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ENVIRONMENT AGENCY

DUNBALL SLUICE REFURBISHMENT

PROJECT : G7639

POST PROJECT APPRAISAL

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Acronyms in this report

PPA -Post Project Appraisal
NRA- National Rivers Authority
PAB – Project Assessment Board
KSD - Kings Sedgemoor Drain
MAFF – Ministry of Agriculture Fisheries and Food
IEE – Institution of Electrical Engineers

Executive summary

The South West Project Assessment Board [PAB] has requested that a post project appraisal [PPA] be undertaken of the flood defence scheme at Dunball Sluice, near Bridgwater.

The sluice was constructed in 1971 at the outfall of the Kings Sedgemoor Drain to the tidal River Parrett. It forms a critical part of the sea defences of the peat moors and controls flood flows from the Parrett Relief Channel [the River Sowy].

The need for emergency and urgent refurbishment works were identified in December 1993 when lifting chains to one sluice gate snapped during operation. The project ran for some 7 ½ years, starting with emergency repairs followed by a series of contracts to refurbish M & E plant and modifications to the structure to provide permanent stop-logging facilities.

These were substantially completed by mid 1998. 'Snagging' and Health & safety modifications were identified in autumn 1998 extending the project until formal hand over to Flood Defence Operations in September 2001.

The PPA assesses whether the expenditure at the Sluice has been effective and has met the project objectives. Lessons are identified regarding the management of major refurbishment projects.

The final scheme cost was £589 344. The final amount approved by MAFF as eligible for grant aid was £493 180. The initial approved project sum was £200 000 . The audit trail relating to internal authorisations is almost complete. Some supporting documentation is not on file. Correspondence with MAFF for grant aid is well documented as are approvals for increases in budget..
A total of 15 grant Variation Orders were submitted and approved. MAFF final account is dated March 2001. With the exception of the internal approvals for the three phases all are retrospective to the work

Contractors' performance was generally acceptable excepting Midas Engineering who clearly took little responsibility for their poor installation work on the bypass.

The Sluice is reported to perform satisfactorily. The electrical and mechanical plant has been completely refurbished or replaced. The asset life [M & E] has been extended to ca. 2014. The GRP enclosures have reduced major deterioration of the sluice mechanisms. Significant flaws have been corrected by the provision of the stop-logging facilities & weed screens on the bypass culverts, the replacement of the main tide flap hinges, the GRP enclosures and of steel tide flaps to the bypass culverts.

The operation and maintenance of the site is significantly safer than was the case previously.

The risk of saline intrusion to the lower KSD has been reduced. The project had minimal environmental impact during construction.

Remote monitoring of site status greatly improves flood event management.

No evidence was found of a strategic programme. Timescales would have been reduced had the project team been able to commit more time to the overall co-ordination of the project components. Sheer volume of work appears to have been the main cause. However the overall cost is unlikely to have been much less. Capital budget constraints may also have influenced the time-scale.

The project time scale does not appear to have affected operational security of the Parrett Relief Channel scheme.

Comprehensive refurbishment schemes of this scale are likely to be infrequent in the SW. They require careful appraisal to ensure that the full extent of the work is identified. The importance must be recognised of the opportunity to resolve operational and design issues. Operator involvement through-out the process is essential.

An extended project time-scale can be expected where there is a series of discrete components. This will moderate usefully the spend per year.
A strategic programme is essential to co-ordinate the separate contracts.
Current project management procedures address the performance issues identified in this PPA.

Overall the scheme has met its objectives and was worthwhile.

1.0 Introduction

1.1 The Environment Agency's Project Assessment Board [PAB] for the South West Region has requested that a post project appraisal be carried out for the Dunball Sluice Refurbishment Scheme, project reference G7639. The report is written in accordance with the document " Project management in the Agency, vol. 14, Appendix N: post project appraisal".

1.2 The aims of this PPA are:

- To determine whether the investment at Dunball Sluice has been worthwhile and that the original scheme objectives were met
- To identify:
  - lessons for the management of projects and assets,
  - good practice improvements.
  - How benefits of experience can be maximised

1.3 The need for the project was identified on the discovery in December 1992 that chains supporting 1 of 8 controlling gates had snapped. A report on the condition of mechanical and electrical plant identified an advanced state of deterioration throughout . The operational capacity of the sluice was at considerable risk. Emergency and urgent refurbishment works were recommended.

1.4 The works continued over an extended period during which time it is clear that project management procedures have changed significantly.

1.5 The environmental impact of the project was local to immediate vicinity of the structure provided the normal function of the sluice was not compromised at any stage of the work. On this basis English Nature supported the proposed works.

2.0 Site description

2.1 Dunball Sluice is situated at the outfall of the Kings Sedgemoor Drain to the River Parrett [NGR ST3099 4071] A critical structure in the defence of the Somerset Moors it protects the KSD from tidal inundation and provides for the management of water levels in Kings Sedgemoor and River Sowy relief channel. The structure was completed in 1971 as part of the R. Parrett Relief Channel Scheme. Further works are recorded in 1977 to correct "certain shortcomings which had become evident during the initial operating period".

2.2 The Engineer's report of Aug 1993 states for the Relief Scheme that : "the area of benefit for the scheme was of the

order of 16000 acres". Figure 1 shows approximately the area protected from inundation, defined by the 5.0m contour. About 50% of all high tides at Bridgwater exceed 5.0mAOD

2.3 The structure consists of a barrage across the KSD with four separate outlet culverts or "eyes", each provided with a tidal flap and two vertical roller gates in tandem. Figures 1 & 2 below illustrate the structure. Each gate is counterbalanced with weights located in separate chambers above the culverts. On each side of the structure is a by-pass culvert to accommodate low &/or summer flows. The flow into each by-pass is controlled by a tilting weir on the up-stream side. The entrance to the bypass culvert is closed by a penstock, with a tidal flap on the outfall to the river.

2.4 The vertical gates and tilting weirs are electrically operated. The control panel is in the control room on the LH side of the structure. The motors and winches for the gates are located on the top of the structure The motors for the by-pass tilting weirs and penstocks are on the lower, up-stream staging.

Fig 3. Plan View of Dunball Sluice c1971

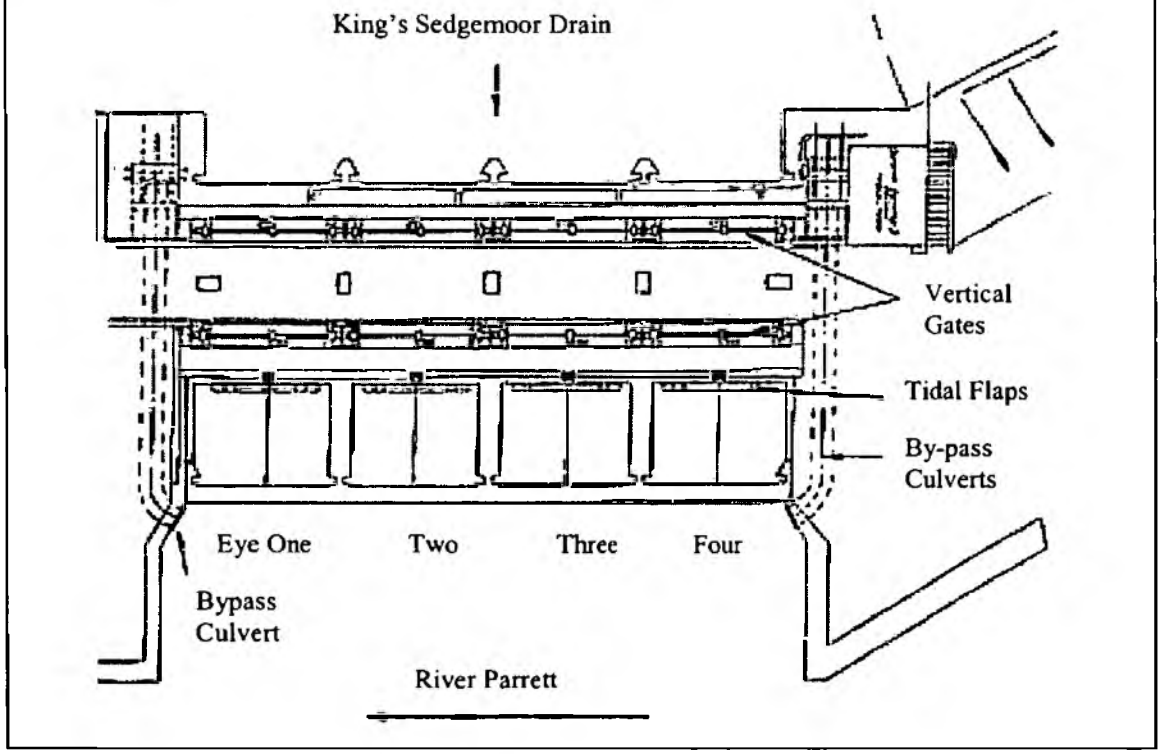
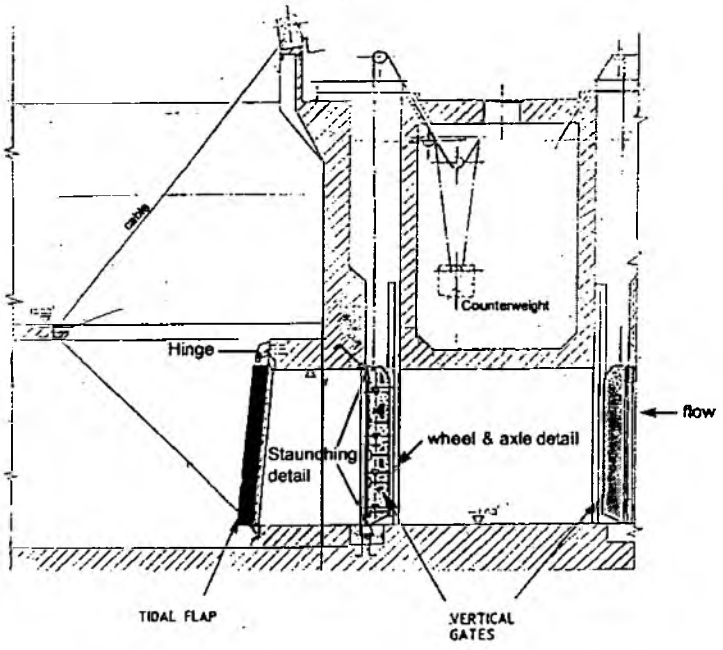


Fig 4. Cross Section of Dunball sluice ca 1971



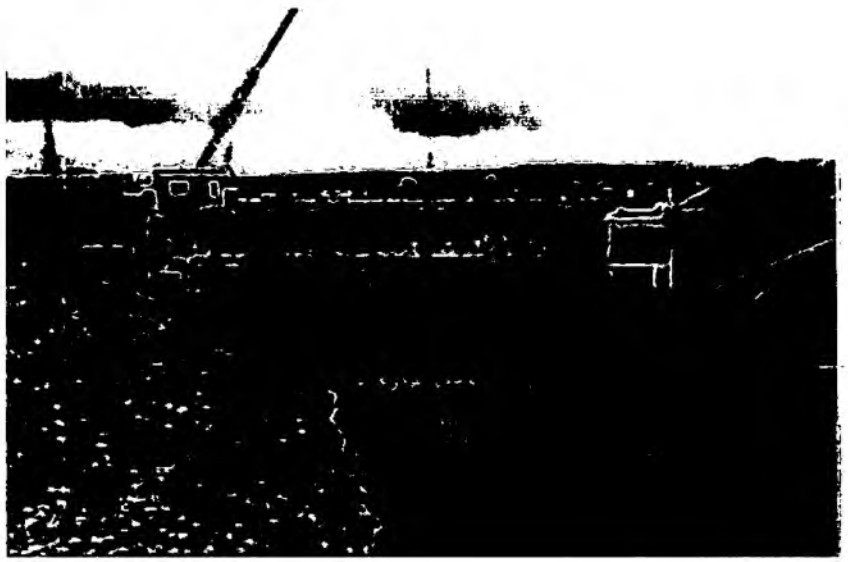


Fig 5.Dunball Sluice viewed from The Kings Sedgemoor Drain c1993

3.0 OPTIONS

3.1 Initial Options considered:

- Do nothing (the flooding and environmental risks remain and worsen with continued deterioration)
- Emergency works & assessment now (Phase I), & full Refurbishment (Phase II) (£88k+£259K)
- Complete refurbishment now (£340k)
- Rebuild structure (£1.5M)

The project proceeded on the basis of Option 2.

3.2 Phase II submission considered the following:

- Refurbishment of site (£200k)
- Total rebuild of structure (£4M)

Refurbishment was selected on cost grounds. Detailed consideration included:

- Upgrading of lifting gear from motors to actuators
- Refurbishment of the summer/low flow bypass culverts.
- Refurbish existing gates
- Replace gates with bespoke penstocks ~ **rejected** on cost grounds (130k *4= 520K)
- Off-peg penstocks ~ **rejected** on cost & performance grounds (90k ea =360K+ civils to adjust eye width).
- Provision of safe access

4. The Scheme

4.1. Phase I

Emergency repairs to restore the site to an operational condition, and to assess refurbishment needs.

- Emergency work to secure the counterweights
- Replacement chains to all roller doors
- Repairs to no. 1 eye roller doors and guides
- Replacement hand-railing to seaward side walkways
- Assessment of extent and value of the refurbishment works for Phase II (Engineer's report)

4.2. Phase II

Delivery of refurbishment as identified through the Engineer's report produced during Phase I

- Replace electrical works – control panel, cabling
- Actuators for roller gates, bypass penstocks and tilting weirs
- GRP enclosures to the main actuators
- Bypass refurbishment [weirs, penstocks, tide flaps]
- Safety works [fencing, walk ways, railing]

4.3. Phase III

This term was applied to works required for the completion of Phase II, but not originally included in the scheme.

- Provision of permanent stop logging facility and weed screens to the bypass culverts

Additional measures subsequently incorporated into the project included:

- GRP enclosure for gate actuators, tilting weirs & penstocks on the RH bypass
- Telemetry.
- Updating of Health & Safety measures
- Modification of the main tide flap mounting plates and hinge bolts

5. Objectives

5.1. The project objectives were :

"To retain the ability to allow the evacuation of flood waters form the Kings Sedgemoor Drain, while excluding tidal waters"

"Efficient and safe operation of the site by:
(i) Replacement of motors and gearboxes
(ii) Refurbishment of all gates and flaps [excluding vertical gates to No. 1 eye]
(iii) Provision of safe access to site"

"To provide a permanent weedscreen and stop-logging facility for the by-pass culverts."

5.2. Documents indicate that these works were not identified within the five-year capital plan of the time. There was no asset management programme in place that would have prevented the need for the emergency works.

5.3. LEAPS and their forerunner, Catchment Management Plans, did not exist at the time of this scheme's inception. Similarly no framework existed for evaluating sustainability.

5.4. The records show that the urgency of the scheme was recognised. Financial provision in the first year was accommodated by slippage within the capital programme.

6. Timing

6.1. The Project Approval forms include planned start and finish dates. Detailed programmes tracking progress against approved target dates were not available from the records, however the individual contracts are well documented with formal start and agreed completion dates, including the design, tendering process, and construction elements.

6.2. The project ran from January 1993 through to September 2001 as follows:

Date	Description	Phase	Detail
15-Jan-93	Project Application	1	PHASE I PM2
28-Jan-93	Project Approval	1	PHASE 1 GRANT AID Approved
18-Jun-93	Project Application	2	PHASE 2 PM2
15-Jul-93	Project Approval	2	PHASE 2 GRANT AID Approved
Aug-93	Project PHASE 1 complete	1	
Mar 98	Project Phase 2 substantially complete	2/3	
Sept 98	H & S works identified	2/3	
05-Sep-01	Project PHASE 2 complete	2/3	USER ACCEPTANCE

6.3. Details within the key stages have been summarised in Table 3, and an overview of the project with time is given as Table 4.

6.4. It is clear that the planned timescale for Phase II was unrealistic. The project element demanded a largely sequential approach. The absence of an initial detailed project programme allowed slippage to accumulate between the elements. Throughout the course of the programme as more detailed planning was brought to bear on the individual elements, there was a clear pattern of refinement that extended the project. These were prudent developments however failure to consider these at the earliest planning stages has extended the scheme considerably increasing costs.

6.5. During the course of the contract, changes in health & Safety standards were identified and these affected the scope of works. It is arguable that the works required could have been delivered separately, however a conscious decision was made to include these works within the contract as an overall more efficient approach but extending the project.

6.6. Sharing of best practice and lessons learned through experience as formalised in current project procedures, now reduces the risk of specification drift.

7. Costs

7.1. The following budget approvals and variation orders are documented within the scheme records.

Table 1. Budget Approvals

Date	File Document	Budget Request / Approval	Comment
28 Jan 1993	Project Approval Phase 1	£116,000	£88K for works, £5K investigations, £10K design and £13K contingencies.
12 Feb 1993	Phase I Grant Application Made	£76,100	£57,500 Engineering, £10,000 staff costs, £8,600 contingencies (@ 15%)
15 April 1993	Phase I Grant Approval given by MAFF	£63,250	deductions were made for ineligible staff costs and a limited contingency of 10%
	Approval in principle given for the total project cost (Phases I & II)	£200,000	
15 Jul 1993	Project Approval Phase II	£200,000 [in addition to Ph I	£60K civils, 115 M&E,£15K design, £10K consultants
27 Aug 1993	Phase II Grant Application Made	£293,180	£243,800 Engineering, £25,00 staff costs, £24,380 contingencies
27 Oct 1993	Phase II Grant Approval given	£268,180	Deductions were made for £25K ineligible staff costs
	Approval in principle given for an increase to the total project cost (Phases I & II)	£331,430	
4 Nov 1994	Phase I Variation Order #1 submitted	£10940.06	Mechanical works exceeded engineer's estimate by £11544.Tthe survey of eyes costing £5529 was not included in the original cost estimates
28 Nov 1994	Phase I Variation Order #1 approved	£10940.06	
17 Feb 1997	Phase II Variation orders # 1,2,3,4,5,6,7,8, & 9 submitted	£141,076.00	#1 Actuation £-10432 #2 Mechanical Works £-2749 #3 Headgear Enclosures £4379 #4Tilting Weir Enclosure £7150 #5 Electrical works £9875 #6 Safety Fencing £7333 #7 Bypass culverts £9760 #8 Additional Works £11,000 #9 Bypass Culverts Stop Logging £104,760

Table 1. Budget Approvals			
Date	**File Document**	**Budget Request / Approval**	**Comment**
7 March 1997	Phase II Variation orders # 1,2,3,4,5,6,7,8, & 9 approved	£212,024.00	#1 Actuation £20488
			#2 Mechanical Works £18417
			#3 Headgear Enclosures£+3893
			#4Tilting Weir Enclosure£+7680
			#5 Electrical works£+18888
			#6 Safety Fencing £+8658
			#7 Bypass culverts penstocks & tidal flaps £+14,000
			#8 Additional Works £+11,000
			#9 Bypass Culverts Stop Logging £+109,000
	Approval in principle given for an increase to the total project cost (Phases I & II)	431,966	
5 Jan 1999	Phase II Variation orders # 10,11,12,& 13 submitted (improvements following health & safety risk Assessments)	£21750	#10 access to tidal stop logging on bypass culverts £8,000
			#11 railing to deter access to top of enclosures £7,000
			#12 re-siting of water level transducers to protect from snagging by mooring ropes £750
			#13 handrailing and gangway for access to weed traps & penstocks on bypasses £6,000
28 Jan 1999	Phase II Variation orders # 10,11,12,& 13 approved	£21750	
	Approval in principle given for an increase to the total project cost (Phases I & II)	£453746	
09 Feb 1999	Phase II Variation orders # 14 submitted	£3500	#14 compensation payment to ARC Southern £3500
1 Mar 1999	Phase II Variation orders # 14 approved	£3500	
	Approval in principle given for an increase to the total project cost (Phases I & II)	457,246	
12 Mar 2001	Final account acknowledged by MAFF	449,536	

7.2. On the 7 February 1997 MAFF expressed concern over the degree of overspend reported in the submission of Variation Order applications 1 through to 10 for Phase II, and for the failure of the Agency to seek Ministry approval prior to exceeding 10% of the approved scheme cost. Attention was also drawn to the allocation of contingency funds to individual elements of the scheme; this did not meet with Ministry protocols. Adjusted variation orders were submitted on the 17 Feb 1997.

7.3. On the 20th February 1997 MAFF accepted that it had not adjusted the approved scheme sum after tenders in excess of the original estimates had been submitted from the Agency, and in doing so had failed to note the increase in scheme costs. MAFF procedures were adjusted to prevent a recurrence. In light of this error MAFF undertook a review of the approved sum had it been progressively amended as a result of tenders received, and coupled this with the additional costs cited in the variation orders. In conclusion the variation orders were approved with slight adjustments over the Agency's original calculations. Concern was again expressed over the significant increase in costs since the formal approval of the scheme. The need to adhere to Ministry procedures was again emphasised

7.4. The Final account total for phases I & II is recorded at £589,334, approx £390K above the original estimate of £200K (or 258K more than the approved costs on completion of the engineers estimate undertaken as part of phase I). Fifteen variation orders were approved throughout the course of the project and these are listed (and justified) below in descending order of additional costs.

Table 2. Variation Order Justifications

Variation Number/(Phase)	Description	Justification	Additional cost (% of overall cost increase)	% change over original estimate	Original Estimate	Final cost (as recorded or estimated in VO applications)
9(II)	Bypass culverts- stop logging	Provision of permanent stop logging facility to penstocks and tidal flaps. Discussions with operational personnel revealed that the culverts were vulnerable to blockages and damage from debris. A decision was made to protect the refurbished mechanisms within the culverts with weed screens. In addition permanent stop logging would be provided to allow removal of the tilting weir for maintenance or repair (the original estimate of £16K was only intended to provide temporary safe access for works on the tilting weirs, penstocks and tidal flaps). The presence of concrete bars on the bed of the KSD and the remnants of the original cofferdam complicated these works and increased costs. [ca£30 000]	109,000 (43.9)	681	16,000	125,000
1(II)	Actuation	Additional visits to site were required to complete works delayed by the refurbishment of the tilting weirs. The VO application indicated that out-turn costs were lower than the estimate, however MAFF confirmed that contingency sums were not to be included within the calculation and in consequence further funds would be required.	20,488 (8.3)	135	58,000	78,488

Table 2. Variation Order Justifications

Variation Number/(Phase)	Description	Justification	Additional cost (% of overall cost increase)	% change over original estimate	Original Estimate	Final cost (as recorded or estimated in VO applications)
5(ii)	Electrical works – provision of lighting in the headgear enclosures and provision of ducting for site cables.	Original cables were not ducted as first anticipated – new ducting had to be installed	18,888 (7.6)	66	25,000	41,500
2(ii)	Mechanical works	Additional works were required to seals, pulley wheel brackets, hinge plate bolts, gate roller wheels & winch mounting plates. Chain guards were up-rated to meet Health & Safety standards, and galvanised steel walkways & railings were required for the actuators to be fitted to the penstocks in the bypass culverts. The VO application indicated that out-turn costs were lower than the estimate, however MAFF confirmed that contingency sums were not to be included within the calculation and in consequence further funds would be required.	18417 (7.4)	23	70,000	85,801
7(II)	Penstocks and tidal flaps	Tenders higher than estimate. Additional costs due to presence of reinforcement, uneven concrete surface and additional visits to site to co-ordinate with other works.	14,000 (5.6)	88	16,000	30,000
8(II)	Additional works	Wall constructed to protect tilting weir enclose from sand damage. Refurbishment and repair of damage to control room from water ingress. Security fencing to reduce site vulnerability to vandal attack	11,000 (4.4)	New work	Nil	11,000
1(I)	• Structural inspection of eyes 2,3 &4, • The fitting of chains, • Extra works apparent at the start of works	Not originally identified in engineer's estimate for phase I (the fitting of replacement chains was intended to form part of phase II but the dangerous condition of the existing chains demanded urgent action). Extra work included new guide rails chain adjusters, chain anchors, additional diamond drilling, silt & sand removal and repairs to the gate seals.	10,940 (4.4)	17	63,250	74,190
6(II)	Safety fencing	Provision of safety fencing in GRP a more expensive but more robust material than the galvanised steel originally quoted	8658 (3.5)	173	5,000	13,658
10(II)	Install access gangways to stop logging on tidal side of low flow bypass channels	Required for safe system of work	8,000 (3.2)	New work	Nil	8,000

Table 2. Variation Order Justifications

Variation Number/(Phase)	Description	Justification	Additional cost (% of overall cost increase)	% change over original estimate	Original Estimate	Final cost (as recorded or estimated in VO applications)
4(II)	Tilting Weir enclosures in GRP	Protect equipment & personnel from the effects of vermin & reduce future costs of access to equipment.	7,680 (3.1)	384	2,000	9,680
11(II)	Railing & catch-netting to deter trespassers from climbing and slipping from machinery roof enclosures	Not originally identified but necessary in the interests of public safety	7,000 (2.8)	New work	Nil	7,000
13(II)	Additional hand-railing and gangway within canopy over right bypass culvert penstock	Not originally identified but required for safe system of work	6,000 (2.4)	New work	Nil	6,000
3(II)	Headgear enclosures	Tenders in excess of estimate Ventilators in enclosure roof were necessary to eliminate condensation.	3893 (1.6)	48	20,000	29,679
14(II)	Compensation & Agents fees in respect of ARC Southern, operators of adjacent wharf.	Disruption to operations during works to the bypass culverts.	3,500 (1.4)	New work	Nil	3,500
12(II)	Re-site water level transducers to protect them from damage by the mooring ropes of vessels using the adjacent wharf	Not originally considered, but subsequently seen to be vulnerable unless moved	750 (0.3)	New work	Nil	750

7.5. Changes in costs may be attributed to four different categories:

- Specification changes (e.g. VO4 Phase II)
- Tender prices exceeding original estimates (e.g. VO 1 Phase II)
- Health & Safety issues (e.g. VO11 Phase II)
- Unforeseen conditions (e.g. VO9 Phase II old coffer dam foundations)

7.6. The in-house workforce appears to have been more expensive than competitive tendering however reduced supervision and preparatory work is offset against the increased costs.

8. Planning and implementation

8.1. The scheme is the first major refurbishment in North Wessex Area. It started as emergency works but the need for more considered second phase was recognised. No evidence has been found of a strategic appraisal to define the work developing the initial engineers report. Additional work and different solutions were identified as the project progressed , ie "specification creep".

8.2. Individual components (e.g. contracts for civil works, mechanical & electrical, enclosures etc) are well documented and have been properly specified and managed. Any claims arising have been addressed robustly.

8.3. On the whole the contractors' performance was acceptable. An exception was noted with respect the work undertaken by MIDAS Engineering Ltd for the manufacture & installation of bypass tidal flaps & penstocks. These leaked from the day they were installed. MIDAS refused responsibility for remedial works despite repeated requests. Repairs were eventually effected by the in-house workforce in 1999 part funded by the retention monies.

8.4. Mowlem Marine appeared to have performed well but they were very claims conscious. This had a significant impact on the Project Manager's time.

8.5. Joe Bird Ltd (supplier of the GRP enclosures) performed well, responding positively to changes in the detailed design, and breaks in construction timing. This is a good example of working with local suppliers.

8.6. The use of the in-house workforce brought in experience of local tidal and river work. They were able to adapt to changes and delays due to uncertain site conditions. Their use retains construction skills within the Agency. The alternative of using external contractors would have required much greater detailed preparation of documents, significant claims risk for unforeseen conditions and required a higher degree of supervision and management.

8.7. Use of in-house work force carries the risk of delay due to emergency response calls and critical rivers maintenance.

8.8. There was no documented environmental damage arising from this project. The improved gate and flap seals has mean less saline intrusion.

8.9. In conclusion, the individual contractual elements of this project appear to be well documented and managed. There was no strategic programme to knit these elements together. The risk of similar cost and time over-run has been considerably reduced through current contract procedures which include:

- Highly structured project appraisal
- Risk/contingency management
- Project review procedure
- Client liaison
- Monthly project management reporting.

9. Post completion and benefits delivery

9.1. The improved water tightness of the tidal flaps will have reduced the amount of saline intrusion to the lower KSD.

9.2. The construction work was organised to have little impact on the essential functioning of the Sluice in protecting the KSD. Where critical operations were needed liaison with Area team and appropriate timing reduced the risks.

9.3. The emergency works in Phase I to secure the operation of the sluice were carried out with all practical speed were successful in achieving the objectives.

9.4. There were significant design flaws in the layout of the original structure when measured by standards of the 1990s. Although maintenance of the roller gate chains will always require entry to confined spaces the completed scheme has resolved some of these flaws:

- stop logging facilities to the by pass culverts for maintenance and inspection, especially on the tidal side flap valves.
- protection of actuators and head works from aggressive conditions
- Safe means of access about the structure
- Protection of the public from a dangerous structure

9.5. Replacement of the control panel, instrumentation and cabling was required for the installation to meet IEE Wiring Regulations safety standards of 1994.

9.6. The mechanical plant on site [gates, penstocks & tilting weirs] was overhauled or replaced.

9.7. The effect has been to extend the working life of the sluice for approximately 20 years. The reliability of a critical Flood Defence structure has been much improved

9.8. Telemetry allows immediate assessment of sluice status and a more considered management of flood events. The need to attend the site for monitoring purposes has been reduced significantly. At present site visits are still required to operate the sluices. Provision of the ability to accommodate remote control gives a significant advantage for the future.

9.9. PPA research has identified that the chains installed in 1993 may be approaching the end of their useful life. A condition survey would be prudent. This information has been passed to North Wessex Flood Defence Operations.

10. Project Management

10.1. There was no apparent resource management at the time and some delays can be attributed to severe competition from other projects.

10.2. It would appear that the detailed engineering and project management rested with one person, placing that individual under significant pressure, and obstructing a strategic overview of the project.

10.3. The project appeared suited to a series of sequential works, and this is likely to be the nature of major refurbishment where the asset needs to remain operational. Changes to the project brief appear to have developed as problems were identified during construction.

10.4. Major refurbishment projects need careful definition at early stages to ensure all aspects are identified and programmed.

10.5. The concept of risk management was not included in capital schemes until after 1996; it was applied to the Dunball scheme from September 1998 (Health and Safety snagging works).

11. Consultation

Name	Position of Dunball Sluice Refurbishment Scheme	Dates	Consulted Y/N
Pete Stothert	Project Manager	Dec 1992-May1993	N
David Kingston	Project Manager & Engineer	Jul 1993- Summer 1998	Y
Graham Quarrier	Project Manager	Sept 1998- July 1999	Y
Andrew Merrick	Project Engineer	Jan 1999-July 2000	Y
Graham Buxton-Smith	Project Manager	Sept 1999-September 2001	Y
Nick Stevens	Flood Defence Operations Team Leader	Oct 1994- Present	Y

12. Conclusions and recommendations

PAB have requested that a PPA be carried out for the refurbishment scheme of Dunball Sluice Near Bridgwater. The Scheme arose as emergency works and general refurbishment. The majority of the works were undertaken more or less continuously from Jan 93 to May 1998. Considerable additional works were identified during the course of construction culminating in Health & Safety improvements completed in June 2001. Final user acceptance was dated September 2001 on receipt of Operation and Maintenance manuals and associated records.

Detailed findings:

12.1. Timing

Table 4 summarises the spread of activities throughout the project period. The majority of the refurbishment was completed within the four years 1994-7.

The serial management of activities over a parallel approach could not be avoided if the structure was to remain operational; in this respect project completion within a reduced time period is limited, although reduced external pressures on project management may have permitted a tighter reign on progress (see 12.4 below). Further delay resulted from the use of the in-house workforce in resolving outstanding works towards the end of the project (Jun 1998–Jun 2000), however other benefits were realised in taking this measure (see 12.5 below). Specification creep was responsible for extending the delivery of individual components of the project.

The original target period for Phase II was far too optimistic.

12.2. Planning & implementation

It is recommended that refurbishment projects distinguish at the scoping stage between work to address worn out assets and work to improve on existing design. It is vital that FD Operations experience is included together with a review of maintenance works. The merging of both elements within this project once it was already underway complicated the management and justification of expenditure.

It is recommended that refurbishment projects must consider the cost implications of applying current health and safety criteria for operation and construction to the site as a whole. These costs will be greater than for a greenfield site where safety of design and operation is an integral part of the process.

12.3. Post Completion & Benefits

Significant original design flaws have been resolved but some maintenance access remains short of modern standards. The structure now incorporates modern materials and specifications that extend the life of the asset. It is expected that the protection afforded by the GRP enclosures will have extended significantly the working life of the chains.

Safe systems of work have been developed and provided for within the construction

12.4. Project Management

There was no apparent resource management at the time and delays can be attributed to competition from other projects for management & design time.

Major refurbishment projects need careful definition at early stages to ensure all aspects are identified. . A strategic programme is essential to co-ordinate and monitor the several components of a complex scheme.

12.5. Costs

The final out-turn cost of £589K is approximately 1.65 times the estimated cost of the project after the Phase I assessment had been completed.

The PPA team encountered significant difficulties in correlating the MAFF cost approval documentation with the accounts of work done. This was due in part to retrospective submissions for grant aid and incomplete evidence within the project records. These data may be in capital programme management files held elsewhere.

The in-house workforce can be more expensive than competitive tendering. Their use in projects is recommended given the benefits to the business of skills development, flexibility, reduced supervision, lower claims risk. Time critical tasks should be avoided given their emergency response duties.

The risk of similar cost and time over-run is considerably reduced through current contract procedures which include:

- risk assessment,
- highly structured project appraisal,
- client liaison and
- monthly project management reporting.

12.6. Experience & Lesson Learned in undertaking this PPA

Much of the project documentation had been archived onto CD-ROM using a software package "CDView" version 6.4.87. This PPA is the first to use the system. The team found that:

- The CD-ROM held a huge amount of data, not just the target project. Reducing a filing cabinet to a single CD with considerable space-saving and ease of transport. Traditional filing would require large table space to spread out files
- Software was useable with very basic training.. A "quick reference" manual would be useful for beginners to learn simple navigation and searches.
- Installation from the Easinet was straight-forward.

- The search/viewing system is straight forward.
- Initially tried to use a copy CD with only the project files extracted from the master CD. This was impossible to use. The files data set on a master CD is not divisible
- A full copy CD was substituted. This caused problems with printing the key documents needed for reference. It proved unreliable and eventually impossible.
- There is no facility to bookmark documents for speedy retrieval later. [the equivalent of a "post-it" in a file.] One must rely on detailed written location references whilst searching. This is time consuming.
- The operating facilities for zooming documents to improve legibility is very crude. This is very frustrating
- There is no scrolling facility when viewing a document.

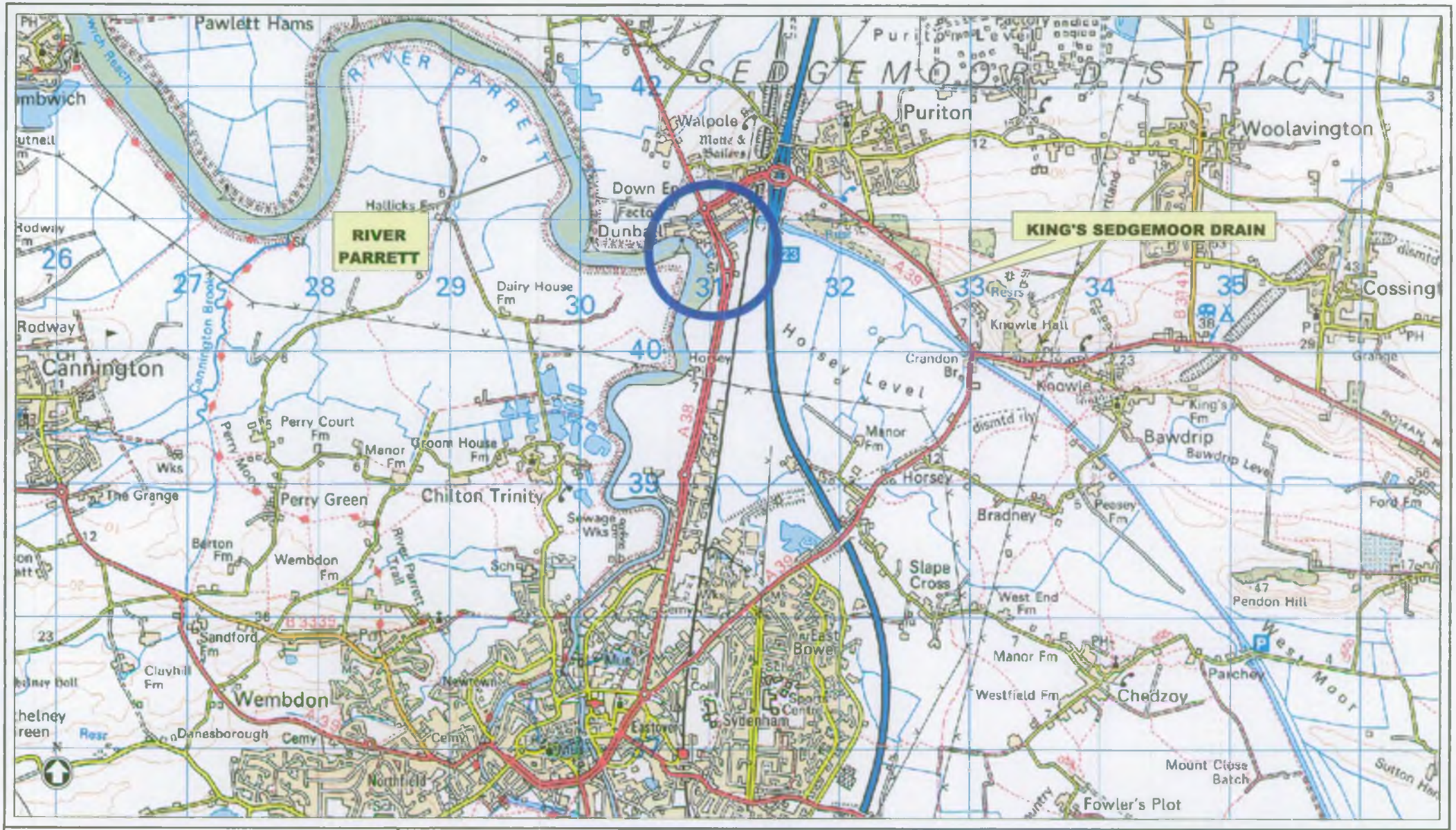
  These latter three aspects greatly reduce the ease of scanning documents when searching for information. Normal speed reading techniques cannot be used. This is a source of considerable exasperation. In time this system may be superseded by the new 'e-Document Management' application.

- For legibility and improved reading speed a VDU monitor at least 20" is highly recommended. An A4 page can then be viewed in entirety at a legible scale.
- Large scale file search and review requires prolonged time at the VDU screen.

The guidance in "Appendix N" was well structured and useful.

13. Appendices

Fig 1	Location plan
Fig 2	Potential inundation area
Table 3	Main activities – timetable
Table 4	Summary timetable



Note :
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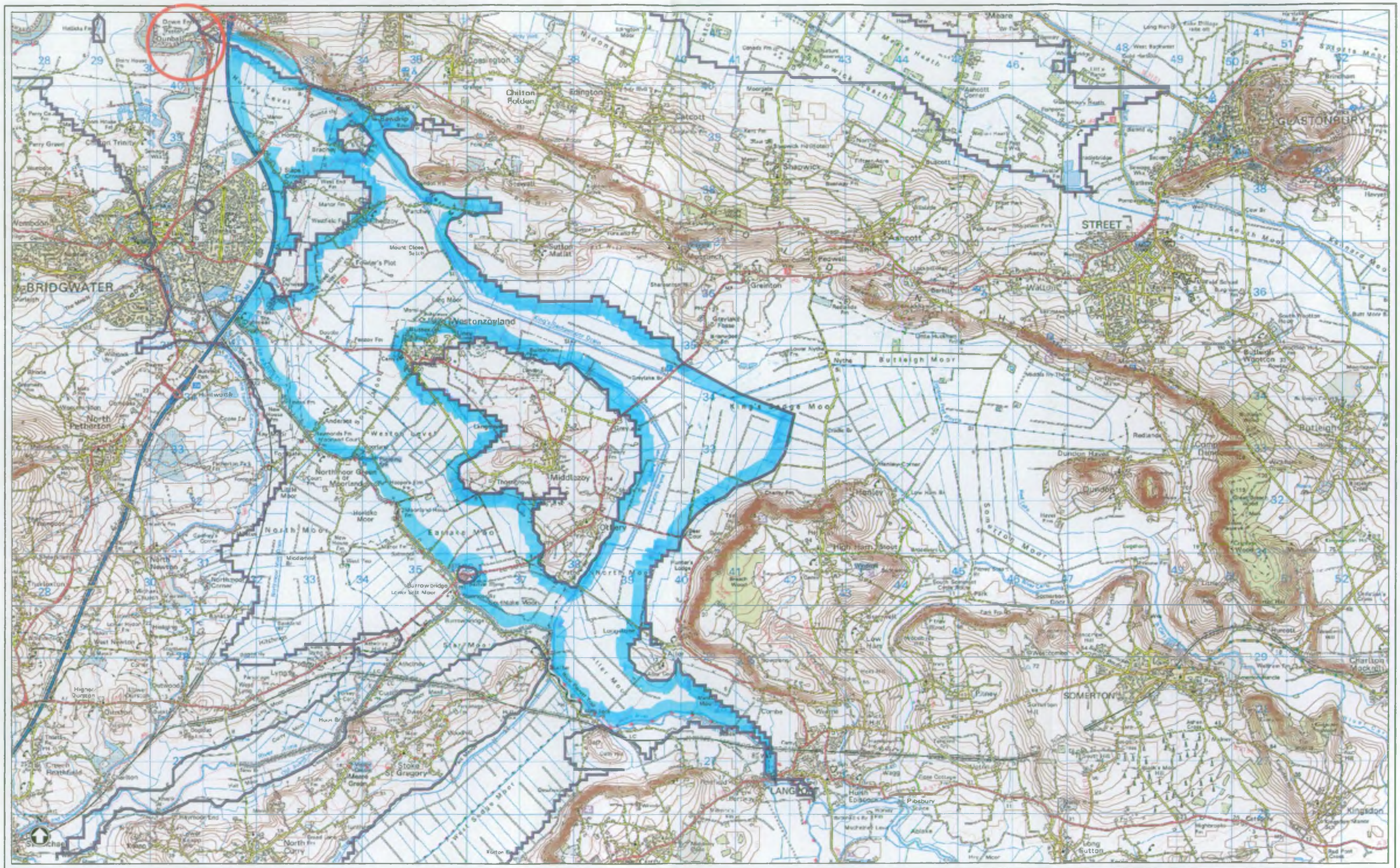
DUNBALL SLUICE REFURBISHMENT POST PROJECT APPRAISAL

ENVIRONMENT AGENCY

Scale : N T S

LOCATION PLAN

Drg. No. G7639/PPA/Fig. 1
MARCH 2003



Scale : 1:100 000

DUNBALL SLUICE REFURBISHMENT POST PROJECT APPRAISAL

PROTECTED AREA – POTENTIAL INUNDATION AREA, 5m Contour

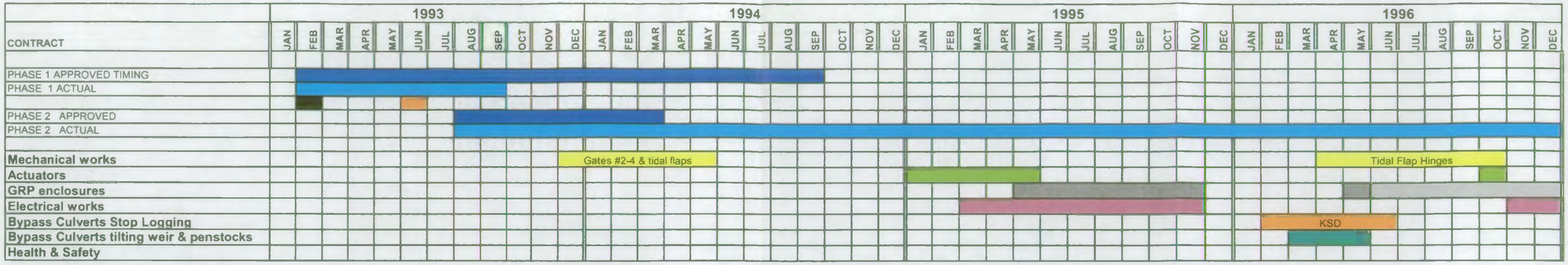
ENVIRONMENT AGENCY

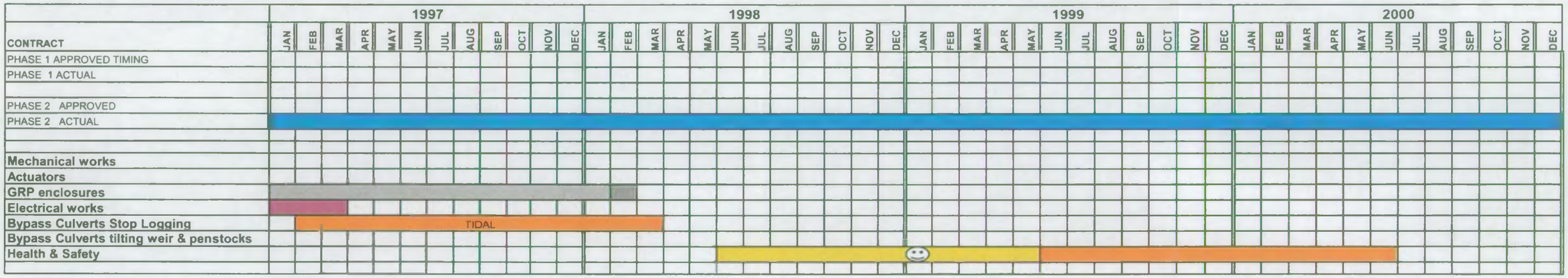
Drg. no. G7639/PPA/FIG2
FEBRUARY 2003

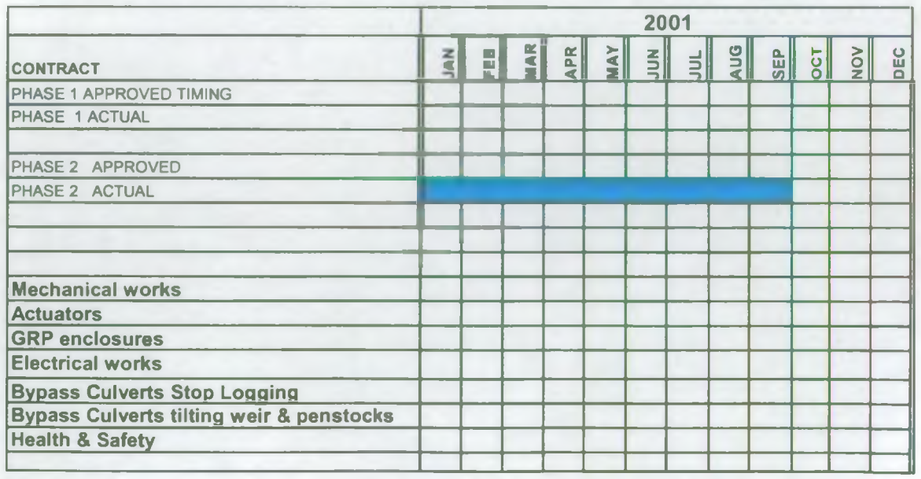
Table 3 Summary of Events (Dunball Sluice Refurbishment)

Reference	Date	Description	Phase	Detail	Phase 1 Overall	Phase 1 chains	Phase 1 #1 gates &	Phase 2 Overall	Phase 2 JWL Mechanical works	Phase 2 ROT Actuators	Phase 2 JB GRP enclosures	Phase 2 GPS Electrical works	Phase 2 EWF Culverts Bypass	Phase 2 MIDAS weirs & tidal flaps	Phase 2 Bypass tilting	Approved expenditure	Estimate	Incured expenditure	Tendered sum	VARIANCE	Notes
	1971			Sluice built																	
	Dec-92			Chain fails for Eve #1																	
1993																					
	11-Jan-93			Project identification PM1																	
		Engineers Report		Engineers appraisal LDW 38405 not found																	
A	12-Jan-93	Financial marker	1	A chain manufacture																	
B			1	B #1 gate refurbishment																	
	15-Jan-93	Project Application		PHASE I PM2													68,000				
	26-Jan-93	Financial marker	1	C structure																	
B1	28-Jan-93	Project Approval		PHASE 1												116000					
	01-Feb-93	Planned start date project	1	PHASE 1																	
	09-Feb-93	all chains & #1 repair Gate acceptance of Tender	1	awarded to Mowlem Marine														35044.33	20058	14986.33	
	Apr-93	all chains & #1 Gate repair works complete	1																		
	15-Apr-93	MAFF approved	1													63250					
	15-Apr-93	MAFF agreement in principle	1&2													200000					
	01-Jun-93			FORM C EWF INSPECTION													1500				
		Purchase of chains															28000	28309.92		309.92	
		EWF survey eyes 2,3 & 4															1500	5529.62		4029.62	
	18-Jun-93	Project Application		PHASE 2 PM2																	
D	21-Jun-93	Financial marker	1	D Structure investigation																	
E			2	E #2,3,4 gate refurbishment																	
B2	15-Jul-93	Project Approval		PHASE 2 GRANT AID												113750					
				PHASE 2 NRA												86250					
	16-Jul-93	Financial marker	2	F Other Works																	
	27-Aug-93	Grant Application														293180					
	Aug-93	Engineers Report	2																		
	Aug-93	Project PHASE 1 complete		PHASE 1																	
	Aug-93	Planned start date project	2	PHASE 2																	
	27-Oct-93	MAFF agreement in principle	1&2													331430					
	27-Oct-93	MAFF approved	2													268180					
	18-Dec-93	Mechanical works gates #2-4 & tidal flaps acceptance of tender	2	awarded JWL maintenance					Mechanical works gates #2-4 & tidal flaps												
1994																					
	23-Feb-94	contract awarded		Mechanical works (flap & gates) commence with JWL Maintenace												74,122	66020				
	Mar-94	TENDER		Bypass refurbishment																	approval not clear in B2
	Mar-94	planned project completion date	2	PHASE 2																	this was clearly very optimistic
	05-May-94	Mechanical works gates #2-4 & tidal flaps work completed															70000	79097		9097	
	Jul-94	Final statement of account	1	PHASE 1														74190			
	Sep-94	planned project completion date		PHASE 1																	
	14-Sep-94		2	Tilting Weirs & Vertical Gates Acuators												46695	46720				
	04-Nov-94	MAFF Variation ORDER	1	Gate refurbishment												10940.06					*+10940.06 new total £74190.06
	13-Oct-94	Accuators for main doors - Tender accepted	2	awarded to ROTORK																	
1995																					
	09-Jan-95	Accuators for main doors - works commence	2	accuator work commences						Accuators for main doors											
	09-Jan-95	TENDER		Electrical works.																	
G	22-Feb-95	Financial marker	2	G GRP enclosures																	
	28-Feb-95	contract awarded		Electrical works General Panel Systems Ltd												24873	25000				orginal estimate Dec '93
	08-Mar-95	GRP enclosures Tender acepted		awarded to Joe Bird																	
	15-Mar-95	pre-start meeting 1 of 2		Electrical works General Panel Systems Ltd																	
	28-Apr-95			accuators delivery to site																	
H	05-Apr-95	Financial marker	2	H Actuators																	
J			2	J Electrical Works																	
K			3	K Bypass culvert refurbishment																	
	08-May-95	Accuators for main doors - work completed		accuators completed													58000	62938			bypass penstock actuator outstanding
	15-May-95	GRP HANDRAILING TENDER ACCEPTED		Joe Bird													5000	13658	11558	8658	orginally steel handrailing grp more appropriate & more expensive
EJ	14-Sep-95			FORM C ELECTRICAL														5000			
	28-Sep-95	pre-start meeting 2 of 2		Electrical works General Panel Systems Ltd																	
B3	09-Oct-95		3	FORM A ACTIVITY K SUMMER CULVERTS REFURBISHMENT												144000	132000				INTENTION TO PRESENT PHASE 3 AS A VARIATION ORDER
				PHASE 3 GRANT AID												85500					
				PHASE 3 NRA												58200					
	01-Oct-95	main electrical works substantially complete		Electrical works General Panel Systems Ltd																	
EK2	17-Oct-95			FORM C SUMMER CULVERT REFURBISHMENT												96000					STOP LOGGING & WEEDSCREENS
	31-Oct-95		2	ELECTRICAL COMPLETE														22300			CONTROL KIOSK CABLING
	Nov-95	GRP enclosures installed		Joe Bird													20000	29679		9679	
1996																					
	Feb-96																				
	Feb-96	Bypass stop logging NRA Contracts start	2	EWF undertaking works										Upstream (KSD) stop log structure							
	Mar-96	MIDAS work on bypass tidal flaps & penstocks		left bank tilting weirs & penstocks (bypass) installed MIDAS contracted to Install penstocks and bypass tidal flaps																	
	Apr-96	Bypass stop logging Left bank KSD completed		delays caused by old coffer dam foundations																	
		MIDAS work on bypass tidal flaps & penstocks		right bank tilting weirs & penstocks (bypass) installed MIDAS contracted to Install penstocks and bypass tidal flaps																	
	28-Apr-96	Mechanical works tidal flaps hinge bolt replacement quote received	2	JWL maintenance					Tidal flaps hinge bolt replace												
	08-May-96	bypass tidal flaps & penstocks - snagging		problems with right bank tilting weir & penstocks reported to MIDAS - rention fee withheld and repairs effected by EWF													26000	30000		4000	
	20-May-96	decision made to replace tilting weir enclosures		Jo Bird quote for work accepted - enclosures manufactured																	
	01-Jul-96	Bypass stop logging works completed KSD side														16000		122000		106000	
	Oct-96	Rotork fit Uweir actustors																			
B4	08-Oct-96		2 & 3	FORM G SUPPLEMENTARY EXPENDITURE																	*+ £90000 ELECTRICAL WORKS, GRP ENCLOSURES AND SAFETY FENCING, ADDITIONAL WORKS
	28-Oct-96	Mechanical works tidal flaps hinge bolt replacement complete																			
EG2	25-Oct-96		3	FORM C GRP COVERS												9650					TILTING WEIR COVERS
	31-Oct-96	ELECTRICAL COMPLETE		kiosk lighting, telemetry & connection for operation of penstocks instruction outstanding													25000	38000		13000	
	01-Nov-96	Mechanical works gates #2-4 & tidal flaps work complete																			
1997																					
	07-Mar-97	MAFF Variation ORDER																		219934	total approved sum increased to 431966
	10-Feb-97	Bypass stop logging - D/S limpet dams designed	2																		
	27-Mar-97	release of electrical O&M manual	2	ELECTRICAL COMPLETE														14000			TELEMETRY AND SAFETY LIGHTING
1998																					
	Feb-98	installation of GRP enclosures for tilting weirs		Jo Bird cleared to proceed with installation													2000	9680			
	Mar-98	Bypass stoplogging Limpet dams complete	2														0	38000		38000	estimate
	May-98	Bypass tide door hinge problem identified	2																		
	Jun-98			H&S & OPS assessment																	snagging issues identified - ordinarily these would have been for operational maintenance issues~ the protracted timescale has meant that the project has included the repairs and modifications in the appropriate contract or separate order. Decision taken in interests of
	Aug-98			MONTHLY REPORT EXPENDITURE FORECAST £577K																	
	Sep-98			site problem report																	
	Nov-98			Andrew Merrick appointed to address H&S design requirements																	
1999																					
B5	Jan-99			FORM G SUPPLEMENTARY EXPENDITURE												58000					approved subject to being the last
	Jun-99	H & S works on site start by EWF		Hand railing work																	
	Jul-99			FORM C												30000					FIX HANDRAIL, DECKING SAFETY FENCING DRAINAGE
2000																					
	Jun-00	H&S works completed																			
2001																					
	05-Sep-01	Project complete		USER ACCEPTANCE																	REPAIR RECORD

Table 4 Gant Diagram of the Dunball Sluice Refurbishment







Key

Phase	Activity	Contractors
I & II	Approved project timiescale	
	Actual project timiescale	
I	Repair Gate #1 & replace all cahins	Mowlem Marine
	Inspection of eyes 2,3 &4	EWF
II	Actuators	Rotork
	GRP enclosures	Joe Bird
	Delays affecting fitting of GRP enclosures	Joe Bird
	Electrical works	GPS

Activity	Contract
Andrew Merrick appointed	Consultant
Bypass penstocks, weirs & tidal flaps	MIDAS
Bypass Culvert Stop logging	EWF
Health & Safety Planning \ delivery of H&S	EWF
Mechanical Works	JWL