USE OF PHYSICAL MODELLING AND BUILDING INFORMATION MODELLING FOR MANGERE WASTEWATER PUMP STATION

Ali Mirza (Jacobs New Zealand), Stephen Grace (Watercare Services), Duncan Kingsbury (Jacobs New Zealand)

ABSTRACT

The Mangere wastewater pump station is part of Central Interceptor (CI) Project and will be located at Mangere Wastewater Treatment Plant (WWTP) in Auckland. It will lift wastewater from the end of a 13 km long tunnel to the Mangere WWTP. The pump station is an essential component of the project, required to control the delivery of flow from the tunnel into the WWTP. The pump station has been designed so that the rate of pumping enables the plant to operate within the consented flow limits. It has been designed to pump a peak flow of 6 m^3/s, however it will be capable of pumping 7.2 m^3/s with the high wet well levels during tunnel surcharge events. The shaft of pump station is approximately 40 m deep and consists of diaphragm wall construction. The paper will discuss the use of the following two valuable tools to deliver the design:

- a Froude scale physical model of the inlet and wet well with the geometric scale of 1:8.6 to maintain dynamic similarity to simulate the full-scale flow conditions. Physical modelling was carried out to understand the hydraulic conditions and evaluate the performance of the proposed design. It proved significantly useful in identifying sub optimal conditions that were resolved in the design phase.

- 3D and 6D Building Information Model (BIM) of the pump station to assist in visualization. This BIM is a digital representation of the physical and functional characteristics of the pump station. The BIM proved extremely useful by improving collaboration within the design team, and during Safety in Design and operability reviews with Watercare staff, and identifying service clashes.

KEYWORDS

Central Interceptor, Mangere pump station, physical model, building information model (BIM)

PRESENTER PROFILE

Ali Mirza is a Senior Water Engineer for Jacobs (NZ), with 12 years of experience including the design of pump stations and pipelines. He is the acting Design Manager for this project and the Workstream Lead for the Mangere pump station.

Stephen Grace has been working in the water industry in a range of roles (planning, design, operations and construction) for 30 years at Watercare and Metrowater. He is currently the Watercare Design Manager for this project.

Duncan Kingsbury is a Principal Water Engineer for Jacobs (NZ), with over 30 years of experience in the design and construction of tunnels, pump stations, pipelines and treatment plants. He is the Design Manager for this project.

1 INTRODUCTION

Watercare Services supplies water and wastewater services to approximately 1.4 million people living in Auckland, New Zealand. Over the next 30 years this population is expected to exceed 2 million. Our challenge is to meet the demands of growth without compromising on our mission to deliver reliable, safe and efficient water and wastewater services.

Over the next 20 years Watercare will invest almost $6 billion on expanding and upgrading the wastewater network. Part of this investment is the construction of the Central Interceptor, a deep tunnel sewer scheme for conveyance and storage of wastewater from the combined sewer network in central Auckland.

Older parts of Auckland’s wastewater system were designed as a combined wastewater/stormwater system collecting both flows in a common pipe. The system includes around 110 overflow structures that discharge diluted wastewater to the harbour and urban streams during heavy rainfall; half of which discharge more than 50 times per year. The Central Interceptor tunnel will divert these overflows to the treatment works resulting in significant environmental improvement. Watercare has obtained resource consents from the regulator to build the scheme which must be operational by 2030.

A further benefit of the tunnel is to reinforce an ageing network which includes a marine crossing that is spigot and socket pipe laid in a shallow trench on the harbour floor. The tunnel will traverse the harbour at depth on a different alignment, which will allow the existing pipe to be inspected and potentially rehabilitated.

The Central Interceptor is being provided to enable growth in the central areas of Auckland, but has wider regional benefits as it provides an alternative flow path to the Mangere WWTP.

After ten years of planning, the project is now moving into the procurement phase. Watercare will appoint a contractor in late 2018, with construction expected to take six years through to 2025. Figure 1 shows the alignment of Central Interceptor Tunnel and its scheme.

Figure 1: Central Interceptor Scheme

2 MANGERE WASTEWATER PUMP STATION

The Mangere Pump Station (MPS) will receive wastewater flows from the downstream end of the Central Interceptor tunnel and will pump the wastewater through twin 1400 OD PE rising mains to the inlet of the Mangere Wastewater Treatment Plant (WWTP). The pump station has been designed to pump a peak flow of 6 m^3/s. The pump station is capable of pumping higher flows with the high wet well levels that occur during tunnel surcharge events (up to 7.2 m^3/s) or if all six pumps are operated under manual control.

The pump station site is located on Watercare land in a low lying flat area at the northern end of Mangere WWTP as shown in Figure 3. The pump station site will have the following main infrastructure:

- Dual cell shaft down to below tunnel level for the pumping station wet and dry wells and inlet chamber
- Building over the pumping station dry well
- Electrical switchrooms
- Standby generators
- Emergency pressure relief to Manukau Harbour

- Biofilter for odour treatment
- Sewer connection from Western Interceptor to MPS for reverse flow
- Dual power supply cables from Mangere West Substation

The shaft of the pump station is approximately 40 m deep and consists of slurry wall construction. The internal diameter of pump station shaft is 26 m and it consists of wet well and dry well. The internal dimeter of inlet chamber is 12 m.

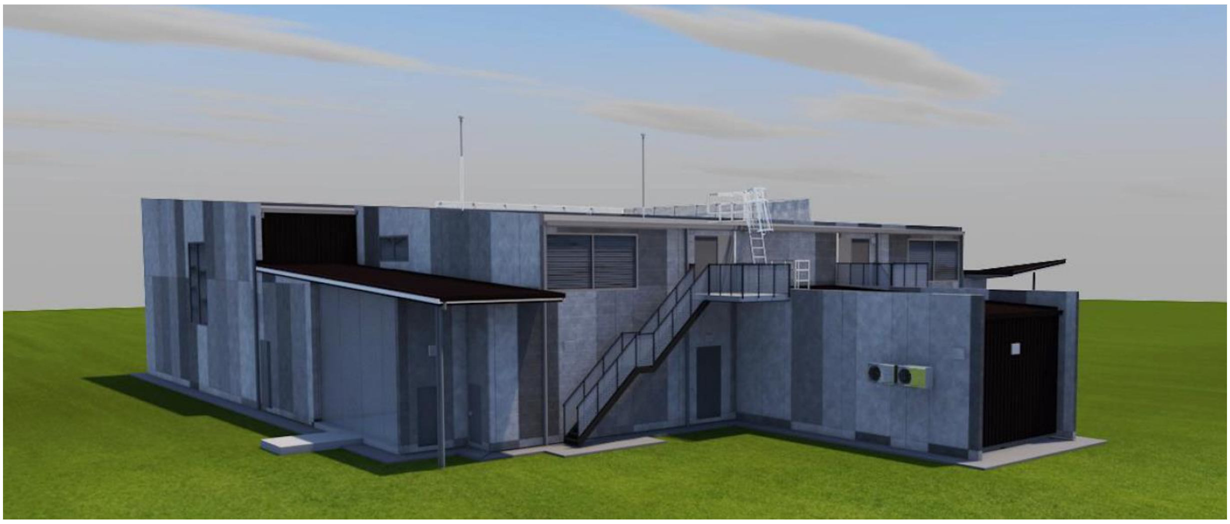


Figure 2: MPS Building

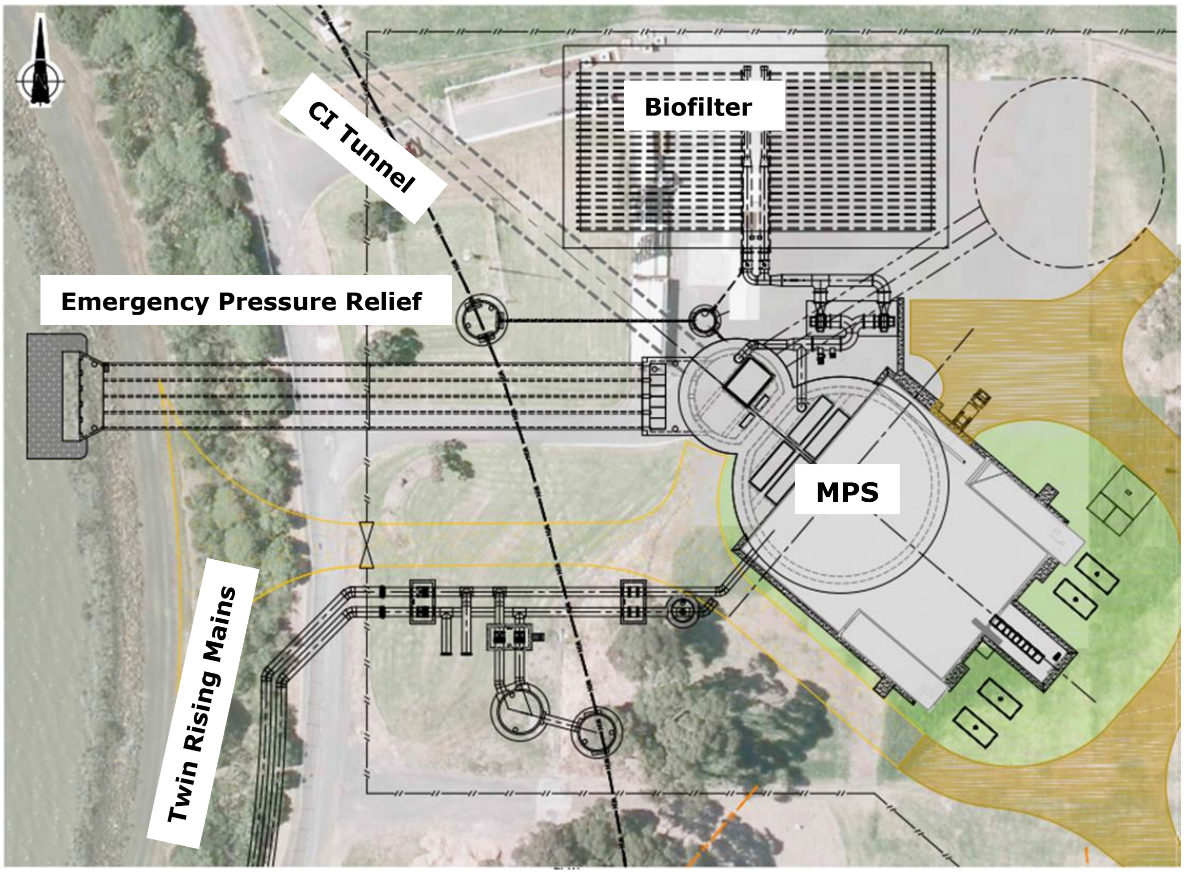


Figure 3: MPS Site Layout

2.1 PUMP STATION LAYOUT AND PUMPING SYSTEM

The pump station layout has been designed according to the analytical methods provided in ANSI/HI standard 9.8-2012. The incoming wastewater first flows into an inlet chamber from the tunnel. The downstream part of the inlet chamber is separated into two channels by an oval headed dividing wall. The wastewater will then flow into the sump via two penstock openings. The sump has two wet wells divided by a wall. The wastewater from the penstock openings flows into the L shaped baffle structure. From there it flows to the wet wells via the openings in the baffle floor.

The floor is sloped to guide the flow to the pump intakes. Figure 4 shows the inlet chamber and wet well. Each wet well contains three suction elbows linked to the pump suction pipes. Each suction pipe is 800 mm diameter and the suction elbow has a bell-mouth with a larger diameter. Benching has been included and acts as divider between each pump intake pipes and flow splitter under each intake to minimize the swirls around the bell-mouths.

The normal pump operating level has been kept below the level of the inlet chamber to allow generation of critical velocities at the penstock opening. This will assist in the movement of solids because of strong circulating flows.

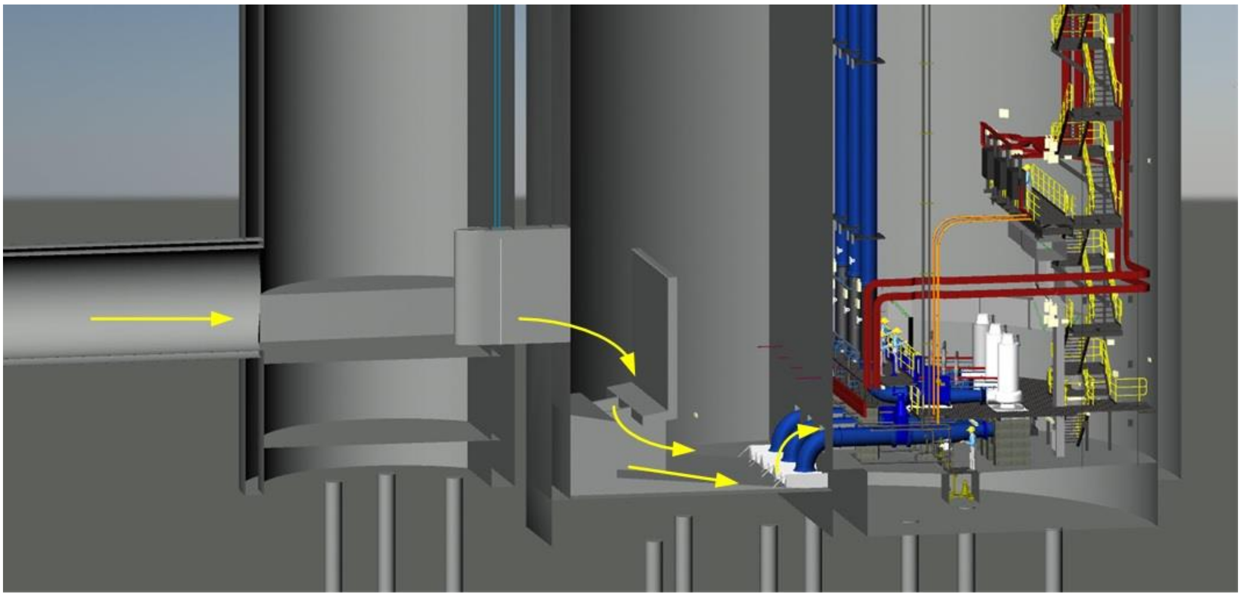


Figure 4: Flow Path in MPS (Inlet Chamber, Wet Well and Dry Well)

2.1.1 PUMPS

The pump configuration consists of six identical dry well submersible pumps to deliver a flow of 6 m^3/s. Five pumps will operate as duty pumps and one pump will operate as a standby pump. This option has been chosen because it is the most economical pump configuration and the use of dry well submersible pumps reduces the risk of pump damage from flooding of the dry well. Figure 5 shows the plan of MPS wet well and dry well.

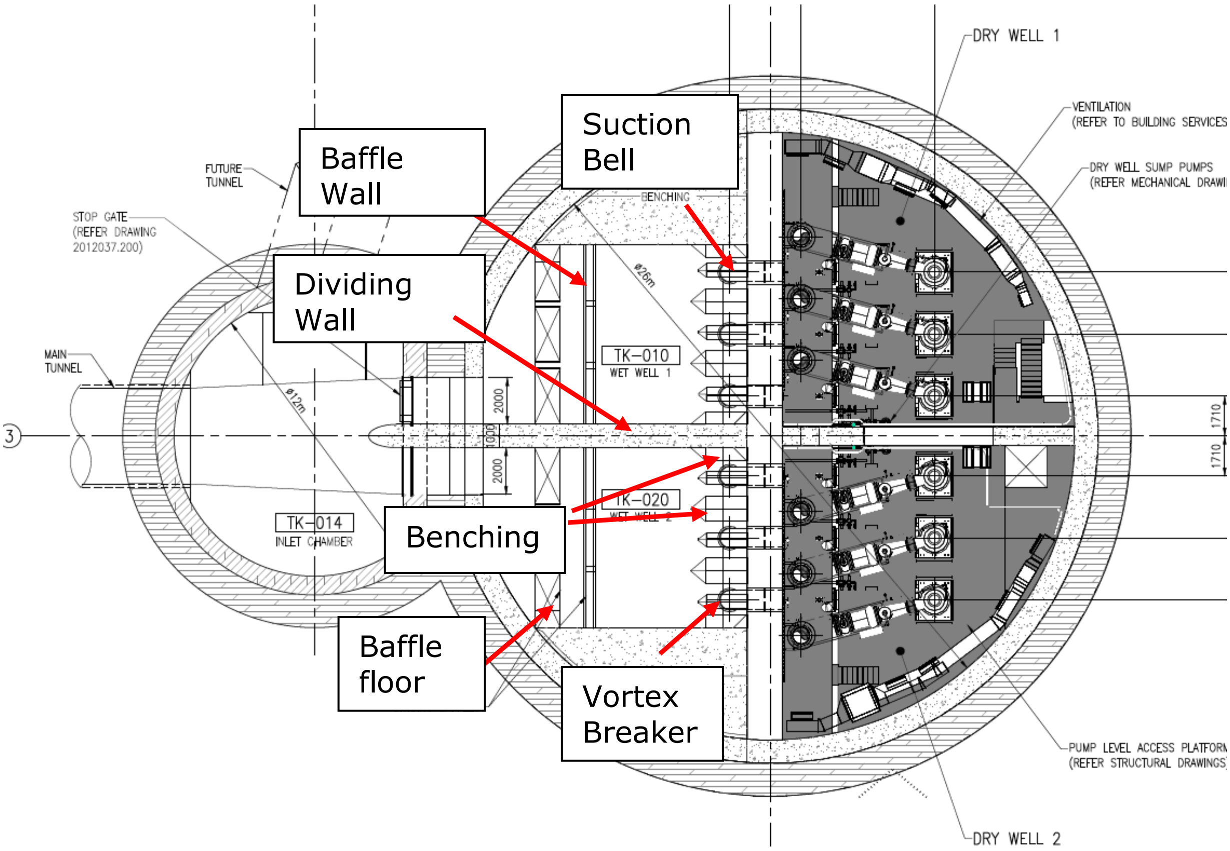


Figure 5: Plan of Mangere Pump Station

3 PHYSICAL MODEL FOR HYDRAULIC TESTING

Improper design of inlet conditions and wet well may result in hydraulic inefficiencies leading to reduction in the performance of pumps due to number of problems including pump cavitation. As mentioned earlier the dimensions of the wet well were determined based on analytical methods provided in ANSI/HI standard 9.8-2012. The primary reason for conducting physical modelling was to test the theoretical flow characteristics and confirm the optimum wet well dimensions. ANSI/HI standard 9.8-2012 requires physical modelling to be carried out for pump stations with flows exceeding 6.31 m^3/s with all pumps in operation. A few other advantages of physical modelling include observation and measurement of complex phenomena that cannot be easily determined by analytical methods. Physical modelling also provides an opportunity to visually observe the flow characteristics.

A physical model of MPS was developed and tested to better understand the hydraulic conditions in the wet well. The model study consisted of constructing a reduced scale, geometrically similar model of the pump station and operating the model to simulate the full-scale flow conditions.

3.1 OBJECTIVE OF PHYSICAL MODEL STUDY

The objectives of the physical model study were to:

- Define the general flow characteristics from the downstream end of tunnel to the pump suction

- Determine the existence and magnitude of adverse flow phenomena that may propagate to the pump suctions
- Document the satisfactory performance of the modified pump station for the anticipated range of operating conditions in accordance with ANSI/HI standard 9.8-2012

Both quantitative and qualitative testing was undertaken for the pump station. Careful observations were made for the corresponding flow patterns, surface agitation, air bubble formation, vortices, swirls and velocity profile. Management of sedimentation and scum was also investigated. The model was constructed and tested at Nanyang Technological University (NTU) in Singapore.

3.2 PROGRAM FOR PHYSICAL MODELLING

The testing was carried out from July to September 2016 at NTU in Singapore. The program for physical modelling consisted of verification of 3D drawings, construction of a mini scaled model for verification of geometry, construction of actual model, test runs, witness testing and preparation of the final report.

3.3 MODEL SCALE

The model study consisted of constructing a reduced scale, geometrically similar model of the prototype system and operating the model to simulate the full scale flow conditions. The geometric scale of the model was 1:8.6. The scale was determined through Froude similarity criteria. Because of the symmetrical geometry of the pump station, only half the sump was required to be modelled. The physical model was constructed with the derived model. The sump model was made of transparent acrylic plates to observe the flow patterns. The corresponding flow and geometrical parameters were calculated for the model study and are detailed in the Table 1.

Table 1: Prototype and Model Parameters

Item		**Prototype**	**Scale**	**Model**
Sump	Width	7.7 m	1:8.6	0.895 m
	Length	1.4 m		1.326 m
	Depth (modelled part)	8.6 m		1.0 m
Pipe Size	Suction pipe	800 mm	1:8.6	93 mm
	Bell mouth	1200 mm		140 mm
Penstock (inlet)	Dimensions	2 m x 4 m	1:8.6	233 mm x 466 mm
Flow rate	Single pump	1200 l/s	1:216.9	5.5 l/s
	Two pumps	2400 l/s		11.0 l/s
	Three pumps	3600 l/s		16.5 l/s
Velocity	At suction bell mouth section	1.061 m/s	1:2.93	0.362 m/s
	In suction pipe	2.387 m/s	1:2.93	0.814 m/s

3.4 PHYSICAL MODEL CONSTRUCTION

The model boundary consisted of a short section of tunnel, inlet chamber, one wet well, three pumps with individual pipework, gate valves and flow meters. The model boundary is shown in Figure 6. The sump model was mainly made of transparent acrylic plates such that clear indication of the flow patterns, pre-rotation, aeration and vortex formation could be readily observed. Figure 7 shows the schematic of the model and Figure 8 shows the actual physical model.

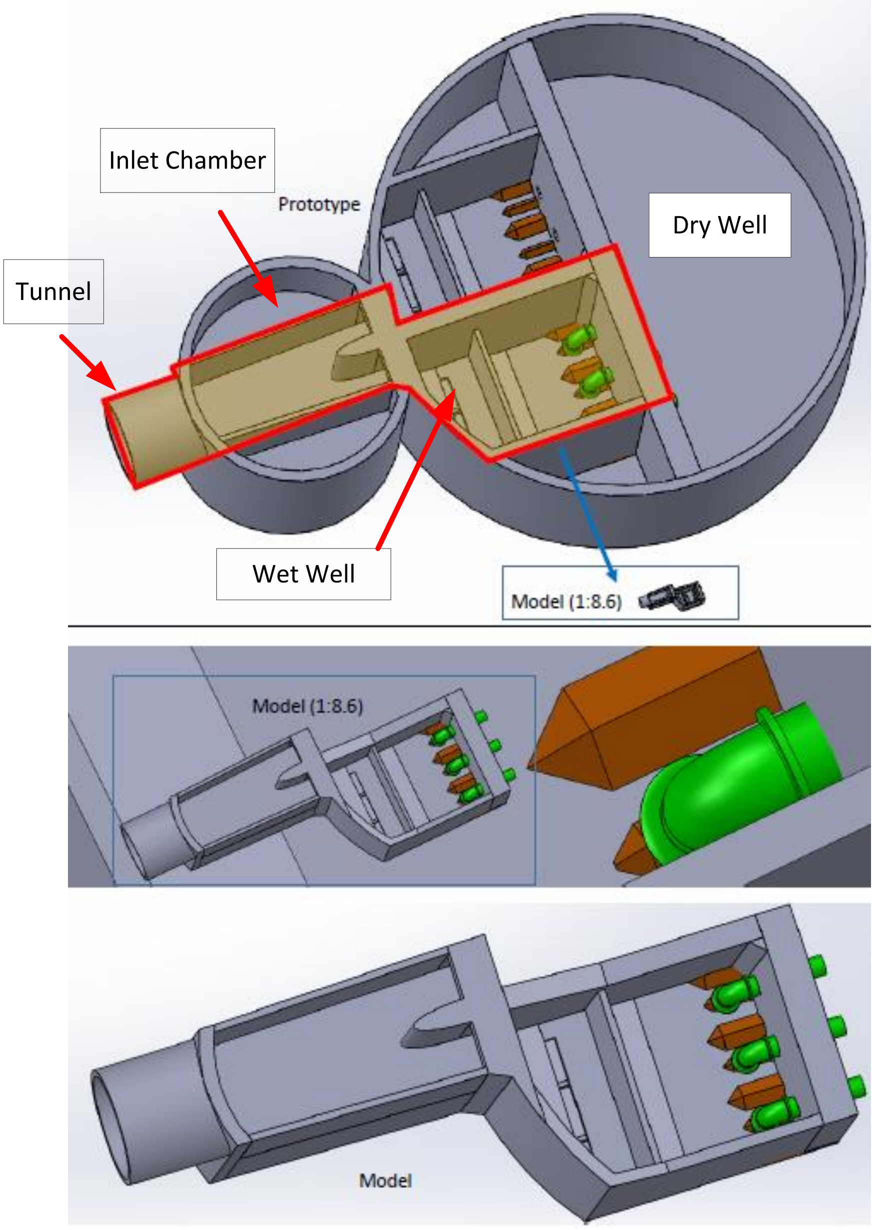


Figure 6: 3D boundary of physical model

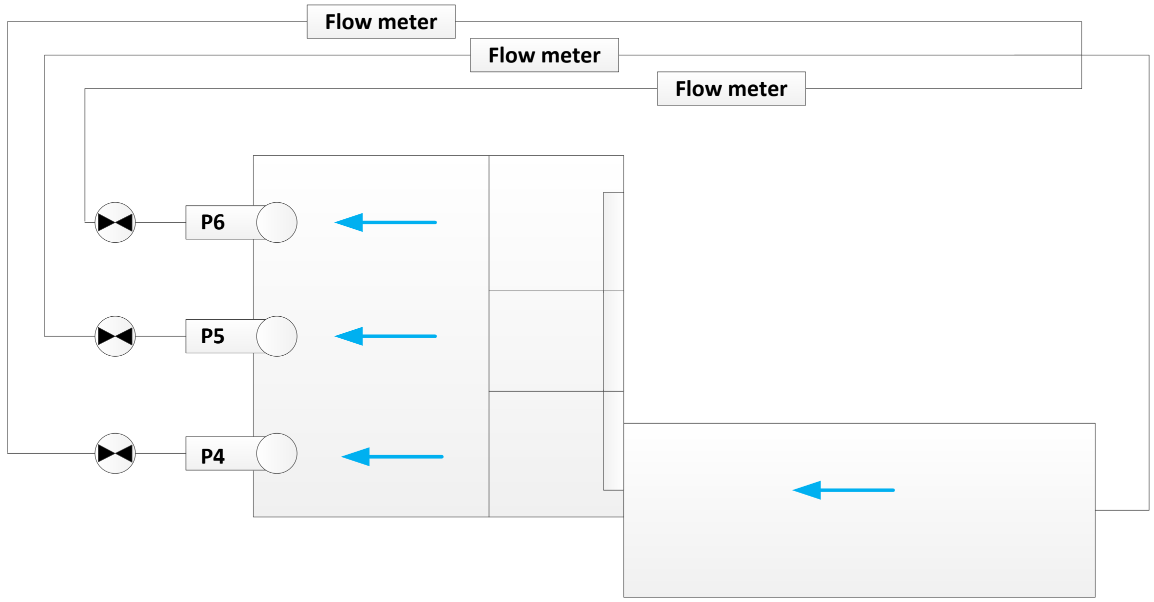


Figure 7: Schematic of physical model and pipework

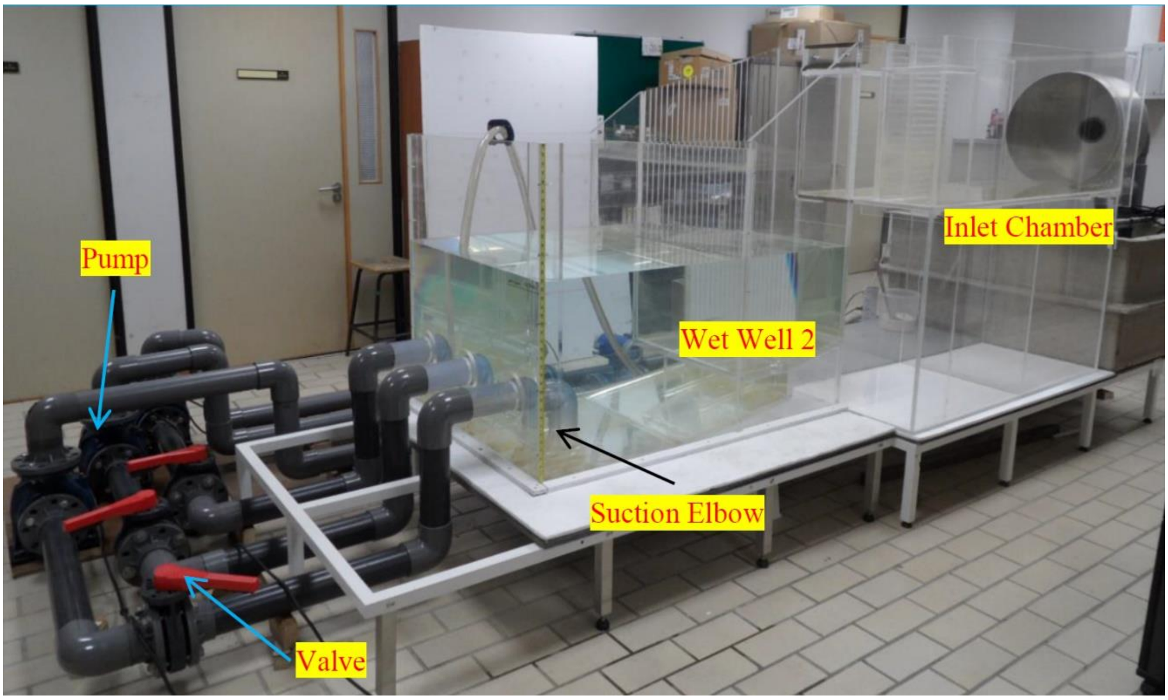


Figure 8: Physical Model for MPS Inlet and Wet well

3.5 INSTRUMENTATION

The instrumentation to observe and measure flow characteristics consisted of the following:

- Flow meter to measure flow from individual pumps
- Ruler to measure liquid level in the wet well
- Dye injection tube to observe free and subsurface vortices
- Yarn to observe pre-swirl and swirl

- Pitot tube to measure velocity profile

Figure 9: Physical Model in operation

3.6 TEST CASES

Various operating scenarios were tested at different duty points and water levels to observe the flow patterns. The worst hydraulic conditions were generated at the lowest water level. This was because of generation of surface agitation and vortices at low water level. A total of 15 operating scenarios were tested to cover various combinations of pumps in operation and water levels. A few key scenarios are described in Table 2.

Table 2: Test Run Matrix for Mangere Pump Station's Physical Model

Case No.	Pump on Duty	Flow Rate	Water Level	Description
1.	P4, P5, P6	3 X 1.2	-26.05	Water level at start level for 5 pumps (maximum operating level) with pumps P4, P5 and P6 in operation at maximum speed
2.	P4, P5, P6	3 X 1.2	-26.47	Water level at start level for 2 pumps with pumps P4, P5 and P6 in
3.	P4	1 X 1.2	-26.83	Water level at start level for 1 pump with P4 in operation at maximum
4.	P4	1 X 1.2	-28.94	Water level at stop level for 1 pump with P4 in operation at maximum speed
5.	P6	1 X 1.2	-26.83	Water level at start level for 1

Case No.	Pump on Duty	Flow Rate	Water Level	Description
				pump with P6 in operation at maximum speed
6.	P4, P6	2 X 1.2	-26.47	Water level at start level for 2 pumps with P4 and P6 in operation at maximum speed
7.	P5, P6	2 X 1.2	-26.47	Water level at start level for 2 pumps with P5 and P6 in operation at maximum speed
8.	P4	1 X 1.8	-28.94	Water level at stop level for 1 pump with P4 in operation at maximum speed. 1.5 times the Froude Scaled flows and keeping the submergence at geometrically scaled value

3.7 TEST METHODOLOGY

The physical test methodology for the model consisted of the following main steps:

- Construct a sump model including the inlet chamber and suction pipes at a reduced scale of 1:8.6
- Set up a re-circulating flow system and operate the model so that the fluid motion in the sump was dynamically similar to the prototype. The flow system includes pumps, PVC pipes, flow meters and control valves
- Measure and control the flow from the pump and into the inlet chamber and wet well using electronic flow meter and control valves
- Observe the flow patterns in the sump and note flow features such as swirls or pre-rotation, aeration of the inflow and vortex formation near the suction bell mouth
- Enhance visualization of the flow patterns with the aids of tracer/dye and yarn and record the tests with photos and videos
- Measure the velocity profile using Pitot tube
- Observe the flow patterns. The flow patterns have been documented using photos and videos

4 RESULTS OF PHYSICAL MODEL TESTING

All 15 cases were tested and observations were made for flow characteristics. Some key design features and results are discussed in this section.

4.1 BAFFLE WALL

A baffle wall is normally used in the wet wells to isolate upstream turbulent hydraulic conditions from the downstream hydraulic conditions to ensure smooth and laminar flow closer to the suction bell. It was observed during physical testing that at low flows and low operating levels in the pump station, the inflow from inlet chamber plunged onto the baffle floor. This resulted in turbulent flow and surface agitation. This generated significant air bubbles. It can be seen from Figure 10 and Figure 11 that the flow upstream of the baffle wall is turbulent with strong surface agitation as it plunges into the wet well. Downstream of the baffle wall, the flow appears to be laminar with no visible signs of surface agitation. A few bubbles managed to pass through the baffle floor opening and made their way to the other side of the baffle. They floated up to the surface and broke up before reaching the suction bell. No visible air bubbles were drawn into the suction bell. This demonstrated that baffle wall was effective in maintaining laminar flow in the sump and closer to suction bell. This also provided confidence in the dimension of the wet well and demonstrated that the length of the wet well is sufficient to generate smooth flow streamlines to suction bell.

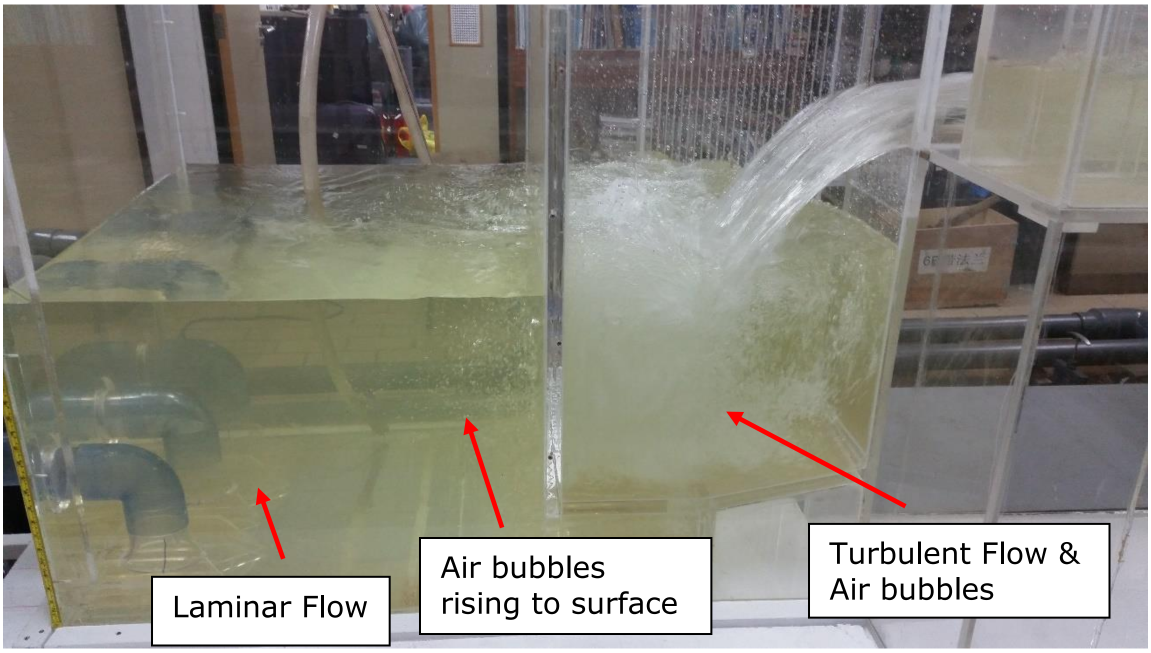


Figure 10: Case 4 – Flow on u/s and d/s of baffle wall

The model was also tested to simulate the case of all 3 pumps in operation at maximum water level to further gauge the effectiveness of the baffle wall. The testing showed occasional overtopping of the flow at the baffle. This generated few air bubbles on the downstream side of the baffle wall. These had no hydraulic impact as the bubbles rose to the surface and broke up before reaching the suction bell. Refer to Figure 12. It is noted that analytical methods would not have been able to identify this phenomenon.

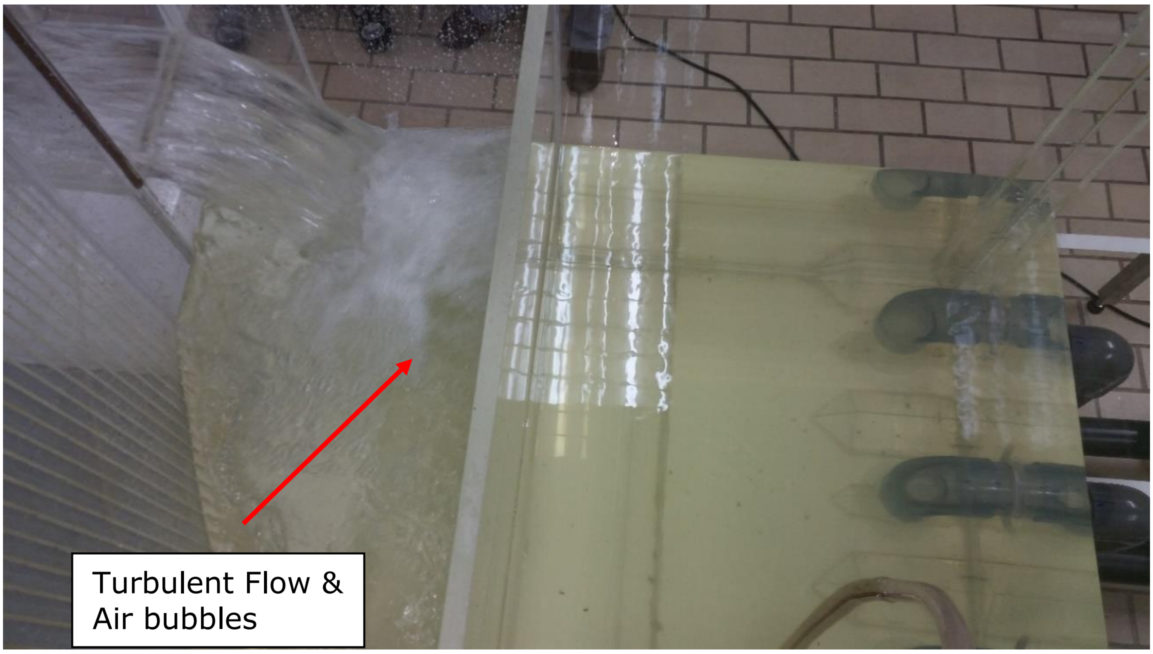


Figure 11: Case 4 – Flow on u/s and d/s of baffle wall

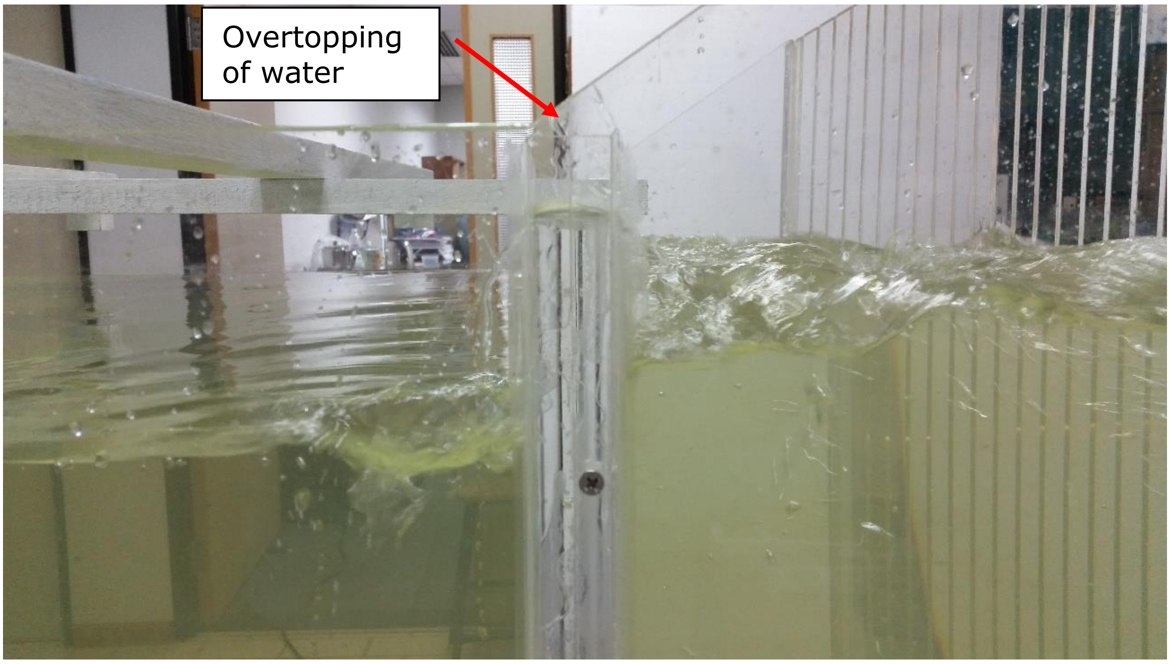


Figure 12: Overtopping of Wastewater at High Flows and High Operating Levels in Wet Well

4.2 VORTICES AND SWIRL

Adverse hydraulic conditions in the wet well may result in the formation of vortices and swirls. The main documented reasons for generation of vortices are the geometric orientation of the wet well and non-uniform approach flow to the suction bell. The vortices if not mitigated have the tendency to pull air bubbles into the suction bell and may result in pump cavitation. An efficient wet well and pump intake design will seek to eliminate or minimize vortices to ensure optimum pump performance.

According to ANSI/HI standard 9.8-2012, vortices can be of two main types – free surface vortices and subsurface vortices. The generation of free surface vortices can be avoided by providing sufficient submergence depth for the suction bell. Surface vortices have a much smaller chance of entering the suction bell if submergence depth is greater as this allows the vortices to be dissipated. The submergence depth for the suction bell was determined in accordance with ANSI/HI standard 9.8-2012. This approach takes into account inertial and gravitational forces. In addition to adequate submergence depth, other useful physical attributes such as floor splitters and corner/edge fillets assist by breaking up the surface vortices before they reach the suction bell.

Subsurface vortices are generated because of change in flow direction in the vicinity of suction bell. By providing sufficient clearance of bell mouth from the wet well, the chances of subsurface vortices reaching the bell mouth can be reduced. Floor splitters and corner/edge fillets also help in breaking up the subsurface vortices.

Pre-swirls are generated if the approach to the pump intake is laterally skewed. This results in rotational flow around the suction bell. Pre-swirls can be minimized by adopting a wet well geometry that encourages uniform flow approach to the suction bell.

The following main design features have been incorporated in the wet well to assist in eliminating and minimizing free surface vortices, subsurface vortices and swirls:

- Optimum intake geometry with no obstructions to the approach flow ensuring uniform approach to suction bell
- Sufficient submergence depth for suction bell
- Triangular shaped flow splitters underneath the suction bell
- Corner/edge fillets
- Sufficient suction bell clearance from the wet well floor and walls

The formation of vortices and swirls was checked for all operating scenarios. The operating scenario that may generate and propagate vortices to the suction bell is the case of minimum water level and only one pump in operation (Case 4). The observations and results of this scenario are discussed in this section. Dye was used to observe vortices and yarn was used to observe swirl. The testing demonstrated the following:

- The clearance of suction bell to the wet well floor and side/ back walls were adequate and did not result in formation of vortices or swirls
- The submergence depth of the suction bell was sufficient to avert formation of surface vortices

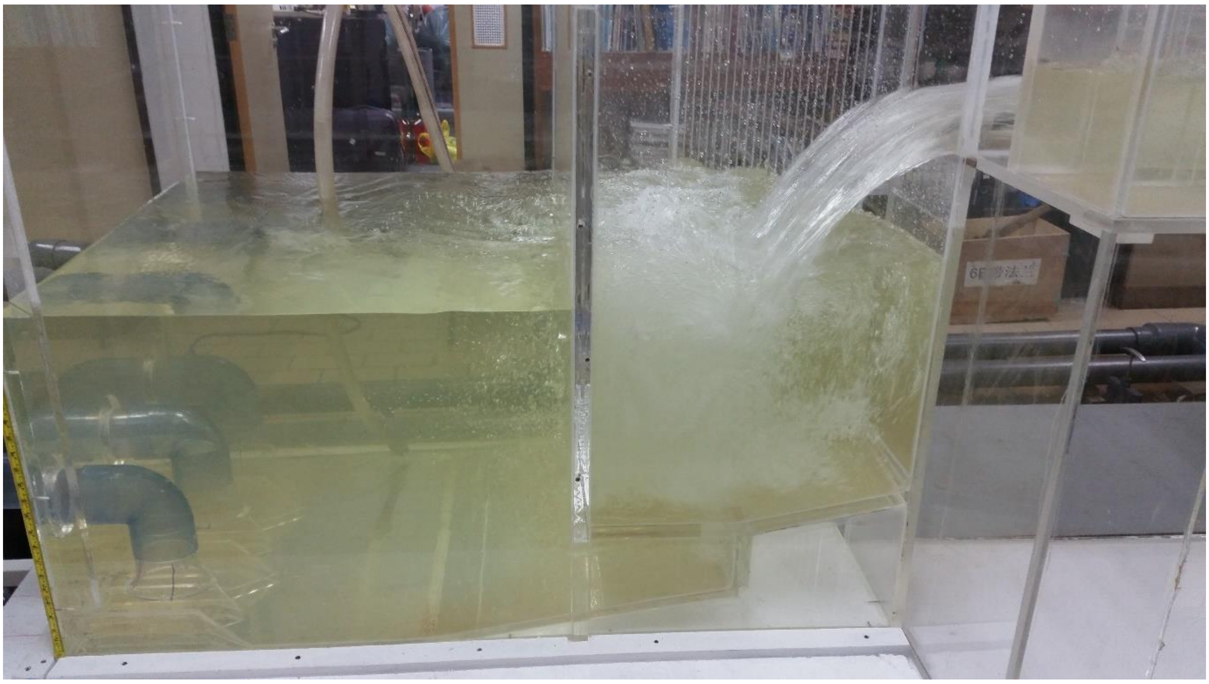


Figure 13: Case 4 – No Vortices at Minimum Operating Level

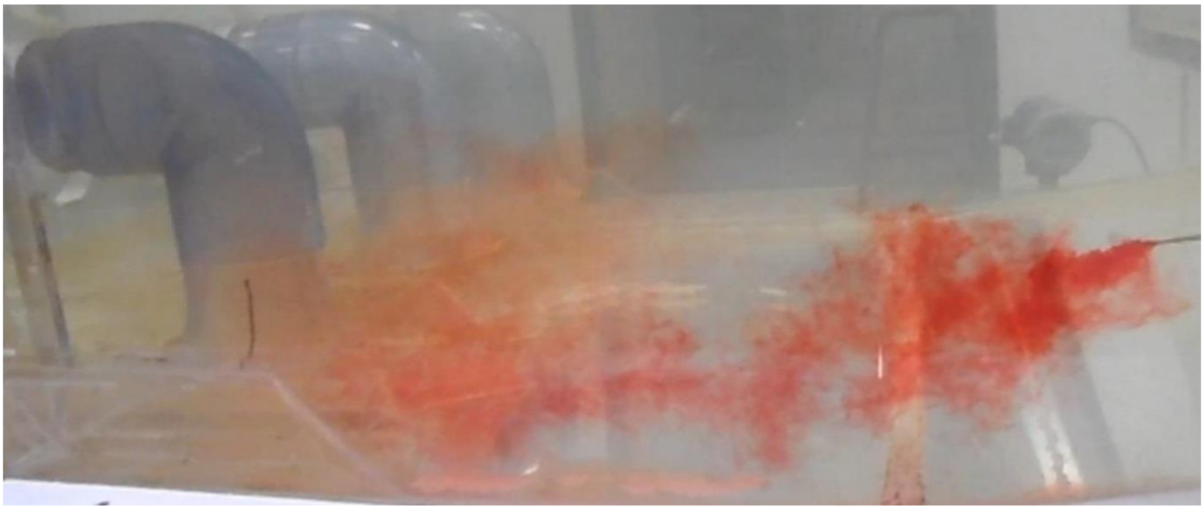


Figure 14: Case 4 – Smooth Streamline into Suction Bell (Dye visualization)

Figure 13 shows the testing for Case 4. No visible vortices were observed in the wet well and around the suction bell. Dye was injected next to the suction bell to enhance the flow pattern and improve the observation of vortices. Figure 14 shows that the flow surface on the downstream of baffle is relatively calm. The dye visualization showed that no surface or subsurface vortices occurred at minimum water level. Figure 15 showed that flow stream lines into the suction bell were smooth. The yarns attached to the bell mouth exhibited small rotational angle which was less than the acceptable limit of 5 degrees according to ASNI/HI standard 9.8-2012.

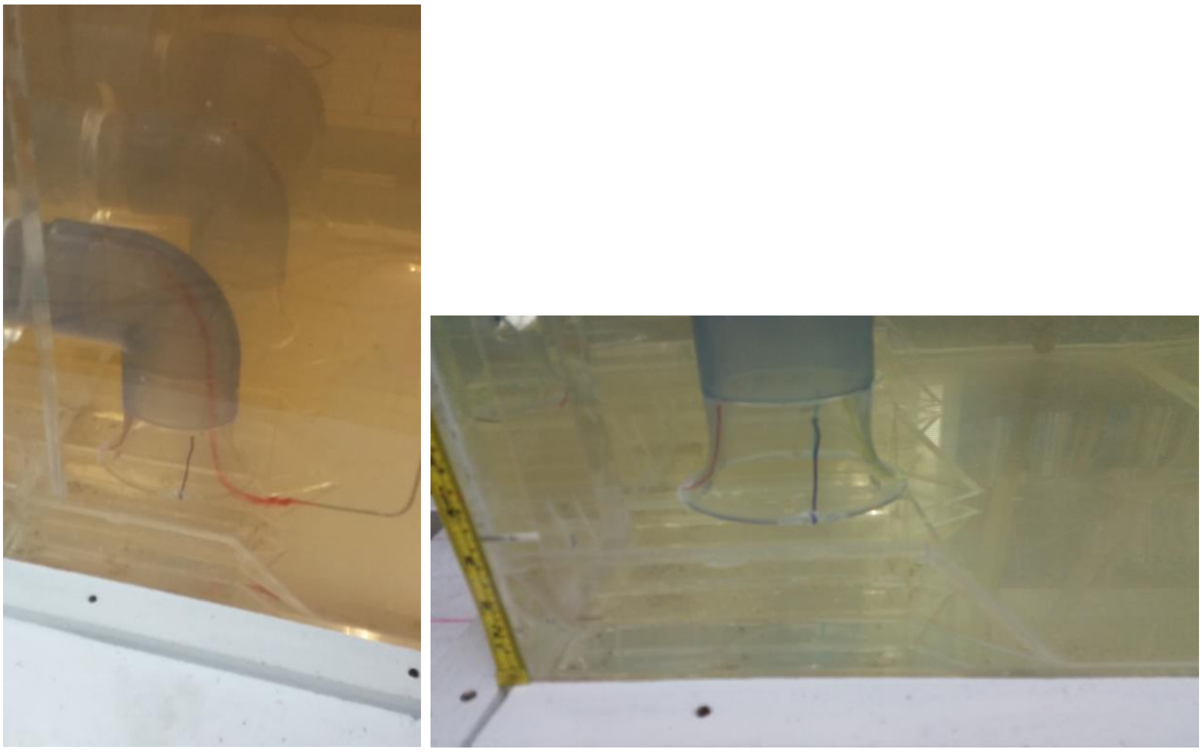


Figure 15: Case 4 – No Vortices at Minimum Operating Level

4.3 EVALUATION OF SCALE EFFECTS

To evaluate the potential scale effects on free surface vortices the model was tested at 1.5 times the Froude scaled maximum flow at minimum water level (Case 8). The results showed that no visible air bubbles were drawn to the suction bell. The yarns attached to the bell mouth exhibited small rotational angle and no swirls of circulation flows were observed at the water surface or around the intake. Dye visualization showed no surface or subsurface vortices. The flow streamlines into the suction bell were smooth. Refer to Figure 16.

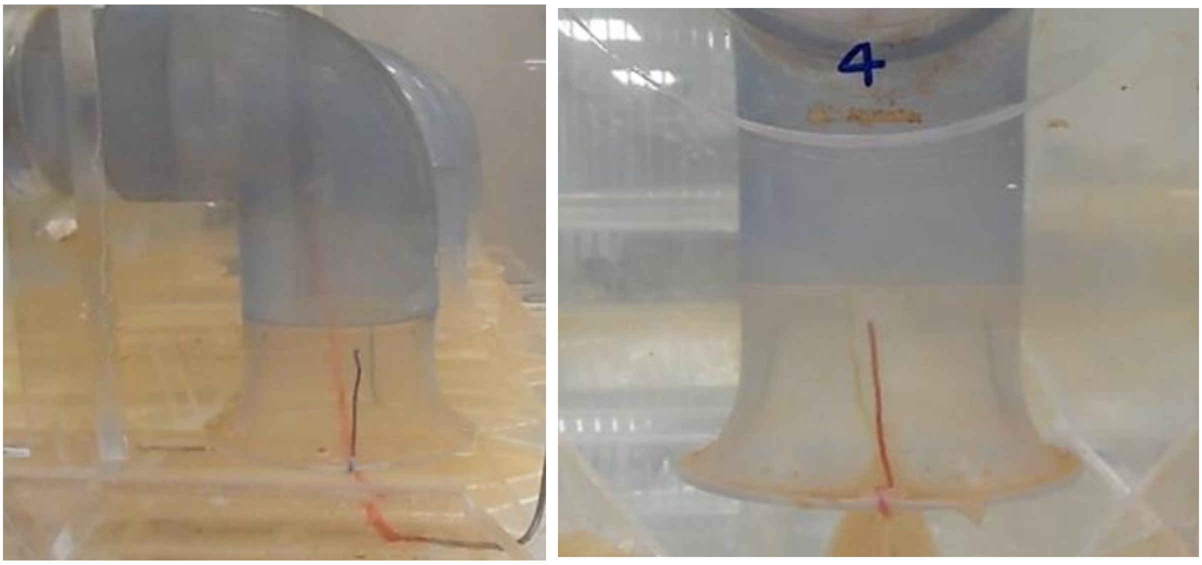


Figure 16: Case 8 – No vortices (left image), small rotational angle (right image)

4.4 SEDIMENTATION

The evaluation of sedimentation is not part of the modelling requirement of ANSI/HI standard 9.8-2012. A qualitative assessment was made during the physical testing to observe the sedimentation zones. Sedimentation would be higher during high operating level and high flows because of less turbulence in the wet well. The incoming flow was submerged for higher water level in the wet well. This resulted in deposition and accumulation of sediments at the baffle structure near the penstock opening.

With one pump in operation at low wet well level, no significant sedimentation was observed at the penstock opening or in the baffle structure. This is because the plunging flow created sufficient turbulence and surface agitation to keep the sediments in motion and transport them to wet well.

4.5 SNORE CYCLE

Similar to sedimentation, the evaluation of snore cycle is not part of the modelling requirement of ANSI/HI standard 9.8-2012. A qualitative assessment was made during the physical testing to observe the effects of running a snore cycle on the flow pattern and movement of sediments in the wet well. Plastic beads were used to evaluate snore cycle operation. It is expected that in real life, the solids will consist of organic matter, small rocks and other small objects but these could not be used for the experiment because of potential damage to the testing equipment. A maintenance case was tested to determine the effectiveness of snore cycle. Snore cycle involves running pumps at just above the bell mouth level at full speed and at minimum pump speed. The idea behind snore cycle is to generate enough turbulence in the intake region to allow movement of sediments and suction of sediments into the pump. The result showed that snore cycle was effective in keeping the sediments in motion and removing most of them via suction through bell mouth. However, not all the sedimentation in the open area of the wet well floor could be removed by the snore cycle.

4.6 SCUM BUILD-UP AND STAGNATION ZONES

Surface scum was observed to be accumulated at the upstream side of the baffle wall towards the corner of the wet well. This is consistent with the observations of authors on other projects as the corner areas create stagnation zones. For the cases with highest water level, occasional overtopping from the baffle wall brought small amount of scum to the downstream of the baffle.

4.7 RECOMMENDATIONS

The testing did not identify the need for any significant changes to the inlet and wet well geometry. The two main recommendations included increase in height of the baffle wall and providing a slope on the baffle floor.

The height of the baffle wall was increased to avoid overtopping of the flow. Occasional overtopping might take place during high water level operations. Although the overtopping has no hydraulic impact small amount of surface scum might be brought to the intake chamber.

The other recommendation was to provide a sloping baffle floor to avoid sedimentation in the baffle and allow movement of solids towards the baffle floor openings. These are shown in Figure 17.

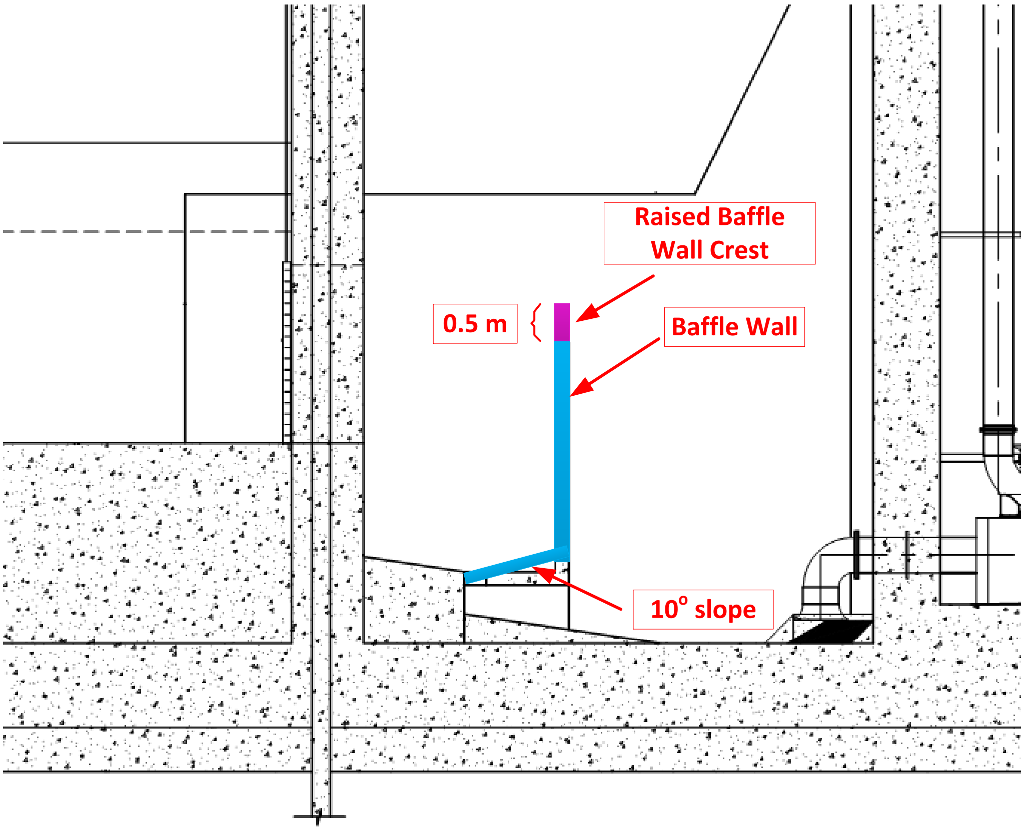


Figure 17: Increase in Baffle Wall Height and Addition of Sloping Baffle Floor

4.8 CONCLUSION OF PHYSICAL MODEL TESTING

The hydraulic performance for all operational cases was satisfactory and no adverse impact was found related to air bubbles or surface agitation. The wet well geometry and size was considered acceptable. The clearance of suction bell to the wet well floor and side/ back walls were adequate and did not result in formation of any visible vortices or swirls. The bell mouth diameter and shape were also considered acceptable as the inlet velocity was within the recommended range and suction flow streamlines were smooth.

It must be noted that there may be differences between the results observed during model testing and the actual flow pattern when the pump station will be commissioned and operated. These may be due to model geometry, scale effects or measurement effects.

5 BUILDING INFORMATION MODEL FOR MANGERE PUMP STATION

The building information model (BIM) is a digital representation of the physical and functional characteristics of the pump station. The BIM was used extensively during the design stage as a communication tool and proved extremely useful in improving collaboration within the design team (including inter-disciplinary reviews), and during safety in design workshops and operability reviews with Watercare staff, and identifying service clashes.

To assist in visualization of the pump station and its components, a 3D building information model (BIM) has been created for the entire pump station to better understand its features. It provides 3D visualization to improve understanding of the design drawings. There are 6 levels of development for BIM. BIM for MPS has been developed to 6D level by including asset information. 6D BIM links intelligence (life cycle management information of the components) to 3D components and will be useful for facilities management purposes. Refer to Figure 18, Figure 19 and Figure 20 for MPS views extracted from BIM.

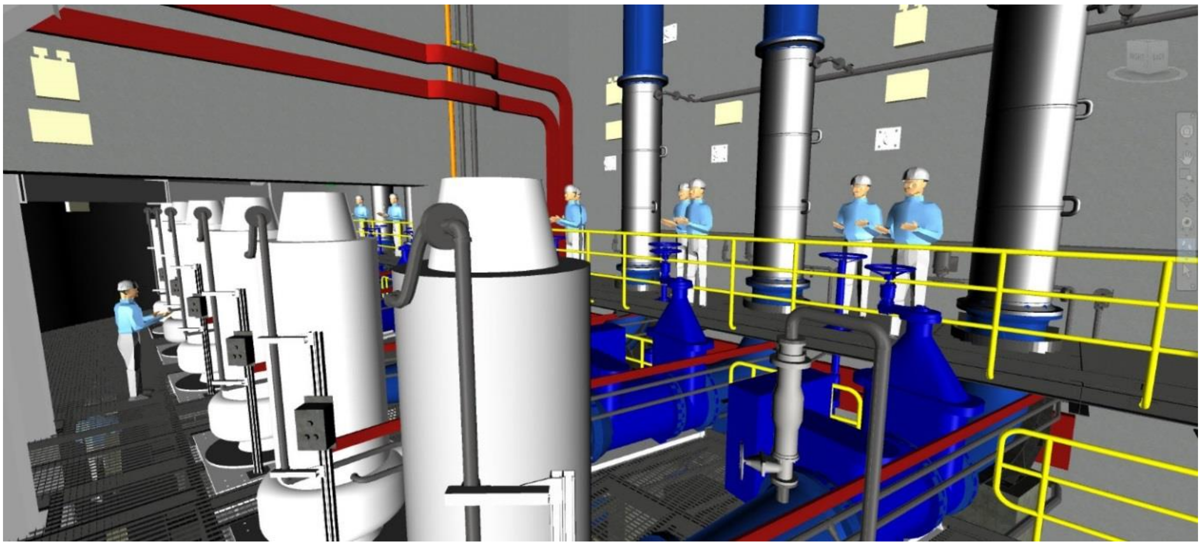


Figure 18: View of Dry Well

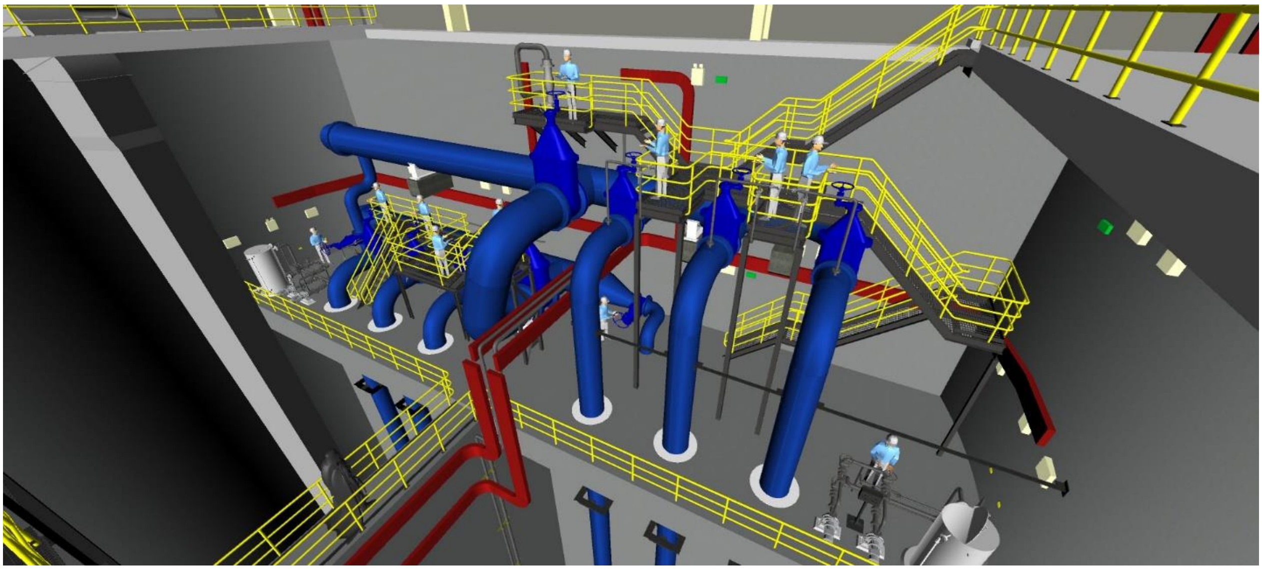


Figure 19: View of Upper Valve Chamber

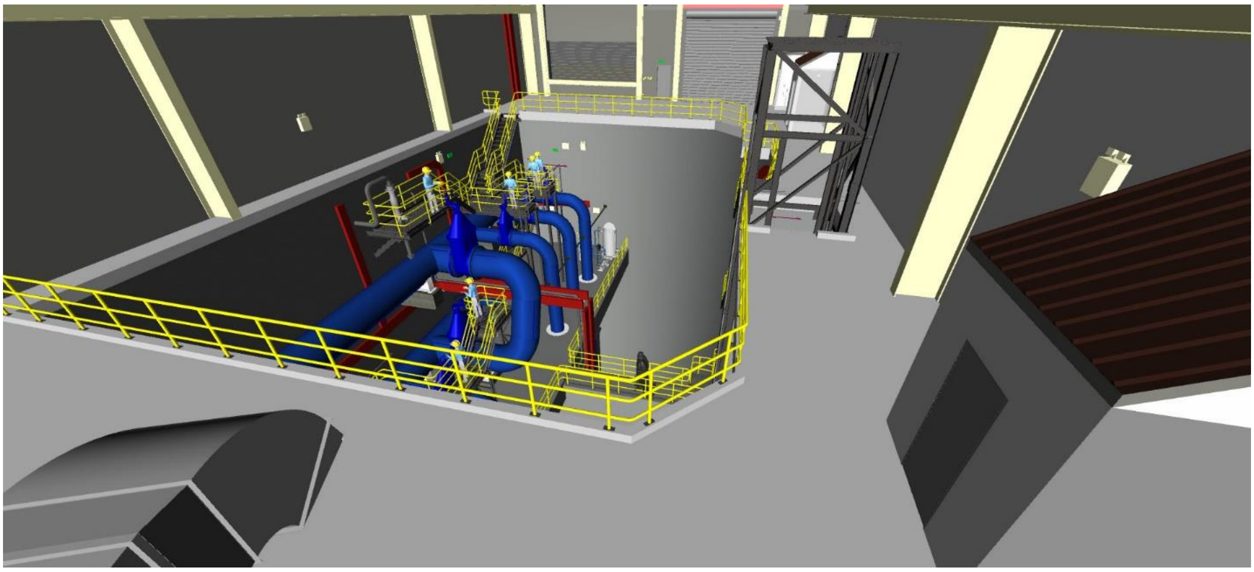


Figure 20: Internal View of MPS Building

5.1 MODELLED ELEMENTS

LOD 300 (level of development) was deemed to be appropriate for the digital representation of all the physical elements for MPS. These elements were then divided into various categories including sub structure, building shell, building interior, services. These categories were further divided based on their sizes and functions. Please refer to NZ BIM Handbook for a description of various levels of development.

5.2 SOFTWARE PACKAGES

The preparation of BIM for MPS was achieved using multiple software tools. The MPS consists of numerous physical features including diaphragm wall, building shell, services, and structural concrete. These features were modelled using various software packages. These packages and their workflow are shown in Figure 21.

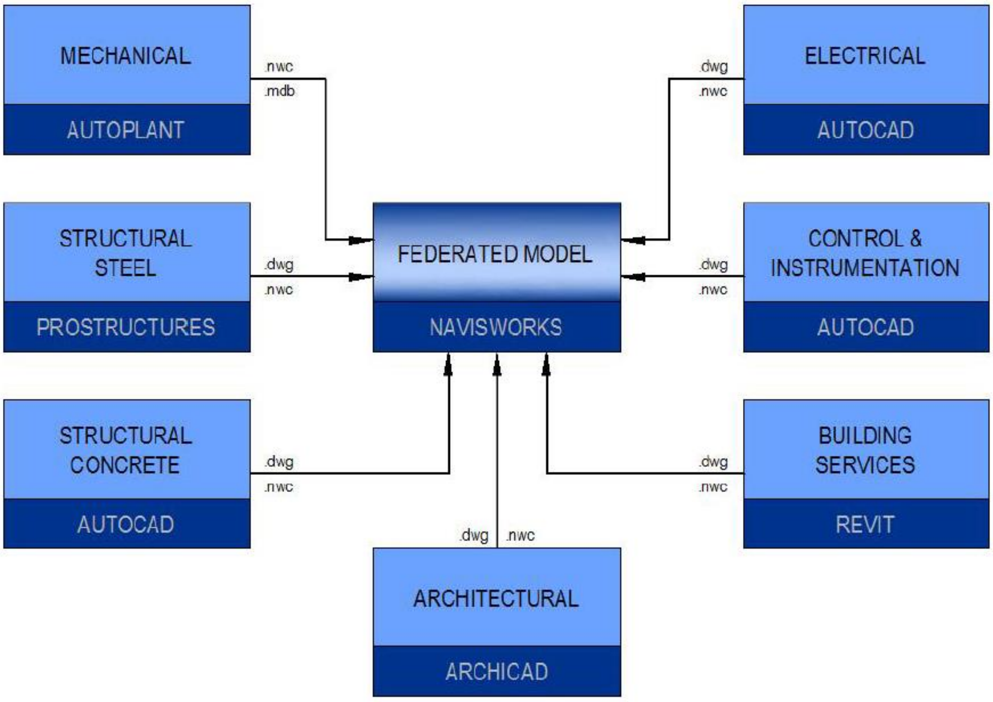


Figure 21: Authoring Tool Workflow for BIM

5.3 CLASH DETECTION

BIM was extremely useful in detecting clashes and avoiding late design changes. Clash detection simulations were run through software applications to determine hard clashes, soft/clearance clashes and workflow clashes. All models were federated together and search sets with clash details were defined to enable the clash simulation to take place. The primary objectives of clash simulations were as follows:

- To audit the models to determine if there were design altering clashes between different disciplines,
- To understand if spatial boundaries between elements are sufficient
- If the installation and safety requirements are in accordance with tolerances specified by global or regional standards.

Figure 22 shows a couple of clashes between various disciplines that were identified early and resolved during the design.

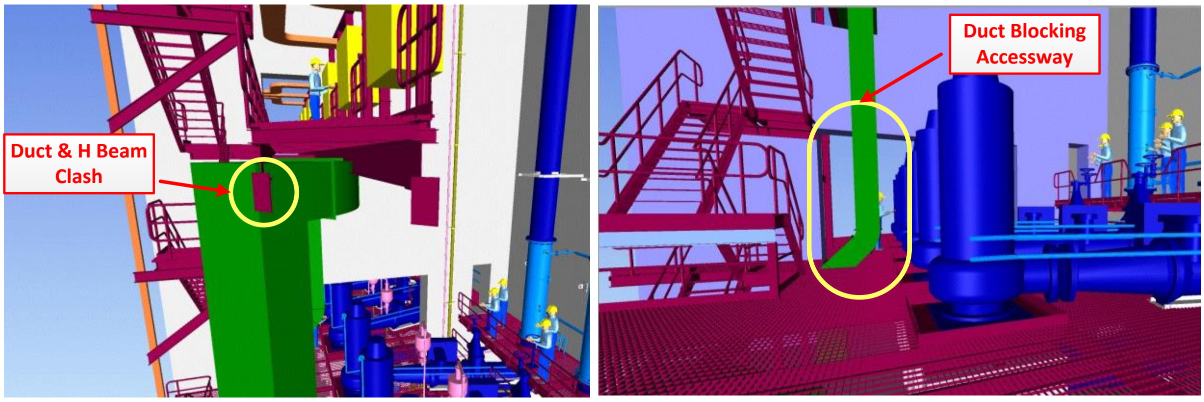


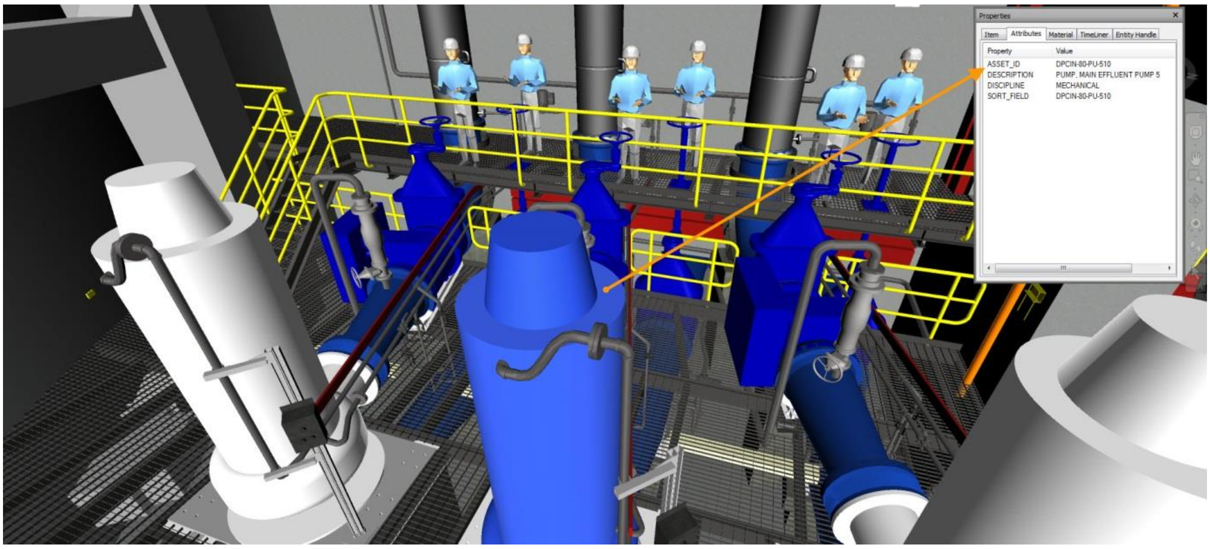
Figure 22: Clashes between Different Disciplines

5.4 USE IN SAFETY IN DESIGN (SID) AND OPERABILITY WORKSHOPS

BIM was used during SiD and operability workshops and proved very useful for facilitation of discussion regarding the access to and around the equipment. MPS pipework consists of large equipment including 3 m high pumps, DN1200 valves and large spool pieces of pipes. The use of BIM during SiD and operability workshops provided a good opportunity to identify and eliminate potential hazards. It provided an opportunity for the operational staff to get more involved in the design process which proved beneficial. As a result of these discussions, a few additional design features were provided to enhance the level of safety for the operators. These included increasing working area around a few valves, providing additional platforms for equipment access, increasing the height of certain valves for easy access.

5.5 6D BIM

Another key feature of the federated model is the 6D data associated to some of the elements. WSL determined what elements (asset types) were required to have this data associated to them. The attribute Asset ID was selected as the unique identifier for facilities management, which is essential for the life cycle management of the MPS. These elements included equipment, valves and instruments. The data consisted of essential properties such as size, material and O&M requirements. Each element has been modelled individually which will allow the contractor to assign attribute data and hyper-links during the construction stage after procurement of the equipment. This will provide a comprehensive tool for the O&M staff for facilities management of MPS. Figure 23 shows a property box displaying attribute data for the effluent pump.



Property	Value
ASSET_ID	DPCIN-80-PU-510
DESCRIPTION	PUMP, MAIN EFFLUENT PUMP 5
DISCIPLINE	MECHANICAL
SORT_FIELD	DPCIN-80-PU-510

Figure 23: Attribute Data for Effluent Pump

6 KEY LEARNINGS

Both physical model and building information model have proved extremely useful during the design of MPS. Physical modelling confirmed the sizing and geometry of pump station. BIM was extensively used as a communication tool which provided an opportunity for different stakeholders to actively participate in the design process. Potential clashes were identified early which avoided late design changes. SiD workshop resulted in improving the safety features of the pump station. This project has successfully shown the benefits of these tools. The use of these tools will gain popularity for large and complex projects.

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