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PLANNING TO MEET THE GROWING DEMANDS ON NORTHLANDS WATER RESOURCES

D.L. ROKE
Manager — Water Resources,
Northland Catchment Commission.

ABSTRACT

The growth in horticultural and some industrial development in selected areas of Northland has led to a need for more specific and careful planning and control of limited resources in a number of major catchments. The potential irrigation demands for horticulture comprise over 60% of Northland's potential water requirements. By contrast, farm water supply needs are only 11% of these needs. Because of their importance to the Northland economy, and in the legislation these needs are given a high priority in water resource management planning. Land uses, including pastoral farming, require careful operation to reduce diffuse sources of pollution.

Keywords:

INTRODUCTION

In 1980 the Ministry of Agriculture and Fisheries identified approximately 13 000 ha or 1% of Northland soils as having potential for horticulture. Of these 8 700 ha of Northland's soils have particular potential for horticultural development. The rapid growth in plantings of kiwifruit and other subtropical crops has led to significant increases in water demand for irrigation. Projected further plantings and the development of industry primarily serving the rural sector reinforces the increasing need for careful planning of water resources to promote the most beneficial and efficient water use.

NORTHLAND WATER RESOURCES

General

Unlike many other areas of New Zealand, Northland is characterised by a large number of small catchments whose rivers and streams are short and of relatively even slope. Because of this large number of river systems it is extremely difficult to gather comprehensive hydrological data on each catchment. To overcome this problem a network of hydrological regions have been established by the Ministry of Works and Development, selected on the basis of the major factors which affect stream flow ie geology, rainfall and slope. Within each region one catchment is continuouly monitored and data can be derived for other similar catchment types using correlation techniques.

Precipitation

The only significant precipitation in Northland is rainfall. The mean annual rainfall varies from 1200 mm to 1600 mm at the lower levels, while at higher altitudes up to 730 metres rainfall is in excess of 2000 mm. As most of the rain falls in the winter months with a minimum in summer, a drought of economic significance occurs in Northland once every three years on average.

Evapotranspiration (ET)

ET is the combined loss of water from water surfaces, the land and from plants to the atmosphere. Annual estimates for Northland vary from 760 mm to 930 mm using the Penman Heat Equation — the most appropriate method for the whole of Northland. (Male A.J.R.; 1978.)

Runoff

The water balance approach using the concept of the hydrological cycle is the method used for determining Northland's water resource. Over lengthy periods of time

Runoff = Precipitation − Evapotranspiration

Potential mean annual discharge for Northland has been prepared by subtracting mean annual ET from mean annual precipitation, resulting in a discharge per unit area (Fig 1). Using this technique discharges from at any point in a catchment and for whole catchment areas can be derived.

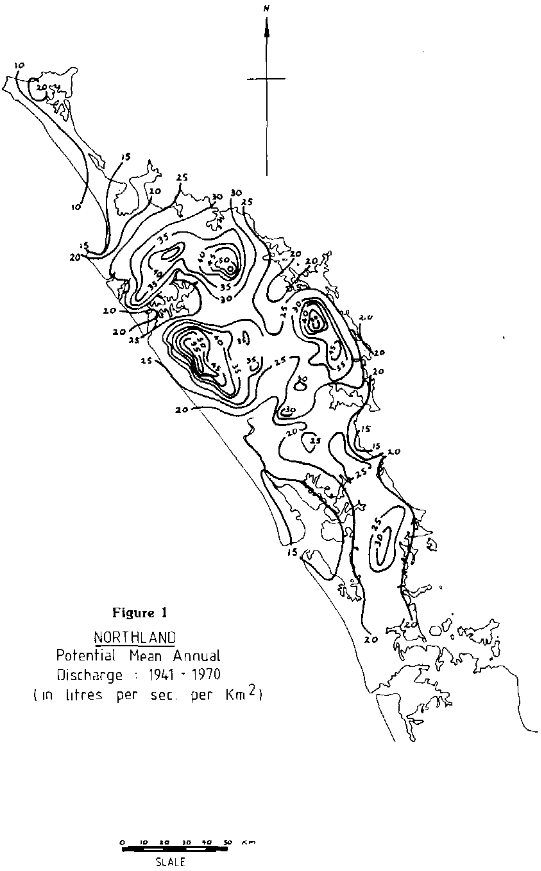

Figure 1
NORTHLAND
Potential Mean Annual Discharge : 1941 - 1970
(in litres per sec. per Km^2)

During periods of drought of known return period, gaugings of catchment discharge from specific representative catchments have been used to derive maps of minimum flows with a probability of recurrence once every 5 years, as the basis for Northland low flow planning purposes (Fig. 2).

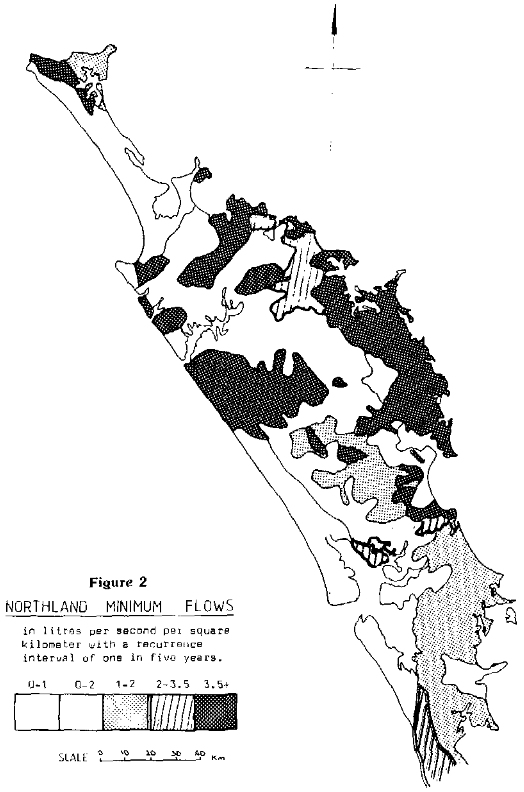

Figure 2

NORTHLAND MINIMUM FLOWS

in litres per second per square kilometer with a recurrence interval of one in five years.

Using the figure of 1600 mm mean annual precipitation the following assessment of mean annual runoff can be derived:

Northland Land Area = 12 600 km^2

Mean Annual Rainfall = *1 600* mm

Therefore Mean Annual Rainfall Input = *12 600* × 10 000 × 100 × 1.6 m^3

= 2×10^{10} m^3/year

(Evapotranspiration = 1×10^{10} m^3/year)

Available Flow — Storage **of** *Annual Runoff:*

Of the total runoff 60% of potential mean annual discharge is considered to be a reasonable economic yield when considering storage of runoff in water supply reservoirs (Northland Catchment Commission, 1968). On this basis annual supply could theoretically be approximately —

6×10^9 m^3/year

However, the use of a water resource is often governed by the variability of that resource. Variability is the average of the difference of the annual totals from the long term mean, expressed as a percentage of the mean. The average variability for Northland is approximately 16%. On this basis the available flow for a dry year storage potential would be:

$$\frac{6 \times 10^9 \times (100-16)\ m^3\ year}{100}$$

$$= 5 \times 10^9\ m^3/year$$

Available flow — Drought Periods:

For Northland, geology (rock type) is the major factor governing stream flows during drought periods (J.R. Waugh, 1970). Flows vary from less than 1 litre/second/square kilometre flowing from mudstone/sandstone catchments to more than 3.5 litres/second/square kilometre from greywacke and some volcanic intrusions. A map of minimum flows with a recurrence interval of 5 years has been prepared for Northland and is shown in Figure 2. From this it is possible to derive a drought low flow (1:5 year return period) runoff from Northland of:

21390 litres/second, or 1848 000 m^3/day

WATER SUPPLY DEMAND

Growth in Development

Early industry in Northland first centred around Kauri timber, and later Kauri gum. Agriculture was slow to develop because of poor transport facilities, poor soils, scattered nature of usable land and small size of many holdings. Agriculture took over in the 1920's as the regions major single industry. Since the 1950's improvements in roading and land development have resulted in significant agricultural and industrial growth. The introduction of resistant *Poncirus trifoliata* rootstock in the late 1940's led to a revival in the citrus industry.

Present Development

More recently (1980) land use changes have shown that on the 687 000 ha of grassland (55% of land area) there are approximately 330 000 dairy cattle and 630 000 beef cattle, with 2 130 000 sheep.

Horticulture has now developed (1985) to the extent that there are 2 000 ha of kiwifruit, citrus and other sub-tropical fruits with a further 800 ha in market garden crops. Other than kumaras at Ruawai most of this development has taken place on the free-draining volcanic soils in the Bay of Islands and Whangarei Counties.

Future Development

In 1980 the Ministry of Agriculture and Fisheries identified seven particular areas covering around 8 700 plantable hectares of "elite" soils on which large scale development could take place given adequate irrigation water supplies. Other smaller pockets of land brought the total suitable area up to approximately 13 000 ha.

TABLE 1: Daily stock water requirements in Northland.

Type of Use	Numbers	Water Requirement (m^3/day)
Cows in milk	461 000	32 300
Other cattle	499 000	19 960
Breeding ewes	1420 000	6 400
Other sheep	710 000	2 100
Dairy sheds	2 000	15 800
Total Farm Needs		76 500 m^3/day
		≈ 110 l/ha

Water Requirements

Stock:

Stock water requirements have been well documented and demands are as follows:

Milking cows 70	litres/head/day
Dry cows and beef 40	litres/head/day
Sheep — ewes 4.5	litres/head/day
Sheep — others 3.0	litres/head/day
Dairy sheds 70	litres/head/day

On this basis daily water requirements are shown in Table 1.

Horticultural Needs:

Considerable research is at present underway into actual plant water requirements for various horticultural crops. The best estimate of orchard irrigation demand in the meantime is an average demand of 35 m^3/day/canopy hectare (Ministry of Works and Development Auckland District Officials Committee on Irrigation). On this basis the present irrigation demand on the 2 000 ha in orchard crops is 70 000 m^3/day.

For many grassland farmers who have set out to develop an area of suitable soils on their land, the increased water demands compared with stock needs has been difficult to comprehend. The daily irrigation needs of a single hectare of mature kiwifruit are equivalent to the needs of 875 beef cattle or 350 ha of pastoral land at 2.5 beasts/ha. To put it another way the needs of 13 000 plantable ha of horticulture (1% Northland) would supply stock needs for 4.5 $\times 10^6$ ha at 10 l/ha/day or nearly 4 × Northland land area.

Future *Development:*

It is anticipated that the major future water demand will come not from a growth in grassland farming but from gradual development up to the potential 13 000 ha of horticultural crops, with a need of 455 000 m^3day. Other developments are anticipated in processing rural based products with particular growth in timber. Current plantings of *Pinus radiata* are 95 000. Projected planting is 130 000 ha by 1990 and 150 000-200 000 ha by 2005 (C. Livesey, Northland United Council pers. corn.). Occasional heavy industrial development is also a likelihood.

Potential Water Requirements

Using the above growth estimates potential water needs are able to be calculated as shown in Table 2.

TABLE 2: Potential water requirements for various uses in Northland.

Use	Daily Demand (m^3/day x 1000)	Flow Equivalent (ell/s)	Annual Demand (m^3/year x 1000)
Stock/farm	80	926	29 200
Public Water supply	140	1 620	51 100
Industry	45	520	16 425
Irrigation	455	5 266	54 600[1]
Total	720	8 332	151 325

[1] irrigation for 120 day irrigation season

SUPPLY VERSUS DEMAND

Summary of Uses

Table 3 compares water demands with available resources:

TABLE 3: Relationship between total Northland supply and demand.

Resource/Use	m^3/year x 1000	m^3/day x 1000
Potential safe annual storage	5 000 000	13 700
Total 1:5 year return drought flow	—	1 848
Present use	96 912	304
Potential use	151325	704

From this table it can be seen that potential demand is less than 2% of the maximum potential storage of available supplies. Even if there were no storage and all supplies tapped run-of-stream sources only the potential needs are 37% of quite severe (1:5 year return period) drought flows from Northland's catchment area (Figure 3).

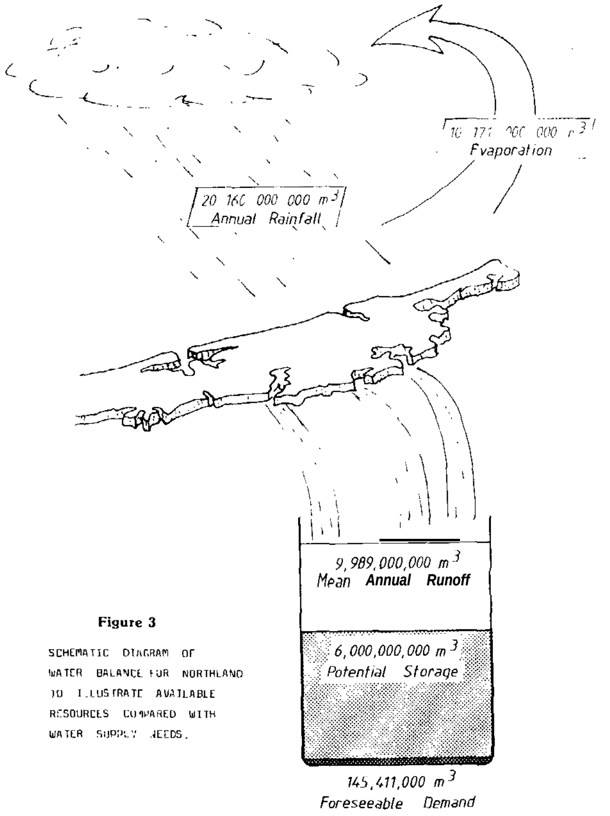

Figure 3

SCHEMATIC DIAGRAM OF WATER BALANCE FOR NORTHLAND TO ILLUSTRATE AVAILABLE RESOURCES COMPARED WITH WATER SUPPLY NEEDS.

Balancing of Local Supply/Demands

There are problems with water allocation which result from the large numbers of smaller catchments isolated from areas of need. Unlike the supply of water, demand tends to be concentrated in more limited areas with the bulk of development likely to take place in the four or five major catchments only. Problems have already occurred and been largely dealt with by the Northland Catchment Commission from a water resource management planning aspect in Kerikeri, the major catchments leading to Bream Bay and the Wairua River catchment. Planning for water use in the Waitangi River and Mangakahia catchments is well under way.

In these catchments the 1:5 year drought flows total only 247 000 m^3/day which is only 35% of potential demand. Table 4 shows drought flow compared with present day demand as indicated by water rights. It has been prepared for Northland using 21 "resource management catchments" as shown in Figure 4. Reference to this table shows the considerable variability in use compared with flows, from 2% to 80% with a Northland average of 16% of drought flow.

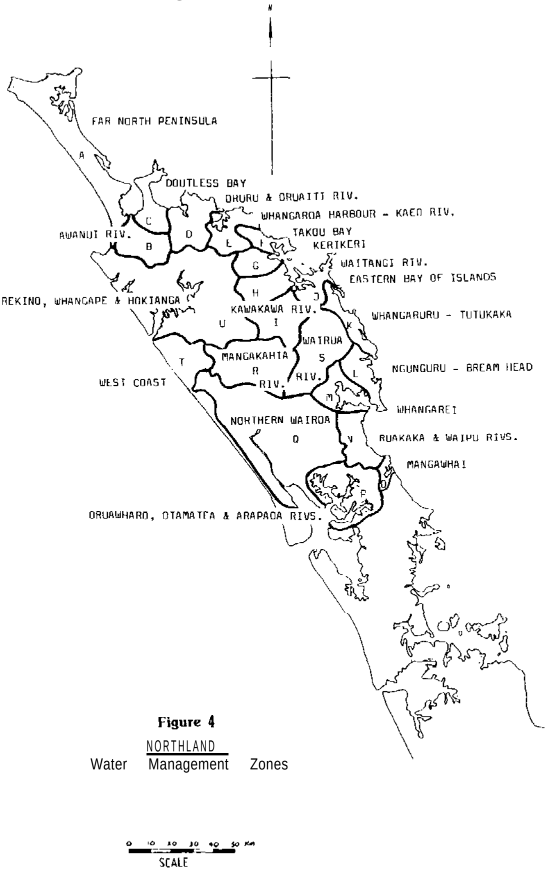

Figure 4
NORTHLAND
Water Management Zones

In-stream Needs

As time has gone on the need for research into the needs of living things in the water resource itself has become increasingly obvious. Traditionally an arbitrary figure of between 100% and 40% of a streams drought flows have been reserved for in-stream

TABLE 4: Showing water use in Northland catchments.

From Fig. 4	Resource Management Catchments	Five Year Minimum Flow ell/s	Irrig	Industrial	Public	Farm	Total	% of Minimum Flow That is Utilised
			Water Uses in Litres per Second					
A	Far north Peninsula	1600 + 871	41	26	3	17	a7	5.4
B	Awanui River	541 + 237	50	42	11	25	128	23.7
C	Doubtless Bay	300 + 212	1	0	0	10	11	3.7
D	Oruru & Oruaiti Rivers	1306 + 206	19	6	0	12	37	2.8
E	Whangaroa Hbr/Kaeo River	511 + 152	1	1	0	8	10	2.0
F	Takou Bay	516 + 7 9	35	3	0	5	43	8.3
G	Kerikeri	350	138	5	13	12	168	48 (324%)
H	Waitangi River	570	128	2	2	18	150	26.3
I	Kawakawa River	748 + 258	4	176	0	16	196	26.2
J	Eastern Bay of Islands	748 + 94	1	0	0	6		9.4
K	Whangaruru/Tutukaka	1000 + 125	8	3	0	7	18	1.8
L	Ngunguru	1000 + 125	28	1	2	20	51	5.1
M	Whangarei	836 + 154	68	104	84	45	301	36.0
N	Ruakaka/Bream Bay	416	56	0	127	6	1891	45.4
0	Mangawhai Hbr	46	16	1	0	20	37	80
P	Oruawhao to Arapaoa Rivers	595 + 310	27	3	17	75	122	20.5
Q	Northern Wairoa	1500	61	55	11	190	317	21.2
R	Mangakahia River	1800	12	1	0	76	89	4.9
s	Wairua River	1460 ·	323	52	388	70	1233	80
T	West Coast	2062 + 575	28	54	0	38	120	5.8
U	Herekino to Hokianga Hbrs	3484 + 1122	65	6	44	90	205	5.8
TOTALS		21389	1510	541	802	766	3519	
	1848000 m³/day		304042 m³/day					

needs, fisheries and the like. Work carried out in recent years has given us greater precision and tools to use to give more reliable estimates of these needs.

WATER RESOURCE MANAGEMENT

Effort by the Northland Catchment Commission has gone increasingly into measuring available resources and planning ahead to promote the most reasonable and beneficial uses of these resources starting in those catchments with the greatest competition for available needs.

Water resource planning has generally been based on a number of guidelines and criteria. These are:

(a) Available resource based on lowest (drought) flows (1:5 year return period).

(b) Provision is made for allocation and use of higher flows by the promotion of run-of-stream combined with storage based supplies for later summer flows.

(c) Priority given to stock and domestic needs, and other existing authorised uses.

(d) Consideration given to potential needs of water users rather than present day needs only.

(e) Promotion of multi-purpose uses of water resource.

If) Allowance made for in-stream needs by preserving some (or all) of natural low flow and maintaining adequate water quality for these needs.

(g) Rights granted to ensure minimal disruption to natural features.

(h) Encouragement of the building of dams to store winter run-off especially for multi-purpose uses. Groundwater takes also to be encouraged where no effect on resource.

(i) Communal supplies promoted in preference to many individual supplies because of greater efficiency.

(j) No right granted where exercise would result in quality dropping below the standard required for consumptive and in-stream needs.

(k) A limited term to provide for reviews of policies and criteria in resource management.

(Northland Catchment Commission, 1981)

Water Resource Land Resource Management

The need for management plan reviews has become increasingly obvious. As point sources of pollution have steadily been brought under control and within acceptable limits there has been a growing awareness by water resource managers of the need to incorporate management of land use practices into catchment planning. As water resource management plans are reviewed and refined the management of land uses giving rise to diffuse source pollution problems will be essential. The effects of eutrophication, nitrate enrichment, pesticides and suspended sediment in rivers and streams deserves further study. On a national scale it has been estimated that pollution from diffuse sources is now at a similar level as that from point sources. The types of activity which have the potential to reduce the risk of diffuse source pollutants entering waterways from agricultural areas are shown in Table 5.

Reviews by the Northland Catchment Commission of management plans will also incorporate controls of forestry operations in catchments where such activities are likely to have a significant impact.

CONCLUSIONS

Grassland farming while only comprising 11% of Northland's water needs covers nearly 50% of Northland's land area.

For those involved in grassland farming the policies of the Commission as regards water resources would tend to leave prudent sensible farmers with considerable

TABLE 5: Summary of the types of activity which have the potential to reduce the risk of diffuse source pollutants entering waterways from agricultural areas (McColl R.H.S., Water in New Zealand's future, 1983).

1 **Modification to Farm Practices**
- adjusting farming type to land capability
- accurate application of fertiliser
- minimising trampling damage, overgrazing, and stock in streams
- careful use of agricultural chemicals
- efficient use of irrigation water

2 **Manipulation of the hydrologic response of the land surface**
- minimising exposure of the soil, maximising vegetation cover and infiltration
- careful control of stocking rates
- use of artificial drainage
- minimum use of tillage

3 **Riparian Management**
- protecting/encouraging streamside vegetation
- exclusion of stock by fencing
- reduction in fertiliser/chemical use

favourable advantages compared to many other users:

In the face of competition:

(a) Priority is generally given to the supply of their own farm water supply needs.

(b) Where adequate care is taken to treat farm wastes approval for their discharge is rarely withheld.

(c) The building of properly designed storage dams for farms needs during droughts is encouraged to meet the varagies of the Northland climate.

(d) Where guidelines are properly followed careful use and management of farming land while promoting greater production should not harm water quality.

(e) Irrigation of grassland, while not normally economic is often approved especially where there is not strong immediate competition for the resource.

However —

The processing of farm products must be carried out at sites carefully chosen and in a proper manner to prevent water pollution.

The clearing of marginal land which would be better left in mature bush or exotic plantations because of erosion potential is likely to be met with concern and stronger controls.

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