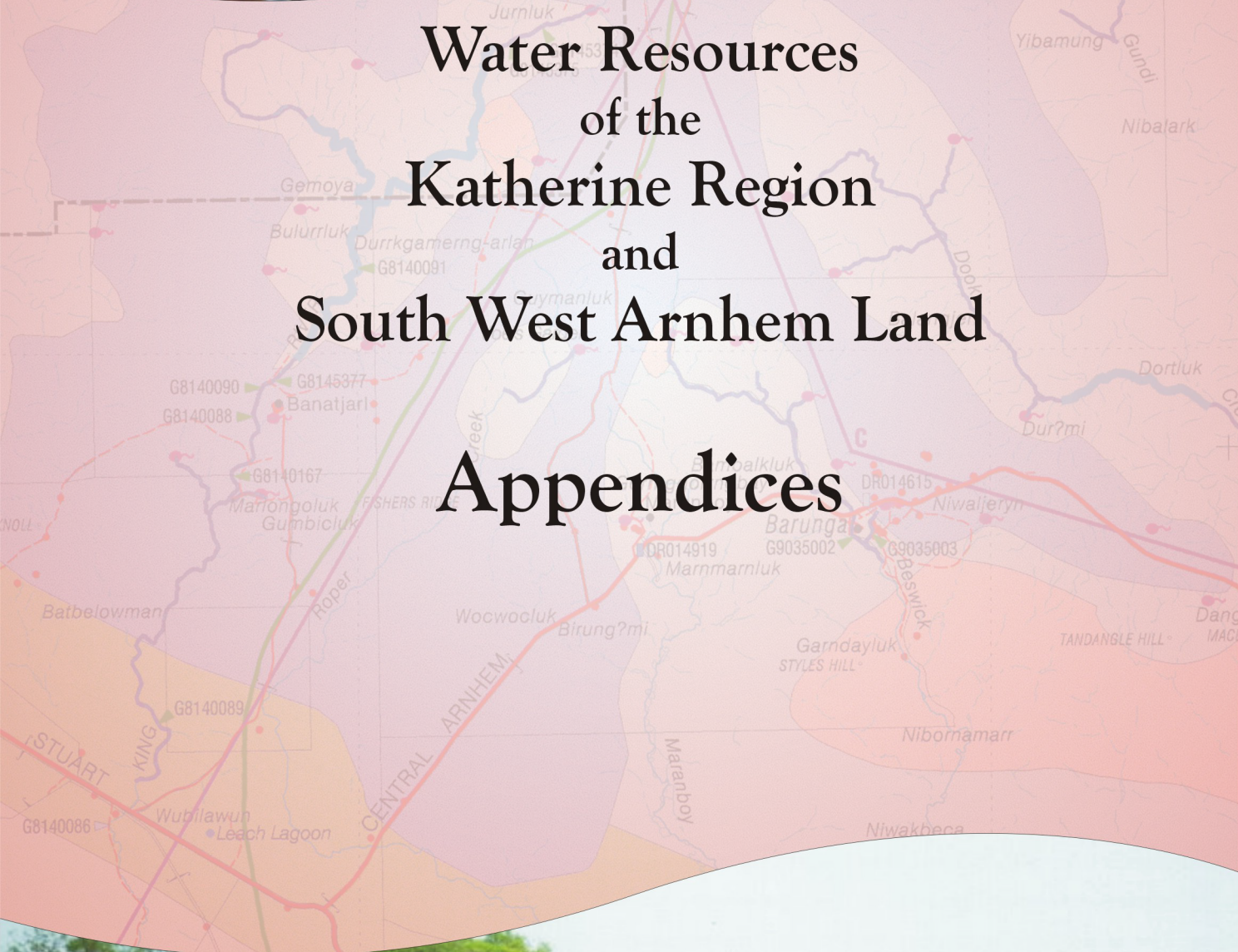




# Water Resources of the Katherine Region and South West Arnhem Land Appendices



NATIONAL  
LANDCARE  
PROGRAM



JAWOYN ASSOCIATION



LANDS PLANNING  
ENVIRONMENT  
Northern Territory Government  
NATURAL RESOURCES

DEPARTMENT OF LANDS, PLANNING AND ENVIRONMENT  
NATURAL RESOURCES DIVISION

**WATER RESOURCES  
OF THE  
KATHERINE REGION  
AND  
SOUTH WEST ARNHEM LAND**

**APPENDICES**



Nitmiluk

REPORT NUMBER 31/2001D  
D. GEORGE  
DARWIN NT

This volume contains additional information referred to in the main report:

- A Aboriginal Traditional Knowledge**
- B Baseflow in the Katherine River – A Summary**
- C Procedures and protocols for the use and management of groundwater**

# APPENDIX A

## Aboriginal Traditional Knowledge

This is a table of place and country names for the study area. Many of these names were sourced from the work by anthropologist Francesca Merlan in 1982, collected as part of the Jawoyn (Katherine Area) Land Claim of 1987. Additional language names were collected during the course of fieldwork for this project, and have been included where appropriate. At all times it was agreed that the names collected would be presented on maps and in reports for this project.

The table gives names in alphabetical order, with brief descriptions of the associations. The “ID” refers to the reference number given in Merlan’s work. Where a new name has been collected, the source is given in the comments column, otherwise there is a brief description or association given. Map coordinates are also given.

This is by no means a definitive list of placenames for the area. It has been compiled in order to make the Water Resources Map more complete and more easily accessible to the landowners and managers. Where additional names have been collected, they have been placed on the maps at the request of the person giving the name.

Language names are thought to all be Jawoyn, and their spelling follows the “practical orthography” as outlined by Merlan in the Land Claim documents. The letters used are pronounced roughly as follows:

b as in ‘bay”

d as in ‘day”

rd as in the American pronunciation of “card”

j as in ‘jay”

g as in ‘gay”

p as in “top prize”

t as in “night train”

rt as in the American pronunciation of “part rtime”

c as in “slight chance”

k as in “sick kow”

? as in uhuh (colloquial English for “no”)

m as in ‘man”

n as in ‘no”

rn as in the American pronunciation of “corrner”

ny as in “can ny”

ng as in “sing”

n-g as in “fine ngoods”

l as in ‘like”

rl as in American pronunciation of “girl”

rr as in “merrrry”

r as in American pronunciation of “Marrry”

w as in ‘way”

y as in ‘yes”

i as in “pick”

u as in ‘tabu”

e as in ‘et”

o as in ‘ot”

a as in “start”

Site Name	Comments	Easting	Northing	ID
Ankarrkarrkarmi	From AUSLIG maps	267074	8527112	
Balangjen	From NLC mining maps	274515	8401124	
Bambalkluk	Ceremonial ground, also associated with wallaby, as is Dorriya Gudaluk (see below). Site bounded by Beswick Creek on southwest and small spring-fed tributary on east	268562	8395018	2
Bamjugiyan	Area of old Army compound near Mataranka.	292718	8355044	3
Barcar	Grace's Creek system, upstream from given co-ordinates.	253564	8433268	4
Barnacal	Association: bolung (rainbow serpent).	245068	8394799	5
Barnaluk	Remotely located on upper Roper Creek.			6
Barnbal	Hills at location shown; also large area of earlier stone spear manufacture.	182207	8480503	7
Barndiyey	Associations: plains kangaroo and nin (finch).	203449	8410105	8
Barnjan	Also referred to as "Blue Hole", site of Bob Markhams station where a number of claimants have lived for extended periods.	187988	8463404	9
Barrakbarrak	Notable 'spur' in river at this locality. Association with male and female diver ducks who submerged on either side of river. Recent campsite.	240820	8420980	10
Barraway	Association: kookaburra who came out here and submerged at Yerreljirriyn. Earlier peanut-farming area.	203315	8404634	11
Barrkmalam	Jim Jim Falls	266345	8531608	
Bartjaynjaynbay	Low expanse between McAdden's Creek and Yerreljirriyn (see below). Association: gupu (plains kangaroo).	206504	8411079	13
Barunga	Area from approximately this point to the south on Roper Creek is known by this name.			14
Batbelowman	Large bluff at point shown and also stone formations upstream. Association: marram (kite). Old telegraph line ran near here, some Jawoyn worked on it.	242317	8389530	15
Batjuloki	Billabong (dries up)	299171	8397256	
Batwirrinay	High jutting hills. Association: mac(wind).			16
Bekluk	Bekjopo (butcher bird).	264782	8512564	17
Belerrkluk	Focus is small rounded hill. Association:belerrk (gecko).	236252	8499396	18
Belparn	Waterhouse West Branch crossing (Peter Bolgi)	297530	8437945	
Bemang Yarl?yarl?ma	Association: bemang (blue tongue).	222633	8412733	19
Benukmiyn	Association: benuk (bustard).	260371	8454450	20
Berndeynluk	Berndeyn (cane grass).	270838	8391472	21
Bertma	possum. Remotely located only, on Dook Creek.			22

Site Name	Comments	Easting	Northing	ID
Bilkbilkbam	Rockhole on tributary of Seventeen Mile Creek. Associations with bilkbilk(galah) and bolung(rainbow serpent). Recent use of area; has been important as a watering point along walking track between 17 Mile area and Gurngurnbam.	218000	8418200	23
Bindalak	Cameco Camp area - Goanna dreaming site (paperbark trees) (Lofty)	336450	8526696	
Birrdguk	Area name, Snowdrop crossing to Blackfella road (Reggie Miller)	317778	8487945	
Birridku	Spring near drilling site (Cameco) (Peter Bolgi)	309116	8470566	
Birung?mi	Also known as "Four Mile Creek". Associations: wakwak (crow) and gurralk (channel-bill cuckoo).	259286	8388967	24
Bocalkluk	Hills. Association: bocalk (archer fish). Initiation ground during War period.	169456	8445409	25
Bogolorkmuy	Range of hills at head of creek. Association: Bornorrong (brolga).	229015	8414713	26
Bolonggorlk	Association with guluwurr (pigeon).	225443	8399162	27
Bolryuluk	Springs	291477	8412028	
Bombom	Area along ridge, association with bolung (rainbow serpent).	203856	8497649	28
Borlarri		173428	8486029	29
Bornbornbe	Association with bornborn (duck). Marayin site.	208551	8403131	30
Bornen	Spring, gurik (olive python) association.	161429	8474135	31
Bornorrongluk	Bornorrong (brolga).	282148	8393088	32
Boywoy	Remotely located. Downstream from Durrkgamernnggarlan.			33
Bulmanggan	Wet season camping area, continuous use, Now especially remembered as birthplace of recently deceased man.	229029	8410109	34
Bulmanjerr	Association: manjerr (star).	184553	8429296	35
Bulpul		238512	8499113	36
Bulumbaluk	Association: kangaroo. On upper Copperfield Creek. Heaps of red stone represent bulumba (fly species). Earlier galngbuy site.	228161	8409313	37
Bulurr?mi	Also known more fully as ngukjirrkbul? miyanay. Association: mam (devil) figure, as at Guynjangnekay.			39
Bulurrluk	Confluence of two creeks flowing in to King River.	250157	8404505	38
Burkba	Association: plains kangaroo	227029	8399112	41
Burrirt mangal ngawuyi	Association: burrirt (flying fox).	246690	8398369	42
Burrirtnguk	Association: burrirt (flying fox). Old Wuwarr ground.	244762	8493606	43
Dakbirlegot-miyinay	Focus is round knob. Association: goymarr (crocodile).	248009	8422688	44
Dangdangjarl	spring	283665	8388348	
Dirtluk	Association: dirt (moon). Striking flat rock shelf one feature of site. Marayin ground.	229693	8410244	48

Site Name	Comments	Easting	Northing	ID
Djorgulk	"Come that axe" (Lofty)	340669	8529452	
Dorriya Gudaluk		266505	8395947	49
Dortluk	Association: Louse, also ngalcurlum (willy willy), Much-used hunting and fishing area, also ceremonial ground in remote part of general locality.	281728	8398322	50
Dulukurrluk	Association: Dulukurr (bony bream). Area near old peanut farms. Formerly bones deposited in limestone pits in the area but bundles have been scavenged.	208603	8401097	51
Dur?mi	Association: Louse, and ngalcurlum (willy willy). Popular hunting and camping area over many years, also contemporary campsite.	277561	8396727	54
Durdurtbay	In the old "Eleven-Mile" area. Association: durt (unidentified fish species). Large number of former campsites in this area.	197360	8406957	52
Durrgamerng-aran	Association: Durrrk (emu), along with waruk (dog). Site of King River compound which preceded move to Dangdangjal.	250169	8403911	53
Gajamarlak	Large area around grid reference 290260 on 1:100,000 map sheet number 5569	328047	8425892	55
Galkdirn	Cutta Cutta caves.			56
Galkjongoy	Mt Shepherd. Sometimes alternatively called by name of larger Maude Creek area, Mangec. Association: plains kangaroo.	223930	8405183	57
Gan-gerrwe	"Nine-Mile", hill and waterhole, former popular campsite	182016	8488975	58
Garadbaluk	Mt Evelyn from Auslig	271971	8495565	
Garnangalki	Popular camping area. Continuous use but most frequent recent use when numbers of people were working at Nixon's and other nearby properties.	205224	8404801	59
Garnbak barlarl?mi		290054	8388858	60
Garndayluk	Association: Garnday (devil), and bolung (rainbow); one part of water not to be disturbed. Frequently visited area; fishing permitted in other parts of the water. Joe Cullen and Jack McKay had station and peanut farm in this area.	271731	8387847	61
Garrajura	Frances Mine area, Association: waruk (dog).	158788	8493801	62
Garrakluk	Striking twin hills on Seventeen Mile Creek.	215463	8429755	64
Garrkngali	Striking linear stone formations associated with burrrit (flying fox), and entire area with gupu (plains kangaroo). Popular area to obtain artefact materials.	239615	8404113	65
Gawucwucmar	"Low Level Crossing." Name descriptive of locality, wucwuc+ma- "boil, bubble". Associations: walec (parrot) and ngalcurlum (willy willy).	203630	8396142	66
Gemngolorr		294574	8392764	67
Gemoya	Jawoyn name rendered as "Comoye" on Eva Valley 1:100000 sheet. Associations: durrrk (emu), bolung (rainbow).	251094	8406188	68

Site Name	Comments	Easting	Northing	ID
Girnluk	Association: Girn?girn (catfish).	250569	8484012	70
Girrilkla	Association: Fish scales.	168331	8422867	71
Goli	Hills extending over large area.	196431	8479680	72
Golorokbun	Hindrance Creek crossing (Peter Bolgi)	267721	8429677	
Gomungluk	Association: Neck of diver duck.	219863	8412439	75
Gorlgorlkbay	Remotely located, downstream from Worreluk.			73
Gorlonjorrluk	Association: kangaroo. Red ochre deposit.	242939	8495841	74
Gorogokluk		277629	8393555	77
Gorrnggorrnbay	Also known as "Ban Springs". Association: Wakwak (crow), Ceremonial ground.	262400	8393767	78
Gumbamiyn		141968	8403551	79
Gumbicbay	Mt. Peckham, Association: gupu (plains kangaroo).	212176	8399365	80
Gumbicluk	Descriptive name: gumbic "lancewood" (Acacia shirleyi).Area of plentiful surface water, former popular wet season camping area.	246818	8393989	81
Gunbokmo	Association: plains kangaroo.	227633	8413066	82
Gundurk gabolkjapjiyi	Also known as Jacbarl, English Double Hill. Name descriptive of mythic association: "female plains kangaroo stands as country".	183534	8401096	83
Gungkurdul	Twin Falls	259419	8526140	
Gun-gurulwam	Large steep-sided rockhole. Continuous use from Eva Valley/Bamyili. Association: bolung (rainbow). Numerous painting sites in higher escarpment.	270400	8457138	84
Gunjola	Snowdrop Creek crossing	321883	8490982	
Gunloklok	Association: Loklok (skink).	209249	8406630	85
Gunlom	UDP Falls.Association:bolung (rainbow).	220251	8514045	86
Gunyar	Plentiful flying foxes. Continuous use from Eva Valley/Bamyili.	248715	8429723	87
Gupuluk	From Auslig	251558	8449027	
Guratba	Coronation Hill.	240961	8496766	88
Gurlkjen	Focus is particular stone in area. Associations: goymarr (crocodile) and gurk (olive)	243676	8423097	89
Gurngurnbam	Association: Plains kangaroo.	215216	8414290	91
Gurrwirluk	from Auslig	206359	8520429	
Gymanluk	Association:guyman (bandicoot). Former ceremonial grounds nearby. Site of Joe's	258110	8401895	92
Guynjangnekay	Mt. Felix. Association: guyn (devil).	247929	8433199	93
Guynjay	Creek system upstream from, the vicinity of the point specified.	224851	8547006	94
Jagerai	Small creek	289529	8417971	
Jambish Creek	Chambers Creek	311310	8389652	

Site Name	Comments	Easting	Northing	ID
Jangaraknga-akluk	Upstream from given co-ordinates throat of plains kangaroo.			95
Japowa	Remotely located upstream from Gemoya. Association: japo (spiny-tailed lizard).			96
Jarlapo yarl?yarlmay	Same lizard association as above, along path made by totemic figure.			97
Jarlunggarn-darnmo	Focus is range of jagged hills north of river. Association: taipan (jarlung=taipan, garndarn=backbone, mo=bone).	243357	8422753	99
Jarrangbarn-miyin	Upstream from this point. Association: bluetongue (male and female).	231609	8401832	100
Jarrlaworpor	Centipede dreaming (Peter Bolgi)	295280	8475796	
Jarruluk	Rendering of Jawoyn name on 1:250,000 sheet is "Charalook Waterhole".	294883	8390798	101
Jarukmele	Association:jaruk (Syzygium suborbiculare)	250818	8420576	102
Jatbula		233188	8501663	103
Jati gandawuyinay	Association: big fight of mythic frogs (jati)	267787	8420416	104
Jawarlluk	Area of Yeuralba mineral fields. Focus of site includes several stone formations. Association: jawarl (tawny frogmouth).	254145	8421510	105
Jaworkluk	Association: jawork (gudgeon). Old wagon road used to pass in vicinity.	240249	8398203	106
Jenbirri	Name rendered on Katherine 1:100,000 sheet as "Yenberrie". Associaton: tongue (jen) of plains kangaroo.	186743	8430474	107
Jey?miluk	Association: jey?mi (blue kingfisher).	238469	8397760	109
Jeywunay	Association: bolung (rainbow).	268249	8474852	108
Jikoymarrwa	Area around point shown. Association: goymarr (crocodile).	203541	8497640	111
Jikumun		293327	8476484	112
Jimunducbay	Association: mun (mud cod), gupu (plains kangaroo), From here common walking track was to Yamicmi.	207292	8410114	114
Jiniynluk	Area used as old brumby yard.	292054	8370754	115
Jipjipbay	Area upstream from point shown; includes large flat expanse. Associations: gupu (plains kangaroo) and, jipjip (unidentified small bird).			116
Jirrbiyuk	Fom NLC mining maps	270613	8417462	
Jirrupuyiyn	Association: whirlpool	139934	8401199	117
Jodetluk	Association: jodet (lefthand wallaby)	224468	8408548	118
Jokbiynluk	Also called "Buffalo hole". Association: jokbiyn (piebald snake). Jack Keel(?) had station	277140	8371105	119
Jonjay	Katherine River crossing place (Reggie Miller)	260916	8465167	
Jornjayi	Mt. Harvey. Association: echidna	251918	8442194	120
Jorrkjorrkyi	Remotely located on Dook Creek between Nibilynmo and Bornorrong (luk) bamberk. Association: possum.			121

Site Name	Comments	Easting	Northing	ID
Jowokba	Especially noted for flying foxes in dense vegetation near spring.	255120	8481703	122
Jucararrk	Area near Dortluk on Dook Creek where ngalcurlum (willy willy) travelled. Remotely			123
Julkarnba	Dingo, travelled on to Gapara in Roper area	219576	8418780	124
Julkbarrabumun	Remotely located. Billabong east of Beswick along Chambers River.			125
Jurnluk	Association: jurn (unidentified non-venemous snake species). Sawmill here before was run by Kenny Harris. Taken over after war by Robert Shepherd and brother Ivor.	257276	8413094	126
Jurrangluk	Associations: jurrang (taipan) and bilil a protean figure who often takes the form of a	224293	8406847	127
Jurugin	Includes low hills. Remembered as watering place on walking track into dry country to	201529	8388304	128
Lambalkluk	Association: barrakbarrak (diver duck).	222485	8414158	129
Lelerkiyn		202628	8496062	131
Leliyn	Edith Falls. Associations: bemang (blanket lizard) and bolung (rainbow).	196693	8430902	132
Lerrmbol	Favoured place for burrlrt (flying fox) and paperbark.	202451	8427964	133
Lirrkwork	Association: gupu (plains kangaroo).	200179	8452130	134
Lirrt	Gorge on Snowdrop road (Peter Bolgi)	310670	8454757	
Lodoluk	Remotely located, between Mt. Peckham and CSIRO. Association: lodo (louse species).			
Lorungluk	Association:lorung (sandfly)	290319	8390708	135
Lurlkmoram	Association: mam (devil).	218206	8480463	136
Maguk	Barramundie Gorge	222885	8525208	
Mamden	Association: gupu (plains kangaroo).	188834	8432342	137
Mangec	Associations: bilil, gupu (plains kagaroo).	219255	8406686	138
Manmanbar	Firestick place (Peter Bolgi)	307991	8466854	
Manyala		262069	8432246	139
Maramo	Association: maramo (wallaby).	273284	8395655	140
Marlgowpmi	Water bird (grey/brown) - stony area is dreaming site (Reggie Miller)	307925	8487142	
Marlongoluk	Association: marlongo (small lizard),	247391	8394149	142
Marlongoluk	Diamond Creek	290934	8421621	
Marlunba	As for Mangec.	220064	8406754	143
Marnangbay	Association: barna (small bird species).	246695	8384559	144
Marndarpa	Site of old telegraph station.	205898	8398683	145
Marnmarnluk	Association: marnmarn (vine, creeper). Remains of old station and living area here, graves of "Dan Gillenly", Audrey Stutterd, Wagon road nearby.	262045	8391336	146
Marram warl?may	Association: marram (kite).	172865	8448858	149
Marram warl?may	Continued track of marram (kite) travelling as jamorr ("policeman") of na-gorrko.	241341	8400727	150
Marramgore	Association: marram (kite).	173173	8440708	147

Site Name	Comments	Easting	Northing	ID
Marramlarr	Pine Yard - from NLC maps	292308	8433991	
Marramluk	Association: marram (kite).			148
Marrgawkmiluk	Association: nankeen night heron.	214793	8505401	151
Mayawar	Association: bolung (rainbow).	195948	8410954	152
Meci	Hatches Spring.	183295	8474288	153
Melkjarlumbu	Association: goymarr (crocodile).	310000	8407000	154
Merlpurrum		211193	8420569	155
Midit-di	Stony Creek, on walking route (Peter Bolgi)	287744	8447619	
Midorldorl	Billabong	297826	8378966	
Mirrirrin	Association: jirrirrin (mistletoe).	275657	8416027	156
Muldi?miluk	Upstream from point shown. Association: gupu (plains kangaroo).			157
Muril	from Auslig	222601	8507589	
Murru warl?may	Association: murru (goose).	223037	8450369	158
Murryyed	No 3 Yard - Flying fox dreaming (Peter Bolgi)	282345	8430352	
Mutmurrluk	Association: mutmurr (march fly).	189813	8457909	159
Muyarlal	Association: bongorl (potato species).	189548	8414750	160
Nadjikluk	Fisher Creek from Auslig	250062	8500663	
Nevegoich	Chambers River	317956	8371292	
Ngalelekluk	Association: ngalelek (cockatoo).	282523	8387954	162
Ngal-gayku		172325	8440224	163
Ngalworreworre	Young girl	295062	8388558	164
Nganbukbuk-gorran	Association: bukbuk (pheasant coucal).	240902	8382395	165
Ngandumla	Association: na-gorrko	172220	8441112	166
Ngan-galkjarlan		157933	8412930	167
Nganjucayarang	Association: juca (water goanna).	222672	8413110	168
Nganmamnur?mi	Association: mam (devil).	296336	8380979	169
Nganggerrkmirla		173553	8486930	170
Ngarracbay	Association: ngarrac (white cockatoo).	209336	8400926	171
Ngartgoleyn		299900	8401000	234
Ngartluk	From Auslig	261278	8475759	
Ngukjirrkbul?- miyanay		249590	8428577	174
Ngulwyng		293080	8401818	
Nibalacguk	Association: balac (leech)	243887	8391596	175
Nibalark	Possum Creek area + springs	281711	8408551	

Site Name	Comments	Eastings	Northing	ID
Nibaliyarra		267623	8444433	
Nibamburl-bamburl	Association: nagorrko	241109	8401974	176
Nibilynmo	Association: wirk (possum).	261998	8410097	177
Nibimbolung		243203	8493802	178
Nibimgorong-gorong	Association: dorriya (wallaby).	278009	8396246	179
Nibornabam	Association: ngalworreworre (young girl).	243268	8395681	180
Nibornamanyirr	Association: gupu (male plains kangaroo) and garndalpurru (female). Old mining camp.	226539	8400261	181
Nibornamarr	Fishing area, also staging point along walking track from Garndayluk to Niwakbeca.	273671	8384447	182
Nidenbam		277828	8502708	183
Nigawatbalat	Upstream from point shown.			184
Nigolmerbay	Association: gupu(male plains kangaroo), and garndalpurru (female).	244513	8392192	185
Nigongba	Remotely located, near Dakbirlegotmiyinay in Eva Valley.			186
Nijililmnu	Little Creek on walking route (Peter Bolgi)	299611	8456899	
Nikawaladbalad	Emu area (Peter Bolgi)	274075	8436428	
Nikodbe	Spring at head of Hindrance Creek (Peter Bolgi)	270983	8425403	
Niletmo		280300	8498538	187
Nilicat	Spring	304004	8392225	
Nilyanjurrung	Big Sunday from Auslig	245202	8487823	
Nimarranyin	Alligator Hole. Association: goymarr (crocodile), forming continuity with a number of sites running up Ngartgoleyn (waterfall, Beswick Falls).	296584	8377543	189
Nimerngbel		231454	8503874	190
Nimirmi	Remotely located on Dook Creek. Association: wirk(possum), forming continuity with several other sites in area.			191
Nimirmi	Remotely located on Dook Creek	270297	8406362	
Ningalele	Association: jamunbuk (young plains kangaroo).	236024	8403839	193
Ningorlkba	Association: goymarr (crocodile), forming continuity with several other sites in area.	245249	8425331	194
Nipbamjarn	Waterfall - Woman's place (Long John)	291568	8444075	
Nitmiluk	Association: nitmi (cicada).	221960	8416293	195
Niwakbarrarn	Association: gupu and garndalpurru, male and female plains kangaroo. Water obtained here before along old wagon road.	237307	8393089	196
Niwakbeca	Association: goymarr (crocodile).	271946	8380679	197
Niwaljeryn	Sunset place	273302	8394149	

Site Name	Comments	Easting	Northing	ID
Wakwakluk	Association: wakwak (crow) of ding-waimet subsection, gurralk (channel-billed cuckoo) of ding-gamarrang subsection, who ran away together in a wrong marriage.	259854	8393389	198
Waluklara		302278	8398464	
Welewurrng	"Four Mile Corroboree area". Association: gupu (plains kangaroo).	208592	8399467	200
Wer?miyam	Association: bemang (blue tongue lizard).	222990	8421561	202
Werrenbun	Artefact manufacture site. Association: unidentified bird species.	182181	8428430	201
Wirarr		220500	8515000	203
Wirniynwirn-iynbay	Association: wirniyn wirniyn (unidentified bird species).	265117	8427774	204
Wocwocluk	Association: wocwoc (small wood-boring insect).	256948	8389009	206
Worreluk	Association: ngalworreworre (young girl).	244996	8394432	208
Wotbunay		244809	8492266	210
Wubilawun	Association: jambala (long-necked turtle).	243910	8380771	211
Wun-gurri	Association: gurri (blue tongue lizard). Divided river represents male and female aspects.	220719	8412313	215
Wurayluk	Billabong area	295185	8387950	
Wurliwirliyn-jang	Association: birndu (mosquito).	202815	8402107	217
Wurunba	Association: wurun (witchetty grub).	252650	8433802	218
Yacayacaluk	Association: yaca ( <i>Grevillea pteridiifolia</i> ).	260527	8391662	219
Yalangamajpun	Camping spot on Stony Creek (Peter Bolgi)	293143	8450881	
Yalangluk	Association: yalang (termite).	265731	8425845	220
Yamarrkarni		206377	8477965	221
Yamicmi	Association: yamic (short-horned grasshopper).	214795	8412610	222
Yanguli	Black Rock. Fishing and camping spot.	292475	8405893	
Yerreljirriyn	Association: barraya (kookaburra, from Barraway), and yerrel ( <i>Flagellarica indica</i> ).	215534	8407353	223
Yibamung	Association: wirk (possum). Marayin area.	279567	8412670	224
Yinangankarrh	from Auslig	218024	8517593	
Yirpbinjorl	Diamond Creek crossing (Peter Bolgi)	290500	8423659	
Yirrinyaluk	by people working at experimental farm, Also rock cairns used in hunting kangaroo with fire.	193849	8408099	229
Yombolyarriyn	Association: na-gorrko	162481	8416538	230
Yowan	Junction of Katherine River and Snowdrop Creek (Reggie Miller)	305854	8486595	
Yowokdec	Association: yowok (bandicoot).	295020	8376729	231
Yoynwele	Association: witchetty grub, Popular campsite.	248381	8427368	232
Yulawem	Association: bemang (blanket lizard).	216696	8437227	233
Yurmikmik	from Auslig	225193	8503296	

# **APPENDIX B**

## **Baseflow in the Katherine River – A Summary**

This section contains part of the DLPE Report 36/2000D, in which the baseflow of the Katherine River is predicted using daily rainfall data. The study also investigated the baseflows in other tributaries of the Daly River system, the Flora and Douglas Rivers.

The study showed great variability in the lowest flows in the Katherine River from 1885 until present. This work is being refined in order to better understand the behaviour of the River as part of a water allocation and management plan.

**Department of Lands, Planning and Environment**

**Analysis of Groundwater Fed  
Flows for the  
Flora, Katherine, Douglas  
and Daly Rivers**

***This is not the complete report***

**Report 36/2000D**

**P Jolly**

**D George**

**I Jolly**

**Z Spiers**

**Natural Resources Division**

**Palmerston NT**

**November 2000**

1	Introduction
2	Interpretation of Dry Season Flow Data
3	Comparison of Flows in Each River
4	Relationship Between Rainfall and Potential Recharge in the Katherine Region
5	Relationship Between Estimated Recharge and Groundwater Fed Baseflows
6	Synthesis of Baseflow Record
7	Summary
8	Recommendations

### **Appendices**

Appendix A	Flora River	-	<i>NOT INCLUDED</i>
Appendix B	Katherine River		
Appendix C	Daly River at Dorisvale	-	<i>NOT INCLUDED</i>
Appendix D	Douglas River	-	<i>NOT INCLUDED</i>
Appendix E	Daly River at Mount Nancar	-	<i>NOT INCLUDED</i>

## Figures

- 1 Location Map
  - 2 Relationship between Groundwater fed flows and time for various Gauging Stations.
  - 3 Gauged flows at various Gauging Stations in early November, 1970 and 1982
  - 4 Relationship between Annual Rainfall and Annual Recharge
  - 5 Relationship between Increase in Springflow and Annual Recharge for Katherine River at the Low Level Crossing
  - 6 Comparison between predicted and actual groundwater fed flows for Katherine River at the Low Level Crossing
  - 7 Synthesised groundwater fed flows from the regional Tindall Limestone Aquifer into the Katherine River at Low Level Crossing
  - 8 Synthesised groundwater fed flows from the regional Tindall Limestone Aquifer into the Katherine River at Galloping Jacks
- 
- B1 Groundwater levels in the Tindall Limestone Aquifer
  - B2 Relationship Between Groundwater Fed Flows and Time for Katherine River
  - B3 (a) Maximum and Minimum Water Levels – G8140001  
(b) Maximum and Minimum Discharge – G8140001  
(c,d,e,f) Expanded minimum discharge hydrograph for GS8140001
  - B4 Relationship between increase in springflow and annual recharge for Katherine River at GS8140001
  - B5 Comparison between predicted and actual baseflows for Katherine River GS8140001
  - B6 Synthesised groundwater fed flows the regional Tindall Limestone Aquifer into the Katherine River at the Low Level Crossing, 3km downstream of GS8140001
  - B7 Comparison between the gauged flows for the gauging stations GS8140001 and GS8140301

## **Tables**

- 1 Gauging Station Details
- 2 Equations for flows at various Gauging Stations
- 3 Gauged flows at various Gauging Stations in Oct/Nov 1970 and 1982
- 4 Annual Rainfall and Annual Recharge Details for DR014902
- 5 Summary of Recharge Events
- 6 Estimated Annual Increase in Baseflow at Katherine River at the Low Level Crossing, 3km downstream of GS8140001

- B1 (a) List of Gaugings for G8140001  
(b) List of Gaugings for G8140301

## **Photographs**

- B1 Katherine River at the Low Level Crossing

## **1. Introduction**

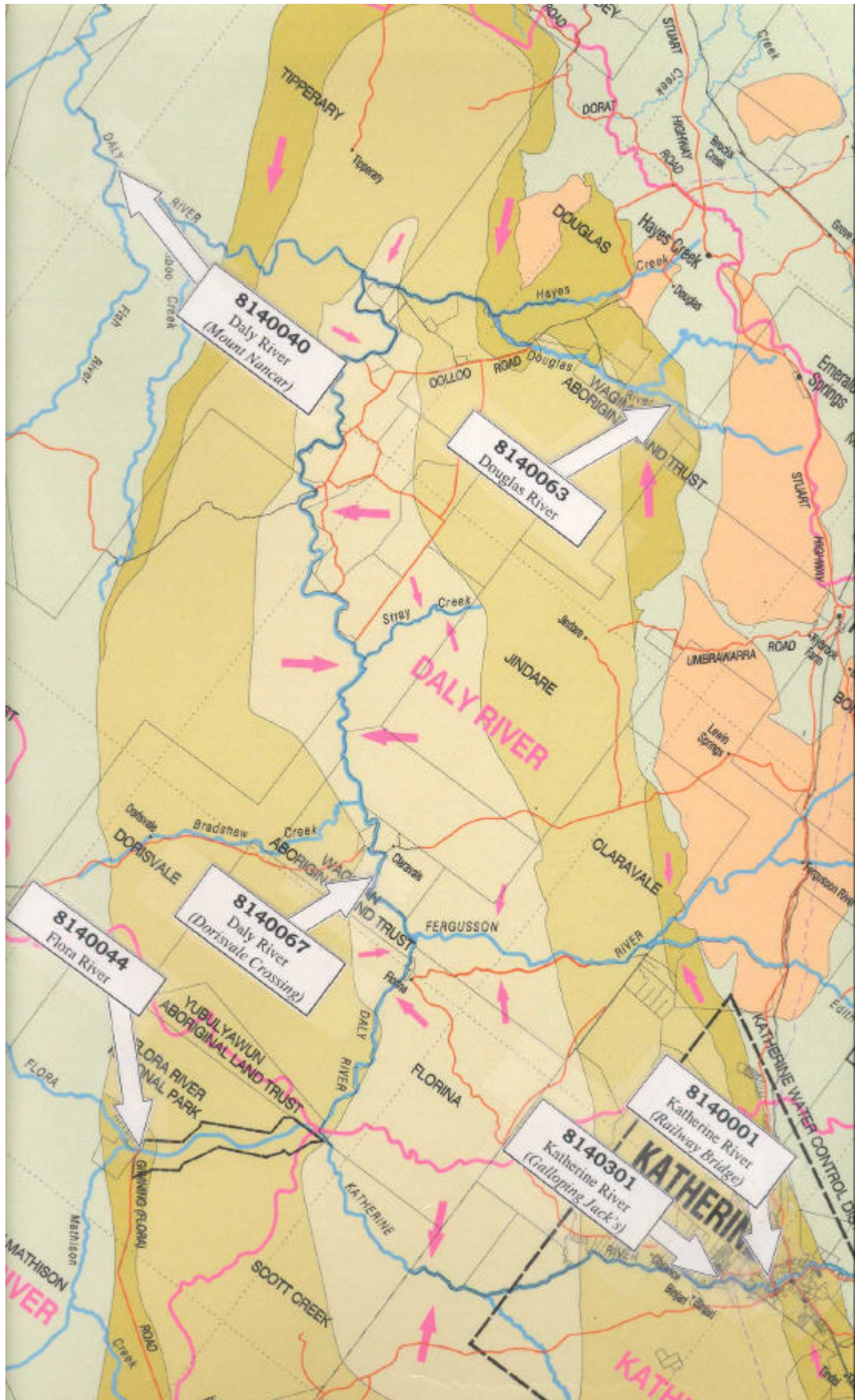
The aim of this study was to undertake a preliminary analysis of groundwater fed flow data. The objective was to develop relationships between rainfall and groundwater fed flows that could be used to predict dry season flows in the absence of detailed low flow gaugings. Good long term daily rainfall data is available for Katherine. The area studied was the Daly Basin with a specific emphasis on the Daly River, the Katherine River, the Flora River and the Douglas River.

Initially, an attempt was made to analyse data from the Daly River in isolation. However, no meaningful results could be achieved. It was then decided that the rivers that are known to be major dry season tributaries to the Daly River should be studied in turn. These rivers are the Katherine River, the Flora River and the Douglas River. The Katherine and Flora Rivers meet to form the Daly River, whilst the Douglas River confluence is approximately 160 kilometres downstream of the junction between the Katherine and Flora Rivers.

Records from Gauging Stations (GS) GS8140001 at the Railway Bridge and GS8140301 at Galloping Jack's, both on the Katherine River, were studied. Records were also analysed for the Flora River at GS8140044; the Daly River at Dorisvale Crossing at GS8140067; the Daly River at Mount Nancar at GS8140040; and the Douglas River at GS8140063. The location of each station is shown on Figure 1.

The primary reference for this work was a paper by Josepf Szilagyi in Volume 1, Number 5 of the journal Groundwater (Sept-Oct 1999). The title of the paper was "On the use of Semi-logarithmic Plots for Baseflow Separation".

**Figure 1** Location Map



## 2. Interpretation of Dry Season Flow Data

The following table indicates the period of record and number of gaugings that have been recorded at each site. A qualitative statement has also been made regarding the quality of data relating to groundwater-fed dry season flows at each site.

**Table 1** Gauging Station Details

<b>Location</b>	<b>Number of GS</b>	<b>Period for which flows have been gauged</b>	<b>Number of Gaugings</b>	<b>Poor or good low flow records</b>
Flora River	GS8140044	1966 – 1999	27	Poor
Katherine River at the Low Level	GS8140001	1952 – 1999	290	Good
Katherine River at Galloping Jacks	GS8140301	1974 - 1998	67	Good
Daly River at the Dorisvale Crossing	GS8140067	1957 – 1998	240	Good
Douglas River	GS8140063	1957 – 1997	280	Poor
Daly River at Mount Nancar	GS8140040	1966 – 1999	287	Good

A procedure for evaluating and analysing the available data was developed. The first step in collating all available data was to view a full record of hydrographs for the various gauging stations. The listing of gaugings for each gauging station was then obtained from the database HYDSYS. These hydrographs and listings of gaugings are contained in appendices A to E.

Initially, during the study of the Daly River as a separate entity, monthly stream discharge records for the gauging station at the Dorisvale crossing were extracted from HYDSYS. However, on further examination and after comparing the monthly stream discharge records with the hydrographs and the record of actual gaugings, it

was found that the table of minimum stream discharge was not accurate enough. As such it was decided that the minimum stream discharge records would not be used in any further analysis.

The slope of log discharge vs. time since the end of the Wet Season, for a river with a strong groundwater inflow, theoretically has a straight-line relationship for the Dry Season period. The slope of the straight-line portion of the hydrographs for a gauging station is theoretically meant to be the same for each year. The straight line, which has a negative slope, represents the decrease in discharge during the dry season when little or no recharge occurs. An average equation can then be found for the line or lines that best represented the dry season flow data. This analysis was applied for gauged flow data for all gauging stations analysed in this study. This relationship was then used to predict groundwater fed flows for rivers during the dry season.

The relationship is of the form:

$$\text{Log } Q = a - bN$$

Where: Q = groundwater fed flow in cumecs,

a = log of the estimated maximum groundwater flow component,

N = the number of days it would take for the maximum groundwater fed flow to reduce to a given flow value,

b = the slope of the line ( negative)

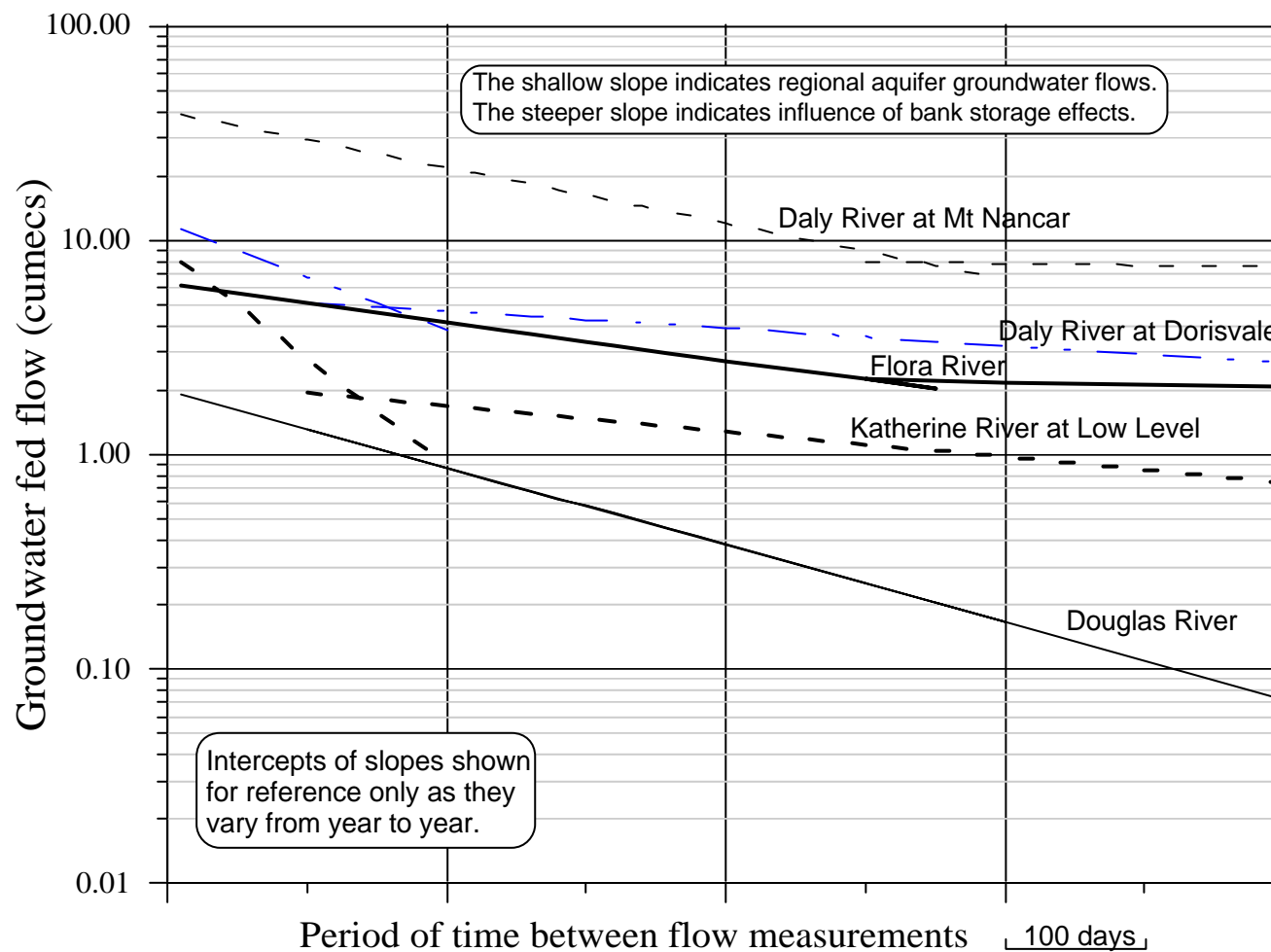
The plot of log Q versus time for the dry season is displayed in Figure 2 for each Gauging Station. The equations for each Station are given in Table 2.

**Table 2** Equations for groundwater fed flow at various Gauging Stations

<b>Location</b>	<b>Gauging Station</b>	<b>Equation for higher flows dominated by “bank storage”</b>	<b>Equation for lower flows dominated by regional groundwater resource input</b>
Flora River	GS8140044	$\text{Log } Q = 0.8 - 0.009N$	$\text{Log } Q = 0.4 - 0.0001N$
Katherine River	GS8140301	$\text{Log } Q = 0.95 - 0.005 N$	$\text{Log } Q = 0.35 - 0.0006N$
Daly River at the Dorisvale Crossing	GS8140067	$\text{Log } Q = 1.08 - 0.0025N$	$\text{Log } Q = 0.75 - 0.0004N$
Douglas River	GS8140063	none	$\text{Log } Q = 0.3 - 0.002N$
Daly River at Mount Nancar	GS8140040	$\text{Log } Q = 1.6 - 0.0013N$	$\text{Log } Q = 0.94 - 0.00008N$

It can be seen from the hydrograph plots that there can be two distinct recession responses during the dry season, for the various tributaries to the Daly River. These are individually discussed in more detail in the respective appendices. For dry season recession following average to below average rainfall years, the recession reaches a relatively flat slope from September onwards. After higher rainfall years, the recession has a much steeper slope, and may not reach the expected shallow baseflow slope at all. This response has been attributed to bank storage and recharge to aquifer systems from the river only after river levels have reached a certain height. In other words, controlled by groundwater discharge emanating from recharge close to the river. The shallow slope is controlled by diffuse recharge. In order to validate this, further analysis needs to be made of river heights, recession rates and groundwater levels in the aquifers in the vicinity of the river itself.

**Figure 2** Relationship between Groundwater fed flows and time for various Gauging Stations.



### 3. Comparison of Flows in Each River

For a comparison of flows to be possible, flow data must be available for all rivers for the same period in a given year. The best data sets for the Daly Basin are displayed in the following table.

**Table 3** Gauged Flows at Various Stations in early Nov 1970 and 1982

Location		Flow in early November 1970 (cumecs)	Flow in early November 1982 (cumecs)
Katherine River at the Railway Bridge	GS8140001	0.88	1.94
Katherine River at Gallopings Jacks	GS8140301	1.1*	2.34
Flora River	GS8140044	3.1*	3.4*
Sum of Flora River and Katherine River Flows	GS8140301 + GS8140044	4.2*	5.74*
Daly River at Dorisvale Crossing	GS8140067	2.8	5.1
Daly River at Oolloo Crossing	GS8140038	5.9	13
Douglas River	GS8140063	0.26	0.66
Daly River at Bee Boon Crossing	GS8140042	7.7	16.9
Daly River at Gourley	GS8140041	8.2	17.2
Daly River at Mount Nancar	GS8140040	8.5	19.4

Note: \* indicates estimated value.

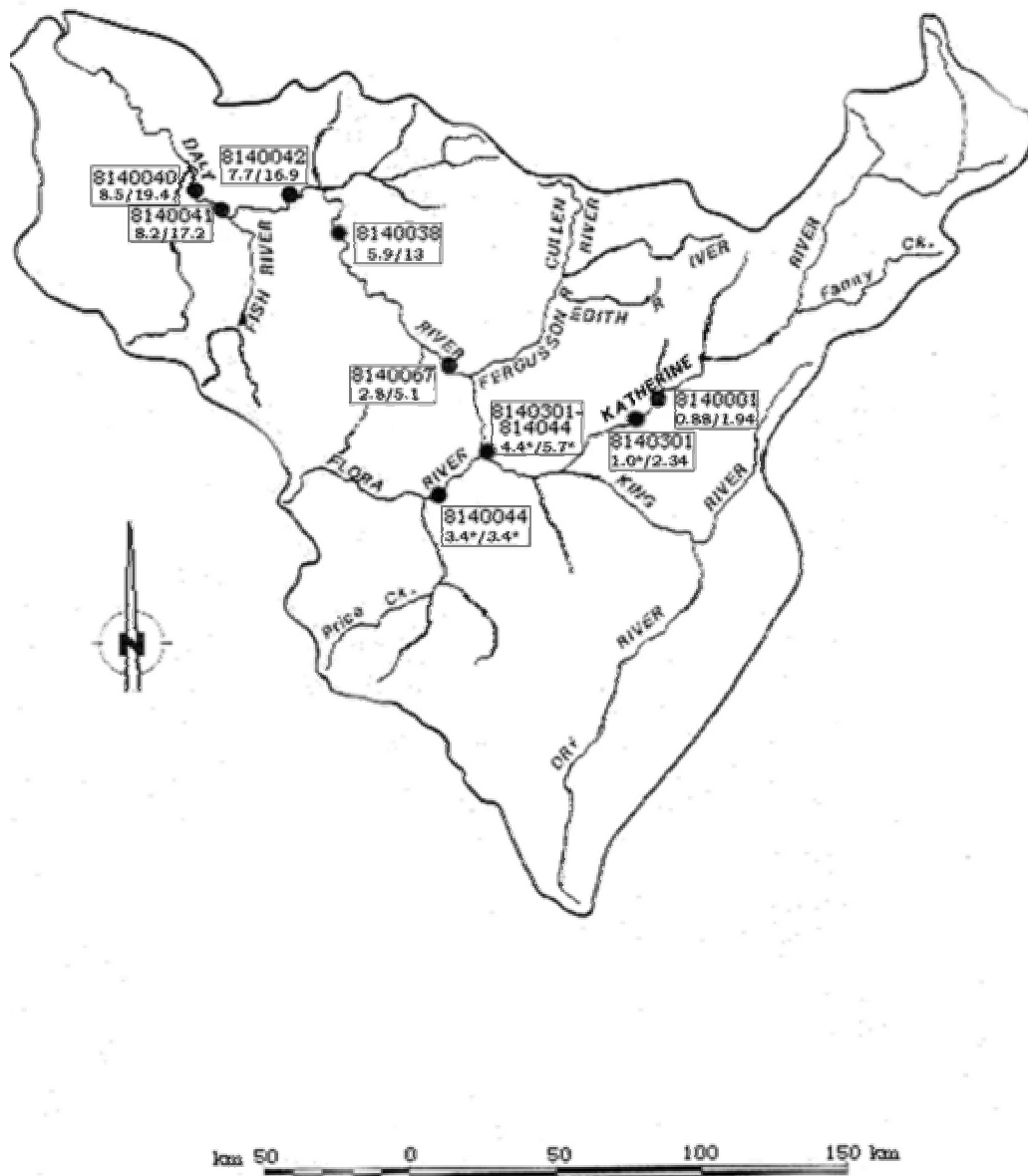
1970 follows a period of below average wet seasons.

1982 follows a period of average to above average wet seasons.

The Tindall Limestone is the main groundwater source for the Katherine, Flora and Douglas Rivers. The Oolloo Limestone is the major source of groundwater for the Katherine River and Daly River downstream of the confluence of the King and Katherine Rivers. Between Beeboon Crossing and Mount Nancar, the Daly River

should receive more springflow from the Tindal Limestone. However, the level of input of the Tindal Limestone to this part of the Daly River is not known.

**Figure 3** Gauged Flows at Various Stations in early November in 1970 and 1982



**814 DALY RIVER**

Note:

- Displayed are gaugings from 1970 and 1982, eg. “1970/1982”.
- \* indicates estimated value

#### 4. Relationship Between Rainfall and Potential Recharge in the Katherine Region

The estimation of potential recharge to the limestone aquifers in the Katherine region is based on the rainfall records obtained from the Katherine Post Office site, DR014902, during the period 1872 to 1999.

Potential recharge was calculated from the daily rainfall record, using estimates for the end of dry season soil moisture deficit and daily losses (evapotranspiration etc). A soil moisture deficit of **150 mm** and wet season evapotranspiration (ET) of **5mm/day** were chosen. It was assumed that there was little surface runoff from the ground overlying the limestone aquifers.

Daily potential recharge is calculated using the following formulae :

If  $SMD_d + PPT_d - ET \leq -150$  then  $SMD_{d+1} = -150$   
 Else if  $SMD_d + PPT_d - ET \leq 0$  then  $SMD_{d+1} = SMD_d + PPT_d - ET$   
 Else if  $PPT_d - ET > 0$  then  $SMD_{d+1} = SMD_d + PPT_d - ET$   
 Else if  $PPT_d - ET \leq 0$  then  $SMD_{d+1} = 0$

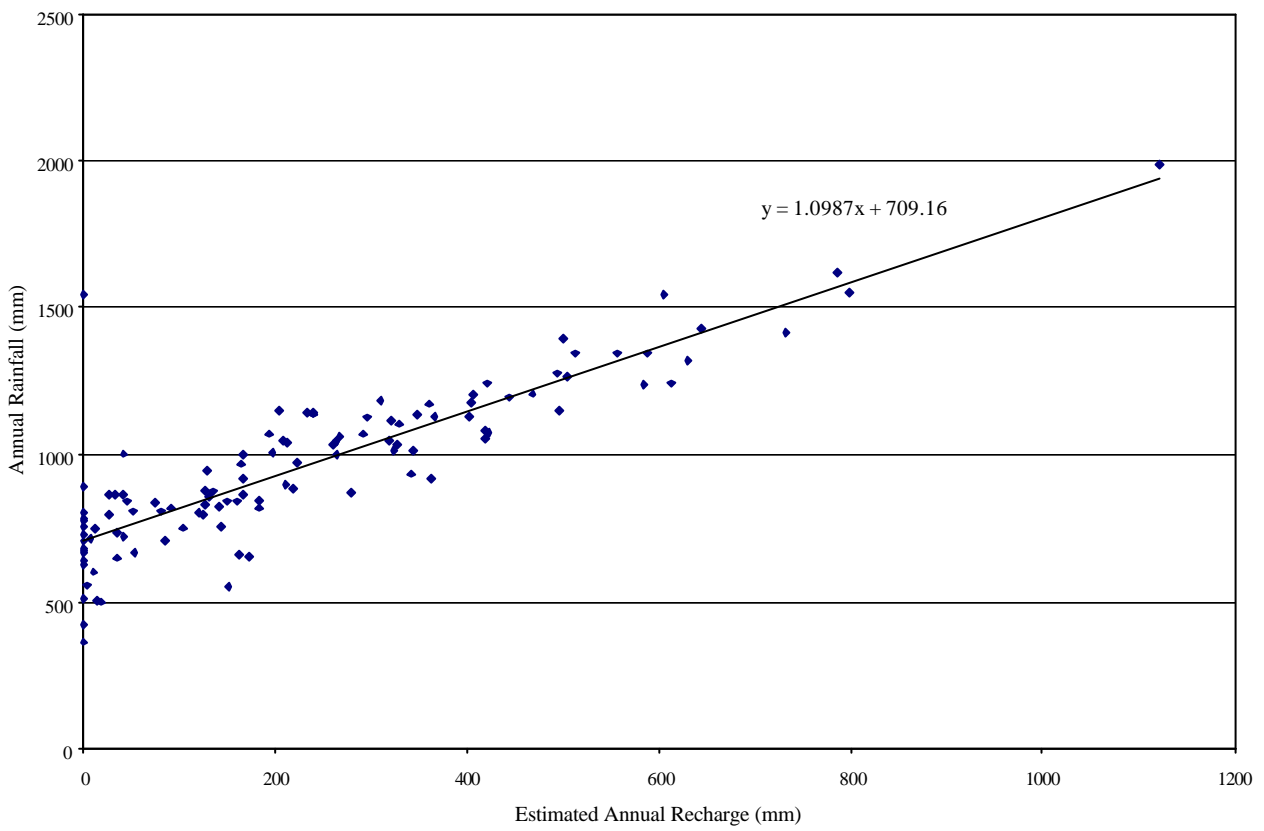
Where  $SMD$  = soil moisture deficit (mm)  
 $PPT$  = daily rainfall (mm)  
 $ET$  = evapotranspiration (mm)  
 $d$  = day  
 $d+1$  where 1 = number of days since previous  $SMD_d$  value

**Daily recharge  $R = SMD_{d+1} - SMD_d$**

Once daily recharge has been calculated, recharge events can be identified from the daily recharge record, and are summarised in Table 5. This is done by summing consecutive daily recharge values to give discrete events. Annual rainfall (1 October to 30 September) and potential annual recharge are given in Table 4 for the period

1884 to 1999 and plotted on Figure 4. The data indicates that an annual rainfall of about 700mm is required before any significant recharge occurs.

**Figure 4** Relationship between Annual Rainfall and Estimated Annual Recharge



**Table 4** Annual Rainfall and Estimated Annual Recharge Details – DR014902

Date	Total Annual Rainfall (mm)	Total Annual Recharge (mm)	Date	Total Annual Rainfall (mm)	Total Annual Recharge (mm)
1884/1885	653	172	1944/1945	805	51
1885/1886	821	182	1945/1946	916	363
1886/1887	N/A	N/A	1946/1947	841	160
1887/1888	552	151	1947/1948	860	26
1888/1889	1033	259	1948/1949	796	124
1889/1890	1136	348	1949/1950	997	263
1890/1891	817	92	1950/1951	1172	360
1891/1892	424	0	1951/1952	364	0
1892/1893	804	119	1952/1953	829	127
1893/1894	1071	194	1953/1954	1103	329
1894/1895	1149	203	1954/1955	1004	42
1895/1896	1045	209	1955/1956	841	46
1896/1897	933	340	1956/1957	1345	588
1897/1898	1990	1121	1957/1958	942	128
1898/1899	1554	798	1958/1959	861	33
1899/1900	725	0	1959/1960	1010	324
1900/1901	1319	630	1960/1961	804	0
1901/1902	498	18	1961/1962	502	13
1902/1903	807	79	1962/1963	1051	263
1903/1904	1543	606	1963/1964	703	0
1904/1905	720	42	1964/1965	861	41
1905/1906	638	0	1965/1966	757	142
1906/1907	1277	493	1966/1967	1131	402
1907/1908	1243	421	1967/1968	1342	555
1908/1909	679	0	1968/1969	1010	344
1909/1910	1202	406	1969/1970	647	34
1910/1911	747	12	1970/1971	1137	238
1911/1912	973	223	1971/1972	1043	212
1912/1913	857	131	1972/1973	899	211
1913/1914	825	141	1973/1974	1345	512
1914/1915	751	103	1974/1975	1051	263
1915/1916	1071	291	1975/1976	1395	499
1916/1917	1142	233	1976/1977	1267	504
1917/1918	1208	468	1977/1978	1131	366
1918/1919	622	0	1978/1979	1063	268
1919/1920	667	0	1979/1980	1194	444
1920/1921	1113	321	1980/1981	1085	418
1921/1922	841	150	1981/1982	1008	197
1922/1923	996	166	1982/1983	756	0
1923/1924	1076	422	1983/1984	1620	786
1924/1925	865	167	1984/1985	894	0
1925/1926	600	10	1985/1986	778	0
1926/1927	663	162	1986/1987	869	279
1927/1928	781	0	1987/1988	915	166
1928/1929	506	0	1988/1989	1137	239
1929/1930	1055	420	1989/1990	714	7
1930/1931	1186	309	1990/1991	1236	584
1931/1932	664	53	1991/1992	557	5
1932/1933	733	34	1992/1993	881	217
1933/1934	970	163	1993/1994	845	183
1934/1935	1142	240	1994/1995	836	75
1935/1936	798	27	1995/1996	675	0
1936/1937	1147	496	1996/1997	1244	613
1937/1938	706	85	1997/1998	1415	732
1938/1939	1031	326	1998/1999	1128	296
1939/1940	1427	644			
1940/1941	876	134			
1941/1942	878	127			
1942/1943	1046	319			
1943/1944	1176	404			

**Table 5** Summary of Recharge Events

Date	Recharge Event	Date	Recharge Event	Date	Recharge Event	Date	Recharge Event
01/02/1885	9	12/03/1898	203	04/02/1916	50	28/01/1937	49
20/02/1885	81	31/03/1898	239	07/03/1916	6	31/01/1937	5
25/02/1885	33	02/01/1899	42	03/01/1917	55	12/03/1937	50
28/02/1885	4	09/01/1899	16	03/02/1917	132	16/02/1938	68
05/03/1885	12	17/01/1899	198	27/02/1917	5	22/02/1938	17
11/03/1885	33	21/01/1899	37	06/03/1917	23	25/01/1939	105
26/12/1885	81	19/03/1899	440	24/03/1917	19	13/02/1939	108
06/02/1886	81	24/03/1899	67	19/11/1917	41	22/02/1939	17
10/02/1886	20	04/01/1901	7	05/12/1917	48	27/02/1939	96
11/01/1888	87	09/02/1901	54	14/12/1917	23	10/01/1940	238
28/01/1888	44	01/03/1901	51	21/12/1917	27	20/01/1940	50
18/02/1888	17	18/03/1901	518	06/01/1918	39	26/01/1940	18
23/02/1888	3	04/02/1902	18	17/01/1918	87	06/02/1940	49
21/02/1889	108	18/02/1903	40	31/01/1918	124	11/02/1940	11
08/03/1889	11	26/02/1903	35	09/02/1918	71	23/02/1940	2
28/12/1889	31	02/01/1904	43	16/02/1918	10	29/02/1940	102
04/01/1890	53	14/01/1904	396	07/01/1921	81	05/03/1940	57
20/01/1890	101	30/01/1904	118	27/02/1921	42	29/03/1940	119
25/01/1890	52	08/03/1904	36	19/03/1921	159	09/03/1941	27
01/02/1890	44	26/03/1904	13	28/03/1921	39	30/03/1941	107
08/02/1890	5	08/02/1905	42	19/03/1922	150	09/01/1942	21
15/02/1890	63	26/12/1906	86	05/01/1923	40	07/02/1942	96
24/01/1891	56	18/01/1907	71	11/01/1923	40	22/02/1942	10
09/02/1891	36	08/02/1907	105	05/04/1923	86	01/01/1943	6
21/02/1893	119	11/02/1907	2	29/12/1923	205	16/01/1943	9
25/01/1894	114	16/02/1907	127	10/01/1924	27	28/02/1943	202
06/02/1894	18	25/02/1907	103	21/02/1924	115	12/03/1943	102
12/02/1894	31	14/12/1907	8	04/03/1924	76	17/01/1944	4
16/02/1894	16	23/12/1907	150	15/02/1925	18	31/01/1944	1
05/03/1894	15	28/12/1907	19	01/03/1925	131	09/02/1944	14
23/01/1895	20	07/01/1908	58	11/03/1925	18	15/02/1944	26
27/01/1895	3	06/02/1908	71	11/01/1926	10	05/03/1944	268
10/02/1895	112	16/02/1908	10	28/12/1926	116	17/03/1944	82
17/02/1895	26	10/03/1908	95	27/01/1927	46	04/03/1945	51
23/01/1896	11	28/03/1908	10	02/01/1930	10	30/12/1945	103
29/01/1896	7	22/11/1909	12	10/01/1930	42	20/01/1946	27
06/02/1896	44	04/12/1909	135	17/02/1930	134	27/01/1946	53
15/02/1896	43	13/01/1910	175	24/02/1930	67	16/02/1946	180
26/02/1896	33	07/02/1910	11	26/12/1930	42	22/02/1947	71
03/03/1896	20	01/03/1910	73	30/01/1931	147	27/02/1947	32
12/03/1896	46	16/02/1911	12	04/04/1931	119	18/03/1947	16
02/04/1896	6	04/02/1912	29	21/03/1932	53	27/03/1947	41
07/12/1896	32	20/02/1912	29	29/12/1932	34	04/01/1948	26
09/01/1897	266	02/03/1912	10	03/01/1934	80	22/02/1949	8
09/02/1897	42	17/03/1912	156	08/01/1934	63	07/03/1949	44
10/02/1897		23/02/1913	85	03/02/1934	21	19/03/1949	73
10/12/1897	308	08/03/1913	33	25/01/1935	23	30/12/1949	68
18/12/1897	14	28/03/1913	14	11/02/1935	30	17/01/1950	37
31/12/1897	140	06/01/1914	54	08/03/1935	169	26/01/1950	59
07/01/1898	30	15/01/1914	61	29/03/1935	18	07/02/1950	58
21/01/1898	31	29/01/1914	26	12/01/1936	23	16/02/1950	41
03/02/1898	23	21/01/1915	47	29/02/1936	0	06/01/1951	70
07/02/1898	13	01/02/1915	37	04/03/1936	3	16/01/1951	151
20/02/1898	85	14/02/1915	20	08/01/1937	316	07/02/1951	6
23/02/1898	8	24/12/1915	205	15/01/1937	18	16/02/1951	96
01/03/1898	25	19/01/1916	29	22/01/1937	59	23/02/1951	6

Date	Recharge Event	Date	Recharge Event	Date	Recharge Event	Date	Recharge Event
02/03/1951	3	02/03/1972	70	23/01/1984	146	15/02/1998	11
08/03/1951	14	09/03/1972	22	30/01/1984	103	30/12/1998	77
07/02/1953	75	17/03/1972	93	20/02/1984	47	10/01/1999	8
08/04/1953	52	21/01/1973	35	25/02/1984	36	16/01/1999	4
01/02/1954	320	07/02/1973	81	06/03/1984	102	19/01/1999	47
26/02/1955	4	14/03/1973	95	17/03/1984	245	08/02/1999	22
09/03/1955	31	18/02/1974	147	07/02/1987	24	17/02/1999	16
05/02/1956	34	25/02/1974	16	11/02/1987	35	25/02/1999	33
19/02/1956	12	02/03/1974	26	14/02/1987	32	14/03/1999	85
20/12/1956	65	09/03/1974	120	18/02/1987	31		
08/01/1957	25	14/03/1974	7	23/02/1987	126		
20/01/1957	25	25/03/1974	196	26/02/1987	30		
11/02/1957	54	17/01/1975	151	13/02/1988	166		
07/03/1957	419	24/02/1975	81	16/12/1988	8		
23/12/1957	47	28/02/1975	31	24/12/1988	17		
29/12/1957	52	09/02/1976	16	30/12/1988	46		
17/01/1958	29	24/02/1976	229	01/02/1989	19		
22/01/1959	17	28/02/1976	17	20/03/1989	138		
08/04/1959	16	05/03/1976	34	24/03/1989	11		
31/01/1960	65	09/03/1976	29	10/03/1990	7		
15/02/1960	165	17/03/1976	128	13/12/1990	41		
25/02/1960	4	23/03/1976	47	22/12/1990	77		
15/03/1960	90	07/02/1977	3	12/01/1991	217		
07/02/1962	10	11/02/1977	26	22/01/1991	19		
16/02/1962	2	21/02/1977	81	05/02/1991	79		
22/02/1962	1	05/03/1977	231	16/02/1991	40		
27/01/1963	194	22/03/1977	164	20/02/1991	27		
01/02/1963	28	18/01/1978	22	23/02/1991	67		
18/02/1963	13	30/01/1978	187	28/02/1991	18		
22/02/1963	4	13/02/1978	6	13/02/1992	3		
02/03/1963	24	25/02/1978	150	26/02/1992	2		
04/12/1964	41	27/01/1979	50	30/01/1993	91		
05/02/1966	133	04/02/1979	22	04/02/1993	24		
12/02/1966	10	11/02/1979	16	09/02/1993	42		
08/02/1967	59	20/02/1979	35	12/02/1993	51		
21/02/1967	100	09/03/1979	145	19/02/1993	1		
02/03/1967	165	06/02/1980	50	28/12/1993	37		
16/03/1967	77	12/02/1980	68	05/01/1994	10		
27/01/1968	129	17/02/1980	98	10/01/1994	7		
02/02/1968	19	26/02/1980	119	03/03/1994	74		
14/02/1968	164	22/03/1980	109	08/03/1994	56		
24/02/1968	128	13/01/1981	160	27/01/1995	30		
11/03/1968	116	17/01/1981	33	02/02/1995	4		
05/02/1969	103	23/01/1981	7	08/02/1995	8		
17/02/1969	1	27/01/1981	5	06/03/1995	34		
28/02/1969	178	02/02/1981	3	04/01/1997	277		
16/03/1969	62	07/02/1981	77	08/01/1997	6		
24/12/1969	34	16/02/1981	101	22/01/1997	124		
19/02/1971	11	20/02/1981	31	25/01/1997	17		
03/03/1971	40	11/02/1982	45	23/02/1997	132		
13/03/1971	3	15/02/1982	26	26/02/1997	15		
24/03/1971	157	26/02/1982	71	04/03/1997	43		
04/04/1971	28	02/03/1982	54	27/12/1997	33		
17/12/1971	8	01/01/1984	23	03/01/1998	249		
25/12/1971	6	07/01/1984	37	21/01/1998	101		
02/01/1972	12	17/01/1984	46	28/01/1998	340		

## **5. Relationship Between Estimated Recharge and Groundwater Fed Baseflows for the Katherine River at the Low Level Crossing**

Hydrographs for GS8140001 and gauged flows at the Low Level Crossing, 3km downstream of the gauging station, were examined to determine increases in annual springflow correlated with the potential annual recharge, as were predicted in Section 4. These increases have been summarised in Appendix B. A linear relationship representing the correlation between probable increases in flow and recharge events was determined:

$$\text{Change in Q (in cumecs)} = A \times (\text{Recharge event in mm})$$

where A = slope of best fit line

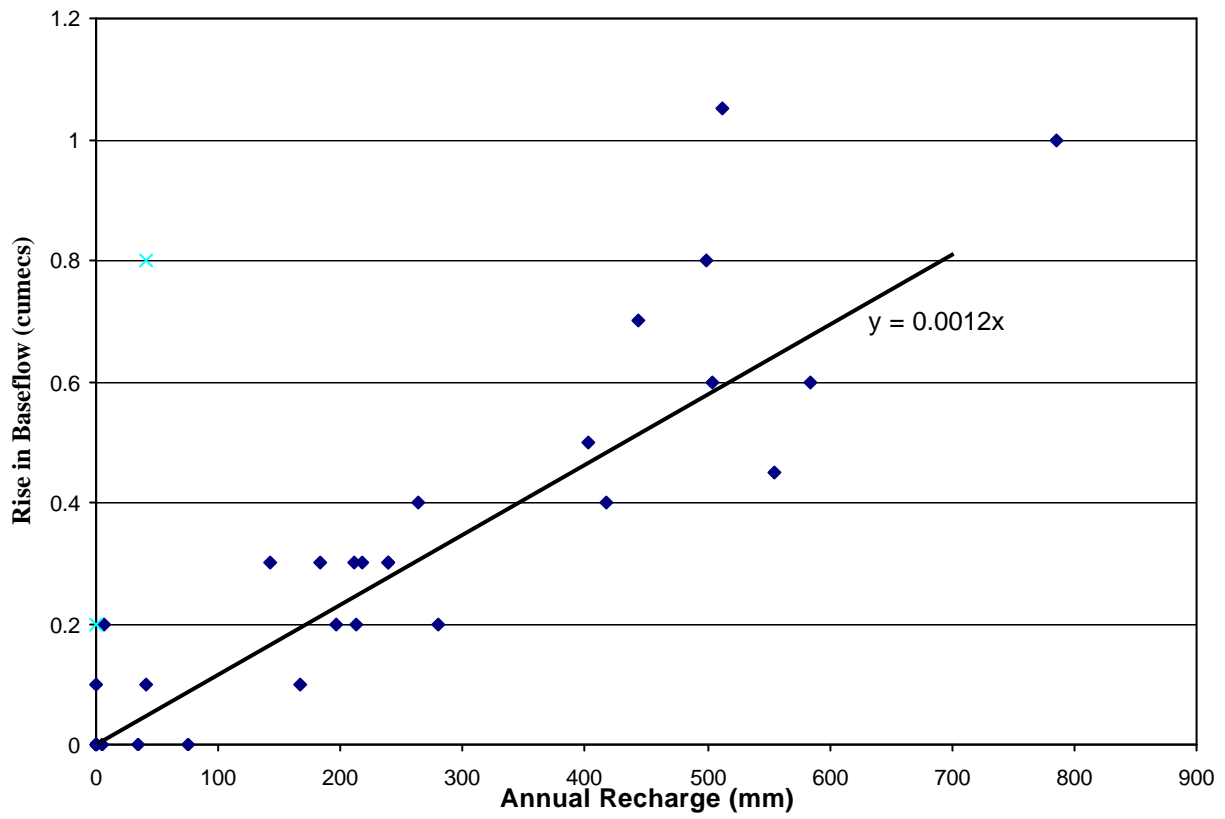
Table 6 shows annual potential recharge and the corresponding estimated annual rise in baseflows for the Low Level Crossing, and the relationship is plotted in Figure 5. A line of best fit through this data gives a linear relationship of :

$$\text{Change in Q (in cumecs)} = 0.0012 \times (\text{Recharge event in mm})$$

This relationship can then be applied to each individual recharge event in order to calculate the corresponding change in baseflow.

**Table 6** Estimated Annual Increase in Baseflow for the Katherine River at the Low Level Crossing, 3km downstream GS8140001

<b>Water Year</b>	<b>Annual Rainfall (mm)</b>	<b>Potential Recharge (mm)</b>	<b>Rise in Baseflow (cumecs)</b>
1963/1964	703	0	0
1964/1965	861	41	0.1
1965/1966	728	142	0.3
1966/1967	1160	402	0.5
1967/1968	1293	555	0.45
1968/1969	1058	344	-
1969/1970	649	34	0
1970/1971	1103	238	0.3
1971/1972	1078	212	0.2
1972/1973	867	211	0.3
1973/1974	1361	512	1.05
1974/1975	1055	263	0.4
1975/1976	1412	499	0.8
1976/1977	1267	504	0.6
1977/1978	1127	366	-
1978/1979	1026	268	-
1979/1980	1236	444	0.7
1980/1981	1066	418	0.4
1981/1982	1026	197	0.2
1982/1983	751	0	0
1983/1984	1618	786	1
1984/1985	889	0	0
1985/1986	677	0	0.1
1986/1987	980	279	0.2
1987/1988	915	166	0.1
1988/1989	1137	239	0.3
1989/1990	714	7	0.2
1990/1991	1233	584	0.6
1991/1992	558	5	0
1992/1993	884	217	0.3
1993/1994	845	183	0.3
1994/1995	833	75	0
1995/1996	677	0	0



**Figure 5** Relationship between Increase in Springflow and Annual Recharge for the Katherine River at the Low Level Crossing, 3km downstream of GS8140001

## 6. Synthesis of Baseflow Record

The relationships developed in Sections 2, 4 and 5 were used to predict the groundwater baseflow component of the hydrograph for the Katherine River. The flows were calculated using an Excel spreadsheet and the formulae and logical expressions given below.

**Formulae used to synthesise springflow** (derived from Szilagyi's paper)

Using  $\text{Log } Q = a - bN$  where  $a = \log(\text{flow})$   
 $b = \text{slope of recession}$

$$\backslash \quad Q = e^{(\log(\text{flow}) - b(\text{time since recharged}))}$$

If  $SF_d > MSF$  then  $SF_{d+1} = \text{increase in flow} + 10^{(\log(MSF) - b(\text{time since recharged}))}$

Else  $SF_{d+1} = \text{increase in flow} + 10^{(\log(SF_d) - b(\text{time since recharged}))}$

Where  $SF_d =$  spring flow (cumecs)

$MSF =$  max spring flow when aquifer fully recharged (cumecs)

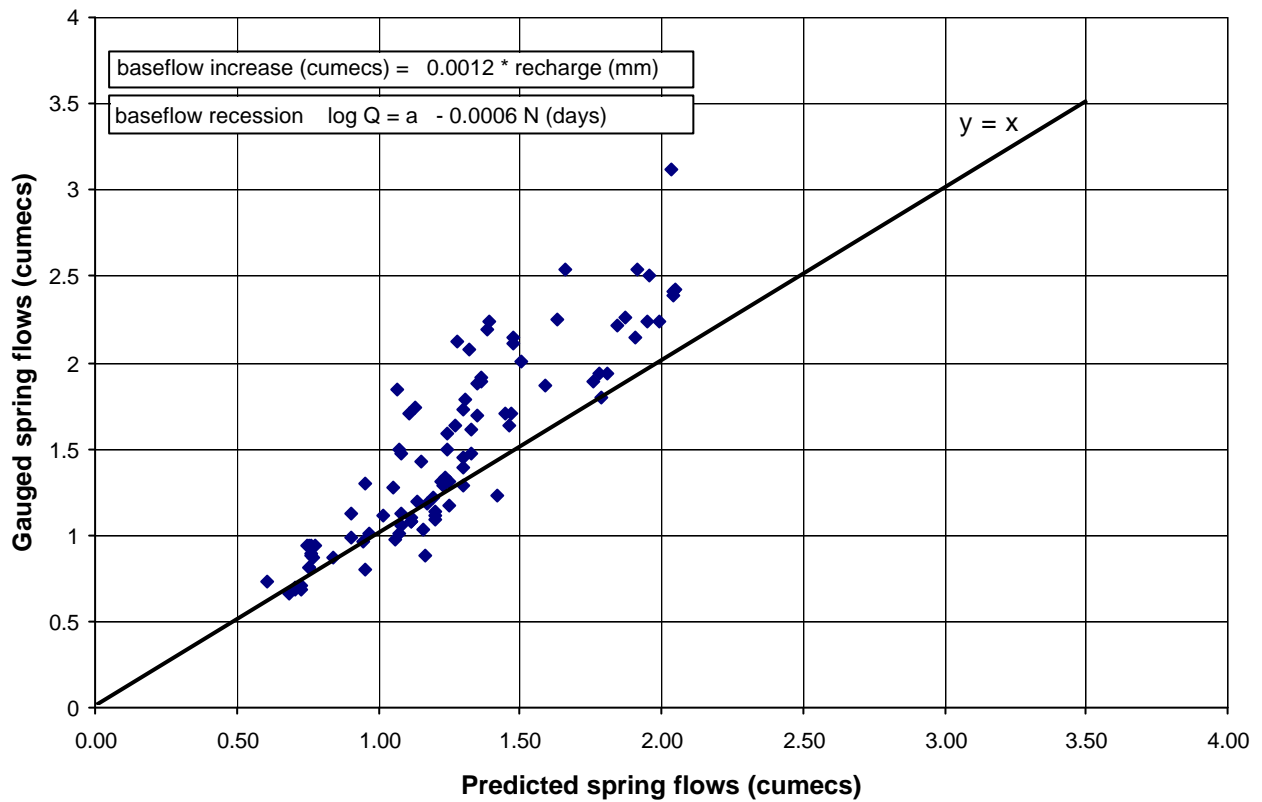
$d =$  day

$d+1$  where 1 = number of days since previous  $SF_d$  value

This method produces a baseflow hydrograph, which represents the groundwater fed flow of the river system. It does not include the runoff or flood flow component. In order to check to validity of modelled baseflow, a comparison is made between actual gauged dry season flows and predicted synthesised baseflows for the same dates. This is in effect, a calibration stage of the modelling, and allows a basic sensitivity analysis to be carried out in order to verify or adjust the parameters and variables.

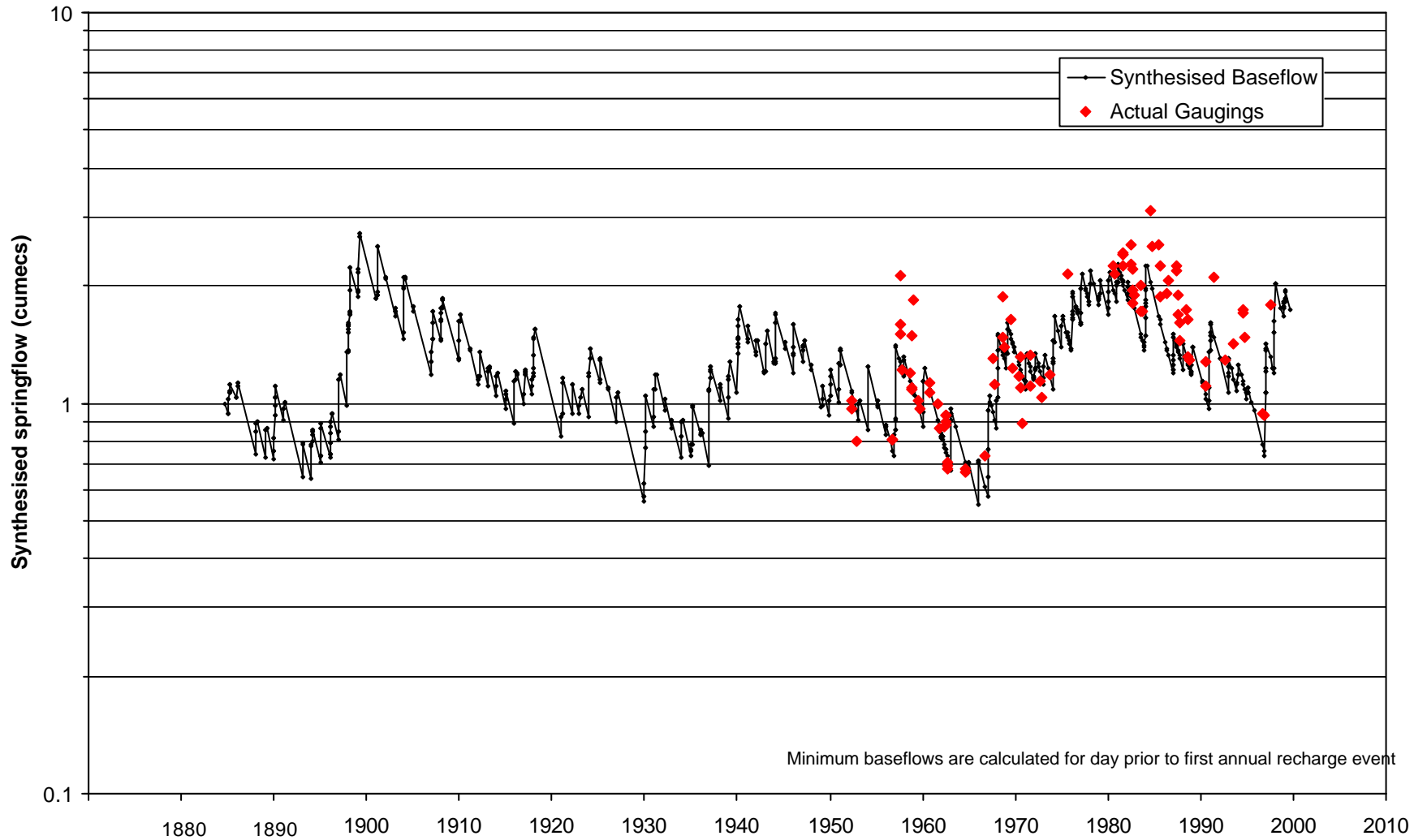
This synthesis has been carried out for the Katherine River (GS814001) and the results are shown in Figures 6 and 7 and in Appendix B.

**Figure 6** Comparison between predicted and actual groundwater fed flows for the Katherine River at the Low Level Crossing, 3km downstream of GS8140001



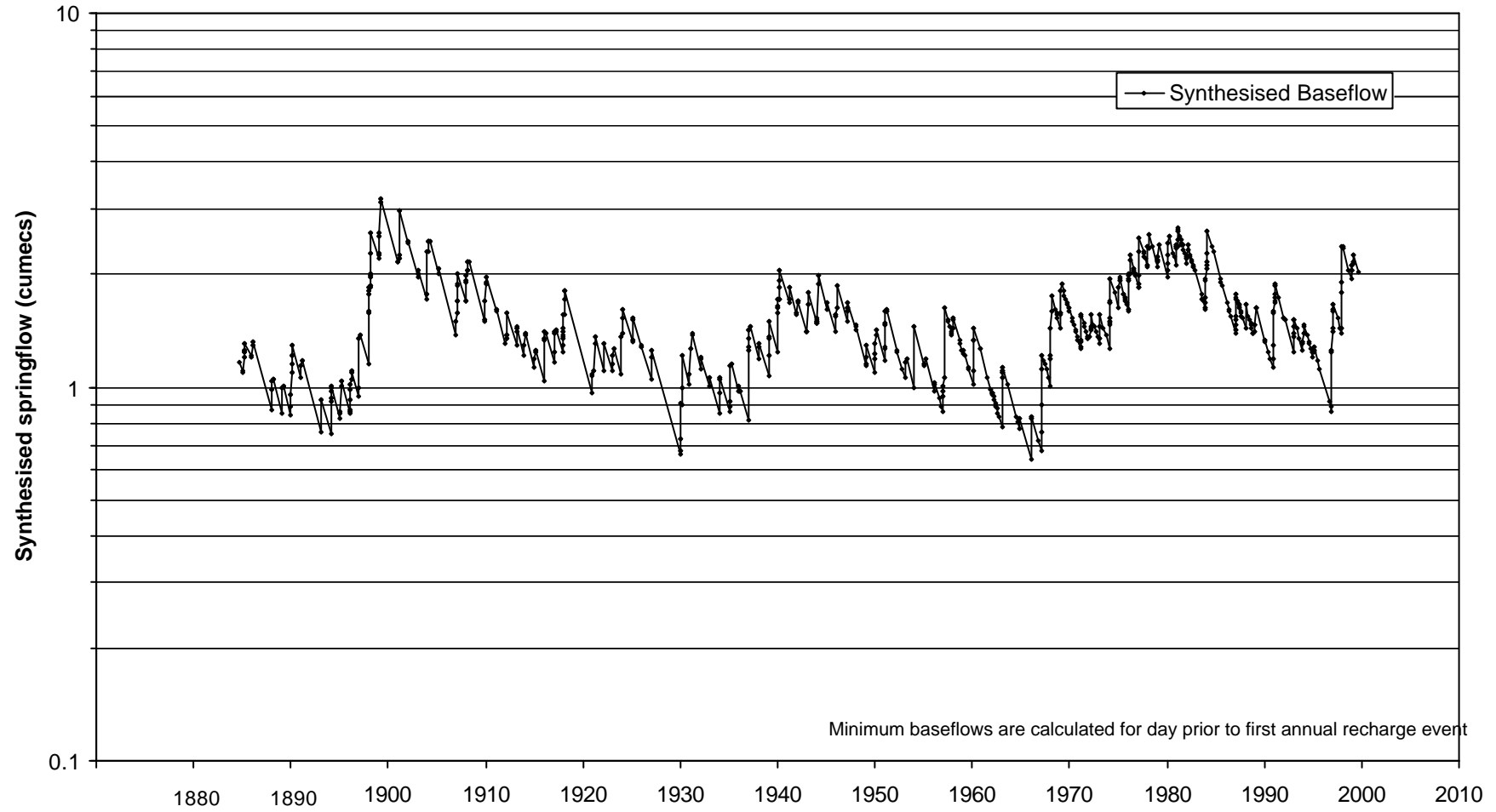
The gauged flows at the Low Level Crossing represent only a portion of the dry season flow which is fed from the Tindall Limestone aquifer. The gauging site GS8140001 at Galloping Jacks was established to gauge flows for the total dry season flow fed by the Tindall Limestone aquifer. Data plotted in Appendix B (Figure B6) indicates flow at GS8140301 is 17% greater than flows at the Low Level Crossing. This relationship has been used to synthesise groundwater fed flows at GS8140301 (refer Figure 8). This data represents the flow record for discharges into the Katherine River from the regional aquifer developed in the Tindall Limestone.

**Figure 7** Synthesised groundwater fed flows from the regional Tindall Limestone Aquifer into the Katherine River at Low Level Crossing, 3km downstream of GS8140001.



**Figure 8**

Synthesised groundwater fed flows from the regional Tindall Limestone Aquifer into the Katherine River at Galloping Jacks, GS8140301



## 7. Summary

Relationships have been developed between groundwater fed flows at 6 gauging stations and time (signified in graphical form by Log Q vs Time). Those Gauging Stations are :

1. G8140044          Flora River
2. G8140001          Katherine River at Railway Bridge
3. G8140301          Katherine River at Galloping Jacks
4. G8140067          Daly River at Dorisvale Crossing
5. G8140063          Douglas River
6. G8140040          Daly River at Mount Nancar

There appears to be two distinct relationships at all stations (except GS8140063). One is controlled by discharge from the regional aquifer, the other is controlled by discharge from the aquifer adjacent to the river, discharge which has been derived from recharge from wet season river flows.

Analysis of Katherine rainfall records and dry season baseflows in the Katherine River has allowed the synthesis of the groundwater components of flows fed by discharges into the Katherine River from the regional aquifer system developed in the Tindall Limestone. This has been done for the period 1885 to present. This analysis indicated that these groundwater fed flows range between a low of approximately 0.65cumecs (1930 and 1966), and a high of about 2.5cumecs (around 1900 and 1980).

## 8. Recommendations

- 1) Refine the recharge estimations derived from Katherine rainfall data. This refinement should initially focus on quantifying runoff for the various times of the wet season.
- 2) Further develop the relationship between near river recharge to the aquifer during the wet season, and subsequent discharge to the Katherine River.
- 3) Redo the synthesis of groundwater fed flows to the Katherine River once (1) and (2) are completed.
- 4) Undertaking similar exercises for groundwater fed flows at gauging stations GS8140044, GS8140063, GS8140067 and GS8140040.
- 5) Determine the reason for the apparent increase in dry season flow at GS8140044 on the Flora River.
- 6) Utilise the data gained in these studies to calibrate regional groundwater flow models for aquifers developed in the Tindall Limestone and Ooloo Limestone in the Daly Basin.

## **Appendix B**

### **Katherine River**

The gauging station GS8140001, while located at the Railway Bridge on the Katherine River, is rated to measure groundwater fed flows at the Low Level Crossing, 3km downstream of GS8140001. GS8140301 is located at Galloping Jacks, a rapids section approximately 15km downstream of the Low Level Crossing.

Hydrographs from the program HYDSYS were used to give an idea as to the general behaviour of the river at GS8140001 throughout the years. A continuous recorder has been installed here since 1960, and gaugings have been carried out at the Low Level crossing since 1952. It can be seen from the hydrograph plots that there are two distinct recession responses during the dry season. For dry season recession following average to below average rainfall years, the recession reaches a relatively flat slope from september onwards. After higher rainfall years, the recession has a much steeper slope, and may not reach the expected shallow baseflow slope at all. This response has been attributed to bank storage and shallow aquifer systems that are activated only after river levels have reached a certain height. In other words, controlled by groundwater discharge emanating from recharge close to the river (refer Figure B1, showing water levels in bores on the levee banks and remote from the river). The shallow slope is controlled by diffuse recharge or subsurface groundwater inflows into the Tindall Limestone. In order to validate this, further analysis needs to be made of river heights, recession rates and groundwater levels in the aquifers in the vicinity of the river itself.

The hydrographs were analyzed in order to ascertain the baseflow recession. The decline of the river's groundwater fed flow in the Dry Season can be represented by two equations of the form  $\log Q = a - bN$ , where  $Q$  is dry season flow (cumecs),  $N$  is the number of days between groundwater-dominated flow in the dry season, and  $a$  represents the maximum groundwater fed flow. For years when river flow heights are low and recharge was estimated to be zero, the following dry season recession will tend to be dominated by discharge from the regional aquifer developed in the Tindall Limestone ( eg 1985/86, 1969/70). This allows a best fit line to be fitted to the recession plot of two consecutive years.

The relationship for GS8140001 was found to be  $\log Q = 0.35 - 0.0006 N$

For years when river flow heights are high, and hence recharge to the aquifer near the river is high, groundwater fed flows are dominated by discharges from the aquifer near the river. During these years the relationship was found to be :

$$\log Q = 0.95 - 0.005 N$$

After plotting the recession slope, the annual rise in baseflow due to recharge could be taken directly from the hydrographs.

The relationship between annual recharge (as previously calculated and explained in Section 4) and change in baseflow is shown in Figure B4. The line of best fit shows a linear relationship of the form :

$$\text{Change in Q (in cumecs)} = 0.0012 \times (\text{Recharge event in mm}).$$

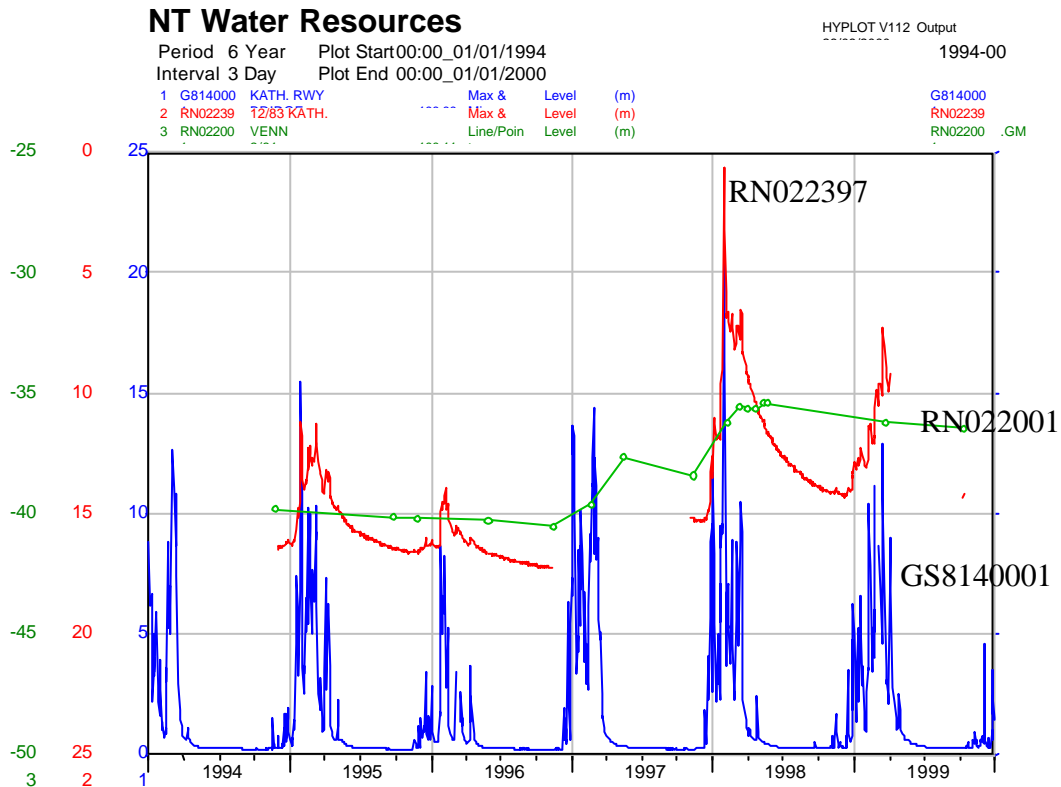
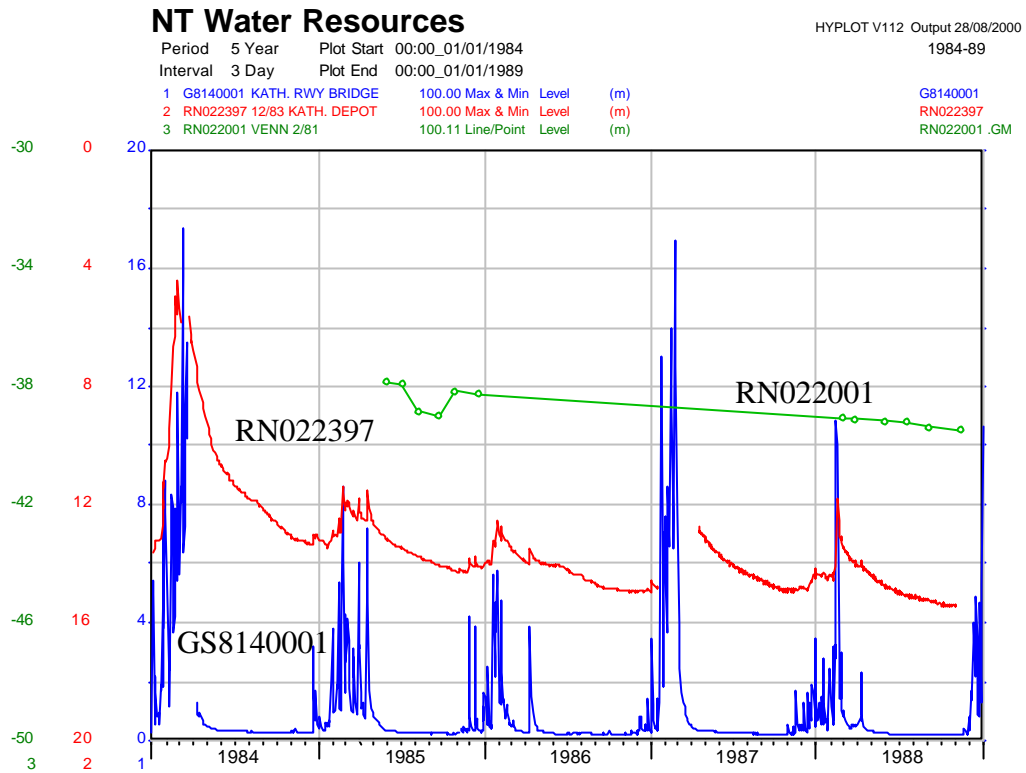
This relationship was used to calculate the change in groundwater fed flows in the Katherine River at the Low Level Crossing for each recharge event.

Groundwater fed flows derived from discharges from the regional Tindall Limestone Aquifer were then synthesised as shown in Figure B6. Actual gaugings are also plotted on this hydrograph.

The comparison between predicted baseflow and gauged flows are shown in Figure B5. The line of linear fit passes through the majority of the low flow gaugings. For higher flows, the model underpredicts slightly. This could be due to the higher flows being influenced by discharges from that part of the aquifer that was recharged by the Katherine River during the wet season.

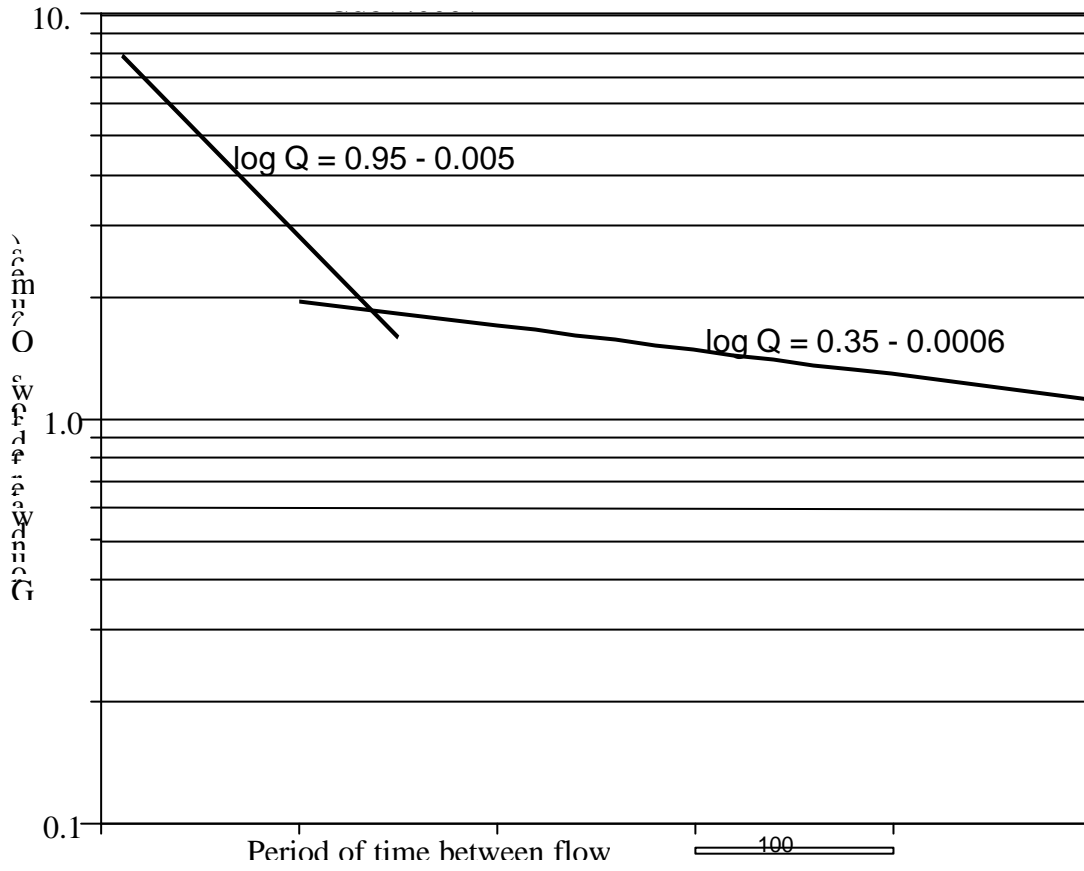
A comparison has also been made between the late dry season gauged flows at the Low Level crossing and Galloping Jacks. There is a good linear relationship between baseflows at these locations, with flows at Galloping Jacks being consistently 1.17 times higher than at the Low Level crossing. This is presented in Figure B7.

**Figure B1** Groundwater Levels in the Tindall Limestone Aquifer



- RN022397 Located on the levee banks of the Katherine River in Katherine
- RN022001 Located in the Tindall Limestone at Venn, remote from the Katherine River

Figure B2 Relationship between groundwater fed flow and Katherine River at



**Table B1(a)** List of Gaugings for GS8140001 – Railway Bridge

Gauge				Gauge			
No	Date	Start Time	Flow	No	Date	Start Time	Flow
1	24/04/1952	0	0	53	09/08/1961	1415	0.991
2	24/04/1952	1030	1.01	54	07/12/1961	1445	0.864
3	08/05/1952	730	0.97	55	16/12/1961	1430	3.65
4	30/10/1952	1500	0.799	56	18/12/1961	1015	9.2
5	19/02/1953	1500	29.6	57	22/01/1962	1500	453
6	01/04/1953	830	19.6	58	28/03/1962	1550	3.96
7	08/04/1953	1000	156	59	04/05/1962	1650	1.08
8	08/04/1953	2330	98.5	60	08/06/1962	1640	0.87
9	30/01/1954	120	204	61	21/06/1962	1245	0.878
10	01/02/1954	910	691	62	21/06/1962	1315	0.892
11	02/02/1954	1000	301	63	28/06/1962	950	0.934
12	03/02/1954	900	188	64	27/07/1962	1635	0.934
13	04/02/1954	1045	95.3	65	05/09/1962	1420	0.68
14	15/02/1956	915	212	66	05/09/1962	1620	0.708
15	21/02/1956	1015	177	67	23/10/1962	1645	0.694
16	21/02/1956	1430	170	68	02/11/1962	1530	7
17	23/02/1956	930	117	69	20/08/1963	1515	1.27
18	30/03/1956	235	756	70	06/02/1964	1720	18.4
19	12/05/1956	830	52.7	71	01/08/1964	750	0.68
20	15/05/1956	300	29.2	72	24/09/1964	1740	0.665
21	15/05/1956	800	31.4	73	18/02/1965	930	4.25
22	16/05/1956	315	26.9	74	01/11/1966	1445	0.733
23	30/07/1956	1045	2.18	75	09/05/1967	1530	4.11
24	30/07/1956	1115	2.24	76	22/06/1967	1230	1.87
25	30/10/1956	1300	0.807	77	12/08/1967	920	1.3
26	30/10/1956	1415	0.807	78	11/11/1967	1700	1.12
27	09/03/1957	1300	2760	79	11/05/1968	1145	9.68
28	26/03/1957	1415	70	80	12/06/1968	1420	5.58
29	28/05/1957	1500	5.49	81	18/06/1968	1610	5.21
30	10/07/1957	915	2.94	82	23/07/1968	830	3.88
31	07/08/1957	1140	2.12	83	29/08/1968	845	1.88
32	18/09/1957	805	1.59	84	24/09/1968	1500	1.47
33	18/09/1957	840	1.5	85	30/10/1968	1800	1.39
34	22/11/1957	1400	1.22	86	15/04/1969	1620	11.2
35	07/12/1957	900	2.18	87	27/05/1969	1645	3.13
36	11/09/1958	1010	1.19	88	02/07/1969	1640	2.13
37	15/10/1958	1430	1.08	89	19/08/1969	900	1.64
38	15/10/1958	1510	1.1	90	18/09/1969	830	2.57
39	15/10/1958	1550	1.08	91	08/10/1969	910	1.23
40	13/12/1958	1240	1.49	92	08/04/1970	830	2.93
41	19/12/1958	1530	1.84	93	22/05/1970	820	1.81
42	13/08/1959	1320	1.01	94	30/06/1970	1000	1.17
43	08/09/1959	945	0.963	95	07/08/1970	930	1.31
44	02/02/1960	1700	309	96	05/09/1970	1655	1.09
45	03/02/1960	917	261	97	21/10/1970	1740	0.884
46	15/02/1960	1500	552	98	21/11/1970	1435	1.56
47	09/03/1960	1050	25.6	99	21/01/1971	1510	4.5
48	10/03/1960	0	20.5	100	13/07/1971	1425	2.17
49	17/10/1960	1045	1.06	101	18/08/1971	900	1.33
50	19/10/1960	1045	1.13	102	04/10/1971	900	1.11
51	11/01/1961	900	9.77	103	30/06/1972	1315	2.38
52	09/02/1961	1115	167	104	27/07/1972	1455	1.74

<b>Gauge No</b>	<b>Date</b>	<b>Start Time</b>	<b>Flow</b>	<b>Gauge No</b>	<b>Date</b>	<b>Start Time</b>	<b>Flow</b>
105	16/09/1972	1405	1.14	157	29/06/1976	1040	7.67
106	11/11/1972	855	1.03	158	07/07/1976	1123	6.31
107	17/07/1973	1725	3.23	159	14/07/1976	1100	5.77
108	08/10/1973	1420	1.18	160	21/07/1976	1120	5.63
109	21/03/1974	1915	0	161	28/07/1976	1330	5.68
110	03/07/1974	1730	6.28	162	04/08/1976	1040	4.66
111	15/08/1974	1155	3.38	163	11/08/1976	1047	4.53
112	12/09/1974	1500	6.99	164	20/08/1976	945	3.88
113	08/05/1975	1445	30.3	165	26/08/1976	1310	3.89
114	15/05/1975	1045	20.1	166	02/09/1976	1047	3.71
115	22/05/1975	1020	16.4	167	09/09/1976	932	3.46
116	28/05/1975	1407	12.7	168	21/09/1976	1055	2.92
117	02/06/1975	1455	11.9	169	27/09/1976	1450	2.81
118	09/06/1975	1340	9.69	170	04/10/1976	1115	2.76
119	18/06/1975	1045	8.23	171	11/10/1976	1140	2.7
120	25/06/1975	1115	8.68	172	01/12/1976	1600	7.68
121	07/07/1975	1440	7.15	173	11/08/1977	1358	4.64
122	15/07/1975	1520	5.56	174	30/08/1977	1445	3.41
123	19/07/1975	1000	5.61	175	27/09/1977	1405	3.06
124	07/08/1975	1415	3.62	176	28/10/1977	1500	2.59
125	14/08/1975	1320	3.33	177	22/02/1978	1610	627
126	18/08/1975	1310	3.47	178	14/03/1978	1155	58.5
127	11/09/1975	1025	2.41	179	20/03/1978	1500	31.7
128	26/09/1975	1335	2.15	180	26/06/1978	1436	4.12
129	03/10/1975	1300	2.37	181	11/09/1980	1110	2.24
130	23/10/1975	1400	3.52	182	22/10/1980	840	2.14
131	06/11/1975	1400	2.82	183	19/05/1981	840	4.6
132	25/11/1975	1440	2.65	184	17/06/1981	1045	3.18
133	28/01/1976	1430	79.3	185	14/07/1981	850	2.98
134	11/02/1976	1415	271	186	06/08/1981	833	2.77
135	16/02/1976	1110	555	187	06/08/1981	835	2.8
136	17/02/1976	1000	1070	188	06/08/1981	852	2.67
137	17/02/1976	1630	1150	189	06/08/1981	902	2.47
138	17/02/1976	2050	1180	190	06/08/1981	1000	2.7
139	18/02/1976	1410	1120	191	06/08/1981	1004	2.47
140	20/02/1976	1035	899	192	06/08/1981	1040	2.42
141	24/02/1976	1115	1110	193	06/08/1981	1100	2.6
142	25/02/1976	1515	747	194	12/08/1981	849	2.39
143	26/02/1976	900	571	195	14/08/1981	900	2.41
144	27/02/1976	1403	558	196	23/09/1981	845	2.24
145	03/03/1976	925	313	197	10/11/1981	1345	2.23
146	11/03/1976	950	1040	198	19/05/1982	1100	4.6
147	17/03/1976	915	1490	199	17/06/1982	855	3.05
148	17/03/1976	1600	1810	200	24/06/1982	1045	2.54
149	18/03/1976	830	1900	201	29/07/1982	845	2.26
150	20/03/1976	830	1440	202	25/08/1982	845	2.21
151	31/03/1976	1530	127	203	24/09/1982	1055	1.94
152	09/04/1976	1415	57.5	204	14/10/1982	1510	1.8
153	23/04/1976	1045	27.8	205	19/10/1982	1331	1.94
154	29/04/1976	1527	22.8	206	11/11/1982	830	1.89
155	05/05/1976	1440	18.4	207	20/04/1983	1100	12.1
156	02/06/1976	1350	10.2	208	06/05/1983	1340	12.7

Gauge No	Date	Start Time	Flow
209	23/05/1983	1530	5.33
210	26/07/1983	1310	2.01
211	07/09/1983	905	1.71
212	27/09/1983	1100	1.71
213	19/08/1984	1345	3.12
214	23/10/1984	1036	2.51
215	25/07/1985	1040	2.54
216	22/08/1985	1045	2.25
217	10/10/1985	0	1.87
218	26/03/1986	828	0
219	04/06/1986	850	2.28
220	18/06/1986	1055	1.91
221	11/08/1986	1040	2.07
222	12/02/1987	1408	815
223	13/02/1987	1002	1210
224	13/02/1987	1406	1280
225	14/02/1987	1301	1430
226	16/02/1987	1413	1010
227	17/02/1987	1005	735
228	18/02/1987	932	567
229	19/02/1987	1004	501
230	20/02/1987	958	386
231	22/02/1987	901	2380
232	22/02/1987	1406	2410
233	24/02/1987	1008	1900
234	25/02/1987	1336	1210
235	26/02/1987	1401	1170
236	27/02/1987	1013	886
237	02/04/1987	1330	12.3
238	13/04/1987	1400	7.33
239	23/04/1987	1330	6.67
240	29/04/1987	1300	5.56
241	08/05/1987	1120	4.98
242	14/05/1987	1335	4.13
243	05/06/1987	1400	2.93
244	09/06/1987	1230	2.97
245	17/06/1987	1350	2.65
246	08/07/1987	1355	2.24
247	16/07/1987	1030	2.19
248	11/08/1987	1325	1.89
249	31/08/1987	1415	1.69
250	29/09/1987	1340	1.61
251	28/10/1987	1005	1.45
252	11/02/1988	920	154
253	11/02/1988	1325	134
254	24/02/1988	950	106
255	25/02/1988	850	55.3
256	26/02/1988	900	43.5
257	29/02/1988	910	38.9
258	01/03/1988	840	29
259	02/03/1988	900	24
260	03/03/1988	850	19.6

Gauge No	Date	Start Time	Flow
261	04/03/1988	850	16.1
262	17/03/1988	910	16.8
263	20/04/1988	850	7.14
264	08/06/1988	1120	2.16
265	12/07/1988	1505	1.73
266	19/08/1988	820	1.63
267	14/09/1988	1320	1.31
268	12/10/1988	900	1.29
269	29/06/1989	1455	4.51
270	18/07/1990	816	1.28
271	12/09/1990	850	1.11
272	16/07/1991	835	2.11
273	25/09/1992	1140	1.29
274	26/05/1993	1200	2.973
275	01/09/1993	803	1.421
276	07/06/1994	817	3.729
277	16/08/1994	1108	1.735
278	15/09/1994	1138	1.705
279	03/11/1994	1416	1.468
280	20/07/1995	1126	3.403
281	14/10/1995	1218	1.729
282	19/09/1996	1521	0.938
283	08/11/1996	854	0.935
284	01/05/1997	1251	8.178
285	22/07/1997	1054	1.783
286	11/11/1997	1512	2.106
287	28/01/1998	1333	8400
288	27/01/1998	0	9300
289	06/10/1998	743	3.381
290	07/09/1999	1106	3.385

**Table B1(b)** List of Gaugings for GS8140301 – Galloping Jack’s

<b>Gauge No</b>	<b>Date</b>	<b>Start Time</b>	<b>Flow</b>	<b>Gauge No</b>	<b>Date</b>	<b>Start Time</b>	<b>Flow</b>
1	15/08/1974	1700	4.08	42	30/09/1983	900	1.65
2	25/06/1975	1425	8.86	43	15/08/1984	930	3.91
3	19/07/1975	1125	6.02	44	25/07/1985	840	3.29
4	18/08/1975	1445	3.99	45	22/08/1985	845	2.42
5	11/09/1975	1525	2.89	46	10/10/1985	0	2.36
6	29/06/1976	1455	9.1	47	18/06/1986	920	2.19
7	07/07/1976	1430	7.19	48	11/08/1986	1250	2.37
8	14/07/1976	1400	6.72	49	09/06/1987	1025	3.65
9	21/07/1976	1415	6.22	50	12/08/1987	1506	2.42
10	28/07/1976	1600	6.23	51	02/09/1987	948	1.97
11	04/08/1976	1300	5.69	52	29/09/1987	1005	1.86
12	11/08/1976	1437	5.25	53	13/07/1988	1350	1.83
13	20/08/1976	1110	4.76	54	18/07/1990	920	1.46
14	26/08/1976	1510	4.55	55	12/09/1990	945	1.35
15	02/09/1976	1435	4.19	56	16/07/1991	925	2.6
16	09/09/1976	1115	4.16	57	21/07/1992	1419	1.624
17	21/09/1976	1445	3.63	58	25/05/1993	1455	3.36
18	27/09/1976	1630	3.1	59	31/08/1993	1430	1.767
19	04/10/1976	1440	3.16	60	06/06/1994	1630	4.109
20	11/10/1976	1440	3.3	61	15/09/1994	1545	1.801
21	11/08/1977	1602	5.17	62	03/11/1994	1302	1.693
22	27/09/1977	1537	3.19	63	20/07/1995	808	3.751
23	11/09/1980	1445	2.81	64	14/10/1995	958	1.864
24	19/05/1981	1140	5.4	65	19/09/1996	1434	1.157
25	17/06/1981	847	4.42	66	03/10/1998	1152	4.319
26	14/07/1981	1110	3.58	67	15/07/1998	1458	5.623
27	11/08/1981	1345	2.82				
28	23/09/1981	1100	2.61				
29	10/11/1981	1540	2.57				
30	19/05/1982	1455	5.21				
31	17/06/1982	1040	3.36				
32	29/07/1982	1035	2.93				
33	25/08/1982	1020	2.53				
34	24/09/1982	1000	2.53				
35	19/10/1982	920	2.34				
36	11/11/1982	1040	2.42				
37	24/05/1983	1430	5.61				
38	24/06/1983	900	2.88				
39	26/07/1983	1000	2.26				
40	07/09/1983	1120	1.93				
41	27/09/1983	856	1.87				

### NT Water Resources

HYPLOT V112 Output 20/07/2000  
1961-01

Period 40 Year Plot Start 00:00\_01/01/1961  
Interval 1 Month Plot End 00:00\_01/01/2001

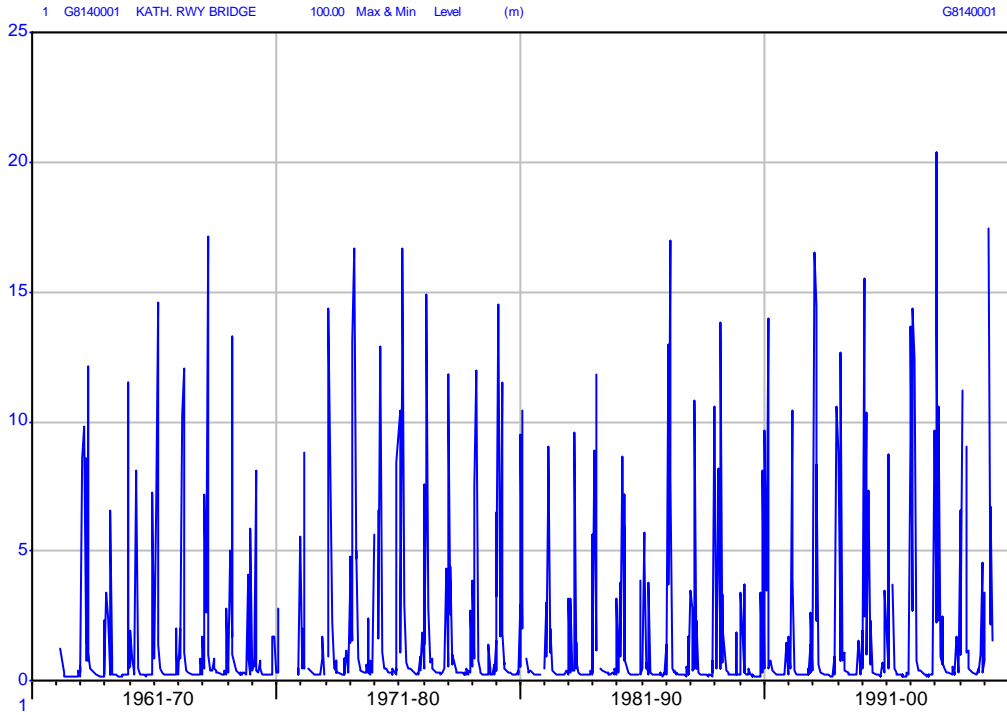


Figure B3(a) Maximum and Minimum Water Levels GS8140001

### NT Water Resources

HYPLOT V112 Output 20/07/2000  
1961-01

Period 40 Year Plot Start 00:00\_01/01/1961  
Interval 1 Month Plot End 00:00\_01/01/2001

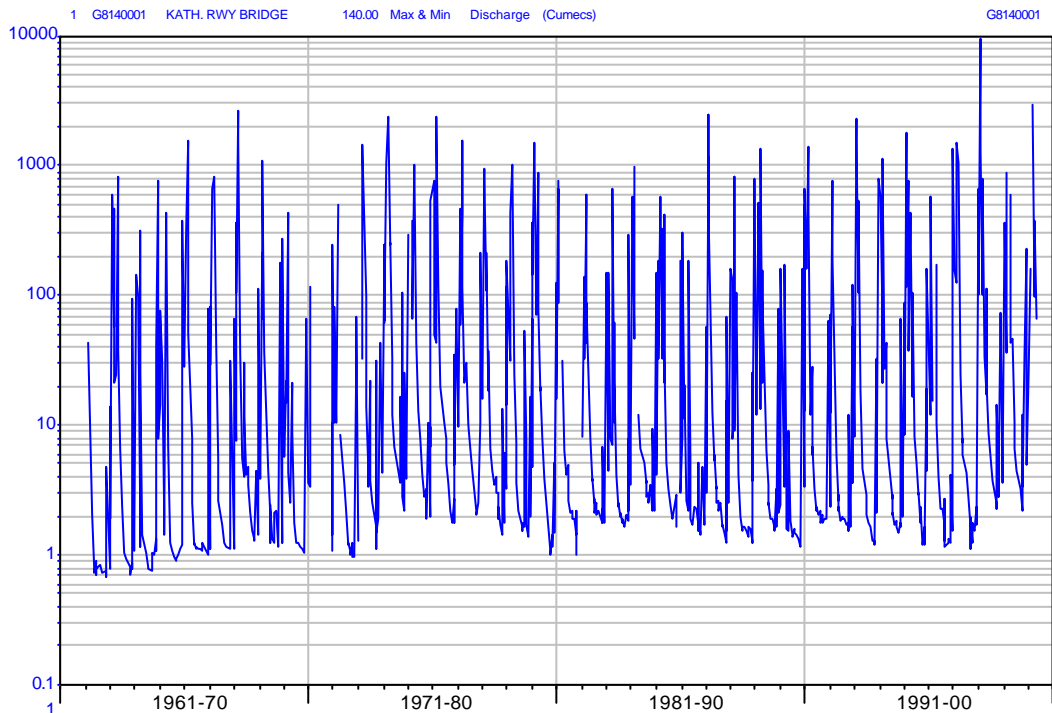
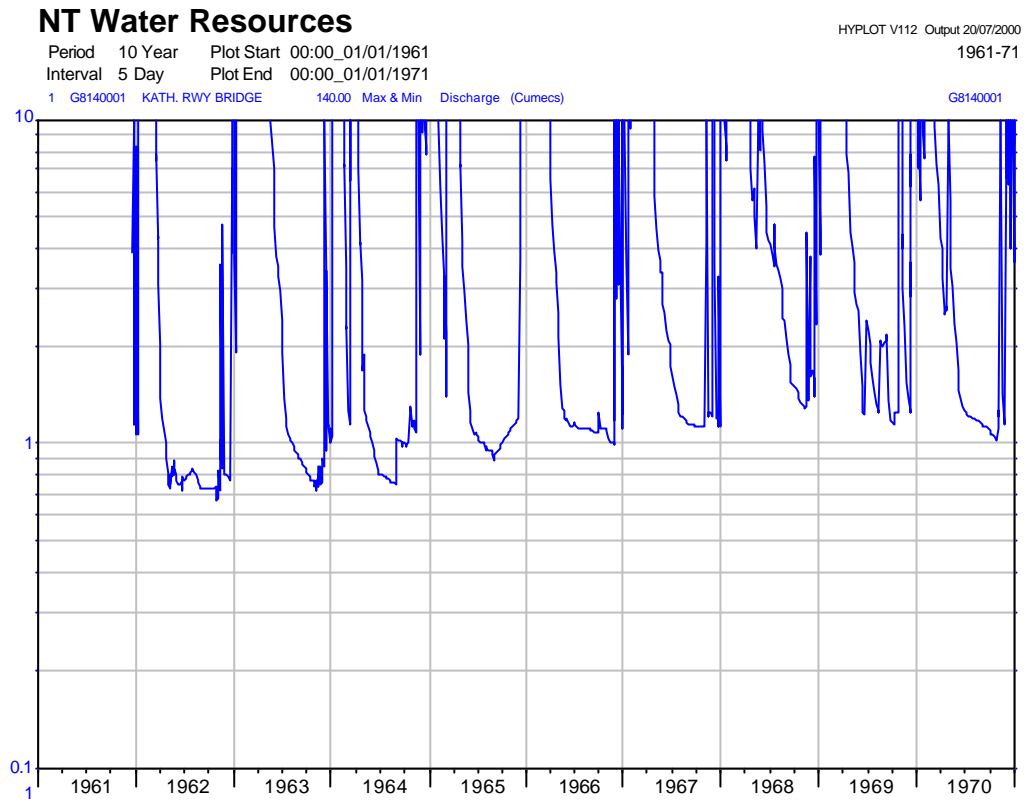
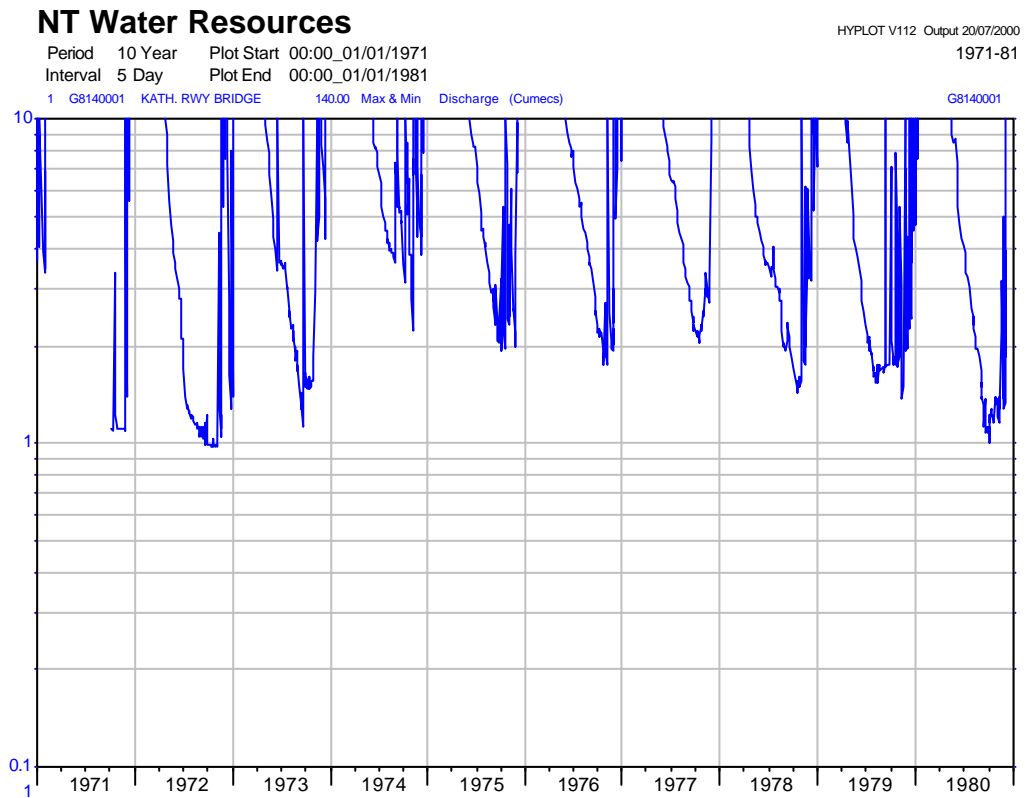


Figure B3(b) Maximum and Minimum Discharge (cumecs) GS8140001

**Figure B3(c,d,e,f)** Expanded Minimum Discharge Hydrograph GS8140001



**B3(c)**

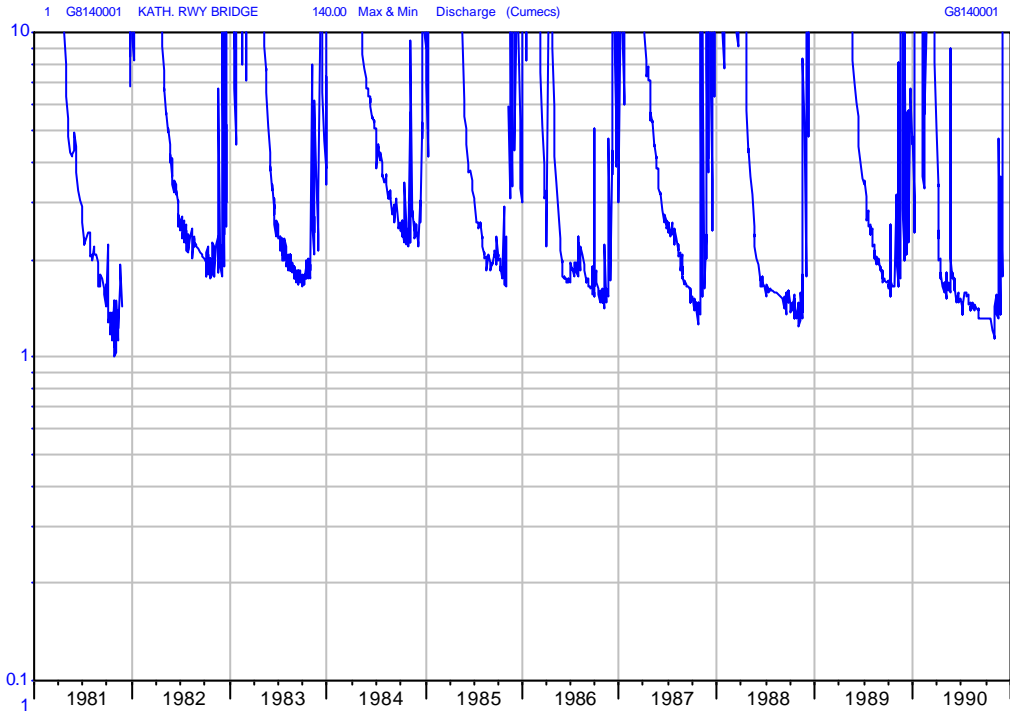


**B3(d)**

### NT Water Resources

HYPLOT V112 Output 20/07/2000  
1981-91

Period 10 Year Plot Start 00:00\_01/01/1981  
Interval 5 Day Plot End 00:00\_01/01/1991

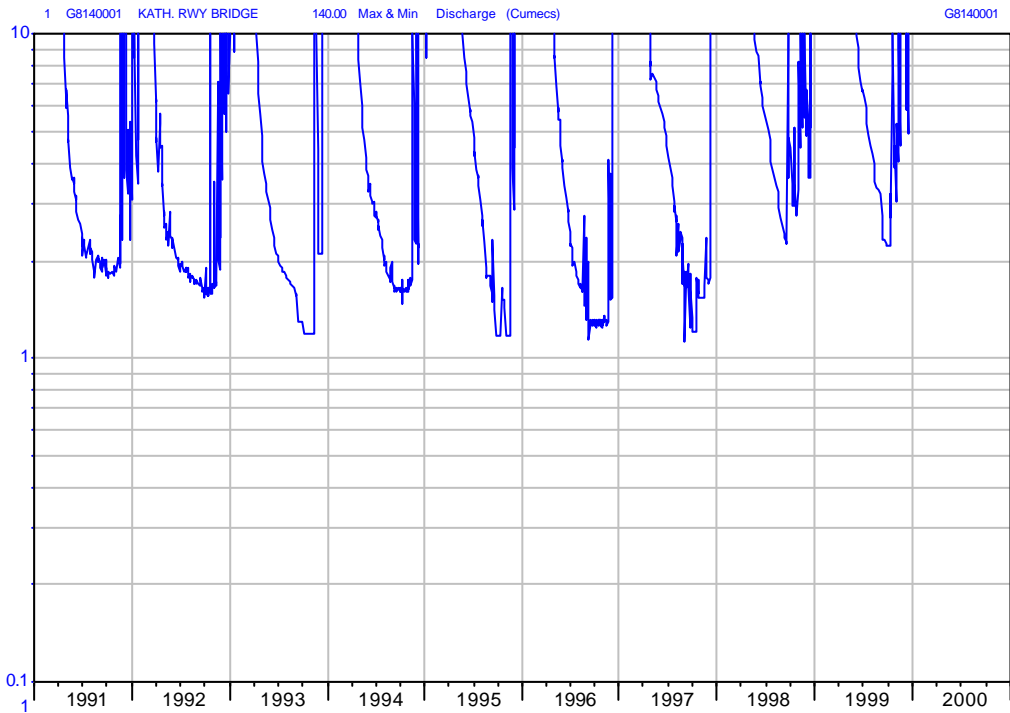


### B3(e)

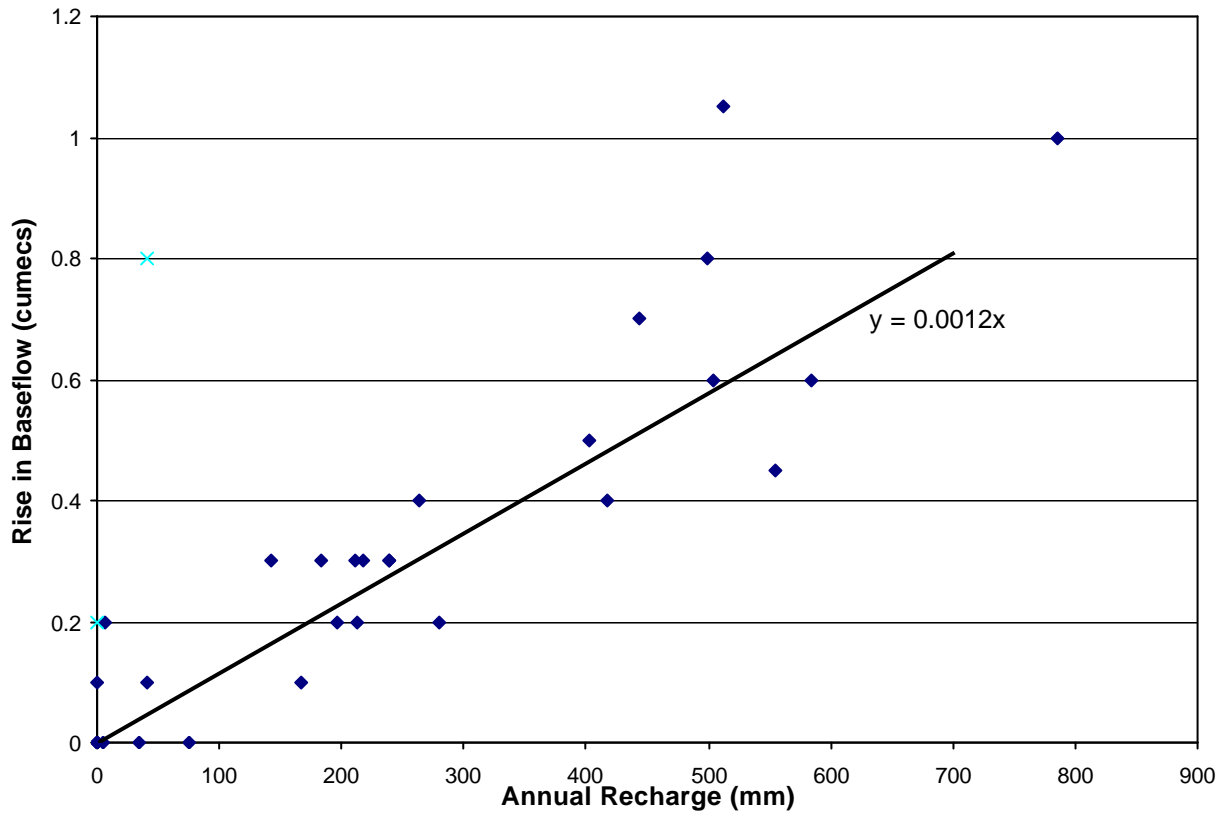
### NT Water Resources

HYPLOT V112 Output 20/07/2000  
1991-01

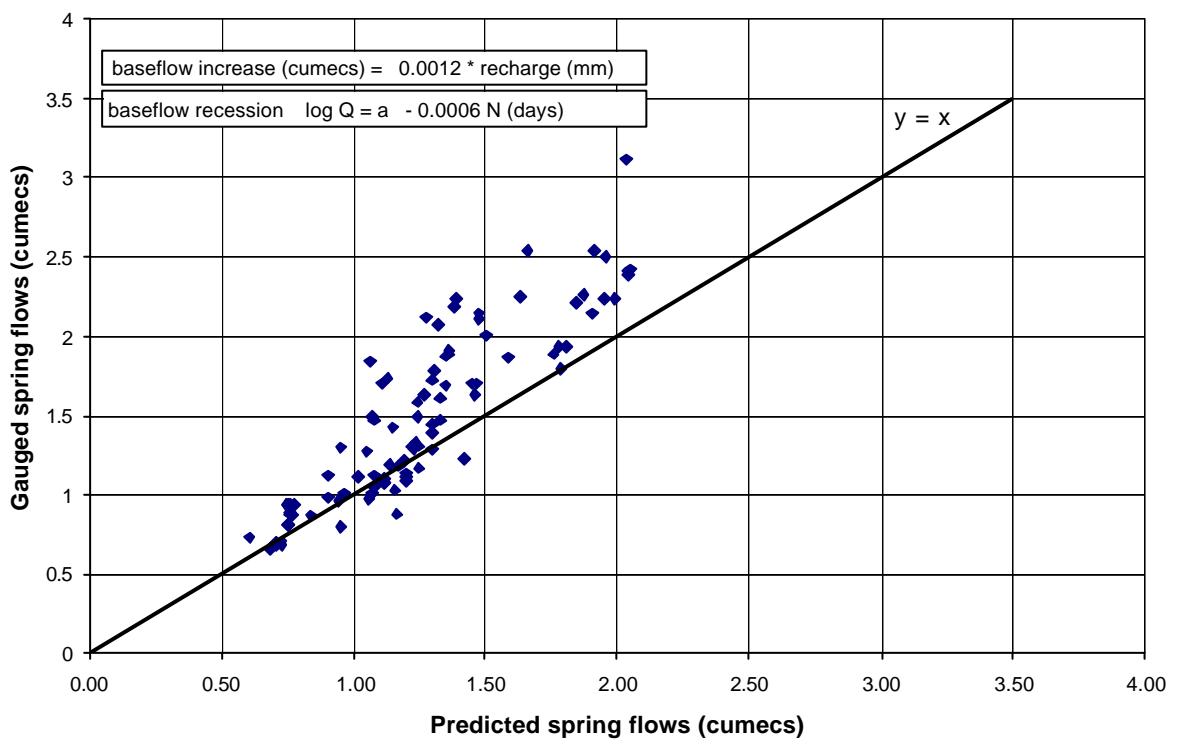
Period 10 Year Plot Start 00:00\_01/01/1991  
Interval 5 Day Plot End 00:00\_01/01/2001



### B3(f)

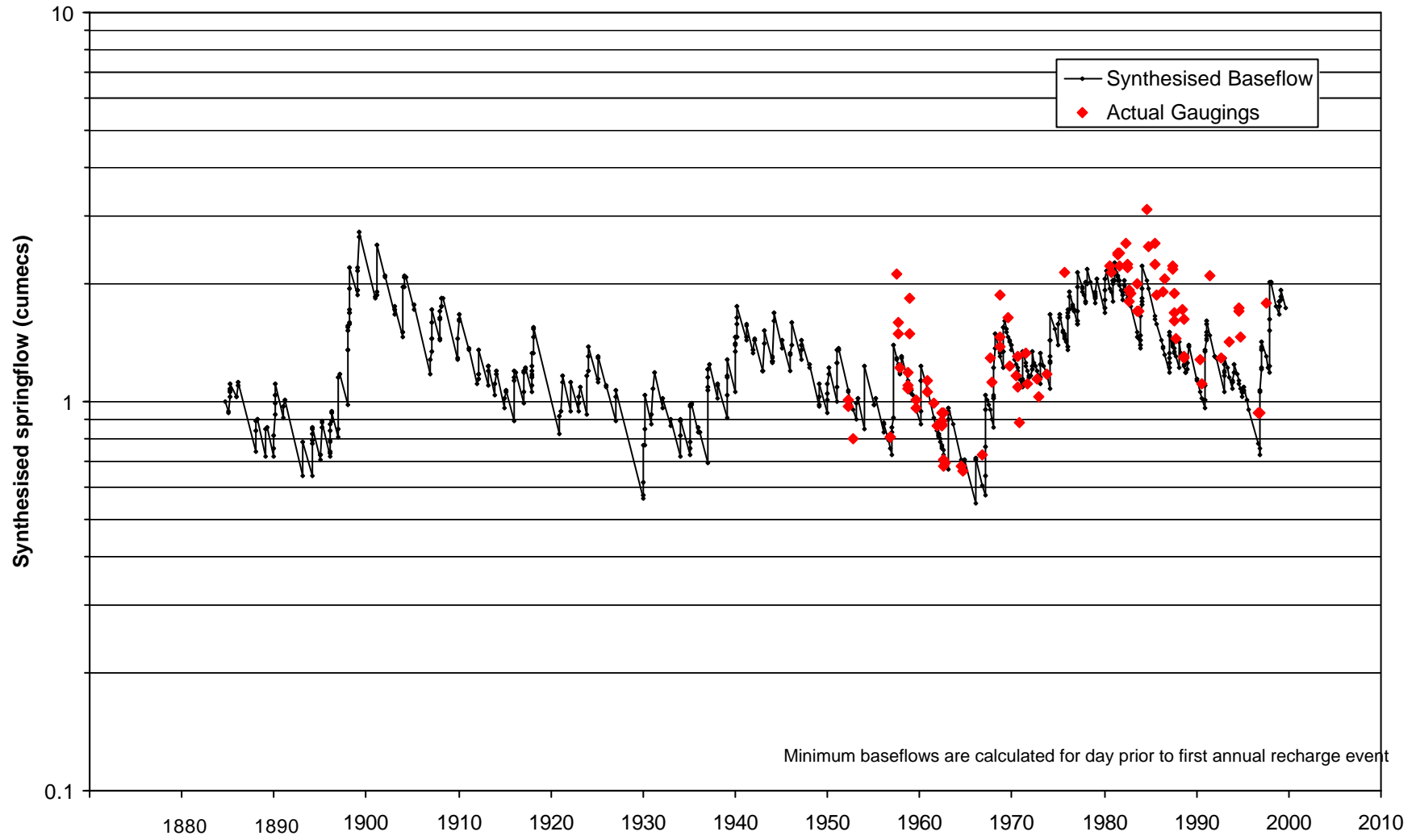


**Figure B4** Relationship between increase in springflow and annual recharge for Katherine River at Low Level Crossing, 3km downstream of GS8140001.

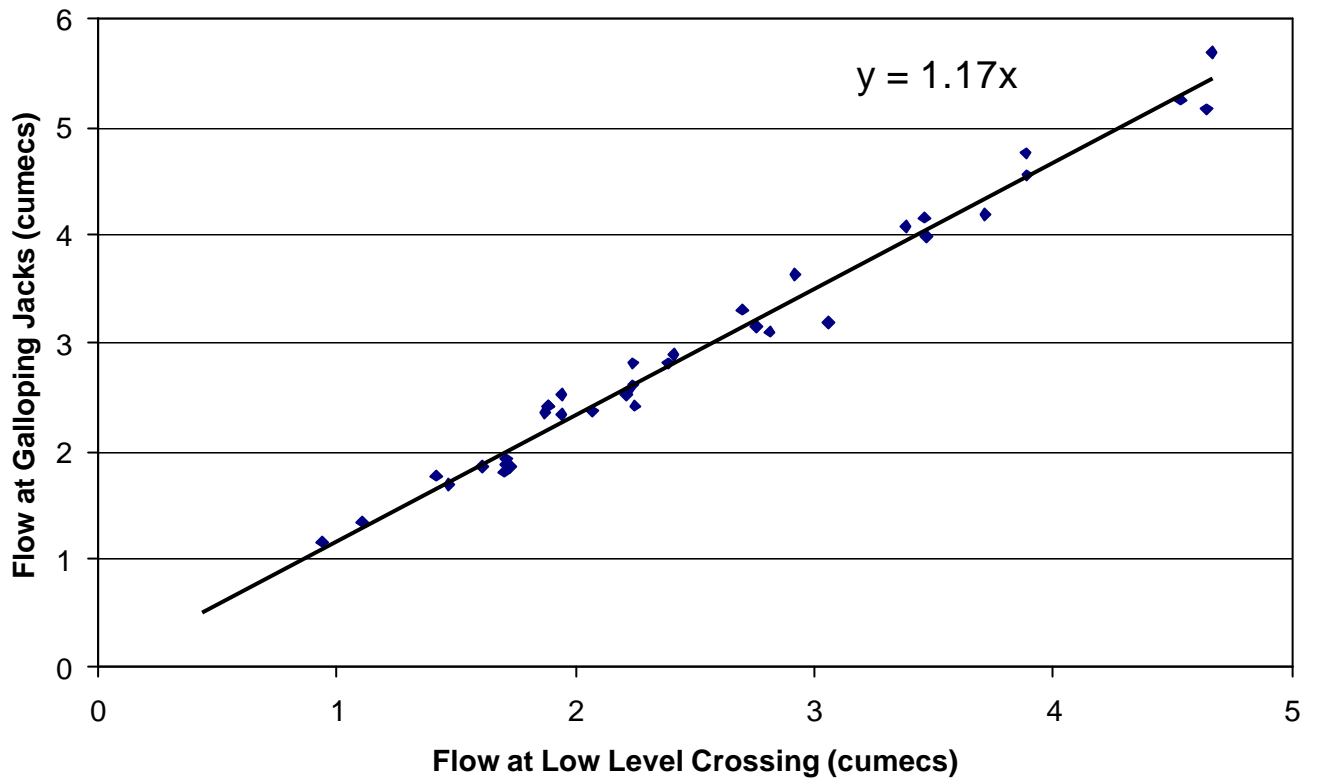


**Figure B5** Comparison between predicted and actual baseflows for Katherine River at Low Level Crossing, 3km downstream of GS8140001.

**Figure B6** Synthesised groundwater fed flows the regional Tindall Limestone Aquifer into the Katherine River at the Low Level Crossing, 3km downstream of GS8140001



**Figure B7** Comparison between the gauged flows for the gauging stations GS8140001 and GS8140301



**Photo B1** Katherine River at Low Level Crossing

# **APPENDIX C**

## **Procedures and Protocols for the use and management of Water Resources.**

This section contains information on water resources and its management, as presented by the DLPE's Advisory Service.

# LAND & WATER ADVISORY SERVICE

The Natural Resources Division through its Advisory Service offers information on a wide range of land and water issues.

If you need advice on developing or testing your water supplies for domestic or industry purposes, feel free to contact us and benefit from 40 years of groundwater and other data.

Gary or David in Darwin, or Scott in Alice Springs can help you gain the best value from the use of your land and water resources.

## Some of the most common questions asked:

- \* What requirements are needed to construct a bore?
- \* Where is the best place to drill a bore, and where should the septic go?
- \* How deep do I have to drill?
- \* What is the groundwater potential?
- \* What is the water quality like?
- \* How can I measure how much water my bore pumps?
- \* Will there be enough water for irrigation?
- \* Is the block prone to flooding or water logging?

## We can assist you with information on:

- \* Licenced drillers
- \* Groundwater potential
- \* Bore site selection
- \* Bore drilling permits
- \* Drilling or pumping problems

## We can also assist with:

- \* Land form
- \* Soils & vegetation maps
- \* Rainfall records
- \* Evaporation
- \* Stream flow/runoff
- \* Flooding (inundation, water logging)
- \* Drainage
- \* Water storage
- \* Water extraction licences (rivers, bores)
- \* Water analyses of surface water and bores
- \* Irrigation

## Need More Information?

Natural Resources Division  
4th Floor Goyder Building, Palmerston  
(PO Box 30 PALMERSTON NT 0831)  
Ring Gary or David for water inquiries  
on telephone: (08) 89 993678 or 993632,  
Fax: 89 993666

For soil & vegetation inquiries,  
telephone: (08) 89 99 4448, 994433 or  
994443

Alice Springs Natural Resources  
Division  
Natural Resources Building  
North Stuart Highway (PO Box 1512)  
Alice Springs NT 0870  
Ring Scott on telephone: 89 518607  
Fax: 89 518620

For a list of other factsheets, phone Bev  
Phelts (08) 89 993660.  
OR visit us on our web page –  
[www.lpe.nt.gov.au](http://www.lpe.nt.gov.au)

# BENEFICIAL USES

Water is an essential part of our daily lives - nowhere more so, than in the Northern Territory, from the deserts of the Centre to the Top End tropics. Water is used to sustain communities, industry, horticulture, agriculture, recreational activities and ecosystems.

As these activities increase, so does the impact on our water resources.

## **NT Water Act 1992**

The management and protection of the Northern Territory's water resources is controlled under the Water Act 1992. The Water Act legislates the extent to which both surface & ground water can be used and for what purpose. Waste discharge to natural waters is prohibited unless licensed under the Act. Licences are only available in areas where Beneficial Uses have been declared.

## **National Water Quality Management Strategy (NWQMS)**

The NWQMS, modified to suit NT conditions provides general guidelines to protect and enhance water quality, and maintain economic and social development.

**Beneficial Uses or Environmental Values are determined by the community and legislated and enforced by Government.**

## ***CATEGORIES OF BENEFICIAL USES***

***Agricultural*** - to provide irrigation water for primary production including related research;

***Aquaculture*** – to provide water for commercial production of aquatic animals including related research;

***Public Water Supply*** – to provide source water for drinking purposes delivered through community water supply systems;

***Environment*** – to provide water to maintain the health of aquatic ecosystems;

***Cultural*** – to provide water to meet aesthetic, recreational and cultural needs;

***Riparian*** – public rights and ownership rights to take water for domestic and/or stock purposes;

***Manufacturing Industry*** – to provide water for secondary industry including related research.

### **So Where do we Start?**

To protect our water resources, the first step is to decide what are the Beneficial Uses of each natural water resource in the Territory. Do we value the resource for drinking or recreation, for agricultural or industrial use, for protection of aquatic ecosystems, or for a combination of these uses?

Beneficial Uses are decided after consultation with the community. Once Beneficial Uses have been legislated, it is then possible to implement water strategy plans which will ensure future protection of the water source.

### **How can I Help?**

Everyone - local communities, industry and government agencies - can play a part and work together in caring about water quality. Look out for notices in the media about public meetings - where you can have your say!

*Natural Resources Division* will work with the community, industry and landholders to-

- identify water resources under threat;
- determine Beneficial Uses of the water resource in consultation with the community;
- implement water quality management plans, licensing and monitoring programs;
- monitor water resources to make sure the Beneficial Uses are protected and water quality targets are met;
- enforce water quality management through Waste Discharge Licences.

Industry and Landholders as well as being involved in decision making on Beneficial Uses of the resource, will -

- set their own waste and land management plans to minimise the risk of pollution;
- apply for Waste Discharge Licences if they are likely to affect the water quality;

- carry out monitoring, reporting and waste control as required under the conditions of a Waste Discharge Licence.

Industry can also -

- seek opportunities for better waste management - reduce, reuse and recycle, rather than discharge;
- support local community groups involved in the protection of our water resources, such as Waterwatch and Landcare groups.

Community members can -

- participate in the consultation process which leads to the decision of Beneficial Uses;
- report pollution of water resources to the Pollution Response Hotline  
Freecall 1800 064 567
- become involved in community groups, Landcare and Waterwatch programs.

### **Need More Information?**

Natural Resources Division  
3rd Floor Goyder Building, Palmerston  
(PO Box 30 PALMERSTON NT 0831)  
Telephone Sue Bellette/ Jo Cruickshank  
on (08) 89 994456

This pamphlet is one of a series on water resource topics in the Northern Territory. For a list of other Waternotes, telephone phone Bev Phelts (08) 89 993660

OR visit us on our web page – [www.lpe.nt.gov.au](http://www.lpe.nt.gov.au)

# RURAL WATER MANAGEMENT

No matter where you live, your land and water use is an integral part of the overall hydrologic cycle. The cycle includes evaporation to form clouds, rainfall, run off from the land via surface streams, infiltration to recharge groundwater reserves and oceans, the major reservoir of the world's water. Your comprehension of the hydrologic cycle and how your land fits into it will help you understand why water and wastewater management is important.

## What is Management?

Water management is the use of the resource without waste and the disposal of used water in such a way that the quality of the receiving environment is not degraded. Proper disposal practices will maintain the quality of water supplies and protect health.

## What is Water Mismanagement?

Mismanagement is when water is unnecessarily polluted. Common examples are:

- \* dumping rubbish in creeks or lagoons;
- \* ineffective sewage disposal practices;
- \* overuse of pesticides; and
- \* unprotected wells/bores which allows access to groundwater by animal activity (eg.carcasses, faeces).

Mismanagement by one water user could have an adverse effect on many neighbouring water users. Mismanagement by many water users may cause long term damage to the water resources of an area.

## Better Water Management

You can help to preserve the status of the water resources you exploit:

*Improve the construction and equipment standard of your bore or well*

Poor construction and equipment standards are major contributors to pollution of groundwater supplies. Make sure the area around the bore or well is well drained. Provide a concrete block at least one metre wide around, and sealed to the casing. The top of the casing should be sealed so dirt, small animals and birds cannot get in. If you have stock or poultry, a five metre perimeter fence should be erected around the bore/well.

Pumps and drives should be maintained in good condition so that water leakage cannot carry contaminants (grease/oil etc.) into the groundwater. Protect your bore or well from surface contamination.

*Improve the pumping regime of your bore or well*

It is common practice to equip bores and wells with pumps of a high capacity in order to be able to fill tanks quickly or provide pressure for sprinklers. The result is that the pump operates for short periods at high flow rates and can cause the following problems:

- \* high iron content in water due to accelerated rusting of casing;
- \* silting or collapse of bores;
- \* malfunction or wear of pumps and switch gear;
- \* provides favourable conditions for the entry of contaminants into the bore or well;
- \* reduced life of bore or well;
- \* higher operating costs.

The preferred operating mode is to have the bore or well pumped continuously at the minimum rate necessary to satisfy all your water needs. This may require a storage tank but it promotes a stable aquifer and minimises changes in water quality. Overall operating costs are reduced. Change your bore or well to continuous low rate pumping.

#### *Maintain your wastewater system*

An inadequate or ineffective waste-water system can be A DANGER TO THE WATER YOU DRINK. Periodically check your septic tank. Desludge it when sludge levels have accumulated to a depth of 250 millimetres. Provide a separation distance of at least 100 metres from your neighbours effluent disposal system.

To reduce loadings on the system:

- \* Repair leaking taps and cistern;
- \* Refrain from over-watering plants close to effluent drains;
- \* Ensure stormwater is directed away from the effluent drains;
- \* Do not flush large amounts of cooking oil or fat down the kitchen sink.

To keep your sewerage system in good working order, do not overload it.

#### *Limit Potential for Pollution*

If you have penned stock or poultry, does stormwater runoff or washwater drain

For a list of other Waternotes, phone Bev Phelts (08) 89 993660 OR visit us on our web page – [www.lpe.nt.gov.au](http://www.lpe.nt.gov.au).

towards your or your neighbours' bore or well? If it does, there is a real risk of contaminating water supplies. Improved, or divert drainage, shift the stock or poultry to a more appropriate place and do not concentrate stock or poultry without careful drainage and manure control.

#### *Prevent soil erosion*

Depletion of vegetation by clearing results in reduced rainfall retention and increased erosion. Rainfall runs off the land rapidly and groundwater recharge is reduced. Your soil may be rapidly transported elsewhere if it is deposited in creek beds. The combination of high rainfall, rapid runoff and reduced stream cross section can produce flooding. Consider the contour of the land when designing paddocks and ploughing. Minimising erosion helps to maximise crop yield, prevents soil loss and limits nutrient input into lakes and creeks.

#### **Need More Information?**

Natural Resources Division  
4th Floor Goyder Building, Palmerston  
(PO Box 30 PALMERSTON NT 0831)  
Gary or David on telephone:  
(08) 89 993632 or 993678.

Alice Springs Natural Resources Division  
Natural Resources Building  
North Stuart Highway (PO Box 1512)  
Alice Springs NT 0870  
Scott on telephone: (08) 89 518607

# SINKING BORES AND SELECTING PUMPS

## *How A Bore Works*

When a water bearing formation (aquifer) is found and penetrated, the water pressure establishes a standing water level in the bore. This level may rise and fall naturally with the seasons. Groundwater is recharged in the wet season and discharged through the dry season. In drier areas there may be little movement of the water level and the water may be many thousands of years old.

When a bore is pumped, the water level in the bore drops. This is known as “drawdown”. This lowers the pressure at the bore inlets and water flows to them from the cracks and spaces in the aquifer.

It is important to realise that the rate at which water can be pumped from the bore depends on the rate it can flow through the aquifer and on the available drawdown.

As pumping continues, the water level in the bore drops further and the area from which the water is coming gradually expands. This area is known as the “area of influence”. In time, the area becomes large and at its margin there is virtually no effect on the general level of groundwater in the region. However, within the area of influence, the groundwater levels are gradually lowered as water flows to the bore.

Seasonal rains recharge the groundwater systems and where extractions are less than or equal to the recharge, then the bore pumping rate or “yield” is “safe”. Over pumping will gradually deplete the resource. If bores are constructed too close together, their areas of influence overlap. This results in each bore yielding less than it should if operating alone.

Hydrogeologists and groundwater engineers are professional experts who can test bores and determine their performance, safe yield and area of influence.

## *Bore Drilling*

There are three main methods of drilling but the method employed depends upon the geographical formation of the ground:

- \* Rotary Drilling
- \* Cable Tool Drilling (mud punching)
- \* Jet Drilling

Rotary Drilling is the main type of drilling used throughout the Territory by government and the private industry. This type of drilling is faster than others and uses a rotating bit attached to the end of a drill pipe and continuous circulation of drilling fluid. The drilling fluid may be air, water or special mud, depending on the drilling conditions. The fluid is forced down the drill pipe and through the openings in the bit. As the bit cuts into the formation, the fluid is forced upward to the surface, bringing up rock chips or “cuttings”.

As a bore is drilled, it may intersect a number of aquifers with the supply of water increasing as drilling proceeds. There are, however, depths beyond which there is unlikely to be further increases of supply.

Because water is often obtained at different depths, it is necessary to construct the bore so that the inlets (slots) in the casing are opposite the aquifers. To ensure this, the driller keeps a log containing information of depths, type of rock and where increases in supply are found.

### ***Fitting your Bore with a Pump***

Pumps are devices which lift water, drawing it in at the bottom and pushing it up the bore, usually in a separate pipe, or pump column. To avoid drawing air, the pump, or its inlet must be safely below the drawdown level.

Types of pumps commonly used in bores:

\* Piston Pumps, commonly called draw plunger pumps, use a piston in a cylinder and are often driven by windmills. On the downstroke a simple valve allows water to pass through the piston. On the upstroke, water is pushed up the pump column and is drawn through another valve into the cylinder below the piston. The piston is operated by long rods to the surface. These pumps are commonly used for stock bores.

\* Submersible Pumps are electrically driven with pump and motor combined to operate under water. They are commonly used for domestic supplies, although large-capacity pumps are also available.

\* Turbine Pumps are composed of a series of interconnected impellers on a common shaft, driven from the surface by diesel motor. Water is drawn into the bottom impeller and boosted in stages through each impeller. They are mainly used for high volume supplies.

What type of pump? What capacity pump? How much piping and cable to set the pump? These vital questions can be answered following a pump test. A simple test is conducted by airlift with the drilling rig for about an hour. This usually gives a fair idea of the supply available and of a suitable depth to set the pump. It is generally satisfactory for domestic and stock supplies.

However for irrigation, industry and town supplies, where reliability and efficiency are paramount, a rigorous professionally supervised pumping test is recommended. This test consists of pumping the bore at a steady, accurately measured rate and observing the behaviour of the water levels in the pumped bore and neighbouring observation bores. The analysis of this information is quite complex but results in an accurate assessment of safe yield and sound recommendations for pumping rate and pump setting.

Before you consider having a bore drilled on your property, you are required to have a bore construction permit and you must only employ a licensed driller. Contact our Advisory Service for help in acquiring a bore permit and for a list of licensed drillers.

### **Need More Information?**

Natural Resources Division

4th Floor Goyder Building, Palmerston

(PO Box 30 PALMERSTON NT 0831)

Gary or David, Advisory Services on Telephone: (08)89 993678 or 89 993632, Fax: 89 993666

Alice Springs Natural Resources Division

Natural Resources Building

North Stuart Highway (PO Box 1512)

Alice Springs NT 0870

Ring Scott Balfour on telephone: (08) 89 518607, Fax: 89 518620

This pamphlet is one of a series on water resource topics in the Northern Territory.

For a list of other Waternotes, phone Bev Phelts (08) 89 993660 OR visit us on our web page – [www.lpe.nt.gov.au](http://www.lpe.nt.gov.au).

# GROUNDWATER QUALITY FOR DOMESTIC USE - What the results of your water sample mean

All groundwaters contain various kinds of dissolved salts (minerals). Small quantities of many of these are essential to good health. Excessive concentrations however, can limit the uses of the water. When a bore is drilled, a water analysis is normally carried out to determine if any of the salts exceed guideline values. This sheet provides some information to help interpret the water analyses.

## ***SOURCE OF DISSOLVED SALTS***

The salts originate from minute quantities dissolved in rain water and from the chemical breakdown of rocks. Nitrate is also produced in the soil by natural biological activity. Over long periods of time evaporation concentrates them to varying degrees.

## ***GUIDELINE VALUES***

The maximum recommended values listed beside each salt are guidelines rather than strict limits. The reason for this is because there are often many factors governing how a particular salt affects the user. These can include a person's age and the total volume of water consumed. The guidelines given below are conservatively chosen in order to cover most situations.

### ◆ ***Nitrate 50 mg/litre***

Based on health considerations a limit of 50mg/litre is recommended for babies less than three months old and 100mg/litre for older children and adults. Nitrate levels can be reduced if necessary with the ion exchange process.

### ◆ ***Fluoride 1.5mg/litre***

This limit is based on health considerations. Excess fluoride can be removed by treating water with aluminium sulphate or bone char.

### ◆ ***Iron 0.3mg/litre***

Above this limit, taste may be unacceptable but it does not pose a health problem. High iron concentrations give water a rust brown appearance resulting in staining of laundry, pipe encrustation and odour problems. A common way to remove iron is to aerate the water by cascading it into a tank and allowing the iron floc to settle.

### ◆ ***Hardness 200mg/litre***

Hardness is a measure of the amount of calcium and magnesium in the water. Hard waters can cause the build up of scale in hot water pipes and fittings. They also require more soap to obtain a lather. It can be reduced by softening the water.

### ● ***pH 6.5 - 8.5***

This is a measure of the acidity or alkalinity. Values less than 6.5 indicate acidic water and can result in corrosion of pipes and fittings. When pH is more than 7.5, the water is alkaline and encrustation of pipes with calcium carbonate can occur. pH can be adjusted to a more desirable level with the addition of either an appropriate acid or alkali.

- ***Total Dissolved Solids(TDS) 500mg/litre***
- ***Chloride 250mg/litre***
- ***Sulfate 250mg/litre***
- ***Sodium 180mg/litre***

Above these limits for TDS, chloride, sulfate and sodium, taste may be unacceptable but it does not pose a health problem. TDS and the other salts can be reduced by reverse osmosis, ion exchange or distillation. If most of the TDS is due to hardness it can be reduced by softening the water. People with severe hypertension or heart disease should seek medical advice if sodium exceeds 20mg/litre in drinking water.

### **Water Treatment**

Various methods are available for improving water quality to acceptable limits. These are relatively expensive but small scale treatment units using reverse osmosis and ion exchange are commercially available for household use. The main methods include:

- *Reverse Osmosis*

Water is pumped through a very fine membrane which allows water to pass through but retains most of the salt.

- *Ion Exchange*

Water is passed through a filter containing special resins which can remove undesirable salts.

- *Distillation*

Distillation units boil water and condense the steam. All salts are removed by this process.

### **Reference**

National Health and Medical Research Council & Agriculture and Resource Management Council of

Australia and New Zealand, 1996 Australian Drinking Water Guidelines, National Water Quality Management Strategy

### **Need More Information?**

Natural Resources Division

4th Floor Goyder Building, Palmerston

(PO Box 30 PALMERSTON NT 0831)

Gary or David, Advisory Services on Telephone: (08)89 993678 or 89 993632, Fax: 89 993666

Alice Springs Natural Resources Division

Natural Resources Building

North Stuart Highway (PO Box 1512)

Alice Springs NT 0870

Ring Scott Balfour on telephone: (08) 89 518607, Fax: 89 518620

This pamphlet is one of a series on water resource topics in the Northern Territory.

For a list of other Waternotes, phone Bev Phelts (08) 89 993660 OR visit us on

our web page – [www.lpe.nt.gov.au](http://www.lpe.nt.gov.au)

# GUIDELINES TO CLEAN WATER

Bacteria-free water is essential for our survival. A polluted water supply can cause major health problems such as gastroenteritis, diarrhoea and the more serious human diseases of typhoid, cholera and hepatitis.

There are three natural water sources:

- rainfall
- surface water (rivers/lagoons)
- groundwater (bores)

Rainfall is subject to airborne pollution. It picks up pollution from roofs and gutters and is easily contaminated by bird droppings. If managed correctly it can be a useful resource. Surface water is open to pollution from animals, birds, fish and the worst polluter of all, humans. Groundwater is normally a secure water source. Provided the bore is properly located, constructed and maintained, groundwater will not normally be polluted.

## **Preventing Sewage and Effluent Contamination**

Do not locate septic tanks and other waste disposal points close or upstream to the supply source. Absorption trenches from septic tanks should be at least 100 metres away from the bore, well or banks of the watercourse pumping site.

Further advice and the legal requirements for waste disposal facilities, including septic tanks, is available from the Department of Health.

## **Protecting the Water Source from Contamination**

### Creek or Lagoon -

- fence off the bank 50 metres each way from the pump intake;
- discourage swimming or fishing near the pump intake; and
- prevent stock wading upstream of the pump intake.

### Bore

- ensure that surface drainage flows away from the borehead;
- build a concrete slab at least one metre square around the bore, sloping away with at least 75 millimetres of bore casing protruding above the slab;
- If an engine driven pump is used, the engine should be mounted on a separate concrete slab. Ensure fuel or oil spillage is prevented from getting in the bore. Fence off at a distance of 5 metres to keep animals and children away from the bore.

### Well

- Protect it in the same way as a bore supply. Roof the well in such a way to make sure that birds or domestic fowls cannot perch where droppings can get in the water. Screen openings with fly wire to prevent mosquitoes breeding.

### Storage Tanks

- Cover all drinking water storage tanks, whether elevated or ground level. Bird droppings and dust-carried bacteria will pollute the water. Screen openings with fly wire.
- Do not allow “first flush” rain water to flow into the tank from roofs of buildings as it may contain bacteria and high concentrations of zinc. (First flush” is the first rainfall after the dry season”.
- Have separate inlet and outlet pipes to storage tanks. This helps chlorine mix well when disinfecting.
- Fit a large diameter drain tap at the bottom of the tank for waste removal when cleaning the tank.
- Do not allow swimming in storage tanks. Fence off ground level tanks.

### Pump and Pipelines

- Do not allow pumps and valves to deteriorate to the point where leaks could allow fuel, lubricants or other mechanical waste to enter the water supply.
- The system may operate under low pressure at times and liquid could be drawn into the system at leaky points.
- Where water is pumped to storage tank, do not connect users to the pipeline before the storage tank. If treatment is being applied to the water at the tank, such connections allow access to untreated water.

### **Disinfection**

If contaminated water is apparent or suspected (indicated by cases of gastric upsets or diarrhoea), immediate action should be taken.

- All components of the water supply should be treated - pump, pipes and storage tank - if the operation is to be successful.
- Until the water supply has been disinfected, boil all drinking water continuously for 10 minutes.
- The cause of pollution should be identified and removed as soon as possible.

### **Bore or Well Disinfection**

- A strong solution of chlorine should be poured into the bore or well, (see quantity guide in this brochure). Switch the pump on and off several times at 10 second intervals to agitate the solution.
- Care should be taken to wash the solution over all surfaces above water level in the bore or well - including the borehead and concrete block and also the pump head unit, if applicable.
- Allow to stand overnight if possible. Following the standing period, the chlorine solution should be pumped through the reticulation system - BUT NOT INTO THE STORAGE TANK. (See Storage Tank Disinfection below).
- If taps are fitted to the rising main, open one at a time and close off when there is a strong chlorine smell. When chlorinated water has reached all parts of the system, let it stand for another two hours. This strongly chlorinated water is not suitable for use. It must be flushed from the system by running the pump and opening taps until the strong smell of chlorine has gone.

### **Storage Tank Disinfection**

- Chlorine should be added to the water in the tank. (See quantity guide).
- DO NOT add the dry chlorine directly to the tank, as an undesirable sediment will form. Instead make up a solution by adding the required total weight of dry chlorine to a 20 litre container full of water. Stir the mixture and allow to settle.
- Pour the clear concentrated solution into the storage tank and stir thoroughly.
- Allow to stand for 30 minutes and then open each tap serviced by the tank, one at a time (including the hot water system)
- Allow to run until there is a slight chlorine smell. This water may be used normally. No flushing is required.

### **Important**

- Do not discharge large quantities of strongly chlorinated water into the septic system, livestock drinking vessels or the storage tank.
- Before disinfecting the distribution systems, temporarily by-pass or disconnect any carbon filter in the system.
- A rubber air-water separator in a pressure tank (if fitted) may be damaged by a strong chlorine solution.

### **Chlorine Quantity Guide**

Dry pool chlorine (calcium hypochlorite) rated at 65-70% available chlorine (600-700g/kg) can be purchased from pool suppliers or hardware outlets.

#### Storage Tank Disinfection

For every 1000 litres in tank use 7 g of dry chlorine eg. for 4500 litres (1000 gals), use  $7 \times 4.5 = 31.5\text{gms}$ .

#### Bore or Well Disinfection

Make up the solution in 200 litre batches, using 60 grams dry chlorine for every 200 litres. Make up volume which exceeds volume of bore or well. Surplus can be used to wash down bore head area.

#### Calculations

Volume of bore or well = Volume/metre x depth

Bore or Well diameter	100	125	150	200	500	750	900
Litres per metre depth	8	12	18	31	196	440	635

### **Chlorine Testing**

- Chlorine test kits are available through swimming pool supply outlets. After a 30 minute retention period, the reading with a test kit should be 0.2-0.5 milligrams of chlorine per litre of water, at a tap serviced by the tank. If the is below 0.2 milligrams per litre, repeat the disinfecting process.
- If you suspect the water is still contaminated, contact Advisory Services for further information.

### **Chemical Content**

The chemical quality of water from bores or wells stays fairly constant but the quality of water from creeks and lagoons may undergo seasonal changes. A bitter taste, unpleasant odour or discolouring are the first signs of deterioration in the water quality.

If you suspect that non-seasonal factors are changing the chemical quality of your water supply, seek advice from the Advisory Services and have a chemical analysis done on a sample of your water.

### **Chemical Pollution of Groundwater**

Chemical or heavy metal pollution of groundwater is a permanent reminder of ignorance and misuse of chemicals or thoughtless dumping of waste.

Be careful when using pesticides, herbicides, fertilisers, fuels and oils. Avoid spills and dumping of these products close to creeks, lagoons, bores, wells or water storage tanks. Advice for the safe use and disposal of chemicals is available from the Work Health Authority. Iron bacteria is not harmful to

your health but can reduce your bore water supply and cause iron staining of clothes and plants. For details of treatment, contact Advisory Services.

***Remember - what you are dumping today, you could be drinking tomorrow!***

**Need More Information?**

Natural Resources Division, 4th Floor Goyder Building, Palmerston (PO Box 30 PALMERSTON NT 0831)

Gary or David, Advisory Services on Telephone: (08)89 993678 or 89 993632, Fax: 89 993666

Alice Springs Natural Resources Division

Natural Resources Building, North Stuart Highway (PO Box 1512) Alice Springs NT 0870

Ring Scott Balfour on telephone: (08) 89 518607, Fax: 89 518620

This pamphlet is one of a series on water resource topics in the Northern Territory.

For a list of other Waternotes, phone Bev Phelts (08) 89 993660 OR visit us on our web page

– [www.lpe.nt.gov.au](http://www.lpe.nt.gov.au)

