DO NOT SCALE

Messing Village
Drainage Schedule

Chamber No.	Cover Level (m)	Invert Levels (m) A	B	C	D	Chamber Depth (m)	Comments
1	43.537	41.89	41.86				Fou Water MH
2	43.573	42.74	42.76	42.73			MH
3	43.594	42.90	42.83				MH
4	43.582	42.68				1.35	Gully
5	43.719	42.75					Gully
6	45.404	44.46	44.46	44.93			MH
6A	45.223	45.04					Side Entry Gully
7	45.527	44.69	44.69	45.31		0.99	MH
7A	45.391	45.25					Side Entry Gully
8	46.119	45.23	45.26	45.16	45.41	1.01	MH
8A	45.99	45.44					Gully
9	46.821	46.14	45.98	46.47		0.91	MH
9A	46.661	46.48					Side Entry Gully
10	47.908	47.13	47.08	47.51	47.18	1.25	MH
10A	47.791	47.61					Side Entry Gully
11	47.873	47.31	47.29				Gully
12	48.182	47.88				0.44	Gully
13	48.384	47.79					Gully
14	49.005	48.38	48.54	48.37	48.54		Gully
15	49.848	49.42	49.45	49.39			Gully
16	49.977	48.95					Gully -Blocked
17	50.154	49.15					Gully -Blocked
18	50.287	49.29					Gully -Blocked
19	50.388	49.39					Gully -Blocked
20	50.78	49.68	49.81				MH
21	50.901	49.99	49.73				MH
22	50.914	50.35					Gully
23	53.031	52.70					Gully - Blocked
24	52.997	52.43	52.40	52.67			Side Entry Gully
25	54.052	53.37	53.36	53.60			MH
25A	54.012	53.56					Gully
26	50.448	49.81					Gully
27	50.441	49.72				1	MH - Soakaway
28	50.255	48.43	48.43				MH
29	49.324	48.80				1.35	Gully
30	49.344	48.40	48.54	48.48		1.41	MH
31	49.135	47.65	47.65				MH
32	48.96	48.42	48.25	48.26		1.27	MH
33	48.651	48.10	48.16			1.45	Gully
34	48.728	47.18	47.17				MH
35	48.905	46.71	46.71				MH
36	47.639	46.14	46.14				MH
37	33.297	32.40	32.40				MH
38	46.259	45.44	45.42				MH
39	46.287	45.15	45.18				MH
40	45.939	45.24	45.22	45.21			Fou Water MH
41	45.946	45.54	45.54				Fou Water MH
42	46.327	46.02	46.02				Fou Water MH
43	46.248	44.00	43.99				Fou Water MH
44	42.61	41.47	41.76	41.83	41.47		MH
45	42.561	42.08					Gully
46	42.535	42.54					UTL-Gully

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

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DECOMMISSIONING/DEMOLITION

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Rev.	Date	Description	By	Chk'd	App'd

Drawing Status

Suitability AB

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www.atkinsglobal.com

Client: Essex County Council

Project Title: MESSING
DRAINAGE INVESTIGATION
AND FLOOD RISK ASSESSMENT

Drawing Title: 3D TOPOGRAPHICAL SURVEY
WITH SURFACE WATER DRAINAGE
INFORMATION

Scale	Designed	Drawn	Checked	Authorised
1:500	N/A	BJM	GJC	NHG
Original Size: A1	Date: –/–/–	Date: 24/03/14	Date: 24/03/14	Date: 24/3/14

Drawing Number: MESSDI-ATK-00-00-DR-L-0003

Revision: 001

DO NOT SCALE

Messing Village
Drainage Schedule

Chamber No.	Cover Level (m)	Invert Levels (m) A	B	C	D	Chamber Depth (m)	Comments
1	43.537	41.89	41.86				Foul Water MH
2	43.573	42.74	42.76	42.73			MH
3	43.594	42.90	42.83				MH
4	43.582	42.68				1.35	Gully
5	43.719	42.75					Gully
6	45.404	44.46	44.46	44.93			MH
6A	45.223	45.04					Side Entry Gully
7	45.527	44.69	44.69	45.31		0.99	MH
7A	45.391	45.25					Side Entry Gully
8	46.119	45.23	45.26	45.16	45.41	1.01	MH
8A	45.99	45.44					Gully
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10A	47.791	47.61					Side Entry Gully
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13	48.384	47.79					Gully
14	49.005	48.38	48.54	48.37	48.54		Gully
15	49.848	49.42	49.45	49.39			Gully
16	49.977	48.95					Gully -Blocked
17	50.154	49.15					Gully -Blocked
18	50.287	49.29					Gully -Blocked
19	50.388	49.39					Gully -Blocked
20	50.78	49.68	49.81				MH
21	50.901	49.99	49.73				MH
22	50.914	50.35					Gully
23	53.031	52.70					Gully - Blocked
24	52.997	52.43	52.40	52.67			Side Entry Gully
25	54.052	53.37	53.36	53.60			MH
25A	54.012	53.56					Gully
26	50.448	49.81					Gully
27	50.441	49.72				1	MH - Soakaway
28	50.255	48.43	48.43				MH
29	49.324	48.80				1.35	Gully
30	49.344	48.40	48.54	48.48		1.41	MH
31	49.135	47.65	47.65				MH
32	48.96	48.42	48.25	48.26		1.27	MH
33	48.651	48.10	48.16			1.45	Gully
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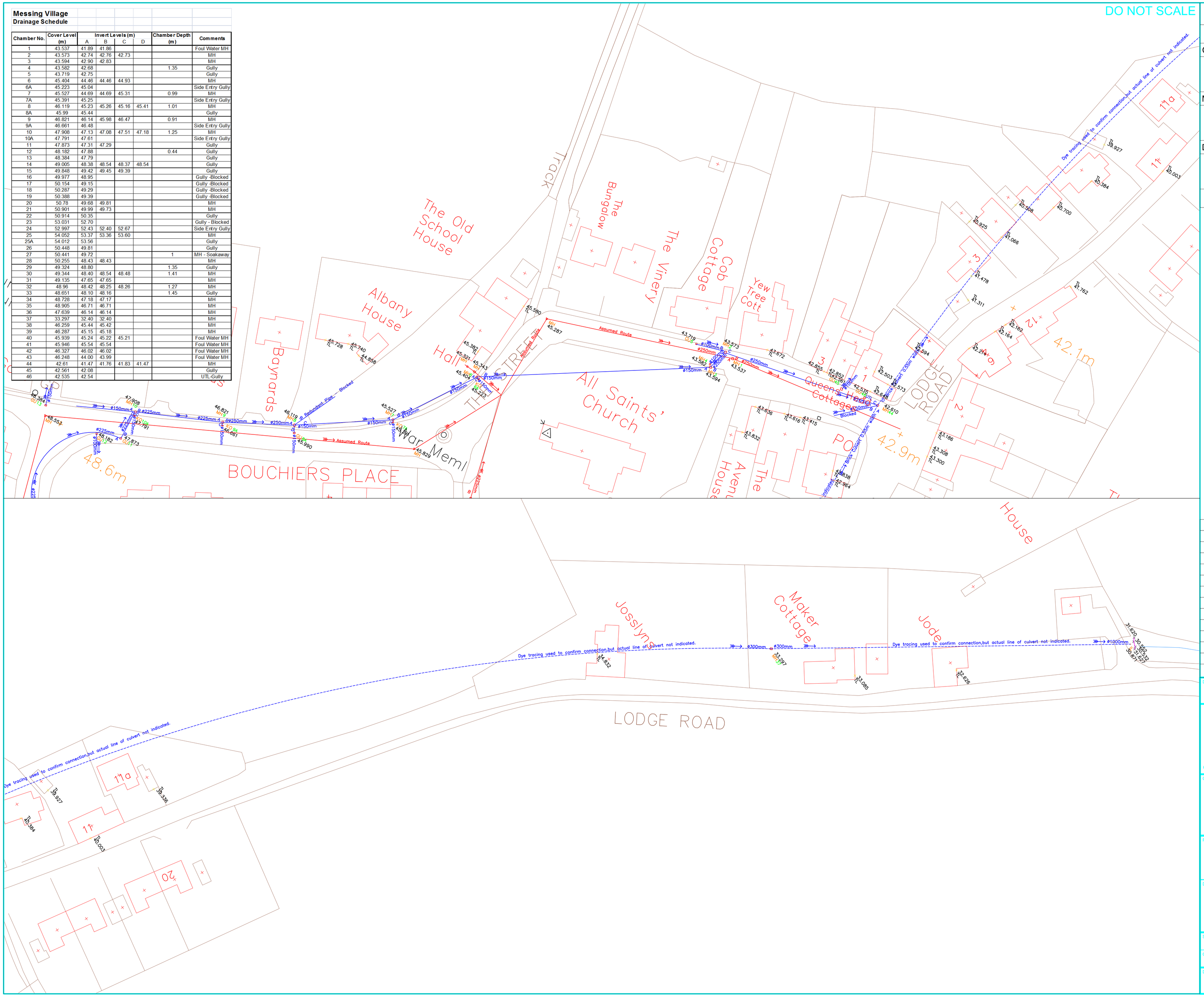
35	48.905	46.71	46.71				MH
36	47.639	46.14	46.14				MH
37	33.297	32.40	32.40				MH
38	46.259	45.44	45.42				MH
39	46.287	45.15	45.18				MH
40	45.939	45.24	45.22	45.21			Foul Water MH
41	45.946	45.54	45.54				Foul Water MH
42	46.327	46.02	46.02				Foul Water MH
43	46.248	44.00	43.99				Foul Water MH
44	42.61	41.47	41.76	41.83	41.47		MH
45	42.561	42.08					Gully
46	42.535	42.54					UTL-Gully



SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

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Project Title: MESSING DRAINAGE INVESTIGATION AND FLOOD RISK ASSESSMENT

Drawing Title: 3D TOPOGRAPHICAL SURVEY WITH SURFACE WATER DRAINAGE INFORMATION

Scale	Designed	Drawn	Checked	Authorised
1:500	N/A	BJM	GJC	NHG
Original Size: A1	Date: --/--/--	Date: 24/03/14	Date: 24/03/14	Date: 24/3/14

Drawing Number: MESSDI-ATK-00-00-DR-L-0004

Revision: 001

DO NOT SCALE

Millimetres 0 10 100

Lych Gate

The Vicarage

Freelands

Baylards

HIGH STREET

War Meml

All Saints' Church

Queens Head Cottages

PO

TCB

LB

Grosmont

Barfields Row

Stoke Claudian

BOUCHIERS PLACE

48.6m

Avenue House

The Store

The Old Vicarage

The Bell House

Osborne House

Tamarisk

Davington

Little Garth

Atlast

Path

SLING GREEN

Sinks

Picotte

Concrete Flagstone

Issues

Colts

Jeldon

Broadlands

Pond

Pond

Bouchiers Hall

Weavers

Collins Green

SCHOOL ROAD

Conifers

Keepers Cottage

HARBOR

50.1m

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SURVEY LEGEND

AV	Air Valve	LB	Letter Box	WH	Weep Hole
BB	Bellaha Beacon	LP	Lamp Post	WM	Water Meter
BL	Bollard	LR	Location Reference Point	WO	Water Outlet
BT	Telecom Cover	LT	Traffic Light	WT	Water Top
BH	Borehole	ME	Marker of Electricity		
BP	Boundary Post	MG	Marker of Gas		
BS	Bus Stop	MH	Manhole		
BT	Telecom Cover	MP	Marker Post		
BX	Box	MS	Mile Stone	C/B	Fence – Close Boarded
CA	Camera	MW	Marker of Water	C/I	Fence – Corrugated Iron
CB	Call Box	NB	Notice Board	C/L	Fence – Chain Link
CC	CCTV	NK	Tank	C/N	Fence – Chestnut
CP	Call Pillar	NP	Name Plate	FP	Fence – Parapet Fence
CT	Cable TV Cover	PB	Park Bench	FPG	Fence – Pedestrian Rail
CX	Control Box	PL	Pillar	FSF	Fence – Safety Fence
DP	Down Pipe	PM	Parking Meter	I/R	Fence – Iron Railings
DF	Drinking Fountain	PO	Post	I/W	Fence – Wattle/Interwoven
DS	Direction Sign	RE	Rodding Eye	L/L	Fence – Larch Lap
EC	Electricity Cover	RP	Reflector Post	P/BW	Fence – Post & Barbed Wire
EP	Electricity Pole	RS	Road Sign	P/R	Fence – Post & Rail
ER	Earth Rod	SC	Stop Cock	P/S	Fence – Pole & Space
FH	Fire Hydrant	SI	Sign	P/W	Fence – Post & Wire
FS	Flag Staff	SNP	Street Name Plate	S/R	Fence – Steel Railings
GP	Guide Post	SO	Soffit Level	TSR	Fence – Tubular Steel Railings
GR	Grating	SP	Spring		
GU	Gully	SV	Sluice Valve		
GV	Gas Valve	SY	Stay/Strut		
IC	Inspection Cover	TL	Threshold Level		
IL	Invert Level	UC	Unknown Cover		
IS	Information Sign	VP	Vent Pipe		
KO	Kerb Outlet	WB	Waste Bin		

Rev.	Date	Description	By	Chk'd	App'd

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WITH ANNOTATED LEVELS

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1:500	N/A	BJM	GJC	NHG
Original Size: A1	Date: --/--/--	Date: 24/03/14	Date: 24/03/14	Date: 24/3/14

Drawing Number: MESSDI-ATK-00-00-DR-L-0001

Revision: 001

DO NOT SCALE

Millimetres 0 10 100

BOUCHIERS PLACE
LODGE ROAD
The Old School House
The Bungalow
The Vinery
Cob Cottage
Yew Tree Cott
Albany House
The Vicarage
Freelands
Baynards
All Saints' Church
Queens Head
Cottages
PO
Avenue House
The House
Josslyns
Maker Cottage
Jode
War Meml
Track
48.6m
42.9m
42.1m

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MESSING
DRAINAGE INVESTIGATION
AND FLOOD RISK ASSESSMENT

Drawing Title

3D TOPOGRAPHICAL SURVEY
WITH ANNOTATED LEVELS

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1:500	N/A	BJM	GJC	NHG
Original Size	Date	Date	Date	Date
A1	--/--/--	24/03/14	24/03/14	24/3/14

Drawing Number: MESSDI-ATK-00-00-DR-L-0002

Revision: 001

Appendix C – Messing Flood Study Preliminary Option Assessment

Ref	Measures	Description	Opportunities (numbers read down through overall option)	Constraints (numbers read down through overall option)	Comments
1	Increase pipe capacity in The Street and Lodge Road	Increase capacity of the 150mm pipe in the Street from the Village Hall to Lodge Road	• Conveys surface water say up to 3.33% AEP from Village Hall • May be undertaken under ECC Highway budget	• Expensive, unlikely ECC will justify • Likely only to get 1 in 30 year standard thus exceedance will still flood village hall and move the problem downstream to the Village	• Driver for option would be if unable to get Mr Sherwood to agree to soak-away in track adjacent to The Bungalow on The Street, or attenuation in Village Hall Garden not feasible
		Construct new culvert In Lodge Road as additional capacity to the 450x450mm until it can enter ditch system. This could be to the west of the existing ditch and extend the ditch behind Josslyns, Maker Cottage and Jode to swales beyond the pumping station	• Conveys surface water say up to 3.33% AEP from the centre of the Village if large enough • May be undertaken under ECC Highway budget	• Expensive, unlikely ECC will justify • Likely only to get 1 in 30 year standard thus exceedance may still flood the village	• Driver for option would be if unable to get Messing Green to be feasible and; attenuation in Village Hall Garden is not feasible or Mr Sherwood does not agree to soak-away in track
2	Messing Green SuDS Attenuation	Provide min 3.33% AEP+cc to max 1% AEP+cc attenuation for School Road and adjacent properties. Will be either:	• Stores surface water close to the source, is sustainable and open space is available in the right place and reduce flooding for 30% AEP+cc or more frequent	• Site is an amenity area and cannot be a wetland • Potentially a spring is located across the Green and the area used to be the site of a pond •	Parish Council agreeable to storage area provided: a. The Green remains relatively flat and accessible b. No pond/wetland for children to be at risk c. No high banks to obstruct views d. Prefer storm crate system
		a. Open storage over most of Green up to say 0.5m deep by cut & fill across 1.5m slope, with a bund on lower slope max 1m high, shallow slopes	• Relatively easy to maintain by grass cutting as now. • Green can be used as amenity • Only earthworks plus silt-trap & control structures required	• Shallow design to take inflow from road and discharge to sewers • 1.5m cross-fall on Green: • Requires the invert to be raised to reduce excavation • Imposes constraint on bund height as shallow slopes mean more land take for bund and less storage.	• Ideally would discharge downhill via sewer system towards Bouchiers Hall access road but this may not be permitted by Messrs Campbell the private sewer owners.
		b. Storm crate type cellular system buried, raising ground level above max 1m.	• Buried storage allows flat and dry amenity area • Raise ground levels above crates	• Crates are costly (£100,000) for materials alone. • Limit on depth by where discharge. If to School Road difficult to fit in. if Bouchiers is OK if permitted.	• Although preferred by Parish Council may be more expensive and more to maintain. PC cannot fund maintenance.
		c. Both systems will have an upstream silt-trap, downstream orifice control at Greenfield Runoff rate and may have an infiltration element	• Location is good to put a silt trap at the corner of Messing Green road and School Road, with exceedance spill into the area • Infiltration would reduce volume required to be stored	• Silt trap would be in sight-line of development, not clear if this can be adopted by highways to maintain. • Silt trap either next to 1st property at junction of Messing Green then cross road or enter next to sub-station and Fire Hydrant which constrains the space. • Infiltration would not be possible if there is a spring	• No spring was evident after heavy rain. The historical spring allegedly drains to Bouchiers Hall private sewer and pond once it had been in-filled. • A land drain assists or takes exceedance from Messing Green soakaways. • Pipes may connect to soakaways from the highway sewer. • Needs a Ground Investigation to confirm infiltration potential and groundwater levels.
		d. Discharge to School Road surface water sewer	• Would take runoff back to highway sewer so no permission issue	• May be difficult to achieve discharge above sewer invert, storage has to be shallow.	• Balance to get active storage to work may mean high bund level on east side of Green.

Ref	Measures	Description	Opportunities (numbers read down through overall option)	Constraints (numbers read down through overall option)	Comments
		e. Discharge to Bouchiers Hall private sewer	• Adequate fall to drain storage area, can vary invert, deeper storage and lower bunds	• No permission to connect to existing private sewer • May not get permission to lay new sewer either to the Street or Bouchiers Stream	• Need to check land titles to see whose land we need permission for. Mainly will be Mr D Sherwood
		f. Discharge to Bouchiers Hall stream	• Uses fall from Green but avoids need to connect to private sewer • Assume can use sewer from Green then need to drain under Bouchiers Hall access road to ditch	• Need permission to cross Bouchiers Hall track and land and then use the existing boundary ditch. • Increase flows into the two 150mm pipes in Bouchiers Stream, consider increase in flood risk	• Main issue is getting permission to cross land assuming no powers are available from ECC. If discharge only at Greenfield runoff rate can argue no different than before Messing Green was built. Also no history of flooding there in 2013/14.
3	Village Hall exceedance measures	a. Drain exceedance from 150mm pipe gully by Village Hall in pipe and possibly surface gully to a soakaway in verge 15m down adjacent farm track	• Drains all exceedance out of road depression away from the Hall safely to fields. Soakaway needed to prevent track becoming a stream except in extreme conditions. • Can be installed by ECC Highways but also need to maintain.	• Permission from Mr Sherwood unlikely to be given • Needs to be a large soakaway say 2x3x3m deep assuming Messing Green SuDS installed to take bulk of flows and exceedance drains down track	• The Street catchment alone without School Road will exceed the existing drainage in a 3.33% AEP event. • Mr N Campbell, as the tenant farmer, has indicated that he will not give permission to use the track; note Mr Sherwood is the landowner. Need to talk to Mr N Campbell's son, perhaps explain more fully why upgrading street drainage is not the best option.
		b. Drain road into enlarged attenuation tank/soakaway in Village Hall Garden	• Does not involve permissions, entirely within control of the Parish • Can be taken off at high level at old weir chamber. • Sand is at shallow depth say 0.5m below ground but is in a depression so may tend to be saturated already	• May need to be large tank/soakaway and deep • Need to be able to reconnect to sewer at lower level possibly in The Street below crest of road • Exceedance may flood Albany House garages unless play area landscaped	• There is an old soakaway in Village Hall Garden some 0.8m diameter and a new soakaway 1.2x1.2.m this would need to be much larger depending on whether messing Green SuDS is installed. Theoretically the entire Garden could be used with a large inlet pipe.
4	School Road sewer exceedance	Take 225mm sewer in School Road and drain into an easement between the Vicarage and Cemetery in a French drain and swale as ground slopes away. May need to profile Kelvedon Road to direct flows across the road. Control on pipeline to divert flows.	• Keeps exceedance away from The Street. • Land may belong to the Church • Water can dissipate before it reaches fields	• Need permission from landowner • Need pipe under road and French drain • Light shrubs, habitat/birds nesting/reptiles etc. to be considered • Need to check flows to see if easement can accommodate flows • Need ECC Highways to agree and undertake works	• Check what land registry is on map. • This option could be standalone to a low Standard of Protection (SoP) but may also allow exceedance management of the SUDs and/or make the Messing Green storage smaller. • Will still need measures at the Village Hall.
5	Kelvedon Road Ditches	Reinstate and extend ditches in field to the west of School Road approx. 100m in length, and install a pipe crossing under Kelvedon Road to connect to a ditch/swale in fields to the north of the road	• Drains water from flooding surface water sewer feeding 225mm at Messing Green • Improves field drainage so landowner/tenant likely to support/carry out • ECC can undertake road work	• Need permission from landowner/tenant for both fields • Need ECC Highways to agree and undertake works	• This option reinstates the original drainage system and protects the sewer network, property and makes this part of the field more viable

JACOBS

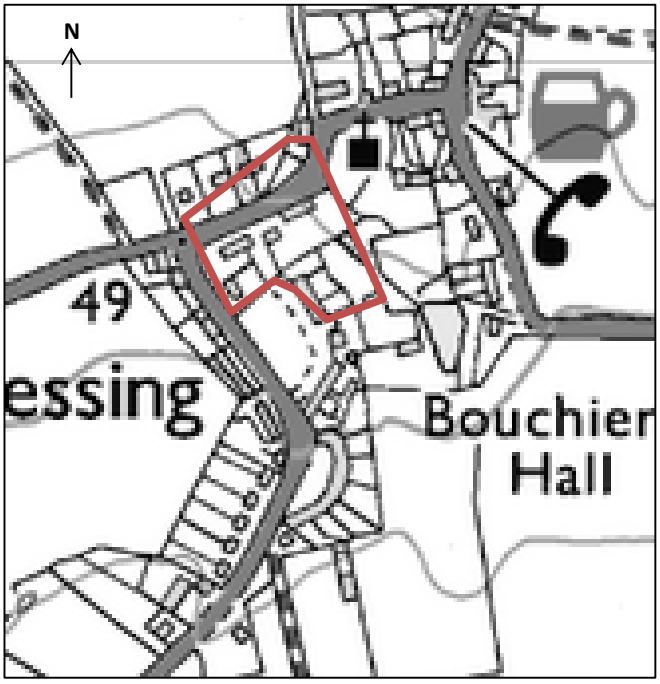
Messing Flood Study - Options Development - Calculations

For the purposes of this assessment Messing has been split into discreet catchments which are assumed to be independent of each other; this would be the case if the design measures are implemented.

Location 1 - Village Hall Catchment (excluding Messing Green and Bouchiers Hall)

It is assumed that only the catchment shown in **Error! Reference source not found.** (1.19 hectares, ha) requires managing at the Village Hall – this includes The Street and its housing to the junction with School Road and Kelvedon Road, and a proportion of the fields north of Bouchiers Hall, up to Bouchiers access road.

Figure 1 – Village Hall Catchment



The drainage pipe in The Street reduces from 250mm to 150mm diameter at Albany House. The smaller pipe continues downstream for approximately 140m until Yew Tree Cottage where this increases back to 250mm diameter pipe.

The capacity of the drainage pipe at the Village Hall (150mm diameter) has been calculated using *Charts for the hydraulic design of channels and pipes*[1]*:*

> Gradient calculated using drainage invert on corner of Kelvedon Road/School Road/The Street to pipe at Village Hall = (48.18-44.46)/116 = 0.032
>
> Ks – assumed as 0.03 for plastic pipes

Using the values above and Fig 4 in the *Charts for the hydraulic design of channels and pipes*[1], the discharge through the drainage pipe, assuming pipe-full conditions, is given as 3.6l/s. This has been assumed as the only outflow from the catchment.

[1] *Charts for hydraulic design of channels and pipes 6th edition* (1990) Hydraulics Research, Wallingford

Runoff from the Village Hall catchment has been calculated for a 3.33% (1 in 30) AEP[2] plus climate change rainfall event.

Mapping of the catchment has been assessed and it is assumed to be 60% permeable (see Figure 1) with a runoff coefficient calculated as 0.007, 40% impermeable with a runoff coefficient of 0.9. Therefore catchment volumetric runoff coefficient, Cv = 0.36.

Peak runoff rates and volume of runoff has been calculated using the Rational Method with results displayed in

Duration (hrs)	FEH rainfall Depth (mm)	Intensity (mm/hr)	Peak Flow Rate (m3/s)	Volume of Runoff (m3)	Volume to Drainage (m3)	Difference in volume (m3)
0.25	30.81	112.04	0.193	134	3	130
0.5	35.33	64.24	0.111	153	6	147
1	40.52	36.84	0.064	176	13	1637
2	46.49	21.13	0.036	202	26	176
4	53.32	12.12	0.021	231	52	179
6	57.76	8.75	0.015	250	78	173
8	61.15	6.95	0.012	265	104	161
10	63.90	5.81	0.010	277	130	147
14	67.69	4.40	0.008	294	181	112
24	72.99	2.76	0.005	316	311	5

.

Table 1 – Runoff and drainage capacity at the Village Hall for a 3.33% AEP event plus climate change

Duration (hrs)	FEH rainfall Depth (mm)	Intensity (mm/hr)	Peak Flow Rate (m^3/s)	Volume of Runoff (m^3)	Volume to Drainage (m^3)	Difference in volume (m^3)
0.25	30.81	112.04	0.193	134	3	130
0.5	35.33	64.24	0.111	153	6	147
1	40.52	36.84	0.064	176	13	1637
2	46.49	21.13	0.036	202	26	176
4	53.32	12.12	0.021	231	52	179
6	57.76	8.75	0.015	250	78	173
8	61.15	6.95	0.012	265	104	161
10	63.90	5.81	0.010	277	130	147
14	67.69	4.40	0.008	294	181	112
24	72.99	2.76	0.005	316	311	5

Using these parameters this suggests the drainage system will be at full capacity, with excess water above ground, for just over a day during a 1 in 30 year rainfall event (with an allowance for climate change). This discounts any flow from Messing Green, Bouchiers Hall or the fields to the west of School Road.

For this reason when designing the flood storage in Messing Green it has been assumed that no water can flow into the existing drainage system.

Measure 1a - Infiltration Trench in Village Hall Garden

It is understood there was once an underground storage tank which has now been in-filled beneath the garden of the Village Hall. The manhole at the southwest tip of the garden (at the end of Albany House's driveway) there is a side weir that once directed water from the drainage system into the storage tank; it is at this point

[2] Annual Exceedance Probability (AEP) is the probability of an event occurring in any given year, ie 3.33% is the equivalent of 1 in 30 probability of flooding in a year.

that the drainage pipe decreases from 250mm diameter to 150mm. There have since been 2 small soakaway units installed within the Garden to receive drainage from the acco drain at the gate to the Hall entrance and are located in the grass close to the Village Hall. The exact level of these units is unknown, they are approximately 1.2m^2 in plan and it is not thought that these significantly reduce flooding.

An option has been developed involving two measures at the Village Hall which are a combination of: storage within the Village Hall's garden and draining water from the depression outside of the Hall gate and then diverting it down the track alongside the Village Hall and The Bungalow (where The Street bends 90 degrees).

Storage in Village Hall's Garden (Measure 1a)

The existing weir that spills into the garden from the manhole in Albany House's driveway is set at 45.41mAOD. The elevation of the drainage system outside the Village Hall (at the northeast corner of the garden) is at 44.46mAOD, therefore allowing for 0.95m of potential storage depth and still allow for positive drainage back into the original system.

Two options were considered to provide storage in the garden: Aquavoid-ECO Storage blocks and 900mm pipes in series. The key difference between the two options is the cost of the raw materials.

Approximately 343m^2 surface area is available for below ground storage in the Garden providing the following assumptions: allowance for an easement of 2m along the garden's boundary with Albany House (providing space for a bund), 2m along The Street and at least 9m from the Village Hall to allow space for the existing soakaways. The two mature trees will have to be removed and also the standards along the street may be replanted or replaced. The play area will need to be disassembled then reinstated or replaced.

The Aquavoid-ECO Storage units could provide storage for surface water up to the 3.33% AEP (1 in 30) event (not including climate change), with approximately 40mm of water ponding above the surface.

The other option for storage in the Garden is within infiltration trenches – a series of 900mm pipes, surrounded by aggregate. This system provides storage for up to the 2% (1in 50) AEP event but not quite the 3.33% AEP plus climate change; this event will result in approximately 10mm ponding across the Garden.

It is understood that these systems would be located in a layer of sand which would allow for infiltration and increase the standard of protection of the design, however there is currently assumed to be no infiltration.

Note the required cover over the storm crates is 0.5m; it has been assumed that cover over the pipes is minimal.

It should be noted that the existing ground levels of the garden vary between 44.72 – 45.79mAOD; therefore this ground may need to be landscaped to provide the appropriate cover over the storage units and also allow for ponded water to be retained within the Garden. The storage can be enhanced by allowing surface ponding within the bund which will drain quickly through the sand to the storage system.

Measure 1b - Track between the Village Hall and The Bungalow

An additional measure to Measure 1a is providing a drain from the depression in The Street outside the Village Hall to allow for water to flow down the track between the Village Hall and The Bungalow within a pipe and enter a new drainage ditch adjacent to the track.

Initially it had been proposed to construct a soakaway to receive this flood water but the landowner has constructed a drainage ditch within the track and has agreed to receive this flow. Consideration will be given to trapping silt and attenuation prior to floodwater arriving at the river approximately 800m away.

The low point in The Street is outside the entrance to the Village Hall at 45.34mAOD; the road elevation is 45.4mAOD at the bend in the road (with a maximum elevation prior to this of 45.45mAOD). It is expected that the drain would be a 300mm diameter pipe as it passes through the crest and over or under the BT cable; the location of the cable will be confirmed using service record drawings and trial pit survey as necessary.

To calculate the size of the pipe required the *Charts for the hydraulic design of channels and pipes* was used again:

Gradient calculated using existing ground levels from topographical survey data – from the Village Hall to the top of the track (at the bend in The Street), as one pipe run and then down the track to the telegraph pole as another pipe run

Gradient = (45.35-45.25)/20 = 0.005

Ks – assumed as 0.03 for plastic pipes

Using the values above and Fig 4 in the book **Error! Reference source not found.** shows the pipe full discharge available in standard sized pipes.

Table 2 – Discharge Capacity of Pipes from Village Hall to top of track

Pipe size (mm)	Discharge (m^3/s)
300	0.008
375	0.011
450	0.023
525	0.037
600	0.050
675	0.068
750	0.096
800	0.110
900	0.150
1050	0.230

Assuming that the rainfall from the 3.33% AEP (plus climate change) is managed by Measure 1a in the Village Hall's garden, larger events will need to be alleviated with this pipe system. The required pipe discharge will be the difference between the extreme event and the 3.33% AEP (plus climate change), see Table 3.

Table 3 – Required Pipe size for Measure 1b

	Peak Runoff (m^3/s)				Req. flow rate down pipe away from Village Hall			
Time (hrs)	3.33% +CC (m^3/s)	2% (m^3/s)	1% (m^3/s)	1% +CC (m^3/s)	2% (minus 3.33%+CC) (m^3/s)	1% (minus 3.33%+CC) (m^3/s)	1%+CC (minus 3.33%+CC) (m^3/s)	Required Pipe size (mm)
0.25	0.191	0.208	0.265	0.317	0.017	0.074	0.127	1050
0.5	0.109	0.118	0.149	0.178	0.009	0.039	0.069	750
1	0.063	0.067	0.084	0.100	0.004	0.021	0.038	600
2	0.036	0.038	0.047	0.056	0.002	0.011	0.020	450
4	0.021	0.022	0.026	0.032	0.001	0.006	0.011	375
6	0.015	0.016	0.019	0.023	0.001	0.004	0.008	300
8	0.012	0.012	0.015	0.018	0.000	0.003	0.006	<300
10	0.010	0.010	0.012	0.015	0.000	0.002	0.005	<300
14	0.007	0.008	0.009	0.011	0.000	0.002	0.004	<300
24	0.005	0.005	0.006	0.007	0.000	0.001	0.002	<300
48	0.003	0.003	0.003	0.004	0.000	0.000	0.001	<300

A pipe size of 450mm from the Village Hall to the track (and continuing down the track) would be sufficient to carry the 2% AEP event, 1% within an hour and the 1% AEP (with an allowance for climate change) within two hours. The Street will be re-profiled to allow any excess surface water to drain down the track over ground, to the ditch.

If a combination of the options was implemented, with the whole of the garden utilised for storage and a 375mm pipe installed down the track to the ditch this should drain the area around the Village Hall, and can accommodate the 2% AEP event, with larger events, flooding the adjacent track, which presently occurs during a flood event. Subject to survey, it is likely that only a 300 diameter pipe and acco drain equivalent will be installed and therefore in some intense rainfall events flooding may still occur. A flood door is recommended for the Village Hall to increase confidence.

Measure 2a - Messing Green Flood Storage Area (FSA)

The Messing Green catchment (to be managed on Messing Green) includes School Road and its housing, from the high point near Red House to the northwest corner of the Green, as shown in Figure 2.

Figure 2 – Messing Green Catchment

Outline calculations have been carried out using as much of the Green as possible as a flood storage area, with the following restrictions:

- The invert of the existing pipe is set at 49.81mAOD (downstream 49.68mAOD) and the invert at the outlet is set at 48.37mAOD; these levels should be used as a guide.
- Bund 1m wide and set approximately 1m higher than the existing ground, along eastern and southern boundaries, where the existing ground is low
- All Slopes 1:4 apart a section along the eastern boundary used for disabled assess which uses (1:10)

- A buffer of 5m around the edge of the Green is undisturbed to avoid interaction with trees, this is extended to 10m along the eastern boundary, where services are located.

Topographic survey of the Green was used to develop the design for the FSA using the above parameters and tying into the existing ground.

The design water level in the FSA has been set as 49.8mAOD, with the bed sloping from 49.5mAOD in the south to 49.4mAOD in the north.

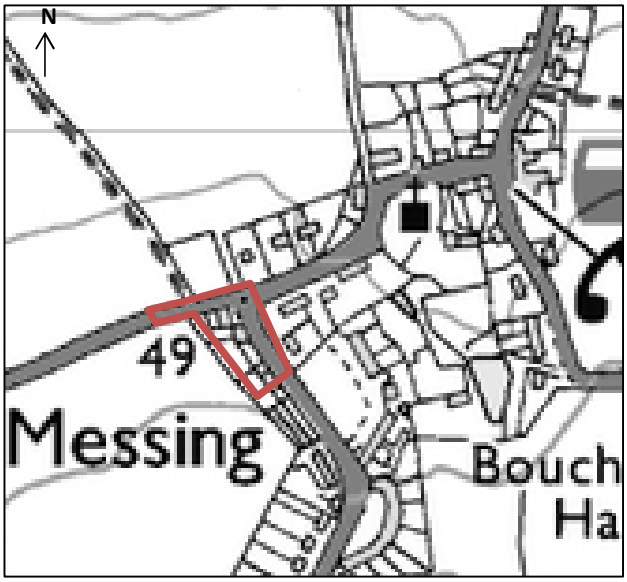
Outline calculations, using these design parameters result in a greater than 3.33% AEP plus climate change standard of protection, with no allowance for infiltration and an assumption that 3.6l/s will outfall into the drainage network, either in School Road (which is likely to be surcharged purely from the Village Hall catchment) or into the local soakaways. Note this assumes all excavated material will be moved off site.

Cross-sections through these proposals are included in Appendix E.

Measure 2b - Cemetery Path – Infiltration Trench

An infiltration trench is proposed for the strip of land between the Cemetery and the Vicarage. This will take excess flows from Messing Green FSA during an extreme event, and the runoff from the small area to the north-west of Messing Green on School Road and Kelvedon Road covering 0.3ha (see Figure 3**Error! Reference source not found.**).

Figure 3 – Additional catchment area for Measure 2b



The difference between the stored 3.33% AEP plus climate change in Messing Green and 1% AEP plus climate change is 279m^3.

When looking at the difference in flows between the events, during the storm, the peak ranges from 100-338l/s in the first hour.

The pipe-full discharge has been calculated from the southwest corner of Messing Green to the corner of Kelvedon Road/School Road:

Table 4 – Discharge Capacity of Pipes from northwest Messing Green to top of cemetery track

Pipe size (mm)	Discharge (m^3/s)
300	0.022
375	0.042
450	0.060
525	0.090
600	0.125
675	0.180
750	0.225
800	0.280
900	0.380
1050	0.580

Assuming that the rainfall from the 3.33% AEP plus climate change event is managed by Measure 2a in Messing Green FAS, larger events will need to be alleviated with this infiltration trench system. The required pipe discharge will be the difference between the extreme event and the 3.33% AEP plus climate change event (see Table 5**Error! Reference source not found.**).

Table 5 – Required Pipe size for Measure 2b

	Peak Runoff (m^3/s)			Req. flow rate down pipe away from Messing Green		
Time	3.33% +CC	1%	1% +CC	1% (minus 3.33% +CC)	1%+CC (minus 3.33% +CC)	Required Pipe size
(hrs)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(mm)
0.25	0.510	0.707	0.848	0.197	0.338	900
0.5	0.292	0.397	0.477	0.105	0.184	675
1	0.1685	0.223	0.268	0.056	0.100	600
2	0.096	0.125	0.150	0.029	0.054	450
4	0.055	0.070	0.085	0.015	0.029	375
6	0.040	0.050	0.060	0.011	0.021	300
8	0.032	0.040	0.048	0.008	0.016	<300
10	0.026	0.033	0.039	0.006	0.013	<300
14	0.020	0.025	0.030	0.005	0.010	<300
24	0.013	0.015	0.018	0.003	0.006	<300
48	0.007	0.008	0.010	0.001	0.003	<300

A pipe size of 375mm from the northwest corner of Messing Green to the top of the cemetery track would be sufficient to carry the 1% AEP event within two hours and the 1% AEP (with an allowance for climate change) within four hours. The existing pipework at this point is 225mm diameter and this would either be replaced or supplemented with a second pipe. Both pipes need to be connected to a new chamber in the kerb covered by a drainage grill to receive exceedance on the surface with an overflow to the cemetery easement soakaway or surface swale to field ditches (Measure 3b).

School Road and The Street will be re-profiled with a 'speed-bump' to divert surface water exceedance to drain down the track next to the cemetery over ground, to the infiltration trench or alternatively over-ground to the field ditch system.

If a combination of the measures was implemented it can accommodate the 1% AEP event, with larger events, ponding in the track (contained within a 1m bund at the northern end) and any further flows overtopping into the field to the north.

Measure 3a – Field drainage Ditch

This measure involves re-establishing the drainage ditch along the eastern boundary of Mr Sherwood's field to the west of School Road. The catchment area for this is highlighted in Figure 4.

Figure 4 – Catchment area for Measure 3a

The catchment draining to this ditch will be purely green field and therefore runoff from the field is minimal (see Table 6).

Table 6 – Peak Runoff rate from Mr Sherwood's field

	Peak Runoff (m^3/s)			
Time (mins)	3.33% +CC (m^3/s)	2% (m^3/s)	1% (m^3/s)	1% +CC (m^3/s)
15	0.015	0.016	0.020	0.024
30	0.008	0.009	0.011	0.014
60	0.003	0.005	0.006	0.008
120	0.002	0.003	0.004	0.004
240	0.001	0.002	0.002	0.002
360	0.001	0.001	0.001	0.002
480	0.001	0.001	0.001	0.01
600	0.001	0.001	0.001	0.001
840	0.000	0.001	0.001	0.001
1440	0.000	0.000	0.000	0.001
2880	0.000	0.000	0.000	0.000

A simple drainage ditch (0.5m deep and 1 in 2 side slopes) along the boundary, following the steep gradient of the field will provide capacity to convey flows up to the 1% AEP plus climate change. This ditch will intersect overland flow from the field and divert this away from School Road.

Measure 3b – Field drainage Ditch

This measure is to use the cemetery path as a bypass for flood flows from the whole of the School Road catchment; it involves using the path as an open channel to allow the surface water pipe on Kelvedon Road to discharge in to the channel and to convey exceedance flow (see Figure 4 in main report).

The peak runoff rate from the School Road catchment, which Measure 3b is to accommodate, is defined in Table 7. Manning's equation has been used to calculate the size of the channel required to accommodate these peak flows in the cemetery path and drainage ditches to the north in Mr Sherwood's fields.

Table 7 – Peak Runoff rate from School Road catchment

	Peak Runoff (m^3/s)			
Time (mins)	3.33% +CC (m^3/s)	2% (m^3/s)	1% (m^3/s)	1% +CC (m^3/s)
15	0.510	0.554	0.707	0.848
30	0.292	0.315	0.397	0.477
60	0.168	0.179	0.223	0.268
120	0.096	0.102	0.125	0.150
240	0.055	0.058	0.070	0.085
360	0.040	0.042	0.050	0.060
480	0.032	0.033	0.040	0.048
600	0.026	0.027	0.033	0.039
840	0.020	0.021	0.025	0.030
1440	0.013	0.013	0.015	0.018
2880	0.007	0.007	0.008	0.010

Cemetery path channel

The channel in the cemetery path needs to connect to the existing pipe run from Kelvedon Road, and therefore the bed level will be set lower than the invert level of this pipe (47.79mAOD in the manhole on Kelvedon Road). Therefore the channel will be approximately 0.9m deep at the upstream end.

Manning's equation has been applied, assuming a roughness of 0.05 and the bed slope to be slightly shallower than existing ground, to tie in with a shallower drainage ditch in the field at the downstream end; the gradient of the existing ground has been assessed using survey data, LiDAR and OS mapping. If the channel side slopes are 1 in 2, there is space to allow for a bed width of approximately 1m. The depth of water up to a 1% AEP plus climate change event would be approximately 0.45m, this allows for capacity to also provide storage within the channel.

Northern Fields (Mr Sherwood's Fields)

A similar approach has been adopted to size the drainage channel proposed in Mr Sherwood's fields to the north of The Vicarage and Village Hall. It has been assumed that, although the cemetery channel is required to be 0.9m deep at the upstream (southern) end, the field drains provide adequate capacity at 0.7m deep. This shallow channel has been designed to reduce the land-take in the fields.

The field drains have been assumed as having 1 in 2 side slopes and Manning's n value for roughness of 0.05. These ditch dimensions are appropriate to convey flood flows up to the 1% AEP plus climate change event.

It should be noted that the bed slope in the field drains has been assumed as the same as ground level in this calculation. Data is very limited with only OS mapping available to base levels on. More detailed topographic survey data will be required in this area for detailed design.

Measure 3c – Field drainage Ditch

This measure involves re-instating a ditch from the south of Josselyn along the western boundary of the properties on Lodge Road, to the Pumping station, north of Jode (see Figure 4 in main report). The catchment draining to this ditch is very small, including Lodge Road and a small stretch of Harborough Hall Road. Table 8 represents the calculated peak runoff for this catchment.

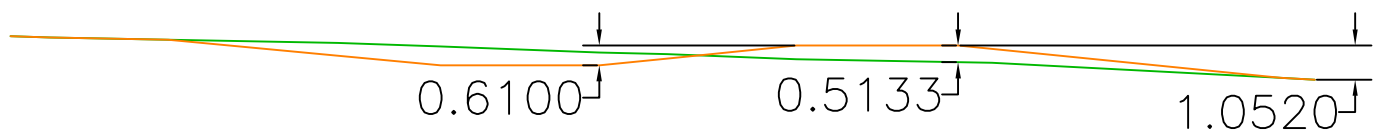
Table 8 – Peak Runoff rate from Lodge Road catchment

	Peak Runoff (m^3/s)			
Time (mins)	3.33% +CC (m3/s)	2% (m3/s)	1% (m3/s)	1% +CC (m3/s)
15	0.112	0.122	0.156	0.187
30	0.064	0.069	0.087	0.105
60	0.037	0.039	0.049	0.059
120	0.021	0.022	0.028	0.033
240	0.012	0.013	0.016	0.019
360	0.009	0.009	0.011	0.013
480	0.007	0.007	0.009	0.010
600	0.006	0.006	0.007	0.009
840	0.004	0.005	0.005	0.007
1440	0.003	0.003	0.003	0.004
2880	0.002	0.002	0.002	0.002

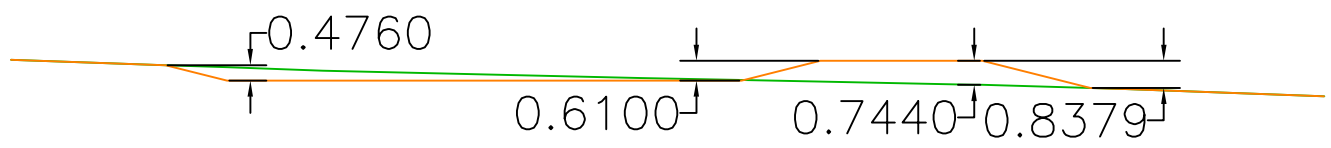
A simple drainage ditch (0.5m deep and 1 in 2 side slopes) connecting the existing channel, south of Josselyn, to the channel adjacent to the Pumping Station, along the property boundaries, would be sufficient to drain this local area and convey flood flows up to 1% AEP plus climate change. This is the minimum size of ditch, the actual depth and width will vary with grade and the required ditch invert level.

CROSS-SECTION A-A

CROSS-SECTION B-B



CROSS-SECTION E-E



CROSS-SECTION G-G

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10

A

B

Path

G

2A

49.39

G

E

B

A

MESSING

GREEN

5

Osborne

House

Ø225mm

Ø225mm

Ø225mm

Ø300mm