The British Dam Society

The role of the Construction Engineer and Panel of Specialists in the modern contracting world

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SYNOPSIS The Reservoirs Act requires that for any new reservoir or alteration to enlarge an existing reservoir, a Construction Engineer is employed to design and supervise the construction or alteration. Procurement procedures have moved on from when the Reservoirs Act was written. Is there a need to rethink the role of the Construction Engineer for the modern contracting arena?

The Coxon report (Coxon, 1986), produced after the failure of Carsington dam in 1984, recommends that a panel of specialists reviews and comments on the design and construction of any major new dam. Expert panels are common on international projects and in some water companies, but there is less recent experience of panels for new dams in UK. We propose possible organisational arrangements for panels of specialists appointed for the new reservoirs that are proposed in England over the next 20 years.

INTRODUCTION

In England and Wales, the role of the Construction Engineer is defined in the Reservoirs Act (HMG, 1975). However, procurement procedures and contracting arrangements are quite different in the 2020s compared with 1975. The Construction Engineer is often from a different organisation to the designer; they do not necessarily directly design or supervise the construction.

The role of the Construction Engineer and the possible organisational arrangements need to be considered as early as possible during the development of a reservoir scheme. In the following section we discuss the alternative arrangements and their advantages and disadvantages based on recent experience on major new reservoir projects.

One of the aims of a panel of specialists is to draw on specialist expertise away from day-to-day project and contract issues. How can they operate to provide the best value possible to a project whilst maintaining independence? The paper will describe possible organisational arrangements, reporting lines and the relationship with the Construction Engineer.

The scale of the future water resources challenges and the possible supply side options was set out in a previous paper (Welbank, 2022). Since then, water companies have refined their Water Resource Management Plans which, subject to approval by Defra, should be published in 2024. A summary of the latest position was issued in March 2024 (EA, 2024). The revised draft water resources management plans contain proposals for seven new reservoirs by 2050.

At least five of the new water supply reservoirs proposed in England may ultimately be delivered by external privately financed entities, following a procurement exercise run by the water companies. How do we ensure that the statutory roles under the Reservoirs Act endure through such a procurement process?

Both the Construction Engineer and the panel of specialists need to fit into, and be an effective part of, the wider team delivering the new reservoir project, which includes:

- The reservoir owner or undertaker (or promoter, as the ultimate owner may change during development of the scheme).
- The designer and the contractor, or potentially the design-build contractor.
- Investors.
- Operation and maintenance teams.

The project team will also need to engage with a wide range of stakeholders, such as investors, financial regulators, quality regulators (Environment Agency and Drinking Water Inspectorate), the public, lobby groups, and potentially third parties who will receive a bulk water supply from the reservoir.

ROLE OF THE CONSTRUCTION ENGINEER

The role of the Construction Engineer is defined by section 6 of the Reservoirs Act (1975):

> *"No large raised reservoir shall be constructed (whether as a new reservoir or by the alteration of an existing structure or area that is not a large raised reservoir) or shall be altered so as to increase or decrease its capacity, unless a qualified civil engineer ("the Construction Engineer") is employed to design and supervise the construction or alteration; and where the use of a reservoir as a reservoir has been abandoned, and the reservoir is to be brought back into use after being altered so as to increase or decrease its capacity, that shall be treated for purposes of this Act as the construction of a new reservoir."*

Ultimately, the Construction Engineer must personally certify to the Enforcement Authority (the Environment Agency in England or Natural Resources Wales) that the works are satisfactory and fit to retain water. The role is non-partisan. In a criminal case, an expert's opinion must be objective and unbiased; it is the duty of an expert witness instructed by either party to act in the cause of justice. In an equivalent way it is the duty of a Construction Engineer to act in the cause of public safety.

The natural meaning of the language in the Act, "*… is employed to design and supervise the construction or alteration…*" is clear. This is the legal requirement set out by the Act – the Construction Engineer is to design and supervise the construction of the works. This may be a one-man exercise for a small dam, but most likely the responsible engineer will direct a team to carry out work to their satisfaction.

However, this clear legal requirement has been corrupted.

Procurement needs and procedures have moved on from those applicable when the Reservoirs Act was written. In the 1970s, the design-bid-build process applied; clients appointed consultants to design infrastructure, projects were tendered and then contractors constructed what was defined on drawings and specifications. Design-build was rare; the ICE

Conditions of Contract were in vogue. The consultant appointed a Resident Engineer to impartially administer the contract and supervise construction with their staff.

Progress, demand for efficiency and less commercial controversy has led to modern procurement of design-build projects and demand for innovation. Application of the Act has evolved so that the Construction Engineer is now often from a different organisation to the designer; they do not necessarily directly design or supervise construction of the works. This is explicitly acknowledged and accepted by the Guide to the Reservoirs Act (ICE, 2014) which is the official guide published by the Institution of Civil Engineers with the help of prominent members of the reservoir community and members of various government agencies, including the Environment Agency and Defra.

The Guide sets out three options for the procurement of the services of a Construction Engineer:

- The Construction Engineer can be an *employee of the consultancy engineering firm* leading the reservoir design.
- The Construction Engineer can be *independent of the design and construction firm*.
- The Construction Engineer could be a *direct employee of the reservoir owner*.

Employee of the consultancy engineering firm

The first approach reflects the original intention of the Act. The Guide notes advantages of this approach such as: the engineer should be better integrated into the design team, have better experience of the staff involved in the design, and communications should be more effective.

This approach allows the Construction Engineer to directly bring to bear all the experience and technical knowledge that qualified them for appointment to the appropriate Panel under the Act. A single mind directing the design should ensure a clean philosophical approach and avoid the potential for design-by-committee compromise. These must be overwhelming advantages to the successful outcome of the project.

This is true under traditional design-bid-build procurement. However, the more recent propensity for design-build contracts brings potential tensions between the parties to the project. Commercial pressures could be brought to bear on a Construction Engineer by members of a design-build consortium team. One might hope that exacting standards of professionalism would provide some protection, but Construction Engineers are only human.

Independent of the design and construction firm

For the second approach, with an independent Construction Engineer, the guide proposes that the arrangement might offer a greater degree of independence and challenge to the design and construction process as well as being contractually independent and free from commercial pressures where the design team is a junior partner in a joint venture.

However, this heightens potential for conflict between the parties.

With this approach the designer would naturally be commercially liable for the design – they expend the effort and receive the design fee; the Construction Engineer is compensated for their time, but their fee is unlikely to be proportionate to the potential liability associated with a major reservoir. The designer is commercially liable, but the Construction Engineer is legally

responsible. There are civil and criminal legal issues to consider. In the event of a problem, would commercial liability stay with the designer? Perhaps, but probably only if there were no controversies during the design. Commercial pressures can be ruthless, and the common-sense approach taken for granted by the engineering community might prove naïve.

With this approach, the Construction Engineer must tread lightly to avoid instructions that will incur claims or compensation events to the employer from the designer or design-build contractor. The guide suggests that this approach frees the Construction Engineer from commercial pressures, but actually it introduces a new set of pressures and an incentive to compromise.

This approach is also not compliant with the black and white requirements of the law – with this arrangement can the Construction Engineer truly be said to be "… employed to design and supervise the construction or alteration…"? The designer is explicitly employed to carry out the design. True, the Construction Engineer can veto aspects of the design that are unacceptable to them, but there are potentially massive pressures to collaborate and compromise unless there is an obvious increase in risk that the Construction Engineer determines is unacceptable. The Construction Engineer's instincts, honed through years of varied experience, may not be sufficient to influence a designer set to follow an alternative course. If the designer is inexperienced, the Construction Engineer will expend effort educating and attempting to influence the designer to their way of thinking. The good instincts of the Construction Engineer might be put down as preferential engineering to the detriment of reservoir safety.

If the designer is also a qualified engineer under the Act, perhaps an All Reservoir Panel Engineer, it is foreseeable that a difference of opinion could be unreconcilable even though both parties aims are to produce a design that is safe.

This is an inefficient approach that could increase project risk and is potentially not legal.

An independent Construction Engineer may be appropriate for small projects where risks are low, and the project is of a scale that makes an independent panel of specialists inappropriate. Success relies upon the professionalism of the engineer and how they negotiate any ethical dilemmas that might arise. However, for a major project with a panel of specialists to provide independent design assurance as recommended by the Coxon report (described below), it could be argued that any advantages of having an independent Construction Engineer are outweighed by the disadvantages.

Direct employee of the reservoir owner

There is no requirement under the Act for the Construction Engineer to be independent of the employer and so the third option listed in the Guide is theoretically legal. However, one might question potential conflicts of interest from an employee simultaneously acting as an agent for the government to police public safety. Professional standards could prohibit this arrangement. In practice this is not an option because there is really no incentive for someone at a client to be an ARPE as they cannot inspect their own reservoirs, and it is unlikely that their employer would cover the professional indemnity insurance for them to do external work.

It is apparent that none of the options offered by the Guide are ideal. It is essential that the arrangements are planned as early as possible in the development of the project, including

some thought applied to how conflicts might be resolved, and contracts are procured appropriately.

This is an industry issue which would be benefit from a joint review and subsequent update to the Guide.

CONTINUITY FOR THE CONSTRUCTION ENGINEER ROLE

The major reservoirs currently contemplated by UK's water companies will take many years to complete (Table 1). Development periods in the range of 10 to 20 years are not uncommon for major projects with Development Consent Order planning, design, construction and filling. The Construction Engineer has responsibilities under the Act for a minimum of three years after construction before the Final Certificate can be issued. The Guide to the Reservoirs Act suggests that the intention of the Act is for a single engineer to be responsible for the complete development of a single reservoir.

Given the potential time scales involved, this is impractical.

Either only the youngest (and least experienced) Construction Engineers could be appointed, or the engineers will be expected to continue well beyond normal retirement age. A more reasonable approach might be to anticipate the need to change a Construction Engineer, perhaps through ill health, accident, or retirement.

A resilient approach would be to assign a Construction Engineer from an organisation that has engineers qualified to step into the gap should it be necessary and has a pipeline for reservoir engineers in development. In such an organisation one would not expect the Construction Engineer to work in isolation, even though personally responsible for the reservoir; there would be design reviews and conferences. The Construction Engineer's work would become a development opportunity for tomorrow's reservoir engineers.

DESIGN ASSURANCE

Large employers developing major infrastructure are rightly concerned about design assurance. Many demand several levels of assurance. This can be provided in a few ways:

- Designers all follow quality control and assurance processes; most are certified to ISO 9001:2015 – Quality Management Systems. This might involve numerical check and review, as well as internal formal design review meetings with independent senior/experience technical staff.
- The Construction Engineer requirement is a form of design assurance.
- The Panel of Specialists process, described below, is another level of design assurance.
- Since the collapse of the steel box girder bridges in Milford Haven and Melbourne in 1970 there has been a culture of independent design checking for major bridges in the UK (Firth, 2007). This culture has organically grown through the major projects arena including projects such as the Millenium Dome, Heathrow T5, Crossrail, and Thames Tideway Tunnel. Given the magnitude of the potential consequences of a dam failure compared to the more limited impacts from a bridge failure, it seems reasonable to apply the independent check culture to reservoirs. For a low additional cost relative to overall project cost, the client can obtain several added benefits including:
    - risk reduction

- confidence that the design criteria are appropriate, especially if the structure or problem is innovative or unusual
- confidence that the design is in accordance with the agreed criteria
- reassurance that the finished structure, if properly built in accordance with the design, is likely to perform as intended
- another consultant who may share some of the liability if problems arise later.

If the Construction Engineer is independent of the designer, once principles are agreed, they must somehow satisfy themselves that the design is numerically correct. For a small low risk project, it may be that a Construction Engineer is satisfied that the designer's quality system is sufficient given that the designer is notionally liable for the design. However, for a major project the Construction Engineer may take the view that the project may not be certifiable without independent checks of safety critical elements.

PANEL OF SPECIALISTS

Purpose of a panel

The main purpose of a Panel of Specialists (also known as Panel of Experts or Reservoir review panel) is to provide a separate independent review of the design and construction of the reservoir. For a major reservoir, the design is now most commonly carried out by a design-build consortium, supervised by the Construction Engineer. The intention is that the panel can scrutinise, challenge, and advise on the design with a different perspective, away from the immediate time and cost pressures of the project.

The report on the failure of Carsington dam (Coxon, 1986) recommended the appointment of a Board (panel) of Specialists to review and comment on a project as the work proceeds. The remit of a panel is described as:

- It requires reports to be prepared in anticipation of routine meetings which, in their very presentation, lead to key elements being identified and assessed.
- Discussion with the parties involved can bring attention to special matters arising.
- The Board, by standing aside normally from contract issues, can, where necessary, interject alternative views.
- Reports, where necessary critical but certainly impartial, are sent to the owner as well as the engineer.

Coxon emphasised that it is important to recognise that the responsibilities placed on the Construction Engineer are in no way diminished by the appointment of a review Board (panel).

The World Bank requires independent reviews of new dams (World Bank, 2020). Their guidance includes:

- The objective of the independent review is to examine safety and quality of the design in an objective manner to detect any potential safety issues that may have been overlooked by the client and designer.
- Effective panels are small (three or four members).
- The panel should be free to review any aspect.

- The panel members should be made up of individuals who are not afraid to state their opinions yet are able to work collectively in a group setting.

The Balmforth independent review of reservoir safety (Balmforth, 2021) includes some consideration of the approach to safety taken in other sectors. It reviews the approaches adopted in the nuclear industry and the rail industry. In both sectors there is specific legislation giving regulators powers and duties to review safety processes and reduce risk.

The Reservoirs Act does not provide the regulator with similar powers, and it places responsibility for reviewing the safety of the design on the Construction Engineer.

After the problems at Carsington, Severn Trent Water has retained a panel of specialists to review all their major reservoir projects (known as the Review Panel). Some details are provided in a paper for the British Dams Society conference in 2012 (Hope, 2012). The panel comprises two eminent dam engineers, who report directly to the Director of Water Services, thus providing an independent route of corporate governance.

Panels of Specialists have been established for some of the upcoming new reservoir projects including the South East Strategic Reservoir Option (SESRO), Fens and Lincolnshire reservoirs. Havant Thicket reservoir, which is under construction, reformulated its Panel of Specialists in 2023.

Composition of the panel and reporting lines

Normal best practice is to have an odd number of panel members with one person acting as the chair.

All the new reservoirs proposed in England will be earth fill embankment dams. Thus, the principal areas of expertise required on a panel are likely to be dam design, embankment stability, geotechnics, and engineering geology. Other aspects that may be significant on a case-by-case basis could include hydrology and hydraulics, mechanical and electrical equipment, and concrete design.

As the reservoir projects will also need to deliver biodiversity and environmental net gain, there may be a case for including an environmental expert.

Panel meetings will include:

- meetings of the panel on their own.
- design review meetings with the design-build contractor's designer, Construction Engineer, owner, and programme management team.

Given the emphasis in the Balmforth review that the ultimate responsibility for the reservoir rests with the owner, and the precedents internationally, the panel should have a direct reporting line to the owner. There are several ways this could be achieved. The independent chairperson for the panel could have a direct reporting line into the owner's Board. Alternatively, the chair of the panel could attend audit committee meetings as required.

Organisational arrangements

Modern practice for major infrastructure projects is to form integrated teams or alliances of designers based on "best person for the job" regardless of organisational allegiance. Whilst this may work in the delivery of other infrastructure projects, they do not operate within a statutory regime such as the Reservoirs Act 1975.

There may be a perceived advantage in reducing the total number of specialists involved. However, with the legislative background for reservoirs, and past experience including the Coxon report, it is considered that an organisational structure that maintains independence is preferable. A possible generic arrangement is shown in Figure 1.

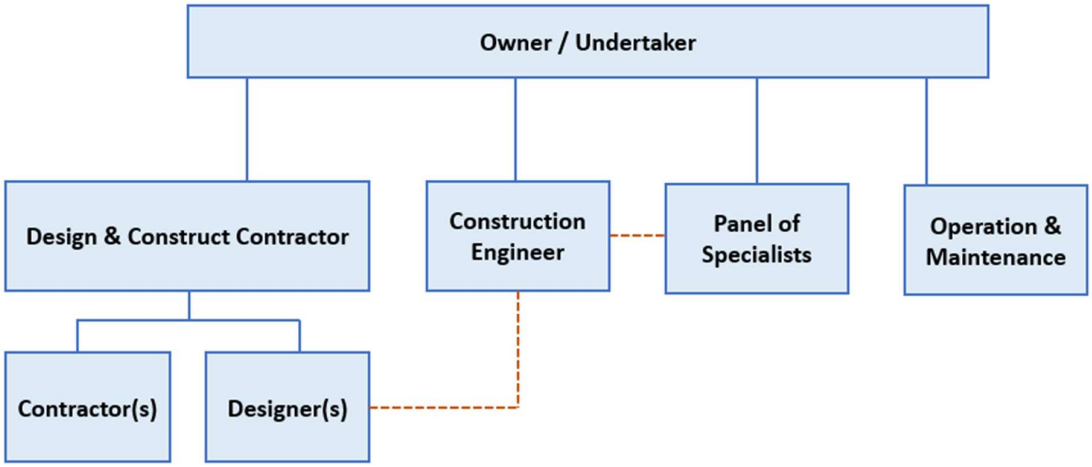

Figure 1. Typical organisation chart for a new reservoir

PROJECT DELIVERY MODELS

Background

Ofwat's policy position is that major new infrastructure should be delivered by competitive delivery models, outside the water companies normal capital investment programme. Two new delivery methods (RAPID, 2023) are proposed:

- **Direct procurement for customers (DPC)**. DPC is a process whereby companies put major infrastructure projects out to competitive tender for delivery by third parties. It is applicable for all discrete projects above a size threshold of £200m. The successful bidders for DPC projects, known as the Competitively Appointed Providers (CAPs), will be responsible for designing, building, financing, maintaining and potentially operating the infrastructure for a defined concession period.
- **The Water Industry (Specified Infrastructure Projects) (English Undertakers) Regulations 2013 (SIPR) model.** This is the model used for Thames Tideway Tunnel. SIPR is appropriate where the size or complexity of the project could threaten the incumbent water company's ability to continue to provide services for its customers. In practice this means SIPR is being considered for projects with a value in excess of £1bn. This model requires the infrastructure to be specified by the Secretary of State or Ofwat if, in their opinion, a project meets various tests (Ofwat, 2024). An Infrastructure Provider (IP) appointed under SIPR may be issued with a project licence, therefore being directly regulated by Ofwat i.e. they become a new undertaker regulated under the Water Industry Act 1991. The IP is responsible for designing, building, financing, maintaining and operating the infrastructure. The IP is the owner of the reservoir in perpetuity.

In both models the initial development of the new reservoir projects, including design, planning permission, stakeholder consultation etc. is undertaken by the incumbent water

company before the project transfers to either the CAP or IP. The promoting water companies are responsible for running the procurement exercise required.

The aim of the projects is to generate additional water resources that act conjunctively with existing reservoirs and sources to provide greater resilience during droughts, thus in all cases the operation of the reservoir in water resources terms will remain with the water company as part of its wider system operation role.

In most cases in the past the owner of the reservoir and the user (or operator) have been one and the same organisation. Section 1(4) of the Act implies that the user of the reservoir for the purposes on an undertaking (such as a water supplier) rather than the owner is the undertaker under the Reservoirs Act. Thus, subject to confirmation by lawyers, although the SIPR model would create a new undertaker, it appears that responsibility for the Reservoirs Act would remain with the water company. This also gives rise to additional considerations regarding maintenance of the reservoir.

The key premise of both models is that, in a similar way to the Thames Tideway Tunnel project, the new investors will be able to raise the finance for the projects efficiently. The approach to risk management will be key, indicating an even greater need for early ground investigations, trial embankments and design resolution etc. as early as possible, ideally before contract and financial closure. The delivery approaches planned for the proposed new reservoirs are summarised in Table 1.

Table 1. Summary of new reservoirs and procurement approaches

Reservoir	Promoters	Procurement approach	Timeline
South East Strategic Reservoir Option (SESRO)	Thames Water	SIPR	Operational in 2039; Construction start 2030
Fens	Anglian Water and Cambridge Water	SIPR	Operational by 2036; Construction start 2029 - 2031
Lincolnshire	Anglian Water	SIPR	Operational by 2040; Construction start 2029 - 2031
Cheddar Two	South West Water and Wessex Water	DPC	Operational by 2035; Construction start 2030
Broad Oak	South East Water	DPC	Operational by 2035; Construction start 2028

Other new reservoirs included in Water Resource Management Plans are at an earlier stage of development with delivery methods still to be determined. If they are smaller in size with less complexity it is possible they will be delivered conventionally as part of the water companies' capital investment programmes with full responsibility for the duties under the Act remaining with the water company.

Implications related to the Reservoirs Act

The Reservoirs Act envisages a single entity is responsible for the planning, design, construction, operation and maintenance of a reservoir, although generally the implementation phase of planning, design and construction are contracted out but under the

direction and control of the owner. The undertaker is generally the owner or operator of the reservoir and has ultimate responsibility for the safety of the reservoir. The undertaker appoints the Construction Engineer and in due course the Supervising Engineer.

Table 2. Procurement approaches and the Reservoirs Act

Procurement approach	Undertaker	Responsibilities
SIPR	Lead promoter is the undertaker up to the appointment of the IP. The IP becomes the owner of the reservoir on award of the project licence by Ofwat. The water company remains as undertaker under the Act.	• The appointment of the Construction Engineer may remain with the water company, but the Construction Engineer will have to interact with the IP and their designer and contractor. • Reporting lines for the Panel of Specialists will need to adapt to suit the split of responsibilities. • Operation of the reservoir will remain with the water company in order that they can optimise its use in the wider water resources system. • Maintenance of the reservoir is likely to require a detailed allocation of responsibilities between the IP and the water company.
DPC	Lead promoter remains the undertaker under the Reservoirs Act throughout.	• Design and construction would be the responsibility of the CAP according to the contract terms between the promoter/undertaker and the CAP. • Operation of the reservoir will remain with the water company. • The appointment of the Construction Engineer and the Panel of Specialist will remain with the undertaker. • Maintenance of the reservoir is likely to require a detailed allocation of responsibilities between the CAP and the water company. • Ofwat also require the appointment of an Independent Technical Adviser, to obtain assurance around the costs and delivery of a DPC project both during the construction programme and to operate over the life of the DPC project.

The alternative delivery methods outlined above create some departures from the vanilla approach set out in the Guide to the Reservoirs Act (ICE, 2014), as highlighted in Table 2.

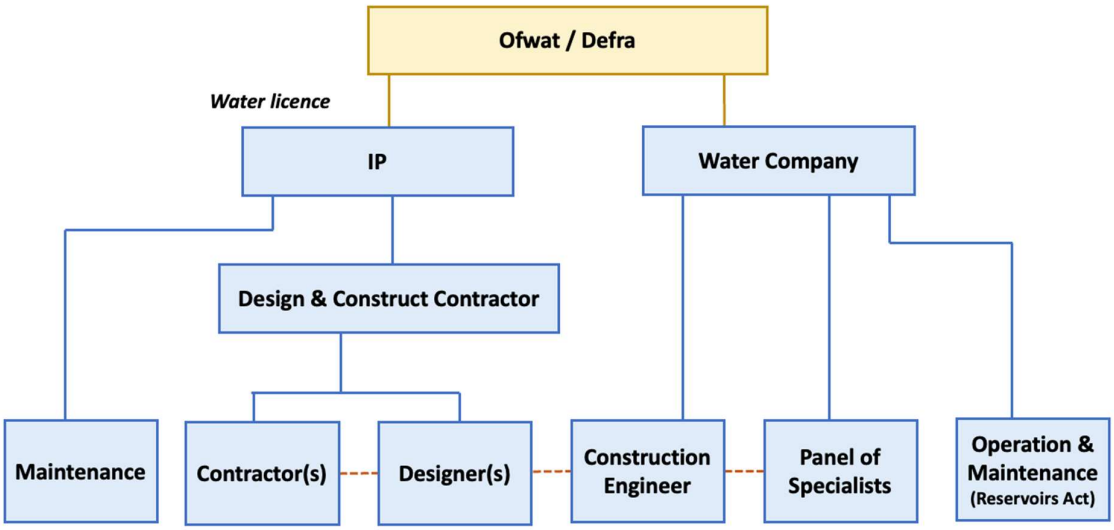

Figure 2. Potential SIPR model

In both cases there will be some migration of roles and responsibilities during the project lifecycle. Figures 2 and 3 provide some initial views of potential organisational arrangements during implementation by which time the CAP or IP will be in place.

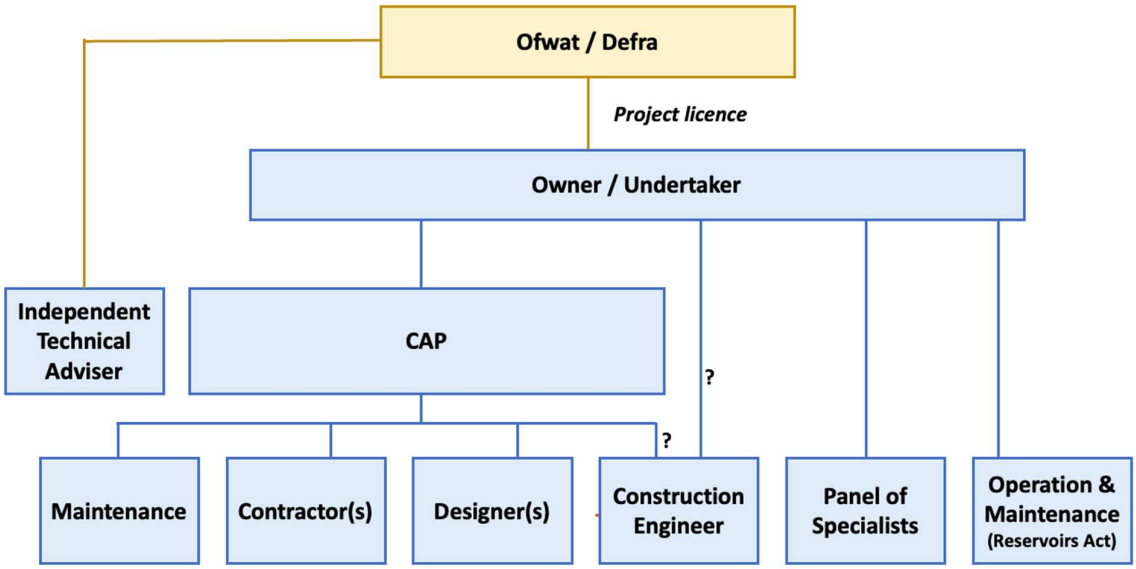

Figure 3. Potential DPC model

CONCLUSIONS

As an industry, we should recognise that procurement and contracting arrangements have moved on since the era when the Reservoirs Act was written and since the last major reservoirs were constructed in the UK. The traditional procurement approach assumed by the Act is unlikely to apply to any of the new reservoirs planned in England over the next 20 years, but the legal requirements do not change.

Managing Risks for Dams and Reservoirs

As a profession, we need to make sure that new infrastructure is safe and as economical as possible.

Regarding the statutory role of the Construction Engineer, organisational arrangements need to be considered as early as possible during the development of a reservoir scheme, with regular reviews as the project progresses over the subsequent 15 to 20 years. None of the options set out in the Guide appear to be ideal, so we would advocate that the industry considers the issues collectively, that the law is reviewed, and the Guide is updated accordingly.

In the initial stages of project development and outline design, the Construction Engineer should be appointed from the design consultancy engaged for the design. Once the project moves into the delivery phase the arrangement for the Construction Engineer's appointment needs to be considered hand in hand with the project procurement plans. The overriding objective is to achieve a completed dam that is safe over its long life, even if this means foregoing some potentially cheaper notions in the short term.

For design-build projects it might be appropriate to novate the Construction Engineer to the successful consortium. Alternatively, a reference design prepared by the Construction Engineer could be made a more rigid contractual requirement, with deviations only permitted with acceptance of the Construction Engineer. This may seem a regression towards design-bid-build, but substantial design work is already required to secure a DCO or planning permission, so this approach avoids duplicating that effort.

A Panel of Specialists serves as an additional safeguard to scrutinise the design and construction away from the day-to-day project and contract issues. To provide best value they need the ability to engage with the designer but also report directly to the owner on the 'big picture.'

At least five of the new water supply reservoirs proposed in England may ultimately be delivered by external privately financed entities following a procurement exercise run by the water companies. It will be critical to carefully define and manage responsibilities for operation and maintenance to ensure the overall requirements of the Act are met. To maintain continuity, it will be necessary for the Construction Engineer role and the Panel of Specialists to adapt to new arrangements as the project moves into its contract and delivery phase.

Overriding all these project and contract specific issues is the need for the industry to resource the multiple roles for panel engineers and reservoir specialists in these projects. Delivering on the recommendations in the review of the future supply of panel engineers (ICE, 2022) will be crucial.

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