

Troqueer sewage treatment works: alterations and extensions

J. M. DUNBAR & W. M. WRIGHT

Mr K. McCrae, New Works Engineer, Dumfries and Galloway Regional Council

The Authors say that it is always preferable to arrange for dewatered sludge to be discharged either direct into a container or onto a belt conveyor. Accepting the fact that this is not always possible, as at Troqueer, I would like to ask what further steps have been taken and how effective they are in solving the sludge cake removal problem.

Mr B. Latimer, Southern Water Authority

The subject of units used in different parts of the Paper for flow rates is, I feel, worth mentioning.

75. Units used were m^3/day , m^3/h and l/s for different parts of the process, but under the SI system flow rates should be in l/s or m^3/s . It may seem a minor point, but lack of standardization of units makes it difficult to visualize flows.

76. The results of using units of measurement which are a combination of MKS and SI units can be seen in flow and pressure gauges now being manufactured with hybrid units. A once-in-a-lifetime opportunity to rationalize calculations and instruments is being lost in Britain.

Mr A. W. Shilston, Consulting Engineer

Principal and not nominated sub-contracts, generally, are the preferred way of dealing with the increasingly complex and significant mechanical and electrical plant and equipment associated with the modern sewage treatment works. The medium-sized civil engineering contractor usually does not possess the technical resources to 'project manage' the entirety of the construction and specialist installation work. Under the almost traditional nominated sub-contract procedure, whilst the main (civil engineering) contractor was supposed to assume complete responsibility for dovetailing all the constituent operations necessary to reach the stage of commissioning and handing over, in practice and contrary to objective contract management, within this system the employer's resident engineer usually, of necessity, had to involve himself in much of the work lying within the main contractor's ostensible domain. The resulting contract administration outcome is usually diffuse.

78. In the abstract the right approach was taken at Troqueer by initiating 12 mechanical and one electrical specialist contracts. Such practice requires positive project management. In turn this calls for a realization by employers that the reduction of a main contractor's tender, by reason of not requiring him to organize the mechanical and electrical work, inexorably will involve additional salary expenditure on account of the employer's enlarged site team, whether that of his own directly employed staff or that of his consultants, as the case might be, to manage the project.

DISCUSSION

79. The concept of project management is easier to implement on large regional schemes. How was the scheme described by the Authors project-managed on behalf of the employer and, having regard to that experience, what forward ranging thoughts do they have on this topic, with medium, rather than large process plant schemes in mind?

80. Was the matter of the temporary lowering of the sub-soil water-table at the treatment plant site wholly left to the civil engineering contractor to arrange without direction? And how was this substantial item of temporary works deemed to be priced within the tender bill of quantities?

81. Problems can arise, generally, in using steel sheet piling as permanent shuttering left-in (§ 36). Pile interlocks must be central, reducing the choice of pile, to allow infiltration water to be contained and collected in the underdrains. If no tolerance is allowed in the thicknesses of wall stems problems arise if piling is not driven in perfect alignment and truly plumb. Disturbance to reinforcement patterns and other structural detailing headaches can result, quite apart from the obvious potential shortcomings. Presumably the pans of the steel piling at Troqueer works were bridged with hardboard or the like and the space subsequently filled with gravel?

82. Regarding the breakdown of contract value and subdivision of materials value included in Fig. 4 and § 68, how were these figures objectively arrived at?

83. Finally, although the Authors may have had reasons for not giving the final contract prices, could they say what is the approximate percentage relationship between the final construction contract price and that of the final mechanical and electrical plant contracts?

Messrs Dunbar and Wright

Mr McCrae raises the problem encountered with the treated sludge discharge arrangement. Belt conveyors, screw conveyors and bucket elevators have all been found to be perfectly acceptable methods of raising the dewatered sludge to the required height for discharge into the collecting vessel. The complications caused by the adoption of any of these basic methods with the particular application at Troqueer prompted the adoption of the 'pumped cake' system on an experimental basis.

85. At the time of writing the Paper the problem had not been resolved to our satisfaction. The larger capacity pump referred to in the Paper was installed and found to be satisfactory when the discharge pipework was also increased in size to 150 mm dia. While operationally satisfactory (without incorporating the 'bridge breaker' device), this arrangement proved unacceptable due to the associated maintenance costs. In order to maintain the high efficiency required for the duty the pump needed a new stator fitted after about 6 weeks' operation (30 h/week). It was considered that the cost of the replacement stators was too great to be met with this frequency.

86. The eventual solution which we consider to be satisfactory from both the operation and maintenance point of view maintains the pump as the prime mover of dewatered sludge from the centrifuge discharge chute but also incorporates a conventional belt conveyor external to the sludge treatment house. The pump's duty is now to convey treated sludge out of the building and raise it only about 0.5 m to discharge on to a portable conveyor which raises it to the final required discharge height of 2.8 m approximately. This arrangement, while not as neat or compact as the original proposals, is considered to be the best suited arrangement to the Troqueer installation because of the physical restrictions imposed by the site.

87. We would agree with **Mr Latimer's** comment regarding the standardization of units for flow rates for calculation purposes and that these units should be l/s or m³/s where practicable. We did however consider that for 'visualization of flow' purposes when speaking in terms of multiples of dry weather flow it was preferable to use the m³/day unit. The m³/h unit used for sludge throughput rate is also, in our opinion, an easily visualized flow and in normal usage for this application.

88. In public health engineering generally we feel it is impractical to standardize completely on l/s or m³/s even for all calculation purposes, since the second is unsuitable

for measuring long periods such as times of concentration of sewerage catchments and sewage tank detention periods. Such parameters as tank surface loadings and upward velocities also call for the use of units of time other than the second, so as to make their application practical. The Authors consider that the Scottish Development Department's recommendations for the use of metric units for water supply and sewerage provides a good practical guide on this subject.

89. Regarding Mr Shilston's first point on project management, we would agree that the policy of undertaking separate mechanical and electrical contracts as opposed to nominated sub-contractors is preferable, considering the complexity of organization required with the management of these separate facets of the overall project. In our opinion it is only the designer, or one closely associated with him, who has the necessary insight into what to the outsider may seem like totally disparate contracts. The additional cost of the increased supervision commitment from the consulting engineer involved with such an approach is more than offset by the removal from the civil engineering contract of main contractor's profit on a nominated sub-contract.

90. As Consulting Engineers, our Client vested in us total responsibility for the project management of the scheme from its inception to 'take-over'. No policy decisions were made without the Client's approval, the liaison with the Client being implemented through regular meetings. The Client received monthly progress reports which also contained the necessary information on financial expenditure, both current and projected. All programming and negotiations with contractors and the various statutory bodies involved were the sole responsibility of the Consulting Engineer.

91. Our forward ranging thoughts on the topic of project management could perhaps be considered as subject matter for another paper! Our basic premise, however, has always been to ensure that the personnel responsible for the management of the project through the construction phase have been involved with the design and planning of the scheme. We consider this to be both a practical and desirable method of approach for medium sized schemes. In comparing differences of approach to medium and large process plant schemes it is basically just a difference in scale, since the philosophy and execution of policy would be identical. There would be differences in implementation of policy, however, since the large scale project would presumably justify a greater number of supervisory site personnel and the opportunity could be taken to employ diverse specializations. The site supervisory staff on the smaller scale project require, of necessity, a broader, more general, range of knowledge. This arrangement has been found to be successful provided that a source of specialized knowledge is immediately available to the permanent site staff as and when required. The resident engineer on the larger project is more of a manager and co-ordinator of specialized knowledge within his permanent site staff.

92. The general impression is that the larger the project the more the project manager's task becomes administrative as opposed to technical, although undoubtedly the technical background is still essential so as to effect sound management policy. Another most important aspect of the planning for process plant schemes is to ensure that as much flexibility as possible is built into the programme of works in order to allow for the seemingly inevitable delays in delivery of plant and materials and other unforeseen problems.

93. The groundwater problem was foreseen before contract documents were issued and a 'provisional sum' item was written into the bill of quantities to cover the situation where it was impractical to deal with groundwater by conventional sub-drains and pumping, which were held to be covered elsewhere in the bill. The cost of pumps removed from service due to the introduction of alternative means of dewatering was deducted from this oncost. The implementation of this facility was under the direction of the Engineer. At Troqueer small excavations were undertaken at an early date in order to assess the problem. Conditions encountered were such that quotations were sought from specialist well-pointing contractors and a nominated sub-contractor was appointed to carry out the dewatering work for the major excavations.

DISCUSSION

94. When driving the permanent steel sheet piling the setting out was such that if the piles were off plumb by the maximum allowable tolerance, then minimum wall thickness was still achieved. It is certainly true that a structure built within a cofferdam has 'another dimension' added to the design problems since waling positions etc. must be considered when detailing the reinforcement and other structural features. At Troqueur it was found to be more economic to pour concrete hard against the permanent sheet piling, the additional cost of the concrete being more than offset by the extra labour involved in lining the piles and infilling the voids with gravel.

95. There were no clear guide lines to follow in the assessment of the breakdown of contract value and subdivision of materials value. The work involved in reconstruction of the sewage works was so diverse in labour, materials and plant utilization that it was a case of laboriously estimating the values attached to each section and using this as a method of weighting the various breakdowns for different types of work, these breakdowns being arrived at from a knowledge of contractors' pricing methods (which in themselves are very diverse!). The answers thus achieved were 'rounded off'. A similar approach was used in assessing the subdivision of materials value, i.e. estimating gross values of materials to be used. Problems arise of course with items such as 'fuel' for which we were unable to establish a theoretically satisfactory method of value assessment. After investigation into fuel costs as a proportion of plant and total costs we made what we hoped was an intelligent guess at the fuel percentage factor.

96. There are in our opinion still no completely satisfactory methods of assessing these breakdowns of value and it is extremely difficult for consulting engineers, or others, to make completely logical calculations in order to arrive at figures which they consider to be an accurate weighting assessment.

97. The total cost of the construction project may be broken down as follows:

civil engineering works:	69%
mechanical contracts:	23%
electrical contract:	8%