Paper 2 - Urban Pollution Management - Optioneering and Implementation

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INTRODUCTION

North West Water's Urban Pollution Management programme encompasses nine studies. These have considered the impact of intermittent discharges of the sewer network from Wastewater Treatment Works (WwTW) and Combined Sewer Overflows (CSO) on receiving water courses.

The development of UPM proposals is via three phases Needs,Optioneering and Implementation. The Needs Phase assessment of wastewater network discharges, river water quality and their interaction was undertaken by Consultants. The Optioneering Phase involved Bechtel Water Technology in assessing the buildability of the solutions generated.

This paper is concerned with the two stage Optioneering Phase and its follow through into the early part of Implementation. It will detail the steps taken and present conclusions to, hopefully, improve the process if its use is repeated.

OPTIONEERING

NWW engaged Bechtel to assess the buildability of the solutions developed by the Needs phase and estimate the costs to implement the solutions. This process itself was split into two stages, a 'Needs/Optioneering link' and a 'Buildability and Estimate' stage. Bechtel were initially involved prior to the completion of the Needs phase and were presented with outline solutions.

NEEDS/OPTIONEERING LINK

To smooth the transition between the Needs and Optioneering phases, NWW implemented a liaison between the parties involved in both phases. In reality there are three parties with an input - NWW, the Consultant engaged by NWW and Bechtel. This was primarily concerned with acquainting Bechtel with the computer model developed solutions and determining if there were any outstanding factors that could prevent construction of the solutions.

BUILDABILITY AND ESTIMATE STAGE

This stage involved Bechtel in working up the solutions to a defined solution and costing them. It was originally envisaged that this stage would involve consideration of only one solution, in the event this proved far from the case.

Bechtel as part of this stage were required to :

- Prepare outline general arrangement details of chambers, flow controls, tanks, screens, etc to ensure model assumptions can be accommodated in practice and to establish estimate base.

- Buildabilty appraisal,discussions with statutory undertakers, highway authorities and police.

- Risk Analysis and Estimate Review of prescribed solutions.

- Review with NWW Whole Life Project Manager general arrangement details to assess feasibility of Operation and Access arrangements.

In addition Bechtel were required to initiate Site Investigation, additional services location and discussions with the Responsible Officer for Sewer Services regarding the interface with the existing network.

The culmination of this stage would result in a Buildability and Estimate Report.

CASE STUDY - MEDLOCK UPM

Historic note

The CSO's contained within the River Medlock catchment are historically linked to the development of the sewer network in Manchester. Originally the sewers in the catchment discharged directly into the river. At the end of the 19th Century and early in the 20th Century Manchester Council constructed a series of deep sewers to intercept all the existing outfalls and convey the flows to the Davyhulme WwTW.

To intercept the flows the deep sewers were constructed and then the final manhole on the network, prior to the river, was converted into a CSO. This conversion was quite simple.A low weir was built into the manhole and a new sewer (typically 225mm/300mm diameter) was laid to turn the flows back to the deep sewers.

This, of course, means that generally the CSO's are at the lowest point in the catchment. It also means that for the deep interceptor sewers to travel all the way from Davyhulme to the boundary of Manchester and Tameside, approximately 8 miles, that they are quite deep in parts of the catchment .

Needs - Optioneering Link

In the case of the Medlock UPM this consisted of several elements.Initially site visits to all the overflows were organised involving all the interested parties. Due to the number of overflows, 33, this resulted in three separate site visits. At several of the sites the discussions that took place resulted in alternative locations being agreed for the new overflow sites. The one drawback that could be identified at this stage was visiting the sites without a copy of the definitive sewer records. The sewer details presented were based on a GIS system that only presented basic sewer patterns on an O.S. background. No sewer/pipe sizes were shown and structures such as overflows and outfalls were rarely presented accurately. The degree of error resulted in one overflow being looked for on the wrong bank of the river.

Subsequent to the initial site visits Bechtel were handed data detailing the proposed solutions. In order to assess the buildability based on the data available a list of criteria was developed against which each overflow solution would be assessed. The criteria were considered for every overflow irrespective of the solution to ensure consistency and to cater for any changes that could occur in the development of the UPM Study.

There were several reasons for standardisation at this stage :

- This element would involve only one or two engineers in producing an output but the next stage would engage up to six engineers and CAD detailers.

- It would ensure that the engineers involved in the optioneering phase would have a set of logically derived criteria/information with which to get a clear picture of the proposed solution.

- It would identify to NWW the areas in which third parties could have an impact and over which Bechtel had no control and there was a risk (financial, time, access, planning etc).

- It would identify the areas where there was a lack of information.

The importance of this standardisation cannot be expressed enough. There are 33 overflows in this phase of the Medlock UPM and it would be too easy to forget/set aside/ignore some of the more minor overflows and concentrate on the more interesting ones.

The inclusion of Bechtel at this stage resulted in amendments to eleven of the CSO's. The amendments generally consisted of relocation of the solution to a position which enabled construction. At this stage no changes were made to the hydraulic elements of the solutions.

Consultant Outputs

At this stage the Medlock UPM contained 33 Unsatisfactory CSO's which had to be resolved by March 2000. The number and associated solutions had not been agreed with the Environment Agency but NWW were confident about the results generated by the Needs Phase.

The 33 CSO's could be sub-divided into the following solutions :

- Seven simple abandonments.
- Ten involved abandonments
- Seven Five year surcharge relief overflows
- Seven new CSO's to FR0488.
- Two new CSO's to FR 0488 with associated Storage.

Simple abandonments were those in which all the necessary works would be contained within a single existing overflow and there were no associated Traffic Management issues. Involved abandonments were either abandonments which required construction works remote from the existing CSO or were in locations which had complex Traffic Management requirements. The five year surcharge relief overflows were new shaft construction overflows which had a short simple weir set at a level such that they would only operate once in every five years. The FR 0488 overflows were to be designed to the Foundation for Water Research document Guide to the Design of Combined Sewer Overflow Structures, November 1994. The FR 0488 overflows with storage were overflows to FR0488 but there was an associated storage volume that had to incorporated into the network adjacent to the overflow.

Bechtel Involvement

NWW engaged Bechtel at this stage to input an engineering overview to the solutions in an attempt to minimise any redesigns due to non constructability of the solutions proposed.Initially this consisted of three site visits to the overflows in question. Bechtel were handed basic information about the solutions and on site discussions were used to put flesh onto the bones.

Analysis of the solutions identified several areas which were considered critical to the implementation of the solutions.

- Connections to outfall pipework downstream of the overflows
- Land access
- Planning consents
- Highway Authority and Police approvals

This process proved invaluable and resulted in the following

- Re location of eleven new CSO's to a location in which they could be constructed. The solutions output by the needs phase tended to be based on the GIS plan of the network and took no account of on site problems.
- Amended designs to simplify solutions involving passing more flow forward to the deep interceptor sewers. These generally consisted of simply diverting the flows to the deep sewers at the point where the shallow sewer crossed the deep sewer.
- Consideration of how storage volumes could be constructed into the existing network. The hydraulic modelling had accounted for the storage simplistically by spilling the storage volume out of the model and not modelling its return. The two sites at which storage was required each had their own difficulties.

    - One site was on a major highway adjacent to an Abattoir which had a large vehicle parking/delivery/pick-up area.
    - The second site was at the bottom of a quite steeply sided valley in the flood plain of the river

Optioneering

Once the optioneering phase was commenced then Bechtel were involved only with NWW. This phase was concerned, therefore, in developing the solutions to the point whereby the solution was definite, buildable, costed and accounted for all foreseeable risks (not strictly a contradiction in terms). Each site was considered in isolation .

Design Constraints

There were several factors which constrained the design but it should not be interpreted that the constraints restricted the ability to implement effective optioneering.

The more important of these factors were :

- NWW proposals for agreement with the Environment Agency on the solutions for each overflow.Where these included figures for permitted volume and frequency of discharge it meant that any changes to enable construction had to reflect the agreement on discharges.

- The hydraulic models used to define the water quality issues had been simplified. This meant that if an alternative solution was developed which moved the location of the overflow it was difficult to check the solution hydraulically

- Land in the centre of Manchester is at a premium. Bechtel had to move the overflows to reflect available land for construction. Due to the size of the new overflows it was not generally practical to locate them in highways .

- The type of overflow was fixed - a high sided weir to FR 0488 - A guide to the design of Combined Sewer Overflow Structures.

- The location of the river and the existing sewer network(overflow and deep interceptor sewers) were fixed topographically. If the location of any proposed overflow is moved then there could be difficulty in getting the continuation flows back to the network due to the relatively flat gradients of the network.

- The design standards for the overflows within the framework of FR 0488 had not been defined.

Lessons Learned

During the course of the optioneering there were several lessons learnt that are applicable to all UPM studies and careful consideration should be given to heeding them.

1. The Network was incorrect. This occurred at a couple of overflows the most serious being where the solution proposed the construction of a 11m long high sided weir overflow and 100m of new pipework. The problem was that in the construction of the hydraulic model as part of a previous DAS an assumption had been put on the connectivity of the network. The reality was that the connectivity could not happen if a simple check on sewer levels had been carried out. The sewer on which the solution was proposed crossed one of the newer interceptor sewers at the same level and had been connected into it over 100 years ago. This meant that the sewer on which the solution was proposed had only 100m of sewer connected to it. The solution eventually developed involved a simple abandonment.

2. There was a lack of knowledge about the network in some areas critical to the solutions. With the method of development of the sewer network, it meant that there was a considerable amount of cross linking of sewers. To ensure that the solutions did not cause or exacerbate problems within the network these areas of uncertainty had to be resolved.

3. Unknown overflows. It is inevitable that the sewer network has ill defined areas and these can lead to problems if associated with overflows. Some overflows were difficult to find on the ground and the existing sewer/manhole records did not always clarify the situation. Checking of historic sewer records and asbuilt drawings from the construction 100 years ago proved invaluable. It is fortunate that Manchester City Council has kept records for such a period of time.

4. Inaccessible locations of overflows. Several overflows are located in private land and also on the steeply sided banks of the river. It can be relatively simple to design a solution to the problem but what can be a problem is getting to the existing

CSO to either Abandon or amend it. One problem that has caused much thought and effort is locating the deep sewers which were constructed to generally follow the curves of the river and have only limited access points. The access points and overflows are never on a straight section of sewer.

5. Inappropriate solutions. Due to the manner of undertaking the UPM studies there is a focus on each overflow in its specific location. At one location this resulted in a proposal to build a high sided weir overflow on a 375mm diameter sewer which was topographically located only 300 m from an oversized, under capacity sewer into which the continuation flow discharged. There is a need to consider the wider impact of UPM solutions on the Sewer network.

6. Simplified models. The problem with a simplified model is that where it is proposed to provide storage to solve a water quality issue then the model will under utilise potential storage in the network. Wherever it is proposed to provide storage then the simplified model should be expanded to utilise in system storage.

8. Lack of knowledge of the interaction of the river and network models. At two locations in the Medlock UPM weir levels on proposed overflows took no account of the water levels in the river with the result that the weirs were actually lower than the river. The solution was definitely buildable, unfortunately, it would have diverted a river to the WwTW.

9. The interaction of the existing network with properties was not accounted for in the solution development. This has resulted in one solution in part of the existing network having to be connected to a pumping station as the solution would result in cellar flooding.

Stage Two - Optioneering

Bechtel were required to provide a Buildability and Estimate Report based on.

- Risk Analysis and Estimate review of prescribed solutions.
- Buildability appraisal, discussions with all interested parties including highway authority, police, planning authorities etc.
- Inform public utilities of the project and negotiate and identify supplies, diversions or other arrangements required before and during the construction of the works.
- Prepare general arrangement details of chambers, flow controls, tanks, screens etc to ensure model assumptions can be accommodated in practice.
- Review with WLPM general arrangement details to assess feasibility of Operation and Access arrangements.

The procedure used to derive the above was to develop the information previously obtained into a definitive solution. Consideration of alternative solutions was not required by NWW which permitted a more detailed working up of the hydraulic solution than would normally be achieved during optioneering.

Early Liaison

Being in the centre of Manchester it was appreciated at an early stage that the opinions of the highway authority and police would influence the construction stage. The highway authority and police were consulted and several constraints were immediately identified.

- Construction works by Statutory Undertakers were not permitted in the city centre between mid-November and mid-January due to Christmas shopping .
- The commonwealth games 2002 involved construction of several stadia, two of which affect construction works.
- Works at some overflows whilst not being hydraulically linked could not be undertaken concurrently due to traffic interaction.
- An extension of the Metro Link tram system is planned, a new station is to be located adjacent to a new overflow.

The purpose of the consultation was two fold. Firstly, it would set up advance liaison for the construction works to come. Secondly, it is too easy to concentrate on the traffic aspects of the permanent works and set aside the smaller elements that would also affect traffic. Most sites would require :

- Boreholes.
- Trial holes to locate services.
- CCTV surveys.
- Topographic surveys
- Service diversions prior to construction.

All of which would affect traffic.

Parameter Changes

As part of the ongoing development of UPM's there were two parameters on which the design would depend which were amended at a late stage:

- 1%ile discharge on TSR events.
- K, the efficiency constant for the CSO chamber.

The 1%ile discharge required that the predicted spills on Annual TSR events should not exceed 1% measured by time of spill.This restricts the spills to 88 hours.The only way of checking this is to run all 99 TSR events.

The process of determining the efficiency constant to be used in the equation $D_{min} = KQ^{0.4}$ had not been defined. The overflows had previously been sized based on how the flow figures(& existing pipe sizes) fitted into table 3.2 of FR 0488. NWW declared that a 20 % efficiency should be used and Bechtel resized all the overflows to suit.

Influences beyond the control of designers

It was recognised at an early stage that irrespective of the resource allocated to the project that external influences would have a great impact on the programme. In an attempt to minimise these influences lines of communication were established to all parties. The external influences included :

- Planning Permission - two District Councils were involved.
- Private Land - both land access and land purchase would be necessary.
- Highway works - the A57(M) Mancunian Way extension is currently under construction and two of the CSO sites are within their working area.
- Other NWW Contracts - Major works under way to Failsworth WwTW which has only one access and into which a deep shaft has to be constructed.
- Commonwealth Games - two CSO's are affected by the construction of new stadia.
- Railways - one site is located adjacent to a level crossing in a traffic sensitive street round the bend at the top of a steep incline.
- Confidentiality of information - one site is located in the land of a former gas works currently being reclaimed and for which details of contaminants are needed.
- Loss of Profit - several sites are adjacent to established businesses or in prime redevelopment sites.

Unforeseen Obstacles

As with all new works the unexpected has to be expected. It is just the degree of the unexpected that is difficult to predict. So far, in addition to general environmental considerations, two potential obstacles have stepped forward :

- Roman Remains - two CSO sites have been identified as potentially containing Roman remains. Amazingly the sites are 4 Km apart.
- Underground caverns - one CSO sandwiched between the Mancunian way and a commercial estate has been found to be on top of some quite extensive voids. These voids are between 3m and 10m below ground, in rock and contain water. They have brick arched roofs. The reason for their construction is unknown but may be linked to either quarrying of sandstone or canals for coal transport.

Buildability and Estimation

Taking into account all the design constraints and external influences Bechtel developed the individual solutions to the point were questions over constructability were resolved. This enabled a well defined and scoped estimate to be produced for each site. The estimate included :

- Cost of further investigations (CCTV, BH etc)
- Cost of construction
- Cost of Service diversions
- Design and supervision costs
- Loss of Profits
- Operating Costs

In addition to all the clearly defined costs, risk values were added to the estimated. These were done on an individual overflow basis in which the perceived risk such as 'Unforeseen artificial obstructions'was assessed and a value put against it. The total risk element for the project averaged out at 6 % of construction cost.

Advanced Design/Implementation

To ensure the smooth passage of the project from optioneering to implementation whilst NWW gained internal approval to the 'Buildability and Estimate Report' a budget for advanced design was included in the optioneering budget. This permitted Bechtel to carry out up front those elements of work which generally delay the initial design - CCTV, MH, Topographic, BH surveys etc. This helped to ensure that the resources allocated to the project at optioneering could carry through to design. Given the variety and scope of the work this has proved invaluable.

Implementation

Bechtel are currently progressing the design of the overflows based on the following :

Design Team :

- 1 Project Engineer
- 1 Lead Discipline Engineer - Networks
- 7 Networks Engineers
- 1 Construction Manager
- 1 Project Controller
- 1 Geotechnic Engineer
- 1 Mechanical Engineer
- 1 Electrical Engineer
- 1 Tunnelling Engineer
- 3 Detailed Designers

Contract Strategy :

- Project divided into 4 contracts
- Contracts out to tender in August,September,October and November
- Contract Values £2M to £4M

Project in use date - March 2000

Conclusion

There is no question that to undertake a UPM needs time. Bechtel have been involved in the Medlock UPM now for 18 months and are only just beginning the detailed design. This may seem like a slow process with too many parties involved. This is not the case. It must be recognised that to achieve the desired output the right blend of engineers is required at each stage of the process. The interaction of all parties on the Medlock has resulted in an efficient process.

The invitation of Bechtel into the later stages of the modelling stage of the UPM resulted in more applicable and constructable solutions. As with most projects the early involvement of engineers versed in construction pays dividends in the passage of time.

DISCUSSION

There were no questions for this speaker.