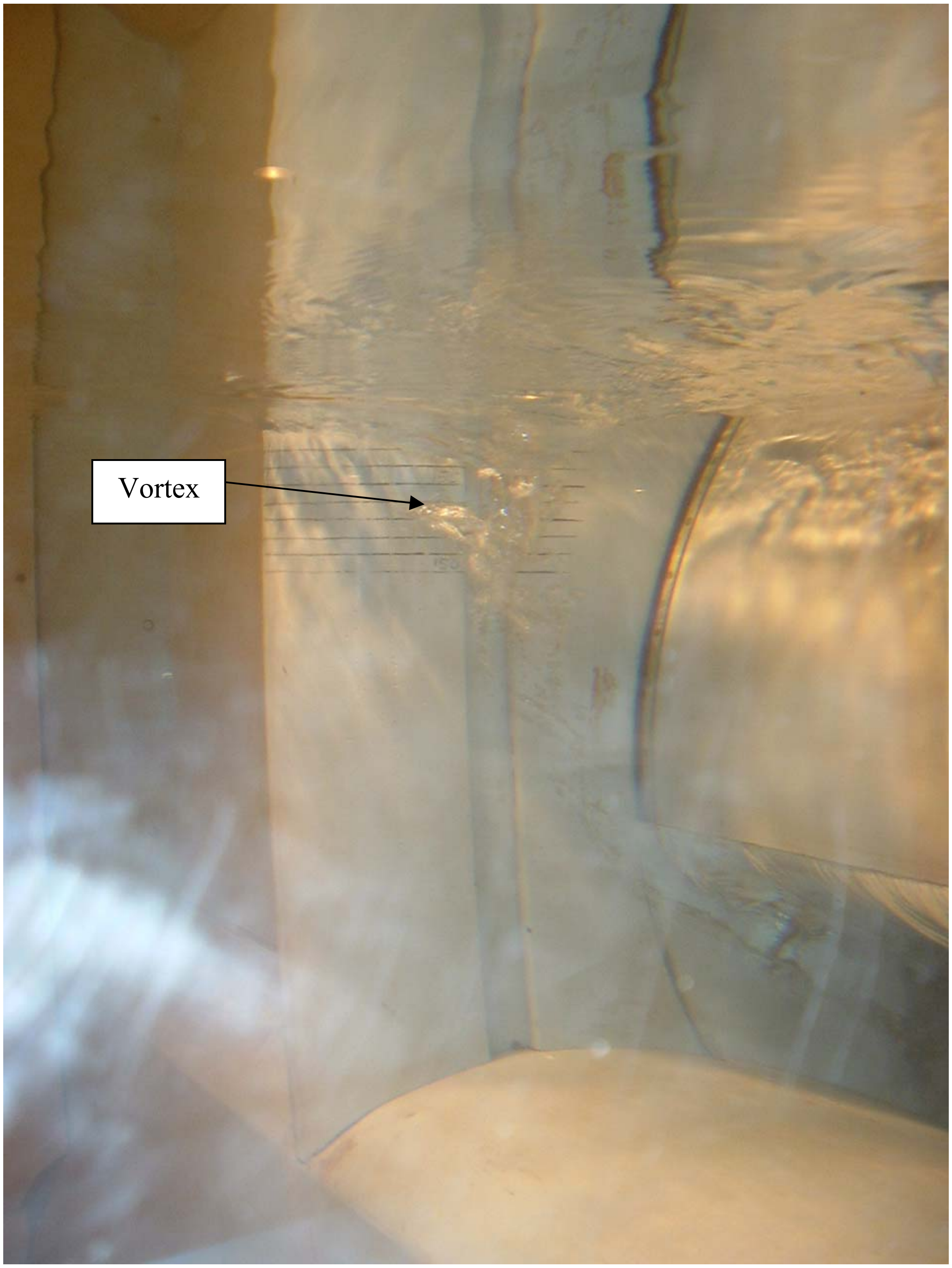


Photo 1. Vortex Formation with no VSD. Tainter Gate 14 ft open, FBEL 160 ft.

Depth of Square Edge Vortex Suppression Device (VSD)								
						Upstream Face of Pier Noses		
Gate Opening	Discharge	Nominal Total River	Forebay Elevation	VSD Bottom El.	Head diff. Across VSD	Depth to Suppress	Depth to Impact Flow	
ft	cfs	cfs	ft	ft	ft	ft	ft	Observations/Comments
5	7500	112500	160	158	0	2	NA	**Vortex suppressed. No vortex formation.**
5	7500	112500	160	150	0.25			No vortex. Small surface eddy on right side of VSD.
5	7500	112500	160	145	0.75			Same as above.
5	7500	112500	160	140	1.5			Same as above.
5	7500	112500	155	153	0.25	2		**Vortex suppressed.**
5	7500	112500	155	150	0.5			No apparent vortex. Small surface eddies.
5	7500	112500	155	145	0.5			Same as above.
5	7500	112500	155	140	1.25			Same as above.
10	15000	225000	160	157	0.75	2	>27	**Excellent vortex suppression.** No apparent surface vortex formed.
10	15000	225000	160	154.5	1			Vortex on left side of spillbay starts to form. occasional surface vortex tries to form.
10	15000	225000	160	150	1			occasional vortex tries to form. Sames as above. Vortex not strong enough to form a visible core. Beads dropped into the vortex center go under the VSD.
10	15000	225000	160	145	2.75			Very weak vortex forms off the left pier.
10	15000	225000	160	140	5.75			Weak vortex forms off the left pier. Does not appear to draw under the VSD. occasional vortices form on the surface that move laterally. Bead dropped in here do not flow under the VSD.
10	15000	225000	160	133	27			VSD on the verge of taking hydraulic control. occasional weak vortex forms mid bay approx. 2-3 ft. u/s of VSD. Cores do form and go under the VSD.
10	15000	225000	155	152	0.75	2	>22	**Vortex suppressed. Weak vortex tries to form off the left pier. occasional weak vortices form u/s at middle of VSD.**
10	15000	225000	155	145	1.75			Small vortex formation on side off the pier. Beads caught in the vortex go under the VSD. Small vortex forms near the right side of VSD, but dissipates.
10	15000	225000	155	140	5			Weak surface vortex a mid VSD that dissipates. Very weak vortex tries to form on left side of spillway bay near the pier.
10	15000	225000	155	133	22			VSD starts to take hydraulic control.
12	18000	270000	160	157	0.75	3		**Vortex suppressed.** Large vortex forms on the d/s side of the VSD. Small surface eddies form at the surface a mid spillbay width.
12	18000	270000	160	152	2			Vortex starts to form on left side. occasional surface eddy at mid spillbay width.

12	18000	270000	160	150	2.25			occasional surface vortex travels laterally across the face of the VSD.
12	18000	270000	160	145	5			Very small surface eddys form. Small depression on left side forms.
12	18000	270000	155	152	0.25	2		**Vortex is suppressed.**
12	18000	270000	155	150	1.5			**Oscillation beginning.** Vortices form mide width of spillway bay. Weak vortex formation on left side.
12	18000	270000	155	147	flucuated too much			**Oscillation.** Approx. 3 ft. surge in forebay.
14	21000	315000	160	140	15.25	8	22.25	**Vortex is suppressed.** Roller develops d/s of VSD. occasional small vortex forms u/s mid spillway bay at the surface. The core travels under the VSD. Vortex moves laterally across the spillway bay and does not appear to affect flowlines under the VSD much.
14	21000	315000	160	152	Too much fluctuation			**Oscillation, surging in forebay poll and in between VSD and tainter gate.** Vortex just starts to suppress. Approx. 3 ft surge in forebay. Surge between VSD and tainter gate approx. 4-5 ft.
14	21000	315000	160	140	2.75			**Surging just begins. occasional small surface vortices form with cores trying to flow under the VSD.**
14	21000	315000	158	140	13.5			Occasional surface vortex forms on the right side close to the VSD face. Primary left side vortex is suppressed. Occasional surface vortex forms 10-12 ft u/s of VSD face.
14	21000	315000	158	145	5.75			Occasional surface vortices travel laterally across the VSD face. Vortex on the left side is suppressed. But, a vortex tries to form. No apparent vortex d/s of the VSD.
14	21000	315000	158	150	Too much fluctuation			**Forebay surge.** Approx. 4-5 ft.
14	21000	315000	158	151	Too much fluctuation			**Forebay surge.** Surge in pool between VSD and tainter gate.
14	21000	315000	158	153	1.25			**Forebay begins to surge. occasional vortices form 25 ft. u/s of the VSD. Primary vortex is suppressed. Strong vortex d/s of VSD on left side.**
14	21000	315000	158	155	1			Vortex forms on the left side. occasional vortex d/s of VSD. Several surface depressions u/s of VSD.
14	21000	315000	155	141	8.25			occasional vortex travels laterally across the spillway bay with vortex core traveling under the VSD at mid bay. Small surface depression on left side (looking d/s) of spillbay. Surface vortices form about 10 ft. u/s of VSD.
14	21000	315000	155	140	9.75			Vortex condition very much less than at el. 141 ft. Vortices that form start at mid spillway bay, but the core does not appear to go undert the VSD. Surface vortices start about 10 ft. u/s of VSD.

20	30000	690000	160	152.5	5.25	7.5	20	**Vortex is suppressed.** Vortex on right side d/s of VSD. **Surge approx. 3 ft between VSD and tainter gate**. **Small surging in forebay approx. 0.5 ft.**
20	30000	690000	160	150	6			**No forebay oscillation. Approx. 1.5 ft. surge between the VSD and tainter gate. Vortex is suppressed. occasional surface vortices travel laterally across the spillway bay. At times the vortex core travels undert the VSD.**
20	30000	690000	160	140	24.25			occasional surface vortices form 10-15 ft. u/s of VSD. < 10% of the vortex cores travel under the VSD. Vortices travel laterally across the face of the spillway bay.
20	30000	690000	160	154				Very little surge in forebay. Do not see the amount of surging as did at forebay el. 155
20	30000	690000	158	140	18			VSD controls. Multiple surface eddys. Occasional vortices form at the face of the VSD.
20	30000	690000	158	145	13			2 deep vortices form at VSD face. Free flow. Large left side vortex suppressed but seems to be broken up into several small vortices.
20	30000	690000	158	150	7.75			4 surface depressions across the face of the VSD. Small vortices form.
20	30000	690000	158	155	1.5			**Left side vortex suppressed.** Left side depression with the bottom attached to the leading edge of the VSD. 4 surface depressions across the VSD face. **Strong vortex downstream of VSD.**
20	30000	690000	155	144.5	12.75	10.5	7.75	**Vortex is suppressed.** occasional multiple vortices form u/s of VSD approx. 5 ft. Vortices do not move laterally.
20	30000	690000	155	147.25	8.25			**VSD controls. Vortex suppressed. Several depressions created u/s of VSD. occasional vortex forms and core do not appear to travel under the VSD.**
25	37500	862500	160	143.8		Do not need to suppress vortex at these gate openings	16.2	VSD controls. No surging or oscillations.
25	37500	862500	155	149			6	Forebay below bottom of tainter gate. Depth to impact flow 6 ft.
30	45000	1035000	160	155			5	Tainter gate does not control
30	45000	1035000	155					
35	52500	1207500	160					
uncontrolled	100000	2300000	182					

Depth of Square Edge Vortex Suppression Device (VSD) Shallow Draft at Pier Nose								
						Upstream Face of Pier Noses		Observations/Comments
Gate Opening	Discharge	Nominal Total River	Forebay Elevation	VSD Bottom El.	Head diff. Across VSD	Depth to Suppress	Depth to Impact Flow	
ft	cfs	cfs	ft	ft	ft	ft	ft	
14	21000	315000	160	157	0.75			Vortex forms d/s of VSD. **Forebay vortex suppressed,** but d/s vortex forms with a deep core and may influence vortex.
14	21000	315000	160	156	1.5			Intermittent deep vortex d/s of VSD. **U/s vortex appears suppressed.**
14	21000	315000	160	154	N/A			**Beginning to oscillate.**
14	21000	315000	160	155	1.25			Ocassional vortex behind the VSD. **U/s vortex suppressed.** Small vortex formed on right side.
14	21000	315000	155	150				Slight oscillation.
14	21000	315000	155	151	1.5			No oscillation. Deep backside vortex. **U/s vortex suppressed.**

Depth of Square Edge Vortex Suppression Device (VSD) Shallow Draft at Pier Nose and Bulkhead Slot								
						Upstream Face of Pier Noses		Observations/Comments
Gate Opening	Discharge	Nominal Total River	Forebay Elevation	VSD Bottom El.	Head diff. Across VSD	Depth to Suppress	Depth to Impact Flow	
ft	cfs	cfs	ft	ft	ft	ft	ft	
14	21000	315000	158	154	0.75			Single Shallow Draft at Pier Nose only for comparison. Deep vortex forms with occasional core.
14	21000	315000	158	154	1.5			Minor surface vortices, occasional deep vortex forms but occurs d/s of the bulkhead VSD. Oscillation improves dramatically, but is still present.

Blocked Left Bulkhead Slot								
						Upstream Face of Pier Noses		Observations/Comments
Gate Opening	Discharge	Nominal Total River	Forebay Elevation	VSD Bottom El.	Head diff. Across VSD	Depth to Suppress	Depth to Impact Flow	
ft	cfs	cfs	ft	ft	ft	ft	ft	
14	21000	315000	158	155	1			Several minor suface depressions. Strong vortex d/s of VSD forms with core traveling d/s. Small decrease in vortex strength versus base condition. Overall, does not make a big difference in vortex,
14	21000	315000	158	154	did not take			Less surface depressions. Strong vortex d/s of VSD occurs frequently with core traveling d/s. Small decrease in vortex strength versus base condition. Overall, does not make a big difference in vortex,

Depth of Square Edge Vortex Suppression Device (VSD) Bulkhead Slot for Bio Test									
							Upstream Face of Pier Noses		Observations/Comments
Gate Opening	Discharge	Nominal Total River	Forebay Elevation	Base Cond. Vortex	VSD Bottom El.	Head diff. Across VSD	Depth to Suppress	Depth to Impact Flow	
ft	cfs	cfs	ft	yes/no	ft	ft	ft	ft	
10	15000	225000	160	yes	157				Vortex tries to form at the surface near the surface near the pier nose. Appears that no core forms. Pretty good at suppressing.
10	15000	225000	160	yes	152				Larger vortex forms. Beads dropped into vortex go under VSD. Vortex is not suppressed.
14	21000	315000	160	yes	157	negligible			Vortex forms at surface near the pier nose. Appears that no core forms.
14	21000	315000	160	yes	152	1.75			Larger vortex forms at the pier nose with the core going under the VSD.

APPENDIX C

Dalles 1:25 Model Study
Vortex Suppression Device (VSD)

22 June 2006 **Two VSD's installed, One @ pier nose and One @ bulkhead slot**

Gate Opening: 5'
Forebay Elevation: 160
VSD Bottom Elevation: 156
Head Differential across VSD: Pier = 0
Slot = 0
No Vortexes.

Gate Opening: 10'
Forebay Elevation: 160
VSD Bottom Elevation: 156
Head Differential across VSD: Pier = 0.75
Slot = 0.50

Vortexes attempting to form on both ends of the vsd. They are basically nothing more than water surface disturbances. Vortexes attempt to form intermittently across the face of the vsd. They also attempt to form cores which rarely reach the bottom of the vsd.

Gate Opening: 12'
Forebay Elevation: 160
VSD Bottom Elevation: 156
Head Differential across VSD's: Pier = 1.50
Slot = 0

Pier: Vortexes are attempting to form on each corner of the VSD. They never seem to amount to anything more than surface disturbances. Intermittent vortexes form across the face of the VSD and dissolve once their cores reach the base of the VSD. The water in front of the VSD becomes intermittently disturbed and form small Vortexes which race toward the VSD and dissolve when they come in contact with the VSD.

Stop Log: Much water disturbance.

Gate: Much water disturbance. Vortexes attempt to form on the right side of the gate against the back of the stop log VSD. These vortexes start to form a core, but dissolve each time the core reached the bottom of the VSD

23 June 2006

Gate Opening: 14'

Forebay Elevation: 160
VSD Bottom Elevation: 156
Head Differential across VSD: Pier = 1.0
Slot = 0.25

Pier: Water surface disturbances on each end of the vsd. Intermittent vortexes form across the face of the vsd, which occasionally form strong cores that upon reaching the bottom of the vsd the vortex will dissolve. The water surface will occasionally become disturbed out to a distance of 1.3' (32.5' prototype) from the vsd. Intermittent vortexes will form with from small to large cores and rush toward the vsd where they will dissolve upon contact with the vsd.

Stop Log Slot: There is strong water disturbance between the pier nose vsd and the Stop Log vsd. On the left side of the vsd a vortex forms intermittently. The core has little cohesion and the vortex dissolves when the core reaches the bottom of the vsd. The vortexes form violently.

Gate: The same as for the Stop Log Slot.

26 June 2006

Gate Opening: 20'
Forebay Elevation: 160
VSD Bottom Elevation: 156
Head Differential across VSD: Pier = 1.0
Slot = 0.25

Pier: Strong water surface disturbances at each end of the VSD. These disturbances have partially formed cores which on the left side extend to the bottom of the vsd and goes under it. The core then mixes with the disturbance formed from the stop log vsd. The disturbance on the right side doesn't form a core which reaches the bottom of the vsd. Intermediate vortexes form across the face of the vsd. Once the core of these vortexes goes under the vsd they dissolve. The water surface is periodically distributed out to a distance of 1.4' (35') from the face of the vsd. From this disturbance is a periodically formed vortex with small cores which race toward the vsd where they dissolve when they reach it.

Stop Log Slot: Strong water disturbance between the pier vsd and the stop log vsd. The Left side forms a strong periodic vortex with a core which extends under the vsd and the gate, before disappearing over the crest.

Gate: Strong water disturbance between the stop log vsd and the gate. Vortexes form on both the left and right sides of the gate. The vortex on the left side of the gate forms when the vortex forms on the left side of the stop log vsd and they combine to make one large, well formed and violent vortex. A vortex also forms on the right side of the gate. Intermittent vortexes form across the face of the gate, with defined cores that reach under the gate. Once the core reaches the bottom of the gate the vortex will dissolve.

Gate Opening: 20’
Forebay Elevation: 158
VSD Bottom Elevation: 154
Head Differential across VSD: Pier = 2.5’
Slot = 0.25’

Pier: Strong vortexes formed on the left and right side of the vsd. The vortex on the left Side extends under the vsd constantly. The vortex on the right side only occasionally extends under the vsd. Vortexes form intermittently across the face of the vsd. They dissolve once there core extends under the vsd. Intermittent air pockets can be seen on the bottom edge of the vsd. Occasional vortexes form at a distance of 1.2’ (30’) from the face of the vsd, where they race toward the vsd and dissolve once they come in contact with the vsd.

Stop Log Slot: Violent water surface disturbance between the pier vsd and the stop log vsd. A vsd forms on the left side intermittently. It is joined by the vortex formed on the left side of the pier vsd. This makes for a well formed vortex with a well defined core which extends under the stop log vsd and the gate and over the crest. There appears to be a vortex which forms on the right side between the vsd’s.

Gate: Violent water surface disturbances between the stop log vsd and the gate. The left side of the gate forms an intermittent vortex which joins the vortexes already formed on that side by the first two vsd’s. A vortex also forms on the right side of the gate.

Gate Opening: 14’
Forebay Elevation: 158
VSD Bottom Elevation: 154
Head Differential across VSD’s: Pier = 1.25’
Slot = 0.50’

Pier: Moderate water disturbances on the left and right ends of the vsd. Intermediate vortexes form across the face of the vsd, but dissolve once the core under the vsd. The is intermediate disturbances in the water out to a distance of 0.90’ (22.5’) from the face of the vsd. From these disturbances intermediate vortexes form and race toward the vsd, where they dissolve when they contact the vsd. No vortexes form on either the right or left ends of the vsd.

Stop Log Slot: Moderate water disturbance between the two vsd’s. An intermediate vortex forms on the left side, where the core reaches under the vsd to join the core of the vortex which forms on the left side of the gate. The newly formed core extends under the gate at which point the vortexes dissolve.

Gate: Moderate water disturbance between the stop log vsd and the gate. A vortex forms on the left side of the gate. (See Stop Log Slot). A vortex also forms on the right side of the gate but it doesn't last long.

Gate Opening: 12'
Forebay Elevation: 158
VSD Bottom Elevation: 154
Head Differential across VSD's: Pier = 0.75'
Slot = 0.50'

Pier: Vortexes form intermittently across the face of the vsd. Some of the vortexes will form a core which will reach under the vsd. At which point the vortex will dissolve. No vortexes form on the ends of the vsd. The water surface is disturbed out in front of the vsd for 0.6' (15'). From this disturbance vortexes will form which will race toward the face of the vsd, where they dissolve when they reach it.

Stop Log Slot: Moderate surface disturbance between the pier vsd and the stop log vsd. The left side will produce an occasional vortex which quickly dissolves.

Gate: This area is the same as the stop log slot, except the vortex formed on the left side of the gate is more intense and last longer.

Gate Opening: 10'
Forebay Elevation: 158
VSD Bottom Elevation: 154
Head Differential across VSD's: Pier = 0.75'
Slot = 0.25'

Pier: Very slight water surface disturbance. There are intermediate attempts to form vortexes across the face of the vsd. None are formed with a defined core. Constant disturbances can be found at each end of the vsd, but they do not produce a core.

Stop Log Slot: Slight water surface disturbance. No vortex formation can be seen.

Gate: Slight water surface disturbance. Vortexes attempt to form on both the left and Right sides of the gate. The left side attempts to form a core which is ill defined and extends to just below the level of the slot vsd. It is not able to come together and form a definite vortex.

Gate Opening: 5'
Forebay Elevation: 158
VSD Bottom Elevation: 154

Head Differential across VSD's: Pier = 0
Slot = 0
No vortexes formed.

Gate Opening: 5
Forebay Elevation: 155
VSD Bottom Elevation: 151
Head Differential across VSD's: Pier = 0.75'
Slot = 0
No vortexes formed.

27 June 2006

Gate Opening: 10'
Forebay Elevation: 155
VSD Bottom Elevation: 151
Head Differential across VSD's: Pier = 0.75'
Slot = 0
Pier: Slight water disturbance on the left and right ends of the vsd. They attempt to form a core but do not quite make it. Intermediate vortexes form across the face of the vsd. When there core reaches the bottom of the vsd the vortex will dissolve. Occasionally vortexes will form at a distance of 0.4' (10') from the face of the vsd. They will then race to the face of the vsd where they will dissolve when they come in contact with it.

Stop Log Slot: Mild water surface disturbance.

Gate: Mild water surface disturbance. Attempts to form vortex on both the left and right sides of the gate are made but with no success.

Gate Opening: 12'
Forebay Elevation: 155
VSD Bottom Elevation: 151
Head Differential across VSD's: Pier = 1.5'
Slot = 0
Pier: Mild water disturbance across the face of the vsd. Vortexes attempt to form at each end of the vsd but with no success. Intermediate vortexes form across the face of the vsd, but dissolve once the core extends under the vsd.

Stop Log Slot: Heavy water surface disturbance between the pier vsd and the slot vsd. A vortex attempts to form on the left side but can not.

Gate: Heavy water surface disturbance between the slot vsd and the gate. Vortexes form on both the left and right side of the gate. Both put down a core toward the gate but cannot complete formation of the core. This causes the vortexes to dissolve and attempt reformation.

Gate Opening: 14’
Forebay Elevation: 155
VSD Bottom Elevation: 151
Head Differential across VSD’s: Pier = 1.5’
Slot = 0.25’

Pier: Mild disturbance in the water surface across the vsd. Vortexes attempt to form at each end of the vsd, but without success. Intermediate vortexes form across the face of the vsd, but dissolve when the core descends below the vsd. Vortexes form at a distance of 0.5’ (12.5’) in front of the face of the vsd. They then race toward the vsd where they dissolve on contact with the vsd.

Stop Log Slot: heavy water disturbance between the pier vsd and the slot vsd. Vortexes will attempt to form on the left side of the vsd. The vortex will send a under the vsd and toward the bottom of the gate. When the core reaches the bottom of the gate the vortex will dissolve and try again.

Gate: Vortexes form at the left and right sides of the gate. The left side vortex forms a core which extends under the gate. Once the core reaches the bottom of the gate the vortex dissolves and attempts to reform again.

Gate Opening: 20’
Forebay Elevation: 155
VSD Bottom Elevation: 151
Head Differential across VSD’s: Pier = 3.75’
Slot = 0.50’

Pier: Heavy water surface disturbance. Vortexes have formed on each end of the vsd. Intermediate vortexes form across the face of the vsd. They will dissolve when their cores descend below the vsd. Vortexes form at a distance of 12” (25’) in front of the vsd. They will race toward the vsd where they dissolve on contact with the face of the vsd. An air cavity can be seen forming along the bottom of the vsd. This cavity will form and dissolve and then reform in one continuous cycle. The vortex which forms on the left end of the vsd forms a core which will descend below the vsd, at which point it will connect with the vortex form on the left side of the slot vsd, the combined cores will descend below the vsd of the slot and merge with the vortex formed on the left side of the gate. This forms one violent vortex whose core descends below the gate. This large vortex will form and reform intermittently.

Stop Log Slot: Heavy water surface disturbance between the pier vsd and the slot vsd. The water surface between these two vsd’s is intermittently drawn down below the slot vsd. See left side vortex information under Pier.

Gate: Vortexes form on the left and right sides of the gate. See left side vortex information under Pier. An intermittent vortex forms on the right side of the gate.

Pier nose VSD only slot VSD lowered to stabilize oscillations

Gate Opening: 14'
Forebay Elevation: 155
VSD Bottom Elevation: 147 Pier nose VSD only
The slot VSD will be lowered into the water one foot at a time until the oscillations have stopped.

For the current settings once the vsd in the slot reached between 3' to 4' the oscillations ceased.

Gate Opening: 14'
Forebay Elevation: 160
VSD Bottom Elevation: 152 Pier nose VSD only
The slot VSD will be lowered into the water one foot at a time until the oscillations have stopped.

For the current setting once the vsd in the slot reached between 5' to 6' the oscillations ceased.

Trip Report – ERDC – July 17 – 21, 2006 Gary Fredricks and Ed Meyer

The primary purpose of the trip was to evaluate vortex suppression devices for the Dalles Dam spillway, other tasks included preliminary looks at surface spill options and spillway egress improvement options with the newly modified general model. We used a 1:25 scale sectional model of the spillway to evaluate vortex suppression capabilities of several vortex suppression devices or VSD's and we used the 1:80 general model to evaluate how well the most promising VSD's altered forebay flows. We also used the general model to evaluate forebay response to surface spill and tailrace egress conditions for each option.

Using the 1:25 sectional model we assessed several variations of vortex suppression devices which consisted of different lengths of bulkheads either attached to the pier noses or positioned in a bulkhead slot in front of the spillway tainter gate or both. The length of the various bulkheads refers to the depth of submergence beneath the forebay water surface. Bulkheads of lengths from 4' to 18' were modeled singly or in tandem. When two devices were used they could be either the same length or different lengths. It turned out that a device in both positions was necessary to adequately suppress a vortex at a 14' gate opening. We found that equal length devices of 8' suppressed the vortex well at the 14' gate opening but did cause a large amount of turbulence and surging in the space between the devices and the gate. A dual length option with the pier nose gate shorter than the slot gate turned out to do slightly better job of vortex suppression and a very good job of reducing the integrate turbulence and surging. After looking at various lengths and configurations of the VSD's we settled on evaluating tandem gate lengths of 8'and 8' (pier nose and bulkhead slot lengths, respectively), 5' and 8' and 8' and 12'in the general model. Later in the week the preferred option of 8 and 12' VSD's were again evaluated under different spill gate settings working down from the maximum of 14' to make sure there were no unexpected hydraulic conditions at the lower gate settings. None arose.

The 1:80 scale general model was used at river flows of 315, 250 and 150 kcfs. The 315 kcfs flow level corresponds to the level at which 40% of the river flow can be passed thorough bays 1-6. We also looked at both 40 and 30% spill levels. VSD's were placed in spillbays 6 and 7 individually and together. We had initially thought that suppression devices would be needed in bay 6 and maybe bay 5 but after working with the model a bit we decided that some training spill from bay 7 would improve egress conditions for fish passing through bay 6. Flow from bay 7 would be limited by only opening the gate 2 or 3 feet. By placing suppressing devices in bays 6 and 7 we were able to limit entrainment of surface confetti, beads and dye into those bays substantially, particularly bay 7. Surface indicators showed that the upper level flow was stalling somewhat in front of these bays and moving slowly laterally to the north. When we included surface spill from bay 5, this stagnation disappeared and the surface flow moved strongly laterally to the open surface spill bay.

We also were able to look at some initial spillway improvement study options in the general model. The model had been recently modified to allow removal of large sections of the spillway tailrace shelf from the stilling basin to the deep thalweg downstream. The upper surface of these sections included greatly improved bathymetry detail obtained from recent more detailed surveys. It became apparent to those who have used this model in the past that this new bathymetry made a significant change in egress conditions, particularly for flow passing through bays 5 and 6 under the lower river flow levels. This flow now moves much more readily to the south and a large portion of the flow (60%+) from both bays eventually moves south along the bridge shelf and into the Oregon channel or over the shelf and into the predator laden shallows beyond.

The ability to remove spillway shelf sections will allow investigation of changes in bathymetry that could improve this egress issue. The more downstream sections of the new spill shelf were actually stacked. Complete removal and subsequent placement of sandbags allowed evaluation of different depths and configurations of excavation. Our very preliminary look at various amounts and configurations of rock excavation in the tailrace didn't show much promise until we decided to use the sandbags to emulate a wall extension which would extend the existing spillwall about three times its current length of about 200 feet. The wall was also curved to the north a bit towards the end. We also simulated removal and shaping of some of the north spill shelf shoreline. These combinations made a dramatic improvement in the egress conditions allowing all the flow from the bays inside the wall to egress swiftly into the thalweg. Some of the participants made the observation that this option might make the VSD's unnecessary, although they would still be useful in reducing fish passage through bays south of the spillwall area when use of those bays was necessary.

Conclusions: The vortex suppression concept shows a lot of promise for reducing passage of fish into problematic spill gates, particularly when used in combination with nearby surface spill. The combination of these devices in gates 6 and 7 and surface spill in gates 3-5 is an alternative that should be pursued at least through the design phase as soon as possible with the idea of implementing the vortex suppression devices in 2007. Spillway improvement study options should be investigated concurrent with this schedule with the idea of implementation of some combination of options in 2008 or 2009. Study results evaluating the fish distribution benefits of the 2007 VSD installation will be useful in defining the next steps. The implementation options fall out something like this, none of these are mutually exclusive but they are in order of how they can or should be completed:

1. Install VSD's in bays 6 and 7 and test effect on passage distribution.
2. Install VSD's in bays 6 and 7 and surface spill in bays 3, 4 and/or 5 and test for full effect.
3. Install VSD's in bays 6 and 7 and pursue SIS options such as extending and shaping the spillwall, bathymetry mods and shoreline mods and evaluate the full effect.
4. Install forebay guidance devices (if needed) and test for changes in distribution.

Several of the Corps personnel stayed in Mississippi an additional week to work with the spillway improvement options. The results of this and subsequent work will be presented to the agencies in future FFDRWG meetings and will be the subject of another ERDC trip later this fall or winter.

CENWP-EC-HD 08 August 2006

MEMORANDUM FOR RECORD

SUBJECT: The Dalles Vortex Suppression (VSD) – 1:25 Sectional Model Trip

1. This MFR documents the subject trip made to ERDC on 17-21 July 2006 to determine and evaluate a prototype VSD configuration to design and construct for the 2007 juvenile fish outmigration at The Dalles Dam spillway. Attending were: Jeff Ament EC-DS, Laurie Ebner, Steve Schlenker and Randy Lee EC-HD, Lance Helwig PM, Mike Adams OP-TD, Mike Langeslay and Bob Wertheimer PM-E, Gary Fredricks and Ed Meyer NOAA Fisheries, Jason Sweet Bonneville Power Administration, Cindy Rakowski PNNL, Glenn Davis, Bobby Fuller and Jimmy Crutchfield ERDC.

   Detailed investigations on the 1:25 model were conducted and/or attended by Jeff, Mike Adams, Randy, Glenn, Bobby Fuller, Jimmy and Bob Wertheimer.

2. Background. Reference MFR "The Dalles Vortex Suppression (VSD) – 1:25 Sectional Model Trip", dtd 15 June 2006.

3. For background, several lengths and positions of VSDs based upon the 5-9 June 2006 trip were briefly demonstrated to the group. Lengths of the VSDs demonstrated ranged from 4 feet to 18 feet below the water surface and were attached to the pier nose or stoplog slot in front of the tainter gate and either stand alone or in tandem. Also demonstrated was the oscillation that occurs in the forebay and between the VSD and tainter gate with an 8 foot draft VSD. Upon observation, it was apparent to the group that two VSDs in tandem are necessary to satisfactorily suppress the vortex.

   The equal length shallow draft (4 ft) VSDs at the pier face and stoplog slot in tandem that was determined on the 5-9 June trip was not acceptable to the group because of the turbulence downstream of the stoplog slot device at the 14 ft tainter gate opening. This configuration also provided minimal guidance of flow to the northern spillway bays.

   VSDs of 8 ft each (8/8) were installed at the pier face and stoplog slot and briefly observed with a 14 ft tainter gate opening. VSDs at this configuration suppressed the vortex well. However, there was turbulence downstream of the devices and upwelling/surging in between the devices. This was not acceptable to the group.

   A tandem VSD option in which the pier face device is shorter than the stoplog device appeared to satisfactorily suppress the vortex as well as reducing the upwelling and surging between the devices. As a result, it was agreed a configuration that has an 8 ft device at the pier nose in tandem with a 12 ft device at the stoplog slot would be further investigated in the 1:25 model (8/12). Concurrently, this configuration was being observed in the 1:80 general model. At the general model, physical evaluations of forebay conditions using multiple surface water flow indicators (e.g., neutrally buoyant beads, confetti, and red dye) demonstrated enhanced water flow approach conditions for fish passage from the 8/12 configuration in relation to the 8/8 or other tested configurations. For instance, surface water flow approaching the 8/12 configuration had a greater propensity to guide laterally to the north and experienced a greater 'cushion affect' than was seen in relation to in the 8/8 or other configurations. This cushion affect was characterized by beads, dye, and confetti approaching from the south progressing laterally north at a greater distance from the pier-noses during tests of the 8/12 configuration than was observed at the 8/8 or other tested arrays. Similarly, beads, dye, and confetti approaching from the east were better guided to the north with the 8/12 configuration, when directly compared to the 8/8 configuration. Taken together, results indicated more optimal surface guidance approach paths were observed from 8/12, than other tested configurations.

4. <u>Summary of Observations.</u> See attached notes for detailed observations for an 8 ft pier device in tandem with a 12 ft stoplog device. For comparison, a limited investigation was conducted using an 8 ft pier device in tandem with an 8 ft stoplog device.

Pier device 8 ft below water surface and stoplog device 12 ft below water (bottom of peir device set at elevation 150 feet and bottom of stoplog device set at elevation 146 feet) surface at forebay elevation 158 feet.

Good vortex suppression for tainter gate openings up to 16 ft at forebay elevations 158-160 feet. There appears to be minor or no upwelling between the two devices at these conditions. However, upwelling intensity increases with tainter gate openings larger than 16 ft. Upwelling on the face of tainter gate at an opening of approximately 18 ft and forebay elevation 158 feet results in a 3.25 ft run-up on the face of the gate. The tainter gate loses hydraulic control at approximately 20-22 foot gate opening.

At forebay elevation 155 feet backrollers in between the stoplog device and tainter gate are more prevalent than backrollers at higher forebay elevations. The devices were less effective in suppressing the vortex at a tainter gate opening of 14 ft at this forebay than at the higher forebays due to reduced draft of the devices (5-9 feet).

Pier device 8 ft below water surface and stoplog device 8 ft below water surface (bottom of both VSDs at elevation 150 feet) at forebay elevation 158 feet.

Good vortex suppression for tainter gates openings up to 14 ft at forebay elevation 158-160 feet. However, it appears upwellings occur at forebay elevation 158 feet and 12 ft gate openings. In comparison, the 8/12 configuration showed the upwellings just starting to develop. Backrollers seemed to be stronger at 14 ft tainter gate opening and forebay 155 feet compared against the 8/12 configuration.

5. Conclusions and Recommendations.

- Good vortex suppression results with an 8/12 configuration. Limited investigations with the 8/8 indicated good vortex suppression. However, the 8/12 configuration resulted in reduced turbulence between the two devices.

- Enhanced surface water flow approach conditions, for fish passage, were documented for the 8/12 configuration in relation to the 8/8 or other tested configurations.

- Although not investigated on the 1:25 model, recommend either a half round edge or knife edge for the VSD bottom. This would result in a smoother transition of flow to the tainter gate and could reduce the potential for upwelling between the devices. In addition, potential for VSD vibration may be reduced.

Randy Lee, EC-HD
Hydraulic Engineer

The Dalles Vortex Suppression Device
The Dalles 1:25 Sectional Model Investigations 17-21 July 2006

Forebay El.	160
Nominal Device Setting (ft. below FB)	
Pier Device	8
Stoplog Device	8
Bottom Elevation	
Pier Device	150
Stoplog Device	150
Actual Device Setting (ft. below FB)	
Pier Device	10
Stoplog Device	10

Tainter Gate Opening (ft.)	Head Diff.Pier Device (ft.)	Head Diff. Stoplog Device (ft.)	Oscillation	Vortex Suppression	Tainter Gate Control	Observations/Comments
3						
5						
8						
10						
12	2.5	0.625	No	Good	Yes	small intermittent vortex mid span. Calm between all slots. Slight backroller exists.
14	2.75	0.5	No	Good	Yes	Small surface dimples. Slight backroller exist behind stoplog device.
20	8	0	No	Marginal	Yes	Uneven loading on tainter gate. No upwelling on stoplog device. Vortex forms north and south side.
25	10.875	no contact	No	No	No	Intermittent upwelling on tainter gate. Uneven loading on tainter gate.

The Dalles Vortex Suppression Device
The Dalles 1:25 Sectional Model Investigations 17-21 July 2006

Forebay El.	158
Nominal Device Setting (ft. below FB)	
Pier Device	8
Stoplog Device	8
Bottom Elevation	
Pier Device	150
Stoplog Device	150
Actual Device Setting (ft. below FB)	
Pier Device	8
Stoplog Device	8

Tainter Gate Opening (ft.)	Head Diff.Pier Device (ft.)	Head Diff. Stoplog Device (ft.)	Oscillation	Vortex Suppression	Tainter Gate Control	Observations/Comments
3						
5						
8						
10						
12	1.5	0.125	No	Good	Yes	Minor upwelling between stoplog device and tainter gate.
14	2.5	0.5	No	Good	Yes	Minor upwelling between stoplog device and tainter gate. Small depressions north and south upstream of pier device.
20	6.75	0	No	Marginal	Yes	Significant backroller between both devices and stoplog device and tainter gate. Backrollers are uniform in distribution.
25	8.25	no contact	No	No	No	Some upwelling on tainter gate. But, not as much as FB 155 condition.

The Dalles Vortex Suppression Device
The Dalles 1:25 Sectional Model Investigations 17-21 July 2006

Forebay El.	155
Nominal Device Setting (ft. below FB)	
Pier Device	8
Stoplog Device	8
Bottom Elevation	
Pier Device	150
Stoplog Device	150
Actual Device Setting (ft. below FB)	
Pier Device	5
Stoplog Device	5

Tainter Gate Opening (ft.)	Head Diff.Pier Device (ft.)	Head Diff. Stoplog Device (ft.)	Oscillation	Vortex Suppression	Tainter Gate Control	Observations/Comments
3						
5						
8						
10						
12	1.625	0.125	No	Good	Yes	Small depressions south side, slight backroller.
14	3.5	1.125	No	Good	Yes	Large backroller between stoplog device and tainter gate. Appear larger at this condition than FB 160.
20	5.125	0.375	No	Poor	Yes	Large backroller between stoplog device and tainter gate. Fairly uniform upwelling that rolls up the face of the tainter gate.
25	5	no contact	No	No	No	Pier device controls flow. Upwelling on tainter gate same as if there were no devices installed.

The Dalles Vortex Suppression Device
The Dalles 1:25 Sectional Model Investigations 17-21 July 2006

Forebay El.	158
Nominal Device Setting (ft. below FB)	
Pier Device	8
Stoplog Device	12
Bottom Elevation	
Pier Device	150
Stoplog Device	146
Actual Device Setting (ft. below FB)	
Pier Device	8
Stoplog Device	12

Tainter Gate Opening (ft.)	Head Diff.Pier Device (ft.)	Head Diff. Stoplog Device (ft.)	Oscillation	Vortex Suppression	Tainter Gate Control	Observations/Comments
3	0.25	0.25	No	Good	Yes	
5	0	0	No	Good	Yes	
8	0.75	0.25	No	Good	Yes	
10	0.75	0.25	No	Good	Yes	Small vortices try to form upstream of pier device. Slight backroller between stoplog device and tainter gate.
12	1.75	0.5	No	Good	Yes	Small votices forming at mid span and south side of pier device. Backroller between stoplog device and tainter gate developing.
14	2.625	0.375	No	Good	Yes	Several small intermittent votices upstream of pier device. Moderate backroller on the stoplog device.
16 +/-*	3.125	2	No	Good	Yes	Some surface depressions upstream of pier device. Some uneven upwelling on face of tainter gate approx. 1.25-2 ft difference from north to south.
18 +/-*	5.25	5.75	No	Marginal	Yes	Several small surface depressions. Upwelling on face of tainter gate approx. 3.25 ft. runup on the face of the gate.
20	6.625	6.75	No	No	Marginal	Uneven loading on tainter gate. Rolls up against stoplog device approx. 3 ft.
22 +/-*	8.5	11.125	No	No	No	Roller between the two devices.
25	7.75	12.25	No	No	No	Free flow. Upwelling on stoplog device.

* Marks to identify gate opening were estimated.

The Dalles Vortex Suppression Device
The Dalles 1:25 Sectional Model Investigations 17-21 July 2006

Forebay El.	155
Nominal Device Setting (ft. below FB)	
Pier Device	8
Stoplog Device	12
Bottom Elevation	
Pier Device	150
Stoplog Device	146
Actual Device Setting (ft. below FB)	
Pier Device	5
Stoplog Device	9

Tainter Gate Opening (ft.)	Head Diff.Pier Device (ft.)	Head Diff. Stoplog Device (ft.)	Oscillation	Vortex Suppression	Tainter Gate Control	Observations/Comments
3	0.25	0	No	Good	Yes	
5	0	0	No	Good	Yes	Minor backroller starting to form between stoplog device and tainter gate.
8	0.25	0	No	Good	Yes	Minor backroller between stoplog device and tainter gate moving back to front. This appears to be stronger than the backroller at FB 158.
10	0.75	0.25	No	Good	Yes	Backroller is stronger.
12	0.5	0.5	No	Good	Yes	Small vortices north and south, moderate backroller between the two devices.
14	2.25	0	No	Fair	Yes	Some surface depressions and the north and south. Moderate backroller between the devices.
16 +/-*	3.25	0.5	No	Fair/Good	Yes	2 ft. difference north to south on tainter gate face.
18 +/-*	3	5.75	No	Marinal/Poor	Yes	Vortex forms north side.
20	5.25	6	No	No	Marginal	Large depressions north and south side, large backroller in between the devices. Uneven loadingon tainter gate with a roll up in the area between the stoplog device and tainter gate of 2'-3'.
25	5	9	No	No	No	

* Marks to identify gate opening were estimated.

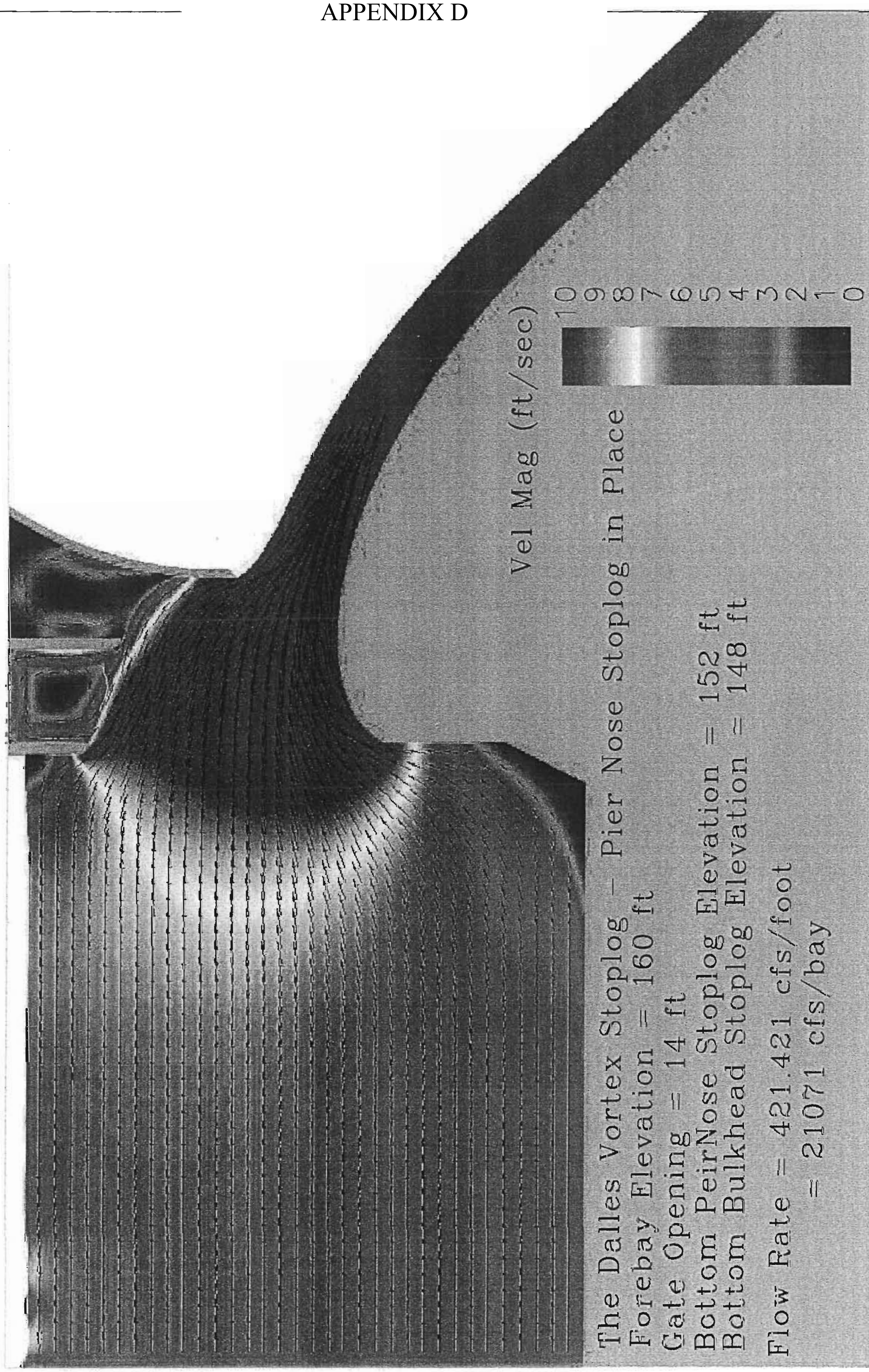
The Dalles Vortex Suppression Device
The Dalles 1:25 Sectional Model Investigations 17-21 July 2006

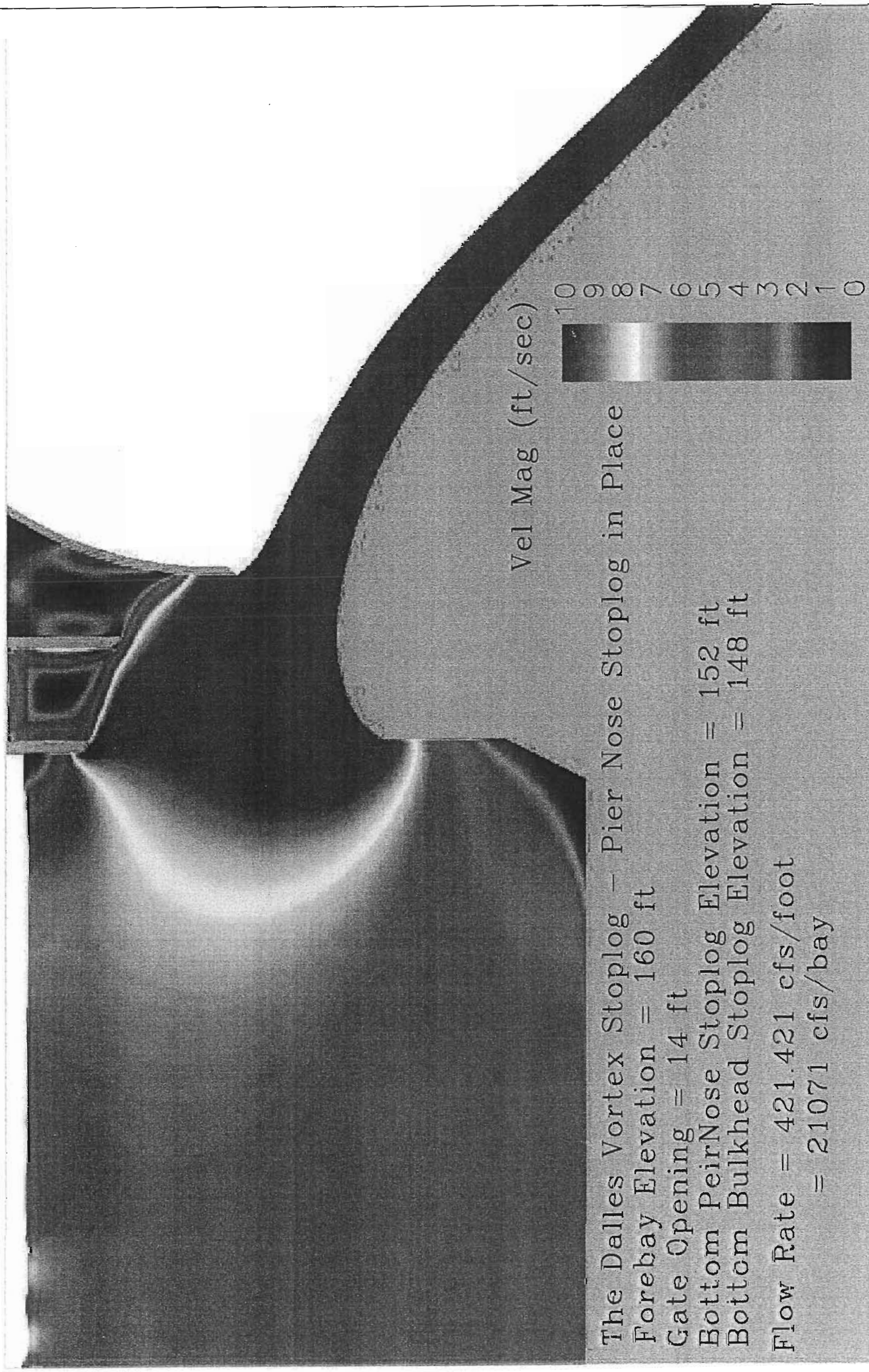
Forebay El.	160
Nominal Device Setting (ft. below FB)	
Pier Device	8
Stoplog Device	12
Bottom Elevation	
Pier Device	150
Stoplog Device	146
Actual Device Setting (ft. below FB)	
Pier Device	10
Stoplog Device	14

Tainter Gate Opening (ft.)	Head Diff.Pier Device (ft.)	Head Diff. Stoplog Device (ft.)	Oscillation	Vortex Suppression	Tainter Gate Control	Observations/Comments
3	0	0	No	Good	Yes	Calm between stoplog device and gate
5	0	0	No	Good	Yes	Calm between stoplog device and gate
8	0.25	0.25	No	Good	Yes	Calm between stoplog device and gate
10	1.5	0.5	No	Good	Yes	Calm between stoplog device and gate
12	2.25	0.5	No	Good	Yes	Calm to minor upwelling between stopglog device and gate
14	3.125	0.375	No	Good	Yes	Small vortex left side
16 +/-*	4.75	0.625	No	Good	Yes	Some water surface dimples. Upwelling in both slots. Approx. 0.375 ft difference from north to south at tainter gate face.
18 +/-*	7	4.75	No	Moderate	Yes	Upwelling in both slots. 1'-2' difference from north to south at tainter gate face.
20	7.75	3.5	No	Marginal	Yes	Secondary vortex forms travels laterally and under devices. Roller between stoplog device and tainter gate that rides up on the face of the stoplog device. Uneven loading on tainter gate. Should remove devices due to eneven loading.
25	9.25	13	No	No	No	Strong roller and upwelling between stoplog device and tainter gate.

* Marks to identify gate opening were estimated.

APPENDIX D – STRUCTURAL

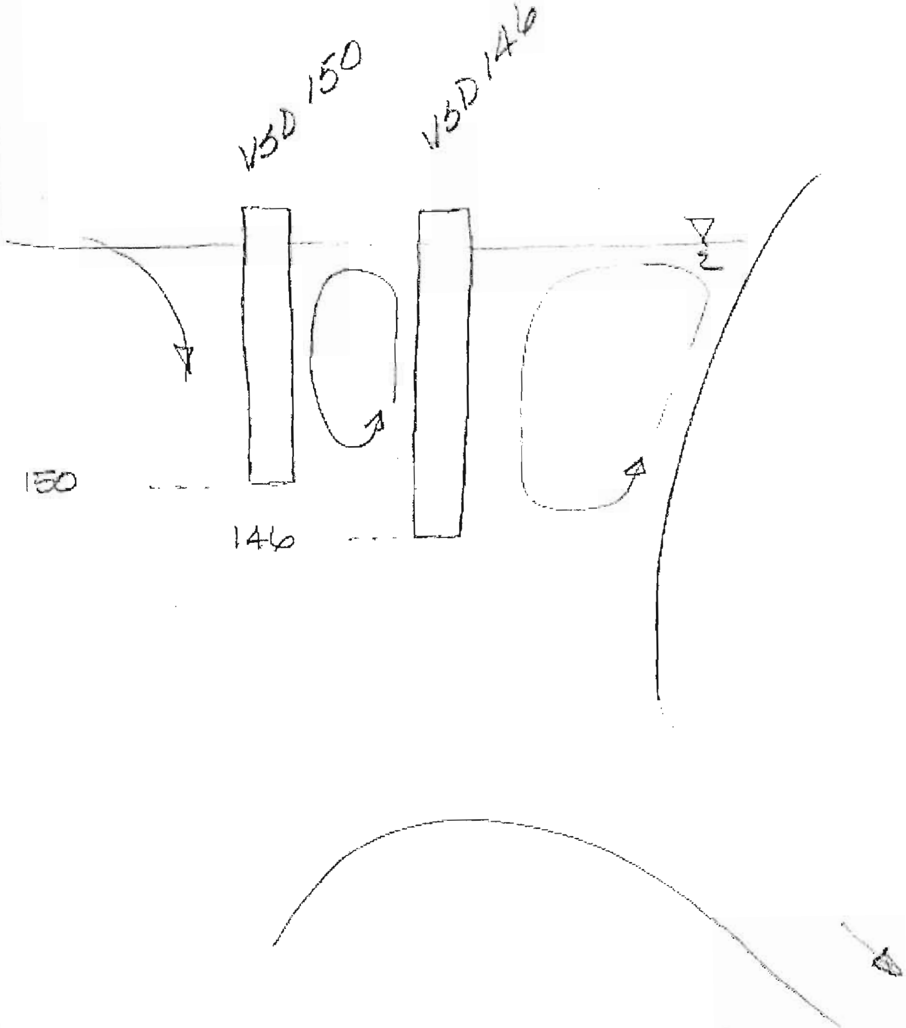

The Dalles Vortex Stoplog - Pier Nose Stoplog in Place
Forebay Elevation = 160 ft
Gate Opening = 14 ft
Bottom PeirNose Stoplog Elevation = 152 ft
Bottom Bulkhead Stoplog Elevation = 148 ft
Flow Rate = 421.421 cfs/foot
= 21071 cfs/bay
Vel Mag (ft/sec)
10
9
8
7
6
5
4
3
2
1
0


The Dalles Vortex Stoplog - Pier Nose Stoplog in Place
Forebay Elevation = 160 ft
Gate Opening = 14 ft
Bottom PeirNose Stoplog Elevation = 152 ft
Bottom Bulkhead Stoplog Elevation = 148 ft
Flow Rate = 421.421 cfs/foot
= 21071 cfs/bay
Vel Mag (ft/sec)
10
9
8
7
6
5
4
3
2
1
0

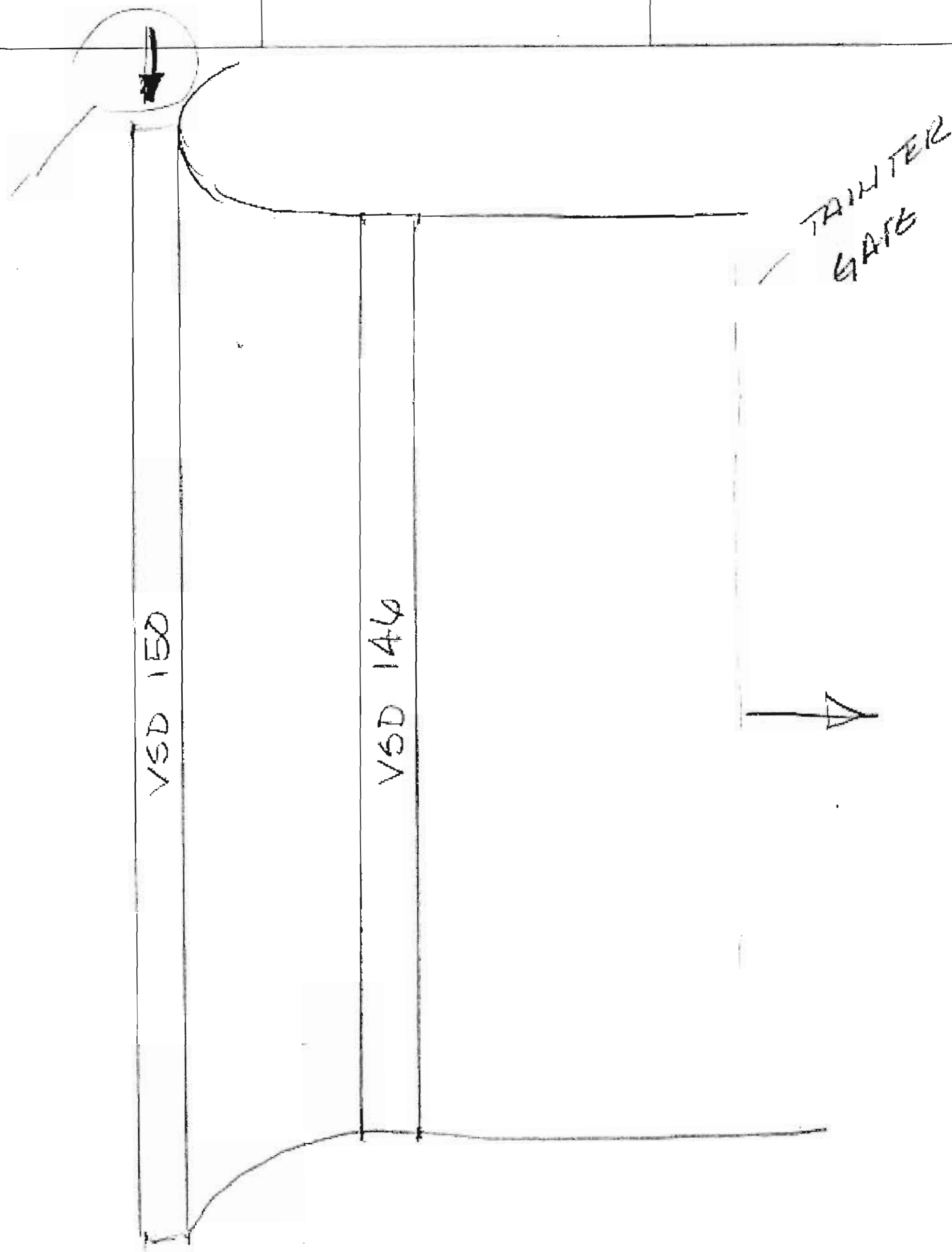
TDA-Vortex Suppression Devices 1/6

Hydraulic Loads

L.L. Ebner
9. Aug 06



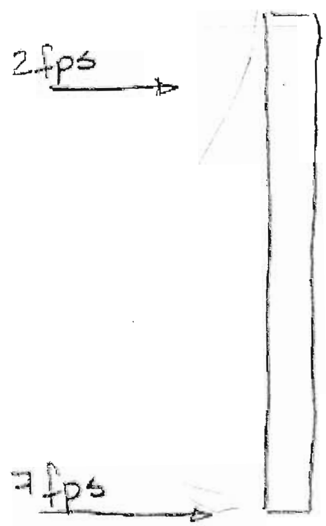
2/6



Bay 6 150_146
315 K6/6
14 ft gate
opening

VSD 150

Load perpendicular downstream to VSD

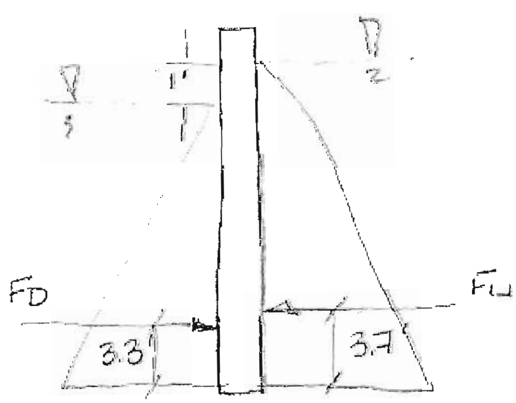


average velocity
is 4.5 fps

$F_D = \frac{1}{2} \rho C_D A V^2$

$F/ft = 393\ lbs/ft$

Load perpendicular upstream to VSD



$F_H = \frac{1}{2} \rho g H^2$

$F_D = (\frac{1}{2})(1.94)32.2(10)^2$

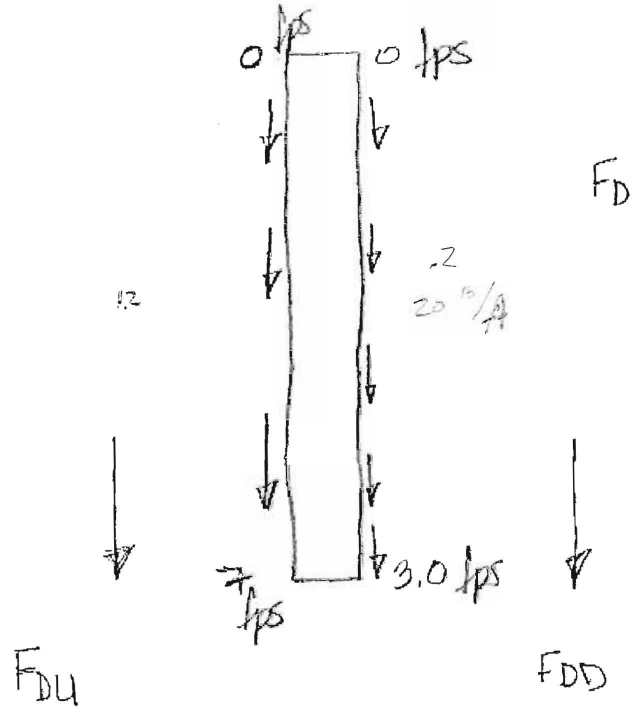
$F_D = 3123.4\ lbs/ft$

$F_u = 3779.3\ lbs/ft$

net upstream force 655 lbs/ft

VSD 150

downward force



$$F_D = \frac{1}{2}\rho C_f A V^2$$

$A = 10$

$\rho = 1.94$

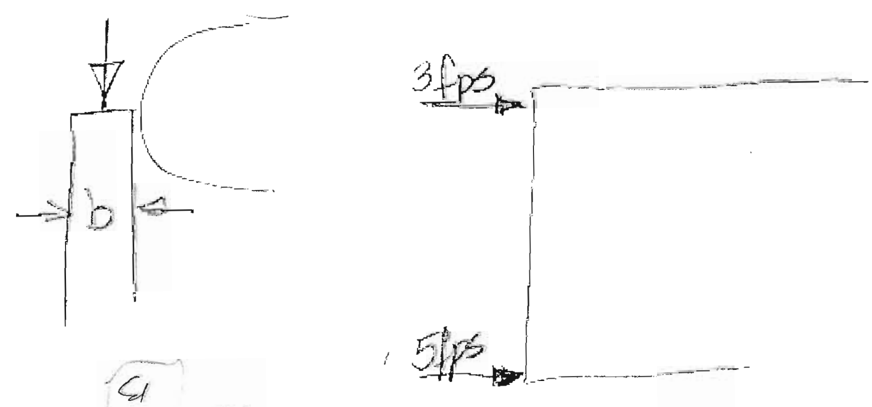
$V_{DU} = 3.5$ fps

$V_{DD} = 1.5$ fps

$C_f = .01$

surface area of Girders.

VSD 150

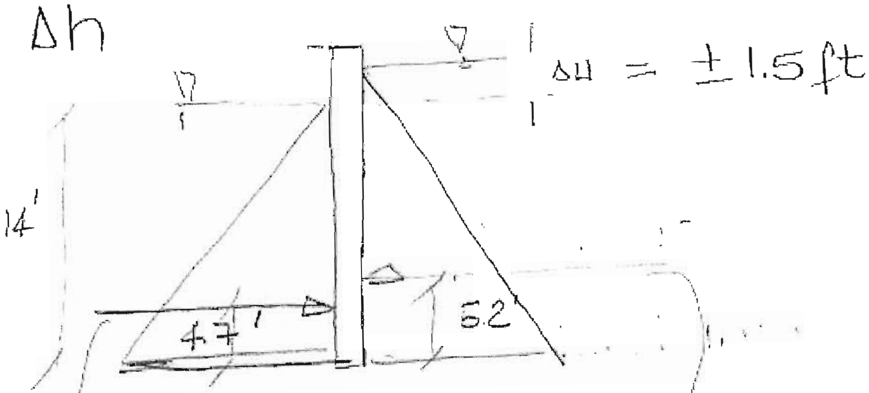


$$F/ft = \left(\frac{1}{2}\right)(1.94)(2)(4^2) = 31\,\text{lbs}/ft \text{ of width } (b)$$

97 lbs/ft Depth

VSD 146
no "velocity" load perpendicular

Δh



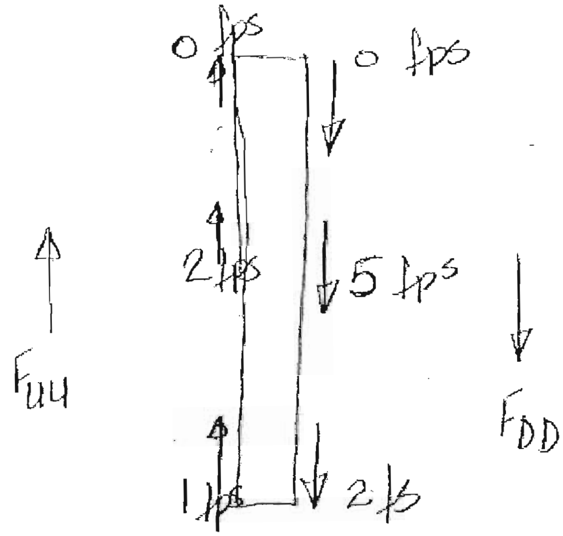
$F/ft = 1/2 \rho g (14)^2$
$= 6122 \text{ lbs}/ft$

$F/ft = (\tfrac{1}{2})(\rho) g (15.5)^2$
$= 7504 \text{ lbs}/ft$

net force = 1382 lbs/ft

* depending on differential could be u/s or d/s

VSD 146



$F_U / F_D = \frac{1}{2} \rho C_f A V^2$

$A = (14)(L)$

$\rho = 1.94$

$C_f =$

$F_U \Rightarrow V = 1.3$ fps

$F_D \Rightarrow V = 3$ fps

Table 7.2.C-1 Summary of Design Loads

Loads on Pier Nose VSD			
Max Pressure from Static Head	0.218	ksf	(Either Direction)
Max Pressure due to Velocity	0.095	ksf	Acting U/S to D/S
Increase pressure due to Hydro-dynamic OBE	0.0795	ksf	Acting U/S to D/S
Increase pressure due to Hydro-dynamic MDE	0.189	ksf	Acting U/S to D/S
Down Drag Force	10	lbs/ft	increase to Gravity
Log Impact	18.8	kips	Acting U/S to D/S
Wave Load	0.141	ksf	Acting U/S to D/S
Loads on Slot VSD			
Max Pressure from Static Head	0.094	ksf	(Either Direction)
Max Pressure due to Velocity	0.059	ksf	Acting U/S to D/S
Increase pressure due to Hydro-dynamic OBE	0.085	ksf	Acting U/S to D/S
Increase pressure due to Hydro-dynamic MDE	0.224	ksf	Acting U/S to D/S
Down Drag Force	3.5	lbs/ft	increase to Gravity
Log Impact	0	ksf	No force due to Pier Device
Wave Load	0	kips	No force due to Pier Device
Loads on Pier Nose Guide			
All loads from Pier Nose VSD			
Max Pressure due to velocity	50	psf	Normal to guide slot

NOTE: All loads are rounded up or max velocity was used for computation. Equations for Hydraulic forces were give by EC-HD.

ENGINEERING DESIGN SHEET
OFFICE SYMBOL:

PROJECT	COMPUTED BY	DATE:
The Dalles Vortex Device	PLD	8-24-06 SHEET: OF:
SUBJECT	CHECKED BY	PART:
Hydro-dynamic Force Calculation		

max pool Elevation = 160'

River Bottom Elevation = 90'

Height of water = 70'

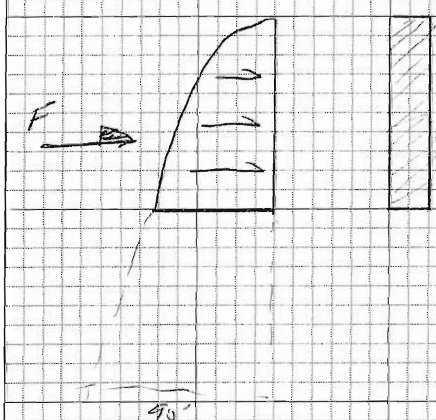
OBE Value = .055 MDE = .131

Westergard for Hydro-dynamic force (OBE)

Bottom of Gate is 150 so y-distance is 10'

$$\text{Pressure} = \tfrac{7}{8}\,\gamma_{water}\,\alpha\sqrt{HY}$$

$$\text{Force} = \tfrac{7}{12}\,\gamma_{water}\,\alpha\,(Y)\sqrt{HY}$$

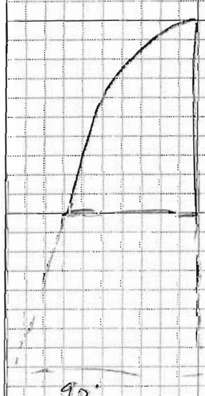


$$\text{Pressure} = \tfrac{7}{8} \cdot .0624 \cdot .055 \cdot \sqrt{70 * 10}$$
$$= .07945\ ^{K}/_{ft^2}$$

$$\text{Force} = \left(\tfrac{7}{12}\right)(.0624)(.055)(10)\sqrt{70 \cdot 10}$$
$$= .529 \text{ Kips}$$

Total force on Pier Nose = 31.74^{K}

Westergaard for Hydrodynamic force MDE $\alpha = .131$



$$\text{Pressure} = \tfrac{7}{8}(.0624)(.131)\sqrt{70 * 10} = .189\ ^{K}/_{ft^2}$$

$$\text{Force} = \tfrac{7}{12}(.0624)(.131)(10)\sqrt{70 * 10} = 1.261 \text{ kip}$$

$$\text{Total Force on Pier Nose} = 60\,(1.261^{K}) = 75.66^{K}$$

NPD Form 1110-4, Aug 96 (V1.00) Replaces NPD Form 7-10 grid which is no longer usable.

Fixed at Pier Nose

Unit Weight of water	0.0624	k/Ft^3	Top EL.	**158**	feet
Unit Weight of Steel	0.49	k/Ft^3	Pier bottom EL.	**150**	feet
Grade of Steel	**50.00**	ksi	Differential	**3.5**	feet
Allowable Stress (0.6*Fy)	30.00	ksi			
Head U/S Surface	8.00	feet			
Head D/S Surface	4.50	feet			
Max pressure U/S	0.499	k/ft^2			
Max Pressure D/S	0.281	k/ft^2			
Net pressure acting on U/S	0.218	k/ft^2			
Average Velocity Downward on Gate	**3.500**	fps			
Velocity Perpindicular to gate	**7.000**	fps			
Force due to Velocity	0.095	k/ft^2			
Force on girder from Velocity	0.190	k/ft			

**** NOTE - assume net pressure acts uniform across entire gate. *****

Girder Spacing C to C	**2.0**	feet		
Girder Span Length	**60.0**	feet		
Girder Depth	**24.0**	in		
Uniform Girder load	0.437	k/ft		
Girder Shear from head (simple span)	13.104	kips		
Girder Moment from head (simple span)	196.560	k-ft		
Shear from Velocity (simple span)	5.704	k		
Moment from Velocity (simple span)	85.554	k-ft		
Required Section Modulus	112.846	in^3		

**** NOTE - Section Properties come from Section Maker Program. *****

Shapes	T18X67.5 welded to 3/8" skin plate			
Area of Skin Plate 14"X.5"	7.00			
Distance from CG to plate	9.00			
Section Modulus	**167.38**	in^3		
Moment of inertia	**2220.60**	in^4		
Modulus of Elasticity	29000	ksi	<u>**Design Deflection**</u>	
Deflection using ASD pg. 2-32	4.655	in	**3.0 in**	
Deflection use L/240	3.000	in		
Expected Deflection	2.839	in		
Required Moment of inertia	2101.263	in^4		
Shear Flow Force per foot	0.534	k/in		
Increase in vetical force U/S (drag)	7.5	lbs/ft	450	Lbs
Increase in vetical force D/S (drag)	1.25	lbs/ft	75	Lbs

Fixed at Pier Nose

Unit Weight of water	0.0624	k/Ft^3	Top EL.	**158**	feet
Unit Weight of Steel	0.49	k/Ft^3	Pier bottom EL.	**150**	feet
Grade of Steel	**50.00**	ksi	Differential	**3.5**	feet
Allowable Stress (0.6*Fy)	30.00	ksi			

Head U/S Surface	8.00	feet
Head D/S Surface	4.50	feet
Max pressure U/S	0.499	k/ft^2
Max Pressure D/S	0.281	k/ft^2
Net pressure acting on U/S	0.218	k/ft^2
Average Velocity Downward on Gate	**3.500**	fps
Velocity Perpindicular to gate	**7.000**	fps
Force due to Velocity	0.095	k/ft^2
Force on girder from Velocity	0.285	k/ft

**** NOTE - assume net pressure acts uniform across entire gate. *****

Girder Spacing C to C	**3.0**	feet
Girder Span Length	**60.0**	feet
Girder Depth	**24.0**	in
Uniform Girder load	0.655	k/ft
Girder Shear from head (simple span)	19.656	kips
Girder Moment from head (simple span)	294.840	k-ft
Shear from Velocity (simple span)	8.555	k
Moment from Velocity (simple span)	128.331	k-ft
Required Section Modulus	169.268	in^3

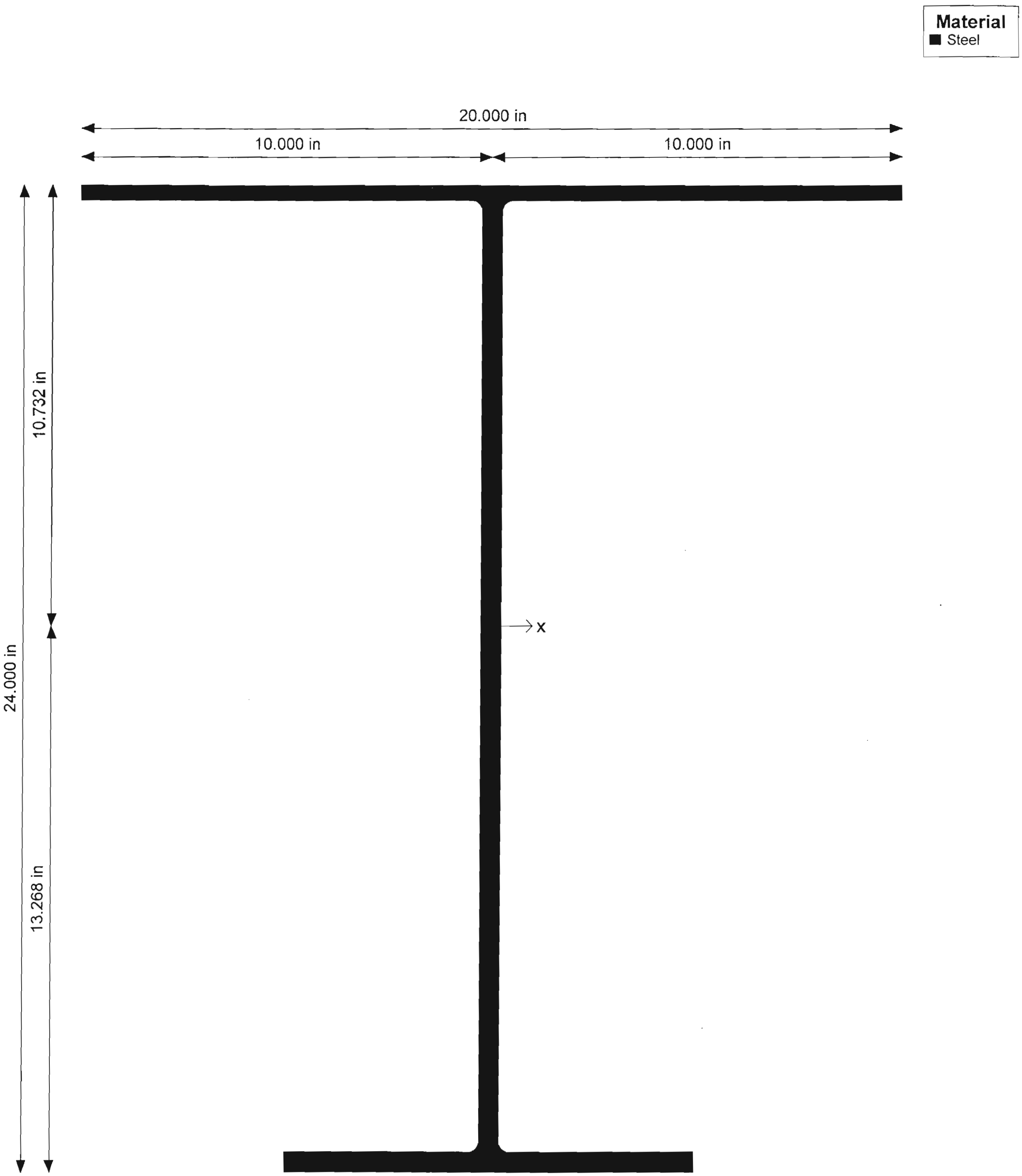
to assume Bottom Girder take all the pressure on the Bottom angled section.

**** NOTE - Section Properties come from Section Maker Program. *****

Shapes	T18X67.5 welded to 3/8" skin plate	
Area of Skin Plate 14"X.5"	7.00	
Distance from CG to plate	9.00	
Section Modulus	**186.95**	in^3
Moment of inertia	**2383.43**	in^4
Modulus of Elasticity	29000	ksi

Design Deflection
3.0 in

Deflection using ASD pg. 2-32	4.655	in	
Deflection use L/240	3.000	in	
Expected Deflection	3.967	in	
Required Moment of Inertia	3151.894	in^4	
Shear Flow Force per foot	0.746	k/in	
Increase in vetical force U/S (drag)	6.5	lbs/ft	390 Lbs
Increase in vetical force D/S (drag)	1.25	lbs/ft	75 Lbs


Material
Steel
20.000 in
10.000 in
10.000 in
10.732 in
24.000 in
13.268 in
x

	Property	Value	Units
1	Mass	82.062	lb/ft
2	A	24.116	in^2
3	Ix	2220.697	in^4
4	Iy	291.913	in^4
5	J	1.809	in^4
6	E	29000.000	ksi
7	G	11153.846	ksi
8	Sxt	206.915	in^3
9	Sxb	167.377	in^3
10	Syl	29.191	in^3
11	Syr	29.191	in^3
12	rx	9.596	in
13	ry	3.479	in
14	Ixc	2220.697	in^4
15	Iyc	291.913	in^4
16	Ixyc	0.000	in^4
17	I1	2220.697	in^4
18	I2	291.913	in^4
19	Ø	-0.000	deg
20	xc	-0.000	in
21	yc	0.000	in
22	D	24.000	in
23	B	20.000	in
24	tw	0.500	in
25	tf	0.375	in
26	xl	-10.000	in
27	xr	10.000	in
28	yt	10.732	in
29	yb	-13.268	in
30	Asx	12.500	in^2
31	Asy	12.000	in^2
32	S1t	206.915	in^3
33	S1b	206.915	in^3
34	S2l	29.191	in^3
35	S2r	29.191	in^3
36	radius 1	0.250	in
37	radius 2	0.000	in
38	xs	-10.000	in
39	ys	-2.185	in
40	P	106.571	in
41	d1	0.500	in
42	d2	0.000	in
43	b1	10.000	in
44	b2	0.000	in
45	Iw	0.016	10^6in^6
46	C	0.000	in^3
47	Zx	211.527	in^3
48	Zy	51.464	in^3
49	Z1	211.527	in^3
50	Z2	51.464	in^3
51	xp	-0.010	in
52	yp	1.299	in
53	radius 1	0.250	in
54	radius 2	0.000	in
55	taper	0.000	deg
56	s	0.000	in
57	Shape	Unsymmetric I	

ENGINEERING DESIGN SHEET OFFICE SYMBOL:

PROJECT	COMPUTED BY	DATE: 8-20-06
The Dalles Vortex	PLD	SHEET: 1 OF:
SUBJECT	CHECKED BY	PART:
Composite Beam Design		

* use 50 ksi steel and ASD for Design.

<u>find Flange limit for Non-compact shape ASD table B5.1:</u>

Flange limit $= \frac{b_f}{2t_f} = \frac{95}{\sqrt{50}} \Rightarrow \frac{95}{\sqrt{50}} = \frac{b_f}{2(.5)} \Rightarrow b_f = 13.5''$

$\therefore$ use 12"

<u>find web limit:</u>

$\frac{d}{t_w} = \frac{640}{\sqrt{F_y}} \Rightarrow \frac{640}{\sqrt{50}} = \frac{d}{.5} \Rightarrow d = 45''$

- for a member that is Non-compact and Non-slinder local Buckling is not Considered and Allowable Bending is .60 Fy

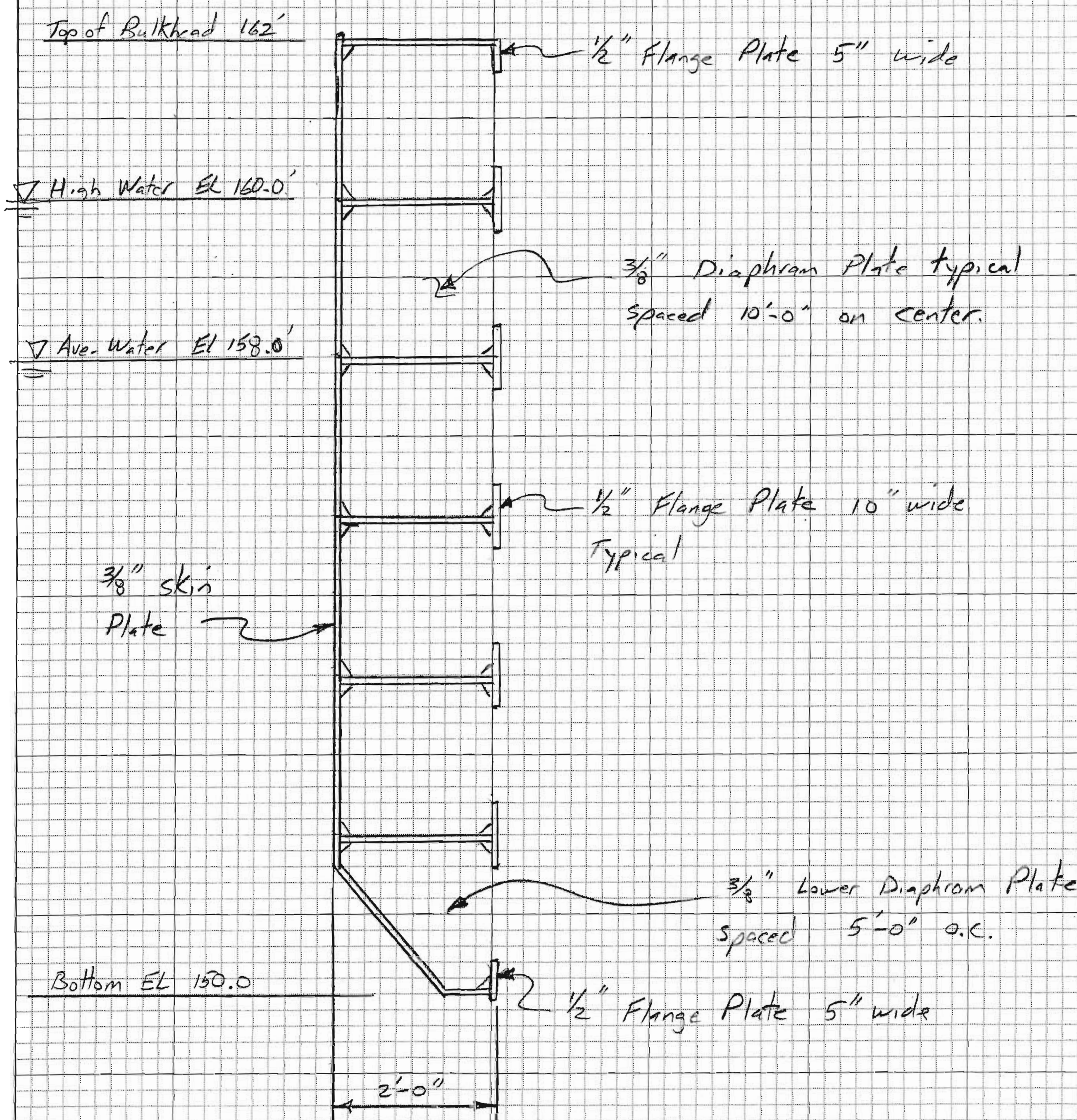
<u>check allowable unbraced length:</u>

$l \leq \frac{76 b_f}{\sqrt{F_y}} \Rightarrow l = \frac{76(13.5'')}{\sqrt{50}} = 145'' = 12'-0''$

$\therefore$ add Diaphrems @ 10'-0" O.C.

ENGINEERING DESIGN SHEET OFFICE SYMBOL:

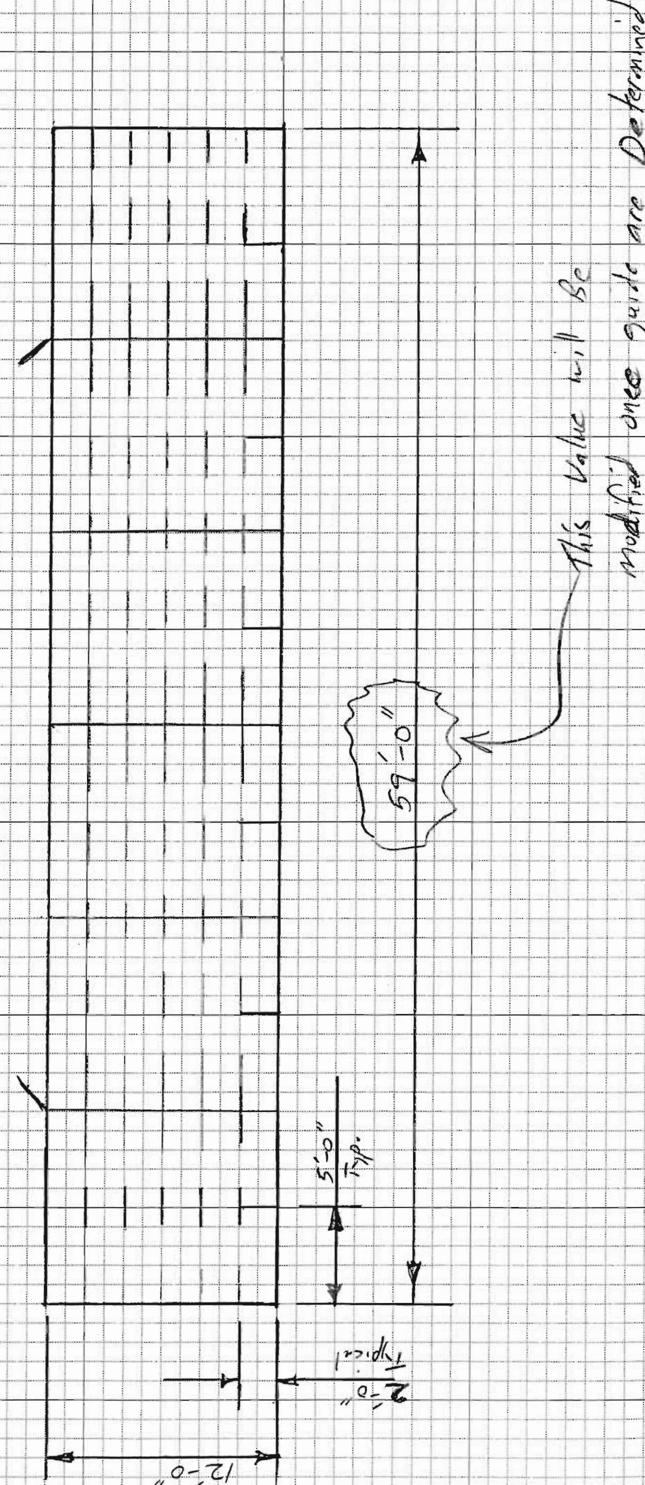
PROJECT	COMPUTED BY	DATE:
The Dalles Vortex	PLD	8-20-06
SUBJECT	CHECKED BY	SHEET: OF:
Pier Nose Bulkhead		PART:



NPD Form 1110-4, Aug 96 (V1.00) Replaces NPD Form 7-10 grid which is no longer usable.

ENGINEERING DESIGN SHEET OFFICE SYMBOL:

PROJECT	COMPUTED BY	DATE:
The Dalles Vortex	PLD	8-20-06
SUBJECT	CHECKED BY	SHEET: OF:
Pier Nose Bulkhead		PART:



Fixed at Slot

Unit Weight of water	0.0624	k/Ft^3	Top EL.	**158**	feet
Unit Weight of Steel	0.49	k/Ft^3	Pier bottom EL.	**146**	feet
Grade of Steel	**50.00**	ksi	Differential	**1.5**	feet
Allowable Stress (0.6*Fy)	30.00	ksi			
Head U/S Surface	12.00	feet			
Head D/S Surface	10.50	feet			
Max pressure U/S	0.749	k/ft^2			
Max Pressure D/S	0.655	k/ft^2			
Net pressure acting on U/S	0.094	k/ft^2			
Average Velocity Downward on Gate	**3.000**	fps			
Velocity Perpindicular to gate	**5.500**	fps			
Force due to Velocity	0.059	k/ft^2			
Force on girder from Velocity	0.235	k/ft			

** **NOTE - assume net pressure acts uniform across entire gate.** ***

Girder Spacing C to C	**4.0**	feet	4' for second Girder max force.
Girder Span Length	**53.0**	feet	
Girder Depth	**24.0**	in	
Uniform Girder load	0.374	k/ft	
Girder Shear from head (simple span)	9.922	kips	
Girder Moment from head (simple span)	131.461	k-ft	
Shear from Velocity (simple span)	6.221	k	
Moment from Velocity (simple span)	82.423	k-ft	
Required Section Modulus	85.554	in^3	

** **NOTE - Section Properties come from Section Maker Program.** ***

Shapes	T18X67.5 welded to 3/8" skin plate		
Area of Skin Plate 14"X.5"	7.00		
Distance from CG to plate	9.00		
Section Modulus	**167.00**	in^3	
Moment of inertia	**2220.00**	in^4	
Modulus of Elasticity	29000	ksi	**<u>Design Deflection</u>**
Deflection using ASD pg. 2-32	3.632	in	**2.65 in**
Deflection use L/240	2.650	in	
Expected Deflection	1.680	in	
Required Moment of inertia	1407.211	in^4	
Shear Flow Force per foot	0.458	k/in	
Increase in vetical force U/S (drag)	1	lbs/ft	53 Lbs
Increase in vetical force D/S (drag)	3.5	lbs/ft	185.5 Lbs

Fixed at Slot

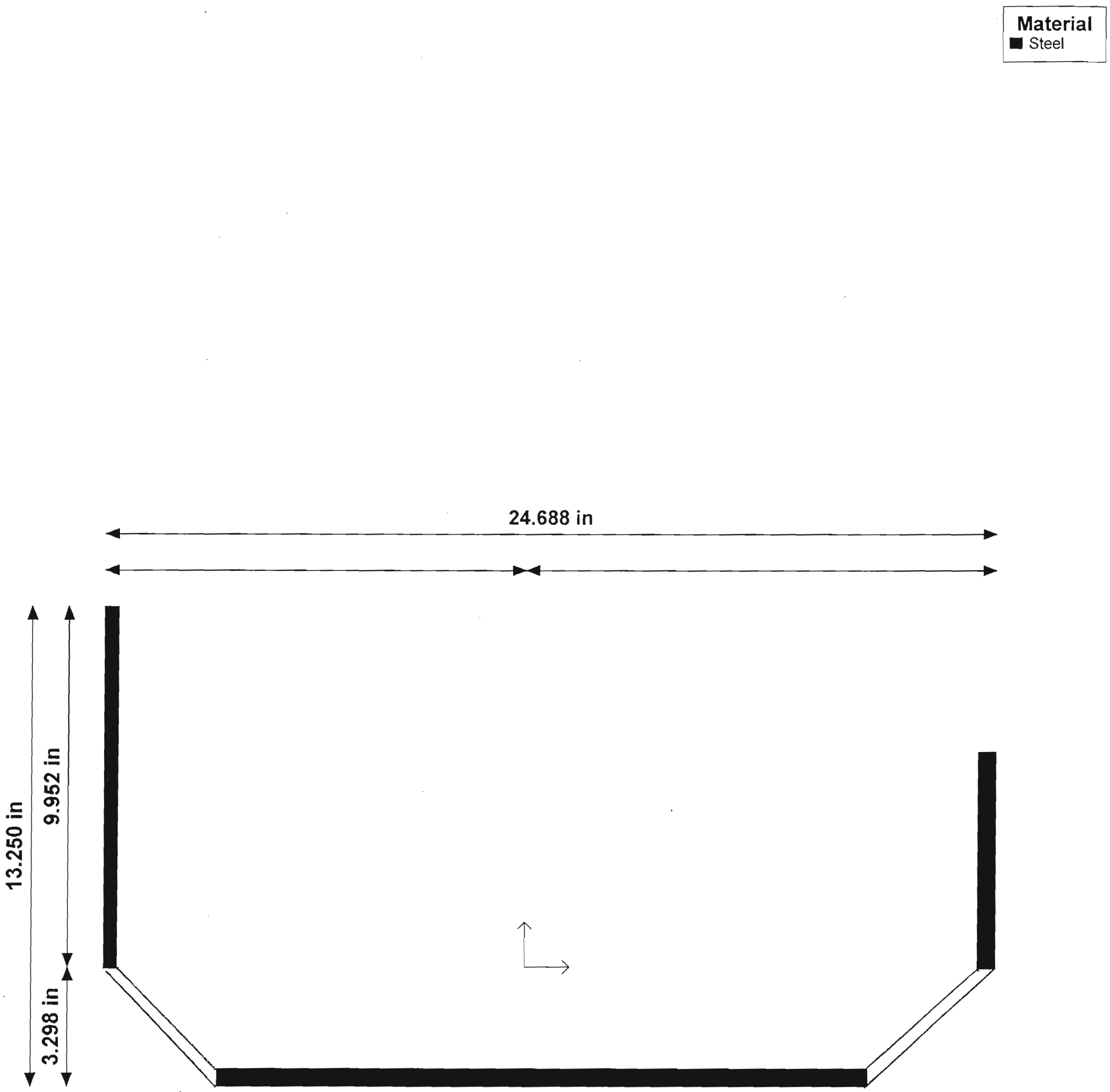
Unit Weight of water	0.0624 k/Ft^3		Top EL.	**158** feet
Unit Weight of Steel	0.49 k/Ft^3		Pier bottom EL.	**146** feet
Grade of Steel	**50.00** ksi		Differential	**1.5** feet
Allowable Stress (0.6*Fy)	30.00 ksi			
Head U/S Surface	12.00 feet			
Head D/S Surface	10.50 feet			
Max pressure U/S	0.749 k/ft^2			
Max Pressure D/S	0.655 k/ft^2			
Net pressure acting on U/S	0.094 k/ft^2			
Average Velocity Downward on Gate	**3.000** fps			
Velocity Perpindicular to gate	**5.500** fps			
Force due to Velocity	0.059 k/ft^2			
Force on girder from Velocity	0.117 k/ft			

**** NOTE - assume net pressure acts uniform across entire gate. *****

Girder Spacing C to C	**2.0** feet	for bottom Girder spacing
Girder Span Length	**53.0** feet	
Girder Depth	**24.0** in	
Uniform Girder load	0.187 k/ft	
Girder Shear from head (simple span)	4.961 kips	
Girder Moment from head (simple span)	65.731 k-ft	
Shear from Velocity (simple span)	3.110 k	
Moment from Velocity (simple span)	41.212 k-ft	
Required Section Modulus	42.777 in^3	

**** NOTE - Section Properties come from Section Maker Program. *****

Shapes	T18X67.5 welded to 3/8" skin plate	
Area of Skin Plate 14"X.5"	7.00	
Distance from CG to plate	9.00	
Section Modulus	**94.36** in^3	approximate from section maker
Moment of inertia	**1228.90** in^4	
Modulus of Elasticity	29000 ksi	
		Design Deflection
Deflection using ASD pg. 2-32	3.632 in	**2.65 in**
Deflection use L/240	2.650 in	
Expected Deflection	1.517 in	✓ OK
Required Moment of inertia	703.606 in^4	
Shear Flow Force per foot	0.414 k/in	
Increase in vetical force U/S (drag)	1 lbs/ft	53 Lbs
Increase in vetical force D/S (drag)	3.5 lbs/ft	185.5 Lbs



* Close approximation to Bottom Girder section.
Section maker wont create a shape on an angle.

	Property	Value	Units
1	Mass	53.594	lb/ft
2	A	15.750	in²
3	Ix	242.152	in^4
4	Iy	1228.973	in^4
5	J	1.145	in^4
6	E	29000.000	ksi
7	G	11153.846	ksi
8	Sxt	24.331	in³
9	Sxb	73.432	in³
10	Syl	105.367	in³
11	Syr	94.364	in³
12	rx	3.921	in
13	ry	8.833	in
14	Ixc	242.152	in^4
15	Iyc	1228.973	in^4
16	Ixyc	-114.357	in^4
17	I1	1242.051	in^4
18	I2	229.073	in^4
19	Ø	-96.524	deg
20	xc	0.000	in
21	yc	-0.000	in
22	D	13.250	in
23	B	24.688	in
24	tw	0.375	in
25	tf	0.500	in
26	xl	-11.664	in
27	xr	13.024	in
28	yt	9.952	in
29	yb	-3.298	in
30	Asx	15.750	in²
31	Asy	15.750	in²
32	S1t	95.949	in³
33	S1b	95.949	in³
34	S2l	54.034	in³
35	S2r	26.620	in³
36	radius 1	0.000	in
37	radius 2	0.000	in
38	xs	0.000	in
39	ys	0.000	in
40	P	0.000	in
41	d1	0.000	in
42	d2	0.000	in
43	b1	0.000	in
44	b2	0.000	in
45	Iw	0.000	10^6in^6
46	C	0.000	in³
47	Zx	48.492	in³
48	Zy	121.969	in³
49	Z1	122.561	in³
50	Z2	48.876	in³
51	xp	-0.236	in
52	yp	-2.858	in
53	radius 1	0.000	in
54	radius 2	0.000	in
55	taper	0.000	deg
56	s	0.000	in
57	Shape	Unknown	

ENGINEERING DESIGN SHEET OFFICE SYMBOL:

PROJECT	COMPUTED BY	DATE:
The Dalles Vortex	PLD	8-20-06 SHEET: OF:
SUBJECT	CHECKED BY	
Skin Plate Design		PART:

check slot skin Plate Bending: (span is 4'-0" C to C.)

Pressure from excel worksheet and EC-HD

static = .094 K/ft²

Velocity = .008 K/ft²

.102 K/ft² ⇐ Look at 1'-0" strip uniform load Becomes .102 K/ft

Plate Bending:

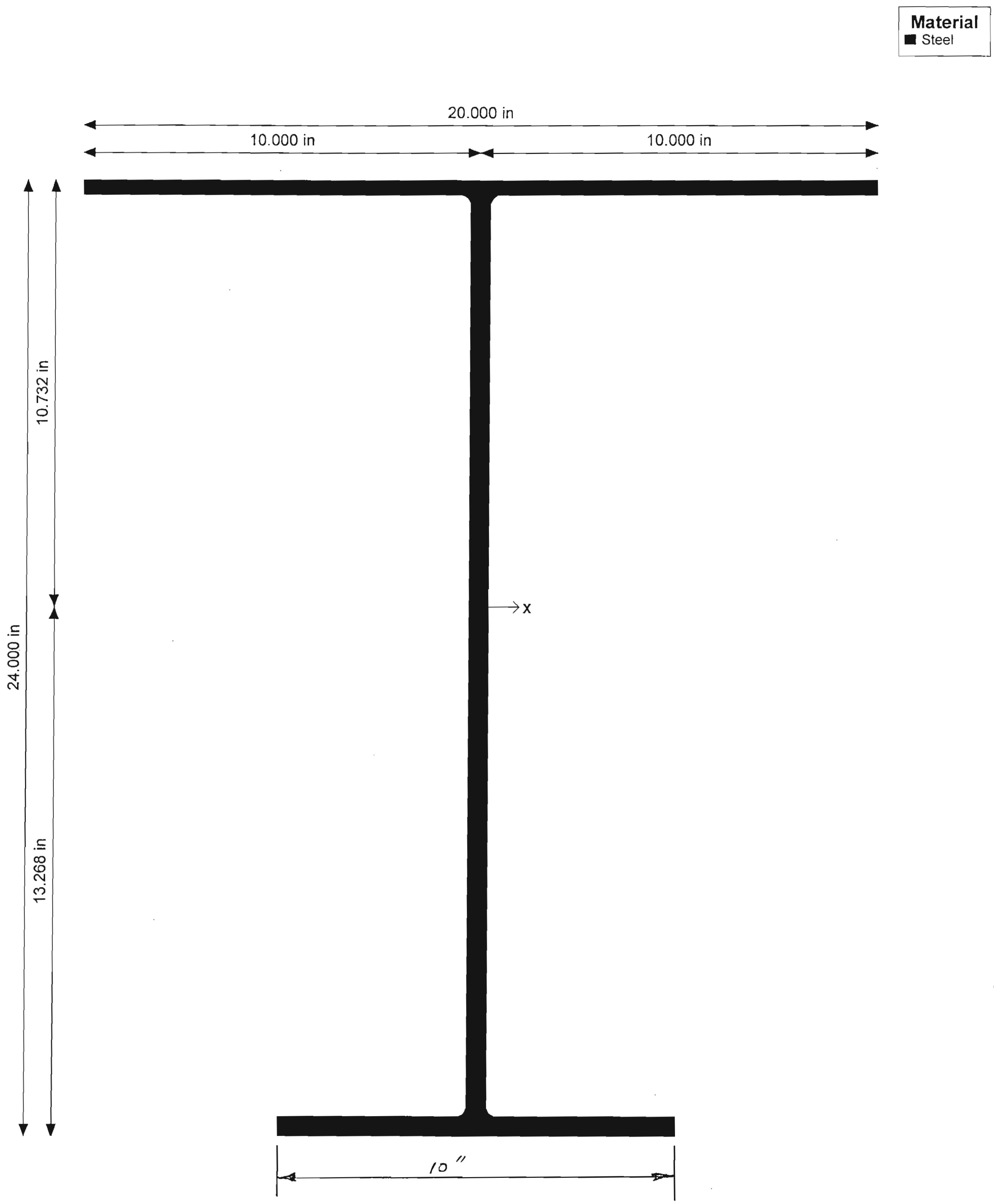
$$M = \frac{wL^2}{8} = \frac{.102^{K/ft}(4')^2}{8} = .204^{k\text{-}ft} = 2.448^{k\text{-}in}$$

Plate section modulus:

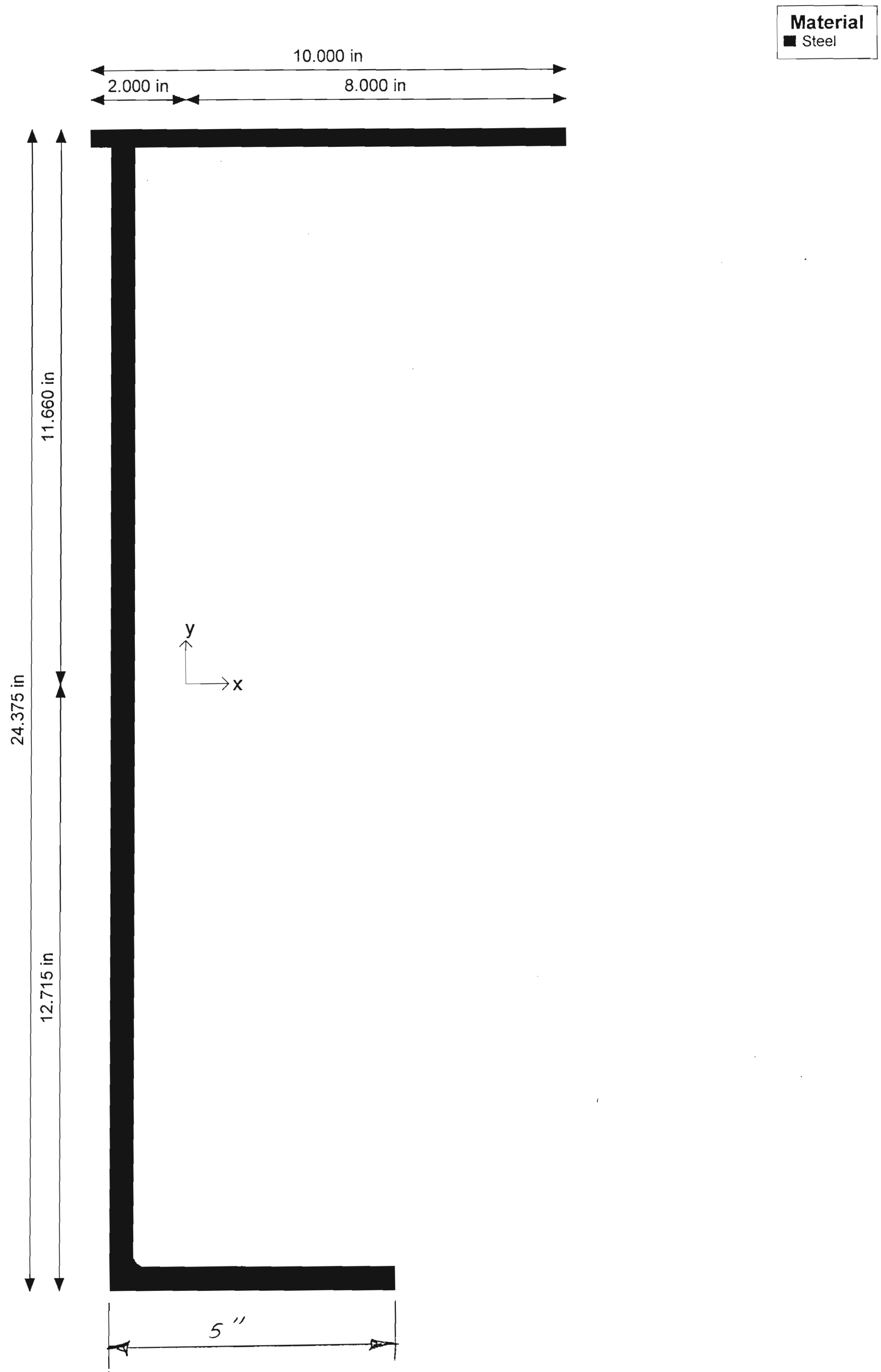
$$S = \frac{bd^2}{6} = \frac{12''(.375^2)}{6} = .281\ in^3$$

Plate Bending stress:

$$f_b = \frac{2.448^{k\text{-}in}}{.281\ in^3} = 8.8\ Ksi \ll 30^{ksi} \checkmark\ OK$$


Material
Steel
20.000 in
10.000 in
10.000 in
10.732 in
24.000 in
13.268 in
x
10"

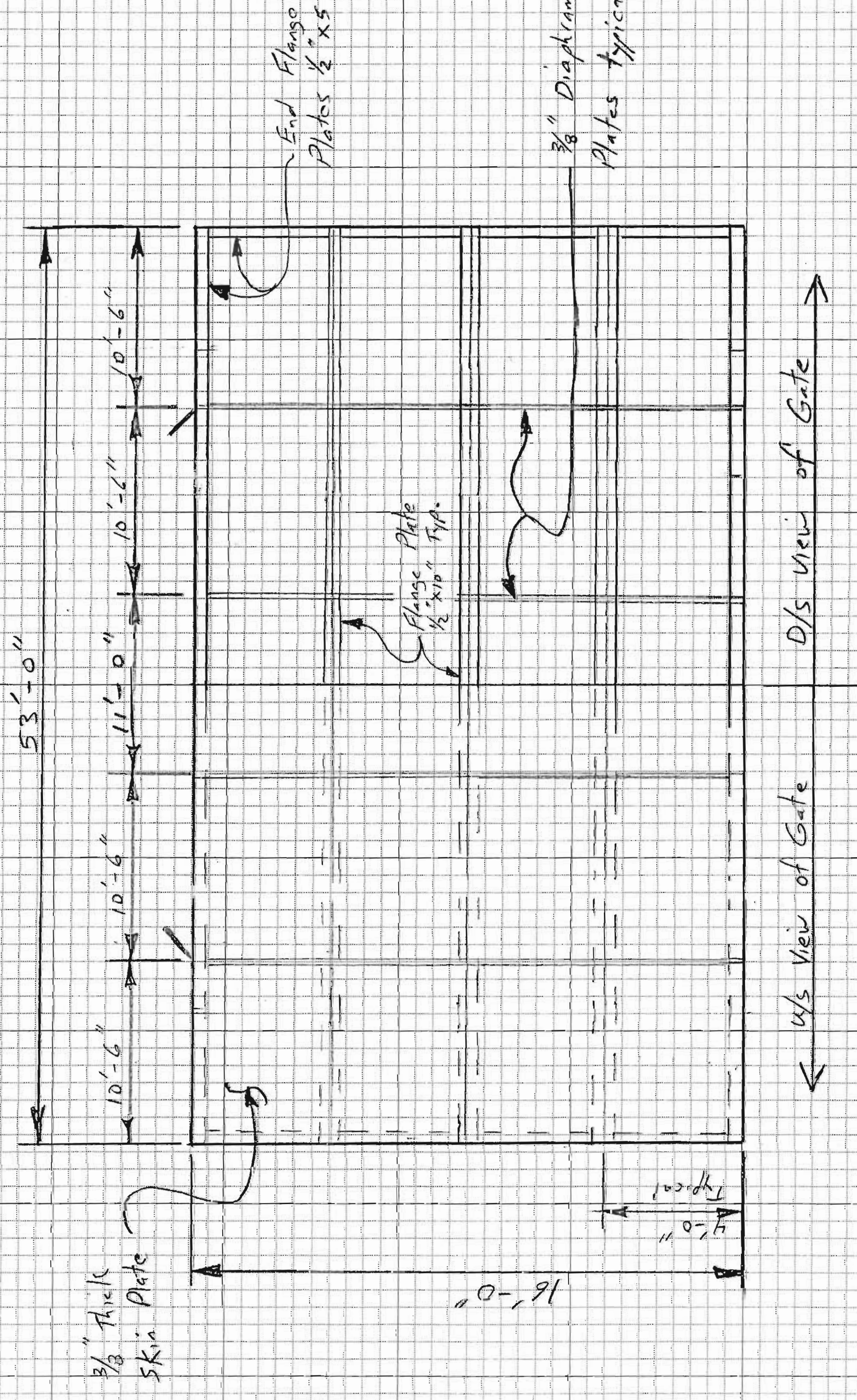
	Property	Value	Units
1	Mass	82.062	lb/ft
2	A	24.116	in²
3	Ix	2220.697	in^4
4	Iy	291.913	in^4
5	J	1.809	in^4
6	E	29000.000	ksi
7	G	11153.846	ksi
8	Sxt	206.915	in³
9	Sxb	167.377	in³
10	Syl	29.191	in³
11	Syr	29.191	in³
12	rx	9.596	in
13	ry	3.479	in
14	Ixc	2220.697	in^4
15	Iyc	291.913	in^4
16	Ixyc	0.000	in^4
17	I1	2220.697	in^4
18	I2	291.913	in^4
19	Ø	-0.000	deg
20	xc	-0.000	in
21	yc	0.000	in
22	D	24.000	in
23	B	20.000	in
24	tw	0.500	in
25	tf	0.375	in
26	xl	-10.000	in
27	xr	10.000	in
28	yt	10.732	in
29	yb	-13.268	in
30	Asx	12.500	in²
31	Asy	12.000	in²
32	S1t	206.915	in³
33	S1b	206.915	in³
34	S2l	29.191	in³
35	S2r	29.191	in³
36	radius 1	0.250	in
37	radius 2	0.000	in
38	xs	-10.000	in
39	ys	-2.185	in
40	P	106.571	in
41	d1	0.500	in
42	d2	0.000	in
43	b1	10.000	in
44	b2	0.000	in
45	Iw	0.016	10^6in^6
46	C	0.000	in³
47	Zx	211.527	in³
48	Zy	51.464	in³
49	Z1	211.527	in³
50	Z2	51.464	in³
51	xp	-0.010	in
52	yp	1.299	in
53	radius 1	0.250	in
54	radius 2	0.000	in
55	taper	0.000	deg
56	s	0.000	in
57	Shape	Unsymmetric I	


Material
Steel
10.000 in
2.000 in
8.000 in
11.660 in
24.375 in
12.715 in
y
x
5 ″

	Property	Value	Units
1	Mass	62.997	lb/ft
2	A	18.513	in²
3	Ix	1505.067	in^4
4	Iy	100.891	in^4
5	J	1.375	in^4
6	E	29000.000	ksi
7	G	11153.846	ksi
8	Sxt	129.080	in³
9	Sxb	118.370	in³
10	Syl	50.435	in³
11	Syr	12.612	in³
12	rx	9.016	in
13	ry	2.334	in
14	Ixc	1505.067	in^4
15	Iyc	100.891	in^4
16	Ixyc	83.014	in^4
17	I1	1509.957	in^4
18	I2	96.000	in^4
19	Ø	-3.372	deg
20	xc	-0.000	in
21	yc	-0.000	in
22	D	24.375	in
23	B	10.000	in
24	tw	0.500	in
25	tf	0.375	in
26	xl	-2.000	in
27	xr	8.000	in
28	yt	11.660	in
29	yb	-12.715	in
30	Asx	18.513	in²
31	Asy	18.513	in²
32	S1t	124.684	in³
33	S1b	124.684	in³
34	S2l	13.110	in³
35	S2r	35.790	in³
36	radius 1	0.250	in
37	radius 2	0.000	in
38	xs	0.000	in
39	ys	0.000	in
40	P	0.893	in
41	d1	0.000	in
42	d2	0.000	in
43	b1	0.000	in
44	b2	0.000	in
45	Iw	0.000	10^6in^6
46	C	0.000	in³
47	Zx	149.682	in³
48	Zy	25.761	in³
49	Z1	149.901	in³
50	Z2	27.938	in³
51	xp	-1.200	in
52	yp	0.282	in
53	radius 1	0.250	in
54	radius 2	0.000	in
55	taper	0.000	deg
56	s	0.000	in
57	Shape	Unknown	

ENGINEERING DESIGN SHEET OFFICE SYMBOL:

PROJECT	COMPUTED BY	DATE:
The Dalles Vortex	PLD	8-21-06
SUBJECT	CHECKED BY	SHEET: OF:
Slot Device Plan View		PART:

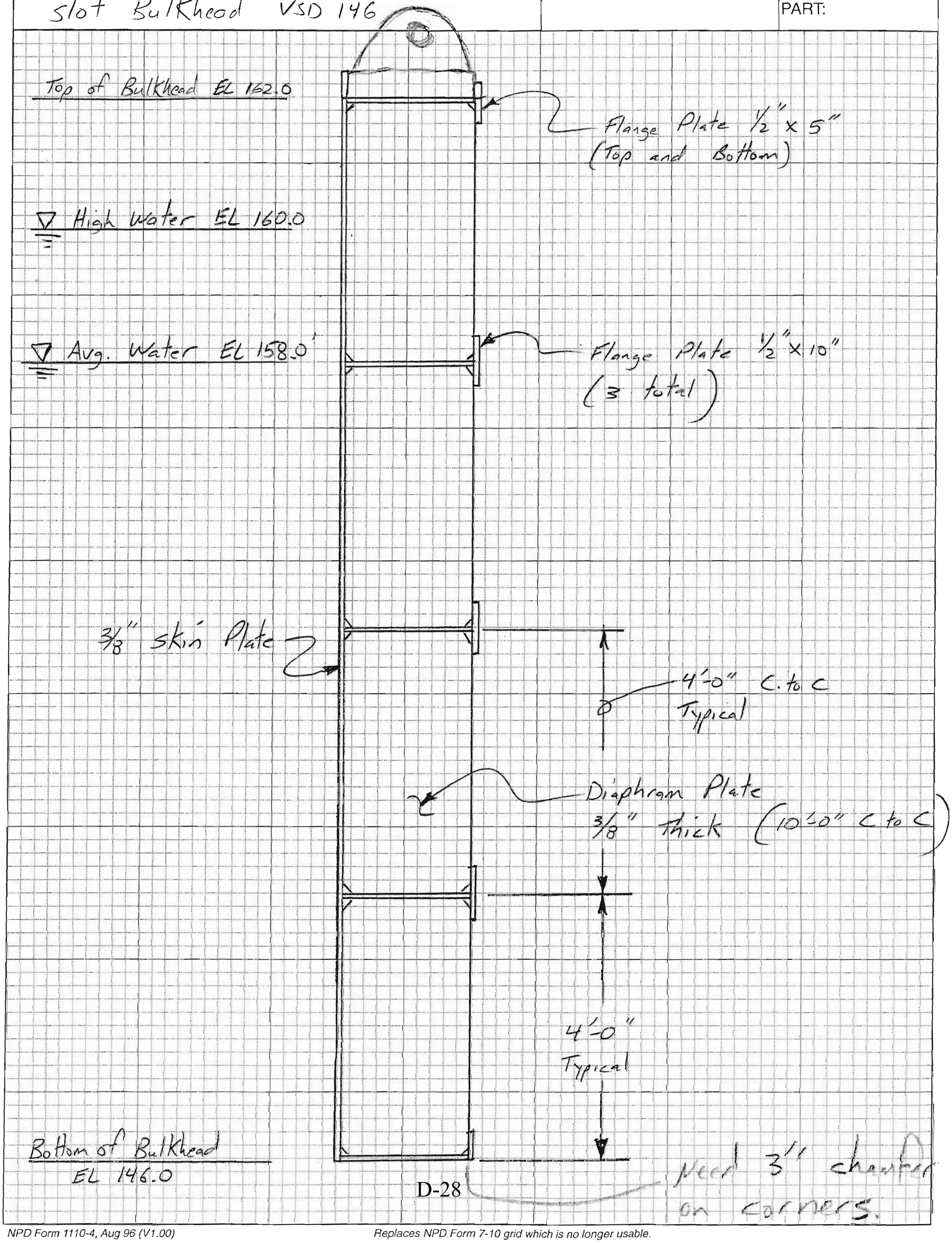


NPD Form 1110-4, Aug 96 (V1.00) Replaces NPD Form 7-10 grid which is no longer usable.

ENGINEERING DESIGN SHEET

OFFICE SYMBOL:

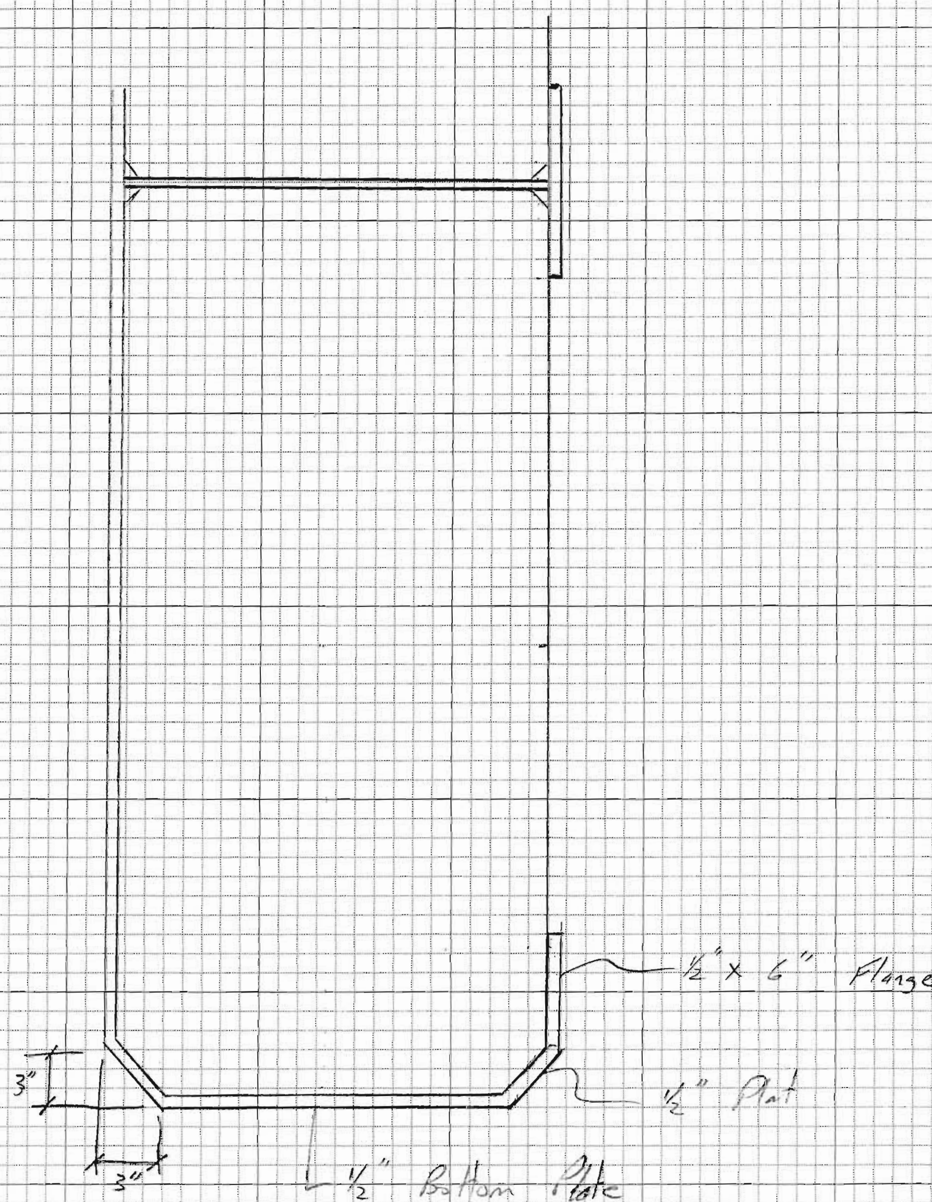
PROJECT The Dalles Vortex	COMPUTED BY PLD	DATE: 8-20-06 SHEET: OF:
SUBJECT slot Bulkhead VSD 146	CHECKED BY	PART:



ENGINEERING DESIGN SHEET

OFFICE SYMBOL:

PROJECT	COMPUTED BY	DATE:
SUBJECT	CHECKED BY	SHEET: OF:
		PART:



NPD Form 1110-4, Aug 96 (V1.00)

Replaces NPD Form 7-10 grid which is no longer usable.

APPENDIX E – COST ESTIMATE

APPENDIX E

TDA_Vortex Suppression Devise Bay 6 & 7

Preliminary estimate for construction of Vortex Suppression Devise for TDA Spillway Bay 6 & 7. Pier nose VSD draft to elev 150, Stoplog Slot VSD to elev 146.

Estimated by	Portland District EC-RC
Designed by	Portland District
Prepared by	Rick Russell
Preparation Date	8/28/2006
Effective Date of Pricing	8/28/2006
Estimated Construction Time	150 Days

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Date	Author	Note
8/28/2006	Narr	August 25, 2006

SPILLWAY BAY 6 VORTEX SUPPRESSION DEVICE
LETTER REPORT
THE DALLES DAM

1. Project Description:

Spillway bays 1 through 6 are typically used to allow 40% of the total river flow to pass the project in an effort to encourage juvenile fish passage by that route. A vortex forms near the pier nose at Bay 6. The vortex seems to attract juvenile fish to that area and test results indicate survival rates are better through Bays 1 to 4. Suppression of the vortex at the Bay 6 location should improve survival rates. Model tests have shown that two steel bulkhead type devices with a draft of 8 and 12 feet in front of the spillway gate minimized the vortex.

2. Basis of Design and Estimate:

a. Basis of Design: The design is based on field data, physical model testing and numerical testing results to determine the configurations.

b. Basis of Estimate. Preliminary engineering calculations from the design team and data presented in this letter report are the basis of estimating the quantities and construction tasks. The estimate is a MCACES MII Version 2.21, using labor and equipment crews, quantities, production rates, and material price quotes.

3. Construction Schedule:

a. Overtime. Because of the In-water-work-period and the expense of having divers on site, overtime is assumed at 10 hour days, 5 days a week.

b. Construction Windows. Site construction is limited to the In-water work period. It is expected that an extension of one additional month for work will be granted by the agencies. Therefore the construction window will be from November 1, 2006 to March 31, 2007.

c. Acquisition Plan. The cost estimate assumes competitive pricing will be obtained by invitation to seal bidding for the construction contract.

4. Subcontracting Plan:

The cost estimate is based on the work being accomplished by a General Construction Contractor being the prime contractor. Subcontractors are expected to be a Dive Company to perform work requiring divers, a steel fabrication shop to fabricate the steel pieces with a subcontractor to paint the finished product, and a marine company to provide floating work platforms, floating cranes, and other boat related equipment.

5. Project Construction.

a. Site Access. Personnel access is assumed by project roads from the north shore via Washington Highway 197. Due to the size of the bulkheads, 52 feet long 16 feet

Date	Author	Note
8/28/2006	Narr	high 2 feet thick, highway transport is probably possible with special oversized permits, however the estimate assumes delivery of the bulkheads by barge. The work requires floating equipment to access work areas.

b. Materials. Steel and concrete quantities required for the project are readily available by commercial sources in the area.

c. Government Furnished Property. None.

d. Construction Methodology. Divers and marine based equipment will be used during site construction. Steel fabrications are typical of large plates and welding and will be done in the shop, delivered to the site ready for installation.

f. Unusual Conditions (Soil, Water, Weather). The site work is during the winter and subject to reduced worker production due to cold, wet weather, shorter daylight hours. Water visibility can be restricted and hinder the diving work. Water visibility is expected to be 0 to 4 feet.

g. Unique Construction Techniques. Construction by divers for installation of brackets and guides to support the bulkheads.

h. Equipment/Labor Availability and Distance Traveled. Labor and equipment is available within a 250 mile radius of the project and includes the areas of Portland/Vancouver (90 miles), Pasco / TriCities area (135 miles), and Seattle/Puget Sound area, (240 miles). Mobilization and demobilization is based on 250 mile travel distance.

i. Overhead, Profit and Bond. Rule of Thumb markups are assumed for the estimate. For the Prime contractor Job Office Overhead is 14%, Home Office Overhead is 6%, Profit of 8%, and Bond Table B, about 1%. For the Subcontractors on site, Job Office Overhead is assumed as 15%, Home office Overhead is 10%, Profit is 10%, and no bond since the prime contractor carries that. Higher markups are assume for the subcontractors due to the highly specialized nature of diving and marine based work, small company size, and additional safety requirements compared to general construction. Since this is marine based and work over water Longshoreman, and Harbors Insurance of 40% is assumed in addition to typical workmen's compensation rates. Markups for the Steel fabrication subcontractors is include in the shop rate assumed to be $65 per hour. The location of the work site is in the state of Washington, which has a sales tax on materials of 7.0% and a "Business and Occupational Tax of 1.5% on the contact amount.

6. Environmental Concerns.

The proximity of the water requires additional attention to eliminate all spills and to control / cleanup debris to prevent it from entering the water.

7. Contingencies by Feature or Sub-Feature.

Contingencies are based on a percentage to assure that unforeseen items of work or level of details that may be needed later are covered. Model testing has established the required geometry, design changes for the project are expected to be minor. Material and construction costs have been unstable and increasing in recent years, therefore a 20% contingency is assumed.

8. Effective Dates for Labor, Equipment, Material Pricing.

Date	Author	Note
8/28/2006	Narr	Effective date for all pricing is August 2006. The most recent Davis-Bacon labor rates were used. The Region 8 2005 Equipment database was employed, as was the 2004 Cost Book Database of MII, which are the most recent MII databases available. 9. Functional Costs: Functional costs for Real Estate, Engineering and Design and Construction Management associated with this work were provided by the Task and Project Managers as follows: a. 01 Account - Lands and Damages: Not Applicable since all construction work is on existing project areas. b. 22 Account - Feasibility Studies: N/A. c. 30 Account - Planning, Engineering and Design: (1) Plans and Specifications: This account covers preparing plans and specifications, District review, contract advertisement and award activities. Costs are determined from an estimate of the expected design and engineering effort at $220,000 plus a 20% contingency. (2) Engineering During Construction: This item consists of Planning and Engineering Division support to Construction Division during construction and participation in the prefinal and final inspections of the contract. This is estimated to at $120,000 plus a 20% contingency. d. 31 Account - Construction Management: This account covers construction management of the proposed work. Cost is estimated from historical data and an expected effort required for supervision and administration of the construction work. This is estimated at $100,000 plus a 20% contingency.
8/29/2006	V2	V2, Updated Labor rates to Davis Bacon WA030001 11Aug06. Add overtime. Added LS&H on Labor burden Added sales tax and B&O tax.
8/29/2006	V3	V3 Updated for review comments.

Direct Cost Markups	***Category***	***Method***
Productivity	Productivity	Productivity
Overtime	Overtime	Overtime

	Days/Week	*Hours/Shift*	*Shifts/Day*	*1st Shift*	*2nd Shift*	*3rd Shift*
Standard	*5.00*	*8.00*	*1.00*	*8.00*	*0.00*	*0.00*
Actual	*5.00*	*8.00*	*1.00*	*10.00*	*0.00*	*0.00*

Day	*OT Factor*	*Working*	*OT Percent*	*FCCM Percent*
Monday	*1.50*	*Yes*	*10.00*	*(20.00)*
Tuesday	*1.50*	*Yes*		
Wednesday	*1.50*	*Yes*		
Thursday	*1.50*	*Yes*		
Friday	*1.50*	*Yes*		
Saturday	*1.50*	*No*		
Sunday	*2.00*	*No*		

Sales Tax	TaxAdj	Running % on Selected Costs
MatlCost		

Contractor Markups	***Category***	***Method***
JOOH14	JOOH	Running %
JOOH15	JOOH	Running %
HOOH6	HOOH	Running %
HOOH10	HOOH	Running %
Profit8	Profit	Running %
Profit10	Profit	Running %
Bond	Bond	Bond Table

Class B, Tiered, 24 months, 1.00% Surcharge

Contract Price	*Bond Rate*
500,000	*15.84*
2,000,000	*9.57*
2,500,000	*7.59*
2,500,000	*6.93*
7,500,000	*6.34*

B&O Tax	Excise	Running %

Owner Markups	***Category***	***Method***
Escalation	Escalation	Escalation

StartDate	*StartIndex*	*EndDate*	*EndIndex*	*Escalation*
Contingency	Contingency	Running %		
SIOH	SIOH	Running %		

Description	Quantity	UOM	DirectCost	SubCMU	CostToPrime	PrimeCMU	ContractCost	C/O
Contract Cost Summary Report			***903,212***	***173,482***	***1,076,694***	***366,378***	***1,443,071***	
			68,182.39		*75,680.31*		*101,432.83*	
Mob Demob	***1.00***	***EA***	***68,182***	***7,498***	***75,680***	***25,753***	***101,433***	
			142,976.13		*192,769.68*		*258,365.41*	
VSD Guides	***3.00***	***EA***	***428,928***	***149,381***	***578,309***	***196,787***	***775,096***	
			100,448.81		*104,599.71*		*140,192.93*	
VSD Bulkheads	***4.00***	***EA***	***401,795***	***16,604***	***418,399***	***142,373***	***560,772***	
			43.06		*43.06*		*57.71*	
Craftman hours Optional	***100.00***	***EA***	***4,306***	***0***	***4,306***	***1,465***	***5,771***	

Description	UOM	Quantity	DirectCost	TaxAdj	JOOH	HOOH	Profit	Bond	Excise	ContractCost
Project Indirect Summary Report			***903,211.55***	***9,632.65***	***130,656.54***	***81,383.95***	***99,863.69***	***7,431.38***	***18,338.21***	***1,443,071.36***
Mob Demob	***EA***	***1.0000***	***68,182.39***	***0.00***	***9,727.36***	***5,510.98***	***7,133.67***	***770.06***	***1,369.87***	***101,432.83***
Mob divers	***EA***	***1.0000***	***9,355.33***	***0.00***	***1,403.30***	***1,075.86***	***1,183.45***	***0.00***	***195.27***	***17,709.41***
USR 2 man Dive Crew (7M) per day	DAY	1.0000	9,355.33	0.00	1,403.30	1,075.86	1,183.45	0.00	195.27	17,709.41
Mob work barge	***EA***	***1.0000***	***8,827.06***	***0.00***	***1,324.06***	***1,015.11***	***1,116.62***	***0.00***	***184.24***	***16,709.40***
USR WorkBarge day	DAY	4.0000	8,827.06	0.00	1,324.06	1,015.11	1,116.62	0.00	184.24	16,709.40
Reg Mob Demob	***EA***	***1.0000***	***50,000.00***	***0.00***	***7,000.00***	***3,420.00***	***4,833.60***	***770.06***	***990.35***	***67,014.02***
USR Mob Demob common	LS	1.0000	50,000.00	0.00	7,000.00	3,420.00	4,833.60	770.06	990.35	67,014.02
VSD Guides	***EA***	***3.0000***	***428,928.40***	***1,886.45***	***63,672.44***	***46,219.41***	***52,270.47***	***1,026.98***	***8,881.77***	***775,096.23***
Demo Existing Test Equipment	***EA***	***1.0000***	***22,905.17***	***0.00***	***3,435.78***	***2,634.09***	***2,897.50***	***0.00***	***478.09***	***43,358.92***
USR 2 man Dive Crew (7M) per day	DAY	2.0000	18,710.67	0.00	2,806.60	2,151.73	2,366.90	0.00	390.54	35,418.82
USR WorkBarge day	DAY	2.0000	4,194.51	0.00	629.18	482.37	530.61	0.00	87.55	7,940.10
Field Verify Pier Dimensions	***EA***	***1.0000***	***22,905.17***	***0.00***	***3,435.78***	***2,634.09***	***2,897.50***	***0.00***	***478.09***	***43,358.92***
USR WorkBarge day	DAY	2.0000	4,194.51	0.00	629.18	482.37	530.61	0.00	87.55	7,940.10
USR 2 man Dive Crew (7M) per day	DAY	2.0000	18,710.67	0.00	2,806.60	2,151.73	2,366.90	0.00	390.54	35,418.82
Fabricated Guides for Pier nose	***EA***	***3.0000***	***66,681.54***	***1,455.30***	***9,335.42***	***4,561.02***	***6,446.24***	***1,026.98***	***1,320.77***	***89,371.96***
USR Fabrication PN Bracket FOB Site (stl Matl seperate)	EA	3.0000	44,436.24	0.00	6,221.07	3,039.44	4,295.74	684.37	880.15	59,557.02
USR Fabricated Steel Raw Matl cost	LB	27,000.0000	22,245.30	1,455.30	3,114.34	1,521.58	2,150.50	342.60	440.61	29,814.94
Drill Grout Install Pier Nose Brackets	***EA***	***1.0000***	***281,314.75***	***431.15***	***42,197.21***	***32,351.20***	***35,586.32***	***0.00***	***5,871.74***	***532,521.81***
USR Drill anchor bolts with bracket as template	EA	54.0000	183,682.72	15.35	27,552.41	21,123.51	23,235.86	0.00	3,833.92	347,706.82
USR Grout & anchor dwl above water	EA	36.0000	8,956.02	277.20	1,343.40	1,029.94	1,132.94	0.00	186.93	16,953.52
USR Grout & install 1"dia x 30" anchor dowel underwater	EA	18.0000	88,676.01	138.60	13,301.40	10,197.74	11,217.51	0.00	1,850.89	167,861.47

Description	UOM	Quantity	DirectCost	TaxAdj	JOOH	HOOH	Profit	Bond	Excise	ContractCost
Install bracket onto pier nose	***EA***	***1.0000***	***35,121.77***	***0.00***	***5,268.26***	***4,039.00***	***4,442.90***	***0.00***	***733.08***	***66,484.63***
USR 2 man Dive Crew (7M) per day	DAY	3.0000	28,066.00	0.00	4,209.90	3,227.59	3,550.35	0.00	585.81	53,128.24
USR WorkBarge day	DAY	3.0000	6,291.76	0.00	943.76	723.55	795.91	0.00	131.32	11,910.14
USR Crane Barge day	EA	3.0000	764.01	0.00	114.60	87.86	96.65	0.00	15.95	1,446.25
VSD Bulkheads	***EA***	***4.0000***	***401,795.25***	***7,746.20***	***56,653.97***	***29,359.08***	***40,043.33***	***5,568.03***	***8,001.29***	***560,771.71***
Pier Nose VSD	***EA***	***2.0000***	***193,204.16***	***3,880.80***	***27,048.58***	***13,215.16***	***18,677.43***	***2,975.58***	***3,826.81***	***258,947.74***
USR Fabricated Pier Nose Bulkhead VSD FOB site	EA	2.0000	193,204.16	3,880.80	27,048.58	13,215.16	18,677.43	2,975.58	3,826.81	258,947.74
Stoplog Slot VSD	***EA***	***2.0000***	***168,327.56***	***3,557.40***	***23,565.86***	***11,513.61***	***16,272.56***	***2,592.45***	***3,334.08***	***225,606.12***
USR Fabricated StopLog slotBulkhead VSD FOB site	EA	2.0000	168,327.56	3,557.40	23,565.86	11,513.61	16,272.56	2,592.45	3,334.08	225,606.12
Install Dogging Ledge at StopLog Slot	***EA***	***4.0000***	***40,263.53***	***308.00***	***6,039.53***	***4,630.31***	***5,093.34***	***0.00***	***840.40***	***76,217.86***
USR WorkBarge day	DAY	4.0000	8,827.06	0.00	1,324.06	1,015.11	1,116.62	0.00	184.24	16,709.40
USR Grout & anchor dwl	EA	40.0000	10,224.91	308.00	1,533.74	1,175.86	1,293.45	0.00	213.42	19,355.50
USR Crane Barge day	EA	4.0000	1,033.96	0.00	155.09	118.91	130.80	0.00	21.58	1,957.26
USR Misc $1000	EA	20.0000	20,000.00	0.00	3,000.00	2,300.00	2,530.00	0.00	417.45	37,859.50
USR Paint 4 coat	SF	40.0000	177.60	0.00	26.64	20.42	22.47	0.00	3.71	336.19
Craftman hours Optional	***EA***	***100.0000***	***4,305.50***	***0.00***	***602.77***	***294.50***	***416.22***	***66.31***	***85.28***	***5,770.58***
USR Misc Craftsman	HR	100.0000	4,305.50	0.00	602.77	294.50	416.22	66.31	85.28	5,770.58

Description	Quantity	UOM	Contractor	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	Overtime	TaxAdj	Payroll	WCI	DirectCost	C/O
Project Direct Detailed Costs Report				***245,746***	***106,977***	***147,242***	***403,247***	***14,749***	***9,633***	***20,132***	***18,469***	***903,212***	
				11,352.76	*4,429.63*	*0.00*	*52,400.00*	*650.12*				*68,182.39*	
Mob Demob	***1.00***	***EA***	***Prime General Contractor***	***11,353***	***4,430***	***0***	***52,400***	***650***	***0***	***874***	***1,190***	***68,182***	
				4,871.47	*2,083.86*	*0.00*	*2,400.00*	*305.21*				*9,355.33*	
Mob divers	***1.00***	***EA***	***Dive Company***	***4,871***	***2,084***	***0***	***2,400***	***305***	***0***	***406***	***350***	***9,355***	
(Note: 1/2 day to mob, 1/2 day to demob)													
				4,871.47	*2,083.86*	*0.00*	*2,400.00*	*10.00*	*0.00*	*12.06*	*11.41*	*9,355.33*	
USR 2 man Dive Crew (7M) per day	1.00	DAY	Dive Company	4,871	2,084	0	2,400	305	0	406	350	9,355	N
(Note: 1/2 day to mob 1/2 day demob)													
				6,481.29	*2,345.77*	*0.00*	*0.00*	*344.91*				*8,827.06*	
Mob work barge	***1.00***	***EA***	***Marine Sub Company***	***6,481***	***2,346***	***0***	***0***	***345***	***0***	***467***	***840***	***8,827***	
				1,620.32	*586.44*	*0.00*	*0.00*	*10.00*	*0.00*	*12.06*	*23.85*	*2,206.77*	
USR WorkBarge day	4.00	DAY	Marine Sub Company	6,481	2,346	0	0	345	0	467	840	8,827	N
(Note: 2 days to mob & 2 day demob (mostly by truck))													
				0.00	*0.00*	*0.00*	*50,000.00*	*0.00*				*50,000.00*	
Reg Mob Demob	***1.00***	***EA***	***Prime General Contractor***	***0***	***0***	***0***	***50,000***	***0***	***0***	***0***	***0***	***50,000***	
USR Mob Demob common	1.00	LS	Prime General Contractor	0	0	0	50,000	0	0	0	0	50,000	Sb
				73,108.34	*32,643.82*	*9,611.90*	*27,612.08*	*4,512.62*				*142,976.13*	

Description	Quantity	UOM	Contractor	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	Overtime	TaxAdj	Payroll	WCI	DirectCost	C/O
VSD Guides	***3.00***	***EA***	***Prime General Contractor***	***219,325***	***97,931***	***28,836***	***82,836***	***13,538***	***1,886***	***18,157***	***15,623***	***428,928***	
				12,764.56	*5,340.61*	*0.00*	*4,800.00*	*782.87*				*22,905.17*	
Demo Existing Test Equipment	***1.00***	***EA***	***Dive Company***	***12,765***	***5,341***	***0***	***4,800***	***783***	***0***	***1,046***	***900***	***22,905***	
				4,871.47	*2,083.86*	*0.00*	*2,400.00*	*10.00*	*0.00*	*12.06*	*11.41*	*9,355.33*	
USR 2 man Dive Crew (7M) per day	2.00	DAY	Dive Company	9,743	4,168	0	4,800	610	0	813	699	18,711	N
				1,510.81	*586.44*	*0.00*	*0.00*	*10.00*	*0.00*	*12.06*	*11.41*	*2,097.25*	
USR WorkBarge day	2.00	DAY	Dive Company	3,022	1,173	0	0	172	0	234	201	4,195	N
				12,764.56	*5,340.61*	*0.00*	*4,800.00*	*782.87*				*22,905.17*	
Field Verify Pier Dimensions	***1.00***	***EA***	***Dive Company***	***12,765***	***5,341***	***0***	***4,800***	***783***	***0***	***1,046***	***900***	***22,905***	
				1,510.81	*586.44*	*0.00*	*0.00*	*10.00*	*0.00*	*12.06*	*11.41*	*2,097.25*	
USR WorkBarge day	2.00	DAY	Dive Company	3,022	1,173	0	0	172	0	234	201	4,195	N
				4,871.47	*2,083.86*	*0.00*	*2,400.00*	*10.00*	*0.00*	*12.06*	*11.41*	*9,355.33*	
USR 2 man Dive Crew (7M) per day	2.00	DAY	Dive Company	9,743	4,168	0	4,800	610	0	813	699	18,711	N
				0.00	*0.00*	*7,415.10*	*14,812.08*	*0.00*				*22,227.18*	
Fabricated Guides for Pier nose	***3.00***	***EA***	***Prime General Contractor***	***0***	***0***	***22,245***	***44,436***	***0***	***1,455***	***0***	***0***	***66,682***	
				0.00	*0.00*	*0.00*	*14,812.08*	*10.00*	*0.00*	*0.00*	*0.00*	*14,812.08*	
USR Fabrication PN Bracket FOB Site (stl Matl seperate)	3.00	EA	Prime General Contractor	0	0	0	44,436	0	0	0	0	44,436	N
(Note: shop fab time 162 hrs plus $300 delivery Steel cost seperate)													
				0.00	*0.00*	*0.82*	*0.00*	*10.00*	*1,455.30*	*0.00*	*0.00*	*0.82*	

Description	***Quantity***	***UOM***	***Contractor***	***DirectLabor***	***DirectEQ***	***DirectMatl***	***DirectSubBid***	***Overtime***	***TaxAdj***	***Payroll***	***WCI***	***DirectCost***	***C/O***
USR Fabricated Steel Raw Matl cost	27,000.00	LB	Prime General Contractor	0	0	22,245	0	0	1,455	0	0	22,245	N
(Note: Bracket for each Pier Nose is 8710# round up to up to 9000# each for 3)													
				174,487.87	*78,636.50*	*6,590.39*	*21,600.00*	*10,797.48*				*281,314.75*	
Drill Grout Install Pier Nose Brackets	***1.00***	***EA***	***Dive Company***	***174,488***	***78,636***	***6,590***	***21,600***	***10,797***	***431***	***14,483***	***12,462***	***281,315***	
				2,324.92	*1,072.27*	*4.34*	*0.00*	*10.00*	*15.35*	*12.06*	*11.41*	*3,401.53*	
USR Drill anchor bolts with bracket as template	54.00	EA	Dive Company	125,546	57,903	235	0	7,760	15	10,433	8,976	183,683	N
(Note: 6 per spot bracket * 3 on each guide/PN * 3 Pier Noses)													
				94.43	*36.65*	*117.70*	*0.00*	*10.00*	*277.20*	*12.06*	*11.41*	*248.78*	
USR Grout & anchor dwl above water	36.00	EA	Dive Company	3,399	1,319	4,237	0	194	277	263	226	8,956	N
(Note: 30 min to grout & install, Dwl at 40 lbs @ 1.5$/# =$60 plus $50grout = $110 6 ea x 2 ea PN x 3 PN)													
				2,530.16	*1,078.58*	*117.70*	*1,200.00*	*10.00*	*138.60*	*12.06*	*11.41*	*4,926.44*	
USR Grout & install 1"dia x 30" anchor dowel underwater	18.00	EA	Dive Company	45,543	19,414	2,119	21,600	2,844	139	3,788	3,259	88,676	N
(Note: 6 ea PN x 3 PNs)													
				19,308.01	*8,613.75*	*0.00*	*7,200.00*	*1,174.64*				*35,121.77*	
Install bracket onto pier nose	***1.00***	***EA***	***Dive Company***	***19,308***	***8,614***	***0***	***7,200***	***1,175***	***0***	***1,582***	***1,361***	***35,122***	
(Note: Assume 1 day to position, grount pad and bolt.)													
				4,871.47	*2,083.86*	*0.00*	*2,400.00*	*10.00*	*0.00*	*12.06*	*11.41*	*9,355.33*	
USR 2 man Dive Crew (7M) per day	3.00	DAY	Dive Company	14,614	6,252	0	7,200	916	0	1,219	1,049	28,066	N
				1,510.81	*586.44*	*0.00*	*0.00*	*10.00*	*0.00*	*12.06*	*11.41*	*2,097.25*	

Description	Quantity	UOM	Contractor	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	Overtime	TaxAdj	Payroll	WCI	DirectCost	C/O
USR WorkBarge day	3.00	DAY	Dive Company	4,532	1,759	0	0	259	0	350	301	6,292	N
				53.72	*200.95*	*0.00*	*0.00*	*10.00*	*0.00*	*12.06*	*11.41*	*254.67*	
USR Crane Barge day	3.00	EA	Dive Company	161	603	0	0	0	0	12	11	764	N
				2,690.57	*1,153.92*	*29,601.55*	*67,002.78*	*140.23*				*100,448.81*	
VSD Bulkheads	***4.00***	***EA***	***Prime General Contractor***	***10,762***	***4,616***	***118,406***	***268,011***	***561***	***7,746***	***776***	***1,394***	***401,795***	
				0.00	*0.00*	*29,660.40*	*66,941.68*	*0.00*				*96,602.08*	
Pier Nose VSD	***2.00***	***EA***	***Prime General Contractor***	***0***	***0***	***59,321***	***133,883***	***0***	***3,881***	***0***	***0***	***193,204***	
				0.00	*0.00*	*29,660.40*	*66,941.68*	*10.00*	*3,880.80*	*0.00*	*0.00*	*96,602.08*	
USR Fabricated Pier Nose Bulkhead VSD FOB site	2.00	EA	Prime General Contractor	0	0	59,321	133,883	0	3,881	0	0	193,204	N
(Note: Misc $1k for delivery 650 Shop hrs fab, 36,000# steel)													
				0.00	*0.00*	*27,188.70*	*56,975.08*	*0.00*				*84,163.78*	
Stoplog Slot VSD	***2.00***	***EA***	***Prime General Contractor***	***0***	***0***	***54,377***	***113,950***	***0***	***3,557***	***0***	***0***	***168,328***	
				0.00	*0.00*	*27,188.70*	*56,975.08*	*10.00*	*3,557.40*	*0.00*	*0.00*	*84,163.78*	
USR Fabricated StopLog slotBulkhead VSD FOB site	2.00	EA	Prime General Contractor	0	0	54,377	113,950	0	3,557	0	0	168,328	N
(Note: Misc $1k for delivery 555 Shop hrs fab, 39,000# steel)													
				2,690.57	*1,153.92*	*1,177.00*	*5,044.40*	*140.23*				*10,065.88*	

Description	*Quantity*	*UOM*	*Contractor*	*DirectLabor*	*DirectEQ*	*DirectMatl*	*DirectSubBid*	*Overtime*	*TaxAdj*	*Payroll*	*WCI*	*DirectCost*	*C/O*
Install Dogging Ledge at StopLog Slot	***4.00***	***EA***	***Marine Sub Company***	***10,762***	***4,616***	***4,708***	***20,178***	***561***	***308***	***776***	***1,394***	***40,264***	
(Note: 4 locations assume 1 day each for work barge, crane, 10 1" x 30" anchors & $5k materials)													
				1,620.32	*586.44*	*0.00*	*0.00*	*10.00*	*0.00*	*12.06*	*23.85*	*2,206.77*	
USR WorkBarge day	4.00	DAY	Marine Sub Company	6,481	2,346	0	0	345	0	467	840	8,827	N
				101.27	*36.65*	*117.70*	*0.00*	*10.00*	*308.00*	*12.06*	*23.85*	*255.62*	
USR Grout & anchor dwl	40.00	EA	Marine Sub Company	4,051	1,466	4,708	0	216	308	292	525	10,225	N
(Note: 30 min to grout & install, Dwl at 40 lbs @ 1.5$/# =$60 plus $50grout = $110)													
				57.54	*200.95*	*0.00*	*0.00*	*10.00*	*0.00*	*12.06*	*23.85*	*258.49*	
USR Crane Barge day	4.00	EA	Marine Sub Company	230	804	0	0	0	0	16	29	1,034	N
				0.00	*0.00*	*0.00*	*1,000.00*	*10.00*	*0.00*	*0.00*	*0.00*	*1,000.00*	
USR Misc $1000	20.00	EA	Marine Sub Company	0	0	0	20,000	0	0	0	0	20,000	N
				0.00	*0.00*	*0.00*	*4.44*	*10.00*	*0.00*	*0.00*	*0.00*	*4.44*	
USR Paint 4 coat	40.00	SF	Marine Sub Company	0	0	0	178	0	0	0	0	178	N
				43.06	*0.00*	*0.00*	*0.00*	*0.00*				*43.06*	
Craftman hours Optional	***100.00***	***EA***	***Prime General Contractor***	***4,306***	***0***	***0***	***0***	***0***	***0***	***326***	***263***	***4,306***	
				43.06	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*12.06*	*9.72*	*43.06*	
USR Misc Craftsman	100.00	HR	Prime General Contractor	4,306	0	0	0	0	0	326	263	4,306	N

Description	CrewHours	MemberType	MemberRate	ManHours	LaborCost	EQHours	EQCost	CrewCost
Crews (Bare Costs) by Contractor, Report	***364.79***			***3,224.67***	***192,211.22***	***3,729.28***	***107,160.62***	***299,371.84***
Prime General Contractor	***364.79***		***0.00***	***3,224.67***	***192,211.22***	***3,729.28***	***107,160.62***	***299,371.84***
				1.00	*37.17*	*0.00*	*0.00*	*37.17*
USR Craftsman 1M	100.00			100.00	3,717.00	0.00	0.00	3,717.00
MIL X-LABORER Outside Laborers, (Semi-Skilled)		*Journeyman*	*37.17*	*1.00*	*37.17*			
EP M10SM004 BOAT, 23' L-GIANT,TRIHULL, 3400#		*EP / Average*	*0.00*			*0.00*	*0.00*	
				1.00	*43.07*	*8.00*	*203.91*	*246.98*
USR Crane Barge 150T	27.62			27.62	1,189.77	220.99	5,632.81	6,822.58
MIL X-EQOPRHVY Outside Equip. Operators, Heavy		*Journeyman*	*43.07*	*1.00*	*43.07*			
USR M10MZ009 RLR Work Barge 60' x 16' section Med Duty rent		*Non-EP Rental / Average*	*13.10*			*4.00*	*52.40*	
MAP C90LB004 CRANE,MECH,TRK MTD,150T/280'BOOM		*EP / Average*	*132.31*			*1.00*	*132.31*	
NON XMIXX010 MISC. POWER TOOLS		*Non-EP / Average*	*6.40*			*3.00*	*19.20*	
				56.00	*3,809.28*	*56.00*	*2,084.97*	*5,894.25*
USR 2MDiveDay 2 Diver Crew Day	41.55			2,326.55	158,258.27	2,326.55	86,621.10	244,879.37
MIL X-DIVERTED Outside Divers Tenders		*Journeyman*	*45.56*	*24.00*	*1,093.44*			
MIL X-DIVER Outside Divers		*Journeyman*	*83.04*	*24.00*	*1,992.96*			
MIL X-DIVER Outside Divers		*Foreman*	*90.36*	*8.00*	*722.88*			
USR Dive Support Air		*Non-EP / Severe*	*64.90*			*16.00*	*1,038.40*	
USR M10MZ009 RLR Work Barge 60' x 16' section Med Duty rent		*Non-EP Rental / Average*	*13.10*			*16.00*	*209.60*	
USR XMIXX020 SMALL TOOLS		*Non-EP / Severe*	*15.00*			*16.00*	*240.00*	
EP M10SM004 BOAT, 23' L-GIANT,TRIHULL, 3400#		*EP / Average*	*74.62*			*8.00*	*596.97*	
				4.00	*150.68*	*6.00*	*73.53*	*224.21*
USR Wbarg4M Work Barge	107.62			430.50	16,216.78	645.74	7,914.13	24,130.91
MIL X-LABORER Outside Laborers, (Semi-Skilled)		*Foreman*	*39.17*	*1.00*	*39.17*			
MIL X-LABORER Outside Laborers, (Semi-Skilled)		*Journeyman*	*37.17*	*3.00*	*111.51*			
EP G10WC002 GENERATOR, 5.6 KW, 120/240V,PORT		*EP / Average*	*3.36*			*1.00*	*3.36*	
EP M10SM006 BOAT, 20' R-RUNNER,V-HULL, 1650#		*EP / Average*	*34.03*			*1.00*	*34.03*	
USR Misc Work Barge Equipment		*Non-EP Rental / Average*	*1.50*			*1.00*	*1.50*	
EP M10XX013 MARINE EQUIPMENT, BOATS & LAUNCHES, 22 FT, SHALLOW DRAFT, INLAND TUG		*EP / Average*	*22.51*			*1.00*	*22.51*	
USR XMIXX01r MISC. POWER TOOLS		*Non-EP / Average*	*6.40*			*1.00*	*6.40*	
NON XX0XX770 WORK BARGE, FD,TRUCKABLE W/SPUDS APPROX. 30'x 27'x 7',WOOD DECK		*Non-EP / Average*	*5.73*			*1.00*	*5.73*	

Description	CrewHours	MemberType	MemberRate	ManHours	LaborCost	EQHours	EQCost	CrewCost
				1.00	*43.07*	*8.00*	*203.91*	*246.98*
USR Crane Barge 150T	4.00			4.00	172.28	32.00	815.64	987.92
MIL X-EQOPRHVY Outside Equip. Operators, Heavy		*Journeyman*	*43.07*	*1.00*	*43.07*			
USR M10MZ009 RLR Work Barge 60' x 16' section Med Duty rent		*Non-EP Rental / Average*	*13.10*			*4.00*	*52.40*	
MAP C90LB004 CRANE,MECH,TRK MTD,150T/280'BOOM		*EP / Average*	*132.31*			*1.00*	*132.31*	
NON XMIXX010 MISC. POWER TOOLS		*Non-EP / Average*	*6.40*			*3.00*	*19.20*	
				4.00	*150.68*	*6.00*	*73.53*	*224.21*
USR Wbarg4M Work Barge	84.00			336.00	12,657.12	504.00	6,176.94	18,834.06
MIL X-LABORER Outside Laborers, (Semi-Skilled)		*Foreman*	*39.17*	*1.00*	*39.17*			
MIL X-LABORER Outside Laborers, (Semi-Skilled)		*Journeyman*	*37.17*	*3.00*	*111.51*			
EP G10WC002 GENERATOR, 5.6 KW, 120/240V,PORT		*EP / Average*	*3.36*			*1.00*	*3.36*	
EP M10SM006 BOAT, 20' R-RUNNER,V-HULL, 1650#		*EP / Average*	*34.03*			*1.00*	*34.03*	
USR Misc Work Barge Equipment		*Non-EP Rental / Average*	*1.50*			*1.00*	*1.50*	
EP M10XX013 MARINE EQUIPMENT, BOATS & LAUNCHES, 22 FT, SHALLOW DRAFT, INLAND TUG		*EP / Average*	*22.51*			*1.00*	*22.51*	
USR XMIXX01r MISC. POWER TOOLS		*Non-EP / Average*	*6.40*			*1.00*	*6.40*	
NON XX0XX770 WORK BARGE, FD,TRUCKABLE W/SPUDS APPROX. 30'x 27'x 7',WOOD DECK		*Non-EP / Average*	*5.73*			*1.00*	*5.73*	

Description	SUIExperience	SUIRate	FICA	FUIRate	PayrollTax	State	ContractorCla	WCIBaseRate	WCIExperience	WCIRate	LSHFactor
Contractors Labor Payroll Markup Report											
Prime General Contractor	***80.00***	***3.61***	***7.65***	***0.80***	***12.06***	***WA***	***Concrete Work -- NOC***	***8.17***	***85.00***	***9.72***	***140.00***
Dive Company	***80.00***	***3.61***	***7.65***	***0.80***	***12.06***	***WA***	***Wrecking***	***9.59***	***85.00***	***11.41***	***140.00***
Marine Sub Company	***80.00***	***3.61***	***7.65***	***0.80***	***12.06***	***WA***	***Pile Driving***	***20.04***	***85.00***	***23.85***	***140.00***

Description	LaborType	ManHours	BaseWage	Travel	TaxableFringe	NonTaxFringe	Subsistence	Payroll	WCI	Overtime	Total
Labor by Contractor, Report											
			69.76	*0.00*	*0.00*	*11.28*	*2.00*				*109.15*
MIL X-DIVER Outside Divers	Journeyman	997	69,557	0	0	11,247	1,994	11,136	7,938	6,956	108,828
			77.08	*0.00*	*0.00*	*11.28*	*2.00*				*119.21*
MIL X-DIVER Outside Divers	Foreman	332	25,619	0	0	3,749	665	4,102	2,924	2,562	39,620
			32.18	*0.00*	*0.00*	*11.38*	*2.00*				*57.60*
MIL X-DIVERTED Outside Divers Tenders	Journeyman	997	32,086	0	0	11,347	1,994	5,137	3,662	3,209	57,435
			30.07	*0.65*	*0.00*	*10.35*	*2.00*				*54.05*
MIL X-EQOPRHVY Outside Equip. Operators, Heavy	Journeyman	32	951	21	0	327	63	138	126	97	1,723
			26.37	*0.65*	*0.00*	*8.15*	*2.00*				*47.41*
MIL X-LABORER Outside Laborers, (Semi-Skilled)	Journeyman	675	17,796	439	0	5,500	1,350	2,760	2,882	1,553	32,280
			28.37	*0.65*	*0.00*	*8.15*	*2.00*				*50.16*
MIL X-LABORER Outside Laborers, (Semi-Skilled)	Foreman	192	5,436	125	0	1,562	383	871	938	556	9,871

Description	*ConditionType*	*Manufacturer*	*Model*	*CostType*	*EQHours*	*Total*
Equipment by Contractor, Report					***3,729***	***105,701***
						3.36
EP G10WC002 GENERATOR, 5.6 KW, 120/240V,PORT	Average	WC WACKER CORPORATION	G 5.6A	EP	192	643
						74.48
EP M10SM004 BOAT, 23' L-GIANT,TRIHULL, 3400#	Average	SM SEAARK MARINE	23'	EP	332	24,755
						33.97
EP M10SM006 BOAT, 20' R-RUNNER,V-HULL, 1650#	Average	SM SEAARK MARINE	20'	EP	192	6,510
						22.34
EP M10XX013 MARINE EQUIPMENT, BOATS & LAUNCHES, 22 FT, SHALLOW DRAFT, INLAND TUG	Average	XX NO SPECIFIC MANUFACTURER	115	EP	192	4,282
						129.35
MAP C90LB004 CRANE,MECH,TRK MTD,150T/280'BOOM	Average	LB LINK BELT CONSTRUCTION COMPANY	HC-238H	EP	32	4,090
						6.25
NON XMIXX010 MISC. POWER TOOLS	Average	XX NO SPECIFIC MANUFACTURER	MISC. EQUIPMENT	Non-EP	95	593
						5.61
NON XX0XX770 WORK BARGE, FD,TRUCKABLE W/SPUDS APPROX. 30'x 27'x 7',WOOD DECK	Average	ZZ GENERIC EQUIPMENT	MISC. EQUIPMENT	Non-EP	192	1,076
						64.28
USR Dive Support Air	Severe	XX NO SPECIFIC MANUFACTURER		Non-EP	665	42,729
						1.50
USR Misc Work Barge Equipment	Average	XX NO SPECIFIC MANUFACTURER		Non-EP Rental	192	287
						13.10
USR M10MZ009 RLR Work Barge 60' x 16' section Med Duty rent	Average	XX NO SPECIFIC MANUFACTURER		Non-EP Rental	791	10,365
						6.25
USR XMIXX01r MISC. POWER TOOLS	Average	XX NO SPECIFIC MANUFACTURER	MISC. EQUIPMENT	Non-EP	192	1,197

Description	*ConditionType*	*Manufacturer*	*Model*	*CostType*	*EQHours*	*Total*
						13.80
USR XMIXX020 SMALL TOOLS	Severe	XX NO SPECIFIC MANUFACTURER	MISC. EQUIPMENT	Non-EP	665	9,173

Description	UOM	Link	Output	Duration	CrewHours	ManHours	LaborCost	EQHours	EQCost	MatlCost	SubBidCost	TotalCost
Assembly (Bare Costs) by Contractor, Report			***5.20***	***1,206.96***	***2.37***	***57.73***	***3,799.82***	***62.84***	***2,153.48***	***53,244.06***	***139,928.84***	***199,126.20***
Prime General Contractor			***5.20***	***1,206.96***	***2.37***	***57.73***	***3,799.82***	***62.84***	***2,153.48***	***53,244.06***	***139,928.84***	***199,126.20***
							0.00		*0.00*	*0.00*	*4,937.36*	*4,937.36*
USR Fabricated PN Bracket FOB Site (stl Matl seperate)	EA		1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	14,812.08	14,812.08
(Note: shop fab time 162 hrs plus $300 delivery Steel cost seperate)												
USR Paint 4 coat		*Q*266*2*		*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*2,362.08*	*2,362.08*
USR Misc $1000		*Q*.3*		*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*300.00*	*300.00*
USR Stl Fab Shop time		*Q*162*		*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*12,150.00*	*12,150.00*
							0.00		*0.00*	*13,860.00*	*33,470.84*	*47,330.84*
USR Fabricated Pier Nose Bulkhead VSD FOB site	EA		0.00	650.00	0.00	0.00	0.00	0.00	0.00	27,720.00	66,941.68	94,661.68
(Note: Misc $1k for delivery 650 Shop hrs fab, 36,000# steel)												
USR Paint 4 coat		*Q*1936*2*		*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*17,191.68*	*17,191.68*
USR Misc $1000		*Q*		*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*1,000.00*	*1,000.00*
USR Fabricated Steel Raw Matl cost		*Q*36000*		*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*27,720.00*	*0.00*	*27,720.00*
USR Stl Fab Shop time		*Q*650*		*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*48,750.00*	*48,750.00*
							0.00		*0.00*	*12,705.00*	*28,487.54*	*41,192.54*
USR Fabricated StopLog slotBulkhead VSD FOB site	EA		0.00	555.00	0.00	0.00	0.00	0.00	0.00	25,410.00	56,975.08	82,385.08
(Note: Misc $1k for delivery 555 Shop hrs fab, 39,000# steel)												
USR Paint 4 coat		*Q*1616*2*		*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*14,350.08*	*14,350.08*
USR Misc $1000		*Q*		*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*1,000.00*	*1,000.00*
USR Fabricated Steel Raw Matl cost		*Q*33000*		*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*25,410.00*	*0.00*	*25,410.00*
USR Stl Fab Shop time		*Q*555*		*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*41,625.00*	*41,625.00*
Dive Company			***4.19***	***0.96***	***2.37***	***57.73***	***3,799.82***	***62.84***	***2,153.48***	***114.06***	***1,200.00***	***7,267.36***
							33.70		*19.89*	*0.08*	*0.00*	*53.67*
USR Drill anchor bolts with bracket as template	EA		2.19	0.46	1.37	27.73	1,819.84	31.84	1,074.23	4.06	0.00	2,898.13

Description	UOM	Link	Output	Duration	CrewHours	ManHours	LaborCost	EQHours	EQCost	MatlCost	SubBidCost	TotalCost
USR Drill for dowels 2" Diam x 24" Marine		*Q*		*0.45*	*0.45*	*25.45*	*1,731.49*	*25.45*	*947.71*	*4.06*	*0.00*	*2,683.27*
USR Crane Barge 150T		*d*			*0.46*	*0.46*	*19.64*	*3.65*	*92.98*			*112.62*
USR Wbarg4M Work Barge		*d*			*0.46*	*1.82*	*68.71*	*2.74*	*33.53*			*102.24*
							110.00		*59.96*	*6.11*	*66.67*	*242.74*
USR Grout & install 1"dia x 30" anchor dowel underwater	EA		2.00	0.50	1.00	30.00	1,979.98	31.00	1,079.25	110.00	1,200.00	4,369.23
USR 2 man Dive Crew (7M) per day		*d*		*0.50*	*0.50*	*28.00*	*1,904.64*	*28.00*	*1,042.49*	*0.00*	*1,200.00*	*4,147.13*
USR Grout & anchor dwl||Note||(Note: 30 min to grout & install, Dwl at 40 lbs @ 1.5$/# =$60 plus $50grout = $110)		*Q*		*0.50*	*0.50*	*2.00*	*75.34*	*3.00*	*36.77*	*110.00*	*0.00*	*222.11*

Designed by
Portland District
Estimated by
Portland District EC-RC
Prepared by
Rick Russell

Design Document	Letter Report
Document Date	8/28/2006
District	Portland
Contact	Rick Russell
Budget Year	2007
UOM System	Original

Direct Costs

LaborCost
EQCost
MatlCost
SubBidCost

Timeline/Currency

Preparation Date	8/28/2006
Escalation Date	8/28/2006
Eff. Pricing Date	8/28/2006
Estimated Duration	150 Day(s)
Currency	US dollars
Exchange Rate	1.000000

Costbook CB04aEB: MII English Cost Book 2004b Final

Labor LB04NatFD: Labor National 2004
Note: http://www.wdol.gov/

Labor Rates

LaborCost1
LaborCost2
LaborCost3
LaborCost4

Equipment EP05R083: MII Equipment Region 8 2005 fuel 3.10

08 NORTHWEST

Sales Tax	4.80
Working Hours per Year	1,540
Labor Adjustment Factor	1.08
Cost of Money	4.25
Cost of Money Discount	25.00
Tire Recap Cost Factor	1.50
Tire Recap Wear Factor	1.80
Tire Repair Factor	0.15

Fuel

Electricity	0.059
Gas	3.100
Diesel Off-Road	3.000
Diesel On-Road	3.450

Shipping Rates

Over 0 CWT	2.08
Over 240 CWT	2.18
Over 300 CWT	2.91
Over 400 CWT	6.59
Over 500 CWT	7.16
Over 700 CWT	5.35
Over 800 CWT	4.68

Equipment Cost Factor	1.00
Standby Depreciation Factor	0.50