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**CONSTRUCTION OF A SMOOTHED
PARTICLE HYDRODYNAMIC MODEL FOR
FLOW OVER AN OGEE SPILLWAY
COMPARISON TO DETERMINE VIABILITY
IN MODELING FLOODING SCENARIOS**

by

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To the Graduate Faculty:

The members of the committee appointed to examine the thesis of Emerald Ryan find it satisfactory and recommend that it be accepted.

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To my mother, Debra Ryan, for supporting me through it all

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Vita

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List of Abbreviations

CFD	Computational Fluid Dynamics
CFEL	Component Flooding Evaluation Laboratory
CPU	Central Processing Unit
FOM	Figure of Merit
GPU	Graphics Processing Unit
IISPH	Implicit Incompressible Smoothed Particle Hydrodynamics
ISU	Idaho State University
LPSPH	Local-Poisson Smoothed Particle Hydrodynamics
MPS	Moving Particle Semi-Implicit
NPP	Nuclear Power Plant
PCISPH	Predictive-Corrective Incompressible Smoothed Particle Hydrodynamics
SPH	Smoothed Particle Hydrodynamics
WCSPH	Weakly Compressible Smoothed Particle Hydrodynamics
XML	Extensible Markup Language

Abstract

The goal was to construct a Smoothed Particle Hydrodynamic (SPH) model and compare the results to physical model results. The construction of the SPH model was performed using the developmental code Neutrino. The 1:30 scale physical model used for comparison was flow over an ogee spillway with the physical model results compared being total head vs. flow rate. Since Neutrino is a developmental code, many setups for the model were attempted to resolve issues of the code. Once a first revision model was constructed, parametric studies of the model width and particle size were performed. However, more issues were found with the model and Neutrino while running simulations. After adjusting parameters to improve the model, the final SPH results provided relative percent errors under 10%. The results also determined that more work needs to be done to determine an efficient and realistic way of creating an SPH model in Neutrino.

Introduction

Flooding is a concern in almost any location. Flooding can occur due to heavy rainfall, snow melt, river flooding, dam break, as well as many other causes. Therefore, flooding scenarios need to be simulated to allow predetermination of actions to be taken to minimize flooding damage.

Smoothed Particle Hydrodynamics (SPH) is a particle based method that simulates fluid flow. Since it is a particle based method, it does not require a mesh to be applied to the fluid which allows for more natural flow to be simulated by not constraining the fluid. Since SPH can simulate natural flow, it can be used to simulate flooding scenarios.

In order for flooding scenarios to be modeled realistically, SPH codes need to be compared to physical results to validate the accuracy of the code. Therefore, two items are needed to execute a comparison between physical results and an SPH model: a physical experiment with results and an SPH code. The physical experiment that is used is flow over an ogee spillway and the SPH code used is the developmental code Neutrino.

The purpose of this thesis is to explain what SPH is and how it works, describe the flow over an ogee spillway experiment, describe the complications and creation of the Neutrino model, compare the SPH results to the physical results, and discuss improvements and future work.

Nuclear Power Plant Risk Analysis

Nuclear Power Plants (NPPs) are required to operate with minimal risk to the public's health and safety [1]. In order to categorize the risk of an initiating event, the consequence and the frequency of the event are used. However, one issue with risk analysis is the lack of data. While some information is known, such as how long a component can operate until it fails, other information is not, such as how long a component can operate while wet until it fails. Therefore, more information needs to be gained so that NPP risk analysis can be more realistic.

One initiating event that needs more research is flooding events. Flooding is a concern for NPPs and it can cause extensive damage. The most widely known example of a devastating flood event is the Fukushima Daiichi accident that happened in March 2011. The accident was caused by a 15 m tsunami that was a result of an earthquake. The flooding from the tsunami ended up disabling 12 of the 13 backup generators as well as the ability to remove heat from the reactors [2]. As of now, work is still being done to cleanup from the accident.

Besides the Fukushima accident, there are many other flooding events that have occurred. For example, on October 17, 1980, nearly 100,000 gallons of water had collected in the containment building covering the lower 9 feet of the pressure vessel at Indian Point Unit 2 due to leakage from the system supplying water to the air conditioners [3]. This increased the thermal stresses on the pressure vessel which resulted in an increased chance of it rupturing. Another example is at Calvert Cliffs where a winter storm dislodged a ventilation cover which allowed snow to enter into an electrical cabinet [3]. As the snow melted, the water caused a short in the electrical cabinet causing both reactors to shut down.

Since flooding is a concern and a reality in NPP, more research needs to be done to better characterize the risk. There are two actions that can be done to better understand the risk of flooding events. One action is to get flooding failure data for components and the other action is to determine a way to simulate flooding events.

The action of obtaining flooding failure data for components is being done at Idaho State University (ISU). ISU is in the process of developing the Component Flooding Evaluation Laboratory (CFEL). At CFEL, components will be flooded using different scenarios, rising water, spraying water, and eventually wave impact, to obtain data about when and how the component will fail. At this time, experiments have already been done on small scale items, such as battery powered radios, and on full scale doors. The data obtained from CFEL will be crucial for the second action.

The second action is to determine a way of simulating flooding events. SPH is a method for modeling fluid flow and is the main method being researched for flooding events. The goal is to be able to either incorporate the flooding failure data obtained from CFEL into an SPH code or to couple an SPH code with a risk assessment code that has the flooding failure data. By incorporating SPH and flooding failure data, it would allow for flooding simulations at NPPs to be modeled before a flooding event occurs. This would allow the NPP to determine what damage would be done if the simulated flooding event was to occur. Additionally, it would also help determine if certain actions need to be taken that would reduce the damage of the flooding event. For example, if a 15 m tsunami at the Fukushima Daiichi plant could have been simulated, the simulation might have showed that the backup generators were going to get wet and possibly fail. Therefore, the plant

could take the action of moving the backup generators which might have resulted in a less devastating accident.

While others at ISU are working on conducting the experiments to obtain the flooding failure data, this thesis focuses on determining the viability of SPH for simulating flooding events. However, both actions are crucial in order to better characterize the risk of flooding events for NPPs.

Smoothed Particle Hydrodynamics

Smoothed Particle Hydrodynamics is a particle based method for obtaining approximate numerical solutions to the equations of fluid dynamics. SPH was originally developed for astrophysics applications in 1977 by Gingold & Monaghan and Lucy [4]. The method was then extended to be used in fluid dynamics. In 1992, Monaghan wrote another paper that outlined the SPH method as well as stated the two golden rules of SPH. The two golden rules for SPH, according to Monaghan, are [5]:

1. If you want to find a physical interpretation, then it is always best to assume the kernel is Gaussian.
2. Rewrite formulas with density inside the operators.

These golden rules of SPH are used and discussed in the following sections.

Besides SPH, there is another method for numerically solving the equations of fluid dynamics which is Computational Fluid Dynamics (CFD). Since there are multiple methods, the differences and advantages/disadvantages of each method should be known.

CFD vs. SPH

CFD and SPH are both methods to numerically model fluid flow. Both of these are implemented from the Navier-Stokes equation [6]. The discretized Navier-Stokes equation, in fluid mechanics, represents a Eulerian approach for solving and analyzing fluid flow. However, the Navier-Stokes equation can be simplified in order to use a Lagrangian approach. The difference between Eulerian and Lagrangian methods provides the difference between CFD and SPH.

CFD uses the Eulerian, grid-based, method in order to analyze fluid flow. Eulerian method is the basis for most theory in fluid mechanics [7]. The Eulerian method means that the fluid is composed of fluid cells aligned in a grid which contain a number of fluid particles [6]. Figure 1 shows an image of the Eulerian structure in fluid flow.

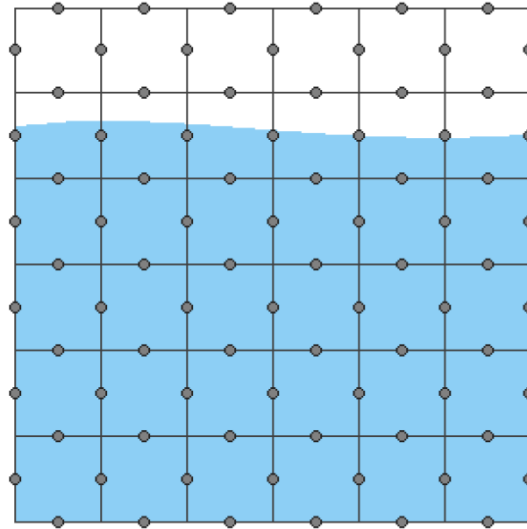


Figure 1: Eulerian structure for fluid flow [6]

CFD has both advantages and disadvantages. An advantage of CFD is that it provides a better description of mass-density and pressure [6]. Another advantage is that it provides steady state solutions quicker than the SPH, Lagrangian, method. This was validated by comparing the Eulerian and Lagrangian methods to model airflow fields [8]. However, the Lagrangian method is more capable to simulate unsteady state conditions than the Eulerian method [8]. Some of the disadvantages with CFD are that it makes it hard to simulate natural flow since the grid constrains the fluid, it can take a lot of memory depending on the grid size and resolution, and it generally cannot produce interactive results [6]. An interactive grid can help fix the disadvantage of simulating natural flow, but it is not perfect.

SPH uses the Lagrangian, particle-based, method in order to analyze fluid flow. Lagrangian method is the most efficient way to sample fluid flow since physical conservation laws are Lagrangian [7]. The Lagrangian method means that the fluid particles can be placed arbitrarily and not in a required grid [6]. Figure 2 shows an image of the Lagrangian structure for fluid flow.

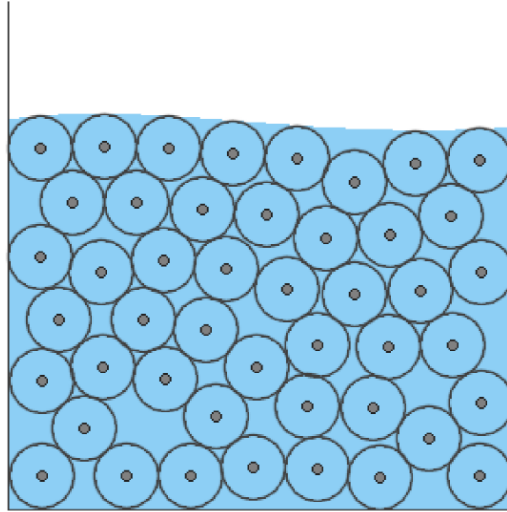


Figure 2: Lagrangian structure for fluid flow [6]

SPH has both advantages and disadvantages. An advantage of SPH is that it can handle free surface boundaries which is difficult for Eulerian methods to handle [9]. Another advantage is that the particles carry specific information, such as mass, position, velocity, as well as other properties and can estimate information like mass-density and pressure [6]. A disadvantage of SPH is that surface rendering is typically inefficient and takes more time to simulate [9]. Another disadvantage is that a specific number of particles are needed in order to provide realistic results [8]. This is due to the fact that SPH is an interpolation method. The interpolation method means that values and derivatives of continuous field quantities are approximated by using discrete sample points [6].

Therefore, in order to get accurate quantities, a specific number of particles have to be simulated in order to provide enough sample points.

CFD and SPH methods are similar in the fact that both are used to analyze fluid flow. However, the applications are slightly different. CFD is typically used in aerodynamic shape design, aerospace applications, automotive applications, biomedical applications, and HVAC analysis [10], [11], [12]. SPH is typically used in astrophysics, fluid mechanics, and solid mechanics [13]. Therefore, CFD is typically used in modeling flow around or through objects where SPH is typically used in modeling fluid motion on its own such as the sloshing of water.

SPH Theory

SPH is a particle based method where the particle's properties are based on the particles around the particle of interest. SPH uses a smoothing kernel and smoothing length to determine how much the particles around the particle of interest affect the properties of the particle of interest. The smoothing kernel and smoothing length is used throughout the equations of motions to determine each particles properties. The details and equations of the method are provided below.

Interpolation Technique

SPH is an interpolation method meaning that the property of one particle will depend on the particles surrounding it. The interpolation technique is based on the interpolation integral, as shown in Equation 1. However, since most properties are not known as a function, the interpolation integral must be rewritten into numerical form which is shown in Equation 2. Additionally, Equation 3 and Equation 4 show the gradient and

Laplacian of the summation interpolant assuming the smoothing kernel is first and second order differentiable [6].

$$A_i(\mathbf{r}) = \int A(\mathbf{r}')W(\mathbf{r} - \mathbf{r}', h)d\mathbf{r}'$$

Equation 1: Interpolation integral

$$A_i(\mathbf{r}) = \sum_j A_j \frac{m_j}{\rho_j} W(\mathbf{r} - \mathbf{r}_j, h)$$

Equation 2: Numerical interpolation

$$\nabla A_i(\mathbf{r}) = \sum_j A_j \frac{m_j}{\rho_j} \nabla W(\mathbf{r} - \mathbf{r}_j, h)$$

Equation 3: Gradient of numerical interpolation

$$\nabla^2 A_i(\mathbf{r}) = \sum_j A_j \frac{m_j}{\rho_j} \nabla^2 W(\mathbf{r} - \mathbf{r}_j, h)$$

Equation 4: Laplacian of numerical interpolation

where A is the property of interest, j is iterated over all particles, W is the smoothing kernel, r is the position of the particle, h is the smoothing length, m is the mass of the particle and ρ is the density of the particle.

The second golden rule can now be applied. It allows for a higher accuracy to be obtained on the gradient [6]. Therefore, the gradient can be rewritten as follows to make use of the second golden rule.

$$\rho_i \nabla A_i = \nabla(\rho_i A_i) - A_i \nabla \rho_i$$

$$\nabla A_i = \frac{1}{\rho_i} (\nabla(\rho_i A_i) - A_i \nabla \rho_i)$$

$$\nabla(\rho_i A_i) = \sum_j \rho_j A_j \frac{m_j}{\rho_j} \nabla W = \sum_j A_j m_j \nabla W \text{ (using Equation 3)}$$

$$A_i \nabla \rho_i = A_i \sum_j \rho_j \frac{m_j}{\rho_j} \nabla W = \sum_j A_i m_j \nabla W \text{ (using Equation 3)}$$

$$\nabla A_i = \frac{1}{\rho_i} \sum_j (A_j - A_i) m_j \nabla W$$

Equation 5: Gradient of numerical interpolation with density inside operators

The higher accuracy for the second golden rule can be checked using error propagation. The general error propagation equation is shown in Equation 6.

$$\sigma_z^2 = \left(\frac{\partial f}{\partial x}\right)^2 \sigma_x^2 + \left(\frac{\partial f}{\partial y}\right)^2 \sigma_y^2 + \dots$$

Equation 6: General error propagation

Using Equation 6 and applying it to Equation 3 and Equation 5, the following variances of the gradients are determined:

$$\begin{aligned} \sigma_{\nabla A_i}^2 = & \left(\sum_j \left(\frac{m_j}{\rho_j} \nabla W \right)^2 \sigma_{A_j}^2 \right) + \left(\sum_j \left(\frac{A_j}{\rho_j} \nabla W \right)^2 \sigma_{m_j}^2 \right) + \left(\sum_j \left(-\frac{A_j m_j}{\rho_j^2} \nabla W \right)^2 \sigma_{\rho_j}^2 \right) \\ & + \left(\sum_j \left(\frac{A_j m_j}{\rho_j} \nabla^2 W \right)^2 \sigma_{\nabla W}^2 \right) \end{aligned}$$

Equation 7: Normal gradient variance

$$\begin{aligned}\sigma_{\nabla A_i}^2 = & \left(-\frac{1}{\rho_i^2} \sum_j ((A_j - A_i)m_j \nabla W))^2 \sigma_{\rho_i}^2 + \left(\frac{1}{\rho_i} \sum_j (m_j \nabla W)\right)^2 \sigma_{A_j}^2 + \left(\frac{1}{\rho_i} \sum_j \right. \\ & \left. - m_j \nabla W)\right)^2 \sigma_{A_i}^2 + \left(\frac{1}{\rho_i} \sum_j ((A_j - A_i) \nabla W)\right)^2 \sigma_{m_j}^2 + \left(\frac{1}{\rho_i} \sum_j ((A_j \right. \\ & \left. - A_i)m_j \nabla^2 W)\right)^2 \sigma_{\nabla W}^2\end{aligned}$$

Equation 8: Second golden rule gradient variance

To show that the variances decrease with the modification of the second golden rule, and therefore the accuracy increases for the gradient, a simple example is used. Assume that there are two particles, each with a mass of 1 kg, density of 1000 kg/m³, and an A function value of 1. For the gradient of the smoothing kernel, ∇W , a constant value of -1 will be used. The uncertainty of each of these values is assumed to be 0.01. Plugging these values into the above equations provides the following results:

Normal Gradient:

$$\begin{aligned}\sigma_{\nabla A_i}^2 = & \left(\frac{1}{1000} * -1 + \frac{1}{1000} * -1\right)^2 * 0.01^2 + \left(\frac{1}{1000} * -1 + \frac{1}{1000} * -1\right)^2 * 0.01^2 + \\ & \left(-\frac{1*1}{1000^2} * -1 - \frac{1*1}{1000^2} * -1\right)^2 * 0.01^2 + \left(\frac{1*1}{1000} * 0 + \frac{1*1}{1000} * 0\right)^2 * 0.01^2 = 8.000004 * \\ & 10^{-10}\end{aligned}$$

Second Golden Rule Gradient:

$$\begin{aligned}\sigma_{\nabla A_i}^2 = & \left(-\frac{1}{1000^2} ((1 - 1) * 1 * -1 + (1 - 1) * 1 * -1)\right)^2 * 0.01^2 + \left(\frac{1}{1000} (1 * -1 + 1 * \right. \\ & \left. -1)\right)^2 * 0.01^2 + \left(\frac{1}{1000} (-1 * -1 + (-1) * -1)\right)^2 * 0.01^2 + \left(\frac{1}{1000} ((1 - 1) * -1 + (1 - \right. \\ & \left. 1) * -1)\right)^2 * 0.01^2 + \left(\frac{1}{1000} ((1 - 1) * 1 * 0 + (1 - 1) * 1 * 0)\right)^2 * 0.01^2 = 8 * 10^{-10}\end{aligned}$$

Based on these results, it does show that by applying the second golden rule of SPH, the variance is decreased and the accuracy is increased for the gradient of the interpolating function.

However, the gradient when using the second golden rule is not symmetric. The gradient is not symmetric because you cannot switch A_i and A_j and get the same answer. This is an issue when determining the pressure force on the particle of interest because the action force does not equal the reaction force [14]. The gradient can then be symmetrized to resolve this issue. The symmetrized gradient is shown in Equation 9.

$$\frac{\nabla A_i}{\rho_i} = \nabla \left(\frac{A_i}{\rho_i} \right) + \frac{A_i}{\rho_i^2} \nabla \rho_i \text{ (using Equation 3)}$$

$$\nabla A_i(\mathbf{r}) = \rho_i \sum_j \left(\frac{A_j}{\rho_j^2} + \frac{A_i}{\rho_i^2} \right) m_j \nabla W(\mathbf{r}_i - \mathbf{r}_j, h)$$

Equation 9: Symmetrized gradient of numerical interpolation

Smoothing Kernels and Smoothing Length

Smoothing kernels are weighting functions that determine how much a certain particle will affect the particle of interest. A particle that is closer to the particle of interest will have a larger influence than a particle that is far away. There are multiple different smoothing kernels each with their own equations. However, there are two properties that a smoothing kernel must have [6]:

1. Kernel must be normalized: $\int W(\mathbf{r}, h) d\mathbf{r} = 1$
2. Kernel must go to a Dirac function as h approaches 0: $\lim_{h \rightarrow 0} W(\mathbf{r}, h) = \delta(\mathbf{r})$

Besides these two properties, the smoothing kernel must also be positive and even to ensure it is an averaging function [6]. If the smoothing kernel is even and normalized, then the interpolation will have a second order accuracy.

Recalling the first golden rule, it states that if you want to find a physical interpretation, then it is always best to assume the kernel is Gaussian. The first golden rule just states that using the Gaussian smoothing kernel will provide realistic results. However, a Gaussian smoothing kernel is not the most computational efficient [5]. Therefore, the Gaussian smoothing kernel is not always incorporated into SPH codes.

Since the Gaussian smoothing kernel is not always included in codes, the smoothing kernel that is used in Neutrino is the cubic spline smoothing kernel, which provides a higher computational efficiency. The equations for the cubic spline smoothing kernel are provided below:

$$q = \frac{\mathbf{r}}{h}$$

$$W(\mathbf{r}, h) = \alpha_0 \begin{cases} 1 - \frac{3}{2}q^2 + \frac{3}{4}q^3 & 0 \leq q \leq 1 \\ \frac{1}{4}(2 - q)^3 & 1 \leq q \leq 2 \\ 0 & q \geq 2 \end{cases}$$

Equation 10: Cubic spline

$$\alpha_0 = \frac{10}{7\pi h^2}$$

Equation 11: Cubic spline 2D coefficient

$$\alpha_0 = \frac{1}{\pi h^3}$$

Equation 12: Cubic spline 3D coefficient

where r is the distance between particle i and particle j and h is the smoothing length. For additional smoothing kernel equations, please refer to Appendix A.

The smoothing length specifies the distance away from the particle of interest where the particles affect the particle of interest. Therefore, a larger smoothing length means that the particles further away will have an effect on the particle of interest. Figure 3 shows an example of how the smoothing kernel and smoothing length work on a set of particles.

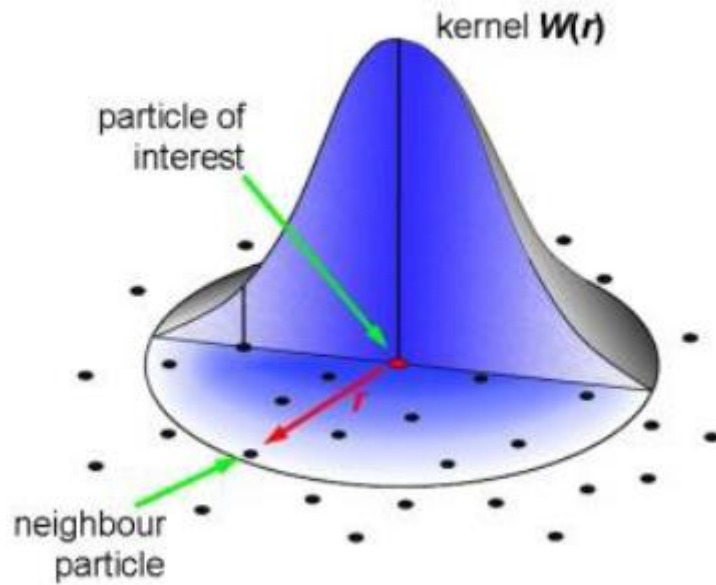


Figure 3: Smoothing kernel and smoothing length [15]

Equations of Motion

Momentum Conservation Equation

The momentum conservation equation for a continuum field is given in Equation 13 [16]. It calculates the change in momentum, or acceleration, of the particle.

$$\frac{D\bar{v}}{Dt} = -\frac{1}{\rho}\bar{\nabla}P + \bar{g} + \bar{\theta}$$

Equation 13: Momentum equation

where $D\mathbf{v}/Dt$ is the acceleration of the particle, $-1/\rho\nabla P$ is the pressure gradient, $\mathbf{g}$ is gravity, and θ is the diffusion term (artificial viscosity, laminar viscosity, full viscosity).

The momentum equation can also be modified to account for forces other than pressure and gravity. The following equation is another form of the momentum equation [14].

$$\rho \frac{D\mathbf{v}}{Dt} = -\nabla P + \mu \nabla^2 \mathbf{v} + \gamma k n + \rho \mathbf{g} + f_{other}$$

Equation 14: Additional momentum equation

where $-\nabla P$ is the pressure, $\mu \nabla^2 \mathbf{v}$ is the viscosity, $\gamma k n$ is the surface tension, $\rho \mathbf{g}$ is gravity, and f_{other} is other forces.

For the momentum equation, there are three different diffusion terms: artificial viscosity, laminar viscosity, and full viscosity. Artificial viscosity is used for simplicity, can handle high Mach number shocks, and conserves total linear and angular momentum [5]. Laminar viscosity is used for modeling more accurate laminar flow and full viscosity is used for modeling turbulent flow [16].

In Neutrino, the only options are artificial viscosity or laminar viscosity. Based on the Neutrino documentation, laminar viscosity is a more physical model. Therefore, the momentum equation with laminar viscosity is provided below:

$$\frac{d\mathbf{v}_i}{dt} = - \sum_j m_j \left(\frac{P_j}{\rho_j^2} + \frac{P_i}{\rho_i^2} \right) \nabla_i W_{ij} + \mathbf{g} + \sum_j m_j \left(\frac{4v_0 \mathbf{r}_{ij} \nabla_i W_{ij}}{(\rho_i + \rho_j) |\mathbf{r}_{ij}|^2} \right) \mathbf{v}_{ij}$$

$$\mathbf{v}_{ij} = \mathbf{v}_i - \mathbf{v}_j$$

$$\mathbf{r}_{ij} = \mathbf{r}_i - \mathbf{r}_j$$

Equation 15: Laminar viscosity momentum equation

where $\mathbf{v}$ is the velocity vector, m is the mass, ρ is the density, P is the pressure, $\mathbf{g}$ is gravity, $\mathbf{r}$ is the position vector, and v_0 is the kinematic viscosity. For the momentum equations with artificial and full viscosity, please refer to Appendix B.

Continuity Equation

The continuity equation calculates the change in fluid density [16]. The equation is given in Equation 16.

$$\frac{d\rho_i}{dt} = \sum_j m_j \mathbf{v}_{ij} \nabla_i W_{ij}$$

Equation 16: Continuity equation

Equation of State

The equation of state is a relationship between the fluid density and pressure. The equation of state is used to determine fluid pressure [16]. There are two ways that pressure can be calculated: the ideal gas law or the Tait equation. The ideal gas law can make the particles behave like a spring mass system because of the stiffness constant. This can cause

the particles to compress and look unnaturally spongy [17]. The Tait equation is used for lower compressibility particles, but can increase computation time. Since water is incompressible, the Tait equation should be used when modeling water. The Tait equation is shown below:

$$P = B[(\frac{\rho}{\rho_0})^\gamma - 1]$$

$$B = \frac{c_0^2 \rho_0}{\gamma}$$

Equation 17: Pressure from Tait equation

where γ is equal to 7, c_0 is the speed of sound at reference density, and ρ_0 is the reference density. For the ideal gas law equation, please refer to Appendix C.

Thermal Energy

Thermal energy is the kinetic energy of the movement of particles [18]. Thermal energy for each particle is given in Equation 18.

$$\frac{de_i}{dt} = \frac{1}{2} \sum_j m_j \left(\frac{P_j}{\rho_j^2} + \frac{P_i}{\rho_i^2} + \theta \right) \mathbf{v}_{ij} \nabla_i W_{ij}$$

Equation 18: Thermal energy equation

where θ is the diffusion term (artificial viscosity, laminar viscosity, or full viscosity).

Moving the particles

Particles are moved using the velocity vector or the XSPH variant [5]. The XSPH variant, where X is the unknown factor, ensures that neighboring particles move with

approximately the same velocity so that particles with different velocities do not occupy the same location [19]. The equation for moving particles is provided in Equation 19.

$$\frac{d\mathbf{r}_i}{dt} = \mathbf{v}_i + \varepsilon \sum_j \frac{m_j}{\rho_{ij}} \mathbf{v}_{ij} W_{ij}$$

$$\rho_{ij} = \frac{\rho_i + \rho_j}{2}$$

Equation 19: Moving the particles equation

where ε is equal to 0.5.

Other Modifications

The above equations are the necessary equations for SPH. However, there are additional modifications that can be made. Other modifications that can be made include density reinitialization to help overcome the large oscillations of the particle pressure field, kernel renormalization when there is an absence of neighboring particles, or Riemann solver to remove the pressure and velocity fluctuations of water [16]. For more information on these modifications, please refer to Appendix D.

Time Stepping

There are multiple different ways of time stepping to determine the new property values of the particle. Five different time stepping methods are discussed although there are many more methods available. The five methods are the predictor-corrector scheme, Verlet scheme, symplectic scheme, Beeman scheme, and implicit Euler scheme. The predictor-corrector scheme determines the properties at the next time step by correcting the properties at the half time step and then solving for the whole time step. The Verlet scheme uses two sets of equations to make sure that the time integration does not diverge. The

symplectic scheme is time reversible with the absence of friction and viscous effects [16]. The Beeman scheme is forth order accurate [16]. The implicit Euler scheme updates the position based on the updated velocity [6].

In Neutrino, the implicit Euler scheme is used. The following are the implicit Euler scheme equations.

$$\mathbf{v}_{t+\Delta t} = \mathbf{v}_t + \Delta t \mathbf{a}_t$$

$$\mathbf{r}_{t+\Delta t} = \mathbf{r}_t + \Delta t \mathbf{v}_{t+\Delta t}$$

Equation 20: Implicit Euler time stepping

where $\mathbf{r}$ is the position vector, $\mathbf{v}$ is the velocity vector, $\mathbf{a}$ is the acceleration vector, t is the time step, and Δt is the time step distance. For more information on the other time stepping schemes, please refer to Appendix E.

Boundary Conditions

There are three different types of boundary conditions: dynamic boundaries, repulsive boundaries, and periodic boundaries [16]. Dynamic boundaries force the boundary particles to obey the same equations as the fluid particles, but they can either move or be fixed. Repulsive boundaries ensure that water cannot cross a solid boundary. Periodic boundaries make it so particles that cross the boundary will reappear at another location.

Compressibility

Compressibility is an important issue to address when dealing with fluids. There are multiple methods that can be used to account for the compressibility of a fluid. Some methods include: Weakly Compressible SPH (WCSPH), Implicit Incompressible SPH

(IISPH), Predictive-Corrective Incompressible SPH (PCISPH), and Local-Poisson SPH (LPSPH). Since water is an incompressible fluid, it is best to use an incompressible method. In Neutrino, the IISPH method is implemented.

IISPH method computes the pressure by iteratively solving a set of linear equations to guarantee the incompressible state [20]. IISPH method is comprised of three steps: advection prediction, pressure solving, and moving particles [21]. The first step is the advection prediction. This is accomplished by predicting the density and velocity of all particles using external forces [21]. Next, the particles enter an iterative pressure solver where the pressure of each particle is updated which in turn updates the density. This continues until the particles have a density error below a certain threshold [21]. Once all the particles' density error is below the threshold, the particle velocity and position are determined. The process is then repeated for the next time step.

Solving Process

Now that the SPH equations are known, the solving process can be determined. Figure 4 shows a flow chart of the SPH solving process.

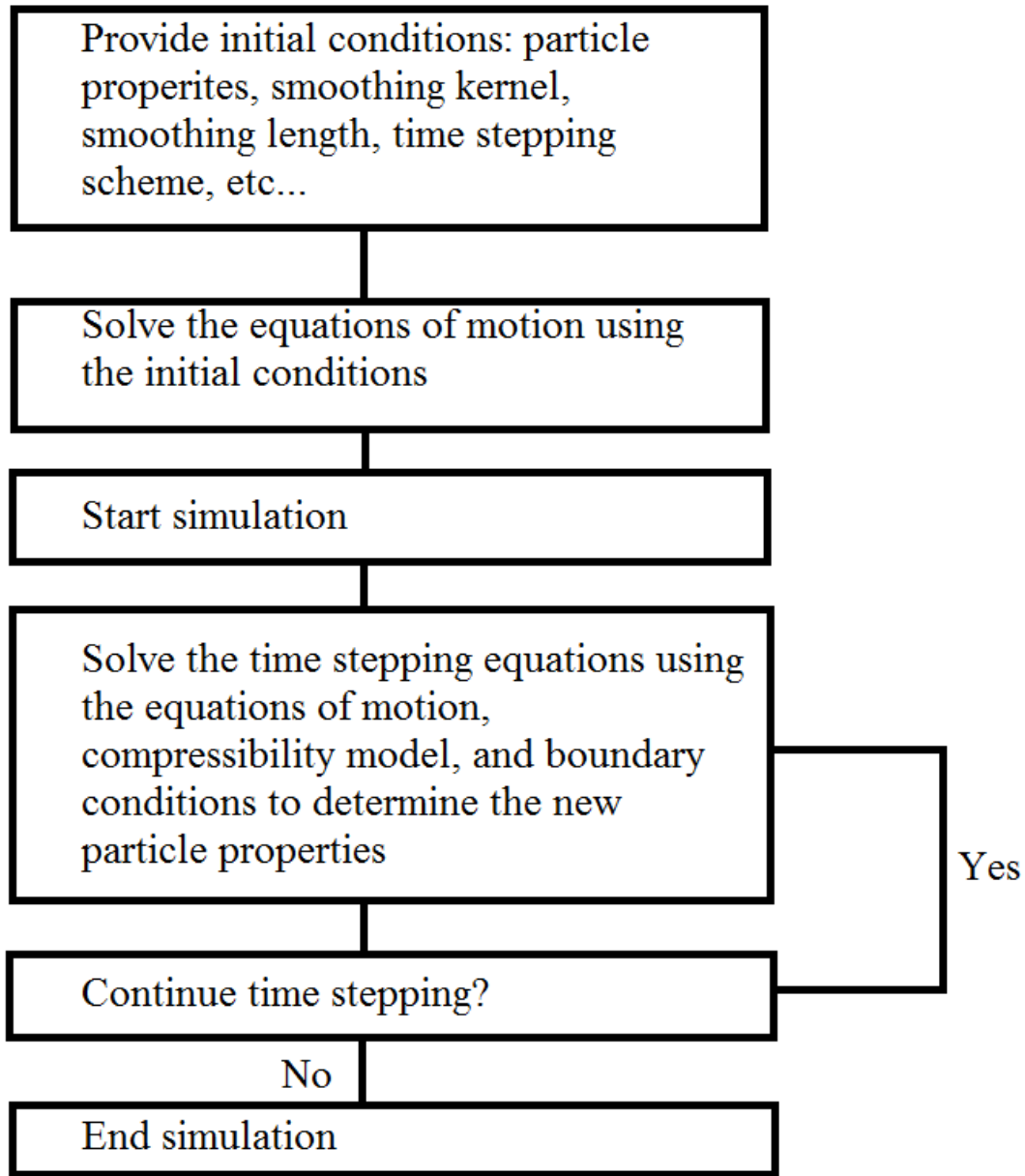


Figure 4: SPH solving process

Computing Platforms

Depending on the SPH code, there are two different systems that can be used to run the code: Central Processing Unit (CPU) or Graphics Processing Unit (GPU). A CPU is the brain of the computer and handles most of the computations in a computer [22]. As

technology has progressed, other items that can help supplement the CPU have been developed, such as microprocessors and GPU. The GPU was originally developed for graphics rendering [22]. The GPU has also become more advanced with it now being able to render 3D graphics as well as perform advanced calculations. Therefore, in order to take some of the load off the CPU, GPUs have been used to supplement the CPU.

By using a GPU to supplement the CPU, it allows for functions to be performed faster. However, it should be known that CPU can perform the same functions as GPU, but it will take more time [22]. It should also be noted that GPUs cannot take the place of a CPU. The CPU is still the brain of the computer. Overall, the use of GPU is just to decrease the computation time.

Ogee Spillway

Background

An ogee spillway is a commonly used hydraulic structure and is the most commonly used spillway structure [23]. An ogee spillway has an S-shaped weir. The shape of the ogee spillway comes from the flow profile over a sharp crested weir. Figure 5 shows the flow profile over a sharp crested weir and Figure 6 shows an ogee spillway.

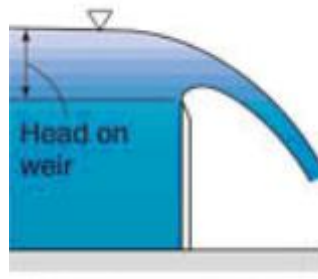


Figure 5: Flow profile over a sharp crested weir [24]

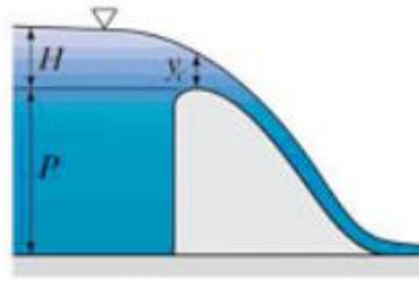


Figure 6: Ogee spillway weir shape [24]

An ogee spillway is comprised of three sections: the crest, the tangent zone, and the toe. The crest is the top curved section of the spillway which is designed to match the profile of the flow over the sharp crested weir. The surface that the ogee spillway is trying to match is called the lower surface of the nappe. By matching the lower surface of the nappe, the pressures on the spillway crest will be atmospheric [23]. The tangent zone is the

section that leads the fluid flow from the crest down to the toe section. Since the fluid will accelerate down the tangent zone, the profile of the tangent zone needs to conform to the design profile of the spillway so that damage does not occur [23]. Lastly, the toe of the spillway is the curve at the bottom of the spillway. The toe allows for the fluid to transfer smoothly from the spillway to the discharge area [23]. Figure 7 shows the sections of the ogee spillway.

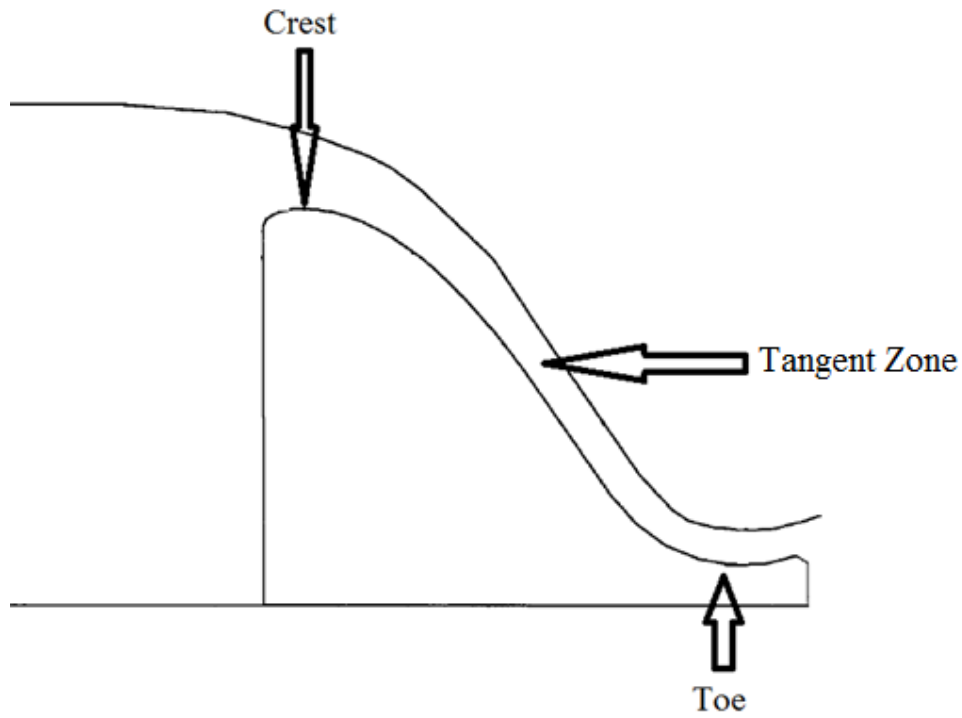


Figure 7: Ogee spillway sections

Since a spillway is used for fluid to flow over it, the discharge should be known. The discharge flow over the ogee spillway is characterized by Equation 21.

$$Q = \frac{2}{3} C_0 \sqrt{2g} L H_T^{\frac{3}{2}}$$

Equation 21: Non-dimensional discharge

where Q is the discharge, C_0 is the discharge coefficient, g is gravity, L is the width of the spillway, and H_T is the total head, which includes the velocity head. The discharge coefficient is not a constant value and depends on a variety of parameters. Some parameters that affect the discharge coefficient are the relationship between the ogee crest and the nappe shape, the depth of approach, the inclination of the upstream face, the contraction caused by the crest piers and abutments, the interference due to downstream apron, and the submergence of the crest due to downstream water level [23]. These parameters have been studied to determine the effects they have on the discharge coefficient which are provided by ranges and design curves.

Comparison Model Setup

For the comparison model setup, an ogee spillway model with a horizontal apron was used. Figure 8 shows the comparison model ogee spillway with a horizontal apron.

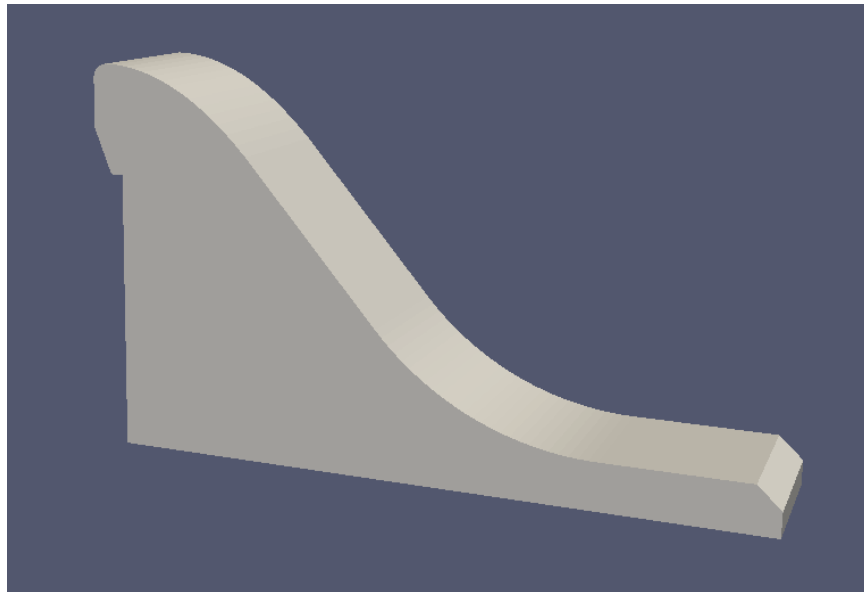


Figure 8: Ogee spillway comparison model with horizontal apron

The physical experiment was conducted using a scaled model with the above ogee spillway. The physical experiment was previously done and is described in the papers *Flow over Ogee Spillway: Physical and Numerical Model Case Study* and *Physical and Numerical Comparison of Flow over Ogee Spillway in the Presence of Tailwater* by Bruce M. Savage and Michael C. Johnson. The scaled model experiment was conducted at the Utah Water Research Laboratory (UWRL) in Logan, Utah [25]. The spillway was constructed of Plexiglas so that smooth curves could be obtained and that pressure taps could easily be installed along the spillway [25]. The ogee spillway was approximately 0.80 m tall, 1.83 m wide, and 1.36 m long and was placed in a flume with approximate dimensions of 12 m long, 1.83 m wide, and 1.22 m high [26].

The experiment consisted of setting different values of the upstream head, measured approximately 2 m upstream, and then taking flow rate and pressure measurements. The flow rate measurements were taken using weight tanks, volumetric tanks, or an ultrasonic flowmeter [25]. The reason for different flow rate measurement tools was because each measurement tool measured different flow rate quantities. The weight tanks were used at low flow rates, the volumetric tanks were used for the middle to high flow rates, and the ultrasonic flowmeter was used at the two highest flow rates [25].

The pressure measurements were taken using a piezometer board with glass tubes vented to the atmosphere [25]. The pressure taps were positioned in the center of the spillway and slightly staggered down the spillway. The pressure taps were placed in the center so that sidewall effects would not contribute to the measurements and they were slightly staggered so they would not affect the pressure taps downstream [25]. Figure 9 shows the pressure tap locations on the spillway.

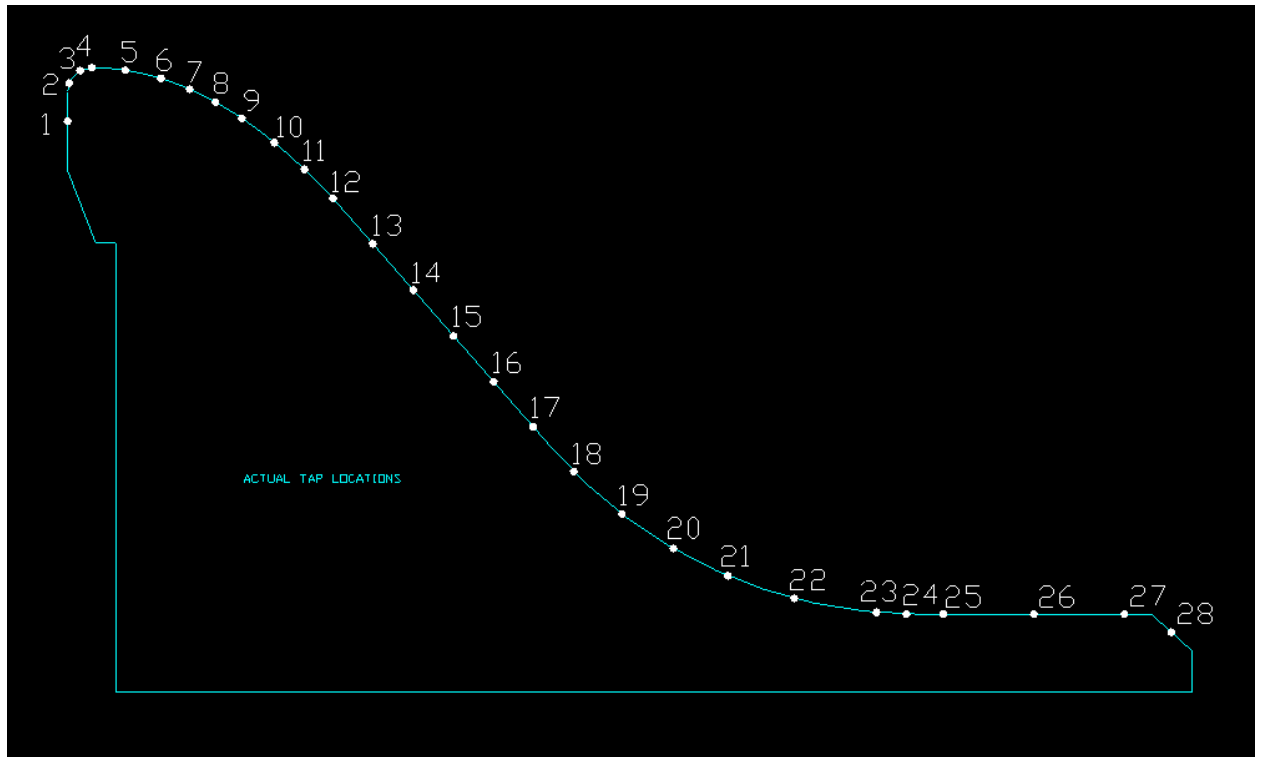


Figure 9: Pressure tap locations

Once the experiment for the scaled model was completed and the results recorded, the results were then scaled up to prototype scale. The scaled model results were scaled up 30 times to the prototype scale. One difference between the scaled model and the prototype is that the prototype has a silt level behind the spillway. The silt level is essentially the ground level behind the spillway after fine sand and clay has built up. The prototype scale is what was used for the SPH comparison.

The prototype ogee spillway model was approximately 40.05 long, 23.25 m high, and 9.0 m wide, the silt level was approximately 13.41 m high, and the measurements were taken approximately 60 m upstream of the spillway. The physical results for the prototype model are shown in Appendix F.

Literature Review of SPH Spillway Comparisons

A literature review was conducted to determine if there have been any ogee spillway comparisons using SPH. From the articles that were investigated, there has not specifically been a comparison model done between SPH and flow over an ogee spillway. The articles *SPH simulation of free surface flow over a sharp-crested weir* by Angela Ferrari and *Comparison between Experimental and SPH Models over a Sharp-crested Weir* by M. Lodomez, et. al. both performed a comparison using SPH to model flow over a sharp crested weir. Both of these articles stated that the SPH model provided good quantitative agreement with physical results and the article by M. Lodomez states upstream head measurements with relative percent errors less than 5% [27] [28]. However, both of these SPH comparison models were done only in 2D.

Another article, *Application of Smoothed Particle Hydrodynamics for modelling gated spillway flows* by Kate Saunders, Mahesh Prakash, Paul W. Cleary, and Mark Cordell, used SPH to compare flow through four gated spillways with a ski-jump design. This comparison was done in 3D and again proved results with good agreement to the physical results with water depth measurements with relative percent errors less than 12% [29]. Some other articles show comparison between SPH and stepped spillways, hydraulic jumps, and spillway tunnels [30] [31] [32].

One method, besides CFD, that has done a comparison of flow over an ogee spillway is the moving particle semi-implicit (MPS) method. The MPS method is a mesh free approach similar to SPH, but is slightly different. The main difference between SPH and MPS is that MPS does not take the gradient of the smoothing kernel like SPH does,

instead it uses a weighted averaging process [33]. In the article, *Modeling of Flow Over an Ogee Spillway Using Moving Particle Semi-Implicit Method* by Masoud Arami Fadafan and Masoud-Reza Hessami Kermani, the results using MPS show good agreement to the physical results [34]. Although this method is similar to SPH, it is not the same as using SPH to model flow over an ogee spillway.

As for Neutrino, there have been three comparison/validation cases done. The three cases are dam break, lid-driven flow, and vortex shedding [35]. None of these cases are similar to flow over an ogee spillway. Additionally, when the Neutrino developer was contacted, he stated that there is a need for comparison between Neutrino simulations and physical results in order to determine the uncertainties of Neutrino and that this comparison will help obtain those needed results. Therefore, this comparison is beneficial to Neutrino as well. Overall, based on the literature review, the comparison of flow over an ogee spillway using SPH is a unique comparison that most likely has not been done in SPH and has not been done using Neutrino.

Neutrino Model Setup

Neutrino is a general purpose simulation and visualization environment developed by Neutrino Dynamics Initiative which includes an SPH solver [35]. Neutrino is being used for a variety of applications including risk assessment and mitigation, hydro-fracturing, energy research, and environmental sciences [35]. Neutrino is a proprietary, developmental code but is available to universities for research.

The reason that Neutrino was chosen over other SPH codes was because it has a particle emitter. Since flow over an ogee spillway is being modeled, it would be more realistic to model if a constant supply of particles can be provided. However, this does not mean that this comparison model cannot be modeled in an SPH code that does not have a particle emitter. There might be a way to move a large volume of water to flow over the spillway by setting an initial velocity or to have a moving plate pushing the water to flow over the spillway. Nevertheless, since Neutrino has a particle emitter and it was able to be used, it was chosen to simulate the comparison model. Therefore, all the results and images shown below are from Neutrino.

Basic Components

The first step of creating the flow over an ogee spillway model was to incorporate the basic components. The basic components of the model are the spillway, the silt level, and the flume. Figure 10 shows the basic component of the Neutrino model. The spillway is in orange, the silt level is in blue, and the flume is the wireframe in red so that everything else can be seen.

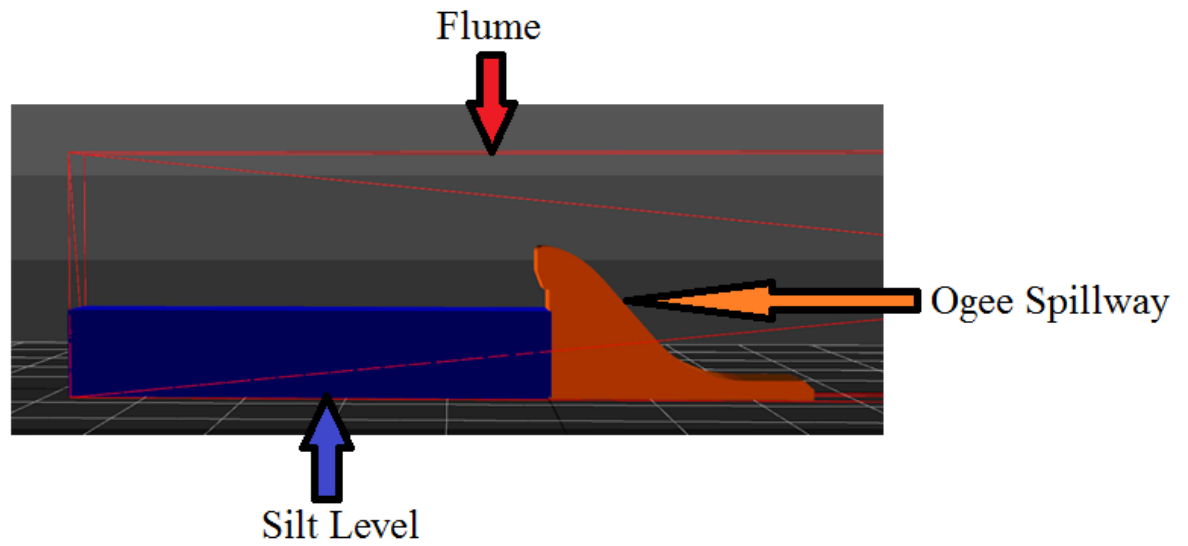


Figure 10: Neutrino model basic components

Particle Emitter Locations for Filling the Flume

Once the basic components were added to the model, the next item to add was the particle emitter. The particle emitter that was first used was a square particle emitter. With a square particle emitter, the initial velocity of the particles is set.

The first purpose of the particle emitter is to fill up the flume area behind the spillway so that the fluid will then flow over the spillway. The first particle emitter location that was tried was a horizontal flow particle emitter. This location was tried because it is similar to creating the flow in a flume. Figure 11 shows the horizontal flow particle emitter location.

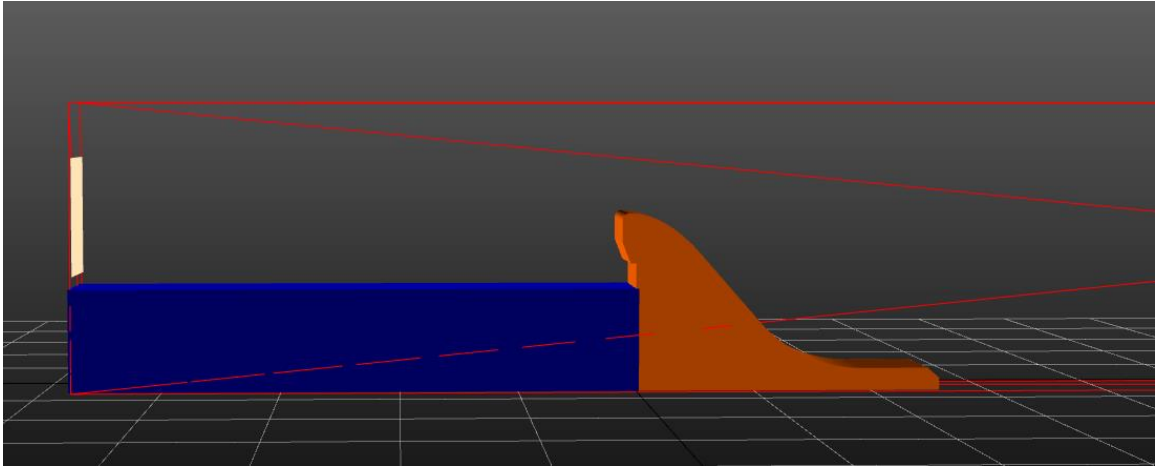


Figure 11: Horizontal flow particle emitter setup for filling

When running the horizontal flow particle emitter setup, there was an issue with the location. The issue was that particle splashing was occurring near the particle emitter. Splashing is a problem because it can result in particles leaving the system or landing in a location on or near the spillway and affecting those particles. Figure 12 shows the splashing caused from the horizontal flow particle emitter setup.

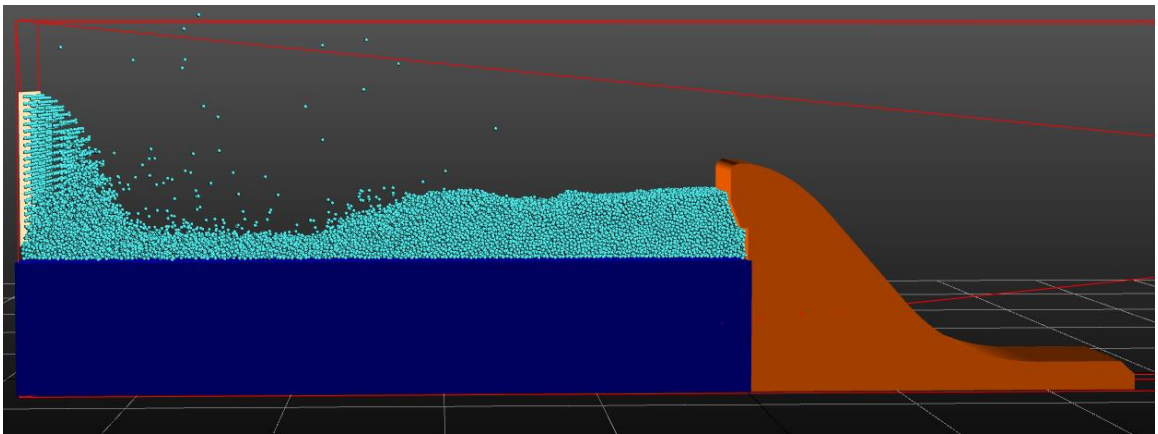


Figure 12: Horizontal flow particle emitter setup for filling with splashing

In order to reduce the amount of splashing that was occurring, a smaller horizontal particle emitter was used. However, splashing occurred again. This time it occurred when the water level was the same height as the particle emitter. The splashing was caused because particles were being emitted in areas where there were already particles. Therefore, the splashing occurred because particles were moving out of the way so new particles could come in. Figure 13 shows the splashing from the smaller horizontal particle emitter setup.

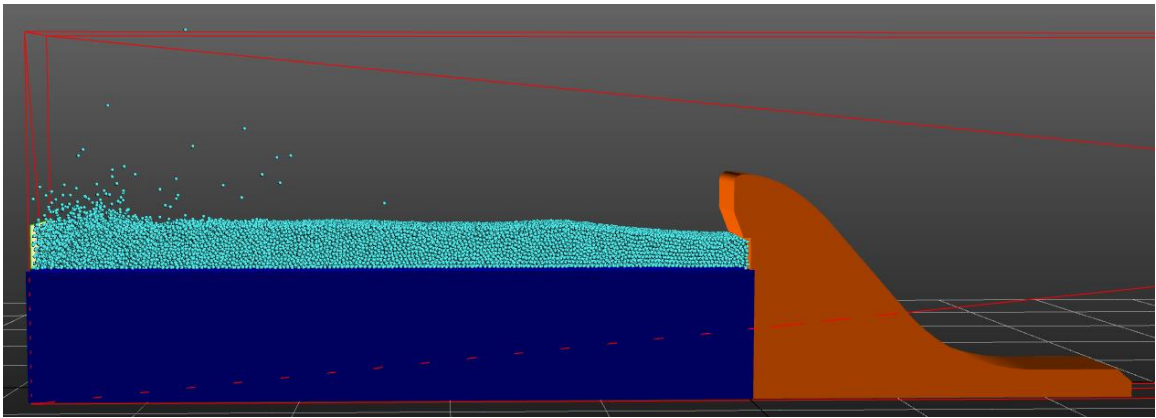


Figure 13: Small horizontal flow particle emitter setup for filling with splashing

Since splashing occurred with this setup as well, the small horizontal flow particle emitter setup should not be used. The next location was a bottom particle emitter that filled the flume from the bottom. The bottom particle emitter setup is shown in Figure 14.

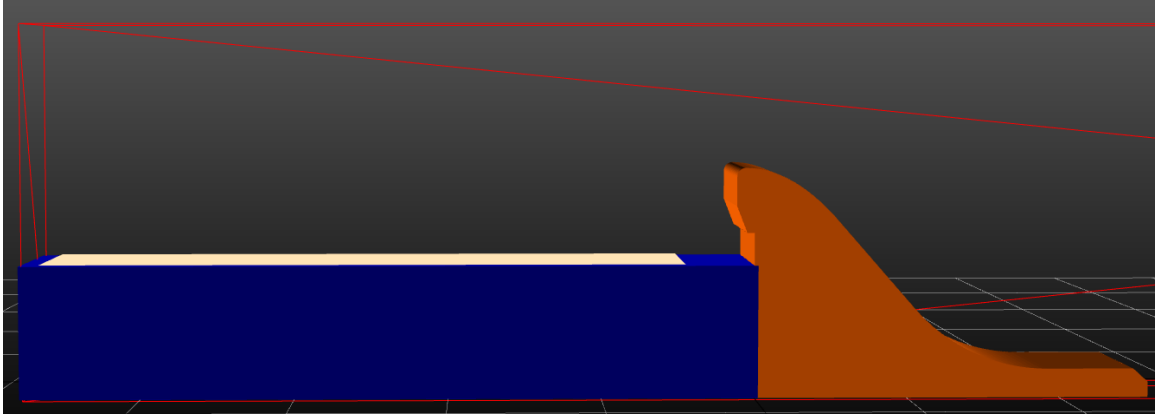


Figure 14: Bottom particle emitter setup for filling

When running the bottom particle emitter setup, particle splashing occurred as well.

Figure 15 shows the particle splashing from the bottom particle emitter setup.

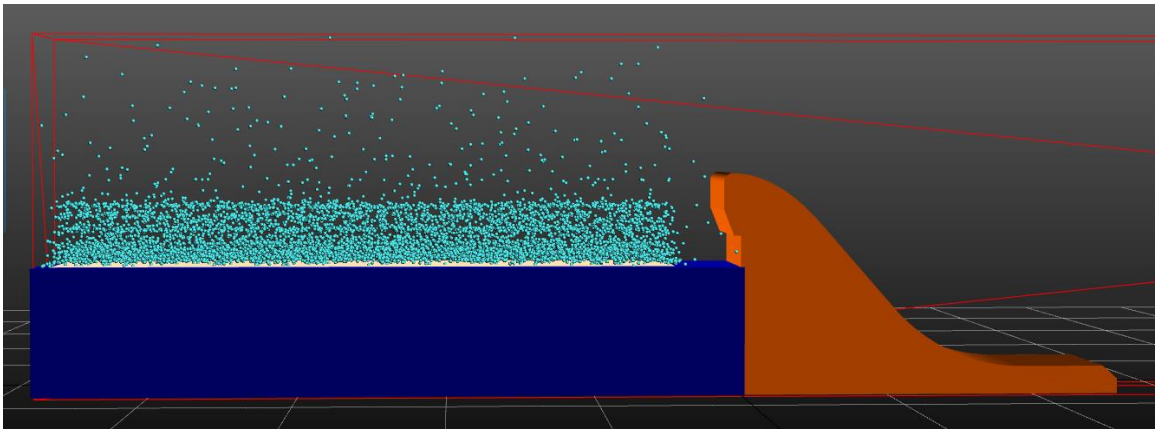


Figure 15: Bottom particle emitter setup for filling with splashing

However, after trying to run the setup again, the bottom particle emitter setup worked without splashing, as shown in Figure 16.

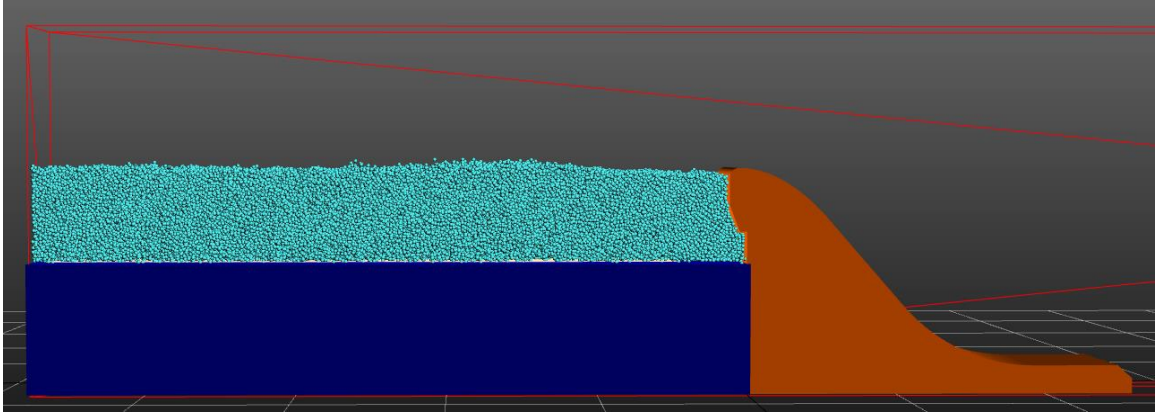


Figure 16: Bottom particle emitter setup for filling without splashing

Since the bottom particle emitter setup gave varying results, it was deemed unreliable and another particle emitter location had to be determined. The next setup was a downpour particle emitter setup. This setup would act as if it was raining in order to fill the flume up behind the spillway. However, since splashing will occur if the particle emitter is placed too high, multiple downpour particle emitters were used to reduce the chance of particle splashing. Figure 17 shows the downpour particle emitter setup.

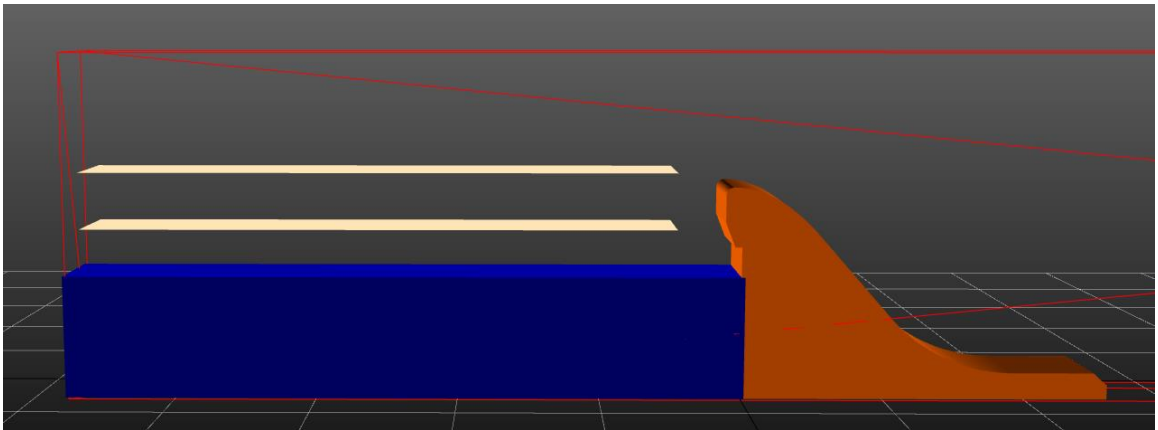


Figure 17: Downpour particle emitter setup

When running the downpour particle emitter setup, the results were that no splashing occurred and the results did not change when rerunning the simulation.

Therefore, this particle emitter setup was determined capable of filling the flume behind the spillway with minimal splashing as shown in Figure 18.

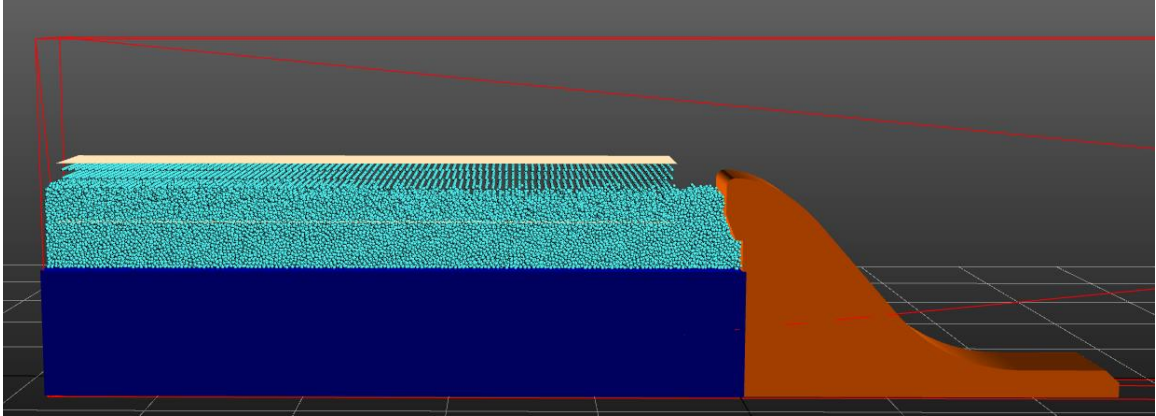


Figure 18: Downpour particle emitter setup for filling

Even though a particle emitter setup was deemed capable, one more approach was tried. The last approach tried was to use a block particle emitter and fill the area behind the spillway with particles all at once. Figure 19 shows the block particle emitter setup.

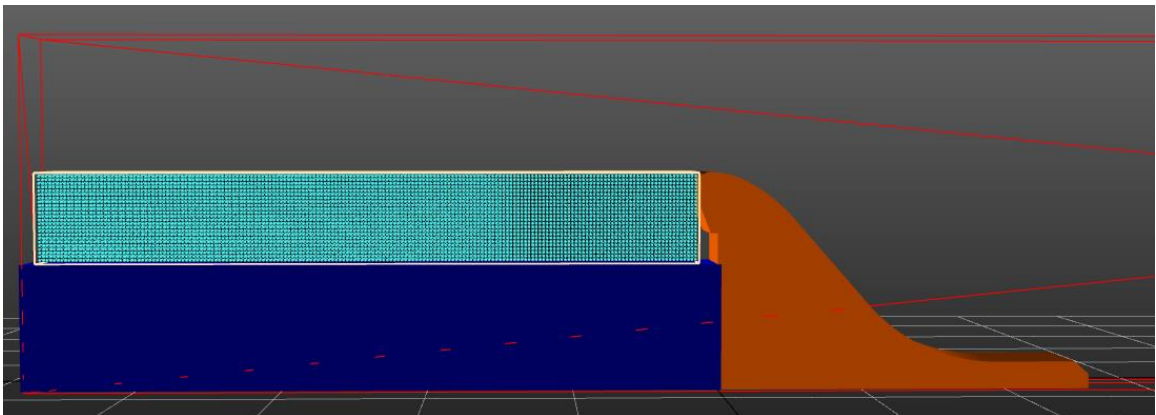


Figure 19: Block particle emitter setup

However, when running the block emitter setup, the particles had to settle into the area behind the spillway. When this happened, splashing occurred again because the

particles were falling down into the areas where there were no particles. Figure 20 shows the splashing from the block particle emitter.

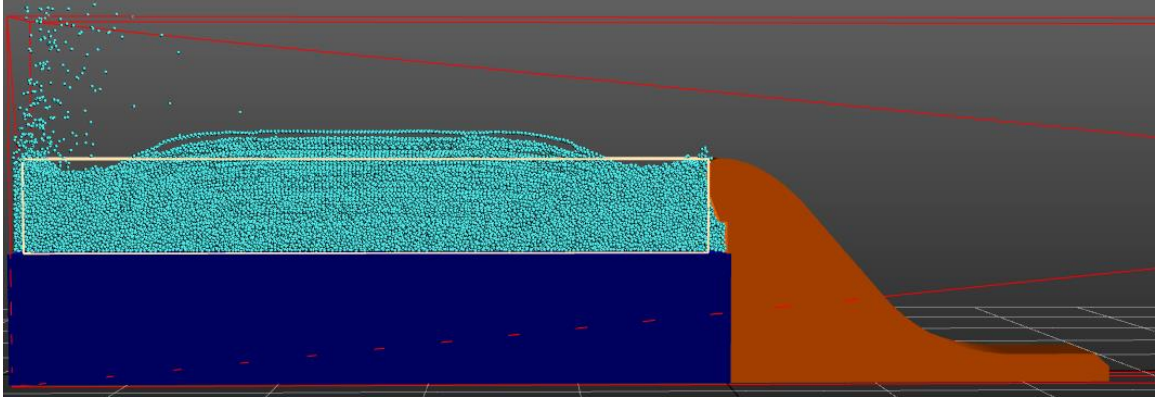


Figure 20: Block particle emitter setup for filling with splashing

With the block particle emitter setup, the splashing would eventually die out over time. Nevertheless, since the downpour particle emitter setup is capable of filling the area behind the spillway without splashing, the downpour setup was chosen to be used for the comparison model.

Leakage

After the particle emitter location for filling the flume was determined, another issue had to be resolved. While running the downpour particle emitter setup, particle leakage was occurring where some of the particles were going through the spillway as if it was not there. Figure 21 shows the particle leakage.

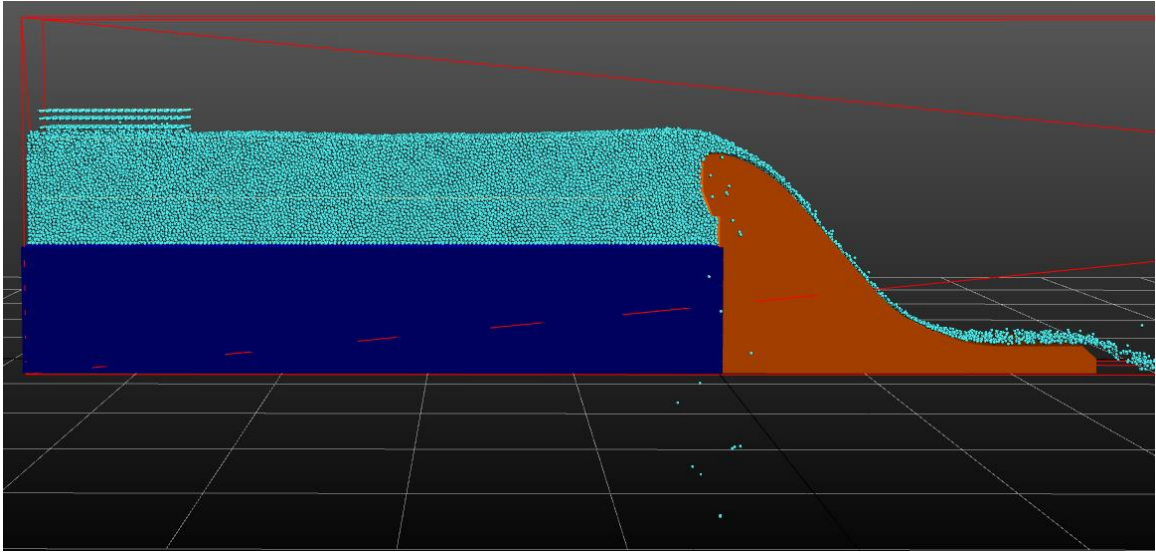


Figure 21: Particle leakage

The developer of Neutrino was contacted about the issue. However, the developer was aware of particle leakage and in fact it is a known bug in Neutrino that particles leak through imported rigid bodies. Therefore, there needed to be a way to reduce the leakage since it is not a realistic result.

The way that the particle leakage was reduced was by placing rigid cuboids, which are native to Neutrino, in the areas where leakage occurred. Particle leakage occurred out the sides of the spillway, out the bottom of the spillway, and through the middle of the spillway. Therefore, rigid cuboids were added to the sides of the spillway, to the bottom of the spillway, and in the middle of the spillway. Figure 22 shows the resolve leakage setup with the rigid cuboids shown in green.

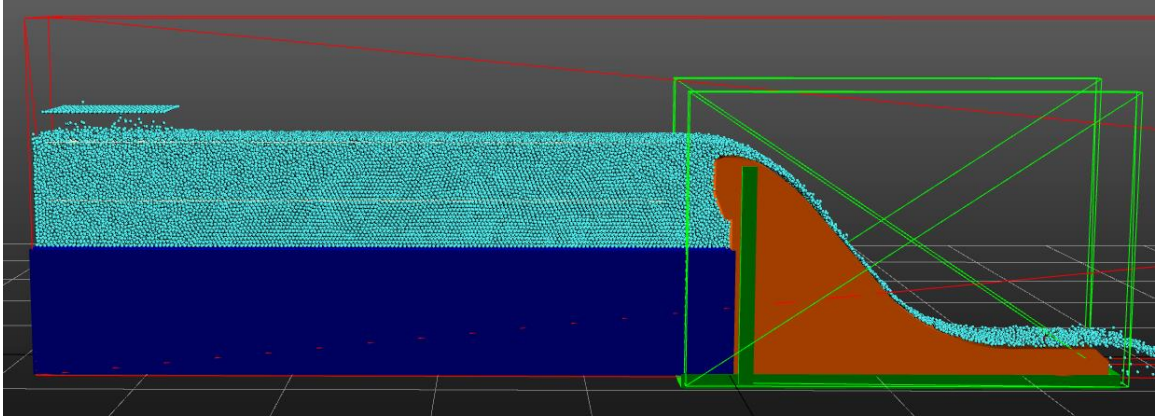


Figure 22: Resolved particle leakage setup attempt

Particle Emitter Location for Creating Each Run

Once the particle leakage was fixed, the particle emitter location for creating the different runs had to be determined. Each of these particle emitter locations still use the downpour setup to fill the area behind the spillway. Since the papers used the total head as the independent variable and the flow rate as the dependent variable, this approach was attempted for the SPH comparison as well.

The first particle emitter location that was tried was a smaller downpour particle emitter placed at the back of the flume. The downpour particle emitter is smaller so that a steady state could be reached closer to the spillway so that measurements can be taken. Figure 23 shows the small downpour particle emitter setup.

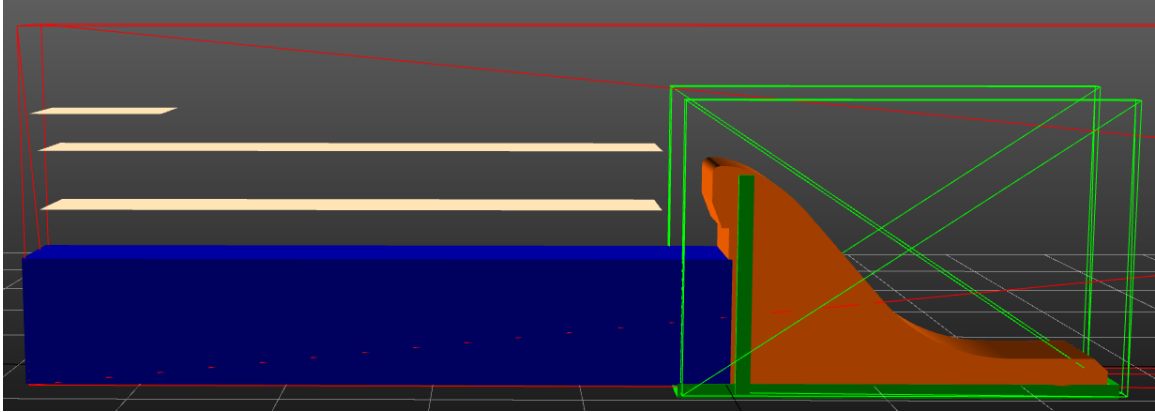


Figure 23: Small downpour particle emitter setup for creating runs

The issue with this setup was that in order to get the upstream head at a steady state position so that it could be compared to the physical runs the simulation had to be ran for 6 hours or longer. This means that if the calculated total head was not the same as the physical total head, then the velocity of the square particle emitter needs to be changed and the simulation reran. Therefore, a particle emitter location with a faster convergence to the steady state total head needed to be determined. Figure 22 above shows the small downpour setup result.

The next location tried was a horizontal flow particle emitter at the back and near the top of the flume. This position was tried so that the particles would move towards the spillway and hopefully reach a steady state quicker. Figure 24 shows the horizontal flow particle emitter at the top.

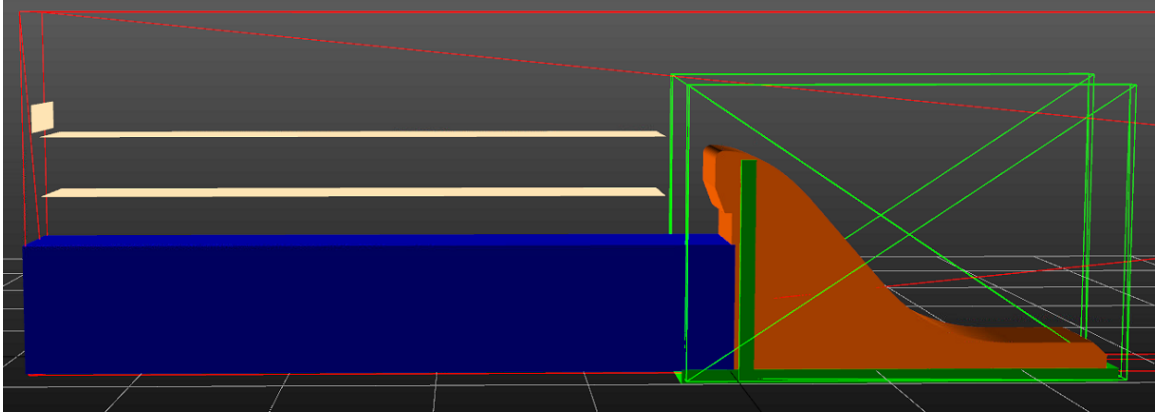


Figure 24: Top horizontal particle emitter setup for creating runs

After running the horizontal flow particle emitter, the particle emitter caused some waves to occur where the particles hit the existing water surface. Even though the waves created eventually settled out, this approach did not reach the steady state quicker than the downpour setup. Figure 25 shows the results of the top horizontal particle emitter setup.

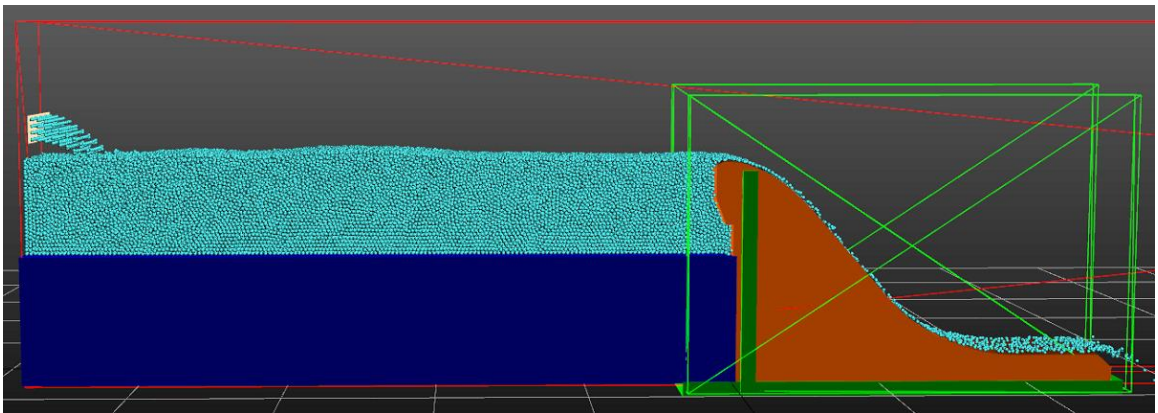


Figure 25: Top horizontal particle emitter setup for creating runs result

In order to try and reach steady state faster, a horizontal flow particle emitter was placed to the back and near the bottom of the model. Figure 26 shows the horizontal flow particle emitter setup placed towards the bottom.

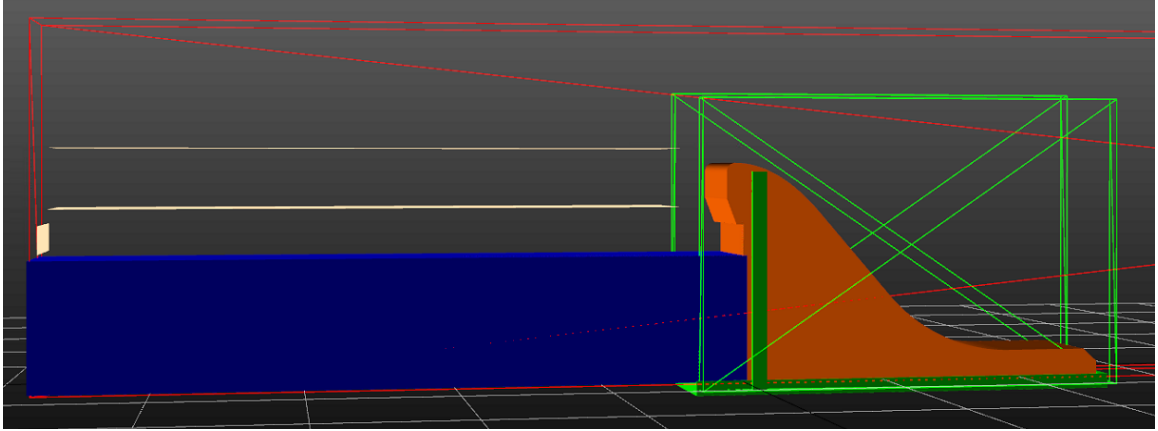


Figure 26: Bottom horizontal particle emitter setup for creating runs

The horizontal flow particle emitter toward the bottom yet again did not decrease the time to steady state. Figure 27 shows the results of the bottom horizontal flow particle emitter setup.

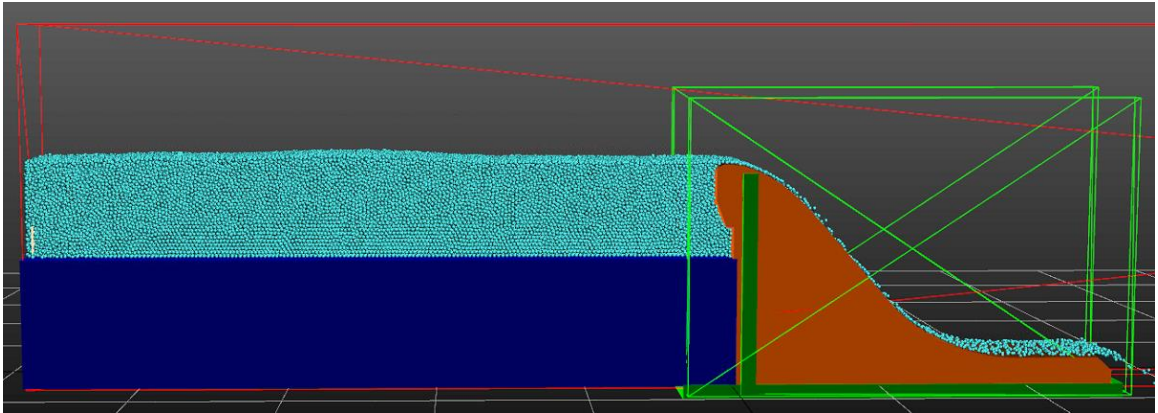


Figure 27: Bottom horizontal particle emitter setup for creating runs results

The next approach was to add a rigid plane to the model in order to set the water level which would be used to compute the total head. Two setups were tried using rigid planes to set the water level. The first approach was to use a vertical rigid plane to set the water level along with a downpour particle emitter. This approach is shown in Figure 28.

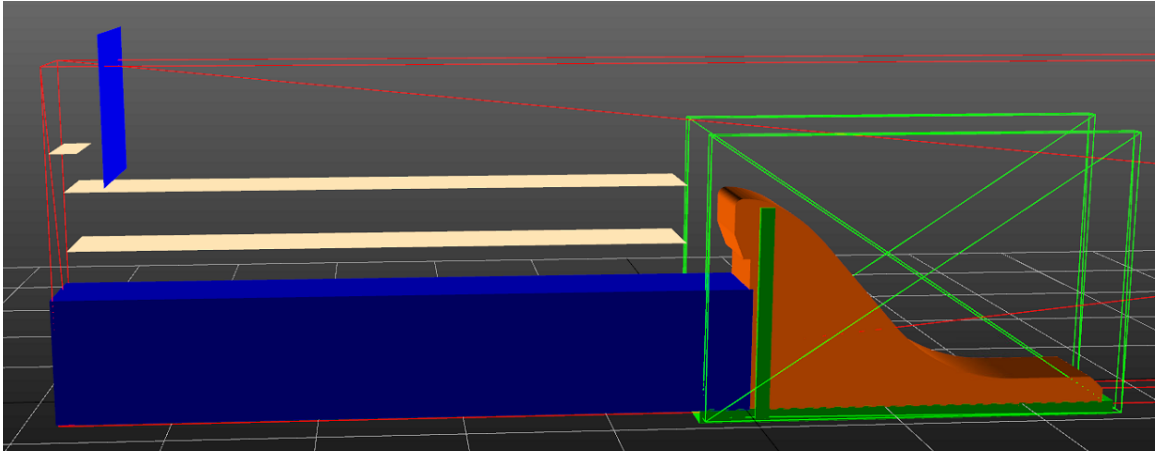


Figure 28: Vertical rigid plane for creating runs

The issue with this approach was that the water would flow underneath the rigid plane and then increase the water level on the other side of the rigid plane. This is shown in Figure 29.

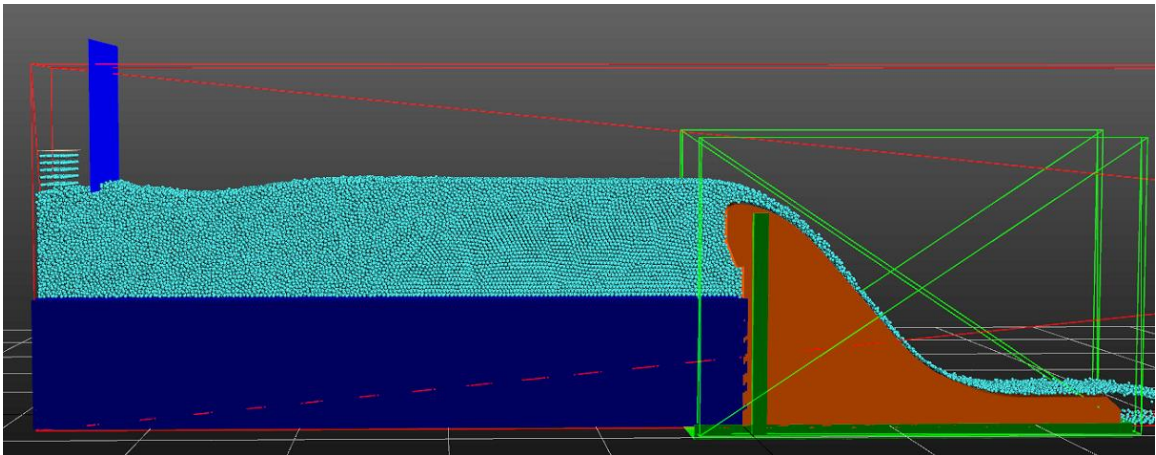


Figure 29: Vertical rigid plane for creating runs result

Since the vertical rigid plane was not able to set the water level, the second rigid plane approach was to add a horizontal plane next to the vertical plane to force the water to flow underneath the rigid plane and hopefully be able to set the water level. The horizontal rigid plane could not go all the way across the flume because the physical

comparison is an open channel model. By placing a rigid plane all the way across, the simulation would be changed to a closed conduit model which would not be able to be compared to the physical results. Figure 30 shows the horizontal rigid plane setup.

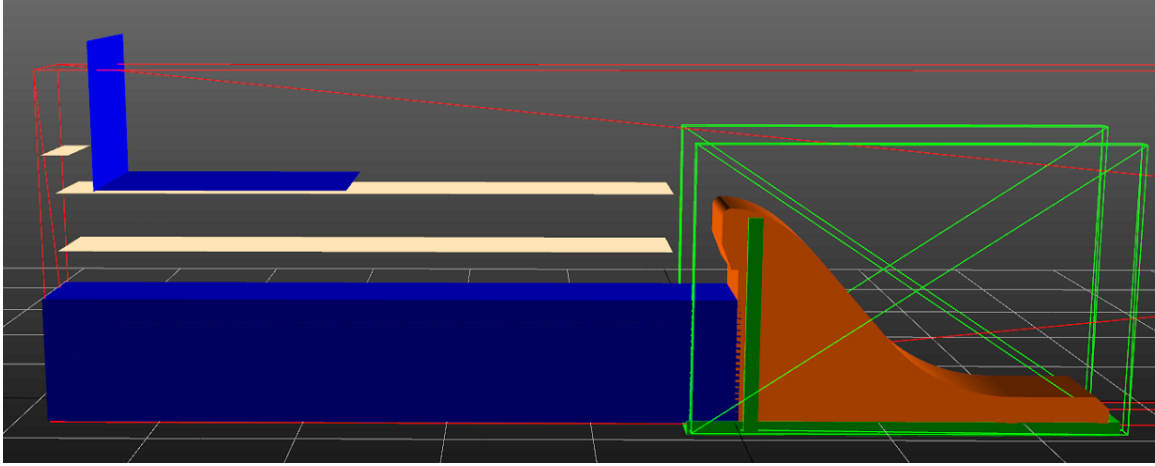


Figure 30: Horizontal rigid plane for creating runs

The horizontal rigid plane setup had a similar issue to the vertical plane setup. The issue is that the water will stay beneath the horizontal rigid plane, but once it is past the rigid plane the water level would rise. This is shown in Figure 31.

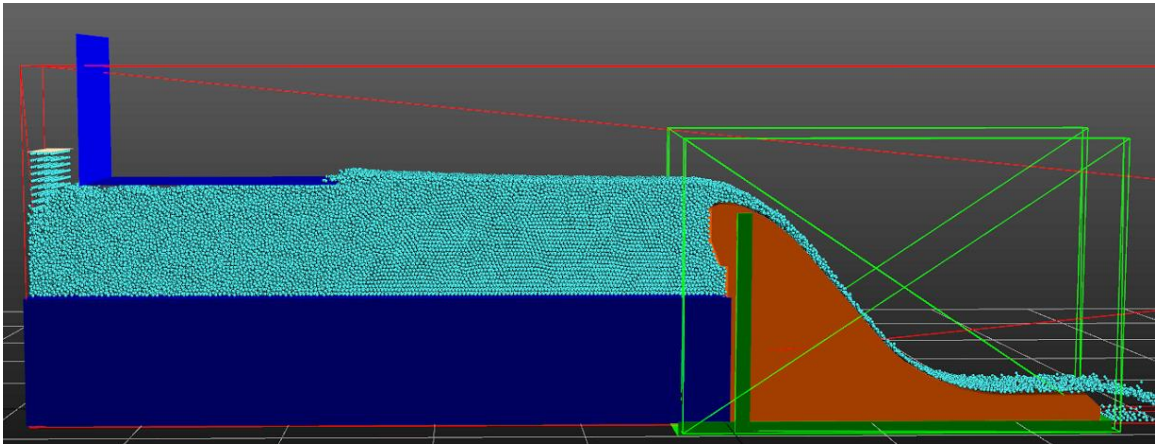


Figure 31: Horizontal rigid plane for creating runs result

After trying multiple approaches to set the water level, a new approach for creating the model was needed. The main purpose for wanting to set the upstream head was because of the papers. However, as shown in Equation 21, the total head and flow rate are related. This means that the flow rate could be set as the independent variable and then the total head could be the dependent variable. Therefore, based on the velocity and the area of the square particle emitter, a flow rate could be set.

Since the small downpour setup seemed to work, but was hard to set the total head, this approach was tried first using the new flow rate approach. With the downpour particle emitter, a measurement field surrounding the particle emitter needed to be added to make sure that the flow rate was the same as the physical runs. The setup is shown in Figure 32 with the measurement field shown in pink.

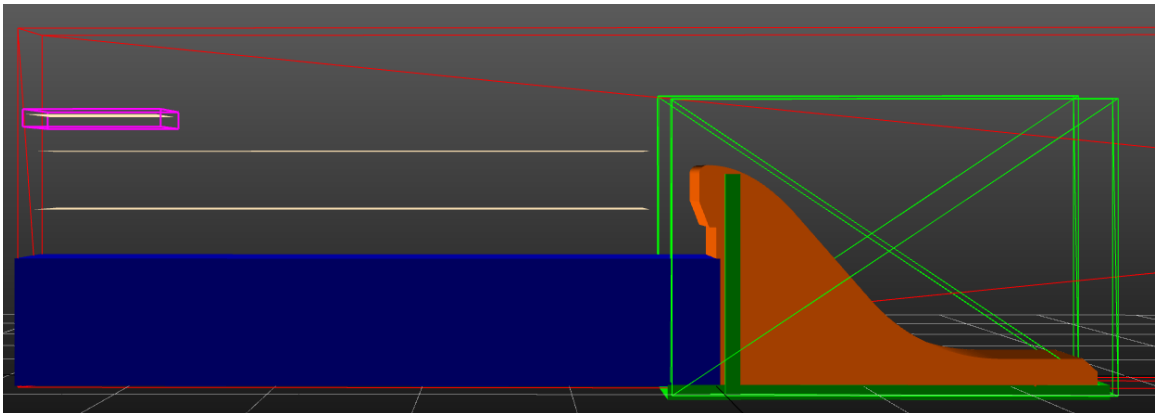


Figure 32: Small downpour particle setup using flow rate

After running this approach, the small downpour setup with a measurement field worked and was capable of setting a flow rate so that the total head can be compared. However, after contacting the developer about a found bug in Neutrino dealing with the export of measurement field data, the developer said that the square particle emitters should not be used because they are unstable. Since the square particle emitters are unstable, this

could explain why some of the particle emitter locations created a lot of splashing or had different results depending on the run.

Instead of using square particle emitters, the developer suggested using flow particle emitters. The difference between the two particle emitters is that the square particle emitter allows the user to set the velocity and the flow particle emitter allows the user to set the flow rate. Therefore, the square particle emitters were replaced with flow particle emitter using the same setup. It should be noted that the other particle emitter locations tried might be able to be used to create the model using flow particle emitters. However, since the downpour setup worked with the unstable particle emitters, it was used with the flow rate particle emitters as well.

Another reason for using the downpour setup was because it seems like a more realistic approach. For water to flow over a spillway, there has to have been an increase in the water level. One way for the water level to increase is by heavy rainfall. By using the downpour setup, it simulates a situation in which a heavy rainfall is occurring upstream of the spillway causing an increase in the water level such that water must flow over the spillway.

Measurement Fields

In order to compare the SPH results to the numerical results, the SPH results need to be recorded. The way the SPH results are recorded is by incorporating measurement fields into the model. The first thing to be compared is the total head. When using a measurement field in Neutrino, it will calculate the water elevation in the measurement

field. However, it does not calculate the total head which includes the velocity head. The equation for the total head is shown below which comes from the Bernoulli equation.

$$H_T = H_o + \frac{u^2}{2g}$$

Equation 22: Total head equation

where H_T is the total head, H_o is the water elevation, u is the velocity in the x direction, and g is gravity.

Since the total head is calculated using the water elevation and the velocity in the x direction, these properties must be calculated in the SPH simulation. The measurement field in Neutrino is capable of calculating the average velocity in each direction. Therefore, the total head can be calculated.

The total head measurement field does not span the entire width of the spillway. This was done to avoid any sidewall effects that might influence the water elevation or velocity. Another item to be mentioned is the measurement field's size. The measurement field length was chosen to be longer so that more particles would be incorporated when determining the measurement properties, but short enough so the measurement was taken in the steady state section.

In order to calculate the difference between the SPH result and the physical result, the relative percent error is calculated. The equation used to calculate the relative error is provided below.

$$Relative \% Error = \frac{H_{SPH} - H_{phys}}{H_{phys}} * 100\%$$

Equation 23: Relative percent error equation

The other measurement that needs to be compared is the pressures along the spillway. Since there are 28 pressure taps, there must be 28 measurement fields in order to determine the pressure at each location. Again, these measurement fields do not span the entire width in order to remove the chance of sidewall effects. However, the length of these measurement fields have to be small since the pressure taps are located at particular points. The pressure measurement fields were added for future work and are not used for calculations. Figure 33 shows the measurement field setup.

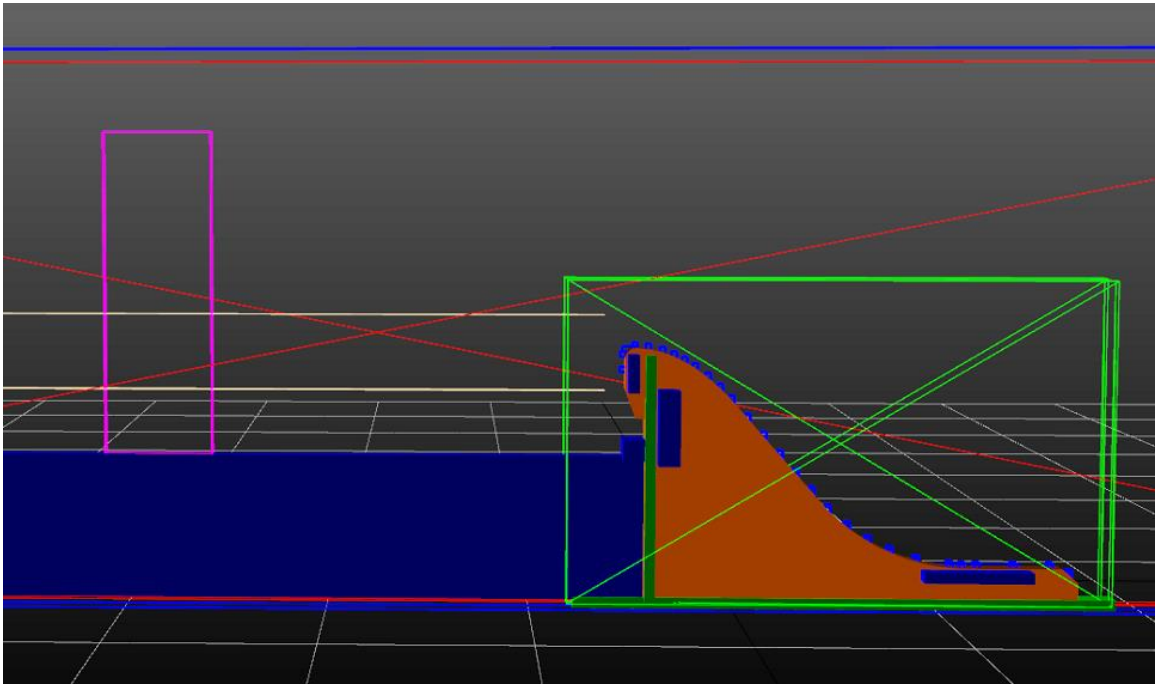


Figure 33: Measurement field setup

Parametric Studies

Two parametric studies were done to determine certain properties of the model. The two parametric studies done were on the width of the model and the particle size of the fluid.

Model Width Parametric Study

The first parametric study done was on the width of the system. This was done because the spillway model is essentially a 2D model. The properties and measurements do not change as a function of width. However, since the Neutrino model includes a flume, the width of the model cannot be so small that sidewall affects are occurring where the measurement is being taken.

The width parametric study was conducted by decreasing the width of the entire Neutrino model, running the model, and then measuring the water surface elevation and recording the simulation time. The water surface elevation was measured to make sure that sidewall affects were not occurring.

Once the model width was adjusted, the model was simulated for 5,000 time steps. At time step 4,500 the water surface elevation measurement began and continued for 500 time steps (10 seconds). The total simulation time comparison was conducted running 5,000 time steps as well. In order to make sure that the steady state was close, the water surface elevation was plotted as a function of time as well as the standard deviation as a function of time. Figure 34 shows the water surface elevation vs. time plot and Figure 35 shows the standard deviation vs. time plot. The below results are for a model width of 1.5 m.

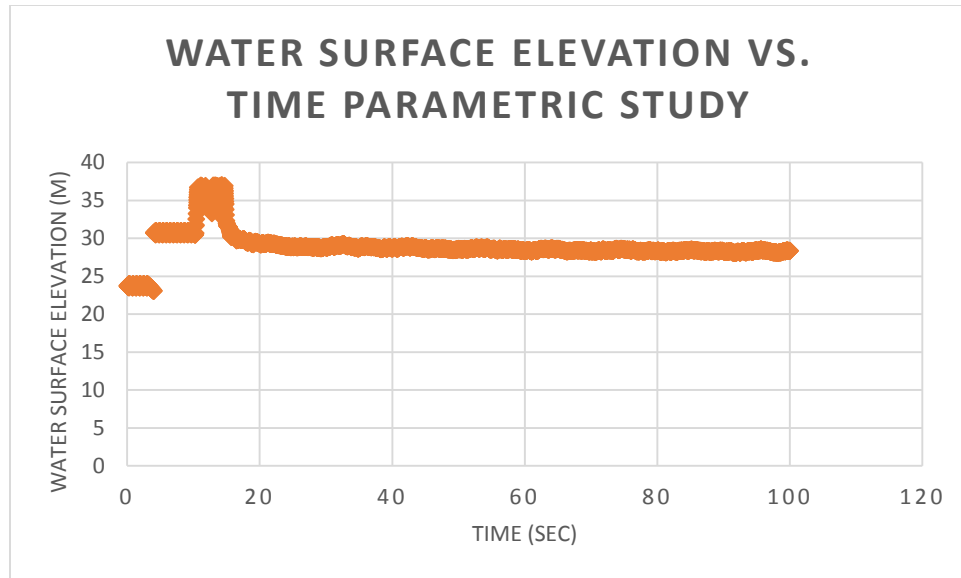


Figure 34: Water surface elevation vs. time for parametric study steady state

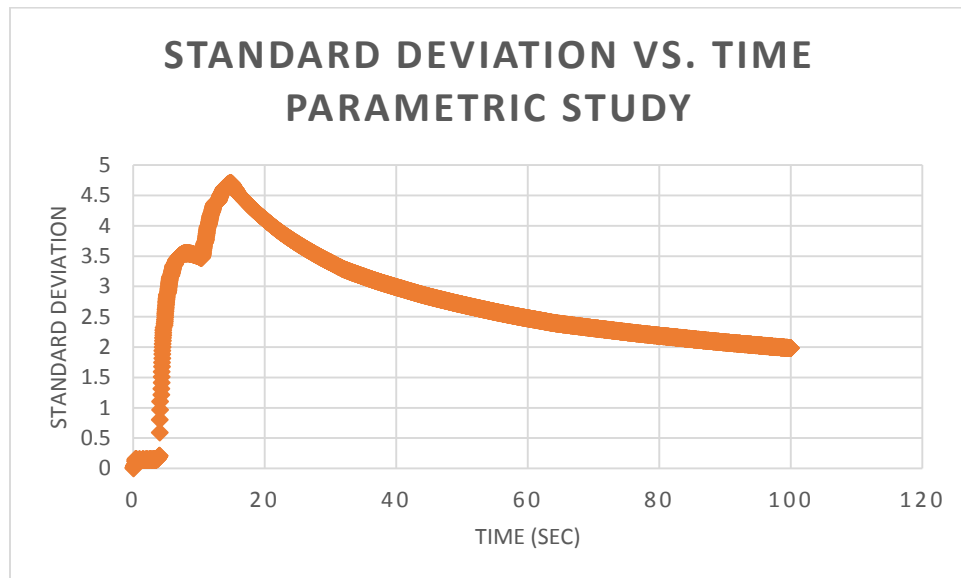


Figure 35: Standard deviation vs. time for parametric study steady state

Based on the plots above, the water surface elevation result shows that the water surface elevation stays fairly constant. However, the standard deviation result has not finished evening out. Therefore, the results show that the steady state was close to being obtained. However, for the final runs, a larger simulation time needs to be used to guarantee that steady state had been reached.

The particle diameter that was used for this parametric study was 0.5 m which was the default Neutrino value and the flow rate used was 1.90 m²/s. Table 1 shows the width parametric study results, Figure 36 shows a plot of the water surface elevation vs. model width, and Figure 37 shows a plot of the total simulation time vs. model width.

Table 1: Width parametric study results

Model Width (m)	Water Surface Elevation (m)	Simulation Time for 5,000 Time Steps (hours)	Output Storage Space (GB)
9	28.30	2.80	236
4.5	28.33	1.54	114
3	28.45	1.00	74.1
1.5	28.26	0.57	32.8
0.75	29.03	0.34	17.4

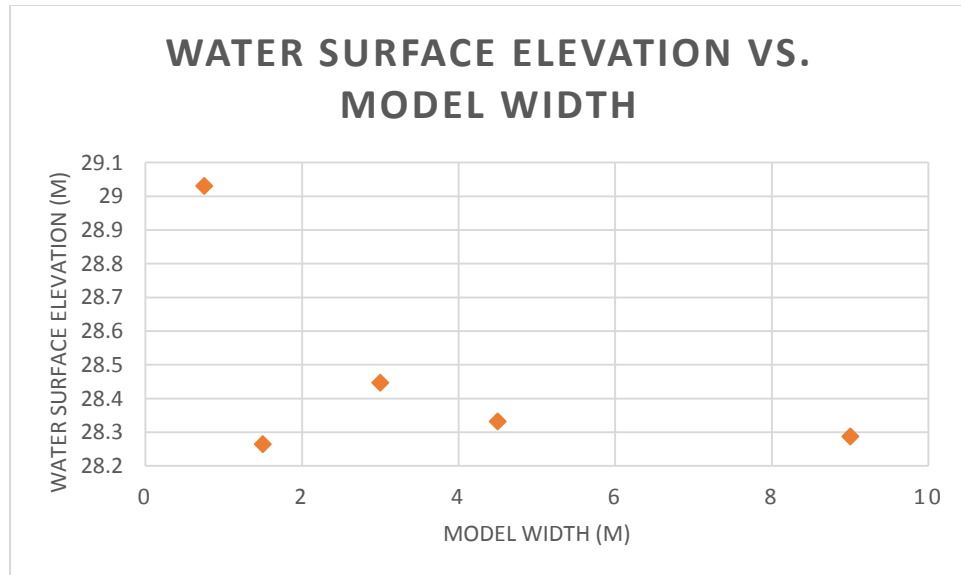


Figure 36: Water surface elevation vs. model width plot

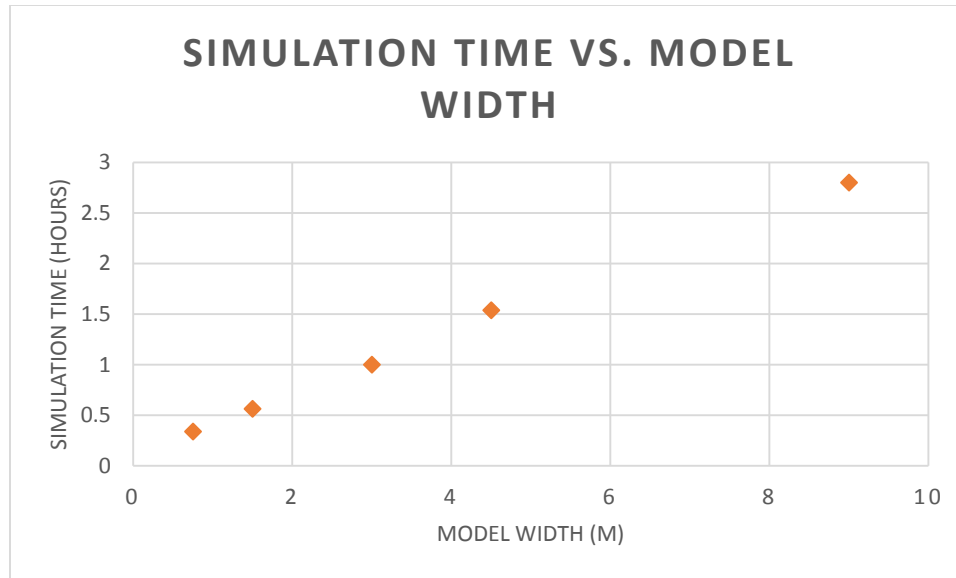


Figure 37: Simulation time vs. model width plot

From the above results, decreasing the model width decreases the simulation time. However, once the model width was at 0.75 m wide the water surface elevation increased from the other water surface elevations. This means that sidewall affects are starting to occur in the measurement field. Therefore, in order for sidewall affects not to occur, the model width of 1.5 m wide is used. This allows for sidewall affects to not occur as well as decreasing the simulation time.

Particle Size Parametric Study

The second parametric study that was done was on the particle size of the fluid. This was done to determine what is the largest sized particle that can be used such that making the particle any smaller will not change the result.

The parametric study was conducted by decreasing the size of the fluid particles, running the model, and then measuring the water surface elevation and recording the

simulation time. The water surface elevation was measured to compare the results of the different particle size and how the size affects the results.

Once the particle size was adjusted, the model was simulated for 5,000 time steps. At time step 4,500 the water surface elevation measurement began and continued for 500 time steps (10 seconds). The total simulation time comparison was conducted running 5,000 time steps as well. The flow rate for this parametric study was $1.90 \text{ m}^2/\text{s}$ and the 1.5 m model width was used. Table 2 shows the particle size parametric study results, Figure 38 shows a plot of the water surface elevation vs. particle size, and Figure 39 shows a plot of the total simulation time vs. particle size.

Table 2: Particle size parametric study results

Particle Diameter (m)	Water Surface Elevation (m)	Simulation Time for 5,000 Time Steps (hours)	Output Storage Space (GB)	Relative Error Between Previous and New Value (%)
0.5	28.26	0.57	32.8	-----
0.375	28.72	1.11	81.0	1.60
0.25	28.12	3.21	275	2.15
0.15	28.12	18.88	1,230	0.002

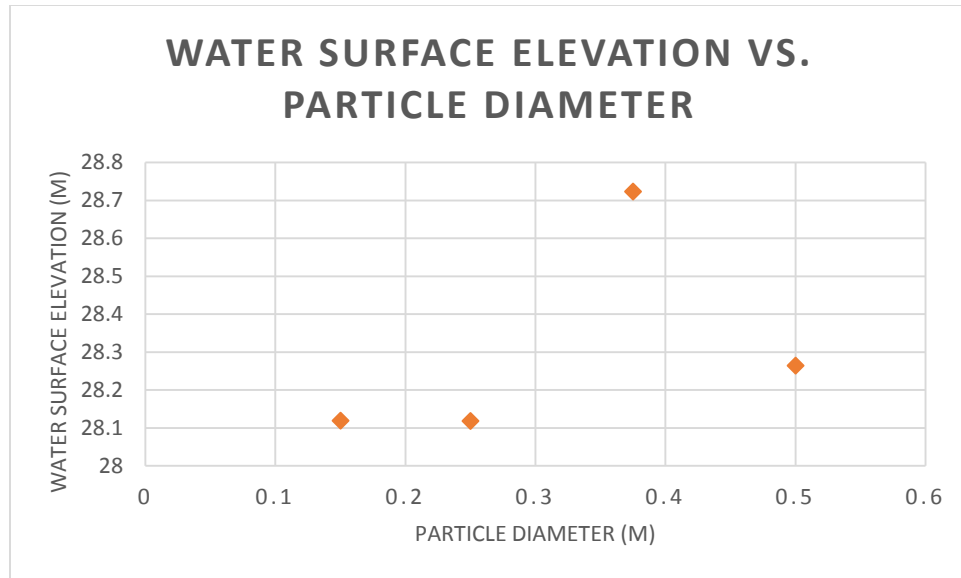


Figure 38: Water surface elevation vs. particle size plot

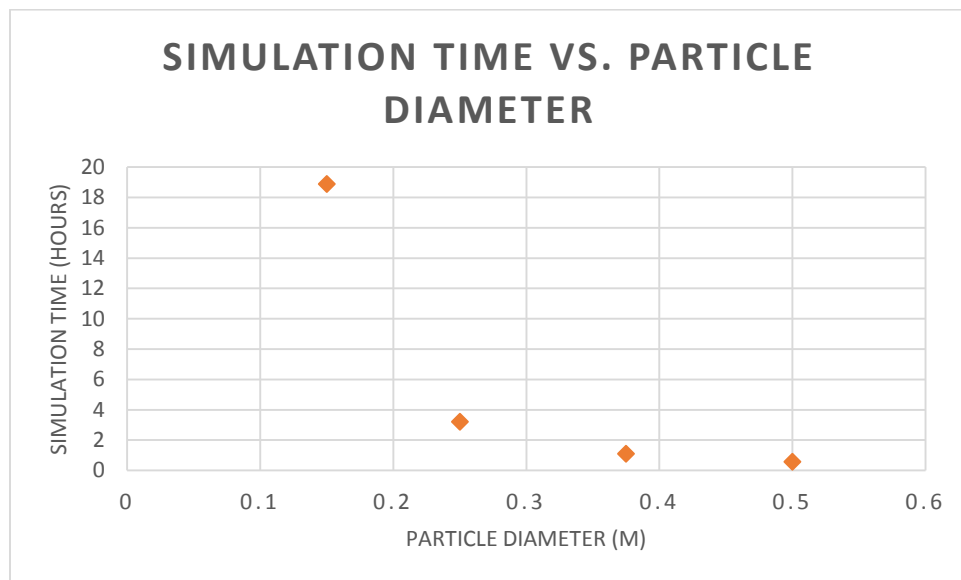


Figure 39: Simulation time vs. particle size plot

From the above results, the water surface elevation result is essentially the same when the particle size is 0.15 m and 0.25 m. Since the results are about the same, the particle diameter of 0.25 m should be used. This is because it greatly reduces the simulation time and the output storage space.

Simulation Issues

After performing the parametric studies, simulation runs began. However, after running the simulation using the flow rate for the first physical run, the particles were moving towards the area where the silt level and spillway meet. Since the particles should not be moving in that direction, the silt level was made invisible to see what was happening. The result was that leakage was occurring where the silt level and the spillway come into contact. This leakage is shown below where the silt level is made invisible in order to see the leakage.

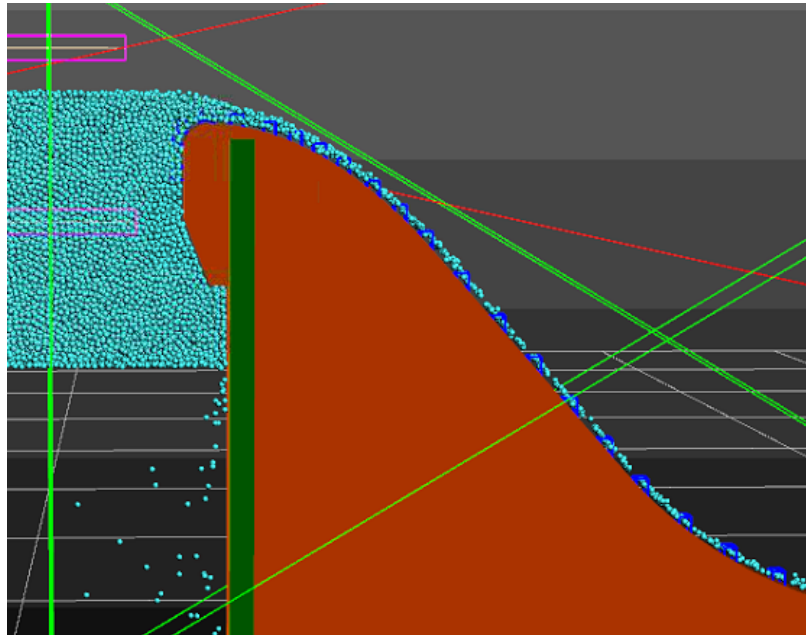


Figure 40: Leakage between silt level and spillway

Therefore, in order to resolve this leakage, another rigid cuboid was added to the section where the leakage was occurring. Figure 41 shows the resolved particle leakage setup.

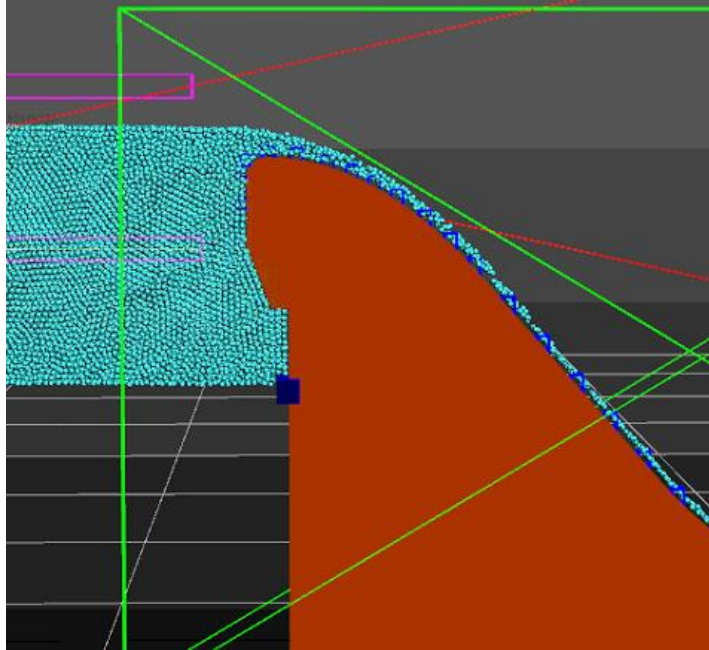


Figure 41: Resolved particle leakage setup

The above setup seemed to fix the leakage in that area, so that simulation was run again. The Neutrino model using the first physical run flow rate worked without leakage. However, when the flow rate was increased for the second and third physical runs, more leakage was occurring. The leakage was determined because the total head measurement kept on decreasing with each run when it should have been increasing because of the higher flow rates. The new leakage was occurring at the back of the flume below the flow rate particle emitter. Figure 42 shows the leakage for the second physical run flow rate and Figure 43 shows the leakage for the third physical run flow rate.

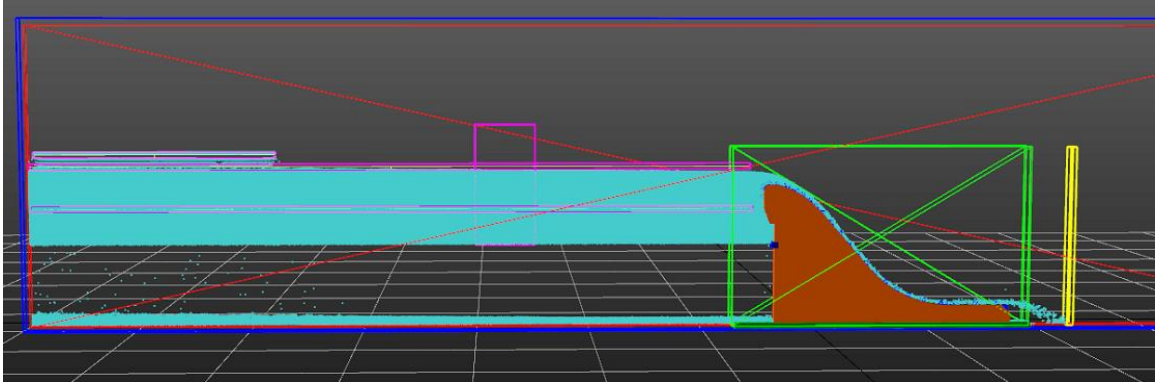


Figure 42: Run 2 leakage

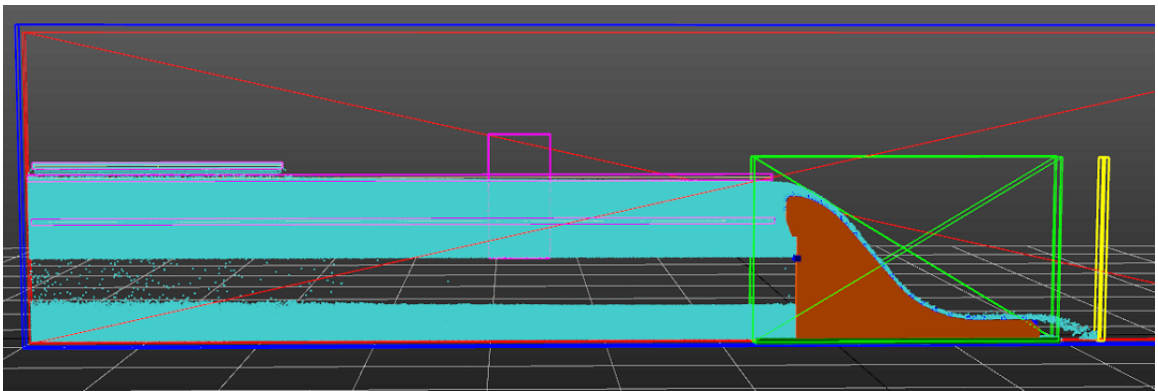


Figure 43: Run 3 leakage

In order to fix this leakage, another rigid cuboid was added. However, when rerunning the simulations, leakage was still occurring in the same location. Since the rigid cuboid did not fix the leakage, it was removed from the model. The next attempt at a solution was to reduce the time step value. Previously, the time step value was set at 0.02 seconds. Therefore, the time step value was reduced to 0.01 seconds. This was done so that the particles location would not be past the silt level between time steps resulting in leakage.

When the time step was reduced to 0.01 seconds while using a particle diameter of 0.25 m, Neutrino kept “Not Responding”. This caused problems because it drastically

increases the runtime if every time step Neutrino freezes up. In order to solve this new problem, the particle size needed to be increased. This was done so that there would be less particles for Neutrino to keep track of therefore resulting in Neutrino not freezing up. To determine what size to increase the particle diameter to, the particle size parametric study was consulted. Figure 44 shows the particle size parametric study results for water surface elevation vs. particle diameter with the points connected by a curved line.

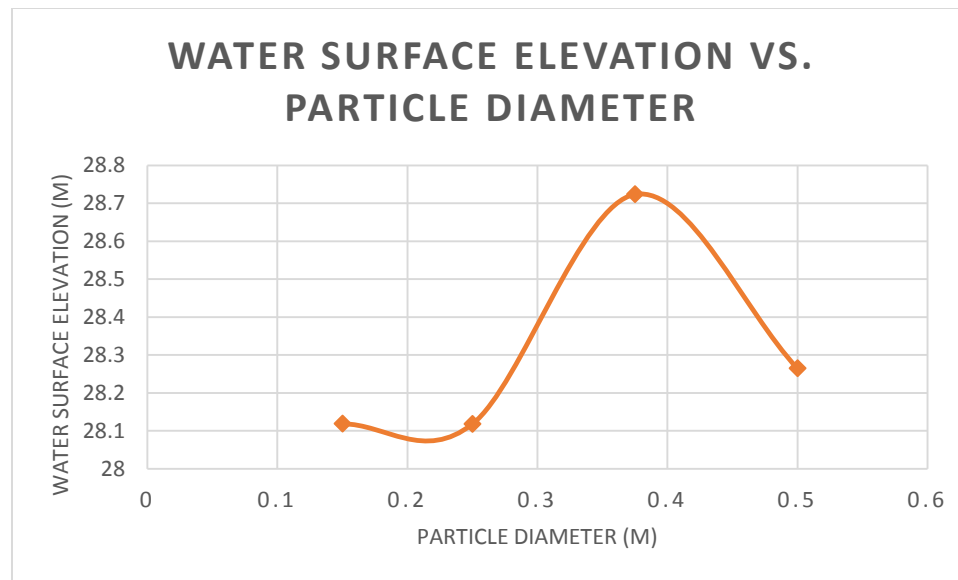


Figure 44: Water surface elevation vs. particle size with curved connection

Based on this plot and linear interpolation, if the particle diameter is increased to 0.3 m, then the water surface elevation would approximately be 24.4 m which is approximately 1.25 % different than the water surface elevation with a particle diameter of 0.25 m. Since the water surface elevation with the particle diameter of 0.5 m is approximately the same as the water surface elevation with the particle diameter of approximately 0.275 m, the particle diameter of 0.5 m is used to see if it fixes the freezing up issue as well as to decrease runtime and storage space. Additionally, the error between the particle diameter of 0.5 m and 0.25 m is only 0.52 % using the linear interpolation

assumption. By increasing the particle diameter to 0.5 m and decreasing the time step to 0.01 seconds, the leakage and “Not Responding” issues were fixed for the lower flow rates.

However, another leakage issue was found. The next particle leakage was going through the rigid body that is placed inside the spillway. Figure 45 shows the leakage in the spillway with the spillway set as invisible.

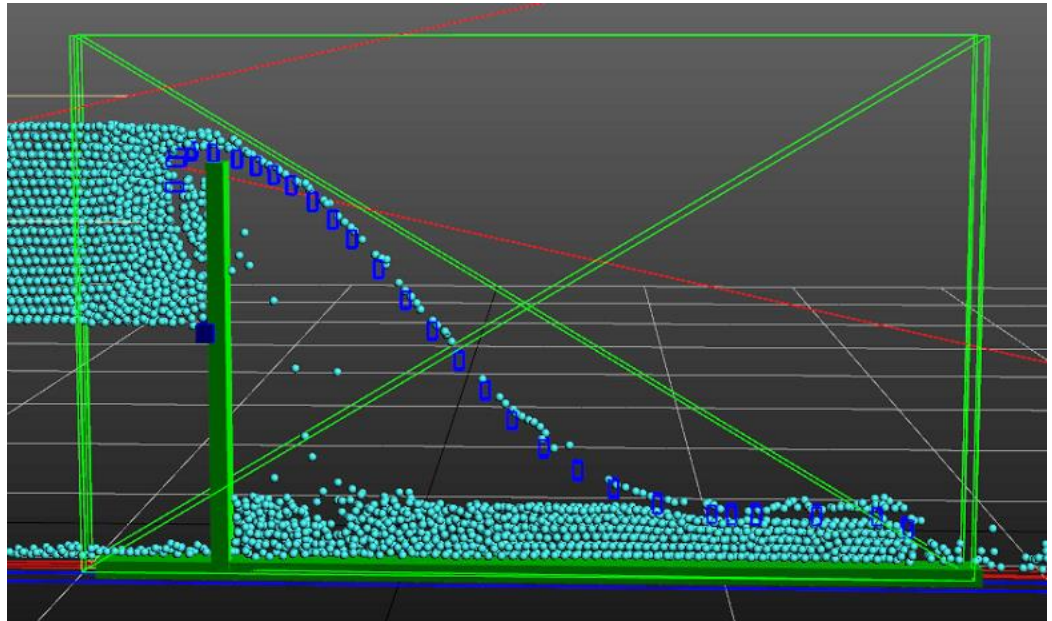


Figure 45: Leakage through spillway

In order to try and fix this leakage, two more rigid cuboids were added inside the spillway. After adding these two rigid cuboids, the leakage was reduced in the spillway. Figure 46 shows the reduced leakage setup.

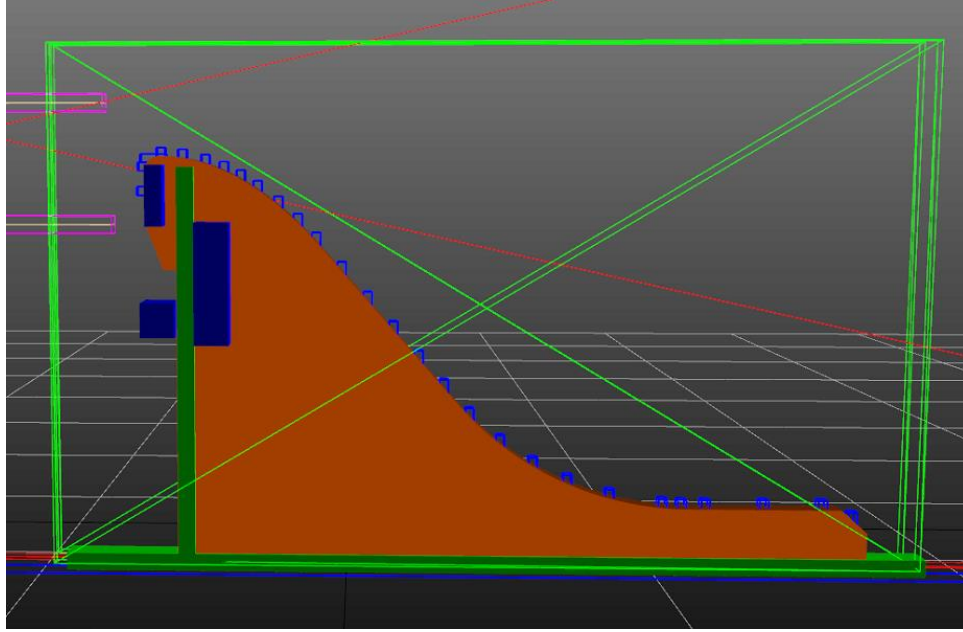


Figure 46: Reduced leakage setup through spillway

After looking at the new setup, more leakage was occurring as the particles went down the spillway. Figure 47 shows the leakage on the spillway.

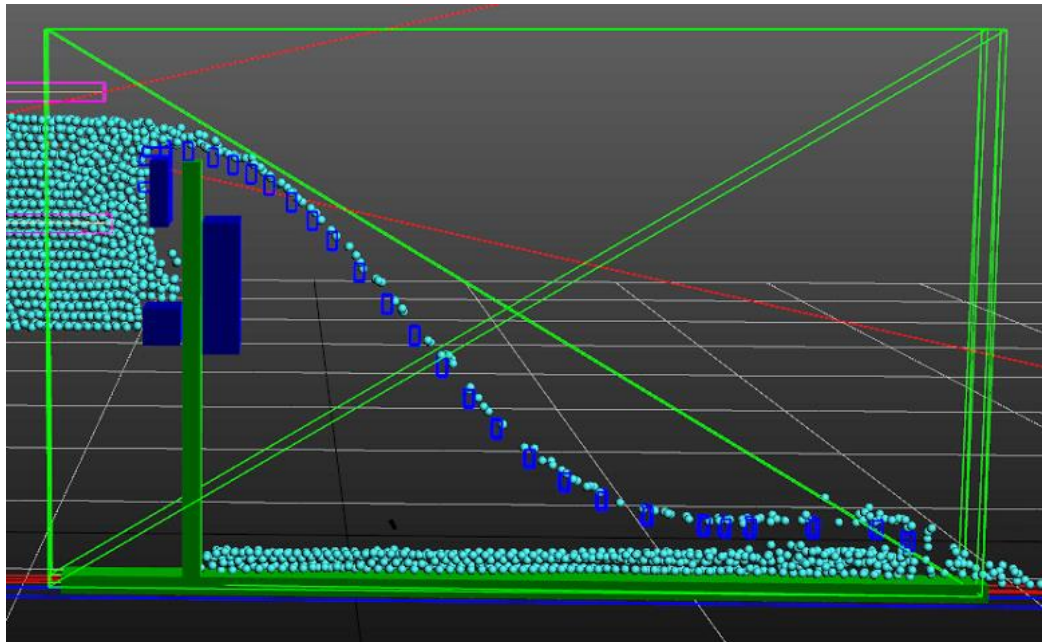


Figure 47: Leakage on the spillway

Since the particles are leaking at one main locations along the spillway, another rigid cuboid was added to that section. After adding the rigid body to the spillway, the leakage was reduced as shown in Figure 48.

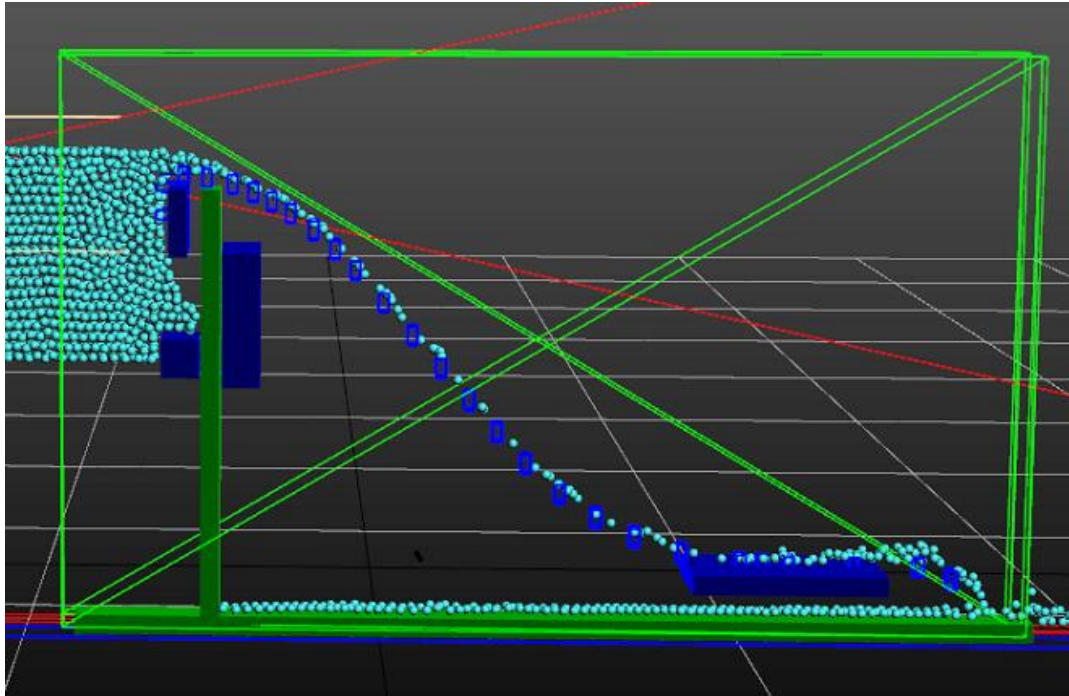


Figure 48: Reduced leakage setup on spillway

After fixing most of the leakage, several issues with the flow particle emitters were determined. The first issue is that the flow particle emitter will queue particles before they are released. Figure 49 shows the particle queue.

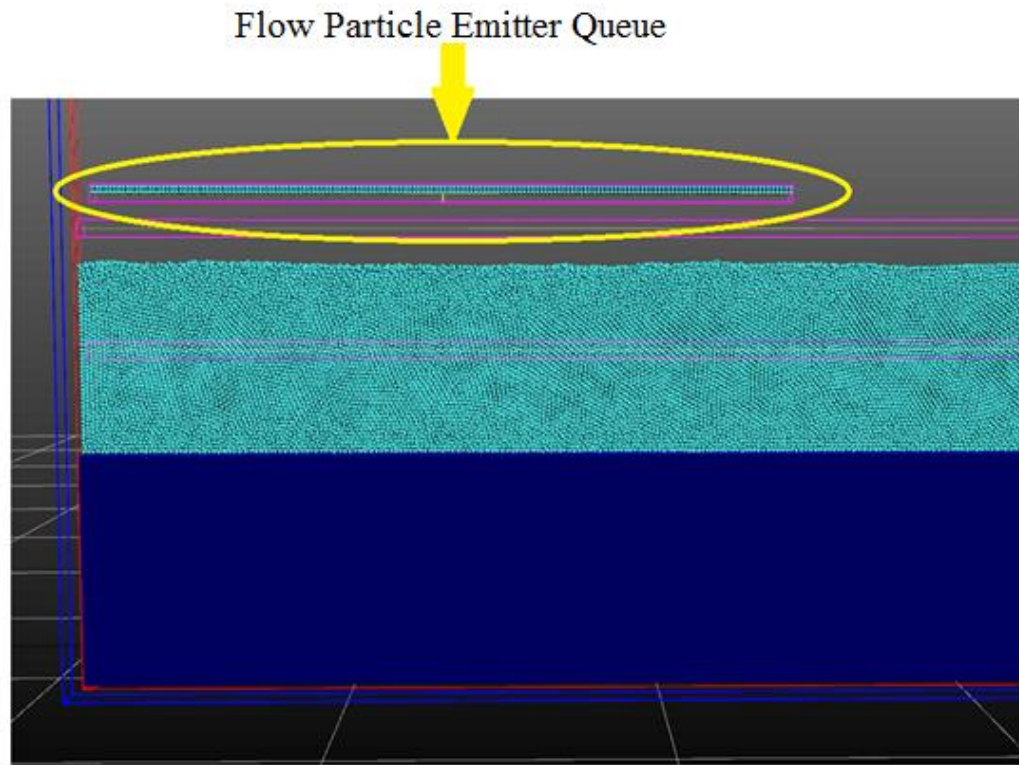


Figure 49: Flow particle emitter queue

The problem that the queue causes is it acts as a wall so that particles cannot go through the queue. This creates a pressure buildup when the particles are filling up the area below the particle emitter. Therefore, once all the particles from the queue have been released, the particles essentially explode out. Figure 50 shows the particle explosion from the buildup.

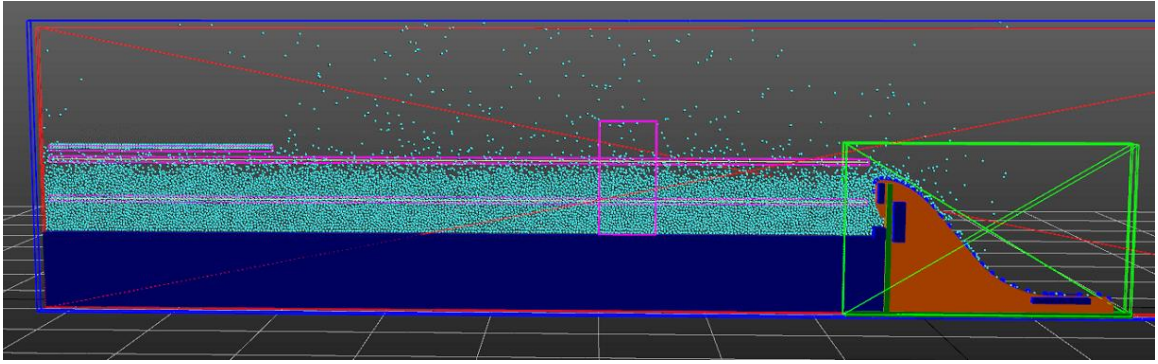


Figure 50: Queue particle explosion

The next issue is that the flow particle emitter will occasionally explode particles out instead of a steady stream of particles. This causes splashing of the water surface particles and results in an uneven water surface. Figure 51 shows the uneven water surface from the exploding flow rate particle emitter.

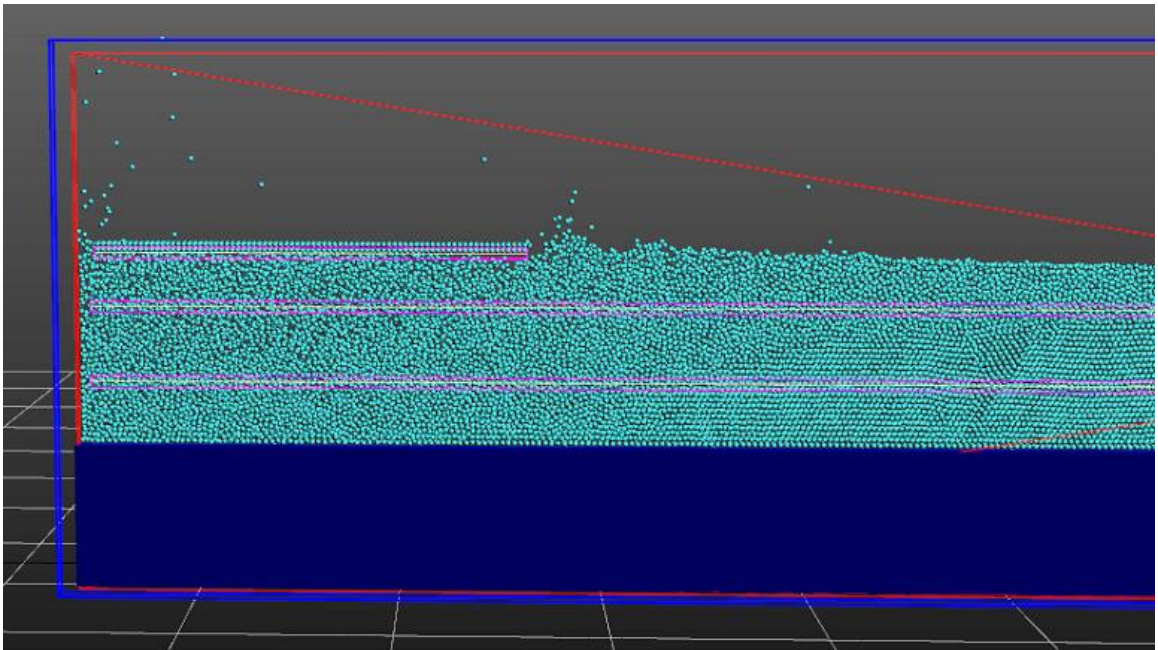


Figure 51: Uneven water surface from flow rate particle emitter

Since these issues kept occurring with the flow particle emitters, the square particle emitters were reconsidered. The developer was contacted regarding why the square particle

emitter was considered unstable. The reason it is considered unstable is because the area of the particle emitter does not match the area of the particles. This means that the velocity of the particles that the user sets and the area of the square particle emitter cannot be used to determine the flow rate. In order to determine the actual flow rate of the particles, a measurement field can be placed around the square particle emitter. Therefore, the square particle emitter can be used, but the flow rate must be measured with a measurement field. The flow particle emitters were replaced back with the square particle emitters since they did not cause splashing and explosion of the particles.

Final Neutrino Model

The final Neutrino model was comprised of the following components:

- 1 rigid custom (spillway)
- 1 rigid box (flume)
- 9 rigid cuboids (1 for silt level, 8 for leakage)
- 1 IISPH fluid solver
- 3 square particle emitters
- 30 measurement fields (1 for flow rate, 1 for head, 28 for pressure)
- 2 particle killers

All of the components above have been discussed previously with the exception of the particle killers. One particle killer was incorporated into the Neutrino model to remove particles once they were off the spillway. The other particle killer was placed around the flume so that any particle that leaves the flume will be removed from the simulation. Both of these particle killers were added in order to decrease the run time by removing particles from the system that no longer mattered.

The final dimensions of the Neutrino model are:

- Spillway: 23.25 m high by 40.05 m long by 1.5 m wide
- Minimum flume: 50 m high by 225 m long by 1.5 m wide
- Maximum flume: 80 m high by 250 m long by 1.5 m wide
- Minimum silt level: 13.41 m high by 125 m long by 1.5 m wide
- Maximum silt level: 13.41 m high by 150 m long by 1.5 m wide
- Minimum fill square particle emitters: 120 m long by 1.5 m wide
- Maximum fill square particle emitters: 145 m long by 1.5 m wide
- Minimum flow rate square particle emitter: 20 m long by 1.5 m wide
- Maximum flow rate square particle emitter: 30 m long by 1.5 m wide

- Minimum head measurement field: 20 m high by 10 m long by 0.75 m wide
- Maximum head measurement field: 50 m high by 10 m long by 0.75 m wide

The particle emitters for filling the flume behind the spillway had a velocity set at 2 m/sec. This velocity was chosen because it allowed for the area behind the spillway to be filled up quickly, but it would not cause splashing of the particles. The lowest particle emitter was turned on for the first 150 time steps. After that, the lowest particle emitter was turned off and all particle emitters were turned off for 50 time steps. This allowed for the particles to calm down before the next emitter was turned on. Next, the middle particle emitter was turned on for 250 time steps and then it was turned off. The highest particle emitter was then turned on for the rest of the simulation using the flow rate based on each of the physical result runs.

Each run was simulated for 9,000 frames where each frame represents 0.02 seconds of real time. Therefore, 3 minutes of each run was simulated. For the measurements, the measurements were taken during the last 1,500 frames, or for the last 30 seconds of the simulation. This was done so that there would be enough data points to get a good average for the measurement and because steady state had been reached by that time frame. The steady state was determined by plotting the water surface elevation vs. time step as well as the standard deviation. This was done for lowest and the highest flow rate. Figure 52 shows the water surface elevation vs. time step plot for the lowest flow rate, Figure 53 shows the standard deviation vs. time step plot for the lowest flow rate, Figure 54 shows the water surface elevation vs. time step plot for the highest flow rate, and Figure 55 shows the standard deviation vs. time step plot for the highest flow rate. The standard deviation plot starts at 60 seconds since prior to that time the area behind the flume was being filled.

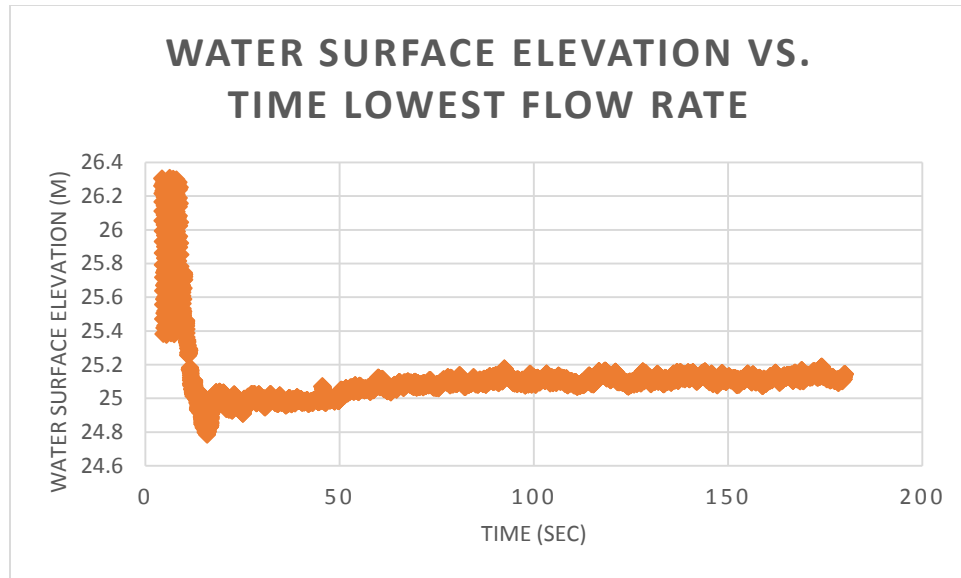


Figure 52: Water surface elevation vs. time lowest flow rate plot

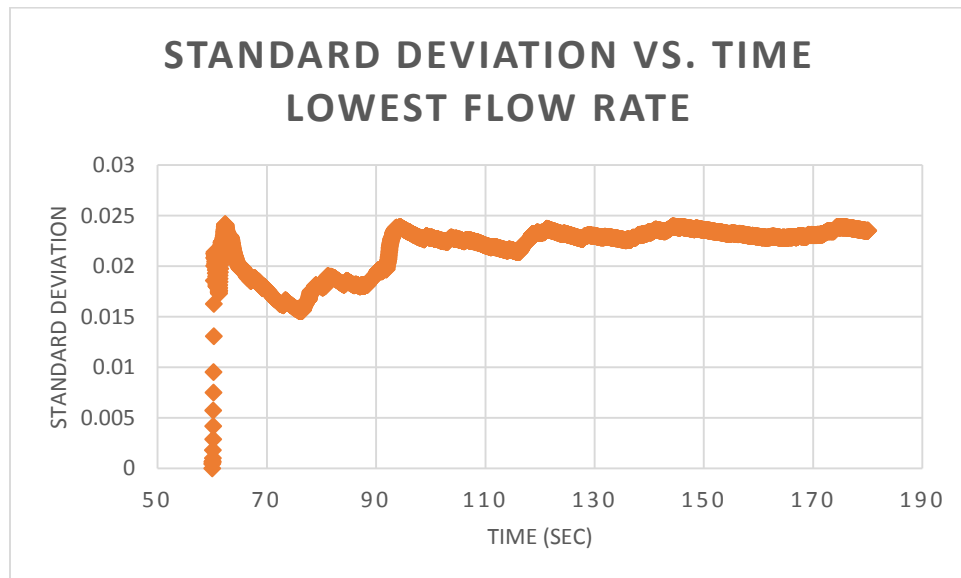


Figure 53: Standard deviation vs. time lowest flow rate plot

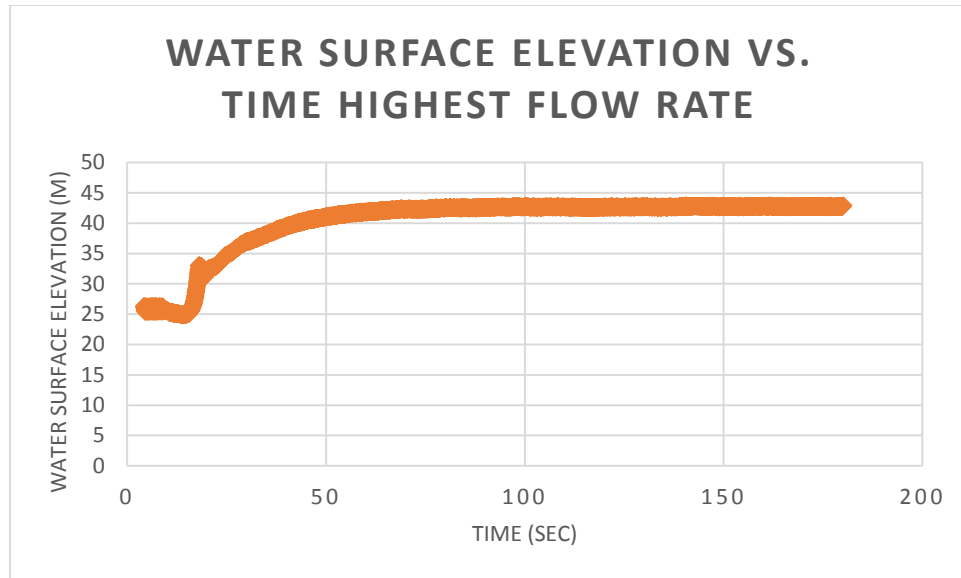


Figure 54: Water surface elevation vs. time highest flow rate plot

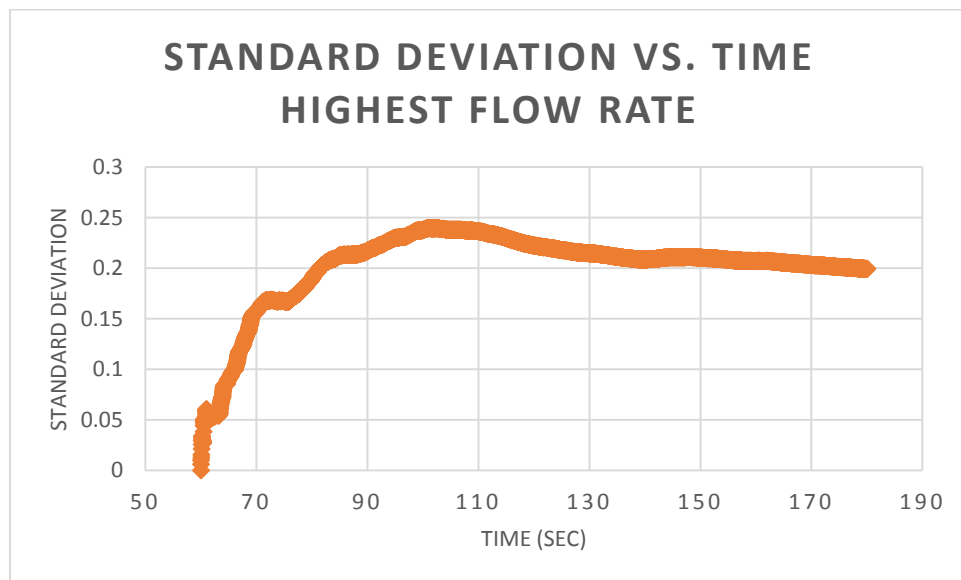


Figure 55: Standard deviation vs. time highest flow rate plot

Based on the above results, both of the water surface elevation plots show that the steady state has occurred. Both of the standard deviation plots show that the standard deviation evens out. Therefore, based on both sets of results, the steady state section has occurred.

As for the fluid properties of the model, most of the values for the fluid and rigid body were left alone such as surface tension, fluid adhesion, and rigid friction. This was because the developer had stated that the values provided are empirical and that the units are not physically accurate. Therefore, the values were not adjusted. The only value that was adjusted was the kinematic viscosity because the developer stated that that term was okay to change. Therefore, the kinematic viscosity value was changed to $1.4 \times 10^{-6} \text{ m}^2/\text{s}$. The reason that this value was chosen was because it is the kinematic viscosity of water at 7.78°C which was the temperature of the water during the physical experiment.

The length of the Neutrino model was adjusted as the flow rate increased. The reason for adjusting the length behind the spillway was because as the flow rate increased, the velocity of the particles increased. This results in more waves occurring which requires a longer section before the uniform flow section occurs.

The height of the flume was also adjusted to allow for a higher water level at the higher flow rates. Additionally, the flow rate square particle emitter length was also adjusted. This was done so that the required flow rate could be reached and so that the velocity would be less in order to reduce the chance of splashing. The flow rate square particle emitter was also raised as the flow rate increased so that the emitter would not be underwater which could cause splashing.

For all of the results, Neutrino version vc12_2016_08_29 was used.

Results

For the following results, the simulations were run on two different computers. One is a Xi computer and the other is a HP computer. The details of the Xi computer are as follows:

- 32 GB RAM
- 1 TB Hard drive
- 15 TB External storage
- 2 NVidia GeForce GTX Titan X 12 GB graphics cards
- 3.00 GHz Intel® Core™ i7-5960X CPU

The details of the HP computer are as follows:

- 16 GB RAM
- 2 TB Hard drive
- 1 NVidia GeForce GTX 850M 4GB graphics card
- 2.40 GHz Intel® Core™ i7-5500U CPU

The reason that two computers were used was so that multiple runs could be conducted at the same time. If more than one run was being simulated on the same computer, the computer and Neutrino would freeze up causing the runtime to drastically increase.

After simulating the ten different runs, the details of each run were obtained. Table 3 shows the details of each run.

Table 3: SPH result details

Run	Simulation Time (hours)	Number of Particles at End	Storage Space (GB)	Length Behind Spillway (m)	Computer Used
1	0.89	11,348	50.5	125	Xi
2	1.98	13,107	56.9	125	Xi
3	1.90	15,189	64.2	125	HP
4	2.01	20,790	86.2	150	HP
5	2.25	23,276	95.8	150	HP
6	2.24	26,008	107	150	Xi
7	2.36	29,110	119	150	Xi
8	4.03	31,345	128	150	HP
9	3.06	35,179	144	150	Xi
10	3.39	38,769	158	150	Xi

The following results are the comparison between the SPH and the physical results for the total head and flow rate calculations. Table 4 shows the physical results, SPH results, and the error between the two for each run. Figure 56 shows a plot of the total head vs. flow rate for both the SPH and physical results and Figure 57 shows a plot of the total head relative errors between the SPH and physical results.

Table 4: SPH and physical results for total head and flow rate comparison

Run	Flow Rate (m³/s/m)	Physical Total Head Result (m)	SPH Total Head Result (m)	Relative Error (%)
1	1.90	24.27	25.13	3.56
2	6.03	25.33	26.96	6.42
3	12.29	26.48	28.89	9.10
4	19.02	27.37	30.61	11.84
5	27.92	28.47	32.26	14.04
6	37.79	29.50	34.53	17.05
7	48.24	30.44	36.83	20.98
8	58.86	31.35	38.50	22.81
9	73.77	32.42	41.17	27.00
10	89.90	33.45	43.65	30.50

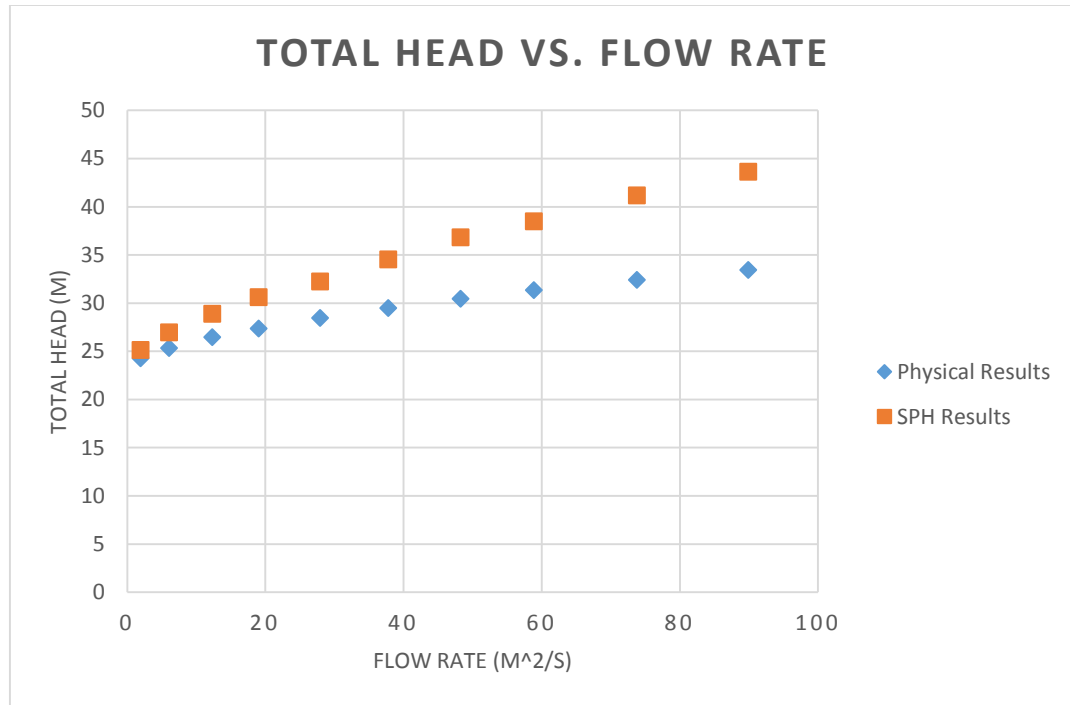


Figure 56: SPH and physical total head results plot

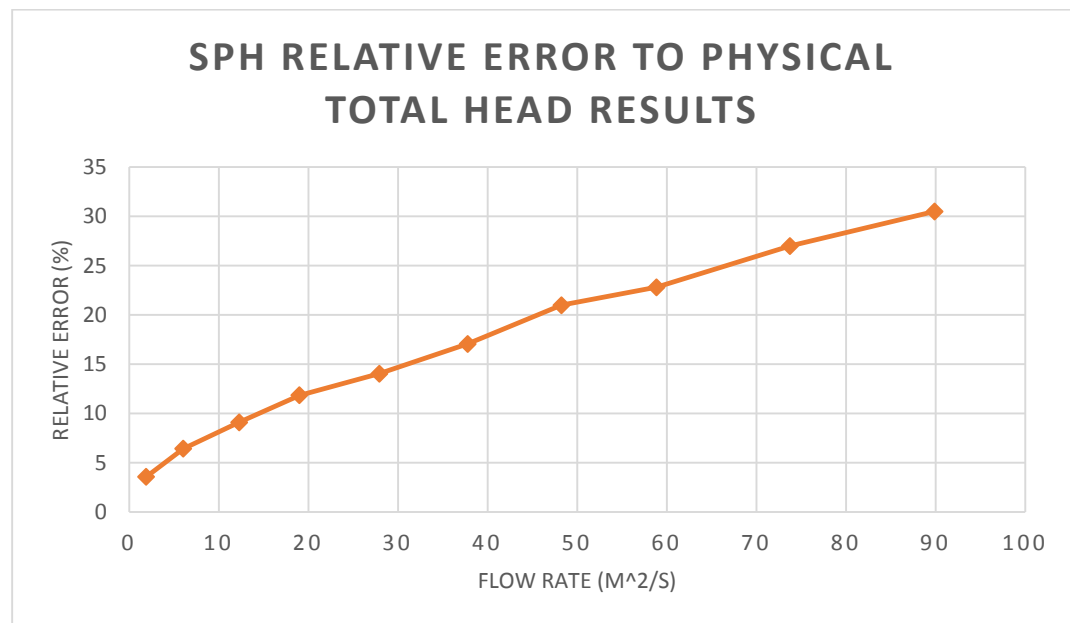


Figure 57: SPH total head relative error plot

From the previous results, the SPH total head results increase as the flow rate increases. However, as the flow rate increases the error between the SPH total head results

and the physical results increases. In order to determine if particle size would make a difference and since it was assumed earlier on that the larger particle size should provide similar results to a smaller particles size, the run with the largest error, run 10, was reran using a particle size of 0.25 m. This was done to determine if the smaller particle size result would provide better data. However, after running the simulation for 3,000 time steps, the simulation had already been running for over 13 hours. Therefore, the total head at time step 3,000 was compared to the total head at time step 3,000 of the 0.5 m particle diameter run.

After comparing the results, the 0.25 m particle diameter provided a total head approximately 7.71% lower than the 0.5 m particle size. If the total head calculated at the time step 3,000 was considered the average total head, then the relative percent error would drop from 30.50% to 18.12%. Therefore, the particle size does provide a reduction in the relative percent error, but it costs in runtime since Neutrino freezes with the smaller particle size.

The next comparison that was done was to see if the model width was wide enough for the higher flow rates. This was done because the width parametric study was done at a low flow rate and not the higher flow rates. Therefore, the width of the model was increased from 1.5 m to 3 m. The first simulation that was done with the larger width was run 10. After rerunning the model, the increased width decreased the total head relative error from 30.50% to 5.43%. Since the increased width decreased the relative percent error drastically, all runs were redone with the wider width. Table 5 shows the details of the 3 m wide runs, Table 6 shows the results of the 3 m wide runs, Figure 58 shows a plot comparing the 3 m wide runs and the physical results, and Figure 59 shows a plot of the relative percent error.

Table 5: SPH 3 m wide run details

Run	Simulation Time (hours)	Number of Particles at End	Storage Space (GB)	Length Behind Spillway (m)	Computer Used
1	3.63	28,174	125	125	Xi
2	4.12	32,844	143	125	Xi
3	3.98	34,760	151	125	Xi
4	8.81	45,863	195	150	HP
5	6.92	50,632	215	150	HP
6	6.13	54,872	233	150	Xi
7	6.29	59,516	252	150	Xi
8	10.01	63,671	268	150	HP
9	5.56	62,116	263	150	Xi
10	5.35	67,233	283	150	Xi

Table 6: SPH 3 m wide run results

Run	Flow Rate (m³/s/m)	Physical Total Head Result (m)	SPH Total Head Result (m)	Relative Error (%)
1	1.90	24.27	24.85	2.40
2	6.03	25.33	26.72	5.50
3	12.29	26.48	27.47	3.73
4	19.02	27.37	28.57	4.37
5	27.92	28.47	30.03	5.48
6	37.79	29.50	31.34	6.23
7	48.24	30.44	32.80	7.74
8	58.86	31.35	34.14	8.89
9	73.77	32.42	33.72	4.02
10	89.90	33.45	35.27	5.43

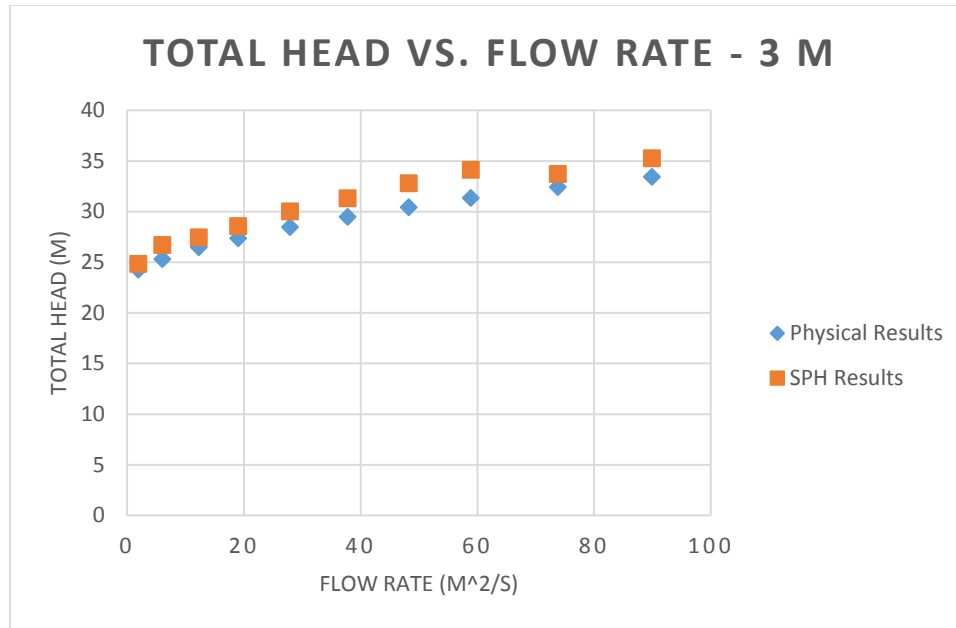


Figure 58: SPH and physical total head plot – 3 m wide

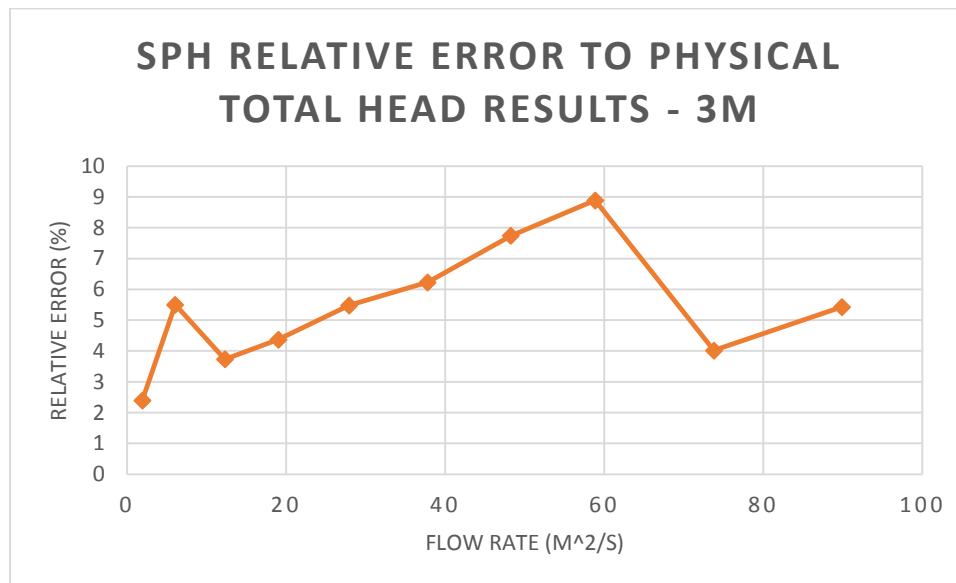


Figure 59: SPH total head relative percent error – 3 m wide

From the above results, the relative percent error for each run was able to be reduced to less than 10% by increasing the width of the model. However, these results show that a parametric study of the width needs to be conducted at different flow rates since the error drastically reduced for the highest flow rate when the width was increased.

Another interesting result was that the relative percent error decreased at the two highest flow rates instead of keeping the linear trend. One possible cause for this might be particle size. With the larger particle size, the entire particle has to be above the spillway in order for it to go over. Therefore, even at lower flow rates the water surface elevation might be the same as higher flow rates because fractions of particles cannot flow over the spillway. This might be the reason for the spike in relative error at run 8 and run 2. In order to determine if this is the case, more runs would need to be done at smaller particle sizes. However, this is left for future work.

The last result that was calculated was the figure of merit (FOM). The FOM is a measure of efficiency [36]. It considers the uncertainty and the runtime to determine if one model is more efficient than the next. Equation 24 shows the equation for calculating the FOM.

$$FOM = \frac{1}{\sigma^2 t}$$

Equation 24: Figure of merit equation

where σ is the uncertainty and t is the runtime. The larger the FOM, the more efficient the model.

The FOM was adapted for this situation in order to use the relative error instead of the uncertainty. The FOM was calculated for all the runs for the 1.5 m width and the 3 m width using the relative error and simulation runtime. Table 7 shows the calculated FOMs.

Table 7: Figure of merit results

Run	FOM – 1.5 m width	FOM – 3 m width
1	886.56	478.27
2	122.54	80.24
3	63.56 *	180.59 *
4	35.49	59.44
5	22.55	48.12
6	15.36	42.03
7	9.63	26.54
8	4.77	12.64
9	4.48	111.29
10	3.17	63.39

* 1.5 m wide run used HP computer and 3 m wide run used Xi computer. However, the run time for the HP and Xi computer at the 1.5 m width are similar so FOM calculations would not be drastically different.

Based on the FOM results, all but two of the runs had an improved FOM with the increased model width. The two runs that did not have an improved FOM were run 1 and run 2. The reason was because the error was not drastically reduced, but the runtime was. Therefore, the 1.5 m wide model was a more efficient model for runs 1 and 2, but the 3 m wide model was a more efficient model for runs 3 through 10.

Improvements and Future Work

The study results for the SPH model provided relative percent errors as high as 30.50% in regards to the physical results when using a model width of 1.5 m. However, the relative percent errors decreased once the model width was increased to 3 m. Nevertheless, there are several improvements that need to be made for this model. The first improvement would be to find a setup that would remove all of the leakage. With the above setup, leakage was drastically reduced, but did not completely remove all leakage. The next improvement would be to rerun the ten runs, at the 3 m width, using a smaller particle size. This would determine if the particle size would change the trend of the relative percent errors for the 3 m width. Additionally, more research needs to be done on the square particle emitter. This needs to be done because the flow rate was determined when the first particles were emitted. The flow rate was not calculated for multiple particle emissions. Therefore, research needs to be done to determine if the flow rate is the same for every particle emission.

Besides improvements, there needs to be more work done with the model. The one thing that needs to be done is to conduct the parametric studies at the higher flow rates. This needs to be done to determine if the flow rate has any influence on the allowed width and particle size. Also, a more detailed particle size parametric study needs to be done in order to determine where the spike in water surface elevation begins and ends. Besides the two parametric studies that were done, there are many other comparison and parametric studies. Other comparisons and parametric studies that could be done are:

- Comparison between model scale and prototype scale
- Comparison between the different compressibility models

- Comparison between the different viscosity models
- Comparison between the different time stepping schemes
- Comparison between the different smoothing kernels
- Comparison between different particle emitter locations
- Comparison between different particle emitter sizes
- Comparison between model width and particle size
- Parametric study on length of model
- Parametric study on the time step value
- Parametric study on fluid properties such as viscosity, density, and surface tension
- Parametric study on rigid body properties such as density, rigid friction, and fluid adhesion
- Sensitivity analysis on SPH parameters

In the future, these comparisons should be done to determine what parameters are most important to know and what SPH setup provides the most realistic results.

Other particle emitter setups also need to be researched more. The reason for this is because more information has been gained about setting up the model that was not known when particle emitter locations were being determined. Therefore, some of the other particle emitter locations and setups might provide a better model. Another task that needs to be done is to create the model in a different code. There have been issues found with Neutrino so it would be a good idea to create a model in a different code to determine if the flaw is with Neutrino or SPH.

Finally, a reliable model needs to be constructed such that the model does not need to be changed depending on the flow rate. From the above results, the length and the height of the flow rate square particle emitter had to be changed as the flow rate increased. Therefore, a model needs to be constructed so that the only thing that gets changed is the

flow rate and not the setup. Once a reliable model is constructed, pressure measurements need to be done to compare the pressure results from SPH to the physical results.

Once the total head and pressure results are determined, the next step is to add tailwater to the spillway and then compare those SPH results to physical results. Another comparison that can be done is to change the spillway from a horizontal apron ogee spillway to a flip bucket ogee spillway. This would allow for another comparison as well as to determine if the constructed model can work with a different spillway. Again, the flip bucket ogee spillway could also be compared with the addition of tailwater to the spillway.

Conclusion

A Neutrino model was constructed for the flow over an ogee spillway comparison. The final results using a model width of 3 m and a particle size of 0.5 m provided relative percent errors less than 10 % for all 10 runs. However, the results also showed that there is a lot more work that needs to be done to create a dependable and realistic model.

At this point, SPH seems to be a reasonable option for the modeling of flooding scenarios as long as more work is done. How to create a realistic model needs to be determined so that models for situations that have not occurred can be simulated and provide realistic results. This is needed because there will not be physical data to compare the SPH results to and therefore the user cannot adjust parameters until the SPH results match physical results.

Once a method for determining how to create a realistic model is identified, more comparisons and test cases need to be performed to verify that method. After that has been done, SPH should be considered reliable for the modeling of flooding scenarios.

As long as SPH is capable of producing realistic models and results, the end goal will be to incorporate flooding failure data into an SPH code or to couple an SPH code with a risk assessment code. This will allow for flooding scenarios to be modeled so that the damage of a flooding event can be determined before it happens. It would also identify actions that need to be taken in order to reduce the damage. Overall, SPH seems like a promising method for modeling flooding scenario as long as more work is done.

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Appendix A: Smoothing Kernels

The following is a list of some of the more common smoothing kernels:

1. Gaussian Kernel

$$W(x, h) = \frac{1}{h\sqrt{\pi}} e^{-\frac{x^2}{h^2}}$$

Equation 25: Gaussian kernel 1D

$$W(\mathbf{r}, h) = \frac{1}{\pi h^2} e^{-\frac{r^2}{h^2}}$$

Equation 26: Gaussian kernel 2D

$$W(\mathbf{r}, h) = \frac{1}{\pi^{3/2} h^3} e^{-\frac{r^2}{h^2}}$$

Equation 27: Gaussian kernel 3D

r: distance between particle a and particle b

2. Quadratic Kernel

$$q = \frac{r}{h}$$

$$W(\mathbf{r}, h) = \frac{2}{\pi h^2} \left[\frac{3}{16} q^2 - \frac{3}{4} q + \frac{3}{4} \right] \quad 0 \leq q \leq 2$$

Equation 28: Quadratic kernel 2D

$$W(\mathbf{r}, h) = \frac{5}{4\pi h^3} \left[\frac{3}{16} q^2 - \frac{3}{4} q + \frac{3}{4} \right] \quad 0 \leq q \leq 2$$

Equation 29: Quadratic kernel 3D

3. Cubic Spline

$$q = \frac{r}{h}$$

$$W(\mathbf{r}, h) = \alpha_0 \begin{cases} 1 - \frac{3}{2}q^2 + \frac{3}{4}q^3 & 0 \leq q \leq 1 \\ \frac{1}{4}(2 - q)^3 & 1 \leq q \leq 2 \\ 0 & q \geq 2 \end{cases}$$

Equation 30: Cubic spline

$$\alpha_0 = \frac{10}{7\pi h^2}$$

Equation 31: Cubic spline 2D coefficient

$$\alpha_0 = \frac{1}{\pi h^3}$$

Equation 32: Cubic spline 3D coefficient

4. Quintic Kernel

$$q = \frac{\mathbf{r}}{h}$$

$$W(\mathbf{r}, h) = \alpha_0 \left(1 - \frac{q}{2}\right)^4 (2q + 1) \quad 0 \leq q \leq 2$$

Equation 33: Quintic kernel

$$\alpha_0 = \frac{7}{4\pi h^2}$$

Equation 34: Quintic kernel 2D coefficient

$$\alpha_0 = \frac{21}{16\pi h^3}$$

Equation 35: Quintic kernel 3D coefficient

5. Spikey Kernel

$$W(\mathbf{r}, h) = \frac{15}{\pi h^6} \begin{cases} (h - \mathbf{r})^3 & 0 \leq \mathbf{r} \leq h \\ 0 & \mathbf{r} > h \end{cases}$$

Equation 36: Spikey kernel

6. Poly6 Kernel

$$W(\mathbf{r}, h) = \frac{315}{64\pi h^4} \begin{cases} (h^2 - \mathbf{r}^2)^3 & 0 \leq \mathbf{r} \leq h \\ 0 & \mathbf{r} > h \end{cases}$$

Equation 37: Poly6 kernel

Appendix B: Artificial and Full Viscosity

The following are the momentum equations with the artificial and full viscosity terms.

1. Artificial viscosity – Used for simplicity [16]

$$\frac{d\mathbf{v}_i}{dt} = - \sum_j m_j \left(\frac{P_j}{\rho_j^2} + \frac{P_i}{\rho_i^2} + \psi_{ij} \right) \nabla_i W_{ij} + \mathbf{g}$$

$$\psi_{ij} = \begin{cases} \frac{-\alpha \mathbf{c}_{ij} \mu_{ij}}{\rho_{ij}} & \mathbf{v}_{ij} \mathbf{r}_{ij} < 0 \\ 0 & \mathbf{v}_{ij} \mathbf{r}_{ij} > 0 \end{cases}$$

$$\mu_{ij} = \frac{h \mathbf{v}_{ij} \mathbf{r}_{ij}}{\mathbf{r}_{ij}^2 + \eta^2}$$

$$\mathbf{c}_{ij} = \frac{\mathbf{c}_i + \mathbf{c}_j}{2}$$

$$\eta^2 = 0.01 h^2$$

$$\mathbf{v}_{ij} = \mathbf{v}_i - \mathbf{v}_j$$

$$\mathbf{r}_{ij} = \mathbf{r}_i - \mathbf{r}_j$$

Equation 38: Artificial viscosity momentum equations

where $\mathbf{v}$ is the velocity vector, m is the mass, ρ is the density, P is the pressure, $\mathbf{g}$ is gravity, and $\mathbf{r}$ is the position vector.

Full viscosity – Used for modeling flow with turbulence [16]

$$\begin{aligned}\frac{d\mathbf{v}_i}{dt} = & - \sum_j m_j \left(\frac{P_j}{\rho_j^2} + \frac{P_i}{\rho_i^2} \right) \nabla_i W_{ij} + \mathbf{g} + \sum_j m_j \left(\frac{4v_0 \mathbf{r}_{ij} \nabla_i W_{ij}}{(\rho_i + \rho_j) |\mathbf{r}_{ij}|^2} \right) \mathbf{v}_{ij} \\ & + \sum_j m_j \left(\frac{\tau_j}{\rho_j^2} + \frac{\tau_i}{\rho_i^2} \right) \nabla_i W_{ij}\end{aligned}$$

$$\frac{\tau_{ij}}{\rho} = v_t \left(2S_{ij} - \frac{2}{3} k \delta_{ij} \right) - \frac{2}{3} C_I \Delta^2 S_{ij} |S_{ij}|^2$$

$$v_t = (c_s \Delta l)^2 |S|$$

$$|S| = (2S_{ij}S_{ij})^{1/2}$$

Equation 39: Full viscosity momentum equation

where τ is the sub particle stress tensor, v_t is the turbulence eddy viscosity, S is the element of SPS strain tensor, k is the SPS turbulence kinetic energy, C_I is 0.0066, c_s is the Smagorinsky constant (0.12), and Δl is the particle-particle spacing.

Appendix C: Alternative Equation of State

Besides the Tait equation, ideal gas law can be used as the equation of state. However, it should generally be used when modeling gas and not fluids. The ideal gas law equation is below:

$$P = k(\rho - \rho_0)$$

Equation 40: Pressure from ideal gas law

where P is the pressure, k is the gas stiffness constant, and ρ_0 is the rest density.

Appendix D: SPH Modification

The following includes more details on the SPH modifications discussed in the SPH theory section. Density reinitialization helps overcome the problem of the pressure field of the particles exhibiting large pressure oscillations [16]. There are two ways this can be done: Shepard filter or moving least squares. The Shepard filter is a zeroth order correction and is applied every 30 time steps. The moving least squares is a first order correction and is applied every 30 time steps.

Kernel renormalization is needed when there is a finite domain and a free surface because the smoothing kernel truncates due to the absence of neighboring particles [16]. There are two methods for kernel renormalization: kernel correction and kernel gradient correction. Kernel correction modifies the kernel so that the polynomial functions are interpolated exactly up to a given degree. Kernel gradient correction is used in the equation of motion instead of the original gradient. Riemann Solver is used to remove the pressure and velocity fluctuations of water [16].

Appendix E: Time Stepping

There are multiple different ways of time stepping to determine the new property values of the particle. To write the equations in simpler form, the following substitutions are used:

$$\frac{dv_i}{dt} = A_i$$

$$\frac{d\rho_i}{dt} = D_i$$

$$\frac{dr_i}{dt} = V_i$$

$$\frac{de_i}{dt} = E_i$$

The following are five different ways that can be used for time stepping:

1. Predictor-Corrector Scheme

$$v_i^{n+0.5} = v_i^n + \frac{\Delta t}{2} A_i^n$$

$$\rho_i^{n+0.5} = \rho_i^n + \frac{\Delta t}{2} D_i^n$$

$$r_i^{n+0.5} = r_i^n + \frac{\Delta t}{2} V_i^n$$

$$e_i^{n+0.5} = e_i^n + \frac{\Delta t}{2} E_i^n$$

Equation 41: Predictor-Corrector half time step equations

where n is the time step and Δt is the time step value.

The above equations will be used twice. The first time they will be used to find the value of the property at half the time step. The above equations will then be solved again with the force values for half of the time step. This means that all of the terms multiplied by delta t divided by 2 will be of $n + 0.5$ not of n . After that is done, the equations below will be used to find the actual value at the next time step.

$$\mathbf{v}_i^{n+1} = 2\mathbf{v}_i^{n+0.5} - \mathbf{v}_i^n$$

$$\rho_i^{n+1} = 2\rho_i^{n+0.5} - \rho_i^n$$

$$\mathbf{r}_i^{n+1} = 2\mathbf{r}_i^{n+0.5} - \mathbf{r}_i^n$$

$$\mathbf{e}_i^{n+1} = 2\mathbf{e}_i^{n+0.5} - \mathbf{e}_i^n$$

Equation 42: Predictor-Corrector full time step equations

2. Verlet Scheme

$$\mathbf{v}_i^{n+1} = \mathbf{v}_i^{n-1} + 2\Delta t \mathbf{A}_i^n$$

$$\rho_i^{n+1} = \rho_i^{n-1} + 2\Delta t D_i^n$$

$$\mathbf{r}_i^{n+1} = \mathbf{r}_i^n + \Delta t \mathbf{V}_i^n + 0.5\Delta t^2 \mathbf{A}_i^n$$

$$\mathbf{e}_i^{n+1} = \mathbf{e}_i^{n-1} + 2\Delta t \mathbf{E}_i^n$$

Equation 43: Verlet general equations

The above equations will be used most of the time, but every M steps (~ 50) the below equations must be used. By using the below equations, it will prevent the time integration from diverging.

$$\mathbf{v}_i^{n+1} = \mathbf{v}_i^n + \Delta t \mathbf{A}_i^n$$

$$\rho_i^{n+1} = \rho_i^n + \Delta t D_i^n$$

$$\mathbf{r}_i^{n+1} = \mathbf{r}_i^n + \Delta t \mathbf{V}_i^n + 0.5 \Delta t^2 \mathbf{A}_i^n$$

$$e_i^{n+1} = e_i^n + \Delta t E_i^n$$

Equation 44: Verlet occasional equations

3. Symplectic scheme is time reversible with the absence of friction or viscous effects [16]

$$\rho_i^{n+0.5} = \rho_i^n + \frac{\Delta t}{2} D_i^n$$

$$\mathbf{r}_i^{n+0.5} = \mathbf{r}_i^n + \frac{\Delta t}{2} \mathbf{V}_i^n$$

$$\mathbf{r}_i^{n+1} = \mathbf{r}_i^{n+0.5} + \frac{\Delta t}{2} \mathbf{V}_i^{n+1}$$

Equation 45: Symplectic equations

Lastly, calculate the change in density using the new velocity and position values.

4. Beeman Scheme

$$\mathbf{v}_i^{n+0.5} = \mathbf{v}_i^n + 1.5 \Delta t \mathbf{A}_i^n - 0.5 \Delta t \mathbf{A}_i^{n-1}$$

$$\rho_i^{n+0.5} = \rho_i^n + 1.5 \Delta t D_i^n - 0.5 \Delta t D_i^{n-1}$$

$$\mathbf{r}_i^{n+0.5} = \mathbf{r}_i^n + \Delta t \mathbf{V}_i^n + \frac{2}{3} \Delta t^2 \mathbf{A}_i^n - \frac{1}{6} \Delta t^2 \mathbf{A}_i^{n-1}$$

$$e_i^{n+0.5} = e_i^n + 1.5 \Delta t E_i^n - 0.5 \Delta t E_i^{n-1}$$

Equation 46: Beeman predictor equations

$$\mathbf{v}_i^{n+1} = \mathbf{v}_i^n + \frac{5}{12} \Delta t \mathbf{A}_i^{n+0.5} + \frac{8}{12} \Delta t \mathbf{A}_i^n - \frac{1}{12} \Delta t \mathbf{A}_i^{n-1}$$

$$\rho_i^{n+1} = \rho_i^n + \frac{5}{12}\Delta t D_i^{n+0.5} + \frac{8}{12}\Delta t D_i^n - \frac{1}{12}\Delta t D_i^{n-1}$$

$$\mathbf{r}_i^{n+1} = \mathbf{r}_i^n + \Delta t \mathbf{V}_i^n + \frac{1}{6}\Delta t^2 \mathbf{A}_i^{n+0.5} + \frac{1}{3}\Delta t^2 \mathbf{A}_i^n$$

$$e_i^{n+1} = e_i^n + \frac{5}{12}\Delta t E_i^{n+0.5} + \frac{8}{12}\Delta t E_i^n - \frac{1}{12}\Delta t E_i^{n-1}$$

Equation 47: Beeman corrector equations

5. Variable Time Step depends on the forcing terms, the viscosity terms, and the Courant condition [16]

$$\Delta t = 0.3 \min(\Delta t_f, \Delta t_{cs})$$

$$\Delta t_f = \min_i \left(\sqrt{\frac{h}{|f_i|}} \right)$$

$$\Delta t_{cv} = \min_j \left(\frac{h}{c_s + \max_i \left(\left| \frac{h \mathbf{v}_{ij} \mathbf{r}_{ij}}{\mathbf{r}_{ij}^2} \right| \right)} \right)$$

Equation 48: Variable time step equations

Appendix F: Result Data

The following table includes the results for the physical prototype model.

Table 8: Prototype flow rate and total head results

Run Number	Flow Rate (m³/s/m)	Total Head (including crest elevation) (m)
1	1.90	24.26
2	6.03	25.33
3	12.29	26.48
4	19.02	27.37
5	27.92	28.47
6	37.79	29.50
7	48.24	30.44
8	58.86	31.35
9	73.77	32.42
10	89.90	33.45

The following tables includes the results for the SPH models.

Table 9: SPH results for 1.5 m wide model

Run	Flow Rate (m³/s/m)	Water Surface Elevation (m)	X – direction Velocity (m/s)	Total Head (m)	Relative Error (%)
1	1.90	25.12236	0.330118	25.12791	3.56
2	6.03	26.92990	0.701696	26.95500	6.42
3	12.29	28.82172	1.159064	28.89019	9.10
4	19.02	30.48683	1.563888	30.61149	11.84
5	27.92	32.26474	1.989752	32.46653	14.04
6	37.79	34.22339	2.447703	34.52875	17.05
7	48.24	36.38967	2.924049	36.82545	20.98
8	58.86	37.96173	3.249073	38.49978	22.81
9	73.77	40.44625	3.778717	41.17401	27.00
10	89.90	42.73827	4.237320	43.65340	30.50

Table 10: SPH results for 3 m wide model

Run	Flow Rate (m³/s/m)	Water Surface Elevation (m)	X – direction Velocity (m/s)	Total Head (m)	Relative Error (%)
1	1.90	24.84377	0.281428	24.84781	2.40
2	6.03	26.69085	0.794937	26.72306	5.50
3	12.29	27.41289	1.037748	27.46778	3.73
4	19.02	28.46166	1.439786	28.56732	4.37
5	27.92	29.83540	1.949668	30.02914	5.48
6	37.79	31.04502	2.396375	31.33771	6.23
7	48.24	32.37718	2.870143	32.79704	7.74
8	58.86	33.59327	3.262874	34.13590	8.89
9	73.77	33.21861	3.147017	33.72339	4.02
10	89.90	34.61081	3.587490	35.26678	5.43

Appendix G: Neutrino Nuances, Issues, and Tips

Throughout the creating of the Neutrino model, a lot of nuances, issues, and tips were gathered about the Neutrino code. The following is a list of these items with an explanation of each.

- Particles have the possibility to leak through all rigid bodies.
 - Particles that leak through imported rigid bodies can generally be fixed by adding a rigid cuboid in the area of leakage.
 - Particles that leak through rigid bodies native to Neutrino can generally be fixed by reducing the time step of the SPH solver.
- The square particle emitter is unstable.
 - The reason it is considered unstable is because the flow rate cannot be calculated by the using the area of the emitter and the velocity of the particles. The square particle emitter includes gaps between the particles so the fluid area is not the same as the emitter area. A measurement field was used to determine the flow rate of the particles at the first time step they were admitted, but more research needs to be done to determine if the flow rate is the same for every particle emission.
- If the Neutrino model was run, the user cannot always add items to the model.
 - The user must shutdown Neutrino, reopen the model, and then add items to the model. This occurred while trying to add rigid cuboids and particle emitters after a model was ran.
- If the Neutrino model contains flow particle emitters, the user cannot pause the simulation and then restart it.

- If the user pauses the simulate, the particles from the flow particle emitter explode away from the emitter. Therefore, the entire simulation must be ran in one shot while using flow particle emitters. However, this is not the case when using square particle emitters.
- Similar to the above, time cannot be added to the Neutrino model if it contains flow particle emitters.
 - The same particle explosion from the source will occur.
- If the delete simulation data is hit, the data will delete no matter what.
 - The user can hit cancel or no, but the data will still be deleted.
- The SPH solver time step can cause a lot of problems if it is set too big.
 - One problem that a large time step can cause is the particle emitters will explode the particles out instead of emitting them at a steady rate.
 - Another problem that a large time step can cause is that the particles will leak through any rigid body. This is because the particles will be at one position at one time step and then the next time step the particle will be past the rigid cuboid which causes leakage.
- Neutrino has no measurement tool.
 - This causes a challenge because the user cannot determine how far away objects are from each other. Therefore, the positions of objects have to be eyeballed.
- The measurement field cannot export data to CSV for all values.

- Some of the parameters can be exported to a CSV file. However, the height and velocity cannot be. This required the text field to be edited into a CSV file so that it could be opened in Excel.
- The force on custom rigid bodies is not calculated.
 - The force on rigid bodies native to Neutrino can be calculated. However, if the rigid body is imported the force is not calculated.
- There is only one option for the time stepping scheme when using the IISPH solved.
- The measurements of imported rigid bodies are not given.
 - The imported rigid body is imported into Neutrino as is. It uses the origin and scale of how the object was drawn outside of Neutrino. However, the position and scale of the imported body is said to be at (0,0,0) and scale (1,1,1). This causes problems because the imported rigid body origin does not match the Neutrino origin. Therefore, it makes it challenging when adding objects native to Neutrino. Additionally, the scale is a challenge because the user needs to know the dimensions of the imported rigid body before importing into Neutrino since Neutrino does not provide the actual scale.
- A particle killer should be placed around the outside of the Neutrino model.
 - This is done so that if any particle leaks out of the model, they will be removed from the system. Otherwise, Neutrino will continue to track those particles no matter where they go.

- If a particle emitter is submerged in other fluid particles, the particle emitter will occasionally explode the particles.
- Originally, the measurement field would not export any data. However, this was fixed after contacting one of the developers.
- The pressure or force at a particular location on a rigid body is not calculated.
 - Only the total force on the rigid body is calculated, as long as the rigid body is native to Neutrino.
- The flow particle emitters queue particles before they are emitted.
 - The queue of particles acts as a wall. This can cause a pressure build up because the particles cannot get past the queue of particles. Therefore, once the queue of particles is removed, the particles explode out.
- Every time the Neutrino model is opened, the particle spacing of the rigid bodies has to be adjusted if it is different from the default value.
- Every time the Neutrino model is opened, the time step value has to be adjusted if it is different from the default value.
- Every time the Neutrino model is opened, the square particle emitter spacing has to be adjusted if it is different from the default value.
- Occasionally, if a change is made to the model and then the data is deleted, the model will then change back to the old model.
 - This can occur even if the model has been saved. Therefore, a way around it is to delete the data first and then make the changes. However, this can be an issue especially when trying to fix leakage. This is because the user wants to add change the model while the data is there

so that the specific location is known. If the user has to delete the data first every time, it makes fixing the leakage a little harder.

- If the particle spacing on the square particle emitter is too small, the particle will explode out of the emitter.
- If the user wants to compute the flow rate using a measurement field, the user must select compute flow rate and set the normal plane every run.
 - This is an issue when trying to determine a velocity that provides a specific flow rate because every time the velocity is changed the user has to reselect the compute flow rate and normal plane which takes time.
- The measurement field computes flow rate when the particles are at the center of the measurement field.
- Occasionally, if the file was created by “saving as” another file, after running the new file, the old model data will load.
 - In order to see the data for the new file, the user must shut Neutrino down and reopen the file.
- Neutrino will crash if the user opened a file and then tries to open a different file.
 - In order to open a new file, the user must shut Neutrino down, restart it, and then open the file.

Appendix H: SPH Run Pictures

The following are pictures of each of the runs provided in the results section.

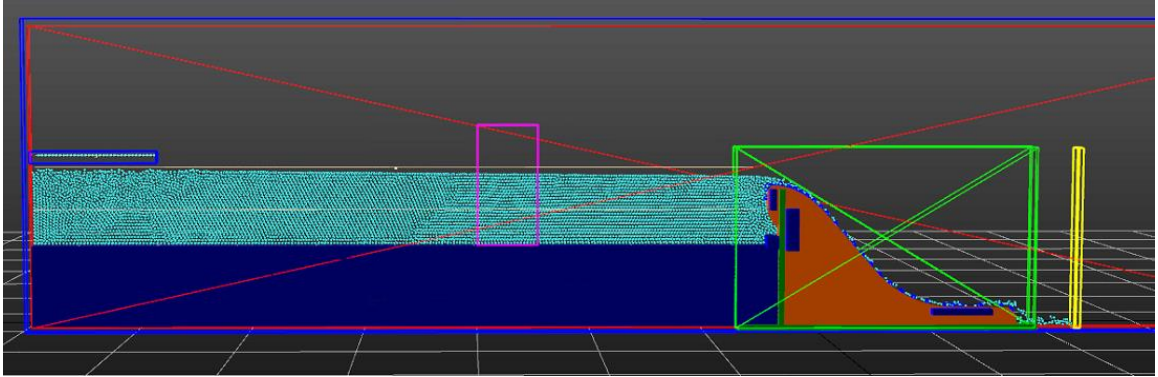


Figure 60: SPH run 1 – 1.5 m wide, 0.5 m particle diameter

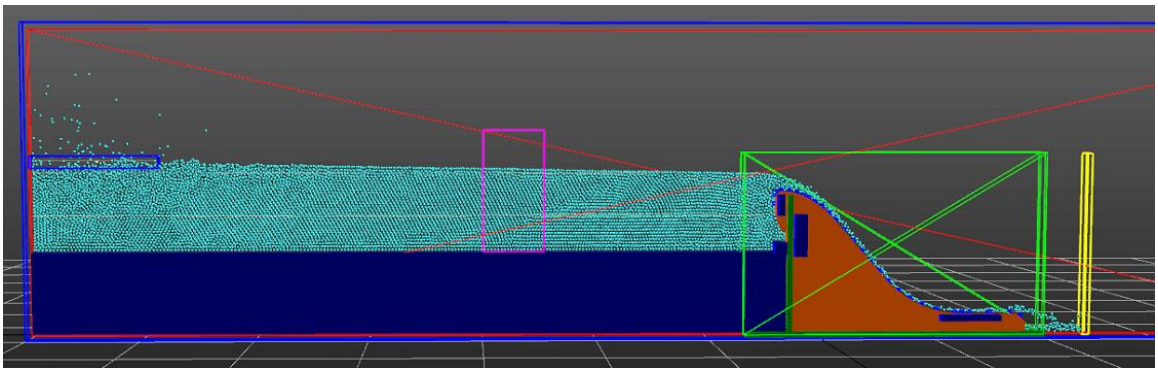


Figure 61: SPH run 2 – 1.5 m wide, 0.5 m particle diameter

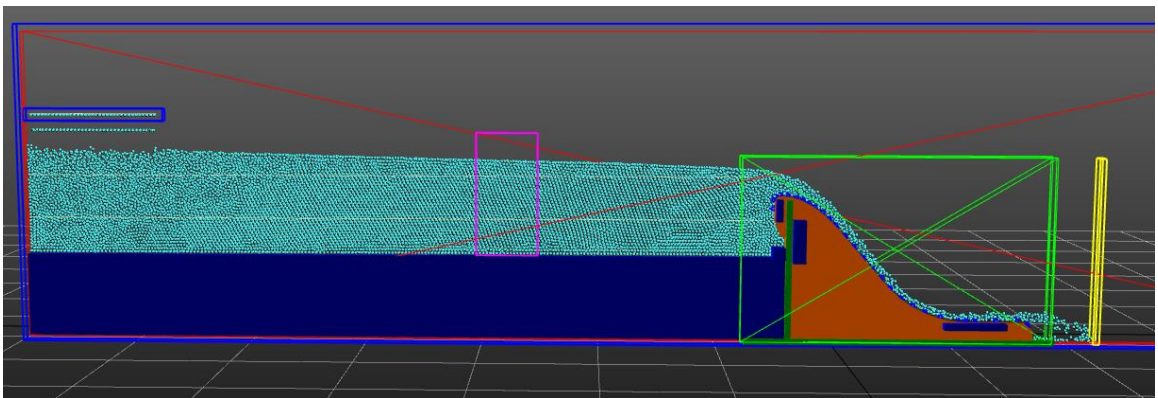


Figure 62: SPH run 3 – 1.5 m wide, 0.5 m particle diameter

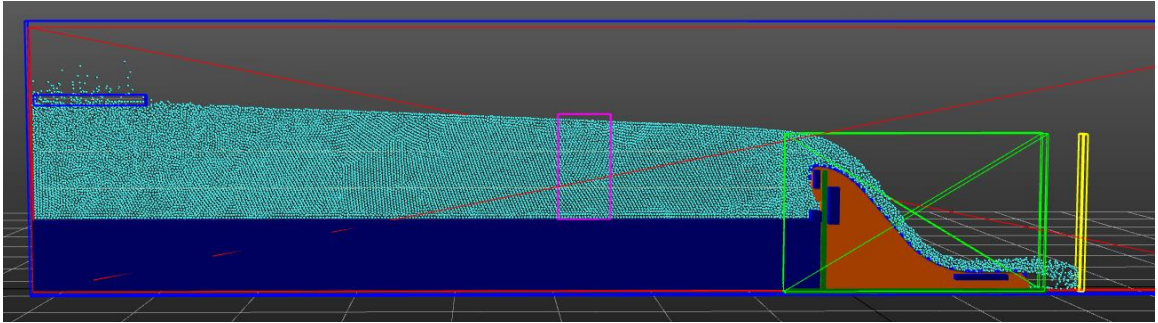


Figure 63: SPH run 5 – 1.5 m wide, 0.5 m particle diameter

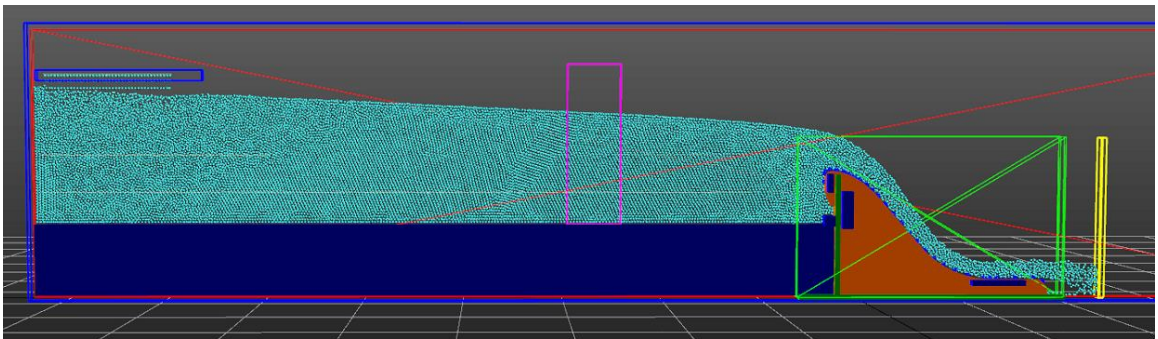


Figure 64: SPH run 6 – 1.5 m wide, 0.5 m particle diameter

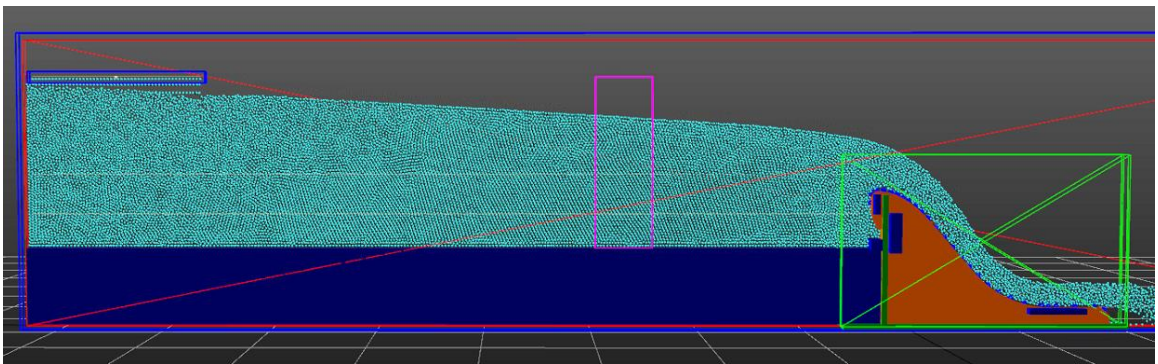


Figure 65: SPH run 7 – 1.5 m wide, 0.5 m particle diameter

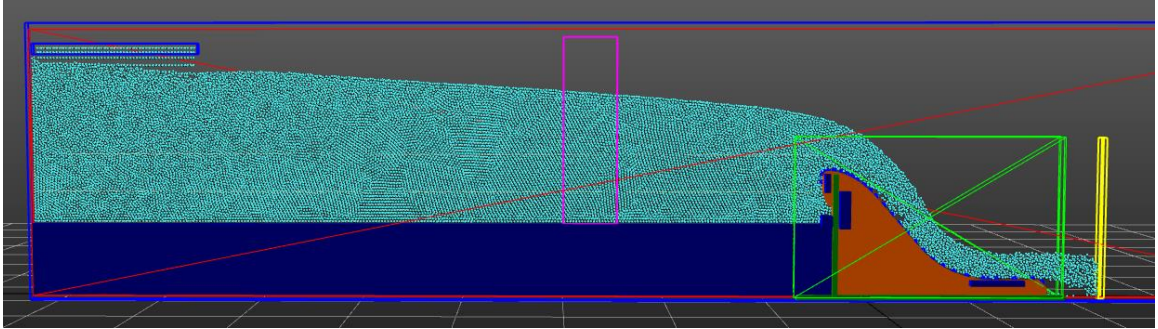


Figure 66: SPH run 8 – 1.5 m wide, 0.5 m particle diameter

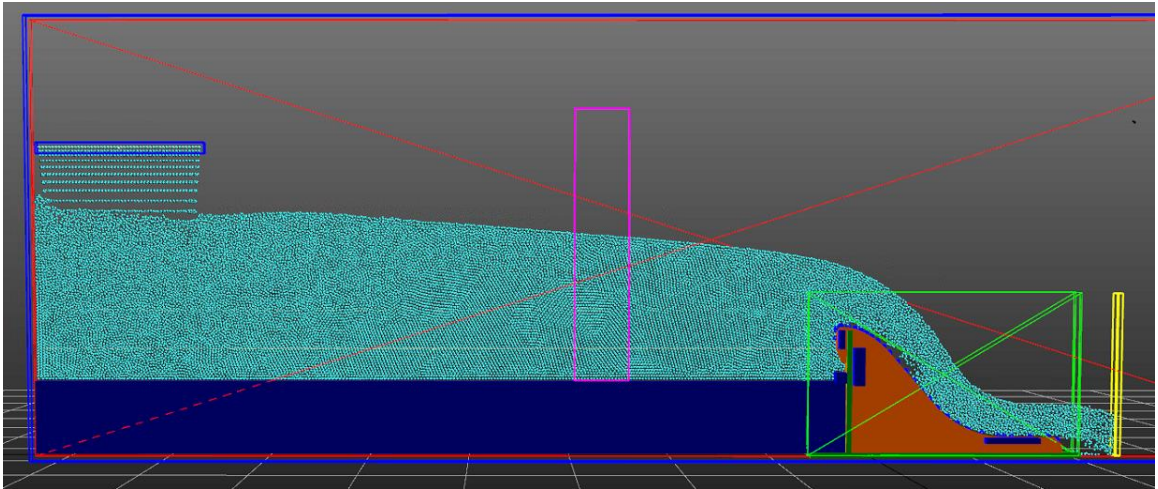


Figure 67: SPH run 9 – 1.5 m wide, 0.5 m particle diameter

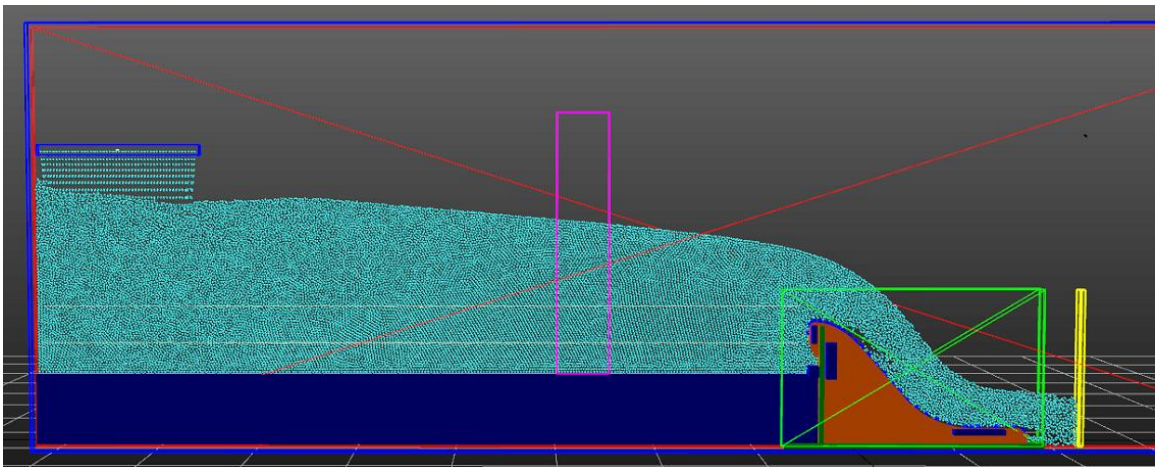


Figure 68: SPH run 10 – 1.5 m wide, 0.5 m particle diameter

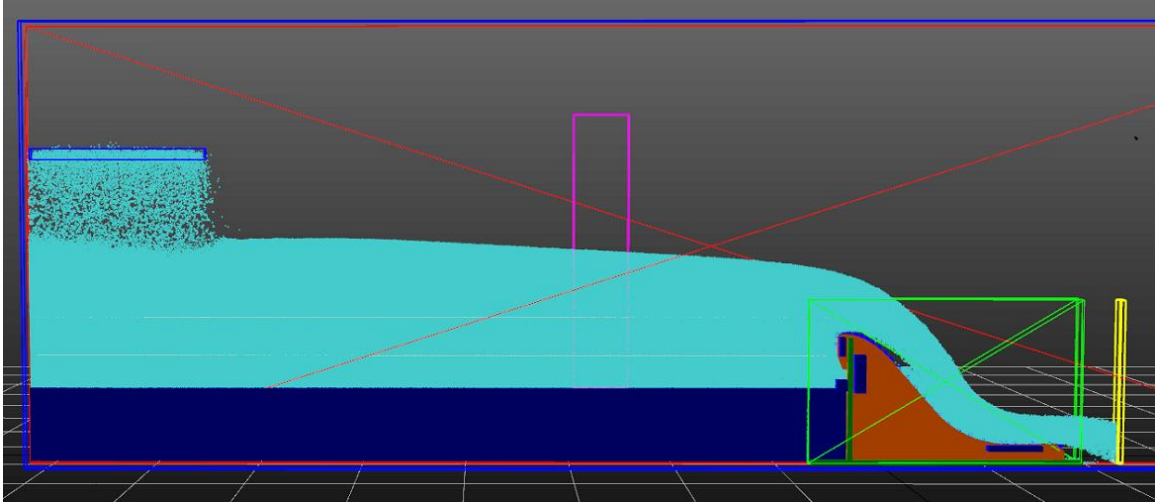


Figure 69: SPH run 10 – 1.5 m wide, 0.25 m particle diameter

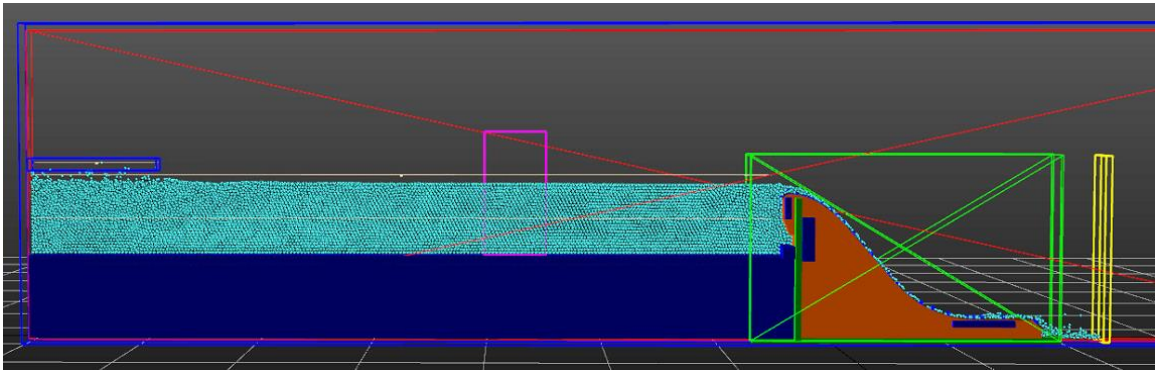


Figure 70: SPH run 1 – 3 m wide, 0.5 m particle diameter

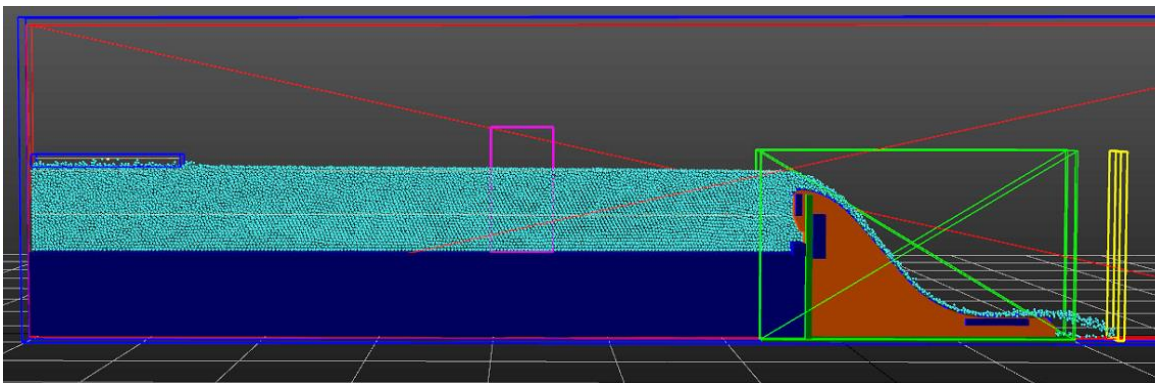


Figure 71: SPH run 2 – 3 m wide, 0.5 m particle diameter

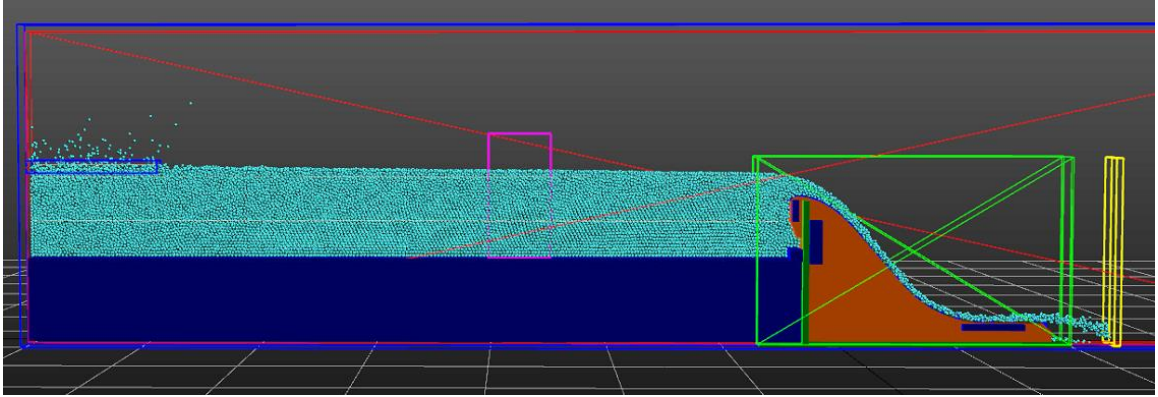


Figure 72: SPH run 3 – 3 m wide, 0.5 m particle diameter

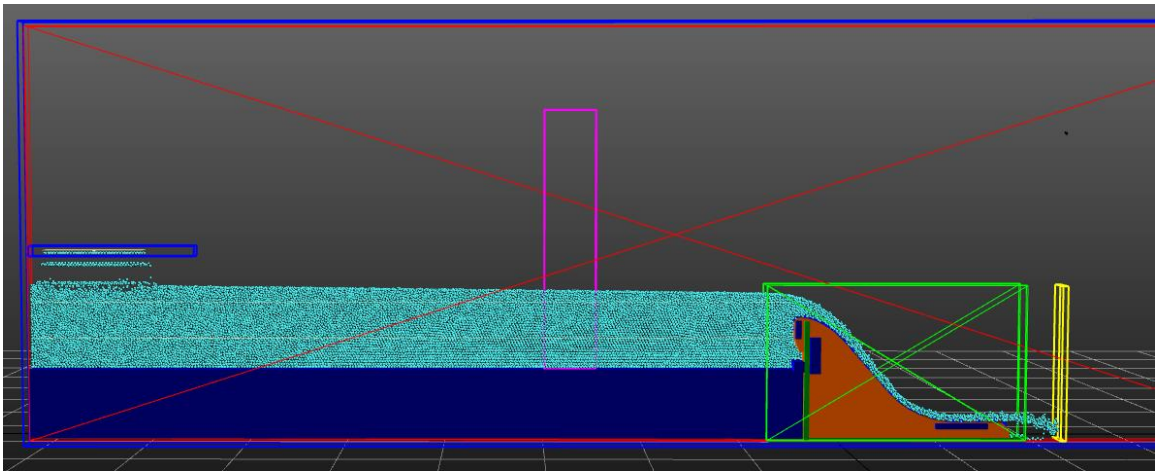


Figure 73: SPH run 4 – 3 m wide, 0.5 m particle diameter

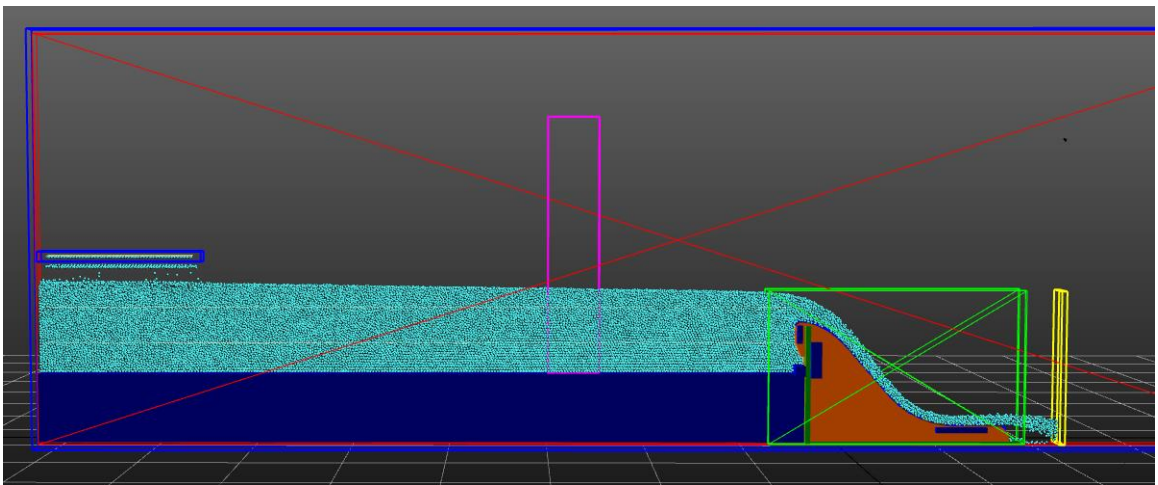


Figure 74: SPH run 5 – 3 m wide, 0.5 m particle diameter

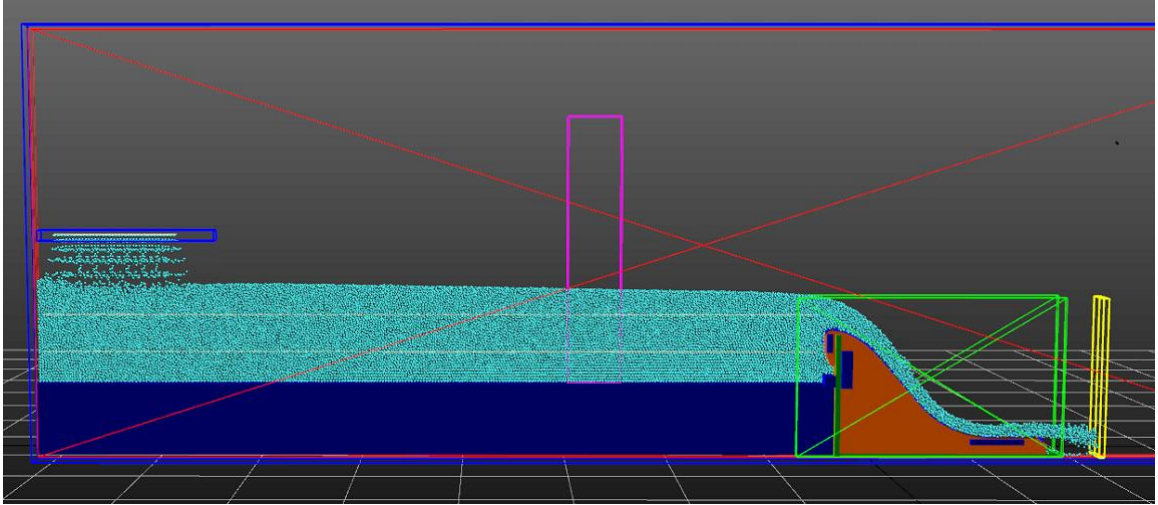


Figure 75: SPH run 6 – 3 m wide, 0.5 m particle diameter

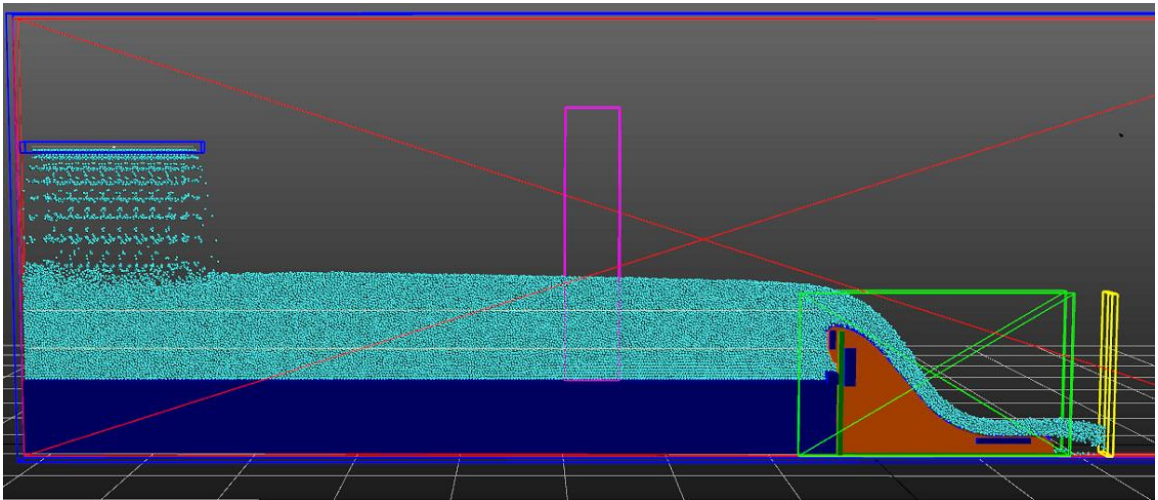


Figure 76: SPH run 7 – 3 m wide, 0.5 m particle diameter

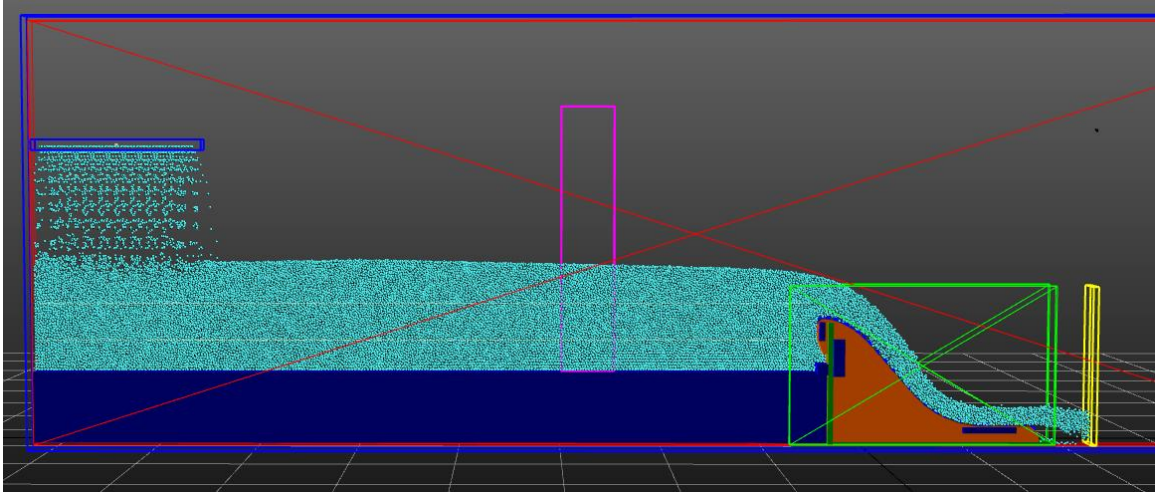


Figure 77: SPH run 8 – 3 m wide, 0.5 m particle diameter

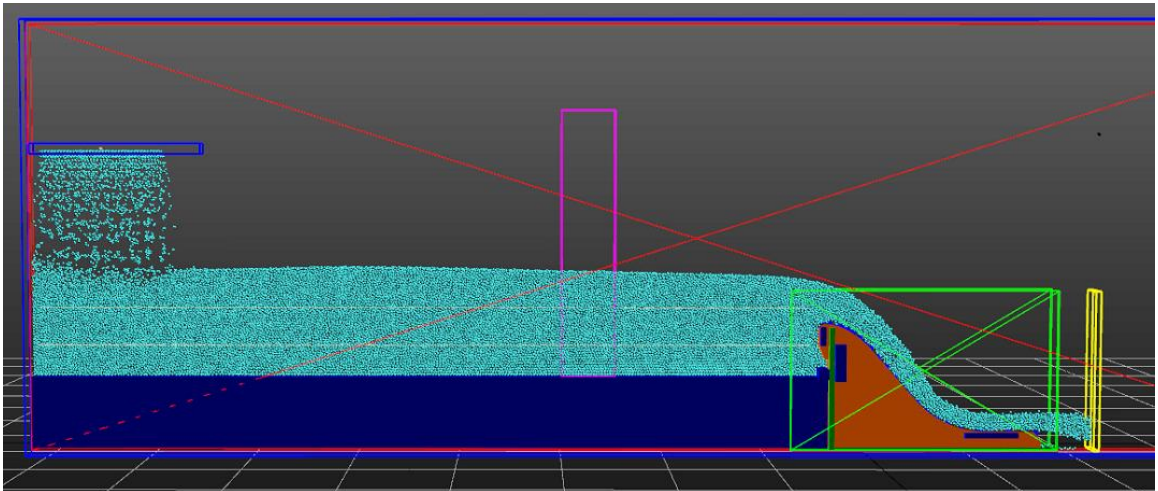


Figure 78: SPH run 9 – 3 m wide, 0.5 m particle diameter

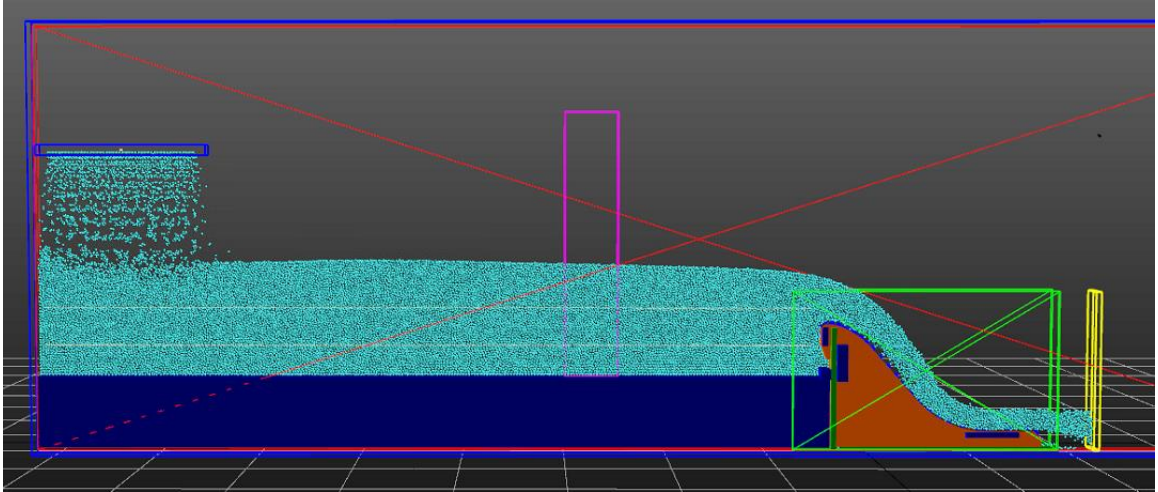


Figure 79: SPH run 10 – 3 m wide, 0.5 m particle diameter

Appendix I: Sample Input File

The input for Neutrino is not conducted by creating an XML file. Instead, the input file is created in the Neutrino GUI. However, the input file can be opened in a text editor as an XML file. The following is the Neutrino input file for run 1 using a model width of 1.5 m and particle size of 0.5 m. However, the input file is just a sample since Neutrino resets some values to default values which must be changed when opened.

```
<?xml version="1.0" encoding="UTF-8"?>
<!--For the program to work correctly, creations should come first, then
the connections, and finally the properties-->
<nescene version="0.1">
  <creations>
    <object      type="Rigid      Custom"      name="RigidCustom_2"
parent="Scene"/>
    <object type="Camera" name="Camera_1" parent="Scene"/>
    <object type="Rigid Box" name="RigidBody_1" parent="Scene"/>
    <object      type="IISPH      Solver"      name="IISphSolver_1"
parent="Scene"/>
    <object      type="Rigid      Cuboid"      name="RigidCuboid_1"
parent="Scene"/>
    <object      type="Rigid      Cuboid"      name="RigidCuboid_2"
parent="Scene"/>
    <object      type="Rigid      Cuboid"      name="RigidCuboid_3"
parent="Scene"/>
    <object      type="Rigid      Cuboid"      name="RigidCuboid_4"
parent="Scene"/>
    <object      type="Rigid      Cuboid"      name="RigidCuboid_5"
parent="Scene"/>
    <object      type="Measurement Field" name="MeasurementField_1"
parent="Scene"/>
    <object      type="Measurement Field" name="MeasurementField_2"
parent="Scene"/>
    <object      type="Measurement Field" name="MeasurementField_3"
parent="Scene"/>
    <object      type="Measurement Field" name="MeasurementField_4"
parent="Scene"/>
    <object      type="Measurement Field" name="MeasurementField_5"
parent="Scene"/>
    <object      type="Measurement Field" name="MeasurementField_6"
parent="Scene"/>
    <object      type="Measurement Field" name="MeasurementField_7"
parent="Scene"/>
    <object      type="Measurement Field" name="MeasurementField_8"
parent="Scene"/>
    <object      type="Measurement Field" name="MeasurementField_9"
parent="Scene"/>
    <object      type="Measurement Field" name="MeasurementField_10"
parent="Scene"/>
```

```

    <object      type="Measurement   Field"      name="MeasurementField_11"
parent="Scene"/>
    <object      type="Measurement   Field"      name="MeasurementField_12"
parent="Scene"/>
    <object      type="Measurement   Field"      name="MeasurementField_13"
parent="Scene"/>
    <object      type="Measurement   Field"      name="MeasurementField_14"
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parent="Scene"/>
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parent="Scene"/>
    <object      type="Measurement   Field"      name="MeasurementField_21"
parent="Scene"/>
    <object      type="Measurement   Field"      name="MeasurementField_22"
parent="Scene"/>
    <object      type="Measurement   Field"      name="MeasurementField_23"
parent="Scene"/>
    <object      type="Measurement   Field"      name="MeasurementField_24"
parent="Scene"/>
    <object      type="Measurement   Field"      name="MeasurementField_25"
parent="Scene"/>
    <object      type="Measurement   Field"      name="MeasurementField_26"
parent="Scene"/>
    <object      type="Measurement   Field"      name="MeasurementField_27"
parent="Scene"/>
    <object      type="Measurement   Field"      name="MeasurementField_28"
parent="Scene"/>
    <object      type="Measurement   Field"      name="MeasurementField_29"
parent="Scene"/>
    <object      type="Extent        Particle      Killer"
name="ExtentParticleKiller_1" parent="Scene"/>
    <object      type="Flow    Particle  Emitter"    name="FlowSource_1"
parent="Scene"/>
    <object      type="Flow    Particle  Emitter"    name="FlowSource_2"
parent="Scene"/>
    <object      type="Flow    Particle  Emitter"    name="FlowSource_3"
parent="Scene"/>
    <object      type="Extent        Particle      Killer"
name="ExtentParticleKiller_2" parent="Scene"/>
    <object      type="Rigid      Cuboid"           name="RigidCuboid_7"
parent="Scene"/>
    <object      type="Rigid      Cuboid"           name="RigidCuboid_8"
parent="Scene"/>
    <object      type="Rigid      Cuboid"           name="RigidCuboid_9"
parent="Scene"/>
    <object      type="Rigid      Cylinder"         name="RigidCylinder_1"
parent="Scene"/>
</creations>

```

```

    <guicreations>
        <guiobject type="glwindow" name="OpenGL0"/>
        <guiobject type="proped" name="propertyEditor"
curobj="RigidCuboid_5"/>
    </guicreations>
    <connections>
        <connect from="DefaultGravity" to="IISphSolver_1"
type="kIOForceField" order="0"/>
        <connect from="RigidCustom_2" to="DefaultMaterial"
type="kIOTriangleMesh" order="0"/>
        <connect from="RigidBox_1" to="DefaultMaterial"
type="kIOTriangleMesh" order="0"/>
        <connect from="IISphSolver_1" to="MeasurementField_29"
type="kIOParticles" order="0"/>
        <connect from="IISphSolver_1" to="MeasurementField_28"
type="kIOParticles" order="0"/>
        <connect from="IISphSolver_1" to="MeasurementField_27"
type="kIOParticles" order="0"/>
        <connect from="IISphSolver_1" to="MeasurementField_26"
type="kIOParticles" order="0"/>
        <connect from="IISphSolver_1" to="MeasurementField_25"
type="kIOParticles" order="0"/>
        <connect from="IISphSolver_1" to="MeasurementField_24"
type="kIOParticles" order="0"/>
        <connect from="IISphSolver_1" to="MeasurementField_23"
type="kIOParticles" order="0"/>
        <connect from="IISphSolver_1" to="MeasurementField_22"
type="kIOParticles" order="0"/>
        <connect from="IISphSolver_1" to="MeasurementField_21"
type="kIOParticles" order="0"/>
        <connect from="IISphSolver_1" to="MeasurementField_20"
type="kIOParticles" order="0"/>
        <connect from="IISphSolver_1" to="MeasurementField_1"
type="kIOParticles" order="0"/>
        <connect from="IISphSolver_1" to="MeasurementField_2"
type="kIOParticles" order="0"/>
        <connect from="IISphSolver_1" to="MeasurementField_3"
type="kIOParticles" order="0"/>
        <connect from="IISphSolver_1" to="MeasurementField_4"
type="kIOParticles" order="0"/>
        <connect from="IISphSolver_1" to="MeasurementField_5"
type="kIOParticles" order="0"/>
        <connect from="IISphSolver_1" to="MeasurementField_6"
type="kIOParticles" order="0"/>
        <connect from="IISphSolver_1" to="MeasurementField_7"
type="kIOParticles" order="0"/>
        <connect from="IISphSolver_1" to="MeasurementField_8"
type="kIOParticles" order="0"/>
        <connect from="IISphSolver_1" to="MeasurementField_9"
type="kIOParticles" order="0"/>
        <connect from="IISphSolver_1" to="MeasurementField_10"
type="kIOParticles" order="0"/>
        <connect from="IISphSolver_1" to="MeasurementField_11"
type="kIOParticles" order="0"/>
        <connect from="IISphSolver_1" to="MeasurementField_12"
type="kIOParticles" order="0"/>

```

```

        <connect      from="IISphSolver_1"      to="MeasurementField_13"
type="kIOParticles" order="0"/>
        <connect      from="IISphSolver_1"      to="MeasurementField_14"
type="kIOParticles" order="0"/>
        <connect      from="IISphSolver_1"      to="MeasurementField_15"
type="kIOParticles" order="0"/>
        <connect      from="IISphSolver_1"      to="MeasurementField_16"
type="kIOParticles" order="0"/>
        <connect      from="IISphSolver_1"      to="MeasurementField_17"
type="kIOParticles" order="0"/>
        <connect      from="IISphSolver_1"      to="MeasurementField_18"
type="kIOParticles" order="0"/>
        <connect      from="IISphSolver_1"      to="MeasurementField_19"
type="kIOParticles" order="0"/>
        <connect      from="RigidCuboid_1"      to="DefaultMaterial"
type="kIOTriangleMesh" order="0"/>
        <connect      from="RigidCuboid_2"      to="DefaultMaterial"
type="kIOTriangleMesh" order="0"/>
        <connect      from="RigidCuboid_3"      to="DefaultMaterial"
type="kIOTriangleMesh" order="0"/>
        <connect      from="RigidCuboid_4"      to="DefaultMaterial"
type="kIOTriangleMesh" order="0"/>
        <connect      from="RigidCuboid_5"      to="DefaultMaterial"
type="kIOTriangleMesh" order="0"/>
        <connect      from="FlowSource_1"      to="IISphSolver_1"
type="kIOParticles" order="0"/>
        <connect      from="FlowSource_2"      to="IISphSolver_1"
type="kIOParticles" order="0"/>
        <connect      from="FlowSource_3"      to="IISphSolver_1"
type="kIOParticles" order="0"/>
        <connect      from="RigidCuboid_7"      to="DefaultMaterial"
type="kIOTriangleMesh" order="0"/>
        <connect      from="RigidCuboid_8"      to="DefaultMaterial"
type="kIOTriangleMesh" order="0"/>
        <connect      from="RigidCuboid_9"      to="DefaultMaterial"
type="kIOTriangleMesh" order="0"/>
        <connect      from="RigidCylinder_1"    to="DefaultMaterial"
type="kIOTriangleMesh" order="0"/>
    </connections>
    <property_connections/>
    <properties>
        <Base>
            <property      name="objectName"      hidden="0"      locked="0"
val="Base"/>
            <property      name="OsdMsgPos"      hidden="0"      locked="0"
val="Left"/>
            <property name="Verbose" hidden="0" locked="0" val="false"/>
            <property name="Threads" hidden="0" locked="0" val="14"/>
            <property      name="ServerPort"      hidden="0"      locked="0"
val="20200"/>
            <property      name="SceneFilePath"    hidden="0"      locked="0"
val="G:/Emerald/Thesis_Runs/Final_1.nescene"/>
            <property      name="SaveDir"          hidden="0"      locked="0"
val="G:/Emerald/Thesis_Runs"/>
            <property      name="CacheDir"         hidden="0"      locked="0"
val="G:/Emerald/Thesis_Runs/Final_1"/>

```

```

        <property name="OptimizeNetCache" hidden="0" locked="0"
val="false"/>
        <property name="CompressFluidCache" hidden="0" locked="0"
val="false"/>
        <Logger>
            <property name="objectName" hidden="0" locked="0"
val="Logger"/>
            <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
            <property name="Verbose" hidden="0" locked="0"
val="false"/>
            <property name="logging" hidden="0" locked="0"
val="false"/>
            <property name="loggingTop" hidden="0" locked="0"
val="false"/>
            <property name="logsPerSecondTop" hidden="0" locked="0"
val="10"/>
            <property name="loggingTopRight" hidden="0" locked="0"
val="false"/>
            <property name="logsPerSecondTopRight" hidden="0"
locked="0" val="10"/>
            <property name="loggingRight" hidden="0" locked="0"
val="false"/>
            <property name="logsPerSecondRight" hidden="0"
locked="0" val="10"/>
            <property name="loggingBottomRight" hidden="0"
locked="0" val="false"/>
            <property name="logsPerSecondBottomRight" hidden="0"
locked="0" val="10"/>
            <property name="loggingBottom" hidden="0" locked="0"
val="false"/>
            <property name="logsPerSecondBottom" hidden="0"
locked="0" val="10"/>
            <property name="loggingBottomLeft" hidden="0" locked="0"
val="false"/>
            <property name="logsPerSecondBottomLeft" hidden="0"
locked="0" val="10"/>
            <property name="loggingLeft" hidden="0" locked="0"
val="false"/>
            <property name="logsPerSecondLeft" hidden="0" locked="0"
val="10"/>
            <property name="loggingTopLeft" hidden="0" locked="0"
val="false"/>
            <property name="logsPerSecondTopLeft" hidden="0"
locked="0" val="10"/>
        </Logger>
    </Base>
    <Scene>
        <property name="objectName" hidden="0" locked="0"
val="Scene"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0" val="false"/>
        <property name="Timestep" hidden="0" locked="0" val="0.02"/>
        <property name="ElapsedTime" hidden="0" locked="0" val="0"/>
        <property name="RecordFrameRate" hidden="0" locked="0"
val="50"/>

```

```

        <property      name="CurrentFrame"      hidden="0"      locked="0"
val="0"/>
        <property name="ResetFrame" hidden="0" locked="0" val="0"/>
        <property      name="RbdSolver"      hidden="0"      locked="0"
val="BulletPhysics"/>
        <property      name="RbdSolveMethod"      hidden="0"      locked="0"
val="SequentialImpulse"/>
        <property      name="PlaybackStartFrame"      hidden="0"      locked="0"
val="0"/>
        <property      name="PlaybackEndFrame"      hidden="0"      locked="0"
val="9001"/>
        <property      name="SimulationEndFrame"      hidden="0"      locked="0"
val="9000"/>
        <property      name="CacheAllPhysicals"      hidden="0"      locked="0"
val="false"/>
        <property name="FrameInfo" hidden="0" locked="0" first="0"
last="0" complete="1"/>
        <property      name="ForceGLUpdate"      hidden="0"      locked="0"
val="true"/>
        <RenderSettings>
            <property name="objectName" val="RenderSettings"/>
            <property name="Renderer" val=""/>
            <property name="OutFileType" val="PNG"/>
            <property
val="G:/Emerald/Thesis_Runs/Final_1/RenderData/">
                name="OutputDir"
            <property name="Camera" val="CamPersp"/>
            <property name="Resolution" width="720" height="480"/>
            <property name="Threads" val="8"/>
            <ThreeDeLightSettings>
                <property
val="ThreeDeLightSettings"/>
                    name="objectName"
                <property name="MotionBlur" val="false"/>
            </ThreeDeLightSettings>
            <PovraySettings>
                <property name="objectName" val="PovraySettings"/>
                <property name="Preset_Preset" val=""/>
                <property name="General_Quality" val="9"/>
                <property
val="0.30000001192092896"/>
                    name="General_AA"
                <property name="General_Jitter" val="0"/>
                <property name="General_Max_Trace_Level" val="16"/>
                <property
val="true"/>
                    name="PhotonMapping_Photon_Mapping"
                <property
val="10"/>
                    name="PhotonMapping_PhotonCount"
                <property name="PhotonMapping_Autostop" val="0"/>
                <property name="Radiosity_Radiosity" val="false"/>
                <property
val="0.079999998211860698"/>
                    name="Radiosity_Pretrace_Start"
                <property
val="0.0099999997764825804"/>
                    name="Radiosity_Pretrace_End"
                <property name="Radiosity_Count" val="320"/>
                <property name="Radiosity_Error_Bound" val="0.25"/>
                <property name="Radiosity_Recursion_Limit" val="1"/>
            </PovraySettings>
            <MentalRaySettings>

```

```

        <property name="objectName"
val="MentalRaySettings"/>
        <property name="Preset_Preset" val="defaultPreset"/>
        <property name="General_Shadow" val="true"/>
        <property name="General_ContrastX"
val="0.10000000149011599"/>
        <property name="General_ContrastY"
val="0.10000000149011599"/>
        <property name="General_ContrastZ"
val="0.10000000149011599"/>
        <property name="General_ContrastW"
val="0.10000000149011599"/>
        <property name="General_Desaturate" val="false"/>
        <property name="General_Dither" val="false"/>
        <property name="General_MinSamples" val="-2"/>
        <property name="General_MaxSamples" val="0"/>
        <property name="General_Scanline" val="scan_on"/>
        <property name="General_Face" val="face_both"/>
        <property name="General_Hardware" val="hw_off"/>
        <property name="Iray_Iray" val="iray_off"/>
        <property name="Iray_ProgressiveRender"
val="false"/>
        <property name="Iray_ProgMinSamples" val="0"/>
        <property name="Iray_ProgMaxSamples" val="0"/>
        <property name="Iray_ProgError"
val="2.8025969286496341e-45"/>
        <property name="GI_Global_Illumination"
val="false"/>
        <property name="GI_Accuracy_Photons" val="500"/>
        <property name="GI_Accuracy_Radius" val="1"/>
        <property name="GI_Scale" val="1"/>
        <property name="Caustics_Caustics" val="false"/>
        <property name="Caustics_Accuracy_Photons"
val="100"/>
        <property name="Caustics_Accuracy_Radius" val="1"/>
        <property name="Caustics_Scale" val="1"/>
        <property name="PhotonVol_Accuracy_Photons"
val="30"/>
        <property name="PhotonVol_Accuracy_Radius" val="0"/>
        <property name="PhotonVol_Scale" val="1"/>
        <property name="PhotonDepth_Reflect" val="5"/>
        <property name="PhotonDepth_Refract" val="5"/>
        <property name="PhotonDepth_Sum" val="5"/>
        <property name="TraceDepth_Trace" val="true"/>
        <property name="TraceDepth_Reflect" val="2"/>
        <property name="TraceDepth_Refract" val="2"/>
        <property name="TraceDepth_Sum" val="4"/>
        <property name="Acceleration_Acceleration"
val="acc_bsp2"/>
        <property name="BSP_Depth" val="40"/>
        <property name="BSP_Size" val="10"/>
        <property name="BSP_Shadow" val="false"/>
        <property name="Importon" val="false"/>
        <property name="Importon_Density" val="1"/>
        <property name="Importon_TraceDepth" val="0"/>
        <property name="Importon_Traverse" val="true"/>

```

```

val="fg_off"/>
    <property name="FinalGather_FinalGather"
    <property name="FinalGather_Rays" val="1000"/>
    <property name="FinalGather_Reflect" val="2"/>
    <property name="FinalGather_Refract" val="2"/>
    <property name="FinalGather_Diffuse" val="2"/>
    <property name="FinalGather_Sum" val="6"/>
    <property name="FinalGather_FilterSize" val="1"/>
    <property name="FinalGather_Points" val="10"/>
    <property name="FinalGather_PresampleDensity"
val="1"/>
    <property name="FinalGather_ScaleR" val="1"/>
    <property name="FinalGather_ScaleG" val="1"/>
    <property name="FinalGather_ScaleB" val="1"/>
    <property name="FinalGather_ScaleA" val="1"/>
    <property name="FinalGather_SecScaleR" val="1"/>
    <property name="FinalGather_SecScaleG" val="1"/>
    <property name="FinalGather_SecScaleB" val="1"/>
    <property name="FinalGather_SecScaleA" val="1"/>
    <property name="FinalGather_FalloffStart" val="0"/>
    <property name="FinalGather_FalloffStop" val="0"/>
    <property name="FinalGather_Rebuild" val="true"/>
    <property name="IrradianceParticles_IP"
val="false"/>
    <property name="IrradianceParticles_Rays"
val="256"/>
    <property name="IrradianceParticles_IndirectPasses"
val="0"/>
    <property name="MotionBlur_Shutter" val="0"/>
</MentalRaySettings>
<VTKSettings>
    <property name="objectName" val="VTKSettings"/>
</VTKSettings>
</RenderSettings>
<DefaultGravity>
    <property name="objectName" hidden="0" locked="0"
val="DefaultGravity"/>
    <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
    <property name="Verbose" hidden="0" locked="0"
val="false"/>
    <property name="Behavior" hidden="0" locked="0"
val="Active"/>
    <property name="CacheData" hidden="0" locked="0"
val="true"/>
    <property name="Position" hidden="0" locked="0" x="0"
y="0" z="0"/>
    <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
    <property name="Scale" hidden="0" locked="0" x="1" y="1"
z="1"/>
    <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
    <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
    <property name="RenderPriority" hidden="0" locked="0"
val="100"/>

```

```

        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="Gravity" hidden="0" locked="0" x="0" y="-
9.81" z="0"/>
        </DefaultGravity>
        <CamPersp>
            <property name="objectName" hidden="0" locked="0"
val="CamPersp"/>
            <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
            <property name="Verbose" hidden="0" locked="0"
val="false"/>
            <property name="Behavior" hidden="0" locked="0"
val="Active"/>
            <property name="CacheData" hidden="0" locked="0"
val="true"/>
            <property name="Position" hidden="0" locked="0"
x="31.0143" y="62.3714" z="54.6896"/>
            <property name="Orientation" hidden="0" locked="0"
phi="-46.4298" theta="47.0413" psi="0"/>
            <property name="Scale" hidden="0" locked="0" x="1.5"
y="1.5" z="1.5"/>
            <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
            <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
            <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
            <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
            <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
            <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
            <property name="Fov" hidden="0" locked="0" val="45"/>
            <property name="NearClip" hidden="0" locked="0"
val="1"/>
            <property name="FarClip" hidden="0" locked="0"
val="5000"/>
            <property name="LookAt" hidden="0" locked="0"
x="12.4257" y="35.6714" z="37.3805"/>
            <property name="OrthoWidth" hidden="0" locked="0"
val="5"/>
            <property name="FlipSide" hidden="0" locked="0"
val="false"/>
            <property name="FlipUp" hidden="0" locked="0"
val="false"/>
            <property name="FlipLook" hidden="0" locked="0"
val="false"/>
        </CamPersp>
        <CamTop>
            <property name="objectName" hidden="0" locked="0"
val="CamTop"/>

```

```

val="Left"/>      <property      name="OsdMsgPos"      hidden="0"      locked="0"
val="false"/>      <property      name="Verbose"      hidden="0"      locked="0"
val="Active"/>      <property      name="Behavior"      hidden="0"      locked="0"
val="true"/>      <property      name="CacheData"      hidden="0"      locked="0"
                    <property      name="Position"      hidden="0"      locked="0"      x="-
27.813" y="-4.4391" z="47.2926"/>
                    <property      name="Orientation"      hidden="0"      locked="1"
phi="167.639" theta="85.5356" psi="180"/>
                    <property      name="Scale"      hidden="0"      locked="0"      x="1.5"
y="1.5" z="1.5"/>
                    <property      name="Pivot"      hidden="0"      locked="0"      x="0" y="0"
z="0"/>
                    <property      name="RenderMode"      hidden="0"      locked="0"
val="SmoothShaded"/>
                    <property      name="RenderPriority"      hidden="0"      locked="0"
val="100"/>
                    <property      name="Color"      hidden="0"      locked="0"      r="0" g="0"
b="255" a="255"/>
                    <property      name="ExternalRender"      hidden="0"      locked="0"
val="true"/>
                    <property      name="FrameInfo"      hidden="0"      locked="0"
first="-1" last="0" complete="0"/>
                    <property      name="Fov"      hidden="0"      locked="0"      val="45"/>
                    <property      name="NearClip"      hidden="0"      locked="0"      val="-
5000"/>
                    <property      name="FarClip"      hidden="0"      locked="0"
val="5000"/>
                    <property      name="LookAt"      hidden="0"      locked="0"      x="-
41.7753" y="-7.50816" z="48.3827"/>
                    <property      name="OrthoWidth"      hidden="0"      locked="0"
val="77.232795715332031"/>
                    <property      name="FlipSide"      hidden="0"      locked="0"
val="false"/>
                    <property      name="FlipUp"      hidden="0"      locked="0"
val="false"/>
                    <property      name="FlipLook"      hidden="0"      locked="0"
val="false"/>
                    </CamTop>
                    <CamLeft>
                    <property      name="objectName"      hidden="0"      locked="0"
val="CamLeft"/>
                    <property      name="OsdMsgPos"      hidden="0"      locked="0"
val="Left"/>
                    <property      name="Verbose"      hidden="0"      locked="0"
val="false"/>
                    <property      name="Behavior"      hidden="0"      locked="0"
val="Active"/>
                    <property      name="CacheData"      hidden="0"      locked="0"
val="true"/>
                    <property      name="Position"      hidden="0"      locked="0"      x="-10"
y="14.7482" z="28.5617"/>
                    <property      name="Orientation"      hidden="0"      locked="0"
phi="0" theta="-1.5708" psi="0"/>

```

```

        <property name="Scale" hidden="0" locked="0" x="1.5"
y="1.5" z="1.5"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="Fov" hidden="0" locked="0" val="45"/>
        <property name="NearClip" hidden="0" locked="0" val="-
5000"/>
        <property name="FarClip" hidden="0" locked="0"
val="5000"/>
        <property name="LookAt" hidden="0" locked="0" x="0"
y="14.7482" z="28.5617"/>
        <property name="OrthoWidth" hidden="0" locked="0"
val="20.692293167114258"/>
        <property name="FlipSide" hidden="0" locked="0"
val="false"/>
        <property name="FlipUp" hidden="0" locked="0"
val="false"/>
        <property name="FlipLook" hidden="0" locked="0"
val="false"/>
        </CamLeft>
        <CamFront>
        <property name="objectName" hidden="0" locked="0"
val="CamFront"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0" x="-
8.37498" y="16.8352" z="-10"/>
        <property name="Orientation" hidden="0" locked="1"
phi="-180" theta="0" psi="180"/>
        <property name="Scale" hidden="0" locked="0" x="1.5"
y="1.5" z="1.5"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>

```

```

        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="Fov" hidden="0" locked="0" val="45"/>
        <property name="NearClip" hidden="0" locked="0" val="-
5000"/>
        <property name="FarClip" hidden="0" locked="0"
val="5000"/>
        <property name="LookAt" hidden="0" locked="0" x="-
8.37498" y="16.8352" z="0"/>
        <property name="OrthoWidth" hidden="0" locked="0"
val="28.305873870849609"/>
        <property name="FlipSide" hidden="0" locked="0"
val="false"/>
        <property name="FlipUp" hidden="0" locked="0"
val="false"/>
        <property name="FlipLook" hidden="0" locked="0"
val="false"/>
        </CamFront>
        <DefaultLight>
        <property name="objectName" hidden="0" locked="0"
val="DefaultLight"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0" x="3"
y="1" z="1"/>
        <property name="Orientation" hidden="0" locked="0"
phi="32.3115" theta="-108.435" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="1" y="1"
z="1"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="255"
g="255" b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="MentalVisibility" hidden="0" locked="0"
val="false"/>
        <property name="MentalEnergy" hidden="0" locked="0"
x="1000" y="1000" z="1000"/>
        <property name="MentalGlobIllumPhotons" hidden="0"
locked="0" val="20000"/>
        <property name="MentalCausticPhotons" hidden="0"
locked="0" val="20000"/>
        <property name="MentalPhysical" hidden="0" locked="0"
val="false"/>

```

```

        <property name="MentalColor" hidden="0" locked="0"
x="1000" y="1000" z="1000"/>
        <property name="PovrayColor" hidden="0" locked="0" x="1"
y="1" z="1"/>
        <property name="ThreeDelightIntensity" hidden="0"
locked="0" val="1"/>
        <property name="Direction" hidden="0" locked="0" x="3"
y="2" z="1"/>
    </DefaultLight>
    <DefaultMaterial>
        <property name="objectName" hidden="0" locked="0"
val="DefaultMaterial"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="PerPixel" hidden="0" locked="0"
val="true"/>
        <property name="Color" hidden="0" locked="0" r="255"
g="255" b="255" a="255"/>
        <property name="KAmbient" hidden="0" locked="0"
val="0.10000000149011599"/>
        <property name="KDiffuse" hidden="0" locked="0"
val="1"/>
        <property name="KSpecular" hidden="0" locked="0"
val="0.5"/>
        <property name="Ambient" hidden="0" locked="0" r="128"
g="128" b="128" a="255"/>
        <property name="Specular" hidden="0" locked="0"
val="0.10000000149011612"/>
        <property name="Ambiance" hidden="0" locked="0" r="85"
g="85" b="85" a="255"/>
        <property name="MrTrace" hidden="0" locked="0"
val="true"/>
        <property name="MrShadow" hidden="0" locked="0"
val="3"/>
        <property name="MrInvertNormals" hidden="0" locked="0"
val="false"/>
        <property name="MrCaustic" hidden="0" locked="0"
val="None"/>
        <property name="preset" hidden="0" locked="0"
val="MRMIA"/>
        <property name="shininess" hidden="0" locked="0"
val="10"/>
        <property name="povPhong" hidden="0" locked="0"
val="0"/>
        <property name="povPhongSize" hidden="0" locked="0"
val="1065353216"/>
        <property name="povSpecular" hidden="0" locked="0"
val="1"/>
        <property name="povRoughness" hidden="0" locked="0"
val="0"/>

```

```

        <property name="difWeight" hidden="0" locked="0"
val="1"/>
        <property name="reflectivity" hidden="0" locked="0"
val="0"/>
        <property name="roughness" hidden="0" locked="0"
val="0"/>
        <property name="textured" hidden="0" locked="0"
val="false"/>
        <property name="imgName" hidden="0" locked="0" val=""/>
        <property name="textureExport" hidden="0" locked="0"
val="MiaVectorExport"/>
        <property name="Select" hidden="0" locked="0" val="0"/>
        <property name="Space" hidden="0" locked="0" val="2"/>
        <property name="Project" hidden="0" locked="0" val="1"/>
        <property name="RepeatX" hidden="0" locked="0" val="1"/>
        <property name="RepeatY" hidden="0" locked="0" val="1"/>
        <property name="RepeatZ" hidden="0" locked="0" val="1"/>
        <property name="Ambience" hidden="0" locked="0"
val="0.5"/>
        <property name="Specular" hidden="0" locked="0"
val="0.10000000149011612"/>
        <property name="Exponent" hidden="0" locked="0"
val="10"/>
        <property name="LightMode" hidden="0" locked="0"
val="0"/>
    </DefaultMaterial>
    <RigidCustom_2>
        <property name="objectName" hidden="0" locked="0"
val="RigidCustom_2"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0" x="-
11.6165" y="0" z="24.902"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="1" y="1"
z="0.1667"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="Invisible"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="255"
g="100" b="0" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="Timestep" hidden="0" locked="0"
val="0.01"/>

```

```

val="false"/>      <property name="ShowStatistics" hidden="0" locked="0"
val="false"/>      <property name="ShowTimings" hidden="0" locked="0"
val="Static"/>     <property name="RigidType" hidden="0" locked="0"
val="true"/>       <property name="TwoWayCoupling" hidden="0" locked="0"
locked="0" val="gImpactMesh"/>
val="PolyhedralMass"/> <property name="CenterMethod" hidden="0" locked="0"
locked="0" val="false"/> <property name="LocalizedTransforms" hidden="0"
val="1"/>          <property name="RigidFriction" hidden="0" locked="0"
val="0.01"/>       <property name="Viscosity" hidden="0" locked="0"
val="0.001"/>      <property name="Adhesion" hidden="0" locked="0"
val="2320"/>       <property name="Density" hidden="0" locked="0"
val="false"/>      <property name="ExportStats" hidden="0" locked="0"
val="C:/Users/Emerald/Documents/Masters Thesis/Miller Dam Neutrino
Runs/Run_1/RigidInfo/Rigid"/> <property name="ExportPath" hidden="0" locked="0"
val="Text"/>       <property name="ExportFormat" hidden="0" locked="0"
x="0" y="0" z="0"/> <property name="LinearVelocity" hidden="0" locked="0"
x="0" y="0" z="0"/> <property name="AngularVelocity" hidden="0" locked="0"
locked="0" val="false"/> <property name="ComputePerVertexVelocity" hidden="0"
val="false"/>      <property name="ShowForces" hidden="0" locked="0"
y="0" z="0"/>      <property name="TotalForce" hidden="0" locked="0" x="0"
y="0" z="0"/>      <property name="TotalTorque" hidden="0" locked="0" x="0"
val="false"/>      <property name="FlipMesh" hidden="0" locked="0"
val="MeshColor"/> <property name="VisType" hidden="0" locked="0"
val=""/>           <property name="ResetStats" hidden="0" locked="0"
locked="0" val="Polygons"/> <property name="ThreeDelightRenderingType" hidden="0"
locked="0" x="1" y="1" z="1"/> <property name="ThreeDelightOpacity" hidden="0"
val="false"/>      <property name="ShowParticles" hidden="0" locked="0"
locked="0" val="false"/> <property name="DrawSurfaceNormals" hidden="0"
val="true"/>       <property name="TwoSidedLighting" hidden="0" locked="0"

```

```

        <property      name="Coloring"      hidden="0"      locked="0"
val="ParticleTypeBased"/>
        <property      name="AutomaticRange"  hidden="0"  locked="0"
val="true"/>
        <property      name="ColoringExponent"  hidden="0"  locked="0"
val="0"/>
        <property      name="MinColoringRange"  hidden="0"  locked="0"
val="0"/>
        <property      name="MaxColoringRange"  hidden="0"  locked="0"
val="0"/>
        <property      name="MinRangeColor"    hidden="0"  locked="0"
r="63" g="126" b="189" a="255"/>
        <property      name="MaxRangeColor"    hidden="0"  locked="0"
r="255" g="255" b="255" a="255"/>
        <property      name="Spacing"          hidden="0"  locked="0"
val="0.5"/>
        <property      name="SurfaceOffset"     hidden="0"  locked="0"
val="0"/>
        <property      name="ObjFile"           hidden="0"  locked="0"
val="C:/Users/Emerald Ryan/Documents/Emerald/Models/Proto B spillway
(1).stl"/>
        <property      name="Reload"            hidden="0"  locked="0" val=""/>
        <property      name="UniformScale"      hidden="0"  locked="0"
val="0.01"/>
        <property      name="RemeshSampling"    hidden="0"  locked="0"
val="false"/>
        <property      name="SwapUpAxes"        hidden="0"  locked="0"
val="false"/>
    </RigidCustom_2>
    <SortedHashingCollider>
        <property      name="objectName"        hidden="0"  locked="0"
val="SortedHashingCollider"/>
        <property      name="OsdMsgPos"         hidden="0"  locked="0"
val="Left"/>
        <property      name="Verbose"           hidden="0"  locked="0"
val="false"/>
        <property      name="ShowTimings"       hidden="0"  locked="0"
val="true"/>
        <property      name="ShowStatistics"    hidden="0"  locked="0"
val="true"/>
        <property      name="Reorder"            hidden="0"  locked="0" val="1"/>
        <property      name="FluidNeighborsVectorLimit"  hidden="0"
locked="0" val="40"/>
        <property      name="nRing"             hidden="0"  locked="0" val="1"/>
        <property      name="MaxExtent"         hidden="0"  locked="0" x="-
5000" y="-5000" z="-5000"/>
        <property      name="ZCurveReorder"     hidden="0"  locked="0"
val="true"/>
        <property      name="TableSize"         hidden="0"  locked="0"
val="12582917"/>
        <property      name="PostProcessSPH"    hidden="0"  locked="0"
val="false"/>
        <property      name="OptimizedDensityInit"  hidden="0"
locked="0" val="true"/>
    </SortedHashingCollider>
    <Camera_1>

```

```

        <property      name="objectName"      hidden="0"      locked="0"
val="Camera_1"/>
        <property      name="OsdMsgPos"      hidden="0"      locked="0"
val="Left"/>
        <property      name="Verbose"      hidden="0"      locked="0"
val="false"/>
        <property      name="Behavior"      hidden="0"      locked="0"
val="Active"/>
        <property      name="CacheData"      hidden="0"      locked="0"
val="true"/>
        <property      name="Position"      hidden="0"      locked="0"      x="-
51.7334"      y="52.529"      z="256.761"/>
        <property      name="Orientation"      hidden="0"      locked="1"
phi="-6.85931"      theta="2.38913"      psi="0"/>
        <property      name="Scale"      hidden="0"      locked="0"      x="1.5"
y="1.5"      z="1.5"/>
        <property      name="Pivot"      hidden="0"      locked="0"      x="0"      y="0"
z="0"/>
        <property      name="RenderMode"      hidden="0"      locked="0"
val="SmoothShaded"/>
        <property      name="RenderPriority"      hidden="0"      locked="0"
val="100"/>
        <property      name="Color"      hidden="0"      locked="0"      r="0"      g="0"
b="255"      a="255"/>
        <property      name="ExternalRender"      hidden="0"      locked="0"
val="true"/>
        <property      name="FrameInfo"      hidden="0"      locked="0"
first="-1"      last="0"      complete="0"/>
        <property      name="Fov"      hidden="0"      locked="0"      val="45"/>
        <property      name="NearClip"      hidden="0"      locked="0"
val="0.100000000000000001"/>
        <property      name="FarClip"      hidden="0"      locked="0"
val="5000"/>
        <property      name="LookAt"      hidden="0"      locked="0"      x="-
57.2748"      y="36.5383"      z="123.945"/>
        <property      name="OrthoWidth"      hidden="0"      locked="0"
val="5"/>
        <property      name="FlipSide"      hidden="0"      locked="0"
val="false"/>
        <property      name="FlipUp"      hidden="0"      locked="0"
val="false"/>
        <property      name="FlipLook"      hidden="0"      locked="0"
val="false"/>
    </Camera_1>
    <RigidBody_1>
        <property      name="objectName"      hidden="0"      locked="0"
val="RigidBody_1"/>
        <property      name="OsdMsgPos"      hidden="0"      locked="0"
val="Left"/>
        <property      name="Verbose"      hidden="0"      locked="0"
val="false"/>
        <property      name="Behavior"      hidden="0"      locked="0"
val="Active"/>
        <property      name="CacheData"      hidden="0"      locked="0"
val="true"/>
        <property      name="Position"      hidden="0"      locked="0"      x="-
21.7281"      y="28.2937"      z="25.6264"/>

```

```

        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="225"
y="50" z="1.5"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="Wireframe"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="255"
g="0" b="0" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="Timestep" hidden="0" locked="0"
val="0.01"/>
        <property name="ShowStatistics" hidden="0" locked="0"
val="false"/>
        <property name="ShowTimings" hidden="0" locked="0"
val="false"/>
        <property name="RigidType" hidden="0" locked="0"
val="Static"/>
        <property name="TwoWayCoupling" hidden="0" locked="0"
val="true"/>
        <property name="CollisionShapeType" hidden="0"
locked="0" val="gImpactMesh"/>
        <property name="CenterMethod" hidden="0" locked="0"
val="PolyhedralMass"/>
        <property name="LocalizedTransforms" hidden="0"
locked="0" val="false"/>
        <property name="RigidFriction" hidden="0" locked="0"
val="1"/>
        <property name="Viscosity" hidden="0" locked="0"
val="0.01"/>
        <property name="Adhesion" hidden="0" locked="0"
val="0.001"/>
        <property name="Density" hidden="0" locked="0"
val="2320"/>
        <property name="ExportStats" hidden="0" locked="0"
val="false"/>
        <property name="ExportPath" hidden="0" locked="0"
val=""/>
        <property name="ExportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="LinearVelocity" hidden="0" locked="0"
x="0" y="0" z="0"/>
        <property name="AngularVelocity" hidden="0" locked="0"
x="0" y="0" z="0"/>
        <property name="ComputePerVertexVelocity" hidden="0"
locked="0" val="false"/>
        <property name="ShowForces" hidden="0" locked="0"
val="true"/>
        <property name="TotalForce" hidden="0" locked="0" x="-
2.76344e+09" y="1.05866e+08" z="7.21669e+07"/>

```

```

x="4.54349e+09" <property name="TotalTorque" hidden="0" locked="0"
y="7.28126e+10" z="-2.66499e+11"/>
<property name="FlipMesh" hidden="0" locked="0"
val="false"/>
<property name="VisType" hidden="0" locked="0"
val="MeshColor"/>
<property name="ResetStats" hidden="0" locked="0"
val=""/>
<property name="ThreeDelightRenderingType" hidden="0"
locked="0" val="Polygons"/>
<property name="ThreeDelightOpacity" hidden="0"
locked="0" x="1" y="1" z="1"/>
<property name="ShowParticles" hidden="0" locked="0"
val="false"/>
<property name="DrawSurfaceNormals" hidden="0"
locked="0" val="false"/>
<property name="TwoSidedLighting" hidden="0" locked="0"
val="true"/>
<property name="Coloring" hidden="0" locked="0"
val="VelocityBased"/>
<property name="AutomaticRange" hidden="0" locked="0"
val="true"/>
<property name="ColoringExponent" hidden="0" locked="0"
val="0"/>
<property name="MinColoringRange" hidden="0" locked="0"
val="0"/>
<property name="MaxColoringRange" hidden="0" locked="0"
val="0"/>
<property name="MinRangeColor" hidden="0" locked="0"
r="63" g="126" b="189" a="255"/>
<property name="MaxRangeColor" hidden="0" locked="0"
r="255" g="255" b="255" a="255"/>
<property name="Spacing" hidden="0" locked="0"
val="0.5"/>
<property name="SurfaceOffset" hidden="0" locked="0"
val="0"/>
<property name="ShowVolumeMark" hidden="0" locked="0"
val="false"/>
<property name="VolumeMark" hidden="0" locked="0"
val="1"/>
</RigidBox_1>
<IISphSolver_1>
<property name="objectName" hidden="0" locked="0"
val="IISphSolver_1"/>
<property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
<property name="Verbose" hidden="0" locked="0"
val="false"/>
<property name="Behavior" hidden="0" locked="0"
val="Active"/>
<property name="CacheData" hidden="0" locked="0"
val="true"/>
<property name="Position" hidden="0" locked="0" x="0"
y="0" z="-87.322"/>
<property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>

```

```

z="1"/>
z="0"/>
val="SmoothShaded"/>
val="100"/>
g="255" b="255" a="255"/>
val="false"/>
first="-1" last="0" complete="0"/>
val="0.01"/>
val="true"/>
val="false"/>
val="false"/>
val="0.6999999999999996"/>
val="0"/>
val="1000"/>
locked="0" val="10"/>
val="None"/>
val="true"/>
val="0.5"/>
val="0"/>
val="3828.291259765625"/>
r="63" g="126" b="189" a="255"/>
r="255" g="255" b="255" a="255"/>
val="ParticleColor"/>
locked="0" val="false"/>
locked="0" val="false"/>
locked="0" val="false"/>
val="false"/>
locked="0" val="1"/>

```

```

        <property name="InflowGhostColor" hidden="0" locked="0"
r="0" g="255" b="255" a="255"/>
        <property name="InflowGhostExtColor" hidden="0"
locked="0" r="255" g="255" b="0" a="255"/>
        <property name="InflowGhostFillColor" hidden="0"
locked="0" r="0" g="255" b="0" a="255"/>
        <property name="OutflowGhostColor" hidden="0" locked="0"
r="255" g="0" b="255" a="255"/>
        <property name="ExportMethod" hidden="0" locked="0"
val="All"/>
        <property name="MinNeighbors" hidden="0" locked="0"
val="2"/>
        <property name="ExportMaterial" hidden="0" locked="0"
val="UniqueMaterial"/>
        <property name="BinaryExport" hidden="0" locked="0"
val="true"/>
        <property name="QueryNeighbors" hidden="0" locked="0"
val="Query_All"/>
        <property name="ThreeDelightRenderingType" hidden="0"
locked="0" val="Spheres"/>
        <property name="ThreeDelightOpacity" hidden="0"
locked="0" x="1" y="1" z="1"/>
        <property name="SoundSpeed" hidden="0" locked="0"
val="80"/>
        <property name="ViscosityModel" hidden="0" locked="0"
val="LaminarViscosity"/>
        <property name="Viscosity" hidden="0" locked="0"
val="1.3999999999999999e-06"/>
        <property name="CohesionModel" hidden="0" locked="0"
val="NadirPaper"/>
        <property name="Cohesion" hidden="0" locked="0"
val="0.01"/>
        <property name="AdhesionModel" hidden="0" locked="0"
val="NadirPaperAdhesion"/>
        <property name="InterfaceTension" hidden="0" locked="0"
val="0"/>
        <property name="ColorValue" hidden="0" locked="0"
val="1"/>
        <property name="AdaptiveTimestep" hidden="0" locked="0"
val="false"/>
        <property name="FirstUpdateTimestep" hidden="0"
locked="0" val="false"/>
        <property name="CorrectDensity" hidden="0" locked="0"
val="false"/>
        <property name="SmoothVelocities" hidden="0" locked="0"
val="false"/>
        <property name="BoundaryCoefficient" hidden="0"
locked="0" val="1.2"/>
        <property name="SphKernel" hidden="0" locked="0"
val="CubicSplineKernel"/>
        <property name="StuckPrevention" hidden="0" locked="0"
val="false"/>
        <property name="ExtractSurfaceParticles" hidden="0"
locked="0" val="true"/>
        <property name="IntegrationMethod" hidden="0" locked="0"
val=""/>

```

```

        <property name="DensityInPressure" hidden="0" locked="0"
val="iiCurrentDensity"/>
        <property name="MinIter" hidden="0" locked="0" val="3"/>
        <property name="MaxIter" hidden="0" locked="0"
val="100"/>
        <property name="InitialPressure" hidden="0" locked="0"
val="iiOldPressure"/>
        <property name="OldPressureWeight" hidden="0" locked="0"
val="0.60000002384185791"/>
        <property name="AvgDensityError" hidden="0" locked="0"
val="0.100000000000000001"/>
        <property name="StopCriterion" hidden="0" locked="0"
val="scDensity"/>
        <property name="SolverError" hidden="0" locked="0"
val="0.001"/>
        <property name="Omega" hidden="0" locked="0" val="0.5"/>
        <property name="IsolatedRemoval" hidden="0" locked="0"
val="false"/>
        <property name="IsolatedDamping" hidden="0" locked="0"
val="false"/>
        <property name="IsoDampingFactor" hidden="0" locked="0"
val="2"/>
        <property name="IsoDampingThreshold" hidden="0"
locked="0" val="5"/>
        <property name="AllowNegativePressure" hidden="0"
locked="0" val="false"/>
        <property name="CacheVorticity" hidden="0" locked="0"
val="false"/>
        <property name="LambdaV" hidden="0" locked="0"
val="0.400000000000000002"/>
        <property name="LambdaVis" hidden="0" locked="0"
val="0.125"/>
        <property name="LambdaMax" hidden="0" locked="0"
val="0.5"/>
        <property name="ShowMaxNrCoefficients" hidden="0"
locked="0" val="true"/>
    </IISphSolver_1>
    <RigidCuboid_1>
        <property name="objectName" hidden="0" locked="0"
val="RigidCuboid_1"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0"
x="8.60439" y="3.26087" z="25.6292"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="50" y="1"
z="2"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>

```

```

        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0"
g="255" b="0" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="Timestep" hidden="0" locked="0"
val="0.01"/>
        <property name="ShowStatistics" hidden="0" locked="0"
val="false"/>
        <property name="ShowTimings" hidden="0" locked="0"
val="false"/>
        <property name="RigidType" hidden="0" locked="0"
val="Static"/>
        <property name="TwoWayCoupling" hidden="0" locked="0"
val="true"/>
        <property name="CollisionShapeType" hidden="0"
locked="0" val="gImpactMesh"/>
        <property name="CenterMethod" hidden="0" locked="0"
val="PolyhedralMass"/>
        <property name="LocalizedTransforms" hidden="0"
locked="0" val="false"/>
        <property name="RigidFriction" hidden="0" locked="0"
val="0.5"/>
        <property name="Viscosity" hidden="0" locked="0"
val="0.01"/>
        <property name="Adhesion" hidden="0" locked="0"
val="0.001"/>
        <property name="Density" hidden="0" locked="0"
val="1000"/>
        <property name="ExportStats" hidden="0" locked="0"
val="false"/>
        <property name="ExportPath" hidden="0" locked="0"
val=""/>
        <property name="ExportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="LinearVelocity" hidden="0" locked="0"
x="0" y="0" z="0"/>
        <property name="AngularVelocity" hidden="0" locked="0"
x="0" y="0" z="0"/>
        <property name="ComputePerVertexVelocity" hidden="0"
locked="0" val="false"/>
        <property name="ShowForces" hidden="0" locked="0"
val="true"/>
        <property name="TotalForce" hidden="0" locked="0" x="-
8412.67" y="-1.49979e+07" z="-722823"/>
        <property name="TotalTorque" hidden="0" locked="0"
x="1.02371e+08" y="-4.22078e+07" z="1.87293e+09"/>
        <property name="FlipMesh" hidden="0" locked="0"
val="false"/>
        <property name="VisType" hidden="0" locked="0"
val="MeshColor"/>

```

```

        <property name="ResetStats" hidden="0" locked="0"
val=""/>
        <property name="ThreeDelightRenderingType" hidden="0"
locked="0" val="Polygons"/>
        <property name="ThreeDelightOpacity" hidden="0"
locked="0" x="1" y="1" z="1"/>
        <property name="ShowParticles" hidden="0" locked="0"
val="false"/>
        <property name="DrawSurfaceNormals" hidden="0"
locked="0" val="false"/>
        <property name="TwoSidedLighting" hidden="0" locked="0"
val="true"/>
        <property name="Coloring" hidden="0" locked="0"
val="VelocityBased"/>
        <property name="AutomaticRange" hidden="0" locked="0"
val="true"/>
        <property name="ColoringExponent" hidden="0" locked="0"
val="0"/>
        <property name="MinColoringRange" hidden="0" locked="0"
val="0"/>
        <property name="MaxColoringRange" hidden="0" locked="0"
val="0"/>
        <property name="MinRangeColor" hidden="0" locked="0"
r="63" g="126" b="189" a="255"/>
        <property name="MaxRangeColor" hidden="0" locked="0"
r="255" g="255" b="255" a="255"/>
        <property name="Spacing" hidden="0" locked="0"
val="0.5"/>
        <property name="SurfaceOffset" hidden="0" locked="0"
val="0"/>
    </RigidCuboid_1>
    <RigidCuboid_2>
        <property name="objectName" hidden="0" locked="0"
val="RigidCuboid_2"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0"
x="7.8176" y="18.3713" z="24.3877"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="50"
y="30" z="1"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="Wireframe"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0"
g="255" b="0" a="255"/>

```

```

        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="Timestep" hidden="0" locked="0"
val="0.01"/>
        <property name="ShowStatistics" hidden="0" locked="0"
val="false"/>
        <property name="ShowTimings" hidden="0" locked="0"
val="false"/>
        <property name="RigidType" hidden="0" locked="0"
val="Static"/>
        <property name="TwoWayCoupling" hidden="0" locked="0"
val="true"/>
        <property name="CollisionShapeType" hidden="0"
locked="0" val="gImpactMesh"/>
        <property name="CenterMethod" hidden="0" locked="0"
val="PolyhedralMass"/>
        <property name="LocalizedTransforms" hidden="0"
locked="0" val="false"/>
        <property name="RigidFriction" hidden="0" locked="0"
val="0.5"/>
        <property name="Viscosity" hidden="0" locked="0"
val="0.01"/>
        <property name="Adhesion" hidden="0" locked="0"
val="0.001"/>
        <property name="Density" hidden="0" locked="0"
val="1000"/>
        <property name="ExportStats" hidden="0" locked="0"
val="false"/>
        <property name="ExportPath" hidden="0" locked="0"
val=""/>
        <property name="ExportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="LinearVelocity" hidden="0" locked="0"
x="0" y="0" z="0"/>
        <property name="AngularVelocity" hidden="0" locked="0"
x="0" y="0" z="0"/>
        <property name="ComputePerVertexVelocity" hidden="0"
locked="0" val="false"/>
        <property name="ShowForces" hidden="0" locked="0"
val="true"/>
        <property name="TotalForce" hidden="0" locked="0"
x="9.27125e+06" y="4.61211e+06" z="-7.1503e+08"/>
        <property name="TotalTorque" hidden="0" locked="0" x="-
7.41079e+09" y="-9.63371e+10" z="-5.62906e+08"/>
        <property name="FlipMesh" hidden="0" locked="0"
val="false"/>
        <property name="VisType" hidden="0" locked="0"
val="MeshColor"/>
        <property name="ResetStats" hidden="0" locked="0"
val=""/>
        <property name="ThreeDelightRenderingType" hidden="0"
locked="0" val="Polygons"/>
        <property name="ThreeDelightOpacity" hidden="0"
locked="0" x="1" y="1" z="1"/>

```

```

        <property name="ShowParticles" hidden="0" locked="0"
val="false"/>
        <property name="DrawSurfaceNormals" hidden="0"
locked="0" val="false"/>
        <property name="TwoSidedLighting" hidden="0" locked="0"
val="true"/>
        <property name="Coloring" hidden="0" locked="0"
val="VelocityBased"/>
        <property name="AutomaticRange" hidden="0" locked="0"
val="true"/>
        <property name="ColoringExponent" hidden="0" locked="0"
val="0"/>
        <property name="MinColoringRange" hidden="0" locked="0"
val="0"/>
        <property name="MaxColoringRange" hidden="0" locked="0"
val="0"/>
        <property name="MinRangeColor" hidden="0" locked="0"
r="63" g="126" b="189" a="255"/>
        <property name="MaxRangeColor" hidden="0" locked="0"
r="255" g="255" b="255" a="255"/>
        <property name="Spacing" hidden="0" locked="0"
val="0.5"/>
        <property name="SurfaceOffset" hidden="0" locked="0"
val="0"/>
    </RigidCuboid_2>
    <RigidCuboid_3>
        <property name="objectName" hidden="0" locked="0"
val="RigidCuboid_3"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0"
x="8.00083" y="18.321" z="26.9346"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="50"
y="30" z="1"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="Wireframe"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0"
g="255" b="0" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="Timestep" hidden="0" locked="0"
val="0.01"/>

```

```

val="false"/>    <property name="ShowStatistics" hidden="0" locked="0"
val="false"/>    <property name="ShowTimings" hidden="0" locked="0"
val="Static"/>   <property name="RigidType" hidden="0" locked="0"
val="true"/>     <property name="TwoWayCoupling" hidden="0" locked="0"
locked="0" val="gImpactMesh"/> <property name="CollisionShapeType" hidden="0"
val="PolyhedralMass"/> <property name="CenterMethod" hidden="0" locked="0"
locked="0" val="false"/> <property name="LocalizedTransforms" hidden="0"
val="0.5"/> <property name="RigidFriction" hidden="0" locked="0"
val="0.01"/> <property name="Viscosity" hidden="0" locked="0"
val="0.001"/> <property name="Adhesion" hidden="0" locked="0"
val="1000"/> <property name="Density" hidden="0" locked="0"
val="false"/> <property name="ExportStats" hidden="0" locked="0"
val=""/> <property name="ExportPath" hidden="0" locked="0"
val="Text"/> <property name="ExportFormat" hidden="0" locked="0"
x="0" y="0" z="0"/> <property name="LinearVelocity" hidden="0" locked="0"
x="0" y="0" z="0"/> <property name="AngularVelocity" hidden="0" locked="0"
locked="0" val="false"/> <property name="ComputePerVertexVelocity" hidden="0"
val="false"/> <property name="ShowForces" hidden="0" locked="0"
y="0" z="0"/> <property name="TotalForce" hidden="0" locked="0" x="0"
y="0" z="0"/> <property name="TotalTorque" hidden="0" locked="0" x="0"
val="false"/> <property name="FlipMesh" hidden="0" locked="0"
val="MeshColor"/> <property name="VisType" hidden="0" locked="0"
val=""/> <property name="ResetStats" hidden="0" locked="0"
locked="0" val="Polygons"/> <property name="ThreeDelightRenderingType" hidden="0"
locked="0" x="1" y="1" z="1"/> <property name="ThreeDelightOpacity" hidden="0"
val="false"/> <property name="ShowParticles" hidden="0" locked="0"
locked="0" val="false"/> <property name="DrawSurfaceNormals" hidden="0"
val="true"/> <property name="TwoSidedLighting" hidden="0" locked="0"

```

```

        <property      name="Coloring"      hidden="0"      locked="0"
val="VelocityBased"/>
        <property      name="AutomaticRange"  hidden="0"      locked="0"
val="true"/>
        <property      name="ColoringExponent"  hidden="0"      locked="0"
val="0"/>
        <property      name="MinColoringRange"  hidden="0"      locked="0"
val="0"/>
        <property      name="MaxColoringRange"  hidden="0"      locked="0"
val="0"/>
        <property      name="MinRangeColor"      hidden="0"      locked="0"
r="63" g="126" b="189" a="255"/>
        <property      name="MaxRangeColor"      hidden="0"      locked="0"
r="255" g="255" b="255" a="255"/>
        <property      name="Spacing"      hidden="0"      locked="0"
val="0.5"/>
        <property      name="SurfaceOffset"      hidden="0"      locked="0"
val="0"/>
    </RigidCuboid_3>
    <RigidCuboid_4>
        <property      name="objectName"      hidden="0"      locked="0"
val="RigidCuboid_4"/>
        <property      name="OsdMsgPos"      hidden="0"      locked="0"
val="Left"/>
        <property      name="Verbose"      hidden="0"      locked="0"
val="false"/>
        <property      name="Behavior"      hidden="0"      locked="0"
val="Active"/>
        <property      name="CacheData"      hidden="0"      locked="0"
val="true"/>
        <property      name="Position"      hidden="0"      locked="0" x="-
9.26545" y="14.8468" z="25.7151"/>
        <property      name="Orientation"      hidden="0"      locked="0"
phi="0" theta="0" psi="0"/>
        <property      name="Scale"      hidden="0"      locked="0" x="1" y="23"
z="2"/>
        <property      name="Pivot"      hidden="0"      locked="0" x="0" y="0"
z="0"/>
        <property      name="RenderMode"      hidden="0"      locked="0"
val="SmoothShaded"/>
        <property      name="RenderPriority"      hidden="0"      locked="0"
val="100"/>
        <property      name="Color"      hidden="0"      locked="0" r="0"
g="255" b="0" a="255"/>
        <property      name="ExternalRender"      hidden="0"      locked="0"
val="true"/>
        <property      name="FrameInfo"      hidden="0"      locked="0"
first="-1" last="0" complete="0"/>
        <property      name="Timestep"      hidden="0"      locked="0"
val="0.01"/>
        <property      name="ShowStatistics"      hidden="0"      locked="0"
val="false"/>
        <property      name="ShowTimings"      hidden="0"      locked="0"
val="false"/>
        <property      name="RigidType"      hidden="0"      locked="0"
val="Static"/>

```

```

        <property name="TwoWayCoupling" hidden="0" locked="0"
val="true"/>
        <property name="CollisionShapeType" hidden="0"
locked="0" val="gImpactMesh"/>
        <property name="CenterMethod" hidden="0" locked="0"
val="PolyhedralMass"/>
        <property name="LocalizedTransforms" hidden="0"
locked="0" val="false"/>
        <property name="RigidFriction" hidden="0" locked="0"
val="0.5"/>
        <property name="Viscosity" hidden="0" locked="0"
val="0.01"/>
        <property name="Adhesion" hidden="0" locked="0"
val="0.001"/>
        <property name="Density" hidden="0" locked="0"
val="1000"/>
        <property name="ExportStats" hidden="0" locked="0"
val="false"/>
        <property name="ExportPath" hidden="0" locked="0"
val=""/>
        <property name="ExportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="LinearVelocity" hidden="0" locked="0"
x="0" y="0" z="0"/>
        <property name="AngularVelocity" hidden="0" locked="0"
x="0" y="0" z="0"/>
        <property name="ComputePerVertexVelocity" hidden="0"
locked="0" val="false"/>
        <property name="ShowForces" hidden="0" locked="0"
val="false"/>
        <property name="TotalForce" hidden="0" locked="0" x="0"
y="0" z="0"/>
        <property name="TotalTorque" hidden="0" locked="0" x="0"
y="0" z="0"/>
        <property name="FlipMesh" hidden="0" locked="0"
val="false"/>
        <property name="VisType" hidden="0" locked="0"
val="MeshColor"/>
        <property name="ResetStats" hidden="0" locked="0"
val=""/>
        <property name="ThreeDelightRenderingType" hidden="0"
locked="0" val="Polygons"/>
        <property name="ThreeDelightOpacity" hidden="0"
locked="0" x="1" y="1" z="1"/>
        <property name="ShowParticles" hidden="0" locked="0"
val="false"/>
        <property name="DrawSurfaceNormals" hidden="0"
locked="0" val="false"/>
        <property name="TwoSidedLighting" hidden="0" locked="0"
val="true"/>
        <property name="Coloring" hidden="0" locked="0"
val="VelocityBased"/>
        <property name="AutomaticRange" hidden="0" locked="0"
val="true"/>
        <property name="ColoringExponent" hidden="0" locked="0"
val="0"/>

```

```

        <property name="MinColoringRange" hidden="0" locked="0"
val="0"/>
        <property name="MaxColoringRange" hidden="0" locked="0"
val="0"/>
        <property name="MinRangeColor" hidden="0" locked="0"
r="63" g="126" b="189" a="255"/>
        <property name="MaxRangeColor" hidden="0" locked="0"
r="255" g="255" b="255" a="255"/>
        <property name="Spacing" hidden="0" locked="0"
val="0.40000000000000002"/>
        <property name="SurfaceOffset" hidden="0" locked="0"
val="0"/>
    </RigidCuboid_4>
    <RigidCuboid_5>
        <property name="objectName" hidden="0" locked="0"
val="RigidCuboid_5"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0" x="-
71.6874" y="10.2263" z="25.6755"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="125"
y="13.41" z="1.5"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="Invisible"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="Timestep" hidden="0" locked="0"
val="0.01"/>
        <property name="ShowStatistics" hidden="0" locked="0"
val="false"/>
        <property name="ShowTimings" hidden="0" locked="0"
val="false"/>
        <property name="RigidType" hidden="0" locked="0"
val="Static"/>
        <property name="TwoWayCoupling" hidden="0" locked="0"
val="true"/>
        <property name="CollisionShapeType" hidden="0"
locked="0" val="gImpactMesh"/>
        <property name="CenterMethod" hidden="0" locked="0"
val="PolyhedralMass"/>

```

```

        <property      name="LocalizedTransforms"      hidden="0"
locked="0" val="false"/>
        <property      name="RigidFriction"      hidden="0"      locked="0"
val="0.5"/>
        <property      name="Viscosity"      hidden="0"      locked="0"
val="0.01"/>
        <property      name="Adhesion"      hidden="0"      locked="0"
val="0.001"/>
        <property      name="Density"      hidden="0"      locked="0"
val="1000"/>
        <property      name="ExportStats"      hidden="0"      locked="0"
val="false"/>
        <property      name="ExportPath"      hidden="0"      locked="0"
val=""/>
        <property      name="ExportFormat"      hidden="0"      locked="0"
val="Text"/>
        <property      name="LinearVelocity"      hidden="0"      locked="0"
x="0" y="0" z="0"/>
        <property      name="AngularVelocity"      hidden="0"      locked="0"
x="0" y="0" z="0"/>
        <property      name="ComputePerVertexVelocity"      hidden="0"
locked="0" val="false"/>
        <property      name="ShowForces"      hidden="0"      locked="0"
val="true"/>
        <property      name="TotalForce"      hidden="0"      locked="0" x="-
1.111e+08" y="-3.29505e+10" z="2.5674e+07"/>
        <property      name="TotalTorque"      hidden="0"      locked="0"
x="3.70968e+10" y="3.99719e+08" z="6.75843e+10"/>
        <property      name="FlipMesh"      hidden="0"      locked="0"
val="false"/>
        <property      name="VisType"      hidden="0"      locked="0"
val="MeshColor"/>
        <property      name="ResetStats"      hidden="0"      locked="0"
val=""/>
        <property      name="ThreeDelightRenderingType"      hidden="0"
locked="0" val="Polygons"/>
        <property      name="ThreeDelightOpacity"      hidden="0"
locked="0" x="1" y="1" z="1"/>
        <property      name="ShowParticles"      hidden="0"      locked="0"
val="false"/>
        <property      name="DrawSurfaceNormals"      hidden="0"
locked="0" val="false"/>
        <property      name="TwoSidedLighting"      hidden="0"      locked="0"
val="true"/>
        <property      name="Coloring"      hidden="0"      locked="0"
val="VelocityBased"/>
        <property      name="AutomaticRange"      hidden="0"      locked="0"
val="true"/>
        <property      name="ColoringExponent"      hidden="0"      locked="0"
val="0"/>
        <property      name="MinColoringRange"      hidden="0"      locked="0"
val="0"/>
        <property      name="MaxColoringRange"      hidden="0"      locked="0"
val="0"/>
        <property      name="MinRangeColor"      hidden="0"      locked="0"
r="63" g="126" b="189" a="255"/>

```

```

        <property name="MaxRangeColor" hidden="0" locked="0"
r="255" g="255" b="255" a="255"/>
        <property name="Spacing" hidden="0" locked="0"
val="0.40000000000000002"/>
        <property name="SurfaceOffset" hidden="0" locked="0"
val="0"/>
    </RigidCuboid_5>
    <MeasurementField_1>
        <property name="objectName" hidden="0" locked="0"
val="MeasurementField_1"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0" x="-
11.6128" y="24.942" z="25.6755"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="1"
y="0.5" z="0.75"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="seaLevel" hidden="0" locked="0"
val="3.6878449999999998"/>
        <property name="computeFlowRate" hidden="0" locked="0"
val="false"/>
        <property name="flowPlaneNormal" hidden="0" locked="0"
x="1" y="0" z="0"/>
        <property name="exportParticles" hidden="0" locked="0"
val="true"/>
        <property name="exportPP" hidden="0" locked="0"
val="false"/>
        <property name="exportInt" hidden="0" locked="0"
val="0.02"/>
        <property name="exportPath" hidden="0" locked="0"
val="Pressure_1_1"/>
        <property name="exportType" hidden="0" locked="0"
val="AvgPressure"/>
        <property name="exportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="plotType" hidden="0" locked="0"
val="Curve"/>

```

```

        <property name="subdivideMeasurementField" hidden="0"
locked="0" val="false"/>
        <property name="subdiv" hidden="0" locked="0" x="10"
y="10" z="10"/>
        <property name="sdArrowScale" hidden="0" locked="0"
val="10"/>
        <property name="sdMaxArrowLength" hidden="0" locked="0"
val="0.050000000000000003"/>
        <property name="sdNormalizeArrows" hidden="0" locked="0"
val="false"/>
        <property name="reset" hidden="0" locked="0" val=""/>
    </MeasurementField_1>
    <MeasurementField_2>
        <property name="objectName" hidden="0" locked="0"
val="MeasurementField_2"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0" x="-
11.5525" y="26.361" z="25.6755"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="1"
y="0.5" z="0.75"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="seaLevel" hidden="0" locked="0"
val="3.6878449999999998"/>
        <property name="computeFlowRate" hidden="0" locked="0"
val="false"/>
        <property name="flowPlaneNormal" hidden="0" locked="0"
x="1" y="0" z="0"/>
        <property name="exportParticles" hidden="0" locked="0"
val="false"/>
        <property name="exportPP" hidden="0" locked="0"
val="false"/>
        <property name="exportInt" hidden="0" locked="0"
val="0.02"/>
        <property name="exportPath" hidden="0" locked="0"
val="MeasurementField_2"/>
        <property name="exportType" hidden="0" locked="0"
val="Velocity"/>

```

```

        <property name="exportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="plotType" hidden="0" locked="0"
val="Curve"/>
        <property name="subdivideMeasurementField" hidden="0"
locked="0" val="false"/>
        <property name="subdiv" hidden="0" locked="0" x="10"
y="10" z="10"/>
        <property name="sdArrowScale" hidden="0" locked="0"
val="10"/>
        <property name="sdMaxArrowLength" hidden="0" locked="0"
val="0.050000000000000003"/>
        <property name="sdNormalizeArrows" hidden="0" locked="0"
val="false"/>
        <property name="reset" hidden="0" locked="0" val=""/>
    </MeasurementField_2>
    <MeasurementField_3>
        <property name="objectName" hidden="0" locked="0"
val="MeasurementField_3"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0" x="-
11.1458" y="26.826" z="25.6755"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="1.5"
y="0.5" z="0.75"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="seaLevel" hidden="0" locked="0"
val="3.6878449999999998"/>
        <property name="computeFlowRate" hidden="0" locked="0"
val="false"/>
        <property name="flowPlaneNormal" hidden="0" locked="0"
x="1" y="0" z="0"/>
        <property name="exportParticles" hidden="0" locked="0"
val="false"/>
        <property name="exportPP" hidden="0" locked="0"
val="false"/>
        <property name="exportInt" hidden="0" locked="0"
val="0.02"/>

```

```

        <property name="exportPath" hidden="0" locked="0"
val="MeasurementField_3"/>
        <property name="exportType" hidden="0" locked="0"
val="Velocity"/>
        <property name="exportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="plotType" hidden="0" locked="0"
val="Curve"/>
        <property name="subdivideMeasurementField" hidden="0"
locked="0" val="false"/>
        <property name="subdiv" hidden="0" locked="0" x="10"
y="10" z="10"/>
        <property name="sdArrowScale" hidden="0" locked="0"
val="10"/>
        <property name="sdMaxArrowLength" hidden="0" locked="0"
val="0.050000000000000003"/>
        <property name="sdNormalizeArrows" hidden="0" locked="0"
val="false"/>
        <property name="reset" hidden="0" locked="0" val=""/>
    </MeasurementField_3>
    <MeasurementField_4>
        <property name="objectName" hidden="0" locked="0"
val="MeasurementField_4"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0" x="-
10.7128" y="26.937" z="25.6755"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="0.5"
y="1" z="0.75"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="seaLevel" hidden="0" locked="0"
val="3.6878449999999998"/>
        <property name="computeFlowRate" hidden="0" locked="0"
val="false"/>
        <property name="flowPlaneNormal" hidden="0" locked="0"
x="1" y="0" z="0"/>
        <property name="exportParticles" hidden="0" locked="0"
val="false"/>

```

```

        <property      name="exportPP"      hidden="0"      locked="0"
val="false"/>
        <property      name="exportInt"      hidden="0"      locked="0"
val="0.02"/>
        <property      name="exportPath"      hidden="0"      locked="0"
val="MeasurementField_4"/>
        <property      name="exportType"      hidden="0"      locked="0"
val="Velocity"/>
        <property      name="exportFormat"      hidden="0"      locked="0"
val="Text"/>
        <property      name="plotType"      hidden="0"      locked="0"
val="Curve"/>
        <property      name="subdivideMeasurementField"      hidden="0"
locked="0" val="false"/>
        <property      name="subdiv"      hidden="0"      locked="0"      x="10"
y="10" z="10"/>
        <property      name="sdArrowScale"      hidden="0"      locked="0"
val="10"/>
        <property      name="sdMaxArrowLength"      hidden="0"      locked="0"
val="0.050000000000000003"/>
        <property      name="sdNormalizeArrows"      hidden="0"      locked="0"
val="false"/>
        <property      name="reset"      hidden="0"      locked="0"      val=""/>
    </MeasurementField_4>
    <MeasurementField_5>
        <property      name="objectName"      hidden="0"      locked="0"
val="MeasurementField_5"/>
        <property      name="OsdMsgPos"      hidden="0"      locked="0"
val="Left"/>
        <property      name="Verbose"      hidden="0"      locked="0"
val="false"/>
        <property      name="Behavior"      hidden="0"      locked="0"
val="Active"/>
        <property      name="CacheData"      hidden="0"      locked="0"
val="true"/>
        <property      name="Position"      hidden="0"      locked="0"      x="-
9.4631" y="26.841" z="25.6755"/>
        <property      name="Orientation"      hidden="0"      locked="0"
phi="0" theta="0" psi="0"/>
        <property      name="Scale"      hidden="0"      locked="0"      x="0.5"
y="1" z="0.75"/>
        <property      name="Pivot"      hidden="0"      locked="0"      x="0" y="0"
z="0"/>
        <property      name="RenderMode"      hidden="0"      locked="0"
val="SmoothShaded"/>
        <property      name="RenderPriority"      hidden="0"      locked="0"
val="100"/>
        <property      name="Color"      hidden="0"      locked="0"      r="0" g="0"
b="255" a="255"/>
        <property      name="ExternalRender"      hidden="0"      locked="0"
val="true"/>
        <property      name="FrameInfo"      hidden="0"      locked="0"
first="-1" last="0" complete="0"/>
        <property      name="seaLevel"      hidden="0"      locked="0"
val="3.6878449999999998"/>
        <property      name="computeFlowRate"      hidden="0"      locked="0"
val="false"/>

```

```

        <property name="flowPlaneNormal" hidden="0" locked="0"
x="1" y="0" z="0"/>
        <property name="exportParticles" hidden="0" locked="0"
val="false"/>
        <property name="exportPP" hidden="0" locked="0"
val="false"/>
        <property name="exportInt" hidden="0" locked="0"
val="0.02"/>
        <property name="exportPath" hidden="0" locked="0"
val="MeasurementField_5"/>
        <property name="exportType" hidden="0" locked="0"
val="Velocity"/>
        <property name="exportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="plotType" hidden="0" locked="0"
val="Curve"/>
        <property name="subdivideMeasurementField" hidden="0"
locked="0" val="false"/>
        <property name="subdiv" hidden="0" locked="0" x="10"
y="10" z="10"/>
        <property name="sdArrowScale" hidden="0" locked="0"
val="10"/>
        <property name="sdMaxArrowLength" hidden="0" locked="0"
val="0.050000000000000003"/>
        <property name="sdNormalizeArrows" hidden="0" locked="0"
val="false"/>
        <property name="reset" hidden="0" locked="0" val=""/>
    </MeasurementField_5>
    <MeasurementField_6>
        <property name="objectName" hidden="0" locked="0"
val="MeasurementField_6"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0" x="-
8.13613" y="26.532" z="25.6755"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="0.5"
y="1" z="0.75"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>

```

```

        <property      name="seaLevel"      hidden="0"      locked="0"
val="3.6878449999999998"/>
        <property      name="computeFlowRate"      hidden="0"      locked="0"
val="false"/>
        <property      name="flowPlaneNormal"      hidden="0"      locked="0"
x="1" y="0" z="0"/>
        <property      name="exportParticles"      hidden="0"      locked="0"
val="false"/>
        <property      name="exportPP"      hidden="0"      locked="0"
val="false"/>
        <property      name="exportInt"      hidden="0"      locked="0"
val="0.02"/>
        <property      name="exportPath"      hidden="0"      locked="0"
val="MeasurementField_6"/>
        <property      name="exportType"      hidden="0"      locked="0"
val="Velocity"/>
        <property      name="exportFormat"      hidden="0"      locked="0"
val="Text"/>
        <property      name="plotType"      hidden="0"      locked="0"
val="Curve"/>
        <property      name="subdivideMeasurementField"      hidden="0"
locked="0" val="false"/>
        <property      name="subdiv"      hidden="0"      locked="0"      x="10"
y="10" z="10"/>
        <property      name="sdArrowScale"      hidden="0"      locked="0"
val="10"/>
        <property      name="sdMaxArrowLength"      hidden="0"      locked="0"
val="0.050000000000000003"/>
        <property      name="sdNormalizeArrows"      hidden="0"      locked="0"
val="false"/>
        <property      name="reset"      hidden="0"      locked="0"      val=""/>
    </MeasurementField_6>
    <MeasurementField_7>
        <property      name="objectName"      hidden="0"      locked="0"
val="MeasurementField_7"/>
        <property      name="OsdMsgPos"      hidden="0"      locked="0"
val="Left"/>
        <property      name="Verbose"      hidden="0"      locked="0"
val="false"/>
        <property      name="Behavior"      hidden="0"      locked="0"
val="Active"/>
        <property      name="CacheData"      hidden="0"      locked="0"
val="true"/>
        <property      name="Position"      hidden="0"      locked="0"      x="-
7.07206" y="26.136" z="25.6755"/>
        <property      name="Orientation"      hidden="0"      locked="0"
phi="0" theta="0" psi="0"/>
        <property      name="Scale"      hidden="0"      locked="0"      x="0.5"
y="1" z="0.75"/>
        <property      name="Pivot"      hidden="0"      locked="0"      x="0" y="0"
z="0"/>
        <property      name="RenderMode"      hidden="0"      locked="0"
val="SmoothShaded"/>
        <property      name="RenderPriority"      hidden="0"      locked="0"
val="100"/>
        <property      name="Color"      hidden="0"      locked="0"      r="0" g="0"
b="255" a="255"/>

```

```

        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="seaLevel" hidden="0" locked="0"
val="3.6878449999999998"/>
        <property name="computeFlowRate" hidden="0" locked="0"
val="false"/>
        <property name="flowPlaneNormal" hidden="0" locked="0"
x="1" y="0" z="0"/>
        <property name="exportParticles" hidden="0" locked="0"
val="false"/>
        <property name="exportPP" hidden="0" locked="0"
val="false"/>
        <property name="exportInt" hidden="0" locked="0"
val="0.02"/>
        <property name="exportPath" hidden="0" locked="0"
val="MeasurementField_7"/>
        <property name="exportType" hidden="0" locked="0"
val="Velocity"/>
        <property name="exportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="plotType" hidden="0" locked="0"
val="Curve"/>
        <property name="subdivideMeasurementField" hidden="0"
locked="0" val="false"/>
        <property name="subdiv" hidden="0" locked="0" x="10"
y="10" z="10"/>
        <property name="sdArrowScale" hidden="0" locked="0"
val="10"/>
        <property name="sdMaxArrowLength" hidden="0" locked="0"
val="0.050000000000000003"/>
        <property name="sdNormalizeArrows" hidden="0" locked="0"
val="false"/>
        <property name="reset" hidden="0" locked="0" val=""/>
    </MeasurementField_7>
    <MeasurementField_8>
        <property name="objectName" hidden="0" locked="0"
val="MeasurementField_8"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0" x="-
6.09735" y="25.647" z="25.6755"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="0.5"
y="1" z="0.75"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>

```

```

        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="seaLevel" hidden="0" locked="0"
val="3.6878449999999998"/>
        <property name="computeFlowRate" hidden="0" locked="0"
val="false"/>
        <property name="flowPlaneNormal" hidden="0" locked="0"
x="1" y="0" z="0"/>
        <property name="exportParticles" hidden="0" locked="0"
val="false"/>
        <property name="exportPP" hidden="0" locked="0"
val="false"/>
        <property name="exportInt" hidden="0" locked="0"
val="0.02"/>
        <property name="exportPath" hidden="0" locked="0"
val="MeasurementField_8"/>
        <property name="exportType" hidden="0" locked="0"
val="Velocity"/>
        <property name="exportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="plotType" hidden="0" locked="0"
val="Curve"/>
        <property name="subdivideMeasurementField" hidden="0"
locked="0" val="false"/>
        <property name="subdiv" hidden="0" locked="0" x="10"
y="10" z="10"/>
        <property name="sdArrowScale" hidden="0" locked="0"
val="10"/>
        <property name="sdMaxArrowLength" hidden="0" locked="0"
val="0.050000000000000003"/>
        <property name="sdNormalizeArrows" hidden="0" locked="0"
val="false"/>
        <property name="reset" hidden="0" locked="0" val=""/>
    </MeasurementField_8>
    <MeasurementField_9>
        <property name="objectName" hidden="0" locked="0"
val="MeasurementField_9"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0" x="-
5.1227" y="25.047" z="25.6755"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="0.5"
y="1" z="0.75"/>

```

```

z="0"/>
    <property name="Pivot" hidden="0" locked="0" x="0" y="0"
val="SmoothShaded"/>
    <property name="RenderMode" hidden="0" locked="0"
val="100"/>
    <property name="RenderPriority" hidden="0" locked="0"
b="255" a="255"/>
    <property name="Color" hidden="0" locked="0" r="0" g="0"
val="true"/>
    <property name="ExternalRender" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
    <property name="FrameInfo" hidden="0" locked="0"
val="3.6878449999999998"/>
    <property name="seaLevel" hidden="0" locked="0"
val="false"/>
    <property name="computeFlowRate" hidden="0" locked="0"
x="1" y="0" z="0"/>
    <property name="flowPlaneNormal" hidden="0" locked="0"
val="false"/>
    <property name="exportParticles" hidden="0" locked="0"
val="false"/>
    <property name="exportPP" hidden="0" locked="0"
val="false"/>
    <property name="exportInt" hidden="0" locked="0"
val="0.02"/>
    <property name="exportPath" hidden="0" locked="0"
val="MeasurementField_9"/>
    <property name="exportType" hidden="0" locked="0"
val="Velocity"/>
    <property name="exportFormat" hidden="0" locked="0"
val="Text"/>
    <property name="plotType" hidden="0" locked="0"
val="Curve"/>
    <property name="subdivideMeasurementField" hidden="0"
locked="0" val="false"/>
    <property name="subdiv" hidden="0" locked="0" x="10"
y="10" z="10"/>
    <property name="sdArrowScale" hidden="0" locked="0"
val="10"/>
    <property name="sdMaxArrowLength" hidden="0" locked="0"
val="0.050000000000000003"/>
    <property name="sdNormalizeArrows" hidden="0" locked="0"
val="false"/>
    <property name="reset" hidden="0" locked="0" val=""/>
    </MeasurementField_9>
    <MeasurementField_10>
    <property name="objectName" hidden="0" locked="0"
val="MeasurementField_10"/>
    <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
    <property name="Verbose" hidden="0" locked="0"
val="false"/>
    <property name="Behavior" hidden="0" locked="0"
val="Active"/>
    <property name="CacheData" hidden="0" locked="0"
val="true"/>
    <property name="Position" hidden="0" locked="0" x="-
3.91834" y="24.147" z="25.6755"/>

```

```

        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="0.5"
y="1" z="0.75"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="seaLevel" hidden="0" locked="0"
val="3.6878449999999998"/>
        <property name="computeFlowRate" hidden="0" locked="0"
val="false"/>
        <property name="flowPlaneNormal" hidden="0" locked="0"
x="1" y="0" z="0"/>
        <property name="exportParticles" hidden="0" locked="0"
val="false"/>
        <property name="exportPP" hidden="0" locked="0"
val="false"/>
        <property name="exportInt" hidden="0" locked="0"
val="0.02"/>
        <property name="exportPath" hidden="0" locked="0"
val="MeasurementField_10"/>
        <property name="exportType" hidden="0" locked="0"
val="Velocity"/>
        <property name="exportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="plotType" hidden="0" locked="0"
val="Curve"/>
        <property name="subdivideMeasurementField" hidden="0"
locked="0" val="false"/>
        <property name="subdiv" hidden="0" locked="0" x="10"
y="10" z="10"/>
        <property name="sdArrowScale" hidden="0" locked="0"
val="10"/>
        <property name="sdMaxArrowLength" hidden="0" locked="0"
val="0.050000000000000003"/>
        <property name="sdNormalizeArrows" hidden="0" locked="0"
val="false"/>
        <property name="reset" hidden="0" locked="0" val=""/>
    </MeasurementField_10>
    <MeasurementField_11>
        <property name="objectName" hidden="0" locked="0"
val="MeasurementField_11"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>

```

```

        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0" x="-
2.79491" y="23.151" z="25.6755"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="0.5"
y="1" z="0.75"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="seaLevel" hidden="0" locked="0"
val="3.6878449999999998"/>
        <property name="computeFlowRate" hidden="0" locked="0"
val="false"/>
        <property name="flowPlaneNormal" hidden="0" locked="0"
x="1" y="0" z="0"/>
        <property name="exportParticles" hidden="0" locked="0"
val="false"/>
        <property name="exportPP" hidden="0" locked="0"
val="false"/>
        <property name="exportInt" hidden="0" locked="0"
val="0.02"/>
        <property name="exportPath" hidden="0" locked="0"
val="MeasurementField_11"/>
        <property name="exportType" hidden="0" locked="0"
val="Velocity"/>
        <property name="exportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="plotType" hidden="0" locked="0"
val="Curve"/>
        <property name="subdivideMeasurementField" hidden="0"
locked="0" val="false"/>
        <property name="subdiv" hidden="0" locked="0" x="10"
y="10" z="10"/>
        <property name="sdArrowScale" hidden="0" locked="0"
val="10"/>
        <property name="sdMaxArrowLength" hidden="0" locked="0"
val="0.050000000000000003"/>
        <property name="sdNormalizeArrows" hidden="0" locked="0"
val="false"/>
        <property name="reset" hidden="0" locked="0" val=""/>
    </MeasurementField_11>
    <MeasurementField_12>
        <property name="objectName" hidden="0" locked="0"
val="MeasurementField_12"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>

```

```

        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0" x="-
1.73282" y="22.071" z="25.6755"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="0.5"
y="1" z="0.75"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="seaLevel" hidden="0" locked="0"
val="3.6878449999999998"/>
        <property name="computeFlowRate" hidden="0" locked="0"
val="false"/>
        <property name="flowPlaneNormal" hidden="0" locked="0"
x="1" y="0" z="0"/>
        <property name="exportParticles" hidden="0" locked="0"
val="false"/>
        <property name="exportPP" hidden="0" locked="0"
val="false"/>
        <property name="exportInt" hidden="0" locked="0"
val="0.02"/>
        <property name="exportPath" hidden="0" locked="0"
val="MeasurementField_12"/>
        <property name="exportType" hidden="0" locked="0"
val="Velocity"/>
        <property name="exportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="plotType" hidden="0" locked="0"
val="Curve"/>
        <property name="subdivideMeasurementField" hidden="0"
locked="0" val="false"/>
        <property name="subdiv" hidden="0" locked="0" x="10"
y="10" z="10"/>
        <property name="sdArrowScale" hidden="0" locked="0"
val="10"/>
        <property name="sdMaxArrowLength" hidden="0" locked="0"
val="0.050000000000000003"/>
        <property name="sdNormalizeArrows" hidden="0" locked="0"
val="false"/>
        <property name="reset" hidden="0" locked="0" val=""/>
    </MeasurementField_12>
    <MeasurementField_13>

```

```

        <property      name="objectName"      hidden="0"      locked="0"
val="MeasurementField_13"/>
        <property      name="OsdMsgPos"      hidden="0"      locked="0"
val="Left"/>
        <property      name="Verbose"      hidden="0"      locked="0"
val="false"/>
        <property      name="Behavior"      hidden="0"      locked="0"
val="Active"/>
        <property      name="CacheData"      hidden="0"      locked="0"
val="true"/>
        <property      name="Position"      hidden="0"      locked="0"      x="-
0.249886"      y="20.382"      z="25.6755"/>
        <property      name="Orientation"      hidden="0"      locked="0"
phi="0"      theta="0"      psi="0"/>
        <property      name="Scale"      hidden="0"      locked="0"      x="0.5"
y="1"      z="0.75"/>
        <property      name="Pivot"      hidden="0"      locked="0"      x="0"      y="0"
z="0"/>
        <property      name="RenderMode"      hidden="0"      locked="0"
val="SmoothShaded"/>
        <property      name="RenderPriority"      hidden="0"      locked="0"
val="100"/>
        <property      name="Color"      hidden="0"      locked="0"      r="0"      g="0"
b="255"      a="255"/>
        <property      name="ExternalRender"      hidden="0"      locked="0"
val="true"/>
        <property      name="FrameInfo"      hidden="0"      locked="0"
first="-1"      last="0"      complete="0"/>
        <property      name="seaLevel"      hidden="0"      locked="0"
val="3.6878449999999998"/>
        <property      name="computeFlowRate"      hidden="0"      locked="0"
val="false"/>
        <property      name="flowPlaneNormal"      hidden="0"      locked="0"
x="1"      y="0"      z="0"/>
        <property      name="exportParticles"      hidden="0"      locked="0"
val="false"/>
        <property      name="exportPP"      hidden="0"      locked="0"
val="false"/>
        <property      name="exportInt"      hidden="0"      locked="0"
val="0.02"/>
        <property      name="exportPath"      hidden="0"      locked="0"
val="MeasurementField_13"/>
        <property      name="exportType"      hidden="0"      locked="0"
val="Velocity"/>
        <property      name="exportFormat"      hidden="0"      locked="0"
val="Text"/>
        <property      name="plotType"      hidden="0"      locked="0"
val="Curve"/>
        <property      name="subdivideMeasurementField"      hidden="0"
locked="0"      val="false"/>
        <property      name="subdiv"      hidden="0"      locked="0"      x="10"
y="10"      z="10"/>
        <property      name="sdArrowScale"      hidden="0"      locked="0"
val="10"/>
        <property      name="sdMaxArrowLength"      hidden="0"      locked="0"
val="0.050000000000000003"/>

```

```

        <property name="sdNormalizeArrows" hidden="0" locked="0"
val="false"/>
        <property name="reset" hidden="0" locked="0" val=""/>
    </MeasurementField_13>
    <MeasurementField_14>
        <property name="objectName" hidden="0" locked="0"
val="MeasurementField_14"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0"
x="1.26294" y="18.657" z="25.6755"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="0.5"
y="1" z="0.75"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="seaLevel" hidden="0" locked="0"
val="3.6878449999999998"/>
        <property name="computeFlowRate" hidden="0" locked="0"
val="false"/>
        <property name="flowPlaneNormal" hidden="0" locked="0"
x="1" y="0" z="0"/>
        <property name="exportParticles" hidden="0" locked="0"
val="false"/>
        <property name="exportPP" hidden="0" locked="0"
val="false"/>
        <property name="exportInt" hidden="0" locked="0"
val="0.02"/>
        <property name="exportPath" hidden="0" locked="0"
val="MeasurementField_14"/>
        <property name="exportType" hidden="0" locked="0"
val="Velocity"/>
        <property name="exportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="plotType" hidden="0" locked="0"
val="Curve"/>
        <property name="subdivideMeasurementField" hidden="0"
locked="0" val="false"/>
        <property name="subdiv" hidden="0" locked="0" x="10"
y="10" z="10"/>

```

```

        <property name="sdArrowScale" hidden="0" locked="0"
val="10"/>
        <property name="sdMaxArrowLength" hidden="0" locked="0"
val="0.050000000000000003"/>
        <property name="sdNormalizeArrows" hidden="0" locked="0"
val="false"/>
        <property name="reset" hidden="0" locked="0" val=""/>
    </MeasurementField_14>
    <MeasurementField_15>
        <property name="objectName" hidden="0" locked="0"
val="MeasurementField_15"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0"
x="2.76261" y="16.947" z="25.6755"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="0.5"
y="1" z="0.75"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="seaLevel" hidden="0" locked="0"
val="3.6878449999999998"/>
        <property name="computeFlowRate" hidden="0" locked="0"
val="false"/>
        <property name="flowPlaneNormal" hidden="0" locked="0"
x="1" y="0" z="0"/>
        <property name="exportParticles" hidden="0" locked="0"
val="false"/>
        <property name="exportPP" hidden="0" locked="0"
val="false"/>
        <property name="exportInt" hidden="0" locked="0"
val="0.02"/>
        <property name="exportPath" hidden="0" locked="0"
val="MeasurementField_15"/>
        <property name="exportType" hidden="0" locked="0"
val="Velocity"/>
        <property name="exportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="plotType" hidden="0" locked="0"
val="Curve"/>

```

```

        <property name="subdivideMeasurementField" hidden="0"
locked="0" val="false"/>
        <property name="subdiv" hidden="0" locked="0" x="10"
y="10" z="10"/>
        <property name="sdArrowScale" hidden="0" locked="0"
val="10"/>
        <property name="sdMaxArrowLength" hidden="0" locked="0"
val="0.050000000000000003"/>
        <property name="sdNormalizeArrows" hidden="0" locked="0"
val="false"/>
        <property name="reset" hidden="0" locked="0" val=""/>
    </MeasurementField_15>
    <MeasurementField_16>
        <property name="objectName" hidden="0" locked="0"
val="MeasurementField_16"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0"
x="4.25439" y="15.246" z="25.6755"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="0.5"
y="1" z="0.75"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="seaLevel" hidden="0" locked="0"
val="3.6878449999999998"/>
        <property name="computeFlowRate" hidden="0" locked="0"
val="false"/>
        <property name="flowPlaneNormal" hidden="0" locked="0"
x="1" y="0" z="0"/>
        <property name="exportParticles" hidden="0" locked="0"
val="false"/>
        <property name="exportPP" hidden="0" locked="0"
val="false"/>
        <property name="exportInt" hidden="0" locked="0"
val="0.02"/>
        <property name="exportPath" hidden="0" locked="0"
val="MeasurementField_16"/>
        <property name="exportType" hidden="0" locked="0"
val="Velocity"/>

```

```

        <property name="exportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="plotType" hidden="0" locked="0"
val="Curve"/>
        <property name="subdivideMeasurementField" hidden="0"
locked="0" val="false"/>
        <property name="subdiv" hidden="0" locked="0" x="10"
y="10" z="10"/>
        <property name="sdArrowScale" hidden="0" locked="0"
val="10"/>
        <property name="sdMaxArrowLength" hidden="0" locked="0"
val="0.050000000000000003"/>
        <property name="sdNormalizeArrows" hidden="0" locked="0"
val="false"/>
        <property name="reset" hidden="0" locked="0" val=""/>
    </MeasurementField_16>
    <MeasurementField_17>
        <property name="objectName" hidden="0" locked="0"
val="MeasurementField_17"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0"
x="5.72775" y="13.566" z="25.6755"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="0.5"
y="1" z="0.75"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="seaLevel" hidden="0" locked="0"
val="3.6878449999999998"/>
        <property name="computeFlowRate" hidden="0" locked="0"
val="false"/>
        <property name="flowPlaneNormal" hidden="0" locked="0"
x="1" y="0" z="0"/>
        <property name="exportParticles" hidden="0" locked="0"
val="false"/>
        <property name="exportPP" hidden="0" locked="0"
val="false"/>
        <property name="exportInt" hidden="0" locked="0"
val="0.02"/>

```

```

        <property name="exportPath" hidden="0" locked="0"
val="MeasurementField_17"/>
        <property name="exportType" hidden="0" locked="0"
val="Velocity"/>
        <property name="exportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="plotType" hidden="0" locked="0"
val="Curve"/>
        <property name="subdivideMeasurementField" hidden="0"
locked="0" val="false"/>
        <property name="subdiv" hidden="0" locked="0" x="10"
y="10" z="10"/>
        <property name="sdArrowScale" hidden="0" locked="0"
val="10"/>
        <property name="sdMaxArrowLength" hidden="0" locked="0"
val="0.050000000000000003"/>
        <property name="sdNormalizeArrows" hidden="0" locked="0"
val="false"/>
        <property name="reset" hidden="0" locked="0" val=""/>
    </MeasurementField_17>
    <MeasurementField_18>
        <property name="objectName" hidden="0" locked="0"
val="MeasurementField_18"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0"
x="7.23512" y="11.901" z="25.6755"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="0.5"
y="1" z="0.75"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="seaLevel" hidden="0" locked="0"
val="3.6878449999999998"/>
        <property name="computeFlowRate" hidden="0" locked="0"
val="false"/>
        <property name="flowPlaneNormal" hidden="0" locked="0"
x="1" y="0" z="0"/>
        <property name="exportParticles" hidden="0" locked="0"
val="false"/>

```

```

        <property      name="exportPP"      hidden="0"      locked="0"
val="false"/>
        <property      name="exportInt"      hidden="0"      locked="0"
val="0.02"/>
        <property      name="exportPath"      hidden="0"      locked="0"
val="MeasurementField_18"/>
        <property      name="exportType"      hidden="0"      locked="0"
val="Velocity"/>
        <property      name="exportFormat"      hidden="0"      locked="0"
val="Text"/>
        <property      name="plotType"      hidden="0"      locked="0"
val="Curve"/>
        <property      name="subdivideMeasurementField"      hidden="0"
locked="0" val="false"/>
        <property      name="subdiv"      hidden="0"      locked="0"      x="10"
y="10"      z="10"/>
        <property      name="sdArrowScale"      hidden="0"      locked="0"
val="10"/>
        <property      name="sdMaxArrowLength"      hidden="0"      locked="0"
val="0.050000000000000003"/>
        <property      name="sdNormalizeArrows"      hidden="0"      locked="0"
val="false"/>
        <property      name="reset"      hidden="0"      locked="0"      val=""/>
    </MeasurementField_18>
    <MeasurementField_19>
        <property      name="objectName"      hidden="0"      locked="0"
val="MeasurementField_19"/>
        <property      name="OsdMsgPos"      hidden="0"      locked="0"
val="Left"/>
        <property      name="Verbose"      hidden="0"      locked="0"
val="false"/>
        <property      name="Behavior"      hidden="0"      locked="0"
val="Active"/>
        <property      name="CacheData"      hidden="0"      locked="0"
val="true"/>
        <property      name="Position"      hidden="0"      locked="0"
x="9.0367"      y="10.317"      z="25.6755"/>
        <property      name="Orientation"      hidden="0"      locked="0"
phi="0"      theta="0"      psi="0"/>
        <property      name="Scale"      hidden="0"      locked="0"      x="0.5"
y="1"      z="0.75"/>
        <property      name="Pivot"      hidden="0"      locked="0"      x="0"      y="0"
z="0"/>
        <property      name="RenderMode"      hidden="0"      locked="0"
val="SmoothShaded"/>
        <property      name="RenderPriority"      hidden="0"      locked="0"
val="100"/>
        <property      name="Color"      hidden="0"      locked="0"      r="0"      g="0"
b="255"      a="255"/>
        <property      name="ExternalRender"      hidden="0"      locked="0"
val="true"/>
        <property      name="FrameInfo"      hidden="0"      locked="0"
first="-1"      last="0"      complete="0"/>
        <property      name="seaLevel"      hidden="0"      locked="0"
val="3.6878449999999998"/>
        <property      name="computeFlowRate"      hidden="0"      locked="0"
val="false"/>

```

```

        <property name="flowPlaneNormal" hidden="0" locked="0"
x="1" y="0" z="0"/>
        <property name="exportParticles" hidden="0" locked="0"
val="false"/>
        <property name="exportPP" hidden="0" locked="0"
val="false"/>
        <property name="exportInt" hidden="0" locked="0"
val="0.02"/>
        <property name="exportPath" hidden="0" locked="0"
val="MeasurementField_19"/>
        <property name="exportType" hidden="0" locked="0"
val="Velocity"/>
        <property name="exportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="plotType" hidden="0" locked="0"
val="Curve"/>
        <property name="subdivideMeasurementField" hidden="0"
locked="0" val="false"/>
        <property name="subdiv" hidden="0" locked="0" x="10"
y="10" z="10"/>
        <property name="sdArrowScale" hidden="0" locked="0"
val="10"/>
        <property name="sdMaxArrowLength" hidden="0" locked="0"
val="0.050000000000000003"/>
        <property name="sdNormalizeArrows" hidden="0" locked="0"
val="false"/>
        <property name="reset" hidden="0" locked="0" val=""/>
    </MeasurementField_19>
    <MeasurementField_20>
        <property name="objectName" hidden="0" locked="0"
val="MeasurementField_20"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0"
x="10.9475" y="9.03599" z="25.6755"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="0.5"
y="1" z="0.75"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>

```

```

        <property      name="seaLevel"      hidden="0"      locked="0"
val="3.6878449999999998"/>
        <property      name="computeFlowRate"      hidden="0"      locked="0"
val="false"/>
        <property      name="flowPlaneNormal"      hidden="0"      locked="0"
x="1" y="0" z="0"/>
        <property      name="exportParticles"      hidden="0"      locked="0"
val="true"/>
        <property      name="exportPP"      hidden="0"      locked="0"
val="false"/>
        <property      name="exportInt"      hidden="0"      locked="0"
val="0.02"/>
        <property      name="exportPath"      hidden="0"      locked="0"
val="Force_20"/>
        <property      name="exportType"      hidden="0"      locked="0"
val="RigidForce"/>
        <property      name="exportFormat"      hidden="0"      locked="0"
val="Text"/>
        <property      name="plotType"      hidden="0"      locked="0"
val="Curve"/>
        <property      name="subdivideMeasurementField"      hidden="0"
locked="0" val="false"/>
        <property      name="subdiv"      hidden="0"      locked="0"      x="10"
y="10" z="10"/>
        <property      name="sdArrowScale"      hidden="0"      locked="0"
val="10"/>
        <property      name="sdMaxArrowLength"      hidden="0"      locked="0"
val="0.050000000000000003"/>
        <property      name="sdNormalizeArrows"      hidden="0"      locked="0"
val="false"/>
        <property      name="reset"      hidden="0"      locked="0"      val=""/>
    </MeasurementField_20>
    <MeasurementField_21>
        <property      name="objectName"      hidden="0"      locked="0"
val="MeasurementField_21"/>
        <property      name="OsdMsgPos"      hidden="0"      locked="0"
val="Left"/>
        <property      name="Verbose"      hidden="0"      locked="0"
val="false"/>
        <property      name="Behavior"      hidden="0"      locked="0"
val="Active"/>
        <property      name="CacheData"      hidden="0"      locked="0"
val="true"/>
        <property      name="Position"      hidden="0"      locked="0"
x="12.9757" y="8.02199" z="25.6755"/>
        <property      name="Orientation"      hidden="0"      locked="0"
phi="0" theta="0" psi="0"/>
        <property      name="Scale"      hidden="0"      locked="0"      x="0.5"
y="1" z="0.75"/>
        <property      name="Pivot"      hidden="0"      locked="0"      x="0" y="0"
z="0"/>
        <property      name="RenderMode"      hidden="0"      locked="0"
val="SmoothShaded"/>
        <property      name="RenderPriority"      hidden="0"      locked="0"
val="100"/>
        <property      name="Color"      hidden="0"      locked="0"      r="0" g="0"
b="255" a="255"/>

```

```

        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="seaLevel" hidden="0" locked="0"
val="3.6878449999999998"/>
        <property name="computeFlowRate" hidden="0" locked="0"
val="false"/>
        <property name="flowPlaneNormal" hidden="0" locked="0"
x="1" y="0" z="0"/>
        <property name="exportParticles" hidden="0" locked="0"
val="false"/>
        <property name="exportPP" hidden="0" locked="0"
val="false"/>
        <property name="exportInt" hidden="0" locked="0"
val="0.02"/>
        <property name="exportPath" hidden="0" locked="0"
val="MeasurementField_21"/>
        <property name="exportType" hidden="0" locked="0"
val="Velocity"/>
        <property name="exportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="plotType" hidden="0" locked="0"
val="Curve"/>
        <property name="subdivideMeasurementField" hidden="0"
locked="0" val="false"/>
        <property name="subdiv" hidden="0" locked="0" x="10"
y="10" z="10"/>
        <property name="sdArrowScale" hidden="0" locked="0"
val="10"/>
        <property name="sdMaxArrowLength" hidden="0" locked="0"
val="0.050000000000000003"/>
        <property name="sdNormalizeArrows" hidden="0" locked="0"
val="false"/>
        <property name="reset" hidden="0" locked="0" val=""/>
    </MeasurementField_21>
    <MeasurementField_22>
        <property name="objectName" hidden="0" locked="0"
val="MeasurementField_22"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0"
x="15.4432" y="7.18199" z="25.6755"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="0.5"
y="1" z="0.75"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>

```

```

        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="seaLevel" hidden="0" locked="0"
val="3.6878449999999998"/>
        <property name="computeFlowRate" hidden="0" locked="0"
val="false"/>
        <property name="flowPlaneNormal" hidden="0" locked="0"
x="1" y="0" z="0"/>
        <property name="exportParticles" hidden="0" locked="0"
val="false"/>
        <property name="exportPP" hidden="0" locked="0"
val="false"/>
        <property name="exportInt" hidden="0" locked="0"
val="0.02"/>
        <property name="exportPath" hidden="0" locked="0"
val="MeasurementField_22"/>
        <property name="exportType" hidden="0" locked="0"
val="Velocity"/>
        <property name="exportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="plotType" hidden="0" locked="0"
val="Curve"/>
        <property name="subdivideMeasurementField" hidden="0"
locked="0" val="false"/>
        <property name="subdiv" hidden="0" locked="0" x="10"
y="10" z="10"/>
        <property name="sdArrowScale" hidden="0" locked="0"
val="10"/>
        <property name="sdMaxArrowLength" hidden="0" locked="0"
val="0.050000000000000003"/>
        <property name="sdNormalizeArrows" hidden="0" locked="0"
val="false"/>
        <property name="reset" hidden="0" locked="0" val=""/>
    </MeasurementField_22>
    <MeasurementField_23>
        <property name="objectName" hidden="0" locked="0"
val="MeasurementField_23"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0"
x="18.5072" y="6.6595" z="25.6755"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="0.5"
y="1" z="0.75"/>

```

```

z="0"/>
    <property name="Pivot" hidden="0" locked="0" x="0" y="0"
val="SmoothShaded"/>
    <property name="RenderMode" hidden="0" locked="0"
val="100"/>
    <property name="RenderPriority" hidden="0" locked="0"
b="255" a="255"/>
    <property name="Color" hidden="0" locked="0" r="0" g="0"
val="true"/>
    <property name="ExternalRender" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
    <property name="FrameInfo" hidden="0" locked="0"
val="3.6878449999999998"/>
    <property name="seaLevel" hidden="0" locked="0"
val="false"/>
    <property name="computeFlowRate" hidden="0" locked="0"
x="1" y="0" z="0"/>
    <property name="flowPlaneNormal" hidden="0" locked="0"
val="false"/>
    <property name="exportParticles" hidden="0" locked="0"
val="false"/>
    <property name="exportPP" hidden="0" locked="0"
val="false"/>
    <property name="exportInt" hidden="0" locked="0"
val="0.02"/>
    <property name="exportPath" hidden="0" locked="0"
val="MeasurementField_23"/>
    <property name="exportType" hidden="0" locked="0"
val="Velocity"/>
    <property name="exportFormat" hidden="0" locked="0"
val="Text"/>
    <property name="plotType" hidden="0" locked="0"
val="Curve"/>
    <property name="subdivideMeasurementField" hidden="0"
locked="0" val="false"/>
    <property name="subdiv" hidden="0" locked="0" x="10"
y="10" z="10"/>
    <property name="sdArrowScale" hidden="0" locked="0"
val="10"/>
    <property name="sdMaxArrowLength" hidden="0" locked="0"
val="0.050000000000000003"/>
    <property name="sdNormalizeArrows" hidden="0" locked="0"
val="false"/>
    <property name="reset" hidden="0" locked="0" val=""/>
</MeasurementField_23>
<MeasurementField_24>
    <property name="objectName" hidden="0" locked="0"
val="MeasurementField_24"/>
    <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
    <property name="Verbose" hidden="0" locked="0"
val="false"/>
    <property name="Behavior" hidden="0" locked="0"
val="Active"/>
    <property name="CacheData" hidden="0" locked="0"
val="true"/>
    <property name="Position" hidden="0" locked="0"
x="19.6204" y="6.59785" z="25.6755"/>

```

```

        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="0.5"
y="1" z="0.75"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="seaLevel" hidden="0" locked="0"
val="3.6878449999999998"/>
        <property name="computeFlowRate" hidden="0" locked="0"
val="false"/>
        <property name="flowPlaneNormal" hidden="0" locked="0"
x="1" y="0" z="0"/>
        <property name="exportParticles" hidden="0" locked="0"
val="false"/>
        <property name="exportPP" hidden="0" locked="0"
val="false"/>
        <property name="exportInt" hidden="0" locked="0"
val="0.02"/>
        <property name="exportPath" hidden="0" locked="0"
val="MeasurementField_24"/>
        <property name="exportType" hidden="0" locked="0"
val="Velocity"/>
        <property name="exportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="plotType" hidden="0" locked="0"
val="Curve"/>
        <property name="subdivideMeasurementField" hidden="0"
locked="0" val="false"/>
        <property name="subdiv" hidden="0" locked="0" x="10"
y="10" z="10"/>
        <property name="sdArrowScale" hidden="0" locked="0"
val="10"/>
        <property name="sdMaxArrowLength" hidden="0" locked="0"
val="0.050000000000000003"/>
        <property name="sdNormalizeArrows" hidden="0" locked="0"
val="false"/>
        <property name="reset" hidden="0" locked="0" val=""/>
    </MeasurementField_24>
    <MeasurementField_25>
        <property name="objectName" hidden="0" locked="0"
val="MeasurementField_25"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>

```

```

        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0"
x="20.9919" y="6.59785" z="25.6755"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="0.5"
y="1" z="0.75"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="seaLevel" hidden="0" locked="0"
val="3.6878449999999998"/>
        <property name="computeFlowRate" hidden="0" locked="0"
val="false"/>
        <property name="flowPlaneNormal" hidden="0" locked="0"
x="1" y="0" z="0"/>
        <property name="exportParticles" hidden="0" locked="0"
val="false"/>
        <property name="exportPP" hidden="0" locked="0"
val="false"/>
        <property name="exportInt" hidden="0" locked="0"
val="0.02"/>
        <property name="exportPath" hidden="0" locked="0"
val="MeasurementField_25"/>
        <property name="exportType" hidden="0" locked="0"
val=""/>
        <property name="exportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="plotType" hidden="0" locked="0" val=""/>
        <property name="subdivideMeasurementField" hidden="0"
locked="0" val="false"/>
        <property name="subdiv" hidden="0" locked="0" x="10"
y="10" z="10"/>
        <property name="sdArrowScale" hidden="0" locked="0"
val="10"/>
        <property name="sdMaxArrowLength" hidden="0" locked="0"
val="0.050000000000000003"/>
        <property name="sdNormalizeArrows" hidden="0" locked="0"
val="false"/>
        <property name="reset" hidden="0" locked="0" val=""/>
    </MeasurementField_25>
    <MeasurementField_26>
        <property name="objectName" hidden="0" locked="0"
val="MeasurementField_26"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>

```

```

        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0"
x="24.3669" y="6.59785" z="25.6755"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="0.5"
y="1" z="0.75"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="seaLevel" hidden="0" locked="0"
val="3.6878449999999998"/>
        <property name="computeFlowRate" hidden="0" locked="0"
val="false"/>
        <property name="flowPlaneNormal" hidden="0" locked="0"
x="1" y="0" z="0"/>
        <property name="exportParticles" hidden="0" locked="0"
val="false"/>
        <property name="exportPP" hidden="0" locked="0"
val="false"/>
        <property name="exportInt" hidden="0" locked="0"
val="0.02"/>
        <property name="exportPath" hidden="0" locked="0"
val="MeasurementField_26"/>
        <property name="exportType" hidden="0" locked="0"
val="Velocity"/>
        <property name="exportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="plotType" hidden="0" locked="0"
val="Curve"/>
        <property name="subdivideMeasurementField" hidden="0"
locked="0" val="false"/>
        <property name="subdiv" hidden="0" locked="0" x="10"
y="10" z="10"/>
        <property name="sdArrowScale" hidden="0" locked="0"
val="10"/>
        <property name="sdMaxArrowLength" hidden="0" locked="0"
val="0.050000000000000003"/>
        <property name="sdNormalizeArrows" hidden="0" locked="0"
val="false"/>
        <property name="reset" hidden="0" locked="0" val=""/>
    </MeasurementField_26>
    <MeasurementField_27>

```

```

        <property      name="objectName"      hidden="0"      locked="0"
val="MeasurementField_27"/>
        <property      name="OsdMsgPos"      hidden="0"      locked="0"
val="Left"/>
        <property      name="Verbose"      hidden="0"      locked="0"
val="false"/>
        <property      name="Behavior"      hidden="0"      locked="0"
val="Active"/>
        <property      name="CacheData"      hidden="0"      locked="0"
val="true"/>
        <property      name="Position"      hidden="0"      locked="0"
x="27.7419" y="6.59785" z="25.6755"/>
        <property      name="Orientation"      hidden="0"      locked="0"
phi="0" theta="0" psi="0"/>
        <property      name="Scale"      hidden="0"      locked="0" x="0.5"
y="1" z="0.75"/>
        <property      name="Pivot"      hidden="0"      locked="0" x="0" y="0"
z="0"/>
        <property      name="RenderMode"      hidden="0"      locked="0"
val="SmoothShaded"/>
        <property      name="RenderPriority"      hidden="0"      locked="0"
val="100"/>
        <property      name="Color"      hidden="0"      locked="0" r="0" g="0"
b="255" a="255"/>
        <property      name="ExternalRender"      hidden="0"      locked="0"
val="true"/>
        <property      name="FrameInfo"      hidden="0"      locked="0"
first="-1" last="0" complete="0"/>
        <property      name="seaLevel"      hidden="0"      locked="0"
val="3.6878449999999998"/>
        <property      name="computeFlowRate"      hidden="0"      locked="0"
val="false"/>
        <property      name="flowPlaneNormal"      hidden="0"      locked="0"
x="1" y="0" z="0"/>
        <property      name="exportParticles"      hidden="0"      locked="0"
val="false"/>
        <property      name="exportPP"      hidden="0"      locked="0"
val="false"/>
        <property      name="exportInt"      hidden="0"      locked="0"
val="0.02"/>
        <property      name="exportPath"      hidden="0"      locked="0"
val="MeasurementField_27"/>
        <property      name="exportType"      hidden="0"      locked="0"
val="RigidForce"/>
        <property      name="exportFormat"      hidden="0"      locked="0"
val="Text"/>
        <property      name="plotType"      hidden="0"      locked="0"
val="Curve"/>
        <property      name="subdivideMeasurementField"      hidden="0"
locked="0" val="false"/>
        <property      name="subdiv"      hidden="0"      locked="0" x="10"
y="10" z="10"/>
        <property      name="sdArrowScale"      hidden="0"      locked="0"
val="10"/>
        <property      name="sdMaxArrowLength"      hidden="0"      locked="0"
val="0.050000000000000003"/>

```

```

        <property name="sdNormalizeArrows" hidden="0" locked="0"
val="false"/>
        <property name="reset" hidden="0" locked="0" val=""/>
    </MeasurementField_27>
    <MeasurementField_28>
        <property name="objectName" hidden="0" locked="0"
val="MeasurementField_28"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0"
x="29.488" y="5.92284" z="25.6755"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="0.5"
y="1" z="0.75"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="seaLevel" hidden="0" locked="0"
val="3.6878449999999998"/>
        <property name="computeFlowRate" hidden="0" locked="0"
val="false"/>
        <property name="flowPlaneNormal" hidden="0" locked="0"
x="1" y="0" z="0"/>
        <property name="exportParticles" hidden="0" locked="0"
val="false"/>
        <property name="exportPP" hidden="0" locked="0"
val="false"/>
        <property name="exportInt" hidden="0" locked="0"
val="0.02"/>
        <property name="exportPath" hidden="0" locked="0"
val="MeasurementField_28"/>
        <property name="exportType" hidden="0" locked="0"
val="Velocity"/>
        <property name="exportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="plotType" hidden="0" locked="0"
val="Curve"/>
        <property name="subdivideMeasurementField" hidden="0"
locked="0" val="false"/>
        <property name="subdiv" hidden="0" locked="0" x="10"
y="10" z="10"/>

```

```

        <property name="sdArrowScale" hidden="0" locked="0"
val="10"/>
        <property name="sdMaxArrowLength" hidden="0" locked="0"
val="0.050000000000000003"/>
        <property name="sdNormalizeArrows" hidden="0" locked="0"
val="false"/>
        <property name="reset" hidden="0" locked="0" val=""/>
    </MeasurementField_28>
    <MeasurementField_29>
        <property name="objectName" hidden="0" locked="0"
val="MeasurementField_29"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0" x="-55"
y="26.9956" z="25.648"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="10"
y="20" z="0.75"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="255"
g="0" b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="seaLevel" hidden="0" locked="0"
val="3.6878449999999998"/>
        <property name="computeFlowRate" hidden="0" locked="0"
val="false"/>
        <property name="flowPlaneNormal" hidden="0" locked="0"
x="1" y="0" z="0"/>
        <property name="exportParticles" hidden="0" locked="0"
val="true"/>
        <property name="exportPP" hidden="0" locked="0"
val="false"/>
        <property name="exportInt" hidden="0" locked="0"
val="0.02"/>
        <property name="exportPath" hidden="0" locked="0"
val="Height_1"/>
        <property name="exportType" hidden="0" locked="0"
val="Height"/>
        <property name="exportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="plotType" hidden="0" locked="0"
val="Curve"/>

```

```

        <property name="subdivideMeasurementField" hidden="0"
locked="0" val="false"/>
        <property name="subdiv" hidden="0" locked="0" x="10"
y="10" z="10"/>
        <property name="sdArrowScale" hidden="0" locked="0"
val="10"/>
        <property name="sdMaxArrowLength" hidden="0" locked="0"
val="0.050000000000000003"/>
        <property name="sdNormalizeArrows" hidden="0" locked="0"
val="false"/>
        <property name="reset" hidden="0" locked="0" val=""/>
    </MeasurementField_29>
    <ExtentParticleKiller_1>
        <property name="objectName" hidden="0" locked="0"
val="ExtentParticleKiller_1"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0"
x="40.3607" y="18.1521" z="25.5714"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="1" y="30"
z="2"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="255"
g="255" b="0" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="TypeToKill" hidden="0" locked="0"
val=""/>
        <property name="killRegion" hidden="0" locked="0"
val="Inside"/>
        <property name="killBoundaryParticles" hidden="0"
locked="0" val="false"/>
        <property name="modified" hidden="0" locked="0"
val="false"/>
    </ExtentParticleKiller_1>
    <FlowSource_1>
        <property name="objectName" hidden="0" locked="0"
val="FlowSource_1"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>

```

```

val="Active"/>      <property      name="Behavior"      hidden="0"      locked="0"
val="true"/>      <property      name="CacheData"      hidden="0"      locked="0"
73.5529" y="23"      <property      name="Position"      hidden="0"      locked="0"      x="-
z="25.6393"/>      <property      name="Orientation"      hidden="0"      locked="0"
phi="180" theta="0" psi="0"/>      <property      name="Scale"      hidden="0"      locked="0"      x="120"
y="1" z="1.5"/>      <property      name="Pivot"      hidden="0"      locked="0"      x="0" y="0"
z="0"/>      <property      name="RenderMode"      hidden="0"      locked="0"
val="SmoothShaded"/>      <property      name="RenderPriority"      hidden="0"      locked="0"
val="100"/>      <property      name="Color"      hidden="0"      locked="0"      r="255"
g="228" b="181" a="30"/>      <property      name="ExternalRender"      hidden="0"      locked="0"
val="true"/>      <property      name="FrameInfo"      hidden="0"      locked="0"
first="-1" last="0" complete="0"/>      <property      name="Timestep"      hidden="0"      locked="0"
val="0.02"/>      <property      name="ShowStatistics"      hidden="0"      locked="0"
val="false"/>      <property      name="ShowTimings"      hidden="0"      locked="0"
val="false"/>      <property      name="particleType"      hidden="0"      locked="0"
val="NEFluidType"/>      <property      name="viscosity"      hidden="0"      locked="0"
val="0"/>      <property      name="spacing"      hidden="0"      locked="0"      val="1"/>
val="0"/>      <property      name="ySpacing"      hidden="0"      locked="0"
val="false"/>      <property      name="finiteVolume"      hidden="0"      locked="0"
val="2000000"/>      <property      name="volume"      hidden="0"      locked="0"
val="0"/>      <property      name="startFrame"      hidden="0"      locked="0"
val="150"/>      <property      name="stopFrame"      hidden="0"      locked="0"
val="0.9259277777777779"/>      <property      name="velocityMag"      hidden="0"      locked="0"
val="false"/>      <property      name="spherePacking"      hidden="0"      locked="0"
val=""/>      <property      name="flowInput"      hidden="0"      locked="0"
val=""/>      <property      name="reloadFlowInput"      hidden="0"      locked="0"
val=""/>      <property      name="clearFlowInput"      hidden="0"      locked="0"
val="Metric"/>      <property      name="units"      hidden="0"      locked="0"
val="Seconds"/>      <property      name="timeBase"      hidden="0"      locked="0"

```

```

        <property      name="timeScale"      hidden="0"      locked="0"
val="1"/>
        <property      name="shape"          hidden="0"          locked="0"
val="Rectangular"/>
        <property      name="flowRate"       hidden="0"       locked="0"
val="166.667"/>
        <property      name="permeable"      hidden="0"      locked="0"
val="true"/>
        <property      name="allowCompression" hidden="0"      locked="0"
val="true"/>
        <property      name="emitEvenIfObstructed"      hidden="0"
locked="0" val="false"/>
        <property      name="delay"          hidden="0"      locked="0" val="0"/>
    </FlowSource_1>
    <FlowSource_2>
        <property      name="objectName"      hidden="0"      locked="0"
val="FlowSource_2"/>
        <property      name="OsdMsgPos"       hidden="0"          locked="0"
val="Left"/>
        <property      name="Verbose"         hidden="0"          locked="0"
val="false"/>
        <property      name="Behavior"        hidden="0"          locked="0"
val="Active"/>
        <property      name="CacheData"       hidden="0"          locked="0"
val="true"/>
        <property      name="Position"        hidden="0"          locked="0" x="-
73.9797" y="30" z="25.6393"/>
        <property      name="Orientation"     hidden="0"          locked="0"
phi="180" theta="0" psi="0"/>
        <property      name="Scale"          hidden="0"          locked="0" x="120"
y="1" z="1.5"/>
        <property      name="Pivot"          hidden="0"          locked="0" x="0" y="0"
z="0"/>
        <property      name="RenderMode"      hidden="0"          locked="0"
val="SmoothShaded"/>
        <property      name="RenderPriority"   hidden="0"          locked="0"
val="100"/>
        <property      name="Color"          hidden="0"          locked="0" r="255"
g="228" b="181" a="30"/>
        <property      name="ExternalRender"  hidden="0"          locked="0"
val="true"/>
        <property      name="FrameInfo"       hidden="0"          locked="0"
first="-1" last="0" complete="0"/>
        <property      name="Timestep"       hidden="0"          locked="0"
val="0.02"/>
        <property      name="ShowStatistics"  hidden="0"          locked="0"
val="false"/>
        <property      name="ShowTimings"    hidden="0"          locked="0"
val="false"/>
        <property      name="particleType"    hidden="0"          locked="0"
val="NEFluidType"/>
        <property      name="viscosity"      hidden="0"          locked="0"
val="0"/>
        <property      name="spacing"         hidden="0"          locked="0" val="1"/>
        <property      name="ySpacing"       hidden="0"          locked="0"
val="0"/>

```

```

val="false"/>      <property name="finiteVolume" hidden="0" locked="0"
val="2000000"/>    <property name="volume" hidden="0" locked="0"
val="200"/>        <property name="startFrame" hidden="0" locked="0"
val="400"/>        <property name="stopFrame" hidden="0" locked="0"
val="0.9259277777777779"/> <property name="velocityMag" hidden="0" locked="0"
val="false"/>      <property name="spherePacking" hidden="0" locked="0"
val=""/>           <property name="flowInput" hidden="0" locked="0"
val=""/>           <property name="reloadFlowInput" hidden="0" locked="0"
val=""/>           <property name="clearFlowInput" hidden="0" locked="0"
val="Metric"/>     <property name="units" hidden="0" locked="0"
val="Seconds"/>    <property name="timeBase" hidden="0" locked="0"
val="1"/>          <property name="timeScale" hidden="0" locked="0"
val="Rectangular"/> <property name="shape" hidden="0" locked="0"
val="166.667"/>    <property name="flowRate" hidden="0" locked="0"
val="true"/>       <property name="permeable" hidden="0" locked="0"
val="true"/>       <property name="allowCompression" hidden="0" locked="0"
locked="0" val="true"/> <property name="emitEvenIfObstructed" hidden="0"
                        <property name="delay" hidden="0" locked="0" val="0"/>
                        </FlowSource_2>
                        <FlowSource_3>
                        <property name="objectName" hidden="0" locked="0"
val="FlowSource_3"/> <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>        <property name="Verbose" hidden="0" locked="0"
val="false"/>       <property name="Behavior" hidden="0" locked="0"
val="Active"/>     <property name="CacheData" hidden="0" locked="0"
val="true"/>       <property name="Position" hidden="0" locked="0" x="-
113.251" y="32" z="25.6082"/>
                        <property name="Orientation" hidden="0" locked="0"
phi="180" theta="0" psi="0"/>
                        <property name="Scale" hidden="0" locked="0" x="40" y="1"
z="1.5"/>
                        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
                        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>

```

```

val="100"/>      <property name="RenderPriority" hidden="0" locked="0"
g="228" b="181" a="30"/>      <property name="Color" hidden="0" locked="0" r="255"
val="true"/>      <property name="ExternalRender" hidden="0" locked="0"
first="-1" last="0" complete="0"/>      <property name="FrameInfo" hidden="0" locked="0"
val="0.02"/>      <property name="Timestep" hidden="0" locked="0"
val="false"/>      <property name="ShowStatistics" hidden="0" locked="0"
val="false"/>      <property name="ShowTimings" hidden="0" locked="0"
val="NEFluidType"/>      <property name="particleType" hidden="0" locked="0"
val="0"/>      <property name="viscosity" hidden="0" locked="0"
val="0"/>      <property name="spacing" hidden="0" locked="0" val="1"/>
val="0"/>      <property name="ySpacing" hidden="0" locked="0"
val="false"/>      <property name="finiteVolume" hidden="0" locked="0"
val="2000000"/>      <property name="volume" hidden="0" locked="0"
val="450"/>      <property name="startFrame" hidden="0" locked="0"
val="15000"/>      <property name="stopFrame" hidden="0" locked="0"
val="0.047500000000000001"/>      <property name="velocityMag" hidden="0" locked="0"
val="false"/>      <property name="spherePacking" hidden="0" locked="0"
val=""/>      <property name="flowInput" hidden="0" locked="0"
val=""/>      <property name="reloadFlowInput" hidden="0" locked="0"
val=""/>      <property name="clearFlowInput" hidden="0" locked="0"
val="Metric"/>      <property name="units" hidden="0" locked="0"
val="Seconds"/>      <property name="timeBase" hidden="0" locked="0"
val="1"/>      <property name="timeScale" hidden="0" locked="0"
val="Rectangular"/>      <property name="shape" hidden="0" locked="0"
val="2.8500000000000001"/>      <property name="flowRate" hidden="0" locked="0"
val="true"/>      <property name="permeable" hidden="0" locked="0"
val="true"/>      <property name="allowCompression" hidden="0" locked="0"
locked="0" val="true"/>      <property name="emitEvenIfObstructed" hidden="0"
      <property name="delay" hidden="0" locked="0" val="0"/>
    </FlowSource_3>

```

```

        <ExtentParticleKiller_2>
            <property name="objectName" hidden="0" locked="0"
val="ExtentParticleKiller_2"/>
            <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
            <property name="Verbose" hidden="0" locked="0"
val="false"/>
            <property name="Behavior" hidden="0" locked="0"
val="Active"/>
            <property name="CacheData" hidden="0" locked="0"
val="true"/>
            <property name="Position" hidden="0" locked="0" x="-
22.3623" y="28.514" z="25.4558"/>
            <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
            <property name="Scale" hidden="0" locked="0" x="226"
y="52" z="2"/>
            <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
            <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
            <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
            <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
            <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
            <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
            <property name="TypeToKill" hidden="0" locked="0"
val="KillFluids"/>
            <property name="killRegion" hidden="0" locked="0"
val="Outside"/>
            <property name="killBoundaryParticles" hidden="0"
locked="0" val="false"/>
            <property name="modified" hidden="0" locked="0"
val="false"/>
        </ExtentParticleKiller_2>
        <RigidCuboid_7>
            <property name="objectName" hidden="0" locked="0"
val="RigidCuboid_7"/>
            <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
            <property name="Verbose" hidden="0" locked="0"
val="false"/>
            <property name="Behavior" hidden="0" locked="0"
val="Active"/>
            <property name="CacheData" hidden="0" locked="0"
val="true"/>
            <property name="Position" hidden="0" locked="0" x="-
10.8462" y="17.5595" z="25.8548"/>
            <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
            <property name="Scale" hidden="0" locked="0" x="2" y="2"
z="3"/>
            <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>

```

```

        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="Timestep" hidden="0" locked="0"
val="0.01"/>
        <property name="ShowStatistics" hidden="0" locked="0"
val="false"/>
        <property name="ShowTimings" hidden="0" locked="0"
val="false"/>
        <property name="RigidType" hidden="0" locked="0"
val="Static"/>
        <property name="TwoWayCoupling" hidden="0" locked="0"
val="true"/>
        <property name="CollisionShapeType" hidden="0"
locked="0" val="gImpactMesh"/>
        <property name="CenterMethod" hidden="0" locked="0"
val="PolyhedralMass"/>
        <property name="LocalizedTransforms" hidden="0"
locked="0" val="false"/>
        <property name="RigidFriction" hidden="0" locked="0"
val="0.5"/>
        <property name="Viscosity" hidden="0" locked="0"
val="0.01"/>
        <property name="Adhesion" hidden="0" locked="0"
val="0.001"/>
        <property name="Density" hidden="0" locked="0"
val="1000"/>
        <property name="ExportStats" hidden="0" locked="0"
val="false"/>
        <property name="ExportPath" hidden="0" locked="0"
val=""/>
        <property name="ExportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="LinearVelocity" hidden="0" locked="0"
x="0" y="0" z="0"/>
        <property name="AngularVelocity" hidden="0" locked="0"
x="0" y="0" z="0"/>
        <property name="ComputePerVertexVelocity" hidden="0"
locked="0" val="false"/>
        <property name="ShowForces" hidden="0" locked="0"
val="false"/>
        <property name="TotalForce" hidden="0" locked="0" x="0"
y="0" z="0"/>
        <property name="TotalTorque" hidden="0" locked="0" x="0"
y="0" z="0"/>
        <property name="FlipMesh" hidden="0" locked="0"
val="false"/>
        <property name="VisType" hidden="0" locked="0"
val="MeshColor"/>

```

```

        <property name="ResetStats" hidden="0" locked="0"
val=""/>
        <property name="ThreeDelightRenderingType" hidden="0"
locked="0" val="Polygons"/>
        <property name="ThreeDelightOpacity" hidden="0"
locked="0" x="1" y="1" z="1"/>
        <property name="ShowParticles" hidden="0" locked="0"
val="false"/>
        <property name="DrawSurfaceNormals" hidden="0"
locked="0" val="false"/>
        <property name="TwoSidedLighting" hidden="0" locked="0"
val="true"/>
        <property name="Coloring" hidden="0" locked="0"
val="VelocityBased"/>
        <property name="AutomaticRange" hidden="0" locked="0"
val="true"/>
        <property name="ColoringExponent" hidden="0" locked="0"
val="0"/>
        <property name="MinColoringRange" hidden="0" locked="0"
val="0"/>
        <property name="MaxColoringRange" hidden="0" locked="0"
val="0"/>
        <property name="MinRangeColor" hidden="0" locked="0"
r="63" g="126" b="189" a="255"/>
        <property name="MaxRangeColor" hidden="0" locked="0"
r="255" g="255" b="255" a="255"/>
        <property name="Spacing" hidden="0" locked="0"
val="0.40000000000000002"/>
        <property name="SurfaceOffset" hidden="0" locked="0"
val="0"/>
    </RigidCuboid_7>
    <RigidCuboid_8>
        <property name="objectName" hidden="0" locked="0"
val="RigidCuboid_8"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0" x="-
10.9273" y="24.7157" z="25.6755"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="1"
y="3.5" z="5"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>

```

```

        <property name="ExternalRender" hidden="0" locked="0"
val="true"/>
        <property name="FrameInfo" hidden="0" locked="0"
first="-1" last="0" complete="0"/>
        <property name="Timestep" hidden="0" locked="0"
val="0.01"/>
        <property name="ShowStatistics" hidden="0" locked="0"
val="false"/>
        <property name="ShowTimings" hidden="0" locked="0"
val="false"/>
        <property name="RigidType" hidden="0" locked="0"
val="Static"/>
        <property name="TwoWayCoupling" hidden="0" locked="0"
val="true"/>
        <property name="CollisionShapeType" hidden="0"
locked="0" val="gImpactMesh"/>
        <property name="CenterMethod" hidden="0" locked="0"
val="PolyhedralMass"/>
        <property name="LocalizedTransforms" hidden="0"
locked="0" val="false"/>
        <property name="RigidFriction" hidden="0" locked="0"
val="0.5"/>
        <property name="Viscosity" hidden="0" locked="0"
val="0.01"/>
        <property name="Adhesion" hidden="0" locked="0"
val="0.001"/>
        <property name="Density" hidden="0" locked="0"
val="1000"/>
        <property name="ExportStats" hidden="0" locked="0"
val="false"/>
        <property name="ExportPath" hidden="0" locked="0"
val=""/>
        <property name="ExportFormat" hidden="0" locked="0"
val="Text"/>
        <property name="LinearVelocity" hidden="0" locked="0"
x="0" y="0" z="0"/>
        <property name="AngularVelocity" hidden="0" locked="0"
x="0" y="0" z="0"/>
        <property name="ComputePerVertexVelocity" hidden="0"
locked="0" val="false"/>
        <property name="ShowForces" hidden="0" locked="0"
val="false"/>
        <property name="TotalForce" hidden="0" locked="0" x="0"
y="0" z="0"/>
        <property name="TotalTorque" hidden="0" locked="0" x="0"
y="0" z="0"/>
        <property name="FlipMesh" hidden="0" locked="0"
val="false"/>
        <property name="VisType" hidden="0" locked="0"
val="MeshColor"/>
        <property name="ResetStats" hidden="0" locked="0"
val=""/>
        <property name="ThreeDelightRenderingType" hidden="0"
locked="0" val="Polygons"/>
        <property name="ThreeDelightOpacity" hidden="0"
locked="0" x="1" y="1" z="1"/>

```

```

        <property name="ShowParticles" hidden="0" locked="0"
val="false"/>
        <property name="DrawSurfaceNormals" hidden="0"
locked="0" val="false"/>
        <property name="TwoSidedLighting" hidden="0" locked="0"
val="true"/>
        <property name="Coloring" hidden="0" locked="0"
val="VelocityBased"/>
        <property name="AutomaticRange" hidden="0" locked="0"
val="true"/>
        <property name="ColoringExponent" hidden="0" locked="0"
val="0"/>
        <property name="MinColoringRange" hidden="0" locked="0"
val="0"/>
        <property name="MaxColoringRange" hidden="0" locked="0"
val="0"/>
        <property name="MinRangeColor" hidden="0" locked="0"
r="63" g="126" b="189" a="255"/>
        <property name="MaxRangeColor" hidden="0" locked="0"
r="255" g="255" b="255" a="255"/>
        <property name="Spacing" hidden="0" locked="0"
val="0.40000000000000002"/>
        <property name="SurfaceOffset" hidden="0" locked="0"
val="0"/>
    </RigidCuboid_8>
    <RigidCuboid_9>
        <property name="objectName" hidden="0" locked="0"
val="RigidCuboid_9"/>
        <property name="OsdMsgPos" hidden="0" locked="0"
val="Left"/>
        <property name="Verbose" hidden="0" locked="0"
val="false"/>
        <property name="Behavior" hidden="0" locked="0"
val="Active"/>
        <property name="CacheData" hidden="0" locked="0"
val="true"/>
        <property name="Position" hidden="0" locked="0" x="-
7.65856" y="19.7044" z="25.6755"/>
        <property name="Orientation" hidden="0" locked="0"
phi="0" theta="0" psi="0"/>
        <property name="Scale" hidden="0" locked="0" x="2" y="7"
z="5"/>
        <property name="Pivot" hidden="0" locked="0" x="0" y="0"
z="0"/>
        <property name="RenderMode" hidden="0" locked="0"
val="SmoothShaded"/>
        <property name="RenderPriority" hidden="0" locked="0"
val="100"/>
        <property name="Color" hidden="0" locked="0" r="0" g="0"
b="255" a="255"/>
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val="0.001"/>    <property name="Adhesion" hidden="0" locked="0"
val="1000"/>    <property name="Density" hidden="0" locked="0"
val="false"/>    <property name="ExportStats" hidden="0" locked="0"
val=""/>    <property name="ExportPath" hidden="0" locked="0"
val="Text"/>    <property name="ExportFormat" hidden="0" locked="0"
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x="0" y="0" z="0"/>    <property name="AngularVelocity" hidden="0" locked="0"
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y="0" z="0"/>    <property name="TotalTorque" hidden="0" locked="0" x="0"
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val="MeshColor"/>    <property name="VisType" hidden="0" locked="0"
val=""/>    <property name="ResetStats" hidden="0" locked="0"
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val="MeshColor"/>
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val=""/>
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