Appendix 11.6

Aquatic Ecology

Plates

Plate 1: Otter spraint

Plate 2: Freshwater sample station S1

Plate 3: Freshwater sample station S2

Plate 4: Freshwater sample station S3

Plate 5: Freshwater sample station S4

Plate 6: Freshwater sample station S6

Plate 7: Freshwater sample station S7

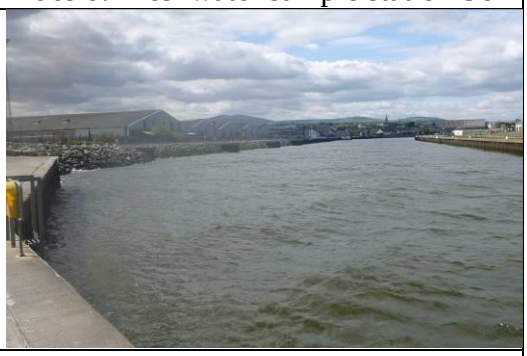

Plate 8: View upstream from breakwater

	
Plate 9: Cobble and pebble beach along estuary	**Plate 10:** Gravel banks just downstream of bridge
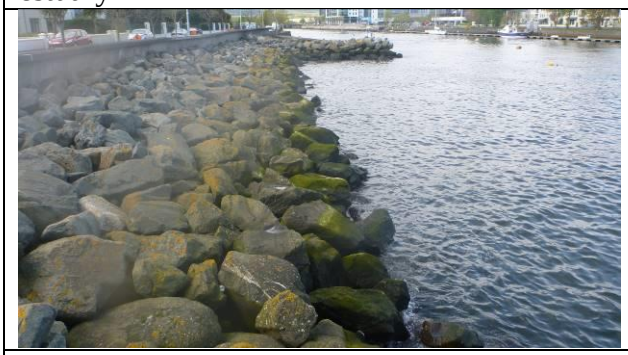	
Plate 11: Rock armour showing algae and lichens	**Plate 12:** Sewage fungus at flap valve on the South Quay
	
Plate 13: Toilet paper & sanitary towel accumulation along the South Quay	

Tables

Table A1: Freshwater macroinvertebrates recorded from the Avoca River and Arklow Town Marsh channel on 26/09/2017. Species names checked by PESI Taxon Match Tool (http://www.eu-nomen.eu/portal/taxamatch.php).

EPA sensitivity group	Taxon	S1	S2	S3	S4	S5	S6	S7
	ANNELIDA							
	Oligochaeta							
E	Naididae (former Tubificoids)	-	-	-	1	-	-	-
C	*Lumbriculus variegatus*	600	16	85	47	30	16	14
	Hirudinea							
D	*Erpobdella octoculata*	-	-	-	-	-	2	-
D	*Glossiphonia complanata*	-	2	-	-	-	-	2
D	*Helobdella stagnalis*	-	-	-	-	1	-	-
	MOLLUSCA							
D	*Pisidium* sp.	-	-	20	2	22	2	8
D	*Physa fontinalis*	-	-	1	-	-	-	49
D	*Radix peregra*	-	-	-	-	-	-	122
	CRUSTACEA							
-	*Gammarus chevreuxi*	110	1	-	-	-	-	-
D	*Crangonyx pseudogracilis*	-	2	-	11	-	14	27
D	*Asellus aquaticus*	-	2	-	2	-	5	106
	INSECTA							
	Coleoptera							
C	*Oulimnius* sp. (adult)	-	-	1	1	-	-	-
C	*Oulimnius* sp. (larva)	-	6	-	-	1	1	-
C	*Haliplus confinis*	-	-	-	-	-	1	1
C	*Haliplus lineatocollis*	-	-	-	1	-	-	-
C	Haliplidae (larva)	2	2	-	-	-	-	2
C	*Stictotarsus duodecimpustulatus* (adult)	-	-	2	-	3	8	-
C	*Stictotarsus duodecimpustulatus* (larva)	-	-	-	1	-	-	-
C	*Nebrioporus elegans*	-	-	-	7	-	11	-
C	*Oreodytes sanmarkii*	-	-	-	-	1	1	-
C	*Ilybius fuliginosus*	-	-	-	-	-	1	-
C	*Ilybius* sp. (larva)	-	-	-	-	-	-	12
C	*Hydroporus tessellatus*	-	-	-	-	-	1	-
C	Hydroporinae (larva)	-	1	-	-	-	-	-
	Hemiptera							
C	*Sigara dorsalis* (nymph)	-	-	2	1	-	-	-
C	*Sigara dorsalis* (adult)	-	-	1	1	-	8	1
C	*Aquarius najas*	-	-	-	2	-	-	-
C	*Gerris* sp.	-	-	-	-	-	1	-
C	*Velia caprai*	-	-	-	-	1	-	-
C	*Notonecta viridis* (nymph)	-	-	-	-	-	1	-
C	*Notonecta viridis* (adult)	-	-	-	-	-	1	-
	Odonata							
B	*Calopteryx virgo*	-	-	-	1	-	2	-
B	*Pyrrhosoma nymphula*	-	-	-	1	-	1	-
	Diptera							
C	Chironomidae (larvae)	88	7	17	7	163	33	20
C	Chironomidae (pupa)	20	-	4	4	1	3	5
C	Tipulidae	1	-	-	-	-	-	-
-	Diptera indet	2	1	-	-	-	-	-
	Ephemeroptera							
C	*Baetis rhodani*	1	-	-	-	-	-	-
	Trichoptera							
B	*Mystacides azurea*	-	-	10	30	45	536	2
B	*Sericostoma personatum*	-	-	-	-	-	5	-
B	*Potamophylax latipennis*	-	-	-	-	-	2	-
B	Limnephilidae (instar II)	-	-	-	-	1	-	-
C	*Lype reducta*	-		1	-	1	-	-
C	*Holocentropus picicornis*		1	-	-	-	-	-
C	*Polycentropus flavomacalutus*	-	-	-	-	1	-	-
	ARACHNIDA							
	Araneae	-	-	-	-	-	1	1
	Hydracarina	2	-	-	-	1	-	2
	Total abundance	**826**	**41**	**144**	**120**	**272**	**657**	**374**
	Total number of taxa	**8**	**11**	**9**	**15**	**12**	**21**	**15**

Table A2: Field data recorded during the freshwater macroinvertebrate survey on the Avoca River on 26/09/2017.

Site no.	ITM_X	ITM_Y	Date	Surveyor	Dissolved O2 (mg/l)	Dissolved O2 (%)	Water temperature (°C)	pH	Conductivity (mS/cm)	Kick sample duration (mins)	Width (m)	Depth (m)
S01	724678	673454	26-09-17	JB/EV	9.2	90	14.4	7.25	0.1	2	160	0.25
S02	724424	673624	26-09-17	JB/EV	9.1	87	13.6	7.15	0.1	2	70	0.4
S03	724133	673608	26-09-17	JB/EV	9.1	88	14.1	7.21	0.1	2	40	0.3
S04	723873	673717	26-09-17	JB/EV	9.1	88	14.2	7.09	0.1	2	40	0.4
S05	723297	674131	26-09-17	JB/EV	9.3	91	14.6	7.12	0	2	40	0.4
S06	723111	674540	26-09-17	JB/EV	9.4	92	14.6	7.15	0.1	2	30	1.5
S07	723432	674393	26-09-17	JB/EV	5.4	54	15.6	6.86	0.2	1	4	0.3

Table A2: continued

Site no.	Flow	Discharge	Siltation	Silted	Water clarity	Habitats sampled	Vegetation	Filamentous algae	Slime	Sewage fungus
S01	Very slow	Normal	Slight	Generally	Slightly turbid	Margins	Open	Absent	Absent	Absent
S02	Very slow	Normal	Slight	Generally	Slightly turbid	Margins	Open	Present	Absent	Absent
S03	Very slow	Normal	Heavy	Generally	Slightly turbid	Margins	Partly shaded	Absent	Absent	Absent
S04	Very slow	Normal	Heavy	Generally	Slightly turbid	Margins	Partly shaded	Absent	Absent	Absent
S05	Very slow	Normal	Heavy	Generally	Slightly turbid	Margins	Shaded	Absent	Absent	Absent
S06	Very slow	Normal	Heavy	Generally	Slightly turbid	Margins	Partly shaded	Absent	Absent	Absent
S07	Stagnant	Normal	Heavy	Generally	Slightly turbid	Margins	Partly shaded	Absent	Absent	Absent

Table A2: continued

Site no.	Site location	Surrounding land
S01	Downstream Arklow Bridge, right bank	Urban
S02	Upstream Arklow Bridge, right bank	Left: Treeline and marsh, Right: Urban
S03	Upstream as railway curves away	Left: Treeline and marsh, Right: Path and waste ground
S04	Upstream Arklow Bridge, alongside railway	Left: Woodland, Right: Path, wasteground, railway
S05	Upstream of school, downstream of M11	Left: Woodland, Right: Woodland
S06	Upstream M11 Bridge, right hand side	Rough pasture/scrub
S07	Marsh backdrain downstream M11 Bridge	Swamp and pasture

Table A2: continued

Site no.	Bankside vegetation	In-stream vegetation/macrophytes (% cover)
S01	Concrete wall with *Taraxacum* sp., *Hedera hibernica* and *Rumex* sp.	None
S02	Left: *Salix* spp., *Ulex europaea*, *Fagus sylvatica*. Right: *Plantago lanceolata*, *Achillea millefolium*, *Festuca rubra*, *Holcus lanatus*,	Filamentous algae 90%
S03	Right: *Salix cinerea*, *Ulex europaea*, *Holcus lanatus*, *Alnus glutinosa*	*Callitriche* sp. 40%, *Phalaris arundinacea* 10%
S04	Right: *Holcus lanatus*, *Rubus fruticosus*, *Betula pubescens*, *Senecio jacobaea*, *Daucus carota*, *Alnus glutinosa*	*Phalaris arundinacea* 1%, *Ranunculus* sp. 5%, *Callitriche* sp 5%
S05	Left: Woodland and *Fallopia japonica* and *Betula* sp., Right: *Acer*	0%
S06	*Agrostis stolonifera*, *Ranunculus repens*, *Rubus fruticosus*, *Alnus glutinosa*, *Ulex europaea*, *Plantago lanceolata*, *Holcus lanatus*, *Cytisus*	*Ranunculus* sp. 15%, *Callitriche* sp. 5%
S07	*Rubus fruticosus*, *Urtica dioica*, *Phalaris arundinacea*	*Sparganium erectum* 60%, *Apium nodiflorum* 10%, *Lemna* sp. 50%, *Phalaris arundinacea* 15%

Table A2: continued

Site no.	Substratum (% cover)	Other information (erosion, rubbish, etc.)
S01	Cobble 20%, Pebble 70%, Gravel 10%, Sand 10%	
S02	Boulder 50%, Cobble 30%, Gravel 10%, Sand 10%	Bank consists of large concrete blocks
S03	Boulder 20%, Silt 80%	Wall bank
S04	Silt 100%	
S05	Silt 100%	
S06	Silt/Clay 100%	
S07	Silt 100%	Channel choked with vegetation.

Table A3: Macroinvertebrates recorded during benthic survey at Arklow on 22/04/2017. Species names checked by PESI Taxon Match Tool (http://www.eu-nomen.eu/portal/taxamatch.php).

Species	Abundance (individuals per sample)													Total
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	
ANNELIDA														
Polychaeta														
Notomastus latericeus	3	3	2	5	10	3	20	-	-	-	-	-	-	46
Aphelochaeta sp.	-	-	-	-	-	-	3	2	-	-	-	-	-	5
Gonadia maculata	-	-	-	-	-	-	2	-	-	-	-	-	-	2
Glycera tridactyla	-	-	-	-	2	1	-	-	1	-	-	-	-	4
Ophelia borealis	-	-	-	-	-	-	-	-		1	-	-	-	1
Nephtys caeca	-	-	-	-	-	-	-	-	1	2	-	-	-	3
Nephtys hombergii	3	1	2	3	3	1	5	3	-	-	-	-	-	21
Nephtys assimilis	1	-	-	-	-	-	-	-	-	-	-	-	-	1
Nephtys sp.	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Ampharete sp.	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Ampharete lindstroemi	1	-	-	-	-	-	1	-	-	-	-	-	-	2
Pholoe inornata	-	-	-	2	1	1	3	2	-	-	-	-	-	9
Phyllodoce groenlandica	1	1	-	-	-	1	3	-	-	1	-	-	-	7
Sthenelais boa	-	-	-	-	-	-	1	3	-	-	-	-	-	4
Aphrodita aculeata	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Owenia fusiformis	-		-	-	-	-	1	-	-	-	-	-	-	1
Spiophanes bombyx	-	14	1	-	-	-	3	-	-	-	-	-	-	18
Pectinaria koreni	-	-	-	-	-	-	4	-	-	-	-	-	-	4
Terebellidae sp	-	-	-	-	4	-	-	-	-	-	-	-	-	4
Heteromastus filiformis	-	-	3	-	-	-	-	-	-	-	-	-	-	3
Lumbrineris tetraura	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Heteroclymene robusta	-	-	-	-	-	-	16	-	-	-	-	-	-	16
Oligochaeta														0
Enchytraeidae	-	-	-	-	-	-	-	-	-	-	-	2	255	257
CRUSTACEA														
Ampelisca brevicornis	-	1	-	2	1	-	6	1	-	-	-	-	-	11
Ampelisca tenuicornis	-	-	-	-	-	-	-	3	-	-	-	-	-	3
Ampelisca sp.	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Nototropis falcatus	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Harpinia antennaria	-	1	-	-	-	-	-	2	-	-	-	-	-	3
Bathyporeia nana	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Gammarus chevreuxi	-	-	-	-	-	-	-	-	-	-	-	-	33	33
Gammarus sp.	-	-	-	-	-	-	-	-	-	-	-	-	1	1
ECHINODERMATA														
Amphiura incana	-	-	-	-	-	-	8	-	-	-	-	-	-	8
Amphipholis squamata	-	-	-	3	-	-	-	6	-	-	-	-	-	9
Ophiura ophiura	-	-	-	1	-	-	-	-	-	-	-	-	-	1
Ophiocten affinis	-	1	1	-	-	-	-	-	-	-	-	-	-	2
MOLLUSCA														
Pharus legumen	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Euspira catena	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Thracia phaseolina	1	-	-	-	-	-	-	-	-	-	-	-	-	1
Thyasira flexuosa	-	-	-	2	-	-	1	4	-	-	-	-	-	7
Nucula nitidosa	6	17	-	51	-	-	4	37	1	-	-	-	-	116
Abra alba	22	13	3	83	53	3	98	172	-	-	-	-	-	447
Modiolus modiolus	-	-	1	-	-	-	-	-	-	-	-	-	-	1
Pisidium sp.	-	-	-	-	-	-	-	-	-	-	-	-	1	1
NEMERTEA														
Nemertea indet.	2	1	-	1	-	-	1	9	-	-	-	-	-	14
ASCIDIACEA														
Ascidiacea indet.	-	-	-	-	-	-	-	-	1	-	-	-	-	1
HEXACORALLIA														
Hexacorallia indet.	-	-	-	-	-	-	-	-	1	-	-	-	-	1
INSECTA														
Coleoptera														
Limnius volckmari	-	-	-	-	-	-	-	-	-	-	1	1	-	2
Diptera														
Diptera indet.	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Total individuals	**40**	**54**	**13**	**153**	**74**	**11**	**181**	**245**	**8**	**6**	**1**	**4**	**290**	**1077**
Total species	9	11	7	10	7	7	19	13	8	5	1	3	4	49

Table A4: Field data recorded during the estuarine and marine benthic survey at Arklow on 22/04/2017.

Sample station	Date	Time	Weather	Sea State	Exposure	Depth (m)	Salinity	Bite depth (cm)	Sediment description
1	22-04-17	10:05	Overcast	2	Moderately exposed	10.5	30	11	Muddy sand
								-	-
2	22-04-17	11:15	Overcast	2	Moderately exposed	11	31.1	7	Fine sand, no RPD, shells
								7	Fine sand, no RPD, shells
3	22-04-17	9:15	Overcast	2	Moderately exposed	8.2	-	8	Coarse sand, fine sand, clay, no RPD
								-	-
4	22-04-17	10:25	Overcast	2	Moderately exposed	12.4	31.1	7	Fine sand, mud, shelly, RPD 1cm
								7	Fine sand, mud, shelly, RPD 1cm, brittlestar
5	22-04-17	9:40	Overcast	2	Moderately exposed	11.2	29.5	13	Sandy mud, RPD 1 cm
								13	Sandy mud, RPD 1 cm
6	22-04-17	11:20	Overcast	2	Moderately exposed	11.7	30.8	7	Sand, very shelly, no RPD
								-	-
7	22-04-17	9:25	Overcast	2	Moderately exposed	12	27.6	7	Fine sand, RPD 0.5 cm
								7.5	Fine sand, RPD 0.5 cm
8	22-04-17	10:40	Overcast	2	Moderately exposed	12.5	30.6	12	Sandy mud, RPD 0.5 cm, worms
								-	-
9	22-04-17	11:35	Overcast	2	Moderately exposed	12.5	31.4	7	Sand, no RPD, anemone & razor clam
								-	-
10	22-04-17	12:20	Overcast	2	Moderately exposed	8.1	31.4	7	Sand, very shelly, no RPD, Lanice casts
								-	-
11	22-04-17	8:40	Overcast	0	Sheltered	3.8	1.3	13	Mud, highly anoxic, RPD 0 cm, fungus, leaves
								-	-
12	22-04-17	8:30	Overcast	0	Sheltered	1.9	1.3	8	Leaf litter, H_2S0_4
								6	Leaf litter, H_2S0_4
13	22-04-17	8:10	Overcast	0	Sheltered	1	1.1	5	Gravel, pebbles, poorly sorted, no RPD
								8	Gravel, pebbles, poorly sorted, no RPD

Table A5: Results of sediment analysis of samples taken on 22/04/2017

Station	% LOI	% ret on 2mm	% ret on 1mm	% ret on 0.5mm	% ret on 0.25mm	% ret on 0.125mm	% ret on 0.063mm	% <0.063mm	Textural Group
		Very Fine Gravel	Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Silt	(Gradistat)
1	2.38	0.2	2.8	2.2	13.6	33.2	6.3	41.6	Slightly Gravelly Muddy Sand
2	0.15	0.3	0.7	2.5	45.2	50.2	0.8	0.4	Slightly Gravelly Sand
3	0.94	9	8.8	5.9	6.4	32.5	1.8	35.6	Gravelly Muddy Sand
4	1.80	1.1	0.8	1	28.3	47.4	4.1	17.3	Slightly Gravelly Muddy Sand
5	3.13	1.6	2.5	3.7	11.8	21	6.8	52.6	Slightly Gravelly Sandy Mud
6	0.73	18.5	8.9	9.7	14.6	35.2	3.6	9.6	Gravelly Muddy Sand
7	1.12	1.6	2.1	2.1	13.2	50.8	4.7	25.6	Slightly Gravelly Muddy Sand
8	2.67	0.6	1.1	1.9	21.3	26.5	7.2	41.4	Slightly Gravelly Muddy Sand
9	0.36	0.1	0.5	1	56.6	41.8	0	0	Slightly Gravelly Sand
10	0.59	2.7	7.1	11.8	57.9	18.5	0.1	1.9	Slightly Gravelly Sand
11	13.54	0	0	0	0	0	3	97	Mud
12	78.04	0	0	0	0	0	0	0	N/A
13	0.56	72.1	23.3	4.4	0.1	0.1	0	0	Sandy Gravel