Water Corporation

Kimberley Pipeline Project

Sustainability Review

Report

September 2004

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Executive Summary

For many decades there have been investigations into the demand and supply options available to meet the future demand for water in the Perth region. Several recent studies on the future of water supply options for the Perth region have been undertaken. One proposal which has been the subject of these studies is the development of a pipeline to supply the Perth region with fresh water from the Kimberley.

This report has involved reviewing those studies and evaluating the impact of the Kimberley pipeline concept from a sustainability perspective. This review has incorporated assessing the environmental, social and economic issues associated with the pipeline.

The conclusions from this review are:

- Although technically feasible, the project is highly complex with significant uncertainties related to aboriginal heritage and environmental approvals.
- The project would consume significant energy (3 times per kL more than desalination) and create significant greenhouse gas emissions (4.5 times per kL more than desalination).
- The project would create significant ecological impacts particularly relating to the Fitzroy River.
- At a revised estimated cost of not less than $6.10 / kL, the project remains economically unviable in comparison with other contemporary sources (eg desalination). The cost escalation mainly relates to recent increases in steel prices.

Under the Water Corporation's "security through diversity" approach, the project at the present time should retain a low ranking in comparison with other source projects, including desalination.

However the Kimberley pipeline proposal is technically feasible, and should remain one of a number of future source options, and subject to ongoing review.

1. Introduction

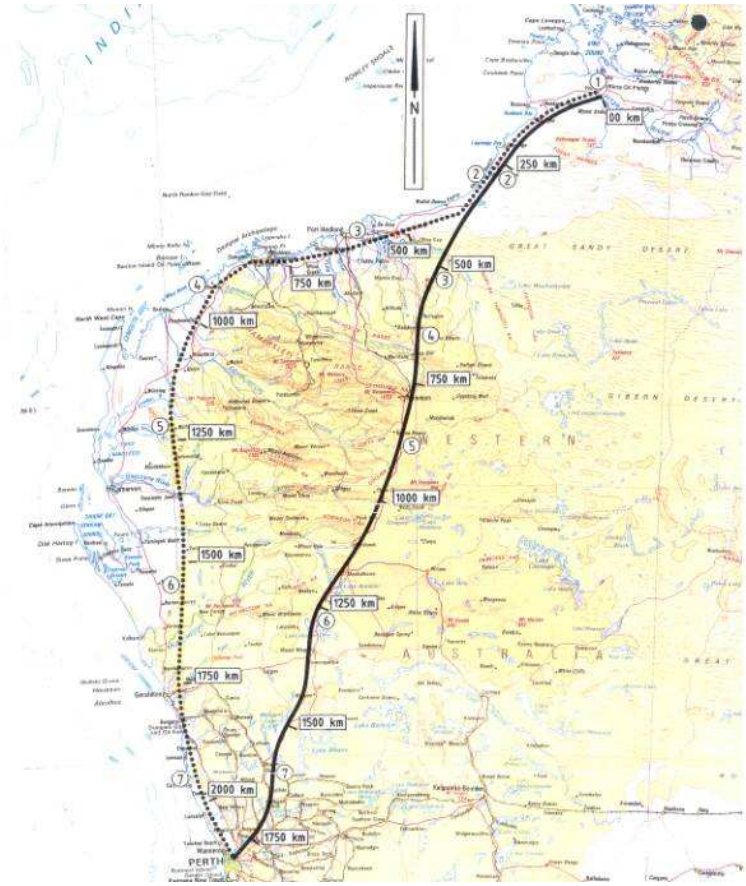
1.1 Background

The concept of a water pipeline from the Kimberley Region in northwestern Australia to supply fresh water to Perth has been considered for some time now. Current source plans are based on a population for Perth of 3 million by 2050 (increasing the current water demand from 300 gigalitres to 570 gigalitres a year).

Additional water supplies will need to be provided to Perth and the surrounding regions if this level of usage growth is to be provided. A number of alternate water sources have been considered. The attraction of water from the Fitzroy River is that apparently very large and generally dependable supplies of high quality water are available for use. There are many challenges in terms of utilising this resource for the Perth consumer, particularly in relation to environmental, social and economic impacts associated with the construction and operation of the pipeline from Kimberley to Perth.

1.2 The Kimberley Pipeline Concept

The provision of water from the Kimberleys to Perth consumers would see construction of a major dam on the Fitzroy River to provide a controlled release down the river to an offtake inland from Derby and then pump the water to Perth along the inland route, essentially via Newman and Meekatharra.



In 1988, Binnie & Partners[1] presented a comprehensive report to the Kimberley Regional Development Advisory Committee examining issues surrounding the proposal. In 1990, the Infrastructure Development Corporation (IDC)[2] was commissioned to undertake a preliminary feasibility study of the concept including a review of previous work. The Water Corporation and its predecessor organisations has considered the project on several occasions, most recently as part of an independent review of feasibility studies, conducted by GHD in 2002[3]. Others have also evaluated the Kimberley water pipeline concept in some detail.

The IDC study evaluated several alternatives for delivery of the proposal including supply options from either the Ord or Fitzroy and conveyencing options such as high pressure pipelines, standard pressure pipelines and by open channel. The most favored option was found to comprise three, long distance (around 1800 km), large diameter (1400 mm) pipelines, seven high-capacity, gas powered pumping stations and a very large dam on the Fitzroy river at Dimond Gorge with a downstream barrage constructed to provide a suitable water supply off take point.

The preferred option for the pipeline, as confirmed through all studies, was established primarily on the basis of water supply cost and included the following features:

- A 50-year project life from commencement of construction in 2000 to the full water supply capability in 2051;
- An infrastructure development timeframe would be staged over this period, with the major expenditure occurring over the first 30-years;
- Three primary stages of infrastructure development with each stage involving construction of an 1840km, high pressure (to 700 metres), fully welded pipeline of 1400mm diameter. Pipelines would be brought into operation in years 2006, 2019 and 2032;
- A maximum flow rate for each of the three staged pipelines of 100GL per year to give a total supply capacity of 300GL per year at full production in 2051, and;
- Seven high-pressure pumping stations constructed at intervals over the full 50-year project lifecycle.

GHD's independent review (2002) concluded that whilst the project was technically feasible, the cost of the project remained high in comparison to other alternatives (specifically desalination) and the potential impact of greenhouse gas emissions needed to be taken into account. This review included a description of the IDC concept engineering design, and this overview is included as Appendix A of this report.

1.3 Pipeline Capacity

The cost of providing water from the Kimberleys is directly related to the quantity provided which must balance the demand for the water. It is understood that the current forecast of extra water demand remains at near 300GL per year by 2050.

Therefore for the purpose of this review, the water demand as studied remains nominally the same at 300GL by 2050.

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[1] Binnie & Partners, Water From the Kimberleys, 1988

[2] Infrastructure Development Corporation, Development of a Water Pipeline: Kimberleys to Perth, 1990

[3] GHD, Development of a Water Supply Pipeline from Kimberleys to Perth, 2002

2. Pipeline Technologies

The GHD report (2002) considered pipeline technology developments since 1990 that might effect the conclusions of the IDC report. The issues covered were:

- Pipe jointing
- The use of plastic or concrete pipes in lieu of steel
- High strength steel pipelines

2.1 Pipe Jointing

The 2002 conclusion that there have been no major pipeline technology changes since 1990 that will have a substantial influence on the technologies adopted for the 1990 reports remains valid, specifically:

- High-pressure large diameter rubber ring jointed ductile iron pipes have been utilized elsewhere in the world. However this technology would not offer any savings in the Western Australia application due to the requirement to construct local casting factories.
- As the proposed Kimberley pipeline has a design pressure up to 700 metres at the booster pump stations, only about one third of the pipeline could be considered for rubber ring jointing and therefore utilisation of this technology will not reduce the overall cost of the pipeline significantly.

2.2 Plastic Pipes

Again the conclusions of the 2002 study remain valid:

- Utilisation of plastic pipes have been proposed as an idea for remote pipelines on the basis that the pipe material can be transported in a compact form as pellets, and moveable factories used to extrude the pipeline.
- Although this may be technically feasible, we are not aware that this method has been used on any large scale or shown to be price competitive.
- In order to utilise plastic pipes, the working pressure of the pipeline would have to be dropped by an order of magnitude and this would require numerous extra booster pump stations along the pipeline route.
- Although plastic pipe technology may be shown to be appropriate for the replacement of open irrigation channels it is not appropriate, nor would it offer any saving, for a pipeline from the Kimberleys to Perth.

2.3 Concrete Pipes

The view taken in the 2002 review, which remains valid, was that reinforced concrete pressure pipes are not considered appropriate for the Kimberley pipeline due to the high pressures involved.

2.4 High Strength Steel Pipelines

The IDC 1990 report proposed the use of X80 and X52 steel and therefore the forecast savings of using higher strength steel are already built into the 1990 estimates.

3. Social Impacts

The development of a pipeline from the Kimberleys to Perth is likely to raise a number of social issues, which could impact on a range of stakeholders. In many cases, the impacts relating to these issues are likely to be manageable. The issues that are likely to create the most significant impacts will be those relating to Aboriginal heritage and native title.

3.1 Aboriginal heritage

Aboriginal heritage issues relating to the location of infrastructure are potentially numerous. These issues are politically sensitive and may prove a major stumbling block.

Although the pipeline route is not fixed, there is the potential that a number of aboriginal sites (areas of significance), communities and native title claims could be impacted in various positions along the pipeline route. These are predominantly in the Wheatbelt, mid west, Pilbara and Kimberley regions and many of those sites are in undisturbed areas.

A number of watercourses along the pipeline route, which are of significant importance to aboriginal culture, could be impacted. In the Kimberley and Pilbara, there are regions where aboriginal sites are quite numerous. Sites of significance often coincide with water and therefore are likely to be factors at Dimond Gorge and the Fitzroy.

The pipeline route could be in the vicinity of a number of properties listed on the State Register of Heritage Places and the Australian Heritage database. There is also a Heritage trail in Cue that could be impacted by the pipeline route. These non-indigenous heritage impacts, including areas of significance and heritage properties are likely to be more easily managed.

3.2 Development along pipeline

The IDC study involved an economic impact review that indirectly considered the social benefits of the pipeline route. The IDC report concluded that there appears to be no significant potential for economic activity or development resulting from the Kimberley-Perth water pipeline. On the question of benefits obtained en-route, the IDC concluded that:

> *A pipeline system designed primarily to deliver an end terminal has variable capacity for intermediate off take depending on a number of factors relating to capacity and demand. Therefore, to supply a significant intermediate load, sustainable over the life of the project would necessarily entail a commensurate increase in capital and operating costs. At best this would have no benefit in terms of unit cost to Perth consumers (IDC 1990, p.3)*

The project would not be able to satisfy large-scale water requirements of communities along the pipeline without substantial additions to the infrastructure costs, and therefore increased impacts such as greenhouse emissions and ecological impact to the Fitzroy River.

3.3 Other social issues

The pipeline route could impact land access throughout the construction phase. However, long-term community severance should be minimal as a result of the underground pipeline. Pipeline access easements may be required for a number of properties along the pipeline route. Landowners most likely

to be affected by land access issues will be those with smaller landholdings, which are generally those closer to Perth (in the Wheatbelt region). Agriculture could continue over the buried pipeline following the initial construction impact.

The project would generate significant volumes of both heavy and light vehicular traffic with the potential to impact the local road network. The majority of traffic would be generated as a result of construction employees, equipment and materials moving to and from various sites. Other service infrastructure could potentially be impacted by construction activities and would need to be carefully managed.

Outside the metropolitan area, the main land uses that may be impacted are agricultural, pastoral and mining. The pipeline should not create any land accessibility issues that could potentially impact on livelihoods (as it will be underground). If there are any impacts they will more likely affect farmers requiring multiple routes of access to properties for grazing cattle and broad acre farming. In those cases, the landowners most likely to be affected will be those with smaller landholdings (rather than large pastoralists), which are generally those closer to Perth (in the Wheatbelt region).

It is possible that the pipeline route could impact some buildings. Land easement acquisition and compensation for loss of land may be required in some cases to mitigate above impacts.

It is likely that the social impacts relating to land access, community severance, impacts to properties and livelihoods, and transport networks will be relevant in the short term only. The majority of these issues are able to be mitigated through planning and good management and are unlikely to be of significant impact.

Other land use issues that would need to be considered in greater detail would include the effect that the pipeline route could potentially have on mining leases and ore bodies in the North. The pipeline route could also potentially impact on a National Park in the north of the State, and some threatened ecological communities in the Wheat belt. These issues would need to be further investigated to determine actual impact.

3.4 Water Quality

The only public health impacts that are likely to be considered an issue would be related to water quality and specifically the use of epoxy resin as a pipeline lining. The issue of contact of potable water with the epoxy lining for extended periods of time requires further investigation. Other issues relating to water quality impacts would be mitigated through treatment processes.

4. Environmental Impacts

The most significant impacts relating to the Kimberley pipeline relate to:

- greenhouse emissions
- the environmental flow of the Fitzroy River, and
- the environmental impacts of constructing a large dam at Dimond Gorge.

Although there are numerous other environmental issues, in most cases they are not likely to be significant in terms of impact. For example issues such as impacts to biodiversity and landform should be effectively mitigated through construction and environmental management plans.

4.1 Greenhouse emissions

The greenhouse emissions from the Kimberley pipeline are likely to be very significant in terms of impact. The main greenhouse emissions would arise from; operational energy consumption, construction materials (including highly intensive energy requirements of steel production) and the transportation of materials over long distances for construction purposes.

The pumping energy consumed is a very significant contributor to greenhouse gas emissions, estimated at 14 kWh/kL. By way of comparison, the operational energy consumption of the pipeline has been estimated to be three times higher than required for seawater desalination (which are approximately 5 kWh/kL)[4]. Assuming that pumping energy is all derived from power generated from a natural gas supply, the pipeline would produce 4.5 times more greenhouse emissions per kL than a desalination plant (powered by combined cycle gas from Kwinana Power Station). When fully operational, the pipeline would produce greenhouse emissions of around 2.5 m T CO_2-e (which is equivalent to the emissions of 320,000 households).

In addition to operational energy, it has been estimated that the energy embodied in the steel pipeline alone would be approximately equivalent to 8 years of operating emissions.

Greenhouse emissions can be mitigated through (for example) carbon sequestration. However in order to sequester this magnitude of emissions, somewhere between 70,000 and 250,000 ha of actively growing forests would be required (depending on species and environmental factors such as rainfall and soils).

The IDC report considered and rejected solar energy as uneconomical, and this assessment remains valid at this stage. However technology developments in both solar and fuel cell technology are gaining pace and may in the future be economical in comparison with natural gas for this project.

4.2 Fitzroy River and Dam Issues

The health of river ecosystems depends on the protection and good management of appropriate water flow regimes, water quality, physical habitat, streamside vegetation and animal life. The Fitzroy is currently unregulated and as such does not have a set environmental flow. The environmental flow requirements in the Fitzroy would need to be established in order to determine the ecological impact.

[4] Metropolitan Desalination Proposal, Section 46 Review, view at http://www.watercorporation.com.au/Docs/Desal_S46.pdf

There are likely to be significant environmental impacts of a large dam on the Fitzroy River, including threats to the habitats of local endemic species.

In addition, a dam in the vicinity would have substantial effects on aboriginal heritage sites and could potentially impact on native title in the area.

4.3 Other environmental issues

The GHD review (2002) raised the issue of providing a balancing storage for water at the Perth end of the pipeline. Accordingly a balancing storage volume of about one third of the average flow is required to attenuate the peaks in demand. This would require storage of about 100GL. If new storage is required to meet such demand, finding a suitable (and available) storage location could potentially create some environmental and social impacts.

The majority of biodiversity impacts, apart from those affected by the environmental flow of the Fitzroy are likely to be mitigated through environmental management plans, construction management and rehabilitation work.

Threatened ecological communities that may be impacted are most likely in the Wheatbelt. The impact on Bush Forever sites is unlikely, but possible around the vicinity of the Perth metropolitan area

The environmental impacts of below ground pipeline construction result directly from soil disturbance or loss of vegetation and habitat. Construction requires the clearing of vegetation from an easement of approximately 30 metres. There are some impacts that could arise from the process of clearing land for construction. The movement of people and vehicles could promote the spread of undesirable plant species along the pipeline easement. Soil and vegetation disturbance associated with construction can assist the establishment of these species.

Removing native vegetation under current legislation requires a clearing permit. The entire pipeline route will necessitate applying for this. A weed management plan will be required prior to commencing construction and rehabilitation of disturbed areas will be required post construction. The main impacts to vegetation are likely through the Wheatbelt. Rangeland impacts to the north of the Wheatbelt, north of Mt Magnet are likely to be fewer.

There may be potential impacts to wetlands, mainly rivers, throughout the proposed pipeline route. It would be necessary to ensure that construction doesn't impact their hydrogeological function. A number of waterways could potentially be crossed by the pipeline and this would result in erosion, sedimentation etc. The possibility of introduction of species to waterways should also be considered an issue.

The pipeline route could potentially intersect with contaminated sites. This is only likely around human habitats and these are few along the pipeline route.

The pipeline route is not likely to impact any site of world heritage significance, including conservation / wilderness sites. One national park south of Newman (Collier Range) could however potentially be affected by the pipeline route.

Other environmental impacts, associated with landform, waste from construction, noise and air quality are likely to be mitigated through careful management and construction plans.

5. Financial and Economic Impacts

The costs relating to the development and operation of a pipeline from the Kimberleys to Perth are likely to be significant.

5.1 Infrastructure Costs

The GHD review (2002) found that an estimated cost of the project infrastructure was likely to be in the range of $9.53 - $12.39 billion and proposed the figure of $10 billion as a minimum “allowing optimistic engineering solutions”. This review also reported that escalation of the IDC estimate using construction cost indices would yield a cost of $11.66 billion in 2002 dollars.

Steel prices in particular have risen steeply in the last year or so and pipeline materials costs are estimated to have increased by 20% since the GHD report in 2002. As the pipe supply component of the project was estimated by IDC at 28.4% of the total capital costs, this escalation alone would add around $570m to the project cost estimate. Pipeline construction costs (31% of project capital costs) can be conservatively estimated to have escalated by 5%[5] in the last 2 years alone ($155m). Taking all of the above into account a revised “optimistic” estimate of the project costs is $11 billion in 2004 dollars.

Reducing project infrastructure costs through new pipeline technology (the use of plastic pipes) was considered as part of the 1990 feasibility study. It was found that plastic pipes would not be price competitive mainly due to the fact that the working pressure of the pipeline would have to be dropped by an order of magnitude, necessitating numerous extra booster pump stations along the pipeline route. As noted in 3.2 above, this finding remains valid. However, technology improvements in future should be monitored to identify innovations that would change this assessment.

5.2 Operating Costs

The annual operating cost of the pipeline is estimated at $100 million per year (GHD, 2002). By far the major component of the operating cost is power. Previous studies have determined the operational costs assuming gas would be supplied via the North West Shelf.

A conservative estimate (based on CPI increases) is that operating costs have escalated to $105 million per year at 2004 prices.

5.3 Cost of Water

The costs to consumers of buying water from the Fitzroy River pipeline have been estimated at $5.50/kL (GHD, 2002). The escalation of the infrastructure and operating costs set out above has increased this figure to around $6.10 / kL. This is far above the current marginal cost of water which has been set by the proposed desalination plant at $1.11 / kL.

[5] In 2002-03 the price indexes for output of the building construction and the non-building construction of the general construction industry increased by 4.3% and 5.7% respectively (table 19.15). The rate of increase during the 12 months ended June 2003 for the non-building construction component (5.7%) was the largest since the beginning of the series. AUSTRALIAN BUREAU OF STATISTICS.

5.4 Other Economic Issues

The costing for this concept was based on a direct pipeline route from the lower Fitzroy River to near Perth. No irrigation, mining, tourism or other developments on route requiring water were designed or costed. Such developments would require more water and therefore higher costs with little if any benefit in terms of lower water costs to water consumers in Perth. The IDC study found that the economics of running arterial pipelines to developments / communities along the pipeline (for water supply) would not facilitate such developments as the cost of water and capital plant would likely exceed the capacity to justify it.

As part of its brief, the IDC study considered the direct economic impact of the proposed investment on the State's economy and the additional or multiplier flow on effects. The multiplier effect included indirect effects on suppliers and induced effects in service industries. The IDC concluded that there appears to be no significant potential for economic activity or development resulting from the Kimberley-Perth water pipeline.

The IDC report also found that the gas pipeline (required to support the provision of water from the Kimberley's to Perth) would be an advantage to communities and mines along the route, but it is not expected to have any significant effect on project economics. This assumption was made based on the fact that the Dampier to Perth natural gas pipeline has not spawned in itself any significant developments in tourism, mining or manufacture en route.

The Kimberley pipeline project is often cited as a visionary project to be compared to the Goldfields pipeline. However this comparison is somewhat misleading as in the case of the Goldfields pipeline water was required to meet the demand of a population growing for other economic reasons, and with no other real supply option. As noted above, there are no significant economic drivers for the Kimberley pipeline project, and there are several competing source options for Perth.

6. Comparisons with Desalination

As can be seen from the figures below the costs for the Kimberley pipeline project are several times greater than the desalination option and the greenhouse emissions would be more than four times per kL that of desalinating seawater, which can be done close to Perth.

The greenhouse emissions for the Kimberley project have decreased since the initial feasibility study conducted in 1990. This has primarily been due to increased energy efficiencies of around 20% in both pumping and generation systems.

Figure 1 Cost of desalination versus Kimberley pipeline

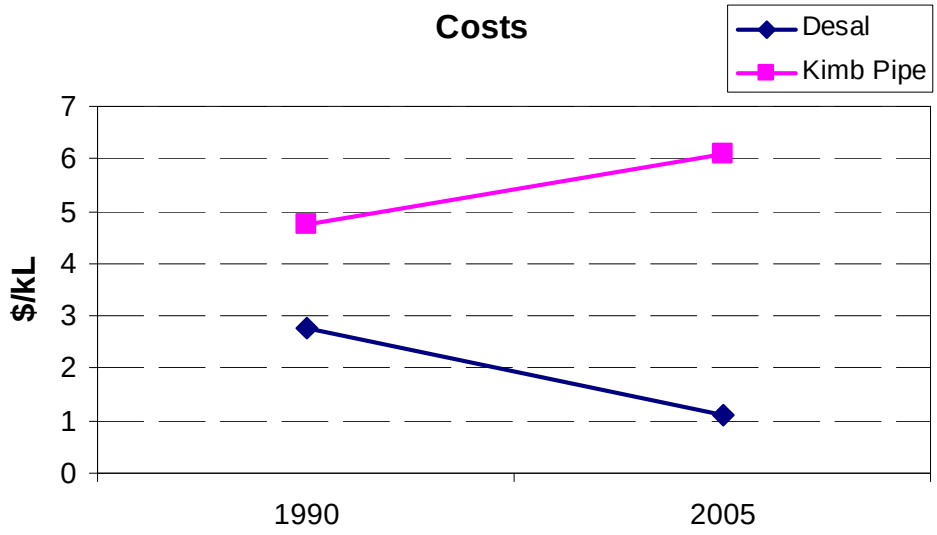
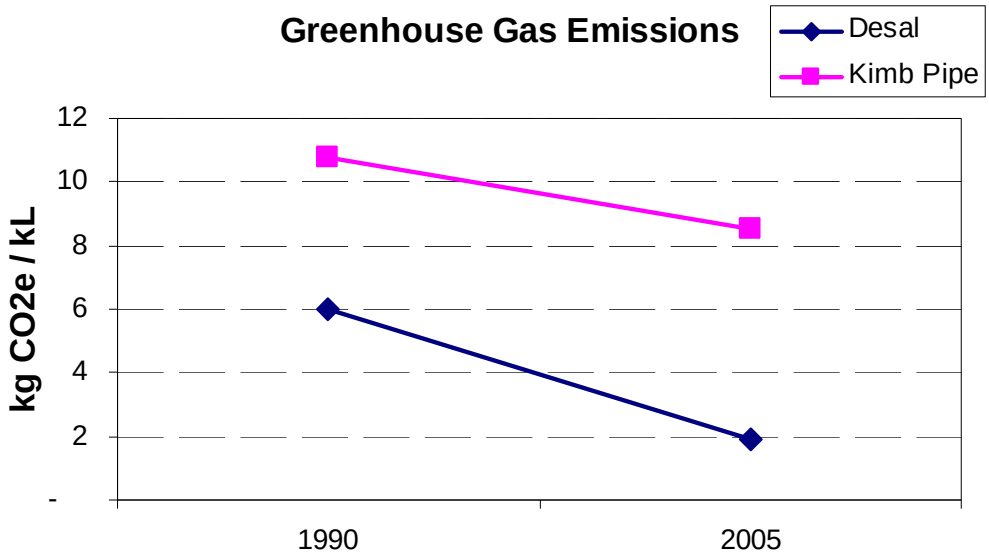


Figure 2 Greenhouse emissions of desalination versus Kimberley pipeline



Desalination has now become the benchmark against which the Water Corporation assesses source development options. While the Kimberley pipeline proposal is technically feasible, and should remain one of a number of future source options, the project is in fact becoming less competitive with desalination for two reasons:

- Cost reductions in desalination technology, while the costs of the Kimberley project have risen considerably due to escalations in the cost of steel, and construction more generally.
- Energy and greenhouse emission reductions in desalination and power generation technology.

While there are many other unresolved environmental and social issues associated with the Kimberley pipeline, there is little benefit in assessing these in any detail unless the gap between these competing options narrows significantly.

Under the Water Corporation's "security through diversity" approach, the project at the present time should retain a low ranking in comparison with other source projects, including desalination.

Appendix A

Review of IDC Concept Engineering Design

Excerpt from GHD 2002 report

IDC Concept Engineering Design

The infrastructure proposal put forward in the IDC 1990 Report comprises:

- A dam in the Fitzroy River at Diamond Gorge
- Seven booster pump stations spaced about 250 to 350km apart along the pipeline.
- Variable speed pumping units directly coupled to natural gas fired engines.
- Welded steel pipeline using high strength steel, and fusion bunded epoxy coatings both internally and externally.

The pipeline is designed to run on a near continuous basis to meet the annual demand.

Our view is that the solution tabled is at the bounds of engineering practice and there are many technical issues that have not been studied in detail, most of which have the prospect of increasing the cost of the project. The main issues are discussed as follows:

Number of Pumping Stations

Pumping of the water is required to overcome:

- The static pressure
- The dynamic friction pressure loss.

The static pressure is fixed by the ground profile and on the inland route this is about 700 metres.

The dynamic friction pressure loss is determined by two main parameters: the water flow velocity; and the roughness of the pipelining. The lower the pipe velocity and the smoother the internal liner, the lower the friction pressure loss.

The number of pump stations is determined by the maximum pipe operating pressure, which in turn is set by the strength of the steel shell of the pipe.

For any given pipeline, the designer must carry out a detail whole of life comparison to identify the most economical arrangement of the size of the pipeline and the number of pump stations.

For the case of the Kimberley pipeline proposal, the dominant cost factor is the tonnage of steel used to fabricate the pipe shell. The IDC proposal has attempted to minimize this by utilising high strength steel, which allows the adoption of very high operating pressures with thin walled steel pipe.

Our review of the IDC Report indicates that the engineering fundamentals used to arrive at their preferred solution are sound and that their design is feasible from a technical viewpoint. The report does not purport to recommend the optimal economical arrangement of the pipeline components, but only to arrive at a reasonable solution for the purpose of costing.

Operating Philosophy

The IDC design allows for the pipeline to run continuously to match the extra water demand for Perth, which is always referred to on an annual basis. However, the water demand will vary considerably over the year and it is difficult to understand how the system could operate without a significant balancing storage at the Perth end.

A balancing storage volume of about one third of the average flow is required to attenuate the peaks in demand. This would require a storage of about 100GL which is about the same size as Canning Dam (90GL). The cost of a new storage would be in the order of $100M which does not have a major cost influence on the overall cost estimate for the project, however it would be a major issue to identify a suitable area near Perth for such a storage.

Intermediate Storage Tanks

The concept design provides for a continuous pipeline without intermediate storages.

The issue of controlling the flow in a continuous pipeline 1840km long using 7 variable speed booster pump stations would be a major engineering challenge. The control of the pump stations would require simultaneous control of all pump stations together to start and stop the flow and control surges and water hammer. This would all have to be done allowing for a failure of any pump station at any time.

Our view is that this arrangement could be over complicated and the design should be broken up into sections with intermediate storages to facilitate control.

This would require storages at each of the pump stations to break up the pipe into discrete sections. Even so, the sections would still be very long by world standards at about 250 to 300km long.

Nevertheless, these storages would not have to be very large, say 2 hours flow, and the cost impact on the overall estimate would not be large.

Corrosion Control

The concept design allows for fusion bonded epoxy lining both inside and outside of the pipe.

For the exterior of pipe, fusion bonded PE coating as used for the Stirling pipeline would be the preferred coating as we believe that it has better resistance to damage during pipe handling and construction.

Epoxy lining of the pipe interior has been proposed in the IDC Report to cut down the weight of the pipeline compared to the more conventional cement lining of steel water pipelines.

The Report acknowledges that this may be more costly but identifies this as the best option for the life of the pipeline.

We do not believe that this conclusion is as clear cut as presented, but as the study includes the higher cost of lining, the project cost estimate has an appropriate allowance included for any lining system.

The discussion on the lining and corrosion protection does not discuss in any detail how the field joints would be made to provide corrosion protection of equal resistance to the factory applied fusion bond coatings. The pipe joints are the weak link in any welded pipeline system.

The issue of contact of potable water with the epoxy lining for extended periods of time also requires much more detail study.

Pipe Shell Thicknesses

It seems that the IDC Report adopted a pipe shell thickness based on pipeline operating pressure.

No account appears to have been made in regard to external earth or traffic loading on the pipe, while it is empty, nor any corrosion allowance.

One third of the pipeline uses steel only 8.1mm thick and this would require constraints to be put on the pipeline in regard to external loading when the pipe is empty, dealing with flotation in saturated soils, and maintaining roundness during manufacture and transport.

These issues have the potential for the wall thickness in the low pressure zones to be increased, leading to a significant cost impact on the project estimate.

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