

OptiFacts



Optimatics

Water Systems Optimization

www.optimatics.com

Darling-Anabranh Pipeline

Single main trunk optimization

UNTIL the Anabranh project, sceptics of genetic algorithm (GA) optimization felt that the use of GAs was only for highly networked and complex systems. However, achieving such impressive results on just a single main pipeline demonstrated that GA optimization can be applied almost anywhere for benefit.

KEY POINTS

- Multiple service criteria
- Water Environment Award
- 18% capital cost saving
- 36.4% reduction in the use of PVC
- 26.6% reduction in total energy and greenhouse gas emissions

Background

Located in western NSW, the Darling-Anabranh Project is one of the most significant infrastructure projects to provide water savings in the Murray-Darling Basin. With over 300km of piping, the scheme supplies agricultural and domestic water to properties along the Darling-Anabranh. The Anabranh previously had water demands met through a 50GL/yr replenishment flow. Supply of flow via 17 weir pools resulted in a loss of some 47 GL/yr and the degradation of a natural ecosystem. The pipeline will enable efficient water delivery and the Anabranh can be returned to pre-regulation condition.

Optimatics' Role

Optimatics was engaged by the NSW Department of Commerce to undertake a review of their preliminary design. The intention of the review was to provide them with any potential cost savings as well as data to allow them to make further design decisions about their system.

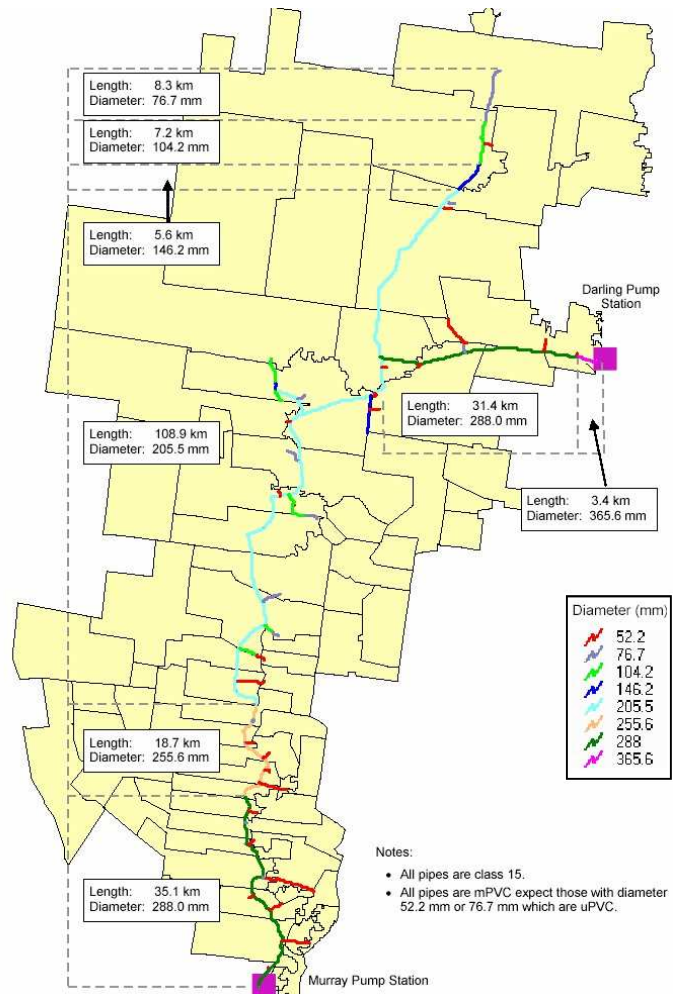
Although the pipeline is a very simple network visually, a number of critical design conditions provided a level of complexity suiting optimization.

These included:

- Balance of water entering the system from two sources on the Murray and Darling Rivers, 170 km apart;
- Balancing capital costs of infrastructure and operating

costs from pumping;

- System performance under Emergency Conditions; and
- Determining the most cost-effective pipe materials and sizes.



Darling-Anabranh Water Distribution System

The GA process was used to quickly produce alternate solutions by altering design variables such as different demand locations, pump station locations, pressure criteria and material selections. The different solutions produced by the Optimatics Genetic Algorithm (OGA) allowed both clients, the NSW Department of Natural Resources and Darling-Anabranche Water Trust, to see the full impact the different options that were being considered had on expense and system performance.

As the study progressed the clients were able to make an educated decision of their preferred design standards and constraints.

The Optimatics solutions provided the Anabranche Trust with an 18% capital cost saving on the preliminary design.

Award winning design

As a further achievement for this project, Vinindex and Optimatics worked together to collaborate on a truly innovative optimization project.

Instead of optimizing the cost of a scheme, the power of the genetic algorithm was used to minimize the total energy input into the pipeline thus minimizing the greenhouse footprint of the project.

Outline of project

It has been recognized that sustainability is an important consideration for engineering projects. A number of measures, other than cost, need to be considered as criteria to meet the aims of sustainability. In this study, the sustainability measures included the mass of material and total energy used, and the production of greenhouse gases.

The original design for the Anabranche system was identified using genetic algorithm optimization and had the objective of minimizing the present value of capital and operating costs. Subsequently, an alternative design was produced that minimized the total mass of PVC used. The pumps operated at lower pressures in the alternative design with class 12.5 PVC-O



Anabranche during a dry period



Future Murray River pump site

pipes utilized as compared to class 15 PVC-M pipes in the original design.

The alternative design is associated with a 36.4% reduction in the use of PVC material and a 26.6% reduction in total energy and greenhouse gas emissions. It also has a present value cost that is lower than that for the original design and as such demonstrates it is better on both economic and sustainability grounds.

Quantity	Original design	Alternative design	Percentage savings associated with the alternative design
Pipe Capital Cost (dollars)	1,284,342	1,181,758	8.0%
Pump Capital Cost (dollars)	311,340	311,340	0.0%
PV of Pumping Costs (dollars)	126,571	94,295	25.5%
PV of Total Costs (dollars)	1,722,253	1,587,393	7.8%
Mass of Pipe Material (kg)	2,863,400	1,821,560	36.4%
Embodied Energy of Pipes (GJ)	219,135	158,879	27.5%
Pumping energy over 40 years (GJ)	163,440	121,766	25.5%
Total energy (GJ)	382,575	280,645	26.6%
Total greenhouse gas emissions over 40 years (tonnes)	102,148	74,932	26.6%

Reduction of indicative cost, mass of material and energy used, and greenhouse gas emissions for each design