Hydrology & Energy Output Summary

Site Name: Mynydd Llandegai community scheme - 165l/s and rated at 12kW (jan-mar) **Date: 29 July 2010**

Data

FDC:	Based on one year's measured data
Turbine:	Semi-adjustable D235 propeller turbine
Generator:	Aysnchronous Marelli

Hydrology

Catchment Area:		sq km
Average Annual Rainfall:		m
Evapotranspiration		m
Net Runoff:	0.000	m
ADF:	0	l/s
Residual: Q95 plus	20%	

Hydraulics

Gross Head:	10.311	m
Head loss for intake screen:	0.800	m
Pipe pressure loss (at design flow):	0.211	m
Pipe pressure loss (%):	2%	
Net head at design flow:	9.3	m

Turbine

Turbine design flow:	165	l/s
Minimum flow (% of design flow):	50%	
Minimum flow:	83	l/s
Derate quoted turbine efficiency by:	0.00%	

Generator

Rating required (kVA)	16
Derate generator efficiency by:	2%

Efficiencies (at design flow)

Pipeline:	98%
Turbine (derated):	87%
Drive / coupling (flat belt)	98%
Generator (derated):	92%
Transformer:	100%
Transmission:	100%
Design System Efficiency:	**77%**

% time flow exceeded	**Normalised FDC** l/s	**Total flow** l/s	**Available flow** l/s	**Turbine flow** l/s	**Hydraulic power** kW	**Fraction of design flow**	**Pipeline Eff**	**Turbine Eff** (quoted)	**Turbine Eff** (derated)	**Shaft power** kW	**Generator Eff** (quoted)	**Generator Eff** (derated)	**Electric power** kW	**Available energy** kWHr/jan-mar
5		5,218.9	4074	165	15	1.00	98%	87.0%	87.0%	12.9	94.0%	92.0%	11.8	5,181
10		2,080.1	1563	165	15	1.00	98%	87.0%	87.0%	12.9	94.0%	92.0%	11.8	5,181
15		1,039.8	731	165	15	1.00	98%	87.0%	87.0%	12.9	94.0%	92.0%	11.8	5,181
20		670.6	435	165	15	1.00	98%	87.0%	87.0%	12.9	94.0%	92.0%	11.8	5,181
25		523.8	318	165	15	1.00	98%	87.0%	87.0%	12.9	94.0%	92.0%	11.8	5,181
30		439.3	250	165	15	1.00	98%	87.0%	87.0%	12.9	94.0%	92.0%	11.8	5,181
35		383.8	206	165	15	1.00	98%	85.0%	85.0%	12.6	93.9%	91.9%	11.6	5,059
40		330.1	163	163	15	0.99	98%	82.0%	82.0%	12.0	93.9%	91.9%	11.0	4,939
45		303.5	142	142	13	0.86	98%	78.1%	78.1%	10.0	93.9%	91.9%	9.2	4,414
50		273.1	117	117	11	0.71	99%	76.6%	76.6%	8.1	93.8%	91.8%	7.5	3,641
55		247.5	97	97	9	0.59	99%	73.8%	73.8%	6.5	93.2%	91.2%	5.9	2,933
60		234.6	87	87	8	0.52	99%	71.7%	71.7%	5.6	92.7%	90.7%	5.1	2,417
65		220.6	75	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
70		207.5	65	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
75		190.8	52	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
80		179.0	42	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
85		165.0	31	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
90		145.8	16	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
95		126.4	0	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
														54,489

Total Abstraction:	**2,776,034**	m3/year
Capacity Factor:	0.13	(electrical output)
Max. power output at point of use:	**11.8**	**kW**
Down time (expected and forced):	4%	
Estimated Jan-Mar Production:	**13**	**MWh**
Guaranteed FIT (miminum) unit price:	22.9	p/kWh
Gross income: £	**2,995**	

DULAS LTD - HYDROSIZE 2009v2

Hydrology & Energy Output Summary

Site Name: Mynydd Llandegai community scheme - 165l/s and rated at 12kW (apr-dec) **Date: 29 July 2010**

Data

FDC:	Based on one year's measured data
Turbine:	Semi-adjustable D235 propeller turbine
Generator:	Aysnchronous Marelli

Hydrology

Catchment Area:		sq km
Average Annual Rainfall:		m
Evapotranspiration		m
Net Runoff:	0.000	m
ADF:	0	l/s
Residual: Q95 plus	40%	

Hydraulics

Gross Head:	10.311	m
Head loss for intake screen:	0.800	m
Pipe pressure loss (at design flow):	0.211	m
Pipe pressure loss (%):	2%	
Net head at design flow:	9.3	m

Turbine

Turbine design flow:	165	l/s
Minimum flow (% of design flow):	50%	
Minimum flow:	83	l/s
Derate quoted turbine efficiency by:	0.00%	

Generator

Rating required (kVA)	16
Derate generator efficiency by:	2%

Efficiencies (at design flow)

Pipeline:	98%
Turbine (derated):	87%
Drive / coupling (flat belt)	98%
Generator (derated):	92%
Transformer:	100%
Transmission:	100%
Design System Efficiency:	**77%**

% time flow exceeded	**Normalised FDC** l/s	**Total flow** l/s	**Available flow** l/s	**Turbine flow** l/s	**Hydraulic power** kW	**Fraction of design flow**	**Pipeline Eff**	**Turbine Eff** (quoted)	**Turbine Eff** (derated)	**Shaft power** kW	**Generator Eff** (quoted)	**Generator Eff** (derated)	**Electric power** kW	**Available energy** kWHr/apr-dec
5		910.1	511	165	15	1.00	98%	87.0%	87.0%	12.9	94.0%	92.0%	11.8	5,181
10		578.4	312	165	15	1.00	98%	87.0%	87.0%	12.9	94.0%	92.0%	11.8	5,181
15		460.4	242	165	15	1.00	98%	87.0%	87.0%	12.9	94.0%	92.0%	11.8	5,181
20		388.8	199	165	15	1.00	98%	87.0%	87.0%	12.9	94.0%	92.0%	11.8	5,181
25		316.7	155	155	14	0.94	98%	87.0%	87.0%	12.1	93.9%	91.9%	11.2	5,033
30		261.3	122	122	11	0.74	99%	87.0%	87.0%	9.6	93.9%	91.9%	8.8	4,377
35		226.9	102	102	9	0.62	99%	85.0%	85.0%	7.8	93.7%	91.7%	7.2	3,507
40		179.0	73	0	0	0.00	0%	82.0%	82.0%	0.0	0.0%	0.0%	0.0	0
45		153.8	58	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
50		136.9	48	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
55		126.4	41	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
60		119.5	37	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
65		112.8	33	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
70		105.7	29	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
75		95.5	23	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
80		84.7	16	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
85		76.8	11	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
90		66.8	5	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
95		57.7	0	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
														33,641

Total Abstraction:	**1,638,476** m3/year	Max. power output at point of use:	**11.8 kW**	Guaranteed FIT (miminum) unit price:	22.9 p/kWh
Capacity Factor:	0.23 (electrical output)	Down time (expected and forced):	4%		
DULAS LTD - HYDROSIZE 2009v2		**Estimated Apr-Dec Production:**	**24 MWh**	Gross income: £	**5,547**

Appendix B – Hydrology; Dam Scheme, Crossflow Turbine

Hydrology & Energy Output Summary

Site Name: Mynydd Llandegai community scheme - 300l/s and rated at 15kW (jan-mar) **Date: 29 July 2010**

Data

FDC:	Based on one year's measured data
Turbine:	Crossflow turbine (Heksa)
Generator:	Aysnchronous Marelli

Hydrology

Catchment Area:			sq km
Average Annual Rainfall:			m
Evapotranspiration			m
Net Runoff:		0.000	m
ADF:		0	l/s
Residual:	Q95 plus	20%	

Hydraulics

Gross Head:	9.2	m
Head loss for intake screen:	0.8	m
Pipe pressure loss (at design flow):	0.7	m
Pipe pressure loss (%):	7%	
Net head at design flow:	7.7	m

Turbine

Turbine design flow:	300	l/s
Minimum flow (% of design flow):	10%	
Minimum flow:	30	l/s
Derate quoted turbine efficiency by:	2.50%	

Generator

Rating required (kVA)	21
Derate generator efficiency by:	2%

Efficiencies (at design flow)

Pipeline:	93%
Turbine (derated):	75%
Drive / coupling (flat belt)	98%
Generator (derated):	92%
Transformer:	100%
Transmission:	100%
Design System Efficiency:	**63%**

% time flow exceeded	**Normalised FDC** l/s	**Total flow** l/s	**Available flow** l/s	**Turbine flow** l/s	**Hydraulic power** kW	**Fraction of design flow**	**Pipeline Eff**	**Turbine Eff** (quoted)	**Turbine Eff** (derated)	**Shaft power** kW	**Generator Eff** (quoted)	**Generator Eff** (derated)	**Electric power** kW	**Available energy** kWHr/jan-mar
5		5,218.9	4074	300	25	1.00	93%	77.9%	75.4%	16.9	94.0%	92.0%	15.6	6,830
10		2,080.1	1563	300	25	1.00	93%	77.9%	75.4%	16.9	94.0%	92.0%	15.6	6,830
15		1,039.8	731	300	25	1.00	93%	77.9%	75.4%	16.9	94.0%	92.0%	15.6	6,830
20		670.6	435	300	25	1.00	93%	77.9%	75.4%	16.9	94.0%	92.0%	15.6	6,830
25		523.8	318	300	25	1.00	93%	77.9%	75.4%	16.9	94.0%	92.0%	15.6	6,830
30		439.3	250	250	21	0.83	95%	78.0%	75.5%	14.5	93.9%	91.9%	13.3	6,331
35		383.8	206	206	17	0.69	97%	76.2%	73.7%	11.8	93.9%	91.9%	10.9	5,297
40		330.1	163	163	13	0.54	98%	72.3%	69.8%	9.0	93.4%	91.4%	8.2	4,183
45		303.5	142	142	12	0.47	98%	69.6%	67.1%	7.6	92.7%	90.7%	6.9	3,302
50		273.1	117	117	10	0.39	99%	65.7%	63.2%	5.9	91.4%	89.4%	5.3	2,661
55		247.5	97	97	8	0.32	99%	61.7%	59.2%	4.6	89.9%	87.9%	4.0	2,045
60		234.6	87	87	7	0.29	99%	59.4%	56.9%	4.0	89.0%	87.0%	3.4	1,638
65		220.6	75	75	6	0.25	100%	56.7%	54.2%	3.3	87.9%	85.9%	2.8	1,371
70		207.5	65	65	5	0.22	100%	54.1%	51.6%	2.7	86.8%	84.8%	2.3	1,118
75		190.8	52	52	4	0.17	100%	50.3%	47.8%	2.0	85.3%	83.3%	1.7	863
80		179.0	42	42	3	0.14	100%	47.5%	45.0%	1.5	84.2%	82.2%	1.3	638
85		165.0	31	31	3	0.10	100%	44.0%	41.5%	1.0	82.9%	80.9%	0.8	459
90		145.8	16	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
95		126.4	0	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
														64,054

Total Abstraction:	**4,457,176**	m3/year
Capacity Factor:	0.11	(electrical output)
Max. power output at point of use:	**15.6**	**kW**
Down time (expected and forced):	4%	
Estimated Jan-Mar Production:	**15**	**MWh**
Guaranteed FIT (miminum) unit price:	22.9	p/kWh
Gross income: £	**3,520**	

DULAS LTD - HYDROSIZE 2009v2

Hydrology & Energy Output Summary

Site Name: Mynydd Llandegai community scheme - 300l/s and rated at 15kW (apr-dec) **Date: 29 July 2010**

Data

FDC:	Based on one year's measured data
Turbine:	Crossflow turbine (Heksa)
Generator:	Aysnchronous Marelli

Hydrology

Catchment Area:		sq km
Average Annual Rainfall:		m
Evapotranspiration		m
Net Runoff:	0.000	m
ADF:	0	l/s
Residual: Q95 plus	40%	

Hydraulics

Gross Head:	9.2	m
Head loss for intake screen:	0.8	m
Pipe pressure loss (at design flow):	0.7	m
Pipe pressure loss (%):	7%	
Net head at design flow:	7.7	m

Turbine

Turbine design flow:	300	l/s
Minimum flow (% of design flow):	10%	
Minimum flow:	30	l/s
Derate quoted turbine efficiency by:	2.50%	

Generator

Rating required (kVA)	21
Derate generator efficiency by:	2%

Efficiencies (at design flow)

Pipeline:	93%
Turbine (derated):	75%
Drive / coupling (flat belt)	98%
Generator (derated):	92%
Transformer:	100%
Transmission:	100%
Design System Efficiency:	**63%**

% time flow exceeded	Normalised FDC l/s	Total flow l/s	Available flow l/s	Turbine flow l/s	Hydraulic power kW	Fraction of design flow	Pipeline Eff	Turbine Eff (quoted)	Turbine Eff (derated)	Shaft power kW	Generator Eff (quoted)	Generator Eff (derated)	Electric power kW	Available energy kWHr/apr-dec
5		910.1	511	300	25	1.00	93%	77.9%	75.4%	16.9	94.0%	92.0%	15.6	6,830
10		578.4	312	300	25	1.00	93%	77.9%	75.4%	16.9	94.0%	92.0%	15.6	6,830
15		460.4	242	242	20	0.81	95%	77.8%	75.3%	14.0	93.9%	91.9%	12.9	6,232
20		388.8	199	199	16	0.66	97%	75.7%	73.2%	11.4	93.9%	91.9%	10.4	5,105
25		316.7	155	155	13	0.52	98%	71.4%	68.9%	8.5	93.2%	91.2%	7.7	3,982
30		261.3	122	122	10	0.41	99%	66.5%	64.0%	6.2	91.7%	89.7%	5.6	2,921
35		226.9	102	102	8	0.34	99%	62.6%	60.1%	4.9	90.3%	88.3%	4.3	2,172
40		179.0	73	73	6	0.24	100%	56.1%	53.6%	3.1	87.6%	85.6%	2.7	1,533
45		153.8	58	58	5	0.19	100%	52.1%	49.6%	2.3	86.0%	84.0%	1.9	1,012
50		136.9	48	48	4	0.16	100%	49.2%	46.7%	1.8	84.8%	82.8%	1.5	748
55		126.4	41	41	3	0.14	100%	47.3%	44.8%	1.5	84.1%	82.1%	1.2	592
60		119.5	37	37	3	0.12	100%	46.0%	43.5%	1.3	83.6%	81.6%	1.1	500
65		112.8	33	33	3	0.11	100%	44.7%	42.2%	1.1	83.2%	81.2%	0.9	433
70		105.7	29	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
75		95.5	23	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
80		84.7	16	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
85		76.8	11	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
90		66.8	5	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
95		57.7	0	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0.0	0
														38,889

Total Abstraction:	**2,694,536**	m3/year
Capacity Factor:	0.20	(electrical output)
Max. power output at point of use:	**15.6**	**kW**
Down time (expected and forced):	4%	
Estimated Apr-Dec Production:	**28**	**MWh**
Guaranteed FIT (miminum) unit price:	22.9	p/kWh
Gross income: £	**6,412**	

Appendix C – Hydrology; Galedffrwd Scheme, Turgo Turbine

Hydrology & Energy Output Summary

Site Name River Galedffrwd - Coetir Mynydd feasibility study (jan) **Date: 30th March, 2010**

Data

FDC:	HydrA & Lowflows software
Turbine:	Gilkes 15 inch single jet Turgo
Generator:	Asynchronous generator - generic

Hydrology

Catchment Area:	4.00	sq km
Average Annual Rainfall:	2.159	m
Evapotranspiration	0.406	m
Net Runoff:	1.753	m
ADF:	222	l/s
Residual: Q95 plus	20%	

Hydraulics

Gross Head:	98.0	m
Head loss for intake screen:	0.8	m
Pipe pressure loss (at design flow):	7.2	m
Pipe pressure loss (%):	7%	
Net head at design flow:	90.0	m

Turbine

Turbine design flow:	147	l/s
Minimum flow (% of design flow):	10%	
Minimum flow:	15	l/s
Derate quoted turbine efficiency by:	0.5%	

Generator

Rating required (kVA)	134
Derate generator efficiency by:	0.5%

Efficiencies (at design flow)

Pipeline:	93%
Turbine (derated):	83%
Drive / coupling:	100%
Generator (derated):	94%
Transformer:	100%
Transmission:	100%
Design System Efficiency:	**71%**

% time flow exceeded	Normalised FDC l/s	Total flow l/s	Available flow l/s	Turbine flow l/s	Hydraulic power kW	Fraction of design flow	Pipeline Eff	Turbine Eff (quoted)	Turbine Eff (derated)	Shaft power kW	Generator Eff (quoted)	Generator Eff (derated)	Electric power kW	Available energy kWHr/month
5	1030.5	1030	725	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
10	742.0	742	494	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
15	599.1	599	380	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
20	483.7	484	288	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
25	438.6	439	252	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
30	397.8	398	219	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
35	358.0	358	187	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
40	322.2	322	159	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
45	299.8	300	141	141	134	0.96	93%	83.6%	83.1%	103.9	93.9%	93.4%	97	43,200
50	278.9	279	124	124	118	0.84	95%	84.2%	83.7%	93.7	93.9%	93.4%	87	40,420
55	257.5	258	107	107	102	0.73	96%	84.2%	83.7%	81.9	93.9%	93.4%	77	35,918
60	237.8	238	91	91	87	0.62	97%	84.0%	83.5%	70.5	93.8%	93.3%	66	31,158
65	222.2	222	79	79	75	0.53	98%	83.8%	83.3%	61.1	93.6%	93.1%	57	26,858
70	207.7	208	67	67	64	0.46	98%	83.3%	82.8%	52.0	93.1%	92.6%	48	23,009
75	190.1	190	53	53	50	0.36	99%	82.0%	81.5%	40.7	91.9%	91.4%	37	18,693
80	173.9	174	40	40	38	0.27	99%	79.5%	79.0%	29.9	90.1%	89.6%	27	14,006
85	158.2	158	27	27	26	0.19	100%	75.2%	74.7%	19.4	87.5%	87.0%	17	9,562
90	143.9	144	16	16	15	0.11	100%	68.9%	68.4%	10.3	84.4%	83.9%	9	5,594
95	124.0	124	0	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
														599,488

Total Abstraction:	**3,027,003**	m3/year
Capacity Factor:	0.05	(electrical output)
Max. power output at point of use:	**100**	**kW**
Down time (expected and forced):	4%	
Estimated Monthly Production:	**48**	**MWh**
Unit price (using FIT rate and 3p export):	20.8	p/kWh
Gross income:	**£ 9,975**	

DULAS LTD - HYDROSIZE 2009v2

Hydrology & Energy Output Summary

Site Name River Galedffrwd - Coetir Mynydd feasibility study (feb) **Date: 30th March, 2010**

Data

FDC:	HydrA & Lowflows software
Turbine:	Gilkes 15 inch single jet Turgo
Generator:	Asynchronous generator - generic

Hydrology

Catchment Area:	4.00	sq km
Average Annual Rainfall:	2.159	m
Evapotranspiration	0.406	m
Net Runoff:	1.753	m
ADF:	222	l/s
Residual: Q95 plus	20%	

Hydraulics

Gross Head:	98.0	m
Head loss for intake screen:	0.8	m
Pipe pressure loss (at design flow):	7.2	m
Pipe pressure loss (%):	7%	
Net head at design flow:	90.0	m

Turbine

Turbine design flow:	147	l/s
Minimum flow (% of design flow):	10%	
Minimum flow:	15	l/s
Derate quoted turbine efficiency by:	0.5%	

Generator

Rating required (kVA)	134
Derate generator efficiency by:	0.5%

Efficiencies (at design flow)

Pipeline:	93%
Turbine (derated):	83%
Drive / coupling:	100%
Generator (derated):	94%
Transformer:	100%
Transmission:	100%
Design System Efficiency:	**71%**

% time flow exceeded	**Normalised FDC** l/s	**Total flow** l/s	**Available flow** l/s	**Turbine flow** l/s	**Hydraulic power** kW	**Fraction of design flow**	**Pipeline Eff**	**Turbine Eff** (quoted)	**Turbine Eff** (derated)	**Shaft power** kW	**Generator Eff** (quoted)	**Generator Eff** (derated)	**Electric power** kW	**Available energy** kWHr/month
5	778.0	778	544	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
10	543.1	543	356	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
15	432.8	433	268	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
20	345.0	345	198	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
25	315.0	315	174	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
30	287.7	288	152	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
35	262.0	262	131	131	125	0.89	94%	84.0%	83.5%	98.6	93.9%	93.4%	92	42,100
40	238.5	239	113	113	107	0.77	96%	84.2%	83.7%	86.1	93.9%	93.4%	80	37,770
45	224.5	225	102	102	97	0.69	96%	84.2%	83.7%	78.2	93.9%	93.4%	73	33,598
50	211.4	211	91	91	87	0.62	97%	84.0%	83.5%	70.5	93.8%	93.3%	66	30,388
55	194.6	195	78	78	74	0.53	98%	83.8%	83.3%	60.3	93.6%	93.1%	56	26,696
60	179.1	179	65	65	62	0.44	99%	83.2%	82.7%	50.7	93.0%	92.5%	47	22,552
65	168.1	168	56	56	54	0.38	99%	82.4%	81.9%	43.6	92.3%	91.8%	40	19,016
70	157.8	158	48	48	46	0.33	99%	81.2%	80.7%	36.8	91.3%	90.8%	33	16,074
75	149.5	150	42	42	40	0.28	99%	79.9%	79.4%	31.2	90.4%	89.9%	28	13,463
80	141.7	142	35	35	34	0.24	100%	78.1%	77.6%	26.0	89.2%	88.7%	23	11,191
85	130.2	130	26	26	25	0.18	100%	74.6%	74.1%	18.4	87.2%	86.7%	16	8,529
90	119.6	120	18	18	17	0.12	100%	70.0%	69.5%	11.7	84.9%	84.4%	10	5,643
95	97.6	98	0	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
														530,324

Total Abstraction:	**2,659,189** m3/year	Max. power output at point of use:	**100 kW**	Unit price (using FIT rate and 3p export):	20.8 p/kWh
Capacity Factor:	0.05 (electrical output)	Down time (expected and forced):	4%		
DULAS LTD - HYDROSIZE 2009v2		**Estimated Monthly Production:**	**42 MWh**	Gross income:	**£ 8,825**

Hydrology & Energy Output Summary

Site Name River Galedffrwd - Coetir Mynydd feasibility study (mar) **Date: 30th March, 2010**

Data

FDC:	HydrA & Lowflows software
Turbine:	Gilkes 15 inch single jet Turgo
Generator:	Asynchronous generator - generic

Hydrology

Catchment Area:	4.00	sq km
Average Annual Rainfall:	2.159	m
Evapotranspiration	0.406	m
Net Runoff:	1.753	m
ADF:	222	l/s
Residual: Q95 plus	20%	

Hydraulics

Gross Head:	98.0	m
Head loss for intake screen:	0.8	m
Pipe pressure loss (at design flow):	7.2	m
Pipe pressure loss (%):	7%	
Net head at design flow:	90.0	m

Turbine

Turbine design flow:	147	l/s
Minimum flow (% of design flow):	10%	
Minimum flow:	15	l/s
Derate quoted turbine efficiency by:	0.5%	

Generator

Rating required (kVA)	134
Derate generator efficiency by:	0.5%

Efficiencies (at design flow)

Pipeline:	93%
Turbine (derated):	83%
Drive / coupling:	100%
Generator (derated):	94%
Transformer:	100%
Transmission:	100%
Design System Efficiency:	**71%**

% time flow exceeded	Normalised FDC l/s	Total flow l/s	Available flow l/s	Turbine flow l/s	Hydraulic power kW	Fraction of design flow	Pipeline Eff	Turbine Eff (quoted)	Turbine Eff (derated)	Shaft power kW	Generator Eff (quoted)	Generator Eff (derated)	Electric power kW	Available energy kWHr/month
5	878.5	879	614	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
10	579.1	579	374	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
15	461.4	461	280	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
20	367.7	368	205	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
25	335.5	335	179	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
30	306.1	306	156	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
35	282.0	282	136	136	130	0.93	94%	83.8%	83.3%	101.5	93.9%	93.4%	95	42,704
40	259.8	260	119	119	113	0.81	95%	84.2%	83.7%	90.2	93.9%	93.4%	84	39,199
45	240.4	240	103	103	98	0.70	96%	84.2%	83.7%	79.2	93.9%	93.4%	74	34,646
50	222.4	222	89	89	85	0.60	97%	84.0%	83.5%	68.7	93.8%	93.3%	64	30,250
55	211.1	211	80	80	76	0.54	98%	83.8%	83.3%	61.9	93.6%	93.1%	58	26,666
60	200.4	200	71	71	68	0.48	98%	83.5%	83.0%	55.3	93.3%	92.8%	51	23,860
65	185.9	186	59	59	57	0.40	99%	82.7%	82.2%	46.1	92.6%	92.1%	42	20,525
70	172.5	172	49	49	46	0.33	99%	81.4%	80.9%	37.3	91.4%	90.9%	34	16,709
75	161.9	162	40	40	38	0.27	99%	79.6%	79.1%	30.2	90.1%	89.6%	27	13,345
80	151.9	152	32	32	31	0.22	100%	77.1%	76.6%	23.5	88.6%	88.1%	21	10,462
85	141.3	141	24	24	23	0.16	100%	73.5%	73.0%	16.5	86.6%	86.1%	14	7,651
90	131.4	131	16	16	15	0.11	100%	68.9%	68.4%	10.3	84.4%	83.9%	9	5,014
95	111.6	112	0	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
														534,332

Total Abstraction:	**2,680,105** m3/year	Max. power output at point of use:	**100 kW**	Unit price (using FIT rate and 3p export):	20.8 p/kWh
Capacity Factor:	0.05 (electrical output)	Down time (expected and forced):	4%		
DULAS LTD - HYDROSIZE 2009v2		**Estimated Monthly Production:**	**43 MWh**	Gross income:	**£ 8,891**

Hydrology & Energy Output Summary

Site Name River Galedffrwd - Coetir Mynydd feasibility study (apr) **Date: 30th March, 2010**

Data

FDC:	HydrA & Lowflows software
Turbine:	Gilkes 15 inch single jet Turgo
Generator:	Asynchronous generator - generic

Hydrology

Catchment Area:	4.00	sq km
Average Annual Rainfall:	2.159	m
Evapotranspiration	0.406	m
Net Runoff:	1.753	m
ADF:	222	l/s
Residual: Q95 plus	40%	

Hydraulics

Gross Head:	98.0	m
Head loss for intake screen:	0.8	m
Pipe pressure loss (at design flow):	7.2	m
Pipe pressure loss (%):	7%	
Net head at design flow:	90.0	m

Turbine

Turbine design flow:	147	l/s
Minimum flow (% of design flow):	10%	
Minimum flow:	15	l/s
Derate quoted turbine efficiency by:	0.5%	

Generator

Rating required (kVA)	134
Derate generator efficiency by:	0.5%

Efficiencies (at design flow)

Pipeline:	93%
Turbine (derated):	83%
Drive / coupling:	100%
Generator (derated):	94%
Transformer:	100%
Transmission:	100%
Design System Efficiency:	**71%**

% time flow exceeded	Normalised FDC l/s	Total flow l/s	Available flow l/s	Turbine flow l/s	Hydraulic power kW	Fraction of design flow	Pipeline Eff	Turbine Eff (quoted)	Turbine Eff (derated)	Shaft power kW	Generator Eff (quoted)	Generator Eff (derated)	Electric power kW	Available energy kWHr/month
5	517.4	517	266	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
10	397.1	397	194	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
15	335.4	335	157	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
20	283.3	283	126	126	120	0.86	95%	84.2%	83.7%	95.1	93.9%	93.4%	89	41,378
25	251.0	251	107	107	102	0.72	96%	84.2%	83.7%	81.8	93.9%	93.4%	76	36,160
30	222.4	222	89	89	85	0.61	97%	84.0%	83.5%	69.3	93.8%	93.3%	65	30,877
35	207.2	207	80	80	77	0.55	98%	83.8%	83.3%	62.4	93.6%	93.1%	58	26,882
40	193.0	193	72	72	68	0.49	98%	83.6%	83.1%	55.9	93.3%	92.8%	52	24,085
45	180.1	180	64	64	61	0.44	99%	83.1%	82.6%	49.7	92.9%	92.4%	46	21,422
50	168.1	168	57	57	54	0.39	99%	82.5%	82.0%	43.9	92.3%	91.8%	40	18,896
55	157.9	158	51	51	48	0.34	99%	81.7%	81.2%	38.9	91.7%	91.2%	35	16,591
60	148.3	148	45	45	43	0.31	99%	80.6%	80.1%	34.1	90.9%	90.4%	31	14,508
65	138.4	138	39	39	37	0.27	99%	79.2%	78.7%	29.1	89.9%	89.4%	26	12,451
70	129.2	129	33	33	32	0.23	100%	77.5%	77.0%	24.5	88.8%	88.3%	22	10,443
75	117.7	118	27	27	25	0.18	100%	74.8%	74.3%	18.8	87.3%	86.8%	16	8,307
80	107.2	107	20	20	19	0.14	100%	71.6%	71.1%	13.7	85.7%	85.2%	12	6,126
85	94.3	94	13	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
90	82.9	83	6	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
95	73.4	73	0	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
														399,779

Total Abstraction:	**1,972,056** m3/year	Max. power output at point of use:	**100 kW**	Unit price (using FIT rate and 3p export):	20.8	p/kWh
Capacity Factor:	0.04 (electrical output)	Down time (expected and forced):	4%			
DULAS LTD - HYDROSIZE 2009v2		**Estimated Monthly Production:**	**32 MWh**	Gross income:	**£ 6,652**	

Hydrology & Energy Output Summary

Site Name River Galedffrwd - Coetir Mynydd feasibility study (may) **Date: 30th March, 2010**

Data

FDC:	HydrA & Lowflows software
Turbine:	Gilkes 15 inch single jet Turgo
Generator:	Asynchronous generator - generic

Hydrology

Catchment Area:	4.00	sq km
Average Annual Rainfall:	2.159	m
Evapotranspiration	0.406	m
Net Runoff:	1.753	m
ADF:	222	l/s
Residual: Q95 plus	40%	

Hydraulics

Gross Head:	98.0	m
Head loss for intake screen:	0.8	m
Pipe pressure loss (at design flow):	7.2	m
Pipe pressure loss (%):	7%	
Net head at design flow:	90.0	m

Turbine

Turbine design flow:	147	l/s
Minimum flow (% of design flow):	10%	
Minimum flow:	15	l/s
Derate quoted turbine efficiency by:	0.5%	

Generator

Rating required (kVA)	134
Derate generator efficiency by:	0.5%

Efficiencies (at design flow)

Pipeline:	93%
Turbine (derated):	83%
Drive / coupling:	100%
Generator (derated):	94%
Transformer:	100%
Transmission:	100%
Design System Efficiency:	**71%**

% time flow exceeded	Normalised FDC l/s	Total flow l/s	Available flow l/s	Turbine flow l/s	Hydraulic power kW	Fraction of design flow	Pipeline Eff	Turbine Eff (quoted)	Turbine Eff (derated)	Shaft power kW	Generator Eff (quoted)	Generator Eff (derated)	Electric power kW	Available energy kWHr/month
5	380.9	381	193	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
10	296.5	297	142	142	136	0.97	93%	83.5%	83.0%	104.8	94.0%	93.5%	98	43,385
15	255.5	256	118	118	112	0.80	95%	84.2%	83.7%	89.5	93.9%	93.4%	84	39,746
20	220.2	220	96	96	92	0.66	97%	84.1%	83.6%	74.4	93.9%	93.4%	70	33,528
25	198.2	198	83	83	79	0.57	98%	83.9%	83.4%	64.6	93.7%	93.2%	60	28,421
30	178.3	178	71	71	68	0.49	98%	83.5%	83.0%	55.5	93.3%	92.8%	52	24,479
35	167.4	167	65	65	62	0.44	99%	83.2%	82.7%	50.3	93.0%	92.5%	47	21,471
40	157.1	157	59	59	56	0.40	99%	82.7%	82.2%	45.3	92.5%	92.0%	42	19,321
45	147.2	147	53	53	50	0.36	99%	82.0%	81.5%	40.5	91.9%	91.4%	37	17,242
50	138.0	138	47	47	45	0.32	99%	81.1%	80.6%	35.9	91.2%	90.7%	33	15,244
55	130.0	130	42	42	40	0.29	99%	80.1%	79.6%	31.9	90.5%	90.0%	29	13,431
60	122.6	123	38	38	36	0.26	100%	78.9%	78.4%	28.2	89.7%	89.2%	25	11,802
65	111.4	111	31	31	30	0.21	100%	76.7%	76.2%	22.6	88.4%	87.9%	20	9,853
70	101.3	101	25	25	24	0.17	100%	74.1%	73.6%	17.6	86.9%	86.4%	15	7,676
75	92.5	92	20	20	19	0.13	100%	71.4%	70.9%	13.4	85.5%	85.0%	11	5,818
80	84.4	84	15	15	14	0.10	100%	68.3%	67.8%	9.7	84.2%	83.7%	8	4,262
85	75.1	75	9	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
90	66.8	67	4	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
95	59.4	59	0	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
														339,563

Total Abstraction:	**1,659,229** m3/year	Max. power output at point of use:	**100 kW**	Unit price (using FIT rate and 3p export):	20.8 p/kWh
Capacity Factor:	0.03 (electrical output)	Down time (expected and forced):	4%		
DULAS LTD - HYDROSIZE 2009v2		**Estimated Monthly Production:**	**27 MWh**	Gross income:	**£ 5,650**

Hydrology & Energy Output Summary

Site Name River Galedffrwd - Coetir Mynydd feasibility study (jun) **Date: 30th March, 2010**

Data

FDC:	HydrA & Lowflows software
Turbine:	Gilkes 15 inch single jet Turgo
Generator:	Asynchronous generator - generic

Hydrology

Catchment Area:	4.00	sq km
Average Annual Rainfall:	2.159	m
Evapotranspiration	0.406	m
Net Runoff:	1.753	m
ADF:	222	l/s
Residual: Q95 plus	40%	

Hydraulics

Gross Head:	98.0	m
Head loss for intake screen:	0.8	m
Pipe pressure loss (at design flow):	7.2	m
Pipe pressure loss (%):	7%	
Net head at design flow:	90.0	m

Turbine

Turbine design flow:	147	l/s
Minimum flow (% of design flow):	10%	
Minimum flow:	15	l/s
Derate quoted turbine efficiency by:	0.5%	

Generator

Rating required (kVA)	134
Derate generator efficiency by:	0.5%

Efficiencies (at design flow)

Pipeline:	93%
Turbine (derated):	83%
Drive / coupling:	100%
Generator (derated):	94%
Transformer:	100%
Transmission:	100%
Design System Efficiency:	**71%**

% time flow exceeded	Normalised FDC l/s	Total flow l/s	Available flow l/s	Turbine flow l/s	Hydraulic power kW	Fraction of design flow	Pipeline Eff	Turbine Eff (quoted)	Turbine Eff (derated)	Shaft power kW	Generator Eff (quoted)	Generator Eff (derated)	Electric power kW	Available energy kWHr/month
5	336.1	336	173	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
10	256.9	257	126	126	120	0.85	95%	84.2%	83.7%	94.8	93.9%	93.4%	88	41,320
15	221.8	222	104	104	100	0.71	96%	84.2%	83.7%	80.3	93.9%	93.4%	75	35,796
20	191.6	192	86	86	82	0.59	97%	84.0%	83.5%	67.0	93.8%	93.3%	62	30,095
25	173.9	174	76	76	72	0.51	98%	83.7%	83.2%	58.9	93.5%	93.0%	55	25,671
30	157.8	158	66	66	63	0.45	99%	83.3%	82.8%	51.4	93.0%	92.5%	48	22,400
35	145.6	146	59	59	56	0.40	99%	82.7%	82.2%	45.5	92.5%	92.0%	42	19,567
40	134.3	134	52	52	50	0.35	99%	81.9%	81.4%	39.9	91.8%	91.3%	36	17,148
45	125.2	125	46	46	44	0.32	99%	80.9%	80.4%	35.4	91.1%	90.6%	32	15,012
50	116.7	117	41	41	39	0.28	99%	79.8%	79.3%	31.1	90.3%	89.8%	28	13,151
55	105.5	106	35	35	33	0.24	100%	78.0%	77.5%	25.5	89.1%	88.6%	23	11,076
60	95.4	95	29	29	27	0.19	100%	75.7%	75.2%	20.5	87.8%	87.3%	18	8,864
65	87.8	88	24	24	23	0.16	100%	73.6%	73.1%	16.7	86.7%	86.2%	14	7,069
70	80.7	81	20	20	19	0.13	100%	71.4%	70.9%	13.4	85.5%	85.0%	11	5,647
75	74.2	74	16	16	15	0.11	100%	69.0%	68.5%	10.4	84.5%	84.0%	9	4,399
80	68.3	68	12	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
85	61.3	61	8	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
90	55.0	55	4	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
95	47.7	48	0	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
														301,098

Total Abstraction: **1,461,213** m3/year
Capacity Factor: 0.03 (electrical output)

Max. power output at point of use: **100 kW**
Down time (expected and forced): 4%
Estimated Monthly Production: 24 MWh

Unit price (using FIT rate and 3p export): 20.8 p/kWh
Gross income: **£ 5,010**

DULAS LTD - HYDROSIZE 2009v2

Hydrology & Energy Output Summary

Site Name River Galedffrwd - Coetir Mynydd feasibility study (jul) **Date: 30th March, 2010**

Data

FDC:	HydrA & Lowflows software
Turbine:	Gilkes 15 inch single jet Turgo
Generator:	Asynchronous generator - generic

Hydrology

Catchment Area:	4.00	sq km
Average Annual Rainfall:	2.159	m
Evapotranspiration	0.406	m
Net Runoff:	1.753	m
ADF:	222	l/s
Residual: Q95 plus	40%	

Hydraulics

Gross Head:	98.0	m
Head loss for intake screen:	0.8	m
Pipe pressure loss (at design flow):	7.2	m
Pipe pressure loss (%):	7%	
Net head at design flow:	90.0	m

Turbine

Turbine design flow:	147	l/s
Minimum flow (% of design flow):	10%	
Minimum flow:	15	l/s
Derate quoted turbine efficiency by:	0.5%	

Generator

Rating required (kVA)	134
Derate generator efficiency by:	0.5%

Efficiencies (at design flow)

Pipeline:	93%
Turbine (derated):	83%
Drive / coupling:	100%
Generator (derated):	94%
Transformer:	100%
Transmission:	100%
Design System Efficiency:	**71%**

% time flow exceeded	**Normalised FDC** l/s	**Total flow** l/s	**Available flow** l/s	**Turbine flow** l/s	**Hydraulic power** kW	**Fraction of design flow**	**Pipeline Eff**	**Turbine Eff** (quoted)	**Turbine Eff** (derated)	**Shaft power** kW	**Generator Eff** (quoted)	**Generator Eff** (derated)	**Electric power** kW	**Available energy** kWHr/month
5	358.2	358	189	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
10	265.7	266	134	134	128	0.91	94%	83.9%	83.4%	100.0	93.9%	93.4%	93	42,401
15	222.1	222	108	108	103	0.73	96%	84.2%	83.7%	82.6	93.9%	93.4%	77	37,351
20	185.7	186	86	86	82	0.58	97%	84.0%	83.5%	66.6	93.8%	93.3%	62	30,501
25	168.0	168	75	75	72	0.51	98%	83.7%	83.2%	58.5	93.5%	93.0%	54	25,528
30	151.9	152	66	66	63	0.45	99%	83.2%	82.7%	51.0	93.0%	92.5%	47	22,252
35	139.7	140	58	58	56	0.40	99%	82.6%	82.1%	45.1	92.5%	92.0%	41	19,415
40	128.4	128	52	52	49	0.35	99%	81.8%	81.3%	39.6	91.8%	91.3%	36	16,993
45	118.9	119	46	46	44	0.31	99%	80.8%	80.3%	34.8	91.0%	90.5%	32	14,814
50	110.1	110	41	41	39	0.28	99%	79.6%	79.1%	30.4	90.2%	89.7%	27	12,874
55	101.7	102	35	35	34	0.24	100%	78.2%	77.7%	26.2	89.3%	88.8%	23	11,058
60	93.9	94	31	31	29	0.21	100%	76.6%	76.1%	22.3	88.3%	87.8%	20	9,374
65	87.5	87	27	27	26	0.18	100%	75.0%	74.5%	19.1	87.4%	86.9%	17	7,919
70	81.5	81	23	23	22	0.16	100%	73.3%	72.8%	16.2	86.5%	86.0%	14	6,678
75	75.4	75	20	20	19	0.13	100%	71.3%	70.8%	13.3	85.5%	85.0%	11	5,514
80	69.7	70	16	16	16	0.11	100%	69.2%	68.7%	10.7	84.6%	84.1%	9	4,433
85	62.4	62	12	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
90	55.8	56	8	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
95	42.6	43	0	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
														310,988

Total Abstraction:	**1,520,039** m3/year	Max. power output at point of use:	**100 kW**	Unit price (using FIT rate and 3p export):	20.8 p/kWh
Capacity Factor:	0.03 (electrical output)	Down time (expected and forced):	4%		
DULAS LTD - HYDROSIZE 2009v2		**Estimated Monthly Production:**	**25 MWh**	Gross income:	**£ 5,175**

Hydrology & Energy Output Summary

Site Name River Galedffrwd - Coetir Mynydd feasibility study (aug) **Date: 30th March, 2010**

Data

FDC:	HydrA & Lowflows software
Turbine:	Gilkes 15 inch single jet Turgo
Generator:	Asynchronous generator - generic

Hydrology

Catchment Area:	4.00	sq km
Average Annual Rainfall:	2.159	m
Evapotranspiration	0.406	m
Net Runoff:	1.753	m
ADF:	222	l/s
Residual: Q95 plus	40%	

Hydraulics

Gross Head:	98.0	m
Head loss for intake screen:	0.8	m
Pipe pressure loss (at design flow):	7.2	m
Pipe pressure loss (%):	7%	
Net head at design flow:	90.0	m

Turbine

Turbine design flow:	147	l/s
Minimum flow (% of design flow):	10%	
Minimum flow:	15	l/s
Derate quoted turbine efficiency by:	0.5%	

Generator

Rating required (kVA)	134
Derate generator efficiency by:	0.5%

Efficiencies (at design flow)

Pipeline:	93%
Turbine (derated):	83%
Drive / coupling:	100%
Generator (derated):	94%
Transformer:	100%
Transmission:	100%
Design System Efficiency:	**71%**

% time flow exceeded	Normalised FDC l/s	Total flow l/s	Available flow l/s	Turbine flow l/s	Hydraulic power kW	Fraction of design flow	Pipeline Eff	Turbine Eff (quoted)	Turbine Eff (derated)	Shaft power kW	Generator Eff (quoted)	Generator Eff (derated)	Electric power kW	Available energy kWHr/month
5	528.4	528	289	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
10	352.3	352	184	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
15	295.6	296	150	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
20	248.1	248	121	121	115	0.82	95%	84.2%	83.7%	91.9	93.9%	93.4%	86	40,724
25	222.5	223	106	106	101	0.72	96%	84.2%	83.7%	81.2	93.9%	93.4%	76	35,390
30	199.6	200	92	92	88	0.63	97%	84.0%	83.5%	71.2	93.9%	93.4%	66	31,167
35	180.4	180	80	80	77	0.55	98%	83.8%	83.3%	62.5	93.7%	93.2%	58	27,318
40	162.9	163	70	70	67	0.48	98%	83.5%	83.0%	54.5	93.3%	92.8%	51	23,825
45	149.1	149	62	62	59	0.42	99%	82.9%	82.4%	47.9	92.7%	92.2%	44	20,743
50	136.5	137	54	54	52	0.37	99%	82.2%	81.7%	41.8	92.1%	91.6%	38	18,048
55	127.0	127	48	48	46	0.33	99%	81.3%	80.8%	37.0	91.4%	90.9%	34	15,743
60	118.2	118	43	43	41	0.29	99%	80.3%	79.8%	32.6	90.6%	90.1%	29	13,808
65	104.9	105	35	35	34	0.24	100%	78.1%	77.6%	26.0	89.2%	88.7%	23	11,480
70	93.2	93	28	28	27	0.19	100%	75.5%	75.0%	20.1	87.7%	87.2%	18	8,883
75	83.1	83	22	22	21	0.15	100%	72.6%	72.1%	15.2	86.2%	85.7%	13	6,691
80	74.1	74	17	17	16	0.11	100%	69.5%	69.0%	11.0	84.7%	84.2%	9	4,879
85	66.0	66	12	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
90	58.7	59	7	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
95	46.2	46	0	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
														390,353

Total Abstraction:	**1,924,019**	m3/year
Capacity Factor:	0.04	(electrical output)

Max. power output at point of use:	**100**	**kW**
Down time (expected and forced):	4%	
Estimated Monthly Production:	**31**	**MWh**

Unit price (using FIT rate and 3p export): 20.8 p/kWh

Gross income: **£ 6,495**

DULAS LTD - HYDROSIZE 2009v2

Hydrology & Energy Output Summary

Site Name River Galedffrwd - Coetir Mynydd feasibility study (sep) **Date: 30th March, 2010**

Data

FDC:	HydrA & Lowflows software
Turbine:	Gilkes 15 inch single jet Turgo
Generator:	Asynchronous generator - generic

Hydrology

Catchment Area:	4.00	sq km
Average Annual Rainfall:	2.159	m
Evapotranspiration	0.406	m
Net Runoff:	1.753	m
ADF:	222	l/s
Residual: Q95 plus	40%	

Hydraulics

Gross Head:	98.0	m
Head loss for intake screen:	0.8	m
Pipe pressure loss (at design flow):	7.2	m
Pipe pressure loss (%):	7%	
Net head at design flow:	90.0	m

Turbine

Turbine design flow:	147	l/s
Minimum flow (% of design flow):	10%	
Minimum flow:	15	l/s
Derate quoted turbine efficiency by:	0.5%	

Generator

Rating required (kVA)	134
Derate generator efficiency by:	0.5%

Efficiencies (at design flow)

Pipeline:	93%
Turbine (derated):	83%
Drive / coupling:	100%
Generator (derated):	94%
Transformer:	100%
Transmission:	100%
Design System Efficiency:	**71%**

% time flow exceeded	Normalised FDC l/s	Total flow l/s	Available flow l/s	Turbine flow l/s	Hydraulic power kW	Fraction of design flow	Pipeline Eff	Turbine Eff (quoted)	Turbine Eff (derated)	Shaft power kW	Generator Eff (quoted)	Generator Eff (derated)	Electric power kW	Available energy kWHr/month
5	659.8	660	358	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
10	427.9	428	219	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
15	350.9	351	173	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
20	287.7	288	135	135	129	0.92	94%	83.9%	83.4%	100.8	93.9%	93.4%	94	42,564
25	254.2	254	115	115	110	0.78	95%	84.2%	83.7%	87.7	93.9%	93.4%	82	38,566
30	224.6	225	97	97	93	0.66	97%	84.1%	83.6%	75.1	93.9%	93.4%	70	33,302
35	202.2	202	84	84	80	0.57	98%	83.9%	83.4%	65.1	93.7%	93.2%	61	28,655
40	182.0	182	72	72	68	0.49	98%	83.6%	83.1%	55.9	93.3%	92.8%	52	24,654
45	171.8	172	66	66	63	0.45	99%	83.2%	82.7%	51.0	93.0%	92.5%	47	21,697
50	162.2	162	60	60	57	0.41	99%	82.8%	82.3%	46.4	92.6%	92.1%	43	19,701
55	150.8	151	53	53	51	0.36	99%	82.0%	81.5%	40.8	91.9%	91.4%	37	17,536
60	140.2	140	47	47	45	0.32	99%	81.0%	80.5%	35.6	91.1%	90.6%	32	15,234
65	127.9	128	39	39	37	0.27	99%	79.3%	78.8%	29.4	90.0%	89.5%	26	12,817
70	116.7	117	33	33	31	0.22	100%	77.2%	76.7%	23.8	88.7%	88.2%	21	10,346
75	103.9	104	25	25	24	0.17	100%	74.0%	73.5%	17.4	86.9%	86.4%	15	7,884
80	92.5	92	18	18	17	0.12	100%	70.3%	69.8%	12.0	85.1%	84.6%	10	5,520
85	80.7	81	11	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
90	70.5	70	5	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
95	62.4	62	0	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
														410,127

Total Abstraction:	**2,025,222**	m3/year
Capacity Factor:	0.04	(electrical output)

Max. power output at point of use:	**100**	**kW**
Down time (expected and forced):	4%	
Estimated Monthly Production:	**33**	**MWh**

Unit price (using FIT rate and 3p export):	20.8	p/kWh
Gross income:	**£ 6,825**	

DULAS LTD - HYDROSIZE 2009v2

Hydrology & Energy Output Summary

Site Name River Galedffrwd - Coetir Mynydd feasibility study (oct) **Date: 30th March, 2010**

Data

FDC:	HydrA & Lowflows software
Turbine:	Gilkes 15 inch single jet Turgo
Generator:	Asynchronous generator - generic

Hydrology

Catchment Area:	4.00	sq km
Average Annual Rainfall:	2.159	m
Evapotranspiration	0.406	m
Net Runoff:	1.753	m
ADF:	222	l/s
Residual: Q95 plus	40%	

Hydraulics

Gross Head:	98.0	m
Head loss for intake screen:	0.8	m
Pipe pressure loss (at design flow):	7.2	m
Pipe pressure loss (%):	7%	
Net head at design flow:	90.0	m

Turbine

Turbine design flow:	147	l/s
Minimum flow (% of design flow):	10%	
Minimum flow:	15	l/s
Derate quoted turbine efficiency by:	0.5%	

Generator

Rating required (kVA)	134
Derate generator efficiency by:	0.5%

Efficiencies (at design flow)

Pipeline:	93%
Turbine (derated):	83%
Drive / coupling:	100%
Generator (derated):	94%
Transformer:	100%
Transmission:	100%
Design System Efficiency:	**71%**

% time flow exceeded	Normalised FDC l/s	Total flow l/s	Available flow l/s	Turbine flow l/s	Hydraulic power kW	Fraction of design flow	Pipeline Eff	Turbine Eff (quoted)	Turbine Eff (derated)	Shaft power kW	Generator Eff (quoted)	Generator Eff (derated)	Electric power kW	Available energy kWHr/month
5	954.1	954	526	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
10	624.6	625	329	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
15	493.4	493	250	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
20	389.7	390	188	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
25	342.0	342	159	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
30	300.2	300	134	134	128	0.91	94%	83.9%	83.4%	100.0	93.9%	93.4%	93	42,401
35	269.6	270	116	116	110	0.79	95%	84.2%	83.7%	88.1	93.9%	93.4%	82	38,468
40	242.2	242	99	99	94	0.67	97%	84.1%	83.6%	76.4	93.9%	93.4%	71	33,630
45	224.7	225	89	89	84	0.60	97%	84.0%	83.5%	68.6	93.8%	93.3%	64	29,649
50	208.4	208	79	79	75	0.54	98%	83.8%	83.3%	61.3	93.6%	93.1%	57	26,525
55	192.0	192	69	69	66	0.47	98%	83.4%	82.9%	53.7	93.2%	92.7%	50	23,390
60	176.9	177	60	60	57	0.41	99%	82.8%	82.3%	46.4	92.6%	92.1%	43	20,253
65	163.9	164	52	52	50	0.35	99%	81.9%	81.4%	40.1	91.8%	91.3%	37	17,375
70	151.9	152	45	45	43	0.31	99%	80.6%	80.1%	34.1	90.9%	90.4%	31	14,761
75	142.1	142	39	39	37	0.27	99%	79.2%	78.7%	29.1	89.9%	89.4%	26	12,451
80	132.8	133	33	33	32	0.23	100%	77.5%	77.0%	24.5	88.8%	88.3%	22	10,444
85	115.6	116	23	23	22	0.16	100%	73.2%	72.7%	16.0	86.4%	85.9%	14	7,746
90	100.6	101	14	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
95	77.1	77	0	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
														496,512

Total Abstraction:	**2,479,312**	m3/year
Capacity Factor:	0.05	(electrical output)
Max. power output at point of use:	**100**	**kW**
Down time (expected and forced):	4%	
Estimated Monthly Production:	**40**	**MWh**
Unit price (using FIT rate and 3p export):	20.8	p/kWh
Gross income: £	**8,262**	

DULAS LTD - HYDROSIZE 2009v2

Hydrology & Energy Output Summary

Site Name River Galedffrwd - Coetir Mynydd feasibility study (nov) **Date: 30th March, 2010**

Data

FDC:	HydrA & Lowflows software
Turbine:	Gilkes 15 inch single jet Turgo
Generator:	Asynchronous generator - generic

Hydrology

Catchment Area:	4.00	sq km
Average Annual Rainfall:	2.159	m
Evapotranspiration	0.406	m
Net Runoff:	1.753	m
ADF:	222	l/s
Residual: Q95 plus	40%	

Hydraulics

Gross Head:	98.0	m
Head loss for intake screen:	0.8	m
Pipe pressure loss (at design flow):	7.2	m
Pipe pressure loss (%):	7%	
Net head at design flow:	90.0	m

Turbine

Turbine design flow:	147	l/s
Minimum flow (% of design flow):	10%	
Minimum flow:	15	l/s
Derate quoted turbine efficiency by:	0.5%	

Generator

Rating required (kVA)	134
Derate generator efficiency by:	0.5%

Efficiencies (at design flow)

Pipeline:	93%
Turbine (derated):	83%
Drive / coupling:	100%
Generator (derated):	94%
Transformer:	100%
Transmission:	100%
Design System Efficiency:	**71%**

% time flow exceeded	**Normalised FDC** l/s	**Total flow** l/s	**Available flow** l/s	**Turbine flow** l/s	**Hydraulic power** kW	**Fraction of design flow**	**Pipeline Eff**	**Turbine Eff** (quoted)	**Turbine Eff** (derated)	**Shaft power** kW	**Generator Eff** (quoted)	**Generator Eff** (derated)	**Electric power** kW	**Available energy** kWHr/month
5	1067.9	1068	577	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
10	722.9	723	370	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
15	580.0	580	285	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
20	465.3	465	216	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
25	414.5	414	185	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
30	369.2	369	158	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
35	340.1	340	141	141	134	0.96	93%	83.6%	83.1%	103.9	93.9%	93.4%	97	43,210
40	313.4	313	125	125	119	0.85	95%	84.2%	83.7%	94.2	93.9%	93.4%	88	40,528
45	290.9	291	111	111	106	0.76	96%	84.2%	83.7%	85.0	93.9%	93.4%	79	36,645
50	270.1	270	99	99	94	0.67	97%	84.1%	83.6%	76.1	93.9%	93.4%	71	32,940
55	250.3	250	87	87	83	0.59	97%	84.0%	83.5%	67.3	93.8%	93.3%	63	29,302
60	231.9	232	76	76	72	0.52	98%	83.7%	83.2%	58.9	93.5%	93.0%	55	25,748
65	210.8	211	63	63	60	0.43	99%	83.0%	82.5%	49.0	92.8%	92.3%	45	21,902
70	191.6	192	52	52	49	0.35	99%	81.8%	81.3%	39.6	91.8%	91.3%	36	17,810
75	178.3	178	44	44	42	0.30	99%	80.3%	79.8%	32.9	90.7%	90.2%	30	14,414
80	165.9	166	36	36	34	0.25	100%	78.4%	77.9%	26.7	89.4%	88.9%	24	11,702
85	146.8	147	25	25	24	0.17	100%	73.9%	73.4%	17.2	86.8%	86.3%	15	8,456
90	129.9	130	15	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
95	105.7	106	0	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
														545,960

Total Abstraction:	**2,741,233** m3/year	Max. power output at point of use:	**100 kW**
Capacity Factor:	0.05 (electrical output)	Down time (expected and forced):	4%
		Estimated Monthly Production:	**44 MWh**

Unit price (using FIT rate and 3p export): 20.8 p/kWh

Gross income: **£ 9,085**

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Hydrology & Energy Output Summary

Site Name River Galedffrwd - Coetir Mynydd feasibility study (dec) **Date: 30th March, 2010**

Data

FDC:	HydrA & Lowflows software
Turbine:	Gilkes 15 inch single jet Turgo
Generator:	Asynchronous generator - generic

Hydrology

Catchment Area:	4.00	sq km
Average Annual Rainfall:	2.159	m
Evapotranspiration	0.406	m
Net Runoff:	1.753	m
ADF:	222	l/s
Residual: Q95 plus	40%	

Hydraulics

Gross Head:	98.0	m
Head loss for intake screen:	0.8	m
Pipe pressure loss (at design flow):	7.2	m
Pipe pressure loss (%):	7%	
Net head at design flow:	90.0	m

Turbine

Turbine design flow:	147	l/s
Minimum flow (% of design flow):	10%	
Minimum flow:	15	l/s
Derate quoted turbine efficiency by:	0.5%	

Generator

Rating required (kVA)	134
Derate generator efficiency by:	0.5%

Efficiencies (at design flow)

Pipeline:	93%
Turbine (derated):	83%
Drive / coupling:	100%
Generator (derated):	94%
Transformer:	100%
Transmission:	100%
Design System Efficiency:	**71%**

% time flow exceeded	Normalised FDC l/s	Total flow l/s	Available flow l/s	Turbine flow l/s	Hydraulic power kW	Fraction of design flow	Pipeline Eff	Turbine Eff (quoted)	Turbine Eff (derated)	Shaft power kW	Generator Eff (quoted)	Generator Eff (derated)	Electric power kW	Available energy kWHr/month
5	1143.5	1143	611	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
10	807.3	807	409	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
15	640.3	640	309	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
20	507.9	508	229	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
25	453.6	454	197	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
30	405.1	405	168	147	140	1.00	93%	83.0%	82.5%	107.2	94.0%	93.5%	100	43,884
35	363.3	363	143	143	136	0.97	93%	83.4%	82.9%	105.0	94.0%	93.5%	98	43,436
40	325.9	326	120	120	115	0.82	95%	84.2%	83.7%	91.3	93.9%	93.4%	85	40,155
45	299.1	299	104	104	99	0.71	96%	84.2%	83.7%	80.0	93.9%	93.4%	75	35,030
50	274.5	274	89	89	85	0.61	97%	84.0%	83.5%	69.3	93.8%	93.3%	65	30,524
55	253.9	254	77	77	73	0.52	98%	83.8%	83.3%	59.9	93.6%	93.1%	56	26,365
60	234.9	235	66	66	63	0.45	99%	83.2%	82.7%	51.0	93.0%	92.5%	47	22,544
65	216.5	217	55	55	52	0.37	99%	82.2%	81.7%	42.1	92.1%	91.6%	39	18,782
70	199.6	200	44	44	42	0.30	99%	80.5%	80.0%	33.7	90.8%	90.3%	30	15,119
75	185.2	185	36	36	34	0.24	100%	78.3%	77.8%	26.4	89.3%	88.8%	23	11,813
80	171.7	172	28	28	26	0.19	100%	75.3%	74.8%	19.7	87.6%	87.1%	17	8,909
85	158.0	158	19	19	19	0.13	100%	71.2%	70.7%	13.1	85.5%	85.0%	11	6,206
90	145.3	145	12	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
95	125.5	126	0	0	0	0.00	0%	0.0%	0.0%	0.0	0.0%	0.0%	0	0
														522,186

Total Abstraction:	**2,622,600** m3/year	Max. power output at point of use:	**100**	**kW**	Unit price (using FIT rate and 3p export):	20.8	p/kWh
Capacity Factor:	0.05 (electrical output)	Down time (expected and forced):	4%				
DULAS LTD - HYDROSIZE 2009v2		**Estimated Monthly Production:**	**42**	**MWh**	Gross income:	**£ 8,689**	

Appendix D – EA information

Environment Agency

GOOD PRACTICE GUIDELINES ANNEX TO THE ENVIRONMENT AGENCY HYDROPOWER HANDBOOK

THE ENVIRONMENTAL ASSESSMENT OF PROPOSED LOW HEAD HYDRO POWER DEVELOPMENTS

Published August 2009

GOOD PRACTICE GUIDELINES ANNEX TO THE ENVIRONMENT AGENCY HYDROPOWER HANDBOOK ON THE ENVIRONMENTAL ASSESSMENT OF PROPOSED LOW HEAD HYDRO POWER DEVELOPMENTS

CONTENTS

1) INTRODUCTION

The number of hydropower schemes submitted to the Environment Agency has increased significantly over the last few years from less than 20 per year to more than 100 per year.

This annex to the Environment Agency Hydropower Manual is based on work undertaken jointly by the Environment Agency and the British Hydropower Association (BHA) and funded by the Department for Trade and Industry (DTI) in 2006. The aim of the work was to provide Good Practice Guidance to supplement the Hydropower Manual on aspects that most often cause difficulty with hydropower proposals. Four studies were commissioned:

1. An Environmental Site Audit (ESA) check list guide to assist in the initial environmental assessment of small hydro schemes.
2. How to establish the acceptable minimum flow in the depleted reach.
3. Monitoring flows abstracted by a hydropower scheme.
4. How to protect fish.

The results of these studies have been supplemented by further input from the Environment Agency and BHA. Detailed technical data related to flow measurement has been removed to an Appendix at the end of the annex.

This Good Practice Guidance was developed for low head hydropower, but the principles may apply to high head hydropower run of river sites.

The Environment Agency has wide ranging responsibilities set out most particularly in the Environment Act 1995, Water Resources Act 1991, Land Drainage Act 1991, Salmon and Freshwater Fisheries Act 1975 and the Water Framework Directive (WFD) which came in to operation in 2004. Section 4 of the Environment Act requires us, in discharging our functions, to contribute to the objective of achieving sustainable development.

The Environment Agency has statutory responsibility for flood management and defence in England and Wales. The Environment Agency advises Local Planning Authorities and applicants on flood risk from new development. Certain types of work affecting watercourses also require flood defence / land drainage consent from the Environment Agency.

This Guidance describes:

- baseline indications of hydropower potential that may be possible on a site while taking account of environmental concerns
- additional environmental factors that will need to be protected in some circumstances, and those that may, upon local inspection, be found to not apply. Where this is the case, there may be greater power potential at that site.

Some environmental aspects have to be satisfied as part of the developer's scheme and costs. Others can be met by wise site choice and application of best design principles that are available. There are some places where we believe the current high environmental status such as designated European sites means that the risks inherent with hydropower are likely to be unacceptable and we have incorporated advice accordingly. We also highlight the potential for cumulative impacts that would need to be addressed in some places.

There has been little monitoring of the ecological impacts of low head hydropower schemes. The Environment Agency will undertake a programme of work to investigate these impacts, but this is likely to require a number of years data pre and post hydro installation.

This Good Practice Guide will also require regular revision in the light of operational experience.

This guidance is for application on existing impoundments (weirs) and may affect existing or proposed hydropower generation.

The recommendations that follow were developed for Low head hydropower schemes – weirs usually less than 4 metres high – but the principles may apply to High Head hydro schemes .

Any proposals for new impoundments would be required to undertake more detailed Environmental Impact Assessments.

2) ENVIRONMENTAL SITE AUDIT (ESA)

An Environmental Site Audit (ESA) check list guide was developed to help identify hydro schemes that are not expected to pose environmental problems, those that require more detailed investigations, or may require an Environmental Impact Assessment (EIA). The procedure makes the licensing process transparent, efficient and technically sound. It is based on the main environmental functions of a river that need to be addressed in each case. The information required to carry out the audit is easy to acquire and developers should be able to initially consider the process themselves. Specific issues identified for a particular site may require further investigation or clarification and a series of notes offer guidance on the likely issues that may arise. In some cases there will be aspects that need to be investigated further. Where the check list indicates that further work may be required this should be discussed with the relevant regulator.

The Environment Agency and other regulators will consider the check list guide provided by the applicant and indicate whether they agree with the developer's assessment, or indicate where further information may be required.

The ESA covers the following areas in individual checklists:

- Water resources
- Conservation
- Chemical and physical water quality
- Biological water quality
- Fisheries
- Flood risk
- Navigation

The seven checklists are reproduced in the remainder of this section. In each case the checklist is broken down into a series of questions. If the green box is correctly ticked no further action will normally be required. If the red box is ticked the associated note to that question needs to be consulted for guidance on additional work that needs to be done to address the issue. All of the checklist notes are either below the checklist or on the page following.

The guidance does not cover local authority planning issues or heritage aspects of a development. Developers will need to satisfy these regulators separately.

tick box YES	tick box NO	A Water Resources Checklist	Note No.
		Is the scheme non-consumptive i.e. will 100% of any water abstracted be returned to the water course from which it was taken?	1
		Is the scheme being built on existing infrastructure?	2
		Will the turbine be placed directly within the weir / water course rather than in a separate channel?	3
		Is there a flow-depleted channel?	4
		Is there a flow-depleted weir?	4
		Is it intended to increase the height of the impoundment?	8
		Do surveys reveal any existing abstractions, including unlicensed ones, which will be derogated by the proposal? (1)	5
		Is there an Environment Agency gauging station in the depleted reach or nearby that is likely to be affected by the scheme?	6
		Will the developer accept derogation consent within the proposed licence?	7

All green boxes ticked require no further action.

Any red boxes ticked require further action, as outlined in the attached notes.

Notes:

1. Hydropower schemes are usually non consumptive abstractions, i.e., they normally discharge the water back into the same reach of the river. If the abstracted water is to be discharged into a different reach or river, the impact of the augmentation on that reach or river needs to be assessed. This is in addition to the impact of the flow depletion on the reach or river from which the water is abstracted. The licence requirements for hydropower are sometimes complex. Further information is provided in sections 3, 4, 5.

2. If new infrastructure is to be built, an impoundment licence or change in licence condition may be needed. The details will depend on what exactly is going to be built. A discharge consent and/or a flood defence consent may be required for the proposed works. Planning permission may be required. A flood risk/consequence assessment may be required in support of the flood defence/land drainage consent application and the planning application.

3. If the turbine is located directly by or within the weir, only an impoundment licence and a flood defence consent may be required, but not an abstraction licence. Flow depletion may not have to be considered, if there is no depleted reach, but other impacts on the river flow may need to be examined. The details of such a scheme need to be discussed with the relevant Environment Agency Area office.

4. In most cases, the turbine will be located on, or adjacent to, a man-made channel (leat) or pipe, to which the water is diverted from the main river. In such cases, an abstraction licence and a flood defence consent will be required, and the impact of the flow depletion on the reach and any parallel distributaries and/or weirpools need to be considered. (See note 1 and sections 3 and 5).

   If the water for hydropower is taken through a channel that is physically separate from the water course there will be a depleted reach in the main watercourse.

If the water is abstracted immediately upstream of a weir and returned immediately downstream, only the weir has a depleted flow, which may affect the aesthetic appearance of the weir, weirpool morphology and ecology and fish passage. Further guidance is provided in sections 3, 4 and 5.

Detailed drawings of the proposed hydropower scheme including the abstraction and return point are required. The ecological value of the deprived reach is important in determining the proportion of flow that can be used for hydropower. The Environment Agency advises developers to avoid schemes that cause a depleted reach, as the necessary mitigation measures will limit the power potential of the scheme.

5. Any abstractions from the depleted reach need to be considered. The exact volume, time and protected status of such abstractions need to be checked (see Water Act 2003). Information on abstractions is available from the Environment Agency Area office.

6. If the answer is yes, the details of the case will need to be discussed with the appropriate Hydrometrics team. Re-location of the abstraction/discharge may need to be considered.

7. The Environment Agency may wish to incorporate a condition within the abstraction licence which reserves a volume for future upstream licensing or improvement to fish passage. The quantity will depend on the location of the site within the catchment, the risk to fish passage, including aspirations for future improvements, the potential for increased future water demand upstream and the time limit of the licence. The quantity will be in accordance with Catchment Abstraction Management Strategies (CAMS) assessments and ecological and fish passage needs.

8. If the impoundment is to be increased or altered, then an impoundment licence will be required from the Environment Agency.

tick box YES	tick box NO	B Conservation Checklist	Note No.
☐	☐	Is the scheme within, or likely to have an impact on a Site of Special Scientific Interest (SSSI)?	9
☐	☐	Is the scheme within, or likely to have an impact on a Special Area of Conservation (SAC)?	10
☐	☐	Does the scheme have any impact on a Special Protected Area (SPA)?	11
☐	☐	Does the scheme have any impact on a National Nature Reserve?	12
☐	☐	Does the scheme have any impact on a Local Nature Reserve?	13
☐	☐	Does the scheme have any impact on an Area of Outstanding Natural Beauty (AONB)?	14
☐	☐	Does the scheme have any impact on a National Park?	15
☐	☐	Does the scheme have any impact on a Conservation Area?	16
☐	☐	Have formal ecological surveys been carried out on the site?	
☐	☐	Does the scheme take appropriate account of protected species (not fish) that may live at the site or elsewhere in the catchment?	17

All green boxes ticked require no further action.

Any red boxes ticked require further action, as outlined in the attached notes.

Notes:

9. Countryside Council for Wales (CCW) or Natural England (NE) should be formally notified of any works that may damage a SSSI. Informal contact with the relevant area office prior to formal notification is encouraged A map of Wales SSSIs is available from (http://www.ccw.gov.uk/interactive-maps/protected-areas-map.aspx) A map of English SSSI sites is available from Natural England www.natureonthemap.org.uk).

10. SACs are protected under the EU Habitats Directive. Natural England/CCW should be formally notified of any works that may damage a SAC. Informal contact with the relevant area office prior to formal notification is encouraged. A map of all English SAC sites is available from Natural England (www.natureonthemap.org.uk). A map of Wales SACs is available from (http://www.ccw.gov.uk/interactive-maps/protected-areas-map.aspx)

11. SPAs are protected under the EU Birds Directive. A map of all UK SPA sites is available from the JNCC (www.JNCC.gov.uk). NE/CCW need to be consulted if we believe the proposal is likely to have a significant affect on the site.

12. National Nature Reserves are managed by different authorities. Advice should be sought from the relevant authority or from the NE/CCW area team. A map of all English National Nature Reserves is available from Natural England. (www.natureonthemap.org.uk). A map of Wales SSSIs is available from (http://www.ccw.gov.uk/interactive-maps/protected-areas-map.aspx)

13. Local Nature Reserves are managed by different authorities, including local governments. Advice should be sought from the relevant authority, or Local Records Centre. A map of all English Local Nature Reserves is available from Natural England (www.natureonthemap.org.uk).

14. Compliance of the scheme with the objectives of landscape protection may need to be sought from the relevant authority A map of Welsh AONBs is available from (http://www.ccw.gov.uk/interactive-maps/protected-areas-map.aspx) A list of English AONBs is available from Natural England

(http://www.naturalengland.org.uk/ourwork/conservation/designatedareas/aonb/default.aspx)

15. Each National Park has its own authority. Approval of the scheme by the National Park authority may be required.

16. Conservation areas are designated by local governments. Approval of the scheme by the local conservation officer may be required.

17. For information on protected species in Wales visit (http://www.ccw.gov.uk/landscape--wildlife/habitats--species/species-protection.aspx) A list of protected species can be found on Defra's website (http://www.defra.gov.uk/wildlife-countryside/index.htm)

tick box		C Chemical & Physical Water Quality Checklist	Note No.
YES	NO		
☐	☐	Will the scheme discharge the abstracted flow entirely back into the same watercourse?	1
☐	☐	Will pollutants be discharged into the river during construction and/or operation of the scheme?	18
☐	☐	Are there existing licensed pollutant discharges into the depleted reach?	19
☐	☐	Is the scheme likely to cause significant algal growth in the depleted reach?	20
☐	☐	Is the scheme likely to significantly increase river turbidity?	21
☐	☐	Is there an Environment Agency water quality monitoring point in the depleted reach or downstream?	22
☐	☐	Has a chemical river quality status been defined for the depleted reach?	22
☐	☐	Is deterioration of chemical status expected at the nearest downstream monitoring point?	23

All green boxes ticked require no further action.

Any red boxes ticked require further action, as outlined in the attached notes.

Notes:

18. Developers should not use toxic chemicals for maintenance, and should prevent spillages. Discharge of silt and other waste will not be permitted.

19. Existing pollutant discharges in combination with abstractions may have an adverse effect on the water quality in the depleted reach.

20. Reduction in the hydraulic residence time may lead to algae growth in the depleted reach. If this is likely, the licensed volume will need to be reduced to protect the ecological requirements under the WFD.

21. Solids discharges will need to be prevented. Compliance with Suspended Solids Standards according to EU Freshwater Fisheries Directive and WFD “no deterioration” objectives will need to be tested.

22. The results of the chemical and biological assessment of many UK rivers and reaches are published on the Environment Agency’s website. Contact with the area office may provide further information. If no data are available, a survey may need to be carried out according to the Environment Agency’s monitoring procedures.

23. Water quality could deteriorate in the depleted reach due to flow depletion. Mass balance calculations may need to be carried out to check if this impact will be significant.

tick box YES	tick box NO	D Biological Water Quality Checklist	Note No.
☐ (green)	☐ (red)	Has a biological status been identified for the affected reach?	24
☐ (red)	☐ (green)	Are planned changes in river flow likely to cause a significant change in the invertebrate community?	25
☐ (green)	☐ (red)	Does the Environment Agency hold aquatic vegetation survey data for the affected reach or for a nearby similar reach?	26
☐ (red)	☐ (green)	Are planned changes in the river flow likely to cause a significant change in the macrophyte, and diatom communities?	26

All green boxes ticked require no further action.

Any red boxes ticked require further action, as outlined in the attached notes.

Notes:

24. The results of the chemical and biological assessment of many UK rivers and reaches are published on the Environment Agency's website. Contact with the area office may provide further information. If no data are available, a survey may need to be carried out according to the Environment Agency's monitoring procedures. Species level aquatic macro-invertebrate data are usually necessary in order that an adequate appraisal of the resident community may take place. See checklist B Conservation.

25. The biology of the depleted reach needs to be investigated in detail. Sites with a higher biological score will be more sensitive to changes in river flow than sites with a lower score. An acceptable minimum flow can be determined following the guidelines in this guidance.

26. If representative survey data of these ecological elements are not available, they should be obtained, to determine that no deterioration or prevention of good ecological status will occur from the scheme. The impact of proposed changes in water level/velocity/submersion on the aquatic plant community may be derived from plant sensitivity studies.

tick box YES	tick box NO	E Fisheries Checklist	Note No.
☐ (green)	☐ (red)	Does the Environment Agency hold data on the fish species present in the affected reach?	
☐ (red)	☐ (green)	Does the river support migratory salmonids?	27
☐ (red)	☐ (green)	Does the river support lamprey species, shad species, or eels?	27
☐ (red)	☐ (green)	Does the river support coarse fish or non-migratory salmonids?	27
☐ (green)	☐ (red)	Is there an existing upstream fish pass?	27
☐ (green)	☐ (red)	Are the provisions for upstream fish passage satisfactory?	28
☐ (green)	☐ (red)	Are the provisions for screening fish and associated bywash satisfactory?	28
☐ (red)	☐ (green)	Will the scheme impact on either the up or downstream passage of fish in the river?	28
☐ (red)	☐ (green)	Will the scheme impact on any fish spawning or nursery areas?	
☐ (red)	☐ (green)	Will the scheme affect any river stretch used for angling?	

All green boxes ticked require no further action.

Any red boxes ticked require further action, as outlined in the attached notes.

Notes:

27. Where Atlantic salmon (*Salmo salar*) and migratory (sea) trout (*Salmo trutta*) are present, or where it is an objective to rehabilitate them to the river, then normally an upstream fish pass will be required. (Salmon and Freshwater Fisheries Act of 1975, Sections 9). Screening (SAFFA, S14) is required to be put in place unless exempted by the Environment Agency. The Environment Agency may reserve the right to ask for future provision of a fish pass around the structure.

    (*) To meet the requirements of the WFD it is necessary to consider passage not only for other major migratory species such as lamprey, eels and shad, but also for brown trout, grayling and coarse fish.

    (*) Some species e.g. lampreys, shad, bullhead are subject to particular protection by the European Habitats Directive.

    (*) As a result of the European eel stock being below its conservation limit, it is the subject of a European management plan requiring specific improvements to obstructions to maximise their migration. Eels are particularly vulnerable on their downstream migration and hence adequate screens are required in all places.

    Conservation legislation and regulations could change after these guidelines have been published. Therefore, up-to-date regulations should be consulted whenever necessary.

    Where Salmon Action Plans, Fisheries Action Plans or Eel Management Plans are available, they should be considered in relation to a hydropower proposal.

28. Fish passage and screening requirements are dealt with in section 4. The effectiveness and efficiency of any existing fish pass will need to be maintained or even improved for a scheme to be consented.

tick box		F Flood Risk Management Checklist	Note No.
YES	NO		
☐	☐	Will the proposed scheme reduce the flood flow capacity of the river, either by reducing the cross section or by slowing flows?	29
☐	☐	Does the scheme propose any alterations to structures or construction of new structures in the river (such as weirs, dams, culverts or outfalls) or alterations to existing flood defences (such as embankments or walls)?	29
☐	☐	Does the scheme propose to create new channels or change the flow path in any way?	29
☐	☐	Does the scheme propose to deepen any existing channels?	29
☐	☐	Is the scheme in the floodplain as shown on the Environment Agency's flood map? Does the scheme reduce the available floodplain area or block potential overland flood flow?	29 & 29a
☐		Will the scheme change the available access to the river or adjacent flood defences for maintenance, including by construction of fences or walls around new structures, or of overhead cables?	29b
☐	☐	Does the scheme involve construction of a new raised reservoir with the capacity of 25,000 cubic metres or more?	29c
☐		Could the cumulative impact of the current proposal along with others increase flood risk or adversely affect land drainage?	29

All green boxes ticked – a flood defence consent application may still be required supported by sufficient information.

Any red boxes ticked require further action, as outlined in the attached notes.

Notes:

29. Formal written consent ('flood defence consent') from the Environment Agency is likely to be required for these activities. To ensure there is no adverse impact on flooding in the locality, a flood risk assessment is likely to be required to demonstrate that the effects of the proposal can be managed satisfactorily. Some construction activities may also require planning permission, and the views of the local planning authority should be obtained. The Environment Agency booklet 'Living On The Edge' (available free from our customer contact centre, or by download from http://www.environment-agency.gov.uk/homeandleisure/floods/31626.aspx) gives more information

29a http://www.environment-agency.gov.uk/homeandleisure/floods/31656.aspx

29b Operating authorities, including the Environment Agency on statutory main rivers, Internal Drainage Boards and local authorities elsewhere, have permissive powers to maintain watercourses to reduce flood risk. This is particularly important at river control structures, which may require operation, clearance of debris or repair. Vehicular access to these structures and ability to work safely around them needs to be retained, to ensure that this work can be carried out.

29c Structures of this size will qualify as statutory reservoirs, and require design and inspection as such. See http://www.environment-agency.gov.uk/business/sectors/32427.aspx for more details.

YES	NO	G Navigation Checklist	Note
☐	☐	Is the proposed scheme in a Navigation Authority controlled area?	30
☐	☐	Will the scheme reduce water levels upstream or downstream of the structure?	30
☐	☐	Will the scheme affect access for other users, e.g. canoeists?	30
☐	☐	Will the scheme affect water availability for navigation (lockage's) during low flows?	30

All green boxes ticked require no further action

All red boxes ticked require further action, as outlined in the attached notes

Notes:

30. Water levels may fluctuate as the turbine(s) are switched on or off. The local Navigation Authority must be consulted at the earliest stage. Formal permission for the works may be required where this has the potential to impact on navigation in the watercourse.

3. HYDROPOWER SITE LAYOUT

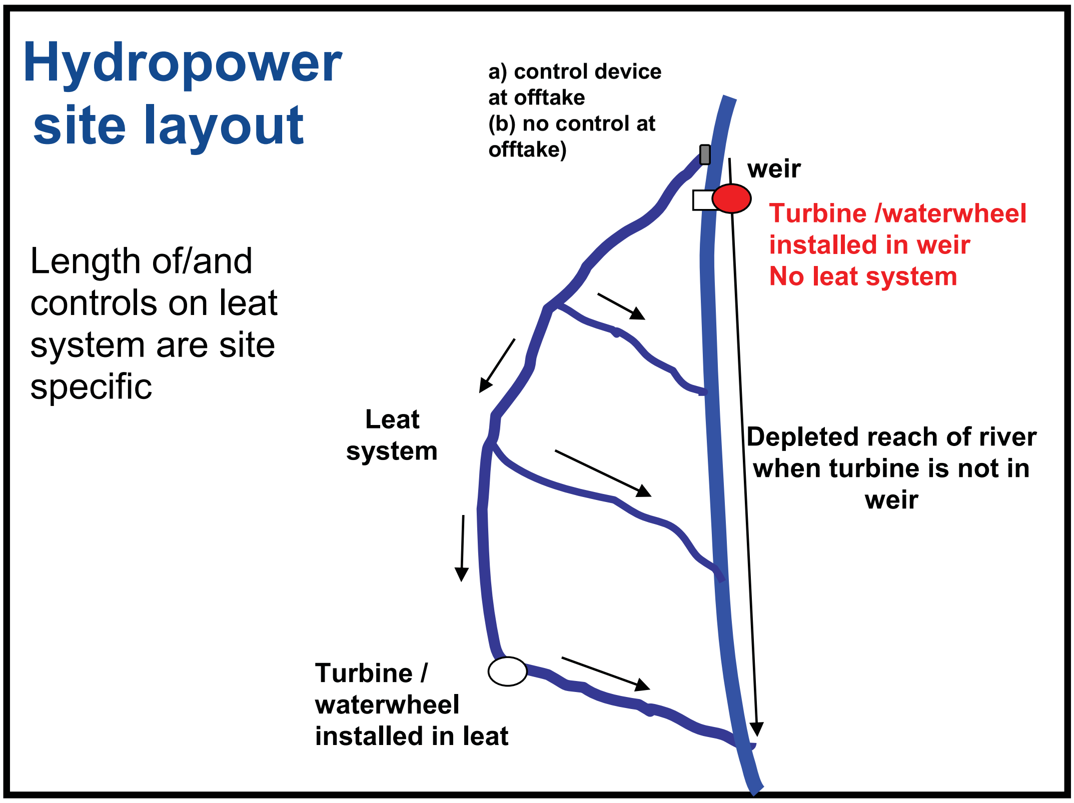

Figure 1 Typical hydropower site layout

Hydropower site layouts vary, but many of the main elements are shown Figure 1.

A weir (impoundment) is present in almost all hydropower sites, and may provide the head drop of water on its own, or in conjunction with a fall in the river over a greater length.

A leat system will divert water from the main channel to some point where the fall in water is used to generate power (often an old water powered mill). The leat system may have overflows to control the flow of water in the system.

The hydropower 'turbine' may be installed within or adjacent to the weir, or may be on the leat system.

A depleted reach occurs where water is diverted from the main channel through a leat system. Where the hydropower turbine is on the weir, the diverted reach is the weir itself. The impact of the hydropower proposals on flow and ecology in the depleted reach is one of the key issues in permitting Hydropower schemes.

The total flow in the stream above the intake and below the return will normally be unchanged (unless there are tributaries joining the depleted reach).

4. ECOLOGICAL REQUIREMENTS

4.1 Introduction

This guidance is intended to ensure sufficient water remains in the river. There is evidence that significant reductions in flows to watercourses lead to an impact on the ecology of that reach. As part of the WFD requirements, the Environment Agency through its regulation must aim to achieve good ecological status and ensure that there is no deterioration in the ecological condition of water bodies. It may be difficult to reconcile these requirements with a large loss of flow from main river channels. We are also obliged to consider the rights of land and fishery owners that may be affected.

Our evaluations indicate that hydropower schemes incorporated within or immediately adjacent to a main channel weir and which would avoid depleting main channel flows, are more likely to be environmentally acceptable.

4.2. Depleted Reach

A “depleted reach” may be an obvious length of watercourse, or it may be a weirpool when the turbine is situated on, or immediately adjacent to, an impoundment (see section 3).

Many old mill sites were built with either a moderate length of intake channel, a tailrace channel, or both (often partly culverted). This helped isolate the millhouse from flood flows and preserve the driving head during high flow conditions (when the weir itself might be drowned out). Many of these mill races still exist and provide the majority of current opportunities for low head projects.

Because of the cost of excavating new waterways, it is rare for a 'green-field' low-head scheme to involve more than a few tens of metres of new channel, so the depleted reach may be very short.

Where water is diverted from the main river, the length of channel from the diversion point to its re-connection will have a depleted flow with a consequential impact on its ecological and fishery status. If this is a migration route and the diversion channel has the majority of the flow, then the fish may be attracted to the higher flows. If the migratory fish enter the tailrace this may prevent migration (if there is no fish pass in the diversion channel), or delay migration possibly resulting in increased predation, disease or inability to reach the destination at the right time. Equally, downstream migrants may tend to migrate into the diversion channel with greater risk of impingement on screens and turbines. For these reasons the Environment Agency recommends avoiding such schemes as it recognises there will generally be less environmental risks for ‘on weir’ schemes and therefore possibly greater power production potential. This avoids causing a depleted reach and the flows can be held to one channel and so minimise fish migration problems and the associated costs for developers.

There is increasing understanding that depleted reaches need to retain a flow regime that mimics the natural flow fluctuations, and that all elements are important including floods, medium and low flows. A depleted reach, caused by a hydropower offtake, will be deprived of a varying proportion of the natural flow that has a complex relationship with the river type (high or low baseflow) and the maximum hydropower volume in relation to the Qmean flow of the river (see section 6). The ecological impact this may have will depend on the river’s ecological status, the length of the depleted reach, and could vary from being acceptable to being quite damaging.

To maintain the ecological integrity of the river, minimum flows in the depleted reach will need to be set and factors such as flow variability and spate flows will become more important for both maintenance of channel form and its ecology as the length of the depleted

reach becomes longer. The quality of the fishery and its significance for fish passage are also likely to be affected. On shallow 'pool and riffle' type rivers there can be significant change in the 'wetted usable area' at low flows, especially below Q95 (the flow exceeded for 95% of the time, and used as a marker of low flow). Q95 is therefore the default 'Hands Off Flow' for licensing consumptive abstractions, see Environment Agency – Managing Water Abstraction.
http://publications.environment-agency.gov.uk/pdf/GEH00508BOAH-E-E.pdf

Increased periods of low flow in the depleted reach will result from a hydropower proposal, and may have significant impacts on fish populations – both in coarse fish dominated rivers and salmonid rivers. There has been little scientific study on this undertaken in England and Wales, but evidence from Europe and elsewhere indicates a considerable reduction in biomass and density of both coarse and salmonid species in the depleted stretch when subjected to lengthy periods of very low residual flows.

If an impoundment has no fish pass but fish are able to pass either at high flows or a flow "window", any diversion of water through a turbine will impact on the migration capacity. Therefore it is unlikely that a project would be allowed unless it included a suitable fish pass.

Weir pools are important habitats in some lowland rivers and, although the volume of water above and below the weir may be the same when the hydropower generation is 'on weir', the change in flow distribution and energy may have effects on the morphological character of the river. There will be different requirements depending whether the hydropower turbine is situated on or adjacent to the impoundment, or is on a channel (or leat) away from the main channel, and whether there are fish migration requirements (this is developed in the scenarios in section 5).

4.3. Salmon and Freshwater Fisheries Act (SFFA) and migratory rivers

Hydropower installations on rivers populated by migrating species of fish, such as salmon or sea trout, are subject to special requirements as defined in the Salmon and Freshwater Fisheries Act (SFFA). Broadly, and subject to certain conditions, the Act requires that "*owners/operators of hydropower schemes on migratory rivers should, at their own expense, ensure that upstream and downstream fish passages, respectively, are catered for by the construction of appropriate fish passes, screens and by-washes*".

In the context of licensing of abstracted flows, the key issues for migratory species are as follows:

- The need for fish passes to overcome the increased obstruction posed to upstream migration by weirs and other river structures that are deprived of flow.
- Where there is no fish pass, adequate residual flow over the weir during the migration seasons for adults (moving upstream) and juveniles (moving downstream).
- Adequate flow in the depleted reach during the migration seasons for adults (moving upstream) and juveniles (moving downstream).
- Protection of spawning areas and the seasonal flows required to allow spawning to occur.

A fish pass will be required on hydropower sites on rivers where there are migratory species if the ability to migrate is compromised. The residual flow calculation will need to include the flow required to service the fish pass.

The requirement for fish passes and screening is likely to extend to all species in the near future to meet the objectives of WFD. These changes will be made through amendment to fisheries legislation. Consultation on the proposals took place in spring 2009. Developers are advised to make themselves aware of the possible implications.

Further consideration of fish passes is in section 8.

4.4. Seasonal fish migration

Different fish species migrate upstream (particularly for spawning) and downstream for spawning, feeding and over-wintering, at different times of the year. The flow requirements for the different species vary significantly.

- Adult salmon and sea trout will generally migrate upstream from May to January to access spawning areas. Upstream migration is triggered by flow spates that will normally exceed Qmean flows. After spawning, adults move downstream through main flow routes in December to February.
- Smolts (juvenile salmon and sea trout) migrate downstream mainly in the spring, prompted by temperatures in excess of 9-10°C. There is evidence of a second migration period in autumn in some rivers.
- Trout will move upstream to spawn from October to February dependent on a range of factors.
- Coarse fish will generally seek to migrate to spawn during March to July, depending on the species.
- Lamprey adults migrate upstream to spawn (sea lamprey, February to June; river lamprey, September – March). Juveniles migrate downstream to feed (sea lamprey, October to December; river lamprey January to April).
- Eels make their main downstream migration mostly during autumn (September to November). Peak migrations will occur over short periods that may be predictable in relation to moon phase, water temperature and high flows.
- Elvers make their upstream migration during March to May depending on location. They may require only relatively low cost solutions to enable them to pass weirs and other impoundments successfully.

All these periods are approximations and vary according to the geographic location and in some case specific strain of fish present. Local confirmation of these will be available from Fisheries consenting teams.

4.5. Hydropower and WFD

Under the WFD Member States should aim to achieve good ecological status and to ensure that no deterioration of ecological status takes place. The freedom of movement of fish, upstream or downstream, is an important component of achieving or maintaining good status or potential. Hydropower schemes must be well designed and carefully sited if they are to avoid disruption of fish migration in both upstream and downstream directions, and thereby create an obstacle to achieving WFD Good Ecological Status. The ecological and amenity impacts in any depleted reach must be considered, both to the reach itself and to the catchment as a whole.

Rivers with low head hydropower structures are not necessarily designated under WFD as Heavily Modified Water Bodies by hydropower use, as the impacts are on a relatively short length of the river compared to the length within the water body.

The UK Technical Advisory Group (UKTAG) recommendations on flow standards for abstraction impacts (WFD 48) are for consumptive abstraction impact. They have been adopted by the Environment Agency in a slightly modified form for water resource regulatory purposes as 'Environmental Flow Indicators', and will be used in the Future Catchment Abstraction Management Strategies (CAMS) process for managing abstraction licences.

UK TAG guidance has also been provided on the assessment of abstraction impacts greater than those indicated in the WFD 48 project on short lengths of river within a water body but which would not be considered sufficient to cause a failure to support Good

Ecological Status. The proposals presented here for considering the length of the depleted reach when assessing hydropower proposals meet the requirements of the UK TAG guidance.

Barriers to fish passage have been highlighted in WFD River Basin Planning as a major impact limiting fish populations, particularly of salmon and trout but also of coarse fish and eels. Improvements in water quality on many rivers in industrial areas have enabled the slow return of salmon and other fish species to rivers that lost their populations due to major weir construction for water use, and later, pollution from industrial processes. There are many thousands of such barriers in England and Wales. The Environment Agency is undertaking work to collate data on barriers, prioritise work to enable fish passage (by removal of the barrier or installation of a fish pass), and to obtain powers and funding to enable such work. The development of hydropower involving a weir that is a barrier to migration would lead to the need to install a fish pass.

4.6 Hydropower and Protected Areas

Where a hydropower proposal has been identified through the Conservation checklist as being likely to have an impact on a designated site (SAC, SPA, SSSI etc) further work will be required to assess the impact of the scheme on designated species.

Consultation with Natural England or Countryside Council for Wales (CCW) will be required in assessing the impacts of the scheme and granting permits.

4.7 Cumulative Impacts

In regulating low-head hydro applications, the Environment Agency will take in to account potential cumulative impact of multiple sites on a river or in a catchment. Without effective fishery protection measures, cumulative impacts may be significant, particularly for diadromous species such as salmon, sea trout, lamprey, shad and eel. They may also be significant for other solely freshwater species that are obliged to migrate between habitats as part of their life cycle. Some rivers are potentially suitable for multiple sites for low-head hydropower applications. A high level of fishery protection needs to be maintained at such sites; even where sites have efficient and effective downstream and upstream passage facilities, the cumulative effects of delays and damage may cause the numbers of migrating fish to decline significantly but there has been no research carried out to provide evidence to show that this actually is happening.

The location of a proposed scheme within a catchment will also be relevant in terms of the environmental protection required. Risks for diadromous fish in particular will generally be higher the lower down the system the site is located. This is because the potential impacts in terms of the number of migrants and proportion of the population affected will be at the maximum for both upstream and downstream moving fish in the lower reaches of a river basin.

5. HYDROPOWER SCENARIOS

Hydropower sites fall in four main scenarios

1. Turbine on or immediately adjacent to an impoundment (weir) – with no fish migration issues.
2. Turbine on or immediately adjacent to an impoundment (weir) – with fish migration issues.
3. Mill leat used for hydropower abstraction – no fish migration issues.
4. Mill leat used for hydropower abstraction – fish migration issues.

5.1. Turbine on or immediately adjacent to an impoundment (weir) – with no fish migration issues

Situation:

- Where an impounding structure (weir) on the river is to have a turbine installed within its longitudinal footprint to return water at the impoundment toe.
- It is not a migratory salmonid river, or there is no Salmon Action Plan.
- Fish, which are interest features of protected sites including the river reaches above and below the weir, are achieving favourable conservation status.
- The river reaches above and below the weir are not failing Good Ecological Status due to obstructions to fish passage, of which this is one of the relevant sites.

Requirements:

- The maximum flow for hydropower will normally be Qmean (Table 2).
- The Hands-Off Flow value for that river type is preserved (Table 2).
- The turbine intake will have the screening arrangements specified in Figure 5, including a bywash.
- The water is returned in the same longitudinal direction of the flow to maintain weirpool form.
- The weir has a required minimum depth of water flowing over it while generation is taking place, taking into account factors such as design of the weir, amenity and whether the river has a high baseflow.
- There are no other parties dependent on or adversely affected by the re-distribution of flows at the structure or the reduced kinetic energy of the flow into the weirpool.
- Where the weir pool is assessed to have high ecological importance – for example on a heavily impounded lowland river, a flow regime may be required to support its continued presence.

5.2 Turbine on or immediately adjacent to an impoundment (weir) – with fish migration issues

Situation:

- Where an impounding structure (weir) on the river is to have a turbine installed within its longitudinal footprint to return water at the impoundment toe.
- It is a migratory salmonid river, or there is a Salmon Action Plan.
- The river has other fish species which need to migrate past the weir to successfully complete their life cycle.
- The river has coarse fish for which it is failing Good Ecological Status due to migration obstructions or impoundment impacts of which this is one of the relevant sites.

Requirements :

- The maximum flow for hydropower will normally be Qmean (Table 2).

- The Hands-Off Flow value for that river type is preserved (Table 2).
- The turbine intake will have the screening arrangements specified in Figure 5, including a bywash, to ensure safe downstream passage of migratory fish.
- The water is returned in the same longitudinal direction of the flow to maintain weirpool form.
- The weir has the required minimum depth of water flowing over it when generation is taking place, taking into account factors such as design of the weir, amenity and whether the river has a high baseflow.
- A fish pass will be required to a design approved by the Environment Agency.
- The fish pass and turbine outflow shall be co-located to ensure fish are preferentially drawn to the fish pass entrance and to ascending it throughout the flow ranges experienced at the site.
- There are no other parties dependent on or adversely affected by the re-distribution of flows at the structure or the reduced kinetic energy of the flow into the weirpool.
- That where fish survey data to classify for WFD above and below the site are not available, that these will need to be provided by the developer to enable assessment against Good Ecological Status (GES) to be made by the Environment Agency.
- Where the weir pool is assessed to have high ecological importance – for example on a heavily impounded lowland river, a flow regime may be required to support it.

Weir pools

- There are a few sites of high ecological value that have been identified by the Environment Agency where weirpool constraints will limit hydropower potential.
- Weirpools are important for spawning and fry development of several riverine fish species, such as barbel, dace, chub, bullhead, stone loach, and as a habitat for macrophytes and invertebrates. These may contribute to the fishery and wider ecology for a distance downstream and therefore affect both WFD achievement of GES and the fishery rights of others.
- The essential habitat for these species is formed and maintained by the energetic water entering the weirpool.
- Whilst flood flows may create the appropriate morphology, moderate flows will maintain it in a suitable condition.
- A turbine situated on, or immediately, adjacent to the weir may discharge water into the weirpool, but the flow pattern and energy will have been changed.

5.3. Mill leat used for hydropower abstraction – no fish migration issues

Situation:

- Abstraction for hydropower through the mill leat creates a depleted reach greater than the longitudinal section of the weir.
- It is not a migratory salmonid river, there is no Salmon Action Plan.
- Fish which are interest features of protected sites including the river reaches above and below the weir are not failing to achieve favourable conservation status.
- The river reaches above and below the weir are meeting GES due to fish migration obstructions or impoundments of which this is one of the relevant sites.

Requirements :

- The maximum flow for hydropower will depend on the river type (Table 2).
- The Hands-Off Flow value for that river type is preserved (Table 2).