

-NRA South West 64

**NRA SOUTH WESTERN REGION
METALLIFEROUS MINES DATABASE**

March 1995

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CONTENTS

1. INTRODUCTION
2. METALLIFEROUS MINE DATABASE PROJECT
 - 2.1 Impact of Mining on the Water Environment
 - 2.2 NRA Information Requirements and Project Specification
 - 2.3 Working Methods
3. PROJECT OUTPUT
 - 3.1 Mines Database
 - 3.2 Associated Land Maps
4. MINE SITE EVALUATION
 - 4.1 Inspection of Associated Land Maps
 - 4.2 Mines Database
 - 4.3 Walkover Survey
 - 4.4 Review of Literature
 - 4.5 Other Sources of Information
 - 4.6 Site Investigation

FIGURES

1. Regional Map
2. Example of Associated Land Map
3. Example of an Associated Land Map used for a Detailed Survey
4. Use of Associate Land Map in Water Quality Planning

APPENDICES

1. Metalliferous Mines Database Retrieval Request Form
2. Metalliferous Mines Database Menu Options
3. Examples of Mines Database Output
 - Summary listing of mine records
 - Half listing of mine record
 - Full listinf of mine record
 - Catchment record



1. INTRODUCTION

This report provides an overview of the NRA South Western Metalliferous Mines database project and briefly describes:-

- concerns over impacts on the water environment arising from metalliferous mining activities and the need for ready access to information on mine systems,
- the Metalliferous Mine database project, its working methods, and its output, and
- provides advice to NRA staff on obtaining information on metalliferous mine systems.

2. METALLIFEROUS MINES DATABASE PROJECT

2.1 Impact of Mining on the Water Environment

The South West has a long history of metalliferous mining which has had a major impact on the water environment. Some 2100 mine sites have been identified as part of the mines database project. These are plotted on Figure 1 showing those areas where mining activity was most intense, throughout much of Cornwall, and in Devon around the Dartmoor granite massif.

Mining affects catchment water quality by releasing and dispersing polluting materials into the environment. Mining creates new drainage pathways for oxygen rich rainwater enhancing the weathering of naturally occurring minerals found in-situ or as mining waste left underground or at surface. This results in removal of dissolved oxygen, increase of acidity and release of toxic metals and large quantities of iron into mine drainage waters. When subsequently discharged into surface waters much of the dissolved material precipitates as iron rich metal hydroxides which coats and smothers streambeds. Similar processes occur in water seeping through mine waste spoil dumps. Pollution from such mine waste dumps may also arise from suspension of solids including toxic metals in surface runoff. Pollution impacts may be particularly severe in the vicinity of former mineral processing plant, tailings dams, smelters etc.

Water quality monitoring has demonstrated that 212 Km of main river within the former NRA South West Region is affected by mining discharges (Abandoned Mines and the Water Environment, NRA Water Quality Series No.14 March 1994). Along these river stretches slight to severe depletion and reduction of diversity of aquatic fauna and flora occurs.

Mining also affects catchment hydrology by providing new drainage pathways and additional storage which may result in lowering groundwater levels, diversion of water from the upper reaches of watercourses to mine adit drainage systems, transferring water between catchments, and altering catchment responses to rainfall events.

Impacts can also arise from catastrophic failure, where for example, a mine adit collapse results in backup of mine drainage with a subsequent sudden large scale release when the blockage gives way. Failure and sudden slippage of a mine spoil dump can also occur with release of contaminated solids directly into surface watercourses.

2.2 NRA Information Requirements and Project Specification

Ready access to information on mine systems is relevant to a wide range of NRA activities. These include :-

- investigation of pollution incidents
- liaison with planning authorities
- investigation of non compliant surface waters
- abstraction licensing
- discharge consenting
- land drainage
- catchment planning

In the past information on mine systems within the NRA was dispersed and very patchy, being highly dependant on local knowledge with individual staff. Such information was also often related to sites where problems associated with mine systems had not been anticipated. Unlike other major features of the water environment the presence of mine systems is not readily inferred from Ordnance Survey maps or recorded through licence or consent records.

The Metalliferous Mines Database project was designed to meet this need and provide ready access to information on mines to NRA staff. The underlying philosophy was to provide systematic coverage upon which area wide working practices could be developed rather than to focus attention on major problem sites. To keep the project within manageable bounds, the information sources used were generally restricted to published references, geological and ordnance survey maps, and aerial survey photographs.

Outputs required under the contract included the following work elements :-

- Design of database to provide for a wide range of searching, sorting and reporting options
- Identification of mine sites and provision of systematic site descriptions
- Provision of 1:25000 Ordnance Survey map overlays showing location of mine sites, adit discharges and areas of land associated with mining activity
- Provision of systematic catchment descriptions providing an overview of geology, mineralization, mining development, adit discharge locations and water quality impacts
- Identification of twenty high risk sites which the NRA may use to target future investigations.

It was specified that information sources used should be internally referenced.

2.3 Working Methods

Following competitive tendering a contract to undertake the work was let to Marcus Hodges Environment Limited in November 1992.

During the initial stages of the contract especially close liaison between the NRA and the contractor was required to ensure that the database design and the protocols for selection and presentation of data met with the NRA's needs. A software package was developed in dBASE IV with data fields and internal structure designed to allow user friendly storage and retrieval of mining related data.

The database allowed for input of site specific material within MINE RECORDS and more general descriptive material within CATCHMENT RECORDS. Details of the data fields and their contents, and of data retrieval and reporting options are given in section 3.1 below.

Collection and compilation of descriptive material commenced with a pilot study in the Caradon-Phoenix mining area near Liskeard. This allowed development of the working practices used throughout the project and also provided an initial data set to demonstrate the satisfactory performance of the newly developed software application.

Details of the protocols as agreed with the NRA are provided within Marcus Hodges Environment Report No. 50217/RRK 2312: 1992, which is held by the Groundwater Protection Section.

Description of the Region's mines has been conducted on a sub-catchment by sub-catchment basis. An initial trawl of the principal reference sources was used to highlight the main areas/sites of metalliferous mining activity within a mining district. This was followed by description of all individual sites identified.

The size and scope of the project dictated that only a select set of core references were used. Principally these included the following:-

- 1:25,000 scale NRA catchment boundary maps.
- 1:10,000 scale Ordnance Survey sheets.
- 1:10,000/1:10,560 or 1:50,000 scale British Geological Survey geology sheets.
- Dines H.G., 1956
- Publications edited by R Burt of the Exeter University Economic History Unit.
- Ove Arup's 1991 report on Mining Instability in the UK.
- Various publications describing local mining areas.

This standard reference material was used to complete Mine Record Proformas and to delineate areas of "Associated Land" on OS 1:10,000 scale working maps.

On completion of the mine descriptions for a given sub-catchment, the records were numbered and together with identified areas of Associated Land digitised onto an AutoCAD System. At this stage Catchment Records were prepared to give an overview of the mining within the sub-catchment, using the data collected during the

description of the mine sites and additional NRA hydrological and water quality data.

Mine and Catchment Records were input to the Mines Database system prior to a final audit.

3. PROJECT OUTPUT

Details of the principal project outputs, namely the Metalliferous Mines Database, which contain text descriptions, and the Associated Land Maps which show mine site locations and areas associated with past metalliferous mining land use, are given below.

3.1 Mines Database

The Mines Database System operates in dBASE IV and is maintained on the Groundwater Protection Section PC in Manley House. The menu options available and the layouts for the main screens are shown in Appendix 2. The principal menu options of interest to users are "Mines", "Catchments" and "Reports".

Mine data

The Mine Records consist of establishment and text data. Screen one contains "establishment" data which can be specified when undertaking a search. This includes :-

- Mine Number, these are numbered by sub catchment so that reports ordered by mine number will be grouped by sub catchment.
- Mine Name
- Alternative Names
- Working Dates
- Metals Worked
- Status
- Dines Group (based on the district/area classification used in Dines, 1956)
- Principal Point NGR
- Parish Council
- District Council
- sub-catchment codes for - principal point, surface land, underground workings and mine drainage.

Use of a mine drainage subcatchment code to select mine sites may retrieve mine sites which geographically lie outside the subcatchment boundary. Such retrieval may be required to investigate catchment water quality failures or following a pollution incidents. For other circumstances use of the catchment principal point avoiding double reporting of sites may be appropriate.

The second screen contains text data, where available, covering the following topics :-

- Location: A brief description of the mine location relative to local settlements, landmarks and towns.

- **Mineralisation:** A description of the site geology and mineralisation including the orientation of the principal mineral lodes and the predominant ore minerals/geochemistry.
- **Mine History:** Provides an indication of working periods, particularly related to alternative names and amalgamations.
- **Recorded Outputs:** An indication of the mine mineralogy based on official mineral returns, where available.
- **Mine Description, Surface Workings:** Primarily a description of actual mineral workings exploited from surface, for example, pits, quarries, alluvial workings. Mineral processing facilities are also included where data is available.
- **Mine Description, Underground Workings:** An account of the depth and extent of the underground workings, including connections with workings on adjacent lodes or neighbouring mines.
- **Mine Drainage:** NGR for the mine adit portal, and elevation, where possible.
- **Associated Land Description:** This section references the source material used for the delineation of Associated Land, e.g. 'tip areas delineated using the 1981 OS sheet'.
- **Potential Contamination:** Elements likely to be present at the site and which may have a potential for contaminating controlled waters. Elements present as sulphide minerals are listed first due to their potential for weathering. Tin and tungsten are not listed as their principal ores, cassiterite and wolframite, are oxides which are almost totally resistant to chemical weathering.
- **Proximity to Water Interests:** The distances in metres to the nearest surface water interest.
- **Investigation, Monitoring and Impact:** These three sections are mainly intended for future NRA use at appropriate sites. Where aware of previous NRA involvement, Marcus Hodges Environment have provided references to appropriate NRA files/reports/Sections.
- **Notes:** A section available for the storage of additional miscellaneous comments generally used to document contradictions within the standard references.
- **References:** Every Mine Record is internally referenced, allowing the user to seek any additional information which may be required.

Data held in the above categories can be interrogated on screen using the View Mine option, or can be accessed via the Reports Menu.

Catchment Data

Catchment Records are accessed from within one screen under the View Catchment menu option. Searches can be performed on the sub-catchment name or number. All other data on the Catchment Records is text data only. This includes the following categories :-

- **Hydrology:** An overview of the watercourses within the sub-catchment, including the number of designated water quality monitoring points (1992/3).
- **Geology and Mineralisation:** A simplified geological history is provided to explain the sequence of lithologies encountered within the sub-catchment. The distribution of the various rock types and any associated mineralisation throughout the catchment is documented.
- **Hydrogeology:** An indication of the groundwater flow conditions likely to be present within the sub-catchment. Fissure flow through fractured rock for the majority of the mineralised areas.
- **Mine Locations:** A very brief summary of the number, character and distribution of mines within the sub-catchment.
- **Catchment Studies:** An internal reference to NRA water quality documents used in the sections on Hydrology and Mining Impact on Catchment.
- **Mining Impact on Catchment:** An examination of available water quality data and comparison with River Quality Objectives; used to ascertain the location of heavy metal impacts on monitored watercourses. These findings are compared to known mine and mine drainage locations.
- **Mine Drainage Discharge Points.** NGR's for adit portals identified during the mine description work, Mine Record numbers and names are also provided where known.

As with Mine Records, Catchment Records can be accessed on screen via the Catchment menu, or through the Reports menu. In addition to reporting on the text data held within Catchment Records, it is also possible to select a report which gives a listing of mines which have surface land, underground workings or mine drainage to a particular catchment.

Retrieval and Reporting Options

The reports option allows mine site data to be selected using a combination of any of the mine establishment data fields, and then presented in subcatchment, 10km square or alphabetical order.

Reports on mine sites can then be generated using a number of preset options :-

- Summary listing, Mine number, Mine name and NGR.
- Half listing, Mine establishment data only - two sites to a page.
- Full listing, Mine establishment data together with full data dump of all descriptive text.

Reports can be viewed on screen, run off as hard copies, or written to a Report.txt file. This latter option allows Mines Database reports to be directly imported to word processing packages.

There is also a provision for "Designer Reports". In conjunction with an experienced dBASE IV operator it is possible to produce a new report option or a customised report if the pre-set options are not applicable.

It should be noted that the data held within the Mines Database Records is based on a desk study project. The brief was to produce a comprehensive regional database of metalliferous mining sites. Consequently the emphasis had been to include all possible sites rather than to produce exhaustive, accurate records for individual sites. Therefore the data held on the system must be regarded as a pointer to further studies, if required, rather than an authoritative text on an individual site. No site examinations have been undertaken in compilation of the Mine Records.

Reports derived from the Mines Database and the Associated Land Maps should be released to outside organisations/interests, if qualified by appropriate caveats and after consultation with the Groundwater Protection Section.

3.2 Associated Land Maps

The Mines Database Associated Land Maps have been compiled by Marcus Hodges Environment at 1:10,000 scale and digitised onto an AutoCAD based digital map system. Although the data is available in digital form, the standard format is as 1:25,000 scale film overlays attached to Ordnance Survey 1:25,000 scale base maps.

This map collection is held by the Groundwater Protection Section at Manley House. Additional copies covering Cornwall Area are also held at Bodmin.

Several relevant features are indicated on these maps:-

- **Associated Land:** Delineates the boundary of land with a past mining land use, excluding stream workings. This generally includes mine tips, mineral processing plants, surface facilities and a 25m default radius surrounding identified mine shafts. THE ATTENTION OF ALL USERS IS DRAWN TO THE COMMENTS INCLUDED ON THE KEY PANEL OF THESE MAPS.

- **Stream Workings:** Delineates areas where alluvial/detrital tin or tungsten has been worked from valley bottoms or moorland marshes. These are generally old workings for geochemically immobile tin and tungsten minerals. These areas are not regarded as high risk areas with respect to the aquatic environment.
- **Adits:** Adit symbols are shown at referenced positions or locations verified by other means, for example, previous site inspection. The closed end of the adit symbol points in the direction of the mine entry (i.e. underground), where known. Not all adit portals will have an associated discharge.
- **Mine Numbers:** Included for quick, easy cross-referencing to the Mines Database.
- **Catchment Boundaries:** NRA sub-catchment boundaries.

4. MINE SITE EVALUATION

This section provides a suggested staged approach for the collection of mine site data according to the nature of the enquiry and resources available for investigation.

4.1 Inspection of Associated Land Maps

For most applications the initial approach to the Mines Database System will be via the Associated Land Maps. These maps provide an excellent visual indication of mining activity and can be used for site specific (e.g. water quality, pollution, planning consultation) or area based enquiries (e.g. catchment planning).

The maps will provide an indication of the proximity and extent of mining at the relevant location/area. This will include areas of Associated Land and possible mine drainage points.

Further information on specific sites can be obtained by consulting the Mines Database Records, using the Mine Reference Numbers displayed on the Associated Land Maps.

Associated Land Maps are available for inspection at Bodmin and Exeter

4.2 Mines Database System

Access to data held on the Mines Database System is via the Groundwater Protection Section in Manley House. A consultation/information request form is included at Appendix This form should also be used to submit any additional information/alterations which may result from more detailed NRA investigation or site inspection.

As discussed in Section 3.1, the system is very flexible in the style and content of report output. A number of examples are given in Appendix 3. Styles of report include:-

- Single full Mine Record, perhaps relevant to a planning consultation.
- Complete Mine Record or establishment data only for a small number of mines, e.g. for investigation of a water quality problem on a single tributary.
- Summary Information (Mine Record Number, Mine Name and NGR) for a complete sub-catchment. This style of report has been valuable in catchment studies.
- Single Catchment Record, also useful for catchment studies.
- Reports based on specific searches, e.g. copper and arsenic mines within a given sub-catchment, map square or district council area.

Data requirements should be discussed with Groundwater Protection Section personnel to ensure an appropriate consultation reply. Information from the database should be used in conjunction with the Associated Land Maps.

4.3 Walk Over Survey

For information relating to specific sites it is strongly recommended that personnel using data from the Associated Lands Maps or Mines Database System visit the appropriate site(s) to verify the extent and nature of the mining activities. It may be possible to conduct a joint site visit with Groundwater Protection Section personnel.

A walk over survey at this stage will be valuable in assessing the need to proceed to a more detailed desk study and/or on site investigation.

4.4 Review of Literature

Water Quality sampling can be conducted at relatively low cost during a walk over survey. However, proceeding with an on site mining/contaminated land/hydrogeological investigation will involve considerable expense. A thorough data review should be attempted prior to any further work. Other than water quality flow monitoring this is probably the final element that can be attempted in-house by NRA personnel. Further stages of investigation are likely to require the expertise of external contractors.

A wealth of literature exists on mining in the Region, but unfortunately much of this is difficult to assess. A core of references which summarise earlier material has been used to compile the Mines Database. Each Mine Record includes an internal listing of the references used. These references are available for further study through the Groundwater Protection Section, who also maintain an overall project reference list.

Examination of number references normally provides little additional useful information, and often results in contradictory reports. For many sites there is no, or very little, reliable data.

4.5 Other Sources of Information

Acquisition of further information becomes increasingly difficult and time consuming. A number of additional sources of information may be available.

- **County Records Office:** These now hold abandoned plans for mine workings. Interpretation can be difficult and it is likely that the assistance of a specialist contractor will be required.
- **County and District Councils:** The amount and quality of information held varies widely. Data is often lodged in different departments in different organisations. The Groundwater Protection Section has a list of some useful District Council contacts.
- **British Geological Survey:** The BGS has an extensive collection of geological and mining maps, including mine plans superimposed onto Ordnance Survey base maps.
- **Specialist Contractors:** It may be appropriate to use a specialist mine search contractor. These will be aware of additional avenues of enquiry and often have extensive collections of reference material.
- **Others:** In some instances it may be possible to obtain information from land owners, mineral owners, mining companies, universities/colleges, local/learned societies or other sources. However, these sources are often reluctant to supply information which will reside in the public domain.

4.6 Site Investigation

Detailed on site investigation may be required in exceptional circumstances. Detailed consideration must be given to the costs and objectives of any investigation by appropriate senior personnel. This will include liaison with contractors to establish the scope and brief of any work put out to contract.

Applicable site investigation methods are too numerous to catalogue here but are detailed within various volumes held in the Groundwater Protection Section (Ove Arup 1991). Methods likely to be encountered will include the following:

- Water sampling
- Hydrological monitoring
- Shallow trial pitting and soil sampling.
- Borehole investigation.

- Various geophysical methods including GPR (Ground Probing Radar).
- Probing.

In normal circumstances investigations directly undertaken by NRA staff would be restricted to sampling of adit discharges and flows or other hydrological measurements.

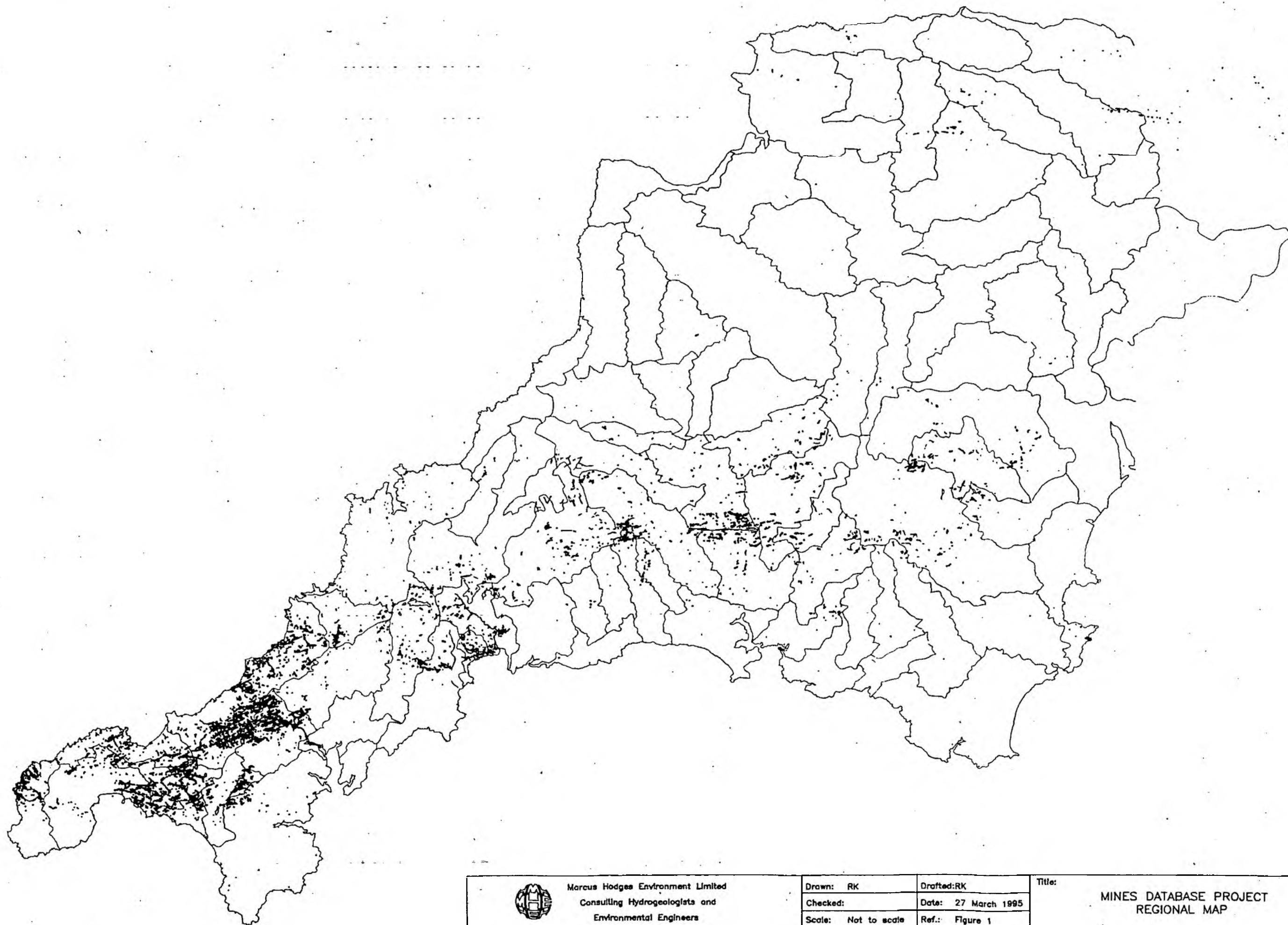
Detailed advice documenting investigation procedures are given in the following reference commissioned by the DoE :-

Review of Mining Instability in Great Britain. Volume 2/V 'Procedures for Locating Disused Mine Entries'. Ove Arup 1991.

Although this document specifically deals with the engineering treatment of mine workings, the approach and methodology remain relevant.

APPENDIX 1

Metalliferous Mine Database Retrieval Request Form



Marcus Hodges Environment Limited
Consulting Hydrogeologists and
Environmental Engineers

Drawn: RK

Drafted: RK

Checked:

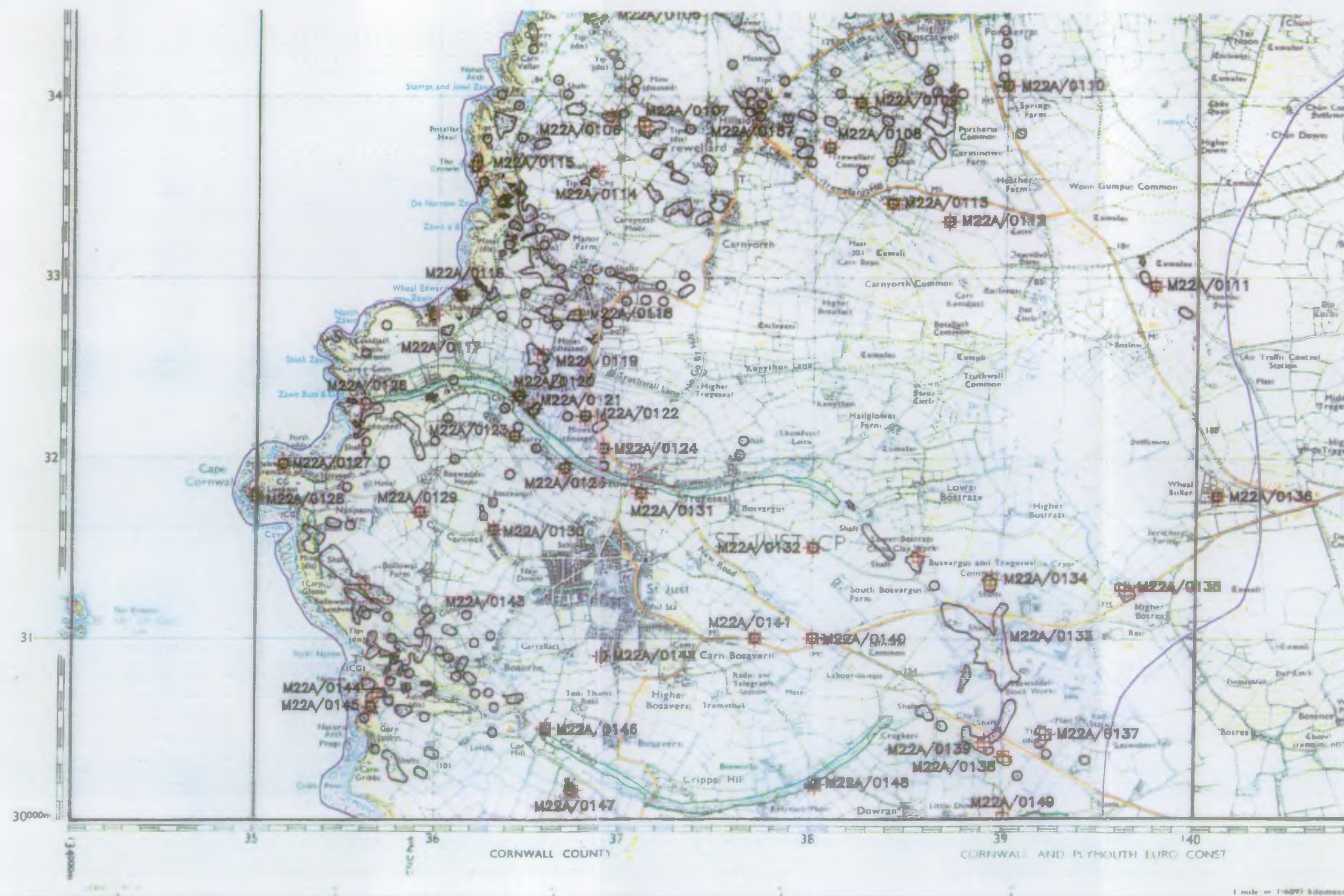
Date: 27 March 1995

Scale: Not to scale

Ref.: Figure 1

Title:

MINES DATABASE PROJECT
REGIONAL MAP



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| | | | |
|--|----------------------|---------------------|--|
|  Marcus Hodges Environment Limited Consulting Hydrogeologists and Environmental Engineers | Drawn: RK | Drafted: RK | Title: EXAMPLE OF ASSOCIATED LAND MAP |
| | Checked: [Signature] | Date: 27 March 1998 | |
| | Scale: Not to scale | Ref.: Figure 2 | |



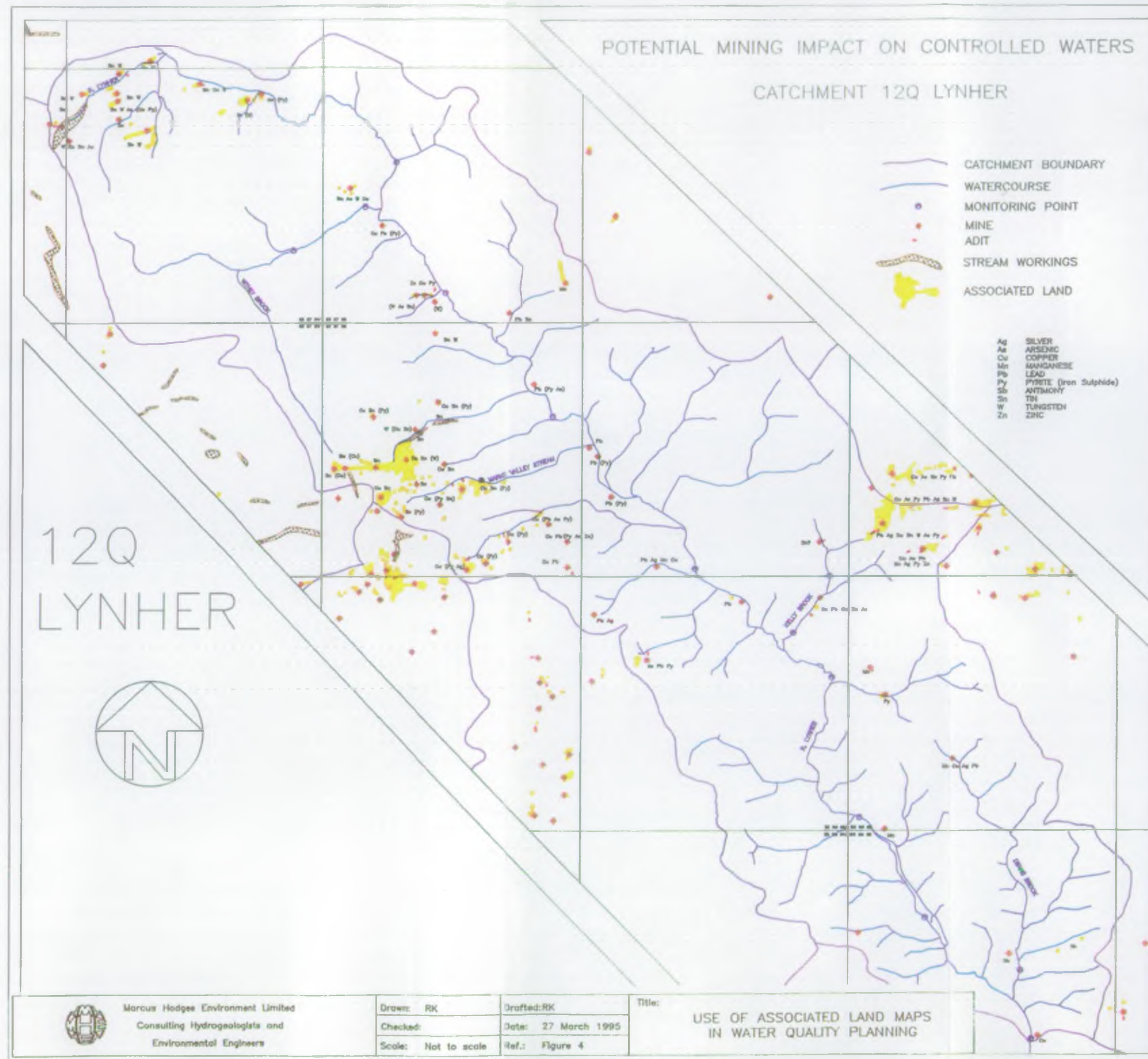
Marcus Hodges Environment Limited
Consulting Hydrogeologists and
Environmental Engineers

Drawn: HY
Checked:
Scale: Not to scale

Drafted: RKK
Date: 27 March 1995
Ref.: Figure 3

Title:

EXAMPLE OF ASSOCIATED LAND MAP
USE FOR A DETAILED SURVEY AREA



METALLIFEROUS MINES DATABASE

To: Groundwater Protection Group
NRA South Western Region
Manley House
Kestrel Way
EXETER EX2 7LQ

From:

Date:

☐ INFORMATION REQUEST

Date Required:

What is the information to be used for?:

Details of Request:

Continue on a separate sheet if necessary

☐ SUBMISSION OF ADDITIONAL INFORMATION / PROPOSED AMENDMENTS

Mine Record Number: Catchment Number/Name:

Details:

Continue on a separate sheet if necessary

For Groundwater Protection Group Use Only

Date Form Received:

Form Processed by:

on:

Post:

Date Request Completed:

Copies to Mines Database File ? :

☐ YES

☐ NO

APPENDIX 2

Metalliferous Mine Database Menu Options

Menu options

| Mines | Catchments | Reports | Maintenance | Exit |
|-------------|------------------|--------------|-------------|----------------|
| Add Mine | Add Catchment | Mines > | Backup Data | Cancel |
| Edit Mine | Edit Catchment | Catchments > | Picklists > | Quit to System |
| Delete Mine | Delete Catchment | User Defined | | |

Metals
Status
Dines Group
Parish
District Council

Set Filter
Set Order
Report Format

Mine Name
10X10 Km Square
Status
District Council
Parish
Metals Worked
Catchments:
- Surface Land
- Underground Workings
- Drainage
End Query Filter

By Name
By Record No.

Full Listing
Summary

To Screen
To Printer

Mines Data Entry and Edit Screens

Screen Page One:

| | | |
|--|--|---|
| Mine Record Number: [REDACTED] | | |
| Mine Name [REDACTED] Alternative Names [REDACTED] | | Working Dates From: [REDACTED] To: [REDACTED] |
| [REDACTED] | | Status: [REDACTED] |
| Dines Group: [REDACTED] | | |
| Metals Worked [REDACTED] | NGR Principal Point: [REDACTED] Parish: [REDACTED] District Council: [REDACTED] Principal Point Catchment: [REDACTED] | |
| Catchments: | | |
| Surface Land [REDACTED] | Underground Workings [REDACTED] | Drainage [REDACTED] |

Mine Entry / Edit Screen Layout

Screen Page Two

| | | | | | |
|---|--|-------------------------------------|--|---|--|
| 1. Location | | 2. Mineralisation | | 3. Mine History | |
| 4. Associated Mines | | 5. Recorded Outputs | | 6. Mine Description - Surface Workings | |
| 7. Mine Description - Underground Workings | | 8. Mine Drainage | | 9. Associated Land Description | |
| 10. Potential Contamination | | 11. Proximity to Water Interests | | 12. Investigation | |
| 13. Monitoring | | 14. Impact | | 15. Notes | |
| 16. Materials Referenced | | | | | |
| Press F9 to Expand / Close Memo Fields | | | | | |

Catchment Records

Screen Design - Add / Edit functions

| | | |
|--|----------------------|-------------------------------|
| Sub-catchment Name: <input type="text"/> | | |
| Sub-catchment Number: <input type="text"/> | | |
| 1. Hydrology | <input type="text"/> | 2. Geology and Mineralization |
| 3. Hydrogeology | <input type="text"/> | |
| 4. Mine Locations | <input type="text"/> | 5. Catchment Studies |
| 6. Mining Impact on catchment | <input type="text"/> | |
| 7. Mine Drainage Discharge points within catchment | <input type="text"/> | |
| Press F9 to Expand / Close Memo Fields | | |

APPENDIX 3

Examples of Mines Database Output

M I N E S D A T A B A S E

15/03/94

A Summary listing of

Mines

filtered on

Drainage Catchment in 12Q.

| Reference | Primary Name | NGR Principal Point |
|-----------|-------------------------------|---------------------|
| M12B/0001 | LADY ASHBURTON | SX 3682 7020 |
| M12B/0003 | SOUTH KITHILL | SX 3743 7094 |
| M12E/0001 | HOLMBUSH | SX 3579 7202 |
| M12E/0003 | KITHILL | SX 3736 7143 |
| M12Q/0001 | GLASGOW CARADON CONSOLS | SX 2879 7021 |
| M12Q/0002 | SLADE | SX 2974 7018 |
| M12Q/0003 | BICTONWOOD | SX 3140 7019 |
| M12Q/0004 | TOKENBURY | SX 2862 7068 |
| M12Q/0005 | PENHARGET | SX 2974 7068 |
| M12Q/0006 | CARGIBBITT | SX 2939 7103 |
| M12Q/0007 | JENKIN | SX 2655 7118 |
| M12Q/0008 | WEST ROSEDOWN | SX 2731 7142 |
| M12Q/0009 | CARADON WOOD | SX 3055 7157 |
| M12Q/0010 | SOUTH PHOENIX | SX 2616 7157 |
| M12Q/0011 | MARKE VALLEY | SX 2773 7173 |
| M12Q/0012 | DUNSLEY WHEAL PHOENIX | SX 2686 7183 |
| M12Q/0013 | WEST PHOENIX | SX 2524 7213 |
| M12Q/0014 | WITHYBROOK | SX 2545 7214 |
| M12Q/0015 | STOWES | SX 2605 7215 |
| M12Q/0016 | PHOENIX UNITED | SX 2664 7231 |
| M12Q/0017 | EAST PHOENIX | SX 2739 7222 |
| M12Q/0018 | BENEATHWOOD | SX 3030 7235 |
| M12Q/0019 | PLUSHABRIDGE | SX 3013 7254 |
| M12Q/0020 | STANBEAR COTTAGE | SX 2682 7291 |
| M12Q/0021 | WEST SHARPTOR | SX 2600 7315 |
| M12Q/0022 | DARLEY | SX 2726 7345 |
| M12Q/0023 | KINGBEAR | SX 2720 7480 |
| M12Q/0024 | MIDDLEWOOD | SX 2719 7543 |
| M12Q/0025 | BERIOW | SX 2700 7554 |
| M12Q/0026 | HAWKS WOOD | SX 2690 7554 |
| M12Q/0027 | LUSKEY | SX 2616 7692 |
| M12Q/0028 | TREBARTHA LEMARNE | SX 2553 7765 |
| M12Q/0029 | CANNAFRAME | SX 2006 7858 |
| M12Q/0030 | HALVANA | SX 2155 7881 |
| M12Q/0031 | TREGUNE | SX 2256 7973 |
| M12Q/0032 | VINCENT | SX 2098 7933 |
| M12Q/0033 | WILHELMINA | SX 2096 7952 |
| M12Q/0034 | ANNIE | SX 2351 7937 |
| M12Q/0035 | TREBURLAND MANGANESE DEPOSITS | SX 2380 7950 |
| M12Q/0036 | HENDRA | SX 2030 7950 |
| M12Q/0037 | TREWINT | SX 2100 7990 |
| M12Q/0038 | EAST CARADON | SX 2782 7013 |
| M12Q/0039 | JANE | SX 1980 7890 |
| M12Q/0040 | TREWINT MARSH | SX 2160 8015 |
| M12Q/0041 | OAKBOTTOM STREAM WORKS | SX 2743 7306 |
| M12Q/0042 | DARLEY STREAM WORKS | SX 2692 7284 |
| M12Q/0043 | COADS GREEN | SX 2969 7578 |
| M12Q/0044 | RODD | SX 2864 7519 |
| M12Q/0045 | WESTCOTT | SX 2910 7379 |
| M12Q/0046 | WEST HOLMBUSH | SX 3542 7175 |
| M12Q/0047 | KELLY BRAY | SX 3618 7141 |
| M12Q/0048 | REDMOOR | SX 3562 7104 |
| M12Q/0049 | BLOGSTERS | SX 3444 7066 |
| M12Q/0050 | FLORENCE | SX 3637 7055 |
| M12Q/0051 | IDA | SX 3024 6924 |
| M12Q/0052 | NEW TRELAWNY | SX 3123 6835 |
| M12Q/0053 | APPLEDORE | SX 3299 6950 |

| Reference | Primary Name | NGR Principal Point |
|-----------|---------------|---------------------|
| 12Q/0054 | COOMBELAWN | SX 3446 6958 |
| M12Q/0055 | PENCREBAR | SX 3540 6820 |
| M12Q/0056 | COLQUITE | SX 3568 6766 |
| 12Q/0057 | BEALBURY | SX 3695 6641 |
| M12Q/0058 | TORWOOD | SX 3568 6503 |
| M12Q/0059 | HOLWOOD | SX 3520 6300 |
| 12Q/0060 | LEIGH | SX 3802 6259 |
| 12Q/0061 | NOTTER | SX 3860 6100 |
| M12Q/0062 | MILLPOOL | SX 0 0 |
| M12Q/0063 | PIXON | SX 0 0 |
| 12Q/0064 | BARNES | SX 0 0 |
| M12Q/0065 | MESSENGER | SX 2100 7900 |
| M12Q/0066 | HOWTON | SX 3750 6325 |
| 15B/0001 | DOROTHY | SX 1967 7891 |
| 15B/0006 | SILVER VALLEY | SX 2532 7155 |

M I N E S D A T A B A S E

15/03/94

A half listing of

Mines

filtered on

Mine name is DEVON GREAT CONSOLS.

| | | |
|-------------|--------------|---------------|
| Mine Record | Primary Name | NGR Reference |
| M12E/0032 | WATSONS | SX 4390 7305 |

| | |
|--------------|---------|
| Worked From | Status |
| 1845 To 1906 | DISUSED |

Dines Group
CALLINGTON AND TAVISTOCK: LUCKETT, LATCHLEY & DEVON GREAT CONSOLS

| | |
|-------------------|------------------|
| Parish | District Council |
| TAVISTOCK HAMLETS | WEST DEVON |

| | |
|---------------------|---------------|
| Alternative Name | Metals Worked |
| DEVON GREAT CONSOLS | COPPER |

Catchments

| | | |
|--------------------|------------------------|---------------------|
| Surface Catchments | Underground Catchments | Drainage Catchments |
| 12E | 12E | 12E |

| | | |
|-------------|--------------|---------------|
| Mine Record | Primary Name | NGR Reference |
| M12E/0033 | EMMA | SX 4386 7369 |

| | |
|--------------|---------|
| Worked From | Status |
| 1856 To 1878 | DISUSED |

Dines Group
CALLINGTON AND TAVISTOCK: LUCKETT, LATCHLEY & DEVON GREAT CONSOLS

| | |
|-------------------|------------------|
| Parish | District Council |
| TAVISTOCK HAMLETS | WEST DEVON |

| | |
|---------------------|-------------------|
| Alternative Name | Metals Worked |
| DEVON GREAT CONSOLS | COPPER ARSENIC |

Catchments

| | | |
|--------------------|------------------------|---------------------|
| Surface Catchments | Underground Catchments | Drainage Catchments |
| 12E | 12E | 12E |

Mine Record . Primary Name
12E/0034 JOSIAH

NGR Reference
SX 4303 7366

Worked From Status
1845 To 1908 DISUSED

Mines Group
CALLINGTON AND TAVISTOCK: LUCKETT, LATCHLEY & DEVON GREAT CONSOLS

Parish District Council
TAVISTOCK HAMLETS WEST DEVON

Alternative Name Metals Worked
DEVON GREAT CONSOLS

COPPER
ARSENIC
TIN

Catchments

| Surface Catchments | Underground Catchments | Drainage Catchments |
|--------------------|------------------------|---------------------|
| 12E | 12E | 12E |

Mine Record Primary Name
M12E/0035 ANNA MARIA

NGR Reference
SX 4268 7364

Worked From Status
1832 To 1908 DISUSED

Mines Group
CALLINGTON AND TAVISTOCK: LUCKETT, LATCHLEY & DEVON GREAT CONSOLS

Parish District Council
TAVISTOCK HAMLETS WEST DEVON

Alternative Name Metals Worked
DEVON GREAT CONSOLS

COPPER
ARSENIC
TIN

Catchments

| Surface Catchments | Underground Catchments | Drainage Catchments |
|--------------------|------------------------|---------------------|
| 12E | 12E | 12E |

| | | |
|-------------|-------------------|---------------|
| Mine Record | Primary Name | NGR Reference |
| M12E/0036 | SOUTH WHEAL FANNY | SX 4258 7286 |

| | |
|--------------|---------|
| Worked From | Status |
| 1845 To 1930 | DISUSED |

Dines Group
CALLINGTON AND TAVISTOCK: LUCKETT, LATCHLEY & DEVON GREAT CONSOLS

| | |
|-------------------|------------------|
| Parish | District Council |
| TAVISTOCK HAMLETS | WEST DEVON |

| | |
|------------------|---------------|
| Alternative Name | Metals Worked |
|------------------|---------------|

| | |
|---------------------|--------------------------|
| DEVON GREAT CONSOLS | COPPER TIN ARSENIC |
|---------------------|--------------------------|

Catchments

| | | |
|--------------------|------------------------|---------------------|
| Surface Catchments | Underground Catchments | Drainage Catchments |
| 12E | 12E | 12E |

| | | |
|-------------|--------------|---------------|
| Mine Record | Primary Name | NGR Reference |
| M12E/0038 | FANNY | SX 4212 7370 |

| | |
|--------------|---------|
| Worked From | Status |
| 1845 To 1923 | DISUSED |

Dines Group
CALLINGTON AND TAVISTOCK: LUCKETT, LATCHLEY & DEVON GREAT CONSOLS

| | |
|-------------------|------------------|
| Parish | District Council |
| TAVISTOCK HAMLETS | WEST DEVON . |

| | |
|------------------|---------------|
| Alternative Name | Metals Worked |
|------------------|---------------|

| | |
|--------------------------------|-------------------|
| DEVON GREAT CONSOLS FORTUNE | COPPER ARSENIC |
|--------------------------------|-------------------|

Catchments

| | | |
|--------------------|------------------------|---------------------|
| Surface Catchments | Underground Catchments | Drainage Catchments |
| 12E | 12E | 12E |

Mine Record Primary Name NGR Reference
12E/0039 MARIA SX 4180 7391

Worked From Status
1844 To 1923 DISUSED

Mines Group
CALLINGTON AND TAVISTOCK: LUCKETT, LATCHLEY & DEVON GREAT CONSOLS

Parish District Council
TAVISTOCK HAMLETS WEST DEVON

Alternative Name Metals Worked
DEVON GREAT CONSOLS COPPER
ARSENIC

Catchments

| Surface Catchments | Underground Catchments | Drainage Catchments |
|--------------------|------------------------|---------------------|
| 12E | 12E | 12E |

Mine Record Primary Name NGR Reference
12E/0061 DEVON GREAT CONSOLS SX 4302 7366

Worked From Status
1832 To 1930 DISUSED

Mines Group
CALLINGTON AND TAVISTOCK: LUCKETT, LATCHLEY & DEVON GREAT CONSOLS

Parish District Council
TAVISTOCK HAMLETS WEST DEVON

Alternative Name Metals Worked
MARIA COPPER
FANNY ARSENIC
JOSIAH PYRITE

MMA
NNA MARIA
SOUTH WHEAL FANNY
WATSONS
AWDENS

Catchments

| Surface Catchments | Underground Catchments | Drainage Catchments |
|--------------------|------------------------|---------------------|
| 12E | 12E | 12E |

M I N E S D A T A B A S E

29/03/94

A full listing of

Mines

filtered on

Mine number is M12Q/0048.

Mine Record Primary Name
M12Q/0048 REDMOOR

NGR Reference
SX 3562 7104

Worked From Status
1843 To 1914 DISUSED

Dines Group
CALLINGTON AND TAVISTOCK: KIT HILL

Parish District Council
CALLINGTON CARADON

| Alternative Name | Metals Worked |
|-------------------------------|---------------|
| CALLINGTON UNITED | LEAD |
| EMMENS UNITED | SILVER |
| EAST CORNWALL UNITED | COPPER |
| REDMOOR CONSOLS | TIN |
| CALLINGTON CONSOLIDATED MINES | TUNGSTEN |

Catchments

| Surface Catchments | Underground Catchments | Drainage Catchment |
|--------------------|------------------------|--------------------|
| 12Q | 12Q 12E | 12Q |

Location

1.5km NNW of Callington. The mine is in the triangle of land between Redmoor Road, South Hill Road and the A388 Launceston Road. 500m SW of Kelly Bray Post Office.

Mineralisation

The lodes are developed in Upper Devonian slate. The main lodes are Johnsons, Vivians and Great South Lode. A group of five small lodes, Martins, Reeds, James and Hockins are north of Redmoor Road. Lead lode is the same crosscourse lode which runs through Kelly Bray and Holmbush mines. Johnsons lode is 4.5 feet wide and carries arsenic, tin and some wolfram. Great South Lode and Vivians Lode are believed to contain arsenic and tin. Little is known about Martins, Reeds, James and Hockins. No. 1 lode, No. 2 lode and North Lode were encountered in an exploratory crosscut adit of 1935. These contain a lot of pyrite and also arsenopyrite, chalcopyrite and chlorite. Underground exploration and sampling has occurred on several other lodes since 1945. Lead Lode contains quartz, galena, pyrite and siderite.

Mine History

Patchy details

1837 - possible Collins reference to Redmoor Consols
1874 - Emmens United
1881 - Not worked
1885-1886 - Not worked
1888-1893 - Callington United
1910 - Not worked
1935 - exploration work
1934-1935 - Known as East Cornwall United
1945 - Exploration work
1934-1944 - Callington Consolidated Mines - reworking of Redmoor

Associated Mines

Holmbush SX 3579 7202, M12Q/0001
West Holmbush SX 3542 7175, M12Q/0046
Kelly Bray SX 3618 7141, M12Q/0047

Recorded Outputs

1858-1860 and 1883-1884 : 217 tons 54% lead ore
1858-1860 and 1883 : 9170 ozs silver
1862, 1873, 1878 and 1883-1884 : 325 tons of 2% copper ore
1869-1873, 1878, 1883 and 1907 and 1913 : 260 tons black tin
1907 : 2.5 tons wolfram
1878 : 7.75 tons argentiferous copper precipitate

Combined Production of Holmbush/Kelly Bray/Redmoor

As Emmens United : 1874-1876 : 2.5 tons black tin
714 tons 3% copper ore
As Callington United : 1889 : 250 tons black tin,, 2550 tons copper
ore, 1326 ozs silver

Mine Description - Surface Works

shafts, tips, surface works etc.

Mine Description - Underground Works

The main shaft is Johnsons Shaft (SX 3562 7104) which is sunk to about 50m below adit (adit level is 18m bgl). Johnsons Lode is stoped between the 10fm level and 125fm level (18m - 228m below adit) for a distance of 85m east and 165m west of Johnsons Shaft. Little is known about Great South Lode apart from the fact that adit level has been driven along some of its length. Lead Lode has been stoped to 112 level (205m below adit) throughout the whole sett and through the Kelly Bray and Holmbush Setts. A lot of underground exploration work was carried out at Redmoor during the first half of the 20th Century. A crosscut adit was driven 380m north into the ground north of Redmoor Road. Work only seems to have been done on adit level - exploration only - no production. In 1943 an old shaft was reopened in this northern section. Again some explorative development was undertaken, but no actual production.

Mine Drainage

Depp adit level starts 230m SW of Johnsons Shaft, near to Little Earland (approx. NGR SX 355 709). This is driven 330m east along Great South Lode then 180m north, joining Lead Lode. Adit level follows Lead Lode north, and eventually connects with Kelly Bray Deep adit.

Associated Land Description

Extensive area of associated land to the north and south of Redmoor Road, between South Hill Road and the A388 Launceston Road. The area is visible on the 1907 Geological Map and the 1983 OS map.

Potential Contamination

Copper, arsenic, lead, iron, (sulphides), pyrite.

Proximity of Water Interests

Tributary of Haye Valley Stream rises in the associated land, fed by adit drainage.

Investigation

Covered by Reconnaissance Survey - R. Knott 1989

Monitoring

Impact

Notes

Materials Referenced

Dines, H. G. 1956

Burt, R. et al 1987

OS 1:10,000 Sheet SX 37 SE

BGS County Series Geological Sheet Cornwall 29NW 1907

Knott, R. 1989. unpublished MSc

M I N E S D A T A B A S E

31/03/94

A Summary listing of

Catchments

filtered on

Catchment 12Q.

| Catchment Reference | Name |
|------------------------|--------|
| 12Q | LYNHER |

1. Hydrology

The River Lynher rises on East Moor of Bodmin Moor (260m AOD) near Trewint (SX 22 80). The river flows south-east until reaching Notter Bridge (SX 3860) where it heads south and flows into the estuary. The length of the River Lynher from source to tidal limit is 34.8km. The catchment area is 153.8km sq.

Water Quality is monitored at 8 locations on the River Lynher. Moving down the catchment four tributaries of the Lynher are monitored. Withey Brook (7.5km), Marke Valley Stream (4.1km), Kelly Brook (3km) and Dean's Brook (6.5km).

Overlying the Bodmin Moor Granite is a peaty soil which supports low density beef and sheep farming. The river has cut a steep sided valley into the Devonian deposits further down the catchment. The valley sides are usually wooded with arable farming being undertaken on the more gentle higher slopes.

Principal settlements within the catchment are North Hill, Rilla Mill, Callington, Pillaton and Landrake.

2. Geology and Mineralisation

The sediments of the Lynher catchment are Devonian in age, and originally consisted of muds and some sands. This terrigenous material was derived from the erosion of a more northerly land mass and then deposited in a deep marine environment. In addition to the sedimentary rocks, there are also contemporaneous basic lava flows and minor basic intrusions.

This volcano-sedimentary pile was heavily deformed; suffering regional metamorphism and several phases of intense folding and thrusting during the Variscan Orogeny. This resulted in a sequence of slaty mudstones/shales with subordinate grits (locally known as killas) and conglomerates and occasional 'greenstones' (meta-basic volcanics: diabase).

The Bodmin Moor Granite intrusion was emplaced about 290-280 Ma BP, at the end of the Carboniferous period. This resulted in thermal contact metamorphism of the country rocks close to the igneous intrusion. The increased thermal heat flow allowed remobilisation of existing metallic elements. Hydrothermal mineralising fluids transported and deposited these elements, generally in high angle fissure lodes.

The River Lynher flows off the granite and cuts a channel into slates and thin limestones of Upper Devonian age. Diabase igneous intrusions trend northwest - southeast and elvan dykes course east-west. Near Callington the river crosses younger shales grits and cherts of Carboniferous age. Below Pillaton (SX 36 64) to the tidal limit the river flows along a valley cut into Upper Devonian slates with contemporaneous volcanic rocks.

The Dines 'North Hill' area embraces the north-east part of the Bodmin Moor granite where the Lynher rises. With only a few exceptions all the

mines of this area are located in the granite. Greisenisation and tourmalinisation has occurred along fissures and joints, some of which are filled with quartz or quartz-tourmaline, occasionally carrying some cassiterite, wolfram and arsenopyrite.

The main mining area within the catchment is situated on the south east flank of the Bodmin Moor granite, referred to by Dines as the Phoenix Group. The granite margin is crossed by a series of east-west faults. In many cases the faults are occupied by lodes. The Phoenix area produced tin and some copper. The ore minerals at Marke Valley mine were chalcopyrite, with some melaconite and occasional small bunches of cassiterite.

Lodes worked around the Kit Hill cupola trend east - west. Cassiterite is present in the lodes, and wolfram is widely distributed not only in the tin lodes, but in narrow quartz veins or stringers in greisenised granite and killas. Copper lodes are worked to the south and west of Kit Hill and are usually accompanied by arsenopyrite and pyrite in a quartz-chlorite gangue.

3. Hydrogeology

Intergranular flow will occur in the regolith. Flow in the unweathered granites, Carboniferous shale and Devonian slate will be predominantly via fractures. The groundwater surface is assumed to follow the catchment topography. The presence of underground mine workings and drainage adits will have a significant local effect on groundwater flow directions and discharge points. Consequently any collapse/blockage within the mine system may alter flow paths and discharge points.

Groundwater within the catchment is likely to supply a large number of dwellings with potable water via boreholes, wells and springs.

4. Mine locations

At the head waters of the River Lynher a cluster (9) of mines work tin and tungsten lodes. Moving down the catchment a few mines (6) are located along the Lynher working lodes on the granite boundary.

The main mining location within the catchment is west of Rilla Mill on the south-eastern corner of the Bodmin Moor Granite. North of Callington five mines are identified situated south-east of Kit Hill.

The remaining mines are scattered throughout the southern half of the catchment.

5. Catchment studies

River Lynher Catchment River Water Quality Classification 1991.
WQP/92/0016, April 1992.

6. Mining impact on catchment

The levels of copper and zinc at the Trebartha Road Bridge sampling point, monitoring the upper reach of the Lynher, meets 1A criteria.

Levels of copper and zinc discharging to the Lynher from the Withey Brook meet 1A criteria, as does the Lynher's quality, measured at Berriowbridge, below the Withey Brook confluence.

The quality, with respect to copper deteriorates at the next Lynher monitoring point at Rilla Mill, with class 2 being attained. Above Rilla Mill two streams draining the south east corner of Bodmin Moor confluence with the Lynher. It is likely that these waters (not monitored) are receiving drainage from the Phoenix United area (M12Q/0016) with an adit portal at SX 2630 7237.

Below Rilla Mill the Marke Valley Stream confluent with the Lynher. Levels of copper and zinc in the stream means the stream quality is classified 3. Statistical analysis of the data set gives a copper 95% ile 0.38 mg/l and a zinc 95% ile 1.3 mg/l. The contamination source is drainage from the mines on the edge of the granite, at the head of the Marke Valley catchment. The locations of adit portals from three of these mines are known. These are: Jenkin (0007), West Rosedown (0008) and Dunsley Wheal Phoenix (0012).

The next downstream Lynher monitoring point is at Bicton Mill Bridge. Copper levels at Bicton remain elevated, class 2 is recorded.

Prior to the next monitoring point i.e. Newbridge the Kelly Brook discharges to the Lynher. The Kelly Brook is monitored at two locations. The 95% ile levels of copper and zinc monitored at the lower reaches sampling point mean the brook is classified 2. The Kelly Brook receives drainage from the Kit Hill mining area.

Monitoring of the Lynher at Newbridge and downstream of Pillaton Bridge indicates class 2 levels of copper. Levels of zinc at these two locations also reach class 2 levels, presumably an effect of the Kelly Brook discharge.

The Deans Brook has its confluence with the Lynher 1km upstream of the last Lynher monitoring point at Notter Bridge. Deans Brook meets the 1A criteria, with regard to copper and zinc.

Levels of zinc at the last Lynher monitoring point at Notter Bridge meet 1A criteria, a result of dilution from Dean's Brook. The 95% ile levels of copper is also markedly reduced, however the concentration is sufficient to attain class 2.

The mine drainage from the Phoenix and Kitt Hill areas are clearly impacting upon the Lynher's water quality.

7. Mine drainage discharge points

| Description | NGR | Mine Name | MRN |
|---|--------------|--------------------------|------|
| ----- | --- | ----- | --- |
| Adit Portal | SX 2983 7009 | Slade | 0002 |
| Crosscut Adit Portal | SX 2855 7080 | Tokenbury | 0004 |
| Adit Portal | SX 267 714 | Jenkin | 0007 |
| 2 Main Adits; Deep at NGR Shallow opens 130m SSE of deep portal. | SX 2745 7165 | West Rosedown | 0008 |
| Adit Portal | SX 2755 7185 | Dunsley Wheal Phoenix | 0012 |
| Adit Portal | SX 2630 7335 | Stowes | 0015 |
| Adit Portal | SX 2630 7237 | Phoenix United | 0016 |
| Adit Portal | SX 2644 7244 | Phoenix United | 0016 |

| | | | |
|--|--------------|-------------------|------|
| Adit Portal (600m east of Morris Shaft) | SX 2630 7315 | West Sharptor | 0021 |
| Adit Portal (Approx) | SX 2725 7305 | East Sharptor | 0022 |
| Adit Portal (Approx) 273m NNW of Kingbear Farm | SX 272 751 | Kingbear | 0023 |
| Adit Portal 6m above level of River Lynher | SX 2616 7692 | Luskey | 0027 |
| Deep Adit Portal 34m west of Kemp Thorne Shaft | SX 2553 7765 | Trebartha-Lemarne | 0028 |
| Shallow Adit commences at Rodd's Shaft | " " | " " | |
| Adit Portal | SX 226 797 | Tregune | 0031 |
| Adit Portals | SX 238 795 | Treburland | 0035 |
| Two Adits driven south west into Hendra Down | SX 203 795 | Hendra | 0036 |
| Adit Portal | SX 2015 7990 | Trewint | 0037 |
| Adit Portal | SX 2787 7034 | East Caradon | 0038 |