STUDY OF SCIENCE RESEARCH INFRASTRUCTURE

EXECUTIVE SUMMARY AND RECOMMENDATIONS

Introduction

1. This report reviews the past investment in infrastructure for science research in UK universities and colleges. It assesses the extent of remedial investment required, and sets out the conditions needed to manage their research infrastructure on a sustainable basis in future.

2. The physical infrastructure in higher education institutions (HEIs) supporting teaching and research is made up of buildings with an insured value of approximately £26bn, plus equipment and contents of a further £8bn. About 15% of this physical infrastructure can be identified as core or dedicated research space, but much of the infrastructure used by research is shared with other university activities (offices; libraries; plant and services). We calculate that overall, approximately 30% of total university space can be attributed to research, and approximately 34% of the costs of the higher education (HE) physical infrastructure can be attributed to science research (details in the Annex and in Chapter 2).

3. Approximately one third of this infrastructure was directly funded by the Exchequer in the past and has an Exchequer Interest. A further proportion has been inherited from other public bodies (chiefly local education authorities) and the remainder has been provided by HEIs using their own resources – mainly surpluses from non-publicly funded activities. Overall, institutions have become increasingly responsible for financing their own infrastructure although the injection of public funds through the Joint Infrastructure Fund (JIF) and the Science Research Infrastructure Fund (SRIF) will off-set this trend in the short term (see Chapter 2).

4. The infrastructure for research also includes some staff (e.g. technicians); and recurrent funding for items such as maintenance contracts; library materials; small items of equipment and consumables; travel; publications etc. We consider these in Chapters 4 and 5, but the main focus of the report is on the remedial and recurrent investment needs in the capital or fixed assets.

Existing evidence and schemes

5. Approximately 50% of the HE estate was built, to relatively low and inflexible specifications, in the 1960s and early 1970s. Much of this infrastructure is nearing the end of its design life, and new requirements arise from scientific and technological advance; from recent growth in research (and student) volumes; and from legislation.

6. There is substantial existing evidence (reviewed in Chapter 2) of significant remedial investment needs in terms of the maintenance condition of buildings and services; their fitness for modern research purpose; and the adequacy and specification of the specialist contents that support research: libraries, information technology (IT) networks, scientific equipment.

7. The maintenance surveys in the early 1990s (Hunter and KDK) showed significant back-logs of buildings maintenance (equivalent to £2.8bn in current costs). Our analysis of expenditure by institutions over the past decade (Chapters 2 and 3) shows that they have invested very broadly the right amount to stand still in maintenance condition terms, but not enough to remedy the maintenance back-logs. The latest Estates Management Statistics (EMS) data show these to be standing at about £3.5bn. EMS data also show that nearly one half of the HE estate is not fully suitable for purpose. There are also costs to be met for legislative requirements relating to health and safety and disabled access.

8. The Dearing Committee assessed the infrastructure for research as in poor state with consequent loss of UK international competitiveness. Other reports since have confirmed this, and there have been several initiatives to remedy infrastructure problems such as the Joint Research Equipment Initiative (JREI - equipment), the Higher Education Funding Council for England (HEFCE) Poor Estates scheme (buildings) and Laboratory Refurbishment scheme, Research Development Grants scheme (Scotland), and most recently JIF and SRIF. We review the contribution of these schemes in Chapter 3.

9. JIF and SRIF have been essential and valuable, but they have made a relatively modest impact on the problems of the existing research infrastructure. We calculate that JIF and SRIF will impact on broadly 15% of institutions' research infrastructure (5% of total infrastructure) across the sector as a whole. This relatively low impact is in part because of the pressure in JIF bids to demonstrate visible research benefits, which made JIF less applicable to existing infrastructure such as generic buildings, plant or services. SRIF has been much better in this regard, and has had a valuable effect of encouraging the development of institutions' strategic thinking about their physical infrastructure in a way that has generally been absent in the past.

Evaluation of remedial need

10. We have assessed infrastructure investment needs using visits and case studies at over 20 institutions which reflect the full range of research in the sector (of which 13 were chosen specifically for in-depth science research studies). These are listed in Appendix A. This work included examination of research and investment strategies; past investment in estates and equipment; current and planned research activity; the impact of JIF and SRIF and other schemes; and the unmet needs of current and already planned research developments (but not future aspirations which we excluded from this study).

11. We describe our findings in Chapter 4. They fall into three categories:

    a. **Generic Institutional Infrastructure** – which we have defined as buildings, plant and services; IT networks and library resources. We calculate that there is a remedial investment requirement in science research of approximately £2.7bn across the sector to put the generic infrastructure of buildings, services, libraries and IT networks into good condition to meet the needs of modern science;

    b. **The well-found laboratory (WFL)** in the science disciplines represents the minimum level of (usually departmental) equipment and facilities that an external sponsor would expect to find in place. This is additional to the generic infrastructure, not a substitute for it. Without this, institutions reduce their ability to attract external income and research staff, and their research is probably on a downward spiral. Here, there is a deficiency of at least £0.5bn across the sector;

    c. at the more **advanced level**, there remain after JIF and SRIF a number of nationally-important projects to consolidate and extend the UK's research capability through step change improvements in particular infrastructure for world-class science. These typically involve major items of equipment, which are too costly to acquire through research project grants, and major refurbishments or new buildings – usually for interdisciplinary research centres.

12. Item (c) is partly developmental as well as remedial, but is an essential condition of remaining in the competitive field of international science. Assessing need here requires a policy judgement about how many world-class facilities the UK needs, and in which fields and institutions. Our judgement is that there remains significant potential for high-quality projects that could easily be of the same order of magnitude as JIF (i.e. £1bn), but at these levels of internationally-excellent science, we would expect institutions to be able to recover realistic prices and to generate some of the funds required for investment, so not all of these projects would necessarily be funded by Government schemes.

Recurrent requirements and future investment

13. As well as these capital requirements, our work has identified recurrent needs in terms of the right level and type of support to academic staff (to permit adequate time for research); technicians and other support staff; departmental expenditure on minor equipment; maintenance contracts; travel; journals and books; conferences etc. These funds have been squeezed by the recent years of efficiency gains in higher education, and in many examples, case study institutions were suffering reduced research productivity as a result. The shortfalls in this area vary greatly and we have not been able to estimate a general figure. Funding activity closer to a full economic basis would enable institutions to remedy these gaps.

14. More generally, the sector needs to be funded, and to manage its infrastructure on a basis that is sustainable into the future and will not lead to a recurrence of this level of deficit in investment. We believe that, over the long term, institutions should be investing approximately 4% of their insured asset value on an annual basis to allow for necessary renewal and replacement of buildings and equipment. (They need to plan to spend over 5% to take into account cost inflation.) Institutions are currently spending just over 50% of this required level (Section 2.2).

How have these back-logs arisen?

15. While HEIs are private bodies, the predominant culture has been a publicly-funded one with annual cash-based budgeting; activities regarded as “not-for profit”; and tight public funding. There has been little opportunity or priority to make surpluses, and no culture of forgoing current activity in order to invest in physical assets.

16. Public funding of capital in recent years has reinforced this culture by mostly coming in the form of specific initiatives or schemes: over 30 in a 15-year period which we review in Chapter 3. These may ensure that funds are targeted to what funding councils or government see as the priorities at the time, but they do not encourage institutions to take responsibility for a long-term asset management strategy.

17. Both strategic asset management and estates strategy have been relatively low priorities in much of HE. Finance and estates staff are paid below their equivalents in business, and, especially in traditional universities where most research is done, have commonly not been seen as top management. These universities have generally been led by academic officers with non-business backgrounds.

18. In recent years, the HE sector has been very successful in expanding both student numbers and research volumes in response to Government policy which has provided financial incentives to expand activity in return for marginal increases in funding. This pattern of funding has been a powerful driver to create what has been called the "low-price culture" in HE, and the climate in which the long-term and sustainable asset management are discounted. It has particularly been apparent in the recent period when volumes of research have grown much faster than government support to infrastructure through the dual support system.

19. The reasons why institutions have significantly under-invested in their research infrastructure are therefore complex and multi-faceted. We review these in Chapter 5. We might summarise the most important factors for many institutions as shown below (not in order of importance). These are inter-related and overlap to some degree:

    - the past public-funded culture of higher education;
    - the bulge of 1960s and 1970s buildings, which are already unsuitable in many cases, and near the end of their design life;
    - perverse incentives in the way that capital and recurrent funding of universities has rewarded expansion and new development, and has not facilitated whole-life asset management;
    - recurrent funding of research below full economic costs;
    - the long-term decline in the unit of resource for teaching;
    - issues about the strategic management of estates, particularly in the more traditional research universities which have been led by academic officers, and have not given priority to long-term estates strategy or to commercial property and investment skills;
    - the absence of properly integrated research and resource strategies in institutions.

20. Institutions have not been helpless in these circumstances, and in Chapter 5 we review a number of indicators which show how some have practised self-help, rather than relying on or waiting for Government schemes. However, some of these now have a debt liability; or have lost valuable assets; or have foregone recurrent funding, and they are concerned that to the extent that they have reduced their infrastructure problems, they have actually made themselves less eligible for future funding schemes.

21. In our sample, a significant degree of self-help is more common amongst new universities, which tend to have a more managerial ethos, but of course do less science research.

What is the impact of these backlogs?

22. The evidence of continued improvement in UK research outputs demonstrated by the Research Assessment Exercise (RAE) 2001 results, which were published as this report was finalised, appears to contrast with the serious under-investment in infrastructure which we have found. However, it would be a mistake to use the continued productivity of UK research as an indicator that the investment back-logs are not serious.

23. Firstly, we should note that any damaging impact of the under-investment in infrastructure is masked by the desire of academic staff to ensure that their research is done, even if this involves working long hours in poor environments with inefficient equipment; and by the understandable reluctance of institutions to admit publicly that their research infrastructure is deteriorating or non-compliant with legislative requirements for healthy and safety. The ability to "make do" has been a powerful factor to the benefit of UK science, but it cannot be relied upon in the long term as a substitute for basic good management of infrastructure.

24. Indeed, there is already evidence that a new generation of researchers are less tolerant of unprofessional working conditions than their predecessors, and there are various other indicators of loss of research productivity and potential in the UK HE system (including inefficient use of academic time; certain higher-cost fields of investigation closed off to some UK research groups; and difficulty in attracting the brightest students into research).

25. Secondly, almost irrespective of the impact on research productivity, it is unavoidable that assets provided for the public service have to be maintained in a satisfactory and productive condition over the long term. Failure to invest may be effectively "hidden" in the very short term, but it is inevitable that the infrastructure will reach a condition from which recovery is both expensive and difficult with consequently greater damage to all other university activities. A policy of always leaving investment until it is unavoidable and then carrying out emergency remedial programmes is probably the most expensive way of managing the infrastructure. It is also poor value for money in that on average UK scientists are condemned to work in conditions that are significantly less suitable than the level of investment should justify.

26. The benefits that will come from taking a more strategic approach in which the back-logs are removed and investment is made on a planned basis as it is required will include the following:

    - all research workers will have space and facilities to do research;

- a higher proportion of academic staff time will be used in productive activity;
- no staff will work in conditions which are unsafe, unsanitary, or seriously below the minimum standards that any professional would expect;
- UK research posts will become more attractive to leading world-class academics, and to research students;
- UK students will be trained using the latest equipment and will therefore be more employable and productive in the economy;
- UK research groups will be able to compete in their main fields of research without restrictions caused by infrastructure;
- the cost of maintaining infrastructure at any given level of functionality will be reduced.

27. It is of course difficult to quantify any of these benefits, but they all point in the direction of:

    - increased research productivity;
    - protecting and further enhancing the performance of UK research on the competitive international stage;
    - a more intelligent and productive use of the limited resources available for UK research and higher education.

28. Without this investment there will remain a serious problem, which is causing significant stress to institutions, and actual damage to the present and future research output. There is the expectation of more serious and destabilising effects if current trends continue. This is not to deny that science research is better off as a result of JIF and SRIF, but JIF and SRIF have only touched a part of the problem, and, as one institution said to us, with the growth these schemes brought “we are now running faster down a steeper slope”.

Recommendations

29. We recommend that the way forward to a sustainable research infrastructure to support UK science requires an integrated package with four main elements:

    - self-help by the HE sector taking greater responsibility for its own asset management;
    - a remedial capital funding programme to address the capital back-logs we have identified;
    - action across the range of research funders to address the low-price culture, and to bring the recurrent funding of research closer to a sustainable level;
    - continuing government support for exceptional advanced infrastructure projects of the type supported by JIF.

Recommendation 1. HE institutions should take full strategic and managerial responsibility for the maintenance of their asset base, supported by a Government policy statement on this, and backed up by an initiative, which we suggest the funding councils should take forward, to improve asset management and financial strategy in the sector.

30. This has implications both for universities and for those who fund research. We consider the funders at recommendation three below. For the universities, the aim of this recommendation is to support them in achieving a change of behaviour which is difficult for individual institutions to achieve on their own. At present, the perception in the sector is that institutions which have invested in infrastructure have tended to be penalised rather than rewarded: the perception is that other institutions will gain a competitive advantage in the short term, and in the longer term, those other institutions will also appear more deserving in any future bidding schemes for remedial funding.

31. To counter these perverse incentives, asset management needs to become a recognised criterion of good institutional management, and institutions need to be encouraged to give it much higher priority in their planning and budgeting. This is a cultural change as much as a technical one, and requires clear and visible leadership which we believe will be facilitated by a Government statement to demonstrate to institutions and to those who fund research that this is now a high priority for their management attention.

32. A possible mechanism to implement this could be by a statement in the announcement of the Spending Review following the cross-cutting review of science and research, reinforced in the Grant Letter sent by the Department for Education and Skills to the HEFCE and in similar statements by the devolved administrations.

33. In terms of strategic asset management, there is already good practice in the sector to build upon, but it would greatly help this process if there was an initiative, led by the funding councils, perhaps with modest funds for pump-priming, to identify good practice, to develop guidance and systems to support this (building upon EMS), and to help institutions collectively to give greater priority, and to achieve more in the area of planning and management of estates and equipment.

34. As a specific part of this we recommend that institutions should be required to assess their own infrastructure needs, and to prepare an asset management strategy, including a five-year plan for remedial investment in both generic and research infrastructure, clearly linked to their estates and research strategies. Submission of such a strategy should be made a condition of the remedial capital funding we recommend below, but we would not wish funding councils to interpret this as requiring detailed scrutiny of institutions' plans which would create extra work for both institutions and the councils.

Recommendation 2. The Government should provide a capital funding scheme, allocated to institutions on a formulaic basis and spread over several years to address the £3.2bn remedial back-log investment (2001 prices) identified above; (i.e. broadly a follow-on to SRIF, for existing infrastructure).

35. This remedial funding is required to protect the sustainability of the UK research capability, and it has to come primarily from public funds for the reasons discussed in Chapter 5. A fund that enables institutions to address their infrastructure needs according to the 5-year strategic plans recommended above will enable the sector to address the 85% of science infrastructure not affected by JIF and SRIF, and to do so in a way which will also contribute greatly to changing the culture and behaviour of institutions.

36. The funding should be allocated on a broadly similar basis to SRIF, i.e. selectively by formula according to research volume and quality. Unlike SRIF, institutions should not be required to provide directly matching funds as the effect of this would be to inhibit or delay the necessary remedial investment, or to cause damage to other activities such as teaching and non-science research.

37. Value for money for this funding would be achieved by (a) the requirement for a holistic institutional strategy for infrastructure linked to academic strategies; (b) the flexibility of the allocations – like SRIF institutions will be able to target their own priorities and will therefore be motivated to stretch the money available; and (c) the contributions from other sources which institutions will need to build into their 5-year investment plans. These conditions should be interpreted in a flexible way by the funding councils with the aim of maximising the support to the science infrastructure rather than seeking any particular narrowly-defined conditions to be met by institutions.

38. This investment in science research infrastructure needs to be seen as part of a holistic investment in institutions' whole asset bases, albeit with the major emphasis on science research. As discussed in paragraph 5.5.10, it cannot be entirely ring-fenced from other activities such as teaching, and arts research (which we hope will be funded by some parallel arrangements). Overall, however, institutions' investment plans should be required to demonstrate a favourable impact on science research infrastructure (for example, through research space improved) which was at least commensurate with the level of science-related funding provided.

39. We are sure that the funding councils would be able to develop a simple method to monitor the implementation of this recommendation in institutions without imposing unreasonable extra burdens. A possible process here would be to allow institutions two years to develop strategies and plans, followed by five years of stable capital funding to enable them to implement these plans. The funding councils

could require periodic reports to demonstrate (a) that the funds had actually been applied to infrastructure, and (b) that overall they had delivered value for science research as discussed above.

40. There is of course an element of "rough justice" in any formulaic approach, but it is a fairer method than any other we can envisage, and much less costly to manage. Any attempt to relate funding to need would in effect penalise institutions which have helped themselves (another perverse incentive). The formulaic approach already incorporates a strong element of selectivity, so that most funds would go to the institutions which were most active in research and performing at the highest quality levels as indicated by the RAE.

41. The size of the science research infrastructure fund that would be required is a matter of policy judgement. £3.2bn (at 2001 prices) is an ideal figure, which would enable institutions to address all the remedial needs we have identified.

Recommendation 3. The Government should facilitate action to improve the recurrent funding of research so that, over time, institutions become capable of covering the full costs of the research work they do, including sustainability of their infrastructure.

42. This recommendation is intended to promote a process by which all interested parties, including all funders of research, discuss how, over time, the funding of research can be put onto a sustainable basis, in which universities are not required to subsidise their research sponsors. We are encouraged that the recommendations of the Quinquennial Review of the research councils, just completed, appear to envisage a suitable mechanism for this (the funders forum).

43. It is important that this is seen as an opportunity for an open discussion of some difficult issues which are important to the national interest. It will inhibit useful progress if any particular interested party feels obliged to take a negative or defensive position before these discussions even begin. These discussions will of course raise issues about the volume of work that research funders support. Our view is that these should be addressed properly, rather than ignored. We are convinced that most sponsors recognise a strong mutual interest in not seeing a decline in the capability of the institutions where they fund research, or of the UK science base more generally.

44. Just as there is a difficult agenda for research funders, there is also an agenda for institutions, They will need to take a more discriminating and strategic approach to the research they undertake. This will occasionally require them to turn away research opportunities which are unaffordable, or do not fit the institution's strategy, or for which they

cannot provide appropriate infrastructure. A degree of co-operation will be required to reduce the impact of unrealistic competition for grants which leads to what has been described as the low-price cartel, in which institutions bid against each other to do work at unrealistically low recovery rates, which none of them can afford in the long term. Some moves in this direction are already underway as a by-product of the implementation of the Transparency Review.

45. We do not expect this recommendation to lead to an overnight change, but the critical first step is to obtain recognition of the damaging effects of the "low-price culture" and a recognition that universities are acting in the national interest when they take steps to change this. The debate and dialogue which we hope will develop as a result of this report and of the actions under Recommendation One will significantly assist this process.

Recommendation 4. To continue to address the evolving needs of UK capability in advanced science, we recommend a more selective project-based scheme for a limited number of advanced research facilities perhaps at a level of £100-200m per year

46. This is a different purpose from sector-wide remedial investment, and the scheme could appropriately be designed on a different basis. The funds could be released in response to proposals submitted by institutions, perhaps invited to do so in particular disciplines where the Office for Science and Technology and the Research Councils assess that there is a national interest in improving the research capability of the UK.

47. This is the "premium end" of UK science, and we would expect institutions operating at these levels to develop pricing policies for both research and related commercial activity (consultancy, technology transfer etc) which permit them to generate some funds to re-invest in their own infrastructure. It would therefore be reasonable to expect institutions to make some matching investment in these projects, as they did for the later rounds of JIF. Unlike the infrastructure schemes covered in the other recommendations these projects would be carefully targeted at raising the capability of UK science in selected institutions, in particular fields, where the institutions concerned could demonstrate a clear business case in terms of growth of capability and research output in a competitive international arena.

In conclusion

48. Our recommendations imply significant commitments of public funds, but these are necessary to ensure good and sustainable management of the HE infrastructure, and hence to protect the past and future investment in UK science, and all the benefits this brings to the UK economy and society. The consequence of neglecting what is in effect basic good stewardship of these assets will be additional costs for the Exchequer as a continuing series of emergency remedial programmes will be required. It will also lead to seriously sub-optimal performance of UK universities in terms of both their own management of their resources, and the outputs of their science.

49. We recognise that Government funding for these improvements may be limited, and it may not be realistic to make up all this ground quickly. These new funding schemes probably should be phased in over several years, but it is important to give institutions a clear signal that change is both possible and required, and an incentive to get started.

ANNEX: SUMMARY OF FINDINGS AND ASSUMPTIONS

The investment needs we have identified, and they way we recommend they are financed can be summarised as follows.

Investment	Definition/category	Amount (2001 prices)	Main source
Remedial capital	Generic Institutional Infrastructure for science research (buildings, plant, libraries, IT) Well-found Laboratory (discipline-specific equipment)	£2.7bn £0.5bn	Government scheme (post-SRIF)
Recurrent	Staffing, IT, Library, equipment, and departmental	not estimated	Institutions
Forward Investment	Advanced facilities Replacement and renewal of physical infrastructure	£1bn 4% of asset value pa	Government scheme (post-JIF), plus matching funds Institutions

Note: institutions would be expected to contribute to all these. Their ability to do so to any significant degree will depend upon improved recurrent funding.

Notes on calculations

Generic institutional infrastructure

1. The total (insured) asset value of buildings and related plant is £26bn.

2. The proportion of this allocated to science research is as follows:

    - EMS data on space usage: 30% research (70% teaching);
    - cost weighted, using BCIS new-build data for teaching and research facilities, this becomes 36% for research (64% teaching);
    - science research accounts for 94% of the costs of research (using QR allocations as a proxy: the remaining 6% is for arts and humanities research); arts and humanities research is however carried out in both teaching and research space and a reduction is made pro rata to the total volume of space for both teaching and research;
    - hence the allocation of space costs to science research is 34%.

This leads to a total asset value of £8.8bn for science research buildings and associated plant.

3. We have data points from 12 institutions (8 research-intensive plus 4 others) calculating the total capital investment they each need to make in the short term (the next three-five years) to bring their buildings and services up to a level where:

- there is adequate space for the current level of work;
- no buildings are in maintenance condition categories C or D;
- all are fit-for-purpose i.e. functionally suitable; including appropriate estates rationalisation where necessary;
- there is no outstanding borrowing associated with these buildings;
- they comply with legislative requirements for health and safety and disabled access;
- the need cannot be met through known sources of external funding (public schemes and other funders) and internal funding (cash generated from surpluses).

We estimated, for these twelve institutions, that they need to spend 30-35% of their total insured asset value to achieve this condition. This varies from 45% in the largest estimate to less than 5% in the lowest (details in Chapter 4).

4. Extrapolating 30% across the whole sector science research infrastructure of £8.8bn (Note 2 above), would lead to a whole sector required capital investment of £2.7bn.

Well-found laboratory

5. The total (insured) value of equipment is estimated at around £8bn.

6. This was calculated from the ratio of equipment insurance to buildings insurance for 12 case study institutions. The average of 30% applied to £26bn totalled £8bn.

7. A shortfall of 12% was calculated from four case study institutions – extrapolated to the whole sector this would total £1bn. Science Research was assumed to account for half of this - £0.5bn. This broadly concurs with the findings of the PREST (2000) study which identified a shortfall of £0.6bn.

Advanced needs

8. The investment need on advanced needs has been estimated at £1bn to £2bn. This is a very subjective estimate, at the higher level equal to half the unfunded JIF bids. Whilst spend in this area is necessary to maintain leading-edge research capability, the figure will include aspiration and expansion of capacity as well as need.

9. We have therefore assumed the lower level of £1bn as the requirement for national facilities (inter-disciplinary and inter-institutional), and the remaining need should be met through institutions' own development plans, supported by the cash generated from fully funded research (PF and NPF).

Annual replacement and renewal

10. The required replacement and renewal of physical infrastructure has been estimated at 4% of insurance value p.a. This is an average for teaching and research and has been calculated on the basis of:

- a 60 year life
- a significant refurbishment/renewal every 20 years at 35% of newbuild costs
- a reconfiguration of 5% of the floor space p.a. at 25% new-build costs

11. However, for planning purposes, investment plans should be inflation-adjusted. A 10 year plan should average nearer 5.4% p.a. of the current year's insurance value.

Sensitivity and assumptions

12. The main assumptions, and their sensitivities, are given in Appendix D. The extrapolation on generic institutional infrastructure assumes that the institutions we have examined are a representative sample for the whole sector. In volume terms they accounted for 13% of the buildings insurance value of the sector. We supported our analysis with data from a further 7 institutions which corroborated the broad thrust of our findings.

13. Our findings are also corroborated through national data. The sector estate is £26bn (buildings). We identified the backlog on the whole estate at 30% from our case study institutions – a total shortfall of £7.8bn on teaching and research (34% or £2.7bn is science research). This is supported by national data which shows a need of around £8bn on research and teaching (see section 2.6).

14. Nonetheless, the figures do include considerable judgement. The areas where changes in assumptions are potentially significant are listed below. These are described in detail in Appendix D:

- building condition should be at B or better;
- functional suitability requirements are as expressed by institutions;
- it is a risky strategy to borrow on academic estate;
- institutions are unable to generate more cash from operations (recovery on PF activities is not improved);
- asset sales are as currently planned;
- the full costs of the backlog should fall on the public purse;
- the split of space and costs between Teaching and Research is correct;
- the WFL shortfall is as stated;
- public funding of equipment through project grants etc will continue.