Alternate Water Supply Scheme Using Superficial Aquifer Interception Drain – Port Coogee Development

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Relevance of the Alternate Water Supply Scheme to Stormwater Harvesting

• The term stormwater includes both surface runoff and groundwater intercepted by drains
  (Towards a water sensitive city, DoW 2010)

• Interception of shallow groundwater and infiltrated stormwater in the superficial aquifer is therefore considered stormwater harvesting.

• Project is relevant to contemporary focus on water efficiency in planning new urban developments.
Port Coogee Development

• Port Coogee Residential and Marina Estate is located within the City of Cockburn approximately 5 km south of Fremantle.

• Proposed estate was assessed by the EPA in 2002 and MRS amendment endorsed by the State Government in 2005.
Background

- Investigations during the Environmental Impact Assessment identified elevated groundwater nutrient concentrations associated with historical market gardens and formerly unsewered residential areas east of development site.

- Migration of groundwater nutrients (particularly N) to a marina and the potential to impact marina water quality and possibly stimulate algal growth was identified as a key issue.

- Source has been removed
Environmental Drivers

- Excess nitrogen and the resulting growth of light-inhibiting algae has been largely blamed for the substantial decline in seagrasses in Cockburn Sound since the 1960s.

- Studies during the project’s initial planning stage indicated that nitrogen rich groundwater significantly contributed to the phytoplankton blooms in the northern harbour of Jervoise Bay during the summer of 97/98, some 4km south of Port Coogee.

- The studies confirmed the need to reduce the groundwater flow and associated inflow of nutrients to any proposed marina in this area.

- Groundwater flow modelling and hydrodynamic modelling of marina concluded that a 90% reduction in flow of groundwater / nutrients to the marina was required.
Solution – Conceptual Design

• Install a sub-surface permeable cut-off drain to intercept groundwater flowing into the marina.

• Position this Groundwater Interception Drain immediately inland of the marina waterbody and abstract sufficient volumes of groundwater so as to lower the local water table and thereby reduce the hydraulic gradient between the source and the receptor. Thus reducing groundwater flow to the marina.

• Groundwater flow model calculated that 0.22 – 0.25 m of drawdown was required to achieve 90% reduction of flow to marina.

• Required abstraction rate to achieve the prescribed drawdown is 7,400 m$^3$/day, or 86 L/s.
Key Objectives of GID Design

• Facilitates a significant reduction of nutrient loads to marina waters and the Owen Anchorage.

• The abstracted intercepted stormwater provides a sustainable non-potable water supply to reduce potable water requirements for the development.

• Supply all POS and streetscape irrigation water requirements.
Key Challenges

- Abstraction rate (7,400 m$^3$/d) far exceeds Irrigation and AWSS demands – excess abstracted water needed to be re-injected.

- Water quality considerations including pre-existing contaminant plumes in GID capture zone – extensive water quality monitoring required.

- Detailed contaminated sites investigation.

- Detailed design of a groundwater abstraction system that allowed the lowering of the water table without upconing the saline wedge in the local aquifer but still achieved the environmental objectives.
Key Challenges (cont.)

• Detailed Engineering Design of an unprecedented system that:
  ➢ has multiple functions.
  ➢ needs to accommodate variability.
  ➢ includes expensive infrastructure.

• Staging of construction and significant dewatering
Water Quality Monitoring

- Extensive monitoring of both on-site and regional GW quality.

- Regular and frequent sampling to monitor water quality for heavy metals, hydrocarbons, pesticides and nutrients.

- Monthly sampling of drain and storage tank water quality.

- Quarterly sampling of approx. 20 monitor bores including 6 located in re-injection borefield.
A good example of an urban development project incorporating water efficiency design at the development-wide scale.

Approvals required included:

- An exemption from a ‘Water Services Operating Licence’ by DoW
- The GID system was approved by DoW, DEC and DoH and approved by the Minister for the Environment through the Environmental Review process.
- DoH approved the AWSS subject to a number of conditions
- DoW granted a 5C licence to abstract and re-inject the superficial groundwater.
Groundwater Interception Drain (GID)

Re-Injection Pipeline

Re-Injection Bores

Pumping Stations & Saline Intrusion Detectors

Storage Tank
Construction Materials

- Minimise cost through use of typical materials.
- Ease of maintenance through use of materials common to industry pipe laying training.
- Testing and QA procedures are common with potable water standards.
- The system was constructed on opposite sides of roads and lots to the potable system to minimise risk of cross connection.
Construction Standards

• Lack of available standards for water re-use infrastructure as few schemes constructed.

• Based construction on Water Corp potable standards as common for WA.

• Extraction pump stations mimicked automatic unattended sewer pump stations.

• Delivery pump sets mimicked booster pump stations.

• Education of residents regarding appropriate non-potable use and signage was to be part of the purchasers information package.
GID Construction

- Constructed before bulk earthworks - trenches up to 9m deep
- Trench was stable without shoring even with high inflows.
- Water inflow varied from approx 20 L/s to 290 L/s
- Pump stations had greater difficulty as they were 2m deeper.
Dewatering

- Dewatering in limestone – 290 L/s
- Preferential flow paths
Construction Challenges & Dewatering

- Soil structure was layered
- Disposal of water to a temporary dam
- Site for disposal limited by other activities
- Constructed as part of bulk earthworks to allow for relocation of main services
- When constructed provided bountiful water for dust suppression and compaction
Groundwater Interception Drain

- 900 m long running north-south located approx. 100 m inland from the original shoreline.

- 375mm reinforced concrete pipe with open joints.

- Surrounded with crushed rock filter material and wrapped in geotextile material.

- Flat graded between RL -1.0 and RL -2.0 mAHD.

- The GID has two abstraction pump stations.
Storage Tank

- Limited in height by groundwater level and public open space to go on top
- Semi circular reinforced concrete – 8,500 m³ capacity
- In situ base & walls. Pre-cast top.
- Timing was important to finish Stage 1 – constructed under separate contract
Pumping Infrastructure

- 2 pumping stations along GID
- 2 pumps at each station – alternating operation to allow maintenance
- Pumps rated at 43L/s for total continuous abstraction of 86L/s

- 2 separate pumping systems for POS Irrigations and Third Pipe Scheme
- High flow/regular interval for POS
- Low flow/irregular demand for supply to residential lots
System Operation / Network Design

- All fault messages relayed to external control site by wireless technology.
- Operators to be trained in understanding fault messages and what is required to correct.
- Data gathered for annual reporting against water use licence.
- Meant to function in perpetuity so operation manuals need to be clear and controlled.
- Manager to have annual service contracts to respond to faults or maintenance.
- Prevention of cross connection with potable supply.
Governance

• Alternate Water Supply Scheme required an operator in perpetuity.

• The AWSS was granted an exemption from the requirement to hold a ‘Water Services Operating Licence’.

• Studies were undertaken and it was agreed with the City of Cockburn that Port Catherine Developments Pty Ltd would manage and maintain the marina, the GID and AWSS for a set period prior to handover to the City of Cockburn.

• City entered into a facilitation agreement with PCD to manage these component in perpetuity with details to be developed progressively.
Conclusions

• The system provide a net benefit to the Cockburn Sound and Owen Anchorage

• The system intercepted infiltrated stormwater from the development in the superficial aquifer without upconing of the saline wedge or creating a drawdown which impacted ecological receptors or other users.

• Environmental Driver for the development of this system of stormwater harvesting separate to water conservation driver.

• The development of this infrastructure provided a large quantity of water to use as a sustainable water supply source for irrigation.

• Reducing the demand for potable water supply across an 850 lot development. Creating Brighter Futures.

• You would not construct this type of system without an environmental driver.
Questions ??