EIS 1107

Hastings District water supply augumentation : environmental impact statement

HASTINGS DISTRICT WATER SUPPLY AUGMENTATION

ENVIRONMENTAL IMPACT STATEMENT

Main Volume

prepared by

Connell Wagner

HASTINGS DISTRICT WATER SUPPLY AUGMENTATION

prepared for

DEPARTMENT OF PUBLIC WORKS AND SERVICES (NSW)

2-24 Rawson Place, Sydney, NSW 2000

on behalf of

HASTINGS COUNCIL

Cnr Burrawan and Lord Streets, Port Macquarie, NSW 2444 *and*

DEPARTMENT OF LAND AND WATER CONSERVATION (NSW)

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Main Volume

Public Works and Services Report No. 95102
ISBN No. 0 7310 4045 7

ENVIRONMENTAL IMPACT STATEMENT

Form 8

Submission of Environmental Impact Statement (EIS)

prepared under the Environmental Planning and Assessment Act 1979
Section 112

EIS prepared by name qualifications	J. O. Brockhoff BSc (hons).
address	Connell Wagner Pty Ltd 116 Military Road NEUTRAL BAY NSW 2089
in respect of	
Part 5 Activity proposal name proposal address	Hastings District Water Supply Augmentation Hastings Council Port Macquarie NSW 2444
land on which activity to be carried out	
• address	• Cowarra Dam • Koree Island Intake and Pump Station • Rosewood to Cowarra Dam Pipeline
• lot no. DP/MPS, vol/fol etc. proposed development	or ☑ map(s) attached (refer Figure 1.1)
environmental impact statement	☑ an environmental impact statement (EIS) is attached
certificate	I certify that I have prepared the contents of this Statement and to the best of my knowledge • it is in accordance with clauses 84 and 85 of the Environmental Planning and Assessment Regulation 1994, and • it is true in all material particulars and does not, by its presentation or omission of information, materially mislead.

signature : J.O. Brockhoff
name : J. O. Brockhoff
date : 10/7/95

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APPROVAL STATUS

Prepared by: John Brockhoff	Signed: J. O. Brockhoff	Date: 10/7/95
Verified by: Ian Dawkins	Signed:	Date: 10/7/95
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QUALITY ASSURANCE CERTIFICATION

The document has been prepared in accordance with the requirements of the Quality Assurance System of Connell Wagner Pty Ltd, a Quality Endorsed company in accordance with AS3901, Lic QEC 3987 Standards Australia.

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GLOSSARY AND ABBREVIATIONS

AADT	Annual Average Daily Traffic Volumes represent the total traffic in both directions at an identified location. The AADT is calculated from mechanically obtained axle counts which are adjusted on the basis of vehicle types and seasonal traffic flows.
ABS	Australian Bureau of Statistics
AHC	Australian Heritage Commission
AHD	Australian Height Datum
ANCOLD	Australian National Committee on Large Dams
ANZECC	Australian and New Zealand Environment and Conservation Council
ARI	Average Recurrence Interval
ARR	Australian Rainfall and Runoff
ASL	Above Sea Level
Biota	The fauna and flora of a given region
Borrow Area	Area where material (clay) is quarried for the dam wall
CaLM	NSW Department of Conservation and Land Management (Now Department of Land and Water Conservation, DLWC)
CEPA	Commonwealth Environment Protection Agency
CH	Inorganic clays of high plasticity
CL	Gravelly clays (Unified Soil Classification System)
Coffer dam	Small temporary dam for the diversion of stream flow
Core Material	Clay material used as an impervious zone within the dam wall
Core trench	Trench excavated beneath the core material under the base of the dam wall
Curtain grout	Cement mortar injected into the ground beneath the dam wall to create an impervious barrier

dB(A)	Decibels using the 'A' weighted scale measured according to the frequency response to the human ear
dbh	Diameter of a tree at breast height
DL	Detection level
DoP	Department of Planning (Now Department of Urban Affairs and Planning, DUAP)
DPWS	Department of Public Works and Services
DSC	Dams Safety Committee
DWR	Department of Water Resources (Now Department of Land and Water Conservation, DLWC)
Endemic	Indigenous to a particular place or region
Environmental Flows	The minimum flows which must be preserved for downstream users and the environment. These minimum flows are based on statistics derived from actual stream flow data.
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
EP&A Act	Environmental Planning and Assessment Act, 1979
EMP	Environmental Management Plan
EP Comparison	Comparison between existing and proposed water extraction regimes from the Hastings River
Filters	Layer of sand or gravel which allows controlled leakage of water to maintain integrity of dam wall
FIS	Fauna Impact Statement
Flow Duration Curve	Graph which shows the volume of stream flows over time
FSL	Full Supply Level
GC	Clayey gravels (Unified Soil Classification System)
Gravity Main	Pipeline with gravity induced flow
Grout Cap	Concrete seal on pervious material beneath the dam wall

HGL	Hydraulic Gradeline
HC	Hastings Council
ID	Internal Diameter
IFHC	Incremental Flood Hazard Category
Inlet	Structure through which water enters the dam
Intake Tower	Structure within water storage which controls abstraction of water at different levels
kl/a/t	Kilolitres per annum per tenement
kPa	Kilopascals
kV	Kilovolts
kVa	Kilovolt amps-a measure of AC power
LA_{10}	Ambient noise exceeded 10% of the time measured on an A-weighted scale
l/d/t	Litres per day per tenement
LEP	Local Environmental Plan
LGA	Local Government Area
l/s	Litres per second
ML	Megalitres (million litres)
ML/a	Megalitres per annum
ML/d	Megalitres per day
ML/s	Megalitres per second
ML/y	Megalitres per year
NCREP	North Coast Regional Environmental Plan
NCUPS	North Coast Urban Planning Strategy
NP Comparison	Comparison between natural river flow (without extraction) and proposed water extraction regime from the Hastings River

NPWS	National Parks and Wildlife Service (NSW)
NSWPW	New South Wales Public Works (Now NSW Department of Public Works and Services, DPWS)
NTU	Nephelometric Turbidity Units
OD	Outside diameter of a pipe
OMC	Optimum Moisture content
Outlet Pipe	Pipeline taking water out of the dam from the intake tower to the pumping station for distribution
Percentile Flow	Statistically derived stream flow values which are exceeded for specified percentage of the time.
PI	Plasticity Index
PLC	Programmable Logic Controller
PMP	Probable Maximum Precipitation
PMF	Probable Maximum Flood
POSSIM	Pumped Off Stream Simulation Model, a computer model of water flows in the river system and the augmentation scheme
ppt	Parts per thousand
PWD	Public Works Department, former name of the Department of Public Works and Services
Race	A narrow section of stream with high velocity flow
REF	Review of Environmental Factors
REP	Regional Environmental Plan
RIFFAREA	Index of area of riffles used as a measure in habitat analysis of aquatic species
Riffle	Area of the stream where flow is agitated by the characteristics of the stream bed
Rip-Rap	Large rocks placed in areas subject to water erosion
Riparian	Pertaining to, or situated on, the banks of the river
Rising Main	Pipeline carrying pumped flow

RL	Reduced Level, a level relative to the Australian height Datum (of approximately mean sea level)
ROTAP	Rare or Threatened Australian Plants list prepared by the Australian NPWS - a register of significant plant species
r_u	Pore pressure ratio - a measure used in calculations to analyse slope stability.
Saddle Dam	Minor dam built in the saddle between two high points enclosing water storage
SC	Clayey sands (Unified Soil Classification System)
Scours	Valves located at low points along a pipeline which allow the pipeline to be emptied of water
SEPP	State Environmental Planning Policy
t/m^3	Tonnes per cubic metre, a measure of density
Total N	Total nitrogen
Total P	Total phosphorus
Turbidity	Cloudiness of the water measured by the extent of light penetration
USCS	Unified Soil Classification System

NOTE: Names of Government agencies are reported as known at the date of reference.

SUMMARY

INTRODUCTION

This Environmental Impact Statement (EIS) and Fauna Impact Statement (FIS) (refer Appendix Volume) were commissioned by the Department of Public Works and Services in their role as construction agent for the Hastings District Water Supply Augmentation Scheme on behalf of Hastings Council and the Department of Land and Water Conservation.

The EIS has been prepared for the proposed construction and operation of a 10,000 Ml off-river water storage dam to be located in Cowarra State Forest 5km south east of Wauchope (Section 5). The storage is required to serve the predicted population growth in the Hastings Local Government Area and provide drought security for that population.

The EIS addresses the dam intake works in the Hastings River at Koree Island 6km upstream of Wauchope (Section 6), pipelines connecting the intake with the dam and also between the dam and a balance tank (Section 7). The distribution mains and other aspects of the augmentation scheme have been previously assessed as components of the total water supply system approved by the Hastings Council in 1994 and 1995 (Figure 1.1).

The works would be completed in stages according to predicted increases in demand. It is expected that the dam would need to be completed by the year 2001. The new pump station at Koree Island and an additional gravity main connecting with the dam are likely to be required by the years 2001 and 2011 respectively.

CONSULTATION

A concept report for the Hastings District Water Supply Augmentation Scheme was first released for public comment in 1991. Public interest in the project led to the convening of two public discussion forums and a number of visits to potential dam sites. In 1994 Council distributed a brochure to highlight water issues during the recent drought and to outline the water supply augmentation concept.

Prior to commissioning the EIS, direct consultation was initiated with potentially affected landowners and key government agencies. This consultation has continued throughout the EIS process and has highlighted a number of issues including:

- that physical services, including water supply, should not constrain the sub-region's growth potential (Department of Planning);
- that a secure supply of water should be available during drought periods, without introducing severe water restrictions for longer than six months (Hastings Council);
- that forest resources should not be depleted (State Forest);
- that the impact on aquatic flora and fauna should be minimised and appropriate safeguards developed, by maintaining minimum river flows to ensure that the river

habitat is not adversely affected. (Department of Water Resources, NSW Fisheries);

- that the impact on rare and endangered terrestrial fauna should be minimised to ensure that populations remain viable in the long term (National Parks and Wildlife Service); and

- that Aboriginal sites which have been identified in the study area and others which could be discovered during construction would be approiately managed. (National Parks and Wildlife Service)

NEED AND JUSTIFICATION

The existing water supply system cannot supply the anticipated long term needs of the Hastings District. This community is projected to grow from 41,000 (1991) to 120,000 (2040). The system will require upgrading to maintain quality water supplies, particularly during extended periods of drought, to ensure that river flows are maintained for downstream users and to safeguard the river habitat.

The proposed dam has been sized at 10,000 ML to meet anticipated increased water supply demands over drought periods for the foreseeable future, assuming that demand management measures can reduce per capita water consumption.

PROJECT ALTERNATIVES

Council currently has in place several demand management initiatives including water user education and a recently introduced "user pays" system of water pricing. These initiatives will delay the need for a new dam and have had an impact on the sizing of its capacity. However, demand management water savings would not be sufficient to cause the dam to be deferred indefinitely. Demand management is a strategy which is complementary to the dam proposal rather than an alternative to the project.

Of the 24 dam sites initially considered, two were chosen for detailed consideration. The subject site (Cowarra State Forest) was ultimately chosen because the storage would inundate and sterilise less land and forest resources and require less land acquisition. The preferred dam site could also most economically accommodate a 10,000 ML water storage.

Alternative river and other water source options were also considered, but these options were dismissed because of their higher capital and operating costs and more significant environmental impact.

COWARRA DAM

The proposed dam would span an unnamed tributary of Kings Creek approximately 5km upstream from the confluence of Kings Creek and the Hastings River. The catchment area of the dam would be approximately 109 ha, of which 62 ha (57%) would be inundated at full storage.

The dam would be a 40m high earth embankment with a clay core, filter layer, earthfill zones and an outer layer of hard rock (refer Figure 5.4). Materials would be won mostly from within the area to be inundated (refer Figure 5.2). The maximum dam height would be approximately 60 metres above sea level. The embankment would be 550 metres long. The dam crest design allows sufficient freeboard to hold the probable maximum flood level (PMF) during a 1:100 year wind (wave) event. The embankment would be designed to remain stable during a 1:10,000 year earthquake event.

Other works are proposed including a saddle dam and spillway diversion, outlet works, intake tower, inlet structure, pumping station, rising main, balance tank, and access roads to the dam. The capital cost of dam construction, excluding the pump station and pipelines, is estimated to be in the order of $25M.

Effect on Water Quality and Creek Flows

Construction of the dam would maintain trickle flows in the creek below via the filter layers through the dam wall. It would also hold back flood flows through the catchment. Flood flows would be periodically reproduced by controlled release of water from the dam at equivalent frequencies, volumes and durations to the natural flow regime of the creek.

Water quality in the Hastings River would be monitored to ensure that turbid water is not pumped into the dam. The quality of water stored in the dam and supplied to consumers would be achieved by chlorination, aeration and regular monitoring in accordance with drinking water guidelines. Vegetation within the inundation area would be removed prior to flooding to prevent excessive oxygen demands as it decays.

Water quality within and downstream of the dam catchment would be protected during construction and operation by employing appropriate construction practices to prevent soil erosion and sedimentation. These measures will be implemented in accordance with actions to be defined in an Environmental Management Plan (EMP).

Flora and Fauna Impacts

The vegetation of the dam area is predominantly open forest (refer Figure 5.7). Approximately 90 ha of forested land would be affected by inundation and dam construction, although about 8 ha could be re-established after construction. The catchment has been frequently logged and it does not represent an old growth forest community. Other areas of similar vegetation in a less disturbed condition are present in the district under conservation oriented management.

Clearing and inundation would impact on a range of mammal, reptile and bird species that were observed or are predicted to be in the area. The inundation of a section of creek would reduce the available habitat of the Spiny Crayfish which is of high conservation value, but which occurs in a number of tributaries of the Hastings River. In addition, the Glossy Black Cockatoo, Little Bent-wing Bat and Large Bent-wing Bat were recorded in the study area. These are considered rare or threatened fauna under Schedule 12 of the National Parks and Wildlife Act (1974) and a Fauna Impact Statement and Section 120 Licence Application has been prepared with respect to these species.

Approximately 46 ha of vegetation in the dam catchment (above full storage level) would be effectively protected from further disturbance by logging, vehicles and stock. In the long term, the habitat value of this area would be enhanced. In addition, the creation of a permanent water body would create a new habitat for aquatic fauna and water birds. The water body is unlikely to create a significant barrier to fauna movement as it is located at the edge of Cowarra State Forest. The forest has an area of approximately 1,600 ha and extends continuously for about 5km around the northern, southern and eastern sides of the dam.

Visual Impact

The visual catchment of the dam is limited by existing topography and vegetation and there are no public viewpoints from which the dam wall or clearing would be clearly visible (refer Figure 5.9 and 5.10). Landscaping below the dam wall would improve the post construction appearance of disturbed areas.

Socio Economic Impact

Some private property and State Forest acquisition is required and compensation would be payable in accordance with the Land Acquisition (Just Terms Compensation) Act. Land within the catchment would be sterilised from all future commercial uses including logging, grazing and mineral exploration. Dam construction would provide temporary employment for contractors, with flow on effects to equipment and material suppliers. Post construction maintenance of the system would employ several staff or contractors on a semi-permanent basis. Indirectly, the dam would facilitate significant urban development in the region by removing an infrastructure constraint to housing, tourism development and population growth.

Forest Resources

Acquisition of State Forest land within the dam catchment is necessary for dam construction and to prevent future incompatible land uses in the catchment. Approximately 109 ha of dry hardwood in the State Forest would be removed from production. This represents a minor impact considering the total area of 207,887 ha within the Kempsey Wauchope Forestry Management Area. None the less, Council proposes to compensate State Forests for the loss of resource area by providing 206 ha of Council owned land (dry and moist hardwood forest) for inclusion in the Bellangry State Forest.

Aboriginal Archaeology

Nine sites of Aboriginal significance have been located within the proposed storage area, catchment and beside the construction access road (Figure 5.7). These include open campsites and isolated stone artefacts. These sites have been assessed as having low scientific significance but general heritage value. The artefacts would be collected and retained by the Bunyah Local Aboriginal Land Council, subject to approval from the National Parks and Wildlife Service. Other sites may be uncovered during earthworks and a member of the Land Council would be present to identify these sites during critical stages in construction.

Other Issues

The EIS addresses other issues in the context of the ecological sustainability of the project including cumulative impacts, resource sterilisation, energy consumption, biodiversity, hazard and risk and non-indigenous heritage. No significant impacts were highlighted by the EIS in respect of these issues.

KOREE ISLAND INTAKE WORKS AND PUMP STATION

The intake works and pump station would be located beside the existing pump stations on the Hastings River opposite Koree Island approximately 6km upstream of Wauchope. The Proposal consists of a dry well pump station housing with electrically driven pumps which would extract water through three screened pipe intakes. The Proposal also includes a transformer yard to receive 33kV power supplied by Oxley Electricity (refer Figures 6.1 and 6.2). The Proposal would require acquisition by Council of 0.81 ha of private land. Access to the existing and proposed pump stations would be via Rosewood Road and a sealed one lane access road. The estimated total capital cost is $4.7 million.

The capacity to abstract water from the Hastings River needs to be upgraded to fill and maintain water levels in Cowarra Dam and thus cater for predicted increases in demand from the Port Macquarie area and the growing communities to the south.

No pumping would occur at the proposed intake during low flow periods in order to maintain environmental flows for the aquatic environment and downstream users. Aquatic ecological surveys have identified critical environmental flows above the 80th percentile which must be maintained at certain times of the year to ensure the survival and passage of key indicator species.

Construction Impacts

Erosion and sedimentation controls including silt curtains and a coffer dam would be installed to prevent any turbidity, sediment infill and pollution of the river caused by excavation. Construction noise would be transient and intermittent and would be unlikely to exceed EPA criteria at the nearest noise sensitive location.

The study area consists of mainly cleared pasture with little remaining native vegetation. No rare or endangered flora species were identified on site. The cleared river bank provides limited habitat opportunities for fauna. A landscape plan would be implemented following construction to partly screen the structure, provide shelter for riparian fauna and to consolidate the bank (refer Figure 6.8 - 6.11).

Operational Impacts and Safeguards

The Proposal would impact on the existing hydrological regime of the Hastings River downstream of Koree Island. There would be small decreases in the duration of very low flow conditions which would result in positive ecological impacts, and decreases in the duration of high flow conditions which would have negligible impacts. There would be decreases in the duration of moderate flows and a corresponding increase in the duration of low flows.

The most significant potential impact on freshwater biota, if 80th percentile flow minimum river levels were adopted, would be the reduction in upstream passage opportunities for adult Australian Bass at critical times in the year. Other species could also experience reduced passage opportunity and reduced reproductive success. The reduction in duration of very low flows would, however, result in less stress on aquatic flora and fauna.

Changes in flow conditions resulting from the pumping regime have the potential to affect the salinity of the upper extent of the estuarine environment. The survival of ribbon grass beds, an important habitat of juvenile Australian Bass, is dependent upon a narrow range of salinity conditions, while adult Bass require a specific salinity zone outside the spawning season.

The proposed approach, to mitigate both seasonal fish passage constraints and salinity effects on the freshwater and estuarine environments, is the management of river flows above specified critical levels. This approach would prevent the most extreme predicted effects occurring and would be more responsive to the stream habitat requirements of key species than simply adopting uniform monthly environmental flow criteria. Ongoing research is proposed to further define critical flows for key indicator species. Regular testing would be performed to monitor salinity and turbidity along with a suite of water quality parameters. Real time monitoring of water flows would be instituted to ensure the control of water abstraction above critical levels. This would be controlled through criteria and responsibilities laid down in an Environmental Management Plan for the construction and operation of the works.

Issues concerning the cumulative impact, the commercial fishery, traffic and access, energy consumption and planning and land use have been considered in the context of ecologically sustainable development principles and the impacts were not found to be significant.

ROSEWOOD TO COWARRA DAM GRAVITY MAIN

By the year 2011, demand on water from Cowarra Dam would occasionally exceed the capacity of the headworks, including the Stage 1 pipeline between the Koree Island Intake Works and Cowarra Dam (via Rosewood Road Reservoir). By 2011, an additional gravity fed pipeline would need to be constructed to maintain flow between the Rosewood Road Reservoir and Cowarra Dam to provide sufficient capacity to utilise favourable pumping conditions in the Hastings River.

The pipeline would have 911mm internal diameter and would have a minimum capacity of 125 Ml/d. The pipeline would be gravity fed and run underground for approximately 10km along the most direct feasible alignment between Rosewood Road Reservoir and Cowarra Dam. A schematic layout of the pipeline in relation to the entire augmentation scheme is shown in Figure 1.3.

Preferred Corridor

Analysis of regional physical and social constraints revealed three feasible pipeline corridors (each 200m wide) (refer Figure 7.1). Comparison of the options indicated that a direct route (Corridor 3), which avoids areas of intensive rural residential development and which minimises severance of forest habitat, performed best in relation to a range of relevant assessment factors.

Impact of the Pipeline

The potential ecological barrier effects of a cleared easement would be minimised by location of the pipeline parallel and adjacent to existing State Forest roads and other linear disturbances. As a result, minimal additional clearing would be required and the impact on the environment of endangered fauna would not be significant.

The pipeline would occupy a 20m wide construction easement to be located within the 200m wide preferred corridor. There is sufficient scope to secure a pipeline easement which would not impact on the development potential of future rural residential land and would avoid the need to acquire existing dwelling allotments. The pipeline passes through a range of rural zones as well as a portion of industrial zoned land south of Wauchope. The pipeline would be permissible with development consent from Council.

There is sufficient flexibility within the corridor to locate the pipeline to avoid localised conflicts and avoid lengthy disturbance of drainage lines. A range of construction techniques and erosion and sediment control measures are proposed to protect water quality of receiving waters and prevent soil loss. These measures are discussed in Section 7.2.7 and would be implemented at the construction stage in accordance with an Environmental Management Plan.

CONCLUSION

The project would have a range of positive and negative impacts on the natural and socio-economic environment, some of which have influenced the design or management of the project or have recommendations for specific treatment or ongoing management. These would be implemented through an Environmental Management Plan for the construction and operational phases of the project.

Design and ameliorative measures were developed to satisfy the objectives of the project and are outlined in Section 8. A critical feedback of the environmental assessment is the need to take account of the critical stream flow requirements of fish in the development of the water abstraction regime from the Hastings River.

The impacts of the resulting proposal are considered acceptable in the context of the project benefits of guaranteeing water supply to the district in the long term.

Deferral or no action on the Proposal would result in greater exposure of the population serviced by the water supply system to more stringent demand management measures. These would include water restrictions during less severe drought and an increased possibility of exhaustion of the water supply during severe drought. In these circumstances, water supply would remain a constraint to the range of future development scenarios planned in the district.

PUBLIC EXHIBITION

The EIS will be on exhibition at the following locations:

- Hastings Council, corner Lord and Burrawan Streets, Port Macquarie (Display)*
- Port Macquarie Public Library, Clarence Street, Port Macquarie (Display)
- Wauchope Public Library, High Street, Wauchope (Display)
- Laurieton Public Library, Laurie Street, Laurieton (Display)
- Department of Urban Affairs and Planning, Governor Macquarie Tower, 1 Farrer Place, Sydney *
- Department of Urban Affairs and Planning, Northern Region Office, 49 Victoria Street, Grafton
- National Parks and Wildlife Service, Roto House, Port Macquarie.
- National Parks and Wildlife Service, Bridge Street, Hurstville
- NSW Government Information Centre, Hunter Street, Sydney
- NSW Environment Centre, 39 George Street, Sydney
- State Forests, Cameron Street, Wauchope

Copies of the EIS and Appendix Volume will be available for purchase at $25 from the locations marked (*).

SUBMISSIONS

Any person or organisation is invited to make a response to this EIS. Submissions will be received during the exhibition period. They will be reviewed by Hastings Council and an assessment report will be prepared. Council will make a decision on whether to proceed after considering the EIS, public submissions and the assessment report.

Submissions should be sent to:

The General Manager
Hastings Council
PO Box 84
PORT MACQUARIE NSW 2444

Attention: The Water Supply Manager

1.0

1.0 INTRODUCTION

1.1 Purpose of the EIS

This Environmental Impact Statement (EIS) and accompanying Fauna Impact Statement (FIS) (refer Appendix Volume) were commissioned by Public Works in their role as construction agent for the Hastings District Water Supply Augmentation Scheme for Hastings Council. Hastings Council is the nominated determining authority for the project. Other determining authorities from whom approvals and licences are required are listed in Section 1.4.

The EIS has been prepared in relation to the proposed construction and operation of a 10,000 ML off-river water storage located in Cowarra State Forest 5 km south east of Wauchope. The storage is required to serve the future water needs of the population in the Hastings Local Government Area. The scope of the statement includes the intake works in the Hastings River at Koree Island and rising mains connecting the intake with the dam and between the dam and a balance tank. The distribution mains and other aspects of the augmentation scheme have been previously assessed.

The EIS aims to define and assess the project in terms of a range of environmental, social, economic and engineering criteria in accordance with the statutory requirements of Part V of the Environmental Planning and Assessment (EP&A) Act 1979. The EIS addresses matters for consideration included in the EP&A Regulation 1994 as well as the requirements of the Director, Department of Planning (DoP) (Appendix A). The FIS addresses the requirements of the Director-General, National Parks and Wildlife Service (NPWS) (refer Appendix B).

The study has several main components including:

- a definition of the project objectives;
- a review of the need and justification for the water supply project;
- consideration of alternative dam sites;
- description of the construction project and characteristics of its operation phase;
- assessment of the environmental and socio-economic impacts of the proposal; and
- a description of the safeguards and mitigation measures to be adopted.

The EIS provides a mechanism for the community to scrutinise the proposal as well as providing Council and other authorities with a basis for determination of the project.

The structure of the EIS is as follows. Section 2 outlines the community and government consultation processes. Section 3 explains the need for and justification of the water supply project. Section 4 includes consideration of both alternative water supply sources as well as alternative dam sites. Section 5 describes the Cowarra Dam proposal and includes an assessment of the impacts of construction and operation of the dam itself. Section 6 addresses the effects of pumping water from the Hastings River from Koree Island to the dam site, this Section assesses the impacts of altered river flows. Section 7 is an assessment of alternate route options for a future pipeline between the Hastings River, Koree Island pump station and Cowarra Dam. Sections 8 and 9 summarise the proposed ameliorative measures and highlight measures to be incorporated in an Environmental Management Plan to control the actual construction and operation of the project.

1.2 Study Area

Regional Context

The Hastings Local Government Area is located on the mid North Coast of New South Wales approximately 400 km from Sydney. The area encompasses the Hastings River Basin which is drained primarily by the Hastings River (83%) and to a lesser extent by the Camden Haven and Stewarts Rivers (17%). To the south lies the Manning River Basin and to the north the Macleay Valley.

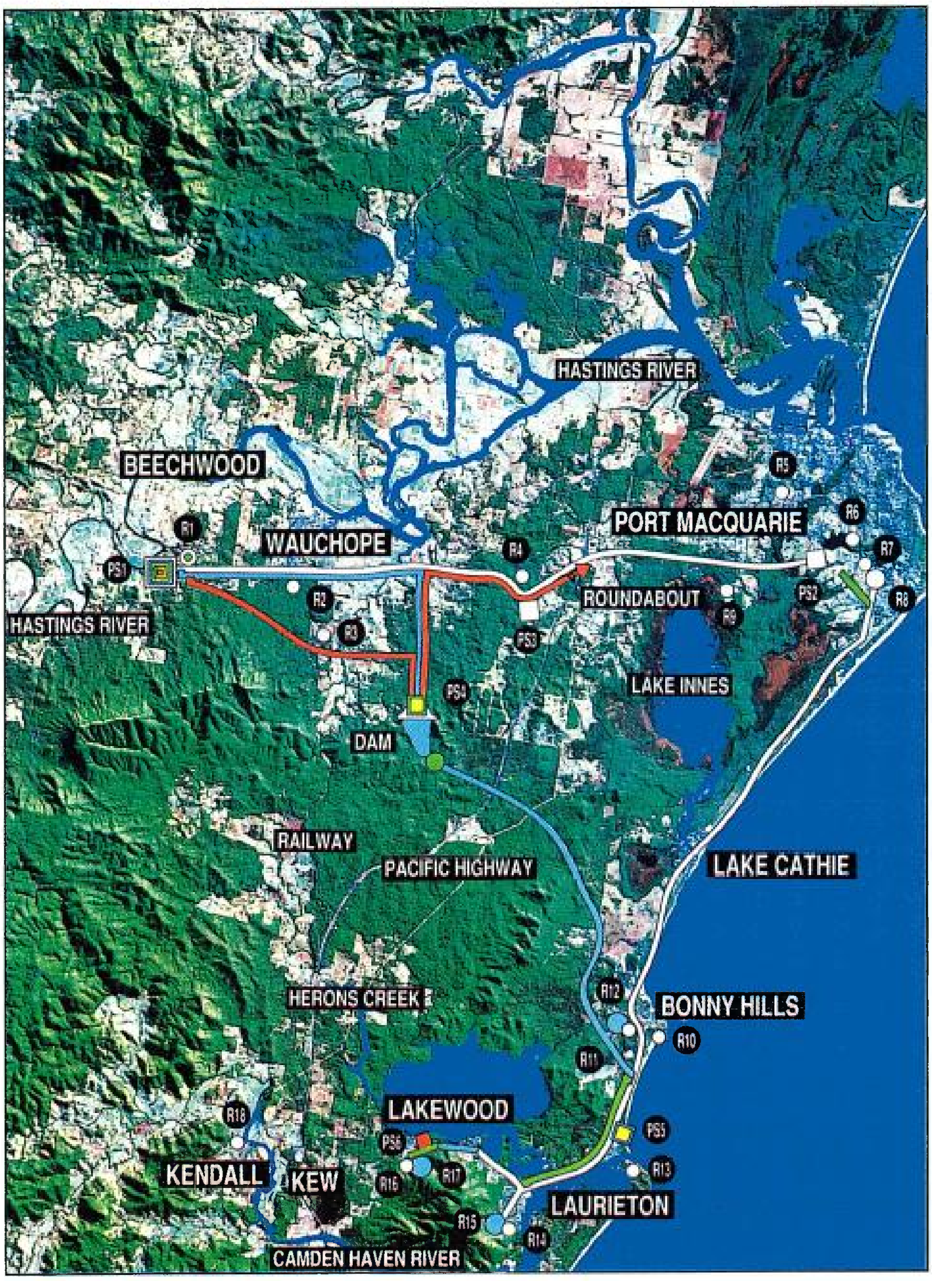
Early development in the Hastings District was based on the timber industry. This was closely followed by beef and dairy cattle on the floodplain. Later this century, tourism, retirement related business and increasing growth of urban centres have become the major industries in the district causing a shift in the population distribution with high growth in coastal areas and limited growth in rural centres.

Augmentation of the existing water supply system is designed to provide for this growth particularly in Port Macquarie, its satellites and the rapidly developing southern communities between Bonny Hills and Laurieton.

Study Area

The preferred dam site lies south east of Wauchope approximately 4 km south of the Oxley Highway and 3 km west of the Pacific Highway. The 109ha catchment area includes 83 ha of Cowarra State Forest and 29 ha of freehold land zoned for rural uses. Figure 1.1 shows the study area in relation to the Port Macquarie district and the augmentation scheme as a whole.

The dam site is located in the upper catchment of an unnamed tributary of Kings Creek. The terrain within the catchment is moderate to steep with gentle slopes on the valley floor and steeper slopes in excess of 20% on the valley sides. The study area has been historically logged at varying intensities. Recent selective pole harvesting has resulted in around 50% canopy cover removal on the lower valley slopes of the Cowarra Dam study area.



Source: Department of Conservation and Land Management, Land Information Centre

Reservoirs		
Pumping Stations		
Existing system	**Projected Timetable**	
Stage 1	1996	
Stage 2	2001	
Stage 3	2006	
Stage 4	2011	

Stage one

Reservoirs	Bonny Hills Laurieton Lakewood Village
Pumping Station	North Haven Booster
Pipelines	Rosewood to King Creek West Haven to Lakewood
Pipelines	Connection to new dam site Southern Arm link to Bonny Hills

Stage two

New dam	Cowarra State Forest
Reservoirs	Dam site Rosewood Road
Pumping Stations	Dam Site Koree Island
Pipelines	Bonny Hills to Laurieton

Stage three

Pumping Stations (upgrading)	Dam site Koree Island North Haven Booster

Stage four

Pipeline	Rosewood to dam
Pumping Stations	New Koree upgrading Lakewood Booster

Reservoirs

R1 Old and new Rosewood Road
R2 Sutherland Street
R3 Bago Road
R4 Sancrox Road
R5 Widderson Street
R6 Granite Street
R7 O'Briens Road
R8 Transit Hill
R9 Mill Hill
R10 Grants Head
R11 Bonny Hills
R12 New Bonny Hills
R13 Camden Head
R14 Laurieton
R15 New Laurietoon
R16 Lakewood
R17 New Lakewood
R18 Kendall

Pumping Stations

P51 Koree Island
P52 Off Creek Storage Dam
P53 Stoney Creek
P54 New Dam
P55 North Haven
P56 Lakewood

Figure 1.1
Hastings District Water Supply Augmentation Scheme
Location Map

The proposed additional Koree Island intake works and pump station are located 5 km west of Wauchope on the southern bank of the Hastings River near Rosewood, opposite Koree Island. The site is several kilometres upstream of the tidal limit of the Hastings River. The gravity main from Rosewood Road Reservoir would traverse grazing land, Broken Bago State Forest and rural residential land in the King Creek valley before entering the proposed dam site in Cowarra State Forest.

1.3 Background and Scope of the Proposal

Increasing population growth in the Hastings Region is placing pressure on the region's already stretched water supplies, particularly during drought periods. The storage capacity of Council's existing water storage at Port Macquarie and a range of demand management initiatives are insufficient to provide drought security for the rapidly growing populations of Port Macquarie, Wauchope, Beechwood and the southern coastal communities around Camden Haven.

Since 1987 Council has progressively developed a strategy for the augmentation of the water supply. This strategy has developed from the 1987 Binnie and Partners Strategy Study which involved new works including an off-river reservoir and duplication of aspects of the existing system. The strategy is based on catering for Hastings water supply needs to the year 2011. Between 1987 and 1991 the strategy was refined through a number of studies of the Hastings River, flow characteristics, population growth and investigations of the preliminary design cost and implementation program for the strategy.

In 1991 a concept report (Binnie and Partners, 1991b) and Review of Environmental Factors (REF) (Binnie and Partners 1991c) which addressed the preferred augmentation scheme were adopted by Council. Alternative sites for a proposed 5000 ML off-river storage were also considered (Binnie and Partners, 1991a) and a preferred dam site (site E) in Cowarra State Forest was selected on the basis of a comparison of 24 potential sites and detailed assessment of two sites located between Wauchope and Port Macquarie.

Following the 1991 Council decision, further investigations undertaken by Kinhill (1994) determined that a dam storage capacity of 10,000 Ml would be required to meet the predicted growth in demand and to meet recent and more stringent environmental flow requirements for the Hastings River as negotiated with the Department of Water Resources. A separate review undertaken by the DPWS based on historic stream flow and rainfall records for the period 1890 to 1990 confirmed that 10,000 ML was the appropriate size for the proposed storage.

A concept report describing the revised scheme design was then prepared by Kinhill (1994). Council determined that the REF should be reviewed to incorporate aspects of the scheme which were changed by the increased storage capacity and environmental flow constraints. Connell Wagner were appointed in 1994 by DPWS on behalf of Council to prepare an EIS based on the changed scope of the project. The EIS scope does not include aspects of the scheme not directly affected by revision of the dam capacity and water uptake requirements as these have been previously addressed in the REF and determined by Council.

The scope of the EIS includes assessment of:

- the 10,000 ML dam construction and operation including access arrangements to be completed by 2001 and pipeline between the dam pump station and balance tank within the dam catchment. The proposed activity also includes salvage logging within the proposed inundated area.

- the headworks associated with the provision of increased water uptake capacity to supply the proposed dam including a new intake works and pump station at Koree Island, (Hastings River) and a gravity main between the Rosewood Road Reservoir near Koree Island and the dam site. These facilities are scheduled for completion in 2011 corresponding to the predicted timing of growth in demand.

The development of the concept and the range of studies previously undertaken are illustrated in Figure 1.2 to demonstrate how the EIS is integrated into the concept development and approval process.

Table 1.1 summarises the proposed schedule of headworks augmentation including the Southern Arm Trunk Main to improve water supply to the Bonny Hills and Camden Haven area. Figure 1.3 is a schematic representation of the augmentation scheme to 2011 (Stages 1 to 4).

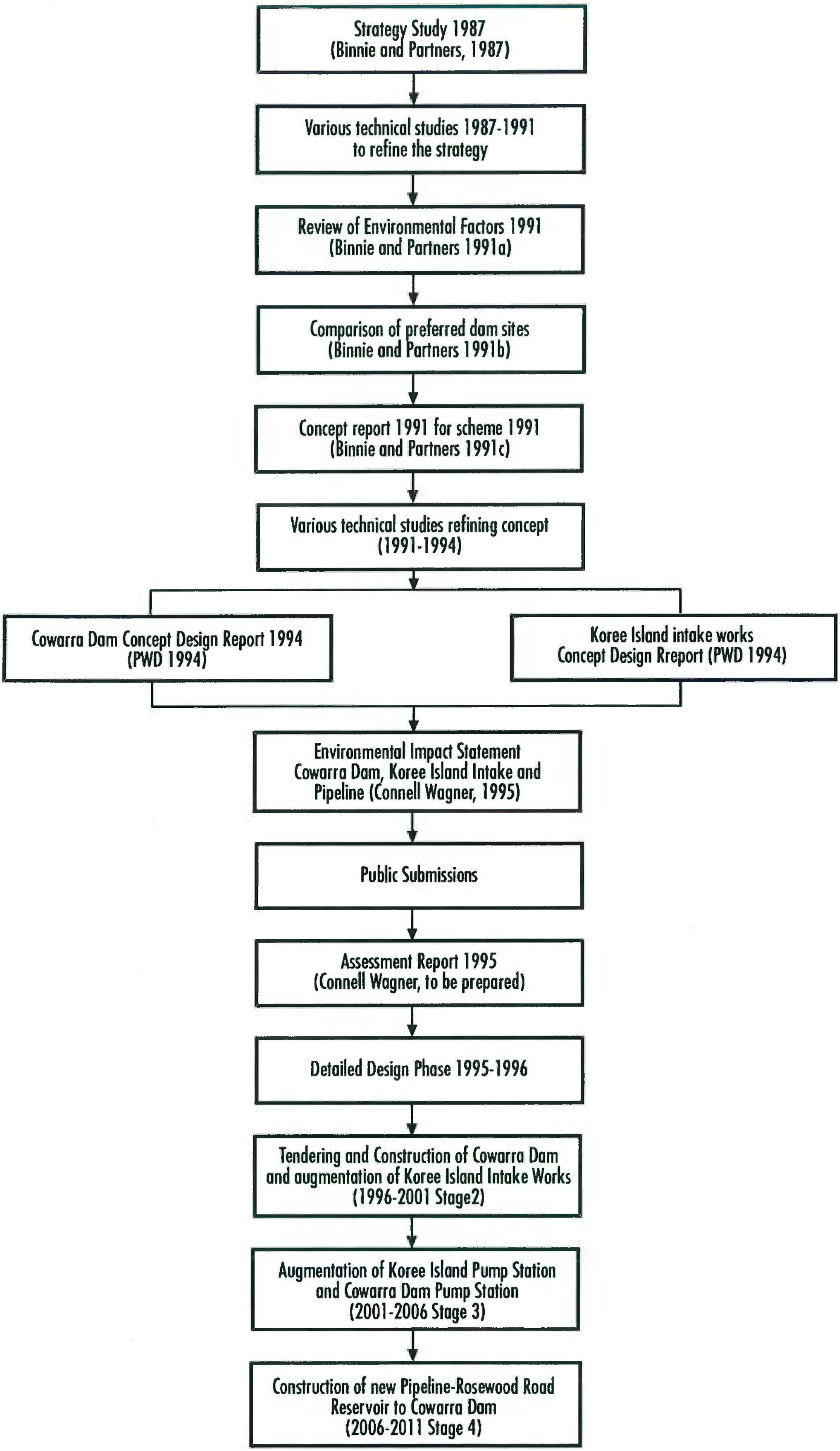
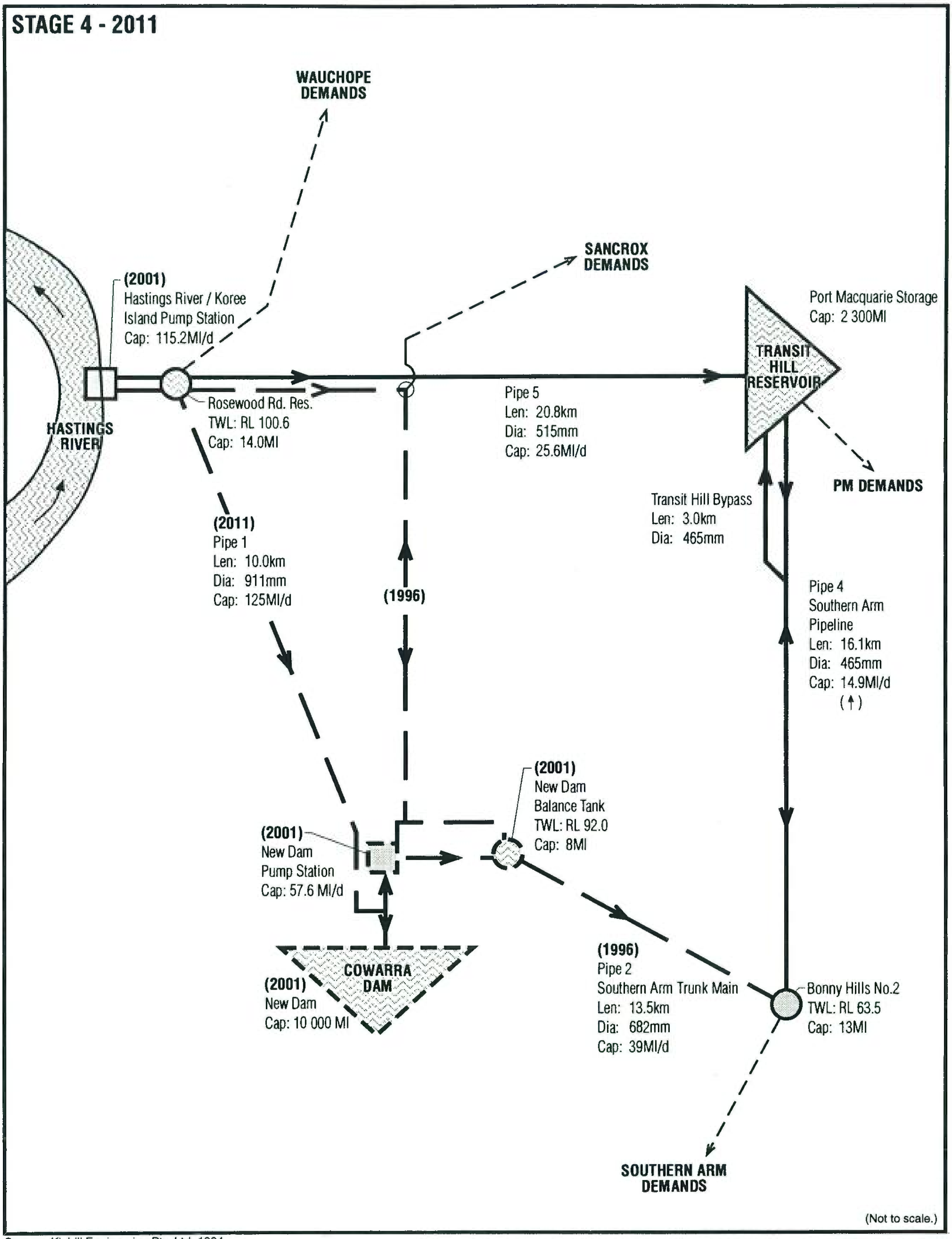


Figure 1.2
Concept Development and Approval Process - Cowarra Dam and Headworks

Table 1.1 : Hastings District Water Supply Headworks Augmentation Schedule

Construction	Size	Year of completion				
		1994	1996	2001	2006	2011
Stage 1						
Main to New Dam[2]	717mm 12.7km		****			
Southern Arm Link Main	682mm 13.6mm		****			
New Dam Balance Tank	8.0ML		****			
Stage 2						
Construction of New Dam	10,000ML			****		
Transit Hill Bypass	465mm 3.0km			****		
Augmentation of Rosewood Road reservoir	10ML[1]			****		
Augmentation of New Dam water pumping station	28.8ML/d[1]			****		
Augmentation of Koree Island water pumping station	28.8ML/d[1]			****		
Stage 3						
Augmentation of Koree Island water pumping station	28.8ML/d[1]				****	
Augmentation of New Dam water pumping station	28.8ML/d[1]				****	
Stage 4						
Augmentation of Koree Island water pumping station	28.8ML/d[1]					****
New Dam pipeline	911mm 10.0km					****

Note:
1 - additional capacity
2 - under construction



Source: Kinhill Engineering Pty. Ltd. 1994

— —	Proposed Augmentation
——	Constructed prior 1995
(2011)	Proposed completion year

Figure 1.3
Hastings District Water Supply Augmentation Scheme Concept

1.4 Approvals and Licences Required

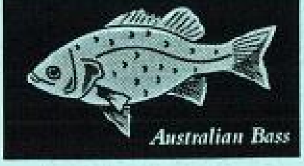
Although Hastings Council is the nominated determining authority for the project, other determining authorities are also required to grant approvals or licences for the project. These are listed below in Table 1.2.

Table 1.2: Approvals and Licenses Required

AGENCY	APPROVAL OR LICENCE REQUIRED
1. Determining Authorities	
Department of Land and Water Conservation	Licences under the Water Act 1912 for dam construction and water abstraction. Approval for the dam under Section 60 of the Local Government Act 1993. Licence to clear protected land under the Soil Conservation Act, 1938.
National Parks and Wildlife Service	Licence to take or kill Schedule 12 fauna Consent to destroy or move aboriginal sites under the National Parks and Wildlife Act 1974.
Department of State Forests	Possible need for Licence to remove trees from State Forests and other land under Section 27 of the Forestry Act 1916. Granting of Easements
Environment Protection Authority	Licence under Section 17K of the Pollution Control Act 1970 pursuant to the Clean Water Act 1970 to discharge any polluted water during construction.
2. Involvement of Other Agencies	
Department of Mineral Resources	Current Exploration licence over part of site to be withdrawn.
Dam Safety Committee	Dam to be prescribed by the Committee under Dam Safety Act 1978.
Department of Land and Water Conservation	Land Assessment required for any Crown Land uses.
NSW Fisheries	Notification under Part 7 of the Fisheries Mangement Act 1994 to construct a dam.

In addition, consent is required under Part IV of the Environmental Planning and Assessment Act 1979 in relation to the Koree Island Pump Station and access roads to Cowarra Dam. Development Applications would be prepared by Council prior to construction with respect to these facilities.

2.0



2.0 CONSULTATION

2.1 Community Consultation Process

The total concept for the Hastings District Water Supply Augmentation was subject to community comment via exhibition of the Concept Report in 1991 and the subsequent Council adoption of the scheme.

Since 1991, Council has disseminated information outlining the progress of further investigations relating to the planning of the scheme including a widely distributed colour brochure "Hastings Council .. Using a precious resource better.. water". Council has taken account of matters raised through direct contact and submissions prompted by the public information provided.

Prior to the commissioning of the EIS, direct consultation had begun with directly affected landowners in the dam study area and with other public and private stakeholders in the scheme including the key resource management agencies.

This consultation has continued through the preparation of the EIS and has involved contact with land owners within the dam catchment area and contact and receipt of submissions from key government agencies which are contributing to or are responsible for resources which are impacted by the proposal. A summary of the consultation process follows in Section 2.2.

The Hastings District Water Supply Augmentation Report (June 1991) was exhibited during July/August 1991. Sufficient submissions were received to warrant a public forum to discuss the issues. These were held in November 1991 and March 1992.

In April 1992, Council Staff, Councillors, Department of Public Works and affected property owners inspected potential dam sites. Council subsequently adopted the site in Cowarra State Forest and on private land as the preferred site. Affected property owners were notified and negotiations commenced for the voluntary acquisition of land required for the dam.

In October 1994, Council published a water supply brochure to highlight water issues during the recent drought. The brochure outlined the proposed augmentation scheme in preparation for the release of the EIS.

The statutory exhibition of the EIS (and Fauna Impact Statement) would provide the wider community with a further opportunity for input by written submissions prior to a determination of the project.

2.2 Consultation with Property Owners

2.2.1 State Forests

Approximately 83 ha of the catchment of the proposed dam site occurs within Cowarra State Forest. Following the adoption of this site as the preferred storage location, Hastings Council has proceeded with negotiations to acquire the State Forest land by way of a land swap. Council proposes to dedicate a 206 ha moist hardwood forest site for inclusion in the adjacent Bellangry State Forest in exchange for the less productive dry hardwood area in Cowarra State Forest.

State Forests have consistently stated that the protection of the forest resource is a prime concern and consequently, State Forest land should not be considered as suitable for the location of unrelated infrastructure without justification. In each case where the proposal impacts on State Forests, measures are proposed to avoid or reduce any justified land take and any indirect disturbance through access management (ie denial of access).

An option selection process has been followed to select and justify the preferred dam site. This is reported in Section 4.4 of the EIS. Following on from the dam site selection is the justification of the location and alignment of ancillary facilities, roads and services. The need to supply power from the nearest appropriate source to the north as well as the need to minimise travel distance on the operational access road has allowed these features to be combined in the same corridor extending north through Cowarra State Forest to Sarahs Crescent. However, construction access to the dam site would not be appropriate via this route due to the proximity of residential development on Sarahs Crescent and the need to directly access the construction site from above the dam wall. As a result, the existing forest access roads leading from the former Pacific Highway (Burrawan Forest Drive) were chosen to be upgraded for construction access. The Southern Arm Trunk Main, which extends from the proposed balance tank in a south easterly direction, will parallel this road to minimise the cumulative impact on State Forest.

In relation to the proposed route of the Rosewood Reservoir to Cowarra Dam pipeline, the impact on forest resources of Broken Bago State Forest would be minimised by avoiding clearing of a new corridor and establishing an easement parallel and adjacent to the Old Highway Road. State Forests have also requested consideration of pipeline routes avoiding Broken Bago State Forest. Routes to the north would affect development in Wauchope and would add a significant additional length and cost to the pipeline. The corridor selection process and justification of this pipeline corridor is outlined in Section 7.2 of this EIS.

Consultation with State Forests is ongoing through the process of land acquisition and negotiation on the future management of access roads and easements during and after the dam and pipeline construction period.

2.2.2 Owner of Lots 28 and 29, Kings Creek Road

Approximately 16 ha of land in the south eastern corner of Lot 29 is located beneath the proposed dam embankment and pump station, Consultations between the owner Mr V Dalton and Council have proceeded in relation to land acquisition for the affected area. Mr Dalton raised the following particular concerns in relation to the project which are addressed in the EIS:

- The Dalton family operate a commercial horse trail ride business and riding school over the subject land and into the State Forest. The value of this business and the recreational potential of the site should be taken into account in the acquisition settlement and EIS;

- The potential for the proposal to cut off water supply to farm dams downstream;

- The subdivision potential of the property would be reduced and the value of the property would be diminished; and

- The area of land proposed to be acquired for the dam within Lot 29 is excessive.

2.2.3 Owner of Lots 30 and 31, Kings Creek Road

The eastern portion of Lots 30 and 31 (50 ha) would be acquired for construction of the proposed dam. The properties are owned by the Graham Family Trust and Mr C Graham has had ongoing dialogue with Council in relation to an appropriate acquisition price for the land. Mr Graham has expressed a desire to retain the house site notwithstanding that it would be close to the embankment.

2.3 Consultation with Authorities

A range of public authorities with a statutory interest in the project were consulted in writing during the preparation of the EIS. Each authority was requested to advise in writing of their interest and comment on the proposed works. These comments were addressed in the preparation of the EIS. The key issues are outlined below and their correspondence is included in Appendix C.

2.3.1 Department of Planning

The Directors requirements have been received and are included in Appendix A. In addition to the statutory requirements, the following matters are required to be addressed in the EIS:

- description of the Proposal including storage facility, pumping stations and pipelines;

- justification for the Proposal including a review of alternatives and reasons for selecting the proposed alternative;

- assessment of impact on existing uses of the Hastings River, including agricultural, recreational and other such uses;

- assessment of construction impacts;

- description of existing hydrologic processes of the Hastings River, identification of likely changes to this regime;

- A soil and water management plan is necessary for construction sites to prevent contamination of existing water environment.

- Assessment of subsoil dispersiveness is required to determine whether the colloidal fraction may cause water quality problems.

- Provision for storage of chemicals and fuels on site to prevent surface and groundwater contamination.

- Assess the impacts of the quality of stored water on downstream systems during and after construction with details of dam maintenance procedures.

- Investigate alternate methods of managing water quality of the storage facility.

- Identify discharge point for any surplus flows from balance tanks and assess the effects of the overflow on the surrounding environment.

- Storm water runoff from all access roads should be managed to prevent erosion and scour of adjacent drainage lines.

2.3.3 State Forests

State Forests have offered the following matters for consideration:

- the cumulative impact of the whole scheme, in particular the pipeline running east of the storage through Cowarra, Queens Lake and Camden Haven State Forests;

- the impact of obtaining dam fill material from a quarry on nearby State Forest;

- the management of the ponded area and catchment including salvage within ponded and non-ponded areas, further timber harvesting and bush fire management;

- access issues such as proposed routes, road upgrading and maintenance;

- environmental impacts on the surrounding State Forest which should not be viewed as a buffer for the proposal;

- historical and background issues;

- the requirement to keep State Forests informed of activities and developments; and

- the requirement to be licensed by State Forests to remove trees.

2.3.4 National Parks and Wildlife Service (NSW)

The NPWS advised that consideration be given to:

- the impact of the development on flora and fauna in the locality with reference to endangered species;
- the fauna survey should address the provisions of the Endangered Fauna (Interim Protection) Amendment Act 1992; and
- an archaeological and anthropological survey should be conducted including consultation with the Local Aboriginal Lands Council.

The NPWS has requested the opportunity to comment on the completed EIS.

2.3.5 Department of Mineral Resources

The Department of Mineral Resources raised the following issues for consideration in preparing the EIS:

- the impact of the proposed water storage on mineral and extractive resources; and
- the impact of mineral and extractive resources and possible future mining or extractive operations on water quality.

At present a part of the catchment is affected by an Exploration Licence Application, however the mineral potential of this area is considered to be low and the area is unprospective based on current information.

2.3.6 Department of Conservation and Land Management (CaLM)

CaLM advised that the EIS should address the existing environment of the study area and the need for sediment and erosion controls. The retention of timber cover in sloped areas greater than eighteen degrees was recommended. An application to close existing Crown roads had already been lodged by Hastings Council.

2.3.7 NSW Fisheries

NSW Fisheries have raised the following points for consideration in the EIS:

- the impacts of the dam construction on aquatic fauna, flora and habitat;
- the impacts of dam construction on water quality and flow regimes downstream and the impacts of these changes on aquatic flora and fauna; and

- the impact of the extraction on flows in the Hastings River and the aquatic flora and fauna of the River.

2.3.8 Commonwealth Environmental Protection Agency

CEPA have stated that no Commonwealth decision is required for this proposal and that the provisions of the Commonwealth's Environment Protection (Impact of Proposals) Act 1974 would not apply.

2.3.9 Optus

Optus Communications have no cable or plant in the area affected by the proposed dam and pipeline. Their optic fibre cable lies east of the Pacific Highway.

2.3.10 Roads and Traffic Authority

The RTA has raised no objection to the proposal.

2.3.11 Dam Safety Committee

Given the height and storage quantity of the dam, the Committee would prescribe it under the Dams Safety Act (1978). This would take place when a final decision to proceed with construction is taken. The dam must meet the Committee's design and construction requirements.

2.3.12 Kempsey Rural Lands Protection Board

The dam proposal does not affect any lands currently under Board control and management.

2.3.13 NSW Agriculture

NSW Agriculture has concerns related to any effects on the water rights of downstream riparian landholders and the effects of the proposed off creek storage and its catchment management on any prime agricultural lands.

2.3.14 Australian Heritage Commission (AHC)

The Commission stated that the proposal does not affect any places listed in the Register of the National Estate.

2.3.15 Hastings Council

Council considers that the EIS should address the following matters:

- effects on flooding;

- effects on downstream water flow and levels in the creek and Hastings River with particular reference to nearby residential properties in Jillala Drive;
- effect on scenic quality; and
- effects on fauna.

2.3.16 Environment Protection Authority (EPA)

The EPA considers that the following issues should be addressed in the EIS.

- Sedimentation and erosion controls based on CaLM guidelines should be implemented in disturbed areas, on access roads and around the new shoreline of the proposed dam;
- Investigation of runoff nutrient levels which may have the potential to cause algal blooms in the dam;
- Monitoring of noise levels during construction and operation and implementation of controls if necessary.

2.3.17 Oxley Electricity

- Oxley Electricity does not have any electricity distribution assets located in the proposed catchment area.
- Any tree clearing required for the construction of overhead lines to future pumping stations should be addressed in the EIS.
- Negotiations with Oxley Electricity are continuing with respect to power supply options for Koree Island Pump Station.

2.3.18 Telecom

Telecom advises that they have no cables in the proposed catchment area and have no future plans for works in that area.

2.3.19 Heritage Branch of Department of Planning

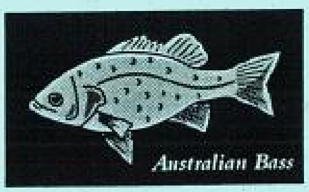
The Heritage Branch requires the following matters to be addressed in the preparation of the EIS:

- assessment of the heritage significance of the land affected by the Proposal;
- reporting of any discovered relics to the Heritage Council;
- any disturbance to a relic or relic site requires a Heritage Council excavation permit.

No properties within the proposed site are listed on the Heritage Council's public register of items protected under the Heritage Act, 1977.

3.0

NEED AND JUSTIFICATION



Australian Bass

3.0 NEED AND JUSTIFICATION

3.1 Existing Water Supply System

The Hastings District Water Supply system provides water to the following urban centres for domestic, commercial, industrial and public consumption:

- Port Macquarie;
- Wauchope and Beechwood;
- Southern Arm Communities:
  - Rainbow Beach, Lake Cathie and Bonny Hills
  - Camden Haven, Laurieton, Camden Head, West Haven, North Haven, Dunbogan and Lakewood
  - Kew, Kendall and Herons Creek.

The supply is fed by two pumping stations at Koree Island on the Hastings River which have a combined pumping capacity of 42 ML/day, based on a 22 hour operating day. The smaller of the pumps (10 ML/day) supplies water to the old Rosewood Road reservoir and then gravity feeds Wauchope, Beechwood and Sancrox. The larger pump (32 ML/day) supplies the new Rosewood Road reservoir which then gravity feeds into the Port Macquarie off creek storage dam. The dam was constructed in 1979 and has a useable storage capacity of 2,300 Ml. It serves Port Macquarie and communities south towards Camden Haven, Kew, Kendall and Herons Creek (ie. in the southern arm).

3.1.1 Existing Constraints

The existing water supply is constrained in relation to turbidity and environmental flows in addition to inadequacies in the capacity of existing pipelines and storage tanks.

Offtake Constraints

The Hastings River has an estimated mean annual flow of 1,030,000 Ml, however, river flows fluctuate and there are times when offtake of water from the River at Koree Island can be restricted by high turbidity or low flows.

With the existing system, when turbidity exceeds 15 NTU (Nephelometric Turbidity Units) offtake pumping ceases. Pumping is restarted when turbidity falls below 9 NTU. It has been estimated that acceptable quality water is accessible 80% of the time or 290 days a year. However, during 1985 turbidity levels in the Hastings River prevented direct offtake for a total of 139 days with the water being of unacceptable quality for 70% of the time between March and June.

The existing Port Macquarie storage is currently able to provide quality water over extended periods when river water is unavailable or excessively turbid and unacceptable. However, population growth would gradually erode the dam's ability to store sufficient water for prolonged periods.

Environmental Flows

Environmental (riparian) flows are the minimum flows which must be preserved to sustain the river environment and provide for water users downstream. The Department of Water Resources target for the maintenance of environmental flows is the 80th percentile level (these are flows that are exceeded 80% of the time). However DWR guidelines provide for mitigating scientific evidence of the severe cost consequences of maintaining environmental flows as would be the case in relation to the existing Hastings Scheme.

Previously, all but minimal (100 ML/d) flows were able to be abstracted from the Hastings River. However, all new Department of Water Resources river abstraction licenses require offtake pumps to be turned off when river flows fall below the target 80th percentile level for any month.

The new DWR policy would affect the abstraction capacity of the existing supply system when water supply is critical (i.e. during droughts). As a result, additional storage capacity is required to maintain current security of supply during prolonged drought periods.

In the interim period, the DWR, Council and DoPWS have negotiated a variation such that when the storage is low (less than 60% capacity) pumping to the 95th percentile level is permitted. Water restrictions of 20% would come into effect once the dam dropped below the 60% capacity level.

Pipeline Rationalisation

The existing system is made up of over 120 km of pipeline, of which approximately 100 km are gravity mains and 20 km are rising mains. Older sections of pipeline are constructed from cast iron with more recent sections using either cement or steel. A pipeline which cannot transfer enough water to meet service reservoir demands is said to have an inadequate transfer capacity. A number of sections in the existing system have an inadequate transfer capacity for peak daily periods.

Long pipelines to southern communities in the Municipality make these areas vulnerable to disruption in supply, especially at times of peak demand. Supply to all parts of the southern arm system is dependent on the function of the 11 kilometre long gravity main from the Port Macquarie storage to Lake Cathie. Although not part of this EIS, Council plans to augment this pipeline with a new Southern Arm Trunk Main which would be constructed in 1995-1996 between the new Rosewood Road Reservoir to link with the existing system in the south of the supply area (in the vicinity of Bonny Hills). This pipeline would be integrated with the proposed Cowarra dam storage when it becomes operative in about 2001.

Storage Tanks

Existing storage tanks, including balance tanks and service reservoirs, are constructed from either concrete or steel. A number of the existing service reservoirs are considered inadequate. This occurs when the capacity of the tank is less than the peak daily demand it must supply. Service reservoirs at O'Briens Road, Bonny Hills High, Grants Head, Camden Head and Laurieton have inadequate capacity. Although not part of this EIS, a range of proposals to augment water supply for the Southern Area communities including increased pipeline and reservoir capacity are proposed to address the existing capacity limitations (refer Figure 1.1).

3.2 Current Water Demand

In 1991, the overall system supplied an estimated permanent population of about 41,000 people. This figure excludes a large tourist population, particularly during summer periods. It also excludes some 6,000 people living in rural areas and small towns that are not connected to the main water supply. Rural areas are served by tank water and by small independent water supply schemes in the case of Telegraph Point, Comboyne and Long Flat (Kinhill, 1994).

Council records for Port Macquarie water consumption between 1984-1993 indicate a maximum daily recorded water usage of up to 3000 l/d/t (litres per day per tenement) for permanently occupied dwellings. The average annual residential demand for permanently occupied dwellings during the same period was about 340 kl/a/t (kilolitres per annum per tenement).

The Port Macquarie off creek storage dam currently has the capacity to supply water at peak demand for 30 to 35 consecutive days without drawing water from the Hastings River. In 1991, the peak demand storage capacity was about 39 days, based on Council records of water usage for permanently occupied dwellings, and estimates for water usage by tourists and industry.

A range of demand management measures, including community education and water restrictions during drought, are in place to control demand growth (refer Section 4.2). However, population growth and increased tourist activity are gradually eroding the system's capacity to withstand prolonged periods when water cannot be drawn from the River for water quality reasons, drought, or to retain environmental flows.

3.3 Future Demand

Population Growth

The North Coast Urban Planning Strategy has identified Port Macquarie as a major urban growth centre. Adequate water supply is a prerequisite to achieving the Department of Planning's growth objectives which could mean that the water supply may ultimately need to serve up to 120,000 permanent residents by the

Year 2040 (Kinhill, 1994). In 1991, it served approximately 41,000 residents. This ultimate figure and timing is based on a number of assumptions:

- Australian Bureau of Statistics "high scenario" population projections based on development projections prepared by Council (Thompson, M., 1993 pers comm);
- Population growth would only be limited by the availability of suitable land;
- All suitable land would be developed;
- Population growth in the area would be approximately 4.1% to 2011 and 1% p.a thereafter; and
- An average occupancy rate of 2.3 persons per household would be achieved.

In future, the four main demand areas would be Port Macquarie, Sancrox/Thrumster, Wauchope and the Southern Arm communities. Significant permanent growth is anticipated in Sancrox/Thrumster (40,000 people) and in Port Macquarie (20,000 people). Permanent populations in smaller centres along the Southern Arm are also anticipated to grow by up to a total of 20,000 people by the Year 2040.

North Coast Urban Planning Strategy Into the 21st Century

The NCUPS was released in 1995 with the main focus of identifying opportunities for the Region's development which best maintain and protect its environmental qualities.

The Strategy identifies Port Macquarie as one of five sub-regional centres and anticipates major urban growth within the Hastings LGA over the next 25 years. By encouraging growth of the Port Macquarie sub-region, the Strategy aims to reduce the incidence of dispersed settlement so that physical and human services can be provided more effectively.

In so doing, it aims to retain the environment and natural resource attributes which are important to the Region's character and economy. The Strategy makes specific reference to provision of physical services and states:

> "The Department of Water Resources, in conjunction with NSW Public Works and local government, should ensure that long term (50 years) water supply strategies are prepared for each sub regional centre. Matters to be considered when strategies are prepared include:
>
> - the centres expected population having regard to the area's capacity for growth
> - demand management options

- appropriate environmental flows (Strategy Action 6, page 43)

When preparing a strategy for reticulated water provision, responsible agencies should also address:

- demand management
- re-use initiatives
- active promotion of resource conservation (Strategy Action 7, page 43).

In addition, service authorities should examine the feasibility of establishing common service corridors "(Strategy Action 8, page 43).

Future Water Consumption

The predicted peak daily and annual unit water demands for permanently occupied houses and seasonal, tourist and other uses are listed in Table 3.1. The predictions are based on 1984 to 1993 Council records of water usage for permanently occupied houses and on standard DoPWS usage rates for other uses. Note that there is no uniform correlation between peak daily demands and total annual demands.

Table 3.1 : Unit Water Demands

Water Users	Peak Daily Demand	Annual Demand
Permanently occupied - Houses - Flats/units	 3,000 l/d/tenement 1,000 l/d/tenement	 340 kl/a/tenement 160 kl/a/tenement
Seasonally occupied - Houses - Flats/units	 2,000 l/d/tenement 750 l/d/tenement	 160 kl/a/tenement 115 kl/a/tenement
Campers and caravans	600 l/d/site	60 kl/a/site
Hotels and motels	200 l/d/bed	30 kl/a/bed
Additional holidayers	180 l/d/person	25 kl/a/person
Other (industry, commercial, etc)	Annual/365	Fixed percentage of total residential

Source: Kinhill, 1994

Table 3.2 indicates the demands on the existing water supply system based on ABS "high level" population projections, Council estimates of tourist and seasonal growth and standard water usage rates. Table 3.2 also indicates the approximate number of peak days water supply that the Port Macquarie Dam could hold without drawing water from the Hastings River. These figures assume that no water restriction were applied to consumers.

Table 3.2 : Predicted Water Demands

Year	Peak Daily ML/d	Annual ML/a	Peak Usage Reserve (days) *
1991	58	7,200	39
1996	70	8,600	33
2001	84	10,400	27
2006	103	12,800	22
2011	122	15,200	19
2040	163	20,400	14

Source: Kinhill, 1994
* Calculated based on 2300 Ml dam capacity and assuming no water restrictions

3.4 Strategic Objectives

Current and future supplies to Hastings Local Government Area must satisfy Council objectives as outlined in Binnie and Partners (1991b).

- Provision of water to meet anticipated increased demands in the foreseeable future (i.e. to Year 2040). Council is concerned that water supply should not limit potential population growth and that the system should accommodate a number of development and growth scenarios.

- Maintenance of supply during periods of drought. Council has adopted a security criterion that no failure of supply (zero storage) should occur during a 1:100 year drought. In addition, supply should not be disrupted when water quality in the Hastings River is poor or if environmental river flows are likely to be a limiting factor. Demand management through water restrictions are assumed to reduce water demand during drought by 20%.

- Be flexible to accommodate changes in the timing and location of development.

- Provide water quality of acceptable standard at all times.

- Be environmentally, socially and economically acceptable to the community; and

- Consideration of demand measurement measures as a long term measure to maintain a standard of service (Binnie and Partners, 1991b). Demand management measures to reduce household demand are regarded as complementary to headworks augmentation to both develop broad community consciousness of the value of water and to identify any aspects of water demand which could impose unreasonably high requirements on the supply headwork and which offer the possibility of reducing the overall financial economic and environmental costs of system operation and expansion. The potential for demand management savings of up to 30% would not replace the need for major headworks augmentation. Council's demand management strategy is outlined in Section 4.1.

3.5 Need for the Project

The existing water supply system would eventually need to be augmented to achieve Council's strategic objectives and the objectives of the North Coast Urban Planning Strategy. The size and timing of augmentation work is discussed below.

The water supply scheme can be simplified to include a storage dam and associated headworks for the purpose of considering scheme sizing. The need to augment headworks (intake pump station, pipelines, reservoirs and pumping stations) is governed by the system's current storage capacity. If storage upsizing is justified, then it follows that headworks augmentation is also required where pump stations, pipelines and reservoirs have insufficient capacity to fill and maintain water storage volumes. Full descriptions of proposed augmentation works are included in Sections 5, 6 and 7.

The project justification is primarily based on the need for increased storage capacity in the system subject to increasing demand and uptake limitations with respect to environmental flows and turbidity constraints. The 1% drought sequence is the design criteria which controls the storage size while the frequency of the trigger event controls the size of the intake, pump station and pipelines.

Need for additional Storage Capacity

The storage capacity of the current system is approximately 2300 ML and, as a measure of its size, it could presently arbitrarily provide for about 30 to 35 days peak usage without drawing water from the Hastings River if water restrictions were not introduced. The 1994 drought period was considered the worst on record and in practice required the introduction of severe water restrictions to meet the demand.

The Strategy Study (Binnie and Partners, 1987), uses stream flow records, dating back to 1946, combined with rainfall records dating back to 1890 to derive a likely worst case (1:100 years) drought event over the life of the dam.

Further analysis indicates that the 1994 drought was shorter and less severe than the theoretical 1:100 years drought sequence derived by Binnie and Partners (1987) which was the key parameter used to model the appropriate size of the storage dam. (Pers. Comm. Anderson, J. 1995).

In terms of future storage sizing, it is essential that the system be able to supply water to a growing community during a severe drought (1:100 year event). Turbidity and environmental flow factors are critical in sizing the transfer capacity of headworks to take advantage of optimum river conditions.

According to the NSW Public Works Water Supply Investigation Manual (1986), a reasonable basis for water supply storage dams is:

- restrictions on supply should not last, in total, for more than 5% of the time (5% rule).
- restrictions on supply should not be necessary more than once every ten years on average (10% rule).
- the system should be able to supply 80% of normal demand (ie. 20% reduction in consumption) through a repeat of the worst recorded drought starting at the time restrictions are first applied (20% rule).

The guidelines seek to provide schemes which are operationally satisfactory so that restrictions are neither of excessive duration nor too frequent and so that adequate capacity is available to allow the operating authority to manage the scheme during drought periods.

The concept report prepared on behalf of the Department of Public Works and Services (Kinhill, 1994) modelled a 10,000 ML storage dam taking into account the 5/10/20 rule, the 1:100 year drought sequence, environmental flow restrictions, turbidity restrictions and the increasing demand for water over time. The full range of design criteria are reported in Section 4.2.1 of Kinhill (1994). The report concluded that:

- The present system does not have sufficient capacity to supply the 1996 demand in the 1:100 year drought sequence if the new environmental flow guidelines are incorporated in the model. However, the system is currently operating under previous licence arrangements which do not strictly apply the new level of environmental flows to be maintained.
- By the year 2001, additional storage capacity would be required to maintain water supplies during a 1:100 year drought sequence, irrespective of environmental flow restrictions.
- By the year 2040, the system would require a storage capacity of about 10,000 Ml to satisfy an assumed permanent population of 112,000 and a peak daily demand of 163 ML/day. If required, the works could be extended to cater for 120,000 people and the ultimate predicted demand of 20,400 ML/a (2040) in the derived 1 in 100 year drought.

Appendix E of Kinhill (1994) (Concept Report) provides detailed summaries of POSSIM modelling results in respect of scheme sizing.

Demand management measures including water restrictions at 20% have been taken into account in the scheme sizing calculations. Further demand management measures including improved water saving measures to reduce demand by a further 7% and potentially increasing restrictions at a higher trigger level would be required to meet the design criteria. Other possible modifications such as installing larger pumps at Koree Island or reducing turbidity constraints by pretreatment would assist in meeting the ultimate predicted demand encountered in the 1 in 100 year design drought.

A 10,000 ML storage is just sufficient to meet water requirements for the planning horizon and is the maximum practical size at the Cowarra Forest site. Construction of a smaller storage at this site would:

- probably require the construction of another storage within the planning horizon;
- would result in less scope to maintain favourable environmental flow conditions during droughts.

If demands are lower than projected through slower growth or if greater water conservation can be achieved then:

- planned increases in Koree Island pump capacity will occur at later dates;
- the system will be more reliable (restrictions will be less frequent);
- the impact on downstream flows will be less, in particular there will be less impact on flows below the 80th percentile flow.

Timing of the Project

Sections 5, 6 and 7 discuss the proposed staging of headworks and the dam construction. As the dam cannot feasibly be constructed in stages, it is proposed that construction be completed by 2001 to ensure that a secure water supply is achieved for the year 2001 and maintained as the population increases towards its projected population within the project planning horizon (2040)

4.0

4.0 ASSESSMENT OF PROJECT ALTERNATIVES

4.1 Project Alternatives

The development of the Hastings District Water Supply Augmentation Scheme concept has involved the investigation of a range of scheme alternatives which have considered:

- how to most efficiently use existing infrastructure and minimise capital expenditure on new infrastructure through work staging and demand management;
- which of a range of water source options is most appropriate to meet the long term needs of the district;
- having justified the need for increased water storage, which of a range of alternative dam sites is most appropriate; and
- what operating strategies are most suited to the preferred dam site and concept design.

These project alternatives are addressed in the following sections.

The option of not proceeding with any of the scheme alternatives is considered incompatible with the strategic project objectives (Refer Section 3.4) and would lead to rapid erosion of the existing water supply and distribution system's ability to meet the needs of the projected future population of the district. This would lead to increased restrictions during drought to the extent that future development in the district would be constrained.

4.2 Demand Management Alternatives

Water demand management initiatives can reduce water consumption and delay the need for augmentation whilst meeting critical periods of predicted supply shortage. Other objectives of implementing demand management measures include:

- raising public awareness of the value of water;
- identifying areas which place unreasonably high demands on the system;
- controlling growth in average annual usage; and
- reducing peak demands.

A range of community education programmes, occasional water restrictions and a water pricing scheme have already been implemented by Hastings Council.

The benefits of water conservation derived through demand management include the following:

- deferral of capital cost expenditure;
- saving of operating cost expenditure;
- more efficient use of water resources;
- reduced environmental pressures; and
- sharing responsibility of the management of water resources among different groups of water users.

To fulfil the broad objectives of demand management a range of approaches is currently employed by Council and would continue if the dam is constructed.

4.2.1 Water Pricing

Council has recently adopted a two part tariff replacing conventional water rates. All residential and strata consumers will pay $220 annually for access to the water supply (businesses $495). In addition all water users will pay a tariff on the basis of the volume of water used at a cost per kilolitre of $0.56. This user pays system is fundamental to a demand management strategy and gives users a financial incentive to use water efficiently and informs them as to the true cost of water. It is necessary to support the water pricing strategy with other demand management programs to assist the user in reducing consumption.

4.2.2 Public Education and Communication

Council is a member of the Department of Public Works and Services Waterwise programme and conducts ongoing public awareness campaigns using various media avenues aimed at changing community attitudes to water consumption. Programs for schools and the wider community educate users in how water can be used more efficiently and how patterns of usage can reduce peak demands.

With the implementation of a water pricing system consumers are encouraged to adopt water efficient appliances to reduce their water usage and water costs. Improved design has raised the efficiency of such household appliances as toilet cisterns, shower roses and washing machines. Implementing mandatory installation of some of these appliances in new and replacement situations would have a long term impact on reducing water consumption. Assistance to builders and home buyers in choosing correct appliances would also be beneficial.

Council is currently developing a water efficient home display in the Port Macquarie Building Information Centre. This will provide the community with a demonstration of practical options for the conservation of household water. Council has also recently resolved that the General Manager report on the feasibility of incorporating water conservation design requirements in the conditions of approval for Building Applications.

When billing for water usage, Council includes an educational brochure on aspects of water conservation in the home. A series of brochures has been proposed covering areas such as bathrooms, kitchens, laundries and garden and outside usage.

4.2.3 Garden Usage

A significant area of inefficient water usage is in the garden. A number of measures can be suggested to aid in controlling future water demands.

- Public education and appropriate water pricing (refer 4.2.2);
- Selection of appropriate water efficient plant species;
- Watering timed to coincide with less evaporative periods of the day; and
- Efficient use of sprinkler systems.

4.2.4 Water Loss

In recommending a range of demand management practises, it is appropriate to recognise that water losses will occur in the supply system. Consideration must be given to evaporation from storage systems, leakage from pipelines and water which is not accounted for through lack of metering. Council currently estimates that approximately 20% of the water abstracted from Koree Island is lost from the system due to leakage. To reduce water loss a program of monitoring and recording water supply and actual usage is in place and would continue if the proposed dam is constructed.

4.2.5 Recycled Water

Increasing the usage of recycled water can be an effective alternative in managing future water demands. Using water recycled from treated sewage effluent reduces the consumption of potable water from existing supplies. However, the cost of treatment and distribution of recycled water suggests this alternative is not appropriate for household use. Potential users of recycled water could include:

- irrigation
- municipal watering
- golf course uses
- industrial uses

Council is committed to investigating potential effluent reuse opportunities, already the following existing uses are in place:

- the Port Macquarie Golf Course which currently uses all dry weather flow from the Lighthouse Beach Sewage Treatment Works;

- school playing fields located on Ocean Drive, Port Macquarie which utilise effluent from the Port Macquarie Sewage Treatment Works; and

- the Wauchope Golf Course and nearby agricultural land (proposed) will see all dry weather flow from the Wauchope Sewage Treatment Plant reused.

Effectiveness of Demand Management Alternatives

Over the ten years since the adoption of a user pays system by the Hunter Water Corporation there has been an overall reduction of 30% in the average domestic water consumption. The implementation of a user pays system in the Hastings Region has commenced and may reduce demand per household to a similar level which would in turn influence projected overall demands.

Each of the above demand management measures are consistent with the project objectives and remain as policy options for Council. However, demand management measures in isolation would not meet the district water usage requirements predicted in Section 3. The consumption projections have been conservatively calculated on the basis of a 10% water usage saving, assuming the implementation of a range of demand management measures.

4.3 Alternative Source Options

4.3.1 Surface Water

Hastings River

The Hastings River system is the most reliable source of surface water in the district and is the sole source of supply in the region capable of meeting demand and quality requirements. The average annual stream flow of 1,030,000 Ml is sufficient to satisfy forecast demands of 18,000 - 26,000 ML (1.75% to 2.5% of average annual stream flow) annually.

Weir on Hastings

Locations above and below the present uptake point at Koree Island were investigated in 1973. These investigations were only carried out on a minor scale and there was no determination with respect to possible weir locations. In view of the flow records of the River and the costs involved, it was considered more desirable to make maximum use of the present intake pool at Koree Island rather than to construct a weir. This interpretation was confirmed in the 1987 Strategy Study (Binnie and Partners, 1987).

Further investigations were conducted by Council and the PWD in 1991 in response to issues raised during public forums held to discuss the Concept Report, July 1991. The results of these investigations confirmed the original findings.

Dam on Pappinbarra River

Preliminary assessments (PWD, 1973) concluded that the capital cost of works and annual operating costs were too high for this to be an acceptable option.

Hartys Creek

This site is a considerable distance upstream from the present uptake and would require a substantial length of new pipeline. This site was considered uneconomic in 1973 (PWD, 1973) and subsequent Strategy Study (Binnie and Partners, 1987).

Ellenborough River

The construction of a weir on the Ellenborough River was considered for direct abstraction to the water distribution system or for controlling river flows. The capital cost of pipelines and pumping stations eliminated the direct abstraction option. Significant areas of pastureland would be inundated by a flow regulating weir. The cost of the acquisition of this land combined with weir construction costs precluded the option of a weir as a flow regulating mechanism.

The damming of the Ellenborough River was considered to be too expensive due to difficult access and rugged terrain. Benefits would be the generation of hydro-electric power, however this would require 30 km of transmission lines to connect with the state grid. Apart from cost, other factors which preclude an on stream storage as a viable alternative are the drowning of wilderness areas upstream, potential effects on downstream landowners and environmental impacts, especially on aquatic life downstream.

Camden Haven River

The Camden Haven River has insufficient yield even for the southern arm of the system, without incorporation an off creek storage. This river has also been known to periodically stop flowing and has poor water quality. Until 1987 an intake at Logans Crossing supplied Kew, Kendall and Herons Creek. This intake was closed due to frequent poor water quality.

4.3.2 Groundwater

Binnie and Partners (1991b) found that there is limited potential for large scale development of groundwater supplies within the Hastings Region. The only two sources of good quality groundwater are the alluvium deposits near Wauchope and the sand dunes to the north of Port Macquarie.

The groundwater near Wauchope is currently utilised and further exploitation is unlikely due to limited recharge and large volumes of highly saline water within the system.

The groundwater potential of the aeolian deposits north of Port Macquarie would require further investigation. However, these dunes occur within Limeburners

Creek Nature Reserve. Groundwater abstraction could be inconsistent with the environmental management objectives of the Nature Reserve.

4.3.3 Rainwater

Reintroduction of the use of residential rainwater tanks could provide a potable water supply and reduce current and future reticulated water demands. However, domestic tank supply would not meet current indoor and outdoor demands. This would require supplementation from the town water supply system.

Problems involved with this system include:

- public health concerns;
- social attitudes;
- cost of tank installation; and
- tank cleaning/pump maintenance.

As discussed in Section 4.2.2, Council is currently investigating the feasibility of the use of rainwater tanks.

4.3.4 Reclaimed Water

Binnie and Partners (1991b) examined the potential for the use of reclaimed or recycled sewage effluent provided treatment meets the relevant quality standards. In practice health regulations, economics and public perception constrain the use of such sources for potable water supply, however, use for farm irrigation and external use through a dual domestic system are feasible.

The Port Macquarie and Wauchope Golf Courses currently irrigate using treated effluent and there are significant further opportunities for increased use in open space irrigation. However, increasing consumer demand would not eliminate the need for augmentation of the potable supply system.

The use of recycled water for external domestic uses would require additional treatment as well as significant costs to the consumer for the installation of separate domestic and street reticulation. The use of recycled water for potable supply would require significant further treatment and testing of effluent including:

- removal of organic chemicals;
- removal of dissolved salts;
- further disinfection to remove pathogenic bacteria and viruses; and
- phosphorus and nitrogen removal.

It is estimated that fully recycled water for potable use would cost at least five times as much as water from conventional sources (Binnie and Partners, 1991b).

The very high costs and the uncertain feasibility of totally avoiding risks to community health have precluded this option.

4.4 Alternative Dam Locations

4.4.1 Identification of Alternative Sites

Council adopted the principal findings of the Strategy Study presented in 1987 and Concept Report in 1991 (Binnie and Partners, 1987 and 1991b) which recommended that the long term physical augmentation of the Hastings District water supply system be based on the provision of a new off-creek storage to be located near the geographical centre of the system.

This augmentation would also include the expansion of the Koree Island Pumping Station and associated pipelines and provision of an off-creek storage to link with the existing southern arm system.

The investigation of potential off-creek storage sites was based on several criteria including available storage capacity, proximity to existing works, land use, environmental impact and cost. This assessment was undertaken by Binnie and Partners (1991b).

Of 24 sites considered, 15 were suitably located and warranted further investigation. Following field inspection this number was reduced to six sites listed as A to F (Figure 4.1). Sites A and B were subsequently rejected due to inadequate storage capacity. Constructing a dam at site C would have required the inundation of an area of sub-tropical rainforest and site F was inappropriate due to the occurrence of a geological fault within the site. The choice was therefore reduced to two sites, D and E, which were further compared. Site D is located immediately adjacent to the Pacific Highway while site E is mainly within Cowarra State Forest.

Lake Innes, lying immediately south of Port Macquarie, was considered as an off-creek storage in 1973. Despite its attractive proximity to areas of high demand, the limited depth of the lake, the potential for brackish water and high evaporation rates precluded the site from selection.

4.4.2 Comparison of Preferred Sites

A Review of Environmental Factors (REF) (Binnie and Partners, 1991c) was undertaken to determine whether the construction of a dam at either of the preferred sites (D and E) would significantly affect the environment. A comparison of the preferred sites (Binnie and Partners, 1991a) was based on the following criteria:

- environmental

- catchment management
- future augmentation potential
- land use
- land acquisition costs
- dam construction and operation costs

The calculations of areas of land affected by the dam proposal and the consequent land valuation reported in Section 4.4.2 are based on figures obtained by Binnie and Partners (1991a). These estimates have been subsequently refined in Section 5 of the EIS.

Environment

Site D has an estimated total catchment of 302 ha of which 129 ha would be inundated by a 10,000 ML storage. Of this area to be inundated, 77 ha is uncleared forest, 72 ha of which is dry sclerophyll forest and 5 ha is wet sclerophyll forest, the remainder is cleared.

Site E has an estimated catchment area of 112 ha. A 10,000 ML dam there would inundate an area of 62 ha of which 50 ha is dry sclerophyll forest and 12 ha is wet sclerophyll forest. Although Site D would require more clearing, Site E has a greater area of wet sclerophyll forest, a greater species diversity and a lower degree of disturbance than site D, and is regarded as having greater habitat and conservation value. Both sites contain freehold land and State Forest which could readily be altered by clearing, logging, or unsympathetic land uses.

Catchment Management

Management practices within a catchment above the level of inundation necessarily constrain land use to protect the quality of the stored water. As the catchment area of site D is three times that of site E and the area to be inundated at Site D is greater than E, a much greater area of land would be effectively sterilised from land all use activities that are incompatible with a water supply catchment. Therefore, in terms of land use management, Site E is preferable to Site D.

Future Augmentation Potential

The original capacity requirement for each dam site envisaged in the 1991 Concept Report was 5000 ML. Both sites D and E have the potential to economically accommodate an increased capacity storage of up to 10,000 ML. A 10,000 ML storage capacity has since been adopted for the proposed dam. Annual evaporation losses would be greater from a dam at site D (200 ML) than at site E (120 ML) given the larger surface area of a dam at site D.

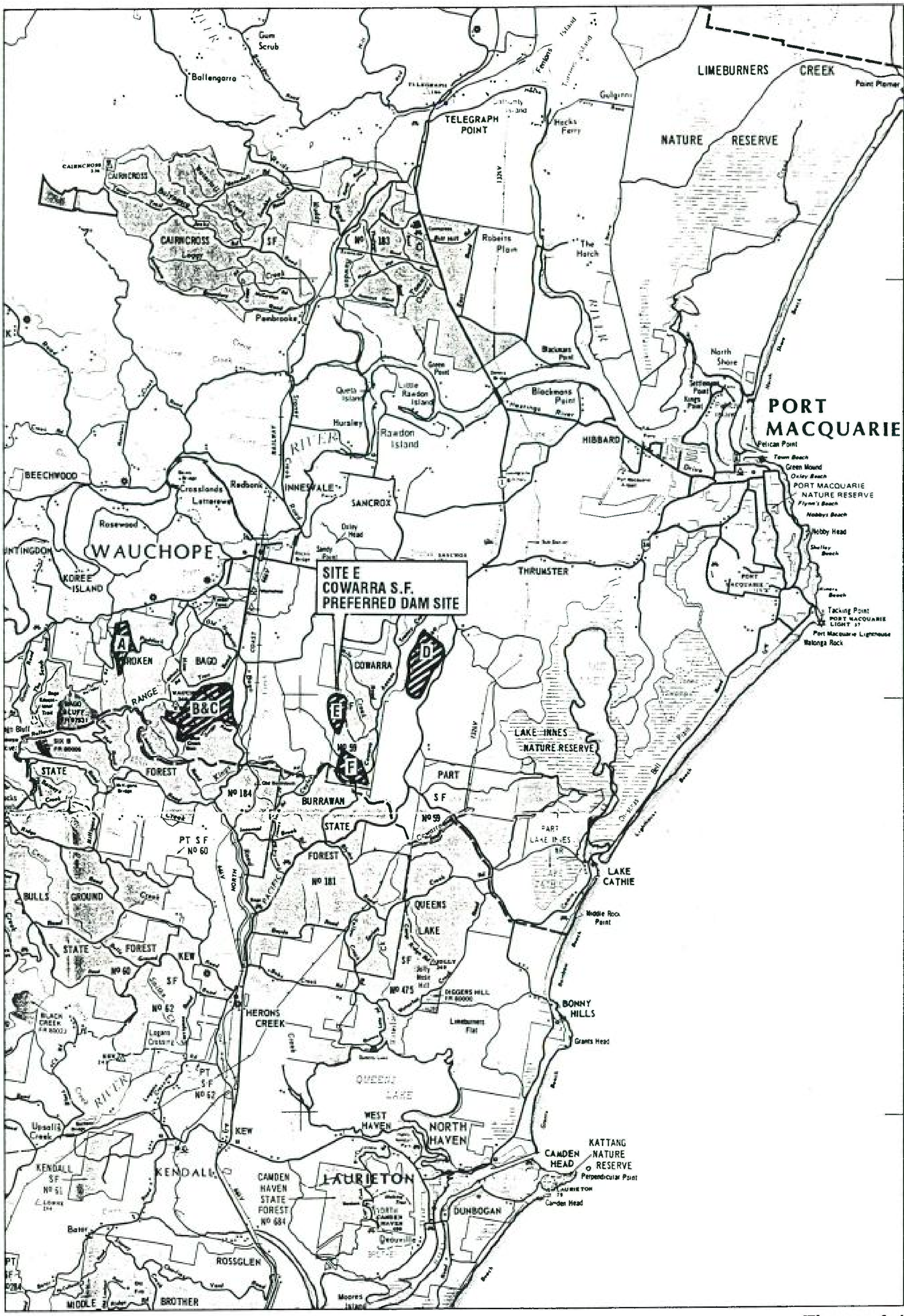


Figure 4.1
Alternative Dam Sites

Land Use

Sites D and E both contain areas of State Forest and areas of freehold land zoned Rural 1(a). About 166 hectares of land in site D falls within a long term residential investigation area and has some potential for rezoning from rural to residential. This would significantly increase the value of this land. The accessibility of land in site D also enhances its value over land in site E. Site E is not within the current or proposed rural residential zone.

The value of the timber resources on the State Forest controlled land was indirectly considered in the selection of a preferred dam site. The area of forestry land which would be inundated or subject to management constraints is greater for site D (136 ha) than for site E (83 ha).

The Department of Mineral Resources has no objection to the sterilisation of Site E as the area is underlain by Carboniferous metasediments which contain no prospective rocks. All of Site D is covered by an Exploration Licence for limestone and the Department provisionally objects to sterilisation of this land.

Land Acquisition

Of the 112 ha comprising Site E, 83 ha is State Forest and 29 ha is rural freehold. Site D covers 302 ha of which 136 ha are State Forest and 166 ha are privately owned. An area of land in Site D has the potential for rezoning to rural residential. As a result the land in Site D has an estimated value of $2000/ha compared with $1500/ha for land in Site E (1989). Based on these figures the cost of land acquisition for site D was estimated at $604,000 and $168,000 for site E. This is balanced by the construction costs of the 4 km access road to site E compared with the 1 km access road to site D ($150,000/km, 1989).

Dam Construction and Operation

Estimates for dam construction indicate that Site E is most economically able to provide a storage capacity of 10,000ML. Subsequent operation and maintenance do not differ significantly between the two sites. The estimated costs in providing pipelines, pumping stations and balance tanks are similar for each site.

Preferred Site

Having considered the relative advantages and impacts of the alternate sites, the preferred location for construction of an off-creek storage was Site E (Binnie and Partners, 1991a). This site was adopted by Council in 1991.

4.5 Alternative Operating Strategies

Five alternative operating strategies were considered to meet the objectives of providing a quality supply which both meets forecast demands and satisfies environmental flow requirements. All of the options reviewed involved the construction of a new off-creek storage facility. Three of the options also included a filtration plant in the supply system.

With the existing system, water uptake from the Hastings River ceases when turbidity levels reach 15 NTU (Nephelometric Turbidity Units) or when river flow drops below 100ML/day. These constraints have restricted the availability of river water for long periods making it necessary to implement water restrictions. With a 10,000 ML off-creek storage dam, a continuous supply could be maintained during extended periods of high turbidity or low flow. A new off-creek storage would primarily supply the Port Macquarie Reservoir at Transit Hill and the southern arm of the system. It would also supply Wauchope during periods of high river turbidity.

The only form of water treatment used in the existing system is chlorination. Water is chlorinated at the Rosewood Road Reservoirs before passing on to the off-creek storage in Port Macquarie. By incorporating a filtration plant into the system, uptake and transfer of water to the existing off-creek storage at Port Macquarie could continue during periods of high turbidity. By installing a filtration plant between the uptake point and the new storage, the plant would only need to cope with average annual flows, whereas a filtration plant located after the off-creek storage would have to cope with peak daily demands. To minimise costs, a smaller capacity filtration plant located before the dam would be preferable. However, all three options which included a filtration plant in the system were found to be too expensive with respect to their potential benefits and were therefore rejected at this stage. Alternative methods are proposed to ensure that the dam water does not require further filtration (refer Section 5).

4.6 Selection of Preferred Alternatives

With the removal of the filtration plant options, the choice of option was based on dam site selection criteria. Site E was preferred over site D (refer Section 4.3). The operating strategy is the same for each of these two options. The system operation would be as follows:

- The Koree Island pumping station, with increased capacity, would pump up to Rosewood Road Reservoirs. From there, water would gravitate to the Port Macquarie Dam and the new 10,000ML off-creek storage in Cowarra State Forest. Both of these storages would be kept full.

- Normal operation would be by drawing from the Port Macquarie dam to supply the Port Macquarie area with the new dam in Cowarra State Forest supplying the southern arm of the system and providing back up storage.

- Wauchope would normally be fed directly from the Rosewood Road Reservoirs. However, during periods of high turbidity water would be fed from the new dam via an elevated balance tank.

In 1994 Council re-affirmed its preference for the Cowarra State Forest dam site and compatible operating strategy on the basis of a revised concept report prepared by Kinhill (1994), and independently reviewed by DPWS.

5.0

Australian Bass

5.0 COWARRA DAM

5.1 Project Description

A 10,000 ML off-river water storage is proposed in Cowarra State Forest in the upper catchment of an unnamed tributary of Kings Creek (refer Figures 5.1 and 5.2). A 62 ha area would be inundated by the dam at full supply level. This area would represent around 57% of the total dam catchment of 109 ha.

The dam would be constructed for commissioning in Stage 2 of the Hastings District Water Supply Augmentation Scheme in 2001 (refer Section 5.1.13). The dam would be supplied by pumping water from the Hastings River near Koree Island via pipelines to the inlet structure at the eastern end of the embankment of the Cowarra Dam.

A glossary is provided for technical terms used in the project description.

5.1.1 Dam Type and Arrangement

The proposed dam is a zoned earthfill embankment consisting of a clay core, filter layers and earthfill zones constructed from ripped weathered rock excavated from within the proposed area of the storage and an outer upstream layer of hard rock rip-rap. The dam would be approximately 40m tall and extend for 550m. Sources of clay core material are within the storage area and in the vicinity of the construction site adjacent to Sarahs Creek (refer Figure 5.1). A schematic representation of the dam is shown in Figure 5.3. Embankment zones are shown in Figure 5.4. The embankment design is described in further detail in Section 5.1.4.

A smaller saddle dam of similar design would be constructed to the south-east of the main embankment. A spillway adjacent to this dam would be lined where required with rockfill mattresses and would direct overflow to the adjacent Sarahs Creek catchment to the east.

The size of the dam and spillway have been calculated on the basis of hydrological investigations which are discussed in Section 3. Further details of the dam concept design are provided in the Concept Report (Kinhill, 1994).

5.1.2 Foundation Conditions

The concept design stage geotechnical investigation (PWD, 1994a, Vols 1-3) was conducted from April until early August 1994. The site was investigated using a number of techniques, including geological mapping, trenches, diamond drilling (with water pressure testing), seismic refraction, test pits, and laboratory testing of soil samples.

Foundation conditions at the site are suitable for a zoned earthfill embankment. Foundation materials were classified by the geotechnical investigation as moderately to highly weathered rocks which are considered to be suitable for

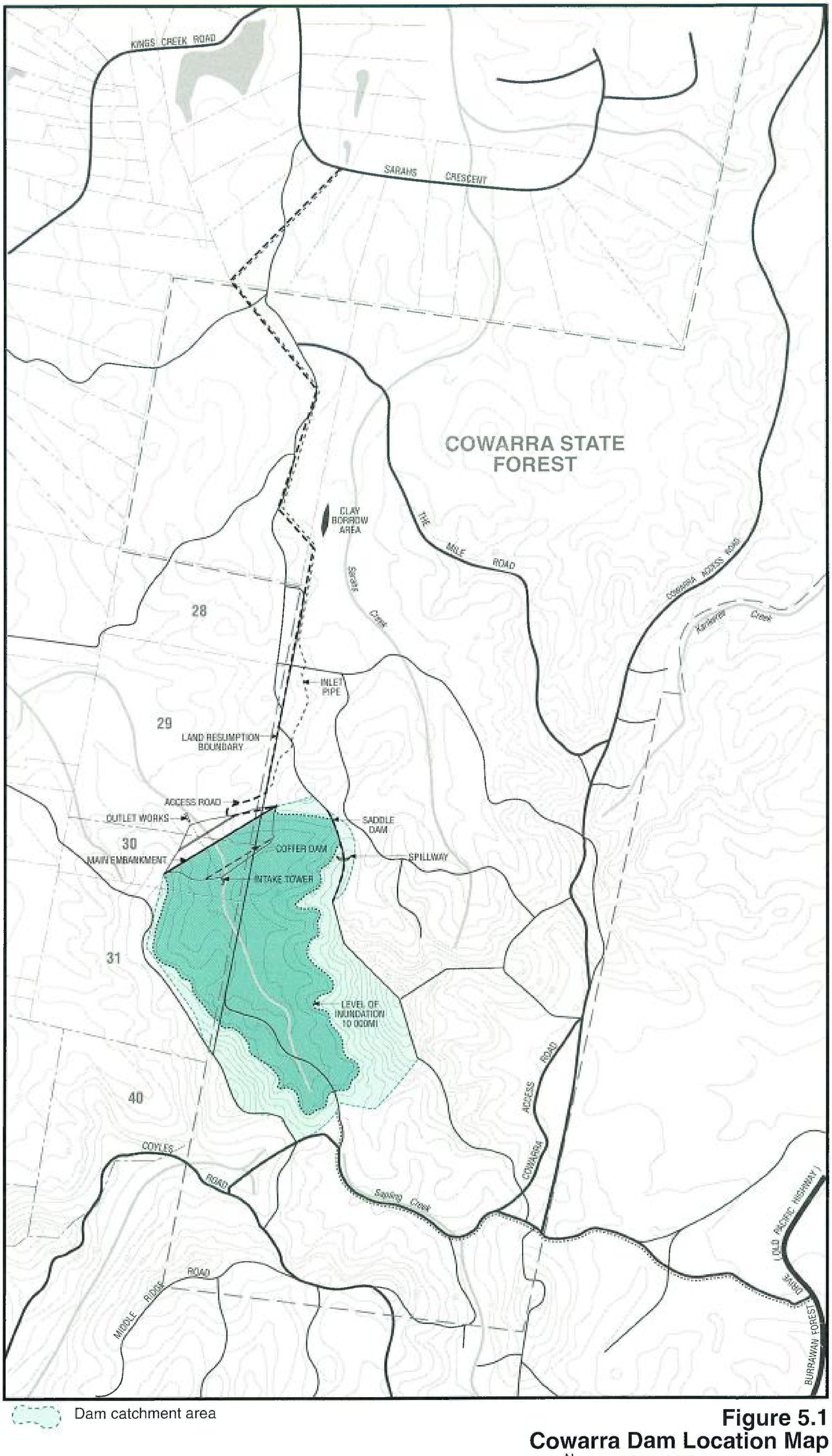


Figure 5.1
Cowarra Dam Location Map

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Hastings District Water Supply Augmentation
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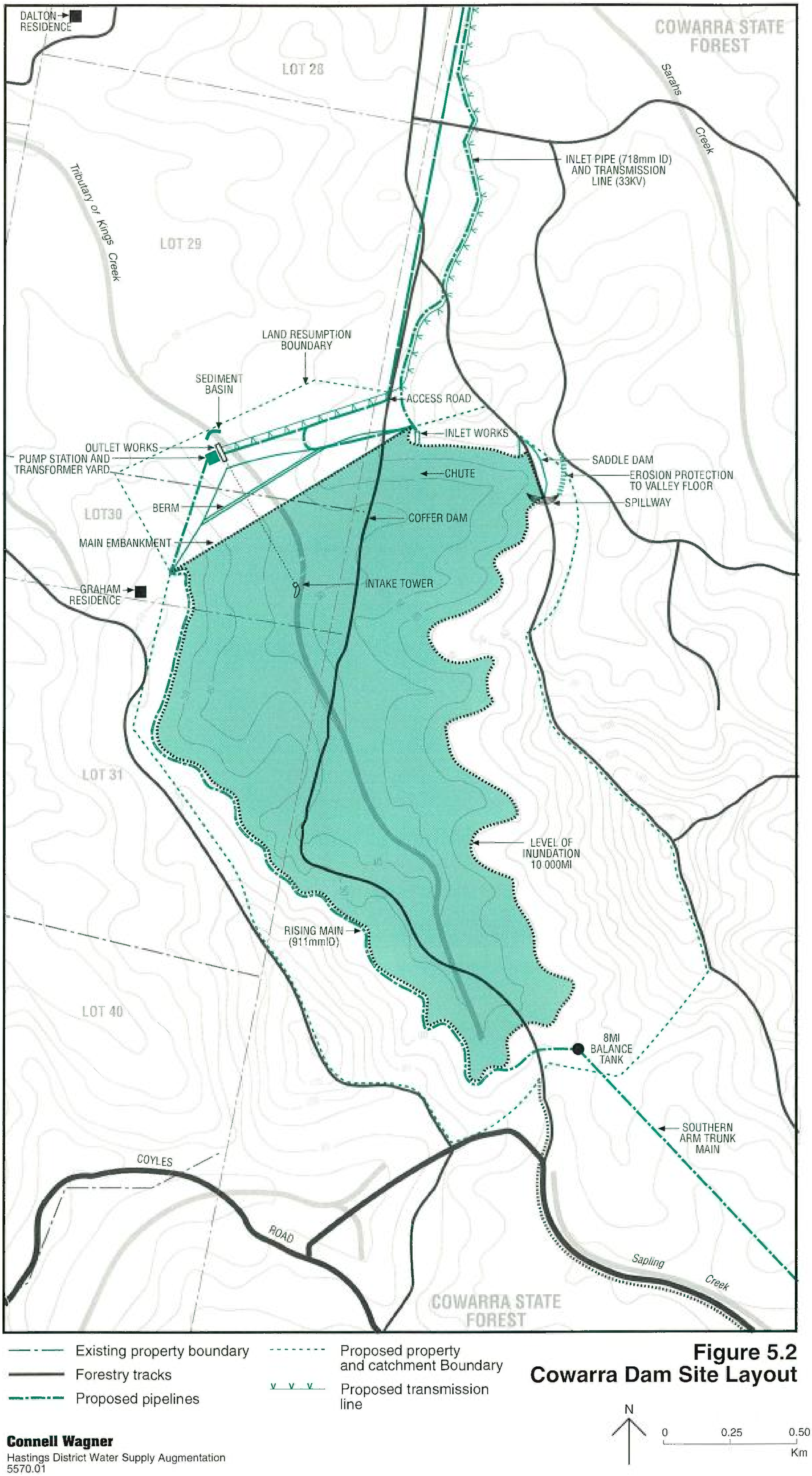


Figure 5.2
Cowarra Dam Site Layout

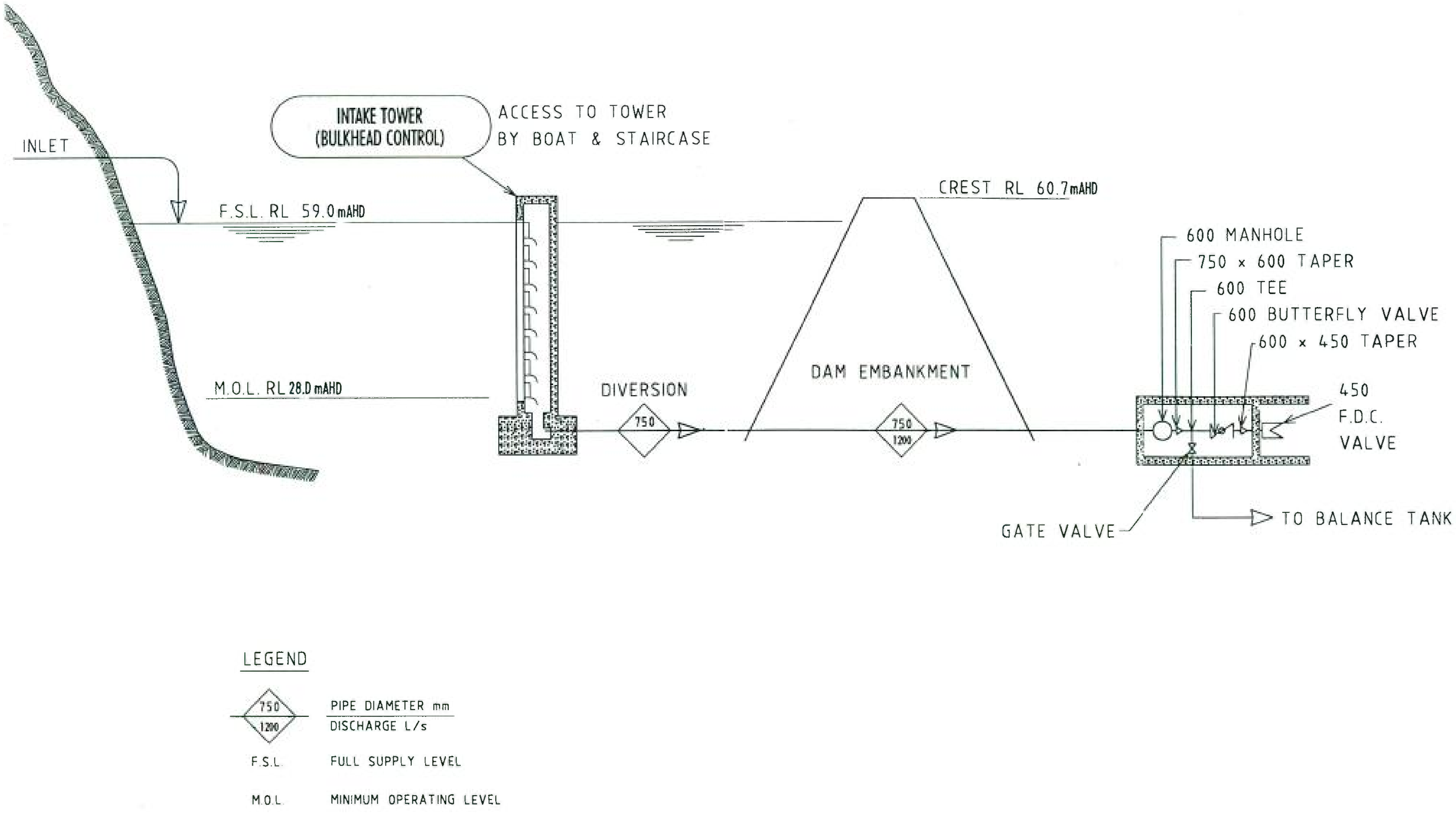


Figure 5.3
Schematic Cross Section of Cowarra Dam

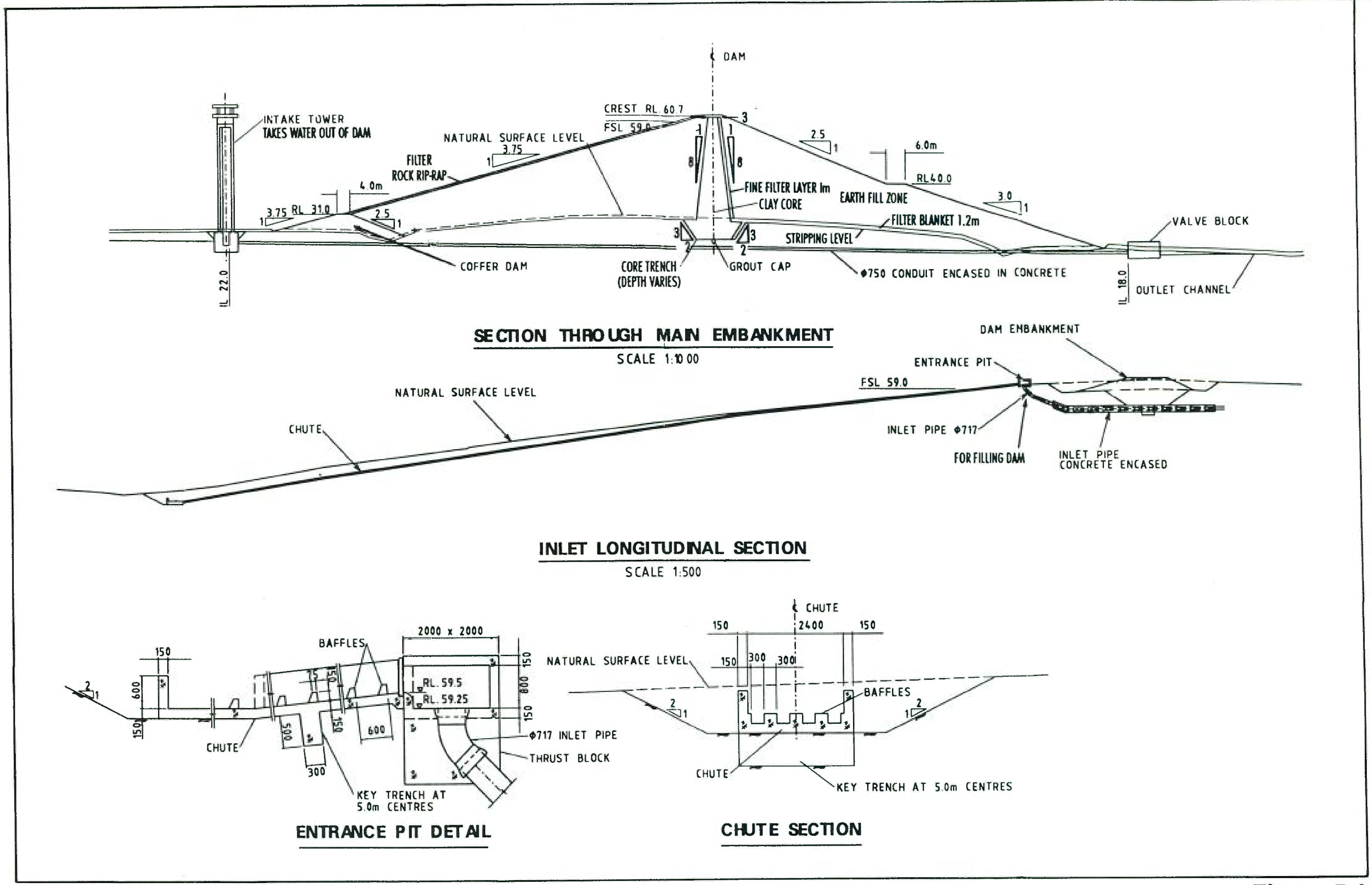


Figure 5.4
Main Embankment Cross Section

foundations (details of site geology and seismicity are provided in Section 5.2). Required depths of excavation for the core trench are likely to be 4 to 6m and approximately 8m on the lower to middle slopes of the western abutment. Beneath the outer zone of the dam, investigations indicate that the extremely to highly weathered rock would provide suitable foundations. About 0.8m of earth would be stripped from beneath the embankment area to provide a sound foundation. However, excavation depths of up to 2.5m may be required in thicker colluvial soils and extremely weathered rock on the lower to middle slopes of the western side of the valley. The saddle embankment would be less demanding with respect to foundation conditions, and excavation depths of 1.5m for the outer zone and 3m for the core trench are expected.

An outlet pipe would be located on the lower western abutment founded in predominantly weathered rock. Foundation treatment may be required in the core trench to remove localised zones of more weathered clayey rock. A coating of slush grout or concrete is likely to be required over the cleaned core foundation surface.

Curtain grouting would be required to reduce the potential for seepage beneath the main embankment. This consists of pumping a cement slurry into holes drilled vertically through the base of the core trench. The slurry moves under pressure into cracks in the ground, forming an underground vertical "curtain" of concrete. A grout cap is also likely to be required, because of the very fractured nature of the rock at the site.

In areas of deeper excavation, the floor of the spillway, located adjacent to the saddle embankment, is likely to be located in predominantly moderately weathered (some slightly weathered) meta-sandstone and meta-siltstone. The spillway discharge channel may be susceptible to erosion and would require erosion protection measures.

5.1.3 Construction Materials

Estimates of the availability of the required quantities and sources of materials have been provided in geotechnical reports (PWD, 1994a, Vols 1-3).

Core

Potential supplies of core material are available from colluvial soil deposits within the storage area, and in a proposed 2.4ha clay borrow area located outside the storage area (refer Figure 5.1 and 5.2). Additional supplies of core material would also be available from embankment stripping on the lower to middle western abutment. The total quantity of core material reserves on the site is approximately 170,000m^3. These deposits would be fully utilised.

Filters and Rip-rap

Supplies of filter material, sand, aggregates and rip-rap would be obtained from commercial sources. A potential source of rock armour is located at a quarry on the Pacific Highway 2km north of the Oxley Highway intersection. The Department of Public Works and Services also operates two quarries in the area, at Port Macquarie and Laurieton, for production of breakwater armour.

Earthfill

Potential supplies of earthfill would be available by ripping weathered rock in the storage area. Approximately 800,000m^3 of earthfill for the outer zones is required and it is anticipated that excavation to approximately 20m depth would be possible. Initial laboratory testing indicates that these materials are likely to partially break down on excavation, haulage and placement in the embankment.

5.1.4 Dam Embankments

Location and Description

The 10,000ML storage embankment has a straight line axis running in a NE-SW direction with each embankment abutment terminating below the natural ridge line. The location of the main embankment is shown on Figure 5.2.

Details of the main embankment for the Cowarra Dam are as follows:

Type	-	zoned earthfill	
Batter Slope	-	upstream	3.75(H):1(V)
	-	downstream	2.5(H):1(V) upper level
			3.0(H):1(V) lower level
	-	6.0m wide bench at RL40.0m AHD	
Maximum Height	-	40m (at centreline)	
Embankment Length	-	550m	
Crest Width	-	6m	
Crest Level	-	RL60.7m AHD	
Full Supply Level	-	RL59.0m AHD	
Design Flood Level	-	RL60.2m AHD	

A typical cross section for the main embankment is shown on Figure 5.4.

The required freeboard (i.e. height from full supply level (FSL) to the dam crest) is determined by a combination of flood rise and wave run-up on the embankment face. Two cases have been considered in the concept design:

- Probable Maximum Flood (PMF) storage level combined with wave run-up from a 1 in 100 year wind event would require a crest design level of 60.7m AHD. Calculations for wave run-up are based on the effective fetch (water surface distance over which wind blows) of 0.83km.

- Storage at FSL and wave run-up due to a 1 in 100,000 year wind event would require a crest design level of 60.2m AHD.

The critical level for the storage is therefore RL60.7m AHD and accordingly the crest of the dam has been set at RL60.7m AHD.

Embankment Core

Owing to the limited availability of local core material it is proposed to optimise the design by adopting a narrow core for the dam (i.e. core width (W) to stored water height (H) ratio of 0.35). This is possible due to the low permeability of the highly plastic clays available for core material.

As shown on Figure 5.4, the clay core within the embankment has a top width of 3 metres (minimum for construction equipment) and batter slopes of 1(H):8(V). The base width of the core trench under the embankment is controlled by the W/H ratio of 0.35, with excavated trench batter slopes of 2(H):3(V). Depths of excavation in the core trench range up to 8m.

The potential core material in the borrow areas is classified under the Unified Soil Classification System (USCS) predominantly as CH (inorganic clays of high plasticity) with some samples identified as GC (clayey gravels) and SC (clayey sands)/CL (gravely clays). The geotechnical properties range as follows:

Maximum Standard Dry Density:		-	1.49-1.64t/m^3 (av. 1.59)
Optimum Moisture Content (OMC):		-	19.5-27.5% (av. 23.3)
Plasticity Index (PI):		-	18 to 76% (av. 47.7)
Clay Content: (particles smaller than 0.002mm)		-	18 to 69% (av. 48.4)
Effective Shear Strength:	Cohesion (C')	-	5kPa
	Friction (Ø)	-	25°

The dispersive characteristics of the clays are variable, ranging from non-dispersive to highly dispersive. Appropriate precautions such as filter layers would be necessary. The potential for dispersive activity of a soil to cause problems is reduced by wetting the clay beyond its optimum moisture content and compaction to a high density. However, the high moisture content makes the highly plastic clay become sticky and difficult to work. The characteristics of the core material given above satisfy the desirable criteria of plasticity index greater than 10% and clay content greater than 15%.

Suitable fine filter material and coarse aggregates would be obtained from commercially available (concrete aggregate) supplies. A one metre thick chimney filter of sand between the clay core and the earthfill zones minimises the movement of clay particles from the core, thus protecting against piping. The chimney filter would also drain away any seepage passing through the core to avoid saturation and consequent failure of the downstream earthfill zone. The downstream blanket filter incorporates a 0.6m thick coarse (gravel) layer between 0.3m thick fine (sand) filter layers. A 0.2m thick filter layer of crusher-run aggregate is considered appropriate for the upstream face under the rip-rap layer.

Outer Zones

The outer earthfill zones of the main embankment would be constructed of weathered rock from within the storage area. The material is predominantly CH classification (inorganic clays of high plasticity) with some samples identified as GC (Clayey Gravels) and SC/CL (Clayey sands/gravelly clays) classified under the unified soil classification system (Casagrande, 1948). The geotechnical properties range as follows:

Maximum Standard Dry Density:		-	1.62-1.71t/m³ (av.1.66)
Optimum Moisture Content(OMC):		-	19.5-22.5% (av.21.0)
Plasticity Index (PI):		-	22 to 68% (av.45.7)
Clay Content: (particles smaller than 0.002mm)		-	18 to 71% (av.47.3)
Effective Shear Strength:	Cohesion (C')	-	3kPa
	Friction (Ø')	-	32°

The shell material, which does contain significant portions of clay material is more permeable than the core material. It would be necessary for this material to be placed and compacted drier than the core to assist with reduction in construction pore pressures.

Embankment Stability

Analysis of embankment stability has been carried out using Bishop's Simplified Method of Slices. Computer programs XSLOPE and GALENA were used for the following cases.

- **Full Supply Level.** The FSL level case has been examined for the downstream slope of the embankment. Pore pressures within the embankment, due to the steady state seepage condition at FSL, were determined from the phreatic surface. The minimum Factor of Safety for significant potential failure surfaces was found to be 1.79 (a Factor of Safety of greater than 1.5 is considered acceptable.)

- **End of Construction.** The "end of construction" case has been examined for the steeper downstream face of the embankment. Two design approaches have been considered in the analysis:

  - Effective stress soil strength parameters and an r_u value, to represent construction induced pore pressures.
  - Total stress soil strength parameters.

  The minimum Factor of Safety for significant potential failure surfaces is 1.23 (effective stress/r_u) and 1.42 (total stress). A value greater than 1.25 is considered acceptable. The marginal shortfall in required stability under effective stress/r_u analysis requires further investigation, however consideration of the recommended placement and compaction criteria for the shell material is likely to demonstrate adequate stability.

- **Rapid Drawdown.** The "rapid drawdown" case has been examined for the upstream face, the stability of which would be reduced by rapid lowering of the storage to minimum operating level (RL28.0m AHD). The embankment has been analysed using effective stress parameters and a phreatic surface representing internal pore pressures within the embankment before loss of the supporting storage water. The minimum Factor of Safety for significant potential failure surfaces is 1.26. A value greater than 1.25 is considered acceptable.

- **Earthquake Loading.** Stability of the main embankment during earthquake loading has been examined for the steeper downstream face of the main embankment. The design earthquake loading for the Cowarra Dam is adopted as an event with an average recurrence interval of 10,000 years. For this event, peak bed rock acceleration is 0.25g.

  Stability analysis was carried out using the pseudostatic seismic coefficient analysis method of US Corps of Engineers. This analysis technique acts as a screening method to separate those dams that are clearly safe against earthquake induced failure from those that require further analyses. The minimum factor of safety for significant potential failure surfaces is 0.87. A value greater than 1 would indicate that the dam is clearly safe against earthquake loading. Therefore further analysis is required, and is being carried out to confirm the design.

  The failure of the embankment to comply with the screening test criteria merely indicates that further, more detailed analyses of the stability of the embankment under seismic loading is required. This would be done as part of the detailed design of the project and is not expected to raise any doubt as to the safety of the proposed dam. The detailed analysis would indicate whether design modifications to the embankment would be required or that the existing design is appropriate to meet the specified design criteria.

The final design will meet the design earthquake loading for the 1 in 10,000 year event.

5.1.5 Saddle Dam

<u>Location and Description</u>

The saddle dam would be located on the eastern ridge of the catchment approximately 300 metres south-east of the eastern abutment of the main embankment. The straight line axis of the saddle dam runs in a NNW-SSE direction. The location of the saddle dam is shown on Figure 5.2.

The saddle dam is of similar design to the main embankment with details as follows:

Type	-	zoned earthfill	
Batter Slope	-	upstream	3.0(H):1(V)

	-	downstream 2.5(H):1(V)
Maximum Height	-	6.7m (above natural surface at centreline)
Embankment Length	-	180m
Crest Width	-	6m
Crest Level	-	RL60.7mAHD
Full Supply Level	-	RL59.0mAHD
Design Flood Level	-	RL60.2mAHD

The saddle dam would be located on the crest of a saddle with both upstream and downstream batters intercepting natural surface at levels below the foundation at embankment centreline. A typical cross section for the saddle dam is shown on Figure 5.5.

Freeboard

Freeboard provisions are the same as those provided to the main embankment. Wind fetch distances to the saddle dam are less than to the main embankment and accordingly design wave heights, at the saddle dam, would be less.

Saddle Dam Zoning

The saddle dam would be zoned in the same configuration as the main embankment with dimensions of core and filters similar to the main embankment. Design parameters are as adopted for the main embankment.

General foundation stripping depths would be 1.5 metres over the entire base of the saddle dam with the cut-off trench excavation to an additional depth of 1.5 metres.

5.1.6 Spillway

Spillway Location and Description

The spillway would be located adjacent to the saddle dam on the ridge above the southern abutment of the saddle dam where suitable quality rock can be expected at the spillway level. To avoid potential problems at the interface of the saddle dam and spillway, the spillway is separated from the end of the embankment. The spillway location is shown on Figure 5.2.

Spillway discharges would be directed towards a small upper tributary of Sarahs Creek which runs approximately parallel to the unnamed tributary of Kings Creek on which the Cowarra Dam would be located. Spillway discharges would run down a drainage line for 500m in easterly direction before meeting Sarah Creek.

The spillway would be 5.1 metres wide at the crest with a small concrete sill acting as the control structure.

Access across the spillway cut is proposed to be provided by construction of a bridge consisting of a pre-cast concrete arch unit supported on reinforced concrete walls at each end. The top of the arch would be overlain by approximately one metre thick road formation supported by reinforced earth walls on each side. A longitudinal section of the spillway structure is shown on Figure 5.5.

Entry and exit channels for the spillway follow a curved alignment matching the topography to minimise excavation quantities and cutting depths. However, this results in the spillway exit channel being in soil foundations. To protect against erosion it is proposed to line the exit channel with PVC coated rockfill mattresses.

The spillway inlet channel is widened to minimise approach velocities at the crest and the exit channel is 5.5 metres wide. Batter slopes of excavated sides of spillway are 1(H):1(V) in weathered rock flattening to 2(H):1(V) at the top of the cuts, in soil. The longitudinal slope of the exit channel is one percent.

Spillway Flows

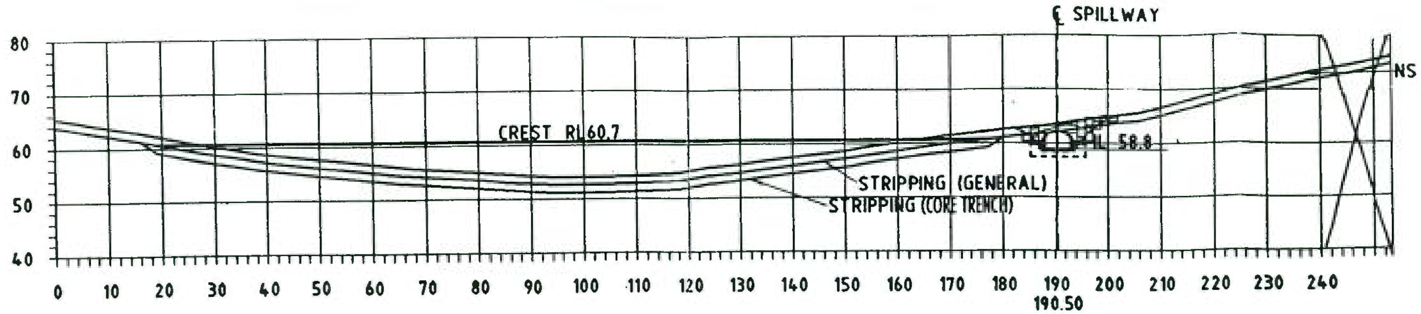
The spillway would operate when runoff from rainfall in the dam catchment exceeds the rate at which the dam outlet and pump stations can operate when storage is already at maximum capacity. Discharge from the spillway would only occur as a last resort. The operational EMP would contain guidelines for optimising the use of the dam outlet and pump station.

The spillway has been designed to carry the PMF. This event produces a peak inflow of 74m^3/sec, with a critical storm of 6 hours as outlined in Section 3 of the Cowarra Dam Concept Design Report (Kinhill, 1994). Peak spillway outflow would be 10.73m^3/sec in conjunction with a discharge of 2.2m^3/sec from the outlet works. The design flood level for the PMF event is RL60.26m AHD.

For more frequent storm events the critical spillway discharges are shown in Table 5.1 for the two scenarios of the outlet works operating in conjunction with the spillway and the spillway operating alone.

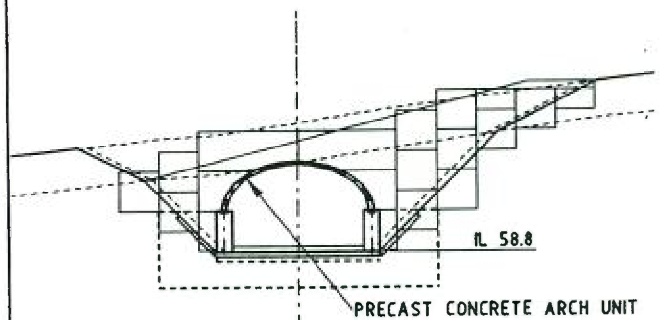
Table 5.1 : Spillway Discharge

Event Average Recurrence Interval (ARI) years	Spillway and Outlet Works			Spillway Only	
	Maximum Flood Level (m AHD)	Spillway Discharge (m^3/sec)	Outlet Works Discharge (m^3/sec)	Maximum Flood Level (m AHD)	Spillway Discharge (m^3/sec)
20	59.17	0.53	2.2	59.40	1.91
50	59.24	0.89	2.2	59.46	2.40
100	59.28	1.13	2.2	59.52	2.83

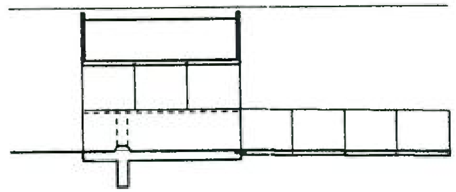


SADDLE DAM AND SPILLWAY - LONGITUDINAL SECTION

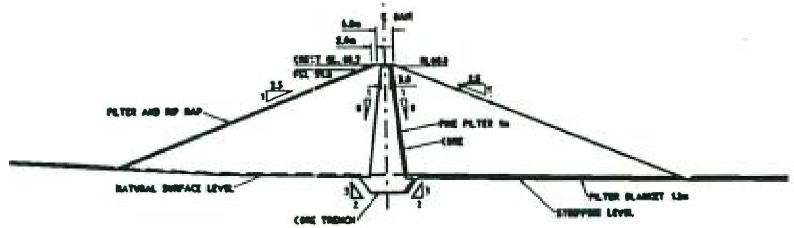
SCALE 1:1000



1:200

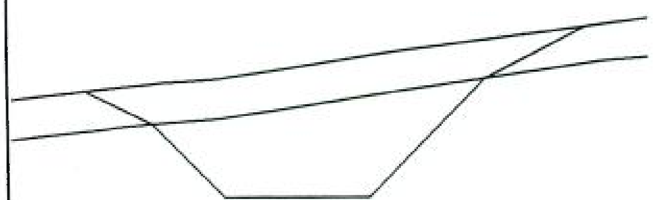


1:200



SECTION THROUGH SADDLE DAM

SCALE 1:2000



1:200

Figure 5.5
Cross Section of Saddle Dam and Spillway

Outflow velocities in the rock mattress lined spillway channel would not erode the spillway. However, once leaving the formed channel, flow could accelerate down the natural slope and potentially cause erosion of the hillside and sedimentation of the creek. Erosion protection measures, would therefore be designed and installed on the slope between the spillway and Sarah's Creek.

The spillway discharges during moderate flows can however be eliminated or reduced significantly by appropriate operation of the outlet works. This would be incorporated into the operational EMP (e.g. open outlet valves when storage level rises to a nominated level thereby avoiding or reducing the erosion and maintenance cost). The effect of operation of outlet works on reduction of spillway discharge can be seen in Table 5.1.

5.1.7 Diversion and Outlet Works

Diversion

During construction it would be necessary to divert creek flows past the construction area. This would be achieved by installing a 750mm diameter pipeline through the dam construction area with a coffer dam upstream of this area to detain storm flow.

As the catchment for the Cowarra Dam is small (1.08km^2) the pipeline would be adequate for low diversion flows, with the coffer dam providing detention storage for larger flows at the pipe inlet. The diversion pipe would ultimately be used as the outlet pipe for the dam, connecting with the pump station. A residual flow of the unnamed creek would also be maintained from this source to maintain the stream's aquatic environment.

The pipe would be installed in a trench through sound in-situ material and fully encased in reinforced concrete. Approach and exit channels would be required at upstream and downstream ends of the conduit. The diversion and outlet arrangements are shown in plan in Figure 5.2 and in cross-section in Figure 5.4.

The coffer dam would have a crest level of RL30.9m AHD. This arrangement would keep storm flows out of the construction area during a storm event with an ARI of 100 years. The peak inflow would be 10.9m^3/sec, peak outflow 1.51m^3/sec and maximum conduit flow velocity 3.4m/sec (maximum allowable velocity for cement lining is 5m/sec). Scour protection would be provided at the outlet.

The upstream coffer dam (Figure 5.2) would be constructed of ripped weathered rock and be incorporated into the upstream toe of the main embankment. The material for the coffer dam would be available from core trench excavation.

Outlet Works

The 750mm diameter cement lined steel pipe used for diversion during construction would also serve as the outlet pipe during operation of the dam. It is the minimum size pipe considered accessible for maintenance and inspection. The required peak operating capacity of the outlet works is 1.2m^3/sec and the maximum discharge capacity at FSL is 2.2m^3/sec with a maximum velocity of 5m/sec (ie. limit for cement lined pipes). The required operating capacity of 1.2m^3/s can be achieved with a lowered storage level at RL33.1mAHD or less than 5% of storage capacity.

To ensure security of the embankment the steel pipe would be fully encased in reinforced concrete which alone would have the capacity to take full water pressure (static plus surge).

At the downstream end of the outlet pipe, a butterfly valve followed by a fixed dispersion cone (FDC) valve would be provided to act as an emergency release and a scour outlet. This outlet would be used to maintain downstream flows for aquatic habitat requirements (refer Section 5.2.7). An offtake with necessary valve arrangements would also be provided for connecting the outlet pipe to the main water supply system. For maintenance of the pipe, the entry of water into the pipe would be blocked by the bulkhead gate in the intake tower and access into the pipe made through a manhole located upstream of the butterfly valve. A filling pipe and an aeration pipe would be provided to equalise pressures for the gate operation.

The arrangement of pipes and valves would be located within a valve block as shown in Figure 5.3. An energy dissipation chamber, would be located downstream of the FDC valve.

Storage Evacuation

During an emergency, draw-down of the storage (from Full Storage Level (FSL) to 10% of FSL storage capacity) can be achieved in approximately 52 days, a rate which complies with United States Bureau of Reclamation (USBR, 1992) guidelines for a "high hazard", "significant risk" dam.

Allowable flow velocities through the cement lined conduit, would be increased to 6m/sec under emergency storage evacuation conditions.

5.1.8 Intake Tower

Water to be taken from Cowarra Dam through the outlet works and distributed throughout the scheme leaves the reservoir through a circular intake tower. Vertical openings and shutters are proposed to allow selective withdrawal of water and control of water quality. Figure 5.2 shows the location of the structure. Figure 5.3 includes a schematic cross-section of the intake tower.

For a circular tower, openings of about 2 metres height and 1.5 metres width are proposed, placed in a vertical line on one side of the tower. Shutters (including one open spacer) would be used for selective withdrawal of water with a minimum operation level of RL28.0m AHD (dead storage of 50ML). Three spare shutters and one spare spacer are considered necessary. A continuous screen formed by

1.5 metre high trashracks would be installed in front of the openings between RL27.5m AHD and the full supply level. During normal operation the velocities through the trashracks would be very low and would not exceed approximately 0.4m/sec during peak demand (0.6m/sec maximum allowable).

A circular bulkhead gate would be provided for closure of the outlet system and would be located on top of the tower during normal operation. For maintenance of the outlet pipe for example, the bulkhead would be lowered into the tower to close the circular opening at the tower base. An overhead portal frame crane would be at the top of the intake tower for operation of the shutters and lowering of the bulkhead gate. No low level intake (ie. below RL27.5m AHD) is proposed for the tower.

Access to the operation platform on top of the tower would be by a boat and a staircase provided on the outside of the tower.

The intake tower would be founded on sound rock having the necessary bearing strength. The tower would be located close to the dam and no geotechnical problems are envisaged for the tower foundation. The tower structure would be designed in accordance with current Standards Australia codes and include consideration of earthquake design based on the appropriate earthquake loading in this area.

5.1.9 Inlet Structure

Water would be gravity fed into the Cowarra Dam storage via an inlet structure located on the eastern abutment of the main embankment (refer Figure 5.2). Water delivery would therefore be at a location remote from the intake tower and hence permit adequate mixing of stored and incoming water.

The inlet structure consists of a buried concrete encased inlet pipe which includes an inlet control valve and flow monitoring equipment. This runs through the abutment and leads to an entrance pit located just upstream of the main embankment. A long section of the inlet structure is shown in Figure 5.4.

Water would be transferred from the entrance pit to the storage via a relatively steep concrete chute with baffle blocks for energy dissipation and provision of aeration. The open flow in the chute commences approximately 0.5 metres above FSL.

5.1.10 Road Access

<u>Construction Access</u>

Access to the dam site for construction and materials haulage, including the import of rock armour, would be from the east off Burrawan Forest Drive (Old Pacific Highway) opposite Houston Mitchell Drive. The access road would be formed on the alignment of Forestry Track Nos. 72/73 and adjacent to the alignment of the Southern Arm Trunk Main (Figure 5.2).

The construction access road would be an unsealed all weather gravel surface. The formation width would be sufficient for two lanes of truck traffic. The carriageway would be approximately 8m wide with 1m shoulder with table drains on each side. The geometry of the existing forestry track would be improved to cater for construction traffic.

Operational Access

Access to the dam once operating would be via the Oxley Highway between Port Macquarie and Wauchope, Kings Creek Road and Sarahs Crescent.

A new sealed access road would be constructed from Lot 42 Sarahs Crescent, then running close to the alignment of forestry tracks No. 68.3, 70.5 and 71.1 to the right abutment of the main embankment (refer Figure 5.1). The access road corridor from Sarahs Crescent would also carry the 717mm diameter inlet pipeline.

The saddle dam and spillway are located along forestry track No. 70/71 and this track would be maintained by provision of access across the crest of the saddle dam and a bridge over the spillway crest control structure.

Access from the eastern abutment, along the toe of the main embankment to the outlet works valve house would also be provided.

In all cases where forestry tracks are upgraded or replaced for access purposes, it has been assumed that existing forestry tracks outside of the land resumption boundaries may be used to provide continuity. Accordingly access roads are designed to align with forestry tracks at boundary fences.

5.1.11 Pumping Station (Cowarra Dam)

The dam outlet would be connected to a pumping station located below the main dam embankment. The pump station would pump water up the rising main to fill the balance tank prior to distribution of water along the Southern Arm Trunk Main. The pump station would have a capacity of 57.6 ML/d. The pump station would have a concrete foundation with brick walls and metal roofing. The pump station would include pipe manifold connections to the electric pumps. A 33kV transmission line would be constructed parallel to the operational access road to supply power to the pumps. A transformer yard is expected to be constructed adjacent to the pump station.

5.1.12 Rising Main (Pump Station to Balance Tank)

A 911mm inside diameter rising main pipeline would be constructed for 2km between the pump station below the main dam embankment above and around the western edge of the area to be inundated. The rising main would be connected to an 8ML capacity circular steel or concrete balance tank to be constructed on the saddle between the dam catchment and the catchment of Sapling Creek at RL 92.0m. This balance tank would gravity feed the Southern Arm Trunk Main.

The balance tank would be designed with an overflow channel and rip rap lined dissipator to prevent soil erosion during tank testing or overflow events.

5.1.13 Construction Methods

Staging

The detailed design and construction of Cowarra Dam would be staged over a five year period following determination of the EIS. Detailed design of the dam and intake structures would take place between 1995 and early 1997. Preparation of the site would occur, following land acquisition, from late 1996 to mid 1997. Construction of the actual dam embankment would commence in mid 1997 for approximately 20 to 24 months to mid 1999. The actual timing and detailed construction method would be developed by the successful contractor(s).

Site Preparation

The initial task would be the reconstruction of forest roads to allow access for construction plant. An 8m wide all weather unsealed road would be constructed between Burrawan Forest Drive (Old Pacific Highway) and the embankment. Standard road construction techniques would be adopted including clearing, earthmoving, reconstruction of drainage structures, regrading, resurfacing and compaction of the new formation. Road design and construction would include appropriate erosion and sediment control measures in accordance with CaLM requirements. These would be installed prior to earthworks commencing.

A site compound and construction site office would be set up within the boundary of the land to be acquired north (downstream) of the proposed embankment site.

Prior to clearing of the water storage and clay material borrow area, (refer Figure 5.1) sedimentation control structures would be established downstream of the proposed work. This would include sediment dams on the creeklines. Trees and other vegetation would be removed from areas to be excavated. Harvestable poles and other timber would be initially removed. There is also potential for harvest of other forest products including woodchips and mulch for landscaping. Remaining vegetation would be windrowed above the level of inundation.

Diversion Works

Prior to construction of the embankment a concrete diversion culvert would be constructed as described in Section 5.1.7 in a trench extending from a coffer dam upstream of the embankment site to a sediment basin proposed below the toe of embankment.

Embankment

Following foundation stripping, the main embankment would be keyed into the bedrock through the construction of a core trench up to 8m deep. The trench would progressively be filled and compacted with clay material imported from the borrow site. The downslope side of the core would be lined with a gravel/sand filter layer to intercept and direct seepage. Excavated material for the bulk of the embankment would be obtained from sites within the proposed inundated area, resulting in a lowering of the topography at these sites by 5m to 10m and the removal of the major spurs extending into the storage. The material would be excavated from the site and moved to form the embankment shell using excavators, bulldozers, scrapers and trucks. The shell would be progressively compacted using rollers or other suitable plant. The actual arrangement of plant and equipment would be determined by the successful construction contractor.

During the formation of the embankment, rip rap or rock armour would be placed for wave protection. The rock (approximately 30,000m^3) would be imported from local quarries by truck via Burrawan Forest Drive (Old Pacific Highway) and the construction access road. The earth wall would be completed with crest pavement and guardrails.

The inlet works would be constructed adjacent to the eastern side of the embankment. Following earthworks, the inlet and chute would be constructed of reinforced concrete. The structure would be connected to the inlet pipeline.

The successful contractor would determine the source of concrete. Any temporary concrete batching plant would require a separate application and review of environmental factors. Most likely it would be located within the area to be submerged or otherwise disturbed in the course of the project, rather than further expanding the disturbed area.

Saddle Dam and Spillway

The saddle dam is a zoned earth embankment which would be constructed using similar methods to the main embankment. The spillway would be constructed of reinforced concrete around the southern edge of the saddle dam. Reno mattress protection and imported rip rap would be placed downstream of the spillway to dissipate potential erosive flows. An access road would be constructed between the saddle dam and main embankment.

Outlet Works

Construction of the reinforced concrete tower would involve excavation to bedrock for foundations, construction of the base and fitting of formwork and reinforcement and pouring concrete for the tower shaft and platform. The valve block, electrical work and metalwork including trashrack and bulkhead, portal frame and crane would then be fitted.

Pumping Station

The pumping station building design and layout would be determined at the detailed design phase. It would be constructed with concrete foundations and would be enclosed for noise shielding. The building is anticipated to be of conventional brick or concrete block construction. The pipe manifold and pumps would be set on reinforced concrete footings. A transformer yard would be constructed over an earthing grid adjacent to the pump station.

Rising Main to Balance Tank

The 911mm ID rising main pipeline would be laid in a benched trench approximately 2m deep. Prior to construction erosion and sedimentation control measures would be installed along the route. The trench would be constructed using bulldozers to clear a 10 to 15m wide construction easement while excavators would dig the trench with assistance from rocksaws and rockbreakers if required. The pipe sections would be laid along the trench and successively backfilled to minimise the length of trench exposed at any one time. Crossings of small gullies may require concrete encasement of pipes and the installation of concrete bulkheads on steep sections.

The balance tank site would be levelled using bulldozers and excavators. Erosion and sedimentation control measures would be installed below the fill embankment before the commencement of earthworks. The base of the tank would be reinforced concrete. The steel tank sides would be erected using a crane to position steel plates which would be welded in place and painted. Valves and pipe connections and other metalwork including access ways and railing would be fitted to the structure. The site would be rehabilitated and revegetated with native species.

Other Works

Ancillary work would include construction and fit out of the control building with instrumentation, removal of site compound and restoration and landscaping of disturbed areas outside the storage. The operational access road and the perimeter of the dam catchment would be fenced with a 1.8m high chain wire fence.

5.1.14 Storage Operation

Following the construction stage a range of rehabilitation testing and precommissioning activities would occur including testing and flushing of valves, pipelines and pumps. Commissioning of the storage and associated facilities is proposed in 2001. Activities at the dam site once operative would include:

- monitoring of storage water levels and water quality;
- monitoring and supervision of inlet and outlet flows;
- monitoring of the stability of the embankment and leakage;
- catchment management activities including ongoing rehabilitation of construction areas and construction access road;
- monitoring of embankment peizometers;

- maintenance of the facility and access roads as required; and

- implementation of an operation stage environmental management plan.

Access to the dam once operative would be via the northern sealed access road off Sarahs Crescent.

5.1.15 Cowarra Dam Catchment Management

The dam catchment would be managed consistent with the objective of maintaining a high quality water supply in Cowarra Dam. This would include:

- cessation of logging and other activities in the dam catchment;

- fencing of the catchment area, embankment and access road to restrict access generally and prevent stock from straying into the catchment;

- prevention of recreational use of the water body;

- construction of diversion banks along forestry tracks, which skirt the boundary of the catchment, to avoid pollution of the stored water by runoff or accidental spillage on the tracks;

- construction of several culverts on the access road to discharge runoff across the road;

- lining of the spillway outlet channel to minimise erosion and sediment transport to the upper arms of Sarahs Creek, into which the spillway discharges; and

- a plan of management for the operation of the dam would be prepared to guide and prioritise catchment management activities. This would include a replanting programme to enhance the catchment as a wildlife refuge.

5.1.16 Cowarra Dam Water Body Management

Managing the catchment would prevent the water body becoming polluted by external sources. However, it is also necessary to manage the water body to prevent deterioration of water quality as a result of storage. The primary water body management objective for Cowarra Dam would be to optimise the volume and quality of water stored and available for use.

The following factors need to be considered in maintaining the quality of water in the dam:

- temperature

- degree and level of stratification

- turbidity
- light penetration
- odour, taste, colour
- nutrient status and balance
- oxygen concentration
- toxic substances
- biological productivity

Hastings Council currently uses Australian Drinking Water Quality Guidelines (NHMRC, ARMCANZ, 1987) as an indication of the quality of water supplied to consumers. Council monitors total coliforms and faecal coliforms, total and free chlorine, PH, temperature and turbidity in accordance with the 1987 guidelines.

Where there is a potential health risk, corrective action is taken when necessary normally, by increasing the level of chlorine used to disinfect the water supply.

New draft guidelines were released by the NHMRC in 1994 which suggest that only minor changes are required to Council's current sampling, corrective action and long term assessment routines. These new routines would be adopted at Cowarra Dam to ensure that the quality of water supply is maintained to levels established by the guidelines.

The proposed dam would also incorporate the following additional measures:

- water chlorination at Rosewood Road Reservoir and at a point below the dam wall (ie. at input and output locations);
- installation of underwater aerators to establish vertical water currents that mix water layers. This reduces stratification of the water body and slows the increase in impurities and prevents impurities from concentrating in the water body. It can also decrease concentrations of heavy metals (eg. iron and manganese), reduce turbidity and pH and increase the oxygen saturation level.
- installation of an "on-line" automatic water quality monitoring system, measuring "real time" results of a range of water quality parameters including temperature, dissolved oxygen, turbidity, conductivity, pH and several nutrients.

5.1.17 Cowarra Dam Cost Estimate

The cost estimate, based on the concept design for the 10,000ML Cowarra Dam (Kinhill, 1994), is approximately $24M. The cost estimate includes the following components of the project:

- Preparatory Works $ 1.13M
- Diversion Works $ 0.76M
- Main Dam Embankment $12.41M
- Saddle Dam $ 0.52M
- Spillway $ 0.17M
- Outlet Works $ 1.29M
- Inlet works $ 0.39M
- Ancillary $ 0.40M
- pre construction, supervision, contingencies $ 6.83M

The following items are not included in the cost estimate:

- Pump Station
- Rising Main
- Balance Tank
- Power to Site

More detailed costing of the dam project is provided in the Cowarra Dam Concept Design Report (Kinhill, 1994).

5.2 Existing Environment, Impacts and Safeguards

5.2.1 Topography, Geology and Soils

Assessment of the landforms, geology and soils assists in identifying constraints to the project and requirements for environmental management and rehabilitation. Potential consequences of disturbing soils and landforms include alteration of drainage patterns and hydrology, soil erosion and sediment pollution, water quality degradation, unstable slopes and the release of acidity when soils in anaerobic conditions containing naturally occurring sulphides are exposed to the atmosphere.

Topography

The land surrounding Port Macquarie comprises a broad gently undulating coastal plain with occasional ridges and hills. This coastal plain extends up the valley of the Hastings River beyond Wauchope.

The chosen dam site lies in the Cowarra State Forest and partially on private land. This area represents the north-eastern limits of the Broken Bago Range.

The study area consists of a wedge shaped drainage basin open to the north-north west and bounded to the south-west and east by ridgelines rising to 140m and 170m ASL respectively. These ridgelines define the catchment boundary (refer Figure 5.1).

The north-eastern abutment of the proposed dam is located on the tip of a short spur running south-west off a north-west aligned ridge. Along this ridge there is a low saddle which would require an embankment of approximately 7m in height. A spillway is to be located at this position.

The south-western abutment is located on a north-west aligned spur. A saddle in the spur to the south of this abutment would not require a saddle embankment.

Stream flows in the site run in a north-north westerly direction with occasional divisions in the creekline forming narrow island sections. The unnamed third order creek which drains the study area joins with another unnamed third order creek before entering the estuary of Kings Creek.

Geology

The site is located in the New England Fold Belt and is on the eastern edge of a structural subdivision known as the Hastings Block. The rocks at the site are regionally metamorphosed sedimentary rocks of Devonian and Carboniferous ages and belong to the Mile End Formation and the Mingaletta Formation, respectively.

A strike-slip fault known as the Sapling Creek Fault passes through the embankment area and has a north-north west orientation. This fault separates the two geological units. The geological sequence consists of meta-sandstone, meta-siltstone and some meta-conglomerate, and minor coal beds on the eastern dam abutment. The embankment design takes the fault into account through the design of a deep core trench and proposed grout capping.

On the eastern abutment (and possibly the lower western abutment) bedding dips steeply in a southerly orientation. On the middle and upper western abutment area bedding is oriented at moderate to steep angles in a westerly orientation. The rocks in the area have undergone at least two phases of deformation. The location of the site near several faults of regional significance has resulted in a rockmass that is highly jointed and sheared. Defect spacing is classified by the geotechnical investigation as generally extremely close (minor-moderately wide), even at 30 to 40m depth beneath the surface. Other major faults of regional significance are located close to the site. The highly jointed nature of the rock would require grout capping to control leakage and maintain embankment stability.

Soils

Soils were developed on sediments comprising lithic sandstone, siltstone, mudstone, tuff and limestone. Topsoils are characterised by dark grey brown silty clay/sandy clay/clayey sandy silt/sandy silt with varying proportions of fine gravel and organic matter. These soils are slightly to moderately acid with weak to moderate coherence and consistency. The soils would be moderately erodible based on moderate subsoil dispersiveness. The uppermost portion of the soil profile would not be suitable for use as core material, although it could be stockpiled and respread as part of any rehabilitation works. Depths of useable soil have been recorded within the proposed borrow pit areas. From these depths volumes of available soil in the borrow areas have been estimated.

Groundwater/Permeability of Rock Mass

No springs were observed on site during the geotechnical investigations and the existing groundwater level was approximately 1.5 metres beneath the creek bed level. These groundwater conditions are suitable for the construction of the proposed embankment. The rock mass underlying the site is effectively impermeable with little possibility of significant leakage from the storage area into adjacent drainage basins. Existing faults and shears do not have potential to transmit large volumes of water from the storage. Some grouting is incorporated in the construction of the proposed embankment.

Storage Perimeter

The slopes of the storage perimeter have little potential for landslide. However, small areas of shallow soil slippage occur around the perimeter and require closer inspection after storage clearing. Measures to stabilise any problem areas would be undertaken during the construction phase.

Seismic Activity

A study of the seismic activity in the vicinity of the proposed dam site was included in the Dam Concept Design Report (Kinhill, 1994). A search of records revealed that no major or minor earthquakes have been recorded in the immediate vicinity since European settlement.

As Cowarra Dam site is located on Carboniferous sandstones overlying plutonic intrusions at relatively shallow depths, it is reasonable to expect the occurrence of shallow earthquakes in the area. However, as it has not been possible to delineate active faults in the area, it is difficult to determine the earthquake hazard of the site.

Distribution and recurrence of earthquakes in the Cowarra Dam site is poorly defined due to the short (33 year) historical recording of seismic data, therefore ground motion estimates for the site must be regarded as preliminary. Calculated peak ground velocities for 1 in 1,000 year and 1 in 10,000 year recurrence intervals are 63 mm/s and 175 mm/s respectively.

Having assessed historic seismic data and the geology of the area, there is no evidence to suggest that abnormal earthquake activity can be expected in the Cowarra Dam area in the near future.

5.2.2 Hydrology

In this study, estimated probable maximum flood (PMF) inflow hydrographs were developed using techniques following the methodology of Australian Rainfall and Runoff (ARR) (Institution of Engineers, Australia, 1987).

Probable maximum precipitation (PMP) for durations up to 6 hours were estimated using the Bureau of Meteorology's publication "Bulletin 51, 1984". The catchment terrain was considered to be "rough" using the classification of ARR for the estimation of PMP.

The runoff routing model RORB was used to transform the PMP estimates to flood hydrographs using model parameters estimated from the regional rainfall provided in ARR. A Kc value of 1.26 and a m value of 0.8 was used.

Estimates of PMP and the resulting PMF peak flows are summarised in Table 5.2.

Table 5.2 : PMP and PMF Peak Flows

Storm Duration (Hours)	PMP Total Rainfall (mm)	PMF Peak Inflow (m^3/s)
0.5	254	216
1	371	160
1.5	477	143
2	558	132
2.5	619	111
3	681	111
4	774	93
5	855	77
6	901	74

The probable maximum precipitation for 0.5 to 6 hour durations range from 254mm to 901mm with corresponding peak inflows reducing from 216 to $74m^3/sec$.

For PMP (and hence PMF) estimates beyond a 6 hour storm duration, Bulletin 51 is not applicable and the Bureau of Meteorology should be commissioned to produce estimates. However, as the rate of rise of the peak storage level with duration suggests that the critical peak storage level may occur very close to the 6 hour duration storm, additional PMP estimates at this stage of design is not considered warranted. The PMF estimates however should be reviewed and possibly extended for final design purposes. A program of hydrometeorlogical data recording for the catchment would be expected to result in flood estimates with reduced uncertainty.

As the dam is in the High Hazard category according to the Dams Safety Committee (DSC) regulations, the spillway is proposed to be sized for the PMF. The marginal cost of providing PMF spillway capacity is very small relative to the total cost of the project, and is considered to be justified on the basis of consistency with the adopted design parameters for the dam.

For diversion capacity during construction the DSC refers to the ANCOLD Guidelines which recommend 1 in 100 year design flood for a High Hazard dam with a diversion construction period of one year or less.

5.2.3 Water Quality and Flows

Existing Conditions

The quality of the water within the unnamed creek running through the proposed dam site, was assessed during near drought conditions. With virtually no flow (0-5 litres/min) in the first and second order creeks in the catchment, the background characteristics were very poor. High levels of suspended solids in ponded areas resulted in very low water clarity with a high coverage of silt substrate (access track runoff contributed to the levels of suspended solids.) The poor quality of creek water at the time of assessment is attributed to prevailing drought conditions. Given average rainfalls, creek water quality would be of a higher standard with improved clarity and a reduced level of suspended solids. Adding Hastings River water to the catchment would provide a reservoir of water similar in quality to that of the existing system.

The construction of a dam in the Cowarra State Forest would reduce the effective catchment of the watercourses downstream. At a point immediately before the confluence of two third order creeks below the dam site, the present catchment area is approximately 200 ha. This area would be reduced to around 75 ha with the proposed dam.

The catchment and subsequent flow would be 38% of what they were prior to dam construction. At a point just below the above mentioned junction the existing catchment is 530 ha. With the proposed dam this would be reduced to 410 ha and natural flows would be reduced to 78% of present levels. At the tidal limit of Kings Creek estuary the present catchment is 715 ha. The future catchment would be approximately 595 ha with flows being reduced to 83% of their current levels. To maintain the natural flow regime in these creeks a controlled release of water from the dam outlet valve is proposed to provide occasional scouring flows to supplement flows derived from dam leakage.

Other potential impacts on the watercourses in the area include the input of sediments from ground disturbances during the construction phase. Elevated levels of sediment in creek water can severely affect creek biota either directly by affecting the health of the biota or indirectly through infilling of their environment. These effects are exacerbated by reduced flows. Erosion mitigation measures consistent with CaLM guidelines are proposed to reduce such impacts.

Water Quality, Erosion and Sediment Control During Construction

The most significant potential impacts in the construction stage would be from soil erosion of disturbed areas and subsequent pollution downstream by sediment, dissolved salts, organic matter and other associated material.

Environmental effects of sediment pollution are mainly due to the smaller clay sized particles know as colloids, which are difficult to remove by physical sedimentation processes. Their presence is indicated by the reduced visibility in the water known as turbidity. This reduces light penetration and impedes aquatic plant growth. Contaminants such as nutrients, heavy metals, pesticides and oxygen demanding compounds attach themselves to these particles and add to the impact. Organic matter in the surface soil has a similar effect. Larger soil particles may settle in the waterway damaging plant and animal life and blocking drainage.

The general principles of controlling these impacts are to minimise the volumes of water becoming contaminated by sediment, keep sediment laden water separate from clean runoff, re-use sediment laden water on site and treat excess contaminated water on site to a standard acceptable for release. These controls are site-specific and are outlined on Figure 5.6. Some controls are intended to be for the construction stage while others would be retained into the operational phase to provide ongoing water quality protection.

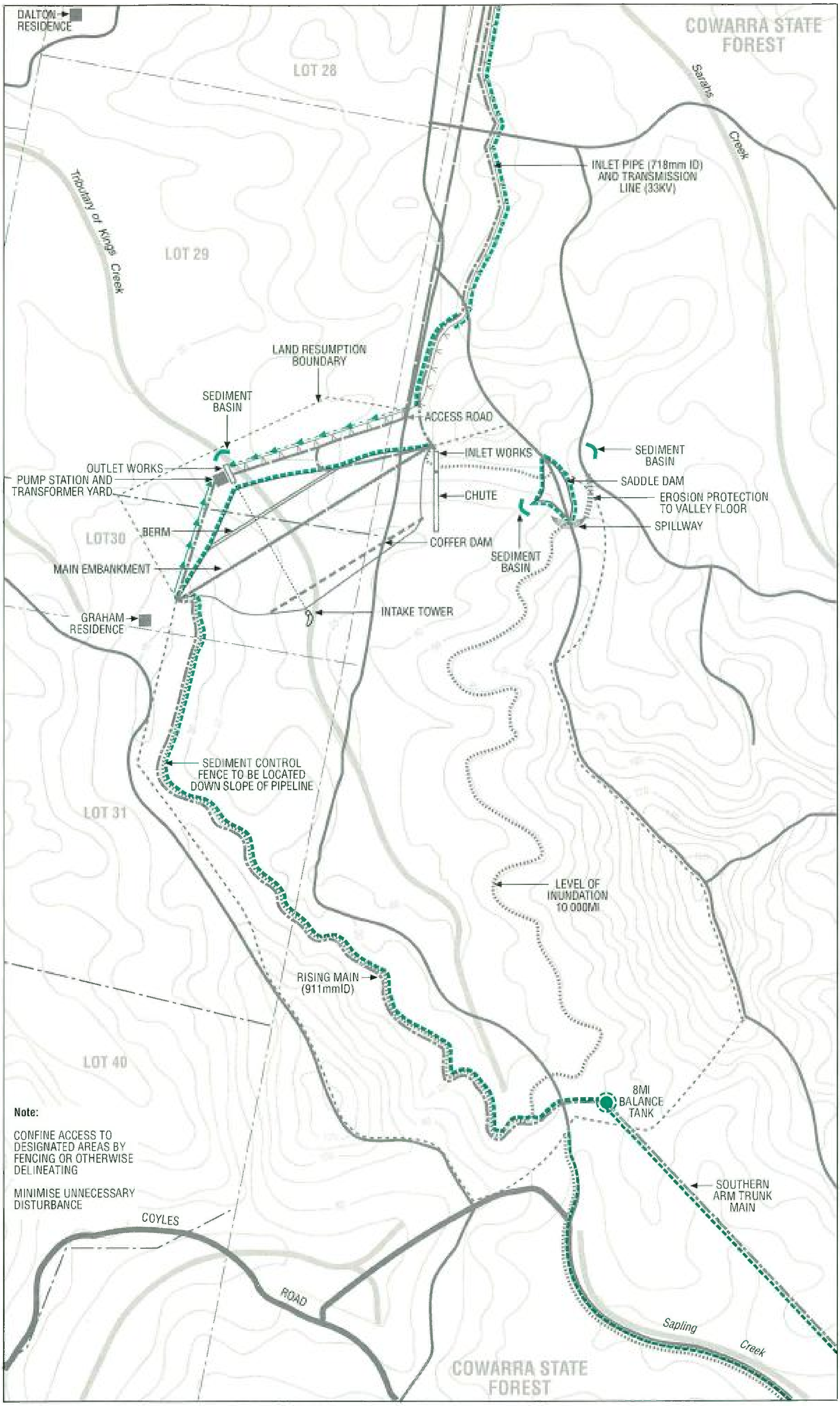
Design of erosion and sediment control measures would be detailed in the Environmental Management Plan which would be prepared following determination of the proposal. The EMP would form part of the contract documents and as such contractors would be bound to comply with all its requirements.

Specific water quality controls to be detailed in the EMP, would be designed using the following criteria:

- minimise the area disturbed at any one time by good planning of the construction program and confine equipment movement to designated areas;

- confine land disturbance to areas to be subsequently filled or submerged, as far as practical. This applies particularly to areas from which construction material would be excavated;

- install drainage works prior to land disturbance to divert runoff from undisturbed areas into stable drainage lines at non-erosive velocities;



Sediment Basin

Diversion drain (clean water)

Catch drain (for run off from disturbed areas)

Sediment control fence

Figure 5.6
Cowarra Dam Preliminary Erosion and Sediment Control Plan

N

0 0.25 0.50 Km

- collect runoff from disturbed areas including tracks and stockpile areas so that it passes through sediment control devices such as silt fences and sedimentation basins. In particular, runoff from the dam construction site would be collected in either the coffer dam or a sediment basin to be constructed immediately downstream of the outlet works. These would be designed and operated in accordance with the requirements of CaLM and EPA;

- the clay borrow area would incorporate a downstream sedimentation basin and sediment fencing around stockpiled overburden. The borrow area would be sequentially cleared and rehabilitated to minimise the extent of exposed earth;

- maximise reuse of contaminated water on site for purposes such as compaction and other construction requirements, dust suppression and revegetation;

- treat excess water, if necessary, prior to discharge to ensure that water quality meets EPA requirements;

- maintain sedimentation basins by removing water after storm events during the construction stage to ensure that capacity is available to contain subsequent storm events (this is subject to the requirement to provide adequate water supply for construction and other purposes);

- maintain vegetation in and adjacent to drainage lines to improve the quality of runoff before entering the stream and to protect the drainage line from erosion;

- ensure that drainage works are stable against erosion, by appropriate selection of channel dimensions, slope and lining, and incorporation if necessary of drop structures and energy dissipaters where appropriate;

- reduce the erosive potential of runoff on disturbed areas including tracks, by installation of banks, bunds or drains along the contour to reduce the distance of overland flow and convey water to stable drainage lines at non-erosive velocity;

- revegetate disturbed areas as soon as practible;

- ensure that any areas for the storage of oils and other hazardous liquids used during construction are surrounded by a bund to contain any spillage which could then be collected and disposed off site at an approved facility. The design and location of any formal structure would be incorporated as part of the EMP; and

- should an on-site concrete batching plant be required, the plan would be designed and operated in accordance with the Department of Planning Guidelines (1991).

Water Quality During Operation

The water quality report produced by PWD (1990) recommended that the following works be carried out at the dam site in order to maintain the quality of the water supply;

- filtration of supplies to the dam (assuming that non turbid water is drawn from the River when available);
- removal of vegetation in the storage zone;
- gypsum addition to the top layer of soil in the storage zone to reduce soil dispersion;
- installation of aeration equipment to prevent stratification of water in the dam;
- installation of water conditioning equipment;
- installation of chlorination equipment; and
- other measures described in Section 5.1.16.

5.2.4 Meteorology and Air Quality

Climate

The Hastings River basin has a humid sub-tropical climate with high summer rainfall and relatively dry winters and springs. Based on 95 years of records, Wauchope's wettest month is February (168mm) and the driest is September (62mm) with a mean annual rainfall of 1300mm.

Summer temperatures range from a mean daily minimum of 16.9°C to a mean daily maximum of 25.9°. Winter temperatures range from 7.1°to 17.7°C. Records indicate that mean daily pan evaporation ranges from 1.5mm in June to 4.6mm in December.

Appropriate site management practices would be employed to ensure that work can continue during wet weather periods without adversely affecting the site.

Air Quality

The project is located in a bushland/rural area with good air quality. Vehicle emissions and dust generation during the construction phase may have potential negative impacts on local air quality.

A range of machinery would be involved during the construction phase. The impact of emissions from these vehicles on the surrounding environment is unlikely to be significant. The volume of fuel consumed during operations is addressed in the energy statement.

Dust generation arising from earthworks and vehicle movement on unsealed areas would be controlled by watering of disturbed areas. In addition, measures implemented to conserve soil and protect water quality would assist in reducing dust potential. The measures include minimising the area disturbed and exposed at any one time, revegetating or otherwise stabilising disturbed areas as soon as practicable and confining vehicle movement to designated areas.

5.2.5 Noise

Existing Noise Levels

A detailed noise impact assessment conducted by James Madden Cooper Atkins is reproduced as Appendix D. Existing ambient noise levels are controlled by local domestic activities and natural elements such as wind, birds and animals. Local farm machinery operation also contributed to the ambient noise levels.

Construction Activities

The construction programme for the dam is described in Section 5.1.13. Stage 1 consists of the main earthworks and involves stripping, ripping, transportation and compaction of materials to form the dam. Stage 2 consists of the building works and associated pipe works. Earthworks could extend over 18 months and the entire project could take up to 40 months. During stage 1, scrapers, dozers (D9's and D10's), excavators, graders, compacters and trucks would be used on site. In addition, hard rock would be transported from quarries at Port Macquarie or Laurieton over a 3 month period and could involve some 2,000 truck loads of material. At this stage, it is anticipated that blasting is not required or proposed for the project.

Construction would take place between the hours of 7.00am and 5.00pm, Monday to Friday and 7.00am to 3.00pm Saturday. Material transportation to the site would generally occur between 7.00am and 4.00pm Monday to Friday and 7.00am to 3.00pm on Saturdays.

Noise Assessment

Potential construction noise was assessed for the three dwellings closest to the dam site, being the Graham Residence, the Dalton residence and the "Tallwood" Property.

Table 5.3 summarises the likely noise emissions from construction activities and makes allowances for distance and shielding by local topography. It also assumes a worst case scenario that all necessary plant is operating simultaneously and that the dam wall would not attenuate noise generated by machinery working behind the wall.

Table 5.3 : Noise Assessment

Reference Location	Current Average Maximum Noise(1)	Predicted Noise (1)	EPA Guidelines (1)
Graham Residence	35-55dB(A)	72dB(A)	40dB(A)
Dalton Residence	35-55dB(A)	40-49dB(A)	40dB(A)
Tallwood	35-55dB(A)	38dB(A)	40dB(A)

Notes: (1) (LA_{10}) - Sound level exceeded for 10% of the measurement periods

Table 5.3 indicates that the Graham residence would be significantly affected by noise throughout the construction period. The other residences, being more distant, could also experience some construction noise during the early stages of the project. However, the noise would be considerably less than the Graham residence and would comply with EPA noise guidelines.

The Graham residence would also be affected by noise associated with truck movements to the site. However, EPA guidelines for traffic noise would not be exceeded in this instance. At "Tallwood" and the Dalton residence, the traffic noise levels would be considerably less than the EPA's recommended criteria.

Impact Amelioration

The Graham residence would be directly exposed to construction noise that generally exceeds EPA recommended guidelines. Negotiations are proceeding to find alternate accommodation for the family during construction. Alternatively, acoustic barriers could be constructed around the residence. The barriers could be earth mounds or precast concrete panels, approximately 3-4 metres higher than floor level. This could reduce noise levels by about 15dB(A). However, for other reasons associated with the proximity of work, the general level of amenity would still be poor during the construction period.

With respect to the Dalton residence, the construction of the dam earth wall would progressively shield the residence from sources of noise from excavation upstream. It is recommended that the first stage of wall construction be brought forward in the construction schedule as early as practicable. Other dwellings in the vicinity would not experience sufficiently increased noise so as to warrant amelioration measures.

Operational noise would include working of electrical pumps and occasional traffic. The pumps would be housed in a noise insulated building and would not be a source of noise nuisance. Noise from dam operations would be within EPA guidelines with respect of the nearest residences.

5.2.6 Flora

Survey Methodology

A survey of the vegetation of the proposed dam site was undertaken over three days on 25 - 27 May 1994. The survey was designed to sample replicate sites in each vegetation unit identified from reconnaissance survey, air photo interpretation and previous mapping. The survey involved sampling of 10m x 10m plots at ten (10) locations in the proposed dam catchment and inundated area.

Variation in vegetation characteristics between the valley floor and ridgeslopes was also measured using 1m^2 quadrats placed at 10m intervals located along on the eastern and western slopes. The sample sites are shown on the vegetation map (Figure 5.7).

The endemic vegetation communities identified through the fieldwork were characterised according to their structure, floristics and habitat. Where appropriate the community description used by Truyard (1993) in the Kempsey/Wauchope Management Areas EIS were adopted so as to place the vegetation of the site in a regional content.

A review of other relevant studies included the vegetation components of:

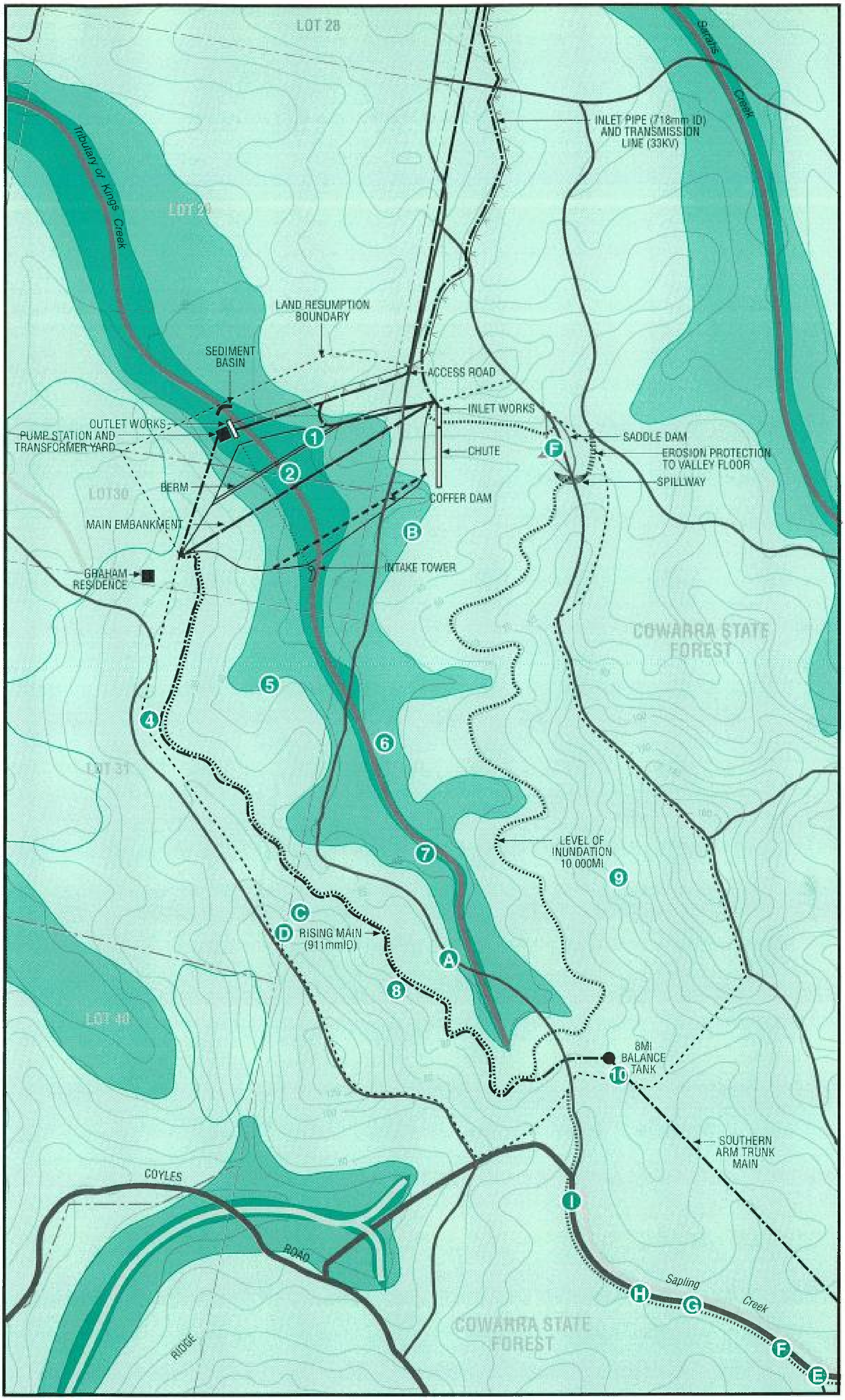
- Hastings Regional Waste Disposal Facility Site Selection Study (Patterson Britton, 1994);
- Wauchope Management Area Forestry Management Plan (Forestry Commission, 1988); and
- Flora and Fauna Survey, Dam Sites D & E (Kendall and Kendall, 1990 and 1991).
- Review of Environmental Factors, Hastings District Water Supply Augmentation Scheme (Binnie and Partners, 1991c).

Plant Community Descriptions

The proposed dam site and its immediate catchment are almost entirely forested. The forest has been selectively logged on an irregular basis, most recently in 1992/93. Improved pasture occurs along the western boundary of the dam catchment in Portions 30 and 31.

For the purposes of comparison with existing literature and distribution records, the vegetation of the study area is classified according to the grouping used by State Forests, Baur (1989) and Truyard (1993) as presented in Table 5.4.

Figure 5.7 illustrates the distribution of endemic plant communities in the study area. The plant communities listed are described further in Table 5.5.



Open Forest /Dry sclerophyll forest
Cleared/Disturbed
Tall open forest/Wet sclerophyll
Creek bank vegetation /Closed forest

1 Vegetation sample sites

A Open camp site
B Isolated stone artefact
C Open camp site
D Open camp site
E Open camp site
F Open camp site
G Isolated stone artefact
H Isolated stone artefact
I Open camp site

N

0 0.25 0.50 Km

Figure 5.7
Vegetation Map and Aboriginal Archaeological Sites

ERRATUM NO 1, FIGURE 5.7
The above three green outlined areas (mostly within Lots 30, 31 and 40) are incorrectly shaded light green. These areas are cleared/disturbed land.

Table 5.4 : Comparable Forest Classifications

Structural Classification	Forest Associations	Forest Types (Baur, 1979)	Classification (Truyard, 1993)
1. Open Forest	- Dry Sclerophyll Forest - Dry Hardwood	- 62 Grey Gum - Grey Ironbark - White Mahogany - 61 Broadleaved White Mahogany	• KWOV 12 White Mahogany - Tallow wood - Forest She-Oak • DWOV 15.2 Forest She-Oak - Turpentine - Pink bloodwood - Thickleaved Mahogany • KWOV 16.1 Thickleaved Mahogany • KWOV 17 Grey Ironbark • KWOV 18.1 Forest Red Gum - Tallowwood - Grey Gum • KWOV 18.2 Grey Gum - Thickleaved Mahogany • KWOV 18.3 Grey Gum - Pink Bloodwood
2. (Tall) Open Forest	- Wet Sclerophyll Forest - Moist Hardwood	- 53 Inland Brush Box - 49 Turpentine - 60 Narrow leaved White Mahogany - Red Mahogany - Grey Ironbark - Grey Gum	• KWOV 8.1 Brush Box - Tallowwood • KWOV 8.2 Brush Box • KWOV 15.1 Turpentine - Forest She-Oak
3. Creek Bank Vegetation	-	-	-

These structural/floristic classifications fall within the Dry and Moist Hardwood Forest Association and a range of Forest Types defined by the Forestry Commission of NSW (Baur, 1989). It is mapped over the region by Truyard (1993). A species list for the study area prepared by Kendall and Kendall (1991) is included as an appendix to the Review of Environmental Factors (Binnie and Partners, 1991c)

Table 5.5 : Plant Community Descriptions

Community Description	Structure			Dominant Species		Habitat	Variation/ Disturbance
	Strata	Height	Cover	Overstorey	Understorey		
1. Open Forest - Dry Sclerophyll Forest (Sites 3, 4, 3, 10)	Trees: Small Trees: Shrubs: Ground Layer:	22 - 30m 10m 1 - 3m 0.5 - 1m	35 - 40% 5% 5 - 15% 50 - 60%	Eucalyptus propinqua E. siderophloia E. microcorys E. intermedia E. resinosa Allocasuarina torulosa	Imperata cylindrica Lomandra longifolia Themeda australis Leucopogon juniperinus Ziera smithii Hardenbergia violacea Breynia oblongifolia Entolasia stricta Pteridium esculentum	Steep, well drained and exposed upper ridge slopes and ridge tops mostly with a west or north aspect. Soils shallow and relatively infertile derived from sandstones and siltstones.	This community has been frequently burnt for hazard control and has been logged for poles. There is low diversity in the understorey and four overmature trees. Pasture grasses are present in the groundlayer on the margin with cleared land in Lot 31.
2. Tall Open Forest Wet Sclerophyll Forest (Sites 1,5,6,9)	Trees: Small Trees: Shrubs: Ground Layer:	30 - 40 m 5 - 15 m 2 - 5 m 0.5 - 1 m	30 - 45% 25% 15 - 35% 20%	Lophostemon confertus Syncarpia glomulifera Eucalyptus microcorys E. propinqua E. resinosa E. umbra E. acmenoides E. siderophloia Allocasuarina torulosa Backhousia myrtifolia Cyrptocarya glauscescens	Citriobatus pauciflorus Blechnum cartilagenum Viola hederacea Eupomatia laurina Cordyline stricta Gymnostachys anceps Entolasia stricta Rhodamnia rubescens Oplismenus imbecillus Lantana camara*	Deeper soils in less exposed valley side and gully locations. There is generally a more humid microclimate beneath the substantial tree and small tree layer.	This community has been frequently logged for poles. The community grades between the creek line vegetation with rainforest affinity to the dry sclerophyll forest of the upper slopes. Weed invasion by lantana has been promoted by forest disturbances.
2a. Creek Bank Vegetation Closed Forest Wet Sclerophyll Forest (Sites 2,7)	Trees: Small Trees: Shrubs: Ground Layer:	30 - 35 m 10 - 15 m 2 - 3 m 0.5 - 1 m	40 - 60% 30% 10 - 20%	Eucalyptus grandis Lophostemon confertus Trochocarpa laurina Backhousia myrtifolia Acmena smithii Callistemon salignus Melaleuca stypheloides Glochidion ferdinandi	Gahnia aspera Gahnia clarkei Blechnum cartilagenum Alpinia caerulea Cordyline stricta Triglochin procera Polygonum decipiens Lantana camara* Cyperus spp. Juncus spp. Lomandra longifolia Ranunculus inundatus	Humid microclimate on moist deep alluvial soils along creek banks of a tributary of Kings Creek.	The creek bank vegetation contains understorey species in common with the wet sclerophyll forest. A range of aquatic plants also occur. The creek bank vegetation has been cleared and disturbed by livestock downstream of the dam site.

NOTE: (*) Introduced Species

Significant Plants

None of the species sampled in the catchment and proposed construction area are considered rare or threatened at a national level (Briggs and Leigh, 1988).

More than ten tree species and a number of shrubs and lianas recorded along the gully floor have rainforest affinity, several of these occur at or near the southern limit of their distribution on the mid-north coast including:

- *Apanathe philippinensis;*
- *Austromyrtus bidwillii;*
- *Backhousia sciadophora;*
- *Drypetes australiasica;*
- *Elattostachys nervosa;*
- *Harpullia hillii; and*
- *Jagera pseudorhus.*

Williams et al. (1984) report the southern limit of *H. hillii* as the Macleay River valley.

Thirty eight significant plant species, including 23 listed as rare or threatened Australian Plants (Briggs and Leigh, 1988), have been recorded in the Kempsey-Wauchope Forestry Management Area by Binns and Chapman (1993). The habitat requirements and distributional patterns of approximately four of these species are consistent with the environment of the study area. While none of these species were observed at the dam site, the occurrence of *Dodonaea megazyga* in particular is possible as it is reported to be abundant in the understorey of heavily logged wet sclerophyll forest and along road edges. The species occurs in National Parks including Barrington Tops, Washpool, Wollemi, Gibraltar Range and Lamington.

The Council owned site adjacent and east of the Cowarra State Forest (location of the proposed Regional Water Disposal Facility) contains a population of significant species *Eucalyptus bancroftii* (Orange Gum). Although not considered rare, the species is significant due to its restricted distribution over its range and the location of the local population near the southern limit for the species extend to the east of the Pacific Highway on soils derived from Serpentinite. However, no specimens have been recorded in the study area probably due to different geology.

Other species which form a striking component of the flora of the study area include several ephiphyic orchids and ferns occurring along the moist gully, these include:

- *Plectorhiza tridentata;*

- *Cymbidium suave;*

- *Platycerium bifurcatum;* and

- *Asplenium australasicum.*

The dam study area has moderate floristic diversity due to the presence of wet and dry sclerophyll forest communities. The lack of extensive rainforest development and disturbance of the gullies by logging has precluded greater plant diversity.

Representation of Plant Communities

The dam study area contains a range of vegetation communities occurring in the Hastings Valley and the mid north coast of New South Wales. The extent to which these communities are widely represented both locally and regionally is outlined in Table 5.6. The conservation status of the plant communities over their range is also assigned with reference to regional botanical surveys including the Truyard (1993) survey of the forests of the Kempsey/Wauchope Forestry Management Area.

Table 5.6: Local and Regional Representation of Plant Communities

Community (Refer Table)	Study Area	Local Area	Hastings Valley and Mid North Coast
1. Open Forest (Dry Sclerophyll Forest)	• The well drained exposed upper slopes of the proposed dam catchment. Approximately 60 ha within the study area	• This is the predominant vegetation of the ridgeslopes of Cowarra State Forest, Broken Bago State Forest and Burrawan State Forest. • Forest Preserves and Flora Reserves containing similar floristic associators occur in Black Creek F. P.	• National Parks which include areas of floristically similar open forest include: - Crowdy Bay National Park - Limeburners Creek National Reserve - Werrikimbe National Park • State Forests - the majority of State Forests in the region are dominated by this association including: - Cairncross State Forest - Ballengarra State Forest - Maria River State Forest - Broken Bago State Forest - Bellangry State Forest • Truyard (1994) report 905km^2 or 43% of the total area of State Forest in the Kempsey/Wauchope M. A. A further 504km^2 occurs on other crown timbered land in the region (76%)

Community (Refer Table)	Study Area	Local Area	Hastings Valley and Mid North Coast
2. Tall Open Forest (Wet Sclerophyll Forest)	• Occurs on deeper soils on the lower more protected slopes and valley floor of the dam catchment over an area of around 20ha.	• This vegetation has a restricted local distribution in moist more protected environments. Including gullies within Cowarra, Broken Bago and Burrowra State Forest and the following forestry reserves: Bago Bluff Forest Reserve; Six B.F.P, Black Creek F.P and proposed Mount Cairncross Forest Reserve.	• This vegetation is included in Dorrigo National Park and Werrikimbe National Park or the mid north coast. • State Forests include: - Mount Boss State Forest - Ballengarra State Forest - Bellangry State Forest - Doyles River State Forest • Truyard (1994) report 490km^2 23% of the total area of State Forest in the Kempsey/Wauchope M A. A further 54km^2 occurs in other crown timbered land in the region (8%).
2a. Creek Bank Vegetation Tall Closed Forest (Wet Sclerophyll Forest)	• A disturbed closed forest community occurs in a narrow strip for approximately 1km along the gully of the tributary to King Creek within the proposed dam catchment. This vegetation covers approximately 7ha of land in the study area. The creek live vegetation is similar to and grades into the wet sclerophyll forest of the lower valley sides.	• Gully closed forest is found in varying degrees of disturbance from logging and weed invasion in sheltered tributary gullies of Sarah's and King Creeks in Cowarra State Forest.	• While disturbed closed forest environments are distributed in the majority of sheltered gullies in State Forests in the district more widespread closed forest habitat is found in Bago Bluff Flora Reserve, Cairncross Flora Reserve and Werrikimbe National Park.

Of the plant communities represented in the study area, both the open forest communities are widely distributed and well conserved in Flora Reserves and Forest Preserves within the State Forest system on a local basis and are also included in National Parks on the coastal ranges of the mid north coast.

The disturbed wet sclerophyll forest community growing in a narrow band along the creek line includes rainforest elements which are generally less well represented in the reserve system. However, the limited floristic diversity creek bank community is represented in State Forests and conserved areas within local State Forests including Bago Bluff Flora Reserve and the proposed Cairncross Flora Reserve. Significant rainforest resources are included in Werrikimbe National Park in the upper catchment of the Hastings River.

Assessment of Flora Impacts and Safeguards

The construction of the dam in Cowarra State Forest would have a range of direct impacts on plant communities affected by inundation (62ha) or cleared for construction of the dam wall and ancillary facilities such as the pump station, balance tank, pipelines, spillway and access roads. The Proposal would result in the removal of approximately 90ha of endemic vegetation comprising the permanent removal of approximately 55ha of open forest (dry sclerophyll forest), 20ha of tall open forest (wet sclerophyll forest) and 7ha of the vegetation of the creek banks. Approximately 8ha of the vegetation removal is considered temporary and would be re-established during and after the construction period. The inundation of the study area and a range of construction activities have land take and clearing requirements as follows:

- 12ha for dam wall construction, pump station and construction compound;
- 62ha inundated by dam waters (inclusive of a portion of dam wall);
- 2ha for spillway construction;
- 4ha for rising main and balance tanks;
- 3ha for core material borrow site;
- 7ha for reconstruction of construction access road (1.5km) and for construction of operational access road (3km).

None of the plant communities affected represent old growth forest. The dam site and its catchment in Cowarra State Forest show characteristics of a long and frequent logging and forestry management history.

The vegetation contains mostly even age class stands of trees many between 40cm and 70cm diameter, with very few over mature specimens (>1m d.b.h) and a floristically simple and frequently burnt understorey. Weed invasion by lantana is prolific in the wet sclerophyll forest vegetation where disturbances due to timber harvesting may have assisted weed colonisation. Recent harvesting of durable poles on the valley floor and lower slopes has caused approximately 40% reduction in tree canopy cover in those areas. The vegetation changes due to harvesting and forest management practices have altered the character of the vegetation and reduced its significance as representatives of the plant communities described in the study area.

The removal of plant communities by dam construction would result in the removal from the study area of specimens and populations of several plant species at or near the southern limit of their distribution. However, no significant plant species listed in the ROTAP Register (Briggs and Leigh, 1988) were recorded in the areas potentially affected. Each of the significant plants recorded in the study area are represented in the State Forest system in Kempsey and Wauchope Forestry Management Areas (Binns and Chapman, 1993). The removal of habitat in the study area would not endanger any plant species.

In addition to direct habitat loss, vegetation would be exposed to indirect effects resulting from dam construction such as the accumulation of dust on vegetation along access roads, potential erosion of exposed sites and sedimentation of drainage lines including the tributary of King Creek downstream of the earth wall dam and in the tributary of Sarahs Creek below the spillway. The importation of materials such as rock armour from off site and vehicle traffic can import weed species and provide suitable disturbed habitats for their colonisation.

Past forestry operations have created similar conditions in the catchment area and are likely to have contributed to weed invasion by Lantana and some stream sedimentation. The control of dust, weed invasion, soil erosion and sedimentation would be addressed through the implementation of an Environmental Management Plan (EMP) for the construction and operation phases of the project.

The operation of the dam as a drinking water supply would require sympathetic management of the remaining 46ha of natural vegetation in the catchment area over the long term.

While the overall total area of endemic vegetation to be removed or disturbed is large, the Open Forest (Dry Sclerophyll) community most directly affected is the most widespread of these communities occurring in the local area and the district. The open forest associations affected represent less than 0.001% of the 1400 km^2 of this vegetation in State Forest and Crown Land in the Kempsey - Wauchope Forestry Management Area (Truyard, 1993).

Tall Open Forest (Wet Sclerophyll Forest) is relatively less well represented in the local area but is included in several State Forest Flora Reserves and Forest Preserves in the district and is well represented on a regional basis in Werrikimbe National Park and Dorrigo National Park on the mid north coast. The 90ha proposed to be disturbed or removed for dam construction and ancillary facilities represents approximately 0.002% of the total area (544 km^2) of this community in State Forest and Crown Land in the Kempsey-Wauchope Forestry Management Area.

The closed forest creek bank vegetation and tall open forest of the valley floor has been most affected by recent harvesting of timber for poles. Approximately 50% canopy cover remains in the area proposed to be inundated. Weed infestation by Lantana is also prolific on the valley floor.

The resulting vegetation community contains some rainforest elements but is not floristically rich and is generally dominated by the same species as those which occur in Tall Open Forest (Wet Sclerophyll forest) of the study area.

The degraded creek bank vegetation is typical of the sheltered drainage lines of gullies throughout the catchment of King and Sarahs Creeks in Cowarra State Forest. More diverse closed forest communities with rainforest associations are conserved in the district in Bago Bluff Flora Reserve, Cairncross Flora Reserve as well as more extensive areas in the Werrikimbe National Park 30 km to the west.

The removal of vegetation for the construction of Cowarra Dam is not considered significant due to the conservation status of similar vegetation in the district and the relatively disturbed nature of the study area.

5.2.7 Fauna

Wildlife Habitat

The bushland within the proposed catchment provides habitat for many of the common fauna occurring in the Kempsey-Wauchope area. The main wildlife habitat features of the study area can be described in relation to the major vegetation classifications and aquatic features:

Dry Sclerophyll Forest

- The remaining mature habitat trees provide food and shelter for arboreal fauna including possums, gliders and bats;
- flowering and fruiting trees and shrubs provide food resources and shelter for a range of avifauna;
- Understorey habitat is grazed and foraged by terrestrial mammals such as Wallabies, Brown Antechinus, Long-nosed Bandicoot and Bush Rats; and
- A range of reptile species feed and shelter in the ground layer, in rock crevices and beneath the bark of trees.

Wet Sclerophyll Forest

- Remnant mature trees provide shelter and food resources for a range of birds and arboreal mammals;

- Rainforest elements within this forest community provide a range of fruits (on a seasonal basis) for specialist feeders such as fruit-eating doves and flying foxes;

- An understorey of shrub and fern species provides habitat for terrestrial mammal and reptile species as with the Dry Sclerophyll Forest; and

- A groundcover of leaf litter contains food resources for insectivorous birds, mammals and reptiles.

Aquatic Habitat

- A network of first, second and third order creeks with a minor flow through connecting pools provides habitat for fish, amphibians, crayfish and other macroinvertebrates.

Disturbed Areas

- Private properties on the western side of the catchment contain small areas of grazing land. Such areas are commonly frequented by Kangaroos and Wallabies and a range of insectivorous and seed eating bird species. Birds of prey often hunt for small mammals in such open grassed areas.

- Recent logging operations within the catchment have left areas of exposed ground of low habitat value.

<u>Occurrence and Distribution of Fauna</u>

A team of fauna specialists were engaged during May/June 1994 to survey fauna groups potentially occurring within the study area. Specialist surveys were undertaken for the occurrence of bats (G. Hoye), terrestrial and arboreal mammals (G. Holmes and S. Lenehan), birds (G. Holmes), the koala (C. Moon), aquatic fauna (K. Bishop) as well as frog and reptile habitat searches (G. Holmes). The results and methodologies of the specialist studies are included in the appendices.

Vertebrate Fauna

A list of observed fauna was compiled by Glen Holmes using diurnal and nocturnal searches across the three vegetation types (Appendix F). This was supported by a program of small mammal trapping (Appendix K). A predictive list of fauna likely to frequent the site was based upon survey results, general accounts of vertebrate distribution and surveys in the region including:

- Binnie and Partners (1991)

- Kendall K and Kendall P (1991)

- Milledge (1979)

- Mount King Ecological Surveys (1991, 1993)

- Reed, Lunney and Walker (1991).

A total of 116 species were observed within the study area (refer Table 5.7), whilst 271 species were predicted to occur in the study area based on their distribution and previous observations.

Three Schedule 12 species, the Glossy Black Cockatoo (*Calyptorhynchus lathami*), and the little and large Bent Wing Bats (*Miniopterus australis* and *M. schreibersii*) were observed in the study area and are addressed further in the Fauna Impact Statement (Appendix E.) along with other potentially occurring Schedule 12 special included in Table 5.8.

Small Mammal Trapping

Elliot and Cage traps were set over 330 trap nights in May 1994. Only two specimens were trapped Black Rat *(Rattus rattus)* and Bush Rat *(Rattus fuscipes).* The Long-Nosed Bandicoot *(Parametes nasuta)* was also observed. The results of the survey may reflect the disturbed nature of the study area and timing of field work. The methodology and results of this survey are outlined in Appendix K.

Table 5.7 : Observed and Protected Fauna

Fauna	No. Species	
	Predicted	Observed
Amphibians	27	2
Reptile	41	-
Birds	108	56
Mammals	54(4*)	17(4*)
Fish	5(1*)	5(1*)
Macroinvertebrates	36	36
TOTAL	271	116
* Denotes introduced species.		

Of the fauna observed and predicted to use the study area 24 species are listed on Schedule 12 of the NP&W Act (refer Table 5.8).

Table 5.8: Potentially Occurring Schedule 12 Species

Common Name	Scientific Name
Barred Frog	*Mixophyes balbus*
Giant Barred Frog	*M. iteratus*
Green-thighed Frog	*Litoria brevipalmata*
Pale-headed Frog	*Hopocephalus bitorquatus*
Stephen's Banded Snake	*H. stephensi*
Rose-Crowned Fruit Dove	*Ptilinopus regina*
Wompoo Fruit Dove	*P. magnificus*
Glossy Black Cockatoo	*Calyptorhynchus lathami* *
Powerful Owl	*Ninox strenua*
Masked Owl	*Tyto novaehollandiae*
Sooty Owl	*T. tenebricosa*
Tiger Quoll	*Dasyurus maculatus*
Koala	*Phascolarctos cinereus*
Brush-tailed Phascogale	*Phascogale tapoatafa*
Common Planigate	*Planigale maculata*
Little Bent Wing Bat	*Miniopterus australis* *
Large Bent Wing Bat	*Miniopterus schreibersii* *
Eastern Blossom Bat	*Syconycteris australis*
Yellow-bellied Sheathtail Bat	*Saccolaimus flaviventris*
Eastern Free-tail Bat	*Mormopterus norfolkensis*
Large-eared Pied Bat	*Chalinolobus dwyeri*
Great Falsistrelle	*Falsistrellus tasmaniensis*
Golden-tipped Bat	*Kerivoula papeunsis*
Fishing Bat	*Myotis adversus*
Greater Broad-nosed Bat	*Scoteanax rueppellii*

* Observed in Study Area

Koalas

Detailed survey undertaken by Moon (1994) found no direct evidence of Koala activity in the Study area. Despite two sightings north of the proposed dam wall in Portion 29 (1991, 1992), it was concluded that the site appeared to be unsuitable for Koalas and that the construction of the dam is unlikely to have a significant affect on Koalas (refer Appendix G). The site does not comprise core Koala habitat with respect to State Environmental Planning Policy No. 44.

During the preparation of the EIS Council and the Department of Public Works and Services were contacted by the Koala Preservation Society to investigate the opportunity for releasing rehabilitated injured Koalas into the protected dam catchment. While this site would provide marginal habitat it is recommended that other more appropriate core Koala habitat sites, with existing resident Koala populations, be investigated for this purpose in consultation with the National Parks and Wildlife Service.

Bats

A survey of Bat species occurring in the study area was undertaken by Glen Hoye. The survey involved the use of harp traps, echolocation call analysis, spotlighting and the recognition of audible calls. From these methods eight bat species were recorded (refer Appendix H) including two species listed on Schedule 12 of the NPWS Act as endangered; the Little Bent Wing Bat (*Miniopterus australis)* and the Large Bent Wing Bat (*Miniopterus shreibersii*). A predictive list of other bat species which may occur within the study area has been prepared on the basis of previous records and available habitat (refer Appendix H). Eight of the sixteen species on this supplementary list are Schedule 12 species. The potential impact of the proposal on Schedule 12 bats is discussed in a Fauna Impact Statement included in Appendix E.

Although the majority of species would be affected through loss of roosting sites and foraging resources, it is considered unlikely that the proposal would affect the status of local populations given the relative abundance of similar habitat in State Forest in the vicinity, and the proposal to cease logging in the remaining 40ha of the dam catchment.

Aquatic Ecology

Sampling of freshwater biota occurring in the creek to be inundated by the proposed dam, revealed 41 species including 36 macroinvertebrates and five fish species (of which four are native) (refer Table 5.7). One of these species the Australian Bass *(Macquaria novaemaculeata)* was previously found in the Kings Creek estuary and is considered of conservation significance. The results of the aquatic survey are included in Appendix I.

The Spiny Crayfish (*Euastacus spinosus*), has limited distribution in New South Wales and accordingly has high conservation value regionally. The species has been located in the Camden Haven, Manning, Myall Lakes, Karuah and Hunter areas. Twelve recordings of this species have been made in the Hastings catchment (Bishop, 1994). The record of the species in the present study results is a small extension of the known distribution.

Populations of the genus *Euastacus* have not been observed to develop in storage facilities, and it is therefore unlikely to become established in the proposed dam.

The condition of creek habitat in the catchment area has been adversely affected by forestry operations and cattle grazing. Given the less disturbed creek habitat in the locality, it is considered unlikely that the proposed inundation would threaten the survival of the species.

A species of atyid shrimp of the genus *Caridinides* was found in waters below the proposed dam site. The taxonomy of this species has not been researched.

Within the area to be inundated the impacts on aquatic biota are generally regarded to be positive. Potential impacts on aquatic fauna downstream of the proposed storage site include reduction in flow and increases in turbidity and sedimentation. Provision for an environmental flow from the dam is advised for the continued survival of species downstream. Environmental flows would be maintained through dam seepage, while controlled scouring flows could be allowed from the outlet according to a programme to be established for the operational environmental management flow. The application of erosion mitigation measures is recommended to contain sediment inputs from construction activities.

Impacts and Safeguards

The impacts on fauna of the proposed dam construction and subsequent inundation would be derived from:

- permanent removal of habitat (82ha) of which approximately 55ha is dry sclerophyll forest, 20ha is wet sclerophyll forest, and 7ha is creekbank vegetation. A further 8ha would be cleared and revegetated upon completion of the dam wall.

- potential for indirect effects due to construction disturbance including changes to downstream water quality, flow volume, erosion and sedimentation.

- barrier effects of the dam to fauna movement.

- disturbance effects due to upgrading of access roads.

Habitat Removal

A total of approximately 82ha of bushland is to be permanently removed during the proposed dam construction. Vegetation types to be removed by this development are Dry Sclerophyll Forest, Wet Sclerophyll Forest and a small area of Creek bank vegetation Forest. A further 8ha of Wet Sclerophyll Forest would be cleared to construct the dam wall and replanted on completion. A range of mammal, reptile and bird species have been observed in or are predicted to use the resources provided by these vegetation types (Appendix F).

The retention and protection of about 46ha of vegetation within the catchment above the proposed water line would provide alternate resources and habitat for displaced fauna. The exclusion of disturbing influences from the catchment area, following construction, would enhance the habitat value of this remaining vegetation.

Approximately 0.2km, 1.1km and 2.5km of third, second and first-order creeks respectively, would be inundated. This effectively removes a portion of the habitat in the Kings Creek catchment of the Spiny Crayfish, *Euastacus spinosus*, a species of high conservation value.

Habitat Creation

Compensating for the loss of habitat to the dam construction and inundation would be the creation of habitat for waterfowl and aquatic fauna.

The impact on aquatic fauna of the proposed dam is expected to be generally positive with predicted increases in fish and macroinvertebrate populations. Frog and turtle species observed in the vicinity are also expected to benefit from the provision of a large permanent body of water.

With the creation of an aquatic habitat, the introduction of communities of water fowl can be expected. There would also be an increase in the overall range of available habitats as a succession of vegetation types develops from the waters edge to the surrounding bushland.

Although the loss of 82ha of forest habitat would reduce the number of roosting and foraging sites for many locally occurring bat species, one species, the fishing bat, *Myotis adversus*, would gain preferred habitat from the proposed dam. In the longer term, management of the 46ha of naturally vegetated catchment would provide a significant habitat resource for a range of terrestrial and arboreal fauna.

Aquatic Ecology

The main impacts on watercourses below the proposed construction site are potential increases in turbidity and sedimentation during construction activities and a decrease in natural flow with the loss of catchment. Increased sediment load in a waterway can adversely affect water fauna and this effect may be exacerbated by a reduced flow. Instigation of erosion mitigation measures, to be put forward in the Environmental Management Plan, are necessary to minimise sediment input into the creek below the dam site. The installation of a sediment pond, in association with catch drains at the toe of the dam embankment is recommended.

The low diversity of fish species sampled in the creek was evidence of its ephemeral nature (refer Appendix I). At the time of sampling the stream consisted only of a few ponds and wet areas. As a result, fish species diversity increased with distance downstream. Only the common Long-finned Eel (*Anguilla reinhardti*) was observed in the stream above the dam wall location. Further downstream the Striped Gudgeon (*Gobiomorphus australis*), Empire Fish (*Hypseleotris compressor*), Pacific Blueye (*Pseudomugil signifer*) and Mosquito Fish (*Gambusia holbrooki*) become more apparent.

Bishop (1994) (Appendix I) anticipates that populations of fish found in the upper reaches of the creek (Long-finned Eels and Striped Gudgeons) will expand greatly with the construction of the dam. A number of other fish species may also colonise the dam following introduction of fish or eggs via the pipeline.

The construction of the dam will eliminate opportunities for recruitment of downstream populations from habitats above the dam. The dam would also reduce the catchment area and variability of flows along the creek below the dam wall. However, flows would be maintained at consistent non-erosive levels by dam seepage, such that drought stresses would be eliminated. While scouring flows would be initiated to replicate the natural frequency of high flows in the creek.

The maintenance of an environmental flow from the dam into the third-order creek below the proposed dam wall would provide for the ongoing survival of all freshwater biota, notably the Spiny Crayfish, *Euastacus spinosus*. Environmental flows would be maintained as a result of dam seepage, while scouring flows would be created by means of a regulated discharge from the outlet valve ensuring periodic flushing of the creek and avoidance of long term infilling. The quality of water released from the dam would be within the ambient range of creek waters with respect to dissolved oxygen concentration and temperature. This would be managed by selective use of intake tower portals and dam water quality monitoring. Scouring flows would be released at a volume and frequency equivalent to the calculated natural flow regime. Guidelines for the frequency and intensity of flows from the outlet valve would be contained in the operational EMP for the dam.

Barrier Effects

The proposed storage facility is not expected to create a significant barrier to fauna movement given the area of surrounding bushland. The Cowarra State Forest (1,606 ha) extends 5km north, 3km east and 3km south of the site, providing wildlife corridors through continuous forest to Burrawan State Forest to the south.

The retention and protection of bushland above the proposed waterline within the catchment also provides an environment sympathetic to fauna movement around the water storage.

Disturbance due to Access Roads

The upgrading of existing roads to the study area for the purposes of providing access during the construction phase could potentially disturb the local environment.

Possible impacts include loss of vegetation through road widening and ground disturbances leading to increased erosion and subsequent sedimentation and turbidity problems downstream.

By implementing road designs in accordance with CaLM guidelines, these effects could be moderated. Other measures proposed to reduce the effects of road upgrading would be outlined in the Environmental Management Plan.

On completion of the construction phase the rehabilitation of access roads is recommended, pending consultation with the Forestry Commission and their ongoing utilisation of these roads.

Rare or Threatened Fauna

The impact of the Proposal on rare or threatened fauna included within Schedule 12 of the National Parks and Wildlife Act (1974) is presented in the form of a Fauna Impact Statement (FIS) attached as Appendix E to this EIS. The Director-Generals requirements, the FIS certification and qualifications of the project team are also attached as appendices to the FIS.

The FIS has been prepared to meet all the requirements of Section 92D(1) of the NPW Act 1974. Pursuant to Section 92D(3), the Director-General NPWS has issued further specific requirements in relation to the impact of the Proposal on the following species:

- Glossy Black Cockatoo (Calyptorhynchus lathami)*
- Little Bent-wing Bat (Miniopterus australis)*
- Large Bent-wing Bat (Miniopterus schreibersii)*
- Eastern Free-tail Bat (Mormopterus norfolkensis)
- Golden-tipped Bat (Kerivoula papuensis)
- Greater Broad-nosed Bat (Scoteanax rueppellii)
- Eastern Blossom Bat (Syconycteris australis)

The FIS is put forward to meet the information requirements of the Director-General NPWS to determine whether a Section 120 General licence to "take or kill" Schedule 12 fauna should be issued by the NPWS and on what conditions. Based on the FIS findings, the three asterisked species would need to be the subject of a Section 120 licence application according to the interpretation of take or kill with respect to the locally occurring Schedule 12 species. A summary of the findings of the FIS with respect to each of the above species appears below.

Impact on Schedule 12 Species

Glossy Black Cockatoos (*Calyptorhynchus lathami*) are found in eucalypt forest and woodland in which the tree species Allocasuarina torulosa and A.littoralis occur. The Glossy Black Cockatoo feeds almost exclusively on the fruit of these trees. Both of these tree species occur within the study area and contribute to the critical habitat of Glossy Black Cockatoos in the area. It is therefore possible that the environment of this bird may be disturbed to the extent that the species may be adversely affected. However, it is noted that State Forests regard this species as locally common with 132 sightings of the species reported in the Forestry district (J. Fulton pers comm, 1995). The definition of "take or kill" under the NPWS Act encompasses the situation with respect to Glossy Black Cockatoos and as a result a request for a Section 120 Licence is made in relation to this species.

To ameliorate impacts on this species clearing of vegetation would be keep to a minimum outside the inundation area, and revegetation of disturbed areas would include planting of *Allocasuarina* species.

<u>The Little Bent-wing Bat</u> (*Miniopterus australis*) was captured at two sites and recorded from call at nine sites in a variety of habitats from moist to dry sclerophyll forest. No cave roosts for this species would occur in the study area however, diurnal roots in trees under loose bark or hollows may be used. This species would be affected by inundation of the proposed dam site through loss of foraging habitat. This impact is unlikely to affect the survival of local populations of the species due to the size of the dam in contrast to the amount of forest surrounding the study area including the protected dam catchment. However, as the foraging habitat of this bat may be adversely affected, a request for a Section 120 Licence is made in relation to this species.

<u>The Large Bent-wing Bat</u>, (*Miniopterus schreibersii*), was detected from call at two sites in dry eucalypt forest. Although no cave roosts for this species were located in the area to be flooded, its presence cannot be ruled out as its diurnal roosts are often difficult to locate. The proposed dam construction would destroy foraging habitat of this bat notwithstanding the conservation of forest in the dam catchment. Therefore, a request for a Section 120 Licence is made for this species.

<u>The Eastern Blossom Bat</u>, (*Syconycteris australis)*, has been recorded to the south at Coopernook State Forest and Harrington and from Port Macquarie to the east and may occur in the study area when suitable food plants are in flower. Wet sclerophyll forest along the larger creeklines in the area to be dammed may provide roosting habitat for this nectivorous bat. This habitat is vital to this bat for roosting purposes, enabling it to maintain stable temperatures throughout the day. Eucalypts, Melaleucas and flowering trees and shrubs throughout the catchment may provide feeding resources for this species within the area to be flooded. This species could be impacted through damming of the catchment, therefore an application for a Section 120 licence is made for this species.

<u>The Eastern Free-tail Bat</u>, (*Mormopterus norfolkensis*), a little known species, has been recorded from dry and moist sclerophyll forests and may occur in forest of the study area. Individuals of this species have been recorded from Kempsey to the north and Coopernook State Forest to the south of the study area. It is considered that the loss of habitat due to the proposed dam is likely to impact on this species due to loss of foraging habitat and a reduction in potential shelter trees (Hoye, 1994). An application for a Section 120 Licence is made for this bat.

The Golden-tipped Bat (*Kerivoula papuensis*), has a high chance of occurring in habitats in the area to be dammed, in particular the moist eucalypt forest. This species may be impacted by the proposed dam due to inundation of foraging habitat and loss of diurnal roosts. Consequently an application for a Section 120 Licence is made for this species.

The Greater Broad-nosed Bat, (*Scoteanax ruepellii*), is known from Wingham and Lansdowne to the south of the study area. It would appear to have a high possibility of occurring in the catchment of the proposed dam as moist eucalypt forest is to be a favoured habitat. This species would be at risk from significant loss of habitat as it is a large species using a greater feeding range than most other species. This species is likely to be affected by the proposed development. Therefore, an application is made for a Section 120 Licence for this species.

FIS Conclusion

Each of the listed species for which a S120 licence application is made would be affected in terms of foraging habitat removal and loss of roost sites. However, the cessation of logging in the dam catchment would promote the development of old growth forest in the long term. The habitat value of the catchment for bats will increase as tree roosts became more abundant over time. It is also noted that extensive areas of logged forest similar to that to be inundated occur throughout the district and remain available to these highly mobile species. While according to the definition of "take of kill" the above species would have their habitat modified such that the development is likely to affect their essential behavioural patterns (i.e. foraging, roosting), the effect would not be significant to the extent that local populations of any of these species would become extinct.

5.2.8 Traffic and Access

Access

Section 5.1.10 describes the proposed means of construction and operational access. Where possible, existing forestry tracks would be upgraded to provide for two way traffic and new access tracks would generally coincide with clearings for construction of the pipelines into the dam. Tracks would generally be 8 metres wide with provision for 1 metre drains on each side of the road. Where permanent post-construction access is required, the roads would be sealed. All construction access tracks not required for forestry access following construction would be rehabilitated. Permanent sealed roads would be maintained by Council.

Some tracks within the Cowarra State Forest would be upgraded by the contractor for use as temporary construction access tracks. These tracks would be maintained by the contractor until construction traffic ceases, whereafter, responsibility for track maintenance would revert back to State Forests.

Traffic Generation

The existing forestry tracks presently carry very little traffic (usually less than ten vehicle trips per day unless harvesting is in progress). However, construction of the dam would considerably increase traffic movements through Cowarra State Forest and within the proposed dam catchment area.

Forestry tracks 72/73 are intended to carry the majority of construction traffic to the site from the Old Pacific Highway near Houston Mitchell Drive. This route has been selected because it minimises disruption to nearby residences and other land uses. Traffic movements are anticipated as follows:

- Hard rock import - 60 inbound trucks per day over a 3 month period.

- Heavy vehicle movements (eg. delivery trucks, graders, backhoes, concrete trucks and equipment floats) - 30 inbound trucks per day (average).

- Construction personnel, small deliveries - 30-40 inbound cars or utilities per day (average).

Traffic movements would take place during working hours (ie. 7.00am - 5.00pm during the week and 7.00am - 3.00pm on Saturdays).

Impacts

The main traffic impacts of the project are potential noise, diminution of air quality and deterioration of roads.

Section 5.2.5 addresses the impact of traffic noise. It concludes that except for the Graham residence, traffic noise would not significantly affect adjoining residences. Negotiations are being made so that the Graham's can be relocated to alternate accommodation elsewhere for the duration of the project if desired.

Section 5.2.4 addresses air quality issues. It concludes that the impact of dust and fuel emissions would be minor if correct soil and water management principles and vehicle maintenance are employed by the contractor.

Sealed roads outside the site are unlikely to deteriorate significantly because of additional usage by construction traffic.

The possible deterioration of unsealed roads 72/73 within the forest and the dam catchment could be significant, given that they would carry significant numbers of heavy vehicles, both in dry and wet conditions. It is recommended that the contractor maintain the construction tracks until completion of the project and then hand the tracks back to State Forests and Hastings Council for longer term maintenance. Access road maintenance guidelines would need to be incorporated into the EMP.

5.2.9 Visual and Landscape Assessment

Existing Visual Environment

The existing landscape of the proposed dam site is heavily forested with tall eucalypts. The forest is dense and as such, views are limited within the site itself, with obscure views available across the surrounding landscape. From the highest point of the site, Boars Head, only glimpses are available of the valley below. Views from the rural landscape below consist of a dark green forested hillside. An artist's impression of the dam when viewed from the air is shown in Figure 5.8.

As a result of this very limited visual catchment, the sensitivity of the area to visual change is low. Areas categorised as having low visual sensitivity are generally those that, like the subject site, have few viewing opportunities and few potential viewers. Recreational use of the forest is currently limited to occasional off-road vehicles, however, this use is not anticipated to continue should the project proceed.

Impacts and Proposed Safeguards

Due to its very limited visual catchment, visual impact of the Proposal is contained within the water catchment of the dam and the area immediately adjacent and below the dam walls.

The proposal would result in the loss of tree cover from the site to allow for the filling of the dam. However, this would not be perceptible from viewpoints below the dam site.

There are two residences which may have their views affected by the dam construction: the Graham residence near the site of the dam wall and the Dalton residence.

The Graham residence would be approximately 100m from the dam wall at its closest point. Given that a 200m clearing of trees would be necessary at the base of the dam wall for construction purposes, glimpses may be seen. However, topography and the dense stand of remaining vegetation (100m wide) would likely prevent or filter through views. Visual impact therefore would be minor.

The Dalton residence would be around 850m from the dam wall at its closest point and is the next closest residence to the Proposal. The dwelling is sited in a clearing which is surrounded by tall eucalypt forest. Again, the density of vegetation between the residence and wall is likely to prevent through views. Even with a 200m clearing of trees at the base of the dam wall for the construction compound, there would be a visual barrier of vegetation 700m deep.

Topography of the residence setting, prevents clear through views to the dam wall. The home is located on low, gently undulating land and combined with the proposed height of the dam wall, the structure is not likely to be tall enough to be seen above the canopy from this location. Visual impact therefore would be minor. A sight line diagram of views towards the dam wall is shown as Figures 5.9 and 5.10.

Numerous rural residences are located along the sealed roads in Sarah's Crescent, Kings Creek Road, and the access roads to "Blue Ridge" and "Tallwood". Given the distance of these residences from the Proposal (between 1 km and 3 km from the dam wall), the nature of the topography, the proposed height of the dam wall and the height, density and extent of vegetation between the houses and the dam, views would remain unaffected by the Proposal.

Landscaping to revegetate and ameliorate any adverse visual impacts is proposed. Planting is possible within the zone of cleared vegetation beyond a 50m off set at the toe of the dam wall. The 50m clearance would remain necessary for maintenance and works purposes.

Proposed landscaping would further obscure views and help restore the natural appearance of the site. Planting should be of species endemic to the area. Topsoil should be removed and stockpiled prior to construction and respread when landscaping to retain the original seed bank. Branches from trees cleared during construction would be chipped and used for mulching when revegetating, to promote plant growth and help prevent weed infestation.

5.2.10 Socio-Economic Impacts

Background

Hastings Local Government Area is experiencing considerable population growth as a result of primarily retiree migration from Sydney, New England and North Western NSW. The growth is fuelled by a pleasant coastal environment and climate and by relatively cheap land prices.

According to the North Coast Urban Planning Strategy into the 21st century (Department of Planning, 1995), Port Macquarie has been identified as one of five sub regional centres in the North Coast Region. Continued growth in accordance with that strategy is dependant on maintaining the supply of serviced residential land and this can only be fully achieved by overcoming existing water supply constraints.

Augmentation of the water supply would have both direct and indirect socio-economic impacts.

Direct Impacts

Construction of the dam would necessitate some private property acquisition within the dam catchment area. Section 4 details the extent of the impact more fully.

All existing and possible future land uses within the dam catchment area would be prohibited to protect the integrity of the water supply. This would result in

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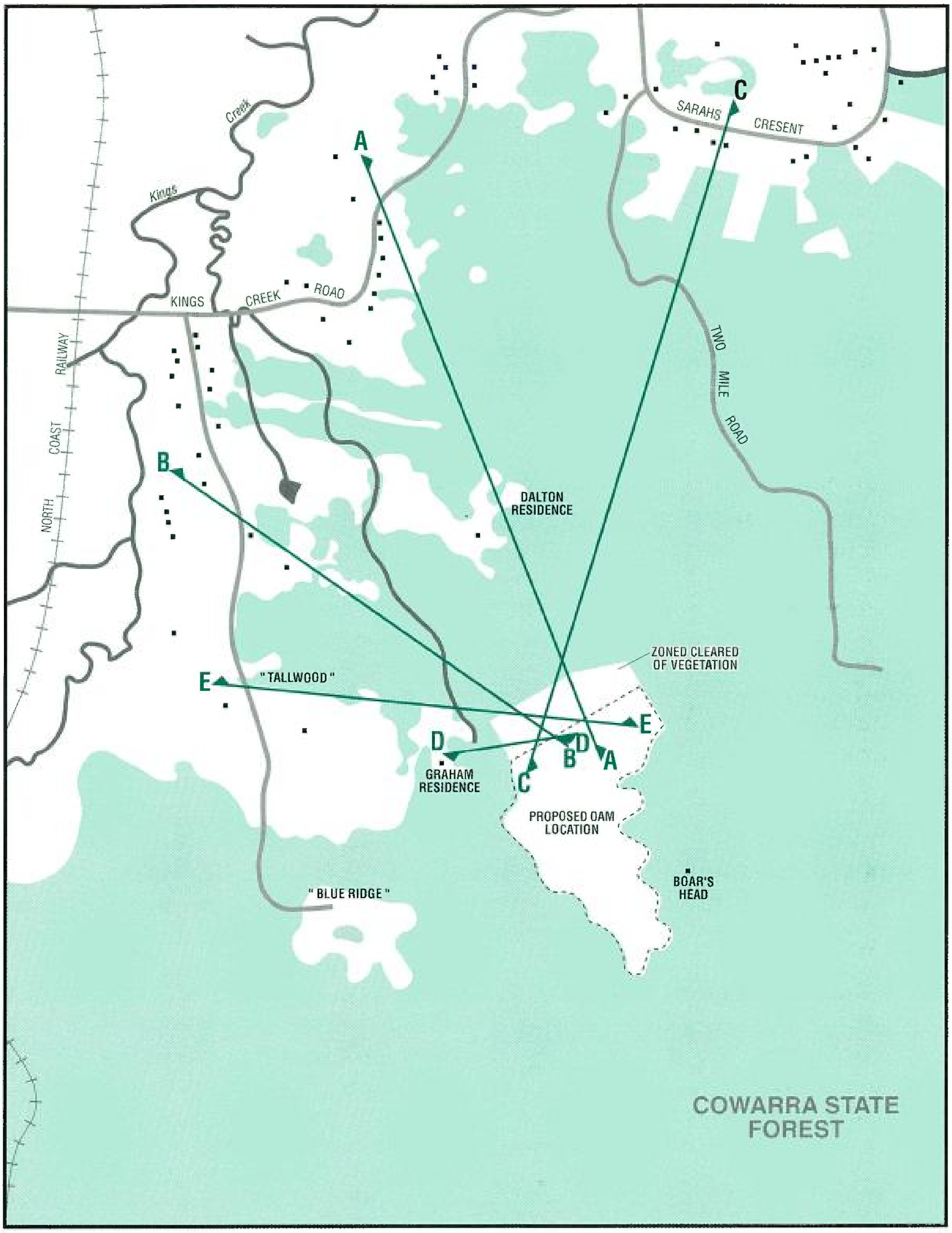
Figure 5.8
Artists Impression of Proposed Cowarra Dam

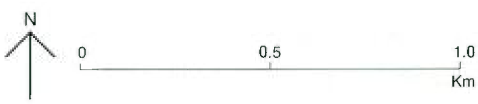


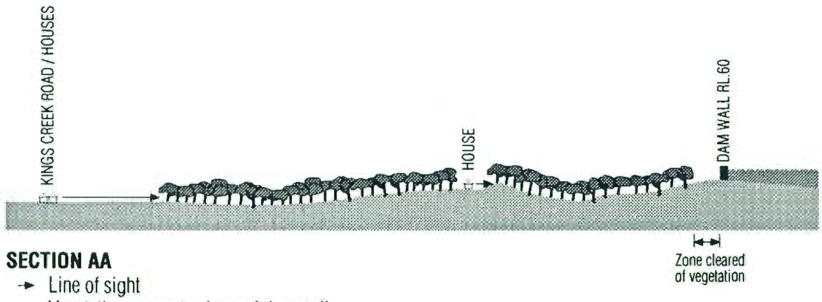
Sight lines

Residences

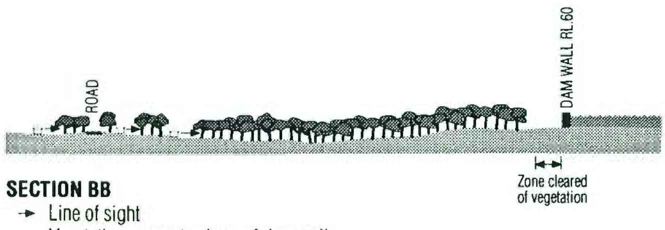
Extent of forestry/Vegetation cover

Figure 5.9
Visual Assessment:
Plan of Sight Lines

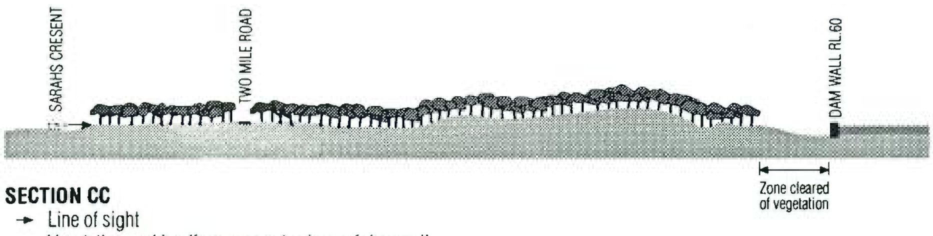




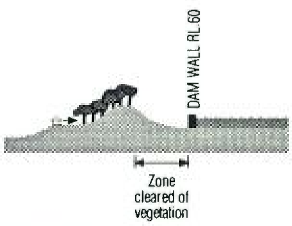
SECTION AA
→ Line of sight
Vegetation prevents views of dam wall



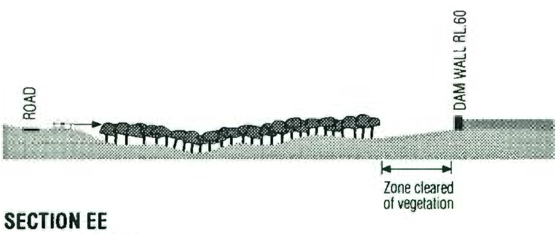
SECTION BB
→ Line of sight
Vegetation prevents views of dam wall



SECTION CC
→ Line of sight
Vegetation and landform prevents views of dam wall



SECTION DD
→ Line of sight
Vegetation and landform prevents views of dam wall



SECTION EE
→ Line of sight
Vegetation and landform prevents views of dam wall

Figure 5.10
Cross Sections of Sight Lines

Scale: Vertical 1:10 000 — 0, 0.25, 0.5 Km

Horizontial 1:20 000 — 0, 0.5, 1.0 Km

sterilisation of potential resources including minerals and timber and land that may be capable of cultivation or grazing. Public access to the catchment would also be denied. Section 4 compares the impact of the preferred site to alternative sites and strategies.

Progressive construction of augmentation works, and the dam in particular, would provide temporary employment for construction contractors. This would have flow on effects to equipment and material suppliers and eventually, other sectors of the local community. Once operational, the water supply system and dam would require regular supervision and maintenance which is likely to generate some employment.

Indirect Impacts

Augmentation of the water supply would have significant indirect socio-economic impacts.

Current restrictions placed on long term population growth are largely a result of an inadequate long term water supply. If the supply constraint is lifted by augmentation and construction of a new dam, it is anticipated that the population could reach 120,000 permanent residents by the year 2040. This would require construction of about 25,000 to 30,000 new dwellings which would provide ongoing employment for builders, suppliers and local industry. It may also provide the impetus necessary to generate new industry.

The increasing population would be expected to gradually generate demand for additional service industries such as shops, banks and entertainment with a resultant increase in employment opportunities.

Migration of retirees to the Hastings Council area would strengthen the Region's economic base by attracting retirement savings, superannuation and pension payments and in particular, housing investment funds. In addition, Council's rate base stands to grow significantly through rezoning of land to higher rateable uses which would allow community services to be provided more effectively.

Augmentation of the water supply would also help the tourist industry to reach its full potential. Based on current projections, it is anticipated that the Region would by 2040, accommodate a significant additional tourist population as indicated by Table 5.9 which is based on 1991-2040 estimates (Kinhill, 1994).

Table 5.9 : Tourist Accommodation Predicted Demand by 2040

Tourist Accommodation	1991	2040	Increase
Seasonal dwellings	1,910	4,370	2460
Seasonal flats	581	1,446	865
Camp/Caravan sites	2,492	5,819	3330
Hotel/Motel beds	5,997	17,504	11500
Other visitors	3,020	7,290	4270

Growth of the tourist industry would increase visitor spending and provide additional employment within the region, both in construction and tourism.

5.2.11 Forest Resources

The catchment of the storage would occupy 109 hectares, of which 81 hectares is State Forests land and almost 38.5 hectares is freehold land. Acquisition of the State Forests component of the dam site and subsequent construction would prevent further forestry activities within the catchment area. However, Forestry operations outside the immediate catchment area will be unaffected by the proposal. Consideration is given to the existing resources within the study area, the impacts of the Proposal on harvesting these resources and future cutting cycles and offers from Hastings Council to compensate any losses in future productivity.

Existing Conditions and Use

The available timber resources within the catchment area may be classified into forest types. Forest types are groups of tree dominated stands possessing a general similarity in composition and character which occur under the influence of relatively uniform environmental conditions of soil, topography, climate and past history (Baur, 1989).

Forest type 37a (Dry Blackbutt) occurs on the southern slopes and ridges of the catchment. Only a few hectares of this forest type would be inundated by the proposed dam. Forest type 62a is a dry sclerophyll forest occupying the slopes east and west of the main creekline. This association is dominated by Grey Gum *(Eucalyptus propinqua)*, Grey Ironbark *(E.paniculata)* and White Mahogany *(E.acmenoides)*. A small amount of this forest type would be affected by the Proposal. Forest type 49 is a wet sclerophyll forest dominated by Turpentine *(Syncarpia glomulifera)*, Sydney Blue Gum *(Eucalyptus saligna)* and Tallow-wood *(E. microcorys)*. The proposed inundation would affect forest mostly of this type.

Logging operations in the study area last took place on the lower slopes and in the central gully areas in 1993. A good distribution of advanced growth now occurs in this area with few over-mature competing trees remaining. Trees retained for future growth after the last logging operation are now merchantable. It is prescribed that within the inundation area that the State Forests would log the site as agents of Council, prior to clearing for the construction site, inundated area and access roads, to ensure utilisation of this timber.

The higher slopes were not logged in the last harvest and currently contain scattered sawlogs and poles. The higher slopes in the catchment above the inundation line are to be left unlogged to protect the quality of the water supply.

The study area makes a minor to moderate contribution to the timber yield of the Cowarra State Forest. Despite the accessibility of the site and the availability of timber for future yields, the long term prospects of the study area are moderate.

Logging activities in this area are opportunistic since planned harvesting of the area was suspended in 1993 pending resolution of the dam site issue.

Impacts on Forest Resources

The construction of the proposed dam would result in a direct loss of forest resources in the Cowarra State Forest. Below the level of inundation, 62 hectares of forest would be cleared. Above the level of inundation and within the catchment, 46 hectares of forest would be sterilised from further forestry activities. While the loss of 109ha is relatively small in the regional context the site is moderately productive and very accessible. Within the Kempsey Wauchope Management Areas, 207,887 hectares of land are held in State Forests, of which slightly less than half is available for sustainable timber production.

Impacts on State Forest Assets

The loss of these forest resources does not necessarily represent a loss of State Forests assets or future timber yields. In taking 81 ha of Cowarra State Forest, Hastings Council has proposed to compensate the Forestry Commission with a 205 ha parcel of forested land in Pappinbarra Junction adjacent to Bellangry State Forest.

Incorporating this Pappinbarra Junction property into the Bellangry State Forest has sound management potential for forestry operations in this area. Features of this site which are favourable to forestry operations include:

- consolidation of Bellangry State Forest boundaries;
- productive stands of moist hardwood species with good long term potential;
- 205 hectares total area compared with 109 hectares in the proposed dam site; and
- good road access;

Given these features it is considered that the Pappinbarra Junction site is preferable to the proposed dam site for future logging operations. As such, it is considered appropriate compensation for State Forests loss of less productive land on the dam site in Cowarra State Forest. Compensation negotiations between Council and State Forest are approaching completion. The finalised agreement would include consideration of the total effect of all aspects of the water supply scheme on the value and availability of State Forest Resources.

The justification for disturbance of State Forest as a result of the construction of ancillary facilities is discussed in Section 2.2.1.

5.2.12 Extractive Resources

The mineral potential of the proposed catchment area is considered to be low (Department of Mineral Resources pers. comm. 1994) as the area is underlain by Carboniferous metasediments that contain no known prospective rocks and are probably unaffected by mineralising granitoids.

No mining leases have been granted and no applications for leases have been lodged over the proposed dam site. However, an Exploration Licence application has been lodged which encapsulates the eastern margin of the catchment area above the level of inundation and a small area (<5%) of catchment below the level of inundation. The mineral potential of this area is low and the area is considered unprospective.

Given the low mineral potential of the site, the proposed dam is not likely to have any significant effect on the availability of mineral and extractive resources or on possible future mining or extractive operations.

5.2.13 Planning and Land Use

The development of the North Coast Region is guided by the release in 1995 of the North Coast Urban Planning Strategy (NCUPS) into the 21st Century (refer Section 3). However, the Environmental Planning and Assessment Act 1979 (NSW) as amended still forms the basis of planning and land use controls throughout the State. Under this Act, the provisions of three tiers of planning control need to be considered for this project:

- State Environmental Planning Policies (SEPP's)
- Regional Environmental Plans (REP's)
- Local Environmental Plans (LEP's)

<u>State Environmental Planning Policies</u>

SEPP 4 - Development Without Consent applies to water storage dams where dams are not a prohibited land use in a particular zone. In this instance the dam is not a prohibited land use and as a consequence, the proposal is assessed under Part V of the Environmental Planning and Assessment Act.

<u>North Coast Regional Environmental Plan (NCREP) 1987</u>

The proposed dam and its catchment falls within the planning control of the NCREP 1987. The aims of this Plan are relevant to the project's objectives, and are listed below. The EIS generally addresses these aims as indicated by Section references:

- to facilitate the continued multiple use of State Forests;

- to facilitate employment opportunities in forestry and the timber industry (Section 5.2.11);

- to protect areas of natural vegetation and wildlife from destruction and provide corridors between significant areas (see Section 5.2.7 and 5.2.8);

- to protect the scenic quality of the Region including natural areas, attractive rural areas and areas adjacent to waterbodies, headlands, skylines and escarpments (Section 5.2.9);

- to protect water quality, particularly within water catchment areas (see Chapter 5.2.3);

- to provide the economic and timely provision of utility services to new urban and residential areas (Section 3).

The proposed dam is consistent with the aims and objectives of the NCREP.

<u>Local Plans</u>

The development of the dam site and surrounding lands is controlled by the Hastings LEP 1987 as amended. The Portions that make up the dam site and catchment area are zoned under that plan as follows:

Table 5.10 : Zoning and Land Use of Properties in Cowarra Dam Area

Portion/Lot No.	Area to be Acquired	Current Zoning	Current Land Uses
28, 29	16ha	Rural 1(a1)	Riding School, trail riding
30, 31	50ha	Rural 1(a1)	Low level grazing
Cowarra State Forest	100ha	Rural 1(f1)	Forestry, trail riding, (other)

The parts of the site that are currently zoned Rural 1(a1) fall within the King Creek rural residential release area. It is anticipated that an LEP and DCP would be gazetted in 1995 to rezone those parts of the site to Rural Small Holding 1(c1) (refer Figure 5.11).

The proposed dam is consistent with the aims and objectives of Hastings LEP 1987 and Roads and Utility Installations are permitted in Rural 1(a1), 1(c1) and 1(f1) zones. Although rezoning of the catchment is not specifically required, to allow approval of the projects, it is suggested that the dam and its catchment be rezoned Special Uses (Water Catchment) to ensure that water quality is protected in the long term by prohibiting incompatible land uses.

Council proposes to acquire all land within the dam catchment, including part of the Cowarra State Forest, and is likely to restrict access into that catchment area.

This would affect current public use of the Forest and particularly the horse riding activities of adjoining landowners. Section 2 discusses compensation negotiations between Council, State Forests and adjoining landowners. A proposed land swap with State Forests to compensate for loss of forest resources is discussed in Section 5.2.11.

5.2.14 Health Issues

Water Supply

Provision of a secure, clean water supply is a primary objective of the project. As Chapter 3 indicates, there are instances when water cannot be pumped from the Hastings River because of the risk to health. Chapter 5 also discusses management of the water body to ensure that the water is suitable for consumption. In addition, during drought periods, the population is inconvenienced by water restrictions. Without augmentation of the supply system, these situations could worsen to the point where health standards are compromised.

Mosquito Risks

Australia is experiencing increased exposure to, and incidence of mosquito-borne tropical health risks such as malaria, dengue fever and Ross River Fever. Other mosquito borne viral diseases potentially becoming more widespread include Barmah Forest Disease and Murray Valley, Kunjin and Japanese Encephalitis. Outbreaks of these diseases occur occasionally throughout Australia and their incidence is gradually spreading to include areas such as the Hastings Region. Whilst it is stressed that the Region has not experienced any outbreak of these diseases, a number of design precautions could be taken to minimise mosquito borne disease risks. These include:

- locating still water bodies away from main population centres;
- minimising shallow ponding areas, particularly where reeds and grass are likely to grow out of the water. Emergent vegetation can provide a suitable environment for mosquito larvae; and
- encouraging the introduction of native fish species that feed on mosquito larvae.

It is suggested that an entomologist be engaged at the detailed design stage of the project to advise on mosquito risk minimisation.

Construction Noise

One residence is located within 100m of the construction zone and the residents are likely to be affected by noise during construction. Section 5.2.5 addresses noise in detail and puts forward measures to manage the amenity of the Graham residence.

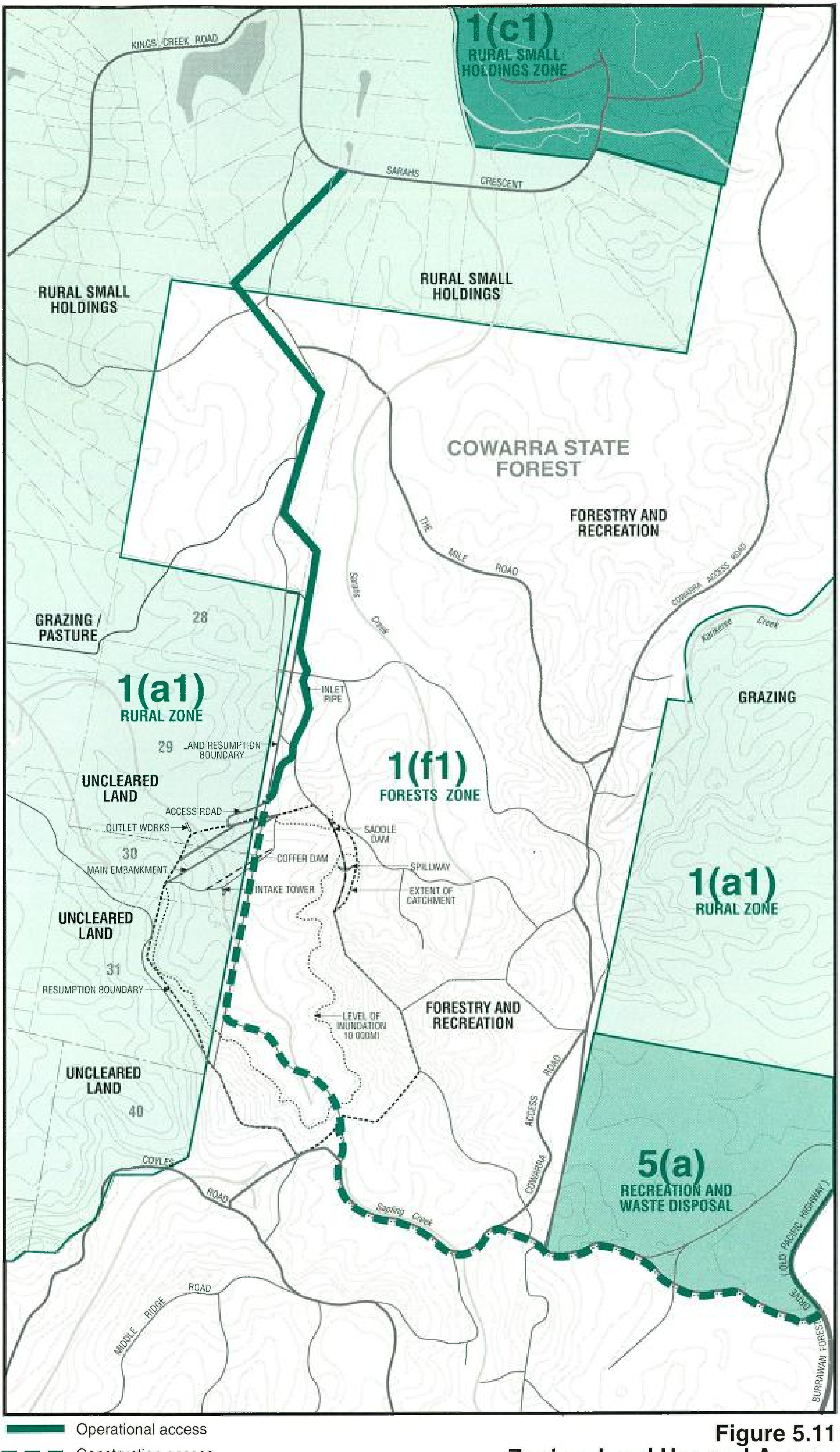


Figure 5.11
Zoning, Land Use and Access

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5.2.15 Aboriginal Archaeology

An archaeological survey of the study area was carried out by Jacqueline Collins (1994) to determine the presence of any sites of Aboriginal significance. This survey included a search of previous studies in the Hastings locality and field survey with representatives of the Bunyah Local Aboriginal Land Council. This report is included in Appendix L.

The field survey was undertaken by Jacqueline Collins and two members of the local Bunyah Local Aboriginal Land Council on foot looking for signs indicative of Aboriginal presence. An area of 23ha was covered during the survey, however limiting factors reduce the area effectively inspected to 4.3ha.

Four sites of Aboriginal significance were located within the catchment area. These included three open camp sites, consisting of surface scatters of flaked stone artefacts and one site, indicated by an isolated stone artefact. Two of these sites occur within the proposed inundation area, the other two occurring on the ridge to the west of the site within the catchment area (refer Figure 5.7).

The two sites within the proposed dam inundation area, (one open campsite and one isolated stone artefact) have been assessed as having low scientific significance, however, they are likely to have some general heritage value to the Bunyah Local Aboriginal Land Council. It is recommended that the artefacts at these sites be collected and retained by the Land Council as a future educational and heritage resource. This action requires the proponent to obtain an Application for Consent to Salvage from the NSW National Parks and Wildlife Service.

The two sites on the western ridge of the catchment area, both open campsites, have been assessed to be of moderate scientific significance with general Aboriginal heritage value. As the proposal may proceed without affecting these sites it is recommended that they remain in-situ and be demarcated by surveyors tape during construction phases. As there is a high probability of other archaeological materials beneath vegetation adjacent to the exposed sites, it is recommended that these areas be protected in a radius of 20m around the site. The sites would be taken into consideration in the location of the balance tanks and pipeline easements at the detailed design stage.

Five scatters were located adjacent to the proposed construction access road near Sapling Creek. It is likely that these artefacts were washed down from near the fault line to the south. It is recommended that the artefacts be collected by Land Council representatives from the southern side of the road (requiring salvage consent from NPWS). The road widening should be effected by filling the downslope (northern) side of the road rather than cutting into the upslope bank between Sapling Creek Crossing and the fork to the dam site (refer Figure 5.7).

A Land Council member would be present on site during critical phases during the clearing and construction of the dam for the possible identification of further sites.

5.2.16 Non-indigenous Heritage

Local History

In 1818, Governor Macquarie sent John Oxley from Bathurst to explore the Macquarie River. Having travelled east across the Great Dividing Range, his party descended to the coast where they found a well sheltered inlet at the mouth of the Hastings River which they named Port Macquarie.

Port Macquarie was established as a convict settlement in 1821 and free settlers soon moved into the area, attracted by the rich natural resources the country offered. Early industries in the 1820's included cedar cutting and growing sugar cane along the Hastings and Wilsons River. As most produce was transported by river, small service towns began to flourish along the Hastings River.

During the 1840's the New England Wool Road was completed using convict labour. The road roughly followed that of John Oxleys earlier expedition and served to connect the coast with inland areas. Today's Oxley Highway still follows the New England Wool Road in some sections.

Timber licences for cutting hardwood in the Hastings District were first issued in 1863 and hard wood mills soon began operation in the area. In 1880 most of what is now Cowarra State Forest was made a forest reserve.

Dairying was the major industry during the late nineteenth century and remained so until the 1940's, whereafter timber and beef industries became more prominent. In 1915 the North Coast Railway reached Wauchope, and opened up the district by permitting transport of produce to Sydney without depending on Port Macquarie for shipping. This raised Wauchope's importance as a service centre and the population grew accordingly.

A tourism boom on the coast during the 1970's led to an influx of retirees into the Port Macquarie area. This led to an increase in local building activity creating demand for local timber products.

A decline in rural economic activity in the 1980s and restrictions on rainforest logging have resulted in populations remaining static in inland towns such as Wauchope while coastal centres have continued to grow.

Although the study area has been subject to logging activity for a long period, no known sites or features of significance to European settlement history are identified in Council's Heritage register which accompanies Hastings LEP 1987.

5.2.17 Hazard and Risk Assessment

Dam Break Hazard

A dam break study was prepared by the PWD (1994c) to determine the appropriate hazard category in accordance with Dam Safety Committee requirements and the Incremental Flood Hazard Category (IFHC).

The dam would be designed to retain its integrity in the modelled 1 in 10,000 year Probable Maximum Flow (PMF) event as well as to resisting the 1 in 10,000 year earthquake event.

The study analysed hazards arising from pre-dam Probable Maximum Flow (PMF) situation, non flood dambreak and PMF dambreak. The hydrodynamic program MIKE11 was used to model dambreak and flow downstream of the dam. RAFTS-XP was used for generating to PMF inflow hydrographs to the dam storage and for inflows below the dam. The models take account of the topography of the Kings Creek Valley including the location of embankments along Kings Creek Road and Elizabeth Drive.

The dam break analyses adopted plausible breach characteristics of:

- 30 minute breach development time
- 35m breach width
- 40m breach depth
- breach side slopes 1:1
- water level 59.0m/60m

The results of the study indicated that around 17 houses in the valley would be flooded in the event of PMF dam break. The hazard rating is high and the Incremental Flood Hazard Category is also high according to Dams Safety Committee regulations.

As a result of the high classifications the dam and spillway would be designed for the Probable Maximum Flow (PMF). During construction the diversion capacity would be based on the 1 in 100 year design flood on the basis of ANCOLD Guidelines.

Dambreak Risk from Earthquake

Based on the geology of the district and review of available historical records of seismic activity the earthquake hazard in the Cowarra Dam area is estimated to be below average for eastern Australia. Preliminary ground motion estimates for a 1 in 1,000 year and 1 in 10,000 year recurrence earthquake peak ground velocities would be 63mm/s and 175 mm/s with peak ground alterations of 0.1g and 0.25g respectively. The design earthquake for Cowarra Dam is adopted as the 1 in 10,000 year event.

The proposed dam was tested against a screening method to determine whether further investigation is required to ensure that the dam is clearly safe against earthquake induced failure. The results indicated that further more detailed analyses would be required to test the stability of the design under the design earthquake conditions. These would be undertaken during the course of detailed design works. The final design will meet the design earthquake loading for the 1 in 10,000 year event.

5.2.18 Energy Statement

An energy statement basically considers the energy required to construct and operate the dam and any energy savings that may accrue over the life of the project. It also considers any potential energy resources that may be sterilised by the project.

Energy Required to Construct the Dam

Major earthworks projects such as dam construction require fuel to operate the heavy machinery, vehicles and equipment that make up the construction fleet. Typically these vehicles operate on distillate, although some smaller machines and vehicles use petrol or LPG. Electricity is also consumed in off site manufacturing operations, although this factor is difficult to measure and relatively minor compared to diesel and petrol consumption.

The fuel required during construction is largely dependant on the volume of earthworks involved in the project. Based on past projects, each cubic metre of earthworks consumes about 1.15 litres of fuel, and on that basis, approximately 1.6 million litres of fuel would be required to complete this project. The figure may vary according to the specifications and age of vehicles in the construction fleet, staging of works and construction methods employed.

Energy Consumed During Operation

Dam maintenance and electrical operations would consume fuel and energy over the life of the project. Actual consumption, however, would be relatively minor and cannot be realistically measured or anticipated.

Energy Savings

Projects such as dams do not normally result in energy savings unless hydroelectric generation is intended. In this instance, the dam would not generate any measurable energy savings.

Energy Resource Sterilisation

The Department of Mineral Resources was consulted regarding possible sterilisation of geological resources as a result of the proposed dam. Their response indicated that no viable resources were likely to be sterilised by the Proposal.

5.2.19 Current Ecological Issues

Climate Change and Greenhouse Effect

Over recent years there has been increasing concern over the warming of the earth's atmosphere due to the raised level of certain gases, which in turn increase the capacity of the atmosphere to retain incoming solar energy.

Some experts contend that the consequences of global temperature rise as a result of an enhanced greenhouse effect include:

- rising sea levels resulting from melting polar ice and reduced ocean water density
- changes in rainfall patterns, impacting on established infrastructure and land use particles.

Predictions for Australia made by CSIRO at the Greenhouse 87 Conference can be summarised as follows:

- average temperature to rise 2° to 4°C with a greater increase for higher latitudes;
- rainfall to increase 20-30% in the summer rainfall regions and decrease 10-20% in the winter rainfall regions;
- sea levels to rise 200 to 1400mm; and
- tropical cyclones to occur 200-400km further south.

The greenhouse gases include carbon dioxide, methane, nitrous oxide and chlorofluorocarbons. Forestry operations are relevant to the greenhouse effect because trees absorb carbon dioxide through photosynthesis, storing carbon as organic matter. This carbon is released during burning or decomposition processes.

Greenhouse related sea level rises in the range predicted are not anticipated to affect river salinity at the intake works on the Hastings River over the life of the project. The uppermost extent of the brackish zone is more than 1km downstream and is separated from the works by two riffle zones.

Greenhouse Emissions

In removing up to 90ha (at least 82ha permanently) of vegetation from within the proposed catchment area the carbon storage capability of the trees in this area is lost. This impact is reduced by the retention of sawn timber products such as sleepers, sawlogs and poles all of which act as ongoing carbon sinks. Prior to inundation, Forestry intends to relog the site to ensure utilisation of this timber.

It is estimated that road transportation makes up some 15% of the total greenhouse gases emitted in Australia (Commonwealth of Australia, 1991). Carbon dioxide released into the atmosphere as a result of vehicle and plant emissions associated with this proposal would contribute marginally to the overall levels of greenhouse gases in the atmosphere. Steps can be taken by the contractor to minimise emissions as outlined in Section 5.2.4.

Biological Diversity

As a signatory to Agenda 21, Rio Earth Summit, the Australian Government is bound by international agreement to conserve biological diversity through the prevention of species extinctions and promotion of habitat conservation.

The EIS and FIS (Appendix E) have addressed the impact of the Proposal on the viability of populations of rare and endangered flora and fauna in the study area. The effects of habitat loss on several species of endangered microchiropteran bats and the Glossy Black Cockatoos would be balanced by the elimination of logging and the sympathetic management of the entire catchment above the inundated area. These measures would also assist in the conservation of the more common locally occurring flora and fauna populations.

5.2.20 Ecologically Sustainable Development Principles

Inter-generational Equity

Inter-generational equity relates to the idea of fairness or justice between different generations (EPA, 1993). According to Schedule 2 of the EPA Regulations 1994, "the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations." Issues of equity arise in respect of this project as discussed below.

Water Resources

The Project would not directly adversely affect the water resources of future generations. Water in the Hastings River is essentially a renewable rainwater resource unless, for some reason, it becomes polluted or made unusable. This could occur as a result of pollution caused by increased agricultural or urban runoff as a result of urban growth facilitated by provision of a secure water supply.

However, the dam itself would not directly compromise the water supply and the decision to maintain the existing quality of supply rests with future generations.

Forest Resources

The dam would flood some 62 ha of Cowarra State Forest and adjoining lands which could have been managed and harvested by future generations for timber. In addition, the remainder of the catchment would be prevented from further harvest to ensure that water supplies within the dam do not become polluted.

Although the timber resources within the catchment would be utilised, the resource cannot be renewed in that location effectively sterilising the catchment from further timber production. Alternate, more productive and more extensive resources would be transfered to State Forests for ongoing management and harvest. Previously, these resources were privately owned and were not explicitly managed as renewable forest resources.

Hard Rock Resources

Up to 32,000m^3 (2000 truck loads) of hard rock (rip rap) and 53,000m^3 of filter material (gravel/sand) would be consumed from commercial sources in Port Macquarie or Laurieton. Although these resources cannot be replaced, it is intended to minimise the off site rock requirements by also using suitable rock resources within the dam site. These resources would be sterilised once the catchment is flooded, irrespective of whether the rock is consumed or not.

Habitat Removal

The issue of habitat removal is addressed in detail by Section 5.2.7. In summary, the impact of habitat removal could be minimised if the catchment became a wildlife refuge. The permanent water on site, restricting public access into the catchment, and preventing logging within the catchment once the project is completed, would all contribute to the site becoming a wildlife refuge.

5.2.21 Cumulative Impacts

The proposed dam has considerable potential to generate regional cumulative impacts, particularly in terms of facilitating positive and negative aspects of major urban growth.

According to the Department of Planning's North Coast Urban Planning Strategy (DoP, 1995), Port Macquarie has been identified as a sub-regional centre which is capable of accommodating significant urban growth in environmentally suitable locations.

Augmentation of the sub-region's water supply is entirely consistent with the DoP's Strategy for the North Coast Region. However, rapid growth facilitated by an improved water supply could place considerable pressure upon Council to augment other physical services and human facilities.

The preferred dam site was selected from a number of alternative sites after considering their relative merits, particularly in terms of land take, resource sterilisation, storage capacity and environmental effects.

Construction of the dam and augmentation of headworks would generate minimal cumulative impacts. These impacts have been addressed throughout the EIS and by a Review of Environmental Factors of the Southern Arm Trunk Main, as well as a Review of Environmental Factors for the overall augmentation scheme (Binnie and Partners, 1991c).

Augmentation of the Hastings Water Supply Scheme would not impact on water supplies to rural properties in the Hastings catchment or other independent water supplies that draw water from the Hastings River (eg. Telegraph Point Village, rural irrigators). In addition, the dam has been sized to accommodate environmental flows in the Hastings River, thus ensuring that downstream water users are not affected by the overall increase in water requirements for the Region. Importantly, the water supply scheme also operates independently of, and in a separate catchment to other schemes that supply water elsewhere in the North Coast Region. Consequently, it would have no adverse impact on other water supplies in the Region.

6.0

6.1 Project Description

6.2 Existing Environment, Impacts and Safeguards

6.0 KOREE ISLAND INTAKE WORKS AND PUMP STATION

6.1 Project Description

As part of Hastings District Water Supply Augmentation Scheme a new intake works and pump station are required opposite Koree Island on the Hastings River approximately 6km upstream of Wauchope (refer Figure 1.1). The scope of this assessment excludes the construction of the rising main between Koree Island and Rosewood Road Reservoir which is assessed in an REF (PWD, 1991). The proposed works would augment the two existing intakes and pump stations commissioned in 1954 (130 l/s capacity) and 1979 (400 l/s capacity).

The proposed intake works and pump station would deliver the forecast additional requirement of 800 l/s at Rosewood Road Reservoir in Stage 1 (1998) increasing to 1200 l/s in stage 4 (2011). Two duty pumps and one stand by pump would be required to deliver the full Stage 4 supply. The augmentation would enable water supply requirements to be maintained from Rosewood Road Reservoir for the Southern arm trunk main in Stage 1, the proposed Cowarra Dam in Stage 2 and an additional pipeline to the dam to be constructed in Stage 4 by 2011. The schematic layout of the proposal in relation to the Hasting District Water Supply Augmentation scheme is illustrated in Figure 1.1.

The concept involves a dry well pump station housing electrically driven pumps which extract water through screened pipe intakes located in the Hastings River. Submersible pumps were not considered on the basis of size and availability. Other types of drives such as diesel or petrol engines were not considered on the basis of higher maintenance and environmental costs. A concept design report (PWD, 1994b) discussing alternative electrical and mechanical arrangements has been prepared for the intake works.

The dam could take up to two years to fill and would require all three pumps to operate during that period, taking into consideration the need to maintain environmental flows.

The construction of the pump station would require the acquisition by Council of approximately 0.18ha of private land.

6.1.1 River Intake and Pump Well Arrangement

The location of the water intake was chosen on the basis of the following factors:

- siting the intake close to the existing intakes to minimise the cumulative visual impact of an additional intake;
- to allow common use of the existing access road and facilities on Council land;
- sites further downstream are inappropriate as Koree Island is close (1.6km) to the downstream limit where salinity starts to occur; and

- siting the intake further upstream or downstream would increase the length of the rising main to Rosewood Reservoir.

The intake site has been selected from two possible sites 75m and 150 m upstream of the existing 400 l/s pump station. The nearer site was preferred on the basis of its less obtrusive location with respect to views from surrounding property. The area of land acquisition required is approximately 0.18ha. The location and layout of the intake and pump station are shown on Figure 6.1.

The three intake screens and intake pipes would be located approximately 2m apart. The intake screens (Johnson Type) would reach for 15m along the stream and extend approximately 5m from the existing river bank. The intake pipes would extend 15m to the pump well (refer Figure 6.2).

The pump well would be sited with consideration to bank materials and the river flood levels. Close to the stream, materials in the top layers of the bank are silty sand overlying sandy clay. With increasing depth particle sizes increase through sand to gravel and boulders with bedrock at the stream bed level. Further from the stream hard rock (basalt) occurs from surface level down.

Options for the location of the pump well close to the stream and set into the river bank have been considered. While a pump constructed close to the river would have the advantage of less costly excavation, this would be offset to a limited degree by the need to double form the well wall and provide an external stairway. However, a well set into the rock behind the river bank would have a reduced visual impact. The site ultimately chosen is 15m from the stream with the pumpwell projecting 10 metres above the bank, 0.5 metres above the 1:100 year flood level.

6.1.2 Electricity Supply and Electrical Equipment

The supply authority North Power (Formerly Oxley Electricity) would provide electricity at 33kV. A substation would be constructed as part of the project and Hastings Council would own and maintain it. These arrangements are currently the subject of negotiation between Council and North Power in relation to the voltage of supply and the location and ownership of the substation.

The substation would be located adjacent to the access road west of the existing transformer yard. The proposed transformer yard would be 40m x 30m with a switch building (8m x 12m) located to the north-east of the yard. The earthing grid would extend over a 0.25ha area beneath and to the west of the transformer yard.

The preferred pump duty arrangement (Duty B) includes one duty and one occasional duty pump to deliver 600 l/s and occasionally 1200 l/s for Stage 1. Two duty pumps and one standby pump to deliver 1200 l/s for Stage 2. The pumps would be auto transformer starting with standard motors and circuit breaker protection for each starter. Direct on-line starting of pumps is also currently being investigated.

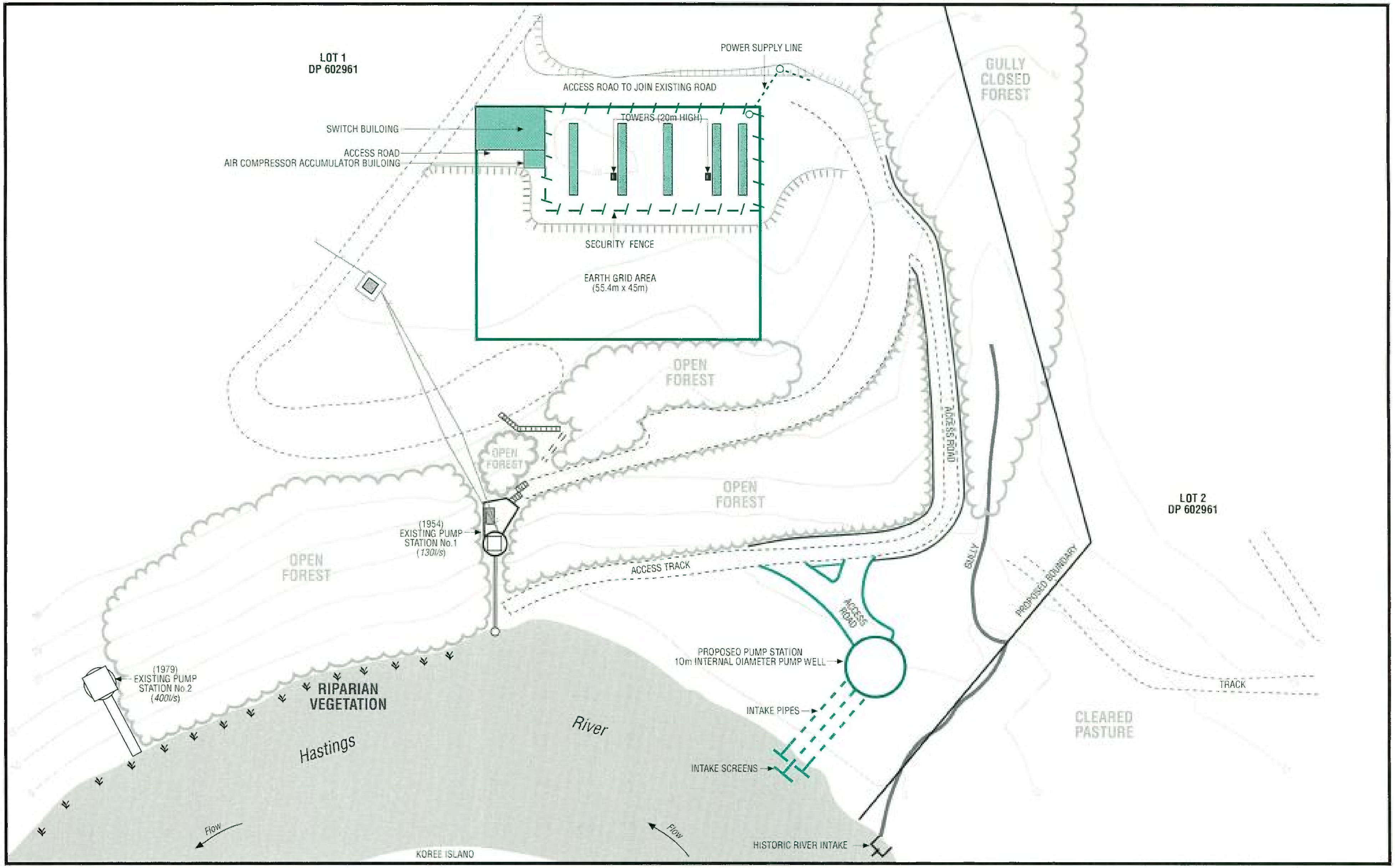
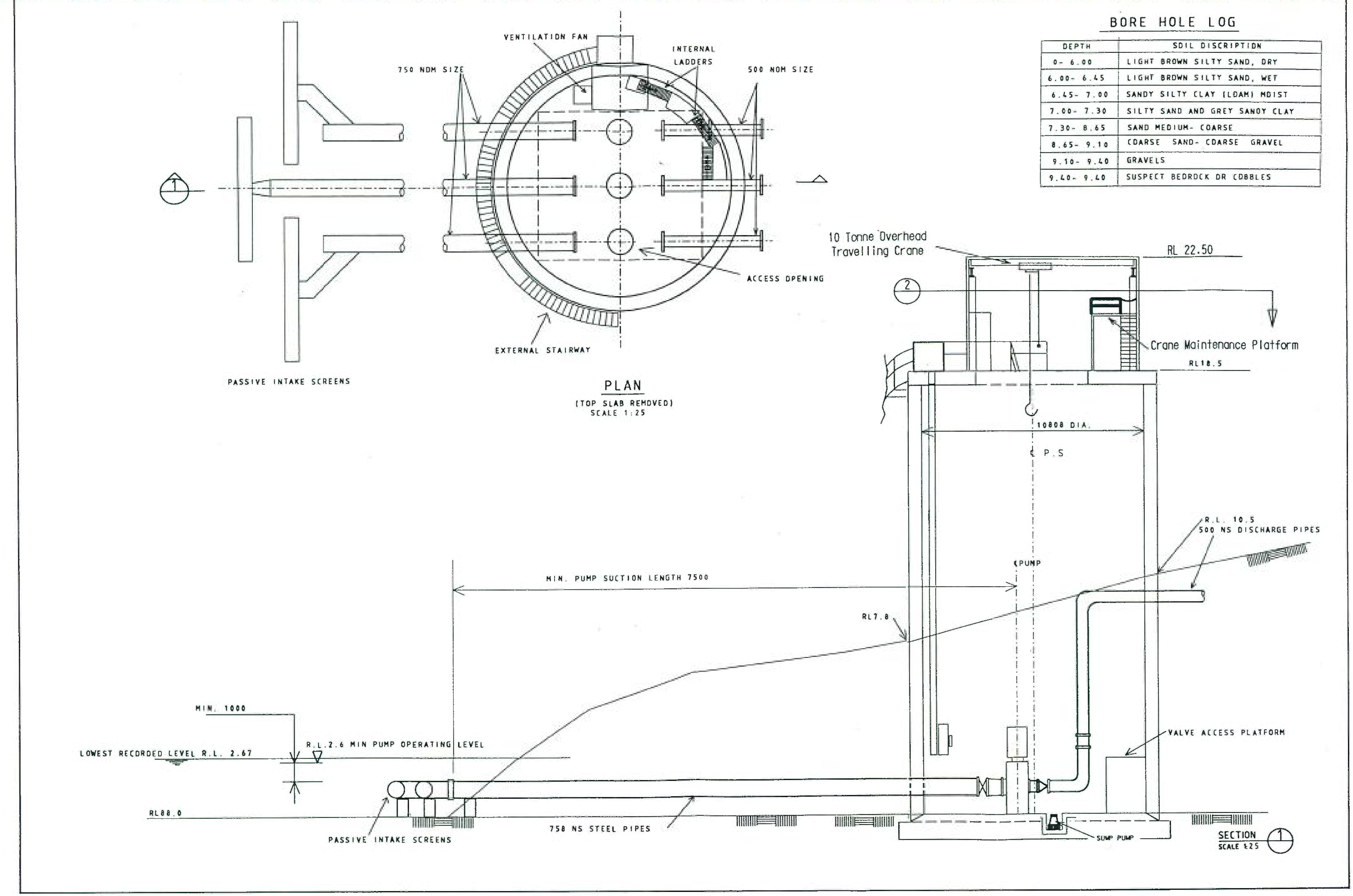


Figure 6.1
Proposed Koree Island Intake and Pump Station



BORE HOLE LOG

DEPTH	SOIL DISCRIPTION
0- 6.00	LIGHT BROWN SILTY SAND, DRY
6.00- 6.45	LIGHT BROWN SILTY SAND, WET
6.45- 7.00	SANDY SILTY CLAY (LOAM) MOIST
7.00- 7.30	SILTY SAND AND GREY SANDY CLAY
7.30- 8.65	SAND MEDIUM- COARSE
8.65- 9.10	COARSE SAND- COARSE GRAVEL
9.10- 9.40	GRAVELS
9.40- 9.40	SUSPECT BEDROCK OR COBBLES

Figure 6.2
Koree Island Intake and Pumping Station Preliminary Arrangement

The preferred duty arrangement would minimise the number of pumps required and consequently the size of well. This would enable higher flows of up to 1200 l/s to be achieved in Stage 1.

The pumping system would be controlled on the basis of a range of detectors to ensure controlled pumping to the Rosewood Road Reservoir. The proposed control system would include:

- an auxiliary river level detection system to ensure that the maximum volume of water is pumped during periods of high river level and that no pumping occurs when river levels are low to allow environmental flows to be maintained (the existing river level detection meter associated with pump station No. 2 will be the primary system);
- Rosewood Road Reservoir low signal to close the value at the proposed dam inlet;
- reservoir full signal to stop the pump;
- Cowarra Dam full signal to stop the pumps;
- Programmable Logic Controller (PLC) for automatic common control of the pumps; and
- one local control station per drive.

A plan and section of the pump well is included in Figure 6.2.

6.1.3 Mechanical Options

Axially split-case pumps are the preferred pump type because of their general reliability and low maintenance requirements in comparison to vertical line shaft pumps. The pumps could be repaired in situ for most common problems.

The electric motor shaft and pump shaft may be coupled with both units mounted either horizontally or vertically. The vertical arrangement is preferred because it would occupy less floor space and require less civil works due to a smaller pump well diameter. This civil cost saving and environmental benefit would outweigh the relatively small cost of a built in cradle.

A permanent crane would be located in a building constructed on top of the well. The crane would have the capacity to lift motor or pump units individually (10t safe working load). The crane building would be 10m x 15m in plan and approximately 5m high. The building would be constructed using concrete blocks (refer Figure 6.2).

6.1.4 Pipework

A 7.5m to 15m straight section of 750mm nominal size suction pipe is required upstream of each pump section for establishment of steady flow conditions and unimpeded pump performance.

The discharge pipes comprise 500mm nominal size pipes each fitted with a non-return valve and motorised butterfly valve for flow control and a manual butterfly valve for isolation during maintenance.

6.1.5 Access

Access to the existing and proposed pump stations is via Rosewood Road (1.5km north of the Oxley Highway). A sealed one lane access road leads to the existing substation and pump stations 200m from Rosewood Road.

An existing unsealed access track would be upgraded to provide construction access and would be subsequently sealed for maintenance access. Cranes and other machinery would be required to access the river bank to place the pipes and intake structures. A temporary access track to a machinery bench would be required for this purpose. However, removal of excavated material would be via the intake pipe trench and existing access track. All access tracks would be protected from erosion and sediment loss by appropriate erosion and sedimentation controls.

At the final stage of construction temporary access tracks would be rehabilitated and the major pump station access road formation would be sealed (refer Figure 6.1).

6.1.6 Construction and Staging

To ensure the reliability of water supply to Rosewood Road Reservoir and Cowarra Dam it is desirable that capacity is available to extract the maximum volume of water during favourable pumping conditions to cover periods of low flow or high turbidity. As a result the staging of pump installation is not considered appropriate. All works are proposed to be constructed in Stage 1 by 1998.

The initial construction task would be the establishment of erosion and sedimentation controls to protect the aquatic environment of the Hastings river and water quality adjacent to existing pump stations. These controls would include runoff diversion banks, road drainage and sediment fences below construction access tracks and stockpile sites as well as floating boom silt curtains around the intake site (refer Section 6.2.3).

A site compound and stockpile site would be established adjacent to the proposed substation. This site would also be managed to minimise erosion and downstream sedimentation.

Excavation of the pump well would initially involve excavators and trucks for removal of overburden ($788m^3$ OTR, $117m^3$ hard rock). Hard rock would be drilled with drilling rigs and broken and removed by excavators/rock breakers. Blasting may be required if drilling and rock breaking is impractical. Appropriate EPA noise and vibration guidelines would be followed in either case. Blasting would not be undertaken in a manner that would affect aquatic fauna.

The pump well would be constructed of reinforced concrete ($437m^3$) using formwork ($1,199m^2$). The crane housing would be constructed of concrete blocks using conventional methods. The fit out of the structure would use the travelling crane for placement of pumps.

The intakes would be anchored to concrete footings set in place using concrete pumped into a tube. The footing would be excavated using a long arm excavator operating within the silt curtain. An alternative method of construction would be the placement of a coffer dam around the intake structure site and excavation and placement of footings in the dry. The intake structures would be placed using a crane mounted on a machinery bench above the creek bank.

The intake suction pipes would be placed in an excavated trench and concrete encased. The trench would be approximately 10m wide and between 2 m and 8m deep. The overburden would be replaced in the trench with any surplus spoil being placed as fill where required on the site. The material would only be used if tested and found appropriate for use with respect to acid sulphate conditions (refer Section 6.2.3).

The construction of the substation transformer yard would involve initial trenching for the placement of the copper earthing grid and construction of concrete footings for the transformer and towers. The transformer yard would be covered with blue metal. The switch building and air compressor/accumulator building would be constructed of concrete blocks and fitted out. The substation would be fenced with a chainmesh security fence.

Each of the construction areas would be rehabilitated, temporary access roads and work areas would be ripped and replanted. The main access road would be sealed for operational use. Key areas including the river bank and pump well would be treated and landscaped to minimise visual intrusion (refer Section 6.2.7).

6.1.7 Operation and Maintenance

Once operational, the site would be fully automated with regular checks for metering and maintenance of equipment. Access to site would be along the one lane sealed road to the pump well. The travelling crane would be used occasionally for removal and replacement of pump equipment. Traffic generated by the facility is likely to average less than 1 trip per day.

The pump duty arrangement is described in section 6.1.1. The operation of the intake would be governed by the abstraction parameters negotiated with the Department of Land and Water Conservation (Water Resources Section). These parameters have been established as the minimum required to maintain environmental flows for the aquatic environment and downstream water users. The basic water abstraction arrangements are discussed in Section 3.1.1 and would operate as follows:

- pumping permitted when river levels are above the 80th percentile level (these are flows that are exceeded 80% of the time);
- pumping permitted when river levels are above the 95th percentile level, only if Cowarra Dam capacity has dropped below 60% capacity and 20% water restrictions have consequently come into operation; and
- pumping not permitted when river levels are extremely low, between the 95th and 100th percentile level.

Further investigation of the aquatic impacts of water abstraction on fish passage and salinity reported in Sections 6.2.4 and 6.2.5 (Mitigation of Impacts) have resulted in the adoption of a modified pumping regime which is more attuned to the ecological requirements of key aquatic indicator species.

A flow monitoring station similar to that proposed is already located at Koree Island to measure the river flows and abstraction rates. The station ensures that water is not abstracted at inappropriate times of low flow. Water quality monitoring equipment is also to be installed and if successful would also be used in the new pump station. The river levels at which the percentile flows occur vary on a seasonal basis as discussed in Section 6.2.2.

6.1.8 Koree Island Intake and Pump Station Cost Estimate

The cost estimate for construction of the intake works and pump station are based on the preferred option involving:

- Pump Duty B;
- 33kV Power supply provided by Oxley Electricity; and
- Permanent Crane.

The estimated total capital cost for the work is $4.7m without contingencies (NSWPW, 1995), this includes the following cost breakdown:

• Electrical	$1.7m (including capital contribution of $0.17m for substation)
• Mechanical	$1.47m
• Civil	$1.76m

Annual costs during Stage 1 include the following estimates:

- Maintenance \$0.02m; and

- Electrical charges \$0.56m.

Further details of the costing are included in the Concept Report (NSWPW, 1995).

6.2 Existing Environment, Impacts and Safeguards

6.2.1 Topography, Geology and Soils

The Hastings River at Koree Island, is approximately 1.6km above its tidal limit and approximately 20km from the coast at Port Macquarie. The Hastings River flows across an alluvial plain bound by the Broken Bago Range to the south and the Great Dividing Range to the west.

The local topography of the study area is dominated by the steep rocky eastern banks of the Hastings River opposite Koree Island. The banks are approximately 40m high with west facing slopes of 40% grading down to 20% at the proposed intake site. An alluvial bank extends from the site to the entrance of a small tributary gully oriented to the south east. The river bends 180° around Koree Island opposite the pump station site. The bend in the river is isolated and becomes an island when the river is in flood. Koree Island itself is elevated approximately 5m to 10m above the river channel and is low lying with minimal relief. However, there is sufficient relief on the banks of the River (as opposed to the island) to site the pump station such that it is not affected by flooding.

The geology of the Hastings catchment in the Wauchope district is described in Section 5.2.1. The slopes above the floodplain are sandstone and siltstone meta-sediments of Devonian to Triassic age with occasional dolerite and serpentinite intrusions of Permian age. A more recent basalt intrusion extends from the study site opposite Koree Island to Rosewood Road Reservoir Hill (80m). This intrusion is hard rock which is quarried near the reservoir site.

Koree Island and the immediate river banks comprise Quaternary fluvial deposits of silt, sand and gravel. Low hills and terraces on the flood plain also incorporate Tertiary alluvial deposits.

The soils of the intake and pump station site fall into two categories. The soils on the river banks are unconsolidated layers of flood deposited silts, sands and gravels. They are moderately erodible. The soils of the basalt intrusion are shallow and rock outcrops over much of the site. Due to the location of the intrusion close to the river much of the soil formed in-situ has been washed away leaving a shallow soil.

Above the river banks near the proposed transformer yard there is more substantial soil development. This soil has a higher proportion of dispersive clays and is potentially more erodible. Both the basalt and alluvial soils are relatively fertile and support pasture grass growth. The alluvial soils of Koree Island are also cultivated.

The construction of the intake works would require excavation of 788m³ of river bank alluvium. Once stripped of soil the construction of the pump well would involve drilling, rock breaking and possibly blasting of hard rock to remove a further 117m³ of rock for the 10m diameter pump well (NSWPW, 1995). A 40m x 30m area would be disturbed for the construction of the transformer yard along with a similar sized adjacent area which would serve as a temporary construction site compound. Erosion and sedimentation control measures to protect the site and river water quality are addressed in Section 6.2.3.

6.2.2 Hydrology

The hydrological assessment of the impact of an altered pumping regime involved comparisons of the natural and existing flow regimes against the minimum flows likely to be experienced under the initially negotiated environmental flow parameters (ie. not exceeding the 80th percentile flows for each month and 95th percentile flow when the dam is <60% full). The subsequent analysis indicated that such a pumping regime could have a significant effect on the hydrology, aquatic and estuarine environments of the river (refer Section 6.2.4 and 6.2.5). As a result a modified pumping approach was subsequently adopted which was better suited to maintaining the ecology of the river.

<u>Existing Hydrologic Regime</u>

The hydrology of the Hastings River Basin is simulated using models detailed in the Strategy Study (Binnie and Partners, 1987). The simulation model (POSSIM - pumped off-stream simulation model) was developed to assess the behaviour of the water supply system by modelling the complex interactions between available streamflow, demands, capacities of component parts of the system and rules under which the supply system is operated. The hydrologic data accumulated was used to justify the capacity of the intake works on the basis of the prevailing hydrologic environment and system constraints. The proposed water abstraction itself would also change the stream environment.

The historical data used in the hydrological investigation and modelling was collected from the DWR gauging station on the Hastings River at Ellenborough (No. 207004). The period of record is from 1946-1987 and has approximately 11% missing data. Rainfall, evaporation, temperatures and streamflow data are included in Appendix D of Binnie and Partners (1987). The regional climatic and meteorological conditions are discussed with respect to the dam site in Section 5.2.4 and in relation to the hydrology of the dam catchment in Section 5.2.2. It is noted that monthly rainfalls in late winter and spring, average less than half the monthly average summer rainfall. The annual average rainfall is around 1200mm.

Streamflows from the Ellenborough gauging station were transposed to Koree Island in proportion to the average annual flows in each catchment. The flow at Koree Island was estimated to be 1.3 times that at Ellenborough. Figure 6.3 shows the adjusted historical streamflows.

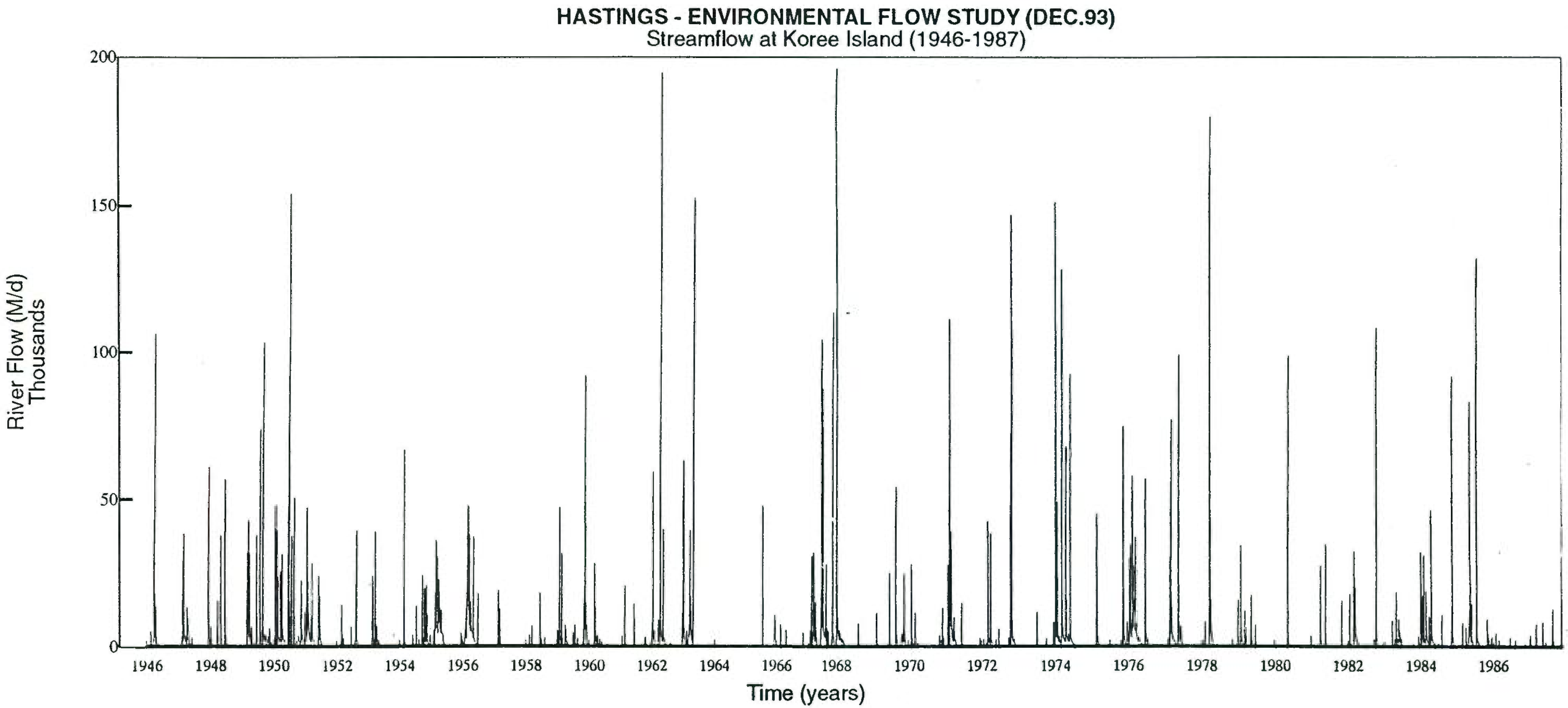


Figure 6.3
Adjusted Historical Streamflows

There are four significant low flow periods and several high flow or flood events during the period of streamflow record. However, the historical streamflow data does not contain a severe drought. A 1% drought sequence was derived in the Strategy Study and used in this and the previous river abstraction investigations. This data was derived on the basis of a flow probability analysis described in Binnie and Partners (1987). The derived 1% drought sequence was more severe than the recent 1994 drought.

Both the actual historical streamflows and the 1% drought sequence were used in the analysis as the drought sequence governed the size of the new storage reservoir and the historical streamflow records became critical when sizing the transfer pipelines and intake works.

The existing average water extraction rate by Hastings Council at Koree Island is 7600 ML/y with a maximum instantaneous extraction rate of 36 ML/d. A 60 ML/d environmental flow has generally been provided. The proposed maximum long term future extraction rate is 20360 ML/y with a maximum instantaneous extraction rate of 127 ML/d. As described in Section 6.1, monthly 80th or 95th percentile environmental flows would be maintained according to a negotiated agreement. However, the proposed abstraction regime was subsequently modified to provide even greater flows at critical periods of the year to improve fish passage opportunity (Refer Section 6.2.4). Table 6.1 shows the minimum environmental flows for the Hasting River subject to the maintenance of the monthly 80th and 95th percentile environmental flow pumping regime for the Hastings River.

Table 6.1 : Minimum Environmental Flows for the Hastings River Proposed for the Upgraded Intake Works at Koree Island for a 80th/95th Percentile Flow Pumping Regime

Month	Storage > 60% capacity 80th percentile flow (ML/d)	Storage < 60% capacity: 95th percentile flow (ML/d)
January	231	107
February	340	145
March	653	255
April	609	195
May	472	247
June	428	271
July	365	244
August	290	182
September	218	145
October	191	102
November	161	78
December	208	101

Source: NSW Public Works (1994)

Effect of Water Abstraction on Stream Flow

A comparison of the duration of natural, existing and proposed flows are shown in Table 6.2 on a monthly basis. Flows referred to as 'very low', 'low', 'moderate' and 'high' are defined in this table. Comparisons between the existing and proposed water extraction regimes are hereafter referred to as 'EP' comparisons, while comparisons between the natural and the proposed situations are referred to as 'NP' comparisons.

The EP comparison indicated that there would be small decreases in the duration of very low flows (maximum of -2.9% or 0.9 days in September) and high flows (maximum of -2.9% in December and May). The NP comparison indicated that the duration of very low flows would be returned to that existing under natural conditions, although there would be a small increase in November. For high flows, the NP comparison indicated a reduction in the duration in the order of 3 to 4% or 0.9 to 1.2 days in May to July inclusively, and December. The size of high flow peaks and the ability to meet the 80th and 95th percentile environmental flow requirements would not be significantly affected by the proposed pumping regime.

Further investigations of the ecological requirements of key fish species, reported in Section 6.2.4 and 6.2.5, have led to a modified pumping regime which is in excess of the minimum negotiated environmental flows. The modified pumping regime is described as Modified Approach No.1. This approach would maximise water flow in the Hastings River during critical months for the passage and breeding of Australian Bass.

Table 6.2 : Comparison of the Percentage Duration of Flows Demonstrating the Impact of the Initially Proposed Water Extraction Regime on Stream Flow (Source: Bishop, 1995)

Flow	Month											
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
<u>Natural (N)</u>												
High	46.6	28.2	22.3	28.2	28.2	43.7	50.5	66.0	70.9	55.3	49.5	49.5
Moderate	38.8	47.5	49.5	43.6	45.6	38.8	36.9	26.2	25.2	27.9	43.7	39.8
Low	11.7	17.5	19.5	25.3	16.5	13.6	10.7	7.8	2.9	4.9	6.8	6.8
Very Low	2.9	6.8	8.7	2.9	9.7	3.9	1.9	0.0	1.0	1.9	0.0	3.9
<u>Existing (E)</u>												
High	44.7	28.2	21.4	28.2	28.2	43.7	49.5	66.0	70.9	55.3	48.5	48.5
Moderate	39.8	45.6	47.5	38.8	41.7	36.9	35.9	24.3	25.2	35.0	44.7	37.9
Low	12.6	17.5	19.5	29.1	17.5	14.5	11.7	8.7	2.9	7.8	5.8	7.8
Very Low	2.9	8.7	11.6	3.9	12.6	4.9	2.9	1.0	1.0	1.9	1.0	5.8
<u>Planned (P)</u>												
High	43.7	27.2	21.4	27.2	28.2	40.8	49.5	66.0	69.9	54.5	45.6	46.6
Moderate	41.7	46.6	37.8	34.0	33.0	33.0	31.1	26.2	25.3	36.9	47.6	42.7
Low	11.7	19.4	32.1	35.9	28.1	22.3	17.5	7.8	3.8	6.8	6.8	6.8
Very Low	2.9	6.8	8.7	2.9	10.7	3.9	1.9	0.0	1.0	1.9	0.0	3.9
<u>Difference (P-E)</u>												
High	-1.0	-1.0	0.0	-1.0	0.0	-2.9	0.0	0.0	-1.0	-0.9	-2.9	-1.9
Moderate	+1.9	+1.0	-9.7	+4.8	-8.7	-3.9	-4.8	+1.9	+0.1	+1.9	+2.9	+4.8
Low	-0.9	+1.9	+12.6	+6.8	+10.6	+7.8	+5.8	-0.9	+0.9	-1.0	+1.0	-1.0
Very Low	0.0	-1.9	-2.9	-1.0	-1.9	-1.0	-1.0	-1.0	0.0	0.0	-1.0	1.9
<u>Difference (N-P)</u>												
High	-2.9	-1.0	-0.9	-1.0	0.0	-2.9	-1.0	0.0	-1.0	-0.9	-3.9	-2.9
Moderate	+2.9	-0.9	-11.7	-9.6	-12.6	-5.8	-5.8	0.0	+0.1	-1.0	+3.9	+2.9
Low	0.0	+1.9	+12.6	+10.6	+11.6	+8.7	+6.8	0.0	+0.9	+1.9	0.0	0.0
Very Low	0.0	0.0	0.0	0.0	+1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

<u>NOTES:</u>

1. Positive difference indicates an increase in duration.
2. The flow categories are: High, >1000 ML/d; Moderate 300 to 1000 ML/d; Low 100 to 300 ML/d; Very Low < 100 ML/d.

The primary hydrological impact of the initially proposed extraction regime is on the duration of low and moderate flows, and this is concentrated into a five month period from September to January inclusive. Impacts in this period are characterised by a decreased duration of moderate flows (EP comparison average reduction 6.4% or 1.9 days/month, maximum of 9.7% or 2.9 days in September; NP comparison average reduction 9.1% or 2.7 days/month, maximum 12.6% or 3.8 days in November) and corresponding increased duration of low flows (EP comparison average increase 8.7% or 2.6days/month, maximum of 12.6% in September; NP comparison average increase of 10.1% or 3.0 days/month, maximum 12.6% or 3.8 days in September.

The reduction in the duration of very low flows, returning durations to virtually the natural situation, is a positive impact of the proposed water extraction regime. This is particularly the case in hot weather when otherwise adverse impacts associated with increasing water temperature are likely with very low flows (i.e. direct stress to fauna caused by high temperatures and lowered dissolved oxygen concentration and greater potential for excessive plant growth). As indicated in Section 3.1.1, the lower Hastings River is likely to be susceptible to such impacts on biota because of the wide, generally shallow nature of the river and the small amount of shadow provided by sparse riparian or river bank vegetation. Riparian vegetation would also benefit from the reduced durations of very low flows, a result of reduced exposure to desiccating conditions caused by the lowering of groundwater levels.

The small decrease in the reduction of high flows is considered to have a negligible impact on biota, and this is addressed later in relation to natural flow variability and flushing of river substrates in Section 6.2.4.

Understanding the impact of the change in duration of moderate and low flows is less straightforward and is discussed in Section 6.2.4 with respect to key fish species. The results of this investigation have led to a modification of the proposed pumping regime to ameliorate the effects on fish passage and salinity changes during critical months of the year.

Effect on Estuarine Hydrology

The duration of high flows (i.e. >1000 ML/d) would only be negligibly altered by the initially proposed water extraction regime. Accordingly, attention to estuarine impacts concentrate on potential changes to the salinity structure of the estuary as this is likely to be altered with change in the duration of moderate and low flows.

The length of estuary containing water with salinity up to key ecological thresholds (5ppt, 13ppt and 25ppt) was calculated by Bishop (1995) (Appendix J). Bishop found that the length of estuary containing water with salinity up to the above mentioned concentrations decreased with decreasing flows, and that the rate of decrease was raised at each of the above ecological thresholds. An EP comparison indicates that the duration of flows >1000 ML/d would decrease by 1% in July and August. An NP comparison indicated that the resultant duration would be 1 to

3% less than what occurs in the natural situation. Although some impact is expected with the corresponding contraction of the suitable salinity zone, the net impact is likely to be negligible given the small time period involved.

Reinforcing this view, the effect of the flow reduction is expected to be buffered further towards the mouth of the estuary as a result of freshwater flows from rivers and streams below Koree Island.

A range of measures to minimise the aquatic ecological, water quality and hydraulic impacts of the uptake regime are further discussed in Section 6.2.4 (Aquatic Ecology) based on research undertaken by Bishop (1995). The key outcome of this research is the adoption of a modified pumping regime as an ameliorative measure on the aquatic ecological effects of the proposal.

6.2.3 Water Quality

Turbidity

High turbidity levels restrict pumping from the Hastings River at Koree Island during and after freshes or floods. At present, pumping is stopped when the turbidity level at the offtake reaches 15 NTU (nephelometric turbidity units) and is recommenced when it recedes to 9 NTU. A similar pumping regime would be adopted for the proposed intake works. Consequently, it is necessary to ensure that the water supply system has adequate storage to supply the predicted demands through the design drought and high turbidity sequences.

Records of the turbidity levels at Koree Island have only been kept for the past 8-10 years. A relationship has been developed between turbidity and streamflow as illustrated in Figure 4.4 of Kinhill (1994). Turbidity is shown to increase with streamflow linearly on a logarithmic scale. Typically, peak flows of around 1,000 ML would correspond with turbidity measures of around 10 NTU.

The relationship was built into the revised simulation model (POSSIM) and subsequent analysis showed that turbidity was a consideration in the sizing of the storage. The impact of turbidity is less significant than the impact of environmental flows and the most recent analysis does not indicate that turbidity is a primary controlling factor in the sizing of the system (Kinhill, 1994).

Salinity

The primary sources of salinity data used in the assessment are included in Section 2.2 of Appendix J (Bishop, 1995). Salinity data from the estuary were found to be limited. Surface water salinities were found to be by far the major portion of salinity data available. For the majority of data sources, the date at which salinity recordings were taken was available, however, the time of day (and hence tidal phase and height) were not known for every datum. Mean salinity values through the water column were therefore calculated to give a more representative indication of salinity conditions at the recording site.

Initial examination of the data was done separately for each data source. Data gathered on a particular day or month were plotted against position of the particular recording sites in the estuary, expressed as kilometres from the tidal limit. By interpolating between sites, or to the tidal limit, the position of the estuary where a particular salinity would be found could be estimated. Given a salinity limit for a component of the life cycle of the primary key fauna, then the length of estuary (which is below this limit) could be estimated (refer Section 6.2.4).

The above derived estuary lengths could then be related to river flow by plotting the lengths against river flow. For salinity data available on a particular day, the river flow used was the estimated mean flow at Koree Island for that day and the previous six days (i.e. a seven day mean). Where sudden increases in flow were apparent within a few days before the salinity recordings, only the flow data before the sudden increase was used. For data available on a monthly basis, the river flow was the estimated mean monthly flow at Koree Island for that month. Curves of best fit between plotted estuary lengths and river flow were drawn by hand (refer Appendix J).

The following four salinity values were considered as indicative of some important ecological limits in the estuary to the primary key fauna:

- 5ppt upper limit for adult Australian Bass outside the spawning season as well as for ribbon grass which is important the shelter of larval and juvenile bass;

- 13ppt upper limit for adult Australian Bass during the spawning season;

- 25ppt upper limit for common reeds which provide shelter for recruiting larval and juvenile bass; and

- 30ppt indicative limit for the Sydney Rock Oyster above which there is an increased chance of winter mortality disease and fouling of attachment substrates by marine animals.

The implications of these salinities in relation to the estuarine biota is discussed in Section 6.2.5.

The relationships between estuary length and river flow for salinities less than the above limits are shown in Figures 10 to 13 of Appendix J. Due to the small amount of data available on mean salinity, only relationships for surface salinities are given. It is expected that the use of surface salinity data would over-estimate the length of usable estuary for a particular limit as, unlike mean salinity, no account is made for the depth changes in salinity. It is recommended that a consistent regime of surface and water column salinity monitoring is undertaken in the upper estuary to monitor the potential for under-estimation of the salinity impacts of the proposal. An appropriate monitoring regime is discussed in Appendix J.

Other Water Quality Parameters

To provide early warning of these adverse effects of deteriorating water quality, it would be beneficial for base limnological parameters to be regularly monitored. These parameters include:

- dissolved oxygen;
- temperature;
- conductivity;
- pH; and
- turbidity.

Ideally, these should be measured in surface and bottom waters, otherwise bottom only. Water quality monitoring has the major disadvantage that if done, for example, monthly or even weekly, it may miss 'pulse' stressors which could profoundly affect biota. Measurements should therefore be done on a 'real-time' basis, a system which could be incorporated into Council's present data gathering network.

The adverse impacts associated with deteriorating water quality are not of central concern in respect to the proposed water extraction regime, particularly as the duration of very-low flows would be reduced. The primary concern is reduced fish passage opportunities over riffles and habitat contraction (e.g. due to changing salinity structure, or water level fluctions over riffles). The impact of these mechanisms can only be ascertained in detail through biological monitoring. The need for such monitoring is discussed in Section 6.2.4 and Section 5 of Appendix J.

It is appropriate that some relevant aspects of other disturbances occurring in the Hastings River are monitored, including the nutrient status of the river water with respect to the potential for aquatic weed growth and extrapolation.

- Total phosphorus - detection level (DL) = 10ug/l
- Total nitrogen - DL = 100ug/l
- Ammonia - DL = 0.02mg/l (also possible toxicant)

According to ANZECC (1992), the above detection limits are the minimum concentrations where problems have been identified in freshwater ecosystems. To obtain some indication of the total load of nutrients moving down the system, it would be useful to increase sampling intensity during flood events, the period when it is expected that the majority of the load of nutrients is being transported. This activity would be prudent as it has been assumed in this assessment that as the duration of high flows would be reduced to a small extent, there would be negligible impact on the productivity of the estuary.

Erosion and Sedimentation Control During Construction

The prevention of turbidity and sediment infill and pollution of Hastings River is an objective of the proposal. The control of construction on the river bank would be critical in this regard. An Environmental Management Plan would be prepared for the construction site which is based on the following components listed in Section 8.2.1.

6.2.4 Aquatic Ecology

Introduction

An investigation of the freshwater and estuary ecological impacts of the proposed water abstraction at Koree Island, Lower Hastings River was undertaken by Dr Keith Bishop (1995). The methodology and results are reported in full in Appendix J.

Under the existing pumping regime the average extraction is 7600 ML/y, the maximum extraction rate is 36 ML/d, and a 60 ML/d environmental flow has generally been provided. The maximum long term extraction rate of the proposed regime would be 20,360 ML/y, the maximum daily extraction rate would be 127 ML/d, and 80th and 95th monthly percentile environmental flows would be provided depending whether the storage is greater than or less than 60% capacity, respectively. The primary hydrological impact is the reduction in duration of moderate flows (300 - 1,000 ML/d) and an increase of low flows (100 - 300 ML/d), particularly in the period September to January inclusive. Small reductions in the duration of high flows (> 1,000 ML/d) and very low flows (< 100 ML/d) would also occur (refer Section 6.2.2). A tailored water extraction regime was consequently developed to optimise fish passage opportunities and salinity conditions during key periods of the year.

Biological impacts were generally assessed by focussing on flow-dependent habitat requirements of selected, sensitive key fauna:

Freshwater:

- Australian bass (high recreational value)
- Bellinger River tandan (moderate recreational value and potentially high conservation value)

Estuary:

- Australian Bass
- Sydney Rock Oyster (high commercial value)
- Twenty-six commercial fish or crustacean species

For habitat-structural features in freshwater, efforts to define relationships with river flow were constrained because suitable flows were not available during the study period. As a result, assessments were primarily based on data gathered in the Bellinger River by Bishop (1993), or were not possible.

Aquatic Environment Description

Stream Habitats

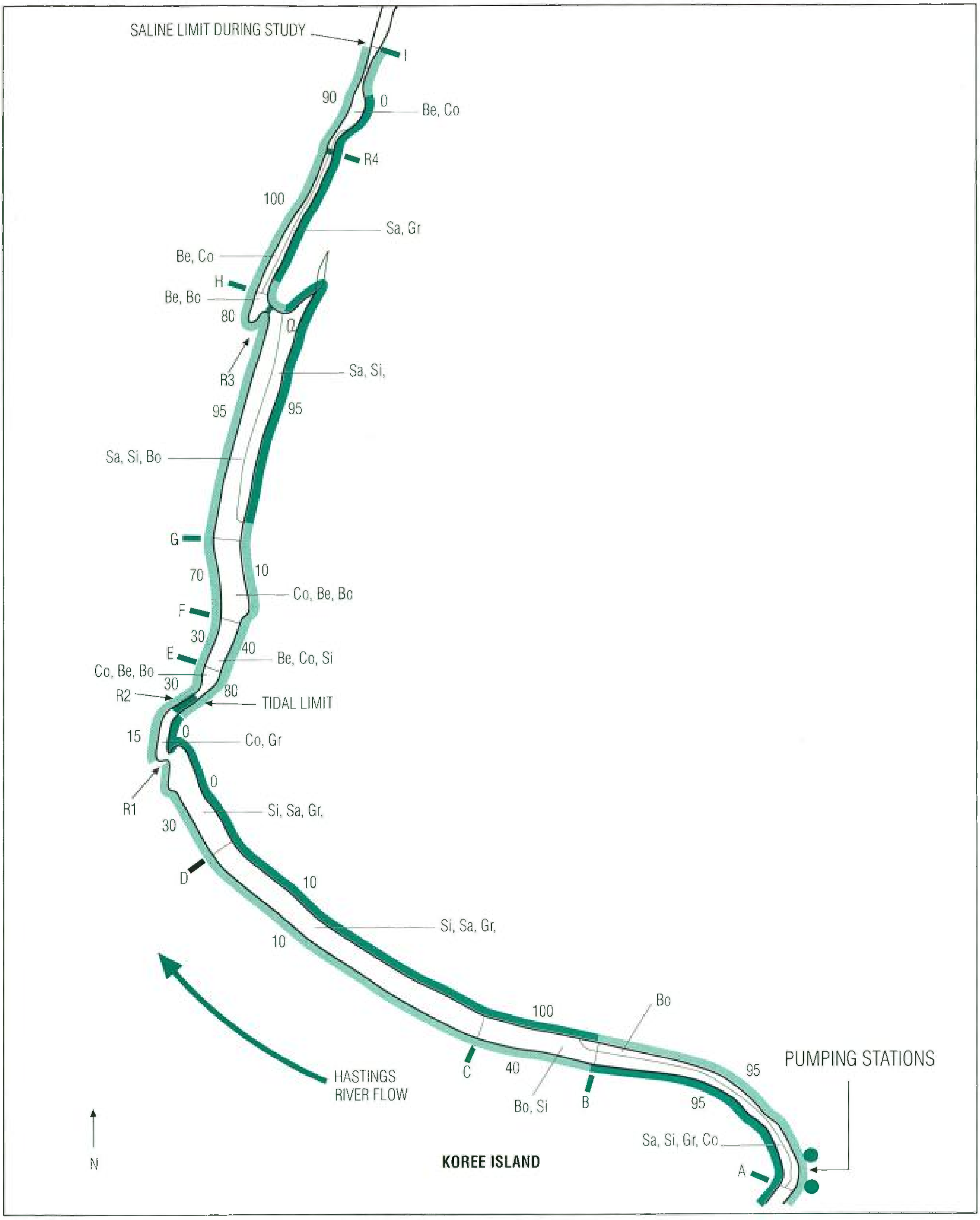
A general description of habitats present was made for the areas surveyed for fish. Features described include:

- channel widths;
- water depths;
- water speeds;
- substrate types;
- aquatic vegetation;
- submerged bank inclines;
- bank cover;
- percentage of bank lined with trees; and
- human-induced degradation.

A more detailed examination of environmental conditions within riffles was made when describing hydraulic conditions in relation to the availability of fish passage. At the time of survey river flows at Koree Island were 115ML/d.

Bishop (1994) reports a total area of approximately 11 ha of aquatic environment incorporating twelve different environmental conditions was surveyed and mapped in Figure 6.4. Approximately 40% of this could be more accurately classified as part of the upper estuary as it was found to be under the influence of the tidal cycle. Generally, habitat diversity was low due to the poor pool/riffle sequence and the low variety of microhabitats present. As a result, pool habitats dominated approximately 93.5% of the area, followed by races (5.6%, only downstream of R2) then riffles (1%, mainly R1 and R2). The pools were characterised by extensive shallows and deeper water areas (depth >2m) suitable for refuge in larger fauna covered only around 18% of the area.

Approximately 96% of the deeper pool habitat was present upstream of the tidal limit. Local landholders indicated that extensive sedimentation has occurred in recent years with a result that currently available deeper water habitat was only a small remnant of that which occurred previously. It was noted that sedimentation



Embankment - Undercutting
Shelving

Substrate - Si - Silt
Sa - Sand
Gr - Gravel
Co - Cobbles
Bo - Boulders
Be - Bedrock

'30' - % of bank lined by trees
'A' - Sections of differing environmental conditions
'R1' - Riffle

Figure 6.4
Stream Habitats

had been most noticeable in pools downstream of the tidal limit. Destabilisation of banks caused by cattle access would undoubtedly be a major cause of such changes and evidence of this process was clearly seen in the pool upstream of Riffle R1.

Aquatic Algae and Weeds

The high abundance of adherent algae on substrates, and the occurrence of algal 'heads', suggests an excess-nutrient problem in the river. This may be expected as agricultural land surrounds the river and native vegetation has been removed extensively from the banks. According to ANZECC (1992), nuisance algal growths can occur with Total-N as low as 0.1 mg/l and Total-P as low as 0.01 mg/l. Unfortunately, the monitoring of nutrient levels in the river to date has generally had detection limits set above these levels (Total-N, 0.5 mg/l: Total-P, 0.02 mg/l). Although the potential for nutrient problems arising from groundwater inputs is low due to naturally low nutrient levels in soils (Mr I. Kelly pers. comm., Grafton DWR), a number of features of the river would exacerbate any problems arising from agricultural practices. The most important of these are the wide, generally shallow nature of the river and the small amount of shading provided by riparian vegetation. Accordingly, in warmer months, water temperatures are liable to reach high levels and periods of high light intensity would be prolonged, conditions which set the scene for extremely high growth rates of aquatic vegetation.

In the above context, a concern is held for the consequences of the expected growth of the exotic water fern, *Salvinia molesta*, which first appeared in the river during April 1994 (M. Thompson pers. comm., 1994). Due to the timing of its entry into the river, and the occurrence of major flows in January 1995, the consequences of warm season growth of this plant have not yet been observed. If no major flows occur during summer months of future years, and growth rates approach maximal levels (doubling time of 5 days, Sainty and Jacobs [1981]), then significant changes to the river can be expected. For example, given 200m^2 of *Salvinia* in the river downstream of the Council's pumping prior to a summer, it is estimated that it would take only 45 to 50 days for the *Salvinia* to completely blanket the surface of the river. There are important implications on the ecology of the river from the consequent reduction of light reaching the water column, the elimination of air-breathing fauna such as platypus and tortoises, and severe reductions in water quality as the mats decay and sink. This latter aspect of course has implication for the water supply use of the river. As the growth of *Salvinia* is severely limited by 3 to 4 ppt salinity after a few months exposure (Sainty and Jacobs, 1981), it would not flourish below the upper section of the estuary.

While the appearance of aquatic weeds in the study area is an important stream management issue, the control of weeds and nutrient inputs to the river is not closely related to the pumping proposal. Opportunities for water abstraction may be reduced if water quality deteriorates due to eutrophication, however the water abstraction regime would not signficantly increase the threat of aquatic weed proliferation downstream of Koree Island.

Fish Communities

Data derived from fish surveying were augmented by information derived from the literature, the examination of fish-stocking records and interviews with landholders and anglers (Bishop, 1995).

The following two fish-surveying areas were selected from the water intake works downstream (refer Figure 6.4):

- Area 1: pool upstream of Riffle R1 (1.5 km in length)
- Area 2: pools, riffles and races downstream of Riffle R2 (1.3 km in length)

Because the position of the tidal limit had not been accurately reported prior to the present study, it was subsequently discovered that Area 2 was downstream of the tidal limit, yet upstream of the saline limit. Accordingly, Area 2 could more accurately be viewed to be part of the upper estuary. Nevertheless, being closely related, the results from this area are examined in association with the results from freshwater.

To characterise fish communities at each site Bishop (1995) used the following surveying methods which are described in detail in Appendix J.

- fish trapping using "Opera House type" fish traps;
- collection of fish in shallow areas and Japanese purse seine nets (10mm mesh);
- observing and classifying fish at night by spotlight; and
- daytime visual observation of fish using polarising glasses.

Surveying with the above standard methods was undertaken on one occasion in late-winter (17-18/8/94). In the course of describing environmental conditions, or sampling fish, the occurrence of other vertebrate fauna was noted.

A list of fish species recorded in freshwater of the Hastings River System, based on the survey and literature are presented in Table 6.3. A total of eighteen native and one introduced species have been recorded. This diversity is very low in comparison to other north coast rivers (e.g. Bellinger River, 28 native species (Bishop, 1991), however, this is a reflection of the sampling effort and reduced flows experienced during the survey period. Of the variety of sampling/observation undertaken in the present study, seine netting and underwater spotlighting were the most effective methods for obtaining representative samples of the fish communities.

Table 6.3: Annotated List of Fishes from Freshwater of the Hastings River System

NATIVE FISHES
Anguilla reinhardtii (Longfinned Eel)
Pomatolosa richmondia (Freshwater Herring)
Retropinna semoni (Australian Smelt)
Galaxias maculatus (Common Galaxias)
Tandanus unident sp. A (Bellinger River Tandan)
Melanotaenia duboulayi (Duboulay's Rainbowfish)
Pseudomugil signifer (Pacific Blue-Eye)
Notesthes robusta (Bullrout)
Ambassis jacksoniensis (Port Jackson Perchlet)
Macquaria novemaculeata (Australian Bass)
Mugil cephalus (Bully Mullet)
Myxus petardi (Freshwater Mullet)
Gobiomorphus coxii (Cox's Gudgeon)
Gobiomorphus australis (Striped Gudgeon)
Hypseleotris compressa (Empire Gudgeon)
Hypseleotris galii (Firetailed Gudgeon)
Philypnodon grandiceps (Flathead Gudgeon)
Philypnodon sp. (Dwarf Flathead Gudgeon)
INTRODUCED FISHES
Gambusia holbrooki (Gambusia)

By weight and numbers the most dominant species sampled by Bishop using each technique was the Freshwater Mullet followed by the Australian Smelt. The Freshwater Mullet was much more abundant in Area 2 downstream of Riffle R2 and at least three size classes were present. This corresponded to trends in the underwater spotlighting and also observations made during the day using polarising glasses. Pertinent here is the observation that 1000 to 2000 Freshwater Mullet were aggregating immediately downstream of Riffle R2. Most of these were the large size class collected by seine and approximately 5% had obvious ulceration along the sides of their body. No such ulcerated fish were observed upstream of Riffle R1. Ulceration is usually indicative of environmental stress. The least abundant species recorded were the Bully Mullet, Bellinger River Tandan, Port Jackson Perchlet, Freshwater Herring the Common Galaxias and Striped Gudgeon.

The freshwater shrimp, *Parataya australiensis*, was abundant in netted samples, particularly at three sites in Area 1. Approximately 50% of specimens were carrying eggs.

When data from shelving sides and undercut sides were separated it was clear that a greater number of species were recorded in the latter. The greater habitat diversity and shelter for larger fish species along the undercut sides is likely to have been responsible for these differences. The number of species recorded in the present study is in the mid-range of that recorded by Bishop (1993) in other NSW north coast rivers using the same methods.

The surveys detected the presence of two fish species of special interest (the Bellinger River Tandan and the Australian Bass) which are described further below.

The identity of the **Bellinger River Tandan** (*Tandanus unident*. sp.A) (a Freshwater Eel-tailed Catfish) from the Hastings River was determined after protein electrophoretic analysis by the Zoology Department of the University of New England.

The literature (Musyl, 1992) indicates that the 'Bellinger River' tandan has a distribution encompassing at least four river systems on the NSW mid north coast. Accordingly, this tandan, which has moderate recreational angling value, has a potentially high conservation value as it is possible that it is limited to a 160km section of the NSW east coast. Sampling in the present study indicated that the Bellinger River tandan is common and widespread in the lower Hastings River frequently associated with undercut stream banks.

Australian fisheries authorities (Jackson, 1992) have classified this tandan as having 'uncertain status' defined as "taxa whose taxonomy, distribution and/or abundance are uncertain but which are suspected of being restricted".

The data on the numbers of individuals observed using the underwater spotlight in suggested that abundance was greatest in Area 2 downstream of Riffle R2. This may partially be explained by the feature that they were more commonly associated with undercut banks rather than shelving banks. The mean numbers observed in both areas in the Hastings River were much greater than observed by Bishop (1993) in the Bellinger River. However, when compared to the mean numbers of the new sub-species in the Orara River, only Area 2, on the undercut sides, had greater mean numbers.

Bishop (1993) indicated that Bellinger River anglers have observed this species moving within riffles during December. Without more detailed observations it is impossible to determine whether this was true migratory activity.

The **Australian Bass** (*Macquaria novemaculeata*) has a high recreational-angling value. Sampling in the present study failed to record this species although Llewellyn (1983) recorded it in the river in the late 1970s and NSW Fisheries (J. Harris pers. comm., 1994) recently recorded an aged population in the upper reaches of the Maria River, a system which enters the Hastings River estuary around 8km upstream from the river mouth.

The lack of record in the present study contrasts with the considerable numbers recorded by Bishop (1993) in the Bellinger and Orara Rivers using the same observation techniques. It is likely that the apparent absence is a result of very low population densities and this is supported by comments, made by ten local recreational anglers, that there has been a drastic crash in bass numbers in the last 5 to 10 years. Potential causes for the reduction of Australian bass populations could include lack of suitable river flows and deep water habitat reduction caused by sedimentation. It is likely that the Australian bass is locally endangered in the Hastings River.

Impacts on Freshwater Biota

Existing Barriers to Fish Passage

Upstream and downstream passage opportunities for adult and juvenile fish occur at Riffles R1 and R2 for a flow of 116 ML/d (Figure 6.4). Both riffles were armoured by cobbles and rocks, and as a result, sites for sheltering from high water velocities were common along the length of the riffles. At this flow adults moving upstream or downstream face a total passage barrier of 37.5m, based on depth, 8m at Riffle R1 and 29.5m at Riffle R2.

High densities of upstream-moving adult and juvenile freshwater mullet, immediately downstream of Riffle R2, provided supportive evidence that the riffles at this flow are a barrier to fish movements. Given its considerable width, and very-shallow sloping banks, it is apparent that a considerably greater flow would be required over Riffle R1 to remove the passage barrier for adult fish caused by low depth. A conservative estimate for the flow required to remove the barrier on Riffle R1 would be 290 ML/d.

Barriers to movements of juveniles were only apparent on Riffle R2 where a 4m passage barrier was identified. Water velocity restrictions were the basis to this barrier, and accordingly, it would only be limiting to upstream moving juveniles. It is important to note that the barrier to juveniles, located in the upper section of the riffle, was created by an arrangement of large rocks which funnels water through the middle of the riffle. These rocks were presumably put in place by landholders to maintain the water level of the pool immediately upstream. Another high-velocity area existed in the lower section of the riffle where it was apparent that only a small decrease in flows, and the associated lowering of the water level in the pool downstream, would create a passage barrier there. Accordingly, with the large rocks in place a passage barrier commences at some flow greater than 116ML/d. With the large rocks removed, it could be reasonably assumed that a passage barrier commences at, or just below 116ML/d. The analysis assumes that these rocks would be removed. NSW Fisheries is the department with responsibility in this regard.

Reduction in Flows

The reduction in the duration of very low flows, returning duration to virtually the natural situation, is a positive impact of the proposed water extraction regimes (Bishop, 1995). This is particularly the case in hot weather when otherwise adverse impacts associated with increasing water temperatures are likely with very low flows (e.g. direct stress to fauna caused by high temperatures and lowered dissolved concentration, greater potential for excessive plant growth). The lower Hastings River is likely to be susceptible to such impacts on biota because of the wide, generally shallow nature of the river and the small amount of shading provided by riparian vegetation. Riparian vegetation would also benefit from the reduced duration of very low flows, a result of reduced exposure to desiccating conditions caused by the lowering of groundwater levels.

The small decrease in the reduction of high flows is considered to have a negligible impact on biota, and this is addressed later in relation to natural flow variability and flushing of river substrates.

The impact of the change in duration of moderate and low flows is potentially more significant. Information derived from the physical habitat analysis is useful in developing an understanding of the nature of impacts on the key fish species in relation to the fish passage constraints of food supply and pool water level stability.

Effects on Fish Passage of Reduced Flows

Table 6.4 provides a comparison of hydrological conditions demonstrating the impact of the initially proposed water extraction regime on fish passage opportunities. The table compares the amount of time on average that critical river flow rates are exceeded in months during which fish migration occurs.

The existing and proposed (EP) pumping regime comparison indicates that the duration of passage opportunities for juvenile Australian Bass would either increase to a small extent or remain the same. The natural and proposed (NP) comparison indicates that the resulting duration would be approximately 1% or 0.3 days/month less than what occurs in the natural situation.

The EP comparison indicates that for adult Australian bass moving downstream to the estuary in April to July inclusive, the opportunity for passage over riffles would increase to a small extent with the proposed water extraction regime. The NP comparison indicates that the resulting duration would be either the same or decrease to a small extent in relation to the natural situation.

In contrast, a marked reduction in opportunity for passage back upstream in September and October is apparent. In these months the reductions are approximately 12.0% and 9.8% respectively of the existing passage opportunity, or 15.1 or 15.8% respectively of the natural passage opportunity. Given the apparent existing very low population densities of this species, these reductions of passage opportunity are of concern. These reductions, in duration, would necessitate extended periods of stay for the returning females in the upper estuary, exposing them to considerable predation pressure and competition.

Table 6.4: Comparison of Hydrological Conditions Demonstrating the Impact of the Proposed Water Extraction on Fish Passage Opportunities
(Expressed as a Percentage Exceedance of the Critical Flow)

Month	Existing vs Proposed (EP)			Natural vs Proposed (NP)		
	Existing	Proposed	Diff.	Natural	Proposed	Diff.
Critical Flow for Adult Fish Passage (290 ML/d):						
April	90.9	91.3	+0.4	93.2	91.3	-1.9
May	93.4	93.6	+0.2	93.6	93.6	0.0
June	87.6	90.1	+2.5	90.1	90.1	0.0
July	85.3	86.2	+0.9	86.4	86.2	-0.2
September	69.5	61.1	-8.4	72.0	61.1	-10.6
October	68.7	62.0	-6.7	73.6	62.0	-11.6
Critical Flow for Juvenile Fish Passage (116ML/d):						
October	94.9	94.9	0.0	95.9	94.9	-1.0
November	85.8	87.4	+1.6	88.4	87.4	-1.0
December	94.8	94.9	+0.1	95.5	94.9	-0.6

Diff. = Difference, a positive value indicates an increase in the percentage exceedance.

In any month of the year other more common species including adult Bully Mullet, Freshwater Mullet or Freshwater Herring require passage between the river and the estuary. Taking 300 ML/d as the critical flow for adult passage, it is apparent that there is reduced passage opportunity from September to January inclusive. Adult Bully Mullet require passage in each of these months, while Freshwater Mullet require passage in January only. Adult Freshwater Herring require passage in September only.

Impact on Food Supply

While riffles are likely to be the areas where macroinvetebrate abundances and diversity is the greatest, it was apparent during surveying that a substantial food supply, ie. the particularly abundant freshwater shrimp (*Parataya australiensis*), was present in extensive shallow margins of large pools. Surveying was undertaken at a flow of 116 ML/d and water depth over these margins did not remotely appear to be limiting shrimp abundance. For the condition when the proposed storage is >60% capacity, the 80th percentile environmental flows in the period when high food supply is most important (ie. December to February inclusive) are greater than 116 ML/d. Accordingly, the integrity of such a food supply is ensured. When the proposed storage is <60% capacity, the 95th percentile environmental flows in the same period are either greater, or at most 15

ML/d (December) lower than 116 ML/d. The water level drop associated with a 15 ML/d flow reduction at a flow of 116 ML/d is approximately 20mm, and this would have a negligible impact on the shallow margins of the pools (Bishop, 1995).

Comparison of the existing versus proposed pumping regime indicate that there would be a small increase in the duration of flows >116 ML/d in December, and analysis of untabled data indicate that this is additionally the case in January and February. Accordingly, a positive impact would result from the proposed water extraction regime, in that there would be a reduced duration of the lowering of water levels over the shallow margins of large pools, and when such events do occur, the impact on the fauna therein is likely to be negligible.

Maintenance of Pool Water Level Stability

The acceptable drawdown depth of 50mm is relevant to the months of catfish breeding (i.e. October to January inclusive) when their nests are located close to the surface. Under the proposed abstraction regime, drawdowns during low flows in October to January would be greater than the identified acceptable drawdown depth.

With water level stability less than the determined acceptable level it is expected that there would be some adverse impact on the reproductive success rate of the catfish downstream of Koree Island. The extent of this impact would be very difficult to determine, although it is highly likely to be only minor.

The threshold where an abstraction rate of 114 ML/d causes a drawdown depth of 50mm is 360 ML/d. Accordingly, a minimum environmental flow to ensure that drawdown exceedances do not occur, is 246 ML/d.

Natural Flow Variability and Flushing Flows

The possibility that water extraction may remove flushing flows which stimulate sexual maturation and downstream migration of Australian Bass was investigated by examining the average size of flood peaks which exceeded the recommended minimum flows for downstream passage of adults (290 ML/d). This indicates that water extraction at the maximum rate would on average have only minor capacity to remove flows capable of stimulating spawning from April to July and virtually no capacity to remove flushing flows.

However, in relation to the stimulation of sexual maturation, these concerns are reduced because water extraction is proposed in the very lower reaches of the river and hence the majority of Bass in freshwater would not be exposed to such an altered flow regime.

A summary of the impacts of the initially proposed extraction regime (ie. maintaining monthly 80th/95th percentile environmental flow criteria) on freshwater biota are summarised in Table 6.5.

Table 6.5 : Summary of Impacts on Freshwater Biota likely to be Caused by the Change from the Existing to the Initally Proposed Water Extraction Regime

Environment	Positive Impacts		Negative Impacts	
	Description	Scale	Description	Scale
Freshwater	Small reduction in duration of very low flows - reduced stress to aquatic and riparian biotta	2	Marked reduction in the duration of flows >290ML/d in September and October - reduced upstream passage opportunity for adult Australian Bass (of concern as population densities are already very low)	2
	Small increase in the duration of flows >116ML/d in October to January inclusive - increased passage opportunity for juvenile Australian Bass +	1	Reduction in the duration of flows >290ML/d in September to January inclusive - reduced passage opportunity variously for adult Bully Mullet, Freshwater Mullet and Freshwater Herring.	1
	Small increase in the duration of flows >290ML/d in April to July inclusive - increased downstream passage opportunity for adult Australian Bass	1	Reduced pool water level stability with an extraction rate of 114ML/d in October to January inclusive - reduced reproductive success for the Bellinger River Catfish	1
	Small increase in the duration of flows >116ML/d in December to February inclusive - ensures high food supply for the Bellinger River Catfish in critical months in shallow margins of pools ++	1	Removal or major alteration to flow peaks (up to 400ML/d) in April to July - reduced spawning and migration stimulation for Australian Bass	1
			Small reduction in the duration of high flows - assumed negligible impact on effective flushing of river substrates	0

NOTES:

Key to Scale of Impact: 0 = negligible; 1 = minor; 2 = moderate; 3 = major

\+ Conditional on the removal of an arrangement of large rocks in the upper section of Riffle R2.
++ The impact on food supply (i.e. macroinvertebrates) in riffles is unknown.

Mitigation of Impacts on Freshwater Biota

Table 6.5 predicts one moderate, three minor and one negligible-scale negative impact as a result of the initially proposed water abstraction regime. Correspondingly, one moderate and three minor-scale positive impacts were considered likely.

Four approaches to mitigating the negative impacts were considered:

(a) **Do nothing** on the assumption that the positive impact of the proposal balance the negative effects. With present knowledge such a balance cannot be accurately quantified and judged. This proposal is not considered appropriate.

(b) **Do nothing except monitor the condition of the river and respond if adverse impacts are identified.** This approach would require intensive field monitoring in order to detect impacts as they occur. However the effects of many changes have a time lag.

(c) **Adjust environmental flows so that the proposed water extraction regime does not contribute to existing stressors (natural or human-induced) on the river system.** This approach is conservative and directed towards ensuring the survival of the most threatened and most sensitive of indicator species. Ensuring that flows are always in excess of critical levels, is considered excessive. The local extent of any endangered species and the extensive alteration of the flow regime and design modifications required to minimise what are considered minor-impacts would not justify this action.

(d) **Adjust environmental flows so that the proposed regime does not contribute stress as per the moderate-scale negative impact mechanisms.** This is the preferred approach. It would require commitments to critical flow maintenance at key times during the year and would require further monitoring to substantiate critical flows.

Given a detected, ecologically significant impact during monitoring in Approach B, it would then be necessary to respond in an effective manner. In the case of further declines in population densities of Australian Bass for example, it may be appropriate to regularly stock the river with juveniles. Alternatively, it may be necessary to adjust environmental flows to above critical levels identified, in relation to fish passage. If the latter was appropriate action, additional research would be necessary to more accurately define the critical flows as the critical flows for passage of adult Bass are based on information gathered primarily from the Bellinger river.

Approach C is pertinent to species with low resilience including the key indicator species. High resilience would be expected for most of the fauna under pristine conditions, but low resilience would be expected in a disturbed system because of cumulative stresses. An examination of the lower Hastings River by Bishop (1995) indicates a reasonably high level of disturbance including:

- extensive sedimentation of deep pools;
- problematic levels of nutrients as evidenced by excessive adherent algal growth;
- obstructions being placed on riffles thus inhibiting passage for aquatic fauna;
- extensive clearing of riparian vegetation;
- excessive and illegal net fishing; and
- the occurrence of the exotic water fern, *Salvinia* (given appropriate conditions, this plant could have a significant impact on the river ecosystem).

Given the level of disturbance of the river, it cannot be assumed that Approach C would provide protection for sensitive species without extensive monitoring and follow up action. As a result this approach is not preferred.

Approach D provides the opportunity to maintain habitat conditions for key indicator species in the river and would mitigate the "moderate" scale impacts described in Table 6.5.

On the basis of Bishop (1995), critical flows relevant to Approach D are:

- 290 ML/d - passage for adult Australian Bass (relevant from April to July inclusive and September and October);
- 250 ML/d - flows to maintain appropriate salinity for aquatic ribbon grass (*Vallisneria gigantica*) and for adult bass (males) outside the spawning season (relevant from September to June inclusive).

Accordingly, environmental flows would be required to be adjusted up to 290 ML/d when appropriate in April to July inclusive, and September and October. In the other months the environmental flows would be adjusted up to 250 ML/d where appropriate. The extent to which these flows would be required to be increased above the proposed minimum flow regime is outlined in Tables 13 to 17 of Appendix J.

The preferred pumping regime therefore represents a modification of the initially proposed pumping regime which was based on only meeting the 80th/95th percentile monthly environmental flow maintenance constraints. The preferred modified pumping regime (Modified No.1) is designed to better meet the critical flow requirements of the key indicator species during the months when these fish are migrating and when water levels are generally low. Figure 6.5 demonstrates

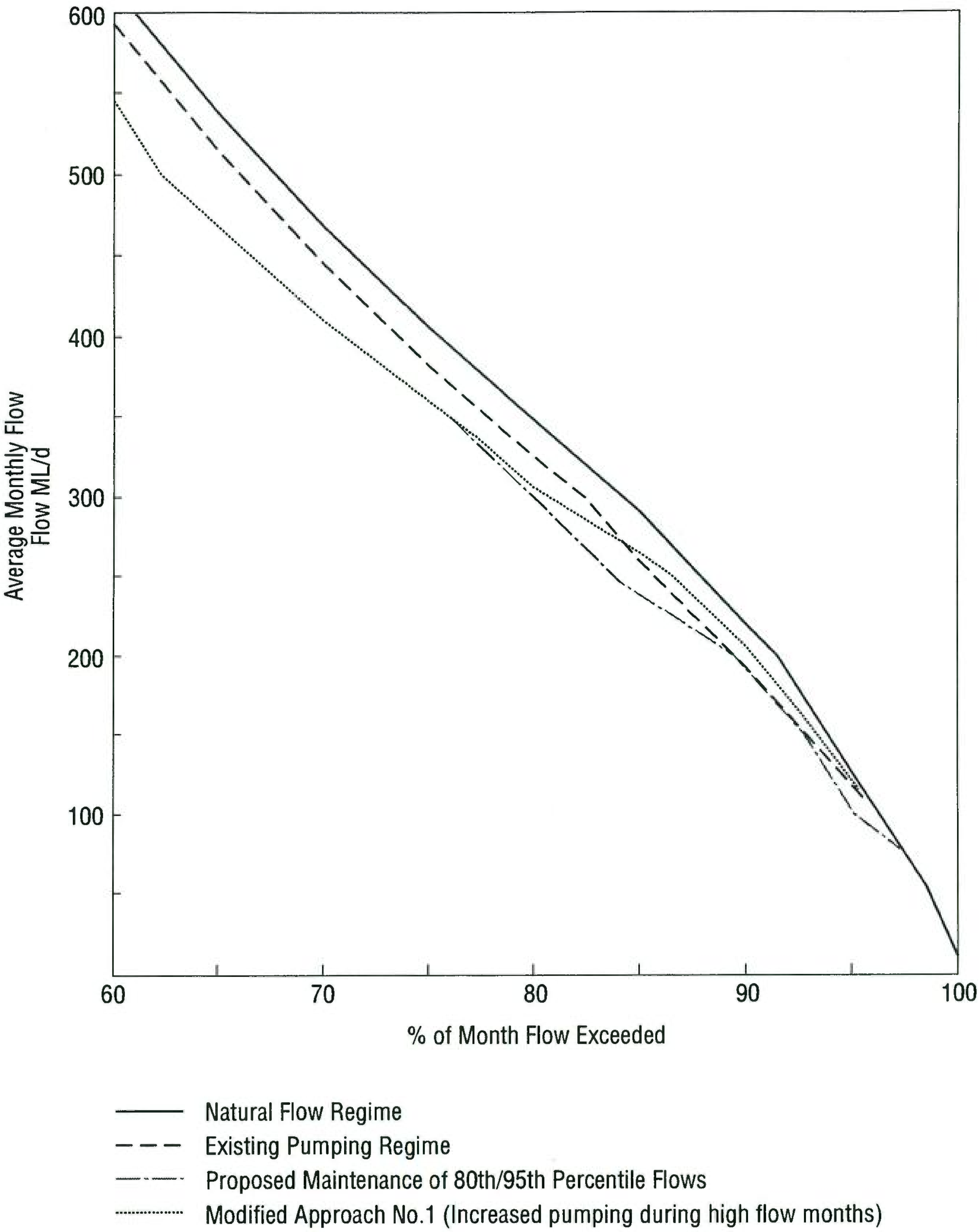


Figure 6.5
Comparison of Water Abstraction Regimes
Hastings District Water Supply
Monthly Simulation 1890-1993 All Months

how the Hastings River at Koree Island would differ with respect to the different pumping regimes, including the adopted Modified No.1 approach. The graph indicates that average monthly flows in the Hastings River in the critical range of 100 to 300ML/d will be exceeded for a greater proportion of time by the preferred modified pumping approach than the originally proposed pumping regime. For example, for a monthly average river flow of 250ML/d the preferred pumping regime (Modified No.1) would exceed this flow approximately 3% more frequently than the originally proposed pumping regime. This would be achieved by increased pumping during months when the river flows are generally higher.

It is important to note that additional research would be required to more accurately define the above critical flows. Additionally, in relation to critical flows for the passage of adults, follow-up monitoring would be required to validate assumptions made with regard to the relationship between stream habitat and river flows.

The requirement for adult passage may be less onerous if investigations into within-day movement patterns show that movements mainly occur within limited periods of the day (e.g. night vs. day). If this was the case higher extraction rates would be acceptable in the non-movement period.

Further analyses of the practicality of the Koree Island pump station operating within the critical ecological parameters has been undertaken by the Department of Public Works and Services. The analysis confirms that the abstraction rate can be adjusted to retain river flows above critical levels. This would be achieved by increasing uptake during the wetter periods at the end of summer and autumn during flows of 300 ML/d to 600 ML/d with a corresponding drop in abstraction during the critical dry spring months (Pers. comm. Anderson J., 1995). The preferred abstraction regime is reported as Modified Approach No. 1 in NSW Public Works correspondence (22 March, 1995) and involves the maintenance of river flows for each month as outlined in Table 6.6. Under the modified pumping regime river flow would on average not fall below critical levels (with respect to fish passage, ribbon grass growth and maintenance of brackish habitat) for more than 20% of each critical month. This modified approach would best meet both the functional parameters and freshwater and estuarine ecological criteria of the project.

The monitoring of a range of stream water quality parameters and action with respect to erosion and sedimentation control are also proposed in Section 6.2.3.

Table 6.6: Minimum Environmental Flow Conditions (ML/d) for the Preferred Modified Approach (No. 1) Pumping Regime

	MONTHS											
Percentile Flows	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80th	250	350	450	450	450	400	350	290	290	290	250	250
95th	125	125	250	250	250	250	250	180	125	125	125	125

6.2.5 Estuarine Ecology

The objective of the assessment of estuarine ecological impacts was to provide a basis to predict the impact of potentially reduced flows into the estuary on key indicator organisms sensitive to changes in the salinity regime. These include:

- Australian Bass (high recreational value);
- Sydney Rock Oysters (high commercial value); and
- 26 commercial fish or crustacean species.

The estuarine assessment component involved the collation of information on salinity tolerances and the dynamics of the saltwater wedge in the estuary. The estuarine effects of the proposal are discussed in detail by Bishop (1995) in Appendix J.

The assessment of estuarine impacts focuses on potential changes in the salinity structure of the estuary which would be related to reductions in the river flow resulting from the operation of the new pump station at Koree Island. This emphasis is appropriate as the proposed increased water abstraction would not significantly alter the duration of high flows which are likely to be primarily responsible for general estuarine productivity or the transport of eggs and larvae. The nature of the hydrologic and water quality effects on the estuary are described in Section 6.2.2 and 6.2.3.

<u>Salinity Tolerance and Impact on Key Species</u>

The ecological influence of salinity changes on the Australian Bass and Sydney Rock Oyster are discussed below and in detail in Section 3.2.1.1 of Appendix J.

Australian Bass

Three salinity levels were identified which are potentially important ecological limits to the survival of Australian Bass:

- 5 ppt - upper level for adults outside the breeding season
  - upper level for ribbon grass (important shelter for juveniles and larvae);
- 13ppt - upper level for adults in the breeding season (July and August);
- 25ppt - upper level for common reeds, important shelter for juveniles and larvae.

The length of the estuary containing water salinity up to the abovementioned levels decreases with decreasing flows. It was found that the rate of decrease was clearly raised as river flows decreased below threshold flows at 250, 500 and 1,000ML/d.

During high flows, an existing versus proposed (EP) abstraction regime comparison indicated that the duration of flows >1,000 ML/d would decrease by 1% in July and August, the breeding season for Australian Bass. A natural versus proposed (NP) abstraction regime comparison indicated that the resultant duration would be 1 to 3% less than what occurs in the natural situation. Although some impact is expected with the corresponding contraction of the suitable salinity zone, the net impact is likely to be negligible, given the small time period involved. Reinforcing this view, the effect of the flow reduction is expected to be considerably buffered further towards the mouth of the estuary as a result of freshwater inputs from rivers and streams in the area.

Appendix J (Table 16) provides a comparison of hydrological conditions demonstrating the impact of the proposed water extraction regime on the duration of flows relevant to the key threshold salinities. In relation to the protection of common reeds for shelter, the EP comparison indicated that there would be a 3 to 7% (0.9 to 2.1 days/month) reduction in the duration of flows greater than the 25ppt (500ML/d) threshold in eight months (August to February inclusive and June). The NP comparison indicated that the reduced duration would be 4 to 8% (1.2 to 2.4 days/month) less than what occurred in the natural situation. The impact on salinity structure of the estuary would be buffered by freshwater inputs to the estuary downstream of the tidal limit. Impacts of salinity changes to the common reed may be reduced due to a well-developed root system enabling low-salinity groundwater from adjacent river banks to be utilised.

In relation to the protection of shelter provided by ribbon grass, and the provision of a suitable salinity zone for adult Australian Bass outside the spawning season, it is apparent from an EP comparison that there would be a marked 11% (3.3 days) reduction in the duration of flows greater than the 5ppt or 250ML/d threshold in October, and lesser reductions of 3 or 4% (0.9 to 1.2 days/month) in September, November and December. A NP comparison indicated that the resulting durations would be 15.5% (4.7 days) less than it was in the natural situation in October. As the suitable zone is typically located in the upper estuary, little buffering from freshwater inputs downstream of the tidal limit can be expected. As ribbon grass does not have well-developed root systems, particularly not focussed along river banks, no buffering of impacts is expected as a result of the presence of low salinity groundwater. Small losses of ribbon grass meadows in the upper estuary would be of concern as they provide shelter for juvenile Australian Bass recruiting towards freshwater.

The impact of an altered salinity regime and its potential to affect the growth and survival of ribbon grass habitat in the upper estuary is considered one of the moderate impacts of the formerly proposed pumping regime. As a result of this factor the water abstraction regime has been modified according to the description outlined in Section 6.2.4. This would improve the growing conditions of ribbon grass and would result in less severe reduction in flows greater than the identified key salinity thresholds.

Sydney Rock Oyster

A salinity of 30ppt was identified as a potentially important ecological limit to the Sydney Rock Oyster (Bishop, 1995). This salinity level is indicative of an upper limit in relation to the incidence of winter mortality (June, July and August) and fouling of attachment substrates by marine animals.

The length of the estuary containing water with salinity below 30ppt decreases with decreasing flows. It was found that the rate of decrease was clearly raised as flows dropped below a threshold flow of around 120 ML/d.

Appendix J (Table 17), provides a comparison of hydrological conditions demonstrating the impact of the proposed water extraction regime on the duration of flows greater than the threshold flow. An EP comparison indicated that there would be virtually no difference or small increases in the duration of flows greater than the threshold flow. A NP comparison indicated that no difference or small decreases in duration would occur in relation to the natural situation. Compared with the existing situation, this indicates a minor positive impact of the proposed water extraction regime in that there would be an associated lower chance of the incidence of winter mortality disease, and a reduced opportunity for marine animals to foul attachment substrates.

Secondary Key Estuarine Fauna

An analysis was made of the potential impact on a group of commercial fish and crustacean species of reducing flows by 114 ML/d (i.e. the 'worst-case') maximum extraction rate for the initially proposed monthly percentile environmental flow based water extraction regime (Bishop, 1995). Calculated yearly dollar losses caused by such an extraction averaged <$121/y for the 25 combinations of species and monthly flows which showed significant positive associations. The dollar return from catches for the Trumpeter Whiting showed the greatest losses. The two highest losses for this species were only $607/y and $411/y for September and January flows, respectively.

These losses are minor, and given that are for the worst-case situation, it is expected that they would be negligible under the modified extraction regime. This view is further strengthened when it is considered that impacts would be buffered by freshwater inputs to the estuary downstream of the tidal limit.

A summary of the impacts of the initially proposed extraction regime (ie. maintaining monthly 80th/95th percentile environmental flow criteria) on estuarine biota are summarised on Table 6.7.

Table 6.7 : Summary of Impacts on the Estuarine Environment likely to be Caused by the Change from the Existing to the Initially Proposed Water Extraction Regime

Environment	Positive Impacts		Negative Impacts	
	Description	Scale	Description	Scale
Estuary	Small increase in the duration of flows >120ML/d - lower chance of incidence of winter morality disease to the Sydney Rock Oyster (not previously recorded in the Hastings) - reduced opportunity for fouling by marine animals or sub-strates suitable for the Sydney Rock Oyster	 1 1	Marked reduction in the duration of flows >250ML/d in October, and lesser reductions in three other months - impact on ribbon grass by high salinity; important shelter for juvenile Bass - reduced suitable salinity zone for adult Bass outside spawning season Marked reduction in the duration of flows >500ML/d in october and lesser reductions in seven other months - impact on common reeds by high salinity; important shelter for juvenile Bass (buffered by other fresh-water inputs and low-salinity groundwater by river banks Small reductions in the duration of high flows - assumed negligible impact on productivity of estuary and advection of eggs and larvae (buffered by other freshwater inputs) Reduced flow volumes - minor lowering of $ return for a range of commercial species (secondary key fauna; buffered by other freshwater inputs)	 2 2 0 0 0

NOTES:

Key to Scale of Impact: 0 = negligible; 1 = minor; 2 = moderate; 3 = major

\+ Conditional on the removal of an arrangement of large rocks in the upper section of Riffle R2.
++ The impact on food supply (i.e. macroinvertebrates) in riffles is unknown.

Mitigation Measures

The mitigation measures proposed in Section 6.2.4 are relevant to the estuarine habitat. The recommended approach is to consider an interactive combination of environmental monitoring (to further determine critical flows for the key indicator species), and the adjustment of environmental flows to maintain habitat conditions within the predicted critical salinity tolerances of key species. The relevant critical flows primarily relate to adult Australian Bass and are:

- 290 ML/d - to allow passage (April to July inclusive and September and October); and

- 250 ML/d - to maintain appropriate salinity for ribbon grass (all months) and for shelter for male adult Australian Bass outside the spawning season (relevant from September to June inclusive).

A regime of salinity and other water quality parameter monitoring is also proposed in Section 6.2.3.

6.2.6 Terrestrial Flora and Fauna

Flora

The original vegetation of the steep river bank and gully sides have been cleared while the forested gully and steep slopes are heavily infested with *Lantana*. The remnant endemic vegetation is structurally and floristically described in Table 6.7 and mapped on Figure 6.1. A reconnaissance survey indicated no endangered species included on the ROTAP register were recorded in the construction area.

The area of direct disturbance for the proposed construction of the pump station would involve approximately 0.15 ha for the pump station and a further 0.30 ha for the transformer yard, construction compound and access road widening. Of this area only 0.08 ha includes disturbed elements of the endemic vegetation of the area. The remainder is cleared pasture.

The endemic vegetation of the river banks would not be significantly affected by the proposal as the intake pipe site is clear of native vegetation and is currently grazed. However, widening of the access road would require an additional 2m strip of fill along the northern side of the gully vegetation for approximately 50m.

The majority of the native vegetation disturbance would be related to the construction of the earthing grid above the 40m high bank. The removal of less than 0.1 ha of open forest is not considered significant on the basis of the disturbed nature of the understorey and the regional abundance of this vegetation type (refer Section 5.2.6).

Following construction of the intake works a landscape plan would be implemented to visually screen the structure (refer Section 6.2.7). The plan would involve the rehabilitation and revegetation of the river bank area to be acquired.

Endemic species would be used to provide compensatory habitat in excess of the total area of native vegetation removed. In particular, the margins of the closed forest gully would be protected by a sympathetic planting scheme. The river bank would be planted with riparian vegetation including *Casuarina cunninghamiana* to consolidate the banks and provide shade and shelter for aquatic fauna.

The condition of the planted vegetation in relation to weed invasion would be monitored through the Environmental Management Plan.

<u>Fauna</u>

The disturbed remnant terrestrial vegetation of the intake works site offers limited habitat opportunities for native fauna which use the river bank. The lack of native vegetation on this 20m section of the river bank reduces the habitat value of the site for roosting waterbirds, terrestrial mammals, reptiles and frogs which use bank vegetation for shelter and foraging.

The loss of up to 0.1ha of open forest regrowth for the transformer earthing grid is insignificant in relation to the availability of this habitat in larger areas in less disturbed condition in the local area including the state forest system.

A reconnaissance survey of the site did not reveal any Schedule 12 fauna (National Parks and Wildlife Act, 1974) in the study area, nor indicate the likelihood of the occurrence of any rare or endangered species. However, one Platypus, *(Ornithorhynchus anatinus)* (not included in Schedule 12), was observed in Area 1 during underwater spotlighting. Mr P Woon, the primary researcher in a survey of Platypus habitat requirements in the Hasting River (Woon and Laxdal 1993), indicated the observation of Platypus only as far downstream as the Koree Island water intake site, but noted that local landholders had observed them along the north-eastern edge of Koree Island upstream of Riffle R1. A Platypus burrow was also observed by Woon's co-researcher behind the township of Beechwood (i.e. several kilometres downstream of the study area. Woon indicated that Platypus are generally more abundant in the Hastings River catchment upstream of the Thone river confluence, and concluded in their report that important habitat features are average water depth, overhanging riparian vegetation, aquatic plant cover and benthic productivity. Bank structure (sand component and plant roots) and riparian vegetation were important determinants of preferred burrow sites. These criteria are not met at the disturbed intake site.

One water rat *(Hydromys chrysogaster)* was also observed by Bishop (1995) in Area 2 during underwater spotlighting. Swamp reduction and flood mitigation practices have removed much habitat for this species (Strahan 1983). The lack of riparian vegetation cover on the creek bank at the intake site reduces the significance of the site for this species.

Tortoises of the genus *Emydura* were observed during underwater spotlighting and one was captured while fish trapping. Only two species of tortoise are found in the Hastings River (pers comm. J Cairn, 1995), an undescribed *Emydura* species and the Eastern Snake-neck Tortoise *(Chelonia longicollis)*. Cairn further noted the undescribed *Emydura* is widespread and abundant in the Hastings catchment and is only found outside the Hastings catchment in the Macleay River system. This restricted distribution clearly indicates a high conservation status. However, the disturbance of the river banks of the intake site indicate that the section to be further disturbed would not provide important habitat for this species.

The restoration of the site, control of localised erosion and sedimentation and appropriate landscaping with riparian vegetation would prevent a local impact of the proposal on frog and reptile habitat, and potentially improve the habitat of the river bank for these and other terrestrial fauna, including water birds.

The environment of any Schedule 12 species is not likely to be significantly affected by the proposal according to the seven criteria of Section 4A of the Environmental Planning & Assessment Act 1979. Neither would the proposal result in the 'take of kill' of endangered fauna under the National Parks & Wildlife Act. As a result, no Fauna Impact Statement (FIS) would be required with respect to the intake works.

Table 6.8 : Koree Island Site Vegetation Description

Community Description	Structures			Dominant Species		Habitat and Disturbance
	Strata	Height	Cover	Over-storey	Under-storey	
Gully - low closed forest	Trees Small trees/vines Shrubs Ground layer	10m variable 2-3m 0.5-1m	30% 40% 10% 10%	Acmena smithii Commersonia fraseri Backhousia myrtifolia Glochidion ferdinandi Callistemon salignus	Lantana camara* Smilax australis Citriobatus pauciflorus Oplisminus imbecilis	The sheltered gully to the south of the intake works provides habitat for regrowth of several rainforest margin species. There are few mature specimens and the understorey is dominated by Lantana.
Upper River Bank - Open Forest	Trees Small trees Shrubs Ground layer	18m 4-5m 2m 0.5-1m	40% 10% 50% 20%	Eucalyptus intermedia E. resinosa E. siderophloia E. microcorys Allocasuarina littoralis	Lantana camara* Acacia spp. Dodonaea triquetra Solanum mauritianum* Pittosporum undulatum Ligustrum lucidum*	Open forest habitat remains uncleared on the steep rocky river banks. This is the predominant vegetation type in the district.
River bank/ Emergent Vegetation	Structure variable	N/A	N/A	Casuarina cunninghamiana Callistemon salignus	Potamophila parviflora Lomandra longifolia Juncus sp.	River bank vegetation is sparse in the study area. Little overshadowing or shelter is provided. The distribution of riparian vegetation is discussed (Bishop 1995).

NOTE: (*) Introduced Species

6.2.7 Visual and Landscape Assessment

Existing Conditions

The landscape surrounding the site is predominantly rural, consisting of scattered forested areas and pasture. The landform varies from hilly in the south-east of the site to almost flat to undulating across Koree Island.

Koree Island represents accumulated alluvial deposits of Hastings River sediment and as such has a low elevation. The opposite bank has been progressively undercut by the river, is elevated well above Koree Island and falls quite steeply towards the water. This side of the river is partly forested. The combination of vegetation and the steep topography obscures most viewpoints from above the ridgeline to the river. There are several houses located beside Rosewood Road which currently do not have views of the existing pump station due to obscuring vegetation and topography.

On Koree Island, the land use is rural, comprising cultivated crops and pasture. A band of trees adjacent the riverbank filters views towards the river, however the existing pump station can be seen from several of the residences, including the "Montrose" and "Koree" homesteads. This is indicated in photographs in Figure 6.6 which shows views to residences from the existing pumping station.

The existing pumping stations are located directly on the river banks, and as such, recreational and other users of the river have clear views of the structures. Views of the existing transformer yard are obscured. Pleasant views from the river of the waterway and rural surrounds are disturbed by the existing pump station and associated works (refer Figure 6.7).

Visual Impacts and Proposed Safeguards

The proposed pump station consists of a 10m wide concrete well which emerges from 12.5 metres above ground at its closest point to the river.

A 6m high shelter storage shed to house a permanent crane would be constructed on top of the well, resulting in a total structure height of slightly more than 2.0m above river level. Three steel pipes would convey water from the river to the pump station. They would generally be located below ground and water level. An artists impression of the proposed pumping station is shown as Figure 6.8.

The proposed pump station is larger and would potentially be more visually obtrusive than the existing pump stations. Views from the river by recreational users would be further disturbed by the additional structure. However, the transformer yard would not be directly visible with the exception of the thin lightning towers. Figures 6.9 and 6.10 shows sight lines from likely viewing points to the proposal. The figures indicate that the proposed pump station is likely to be seen from residences located on Koree Island and from the river. Landscaping therefore would be necessary to mitigate adverse impacts.

Landscaping and Planting

Planting along the eastern river bank would increase the screening potential offered by the existing trees located in this area. Planting would be dense and of species endemic to the Hastings River as well as complementary to the existing landscape.

Areas cleared in the vicinity of the pump station for construction purposes would be revegetated. Trees would be planted at all strategic locations possible to prevent views of the pumping station and transformer yard from residences. Planting would also occur directly on the river frontage, adjacent to the pump station, to screen it from its most obvious viewpoint, from the river itself.

The concrete well would be painted in a dull, dark colour complementary with the surrounding landscape. Surface treatment, such as painting or rendering the well, would mitigate the striking contrast between the concrete and the green/brown riverside colours, making the well less visually intrusive.

The shed would also be treated in a similar manner. Its construction could be of rendered or pointed concrete blocks or pre-coloured, prefabricated material, that would blend with the landscape and be a less startling feature of the river environment.

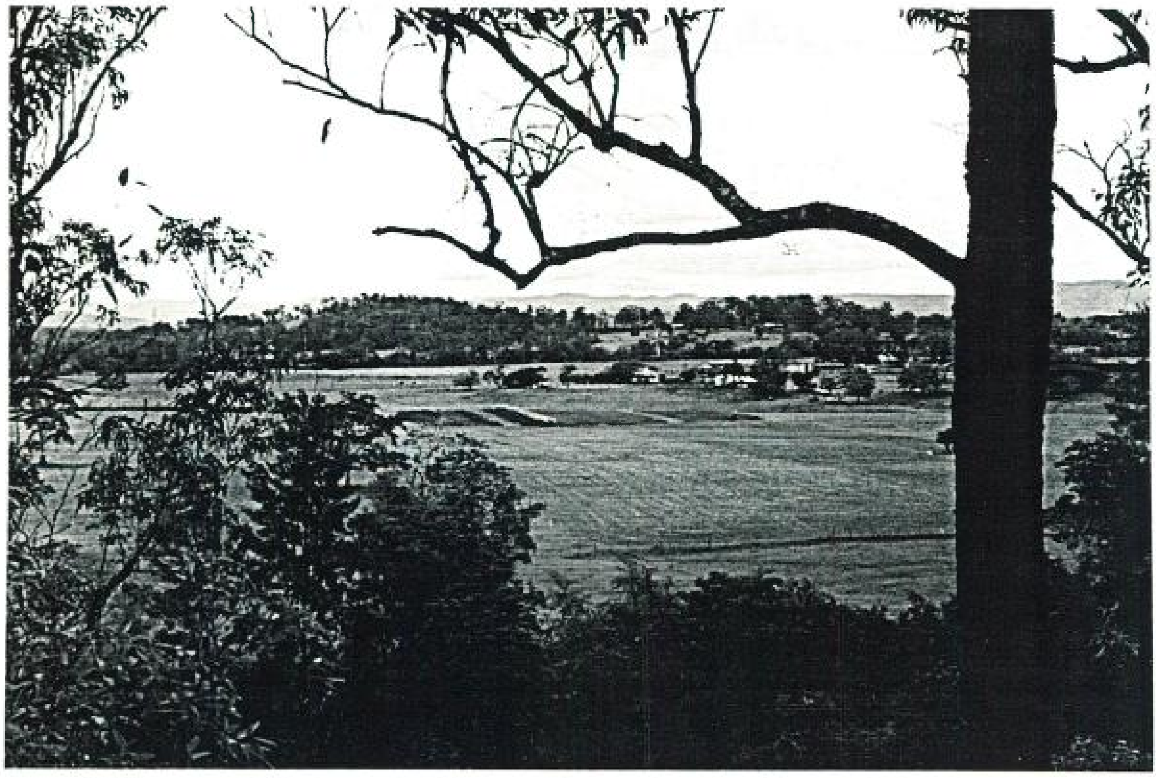
Measures planned for the proposed pump station are also recommended for the existing pump stations. Such treatments would help improve views for recreational and other river users and residents alike. The red brick shed and grey/white pump well of the 1979 pump station are especially obtrusive.

The exposed nature of the site, being directly on the river bank, means the proposed pump station would always be exposed to view in some respect. However, the proposed construction finishes associated with the landscaping measures as outlined, would lessen adverse visual impact of the proposal.

A concept landscape plan has been developed to provide guidelines for landscaping the intake works. The general parameters for development of the landscape plan were:

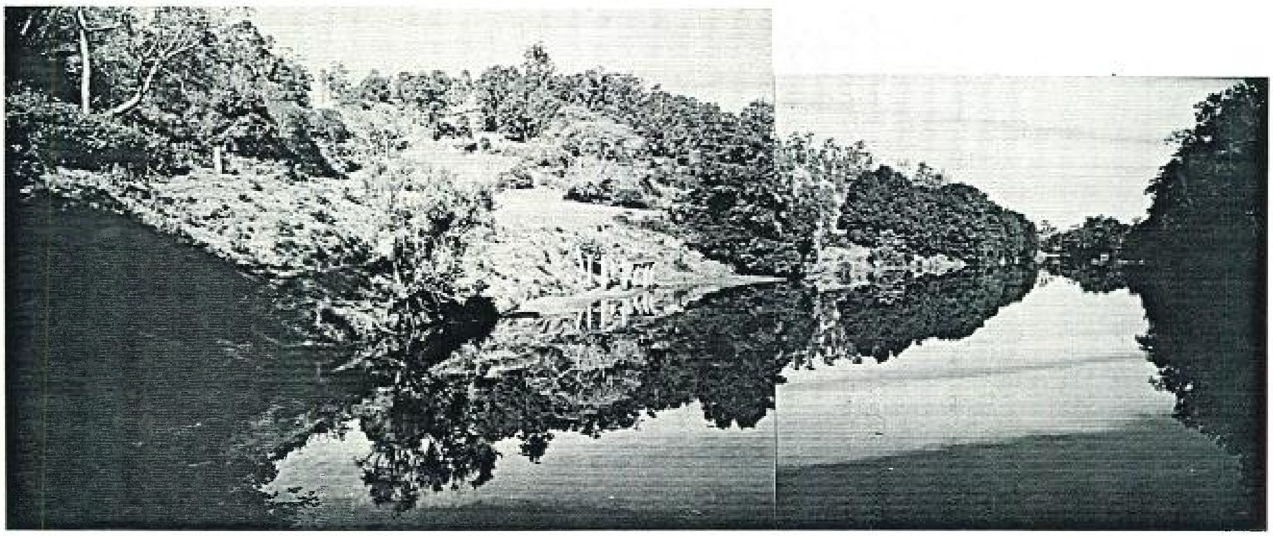
- retention of existing vegetation and particularly native forest as far as practicable;
- maximum gradients of 2:1 (2 horizontal to 1 vertical) for fill embankments and cut batters except in hard rock;
- landscaping and stabilisation of all earth batters and fill embankments;
- planting of species endemic to the local area to maintain vegetation that is both compatible visually with the existing landscape and does not introduce new or invasive species;

a. Views from the existing pumping station of residences on Koree Island

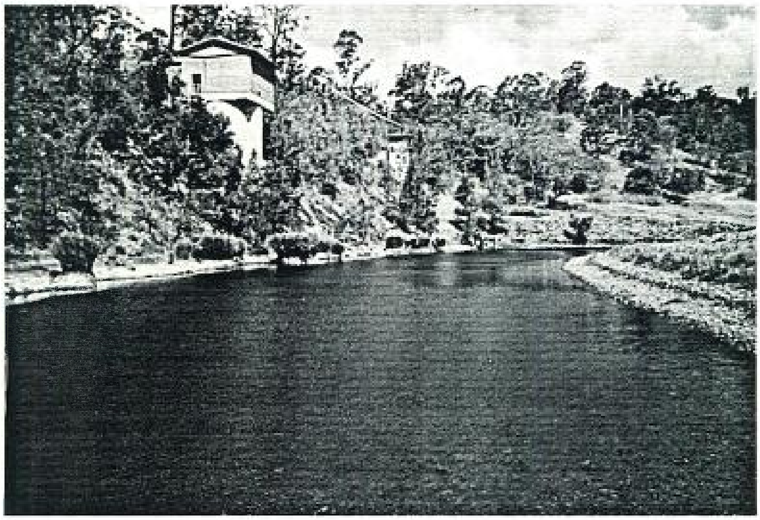


b. Views from Ridgeline at existing pumping station of residences in Koree Island

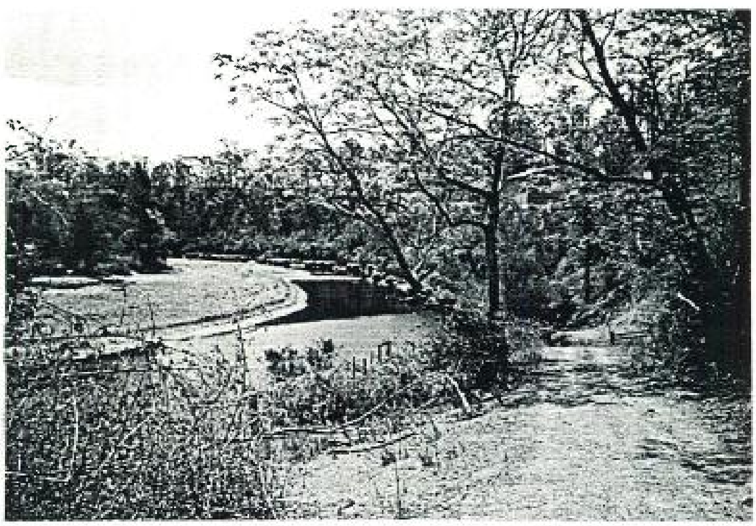
Figure 6.6
Views to Residences on Koree Island



a. Picturesque views along Hastings River at the point of the proposed pumping station



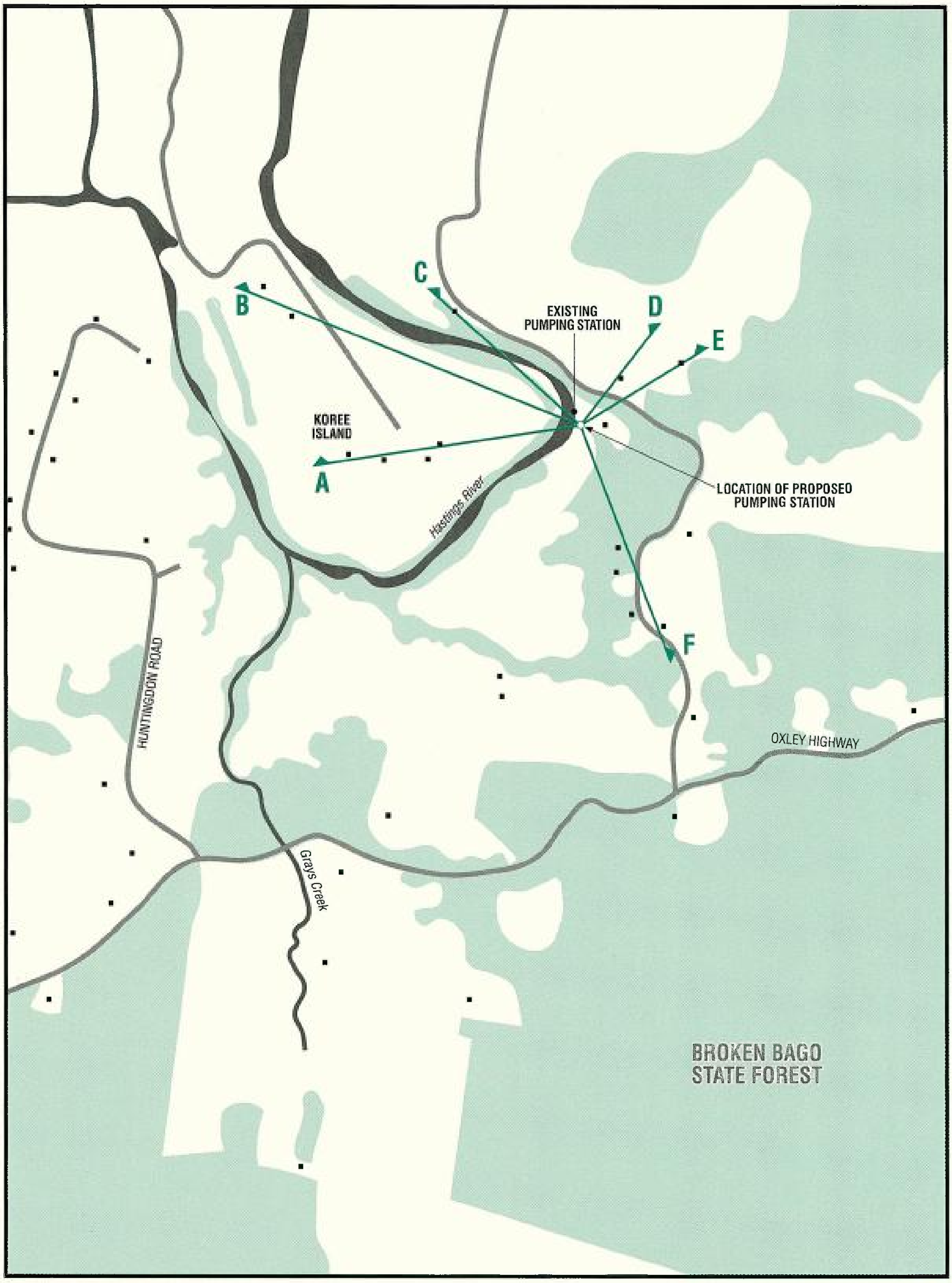
b. Views from the River are disturbed by the existing pumping station and associated structures



c. Access track to proposed pumping station

Figure 6.7
Views from Hastings River of existing environment

Figure 6.8
Artists Impression of the Proposed Pump Station



Sight lines

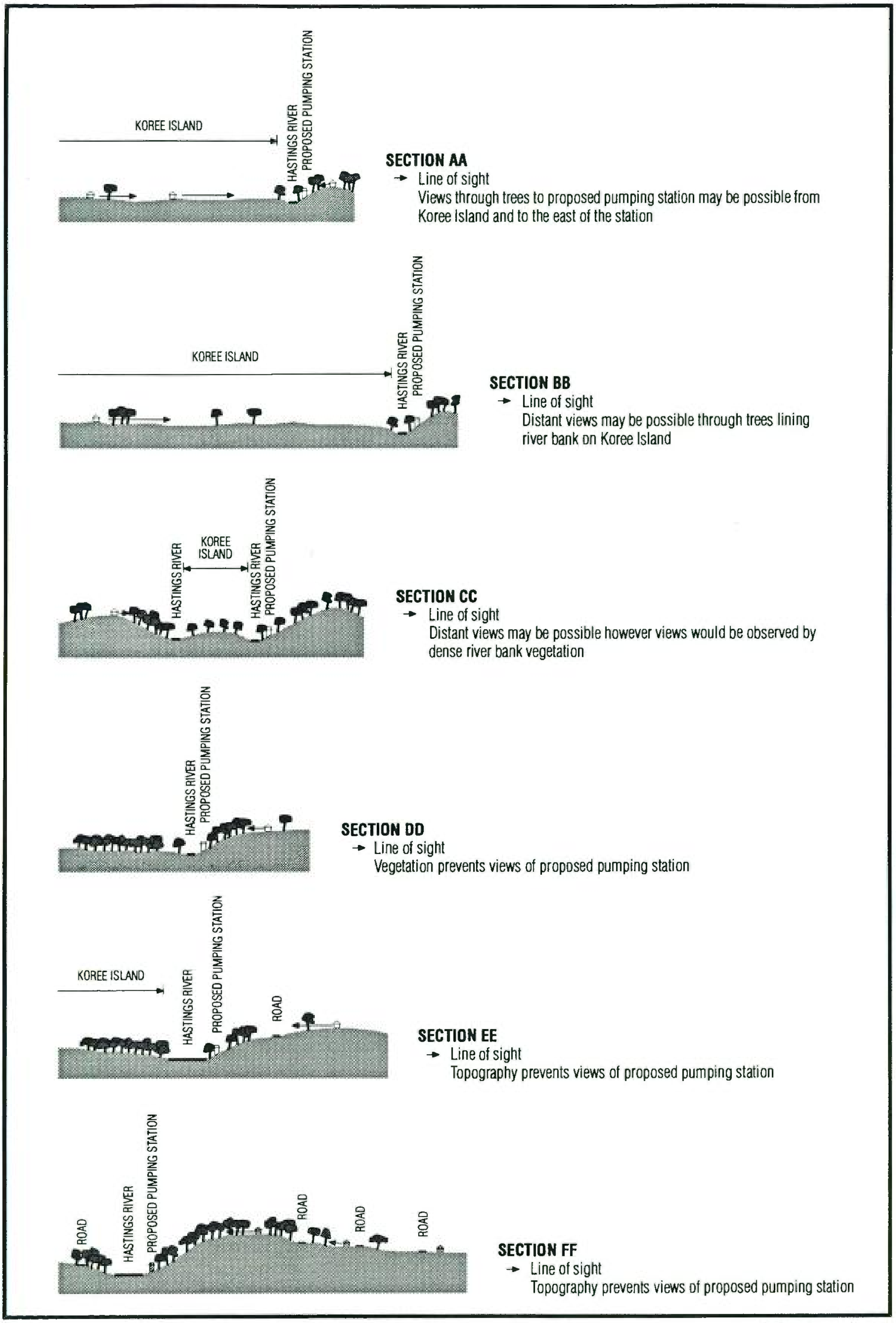
Residences

Extent of forestry/Vegetation cover

Figure 6.9
Visual Assessment:
Plan of Sight Lines

N

0 0.5 1.0
Km



House
Proposed Pumping Station

Figure 6.10
Visual Assessment:
Cross Sections of Sight Lines

Scale: Vertical 1:10 000 (0 – 0.25 – 0.5 Km)

Horizontial 1:25 000 (0 – 0.5 – 1.0 Km)

- non-endemic species (e.g. sterile cover crops) may be used for specific earth stabilisation where there is no danger of invasion into natural areas;
- planting of strategic points to screen direct lines of sight from residences and from river users to the proposal.

The concept landscape plan is shown in Figure 6.11.

6.2.8 Noise

The existing ambient noise levels are controlled by natural elements including river flow, wind, birds and animals, as well as occasional farm machinery. Background noise levels would be similar to those measured in Section 5.2.5. The humming of the operation of the pumps at the two existing pump stations is not audible outside the immediate study area.

The intake works is remote from noise sensitive premises. The nearest residence is located off Rosewood Road, 500m to the south-east above the steeply rising river banks. The "Montrose" homestead is located 850m to the west on Koree Island.

The construction of the intake works is described in Section 6.1.6. Construction would take place between the hours of 7.00am and 5.00pm, Monday to Friday and 7.00am to 3.00pm Saturdays. Material transportation would take place during the same hours. Construction noise would be transient and intermittent over the construction period.

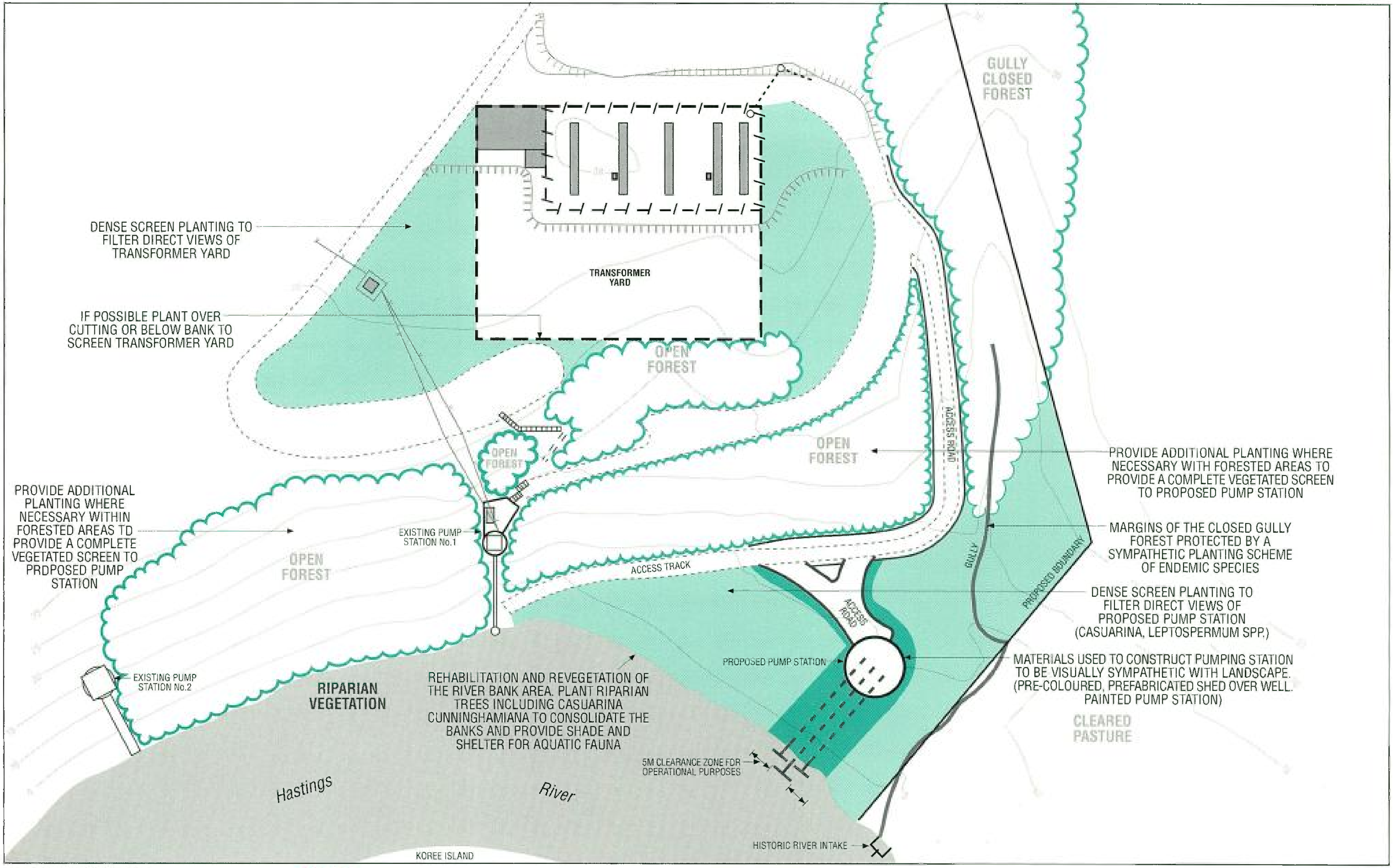
The period of greatest noise would occur during the excavation of hard rock for the pump well. During a three to four week period drill rigs and rock breakers would operate. The option of blasting would be investigated if vibration can be kept within the relevant EPA tolerances with respect to surrounding residences and the existing pump stations. Residents within 1km would be notified of the operation of noise generating equipment or blasting.

Although probably audible at the nearest noise sensitive premises, the construction work is unlikely to exceed EPA criteria (20dB(A) above background) during the excavation period. Over 500m and 850m, construction noise can be expected to be attenuated (from 1m) by 54dB to 58dB respectively.

During the operational stages plant and equipment would be installed not to increase the existing noise environment. The pump would not be audible at the identified noise sensitive premises.

6.2.9 Traffic and Access

The intake works is currently accessed via Rosewood Road, a two lane sealed road signposted at 80kph. Rosewood Road intersects with the Oxley Highway west of Wauchope. Existing traffic on Rosewood Road would be less than 500 vehicles per day while the Oxley Highway carries around 5,000 AADT (Annual Average



Note: Plan is symbolic only.
Individual trees are not shown.

- Existing vegetation to be retained. Provide protection during construction phase.
- Plant cover crop of sterile grasses and native shrubs to stablise slope and screen proposed pump station and access road from river.
- Landscape with endemic species where ever possible (ie. where hard rock does not occur).

Figure 6.11
Concept Landscape Plan

N

0 10 20
Metres

Daily Traffic) (RTA, 1990). This traffic includes heavy haulage vehicles operating from the nearby Rosewood Road basalt quarry.

The operational stage is likely to generate minimal traffic of between 1 and 5 trips per week. During the construction period the project would be likely to generate up to 30 vehicles per day during peaks in construction progress. Heavy vehicles including semi-trailers, low loaders and tippers, would access the site during the construction stage. Heavy vehicles are estimated to form approximately 10% of the construction traffic volumes.

Given the low traffic volumes and a sight distance in excess of 100m at the intersection to the site, it is considered that construction traffic would not cause a traffic safety or road capacity problem.

6.2.10 Planning and Land Use

The proposed pumping station and ancillary work would be sited on land vested in the Minister for Land and Water Conservation and on a portion of an adjoining private property (0.18 ha) which is proposed to be acquired by Council.

The Department of Public Works and Services site (Lot 1, DP 602961) occupies 3.57 ha and has sufficient vacant land to accommodate the ancillary works. It is currently zoned 5(a) Water Supply under the Hastings LEP 1987 which is consistent with the proposed intensification of the current use which includes the two existing pumping stations.

Part of the adjoining privately owned site (Lot 2, DP 602961) is required for construction of the pumping station and intake works. It is currently zoned 1(a1) Rural under Hastings LEP 1987 and utility installations are permitted on the site with Council's consent. The area required is about 0.18ha and is partially cleared and pasture improved for grazing. Part of the area is subject to periodic inundation. This portion would be rezoned following Council acquisition. The sterilisation of a small area of grazing land is considered insignificant with regard to the regional extent of this resource.

6.2.11 Property Impacts

There would be limited property impacts associated with construction of the pumping station and ancillary works.

Lot 2 in DP 602961 is partially required for construction of the intake works and pumping station. This would necessitate acquisition of about 0.18ha of private land with a resultant loss to the owners of about 50 metres frontage to the river. Although the land is reasonably suitable for grazing, the loss only amounts to about 2% of the overall property (currently 10.47ha) and is unlikely to affect the agricultural viability of the remaining land parcel.

The rural residential subdivision potential of Lot 2 is also unlikely to be affected by the proposed land acquisition. Under Hastings LEP 1987, Clause 15 requires

Rural 1(a1) lands to have a minimum area of 30 hectares for Council to consider subdivision. Under this clause the site must also be able to yield a minimum of seven lots with an average area of 4 hectares.

6.2.12 Socio-Economic Impacts

The socio-economic impacts of the proposed intake works and pumping station are integral to the impacts associated with augmenting the overall water supply scheme. Section 5 of the EIS covers the wider socio-economic impacts of the proposal. The socio-economic impacts that are specific to the intake and pumping station works relate to land acquisition and this has been addressed by Sections 6.2.10 and 6.2.11. An agreed level of compensation would be paid to the owners of Lot 2 for part acquisition of that lot, subject to the terms of the Land Acquisition (Just Terms Compensation) Act, 1991.

6.2.13 Riparian Users

The term 'riparian user' relates to use of the river by landowners who front the River. According to common law, downstream river users on the Hastings River would not suffer loss of river use as a result of the Proposal.

There are 8 irrigation licences held by landowners downstream of the Koree Island offtake. In addition, numerous freehold landowners are able to draw water from the River for domestic use without a licence. The actual riparian usage is unknown, although in 1990, the Department of Water Resources (DWR) estimated that 1 ML of water per day would be sufficient to satisfy riparian requirements (Binnie and Partners, 1990).

The DWR would require that minimum environmental river flows are maintained as part of the Proposal's water abstraction licence arrangements. The concept of environmental flow incorporates riparian user rights and includes an additional allowance for minimum flows required to sustain the river environment.

Section 3 of the EIS addresses environmental flows in detail. However, in summary, the dam has been sized to ensure that environmental flows are maintained and that riparian user rights are not affected.

6.2.14 Energy Statement

The proposed works would consume energy during construction and throughout the operational life of the facility.

Construction

The proposed works are relatively minor compared to construction of the dam and pipelines. Approximately 1000 cubic metres of earthworks are involved in constructing the intake works, electricity substation and minor access roads. Earthmoving machinery such as excavators, bulldozers and trucks are most commonly powered by diesel and each cubic metre of earthworks consumes an average of 1.15 litres of diesel fuel resulting in the consumption of around 1,150 litres of diesel.

Deliveries of concrete, pipes, machinery and components would also consume a relatively small amount of fuel. In addition, off-site manufacturing of components would consume electricity in minor quantities relative to the pumping operations throughout the life of the project.

Operation

Public Works prepared a draft Concept Design Report for "Hastings District Water Supply Augmentation Intake Works and Pump Station at Koree Island". The report considered alternate options for electrical supply and pumps (NSW Public Works, January 1995) and concluded that the following electrical components would be best suited to the needs of the project:

- 33kV electricity supply and transformer
- 10t capacity electrically operated crane.

Other types of drives such as diesel and petrol engines, were not considered appropriate because of their high maintenance and running costs, noise and unfavourable environmental aspects.

Annual electricity consumption is anticipated to increase over the life of the project as water demands increase and the pumps are required to operate more frequently. For Stage 1 of the project, electrical charges could vary from $135,000 to $555,000. North Power is able to supply the pumping stations full electrical requirements at a "Time of Use High Voltage Demand Tariff" (currently $11.57 per kVa). Stage 2 pumping electricity demands are unable to be accurately estimated at this stage of the project. However, it is anticipated that it would be in the order of $750,000 in today's terms and at today's rate of $11.57 per kVa.

The amount of electrical energy that would be consumed at full operation of all pumps is a minor component of North Power's current supply commitments and would not be likely to require any augmentation of that supply.

6.2.15 Aboriginal Archaeology

The construction of the intake works would occur over an area of less than 0.3ha of mostly cleared and grazed river bank land. The area to be excavated on undisturbed land is steeply sloping gully sides.

A reconnaissance survey of the pump well site did not indicate any items of Aboriginal archaeology significance. However dense pasture grass growth hindered in the search. No items of Aboriginal significance have been recorded in the vicinity of the study area. However, Koree Island on the opposite bank is believed to have been used by Aborigines as a camp site since European settlement (pers. comm. J Collins, 1995).

6.2.16 Non-Indigenous Heritage

No heritage sites are recorded in the study area that are listed in Hastings LEP 1987 Schedule of Items of Environmental Heritage Significance. A former cast iron water intake pipe which predates the 1954 pump station is located immediately upstream of the proposal (refer Figure 6.1). Although not listed, this relic represents an aspect of the former water supply system for the district and would be protected from disturbance during construction by temporary protective safety fencing.

6.2.17 Hazard and Risk Assessment

The intake works, pumping station and electrical supply would present little if any hazard or risk if constructed as proposed. The following safeguards would be implemented as part of the proposal:

- Johnson type filters over the river intakes to prevent floating objects entering the pipes;
- security fencing around all electrical components;
- site access restricted to authorised personnel;
- no chemical or fuel storage on site; and
- construction methods designed to withstand 1:100 year flood levels.

6.2.18 Current Ecological Issues

The potential effects of climate change and the greenhouse effect are discussed in Section 5.2.20.

Climate Changes and Greenhouse Effect

In recent years there has been increasing concern over warming of the earth's atmosphere due to the raised level of certain gases, which in turn increase the capacity of the atmosphere to retain incoming solar energy. Some experts contend that the consequences of global temperature rise as a result of an enhanced greenhouse effect, include:

- rising sea levels resulting from melting polar ice and reduced ocean water density;
- changes in rainfall patterns, impacting on established infrastructure and land use particles.

Predictions for Australia made by CSIRO at the Greenhouse 87 Conference can be summarised as follows:

- average temperature to rise 2° to 4°C with a greater increase for higher latitudes;

- rainfall to increase 20-30% in the summer rainfall regions and decrease 10-20% in the winter rainfall regions;

- sea levels to rise 200 to 1400mm; and

- tropical cyclones to occur 200-400km further south.

The greenhouse gases include carbon dioxide, methane, nitrous oxide and chlorofluorocarbons.

The proposed works require some minor clearing of the site, resulting in loss of vegetation which has some capacity to absorb carbon dioxide through photosynthesis. The impact would be minor.

The construction works would result in some vehicle and plant emissions into the atmosphere. Vehicle emissions (carbon dioxide) are a major contributor to greenhouse gases in the atmosphere, although in this case the impacts would be minor. Steps can be taken by the contractor to minimise emissions as outlined in Section 5.2.4.

The top of the pump well has been designed with a 0.5 metre freeboard over current 1:100 year flood levels. However, it is possible that if expert predictions are realised, heavy rainfall events could occur more frequently. This could have some impact on the operation of the pumping station if it caused river levels to rise significantly above the current 1:100 year flood levels. However, the full effects of global warming are unlikely during the operational lifetime of the pumping station.

The potential for a greenhouse induced sea level rise of up to 1400mm would not be likely to effect the flow of freshwater at Koree Island nor is such a rise anticipated are over the life of the project. Although the tidal limit is located only 1.6km downstream, two riffles separate the intake works from the existing tidal limit, while the upstream extent of the saline wedge is located several kilometres further downstream.

6.2.19 Ecologically Sustainable Development Principles

<u>Inter-generational Equity</u>

Inter-generational equity relates to the idea of fairness or justice between different generations (EPA, 1993). According to Schedule 2 of the EPA Regulations 1994 (as amended), "the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations". Issues of equity arise in respect to the long term management of water resources.

Water Resources

The project would not directly adversely affect the water resources of future generations. Water in the Hastings River is essentially a renewable rainwater resource unless, for some reason, it becomes polluted or made unusable. This could occur as a result of pollution caused by increased agricultural or urban runoff as a result of urban growth facilitated by provision of a secure water supply. However, the intake works would not necessarily compromise the water supply and the decision to maintain the existing quality of supply rests with the present and future generations.

6.2.20 Cumulative Impacts

Construction and operation of the proposed pumping station and ancillary works would in itself have minimal cumulative impact. However, it is an integral part of the overall augmentation proposal which has potential to generate considerable cumulative impacts. These impacts are also addressed in Section 5.2.22 of the EIS and the Review of Environmental Factors (Binnie & Partners, 1991c) prepared for the entire scheme.

The minor cumulative impacts that result from the pumping station in isolation include negligible loss of agricultural land and reduced availability of water resources for alternate users (refer Section 6.2.12).

A significant cumulative impact of the proposal relates to the visual intrusion of an additional pump station. This aspect of the project is addressed in Section 6.2.7 of the EIS.

7.0

Australian Bass

7.0 ROSEWOOD TO COWARRA DAM GRAVITY MAIN

7.1 Project Description

This section addresses the predicted need for an additional pipeline to supply water from the Hastings River to Cowarra Dam in Stage 4 of the augmentation scheme. By the year 2011 demand on water from Cowarra Dam would occasionally exceed the capacity of headworks, including the existing Stage 1 gravity main. The proposed pipeline would maintain sufficient flow between Rosewood Road reservoir and Cowarra Dam during favourable conditions for water abstraction from the Hastings River.

This section includes an evaluation of alternative pipeline corridors and assessment of their key impacts. The impact assessment will be reviewed at the time of implementation to take into account altered environment, changed land use and new technology. The assessment in Section 7.0 identifies a suitable pipeline corridor within which Council may declare an easement to ensure that future land uses do not compromise the installation of the pipeline.

7.1.1 Pipeline and Corridor Description

A 911mm Internal Diameter (ID) Mild Steel Cement Lined (MSCL) pipeline is proposed to run underground for approximately 10km between the augmented Rosewood Reservoir and the inlet to Cowarra Dam. The pipeline would be gravity fed and have a maximum capacity of 125 ML/d. The pipeline would augment a Stage 1 pipeline to supply water to Cowarra Dam from the Hastings River via Koree Island intake works and the Rosewood Road Reservoir.

The pipeline would have a source water level of 100.6m (maximum) to 96.0m (minimum) HGL at Rosewood Road Reservoir, and delivery water level of 57.6m (maximum) to 21.0m (minimum) HGL at Cowarra Dam. A head loss of approximately 4.3m/km is anticipated. The supply of water from Koree Island to Rosewood Road Reservoir is described in Section 6.1, while the dam inlet at Cowarra Dam is addressed in Section 5.1.

The pipeline would be located on the most direct feasible corridor between Rosewood and Cowarra Dam that meets the planning and environmental criteria put forward in the constraints analysis. The approximate alignment of the corridor is shown on a regional map (Figure 1.1). A schematic layout of the pipeline in relation to the entire augmentation scheme is shown in Figure 1.3.

7.1.2 Project Need and Justification

By Stage 4 (2011) of the augmentation scheme, water demand from the Southern Arm Distribution network via Cowarra Dam would begin to exceed the capacity of the headworks supplying the dam. Kinhill (1994) have identified that the capacity of the Stage 1 gravity main between the augmented Rosewood Road Reservoir (10 ML) and Cowarra Dam would be insufficient.

Kinhill (1994) predict total peak daily demand for the system to exceed 122 ML/d and 15,200 ML/a by 2011. In particular, the communities to be supplied via Cowarra Dam (Port Macquarie, Sancrox/Thrumster and Southern Arm communities) are predicted to have a peak daily demand of 110 ML/d and an annual demand of 13,880 ML/a by 2011.

The Stage 4 pipeline, with a capacity of 125 ML/d, is proposed to enable Cowarra Dam to maintain sufficient capacity to supply the water needs of Port Macquarie, Sancrox/Thrumster and the Southern Arm communities to their ultimate predicted demand.

The Stage 1 pipeline (12.7km, 717mm ID) was designed with a maximum flow of 57 ML/d sufficient to supply the previously proposed 5,000 ML storage (Binnie & Partners, 1991). During the early construction phase of the Stage 1 pipeline, design parameters for the water storage and intake works were revised primarily to take account of more stringent environmental flow requirements for the Hastings River. The proposed storage (Stage 2) was doubled in capacity to 10,000 ML and as a result, the pump station and pipeline headworks were required to be upsized in order to exploit high flows for a shorter period. As construction of the Stage 1 pipeline had commenced, an additional pipeline was proposed to augment the water supply to the dam. The construction of this pipeline would ensure that Cowarra Dam could meet the ultimate demand requirements of the scheme.

The proposed Stage 4 pipeline (10km) could be constructed on a considerably shorter corridor avoiding construction constraints around Wauchope. This is because the Stage 4 pipeline would not be required to have a dual function. The Stage 1 pipeline (12.7km) also serves to provide additional transfer capacity from Rosewood Road Reservoir to Transit Hill Reservoir in Port Macquarie and runs parallel to existing mains heading east before turning south towards the proposed Cowarra Dam site.

7.1.3 Design Parameters and Construction Methods

The pipeline would be constructed subject to the following parameters. However, as the pipeline would not be constructed for 15 years, some design standards may change:

- the 911mm ID/965mm OD pipe would be placed in a benched trench on the basis of Workcover requirements for trenches greater than 1500mm depth;

- the pipeline would have a minimum cover depth of 750mm (or 900mm in trafficked areas) and would have cover of 150mm to 300mm on either side and a minimum of 150mm beneath. The resulting trench would generally be 1865mm deep. These parameters may vary in soft substrate;

- the pipe would have a bedding of sand or other suitable material upon which excavated trench overburden would be backfilled;

- the pipe would be supported with concrete bulkheads where slopes exceed 1(v):6(h), which would become increasingly closer together with increasing slope such that concrete encasement would become feasible on slopes steeper than 1(v):2(h);

- concrete encasement would also be required for creek and gully crossings to avoid erosion hazards;

- pipes would be joined by welding unless pipes suitable for rubber ring seal connections are selected;

- a 15m to 20m wide easement would be required to access and construct the pipeline;

- scours would be required at low points to enable flushing along the pipeline. These would require erosion protection.

The strategy adopted in the specification and successful tender for the staging of the work would be determined prior to construction. Typically, a pipeline of this length would involve more than one pipe crew. A crew would generally consist of the following plant, equipment and personnel:

- Plant including 1 dozer, 1 grader, 1 or 2 excavators/rock breakers and, 1 side boom/pipelayer, compressors and jack hammers, rock saw and drilling rig (for line drilling) if required, tipper trucks, concrete trucks and pumps as required

- construction compound shed and equipment;

- crew of around 10 pipelayers, foreman, site engineer and occasional form workers, welders and survey team.

Construction progress for each pipelaying crew would generally include the following steps:

- detailed route survey along the acquired pipeline easement;

- placement of erosion and sediment controls along route;

- construction of temporary access roads;

- clearing by dozers/chainsaws of vegetation along a 15m to 20m wide construction easement;

- digging of the trench using excavators, rock breakers and rock saws as required. Topsoil would be stockpiled separately from overburden;

- laying of pipes and bedding followed by compaction and testing, thence respreading of overburden and topsoil;

- rehabilitation, site restoration and planting in consultation with landowners and managers;

- clearing, excavation, pipelaying, filling and restoration should take place sequentially along the pipe route such that the minimum practical length of trench is exposed at any one time;

- pipelaying on steep slopes, creek crossings, railway or road crossings and pipe connections would be undertaken independently of the general pipelaying progress as these works would take longer and would require additional welding, form work and concreting;

- once tested and operational the pipeline easement would require minimal maintenance such as checking on functioning of scour and monitoring potent.

No concept design is available for the pipeline and detailed costing has not been undertaken. A construction cost in the order of $10M to $20M is estimated for a pipeline of around 10km.

7.1.4 Corridor Alternatives

Identification of Corridor Alternatives

Prior to this study, Department of Public Works and Services in consultation with Hastings Council, had identified one corridor for the pipeline which extended directly between Rosewood Road Reservoir and the proposed Cowarra Dam inlet. This corridor option is identified as Option 1 on Figure 7.1 and is 10km in length.

Consultation with State Forests indicated their preference for a corridor which avoided impacting on State Forest activities. As the existing Stage 1 pipeline corridor avoids Broken Bago State Forest and does not create an additional corridor through Cowarra State Forest, this corridor was identified for consideration as Corridor 2 (Figure 7.1). This corridor follows the Oxley Highway for most of its path and passes through the town of Wauchope. Corridor 2 is approximately 12.7km long.

To identifying other possible corridor options, it was just necessary to define the north-south extent of the study area, given that the start and end points of the gravity main are fixed by previous investigations (Kinhill, 1994).

Regional Constraints

The study area is flanked by very steep terrain to the south. The slopes of Broken Bago, which reaches a height of 360m, dominate the landscape of the district and form a range dividing the Hastings and Manning catchments. Investigations of alternative corridors much further south of Option 1, would not be practical on the basis of the topography.

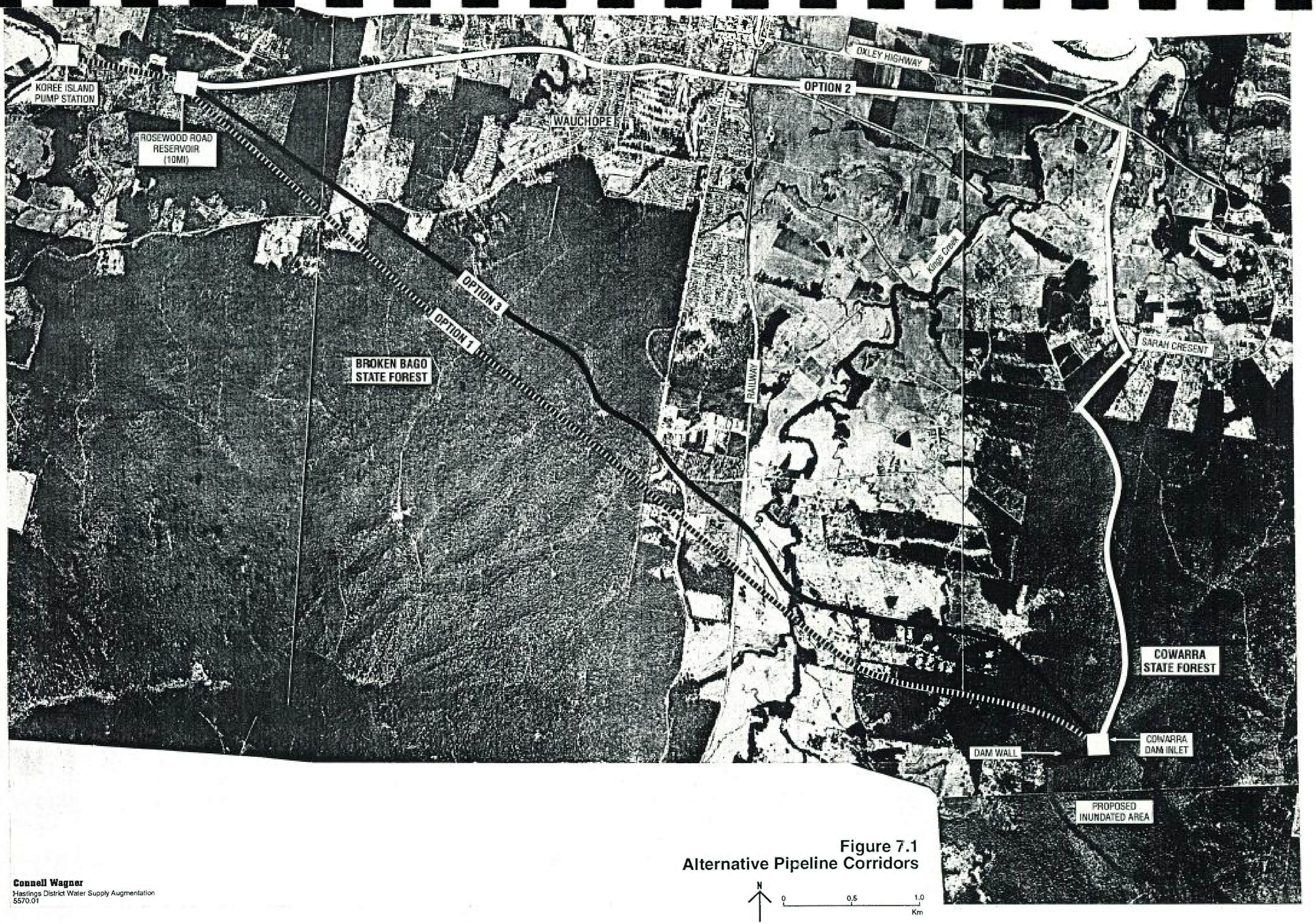


Figure 7.1
Alternative Pipeline Corridors

To the north of the study area the topography of the district becomes gently undulating towards the Hastings River floodplain. While few physical constraints other than the River exist to the north, land use becomes increasingly intensive. High value agricultural land and some flood prone land occur close to the Hastings River. Human constraints such as the alignment of the Oxley Highway and the urban development of Wauchope preclude the investigations of options north of the Oxley Highway other than along existing service corridors.

A further practical consideration in setting the north-south limits of the study area is the basic requirement to achieve a satisfactory economic benefit from the expenditure which would be involved. Previous experience has shown that the high cost associated with indirect routes between nominated end points would prevent much longer corridors from being viable. For example, each additional kilometre would be expected to add more than $1M to the construction cost of the pipeline. As a result of these regional constraints, the study area was defined in Figure 7.2 and 7.3.

Constraints Analysis

A constraints analysis was conducted in order to identify any other potentially suitable pipeline corridor options within the study area. The method used a site reconnaissance and mapping procedure involving overlaying different theme maps representing constraints to pipeline corridor alignment.

A major objective of this assessment was to eliminate or minimise major conflicts and incompatibilities at the earliest stage in formulating further corridors. As such, the actual process was one of identifying alignments through the study area which follow lines of least resistance or conflict.

Given the nature of the study area, the following constraint categories were adopted for mapping:

- Biophysical Constraints: native vegetation, wildlife habitat, hydrologic considerations, steep topography, geology, soils and visual considerations (Figure 7.2);

- Land Use/Planning Constraints: land use, zoning, existing development and services, proposed rural residential development in Kings Creek, transport corridors, archaeological/heritage resources and agricultural land (Figure 7.3).

The composite constraints maps were produced to summarise the key constraints to the alignment of a pipeline corridor. From the constraints analysis it was clear that a corridor alignment similar to Option 1 could be developed that better avoided the range of constraints in the study area. This corridor would exploit existing linear disturbances, and would have a reduced effect on rural residential development in Kings Creek Valley. This corridor was identified as Option 3 and was confirmed as feasible by ground truthing in consultation with the Department

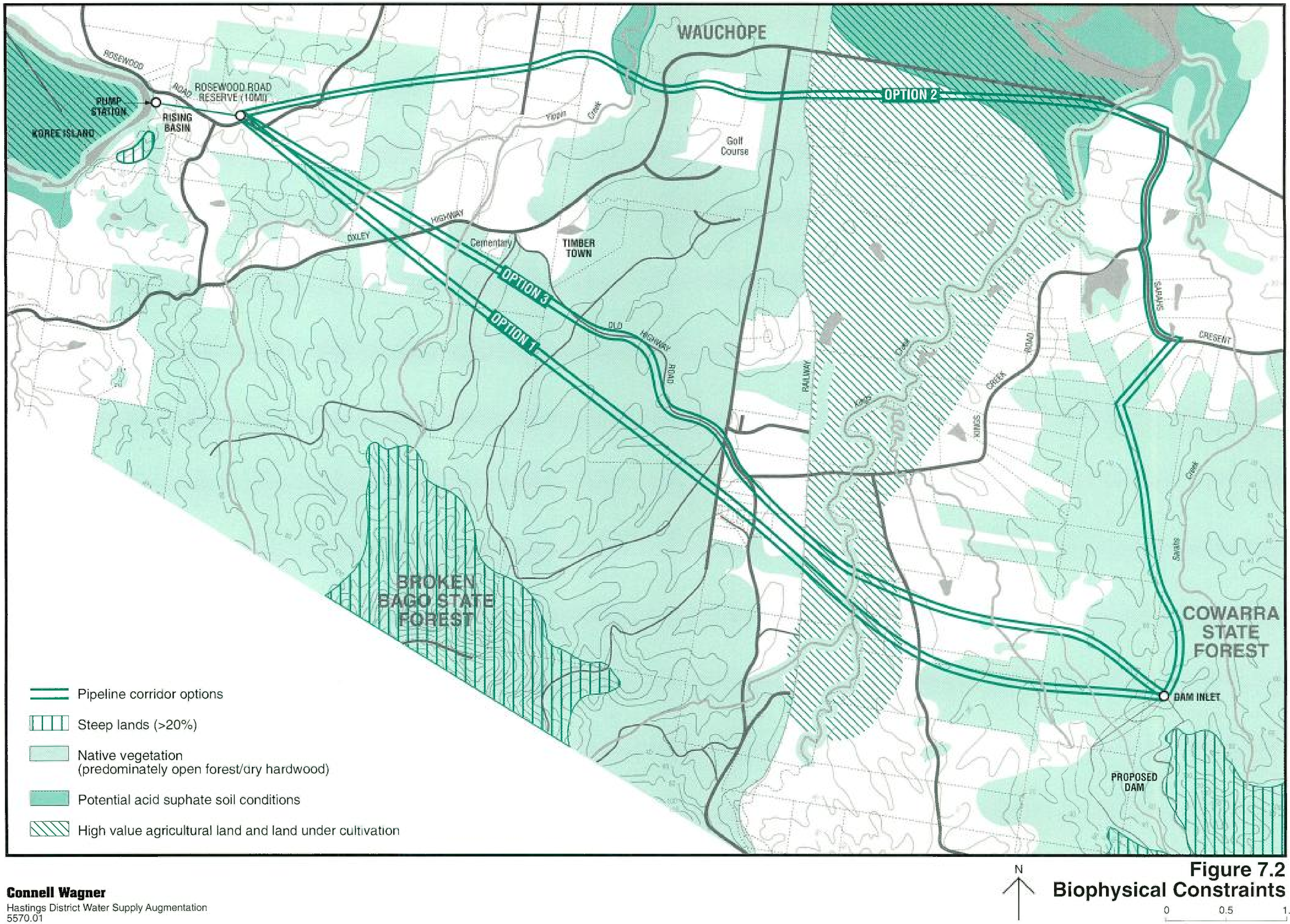


Figure 7.2
Biophysical Constraints

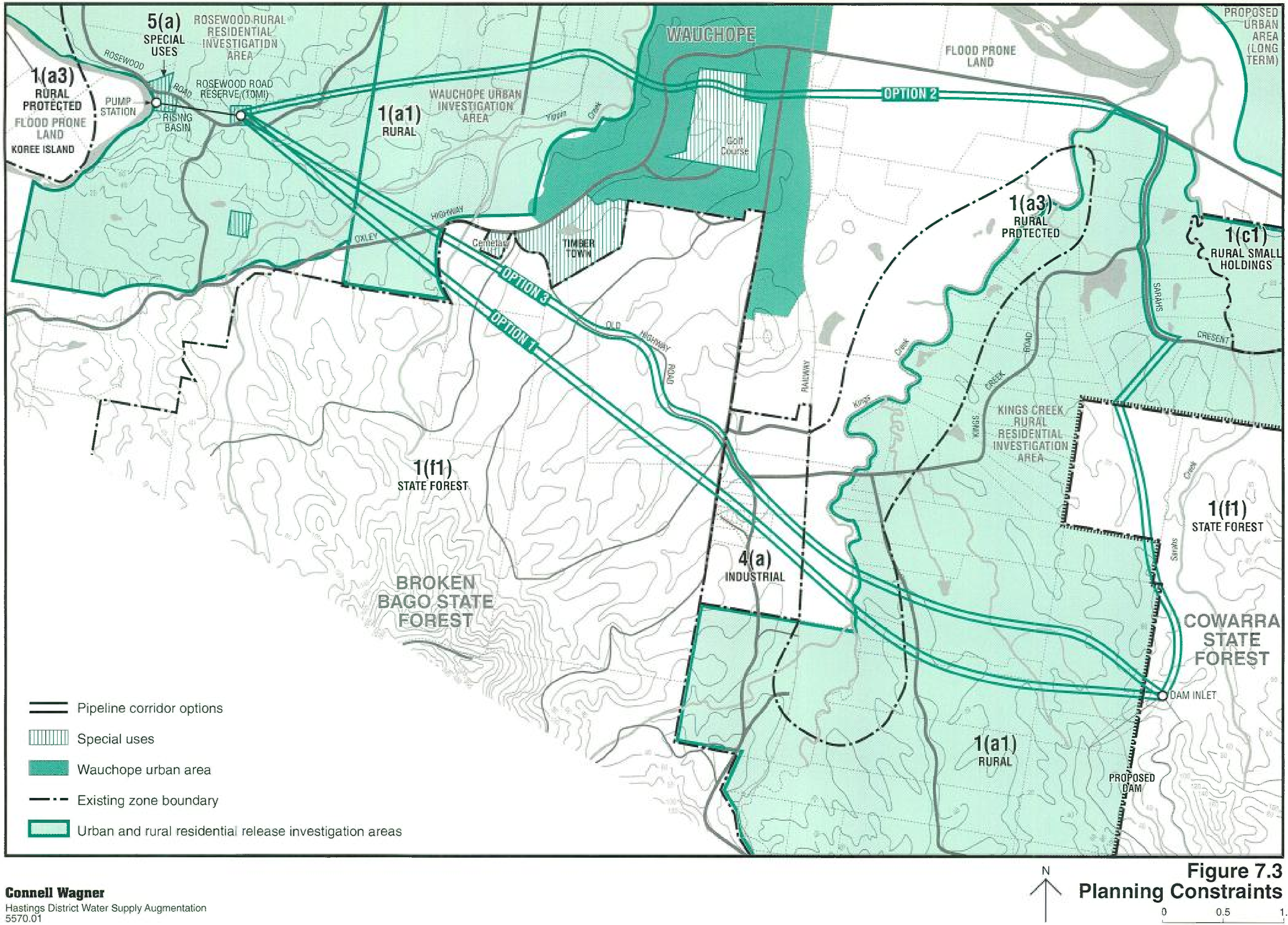


Figure 7.3
Planning Constraints

Connell Wagner
Hastings District Water Supply Augmentation
5570.01

of Public Works and Services. Each of the corridor options are shown on Figures 7.2 and 7.3.

The corridors chosen do not represent the actual route of the pipeline. For the purpose of corridor selection, a 200m wide band has been considered within which it would be feasible to locate the actual pipeline route. Further detailed route investigation and consultation with Council planners with respect to the strategic planning of Kings Creek Valley is necessary prior to the adoption and reservation of a narrower pipeline easement. A 15m to 20m wide construction easement with suitable access arrangements would be required to construct and maintain the gravity main.

Corridor Descriptions

Each of the three corridors was developed to a strategic level of detail sufficient to:

- confirm that the engineering parameters of the pipeline and other physical project requirements can be achieved;
- serve as a basis for relative cost comparisons;
- ascertain the likely extent of land acquisition or affectation; and
- determine the relative environmental impacts of the options (viz. biophysical and social effects).

Option 1 - Southern Corridor

This corridor is the most direct and marginally the shortest corridor at 10.0km in length. All options traverse forested private land before entering Cowarra State Forest. The key features of the route are illustrated in Figures 7.1, 7.2 and 7.3. This option:

- is in common with each corridor, the western 2km traverses cleared rural small holdings and a band of dry sclerophyll woodland north of the Oxley Highway;
- crosses Broken Bago State Forest for 3.5km along a new alignment which would create an additional barrier between the north-eastern corner of the forest and the main body of the State Forest;
- crosses Cameron Street and Kings Creek Road near a light industrial area and traverses small lot rural residential land across the Kings Creek Valley;
- passes within 100m of six residences within 100m in the eastern section of the corridor;

- does not exploit linear features such as roads or service easements in traversing the Kings Creek development investigation area; and

- traverses bushland for 1km in this area.

Option 2 - Northern Corridor

This corridor is the longest route (12.7km). It follows the existing easement for the proposed Stage 1 pipeline, which has a dual role in directly supplying Port Macquarie. This option avoids disturbance of Broken Bago State Forest. Key features of the route include:

- traverse of potential future urban development area to the west of Wauchope;

- difficulty to route the pipeline through residential development and open space in Wauchope without private land acquisition and significant disturbance during construction;

- potential disturbance of likely acid sulphate soils near Hastings River estuary east of Wauchope;

- greater effect on high value agricultural land under cultivation parallel to the Oxley Highway east of Wauchope;

- approximately 60 houses located within 100m of the corridor;

- approximately 9 properties with frontage to Sarahs Crescent affected by access disruption during construction;

- additional disturbance to estuary at pipeline crossing of Kings Creek near its confluence with the Hastings River; and

- widening of the Stage 1 pipeline easement for 2.5km through Cowarra State Forest would accommodate a 15m - 20m wide construction easement. Potential exists to reduce the easement width and extent of clearing along the corridor due to the alignment of the existing pipeline.

Option 3 - Central Corridor

Corridor 3 is a refinement of corridor Option 1 which better exploits existing linear disturbances and avoids, where possible, further isolation of natural habitat and disturbance to development areas. Option 3 is marginally longer than Option 1 at around 10.1km. Other key features of Option 3 include:

- crossing Rosewood rural residential investigation area east of the Reservoir (Figure 7.4a);

- avoidance of cemetery and Timber Town historic village;

- use of the existing alignment of the Old Highway Road through Broken Bago State Forest for 2.5km to avoid further barriers and isolation of native habitat (refer photograph in Figure 7.4b);

- exploiting the alignment of Kings Creek Road in traversing the industrial area south of Wauchope (Figure 7.4c);

- crossing the northern railway at a suitable embankment (Figure 7.4d);

- a single narrow crossing of Kings Creek and temporary disturbance of pasture on the floodplain (figure 7.4e);

- utilising existing property access road rights of way east of Kings Creek (Figure 7.4f);

- minimising disturbance of bushland (1km) on approach to Cowarra Dam;

- proximity to houses between Kings Creek and Cowarra Dam Option 3 would pass within 100m of approximately six existing houses; and

As with Option 1, Option 3 crosses the Kings Creek development investigation area. Further rural residential development can be expected along the eastern portion of the corridor prior to its construction.

7.1.5 Cost Comparison of Corridor Options

No concept design of the alternative corridor options is available to provide a definitive present day value of the cost to construct the pipeline on any corridor. It is assumed that cost would be roughly proportional to length. Options 1 and 3 have a similar length (10km and 10.1km respectively), while Option 2 is approximately 12.7km in length. From experience with similar projects, a typical unit cost for the pipeline would be around $1.5M/km (pers comm. S. Randhawa, 1994).

Other factors affecting cost would include the number and complexity of gully, stream, road and rail crossings. Option 3 would be marginally less complex to construct in this regard due to more gentle topography and better access than Option 1. Option 2 would have significant construction costs associated with bridging Kings Creek at its widest point and costs associated with replacing roads, rail, services and landscaping through suburban Wauchope.

Property acquisition costs would affect Options 1 and 3 to a similar extent, while the widening of the pipeline easement thorough more valuable urban land would penalise Option 2. In addition, the greater length of Option 2 would require a greater land acquisition cost.

In general the costs of acquiring land and constructing the pipeline on corridor Options 1 and 3 would be less than Option 2.

7.2 Planning and Environmental Assessment of Corridor Options

7.2.1 Assessment Factors

Aside from potential cost and engineering feasibility measures, other less tangible costs and benefits also obviously influence the choice of corridor. These include the relative merits of the options in terms of the various environmental, land use, social and local development effects they would have.

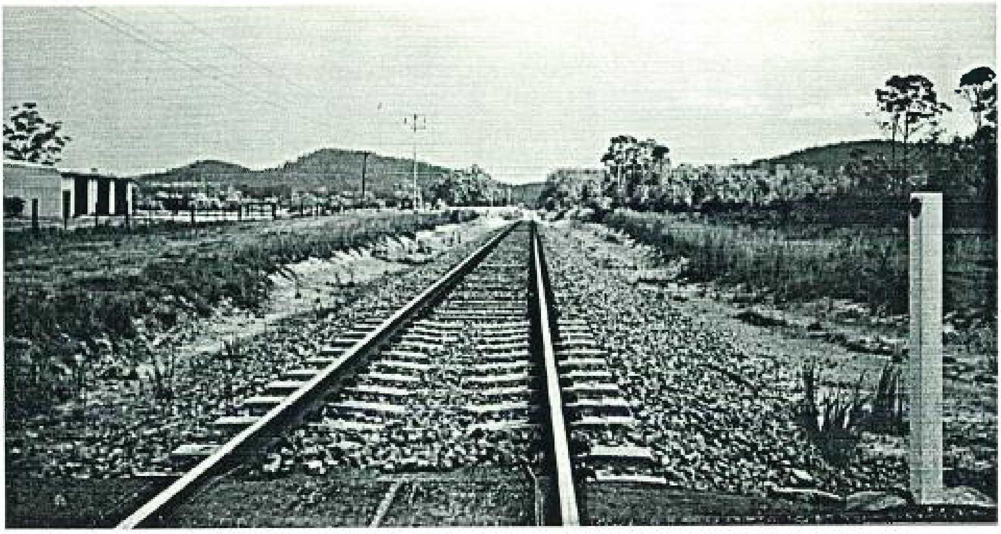
A weighted factor analysis technique was undertaken to compare the options. Details of the technique are provided in this section along with the key findings. A range of factors were developed by the study team in consultation with the DPWS and Council and through the issues raised in consultation and government agency submissions. The following factors, defined in Table 7.1, were used to compare the corridor options.

a. Rosewood rural residential area looking east.

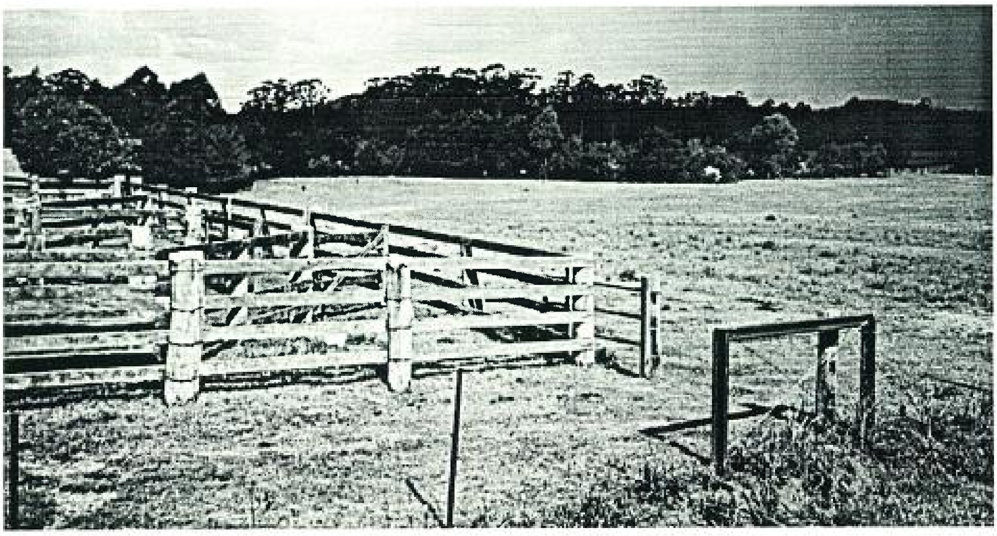
b. Broken Bago State Forest, Old Highway Road.

c. Option 3 would use road reserve to cross Wauchope Industrial Area.

Figure 7.4
Pipeline Corridor Option 3 Western Section



e. Pipeline would cross North Railway at embankment 400m to south.



f. Kings Creek flood plain

g. Pipeline could utilise existing access road easements east of Kings Creek.

Figure 7.4
Pipeline Corridor Option 3 Eastern Section

Table 7.1 : Corridor Assessment Factors and Definitions

Factor	Definition
A. Effect on Flora and Fauna Habitats	Degree to which pipeline construction and easement would adversely affect or reduce the significance of values of the natural environment including: - how well affected communities or ecosystems are represented and protected in the district and elsewhere; - presence and sensitivity of any rare flora and fauna; - importance of links and buffer zones providing connection to other natural areas outside the study area; - extent to which work creates barriers or isolates viable habitat or allows for the introduction of weeds or other disturbances; and - presence of significant ecological associations (i.e. wetland, rain forests).
B. Visual Impacts	The visual impact of the corridor options is based on an assessment of: - the existing landscape quality of landscape units in the study area; - the sensitivity of the landscape to visual change; and - the extent of visual intrusion of the corridor.
C. Impact on Forestry	The extent to which any corridor would reduce the forest productivity or affect the ability to manage native hardwood forests for their timber resources.
D. Impact on Agribusiness	The extent to which any corridor would impact on prime agricultural land (grazing or cultivation) and reduce the productive potential of this land either directly or through affecting the ability to manage the property resources.
E. Property, Land Use and Potential Development	Likely future patterns of development or other land use changes are evident in Council and state planning policies. The Kings Creek area is currently under investigation for increased rural residential development, while the town of Wauchope is also expanding to the west. The selected corridor would preferably cause the least interference or conflict with such plans or proposals. The number of properties and residences and land area affected is a component of the assessment notwithstanding the pipeline being underground. The effect on any property to operate according to its existing uses and realise its potential improvements is also a significant issue.
F. Disruption during Construction	This element considers the extent of disturbance to the community throughout the construction phase. Elements to consider include: - the duration of construction; - temporary road closures; and - nuisance due to dust, noise, visual disruption, driveway blockages, etc.
G. Impact on Soils and Water Quality	The extent to which pipeline construction could promote soil erosion and sedimentation is a concern. Other issues include: - potential for turbidity of waterways; - toxic agricultural chemicals in soil (eg. cattle dip sites) - potential disturbance of acid sulphate soils; and - the extent of work in flood prone areas or areas with erosion hazards such as steep slopes and creek banks
H. Impact on Sites or Items of Heritage, Archaeological or Anthropological Significance	The extent to which any corridor directly or indirectly affects the significance of sites or items of Aboriginal or non-indigenous heritage. A review of items on Council's heritage register and the NPWS register of archaeological sites has been undertaken. In the absence of identified routes which follow already disturbed alignments are assumed to have a lesser impact in regard to this factor.

7.2.2 Weighting of Assessment Factors

Of the 10 assessment factors described in Table 7.1, it is apparent from consultation that some factors should be recognised as being of more importance or relevance than others in determining a preferred option. To account for this, a numeric weighting is applied to reflect the perceived relative importance in the overall score for each option.

The procedure of importance weighting is central to the weighted factor analysis technique of option selection. In this assessment the EIS project team, comprising professionals in the fields of engineering, ecology, community consultation, landscape architecture and environmental planning, prepared individual weightings which were combined to form a team weighting. Table 7.2 presents the results of the assessment factor weightings and shows the ranked order of importance of each assessment factor.

Table 7.2 : Assessment Factor Weightings

Factor	Weighting	Importance Ranking
A. Effect on Flora and Fauna Habitats	29	1
B. Visual Impacts	16	5
C. Impact on Forestry	18	4
D. Impact on Agri-Business	19	3
E. Property, Land Use and Development Potential	19	3
F. Disruption During Construction	12	6
G. Impacts on Soils and Water Quality	19	3
H. Heritage/Archaeology	23	2

From Table 7.2 it is clear that the factors relating to the effects on the natural environment are weighted most highly, while factors such as temporary disruptions during construction and visual effects are regarded as less important.

7.2.3 Rating the Pipeline Corridor Options

The approach adopted for the comparative assessment of the corridor options involves a rating based on the same eight factors defined in Table 7.1. The assessment of the corridor options with respect to each factor is presented in Table 7.3. A simple rating in a range of 1 to 5 is given to each corridor option for each factor. A rating of 5 indicates that a corridor option performs very well in terms of the definitions and performance criteria given in Table 7.1 for each factor, whilst a 1 rating indicates a relatively poor performance by a corridor option.

It is emphasised that comparative assessment seeks to distinguish the relative advantages and disadvantages of the options rather than their absolute performance. As such, a high rating for one or more criteria does not mean the potential impacts on changes are not significant, but rather that the option rates well compared to other corridor options.

Table 7.3: Rating of Pipeline Corridor Options

FACTOR	OPTION 1 (Southern Corridor)	OPTION 2 (Northern Corridor)	OPTION 3 (Central Corridor)
A. EFFECT ON FLORA AND FAUNA HABITAT	• Direct effect of 15m - 20m wide easement on open forest: - east of Rosewood Road Reservoir for 750m (1.5 ha); - Broken Bago State Forest 3500m (7 ha); - between Kings Creek and Cowarra State Forest 1500m (3 ha); and - Cowarra State Forest 100m (0.2 ha). • Crossing of Yippin Creek and Kings Creek (freshwater). • Creation of an additional linear disturbance through Broken Bago State Forest further isolating habitat in the north eastern portion of the State Forest.	• Direct effect of 15m - 20m easement on open forest/swamp forest: - east of Rosewood Road Reservoir for 450m (0.9 ha); - open forest and swamp forest south of Sarahs Crescent for 2500m (5 ha); • Bridge crossing and disturbance of banks of Kings Creek estuary near confluence with the Hastings River. • Crossing of Yippin Creek downstream of the Oxley Highway. • Widening of potential fauna barrier along Stage 1 pipeline and Cowarra Dam access Road.	• Direct effect of 15m - 20m easement on open forest: - east of Rosewood Road Reservoir for 500m (1 ha); - Broken Bago State Forest 300m (6 ha); - between Kings Creek and Cowarra State Forest 900m (1.8 ha); - Cowarra State Forest 100m (0.2 ha); • Crossing of Yippin Creek and Kings Creek (freshwater). • Follows existing linear disturbance (Old Highway Road) through Broken Bago State Forest and avoids further cumulative impact to open forest habitats. • Follows disturbed or cleared land for the majority of the distance between Kings Creek and Cowarra State Forest.
RATING	1	2	3.5
B. VISUAL IMPACT	• Cumulative visual impact of new easement construction through Broken Bago State Forest (3500m), and forest east of Kings Creek. • Visual impact of underground pipe cleared land would be temporary.	• Potential minor visual intrusion of easement through urban Wauchope. • Visual intrusion of aqueduct over Kings Creek estuary. • Visual intrusion of wider clearing of forest south of Sarah's Crescent, however this land has a limited visual catchment. • Visual impact across cleared land temporary.	• Widening of cleared corridor parallel to Old Highway Road through Broken Bago State Forest. • Visual impact across cleared land temporary.
RATING	2	2.5	3

FACTOR	OPTION 1 (Southern Corridor)	OPTION 2 (Northern Corridor)	OPTION 3 (Central Corridor)
C. IMPACT ON FORESTRY	• Direct loss of 7 ha of open forest (dry hardwood) in Broken Bago State Forest. • Creation of new cleared easement with the potential to aid the dispersal of weeds and the creation of new tracks.	• Direct loss of around 5 ha mostly in Cowarra State Forest of mostly open forest (dry hardwood) and some swamp forest along proposed Stage 1 pipeline and access road. • Widening of Stage 1 pipeline and access road easement.	• Direct loss of around 6ha of open forest (dry hardwood) besides the Old Highway Road in Broken Bago State Forest.
RATING	1.5	2.5	2
D. IMPACT ON AGRIBUSINESS	• Temporary affect on agricultural land use mostly pasture in King Creek Valley of around 2.0ha. No long term affect.	• Crosses high value agricultural lands including cultivated land parallel to the Oxley Highway east of Wauchope. Temporary affect on 4.0 ha.	• Temporary affect on agricultural land use mostly pasture in King Creek Valley around 2.0 ha. No long term affect.
RATING	4	3.5	4
E. PROPERTY, LAND USE AND DEVELOPMENT POTENTIAL	• Crosses Rosewood Rural Residential Investigation Area (2 ha). • Crosses Kings Creek Rural Residential Investigation Area (4 ha). • Crosses South Wauchope industrial area (1.4 ha).	• Crosses Rosewood Road Residential Investigation Area (3 ha). • Crosses Wauchope (West) urban investigation Area (2 ha) as well as potential conflicts through the township of Wauchope and Golf Course area (3 ha) • Follows frontage of Sarah's Crescent and properties included in the Kings Creek Rural Residential Investigation area (3 ha).	• Crosses Rosewood Rural Residential Investigation Area (2 ha). • Crosses Kings Creek Rural Residential Investigation Area (4 ha). • Crosses South Wauchope industrial area partly parallel to existing road reserves (0.8 ha). • This corridor has greater flexibility to follow undeveloped property boundaries and access easements through Kings Creek Valley.
RATING	3	1	3.5
F. DISRUPTION DURING CONSTRUCTION	• Minor impact generally with localised affects in rural residential areas in Kings Creek Valley (6 residences within 100 m of the corridor centre) and near Rosewood Reservoir.	• Significant nuisance to residents of Wauchope during construction with up to 60 houses within 100m of the corridor centre. More residences would be affected by 2011 following development west of Wauchope and east of Rosewood Road.	• Minor impact generally with localised affects at rural residential areas in Kings Creek Valley (6 residences within 100m of the corridor centre) and near Rosewood Reservoir.

FACTOR	OPTION 1 (Southern Corridor)	OPTION 2 (Northern Corridor)	OPTION 3 (Central Corridor)
	• Temporary disruption at road and rail crossings including: - Oxley Highway - Northern Railway - Cameron Street - Kings Creek Road.	• Disruption to property access during construction along Sarah's Crescent. • Temporary disruption at road and rail crossings including: - Oxley Highway (in Wauchope) - Short Street - Allan Road - Cameron Street - Northern Railway - Kings Creek Road (off Sarah's Crescent)	• Temporary disruption at road and rail crossings including: - Oxley Highway - Northern Railway - Cameron Street - Kings Creek Road
RATING	4	1	4
G. IMPACT ON SOILS AND WATER QUALITY	• Potential erosion and sedimentation hazards occur along the entire route. These would be managed through appropriate soil conservation measures. • creation of a new cleared corridor in Broken Bago State Forest would create an a cumulative risk of soil loss.	• Longest route by 2.7 km, greater potential exposure to soil loss. • Crosses floodplain and is close to Hastings estuary for 1000m in an area with characteristics of soils with a potential acid sulphate condition. • Bridging would disturb creek banks of Kings Creek estuary.	• Potential erosion and sedimentation hazards occur along the entire route. These would be managed through appropriate soil conservation measures.
RATING	3	2.5	3.5
H. HERITAGE/ARCHAEOLOGY	• No items of heritage or aboriginal archaeological significance appearing on Council or NPWS registers occur in any corridor. It is anticipated that a 20m easement could be aligned to avoid any site discovered in the 200m wide corridor. • Option 1 traverses the largest area of uncleared land which has not been surveyed and thus carries the greatest potential for discovery of sites of aboriginal or non-indigenous heritage.	• No items of heritage or aboriginal archaeological significance appearing on Council or NPWS registers occur in any corridor. It is anticipated that a 20m easement could be aligned to avoid any site discovered in the 200m wide corridor.	• No items of heritage or aboriginal archaeological significance appearing on Council or NPWS registers occur in any corridor. It is anticipated that a 20m easement could be aligned to avoid any site discovered in the 200m wide corridor.
RATING	3	4	4

7.2.4 Assessment Findings

Having completed the comparative rating of pipeline corridor options and established the importance weightings for each assessment factor, the total suitability scores were computed. These scores are the sum of the product of the rating and weighting values for each factor as summarised in Table 7.4. The suitability score is an indication of the cumulative outcome for the corridor option with respect to the weighted scores for all factors.

Table 7.4: Suitability Scores

FACTOR	FACTOR WEIGHTING	WEIGHTED RATING SCORES					
		OPTION 1 (Southern)		OPTION 2 (Northern)		OPTION 3 (Central)	
		Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score
A. Effect on Flora and Fauna Habitat	29	1	29	2	58	3.5	101.5
B. Visual Impacts	16	2	32	2.5	40	3	48
C. Impact on Forestry	18	1.5	27	2.5	45	2	36
D. Impact on Agribusiness	19	4	76	3.5	66.5	4	76
E. Property, Landuse and Development Potential	19	3	57	1	19	3.5	66.5
F. Disruption During Construction	12	4	48	1	12	4	48
G. Impacts on Soils and Water Quality	19	3	57	2.5	47.5	3.5	66.5
H. Heritage/Archaeology	23	3	69	4	92	4	92
Suitability Scores			395		380		534.5

From Table 7.4 it is clear that Option 3, the modified direct corridor option has the highest suitability score. There is a clear margin in the suitability score for this option as the margin is at least twice the value of the most heavily weighted factor. This margin is of sufficient size to cover shifts in the suitability score that might result from other reasonable interpretations in the option rating.

Option 3 performs well across the full range of factors, although other options are marginally superior, in several respects (eg. impact on forestry). The use of the existing linear disturbances elevate the overall advantage of the central corridor.

Table 7.4 also indicates that the northern corridor (Option 2) is the least well performed although close in suitability score to Option 1. The northern corridor is disadvantaged by cost and the lack of detailed consideration of local constraints made apparent through the constraints analysis investigation.

7.2.5 Preferred Corridor

Based on the corridor evaluation findings Option 3, the central corridor is concluded to be the most suitable for the location of the easement to contain the underground Stage 4, 911mm ID gravity main between Rosewood Road Reservoir and Cowarra Dam inlet.

7.2.6 Pipeline Route Alignment

The identification and concept design of an appropriate pipeline route alignment would be an iterative process developed during the concept design investigations. The corridor option proposed is capable of fitting a 15m - 20m wide pipeline route within it such that a significant impact of the pipeline would be avoided. A concept design of the actual pipeline route within Corridor Option 3 has not yet been developed.

7.2.7 Environmental Assessment of the Preferred Corridor

The impacts of the proposed underground pipeline have been assessed on a comparative basis in Section 7.2.4. The most important issues with respect to the preferred 200m wide corridor are further addressed below. However, it is noted that impacts could be minimised further by careful location of the pipeline within the wider corridor.

Flora and Fauna Habitat

The Open Forest (dry hardwood) vegetation of Broken Bago State Forest is typical of the open forest of the district described in Section 5.2.6. The understorey has low plant diversity and has been affected by frequent logging and regular control burns as evidenced by extensive Blady Grass (*Imperata cylindrica*) and Bracken (*Pteridium esculentum*) growth.

A reconnaissance survey of the proposed corridor and detailed survey of the Open Forest in Cowarra State Forest did not indicate the occurrence of plant communities or species which are rare or poorly represented in the district or region. No ROTAP species (Briggs and Leigh, 1988) were observed in the corridor or in similar vegetation in the Cowarra Dam study area.

The impact of the proposal on riparian vegetation and habitat at Yippin and King Creeks would be minimised by location of crossings to utilise existing disturbed areas within the corridor.

Based on the local and regional representation of plant communities in the study area the pipeline is not likely to endanger any plant community or species.

The same rare or endangered fauna (Schedule 12 NPW Act) as were considered in the Fauna Impact Statement (FIS) for the dam proposal were addressed with respect to the seven criteria of Section 4A of the EP&A Act. On this basis the environment of endangered fauna was not considered likely to be significantly affected by the pipeline proposal. No rare or endangered fauna would be taken or killed according to the definitions of the NPW Act. Accordingly, no Fauna Impact Statement would be required for the pipeline proposal.

Property, Land Use and Potential Development

The preferred corridor crosses rural residential investigation areas at Rosewood and in the Kings Creek Valley. The existing pattern and density of development within the corridor would enable a 20m pipeline easement to be accommodated without acquisition of any houses and without a significant effect on the ability of existing properties to reach potential future subdivision densities. In this regard it is advisable that an easement is secured during Council's planning investigation phase to ensure that future property and land use conflicts are minimised.

The preferred pipeline corridor crosses four zonings under Hastings Local Environmental Plan (1987). The proposed pipeline falls under the definition of utility installations and would not be prohibited in any zone as outlined below:

- 1(a1) Rural A1 - permitted with consent;
- 1(a3) Rural A3 (Agricultural Protection) - permitted with consent;
- 1(f1) Rural (Forests Zone) - permitted without consent;
- 4(a) General Industrial - permitted with consent.

A Development Application to Council would be required for the pipeline proposal. In addition State Forests would be requested to issue an easement licence.

Soils and Water Quality

The construction of the pipeline has the potential to disturb the terrain and create areas of erosion hazard. Steep slopes and creek crossings typically have the greatest potential hazard.

The crossing of the Kings Creek floodplain also has the potential to disturb any existing soil contaminants. During detailed design, testing would be conducted at 200m intervals along the pipeline route in each soil horizon to determine the potential for acid sulphate soils and agricultural chemicals including persistent organochloride pesticides.

There is sufficient flexibility within the corridor to avoid localised potential problems and avoid a potentially significant effect on the environment and water quality of the local drainage systems.

Mitigation Measures and Environmental Management

The pipeline is proposed for construction by about 2011. The environmental effects of the proposal may alter over this period and hence require review. Two measures are proposed to manage uncertainty. Firstly, the early reservation of an appropriate easement is proposed to avoid land use conflicts. Secondly, the preparation of an Environmental Management Plan (EMP) for the construction and operation of the pipeline would be prepared at the detailed design stage to ensure that the potential impacts of the proposal are minimised or avoided. The EMP would be based on the following principles:

- The width of clearing should be controlled within the minimum practicable pipeline construction easement (15m - 20m);

- Pipeline construction should proceed in tandem with progressive site rehabilitation and revegetation such that prolonged exposure of a disturbed pipe trench is avoided;

- Excavated topsoil and overburden should be stockpiled separately on the upslope side of the trench such that the trench acts as a sediment trap. Appropriate erosion and sedimentation controls should be installed on the downslope side according to the guidelines of the Department of Conservation and Land Management (1993) (Green Book);

- Revegetation of the easement should initially use a sterile cover crop. Cleared material should be respread on previously naturally vegetated sites to promote native plant growth. Revegetation of cleared pasture should be undertaken in consultation with the land owner or manager;

- Responsibility for managing weed growth along the pipeline easement should be allocated to Council in the EMP;

- Specific erosion and sediment control plans should be prepared for each creek crossing and sections of steep slope greater than 1(v):5(h);

- Soil testing for agricultural contaminants and potential acid sulphate soil conditions should be undertaken at 200m intervals at each soil horizon across the Kings Creek floodplain between the railway and Cowarra Dam;

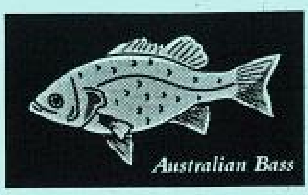
- Any potential contaminants or acid sulphate soil conditions should be left undisturbed and avoided;

- An archaeological survey of the proposed route should be undertaken prior to construction. Identified sites of aboriginal or non-indigenous heritage should be avoided; and

- The implementation of the EMP should be monitored and audited by Hastings Council according to a regime established by the EMP.

8.0

ENVIRONMENTAL MANAGEMENT AND PROPOSED SAFEGUARDS



Australian Bass

8.0 ENVIRONMENTAL MANAGEMENT AND PROPOSED SAFEGUARDS

The Hastings District Water Supply Augmentation will create environmental management responsibilities during the construction and operational phases of the project. The EIS and FIS have identified a range of safeguards to be implemented to mitigate or minimise the predicted negative effects and maximise the positive effects of the proposal. These measures have been identified in Sections 5.2, 6.2 and 7.2 of the EIS and are outlined below.

Detailed design and specification of all environmental safeguards are beyond the scope of the EIS. The purpose of the EIS is to demonstrate the environmental feasibility of the project. Should approval be given for the project to proceed then detailed design of all aspects of the project would take place.

While many safeguards can be guaranteed as conditions of consent and incorporated into the project design, some safeguards require a response to future change and can best be implemented through an Environmental Management Plan (EMP). An EMP sets out environmental objectives and establishes prioritised tasks and responsibilities to ensure appropriate action takes place at the right time to manage a predicted impact.

The specific safeguards and issues to be addressed in the preparation of construction and operational stage Environmental Management Plans are described in concept in Sections 8.1 to 8.3.

8.1 Cowarra Dam

8.1.1 Topography, Geology and Soils

The following measures are proposed to protect the integrity of the dam:

- Grout capping of identified faults and shears is proposed to prevent significant water leakage and maintain embankment stability.
- Areas of potential soil slippage around the perimeter of the inundated area would be investigated for instability and stabilised to prevent land slip following dam site clearing.

8.1.2 Hydrology and Water Quality

Specific soil erosion and sedimentation controls to protect water quality of receiving waters during construction would be incorporated within the EMP as shown in Figure 5.6. The controls would be based on the following criteria:

- minimise the area disturbed at any one time by specific planning of the construction program and confinement of equipment movement to designated areas;

- confine land disturbance to areas to be subsequently filled or submerged, as far as practical. This applies particularly to areas where construction material would be excavated;

- install drainage works prior to land disturbance for access road or dam construction to divert runoff from undisturbed areas into stable drainage lines at non-erosive velocities;

- collect runoff from disturbed areas including tracks and stockpile areas so that it passes through sediment control devices such as silt fences and sedimentation basins. In particular, runoff from the dam construction site would be collected in either the coffer dam or a sediment basin to be constructed immediately downstream of the outlet works. These would be designed and operated in accordance with the requirements of CaLM and EPA;

- the clay borrow area would incorporate a downstream sedimentation basin and sediment fencing around stockpiled overburden. The borrow area would be sequentially cleared and rehabilitated to minimise the extent of exposed earth;

- maximise reuse of contaminated water on site for purposes of compaction and other construction requirements, dust suppression and revegetation;

- treat excess water, if necessary, prior to discharge to ensure that water quality meets EPA requirements;

- maintain sedimentation basins by removing water after storm events during the construction stage to ensure that capacity is available to contain subsequent storm events. Sediment basins would be sufficiently sized to maintain adequate water supply for construction and other purposes without compromising storage capacity during storms;

- maintain vegetation in and adjacent to drainage lines to improve the quality of runoff before entering the stream and to protect the drainage line from erosion Macrophytes such as Typha sp. would be planted in the sedimentation basin below the dam wall;

- ensure that drainage works are stable against erosion, by appropriate selection of channel dimensions, slope and lining, and incorporation if necessary of drop structures and energy dissipaters where appropriate;

- reduce the erosive potential of runoff on disturbed areas including tracks, by installation of banks, bunds or drains along the contour to reduce the distance of overland flow and convey water to stable drainage lines at non-erosive velocity;

- revegetate disturbed areas as soon as practicable;

- ensure that any areas for the storage of oils and other hazardous liquids used during construction are surrounded by a bund to contain any spillage which could then be collected and disposed off site at an approved facility. The design and location of any formal structure would be incorporated as part of the EMP;

- should an on-site concrete batching plant be required, the plan would be designed and operated in accordance with the Department of Planning Guidelines (1991);

- test for the potential for acid sulphate soils prior to excavation and monitor wet basin for changes in acidity during construction ensuring no acidic discharge occurs outside the natural pH range of the receiving waters.

The quality of the water supply would be affected by land management practices in the catchment. The following measures are proposed to be incorporated in the Environmental Management Plan for the dam catchment:

- no forest harvesting or other activities would occur in the catchment after completion of the dam;

- construction sites and access tracks would be rehabilitated and revegetated to avoid the potential for soil erosion from these sources.;

- unauthorised road access and stock encroachment in to the catchment would be restricted by perimeter fencing;

- the rising main between the dam pump station and balance tank would be rehabilitated and revegetated to prevent soil loss; and

- inspection and repair of erosion damage would take place following any dam spillway overflow or unanticipated release of water from the dam to the creek downstream.

Measures proposed by PWD (1990) for the operational EMP to maintain the quality of potable water in the dam include:

- the removal of vegetation from the storage zone to prevent excessive Biological Oxygen Demand and subsequent water deoxygenation;

- gypsum addition to the top layer of soil in the storage zone to reduce soil dispersion;

- installation of chlorination equipment and water aerators to break down stratification;

- on line real time monitoring of water quality of the dam waters and the intake tower at surface and depth.

8.1.3 Hydrology

The earth wall is designed to allow controlled leakage through the filter layer. This leakage would maintain environmental flows in the creek downstream of the dam sufficient for riparian uses. Scouring flows essential to maintaining the downstream environment would be initiated by release of water from the dam outlet valve at a similar frequency to the natural occurrence of high flows. Water released from the dam would be within the ambient dissolved oxygen and temperature range measured in the creek.

The potential impacts of dam overflow from the spillway would be minimised by the establishment of operational guidelines to control dam water levels and pump operations during an extreme rainfall event (refer Section 5.1.6).

8.1.4 Air Quality and Dust

Measures proposed in Section 8.1.2 with respect to soil erosion control would reduce the extent of disturbed areas and the potential for a dust problem. Dust generation would be controlled by watering of disturbed areas as required.

8.1.5 Noise

Construction hours have been specified in Section 5.2.5. Of the nearby noise sensitive premises only one is located within 800m of the construction site. The Graham residence would be significantly affected during the construction period. As the residence would be difficult to protect from noise, alternative accommodation would be made available for the residents during the construction period.

8.1.6 Vegetation and Forestry

Measures to minimise the impact of the proposal on plant communities during and post construction include:

- delineation of areas to be cleared which are required for dam construction;
- clearing pipeline and road construction easements to the minimum extent required;
- rehabilitation of disturbed construction sites using local native species according to a landscape plan;
- sympathetic management of bushland in the catchment by avoiding disposal of weed material from cleared areas in natural bushland and adoption of management principles including control of access, fencing and erosion and sedimentation controls within the EMP.

The acquisition of 205 ha of dry and moist hardwood forest on private land at Pappinbarra Junction for inclusion in Bellangry State Forest is proposed as compensation for the loss of 81ha of mostly dry hardwood forest in Cowarra State Forest. In addition a further 12ha of the land to be acquired is currently cleared and would be revegetated as hardwood forest.

Timber resources within areas to be disturbed would be harvested prior to clearing. Where practicable, other vegetation would be chipped for use in landscaping.

8.1.7 Fauna

The Fauna Impact Statement includes the following safeguards and management measures which are relevant to both the specific Schedule 12 species and the fauna generally:

- the minimisation of habitat removal by clear delineation of areas to be disturbed;

- the implementation of sympathetic catchment management measures with respect to soil erosion and sedimentation control measures;

- revegetation using locally occurring species; and

- management of the downstream aquatic environment by the installation of water quality, erosion and sedimentation controls below the dam wall during the construction period; and

- maintenance of the downstream aquatic habitats below the dam wall by providing scouring flows from the dam outlet valve at intervals equivalent to the natural occurrence of high flows.

8.1.8 Visual Impacts and Landscaping

A concept landscape plan has been prepared to guide rehabilitation of the construction site and further screen the mostly obscured views of the dam wall. The landscaping would make use of materials mulched on site and would use locally occurring native plant species.

8.1.9 Health Issues

Control of health risks from mosquito borne diseases including Ross River Fever is a concern of the project. A key control measure would include the avoidance of the formation of shallow ponded areas as the water level of the dam rises and falls. The topography of the area to be inundated would be altered to ensure that any potential ponds drain into the main water body. The sides of the inundated area are generally steep and offer a limited euphotic zone for emergent plant growth.

It is proposed to consult an entomologist at the detailed design phase to ensure that appropriate measures are incorporated to minimise the health risks.

8.1.10 Aboriginal and Non-indigenous Heritage

Two artefact sites would be inundated by the dam. These sites have been recorded and applications for licences to destroy would be submitted to the National Parks and Wildlife Service. The design and location of the pipelines and balance tank would avoid disturbance to other sites in the catchment.

A representative of the Bunyah Local Aboriginal Land Council is proposed to be present at key stages during dam construction for the possible identification and management of further sites.

There are no reported sites of non-indigenous heritage significance in the dam study area.

8.1.11 Hazard and Risk Management

The preliminary dam break study confirmed that the proposal falls into the high incremental flood hazard category. As a result the design must meet Dam Safety Committee requirements to retain its integrity in both the predicted 1 in 10,000 year Probable Maximum Flow and the 1 in 10,000 year earthquake event.

8.1.12 Property and Land Use

Hastings Council proposes to acquire all land within the catchment as well as land required for the dam wall construction. Acquisition of private land would occur under the provisions of the Land Acquisition (Just Terms Compensation) Act 1991. An agreement for acquisition of a portion of Cowarra State Forest and a land swap involving the purchase of private land for inclusion in Bellangry State Forest has been negotiated between Council and State Forests.

8.1.13 Environmental Management and Monitoring

An Environmental Management Plan (EMP) would be prepared for inclusion in the contract documentation to ensure the implementation of environmental controls at the construction stage. An operational EMP would also be prepared by Council prior to commissioning to guide the management of the catchment and manage the operational impacts of the proposal including water quality in the dam and stream flows below the dam.

To ensure the interest and spirit of the principles and actions in the EMP are complied with by the contractor(s) for the project construction, an environmental specialist would be appointed to oversee its implementation and that specialist would have suitable powers to ensure such compliance.

A monitoring regime would be established under the EMP to monitor compliance with consent conditions and the implementation of the EMP. This would include measurement of water quality, construction noise, vibration and dust generation.

EMP preparation and implementation would involve continued consultation and where necessary, input from relevant authorities such as the EPA, CaLM (Soil Conservation Service), DoPWS, DWR and NPWS.

8.2 Koree Island Intake Works and Pump Station

8.2.1 Erosion, Sedimentation and Water Quality

The prevention of turbidity and sediment infill and pollution of the Hastings River is an objective of the proposal. The control of construction on the river bank would be critical in this regard. An Environmental Management Plan would be prepared for the construction site based on the following components:

- A silt curtain or boom would be placed around the section of bank to be disturbed during intake screen construction to prevent the escape of turbid water. An alternative method would be the construction of a coffer dam around the screens in order to allow foundation work in the dry;

- Excavation and construction work for the intake pipes and well should be isolated from the river. A narrow section of bank should remain intact until required to be removed to enable connections with the screens. This strategy would minimise the time of exposure of disturbed earth to river flows;

- Once constructed, the intake pipe excavation should be sealed from the erosive flows of the river by concrete encasement at least at the immediate river bank;

- Clean runoff from upstream of all disturbed areas including road works, transformer yard, pump well and any stockpiles should be diverted around the disturbed areas to prevent erosion of unconsolidated soil;

- Runoff from already disturbed sites should be collected in sediment basins and either allowed to settle before release, or released during higher turbidity flows in the Hastings River;

- Clearing and stripping of top soil prior to excavation should be delayed to reduce the time of exposure of disturbed earth;

- Sediments to be excavated would be tested for their potential acid sulphate condition prior to construction;

- Any potential acidic material excavated from the river bed or banks should be isolated in separate stockpile with a collecting drainage system leading to a wet basin. Runoff on leachate from these stockpiles should be tested for acidity resulting from potential acid sulphate soil conditions. Any acid runoff or leachate should be treated prior to discharge according to EPA guidelines. Acid spoil should not be used for fill elsewhere on site and should be treated or disposed off-site according to EPA guidelines;

- Silt fences should be erected on the downslope side of any earth batter;

- Revegetation of disturbed sites using cover crops followed by landscape plantings should commence as soon as practicable following early site rehabilitation;

- The minimisation of the construction phase is central to reducing the timing and extent of potential turbidity and other water quality impacts; and

- Any hazardous liquids or other materials should not be stored on the immediate intake site. Elsewhere such liquids should be stored in bunded areas of at least 110% capacity of the largest container. Similarly, machinery should not be repaired or refuelled on the river bank site.

Water quality monitoring of salinity and several key parameters is proposed to establish existing conditions and to provide a baseline for monitoring of the proposal once operative.

- It is recommended that a consistent regime of surface and water column salinity monitoring be undertaken in the upper estuary to monitor the potential for under-estimation of the salinity impacts of the proposal. An appropriate monitoring regime is described in Appendix I.

- It is recommended that Council incorporate the measurement of pH, turbidity, dissolved oxygen, temperature and conductivity in surface and bottom waters into their present data gathering network on a real time basis;

- Key nutrient parameters are also recommended for monitoring as discussed in section 6.2.3. These include Total Phosphorus, Total Nitrogen and Ammonia. The design of the monitoring regime would be sufficient to characterise the nutrient load and determine the potential for aquatic weed growth.

8.2.2 Hydrology and Aquatic Ecology

The proposed pumping regime will influence stream flows in the Hastings River downstream of Koree Island. The maintenance of stream flows during low flow periods and during migration periods is critical to the passage and survival of significant fish species (refer Section 6.2.4). Bishop (1995) has identified critical flows for the survival of Australian Bass which, once confirmed, should be the basis for managing environmental flows:

- 290 ML/d - passage for adult Australian Bass (relevant from April to July inclusive and September and October);

- 250 ML/d - flows to maintain appropriate salinity for aquatic Ribbon Grass and for adult Australian Bass (Males) outside the spawning season (relevant September to June inclusive);

Accordingly, environmental flows would be required to be adjusted up to 290 ML/d when appropriate in April to July inclusive and September and October. In other months the environmental flows would be adjusted up to 250 ML/d where appropriate. The extent to which these flows would be required to be increased above the proposed minimum flow regime is outlined in Tables 13 to 17 of Appendix J and Table 6.6 of the EIS.

Additional research is required to more accurately define the above critical flows due to the low flows experienced during the study period. Follow up monitoring of fish passage at the proposed flow regime would also be required to validate the assumptions made with respect to the relationship between stream habitat and river flows.

The aquatic ecological study also recommends the removal of temporary stream barriers put in place at the upper section of Riffle R2. NSW Fisheries have a responsibility in this regard.

8.2.3 Noise

Construction noise would be transient and intermittent over the construction period. Construction would take place between the hours of 7.00am and 5.00pm, Monday to Friday and 7.00am to 3.00pm Saturdays. Given distances in excess of 500m to the nearest residence, noise monitoring would not be required. Construction noise during the four weeks of peak activity during excavation would be audible but would not exceed EPA guidelines. Residences within 1km of the site would be notified of the operation of noise generating equipment or blasting.

8.2.4 Visual Impacts and Landscaping

A landscape concept plan has been prepared to screen the pump station and recreate a natural riverbank environment near the pump station site (refer Figure 6.10). The key landscape principles include:

- treatment of exposed pump well and crane housing with render or paintwork to reduce their contrast with the natural environment;
- vegetation screening of the pump well using endemic riverbank species such as *Casuarina cunninghamiana*;
- retention of existing vegetation and particularly native forest as far as practicable;
- maximum gradients of 2:1 (2 horizontal to 1 vertical) for fill embankments and cut batters except in hard rock;
- landscaping and stabilisation of all earth batters and fill embankments;

- planting at species endemic to the local area to maintain vegetation that is both compatible visually with the existing landscape and does not introduce new or invasive species;

- non-endemic species (eg. sterile cover crops) may be used for specific earth stabilisation where there is no danger of invasion into natural areas;

- planting of strategic points to screen direct lines of sight from residences and from river users to the proposal.

8.2.5 Riparian Users

The proposed flow regime (refer Section 6.1.7) would reduce the frequency of extremely low flows and protect downstream riparian users.

8.2.6 Property and Land Use

Council would purchase 0.18ha of adjacent pasture land on the riverbank. Acquisition of the land would be negotiated on the basis of market rates and would be subject to the conditions of the Land Acquisition (Just Terms Compensation) Act, 1991.

8.2.7 Environmental Management and Monitoring

Environmental Management Plans for the construction and operational stages of the project would be prepared to ensure the implementation and monitoring of the proposed safeguards. In particular, the allocation of monitoring tasks and responsibilities for pump adjustment will be critical in ensuring that environmental flows are maintained with respect to the critical aquatic fauna.

The arrangement for EMP preparation and monitoring would be as described for the dam in Section 8.1.13.

8.3 Rosewood to Cowarra Dam Gravity Main

The pipeline is proposed for construction by about 2011. The environmental effects of the proposal may alter over this period. As a result two management measures are proposed to manage uncertainty. Firstly, the early reservation of an appropriate easement is proposed to avoid land use conflicts. Secondly, the preparation of an Environmental Management Plan (EMP) for the construction and operation of the pipeline would be prepared at the detailed design stage to ensure that the potential impacts of the proposal are minimised or avoided. The EMP would be based on the following principles:

- The width of clearing should be controlled within the minimum practicable pipeline construction easement (15m - 20m);

- Pipeline construction should proceed in tandem with progressive site rehabilitation and revegetation such that prolonged exposure of a disturbed pipe trench is avoided by the pipeline;

- Excavated topsoil and overburden should be stockpiled separately on the upslope side of the trench such that the trench acts as a sediment trap. Appropriate erosion and sedimentation controls should be installed on the downslope side according to the guidelines of the Department of Conservation and Land Management (1993) (Green Book);

- Revegetation of the easement should initially use a sterile cover crop. Cleared material should be respread on previously naturally vegetated sites to promote native plant growth. Revegetation of cleared pasture should be undertaken in consultation with the land owner or manager;

- Responsibility for managing weed growth along the pipeline easement should be allocated to Council in the EMP;

- Specific erosion and sediment control plans should be prepared for each creek crossing and sections of steep slope greater than 1(v):5(h);

- Soil testing for agricultural contaminants and potential acid sulphate soil conditions should be undertaken at 200m intervals at each soil horizon across the Kings Creek floodplain between the railway and Cowarra Dam;

- Any potential contaminants or acid sulphate soil conditions should be left undisturbed and avoided by the pipeline;

- An archaeological survey of the proposed route should be undertaken prior to construction. Identified sites of aboriginal or non-indigenous heritage should be avoided; and

- The implementation of the EMP should be monitored and audited by Hastings Council according to a regime established by the EMP.

9.0

CONCLUDING STATEMENT

Australian Bass

9.0 CONCLUDING STATEMENT

This Environmental Impact Statement has been prepared on behalf of the Department of Land and Water Conservation and Hastings Council to evaluate the direct environmental effects as well as changes to the river environment of the construction and operation of:

- a 10,000ML water storage dam and associated facilities (Cowarra Dam);
- the Koree Island Intake works and Pump Station on the Hastings River; and
- the Rosewood Road Reservoir to Cowarra Dam Gravity Main.

The proposal is an activity subject to determination by Hastings Council and the other determining authorities under Part V and consent from Hastings Council under Part IV of the Environmental Planning and Assessment Act 1979.

The proposal is designed to achieve a range of water supply and environmental objectives over the design life of the project including:

- the provision of water to meet anticipated increased demands in the foreseeable future (2040) such that water supply does not limit the range of future development scenarios in the district;

- maintenance of water supply during the 1 in 100 year drought;

- be flexible to accommodate changes in the timing and location of development;

- provide drinking water quality of an acceptable standard at all times;

- be environmentally, socially and economically acceptable to the community; and

- incorporate demand management measures as a long term measure to maintain the standard of service.

In meeting these objectives the project would have a range of positive and negative impacts on the natural and socio-economic environment, some of which have influenced the design or management of the project or have recommendations for specific treatment or ongoing management.

Design and ameliorative measures were developed to satisfy the objectives of the project and are outlined in Section 8. A critical feedback of the environmental assessment stage is the need to take account of the critical stream flow requirements of fish in the development of the water abstraction regime from the Hastings River.

The impacts of the resulting proposal are considered acceptable in the context of the project benefits of guaranteeing water supply to the district in the long term.

Deferral or no action on the proposal would result in greater exposure of the population serviced by the water supply system, to more stringent demand management measures. These would include water restrictions during less severe drought and the increasing potential for exhaustion of water supply during severe drought. In these circumstances water supply would remain a constraint to the range of future development scenarios in the district.

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Australian Bass

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