Nutrient Neutrality Statement

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For: FI Real Estate Management

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1. Introduction

1.1 Acknowledgement

1.1.1 This report has been prepared for the sole and exclusive use of FI Real Estate Management in accordance with the scope of work presented by Arthian, Letter Agreement (319585/JR/05062025/1.0), dated 09/06/2025. This report is based on information and data collected by Arthian. Should any of the information be incorrect, incomplete, or subject to change, Arthian may wish to revise the report accordingly.

1.1.2 Arthian have been instructed to provide a Phosphates and Nutrient Strategy at the Oaks, Wrexham Industrial Estate.

1.2 Project Understanding

1.2.1 In response to the Dutch N court judgment, Natural Resources Wales (NRW) has advised Wrexham County Borough Council (WCBC) that, due to the unfavourable condition of the River Dee Special Area of Conservation (SAC), competent authorities must undertake a Habitats Regulations Assessment (HRA) before determining any planning application that may give rise to additional phosphorus loading within the catchment.

1.2.2 As the River Dee SAC is currently failing to meet the tightened phosphorus targets set by NRW, the Welsh Government's new Nutrient Budget Calculator must now be used to assess nutrient inputs (with a particular focus on phosphorus) from all new development within affected catchments. Developments in the Dee SAC are therefore required to demonstrate nutrient neutrality, meaning that they will not result in increased phosphorus loading, or that any such increases are fully mitigated.

1.2.3 This guidance seeks to reduce phosphorus inputs to the Wrexham Levels and wider catchment from new development, in response to growing concerns over eutrophication and its impacts on these sensitive and scientifically important environments.

1.3 Sources of Information

1.3.1 The following sources of information have been reviewed and assessed for the purpose of this Nutrient Neutrality Strategy:

- LandIS® Soilscapes Mapping[1];
- FEH Rainfall Data[2];

[1] https://www.landis.org.uk/soilscapes/
[2] https://fehweb.ceh.ac.uk/Map

- NRW's Phosphorus sensitive catchments and Phosphorus compliant waterbodies[3];
- WCBC New River Phosphate Level Targets[4];
- The Dee Catchment Phosphorous Reduction Strategy Draft (2021 PRS)[5];
- Hafren Dyfrdwy – Drainage & Wastewater Management Plans (DWMP 2023)[6];
- River Wensum SAC & Broads SAC Nutrient Budget Calculator V2.2 (2024 River Wensum SAC Calculator);
- Welsh Government Nutrient Budget Calculator (2025 Nutrient Budget Calculator); and
- Welsh Government Nutrient Budget Calculator Guidance (2025 Calculator Guidance)[7].

1.4 Project Limitations

1.4.1 The wider Arthian limitations are contained within Appendix A.

1.4.2 The available desk top statutory regulatory data available for UK may not accurately consider the potential impacts of climate change. If a full detailed assessment across all climate change scenarios is required to inform wider ESG reporting or asset risk, further assessment may be needed.

[3] https://datamap.gov.wales/maps/new?layer=inspire-nrw:ComplianceAssessmentOfWelshRiverSacsAgainstPhosphorusTargets#/
[4] https://www.wrexham.gov.uk/service/development-plans-and-other-planning-policy/new-river-phosphate-level-targets
[5] https://www.flintshire.gov.uk/en/PDFFiles/Planning/Examination-Library-Documents/FCC/FCC031-Phosphate-Strategy.pdf
[6] https://www.hdcymru.co.uk/content/dam/hdcymru/about-us/drainage-and-wastewater-management-plan/2023/HDD-fDWMP23-L1-Non-Technical-Report.pdf
[7] https://www.gov.wales/sites/default/files/publications/2025-06/nutrient-budget-calculator-guidance.pdf?utm_source=chatgpt.com

2. Site Details

2.1.1 The aim of this section of the report is to outline key environmental information associated with the baseline environment.

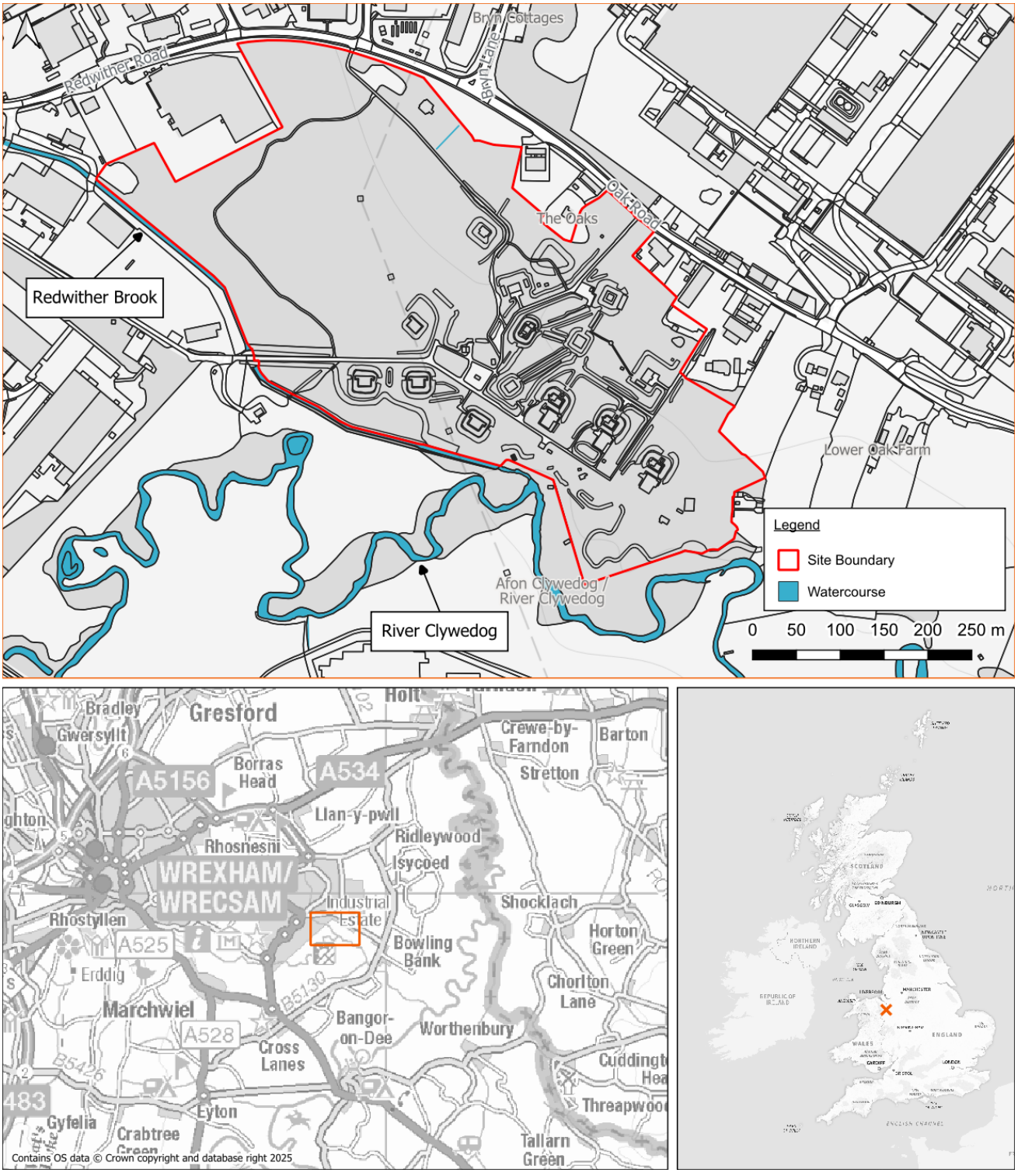


Figure 1: Site Location

2.2 Site Location

2.2.1 The site is located in the south-west of Wrexham Industrial Estate, 4.6km east of Wrexham City Centre, directly south from Redwither Road and Oak Road. The site is approximately 21.67Ha in size (measured on AutoCAD using plan provided by the client). The National Grid Reference for the site is 338750, 349190.

2.3 Existing Site Conditions

2.3.1 Online mapping (including Google Maps / Google Streetview imagery, accessed 25/08/2025) indicates that the site is predominantly woodland, interspersed with several unnamed access roads and industrial buildings. It is bounded by Redwither Road to the north and Oak Road to the northeast, beyond which further industrial development is present. To the east and south, the surrounding land remains undeveloped greenfield, while additional industrial development lies to the west. Site access is available from both Redwither Road and Oak Road.

2.4 Proposed Development

2.4.1 The proposed development at The Oaks, Wrexham Industrial Estate, comprises a green eco-heritage park and a single employment unit with integral offices, together with new vehicular access, car and HGV parking, servicing and storage areas, landscaping, heritage and ecological mitigation, and associated ancillary development.

2.4.2 A proposed development plan is included as Appendix B.

2.5 Receiving WwTW

2.5.1 The receiving Wastewater Treatment Works (WwTW) for the proposed development is Five Fords.

3. Nutrient Neutrality Statement

3.1 Background

3.1.1 Nutrient neutrality is a statutory requirement ensuring that new developments do not exacerbate phosphate pollution within sensitive Special Areas of Conservation (SACs), particularly those currently failing to meet water quality targets (such as the River Dee SAC, which covers parts of Wrexham). Therefore, Nutrient neutrality must be demonstrated, meaning that any additional phosphate loading from a development must be fully offset to ensure no net increase in nutrient inputs to the SAC.

3.1.2 The proposed development involves the erection of up to three warehouse / commercial units with associated parking, access, landscaping and ecological zone. A proposed development plan is included in Appendix B.

3.1.3 To support this requirement, the Nutrient Budget Calculator for Wales, created in early 2025 and first issued to the Welsh Government in May 2025, provides a structured process for quantifying and managing nutrient impacts of new developments. The calculator aims to assist developers and local planning authorities in demonstrating nutrient neutrality within nine SAC river catchments across Wales, including the River Dee and Bala Lake SAC.

3.2 Justification

3.2.1 The Dee Catchment Phosphorus Reduction Strategy (2021 PRS) details the approach by which developments should undertake a high-level nutrient budget assessment.

3.2.2 Section 4.3 outlines the outcome (along with the approach, methodology and key parameters) of the high-level nutrient budget assessment undertaken by the affected authorities completed as part of the DCPRS, which was used to inform the identification of the required measures to mitigate any surplus P loading arising from growth anticipated as a result of the emerging LDP. Both Councils (WCBC and Flintshire County Council) have said in their respective letter to the Planning Inspectors that “A proportionate assessment of the overall nutrient budget of the development in each plan will be made (i.e. how much phosphorus the planned development in each plan is likely to produce)”. The councils reiterated that the catchment wide HRA’s do not replace project specific HRAs or implementation monitoring that must be undertaken to provide the necessary certainty required under the Habitats Regulations.

3.2.3 The report reiterates that the approach utilised by Natural England’s Stodmarsh Lake Nutrient Neutrality Guidance was used and that only new residential developments and other new commercial/employment developments that involve overnight accommodation (e.g. hotels) or any new tourism attractions that will be connected to a WwTW are included in nutrient budget assessment. This is because anyone living in the local WwTW catchments assessed in Flintshire and Wrexham also work and uses facilities in these catchments. Therefore, wastewater generated by that person can be calculated using the population increase from new homes and other overnight accommodation, to avoid double counting. However, new tourism attractions and tourism accommodation are exceptions as these land uses attract other people into the local catchments and generate additional wastewater and consequential nutrient loading to the

impacted River Dee freshwater catchment.

3.2.4 According to WCBC, the types of development that may be affected by phosphorous river levels and require use of a Phosphate Budget Calculator include:

- ‘New residential units including homes, gypsy and traveller sites/pitches;
- Tourism attractions and commercial developments where overnight accommodation is provided;
- Agricultural development, including prior notifications (developments that don’t require planning permission, but where we need to check that it is allowed) including additional barns and slurry stores likely to lead to increased herds;
- Prior notifications for change of use of office to homes and agricultural buildings to homes;
- Operations which generate phosphate such as fisheries and car washing facilities.’

3.2.5 The proposed development is a commercial development and, no overnight accommodation is included as part of the proposals. The proposals will not increase the local population and therefore site users and their phosphate loading has already been accounted for in their residential setting.

3.2.6 The Welsh Government’s Nutrient Budget Calculator applies to both residential and non-residential development. For commercial schemes it calculates a wastewater component using employee numbers and water use, and a land cover component for changes in surface cover, soils and rainfall. The Oaks therefore falls within scope of the calculator. We have applied the 2025 tool using conservative inputs where evidence is uncertain, to quantify the additional nutrient load and confirm the mitigation requirement.

4. 2025 Welsh Government Nutrient Budget Calculator

4.1 Introduction to the Nutrient Budget Calculator

4.1.1 The Nutrient Budget Calculator allows users to estimate net changes in phosphorus loading resulting from a proposed development and to calculate mitigation needs. Its structured approach comprises the following key stages of analysis:

- Stage 1 – Quantifies the annual additional nutrient load from wastewater generated by the development (for example via occupancy or anticipated users commuting into the catchment)
- Stage 2 – Calculates the nutrient loading from existing, pre-development landcover, based on site-specific characteristics such as landcover types, soil drainage class, and average annual rainfall
- Stage 3 – Estimates the nutrient output post-development, using the same environmental parameters (landcover, soil and rainfall) to assess new land use impacts
- Stage 3S – Optionally calculates the phosphorus removed by Sustainable Urban Drainage Systems (SuDS), but only if they are implemented to national standards and supported with robust design and maintenance evidence
- Stage 4 – Automatically derives the nutrient budget: the difference between post-development and pre-development phosphorus loads, plus a built-in 20% precautionary buffer, to determine the mitigation requirement in kilograms per year

4.1.2 Together, these stages enable a transparent, defensible assessment of nutrient impacts, including wastewater contributions, changes in land use and mitigation via SuDS, while the 20% buffer accounts for inherent uncertainties in data inputs.

4.1.3 The stages of the calculator, including inputs used to assess nutrient loads at the site are detailed below, with calculator outputs also included as Appendix C.

4.2 Stage 1- Additional Nutrient Loading from Wastewater

4.2.1 Stage 1 Stage 1 of the Nutrient Budget Calculator estimates the annual phosphorus load from wastewater generated by the proposed development. For The Oaks, the following inputs and assumptions were applied:

- Development type: Commercial
- Employees: 90
- Daily water use: 50 litres per person per day
- Proportion from outside catchment: 20% (equivalent to 10 employees)
- Receiving WwTW: Five Fords WwTW (Dŵr Cymru Welsh Water)
- Permit assumption: AMP8 total phosphorus limit of 1.0mg/L (reported as compliant)

4.2.2 Based on these values, the calculator outputs an annual phosphorus load of **0.33kg TP/yr** from wastewater associated with the development.

4.3 Stage 2- Nutrient Loading from Pre-Existing Landcovers

4.3.1 Stage 2 of the Nutrient Budget Calculator quantifies the phosphorus load arising from the site's existing land use before any development takes place. This is calculated using inputs for current landcover types across the site, the corresponding area of each landcover type, the soil drainage classification, and the average annual rainfall for the location. The calculator applies standard phosphorus export coefficients, as provided in the Welsh Government guidance, to estimate nutrient losses from each landcover category. For this site, the existing landcover was identified using OS mapping descriptions, where the following assumptions in Table 1 have been made for the areas to align with the calculator.

Table 1: Existing Land Use Areas

OS Mapping Land Use Description	Area (Ha)	2025 Nutrient Budget Calculator Land Use Description	Area (Ha)
General Surface	0.71	Open Land – Built Environment	3.44
Path	0.01		
Landform	2.08		
Road or track	0.61		
Structure	0.03		
Inland Water	0.01	Water	0.01
Building	0.17	Commercial/industrial land	0.17
Natural Environment	18.04	Greenspace	18.04
Total	21.67	Total	21.67

4.3.2 The drainage was input as impeded in line with Soilscapes mapping, and the rainfall value adjusted from the default 705 mm/year to 675.1–700 mm/year, consistent with the SAAR (1961–1990) value of 684mm derived from FEH.

4.3.3 The above parameters produce an estimated baseline phosphorus load of **3.06kg TP/year**, which will be compared against the post-development scenario in later stages.

4.4 Stage 3- Nutrient Loading from New Landcovers

4.4.1 Stage 3 of the Nutrient Budget Calculator estimates the phosphorus load associated with the site once the proposed development is completed. This stage uses the same input parameters as Stage 2 (landcover type, area, soil drainage classification, and average annual rainfall), but applies them to the new post-development land use layout. Standard phosphorus export coefficients are used for each landcover category as outlined in the Welsh Government guidance. Proposed area parameters were derived from the proposed development plan (ref: TOS-BML-XX-XX-DR-C-0500 P04), Appendix B, as well as the existing OS mapping descriptions for the south-eastern extents of the site where no development

is proposed. Table 2 below details the proposed development areas, and Table 3 details the total areas used to input the calculator.

Table 2: Sum of Proposed Development Areas

	Land use type	Area (Ha)	2025 Nutrient Budget Calculator Land Use Description Used
Proposed areas (derived from plan ref TOS-BML-XX-XX-DR-C-0500 P04)	Swales	0.43	Water
	Pond	0.19	Water
	Green Area	2.8	Greenspace
	Building	0.6	Commercial/industrial land
	Proposed hardstanding excluding building	1.97	Open Land – Built Environment
Remaining OS area	General Surface	0.6	Open Land – Built Environment
	Path	0.01	Open Land – Built Environment
	Landform	2.08	Open Land – Built Environment
	Road or track	0.51	Open Land – Built Environment
	Structure	0.03	Open Land – Built Environment
	Inland Water	0.01	Water
	Building	0.17	Commercial/industrial land
	Natural Environment	12.26	Greenspace

Table 3: Final Proposed Development Areas

2025 Nutrient Budget Calculator Land Use Description	Areas (Ha)
Open Land – Built Environment	5.2
Water	0.63
Commercial/industrial land	0.77
Greenspace	15.06

4.4.2 Based on these inputs, the post-development phosphorus load is calculated as **4.9kg TP/year** prior to any mitigation measures being applied.

4.5 Stage 4- Final Nutrient Budget Calculation

4.5.1 Stage 4 of the Nutrient Budget Calculator determines the net change in phosphorus loading by comparing the total post-development load (including wastewater and land use components) with the pre-development baseline. The calculator then applies a precautionary buffer of 20% to the net increase to account for uncertainty in data inputs and assumptions, in line with Welsh Government guidance. For this site, the baseline phosphorus load from Stage 2 is **3.06kg TP/yr**, while the post-development load is

4.9kg TP/yr from land use plus **0.33kg TP/yr** from wastewater. This results in a net change of **2.17kg TP/yr** before the buffer, and a mitigation requirement of **2.6kg TP/yr** once the 20% buffer is applied. Any positive value represents the amount of phosphorus that must be mitigated to achieve nutrient neutrality, which for this site is therefore calculated as **2.6kg TP/yr**.

4.6 2025 Nutrient Budget Calculator Summary

4.6.1 Table 4 below details the phosphorous loads calculated during each stage of the Nutrient Budget Calculator.

Table 4: Calculator Summary

Stage	Stage Description	Phosphorus Load (kg TP/year)
1	Additional Nutrient Loading from Wastewater	0.33
2	Nutrient Loading from Pre-Existing Landcovers	3.06
3	Nutrient Loading from New Landcovers	4.9
4	Net Change before buffer	2.17
4b	Mitigation requirement after 20% buffer	2.6

5. Mitigation

5.1 Mitigation Options

5.1.1 The Nutrient Budget Calculator shows a net increase of 2.17kg TP/yr after development, which equates to a mitigation requirement of 2.6kg TP/yr once the 20% precautionary buffer is applied. This mitigation can be achieved through a combination of on-site SuDS features designed to remove phosphorus, potential sewer network interventions, or the purchase of off-site credits. The following sections set out each option.

5.2 Method 1: Mitigation using land use (Stage 3)

5.2.1 The first step in the mitigation hierarchy is to minimise phosphorus export through the optimisation of proposed land uses. The Welsh Government Nutrient Budget Calculator (2025) accounts for land cover changes at Stage 3, applying published export coefficients for each category. By maximising low-export categories (greenspace, open water) and reducing high-export categories (open land–built environment, commercial hardstanding), the baseline phosphorus load can be reduced before any treatment is applied.

5.2.2 For The Oaks, the proposed layout already incorporates substantial areas of greenspace (15.06ha) and open water (0.863ha), which limit phosphorus export. The development footprint is compact, with hardstanding (1.97ha) and commercial/industrial land (0.6ha) carefully controlled. Opportunities for further optimisation include:

- Maximising permeable paving rather than impermeable surfacing in parking and yard areas.
- Extending green roof coverage on ancillary buildings.
- Designing verge planting, filter strips and swale margins as functional greenspace and ensuring these are captured correctly in the Stage 3 inputs.
- Avoiding phosphorus-rich topsoil in landscaping, prohibiting routine fertiliser use, and selecting species mixes that establish without nutrient additions.

5.2.3 These measures ensure that the Stage 3 baseline phosphorus load of 4.9kg TP/yr (compared with 3.06kg TP/yr under baseline land use) is the lowest practicable value, and that the net increase of 2.17kg TP/yr (2.6kg TP/yr including buffer, Stage 4) is an appropriately conservative basis for mitigation.

5.2.4 To provide additional context, the River Wensum & Broads Nutrient Budget Calculator (Natural England, 2020) was reviewed as a proxy. While not applicable in Wales, it demonstrates order-of-magnitude land take requirements for different mitigation land uses. Scaled to the Oaks' mitigation requirement of 2.6kg TP/yr, the indicative land areas are shown in Table 5 below.

Table 5: Proxy Land Use Mitigation Options (scaled to 2.6kg/yr mitigation requirement)

Land Uses for Mitigation	Area required to offset 2.6kg/year of Phosphorous (Ha)
Constructed Wetland	~0.32
Urban Open Space	~11.6
Water	~11.7
Woodland	~12.9
Heathland / Bog	~12.9
Meadow / Semi-natural Grassland / Greenspace	~12.9

5.2.5 These figures have been scaled from the published Wensum/Broads Nutrient Budget Calculator values to the Oaks' mitigation requirement of 2.6kg/yr. Although developed for English catchments, the Wensum/Broads tool is regulator-accepted and provides a useful proxy, demonstrating that alternative methodologies also indicate the scale of land required for mitigation is modest and readily achievable.

5.2.6 The Welsh Government Nutrient Budget Calculator does not currently include land use mitigation coefficients, which is why the Wensum/Broads dataset has been referenced as a cross-check only. The formal nutrient budget for The Oaks will be evidenced through the Welsh Government Nutrient Budget Calculator (Stages 3 and 3S), supported by the SAB submission. The proxy analysis strengthens confidence by showing that independent tools converge on the same conclusion: the site can deliver sufficient mitigation within its boundary through a combination of optimised land use and SuDS.

5.3 Method 2: On-site SuDS Treatment (Stage 3S)

5.3.1 Stage 3S of the Welsh Government Nutrient Budget Calculator (2025) provides the mechanism to account for nutrient removal through Sustainable Drainage Systems (SuDS). This ensures mitigation is only credited where SuDS are compliant with the Statutory SuDS Standards for Wales and secured through the SAB approval process. The calculator automatically incorporates nutrient reductions where contributing areas are assigned, SuDS features are selected from the prescribed list, and phosphorus removal rates are supported by robust evidence.

5.3.2 For The Oaks, the Stage 3S assessment has been applied using the proposed drainage layout (drawing ref. TOS-BML-XX-XX-DR-C-0500 P04). The drainage strategy incorporates a treatment train of SuDS features designed to both manage surface water quantity and deliver water quality betterment, including phosphorus removal. The key features include:

- **Permeable paving (~1.0ha)** – providing infiltration, filtration and adsorption.
- **Vegetated swales (0.43ha)** – providing sedimentation, infiltration and pollutant stripping.
- **A wet pond (0.19ha surface area, ~2,143m^3 permanent pool)** – providing extended detention and biological uptake.

5.3.3 Evidence from CIRIA C753, Defra/UKWIR research, and peer-reviewed studies indicates the following typical total phosphorus (TP) removal efficiencies under UK conditions, included as Table 6.



Table 6: Indicative Phosphorus Removal Efficiencies

SuDS Feature	Evidence Range (TP Removal)	Applied Value	Indicative Removal (kg TP/yr)
Permeable paving	30–60%	40%	0.6–1.0
Vegetated swales	20–50%	35%	0.5–1.0
Wet pond	50–80%	65%	1.5–2.5
Combined capacity			**2.6–4.5**

5.3.4 The combined treatment capacity comfortably exceeds the mitigation requirement of 2.6kg TP/yr identified in Stage 4.

5.3.5 As a cross-check, a conservative site-based mass balance was undertaken using rainfall depth (0.69m/yr), contributing impervious area (~6.3ha), and an event mean TP concentration of 0.35mg/L. This gives an untreated annual load of ~15.1kg TP/yr. Sequential treatment through permeable paving, swales and the wet pond reduces this to ~2.1kg TP/yr, equating to ~13.1kg TP/yr removed. This order-of-magnitude surplus confirms that the SuDS treatment train is more than capable of achieving the required phosphorus reduction, validating the assumptions used in Stage 3S.

5.3.6 The final Stage 3S outputs will be provided in Appendix C once the DWG take-off is confirmed. The SAB application will secure detailed design parameters (contributing areas, residence times, forebays, planting) and long-term maintenance, ensuring that the phosphorus reduction is permanent and enforceable.

5.3.7 Taken together with Method 1 (land use optimisation), this demonstrates that The Oaks can achieve nutrient neutrality entirely within its boundary through regulator-compliant measures.

5.4 Method 3: CSO Surcharge Storage / Benefit-in-Kind

5.4.1 In addition to on-site land use optimisation (Method 1) and SuDS treatment (Method 2), The Oaks provides a unique opportunity to deliver strategic catchment-scale betterment by hosting infrastructure that directly mitigates Combined Sewer Overflow (CSO) risk.

Context

5.4.2 The Hydraulic Modelling Assessment (HMA) prepared by RPS on behalf of Dŵr Cymru Welsh Water (2025) (Appendix D) identified that:

- Five of the eleven manholes most at risk of surcharge are located within The Oaks estate.
- Modelled surcharge volumes increase to 578.8m^3 in the developed scenario, compared with 515.4m^3 without the development.
- The Oaks is therefore responsible for a net contribution of approximately 63 m^3, equating to around 11% of the total.
- During extreme events, the combined sewer system may also interact with the Redwither Brook in Flood Zone 3, further increasing the risk of untreated discharges to the River Dee SAC.

5.4.3 These findings are drawn from the HMA's Chapter 5 (Surcharge Modelling) and Chapter 6 (Option Appraisal), which identify The Oaks as a critical location for network intervention.

Proposals

5.4.4 In response, the landowner has offered to provide land within The Oaks at a nominal cost (e.g. £1 lease) to host a below-ground surcharge storage tank, in line with the HMA's recommendation of this location as the most technically advantageous site.

5.4.5 The facility could be oversized beyond the site's direct 63m^3 contribution, enabling wider catchment resilience and reducing the risk of surcharging across the estate. The HMA's Solution 3 (548m^3 storage combined with 0.176ha impermeable area removal) demonstrated that such interventions could fully resolve surcharging issues.

5.4.6 Welsh Water would be responsible for detailed design, funding and long-term operation, ensuring permanence and regulatory oversight.

Nutrient Benefit

5.4.7 Preventing CSO surcharge events directly reduces the risk of untreated wastewater discharges containing phosphorus. To quantify this benefit, a concentration of 7mg/L Total Phosphorus (TP) has been applied, consistent with published evidence:

- UKWIR (2012) and the Defra/EA nutrient neutrality evidence base report untreated sewage TP concentrations typically in the range 5–10mg/L.
- The Solent and Stour Nutrient Neutrality methodology (Natural England, 2019) adopts 7mg/L TP as a central estimate for untreated wastewater.
- CIRIA C753 guidance on SuDS treatment references comparable values for wastewater-derived nutrient loads.

5.4.8 On this basis, 7mg/L TP is an appropriate mid-range, regulator-accepted value. Applying this to the HMA-identified surcharge volume gives: 600m^3 × 7mg/L × 0.001=4.2kg TP/yr

- The 600m^3 surcharge reflects the emergency storage volume identified in the HMA.
- The calculation assumes this event occurs only once annually, which is precautionary. More frequent spill events would increase the phosphorus benefit.

5.4.9 Accordingly, the provision of surcharge storage at The Oaks could deliver a conservative nutrient benefit of ~4.2kg TP/yr, in addition to the 2.6kg TP/yr already mitigated on-site through Methods 1 and 2.

Deliverability

- **Feasibility**: The HMA confirms technical viability and identifies The Oaks as the most suitable tank location.
- **Alignment**: Supports NRW's policy objectives to reduce CSO spills into the River Dee SAC.
- **Land control**: Guaranteed through FI Real Estate ownership, enabling delivery.
- **Permanence**: Welsh Water would adopt responsibility for design, funding, and maintenance.
- **Track record**: FI Real Estate has already delivered **~12,000m^3 of SuDS attenuation** across the



estate, demonstrating long-term commitment to proactive water management.

Conclusion

5.4.10 While not required to achieve nutrient neutrality for The Oaks, the CSO surcharge storage option represents a voluntary, above-and-beyond partnership measure. By hosting infrastructure at the location identified in the HMA as most technically advantageous, the development can resolve a known network constraint, prevent untreated discharges, and deliver measurable catchment-scale phosphorus betterment. This supplementary option strengthens the overall nutrient strategy and demonstrates proactive collaboration with Welsh Water and NRW.

5.5 Method 4: On-Site Proprietary Treatment Technologies

5.5.1 Alongside land use optimisation (Method 1), SuDS treatment (Method 2), and CSO surcharge storage (Method 3), further opportunities exist to trial proprietary on-site treatment systems designed to enhance phosphorus removal.

Context

5.5.2 The client has explored options such as natural filter treatment units, reed bed polishing, or chemical dosing systems that could be applied to intercept runoff or wastewater before discharge. Similar technologies are used in other sectors (e.g. packaged treatment plants in rural foul drainage schemes) and can achieve significant phosphorus removal under controlled conditions.

Proposed Measure

5.5.3 For The Oaks, potential applications could include:

- **Filter media units** designed to capture dissolved phosphorus in surface water runoff.
- **Reed bed or wetland polishing cells** installed downstream of SuDS basins.
- **Proprietary dosing systems** to precipitate phosphorus in collected flows before discharge.

5.5.4 These systems can deliver removal rates ranging from 50% to 90%, depending on influent concentration, flow conditions, and maintenance.

Nutrient Benefit

5.5.5 If implemented, the benefit would need to be evidenced through site-specific design and monitoring. For example, a treatment wetland receiving 8,000m^3 runoff annually at 1.5mg/L could remove up to 6kg TP/yr at 50% efficiency, and potentially more if higher removal rates are demonstrated.

5.5.6 However, while the performance potential is high, NRW's current guidance and the Welsh Nutrient Budget Calculator do not allow such proprietary systems to be credited within the formal nutrient neutrality calculation, due to concerns around permanence and maintenance.

Deliverability

- **Feasibility**: Technically straightforward; systems are widely available and could be integrated with the SuDS train.
- **Maintenance**: Requires long-term management and potential media replacement; these obligations would need to be formally secured.

- **Regulatory acceptance**: Not currently creditable within the Welsh Nutrient Budget Calculator, though could be considered as supplementary betterment if supported by monitoring.

Conclusion

5.5.7 On-site proprietary treatment technologies offer a potential route to further phosphorus reductions and betterment, complementing the embedded mitigation already secured through Methods 1–3. However, due to the current limitations of NRW guidance and the nutrient calculator, these systems are considered supplementary and innovative rather than core to the neutrality case.

5.6 Method 5: Off-Site Nutrient Credit Purchase

5.6.1 The Welsh Nutrient Budget Calculator (2025) provides a formal mechanism at Stage 4 for mitigation through the purchase of off-site nutrient credits. This is recognised within both the calculator guidance and the accompanying Frequently Asked Questions as a policy-compliant pathway to achieve phosphorus neutrality where on-site and catchment measures are not sufficient.

5.6.2 For The Oaks, the residual phosphorus load requiring mitigation, after application of Stages 1–3S, has been calculated as 2.6kg TP/yr. This value represents the maximum mitigation requirement and therefore the upper bound of credits that would need to be secured. The calculator treats this option as equivalent to direct land-use change or on-site treatment, provided that the credits are demonstrably secured, maintained, and monitored for the required duration of the project, in line with Habitats Regulations requirements.

5.6.3 NRW has confirmed in its published guidance that credit-based mitigation may be relied upon as a valid means of demonstrating compliance, provided it meets the tests of permanence, deliverability, and monitoring. In practice, this requires credits to be sourced from a recognised scheme operating within the River Dee SAC catchment or otherwise formally endorsed by NRW.

5.6.4 By explicitly referencing Stage 4 of the Welsh Nutrient Budget Calculator, the use of off-site nutrient credits is embedded within the assessment framework itself and is therefore considered a robust contingency mechanism. While the preferred approach at The Oaks is to deliver neutrality through land use optimisation (Method 1), on-site SuDS treatment (Method 2), and sewer network betterment (Method 3), the ability to draw on nutrient credits provides certainty that neutrality can be achieved under all circumstances.

6. Conclusions

6.1.1 The Nutrient Budget Calculator identifies a net increase of 2.6kg TP/yr requiring mitigation after the precautionary buffer is applied. A comprehensive, multi-layered mitigation strategy has therefore been developed for The Oaks, aligned with the Welsh Nutrient Budget Calculator (2025) and Natural Resources Wales guidance.

6.1.2 The preferred solution is to achieve neutrality within the site boundary through land use optimisation (Method 1) and high-quality SuDS treatment (Method 2). These measures are embedded in the design, secured through the SAB process, and deliver measurable phosphorus reductions.

6.1.3 Further resilience is provided through catchment-scale betterment, specifically the opportunity to host a combined sewer overflow (CSO) storage tank within the Oaks site (Method 3). This responds directly to the Hydraulic Modelling Assessment (RPS, 2025), which identified the Oaks as the critical location for surcharge risk, and offers significant catchment-wide improvements alongside proportional mitigation of the site's contribution.

6.1.4 Innovative proprietary treatment technologies (Method 4) have also been considered, offering potential supplementary reductions where long-term management and monitoring can be secured.

6.1.5 Finally, should any residual requirement remain, the Welsh Nutrient Budget Calculator includes a Stage 4 option for mitigation through nutrient credit purchase (Method 5). This provides a clear and enforceable backstop, ensuring phosphorus neutrality is achieved in all circumstances.

Table 7: Mitigation Options Summary

Method	Description	Calculator Status	Estimated Benefit	Permanence & Deliverability
1. Land Use Optimisation	Use of greenspace/wetland landcovers to reduce export	Stage 3 (proxy via Wensum/Broads values)	Up to full 2.6kg TP/yr if applied	Secured in site layout; low maintenance
2. On-Site SuDS	Swales, ponds, wetlands providing phosphorus removal	Stage 3S	~2–3kg TP/yr (conservative)	Secured via SAB approval; strong permanence
3. CSO Storage	Below-ground tank to intercept surcharges	Outside calculator; HMA evidence base	Equivalent to ~4.2kg TP/yr captured	Partnership with WW; requires formal agreement
4. Proprietary Treatment	Filter media, reed beds, dosing systems	Not currently creditable	Variable (up to 6+ kg TP/yr)	Requires O&M plan; innovative but supplementary
5. Off-Site Credits	Nutrient credit purchase	Stage 4 (Welsh calculator)	Up to 2.6kg TP/yr	Requires NRW-approved scheme; backstop measure

6.1.6 Taken together, these measures form a robust and comprehensive mitigation strategy. The Oaks not only secures compliance with nutrient neutrality requirements but also provides wider environmental betterment at both site and catchment scale, setting a precedent for future schemes within the Dee catchment.

Appendices

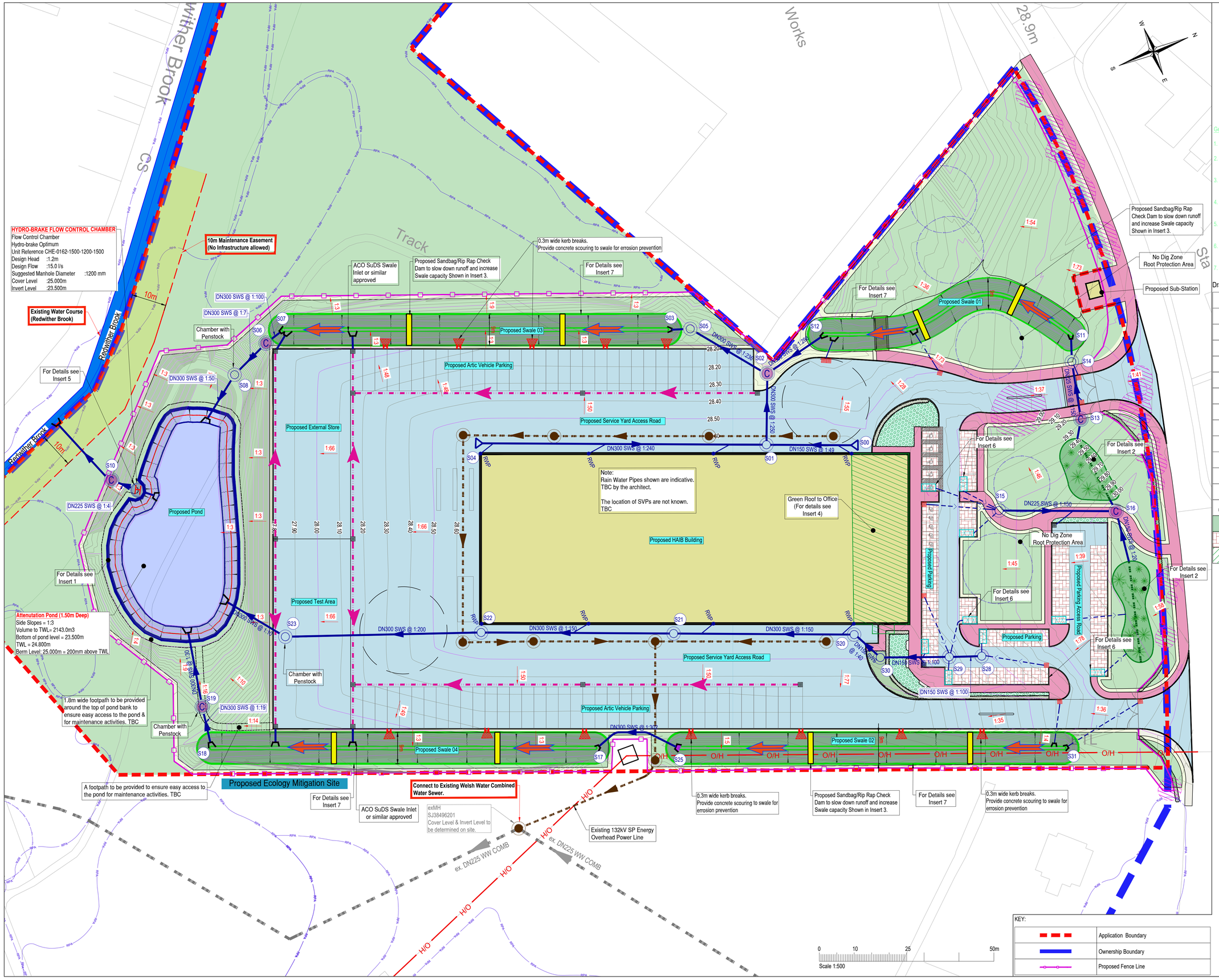
Appendix A- Limitations

Limitations

This report contains recommendations from Arthian, which are based on the information listed in the report and reflect the professional opinions of an experienced Environmental Consultant. Arthian obtained, reviewed, and evaluated information from the Client and others to prepare this report. The conclusions, opinions, and recommendations presented in this report are based on this information. However, Arthian does not guarantee the accuracy of the information provided and will not be held responsible for any opinions or conclusions reached based on information that is later proven to be inaccurate.

This report was prepared exclusively for the Client and for the specific purpose for which Arthian was instructed. It is not intended for use by anyone other than the Client without Arthian's written consent. Any unauthorized use of this report is at the sole risk of the user. Anyone using or relying on this report, other than the Client, agrees to indemnify and hold harmless Arthian from any claims, losses, or damages arising from the performance of the work by the Consultant.

Appendix B- Proposed Development Plan



KEY:

	Application Boundary
	Ownership Boundary
	Proposed Fence Line

Safety, Health & Environmental Information:

In addition to the hazards and risks normally associated with the types of work detailed on this drawing, please note the significant hazards identified by symbols below,

⚠ INDICATES A RESIDUAL RISK AS A WARNING

ⓘ INDICATES A RESIDUAL RISK FOR INFORMATION

and described below:

Construction/Maintenance/Cleaning/Demolition

Refer to Drawing:

General Notes:

1. Do not scale from this drawing.
2. All dimensions are in millimetres (mm), all levels in metres (m) unless noted otherwise.
3. Discrepancies or omissions are to be reported to the Engineer prior to work commencing.
4. Materials and workmanship are to comply in all respects with current British Standard Specifications, Codes of Practice, and Building Regulations Approved Documents.
5. The copyright of this drawing is vested in the Engineer and must not be copied or reproduced without written consent.
6. The Contractor is to check and verify all building and site dimensions, levels and sewer invert levels at connection points before work commences.
7. This drawing is to be read in conjunction with all relevant specifications and drawings issued by the Engineer, Architect and other Specialists.

Drainage Key:

DNXXX SWS @ 1:XXX	Proposed Stormwater
	Proposed ACO Channel Drain
	Proposed Foul Sewer
SXX	Proposed Stormwater Manhole
FXX	Proposed Foul Sewer Manhole
H SXX	Proposed Stormwater Hydro-brake
C S0X	Proposed Ridgistorm Separate Catchpit
	Proposed Road Gully
	Proposed ACO Drain Gully Outlet
	DN150 Gully / RWP Connector
RWP	Proposed Rain Water Pipe
	Proposed Permavoid Diffuser Unit and Connector Dimension: L=708mm x W = 354mm x D = 150m
	Proposed 0.3m wide kerb breaks
ex. DN225 WW COMB	Existing DN225 mm Welsh Water Combined Water Sewer
	Rain Garden
	Permeable Paving
	Green Roof

Rev	By / Chk'd	Date	Description
P04	IW/AM	07/07/2025	Pond realignment
P03	IW/AM	09/06/2025	Updated to suit Pre-SAB comments
P02	IW/AM	20/05/2025	Drainage details updated
P01	IW/AM	04/03/2025	Preliminary issue for client comments

PRELIMINARY DRAWING
This drawing is not to be used for construction

Client

FI REAL ESTATE MANAGEMENT

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BarnsleyMarshall

Project

The Oaks Site
Wrexham Industrial Estate

Drawing

Drainage Plan Layout

By	IW/AM	Date	18/02/2025
Drawing No. (Project / Originator / Volume / Level / Type / Role / Number)	TOS-BML-XX-XX-DR-C-0500	Revision	P04
BML Job No.	1000-06	Status	-
Drawing Scale at A1:	1:500		
CAD Filename:	G:\Opportunities & Projects\319500 - 19999\319585 The Oaks - Phosphates and Nutrient Strategy\MF-3 Data\cadd\Proposed Plans\TOS-BML-XX-XX-DR-C-0500 P04 - Drainage Plan Layout.dwg		

Appendix C- Calculator Inputs

Stage 1

Description of required information	Data entry column - user inputs required
Special Area of Conservation (SAC):	River Dee and Bala Lake/ Afon Dyfrdwy a Llyn Tegid
Postcode:	LL13 9XN
Local Planning Authority (LPA):	**Wrexham County Borough Council**
Rainfall:	**705**
Project type:	Commercial
Development proposal (number of additional units):	1
Not applicable	Not applicable
Not applicable	**Not applicable**
Not applicable	Not applicable
Number of customers / users per unit:	
Water usage per customer / user (litres/person/day):	
Percentage of customers / users from outside catchment:	
Number of employees (per unit):	90
Water usage per employee (litres/person/day):	50
Percentage of employees from outside catchment:	20
Wastewater treatment works:	Five Fords STW
Not applicable	
Not applicable	
Phosphorus permitted limit (mg TP/l):	**1.00**
Nitrogen permitted limit (mg TN/l):	**27.00**
Final calculation of nutrient load from wastewater	
Description of values generated	**Values generated**
Additional population:	**18.00**
Annual wastewater production (litres):	**328725.00**
Annual phosphorus load (kg TP/year):	**0.33**
Annual nitrogen load (kg TN/year):	**8.88**

Stage 2

Physical characteristics			
Description of required information	**Data entry column - user inputs required**		
Soil drainage:	Impeded drainage		
Rainfall identified using postcode (mm/year):	**705**		
Is this rainfall value correct?	No		
Rainfall (mm/year):	675.1 - 700		
Pre-existing landcovers			
Landcover	**Area (hectares)**	**Phosphorus load (kg TP/year)**	**Nitrogen load (kg TN/year)**
Open land – built environment	3.44	**2.53**	**25.94**
Water	0.01	**0.00**	**0.00**
Commercial/industrial land	0.17	**0.17**	**1.16**
Greenspace	18.04	**0.36**	**54.12**
		0.00	**0.00**
		0.00	**0.00**
		0.00	**0.00**
		0.00	**0.00**
		0.00	**0.00**
		0.00	**0.00**
		0.00	**0.00**
		0.00	**0.00**
		0.00	**0.00**
		0.00	**0.00**
		0.00	**0.00**
Total:	**21.66**	**3.06**	**81.22**

Stage 3

New landcovers				
Landcover	**Area (hectares)**	**Phosphorus load (kg TP/year)**	**Nitrogen load (kg TN/year)**	**Notes on data**
Open land – built environment	5.2	**3.83**	**39.21**	**Not applicable**
Water	0.63	**0.00**	**0.00**	**Not applicable**
Commercial/industrial land	0.77	**0.77**	**5.25**	**Not applicable**
Greenspace	15.06	**0.30**	**45.18**	**Not applicable**
		0.00	**0.00**	**Not applicable**
		0.00	**0.00**	**Not applicable**
		0.00	**0.00**	**Not applicable**
		0.00	**0.00**	**Not applicable**
		0.00	**0.00**	**Not applicable**
		0.00	**0.00**	**Not applicable**
		0.00	**0.00**	**Not applicable**
		0.00	**0.00**	**Not applicable**
		0.00	**0.00**	**Not applicable**
		0.00	**0.00**	**Not applicable**
Total:	**21.66**	**4.90**	**89.64**	**Not applicable**

Stage 4

Total phosphorus budget	
Description of phosphorus values generated	**Values generated**
Stage 1 phosphorus load (kg TP/year):	**0.33**
Stage 2 phosphorus reduction (kg TP/year):	**3.06**
Stage 3 phosphorus load (kg TP/year):	**4.90**
Stage 3S phosphorus load removed through SuDS (kg TP/year):	**0.00**
Phosphorus budget ((Stage 1 - Stage 2) + (Stage 3 - Stage 3S)):	**2.17**
Phosphorus budget + 20% buffer	**2.6 kg TP/year requires mitigation**
Total nitrogen generated	
Description of nitrogen values generated	**Values generated**
Stage 1 nitrogen load (kg TN/year):	**8.88**
Stage 2 nitrogen reduction (kg TN/year):	**81.22**
Stage 3 nitrogen load (kg TN/year):	**89.64**
Stage 3S nitrogen load removed through SuDS (TN kg/year):	**0.00**
Nitrogen budget ((Stage 1 - Stage 2) + (Stage 3 - Stage 3S)):	**17.30**
Nitrogen budget + 20% buffer:	**20.76 kg TN/year will be generated**
Calculator version 2 - July 2025	

Appendix D- RPS Hydraulic Modelling Assessment

Dŵr Cymru
Welsh Water

Developer Services Hydraulic Modelling Report

Land East of Bryn Lane, Wrexham – Hydraulic Modelling Assessment

Prepared By	Date	Approved By	Date	Rev	Section(s)	Comments
Ben Cooper	19/04/2024	Zoë Hancock	29/05/2024	1	1-5	Draft
Ben Cooper	31/05/2024	Matthew Frost	03/06/2024	All	Final	Final Issue

Dŵr Cymru
Welsh Water

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Executive Summary

RPS were appointed in 2023 to undertake a Hydraulic Modelling Assessment (HMA) for a proposed 25 hectare development comprising of three warehouse units, potentially providing employment for up to 1,033 people. The development is located on the land to the east of Bryn Lane, at Wrexham Industrial Estate, within the Five Fords (Wrexham) Wastewater Treatment Works (WwTW) catchment. Dŵr Cymru Welsh Water (DCWW) has advised in order for the increase in flow and volume to be permitted a Hydraulic Modelling Assessment (HMA) must be carried out on the sewer network to identify what affect this development may have on the existing network.

The proposed connection point for the development is manhole SJ38509101 located on Bryn Lane, on a sewer leading down to Wrexham Industrial Estate SPS (asset ID 1260). The SPS provides an existing break point between the industrial estate where the development is located and the WwTW. The development will be delivered in one phase and, due to the site topography, will be connected via an onsite SPS.

A hydraulic model of the Five Fords WwTW catchment exists, the model was last fully verified in AMP5 (2014) for the catchment Sustainable Drainage Plan (SDP). Since then, the model has been updated by WSP in AMP6 SDP, although there is no supporting information about the upgrades made. The model has also undergone other phases of updates with additional studies being undertaken on the model. The model was partially verified most recently in 2023 for Lower Berse Farm HMA.

The model was upgraded using survey data collected for this HMA as well as any other available supporting documentation. The upgraded base model then went through hydraulic assessments to determine the impact of the development upon the existing network. The assessment revealed that the addition of the development caused 11 manholes to experience flooding detriment, totalling 239.0 m^3 throughout the industrial estate (see Figure 6).

Based on the detriment assessment, three solutions have been developed which adequately resolve the detriment caused by the development. These solutions are:

- Solution 1 – Increasing the maximum pass forward capacity of Wrexham Industrial Estate SPS by 9 l/s. The cost for this solution is £295,000. This option may incur a much higher cost if an entirely new rising main is required, increasing the cost significantly to £4,265,000.

- Solution 2 – A total of 1.375 hectares of surface water removal upstream of the Wrexham Industrial Estate SPS. The cost for this solution is £810,000.

- Solution 3 – A combined solution which incorporates both the addition of 548 m^3 of below ground storage upstream of Wrexham Industrial Estate SPS and a total of 0.176 hectares of surface water removal. The cost for this solution is £1,290,000.

The preferred option for this development is solution 2. The green aspect of the solution 2 is also preferred over the grey, hard engineering solutions.

1 Introduction

1.1 Appointment

RPS were appointed by Dŵr Cymru Welsh Water (DCWW) in 2023 to undertake a Hydraulic Modelling Assessment (HMA) for a proposed 25 hectare development comprising of three warehouse units, potentially providing employment for up to 1,033 people. The development is located on the land east of Bryn Lane, at Wrexham Industrial Estate, within the Five Fords (Wrexham) Wastewater Treatment Works (WwTW) catchment.

Dŵr Cymru Welsh Water (DCWW) has advised that the existing public sewerage system is unlikely to have sufficient capacity to accommodate the additional flows generated by the development. An HMA has been undertaken to establish whether a point of adequacy exists within the network. The purpose of this HMA is to quantify the effects that the development would have on the existing sewer network performance and identify notional solutions to resolve any potential detriment and consider further recommendations.

This report presents the findings of the HMA for the proposed Land East of Bryn Lane development.

1.2 Development Site

- Size – Three warehouse units covering 25 hectares and potentially providing employment for up to 1,033 people.
- Location – Located on land east of Bryn Lane. This is located to the east of the Wrexham Industrial Estate which is in itself the eastmost point of the Five Fords (Wrexham) catchment.
- Topography – The development area generally slopes down towards the east. The highest point is approximately 32 mAD in the southwest corner, and the lowest is on the east side at approximately 23 mAD. The site is proposed to connect to the sewer around the southwest corner of the development which is also the highest point.
- Previous/Current Usage – Greenfield site.
- Proposed Usage – Entirely industrial use.
- Sewerage Details – The development is proposed to connect to the existing network at manhole SJ38509101.
- Connection Type – The site slopes down towards the east, meaning that much of the site lies below the estimated ground level of the connection point. Therefore, it is considered likely that at least part of the development will have to be pumped to the connection point. For the purpose of this HMA it is assumed that the development is to be pumped.
- Phasing – No phasing details have been provided so it is assumed the development is to be delivered in one phase.
- Surface Water – No surface water plans have been provided by the developer.

1.3 Background Information

The proposed Land East of Bryn Lane development is within the Five Fords (Wrexham) Wastewater Treatment Works (WwTW) catchment.

A hydraulic model of the Five Fords WwTW catchment exists, the model was last fully verified in AMP5 (2014) for the catchment Sustainable Drainage Plan (SDP). Since then, the model has been updated by WSP for the AMP6 SDP, although there is no supporting information about the upgrades undertaken. Other upgrades were also undertaken throughout AMP6, namely Bangor Road HMA, Stansy Road HMA and the Wynstay Avenue scheme, which was undertaken by Arup. Gatewen Road HMA was undertaken in 2022. The model was last partially verified in 2023 for Lower Berse Farm HMA.

The model was upgraded to InfoWorks ICM 9.5 for the AMP7 DWMP. Following the upgrade to the newer version of the InfoWorks ICM 9.5.5, a series of model upgrades were performed as part of the DWMP. The main updates to the model included the addition of new network around the New Broughton area which comprises of two pumping stations.

The Land East of Bryn Lane development is planned to go ahead in the Wrexham Industrial Estate, an area of the model which is connected to the WwTW via Wrexham Industrial Estate SPS (Asset ID 1260). This pump creates a break in the network. The most recent updates to the modelling of the industrial estate took place in 2015 when RPS undertook an HMA on a prison which was proposed to be added to the network.

The starting model used for this study is based on the model used for the Lower Berse Farm HMA. This is believed to be the most recent model with the greatest confidence.

2 Land Usage

The proposed development is planned to be delivered in one phase. The development will cover an area of approximately 25 hectares, consisting of three warehouse units providing employment for up to 1,033 people.

Subject to final development plans being provided, it is assumed that the roof area of the warehouses will take up half of the total development area.

The warehouse units will connect to the existing sewer network at manhole SJ38509101 via a pumping station. Table 1 shows the details of the proposed development.

Description / Name	Type	Area / No. of Units	No. of Staff	Discharge Vol. (m^3/day)	Discharge Rate (m^3/hr)
Warehouses	Dry Industry	12.5 ha / 3 units	1,033	99.59	4.156

Table 1 – Proposed Non-Domestic Development Contribution.

2.1 Proposed Connection Details

The following connection points have been proposed by developer/modeller:

Connection Point 1: Manhole reference SJ38509101 is the only connection point provided.

Figure 1 shows a plan of the development site and proposed connection point. Based on the development details provided/desk top assessment, the topography of the catchment suggests that the flows from the development would require a pumped connection to the connection point.



Figure 1 – Development Site Overview Plan - Including Connection Point SJ38509101.

3 Developed System Modelling

3.1 Model Build / Enhancement

Model updates were required for this HMA to improve confidence in model predicted flooding. Data to assist the model build / enhancement was obtained from the following sources:

- Existing DCWW Geographical Information Systems (GIS)
- Manhole Survey
- Impermeable Area Survey (IAS)
- SPS Survey

It should also be noted that this HMA has been undertaken concurrently with two other studies. These studies include their own survey data which has also been input into this model. The survey data from these studied comprised of:

- Manhole Survey
- Impermeable Area Survey (IAS)

The following sections detail the infill data used to build / enhance the hydraulic model and the other model build activities undertaken to ensure the model was suitable to undertake the HMA assessment.

3.1.1 STC25 Manhole Survey

As part of this study a manhole survey consisting of 10 manholes was commissioned to supplement the existing DCWW GIS data. Further manhole survey data was collected as part of two separate studies in the catchment, one of which (10 manholes) was located within Wrexham Industrial Estate. This survey data has also been added to the model.

This survey data was identified with the InfoWorks flag “SA” and notes included within the model. Figure 2 shows the locations of the manholes that were surveyed for this study.

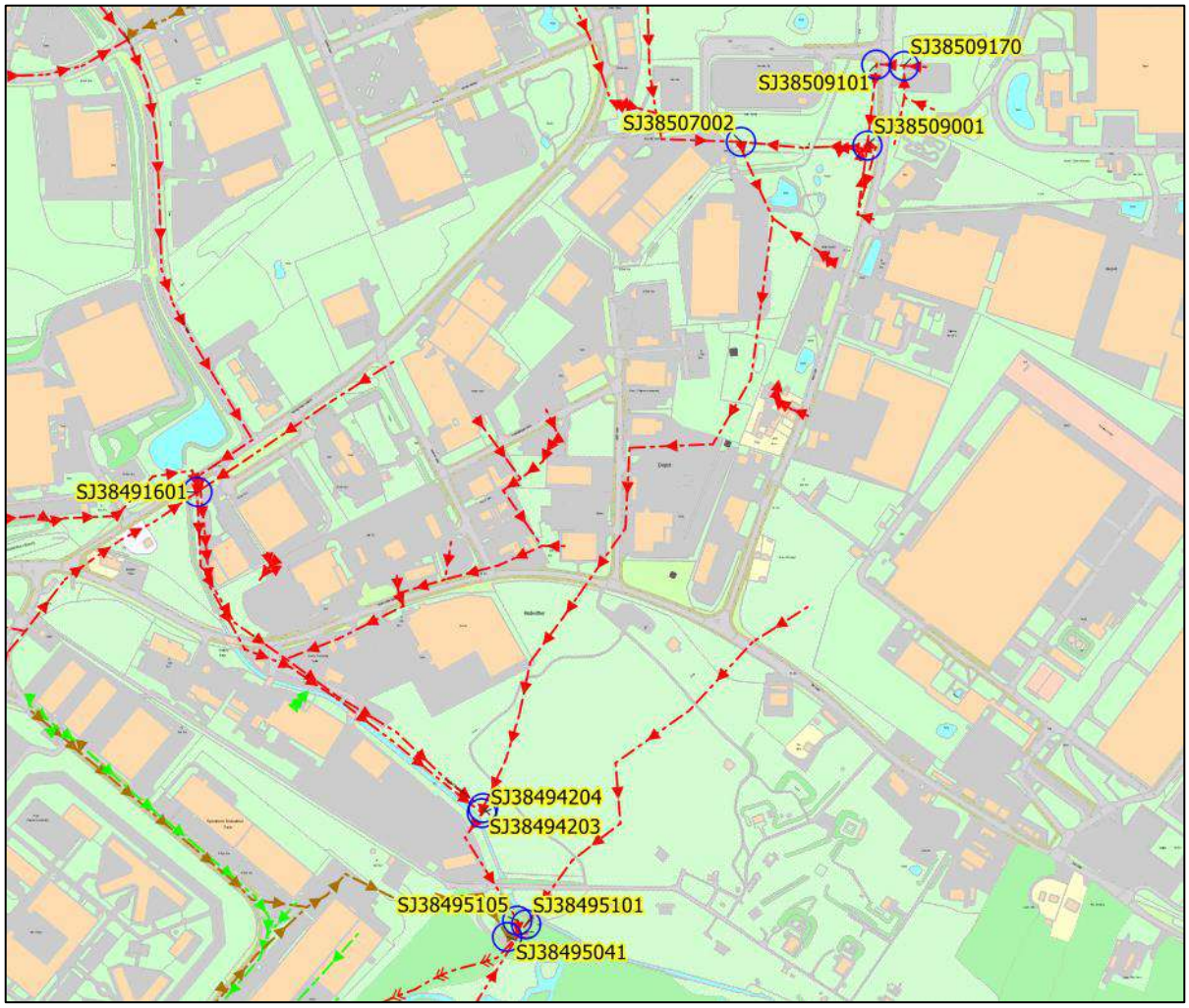


Figure 2 – Manhole survey locations overview.

3.1.2 Impermeable Area Survey (IAS)

15 hectares of IAS were requested to supplement previous surveys. The aim was to improve model flow predictions by increasing the confidence of contributing impermeable areas to the network. This information can also be used to find opportunities for surface water removal to offset development flows if solutions are required. The impermeable area survey was conducted downstream of the proposed development to gain a better understanding of the flows arriving at Wrexham Industrial Estate SPS.

An additional 21 hectares of IAS has been undertaken for other studies within the catchment which are being undertaken concurrently with this study.

All historical IAS that was collated for this study from the DCWW database was also considered and incorporated into the model where it had not been previously.

This survey data was identified with the InfoWorks flag “SA” and detailed notes included within the model. Figure 3 shows the location of the IAS within the Wrexham Industrial Estate.

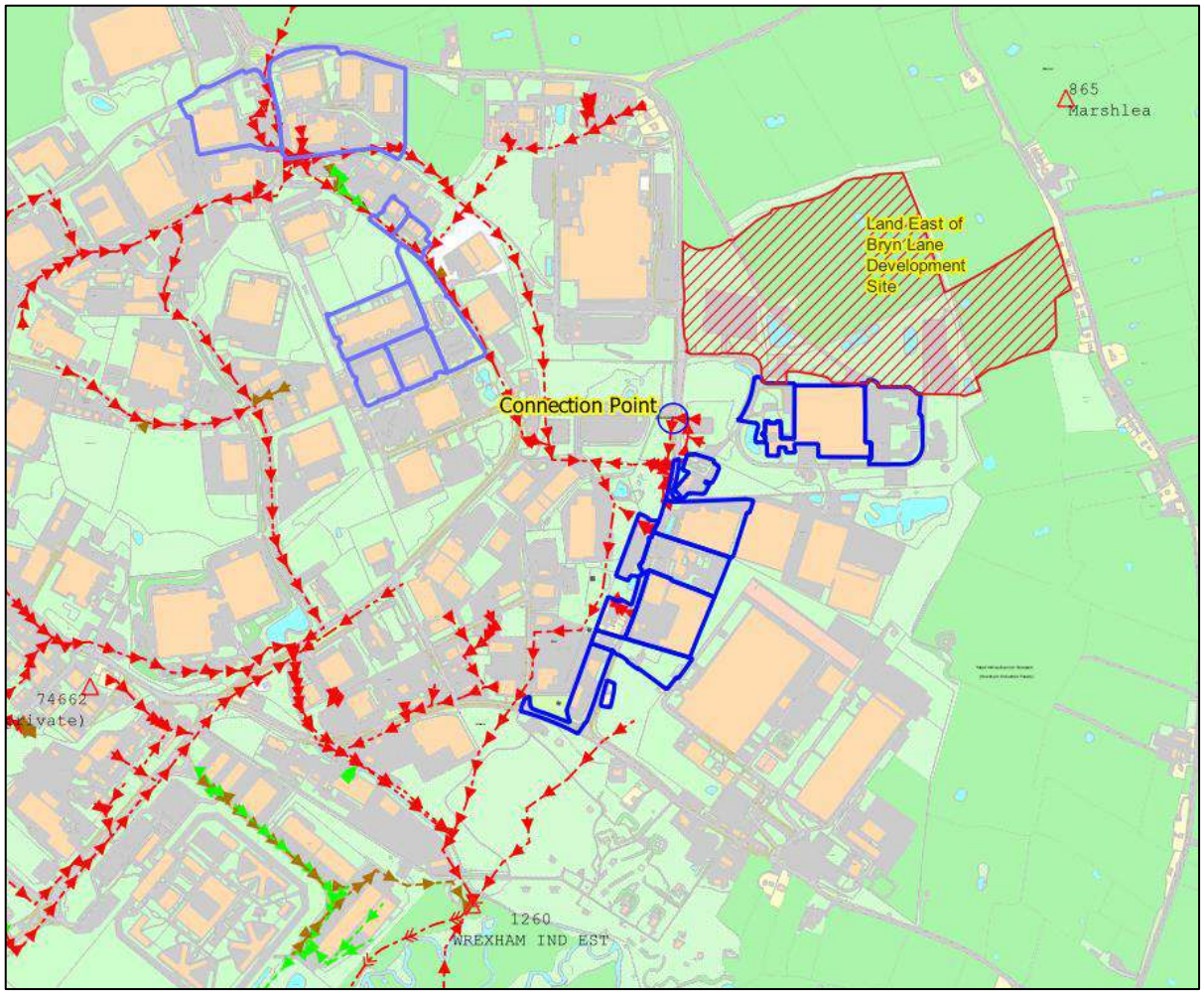


Figure 3 – Impermeable area survey overview showing the location of the development and connection point.

Note: Both Land East of Bryn Lane IAS (dark blue, south of the development) and the IAS for another study in the area (pale blue, west of the development) are shown above.

3.1.3 SPS Survey

A survey on Wrexham Industrial Estate SPS (asset ID 1260) has been undertaken for this study. The survey showed that the SPS is a variable speed pump and consequently has been modelled using a real time control (RTC). There remain some uncertainties with a variable speed pump that have been inferred or assumed. The SPS modelling was also compared to telemetry data to ensure that all inferences and assumptions are reasonable.

This survey data was identified with the Info works flag “SA” and notes included within the model. Figure 4 shows the location of Wrexham Industrial Estate SPS.



Figure 4 – Location of Wrexham Industrial Estate SPS.

3.1.4 Summary of Model Build / Enhancement Activities

Model build activities were undertaken in consideration of the surveys and the addition of the development. This included the addition of the survey data mentioned in the previous sections.

One key change to the modelling of the industrial estate was the addition of the prison (HMP Berwyn) to the model. When considering the DCWW specification the most appropriate commercial flow derivation for a prison is accommodation (non-domestic). This gives a daily flow rate of 73,260 l/day/ha, considering a 2.69 hectare roof area, resulting in a total estimated flow of 2.28 l/s. Trade profile 1 (24 hour continuous flow) was used. Due to the age of the prison and connectivity of the surrounding network, it was assumed that all impermeable area will contribute to the storm network. An HMA for the prison was undertaken by RPS in 2015 and this was used as the base for the prison modelling.

The 2015 HMA and 2023-2024 flow survey data show that it is likely a pumped connection. Both the above ground and the below ground modelling of the prison was reviewed as part of the verification process (section 3.2) and the model underwent the relevant changes based on the flow survey data.

The model was reviewed against the latest DCWW model build and verification specification to identify any necessary updates. There were no immediately obvious errors in the modelling of the industrial estate and the modelling was generally up to DCWW specification standards.

3.2 Verification

A short-term flow survey was conducted, comprising of four flow-monitors (FMs), and two rain-gauges (RGs) located within the industrial estate area. There were an additional two rain gauges installed for another flow survey undertaken over the same period. To gain the best possible coverage of rainfall data across the catchment the data from these gauges was also used to aid the verification.

This part of the model (Wrexham Industrial Estate) has never undergone any level of verification. Figure 5 shows the locations of all four flow monitors and two rain gauges.

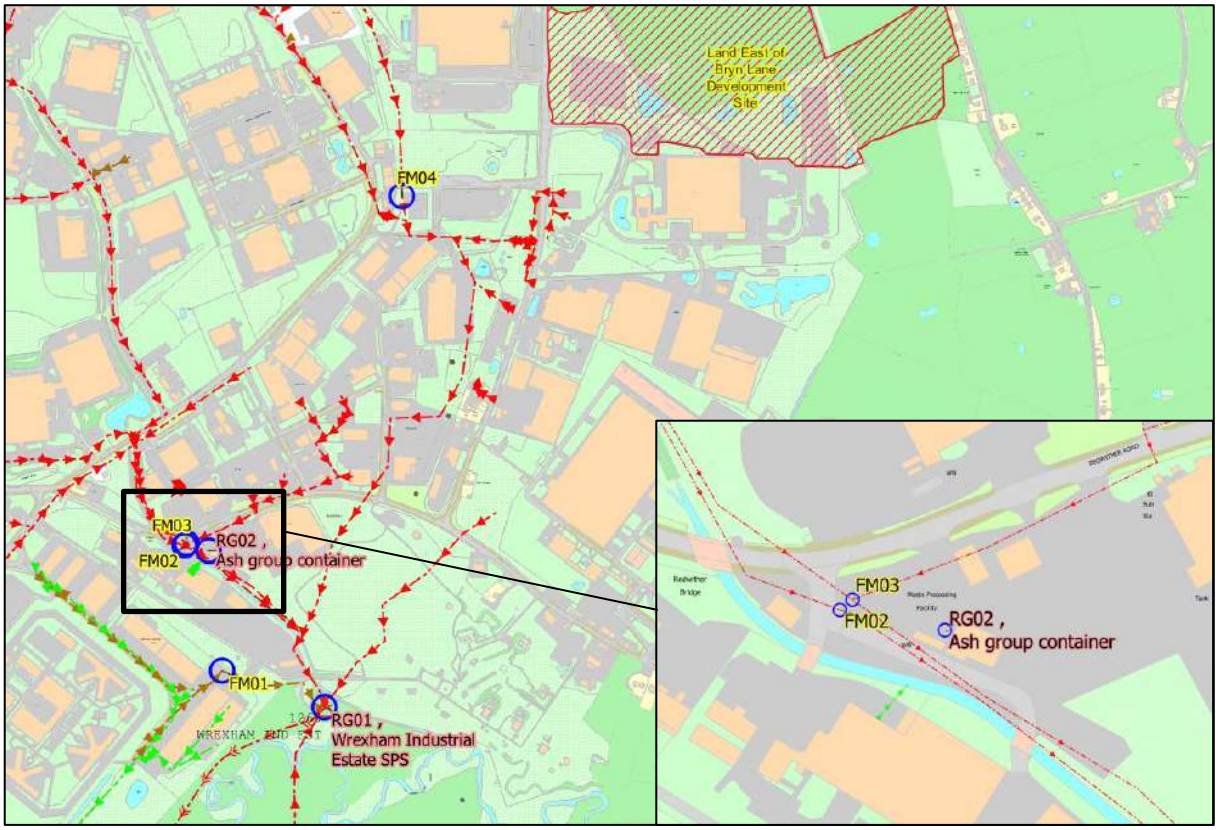


Figure 5 – Flow monitor and rain gauge location plan.

The flow survey began on 12/12/2023 and was terminated on 06/02/2024, a total duration of 56 days.

The performance of the system was initially verified for Dry Weather Flows using diurnally varying profiles.

The model was then run using four storm events observed during the flow survey that achieved the specific requirements as stipulated in the CIWEM UDG Code of Practice.

The resulting model predictions of the flow, depth and velocity were compared to those observed during the flow survey. Where significant differences were found between predicted and observed data, justifiable amendments to the model were made, especially where previously interpolated levels had been used. The model was then refined by a process of continuing iteration until reasonable verification plots were obtained.

Verification graphs are shown in Appendix B.

Table 2 shows a summary of the flow monitor locations as shown in Figure 5.

Flow/Depth Monitor	Manhole Ref.	Model Conduit Ref.	Pipe Size (mm)	Date Installed	Date Removed
FM01	SJ38493149	SJ38492173.1	300	12/12/2023	06/02/2024
FM02	SJ38492402	SJ38492404.1	375	12/12/2023	06/02/2024
FM03	SJ38492403	SJ38492403.1	375	12/12/2023	06/02/2024
FM04	SJ38506003	SJ38506003.1	300	12/12/2023	06/02/2024

Table 2 – Flow Monitor Location Details.

3.2.1 Dry Weather Flow Verification

Two dry days were selected for the Dry Weather Flow (DWF) verification:

- Thursday 11th January 2024
- Friday 12th January 2024

FM01

The SPS at HMP Berwyn had too many activations so the pump rate was increased to 17 l/s, the on level was increased and the wet well size was increased.

Trade flow from the prison was increased to 4.25 l/s and baseflow was added upstream of the flow monitor. Trade flow from businesses upstream was also increased to 2.52 l/s to better reflect the 12 hour profile in the observed data.

Finally, 100 mm sediment depth was added, and pipe roughness was changed to 30 (Colebrook-White mm) on the line between the prison and Wrexham Industrial Estate SPS.

FM02

The quality of data recorded at FM02 was poor. The flow data regularly dropped out and was inconsistent throughout. This is likely due to both sediment creating problems for the flow monitor and velocity dropouts as a result of surcharging from downstream. The high levels of observed sediment are likely caused by the large amount of trade effluent upstream. Due to the poor quality of the flow data the monitor was mainly verified to depth.

All upstream baseflow was removed to get a slightly improved match on flow data when the data was okay. Due to the poor quality of flow data at this monitor, this level of verification was deemed acceptable.

FM03

As with FM02, the quality of data recorded at FM03 is poor. The flow data regularly dropped out and was inconsistent throughout.

The only change required for this flow monitor was to change the profiles of the upstream trade flow. The model predicted too much variation in flow throughout the day so changing the profiles from 12 hour to 24 hour better replicated the observed flow pattern.

FM04

The data clearly showed that there is something being pumped upstream which was not replicated in the model. Analysis of Google Earth shows that it is likely the Kellogg's factory (located just north of the monitor). An SPS was added to the model with assumed on/off levels, pump rate, and wet well capacity.

Sediment and roughness were also added to reflect the observed depths.

3.2.2 Storm Flow Verification

Four storm events were selected for storm flow verification. These are detailed in Table 3 below.

Event	Date	Weekday	Start Time	End Time	Duration (hrs.)	Peak Intensity (mm/hr.)
A (Partial)	30/12/2024	Saturday	13:00	17:00	4	24
B (Reduced Intensity)	21/01/2024	Sunday	18:00	22:00	4	6
C (Reduced Intensity)	01/01/2024	Monday	15:00	21:00	6	6
D (Reduced Intensity)	02/01/2024	Tuesday	08:00	17:00	9	6

Table 3 – Flow Survey Storm Events.

FM01

Observed data shows there is slow response from both the prison and elsewhere. Therefore, two ground infiltration (GI) subcatchments were added, one from inside the prison (2 hectares) and one from upstream of the prison (8 hectares). This addition is supported by the large green areas surrounding the industrial estate where infiltration is likely to occur.

FM02 and FM03

FM02 and FM03 were located on parallel pipes approximately 425 m upstream of the Wrexham Industrial Estate SPS (Figure 4). As these two monitors are so clearly hydraulically linked their verification was conducted simultaneously.

All the data shows that flows were surcharging from the Wrexham Industrial Estate SPS up the two lines to FM02 and FM03. There is also a lot of evidence for the network flooding in the surrounding area; for instance, several manhole surveys undertaken in the area showed signs of flooding. This included discharge on the ground around the manhole, and a manhole lid being physically moved as a result of pressure from the surcharging.

The shape of the peaks in surcharging made it clear that the reason for this was some kind of GI rather than solely impermeable area. The IAS also showed that most of the roof area in the industrial estate drains to storm anyway.

A total of four GI subcatchments were added to represent the slow response. These subcatchments had 50 hectares of GI with 0.5 percolation coefficient, 40 hectares of GI with 3.0 percolation coefficient, and 10 hectares of GI with 0.1 percolation coefficient. This very large amount of GI is supported by the fact that the lines going into the wet well all run through heavily wooded areas with several streams and brooks. Therefore, it is likely that when the levels in these streams and brooks gets above the cover level of the manhole's flows will spill directly into the network.

Other changes that were made for these flow monitors were:

- Re-defining the flood types for the industrial estate,
- Inferring ground levels from LiDAR around the flow monitors.

These changes managed to achieve an acceptable level of verification for this study. To fully understand the flows to the pumping station a much more detailed study would be required. On the evidence available at present the best possible match has been achieved however several assumptions have had to have been made surrounding the GI.

FM04

The predicted response to rainfall was much faster than observed. As a result, all of the contributing area from Kellogg's was removed and GI added to replicate the observed storm response shape. 7.0 hectares of GI was added upstream of the flow monitor where pipes run under trees and infiltration is likely.

3.3 Historical Verification

A review of DCWWs flooding incident databases has been undertaken to determine where historical reports of flooding have been recorded within the catchment.

Design storms based on a 1, 2, 5, 10, 20 and 30 year return periods were simulated with the verified model to determine where the model predicts flooding.

The model predicts flooding at several locations throughout the industrial estate, with the highest volumes of flooding located around the pumping station. There is no evidence of flooding from the DCWW flooding incident database in this area. This is possibly because the industrial estate is mostly trade, the flooding incidents may not be reported as readily as if they were in residential areas. Similarly, the flooding locations are mostly in wooded areas near rivers or streams so any flooding from these manholes would likely go unnoticed and unreported.

About 400 m from the predicted flooding locations, upstream of the Wrexham Industrial Estate SPS, there are areas of reported flooding. This makes sense as the topology of the catchment suggests any flooding, especially in larger volumes, would also impact these areas.

Telemetry (depth) data was collected for the Wrexham Industrial Estate SPS wet well for the same duration as the flow survey. This data showed that the flows were beating the pump and causing the flows to surcharge to the flow monitors. The telemetry data however was poor quality so verifying against this data was difficult. The telemetry data supported what was shown in the flow survey data and therefore supported the changes laid out in section 3.2.2.

3.4 Verification Summary

Verification was undertaken against the flow survey data to increase the confidence in the modelling. The main changes were:

- The addition of an SPS at the Kellogg's factory,
- Long section re-modelling around FM02 and FM03,
- Changes to the assumed SPS at HMP Berwyn,
- The addition of seven GI subcatchments, totalling 117 hectares.

There are still some unknowns surrounding how the network surcharges, which was difficult to recreate in the model. Further investigation would be required into what is causing the network to surcharge, as well as the flooding that was observed in the manhole survey data upstream of Wrexham Industrial Estate SPS.

The model has been verified and is considered acceptable for assessing the impact of the proposed development on the existing combined network. Verification graphs are presented in Appendix B.

3.5 Model Assumptions & Limitations

A number of assumptions have been made during the model build and verification. The hydraulic model utilised for this HMA study is also considered to have some limitations. Below is a list of these assumptions and limitations:

- Large amounts of GI have been added in response to the flow survey data; however, it is not known how or where exactly the infiltration is entering the network.

- It is possible that the rivers around the pumping station are interacting with the network. It is possible that when the river level gets above a certain threshold it is spilling directly into an upstream manhole, or the opposite is possible, effluent from the network is flooding out of a manhole directly into the river unnoticed.

- Wrexham Industrial Estate SPS is modelled based off 2024 survey data. The survey data showed that the pump is a variable speed pump and has been modelled as accurately as possible with that information. The SPS is linked to the flooding observed and predicted upstream and therefore additional data could help better represent the reasons for the surcharging observed at FM02 and FM03.

- The confidence of the impermeable area within the industrial estate is limited. The majority of the area has not been surveyed, and there is no supporting documentation for why some of the area has been set to contribute to the foul network.

- No survey has been undertaken to determine how HMP Berwyn connects to the network, so the modelling has been assumed based on the 2015 HMA and the flow survey data.

- No survey has been undertaken to determine how the Kellogg's factory connects to the network, so an SPS has been assumed based on flow survey data and GIS data.

- Private connections have not been represented within the model.

- Developer services have not provided any details regarding the connection of the development, so it has been modelled based entirely on assumptions.

4 Development System Analysis

4.1 Dry Weather Flow

The DWF for the development has been calculated as below for the total development. The DWF parameters are shown in Table 4.

Parameter	Value	Comment
Development site area	24.898 ha	
Building Area	12.449 ha	Assumed as half of the total development site area
Maximum No. of Staff	1,033	Not used in DWF calculations but outlined by developer services
Daily Trade Flow Rate	8,000 l/ha/day	Daily flow rate provided by DCWW specification for dry Industry (e.g., warehousing)
Trade Profile	1	24 hours continuous (Weekdays and Weekends)
Trade Flow – E	1.152685 l/s	Calculated as the daily flow rate multiplied by the assumed building area
Infiltration – I	0.115269 l/s	10% DWF (trade) assumed
Total DWF Calculations		
Total DWF	**1.267954 l/s**	PG + I + E
DWF Peak Hydraulic Assessment Multiplier	**1 and 2**	DWF Peaking factor for CSO (1) and flooding (2) level of performance investigation.

Table 4 – HMA – DWF Parameters – Single Phase (Total).

4.2 Surface Water Run-off

The developer has been advised that surface water runoff is to be separated from foul flows and it will not be discharged into the existing foul/combined system. The HMA specification states that potential misconnections and creep should not be considered in the assessment.

5 Existing / Developed Comparison

5.1 Hydraulic Assessment

Design storms based on a 30-year return period were used to determine the potential flood volumes in the existing and development scenarios. Winter and summer design storms with durations of 15, 30, 60, 90, 120, 240, 360, 480, 720, 960 and 1440 minutes were applied to the existing and developed models. Summer events were considered the 'worst case' scenario. It has been found that most flooding incidents occur during the 1440-minute summer storm duration. However, model predicted flood volumes vary with the duration of event and therefore all storm durations have been assessed to highlight the worst-case scenario. Existing flooding is predicted at a number of locations downstream of the connection point. The flooding is caused by a localised hydraulic incapacity and is affected by the development flows. The flooding reported in the tables below focuses on the locations where there is historically reported flooding and the model predicted detriment is greater than 1 m^3. See Figure 6.

5.1.1 Scenario 1A – Single Phase 1 – SJ38509101

This scenario assesses the impact of the development connecting to SJ38509101 for the future scenario comprising of three warehouse units. Table 5 shows a summary of the flooding detriment results.

Model Node ID	Critical Duration (min)	Flood Volume (m^3)		Flooding Detriment	
		Existing	Developed	Absolute (m^3)	Percentage (%)
SJ37494506*	240 - summer	868.1	869.1	1	0%
SJ38484801	1440 - summer	773.6	775.1	1.5	0%
SJ38493301	960 - summer	34	38.6	4.6	14%
SJ38493304	1440 - winter	399.1	403.9	4.8	1%
SJ38494201	1440 - winter	562.9	567.8	4.9	1%
SJ38494203	1440 - summer	1422.4	1427.5	5.1	0%
SJ38495101	1440 - summer	9626.4	9683.6	57.2	1%
SJ38495105	1440 - summer	5798.8	5837	38.2	1%
SJ38505502	1440 - summer	244.2	245.2	1	0%
SJ38494202	1440 - winter	14500	14612.9	112.9	1%
SJ38494204	1440 - summer	1610.7	1615.7	5	0%
SJ38494205	90 - winter	270.8	274.6	3.8	1%

Table 5 – Hydraulic Assessment Results – Scenario 1A Phase 1 (Total).

Note: The manhole highlighted with * is located in the storm network and therefore is not hydraulically linked to the development. Any detriment at these manholes is considered to be caused by a modelling instability.

The majority of the flooding detriment is located upstream of the Wrexham Industrial Estate SPS. This shows that the flows entering the pumping station are beating the pump rate for longer periods. This is to be expected as all of the observed data and the verification shows that the network was surcharging from the SPS up towards the locations of FM02 and FM03. Detriment at SJ37494506 should be discounted from this assessment as this is a storm manhole, meaning it is not hydraulically linked to the development and can be assumed is a modelling instability.

None of the nodes experiencing flooding detriment are new flooders. The model predicts a total detriment of 239.0 m^3 of detriment in the foul/combined system.

Figure 6 shows the locations of the manholes experiencing flooding detriment stated in Table 5.

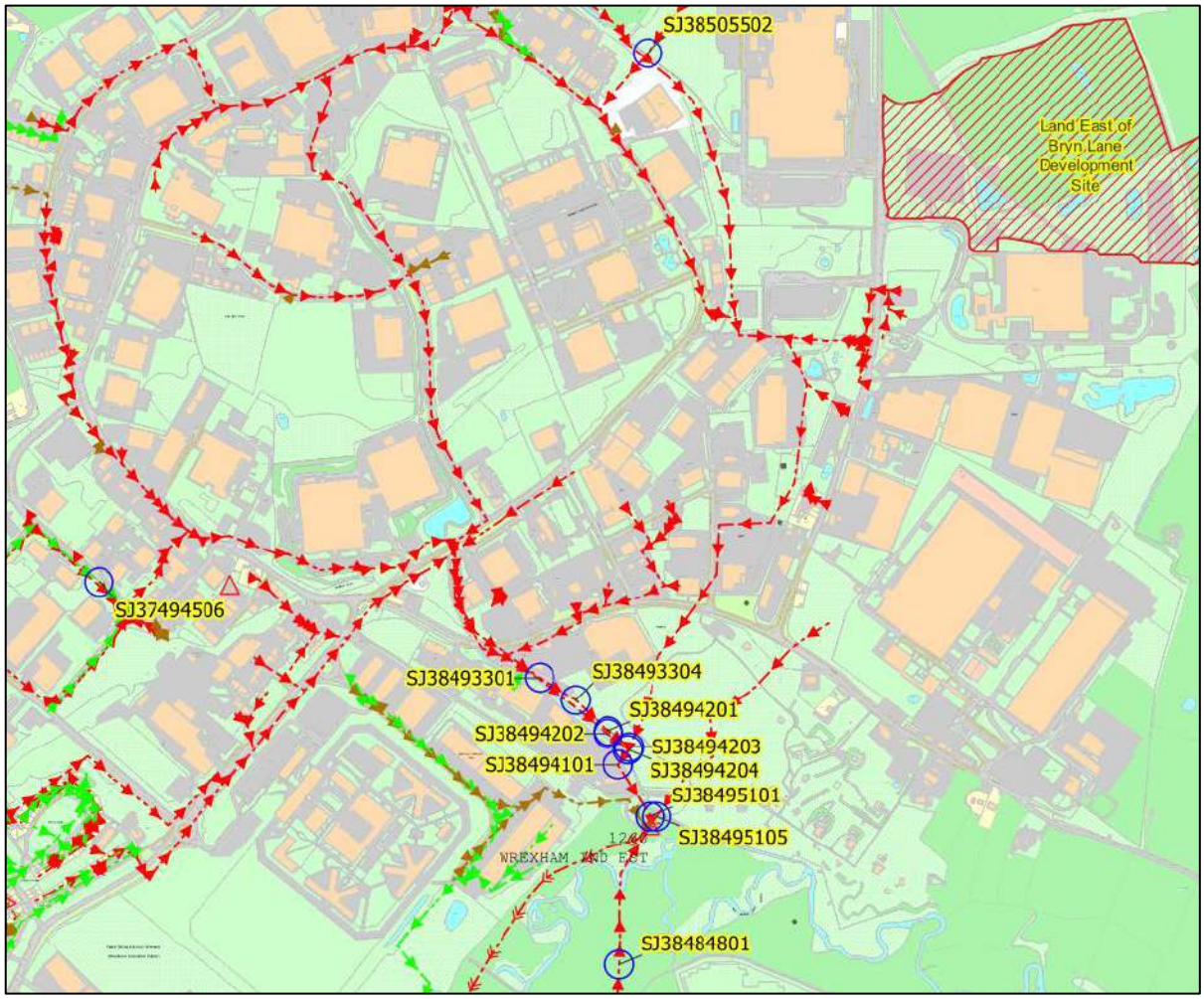


Figure 6 – Model Predicted Flooding Detriment Location Plan – Total Development.

5.2 CSO Assessment

There are two overflows located downstream of the development that could be potentially impacted by additional flows. These overflows are:

- Five Fords D Works CSO (3099),
- Five Fords F Works CSO (2193).

Both of these overflows are located at Five Fords (Wrexham) WwTW. No detriment assessment was proposed for the above overflows. As the two overflows are situated at the treatment works and the consented FFT is 802 l/s, the additional flows from the development (1.27 l/s) would have an almost negligible impact. The flows from the development are expected to constitute less than 0.16% of the FFT. Given the lack of other overflows downstream of the development, it was determined that overflow detriment assessments are not required for this study.

5.3 SPS Assessment

The impact of development flows has also been assessed at relevant downstream SPS in relation to operational performance including number of pump starts, pump runtimes and pump volumes. The assessment also determines the impact on emergency storage requirements. The normal requirements for emergency storage are for 2 hours of storage at 3DWF.

Storage calculations are presented in Table 6.

	3DWF	Pump Rate	Storage (2hrs @ 3DWF)	Pump Rate Acceptable	Storage Acceptable
Current	-	132.0 l/s *	258.52 m^3	-	-
Existing	76.58 l/s	-	551.4 m^3	Yes	No
Developed	80.39 l/s	-	578.8 m^3	Yes	No

Table 6 – SPS Assessment Emergency Storage – (Total).

Note: Wrexham Industrial Estate SPS is a variable speed pump, therefore the pump rate is not consistent. The value (*) stated in Table 6 is the base pump rate input into the model, as per the 2024 survey.

The existing pump rate is shown to be well within the requirements for pump rate in both the existing and the developed scenarios.

The current storage volume in the pump wet well (above duty start) and the upstream network below the lowest escape point (in this case manhole SJ38494204) was calculated as approximately 258.52 m^3.

The emergency storage requirement for the developed situation is 515.4 m^3 rising to 578.8 m^3 with the inclusion of the development.

This means that the emergency storage of the SPS is approximately half of what is required without the development and under half of what is required with the development. This is reflected in the model with significant flooding at the lowest escape point (SJ38494204) in the model, which is also supported by survey data. Manhole SJ38494204 was surveyed for this study, and it was determined that there was significant evidence of flooding at the site.

Pump performance results are presented in Table 7.

SPS Name	Existing		Developed		Run Time Difference		Run Volume Difference	
	Run Time (mins)	Run Vol. (m^3)	Run Time (mins)	Run Vol. (m^3)	Absolute (mins)	Percentage (%)	Absolute (m^3)	Percentage (%)
Wrexham Industrial Estate SPS	147,174	1,165,620	151,657	1,201,119	4,483	3.05	35,499	3.05

Table 7 – SPS Assessment – Runtime & Volume – Total.

In accordance with Sewers for Adoption, all pumping stations should operate with a maximum of 15 starts per hour. Table 8 gives the maximum number of dry weather starts per hour for all pumps, on a weekday 29/03/2024 and weekend 30/03/2024.

The assessment compares the predicted number of starts per hour for the existing system with the number for the developed system.

SPS Name	Existing Pump Starts		Developed Pump Starts	
	Dry Day 1	Dry Day 2	Dry Day 1	Dry Day 2
Wrexham Industrial Estate SPS	4	3	4	3

Table 8 – SPS Assessment – Number of Pump Starts – Total.

These results show that there is no detriment in terms of the number of times the pump at Wrexham Industrial Estate SPS starts, this is in accordance with Sewers for Adoption, which limits the maximum number of starts per hour to 15.

5.4 Flows Arriving at Five Fords (Wrexham) WwTW

Using the annual time series 'typical year', it was calculated that 10,820,873 m^3 of flow arrives at Five Fords (Wrexham) WwTW in the existing system. With the new development, this figure increases to 10,861,027 m^3. This corresponds to an increase of 40,154 m^3 or 0.371%.

5.5 Network Performance Assessment Summary

- The hydraulic assessment has shown that the development would cause a total of 11 manholes to experience detriment, with a total of 259 m^3 of additional flooding across the industrial estate. This detriment is mostly concentrated at locations already experiencing heavy flooding, upstream of the Wrexham Industrial Estate SPS, caused by surcharging from the pumping station. Detriment recorded at storm manholes has been discounted as a modelling instability.

- No CSO assessment has been undertaken on the catchment as part of this study.

- Wrexham Industrial Estate SPS has experienced slight detriment in terms of pump rate, with the required pump rate increasing slightly, however the actual pump rate is acceptable for both the existing and the developed system.

- Wrexham Industrial Estate SPS has also experienced slight detriment in terms of the required emergency storage which has slightly increased. However, in this case, the storage requirements are not met in either the existing or future scenarios.

- There has been no detriment in terms of the number of pump starts in the developed scenario, with both the developed and existing scenarios being well under the limit of 15 starts per hour as per sewers for adoption.

- The total flows arriving at Five Fords WwTW have increased from 10,820,873 m^3 to 10,861,027 m^3 in the developed scenario. This is an increase of 40,154 m^3 or 0.371% with the full phase development.

6 Solution Development

The hydraulic assessment has indicated that the addition of development flows has caused detriment with regards to network performance. Therefore, solutions have been investigated to resolve this detriment caused by the development flows. Solutions have been developed to remove all flooding detriment greater than 1 m^3.

The notional solutions described in the following sections show conceptual arrangements only and are presented to illustrate the adequacy of the solutions in terms of gross parameters (e.g., pipe capacities); their inclusion does not infer buildability and they are not to be considered as detailed design proposals.

6.1 Discounted Solutions

A number of solutions were considered but discounted because they did not resolve the predicted detriment and/or were not considered feasible:

1. The onsite SPS for the development being controlled by a real time control (RTC), where the pump would only activate based on certain conditions elsewhere in the network, was deemed nonviable. This is because the network can remain surcharged for a long period of time so when the RTC activates the network is still surcharging. This means that when the pump does turn on, the flows are pumped to an already surcharged and flooding network, and they only add to the current flood volume, causing more flooding.

2. The addition of a storm tank with a weir and a pumped return at the Wrexham Industrial Estate SPS was discounted. This is because the SPS is surcharging so much without the development that the addition of a weir and tank would mean all of the surcharged flows spill into the tank. When a test weir was added at the Wrexham Industrial Estate wet well, over 18,300 m^3 spilled over it in the M30-1440 simulation, indicating a storm tank here would not be viable.

3. Upsizing the line directly between the connection point and the Wrexham Industrial Estate SPS was also discounted as this would require upsizing the entire 1.4 km of pipework. This in turn would cause increased detriment due to more surcharge from the SPS. This would incur such high costs that this option has been deemed nonviable.

6.2 Solution 1 – Wrexham Industrial Estate SPS PFF increase

6.2.1 Description

This solution addresses the full development flows utilising connection point SJ38509101. It requires only one element which is the increased maximum pass forward flow capacity of the Wrexham Industrial Estate SPS. The SPS has been modelled using a 2024 survey and some assumptions. The only change the model suggests is required is an increase in the maximum pass forward capacity of the pump.

Although this solution is possible in theory, following discussion with operations, it may not be viable in practice. Operations have stated that the rising main from the Wrexham Industrial Estate SPS is fragile and known to be prone to damage. Therefore, an entire new rising main may be required as part of this option. The cost of a new rising main will be included in the cost (see section 7).

This solution elements are as follows:

- An increase in the maximum pass forward capacity of Wrexham Industrial Estate SPS.
- A new 2.967 km rising main (depending on what PFF the current rising main can manage).

This solution is estimated to cost £295,000, however if a new rising main is needed, this will rise to £4,265,000.

6.2.2 Notional Design Solution

There is model predicted flooding and detriment downstream of the connection point and upstream of Wrexham Industrial Estate SPS. The solution proposes an increase in the flow pumped through the SPS, preventing the flows from the industrial estate from surcharging back up and flooding. The increase in maximum flow fate would be 9 l/s from 137 l/s to 146 l/s (see Figure 4 for SPS location).

Following discussions with operations in Wrexham, it has become apparent that the existing rising main is susceptible to issues such as bursts. Concerns were raised about the risks of more damage if more flow were pumped through the main as it is.

6.2.3 Solution Assessment

The assessment which was undertaken in section 5.1.1 has been repeated for the scenario with this option. Table 9 shows this comparison between the existing network (with no development and no option) and the developed network with the option. As no detriment was recorded at any manholes in the network, the table shows only the same nodes as in section 5.1.1 to show how this option has removed the predicted detriment, however it should be noted that all nodes in the industrial estate were considered in this assessment.

Model Node ID	Critical Duration (min)	Flood Volume (m^3)		Flooding Detriment	
		Existing (pre-development)	Developed (with option)	Absolute (m^3)	Percentage (%)
SJ38484801	90 - winter	19.7	19.5	-0.2	-1%
SJ38493301	15 - summer	0	0	0	0%*
SJ38493304	15 - summer	0	0	0	0%*
SJ38494201	240 - summer	513	513.1	0.1	0%
SJ38494203	1440 - summer	1422.4	1422.6	0.2	0%
SJ38495101	15 - winter	115.6	51.7	-63.9	-55%
SJ38495105	15 - summer	0	0	0	0%*
SJ38505502	1440 - summer	244.2	245	0.8	0%
SJ38494202	15 - winter	275	222.6	-52.4	-19%
SJ38494204	1440 - summer	1610.7	1610.8	0.1	0%
SJ38494205	15 - winter	1.4	0.9	-0.5	-36%

Table 9 – Solution 1 Hydraulic Assessment.

Note: Where values are highlighted with *, percentage increase in flood volume is not 0%, the node is not flooding in either scenario for this critical duration therefore the percentage increase is not applicable.
Note: Although the base simulations are the same for both this assessment and the detriment assessment in section 5.1.1, the critical duration may change as this is based on the volume of detriment, rather than the volume of predicted flooding.

The addition of this option to the developed network has removed all of the flooding detriment that the network experienced above 1 m^3.

The total flooding among the nodes which were experiencing detriment has now decreased by a total of 115.8 m^3.

This solution does not resolve the fact that the emergency storage requirements upstream of the Wrexham Industrial Estate SPS is not within the acceptable range given the upstream DWF. This option involves only one element which is to increase the pass forward capacity of the pump. This change alone has no further impact on the storage requirement. Any changes to the existing network to improve the performance of the SPS would sit outside the scope of this HMA and should be investigated further outside of this study.

6.2.4 Option Considerations

This option relies on the accurate modelling of the Wrexham Industrial Estate SPS. Although the pumping station has been modelled based on survey data some assumptions have had to be made. The model shows that the only required change to the SPS is an increase in the maximum pass forward flow. This is what has been included for this option. Further investigation into the operation of the pump would be required to find out exactly what alterations to the pump are required.

This option will potentially incur large costs due to the requirement of an entire new rising main between Wrexham Industrial Estate SPS and Five Fords (Wrexham) WwTW. This might make this solution unviable, however it is recommended that further communications and investigations be undertaken to understand to what extent a new rising main is needed.

Another caveat with this solution is the fact that changing the pump rate at Wrexham Industrial Estate SPS (which pumps directly to the WwTW) will require an investigation into the impacts on the two CSOs at the works (see section 5.2). With an increased pump rate there is the added possibility of additional maximum flows arriving at the WwTW. This could potentially increase the volume, duration, and number of spills.

6.3 Solution 2 – Surface Water Removal

6.3.1 Description

This solution addresses the full development flows utilising connection point SJ38509101. It requires only one element which is the removal of roof impermeable area (IA). The IA within the industrial estate is limited. The majority of the roofs that have been surveyed are set to drain to the storm network, which is assumed to be the case throughout. Most of the response to storm water in the network is slow response through infiltration (see section 3.2.2). Therefore, although there is enough IA in the industrial estate to be removed successfully, it has to take place in several different locations. The confidence of the impermeable area within the industrial estate is limited. The majority of the area has not been surveyed, and there is no supporting documentation for why some of the area has been set to contribute to the foul network.

This solution elements are as follows:

- The removal of a total of 1.375 hectares of roof IA upstream of the Wrexham Industrial Estate SPS.

This solution is estimated to cost £810,000.

6.3.2 Notional Design Solution

The flooding detriment experienced in the network is a result of the Wrexham Industrial Estate SPS surcharging. Therefore, the removal of contributing area upstream of the pumping station should remove enough contributing flows to be able to remove any flooding detriment in storm events.

Figure 7 shows the locations in the model where roof IA has been removed from the foul network in the model.

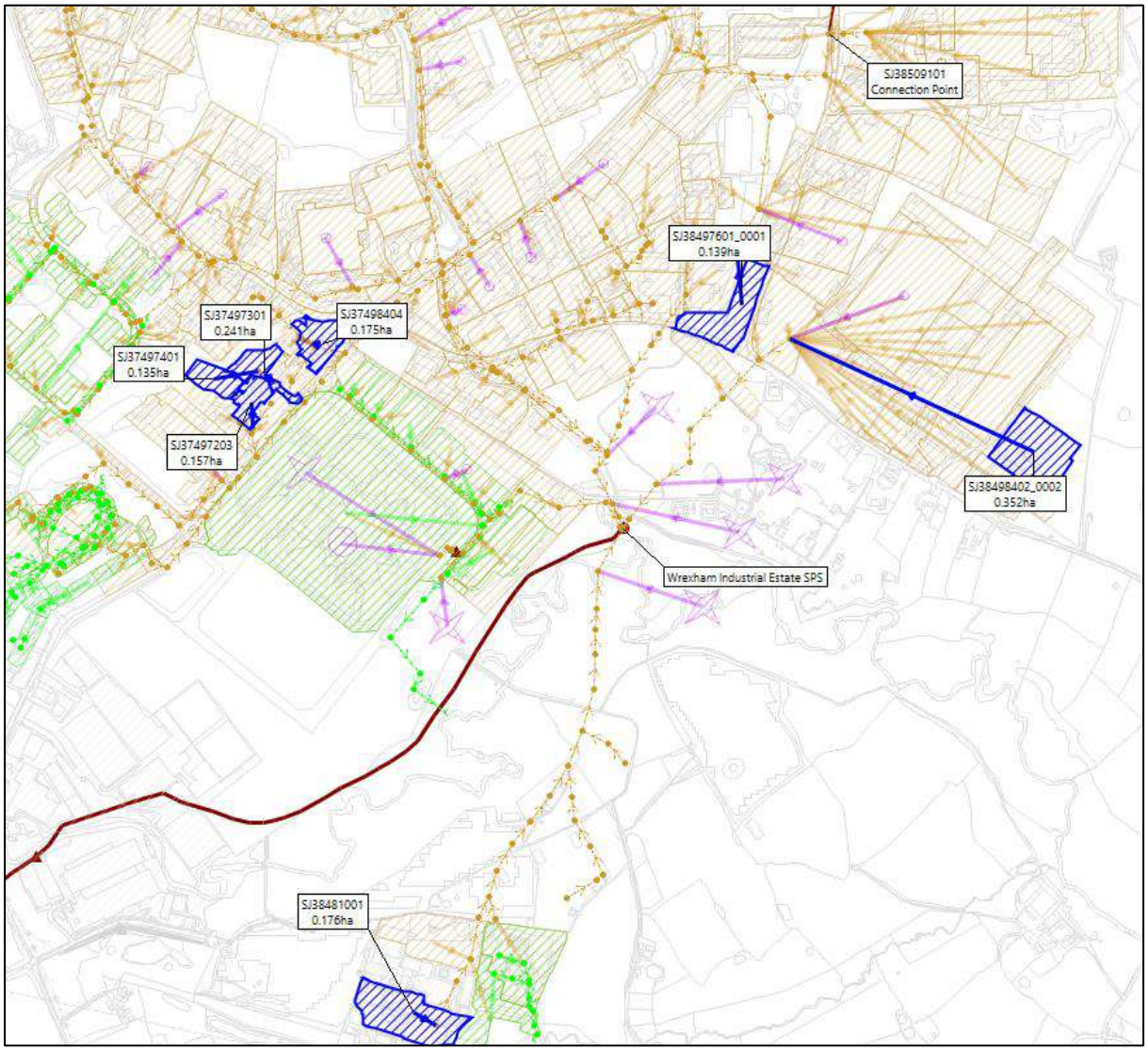


Figure 7 – Solution 2 suggested IA removal locations.

6.3.3 Solution Assessment

The assessment which was undertaken in section 5.1.1 has been repeated for the scenario with this option. Table 10 shows this comparison between the existing network (with no development and no option) and the developed network with the option. As no detriment was recorded at any manholes in the network, the table shows only the same nodes as in section 5.1.1 showing this is a no detriment option, however it should be noted that all nodes in the industrial estate were considered in this assessment.

Model Node ID	Critical Duration (min)	Flood Volume (m^3)		Flooding Detriment	
		Existing (pre-development)	Developed (with option)	Absolute (m^3)	Percentage (%)
SJ38484801	15 - winter	0.8	0	-0.8	-100%
SJ38493301	15 - summer	0	0	0	0%*
SJ38493304	15 - summer	0	0	0	0%*
SJ38494201	15 - summer	0	0	0	0%*
SJ38494203	90 - summer	901.1	891	-10.1	-1%
SJ38495101	15 - winter	115.6	80.3	-35.3	-31%
SJ38495105	15 - summer	0	0	0	0%*
SJ38505502	120 - summer	33	33.2	0.2	1%
SJ38494202	90 - winter	4418.4	4358.9	-59.5	-1%
SJ38494204	60 - summer	985.3	976	-9.3	-1%
SJ38494205	15 - winter	1.4	0.7	-0.7	-50%

Table 10 – Solution 2 Hydraulic Assessment.

Note: Where values are highlighted with *, percentage increase in flood volume is not 0%, the node is not flooding in either scenario for this critical duration therefore the percentage increase is not applicable.
Note: Although the base simulations are the same for both this assessment and the detriment assessment in section 5.1.1, the critical duration may change as this is based on the volume of detriment, rather than the volume of predicted flooding.

The addition of this option to the developed network has removed all of the flooding detriment that the network experienced over 1 m^3.

The total flooding among the nodes which were experiencing detriment has now decreased by a total of 115.5 m^3.

This solution does not resolve the fact that the emergency storage requirements upstream of the Wrexham Industrial Estate SPS is not within the acceptable range for the upstream DWF. As this is an entirely green option, any addition to the existing storage in the network would require a grey element. Any changes to the existing network to improve the performance of the SPS would be outside the scope of this HMA and should be investigated further outside of this study.

6.3.4 Option Considerations

As previously discussed, the contributing area in the Wrexham Industrial Estate is not high confidence. The IAS showed that the vast majority of the IA drains to storm network. Further IAS and connectivity surveys would be required to gain a greater understanding of how and where IA removal would be possible.

It should also be considered that what IA there is in the model is disbursed between several subcatchments so several schemes may be required to remove the flows from each area.

It is recommended that further investigation is undertaken at the detailed design stage to outline the most applicable method of IA removal (i.e., SuDS solutions, new or existing surface water systems, etc.).

6.4 Solution 3 – Combined

6.4.1 Description

This solution addresses the full development flows utilising connection point SJ38509101. It requires only two elements which are the addition of below ground storage just upstream of Wrexham Industrial Estate SPS and a small area of IA disconnection.

This solution elements are as follows:

- The addition of a large 548 m^3 storm tank upstream of the Wrexham Industrial Estate SPS. The storage is ground storage to accommodate the surcharging flows from the SPS in storm events.
- The removal of a total of 0.176 hectares of IA from the area to the south of the SPS.

This solution is estimated to cost £1,290,000.

6.4.2 Notional Design Solution

There is model predicted flooding and detriment downstream of the connection point and upstream of Wrexham Industrial Estate SPS. This solution proposes an increase in the storage alone this line to hold the surcharging flows rather than allowing them to flood out of a manhole. The solution also includes the removal of approximately 0.176 hectares of impermeable area from the southern line leading into the Wrexham Industrial Estate SPS.

This has been added to the model as a bifurcation at manhole SJ38496501 to a 1500 mm pipe which runs parallel to the existing sewer down to manhole SJ38495201 (approximately 310 m long), where the storm tank will connect back to the existing sewer via a 100 mm orifice.

In the model, surface water removal has been undertaken in subcatchments SJ38481001. In this subcatchments, 0.176 hectares of IA has been removed, preventing as much flow arriving at the Wrexham Industrial Estate SPS from the southern line.

Figure 8 shows the modelling of the storm tank and the location of the IA removal in relation to the Wrexham Industrial Estate SPS.

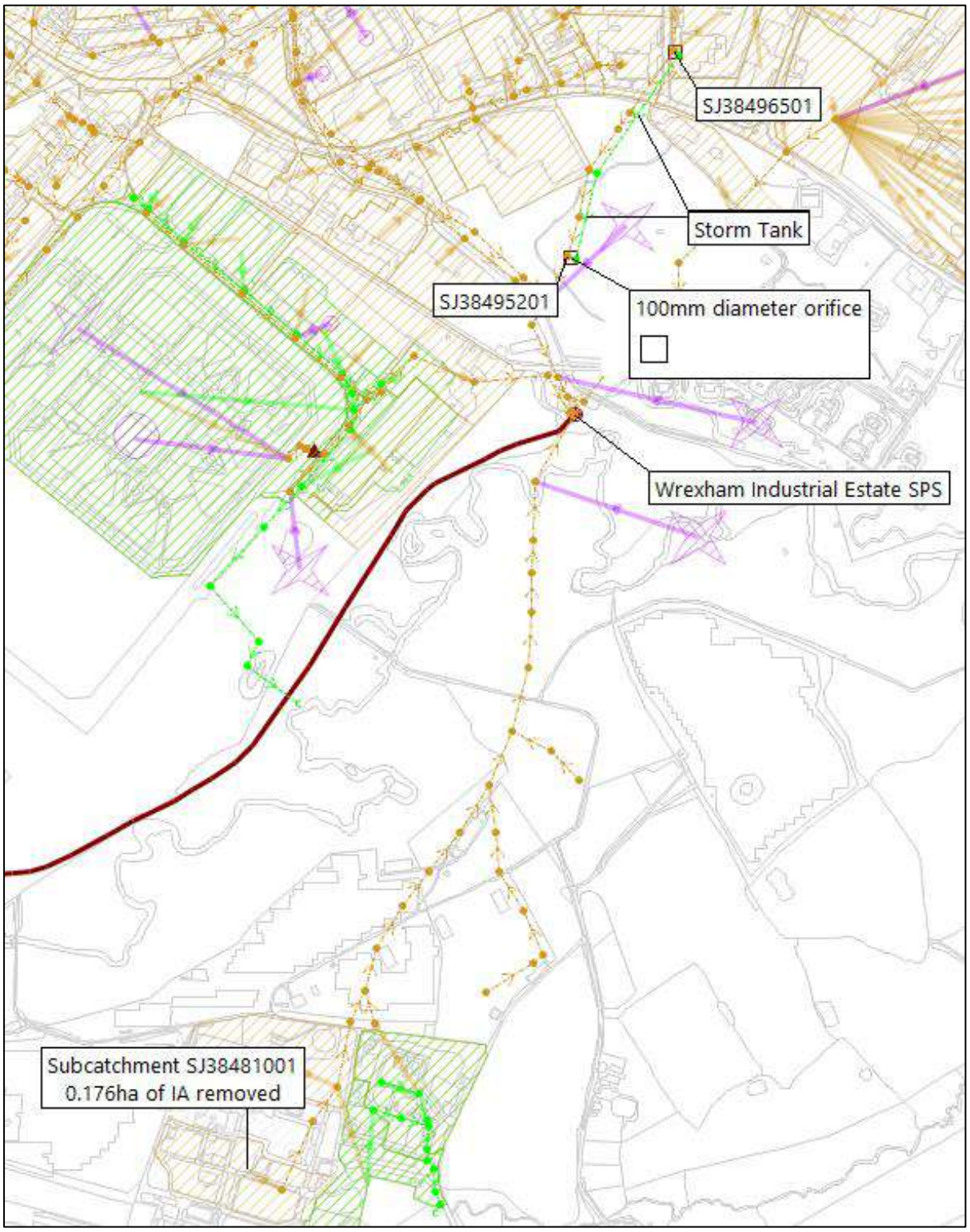


Figure 8 – Solution 3 storm tank and IA removal locations.

6.4.3 Solution Assessment

The assessment which was undertaken in section 5.1.1 has been repeated for the scenario with this option. Table 11 shows this comparison between the existing network (with no development and no option) and the developed network with the option. For this option there are no manholes that continue to see detriment. Table 11 shows only the same nodes as in section 5.1.1 showing this is a no detriment option, however it should be noted that all nodes in the industrial estate were considered in this assessment.

Model Node ID	Critical Duration (min)	Flood Volume (m^3)		Flooding Detriment	
		Existing (pre-development)	Developed (with option)	Absolute (m^3)	Percentage (%)
SJ38484801	15 – winter	0.8	0	-0.8	-100%
SJ38493301	15 – summer	0	0	0	0*
SJ38493304	15 – summer	0	0	0	0*
SJ38494201	15 – summer	0	0	0	0*
SJ38494203	1440 – winter	1214.9	1209	-5.9	0%
SJ38495101	480 – summer	7207.6	7202.1	-5.5	0%
SJ38495105	15 – summer	0	0	0	0*
SJ38505502	15 – summer	0	0	0	0*
SJ38494202	960 – summer	14734	14573.2	-160.8	-1%
SJ38494204	1440 – winter	1403.6	1397.4	-6.2	0%
SJ38494205	15 – winter	1.4	0	-1.4	-100%

Table 11 – Solution 3 Hydraulic Assessment.

Note: Where values are highlighted with *, percentage increase in flood volume is not 0%, the node is not flooding in either scenario for this critical duration therefore the percentage increase is not applicable.
Note: Although the base simulations are the same for both this assessment and the detriment assessment in section 5.1.1, the critical duration may change as this is based on the volume of detriment, rather than the volume of predicted flooding.

The addition of this option to the developed network has removed all of the flooding detriment that the network experienced over 1 m^3.

The total flooding among the nodes which were experiencing detriment has now decreased by a total of 180.6 m^3.

This is the only solution that also resolves the emergency storage requirements at Wrexham Industrial Estate SPS. With the addition of the new storm tank the storage upstream of the SPS is now 822 m^3, which is greater than the requirement of 578.8 m^3.

6.4.4 Option Considerations

The storm tank in this option does not remove all of the flooding upstream of the SPS but only removes the detriment caused by the development. The network does still surcharge in the storm events; however, it essentially provides storage for the extra flows to be held, rather than allowing them to spill out the top of manholes with the existing flood volumes.

At this stage, no investigation has gone into the buildability of the storm tank proposed for this option. Further investigation would be required to determine just how viable this below ground storage is.

It should be noted that this option, with just the storage tank and excluding the IA removal will solve almost all of the detriment in the network. Just the storage tank will leave a remaining 1.3 m^3 at manhole SJ38484801. This manhole is located on the southern leg entering the Wrexham Industrial Estate SPS (see Figure 6). There is only 1.3 m^3 (0.168%) of detriment remaining at this node, however, has been deemed unacceptable for this study.

It should also be noted that the contributing area in the Wrexham Industrial Estate is not high confidence, the IAS showed that the majority of the IA drains to storm network. There is no confidence in the connectivity where the IA has been removed for this option. Additional IAS or connectivity survey would be required to gain greater understanding of where surface water removal would be possible.

It is also recommended that further investigation is undertaken at the detailed design stage to outline the most applicable method of IA removal (i.e., SuDS solutions, new or existing surface water systems, etc.).

6.5 Solution Summary

- Solution 1 – SPS Upsize – This solution included the increase of the pass forward capacity of the Wrexham Industrial Estate SPS from 137 l/s to 146 l/s. The solution would also potentially require a totally new rising main from the Wrexham Industrial Estate SPS all the way to the WwTW. The consequences of increasing the flow through the rising main would need to be more thoroughly investigated to discover if a new main is required.

- Solution 2 – Surface Water Removal – This solution involves the removal of a total of 1.375 hectares of roof IA. The option removes all the detriment within the industrial estate and improves the overall flooding throughout significantly. This option would be difficult to deliver as there are several different areas that would require roof areas to be disconnected. Similarly, there would be difficulty in identifying the areas where surface water removal could be undertaken due to the sparseness areas where roof IA is contributing to the network. Therefore, this solution would require further investigation into where IA removal is actually possible, and where IA removal would be the most cost effective.

- Solution 3 – Combined – This solution has two key elements, the first being the addition of 548 m^3 of below ground storage upstream of the Wrexham Industrial Estate SPS to prevent the surcharging flows from all flooding out. The other element of this option is the removal of approximately 0.176 hectares of roof area on the southern leg leading to the SPS. The solution requires some IA removal which would in itself need investigation to determine where is most suitable. At this stage, no investigation has gone into the viability of adding a storm tank in this location. This would be undertaken at the detailed design stage.

7 Solution Costs

The solution costs provided are based on the DCWW AMP7 Yr5 Cost & Carbon Estimating Tool (CCET). This cost model predicts costs based on final costs of completed schemes. These are intended to be high level cost estimates and are for option comparison only. It is recommended that a detailed cost estimate is undertaken during the detailed design phase. Table 12 shows an overview of the whole life cost of each of the options.

Solution	Description	Whole Life Cost
1	Solution 1 – Wrexham Industrial Estate SPS PFF increase	£295,000
2	Solution 2 – Surface Water Removal	£810,000
3	Solution 3 – Combined	£1,290,000

Table 12 – Solution Costs.

The cost of solution 1 (Wrexham Industrial state SPS PFF Increase) includes the changes detailed in section 6.2 but does not include the cost of re-laying the entire rising main. The whole life cost of just re-laying the rising main is £3,975,000. That would increase the overall cost of solution 1 from £295,000 to **£4,265,000**. This takes solution 1 from being the cheapest to the most expensive solution. It is recommended that further investigation be undertaken to find out how much additional flow the existing rising main can take, and whether the re-laying of the whole new rising main is required.

As stated in section 6.4.3, the addition of just the storm tank in option 3 solves almost all of the detriment (excluding 1.3 m^3 at one manhole). The cost of just the storm tank is the large majority of the cost for option 3, at £1,130,000. The surface water removal increases the cost by only £160,000.

The surface water removal in both solutions 2 and 3 has been costed for using raingarden SuDS. This is deemed to be an appropriate method due to the sparsity of IA in the industrial estate. It is considered to be a conservative estimate of a surface water removal scheme, whereas a new IAS may identify cheaper and easier solutions.

It should also be noted that the costs stated in Table 12 do not include any costs of land purchase, as the exact locations of these solutions will be discussed at the detail design stage.

8 Conclusions & Recommendations

- RPS were appointed by Dŵr Cymru Welsh Water (DCWW) in 2023 to undertake a Hydraulic Modelling Assessment (HMA) for a proposed 25-hectare development comprising of three warehouse units, potentially providing employment for up to 1,033 people. The development is located on the land to the east of Bryn Lane, at Wrexham Industrial Estate, within the Five Fords (Wrexham) Wastewater Treatment Works (WwTW) catchment. The development is to be completed in one phase.

- The proposed Land East of Bryn Lane development has been assessed using one connection point:

    - Connection Point 1: Manhole *SJ38509101* located on Bryn Lane, on a sewer leading down to Wrexham Industrial Estate SPS.

- DCWW GIS records, historical survey data, DCWW telemetry data for Wrexham Industrial Estate SPS wet well, 16 manhole surveys, 20 hectares of IAS, SPS Survey of Wrexham Industrial Estate SPS, and 4 monitor flow survey verification have all been used to update the model for this HMA.

- The key model build activities undertaken for this study were as follows:

    - The addition of all survey data to the model.

    - The addition of HMP Berwyn to the model based on flow survey data from downstream of the prison.

    - The addition of several hectares of GI throughout the industrial estate, especially focused on the area immediately upstream of the Wrexham Industrial Estate SPS. This is evidenced by the flow survey data, wet well telemetry and surcharging observed in manhole survey data.

- Model assumptions and limitations:

    - Large amounts of GI added in response to the flow survey data; however, it is not known how or where infiltration is entering the network.

    - It is not known how the rivers around the pumping station are interacting with the network.

    - Although the modelling of Wrexham Industrial Estate SPS is based on current 2024 survey data, some assumptions have been made which could improve the quality of the modelling and better represent the reasons for the surcharging observed at FM02 and FM03.

    - No survey has been carried out to determine how HMP Berwyn connects to the network, so the modelling has been based on assumptions made for the 2015 HMA and flow survey data.

- No survey has been carried out to determine how the Kellogg's factory connects to the network.
- Private connections have not been represented within the model.
- Developer services have not provided any details regarding the connection of the development, so it has been modelled based entirely on assumptions.
- The solutions described in this report have not been developed in order to resolve existing network problems, meaning the emergency storage requirements of Wrexham Industrial Estate SPS have not been directly considered in the option development stage. The check has been made in all option scenarios, and solution 3 is the only one that also meets the existing storage requirements of this SPS. No other options involve the grey element of adding further storage upstream.

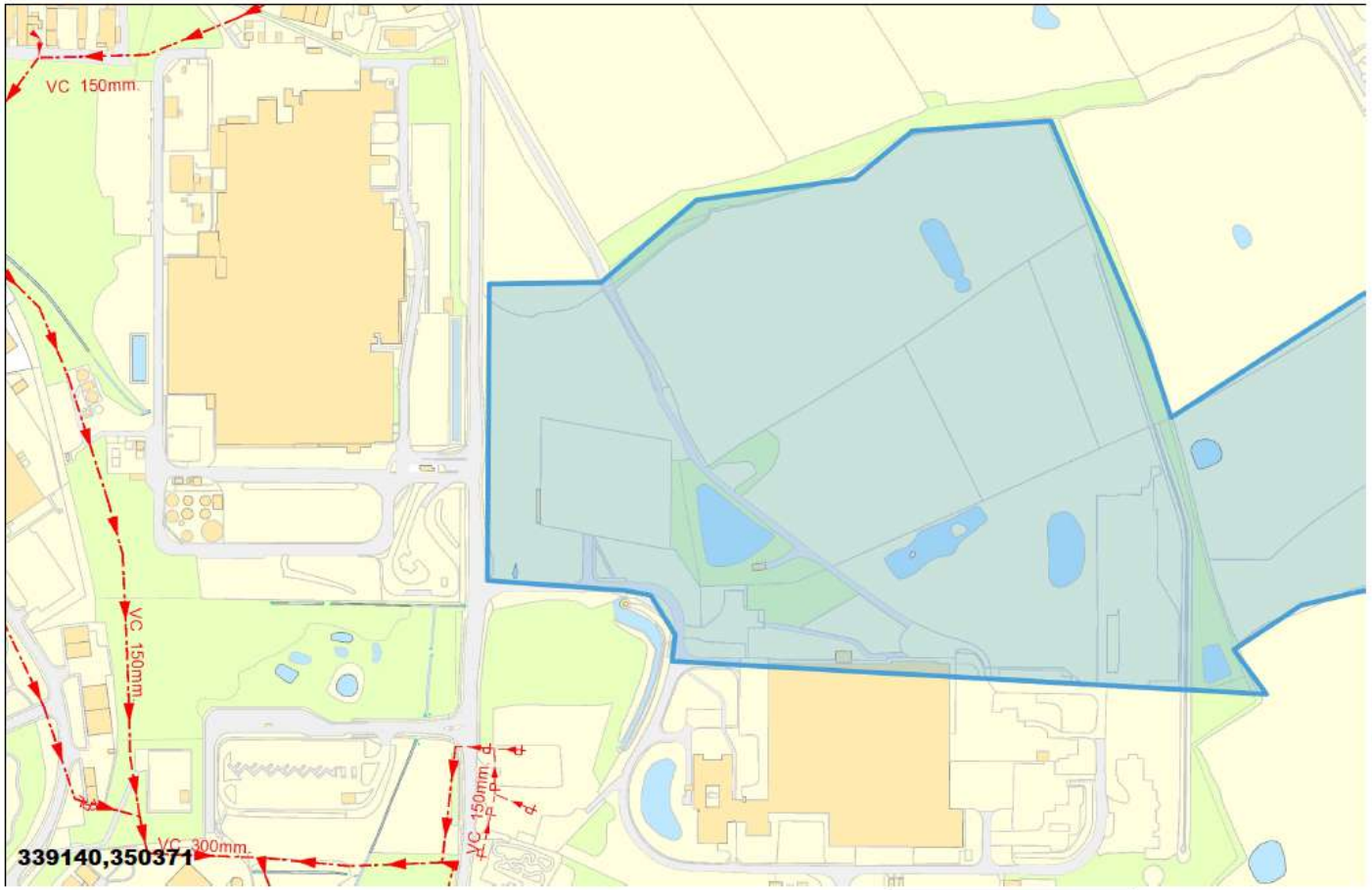
- The hydraulic assessment was undertaken using one building phase, delivering the total trade flow into the system all at once. The hydraulic assessment suggested that the proposed development will cause a notable increase in flood volume primarily around the Wrexham Industrial Estate SPS.
- Solution development has identified three solutions to resolve the predicted detriment. The solutions are:
  - Solution 1 – Increasing the maximum pass forward capacity of Wrexham Industrial Estate SPS by 9 l/s. Raising the PFF at the SPS from 137 l/s to 146 l/s removes all of the detriment caused by the development. The cost for this solution is £295,000. It should be noted however that this option may incur a much higher cost if an entirely new rising main is required. This would increase the cost to a total of £4,265,000.
  - Solution 2 – A total of 1.375 hectares of surface water removal upstream of the Wrexham Industrial Estate SPS at several locations removes all of the predicted detriment. The cost for this solution is £810,000.
  - Solution 3 – A combined solution which incorporates both the addition of 548 m^3 of below ground storage and a total of 0.176 hectares of surface water removal. The cost for this solution is £1,290,000.
- The preferred option for this development is solution 2. This is because:
  - Assuming a whole now rising main needs to be constructed for solution 1, solution 2 is the cheapest solution developed in this assessment.
  - Solution 2 requires only green solutions which are generally preferred to grey solutions.
  - Although the costs for the whole solution is higher for solution 2, it is likely that with additional investigation into the connectivity within the catchment, and suitable surface water removal methods, a cheaper alternative would be viable.

Dŵr Cymru
Welsh Water

Land east of Bryn Lane

14/03/2023

Scale: 1: 4999



LEGEND

Clean Water

- Sluice Val
- Air Val, SINGLE
- Tap
- Pressure Reducing Valve
- Meter
- BULK Meter
- FH
- Cap
- Existing Main
- NON COMPANY

Sewerage External

- Foul
- Surface Water
- Combined
- Rising Main
- Private
- Treatment Works
- Pumping Station
- Special Purpose
- Unknown End
- Change, Combined Overflow
- Outfall, FOUL
- Lamp Hole, Foul
- Private Sewer Transfer
- Lateral Drain
- Inspection Chamber

Dwr Cymru Cyfyngedig ('the Company') gives this information as to the position of its underground apparatus by way of general guidance only and on the strict understanding that it is based on the best information available and no warranty as to its correctness is relied upon in the event of excavations or other works made in the vicinity of the company's apparatus. The onus of locating apparatus before carrying out any excavations rests entirely on you. The information which is supplied by the Company, is done so in accordance with statutory requirements of sections 198 and 199 of the Water Industry Act 1991 which is based upon the best Information available and, in particular, but without prejudice to the generality of the foregoing, it should be noted that the records that are available to the Company may not disclose the existence of a water main, service pipe, sewer, lateral drain or disposal main and any associated apparatus laid before 1 September 1989, or, if they do, the particulars thereof including their position underground may not be accurate. It must be understood that the furnishing of this information is entirely without prejudice to the provision of the New Roads and Street Works Act 1991 and the Company's right to be compensated for any damage to its apparatus.

EXACT LOCATION OF ALL APPARATUS TO BE DETERMINED ON SITE

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Whilst every reasonable effort has been taken to correctly record the pipe material of DCWW assets, there is a possibility that in some cases pipe material (other than Asbestos Cement or Pitch Fibre) may be found to be Asbestos Cement (AC) or Pitch Fibre (PF). It is therefore advisable that the possible presence of AC or PF pipes be anticipated and considered as part of any risk assessment prior to excavation

Appendix B – Verification Plots & Comparative Analysis

Title	Style
Observed Rainfall	
Observed Depth/Flow/Velocity	
Pre-verification	
Post verification	

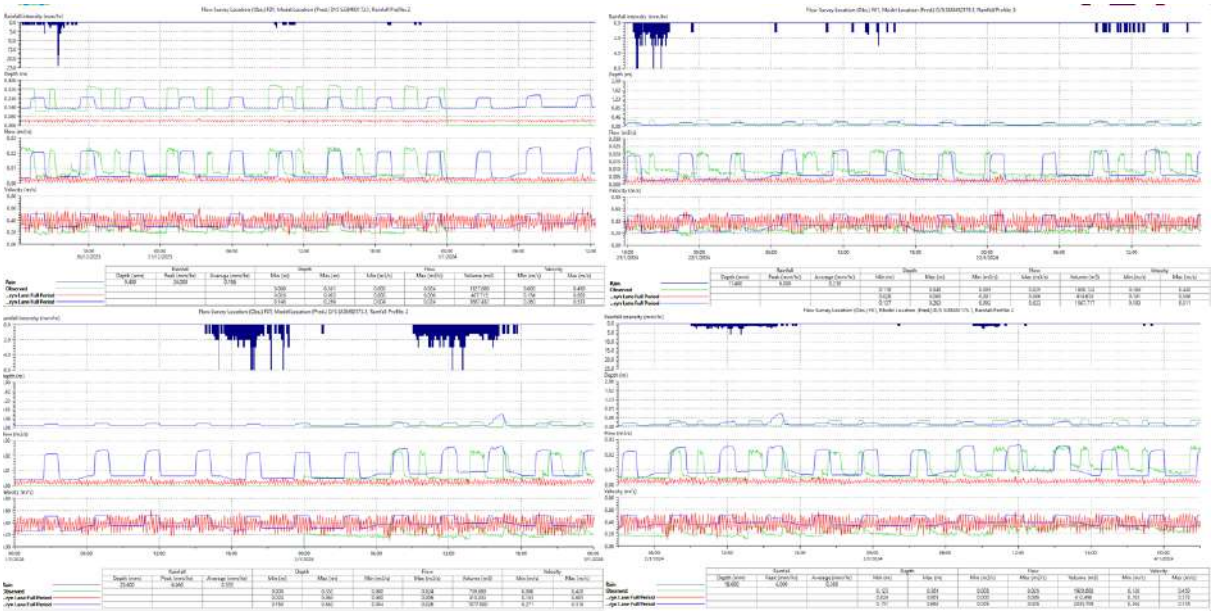
Key for Verification Plots

FM01 DWF



	Depth		Flow			Velocity	
	Min (m)	Max (m)	Min (m3/s)	Max (m3/s)	Volume (m3)	Min (m/s)	Max (m/s)
Observed	0.115	0.347	0.000	0.023	1120.440	0.000	0.480
...4> Bryn Lane Full Period	0.027	0.060	0.001	0.006	503.782	0.170	0.584
...on Bryn Lane Full Period	0.139	0.258	0.002	0.022	1697.904	0.197	0.509

FM01 Storm Events

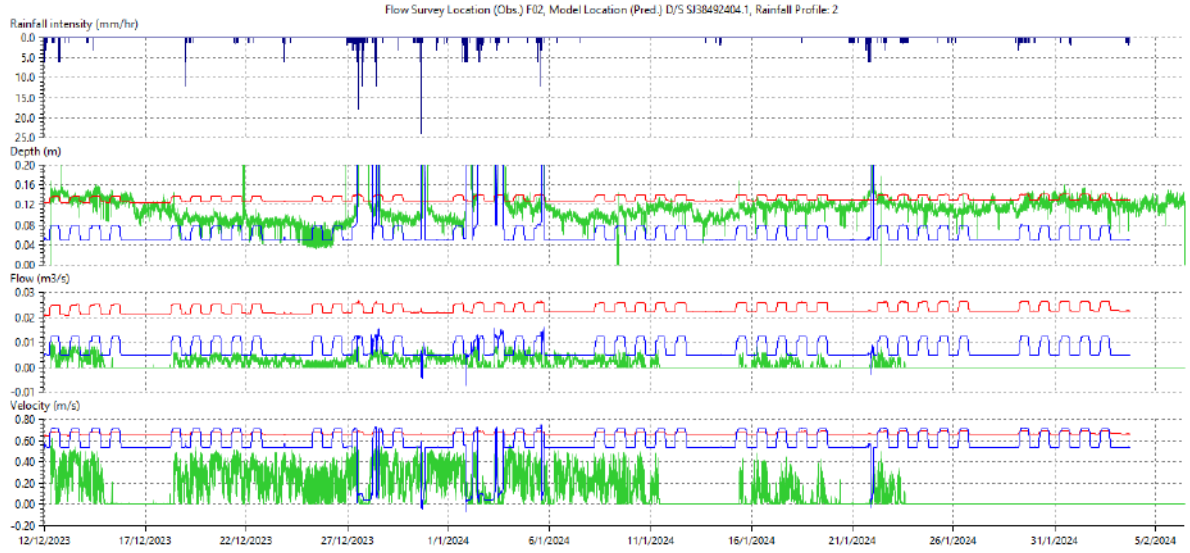


FM01 Full Period



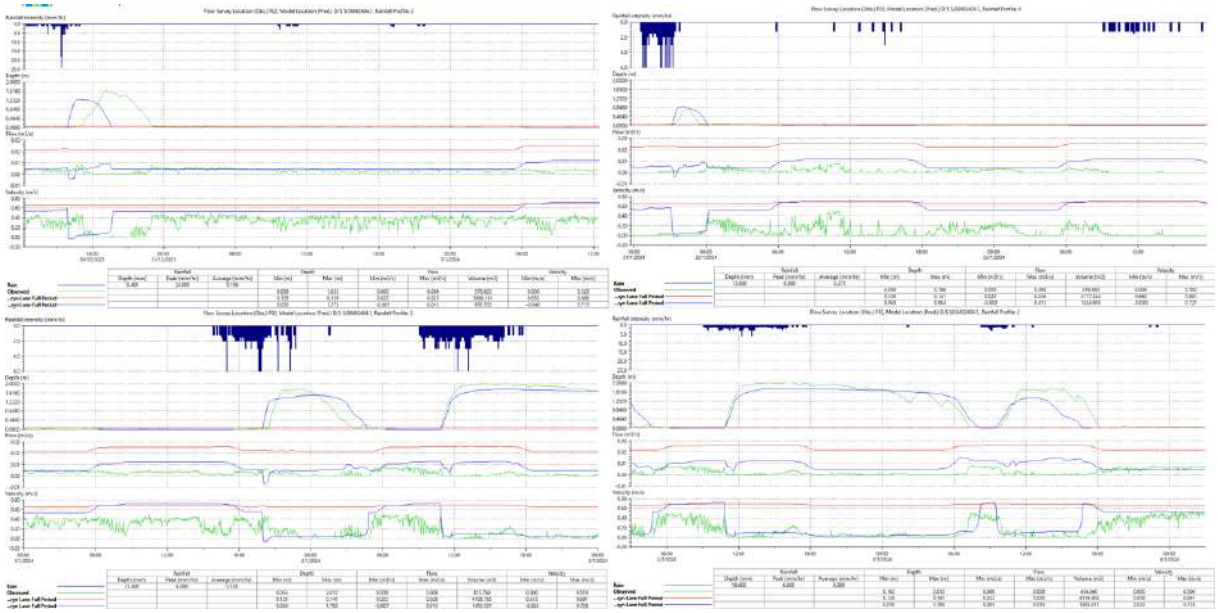
	Rainfall			Depth		Flow			Velocity	
	Depth (mm)	Peak (mm/hr)	Average (mm/hr)	Min (m)	Max (m)	Min (m3/s)	Max (m3/s)	Volume (m3)	Min (m/s)	Max (m/s)
Rain	125.760	24.000	0.097							
Observed				0.000	0.381	0.000	0.026	36223.320	0.000	0.510
...yn Lane Full Period				0.024	0.063	0.000	0.006	11039.925	0.103	0.605
...yn Lane Full Period				0.133	0.662	0.002	0.026	38213.375	0.154	0.518

FM02 DWF (full period different scale)

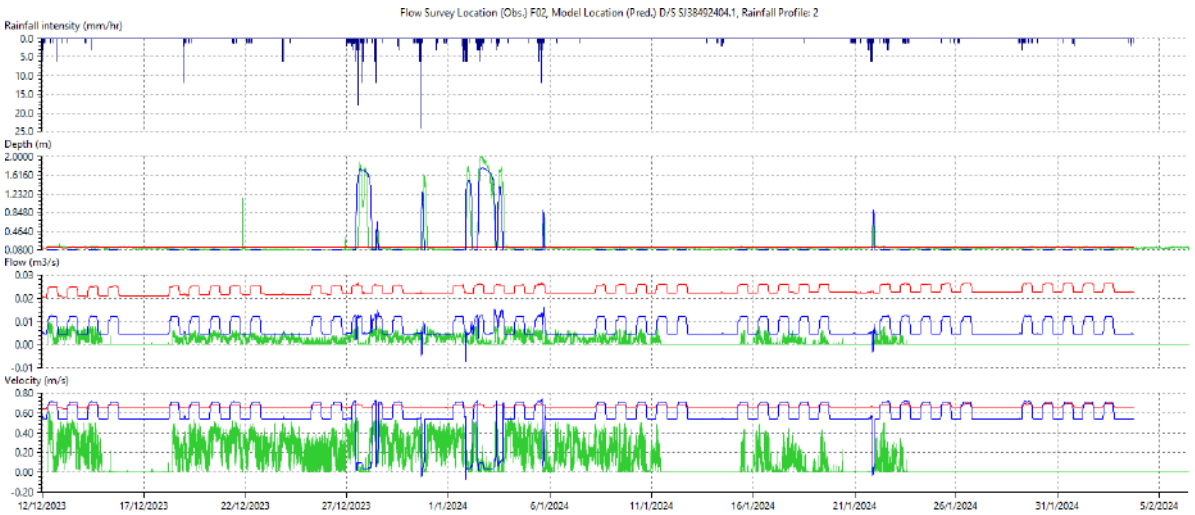


	Rainfall			Depth		Flow			Velocity	
	Depth (mm)	Peak (mm/hr)	Average (mm/hr)	Min (m)	Max (m)	Min (m3/s)	Max (m3/s)	Volume (m3)	Min (m/s)	Max (m/s)
Rain	125.760	24.000	0.097							
Observed				0.000	2.012	0.000	0.010	6853.560	0.000	0.620
...n Lane Full Period				0.124	0.142	0.020	0.027	108223.526	0.643	0.695
...n Lane Full Period				0.050	1.783	-0.007	0.016	33641.118	-0.065	0.745

FM02 Storm Events

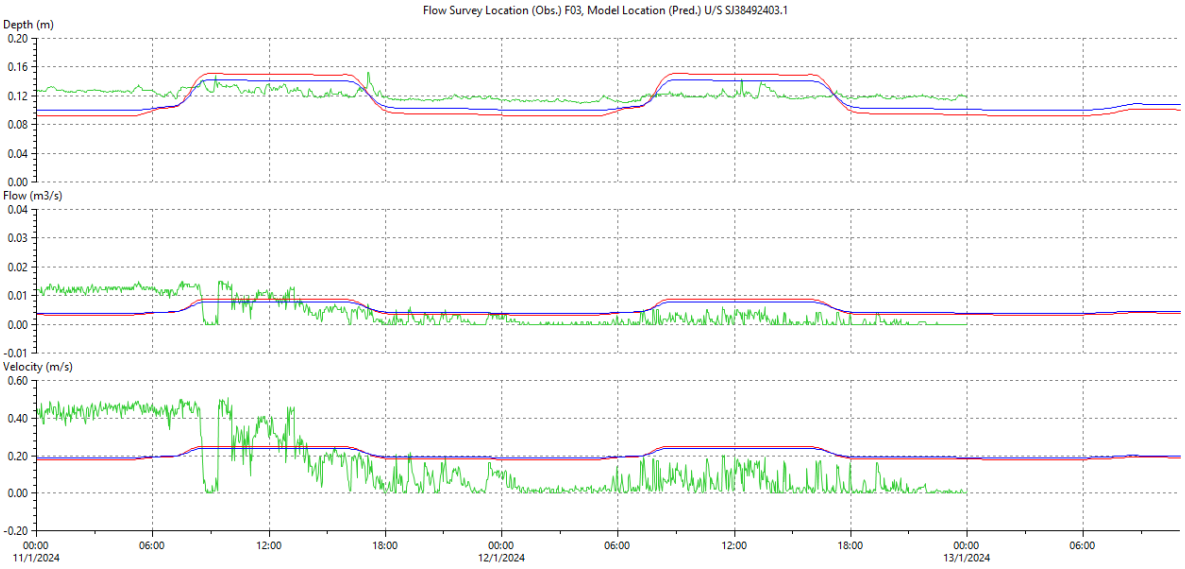


FM02 Full Period



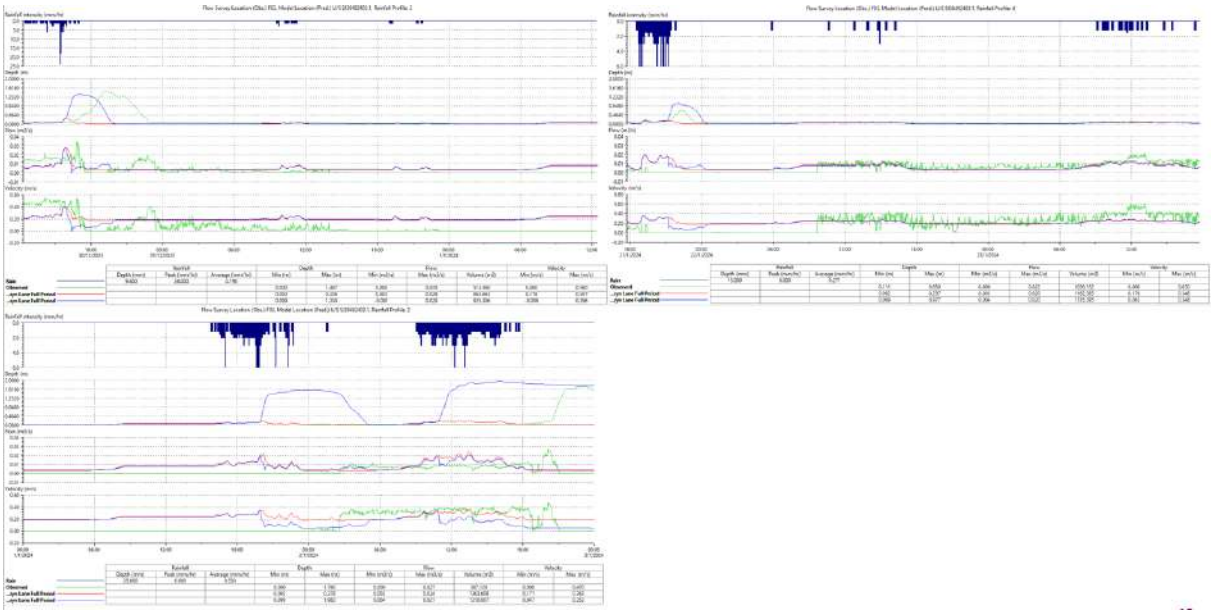
	Rainfall			Depth		Flow			Velocity	
	Depth (mm)	Peak (mm/hr)	Average (mm/hr)	Min (m)	Max (m)	Min (m3/s)	Max (m3/s)	Volume (m3)	Min (m/s)	Max (m/s)
Rain	125.760	24.000	0.097							
Observed				0.000	2.012	0.000	0.010	6853.560	0.000	0.620
...yn Lane Full Period				0.124	0.142	0.020	0.027	108223.526	0.643	0.695
...yn Lane Full Period				0.050	1.783	-0.007	0.016	33641.118	-0.065	0.745

FM03 DWF

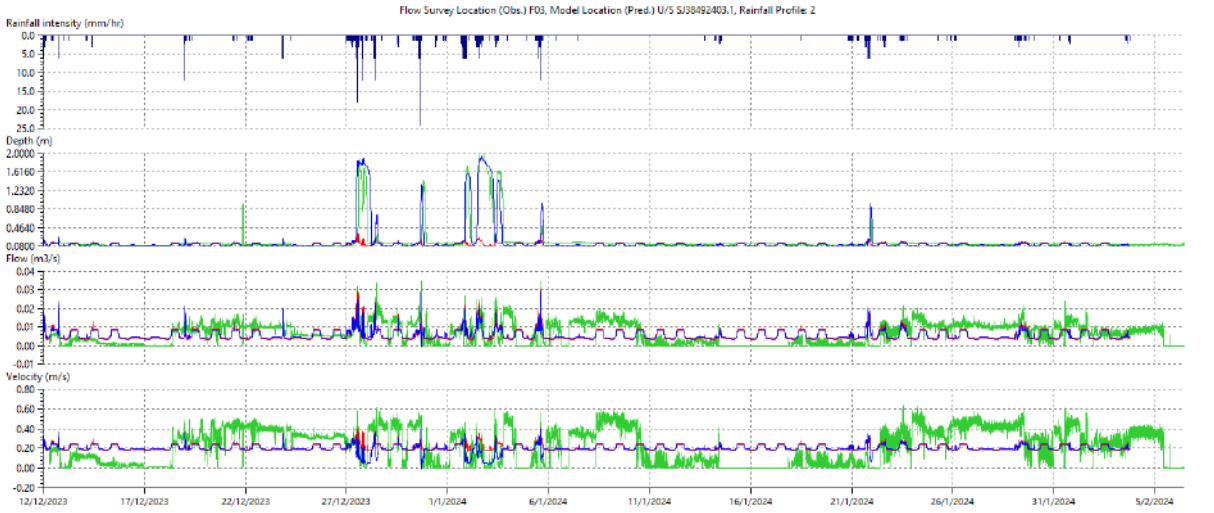


	Depth		Flow			Velocity	
	Min (m)	Max (m)	Min (m3/s)	Max (m3/s)	Volume (m3)	Min (m/s)	Max (m/s)
Observed	0.109	0.153	0.000	0.015	714.360	0.000	0.510
...4> Bryn Lane Full Period	0.092	0.151	0.003	0.009	1088.703	0.178	0.249
...on Bryn Lane Full Period	0.099	0.142	0.004	0.008	1104.323	0.188	0.240

FM03 Storm Events

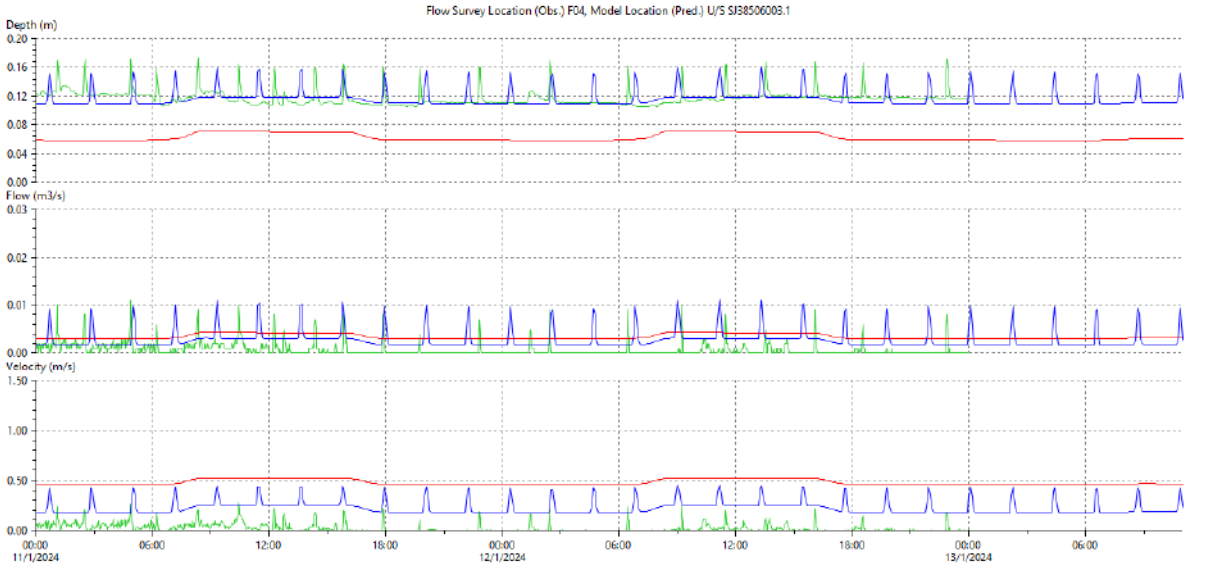


FM03 Full Period



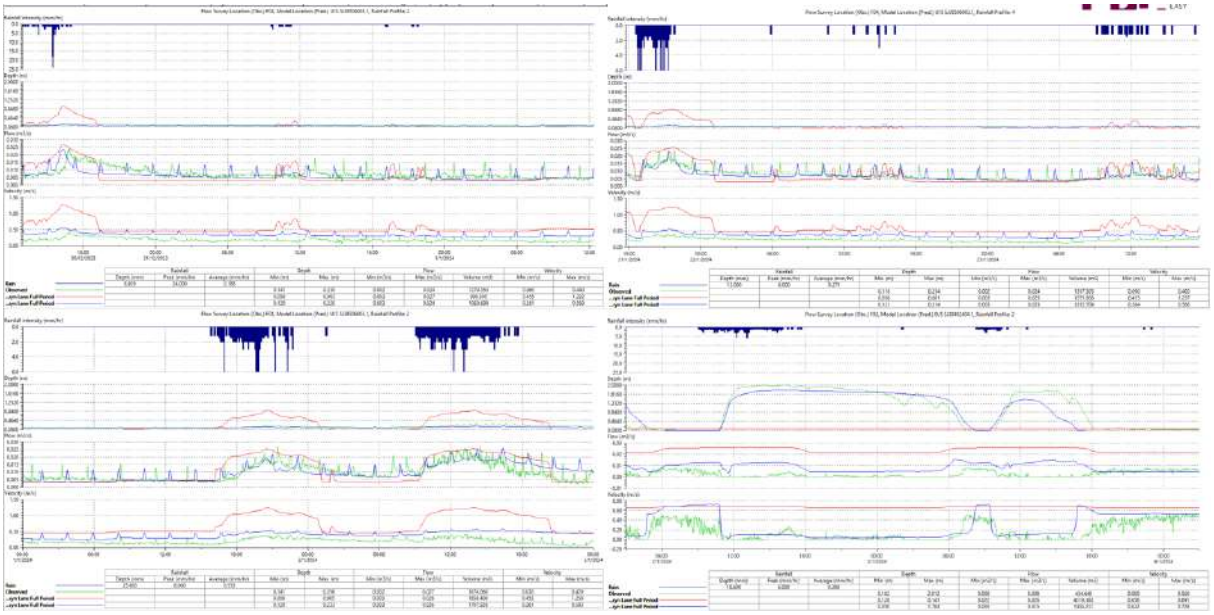
	Rainfall			Depth		Flow			Velocity	
	Depth (mm)	Peak (mm/hr)	Average (mm/hr)	Min (m)	Max (m)	Min (m3/s)	Max (m3/s)	Volume (m3)	Min (m/s)	Max (m/s)
Rain	125.760	24.000	0.097							
Observed				0.000	2.152	0.000	0.035	30618.480	0.000	0.630
...ryn Lane Full Period				0.092	0.383	0.003	0.031	25152.577	0.166	0.417
...ryn Lane Full Period				0.099	1.960	-0.001	0.030	25548.401	-0.008	0.403

FM04 DWF

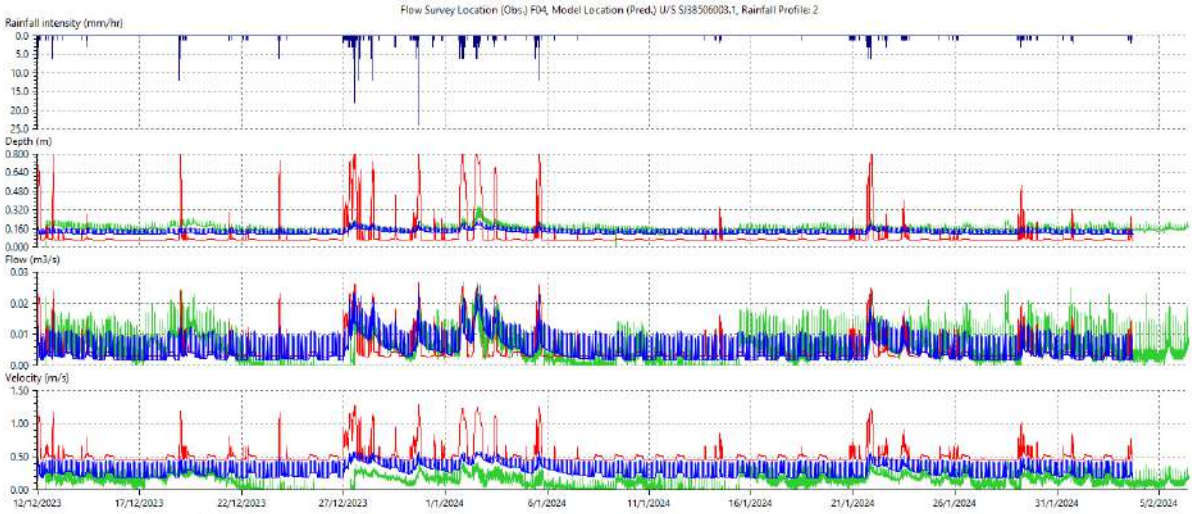


	Depth		Flow			Velocity	
	Min (m)	Max (m)	Min (m3/s)	Max (m3/s)	Volume (m3)	Min (m/s)	Max (m/s)
Observed	0.105	0.174	0.000	0.011	113.040	0.000	0.270
...4> Bryn Lane Full Period	0.058	0.071	0.003	0.004	712.025	0.455	0.522
...on Bryn Lane Full Period	0.109	0.161	0.002	0.011	580.688	0.172	0.451

FM04 Storm Events



FM04 Full Period



	Rainfall			Depth		Flow			Velocity	
	Depth (mm)	Peak (mm/hr)	Average (mm/hr)	Min (m)	Max (m)	Min (m3/s)	Max (m3/s)	Volume (m3)	Min (m/s)	Max (m/s)
Rain	125.760	24.000	0.097							
Observed				0.000	0.356	0.000	0.027	24360.840	0.000	0.440
...yn Lane Full Period				0.058	0.993	0.003	0.027	21603.333	0.455	1.292
...yn Lane Full Period				0.109	0.233	0.002	0.026	19136.872	0.172	0.583

Tank

SJ38495403

493301

VC 300 mm.

INDICATIVE MANHOLE ACCESS POINTS TO POSITIONED CENTRALLY OVER FLOW CHANNEL WITHIN TANK

SJ38495301

SJ38493304

5m

SJ38493303

PROPOSED CONCRETE STORAGE TANK TO BE 120m x 5m x 1m AND TO STORE APPROXIMATELY 600m3 OF FOUL STORAGE CAPACITY. TOP OF TANK LEVEL TO BE BELOW LOWEST COVER LEVEL IN SYSTEM.

Track

120m

CONC 300 mm.

VC 375 mm.

SJ38495201

SJ38494202

CS

Redwither Brook

NEW PIPE TO CONNECT PROPOSED TANK INTO EXISTING MANHOLE AT SJ38494203.

SJ38494203

SJ38494204

SJ38494101

CARLOW CONCRETE

Burren Precast Group



Tanks for Residential developments



Bellway Homes Project
– Section 104 Project

Marcus Jordan
Head of Sales & Business Development

M: 07596 066431
E: mjordan@carlowconcrete.com

Tanks for Commercial projects



Recycling & Waste
Management Facility

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Tanks for Water Utility Projects



Flood Alleviation
– Capital Delivery Project

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Tanks for Water Utility Projects



Flood Alleviation
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Irregular tank layouts



Persimmon Homes
Section 104

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Irregular layouts



Sample L
shaped layout

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Shallow tanks



Yorkshire Water
s104 project

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Deep tanks



Northumbrian
Water Scheme

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Small Tanks



Severn Trent
Water section 104

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Tank is sheet piled excavations



Flood Alleviation Project
Mott Macdonald Bentley

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Carlow Concrete taking the Construction Industry by *Storm*



Rapid Site Installations

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