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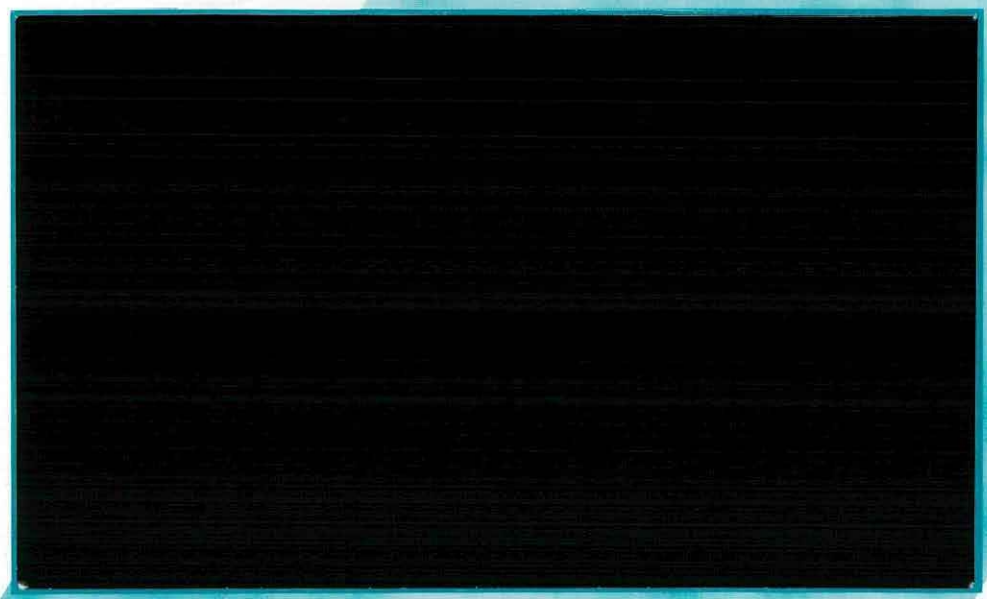

Centre for Ecology & Hydrology

Natural Environment Research Council

ITE has six Research Stations throughout Britain, which allows the efficient use of resources for regional studies and provides an understanding of local ecological and land use characteristics. The Institute's administrative headquarters is at Monks Wood.

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Details about the Institute are available on the Internet via the World Wide Web (http:/www.nmw.ac.uk/ite)

MASQ: MONITORING AND ASSESSING SOIL QUALITY

DETR funded project: ITE Project Number T01069a5

Module 6: Soils and Pollution

Second Quarterly Report

August 1998 – October 1998

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Background

The Royal Commission on Environmental Pollution on Soil Sustainability (1996) identified the development of indices of soil biological activity and diversity as a key research priority. The major difficulty in developing such indices is the need for baseline data from which a set of standards can be developed. A recent review by ITE (SOILPACS, 1996) has shown that existing data are inadequate to develop bioindicators of soil quality, as the data are poorly structured and inconsistent in methodology and objectives. A nationwide survey is necessary if we are to establish a comprehensive baseline dataset. This task requires considerable logistical commitment, since soil biological sampling is meaningless without detailed site information. In addition, issues related to the contamination of soil by past, present and future economically valuable activity involving chemical use and disposal, are proving difficult to resolve in the absence of a framework of national information on soil contamination that is related to land use type.

Countryside Survey 2000 (CS2000) provides a cost-effective framework for integrating a soil biological survey with existing and subsequent soil and land use data status and for a comparison with soil data from the 1978 Countryside Survey (pH, loss on ignition, basic soil descriptions). The programme of sampling would be targeted to enable the CS2000 field surveyors to re-sample X-plots used for soil sampling in the 1978 survey (ca. 1280 sites). The surveyors would be trained to collect suitable soil material for subsequent laboratory evaluation of soil pH, carbon content, faunal and microbial diversity and soil heavy metal and organic contents.

Objectives for 1998-99

Soil fauna. Characterisation and quantification of the soil invertebrate in every one of the CS2000 soil samples by the extraction of returned samples using conventional extraction techniques. The most important groups (collembola, mites) to be identified, where practicable, to species level.

Soil microflora. Microbial diversity will be assessed in terms of metabolic potential, using the BIOLOG approach for quantifying and assessing the ability of the microbial populations in each soil sample to degrade a variety of simple and complex substrates. This approach is becoming established as an index of microbial diversity and functional capability.

Soil chemistry

As noted above, some 1280 soil samples were collected during the Countryside Survey 1978 and analysed for pH and loss on ignition. Analysis of the CS2000 samples for pH and loss on ignition will allow, in combination with the data available from 1978, an evaluation of change in these parameters over the 20 year period between the two surveys. The data from CS2000 will also

provide important contextual information for the outputs from the biological studies. Analysis of the CS 2000 samples for heavy metals and organic compounds would establish a large and robust national baseline against which future sampling and analytical programmes could be compared.

Outputs

Staff

The full-time processing staff continued to receive and process the CS2000 cores as they arrived at ITE Merlewood and enter the weekly data from the log-in sheets onto an EXCEL spreadsheet. A third (part-time) member of staff verified the 1978 soils data and monitored the progress of the fieldwork. Dr Black completed the first progress report and an article for inclusion in the CS2000 web pages (http://www.cs2000.org.uk).

Field sampling

The CS2000 surveyors carried out the soil sampling to schedule and with few problems. Communication between the surveyors, co-ordinators and the samples processors meant that any outstanding sampling issues (e.g. numbering changes) were resolved quickly. The field sampling was completed by the end of October 1998 and the field equipment has being collected by the co-ordinators. This is being returned to ITE Merlewood along with the other CS2000 field equipment as transport is made available.

Sample processing and protocols

MASQ Laboratory

The renovated laboratory proved ideal for the processing of such a large number of samples. The soil faunal and microbial cores arrived at an average rate of 50 per week while the soil chemistry cores arrived in larger numbers in a less regular manner since they were returned by the ITE co-ordinators when transport was available.

The last soil microbial and faunal cores were received on 28.10.98. All soil microbial samples are now frozen and accessible by date. The extraction of the last soil faunal core was completed on 2.11.98 and all faunal samples, in 70% ethanol, are now stored in according to square/X-plot in flammable cupboards at ITE Merlewood. The remaining cores for soil chemical analyses were received on 29.10.98 and are currently air-drying before analyses and storage. The remaining samples will be analysed by mid-November

1998. Soil for organics analyses are frozen as part of the soil microbial core. The methods for sampling from these cores for organics are currently being discussed with Dr D Osborn at ITE Monkswood.

Deliverables

1. Table 1 indicates the total number of samples received for soil biota assessments and soil heavy metal analyses.

Table 1 Total number of soil cores received from CS2000 surveyors by 31.10.1998

Month	Biota cores	Chemistry
TOTAL	994	988

*the number is the same for faunal and microbial assessments

2. The wet pH has been determined on all soil chemical samples in Table 1. The dry pH has been determined on over 95% soil chemical samples in Table 1.

3. All available data for soil chemistry and biota have been entered on EXCEL spreadsheets. The first stage of data verification has been carried out and all anomolies with square and plot numbers have been resolved. The requirements for user-access and data storage have been discussed with John Watkins (CS2000 Module 13) and, consequently, the best methods to integrate the MASQ data with the 1978 soils data and CS2000 survey data are being assessed.

4. All soil biota samples are stored in preparation for the next stage of analyses: soil fauna have been extracted for all faunal soil cores in Table 1 and are now stored in 70% ethanol for identification. All soil microbial cores in Table 1 have been frozen for storage.

5. Modifications to the MASQ extraction and preparation protocols for biotic and chemical analyses have been edited into the protocol sheets; see appendix for a copy.

6. All current data (until 1.12.98) have been copied onto a CD-ROM which is now stored off-site. Further copies will be made on a regular basis.

7. Web page for MASQ completed (see Appendix).

APPENDIX

Processing Protocols for CS2000 Soil Samples

Updated version from 1.12.98

and

WWW page for MASQ

CS2000 POSTED CORES

check box in reception for core envelopes after each post delivery (usually 8 am and 4 pm)

take envelopes to drive store for processing

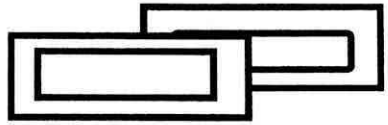
record date of arrival and, if visible, post mark date and/or written date on envelope on the log-in sheets

remove cores from envelopes

check for written comments in or on the envelope. Copy comments to limerick file (T:\HBL\CS2000\limer.doc)

Each day record todays arrivals -
sheets
the process

CS2000 POSTED CORES



From envelopes: two white cores in labelled self-sealed bags

one core for microbial assessment

one core for zoology assessment

follow extraction protocol

Record date in freezer column of log-in sheets

Is this is the first sample from a square ?

NO

YES

Take this core to the freezer

Place core+bag in larger self sealed bag labelled with square N

Is this is the fifth core in the bag ?

YES

Seal the bag and place in the main freezer compartment at location stated on the freezer sheet

Label a large self-sealed bag with the square N

Place core+bag in this larger bag

Take this bag to the freezer

Place bag in one of the baskets in the freezer

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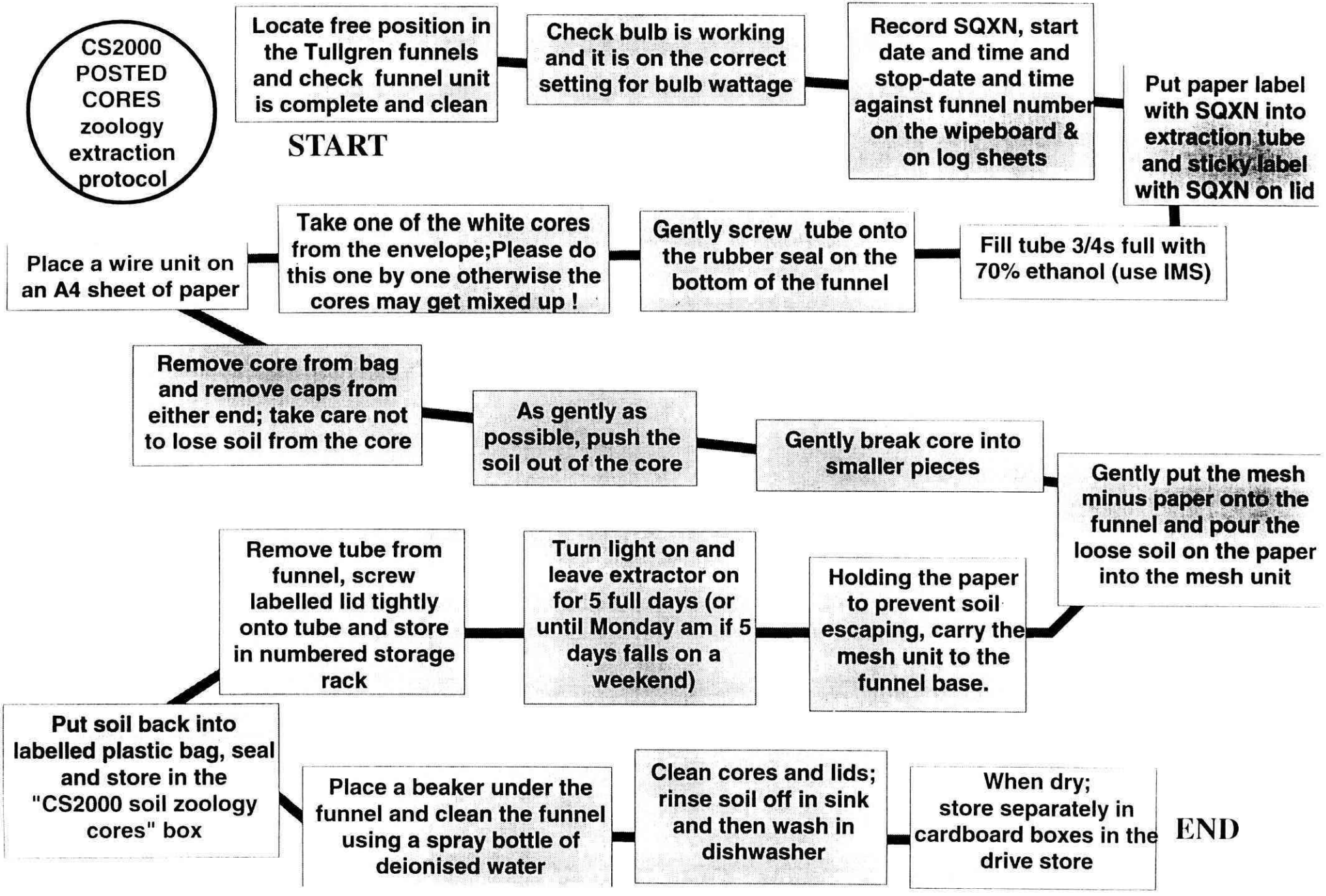
t:\hbl\cs2000\protocols\prot_fin.prs


CS2000 POSTED CORES zoology extraction protocol
START
Locate free position in the Tullgren funnels and check funnel unit is complete and clean
Check bulb is working and it is on the correct setting for bulb wattage
Record SQXN, start date and time and stop-date and time against funnel number on the wipeboard & on log sheets
Put paper label with SQXN into extraction tube and sticky label with SQXN on lid
Fill tube 3/4s full with 70% ethanol (use IMS)
Gently screw tube onto the rubber seal on the bottom of the funnel
Take one of the white cores from the envelope;Please do this one by one otherwise the cores may get mixed up !
Place a wire unit on an A4 sheet of paper
Remove core from bag and remove caps from either end; take care not to lose soil from the core
As gently as possible, push the soil out of the core
Gently break core into smaller pieces
Gently put the mesh minus paper onto the funnel and pour the loose soil on the paper into the mesh unit
Holding the paper to prevent soil escaping, carry the mesh unit to the funnel base.
Turn light on and leave extractor on for 5 full days (or until Monday am if 5 days falls on a weekend)
Remove tube from funnel, screw labelled lid tightly onto tube and store in numbered storage rack
Put soil back into labelled plastic bag, seal and store in the "CS2000 soil zoology cores" box
Place a beaker under the funnel and clean the funnel using a spray bottle of deionised water
Clean cores and lids; rinse soil off in sink and then wash in dishwasher
When dry; store separately in cardboard boxes in the drive store
END

[redacted]

black core arrival

[redacted]

CS2000 BLACK CORES chemistry preparation

Record date of delivery of the black core SQXN number on the log sheet

Remove black core from bag

Weigh a clean aluminium tray and record weight on log sheets

Place core in an aluminium tray with the SQXN number written with a permanent pen on the side of the tin

Weigh the whole core in tray and record weight on log sheets

Remove soil from core into tray

Weigh black pipe alone and record on log sheets

wet soil pH

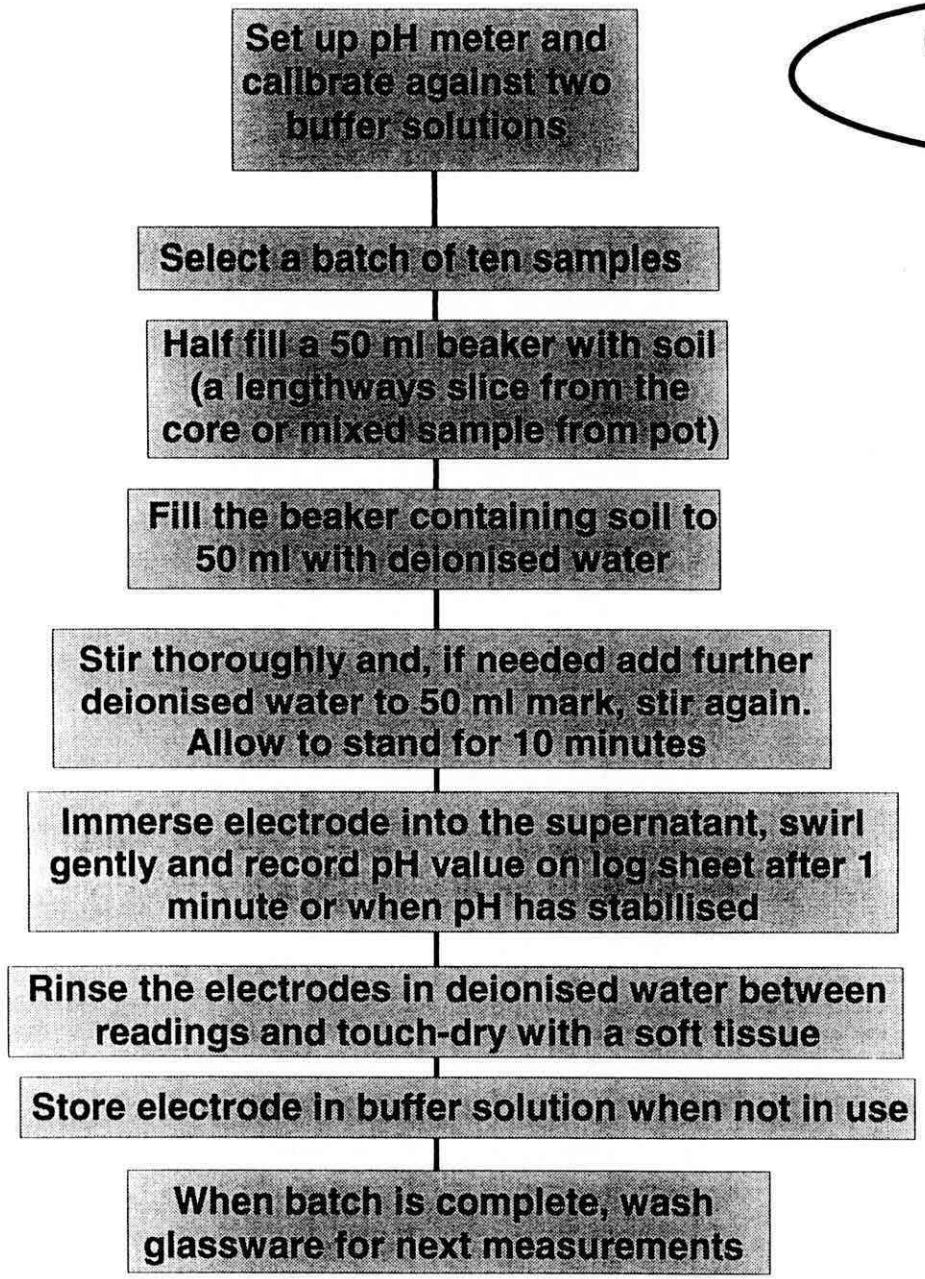
Re-weigh the core in tray and record weight on log sheets

[redacted]

[redacted]

pH protocol

CS2000 BLACK CORES chemistry preparation



[redacted]

CS2000 BLACK CORES chemistry preparation

AIR DRY SOIL

Air dry soil in trays on racks until dry (typically 2 weeks) or in oven (25-30 deg C)

Weigh soil in tray and record weight on log sheets

Sieve soil using the 2 mm stainless steel mesh sieve

Reweigh after sieving and record in log-sheets

Label storage pots with SQ/X/N and with number of pots used per sample e.g. 1/3 for pot 1 of 3 pots containing the sample

Put sieved soil into storage pot

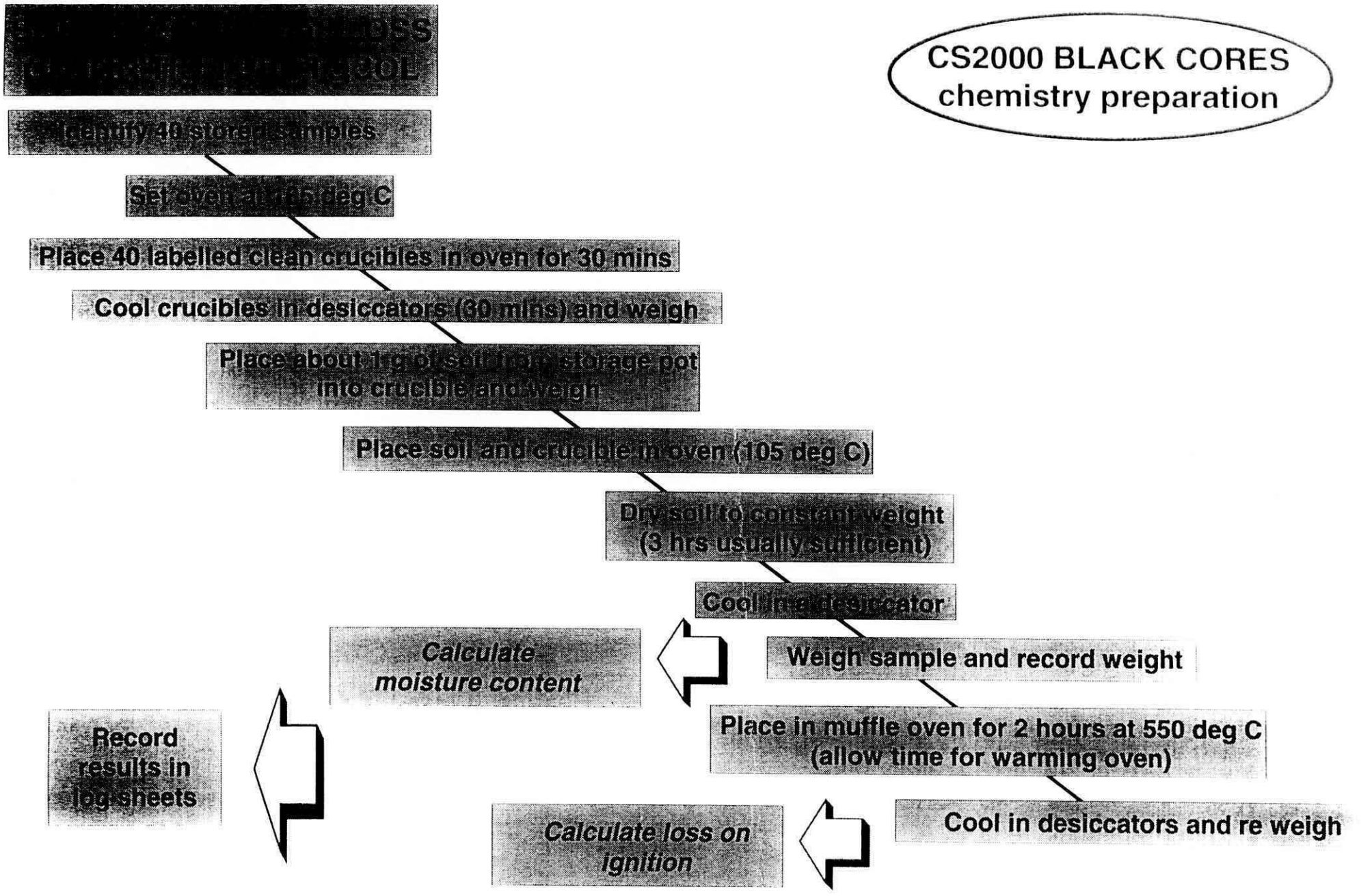
Store pot on shelves in sample prep room.

DRY pH

Follow pH protocol

Move pot to long-term storage in drive store

[redacted]


CS2000 BLACK CORES
chemistry preparation
Identify 40 stored samples
Set oven at 105 deg C
Place 40 labelled clean crucibles in oven for 30 mins
Cool crucibles in desiccators (30 mins) and weigh
Place about 1g of soil from storage pot into crucible and weigh
Place soil and crucible in oven (105 deg C)
Dry soil to constant weight (3 hrs usually sufficient)
Cool in a desiccator
Weigh sample and record weight
Calculate moisture content
Place in muffle oven for 2 hours at 550 deg C (allow time for warming oven)
Cool in desiccators and re weigh
Calculate loss on ignition
Record results in log sheets

Soil Quality

DETR and NERC

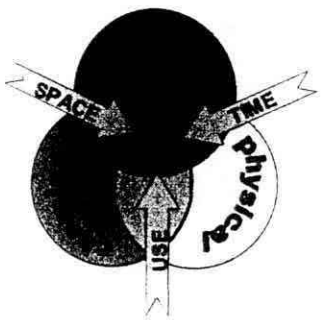
MASQ: MONITORING AND ASSESSING SOIL QUALITY

In 1996, The Royal Commission on Environmental Pollution, in its nineteenth report "*Sustainable Use of Soil*", stressed the need for the assessment and monitoring of soil quality. Such information would be useful for Government Departments and Agencies e.g. the DETR, MAFF, SOAEFD, the Environment Agency and SEPA, in various aspects of policy-making including:

- acidification of soils and its effects
- soil as source and sink for greenhouse gases
- effects of climate change on soil processes
- sustainable management of arable soils
- waste management and pollution control

Soils sustain much of the earth's biological activity, diversity and productivity by storing and cycling nutrients and other elements, regulating water and solute flow as well as filtering and buffering inorganic and organic materials, including industrial and municipal pollutants and waste materials.

The capacity of a soil to carry out these functions can be defined as *soil quality* and integrates the innate soil chemical physical and biological attributes within a framework of space, time and land use. The Countryside Survey 2000 provides a cost-effective framework to link a soil biological survey with other soil and land use data to develop the integrated approaches necessary for soil quality assessment and monitoring in Great Britain.



The principal objective

To provide spatially referenced baseline datasets of soil chemical and biological attributes for the monitoring and assessment of soil quality in Great Britain.

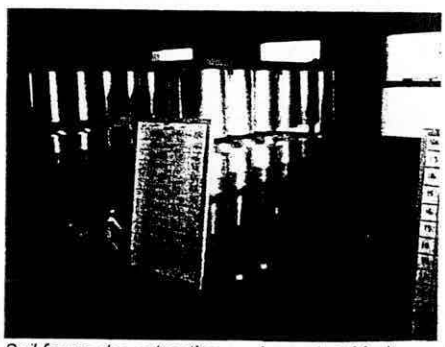
Programme of work

- To carry out a programme of soil sampling by the CS2000 field surveyors at the locations sampled in the 1978 Countryside Survey.

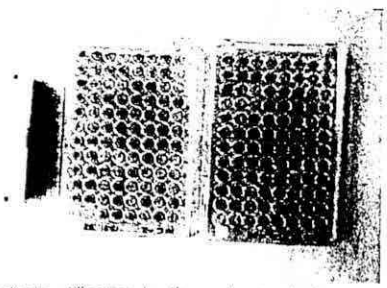
- To identify and quantify soil meso-fauna by the extraction of returned samples using conventional extraction techniques and to assess soil microbial diversity using the BIOLOG approach.

- To analyse the CS 2000 soil samples for pH and loss on ignition to allow an evaluation of change in these properties over the 20 year period between the 1978 and 1998 surveys.

- To analyse the CS 2000 soil samples for heavy metals and for a suite of organic compounds to establish a large and robust national baseline against which future sampling and analytical programmes could be compared.



Soil fauna dry extraction equipment at Merlewood



Substrate utilisation by the soil microbial community in a BIOLOG$_{GN}$ microtitre plate

Natural Environment Research Council