Trewinnard Manor Pond
Pollution Incident November 1990

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CONTENTS

1. GENERAL BACKGROUND 1

2. EXISTING POND CONDITIONS 1

   Ground and Surface Water Flow Regimes
   Water Quality

3. POSSIBLE CAUSES OF POND CONTAMINATION 2

   Natural Seasonal Processes
   Contamination of Pond from Domestic Landfill Site
   Contamination of Pond from Slag and Ash Deposits
   Contamination of Pond from Sewer Pipe
   Contamination of Pond by Bird Effluent
   Combination of Contaminant Sources

4. SPECIFICATION FOR INVESTIGATION OF DOMESTIC LANDFILL AND SLAG/ASH DEPOSITS 5

   Phase One - Site Reconnaissance and Desk Study
   Phase Two - Ground Investigation
   Phase Three - Detailed Study and Assessment of Waste Contamination

5. SOURCES OF INFORMATION 8

   Sketch Plan of Trewinnard Manor Pond and Adjacent Features

1. GENERAL BACKGROUND

1.1. As a result of a pollution incident of the River Hayle reported on the 21st November 1990, a wildlife pond adjacent to the river immediately upstream of the St. Erth gauging station was identified to be discharging a septic looking effluent. Subsequent investigation of the pond identified anaerobic conditions with particularly high BOD, ammonia and hydrogen sulphide gas.

1.2. This report describes the groundwater regime in the vicinity of the pond and the potential for contamination from existing waste disposal sites nearby. A specification for further ground investigation has been included along with the cost implications to the Authority. Information and results included within this report are from a site inspection carried out with the Catchment Planner (Malcolm Newton) on 6th December 1990 and from previous investigations by Pollution staff and Cornwall Waste Disposal Authority (C. Brewer - Cornwall WDA). A sketch plan of the pond and adjacent features is included at the end of the report.

2. EXISTING POND CONDITIONS

Ground and Surface Water Flow Regime

2.1. The pond is situated adjacent to the River Hayle just outside of the elevated flood protection banks immediately upstream of St. Erth gauging station. It is approximately 200 metres in length, up to 50 metres across and is estimated to be on average 1 metre deep. Heavy reed growth covers much of the pond area and it is understood that a large number of ducks and starlings frequent the pond. it has also been claimed that the pond is teaming with fish!

2.2. The pond is fed by two surface water ditches one entering at the north and the other at the south of the pond. The 1908 Ordnance Survey map shows the existence of a leat passing to the west of the pond (not shown on the 1908 map) providing water and power to the Corn Mill at Trewinnard and the Iron Works at Battery Mill. This leat has been intercepted and now enters at the southern end of the pond. Flow within the ditch was less than 1 l/s on the 6th December 1990. The ditch entering at the northern end was flooded at the time of the site visit due to the artificially high pond level. However it is understood that this ditch drains the surface run off from a small drainage network surrounding the old domestic landfill site to the north. It is likely that inflows from the ditch will only be significant during winter months or periods of heavy rainfall.

2.3. Groundwater seepage through the base and side of the pond is also likely to make a significant contribution to the water balance. The pond is located in the old flood plain of the River Hayle (prior to the flood bank being constructed) where groundwater levels are likely to be high particularly during winter months. Indeed the 1908 Ordnance Survey map extract shows a spring close to the Corn Mill and the pond site as fields, presumably drained, bounded up and down valley by marshy scrub land.

2.4. The rate and proportion of surface water to groundwater inflow to the pond will vary seasonally. On the 26th November pollution staff blocked the outlet to prevent contamination of the river and levels backed up such that by the 6th December it was estimated the pond had risen by 0.3m. This equates to approximately 3000m^3 inflowing of which say 1 l/s from the surface water ditches and 2 l/s average from groundwater. It is likely that the pond is in continuity with much of the surrounding alluvial flood plain and therefore in practice groundwater flow to the area would be considerably larger.

Water Quality

2.5. A number of water quality samples have been taken of the River Hayle its outfalls and tributaries between the St. Erth intake and the pond during the pollution investigation. The pond, adjacent surface water ditches and River Hayle were sampled by pollution staff on the 23rd November. Conductivity measurements of surface waters adjacent to the pond have been carried out by Cornwall Waste Disposal Authority on the 29th November.

2.6. The analysis indicates the pond to be of very poor quality. The outfall has extremely high ammonia (approximately 40mg/l) and BOD (approximately 135mg/l) levels and has the appearance and smell of a septic effluent. The pond itself has slightly lower levels of ammonia and BOD but appears black, completely anaerobic and is giving off significant amounts of hydrogen sulphide gas.

2.7. The surface water ditch entering the pond from the north was found to have low levels of ammonia and BOD. The ditch inflowing from the south did have slightly elevated ammonia (0.25 mg/l) but this is significantly lower than measured in the pond.

2.8. The site inspection carried out on the 6th December identified visually contaminated water in several of the surface water ditches adjacent to the domestic landfill site, to the north of the pond. Field conductivity measurement of these ditch waters carried out by Cornwall WDA indicated slightly elevated levels (570 to 700 us)

3. POSSIBLE CAUSES OF POND CONTAMINATION

3.1. The reason for the pond to become severely contaminated is not clear. The following scenarios are discussed in further detail; natural seasonal processes possibly made worse by the recent "drought" summers, contamination of ground and surface water entering the pond from the domestic landfill to the north, contamination of groundwaters from slag (Hayle Power Station) possibly disposed adjacent to the west of the pond. Other possibilities include contamination from the nearby sewer pipe and high input of urea from the large numbers of birds which frequent the pond.

Natural Seasonal Processes

3.2. It is understood that the pond level falls each summer and the first rains of Autumn flush the pond after which is settles down to normal within a week or so. The reduction in pond quality may happen each year, clearing naturally and by chance identified this year.

3.3. The past two drought summers have caused groundwater levels throughout the South West to fall to low levels. As levels recover it is possible that the groundwater quality already low in dissolved oxygen will be of a worse quality than normal due to reduced flow velocities through contaminated strata. The recent dry hot summers have also caused the growth of algae and associated vegetation in surface waters throughout the South West. It is possible that an algal bloom or growth of vegetation in the pond has caused a reduction in water quality.

3.4. Perhaps a combination of poor quality groundwater, low in dissolved oxygen, percolating through a thick biomass and mixing with a poor quality pond water may have resulted in the pond going anaerobic producing a septic effluent discharge.

Contamination of Pond from Domestic Landfill Site

3.5. It is understood that the flood plain area extending to the north of the pond as far as the old Iron Works at Battery Mill, has been used for the disposal of domestic wastes. Disposal was carried out by West Penwith, St. Ives and Penzance District Councils and ended approximately 20 years ago.

3.6. Information provided by Cornwall WDA and site topography viewed during the field inspection (6th December, 1990) indicates that the tip is between 50 and 100 metres in width and approximately 400 metres in length. The nearest wastes to the pond are approximately 30 metres to the north west. The 1908 Ordnance Survey map extract shows the area to be flat and marshy and the present topography indicates that the wastes are unlikely to be more than 1 or 2 metres in depth. The map also shows the mill leat passing beneath the present waste site and it is likely that this has been filled over.

3.7. The potential for the waste tip to generate leachate over the past twenty years will depend on a number of site specific physio-chemical conditions. It is unlikely that the site was engineered to contain or properly disperse leachate. Some compaction of wastes may have occurred from a dozer recorded on site and indeed tip and burn practices were still common at this time which if practised will have considerably reduced the putrescible content of the waste. The tip area has been reinstated to poor quality grazing land although it is unlikely that an impermeable cap has been placed to reduce infiltration. Surface water ditches are present along the southern and north eastern boundaries of the site which in places are visibly contaminated by leachate.

3.8. The 1:50,000 scale geological map (sheet 351/358) shows the waste site to be underlain by alluvial silts and gravels beneath which are Mylor slates of Devonian age. The permeability of these deposits can be extremely variable, but the presence of the pond immediately to the south, excavated by tin streamers indicates that the alluvium may have a high gravel content and therefore high permeability. Prior to waste disposal the area was apparently marshy and it is likely that groundwater levels extend into the base of the waste during winter periods receeding during the summer. The groundwater gradient beneath the site has not been identified and although it would normally be towards the river and down valley, this area is flat and without localised groundwater monitoring it is not possible to be certain that groundwater flow does not occur to the south, towards the pond.

3.9. It is likely that the wastes deposited at Trewinnard 20 years ago will still be generating an "aged" leachate. In particular aged leachate is characterised by relatively high concentration of ammonia, low concentration of iron and organic carbon compounds which are resistant to biodegradation. It tends to be weaker than leachate from recent wastes because of the depletion of readily soluble and degradable material. The concentration of organic carbon compounds diminishes relative to the concentration of ammonia, presumably because the ultimate products of decomposition of carbon compounds can escape from the tip gases while ammonia is retained in the leachate because of its high solubility. As a result ammonia is often the most significant pollutant in an aged leachate. In addition there is often a decrease in the concentration of iron in aged leachate indicating that the leachate has become sufficiently aerobic for the soluble ferrous iron to have precipitated as the insoluble ferric form.

Below is shown a 'typical analysis of an "aged" leachate'

Constituent	Concentration (mg/l except pH)
pH	7.1
COD	125
BOD	5.0
TOC (as C)	40
Total fatty Acids (as C)	>2
NH3 - N	40
Ox - N	2.0
Cl-	225
Fe	0.1

3.10 The potential for leachate generated by the waste tip to contaminate ground and surface waters inflowing to the pond is not clear. It is likely that the waste is continuing to generate leachate and indeed leachate is visible breaking out to the surface water ditch long the southern and north eastern boundaries of the landfill. These surface water ditches appear to drain south and it is likely that some poor quality water enters the pond. It is not possible to identify the groundwater gradient between the waste tip and pond and it is likely that this varies seasonally with possible perched levels. A ground investigation is required to identify the composition of the alluvial deposits, groundwater level and groundwater quality in the area between the pond and waste/slag deposits. Specifications for further investigation have been included in section 4.

Contamination of Pond from Slag and Ash Deposits

3.11. It has been suggested that slag and ash from the old Hayle Power Station has been tipped adjacent to the south west of the pond. The topography and vegetation over this area does not indicate that significant quantities have been placed but it is possible that a small amount is present. A ground investigation is required to identify its presence, a specification is included in section 4.

3.12. Percolation of ground and surface waters through slag and ash wastes can produce an anaerobic sulphide rich leachate. Any iron within the waters is converted to ferrous sulphide and the excess sulphide either remains in solution or is emitted as hydrogen sulphide gas. This is one possible source of the large amounts of sulphide and hydrogen sulphide gas present within the pond.

Contamination of Pond from Sewer Pipe

3.13. A foul sewer pipe exists beneath the flood bank adjacent to the pond. It is possible that this has broken and effluent is leaching into the pond. Further examination of the sewer is to be carried out by pollution staff.

Contamination of Pond by Bird Effluent

3.14. It is understood that a large number of starlings and ducks frequent the pond during summer and winter months. It is considered unlikely that the effluent generated by these birds alone is sufficient to cause the severe contamination present within the pond but possibly is a small contributing factor.

Combination of Contamination Sources

3.15. From the information presently available it appears that the pond has become septic due to a combination of the above scenarios. Providing the integrity of the sewer pipe is confirmed, it is likely that the anaerobic condition within the pond has been caused by poor quality groundwaters percolating through a thick biomass in the pond base and mixing with already poor quality pond water. Inputs of contaminated surface waters from the waste tip area may have reduced the pond quality still further. The quality of the groundwater entering the pond is not known. It is likely to be low in dissolved oxygen and may be contaminated by aged leachates with high ammonia levels from the domestic waste tip and possible elevated in sulphide from slag and ash deposits.

4. SPECIFICATION FOR INVESTIGATION OF DOMESTIC LANDFILL AND SLAG/ ASH DEPOSITS

4.1. Investigation of the ground conditions surrounding Trewinnard Manor Pond should be carried out in three phases. The first phase should include a site reconnaissance and desk study. Phase two to entail a ground investigation and in phase three long term monitoring and further investigation will allow an understanding of the hydrogeological and geochemical conditions in the vicinity of the pond to enable recommendations for remedial works to be made.

Phase One - Site Reconnaissance and Desk Study

4.2. The site reconnaissance and desk study should gather all available information on waste tip history and inputs, topography, drainage, geology and basic surface water quality. This phase has now been virtually completed and information gathered by Cornwall WDA, NRA Pollution, Freshwater Quality and Groundwater Quality staff is included within this document. It is possible that aerial photographs may be of use and suitable images should be obtained and viewed.

Phase Two - Ground Investigation

4.3. In order to identify the potential for leachate to contaminate groundwater entering the pond it is necessary to carry out a ground investigation.

4.4. The object of the investigation is to identify the subsoil strata between the pond and the landfill site and also in the area of possible slag/ash deposits. Groundwater samples from these areas will help to identify possible leachate migration towards the pond. Installation of piezometers will enable groundwater levels to be monitored and seasonal groundwater fluctuation to be identified within phase three of the investigation.

4.5. It is suggested that the following works are carried out within phase two:-

1. Excavation of say 6 to 10 trial pits approximately 3 metres in depth using a powered excavator. The location of pits should be identified on site with at least one through the waste tip. Soil and geological logs to be drawn for each pit. Soil and subsoil samples to be taken at appropriate horizons and stored for future testing (phase 3)

2. Sampling of leachates and groundwaters within trial pits by baller or excavator bucket. Analysis to be carried out internally by NRA for BOD, COD, TOC, NH3 and major ions.

3. Installation of say 3 to 5 piezometers to monitor groundwater level possibly within trial pit holes or preferably "driven piezometers" where ground is suitable. Levelling of piezometer covers.

4. Field survey of relevant surface water ditches and ponds using field D.O., conductivity and pH meters. Walk over gas survey of waste site.

5. Further sampling and analysis of relevant surface waters to link with ground investigation. Sampling of pond sediments etc. This may be carried out internally by NRA.

6. A factual report to include trial pit logs, ground and surface water quality analysis and a brief interpretation of the date.

4.6. A guideline of external costs for this phase of the investigation has been listed below:-

The investigation is likely to take 2 days. Costs are based on the professional fees of a suitably experienced consultant, contractors costs and materials

Consultant Costs (2 days, including travelling and subsistence)	allow £650
Contractor - (JCB hire 2 days)	allow £250
Materials - piezometers etc.	allow £200
Report	allow £200
Total external costs	**allow £1300**

Analytical costs have not been included in the above.

4.7. On conclusion of this phase of the investigation it should be possible to identify whether leachate is migrating from the landfill site towards the pond. It will be necessary to carry out further investigation outlined in phase 3 below in order to identify the concentration and effect of leachate entering the pond.

Phase Three - Detailed Study and Assessment of Waste Contamination

4.8. Where the findings of the ground investigation carried out in phase two identify that leachate is migrating from the tip towards or into the pond, further detailed investigation may be required.

4.9. This investigation should include:-

1. Excavation of further trial pits and possibly shallow boreholes. Installation of further piezometers some at multiple depths and at a diameter to allow groundwater sampling.

2. Monitoring of groundwater levels and quality over a period of several months.

3. A complete water balance to identify flow and chemical constituents into and out of the pond.

4. Comprehensive report to identify the effects of contamination from the landfill site and adjacent slag/ash deposits on the water quality of the pond.

4.10. The external costs for this phase of the investigation are difficult to identify at this time, however if routine monitoring and analysis is carried out by local NRA staff it is considered that a sum of approximately **£6,000** should be allowed for external costs.

5. Sources of Information

1. Memorandum 22nd November 1990 by Ray Waite, Senior Pollution Inspector, Bodmin.

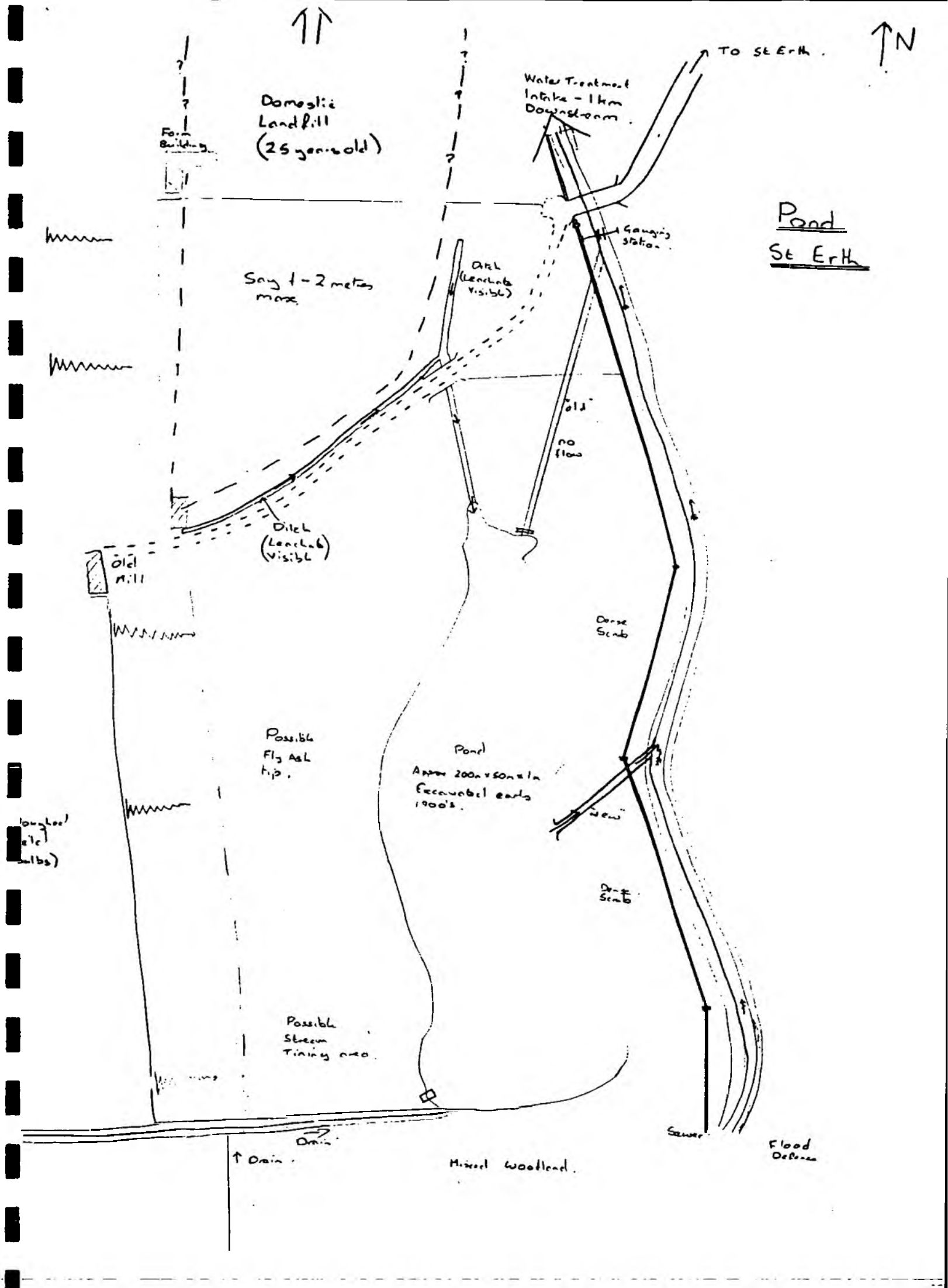
2. Ordnance Survey Map 1908

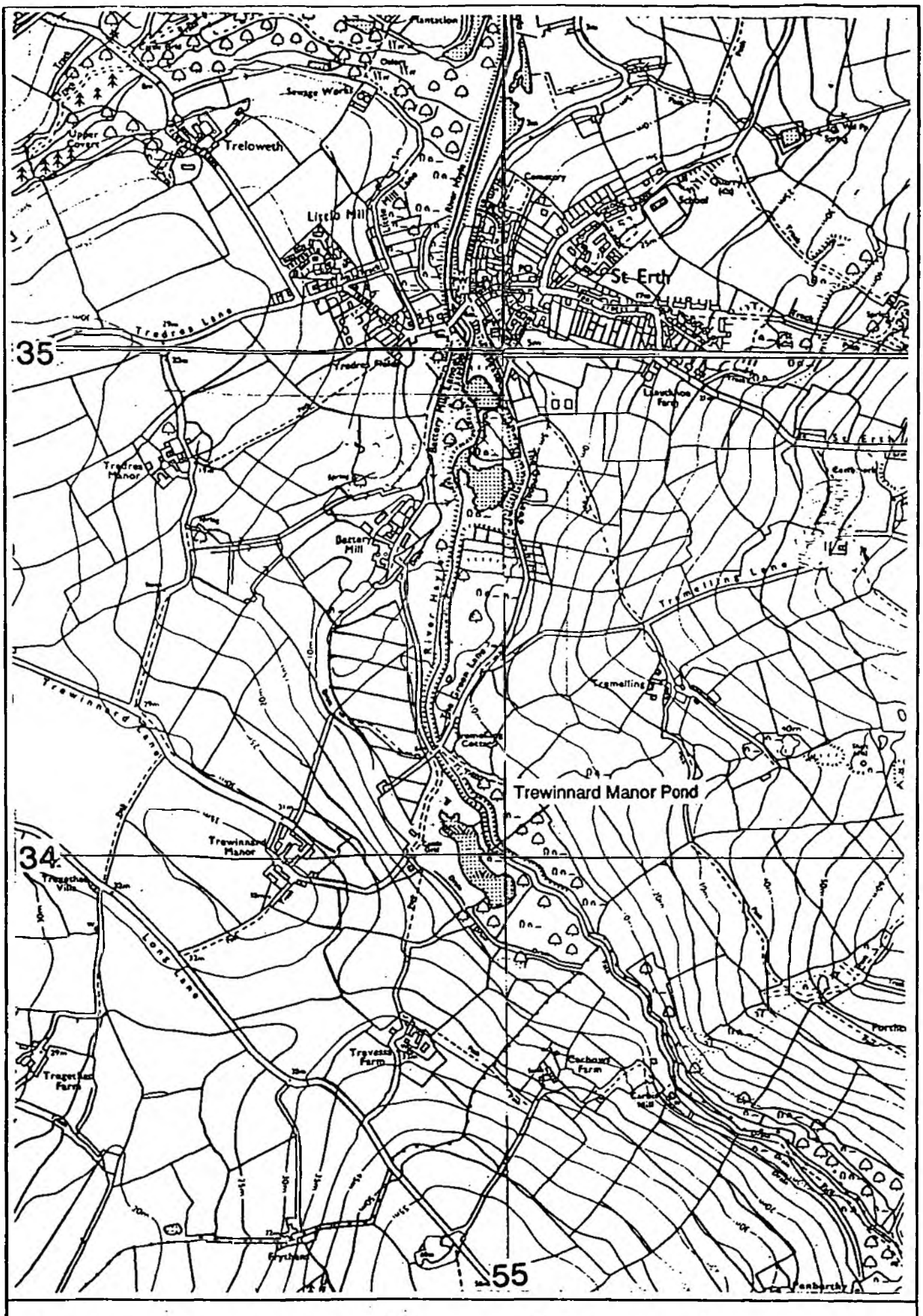
3. Ordnance Survey Map 1:10,000 scale

4. British Geological Survey Map 1:50,000 scale sheet 351 and 358

5. Cornwall Waste Disposal Authority note 28th November, 1990. Note prepared by Colin Brewer.

6. County Surveyors Society Report Number 4/1 1984.
The Treatment of Leachate from Landfill Sites.


N
TO St Erth.
Water Treatment Intake - 1km Downstream.
Domestic Landfill (25 years old)
Pond
St Erth
Gauging station
Say 1-2 metres max.
Old
no flow
Dilek (Leachate Visible)
Dilek Mill
Dense Scrub
Possible Fly Ash tip.
Pond
Approx 200m x 50m x 1m
Excavated early 1900's.
New
Dense Scrub
Possible Stream Mining area.
Drain
Drain
Mixed Woodland.
Sewer
Flood Defence



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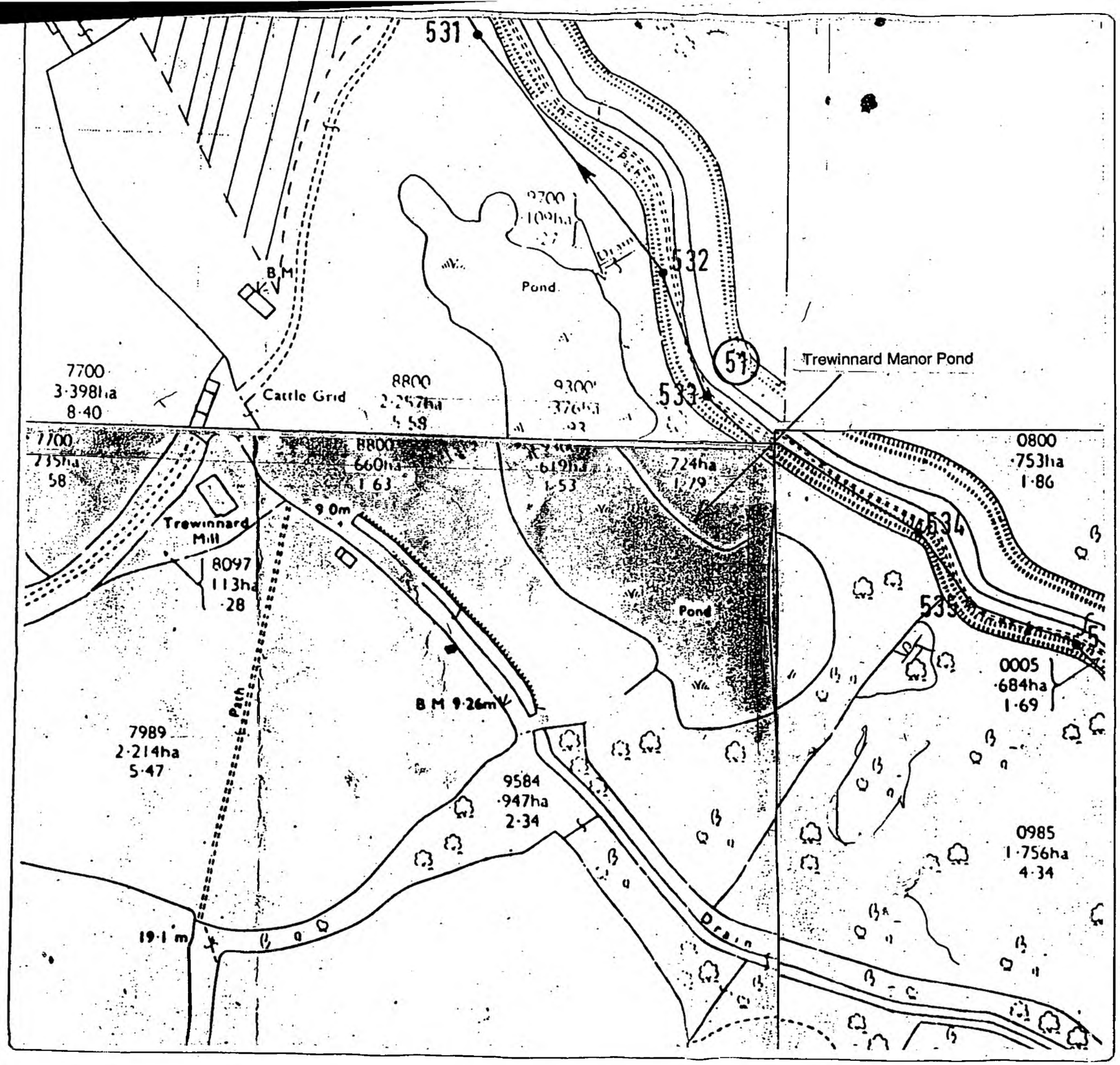

CLIENT

PROJECT

DRG. TREWINNARD MANOR POND
LOCATION PLAN

No. SCALE —

DRAWN CH DRAFTED CH

CHECKED GB DATE 18/01/91