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TOOLIBIN FLATS SURFACE DRAINAGE NETWORK PRELIMINARY DESIGN PROPOSALS

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INTRODUCTION

Concern over flooding of the Toolibin flats has been evident for many years. The author can remember inspecting flooding in the Toolibin East Catchment along Brown Road in about 1970.

In 1977 the Northern Arthur River Wetlands Committee was formed to investigate and monitor adverse trends in Toolibin Lake itself; this committee issued several interim reports with a final report in 1987.

Farmers to the north of Reserve 27286, and particularly Mr. John Chadwick have been requesting advice on flooding control and waterlogging since about 1983 and several advisers from the W.A.D.A. have attempted to assist them. The problem of disposal of channelised flood water into and through Reserve 27286 has repeatedly been a stumbling block.

This report aims to initiate a planned drainage programme, for which the downstream impacts can be anticipated, which is acceptable to all parties involved i.e. the farmers, C.A.L.M. Dept, Wickepin Shire, W.A.D.A. and the Wickepin L.C.D.C.

Historical Review

The first Europeans to have any impact on the Northern Arthur River catchment were nomadic shepherds and sandalwood cutters before the turn of the century.

Land was first taken up for farming during the late 1890's. As farming practices then were pastoral rather than arable, there was little clearing of natural vegetation. By 1910, clearing was confined to twelve farms established south-east of Lake Toolibin.

Large scale clearing of the better class, clay soils occurred after World War 1, and most of the heavy land was under cultivation by about 1934. Development of the lighter, sandier soils did not commence until the late 1940s or early 1950s.

A local farmer, resident since 1904, has recorded that Lake Toolibin had not been dry until the drought period commencing in 1969. In his experience, the lake always filled in wet years, but water was confined to the centre of the lake when rainfall was below average.

Lake Taarblin, downstream of Lake Toolibin, consisted of a series of swampy lagoons prior to 1926 when it completely filled for the first time. It was after this inundation that trees within the southern half of the lake died. During the 1930s Lake Taarblin was mostly dry and the trees in the northern half were dead by the mid 1930s. The lake was flooded again in 1945 and 1955 when, as in 1926, the annual rainfall was some 200 mm above average. The dense thickets of *Casuarina obesa* round the perimeter of the lake regenerated

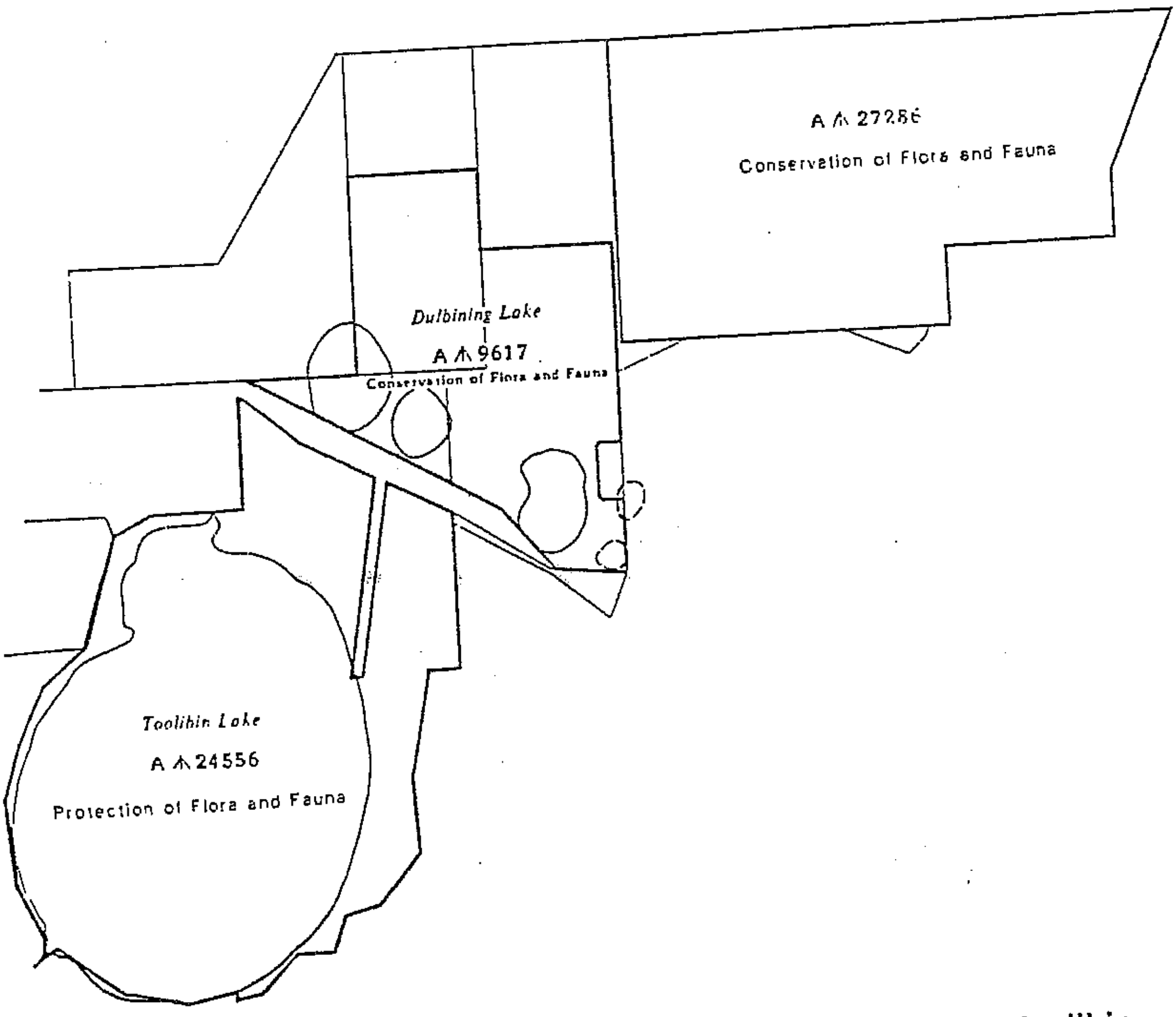
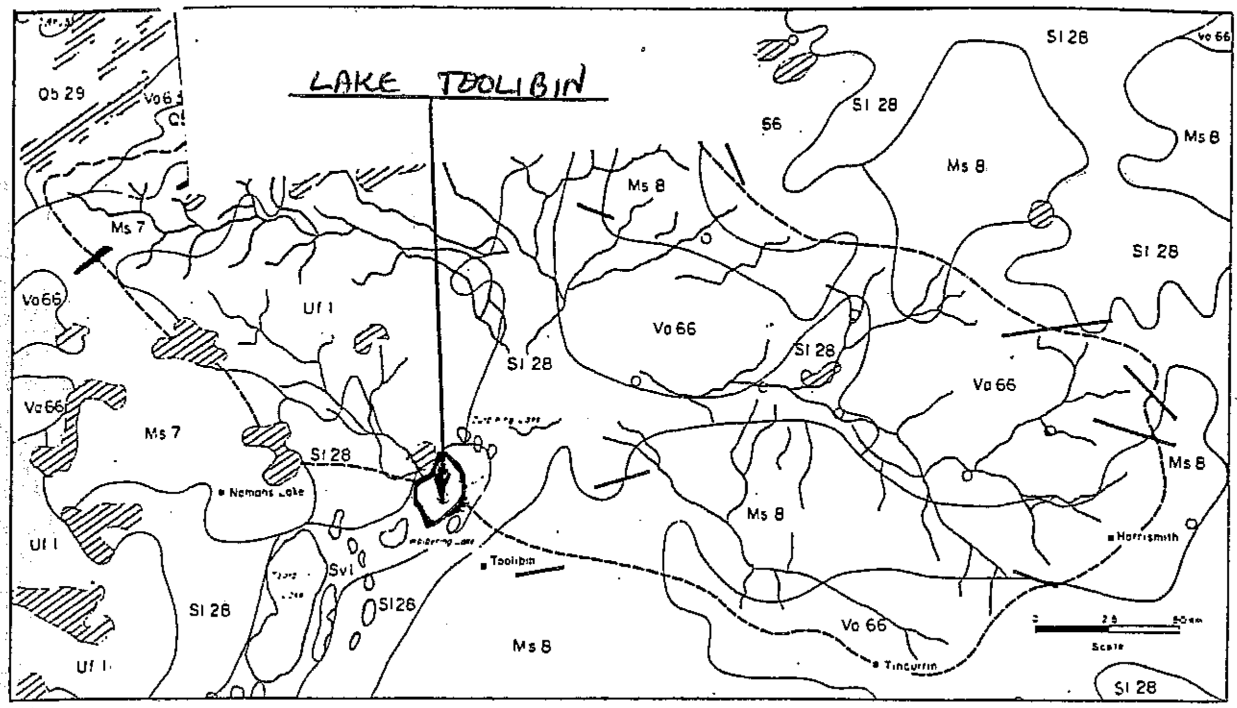


Figure - Flora and Fauna Conservation Reserves around Lake Toolibin



Soil Landscape Units (C.S.I.R.O. Atlas of Australian Soils)

Hard-setting loamy duplex soils, mottled yellow clayey subsoils, bleached A_2 horizon (waterlogging prone):
- Ul 1 - undulating with ridges, spurs and lateritic mesas and buttes.
- Va 63 - valley plains and terraces.
- Va 66 - gently undulating to rolling terrain.

Yellow earths:
- Ms 7 and Ms 8 - gently sloping to gently undulating plateau area. Sandplain soils and gravelly ridges.

Hard-setting loamy duplex soils, red clayey subsoils:
- Ob 29 - Rolling to hilly with some steep slopes, gneiss outcrops common.

Hard-setting loamy soils, yellow clayey subsoils:
- Sl 28 - broad flat valley with clay pans.

Calcareous and siliceous loamy soil of minimal development:
- Sl 1 - Saline valleys and salt lakes.

Key
- Dolerite dykes
- Catchment divide
- Rock outcrop
- Soak
- Drainage
- Townsite

Figure 3 - Soils and geology of the Lake Toolibin Catchment

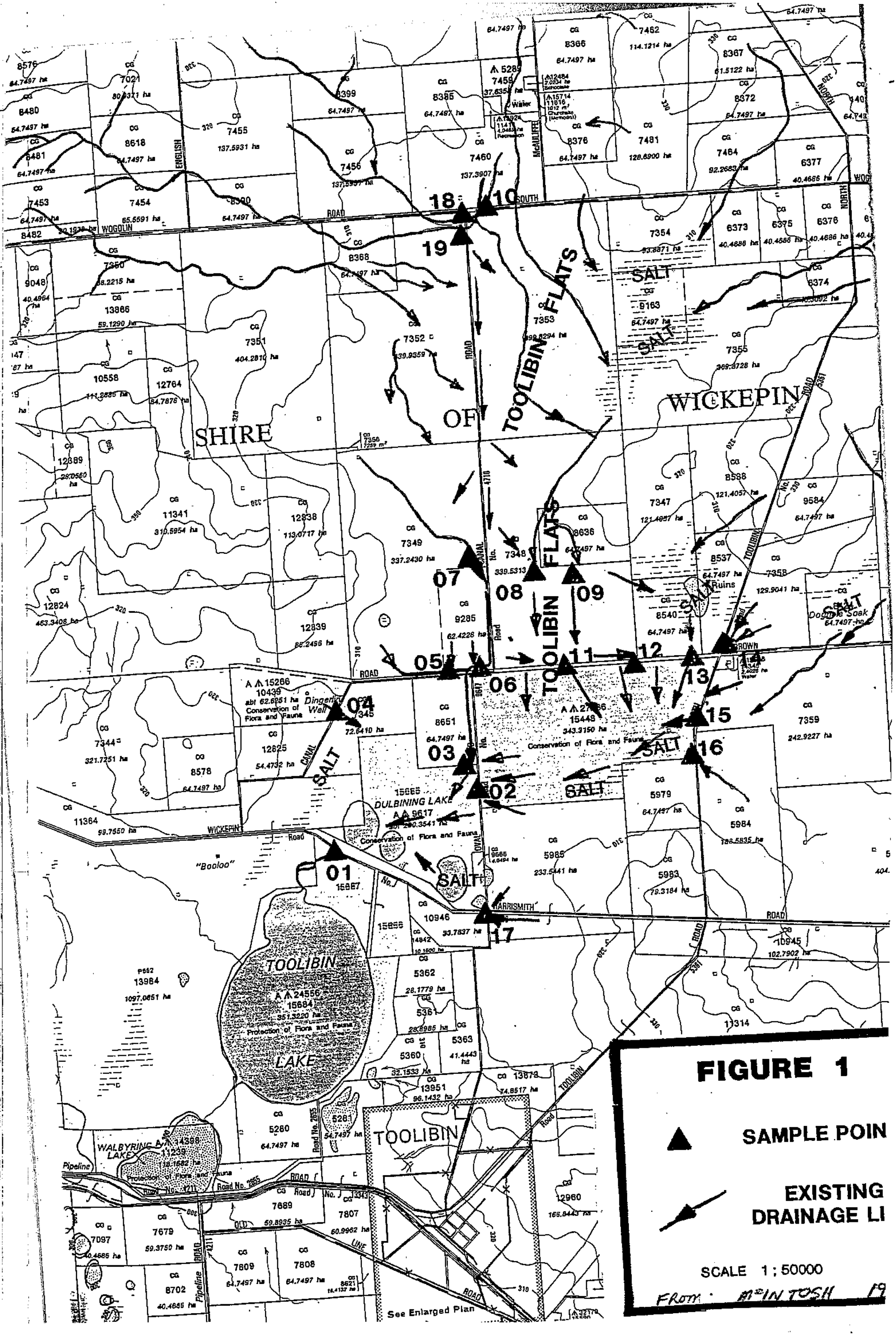
above the 1955 highwater mark, and salt crusting became evident in the lake bed at about this time. In the 1950s sampling of the water in Lake Taarblin revealed salinities ranging between 6000 mg/L (September 1956) and 57000 mg/L (March 1957).

Little White Lake, some 15 km downstream of Toolibin, did not fill regularly before the 1940s although it held water in wet seasons. By the 1920s the trees within the lake were dead, or dying; however *C. obesa* and Paperbarks *(Melaleuca spp.)* have persisted above high water level.

Figure 2 shows the gazetted reserves around Lake Toolibin. All are A Class Reserves vested in the National Parks and Nature Conservation Authority for the purpose of conservation of flora and fauna. The Department of Conservation and Land Management is responsible for their management.

Reserves 24556 (351 ha) and 27286 (343 ha) were gazetted as reserves in 1956 and 1964, respectively. Reserve 9617 (290 ha) was originally vested in the Narrogin Road Board in 1908 for water supply purposes. This vesting was transferred to the Western Australian Wildlife Authority (now National Parks and Nature Conservation Authority) in 1963.

(copied from "Status and Future of Lake Toolibin as a Wildlife Reserve" a report prepared by Northern Auther River Weltalnds Committee May 1987. Published by WAWA).


SHIRE OF WICKEPIN
TOOLIBIN FLATS
SALT
TOOLIBIN LAKE
DULBINING LAKE
WALBYRING LAKE
TOOLIBIN
"Booloo"
Dingerlin Well
Conservation of Flora and Fauna
Protection of Flora and Fauna
WOGOLIN SOUTH ROAD
WICKEPIN HARRISMITH ROAD
TOOLIBIN NORTH ROAD
BROWN
See Enlarged Plan
01
02
03
04
05
06
07
08
09
10
11
12
13
15
16
17
18
19
FIGURE 1
SAMPLE POIN
EXISTING
DRAINAGE LI
SCALE 1 ; 50000
FROM McINTOSH 19

2. DRAIN DESIGN

2:1 LOCATION OF DRAINS (SEE MAP)

Nine drains (A - I) will be required to channelize flood waters across the Toolibin Flats and around or through Reserve No. 27286 to Toolibin Lake.

These drains will collect water from six sub-catchments:-

		km^2	
1.	Fran's	62.0	All part of the Toolibin North Catchment
2.	Phil's	15.9	
3.	Keith's	19.3	
4.	Syd's	37.9	
5.	Reg's	34.0	
	Sub Total	169.1	
6.	Toolibin East Catchment	281.0	
	Grand Total	450.0	

The surface run off from Fran's, Phil's, Keith's and Syd's catchments is very low in soluble salts and the prime aim is to keep these flows separate from the saline flows from Reg's catchment. This will be achieved by collecting non-saline flows and diverting them in a drain, alongside Canal Road and around the western boundary of Reserve No. 27286. Extension and enlargement of the existing drain will be required. The saline flows from Reg's catchment will be intecepted and diverted to the south-east by a drain in Chadwick's property 1800 metres north of Reserve 27286. A drain along the northern boundary of this reserve will prevent any inflowing of surface flood water into the reserve and should have benefical effect on the health for native vegetation. At present flood water flows slowly eastwards along Brown Road and spills into the Reserve at numerous points.

Flows from the Toolibin East Catchment are also quite fresh but will mix with the saline flows from Reg's catchment as they flow through Reserve 27286.

2:2 ESTIMATION OF DESIGN RUN-OFF (TABLE 1)

Peak run-off rates (m^3/s) were calculated for each of the nine proposed drains using the procedure developed by Flavell, Martin and Belstead (1987) of the Main Roads Dept, W.A. and now incorporated in the Soil Conservation Earthworks Design Manual of the W.A. Dept. of Agriculture. Two average reccurrence intervals were used, 5 and 10 years.

These estimated peak run-off rates were compared with actual peak run-off rates at the Water Authority gauging station near the inlet to Toolibin Lake. Since records began in 1977, the peak of 34.9 m^3/s in June 1983 stands out from all other events. Although winter 1983 was regarded as the wettest in living memory by local farmers, Flavell's method would suggest that it was a 7.5 year recurrence interval or thereabouts. It appears that for the Toolibin Lake Catchment, Flavell's method will tend to estimate higher than actual run-off rates (m^3/sec). As a result, the author considers that a 5 year recurrence interval will prove adequate for use in the design of the flood control drains.

2:2 DESIGN OF DRAINS (SEE TABLE 2)

The Soil Conservation Earthwork Design Manual of the W.A. Department of Agriculture was used to design each of the nine drains (A -I).

Drains A - E and I were designed with a standard channel depth of 0.7m which is suitable for bulldozer construction. Drains E and G have a 0.9 m deep channel and are of much larger capacity necessitating the use of a scraper and dozer for construction. Costs are based on 50 cents/m^3 of earth moved. This may prove an underestimated due to the very hard nature of the subsoil clay and the need for ripping. All drains are trapezoidal in cross-section with a flat bottom and 1:1 batters.

TABLE 1 - ESTIMATED PEAK RUN-OFF RATES

Drain No	Location of Drain	Catchments collected by drain	Total Catch Area km^2	Peak Flow (m^3/s) 5 year Rec. Int.	10 year Rec.Int
A	Upper Canal Rd (Davenport/Chadwick)	Phil's, Keith's	35.2	6.6	12.1
"	Loc. No.7353/7348	Phil's, Keith's, Syd's	73.0	9.6	17.7
B	Wogolin South Rd Loc. 7460	Syd's	37.8	6.9	12.6
C	Chadwick's Loc. No.9285/8651	Fran's, Phil's, Keith's	97.1	11.2	20.6
"	"	Fran's,Phil's,Keith's,Syd's	135.0	13.3	24.4
D	Chadwick's Loc. No. 7348	Toolibin Flats	2.6	1.7	3.1
E	Chadwick's Loc. No. 7348	Reg's	15.0	4.2	7.8
F	Toolibin North Road Loc. No 7359	Toolibin East Catchm	281.0	19.5	35.4
G	Possible Drain Thr' Res. 9617	Toolibin East & Toolibin Nrth Catchm	467.0	25.2	45.[illegible]
H	Possible drain Thr'Res. 27286	Toolibin East & Regs	296.0	19.9	36.[illegible]
I	Through Reserve 27286 to carry saline flows	Reg's, Toolibin Flats	10.9	4.6	8.[illegible]

TABLE 2 DESIGN AND COST OF DRAINS

A - E Based on a (Progress) coefficient of 0.03, maximum safe velocity of 1 m/s and a drain gradient of 0.15%, E - G Max. safe velocity of 1.2 m/s.

Drain No.	Length (m)	Channel Depth (m) 5yr ARI	Channel Depth (m) 10yr ARI	Channel Width (m) 5yr ARI	Channel Width (m) 10yr ARI	Estimated Cost For 5yr ARI Drain ($)
A -Syd's +Syd's	3700 3700	0.7 0.7	0.7 0.7	9.4 13.7	17.3 25.3	12172
B	800	0.7	0.7	9.9	18.0	2772
C -Syd's +Syd's	2800 2800	0.7 0.7	0.7 0.7	16.0 19.0	29.4 34.9	15680 18620
D	2000	0.7	0.7	2.4	4.4	1680
E	2300	0.7	0.7	6.0	11.1	4830
F	650	0.9	0.9	17.7	32.2	5178
G	1300	0.9	0.9	22.9	41.7	13396
I	3000	0.7	0.7	6.6	12.1	6930
					Totals	62638 (71148)

3. SEPARATION, STORAGE AND DIVERSION OF SALINE FLOWS

A prime aim of the drainage scheme on the farming land upstream of Toolibin Lake should be the separation of non - saline and saline stream flows. EVERY EFFORT SHOULD BE MADE to prevent the saline flows from entering Toolibin Lake. This may be achieved either by a storage/evaporation system or by a storage/pumping system around the east side of the lake or by a diversion channel around the west side of the lake.

These engineering solutions need to be backed up by further revegetation of existing saline land and land at risk to prevent a further rise of saline watertables, which concentrates salts on the soil surface. It is these salts that are annually transported into the Lake.

3:1 STORAGE/EVAPORATION BASIN

In this option saline run-off from Reg's catchment would be diverted to Millar's swamp on Loc. No. 8540/8537. This holds approximately 60,000 m^3 at 0.4 m depth. This depth is probably the safe maximum consistant with avoiding salinisation of good farming land nearby. An absolute maximum of 195,000 m^3 stored at a depth of 1.0 m could be engineered by completely replugging the southern and eastern exists from this swamp, but the risk of inducing further land salinity should be carefully considered.

In average rainfall years, the total run-off volume from Reg's catchment should be similar to the swamp's capacity at 0.4 m depth eg 1981 when 75,00 m^3 is estimated to have flowed. In exceptionally wet years the capacity of Millar's Swamp would be exceeded by ten times; eg in 1983 when 570,000 m^3 are estimated to have flowed from Reg's catchment. This was probably a 1 in 50 to 1 in 100 year event. It is expected that Miller's drainage would overflow at least once every 5 to 10 years.

Crystalline salts accumulating in the swamp should ideally be removed mechanically. If allowed to dissolve and flush into Reserve 27286 the salts will:-
(a) cause further degradation of the native ti-tree bush
(b) mix with good quality flood water from the Toolibin East Catchment
(c) eventually flow through to Toolibin Lake.
This option might entail purchasing the saline parts of Loc. No. 8540/8537 from Mr. Ron Miller if he is willing to sell.

3.2 STORAGE/ PUMPING SYSTEM

A second option is to accept that the saline flows from Reg's catchment will periodically be flushed out of Miller's Swamp and into Reserve 27286. The saline flows could be kept separate from the non-saline flows from the Toolibin East Catchment right through the southern side of the Reserve. Somewhere close to the western boundary of this Reserve a storage sump and pumping system would be needed to stockpile saline flows and pump them in a pipeline around the eastern side of Toolibin Lake. The pipeline could discharge into the highly degraded salt lakes downstream of Walybring Lake. This option would probably cost about $60,000 for drainage channel, storage reservoir, pumps and S.E.C. connections and the pipeline.

3.3 DIVERSION CHANNEL AROUND THE WEST SIDE OF TOOLIBIN

This option would involve collecting saline flows from Reg's catchment in Chadwick's Location 7348 and diverting it in a westerly direction across Canal Road through Location 9285 across Brown Road and through Locations 7345 and pt 13984. The saline flows would then have to be taken under the main Wickepin - Harrismith Road and into Location 13984. Here it would have to be pumped over the North-West Creek which flows direct into Toolibin Lake, before discharging into the existing drain through the interception bank layout in Location 13984 (Nepowie).
The main technical problems with this option are
(a) passing the saline flows over or under the fresh flows in Drain "C" next to Canal Road
(b) passing the saline water across N.W. Creek
(c) finding enough fall from the collection point on Chadwick's Location 7348 to the discharge point on Nepowie's Location 13984 (this possible drainage route would need to be surveyed). The possible costs of this drainage system are difficult to estimate but the channel construction alone would be about $ 60,000. The various siphons and aquaducts to enable the saline flow to cross fresh flows could increase this figure dramatically.

4. DRAINAGE OF "LOCAL" WATER FROM TOOLIBIN FLATS

Despite the control of floodwaters from the upper catchment via the main drainage system described in 2:1 above, in situ rainfall will still accumulate in depressions on the 2500 hectares of flat farmland to the north of Toolibin Reserve. Many of these waterlogged depressions were pegged in July 1990 and should be permanently marked to facilitate the survey and construction of a random system of W or U drains. These can be considered totally the responsibility of the farmers concerned and should be connected into the main drainage system. Removal of this "local" surface water is important
(a) to reduce direct recharge to the saline water table which is only 1 - 1.5 metres below the ground surface
(b) to help improve crop yields and pasture production.

It should be recognised, however, that the poor soil structure of the heavy grey and brown clays on the Toolibin Flats will always limit agricultural production levels. Trials by the Department of Agriculture on Chadwick's showed no response to heavy rates of gypsum (5t/ha) but a marked response to artificial nitrogen.

Despite the construction of a total flood control and "local" drainage system, in the highest rainfall winters such as 1983, or during summer cyclones, some flooding and waterlogging may still occur on farmland. The presence of the drains will however expediate removal of flood water soon after these rainfall events.

5. PROVISION OF FLOODWAYS ON SHIRE ROADS

The implementation of the main flood drainage system will require the approval and assistance of Wickepin Shire Council in relation to the provision of adequate floodways on public roads. One has already been constructed at the western end of Brown Road but 4 others will be required:-

1. At the northern end of Canal Road at the junction with the Toolibin South Road.

2. Towards the southern end of Canal Road to convey flow water across this road in a westerly direction.

3. On the Toolibin North Road to convey flow water from the Toolibin East Catchment in a westerly direction from Ron Miller's Loc: 7359 into Reserve 27286.

4. On Brown Road to convey saline flows from Miller's Swamp into Reserve 27286.

It is suggested that these floodways be constructed as low-level bitumenised sections of road with adequate cross-section to convey major floods. Normal culverts and raised roads are not adequate to handle major floods and result in damming and the undesirable diversion of floods.
There may be some opportunities to utilize surplus excavated soil from the main drains to raise and improve the drainage of some shire roads. eg Brown Road.

GAUGING STATION 609 010
NORTHERN ARTHUR RIVER LAKE TOOLIBIN INFLOW
CATCHMENT AREA = 434.9 SQ KM

INSTANTANEOUS MAXIMA (m³/s)

YEAR	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1977	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0#
1978	0#	0	0	0	0	0	0.0020	0.0012	0#	0	0	0
1979	0	0	0	0#	0#	0	0	0	0.0010	0	0	0
1980	0	0.0007	0	0	0#	NR	0#	NR	NR	NR	0#	0.0036
1981	0	0	0	0	0.0031#	2.448	1.279	1.545	0.0115'	0.0013	0	0
1982	6.650	0.0155	0	0	0	0	0	0.0010	0.0011	0.0008	0	0
1983	0	0	0	0	0"	34.90	32.98*	4.253	5.245	0	0	0
1984	0	0	0	0.0000	0.0004	0.0004	0.0002	0.0001	0.0024	0#	0	0
1985	0	0	0	0	0	0	0.0005	0.0004	0.0000	0	0	0
1986	0	0.0002	0	0	0	0.0006	0.0000	0.0000	0	0	0	0
1987	0	0	0	0	0	0	0.0001	0.0000	0	0	0	0
1988	0	0	0	0	0	0.0001	0.4995#	0.2057	0.0198	0.0006	0	0
1989	0	0	0	0	0	0.0003	0.0014	0.0001	0.0000#	0#	0	0
1990	0.4646#	0.4995#	0	0	0.4723	0.0113"	0.4995#	0.1330	0.0495#	NC	NC	NC

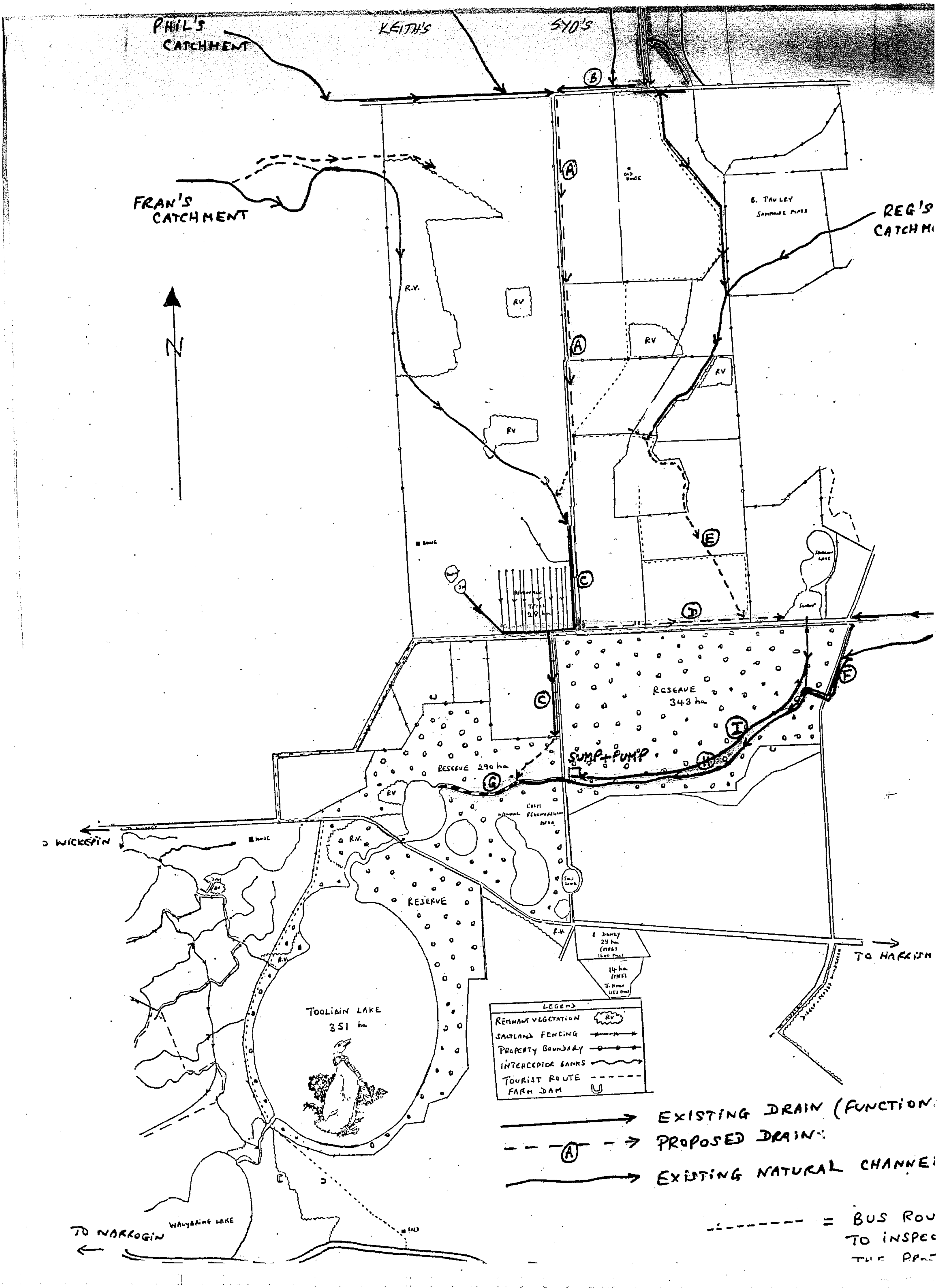
TOTAL(THOUSANDS OF CUBIC METRES)

YEAR	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1977	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0#
1978	0#	0	0'	0	0	0	0.8495	0.1729'	0#	0	0	0
1979	0	0	0	0#	0#	0	0	0	0.1029	0	0	0
1980	0	0.0081	0	0	0#	NR	0#	NR	NR	NR	0#	0.0626
1981	0	0	0	0	0.0484#	604.4#	598.2'	952.5'	6.800'	0.5609	0	0
1982	1091"	2.572	0	0	0	0	0	0.0634	0.3283	0.0394	0	0
1983	0	0	0	0"	0"	3619	8364*	1217	2512"	0	0	0
1984	0	0	0	0.0043	0.0267	0.0215"	0.0390	0.0234	0.0628"	0#	0	0
1985	0	0	0	0	0	0	0.0597	0.0544	0.0001	0	0	0
1986	0	0.0018	0	0	0	0.0084	0.0015	0.0072	0	0	0	0
1987	0	0	0	0	0	0	0.0033	0.0002	0	0	0	0
1988	0	0	0	0	0	0.0006	83.23#	173.8'	12.38'	0.2780	0	0
1989	0	0	0	0	0	0.0902	0.5317	0.0452	0.0034#	0#	0	0
1990	1.419#	74.23#	0	0	148.6"	11.59"	101.6#	201.8	18.03#	NC	NC	NC

KEY

NA RECORD NOT AVAILABLE
NR NOT RECORDED
BI STAGE BELOW LOWEST RECORDABLE LEVEL
UR NOT PRESENTLY RATED
' FAULTY, VERY CONFIDENT IN CORRECTED RECORD
" FAULTY, SOME DOUBT IN CORRECTED RECORD
* ESTIMATED RECORD
# DERIVED FROM INCOMPLETE RECORD
NC NOT CALCULATED

—— peaks probably higher (no record or un-rated)



PHIL'S CATCHMENT
KEITH'S
SYD'S
FRAN'S CATCHMENT
REG'S CATCHM
N
R.V.
RV
B. TAULEY
Reserve 343 ha
SUMP + PUMP
Reserve 290 ha
Reserve
TO WICKEPIN
TO HARRISM
Toolibin Lake 351 ha
Walyorming Lake
TO NARROGIN
LEGEND
Remnant vegetation
Saltland fencing
Property boundary
Interceptor banks
Tourist route
Farm dam
EXISTING DRAIN (FUNCTION
PROPOSED DRAIN
EXISTING NATURAL CHANNE
= BUS ROU
TO INSPEC