OPTIMISING SEWERAGE PUMP STATION WET WELLS FOR CONTINGENCY STORAGE

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South East Water Ltd

62nd Annual Water Industry Engineers and Operators' Conference
Civic Centre - Wodonga
8 and 9 September, 1999

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ABSTRACT

This paper illustrates, through a worked example, how planners can work with operators to expand the options considered when confronted with a problem.

South East Water Limited (SEWL) had to increase the storage available at one of its sewerage pump stations to meet the minimum storage time required to get emergency response teams to rectify problems.

By involving operations staff, the number of options to provide contingency storage expanded from one to eight.

The initial option was to construct three concrete contingency tanks at a cost of approximately $470 000. After collaboration between planning and operators, an innovative solution combining conversion of existing wet and dry wells together with the utilisation of the available storage capacity at the upstream Pump Station was adopted at a total cost of $50 000. This example illustrates how rethinking problems can often produce more economic solutions.

KEY WORDS

Contingency Storage, Sewerage Pump Station, Peak Dry Weather Flows

1.0 INTRODUCTION

SEWL and the EPA have a Memorandum of Understanding (MOU) for administering the Environmental Protection Act 1970 in relation to SEWL's operations. A protocol under the MOU requires SEWL to consult with the EPA to reduce the possibility of sewage spills from sewerage pump stations as a result of pump, power or rising main failure. A means of satisfying the protocol is to ensure that all new sewerage pump stations have a minimum of two hours contingency storage under peak dry weather flow conditions.

SEWL has 192 sewerage pump stations and has embarked on a program of reviewing the available contingency storage at each pump station.

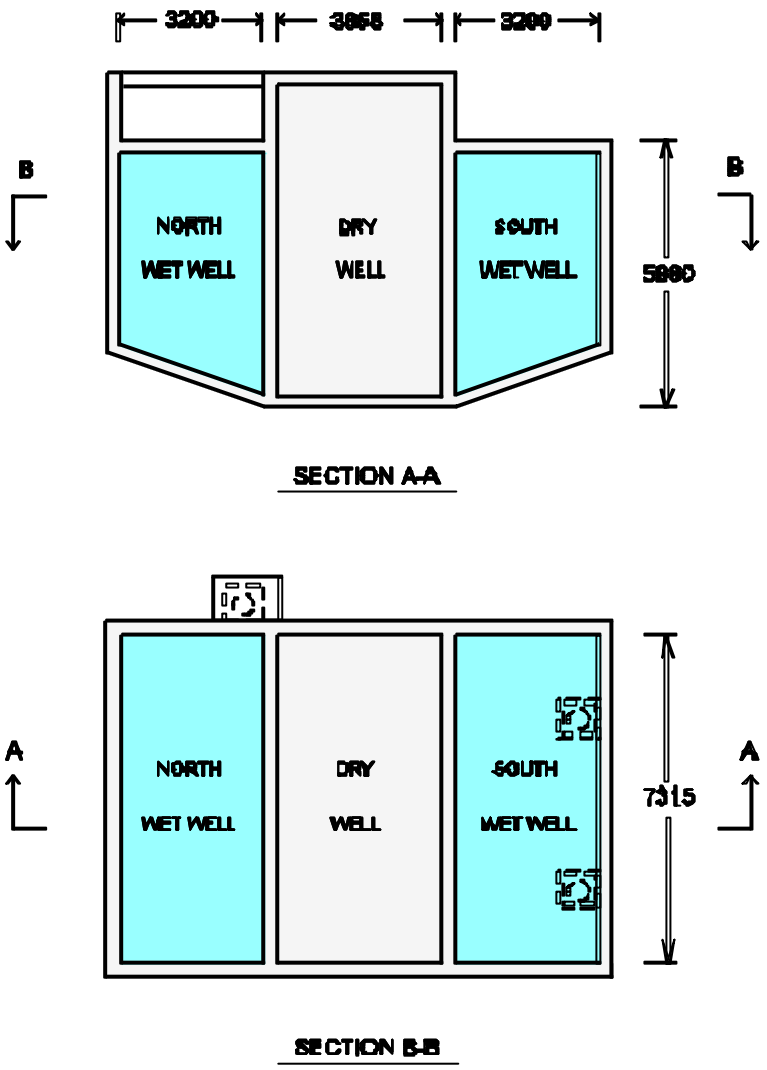
The Black Rock Pump Station is an example of an existing station where there is minimal storage capacity. It was found to have 36 minutes contingency storage under peak dry weather flow conditions. Black Rock Pump Station contingency treatment is the subject of this paper.

The Black Rock Pump Station Catchment is largely residential with some small commercial areas. There is one upstream pump station, the Beaumaris Pump Station, which pumps into a sewer that gravitates into the Black Rock Pump Station. The Beaumaris Pump Station has the required two hours contingency storage.

Both pump stations are connected to SEWL's telemetry system that is used for remote monitoring of the pumps to provide information on pump operation including alarms.

The Black Rock Pump Station was constructed with two wet wells and a dry well as shown in Figure 1. The pump station has two submersible pumps in a dry well installation.

Figure 1: ***Black Rock Pump Station - layout prior to contingency modification***



Note: Pipe work is omitted for clarity and all measurements are in millimetres

The Black Rock Sewerage Pump Station is situated in a sensitive area. The pump station Emergency Relief Structure (ERS) discharges into a stormwater drain, which discharges at Quiet Corner into Port Philip Bay 100 metres from the ERS. This is a particularly ecologically sensitive area, which includes a significant inshore reef habitat. The shallow waters attract a number of birds to the area, particularly wader birds. The area is proposed to be zoned as a marine park and sanctuary (Land Conservation Council 1996).

A spill from this pump station is to be avoided because in addition to the cost of cleaning, the impact on the environment and the resulting impact on the organisation's reputation would be damaging.

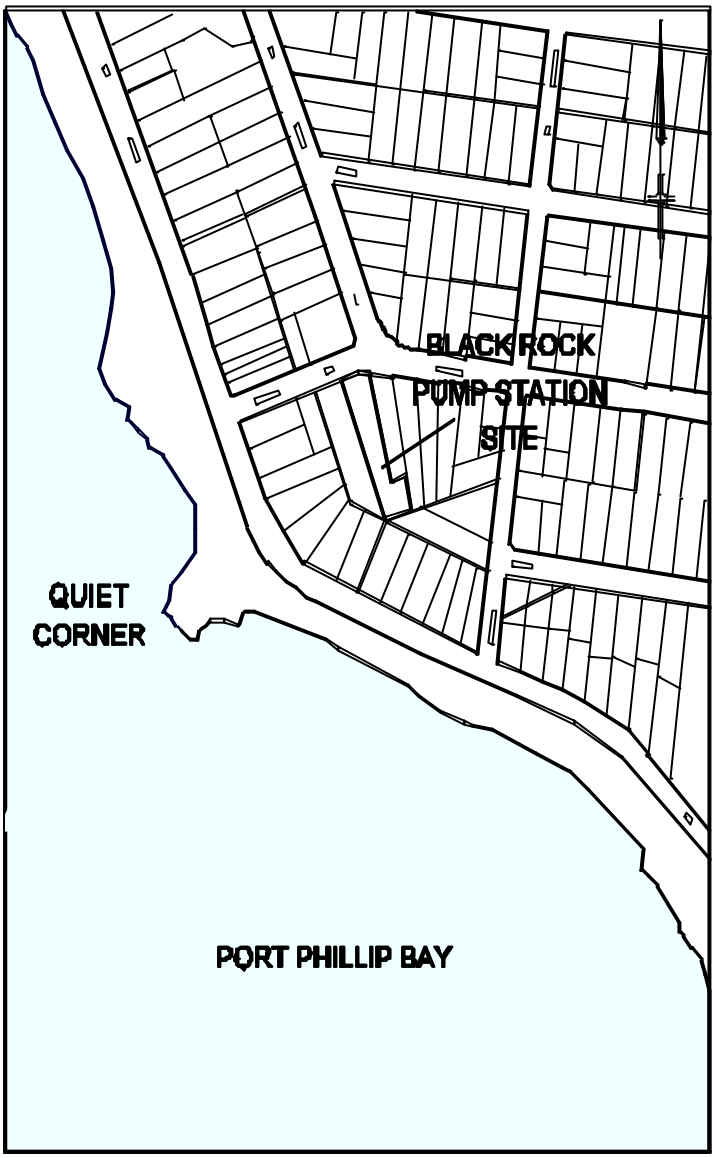
The contingency storage volume required was determined by calculating the volume of storage in the pump station wet wells, the incoming sewers and sewer access chambers (manholes) between the high level alarm in the pump station and the spill level at the ERS.

The peak dry weather flow was determined from telemetry pump station data and confirmed by field tests during peak hours. The required volume to store two hours of peak dry weather flow was calculated. The difference between the available storage and the capacity necessary to detain two hours of peak dry weather flow was 236 m^3.

2.0 DISCUSSION

The initial option was to construct three concrete contingency tanks at a cost of $470 000. The Black Rock Sewerage Pump Station is situated in a residential area with houses adjacent and behind (refer to Figure 2). For ease of construction and to limit disturbance to adjacent properties, it was decided that the 236 m^3 contingency storage would be best provided by three separate tanks.

Figure 2: ***Location of the Black Rock Pump Station***



As a result of the high cost, planners and operators collaborated to produce seven more options to provide the required contingency storage.

Each option was considered using the following assumptions:

- The PDWF flows for both pump stations were derived by averaging the flows over the peak two hours (Flows were derived from telemetry data)
- The peak dry weather flows were assumed to occur concurrently at Black Rock and Beaumaris Pump Station
- The contingency storage for both pump stations were calculated above the High Level Alarm

The options eventually considered included:

Option 1: ***(Original Solution) Construct contingency storage tanks***

Construction of three contingency storage tanks to contain the necessary storage at Black Rock to detain two hours of Peak Dry Weather Flow (236m^3). The capacity is to be provided by three tanks due to site restrictions.

Option 2: ***Utilise the existing storage of the upstream pump station***

Reduce the necessary storage at Black Rock to detain two hours of Peak Dry Weather Flow by remotely stopping the pumps at Beaumaris Pump Station on the receipt of a high level alarm at Black Rock Pump Station. This option requires the telemetry system to be set up in such a way that the pumps in the Beaumaris Pump Station will automatically stop for 75 minutes on receipt of a high level alarm occurring at Black Rock. The Beaumaris Pump Station system has the necessary capacity to store the incoming PDWF in its own catchment for two hours. The Beaumaris Pump Station is stopped for only 75 minutes because the travel time of the flow from the Beaumaris Pump Station to the Black Rock Pump Station is approximately one hour. This will provide additional contingency storage in the order of 50 m^3 reducing the volume of the contingency tank required to approximately 170 m^3.

Option 3: ***Raise the ERS***

The spill level in the ERS adjacent to Black Rock Pump Station could be raised from 4.20m AHD to 5.28m AHD. This extra 1.08m yields an additional storage of 77 m^3. The effect of raising the spill level on property connections was checked. It was determined that by raising the spill level by this amount, in the event of operation of an ERS, two properties would be flooded. To prevent this, reflux valves could be installed in SEWL's sewer adjacent to these properties. A manhole should be installed to house the reflux valves to allow access for maintenance. It may also be desirable to install a manually operable valve, in case the reflux valve fails. This will provide additional contingency storage in the order of 80 m^3 reducing the volume of the contingency tank required to approximately 150 m^3.

Option 4: ***Convert the dry well and one wet well at Black Rock to a contingency tank***

The Black Rock Pump Station has two wet wells and a separate dry well as shown in Figure 1. Conversion of the dry well and the northern wet well to act as a contingency tank yields an additional 173 m^3 of contingency storage. It would involve replacing the pumps with submersible pumps and installing them in the southern wet well.

The southern wet well has sufficient volume to have less than 15 pump starts per hour as recommended by pump manufacturers. A modification to the walls between the wet well and the contingency wells would be required to enable them to fill at a designated level.

The construction of a sump and re-coating of the walls to prevent leakage may also be required. This will provide additional contingency storage in the order of 170 m^3 reducing the volume of the contingency tank required to approximately 50 m^3.

Option 5: (Options 2 & 3 combined) ***Raise the ERS and Utilise the Storage of the Upstream Pump Station:***

This option requires the telemetry system to be set up in such a way that the pumps in the Beaumaris Pump Station will automatically stop for 75 minutes on receipt of a high level alarm occurring at Black Rock, and the ERS spill level adjacent to the Black Rock Pump Station be raised by 1.08 m.

Raising the spill level requires that reflux valves be installed in the sewers near low-lying properties.

Option 6: (Options 3 & 4 combined) ***Raise the ERS and convert the dry well and one wet well at Black Rock to a contingency tank***

This option involves raising the ERS spill level adjacent to the Black Rock Pump Station by 1.08 m and converting the dry well and the northern wet well at Black Rock to act as a contingency tank. The necessary works involved are described in options 3 and 4.

Option 7: (Options 2 & 4 combined) ***Utilise the existing storage of the upstream pump station and convert the dry well and one wet well at Black Rock to a contingency tank***

This option involves the telemetry system to be configured in such a way that the pumps in the Beaumaris Pump Station will automatically stop for 75 minutes on receipt of a high level alarm occurring at Black Rock, and the use of the dry and northern wet well at Black Rock Pump Station as a contingency storage. This option yields two hours storage. The necessary works involved are described in options 2 and 4.

Option 8: ***Options 2, 3, and 4 combined***

This option involves the telemetry system to be set up in such a way that the pumps in the Beaumaris Pump Station will automatically stop for 75 minutes on receipt of a high level alarm occurring at Black Rock. The use of the dry well and the northern wet well at Black Rock Pump Station as a contingency storage tank and raising the ERS, are also involved in this option. The necessary works involved are described in options 2, 3 and 4.

2.1 Assessment

Upper and lower bound solutions were calculated for each option when reviewing the necessary contingency storage required at Black Rock to make allowance for uncertainty of the pump capacities and the interpretation of PDWF from the pump station data (Table 1).

Table 1: ***Results of investigations***

Option	Additional Storage Provided by option(m^3)		Total Additional Storage Still Required (m^3)		Estimated Cost ($)
	Upper Bound	Lower Bound	Lower Bound	Upper Bound	(Upper Bound)
1	236	174	0	0	470,000
2	54	61	149	182	330,500
3	77	77	133	159	285,950
4	173	173	37	63	246,500
5	131	138	72	105	203,450
6	279	279	-69	-43	68,700
7	227	234	-24	9	50,000

8	333	340	-130	-97	31,700

The preferred option was determined as a result of collaboration between all relevant areas of the organisation: System Planning, Asset Creation, Wastewater Operations and Mechanical and Electrical Services.

Option 1, construction of the three contingency tanks was rejected on the basis of the high cost. It was decided that raising the spill level of the ERS was adding to the risk of a spill occurring in low-lying houses. The risk was considered too great for this option to be adopted as a contingency option. For this reason Options 3,5,6 and 8 were rejected. Of the remaining options, Options 2, 4 and 7, Option 7 had the least cost and was therefore the preferred option.

Option 7 is an extension of options 2 and 4 which involves the use of one of the wet wells as well as the dry well of the Black Rock Pump Station as a contingency storage. In addition Option 7 requires the telemetry system to be set up in such a way that the pumps in the Beaumaris Pump Station will automatically stop for 75 minutes on receipt of a high level alarm occurring at Black Rock. The Beaumaris Pump Station system has the necessary capacity to store the incoming PDWF in its own catchment for two hours. This preferred option provides two hours storage above the High Level Alarm under PDWF at the Black Rock Pump Station and has the lowest estimated cost of $50 000.

3.0 CONCLUSION

The example provided has shown that there are a number of ways of optimising the contingency storage. These include:

- Remotely controlling upstream pump stations
- Raising ERS levels
- Making use of existing wet and dry well storage.

Close cooperation between planners and operators from the onset can lead innovative low cost solutions.

4.0 REFERENCES

Land Conservation Council (1996). Marine and Coastal Special Investigation Draft Final Recommendations, Land Conservation Council, Victoria.