SERVICES & FACILITIES ANNUAL REPORT - FY April 2010 to March 2011

SERVICE	FUNDING	AGREEMENT	ESTABLISHED as S&F	TERM
Sorby Environmental Fluid Dynamics Laboratory - SEFDL			2001 – recontinued 2007	6 years

TYPE OF SERVICE PROVIDED:

The Sorby Environmental Fluid Dynamics Laboratory (SEFDL) is hosted by the University of Leeds and provides a unique and world-leading array of facilities for the study of environmental fluid dynamic problems. Users of the facility have access to a wide range of different flume facilities and pipe loops, and a unique suite of measurement equipment. These include laser and phase Doppler anemometry, multiple particle image velocimetry (PIV) systems capable of running at up to 3000 Hz, and a number of ultrasonic Doppler velocimetry systems. Additionally SEFDL possesses a broad range of instrumentation for measuring other variables such as rheological parameters, concentration, grain-size, salinity, temperature, flow structure and deposit morphology. Some of the measurement facilities are available as an equipment pool for loan to suitably equipped laboratories.

Coupled to these facilities the SEFDL provides access to considerable expertise in the design of experimental facilities, the application and optimisation of fluid measurement techniques, and the post-processing of data collected from such instruments. In particular, the SEFDL has pioneered the application of a number of these techniques to the field of environmental fluid dynamics, most notably for opaque, sediment-laden, and multiphase flows and consequently can provide extensive expertise in these areas.

Increasingly, SEFDL provides validation data for sophisticated numerical models; techniques such as PIV are ideally suited to providing spatial and temporal datasets that can be compared to computational fluid dynamic models. SEFDL aims to support the numerical modelling community in the environmental sciences as extensive validation of models becomes more routine.

The SEFDL also has access to both excellent mechanical and electrical workshop facilities in order to construct specific user-defined apparatus. For further information on our facilities see the SEFDL website: http://www.see.leeds.ac.uk/research/facilities/sefdl

ANNUAL TARGETS AND PROGRESS TOWARDS THEM

- Technical support. A second laboratory technical post has been fully operational over this period, enabling both improved user support and an increase in the range and quantity of work that SEFDL can accommodate.
- Enhance range of facilities. Investment continued across the laboratory; new PIV timer hub, work station and software, a new PIV endoscope, as well as ancillary computers, light sources, cameras, pressure sensors, and pH/salinity loggers. We have also been trialling new PIV cameras prior to purchasing one in the coming year.
- Commission new facility. Work has continued on the long-term commissioning of a major new facility, a 10 m long, 2.5 m wide flume in the new laboratory annexe. This has been a large programme that we aim to complete in the coming year.
- Sediment storage and handling. Work has been completed on the planning of a complete overhaul in the handling of sediment within the facility. Implementation of this over the next year should enable us to handle large loads of sediment far more efficiently, and enabling a wider range of experiments to be undertaken.

SCORES AT LAST REVIEW (each out of 5)		Date of Last Review:		
Need	Uniqueness	Quality of Service	Quality of Science & Training	Average
4	4	Not reviewed	5	4.3

CAPACITY of HOST ENTITY FUNDED by S&F	Staff & Status	Next Review (March)	Contract Ends (31 March)
%	Jeff Peakall – Director and Reader in Process Sedimentology Gareth Keevil – Experimental Officer Russell Dixon - Technician		

FINANCIAL DETAILS: CURRENT FY						
Total Resource Allocation £k	Unit Cost £k			Capital Expend £k	Income £k	Full Cash Cost £k
	Unit 1	Unit 2	Unit 3			

FINANCIAL COMMITMENT (by year until end of current agreement) £k				
2010-11	2011-12	2012-13	2013-2014	2014-2015

STEERING COMMITTEE	Independent Members	Meetings per annum	Other S&F Overseen

APPLICATIONS: DISTRIBUTION OF GRADES (current FY — 2010/11)								
	α5	α4	α3	α2	α1	β	R*/Pilot	Reject
NERC Grant projects*								
Other academic								
Students								
Pilot								
TOTAL								
APPLICATIONS: DISTRIBUTION OF GRADES (per annum average previous 3 financial years —2007/2008, 2008/2009 & 2009/2010)								
	α5	α4	α3	α2	α1	β	R*/Pilot	Reject
NERC Grant projects*								
Other Academic								
Students								
Pilot								
TOTAL								

PROJECTS COMPLETED (current FY – 2010/11)							
	α5	α4	α3	α2	α1/β	R*/Pilot	Not Graded
NERC Grant projects*		2					
Other Academic							6
Students							4
Pilot							

Project Funding Type (current FY – 2010/11) (select one category for each project)										
Grand Total	Infrastructure					PAYG				
	Supplement to NERC Grant *	PhD Students		NERC C/S	Other	NERC Grant*	PhD Students		NERC C/S	Other
		NERC	Other				NERC	Other		
32						6	5	11	0	10
Project Funding Type (per annum average previous 3 financial years - 2007/2008, 2008/2009 & 2009/2010)										
Grand Total	Infrastructure					PAYG				
	Supplement to NERC Grant *	PhD Students		NERC C/S	Other	NERC Grant*	PhD Student		NERC C/S	Other
		NERC	Other				NERC	Other		
25						5.7	2.3	9.7	0	7.3

User type (current FY – 2010/11) (include each person named on application form)				
Academic	NERC Centre/Survey	NERC Fellows	PhD Students	Commercial
22	1	0	16	1
User type (per annum average previous 3 financial years - 2007/2008, 2008/2009 & 2009/2010)				
Academic	NERC Centre/Survey	NERC Fellows	PhD Students	Commercial
18.7	0	0.7	12.3	0.3

OUTPUT & PERFORMANCE MEASURES (current year)									
Publications (by science area & type) (calendar year 2010)									
SBA	ES	MS	AS	TFS	EO	Polar	Grand Total	Refereed	Non-Ref/ Conf Proc	PhD Theses
0	14.8	9	0	2.2	0	0	26	10	12	4

Distribution of Projects (by science areas) (FY 2010/11)							
Grand Total	SBA	ES	MS	AS	TFS	EO	Polar
32	0	12.25	8.6	2.1	9.05	0	0

OUTPUT & PERFORMANCE MEASURES (per annum average previous 3 years)									
Publications (by science area & type) (Calendar years 2007, 2008 &2009)									
SBA	ES	MS	AS	TFS	EO	Polar	Grand Total	Refereed	Non-Ref/ Conf Proc	PhD Theses
0	6.4	12.8	0.2	4.9	0	0	24.3	5.3	17.3	1.7

Distribution of Projects (by science areas) (FY 2007/2008, 2008/2009 & 2009/2010)							
Grand Total	SBA	ES	MS	AS	TFS	EO	Polar
24.3	0	7.8	9.1	0.4	7	0	0

Distribution of Projects by NERC strategic priority (current FY 2010/11)							
Grand Total	Climate System	Biodiversity	Earth System Science	Sustainable Use of Natural Resources	Natural Hazards	Environment, Pollution & Human Health	Technologies
32	2.1	0	8.8	12.85	4.25	1	3

**Combined Responsive Mode and Directed Programme grants*

NOTE: All metrics should be presented as whole or part of whole number NOT as a %

OVERVIEW & ACTIVITIES IN FINANCIAL YEAR (2010/11):

Overview: SEFDL supported a total of 32 research projects, including 16 PhD students; this is the largest number of projects ever supported by SEFDL in a single year. This continues a period of rapid growth in the user base, and was enabled by the addition of a second full-time technical post in the facility. Major funding bodies include NERC, the global hydrocarbon industry, the nuclear industry, EPSRC, Yorkshire Water, and Speedo International, alongside a number of international awards. A wide range of work within the field of environmental fluid dynamics was undertaken at SEFDL over the past year, including programmes in deep-water sedimentary processes, sediment transport processes and fluid dynamics in support of nuclear waste remediation, the influence of vegetation and turbulence on fluvial systems, and the impact of gravitationally driven cold fronts from atmospheric storm systems.

Major improvements: This was the first full year with a second technician in post, enabling a larger number of users to be supported than ever before. Work is now almost complete on the new laboratory annexe and associated flume, with much effort again committed to this major project this year. Funding is in place to support this facility, with work initially planned to look at mineral placers and submarine channel overbank flows.

Capital spending: Investment continued across the laboratory. A new PIV timer hub, work station and software represent a significant upgrade of this key instrument. Alongside this a new PIV endoscope has been purchased enabling very small areas of flow to be looked at in great detail, opening up lots of new possibilities scientifically. In addition to these the laser diffractometer grain-sizer has had a major overhaul and there has been considerable investment in ancillary computers, light sources, cameras, pressure sensors, and pH/salinity loggers.

Future capital spending: We have obtained funding for a new state-of-the-art PIV camera, and have been trialling potential PIV cameras prior to purchasing one in the coming year.

New research projects: A number of new research projects were initiated in 2010/2011. These include a new NERC grant using NERC's autonomous submarine, *Autosub 3*, to investigate in a natural submarine channel system many of the ideas that have been developed at SEFDL over the previous decade (see Research Highlights for more details). A new three year phase of the Turbidite Research Group consortium was also launched funded by a consortium of hydrocarbon companies, and seeking to examine an array of issues in the field of deep-sea sedimentary deposits. Work on gold placers was also initiated, and is a novel area of research for the laboratory; placers are caused where minerals become concentrated during sedimentary transport and are found in places such as rivers and beaches. We also worked with the United States Department of Agriculture National Sedimentation Laboratory in Oxford, Mississippi, utilising some of our skills with acoustic instrumentation in order to aid some of their ongoing research on river restoration. Finally, our work with Speedo International on testing of novel swimsuit materials (see Research Highlights for more details) deepened with the completion of one phase, and the initiation of a second phase of work.

New developments: SEFDL is a key component of the recently announced Sellafield Sites Ltd sponsored Sludge Centre of Expertise. Sludge in this context is a relatively high concentration particulate-rich flow. Sellafield Sites is the main operating company for the Sellafield complex, and this Centre of Expertise positions SEFDL as the primary contractor for all physical modelling of sludge required by the company. This has been complimented by a Doctoral Training Centre in nuclear engineering where SEFDL is also a key contributor.

SEFDL will also play a key role as part host for the 4 yearly International Fluvial meeting which is being hosted at Leeds in 2013.

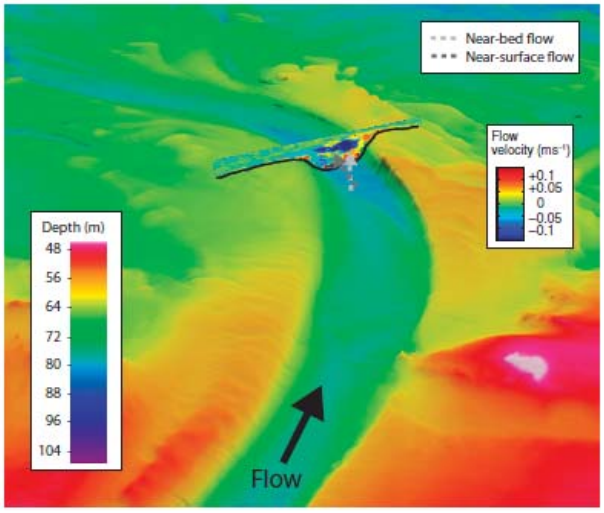
SCIENCE HIGHLIGHTS:

Here we highlight just three of the areas that SEFDL has been contributing towards. In addition to these, there have been major contributions in the past year in the fields of sediment transport, river dynamics, flooding, and deep-sea deposits amongst others.

Measuring novel swimsuit materials, and using biomimetics to inform future swimsuit design

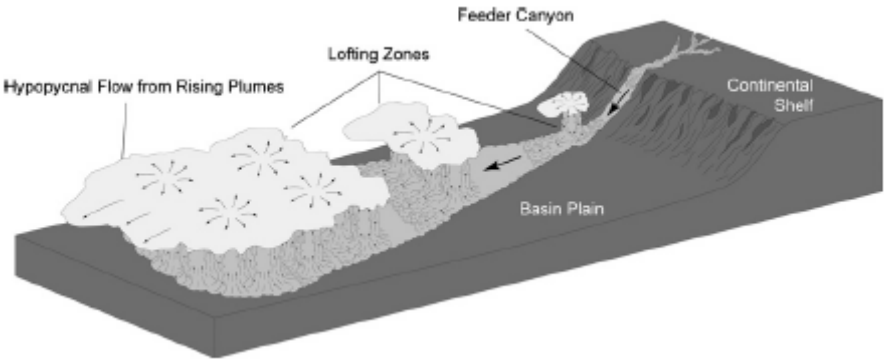
In a departure from our normal areas of research SEFDL has been utilising its expertise and facilities in order to help Speedo International determine which of their novel swimsuit materials is the fastest. Each material has a 'skin-friction' which measures the drag of the flow over that material, in the absence of form drag (in this case the drag caused by the swimmer's shape). We have developed a new methodology in order to be able to accurately measure this skin-friction under conditions typical of those experienced by elite swimmers. The fastest material will form the basis for Speedo's new 2012 elite performance swimsuits, out in time for the London Olympics. Building on the techniques developed for measuring swimsuits, we are about to start a NERC funded PhD, with Speedo International as a CASE sponsor, looking at the evolution of speed in early fish. Here we aim to examine how speed in early scaly fish evolved and examine the potential for applying biomimetics ('learning from nature') to produce future generations of swimsuits.

Submarine channel flow dynamics: from laboratory to nature



Submarine channels are giant ocean floor 'rivers' that transport sediment, nutrients, carbon, and more recently pollutants to the deep sea. The flows in these channels can pose a significant geohazard, whilst their deposits are economically important as reservoirs for offshore hydrocarbon production. SEFDL has enabled a host of advances to be made in this research field. Perhaps most controversially, work undertaken at SEFDL, suggested that the three-dimensional nature of flow through these channels could be exactly opposite to that in rivers. Flow in sinuous channels is known to spiral in much the way that a 'slinky' (the children's toy) does, and in rivers the spiral directs basal flow at bend apices towards the inner bank. Laboratory experiments on submarine channel flows showed that basal flow at bend apices could instead be outwardly directed, with significant implications for the nature of deposits in these systems. These pioneering experiments sparked much debate given that the fluid flow ultimately drives both deposition and channel evolution in submarine channels, and led to a NERC funded project to look at natural flows. The Bosphorus Strait is one of the world's busiest shipping lanes, and an extremely difficult place to undertake fieldwork. However, its exit into the Black Sea is a key location globally, as in this location dense salty water from the Mediterranean flows through a sinuous channel on the floor of the Black Sea. Field data from this sinuous seafloor channel have confirmed the observations from the small-scale SEFDL laboratory experiments that the circulation in submarine channels really can be opposite to that in river channels. *See Parsons et al., 2010, Geology, 38, 1063-1066.*

Deep-water massive sands: addressing an enigma



Deep-water massive sands are large thicknesses of near structureless sand that are present in deep-sea deposits. They make perfect reservoir rocks for hydrocarbon production yet the origin of these deposits has been an enigma: known processes simply do not account for such deposits. Experiments at SEFDL have enabled an explanation for at least some of these deposits for the first time. Flows of freshwater and particles, for instance at river mouths during floods, can in some cases produce flows that descend and run along ocean floors because they are denser than the surrounding seawater. We see spectacular examples of this when Icelandic volcanoes melt ice and create huge outburst floods. As sediment is deposited the flow gets progressively less dense and there comes a point when the freshwater plus sediment in the flow becomes less dense than the surrounding sea-water, at which point it 'lofts' that is lifts away from the bed as a plume (see figure). When it does this large amounts of sediment can be deposited at a point creating clean structureless sands, however, the point of lofting will migrate over time, and consequently sediments will be spread widely. The experiments demonstrate however that the presence of sea-floor topography such as ridges can stabilise the lofting point enabling large thicknesses of deep-water massive sands to accumulate. *See Stevenson and Peakall, 2010, Marine and Petroleum Geology, 27, 1366-1378.*

FUTURE DEVELOPMENTS/STRATEGIC FORWARD LOOK

Work should be completed this year on the long-term project to add an additional laboratory space to SEFDL and with it the largest flume facility that the laboratory has ever had. Funding is in place from NERC, hydrocarbon companies, and the minerals exploration industry to fully utilise this new facility once it is up and running.

Alongside the new annexe and flume, a complete overhaul of sediment storage and sediment transport in the laboratory is being undertaken. Storage space will be tripled, a forklift will be purchased, a new loading bay will be developed, and a flexible artificial screw will be purchased to enable efficient and safe movement of sediment into the large flume facilities. These changes will be made alongside implementation of new mixing facilities and protocols enabling sediments to be mixed safely without generating a dust hazard. Together, these new facilities will enable SEFDL to accommodate larger scale experiments, to increase efficiency of operation, and to minimise the manual handling risks. In so doing, SEFDL will be able to support work tackling a wide range of scientific problems that could not previously have been attempted.

The user profile continues to expand, with a number of projects incorporating the biosciences starting this coming year. It has long been an aim to support this area of NERC's mission, and this in part reflects the strategic investment in a suite of facilities that can accommodate both fresh and salt water flows. Alongside this, work in the areas of atmospheric science and nuclear waste remediation continues to grow. This growth in the breadth and number of the user base remains a key challenge to manage, whilst maintaining a high level of service to the user community.