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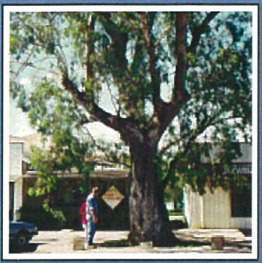

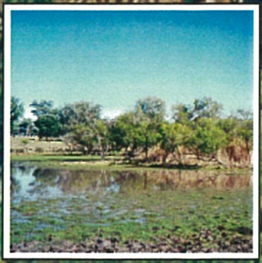

IMPACT ASSESSMENT STUDY FOR PROPOSED DAWSON DAM

HYDROLOGY

REPORT PREPARED FOR HYDER BY:
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Water Studies Pty Ltd

OCTOBER 1997

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1. INTRODUCTION

This report has been prepared for Hyder Environmental Pty Ltd by Water Studies Pty Ltd as part of the Impact
Assessment Study (IAS) for a large Dam on the Dawson River. Full details of the background to the dam proposal and other associated studies are contained in the IAS document (Hyder, 1997).

This study covers the entire Dawson River catchment to its junction with the Mackenzie River, excluding the catchment of the Don River. A locality plan of the study area is shown in Figure 1.1.

The Dawson River system currently supplies water for irrigation, town water supply and extractive industries. These supplies are regulated via a series of 6 weirs built along the river. The yield from the system is estimated to be approximately **60,000 ML/year** at monthly and annual reliabilities of about **93%** and **73%** respectively for the situation with maximum diversions from the system. More realistic assumptions regarding the announced allocation rule and the irrigation planting strategy would probably lower the above reliabilities (see Section 4.5b). The current water use from the system is **significantly less** than 60,000 ML/year.

The demand from the system for irrigation and other uses is much greater than the current yield. To meet the additional water demand, the Department of Natural Resources (DNR) investigated a large number of potential sites for dams and weirs along the Dawson and its many tributaries. On the basis of these investigations, DNR identified a large dam upstream of Nathan Gorge as the preferred solution to meet future water needs in the Dawson Valley. This dam (hereafter referred to as the Nathan Dam), is to be constructed at AMTD **315.3 km**. Two new weirs, namely Paranui and Duaringa at AMTD's **169.7 km** and **30.1 km** respectively are also likely to be constructed to service the additional demand. The investigations and findings of this report have assumed that both these weirs will be constructed.

This study has investigated the performance and hydrological impact of 3 different full supply levels (FSL's) for the proposed Nathan Dam: **180 m AHD, 183.5 m AHD** and **185 m AHD**. These FSL's correspond to storage capacities of **521,000 ML, 880,000 ML** and **1,079,000 ML** respectively. The capacities of the Paranui and Duaringa Weirs were kept fixed at **11,000 ML** and **6,000 ML** respectively.

Reports from a number of detailed support studies undertaken or commissioned by DNR on future water demands, groundwater resources, environmental flow requirements, flooding, catchment yield, etc. were to be made available to Water Studies. Results from daily hydrologic simulation modelling (IQQM modelling) and the investigation of environmental flow requirements undertaken as part of the Fitzroy Basin Water Allocation and Management Planning (WAMP) study, are essential inputs to the present study. The WAMP study, which was to be completed some 12 months ago, is still incomplete. Only preliminary results from the IQQM modelling have been made available to date. No results at all have been made available on environmental flow requirements.

It is noted that Water Studies was not required to undertake any modelling work as part of this hydrological impact assessment study. Rather, Water Studies was to base its findings on a review and evaluation of results of the modelling studies undertaken by DNR on catchment yield, with and without environmental flow requirements. Ideally, the WAMP study should have been completed prior to the commencement of the IAS. In addition, a number of sensitivity checks on future demand distributions, dam operation rules, etc. should have been undertaken as part of this study. However, for reasons given above and time constraints to complete the IAS, **the impact assessment**

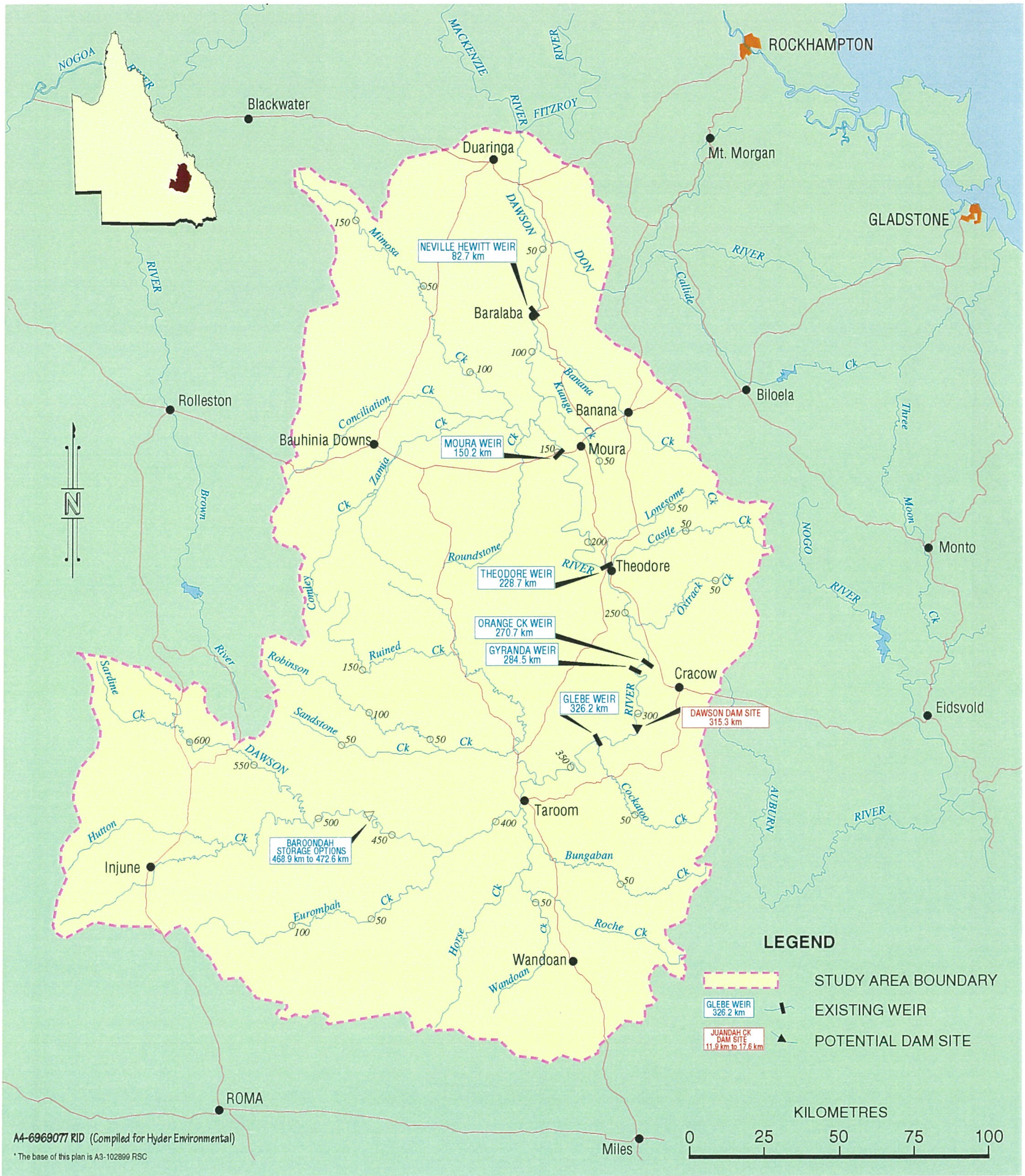
undertaken in this study is necessarily based on preliminary results from the catchment yield studies. Impact of environmental flow requirements on the yield from the Dawson River system has not been assessed in this study.

The initial draft report of this study (1st October 1997) was prepared on the basis of findings from a future irrigation water demand survey undertaken for the Dawson River System (Rolfe & Teghe, 1997). DNR subsequently revised the Rolfe & Teghe (1997) irrigation demand distribution along the Dawson River, apparently on the basis of a number of factors not considered in the original survey. Details of the subsequent DNR investigation are given in Appendix A. The findings of this report are based on DNR's revised demand distribution.

This report is structured as follows:

- Section 2 describes the existing surface and groundwater hydrology of the Dawson River catchment. The existing water quality of surface and groundwater is also described.
- Section 3 describes the current water use and demand in the Dawson River system.
- Section 4 describes the current operation of the Dawson River system.
- Section 5 presents the projected future demand from the system.
- Section 6 evaluates the performance of the proposed Nathan Dam.
- Section 7 discusses the impact of the proposed dam on the existing surface and groundwater hydrology.
- Section 8 contains the broad conclusions to the study.
- Section 9 provides a list of references.
- Appendix A provides the basis for DNR's revision of Rolfe & Teghe's (1997) agricultural water demand distribution along the Dawson River.

FIGURE 1.1



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NATURAL RESOURCES

DAWSON DAM IMPACT ASSESSMENT STUDY
DAWSON RIVER STUDY AREA

LOCALITY PLAN

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2. EXISTING HYDROLOGY

2.1 CATCHMENT DESCRIPTION

The Dawson River is a major tributary of the Fitzroy River. The catchment area of the Dawson River, excluding the Don River catchment, is some **50,830 km^2**. The catchment area of the Fitzroy River is some 139,000 km^2.

The Dawson River catchment is bound by the Carnarvon, Lynd and Expedition Ranges to the west, the Great Dividing Range to the south-west and south, and the Auburn and Banana Ranges to the east. A map of the catchment is shown in Figure 1.1.

Vegetation in the catchment is predominantly woodland scrub and rugged forest, with tussocky grasslands predominantly along the Dawson River and its tributaries (DPI, 1994a). Predominant soil types in the catchment are shallow sands and neutral to acid mottled bleached duplex soils with some areas of shallow loams (QWRC, 1983).

2.2 SURFACE DRAINAGE NETWORK

The surface drainage network of the Dawson River catchment is shown in Figure 1.1. The Dawson River rises in the Great Dividing Range, initially flowing in an easterly direction up to about Taroom. From Taroom the Dawson travels in a northerly direction through Theodore, Moura, Baralaba and Duaringa before joining the Mackenzie River just downstream of Duaringa.

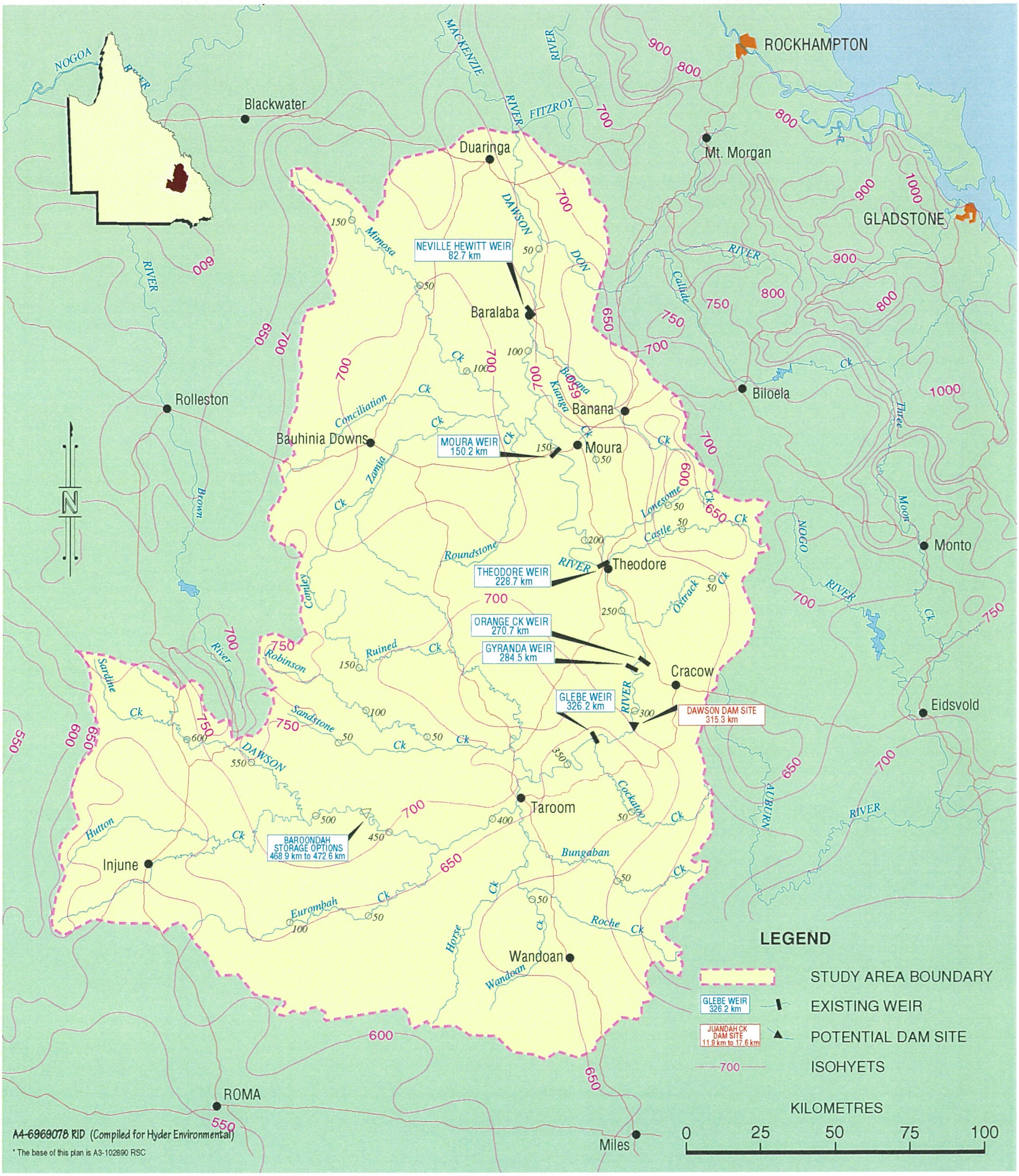
There are a number of significant tributaries discharging into the Dawson River. These include Hutton, Eurombah, Horse, Robertson, Ruined Castle, Cockatoo, Banana and Mimosa Creeks and Don River. The tributaries of the Dawson River are generally characterised by long winding upper and middle reaches due to the low gradients within the catchment. Within the headwaters, some sections of the river system flow through relatively narrow valleys and gorges. There is a gradual broadening of the Dawson River valley to wide alluvial plains as the river approaches the Mackenzie River and around the junction with the Don River.

The Dawson River downstream of Taroom is a regulated system. There are 6 storage weirs along the Dawson River: Glebe, Gyranda, Orange Creek, Theodore, Moura and Neville Hewitt Weirs. The location of these weirs are shown in Figure 1.1. Details on these weirs and their operations are given in Section 4.

2.3 RAINFALL

Figure 2.1 shows isohyets of average annual rainfall in the Dawson River catchment. The average annual rainfall in the catchment varies from about **600 mm to 750 mm** (DPI, 1994a). Rainfall in the catchment is seasonal, with about **52%** of the annual rainfall usually occurring in the 4 month period November to February. Rainfall is lowest during the period June to September.

FIGURE 2.1



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NATURAL RESOURCES

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DAWSON DAM IMPACT ASSESSMENT STUDY
DAWSON RIVER CATCHMENT
AVERAGE ANNUAL RAINFALL ISOHYETS

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2.4 STREAMFLOWS

Streamflows in the Dawson River and some of its tributaries have been recorded since 1910 at a number of gauging stations throughout the catchment. Locations of these gauging stations are shown in Figure 2.2.

Table 2.1 shows a summary of annual streamflow characteristics at 6 key gauging stations along the Dawson River (see Figure 2.2 for locations). Annual discharge volumes progressively increase in a downstream direction from an average of some **118,000 ML/year** at Utopia Downs to **1,127,000 ML/year** at Boolburra. Table 2.1 also indicates that annual discharge volumes are quite variable.

Streamflows in the Dawson River are highly seasonal, with more than **50%** of the average annual flow generally occurring in the three month period January to March. About **75%** of the annual runoff generally occurs during the 6 month period November to April (DPI, 1994a). The driest months are September and October. It is not unusual for the river to cease flowing at times during the dry season May to November.

Table 2-1 Annual Streamflow Discharge Characteristics, Dawson River

Gauging Station		Period of Record	AMTD (km)	Catchment Area (km^2)	Annual Discharge Volume (ML)		
No.	Name				Minimum	Maximum	Average
130 324	Utopia Downs	1966 to Date	453.5	5,955	11,000	627,000	118,000
130 302	Taroom	1911 to Date	384.6	15,720	8,000	3,106,000	392,000
130 303	Glebe	1919 - 1984	330.1	22,935	11,000	3,857,000	504,000
130 305	Theodore	1924 to Date	230.1	27,350	10,000	5,361,000	652,000
130 304	Baralaba	1924 – 1961	84.7	40,225	20,000	6,652,000	1,120,000
130 301	Boolburra	1910 - 1978	16.1	49,290	11,000	6,465,000	1,127,000

2.5 EVAPORATION

Theodore is the only location for which evaporation records are available within the catchment. The records at Theodore (Station No. 039 090), however, are limited to only 11 complete years (1969 – 1979). Table 2.2 summarises average monthly Class A pan evaporation values for Theodore. Average annual pan evaporation is some **2,192 mm**.

Table 2-2 Average Monthly and Annual Pan Evaporation, Theodore

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Evaporation	238	190	214	178	134	103	111	140	173	221	239	251

Source: QWRC, 1983

2.6 GROUNDWATER RESOURCES

Groundwater resources of the Dawson River catchment are described in detail in DPI (1994a). Regional geology and groundwater behaviour near the proposed dam site are described in DNR (1996). Details given below have been obtained from the above reports and additional information supplied by DNR.

There are 5 distinct geological formations/aquifer types in the catchment area: Permian, Triassic, Jurassic, Tertiary and Alluvium. Of these, only Jurassic formations and Alluvium are of interest to this study. The regional groundwater behaviour near the proposed Nathan Dam site is influenced by the geological formations of the Jurassic group. The groundwater resources along the Dawson River itself are located in the alluvial deposits of the river.

2.6.1 *Regional Resources near the Dam Site*

There are 4 major stratigraphic divisions within the Jurassic group, in the proposed Nathan Project area: Birkhead Formation, Eurombah Formation, Hutton Sandstone, and Precipice Sandstone. Each of these formations are briefly described below.

- **Birkhead Formation** is a freshwater sedimentary formation which consists mainly of shales with basal sandy sequence. It contains discontinuous and other extremely localised aquifers in sandstone, shale and thin coal seams with sub-artesian supplies which are generally of poor quality.

- **Eurombah Formation** consists mainly of sandstones, but is erratic in its occurrence in this district and varies in thickness from zero to 30 m. This formation has produced generally small artesian supplies of low pressure.

- **Hutton Sandstone** is an extensive formation which is from 120 m to 180 m thick. This is not a realistic source of groundwater and has been found to be extremely variable in regard to supplies obtained, water quality and supply reliability.

- **Precipice Sandstone** is an extensive quartzose sandstone formation which, on average, is about 90 m thick in the area of interest. Precipice sandstone constitutes a regional confined aquifer with reasonably large flowing and pumping supplies of good quality water. This formation forms the major aquifer system of the area around Nathan Gorge.

Thus, the **Precipice Sandstone forms the major aquifer in the region**. On a regional scale, the flow in the Precipice Sandstone is towards south and south-west. The Dawson River around Nathan Gorge has captured some of these regional discharges, at locations where the aquifer outcrops and becomes unconfined at approximately AMTD 316 km. Starting at this point, for several kilometres downstream, the river acts as a drain on the aquifer. This draws down the groundwater level over a large area.

Measurements of static heads in artesian basins in the Nathan Project area has found minimal variation in aquifer head with time, indicating that the aquifer is in a steady state condition.

FIGURE 2.2

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DAWSON DAM IMPACT ASSESSMENT STUDY

DAWSON RIVER CATCHMENT

LOCATION OF STREAMGAUGING STATIONS

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2.6.2 *Resources along the Dawson River*

The alluvial deposits along the Dawson River can be broken into 3 main sections: Headwaters to Cracow, Cracow to Theodore and Theodore to Mackenzie River.

2.6.2.1 Headwaters to Cracow

Although there are some significant areas of alluvium along this reach of the river, drilling by DNR to date has failed to locate any significant groundwater resources within the alluvium.

2.6.2.2 Cracow to Theodore

Alluvial plains of over 1 km in width have developed in this reach. According to DNR, groundwater supplies have been discovered in this reach at depths to about 30 m, which have been utilised for irrigation supplies. Supplies in the order of 25 l/s have been obtained from individual bores.

2.6.2.3 Theodore to Mackenzie River

In this reach alluvium is restricted as the river passes through a gap in the Malakoff Range. Below the gap alluvium broadens and becomes several kilometres wide at Paranui and remains extensive right through to Mackenzie River junction. DNR has drilled a series of cross-sections in this reach, but has found the prospect of groundwater supplies to be almost nil.

2.7 BOGGOMOSSES

Boggomosses are a type of mound spring. Similar springs are known to occur elsewhere in Queensland and in Australia. However, the name boggomosses for these springs is unique to the Taroom district. A recent study (DNR, 1996) surveyed and made an inventory of boggomosses in the Nathan Dam Project area as part of an investigation into the impact of the proposed dam on these boggomosses.

DNR (1996) identified **4 different types** of boggomosses in the study area on the basis of their vegetation and maturity. All 4 types were considered to be 'dynamic' in that the outlets of the boggomosses close over from time to time and new outlets appear. Occasionally, entire mounds appear to be inactive. The largest flow measured from a boggomoss in the study area was only **0.35 l/s**.

The above study found **68** boggomosses in the study area distributed into 5 main geographical groups. All of these groups appeared to be fault controlled and were expressions of leakage from the Great Artesian Basin Aquifer System. Four of the groups were the result of leakage from the Precipice Sandstone, while the remaining group was attributed to leakage from the Eurombah Formation/Hutton Sandstone (see Section 2.6a).

2.8 SURFACE WATER QUALITY

2.8.1 *General*

The existing water quality along the Dawson River was investigated as part of a comprehensive study of the water quality in the Fitzroy River Basin (Noble et al, 1996). Noble et al (1996) presented the findings from a 3 year water quality monitoring program (1994 to 1996) in the Fitzroy River Basin. Water quality data collected since 1990 from the Ambient Water Quality Monitoring network of the Department of Natural Resources were also used in the above investigation.

Along the Dawson River, water quality has been monitored at 7 locations. Details of these locations are given in Table 2.3. All sites shown in Table 2.3, except Site 6 (Taroom Lagoon) were considered as primary sites. Samples were taken both during low flow (i.e. baseflow) and after significant runoff events. The parameters sampled are listed below:

- Physical Parameters:
  - Dissolved Oxygen (DO)
  - pH
  - Electrical Conductivity (EC)
  - Turbidity
  - Suspended Solids (SS)
- Nutrients
  - Total Nitrogen (TN)
  - Total Phosphorus (TP)

Limited sampling had also been undertaken on pesticides, heavy metals and major ions, but these sample sizes were too small to make any meaningful conclusions (Noble et al, 1996).

Table 2-3 Locations of Water Quality Monitoring Sites, Dawson River

Site No.	Site Name	Description
1	Capricorn Highway Crossing	Lower Dawson near Duaringa
2	Becker's Gauging Station	Lower Dawson
3	Moura Weir	Mid Dawson (Impounded Water)
4	Theodore Weir	Mid Dawson (Impounded Water)
5	Delusion Creek Junction	Mid Dawson (Upstream of Theodore Irrigation Area, but downstream of Orange Creek Weir)
6	Taroom Lagoon	Upper Dawson (wetland)
7	Baroondah	Upper Dawson (just upstream of Yebna Crossing)

The actual recorded data used in Noble et al (1996) were not available for this study. The number of samples tested for each parameter at each location, and the flow conditions at the time of sampling are also not known. The description of water quality below is thus based on summary results presented in the above report.

2.8.2 *ANZECC Water Quality Guidelines*

The ANZECC (1992) Guidelines for protection of aquatic ecosystems in rivers and streams for available water quality parameters are summarised below in Table 2.4.

2.8.3 *Physical Parameters*

2.8.3.1 Dissolved Oxygen

For most sites, especially for the surface water samples, DO levels met the ANZECC (1992) ecosystems protection guidelines for most samplings. However, some low DO levels in surface waters were recorded occasionally in the mid-Dawson River. These low levels would most likely have been at the two weir sites (Moura and Theodore). Low levels of DO had also been recorded at depths greater than 1.5 m at several river, storage and wetland sites. The sites that fall into this category along the Dawson are not known.

Table 2-4 ANZECC (1992) Water Quality Guidelines for Aquatic Ecosystem Protection

Parameter	ANZECC Guideline
Dissolved Oxygen	Not less than 6 mg/l or 80 – 90% saturation
pH	6.5 – 9
Electrical Conductivity	< 1,500 µS/cm
Turbidity	Not available
Suspended Solids	Not available
Total Nitrogen	0.1 – 0.75 mg/l for rivers and streams 0.1 – 0.50 mg/l for lakes and reservoirs
Total Phosphorus	0.01 – 0.1 mg/l for rivers and streams 0.005 – 0.05 mg/l for lakes and reservoirs

2.8.3.2 pH

According to Noble et al (1996), all samples collected from the Dawson River satisfied the ANZECC (1992) pH criteria shown in Table 2.4. For the baseflow samples taken during 1994 and 1995 the pH was in the range **7.1 – 7.3**. For the samples taken after a flow event in the same period the pH was in the range **7.4 – 7.9**.

2.8.3.3 Electrical Conductivity

Noble et al (1996) report that EC levels in the Dawson River satisfy ANZECC (1992) guidelines given in Table 2.4. For baseflow samplings, the recorded value was generally between **150 – 200 µS/cm**. For samples taken after a flow event, the recorded value was generally in the **range 200 – 250 µS/cm**. These values are low and are acceptable for irrigation water.

The Queensland Water Quality Atlas (DPI, 1994b) provides a summary of salinity trends along the Dawson River at a number of streamgauging stations over the 20 year period 1970 – 1990. These values are shown in Table 2.5. The trend values show that the salinity at Taroom and Becker's have been gradually decreasing over the last 20 years, whilst the salinity at other locations have been gradually increasing. The reason for this behaviour is not known.

Table 2-5 Salinity Trends in the Dawson River

Gauging Station No.	Location	Salinity Trend (µS/cm/yr)
130 322	Becker's	-0.60
130 350	Moura Weir	2.38
130 317	Woodleigh	3.51
130 305	Theodore	4.38
130 302	Taroom	-2.18
130 324	Utopia Downs	2.30

2.8.3.4 Turbidity

Turbidity in the Dawson River has been estimated using a Secchi disc and thus has been measured under low flow (i.e. baseflow) conditions only. During and after flow events the Dawson was found to be **moderately to highly turbid**.

For the Dawson River, the median values for Secchi readings were higher at the **upper (0.68 m, Site 7)** and lower **(0.38 m, Site 1)** locations than at the mid-Dawson **sites (0.23 m, Site 4; 0.18 m, Site 3)**. The highest and lowest readings **(1.9 m and 0.05 m** respectively) were made at the same location on the lower Dawson (Site 2).

2.8.3.5 Suspended Solids

For the total data set, the median level of SS was reported as **157 mg/l** (Noble et al, 1996). When only the data after a flow event were considered, the median value increased to **244 mg/l.**

Along the Dawson, the median value for SS increased from **25 mg/l** upstream at Site 7 (Baroondah) to **219 mg/l** at Site 1 (Capricorn Highway Crossing). However, quite high levels of SS (337 mg/l) were reported at Taroom after a flow event. Note that the six weirs along the Dawson River will impact on the passage of suspended solids down the river.

2.8.3.6 Hardness

The Queensland Water Atlas (DPI, 1994b) reports that the water in the Dawson River system has an **acceptable** hardness of **less than 200 mg/l, $CaCO_3$**, except Castle Creek, which flows into the Dawson River at Theodore. Hardnesses of 200 – 500 mg/l $CaCO_3$ have been recorded in Castle Creek.

2.8.4 *Nutrients*

2.8.4.1 Total Nitrogen

The median value for TN for 102 samples taken along the Dawson River was **1.065 mg/L**. This median level **exceeds** the ANZECC (1992) upper limit of **0.75 mg/l**, above which algal problems have been known to occur for Australian conditions (Noble et al, 1996).

Under baseflow conditions, samples from all river sites had median TN values of **less than 0.75 mg/l**. Under flow conditions, median TN values for all sites were **greater than 0.75 mg/l**. The highest individual TN value recorded was **3.434 mg/l** in the mid-Dawson. Even the Upper Dawson site (Site 7) recorded a TN value of **1.49 mg/l** under flow conditions.

Median TN values for all sites, except Baroondah (Site 7), exceeded 0.75 mg/l. Under both baseflow and flow conditions, TN values tended to **increase in a downstream direction**, although the median TN values for the mid-Dawson sites at Theodore and Moura (Weir Sites 3 and 4) were higher than those for the lower Dawson Site 15.

2.8.4.2 Total Phosphorus

The median TP value for 102 samples taken along the Dawson River was **0.215 mg/l.** This value is **significantly higher** than the ANZECC (1992) upper limit of **0.1 mg/l.** Algal problems have been reported under Australian conditions for TP values greater than 0.1 mg/l (Noble et al, 1996).

Under baseflow conditions, the median TP value was generally less than 0.1 mg/l, except for mid-Dawson at Theodore and Moura where the median TP was 0.14 mg/L. During flow events, values greater than 0.1 mg/l were recorded along the entire length of the river, with highest concentrations occurring in the mid and lower reaches of the river.

2.8.5 *Algal Blooms*

Although other factors such as turbidity, temperature, bioavailability of nutrients, etc. also affect the occurrence of algal blooms, the total nitrogen to total phosphorus (TN:TP) ratio serves as a guide to blue-green algal growth problems. The New South Wales Blue-Green Algal Task Force (1992) indicated that a TN:TP ratio of less than 29:1 is conducive to the growth of blue-green algae.

The median TN:TP ratios for all sites along the Dawson River were **less than 10**. This, considered in isolation, would suggest that blue-green algal blooms (Cyanobacterial blooms) are a common occurrence in the Dawson River. Although a number of occurrences of blue-green algal blooms have been reported in the Fitzroy River basin over the last few years (e.g. Callide Dam, Theresa Dam), only one reported occurrence of an algal bloom in the Dawson (at Moura Weir in December 1994) is currently known (Noble et al, 1996). It is suggested that other factors, such as limitations on light penetration and flushing, are controlling growth of algae (Noble et al, 1996).

2.9 GROUNDWATER QUALITY

Groundwater quality in aquifers and boggomosses in the study area were assessed in recent studies on the groundwater resources in the Dawson River Catchment (DPI, 1994a and DNR, 1996). In these studies, the groundwater quality was determined by analysing samples taken from artesian bores in the area of interest. Available information on groundwater quality is summarised below.

2.9.1 *Precipice Sandstone*

Water from the Precipice Sandstone in the Taroom area was found to have EC's in the **range 100 – 350 μS/cm.** The concentrations of iron and manganese were high and in some samples the pH was very low. High levels of bicarbonate were also found in some samples. The test results indicated that this groundwater is generally suitable for irrigation and stock watering purposes, except in certain areas where the high bicarbonate content may limit its suitability (DPI, 1994a). Groundwater from this source is suitable for domestic use after some treatment.

2.9.2 *Alluvium*

Alluvial sections upstream of the Nathan Dam site are considered to contain water that is suitable for both domestic and irrigation purposes (DPI, 1994a). However, water quality of Alluvial sections downstream of the dam site is expected to be highly variable. The reported range of EC's in the Alluvium in the Theodore area is **3,000 – 20,000 μS/cm**.

2.9.3 *Boggomosses*

Quality of water in boggomosses were found to be **very similar** to the quality of water in adjacent artesian bores (DNR, 1996). Thus, the chemistry of the water discharging from the boggomosses varied with location and was dependent on the quality of adjacent groundwater quality.

2.10 FLOODING BEHAVIOUR

2.10.1 *Historical Flood Events*

Table 2.6 lists 7 major floods that occurred in the Dawson River since the 1950's. The magnitude and duration of each flood immediately downstream of the proposed dam site (at Nathan Gorge, Gauging Station No. 130 320 A) are also shown in Table 2.6 (DNR, 1997a). The AMTD and catchment area at the gauging station are 307.2 km and 23,620 km^2 respectively. Needless to say, both the duration and magnitude of the flood would generally be greater further downstream in the river with increasing catchment area.

Table 2-6 Recorded Historical Floods, Dawson River at Nathan Gorge, 1954 - 1997

Event	Duration (Hours)	Peak Discharge (m^3/s)
February 1954	600	3,444
May 1955	552	2,436
February 1956	624	4,279
February 1971	786	1,550
February 1971	360	1,233
May 1983	642	3,100
May 1983	618	1,088

2.10.2 *Design Flood Events*

Design flood discharges at the proposed dam site have been estimated in DNR (1997a) for flood events ranging from the 100 year Average Recurrence Interval (ARI) to Probable Maximum Flood (PMF). These design flood estimates are summarised in Table 2.7. The critical storm duration associated with these design flood events was 96 hours (4 days). Again, needless to say, the magnitude of the design discharges for each event will be greater downstream in the river with increasing catchment area.

Table 2-7 Recorded Historical Floods, Dawson River at Nathan Gorge, 1954 - 1997

Flood Event	Peak Discharge (m^3/s)
100 Year ARI	5,600
1,000 Year ARI	12,100
10,000 Year ARI	20,600
PMF	26,300

Source: DNR (1997)

2.11 ENVIRONMENTALLY SENSITIVE AREAS

A detailed inventory of environmentally sensitive areas along the Dawson River is not available. Only a general and indicative description of key features is available. Based on preliminary information obtained for the WAMP study and supplied by DNR, this section summarises stream features that may be of environmental significance along the Dawson River above the main channel (waterholes, anabranches, wetlands, etc.), on a river reach-by-reach basis. Estimates of river flows that are required to wet/inundate and generally maintain the well-being of each set of features at various locations are also indicated.

Note that some of the features described below may have their own local catchments. The flow rates specified below are the flows required for these features to connect with the Dawson River.

2.11.1 *Downstream of Duaringa*

This reach of the Dawson River contains a few very large waterholes. The river is flanked on both sides by a wide floodplain. Table 2.8 shows the different sensitive features and the river flows required to wet/inundate them.

Table 2-8 Environmentally Sensitive Features Along the Dawson River - Downstream of Duaringa

Feature	Required Flow	
	(m^3/s)	(ML/d)
General features on low terraces within the river channel, including both stable and unstable backwaters and waterholes.	600	51,800
General features within the river channel and also within the confluence of major tributaries and the river.	800	69,100
General higher level alluvial terraces within high banks, including wetlands and waterholes.	1,400	121,000
General features on the floodplain, including swamps and billabongs at the Dawson/MacKenzie Confluence.	2,500[a]	216,000[a]

[a] This floodplain area can be inundated by major events on the MacKenzie River too.

2.11.2 *Duaringa to Moura Weir*

This reach of the Dawson River is characterised by higher alluvial plains and apparent absence of large active meanders. There are several major anabranches as well as lagoon/oxbow lake storages on the floodplain. This reach of the river also contains the Neville Hewitt and Moura Weirs. Table 2.9 shows the different sensitive features along this reach, together with the flows required to wet/inundate them.

Table 2-9 Environmentally Sensitive Features along the Dawson River - Between Duaringa and Moura Weir

Feature	Required Flow	
	(m^3/s)	(ML/d)
General features on low terraces within the river channel, including both stable and unstable backwaters and waterholes.	360	31,000
General features within the river channel and also within the confluence of major tributaries and the river.	580	50,000
General higher level alluvial terraces within high banks, including wetlands and waterholes.	830	71,700
Bears Lagoon @ AMTD 142	1,500	130,000
Maloneys Creek Waterholes @ AMTD 152	1,500	130,000

2.11.3 *Moura Weir to Gyranda Weir*

The Dawson River in this reach is characterised by higher alluvial plains which widen significantly around the confluence of major tributaries. Anabranches and multiple river channels with associated 'islands' are common in this reach. This reach contains 3 weirs: Theodore, Gyranda and Orange Creek Weirs. Table 2.10 shows the different sensitive features along this reach, together with the flow rate required to wet/inundate the different features.

Table 2-10 Environmentally Sensitive Features along the Dawson River - Between Moura Weir and Gyranda Weir

Feature	Required Flow	
	(m^3/s)	(ML/d)
General features on low terraces within the river channel, including both stable and unstable backwaters and waterholes.	360	31,000
General features within the river channel and also within the confluence of major tributaries and the river.	580	50,000
General higher level alluvial terraces within high banks, including wetlands and waterholes.	830	71,700
Medium and high level billabongs within the high banks of the river between AMTD 254 to 266 km:		
- Commence Filling	90	8,000
- Inundate high level features	800	69,000
- Major flooding of lagoons	2,000	173,000

2.11.4 *Gyranda Weir to Taroom*

The Dawson River flows through a variety of landscapes in this reach from lower alluvial plains to Nathan Gorge. The proposed Nathan Dam site is in this reach. This reach contains the Glebe Weir. Table 2.11 shows the different sensitive features along this reach and the flows required to wet/ inundate the different features.

Table 2-11 Environmentally Sensitive Features along the Dawson River - between Gyranda Weir and Taroom

Feature	Required Flow	
	(m^3/s)	(ML/d)
General features on low terraces within the river channel, including both stable and unstable backwaters and waterholes.	340	30,000
General features within the river channel and also within the confluence of major tributaries and the river.	710	61,300
General higher level alluvial terraces within high banks, including wetlands and waterholes.	900	77,800

2.11.5 *Taroom to Utopia Downs*

The Dawson River in this reach flows through an undulating landscape with pockets of alluvial plains. Wetlands, lagoons and oxbow lakes are common on the alluvial plains. Significant areas of Coolabah floodplain also occur in this reach. Table 2.12 shows the different sensitive features along this reach and the flow required to wet/ inundate the different features.

Table 2-12 Environmentally Sensitive Features along the Dawson River - Between Taroom and Utopia Downs

Feature	Required Flow	
	(m^3/s)	(ML/d)
General features on low terraces within the river channel, including both stable and unstable backwaters and waterholes.	432	37,300
General features within the river channel and also within the confluence of major tributaries and the river.	690	60,000
General higher level alluvial terraces within high banks, including wetlands and waterholes.	875	75,600
Anabranches and billabong storages near Eurombah Crossing @ AMTD 425 km	400	34,600

2.11.6 *Upstream of Utopia Downs*

This most upstream reach of the Dawson traverses a landscape varying from dissected tablelands - with canyons, gorges, escarpments and high cliffs - to rolling hills, with pockets of alluvial plains throughout. Wetlands and lagoons occur within the area defined by the high bank throughout. Table 2.13 shows the different sensitive features along this reach and the minimum flow required to wet/inundate the different features.

Table 2-13 Environmentally Sensitive Features along the Dawson River - Upstream of Utopia Downs

Feature	Required Flow	
	(m^3/s)	(ML/d)
General features on low terraces within the river channel, including both stable and unstable backwaters and waterholes.	120	10,400
General features within the river channel and also within the confluence of major tributaries and the river.	300	25,900
General higher level alluvial terraces within high banks, including wetlands and waterholes.	600	51,800

3. CURRENT WATER USE AND DEMAND

3.1 DEMAND TYPES AND SOURCES OF SUPPLY

There are 5 types of water licences in the Dawson River catchment:

- Irrigation (regulated and unregulated),
- Urban (town water supply),
- Industrial (mining),
- Stock and Domestic, and
- Water Harvesting.

The primary source of water supply in the Dawson River catchment is surface water. Groundwater is also used to supply some demand. Surface water supplies are provided from both regulated and unregulated sections in the Dawson River and its tributaries. Regulated water is supplied from the regulated reach of the river as per announced allocations (see Section 4). Unregulated water is supplied via water extraction licences from unregulated reaches of the river and water harvesting licences from the regulated sections. Conditions are attached to the unregulated and water harvesting licences.

Each of the demand types and their sources of supply are described below. The river system operation is described in Section 4. **No water from the Dawson River is currently specifically set aside for environmental/riparian requirements.**

3.2 IRRIGATION (REGULATED)

3.2.1 *Surface Water*

Irrigation is the largest water user in the Dawson River catchment. Most of the irrigation water is used in the Dawson Valley Irrigation Area (DVIA). Irrigation water to the DVIA, which commenced in 1924 and now covers about 9,000 ha, is provided from Theodore Weir via channel systems on the left and right banks of the Dawson River at Theodore. Water is also supplied directly from the Dawson River (private diversions). Water for irrigation outside the DVIA is supplied by private diversion from the regulated sections of the Dawson River from Glebe Weir downstream to Boolburra.

Table 3.1 shows the break-up of current nominal water allocations for irrigation use along the Dawson River on a reach-by-reach basis between the regulatory structures. It should be noted that the values in Table 3.1 represent the current entitlement from the river. The actual total regulated irrigation water supply from the river during the last few years has been in the order of **only 35,000 ML/year**. The actual regulated supply could be less than the nominal allocation for three reasons:

- The full entitlement is not used because the area irrigated is less than the maximum permissible,

- There is excess water stored on-site from water harvested from the river during off-allocation periods.

- There are non-active (i.e. dormant) water licences.

Table 3-1 Distribution of Irrigation Nominal Allocations along the Dawson River

River Reach	Nominal Allocation (ML/year)
Glebe Weir (Direct)	1,160
Gyranda to Theodore	8,550
Theodore to Moura (Channel)	19,280[a]
Theodore to Moura (River)	10,837
Moura to Neville Hewitt	10,823
Downstream of Neville Hewitt	5,435
Total	56,085

[a] Allows for 20% extra allocation for the channel section (see Section 4.3)

Irrigation supplies are of 'medium security', i.e. irrigation water is provided only after sufficient reserves are set aside for 'high security' urban and industrial users.

3.2.2 *Groundwater*

Groundwater use for irrigation is limited. The areas of use are mainly in the Alluvial sections in the vicinity of Theodore along Castle and Lonesome Creeks. Total current groundwater usage for irrigation is estimated at about **1,500 ML/year** (DPI, 1994a).

3.3 URBAN

Town water supplies for the urban centres in the Dawson Valley are sourced from either the Dawson River or from groundwater. Table 3.2 shows the licenced volumes (i.e. entitlements) for each of the towns supplied from the Dawson River. Actual supplies over the last few years have been **significantly less** than the licenced volumes. Note that urban water supply licences are given the highest priority and thus first preference at times of water shortage.

Table 3-2 Town Water Supply Allocations, Dawson River

Town	Source	Licenced Volume (ML/Yr)
Theodore	Theodore Weir	250
Moura	Moura Weir	800
Baralaba	Neville Hewitt Weir	347
Duaringa	Dawson River	350
Total		1,747

Table 3.3 shows the average annual design capacity of treatment works in towns using groundwater for urban water supply. The licenced volumes or the actual current usage for these towns are not known.

Table 3-3 Design Capacity of Treatment Works for Groundwater Supply

Town	Type of Bore	Average Annual Design Capacity of Treatment Works (ML)
Injune	Sub-Artesian	220
Wandoan	Sub-Artesian	127
Taroom	Artesian	173
Woorabinda	Artesian & Sub-Artesian	240
Total		760

Source: DPI (1994a)

3.4 INDUSTRIAL

There are currently 2 industrial (mining) water users with licences for water from the Dawson River. Details of their allocations are given in Table 3.4. The actual usage by the industrial users over the last few years has been **significantly less** than the allocated volume. There is no reported groundwater use in the Dawson River catchment for industrial purposes.

Table 3-4 Industrial Water Allocations, Dawson River

Company	Industry	Allocation (ML/Yr)
BHP-Utah	Coal Mine	1,192
Sedimentary Holdings	Gold Mine	400
Total		1,592

3.5 STOCK AND DOMESTIC

Stock and domestic water use in the Dawson River catchment is quite small.

There are currently approximately **30** stock and domestic licences along the Dawson River. Only 2 or 3 of these licences are within the regulated reaches. Most stock and domestic licences are generally for 1 – 2 ML/year. Total water usage for stock and domestic purposes in the last few years has been estimated at **125 – 150 ML/year.**

With respect to groundwater, all aquifer systems in the Dawson Valley have been extensively developed for stockwater (DPI, 1994a). In the Taroom area, controlled artesian bores exist on many properties for stock water supplies. In the remainder of the valley, the majority of bores are sub-artesian and are equipped with windmills. Groundwater is not generally used for domestic purposes because of the marginal quality of water (DPI, 1994a).

3.6 WATER HARVESTING

Water harvesting licences have been issued to irrigators in the regulated sections of the river to pump water from the river during periods of high flows and off-allocation periods. Licences issued prior to 1994 allow harvesting when river flows exceed 15 m^3/s (1,296 ML/d). Licences issued after 1994 allow harvesting only when river flows exceed 30 m^3/s (2,592 ML/d).

The water harvesting licences allow farmers to store water in on-site storages for subsequent irrigation or other uses. Water harvested in this way is available to the farmer in addition to the normal allocation. Thus, the harvested water is available to the farmers to supplement shortfalls in allocated water, to irrigate additional land or to reduce the amount of water ordered from their allocation.

Significant amounts of water are currently being harvested from the system for irrigation use under these licences. In 1995/96, **13,625 ML** was harvested from the system.

3.7 UNREGULATED WATER USE

Unregulated water use refers to licenced water use from unregulated sections of the Dawson River system. The Dawson River upstream of Glebe Weir and downstream of Duaringa and the tributaries of the Dawson River are unregulated. There are two types of unregulated flow licences:

- Area-based licences (for direct irrigation from the water course), and
- Water harvesting licences (for irrigators with on-farm storages).

Water supply is not guaranteed for these users. It is estimated that approximately **2,700 ha** and **1,800 ha** respectively are irrigated annually via these licences.

3.8 SUMMARY OF CURRENT ALLOCATIONS FROM THE DAWSON RIVER

Table 3.5 summarises the current nominal allocations from the regulated sections of the Dawson River for irrigation, urban and industrial demands. Note that stock and domestic, water harvesting and unregulated water use from the Dawson River system are not included in Table 3.5.

Table 3-5 Summary of Current Water Allocations from the Dawson River

Water Use Category	Nominal Allocation (ML/year)	Supply Security
Irrigation	56,085	Medium
Urban	1,747	High
Industrial	1,592	High
Total	59,424	

4. CURRENT OPERATION OF THE DAWSON RIVER SITUATION

4.1 REGULATORY STRUCTURES

The Dawson River is regulated via a system of weirs along a length of some **310 km** from Glebe Weir (near Taroom) down to Boolburra (near Duaringa). The downstream limit is some 16 river km upstream of its confluence with the MacKenzie River. There are 6 weirs which make up the weir system along the Dawson, with a total storage capacity of some **61,670 ML**. The locations of these weirs are shown in Figure 1.1. Details of these weirs are given in Table 4.1.

Table 4-1 Details of Existing Storages on the Dawson River

Storage	Year of Completion	AMTD (km)	Catchment Area (km2)	Storage Capacity (ML)	Dead Storage (ML)	Surface Area At FSL (ha)
Glebe Weir	1972	326.2	23,000	17,300	1,420	542
Gyranda Weir	1987	284.5	24,600	14,700	320	380
Orange Creek Weir	1932	270.7	24,685	6,360	680	110
Theodore Weir	1929	228.5	27,350	4,760	780	100
Moura Weir	1946	150.2	27,010	7,250	630	151
Neville Hewitt Weir	1976	82.7	40,225	11,300	1,110	295

4.2 REGULATED REACHES

There are 5 regulated reaches of the Dawson River. The length and the type of water demands met from each reach are summarised in Table 4.2.

Table 4-2 Details of Regulated Reaches, Dawson River

Reach	Length (km)	Demands Supplied
Glebe Weir – Gyranda Weir	42	Irrigation
Gyranda Weir – Theodore Weir	56	Irrigation, Urban, Industrial
Theodore Weir – Moura Weir	78	Irrigation, Urban
Moura Weir – Neville Hewitt Weir	68	Irrigation, Urban, Industrial
Neville Hewitt Weir - Boolburra	67	Irrigation, Urban

4.3 ANNOUNCED ALLOCATION PROCEDURE

The Dawson River system is operated via announced allocations. Announced allocation is the percentage of the nominal allocation that the system would be capable of supplying to the customer during the water year. Allocations are announced at the start of the water year (1st October) and are re-assessed at the beginning of every month or after significant flow events.

In making the initial announced allocation at the start of the water year, the operator considers a range of operational needs (DNR, 1997c), including:

- Volume of water in storage(s) at the start of the water year.
- Expected inflows into the storage(s) during the coming year.
- Projected losses from the storage(s) due to evaporation, seepage, etc.
- High security allocations for urban and industrial users (i.e. fixed demands).
- Carryover storage volume to be reserved for the following year.

Having assessed the operational needs for the coming year, the operator will allocate the available volume to individual customers holding medium security allocations (e.g. irrigation) as a proportion of their nominal allocation. The same proportion is allocated to all medium security irrigators, except channel irrigators. Channel irrigators in the DVIA are allocated **up to 20% more** water than private diversion irrigators because they do not have access to water harvesting direct from the river during high flows.

The announced allocation is limited to 100% of nominal allocation. Because of the small storage capacity in the system (61,670 ML) compared to nominal allocation for the Dawson River system (59,400 ML), announced allocation at the start of the water year for medium security water users along the Dawson River is generally less than 100%. However, the allocation generally increases through the water year. Announced allocation will not be reduced during the water year.

4.4 CURRENT OPERATION OF STORAGES

Glebe and Gyranda Weirs are operated to cater for local demands and to supplement downstream weirs. An attempt is made to always keep both Glebe and Gyranda Weirs half full, or alternatively keep one of the storages full. The maximum possible release from Glebe Weir is about **800 ML/day**. Gyranda Weir can release up to **1,000 ML/day**. There is little tributary inflow to the system between Glebe and Gyranda Weirs.

Orange Creek Weir is kept full at all times and is not used for water supply purposes unless the rest of the system is dry. The maximum possible release from the weir is about **100 ML/day**. Orange Creek Weir is currently in a poor state and it is understood that this weir may be removed from the system after the construction of the new dam.

Theodore Weir, located close to the DVIA, supplies water to both the Theodore and Gibber Gunyah sections of the DVIA. The weir is kept as full as possible, with a **120 ML/day** pump to supply the Theodore Section and a **110 ML/day** pump to supply the Gibber Gunyah sections. Return flows from the Theodore section of the DVIA flow back into the river upstream of Theodore Weir, while return flows from the Gibber Gunyah section enter the river below Theodore Weir.

The maximum recommended release from Theodore Weir to the river is about **250 ML/day.** Larger releases apparently cause flooding at some downstream river crossings. It is understood that river releases cannot be made from Theodore Weir from 1.5 m below full supply level. Under normal operations, very little of the releases from the Theodore Weir reach Moura Weir because of the large waterholes in this reach.

An attempt is made to maintain Moura Weir levels at approximately 0.3 m below FSL. The maximum possible release from Moura Weir is about **600 ML/day**. Releases are made from Moura Weir for water uses between Moura and Neville Hewitt Weirs. Some individual irrigators in this reach require up to 125 ML/day and the release capacity (600 ML/d) is insufficient to meet a large demand in some days. Thus, to manage large demands water is released in advance to fill the large waterholes from which the irrigators can pump water for their irrigation needs. Releases are not usually made from Moura Weir to supplement Neville Hewitt Weir.

Significant tributary inflows from the Mimosa Creek system enter the Dawson River downstream of Moura and upstream of Neville Hewitt Weir. Thus, for operational purposes, Neville Hewitt Weir is considered to behave independently of other storages.

4.5 PERFORMANCE OF THE EXISTING SYSTEM

4.5.1 *General*

DNR has configured and calibrated a daily hydrological simulation model (IQQM) for the Dawson River catchment. This model has been run by DNR for a number of situations, including the existing situation in the catchment. Details of this model and its configuration, calibration, etc. for the Dawson River system are given in DNR (1997b).

The performance of the existing system was investigated under existing entitlements and operational rules described earlier. The results are based on simulation runs undertaken using historical rainfall and streamflow data over the 95 year period 1900 to 1995. The results presented below are based on output from the IQQM model provided by DNR.

4.5.2 *Model Simplifications/Assumptions*

The following key simplifications/assumptions have been made in the model for the analyses of the existing system.

- Fixed demands (urban and industrial) are uniform throughout the year.
- Monthly irrigation demand pattern for the entire Dawson River System is represented by the current water use pattern in the DVIA.
- On-farm storage capacity in existing irrigation areas has been increased to reflect future potential capacity of these areas.
- Twenty percent of the Theodore Channel irrigation demand is modelled as a 'Fixed Irrigation Demand' with high security to reflect the existing 20% higher allocation to this area.
- Announced allocation is constant at 100% throughout the simulation period.

- Farmers will plant 100% of the area every year.

The above simplifications will have some impact on the results, the significance of which can only be determined by additional model runs. Results of sensitivity analyses to check the impact of some of the above simplifications/assumptions on system performance have not been available for review.

4.5.3 *Data Used*

For the existing system, the system was assumed to include all currently committed entitlements and be operated to maximise diversions from the system. Table 3.5 shows a summary of adopted regulated annual demands from the system for different types of committed entitlements. The modelled yields for the existing system are **3,339 ML/year** for high security urban and industrial users and **56,085 ML/year** for medium security irrigators.

4.5.4 *Existing System Reliability*

Table 4.3 shows the monthly and annual reliabilities for irrigation and other demands from the regulated sections of the river. Note that reliability has been defined as the percentage of months and years when 100% of the demands were satisfied.

Table 4-3 Monthly and Annual Reliabilities, Existing System

Demand Type	Yield (ML/Yr)	Monthly Reliability	Annual Reliability
Irrigation	56,085	92.6%	72.6%
Urban and Industrial	3,339	93.8%	81.0%

Monthly and annual irrigation supply reliabilities obtained from the above analysis were approximately **93%** and **73%** respectively. According to DNR, more realistic assumptions regarding the announced allocation rule and planting strategy (see Section 4.5b) **would have lowered** the above reliabilities.

Table 4.4 shows the mean annual irrigation water use in both regulated and unregulated sections of the river over the 95 year simulation period. The break-up of on and off-allocation water use in the regulated sections is also shown in Table 4.4.

Table 4-4 Monthly and Annual Reliabilities, Existing System

Demand Type	Mean Annual Supply (ML)
Regulated Sections	
- On-Allocation Water	29,556
- Off-Allocation Water	39,550
- Total (On and Off Allocation Water)	69,111
Unregulated Sections (Total)	6,926

The results in Table 4.4 indicate that only about **53%** of nominal allocation is supplied via on-allocation diversions. The remaining crop water requirement is met by off-allocation diversions. The average annual volume of water harvested from the Dawson River is **72,273 ML**, of which **65,104 ML** are harvested from the regulated reaches.

4.5.5 *Effect of the Existing System on Natural Catchment Flow Behaviour*

The flow characteristics in the Dawson River under existing conditions were compared with flow characteristics under 'natural catchment flow' conditions. Natural catchment flow conditions represent conditions in the catchment with no demands, no extractions and no storages. This situation was also simulated using the IQQM Model by DNR to establish natural flow conditions along the River.

Table 4.5 shows predicted mean daily and annual flows along the Dawson River at a number of locations for the existing and natural flow conditions for the simulation period 1900 – 1995.

Table 4-5 Mean Daily and Mean Annual Flows along the Dawson River, 1900 - 1995

Location	Mean Daily Flow (ML)		Mean Annual Flow (GL)	
	Natural Catchment Flow Conditions	Existing Conditions	Natural Catchment Flow Conditions	Existing Conditions
Utopia Downs	376	376	138	138
Taroom	1,102	1,097	402	400
Glebe	1,565	1,539	572	562
Woodleigh	1,820	1,642	665	600
Beckers	2,771	2,474	1,012	904
Boolburra	3,844	3,407	1,404	1,244

The existing developments have had little or no impact on Dawson River 'natural' flow behaviour upstream of Glebe Weir. Downstream of Glebe Weir the impact of existing development on river flows has progressively increased in the downstream direction. The existing water use has reduced the 'natural flows' at Woodleigh, Beckers and Boolburra by approximately **9.8%, 10.7%** and **11.4%** respectively.

5. PROJECTED FURTURE DEMANDS

A study on potential future agricultural demand for water in the Dawson River system has recently been completed (Rolfe & Teghe, 1997). A similar study is currently underway for potential future industrial demands. The demand estimates made in these studies are based on a comprehensive survey of potential future water users along the entire length of the Dawson River.

The irrigation demand distribution determined by Rolfe & Teghe (1997) has been subsequently revised by DNR, apparently on the basis of a number of factors not considered in the original study. DNR's revised distribution of demands is presented in Appendix A.

5.1 IRRIGATION DEMAND

5.1.1 *Demand Distribution*

In the irrigation demand study, the 'raw' survey results were weighted according to factors such as irrigation experience, ownership of land in the water supply area, etc. before determining a set of 'optimistic', 'moderate' and 'pessimistic' potential demand values for years 2000 and 2005.

Table 5.1 shows these demand values for different river reaches. The 'raw' values from the survey and DNR's revised estimates are also shown in Table 5.1. There was also a significant 'location not known or specified' component for future irrigation water demand. The magnitude of this component along the Dawson River is not known. Thus, the 'not known' component is **excluded** in Table 5.1. Note that the demand values given in Table 5.1 are in addition to the existing demand in the system.

5.1.2 *Crop Types*

The survey also invited respondents to indicate the type of crop the respondents planned to plant. According to the response received, **about 50%** of the future demand was for cotton. The remainder was for peanuts, grains, small crops, horticulture, etc.

5.1.3 *Supply Reliability*

The survey also requested respondents to indicate the required reliability of water supply. Water supply reliability was classified into 3 groups: **high security** (99% monthly reliability of supply), **medium security** (85% monthly reliability of supply), and **low security** (75% monthly reliability of supply). An overwhelming majority of respondents requested medium security water. Approximately **10%** of the respondents who indicated a preference requested high security water.

Table 5-1 Potential Future Irrigation Demands, Dawson River

River Reach	Demand Value (ML/Year)								
	Year 2000				Year 2005				DNR's Revised Estimates
	'Raw'	'Pessimistic'	'Moderate'	'Optimistic'	'Raw'	'Pessimistic'	'Moderate'	'Optimistic'	
Upstream of Nathan Dam Site (D1)	73,855	23,038	32,415	44,267	118,469	37,015	52,325	62,014	30,000
Nathan Dam Site to Gyranda Weir (D2)	0	0	0	0	0	0	0	0	0
Gyranda Weir to Theodore Weir (D3)	28,725	8,991	12,801	17,402	39,725	13,716	18,811	23,491	15,000
Theodore Weir to Moura Weir (D4)	25,571	7,928	11,260	15,620	34,021	10,382	14,926	16,538	25,000
Moura Weir to Neville Hewitt Weir (D5)	37,399	12,313	17,046	22,669	50,949	16,229	22,634	27,098	75,000
D/S of Neville Hewitt Weir (D6)	42,656	16,341	21,659	27,967	67,256	23,917	32,878	34,566	75,000
Totals	208,146	68,611	95,181	127,925	310,420	101,259	141,574	163,707	220,000

Source: Rolfe & Teghe (1997)

5.2 INDUSTRIAL DEMAND

Only preliminary results are currently available from the survey on potential future industrial demands.

Table 5.2 shows the distribution of potential future demand for industrial uses from the Dawson River in Year 2005. Demands are shown on a reach-by-reach basis similar to Table 5.1. Note that these demands would have to be supplied under high security licences. All future industrial demands are for mining projects, except for the demand direct from the proposed Nathan Dam for a 1,400 MW thermal power station at Wandoan.

Table 5-2 Potential Future Industrial Demands, Dawson River

River Reach	Demand Value (ML/Yr)
Upstream of Nathan Dam Site (D1)	25,000[a]
Nathan Dam Site to Gyranda Weir (D2	1,100
Gyranda Weir to Theodore Weir (D3)	0
Theodore Weir to Moura Weir (D4)	4,500
Moura Weir to Neville Hewitt Weir (D5)	1,500
D/S of Neville Hewitt Weir (D6)	1,000
Total	33,100

[a] Direct from Nathan Dam

6. EVALUATION OF THE PERFORMANCE OF THE PROPOSED DAM

6.1 NATHAN DAM PROPOSAL

6.1.1 *Background*

A number of preliminary hydrologic modelling studies have been undertaken by DNR to identify future water storage options in the Dawson River catchment (eg. QWRC, 1983; DPI, 1994a). Based on these studies, major dams at Nathan Gorge and Baroondah, as well as augmentation of existing weirs, plus construction of purpose-built weirs to service local areas, were considered for further investigation.

Further investigation by DNR on major dams at Nathan Gorge and Baroondah found that the increase in catchment yield provided by an additional dam at Baroondah is insignificant compared to the single dam just upstream of Nathan Gorge. On this basis, DNR concluded that an additional dam at Baroondah is not justified and that a single large dam just upstream of Nathan Gorge at AMTD 315.3 km is the preferred option for the Dawson River catchment. Details of the hydrological investigations on the feasibility of the Baroondah Dam were not available for review, and thus the impact of an additional dam at Baroondah on the overall yield from the Dawson River catchment has not been assessed in this study.

6.1.2 *Full Supply Level*

The full supply level (FSL) for the proposed Nathan Dam has not yet been determined. Thus, three FSL's in the range 180 – 185 m AHD were investigated. Table 6.1 shows the 3 FSL's and the corresponding storage capacities investigated for the Nathan Dam. As part of this proposal, two new weirs may also be constructed along the Dawson : Paranui Weir at AMTD 169.7 km and Duaringa Weir at 30.1 km. The storage capacities of Paranui and Duaringa Weirs are 11,000 ML and 6,000 ML respectively. In this study it has been assumed that these two weirs will be built and their storage capacities would remain the same, irrespective of the adopted FSL for the Nathan Dam.

Table 6-1 Range of Dam Sizes Investigated

Full Supply Level (m AHD)	Full Supply Storage Capacity (ML)
180	521,000
183.5	880,000
185	1,079,000

6.2 METHOD OF EVALUATION

The performance of the Nathan Dam has been evaluated on the basis of preliminary results from the daily hydrologic simulation model (Dawson River IQQM Model) configured and calibrated for the Dawson River catchment. All hydrologic modelling concerning the Nathan Dam performance was undertaken by DNR. Full details of the model, its calibration and its application to the Dawson River catchment will be given in DNR (1997b).

Simulation runs with the Dawson River IQQM model have been undertaken for two demand scenarios (discussed later) over the 95 year historical data period 1900 to 1995. For each demand scenario, runs have been undertaken for each of the three dam sizes described in Section 6.1b. Results of analyses undertaken to ascertain the sensitivity of the predicted results to model simplifications, assumptions, allocation rules, operation strategies, etc. were not available for review.

To estimate the catchment yield for each dam size and demand scenario, the Dawson River IQQM model has been run iteratively, progressively adjusting the demand distribution until the adopted demand distribution produced **an 85% monthly reliability of supply to medium security users** and **a 99% monthly reliability for high security users.**

The results presented below are on the basis of no environmental demands in the Dawson River system (i.e. no releases from Nathan Dam, specifically for environmental or riparian requirements).

6.3 ADOPTED DEMAND DISTRIBUTIONS

Hydrological modelling undertaken by DNR for the assessment of the Nathan Dam Proposal investigated two demand scenarios:

- **Scenario 1** - Medium Security Irrigation demand direct from Nathan Dam itself and from the Dawson River downstream of the dam.

- **Scenario 2** - High Security Industrial demand direct from Nathan Dam itself, in addition to Medium Security Irrigation demand as per Scenario 1.

Scenario 1 did not consider additional non-irrigation demand. Additional irrigation demand upstream of the dam was also not considered. Scenario 2 considered some industrial demand direct from Nathan Dam, in addition to irrigation demands, as per Scenario 1.

Tables 6.2 and 6.3 present the adopted additional irrigation and industrial demands of the two scenarios for the three dam sizes. The projected demands for Year 2005 obtained from the demand survey results (Rolfe & Teghe, 1997), together with the revised demand estimates of DNR are also shown in Tables 6.2 and 6.3.

There are a number of inconsistencies between the modelled distributions of potential additional demand from the Dawson River System and the findings from the demand survey and subsequent revision to survey values. The following observations are made on the modelled additional demand distributions.

- All future irrigation demands have been assumed to be of medium security type. Note that according to the demand survey results, approximately 10% of the respondents requested high security water (see Section 5.1c).

- The modelled demands for some river reaches for certain runs are higher than DNR's revised demand estimates (see Table 6.2).

- Future industrial demands downstream of Nathan Dam have been ignored (see Table 6.3).
- Future industrial demand direct from Nathan Dam has been reduced from 25,000 ML/Year to 20,000 ML/Year (see Table 6.3).

Table 6-2 Projected and Modelled Additional Irrigation Demand Distributions, Dawson River System

River Reach	Projected Demand in Year 2005 (ML/Yr)		DNR's Revised Estimate	Adopted Demand (ML/Yr)					
				Scenario 1			Scenario 2		
	'Raw'	'Optimistic'		180 m FSL	183.5 m FSL	185 m FSL	180 m FSL	183.5 m FSL	185 m FSL
Upstream of Nathan Dam Site (D1)	118,469	62,014	30,000[a]	30,000[a]	30,000[a]	30,000[a]	30,000[a]	30,000[a]	30,000[a]
Nathan Dam Site to Gyranda Weir (D2)	0	0	0	0	0	0	0	0	0
Gyranda Weir to Theodore Weir (D3)	39,725	23,491	15,000	12,000	15,000	20,000	10,000	15,000	15,000
Theodore Weir to Moura Weir (D4)	34,021	16,538	25,000	24,000	25,000	30,000	20,000	25,000	25,000
Moura Weir to Neville Hewitt Weir (D5)	50,949	27,098	75,000	54,000	81,900	90,900	36,000	65,400	76,500
D/S of Neville Hewitt Weir (D6)	67,256	34,566	75,000	54,000	81,900	90,900	36,000	65,400	76,500
Total	310,420	163,707	220,000	174,000	233,800	261,800	13,200	200,800	223,000

[a] Direct from Nathan Dam

Table 6-3 Projected and Modelled Additional Industrial Demand Distributions, Dawson River System

River Reach	Projected Demand[a] in Year 2005 (ML/Yr)	Adopted Demand (ML/Yr)					
		Scenario 1			Scenario 2		
		180 m FSL	183.5 m FSL	185 m FSL	180 m FSL	183.5 m FSL	185 m FSL
Upstream of Nathan Dam Site (D1)	25,000[b]	0	0	0	20,000[b]	20,000[b]	20,000[b]
Nathan Dam Site to Gyranda Weir (D2)	1,100	0	0	0	0	0	0
Gyranda Weir to Theodore Weir (D3)	0	0	0	0	0	0	0
Theodore Weir to Moura Weir (D4)	4,500	0	0	0	0	0	0
Moura Weir to Neville Hewitt Weir (D5)	1,500	0	0	0	0	0	0
D/S of Neville Hewitt Weir (D6)	1,000	0	0	0	0	0	0
Total	33,100	0	0	0	20,000	20,000	20,000

[a] Only one set of projected demand values are available; [b] Direct from Nathan Dam

Note that in analysing the future yield of the Dawson River system with Nathan Dam, all other existing water use entitlements along the river (existing allocations, unregulated water use licences, water harvesting licences, etc.) have been maintained at current levels, except for water harvesting licences along the regulated reaches of the river. Water harvesting licences issued prior to 1994 allow harvesting from the river when the flow rate exceeds 15 m^3/s. When modelling the future system, the 15 m^3/s threshold was assumed to be increased to 30 m^3/s.

6.4 MODEL SIMPLIFICATIONS/ASSUMPTIONS

The following key simplifications/assumptions have been made with respect to the system configuration and demand pattern in the Dawson River IQQM model when investigating the performance of the Nathan Dam.

- Urban and Industrial demands (i.e. fixed demands), including the potential future industrial demand from Nathan Dam (under Demand Scenario 2) are uniform throughout the year.
- The current cropping mix in the DVIA is representative of the future monthly irrigation demand pattern.
- On-farm storages will not be available for water harvesting by future irrigators.
- Outlets of all existing weirs along the river will be augmented to cater for extra releases.
- Orange Creek Weir will be rehabilitated and maintained.
- Twenty percent of the existing Theodore Channel irrigation demand was modelled as a 'fixed irrigation demand' with high security to reflect the current 20% higher allocation to channel irrigators.
- All storages along the River (including Nathan Dam) are full at the beginning of the simulation period.
- To overcome problems of handling small weirs in the IQQM model, existing Gyranda, Orange Creek and Theodore Weirs are combined into a single storage located at Gyranda. Similarly, the existing Moura Weir and proposed Paranui Weir are combined into a single weir located at Moura.
- Farmers will plant 100% of the area regardless of the announced allocation level at the start of the water year (on 1 October).
- All existing fixed demands and unregulated water uses remain unchanged in the future, except for the increase in water harvesting threshold from 15 m^3/s to 30 m^3/s in the regulated river reaches downstream of Nathan Dam.

Some of the above simplifications/assumptions (e.g. uniform industrial demand, representativeness of the current monthly irrigation demand pattern, starting Nathan Dam full, etc.) will have an impact on IQQM model results. Results of analyses undertaken to ascertain the sensitivity of some of these assumptions on the predicted performance of the dam were not available for review.

6.5 NATHAN DAM PERFORMANCE

6.5.1 *Yield and Reliability*

Tables 6.4 and 6.5 show the monthly and annual system reliabilities for fixed (high security) and irrigation (medium security) demands for the two modelled demand distribution scenarios. It is recalled that under Scenario 1 the additional demand is only for irrigation, and under Scenario 2 additional demand includes 20,000 ML/year in fixed demand direct from Nathan Dam. Results are shown for three dam FSL's: 180 m AHD, 183.5 m AHD and 185 m AHD. Tables 6.4 and 6.5 also show the additional yields from the system for the different dam sizes and demand scenarios.

Table 6-4 Monthly and Annual System Reliabilities and Yields, Demand Scenario 1

Dam Full Supply Level (m AHD)	Monthly Reliability		Annual Reliability		Additional Yield (ML/Yr)		
	Urban & Indust. Demand	Irrigation Demand	Urban & Indust. Demand	Irrigation Demand	Urban & Indust. Demand	Irrigation Demand	Total
180.0	99.3%	85.0%	95.8%	66.3%	0	174,000	174,000
183.5	98.9%	85.1%	94.7%	62.7%	0	233,800	233,800
185.0	99.3%	84.9%	96.8%	63.2%	0	261,800	261,800

Table 6-5 Monthly and Annual System Reliabilities and Yields, Demand Scenario 2

Dam Full Supply Level (m AHD)	Monthly Reliability		Annual Reliability		Additional Yield (ML/Yr)		
	Urban & Indust. Demand	Irrigation Demand	Urban & Indust. Demand	Irrigation Demand	Urban & Indust. Demand	Irrigation Demand	Total
180.0	99.6%	84.9%	94.8%	67.4%	20,000	132,000	152,000
183.5	99.0%	84.9%	95.8%	62.1%	20,000	200,800	220,800
185.0	99.0%	85.1%	95.8%	67.4%	20,000	223,000	243,000

The reliability in Tables 6.4 and 6.5 has been defined as the percentage of months or years when 100% of the monthly or annual demand was satisfied. Figures 6.1 and 6.2 are plots of annual system reliabilities for additional irrigation supply for demand Scenarios 1 and 2 respectively for irrigation yields shown in Tables 6.4 and 6.5. The above plots indicate that the reliability of the system satisfying (say) 75% of the annual demand would be about **5 – 10% greater** than the equivalent annual reliability.

For all cases analysed the monthly reliability for irrigation demand is about **85%**. (Recalling from Section 6.2 that the demand distribution was adjusted iteratively in the IQQM Model until an 85% monthly reliability for irrigation demand was achieved). The annual reliabilities for different cases analysed range from **62.1% to 67.4%**.

For urban and industrial demands, the monthly reliabilities are generally equal or more than **99%** for all cases. The annual reliabilities for the different cases range from **94.7% to 96.8%.**

The results show that a 20,000 ML high security demand from the Nathan Dam (Scenario 2) would lower the total irrigation yield from the system by **33,800 ML** to **42,000 ML** when compared with Scenario 1. Note that the magnitude of this reduction will depend on the locations from where high security demands are met.

6.5.2 *Average Annual Water Diversions For Irrigation*

Figures 6.3 and 6.4 show time series plots of water diversions for additional irrigation use on an annual basis for the different dam sizes for demand Scenarios 1 and 2 respectively. Note that water diversions to irrigation areas are comprised of both on-allocation and off-allocation water. On-allocation water is obtained from water released from regulated storages specifically for irrigation orders by the farmers. Off-allocation water is obtained from water harvested from the river when the flow rate exceeds a specified threshold value (30 m^3/s).

Tables 6.6 and 6.7 show the average annual on-allocation, off-allocation and total water use for irrigation for the two demand scenarios on a reach-by-reach basis. Note that the values in Tables 6.6 and 6.7 include the water used by existing irrigators. Tables 6.6 and 6.7 also show the average annual diversions under existing conditions.

6.5.3 *Discussion On Yield Estimates*

The yield estimates obtained from the Dawson River IQQM model are sensitive to the adopted type and level of demand and its distribution along the Dawson River, as well as the variation of demand through the year, i.e. monthly pattern. The yield estimates are also sensitive to a number of modelling assumptions (see Section 6.4).

For reasons given above there is considerable uncertainty in yield estimates obtained from IQQM modelling undertaken to date. Nevertheless, the yield estimates given by DNR are considered to be **high** for a number of reasons, including:

- Nathan Dam has been assumed full at the commencement of simulation runs. If this is not the case, the predicted yields are likely to be lower.

- Future high security demands (irrigation, urban and industrial) downstream of Nathan Dam have been ignored. Taking these demands into account will lower the total yields.

- The projected future industrial demand from Nathan Dam was estimated at 25,000 ML (see Section 5). However, only 20,000 ML of this has been modelled under Scenario 2. The incorporation of the additional demand will further lower the predicted yield.

- The modelling undertaken has assumed that on average, 233 GL/year would be available from the Don River for Dawson River water users. Should this inflow be reduced because of increased future water use in the Don River catchment, the yield available from the Dawson River would be lower than estimates given by DNR.

FIGURE 6.1

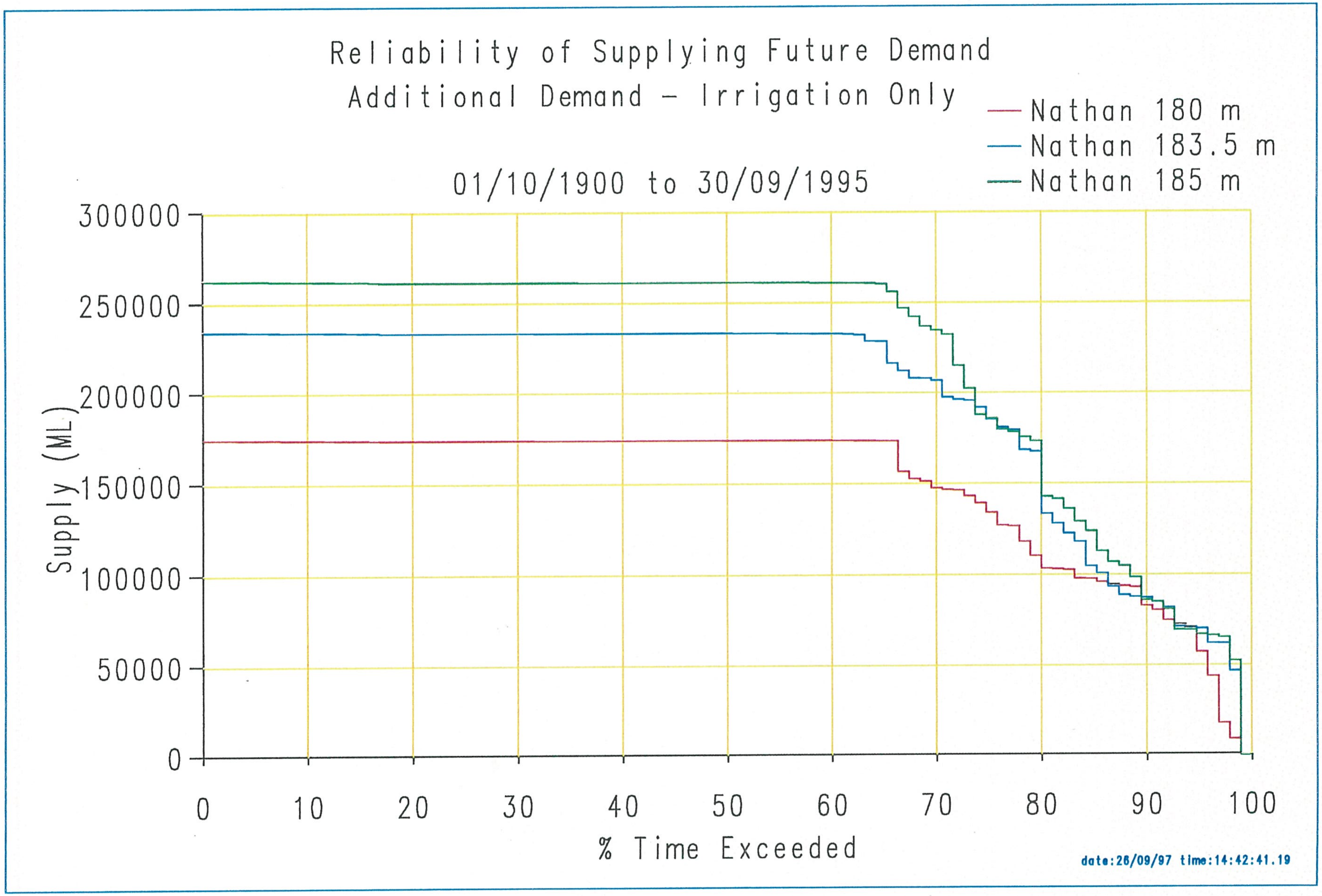

Figure 6.1 Annual Irrigation Supply Reliability, Additional Demand Scenario 1 (Irrigation Only)

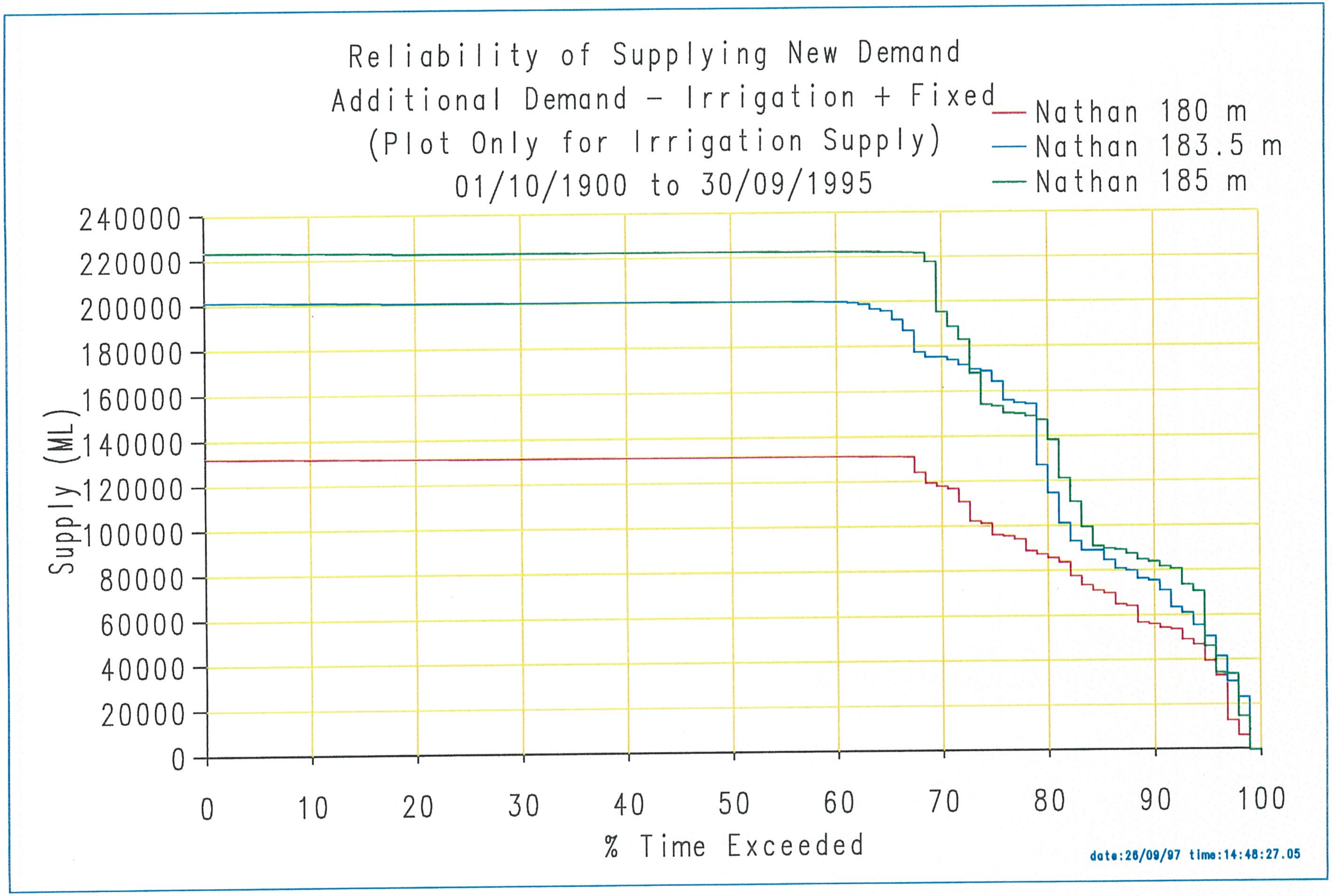

Figure 6.2 Annual Irrigation Supply Reliability, Additional Dam and Scenario 2 (Irrigation plus 20,000 ML Industrial)

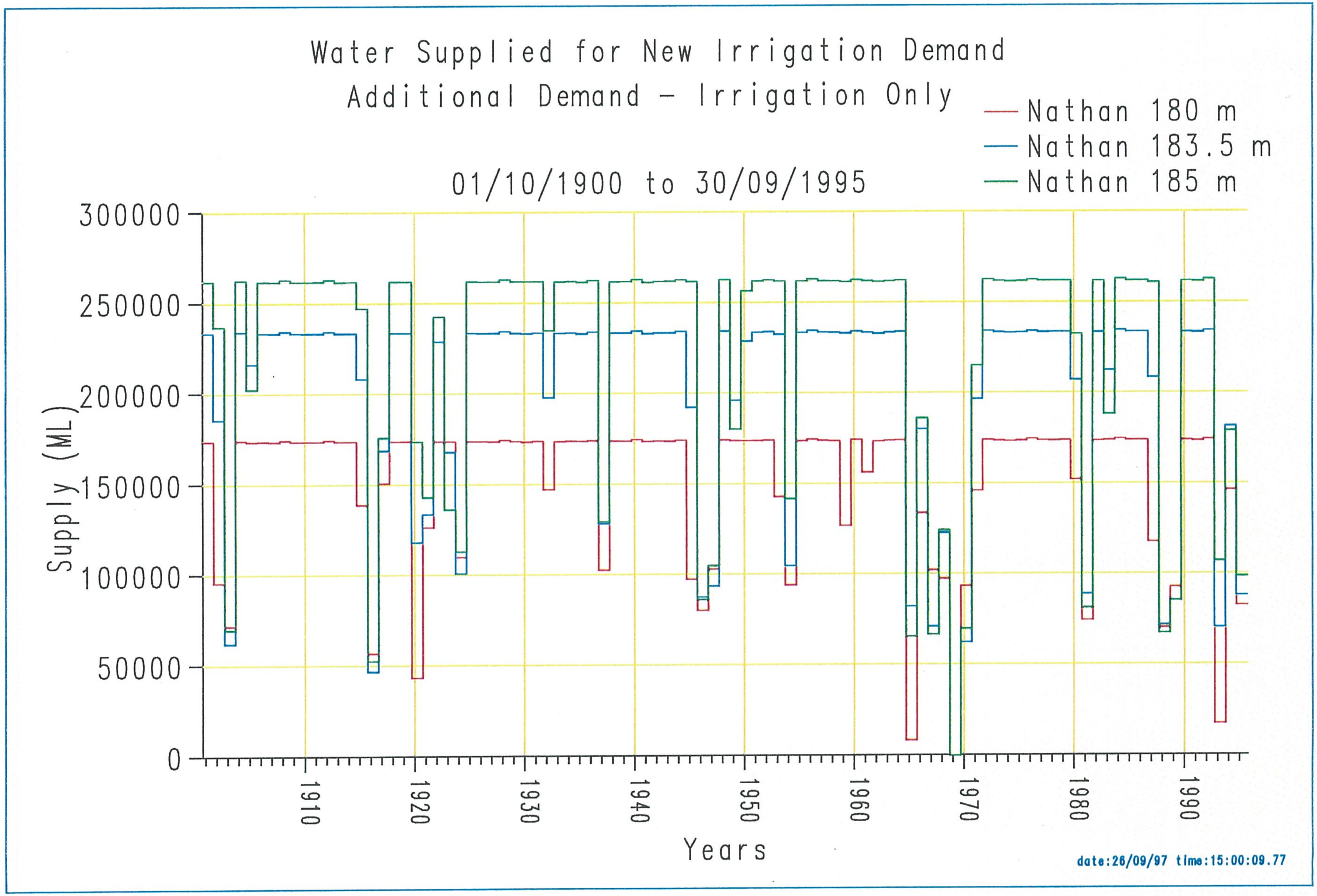

Figure 6.3 Annual Water Diversions for Additional Irrigation, Demand Scenario 1 (Irrigation Only)

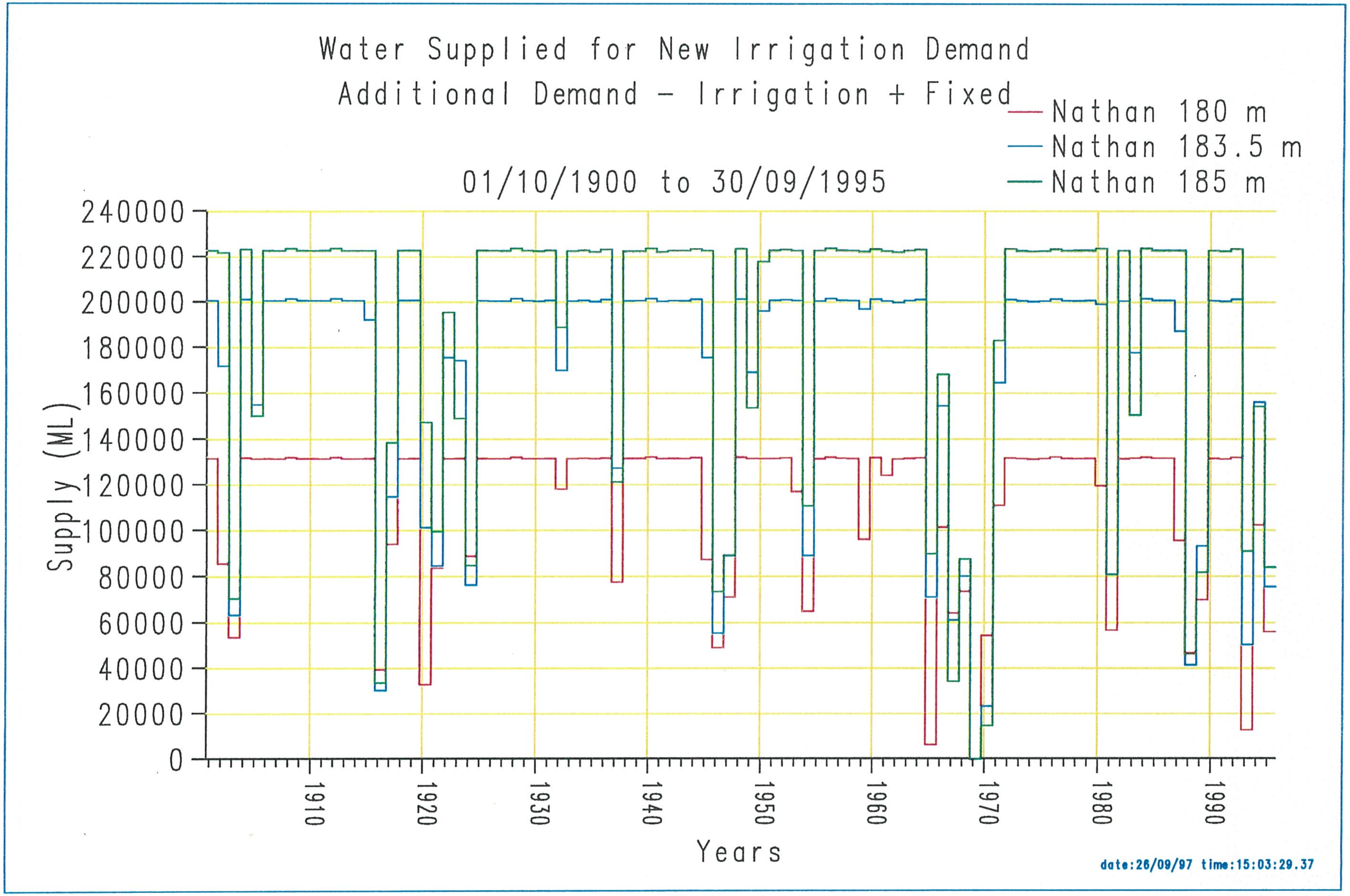

Figure 6.4 Annual Water Diversions for Additional Irrigation, Demand Scenario 2 (Irrigation plus Industrial)

Details of sensitivity analyses undertaken to date to investigate the impact of significant assumptions/ simplifications on system performance (i.e. yield, reliability, etc.) were not available for review. Some of the assumptions outlined in Section 6.4 (e.g. retention of Orange Creek Weir, starting water level in Nathan Dam, etc.) could have a significant impact on estimated reliabilities and yields. Additional modelling is required to refine the estimates of the yield from the Dawson River system.

It is also noted that the yield analyses to date have not catered for environmental/riparian releases from the Dam. These releases will lower the available yield further.

6.6 UNREGULATED SECTIONS

There are two types of licences for unregulated flow extraction: Direct irrigation from the water course and harvesting into on-farm storages for subsequent use for irrigation or other purposes. To date, modelling undertaken by DNR has assumed that water use along unregulated sections of the Dawson River upstream of Nathan Dam and the tributaries of the Dawson River will remain unchanged from existing conditions. Thus, the average annual water extractions for direct irrigation and water harvesting will remain at **6,926 ML** and **7,169 ML** respectively.

It should be noted that the yield available from the system for regulated water supply will be reduced from values presented in Section 6.5 if new licences, or increases to the existing licenced volumes are granted.

6.7 WATER HARVESTING

As explained in Section 6.3, construction of Nathan Dam will result in an increase in the threshold for water harvesting for the pre-1994 licence holders downstream of the dam. Furthermore, the construction of the dam would reduce the number of events generating flows greater than 30 m^3/s downstream of the dam. Thus, the construction of the dam will reduce water harvesting opportunities for existing licence holders. Tables 6.6 and 6.7 show that the reduction in availability of harvested water (off-allocation water) for the various cases analysed is between **3.5%** to **24.0%** compared with the existing situation. The reduction is not greater, probably because of the significant uncontrolled tributary inflows that enter the Dawson River downstream of the dam.

Table 6-6 Average Annual Water Use for Irrigation, Demand Scenario 1

River Reach	Average Annual Irrigation Diversion (ML/Year)											
	Existing Conditions			180 m FSL			183.5 m FSL			185 m FSL		
	On-Alloc.	Off-Alloc.	Total	On-Alloc.	Off-Alloc.	Total	On-Alloc.	Off-Alloc.	Total	On-Alloc.	Off-Alloc.	Total
Upstream of Nathan Dam Site (D1)	0	0	0	24,392[a]	-	24,392[a]	24,499[a]	-	24,499[a]	24,394[a]	-	24,394[a]
Nathan Dam Site to Gyranda Weir (D2)	679	433	1,112	840	145	985	880	95	975	892	74	966
Gyranda Weir to Theodore Weir (D3)	3,500	5,934	9,434	15,265	2,744	18,009	17,934	2,279	20,213	21,856	2,367	24,223
Theodore Weir to Moura Weir (D4)	19,352	15,087	34,439	39,800	10,174	49,974	37,710	13,036	50,746	40,151	14,954	55,105
Moura Weir to Neville Hewitt Weir (D5)	4,573	8,358	12,931	49,076	8,078	57,154	71,368	8,367	79,735	78,173	8,463	86,636
D/S of Neville Hewitt Weir (D6)	1,576	13,332	14,908	43,785	14,343	58,128	65,191	15,373	80,564	71,749	15,780	87,529
Total	29,680	43,144	72,824	172,858	39,611	212,469	217,042	39,690	256,732	237,215	41,638	278,853

[a] Direct from Nathan Dam

Table 6-7 Average Annual Water Use for Irrigation, Demand Scenario 2

River Reach	Average Annual Irrigation Diversion (ML/Year)											
	Existing Conditions			180 m FSL			183.5 m FSL			185 m FSL		
	On-Alloc.	Off-Alloc.	Total	On-Alloc.	Off-Alloc.	Total	On-Alloc.	Off-Alloc.	Total	On-Alloc.	Off-Alloc.	Total
Upstream of Nathan Dam Site (D1)	0	0	0	24,397	-	24,397	24,376	-	24,376	24,394	-	24,394
Nathan Dam Site to Gyranda Weir (D2)	679	433	1,112	836	151	987	873	99	972	886	82	968
Gyranda Weir to Theodore Weir (D3)	3,500	5,934	9,434	13,547	2,760	16,307	17,876	2,214	20,090	17,856	2,102	19,958
Theodore Weir to Moura Weir (D4)	19,352	15,087	34,439	37,109	9,258	46,367	39,221	10,560	49,781	37,629	12,516	50,145
Moura Weir to Neville Hewitt Weir (D5)	4,573	8,358	12,931	34,467	7,263	41,730	57,755	7,774	65,529	66,520	8,009	74,529
D/S of Neville Hewitt Weir (D6)	1,576	13,332	14,908	29,536	13,349	42,885	52,015	14,478	66,493	60,352	14,978	75,330
Total	29,680	43,144	72,824	139,892	32,781	172,673	192,116	35,125	227,241	207,637	37,687	245,324

[a] Direct from Nathan Dam

7. IMPACT OF THE PROPOSED DAM ON EXISTING HYDROLOGY

7.1 GENERAL

The construction and operation of the proposed dam and the release of stored water will have an impact on the existing hydrology of the Dawson River. Because no works or additional water demands are to take place upstream of the dam site, all potential hydrological impacts will be at and downstream of the dam site. These include:

- Impacts on flow behaviour, including flooding,
- Impacts on other storages on the Dawson River,
- Impacts on groundwater recharge,
- Impacts on sediment transport and deposition,
- Impacts on water quality,
- Impacts on environmentally sensitive features, including wetlands, and
- Impacts on environmental and riparian flows.

This section identifies and describes each of the above impacts, except for impacts on environmental and riparian flows. Environmental and riparian flow impacts are not discussed or assessed in this report for reasons given in Section 1.

The Dawson River already has a series of impoundments and thus a modified hydrological regime (alterations to natural flow, changes to sediment transport behaviour, changes to water quality, etc.) downstream of the proposed dam. This fact has to be taken into consideration when assessing the downstream impacts of the proposed dam.

7.2 IMPACT ON DOWNSTREAM FLOW BEHAVIOUR

7.2.1 *Flow Distribution*

Figures 7.1 through to 7.6 show the ranked predicted daily Dawson River flows at Woodleigh, Beckers and Boolburra streamgauging stations (see Figure 2.2 for locations) for the two demand scenarios investigated. The ranked predicted daily flows are also shown for the natural flow and existing flow conditions. Comparisons with the natural flow case demonstrate the impact of the impoundments and water use in the system on downstream flow behaviour. In general, the proposed dam will decrease the occurrences of high flows and increase the occurrence of low flows compared to 'natural flows' in the River.

7.2.2 *Mean Daily and Annual Flows*

Tables 7.1 and 7.2 show the predicted mean daily and mean annual flows respectively in the Dawson River at Woodleigh, Beckers and Boolburra for the various situations analysed for the simulation period 1900 – 1995.

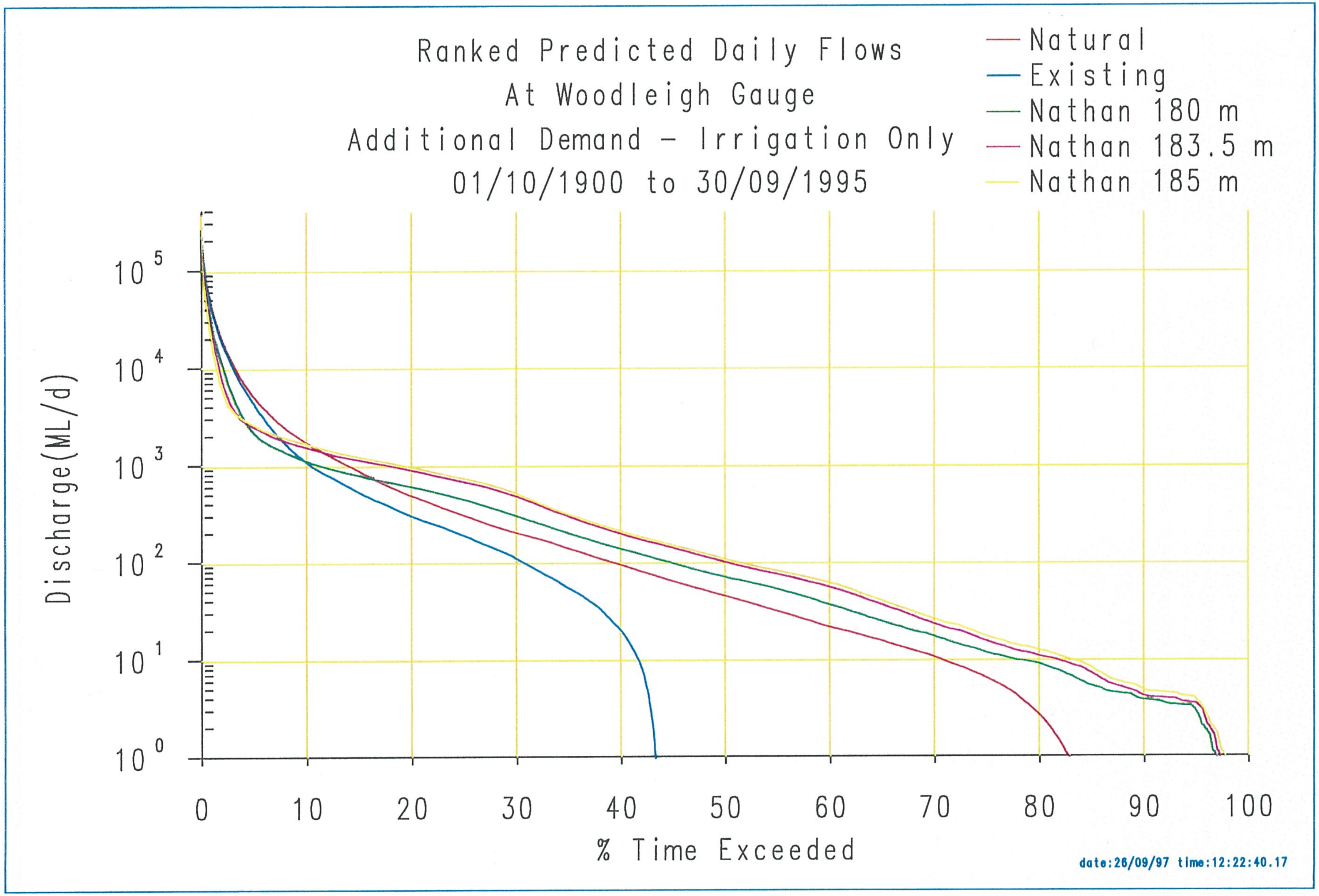

Figure 7.1 Ranked Predicted Dawson River Flows at Woodleigh vs Percentage Time Exceeded, Demand Scenario 1 (Irrigation Only)

FIGURE 7.1

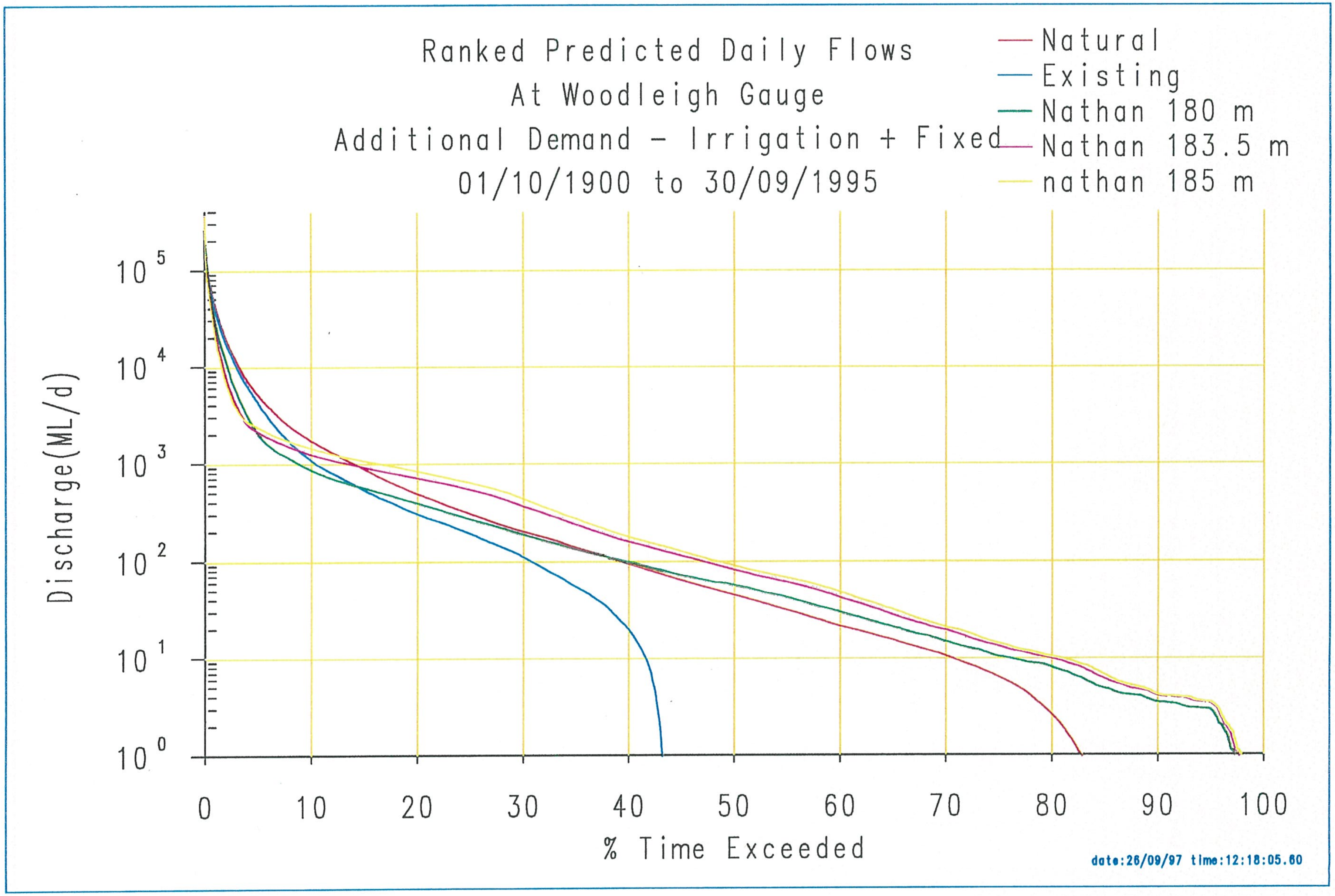

Figure 7.2 Ranked Predicted Dawson River Flows at Woodleigh vs Percentage Time Exceeded, Demand Scenario 2 (Irrigation and Industrial)

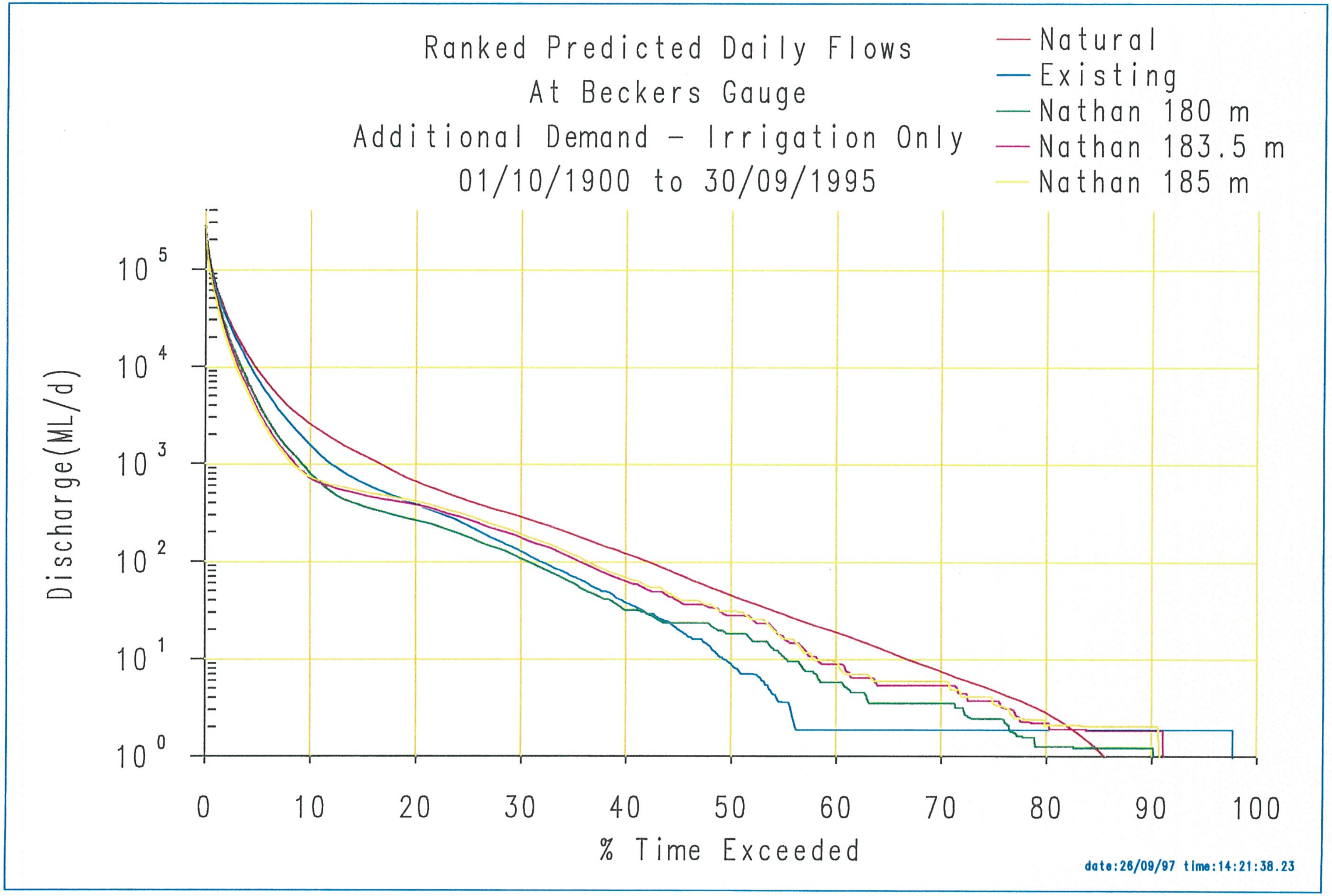

Figure 7.3 Ranked Predicted Dawson River Flows at Beckers vs Percentage Time Exceeded, Demand Scenario 1 (Irrigation Only)

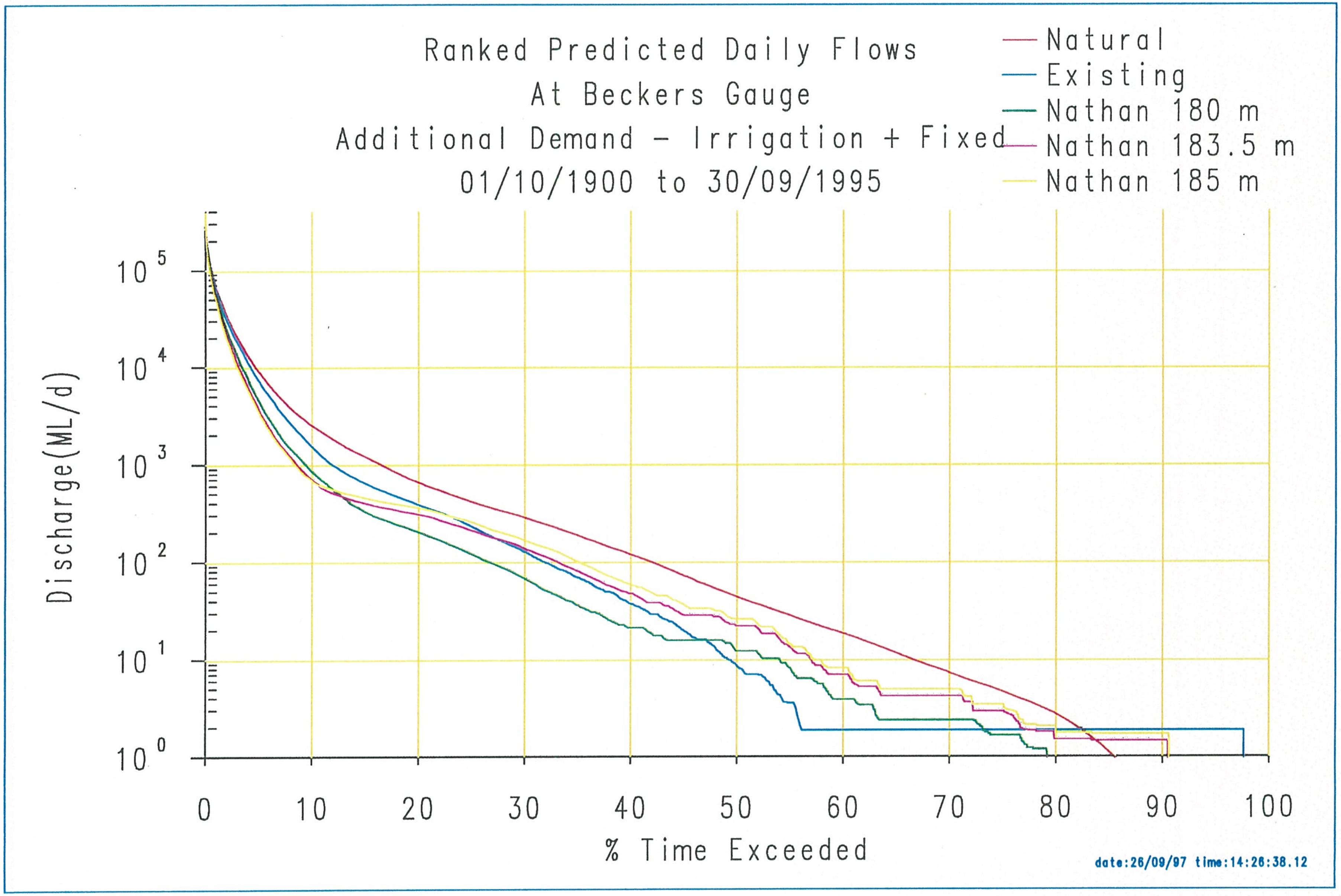

Figure 7.4 Ranked Predicted Dawson River Flows at Beckers vs Percentage Time Exceeded, Demand Scenario 2 (Irrigation and Industrial)

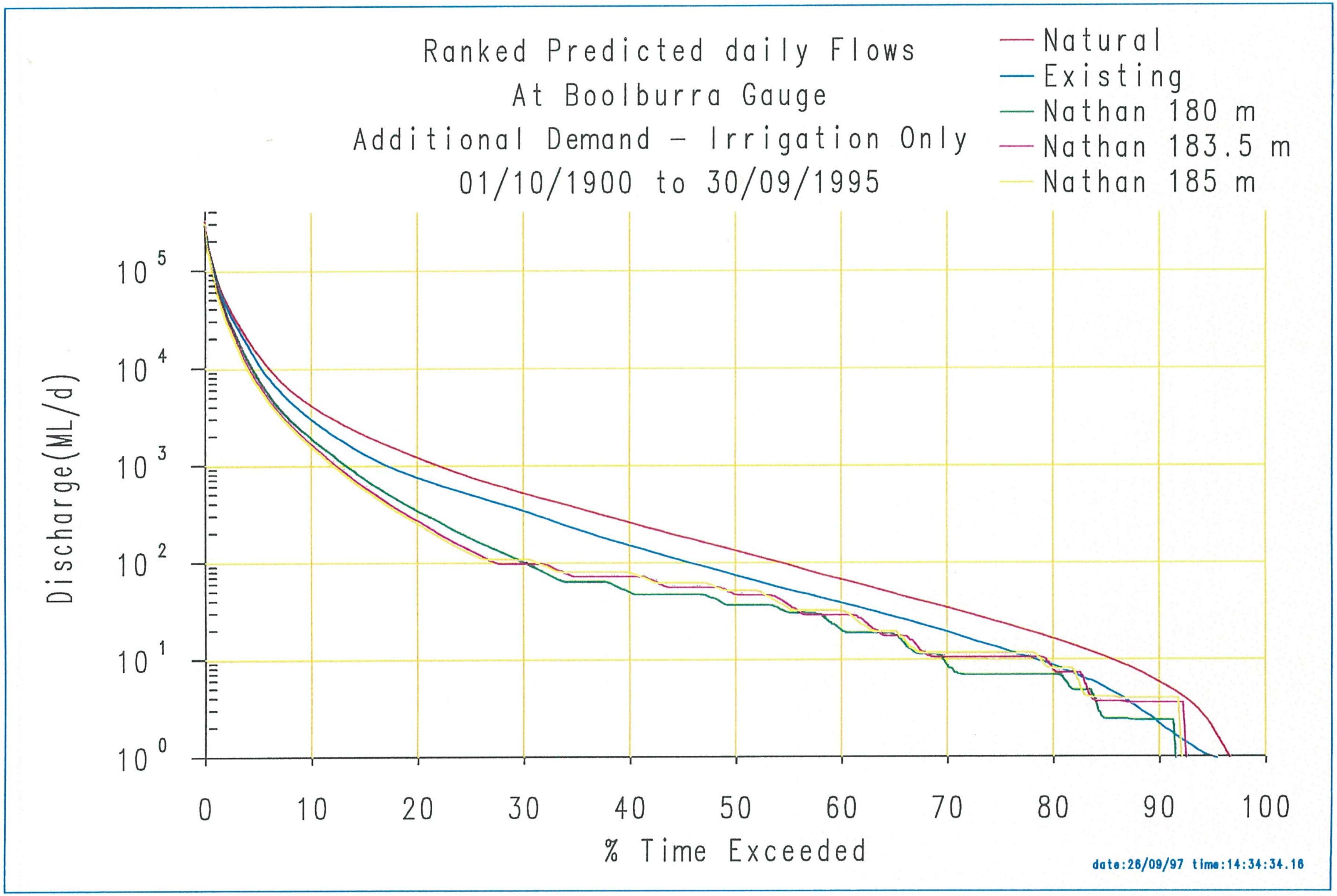

Figure 7.5 Ranked Predicted Dawson River Flows at Boolburra vs Percentage Time Exceeded, Demand Scenario 1 (Irrigation Only)

FIGURE 7.5

FIGURE 7.6

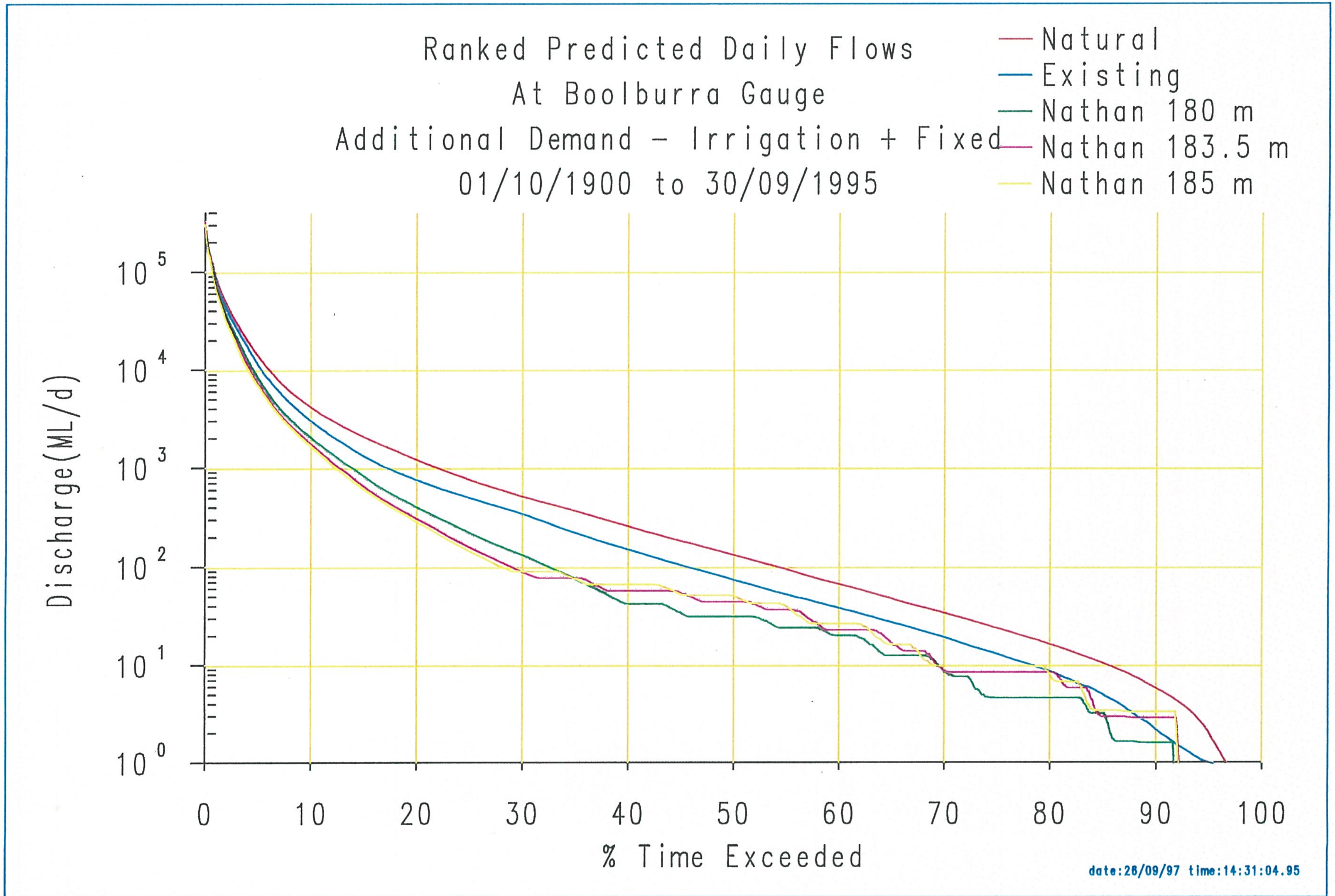

Figure 7.6 Ranked Predicted Dawson River Flows at Boolburra vs Percentage Time Exceeded, Demand Scenario 2 (Irrigation and Industrial)

Table 7-1 Predicted Mean Daily Flows for the Simulation Period, Dawson River

Location	Mean Daily Flow (ML)							
	Natural Flow Case	Existing Conditions	Demand Scenario 1 (Irrigation Only)			Demand Scenario 2 (Irrigation plus Industrial)		
			180 m FSL	183.5 m FSL	185 m FSL	180 m FSL	183.5 m FSL	185 m FSL
Woodleigh	1,820	1,642	1,359	1,292	1,241	1,321	1,246	1,212
Beckers	2,771	2,474	2,038	1,875	1,796	2,068	1,893	1,820
Boolburra	3,844	3,407	2,882	2,677	2,585	2,940	2,721	2,631

Table 7-2 Predicted Mean Annual Flow Volumes for the Simulation Period, Dawson River

Location	Mean Annual Flow (GL)							
	Natural Flow Case	Existing Conditions	Demand Scenario 1 (Irrigation Only)			Demand Scenario 2 (Irrigation plus Industrial)		
			180 m FSL	183.5 m FSL	185 m FSL	180 m FSL	183.5 m FSL	185 m FSL
Woodleigh	665	600	496	472	453	483	455	442
Beckers	1,012	904	744	685	656	755	695	665
Boolburra	1,404	1,244	1,053	978	944	1,074	994	961

The results in Tables 7.1 and 7.2 show that the impact on downstream flow behaviour will increase with Nathan Dam FSL (and accompanying increase in water use). The existing entitlements (i.e. existing storages and water use) have reduced the 'natural flows' at Woodleigh, Beckers and Boolburra by approximately **9.8%, 10.7%** and **11.4%** respectively. The proposed dam will reduce the 'natural flows' by approximately **25.3% to 33.4%** at Woodleigh, **25.4% to 35.2%** at Beckers and **23.5% to 32.8%** at Boolburra, depending on the selected dam FSL and demand scenario. This represents a further reduction of **15 – 20%** compared to the flows under existing entitlements.

7.2.3 *Flood Flows*

Table 7.3 shows the impact of the proposed dam on flows greater than 50,000 ML/d, 100,000 ML/d, 200,000 ML/d and 300,000 ML/d at 3 locations in the river. The simulation results indicate that the proposed dam will have little impact downstream on flows greater than 200,000 ML/d (i.e. large floods) when compared with the existing river conditions. They also show that the proposed dam will have most impact on small to moderate flood events (i.e. 50 – 100,000 ML/d flows). There is little difference in results for the two demand scenarios.

Table 7-3 No. of Days in Which Flows in the Dawson River Exceeded 50,000 ML, 100,000 ML, 200,000 ML and 300,000 ML during the Simulation Period for the Different Situations Analysed

System Condition	No. of Days > 50,000 ML			No. of Days > 100,000 ML			No. of Days > 200,000 ML			No. of Days > 300,000 ML		
	Woodleigh	Beckers	Boolburra	Woodleigh	Beckers	Boolburra	Woodleigh	Beckers	Boolburra	Woodleigh	Beckers	Boolburra
Natural Flow	290	500	670	110	205	320	15	40	85	4	8	8
Existing Conditions	275	460	620	105	195	290	14	33	75	5	7	5
Nathan (Demand Scenario 1)												
180 m FSL	210	400	540	85	170	260	14	30	70	4	7	5
183.5 m FSL	175	365	490	70	150	245	12	30	55	4	7	4
185 m FSL	155	340	475	65	145	240	11	27	55	4	7	4
Nathan (Demand Scenario 2)												
180 m FSL	215	405	545	90	170	260	14	30	70	4	7	5
183.5 m FSL	185	375	500	75	150	245	12	30	55	4	7	4
185 m FSL	170	350	490	65	150	240	12	28	55	4	7	4

7.3 IMPACT ON OTHER STORAGES

There are currently 6 weirs (storages) along the Dawson River. The combined storage capacity of these weirs is **61,670 ML**. Individually, all of these weirs are quite small, the capacities varying from 4,760 ML to 17,300 ML. The largest of these storages, the Glebe Weir (with a storage capacity of some 17,300 ML), will be drowned by the proposed dam. The remaining storage capacity is thus **44,370 ML**. The construction of two new weirs, Paranui Weir (11,000 ML) and Duaringa Weir (6,000 ML), will boost the storage capacity downstream of the proposed dam to approximately **61,400 ML**. The combined storage capacity of all weirs is not very significant compared to the storage capacity of the proposed dam (from 521,000 ML for a dam with an FSL of 180.0 m AHD, to 1,079,000 ML for a dam with and FSL of 185.0 m AHD).

Notwithstanding the insignificance of the storage capacity of downstream weirs, the proposed dam will change the characteristics of the Dawson River (including the weirs) downstream of the dam over a considerable distance. The primary impacts of the proposed dam on these smaller storages will include:

- Reduction of inflow variability,
- Changes to sediment transport behaviour, and
- Changes to water quality.

Only the first of the above impacts, i.e. inflow variability, is discussed in this Section. Changes to sediment transport behaviour and water quality are discussed in Sections 7.5 and 7.6 respectively.

The existing storages along the Dawson River have little impact on downstream reaches at times of high flow. However, at times of low flow they can produce significant impacts on downstream flow behaviour. They can even lead to the cessation of downstream flows during the dry season as demonstrated in the flow distribution plots in Figures 7.1 through to 7.6. The entrapment of upstream inflows and expected year round release from the proposed dam for water demands along the entire downstream reach of the Dawson River is likely to reduce the inflow variability into these storages, and thus minimise the potential for the river to run dry during the dry season.

7.4 IMPACT ON GROUNDWATER BEHAVIOUR

The construction of the proposed dam will impact on the boggomosses near the dam site and groundwater recharge near the dam site and downstream. Some of these impacts have been investigated in a detailed study on boggomosses and regional groundwater hydrology (DNR, 1996).

7.4.1 *Boggomosses*

About 46 out of the 68 boggomosses found in the vicinity of the dam will be inundated if the proposed dam is built with an FSL of 185 m AHD (DNR, 1996). However, many of these boggomosses, which are below FSL, are expected to continue flowing because the artesian heads in this region are higher than 185 m AHD.

The proposed dam is also likely to indirectly impact on those boggomosses that are not inundated because of their connection with the Precipice Sandstone. The Precipice Sandstone outcrops provide a connection between the underlying aquifer and the dam storage. This will cause a backup effect to occur in the aquifer heads. The change in head distribution within the aquifer will in turn affect the regional flow patterns, which in turn will impact on the boggomosses (DNR, 1996). The modelling that was undertaken in the DNR Study showed that:

- Artesian heads where boggomoss leakage occurs will increase by up to 3 m.
- Boggomoss discharges will increase by between 6% and 85%.
- The bulk of the above head and discharge effects will be felt after approximately 9 years.

7.4.2 *Dam and Local Tributary Inflows*

The effect of the dam on the regional flow patterns will result in changes to the volume of discharge that will occur from the aquifer to the nearby tributaries of the Dawson River (DNR, 1996). However, detailed modelling studies undertaken in DNR (1996) indicate that the magnitude of the changes to in-stream baseflows are not large and hence, not significant.

7.4.3 *Downstream Impacts*

After the construction of the proposed dam, extensive irrigation and larger regular river flow may result in rising water tables downstream along the alluvium.

The alluvial sections between Cracow to Theodore are currently saturated (J. Lloyd – Pers. Comm.). The increased irrigation activity and larger river flows may cause water tables to react quickly in this reach.

Although storages have been present and irrigation has taken place for many years in the areas of dry alluvium downstream of Theodore (see Section 2.6b), to date there has not been any evidence of a significant impact on rising water tables in this area as a result of past activities (J. Lloyd – Pers. Comm.). In any case, because this section of the alluvium is currently dry, it is unlikely to cause significant problems for many years.

7.5 IMPACT ON SEDIMENT TRANSPORT AND DEPOSITION

Levels of suspended solids and turbidity in the Dawson River are moderate to high, especially during flow events. The suspended solid levels appear to generally increase in a downstream direction (see Section 2.8c). Quite high levels have been recorded (337 mg/L) even upstream of the proposed dam site at Taroom after a flow event (Noble et al, 1996).

The proposed dam is likely to trap most of the sediment transported down the river. This in turn will reduce sediment supply to downstream reaches. Because of the series of downstream weirs, in conjunction with the gentle hydraulic gradients between these weirs, it is unlikely that significant amounts of sediment will be mobilised in the Dawson River downstream of the proposed dam, except during large flow events, which are infrequent. Thus, the proposed dam is likely to improve the turbidity and reduce the suspended solid loads downstream of the dam site.

7.6 IMPACT ON WATER QUALITY

The proposed dam is unlikely to impact on the groundwater quality in the study area, any impact is likely to be confined to surface water quality. The proposed dam is likely to affect the water quality parameters discussed below.

7.6.1 *Dissolved Oxygen*

Irrigation outlets at the proposed dam are likely to be at the bottom of the dam. Water released from the bottom of the dam will be at a lower temperature and will have a lower DO level than waters downstream. These differences are likely to be evident for a considerable distance downstream from the dam. This impact could be minimised by using multi-level outlets for irrigation releases.

7.6.2 *Nutrients*

The total nitrogen (TN), total phosphorus (TP) and median TN:TP ratios along the Dawson River are quite high (see Section 2.8). All of the above nutrient parameters are generally well above ANZECC (1992) upper limits for protection of aquatic ecosystems in rivers and streams. Land use changes and additional irrigation (as a consequence of intense agricultural activities) that will follow the construction of the proposed dam are likely to increase nutrient concentrations further unless appropriate action is taken to reduce nutrient loads into the Dawson River.

7.6.3 *Algal Blooms*

Most of the factors conducive to the growth of blue-green algae (Cyanobacterial blooms) are present in the Dawson River system. This would suggest that algal blooms are a common occurrence in the Dawson River. Although algal blooms have occurred in a number of rivers in the Fitzroy system over the last few years, only one incidence of algal blooms has been reported in the Dawson River in recent times (Moura Weir, December 1994).

According to Noble et al (1996), low penetration of light into the water column, because of high suspended solids levels, may have produced conditions extremely difficult for algal growth along the Dawson River. Low algal densities are often associated with high levels of suspended solids. This hypothesis is supported by the formation of the algal bloom in Moura Weir in December 1994, when the sediment load had decreased (Johnstone et al, 1995). Thus, it is likely that downstream of the dam, the potential for algal blooms in the Dawson River may increase because of reduced sediment supplies from upstream reaches.

7.7 IMPACTS ON DOWNSTREAM ENVIRONMENTALLY SENSITIVE FEATURES

There are a number of key stream features including wetlands along the Dawson River, as outlined in Section 2.11. Each river reach downstream of the proposed dam contains a variety of these features, which rely on river flows over a broad range for their continued existence and well being. Most of these features require flows in the range 30,000 – 70,000 ML/d to connect with the river (see Section 2.11).

The impact of the proposed dam on the frequency of moderate to large flow events was discussed in Section 7.2c. The results in Table 7.3 show that there will be permanent reduction in predominantly the small to medium flow events downstream of the proposed dam. The investigation of the impact of this reduction on the wetlands, floodplain and riparian zones that are dependent on these flows is beyond the scope of the study.

8. CONCLUSIONS

8.1 GENERAL

The performance and hydrological impact of the proposed Nathan Dam on the Dawson River at AMTD 315.3 km have been investigated for 3 full supply levels (FSL's): 180 m AHD, 183.5 m AHD and 185 m AHD. These FSL's correspond to storage capacities of 521,000 ML, 880,000 ML and 1,079,000 ML respectively. This investigation has also included the proposed 2 new weirs that may be constructed on the Dawson River as part of the Nathan Dam proposal: Paranui Weir (11,000 ML) and Duaringa Weir (6,000 ML) at AMTD's 169.7 km and 30.1 km respectively.

This study has been undertaken prior to the completion of the WAMP study by DNR that was to provide essential inputs for this study, namely the results from the daily hydrologic modelling (IQQM Modelling), and the investigations on environmental and riparian flow requirements. Only preliminary results from the IQQM model were available. No results at all were available on environmental and riparian flow requirements. Thus, the findings made in this study concerning the performance and hydrological impact of the Nathan Dam are necessarily based on preliminary results from the catchment yield studies. The impact of environmental and riparian flow releases on catchment yield from the Dawson River system has not been assessed in this study.

8.2 FUTURE DEMAND AND PREDICTED YIELD

Based on a recent demand survey, future irrigation demand estimates in the Year 2005 for the Dawson River catchment range from about 101,300 ML under a 'Pessimistic' scenario to 163,700 ML under an 'Optimistic' scenario. The 'raw' unprocessed irrigation demand in the Year 2005 was some 310,000 ML. About one-third of this demand is upstream of the proposed dam site. The above demand values do not include the 'location not known or specified' component of the survey. A subsequent revision of demand estimates by DNR based on local factors that were apparently not taken into account in the original survey estimated the maximum potential future irrigation demand from the Dawson River System to be some 220,000 ML/year. The potential future additional industrial demand in the Year 2005 has been estimated at 33,100 ML. Of this, 25,000 ML is for a proposed thermal power station at Wandoan.

The current yield from the Dawson River system is estimated to be approximately 60,000 ML/yr with monthly and annual reliabilities of about 93% and 73% respectively for the situation with maximum diversions from the system. More realistic assumptions regarding the announced allocation rule and irrigation planting strategy would probably lower the above reliabilities. The current water use from the system is significantly less than 60,000 ML/yr.

The proposed dam will increase the yield from the Dawson River system significantly. Modelling undertaken by DNR has predicted that Nathan Dam will provide an additional 152,000 to 174,000 ML/yr with an FSL of 180.0 m AHD, an additional 220,800 to 233,800 ML/yr with an FSL of 183.5 m AHD, and an additional 243,000 to 261,800 ML/yr with an FSL of 185.0 m AHD. These yields have been derived to achieve a monthly irrigation water supply reliability of 85%. Annual irrigation water supply reliability for the post-Nathan system has been estimated at between 62.1% and 67.4%.

Reliability of urban and industrial water supply is much higher with monthly and annual reliabilities of generally over 99.0% and 95% respectively.

The above yield estimates are sensitive to the adopted total demand and its type and distribution along the Dawson River, as well as the distribution of these demands through the year. The yield estimates are also sensitive to a number of simplifications and assumptions made in the IQQM model of the Dawson River system.

For reasons given above, there is considerable uncertainty in yield estimates obtained from IQQM modelling undertaken to date. Nevertheless, the yield estimates obtained by DNR are considered high for a number of reasons that are outlined in Section 6.5c. Additional modelling is required to refine the estimates of the yield from the Dawson River system. It is also noted that the yield analyses presented to date have not catered for environmental/riparian releases from the dam. These releases will further lower the available yield.

The construction of the proposed Nathan Dam will reduce water harvesting opportunities for existing licence holders. The reduction in availability of harvested water (off-allocation water) is between 3.5% and 24.0% compared to the existing situation, depending on the adopted FSL for the dam and demand distribution.

8.3 HYDROLOGICAL IMPACTS

All potential hydrological impacts of the proposed Nathan Dam will be at, and downstream of the dam site. There will be no hydrological impacts upstream because no works or additional water demands are to take place upstream of the dam site.

Any impacts of the proposed dam on existing groundwater hydrology are likely to be minor. However, there will be significant impacts on surface water hydrology. The Dawson River already has a series of impoundments and thus a modified hydrological regime (alterations to natural flow, changes to sediment transport behaviour, changes to water quality, etc.) downstream of the proposed dam. This fact has to be taken into consideration when assessing the downstream impacts of the proposed dam.

The existing series of impoundments has reduced 'natural flows' in the river downstream of the proposed dam by about 10%. The proposed dam will further reduce natural flows by an additional 15 – 20%, depending on the adopted FSL for the dam. The total reduction to 'natural flow' after the construction of Nathan Dam will be 25 – 30%.

The proposed dam will have little impact downstream on large floods (i.e. flows greater than 200,000 ML/d) compared to existing conditions. However, it will have a noticeable impact on small to moderate flood events (i.e. 50,000 – 100,000 ML/d flows). The reduction in small to moderate flood flows may affect the wetlands, floodplain and riparian zone along the river that are dependent on these flows.

Levels of suspended solids and turbidity in the Dawson River are moderate to high, especially during flow events. Suspended solids levels appear to generally increase in a downstream direction. The proposed dam is likely to trap most of the sediment transported down the river. This in turn is likely to improve the turbidity and reduce the suspended solid loads downstream of the dam site.

Releases from the proposed dam are likely to lower dissolved oxygen levels in the Dawson River for a considerable distance downstream from the dam, especially during times of low flow. In addition, land use changes and additional irrigation (as a consequence of intense agricultural activities) that will follow the construction of the proposed dam are likely to further increase the already high nutrient concentrations in the Dawson River. High nutrient concentrations, together with the likely reduction in turbidity and suspended sediment concentrations, may increase the potential for algal blooms in the Dawson River downstream of the dam.

9. REFERENCES

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APPENDIX A

REVISED FUTURE IRRIGATION WATER DEMAND DISTRIBUTION ALONG THE DAWSON RIVER.