Appendix H – Pump Stations Memorandum

Memorandum

01 April 2018

To	Melbourne Water Corporation		
Copy to			
From		Tel	
Subject	Fishermans Bend Pump Stations	Job no.	3136555

1 Introduction

This memorandum summarises information prepared to date on the proposed pump stations for Fishermans Bend to inform development of the *Fishermans Bend Water Sensitive Drainage and Flood Management Strategy* and to assist scoping next steps.

This is a minor update to a memorandum issued on 13 December 2018. The only changes are additional information provided on pump station timing/implementation.

2 Purpose

This memorandum compiles the relevant information prepared to date by GHD, Melbourne Water and other parties on the proposed pump stations for Fishermans Bend, to inform discussions between GHD, Melbourne Water, Councils and the Fishermans Bend Taskforce on the proposed pump stations.

3 Background

- Fishermans Bend is relatively low lying with ground levels varying from 1.0-4.0m AHD.
- Pump stations are required as part of the overall drainage solution, because the water levels in the Yarra River are higher than the ground surface levels during (1) tidal events in Port Phillip Bay (coastal flooding) and (2) flood events in the Yarra River (riverine flooding). *Noting that water level in the Yarra River downstream of Wurundjeri Way is principally determined by the bay level, whereas the water level upstream of Wurundjeri Way is principally flow-dominated during flood events in the lower Yarra River.*[1]
- Whilst a levee can protect against inundation directly from the Yarra River, a high water level behind a levee (the 'tailwater level' for the underground drainage network) means that the stormwater can't free drain under gravity. Pumping is required to alleviate the constraint.

[1] Flood events in the lower Yarra have not been modelled as part of any of the Fishermans Bend studies.

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- This is the case regardless of whether pipe upgrades or distributed storages are used within the catchments, that is, regardless of whether a baseline drainage or hybrid drainage approach is used.

4 Explaining Flood levels

4.1 Tidal water levels (influences downstream of Wurundjeri Way)

Melbourne Water's 100 year ARI tide level in Port Phillip Bay is 1.6m AHD today. [2] This means that parts of Fishermans Bend are currently subject to inundation under tidal events, particularly towards the North-East (see map of ground levels in Figure 1 below).

By 2100, allowing for a projected sea level rise of 0.8 m in Port Phillip Bay, the 100 year ARI tide level would increase from ~1.6m AHD to ~2.4m AHD.[3] This means that over time, due to sea level rise resulting from climate change, greater areas of Fishermans Bend would be subject to inundation under tidal events.

4.2 Lower Yarra flood levels (influences upstream of Wurundjeri Way)

Melbourne Water's designated flood levels in the lower Yarra River are currently subject to review in the Lower Yarra flood modelling project (GHD for Melbourne Water). The current levels Melbourne Water uses we understand are those recorded from the 1943 flood, which was considered to be a 100-yr ARI event. Initial modelling for the project, which is modelling current conditions (rather than an historical event), indicates much higher flood levels are likely for the Lower Yarra.[4]

This uncertainty around the flood level has broader implications for the extent and height of the levee, drainage infrastructure (including pump stations), and planning controls.

Given this uncertainty, for the purpose of all past drainage modelling for Fishermans Bend the same level (i.e. the level in Port Phillip Bay) has been used as the boundary condition for both downstream and upstream of Wurundjeri Way.

[2] Melbourne Water's 1% AEP (Annual Exceedance Probability) flood levels within Port Phillip Bay include a projected sea level rise of 0.8 m by 2100. Under these guidelines the flood levels applicable to Fishermans Bend for a 1% AEP flood level are 1.6 m AHD (today), 1.8 m AHD by 2040, and 2.4 m AHD by 2100. *Source: Planning for Sea Level Rise Guidelines, Melbourne Water, 2017*.

[3] It is important to note however that many of the modelling assumptions are slightly different to these levels. For example, modelling for the latest Fishermans Bend Baseline Drainage Plan (from GHD, 2018) used a time varying tail-water level peaking at 2.25m AHD (from Water Technology 2017), which combines a 1% AEP extreme water level event in Port Phillip with sea level rise of 0.8m, in line with the current planning requirements for sea level rise. This is considered appropriate and is not inconsistent with the general 2.4m AHD requirement.

[4] Yarra River 1% AEP flood profiles given in current Yarra River Flood Mapping project – Modelling Assumptions & Implications (Memo from GHD to Melbourne Water dated 29 March 2018) show that for the river below Wurundjeri Way are principally determined by the bay level and river flow has a very minor influence. However, upstream of Wurundjeri Way the river levels are flow-dominated during flood events and are higher than the Bay level. As flood flows are not included in the current modelling it will be underpredicting flood levels in the eastern-most part of the site which floods from the Yarra upstream of Wurundjeri Way.

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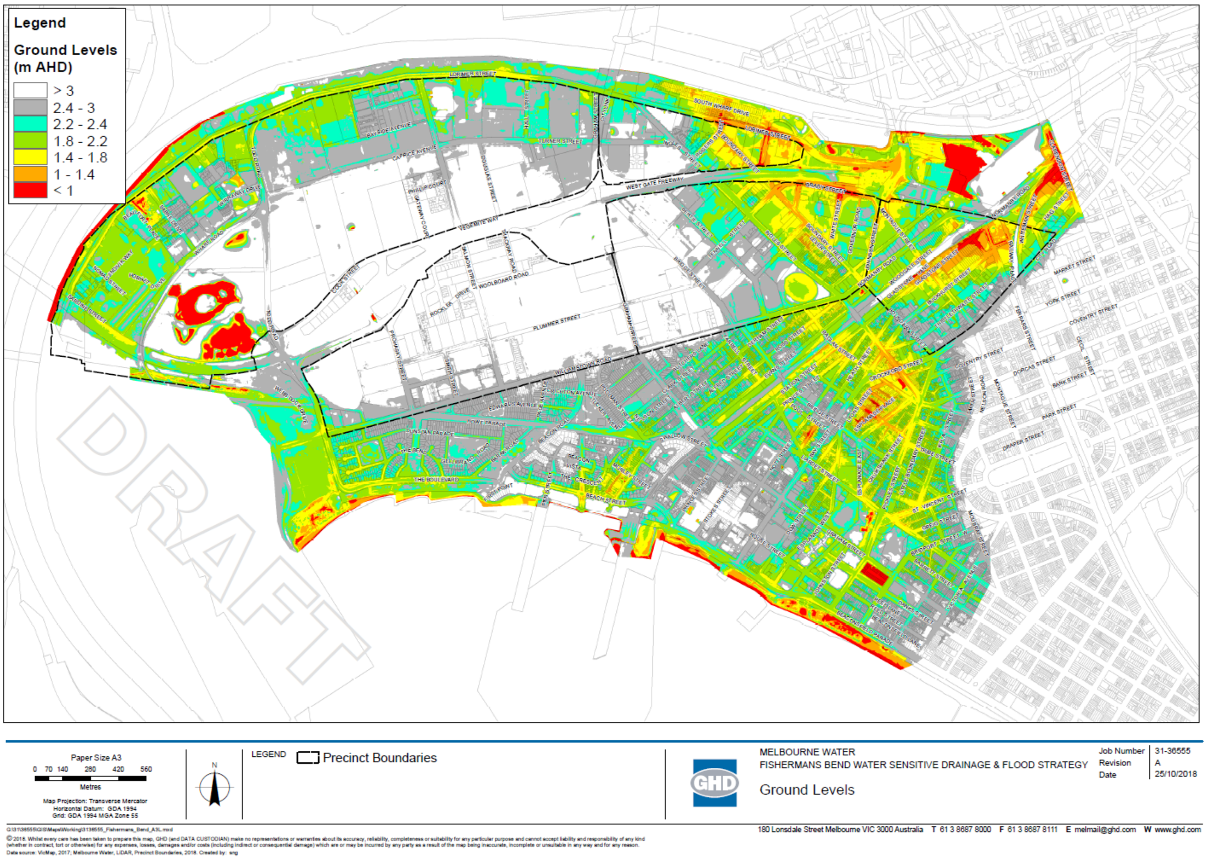
For the purposes of this strategy, the same approach has also been used. However the uncertainty will be explicitly stated, and there will be a need to revisit the planning assumptions once (or if) a new Yarra River flood level is determined.

Figure 1 Ground Levels



5 Flood Plots

Flood depth plots are provided below. These show the extent and depth of flooding under different conditions. It is important to highlight for the purpose of interpreting these plots, that Melbourne Water's safety risk criteria for the 100 year ARI event is that flooding on roads must be less than 0.4m. This means any flooding on footpaths or private property, or any flooding on roads greater than 0.4m does not meet the required 100 year level of service.

5.1 Existing conditions flooding, without mitigation

A flood depth plot for existing conditions without mitigation for the 100 year ARI event is shown in Figure 2 below. This demonstrates that there is flooding that does not meet the level of service in the following areas:

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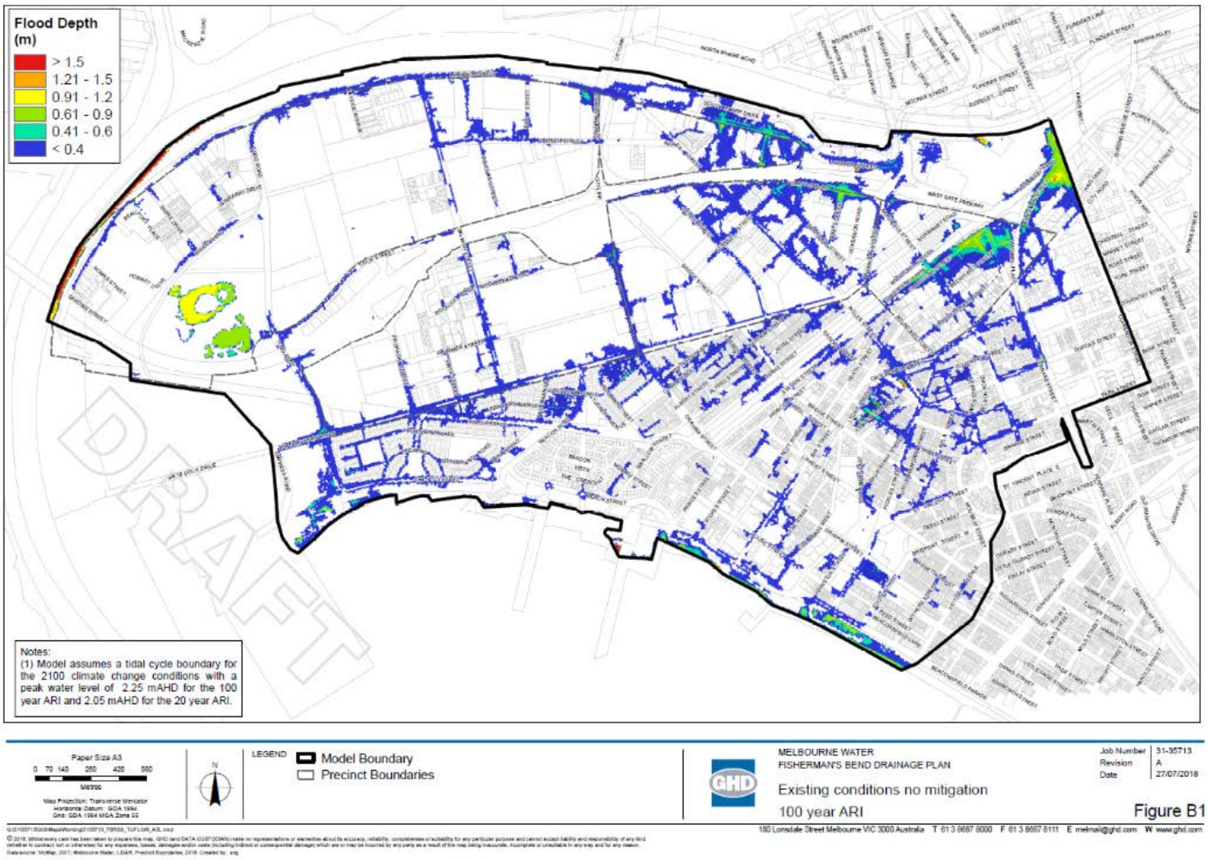
- around Ferrars St and Gladstone St (Montague precinct),
- around the intersection near White St and Brady St (Sandridge precinct), and
- along Lorimer St (east end of the Lorimer precinct).

Figure 2 Existing conditions flooding, 100 year ARI, no mitigation



5.2 Future (2100) flooding, without mitigation

The flood depth plot for conditions in 2100 (with the potential effects of climate change) without mitigation for the 100 year ARI is shown in Figure 3 below. Due principally to the higher tidal level, there is flooding that does not meet the level of service around:

- a large portion of the Montague precinct;
- the lower lying eastern end of the Sandridge precinct;
- the lower lying eastern half of the Lorimer precinct;
- almost the entire length of Lorimer St;

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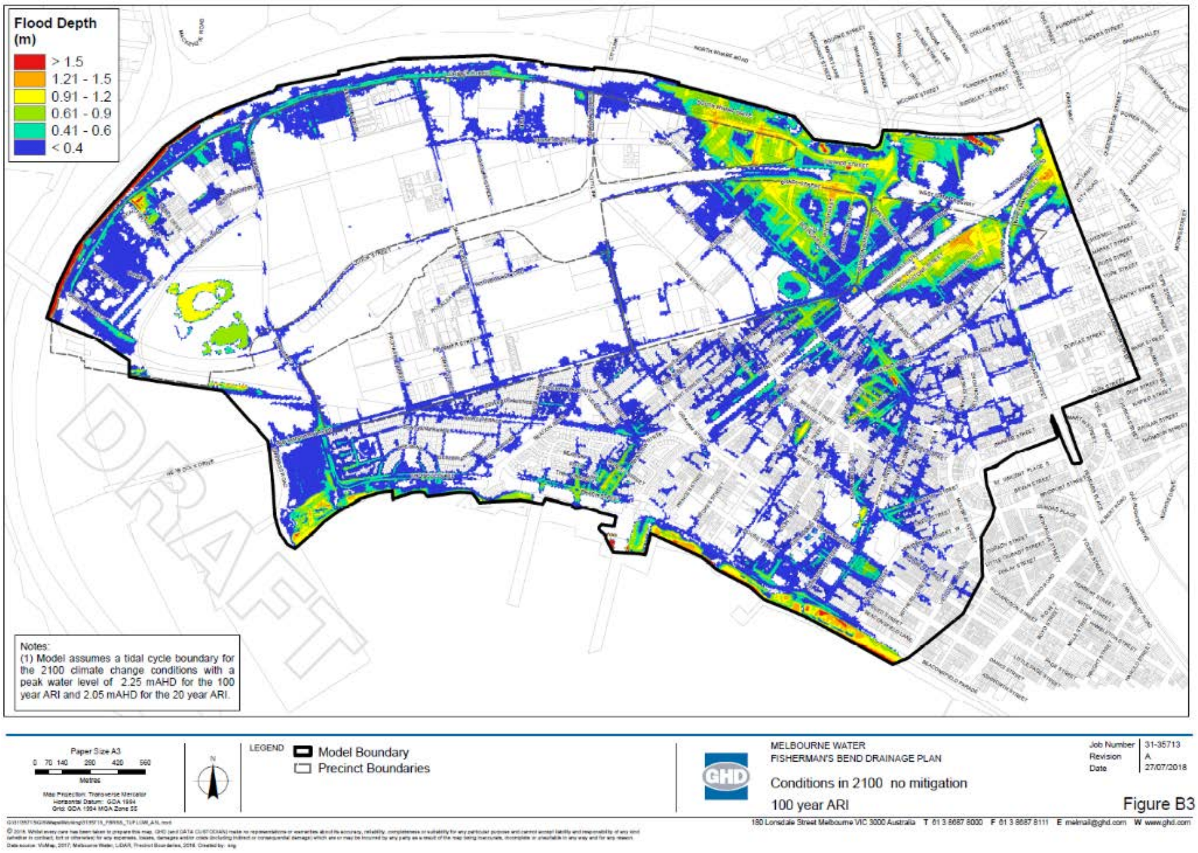
However, much of this is a direct result of tidal flooding, which can be alleviated with a levee (see next section below).

Figure 3 Future (2100) conditions flooding, 100 year ARI, no mitigation



5.3 Future (2100) flooding, with a levee as the only flood mitigation

The flood depth plot for conditions in 2100 (with the potential effects of climate change), with a levee as the only mitigation measure, for the 100 year ARI is shown in Figure 4 below.

This represents the impact of stormwater flooding, as the area is protected from tidal flooding by the levee. Noting that the tidal water level still influences the stormwater flooding, because the water level behind the levee is a constraint on the ability of the drainage system to free-drain under gravity.

This shows that even with the levee, there is still flooding that does not meet the level of service in many of the same areas.

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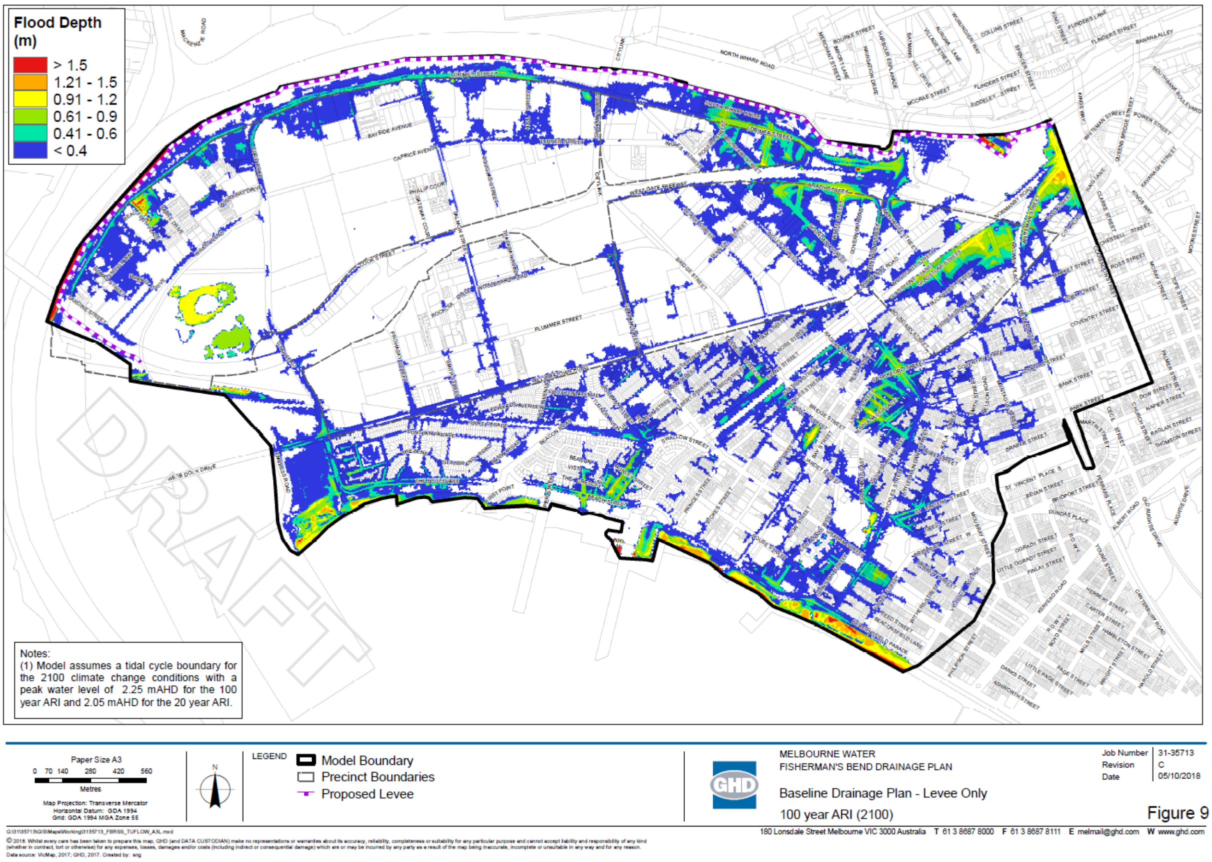
Figure 4 Future (2100) conditions flooding, 100 year ARI, with levee as only mitigation



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6 Past Studies

This section summarises the information on pump stations presented in past studies.

6.1 Integrated Water Management Strategy (GHD, 2015)

The IWM Strategy was the first detailed consideration of drainage and flood management for Fishermans Bend. Various scenarios considered different types of flood mitigation, including rainwater tanks, streetscape storage and unconventional ‘inverted’ roads (noting the latter unconventional solutions were not subsequently considered in the baseline drainage plan work, but were further explored in the Ramboll work).

In low lying areas that do not free drain (i.e. where the tail water conditions presented a significant impediment to drainage capacity), sump and pump infrastructure was used with non-return valves to eliminate back-watering.

The conventional flood management option including $7.1M for pumps, although this was less under other scenarios.

The study has two key limitations: it did not consider the impacts of climate change, and it did not include the employment precinct.

6.2 Baseline drainage plan options (GHD, 2017)

This work built upon the initial consideration of drainage and flood management in the IWM Strategy. In particular, this explored the difference in providing a 5 year or 20 year level of service (LOS), and for each of these, whether to provide a “base” or “higher” LOS. The 5 and 20 year LOS was considered for two scenarios:

1. Base LOS: Rainwater tanks, pipe capacity upgrades and raised roads for providing access and egress.
2. Higher LOS: Rainwater tanks, levees, pipe capacity upgrades <u>and pumping</u>.

Ultimately the higher level of service was adopted, which included levees and pumping rather than road raising. This included a total of fifteen pumping stations, located on the land within the Urban Renewal Area.

The peak pumping rates ranged between 0.26 – 6.40 m3/s.

The cost estimate for the pumping stations was $12.5M. It was assumed these would be owned and operated by the respective councils, with about 25% of the costs distributed to CoPP and 75% of the costs to CoM.

This identified that further work should be undertaken to update the costs of the drainage works to include an estimate of the operational and maintenance costs. This would provide a more complete picture, in particular the total cost of the pumping stations.

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6.3 Baseline Drainage Plan (GHD, 2018)

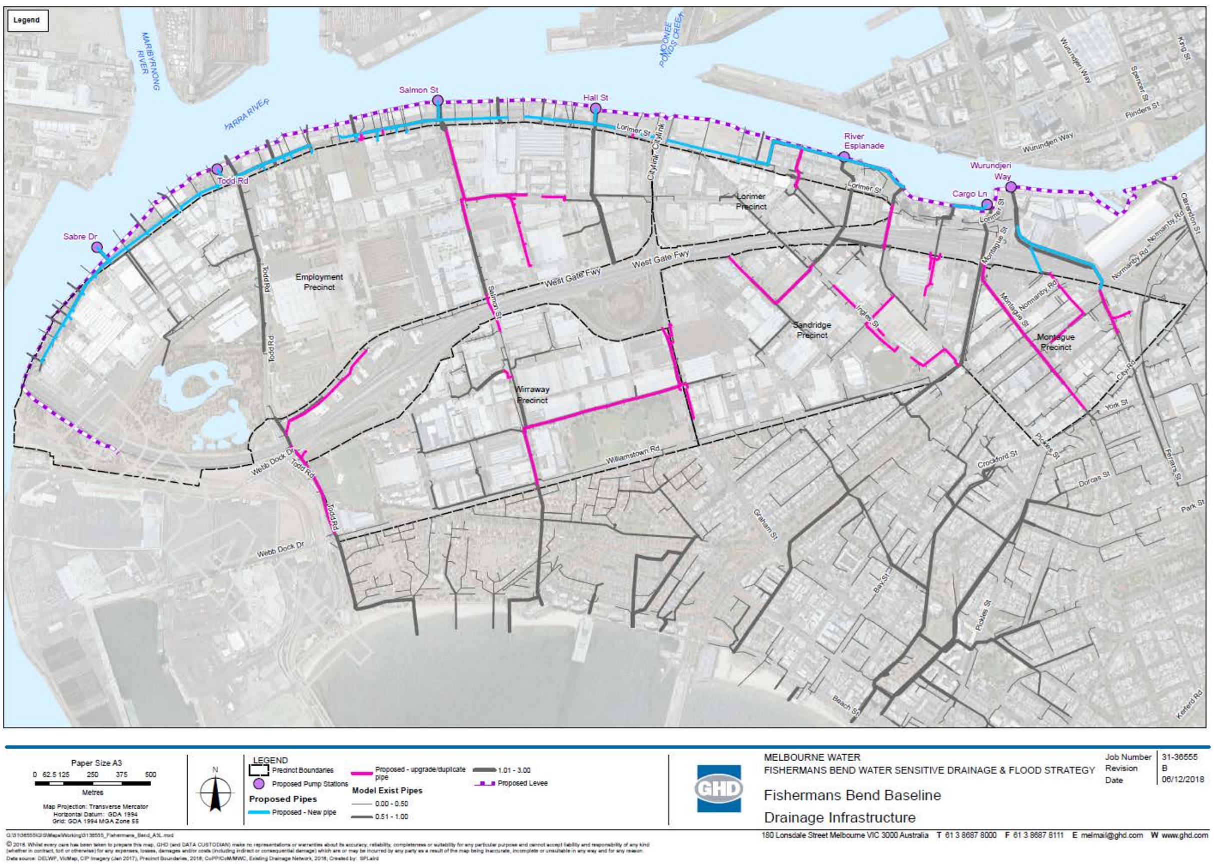
Pumping stations were identified as being required as part of the baseline drainage plan, in combination with the flood levee and pipe upgrades, to enable stormwater entering the Fishermans Bend underground drainage network to be pumped out to the Yarra River when tide levels are high, because high tide levels don't allow this to occur under gravity.

Flap gates would be required at the outlets of all stormwater pipe outlets to prevent tidal waters backwatering the underground drainage network in Fishermans Bend when tide levels are sufficiently high and flooding areas in Fishermans Bend.

6.3.1 Location

Seven pumping stations were identified (as shown in the Figure below). The pump station locations were identified based on hydraulic considerations only. No consideration was given to the exact location of the pumping station and the practicality or constructability of that location (including land ownership or availability). They were generally located at the outlet of the existing main drainage lines in close proximity to the proposed levee.

Figure 5 Baseline Drainage Infrastructure



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Note the number of pump stations was reduced (from the previous study) in an attempt to both reduce costs, and because of stakeholder preferences relating to maintenance and operation and other factors.

6.3.2 Capacity

The pumping stations were represented in the hydraulic model simply as discharge points where water was allowed to freely leave the model to prevent flooding from occurring. The peak flow rates at each pumping station from the model are presented in Table 1. This approach has not considered any optimisation of the pumping rate through potential additional storage at the pump station to reduce the peak pumping rate.

Table 1 Pump Station Capacities *(Source: Table 2, Baseline Drainage Plan, August 2018)*

Pump station location	Modelled peak pumping rate in the 100 year ARI event (m^3/s)
Sabre Drive	2.02
Todd Road	3.96
Salmon Street	4.33
Hall Street	3.06
River Esplanade	5.95
Cargo Lane	4.83
Wurrundjeri Way	2.66

*It is **important to note** that these peak pumping rates have been revised in more recent work because a different critical duration storm for sizing the pump stations has been adopted. This should be taken into account if comparing Table 1 and Table 2.*

6.3.3 Cost

The preliminary cost estimate for all pump stations was $4.59M.

Cost Basis

The cost estimate was generally in accordance with the approach and assumptions for the cost estimates undertaken by GHD for the Baseline Drainage Plan Options Report in 2017. It was based on available documented rates and relevant tender prices that GHD was aware of as follows:

- NSW Reference Rates Manual, NSW Office of Water, June 2014.
- Tender price for the stormwater pumping station at Flemington Racecourse.

Contingency

The preliminary pumping station cost estimates include a contingency of 30%.

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Uncertainty

There is significant uncertainty with these pump station cost estimates as they will depend on a number of factors that have not been determined at this stage including:

- Pump station configuration and amount of civil works needed.
- Actual site location and the cost of the land.
- Access to the site for construction.

Exclusions

In addition to the above uncertainty, the cost estimates make no allowance for the following:

- Land take costs.
- Operation and maintenance costs.
- Civil works

6.4 Integrated and Innovative Water Management (Ramboll, 2018)

Ramboll were commissioned by City of Port Phillip to explore at a high level alternative flood management techniques for Fishermans Bend. The proposed approach included levees, rainwater tanks and surface storages in streets and open spaces (referred to as blue laneways, green streets, cloudburst boulevards and cloudburst detention). The proposed strategy did not include any pumps, as it was assumed that stormwater could free drain.

6.5 Alternative Drainage Plan – Distributed Storages (GHD, 2018)

In parallel with the Baseline Drainage Plan (discussed above), GHD were commissioned by Melbourne Water to undertake a hydraulic assessment of the proposed concept for a "distributed storage approach" to the drainage plan for the Fishermans Bend Urban Renewal Area, as presented in the Ramboll report commissioned by City of Port Phillip (discussed above).

Importantly relating to pump stations, the report showed that the distributed storage approach does not provide the level of service required at Fishermans Bend. It found the main reason for why flooding would still occur in certain locations is because the stormwater discharged from the distributed storages would be unable to drain adequately under gravity to the River Yarra within the 24 hour period following the peak 20-yr ARI tide level (under conditions in 2100). While two low tides would occur in the 24 hour period following the peak tide level, only the second low tide would marginally fall below 1m AHD. At certain locations ground levels are less than 1m AHD, meaning the opportunity for stormwater to drain under gravity would be severely limited.

These results indicate that some form of pumping under conditions in 2100 (including the potential effects of climate change) will be required to assist with the discharge of stormwater from the distributed storages to the River Yarra.

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This showed the need for a hybrid approach, potentially including pump and/or pipe upgrades in conjunction with the distributed storage approach to provide the agreed level of service.

6.6 Melbourne Water Cost Estimates (2017-18)

Melbourne Water are understood to have separately prepared cost estimates for drainage infrastructure at Fishermans Bend, with inputs from KBR/John Holland and Major Projects Delivery at Melbourne Water. The information below in sections below should be reviewed and updated when this is available.

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7 Precedent Examples of Pump Stations from Other Locations

Information has been provided on some pump stations GHD has designed or been involved in the construction phase. This is simply intended to give stakeholders an understanding of the type and size of structures, pumps, land take and costs for low-lift high capacity stormwater pump stations.

7.1.1 Margaret Street Pump Station, Launceston

The Margaret Street Combined Sewer Pump Station in Launceston, Tasmania, was constructed for Launceston City Council in 1989 at a value of $5M **(~$10M today**), to significantly reduce lower catchment flooding particularly in the CBD. At the time, it was the largest stormwater pump station of its type in the Southern Hemisphere, capable of discharging **10 m^3/s** under flood conditions. GHD provided all feasibility, detailed design and construction phase services.

It is a stormwater pump station, but also pumped low (sewage) flows to the STP – as Launceston has a combined drainage system. It lifts stormwater over the levee during river high tides/flood periods, as the drainage system cannot gravity drain in these conditions (during high rain periods).

The well is a caisson about 18 m diameter and 10 m deep. There are 6 No. Flygt low lift/high flow pumps in Draft Tubes. The pump station is in a public park.

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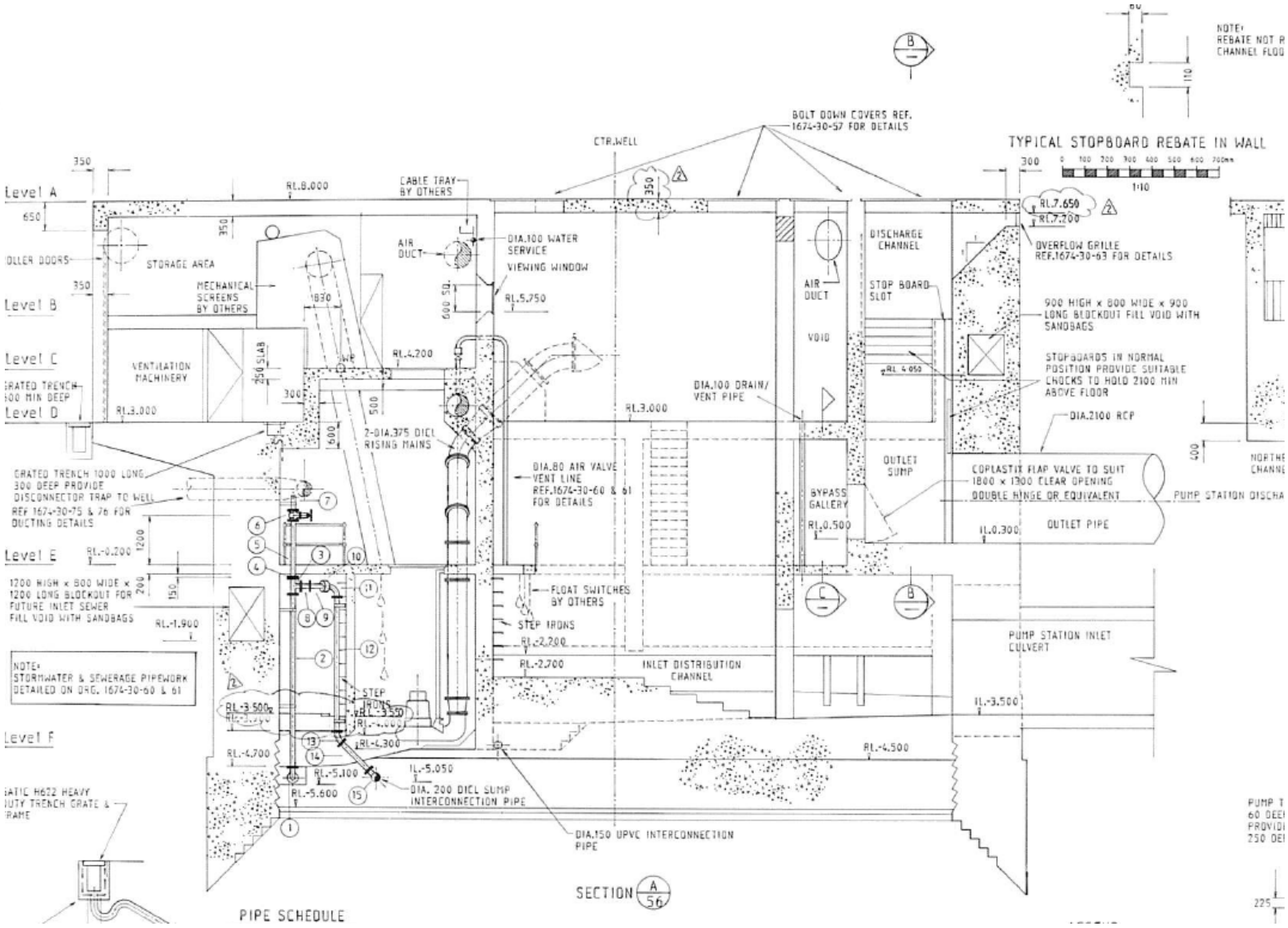

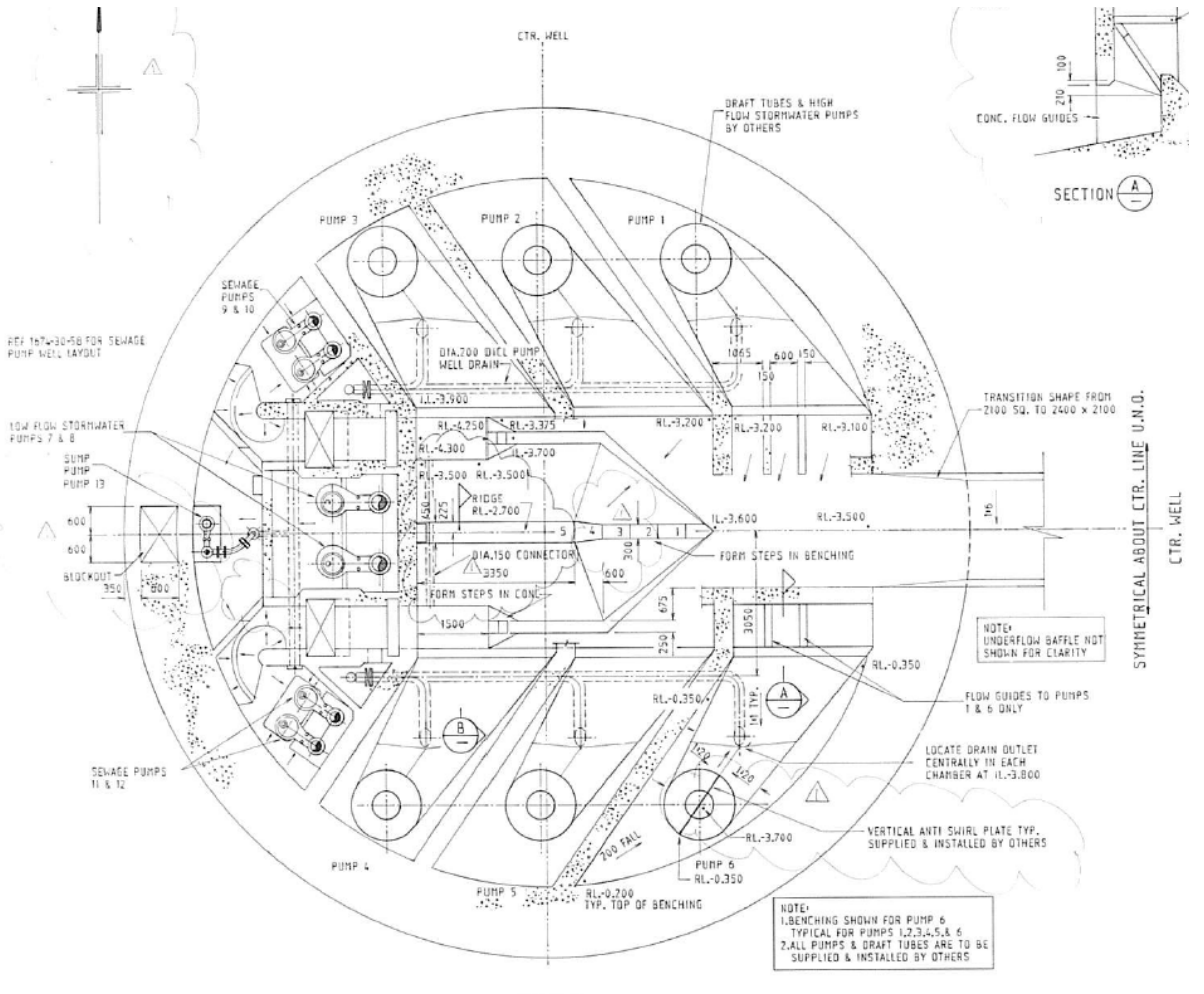

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7.1.2 Murray Valley no. 1 (Goulburn Murray Water)

This pump station includes a river offtake and two submersible pumps.

The capital cost was $0.88M in 2006 ($1.1M in today's dollars) for a 1 m^3/s PS.

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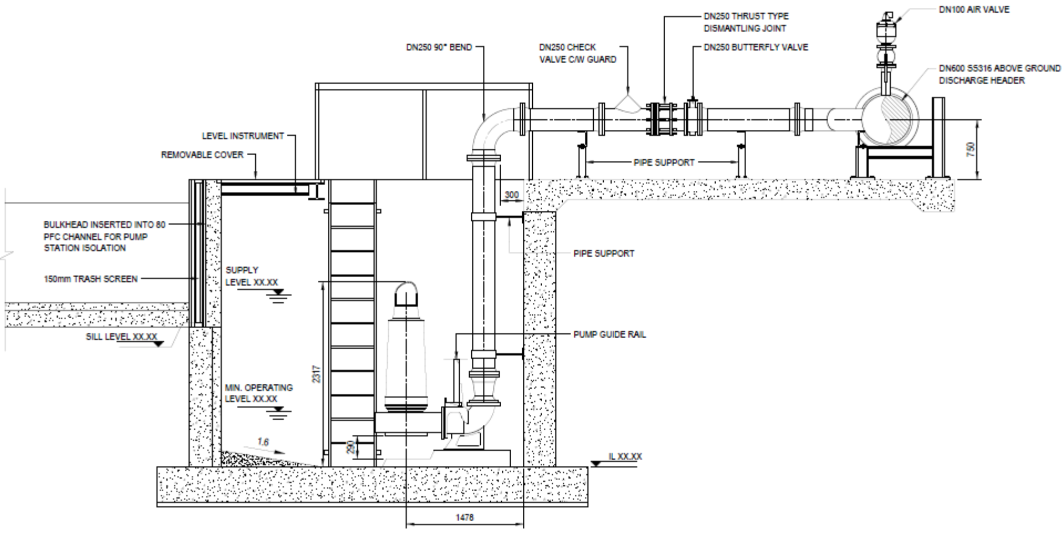
7.1.3 GMW Irigation Pumps

General arrangements for a 2 m³/s PS. Irrigation PS has multiple pump sizes because of the need to cover a full flow range so single pump sizes cannot cover low flow rates.



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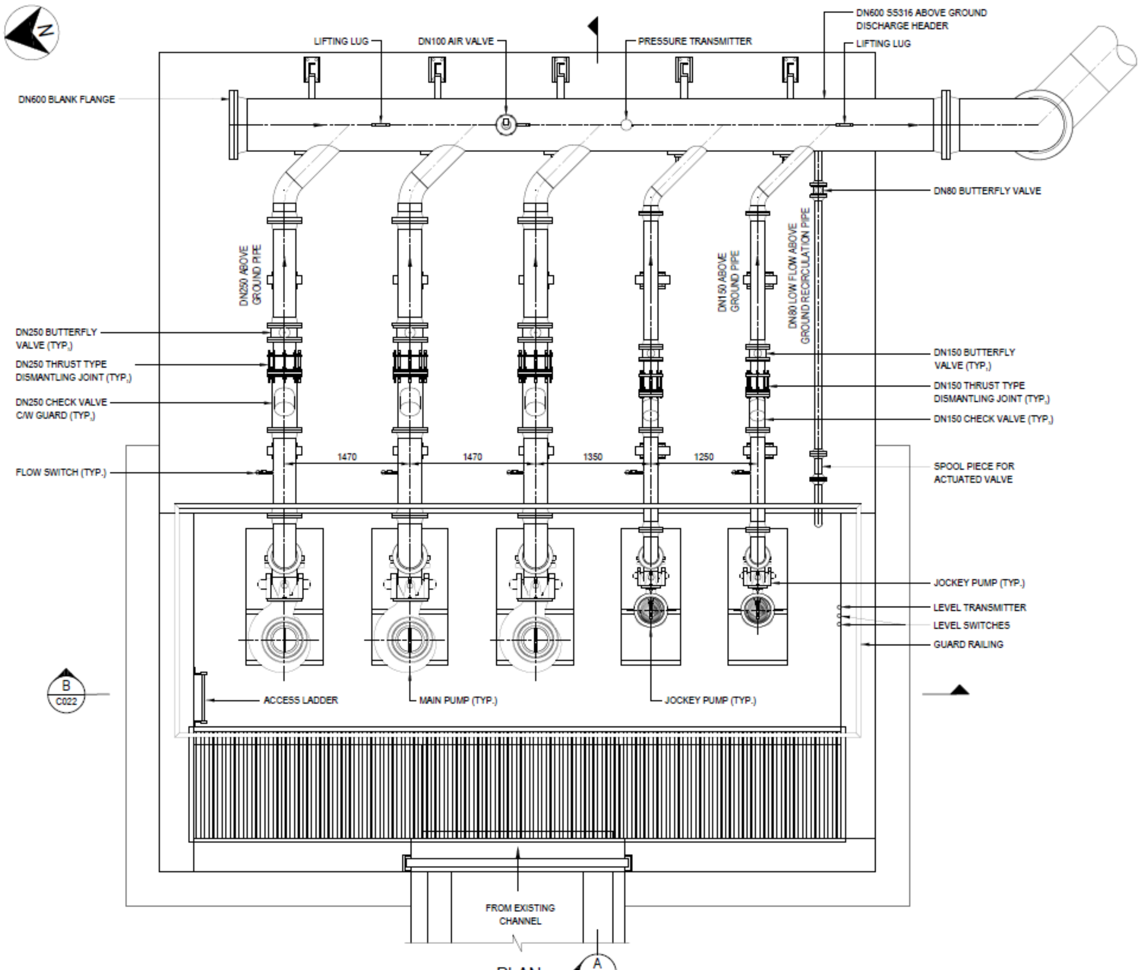

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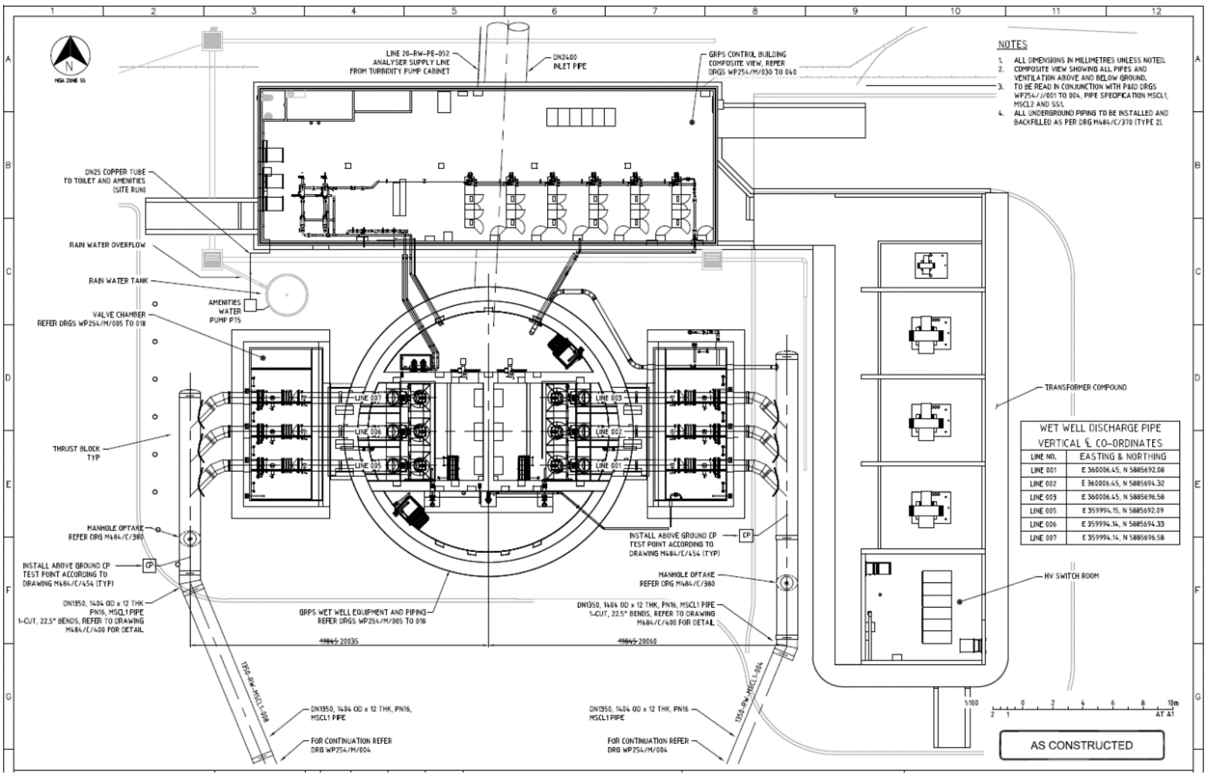
7.1.4 Sugarloaf Pipeline

Example of submersible PS footprint. Sugarloaf is very deep because of the minimum river water level. Capacity was for 4.2 m3/s, at an approximate cost of $8M.



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7.1.5 United Kingdom

GHD were involved in a large Storm water pumping station (SWPS) at Bransholme in Hull, UK. Our works were associated with the building structure over the SWPS.

The capacity of the PS is almost 23 m^3/s. The pumping station comprises 8 Archimedes screw pumps. Two lower capacity and six higher capacity.

4 The Development Proposal

4.1 Amount and Layout

4.1.1 Overview

The overall application site is approximately 0.75 hectares in size, with the proposed SWPS building (including underground structures) taking up around 0.2 hectares.

The proposed development includes a new pumping station building, including facilities for inspection and removal of pumps, electrical switchrooms and motor control rooms. Following completion and commissioning of the new SWPS, the existing pumping station would be decommissioned and removed and the area re-landscaped. A new 3m-high security fence is also to be provided.

Further detail is provided later in this section and in the Landscape Report and scale drawings that accompany this application.

4.1.2 The Pumping Station Building

The nature of this project is such that the overall scale and form of the building are dictated largely by technical constraints. Some key considerations are set out below.

Pump Selection and Operation

The first stage of design development involved setting out the fundamental technical criteria to deliver the most robust pumping solution. A series of larger pumps would be required for storm events, with two smaller pumps for normal flows. The overall capacity on the site station would be increased by over four times, from 5.4m^3/s to 22.9m^3/s. A range of alternative pumping options were considered. These are discussed in Section 3.1 of the Location Options Report that accompanies this application.

Archimedes Screw Pumps

Archimedes screw pumps emerged as the most reliable solution. They offer a range of advantages, including that they can be tested in dry weather, ensuring they are able to run when required. Figure 4.1 shows a schematic section through the pumping station. This indicates how the unique configuration of the archimedes screw pumps dictates, to a large extent the overall scale and form of the building. The large area of removable covers slopes up to a high-level superstructure which contains - safely above predicted flood levels - electrical equipment and essential lifting facilities for maintenance and removal of equipment.

With the pumps lined up side by side, the building would need to be over 40 metres long (see Figure 4.4) and in height, in the region of 15.5m above surrounding ground levels (with potential height reduction during detailed design - see Figure 4.7). Within the constraints of this basic technical solution, care has been taken to address, where possible, the form of the building and the way that it sits in its context. This is discussed further in section 4.2. Before this stage a key decision was to consider, given the basic form indicated in Figure 4.1, the most appropriate location for the building within the YWS site.

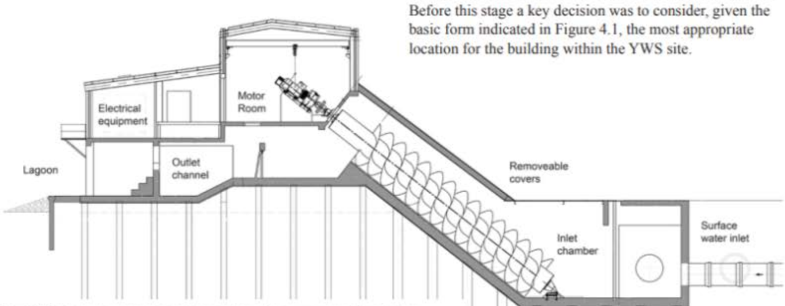

Figure 4.1: The basic engineering solution: archimedes screw pumps lift water from incoming surface water mains into an outlet channel that flows either to the river or to the lagoon. Motors and electrical equipment are housed at high level to protect from flooding. A lifting beam is provided over the pump motors for maintenance.

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7.1.7 New Zealand

GHD has undertaken a number of rural land drainage pump station inspections in New Zealand in recent years. Typically these were 1 - 1.2 m^3/s per pump x 2 - 4 pumps. Typically used axial flow pumps to lift 2 - 6m.

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8 Pump Station Footprints and Costs

This section provides an estimate of the footprint and costs for the pump stations, based on interpretation of the examples provided above and general engineering judgement.

8.1.1 Pump Station Footprints

Indicative footprint areas for pump stations including allowance for driveway access, parking and superstructure have been estimated.

Pump superstructure: **30 m^2 per 1 m^3/s PS capacity**

Access/parking: **40 m^2 per PS**

E.g. For a 1 m^3/s pump station the footprint would be 70 m^2.

E.g. For a 5 m^3/s pump station the footprint would be 190 m^2.

The sizes are based on existing stormwater pump stations in Kensington that discharge to Moonee Ponds Creek, however these are quite small for their size and are located within relatively tight drainage easements.

The pump stations at Fishermans Bend may be much larger, and in practice the actual size will depend on many factors, including:

- Arrangement, configuration and location of incoming pipe infrastructure and receiving waters.
- Total number of duty pumps, plus requirement for stand-by pumping.
- Requirement for inlet screens? Access to screens, automatic vs manual operation?
- Maintenance vehicle size and manoeuvrability, requirement for parking, turning circles vs driveway etc.
- Location of electrical switchgear and control assembly relative to flood levels, i.e. will the superstructure need to be double-storey, or single-storey and larger footprint?

8.1.2 Pump Station Costs

The pump station costs used in previous studies are likely to underestimate the actual costs. It is proposed that for the purposes of the current work, a generic rate of **$1M per 1 m^3/s capacity** is adopted (based on examples provided above).

Additionally, the cost for disposal of contaminated soil will need to be accounted for. The rate of \$340/m^3 will be adopted (based on Golder Associates advice to the Fishermans Bend Taskforce). As an example, the underground structure for a larger pump station could be ~300m^3. This could add a further $100k to the cost of a PS. For the purposes of the current work, this cost has not be separately allowed for.

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9 Water Sensitive Drainage and Flood Management Strategy

This section presents the latest thinking on the pump stations required at Fishermans Bend.

9.1 Capacity

Table 2 below presents the estimated capacity requirements for the pump stations. It shows pump station capacities will likely range from around 2-7 m^3/s.

Column 2 presents the pump capacities for the baseline drainage option. Note these are marginally higher than reported in the 2018 Baseline Drainage Plan, because they needed to be adjusted to reflect the required flow rates for the critical duration event for pump stations (1 hr duration) which was not specifically run for that the previous work (which had used a 6 hr duration event).

Column 3 presents the pump station capacities if implementing distributed storages rather than pipe upgrades within the catchment.

This shows that where distributed storages are implemented in a given catchment, it can reduce the size of the pump station (although not significantly).

Table 2 Pump Station Capacities

	Peak Flows (m3/s)	
Pump Name	Baseline Drainage *	Distributed Storage
Wurundjeri Way	3.7	2.9
Cargo Lane	5.5	4.9
River Esplanade	7.8	6.7
Hall Street	4.0	3.3
Salmon St	5.1	3.9
Todd Road	5.5	4.9
Sabre Drive	2.3	2.0
Average	**4.8**	**4.1**

** Note these are marginally higher than reported in the 2018 Baseline Drainage Plan. This is discussed above.*

An additional consideration is that, the pump stations at Wurundjeri Way and potentially also Cargo Lane are mitigating flooding that is being exacerbated/contributed to by flooding from the Hannah St Main Drain (outside of Fishermans Bend). If flooding from the Hannah St Main Drain was resolved outside of Fishermans Bend, this would impact the sizing of these pump stations.

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9.2 Land Take

Land take and site location requirements will need to be confirmed (noting the previous section presents an indicative footprint requirement).

Land purchase costs have not been considered in past work.

The practical implementation issues associated with land purchase have not been considered.

9.3 Costs

The costs estimates from the 2018 Baseline Plan have been reviewed and compared to cost estimates from other pump stations (including those presented above). The 2018 Baseline Plan costs are likely to be too underestimated, and so have been revised.

A rough estimate of $1M per 1m^3/s pump station capacity has been adopted as an interim cost estimate, until more detailed costings can be developed (or are provided by MW).

Note that land purchase may be an additional cost.

Table 3 Preliminary Pump Station Costs

	Cost ($M)		
Pump Name	**Baseline Drainage**	**Distributed Storage**	**WS Strategy**
Wurundjeri Way	3.7	2.9	**3.7**
Cargo Lane	5.5	4.9	**5.5**
River Esplanade *	7.8	6.7	**6.7**
Hall Street *	4.0	3.3	**3.3**
Salmon St *	5.1	3.9	**3.9**
Todd Road	5.5	4.9	**5.5**
Sabre Drive	2.3	2.0	**2.3**
Total	33.9	28.6	**30.9**

The table above highlights the pump stations capacities that would be needed for the current agreed water sensitive drainage and flood management strategy, as presented at the Drainage Sub-Committee Meeting on the 6th December 2018. The use of a distributed storages (hybrid) approach in certain sub-catchments (denoted by *) reduces the pump station capacities marginally, which will also marginally reduce the cost. **The total cost would $30.9M (includes a cost reduction of approximately $3M relative to the baseline).**

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9.4 Timing

Under existing conditions for the 1% AEP rainfall event, there are small areas of all the catchments draining North to the Yarra River that do not technically meeting the level of service criteria (see Figure 2 for an existing conditions flood plot). However:

- The flood extents, depths and durations are more extensive in the catchments for the following three proposed pump stations: Wurundjeri Way, Cargo Lane and River Esplanade.
- Flooding is less extensive for the following two sub-catchments in current conditions: Hall Street and Salmon St.
- There is only a small amount of flooding under existing conditions in the following two sub-catchments: Todd Road and Sabre Drive.

For 2100 conditions for the 1% AEP rainfall event pump stations will be needed in all catchments.

In terms of timing for implementation of the pump stations, it is not clear based on the current information (current and 2100 flood maps) when this should occur. In practice, the decision to implement the pump station may be triggered by either (1) sea levels (and therefore tailwater levels) rising to a point which increases the flood risk in the catchment to a level that is unacceptable, and (2) development in the catchment.

Further work to understand the flood depths and extents for interim time slices (e.g. 2040 and 2060) would be a first step to assist understand the staging better. Additionally, it may be necessary to consider flood risk (e.g. a flood risk assessment), and to explore with stakeholders what would trigger the implementation of a pump station considering the interaction of increasing flood risk and the timing of development.

Additionally, when the Lower Yarra Flood Modelling Study (GHD for Melbourne Water, current) is completed the timing of the Wurundjeri Way and Cargo Lane pump stations will need to be reassessed, as this may be driven by riverine flooding rather than tidal flooding.

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