

**Support to UKTram Activity Group 1
Protection and Diversion of Apparatus**



Phase 2

**Guideline 3: The Causes and Control
of Cost Creep and Cost Escalation**

Title	Support to UKTram Activity 1 “Protection and Diversion of Apparatus” Phase 2 Guideline 3: The Causes and Control of Cost Creep and Cost Escalation
Customer	UKTram
Customer reference	
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File reference	C:\Users\David\Documents\C154-UKTram Activity 1\A1-Final document set\Phase 2 guidelines-guideline 3-word 2003.doc
Report number	
Issue number	Final

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Preface

UKTram is an organisation that represents the promoters and operators of tramways and light railways in the United Kingdom. It is a limited company owned in equal parts by Transport for London, the Passenger Transport Executives Group, the Confederation of Passenger Transport and the Light Rapid Transit Forum. Its main purpose is to carry out research into a variety of aspects of light railway design, construction and operation. It publishes the results in the interests of improving understanding of the factors involved in the development of light railways and uniformly raising standards throughout the industry. It is supported in its activities by the Department for Transport.

Its purposes are achieved by the establishment of Activity Groups consisting of practitioners having considerable experience in the field of interest. Twelve such groups have been established, and the subjects they cover are listed in Appendix 1. The remit of Activity Group 1 is to review the various approaches that have been adopted by promoters and operators in the UK to the task of protecting and diverting utilities' apparatus.

This Guidance Document is the third in a series of three guidelines that have been developed by Activity Group 1. These are:

Guideline 1: Standard methodology for assessing utilities' works requirements

Guideline 2: Mitigation of Utility Diversion Requirements

Guideline 3: The Causes and Control of Cost Creep and Cost Escalation

Guideline 3 is intended to inform promoters, designers and where appropriate, Concessionaires, of practices adopted by the builders of tramways already operating in the UK to control and minimise costs associated with the diversion of utilities' apparatus.

GUIDELINE 3: THE CAUSES AND CONTROL OF SCOPE CREEP AND COST ESCALATION IN DIVERSION AND PROTECTION OF UTILITIES' APPARATUS FOR BRITISH TRAMWAYS

Introduction

The work of Activity Group 1 has been arranged in three phases. Phase 1 has been concerned with the collection and analysis of data provided by the promoters and operators of current and potential tramway schemes in the United Kingdom, UK utility companies and tramway promoters and operators on the continent. Phase 2, of which this is the concluding part, concentrated on the production of guidelines based on the work carried out in Phase 1, while Phase 3 will consider how to ensure that the findings of Phase 2 will be adopted, through changes to relevant legislation and co-operation with the Highway Authorities and Utilities Committee ("HAUC") and National Joint Utilities Group ("NJUG") to obtain general acceptance of the proposals.

This document comprises a number of case studies of tramway projects that have been undertaken in the UK, or in one case was planned but not carried out. The projects considered are:

- Manchester Metrolink Phases 1, 2 and 3A;
- Croydon Tramlink;
- Edinburgh Trams; and
- West London Trams.

The topics that have been considered were set down in the brief provided by UKTram:

"The consultant shall report on the causes and control of scope creep and cost escalation using the experiences identified in Phase 1 by developing a set of 4 case studies and guidelines that identify the causes, relative impact and means of mitigating scope creep and cost escalation throughout the project lifecycle. The guidelines will consider:

- *Availability and pooling of critical resources.*
- *Availability and quality of information/detail on actual scope of work required (e.g. high costs can be driven by aspirational and conservative assumptions at initial design stage persisting through to construction).*
- *Quality of information relating to utilities' locations.*
- *Obtaining project 'buy-in' from utility companies to Project proposals.*
- *Obtaining a realistic co-ordinated programme and utilities' resource availability/constraints.*
- *Determination of clear lines of responsibility and decision making (specifically on site).*
- *The impact of extended periods between scheme development and implementation.*

- *The method of valuation of diversion costs (often based/derived upon high unit costs associated with small packets of work) and the opportunities for gaining economies of scale.*
- *The allocation of utilities' responsibilities and timing of diversion works within the design and construction procurement structure.*
- *Traffic management risks and the optimum timing and allocation of responsibility for traffic management design and co-ordination in the light of the Traffic Management Act etc.*
- *The impact of rigid construction regimes and working hours imposed at TWAO (or similar in Scotland) powers stage to assuage local authority objections.*
- *'One-stop shop' approach on site – good project co-ordination.*
- *Development of the Lump sum/Target Cost approach to the contractor/maintainer.*
- *Opportunities for 'economies of scale' when diverting large numbers of utilities e.g. double counting on the temporary traffic management, common trenching etc.*
- *Explore opportunities for rationalisation of the scope of works (this could yield 10% to 20% of the budget cost).*
- *An approach to stray current, to feed into the future workload of UKTram Activity Group 12"*

1. Manchester Metrolink

- a) Manchester Metrolink was the UK's first new-generation tramway. The first phase began operating commercially in 1992, opening in stages between April and July. This runs from Bury in the north of Manchester to Altrincham in the south, passing through the city centre where it runs in the streets. A short spur connects the main route to the Undercroft at Piccadilly Station. A second phase was constructed through Salford and Eccles, linking to the first phase at Cornbrook Junction.
- b) A third phase (Phase 3A) is currently under construction, while Phase 3B has recently been approved. When complete, the network of tram lines will extend to Oldham and Rochdale in the north, Ashton-under-Lyne in the east, and Wythenshawe and Manchester Airport in the south.
- c) This study considers the completed Phases 1 and 2, and the advance works being undertaken for Phase 3A.

1.1 Phase 1

1.1.1 The construction and operation of Metrolink was authorised in January 1988 by an Act of Parliament – the Greater Manchester (Light Rapid Transit System) Act 1988. Approximately 1 year earlier the promoter, Greater Manchester Passenger Transport Executive (GMPTE) had begun detailed discussions with all the utility companies with apparatus installed in the streets affected by the proposed tramway.

1.1.2 Throughout the period of construction of Phase 1, all works carried out in the street were controlled under the Public Utilities Street Works Act 1950 (PUSWA), which remained in force until its repeal on 1st January 1993. On this date it was replaced for all purposes by the New Roads and Street Works Act 1991 (NRSWA).

1.1.3 Phase 1 consisted of the conversion of the Bury line, which was previously a heavy rail route operated on a third rail system at 1200V d.c.; the Altrincham line, which was also a heavy rail route, operated from an overhead contact wire electrified at 25kV a.c.; and the construction of new street track from GMex to Victoria Station via Piccadilly Gardens, and east from Piccadilly Gardens to Piccadilly rail station. This study concerns itself only with the street-running part of the route.

1.1.4 Consultations began with the utility companies in the early part of 1987. Although privatisation of utility companies was already under way by that time, there were relatively few new communications companies, and the number of organisations affected by the tramway proposals was limited to six – British Gas, Norweb (electricity), North West Water Authority (clean water), Manchester City Council (as sewerage agency), BT and Cable & Wireless.

1.1.5 Two working parties were set up in May 1987, one to make plans for the diversion and protection of utilities' apparatus, the other to look into the minimisation of stray current. The two groups were attended by different representatives of the

utilities, and it was agreed at a very early stage that stray current issues would not be taken into account when considering what apparatus needed to be moved. This decision was based on the knowledge that GMPTE were obliged to use their best endeavours to minimise the loss of current into the ground, so that any impact on the apparatus would be negligible. However, the proposals for diversion were taken into account when deciding which apparatus should be monitored, as there was clearly no benefit in monitoring apparatus which was subsequently to be removed and thus could not provide a “before and after” comparison, required to establish whether stray current was causing a problem.

1.1.6 Records were received from each of the utility companies in the form of drawings, or in some cases as lines marked on the preliminary alignment drawings provided by GMPTE. No problems were experienced with this process; the utility representatives at working group level were all very co-operative and, with one exception, prompt in the provision of information. The records were provided with the usual caveats regarding their accuracy, but they were found to be satisfactory for the initial stages of planning. The detail provided varied, however; whereas some records contained measurements of horizontal position and depth, the age of the apparatus, and in the case of the electrical records, cross sections, others provided no more than a pencil line on the drawing. No records were paid for. At this time, no records could be supplied electronically.

1.1.7 All utility representatives were very co-operative throughout the course of the scheme. Working Group and individual meetings were held regularly and were invariably productive. Nevertheless, there was some initial scepticism about the prospects of the scheme going ahead. In the 1970s there had been a proposal for an underground network in Manchester (the Pic-Vic line) which was abandoned, but not before some diversionary work had already been carried out.

1.1.8 Following initial meetings and discussions, the utilities provided budget estimates of the costs of diversion and protection of their apparatus (equivalent to C3 estimates). These were considerably more, even accounting for the effects of inflation, than the estimates provided by consultants in producing the scheme feasibility report in 1982. A topographical survey was carried out, which was used to record the positions of all utilities’ ironwork, such as manhole and chamber covers, fire hydrants, electrical link boxes, valves and so on. This information was used to refine the utilities’ records. Using the information provided by the utilities, as modified, the alignment was further developed. It was possible from this information to make relatively small deviations in the alignment that resulted in major cost savings.

1.1.9 Meanwhile, the scheme was developing on other fronts, and the Government decided that the scheme would be operated as a PFI-type of contract, referred to as DBOM (design, build, operate and maintain). This meant that the alignment developed by the promoter would not necessarily be adopted in all its detail by the Concessionaire. However, the alignment was heavily constrained by the highway

layout necessary to put into effect the final traffic management arrangements, so there was relatively little scope for change. It was agreed as a matter of policy that the utilities' apparatus would be diverted in advance of the main track construction, and carried out under the control of the promoter. The alignment design was therefore completed by GMPTE, and diversions planned accordingly. The detailed budget estimates (equivalent to C4) were then obtained from the utilities. This showed an increase in the total cost of about 10%. In the case of some utilities costs came down. The main cause of the increase was that there were some highway modifications in the final scheme that had not been taken into account at the budget estimate stage. Without this, there would have been little difference between the budget and final estimates.

1.1.10 The main build-up to the diversion works began in November 1988, when the Government agreed to underwrite 50% of the cost of the advance works, regardless of whether or not funding for the whole scheme was granted. Manchester City Council carried out a number of trial holes on behalf of GMPTE to establish the positions of some crucial or ambiguous items of apparatus. The first enabling works were carried out in February 1989 on a sewer manhole in Peter Street, but this was not publicised as being Metrolink work. The formal start was made on 13th March 1989, when Mosley Street was closed to traffic between York Street and Princess Street.

1.1.11 Manchester City Council had initially, when requested, strenuously opposed the closure of Mosley Street. As the project developed, the highway layout in Manchester was altered to take passing traffic away from the central area, including Mosley Street, and to allow the tram operation to be segregated from other vehicles as far as possible. This ultimately made it possible to close Mosley Street to all traffic except trams, and buses running north towards Piccadilly Gardens. The ability to give the utilities free rein in Mosley Street resulted in a significant, though unquantifiable, saving in cost and time.

1.1.12 Diversionary works were carried out in all sections of the route. In some cases it was necessary to modify highway layouts to allow the carriageway to be diverted, or modify turning movements. Throughout the Metrolink works, a total of some 450 temporary Traffic Management Orders were produced, of which many related to the diversions stage of the project. The largest single element of preparatory works was the construction of a new bus station on Lever Street to replace lost capacity in Piccadilly Gardens.

1.1.13 While each utility was responsible for carrying out works on its own apparatus, it was carried out within a framework controlled by GMPTE. As part of their final estimates, each utility provided durations of their works. These were then taken and incorporated into a master programme of works prepared by GMPTE. This was modified when necessary by the Working Group; it then provided the basis for the preparation of temporary TROs and the carrying out of any highway modifications needed to facilitate the works. Where a utility was working on its own in a street, it

was responsible for traffic management: elsewhere traffic management was introduced and maintained by the City's direct labour organisation.

1.1.14 Traffic management issues were supervised by a separate working party, which included representatives of the City and the police. This continued into the main contract period, when it was joined by representatives of the Concessionaire.

1.1.15 Diversion works were substantially complete by November 1990, with a Christmas break from mid-November 1989 to early January 1990. A few final items of work were completed in March 1991, two years after the start.

1.1.16 When the final accounts were received and assessed, the costs had increased from the detailed cost estimate stage by a further 7½%. This was in large part due to inflation between the two stages, as well as a small amount of scope change. In particular, no provision was made in the original estimates for the impact of supports for the overhead contact wire. This led to a small amount of additional and re-diversion, although this was mainly handled by building the apparatus into the support bases (gravity bases were used throughout). Both British Gas and North West Water managed to rationalise their networks to remove unused capacity, rather than to divert or replace it.

1.1.17 No problems were experienced with a shortage of resources. British Gas initially offered to complete all their diversion works in the space of 6 months, working in up to 33 areas at the same time. This was clearly impractical, as it would have led to unacceptable disruption to traffic.

1.1.18 GMPTE played no direct part in the physical diversion works, but employed a clerk of works to observe the work, record progress and intervene if the work was not being undertaken in accordance with agreements as to the altered position of the apparatus.

1.1.19 There was relatively little delay between reaching agreement on what needed to be done, and actually carrying out the works. As a result, the impact of inflation was slight.

1.1.20 The approach chosen, to provide a clear site to the Concessionaire, was fully appreciated by Mowlem, who were appointed to carry out the construction of the tramway. There were very few areas of overlap between the two strands of work, as the advance works programme was adapted once the Concessionaire's order of working became known and was incorporated into it. A very few diversions had to be added or repeated as a result of a change of rolling stock. This came about because the rolling stock assumed in the development of the alignment was the DUEWAG Stadtbahn 'B' as used on the Cologne to Bonn line in Germany. The Concessionaire chose instead to use the Firema T68 rolling stock, which caused the tracks to have a wider separation on bends. The consequences were very minor.

1.1.21 Some restrictions were placed on working hours in specific areas where there were hotels or domestic properties near to the alignment, but these had no measureable effect on the duration or cost of the works. The annual Christmas Closedown imposed by Manchester lasted approximately six weeks, but was not applied to the whole of the route. This meant that by careful planning, work could continue during this period in areas outside the commercial core and it is unlikely to have significantly affected the overall cost.

1.1.22 Few opportunities were identified for the use of common trenching, although it was used for gas and BT in the Piccadilly Gardens area. Costs were saved in a number of areas on reinstatement of the highway, because in many areas the full width of the highway was replaced with new materials, and it was recognised that interim reinstatement of excavations would suffice for the short period between completion of the diversions and the start of trackwork.

1.1.23 There was no provision for sharing of the costs of works under PUSWA. However, a small rebate was received in respect of deferment of the time for renewal.

1.2 Phase 2

1.2.1 The first extension to the Metrolink system was carried out in Trafford and Salford. A new connection was made to the Altrincham line at Cornbrook Junction. On leaving Cornbrook Station, the line crosses the Bridgewater Canal, then runs between it and the Manchester Ship Canal. It crosses the latter to run into the Salford Quays area. Up to this point, the alignment is entirely off-street, but several street crossings follow in this area, notably at Trafford Road and Broadway which are recognized high load routes. North of Broadway, the alignment runs mainly on street. As the alignment approaches the terminus at Eccles, it passes through an underpass beneath a heavily used roundabout. Approximately half of the 6½ kilometre route is on street.

1.2.2 The construction and operation of this extension is authorised by two statutes – the Greater Manchester (Light Rapid Transit System) Act 1990, which covered the area from Cornbrook Junction to Broadway, and the Greater Manchester (Light Rapid Transit System)(Eccles Extension) Order 1996 which extended the line to Eccles Town Centre. By the time work started on the extension in 1997, works in the street were controlled by NRSWA. The line opened in two stages, with the complete line being opened in July 2000.

1.2.3 GMPTE initially adopted the same approach to diversion of utilities' apparatus as had been used for Phase 1, namely for the works to be carried out directly under the control of GMPTE as advance works, to provide the Concessionaire with a clear site. The working party that had briefly been disbanded in 1992 was reformed and had its first meeting on 30th September 1994, including representatives of Salford City Council and the police.

1.2.4 At this time the powers to extend the alignment into Eccles were still being sought. The main focus of the work was consequently a contemporary scheme by Salford City Council to widen Trafford Road to dual carriageway. The main purpose was to ensure that diversions carried out for this work also took the Metrolink scheme into account.

1.2.5 Subsequently the planning began to consider the entire route. There were isolated areas of Salford Quays where the tracks crossed or ran alongside highway, necessitating protection of apparatus. The main impact was however to the north of Broadway.

1.2.6 The utilities encountered on Phase 1 were now augmented by Norweb Communications, a cable company since absorbed into Cable & Wireless. In one very localised area, apparatus of Orange Communications was also affected. Relationships between GMPTE and the utilities were very good. The experience of working on Phase 1 meant that there was already an acceptance of the usefulness of the scheme, and many of the same people worked on both phases. One particular utility did not perform as well as the others on either phase, although this did not affect personal relationships.

1.2.7 Records of apparatus and budget estimates were obtained from all utilities, and an assessment was made of the work involved. The sewer records were of poor quality, as there was more than one set of records which contradicted each other. Some records were still based on an old street pattern. C3 budget estimates were reviewed, and several opportunities for scope reduction were discovered. Transco proposed to divert a large low pressure gas supply from Eccles New Road into the parallel Eccles Old Road, a very lengthy diversion. They were persuaded to replace the pipe in Eccles New Road, clear of the tracks. This involved some detriment to their access to the pipe, but reduced the cost of the works by a considerable amount. At the east end of Eccles New Road where the pipe is 36" in diameter, it was already clear of the tracks over some distance, but there were concerns about the integrity of the pipe. An agreement was reached for the pipe joints to be encapsulated in resin to reduce the risk of failure.

1.2.8 At C3 stage, BT proposed a programme of cable replacement through chambers affected by track construction. This was based on the assumption that cables would be replaced and jointed between adjacent chambers, as they were concerned about the effect on traffic if their ductwork extended over a long distance. An alternative strategy was agreed in conjunction with the highway authority that extended the distance between cable joints. As the jointing of cables is the most expensive element in the diversion process, this allowed the cost to be considerably reduced. However, in South Langworthy Road diversion work was doubled for BT, because the carriageway had to be diverted during construction of the tramway. This led to them having to reconstruct all affected chambers to convert them to a form suitable for carriageway use, then construct them again to return them to footway

standard. Elsewhere BT permitted their ducts to remain beneath the track slab where the access manholes and chambers were sufficiently clear. In Salford Quays, a very significant BT manhole, containing half of all cables linking Manchester and Salford, remains beneath the tracks after a careful strength assessment was carried out and approved by BT.

1.2.9 Gas and BT between them accounted for more than half the cost of the diversionary works.

1.2.10 The majority of the sewers were left in place, and access was provided through side entry manholes where appropriate. All sewers crossing the tracks were subjected to CCTV survey to establish their condition, and brought up to a minimum Grade 3 standard where necessary.

1.2.11 GMPTE also worked with North West Water Limited to reduce costs, and their C4 estimate was less than the C3 estimate in consequence.

1.2.12 The need for temporary diversions was identified in two areas. The first was in Throstle Nest Lane, where the Pomona Viaduct was to be built, and the existing carriageway had to be diverted to make way for it. The other was in the vicinity of the Ladywell Underpass, where apparatus that crossed above it had to be maintained while the underpass was constructed.

1.2.13 The method of procurement changed at the point of letting the Concession for the construction and operation of the tramway. GMPTE decided to give the responsibility for controlling and supervising the utilities to the Concessionaire, while GMPTE placed orders and paid for the works. The risk associated with utility programme overruns was shared between GMPTE and the Concessionaire, although the degree of planning already undertaken meant that the risk was minor in nature. The Concessionaire received an additional £1.5 million as the price for overseeing the works and taking the risk. GMPTE continued to take an interest in the works, as part of the risk of cost overruns remained with them.

1.2.14 A draft programme had been prepared by GMPTE, but maintenance of the programme became the responsibility of the Concessionaire. The Working Party, which had been chaired by GMPTE up to the point of signing the Concession Agreement, was then taken over by the Concessionaire. Each utility carried out the work on its own apparatus. The majority of the works was carried out by term contractors, although Transco, for example, let out smaller scale works (approximately a third of the value of their works) on individual tenders. There was a limited amount of shared trenching, but a significant cost was saved by setting up traffic control measures for the joint benefit of several utilities at a time. Wherever possible, interim reinstatements were carried out pending the full reinstatement of the highway under the Concession contract. Working hours were restricted in some areas due to the residential nature of the surrounding area. The diversion works were

completed within the time set aside for them with no significant delays. No problems were experienced with the programme resulting from a lack of resources.

1.2.15 The foundations for overhead line poles in Manchester City Centre had been exclusively gravity bases, but on Phase 2 use was made of piled foundations, in which augured holes 0.75 to 1 metre in diameter and 4 to 5 metres deep were filled with concrete, leaving a vertical hole through the centre into which the support pole was placed. It was appreciated when this method was proposed that it would not be possible to leave or place apparatus in the space occupied by the pile, and a zone was left clear of apparatus as far as possible. Gravity bases were used in a few locations where leaving a clear zone was not possible. In these locations, the gravity base was constructed underneath the utilities' apparatus, and the pole bolted to it, being threaded between the apparatus. Adoption of a service-free zone was only possible because the footways were generally wide.

1.2.16 The cost share provisions contained in the Street Works (Sharing of Costs of Works) Regulations 1992 were waived as a result of undertakings given to the main utilities at the time of passage of the 1988 Act, and reinforced by undertakings given leading up to the passing of the 1994 Act. BT was not a party to these undertakings, but it was agreed that the concession should be extended to all utilities. However, this did not apply to deferment of the time for renewal, and this accounted for a considerable cost reduction in BT's final account, compared to the C4 estimates. Planning of diversions began in 1994, and work continued until 1998. Inevitably, there were cost increases due to inflation, but these were easily offset by agreements to reduce the scope by adopting innovative measures.

1.2.17 There was no consideration of the use of lump sum or target cost provisions. Each utility was given an order by GMPTE, and carried out work on its own apparatus. Utilities were reimbursed the cost of the works in accordance with NRSWA, although auditors queried some claims and in one case reduced the final account due to what they considered excessive overheads. (Note: this was before the introduction of the Street Works (Recovery of Costs) (England) Regulations 2002, issued under section 96 of NRSWA).

1.2.18 In parallel with the Working Party, the Stray Current Working Party was reconvened, and followed a similar process to Phase 1. The detail of the track construction proposed by the Concessionaire was different from that adopted for Phase 1. This caused concern to some of the utilities, but was eventually accepted, and there have been no problems associated with stray currents. As with Phase 1, no apparatus was diverted or protected because of concerns over stray current.

1.3 Phase 3

1.3.1 Phase 3 of Metrolink was identified during the 1990s as consisting of the conversion of a heavy rail alignment from Manchester via Oldham and Rochdale (not previously electrified); construction of a new alignment east of Manchester to Ashton-

under-Lyne; and a line serving Wythenshawe and Manchester Airport. The latter line was to incorporate a loop from the junction of Southmoor Road and Hollyhedge Road that would take trams past Wythenshawe Hospital, through Manchester Airport and through Wythenshawe Town Centre. Plans to run past the hospital were shelved, so that now only the Town Centre and the Airport are to be served.

1.3.2 Other routes that were to have formed part of Phase 3, subject to the availability of sufficient private funding, were to serve East Didsbury and Stockport, the Trafford Centre, and the Lowry Centre.

1.3.3 A new depot was also needed to stable and carry out light maintenance on the expanded fleet of trams.

1.3.4 Provisional funding agreement for the whole of Phase 3 was received from the Government in 2000. Following a tendering exercise, the costs of the work were considered to be too high, and the Government withdrew their funding offer in July 2004. The project was then divided into a number of packages, including the upgrading of Phases 1 and 2, the purchase of additional trams, construction of the second depot, and the phased construction of the new lines. The current review considers the preparations for Phase 3A. This comprises the conversion of the Oldham and Rochdale heavy rail line to use by Metrolink; construction of the section of the Ashton line linking Manchester and Droylsden; construction of the section of track between Trafford Bar and St Werburghs Road, common to the Airport and East Didsbury lines; and construction of the Eccles line spur to Mediacity:UK. Final approval for the works was received in May 2008, and a contractor was appointed to design, build and maintain the infrastructure. Operation will remain with the current operator, Stagecoach, while trams have been procured through a separate contract.

1.3.5 The major impact on utilities occurs on the eastern extension to Droylsden, with the remainder of Phase 3A being almost entirely on existing railway permanent way. Some advance works were carried out in the area of the City of Manchester Stadium on the Ashton line in the lead up to the Commonwealth Games in 2002. The remainder of the diversion and protection works are being undertaken under the control of GMPTE in advance of the main construction works.

1.3.6 Ideas for the nature of the full Metrolink network have evolved over a period of nearly three decades, but the present layout began to crystallise shortly after the opening of Phase 1 in 1992. In the intervening period, numerous studies have been carried out of complex areas to consider alignment design and the impact on utilities' apparatus.

1.3.7 In 2001 the utilities were requested to provide C3 estimates for all the Phase 3 routes (including the Trafford Park line). This was commonly referred to as an "Enhanced" C3 estimate, because it was based on a well developed alignment and traffic management proposals that allowed for a degree of accuracy and detail that would not be expected from a C3 estimate. Requesting a C4 was not possible, because

the intention was to include the diversionary works project in the Concession contract, so the final details of the work could not be known until the Concessionaire had been appointed and carried out its own review of the scheme. Nevertheless, GMPTE agreed to pay the utilities for the preparation of the cost estimates, on the understanding that they would not then be paid again for the full C4 estimate.

1.3.8 In February 2000 an internal GMPTE estimate had been prepared of the cost of diverting apparatus. This was based on an incomplete understanding of the scope of the works, because previous assessments had been carried out piecemeal. When the utilities' estimates were received, they exceeded GMPTE's estimates. However, exercises carried out to explain some of the larger differences deduced that the utilities' estimates were generally too high. For example, a saving of £6 to 7 million was identified against the estimate for diversion of electricity apparatus, of around £18m. A similar exercise carried out jointly with Transco, then the owner of the gas pipes, concluded that their estimate could be reduced by about £2.1m. Later, a larger study was carried out considering all utilities in selected areas, which had been identified by the potential Concessionaires (the two preferred bidders). This was reported on in mid-2003, and concluded that the cost of diversion works in these areas alone could be reduced by up to £14m.

1.3.9 An outstanding example of the opportunity for cost reduction was encountered in Oldham Town Centre. BT estimated that the cost of moving a large manhole with all the cables passing through it would be in the region of £2.5m. After the proposal had been discussed in detail, it was agreed that the same purpose could be achieved by demolishing and rebuilding the manhole with the access clear of the tracks, for a cost of less than £100,000.

1.3.10 Other opportunities presented themselves in Oldham Town Centre. Transco needed to replace cast iron mains in Union Street, and opted to place them elsewhere, clear of the tracks. A water main affecting the alignment in the same street was moved early into a new street being constructed for the development of a supermarket, at a considerable cost saving, as it was placed before the road surfacing was carried out.

1.3.11 The development work was carried out to give the preferred bidders the confidence to reduce their best and final offers, based on a clearer understanding of the scope of the diversionary works. However, this aim was thwarted when the Government, in July 2004, withdrew their offer of funding. At this point, GMPTE reconsidered their means of procurement, and divided Phase 3 into two stages, 3A and 3B. It was decided that GMPTE should procure and pay for diversionary works for Phase 3A in advance of the tramway construction, although the works are being carried out under the control of the tramway design and build contractor. The final section of this case study considers the work currently being carried out on Phase 3A.

1.4 Phase 3A

1.4.1 Due to the protracted period since the initial estimates were made, the process of obtaining records and cost estimates was begun again. GMPTE now found themselves dealing with eleven different utility companies. The quality of the records provided was generally good. However, BT's records have never been considered fit for purpose by GMPTE, with a considerable amount of further investigation being necessary before the desired information can be extracted from them. Sewer records were also generally of poor quality. No payment was required for the provision of the records; some were made available through an extranet facility, others were provided on DVD, but the majority were provided in the form of paper copies.

1.4.2 Relations with utilities, developed over many years, have been generally good, with active co-operation from most. However, GMPTE considers that the sewer authority has been attempting to take unreasonable advantage of the scheme: many of their records had been destroyed, and they have been looking for the opportunity to use others to prepare new ones on their behalf. They have in particular relied on CCTV surveys paid for by GMPTE to establish not only the condition of the sewers, but also the positions or presence of apparatus. This work has now been completed. (Note: this conflicts directly with the recommendations given in paragraph C.1.4 of the Diversionary Works Code, which states "At the draft scheme stage, if the undertaker is not confident of the general position and nature of the apparatus, it should take any necessary steps to determine this information, this would be at its expense".)

1.4.3 A long period elapsed between the preparation of the initial estimates in 2000 and the placing of orders with the utility companies. There was consequently much duplication of design and effort, resulting in abortive work. Changes of personnel meant that much relearning had to take place.

1.4.4 Work on preparing for the new Trafford Depot began late, so that utilities' information had to be procured for this work as a separate exercise. The quality of information was again variable: that provided by National Grid Gas, Virgin Media, United Utilities Electricity (LV) was very good, while others (the minority) was poor. The initial cost estimates for this work increased, mainly as a result of the lack of time to carry out planning and assessment of the opportunities to reduce the scope.

1.4.5 Utilities' proposals at the C3 stage were reviewed critically, and some modifications were made to track alignments to reduce their impact on apparatus. Other modifications were discussed and agreed with the utilities. For example, a 30" water main runs parallel to the tracks in Ashton New Road: by a small modification of the alignment in a few areas, the water authority was satisfied that it would be sufficient to slip-line the pipe, rather than move it completely, approximately halving the cost of the works. In some cases, agreement was reached to leave apparatus in place, while the gas company agreed to an alternative routing for a replacement gas main alongside the Ashton route. The gas company also agreed that a main could be decommissioned in Great Ancoats Street while a tram underpass was constructed.

Kingston Communications initially resisted proposals to slew and lower their cables in Sheffield Street at the rear of Piccadilly Undercroft, preferring to divert them, but were eventually persuaded of the necessity of the cheaper course of action.

1.4.6 GMPTE's design and build contractor, MPT, prepared a programme for the Phase 3A works, based on duration data provided by the utilities. The programme is regularly discussed with the utilities and revised based on any comments or new or additional information.

1.4.7 Each utility carries out the work on its own apparatus. The project is currently working well. National Grid Gas changed their term contractors near the beginning of the programme of works, with the result that their start was delayed, but this did not cause a serious problem. There is however a restriction on resources, as several utilities use the same consultants to carry out their design work, and these are under-resourced. This applies particularly to BT and United Utilities Electricity, who have been giving their priority to development works.

1.4.8 GMPTE have not provided any supervision to the works, or provided a clerk of works. However, GMPTE is the lead client for the purposes of the CDM regulations, and the utilities' contractors are principal contractors.

1.4.9 The C4 costs were generally higher than the C3 estimates. This is in part due to an increase in the scope due to additional companies emerging. In some cases there has been a misinterpretation of the drawings on the part of the utilities. The outturn costs are also generally higher than the cost estimates.

1.4.10 Where there was a cluster of utilities (for example at Market Street, Droylsden) BT provided the traffic management for all utilities. At Pollard Street, MPT (the Concessionaire) dealt with the traffic management and began track construction immediately after the diversions were complete. The utilities were offered a compound at Pollard Street on land acquired for the purposes of the tramway. The offer was not accepted, so that an opportunity for cost savings was not realised.

1.4.11 Working hours were initially based on a Code of Construction Practice agreed with the local authorities. Restrictions have been relaxed in less sensitive areas. The areas in which work can be carried out is also determined by restrictions imposed by local authorities on working in the street during the period leading up to Christmas ("the Christmas embargo"). The area affected by the Christmas embargo, which mainly affects busy shopping areas, was extended by Manchester, though not by Tameside. Despite this, MPT are ahead of their programme, but this is because the programme has been accelerated to dispose of 33kV cables on Ashton New Road.

1.4.12 A one-stop shop approach, such as has been used in Edinburgh, was not used although works were closely co-ordinated in some areas. Wherever possible, methods of reducing costs through economies of scale have been sought, by the use of

temporary traffic management on behalf of several utilities, common trenching and so on. However, all reinstatements are permanent due to the significant time, in most areas, between the diversions and the following trackwork.

1.4.13 Rationalisation of the scope of works was automatically taken into account by adopting the most cost effective solution, as in the lining of the water main in Ashton New Road referred to above. Where possible, apparatus was protected rather than diverted.

1.4.14 Use of a lump sum or target cost approach was considered, but was not considered suitable or practicable as the utilities were working on their own behalf.

1.4.15 Stray current was never considered as a reason for diversion.

2. Croydon Tramlink

2.1 Trams operated in Croydon until April 1951, when operations ceased to make way for buses and cars.

2.2 Development of Croydon Tramlink began in the second half of the 1980s, and continued during the first half of the 1990s, culminating in the passage through Parliament of the Croydon Tramlink Act 1994. Initial consideration of the impact of the proposed tramway on utilities' apparatus was undertaken during the period leading up to the time of the Act coming into force. The initial budget estimates indicated that the cost of diversion and protection might be as high as £42 million. At this stage development of the tramway, including planning diversion works, was carried out by Croydon Council in conjunction with a consortium of companies who hoped eventually to be appointed to construct the system. The grouping was dissolved in 1995 when tenders were sought for a Concessionaire to design, build, finance and operate the tramway for a period of 99 years. The Concession was let to Tramtrack Croydon Limited (TCL), and the tramway opened to commercial traffic in three stages during May 2000.

2.3 Under the terms of the concession, responsibility for diversion of utilities' apparatus remained with the council and London Regional Transport (LRT). A context study alignment was agreed between LRT, TCL and London Borough of Croydon, and the works needed to provide a clear path for the construction of the tramway were agreed between the parties and the utility companies.

2.4 LRT took the risk on the scope of works and cost associated with diversion for the context study alignment. The concessionaire took the risk on any additional diversions required if their chosen alignment departed from the context study alignment.

2.5 A total of twelve utility companies were involved: these were British Gas Transco, BT, Mercury, Nynex, Telewest, Bromley and Croydon councils (highway drainage), London Electricity and Seeboard, National Grid and Thames Water (both clean water and sewers).

2.6 Turner and Townsend were appointed as project managers, taking control of the scope, programme and cost change control for the diversion works. C2 and C3 stages were carried out before T&T became involved. A strict change control procedure was introduced on their appointment.

2.7 T&T inherited information collected by the P.D.G. (Project Development Group) and LRT's previous advisors. Based on this they supervised the preparation of composite service plans. They used a term contractor, appointed by LRT, to carry out trial holes, and later for traffic management. Cost estimates, with the exception of Mercury, originally included individual traffic management schemes, so a considerable sum was saved by using common traffic management measures wherever possible. The term contractor also carried out all permanent reinstatements. It was a requirement of the Concessionaire that all reinstatements should be to the permanent standard, rather than interim, so that they could be sure of the

quality of finish that they were taking over. This resulted in reinstatement costs being higher than would have otherwise been necessary.

2.8 On being appointed, T&T organised a series of workshops, which mainly focused on the programme. The route was divided into zones, each of them having a handover date to the main contractor.

2.9 There was generally a good relationship between the project team and the utilities, who took a pragmatic approach to the need for diversions. BT in particular were open to the idea of adopting the best all-round solution. Thames Water's final cost was nearly half of the cost at C3 stage. However, there was a recurring attempt to inflate overheads by many of the utilities. National Grid were demanding on a technical level, but were fair when it came to financial matters.

2.10 Water and gas both employed Morrisons for civil works. Transco initially employed AHAC, who went into administration in the course of the works, so went to Morrisons who were already working for Thames Water. BT had a major works programme which tended to absorb resources, but this generally wasn't critical – it was generally possible to sequence the decommissioning and removal of apparatus satisfactorily to allow the tramway construction to proceed on time. It was sometimes necessary to put pressure on BT to relinquish resources

2.11 BT were active in looking for cost reduction measures. For example they slewed a fibre optic cable to the inside of a curve rather than replace it. They reduced their presence in George Street to a few copper cables, replacing most of them with fibre optics in parallel streets. During the final account stage, a reduction in BT's overheads was negotiated, which led to a reduction in the overall cost of the works.

2.12 Thames Water had no method in place for checking what work had been carried out on their apparatus. Their project and programme management was found to be weak and ineffective, although the front line staff were good. However, T&T employed a clerk of works who recorded all the work.

2.13 In planning their sewer diversion works, Thames Water failed to allow for reconnecting drains from properties alongside the route. A large amount of sewer replacement was required. In order to avoid deep excavation, numerous secondary diversions and highway impacts, many of these were dug as headings using mines recently made redundant from the coal industry.

2.14 The master programme was prepared and maintained by T&T based on the durations provided by the utilities to the previous consultant as part of the C4 estimates. The first workshop led to a six month saving in duration of the diversionary works programme. In this respect, there was a very positive approach from almost all of the utilities.

2.15 Hand-over dates for the various zones were written into the Concessionaire's contract, so meeting the targets was important. Before the target dates were notified to the utility companies, the available period was shortened by 6 weeks to provide some leeway in the event of the works overrunning. The original handover dates were altered in some cases by

the Concessionaire, in both directions. Only one handover date was missed, by four weeks. However, this had no impact on the main programme, which was already three months behind. The work was prioritised by T&T, but the reasoning for the prioritisation was kept from the utilities.

2.16 A Code of Construction Practice was adopted for the works, which limited works to certain times. The CoCP was referred to in the C5 notices at the requirement of the London Borough of Croydon. It was also referred to by Croydon when responding to notices issued under sections 54 and 55 of the New Roads and Street Works Act 1991. The initial notices were served by T&T on behalf of the utilities, with the utilities' own contractors serving the shorter notices.

2.17 First work carried out was the lowering of the highway drainage to allow other apparatus to be lowered.

2.18 Meetings with the utilities were either all-inclusive, or held with one or a few companies, and were initially held on a weekly basis. As each zone was completed, the final account was prepared, and in this way problem issues were identified at an early stage. Each utility appointed contractors to carry out the agreed measures on their behalf, and adopted methods of reimbursement to suit their preferred approach. Some costs were calculated on the basis of a schedule of rates, while others were based on target costs. As a result there was often no opportunity to obtain a detailed breakdown of the actual costs of the works. The costs were tracked against the C5 orders.

2.19 In most cases, no account was taken of ohle pole positions, because no information was provided in time by the Concessionaire. When positions were provided in time, they were avoided. Pole foundations were a mixture of piles and gravity bases. Some small apparatus was built into the gravity bases, by agreement with the utilities.

2.20 As mentioned above, LRT had a term contractor managed by T&T but the majority of the works were carried out by the utilities' own contractors, almost all of them different. There were two clerks of works employed on behalf of the promoters, who monitored the works. They built up good working relationships with the utilities' contractors, but had no power to instruct them. Their main role was to log non-compliance with the agreed programme of works. T&T was designated as the planning supervisor and principal contractor under the Construction (Design and Management) Regulations 1994. Each utility appointed T&T independently.

2.21 The tramway alignment was altered by the Concessionaire on the approach to New Addington and through South Norwood Country Park. The consequence was that some diversion and protection works, which had already been carried out, was made unnecessary. Additional work was also required where the alignment was moved closer to previously unaffected apparatus. This work was carried out at the expense of the Concessionaire, in accordance with the contract. There was also a provision in the contract that permitted the promoter to refuse to undertake additional work at the request of the Concessionaire if it would delay the handover date.

2.22 Temporary Traffic Regulation Orders were prepared by Croydon Borough. They were members of the Working Group, and based the production of tTROs on the programme as it was prepared and adapted. Advice to the public was generally managed by Croydon Borough. Use was made of a shop where people could find out what work was being carried out and how local roads and transport were being affected. Temporary traffic management changes were also publicised weekly.

2.23 While economies were obtained from using a single contractor for the traffic management, there was not much use of common trenching.

2.24 However, the costs came down from the original C3 estimate of £42m to a final outturn cost of £17m. This figure was arrived at following successive reductions at various stages of the project, from the initial £42m, to £33m at C3 stage, to £25m at C4 stage. The Concessionaire was offered the opportunity to carry out the diversion works as part of the Concession contract, who would have required £40m to accept the risk. This persuaded the promoters to take on the risk themselves.

2.25 As with other UK tramway systems, no apparatus was moved with stray current in mind. However new and diverted apparatus was treated in order to minimise the risk of stray current. Subsequent to the opening of the system a single BT route was replaced in Addington village (Cravel Hill) due to suspected stray current. The source of stray current was not proven to be Tramlink but LRT agreed to the works in order to demonstrate good faith to the utilities.

3. Edinburgh Trams

3.1 Edinburgh had a tram system which operated in the city and surrounding areas for 85 years. In common with the majority of other British tramways, it was dismantled in the 1950s.

3.2 From some as yet undisclosed date, trams will run from Newhaven and the Port of Leith, approximately 4km north of the City Centre, to Edinburgh Airport, some 8km to the west of Princes Street. Extensions are planned in the future.

3.3 The construction and operation of the tramway is authorised by parts of both of the Edinburgh Tram (Line One) Act 2006 and the Edinburgh Tram (Line Two) Act 2006, both Acts of the Scottish Parliament.

3.4 The contract for the provision of the tramway and manufacture of the trams was let to the consortium of Bilfinger Berger and Siemens Group.

3.5 It was decided that diversion and protection of utilities' apparatus should be carried out in advance of the main contract, to provide a clear site for the tramway construction. The Client for the works, TIE (Transport Initiatives Edinburgh) chose to let a management contract to a company who would plan, co-ordinate and carry out some of the diversionary works on behalf of the utilities. The contract, referred to as the MUDFA (Multi-utility Diversion Framework Agreement), was let to Alfred McAlpine, (who were subsequently taken over by Carillion). The value of the contract, formed in October 2006, had a value that was variously reported as £40 million by Edinburgh Trams, and £64 million by Carillion. In a press release of 14th August 2009, Edinburgh City Council revealed that the cost of the MUDFA works had increased by "up to" £7million, or approximately 12% of the contract value. Subsequently, the contract with Carillion was terminated, and the relatively small balance of the works has been carried out by two separate contractors, Clancy Docwra and Farrans. It is understood that the scope of the works originally assumed has increased by approximately 50% in terms of the length of apparatus diverted.

3.6 At Parliamentary stage, most utilities objected to the perceived effect of the tramway on their apparatus. After lengthy discussion and persuasion, MUDFA was accepted as a concept. It was also agreed that it would be acceptable for the MUDFA contractor to carry out core gas and water diversion works, as they were already qualified for this.

3.7 There are six utility companies affected scheme-wide, with one or two others in some areas, including Virgin Media.

3.8 The records provided were generally of poor quality. In the case of the sewers, there was inadequate information on their condition. They were surveyed using cctv, and were mainly left in place. While none of the utilities charged for the provision of record drawings, TIE suspect that the cost of supplying sewer records was included as part of the cost of preparing C4 estimates. The sewer authority lacked knowledge of the many connections to

the sewers from adjacent properties, so that they gained a significant benefit from the survey works.

3.9 TIE commissioned ground probing radar surveys, but are unsure how effective this has been. The roads are very congested, and it was often difficult to find a suitable diversion route.

3.10 The MUDFA contractor worked out the duration of works and put the overall contract together. They fed in the work that needed to be carried out directly by the utilities, for example jointing of electric cables, which were fed into ducts installed by the MUDFA contractor. The main problems stemmed from uncertainty about what would be found, for which a contingency was provided. Once the road was opened, apparatus was sometimes found to be in a worse condition than anticipated. As an example, where BT ducts were to go beneath a gas pipe, the pipe would sometimes be found not to be in a good enough condition to survive the removal of ground support.

3.11 The Act only allows the tramway promoter, or their contractor, to carry out works within the limits of deviation. In consequence, any works carried out outside the limits of deviation had been carried out directly by the utility company.

3.12 TIE's policy was to reduce the scope of the diversion works as far as possible. The team developed by TIE includes expertise in each discipline taken from utilities' backgrounds. The final measures were jointly agreed between TIE and the utilities, reached through an iterative process. Project managers are responsible for an area, controlling a small group with site supervisors. TIE has a supervisory role because it is their contractor and their risk. The utilities' own on site representatives sometimes attempt to obtain a solution more favourable to themselves, beyond what TIE believe to be necessary. The presence of people with experience in undertakers' organisations representing TIE helps to ensure that realistic solutions are adopted.

3.13 Due to the method adopted to implement the diversions programme, there is little problem with a lack of resources. However, the number of water connections has presented a problem. TIE installed ducting for BT, but they pull in and joint their own cabling. All new gas mains and service pipes have been installed in plastic, which has gone some way towards the gas transporter's obligation to replace cast iron mains within 30 metres of buildings.

3.14 A code of construction practice was agreed as part of the legislative process. The standard working hours based on the code are 7a.m. to 7p.m. Monday to Friday. It is possible for the contractor to apply for a relaxation, and they have done so on occasions.

3.15 Edinburgh City Council has tried to reduce the numbers of other projects being undertaken at the same time as the tramway works. Originally the council imposed an embargo on works at both Christmas and during the Edinburgh Festival, although work continued in Princes Street throughout the summer of 2009. The embargo was originally imposed between Haymarket and Picardy Place, but was then extended under trader pressure to Bernard Street.

3.16 The council now wishes to see more continuous working to speed up the construction process. Some hotels were given undertakings concerning periods of working, but they are always consulted in appropriate cases when works are to be carried out outside standard hours.

3.17 In retrospect, TIE would have liked more time between completion of utilities and the start of the main works. In some areas work has been completed for some months, while in others (such as Leith Walk) diversion work has been continuous and will continue until track construction begins.

3.18 Traffic management schemes are designed by TIE's consultant, but then implemented by the MUDFA contractor. There is a blanket temporary Traffic Regulation Order which forms part of the Act. TIE has its own traffic management review panel, attended by the City and the bus company. The contractor produces plans and method statements showing how the proposed traffic management is to be implemented. These are submitted to the group for approval.

3.19 Road crossings of live streets, for example in Haymarket and Leith Walk, are carried out in sections to minimise disruption of traffic flows.

3.20 Trees have been removed for traffic management purposes, for example to introduce new bus routes. Some of these have been removed by the City, some by the MUDFA contractor and some by the infrastructure contractor.

3.21 Diversionary works are measured for reimbursement purposes. The works are carried out in identifiable packages, and the final works are checked against the package. TIE checks the measures to identify and guard against unauthorised changes.

3.22 There are no incentive provisions attached to the MUDFA contract, although some future works may be carried out on a lump sum or target cost contract. The budget was set in 2006, and the diversion works are expected to come in on budget, within the risk allowance. There have clearly been opportunities for economies of scale, with all the work being carried out by a single contractor, although it is difficult to assess what these might be.

3.23 There is a section within TIE dealing with public relations. A customer service help desk provides information and advice. Tram construction advisers walk the site. There are leaflet drops door-to-door, and a website to provide up-to-date information about the progress of the scheme. Radio updates are provided, although this is not under the control of TIE. The newspapers were originally largely against the scheme, but their position has been changing. TIE has tried to emphasise the benefits that result from the improvement to the utilities' apparatus, arising from reduced disruption in the future.

3.24 Overhead line poles are bolted to gravity bases, rather than inserted in piles. This means that there is less restriction on the positions of diverted apparatus.

3.25 There is a stray current working group, which includes all utilities. They monitor apparatus. The philosophy is not to move apparatus simply because stray current might be a problem.

4. West London Trams

4.1 The West London Tram was proposed by Transport for London. It would have replaced three bus services running along Uxbridge Road (the A4020) between Shepherds Bush and Uxbridge town centre, and followed the same route as an earlier tramway built in 1904.

4.2 Trams would have passed through three London Boroughs: Ealing, Hammersmith and Fulham, and Hillingdon. Each of the boroughs opposed the proposals, although Ealing initially supported the proposal, who considered being joint promoters. Support was withdrawn following a local election which was fought on an anti-tram agenda. A public consultation carried out during 2006 also failed to provide the firm endorsement of the scheme hoped for by the promoter.

4.3 The proposals for the tramway were officially abandoned in August 2007, shortly before funding was formally announced for the Crossrail scheme. The two events were linked, as it was considered that the two transport systems would largely duplicate the provision of transport in the areas to be served by the tramway.

4.4 In the meantime, a significant amount of work had been carried out by TfL to prepare for the diversion of utilities' apparatus, based on a preliminary alignment and traffic management proposals.

4.5 Records were obtained from about twenty utility companies. Apparatus belonging to the Ministry of Defence was also found to be present, although it proved difficult to obtain useful information in relation to it. Two water supply companies were involved, with Veolia Water Three Valleys providing water to properties at the west end of the route, and Thames Water at the east end. Similarly, the supply of electricity was divided between EDF and Scottish and Southern Energy, depending on which section of the route was being considered.

4.6 Most of the route was explored with ground probing radar. In retrospect, it is considered by the project team that it may have been too early for exploration at this level of detail. However, it provided an opportunity for comparison between the survey results and the utility companies' records. All records of apparatus were provided on paper. A topographical survey was also carried out, which provided a further point of comparison. The survey work revealed more apparatus than had initially been expected, which alerted the project team that there were more utility companies present than originally expected. This led to more records being obtained to fill in the gaps. All chambers were also opened to determine directions of flow in the case of sewers, or orientation of cables in the case of communications and power supplies. The alignment was overlaid on the composite service plans, and from this it was possible to identify which apparatus needed to be moved, and which could be protected or left in place. Locations of trial pits were chosen, but the physical work was never carried out. A cost was assigned to the work by the project team. The assessment of the necessary measures was not carried out uniformly for the whole route: for example, where the route crossed a bridge, the conflicts and solutions were looked into in

some detail. However, where the tram was to run in dual carriageway, the project team adopted a more broad-brush approach. No diversion proposals were provided by the utility companies. Instead, the work was given to two consultants, of whom one dealt with apparatus in two boroughs, and the other took the third. Preliminary estimates of diversion and protection costs were made by the consultants advising the project team. Also, the process did not get as far as preparation of a programme of works.

4.7 Most of the utility companies were co-operative, as they saw the benefits of being provided with new apparatus as a result of the diversion works. However, Thames Water agreed to attend one meeting free of charge, then wished to charge for further meetings.

4.8 TfL sought to keep their records of apparatus up-to-date. One of the methods they used was to record the apparatus exposed in excavations in the highway, comparing the actual positions with the positions indicated on the records.

4.9 If the scheme had been undertaken, it was TfL's intention to procure the diversion of apparatus as they had done in Croydon, namely by appointing a contractor to manage and co-ordinate the works, carry out highway modifications and changes to traffic management, but leaving the utilities to carry out works on their own apparatus. TfL believed that they had benefited from such an approach in Croydon through cost and efficiency savings. In some places it would have been necessary to remove trees for the tramway construction, though not for diversionary works.

4.10 Working hours would have been restricted by agreements with the boroughs through which the route passed, with no work being allowed during rush hours, overnight or on Sundays.

4.11 In view of the arrangements expected to be made, there would have been no opportunity for lump sum or target cost arrangements as between the utilities and TfL.

4.12 TfL had considered the phasing of construction in some areas, using common trenching and temporary reinstatement of highways wherever possible. The options for doing this had been discussed with some of the utilities, but no proposals were developed in detail.

4.13 TfL had also carried out detailed studies in some areas on ways in which the scope of the works could be reduced by innovative measures.

4.14 The stray current protection strategy was developed in line with the approaches used elsewhere.

APPENDIX 1

UKTram Activity Groups

Activity 1 – Protection and Diversion of Apparatus

Activity 2 – Tram Design Standards and DDA/RVA Issues

Activity 3 – Signing and Highway Interface

Activity 4 – Noise and Vibration

Activity 5 – Network Rail Interface

Activity 6 – Trackform Design

Activity 7 – Benefits included in the Appraisal Process

Activity 8 – Commercial Structure

Activity 9 – Operational Performance Measures

Activity 10 – Tender Documentation

Activity 11 – Wheel/Rail Interface

Activity 12 – Traction Power Supplies