

Preston 32 UIDs

water quality improvement for the River Ribble and the Fylde coast

by John Littlewood, Will Taylor & Charlie Grealis

United Utilities has invested £49m addressing 32 unsatisfactory intermittent discharges (UIDs) in Preston to both improve the Fylde Coast bathing waters and to protect shellfish beds. Clifton March WwTW treats waste from six sub-catchments. The Fairhaven, Lytham and Freckleton catchments are located to the west of Clifton Marsh WwTW, within the Fylde district. The Lea Gate and Watery Lane catchments are located predominantly within the borough of Preston, and Penwortham is located to the south of the River Ribble, within the South Ribble council boundary. The UIDs are spread across four of the six sub-catchments (Freckleton, Lea Gate, Watery Lane and Penwortham). There were no UIDs identified in the remaining two WwTW sub-catchments, Fairhaven and Lytham in this Asset Management Period.



Watery Lane West - Tunnel Shaft 402 - Shaft C4 - Courtesy of Macrete

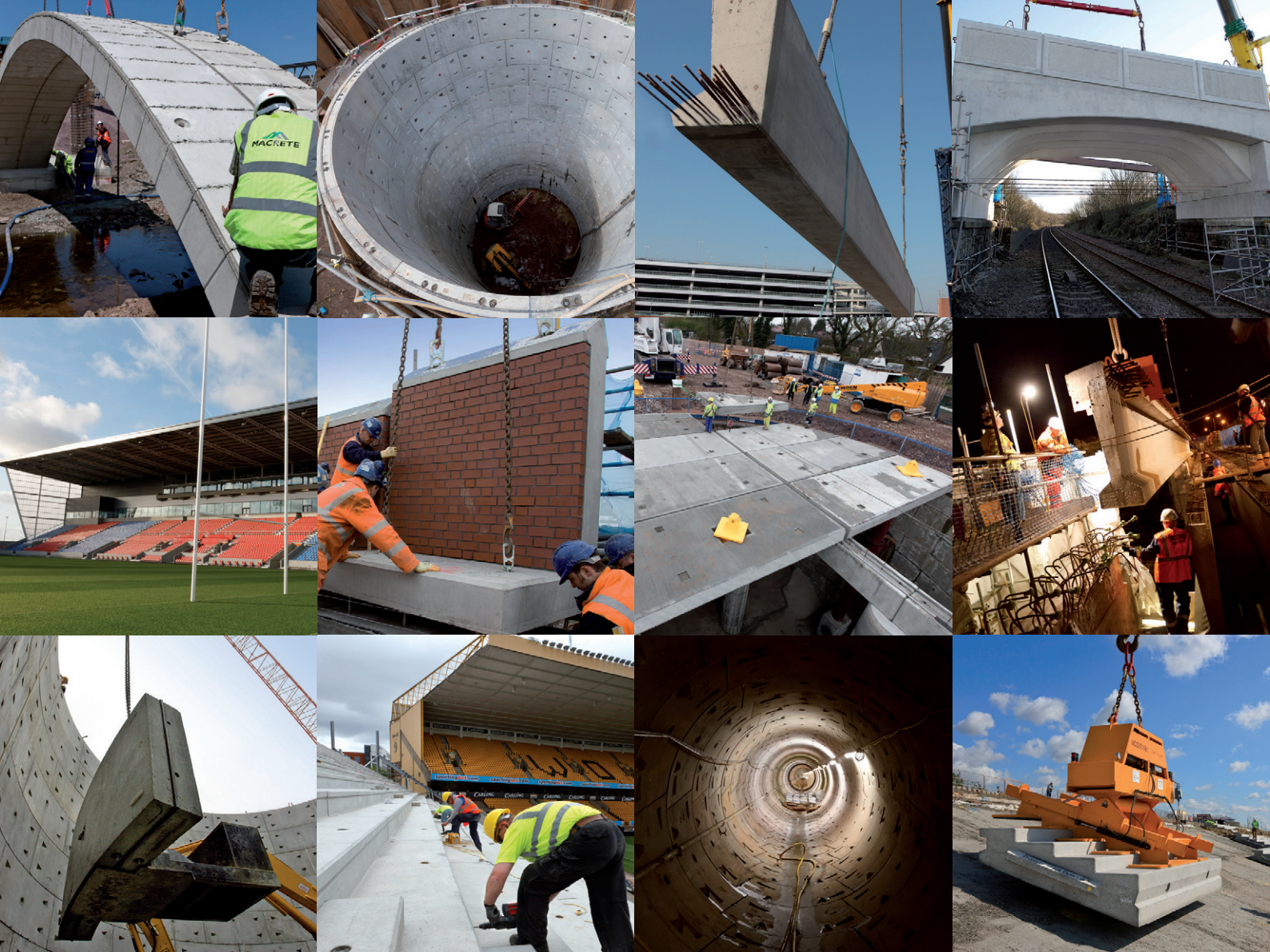
Introduction

The regulatory drivers for each of the 32 UIDs are detailed in the table overleaf, and include:

- **Aesthetic Driver:** These UIDs feature screens of various types which screen spills up to and including those from a 1 in 5 year event.
- **Bathing Water Driver:** These outputs have to spill no more than 3 times per bathing season (which is defined as 1 May to 30 September). This is assessed by running a continuous simulation data set of a 10 years' worth of rainfall through

the network model, and averaging the annual number of spills between the specified dates.

- **Shellfish Driver:** The UIDs have to spill no more than 10 times per full year, a different analysis of the same set of results from the aforementioned continuous simulation modelling.
- **Emergency Storage Driver:** This driver applies to existing pumping stations which did not have adequate emergency storage volume, typically equating to 2 hours of inflows, in the event of (for example) power failure, to establish (for example) the connection of a temporary generator.



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There is a requirement for some of the UIDs with a Bathing Water or Shellfish driver to have spills agglomerated together. Agglomerated spills are considered as a single discharge and must comply with the Bathing Water and Shellfish Water criteria.

The regulatory dates, the date by which the solutions had to be fully operational, were fixed for each output and varied between the 31 December 2011 and the 30 September 2012, providing some flexibility for practical scheduling within the various project constraints.

Undertakings

United Utilities defined the design criteria and outlined buildable solutions to overcome the many challenges facing the design team in identifying arrangements to address all of the UID drivers.

MWH assessed the storage volumes necessary to satisfy the spill criteria using a verified sewer network model and consultants Mouchel and GHA Livigunn undertook the detailed design. KMI+ were the main contractors, and DCT Civil Engineering and Donegan Civil Engineering were the principal sub-contractors.

Each site had a unique set of circumstances that needed to be fully understood to enable an efficient solution to be developed. The interconnecting pipework was constructed using a number of different techniques dependent upon available working area, ground conditions, congestion of statutory undertaker's plant and disruption to pedestrian and vehicular traffic. Various no-dig methods were utilised including traditional pipe jacking up to 1,500mm diameter, pipe jacking steel sleeves and inserting product pipes, timber headings and auger boring.

The majority of the solutions with a storage requirement evolved during the design process to become off-line, below ground, segmental shafts with pumped return. Pumps and associated controllers were provided by Xylem (Flygt) and CSO Technik provided Vacflush™ tank cleaning systems.

Exceptions to this were Station Road and Dow Brook in the Freckleton catchment. At Station Road, an in-situ rectangular tank features a CSO Technik tipping bucket flushing system. At Dow Brook the storage is on-line within an oversized tank sewer and spills are screened via an Ovivo static screen (both the screen and tank cleaning is via a tipping bucket from Ovivo).

For Powis Road, Peddars Lane & Riversway in the Watery Lane catchment, the combined solution was for an oversized tunnelled connection to the Preston 7 UID tunnel system, due to site constraints prohibiting conventional storage.

Scheduling

Numerous schedule constraints were successfully managed in order to meet agreed EA output dates. The majority of the sites involved excavation within the highway, necessitating either lane closures or complete road closures. Careful advance planning and close cooperation with Lancashire County Council (LCC) was essential, especially as 2012 was a Preston Guild Year and understandably LCC were keen not to have major traffic routes disrupted. At the peak of construction there were 22 live sites throughout the city of Preston.

Segmental shaft construction

The segmental shafts varied in diameter up to a maximum of 20m and the deepest shaft was 26m to formation level. The majority of sites comprised some made ground overlying drift deposits of inter-stratified clays, silts with sand and gravel layers, overlying Sherwood Sandstone. Artesian groundwater conditions were present at a number of the sites.

To overcome the ground conditions, various techniques were utilised to construct the shafts, including:

UIDS in Clifton Marsh WwTW Catchments

Project sites, their locations, individual drivers and any storage requirements are scheduled in the following table

Freckleton Catchment

Population: 27,859 Area: 1,330 Ha Investment: £10m

Location	Driver	Screen Type	Storage (m ³)
Lamaleach PS	AEG	Static	2,020
School Lane	A	Static	0
Station Road	AEG	Powered	733
Bunker Street	A	Static	0
Dow Brook	AEG	Static	182
Warton PS	AS	Static	82

Lea Gate Catchment

Population: 79,112 Area: 2,400 Ha Investment: £8m

Location	Driver	Screen Type	Storage (m ³)
Sharoe Green Lane	A	Powered	0
Clarkson's Fold, Cow Hill	AEG	Powered	3,800
Garstang Road Bridge	A	Static	0
Watling Street Road	AEG	Powered	857
Victoria Road	A	Powered	0
Clifton Village PS	AS	Static	79

Watery Lane Catchment

Population: 66,439 Area: 1,300 Ha Investment: £24m

Location	Driver	Screen Type	Storage (m ³)
Albyn Street East	AEG	Powered	2,067
Ribbleton Lane	AEG	Powered	3,113
London Road		Weir raised above 1 in 5 year level	
Deepdale Road		Weir raised above 1 in 5 year level	
St. Georges Road	A	Static	0
Powis Road, Peddars Lane & Riversway	AEG	Powered*	4,012*
Wolseley Road	AEG	Static	549
Manchester Rd/Selbourne Rd /James St/Frenchwood Ave	A	Static	0
Bank Parade		No spill pipe	5,014
Frenchwood Knoll	A	Static	0
Watery Lane		Weir raised above 1 in 5 year level	

Penwortham Catchment

Population: 25,021 Area: 580 Ha Investment: £6m

Location	Driver	Screen Type	Storage (m ³)
Riverside Road	A	Static	0
Valley Road PS	AEG	Self-Cleansing	1,664
Cop Ln/Poplar Drive	AEG	Static	1,078

- A Aesthetic (requires screening to discharges)
 E Bathing Waters (requires storage to spill no more than 3 times a bathing season)
 G Shellfish Waters (requires storage to spill no more than 10 times per annum)
 S Emergency Storage (2 hours)
 * Alternative Solution refer to later text

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Watery Lane East - Ribbleton Lane detention tank
Courtesy of DCT Civil Engineering



Penwortham - Cop Lane detention tank
Courtesy of KMI



Watery Lane East - Oxford Street detention tank
Courtesy of KMI



Watery Lane West - Shaft 402
Courtesy of KMI

- Secant piles socketed into the rock, with the shaft lined with segments from the rock to the surface and segments underpinned through the rock to formation.
- Sheet piles driven to the rock and the segmental shaft sunk as a caisson through the cofferdam to the rock and then underpinned through the rock to formation.
- Segmental shafts sunk by caisson to rock, followed by underpinning to formation.
- Segmental shafts sunk by caisson to formation.

Anti-floatation measures in ground conditions with a high water table can add significant costs, and special attention was paid to minimise those costs during the detailed design process. In addition to the self-weight of the structures, where appropriate, the cost was reduced by increasing the mass of the structures through the use of steep concrete benching on the base slab, in lieu of proprietary flushing systems for cleaning larger diameter tanks. Where practicable under-reamed bases were specified to mobilise the resistance of the surrounding ground against up thrust.

The shafts sizes were adjusted to suit the particular ground conditions and in particular to minimise the anti-floatation requirements. Lamaleach Pumping Station (Freckleton catchment), the diameter of the shaft was reduced to increase the depth of the shaft and lower the formation level below rockhead. This enabled the use of an under-reamed base solution to resist floatation.

Similarly at Bank Parade the diameter of the shaft was reduced to limit the disposal of the contaminated material containing arsenic and heavy metals in the made ground, at the higher levels within the shaft.

London Road - Watery Lane catchment

At London Road the conceptual solution was to raise the weir within the existing CSO structure. The detail also incorporated the provision of a second access aperture within a replacement chamber soffit section to supplement the existing single 600mm square access within an arched brick soffit.

This arrangement was to provide access to both the continuation and spill sides of the 4m deep brick built chamber.

Lancashire County Council were reluctant to approve any lane closures due to the chamber location being in the centre of a busy junction on two adjoining main routes into the city. To overcome this constraint, the team devised a method of providing the necessary permanent access and constructing the raised weir without adding the additional access or disturbing the chamber soffit.

Due to the configuration of the chamber, it was not practicable to provide the necessary access via use of internal ladders. A set of stairs with integral platform and a composite weir were prefabricated off site, and were installed through the existing opening and assembled within the chamber over five overnight road closures.

Ribbleton Lane - Watery Lane catchment

At Ribbleton Lane, an arterial traffic route into the city, the solution required the construction of 3,113m³ of storage and a new Longwood Engineering powered screen chamber. What initially looked like a promising site was not chosen, due to it being the site of a former gas holder, with heavily contaminated ground.

The only other available site was within the grounds of a low rise block of flats. As space was so tight the designers minimised the footprint of the proposals by specifying a small diameter, deep shaft with a CSO arrangement, complete with powered screen within the detention tank. The storage volume was provided utilising a 15m diameter 26m deep shaft constructed as a dry caisson through drift deposits of inter-stratified clays, silts with sand and gravel layers.

The shaft was successfully constructed within 8.5m on plan of the adjacent low rise flats.

The existing CSO and associated continuation sewer were situated in the centre of Ribbleton Lane, between a pair of 600mm diameter cast iron water mains operating at 10 bar, and below a number of other services. Upon investigation it was established that the cast iron water mains could not be diverted, or even be reduced in pressure, whilst the works were undertaken.

To facilitate the connection to the existing sewer and the crossings of the water mains, a temporary works solution was developed. This was to clamp each joint of the water mains adjacent to the proposed connection MH and the existing CSO location with proprietary clamps. The clamped joint and pipe was then encased in reinforced concrete to act as a beam to span the open excavation. On completion of the works flexibility was restored to the water mains by core drilling the reinforced concrete beam at each joint location.

Powis Road, Peddars Lane, Riversway and Watery Lane

At these sites, engineers on the team identified that the provision of a tunnel solution, rather than the construction of large detention tank adjacent to the highway, would minimise stakeholder impact and associated health and safety issues. The tunnel solution also had the added benefit of providing the greatest operational protection against 'tidal locking' of the outfalls into the River Ribble.

The tunnel solution collects spills from 4 (No.) existing UIDs and transfers flows into a storage tunnel connected to the Preston 7 UID Tunnel (which is currently being constructed), providing both capital and operational cost savings when compared with the original standalone solutions.

The tunnel solution was further rationalised by the deletion of an intermediate (drive) shaft following close liaison with the Preston 7 UID team and utilisation of their (already constructed) shaft C4 as the drive shaft.

The tunnel was constructed using 'Dorothy', a Lovat Earth Pressure Balance Machine (EPBM) Tunnel Boring Machine (TBM). The TBM was launched from shaft C4 at an upgrade of 1:100 towards the reception Shaft 402. The tunnel is 750m long, comprising precast concrete rings of trapezoidal segments, 2.44m in diameter and approximately 26m below ground within the Sherwood Sandstone.

The tunnel route passes close to the historic course of the River Ribble prior to it being realigned to accommodate construction of Preston Docks and crosses below a number of critical services and a busy dual carriageway.

The tunnel portal from Shaft C4 to Shaft S402 was purposefully 2m higher than the adjacent Preston 7 UID tunnel portal. To launch the TBM from C4, the shaft was backfilled up to the invert level for the new drive, and an 8m long, 3m diameter launch tunnel was constructed. The TBM was assembled at the base of C4 and advanced into the launch tunnel with a jacking frame.

The step in invert levels across shaft C4 initially prohibited the use of the Preston 7 UID tunnel as a back shunt to service the construction of the Preston 32 UID tunnel. Once the TBM and backup sledges were buried, the fill placed within C4 was re-profiled across the shaft to allow the support trains to negotiate the change in direction and gradient and travel to Shaft S4 (constructed as part of the Preston 7 UID scheme).

The Preston 32 UID tunnel was serviced from shaft S4, which allowed safe and efficient servicing with the support trains, along with maintaining all the existing traffic routes during construction of the tunnel.

The tunnel advanced at an average rate of production of 50m per week, based on two shifts working 5 days per week. The Sherwood Sandstone proved variable along the route and required the use of ground conditioning to dry the spoil in various locations.

Conclusion

The success of Preston 32 is as a result of collaborative working and the excellent working relationships developed between the United Utilities design team, the construction partner and their detailed designers, United Utilities Operations and the many external stakeholders.

The team overcame a number of significant challenges to identify suitable sites across the City of Preston, to develop innovative design and construction solutions for those sites whilst coordinating the delivery of the works, with Lancashire CC and the Preston Guild celebrations.

The strength of the relationship has enabled the successful delivery of twenty-four of the twenty-eight UID schemes within 18 months, with many of the outputs delivered in advance of the regulatory date.

At the time of writing (July 2013) the construction of the remaining 4 (No.) outputs is nearing completion with the turning of the flows linked to the turning of the flows of the Preston 7 works, scheduled for completion in February 2014.

The Editor & Publishers would like to thank the following for providing the above article for publication:

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Watery Lane West - Tunnel Service Shaft S4
Courtesy of KMI