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2004 G-BASE Field Procedures Manual

Economic Minerals and Geochemical Baseline Programme

Internal Report IR/04/134

BRITISH GEOLOGICAL SURVEY

ECONOMIC MINERALS AND GEOCHEMICAL BASELINE PROGRAMME

INTERNAL REPORT IR/04/134

2004 G-BASE Field Procedures Manual

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Foreword

The G-BASE project has spanned more than four decades and remains one of BGS's primary survey programmes in the United Kingdom. The key to the project's success lies in the reliability and high quality of data produced which has been consistent over a long period of time covering changes in personnel and strategies. This has been achieved by following the procedures detailed here, which, with regular recorded updates, also serves as a means of monitoring changes as the project evolves. Although written essentially as instructions for internal use within BGS this manual will also act as a guidebook for regional geochemical mapping worldwide.

Dr C C Johnson
G-BASE Project Manager
August 2004

Acknowledgements

This manual has been compiled by the G-BASE project team and is based on procedures which have evolved since the geochemical mapping started at the end of the 1960's. Much of it is based on protocols written by Dee Flight during the 1990s. We acknowledge the input of previous G-BASE team workers and those under its previous guises as the GSP (Geochemical Survey Programme) and the Regional Geochemical Reconnaissance Programme. Not least we acknowledge the hundreds of volunteer student workers who over many years have been the principal agents in carrying out the procedures described here.

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Summary

The G-BASE project is a long-term systematic geochemical survey that has required a high degree of consistency in its sampling methodologies. This report gives in detail all the project procedures associated with the collection of geochemical samples from the planning phase in the office through to sample reception and reporting of the completed field campaign. The procedures described here should be diligently followed in order to maintain the high levels of quality control the project aspires to. Any changes to procedures are indicated in the latest version of this manual and documented in an updates list in Appendix J.

In addition to describing all the fieldwork procedures, the recruitment and training of "voluntary" student workers is described along with discussions relating to health and safety issues likely to be encountered during sampling.

When describing the methods used by G-BASE in reports or publications, reference should be made to this manual.

1 Introduction

The Geochemical Baselines Survey of the Environment (G-BASE) project is a systematic high-resolution survey to establish a geochemical baseline across the United Kingdom. In 1968 the Institute of Geological Sciences (IGS) (now the British Geological Survey, BGS) began a regional geochemical sampling programme in the northern Highlands of Scotland. This work was aimed at producing maps to show the distribution of trace elements in stream sediments. Prior to this, earlier geochemical studies were mainly involved with uranium reconnaissance work, a programme supported by the UK Atomic Energy Authority (1967 –1972).

The establishment of a Geochemistry Division on 1st August 1967 was the step that initiated the regional geochemical mapping programme. Funded by the Department for Trade and Industry (DTI) the project in the early 1970's was known as the Regional Geochemical Reconnaissance Programme and was closely associated with the work of the DTI Mineral Reconnaissance Programme. The project was then based in the Radioactive and Metalliferous Minerals Unit. The earliest samples were collected from the Sutherland atlas area in the summer of 1968 as part of the uranium reconnaissance work. The first systematic sampling for the regional geochemistry started in Orkney and Shetland in the summer of 1970. The work has progressed southwards from northern Scotland ever since. The first geochemical data from the regional survey of northern Scotland was placed on open file in 1972 for the Caithness quarter inch Geological map sheet area.

A further reorganisation of the IGS saw the creation of a Special Surveys Division in 1977 and the Regional Geochemical Reconnaissance Programme became a major project within the Metalliferous Minerals and Applied Geochemistry Unit. Work on the Orkney and Shetland geochemical atlases commenced in 1974 and the Shetland atlas was the first to be published in 1978. Between 1975 and 1990 the work was funded by the UK Department for Trade and Industry (DTI). After 1990 funding for the work came from the Department of Education and Science and subsequently, the Office of Science and Technology. The project was renamed the Geochemical Survey Programme (GSP) in 1988 and again in 1994 to the Geochemical Baselines Survey of the Environment Project (G-BASE).

Under the reorganisation of BGS in 2000 the project was placed in the Lands and Resources Directorate and is currently managed within the Economic Minerals and Geochemical Baseline (EMGB) Programme.

This manual relates to the procedures employed in collecting the geochemical samples. It supersedes all previous manuals the last of which was an unpublished "G-BASE Field Procedures Manual 2000" produced by Bob Lister that had been derived from the draft G-BASE Field Procedures Manual written by Flight and Lister in June 1998 as an unclassified report in the Applied Geochemistry Report Series (Flight and Lister, 1998).

The manual is written in sections and any changes to procedures will be inserted as updates. An update history is found at the back of this report (Appendix J) and the footer details the version number and date for each section.

2 G-BASE Sampling Strategy

The basic sampling methodology has developed from that described by Plant (1971) and the organisational aspects of the sampling programme from Plant and Rhind (1974). Drainage samples have been the primary material collected for producing geochemical maps as sediments from low order streams have demonstrably been a very effective "average" representation of large areas of drainage catchment. The regional geochemical mapping strategies employed by G-BASE in the UK have successfully been transferred to numerous geochemical surveys around the world (e.g. Sumatra, Indonesia (Machali et al, 1997); Hong Kong (Sewell, 1999); and Morocco, (Johnson, 2001)). G-BASE procedures have been incorporated into international initiatives and some of the G-BASE methodology has been modified to correspond to international standards of geochemical mapping (Darnley et al, 1995 and Salminen et al, 1998).

The sampling strategy has evolved since the inception of the project to reflect:

- the shift from mineral exploration to environmental issues
- the improved methods of chemical analysis that allow the low concentrations of elements found in stream waters to be determined
- the collection of soil samples in areas where there is no surface drainage (e.g. limestone areas), or low drainage density e.g. flat, low lying areas.
- the collection of soil samples from urban areas to reflect the demand for data for areas where most of the population is based
- the collection of soil samples from rural areas where the drainage system has been extensively modified by intensive agriculture.

A summary of samples collected by the G-BASE project is given in Table 2-1. The location of all G-BASE samples collected is given in the BGS GeoScience data index[1].

In-field quality assurance (QA) and quality control (QC) measures have always been afforded the highest priority (Plant, 1973 and Plant et al, 1975). Procedures described in this manual are part of the QA and are to be strictly followed. Procedures are enforced by strict supervision by team leaders, regular monitoring by managers and discussion at biannual project meetings. The process is to be further enhanced with the introduction of a post-field campaign report (described in Section 18).

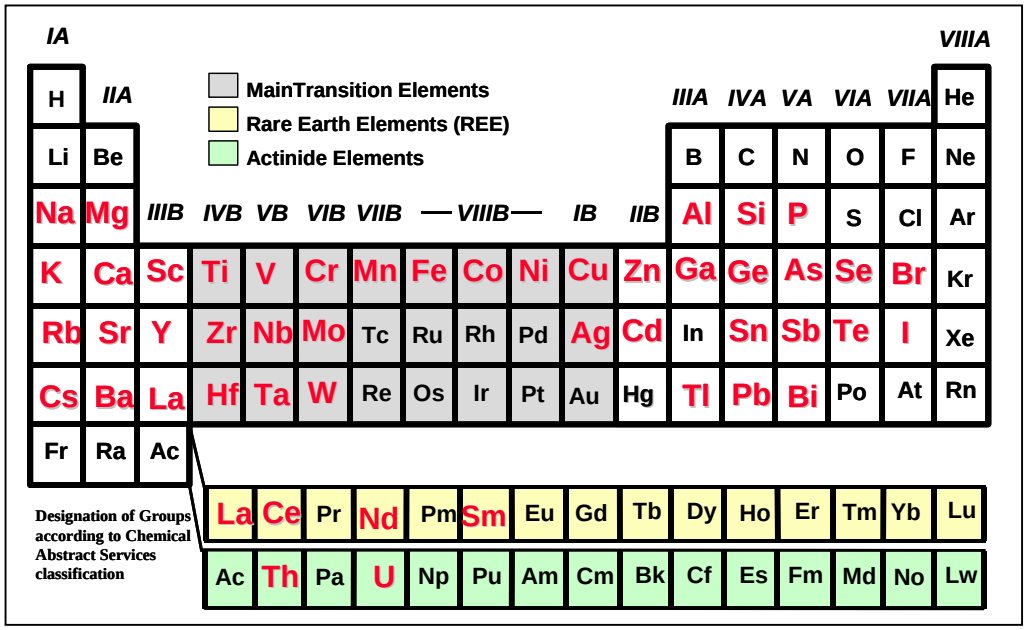
A central part of the strategy is the employment of students (of Earth or Environmental Sciences) referred to as voluntary workers (VW) to make up field sampling teams of normally four sampling pairs. They are not paid a wage but are provided with accommodation and a per diem which in 2003 was increased to £25. These form four sampling pairs on a daily basis and are supervised by one experienced BGS field geochemist (team leader) and one or two support staff (assistant team leaders). This provides a cost effective way of collecting samples and provides university graduates with valuable geochemical sampling experience. The number of support staff depends on the experience of the BGS personnel. The optimum is a BGS staff member as assistant team leader and an experienced VW who will fill the role of a SVW ("super voluntary worker").

[1] http://www.bgs.ac.uk/geoindex/home.html

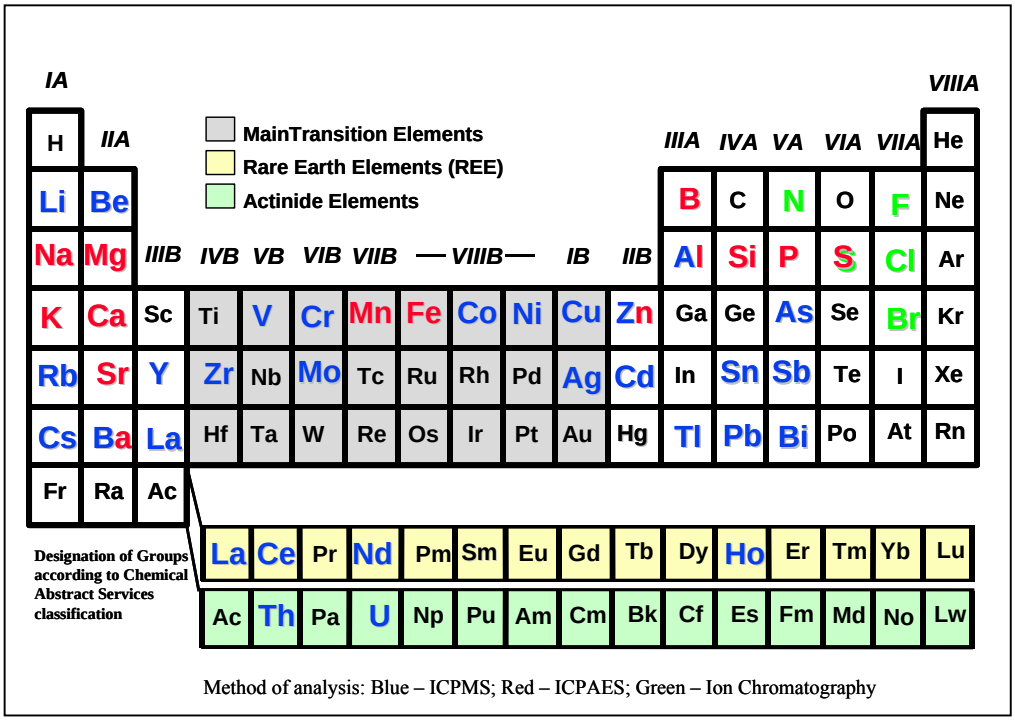
Sample Type	*Sample Code*	*Density of sampling (1 sample/km^2)*	*Description*
Stream Sediment	C	1.5 - 2.0	Fine stream sediment wet sieved at site to <150µm collected from low order (i.e. smallest) streams. Routinely analysed by XRF (see Figure 2-1 for elements determined).
Panned Concentrate	P	1.5 - 2.0	<2mm sediment from drainage site panned in wooden dulang-style pan. 3-5 kg of sediment (a full pan) is panned until 20-40g of heavy minerals remain. Inspected at site with a hand lens. Not routinely analysed.
Stream water	W	1.5 - 2.0	Collected from site of C and P samples. Four samples are collected at each site for: (i) pH; (ii) alkalinity and conductivity; (iii) filtered/unacidified for 7 anions and NPOC (labelled 'F/UA'); and (iv) filtered/acidified for ICP-AES and ICP-MS (labelled 'F/A') (see Figure 2-1 for elements determined).
Surface soil	A	2.0	Collected to a depth of 20 cm using a hand held Edelmen soil auger with a 15 cm flight length and a composite of 5 samples collected at points on a 20 x 20 m square. Where present (e.g. grassland) the surface organic litter and root-zone (0-5 cm) is removed. Dried, disaggregated and sieved in the laboratory to < 2mm. Routinely analysed by XRF (see Figure 2-1 for elements determined).
Deep soil	S	2.0	Collected to a depth of 50 cm (i.e. sample from 35 – 50 cm) using hand held Edelmen soil auger with a 15 cm flight length and a composite of 5 samples collected at points on a 20 x 20 m square (using same auger holes as A sample). Dried, disaggregated and sieved in the laboratory to <2 mm. Stored for future reference. Not routinely analysed.

Table 2-1: Summary of sample types collected by G-BASE. Note that, generally, in urban areas only soils are collected at a density of 4 samples per km^2. An expanded version of this table is given in Appendix I.

The sampling campaign normally takes place during the summer months to correspond to the student summer vacation. The duration of a field campaign and the number of sampling teams deployed depends on the available annual budget. With the present level of staff experience and equipment, two teams sampling for 10 weeks is the optimum sampling strategy.



(a) *Elements determined (by XRF) in surface soils and stream sediments (highlighted in red). Loss-on-ignition and pH are also routinely measured on soils.*



(b) Elements determined in surface waters (highlighted in red, blue and green). Conductivity, pH, bicarbonate and non-purgeable organic carbon (NPOC) are also routinely measured.

Figure 2-1: Periodic tables summarising elements determined on (a) stream sediments and surface soils and (b) surface waters

3 Health and Safety

Health and Safety (H&S) is an integral part of all G-BASE procedures and any activity considered to be of medium to high risk to health and safety is investigated by a risk assessment. H&S is of sufficient importance to merit its own procedures file and so these are not duplicated in this manual. The G-BASE H&S file is available in the project office at Keyworth and it is a requirement that all staff should sign to acknowledge they are aware of the existence of the file and their duty to read it. A copy of the G-BASE H&S file will be available for the field team to read on location at the field campaign base. The student workers will be informed of H&S issues during their training day (see Section 5).

A summary of the medium/high risk activities in the field and measures to reduce the risks is given in Table 3-1. The overriding principle of Health and Safety measures is that we have a duty to safeguard our own health and safety, those with whom we work and those on whom our work impacts. One of the main measures to reduce risks is training and all BGS staff working in the field should receive training in:

- first aid at work
- driving 4x4 vehicles (on and off road including trailer towing)
- manual handling
- Minibus driving (unless category D1 stated on driving license)

Field team leaders must be made aware (in confidence) of any health issues affecting members of their team (food allergies, health problems etc.) and such information should be requested by team leaders prior to the commencement of fieldwork. Leaders must also have readily available a list of emergency contact numbers both for personnel, the local area (e.g. Police) and work (e.g. contact for senior managers).

In addition to the project Health & Safety file all BGS fieldworkers should have read the BGS Transport Manual[2] (latest version May 2003) and the BGS Guidance Note "A safe system of fieldwork" issued to all BGS fieldworkers.

It is important that all health and safety incidents (including near misses) are recorded in the field H&S incident book. The field operations manager includes a health & safety section in the annual field campaign report (see Section 18).

Photograph 1: Samplers are transported by a minibus that has a place to secure samples and equipment whilst travelling

[2] available in Keyworth from http://intranet/docs/facilities/Transport_Manual.doc

High/Medium risk activity	Summary of measures to reduce risk
Driving in field area	• receive appropriate vehicle driving training • use vehicle appropriate for type of fieldwork
Transporting heavy loads and equipment by vehicle	• do not overload vehicles • secure equipment and samples • transport acid in special anti-spill containers
Lifting heavy loads/ loading and unloading samples	• receive manual handling training • use appropriate storage crates for sample transportation • don't overload storage crates • do not load/unload heavy items alone
Carrying heavy loads in the field	• use good quality rucksacs offering high level of support and adjusted appropriately for the carrier • share the load between the two samplers • sensible handling of load whilst negotiating obstacles (e.g. pass load across a wall rather than climbing over the wall with rucksack still on)
Sampling soils and drainage samples	• attend G-BASE sampling training day • dress appropriately with good footwear and always take waterproof clothing • stick to recognised paths. Do not take risks crossing barbed wire fences/stone walls or rivers/streams for the sake of making a shortcut
Walking on country roads	• always use Hi-vis jackets and rucksacks • seek alternative footpaths if available • walk into oncoming traffic except when approaching the brow of a hill
Remote working	• always sample in pairs • inform team leaders of proposed route • carry emergency telephone numbers
Adverse weather	• pay attention to weather forecasts • do not sample areas in times of flood • take appropriate measures against exposure to the sun • during thunderstorms follow standard procedures to avoid lightening strikes and in particular don't carry a metal soil auger.
Attack by animals	• avoid potentially dangerous animals (e.g. bulls and guard dogs) where possible by choosing an alternative route
Military, shooting area and other hazardous land use	• always have permission to enter such areas first • team leaders to advise samplers of such potential areas on their map • team leaders plan daily sampling areas so hazards such as large rivers or railways do not have to be crossed • always wear Hi-vis jackets
Exposure to infection, agrochemicals and pesticides	• samplers to be advised of dangers on training day • avoid contaminated sites or fields being sprayed • observe DEFRA exclusion notices when encountered in the field
Exposure to substances used by the field team	• acidify F/A samples and undertake alkalinity titrations using safe methods and appropriate PPE. • glue sediment and pan bags in a well ventilated area, preferably out-doors in or in a barn doorway (if raining).

Table 3-1: Summary of the high/medium risks in fieldwork and measures to reduce the risks

4 Pre-field campaign planning

4.1 SITE PLANNING

1. Detailed planning is carried out well in advance of the commencement of fieldwork. This is essential in order that field accommodation and sampling boundaries can be identified. The total number of samples to be collected from the area must be calculated accurately in order to determine the duration of the field season and to sub-divide the area efficiently.

2. It is important to consult the stable base maps from adjacent areas in order to establish the sampling boundary for the new campaign. This is especially important in the case of soils.

3. Site planning is carried out on flat, coloured copies of the relevant 1:50 000 Ordnance Survey (OS) sheets (see Figure 4-1). Black and white maps are not suitable for this purpose, as different topographic features are distinguished by colour.

4. Sediment sites should be planned at an average of 1 per 1.5 sq. km where surface drainage is well defined. Sites should be located mainly on first and second order streams and situated upstream of obvious sources of contamination such as road intersections and farm buildings. Care must also be taken to locate sites upstream of confluences to minimise effects caused by sediment mixing and upstream dispersion.

5. G-BASE soil sites should be planned at the pre-determined density, generally one per 2 sq. km, on a regular grid. Sites should be located away from obvious sources of contamination, but a much greater degree of flexibility, with respect to the precise site location, is available to the sampler when collecting soils in the regional survey. Urban soils should be planned at one per 500 m x 500 m quadrant within each km grid square. The sample site should be located as near to the centre of the quadrant as possible.

6. If there is to be more than one sampling team operating from a different field base, then once all planning has been undertaken, and boundaries established, a sets of duplicate maps must be prepared to ensure that different field teams understand the sub-division of sampling areas.

7. The sampling rate also has to be established so that the final total number of samples and the area of samples taken can be estimated. This has to take into account, training weeks and weeks when Saturday mornings are not worked due to an accommodation move (see Table 4-1). This should be an estimation to within 5% of the actual number of samples that will be collected.

	Wk1 (training)	Wk 2	Wk 3 (move)	Wk 4	Wk 5 (training)	Wk 6 (move)	Wk 7	Wk 8	Wk 9
Mon	7x4 = 28	11x4 = 44	11x4 = 44	11x4 = 44	7x4 = 28	11x4 = 44	11x4 = 44	11x4 = 44	11x4 = 44
Tue	9x4 = 36	11x4 = 44	11x4 = 44	11x4 = 44	9x4 = 36	11x4 = 44	11x4 = 44	11x4 = 44	11x4 = 44
Wed	10x4 = 40	11x4 = 44	11x4 = 44	11x4 = 44	10x4 = 40	11x4 = 44	11x4 = 44	11x4 = 44	11x4 = 44
Thu	11x4 = 44	11x4 = 44	11x4 = 44	11x4 = 44	11x4 = 44	11x4 = 44	11x4 = 44	11x4 = 44	11x4 = 44
Fri	11x4 = 44	11x4 = 44	11x4 = 44	11x4 = 44	11x4 = 44	11x4 = 44	11x4 = 44	11x4 = 44	11x4 = 44
Sat(1/2 day)	6x4 = 24	6x4 = 24	N/A	6x4 = 24	6x4 = 24	N/A	6x4 = 24	6x4 = 24	6x4 = 24
Total	216	244	220	244	216	220	244	244	244
Overall Total									**2092**

Table 4-1: Example of sampling rate calculation for a 9 week field campaign with four sampling pairs

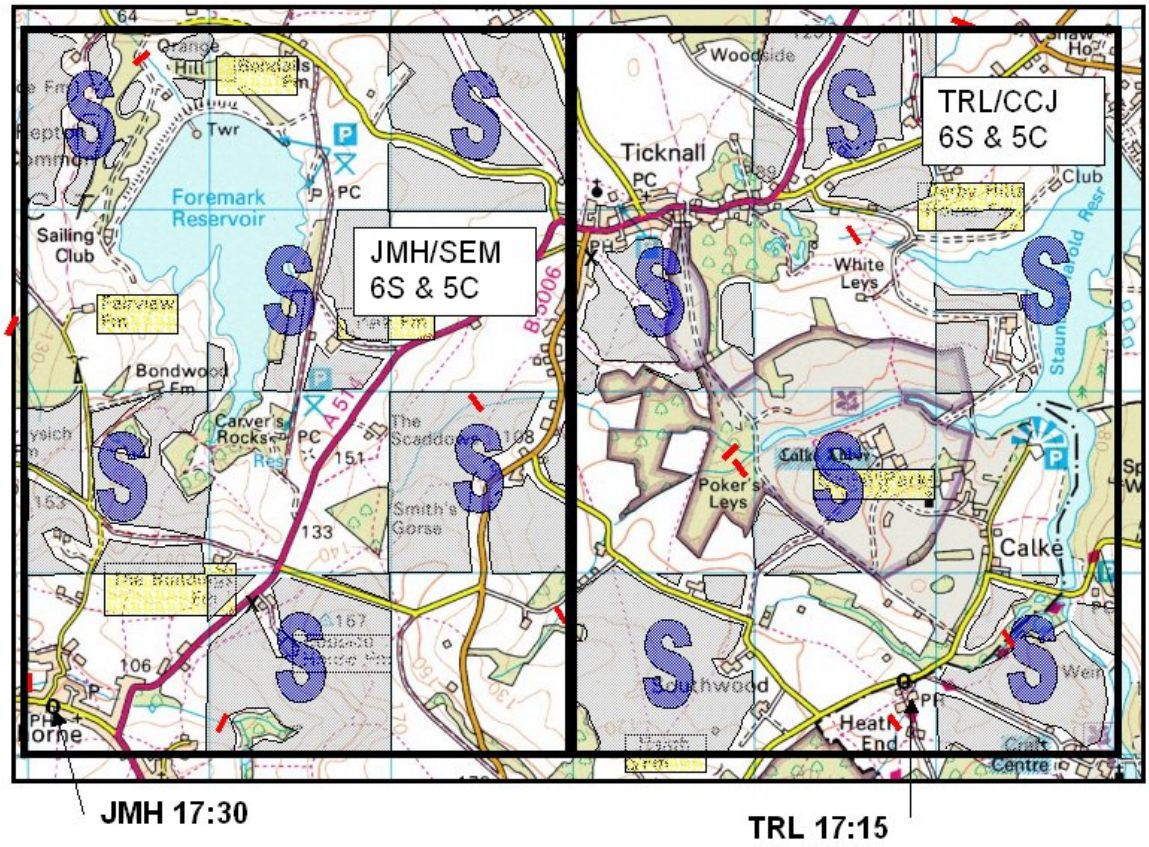


Figure 4-1: Diagram of sample site planning on 1:50,000 OS topographic maps

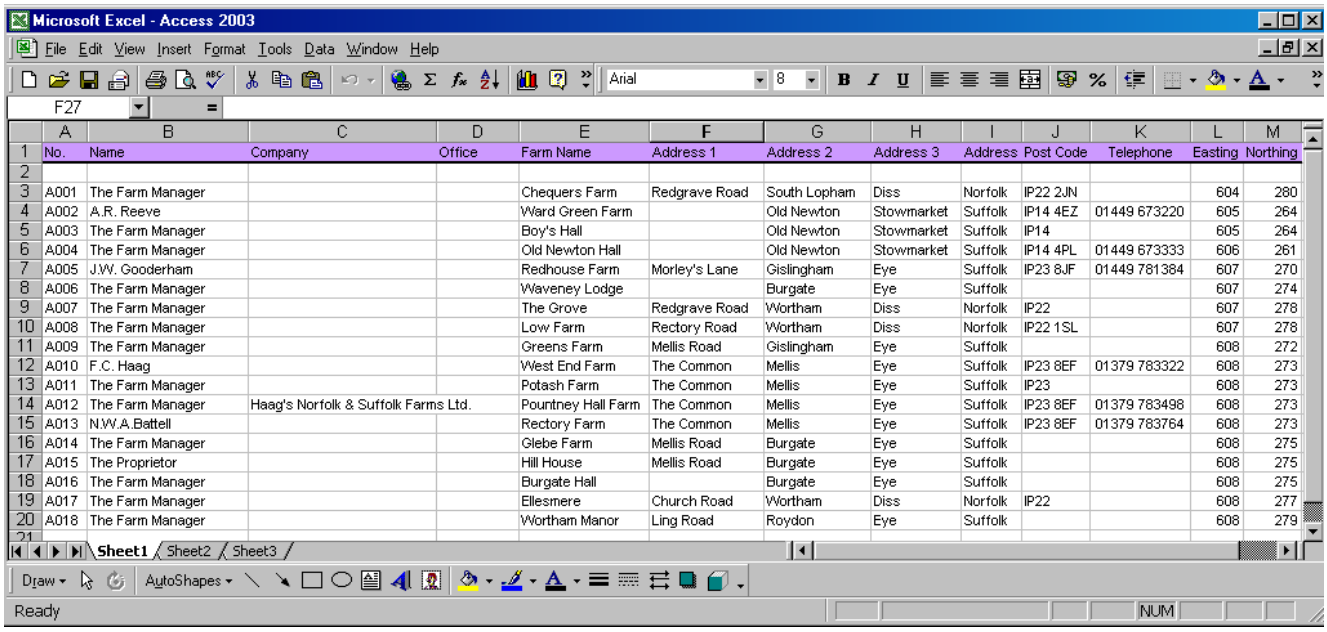
This is an idealised figure combining the planning map and the field map. Drainage sample locations (red line), soil sample areas ("S" in kilometre square, sample within shaded area) and farms (highlighted in yellow) are marked on the planning map. The day before sampling the team leader will mark out field maps allocating suitably sized areas to a sampling pair indicating the number of soils and sediments to be collected. The sampling pair will indicate on the map where they wish to be dropped off in the morning and picked up (with a time) in the evening.

4.2 SITE ACCESS

1. In order to gain access for the field season, written notice is sent to estates and farmers whose land falls on or near the planned sediment or soil sample sites.

2. The estates and farms are identified on the 1:50 000 planning map, and the addresses are located using www.yell.co.uk, www.streetmap.co.uk and www.royalmail.com.

3. The names and addresses of these farms are then entered into an Excel spreadsheet (see Figure 4-2 for an example). The finished spreadsheet is then used as a mail merge for a standard access letter and permission slip (see Appendix A).



Microsoft Excel - Access 2003

File Edit View Insert Format Tools Data Window Help

F27

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	No.	Name	Company	Office	Farm Name	Address 1	Address 2	Address 3	Address	Post Code	Telephone	Easting	Northing
2													
3	A001	The Farm Manager			Chequers Farm	Redgrave Road	South Lopham	Diss	Norfolk	IP22 2JN		604	280
4	A002	A.R. Reeve			Ward Green Farm		Old Newton	Stowmarket	Suffolk	IP14 4EZ	01449 673220	605	264
5	A003	The Farm Manager			Boy's Hall		Old Newton	Stowmarket	Suffolk	IP14		605	264
6	A004	The Farm Manager			Old Newton Hall		Old Newton	Stowmarket	Suffolk	IP14 4PL	01449 673333	606	261
7	A005	J.W. Gooderham			Redhouse Farm	Morley's Lane	Gislingham	Eye	Suffolk	IP23 8JF	01449 781384	607	270
8	A006	The Farm Manager			Waveney Lodge		Burgate	Eye	Suffolk			607	274
9	A007	The Farm Manager			The Grove	Redgrave Road	Wortham	Diss	Norfolk	IP22		607	278
10	A008	The Farm Manager			Low Farm	Rectory Road	Wortham	Diss	Norfolk	IP22 1SL		607	278
11	A009	The Farm Manager			Greens Farm	Mellis Road	Gislingham	Eye	Suffolk			608	272
12	A010	F.C. Haag			West End Farm	The Common	Mellis	Eye	Suffolk	IP23 8EF	01379 783322	608	273
13	A011	The Farm Manager			Potash Farm	The Common	Mellis	Eye	Suffolk	IP23		608	273
14	A012	The Farm Manager	Haag's Norfolk & Suffolk Farms Ltd.		Pountney Hall Farm	The Common	Mellis	Eye	Suffolk	IP23 8EF	01379 783498	608	273
15	A013	N.W.A.Battell			Rectory Farm	The Common	Mellis	Eye	Suffolk	IP23 8EF	01379 783764	608	273
16	A014	The Farm Manager			Glebe Farm	Mellis Road	Burgate	Eye	Suffolk			608	275
17	A015	The Proprietor			Hill House	Mellis Road	Burgate	Eye	Suffolk			608	275
18	A016	The Farm Manager			Burgate Hall		Burgate	Eye	Suffolk			608	275
19	A017	The Farm Manager			Ellesmere	Church Road	Wortham	Diss	Norfolk	IP22		608	277
20	A018	The Farm Manager			Wortham Manor	Ling Road	Roydon	Eye	Suffolk			608	279
21													

Sheet1 Sheet2 Sheet3

Draw AutoShapes

Ready NUM

Figure 4-2: Example of the Farm Access Excel Spreadsheet

4. The letters are sent out in the middle of May. The replies are then filed in order (all permission slips have a unique number) and marked on the map with a highlighter pen. Green = OK, Yellow = telephone call, blue = visit and red = no permission granted.

5. These slips are taken into the field and used as necessary. The used permission slips are filed away separately and marked as used.

4.3 ACCOMMODATION

Accommodation is usually booked by the beginning of the year. This is imperative in areas that are holiday destinations. The criteria for choosing G-BASE accommodation is as follows:

- Adequate room for 8 voluntary workers, 1 super voluntary worker and 2 members of staff.
- Centrally located in field area (no more than one hours drive away from furthest sample site).
- The owners must be aware of what the accommodation is being used for and agree to our using it for work purposes.
- If possible, space for sample storage.
- Preferably some indoor space where samples can be dried and checked off (garage or barn).

4.4 EQUIPMENT

Equipment is kept in the G-BASE field equipment store in Keyworth. Daily equipment used by each sampling team is listed in Section 10 and sufficient numbers of each of these items should be taken to the field to supply the number of sampling pairs used with some spares. In addition, the field base requires the following equipment:

1. pH electrode (x 3)
2. pH meter
3. pH buffers (4, 7 and 9)
4. Conductivity meter
5. Conductivity standard (1415µS cm^{-1} @ 25°C)
6. Alkalinity titrator
7. Bromocresol indicator
8. H_2SO_4 cartridges (1.6 N and 0.16 N) plus spare dispenser tips
9. Water chemistry book (for recording analysis data)
10. Thermometer
11. 100 ml measuring cylinder and plastic conical flask
12. Binocular microscope and lamp for mineral inspection
13. Deionised water (obtained from
14. Paper tissues and laboratory paper rolls
15. Laboratory coat, safety goggles and gloves
16. H&S file
17. Acetone
18. Concentrated HNO_3 in 100 ml bottles (1 bottle for each week of the field season)
19. Secure, break-proof 'Safepak' containers for each HNO_3 bottle
20. Short dropping pipettes
21. Acetate stable base maps (1:50 000, covering field area)
22. 10 x 1:50 000 folded Ordnance Survey maps for each map covering field area
23. Laptop loaded with G-BASE farms access database and the MS ACCESS field database.
24. Numbered field cards (allowing enough for field season).
25. Random number checklists
26. Water sample checklists
27. Mobile phones & chargers (1 for each team leader and one spare)
28. Stationery (including map pens)
29. Field access permission slips
30. Geological maps of the area
31. AA batteries for the GPS's
32. Cool-boxes and 'ice-blocks'

Photograph 2: A trailer is useful for transporting equipment to the field and provides valuable storage space

4.5 FIELD BUDGET

Field budget comes from the "Other Recurrent" (OR) part of the general G-BASE budget. This is generally allocated in January of each year and it is the responsibility of the G-BASE Project Manager to monitor expenditure and determine the allocations. Day to day expenditure in the field is the responsibility of the Field Operations Manager.

Photograph 3: Monk Soham field base, Suffolk, August 2003.

5 Voluntary Workers

5.1 RECRUITMENT

Voluntary workers are recruited through an advertisement placed on the BGS web site or through posters sent to UK university earth or environmental science departments (see Appendix B). The current application and medical declaration forms are given in Appendix C. All applications are sent to BGS Personnel Section who then pass on the applications to the G-BASE field operations manager for selection.

The following criteria form the basis for selection:

- previous experience
- availability
- fitness to carry out sampling in difficult terrain and conditions
- geoscience background (preference should be given to those with a geochemical interest)
- team players / sociable
- legible handwriting

The number of voluntary workers (VW) required depends on the length of field season and number of field teams operating during the season. The average number employed per team is sixteen (eight working the first half of the season and eight the second half) with one super voluntary worker (SVW) for the entire period. At least six reserves, all with varying dates of availability are chosen in case any VWs drop out.

Offers of employment need to be sent out at least 4 weeks before the commencement of the field season. Applicants are contacted by phone in the first instance, if the post is accepted the following information is sent by mail:

- contact telephone number for the Field Operations Manager
- the timetable for their work including accommodation addresses, and pick up point for commencement of work
- what clothes and footwear to bring

Personnel Section must provide team leaders with information regarding any health issues and emergency contact numbers (next-of-kin) for the employed VWs.

Payment of the VWs will be made weekly into a bank account so students need to provide an account number for payment. It can take several weeks before the first payments are received so (commencing in 2003) VWs will receive an advance of two weeks once they have commenced employment. The team leader should notify BGS Personnel shortly after work has commenced as to who should receive advances. This will ensure that any students who fail after the initial training day are not paid an advance.

Team and assistant leaders usually look after food and drink purchases for the student workers. This often means VWs owe large sums to the team leaders. It is strongly recommended that the students are encouraged to bring cheque books so debts can be rapidly repaid.

5.2 TRAINING

Voluntary Workers (VWs) must be given adequate training in all aspects of geochemical sample collection before being asked to collect routine samples. Training is formally undertaken on the day after the field group has assembled, so no other activities should be scheduled for that day. It is advisable to identify suitable training and have the landowner's permission in advance of the training exercise. Sampling videos are available on CD-ROM and these can be made available to VWs throughout the duration of the sampling.

1. Stream Sediment and Water Sampling: The entire site procedure for collection of a stream sediment sample, a heavy mineral concentrate, and all types of water samples should be demonstrated and explained by members of BGS staff. This should include completion of a field card including all site observations. VWs should then split into pairs and repeat the collection process, with staff supervision. In general, 3 - 4 hours should be allocated for this stage of training.
2. Soil Sampling: Soil sampling methodology can normally be demonstrated at the field base. Sampling should be demonstrated by staff and/or experienced VWs, before allowing VWs to practice for themselves with staff supervision. All relevant field card information should be discussed with particular attention to textural observations.
3. Field Cards - familiarisation and data recording: VWs must be familiar with the layout and understand the protocol involved in completing a field card. Staff should ensure that each member of the field team receives as much training as is necessary to make them fully competent with respect to field cards. (Very few VWs are able to complete faultless field cards during the first few days of a field season). VWs must be made familiar with grid reference conventions and in the use of a compass.

VWs should be carefully supervised in the field by members of staff and experienced VWs during the first few days of the sampling programme. Guidance on dealing with access negotiations must be given to VWs. It is important that everyone understands why they are actually collecting the samples and the general G-BASE rationale. Each VW should receive a copy of the G-BASE brochure at the commencement of their work (Johnson and Breward, 2004). VWs should be issued with a number of information cards (see Appendix D). They must always be prepared to approach farmers/landowners whilst carrying out their work. Where possible, staff should make every attempt to explain land access arrangements to VWs on a day-to-day basis. This should include marking relevant information on field maps.

Samplers must be polite and courteous when dealing with members of the public. A general knowledge of field ‘etiquette’ is required and the country code must be adhered to at all times. It is important that the BGS maintains a good public image and is not misrepresented by poorly informed VWs.

Staff have a responsibility to ensure the reasonable safety of VWs at all times. The risk assessment and field register for all field procedures must have been completed by the project manager prior to commencement of fieldwork (see Section 3).

Safety booklets should be forwarded to all VWs when they have formally accepted their posts, along with advice on tetanus vaccination. Leaflets regarding Lyme Disease, Weil's Disease and other Occupational Zoonoses must be made available to all VWs. These should be signed for.

Contents of the first aid and safety kits must be explained to the VWs. These kits must remain in the field rucksacks at all times. If the first aid kit has been used VWs should inform team leaders so the kit can be restocked. Sampling pairs should carry a whistle, torch and survival bag in the field rucksacks and these should be checked each day before sampling commences. Conventional International Distress Signals must be explained, i.e. send out six long whistle blasts within one minute; pause for one minute and repeat the same. Other ways of sending

distress signals are: reflecting light with a mirror or metal sheet; flashing with a torch light at night; and waving colourful, light reflective or shiny clothes to attract attention.

Sampling must always be undertaken in pairs. It is important to stress the necessity for sampling pairs to remain together at all times during the day. At all times VWs must wear "Hi-Vis" reflective waistcoats and be advised when offered the job of the requirement for strong boots and waterproofs. The use of trainers or trekking sandals for fieldwork is unacceptable.

All VWs should carry their official BGS identification pass at all times in case of difficulties with landowners or the public. The mobile phone contact numbers must also be carried by samplers so that emergency contact can be made when necessary.

6 Daily Field Campaign Procedures

Preparation for fieldwork is described in Section 4 where site planning and access is discussed. As part of the daily routine in the field the team leader and assistant should carry out the following procedures:

1. The number of samples to be collected per day depends on the types of sample being collected and on the terrain. Formerly only drainage samples were routinely collected, with a maximum of nine or ten sites per pair per day recommended. Now both drainage and soil samples are required, six drainage sites and six soil sites per pair make an average day. Where soils only are required, fourteen samples should be within most sampling pairs capabilities. The distance to be covered and weight of load has to be considered.
2. It is good practice to have all sampling days for any particular field-base planned in detail in advance. This is done by sorting the sites into convenient and sensible groups: relief, roads, major rivers and suitable bridging points should be taken into account. This stage must be done meticulously in order to facilitate smooth day-to-day operation of the field programme.
3. Field maps should be prepared one day in advance of the sampling in order to allow VWs to familiarise themselves with the area and to transfer relevant geological data. Any access information should also be clearly marked on the field maps. All field maps are 1:50 000 OS Landranger series sheets for regional sampling and 1:25 000 for urban sampling. No other scale maps should be used as site maps.
4. The VW field maps are prepared by transcribing planned sample sites from the main G-BASE planning map onto a separate 1:50 000 OS map. This has to be done in a logical order to ensure that the VWs have a reasonable route (e.g. bridges to cross rivers, no major roads to cross etc…). When a day has been planned onto the map, any access details have to be plotted onto the map and any permission slips from farms placed into the VWs kit for the next day. The maps are then placed into an A4 self seal bag, this is then placed into a large self seal bag, along with the following equipment:

    - Compass
    - GPS
    - Knox Protractor
    - Pentel black marker pen
    - Red Biro
    - Filofax with relevant number of field cards and codes for use on field cards
    - hand lens

    The map kits are then assigned to a pair of VWs. Different pairings are chosen each day, this is to make sure that sampling bias is not introduced by a particular pair of samplers getting into non-standard habits.
5. The VWs are expected to pack their rucksacks the night before. For every stream sediment site a "site bag" is needed, this contains a sediment bag, panned mineral concentrate bag, plastic sediment outers, five bottles for the various water samples, two syringes and enough water filters for one per site and a couple spare. It is also necessary

to take two or three spare 250ml polythene Nalgene™ bottles in the event that the water at site is too dirty to be filtered, these are then filled with the water and filtered back at the field base on the VWs return. For soil samples, two soil sample bags are needed per site and an A4 size self seal bag to put the filled soil bags into.

6. Each sampling pair should check that they are carrying a spare wrapped red biro and black marker pen.
7. Spare self-seal bags are required in case dry sediments have to be collected (Section 11.4).
8. Permission slips from farmers are filed into numerical order and stored in a box file. On each 1:50 000 OS map, contacted farms are marked onto the map along with details of whether they have given permission for sampling. The relevant permission slips are retrieved from the box file and put into the field site bags. If the farmers have requested the VWs visit the farmhouse before taking a sample then this is also stated. Used permission slips are then filed in a new box file to avoid duplication.

Special procedures to ensure the high level of quality control for the water samples is described in Section 11.2.6.

7 Site Numbering

Sample site numbers are pre-allocated and based on a random numbering system as described by Plant (1973). The first two digits of the site number are a numeric area code. G-BASE area codes are summarised in Table 7-1. Note that when the project started area codes were alphanumeric and have since been substituted in the geochemistry database with all numeric values.

Area/Map Sheet	Letter Code	Number Code
Shetland	AS	01
Orkney	AR	03
Caithness	AR	02
	AQ	03
	AP	04
	FN	05
	SN	06
Sutherland	AP	03
		04
	FN	05
	SN	06
Lewis	DP	07
Little Minch	CP	20
	DP	07
Great Glen	AP	04
	SN	06
	FN	05
	DP	07
	BP	10
	TZ	12
	TB	13
	TD	14
	TA	15
	SR	16
	TX	17
	CP	20
Moray-Buchan	BP	10
		18
Argyll-Tiree	CP	20
		21
	CZ	22
Tay-Forth	CZ	22
	CW	23
	CX	23
		24
Clyde-Malin		27
		28

Area/Map Sheet	Letter Code	Number Code
Borders-Farne		29
		34
		39
Isle of Man		31
Lake District		32
	HB	33
Tyne Tees		30
Abingdon	RZ	99
Liverpool Bay -		35
Anglesey		
Mid Wales -		36
Cardigan Bay		37
		38
Humber Trent		40
		41
Northern Ireland		55
& RESNI		56
Shetland Re-Survey		83
East Midlands		42
		43
East Anglia		44
Stoke-on-Trent		38
Wolverhampton		99
Manchester		63
All Other Urban		60
		61
Glasgow Peri-Urban		62
SW England		50

Table 7-1: Summary of G-BASE Geochemical Atlas regional and area codes

The rest of the sample number is allocated according to the following procedure.

1. Field cards are allocated according to one of four random number lists (RNLs) currently used by G-BASE (see Appendix E). These lists are identified as RNL1, RNL2, RNL3, and RNL4. Each RNL covers a batch of 100 samples. In the event of two field teams being deployed, one field team will use RNLs 1 & 3, the other RNLs 2 & 4. The two RNLs allocated to each field team should be used alternately for consecutive batches of 100 samples. If one field team is working all four RNLs should be used consecutively.
2. There are different RNLs for drainage and soil samples.
3. Field cards are pre-numbered and sorted into random order corresponding to the associated RNL. The RNLs double up as field sample check lists and are therefore very important documents. Under no circumstances should cards be issued without reference to the RNL.
4. The reverse side of the RNL lists the numbers in random order. Field cards should be issued from the first available (unused) number in this list. The first card issued should correspond to the first available number on the list. Count off the number of sites allocated to each sampling pair for the day, and allocate the cards in sequence. On the RNL, indicate which sampling pair has been allocated each set of cards and on which date. It is essential that cards can be attributed to the samplers. This may be the only way in which field numbering errors or other mistakes may be resolved and allows clear tracking of samples.
5. Any cards which are returned unused at the end of a days' sampling should be retrieved and re-allocated. When this occurs, the initials of the new sampling pair should be marked next to the number on the RNL, along with the new date of issue. This procedure ensures that all field cards in each 100 are linked to a sample.
6. In each 100 cards there is a field duplicate pair. These cards should be allocated together for THE SAME site. Allocation of the duplicate site should take account of the day's schedule, as it will undoubtedly add 30-40 minutes to the sampling pairs' day.
7. Ensure that the cards allocated to standards (STDs), sub-samples (SSs) and blank waters (BWs) are not issued by mistake for field use .

Any labelling or numbering errors which can be identified from the RNL should be rectified immediately. RNLs are submitted to the laboratory along with the samples, so corrections must be made before the samples are dispatched to the laboratory.

Between field seasons sample numbers can be continued from the previous field campaign though it is advised to start numbering on a new set of "hundreds" rather than overlapping field sample batches.

8 Field Cards

8.1 RECORDING SITE AND SAMPLE INFORMATION

The primary method of data collection in the field is a hardcopy record referred to as a field card. Examples of the latest field card are shown in Figure 8-1. Codes used to complete the field cards are given in Figure 8-2 and Figure 8-3. VWs are trained to complete field cards during their training day (Section 5.2), and through the diligent validation of field cards and maps, team leaders ensure a high level of consistency and accuracy is achieved.

1. Field cards are numbered prior to fieldwork commencing
2. At the start of each day sampling teams are issued with a set of field cards corresponding to the number of sites to be sampled. The sampling team allocate the site number on arrival at site based on the next numbered blank field card to be used, according to the type of sample to be collected (stream or soil). This number is transcribed on to all sample bags and bottles and the field map at the site.
3. The field cards are completed at site using a red biro and all sections should be completed on location.
4. The sampling pair responsible for collecting the sample is identified by their initials on the field card. The individual responsible for completing the field card lists their initials first.

Photograph 4: Site location is recorded using a GPS

The most common problem facing VWs when completing field cards is unfamiliarity with the codes to be used. This can be overcome by providing a plastic laminated 'crib-sheet' in each filo-fax booklet. This contains information on all the relevant data entry fields to be completed. Only acceptable codes and abbreviations are listed, which reduces the amount of free-text information written on each field card.

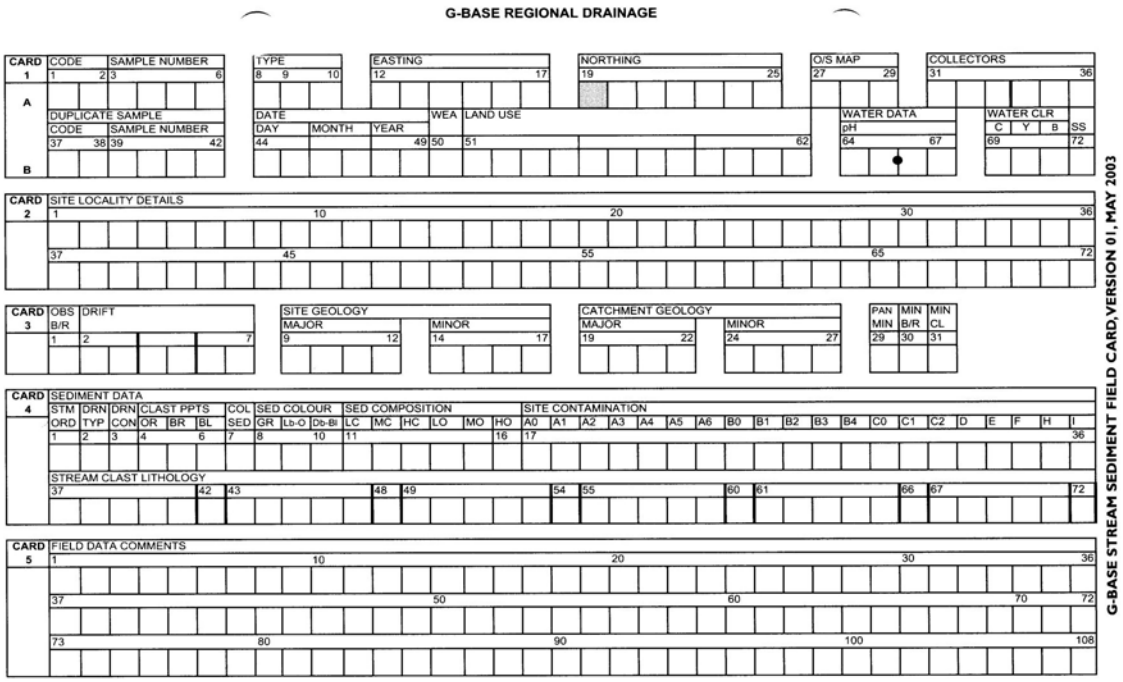
Common errors are due to transcription mistakes, especially when copying the National Grid Reference of the site from the GPS onto the field cards. All data stored in the GPS are checked by team leaders at the field base, against the information on the field cards to eliminate location data errors.

GPS coordinates may have a much lower precision when used in proximity to tall buildings or within woodlands. In such an instance the grid reference should always be taken from the map.

Photograph 5: Completing a field card at site

Occasionally the wrong sample number may be written onto all the sample containers. This can happen for a number of reasons. This mistake will be made obvious and can be rectified when samples are checked in at the field base.

(a)



(b)

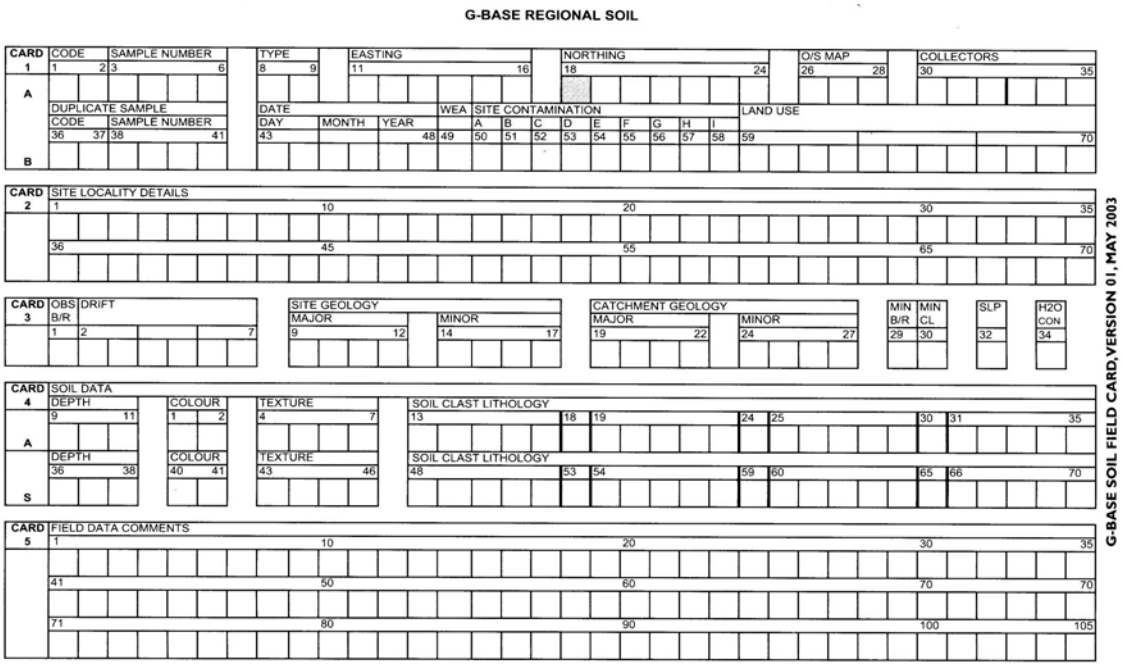


Figure 8-1: Example of G-BASE field cards: (a) drainage and (b) regional soil

SAMPLE TYPE
C Stream Sediment
P Panned Concentrate
W Water
S Soil

EASTING/NORTHING
As taken from GPS reading

O/S MAP O/S Field Map Number

COLLECTORS Collectors initials person filling in card first.

WEATHER (RAINFALL)
1 Rain heavy within 12 hours
4 Rain heavy within 24 hours
6 Rain heavy within 48 hours
7 Rain heavy 2-7 days
8 No rain within a week

LAND USE
AEBB Mature Coniferous Forest
AEBA Recent Coniferous Forest
AEAB Mature Deciduous Forest
AEAA Recent Deciduous Forest
AC00 Rough Grazing
ABB0 Heather Moor
BD00 Arable
BAB0 Pasture
DD00 Recreational
DAC0 Urban Open Space
E000 Industrial

WATER COLOUR
C Clear
Y Yellow
B Brown

OSERVED BEDROCK (within 100m of site)
1 No outcrop
2 Moderate outcrop
3 Abundant outcrop

DRIFT
A1 Blown Sands
A4 Raised Beach
A5 Estuarine

B2 Alluvium
B3 Coarse Gravel

C1 Soil
C2 Marsh
C3 Peat Bog

D1 Clay with Flints
D2 Scree

E1 Till
E2 Moraine
E3 Fluvioglacial

DRAINAGE TYPE
1 Seepage or Spring
2 Ditch
3 Drains – land drains etc.
4 Small Stream<3m wide
5 Stream 3-10m wide
6 Small River 30-33m wide
7 Large River >33m wide
8 Estuary

DRAINAGE CONDITION
1 Dry – no visible surface drainage
2 Ponded with dry sections
3 Low Flow – river bed not covered by running water
4 Moderate Flow – stream boulders visible only
5 Strong Flow – large boulders visible only
6 Channel filled from bank to bank
7 Overflow – stream banks burst
8 Spate

CLAST PRECIPITATES

COLOUR
OR Orange
BR Brown
BL Black

ABUNDANCE
1 Light
2 Moderate
3 Heavy

SEDIMENT COLOUR

GR Grey
LB-O Light Brown/Orange
Db-Bl Dark Brown/Black

SEDIMENT COMPOSITION
LC Low Clay
MC Medium Clay
HC High Clay
LO Low Organics
MO Moderate Organics
HO High Organics

COLLOIDS IN SEDIMENT
1 Light
2 Moderate
3 Heavy

CONTAMINATION

A0	METAL	E0	RUBBER
A1	Iron/Steel Wire		
A2	Galvanised Iron	F0	PAINT
A3	Copper		
A4	Lead	G0	EFFLUENT
A5	Zinc	G1	Farm Effluent
A6	Brass	G2	Domestic Effluent
B0	CERAMICS	H0	BULK INDUSTRIAL WASTE
B1	Pottery	H1	Metal Mine Tailings
B2	Tiles	H2	Coal Tailing
B3	Bricks	H3	China Clay Tailings
B4	Glazed China	H4	Slag (furnace waste)

ROCK NAME

AGATE	Agate	BA	Basalt
CHLK	Chalk	CHRT	Chert
COAL	Coal	CLAY	Clay
COLSHL	Coal Shale	DOLR	Dolerite
DL	Dolomite	OILS	Oil Shale
DI	Diorite	FELS	Felsite
FLNT	Flint	FEST	Ironstone
GNSS	Gneiss	GB	Gabbro
LMST	Limestone	GN	Granite
SMARL	Marl	MARBLE	Marble
QZITE	Quartzite	MDST	Mudstone
SDST	Sandstone	PEL	Pelite
SCH	Schist	SLTE	Slate
SLST	Siltstone	TUF	Tuff
AGG	Agglomerate	CONG	Conglomerate
SI	Silicate	CRBAC	Carbonaceous Material
IGRU	Igneous Rock	METR	Metamorphic Rock
SR	Sedimentary Rock		

MINERALS GENERAL

Arsenopyrite	AsFes
Baryte	Ba
Bornite	Born
Calcite	Cal
Cassiterite	Cass
Chalcopyrite	CuFeS
Chromite	Cr
Cinnabar	HgS
Epidote	Epi
Fluorite	Fluor
Galena	PbS
Garnet	Gt
Gold	Au
Haematite	He
Ilmenite	FeTiox
Magnetite	Mag
Molybdenite	MoS
Monazite	Mon
Pyrite	FeS
Pyrrhotite	Pyrr
Quartz	Qtz
Realgar	AsS
Rutile	Tiox
Scheelite	Schee
Sphalerite	Zns
Stibnite	SbS
Tourmaline	Tour
Wolframite	Wolf
Zircon	Zr

Figure 8-2: Codes used on G-BASE stream sediment field cards

SAMPLE TYPE A Horizon
S Horizon

EASTING/NORTHING
As taken from GPS reading

O/S MAP O/S Field Map Number

COLLECTORS Collectors initials person filling in card first.

WEATHER (RAINFALL)
1 Rain heavy within 12 hours
4 Rain heavy within 24 hours
6 Rain heavy within 48 hours
7 Rain heavy 2-7 days
8 No rain within a week

SOIL COLOUR
BL Black
DB Dark Brown
LB Light Brown
RE Red
OR Orange
YE Yellow
GR Green
GY Grey

SOIL TEXTURE
SAND – Sand
SILT – Silt
CLAY – Clay
SACL – Sandy Clay
SICL – Silty Clay
SASI – Sandy Silt (loam)

CONTAMINATION

A0	METAL	E0	RUBBER
A1	Iron/Steel Wire		
A2	Galvanised Iron	F0	PAINT
A3	Copper		
A4	Lead	G0	EFFLUENT
A5	Zinc	G1	Farm Effluent
A6	Brass	G2	Domestic Effluent
B0	CERAMICS	H0	BULK INDUSTRIAL WASTE
B1	Pottery	H1	Metal Mine Tailings
B2	Tiles	H2	Coal Tailing
B3	Bricks	H3	China Clay Tailings
B4	Glazed China	H4	Slag (furnace waste)
C0	GLASS	I0	AGRO-CHEMICALS
C1	Clear Glass	I1	Solid Fertilisers (pellets)
C2	Coloured Glass	I2	Liquid Fertilisers (sprays
D0	PLASTICS		

DRIFT
A1 Blown Sands
A4 Raised Beach
A5 Estuarine
B2 Alluvium
B3 Coarse Gravel
C1 Soil
C2 Marsh
C3 Peat Bog
D1 Clay with Flints
D2 Scree
E1 Till
E2 Moraine
E3 Fluvioglacial

OBSERVED BEDROCK
1 No Outcrop
2 Minor Moderate Outcrop
3 Abundant Outcrop

LAND USE
AEBB Mature Coniferous Forest
AEBA Recent Coniferous Forest
AEAB Mature Deciduous Forest
AEAA Recent Deciduous Forest
AC00 Rough Grazing
ABB0 Heather Moor
BD00 Arable
BAB0 Pasture
DD00 Recreational
DAC0 Urban Open Space
E000 Industrial

SLOPE
1 None
2 Moderate
3 Steep

H_2O CONTENT
1 Dry
2 Moderate
3 Waterlogged

ROCK NAME

AGATE	Agate	BA	Basalt
CHLK	Chalk		
CHRT	Chert	CLAY	Clay
COAL	Coal	DOLR	Dolerite
DL	Dolomite	FELS	Felsite
FEST	Ironstone	FLNT	Flint
GNSS	Gneiss	GN	Granite
LMST	Limestone	MARBLE	Marble
SMARL	Marl	MDST	Mudstone
SCH	Schist	SDST	Sandstone
SLTE	Slate	SLST	Siltstone
TUF	Tuff		
AGG	Agglomerate	CONG	Conglomerate
SI	Silicate	CRBAC	Carbonaceous Material
METR	Metamorphic Rock	IGRU	Igneous Rock
SR	Sedimentary Rock		

Texture:

Most particles > 200 mm = Boulders
Most particles < 200 mm >60 mm = Cobbles
Most particles < 60 mm > 2 mm = Gravel
Most particles < 2 mm > 0.06 mm= sand
Most particles < 0.06 mm > 0.006 mm = silt
Most particles < 0.006 mm > 0.002 mm = clay/silt
Most particles < 0.002 mm = clay
Soil is dark, black and of low density = organic
Soil laid down by man = Made ground

Soil (omitting boulders and cobbles) containing > 35% of fine material should be described as silt or clay.

Soil with < 35% fine material should be described as sand or gravel

Sand/Silt/Clay Texture:

Sand - Visible to naked eye; no cohesion when dry.

Silt - Only coarse silt visible with hand lens; exhibits little plasticity and marked dilatancy; slightly granular or silky to the touch; disintegrates in water; lumps dry quickly; possesses cohesion but can be powdered easily between fingers

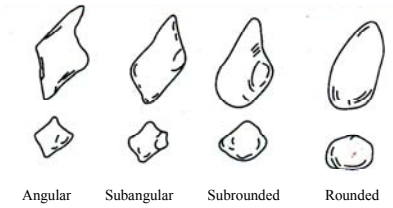
Clay/silt - Intermediate in behaviour between clay and silt. Slightly dilatant.

Clay - Dry lumps can be broken but not powdered between the fingers; they also disintegrate under water but more slowly than silt; smooth to the touch; exhibits plasticity but no dilatancy; sticks to the fingers and dries slowly; shrinks appreciably on drying usually showing cracks.

Made Ground:

Does soil comprise natural or man made materials?

If natural, describe as natural soils



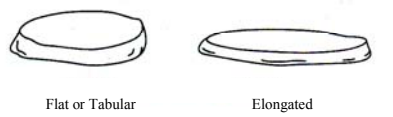


Figure 8-3: Codes used on G-BASE soil field cards

8.2 FIELD CARD VALIDATION

1. VWs must be encouraged to check their field cards rigorously before handing them in at the end of each day. National Grid References (NGR) and field data comments are particularly prone to error. Geological information should also be completed in the evening with the aid of geological maps.
2. Staff should designate a location for VWs to deposit the field cards, along with 'Filofax' books, field maps, pens and any access slips that they have used that day. This minimises the potential for loss or misplacement of these primary field documents.
3. The validation procedure is carried out on the day following sampling. Firstly, ensure that the number of field cards returned corresponds to the number of cards issued. Remove any unused cards and ascertain the reasons for this. VWs should indicate on the field map why samples were not collected. Check each card in turn against the field map to establish the correct location. Ensure that the National Grid Reference and field site locality description are consistent. Check that all other entries on the field card are correct, especially codes and abbreviations. Field card errors should be logged against the VWs responsible. It is important to iron out problems as early as possible. Once habits are formed, they are difficult to break.
4. Once all cards have been checked, sites should be plotted onto the transparent copies of the 1:50 000 OS sheets (stable base maps). Locations must be accurately transferred using the Knox protractor. Pilot permanent marker pens should be used, and by convention, drainage sites are marked in red, soil sites in blue, and duplicate B in green next to the duplicate A number. Annotation of the stream site locations prior to the soil sites reduces the likelihood of obscuring the stream sites with the soil sample number. Error can be reduced if this step is carried out by two persons, one reading the NGR whilst the other plots the sites on the map.
5. When the sites have been plotted on the stable base maps, the field cards should be arranged into numerical order before field card data is entered into the database. Keep the database up to date and do not allow a backlog of un-entered cards to build up. This will avoid confusion during staff changes and will help to establish a daily routine of working practice. Errors picked up at this stage should be added to the comments noted during the main phase of checking (3). Water chemistry data from the previous days' samples may only be entered **after** the data from the field card has been entered.
6. When all card data has been entered, the field cards should be recombined in numerical order in the field card storage trays.

9 Working with Landowners, Farmers and the Public

The G-BASE fieldwork depends on good cooperation with landowners, farmers and the public. Sampling teams need to be aware of important issues that may lead to potential problems in the field and at all times must remain polite, courteous and respectful. Team leaders need to monitor carefully the behaviour of sampling pairs in the field and any incidents that breach a respectful code of conduct or cause upset to local landowners or farmers must be dealt with firmly and swiftly.

Strategies for reducing such incidents should include the following:

1. Pre-fieldwork planning. Site access planning is described in Section 4.2 and it is important to establish who is responsible for ownership or custodianship of areas to be sampled. This may involve some pre-fieldwork reconnaissance to the area and meeting with different individuals/organisations involved. Individual farms are covered in the farms access database that gives team leaders an indication of farms that should be avoided. The pre-fieldwork planning should identify:
    - military areas
    - Forestry Commission
    - National Trust or sites of special scientific interest
    - large country estates
    - natural and man made hazards

    Permission to work in these areas should be obtained before fieldwork commences.

2. Informing the local community. Effort should be made to inform local communities of our activities. This can be done by contacting the local branch of the National Farmers Union.

3. High visibility and low profile. High visibility jackets are worn by all samplers as a health and safety measure. Since these were introduced, it has been noted that samplers are shown a much greater respect. The Hi-vis jackets reinforce the fact that we are on official business and reassures landowners that samplers are not suspicious characters clandestinely moving around the countryside. Although maintaining a high visibility samplers should not behave in a way that unnecessarily draws attention to themselves. Public roads and footpaths should be used wherever possible and vehicles should be parked in public rather than private areas.

4. Training. BGS staff and students need to be coached in how to deal with farmers and the general public. This is covered during the training of VWs (Section 5.2). Team leaders should have examples of G-BASE work available at the field base that can be shown to interested parties (e.g. the G-BASE brochure, Johnson and Breward, 2004).

5. Awareness of Agricultural Issues. Sampling teams must be aware of current agricultural issues including arable and pastoral diseases and the precautions to be used whilst working in such areas. Information on these issues is given in Appendix F and include:
    - Foot and Mouth
    - Swine Fever and pig rearing
    - sugar beet rhizomania

10 Field Equipment carried by sampling team

Staff should ensure that VWs are fully equipped for each day in the field. Each sampling pair should have:

1. ID passes
2. First aid kit containing : plasters, triangular bandages, antiseptic wipes, eye pads, two standard bandages and eye wash solution
3. Whistle
4. Polythene survival bag
5. Torch and batteries
6. “Hi-Vis” jacket
7. Enough money for emergency phone-calls
8. Sieve rucksack and sample transport rucksack
9. Sieve set (two sieves with 2 mm and 150 μm nylon mesh), 2 pans, funnel and rubber gloves
10. Trenching tool (shovel)
11. Auger
12. Spare 10 x 14 in (approx A4) self-seal for dry sediment samples
13. 2 ½ lb geological hammer and safety glasses or goggles
14. Soil bags (5 x 10 in) (sufficient for A and S at each soil site plus spares)

Map pack (an "over-size" self-seal polythene bag), labelled with the pair’s names, containing:

15. Hand lens
16. Compass
17. GPS
18. Knox Protractor
19. Field map with sites marked stored in an "over-size" (14 x 16 in) self-seal polythene bag
20. Filofax with field cards and mobile phone number
21. Red biro and black Pentel marker plus spares sealed in plastic bag (in rucksack)
22. Relevant access information including spare copies of standard access letter in case needed by the general public

23. Filter kit: enough clean filters for each site plus 2 spares in a clean self sealing bag; 2 clean syringes; and a bag for used filters. All stored in clean self-sealing bag

Site bags (sufficient for each stream site plus spares) each containing:

24. One 10 x 14 in. (approx A4) self-seal polythene bag containing
25. One Kraft™ sediment bag (4 x 8 in), and one heavy mineral concentrate bag (3 x 5 in)
26. Two 6 x 17 in polythene bags ("sedi-outers") for safe-keeping of the sediment sample and filtered water samples
27. One 60 ml Nalgene™ bottles for F/A (filtered / acidified sample) (in a "sedi-outer")
28. One 30 ml Nalgene™ bottles for F/UA (filtered / unacidified sample) (in a "sedi-outer")
29. One 30 ml polythene bottle with black lids for the pH sample
30. One 250 ml Nalgene™ alkalinity/conductivity sample bottle

Photograph 6: Regular checking of sieve sets is important to ensure only fine sediment passes through the sieve

Photograph 7: The sieve set is the geochemist's basic equipment

Samplers should check certain equipment on a weekly basis, a job usually done Saturday afternoon or Sunday. Tasks include:

- checking, cleaning and reassembling sieve sets
- checking that the Kraft™ sample bags are glued correctly, breaking them apart and re-gluing those that are not (sediment and panned concentrate bags).
- checking state of first aid kit, torch, whistle, spare pens and survival bag and informing staff where these items are not complete or operational
- assembling sufficient 'site bags' for the forthcoming week, plus spares.

11 Collecting Stream Drainage Samples

11.1 SITE SELECTION

The sample site should be located as closely as surface conditions allow to that indicated on the field map. Obvious contamination should be avoided, e.g. locate sites >75 m upstream of stream or road intersections, drain discharge points or livestock access points to streams. Every attempt must be made to collect active sediment from the middle of the stream channel. One sampler should walk 50-100 m upstream (along the bank) of the intended site to check for any localised contamination, prior to initiating sample collection.

11.2 STREAM WATER COLLECTION

Hands must be clean, rinsed in stream water and free from jewellery, plasters, sun screen or any hand creams or lotions. At sites where water samples are required, all water samples must be collected before disturbance of the stream bed. A total of four samples are normally collected - pH; total alkalinity/conductivity; F/A sample by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES) and by Inductively Coupled Plasma Mass Spectrometry (ICP-MS); and F/UA sample by ion chromatography/NPOC. F/A and F/UA samples require filtration at site.

During the 2003 field campaign five samples were collected, with a 30 ml Greiner™ tube (F/A) collected in addition to two 30 ml Nalgene™ bottles, to provide the ICP facility with a separate sample for each instrument.

11.2.1 Sampling Equipment

- 2 x 25 ml plastic syringes
- 10 x Millex™ sealed filters pre-loaded with 0.45 µm millipore cellulose filters in a clean small self-seal bag (the actual number of filters should be adjusted according to number of stream sites to be visited)
- a labelled bag for the dirty filters to be placed in
- four different sample container types are supplied;

i) 30 ml polyethylene bottles with black watertight caps (pH).

ii) 250 ml polyethylene bottles 'Nalgene'™ with watertight caps (total alkalinity/conductivity).

iii) 30 ml high-density polyethylene 'Nalgene'™ bottles with watertight polyethylene cap.

iv) 60 ml high-density polyethylene 'Nalgene'™ bottles with watertight polyethylene cap.

11.2.2 Sample labelling

Write the sample number (taken from the field card) on the sample containers, using the black 'Pentel' marker. The following sample–type codes must also be written on each container:

i)	Major anions/NPOC	-	F/UA	(30 ml Nalgene™ bottle)
ii)	ICP-MS & -AES	-	F/A	(60 ml Nalgene™ bottle)
iii)	pH	-	pH	(30 ml polyethylene bottle)

iv) Total Alkalinity/Conductivity – (250 ml Nalgene™ polyethylene bottle)

11.2.3 Filtered stream water sample collection

These samples must be collected first, from the mid-stream flow, on the upstream side of the sediment sample location (this procedure must be performed separately for each duplicate site too). The sampler should stand facing upstream and sediment must not be disturbed. Flush the syringe three times with stream water before connecting a clean Millex™ filter; filters should never be used at more than one site. Flush the filter with 5-10 ml of stream water. Carefully rinse the Nalgene™ bottles and caps with filtered stream water (minimum 10 ml). Special care must be taken to ensure that the sample containers and lids remain uncontaminated; the inside of lids and containers should not be handled and must not be allowed to come into contact with hands, soil, vegetation, or unfiltered water. If they need to be put down while open they must be placed on a clean polythene bag. Fill the 60 ml bottle to the neck and completely fill the 30 ml bottle. Apply caps tightly, ensuring that no leakage occurs. Place the filtered samples into a clean 6 x 17 in polythene bag tied with a knot then transported inside a self-seal polythene bag.

If the bottle, cap or filter are dropped, or otherwise contaminated, a replacement must be used and the process re-started.

In situations where filtration is difficult, the ICP sample (F/A) should be collected first. An additional 250 ml Nalgene™ bottle may be filled with unfiltered water, marked with the sample number and the relevant sample type(s), and taken to the field base for filtration (see Section 11.2.6). It is important to try and filter the sample for trace element analysis at site, as an unquantifiable rate of cation adsorption onto container walls and suspended sediment may occur from the larger bottle before filtration.

In areas where the water tends to have a particularly high proportion of suspended material 'pre-filters' are included in the sampling kit. This should only be done where absolutely necessary in order to avoid confusion and incorrect filtration; the sample teams should be reminded of the procedure to use. The pre-filtering process uses a coarser 25 µm pre-filter mounted in a Swinnex ™ filter holder. The sample is first passed through the coarse pre-filter then through the 0.45 µm Millex™ disposable filter

11.2.3.1 PROCEDURES FOR MAINTAINING PRE-FILTERS AND SYRINGES

The 0.45 µm Millex™ filters are disposable, and should never be re-used. The pre-filter units are cleaned and re-used, with a new filter paper for every sample. Cleaning of the pre-filter unit should be undertaken as follows:

i) Pre-filter holders should be taken apart.

ii) The papers removed.

iii) Soaked in a bowl of tap water (**no detergent of any kind should be used).**

iv) Scrubbed with a clean plastic brush (reserved for this sole purpose) as necessary.

v) Rinsed with de-ionised water.

vi) Reloaded with a new paper using plastic tweezers (without handling the paper or inside of the filter holder)

vii) Blown through to check for seal.

The syringes used are nominally disposable, but they will last for 1 to 2 weeks depending on the nature of the sampling area and the amount of use they receive. Syringes should be checked before being issued to a sampling pair; when the syringe plunger no longer easily moves then the syringe should be pulled apart and disposed of. When the syringe is observed to return from the field with much sediment adhered to it, it should be removed using tap water (no detergent), or

disposed of if it is not possible to clean. The syringes do not need to be routinely washed in tap water, as they are rinsed at each stream before every sample collection.

11.2.4 Unfiltered stream water sample collection

The pH and conductivity/alkalinity samples should be collected immediately after the filtered water samples. Like the filtered samples, they should be collected from the mid-stream flow, on the upstream side of the sampler.

Thoroughly rinse the sample containers and caps with stream water **thrice**. Submerge the containers in the stream to fill; then seal underwater, ensuring that all air has been expelled. Place the unfiltered samples into a clean, self-seal polythene bag along with the knotted bag containing the filtered water samples.

11.2.5 Water colour and suspended solids

The water colour and suspended solids need to be determined and entered on the field card, a job undertaken during the sediment collection. This is assessed by filling a polythene bag (6 x 17 in) with water and holding it up against the sky as a background.

11.2.6 General quality control procedures for filtered water samples

Filtered water samples, especially those for trace element analysis undergo the most low-level and sensitive analyses and are the most susceptible to contamination of all the samples collected by G-BASE. Special attention must be paid during their collection, collation and storage.

1. Unused sample containers must be stored in a covered, dust-free environment. This should be checked daily and any contaminated bottles disposed of.
2. Field samplers must use clean plastic bags for storage and transportation of unused sample containers and collected samples. They should not use recycled dirty bags for either of these purposes.
3. Filtered water samples should be placed inside a clean 6 x 17 in polythene bag tied with a knot, then transported in a self-seal polythene bag to avoid contamination.
4. Filters should be used for one sample site only and changed for duplicate sites.
5. If samples cannot be filtered at site due to a high proportion of suspended material, a second 250 ml container of unfiltered water should be collected. Samples (especially F/A) should be filtered as soon as possible on return to the field base using pre-filters as necessary. Adsorption of cations to walls of the container presents an unquantifiable error that must be minimised. If only one sample can be filtered at site then the priority should be to do the F/A sample first. Particularly difficult samples may be allowed to stand overnight prior to filtering but this should be avoided where possible and recorded on the card and in the database.

Photograph 8: Filtered water is collected with a syringe and passed through a filter into a Nalgene™ bottle

11.3 STREAM SEDIMENT AND PANNED CONCENTRATE SAMPLE COLLECTION

Before proceeding with the collection of a stream sediment sample hands must be clean, rinsed in stream water and free from jewellery, plasters or any hand creams or lotions

1. *Sampler 1.*

Following collection of any water samples (Section 11.2) wash the trenching tool, sieve nest, both pans, the plastic funnel and both sets of thick black rubber gloves with stream water. The sieve nest comprises two circular wooden frames (approximately 45 x 15 cm), housing 2000 µm and 150 µm aperture nylon sieve cloth in the upper and lower sieves respectively. The sieve nest should be assembled on top of the glass-fibre pan, in a stable position, as close to the sediment collection point as possible. The collection pan and sieves must be clean and free from any particulate matter prior to commencement of sampling.

The sediment collection position should be an active area of the stream bed, and should ideally be centrally placed in the stream, to minimise contamination from any bank slip material. Firstly, remove the uppermost (10 to 20 cm) heavily oxidised sediment using the trenching tool. Secondly, load the top sieve with coarsely sorted sediment from beneath the oxidised layer, taking care to drain off excess water and remove any large clasts before placing the material into the top sieve. If the sediment lies on a base of peat or clayey till, take care to ensure that the sediment is sampled without digging into the underlying fixed material. It will normally be necessary to dig 15 - 25 kg (wet weight) of material to provide a sufficient final sample weight.

2. *Sampler 2.*

As loading proceeds, the other member of the team rubs the stream sediment through the top sieve, providing sufficient <2000 µm material in the lower sieve to produce adequate <150 µm material (normally 2-3 kg). During this process look out for any contaminant material in the sediment, which should be removed from the sieve and the details noted on the field data card. Before the upper sieve becomes too full and heavy it should be removed and shaken to allow more <2000 µm material to fall through into the bottom sieve. The upper sieve material can then be discarded and this material is often worth observing for stream clast lithologies, which are noted on the field data card. Several cycles of filling, rubbing, shaking and discarding of the top sieve material may be required to provide enough material in the lower sieve. This is dependant on the physical nature of the stream sediment material. Once there is sufficient material in the lower sieve it should be mixed around and rubbed, to allow < 150 µm material to pass through into the grey glass-fibre pan. If the lower sieve material is very dry and sandy it is often necessary to sprinkle a small amount of water into the lower sieve while mixing and rubbing the material. When the lower sieve material has been well mixed and rubbed through, rinse the rubber gloves and then use the funnel to rinse any particulate material off of the top rim and outer sides of the lower sieve, ensuring that the volume of water which goes into the sieve is kept to a minimum. The lower sieve should then be picked up carefully, without disturbing the glass-fibre collecting pan, and gently shaken to allow additional <150 µm material to fall through into the collecting pan. If there appears to be insufficient material in the collecting pan, the lower sieve may be replaced and the material re-mixed and rubbed while sprinkling with a small volume of water (<100 ml). The gloves and sieve top and outer sides should then be re-rinsed and the sieve carefully lifted and shaken as before. Take particular care at this stage to avoid biasing the sediment sample by incorporating oversize material. Once there is enough sediment in the collecting pan, remove the lower sieve and retain the <2000 µm material which it contains. Leave the pan containing the <150 µm sample undisturbed for 20 to 25 minutes to allow the settling out of suspended material. During the settling out period, collect the heavy-mineral concentrate

.

3. *Sampler 2.*

To obtain the panned heavy-mineral concentrate, transfer the <2000 µm material retained from the sediment collection process into the wooden Malaysian "dulang" style pan, using water from the funnel to wash all the material from the sieve. In addition, collect further wet <2000 µm sediment from as deep as possible within the stream bed, using the top sieve placed directly on the wooden pan. Copious amounts of water may be used to aid sieving at this stage. Once the wooden pan is almost full of <2000 µm material the panned heavy mineral concentrate is then collected using the following three stages;

1) Removal of clay and organic material which binds grains together by repeated washing and stirring of the material in the pan. The pan should not be submerged during this procedure but clean water should be continually added and dirty water poured out. Once the grains feel well separated and the water being poured out looks relatively clean, proceed to stage 2.

2) Formation of heavy-mineral bed by vigorous shaking of pan with ample water for a minimum duration of two minutes. This allows density separation in the pan material and is extremely important before proceeding to stage 3.

3) Selective removal of the less dense fraction by circulating the pan on the surface of the water in an elliptical fashion to yield 20 to 40 g of heavy mineral (density greater than 2.9 g/cm^3) concentrate. This process is best demonstrated by an experienced sampler and it is important during stage 3 to regularly stop circulating and re-shake the material to maintain density separation.

Inspect the final concentrate with a hand lens and note the presence and relative abundance of heavy minerals on the field data card. Finally, use the funnel to transfer the concentrate material to a numbered (see below), 3 x 5 in Kraft™ envelope using sufficient water to ensure complete recovery of all grains.

4. *Sampler 1.*

After digging the material for the stream-sediment and heavy-mineral concentrate samples, copy the sample number from the pre-numbered field card to all the sample containers required for the site, using the black marker pen. Below the sample number, write the sample type code (C for sediments, P for pan concentrates) and below that, the initials of the sampling pair with those of the person completing the data card first. Using co-ordinates from a GPS and a Knox Protractor, mark the exact site location, in red biro, on the field map by means of a small line perpendicular to the stream flow. Beside this line write the final four digits of the sample site number as shown on the field data card. At this stage also note other details on the field card in red biro. These include stream clast composition and relative abundance and also the presence and colour of any clast precipitates. Also note the type of stream channel, level of flow, bedrock type, drift composition, surrounding land use and the details of any contamination. Site locality details should also be noted on the field card as a back up to the field map and GPS co-ordinates.

Next, put on a pair of rubber gloves, clean them in the stream water, then return to the grey sediment collection pan and slowly decant excess water from the surface. Homogenise the remaining sample by firmly, but carefully, shaking the pan to mix the dense, particulate material with the fine colloidal fraction. This is important as if there is an excess of material, any portion discarded must be the same as the portion which is retained (final sample volume = 200–250 ml). At this stage, the sediment details (colour, clay, organic and colloidal content) should be noted. Next, thoroughly rinse clean the polypropylene funnel with stream water then transfer the sample, via the funnel, to the appropriate, numbered Kraft™ paper bag (4 x 8 in). Seal the Kraft™ envelope by folding the tab over three times and bending the wire fixings over the ends of the envelope. Place the sealed Kraft™ envelope in a 6 x 17 in polythene bag and tie a loose knot in the polythene bag to prevent loss or contamination during transport. Place this sealed

sample into a plastic box, and then into a rucksack, taking care to ensure that the Kraft™ bag is upright.

Before leaving the site, as was performed on arrival, thoroughly rinse all equipment to remove traces of particulate material to avoid between site contamination. Also, check the field data card to ensure that all observations have been noted. If any field observations are not applicable at a site, e.g. there is no contamination, score through the relevant box so it is clear that the observation was investigated. Finally, on departure, check that all of the samples and field equipment have been packed in the rucksacks to be taken to the next site.

11.4 SAMPLING A DRY DRAINAGE SITE

1. If a site is dry (or too little water is present to allow the normal stream-sediment sampling procedure to be carried out), but not grassed over, a ‘dry sample’ should be collected.
2. Select the site in the usual manner and set up the coarse sieve and wooden pan. After removal of the surface sediment layer, sieve enough of the - 2 mm dry sediment to fill two large plastic self-seal bags. Number the bags with the appropriate sample number and collectors initials.
3. Mark the sample number on the map and fill in the field card as normal, except for the sediment details that can be completed after the sample has been wet-sieved through the 150 µm sieve at another site or at the field base. The sample should be recorded as a ‘dry sample’ in the field data comment box and annotated on the field map as such.
4. Clean the sieves as well as possible at site and then wash before use at the next stream site. If a convenient site for washing equipment is passed between sites, this should be used in case the next site is also a ‘dry site’.
5. Wet sieve the dry material at the next wet site (if time permits) or on return to the field base, remembering to add the sediment details to the field card. A panned heavy-mineral concentrate should be collected if possible and it should be noted on the card if this was from a smaller than normal volume of starting material.

Photograph 9: Sediment is shovelled from the stream bed

Photograph 10: The sediment (with large stones removed) is initially rubbed through a 2 mm screen

Photograph 11: The fine sediment is wet sieved through a 150 µm screen and collected in a fibre-glass pan

Photograph 12: The -2mm +150 µm is panned using a wooden "dulang" style pan

11.5 WATER MONITOR SITE

1. Each team should maintain a stream-water monitoring site from each field base. This should be sampled every day that field teams are working.
2. The site should be selected using the normal guidelines and should preferably be on a 1st or 2nd order stream. Ideally the stream should be representative (in terms of geology and geomorphology) of the majority of sites intended to be sampled from the field base. Ease of access to the site; proximity to the field-base and a parking place for the Landover also form part of the site selection process.
3. Monitor-sample location and NGR should be noted in the water chemistry book and on the planning map. It is also useful to note ownership details if the site is to be used in future years.
4. The daily sample should be allocated the next available number on the random number list in current use for sediments/ waters. The 'sample type' should be listed as 'MS*x*', where MS represents Monitor Site and *x* the sequential number applied to the monitor site through the field season, e.g. the first monitor site used will be 'MS1'; this labelling allows easy extraction of the data from the database. Where more than one field team is operational, the allocation of odd and even values of '*x*' to the respective teams should be determined before the field season commences.
5. Five samples are collected: pH; alkalinity/conductivity; F/A; F/UA; and Fe(II). The Fe(II) sample consists of a 15 ml test tube pre-dosed with 2',2-dipyridyl, which should be filled to the 15 ml mark with filtered water. Ideally these samples are collected at a similar time of day, each day.
6. It is not necessary to record full details of the site on the sample card every day, but it important that all details are recorded on the first visit and then any observed changes in conditions are noted on subsequent field cards. An example of the expected information recorded is given in Figure 11-1.
7. Subsequent to collection the samples are treated exactly as the other stream water samples, according to sample type. The Fe(II) samples are stored in numerical order in a test tube rack.

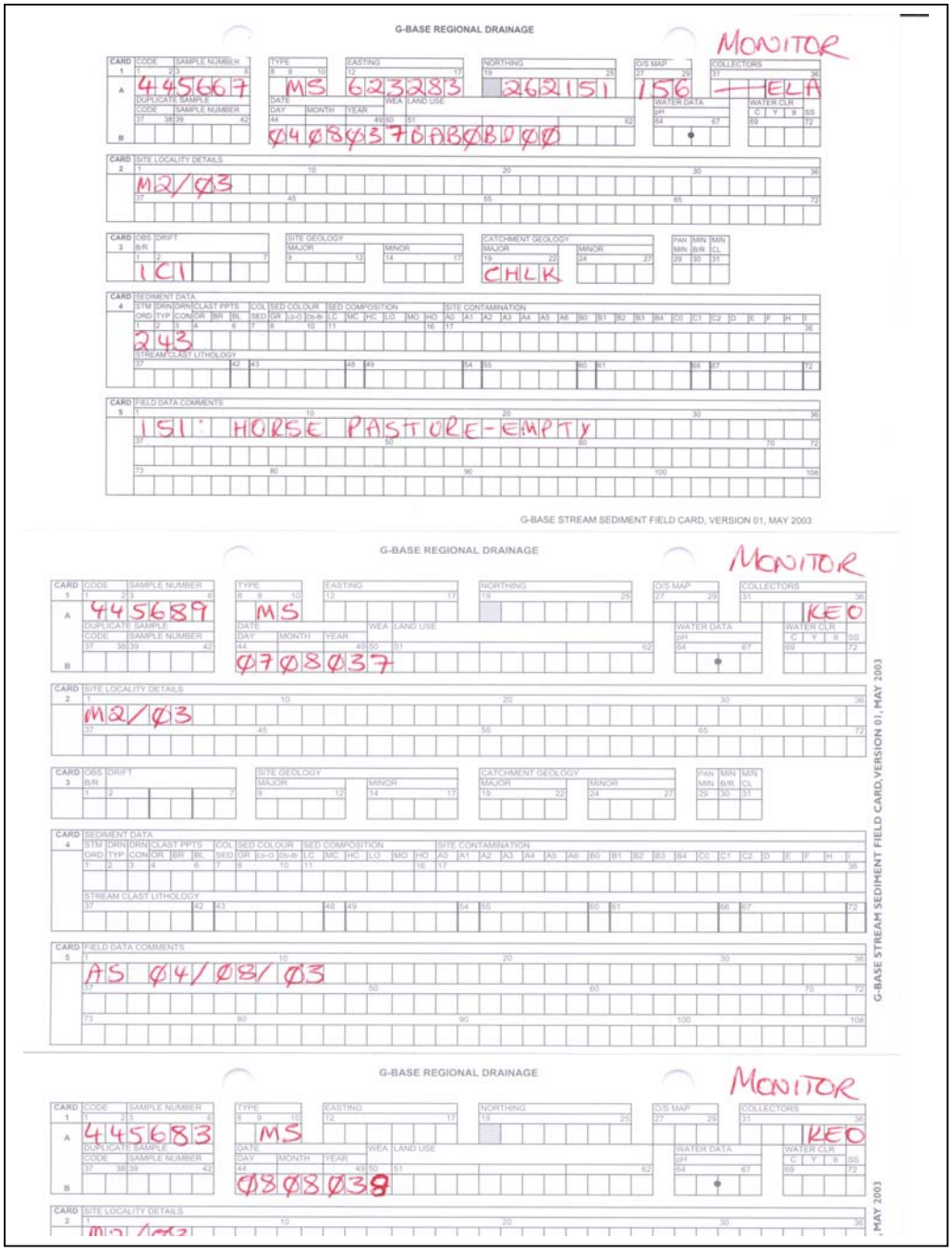


Figure 11-1: Examples of Monitor Site field card entries

12 Collecting Soil Samples

Soil samples are routinely collected as part of the G-BASE sampling strategy. There is a distinction made between soils collected in urban and non-urban areas, the latter are also referred to as "regional" soils reflecting their collection as part of the regional geochemical mapping. Urban areas for the purpose of G-BASE work have no strict definition but are indicated by the Ordnance Survey 1:50 000/1:25 000 scale maps as built up areas and are easily delineated. There is often a 1 to 2 km overlap between regional and urban area.

12.1 NON-URBAN

For non-urban areas the following procedure is used:

1. One sample site per alternate 1 km grid square on the OS 1:50 000 topographic maps - preferred site locations to be indicated on field maps. Sites are located at least 100m from roads, buildings, railways, electricity pylons etc. on open unforested, undisturbed ground whenever possible.
2. Two samples (**A** and **S**) are collected from each site, with the same sample number. The sample bags should be labelled with the sample number, with **A** or **S** as appropriate and with the samplers' initials. The initials of the person marking the map and field card should be written first.
3. Each sample is made of a composite of material from auger flights taken from 5 holes distributed within an area (where possible) of approximately 20 m x 20 m. Auger holes should be located at the corners and centre of a square (Figure 12-1). Large 5 x 10" (12.5 x 27cm) Kraft™ bags are used. The auger should be vertical when used. **An initial auger sample should be collected and discarded at each site so as to "clean" the auger flight.**
4. Sample **A** is collected to a depth of 20 cm, after removal of surface vegetation and surface litter and root zone. Generally in ploughed fields with growing crops an organic surface litter and root zone will be absent, in grasslands a rootlet zone may extend down to 5 cm. With a 15 cm auger flight the sampling depth can be generalised to 5 to 20 cm. The bottom depth is recorded on the field card and the depth of any rootlet zone and surface litter should also be noted.
5. Sample **S** is collected to a depth of 50 cm with the objective of sampling below any ploughed horizon, the actual depth sampled to is recorded on the field card. A maximum sampling depth of 50 cm is indicated by a mark (usually tape) on the sampling auger. With a 15 cm auger flight the sampling depth can be generalised to 35 to 50 cm.
6. Over terrains where only thin soils have developed e.g. over chalk, then a surface A sample should be collected from the normal surface depth, i.e. 5 to 20 cm and the S sample from as deep as possible down to bedrock. In such instances there may be little difference in the sampling depths between the A and S samples.
7. At duplicate sites, a second series of A and S samples (with different sample number) should be collected from an adjacent 20 m x 20 m square (see Figure 12-1) with no more than 1 m separation from the original sampling square.
8. Each sampling pair should use only one soil auger. Using two augers will speed up sampling, but will also introduce non-standard sampling practice.
9. The national grid reference cited for the sample site should be that of the central hole in the five hole sampling plan.

10. If good full auger flights are collected from each of the five auger holes (e.g. in clay soils) more sample may be collected than can be fitted into the sample bag. In such instances a representative sample of each auger sample should be collected by taking a sub-sample of the entire length of the auger flight.
11. In all instances, every auger sample should inspected prior to putting in the sample bag and extraneous material on the peripheries of the auger flight should be removed and discarded.

12.2 URBAN

In urban surveys the following procedures should be followed:

1. Four sample sites are located within each National Grid one km square on 1:25 000 topographic OS map. Sample sites are notionally located at the centre of each the four 500m x 500m squares within the kilometre square (see Figure 12-2). Sampling is carried out on the least disturbed area of unbuilt ground as close to the centre of each of the 500m sub-cells. This may be domestic gardens, allotments, parks, recreational ground, or road verge. Point source contamination will be avoided (e.g. soil under a pile of tipped rubbish will not be sampled) and the choice of site should be a good representation of the land-use in the sub-cell being sampled.
2. Two samples (**A** and **S**) should be collected from each site, with the same sample number. The Kraft bag should be labelled with the sample number, with **A** or **S** as appropriate and with the samplers' initials. The initials of the person marking the map and field card should be written first.
3. Each sample should be made of a composite of material from auger flights taken from 5 holes distributed within an area (where possible) of approximately 20 m x 20 m. Auger holes should be located at the corners and centre of a square (Figure 12-1). Large size Kraft bags should be used (10 x 5" 27 x 12.5 cm). **An initial auger sample should be collected and discarded at each site so as to "clean" the auger flight.**
4. Sample **A** is collected to depth 20 cm, after removal of surface vegetation and the surface litter and rootlet zone (usually < 5 cm). With a 15 cm auger flight the nominal sampling depth is therefore 5 - 20 cm. The depth sampled to is recorded on the field form and the depth of surface litter (and rootlet zone) removed should also be recorded.
5. Sample **S** is collected to a depth of 50 cm, with a 15 cm auger flight the nominal sampling depth is therefore 35 - 50 cm. A maximum sampling depth of 50 cm is indicated by a mark (usually tape) on the sampling auger.
6. Where sampling at depth is difficult, S should be collected from as deep as possible and the details marked on the field data card.
7. At duplicate sites a second series of A and S samples (with different sample number) should be collected from an adjacent 20 m x 20 m square (see Figure 12-1) with no more than 1 m separation from the original sampling square.
8. Each sampling pair should use only one soil auger. Using two augers will speed up sampling, but will also introduce non-standard sampling practice.
9. Location details in urban areas should be appropriate to the environment being sampled, e.g. including the road name or house number where it is a verge or garden sample. The grid reference for the site should be that of the central auger hole. GPS readings for the grid reference should be checked against the map **whilst at site**, because considerable errors can be introduced by large buildings or trees, which are common in urban areas. Where there is a discrepancy between the GPS and the map grid coordinates, it is the latter that should be entered in to the field database and a note made on the field card.

10. If good full auger flights are collected from each of the five auger holes (e.g. in clay soils) more sample may be collected than can be fitted into the sample bag. In such instances a representative sample of each auger sample should be collected by taking a sub-sample of the entire length of the auger flight.
11. In all instances, every auger sample should inspected prior to putting in the sample bag and extraneous material on the peripheries of the auger flight should be removed and discarded.

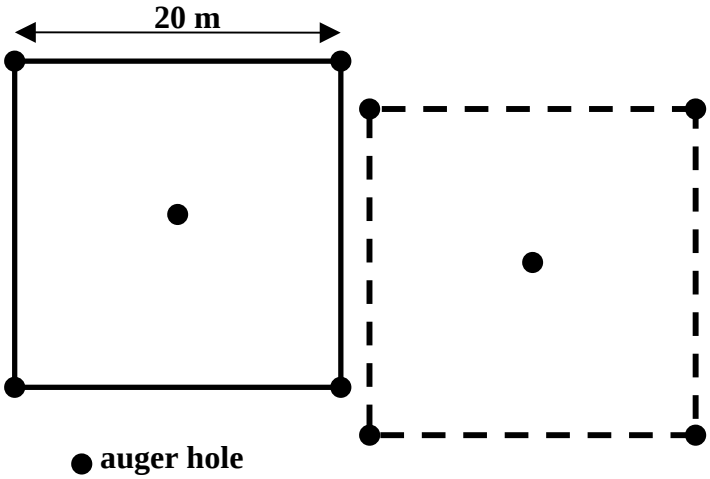


Figure 12-1: Plan of composite auger holes for collecting a soil sample (dashed square represents adjacent duplicate sample)

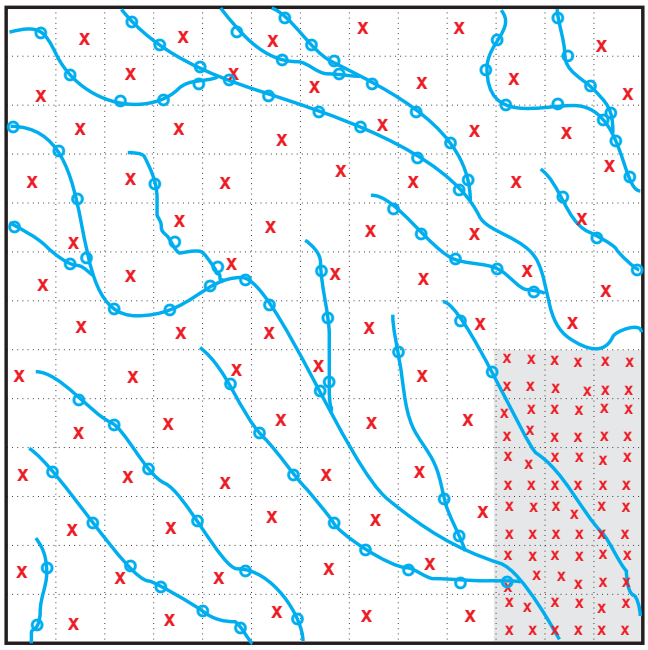


Figure 12-2: Idealised plan of G-BASE sampling strategy showing soils sites for urban and non-urban areas

The grid represents one kilometre squares and the urban region is shaded. Circles represent drainage sites (on streams) and crosses represent soil sites

Photograph 13: Soil sampling is done using a one metre soil auger

Photograph 14: Soil from the auger head is transferred to a Kraft™ paper bag

13 Collecting Samples for Quality Control and Quality Assurance monitoring

Some samples are collected for error monitoring procedures to establish the validity of variation between samples collected. The different control samples collected are described below.

13.1 STREAM SEDIMENTS AND SOILS

13.1.1 Duplicate samples

1. One site in every batch of 100 is designated for collection of a duplicate field sample. Specific pairs of sample numbers, and field cards, are allocated to the primary sample and the duplicate.
2. At soil sites the duplicate should be collected from an adjacent 20 x 20 m square to the original sample (see Figure 12-1). Both A and S samples should be duplicated. The bags should be labelled normally with the appropriate sample number, sample-type code and samplers' initials.
3. At drainage sites, the duplicate sediment should be collected from within 25 m of the original. The stream sediment sample should be duplicated, but not the panned concentrated. Details on the aqueous duplicates are given below. All are labelled normally, with the appropriate allocated number. They should not be marked as a duplicate as these control samples should be seen by the laboratories as a normal routine sample.

   In areas of the country with significant numbers of 'dry sites', the duplicate sediment/ aqueous sample numbers should be allocated to a sample pair with sufficient sediment sites to enable them to choose a non-dry site for the duplicate sample collection.

13.1.2 Replicate samples

Replicate samples are prepared in the laboratory by taking a sub-sample from the duplicate sample. Replicate A is a sub-sample of Duplicate A and Replicate B is a sub-sample of Duplicate B. ANOVA analysis of results helps to determine the within site, between site and laboratory variability. Replicate samples are also referred to as "sub-samples".

13.2 STREAM WATERS

13.2.1 Duplicate and Replicate Samples

Duplicate stream waters are collected at a drainage site designated for duplicate collection as per item 3 in Section 13.1.1. The samples for pH and alkalinity are collected as per standard site, i.e. one sample of each is collected at each duplicate site.

Rather than the standard sample bottles used for filtered water collection, a single, pre-labelled new 250 ml Nalgene^{TM} sample bottle should be filled with filtered water at each site. These sample bottles are provided to the sample team in their 'map pack', each in a polythene bag (6 x 17 in). The sample bottles are pre-labelled with the sample numbers of duplicate A and duplicate

B respectively and the text ‘Filtered Water’. The latter point is to avoid any possible confusion with the alkalinity sample bottles. The sampling team allocated these samples should be provided with extra 0.45 μm filters.

After rinsing and filling with filtered water at the appropriate site according to the sample number on the field card (taking all the usual care to maintain the cleanliness of the sample during sampling), the bottle should be returned to the polythene bag, a knot tied and placed in a larger self-seal polythene bag with the pH and alkalinity bottles.

After all the daily samples have been checked in by BGS staff the duplicate samples should be split, to provide F/A and F/UA samples for the Duplicate A (DupA), sub-sample A (SSA), Duplicate B (DupB) and sub-sample B (SSB) sample numbers. These bottles should be pre-labelled with the appropriate numbers and text and the ‘A’ split bottles and ‘B’ split bottles stood apart from each other in order to avoid incorrect transfer of samples.

The duplicate A 250 ml sample should be used to rinse and fill the duplicate A and sub-sample F/A and F/UA bottles (which should be labelled only with the sample number and appropriate text). This procedure should be repeated with the duplicate B 250 ml sample. The F/A samples should then be acidified with the rest of the day’s samples and both sample types should be checked off on the RNL and stored appropriately. Because these samples are labelled in identical fashion to the field collected samples they provide ‘blind’ quality control checks within the analytical batches, as described for sediments and soils (Section 13.1.2).

13.2.2 Blanks

In every batch of 100 stream water sample numbers there should be two blank waters. These are made up in the field camp by using deionised (18 μΩ Millipore) water (DIW) from a 5 litre carboy. The carboy in the field base should be stored in a clean environment and its tap protected from contamination by parafilm, especially when being transported, where experience shows that the carboy is most likely to become contaminated. The deionised water will be issued from the BGS "E" block laboratory on a regular basis. Two blanks should be made up for each sample number, i.e. F/UA and F/A and labelled with the appropriate sample number. There should be no additional labelling as the samples should appear like any normal sample to the analyst.

It is important to note that these samples are created by rinsing the F/A and F/UA sample bottles with the DIW, before filling them and then acidifying the F/A with the rest of the day’s samples. These samples (although labelled F/A and F/UA), are not filtered and are therefore not full procedural blanks.

The carboys used by the field team should be acid cleaned before the start of the field season, including the outer part of the tap fitting in order to maintain the quality of the water used.

13.3 STANDARD REFERENCE SAMPLES

For every batch of 100 samples collected in the field there are two sample numbers are reserved for standard samples (see Appendix E). These standards are inserted into batches during sample preparation at the BGS laboratories in Keyworth. These standards are more correctly referred to as "secondary reference material" and they are used for G-BASE error control. Primary reference materials (international standards) are routinely analysed by the laboratories for their own error control and are independent of the G-BASE QA/QC procedure.

The standard reference materials have been prepared by the G-BASE project to be representative of materials collected from the on-going field areas. These are included in laboratory batches "blind" to the analysts to ensure strict monitoring of laboratory and analytical error. Reference materials used by G-BASE are summarised in Table 13-1. Secondary water standards are included in the water sample submission.

Sample ID	Media Type	Origin of sample	Collected by	Date
S3B	Stream Sediment	Grudie Granite, Sutherland	R T Smith T R Lister	Sept 1987
S13B	Stream Sediment	Mineralised Carboniferous Limestone	D M A Flight T R Lister	Sept 1997
S15B	Stream Sediment	Triassic Sandstone/Shale	D M A Flight T R Lister	Sept 1997
S23B	Stream Sediment	Shap Granite	D M A Flight T R Lister	Sept 1997
S55	Soil (Sub-surface)	Mercia Mudstone	D M A Flight J Freeman	Sept 1997
S56	Soil (Sub-surface)	Sherwood Sandstone	D M A Flight J Freeman	Sept 1997
S57	Soil (Surface)	Sherwood Sandstone	D M A Flight J Freeman	Sept 1997
S22B	Stream sediment	Carrock Fell Granite	T R Lister et al	Dec 2003
S24B	Stream sediment	Mineralised shale, Lake District	T R Lister et al	Dec 2003
FERN	Stream water	Mercia Mudstone Group, Notts	E L Ander S E Brown	Feb 04
PLT	Stream water	Mercia Mudstone Group, Notts	E L Ander S E Brown	Feb 04

Table 13-1: Summary of secondary reference materials used by the G-BASE project

14 Field sample checking, collation and storage

14.1 CHECKING SAMPLES

Samples collected in the field by VWs must be checked off on a daily basis and then double-checked before dispatch to Keyworth.

14.1.1 Daily checking

1. On return from the field, each sampling pair should lay their samples out in ascending numerical order (left to right), with samples from each individual site arranged horizontally. The order of each sample type should be consistent: e.g. samples from each drainage site should always be laid out top to bottom in the order C, P, alkalinity/conductivity, pH, F/UA, F/A. Soils should be laid out in numerical order in two rows with 'A' samples on the top row above respective 'S' samples. Samples should not be laid out on dusty or gravely ground where water sample containers may become contaminated - lay them out on a clean plastic bag.
2. Checking off should be carried out by staff or SVW and, when possible, by two persons; one person to check the numbers marked on samples and to call them out, and the second to mark off the checklist (printed with the corresponding RNL as a double-sided document).
3. Before marking off on the check list, the number and sample-type code on each sample should be checked for legibility and any obvious inconsistency with other samples from that site. Corrections should be made clearly in black marker pen.
4. The member of staff calling out the numbers should use the VWs field cards to ascertain which soil samples will be selected for pH and LOI analysis in the Keyworth laboratories. This is done by taking the soil samples that have an even numbered 1 km grid square Easting. This selection process ensures that overall 50% of the samples are selected (the desired target). Duplicate soil sites should also always be selected along with the associated sub-samples. This procedure has been automated in MS Excel, but is found to be a useful double check on VWs cards immediately on their return from the field.
5. Two types of checklist are used, one for samples that are dispatched to the sample preparation facility at BGS headquarters in Keyworth and a second for filtered water samples which are dispatched to the Keyworth laboratories (see Appendix G). Both have four variations (corresponding to RNL 1, 2, 3 or 4) and it is essential that for each batch of 100 the two different check lists are from the same RNL. Numbers and sample types should be called out and marked off on the sample checklist with a diagonal line through the check box.
6. If a sample has previously been checked off, the problem should be resolved immediately. Firstly, by reference to the reverse of the checklist establish whether that sample number was issued to the sampler in question. If so, then the problem lies with an earlier mis-numbered sample suite that should be found and re-numbered. Conversely, if the sampler was not issued with the sample number then it has probably been wrongly transcribed from the field card by the sampler and this should be checked. Occasionally two field cards may have erroneously been numbered alike; in this event one set of samples and the map and field card must be re-numbered. In this case the newly collected samples must be kept separate until the numbering conflict has been resolved.

7. When checking off has been completed, samples should immediately be put away in appropriate storage containers (except those requiring further treatment, i.e. F/A).
8. Any soil, panned or sediment samples requiring re-bagging should be dealt with immediately. A water sprayer (using clean tap water) helps in the task of washing sediment into the bag.
9. Water samples that could not be filtered in the field should also be attended to as a matter of priority, and identified as 'TBF' (to be filtered) on the water checklist.

Photograph 15: Samples are checked in after each day of sampling

Photograph 16: Samples are hung out to dry

Photograph 17: Batches of 100 samples are stored in crates after being checked ready for transportation to the BGS laboratories

14.1.2 Double checking:

1. On completion of each batch of a hundred samples, every sample number should be double checked before dispatch to the Keyworth laboratories. This is most efficiently carried out by two persons at least one of whom should be staff or SVW. The A, S and C samples should be checked into crates in numerical order for return to Keyworth, in order to minimise errors on dispatch and receipt.
2. For each sample type every individual sample should be identified and checked off on the sample-number list (using a diagonal stroke perpendicular to the original).
3. Any unclear labelling should be dealt with.
4. Lids should be tightened on water bottles.
5. Any inconsistencies should be dealt with by reference to check lists, field cards, field maps and initials on sample bags. In the worst instance, if two samples are numbered alike and the problem cannot be resolved then both should be disposed of and another recollected from the appropriate site or sites.
6. Decomposing soil bags should be replaced by new ones.

14.2 COLLATION OF WATER SAMPLES AT FIELD BASE

After the samples have been checked in at the end of the day the following procedures should be carried out with the water samples:

1. pH sample: All numbered 30 ml bottles labelled ‘pH’ are placed in an appropriate receptacle, e.g. clean plastic bucket. Samples are placed in the designated water chemistry room, along with pH buffer solutions and pH meter for a minimum of two hours to allow temperature equilibration to take place. Analyses should be conducted the same evening, in the water chemistry room (Section 16.1).
2. Total alkalinity/conductivity sample: All numbered 250 ml bottles are placed in an appropriate receptacle, e.g. clean plastic tub. Samples are left to stand in the field office overnight, to equilibrate with the standards. Analyses are conducted the following morning using the procedures in Sections 16.2 and 16.3.
3. Major anions/ NPOC sample: All numbered 30 ml Nalgene™ bottles labelled ‘F/UA’ are placed in an appropriate receptacle, e.g. clean plastic bucket. Ensure that sample numbers are written legibly and bottle caps are tightly secured. Rinse any dirt from the caps using DIW. Samples are then placed into the appropriate large self-seal plastic bag, pre-numbered with the "hundred" sample number range. These are then stored in a fridge. The samples are transported to BGS Keyworth in cool boxes.
4. ICP sample: All numbered 60 ml Nalgene™ bottles labelled ‘F/A’ are placed in an appropriate receptacle, e.g. clean plastic bucket. Ensure that numbers are written legibly and bottle caps are tightly secured. Rinse any dirt from the caps using DIW. Samples are treated with concentrated nitric acid the same evening (see Section 14.3). Samples are then placed into the appropriate large self-seal plastic bag, pre-numbered with the sample-number range, in batches of 50 sequential numbers. These can be placed in a box and stored in a secure and cool place.

14.3 ACIDIFICATION OF WATER SAMPLES

1. This is a high risk procedure, if not carried out correctly, and Health and Safety information provided (Appendix F of the project Health & Safety file) must be consulted before commencing the acidification. Only BGS staff should carry out this procedure. Goggles, plastic gloves and a laboratory coat must be used. Any skin exposure to the nitric acid should be treated immediately with copious water.
2. The F/A samples should be acidified each evening as soon after collection as possible.
3. Acidification is carried out in a clean, well-ventilated, dust-free area, and clear of cigarette smoke. Hands must be clean and plastic gloves worn. This task should be commenced when it can be completed uninterrupted (to minimise errors). Be aware of possible contamination: e.g. putting hands in pocket and handling coins.
4. Aristar-grade nitric acid 100 ml bottles are used. One bottle should be used per week of sampling (Mon-Sun). The day of starting the bottle it should be labelled with the year, field base, week and the date of starting (e.g. 2003 - Monk Soham - week 5 – 02/08). If more than one field team is operating, then that should be identified on the bottle too. This information may prove invaluable should contamination be found in the F/A samples with which the acid was used.
5. Samples are lined up in clean, dry, dust-free area. Lids should be removed for the least possible time. Ideally lids should be loosened before starting to use the acid, and then removed only to drop in the acid. Alternatively (for less experienced operators) lids may be placed rim down on a clean polythene bag or a new piece of blue lab roll. Any lids containing any visible particulate matter should be rinsed with a small volume of the sample itself.
6. A new plastic pipette should be used each day when samples are acidified. Used pipettes should be disposed of safely (rinsed 3x with tap water) after acidifications are completed. The pipettes must be kept in a clean sealed polythene bag. Care should be taken not to touch the dispensing end of the pipettes when selecting one. The pipette must not be put down once removed from the bag, and **the pipette tip must not be allowed to touch any surfaces**, except the concentrated HNO_3. This includes the sample bottles into which the acid is being dispensed, and any work-top surfaces.
7. The lid of the acid bottle should be removed only when the pipette is being filled. The lid should be replaced on the acid bottle whilst samples are being acidified; this is to minimise both any vapour release (H&S) and contamination of the acid (QC).
8. The samples are acidified to 1% v/v i.e. 0.6 ml per 60 ml. The pipettes vary in dimensions and are marked for volume along the side. The appropriate number of drops to be added must be checked and standardised at the start of each field season. For 2004 this has been determined as 14 drops of acid for every full 60 ml water sample. For samples less than the full volume then the acid should be added in proportion. One fill of the pipette contains enough acid to treat several samples.
9. Lids must be replaced carefully, and can be tightened once the overall procedure is complete.
10. Samples must be kept a in cool, dark place at all times.
11. The new and used acid must be kept in a safe place in a robust container ('Safepak') which can hold >100% of the bottle volume and is clearly labelled. Once the acidification process is complete the bottle lid should be tightened immediately and the bottle replaced into the closed Safepak container.
12. Used, labelled, 100 ml HNO_3 bottles in Safepak containers should be returned to Keyworth once they are finished with (after the week of use) for more appropriate long-

term storage, rather than all being transported at the end of the field season. They should be left in P035A on the weekend return from the field.

14.4 STORAGE OF SAMPLES

1. Stream sediments: After checking off, stream sediment samples, in Kraft™ bags, should be removed from the plastic outer bag (re-bagged if the Kraft™ bag is damaged) and hung to dry on a line. When they become plastic (like plasticine in consistency) they should be removed from the line and stored upright in crates in batches of 100. Before dispatch to the field laboratory any sloppy samples should be placed in a plastic outer bag.
2. Panned concentrates: Samples in Kraft™ bags should be stored in batches of 50 or 100 in a clearly labelled seal-again plastic bag. The labelling should indicate the sample type and number range, e.g. 420001- 420050 P.
3. Soil samples: Soil samples, in Kraft bags, should be stored carefully (i.e. stacked) in sturdy bread crates in batches of 25 to 30 samples. Crates should not be overloaded to reduce risk of a strain when loading into the vehicle. 'A' and 'S' soils should be stored separately. When possible, soils should be laid out in an open sunlit area, on plastic sheeting, to dry.
4. F/UA Samples should be stored in their 'hundred' in clearly labelled self-seal plastic bags and kept in a fridge. They should be returned to Keyworth in a cool box, and placed directly into the fridge in P035A; they should not be left in a vehicle beyond the time taken to transport them to avoid them becoming heated.
5. F/A: Samples should be stored in batches of 50 (i.e. two for each 'hundred') in clearly labelled self-seal plastic bags and kept inside an appropriate box. They should be placed into the fridge in P035A with the F/UA samples upon return.

All water samples should be stored in a clean environment with minimal contamination potential. Care must be taken to ensure that samples are stored in a location that is not readily open to vandalism, burglary, or sabotage and away from livestock that will cause damage to the samples. Particular care should be taken with hanging the sediment samples to dry - experience has shown that these are the most vulnerable.

Photograph 18: Samples in damaged bags are rebagged during the sample check-in

15 Field Database

Field data is stored in a Microsoft Access 2000 Meta-Database (MDB). All relevant data from the field cards are entered via user-friendly input screens. Field cards should be separated into cards containing sediment data, and cards containing soil data. Each set of cards should then be arranged in numerical order; from lowest to highest sample number.

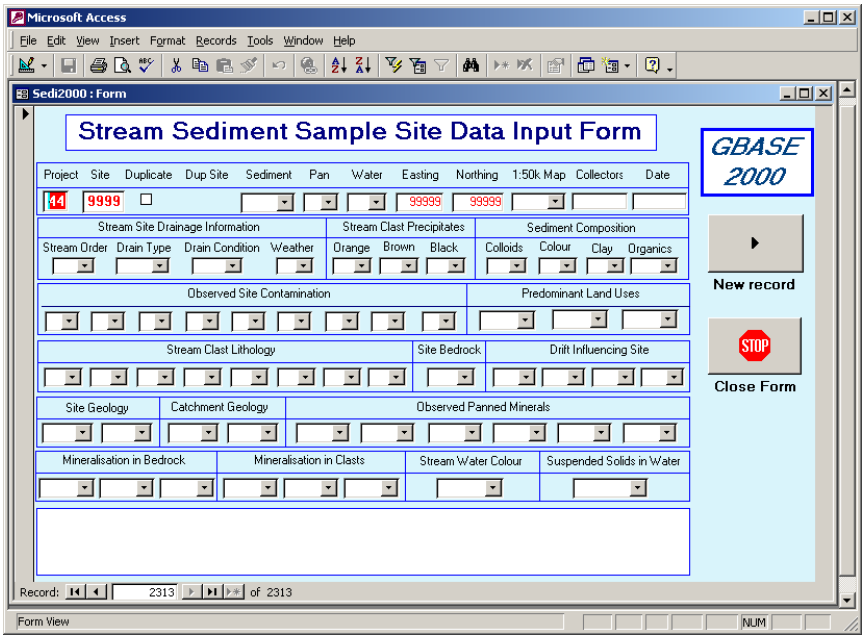


Figure 15-1: Example of field database stream sediment data entry screen

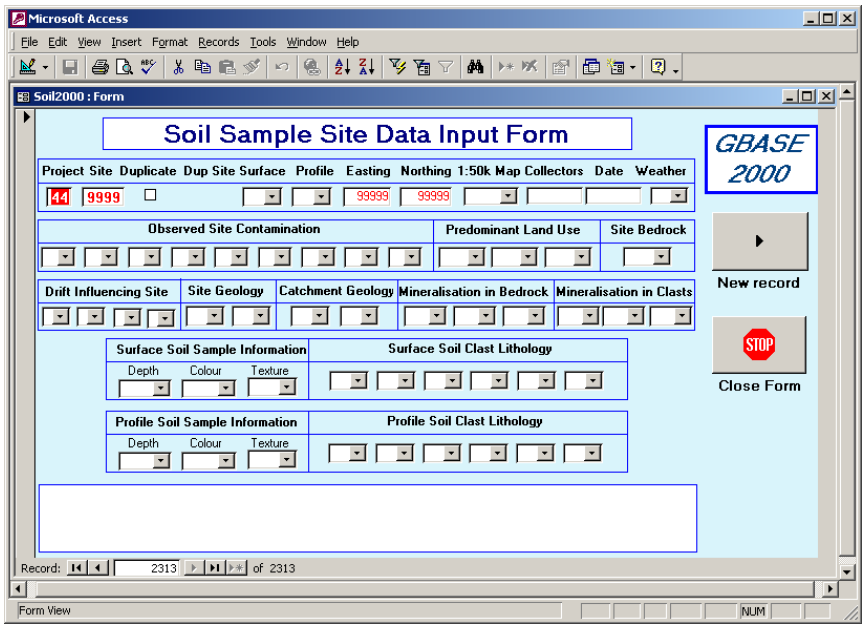


Figure 15-2: Example of field database soil data entry screen

Input screens are designed to facilitate easy data entry, and resemble the field card layout as much as possible (Figure 15-1 and Figure 15-2). Separate input screens are used for sediments and soils. Most data fields are completed using drop-down menus in the input screens. These drop-down menus access data from linked look-up tables, ensuring that only acceptable data may be entered into each field. Key fields such as sample number and grid reference have built-in rules, which prevent, for instance, duplication of sample number, and locations out-with the sampling area being entered. On completion of each record, a blank input screen will appear for entry of the next field card.

15.1 FIELD DATABASE MAINTENANCE

1. The field database is designed to be consistent with field databases used in other areas of work (e.g. Urban geochemistry) and to ensure greater ease of data transfer to the BGS Geochemistry Database.
2. The whole process is menu driven by initialising the file 'MENU.MPX'. A customised pull-down menu bar appears with all the available data operations. The command window also appears by default, and this can be closed by clicking on the white box in the top left corner of the window.
3. Choosing the 'Add Data' option gives three further choices - Sediment, Soil, or STD's. Select as appropriate according to sample type. It is easier if the sediment and soil cards are separated and arranged in ascending numerical order for each sample type before commencing data processing. The data input screens are much revised, having scrollable option windows for many of the entry fields. Previous records may be accessed and amended by using the navigation buttons to move through the database.
4. The 'Browse' option from the 'Database' main menu will allow you to view, but NOT make changes to, the database. 'Edit Data' will allow you to edit records one at a time. The edit mode does not use the data input screen format.
5. 'Add Water Data' will select all the records following your initial entry number which have a 'W' sample-type code. The sample numbers should be the same as those entered in the water chemistry book. Once all water data has been entered, close the data input screen by clicking on the white box in the top left corner of the window.
6. 'Print Report' will print a summary report of the next 100 records following your initial entry number. There is as yet no 'Escape' function available to exit once you have selected this option, so make sure you choose this option intentionally, and that you enter the initial sample number with care.
7. The 'Quit' option automatically creates a back-up (Stream03.bak) of the database (Stream03.dbf). You will be asked each time whether you wish to overwrite the existing version of Stream03.bak. The response is '**YES**'.
8. The database should be backed up onto floppy disk on a daily basis, and the floppy disks stored and transported separately from the lap-top.

15.2 FIELD DATABASE VALIDATION

It is essential that the key fields entered to the database are checked and validated before return from the field campaign. Mistakes are much easier to trace and correct when those involved in collection and entry of the data are still present. All checking operations should be carried out in pairs and should address batches of 100 field cards.

1. For each batch of 100 field cards, the key fields entered on the database should be listed using the "print report" command. The list should be folded and stored with the cards.
2. The location of each sample plotted on the stable base map should be checked against the field card. *Person 1* should read out the 3 digits each for easting and northing which define the 100 kilometre square and the kilometre square part of the NGR (e.g. 350, 462). *Person 2* should locate the square on the stable base map. *Person 1* should read out the remaining two digits of easting and northing which define the sample location to the nearest 10 m. *Person 2* should locate this using a Knox protractor and confirm whether the sample is located correctly on the map. An error of plus/minus 30 m is acceptable. If there is a problem locating the sample then reference should be made to the written locality details on the field card and the original field map. VWs should refer to the field team leader for help as necessary. On occasion the map, database or field card may require modification. When a batch of 100 has been completed the checkers should note this on the list with any modifications made. They should note their initials and the date.
3. On completion of stable base checking, they should proceed onto checking of the printed list against the field card. The key fields checked will include sample number, sample type, easting, northing, date collected and samplers' initials. The checkers should work sequentially through the batch of 100, noting any necessary amendments on the printed sheet. They should note their initials and the date on completion.
4. pH, conductivity and alkalinity measurements should be printed from the database and checked against the hand-written recording book. This print-out should be arranged in date, then sample number, order to facilitate accurate checking (as this layout mimics that of the book). This leads to fewer errors in doing the checking; it will also highlight any errors in the date entry field. Again, this should be carried out in pairs. One person reads from the book while the other checks the list and notes any amendments. On completion they should date and initial the list.
5. Amendments to the database should only be made by the field team leader using the "edit data" option. On completion of edits for a batch of 100 samples, the team leader should note and sign the appropriate listing.
6. The database must be backed up after edits have been made.

Photograph 19: Some water measurements such as pH, conductivity and alkalinity are done at the field base

16 Field Water Sample Measurements

16.1 pH MEASUREMENT USING RADIOMETER PHM80 WITH COMBINATION ELECTRODE

pH measurements must be made on the same day as sampling, after allowing time for samples and buffers to equilibrate to similar temperature.

1. Electrode preparation: Remove the parafilm covering from KCl filling hole at top of combination glass electrode. Ensure that 0.5 - 1.0 cm of KCl crystals (see separate hazard sheet) are present in base of electrode (refill as necessary using crystals or saturated solution provided, referring to manufacturers instructions). Air bubbles in the electrode bulb or red reference stems should be removed by gentle shaking. Insert the electrode plug into the combination socket at the side of the meter.
2. Samples should be arranged in ascending numerical order and listed in the water chemistry book, along with weather, temperature (of samples), ID number of the electrode used and calibration details. The initials of the analyst should also be recorded.
3. Calibration: **Calibration must be undertaken before any pH measurements of samples are made.**
    a. Using the thermometer provided, measure and record the temperature of the first sample (all buffer solutions and samples should be left to equilibrate at room temperature for at least 2 hours before measurement). Immediately replace the lid of the sample bottle after temperature measurement. Press the 'Temp' button on the meter. Using the ***set temp*** control, adjust the displayed temperature until it is equal to the temperature of solutions to be measured.
    b. Press the 'pH' button on the meter. Rinse electrode with de-ionised water (DIW) and dry gently with tissue. Immerse electrode in buffer 7 solution, gently agitate and allow the reading to stabilise. It should do so rapidly when measuring buffer solutions. Adjust the displayed value to 7.00 using the ***buffer*** control. Note that electrode is very delicate and must not be allowed to touch the base or walls of the sample container.
    c. Rinse electrode thoroughly with DIW. Dry gently with clean tissue. Place in buffer 9 and measure as above. Adjust the displayed value to 9.00 using ***set temp*** control.
    d. Rinse electrode thoroughly with DIW. Dry gently with clean tissue. Place in buffer 7 and allow reading to stabilise. If correctly calibrated the instrument reading should be 7.00. If this is not the case, recalibrate as from b above, otherwise proceed to e.
    e. Rinse electrode with DIW and dry gently with clean tissue. Immerse in buffer 4 solution and record the reading (an acceptable pH range is 3.9 - 4.2). If overall pH range of samples is acidic then calibration should be carried out using buffers 7 and 4.
4. Sample pH measurement:
    a. After rinsing with DIW, rinse the electrode again with a small volume of the sample to be measured. Immerse the electrode in the bottle containing the sample, gently agitate, and record the reading after it has stabilised. If pH

reading drifts, leave for a maximum of 1.5 minutes before recording reading. As above, do not allow the electrode to rest on the bottle base

b. This procedure is repeated for every sample. Caps should only be removed from individual sample bottles as they are measured, and replaced immediately after measurement. No samples should be discarded until the whole procedure is complete (including re-checking the calibration at the end). The first three samples in each daily batch are re-measured at the end; values should be clearly recorded next to the original reading. Any "unusual" results (i.e. notably different from neighbouring samples) should also be re-measured and the second value noted.

5. Re–measurement of buffers:

   a. Buffers 7, 4 and 9 should be re-measured and the readings recorded.

   b. If the repeated measurements of samples are more than 0.4 pH units out and the buffers are more than 0.1 pH units out, the instrument should be recalibrated and the entire batch should be re-measured after recalibration of the pH meter. Remember to switch off the pH meter after use.

After use, the electrode should be stored in pH buffer 7; if it is to be left for more than 12 hours without use, the KCl filling hole should be covered with parafilm. At no stage should the electrode be allowed to dry out. The electrode should not be inverted as the KCl solution will leak from the filling hole. The electrode must be cleaned using Renew solutions at least every 2 weeks during the field campaign. After pH determinations have been completed sample bottles should be rinsed with tap water and labels removed with acetone so the bottles are ready for re-use. Acetone should be used with due care and attention to Health & Safety procedures.

16.2 CONDUCTIVITY MEASUREMENT USING HANNAH HI9033 PORTABLE CONDUCTIVITY METER

1. Measurement of stream water conductivity is undertaken the day after collection, in conjunction with alkalinity determination and so this procedure is done at the same time as that described in Section 16.3. Both sets of equipment for procedures 16.2 and 16.3 need to be set up simultaneously. The conductivity standard should be stored overnight alongside the samples to ensure temperature equilibration.

2. Check that the probe is properly connected to the meter. Rinse the probe thoroughly with deionised water (DIW). Using the thermometer provided, measure and record the temperature of the conductivity standard. Immerse the probe in the conductivity standard and calibrate the meter using the precision screwdriver, to the correct value for that temperature. (A look-up table of temperatures and corresponding conductivity standard values is provided on the standard solution bottle). Note the value in the lab book.

3. Samples should be arranged in ascending numerical order. The numbers should have been copied into the water chemistry book the previous evening when pH measurements were made. A common error here usually arises from poor handwriting on the sample bottles. Record the initials of the analyst.

4. Remove the probe cover, rinse the probe with DIW and replace cover. Sequentially immerse the probe in each solution to be measured. On each occasion the solution must be deep enough to cover the holes in the probe sheath. If there is insufficient solution use the sample in the plastic measuring cylinder that will be used for the alkalinity measurement. When the reading has stabilised it should be recorded in the book alongside the appropriate sample number. The sheath should be removed and the probe rinsed between each sample.

5. The first three samples from each batch are re-measured at the end. If these readings are not within 5 % of the original, the sample should be re-measured, as should any results that appear unusual for the area. If the meter needs recalibration the entire batch should be repeated.

16.3 ALKALINITY MEASUREMENT

Equipment required: 100 ml measuring cylinder, 250 ml conical flask, bromocresol green indicator and pipette, Hach digital titrator and delivery tubes, Sulphuric acid cartridges (1.6 N and 0.16 N). Spare titrator, delivery tubes and cartridges should also be available.

1. Team leaders will ensure that the person carrying out the procedure has adequate safety equipment (eye protection and lab coat), and is made aware of health and safety controls. Any person carrying out the procedure should have read and signed the COSHH regulations (Control of Substances Hazardous to Health) that are provided along with the equipment.
2. This procedure should be carried out in a well-lit area (but not direct sunlight) over a piece of white paper or a white surface. It follows the immersion of a clean dry conductivity probe into the sample (see Section 16.3, item 4). When the conductivity measurement has stabilised, the probe is removed and the alkalinity determination by the procedure described below is immediately carried out.
3. Alkalinity measurements should be made the day after sample collection. Samples should not be left for more than 24 hours before measurement, in order to minimise degassing of CO_2. They should have no gas volume visible in the bottle. If they have, then this should be recorded in the laboratory book. If there is a high suspended load, or a colouration, in the sample this should be recorded in the lab book, as the titration result may be affected by species other than dissolved inorganic carbon.
4. The sulphuric acid cartridge should be loaded to the titrator and any air expelled by pointing the cartridge in the air (away from any persons) and, very carefully, depressing the plunger until all visible bubbles are removed, with a suitable receptacle being present for any inadvertently expelled acid.
5. The delivery tube should be inserted into the acid cartridge and air removed by rotating the release wheel on the titrator until a few drops are released from the end and no air bubbles remain. (Note that the delivery tubes must remain bagged with the normality acid that they have been used with.)
6. Samples should be pre-sorted by pH into those which require 1.6 N acid and those that require the more dilute acid (0.16 N). The cut off is generally around pH 6.8, with those of pH <6.8 requiring the more dilute acid. If a sample requires <30 units of 1.6 N acid then the measurement should be repeated using the 0.16 N acid.
7. The measuring cylinder should be rinsed with a small volume of DIW. 100 ml of sample should then be accurately measured and transferred to the clean flask. A few drops of bromocresol should be added (2 to 5 drops depending on the strength of the bromocresol solution). The solution should be a blue colour that is sufficient to clearly see a colour change when held over a white surface. It must not be so dark blue that the solution becomes opaque and the titration inaccurate. (If the sample immediately turns to green or yellow on addition of the indicator then the alkalinity is recorded as <1 in the book and entered as 0.01 on the database).
8. The unused sample should be retained with the lid on in case a repeat measurement is required.

9. Before adding acid, **the counter on the titrator must be set to zero**. Acid should be added rapidly at first using the release wheel while the flask is gently and constantly swirled with the other hand. The end point value to be recorded is when the solution has turned green. If the operator is unsure that this point has been reached, the reading should be noted and the titration continued in small increments (noting each reading) until an endpoint has definitely been reached. Inexperienced operators should approach endpoints in this way. At the end point the reading on the titrator should be recorded in the book. **If the more dilute acid (0.16 N) is used, the reading should be divided by 10 before being recorded.** If the sample has changed to bright green or yellow then the end point has been passed and the titration should be repeated.
10. At this point the dial on the dispenser should be reset to zero. The most common error arises from operators forgetting to reset the dispenser. Careful attention should also be paid to the amount of acid left.
11. The sample in the flask is disposed of and the flask shaken empty. If the titration was stopped precisely at the end point there is no need for rinsing though the flask should be rinsed with a small volume of DIW.
12. Approximately 10% of measurements should be repeated to check the reproducibility of the method, and any new operators should always repeat their first few measurements until they have satisfactorily managed to produce results within 5% of the first reading. The days measurements should be reviewed and **any unusual results should be repeated**.
13. After completion of measurements, the excess samples can be disposed of, the containers rinsed clean with tap water as necessary and the numbers removed with acetone. The acetone must be used with due care and attention to Health & Safety procedures. Bottles can then be recycled for future use.
14. Water chemistry data should be added to the database each day after the field cards have been entered. Any additional notes should be recorded in the database such as coloured solutions or presence of air in the sample bottle.

Photograph 20: Water alkalinity being determined at the field base

17 Sample reception and registration for laboratories

1. G-BASE samples are sent to BGS Keyworth on a regular basis determined by the rate of sampling and the availability of someone to transport the samples. The project will try to combine journeys back to Keyworth with other activities, such as staff changeovers, so as to make efficient use of transport.
2. Staff in sample preparation should be given at least 24 hours notice of arrival of samples, preferably a three day warning. If a vehicle transporting the samples is parked on site over a weekend, instructions must be left as to where the vehicle keys can be found. Water samples **must not be left in vehicles** and need to be immediately stored in the project fridge (P035A). Thereafter water samples will continue to be handled by G-BASE staff, unlike the solid samples (see 8).
3. Samples will be transported to Keyworth in batches corresponding to every one hundred allocated sample numbers. If all numbers have been allocated a batch will contain 100 samples. The field batch of 100 will include numbers reserved for standard quality control samples to be added during sample preparation. Thus, in reality a batch will have less than 100 field samples. Each batch will consist of a particular media type, and different types must not be mixed in a single batch. Media types are, stream sediment (C), surface soil (A), profile soil (S), panned concentrate (P) and surface water (W).
4. Samples should be packed in the provided crates and H&S considerations regarding the loading of vehicles, the transport of equipment and samples, and manual lifting should be observed. It is recommended that no more than 25 to 30 soil samples should be packed in each crate. Samples should be packed in numerical order to assist the checking of the samples on arrival at Keyworth.
5. Every field batch will be accompanied by a hardcopy **sample checklist** (see Appendix G) and an Excel file listing the sample numbers (i.e. the "**sample list**" see Table 17-1 and Table 17-2). There is a different checklist for drainage and soil samples and checklists will differ according to the random number sample list used to generate them.
6. The Excel sample list file will be named according to the sample type and the lowest sample number e.g. C4400500.xls or A4401500.xls. This file will be generated from the field database and will be printed as hardcopy to accompany the G-BASE registration (see 12 below).
7. The "master sample checklist" will be retained by the G-BASE project in a file stored in P006, a photocopy of each checklist will be made for the laboratory receiving the samples.
8. Water samples will be placed in their correct location in the sample boxes and checked by G-BASE staff, before storage in the Cold Store Number 2 until collected by the laboratories, as arranged. All samples except 'standards' should be returned from the field; 'standards' will be incorporated at this stage by G-BASE staff according to a pre-determined list. The checklist is generated in Access and includes the conductivity value ($\mu S\ cm^{-1}$) of each sample (including 'standards'), but includes no information on control sample locations. The space for initialling and dating the checklist should be completed by the staff undertaking the task.
9. Those tasked with checking the samples in (sample preparation section for solid samples and G-BASE for water samples) should sign the copy of the checklist to acknowledge that all samples have been received as stated. **ANY SAMPLE NUMBERING ERRORS OR DISCREPANCIES IN THE SAMPLE CHECKLISTS SHOULD BE NOTIFIED TO THE FIELD OPERATION MANAGER IMMEDIATELY.**

10. G-BASE will register samples for submission to the laboratories in batches of 500 sample numbers (i.e. five field batches)
11. Every laboratory batch of samples will have a unique G-BASE ID assigned by the nominated G-BASE team member in Keyworth. The ID will be a four letter code (e.g. EA03) comprising of two letters to signify the area (e.g. EA for East Anglia) plus a two digit year code (e.g. 03 for 2003). The code is completed by a three digit sequential number starting with 001. An example of a full G-BASE ID would be EA03001, EA03002, EA03003 etc. This G-BASE-ID should be registered by the laboratory LIMS system as the customer ID number
12. The sample lists delivered as Excel files on a diskette will be received from the field by a member of the G-BASE team who will enter each laboratory batch into the G-BASE sample registration system (see Figure 17-1). The sample list will be checked to ensure all the information regarding control samples, missing samples and samples to be selected for LOI and pH are included.
13. For each batch a registration report form is printed twice. Examples of forms are given in Appendix H. One copy is sent to the head of the relevant laboratory and one copy is retained for files.
14. The head of the relevant laboratory will register the samples in the LIMS system assigning a Lab. No. to each batch. This will include samples which are not routinely analysed (panned concentrates and deep soils) but will require some sample preparation before storage.
15. The head of relevant will complete an IR form for each batch and any other forms as required by the laboratory management system. These forms, which should include a Lab. No. for each batch submitted, will be sent to the G-BASE project leader or deputy for signing. ANY DISCREPANCY BETWEEN THE G-BASE REQUEST FOR SAMPLE ANALYSES AND THE SAMPLES SUBMITTED SHOULD BE BROUGHT TO THE ATTENTION OF THE FIELD OPERATIONS MANAGER IMMEDIATELY.
16. On completion of analyses results will be sent to the G-BASE data manager (Bob Lister for sediments and soils, Louise Ander for stream waters). They will maintain an Excel spreadsheet to indicate progress with receipt of results (laboratory progress log), quality control and loading results to the corporate geochemistry database.
17. The G-BASE project manager will monitor receipt of results and payment for completed services. Samples not analysed by the date stated on the registration form will be brought to the attention of the laboratory manager who will provide the G-BASE project manager with corrective action plan for ensuring sample analyses are completed. The corrective action plan for completing overdue samples will be detailed on the laboratory progress log.

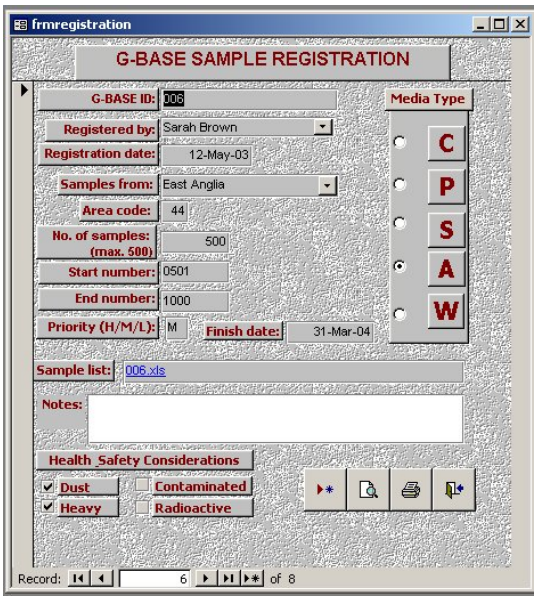


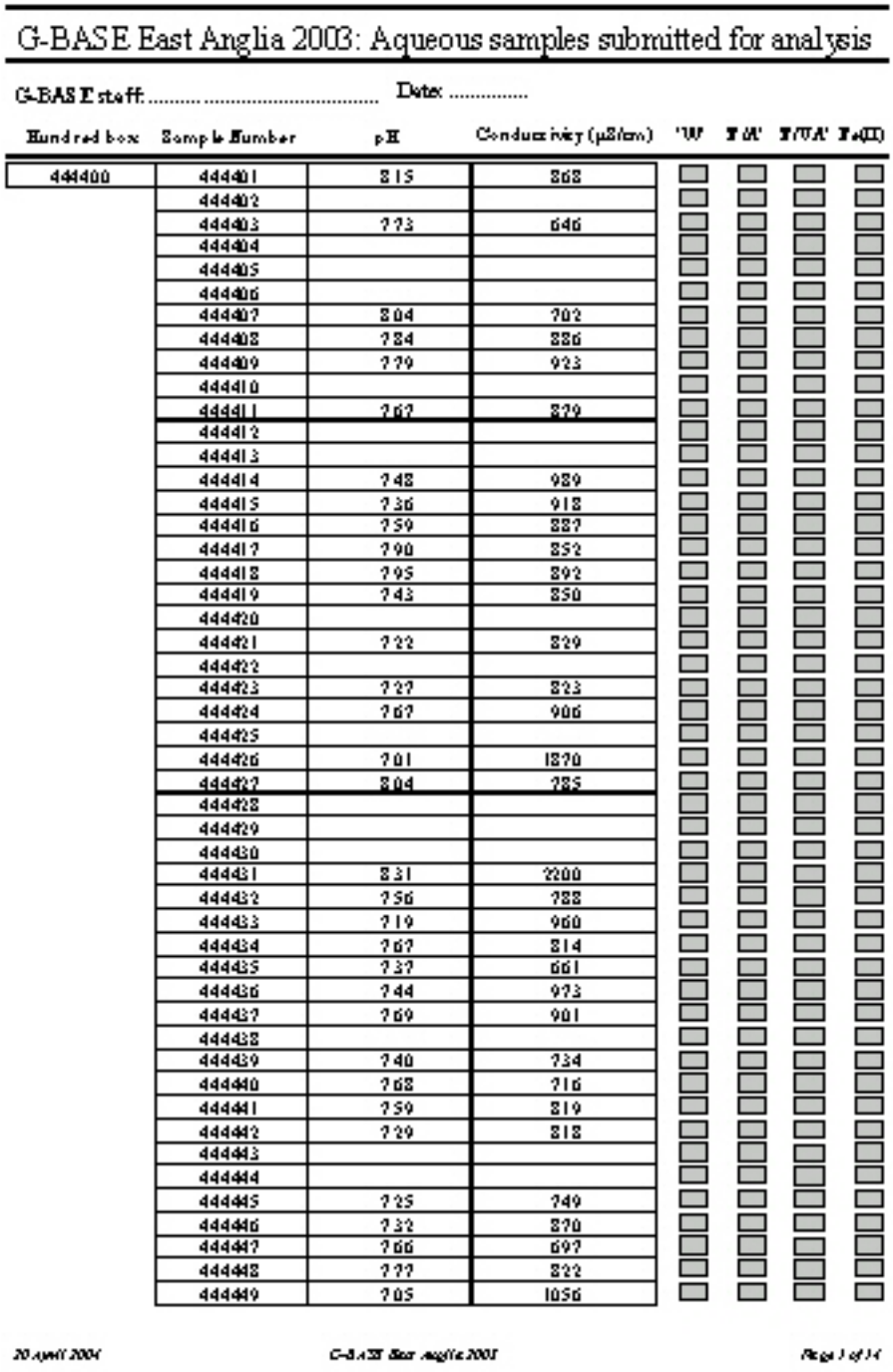
Figure 17-1: G-BASE sample registration program written in MS ACCESS

Project Code	Site Number	Control sample	pH / LOI requested?
44	5701	~	YES
44	5702	~	YES
44	5703	~	YES
44	5704	~	YES
44	5705	~	YES
44	5706	~	YES
44	5707	~	~
44	5708	~	YES
44	5709	~	YES
44	5710	~	YES
44	5711	~	~
44	5712	~	~
44	5713	~	YES
44	5714	~	YES
44	5715	~	YES
44	5716	~	YES
44	5717	~	YES
44	5718	~	~
44	5719	~	~
44	5720	~	~
44	5721	~	YES
44	5722	~	YES
44	5723	~	YES
44	5724	~	YES
44	5725	~	~
44	5726	~	YES
44	5727	~	YES
44	5728	STD-XXX	~
44	5729	~	~
44	5730	~	YES
44	5731	DUPA	YES
44	5732	~	~
44	5733	~	YES
44	5734	~	~
44	5735	~	YES
44	5736	~	YES
44	5737	DUPB	YES
44	5738	~	~
44	5739	~	YES
44	5740	~	~
44	5741	~	~
44	5742	~	~
44	5743	~	YES
44	5744	~	~
44	5745	~	YES
44	5746	~	~
44	5747	~	~
44	5748	~	YES
44	5749	~	YES
44	5750	~	YES

Project Code	Site Number	Control sample	pH / LOI requested?
44	5751	~	~
44	5752	~	YES
44	5753	~	YES
44	5754	~	YES
44	5755	~	YES
44	5756	~	~
44	5757	~	~
44	5758	SSB	YES
44	5759	~	~
44	5760	~	YES
44	5761	~	~
44	5762	~	~
44	5763	~	~
44	5764	~	YES
44	5765	~	~
44	5766	~	~
44	5767	~	YES
44	5768	~	YES
44	5769	~	YES
44	5770	~	YES
44	5771	~	YES
44	5772	~	~
44	5773	~	YES
44	5774	~	YES
44	5775	~	~
44	5776	~	~
44	5777	SSA	YES
44	5778	~	~
44	5779	~	YES
44	5780	STD-YYY	~
44	5781	~	~
44	5782	~	~
44	5783	~	~
44	5784	~	YES
44	5785	~	YES
44	5786	~	~
44	5787	~	YES
44	5788	~	~
44	5789	~	YES
44	5790	~	~
44	5791	~	YES
44	5792	~	~
44	5793	~	~
44	5794	~	YES
44	5795	~	~
44	5796	~	~
44	5797	~	YES
44	5798	~	~
44	5799	~	YES
44	5800	~	YES

Total number of samples:	100
Total number of pH & LOI samples:	54

Table 17-1: Example of the digital sample list to accompany each field batch of surface soil samples



G-BASE East Anglia 2003: Aqueous samples submitted for analysis

G-BASE staff: ..... Date: .....

Hundred box	Sample Number	pH	Conductivity (µS/cm)	'W'	'M'	'WM'	Fe(II)
444400	444401	815	868				
	444402						
	444403	773	646				
	444404						
	444405						
	444406						
	444407	804	702				
	444408	784	886				
	444409	779	923				
	444410						
	444411	767	879				
	444412						
	444413						
	444414	748	989				
	444415	736	918				
	444416	759	887				
	444417	790	852				
	444418	795	892				
	444419	743	850				
	444420						
	444421	722	829				
	444422						
	444423	727	823				
	444424	767	906				
	444425						
	444426	701	1870				
	444427	804	785				
	444428						
	444429						
	444430						
	444431	831	2200				
	444432	756	788				
	444433	719	960				
	444434	767	814				
	444435	737	661				
	444436	744	973				
	444437	769	901				
	444438						
	444439	740	734				
	444440	768	716				
	444441	759	819				
	444442	729	818				
	444443						
	444444						
	444445	725	749				
	444446	732	870				
	444447	766	697				
	444448	777	822				
	444449	705	1056				

20 April 2004 G-BASE East Anglia 2003 Page 1 of 14

Table 17-2 : An example of the printed laboratory information list to accompany each batch of aqueous samples. The accompanying digital file simply includes the 3 data fields (sample number, pH and conductivity).

18 Post-Field Campaign Report

At the completion of each year's field campaign the Field Operation Manager will be responsible for writing a report on the field sampling to be completed within one month of the completion of sampling. This report will act as the definitive record of the fieldwork activities and will provide a reference to the work completed.

The report should have the following sections:

1. Schedule of fieldwork detailing what was done where and when.
2. A simplified map showing the area sampled.
3. A reference to the version of the field procedures manual used.
4. Details of the field team including all the VWs. This should include a table of samplers' initials.
5. Details of accommodation - its suitability and any problems.
6. Logistical report of operating in the area (shops, petrol stations, road access, railway stations etc.)
7. Health and Safety report detailing any incidents, near misses or recommendations for improving safety. This should be taken from the field base H&S incident book.
8. Summary table of number of samples collected indicating number ranges and any missing samples.
9. Details of each monitor site samples were collected from
10. Details of laboratory batch numbers and how they related to G-BASE sample numbers.
11. Annex of sample checklists.

19 References

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Appendix A: Standard farm access letter

Dear Sir,

REGIONAL GEOCHEMICAL SURVEY 2004

I am writing on behalf of the British Geological Survey (BGS) to seek your agreement to the collection of geochemical samples over your land. BGS is responsible for the geological survey of Great Britain and for several years has been engaged in the preparation of maps showing the distribution of chemical elements in stream sediment, stream water and soil. This is a continuation of a nation-wide survey, which has already covered Scotland, Wales, northern and central England.

The geochemical survey results have applications to studies of a wide range of topics, including some with particular benefits to agriculture, human and animal health. Particular interest has been shown, for instance, in the possible identification of areas over which trace element imbalances may lead to disease in livestock or affect the growth of crops.

During this spring/summer we shall be extending the sampling over the area which includes your property. I am therefore seeking your co-operation in allowing access for one of our survey teams to collect small samples from streams which cross your land or a soil sample; about 1 kg of soil is collected by hand auger. The number of samples taken is only approximately one per square kilometre and the work is carried out between July and September by sampling teams of two persons on foot. The time spent at any locality seldom exceeds thirty minutes. All staff of the Survey are well acquainted with the Country Code and the need to avoid disturbance to agricultural and other activities.

Should you require further information I shall be happy to arrange for a member of BGS staff to telephone or visit you prior to the sampling. Please could you confirm that you are willing to allow our team to enter your land by forwarding the reply slip in the prepaid envelope provided.

Yours faithfully

Sarah Brown

G-BASE Field Operations Manager

British Geological Survey

Appendix B: Voluntary Worker Recruitment Advert

SUMMER VACATION WORK 2003

Geochemical Baseline Survey of the Environment (G-BASE)

The British Geological Survey (BGS) will be recruiting Earth Science students for the 2003 summer vacation to assist with geochemical sampling in support of the above programme. Field work, based in East Anglia, will involve the systematic collection of geochemical samples. There will also be a limited number of vacation posts in other departments within BGS.
Applicants need to be able to traverse difficult terrains and have a high degree of commitment to field work and be capable of integrating into a team. Sampling is usually undertaken by students working in pairs and will involve walking long distances in all weather conditions. Students work a six day week and will be expected to undertake evening work as necessary. It will not be possible for students to take time off during their period of employment, except in an emergency. The work will give successful applicants an opportunity to gain valuable experience in the more practical aspects of geology and geochemistry.
A standard subsistence allowance of £25 per night (£175 per week) will be paid. Accommodation (self-catering) will be paid by BGS but students will be required to pay for food. Posts will be available from July to September 2003 and preference will be given to those available for a minimum of 5 consecutive weeks. Application forms and further details are available from your departmental secretary or from the BGS web site, www.bgs.ac.uk/gbase. The closing date for applications is Friday 11th April 2003.
Download Application form and Health Declaration.

The above is an example of the advertisement on the BGS internet site. The next page is an example of the poster sent out to university Earth Science Departments.

British Geological Survey

NATURAL ENVIRONMENT RESEARCH COUNCIL

Summer Vacation Work

GEOCHEMICAL BASELINE SURVEY OF THE ENVIRONMENT (G-BASE)

The British Geological Survey (BGS) will be recruiting Earth Science students for the 2003 summer vacation to assist with geochemical sampling in support of the above programme. Field work, based in East Anglia, will involve the systematic collection of geochemical samples. There will also be a limited number of vacation posts in other departments within BGS.

Applicants need to be able to traverse difficult terrains and have a high degree of commitment to field work and be capable of integrating into a team. Sampling is usually undertaken by students working in pairs and will involve walking long distances in all weather conditions. Students work a six day week and will be expected to undertake evening work as necessary. It will not be possible for students to take time off during their period of employment, except in an emergency. The work will give successful applicants an opportunity to gain valuable experience in the more practical aspects of geology and geochemistry.

A standard subsistence allowance of £25 per night (£175 per week) will be paid. Accommodation (self-catering) will be paid by BGS but students will be required to pay for food. Posts will be available from July to September 2003 and preference will be given to those available for a minimum of 5 consecutive weeks. Application forms and further details are available from your departmental secretary or from the BGS web site, www.bgs.ac.uk/gbase. The closing date for applications is Friday 11th April 2003.

Appendix C: Voluntary Worker Application Forms

Please return completed form by 11th April to:-

Mr. A.L. Crosby

Personnel Section
British Geological Survey
Keyworth
Nottingham
NG12 5GG

PLEASE ATTACH 1 PASSPORT SIZE PHOTOGRAPH WITH A PAPER CLIP (PLEASE WRITE NAME ON THE REVERSE)

Ref No:_____
(for office use)

VOLUNTARY WORKER

APPLICATION 2003

Please use HAND-WRITTEN BLOCK CAPITALS.

Dates available for employment:- From: Day_____/Month_____

To: Day_____/Month_____

Title:_____ Surname:_____ Forename(s):_____ Age:_____

Undergrad. year:_____

University or College:_____

Main subjects(s):_____

Subsidiary subjects(s):_____

Term address:_____

_____

_____

_____Post code:_____ Tel. no.:_____

email:_____

Date of leaving this address: Day_____/Month_____

Home address:_____

_____

_____

_____Post Code:_____ Tel. no.:_____

Have you held a driving licence for at least 1 year? yes / no
Do you have any endorsements? yes / no

Have you been employed by BGS before? Group:_____ Year:_____

Give a brief summary of your field experience, past employment, outside interests and state why you are applying for vacation employment with BGS (continue overleaf if necessary).

SIGNED:_____ DATE:

Due to limited resources it is not possible for BGS to write to unsuccessful applicants

NERC

HEALTH DECLARATION: Voluntary Workers Scheme

We want to be sure that we can reasonably expect you to be able to give an effective service, and we therefore ask you to provide us with some details about your health record. Each declaration we receive is considered individually and no decision to reject you on medical grounds will be made without further discussions with yourself.

The Natural Environment Research Council is an equal opportunities employer and will recruit on the basis of ability, not perceived disability.

Full name			
Post applied for			
1a. Do you have any disability which may affect your ability to undertake the tasks set out in the duties of this post? (If yes, please give details) 1b. If your answer to 1a. was yes, which facilities, adjustments or equipment (if any) would enable you to perform the duties of the post most effectively (use a separate sheet if necessary)?		Yes ☐	No ☐
2. Are you now or have you been in the past under any medical treatment or observation, taken any form of medication to control or stabilise a condition (eg insulin for diabetes or ventolin for asthma), undergone any operation or hospital treatment, or had any serious accident? (If yes, please give details including dates)		Yes ☐	No ☐
3. Have you now or in the past had any disease or complaint, other than normal childhood illnesses, colds and flus? (If yes, please give details including dates and treatment received)		Yes ☐	No ☐
4. Have you now or in the past had any drug or alcohol related problem? (If yes, please give details, including dates and medication (if any) prescribed.)		Yes ☐	No ☐
5. Have you now or in the past had any back, muscle or joint problems (eg slipped disc, rheumatism, arthritis etc) or any work-related upper limb disorder (eg from keyboard/VDU use)? (If yes, please give details, including dates and medication (if any) prescribed.)		Yes ☐	No ☐

6.	Have you now or in the past had depression or any stress related illness? (If yes, please give details, including dates and medication (if any) prescribed.)	Yes ☐	No ☐
7.	Have you consulted a doctor at any time regarding an illness or condition in the past five years? (If yes, please give details.)	Yes ☐	No ☐

8. What is the name and address of your GP? (medical emergency contact)

Name .....

Address .....

.....

.....

Telephone .....

MEDICAL IN CONFIDENCE (WHEN COMPLETED)

I declare that the information given on this form is to the best of my knowledge correct and understand that if at any time in the future the information is found to be false, any contract of employment I have with the Natural Environment Research Council may be terminated by the Natural Environment Research Council without notice.

Name
.....

Signed ..... Date
.....

MEDICAL IN CONFIDENCE (WHEN COMPLETED)

Appendix D: G-BASE Information card

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

For further information about our geochemical survey project (G-BASE):

email : enquiries@bgs.ac.uk
telephone : 01159 363143
internet: www.bgs.ac.uk/gbase

We are collecting soil, water and stream sediment samples as part of a national survey to make geochemical maps. This work started at the end of the 1960's in northern Scotland and we collect samples every summer using student workers. We have now progressed southwards to your area and have to date covered about 80% of the country sampling more than 125,000 sites. We collect samples at a high density, for example we collect one soil sample every 2 km². Samples are analysed for wide range of chemical elements including those important to the health and nutrition (e.g. Ca, Cu, Se etc.) and those that are potentially harmful elements such as As, Pb and Cd. We are interested in regional trends rather than site specific results and the final maps generally reflect the underlying geology. In areas where there are no rock outcrops this can help geologist to make better geological maps. Our work helps us to establish a natural geochemical baseline for our surface environment against which we can monitor past and future activities that cause changes to the soil and water. Hence the name of our project - Geochemical Baseline Survey of the Environment (G-BASE).

Appendix E: Random Number Lists

RANDOM NUMBER LIST 1
SEDIMENT

AREA CODE……..

NUMBER RANGE…….

18		01		36		29	
49		99		70		73	
46		03		59		43	
41		38		88		82	
32		91		66		55	
45		67		64		14	
94		07		52		87	
98		34		79		06	
56		89		05		12	
15		83		60		92	
26		95		08		02	
19		21		96		63	
39		84		25		31	
28		93		47		53	
54		40		100		27	
62		71		24		30	
80		57		77		11	
16		61		09		76	DUPLICATE A
17		48		85		81	DUPLICATE B
72		35		50		86	SUB SAMPLE A
65		13		33		78	SUB SAMPLE B
37		51		42		68	STANDARDS
04		97		20		22	
90		74		58		10	BLANK WATERS
69		23		44		75	

RANDOM NUMBER LIST 2
SOIL

AREA CODE……..

NUMBER RANGE…….

11		05		32		89	
76		86		49		07	
01		15		50		74	
71		29		63		24	
68		100		79		66	
73		19		91		97	
38		06		95		92	
25		23		67		26	
85		78		10		53	
46		72		90		55	
21		17		60		20	
41		88		40		61	
64		93		99		84	
82		35		75		83	
70		59		16		33	
47		03		12		02	
22		44		18		43	
34		87		69		62	
39		65		42		14	
54		30		09		31	DUPLICATE A
48		81		45		37	DUPLICATE B
96		94		98		77	SUB SAMPLE A
27		51		13		58	SUB SAMPLE B
04		57		52		28	STANDARDS
36		08		56		80	

RANDOM NUMBER LIST 3
SEDIMENT

AREA CODE……..

NUMBER RANGE…….

86		19		21		99	
43		31		20		80	
23		32		73		98	
29		16		35		33	
69		25		36		01	
57		26		77		40	
94		45		92		37	
03		71		64		11	
88		34		42		14	
48		55		100		76	
50		79		30		60	
54		22		65		72	
39		67		09		52	
18		95		13		05	
63		46		58		68	
81		97		59		47	
66		49		02		91	
84		28		27		04	DUPLICATE A
38		78		61		96	DUPLICATE B
24		10		83		62	SUB SAMPLE A
74		15		06		53	SUB SAMPLE B
70		07		82		17	STANDARDS
85		90		12		87	
93		08		51		44	BLANK WATERS
41		56		89		75	

RANDOM NUMBER LIST 4
SOIL

AREA CODE……..

NUMBER RANGE…….

83	64	61	55	
05	52	74	78	
37	82	36	100	
99	23	65	49	
75	76	95	12	
22	16	29	91	
13	41	58	63	
62	43	59	68	
84	98	90	02	
89	97	88	53	
87	73	77	51	
27	17	50	19	
01	81	15	08	
33	42	45	28	
79	25	57	07	
11	06	67	54	
93	18	48	30	
14	56	46	03	
39	94	85	32	
24	92	26	71	DUPLICATE A
21	80	70	66	DUPLICATE B
44	04	09	60	SUB SAMPLE A
20	72	31	34	SUB SAMPLE B
10	35	69	96	STANDARDS
86	38	40	47	

Appendix F : Important Agricultural Issues

1. Sugar Beet Rhizomania

Reference: Asher, M. 1999. Sugar-beet rhizomania: the spread of soil-borne disease. Microbiology Today, 26, 120-122. August 1999.
http://www.sgm.ac.uk/pubs/micro_today/pdf/039906.pdf

"Sugar-beet crops can be decimated by rhizomania, a disease caused by a virus, yet transmitted by a fungus in the soil. Although stringent control measures are in place in the UK to prevent its spread; severe economic losses are being experienced in other parts of the world."

"Rhizomania disease of sugar-beet – so-called because of its 'mad root' symptoms – is caused by a virus (beet necrotic yellow vein virus) transmitted by a soilborne parasitic fungus, *Polymyxa betae*. *Polymyxa* species are members of a small group of zoosporic fungi that do not produce hyphae; indeed the debate continues as to whether they are truly fungi or more closely related to the protozoans. They infect by means of swimming spores which attach themselves to the rootlets and inject their contents (which may contain the virus) into the superficial cells. Here the fungus develops and differentiates to produce a further generation of zoospores which are released to infect neighbouring roots. Several such cycles of multiplication occur during the growing season. At some stage, however, usually in more mature plants, the fungus switches to producing thick-walled resting spores, which are released into the soil when the rootlets decay and can survive almost indefinitely, protecting the virus particles they contain"

"Current statutory measures to contain the disease
Over the years the statutory containment measures have gradually been relaxed as more and more outbreaks have been confirmed. When an outbreak occurs now, the infected patch plus a *cordon sanitaire* of 25 metre radius from the edge of the patch is destroyed with glyphosate. Any remaining crop in the field can be harvested but it can only be processed at a factory with a tidal outlet. Cropping restrictions are imposed. No transplants such as seed potatoes or strawberry runners can be grown; ware potatoes can be produced in the infected field with the harvested tubers subject to soil level restrictions. Partially resistant varieties can be grown on outbreak farms but not in outbreak fields. Hygiene measures are required for machinery."

from Technical Briefing held at Central Science Laboratories (CSL), York, 28 November 2001

http://www.defra.gov.uk/planth/Rhizback.pdf

G-BASE protocol for dealing with sampling in sugar beet fields- preventing the spread of soil-borne Rhizomania

In certain parts of the UK (and throughout the world), sugar beet is susceptible to a disease called rhizomania, a fungus that can be spread from field-to-field by farm machinery and on footwear/augers. It can lead to the decimation of crops. It is therefore

important that field samplers are able to disinfect their footwear and soil auger **if they have to sample** soil from a field of sugar beet. For example, where no other fields other than where beet is growing are available in the 1 square kilometre for that soil sample.

If a land-owner/land manager is concerned that you may not be taking sufficient precautions, you can explain that the G-BASE project has a protocol for dealing with preventing the spread of rhizomania as a result of our soil sampling. This includes:

- avoiding beet fields where possible, but where this is infeasible by adopting,
- a protocol for the disinfection of footwear and soil augers.
- as we **do not use vehicles to access fields**, we do not include this in our protocol

You may decide that showing the land owner/land manager this sheet would be helpful, or suggest contacting the field base team leaders on the mobile numbers provided.

Procedure for the disinfection of footwear and soil auger after sampling in a sugar beet field

1. Upon leaving the cropped area, find an area to remove footwear and prepare for following procedure
2. Take out the large self-seal containing the spray bottle, water, disinfectant and brush
3. Use the brush to remove soil from boots and auger
4. Pour about 5 ml of the disinfectant (the dark fluid in the 250 ml Nalgene bottle) into the spray bottle and add half the water from the other Nalgene bottle to the spray bottle
5. Insert the spray tube into bottle and secure top. Use the spray over the soles and sides of all affected footwear and auger. Leave for 10 minutes. Use the remainder of the clean water to rinse the footwear
6. Dispose of disinfectant in the sprayer in an area that will not affect the crop/other plants
7. Put on footwear and continue to next site avoiding re-entry to the sugar beet field. Re-fill 250 ml water bottle at next drainage site.

If any part of this protocol is not clear, or you have doubts over the requirements for avoiding the spread of rhizomania through sampling of sugar beet, contact your team leader at the field base using the mobile phone numbers in the filofax.

Barry Rawlins (Summer 2004: G-BASE field sampling)

2. Foot and Mouth

Reference: DEFRA Foot and Mouth Web pages (http://www.defra.gov.uk/footandmouth/)

BGS policy towards the Foot and Mouth Outbreak in 2001

BGS is treating the outbreak of Foot & Mouth Disease with the utmost seriousness and will do everything it can to avoid the risk of spreading the disease. Field work was suspended on 22nd February. Procedures in force during the period of the outbreak are as follows:

1. BGS policy during the crisis will be co-ordinated by Dr Lee. He will work with Mr Holmes to monitor the situation on a regular basis as the outbreak develops and issue further guidance as necessary. In the case of Northern Ireland, Mr Arthurs will monitor the situation and issue instructions based on local advice.

2. The suspension currently applies to all onshore field activities in rural and semi-rural areas THROUGHOUT THE UK (i.e. it includes site visits, borehole logging, geophysical surveys, geochemical surveys and any other type of field-based activity).

3. Field activities in urban areas and along coasts may be approved on a case by case basis. A risk assessment must be carried out prior to any proposed survey or site visit. This should consider the likelihood of coming into contact with livestock during the field operation itself or during travel to/from the field site. The case for proceeding with an urban or coastal field activity (together with the risk assessment) should be submitted through Programme Managers to Dr Lee (or to Mr Arthurs in the case of GSNI). No work should be undertaken until permission has been granted.

4. Offshore field surveys may continue but staff should be aware of guidelines (below) related to travel. Similarly, staff travelling overseas should be aware of the need to observe procedures put in place by other countries to stop the spread of the disease.

5. BGS is dependent on the goodwill of the farming community to carry out its field surveys and staff should avoid any actions during the course of their normal business that might risk spreading the disease or even give the impression that we are not treating the outbreak seriously. For example, staff using official vehicles for any purpose (e.g. travelling to and from meetings) should avoid driving along country lanes and gated roads wherever possible.

6. Staff should be aware that information about the progress of the outbreak and the measures in place to contain it are posted on the MAFF web site (www.maff.gov.uk). This will be kept under constant review.

7. It is not possible to predict at the present time when the outbreak will end or when restrictions may be lifted. Even when restrictions are removed, farmers may still be unwilling to see BGS recommence survey operations on their land.

8. Project Leaders and Programme Managers should review their fieldwork operations for the coming year and make contingency plans. Where possible, work should be rescheduled for later in the year. 'Decision dates' should be defined for all field programmes as the last date at which the decision can be taken to proceed, postpone or cancel.

9. As the outbreak develops, the authorities may impose movement restrictions which might prevent staff from travelling to work. Staff affected by such restrictions should contact their HoD and relevant Programme Managers to discuss alternative working arrangements.

10. It is accepted that the Foot and Mouth outbreak is likely to affect project schedules and deliverables in some programmes. The Board will be kept informed of the impact through Programme Directors. In the case of commissioned research, Programme Managers should take on board the views of clients, discuss the impact of the restrictions on the project timetable and negotiate contract extensions where possible. Finance staff should be kept informed of any changes to budgets and timetables.

3. Classical Swine Fever

http://www.ukagriculture.com/uk_farming/livestock/classical_swine_fever.htm

Classical swine fever is a highly contagious virus disease of swine. No other animals are affected. First recognised in Tennessee in 1810, it then rapidly spread around the world. It was first seen in Great Britain in 1864 and controls were instigated in 1878. The disease was eradicated from the country in 1966. Since then breakdowns have occurred in 1971 (215 pigs slaughtered), 1986 (7,800 pigs slaughtered) and most recently in 2000 in East Anglia when 75,000 diseased and in-contact pigs were slaughtered before the disease was beaten.

In the acute form of the disease, affected pigs develop a very high temperature followed by a variety of other clinical signs which may include coughing, diarrhoea, abortion, skin lesions and nervous signs. In young pigs the mortality rate may approach 100%. Apparently healthy pigs may be incubating the disease and recovered pigs can carry on excreting the virus and so be a source of infection for others. This means that movements of pigs from farms can easily spread the disease. The virus can also remain in the environment, for example on people, boots and lorries and this is another source of spread and infection.

The disease is controlled by various means. There are very strict controls on the import of meat and meat products into the UK - the outbreak in 2000 was suspected to have been caused by pigs (or a pig) consuming a contaminated imported pig product. Movement orders, in place since 1995, prevent the movement of pigs from a farm until 20 days after pigs have moved on. By law, all owners must inform DEFRA immediately if any sick pigs are showing any signs suggestive of swine fever. All affected and in-contact animals are slaughtered. In addition no feeding of swill to pigs is allowed.

Other EU countries have had large numbers of outbreaks, with Holland in 1997 taking over a year to bring an outbreak under control. Currently the all - slaughter policy is still in use, but cost-benefit analysis into the use of vaccines have shown that their use may decrease the cost of an outbreak. However at present there is not a vaccine available where vaccinated pigs on test can be differentiated from infected ones.

Appendix G: Sample Checklists

Atlas Name	Area Code	Sample Number Range
South West England	50	Random Number List 1 (Sediment)

	C	P					C	P					C	P					C	P			
1						26						51						76			DUP		A
2						27						52						77					
3						28						53						78	SUB-SAMP				
4						29						54						79					
5						30						55						80					
6						31						56						81			DUP		B
7						32						57						82					
8						33						58						83					
9						34						59						84					
10	BW					35						60						85					
11						36						61						86	SUB-SAMP				
12						37						62						87					
13						38						63						88					
14						39						64						89					
15						40						65						90					
16						41						66						91					
17						42						67						92					
18						43						68	STANDARD					93					
19						44						69						94					
20						45						70						95					
21						46						71						96					
22	STANDARD					47						72						97					
23						48						73						98					
24						49						74						99					
25						50						75	BW					100					

Summary

Dup Sample	Sub-Sample		Standards		Unused Numbers	Blank Water
76	86		68	22		10
81	78					75

Atlas Name	Area Code	Sample Number Range
South West England	50	Random Number List 2 (Soil)

	A	S					A	S					A	S					A	S			
1						26						51						76					
2						27						52						77	SUB-SAMP				
3						28	STANDARD					53						78					
4						29						54						79					
5						30						55						80	STANDARD				
6						31		DUP	A			56						81					
7						32						57						82					
8						33						58	SUB-SAMP					83					
9						34						59						84					
10						35						60						85					
11						36						61						86					
12						37		DUP	B			62						87					
13						38						63						88					
14						39						64						89					
15						40						65						90					
16						41						66						91					
17						42						67						92					
18						43						68						93					
19						44						69						94					
20						45						70						95					
21						46						71						96					
22						47						72						97					
23						48						73						98					
24						49						74						99					
25						50						75						100					

Summary

Dup Sample	Sub-Sample		Standards		Unused Numbers
31	77		28	80	
37	58				

Atlas Name	Area Code	Sample Number Range
South West England	50	Random Number List 3 (Sediment)

	C	P					C	P				C	P				C	P			
1						26					51					76					
2						27					52					77					
3						28					53	SUB-SAMP				78					
4		DUP		A		29					54					79					
5						30					55					80					
6						31					56					81					
7						32					57					82					
8						33					58					83					
9						34					59					84					
10						35					60					85					
11						36					61					86					
12						37					62	SUB-SAMP				87	STANDARD				
13						38					63					88					
14						39					64					89					
15						40					65					90					
16						41					66					91					
17	STANDARD					42					67					92					
18						43					68					93					
19						44	B W				69					94					
20						45					70					95					
21						46					71					96		DUP	B		
22						47					72					97					
23						48					73					98					
24						49					74					99					
25						50					75	B W				100					

Summary

Dup Sample	Sub-Sample	Standards	Unused Numbers	Blank Water
04	62	17 87		44
96	53			75

Atlas Name	Area Code	Sample Number Range
South West England	50	Random Number List 4 (Soil)

	A	S					A	S					A	S					A	S			
1						26						51						76					
2						27						52						77					
3						28						53						78					
4						29						54						79					
5						30						55						80					
6						31						56						81					
7						32						57						82					
8						33						58						83					
9						34	SUB-SAMP					59						84					
10						35						60	SUB-SAMP					85					
11						36						61						86					
12						37						62						87					
13						38						63						88					
14						39						64						89					
15						40						65						90					
16						41						66		DUP	B			91					
17						42						67						92					
18						43						68						93					
19						44						69						94					
20						45						70						95					
21						46						71		DUP	A			96	STANDARD				
22						47	STANDARD					72						97					
23						48						73						98					
24						49						74						99					
25						50						75						100					

Summary

Dup Sample	Sub-Sample	Standards	Unused Numbers
71	60	47 96	
66	34		

Appendix H: G-BASE Sample Registration Forms

G-BASE SAMPLE REGISTRATION C

G-BASE Ref: **EA03 006**

Lab No:

Samples from : East Anglia *Registered on:* 12-May-03 *by:* Sarah Brown

From number: 440501 *To number:* 441000 *Number of samples:* 500

Sample list file: 006.xls *Priority* M *Required by:* 31/03/2004

Health and Safety considerations Dust ☑ Contamination ☐ Heavy ☑ Radioactivity ☐ Other:

SAMPLE PREPARATION

Air dry. Disaggregate.
Agate Milling.
Excess sample to be stored in core store.
Mill with binder for XRF pellet.
Pelletise for XRF analysis (xx mm pellets).
Add standards as indicated on sample list.

ANALYSIS

XRF: Standard G-BASE rural. Elements reported: Ag, Al2O3, As, Ba, Bi, Br, CaO, Cd, Ce, Co, Cr, Cs, Cu, Fe2O3, Ga, Ge, Hf, I, K2O, La, MgO, MnO, Mo, Na2O, Nb, Nd, Ni, P2O5, Pb, Rb, Sb, Sc, Se, SiO2, Sm, Sn, Sr, Ta, Te, Th, TiO2, Tl, U, V, W, Y, Zn and Zr. Ag, As, Ba, Bi, Ca, Cd, Ce, Co, Cr, Cu, Fe, Ga, K, La, Mg, Mn, Mo, Nb, Ni, P, Pb, Rb, Sb, Se, Sn, Sr, Th, Ti, V, Y, Zn, Zr, U (33 elements required).

****** PLEASE REPORT RESULTS TO T R LISTER (trl@bgs.ac.uk ext.3536) *********

Notes from field team :

Submitted electronically/as hardcopy to lab : on: .....

Signed : .....

Example sample registration form for stream sediment

G-BASE SAMPLE REGISTRATION

A

G-BASE Ref: **EA03 006**

Lab No:

Samples from : East Anglia *Registered on:* 12-May-03 *by:* Sarah Brown

From number: 440501 *To number:* 441000 *Number of samples:* 500

Sample list file: 006.xls *Priority* **M** *Required by:* 31/03/2004

Health and Safety considerations

Dust ☑ Contamination ☐ Other:

Heavy ☑ Radioactivity ☐

SAMPLE PREPARATION

Air dry. Disaggregate.
Agate Milling.
Excess sample to be stored in core store.
Mill with binder for XRF pellet.
Pelletise for XRF analysis (xx mm pellets).
Add standards as indicated on sample list.
Select samples for pH and LOI as indicated on sample list

ANALYSIS

XRF: Standard G-BASE rural.
Elements reported: Ag, Al2O3, As, Ba, Bi, Br, CaO, Cd, Ce, Co, Cr, Cs, Cu, Fe2O3, Ga, Ge, Hf, I, K2O, La, MgO, MnO, Mo, Na2O, Nb, Nd, Ni, P2O5, Pb, Rb, Sb, Sc, Se, SiO2, Sm, Sn, Sr, Ta, Te, Th, TiO2, Tl, U, V, W, Y, Zn and Zr.
Elements required: Ag, As, Ba, Bi, Ca, Cd, Ce, Co, Cr, Cu, Fe, Ga, K, La, Mg, Mn, Mo, Nb, Ni, P, Pb, Rb, Sb, Se, Sn, Sr, Th, Ti, V, Y, Zn, Zr, U (33).

LOI @ 450°C
pH with CaCl2 slurry

******* PLEASE REPORT RESULTS TO T R LISTER (trl@bgs.ac.uk ext.3536) *********

Notes from field team :

Submitted electronically/as hardcopy to lab : on: .....

Signed : .....

Example sample registration form for surface soil

G-BASE SAMPLE REGISTRATION

W

G-BASE Ref. EA03 012

Lab No.

Samples from : East Anglia Registered on: 04-Feb-04 by: Louise Ander

From number: 44 4401 To number: 445700 Number of samples: 503

Sample list file: 012.xls Priority M Required by: 31/03/2004

Health and Safety considerations Dust ☐ Contamination ☐ Other:

Heavy ☑ Radioactivity ☐

SAMPLE PREPARATION None

ANALYSIS

ICP Section:
ICP-MS ('W' 30 ml Nalgene bottle, 0.45 µm filtered, acidified with Aristar conc. HNO3) for:-
Ag, Al, As, Ba, Be, Bi, Cd, Ce, Co, Cr, Cs, Cu, Ho, La, Li, Mo, Mn, Nd, Ni, Pb, Rb, Sb, Se, Sn, Th, Tl, U, V, Y, Zn & Zr (31 elements)
ICP-AES ('FA' 30 ml Chemex tube, 0.45 µm filtered, acidified with Aristar conc. HNO3) for:-
Al, B, Ba, Ca, Fe, K, Mg, Mn, Na, P, Si, S (reported as SO4), Sr & Zr (14 elements)

Aqueous analytical section:
Ion Chromatography ('FLA' 30 ml Nalgene bottle, 0.45 µm filtered, unacidified) for:-
Br, Cl, F, NO2, NO3, SO4, HPO4 (7 ions)
TIC/TOC analyser ('FLA' bottle) for:-
Non-purgable organic carbon (NPOC)
2,2'-dipyridyl pre-dosed test-tubes for colorimetric determination of Fe(II) (limited number of samples).

Reporting requirements ICP Section to run but not report Ag & Se until further validation work is carried out. ICP Section to report the data with total analytical values (i.e. without detection limits), detection limits, date of analysis, run order and dilution factors. Aqueous section to report the data &/or list quantification.
Both sections to provide written documentation (c.1-2 pages of text plus appropriate diagrams / tables as necessary) for each analytical method, detailing the instrumentation, procedures used to run the samples, QC protocols and comments on data quality. The text should be suitable for inclusion in an IR report on the data QC.

******** PLEASE REPORT RESULTS TO E.L. Ander (lanal@bgs.ac.uk ext 3006) **********

Notes from field team:

Samples 444401-444500 and 445001-445100 'FA' stored in metal frames until Feb 2004.
Sample 444456 "W" missing. Only 54 samples for Fe(II).

Submitted electronically as hardcopy to lab: on: .....

Signed. .....

Example of sample registration form for surface water

G-BASE SAMPLE REGISTRATION

P

G-BASE Ref: **EA03 006**

Lab No:

Samples from : East Anglia *Registered on:* 12-May-03 *by:* Sarah Brown

From number: 440501 *To number:* 441000 *Number of samples:* 500

Sample list file: 006.xls *Priority* **M** *Required by:* 31/03/2004

Health and Safety considerations

Dust ☑ Contamination ☐ Other:

Heavy ☑ Radioactivity ☐

SAMPLE PREPARATION

Air dry.
Samples to be stored in core store.

ANALYSIS

None

******* PLEASE REPORT RESULTS TO T R LISTER (trl@bgs.ac.uk ext.3536) *********

Notes from field team :

Submitted electronically/as hardcopy to lab : on: .....

Signed : .....

Example of sample registration form for panned concentrate

Appendix I: Summary of G-BASE sampling methods

	Sampling	*Sample Preparation and Analyses*
 Stream sediment	Sediment is collected from the active drainage channel of 1st or 2nd order streams. The sediment is wet sieved firstly through a 2 mm nylon screen then a 150 µm nylon sieve. The fine stream sediment is collected in a Kraft™ paper bag. Sampling density varies according to land use and drainage pattern but averages at one sample every one to two square kilometre.	Sediments are dried initially by air drying then freeze drying before being pulverised in agate ball mills. Samples are pelletised ready for XRFS analyses at the BGS laboratories in Keyworth, UK. A combination of emission and dispersive techniques gives a range of 48 elements (Ag, Al, As, Ba, Bi, Br, Ca, Cd, Ce, Co, Cr, Cs, Cu, Fe, Ga, Ge, Hf, I, K, La, Mg, Mn, Mo, Na, Nb, Nd, Ni, P, Pb, Rb, Sb, Sc, Se, Si, Sm, Sn, Sr, Ta, Te, Th, Ti, Tl, U, V, W, Y, Zn and Zr)
 Panned concentrate	The -2mm+150µm fraction from the sieving of the sediment is panned on site in a wooden Malaysian-style "dulang" pan. A full pan is panned down to give a constant volume in the centre of the pan. The heavy minerals are scanned for evidence of mineralisation or pollution.	Panned concentrates are not routinely analysed or examined in detail. They are stored for future reference and follow-up as required.
 Stream water	Filtered (0.45 µm cellulose filter) and unfiltered waters are collected from the same site as the drainage sediment. Samples are stored in Nalgene™ bottles and acidified as required by the analytical method.	Alkalinity (by colorimetric titration), pH and conductivity determined on location. Samples analysed at BGS. **ICP-MS**: Ag, Al, As, Ba, Be, Bi, Cd, Ce, Co, Cr, Cs, Cu, Ho, La, Li, Mo, Mn, Nd, Ni, Pb, Rb, Sb, Se, Sn, Th, Tl, U, V, Y, Zn & Zr [31 elements]. **ICP-AES**: Al, B, Ba, Ca, Fe, K, Mg, Mn, Na, P, Si, S (reported as SO_4), Sr & Zn [14 elements]. **Ion Chromatography**: Br, Cl, F, NO_2, NO_3, SO_4, PO_4 [7 ions]. **TIC/TOC analyser** for Non-purgeable organic carbon (NPOC)
 Soil	Soils are collected using a one metre Dutch auger taking five sub-samples at the corners and centre of a 20 m square. A surface sample (5 to 20 cm) and a deeper sample (35 to 50 cm) are taken at each site. Samples are collected from alternate 1 km grid squares though in urban areas sampling density is increased to four samples every 1 km^2. Samples are collected in Kraft™ paper bags	The deeper soil samples are dried then sieved to -2 mm. Samples are only routinely analysed in areas where drainage is absent. The surface samples are dried and sieved to -2 mm and pulverised in agate ball mills then palletised for XRFS analyses as per stream sediment samples. Loss-on-ignition (450ºC) and pH is also routinely measured for soils.

Appendix J: Manual Update History

Version 1.1 to 1.2 Update history (page numbers and sections refer to version 1.1

Date	Page(s)	Section	Description of update	Updated by:	Authorised by:
18/06/04	Title pages	-	Report reformatted to conform to BGS occasional report format	CCJ	J Thomas
18/06/04	Title pages	-	Authors list revised to reflect manual is a G-BASE team effort. Stronger acknowledgement given to Dee Flight for her contribution to protocols	CCJ	CCJ
18/06/04	2-2	Table 2-1	Number of water samples collected changed from five to four	CCJ	CCJ
18/06/04	2-2	Table 2-1	Soil sampling depths clarified. Top soil sampled down to 20 cm and deep soil down to 50 cm. Surface litter and roots (< 5 cm) remove where appropriate	CCJ	CCJ
18/06/04	3-2	Table 3-1	Carrying heavy loads in the field added as a risk in H&S table	DMAF	CCJ
18/06/04	11-1 - 11-2	11.2 and through-out	Water procedures modified to the collection of four rather than five samples as two ICP samples now collected as single sample in 60 ml Nalgene bottle. References to W samples deleted - F/A and W now a single F/A sample.	CCJ	CCJ
18/06/04	11-2	11.2.3	Comment about use of pre-filters in filed added	CCJ	CCJ
18/06/04	11-6	11.4	The section on collection of stream sediment samples from dry sites deleted as repeated in section 11.5	CCJ	CCJ
21/06/04	21-1 - 12-2	12	Soil sampling procedures rewritten re-establish correct sampling depth and other procedures previously omitted	G-BASE team	CCJ
23/06/04	14-1	14.1.1	Soils included in the daily checking routine	CCJ	CCJ
23/06/04	14-4	14.3	Sentence added to say water acidification should only be carried out by BGS staff	CCJ	CCJ

23/06/04	5-2 and 9-1		Insert references to the G-BASE brochure	CCJ	CCJ
23/06/04	H-3		Example of G-BASE registration form for waters updated	ELA	CCJ
02/08/04	3-2	Table 3-1	Addition of exposure of staff and VWs to reagents in water chem., and gluing of sediment/ pan bags	ELA	CCJ
02/08/04	4-4	4.4	Addition of water sample checklists, cool boxes and Safepak containers to equipment list	ELA	CCJ
02/08/04	11-1 to 11-3	11.2	Updating of stream water collection methods to include single F/A sample and reinforce QC points	ELA	CCJ
02/08/04	11-8	11.5	Numbering and field card entries for monitor sites described	ELA	CCJ
02/08/04	13-1 to 13-2	13.2	Duplicate water sample collection updated, and more information provided with blank water procedure.	ELA	CCJ
02/08/04	14-3 to 14-4	14.3	Acidification procedure updated with more H&S and QC information.	ELA	CCJ
02/08/04	16-1 to 16-4	16	QC procedures reinforced in an update of the text	ELA	CCJ
02/08/04	14-1	14.1.1	Selection procedure for LOI and pH soil samples subset described.	ELA	CCJ
19/08/04	Annex I		New Appendix inserted as simple summary of sampling methods. Annex I becomes Appendix J	CCJ	CCJ
19/08/04	5-3	5-2	Conventional International Distress Signals explained	CCJ	CCJ
19/08/04	2-3	Figure 2-1	Water chemistry analyses updated	CCJ	CCJ
19/08/04	Annex F		Barry Rawlin's protocol for working in areas of Rhizomania	BGR	CCJ

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