

APPENDIX G: SENSITIVITY ANALYSIS TABLE

Table 2: 1 in 100o year CC45 Sensitivity Analysis

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Node	Max Stage (mAOD)	Manning's n+20% (mAOD)	Diff. (m)	Manning's n-20% (mAOD)	Diff. (m)	Structure coeffs. +20% (mAOD)	Diff. (m)	Structure coeffs. -20% (mAOD)	Diff. (m)	Flow+20% (mAOD)	Diff. (m)	Boundary h+0.5m (mAOD)	Diff. (m)
Alr15d	16.176	16.257	0.081	16.053	-0.123	16.158	-0.018	16.097	-0.079	16.239	0.063	16.176	0.000
Alr14	15.882	15.933	0.051	15.806	-0.076	15.865	-0.017	15.825	-0.057	15.940	0.058	15.882	0.000
Alr13	15.765	15.793	0.028	15.712	-0.053	15.750	-0.015	15.712	-0.053	15.826	0.061	15.765	0.000
Alr12	15.685	15.692	0.007	15.656	-0.029	15.669	-0.016	15.620	-0.065	15.747	0.062	15.684	-0.001
Alr12d	15.685	15.692	0.007	15.656	-0.029	15.669	-0.016	15.620	-0.065	15.747	0.062	15.684	-0.001
Alr11	15.008	15.048	0.040	14.960	-0.048	14.999	-0.009	14.980	-0.028	15.047	0.039	15.008	0.000
Alr11i	14.821	14.839	0.018	14.773	-0.048	14.806	-0.015	14.761	-0.060	14.882	0.061	14.821	0.000
Alr10	14.412	14.442	0.030	14.360	-0.052	14.401	-0.011	14.371	-0.041	14.458	0.046	14.412	0.000
Alr09	14.133	14.147	0.014	14.085	-0.048	14.114	-0.019	14.059	-0.074	14.208	0.075	14.133	0.000
Alr08	13.355	13.375	0.020	13.327	-0.028	13.347	-0.008	13.322	-0.033	13.386	0.031	13.354	-0.001
Alr07	12.535	12.543	0.008	12.496	-0.039	12.520	-0.015	12.479	-0.056	12.590	0.055	12.534	-0.001
Alr06	12.401	12.385	-0.016	12.405	0.004	12.384	-0.017	12.333	-0.068	12.470	0.069	12.401	0.000
Alr05	11.628	11.668	0.040	11.561	-0.067	11.612	-0.016	11.565	-0.063	11.689	0.061	11.628	0.000
Alr04	11.314	11.320	0.006	11.281	-0.033	11.300	-0.014	11.258	-0.056	11.367	0.053	11.313	-0.001
Alr03	11.155	11.156	0.001	11.145	-0.010	11.144	-0.011	11.109	-0.046	11.197	0.042	11.154	-0.001
Alr02u	10.799	10.792	-0.007	10.803	0.004	10.784	-0.015	10.741	-0.058	10.854	0.055	10.797	-0.002
Alr02d	10.585	10.617	0.032	10.535	-0.050	10.572	-0.013	10.536	-0.049	10.632	0.047	10.583	-0.002
Alr01	10.559	10.558	-0.001	10.548	-0.011	10.546	-0.013	10.511	-0.048	10.605	0.046	10.538	-0.021
Alr00u	9.885	9.913	0.028	9.853	-0.032	9.883	-0.002	9.878	-0.007	9.893	0.008	9.951	0.066
Max			0.081		0.004		-0.002		-0.007		0.075		0.066
Mean			0.020		-0.040		-0.014		-0.053		0.052		0.002

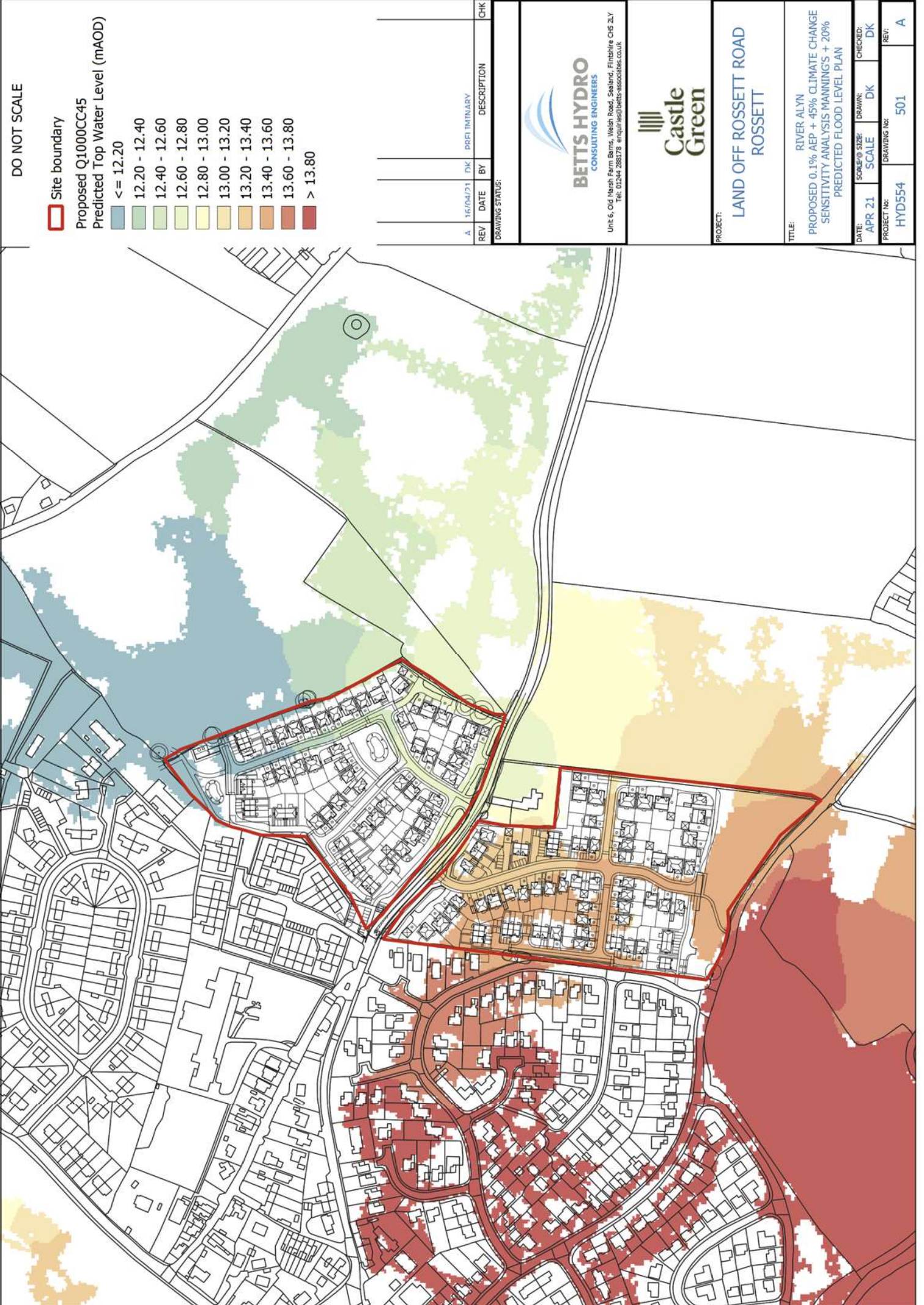
Table 2: Sensitivity analysis on the 0.1% AEP plus 45% climate change event

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APPENDIX H: SENSITIVITY ANALYSIS LEVEL PLANS

Drawing no. HYD554/501/A 1 IN 1000CC45 MANNING'S PLUS 20%
Drawing no. HYD554/502/A 1 IN 1000CC45 FLOW PLUS 20%
Drawing no. HYD554/503/A 1 IN 1000CC45 BOUNDARY H+0.5m

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DO NOT SCALE

Site boundary

Proposed Q1000CC45

Predicted Top Water Level (mAOD)

<= 12.20

12.20 - 12.40

12.40 - 12.60

12.60 - 12.80

12.80 - 13.00

13.00 - 13.20

13.20 - 13.40

13.40 - 13.60

13.60 - 13.80

> 13.80

REV	DATE	BY	DESCRIPTION	CHK
A	16/04/21	DK	PRELIMINARY	
DRAWING STATUS:				



Unit 6, Old Nash Farm Barns, Welsh Road, Sealand, Flintshire CH5 2LY
Tel: 01244 288378 enquiries@betts-engineers.co.uk



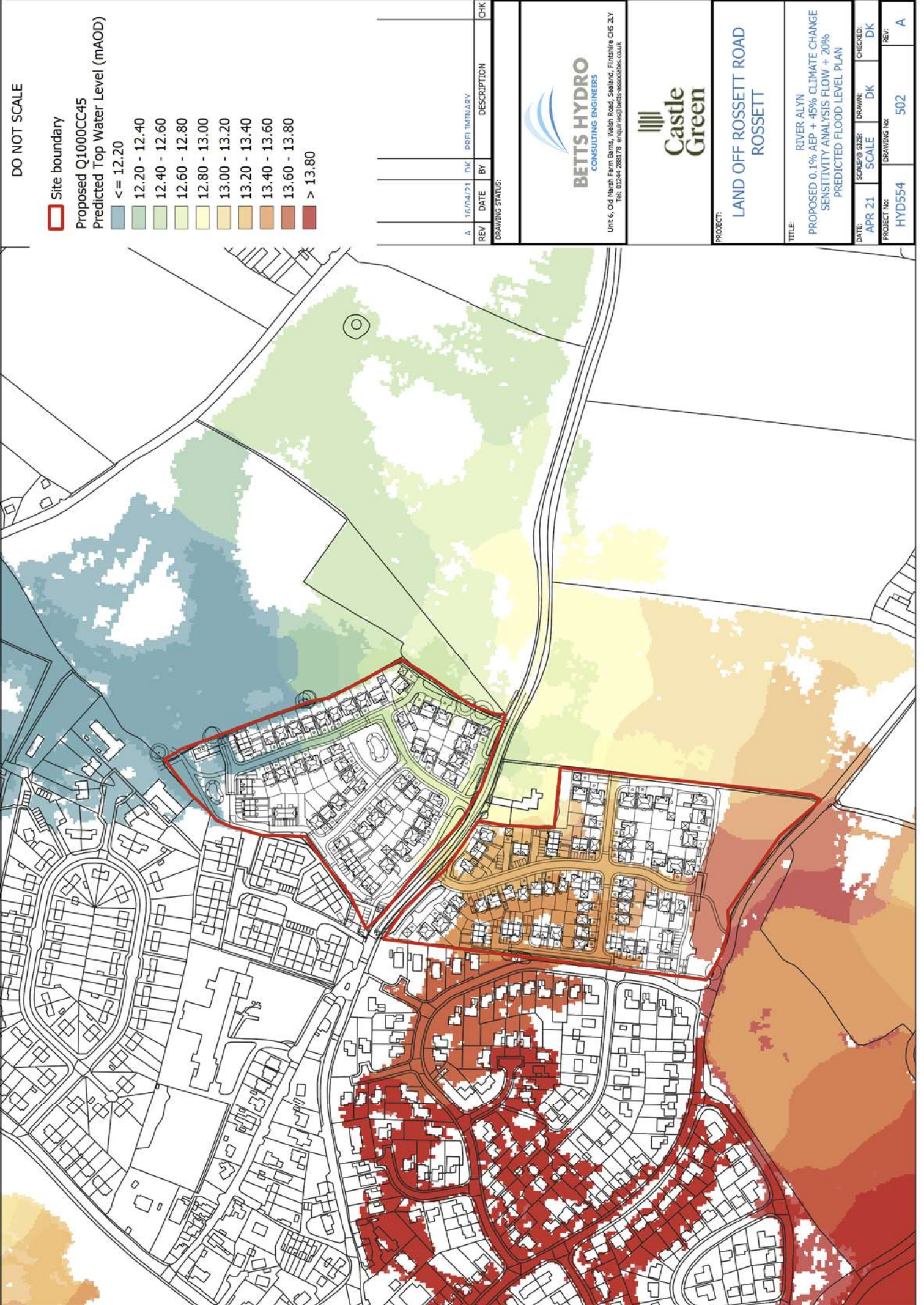
PROJECT:

LAND OFF ROSSETT ROAD
ROSSETT

TITLE:

RIVER ALYN
PROPOSED 0.1% AEP + 45% CLIMATE CHANGE
SENSITIVITY ANALYSIS MANNINGS + 20%
PREDICTED FLOOD LEVEL PLAN

DATE:	SCALE:	DRAWN:	CHECKED:
APR 21	501	DK	DK
PROJECT No:	DRAWING No:	REV:	
HYD554	501	A	



DO NOT SCALE

Site boundary

Proposed Q1000CC45

Predicted Top Water Level (mAOD)

<= 12.20

12.20 - 12.40

12.40 - 12.60

12.60 - 12.80

12.80 - 13.00

13.00 - 13.20

13.20 - 13.40

13.40 - 13.60

13.60 - 13.80

> 13.80

REV	DATE	BY	DESCRIPTION	CHK
A	16/04/21	DK	PRELIMINARY	
DRAWING STATUS:				



Unit 6, Old Nash Farm Barns, Welsh Road, Sealand, Flintshire CH5 2LY
Tel: 01244 288378 enquiries@betts-associates.co.uk



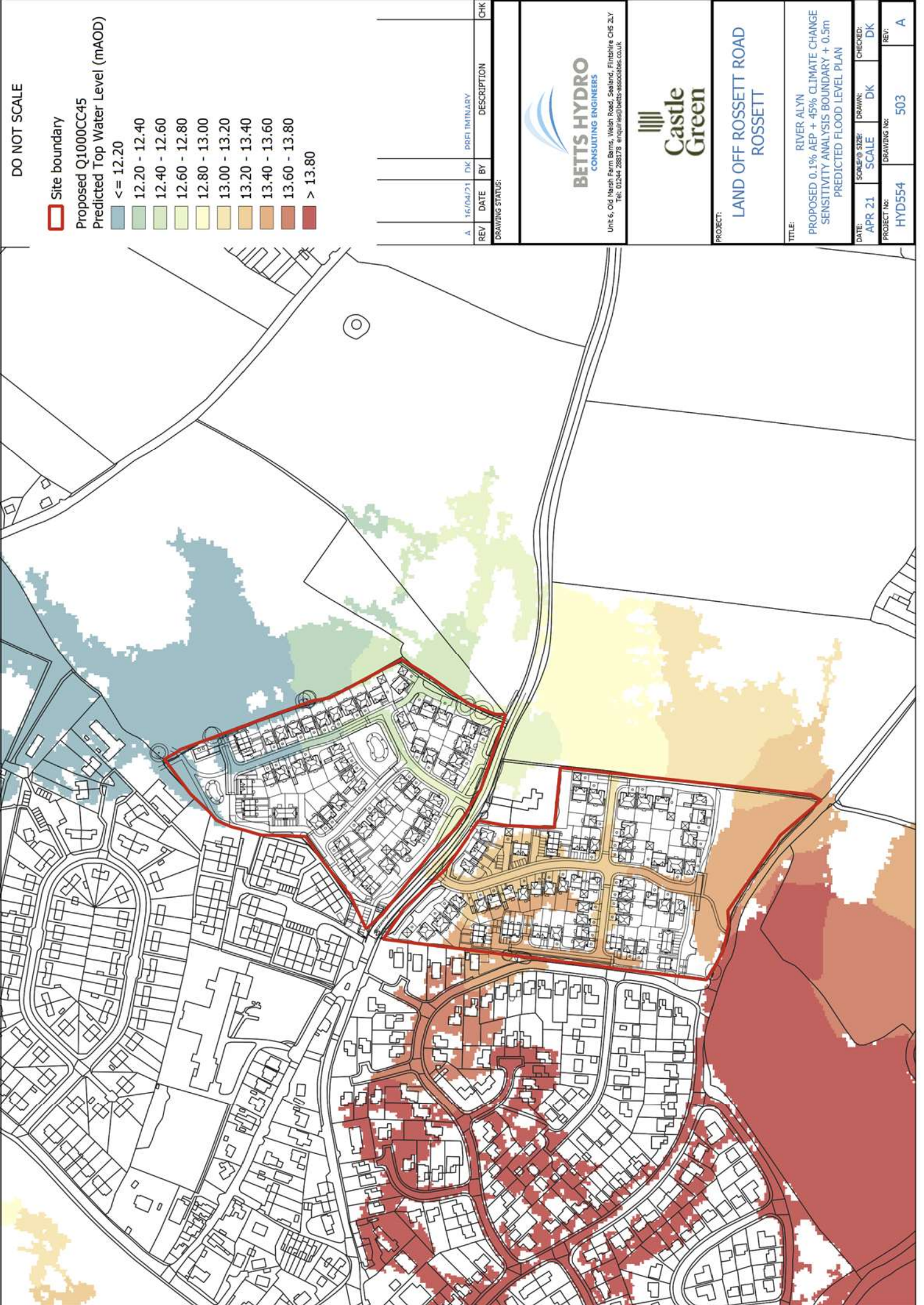
PROJECT:

LAND OFF ROSSETT ROAD
ROSSETT

TITLE:

RIVER ALYN
PROPOSED 0.1% AEP + 45% CLIMATE CHANGE
SENSITIVITY ANALYSIS FLOW + 20%
PREDICTED FLOOD LEVEL PLAN

DATE:	SCALE:	DRAWN:	CHECKED:
APR 21	502	DK	DK
PROJECT No:	DRAWING No:	REV:	
HYD554	502	A	



DO NOT SCALE

Site boundary

Proposed Q1000CC45

Predicted Top Water Level (mAOD)

<= 12.20

12.20 - 12.40

12.40 - 12.60

12.60 - 12.80

12.80 - 13.00

13.00 - 13.20

13.20 - 13.40

13.40 - 13.60

13.60 - 13.80

> 13.80

REV	DATE	BY	DESCRIPTION	CHK
A	16/04/21	DK	PRELIMINARY	
DRAWING STATUS:				



Unit 6, Old Nash Farm Barns, Welsh Road, Sealand, Flintshire CH5 2LY
Tel: 01244 288378 enquiries@betts-associates.co.uk



PROJECT:

LAND OFF ROSSETT ROAD
ROSSETT

TITLE:

RIVER ALYN
PROPOSED 0.1% AEP + 45% CLIMATE CHANGE
SENSITIVITY ANALYSIS BOUNDARY + 0.5m
PREDICTED FLOOD LEVEL PLAN

DATE:	SCALE:	DRAWN:	CHECKED:
APR 21	SCALE	DK	DK
PROJECT No:	DRAWING No:		
HYD554	503		A

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APPENDIX I: NOTES OF LIMITATIONS

The data essentially comprised a study of available documented information from various sources together with discussions with relevant authorities and other interested parties. There may also be circumstances at the site that are not documented. The information reviewed is not exhaustive and has been accepted in good faith as providing representative and true data pertaining to site conditions. If additional information becomes available which might impact our conclusions, we request the opportunity to review the information, reassess the potential concerns and modify our opinion if warranted.

It should be noted that any risks identified in this report are perceived risks based on the available information.

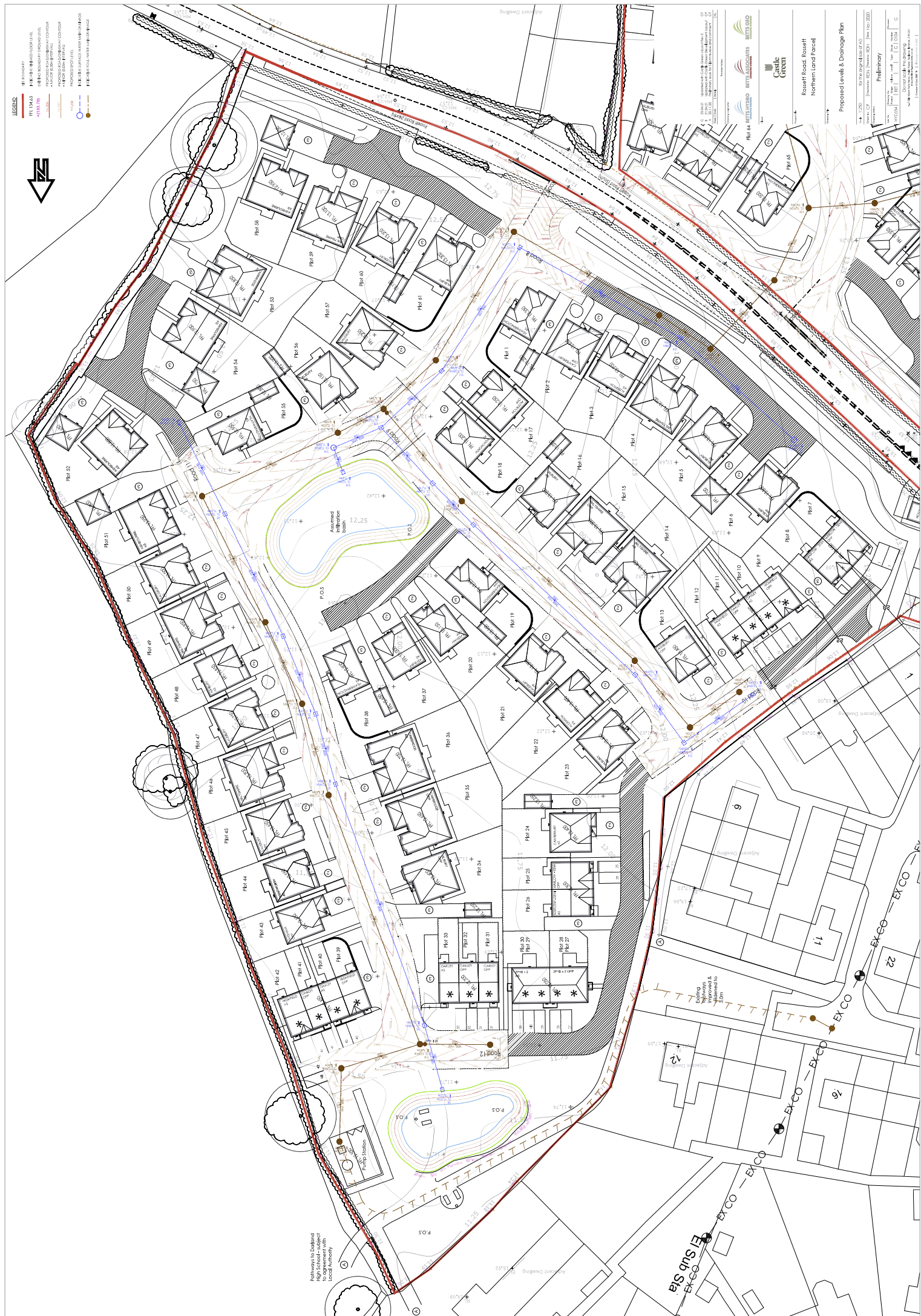
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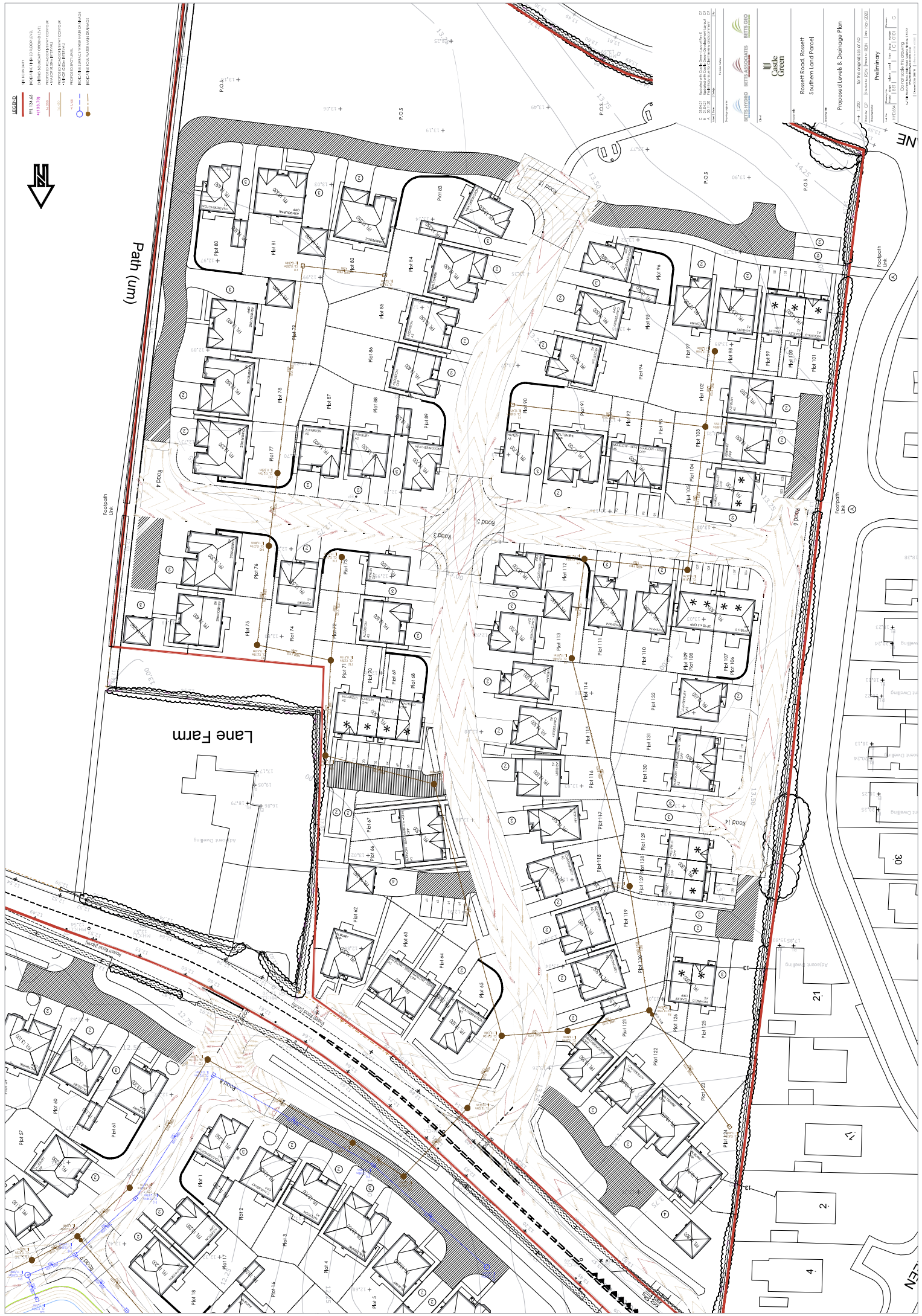
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APPENDIX J: PROPOSED LEVELS PLANS

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APPENDIX K: PFRA/SPRA INFORMATION

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Volume Pumps (HVP's) pumps were brought in to extract the excess surface water in to the river system.

In Wrexham County Borough there were no areas identified as significant risk threshold with an affected population, greater than 5,000 people. Within the Wrexham County Borough Council Preliminary Flood Risk Assessment (PFRA) 2011⁶, 20 1km square areas of 200 properties, 20 businesses or 1 critical infrastructure have been identified. These are areas which do not meet the statutory flood risk areas of 5,000 people but areas which are locally significant. These areas are concentrated around Wrexham, Llay Industrial Estate, Wrexham Industrial Estate and urban villages of Gwersyllt, Rhosllanerchrugog, Ruabon, Coedpoeth, Cefn Mawr, Acrefair, Chirk and Glyn Ceiriog, Ceiriog Valley. This local threshold will continue to form the basis of the LFRMS supported by continuing collection of information on local flood events.

The PFRA (2011) 1km² squares show that local flood risk could potentially affect 20,696 properties. The Environment Agency maps on surface water show a total number of 451 properties within areas susceptible to surface water flooding. The Environment Agency Flood map for surface water shows that 1922 properties could potentially be affected by 1 in 30 flood event, and 5312 properties are shown at risk from the 1 in 200 flood map for surface water. To date, the County Borough has received 383 flooding incidents.

The flooding events that have occurred this year 2012-2013 within the County Borough I have varied in size and caused different patterns of events. In April prolonged and heavy rainfall caused problems associated with surface water run off and river flooding alerts in Acrefair and Rossett. The events in July and August were associated with surface water flooding and flash flooding in urban villages of Gwersyllt, Gresford, Marford, Llay and Burton Green. In September, flooding events covered the borough causing surface water and river flooding to the Alyn and surrounding farmland around Holt, Farndon and Rossett.

The flood risk areas for Wrexham are listed in Figure 1.8 shows the PFRA squares in relation to the community council areas and shows how many properties, business or infrastructure could be affected. The table compares this information in relation to the EA Areas Susceptible to Surface Water Flooding and Flood Map for Surface Water, groundwater flooding areas, the historic flood outline and flood zones, canal flooding from Civic Canal and River Trust and sewer flooding from Welsh Water and the historical flooding data captured by the LLFA. The table also shows how these areas relate to the policy areas of the River Dee Catchment Plan and River Dee Basin Management Plan. Figure 1.9 will help identify the highest risk areas for the implementation of measures (L1-11) and forthcoming flood risk maps and flood risk management plans.

Environment Agency River Dee Catchment Flood Management Plan (2010)

Flood risk is the combination of the likelihood (or probability) of a particular flood event occurring and the consequence (or impact) of the flood event if it occurred. within a one year period. This is known as an Annual Exceedance Probability which is expressed as a % AEP and is the probability of a particular flood event (or size) occurring in one year. Flood risk is likely to be exacerbated by climate

⁶ WCBC (2011) Preliminary Flood Risk Assessment
April 2013 Version 3.1

change, and UKC09 projections indicate that rainfall will change significant with 90% probability, wetter winters causing higher river flow, especially when combined with sea level rise and more frequent and intense extreme rainfall events. The main sources of flood risk in Wrexham County Borough include river flooding, surface water flooding, some sewer, ground water and ordinary watercourse flooding.

Flooding has occurred at many locations throughout the River Dee Catchment Flood Management (CFMP) area, mostly from the main River Dee and its major tributaries but also from several small watercourses. Significant floods were recorded in 1890, 1946, and 2000.

The River Dee CFMP ⁷ identifies a number of populated areas which are affected include Rossett, Holt, Wrexham, Coedpoeth and Rhosllanerchrugog. In 2000, flooding was widespread across the catchment to places which have never flooded before

In the River Dee catchment area, a 1% AEP event could affect approximately 4,200 properties. In the County Borough of Wrexham there are considered to be 100-500 number of properties within Wrexham and Bangor on Dee and between 50-100 properties in Cefn Mawr at risk from flooding. This would equate to a flood risk to 0.5% of the population in 2010 and is because large amounts of area that are at risk of flooding from fluvial sources forms agricultural low land areas. There are limitations to this data given the lack of historic records associated with surface water flooding.

The CFMP (2010) has six policy areas cross the catchment area. These policy areas are incorporated into sub area action plans. The key policy options 2, 3 and 4 for Wrexham are listed in Figure 1.7 below.

Figure 1.7 River Dee Catchment Management Policies for Wrexham

Policy 2: Middle Dee, Bangor on Dee and East of the Borough

Areas of low to moderate flood risk where we can generally reduce existing flood risk management actions.

This policy will tend to be applied where the overall level of risk to people and property is low to moderate. It may no longer be value for money to focus on continuing current levels of maintenance of existing defences if we can use resources to reduce risk where there are more people at higher risk. We would therefore review the flood risk management actions being taken so that they are proportionate to the level of risk

Policy 3: Lower Dee (Rossett, Holt Farndon and Main Alyn West of Wrexham)

Areas of low to moderate flood risk where we are generally managing existing flood risk effectively;

This policy will tend to be applied where the risks are currently appropriately managed and where the risk of flooding is not expected to increase significantly in the future. However, we keep our approach under review, looking for improvements and responding to new challenges or information as they emerge. We may review our approach to managing flood defences and other flood

⁷ EA (2010) The River Dee Catchment Management Plan
April 2013 Version 3.1

risk management actions, to ensure that we are managing efficiently and taking the best approach to managing flood risk in the longer term.

Policy 4: Wrexham (Rossett to Erddig and Rhostyllen)

Areas of low, moderate or high flood risk where we are already managing the flood risk effectively but where we may need to take further actions to keep pace with climate change;

This policy will tend to be applied where the risks are currently deemed to be appropriately-managed, but where the risk of flooding is expected to significantly rise in the future. In this case we would need to do more in the future to contain what would otherwise be increasing risk. Taking further action to reduce risk will require further appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

The sub areas relevant to Wrexham County Borough include, Sub area 1: Upper Dee, Sub Area 2: Main Alyn, Sub Area 3: Middle Dee, Sub Area 4 Wrexham and Sub Area 5: Lower Dee. For each of these sub areas there are a list of partners, an outline of the issues, and outline of the policy approach required and actions required to implement them.

Environment Agency River Dee Basin Management Plan (2009)

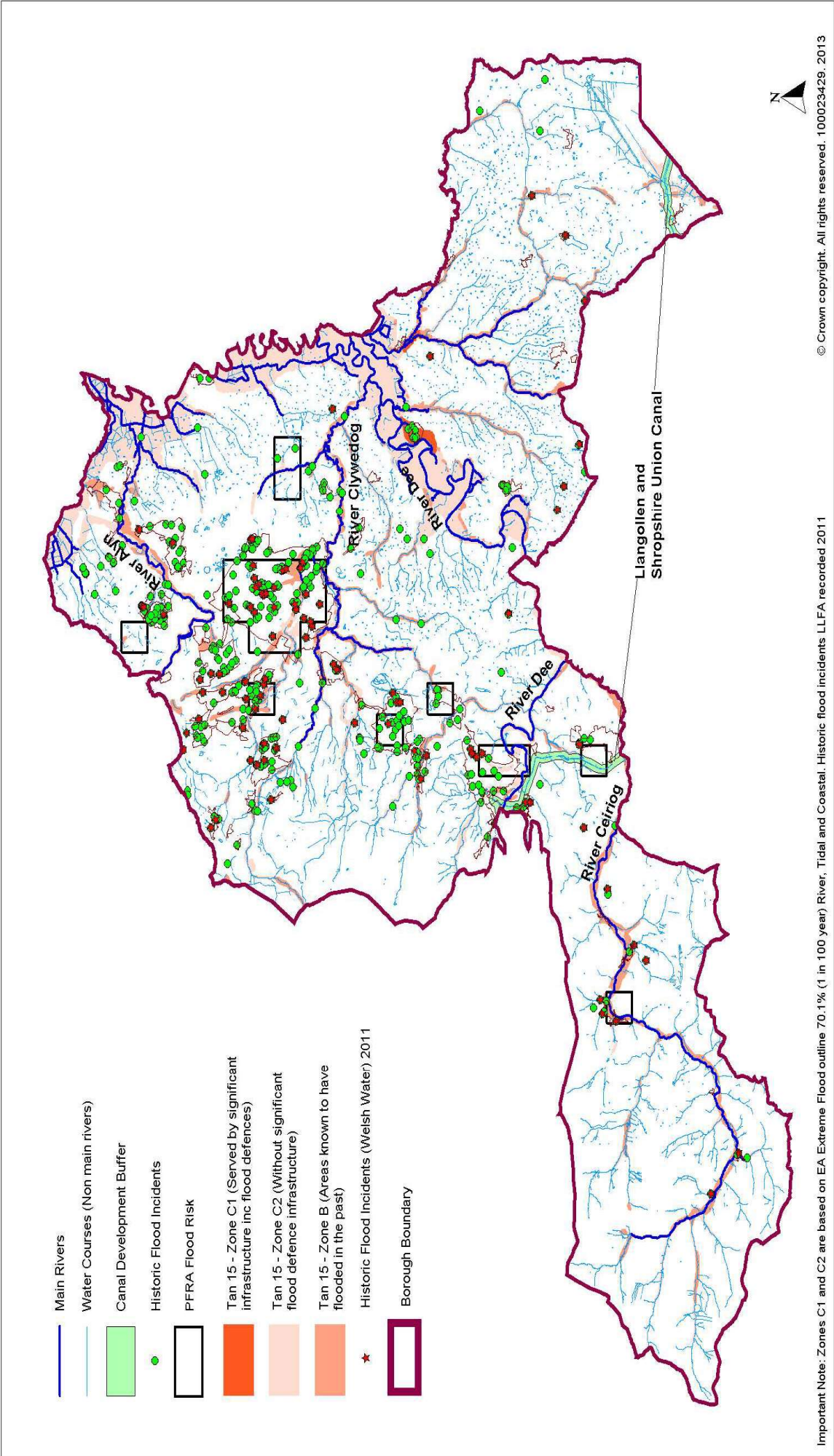
The River Dee is considered as part of a wider river basin including the river, its tributaries and estuary. The source of the Dee is near Bala and the whole basin includes Llyn Tegid Special Area of Conservation (SAC) through to the Dee Estuary (SPA) including reservoirs at Llyn Tegid, Celyn and Brenig. The Dee is of high biodiversity value due to its originally low nutrient status and high quality riparian habitats. Its interest includes a number of species that are typical of high quality rivers with low nutrient levels in the water. Of particular note is the use of the River Dee as a migration route by Atlantic salmon, up to spawning grounds in the river, some of which are within Wrexham County Borough.

The River Basin Management Plan current status of the water environment states that 28% of the surface waters are at good or better ecological/potential status now. 51% of the assessed surface waters are at a good or better ecological status now. 108 surface water bodies have been assessed for ecology and 72 have been assessed for biology. The River Dee and Bala lake is a SAC, is vulnerable to specific flood risk management measures and pressures in relating to canalised stretches altering habitats, collapsing embankments, nutrient levels, provision of water resource locally and to parts of the West Midlands and North West of England, recreational disturbance, siltation from construction and invasive species.

Limitations

There are limitations to the data provided with each source of information varying in format and level of detail. Improvements in the recording system have been identified and are included as a measure of the LFRMS. Once adopted and monitored improvements in flood risk information held by the Lead Local Flood Authority will inform local flood risk management approach and ongoing review of the strategy.

Figure 1.8 Flood Risk Assessment across Wrexham County Borough (Local Flood Risk Management Strategy 2012)



and mapping them against green spaces, initiatives for investment and improvements can be identified. It provides evidence of existing initiatives within the regional area which includes Stamford Brook and Northern Gateway which demonstrate the principles of this policy approach to Lower River Dee and actions required. This action plan forms one of two areas that have been prioritised for green infrastructure investment under the Green Infrastructure Framework.

Natural approaches to flood risk management is more sustainable and cost effective than hard engineering defences and can bring added benefits to wildlife and amenity to regenerated areas and urban spaces. The Environment Agency has conducted research and there evidence to demonstrate the benefits of this approach. Natural approaches can include techniques which use land to temporarily store water away from high risk areas, reconnect rivers to floodplains, lengthening watercourses to a more natural alignment, restoring peat bogs, blocking artificial drainage channels, reforesting floodplains, green roofs, permeable paving, and surface water attenuation ponds

Improvements to the collection of data onto a single mapping system for the local authority ensures that different functions take account or have regard to local flood risk and their interrelatedness. That will facilitate the analysis and monitoring of flood event patterns in relation to existing assets and infrastructure. Highlighting repeat issues or issues in regards to maintenance. The development of an annual asset maintenance schedule will ensure that the required ordinary watercourse consents will be scheduled and pre-application discussions can limit the issues in regards to design, ecology or proposed methods involved. The investigation process and asset register can reduce costs associated with flood damage from flood events and reduce the costs from repetitive actions which do not resolve the issues associated with the source of the flooding. Small measures, that could save long term higher costs associated with the continued flood risk we can anticipate from Climate Changes.

The Lead Local Flood Authority has permissive power to designate structures which affect flood risk so the owners can not alter or remove the structures. This designation procedure is assessed and has to satisfy four conditions for the consideration of formal designation. These four conditions are;

- Condition 1: that the designating authority thinks the existence or location of the structure or feature affects a flood risk or coastal erosion risk;
- Condition 2: that the designating authority has flood or coastal erosion risk management functions in respect of the risk which is affected;
- Condition 3: that the structure or feature is not already designated by another authority;
- Condition 4: that the owner of the structure or feature is not a designating authority;

Designation and asset maintenance can reduce the consequences and improve the approaches of flood risk management within the Borough. The flooding events that have occurred this year 2012-2013 within the Borough Council have varied in size and caused different patterns of events. In April prolonged and heavy rainfall caused problems associated with surface water run off and river flooding alerts in Acrefair and Rossett. The events in July and August were associated with surface water flooding and flash flooding in urban villages of Gwersyllt, Gresford, Marford, Llay and Burton Green. In September, flooding events covered the borough

The identification of communities at risk and vulnerable people can be assessed through the careful use of datasets across the Authority. Using the principles of the Community Flood Plans in Rossett and Bangor on Dee, and utilising the databases held on the private rented sector, council owned assets.

Wrexham County Borough Council in partnership with Environment Agency is committed to ensuring that everyone in the County Borough of Wrexham is informed or aware of the risks of local flooding. This awareness and information sharing is important to enable households and businesses to adopt suitable resistance and resilience measures.

In Wales, six pilot studies have been completed, two of these areas include Prestatyn and Pwllheli and provide important lessons in regards to the importance of awareness rising and adaptation to climate change. Climate change and adaptation forms an important role within all flood risk management measures.

The Multi-agency Flood Plan (MAFP) (2010) provides the framework produced by North Wales Resilience Forum and Multi Agency Response Plan for Major Emergencies (2010) for Emergency responses within the Borough. There are flood warning systems in place for Alyn Catchment, Rossett, Lower Dee Valley Llangollen to Chester, Lower Dee and Bangor on Dee.

The Area Flood Partnership includes representatives from the Council's Emergency Management Response Teams, Lead Local Flood Authority, Flood Risk Management Authorities and communities of Bangor on Dee, Rossett. This group hold meetings throughout the year and exercises every three years.

The Local Authority has an Emergency Planning Team (EP) and out of hours service with contact numbers, information and advice available on the website. During working hours flood event calls are dealt with by the Contact Centre through the Pride in Your Streets and passed to; Emergency Planning, Environment, Housing, or Public Protection. Most of the calls received are directed to Environment Street Scene section because of their responsibilities in regards to highways and land drainage.

In an Emergency flooding event, an established emergency response will be initiated. Flooding events are monitored carefully and co-ordination of information and updates across the various departments, external organisations and emergency responders are very important

The LFRMS has the potential to adversely affect such features, especially aquatic features as a result of any flood management measures that are implemented. Construction, land use change, changes in flood regime and frequency or changes in water levels that have the potential to adversely affect nature conservation and biodiversity features. Conversely, such changes present opportunities to enhance the condition of existing habitats and create new habitats. Trees form important character and functions within areas for biodiversity and drainage and flood risk alleviation. Trees within urban areas and Green Networks are important to flood risk management approach of quality, quantity and amenity.

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APPENDIX L: NOTES OF LIMITATIONS

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