Wat. Sci. Tech. Vol.17, Amsterdam, pp.1465-1467. 0273-1223/85 $0.00 + .50

INVESTIGATION, DESIGN AND CONSTRUCTION OF SUBMARINE OCEAN OUTFALL PIPELINE OFF NINETY MILE BEACH, GIPPSLAND, VICTORIA, AUSTRALIA

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INTRODUCTION

Saline water, a byproduct of power generation boiler and stack precipitator ash transport systems, is collected from power stations in the Latrobe Valley Victoria and stored in a central pond. Due to its salinity and the presence of Selenium, a heavy metal, the saline water cannot be discharged from the pond to the adjacent river system and is therefore pumped a distance of 52 km to the Ninety Mile Beach and thence discharged to the ocean waters of Bass Strait through a submarine pipeline fitted with a multi-port diffuser.

PROJECT DETAILS

Flow	o 35 ML day $^{-1}$ (max), 15 ML day $^{-1}$ (min)
Product Characteristics	o T.D.S. - Range 6 000 - 25 000 mgL^{-1} o Sodium - Range 1 800 - 7 000 mgL^{-1} o Sulphate - Range 2 900 - 25 000 mgL^{-1} o Selenium - Range 200 - 300 μgL^{-1}
Pipeline	o Diameter - 610 mm o Length - 500 m o Material - Mild steel, 10 mm thick wall, concrete weight coat 50 mm thick
Diffuser	o 28 No. 60 mm diameter ports at 2 m centres o Total water depth 8 m o Initial dilution 70:1

INVESTIGATIONS

Studies carried out over a period of 12 months included measurement of current speed and direction at the discharge point by means of fixed current meters deployed as shown in Figure 1. Data recovery of 85% was considered particularly satisfactory and indicated currents were significantly influenced by tides.

"Daily cruises" at intervals of one month over the 12 month period were utilised to obtain temperature, salinity, dissolved oxygen and instantaneous current measurements at discrete depths in the water column at the discharge point and during which drift cards, drogues and sea bed drifters were released. The fixed current meters were serviced during each daily cruise.

Geotechnical and hydrographic investigations included bathymetry and seismic sub-bottom profile surveys complemented by side scan sonar surveys which were useful in locating reef structures and ripple effect of wave action on the seabed sediments. Sub-seabed strata was physically proved by jet probing to a maximum depth of 6 metres.

Biological surveys included the collection, examination and identification of infauna and and epi-biota and an assessment of the discharge effects on this marine life.

STEEL TOWER AND TAUT WIRE CURRENT METER MOORINGS

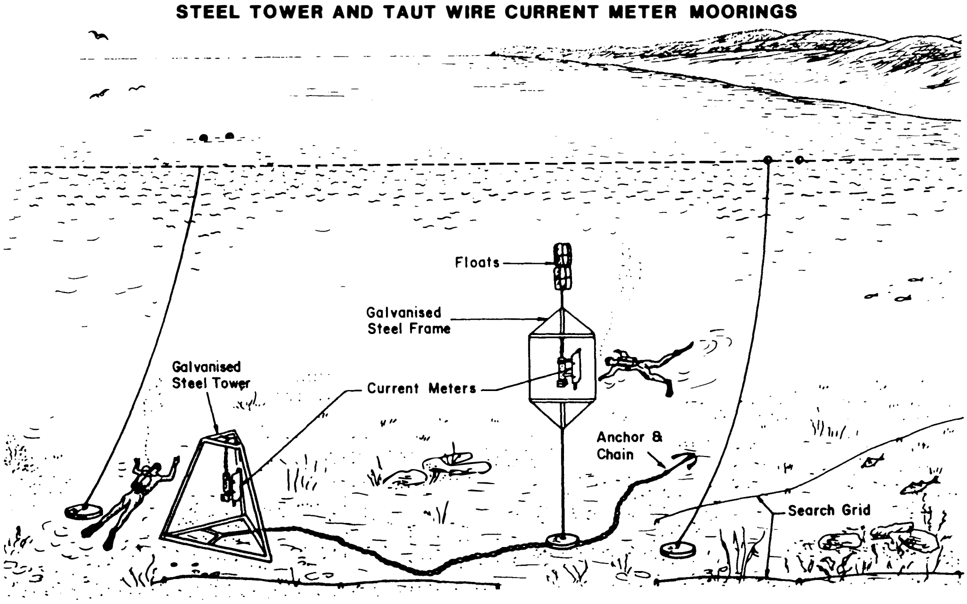

FIGURE 1

DESIGN

Apart from ensuring the structural stability of the submarine pipeline entrenched up to 6 m in the seabed the main design effort on this project centred on the diffuser configuration necessary to ensure the minimum dilution required is achieved under all conditions of the water body.

The required initial dilution is achieved by correctly selecting the discharge port diameter to ensure that each port flows full over the range of flows, that the port velocity is limited to minimise head losses in the system and that the variation in port flow is within certain limits.

A number of unusual design aspects were incorporated in this submarine pipeline.

- The diffuser is located on a limestone reef and has been embedded in concrete. To take up possible differential settlement between the diffuser and the more flexible submarine pipeline, three flexible joints at 20 m centres have been incorporated in the pipeline, inshore from the diffuser.

- o Diffuser port risers are above the seabed and thus subject to fouling by ships anchors and fishing nets. The bolts connecting the port riser to the remainder of the port pipework have been designed to fail at loads greater than 35 kN as it was considered desirable to replace a port rather than risk more substantial damage to the diffuser or pipeline.

- o To prevent ingress of sediments and seawater to the diffuser during periods of low flow, check valves incorporating a rubber duckbill diaphragm have been incorporated in each diffuser port.

Figure 2 illustrates the detail of the diffuser and port arrangements.

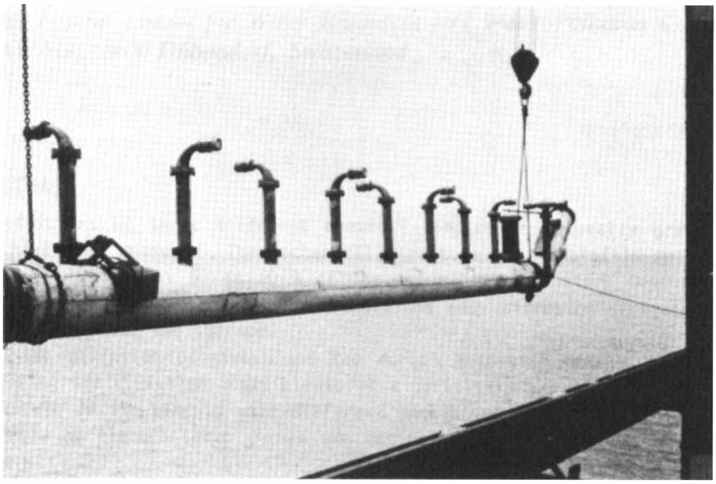

FIGURE 2

CONSTRUCTION

Due to the adverse construction conditions with breaking waves up to 6 m being a common occurrence a temporary steel piled jetty fitted with crane rails and a timber access roadway was constructed for the full length of the proposed pipeline.

From the jetty steel sheet piles were driven on both sides of the pipeline to form coffer sections some 60 m long. The seabed material was then excavated between the piling by means of an air lift pump. 20 m lengths of 610 mm Mild steel pipeline with flanged ends were factory produced and weight coated on site with 50 mm thick concrete. Internal pipe protection was with 0.40 mm solventless epoxy.

Each 20 m length of piping was lowered from the jetty into the previously excavated trench and jointed underwater by divers. After laying and pressure testing the trench was backfilled to 1 m above the pipe with 100 mm diameter crushed rock, the steel sheet piles were then withdrawn and re-driven for the next length of pipeline. The natural processes of wave and current action completed the backfilling operation.

The 54 m long diffuser was assembled on shore in 3 sections and lowered into place from the jetty prior to concrete encasement.

With this method of construction downtime due to sea conditions was kept to a minimum and construction was completed in 18 months at a cost of AUD$4.7 million.