

# White Paper

## Prefabrication, the key to the transformation of construction.



# The role that prefabricated water management systems can play in meeting the problem of skill shortages and associated challenges in the construction industry.

## The challenges

### The challenges of a changing construction industry.

The construction industry continues to face a number of challenges, one of the most acute of which is probably the shortage of skilled labour in a number of key areas. This allied with tightening build schedules and the need for commercial projects to deliver ever faster returns while meeting sustainability targets creates an almost perfect storm for project managers.

Prefabrication is not a panacea, but in this paper we hope to demonstrate the significant benefits it can deliver in the area of skill shortages and the resultant benefits in the associated areas of time pressures and sustainability.

The construction industry continues to face challenging times as regards the availability of sufficient skilled labour. The Construction Skills Network (CSN) estimates that an additional 225,000 workers will be required if the industry is to meet anticipated demand in the years to 2027.

Given that a broad range of different skillsets are needed to deliver them successfully, large scale commercial developments, such as high-rise apartment blocks or office buildings, are among the types of projects most at risk should a solution not be found. Without having the right numbers of skilled people these projects will be more costly to produce, take longer to complete, and in some cases may never reach site in the first place.

This is certainly the case in the building services sector; we know first-hand that the likes of drainage and water supply system installation specialists are in high demand.

What's more, this is a situation impacted further by other increasing project demands. Clients want their buildings open and returning on their investment as soon as possible, which puts pressure on workflows to be completed in shorter and shorter timeframes. Meanwhile the welcome changes made to standards and regulations following the Hackitt report has meant that all industry players share greater responsibility and scrutiny in completing projects safely and to the requisite quality.

### So, what can be done?

Strong industry collaboration is needed if we are to find mitigations against the lack of skilled labour. As a manufacturer of drainage and water supply systems for commercial projects we have explored several options as to how we play our part and have identified prefabrication as one of the most promising options.

This white paper explores the role that the prefabrication of drainage pipe systems can play in tackling skills shortages and helping commercial projects complete on time and to standard.

It details how our prefabricated HDPE solution has been put to a first of its kind test with an independent expert to verify its commercial benefits in comparison with alternative materials and methods.



# The solution

## Why is fabrication a solution?

The prefabrication of HDPE drainage systems can offer important benefits to commercial projects. By completing work in factory-controlled conditions that would otherwise need to be handled on-site, project managers are able to reduce the time taken to complete installation and re-deploy valuable skilled labour where it's needed.

Importantly, prefabrication allows for the unique project requirements to be considered from the initial design stage, including:

- Multiple different drainage connections needed
- Minimising the space needed for pipework
- Unique wet room/kitchen/utility room/pod layouts
- Drainage solutions in confined spaces

Therefore, when adopting a DfMA (Design for Manufacture & Assembly) approach, prefabrication can unlock benefits such as space saving, future-proofing and simplified assembly.

## The benefits of prefabrication – third party confirmation.

Polypipe Building Services had been looking at the potential of innovative pipe materials and their suitability for prefabrication techniques. In 2015 Polypipe Building Services put the potential of prefabrication to the test by commissioning an independent consultant to undertake a cost analysis of the different drainage system materials and installation techniques used for commercial developments.

John O'Reilly is a building services industry veteran, having started as an apprentice and worked his way up to become a senior director of a large company specialising in delivering large-scale residential and commercial M&E projects. His combination of hands-on experience with the products and methods covered in the report, alongside board level expertise, means he is uniquely qualified to deliver an expert, impartial view. He now works as an independent consultant providing advice to companies and industry bodies.

## Scope of the study.

- a. Base material costs
- b. Basic site install and labour
- c. Allowances for inductions
- d. Supervision
- e. Site logistics
- f. PPE
- g. Testing

This was the first ever study of its kind – taking a comprehensive view of cost factors impacting the selection of prefabricated HDPE drainage systems alongside other common material and installation options.

The study is based on a typical high-rise residential development in London, comprised of 360 apartments across two towers – one of 23 storeys and one of 22 storeys. However, the principles used are relevant to any building where prefabricated drainage stacks can be installed.

Key to establishing which option is the most cost effective is a full assessment of the different dynamics at play on a typical project. To achieve this, we have analysed the following categories:

- Materials
- Labour and associated costs including inductions, supervision, PPE and other equipment
- Logistics
- Testing
- Tooling

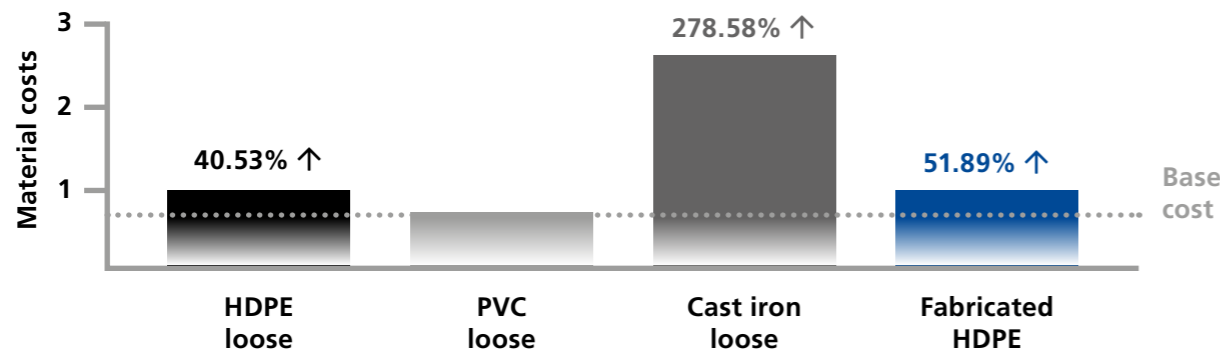
The following pages provide the results of this analysis, setting out comparative costs. This is then concluded with a comprehensive total installed cost that consolidates the above factors.



# Base material costs

Loose PVC represents the most competitive base material cost, followed by loose HDPE. Prefabricated HDPE is 51.89% more expensive than PVC, with the cost of cast iron by far the most expensive.

HDPE figures have been calculated by allowing for electrofusion couplings on all joints. However, dependent on the overall skill level of available labour, costs could be saved by incorporating a significant level of on-site butt welding.



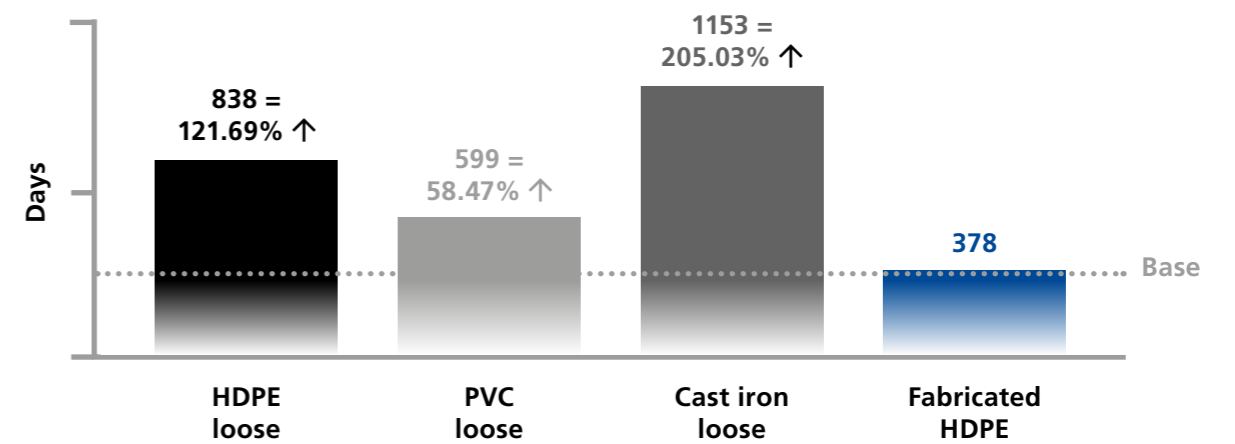
# Basic site installation labour

Prefabricated HDPE represents a significant reduction in on-site installation time in comparison to other options. It should be noted that as the fabrication element clearly takes place off-site the cost of this labour is therefore included within the purchase price of the fabricated material costs.

Prefabricated segments only cover the vertical elements on the accommodation floors, all other drainage offsets are built on-site including the drainage located within the basement, ground floor and roof levels.

From a site build point of view, out of the three other products PVC represents the fastest on-site install at 599 days. PVC requires 58.46% more labour than prefabricated HDPE but 28.52% less labour than the 838 days required to fit loose HDPE and 48.05% less than the cast iron option at 1153 days.

Note - installation labour figures have been calculated by applying labour constants or norms to each product item.

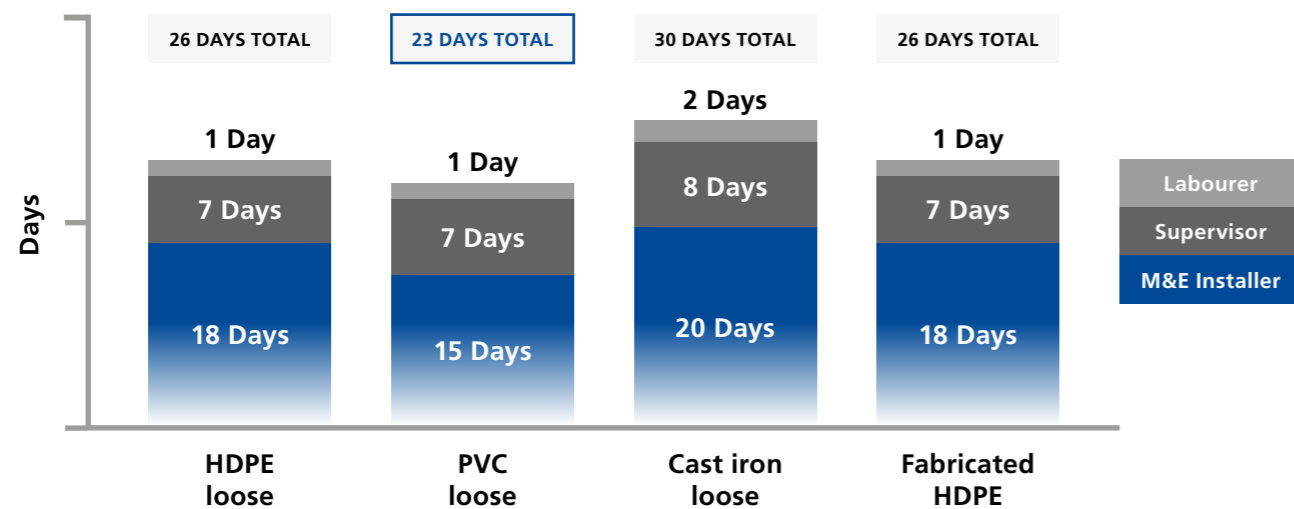


# Allowances for inductions

Inductions on modern UK sites can take anything from 2 to 8 hours to perform and although a relatively small cost in comparison to other factors must still be taken into account.

Loose PVC typically requires lower induction costs than other materials, with cast iron taking the most – a total of 3 days more than for HDPE.

Note - the table illustrates the allowances made for inductions based upon the peak requirement plus 25% wastage. Contractor costs could increase further if they are not using prefabrication to cut down site labour and instead rely heavily on labour agencies, whereby a significant rejection rate of up to 30% can cause an additional burden.

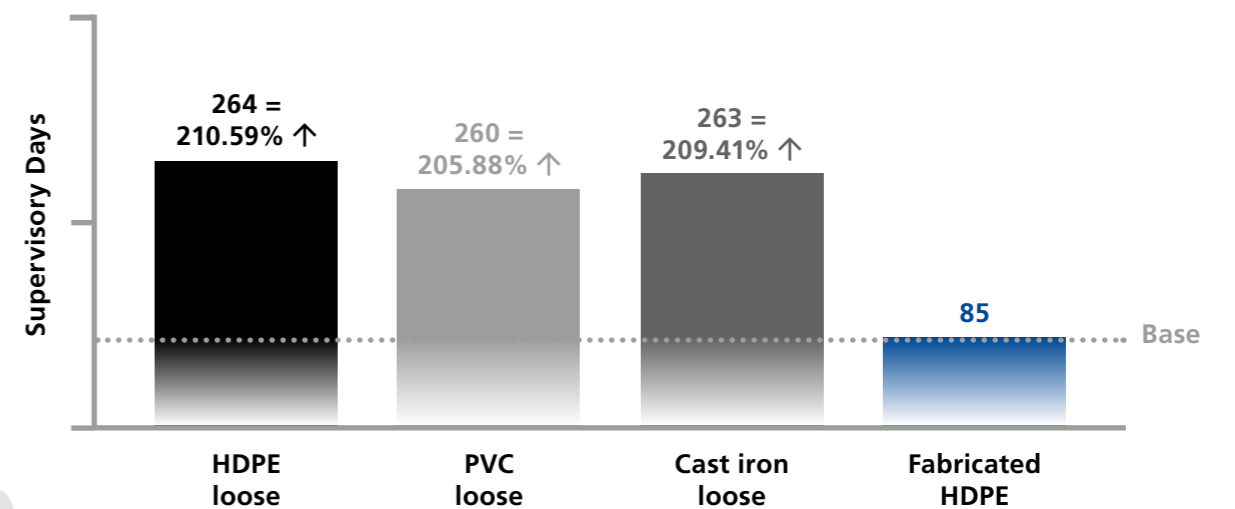


# Supervision

A high level of supervision is essential for three principal reasons:

1. To monitor the workforce
2. To monitor the installation progress and ensure deadlines are met
3. To help ensure regulatory and safety standards are complied with

Prefabricated HDPE systems are much quicker to install, which means supervision time is dramatically lower than for other materials using loose installation, which have similar demands in terms of supervisory days.



# Site logistics

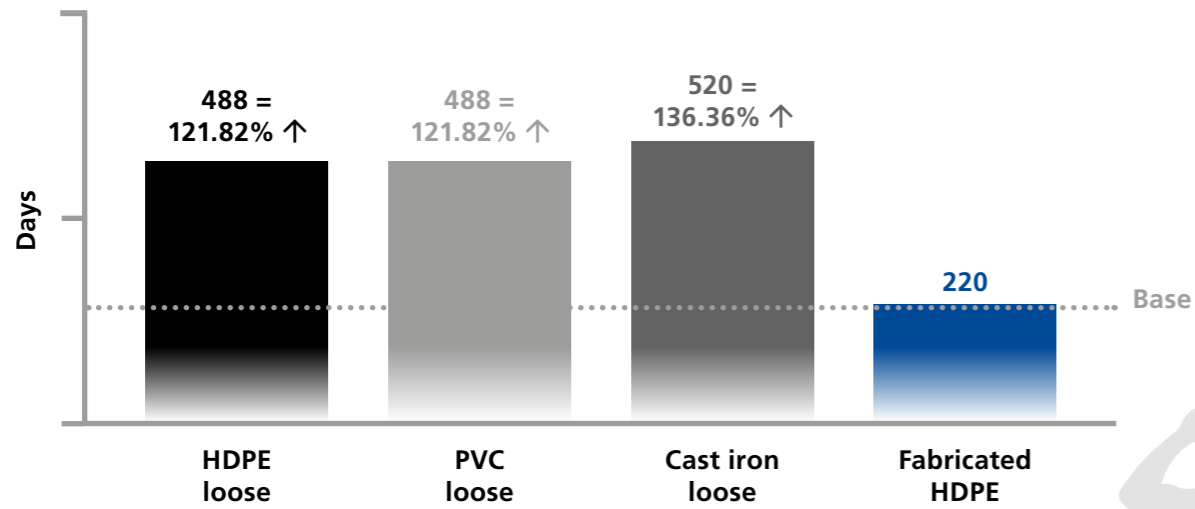
Site logistics is a key cost element for commercial projects. Good co-ordination is also required to meet timescales for shared site resource such as cranes and lifts. This means that fewer logistical demands can support cost and schedule reductions.

The markedly lower logistics days required for prefabricated HDPE reflects both its lower weight and just-in-time availability.

Weight is a major factor in calculating logistical requirements. As HDPE is lightweight and robust, a stack can be handled manually to its position and installed safely, whereas our study found PVC to be typically 5.75% heavier and cast iron 436% heavier – therefore it needed significantly more equipment and resource to handle it.

Prefabricated HDPE can be delivered ‘just-in-time’ with a floor or floors being delivered when called for. This facilitates less on-site storage and significantly reduces the number of journeys that would be required under a loose installation method.

Reduced deliveries to site are just one of the benefits that prefabricated HDPE systems offer. Off-site prefabrication means fewer cuts and therefore less off-cuts or waste for the contractor to deal with. Off-site prefabrication means that any production waste can be collected for recycling at the point of manufacture.



# PPE

A small but significant cost to be considered. The nature of on-site work required for loose installation means costs per operative are over 100% higher than for prefabricated PPE – due to most of the work such as cutting and welding being carried out before the system arrives to site.

Per site operative	Quantity	Rate	Total
Branded Hi Viz Vest	2	£4.00	£8.00
Hard hat	1	£6.00	£6.00
Level 5 Gloves	3	£4.50	£13.50
Glasses	2	£4.75	£9.50
<b>Total per operative</b>			<b>£37.00</b>

<b>HDPE Option</b>	38 men	£37.00	£1,406.00
<b>PVC Option</b>	38 men	£37.00	£1,406.00
<b>Cast Iron Option</b>	41 men	£37.00	£1,517.00
<b>Fabricated HDPE</b>	19 men	£37.00	£703.00

Based on peak numbers of operatives plus wastage.



**Failing to prioritise stage testing could push contractors into delaying the final handover of a project, potentially costing them serious amounts of money in penalties. Testing is made up of two principal elements: stage testing and final testing. Stage testing takes place at intervals usually defined at every other floor although where significant lateral drainage exists it is recommended that these be tested on a per run basis.**

The importance of this stage testing cannot be over emphasised, as it is the effectiveness of this that ensures the successful final testing witnessed at the completion of the project by the district surveyor.

Testing costs are the same across different material types of factory fabricated and tested assemblies, however there are significant differences in reliability – and the likelihood of remedial work being required for certain materials before final testing can be passed.

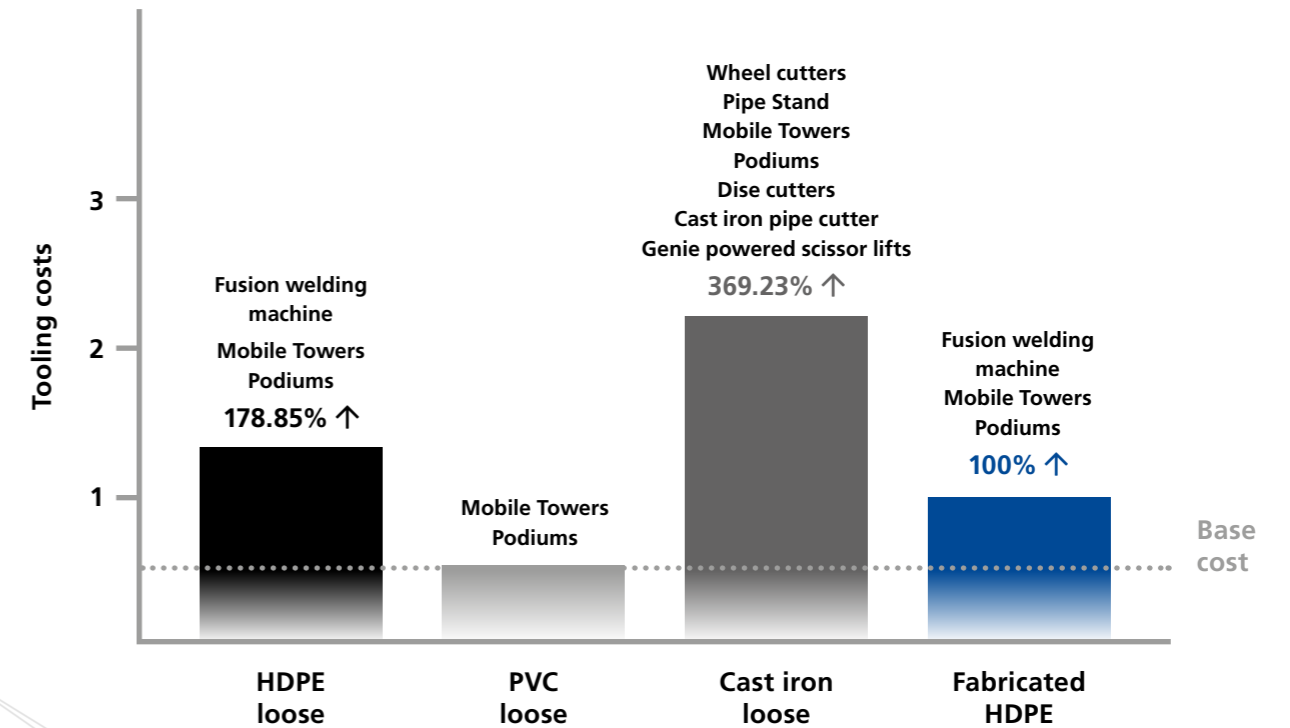
HDPE has a much lower potential for latent movement leaks than other materials due to the exceptional reliability of butt or electro-fusion welded joints. Furthermore, prefabricated systems are tested within the factory with a 200mm column of water prior to delivery. Whilst this does not remove the need for on-site testing, it does provide additional reassurance that this will not reveal the need for remedial work.

HDPE Drainage system	115 Days	Potential for latent movement leaks 5%
PVC Drainage system	115 Days	Potential for latent movement leaks 30%
Cast Iron system	115 Days	Potential for latent movement leaks 40%

**Cast iron is by some way the most expensive material for tooling. This is due in part to the additional powered lifting equipment required because of its weight.**

Note - the majority of hire costs used in our calculations have been derived from a company generally regarded as one of the leaders in supplying London sites with their plant and equipment needs.

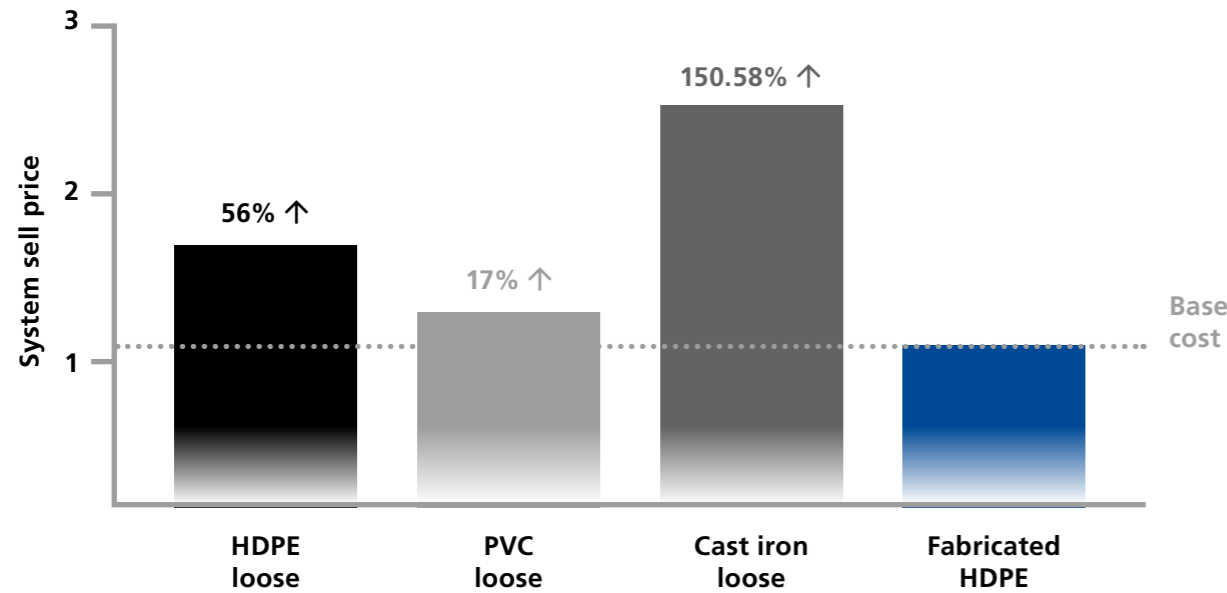
There may be some variance in HDPE costs if greater on-site butt welding is planned.



Here is a summary of all costs analysed, aggregated against each material and installation type. Prefabricated HDPE offers the lowest cost option with cast iron significantly more expensive than loose alternatives.

Although prefabricated HDPE was found to have a higher base material cost than loose HDPE or PVC, this is outweighed by other costs required to complete their installation.

- The % difference in total installed cost between PVC site installed and prefabricated HDPE is 17%
- The % difference in total installed cost between prefabricated HDPE and HDPE loose is 56%
- The % difference in total installed cost between Cast Iron and prefabricated HDPE is 150.58%



## Conclusions

The results of the study are clear. When all factors are considered regarding the purchase and installation of drainage systems, prefabricated HDPE is shown to offer superior commercial benefits.

Reduced demand for skilled labour means that experienced employees can be deployed on other elements of the building services scope, relieving pressure where demand for these skills can outstrip supply.

*The combined benefits of prefabrication with lightweight HDPE material mean projects can also benefit from a reduced need for site logistics and tooling, as well as superior reliability.*

*Furthermore, the logistics efficiencies gained – both in terms of site management and site deliveries, together with the reduction of on-site waste, mean that prefabrication can also deliver significant benefits in terms of sustainability.*

## Moving forward

Since the O'Reilly Study was conducted, Polypipe Building Services has increased its focus on system prefabrication. The company has developed a complete line of prefabricated two part drainage stacks which provide a highly adaptable and cost effective solution for many developments.

For more complex or innovative projects, or where modular construction methods are being used, the Advantage Off-site Prefabrication service provides bespoke solutions which use BIM and digital twinning technologies to ensure that systems are tailored perfectly to requirements.

As demonstrated by John O'Reilly, such advances deliver significant benefits in terms of time, cost and project management. Following on from the 'O'Reilly Study, PBS has developed a set of analysis and modelling tools which provide clear illustrations of the savings that can be achieved through an integrated design and prefabrication approach.



To find out more, please visit [www.polypipe.com/advantage-page](http://www.polypipe.com/advantage-page)





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