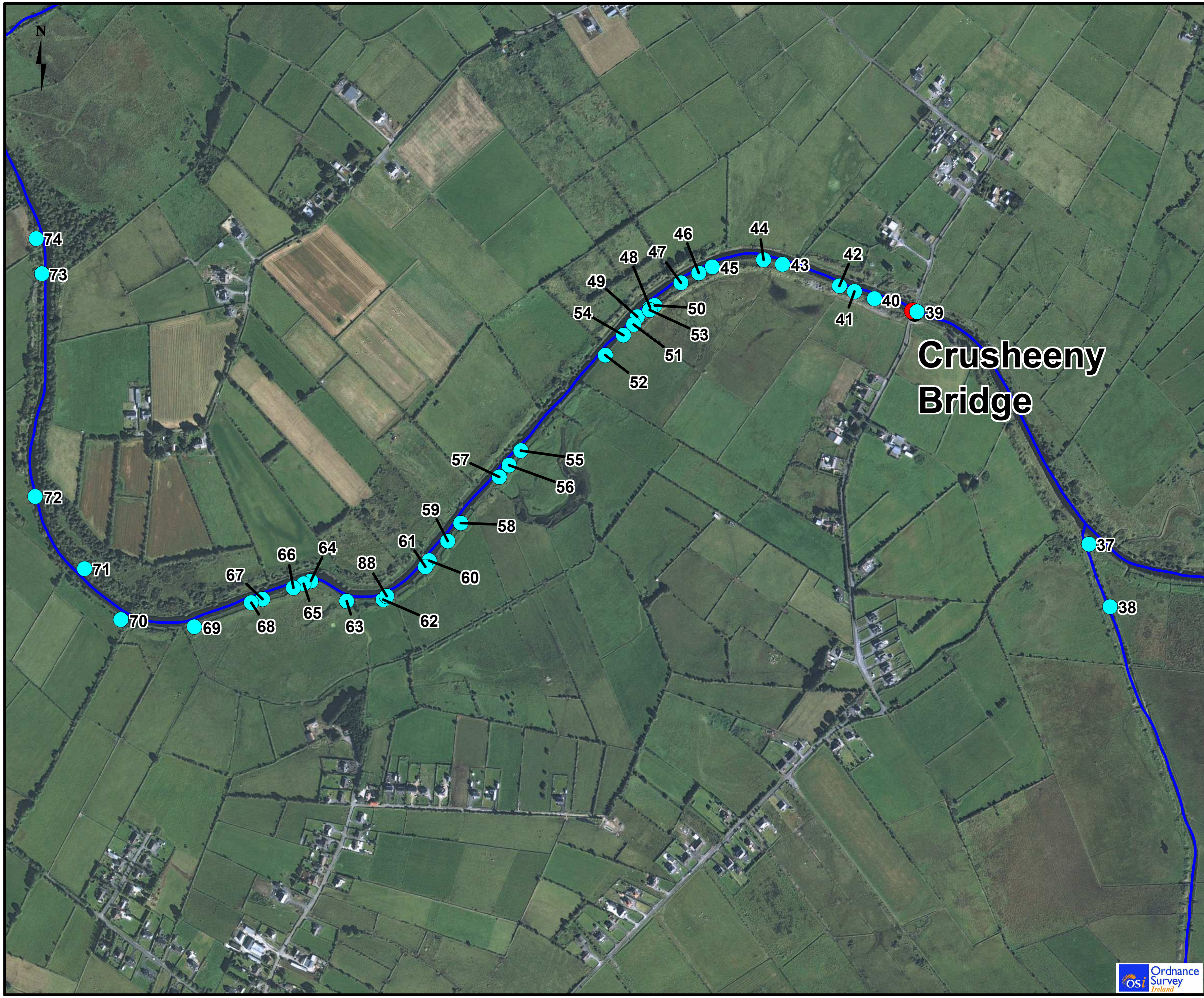
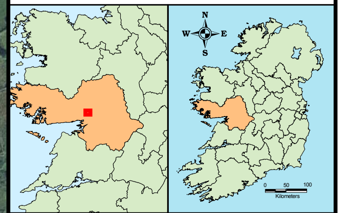


Legend

- Clare River
- Aquatic Points



Client

OPW
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Oifig na nOibreacha Poiblí

Project

Clare River (Claregalway) Flood Relief Scheme

Title

Aquatic points

Figure 11.4

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Date: Nov 2012			

Notes

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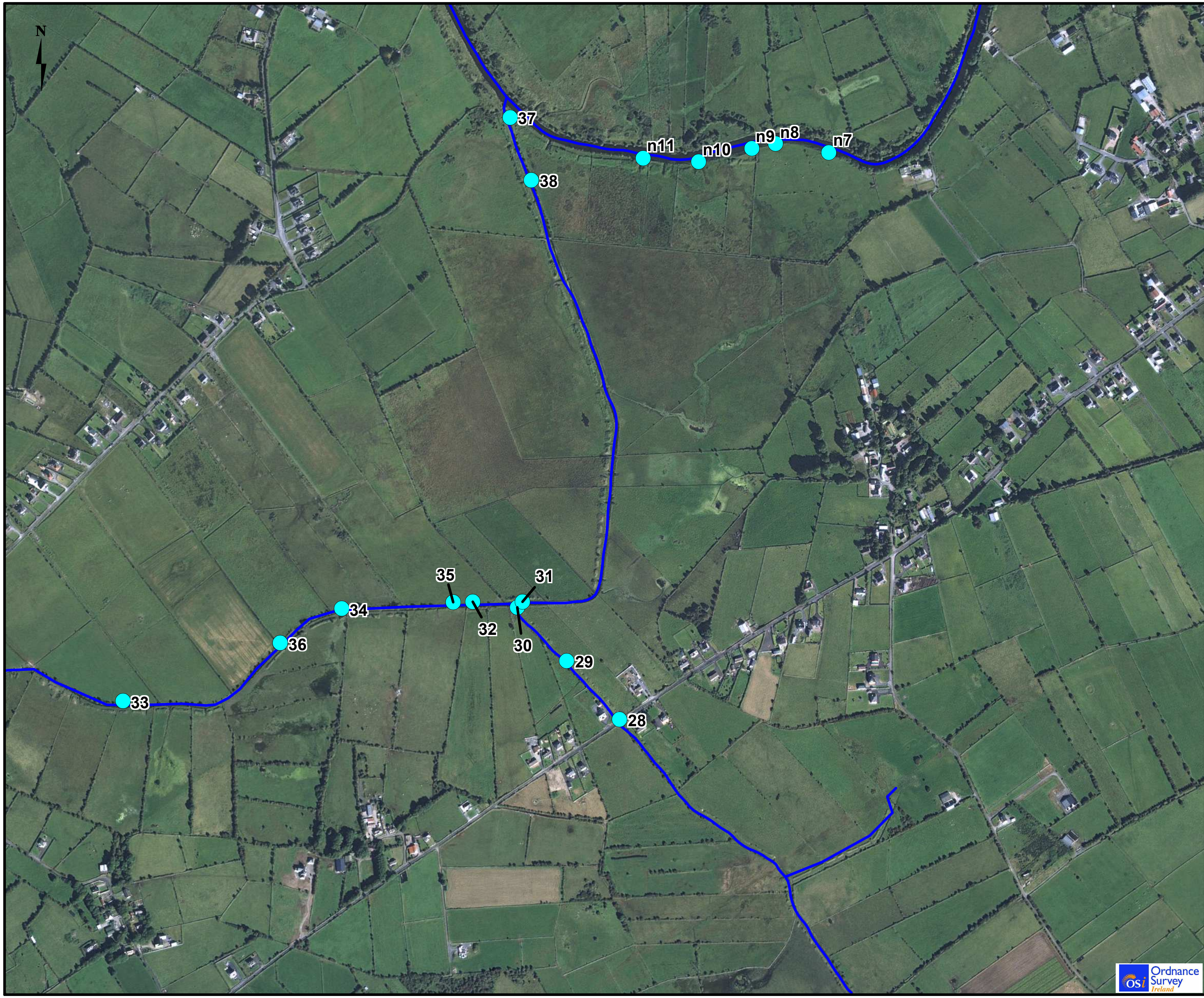
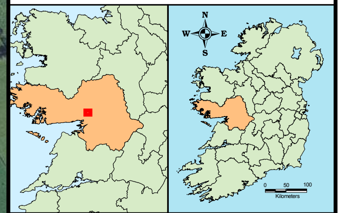


Legend

Clare River

Aquatic Points



Client

OPW
The Office of Public Works

Project

Clare River (Claregalway) Flood Relief Scheme

Title

Aquatic points

Figure **11.5**

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Scale: NTS		**Drawing No.**	**Rev.**
Date: Nov 2012		MI0019	F01

Notes

2. All levels are referred to Ordnance Datum, Malin Head.

In 2006 the EPA Quality Rating System was intercalibrated[1] in order to ascribe EQRs for the benthic invertebrate fauna element in the rivers National Monitoring programme (McGarrigle and Lucey, 2009) under the Water Framework Directive (WFD). When the EQR is derived from the Q-value the site is assigned to one of five ecological status classes ranging from High to Bad (EPA, 2009). The EQR allows comparison of water quality status across the European Union as each member state has an EQR value for 'High'; 'Good' etc., based on the intercalibration of boundaries between water quality categories e.g., 'High-Good'; 'Good–Moderate' (McGarrigle and Lucey, 2009). The WFD requires "good status" and/or "good ecological status" for rivers by 2015, to be achieved through integrated catchment management (EPA, 2006). Sites are classified in the present study by "potential" WFD Status. The use of the term "potential" is a technicality based on the fact that data from outside the formal WFD monitoring programmes are not included in reporting of ecological status at a national level. Formal EU classification of Ecological Status is carried out by public bodies designated by the Regulations (S.I. 272 of 2009), at nominated monitoring sites. All other data would be considered to have "potential" WFD status based on the criteria set out in the Fifth Schedule to the S.I. 272 of 2009. **Table 11.1** shows the relationship between Q-values and WFD status.

Table 11.1 EPA water quality status summary

Biotic Index	EQR[2]	EPA Quality Status	Water Quality	WFD[3] Status
Q5	1.0	Unpolluted	Good	High
Q4-5	0.9	Unpolluted	Fair-to-Good	High
Q4	0.8	Unpolluted	Fair	Good
Q3-4	0.7	Slightly Polluted	Doubtful-to- Fair	Moderate
Q3	0.6	Moderately Polluted	Doubtful	Poor
Q2-3	0.5	Moderately Polluted	Poor-to-Doubtful	Poor
Q2	0.4	Seriously Polluted	Poor	Bad
Q1-2	0.3	Seriously Polluted	Bad-to-Poor	Bad
Q1	0.2	Seriously Polluted	Bad	Bad

11.2.2.4 Crayfish Survey

Presence/absence crayfish surveys were carried out on 11th July and 12th July 2011. These involved a combination of manual searching and/or (limited) overnight trapping with recording of general physical habitat suitability. Further, manual searches were carried out in the Clare River in the reach upstream of the Islandmore confluence on 3rd September, 2012. The surveys were conducted within the recommended period for carrying out surveys for white-clawed crayfish (May to October inclusive). Owing to high water levels in the river at the times of surveying, manual search efforts were quite difficult. Surveys were carried out under NPWS license C106/2011. IFI Biosecurity Field Survey Protocols (IFI, 2010) were adhered to.

The survey was adapted to the type of habitat encountered. Owing to the high water levels, it was only possible to enter and manually search the main channel of the Clare River at limited stretches of bank-side margin. Suitable habitat patches within representative habitat in each watercourse were targeted with timed manual searches. Due to limitations on manual searching, baited traps were also deployed overnight at a few locations on the Clare River and tributaries where habitat was difficult to manually search.

11.2.2.5 Hydromorphology Survey

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[1] In order to achieve consistent implementation of the WFD across the EU, the intercalibration process was undertaken to ensure a common understanding of 'high', 'good', 'moderate', 'poor' and 'bad' status is used in making water body status assessments.

[2] EQR = Environmental Quality Ratio (Observed/Reference)

[3] WFD = Water Framework Directive (EPA, 2006)

River Hydromorphology Assessment Technique (RHAT) was used to categorise the Clare River. The survey stretch was 640m (i.e., 40 x wetted width) beginning at Crusheeny Bridge and working downstream. The tool classifies river morphology in terms of departure from naturalness and is, essentially, a field technique that can show why a water body might be failing to achieve Good Ecological Status (Anon., 2009). It assigns a morphological classification related to that of the WFD – high, good, moderate, poor and bad. Eight criteria were scored at each site: (1) channel morphology and flow types; (2) channel vegetation; (3) substrate diversity and embeddedness; (4) channel flow status; (5) bank and bank top stability; (6) bank and bank top vegetation; (7) riparian land use, and (8) floodplain connectivity.

11.2.3 Valuation of Ecological Resources

Values were assigned to the receiving watercourses on the basis of their known (or perceived) rarity, status and distribution. This involved, in as much as possible, consideration of contextual information for the resource at a geographic level (NRA, 2009). It was also appropriate to take account of considerations of social value (access and amenity) with regard to the Clare River fishery, as far as this relates to ecology.

Observations and biological sample results were assessed in the context of national trends, guidelines and standards and EU (WFD) standards as appropriate. In the absence of any standards or guidelines, scientific literature was consulted for direction. **Appendix 11.1** shows the Ecological valuation of Aquatic Resources table (adapted from NRA, 2009), which details criteria used to classify sites in these assessments.

11.2.4 Impact Assessment and Levels of Significance

Given that all the relevant watercourses are either part of, or in close proximity to the Lough Corrib cSAC, all sites were included for detailed assessment. Each of the Proposed Measures have the potential to impact on the cSAC, so whilst the intrinsic value of some of the tributary and drainage network habitats may be low, any potential effects in terms of impacts to the cSAC are given consideration. This concurs with most recent NRA Guidelines which state: "*Whilst the EcIA process should focus only on likely significant impacts, any effects on a European site may need to be the subject of further investigations and actions*"(p.15, NRA, 2009).

All direct, indirect and cumulative impacts that could arise from the Proposed Measures were assessed. Assessments were carried out in line with International and National Guidelines for EcIA[4] such as IEEM (2006) and NRA (2009). The magnitude, extent, timing and duration of potential impacts have been considered as well as their likelihood of occurring using the following scale (IEEM, 2006):

- Certain/near-Certain: probability estimated at 95% chance or higher;
- Probable: probability estimated above 50% but below 95%;
- Unlikely: probability estimated above 5% but less than 50%, or
- Extremely Unlikely: probability estimated at less than 5%.

Special consideration was given to the prediction of how proposed measures may affect the *integrity* of the cSAC and the *conservation status* of Annex I habitats and Annex II species. Overall, impact types and levels of significance were assigned according to the terminology of EPA (2002).

Fisheries enhancement measures proposed under OPW's Environmental River Enhancement Programme (EREP) have been described and assessed in conjunction with the broad measures proposed as part of the Scheme.

[4] EcIA = Ecological Impact Assessment

11.2.5 Timing of Aquatic Surveys

Ecological assessment and sampling was carried out on 11th July and 12th July 2011 and on 3rd September, 2012, at selected sites on watercourses indicated to be subject to measures in relation to the scheme.

11.3 EXISTING ENVIRONMENT

11.3.1 Overview

The aquatic study area encompassed the lower reaches of the Clare River from a location 0.9 km upstream from Crusheeny Bridge to Lough Corrib, including a number of tributaries and arterial drainage channels that confluence with the Clare within that reach. The focus, in terms of field studies, was on channels that may be affected as a result of measures proposed under the Scheme. For reporting purposes, the aquatic element of the study area has been separated into three components:

- Clare River – main channel from 1.3km upstream of Crusheeny to the confluence with Lough Corrib.
- Tributaries and major arterial drains of the Clare River - that confluence with the main channel within the study reach.
- Lough Corrib Lower – area downstream of confluence of Clare River with Lough Corrib.

Section 11.3.3 describes the aquatic habitat characteristics of the Clare River. **Section 11.3.4** describes the aquatic habitat of significant tributaries and arterial drainage channels that confluence with the Clare River within the study area. **Section 11.3.5** describes, by way of desk top study, the receiving environment at Lough Corrib. **Photographs (P)** are referenced within the text and are shown in **Appendix 11.2** to this report. **Table 11.2** outlines the proposed measures and indicates the watercourses that that were surveyed in relation to the scheme. The watercourses, with the names by which they are referred to hereafter in this chapter, are shown on **Figure 11.6.**

It is important to note that the present day course of the Clare River and its drainage network are the result of two major periods of historical drainage: (1) diversion and deepening in 1765 of the Clare River up to Lackagh townland in an attempt to make the river navigable to Tuam, and; (2) early nineteenth century arterial drainage schemes that included draining the large turlough at Turloughmore, which established the lower Clare River and hence a continuous surface water conduit from Ballyhaunis through to Lough Corrib (see **Chapter 5**). The Clare is the largest sub-catchment of Lough Corrib, occupying one third of the Lough Corrib catchment and discharging to Lough Corrib lower (Krause and King, 1994). Prior to artificial drainage, streams went underground at a number of turloughs in the catchment. The upper Clare River and its tributaries (including Abbert, Grange, Dalgan and Sinking Rivers) originally sank at Turloughmore. The lower Clare River appears to have originally risen in Kiniska townland, near to the present day Claregalway village (GSI, 2004). The Clare River is the principle drainage channel in the study area and, owing to very flat terrain locally, an extensive arterial drainage network connects to the main channel. According to Coxon and Drew (1983, cited GSI, 2004) much of the current tributary stream network is a storm runoff system, inactive during summer months.

The catchment, including the study area, is underlain by highly karstified, Burren limestone, which is generally pure with low clay content, often present at or close to the ground surface and with only a thin cover of free draining sandy till (see **Chapter 9** for further details). A number of karst features occur within the study area, notably, turloughs in Caherlea, Lisheenavalla and Lakeview; and an estevelle in the vicinity of Crusheeny Bridge (see **Chapter 9** for further details). There is a close

interaction between surface water and groundwater in karstified aquifers, which can be reflected by closely linked water quality since any contamination of surface water is rapidly transported into the groundwater system, and vice versa (GSI, 2004). Surface waters on the Clare River within the study area are currently classified 'Good' WFD status, whilst the groundwater body (GWB) is classified 'Poor'[5]. The hydromorphological character of the Clare River within the study area has meant that the main channel does not, generally, accumulate silt (Flood Studies Reports, 2010; OPW *pers. comm.*). As such, ongoing main channel maintenance and/or drainage has, to date, been unnecessary (OPW, *pers. comm.*). Tributary streams and drains are subject to periodic maintenance to remove in-stream vegetation and silt accumulation.

Table 11.2 Watercourses Affected by Measures Proposed under the Scheme

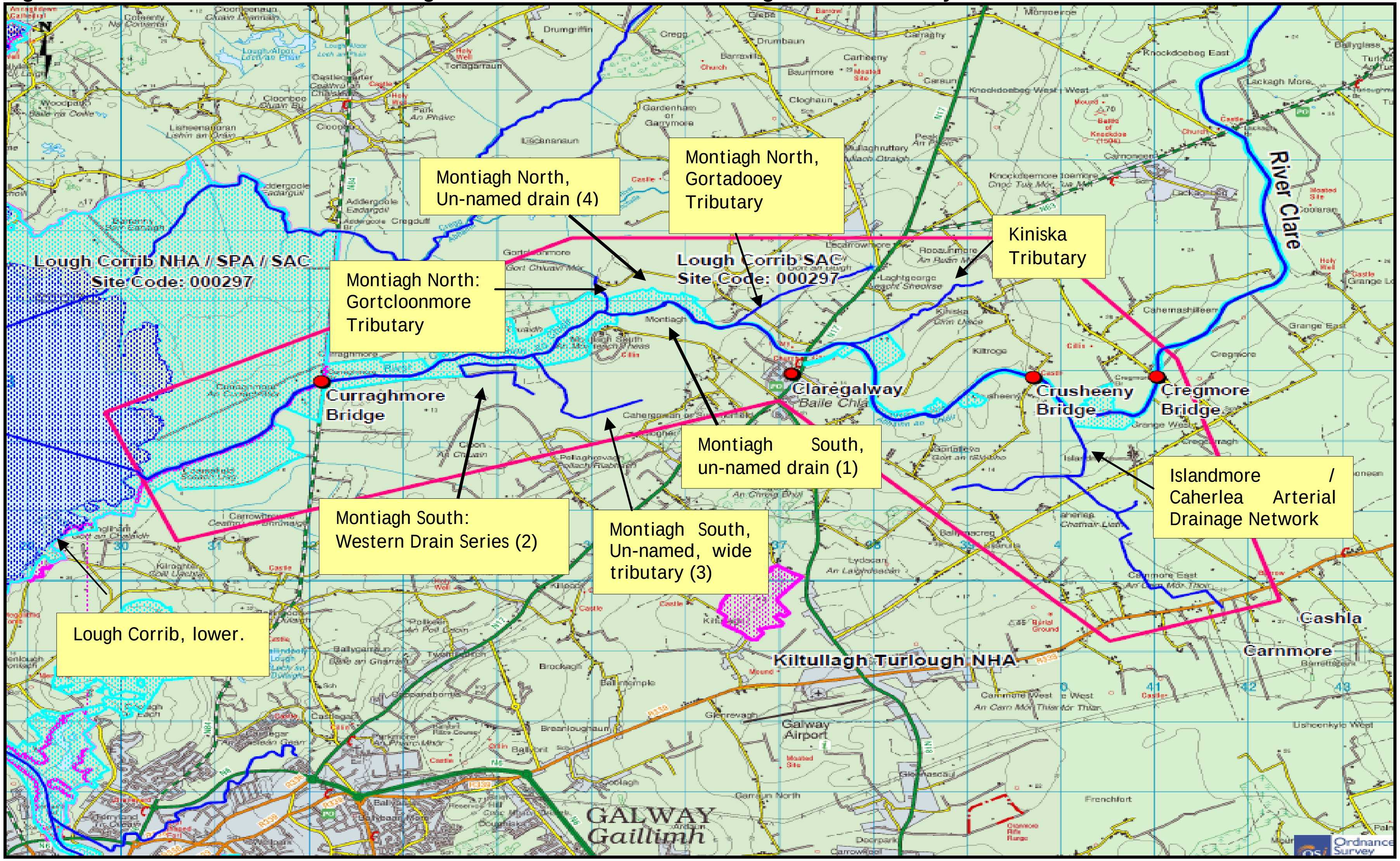
Location		Proposed Measures	Watercourse directly affected
Lough Corrib to Curraghmore Bridge		– No channel alteration measures proposed. See Item 10 for Channel Maintenance requirements.	
Montiagh South	**2a**	– Raise approx. 1km of road	**Un-named drain (1)**
	2b	– Upsize existing road culvert	**Un-named drain (1)**
	2c	– Clean Drains	**Western Drain Series (2)** **Un- named wide tributary (3)**
Montiagh North	**3a**	– Raise approx. 0. 460 km of road	**Gortadooey tributary**
	3b	– Raise approx. 0. 785 km of road	**Gortcloonmore tributary** **And Un-named drain (4)**
Claregalway Village	**4a**	– Install Flood eye at Claregalway Bridge (complete)	**Clare River**
	4b	– Regrade Clare River channel upstream and under Claregalway bridge	**Clare River**
	4c	– Address gap in wall at An Mhainistir housing estate	**Clare River**
	4d	– Provide local embankment at old Nine Arches bridge & infill old river channel	**Clare River**
Kiniska	**5a**	– Increase capacity of culverts on OPW C3/5 stream	**Kiniska tributary**
	5b	– Clean OPW stream C3/5	**Kiniska tributary**
Lakeview	**6a**	– Provide surface water outlet through fields to upstream of Claregalway Bridge (open channel and piped culvert)	**Clare River**
Gortatleva		– No additional measures proposed (Measures for Area 4 apply)	
Caherlea/ Lisheenavalla	**8a**	– Replace Crusheeny Bridge (complete)	**Clare River**
	8b	– Channel widening from 1.3km upstream of Crusheeny Bridge to immediately downstream of Crusheeny Bridge to form a two-stage channel	**Clare River + Islandmore /Caherlea arterial drainage network (5)**
	8c	– Cleaning and regrading of Islandmore OPW C3/7 and F.799/1 arterial drains	**Islandmore /Caherlea arterial drainage network (5)**

5 http://maps.epa.ie/InternetMapViewer/mapviewer.aspx

Location		Proposed Measures	Watercourse directly affected
	8d	– Raise local road in Caherlea/Lisheenavalla (future measure)	**Islandmore /Caherlea arterial drainage network (5)**
	8e	• Construction of an embankment along the southern bank of the Clare River from 1.3km upstream of Crusheeny Bridge to the Islandmore Drain and the installation of a Non-return valve on the discharge from the Islandmore Drain	**Clare River + Islandmore /Caherlea arterial drainage network (5)**
Carnmore/Cashla		• Drainage of floodwater from the affected area via a new drainage pipeline/open drain to a local surface water stream at Islandmore.	**Islandmore /Caherlea arterial drainage network (5)**
Channel Maintenance		• Selective Channel Maintenance along the Clare River from Lough Corrib to Cregmore Bridge incl. localised rock removal downstream of Curraghmore Bridge.	**Clare River**

In addition to the flood relief scheme, a footbridge across the Clare River is proposed at Claregalway.

Figure 11.6 Location and names of bridges and tributaries / arterial drainage channels surveyed in relation to the Scheme



11.3.2 Aquatic Qualifying Interests of the Lough Corrib cSAC

The Clare River is included in the Lough Corrib cSAC (000297). **Tables 11.3** and **11.4** show the aquatic qualifying interests for the Lough Corrib cSAC.

Table 11.3 Qualifying aquatic Annex II Species of the Lough Corrib cSAC listed on Council Directive 92/43/EEC (the Habitats Directive)

Species	Species Name
Fishes listed on Annex II of the Habitats Directive	*Salmo salar* (Atlantic salmon) *Petromyzon marinus* (L.) (Sea Lamprey) *Lampetra planeri* (Bloch). (Brook lamprey)
Invertebrates listed on Annex II of the Habitats Directive	*Austropotamobius pallipes* (White clawed crayfish) *Margaritifera margaritifera* (Freshwater Pearl Mussel)
Plants listed on Annex I of the Habitats Directive	*Najas flexilis* (Slender Naiad)

Table 11.4 Qualifying aquatic Annex I habitats of Lough Corrib cSAC

Qualifying Habitat	Code	% Cover (approx.)	Representivity
Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation	3206	1	C
Oligotrophic waters containing very few minerals of sandy plains (*Littorelletalia uniflorae*)	3110	3	A
Hard oligo mesotrophic waters with benthic vegetation of *Chara* spp.	3140	85%	A

11.3.3 Existing Environment of the Clare River

11.3.3.1 Clare River Habitat Descriptions

There are, broadly, four different habitat types within the Clare River study stretch. **Table 11.5** shows the aquatic habitat types that were recorded. Two of these habitat types: glide (Type 1) and riffle / run (Type 2) clearly dominate the study reach. Generally, from between a point approximately 100m upstream of the Islandmore drain confluence to the Curraghmore Bridge the Clare River is characterised by long meandering, glides with submerged and marginal emergent macrophyte stands (Type 1). There were very limited pockets of riffle / run and turbulent water (Types 2 and 3) observed along this stretch, but glide predominated. Approximately 100m upstream of the Islandmore confluence, in the direction of Cregmore Bridge, the bed gradient was a little steeper and the river was dominated by riffle / run type flow over more coarse substrates (Type 2). Historical drainage was in evidence, along the entire study stretch, owing to an over-widened, deepened and uniform channel width, combined with vertical banks backed by high spoil heaps generally running parallel to the channel. The base of the banks comprised fractured bedrock in places (P1) and subsoil with limestone till elsewhere (P2).

Table 11.5 Clare River Habitat Type Summary

Habitat type	Description
1	Deep, slow flowing glide with marginal emergents
2	Moderate to swifter, shallow flow of a riffle /run type over various combinations of small boulder, cobble, gravel and sand.
3	Deeper pools with submerged, marginal, macrophyte 'beds' (primarily pondweeds).
4	Turbulent flow associated with coarse substrate at the natural weir below Claregalway Bridge, and downstream of Crusheeny Bridge.

The banks were largely open and grassed with a variety of typical plant species. The riparian zone of the left bank was heavily overgrown by trees for a 1km stretch (Points 71 and 75) upstream of the Kiniska tributary confluence. The riparian zone of the right bank had a greater linear length of tree cover, notably toward the Claregalway end of the reach. Tree cover was generally lacking elsewhere. In-stream vegetation was most prominent at the margins of the channel where Common club rush (*Schoenoplectus lacustris*) (P3) was the dominant species, with un-branched Bur-reed (*Sparganium erectum*) also prominent in places, along with occasional clumps of Great Yellow-cress (*Rorippa amphibian*) (P4). Reed canary grass (*Phalaris arundinacea*) (P5) also dominated in some stretches. These tall herb species formed long continuous or patchy marginal stands of varying densities at either side of the channel. They were recorded only once in the mid channel area in a shallower stretch about 650m downstream of Crusheeny Bridge where gravel and mixed gravel and cobble substrates were observed near Point 49 (P6). Two species of pondweed *Potamogeton* x *nitens* and *Potamogeton gramineus* (P7) formed marginal submerged macrophyte 'beds' that were well represented in places. These tended to be located in deeper slacker marginal water where Club rush and other emergents were absent. They were noted from about Point 48 to at least Point 63.

River water levels were elevated but not flooded at the times of surveying owing to heavy rainfall in the previous week. The main flow type was a moderately deep glide throughout (P10), interrupted in places by up-wellings above submerged boulders. Just north of Gortatleva, a 'kink' in the channel contained deep pools (P11, near Point 62) which have been identified by the IFI as popular angling locations. An estevelle[6] on the right bank downstream of Crusheeny Bridge discharges to the Clare (Point 40) and was flowing strongly at the time of the survey giving rise to localised turbulence in the channel (P8). Turbulent flow was also noted at a further two locations, i.e., immediately below Crusheeny Bridge, and downstream of Claregalway Bridge. At the former, submerged cobbles and boulders had created turbulence and upwelling, while at the latter a mixture of cobble, boulder and bedrock formed a natural weir (P9; Point 81) and generated turbulence, including standing waves. Swifter, shallower water flowed over gravel beds in two places: about 700m downstream of Crusheeny Bridge (centred on Point 49, P14), and a stretch just upstream of Claregalway Bridge, where cobble substrates were interspersed with gravel and sand patches (Point 79). This shallower water continues as far as the natural weir just below the bridge at Point 81 where the water cascades forming short standing waves in elevated flows and turbulence diminishing again opposite the old priory (Pt 83) after which the more typical glide habitat

[6] Estevelle = depression spring that discharges when the groundwater table is high, but can become a surface water sink when the water table is low.

resumes and continues downstream. Upstream of Crusheeny Bridge to a point about 100m upstream of the Islandmore Drain the river generally forms one long glide with steep banks and sparse marginal emergents (P10, 11 and 12). Upstream of there, however, aquatic habitat was significantly different comprised in the main of shallower water flowing over cobble, gravel and sand, forming a long riffle/run up as far as the proposed extent of works an on up as least as far as Cregmore Bridge.

In general, a riparian strip of semi-mature and mature broadleaved trees line the true right bank of the river along the whole length of the Clare River within the study area, whilst the true left bank is more open with a set bank embankment of previously dredged spoil.

11.3.3.2 Clare River Hydromorphology

A RHAT score of 0.34, equating to 'Poor' WFD classification was assigned to the Clare River in a representative glide stretch (640m in length) downstream from Crusheeny Bridge. The site scored poorly for channel form and flow type, substrate condition, channel vegetation, bank structure and floodplain connectivity (highly embanked). The channel was over deep and over wide, resulting in limited flow diversity, uniform bank slope, quite low substrate diversity and disconnection from the floodplain. A slightly better RHAT score of 0.39 was assigned to a representative riffle / run stretch surveyed upstream of the Islandmore drain confluence. Whilst still in the 'Poor' WFD category, this stretch scored better for substrate condition and flow type.

11.3.3.3 Clare River Water Quality

Two suitable sites were sampled for benthic macroinvertebrates on 12th July 2011. Site 1 was located at a shallower area of gravels in the mid-channel of the Clare River, approximately 650m downstream of Crusheeny Bridge. Site 2 was located a distance of approximately 40m downstream of Claregalway Bridge in an area of shallower, turbulent flow over a mix of boulder/cobble/gravel and (to a lesser extent) bedrock substrates with a moderately high coverage of bryophytes, predominantly *Cinclidotis fontinaloides*.

Appendix 11.3 contains the species lists and biotic water quality index calculations. The results were very similar at both locations. Both sites merited a Q4, or 'unpolluted' quality rating, with an EQR of 0.8 equating to potential 'Good' WFD status. Total BMWP scores were high (133/136) reflecting the fact that species diversity was quite high, with 22 scoring taxa recorded at each site. ASPT values of 6 and 6.2 for Sites 1 and 2, respectively, were indicative of 'good water quality'. These results concur with the most recent EPA monitoring data from this stretch of the Clare River as summarised in **Table 11.6.**

Table 11.6 Summary of EPA biological water quality monitoring on the Clare River at Cregmore Bridge (upstream) and Claregalway Bridge (downstream) (Source: EPA ENVision online map viewer)

EPA Station	1971	1977	1980	1985	1989	1993	1996	2000	2003	2006	2009
Cregmore Bridge 30C011100	-	-	4	4	4	3-4	3-4	3	4	4	4
Claregalway Bridge 30C011200	4	5		3-4	4	3	3	3-4	3-4	4	-
Curraghmore Bridge 30C011300			4	4	4	4	4	4	4	4-5	4-5

Table 11.7 shows EPA water chemistry quality monitoring at 3 locations on the Clare River, i.e., Cregmore Bridge (c. 1km upstream of proposed works), Claregalway Bridge and Curraghmore Bridge (near the confluence with L. Corrib). The data provides an overview of historical water quality trends.

Data suggests a pattern of poorer water quality for a period of about 10 years on this part of the Clare River from 1993, with an improvement evident since 2006. Recent monitoring shows that most of the stretch is presently 'unpolluted', equating to 'Good' WFD status, with the most downstream site (Curraghmore Br.) presently rated as 'High' WFD Status.

Table 11.7 Summary of EPA water chemistry monitoring on the Clare River at Claregalway Bridge (St,. 1200) just downstream of the proposed works and at Curraghmore Bridge (Stn 1300) just upstream of Lough Corrib) (Source: EPA 2007-2009 sampling campaign)

	Number of samples	Min	Mean	Max	Stdev
Claregalway Bridge					
Alkalinity-total (mg/l CaCO3)	16	196.0	273.4	344.0	40.7
Conductivity @25°C (µS/cm)	16	407.0	597.2	681.0	73.5
pH	16	7.5	8.0	8.3	0.2
Temperature °C	16	3.5	10.8	17.0	4.1
True Colour (Hazen)	16	23	44	123	24
ortho-Phosphate (mg/l P)	16	0.006	0.028	0.048	0.015
Total Oxidised Nitrogen (mg/l N)	16	0.600	1.531	2.500	0.474
Ammonia-Total (mg/l N)	16	0.015	0.022	0.060	0.016
BOD - 5 days (Total) (mg/l O_2)	16	0.5	0.6	2.0	0.4
Dissolved Oxygen (% Saturation)	16	89.0	100.4	129.0	10.2
Curraghmore Bridge					
Alkalinity-total (mg/l CaCO3)	43	75.0	259.8	340.0	48.7
Conductivity @25°C (µS/cm)	39	421.0	578.9	674.0	64.4
pH	45	7.3	7.8	8.3	0.3
Temperature °C	45	3.5	11.3	18.7	3.9
True Colour (Hazen)	45	19	58	154	32
ortho-Phosphate (mg/l P)	43	0.006	0.031	0.072	0.015
Total Oxidised Nitrogen (mg/l N)	45	0.900	1.474	2.720	0.451
Ammonia-Total (mg/l N)	45	0.003	0.022	0.090	0.018
BOD - 5 days (Total) (mg/l O_2)	43	0.5	0.6	2.3	0.4
Dissolved Oxygen (% Saturation)	44	44.0	92.7	122.0	13.1

The data in **Table 11.7** confirms the alkaline, hard water nature of the Clare River in terms of its conservative chemistry as well as relatively its low pollution levels as revealed by the low mean BOD, total ammonia and total oxidized nitrogen concentrations. Mean ortho-phosphate concentration is also quite low and compatible with a Q-rating of Q4 at both stations (EPA, 2001). Note that more recent data for Curraghmore Bridge for 2011 has mean ortho-phosphate levels at 0.021 ml/l, P, for nine sample runs, i.e. compatible with a Q-rating of Q4-5 (EPA, 2001).

11.3.3.4 Clare River Fisheries

An electrofishing survey was not undertaken as part of this study. The most recent published data for the study reach is that undertaken in 2010 by IFI as part of the WFD fisheries surveys as shown in **Table 11.8**.

Table 11.8 Fish species and numbers caught on the Clare River near Crusheeny Bridge (IFI, 2010)

Species	Salmon	Brown Trout	Eel	Perch	Pike	Stickleback	Lamprey	Roach
No.	104	24	1	42	2	25	1	44
Density (nos./m2)	0.03044	0.00702	0.00029	0.01229	0.00059	0.00732	0.00029	0.01288

The survey was undertaken at Kiltroge (Crusheeny Bridge) on 24th August, 2010 by 2 boat-based electrofishing units. The total area fished was 3416m^2 (234m of channel, average width 14.6m, average depth 0.53m). The overall salmon density was the 2nd highest of the seven river sites in the Western Basin District Region fished using boat based units during 2010 in which salmon were recorded. Of the 104 salmon recorded at Crusheeny (Kiltroge) 39% were 0+ (i.e. young-of-the-year), while 61% were 1+ salmon (fish in their 2nd year). The assemblage at the site was quite diverse, which probably reflects the size of the channel and the diversity of its microhabitats for fish as well as the connection to the greater Corrib catchment. The highest fish densities were of salmon (104 fish). What is notable about these salmon is that the proportion of 0+ fish is the same as in the much shallower (12cm) tributary, the Abbert River, which also had 39% 0+ fish. According to Dr. Martin O'Grady, Inland Fisheries Ireland, the 1+ salmon parr are likely to be moving down from the main spawning tributaries (Abbert and Grange River) in their second year of growth. However, the relatively high proportion of 0+ fish may indicate that there is some spawning in the main channel of the Clare (author's suggestion) In general, the main channel of the Clare is not currently utilised by salmon for spawning although it is recognised that some pockets of spawning may occur (M. O'Grady, IFI, *pers comm*.). Salmon redds have, in fact, been noted on occasion within the study area both in the Crusheeny Bridge vicinity and about 1km downstream of Claregalway Bridge where beds of suitable spawning gravels exist (Sean Francis, IFI Galway, *pers comm*.). Generally, however, water depth at the site precludes a systematic annual redd count like that which takes place elsewhere in the system. **Table 11.9** presents the summarised salmon redd count data for the 5 spawning seasons 2006/2007 to 2010/2011, which clearly shows the importance of the system for spawning salmon, especially the main channel upstream of Milltown (Dalgan River) and the Abbert and Grange tributaries.

Table 11.9 Summarised salmon redd count data for the spawning seasons 2006/7 to 2010/11 (data courtesy Mr Sean Francis, IFI Galway)

River Name	Mean (Std Dev)	Max-Min
Abbert	486 (126)	(620-372)
Grange	331 (105)	(442-234)
Sinking	171 (94)	(276-71)
Dalgan	301 (169)	(479-119)
Tonemoyle	35 (8)	(45-27)
Knocknagur	33 (7)	(44-27)
Dawros	39 (15)	(57-24)
Nanny	18 (23)	(59-5)
Bluepig	25 (19)	(45-5)
Illaun	10 (5)	(15-5)
Total Count	1441 (489)	(1814-906)

Deeper, slow flowing stretches and pooling areas (P13) on river bends would be more likely to hold older salmonids i.e. mainly 2+ or older trout as well as pike and coarse species such as roach and perch. Shallower, more turbulent areas would be expected to hold 1+ trout and perhaps 0+ (young-of-the-year) salmon as well, if spawned locally. Several 0+ salmonids were observed during the current survey over

shallow gravel beds below the bend at Point 49 (P14), lending further support to the possibility that salmon may have spawned locally in the 2010/2011 season. Salmon and trout spawning occurs in the main, further upstream, primarily in the Abbert and Grange tributaries and on the main channel upstream of Milltown where the Clare main channel divides into the Dalgan and Sinking Rivers.

The stretch of the Clare River downstream of Cregmore Bridge to about halfway to Crusheeny Bridge, would also seem to be an ideal area for 0+ and 1+ salmon given its higher flow velocities and generally coarse substrate dominated by riffle/run and run/glide type hapitats (Section 99-93/94, **Figure 6.12c)**. Costello's Pool, also in this stretch, is a noted angling spot, which probably acts as a holding area for older fish.

There is, currently, no firm evidence that Sea Lamprey, *Petromyzon marinus,* is present in Lough Corrib and its tributaries, including the Clare River. Sea lampreys seem to be confined to below the Galway Regulating Weir and whilst there are historical records of sea lampreys in some of the tributaries of Lough Corrib, these pre-date the construction of the existing weir (O'Connor, 2007). The only species definitively recorded in the Clare is the Brook lamprey (*Lampetra planeri*), which were found in a recent survey at only a few sites on the lower channel of the Clare River, in the vicinity of Claregalway. There are records of lamprey (records of undifferentiated river/brook lamprey (*Lampetra* spp.) on the Clare just downstream of Claregalway Bridge in an area that was used for cattle watering (O'Connor 2007) and the IFI found one lamprey (not identified) in their 2010 survey at Crusheeny Bridge. Lamprey habitat is generally considered sub-optimal within the Corrib system (O'Connor, 2007).

According to local coarse fish anglers, roach, perch and pike occur in suitable habitat throughout the main channel of the Clare from Lough Corrib to above Tuam on the main channel. Bream occur occasionally in the lower reaches around Curraghmore Bridge.

In addition to the remains of salmonid species, Breathnach and Fairley (1993) found the remains of perch, pike, roach, stoneloach *Noemacheilus barbatulus* (L.), stickleback *Gasterosteus aculeatus* L., *Pungitius pungitius* (L.), and minnow *Phoxinus phoxinus* (L.) in otter spraint collected along the Clare river within the study area in 1991. Eel, *Anguilla anguilla* (L.), also a component of otter diet, they suggested was common mainly towards the mouth of the Clare River. Bream, *Abramis brama* (L.) was reported by Breatnach and Fairley (1993) as being known to occur very locally and in small numbers.

11.3.3.5 Clare River Angling

The Clare River is a popular angling river for both salmon and brown trout with the main activity concentrated in three places: (1) the souther bank upstream and downstream of Claregalway Bridge, (2) around the deep holding pools north of Gortatleva (Point 62 and 63) and (3) the northern and southern bank downstream of Crusheeny Bridge and the northern bank upstream. Costello's Pool on the first main bend on the river downstream of Cregmore Bridge is also a popular spot for game fish anglers (Mr. Pat Gorman, IFI, *pers. comm*). Anglers avoid stretches with heavy marginal aquatic weed growth and/or banks overgrown by trees. Thus, the main angling spots are well established but more dedicated anglers will walk farther to reach less accessible spots. The river is especially popular during the salmon season (February 1st to September 30th) after heavy rain when it is fished on rising and falling floods. It would appear as if the Clare is not a stronghold of coarse angling in the same way that it is for game fishing, with for example the lakes around Moycullen offering much better coarse angling and hence more popular venues. Nevertheless the Clare is exploited annually by coarse fish anglers with the main activity in the lower reaches, around Curraghmore Bridge on the Headford Road and between it and Claregalway. However, coarse anglers fish at points throughout the Clare and to illustrate the fact, a 24lb pike was landed just upstream of Tuam in 2011 and large roach are not uncommon within the system also (Jason Leavy, *pers comm*.). As with all anglers, access is important, particularly for coarse anglers who tend to carry a considerable amount of gear.

11.3.3.6 Clare River White Clawed Crayfish

No crayfish were captured during surveys conducted in July, 2011 or August, 2012, on the Clare River within the defined study area. **Tables 1** and **2** of **Appendix 11.4** show details of survey locations, crayfish habitat appraisals and survey methods employed. Survey methods were adapted to be appropriate to habitats encountered, based on Peay (2003) and Reynolds *et al.* (2010). Crayfish habitat was assessed according to criteria listed in **Table 3** of **Appendix 11.4**. Though water was high during both survey periods it was clear that crayfish habitat in the lower Clare was classified as 'sub-optimal' in the main, however, crayfish can often be found in habitat that is not considered to be ideal for the species (King *et al*., 2008), and there were certainly patches of potentially good crayfish habitat.

Current water quality (Q4) in the lower Clare would be considered favourable for crayfish (Demers *et al.,* 2005; Reynolds, 2007), however, a period of poorer water quality in the past (EPA monitoring on lower Clare River = Q3 in 1993/1996/2000; **Section 11.3.3.3**) may have affected their current distribution. The recent NPWS conservation assessment for white clawed crayfish showed that only 10% of crayfish records were from sites of Q3 or lower (Reynolds, 2007).

It is considered that poor hydromophology generally limits the availability of optimal crayfish habitat on the lower Clare River between the Islandmore confluence and Lough Corrib. This stretch generally formed a series of long, uniform glides of varying depths and while there were suitable microhabitats available to crayfish of various size-classes (juvenile/adult), these were very limited. The shallower riffle / run reach upstream of the Islandmore confluence represented more optimal crayfish habitat. Overall, the limited diversity of suitable refuges, paucity of in-stream vegetative cover and swift flows were generally such that crayfish may find it hard to forage and find stable refuges within the majority of the mid-channel in the lower reaches of the Clare River. In contrast, long stretches of the river margins possessed un-embedded, small boulders and groups of large cobbles overlying silty gravels, and these areas could provide good refuges for crayfish. Stands of emergent macrophytes in softer substrates at channel margins.may also provide valuable habitat for crayfish, particularly juveniles. Young crayfish have been found to show a particular preference for marginal stands of Reed Canary Grass, *Phalaris arundinacea* (King *et al.,* 2008; Williams, 2009, 2010) which was reasonably common in the river margins along the study reach, though the majority of this was overhanging from the banks and not rooted in the channel, thereby limiting the habitat potential since crayfish would ideally use the submerged root mats and stems of that species. Emergent 'flaggers' (*Sparganium erectum*) are also known to provide shelter for crayfish in lowland rivers (King *et al*., 2008; Williams, 2009; 2010) but these were less common than the extensive stands of emergent Club Rush (*Scheonoplectus lacustris*) along the lower Clare River. During other drainage operations on crayfish channels, the author has observed that *S. lacustris* is less preferable as crayfish habitat compared to either *S. erectum* or *P. arundinacea*. Adult crayfish can be found in the slower flowing areas towards the river margins where they may also burrow, however, suitable stable banks with submerged tree roots with easily forageable areas at their base and were quite rare. Cracks and crevices within submerged rock ledging were present along parts of the river banks (particularly near Crusheeny Bridge) and these offered excellent potential as crayfish refuges. Un-mortared or eroded stonework of bridge abutments and central piers can also provide stable crayfish habitat. At Crusheeny and Claregalway Bridges, however, habitat was generally considered unsuitable for crayfish owing to the canalised nature and swift flows. Surveys targeted the most suitable habitat patches during manual search efforts, but no crayfish of any size class were detected. Results of the current survey, therefore, suggest that white-clawed crayfish either, (1) are not present on this part of the Clare River; or, (2) are present at very low densities that are beyond the level of detection using these standard methods.

An indication of historical crayfish distribution in the lower Clare was provided by Breathnach and Fairley (1993) who studied Otter (*Lutra lutra*) diet by examining percentage occurrence of food categories in spraints. They compared 1991 survey results to a 1981 survey undertaken at the same locations by McFadden and Fairley (1984, cited Breathnach and Fairley, 1993). At Claregalway Bridge crayfish comprised 64.6% of diet in 1981 compared to 27.1% in 1991. A similar decline was recorded at a site near Curraghmore Bridge where crayfish comprised 13.1% of otter spraints in 1981 compared to 2.9% in

1991. Crayfish generally remained a common component of otter diet in the upper catchment during that same period, suggesting that declines recorded in the lower catchment may have been owing to either a reduction in availability of crayfish as prey (population decline), or perhaps a greater abundance of alternative food sources. Of note was that the introduced, cyprinid fish, Roach (*Rutilus rutilus*), which entered the Clare from Lough Corrib, had appeared as a high percentage of component in spraints at both sites on the lower Clare River in 1991, having been absent in 1981. Breathnach and Fairley (1993) also suggest that crayfish density is low in the lower stretches of the Clare River owing to predation by eels, which are known to be common there. Eels have been shown to have an allopatric distribution with regard to crayfish in Sweden (Svardson, 1972, cited Breathnach and Fairley, 1993).

The National Biodiversity Data Centre (NBDC) holds the Irish National Crayfish Database which consists of Central Fisheries Board (now IFI), EPA and Reynolds datasets for White-clawed crayfish. NBDC online maps[7] show there are no reported records found for crayfish within or in close downstream proximity to the study area on the Clare River. Previous records (ranging between 1971 and 2009) are confined to areas well upstream on the Abbert, Grange and Sinking Rivers. Reynolds (2006) has reported crayfish at the mouth of the Clare River, but the year of the record is currently unknown. Reynolds (2007) also noted declines in crayfish populations of drained rivers such as the Clare River in recent years, despite indications that water quality has improved (**Section 11.3.3.3**).

In summary, White-clawed crayfish were not detected during the current surveys, whilst more recent historical data suggests that populations in the lower Clare River may have declined. However, given that water quality is suitable and there are some habitat opportunities, their presence can not be entirely ruled out. If present, crayfish population densities within the study area and on the lower Clare River in general, appear likely to be low.

11.3.3.7 Clare River Annex I Aquatic Flora

One of the qualifying Annex I habitats for the cSAC is No. 3206: *Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation.* Owing to high water levels, it was difficult to accurately assess the extent of this plant community but characteristics of this vegetation type were present. It appeared that the community was a somewhat poor example of the habitat type (Hatton-Ellis and Grieve, 2003), given that the main characteristic species were uncommon along much of the stretch. It is possible that past drainage, which has effectively canalised the stretch, may have prevented a more representative example of the habitat from developing. Characteristic species of 3206 recorded along the stretch included: *Ranunculus* spp., *Oenanthe fluviatilis*, *Potamogeton* spp. and *Callitriche* spp.

11.3.3.8 Clare River Annex II Species

The aquatic qualifying Annex II species for Lough Corrib cSAC, were listed in **Table 11.3**, **Section 11.3.2**. The relevant qualifying interests, i.e., those with a presence on the lower Clare River between the Islandmore drain confluence and Lough Corrib are the Annex II species; Atlantic salmon (*Salmo salar*) and Brook lamprey (*Lampetra planeri*). White-clawed crayfish (*Austropotamobius pallipes*) are possibly present, at low densities within the study area. There is, currently, no firm evidence that Sea Lamprey, *Petromyzon marinus,* are present in Lough Corrib and its tributaries, including the Clare River. Freshwater pearl mussels (*Margaritifera margaritifera*) have not been recorded in the Clare sub-catchment of Lough Corrib.

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7 http://maps.biodiversityireland.ie/#/SpeciesGroup/44/Species/17487?FullDictionary=false&UseCommonNames=false

11.3.3.9 Other Species of Interest

Remains of common frogs, *Rana temporaria* L., comprised a significant proportion of otter spraints at sites within the current Clare River study area during 1991 studies of otter diet (Breathnach and Fairley, 1993). There is quite widespread availability of suitable amphibian habitat along the banks and riparian zone of the lower Clare River.

11.3.4 Existing Environment of the Clare River Arterial Drains and Tributaries

Each of the tributaries and arterial drains described below confluence with the Clare River within the study reach. Streams (Kiniska, Gortadooey, Gortcloonmore) and the un-named, wide, tributary (3) have all been extensively drained and generally have poor hydromorphological characteristics. The remaining channels are manmade, arterial drains which also have poor hydromorphology. Note that, photographs (P) referred to in the text are shown in **Appendix 11.2**.

11.3.4.1 Gortcloonmore tributary at Montiagh North

This short (~1.5km) drained stream flows east from Gortcloonmore and then south to join the Clare River at Montiagh North. Two by-roads cross the stream: the upper two thirds of the stream between the crossings was enclosed and heavily shaded by bankside trees and shrubs (ash, willow, hawthorn, and sycamore) (P15). Consequently, in-channel plant cover was patchy and dominated by *Berula erecta*, *Apium nodiflorum*, *Lemna minor*, *Lemna trisulca*, *Myosotis scorpioides* and occasional *Oenanthe fluviatilis*. The substrates in this stretch comprised clay with scattered large pebbles either embedded or lying on the surface with a overlying layer up to 0.5m deep of soft detritus and silt. There were no gravels suitable for spawning salmonids or lamprey, observed. Just upstream of the southerly bridge the banks were open with grasses, Meadowsweet (*Filipendula ulmaria*), Valerian (*Valeriana officinale*) and Purple Loosestrife (*Lythrum salicaria*) (P16). The channel was 3m-3.5m wide. Downstream of the bridge the channel was completely open and the community canal-like dominated by Yellow water lilies (*Nuphar lutea*) and Spiked Water-milfoil (*Myriophyllum spicatum*) (P17) with marginal growths of *Sparganium erectum*, and emergent growth of *Phalaris arundinacea*, *Myosotis scorpioides*, *Mentha aquatica* and *Berula erecta*. A net sweep included *Asellus* (very common), dytiscid beetles, water bugs (*Notonecta* and Corixidae) and the pond snail *Lymnaea stagnalis*. Damselflies of the genera *Calopteryx* and *Coenagrion* were on the wing.

<u>Water Quality, Fisheries and Protected Species:</u> Although not suitable for kick-sampling using the Q-value system, the nature of the life present and the general diversity would suggest that the water quality is slightly to moderately impaired. No fish were observed in the channel but stickleback and minnow are possible and if there are any patches of gravel, small trout and brook lamprey may also be present, though this is not thought to be a strong possibility. Eel may also be present. White clawed crayfish were not detected and they are unlikely to be present as habitat potential for the species was poor. The stream has no value for angling.

11.3.4.2 Unnamed Drain (4) at Montiagh North

This drain was wide (~4m) and probably at least 1m deep. It had imperceptible flow and its channel was fairly open and plant free with just marginal loose stands of *Sparganium erectum*, *Phalaris*, *Schoenoplectus* and occasional *Oenanthe fluviatilis* (P18). There were floating rafts / scum of filamentous algae and *Lemna* sp. Upstream of the road, the channel was more plant-chocked.

<u>Water Quality, Fisheries and Protected Species:</u> The drain is of low fisheries value and unlikely to contain any salmonids or lamprey; it has no angling value. White clawed crayfish were unlikely to be present as habitat potential for the species was poor.

11.3.4.3 Gortadooey tributary - Montiagh North

This stream flows south west from Gortadooey to reach the right bank of the Clare between Claregalway and Montiagh North, it is just over 1.5km in length. The channel is fully drained and canal like for most of it course as far as the road bridge east of Montiagh North. Downstream from this bridge the channel habitats and substrates are more varied and contain patches of gravel and coarse sand where spawning for both salmonids (probably only trout) and Brook lamprey is possible. The IFI in Galway have an understanding with the OPW as to how the lower, more habitat rich section should be maintained. The channel upstream of the bridge is about 2.5m wide and 0.8m deep with well developed marginal stands of *Sparganium* and *Phalaris* backed in places by Meadowsweet and Purple Loosestrife with in-channel cover of *Berula erecta* (P19). A week after the survey, the upstream channel was maintained with all the in-stream plant cover being removed (P20). Close to the bridge both upstream and downstream the flow picks up and the substrate was of coarse angular cobbles and gravel with *Apuim* and *Berula* marginally (P21). A spot kick sample just upstream of the bridge was dominated by *Gammarus* with occasional *Asellus*, *Limnephilidae*, Gyrinid beetles, and several molluscs including *Lymnea peregra*, *Physa* and *Planorbis*. While downstream of the bridge, Simuliidae, *Sericostoma personatum* and Glossosomatidae were also recorded. After 50m or so below the bridge the turbulence and current diminished and the substrate became more silted (P22) but closer to the Clare confluence the flow picked up again and the substrate was swifter and the substrate coarser. There, in-stream vegetation was dominated by *Sparganium emersum* and *Berula* (P23). A spot kick sample contained numerous *Lymnea peregra, Limnephilidae, Planorbis*, Chironomidae (Orthocladinini) ,and *Sigara*. The stream is spring-fed, and near the source at Gortadooey the channel was wide (3-3.5m) and uniform with open unshaded banks and sluggish, but not stagnant flow. The channel was dominated by *Callitriche stagnalis, Rorippa nasturtium-aquaticum agg. Apium nodiflorum*, with Flote grass (*Glyceria fluitans*) also present (P24). The center of the channel contained fine coarse sediment and a spot kick sample revealed high numbers of *Gammarus* along with Baetidae, Chironomidae, Limnephilidae, *Asellus*, Coleoptera, *Physa* and oligochaetes.

<u>Water Quality, Fisheries and Protected Species:</u> Overall, the water quality was judged to be slightly-to-moderately impaired, probably somewhere around Q3-4 with slightly better quality in the lower reaches and slightly poorer in the upper reaches. The stream was generally of little or no fisheries value upstream of the Montiagh Road, although downstream it was possible that small salmonids (probably only trout), brook lamprey and eel might be present because of the varied substrates and habitats, some of which may be suitable for spawning, and swifter flows. White clawed crayfish were not detected, but there was considerable habitat potential for the species in the form of boulder/cobble glides and an abundance of marginal emergent vegetation. Drainage of the stream has since removed a great deal of potentially good crayfish habitat.

11.3.4.4 Kiniska tributary

The Kiniska stream / drain can be broadly described as a narrow (~1m), shallow (~20cm), plant-chocked watercourse throughout (P25), although upstream of the road bridge in Kiniska townland it was deeper and wider in places (P26). There were signs in its upper reaches downstream from the road crossing (at Pt 12) that the it may be receiving some contaminated run-off because a spot kick was dominated by *Asellus* and also included *Potamopyrgus jenkensi*, *Planorbis* spp, and *Physa* sp. along with gyrinid and haliplid adults beetles, many dytiscid larvae, *Sigara*, *Gammarus* and ologochaets. Dominant in-stream macrophytes included *Apium nodiflorum*, Flote grass, Watercress, Water starwort (*Callitriche obtusangula*), Creeping bent (*Agrostis stolonifera*) and *Cladophora*. Stickleback and frog tadpoles were also taken in spot samples. Banks tended to be high and overgrown (Great Willowherb, Meadowsweet, Valerian, Himalayan balsam, grasses etc.) (P27). The substrate comprised gravel and cobble in shallow narrow areas and more silted in a wider, heavily shaded shallow pool (Point 14).

<u>Water Quality, Fisheries and Protected Species:</u> Water quality of the Kiniska Stream is thought to be at least slightly impaired i.e. somewhere between Q3-4 and Q3 and its low flows and heavy plant growths indicates that it is of minor or no fisheries interest. There is a slight possibility that lamprey ammocoetes

could be found in soft substrates. White clawed crayfish were not detected and they are unlikely to be present as water quality was unsuitable and habitat potential was generally poor for the species.

11.3.4.5 Un-named wide tributary (3) - Montiagh South

This was the more eastern of the streams in the Montiagh South area, earmarked for works. It is a wide (6-7m) and deep (0.8m) channel with a fairly uniform morphology and low open banks (P28). The in-channel area was dominated by *Potamogeton natans* with *Sparganium emersum* upstream and downstream of the bridge and further upstream also by *Myriophyllum* sp., *Callitriche* sp., and the filamentous diatom *Melosira*. (P29) Loose marginal stands of *Sparganium erectum* were present, in wider stretches with marginal rafts of filamentous alga (*Cladophora*) present throughout. A spot kick sample upstream of the bridge revealed numerous Limnephilid cased caddis, and numerous pea mussels (Sphaeridae) along with *Asellus*, *Sigara*, Dytiscid larvae and several snails including the *Physa*, *Lymnaea stagnalis* and *Planorbis planorbis*. There were numerous damselfly of the genus *Calopteryx* on the wing along the banks.

Water Quality, Fisheries and Protected Species: The water quality of this drain was probably enriched with a Q-rating equivalent to Q 3-4, i.e. slightly polluted. The waters were not suitable for salmonids or lamprey, given the lack of suitable spawning gravels but there is a possibility that small pike or cyprinids such as roach may be present in the lower reached downstream of the bridge. White clawed crayfish were not detected but there was limited, sub-optimal, habitat potential for the species in the form of bouldery glides and marginal emergent vegetation.

11.3.4.6 Western drain series (2) - Montiagh South

This part of the study area comprises an interconnected series of drainage ditches of varying widths generally without perceptible flow and with low open banks. One channel at Point 21 was completely plant-choked resembling more a marsh than a watercourse, this was dominated by Bulrush (Reedmace) *Typha latifolia* with floating filamentous algae common and with emergent Valerian and Marsh bedstraw (*Galium palustre*), also recorded were spike clubrush (*Eliocharis* sp.), Bogbean (*Menyanthes trifoliata*), Bottle sedge (*Carex rostrata*) and a narrow-leaved *Potamogeton* sp.; Bladderwort (*Utricularia* sp.) and *Lemna minor* were also present and small willow and gorse bushes at intervals on the banks (P30). A spot check for invertebrates in this stagnant ditch recorded numerous *Asellus* and planorbid snails, and *Lymnaea stagnalis*. This channel joins a deeper wider channel (Pt 22 and 23), which was a wide (4m) deep (1m+) ditch with low peat / subsoil banks, running east west parallel to the main river. In channel the flow was virtually imperceptible with mainly submerged and floating vegetation the latter dominated by *Myriophyllum*, with scattered areas of *Potamogeton natans* and Canadian pondweed (*Elodea canadensis*) (P31). *Sparganium erectum* was present also as scattered stands, with occasional bottle sedge at the margins and scattered Common Reed (*Phragmites australis*) also present farther upstream. *Asellus* were common in net sweeps of the bottom and water beetles were diverse. Another perpendicular drain at Point 24 was narrower and plant chocked ditch with floating filamentous algae, emergent *Sparganium erectum*, and *Eliocharis* and scattered stands of *Alisma plantago aquatica*, again with no perceptible flow. Across the trackway from this was a parallel ditch to the east also plant-choked (2.5m wide, 0.8m deep) which yielded numerous smooth newt tadpoles (efts) ([8]*Lissotriton vulgaris*) in net sweeps (P32). Also present were Greater Duckweed (*Spirodela polyrhiza*), *Myriophyllum alterniflorum* and *Elodea canadensis* at Point 27. Other invertebrates taken in net sweeps include *Asellus*, dytiscid beetles, *Notonecta* sp. and *Sigara* sp. This latter ditch extends farther south into farmland, where it is also plant checked (P33).

[8] formerly *Triton vulgaris*

Water Quality, Fisheries and Protected Species: The water quality in these ditches was thought to be unpolluted or slightly enriched ranging from Q3-4 to Q4. They have little or no fisheries value, and no angling value. The presence of newt efts (terrestrial juveniles) in one of the ditches is of conservation significance as this species is protected under national legislation. White clawed crayfish were not detected and they are unlikely to be present as habitat potential for the species was poor.

11.3.4.7 Unnamed drain (1) - Montiagh South

This drain was completed overgrown by emergent vegetation (mainly Common Reed (*Phragmites austarlis*) upstream of the road bridge at Pt 87 (P34). Downstream of the bridge the channel was less enclosed and the open water was covered with floating algal scum with marginal emergents (P35). The flow was stagnant.

Water Quality, Fisheries and Protected Species: This drain would have very low fisheries value and no salmonids or lamprey would be likely to be present. White clawed crayfish were not detected and they are unlikely to be present as habitat potential for the species was poor.

11.3.4.8 Islandmore/ Caherlea Arterial Drainage Network (5)

The Islandmore arterial drainage network comprised of one large, manmade drain that runs through the centre of the Caherlea Turlough and confluences with the Clare River at Pt 37, with a network of smaller, connected drains. The hydromorphology of the watercourse was poor, being highly canalised with steep banks, low flow diversity and a high level of aquatic plant growth. It was clear that water levels had risen in this drain system in the few days prior to the survey and part of the drain between the road at Pt 28 and the confluence with the cross drain at Pt 30, is normally dry or with very little water. This latter portion of the drain network has steep banks which were grassed or bare (P36). The main Islandmore drain which flows east to west and then north-west to reach the Clare was generally rather uniform with imperceptible flow throughout most of its course except closer to the Clare where it was shallower and the flow faster. Where it was joined by the Caherlea branch, the dominant in-stream macrophyte was *Berula erecta* with scattered *Equisetum fluviatile* and much filamentous green alga on the substrates (P37). A spot kick sample / net sweep here (Pt 31) returned, Limnephilidae, *Lymnaea peregra*, *L. stagnalis*, *Planorbis* sp., *Asellus*, numerous leeches, and numerous dytiscid and haliplid beetles and *Chironomus*. At that point the drain ranged from 3-4m wide and about 1m or more deep. Further east, in-channel macrophytes were dominated by *Potamogeton natans* with *Hippuris vulgaris* common locally e.g. Point 36 (P38). Other species less represented in that stretch include *Equisetum fluviatile*, *Schoenoplectus lacustris*, *Lemna minor*, *L. trisulca*, *Myosotis* and *Mentha*. According to a local farmer, the drain can become very shallow in some summers, with very little flow. Upstream from its confluence with the Clare River the banks are high (>3m) and vegetated with grasses and Meadowsweet and valerian topped in places by shrubs (P39). The wetted width at the base of the channel was about 3 m and the depth ~30cm. The in-stream vegetation comprises *Myriophyllum alternifolium*, *Sparganium emersum*, *Potamogeton natans*, *Chara* sp. and scattered *Equisetum*. (Pt 38). Marginally, *Berula* and *Callitriche* sp. and Flote grass (*Glyceria* sp.) are also prominent. Scattered clumps of Water plantain *Alisma plantago-aquitica*, *Oenanthe fluviatilis* and *Myosotis*. (P40).

Water Quality, Fisheries and Protected Species: The water quality of the Islandmore was considered to be slightly enriched and probably equivalent to Q3-4 with some improvement evident toward the downstream end just upstream of the Clare River. Overall, there was no fisheries value within this system except possibly in the last stretch upstream of the confluence with the Clare. Here the substrate was coarser and the flow moderate, so there was an outside possibility of some lamprey or trout spawning, only an electrofishing survey can establish if this is the case. White clawed crayfish were not detected but there was limited, sub-optimal, habitat potential for the species in the form of marginal emergent vegetation, cobbles overlaying silty gravel, and a few scattered small boulders in a slow glide upstream of the road bridge.

11.3.5 Existing Environment of Lough Corrib

Lough Corrib at around 170km^2 is Ireland's second largest lake after Lough Neagh in Northern Ireland. It is of high conservation value and forms the bulk of two Natura 2000 sites: Lough Corrib cSAC and SPA. The lake can be divided into two parts: a relatively shallow basin underlain by Carboniferous limestone in the south, and a larger, deeper basin to the north underlain by a combination of Carboniferous limestone in the south and east and by more acidic granite, schists, shales and sandstones, to the north and west. The maximum depth in the upper lake is 44-46m, with very extensive shallow embayments, while the entire lower lake rarely exceeds 3m depth. The Clare River occupies one third of the entire Lough Corrib catchment and is the main tributary of Lough Corrib, flowing into the eastern shore of the lower lake just 3km from its outlet to Galway Bay.

The lake and number of its tributary rivers including the Clare River form the Lough Corrib cSAC. The cSAC contains 14 Annex I habitats, including six priority habitats as well as several Annex II species. The site is also very important for wintering waterfowl. The lake is very popular with anglers for its brown trout and salmon fishing. One of the most significant features of the site are the submerged beds of aquatic macrophytes which cover extensive areas of the shallow littoral of the lake, these include several *Chara* species, *Potamogeton* and other aquatics. These latter habitats are very seriously threatened by the recent arrival of a non-native macrophyte (*Lagarosiphon major*), which has rapidly spread within the lake.

There are, in fact, three significant invasive species in Lough Corrib which are undoubtedly impacting on the lakes ecology. These include the cyprinid fish, Roach (*Rutilus rutilus*) introduced in the early 1980's; *Lagarosiphon major* (Curly waterweed) first identified in the Upper Lake in 2005, and the Zebra mussel (*Dreissena polymorpha*) first recorded in 2007 but thought to have been introduced to the lake in 2000 or 2001 (CFB, 2009). Roach have proliferated in the lake and, in a recent survey (CFB, 2009), it was the most abundant fish caught. *Lagarosiphon* spread rapidly after 2005 and by 2010 had been recorded at over 160 locations in the upper lake (IFI web[9]) several of which contained very dense populations which were out-competing the native *Chara* and *Potamogeton* and other native macrophytes at these sites. There is also evidence that it is facilitating the survival of overwintering juvenile cyprinids (perch and roach) which in the long run may prove detrimental to the salmon and trout stocks for which the lake is renowned. Finally it is also providing an ideal substrate for the early stages of invasive Zebra mussels (veligers or larvae and juveniles). By 2010, *Lagarosiphon* had not yet spread to the Lower Lake, where given the latter's uniform shallow nature, it would be expected to be extremely destructive for the extensive beds of native macrophyte species.

Although Lough Corrib has always been renowned for its brown trout population, it is now dominated by the cyprinid species, perch and roach. In a recent survey (2008) a team from the then Central and Regional Fisheries Boards (now IFI) assessed the fish stocks using various types of net. The results showed the numerical dominance of these two species even though other methods would have resulted in higher catches of several of the other species including trout (see **Table 11.10**).

NBDC White-clawed crayfish records for Lough Corrib are at locations c.9km north of the Clare River confluence with the lake. O'Connor *et al*. (2009), in a survey of Irish lakes, found no crayfish at two sites on lower Lough Corrib (one on the eastern, and one on the western, shore), but reported 2004 anecdotal records from Kilbeg and Knockferry piers, c.10km northwest of the Clare River mouth.

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9 http://www.fisheriesireland.ie/Lagarosiphon-major/rapid-invasion-of-lough-corrib.html

Table 11.10 Total numbers of fish taken in a netting survey of Lough Corrib in 2008 (CFB, 2009)

Species	No.
Brown trout (*Salmo trutta*)	19
Perch (*Perca fluviatilis*)	285
Roach (*Rutilis rutilis*)	275
Pike (*Esox lucius*)	17
Roach x Bream	8
Bream (*Abramis brama*)	1
3-spined stickleback (*Gastrosteus aculeatus*)	4
Eel (*Anguilla anguilla*)	8

Table 11.11 Trophic status in Lough Corrib based on average maximum chlorophyll *a*

	1976-1981	1982 - 1986	1987-1990	1991-1994	1995-1997	1998-2000	2001-2003	2004-2006	2007-2009
Corrib (upper)	11	5	9	8	11	9	13	8	7
Corrib (lower)	28	18	10	8	11	9	8	8	8

Blue = oligotrophic, green = mesotrophic, yellow = eutrophic

Between 1982 and 1986 the trophic status of the two lake basins has generally been either mesotrophic or oligotrophic based on average maximum chlorophyll *a* concentrations, whereas, during an earlier period, 1976-1981, the Lower Lake was just eutrophic, while the Upper Lake was oligotrophic (**Table 11.11**). Lough Corrib (Upper and Lower) is currently classified under the Water Framework Directive as being of Moderate Ecological Status because the fish population in the lake has been classified as Moderate (CFB, 2009). Other biological and chemical indicators are either high or good (**Table 11.12**) although low confidence is associated with the chlorophyll status recorded due to the presence of zebra mussels in the lake. Since 2006 the lowest EPA monitoring station on the Clare River (Curraghmore Bridge) has been rated 'High' ecological status with a Q-value of Q4-5. Prior to that, at least as far back as 1980, the same site had 'Good' Ecological Status (Q4), suggesting that its impact on the lake is not especially adverse, which appears to be borne out by the mesotrophic or oligotrophic status of the lake over 3 decades. In a 1986 plant survey of the lake (Krause & King, 1994), the lower lake held very low densities of the more sensitive *Chara* species, whereas *Potamogeton pectinatus* a species very tolerant of enrichment and several filamentous algal species totally dominated the central and eastern part of the lower lake, and were locally very abundant. The authors attributed this to inputs from the Clare River. It is, however, possible that more recent improvements in water quality on the Clare River may have facilitated re-establishment of more sensitive *Chara* spp., an Annex I qualifying habitat for the L. Corrib site, for which there are specific conservation objectives. The EPA monitors macrophytes along many transects throughout the upper and lower lake as part of WDF Lake monitoring programme (pers. comm., Ms. Caroline Plant, EPA). The two transects closest to the confluence of the Clare with the lower lake (Transect 16 just to the north and Transect 17 to the south) were surveyed in 2007 and 2010 and on both occasions returned abundances of filamentous algae generally higher than the majority of other transects within the lower lake, especially transects farther north or on the western side. Transect 16 and 17 also had somewhat lower representation of *Chara* species. These data partially support the findings of (Krause and King, 1994) for the eastern side of the lower lake. However, the EPA transects in general show that Lower Lough Corrib has a very strong representation of *Chara* species, which contributes to its good macrophyte status, concurring with its overall Good water chemistry status. Furthermore, *Potamogeton pectinatus* a species tolerant of higher nutrients and turbidity levels than *Chara* was only rarely or occasionally recorded in the 2010 EPA survey of Lower Lough Corrib compared to the earlier

findings of Krause & King (1994), when it was abundant. *Chara* is believed to out compete *Potamogeton pectinatus* in lakes where the transparency is high (Van den Berg *et al,* 1999).

Table 11.12 Chemical and biological criteria used to assess status of Lough Corrib under the WFD.

Lake	Corrib Lower	Corrib Upper
Oxygenation Status	High/good	High/good
Ammonia Status	High	High
TP Status	Good	High
Nutrient Conditions Status	Good	High
Acidification Status	Pass	Pass
Thermal Status	Pass	Pass
Overall Status for GPC	Good	High
Macrophyte Status	Good	High
Chlorophyll Status	High	High
Fish Status	Moderate	Moderate
Overall Status for BQE	Moderate	Moderate
Hydromorphology Status		
Alien /Invasives/Introductions/artificial	High to Good	High to Good
Ecological Status 2007-2009	Moderate	Moderate

11.3.6 Turloughs

At least three turloughs were identified by the 2010 Flood Study Reports: at least one at Caherlea/Lisheenavalla, and two at Lakeview (see **Chapter 9**). No specific ecological information could be sourced for any of the turloughs which all appear to be reasonably small, and previously impacted. The Caherlea turlough is currently drained by the Islandmore/Caherlea Arterial Drainage Network (**Table 11.2** – drain 5). The proposed extension of that drainage network, in a south-easterly direction, will further drain the area up into the townland of Lisheenavalla. The two Lakeview turloughs have already been heavily impacted by infrastructural development. The smaller of the two is now the site of the Cuirt na hAbhainn housing estate, while the larger is now almost entirely covered by Claregalway Corporate Park.

11.3.7 Ecological Valuation

Ecological valuation of each watercourse was undertaken in accordance with criteria shown in **Appendix 11.1**. **Tables 11.13, 11.14 and 11.15** provide habitat summaries and ecological evaluations for, respectively: habitat units of the Clare River; connecting tributaries and arterial drainage channels; and Lough Corrib.

11.3.7.1 Areas of particular ecological significance

The following areas were identified as being of particular ecological and/or conservation value:

- **Clare River** – International Importance
- **Lough Corrib -** International Importance
- **Western Drain Series (2) at Montiagh North** – High local value
- **Gortadooey Tributary (lower)** – Moderate local value
- The lower reaches of the **Islandmore** and parts of **Gortcloonmore** and **Kiniska tributatries** may be of higher importance if lamprey ammocoetes are detected there.

Details of these sites are found in **Tables 11.13 to 11.15**. **Figure 11.7** highlights areas of ecological significance and shows the locations of each of the broad habitat types on the Clare River between the Islandmore confluence and downstream of Claregalway Bridge.

Table 11.13 Clare River – valuation of aquatic ecological resources (adapted from NRA, 2009)

SITE	Aquatic habitat summary	Water quality indicators	Fisheries values	Relevant protected habitats and species[10]	Evaluation	Class.
Clare R. Habitat Type 1	Deep, slow flowing glide with marginal emergents	Q4; unpolluted	- Holding areas for coarse fish and larger trout; - Migration routes of adult salmon; - Lamprey ammocoetes utilising marginal soft sediments.	Annex II species: • Atlantic Salmon • Brook/river lampreys • White-clawed crayfish (possible at low density) Annex I Habitat: • No. 3206: *Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation (poor example)*	International importance (Lough Corrib cSAC)	A
Clare R. Habitat Type 2	Moderate to swifter, shallow flow over various combinations of small boulder, cobble, gravel and sand.	Q4; unpolluted	- Possibility of patchy spawning for salmon and lamprey; - Nursery area for salmon; - Migration routes of adult salmon.	Annex II species: • Atlantic Salmon • Brook/river lampreys • White-clawed crayfish (possible at low density) Annex I Habitat: 1. No. 3206: *Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation (poor example)*	International importance (Lough Corrib cSAC)	A
Clare R. Habitat Type 3	Deeper pools with submerged, marginal, macrophyte 'beds' (primarily pondweeds).	Q4; unpolluted	- Holding areas for larger fish; - Lamprey ammocoetes in soft sediments; - Migration routes of adult salmon	Annex II species: • Atlantic Salmon • Brook/river lampreys • White-clawed crayfish (possible at low density) Annex I Habitat: No. 3206: *Water courses of plain to montane levels with the Ranunculion fluitantis and*	International importance (Lough Corrib cSAC)	**A**

10 Habitats and Species listed in Annex I & Annex to the Habitats Directive (92/43/EEC); species protected under the Wildlife Acts (1976 and 2000).

Callitricho-Batrachion vegetation

SITE	Aquatic habitat summary	Water quality indicators	Fisheries values	Relevant protected habitats and species[11]	Evaluation	Class.
Clare R. Habitat Type 4	Turbulent flow associated with coarse substrate at the natural weir below Claregalway Bridge, and downstream of Crusheeny Bridge.	Q4; unpolluted	- Feeding area for older trout and juvenile salmon; - Migration routes of adult salmon	Annex II species: • Atlantic Salmon • Brook/river lampreys • White-clawed crayfish (possible at low density) Annex I Habitat: No. 3206: Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation (poor example)	International importance (Lough Corrib cSAC)	**A**

Table 11.14 Clare River Tributaries and Arterial Drainage Channels - valuation of aquatic ecological resources (adapted from NRA, 2009)

SITE	Aquatic habitat summary	Water quality indicators	Fisheries values	Relevant protected habitats and species[12]	Evaluation	Class.
Montiagh South: Un-named drain (1)	Stagnant drain, choked with emergent vegetation u/s of bridge; d/s of bridge more open water and less enclosed with floating and emergent macrophytes.	Slightly- to-moderately polluted.	None	None	Low, local importance.	E

11 Habitats and Species listed in Annex I & Annex to the Habitats Directive (92/43/EEC); species protected under the Wildlife Acts (1976 and 2000).

12 Habitats and Species listed in Annex I & Annex to the Habitats Directive (92/43/EEC); species protected under the Wildlife Act (1976 and 2000).

SITE	Aquatic habitat summary	Water quality indicators	Fisheries values	Relevant protected habitats and species[13]	Evaluation	Class.
Montiagh South: Western Drain Series (2)	Series of arterial drainage ditches, some recently cleaned and others choked with emergent and floating macrophytes with peaty detritus substrates.	Unpolluted or slightly polluted.	None	Wildlife Acts (1976 and 2000) - Newt breeding and nursery area - Common frog (probable)	High, local importance.	D
Montiagh South: Un-named wide tributary (3)	Moderately fast flowing, large volume stream within uniform, overdeepened, overwidened channel. Some submerged and emergent marginal vegetation and combination of boulder and detritus substrates.	Slightly polluted (Q3-4 bankside assessment).	Potential nursery habitat for young coarse fish.	None	Moderate, local importance	D
Montiagh North: Gortadooey tributary	Spring fed. Wide (3-4m) and sluggish with fine, and coarse sediments. Recently drained upstream of the road bridge near R. Clare confluence.	Slightly polluted (Q3-4, bankside assessment). slightly better quality in lower reaches; poorer in upper reaches.	Possible spawning substrates that could be utilised by trout and brook/river lamprey in lower stretches towards R. Clare confluence.	Annex II species: • Brook lamprey (probable)	International importance if lamprey present, otherwise of moderate, local value in the lower reaches only (d/s of road bridge closest to R. Clare).	D (A)

13 Habitats and Species listed in Annex I & Annex to the Habitats Directive (92/43/EEC); species protected under the Wildlife Act (1976 and 2000).

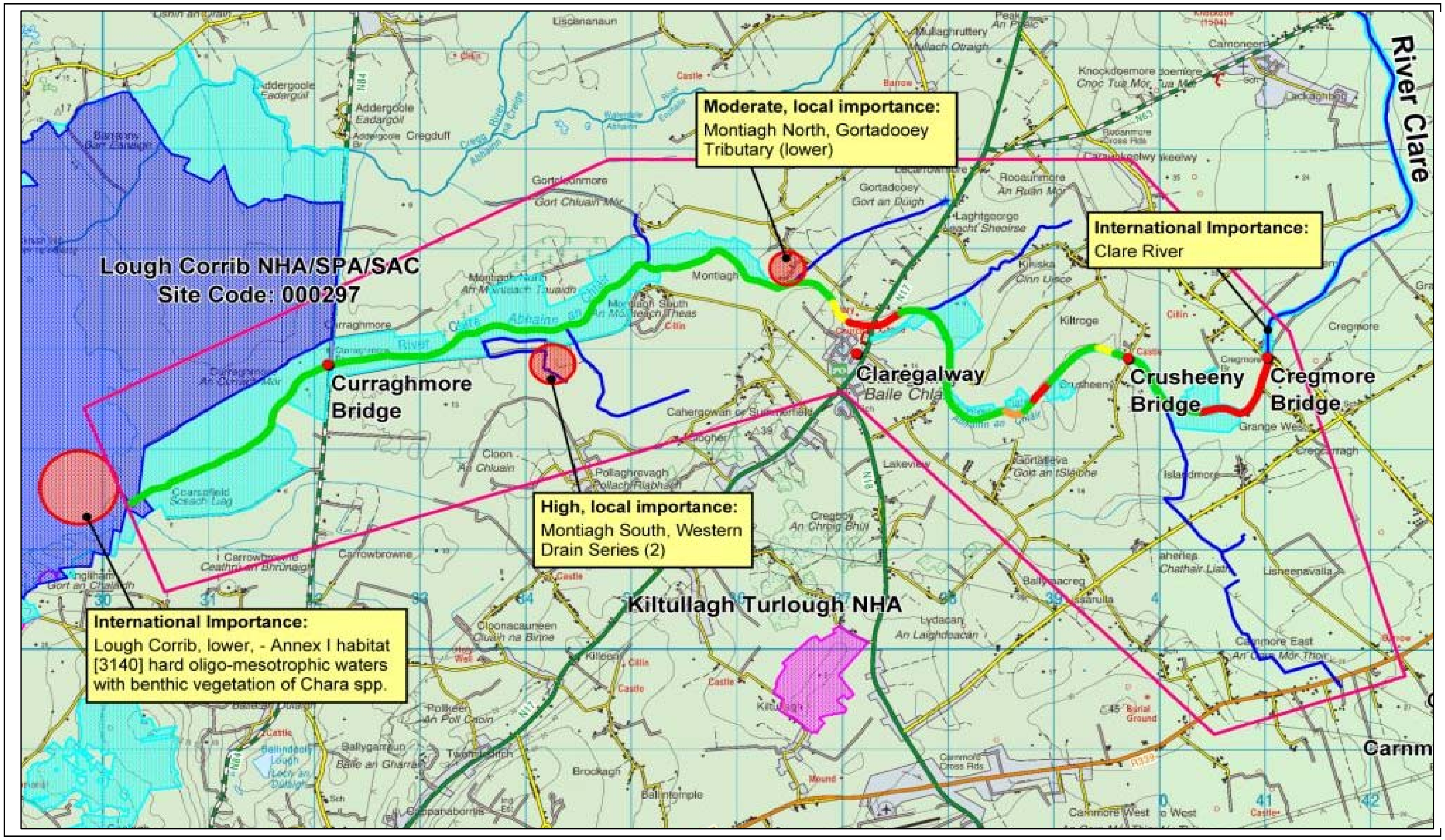
SITE	Aquatic habitat summary	Water quality indicators	Fisheries values	Relevant protected habitats and species[14]	Evaluation	Class.
Montiagh North: Gortcloonmore tributary	Predominantly weed choked, deepened and widened; almost stagnant drain with open banks and soft sediments. Short tree-tunnelled section, similar, but without dense aquatic vegetation.	Slightly- to-moderately polluted.	Marginal possibility of Brook/river lamprey ammocoetes utilising soft sediments, although suitable spawning gravels not noted.	Annex II species: ▪ Brook lamprey (possible).	International importance if lamprey present, otherwise of low, local value.	E (A)
Montiagh North: Un-named drain (4)		N/A	None	None	Low, local value.	E
Kiniska tributary	Drained stream with very low flows within an over-deepened, over-widened, trapezoidal channel that has become choked with aquatic vegetation and tall herb at banksides. Limited flow and substrate diversity.	Slightly- to-moderately polluted.	Very low possibility of brook/river lamprey ammocoetes utilising soft sediments.	Annex II species: - Brook lamprey (possible).	International importance if lamprey present, otherwise low, local value.	E (A)
Islandmore /Caherlea arterial drainage network (5)	Manmade drainage channel – generally highly canalised with steep banks, low flow diversity and a high level of aquatic plant growth.	Slightly polluted (Q3-4, bankside assessment). Slight improvement towards confluence with Clare R.	Slight possibility of lamprey / salmonid spawning in coarse substrates in lower stretch near Clare R. confluence. Possibility of Brook/river lamprey ammocoetes in sediment of lower reach.	Annex II species: • Brook/river lamprey (possible).	International importance if lamprey present in lower reaches, otherwise low, local value.	E (A)

14 Habitats and Species listed in Annex I & Annex to the Habitats Directive (92/43/EEC); species protected under the Wildlife Act (1976 and 2000).

Table 11.15 Lough Corrib - valuation of aquatic ecological resources (adapted from NRA, 2009)

Site	Aquatic habitat summary	Water quality indicators	Fisheries values	Relevant protected habitats and species[15]	Evaluation	Class.
Lough Corrib	See Section 11.3.5	Mesotrophic/ Moderate WFD Status	Popular with anglers for its brown trout and salmon which spawn in the numerous tributaries of the lake. In recent decades it has become dominated by cyprinid fish species, in particular perch and introduced roach. Pike, Bream, Roach X Bream hybrid, Stickleback and Eel also occur.	Annex II species: • Atlantic Salmon • White-clawed crayfish Annex I Habitat: • [3140] Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.	International importance (Lough Corrib cSAC)	**A**

15 Habitats and Species listed in Annex I & Annex to the Habitats Directive (92/43/EEC); species protected under the Wildlife Act (1976 and 2000).



KEY TO CLARE RIVER HABITATS	Type 1	Type 2	Type 3	Type 4
Description	Glide or Glide/Pool	Shallow gravels and coarse substrate	Deeper Pools	Turbulent flow

Figure 11.7 Clare River Habitat Types and Study Area Sensitivities

11.4 POTENTIAL IMPACTS

The Clare River would potentially be impacted by Measures 4a, 4b, 4c, 4d, 6a, 8a, 8b and 10 (channel maintenance) as well as the construction of a footbridge parallel to Claregalway N17 Bridge. Each of the measures has been set out below with a description of potential impacts during construction, operational and maintenance phases. Cumulative impacts are also considered.

Of all the potential impacts on the Clare River, measures 4b (channel regrading Claregalway) and 8b (two step channel creation upstream of Crusheeny Bridge) in combination with measures 4a (flood eye insertion at Claregalway) and 8a (replacement of Crusheeny Bridge) have the potential for quite major changes to the hydraulic environment of the Clare River, which, in turn, may impact aquatic ecology. For this reason, **Section 11.4.1.1** presents an overview of this potential impact as a preface to the consideration of each of the measures individually.

11.4.1 Potential Impacts on the Clare River

11.4.1.1 Overview of potential changes to hydraulic environment of the Clare River

Hydraulic modelling and comparison of pre- and post- works conditions

As an aid to assessing the potential impacts of the proposed measures on the hydraulic (flow) environment of the river, and by extension certain aspects of its ecological impact, the pre- and post-works values for three hydraulic parameters were measured by modelling of low (85%ile & 95%ile), intermediate (50%ile and 65%ile) and high (Q-Bar) flow conditions. The measured parameters included channel velocity (m/s), stream power (watts / m^2) and Froude number. The latter is a dimensionless descriptor of the flow environment of a river combining both depth and velocity. It has been used here as it is also used as a parameter to assess the suitability of river stretches for salmon spawning. The data are presented graphically in Figures 1 to 15 of **Appendix 11.6**, each figure with two graphs (a) and (b), as follows: covering the entire study reach from upstream of Cregmore Bridge to downstream of Claregalway Bridge, and, looking in detail at the stretch between Cregmore Bridge and just downstream of Crusheeny Bridge.

Note that points on the ‘b’ graphs are broadly proportional to the distance between stations, whereas in the ‘a’ graphs, points are spaced equidistant.

Summary of Hydraulic Changes

The greatest hydraulic changes are evident at the higher flows, mainly at 50%ile and QBar, particularly the latter. These changes tend to be concentrated in four main areas, namely upstream and downstream of the three bridges (Cregmore, Crusheeny and Claregalway) and between Cregmore Bridge and Crusheeny Bridge. In most cases there is reduced velocity, stream power and Froude number at Crusheeny and Clargegalway Bridge stretches and between Cregmore Bridge and Crusheeny Bridge, whereas around Cregmore Bridge, velocities are generally predicted to rise under higher flow scenarios. A localised rise in velocity will also be noticeable, at high flows only (QBar), in the lower part of the Crusheeny to Clargegalway reach (section 76.6-75), possibly due to rock removal downstream of this area. At lower flows (85%ile and 95%ile) the changes in all of the parameters are marginal in most cases, because there is minimal interference with the low-flow channel.

Reductions in each of the parameters (velocity, stream power and Froude No.) are owing to the bridge works at Crusheeny and Claregalway, whereas increases in these parameters around Cregmore Bridge and reductions (primarily) from section 92 to 96 are owing to the construction of the 2-stage channel along this stretch. These changes will be referred to in more detail in the following sections in relation to potential impacts of specific measures, i.e., 4a, 4b, 8a and 8b.

11.4.1.2 Measure 4a: Install Flood Eye at Claregalway Bridge

Construction Phase

Works were completed in June, 2011.

Operational and Maintenance Phase

Increased channel width has the effect of reducing main channel peak velocity on Clare River beneath the bridge during elevated flow. This may, in turn, lead to the need for river maintenance if the self cleaning nature of the river declines and silt deposition increases. River maintenance can have impacts on the aquatic qualifying interests of the cSAC (e.g. King *et al*., 2008a, 2008b).

Cumulative Impacts

In combination with Measure 4b this measure has potential to alter water current velocities in the main channel in the vicinity of the Claregalway Bridge. A relative reduction in channel velocity is expected for a Mean Annual Flood (Q_{BAR}) event (see **Appendix 11.6**, **Figures 13-15**) in this reach (section 71 - 73.5) compared to the present situation. In contrast, an increase in velocity, thought also to relate to these works or possibly a combination of these and rock removal upstream will result in a significant increase in velocity, stream power and Froude number at section 76.6-75. At intermediate flows (50%ile – 65%ile), while there are reductions in velocity, and channel power, the changes are very marginal. Froude Number is, in general, the parameter to show the least change at any given flow. There is the potential for **permanent, moderate**, **negative** impacts on salmonid fish in reaches experiencing reductions in velocity and related parameters, but the impact of such changes may be offset by the fisheries enhancements (**Section 11.4.1.3**). Where velocity increases are predicted, there may be a **permanent**, **slightly positive** impact on aquatic ecology as silt will more readily scour from substrates increasing the possibility of some spawning in suitable substrates. Predicted Froude numbers indicate this stretch may become optimal in terms of salmonid habitat (0.3-0.4) during high flows (**Appendix 11.6**, Figure 15a).

11.4.1.3 Measure 4b: Regrade Clare River channel upstream and under Claregalway Bridge

Overview of Measure 4b

Approximately 80m of the Clare River channel will be affected by regrading (river deepening). The newly constructed second stage channel beneath Claregalway Bridge will be used as a temporary diversion and the river will be diverted through the flood eye for a period of up to approximately 3 weeks. **Phase 1** involves excavating the southern bank - the second stage channel upstream and downstream of Claregalway Bridge will initially be excavated to a level of approximately 6.1m OD (minimum) using a cofferdam to dewater the area prior to works. The cofferdam will then be relocated to the northern side of the channel for **Phase 2** which involves dewatering the remaining section of the river on the northern bank (see **Figures 6.5 and 6.6**) . At that time the flow will be diverted through the newly installed flood eye. The river will be deepened to a minimum level of 4.60m OD which will mean deepening of up to approximately 1.2m in some areas. The work will be performed during summer months at periods of low flow. It is anticipated that the work along one side will be completed in its entirety prior to working on the other half of the river. It is also anticipated that the entire length of the river stretch (80m) will be isolated completely for the duration of the works. As noted above it is proposed to use the second stage channel and culvert installed as part of the advanced works at

Claregalway Bridge as a temporary diversion during the works. Diagrams of the proposed temporary works are shown in **Figures 6.5** and **6.6**. It is anticipated that regrading works will take a total of approximately three weeks.

Construction Phase

<u>Dewatering and excavation of the channel</u>
Phase 1 of this measure involves cofferdam construction and dewatering of the stretch on the southern bank. This will result in a small section of the river downstream of the bridge being dewatered whilst excavation is carried out. The southern bank will be widened upstream of the bridge in association with measure 8b (bank widening). Phase 2 involves the cofferdam then being placed on the opposing side of the river causing dewatering of 80m of the Clare River main channel (approximately 40m either side of Claregalway Bridge). Dewatering will cause **imperceptible-to-slight** impacts for fish provided they can move out of the area during draw down. Dewatering and subsequent excavation will cause the mortality/removal of all aquatic plants and invertebrates in the affected stretch. Macroinvertebrates will be a combination of sensitive and tolerant forms common to shallower flows over fine and coarse substrates. Their loss in this short stretch will not affect the integrity of the food chain supporting Annex II species of the cSAC. Crayfish, if present, may emerge from refuges within the de-watered stretch, in which case, given the limited length of channel affected, it would be straight forward to collect crayfish and relocate them to a suitable area upstream of the works. Given that crayfish are widely distributed further upstream and are probably present, at best, at low density around Claregalway Bridge, the habitat disturbance caused by dewatering a relatively small stretch at Claregalway Bridge would not affect their overall conservation status in the cSAC and the impact on this Annex II species would be, at worst, **slightly negative** and **short term**. Aquatic vegetation of the Annex I habitat 3206, such as *Ranunculus* spp., *Oenanthe fluviatilis*, *Potamogeton* spp.,*Callitriche* spp. and mosses, are likely to be present in the stretch and these will die during the dewatering. Given the relatively small stretch of the cSAC affected, and the proportion of this habitat type remaining in the cSAC, this will cause an **imperceptible** impact. These impacts will be localised - confined to the immediate foot-print of the works. Given the relatively small stretch affected, this would not affect the overall integrity of the cSAC and would have an overall **slight**, **negative** impact.

<u>Change in hydromorphology of the channel during excavation works</u>
Use of cofferdams will confine the river to a narrower channel width for a short time and will alter flow dynamics, causing short term local increase in water velocities over a small stretch of the river and may also generate upwelling and/or turbulence where the channel opens out again. This may have the effect of flushing the substrates of any accumulated silt and other fine substrates may shift also. Velocities would not be expected to increase much except if flooding occurred during the works. Silt disturbance is unlikely to be significant given the localized effect and present flow characteristics that do not favour silt deposition in the area. Any scouring of substrates would only affect fine sediments which do not predominate in the area downstream of the bridge. The velocities are unlikely to affect fish migration, but should be timed to avoid peak migration periods. There are no known spawning sites in the affected area, but presence of juvenile fish is likely and these may be impacted. The predicted localized increase in bed disturbance downstream of the bridge will result in the removal of filamentous algae and dislodgement and increased downstream drift of macroinvertebrates. These **negative** impacts are considered to be **temporary** and **imperceptible-to-slight**. In the case of fish, the duration and timing of the impact in terms of migration to upstream spawning sites is such that this impact will be **temporary** and **imperceptible**.

<u>Release of sediment</u>
The nature of the measure means that there is a potential for the release of sediment during the construction phase. This may arise from earth movement associated with the excavation of the channel upstream and downstream of the bridge down to the new bed level of the second stage channel. The measure will be carried out using cofferdams to protect the working area. Works in the dry reduce the likelihood that sediment will be released directly to the channel. Sediment loss can give rise to increased bottom sedimentation, which in turn can adversely impact macroinvertebrates. It can also damage the gills of fish (including Annex II species such as salmon) and white-clawed crayfish. The natural weir area downstream of the bridge may hold some juvenile salmon and trout given the more turbulent flows and coarser substrate in the area, which would provide cover for them,

and these would be more susceptible to gill damage than older fish present in deeper water farther downstream. Spawning by Annex II species is unlikely downstream of the works, but cannot be discounted completely. The main spawning grounds for the Clare are in upstream tributaries such as the Abbert and the Grange, nevertheless, minor adverse impacts to juvenile fish downstream owing to sediment escape cannot be ruled out. This **temporary** impact, in the context of the cSAC as a whole would be considered **negative** and **slight**. River/brook lamprey ammocoetes have been recorded in silt downstream of the bridge, but these would not be expected to be adversely impacted by small amounts of additional silt.

Localised rock removal
In the case of large boulders being removed, these could be stockpiled and strategically replaced in the deepened channel as part of fisheries enhancements to help create flow diversity. There would be no significant effects on fisheries, macroinvertebrates or crayfish by limited, select large boulder removal and overall impact would be **temporary** and **imperceptible**. Removal of bedrock outcrops usually involves rock breaking during low flow removal of loose material. Cyprinid fish are more susceptible to noise disturbance associated with rock breaking, and salmonids less so (Amoser *et al.,* 2004). Fish would therefore be likely to avoid the area for a short time while rock breaking occurs. Correct grading of the channel into newly created (fisheries enhancement) pools should be considered in relation to mitigation and reinstatement (see sections on proposed Fisheries Enhancement Measures).

Loss of hydrocarbons
The nature of the project means that there is a potential for the loss of hydrocarbons such as diesel and hydraulic fluids during the construction phase. Hydrocarbon spills from poorly secured or non-bunded fuel storage areas, leaks from vehicles or plant or spills during re-fuelling can all give rise to the escape of hydrocarbons from construction sites to water courses. These spills can give rise to tainting of fish or if large enough fish kills and invertebrate kills which would be a **moderate, short term, negative** impact. The likelihood of their occurrence, though, in a well equipped, maintained and managed construction site is low.

Operational and Maintenance Phase

Change in hydromorphology and habitats associated with channel deepening
The stretch of the Clare affected by these works is currently a moderately shallow glide over fine and coarse substrates. Deepening here will cause loss of the former habitat type and creation of deep glide or pool type habitat, most likely with less substrate and flow diversity as a result of excavation of bedrock and removal of rubble. The combination of channel deepening and proposed fisheries enhancements (see below) will remove habitat that is ideal for supporting sensitive macroinvertebrate groups, and is presently ideal salmonid nursery habitat. In its place will be habitat more suitable for holding larger salmon and trout and coarse fish (primarily as an angling amenity). Deepening around the bridge is likely to alter flow dynamics upstream of the deepened section depending on how the bed levels are set. There may be a decrease in channel depth and increase in channel velocity/turbulence in a short section at the inflow to newly created pools. This represents a **permanent** impact and given the relative scarcity of nursery habitat on the lower Clare the impact is **significant** and **negative**. Hydraulic parameter changes will be in line with those described in **section 11.4.1.2**, above.

EPA water quality monitoring station 30C011200, presently located at Claregalway Bridge, is included in Irelands' formal WFD monitoring and water quality reporting programme. The change in hydromorphology associated with channel deepening and pool creation will alter channel substrates and water depths and is likely to render the current monitoring site unsuitable for Q-rating assessment.

Habitat and hydromorphological changes associated with fisheries enhancements
Using historical data for the Clare and similar lowland drained rivers elsewhere, combined with the knowledge of the study reach by local IFI staff in Galway, IFI have recommended an EREP measure that is designed to improve the holding capacity of the Clare study reach for salmon and trout. The approach is to work with the existing channel form in the stretch beneath Claregalway Bridge in order

to create a holding pool. This measure is designed to improve angling in the reach. Physical works are to be carried out in conjunction with the channel regrading construction phase.

The following paragraphs paraphrased from O'Grady (2006) give a brief outline of each measure and the intended outcome. Plates illustrating each measure detail are provided in **Appendix 11.5.**

- *Creation of centre channel pools.* Central channel pools provide lies for larger fish as well as being an important site for angling. During periods of low flow they also act as fish refuges. Where the conditions are suitable spawning gravels can be placed below such pools.
- *Gravel* is often scarce or lacking in drained river stretches because it may have been completely removed down to unsuitable bed material (e.g. boulder clay or bed rock) and the new bed material may be unsuitable to allow new gravels to be eroded. Thus the necessity to re-introduce gravels in some drained rivers. Any spawning gravel placed in this part of the Clare will probably be coarse and aimed at enhancing salmon rather than trout spawning; coarser gravel is also more likely to remain in place for longer in the main channel. It will be introduced below pools where upwelling water from the pool will help to keep deposited eggs aerated and silt free.
- *Random boulders* strategically placed can have several positive impacts e.g. providing lies for salmon and trout in their lee, result in the excavation of small scour pools downstream, or increase deposits of fine gravel immediately below which can be used by trout to spawn. Essentially they can create more dynamic flows and microhabitats in otherwise uniform stretches with favourable outcomes for salmonids.

Cumulative Impacts

Cumulative impacts would be primarily in association with other measures as part of the Claregalway Flood Relief Scheme. Of these, measures 4a (flood eye at Claregalway Bridge), 8a (replacement of Crusheeny Bridge), 8b (channel widening upstream of Crusheeny Bridge) and 10 (selective channel maintenance on the Clare River). Each have potential for cumulative impact in association with measure 4b with respect to aquatic ecology of the lower Clare River. The main impacts would be in relation to (i) negative effects of sediment release on fish and invertebrates downstream of works, and (ii) changes in the hydraulic environment of the Clare River and, (iii) combined impact of loss of similar habitat around Crusheeny Bridge.

Measure 4b limits the probability of sediment release through use of cofferdams, but there may be a **slight, temporary, negative** impact if channel maintenance works upstream occur simultaneously, exacerbating the sediment release risk associated with Measure 4b. Ideally, channel maintenance within the 1km of river upstream of Claregalway Bridge should occur at a different time to measure 4b. In that case, cumulative impacts arising from sediment release would reduce and be **temporary and imperceptible-to-slightly negative**.

Taking into account the entire study reach, any negative impacts associated with cumulative loss of fisheries habitat and changes to hydraulic characteristics of the Clare River, as a result of this measure, have the potential to be **permanent, significant** and **negative** but is likely to be offset by carefully implemented mitigation and proposed fisheries enhancements.

11.4.1.4 Measure 4c: Address the Gap in the Wall at An Mhainistir Housing Estate

Construction Phase

The proposed wall construction is located well away from the Clare River and outside of the cSAC. The very limited potential exists, as with any construction in an urban area, that concrete or mortar associated with wall construction may enter stormwater drains that spill to the Clare River. Cement is highly alkaline and can give rise to fish kills with similar effects on invertebrates, including white-

clawed crayfish. Wash off from poorly cured cement can also be highly alkaline and potentially dangerous to fish. Careful supervision of cement handling and general good practice can greatly reduce the risk from concrete-related impacts so that the likelihood of impacts is best described as low. The potential for **short term**, **negative** impact given the toxicity of concrete to aquatic life within a cSAC is considered **moderate**.

Operational and Maintenance Phase

There are no foreseeable operational or maintenance phase impacts on the Clare River arising from Measure 4c.

Cumulative Impacts

Cumulative impacts would be primarily in association with other measures as part of the Claregalway Flood Relief Scheme, but given the location and nature of measure 4c there are no foreseeable combined impacts on aquatic ecology expected to arise.

Measure 4d: Provide Local Embankment at Old Nine Arches Bridge Construction Phase

The 53m long, 4m wide, 2.5m high embankment is located well away from the main channel of the Clare River, though the potential exists for silt to wash off the spoil heap and flow, perhaps via existing drains, along the N17 and into the Clare River. Suspended solids can have negative effects on fish, macroinvertebrate and crayfish respiratory functions and on their respective habitats. There is potential for **temporary**, **slight, negative** impacts on the aquatic ecology of the Clare River as a result of this measure.

Operational and Maintenance Phase

There are no foreseeable operational or maintenance phase impacts on the Clare River arising from measure 4d.

Cumulative Impacts

Cumulative impacts would be primarily in association with other measures as part of the Claregalway Flood Relief Scheme. Measure 4b would be the main element of the Scheme that in conjunction with measure 4d would have potential for **temporary**, **slight negative** impacts on aquatic ecology and qualifying interests of the cSAC with respect to silt inputs to the Clare, though these impacts have a high probability of being reduced through careful mitigation. The embankment is not in the line of the surface water outlet (Measure 6a).

11.4.1.5 Measure 6a: Surface Water Outlet to Upstream of Claregalway Bridge

Construction Phase

<u>Release of sediment</u>
The nature of the measure means that there is a potential for the release of sediment during the construction phase. This may arise from earth movement associated with the excavation of new open and piped drains.

Operational and Maintenance Phase

<u>Changes to Clare River water quality</u>

Water quality changes may be associated with increase in potentially polluted run-off to the Clare River from the semi-urban/rural/industrial area. This would enter the river as a point source discharge from the newly created drain network. The proposed network will comprise sections of open drain, with connecting arterial drains, alternating with piped sections (locations not specified). Such run-off, particularly when drained by pipe systems, results in run-off from virtually every rainfall event and can contain high levels of pollution, particularly in the first part of the run-off. It has been accepted that measure 6a will not eliminate 2009 extreme flood levels (2010 Flood Studies) but it is likely to increase run-off for smaller, more frequent events. Given that the land use is a combination of urban, semi-urban, rural and non-manufacturing industrial, and also includes sections close to roads and car parks, the run-off could contain various pollutants, including silt. The discharge to the Clare River has the potential for at least **moderate** impacts on water quality and aquatic ecology if the run-off is not managed correctly.

Cumulative Impacts

Cumulative impacts would be primarily in association with other measures as part of the Clare River Flood Relief Scheme. It should be recognised that the mixing zone of the drain discharge (upstream of Claregalway Bridge) will occur in the area of proposed fisheries enhancement pools (in association with Measure 4b). Depending on the flow dynamics, the discharge is thus likely to have a slightly increased residence time within pool type habitat compared to if it was discharging to a faster flowing environment. This may have impacts on larger fish held in the pools.

11.4.1.6 Measure 8a: Replace Crusheeny Bridge

Works began at Crusheeny Bridge at the end of September, 2011 and were completed by the time further surveys were conducted in September, 2012. Measure 8a was subject to a stand alone Natura Impact Statement (NIS) as part of the Appropriate Assessment process. An associated Aquatic Ecological Assessment Report (EcIA) of August, 2011, is contained in Appendix D of that NIS. It must be noted that further fisheries information was made available since August, 2011 that gave definitive information on Clare River fisheries values, downstream of the bridge replacement (see **Section 11.3.5**). The EcIA was written under the assumption that there were sensitive fisheries interests downstream of Crusheeny Bridge, therefore, none of the aquatic assessments or conclusions have altered with regard to Measure 8a. Impacts of the bridge replacement on the flow environment of the channel are covered in the following **Section 11.4.1.7**.

Measure 8b: Channel widening from 1.3km upstream of Crusheeny Bridge to immediately downstream of Crusheeny Bridge to form a two-stage channel

Construction Phase.

The construction of the new second stage channel affects 1.3km of channel, entailing the widening of the banks on the northern side of the river (True Right) a distance of approximately 0.9km upstream of Crusheeny Bridge (as far as Islandmore drain confluence) and widening of the southern bank (True Left) for a further 400m upstream of the Islandmore confluence.

The low flow channel will generally not be affected by works, though a limited amount of instream works have been earmarked in association with measure 8a (Crusheeny Bridge replacement) and 10 (channel maintenance) which involves removal of instream tree growth during the construction phase with some silt and vegetation management and localised rock removal proposed. There are currently no EREP works proposed for this stretch of the Clare as part of this scheme.

<u>Release of sediment</u>
The proposed bank widening will involve extensive earthworks beside the main channel of the Clare River and will generate large amounts of spoil which will be either spread on lands adjacent to the river or utilised to form embankments along the southern (True Left) bank of the Clare, upstream of the Islandmore drain confluence. There is the potential for heavy rainfall to wash some of these sediments back into the river, during the bank excavations and from land-drainage outlets. Given the

scale of this measure, this could result in high suspended sediment loads in the river leading to **short term, significant, negative** impacts particularly on salmonids and their habitat, but also on crayfish, if present.

Operational and Maintenance Phase

Changes to channel velocity in relation to bank widening

- *Low Flows - 95%ile and 85%ile (Appendix 11.6, Figures 1-6)*

These flows result in very little change in any of the hydraulic parameters between the existing and proposed works with the exception of sites close to Cregmore Bridge (Section 99) where there is an increase in all three parameters for both the 95%ile and 85%ile flows.

- *Intermediate Flows - 65%ile and 50%ile (Appendix 11.6, Figures 7-12)*

At these higher flows there tends to be a greater difference between the existing hydraulic environment and the post- works environment. At 65%ile flow the velocity is higher again around Cregmore Bridge, and lower downstream at cross-sections 94 to 92, while at the 50%ile flow this trend is extended and the post works velocity is also lower at Section 97 and from 91 to 87.6, the latter from upstream of Crusheeny Bridge extending downstream around the next broad bend. Outside of these stretches, the changes in velocity tend to be more marginal. In the case of stream power, the same general trend is followed for both 65%ile and 50%ile flows, whereas in the case of Froude number the changes throughout tend to be marginal.

- *High Flows - QBar (Appendix 11.6, Figures 13-16)*

At this higher flow (flood return period of 2.3 years) the changes in velocity and other hydraulic parameters, both up and down, tend to be more pronounced, sometimes much more so, and while they broadly follow the trends of the 50%ile flows, this is not always the case. The most obvious change is the pronounced drop in velocity upstream and downstream of Crusheeny Bridge (section 91-87.3) and to a lesser extent between Cregmore and Crusheeny (section 96-93). There are also predicted velocity increases around Cregmore Bridge (section ~100 to 97).

In terms of stream power there was a pronounced drop around Crusheeny Bridge, at the same cross-sections that will experience velocity decreases. In contrast, there was an unexpected rise in stream power between section 93 and 96 despite the drop in velocity predicted for these sites. The explanation for this relates to the proposed flood protection berm which will be set back from the southern (left) bank and have the effect of narrowing the flood plain compared to the existing situation (PJ Griffin, RPS, *pers comm*). Froude number changes at high flow follow very much the same trend as velocity with proportional changes at all the same points, although to a slightly lesser degree.

Increased sedimentation associated with hydraulic changes

Any of the predicted decreases in average velocity under the different flow conditions, but especially under high flows, would be expected to increase the amount of sedimentation in the affected reaches and be generally beneficial to macrophytes by reducing the mechanical stress on plants and providing more sediment to assist root growth. This is particularly relevant to the stretch from Crusheeny Bridge to just below the first main bend downstream (i.e. section 91-87). Under the existing configuration in the channel, deposited silt or excessive build-up of macrophytes is probably kept in check by the scouring affect of larger floods occuring every couple of years. According to the OPW, the current flow regime in the Clare generally eliminates the necessity for maintenance within the study reach. It is unknown whether this characteristic may change as a result of projected reductions in average velocities.

Increased sedimentation may also increase the amount of fines in any salmon spawning redds in the study reach, which in turn would tend to reduce the survival rates of deposited eggs. On balance, such conditions would tend to favour coarse fish rather than salmonids.

Changes to fisheries habitat associated with hydraulic changes

The area around Crusheeny Bridge (section 89-90) will also see a drop in Froude number during high flows from its current optimum level (0.3-0.4) to below 0.2, suggesting that any spawning that might have occurred there in the past is unlikely to continue. In contrast, the increased velocities downstream of Cregmore Bridge (sections 99-97) result in an increase in Froude number moving these sites farther above the optimum range (0.3-0.4) which may also reduce the attractiviness of this stretch for spawning salmon. Indeed the higher velocity of this stretch during floods (**Appendix 11.6**, Figure 13 (a) & (b)) will reduce its attractiviness to juvenile salmon at such times and they will require to seek slower velocities closer to the substrate, the margins or farther downstream. However, it will remain an important area of salmonid habitat. In general, while the introduction of a two-staged bank from below Crusheeny Bridge to section 96, will result in some reductions in velocity between sections 96-91 at most flows, the resultant velocity range will still be suitable for juvenile salmon, with 0+ (young-of the-year fish) reported from areas with 20-65cm/s surface velocity and 20-40cm/s mean column velocity (Armstrong *et al.,* 2003). It is worth noting that young salmon cope with faster flows by staying close to the river bed where the velocity is generally slower than in the water column. Furthermore, older parr (1+) will tend to use areas with slightly higher velocities and may cope better at sites where the velocity is predicted to increase. Overall salmon will avoid excessive velocities (>100cm/s) and very slow velocities (<5-15cm/s). The high velocities predicted for the Cregmore Bridge stretch downstream to section 97 during high flows (Q-Bar) are excessive and sub-optimal for salmon and trout.

Overall, the proposed velocity changes in the riffle / run reach of the Clare between the Islandmore confluence and Cregmore Bridge will not significantly alter the character of the in-channel habitats there nor appreciably reduce its high value for juvenile salmon, though, without some fisheries enhancement there is potential for **permanent, moderate, negative** impact under high flow conditions there.

The increase in velocity during high flows in this upper part of the reach (100-97) will tend to be offset, however, by a reduction in velocity in the middle to lower section immediately downstream (96-91), i.e., in the slower, deeper glide habitat between the riffle / run habitat and Crusheeny Bridge. In that stretch the impacts of hydraulic change will be **permanent and slightly negative**.

Generally, velocity in the upper part of the reach (97-100) is such that excessive build-up of marginal macrophyte beds is less likely, though increases in sediment deposition and macrophyte growth cannot be ruled out in the lower sections (91-96). Overall the impact of proposed velocity changes, without mitigation, can be described as ranging from **permanent, slight, negative** (in stretches currently consisting of slower, deeper glide) to **permanent, moderately negative** impact in stretches which currently have swifter currents and coarser bottom material.

Artificial floodplain creation

Creation of a two step channel along this reach effectively connects of the river to a low floodplain with a stepped bank embankment which can be positive for river ecology. The erosive effects of the high channel velocity are reduced by allowing out-of bank flows. Suspended sediment may tend to settle on the 2nd stage channel (effectively the artificial floodplain) as flood waters recede, rather than within the river channel. In terms of river ecology these effects have the potential for a **permanent, slight, positive** impact,

New aquatic habitat creation

The hydromorphology of the Clare River will visibly alter as a result of measure 8b in the widened stretch upstream of Crusheeny Bridge compared to the current situation. **Table 11.16** shows the percentage of time that the newly created 2nd stage channel would be predicted to inundate, post-works. It is clear that, in the reach that includes sections 93-94, the new river configuration would result in out of bank flows (onto the 2nd stage channel) a significant amount of the time (i.e., 88% and

95% of the time). The 2nd stage channel in the reach closer to Crusheeny Bridge will be inundated around 65% of the time. The impact is much less dramatic in the upper reaches, (upstream of section 95) where out-of-bank flows that inundate the 2nd stage channel, will be quite rare (7% and 2% of the time at sections 95 and 95.8, respectively). The visual impact of this is permanent and quite significant in the lower sections (91-94), changing from the current canalised nature to a much wider, largely open waterbody for a considerable amount of the time. It is unknown to what extent aquatic fauna may utilise the new habitat created atop the predominantly submerged reaches of the 2nd stage channel. The sections that are more commonly submerged (93-94) are likely to develop semi-aquatic habitat, most probably stands of Reed Canary Grass which can be utilised by birds and invertebrates, and can be especially beneficial to white-clawed crayfish depending on the level of submersion. This would be a **moderately positive** impact in the short term in terms of increased biodiversity and habitat opportunities, though any future maintenance of the 2nd stage channel may lead to recurring and at least **moderately negative, medium term** impacts as a result of such maintenance.

Table 11.16: **Predicted % of time that water level of the Clare River will exceed the low flow channel and inundate the the 2nd stage channel**

Section	Flow (m^3/s)	% of time flow equalled or exceeded	Predicted WL (mOD)	Two-stage channel level -upper (mOD)
91	7.0	64%	7.97	8.00
92	6.9	66%	8.15	8.19
93	4.5	94%	8.18	8.20
94	5.5	88%	8.54	8.56
95	16.0	7%	9.37	9.40
95.8	22.5	2%	9.96	10.00

Increased bank and channel erosion

Limited parts of the channel, in particular the stretch between the end of the proposed widening (at Grange West) upstream towards Cregmore Bridge, may experience increased sediment washout or limited bank erosion during heavy floods, at least in the first few years after the proposed works. The majority of the stretch however, will experience a decrease in average velocities, after the works are complete which should reduce the amount of solids generated from these reaches compared to the existing situation.

Introduction of a fish barrier on Islandmore Drain

There is some, albeit limited, potential for salmonid and lamprey spawning (and nursery) in the lower (riffle) stretch of the Islandmore drain. Much of this habitat will be removed as part of measure 8b (channel widening), but any remaining riffle will be obstructed by the non-return sluice on Islandmore drain at the downstream end, thus presenting a barrier to any potential fish movement during the operational phase. The type and magnitude of this impact can not be determined unless fisheries values of the lower Islandmore drain are established through an electrofishing survey.

Angler Access and Safety

The building of a wide second stage channel, which will flood quite often at the Crusheeny Bridge end, but less so upstream towards the Cregmore Bridge end of works, means that anglers will be up to 20m farther away from the main channel on one bank, than at present. The extent of this impact will depend on the degree of current usage. It is extremely unlikely to be an issue at Crusheeny Bridge because the left bank upstream of the bridge, is more often used by anglers and this will not be affected by the proposed works in the stretch between the bridge and the outflall from the Islandmore drain. At the Cregmore end, works occur on the southern (True Left) bank only upstream as far as Costello's Pool (around section 97), so the overall impact may be minor.

Cumulative Impacts

Cumulative impacts would be primarily in association with other measures as part of the Clare River Flood Relief Scheme, primarily measures 8a (replacement of Crusheeny Bridge), 8c (Islandmore drain maintenance) and 10 (selective channel maintenance on the Clare River). Channel maintenance has potential for at least **moderate negative** cumulative impacts over the **short-to-medium term** in association with the permanent impacts of measure 8b. There is potential for localised, **permanent, significant, negative** impact around, and downstream, of Crusheeny Bridge in combination with the hydraulic changes predicted as a result of Measure 8a (replacement of Crusheeny Bridge). The Froude Numbers show a dramatic decrease in the suitability of habitat for salmonids from cross-sections 91-87.3 (upstream and downstream of the new Crusheeny Bridge). Fisheries enhancements could not offset the negative impact since the hydraulic character simply will no longer be conducive to salmonid production, hence the importance of fisheries enhancements further upstream as part of Measure 8b in order to compensate for loss of salmonid habitat around the new bridge.

11.4.1.7 Footbridge parallel to Claregalway N17 Bridge

Construction Phase

The proposed footbridge design utilizes existing abutments that were constructed during the Claregalway N17 Bridge diversion associated with flood eye installation (Measure 4a), so there are no foreseeable impacts associated with abutment construction. The bridge deck can be laid using a crane from one bank and there is no requirement for in-stream works. An additional single steel pillar will be required to support the footbridge located towards the southern bank. The pillar will be anchored using a concrete footing. A single concrete footing will also be required on the northern bank to secure the bridge at the existing abutment. The use of liquid concrete in close proximity to the Clare River carries the risk of spills which could reach the river. Cement is highly alkaline and can give rise to very serious fish kills with similar effects on invertebrates, including white-clawed crayfish. Wash off from poorly cured cement can also be highly alkaline and potentially dangerous to fish. Careful supervision of cement handling and general good engineering practice can greatly reduce the risk from concrete-related impacts so that the likelihood of impacts is best described as low, but the potential for **negative** impact given the toxicity of concrete to aquatic life within an cSAC is considered **moderate**.

Operational and Maintenance Phase

There are no foreseeable operational or maintenance phase impacts.

Cumulative Impacts

Cumulative impacts would be primarily in association with other measures as part of the Claregalway Flood Relief Scheme. Given the minimal level of construction works required for the footbridge, the cumulative impact would be **imperceptible**.

11.4.1.8 Selective channel maintenance on Clare River

Proposed channel maintenance is described in detail in Chapter 6 (project description) and can be broadly classified under seven headings:

A – Silt and Vegetation Management;

B – Aquatic Vegetation Cutting;

C – Bank Protection;

D – Bush Cutting / Branch Trimming;

E – Tree Cutting, and

F – Bridge/ Structure Repairs

An additional measure was identified by the OPW specific to this scheme as follows;

G - Rock Removal from River Bed

Construction Phase

Release of silt
The nature of the activity is such that maintenance can release previously deposited silt back into suspension in the watercourse which, given the lack of spawning gravels and apparent lack of crayfish population in the Clare represents a **slight, temporary, negative** impact. Migrating fish can move away from localised effects of silt re-suspension.

Loss of biodiversity through removal of instream flora and fauna
Studies have shown that maintenance in depositing areas of watercourses, including those with silt and aquatic macrophytes, e.g., *Sparganium erectum, Phalaris arundinacea* have the potential to remove large numbers of juvenile lamprey and their habitat (King *et al*., 2008a; Williams 2009 and 2010). White clawed crayfish can also utilise muddy habitat with associated aquatic macrophytes (Holditch, 2006; Williams 2009 and 2010) and populations of this species can suffer negative impacts as a result of maintenance (King *et al.,* 2008b). Lamprey ammocoetes are the most likely to be present in silt removed from the margins of the Clare River. Given the highly selective nature of proposed maintenance works this will affect short stretches in a patchy distribution along the study reach and represents a **short-to-medium term**,**moderate, negative** impact locally.

Operational and Maintenance Phase

Changes to river hydromorphology associated with maintenance
Removal of patches of marginal emergent vegetation and underlying silt are unlikely to greatly affect the overall hydromorphology throughout deeper glide sections from Lough Corrib upstream as far as the Islandmore drain confluence. However, removal of more substantial, well formed, vegetated berms at river margins along any of these stretches may have a **moderate, short-to-medium** term, **negative** impact on aquatic ecology in that low flow channels may not be adequately maintained and may take some time to re-establish.

Loss of habitat through removal of instream flora
OPW Standard Operating Procedures recommend that marginal vegetation should be left intact during river maintenance primarily ensuring conveyance through the midchannel. Given that the mid-channel of the Clare River is largely free of conveyance issues, there are aspects of the current maintenance proposal that appear to depart from the SOPs.

There are predominantly two types of marginal emergent vegetation along the Clare River: (1) pure stands of Reed Canary Grass, *P. arundinacea*, which are generally rooted on more solid berms, and, (2) stands of primarily Common clubrush, *S. lacutris*, with some Branched burr reed ("flaggers"), *S. erectum*, which tend to be rooted in soft sediments in deeper water.

Stands of Common clubrush and Branched burr reed are likely to be utilised by coarse fish, and salmonids (to a lesser extent) for more permanent cover, since they are well submerged even at low flow. These areas may provide refuge during high flow periods when velocities are naturally lower at river margins. In contrast, Reed Canary Grass most often indicates presence of a more solid underlying berm that has developed through longterm sediment depositon and it generally signifies the edge of a low flow channel that has formed within a previously drained (overdeep / overwide) channel. It provides an element of overhanging cover from the berm, but tends not to be well submerged at low flow. These marginal vegetation types should be approached differently in terms of maintenance as recommended in the mitigations (**Section 11.5.1.8)**.

Given that over a large part of the study area, there is a paucity of bankside tree cover, removal of marginal, instream cover has potential for between **slight** and **significant negative** impacts, in the **short-to-medium term** at least, depending on the location of the works and the time period between future maintenance rounds. Removal of cover would be less significant in the wide lower reaches towards Curraghmore Bridge where the margins at one bank can easily be left intact, but the impact may be more significant as the channel narrows up towards Crusheeny Bridge and marginal macrophyte stands tend to be present along one margin, alternately. In these sections removal of all maginals along the one dominant bank will result in significant loss of cover with potential for **moderate negative** impacts for both coarse and game fish. The duration of the impacts would be **short-to-medium term** but possibly recurring depending on the future maintenance schedule.

Cumulative Impacts

Cumulative impacts would be primarily in association with other measures as part of the Claregalway Flood Relief Scheme. Measures directly affecting the Clare River (4a, 4b, 8a and 8b) are likely to have the greatest cumulative impact. Cumulative impacts related to measures 4a and 8a are significantly reduced given they have been phased separately and are complete. Ideally, channel maintenance in at least the 1.5km downstream of Crusheeny Bridge could be phased to occur at a separate time to measure 8b (channel widening) so as to limit cumulative impacts of suspended solids in the water column.

11.4.1.9 'Do nothing' scenario

If the Clare River Flood Relief scheme does not proceed then the current situation will continue, i.e. the habitats and species currently inhabitating the main channel of the Clare River will persist with the normal interannual variation associated with discharge and temperature. Taking climate change scenarios into account, shorter return periods have been predicted for large flood events (Flood Studies, 2010) which would mean the lower Clare may be subject to greater frequency of elevated and peak channel velocities. The Clare River, being artificial, does not presently function with natural floodplain connectivity[16] and is subject to channel velocities that already affect aspects of aquatic physical habitat and biota. It is difficult to say what the likely ecological response to increased frequency of elevated channel velocity would be. Certainly additional flushing would ensure that the channel remained self-cleaning and without maintenance requirements, as it currently is, which is a **positive** impact in terms of salmonids and sensitive macroinvertebrates in swifter areas with fine and coarse substrates. Increased frequency of elevated channel velocity would be unlikely to have further negative impacts on adult crayfish or their habitat, since any crayfish resident in this part of the Clare River would have access to stable refuges and would normally seek refuge during high flows under the present flow regime. Juvenile crayfish, if present, may be impacted if the channel was to undergo a reduction of marginal stands of macrophytes owing to any greater level of self-cleaning capacity. Generally, it would be expected that Annex I habitat 3206 would remain limited, and salmonid spawning potential would remain somewhat patchy as a result of the present hydromorphological characteristics of the reach Overall the **do nothing impact** would be neutral or even a slightly **positive** in terms of aquatic ecology.

11.4.2 Potential impacts on Clare tributaries and drainage channels

Measures are grouped according to the general nature of the works involved. Potential impacts are then identified with respect to the ecological values of specifically affected watercourses.

16 Lowland Rivers would naturally have a greater degree of lateral connectivity with the floodplain and would reach out of bank flow levels more rapidly than a deepened, widened channel like the Clare.

11.4.2.1 Arterial drainage channel cleaning, regrading and capacity increase

Construction Phase

These activities are, in general terms, elements of arterial drainage maintenance, and involve removing obstructions to conveyance of a channel. In the case of the waterbodies affected under this scheme, works will involve removal of silt; removal of instream macrophyte growth, clearance of low hanging tree branches and clearance of any other obvious blockages, e.g., woody debris dams. Deepening and widening also affects channel hydromorphology, which in turn affects aquatic habitat and species.

Measures relating to channel maintenance will affect four areas under the proposed Scheme:

- **Montiagh South western drain series (2**) (Measure 2c)
- **Kiniska Tributary** (Measure 5b)
- **Islandmore/Caherlea arterial drainage network (5)** (Measure 8c)
- **Gortadooey Tributary**

Removal of instream aquatic vegetation and silt will be the primary activity involved with respect to watercourses earmarked for maintenance as part of this scheme. Whilst none of the watercourses investigated as part this study were found to have plant communities of significant conservation value, there were patches of habitat identified that support species protected under national and international legislation (see **Table 11.15**). The impacts are listed below.

<u>Loss of biodiversity through removal of instream flora and fauna</u>
Of the three areas earmarked for maintenance it is considered that lamprey ammocoetes are the most likely Annex II species to be directly affected by maintenance. Studies below have shown that maintenance in depositing areas of watercourses, including those with silt and aquatic macrophytes, e.g., *Sparganium erectum, Phalaris arundinacea* have the potential to remove large numbers of juvenile lamprey and their habitat (King *et al*., 2008a; Williams 2009 and 2010). White clawed crayfish can also utilise muddy habitat with associated aquatic macrophytes (Holditch, 2006; Williams 2009 and 2010) and populations of this species can also suffer negative impacts as a result of maintenance (King *et al.,* 2008b). Atlantic salmon are unlikely to be present or spawning in any of these channels owing to poor water quality and lack of suitable habitat, however there was one stretch of potential trout spawning habitat on the lower Gortadooey Tributary which could be removed under general maintenance. A newt breeding area was identified in the Montiagh South western drain series (2). The area is likely to be important for frogs also. Standard maintenance would remove all of the necessary instream newt breeding habitat.

Large numbers of macroinvertebrates including molluscs and waterbeetles will be removed during maintenance. Lamprey ammocoetes, white-clawed crayfish, newts and frogs would be physically removed. Fish tend to escape the excavation bucket particularly if a slotted bucket is used. Removal of protected species represents a **significant, negative** impact. Plant communities identified in the four areas affected by these measures, whilst not considered to be of conservation importance, are important biotic elements of the habitat of protected species and macroinvertebrate fauna, e.g., aquatic vegetation increases the habitat suitability for newts (Flood, 2010).

<u>Changes to hydromorphology associated with maintenance</u>
The four areas affected by maintenance have been previously drained and their present hydromorphology reflected that. In the case of the Montiagh drains, cleaning will not significantly alter the present hydromorphology given that these are essentially u-shaped drainage ditches. However it must be noted that the newt breeding area is currently likely to be isolated from the presence of fish and it is essential that the fish barrier remains intact because presence of fish is unfavourable to newts owing to predation (Flood, 2010). There is the potential for changes in water levels associated with

drainage of these ditches, which could have negative impacts on the newt breeding area if water levels become variable, or dry, owing to drainage. Retaining the fish barrier, however, may cause a sufficient dam effect and maintain the wetland.

The Kiniska tributatary will not be significantly altered by further cleaning or increase in capacity, though the bed levels should be kept such that patches of gravelly substrates are unaffected, even though these appear to be few.

The upper section of Gortadooey tributary was cleaned (removal of macrophytes and silt) during August, 2011. Hydromorphology in the downstream section between the road and the Clare River was overall better, with more flow and substrate diversity and this section remained uncleaned. The stretches of hard substrates (gravel/cobble) generally have few conveyance obstructions and should be protected during further maintenance. The potential for **negative** impact is **moderate** as these areas are likely to support trout (and possibly lamprey) spawning, and are likely to be locally important trout nursery habitat.

There is the potential that lamprey utilise Islandmore/Caherlea arterial drainage network given the (albeit limited) presence of gravel/cobble + silt substrates near the confluence with the Clare River. The lower part of the channel presently graded such that coarse substrates are maintained free of excessive silt. It has a slightly higher hydromorphological value compared to the upper network and was generally free of conveyance obstruction. The more upstream parts of the Islandmore drain network will not be negatively impacted by regarding, though some temporary loss of general biodiversity will result during the regrading works.

<u>Release of silt</u>
The nature of the activity is such that maintenance can release previously deposited silt back into suspension in the watercourse. Given the generally very low gradients of all of the tributatries and drains flowing into the Clare River, there is at most a **slight** chance of **negative** impacts within the Clare River as a result of silt inputs during proposed maintenance since most silt would settle within the sluggish channel before reaching the Clare. The potential for impact can be limited by undertaking works during lower flow periods, or in the case of Islandmore /Caherlea, when channels are (periodically) dry.

Operational and Maintenance Phase

Repeated channel maintenance is likely to be required on a periodic basis.

Cumulative Impacts

Each of the maintenance measures have cumulative impacts in association with other measures proposed in relation to the Clare River Flood Relief Scheme. Culvert replacement and road raising should be phased with other Measures within the Scheme to minimise release of silt to the Clare River. This primarily applies to Islandmore/Caherlea drain which flows into the stretch that will undergo the channel widening measure 8b.

11.4.2.2 Road raising and culvert replacements

Construction phase

Existing culverts need to be replaced in line with raising the level of the road. In stream works have the capacity to give rise to significant amounts of silt especially if there is heavy rain and increased flows during the culvert insertion. The latter will result in deposition in the channel downstream potentially impacting on trout spawning gravel and macroinvertebrates - in the case of the Gortadooey downstream of the existing road culvert. Increased suspended solids levels would also be likely to reach the main channel of the Clare River during these operations.

Operational and maintenance phase

If the bases of the new culverts remain above the drain/stream bed then the passage of fish upstream and downstream may be prevented during periods of low flow.

Cumulative impacts

Each of the maintenance measures have cumulative impacts in association with other measures proposed in relation to the Clare River Flood Relief Scheme. Culvert replacement and road raising should be phased with other Measures within the Scheme to minimise release of silt to the Clare River. This only applies to the Islandmore/Caherlea drain which flows into the stretch that will undergo widening measure 8b.

11.4.2.3 Drain network extension from Islandmore to Carnmore/Cashla

The upper section of the Islandmore/Caherlea drain network appears to run dry at times probably only being active as a stormwater runoff channel. The extension to this network could be undertaken during a dry period allowing sufficient time for settling of excavated ground before any flooding was likely to occur. Whilst there will be more frequent runoff during smaller events from upstream areas, this will have an **imperceptible** impact on the aquatic ecology of the Islandmore/Caherlea drains and any sediment mobilized during activity will be likely to settle in the sluggish areas of the Islandmore drain. Ideally, this upper section of drain should be excavated prior to cleaning and regrading on the main Islandmore/Caherlea drains as in their uncleaned state they would be more efficient at trapping silt generated during the excavation of the new drain.

11.4.2.4 Non-return sluice at mouth of Islandmore Drain

There is a limited potential that salmonid and / or lamprey spawning occurs in the lower reach of this drainage channel. An impassable fish barrier in the form of a non-return sluice, as proposed, would impact on this function. This has not been identified as an issue by IFI.

11.4.3 Potential Impacts on Lough Corrib

11.4.3.1 Introduction

Many aspects of the proposed flood relief works have the capacity to increase the amount of suspended solids which discharge to the Clare River and ultimately to Lower Lough Corrib and it is this aspect of the proposed measures which is considered the most likely to have any potential for adverse impact on the lake.

The following proposed measures have the potential to generate additional suspended solids:

- Bank widening in the main channel, i.e. both during the (i) construction phase and (ii) the operation phase;
- Re-grading of the channel just upstream and downstream of Claregalway Bridge;
- Regrading of drainage ditches at Montiagh north and south, Kiniska and Islandmore;
- Insertion of culverts on drainage ditches in Montiagh North and South as part of road-raising measures;
- Channelling of surface drainage from Claregalway Estates to the Clare River at Claregalway; and,
- Fisheries enhancement measure at Claregalway Bridge
- Selective channel maintenance in the Clare River.

11.4.3.2 Sources of sediment to Lough Corrib

Construction Phase

Channel Regrading at Claregalway Bridge
The deepening of the channel bed upstream and downstream of Claregalway Bridge has the potential to generate silt and suspended solids during the works. However, the use of coffer dams during this process will significantly reduce the opportunity for silt generation. It is also worth noting that the bottom materials in this stretch are generally coarse with cobbles, gravels and coarse sands very prevalent.

Cleaning and Regrading of Drainage Channels
The removal of excess macrophyte growth and silt beds from the main drainage channels within the study area will generate increased silt levels while those operations are on-going. It is important to note however, that this channel cleaning is carried out from time to time on these and other drainage channels by the OPW as they become clogged. Limited regrading is also proposed in parts of the Islandmore and Kiniska drainage channels. This will involve deepening and perhaps also widening of the stretches in question, which will tend to generate more silt and suspended solids than cleaning alone.

Insertion of culverts on drains in Montiagh North and South as part of road-raising measures.
The installation of new culverts has the potential to generate large amounts of suspended sediment during their insertion, unless adequately mitigated.

New surface drain from Lakeview commercial and residential estates to the Clare River at Claregalway
The new surface water outfall in Claregalway will lead to episodic increases in suspended sediment in the Clare River, in particular after the first flush during intense rainfall events.

Fisheries Enhancement Measure (under EREP)
The proposed EREP measure at Claregalway has the potential to generate suspended sediment during pool excavation and importation of gravel/cobble. These will involve heavy vehicle activity during low flow conditions along the banks or in the channel. Introduced material will be low in fines and so the only operation likely to generate significant amounts of silt will be the excavation of pools, depending on the nature of the bed material. It is important to note that pool excavation at Claregalway could be carried out in the dry whilst coffer dams are in place during channel regrading. This activity will be confined to only a small section of the channel and will only be undertaken during low flows in the May-September.

11.4.3.3 Potential Impact of Increased Suspended Solids in Lough Corrib

Lower Lough Corrib, which receives outflow from the Clare River, is protected for its Chara beds in particular, which grow profusely in the very shallow water body. The results of recent water quality monitoring in the lower lake indicate that the water has a mean transparency of about 4.25m, which means that across most or all of the lower lake that light penetrates to the bottom most of the time, which, along with the good water chemistry explains the success of *Chara* growth. Furthermore, the presence of extensive macrophyte beds tends to reduce wind-generated re-suspension of bottom sediments, tending to perpetuate the conditions leading to their success. To change this situation, silt generated by the proposed works would have to significantly reduce the transparency within the lower lake for extended periods during the growing season which does not seem likely. Firstly, all the works will be scheduled to take place over at least two years, and not all at once so that any sediment output will be spread out over time. In addition all of the measures come with an extensive series of mitigation measures which will be implemented as the works are being undertaken, e.g. use of a dam to protect the newly excavated widened channel, as will the stabilisation of the newly spread spoil – see **Chapter 10** for further details.

11.5 MITIGATION MEASURES

11.5.1 Clare River Measures

11.5.1.1 Measure 4a: Install Flood Eye at Claregalway Bridge

Any future maintenance requirements would require consultation with NPWS and IFI and should be carried out using OPW's Environmental Management Protocols and Standard Operating Procedures (see **Appendix 1.1**).

11.5.1.2 Measure 4b: Regrade Clare River channel upstream and under Claregalway Bridge

A detailed method statement should be drawn up by the contractor indicating what measures will be taken, including cofferdam installation, to avoid sediment or soil loss associated with all aspects of the construction and how these will be monitored for effectiveness. Best practice in protection of bare soil or spoil heaps to prevent slumping or wash-off of solids must be stated. Other aspects to be addressed include: Best practice in hydrocarbon storage and handling and on-site re-fuelling; response strategy in the case of accidental hydrocarbon spillage or hydraulic fluid leakage; response strategy and details of chain of command in the event of flooding occurring during works.

During regrading works at Claregalway Bridge, OPW SOPs will be applied to respond in the case white-clawed crayfish are present and emerge from refuges at the times of channel dewatering on both banks (2 separate occasions). In the event that significant populations of white clawed crayfish emerge, advice will be sought from IFI and NPWS to facilitate any necessary rescue and relocation.

The fisheries enhancement (EREP) should include a suitably graded run out section from the pools with gravel / cobble substrates which could compensate for fish nursery and macroinvertebrate habitat lost during deepening and pool creation. The same should occur further upstream of the bridge, around cross-sections 76.6-75, where a predicted improvement in Froude Number as a result of measure 4b shows that habitat will become more ideal for salmonid production. The Claregalway EPA monitoring station 30C011200 can be relocated slightly into suitable habitat created as part of EREP design. Consideration should be given to inserting the proposed angling pool for Claregalway Bridge at the same time that the channel is restrained within coffer dams in order to reduce the possibility of generating excessive silt.

The EREP works should be monitored at stages throughout the construction phase with the approval and co-operation of the contractor(s) and the IFI. Post works surveys should be undertaken annually for an agreed period to determine if the new works are giving rise to excessive bank erosion (or deposition) anywhere along the channel.

Works are to be carried out between May and September which is acceptable to avoid salmon spawning times. This period will also avoid critical periods for river/brook lampreys and crayfish. The sea lamprey critical spawning period (summer months) will not be avoided by the timing of the works, and though they are unlikely to be spawning in this part of the Clare River, it cannot be entirely ruled out.

11.5.1.3 Measure 4c: Address the Gap in the Wall at An Mhainistir Housing Estate

The OPW will draw up a detailed method statement that addresses Best Practice in liquid and/or mortar management addressing batching on site (if that is proposed), pouring and handling, secure shuttering / form-work, adequate curing times and management of spills. No washings should be allowed to enter nearby drains. Works should occur in the dry.

11.5.1.4 Measure 4d: Provide Local Embankment at Old Nine Arches Bridge

A detailed method statement will be drawn up by the OPW indicating what measures will be taken to avoid sediment or soil loss associated with all aspects of the construction and how these will be monitored for effectiveness. Embankment material should be selected that has low silt content. Works should be carried out during a period of settled weather with no flood risk which will allow sufficient time for construction materials to settle. Any currently existing drains that may be direct conduits to the Clare will require additional silt traps. These mitigation measures in combination with the considerable buffer area between the works and the river will reduce the likelihood of silt mobilization.

11.5.1.5 Measure 6a: Surface Water Outlet to Upstream of Claregalway Bridge

A detailed method statement will be drawn up by the OPW indicating what measures will be taken to avoid sediment or soil loss associated with all aspects of the construction phase and how these will be monitored for effectiveness. Excavation of the drain network should be undertaken with the presence of at least 20m of undisturbed buffer section between works and the Clare River. The final section of the drain connecting the conduit to the Clare River should occur once all drain construction works are complete and fines and spills have settled or been removed.

Guidance and design of Sustainable Urban Drainage Systems[17] (SuDS) or other proven silt control measures should be incorporated upstream of the outfall to the Clare to help reduce sediment and pollutant loading to Clare River that may arise during more frequent small run-off events. Hydrocarbon interception systems should be included in the drainage design since car-parking areas and roads are contained within the drainage catchment.

The specific location of the drain discharge should be decided in consultation with IFI with specific regard to proposed fisheries enhancements.

11.5.1.6 Measure 8b: Channel widening from 1.3km upstream of Crusheeny Bridge to immediately downstream of Crusheeny Bridge to form a two-stage channel

General mitigation

A Method Statement will be drawn up by the OPW listing in detail the methods which will be used for the proposed bank widening and associated spoil spreading. This needs to be sufficiently detailed to allow interested parties, in particular the IFI and NPWS, to understand the extent and location of the works and the exact limits of what is being proposed and where. This will mean that non-scheduled or non-approved works will not take place and will allow more focussed mitigation in areas which are considered more sensitive or more prone to risk than others. Furthermore, there must be ongoing consultation by the contractor(s) with IFI and NPWS throughout all phases of the works which should include attendance at progress meetings at stages agreed in advance by the contactors and designated IFI and NPWS representatives.

A mechanism for reporting of pollution incidents should be agreed in advance between the contractor(s) and the IFI.

The work flow on site must be designed to minimise damage to the edge of the banks by heavy construction vehicles or cause rutting which would increase the risk of gully erosion or solids wash-out during intense rainfall.

The fringing stands of reeds (mostly *Phalaris*) should not be removed nor damaged during construction, unless specifically agreed in advance by the IFI. This is because these beds will act as partial protection against erosion of the edges of the new bank and help to trap escaped solids from

17 http://www.irishsuds.com/guidance_criteria.htm

the earth works. Trimming back may be an option, where they are considered a hindrance to angling for example.

It is proposed that a section of the existing Clare river bank will be retained as a dam between the river and the works area (discussed in **Chapter 10**). The dimensions of this retained bank or 'dam' will be dependent on the depth of excavations at a given location, i.e. it will be as wide as it is deep. Typically this will be of the order of 2m.

The 'dam' will be maintained during widening of the channel to prevent any loose material from the newly excavated upper stage of the two-stage channel or "berm" from running into the lower stage (existing) channel during works.

Furthermore, until the spoil sites have stablised, surface water runoff from the spoil heaps and landspreading sites will be collected via a shallow interceptor ditch with check dams (inside the dammed off area) to provide short term attenuation and serve as an additional silt-trap. The interceptor ditch will be excavated prior to works commencing for a distance of 100m even if the working area is confined to 20m. The number of check dams to be provided will have to be determined once the ditch is constructed and surveyed to determine the slope. Please refer to **Chapter 10** for illustrative details.

In addition at 100m intervals along the 'dam' retained, a filtered outfall will be provided to accommodate any surface water runoff retained by the works. Similar stone filters will be constructed intermittently along the works area to further filter any runoff (see **Chapter 10**).

In year 2 the dam will be excavated and disposed of into the interceptor ditch and covered with washed stone or reseeded as appropriate. The exposed bank at the site of the excavated berm will also be covered in rock to stabilise the bank or reseeded as appropriate. This work should run in parallel to the widening works.

Stockpiling of any soil should be placed on flat ground on the Clare River bank or at least 5m from the nearest drainage ditch and preferably in a grassed area, so that any run-off can filter through the grass and prevent sediment run-off. Stone will be stockpiled since it will not be suitable for landspreading.

Spoil spread on adjacent lands should be kept at least 2m back from the edges of land drains and 5m from larger watercourses. All spoil should be re-seeded as soon as it has been spread in order to stabilise it and reduce the possibility of solids wash-out to surface waters.

All fuel and hydraulic fuels stored on the worksite should be in a locked and bunded container. Refuelling should only take place well back from the edge of watercourses and all stationary plant should be placed on drip trays to prevent leaking oils reaching the river or entering groundwater.

Fisheries Mitigations

The lower stretch of the Islandmore drain (just upstream of the Clare River confluence) should be electrofished to determine fisheries values in 2 places: (i) within the first 30m stretch to be excavated as part of the channel widening measure, and (ii) within any suitable remaining habitat just upstream of that point that may be affected by introduction of the non-return valve flap.

Consider introducing coarse gravels into suitable sections of the stretch upstream of Crusheeny Bridge (between sections 95 – 97, for example) to compensate the cumulative impact of loss of channel velocity as a result of bank widening and the dramatic decrease in Froude number around Crusheeny Bridge which is likely to have seriously reduced or eliminated any salmon spaning activity at that point.

Random boulders could be placed in the first stretch downstream from Cregmore Bridge (cross-section 100 downstream to about cross-section 97), in order to provide additional cover for juvenile salmon during periods of high flow, when the model predicts significant increases in velocity there. The boulders would also increase microhabitat diversity in the stretch.

Any enhancement works would require the approval of the IFI and be supervised by them during their introduction.

Mitigation for anglers

Any recommendations for mitigation of access difficulties as a result of the bank widening measure 8b will depend on the extent to which this particular stretch is used, downstream of Costello's Pool.

Warning signs alerting anglers to the danger of a drowned bank during low to moderate floods, should be considered along the bank above the second stage channel since the second stage channel is likely to be submerged particularly between Crusheeney Bridge and Section 94. Signage at Cregmore and Crusheeny Bridges, alerting anglers (Irish and Eastern European) to the potential danger of drowning, if they walk on the submerged 2nd-stage channel during floods, is recommended. This needs to be confirmed by IFI.

Future maintenance management of the second stage channel

Future maintenance of the second stage channel should follow OPW Standard Operating Procedures with respect to lamprey and crayfish, which may utilise these new habitat areas in the future, i.e., probably stands of Reed Canary Grass (*Phalaris* sp.) in new semi-aquatic reaches (sections 91-94).

11.5.1.7 Footbridge parallel to Claregalway N17 Bridge

The main aspects to make sure to address are: best practice in bulk-liquid concrete management addressing pouring and handling, secure shuttering / form-work, adequate curing times. Works should occur during dry weather in a low flow period where possible when there is little chance of flood waters rising onto the second stage channel. The timing of the works must be specified and agreed with the IFI in relation to fish migration and spawning periods.

11.5.1.8 Selective channel maintenance on Clare River

Mitigations should adhere to the OPW's Environmental Management Protocols and Standard Operating Procedures. Of particular importance in the context of the Clare River Scheme under each element of maintenance proposed are the following:

A – Silt and Vegetation Management

- Carry out this element only during low flows.
- Reed Canary Grass – top the underlying berm, but not below the low flow mark.
- Common Club rush / Branched Burr reed – remove from deeper water along with rootballs and silt.
- Leave marginal vegetation intact on one bank (i.e., avoid clearing both banks/margins) **or,**
- Leave a proportion of vegetation intact on one bank in places where marginal growth is dominant along one bank.
- Skipping sections where there are no conveyance issues.
- Regular checking of spoil for lamprey and crayfish and subsequent adherence to mitigations as stated in OPW Environmental Management Protocols and Standard Operating Procedures with respect to these species.
- Never remove gravels and other hard substrates as part of this element.

B – Aquatic Vegetation Cutting

None proposed under this scheme.

C – Bank Protection

OPW's Environmental Management Protocols and Standard Operating Procedures.

D – Bush Cutting / Branch Trimming
OPW's Environmental Management Protocols and Standard Operating Procedures.

E – Tree Cutting
- Maintain cover and shade on at least one bank
- Trim lower branches of mature trees to high flow levels while retaining cover.

F – Bridge/ Structure Repairs
None proposed under this scheme.

G - Localised rock removal
- Never remove cobbles or gravels and other finer substrates as part of this element

General mitigation
It is important to avoid cleaning of entire stretches of marginal emergent vegetation. Intermittent stands of emergent marginal vegetation should be left intact to provide cover/ refuge areas for salmonid and coarse fish and other aquatic fauna. This is especially relevant in locations where marginal vegetation is dominant along one bank only, e.g., long glide downstream of the estevelle, downstream of Crusheeny Bridge. It is less relevant where the river is either very wide (closer to Curraghmaore Bridge / Lough Corrib) or where a stretch of marginal vegetation can be left intact along the opposing river bank. Works should, therefore, be carried out so that a suitable proportion of marginal vegetation is left intact either along one entire river margin or along at least 30% of one margin in those places where growth is predominantly confined to one side of the river.

Vegetated berms, usually indicated by presence of Red Canary Grass, that have developed within the profile of the channel should be topped to the low flow level only, and not removed, so as to protect and maintain the existing low flow channel which has developed over time.

Stockpiling of any spoil should be placed on flat ground on the Clare River bank or at least 5m from the nearest drainage ditch and preferably in a grassed area, so that any run-off can filter through the grass and prevent sediment run-off. Spoil spread on land should be kept at least 2m back from the edges of land drains and 5m from larger watercourses.

All fuel and hydraulic fuels stored on the worksite should be in a locked and bunded container. Refuelling should only take place well back from the edge of watercourses and all stationary plant should be placed on drip trays to prevent leaking oils reaching the river or entering groundwater.

Specific mitigation
Ideally, no channel maintenance should be carried out in the stretch upstream of Crusheeny Bridge undergoing bank widening (Measure 8b) At the least, any maintenance in this reach, especially silt and vegetation management, should not occur until after the second stage channel has been completed and bedded in, for two reasons: (i) a level of buffering and sediment filtration will be provided by leaving marginal vegetation in-situ during the 8b construction phase, and (ii) the existing low flow channel of the Clare River will be protected and maintained.

The importance of checking spoil for lamprey ammocoetes and crayfish and notifying both IFI and NPWS according to OPW SOPs is emphasised. A suitably qualified aquatic ecologist and / or member of the IFI should be on hand during, at least, the first few hours of silt deposit removal at various places along the channel to determine the magnitude of this potential impact.

11.5.2 Clare tributaries and drainage channels

11.5.2.1 Arterial drainage channel cleaning, regrading and capacity increase

General mitigation should involve implementation of the OPW's Environmental Management Protocols and Standard Operating Procedures (OPW, 2011). Given the proximity of these channels to the Lough Corrib cSAC and the potential that they support populations of Annex II species further measures proposed under OPW's Standard Operating Procedures with respect to Lampreys and White clawed crayfish should be used, including the requirement to record and report presence of Annex II species (OPW, 2011).

Three areas require specific mitigation in relation to maintenance measures:

1. At **Montiagh South** (Measure 2c), the newt breeding area should not be interfered with and all drain cleaning in that area must be carried out under NPWS licence. In Ireland, although their habitat is not afforded legal protection, it is an offence to capture or kill smooth newts without a licence. Any disturbance to a newt breeding site, therefore, requires a licence from NPWS and potentially a compensation plan would need to be proposed if the site was to be lost. Further investigation of the drains in that area may be necessary to see how much residual habitat will remain after the proposed drainage. Works need to be timed here to avoid the critical breeding period. Adult newts generally move to ponds in February and March where females lay eggs that hatch and develop into a tadpole within about 10 – 20 days. Over the summer the newt efts develop into adults and emerge around September to spend two to three years on land until they become sexually mature (Flood, 2010).
2. At **Gortadooey Tributary**, the IFI have an agreement with the OPW with respect to the potential spawning area in the lower stretch near the Clare confluence. This should be respected during any future maintenance. An electrofishing survey is recommended in the lower stretch of the tributary to establish current fisheries values.
3. At **Islandmore/Caherlea** drainage channel (Measure 8c), the stretch upstream of the Clare confluence should also be electrofished to establish fisheries values and this may need to be protected from invasive maintenance particularly since conveyance through the stretch is good.

Works should follow general timing restrictions with respect to lamprey (April through to late July), trout spawning (May – October) and white clawed crayfish (November to June). Overall, works should ideally occur in August and September, but electrofishing surveys in the Islandmore and Gortadooey channels may help expand this window if sensitivities were found to be absent.

11.5.2.2 Road raising and culvert replacements

Gortadooey Tributary downstream of the proposed culvert should be electrofished in advance of any works to assess whether there are any fish or lamprey ammocoetes in the affected channels. This will determine the degree of sensitivity of the channel prior to proposed works.

In order to limit the escape of silt, it is recommended that short, temporary by-pass channels are excavated around the culverts being replaced and that these bypasses are lined with geotextile before the flow is diverted into them. This will allow the new culvert to be inserted in the dry in the existing channel, thereby reducing the quantities of silt generated by the construction. Culverts will be pre-fabricated and inserted or assembled on site without the use of bulk liquid concrete. If concrete is required then all the necessary precautions associated with using cement in or by watercourses should be followed. The base of each culvert should be placed below the current bed level and any coarse material present under and arounds the existing channel should be removed, set aside and then replaced over the base of the new culvert after they have been inserted. This will help preserve the existing habitats as much as possible.

11.6 RESIDUAL IMPACTS

11.6.1 Clare River

11.6.1.1 Measure 4a: Install Flood Eye at Claregalway Bridge

Residual impacts are neutral to imperceptible.

11.6.1.2 Measure 4b: Regrade Clare River channel upstream and under Claregalway Bridge

There will be a fundamental change to channel hydromorphology over an 80m stretch of the Clare River and this may in turn alter flow characteristics of upstream and downstream sections to some extent. However, the inclusion of the fisheries enhancement (EREP) measure is likely to determine the residual habitat, more so than the channel deepening measure in isolation.

Provided mitigation is carried out as specified including EREP measures that replace shallower run/glide habitat downstream and upstream, of newly created pools, this may compensate for the loss of the present extent of fisheries nursery habitat. EREP must provide substrates and habitat conditions that are suitable to more sensitive macroinvertebrate species in order to maintain the potential for benthic macroinvertebrate diversity. Macroinvertebrates and aquatic plants will recolonise, albeit in slightly different distribution patterns depending on flow types. Pools are likely to accumulate some soft sediments which will create new nursery habitat for lamprey ammocoetes. Crayfish, if present in the area will recolonise suitable areas especially if rock and boulder are replaced in the channel towards pool inflow and outflow areas.

The in-channel works will remove plant cover by the bridge, which cause local damage to what is considered to be a poor example of Annex I habitat No. 3206: *Watercourses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation.* This impact will be **slight**, with vegetation expected to re-colonise rapidly, albeit with a different distribution which will be dependent on residual flow types created by EREP measures. Over the relatively short affected stretch, all other removed plant species will be rapidly replaced by re-growth, and invertebrates will recolonise primarily through downstream drift from the undisturbed upstream areas.

Provided works are carried out in accordance with details outlined in the overview section above, the residual impact will be permanently slightly negative, given that a habitat type that is scarce (juvenile fish nursery area) will have been permanently replaced with a fish holding area. It is critical that fisheries enhancements focus, not just on pool creation, but on replacement/reinstatement of fish nursery habitat and macroinvertebrate habitat downstream of the newly created pooling area (and upstream also if bed levels are designed to allow for it). In that case the overall conservation status of aquatic qualifying interests of the cSAC would not be significantly affected.

11.6.1.3 Measure 4c: Address the Gap in the Wall at An Mhainistir Housing Estate

Provided works are carried out in accordance with mitigation section above, associated residual impacts on the Clare River and the cSAC overall will be **neutral**.

11.6.1.4 Measure 4d: Provide Local Embankment at Old Nine Arches Bridge

Provided works are carried out in accordance with mitigation section above, associated residual impacts on the Clare River and the cSAC overall will be **neutral**.

11.6.1.5 Measure 6a: Surface Water Outlet to Upstream of Claregalway Bridge

There will be ongoing, intermittent, inputs to the Clare River from the newly constructed drain, which is likely to only flow during run-off events. Residual impacts would be reduced to **long term**, **slight, negative** if SuDS design and hydrocarbon interceptors are implemented and more so if the drain discharged downstream of angling amenity pools. Design should be agreed with IFI and NPWS.

Measure 8b: Channel widening from 1.3km upstream of Crusheeny Bridge to immediately downstream of Crusheeny Bridge to form a two-stage channel

With correct implementation of mitigation measures, correct phasing of this measure with the channel maintenance measure, and some forethought as to the future maintenance management of the second stage channel (i.e., no maintenance), this aspect of the scheme will, on balance, have a **neutral** impact on aquatic ecology and qualifying interests of the cSAC. Without fisheries enhancement measures, however, the changes, would be expected to be overall **slightly negative** and **permanent**.

11.6.1.6 Footbridge parallel to Claregalway N17 Bridge

If correctly mitigated during the construction phase there will be a **neutral** impact on aquatic ecology and qualifying interests of the cSAC.

11.6.1.7 Selective channel maintenance on Clare River

Lamprey juveniles are most likely to be affected by silt removal, however studies have shown that lamprey can rapidly colonise newly-created or residual areas of sediment deposition (King *et al.,* 2008a). So long as a proportion of marginal vegetation is left intact within each stretch where element A (silt and vegetation management) is proposed, and berms are topped not removed, then residual cover and low flow channels should remain adequate for salmonid and coarse fish.

There is not expected to be any significant impacts on qualifying species or habitats of the cSAC as a result of the selective maintenance proposed, but recovery of, for instance, marginal macrophyte stands can take some time. Therefore, if all mitigation measues outlined above are implemented, there are expected to be **short-to-medium term, slight, negative** residual impacts overall.

11.6.2 Clare tributaries and drainage channels

11.6.2.1 Arterial drainage channel cleaning, regrading and capacity increase

Lamprey juveniles are most likely to be affected, however studies have shown that lamprey can rapidly colonise newly-created or residual areas of sediment deposition (King *et al.,* 2008a). Whilst there are not expected to be any significant impacts on qualifying species or habitats of the cSAC, recovery of drained channels can take some time (1.5-3 years). Therefore, if all mitigation measues outlined above are implemented, residual impacts are expected to be **short term, moderate, negative** overall.

11.6.2.2 Road raising and culvert replacements

If all mitigation outlined above is properly implemented, there will be **temporary, slight negative** residual impact overall.

Table 11.17 summarises mitigation recommendations and residual impacts in relation to individual measures.

Table 11.17 Clare River Flood Relief Scheme – Impact mitigation and residual effects (adapted from NRA, 2009)

Location	Measure	Mitigation	Residual Impact
Montiagh South	**2a**	General good practice in road building with particular respect to silt control, especially at small land drain crossing points.	Slight, temporary, negative during construction. Overall imperceptible, neutral.
Montiagh South	**2b**	Gortadooey tributary downstream of the proposed culvert should be electrofished in advance of any works to assess whether there are any fish or lamprey ammocoetes in the affected channels. In order to limit the escape of silt, it is recommended that short, temporary by-pass channels are excavated around culvert locations and the bypasses are lined with geotextile before flow is diverted into them. This will allow culvert installation in the dry within the existing channel. The culverts will be pre-fabricated and inserted or assembled on site without the use of bulk liquid concrete. If concrete is needed then all the necessary precautions associated with using cement in or by watercourses should be followed. The base of each culvert in accordance with standard OPW Section 50 requirements will be placed below the current bed level. Where appropriate, as directed by IFI, any coarse material present under and around the existing channel will be removed, set aside and then replaced over the base of the new culvert after they have been inserted. This will help preserve the existing habitats as much as possible.	Slight, temporary, negative during construction with resultant imperceptible, long term, negative.
Montiagh South	**2c**	Implement OPW's Standard Operating Procedures (OPW, 2011). Obtain NPWS licence for works in this area to protect newts and breeding habitat. Retain fish barrier between newt wetlands and main channel.	Locally moderate, short term, negative.
Montiagh North	**3a**	As for 2a and 2b, above.	Slight, temporary, negative during construction. Overall imperceptible, neutral.
Montiagh North	**3b**	As for 2a and 2b, above.	Slight, temporary, negative during construction. Overall imperceptible, neutral.
Gortadooey Trib.		Electrofishing survey recommended in lower stretch prior to works commencing. Do not remove gravels and other hard substrates – skip sections - in agreement with IFI.	Slight, short term, negative
Claregalway Village	**4a**	*Construction works complete*. Future channel maintenance will require application of OPW Standard Operating Procedures for works within cSAC with reference to Atlantic Salmon, White-clawed crayfish and Lampreys.	Permanent, neutral.
Claregalway Village	**4a**	Any future maintenance requirements would require consultation with NPWS and IFI and should be carried out using OPW's Standard Operating	Permanent, neutral.

Location	Measure	Mitigation	Residual Impact
		Procedures which include Environmental Drainage Maintenance (EDM) guidance. Regrading works are discussed below.	
	4b	A detailed method statement should be drawn up by the OPW indicating what measures will be taken, including cofferdam installation, to avoid sediment or soil loss associated with all aspects of the construction and how these will be monitored for effectiveness. Best practice in protection of bare soil or spoil heaps to prevent slumping or wash-off of solids must be stated. Other aspects to be addressed include: Best practice in hydrocarbon storage and handling and on-site re-fuelling; response strategy in the case of accidental hydrocarbon spillage or hydraulic fluid leakage; response strategy and details of chain of command in the event of flooding occurring during works. A mechanism for reporting of pollution incidents should be agreed in advance between the contractor(s) and the IFI. OPW Environmental Protocols and SOPs will be applied to respond in the case white-clawed crayfish are present and emerge from refuges at the times of channel dewatering on both banks (2 separate occasions). In the event that significant populations of white clawed crayfish emerge, advice will be sought from IFI and NPWS to facilitate any necessary rescue and relocation. Fisheries enhancement (EREP) must include a suitably graded run out section from the pool with fine and coarse substrates which could compensate for fish nursery and macroinvertebrate habitat lost during deepening and pool creation. The same should occur further upstream of the Bridge, around cross-sections 76.6-75, where a predicted improvement in Froude Number as a result of measure 4b shows that habitat will become more ideal for salmonid production. It may be possible to create similar habitat at the run into the pool at the upstream end since there is likely to be a bed level change. Consider, in agreement with IFI, inserting new angling pools when the river is constrained by cofferdams.	Permanent, slight negative with the implementation of EREP fisheries enhancements.

Location	Measure	Mitigation	Residual Impact
Claregalway Village (continued)	**4b (contd)**	To limit cumulative impacts, 4b construction phase should be sequenced to occur a sufficient time after channel maintenance in the Clare (say within 0.5-1km) upstream of the Claregalway Bridge. Works to be carried out between May and September to avoid critical breeding periods for future channel maintenance will require application of OPW Standard Operating Procedures for works within cSAC with reference to Atlantic Salmon, White-clawed crayfish and Lampreys. Water quality will be monitored at stages throughout the construction phase with the approval and cooperation of the OPW and their contractor(s) and the IFI. Post works site surveys will be undertaken annually by the OPW to determine if the new works are giving rise to excessive bank erosion or deposition anywhere along the channel.	
Claregalway Village	**4c**	The OPW will draw up a detailed method statement that addresses Best Practice in liquid and/or mortar management addressing pouring and handling, secure shuttering / form-work, adequate curing times and management of spills. No washings should be allowed to enter nearby drains. Works should occur in the dry.	Neutral
Claregalway Village	**4d**	A detailed method statement should be drawn up by the OPW indicating what measures will be taken to avoid sediment or soil loss associated with all aspects of the construction and how these will be monitored for effectiveness. Use low silt content embankment material. Works undertaken during period of settled weather where possible to allow sufficient time for construction materials to settle. Any currently existing drains that may be direct conduits to the Clare will require additional silt traps.	Neutral

Location	Measure	Mitigation	Residual Impact
Claregalway Footbridge	**N/A**	The main aspects to make sure to address are: best practice in bulk-liquid concrete management addressing pouring and handling, secure shuttering / form-work, adequate curing times. Works should occur during dry weather in a low flow period where possible when there is a reduced chance of flood waters rising onto the second stage channel. The timing of the works must be specified and agreed with the IFI in relation to fish migration and spawning periods. A mechanism for reporting of pollution incidents should be agreed in advance between the contractor(s) and the IFI.	Neutral
Kiniska	**5a**	Implement OPW's standard operating procedures (OPW, 2011). Retain sections of hard substrates and grade bed accordingly.	Locally moderate, short term, negative
Kiniska	**5b**	Implement OPW's standard operating procedures (OPW, 2011). Retain sections of hard substrates and grade bed accordingly.	Locally moderate, short term, negative
Lakeview	**6a**	A detailed method statement should be drawn up by the OPW indicating what measures will be taken to avoid sediment or soil loss associated with all aspects of the construction phase and how these will be monitored for effectiveness. Excavation of the drain network should be undertaken with the presence of undisturbed buffer zone between works and the Clare River with final section of the drain connected once all drain construction works are complete and fines and spills have settled or been removed. Use SuDS Guidance or other proven silt trap measures to reduce sediment loading to Clare River. Incorporate hydrocarbon interceptors.	Slight, short term, negative during construction. Slight, long term, negative during operation.
Caherlea/ Lisheenavalla	**8a**	See Crusheeny Bridge NIS report.	See Crusheeny Bridge NIS report.
Caherlea/ Lisheenavalla	**8b (operational phase)**	In order to off-set potential negative impacts with respect to predicted changes in the hydraulic character of the Clare fisheries enhancement measures should be implemented in this reach, especially to offset the loss of salmonid habitat upstream and downstream of the new Crusheeny Bridge itself.	With implementation of mitigation measures and incorporation of the proposed fisheries enhancements this aspect of the Scheme will, on balance, have a neutral impact on the overall ecology of the affected reach. Without EREP the residual impact would be permanent, slight, negative.

Location	Measure	Mitigation	Residual Impact
Caherlea/ Lisheenavalla (continued)	**8b (construction phase)**	Water quality will be monitored at stages throughout the construction phase with the approval and cooperation of the OPW and their contractor(s) and the IFI. Post works site surveys will be undertaken annually by the OPW to determine if the new works are giving rise to excessive bank erosion or deposition anywhere along the channel. A Method Statement must be drawn up by the OPW listing in detail the methods which will be used for the proposed bank widening and associated spoil spreading or stockpiling. This needs to be sufficiently detailed to allow interested parties, in particular the IFI and NPWS, to understand the extent and location of the works and the exact limits of what's being proposed and where. This will mean that non-scheduled or non-approved works will not take place and will allow more focussed mitigation in areas which are considered more sensitive or more prone to risk than others. Furthermore, there must be ongoing consultation by the contractor(s) with IFI and NPWS throughout all phases of the works which should include attendance at progress meetings at stages agreed in advance by the contactors and designated IFI and NPWS representatives. A mechanism for reporting of pollution incidents should be agreed in advance between the contractor(s) and the IFI. The work flow on site must be designed to minimise damage to the edge of the banks by heavy construction vehicles or cause rutting which would increase the risk of gully erosion or solids wash-out during intense rainfall. Fringing reeds should not be removed nor damaged during construction, unless specifically agreed in advance by the IFI. These beds will act as partial protection against erosion of the edges of the new bank and help to trap escaped solids from the earth works. The newly exposed subsoil on the widened banks will be protected through the creation of a 'dam' at the river banks edge. This work should run in parallel to the widening works. If stockpiling, place on flat ground on the Clare River bank edge or at least 5m from the nearest drainage ditch and preferably in a grassed area to filter run-off.	

Location	Measure	Mitigation	Residual Impact
		Spoil spread on adjacent lands should be kept at least 2m back from the edges of land drains and 5m from larger watercourses. All spoil should be re-seeded as soon as it has been spread in order to stabilise it and reduce the possibility of solids wash-out to surface waters. All fuel and hydraulic fuels stored on the worksite should be in a locked and bunded container. Refuelling should only take place well back from the edge of watercourses and all stationary plant should be placed on drip trays to prevent leaking oils reaching the river or entering groundwater. Future channel maintenance will require application of OPW Standard Operating Procedures for works within cSAC with reference to Atlantic Salmon, White-clawed crayfish and Lampreys.	
Caherlea/ Lisheenavalla	**8c**	Electrofishing survey recommended in lower stretch prior to works commencing. Implement OPW's standard operating procedures (OPW, 2011). Do not remove gravels and other hard substrates – skip sections - in agreement with IFI.	Locally moderate, short term, negative
Caherlea/ Lisheenavalla	**8d**	General good practise in road building with particular respect to silt control, especially at small land drain crossing points.	Imperceptible
Carnmore/Cashla		Ideally, this upper section of drain should be excavated prior to cleaning and regrading on the main Islandmore/Caherlea drains as in their uncleaned state they would be more efficient at trapping silt generated during the excavation of the new drain	Imperceptible
Clare River - Selective Channel Maintenance	10	Careful adherence to OPW's SOPs and EDM Protocols, particularly: - skipping sections - leaving marginal vegetation intact on one bank (i.e., avoid clearing both banks/margins) - checking spoil for lamprey and crayfish and employing mitigations as listed in the SOPs with respect to these species. - Topping of vegetated berms as opposed to removal. - Do not remove gravels and other hard substrates from riffle / run habitat	Short-to-medium term, slight, negative (periodically recurring impact depending on future channel maintenance schedule)

Location	Measure	Mitigation	Residual Impact
		Minimise or preferably avoid carrying out channel maintenance in the stretch undergoing channel widening upstream of Crusheeny Bridge.	

11.7 CONCLUSIONS

The Clare River Flood Relief Scheme encompasses a range of specific measures designed to reduce floodplain inundation by improving capacity and conveyance in the main channel of the Clare River between approximately 1.3km upstream of Crusheeny Bridge to Lough Corrib. Several of the larger drainage channels in the vicinity, that confluence with the Clare River in the stretch described, are also included in the Scheme. Associated works include alterations to both Claregalway and Crusheeny Bridges to increase capacity to take high flows; the regrading of the river bed just upstream and downstream of Claregalway Bridge; creation of a second stage channel upstream of Crusheeny Bridge; the raising of culverts on some of the drainage channels in Montiagh North; the laying of an extension to the Islandmore – Caherlea drainage channels; the laying of a new surface water drain to carry run-off from a residential and commercial area of Lakeview to the river just upstream of Claregalway Bridge and selective channel maintenance along the Clare River between (just downstream of) Curraghmore Bridge and 1.3km upstream of Crusheeny Bridge. The project is primarily set in the Lough Corrib cSAC.

The most significant of the measures, in terms of the extent of the works involved are the widening of the Clare River banks along a 1.3km reach upstream of Crusheeny Bridge, in order to create a new second stage channel and the regrading of the river bed in the vicinity of Claregalway.

These changes will result in only very minor alterations in the in-channel flow environment during low flows (85%ile – 95%ile). However, at intermediate flows (e.g. 50%ile and 65%ile) and high flows (e.g. Q-Bar), the changes in flow characteristics are likely to be more pronounced. In general, the alterations to habitat and hydromorphology are considered more significant at Clargegalway, with flow alterations contributing less to the level of negative impact there. In contrast, at Crusheeny Bridge the alterations in flow are more significant and affect a longer stretch (downstream of the bridge) and in combination with alterations to the river bed during the construction of the new bridge, will probably reduce salmon spawning and nursery capacity of this stretch. Upstream of Crusheeny Bridge, aterations in flow environment will generally result in a reduction in velocity from Section 92 to 96 and increases in the Cregmore Bridge stretch and downstream (sections 97-100). Overall, these changes are expected to off-set each other and generally not significantly reduce the suitability of the riffle / run stretch upstream of the Islandmore drain confluence for juvenile salmonids because predicted reductions in velocity in that stretch during intermediate and high flows, will remain within a suitable range for juvenile salmon. Overall, however, targeted mitigation is recommended and will be required to fully offset what are otherwise expected to be permanent, slightly negative impacts on salmon generative and nursery capacity in the main channel of the Clare River within the study area from just downstream of Claregalway Bridge (section 69) to Cregmore Bridge (section 100) as a result of the combined works. Fisheries enhancements through this stretch would need to be discussed, designed and agreed with the IFI.

Any fisheries enhancement under the EREP in combination with the predicted reductions in intermediate and high flow channel velocity may lead to creation of more favourable habitat for lampreys and white-clawed crayfish. This would be positive in terms of the conservation objectives of these Annex II species in the context of the Lough Corrib cSAC.

During the construction phase of this part of the project, including the landspreading or stockpiling of excavated spoil there is significant opportunity for the escapement of large amounts of silt into the river unless detailed mitigation measures are implemented from the outset. Channel widening is, thus, a major aspect of the project, however, with implementation of mitigation measures and incorporation of the fisheries enhancements, this aspect of the Scheme will on balance have a neutral impact on the overall ecology of the affected reach.

Owing to the level at which flows are predicted to inundate the proposed second stage channel there is a strong possibility that semi-aquatic habitat will develop atop the second stage channel in the reach from Crusheeny Bridge upstream to, at least, cross section 94. This may provide new aquatic habitat opportunities (primarily within stands of Reed Canary Grass) which should be protected by an agreement to preclude future maintenance along the second stage channel.

The primary adverse impact in association with selective channel maintenance along the Clare River is the possibility of removal and subsequent mortality of lamprey ammocoetes within silt deposits. There is less likelihood of crayfish being present, but their presence cannot entirely be ruled out. Given that lampreys and crayfish are qualifying interests of the cSAC, careful adherence to OPW Standard Operating Procedures with respect to these species is essential. A suitably qualified aquatic ecologist and member of the IFI should be on hand during the first couple of hours of silt deposit removal at agreed locations along the Clare River to determine the magnitude of this potential impact. Recovery of ammocoetes (and crayfish, if present) from spoil may need to be considered if populations are moderate or significant. The overall magnitude of this impact, however, is lessened by the selective nature of this element of maintenance and the relatively small amount of cSAC channel overall that the proposal suggests will be affected. The second most important thing is that any vegetated berms, which have developed in places along margins (very limited), should be topped and not fully removed from the cross section, which is in line with berm management methods outlined in the OPWs Environmental Drainage Maintenance practices (OPW, 2007).

The cleaning and partial regrading of several drainage channels at Montiagh North and South, Kiniska and Islandmore/Caherlea will result in a temporary reduction in biodiversity in aquatic plant, macroinvertebrate and to a lesser extent fish communities. None of these watercourses appears to hold protected species, with the exception of newts in one, and most are very sluggish and plant-choked. However, some short stretches have more diverse habitats and electrofishing surveys are recommended to eliminate the possibility that brook lamprey ammocoetes may be present in some stretches and perhaps brown trout also. In either case, these channels should be cleaned and regraded following the OPW's Standard Operating Procedures (OPW, 2011), which can facilitate a more rapid and complete recovery of the biodiversity and can be adapted to retain more valuable habitat (by skipping sections) to avoid damage to sections, which may contain suitable spawning habitat.

The proposal to upgrade several culverts on the Montiagh drainage channels in association with road raising, is a relatively straightforward aspect of the work which, with good engineering practice, proper culvert design and proper mitigation during their insertion will lead to minimal adverse impacts from this aspect of the works.

The extension of the Islandmore/Caherlea drainage channel is unlikely to have any adverse impacts, while the construction of a new surface water discharge point within Claregalway, should have no more than a minor localised impact, provided it is designed and built following the SuDS principles and provided it includes sedimentation and hydrocarbon interception in the finished line.

With regard to downstream impacts on Lough Corrib the primary concern would be sediment loss associated with individual measures. The timing and sequencing of upstream measures coupled with mitigation applied with respect to each measure will reduce the potential for silt generation at source and stem the potential for losses. Moreover, all of the instream works will be undertaken during the May-September low flow period but even then only when water levels allow. It is worth noting that all of the study area has a very low gradient so that any substantial amounts of silt generated by instream works associated with drainage channel cleaning and regrading will tend to settle within the channels themselves. Furthermore, most activities will be situated several kilometres upstream of the lake, allowing for dilution and settlement within the main channel, before reaching the lake. Finally, it should be remembered that the Clare River drains a very extensive catchment about 30% of the whole Lough Corrib cSAC, such that during floods, the additional solids load from the area of the works is likely to form only a small contribution to the total load. That, combined with the episodic nature of suspended solids transport suggests that the proposed works, after mitigation, are unlikely to have an adverse impact on the receiving waters of Lower Lough Corrib and any qualifying interests present in the lake. Impacts to the wider Corrib cSAC from the proposed measures are not expected once the mitigation measures recommended are implemented in full.

The Clare River Flood Relief Scheme as a whole is a large and varied project, which will require careful phasing and coordination to ensure it runs smoothly. It will require considerable liaison between OPW and their contractors, IFI and the NPWS, therefore adequate and timely communication between these parties on the project will be a key determinant of a successful environmental outcome.

To that end, a small working group involving these three parties and Galway County Council should be set up as soon as the project receives statutory approval.

APPENDICES

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APPENDIX 11.1: Ecological valuation criteria for aquatic resources (adapted from NRA, 2009)

Relevant Criteria	Classification
International Importance: • 'European Site' including Special Area of Conservation (cSAC), Site of Community Importance (SCI), Special Protection Area (SPA) or proposed Special Area of Conservation. • Features essential to maintaining the coherence of the Natura 2000 Network. • Site containing 'best examples' of the habitat types listed in Annex I of the Habitats Directive. • Resident or regularly occurring populations (assessed to be important at the national level) of species of animal and plants listed in Annex II and/or IV of the Habitats Directive. • Salmonid water designated pursuant to the European Communities (Quality of Salmonid Waters) Regulations, 1988, (S.I. No. 293 of 1988). • Major salmon river fisheries	**A**
National Importance: • Site designated or proposed as a Natural Heritage Area (NHA). • Statutory Nature Reserve. • Refuge for Fauna and Flora protected under the Wildlife Acts. • National Park. • Statutory Nature Reserve; Refuge for Fauna and Flora protected under the Wildlife Act; and/or a National Park. • Resident or regularly occurring populations (assessed to be important at the national level) of species protected under the Wildlife Acts; and/or; species listed on the relevant Red Data list. • Site containing 'viable areas' of the habitat types listed in Annex I of the Habitats Directive. • Major trout river fisheries • Commercially important coarse fisheries • Waterbodies with high amenity value.	**B**

County Importance:	**C**
• Area of Special Amenity. • Area of High Amenity, or equivalent, designated under the County Development Plan. • Resident or regularly occurring populations (assessed to be important at the County level)10 of species of animal and plants listed in Annex II and/or IV of the Habitats Directive, and/or; species protected under the Wildlife Acts; and/or; species listed on the relevant Red Data list. • Site containing area or areas of the habitat types listed in Annex I of the Habitats Directive that do not fulfil the criteria for valuation as of International or National importance. • County important populations of species, or viable areas of semi-natural habitats identified in the national or Local BAP if this has been prepared. • Sites containing semi-natural habitat types with high biodiversity in a county context and a high degree of naturalness, or populations of species that are uncommon within the county. • Sites containing habitats and species that are rare or are undergoing a decline in quality or extent at a national level.	

Relevant Criteria	Classification
Local Importance (higher value): • Locally important populations of priority species or habitats or natural heritage features identified in the Local BAP, if this has been prepared; • Resident or regularly occurring populations (assessed to be important at the Local level) of species of animal and plants listed in Annex II and/or IV of the Habitats Directive, and/or; species protected under the Wildlife Acts; and/or; species listed on the relevant Red Data list. • Sites containing semi-natural habitat types with high biodiversity in a local context and a high degree of naturalness, or populations of species that are uncommon in the locality; • Sites or features containing common or lower value habitats, including naturalised species that are nevertheless essential in maintaining links and ecological corridors between features of higher ecological value. • Sites of 'High' water quality status (Q4-5, Q5) • Water body with some fisheries values and potential salmonid habitat.	**D**
Local Importance (lower value): • Sites containing small areas of semi-natural habitat that are of some local importance for wildlife; • Sites or features containing non-native species that are of some importance in maintaining habitat links. • Waterbody with no fisheries value and poor fisheries habitat.	**E**

APPENDIX 11.2: Site Photographs

1. CLARE RIVER

Plate 1: Fractured rock at base of left bank just downstream of Crusheeny Bridge (12-7-2011)

Plate 2: Exposed subsoil on right bank of Clare River (Point 75) (12-7-2011)

Plate 3: Heavy marginal growth of Club-rush (*Schoenoplectus lacustris*) on the right bank of Clare River (12-7-2011)

Plate 4: Great Yellow within marginal emergent macrophytes – Clare River (12-7-2011)

Plate 5: Reed Canary-grass (*Phalaris arundinacea)* on left bank of Clare River (12-7-2011). Note – smooth, laminar flow over the whole river cross section.

Plate 6: In-channel submerged Club-rush - Clare River (12-7-2011)

	
Plate 7 Submerged marginal Pondweed beds (*Potamogeton* x *nitens* and *P. gramineus*) Clare River (12-7-2011)	**Plate 8:** Estevelle just downstream of Crusheeny Bridge, causing turbulence on the Clare River (12-7-2011)

	
Plate 9: View upstream toward weir downstream of Claregalway Bridge (12-7-2011)	**Plate 10:** Glide upstream of Crusheeny Bridge (12-7-2011)

	
Plate 11: View downstream from confluence of Islandmore tributary with R. Clare showing long glides, steep banks and sparse marginal emergents (12-7-2011)	**Plate 12:** View upstream from confluence of Islandmore tributary with R. Clare showing long glides, steep banks and sparse marginal emergents (12-7-2011)

Plate 13: View downstream toward deep holdings on the bend by Point 62 - (12-7-2011)

Plate 14: Close up of gravel beds by Point 49 where 0+ salmonids were observed by – Clare River (12-7-2011)

2. CLARE RIVER TRIBUTARIES

Plate 15: Gortcloonmore drain showing still flow and heavy shade at Point 1 (11-7-2011)

Plate 16: Gortcloonmore drain upstream of by road bridge (Point 5) showing in-channel growth of *Oenanthe* and bankside Valerian and Meadowsweets Montiagh North (11-7-2011)

Plate 17: Pond-like stretch of Gortcloonmore drain downstream of byroad bridge (Point 6) showing in-channel growth of Yellow water lilie (*Nuphar lutea*) and emergent *Sparganium erectum* (11-7-2011)

Plate 18: Unnamed drain (3) at Montiagh North (Point 8) (11-7-2011)

Plate 19: Gortadooey drain upstream of bridge showing dense marginal stands of emergent vegetation - Montiagh North (11-7-2011)

Plate 20: Gortadooey drain as in Plate 5 after drainage one week later (20-7-2011)

Plate 21: Gortadooey stream downstream of road bridge where there were patches of emergent and submerged *Apium* in faster current speeds (11-7-2011)

Plate 22: Gortadooey stream farther downstream (Point 11) showing more silted substrate with less instream vegetation.(11-7-2011)

Plate 23: Gortadooey stream just upstream of confluence with Clare River showing heavy instream growth of *Sparganium emersum* and marginal growths of *Berula erectum* in moderate/swift flows (Point 9) (11-7-2011)

Plate 24: Gortadooey upstream nearer its source (Point 86) with heavy marginal floating and emergent macrophyte growth. (11-7-2011)

Plate 25: Kiniska trib. showing heavy in-channel growth of macrophytes obscuring the channel (Point 12) with heavy marginal floating and emergent vegetation.

Plate 26: Kiniska trib. upstream of road bridge (Point 80) showing limited open water with *Ranunculus* sp. and fringing Flote Grass (*Glyceria* sp.) - (11-7-2011)

Plate 27: Kinsika trib. showing banks with Valeria, Meadowsweet and Great Willowherb (Point 13) – (11-7-2011)

Plate 28: Montiagh South un-named tributary (3), view downstream from bridge (Point 17), showing submerged *Potamogeton natans* (11-7-2011)

Plate 29: Montiagh South un-named tributary (3) upstream from bridge (Point 19), showing submerged *Callitriche*, *Apium* and *Melosira* with floating filamentous algae marginally - (11-7-2011)

Plate 30: Montiagh South drain series (2) (Point 21) showing *Typha* and *Valerian* in drainage ditch. (11-7-2011)

Plate 31: Montiagh South, main east-west drain in drain series (2) (Point 22) showing emergent and floating macrophytes (11-7-2011)

Plate 32: Montiagh South drain series (2): smooth newt (*Lissotriton vulgaris*) tadpole (eft) from a ditch at Point 27 (11-7-2011)

Plate 33: Montiagh South drain series (2): plant-chocked drain running south and east from Point 27 Sedges (*Carex* sp.) and Valerian as emergents. (11-7-2011)

Plate 34: Montiagh South drain series (2) (Point 87) overgrown by Common Reed and with *Typha* and *Valerian* also present – view upstream (20-7-2011)

Plate 35: Montiagh South drain series (2) (Point 87) view downstream showing stagnant flow floating algal scum and dense marginal emergents – (20-7-2011)

Plate 36: Caherlea drainage ditch: this ditch was effectively dry at this point (Pt 29) (11-7-2011)

Plate 37: Islandmore drain at Point 31 showing emergent *Berula erecta* in still water (11-7-2001)

Plate 38: Islandmore drain at Point 36 showing submerged *Potamogeton* and *Hippuris* in still water (11-7-2001)

Plate 39: Islandmore drain at Point 38 close to outlet to Clare River showing steep banks (11-7-2011)

Plate 40: Islandmore drain near Point 38 showing submerged and emergent macrophytes in shallow flow (11-7-2011)

APPENDIX 11.3: Aquatic Macroinvertebrates

	EPA Quality Category	SITE 1 D/S Crusheeny Br.	SITE 2 D/S Claregalway Br.
MAY FLIES (Ephemeroptera)			
Heptageniidae:	A	*	*
Heptagenia sulphurea		2	3
Ecdyonurus dispar		1	2
Ephemerella ignita	C	100+	100+
Baetis rhodani	C	54	200+
Baetis muticus	B		50
Caenis rivulorum	C	6	7
STONE FLIES (Plecoptera)			
Isoperla sp. (indet)	A		2
Leuctra spp.	B	100+	27
CADDIS FLIES (Trichoptera)			
Sericostoma personatum	B	5	3
Lepidostoma hirtum	B	7	10
Athripsodes sp.	B	13	21
Rhyacophila dorsalis	C	2	5
Hydropsychidae	C	47	22
Agapetus sp.	~	5	2
Plectrocnemia conspersa	C	2	1
Potamophylax latipennis	C	8	
TRUE FLIES (Diptera)			
Chironomidae	C	200+	100+
Simuliidae	C	24	14
Tabanidae	C		1
BEETLES (Coleoptera)			
Nebrioporus depressus depressus	C		1
Elmidae	C	26	58
F/W SHRIMPS (Crustacea)			
Gammarus duebeni	C	500+	45
Asellus aquaticus	D	2	11
SNAILS (Mollusca)			
Bithynia tentaculata	C	2	2
Ancyclus fluviatilis	C		5
Planorbis spp.	C	1	2
Potomapyrgus sp.	C		3
Lymnaea peregra	D		5
WORMS (Annelida)			
Oligochaetae	E	100+	30
LEECHES (Hirudinea)			
Erpobdellidae indet.	D	1	
FLATWORMS (Tricladia)			
Polycelis sp.	D	1	
EPA Q Value		**Q4**	**Q4**
Total BMWP Score		**133**	**136**
ASPT		**6**	**6.2**
EQR/WFD Classification		**0.8/Good**	**0.8/Good**

APPENDIX 11.4: White clawed Crayfish surveys and assessment criteria

Table 1: RIVER CLARE - Crayfish survey locations, habitats and methods employed

Location	Grid Reference	Habitat description of survey 'patch' and methods employed.	Site Photograph	Crayfish habitat assessment
Approx 1km US Crusheeny Bridge	M 40574 32404	30m stretch of cobble overlaying silty gravels at river margin, with emergent and overhanging Reed Canary Grass (*Phalaris arundinacea*). 20min search of refuges + weed sweeping for juveniles.		**Quite extensive stretches of potentially optimal habitat at river margins; Slightly sub-optimal habitat at the mid-channel owing to potential for very swift flow + lack of stable refuges.**
c. 100m U/S Crusheeny Bridge	M 39826 32835	10m stretch of boulder/cobble overlaying silty gravels at river margin, with some emergent and overhanging Reed Canary Grass and submerged *Sparganium emersum*. 30min search of refuges + overnight trapping.		**Sub-optimal habitat at river margin and poor habitat in**

30m US Crusheeny Bridge	M 39750 32886	10m stretch of emergent and overhanging Reed Canary Grass with slightly undercut banks and small boulders overlaying very silty gravel at river margin. 30min net sweep search + overnight trapping.		**Sub-optimal or Poor habitat for juveniles and adults at river margins owing to the majority of Canary Grass not being rooted in the channel; Poor habitat mid-channel owing to lack of cover. Possibility of burrowing where stable banks are vertical or undercut beneath overhanging vegetation.**
30m DS Crusheeny Bridge	M 39671 32917	Combination of cut limestone stepped banks with numerous cracks and crevices and some small boulder and large cobble at river margin. Difficult to manually search. Overnight trapping		**Patches of optimal habitat at river margins; Poor habitat at mid-channel.**
c. 700m DS Crusheeny Bridge		10m stretch of emergent and overhanging macrophytes, mainly Reed Canary Grass with some submerged *S. emersum.* Small boulders and large cobbles overlaying very silty gravel at river margin. 30 min net sweep + search of refuges.		**Sub-optimal habitat at river margins owing to low vegetative cover in-stream – much of the canary grass was not be rooted in the channel as the river had formed a low berm along the stretch; Sub-optimal/poor habitat at mid-channel.**

40m DS Claregalway Bridge		Margins of turbulent flow at the 'natural' weir below the bridge. Some mossy boulder overlying gravel + coarse sand, plus patches of bedrock with moss. Manual search of refuges for 30 minutes using net and viewing bucket.		**Patches of optimal habitat at the river margins and just upstream of the weir in shallower bouldery parts of glide/run; turbulent areas poor owing to water velocity.**

Table 2: RIVER CLARE TRIBUTARIES AND DRAINS – Crayfish survey locations, habitats and methods employed.

Location	**Grid Reference**	**Habitat description of survey 'patch' and methods employed.**	**Site Photograph**	
Gortcloonmore Tributary	M 35056 34223	10m stretch of deep (>1m) stagnant, weed choked drain manually searched. Poor (100%) crayfish habitat. 30min weed sweep. Crayfish = 0.		**Poor crayfish habitat, however crayfish can be found in these types of sluggish drains.**

Gortadooey Tributary	M 36720 33849	20m stretch of emergent Burr reed and emergent and overhanging Reed Canary Grass. Substrates of small boulder over gravel, sand and silt. crayfish habitat. 30min net sweep search + overnight trapping. Crayfish = 0.		**Patches of optimal habitat within emergent vegetation and in areas of boulder/cobble glide, but these were removed by dredging u/s of the bridge. Some sub-optimal habitat remains below the bridge. Habitat for crayfish in the upper Gortadooey stream, near the source was poor, with very little cover available once summer vegetation disappears.**
Kiniska Tributary	M 38173 33583	Two x 10m stretches of potential habitat manually searched for 15 minutes each. Limited patches of cobble over silty gravel and sand with overhanging vegetation. Patches of instream emergents also searched. Crayfish = 0.		**Poor crayfish habitat but crayfish can be found in these types of sluggish drained streams. Water quality may be too impaired to be ideal for crayfish. There was a sewage input towards the u/s end of the channel.**
Montiagh South Un-named Tributary (3)	M 34467 33063	15min manual search of marginal vegetation and accessible bouldery glide in suitable patches. Crayfish = 0.		**Sub-optimal- to-Poor. Presence of small boulder and large cobble substrates, plus mainly submerged aquatic macrophytes and bank side tree roots may provide refuges for crayfish.**

Site 1 - Montiagh South Western Drain Series (2)	M 33925 32998	This was one of 2 sites searched in this drain series. 10min search of emergent and submerged aquatic vegetation within channels with some open water. Crayfish = 0.		**Some of the drains were totally unsuitable for crayfish owing to level of weed growth (mire like). Other drains were either stagnant pools with mostly floating vegetation. or recently drained with no habitat remaining. Poor in general.**
Site 2 - Montiagh South Western Drain Series (2)	M 33918 33078	15min search in any available patches of submerged vegetation. Crayfish = 0.		**Poor, no suitable habitat owing to quite recent drainage.**
Islandmore / Caherlea Arterial Drainage network (5) – just upstream of R. Clare confluence	M 40053 32446	Shallow glide with some scattered large cobbles over gravel and fine substrates in places. Submerged aquatic vegetation, mostly Myriophyllum *alternifolium* and *Potamogeton natans*.. 15mins manual search and overnight trapping. Crayfish = 0.		**Sub- optimal with patches that could be optimal. Flow and water quality characteristics suitable also.**

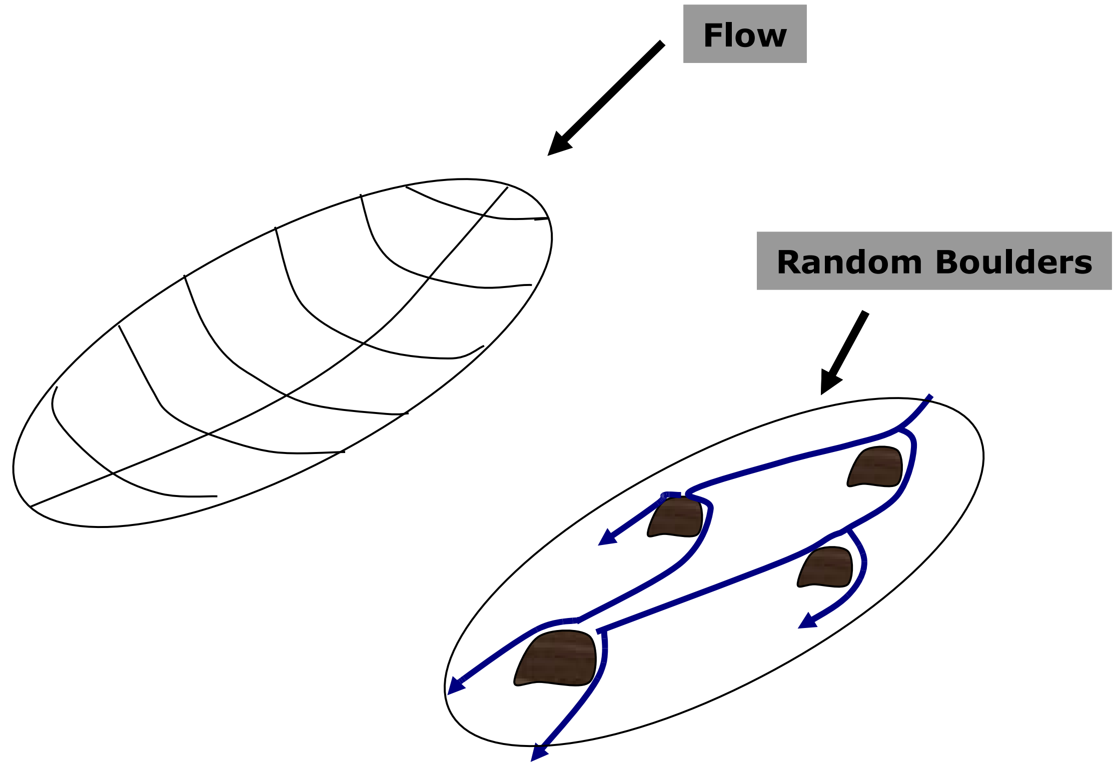
Islandmore / Caherlea Arterial Drainage network (5)	M 40075 31507	Canalised drain, approx. 1m deep with an abundance of emergent and submerged aquatic vegetation, primarily *Berula* sp.		**Poor, though crayfish can be found in these types of sluggish drains.**
Islandmore / Caherlea Arterial Drainage network (5)	M 40161 31392	Recently drained, probably not active during dry weather. Crayfish = 0.		**Unsuitable – temporary flow; very little refuge habitat or cover.**

Table 3: Crayfish habitat evaluation criteria

OPTIMAL	SUB-OPTIMAL	POOR
Boulders (>25 cm), stone or other material >	large cobbles (15–25 cm) >>	small cobble (6–15 cm)
Slow-flowing glides and pools (provided there are refuges) >	riffles >>	high-energy areas such as rapids (avoided).
Localised velocity of 0.1m s-1 or less >	less than 0.2m sec-1 >>	more than 0.2 m sec-1 (avoided).
Boulders or large cobbles in groups with crevices between them >	isolated large stones on smaller substrate such as pebble and gravel >>	a lot of small stone (small cobble and pebble).
Deep crevices in bedrock (can't usually search) >	partly flattened boulders and large cobbles >>	high-sided, rounded cobbles (more easily rolled in spates).
Underlying substrate of fine gravel/sand with some pebbles >	pebble and coarse gravel >>	Silt and clay.
Loose boulders	>>	deeply bedded boulders in a compacted bed (not accessible to crayfish).
Submerged refuges in stable banks (e.g. natural crevices, stone block reinforcement or stable, slightly undercut banks with overhanging vegetation, large tree roots, etc.) >	refuges in the slow-flowing margins >	refuges in mid-channel (avoided especially if flow is a run or higher energy).
Margins with submerged and emergent aquatic vegetation and favourable bankside habitat >	margins where adjacent banks have no scope for refuges (e.g. bare shallow slopes) >>	margins where adjacent earth banks are slumped and actively eroding.

APPENDIX 11.5

Detail 1. Centre Channel Pool



Key Features

Pool should be egg-shaped.

Pool Length 1.5 times channel width.

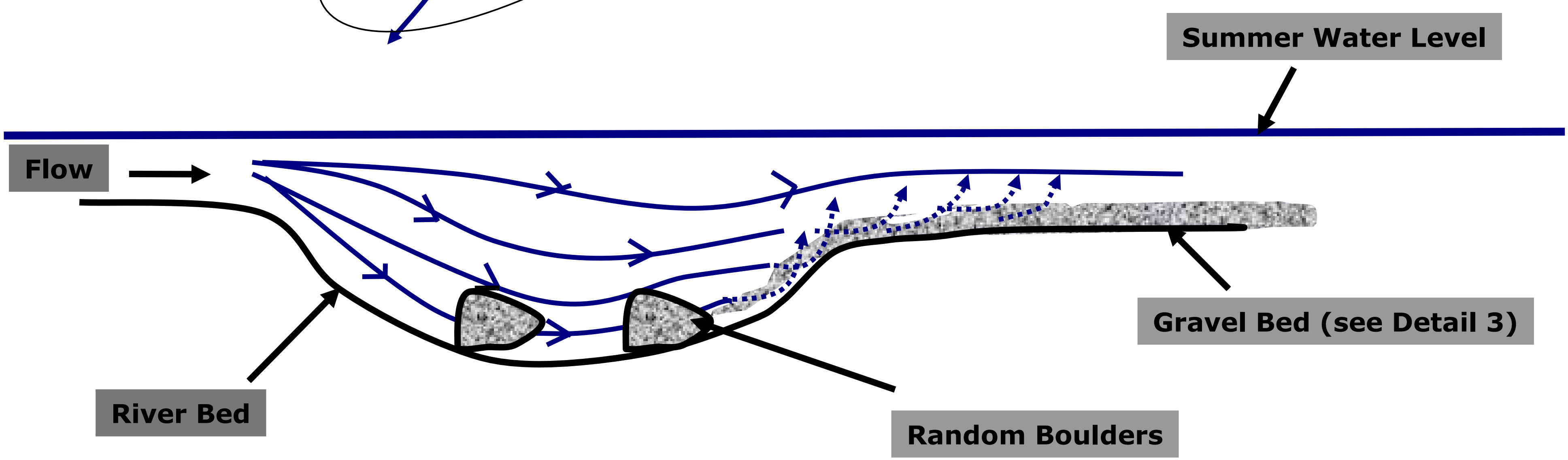
Gradually slope down to the deepest point (1.5m) in the centre and taper back up towards the tail.

Should also taper down from either side towards the centre.

Should occupy the central 2/3 area of the channel cross section.

Place a number of boulders in the pool. Boulders should be placed in a triangular or diamond shaped pattern

Pool should be placed on average 5-7 channels widths in distance apart



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The Office of Public Works
Oifig na nOibreacha Poiblí

Iascach Intíre Éireann
Inland Fisheries Ireland

Detail 2. Gravel Placement

Key Features

Pool and gravel bed should be approx same length (1.5 times channel width).

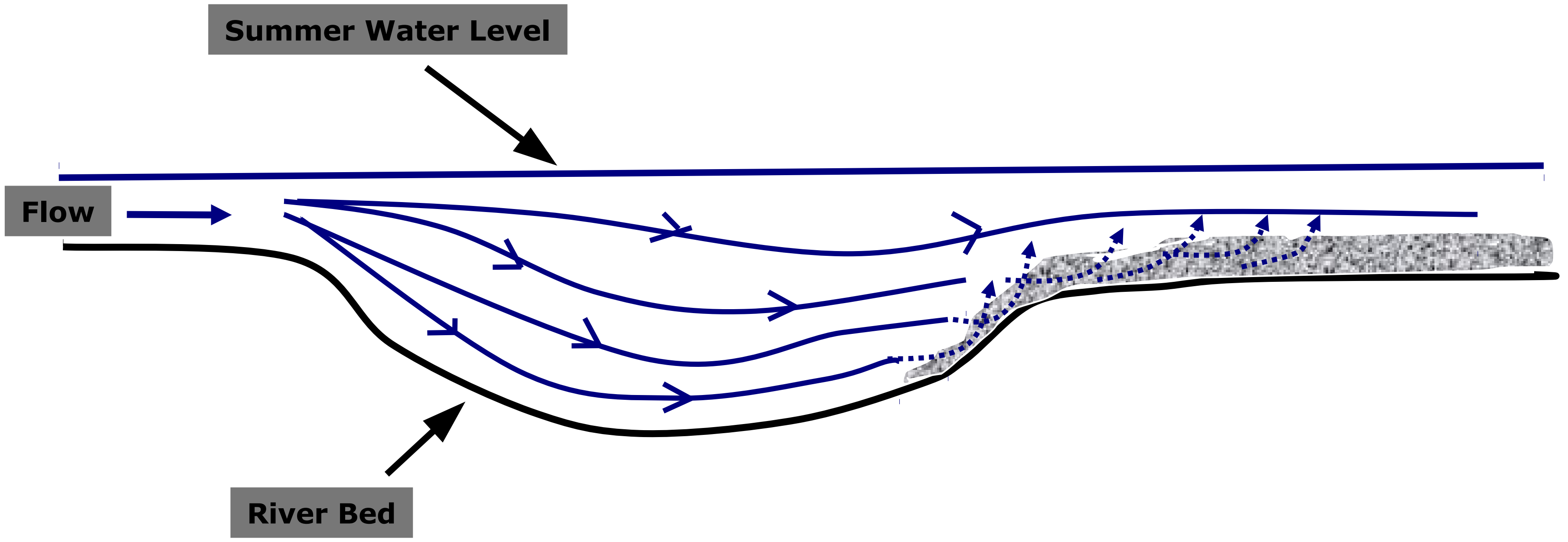
Should occupy the central 2/3 area of the channel cross section.

Start to place gravel at tail of pool (downstream end).

Gravel bed should be 35 to 40cm deep.

Gravel size (see Detail 3 Spawning Gravel).

Up-welling of water through the gravel is essential.



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Detail 3. Spawning Gravel

Table 3.1

Type	Grade	% Composition
Cobble	64 - 190mm	10%
Very coarse gravel	32 - 64mm	35%
Coarse gravel***	16 – 32mm	25%
Medium gravel***	8 - 16mm	20%
Fine gravel***	4 – 8mm	10%

Table 3.2

Type	Grade	% Composition
Cobble	64 - 190mm	0%
Very coarse gravel	32 - 64mm	15%
Coarse gravel***	16 – 32mm	35%
Medium gravel***	8 - 16mm	30%
Fine gravel***	4 – 8mm	15%

Key Features

Wide variation in particle size.

Washed, rounded stones.

See table 3.1 below for range and % composition of stones required for **Irish salmon** and **sea trout** spawning gravels.

See table 3.2 below for range and % composition of stones required for **brown trout** spawning gravels.

***Least critical component of this mix as they will settle naturally once the cobble and very coarse gravel is placed.

Ratio of cobble to very coarse gravel to be placed - 50:50 .

For placement of gravel see Detail 2.

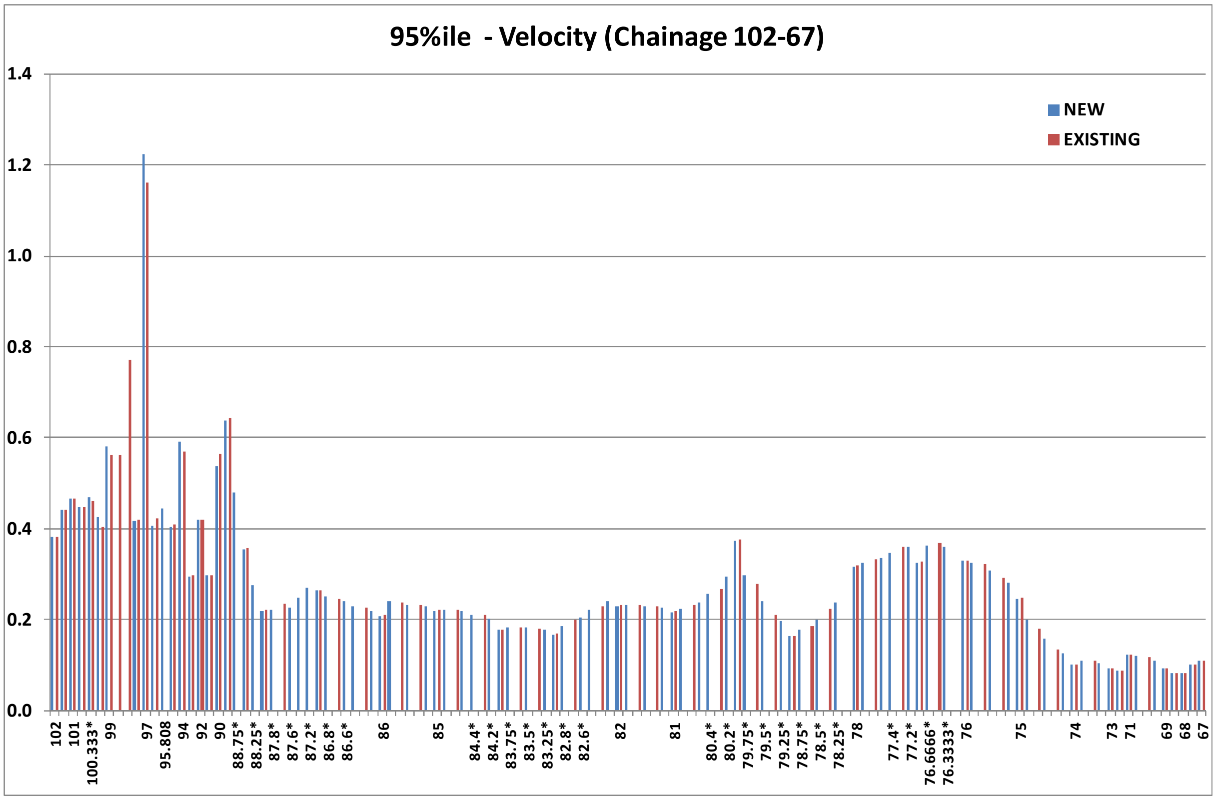
APPENDIX 11.6

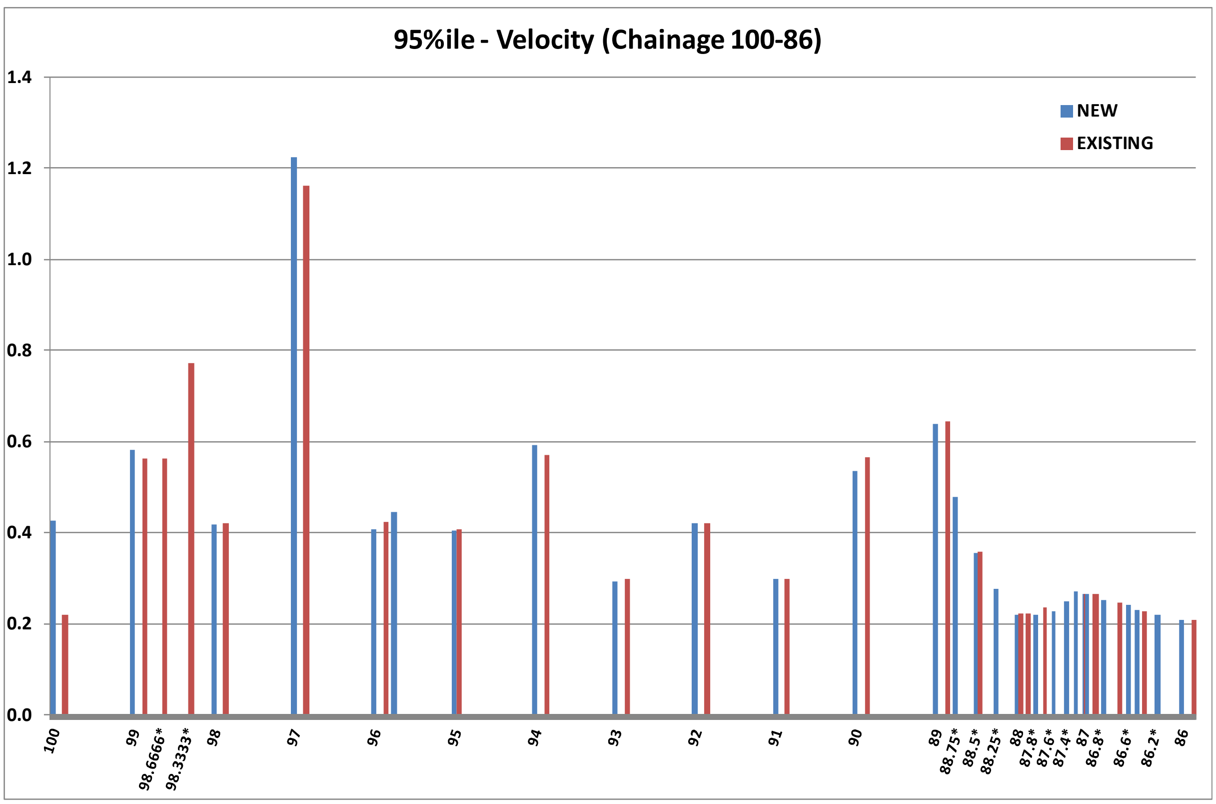
APPENDIX 11.6

Changes to the Hydraulic Environment of the Clare River

Comparison of pre- and post-works scenarios at low (85%ile & 95%ile), intermediate (50%ile and 65%ile) and high (Q-Bar) flow conditions for:

- channel velocity (m/s),
- stream power (watts / m^2) and,
- Froude number.





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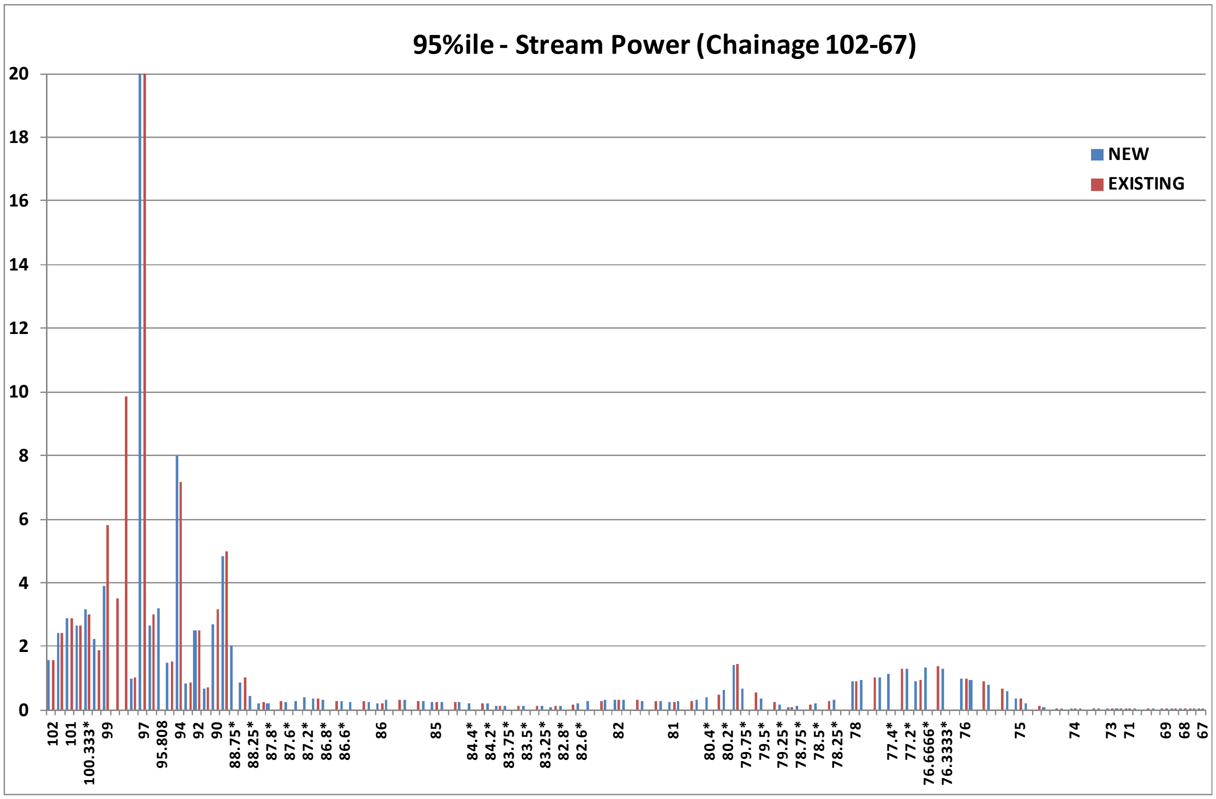

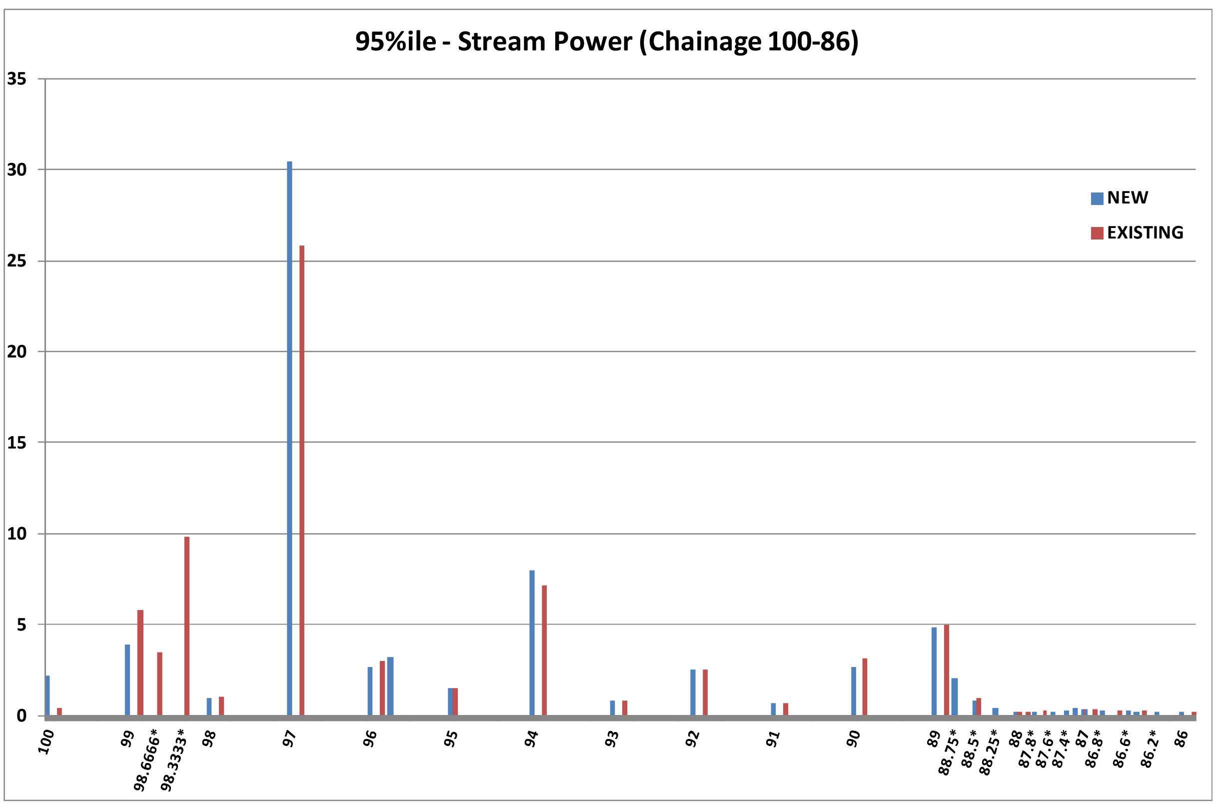

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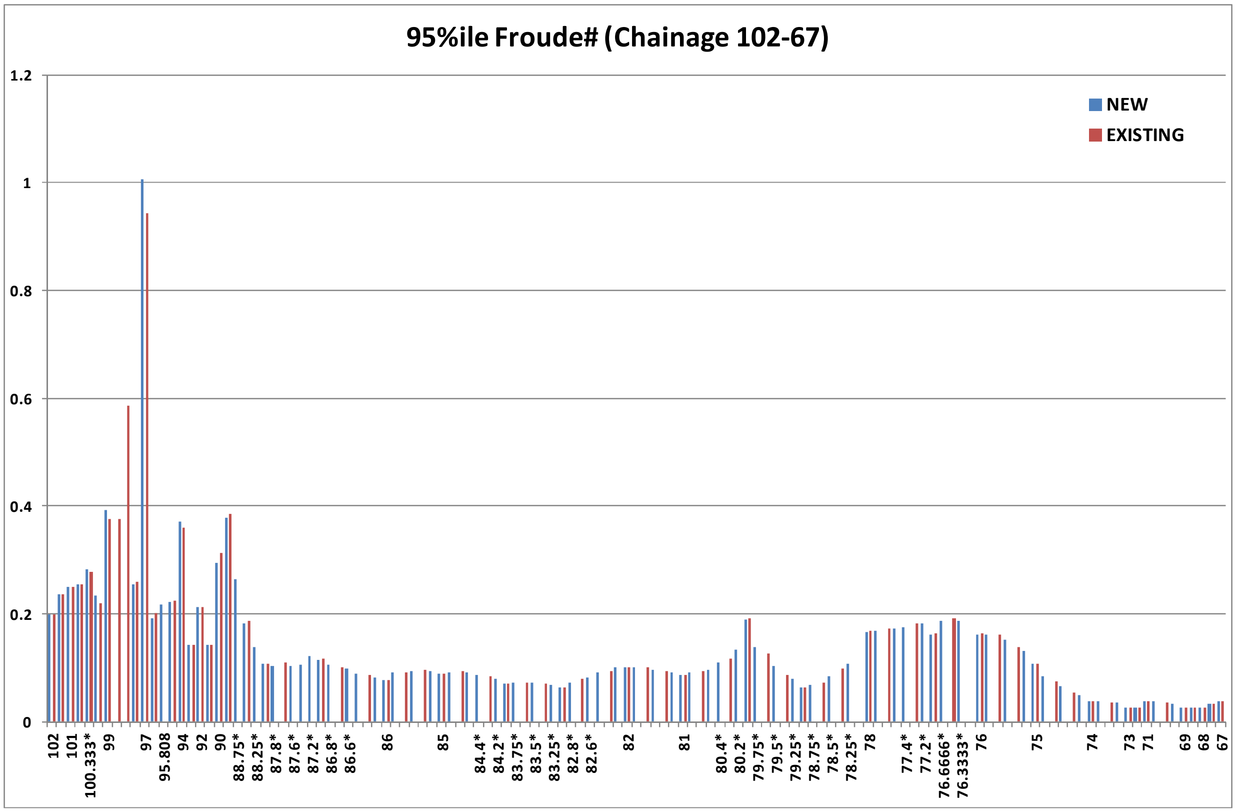

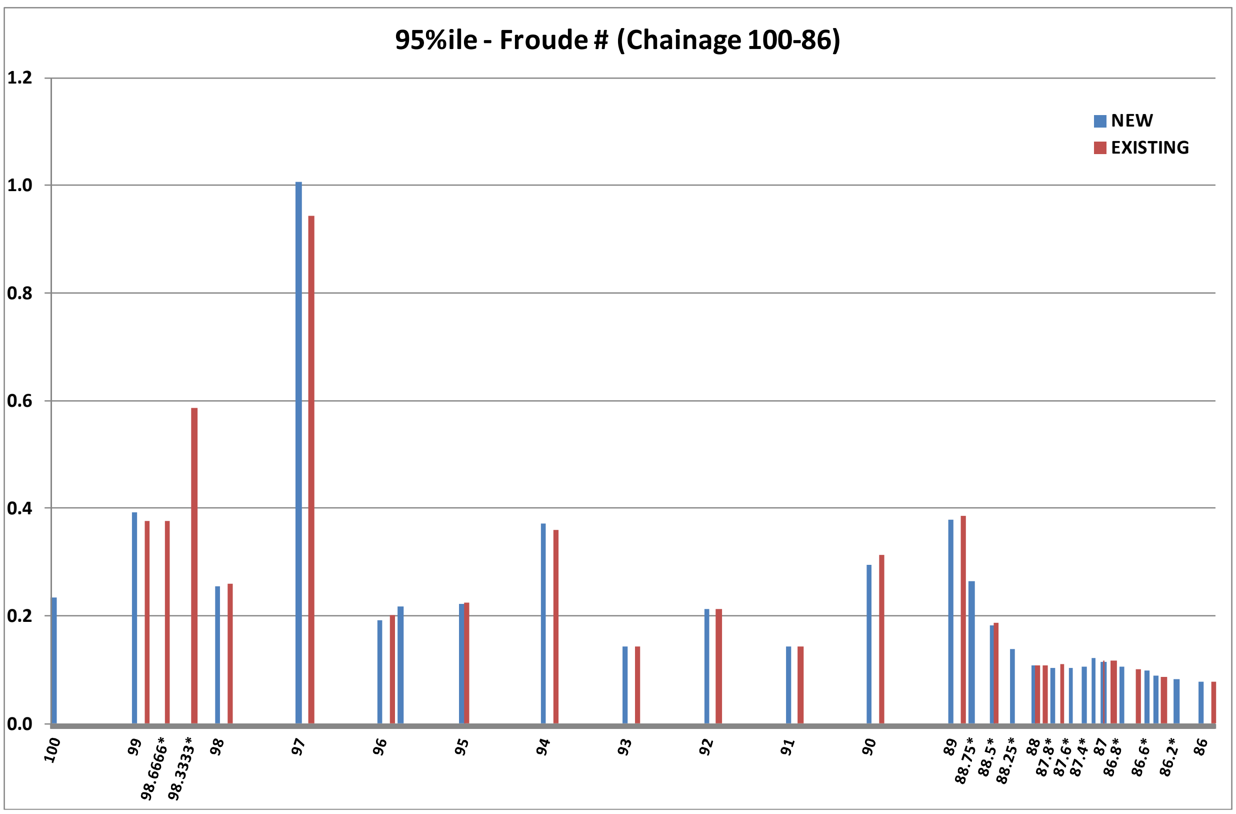

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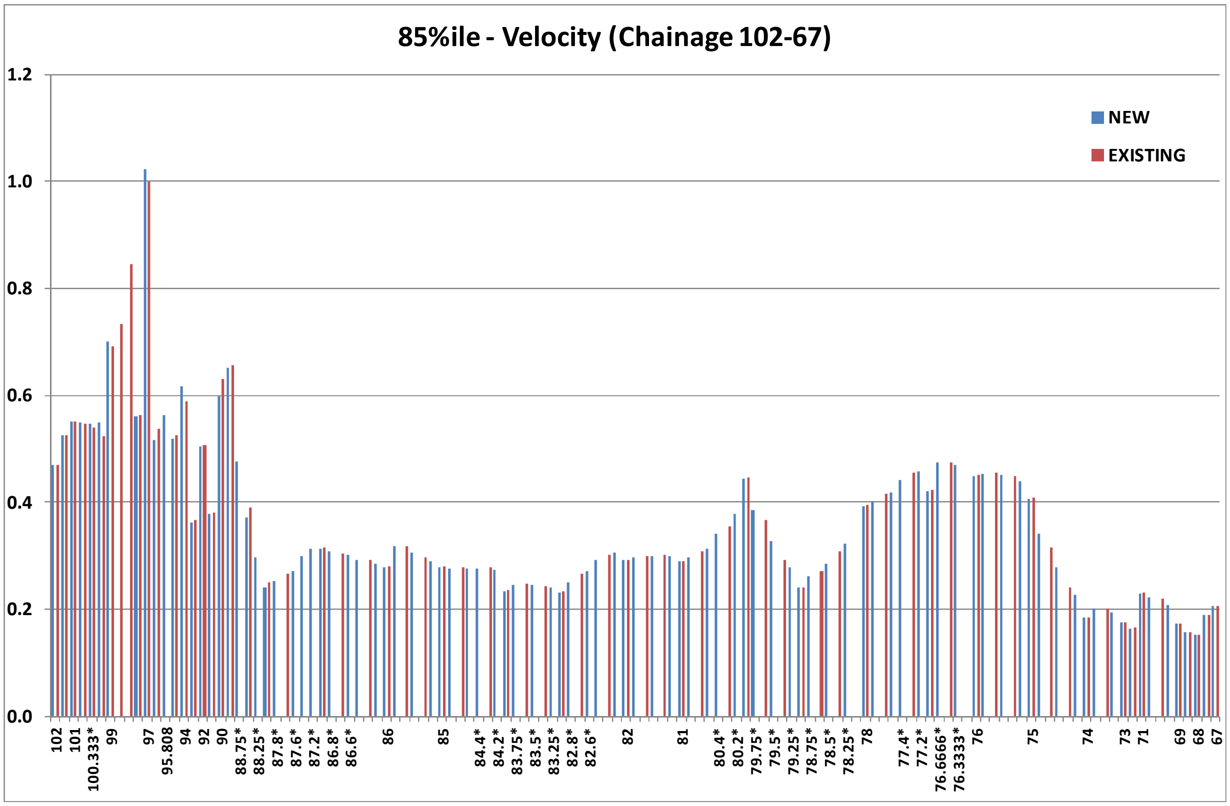

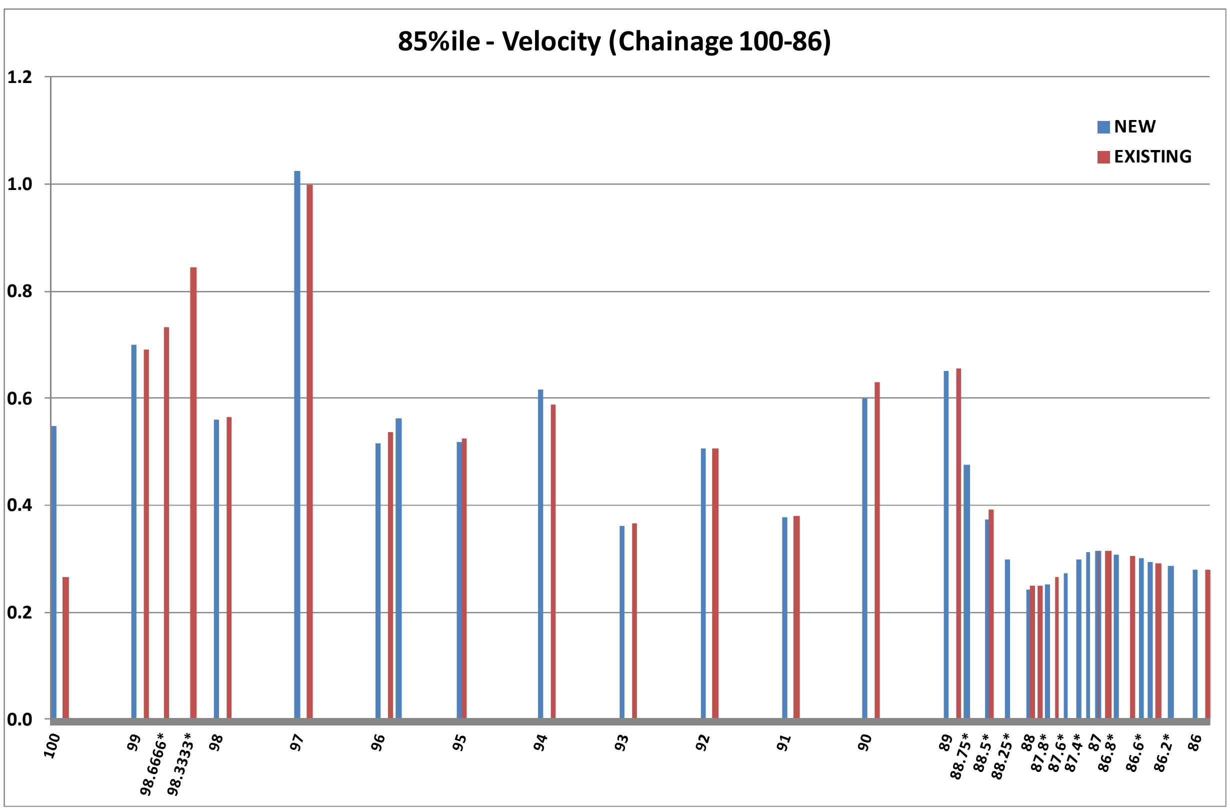

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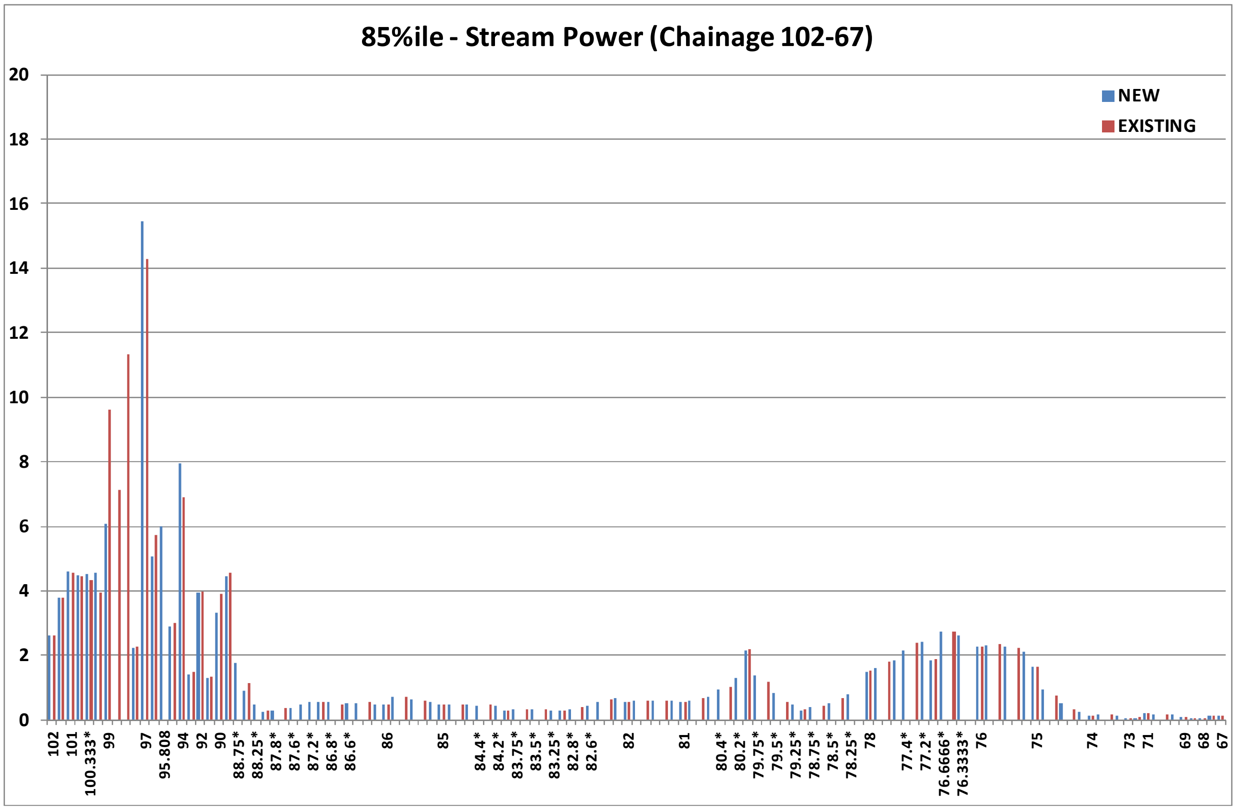

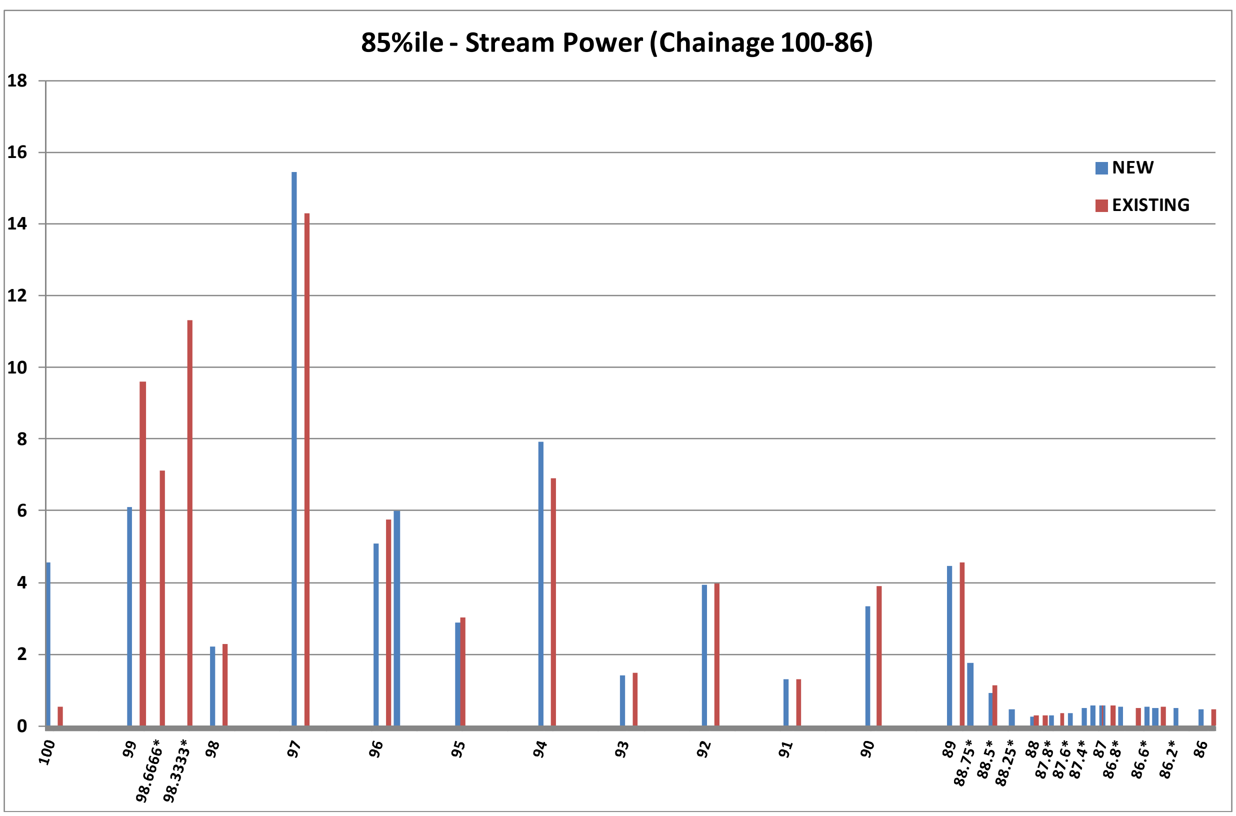

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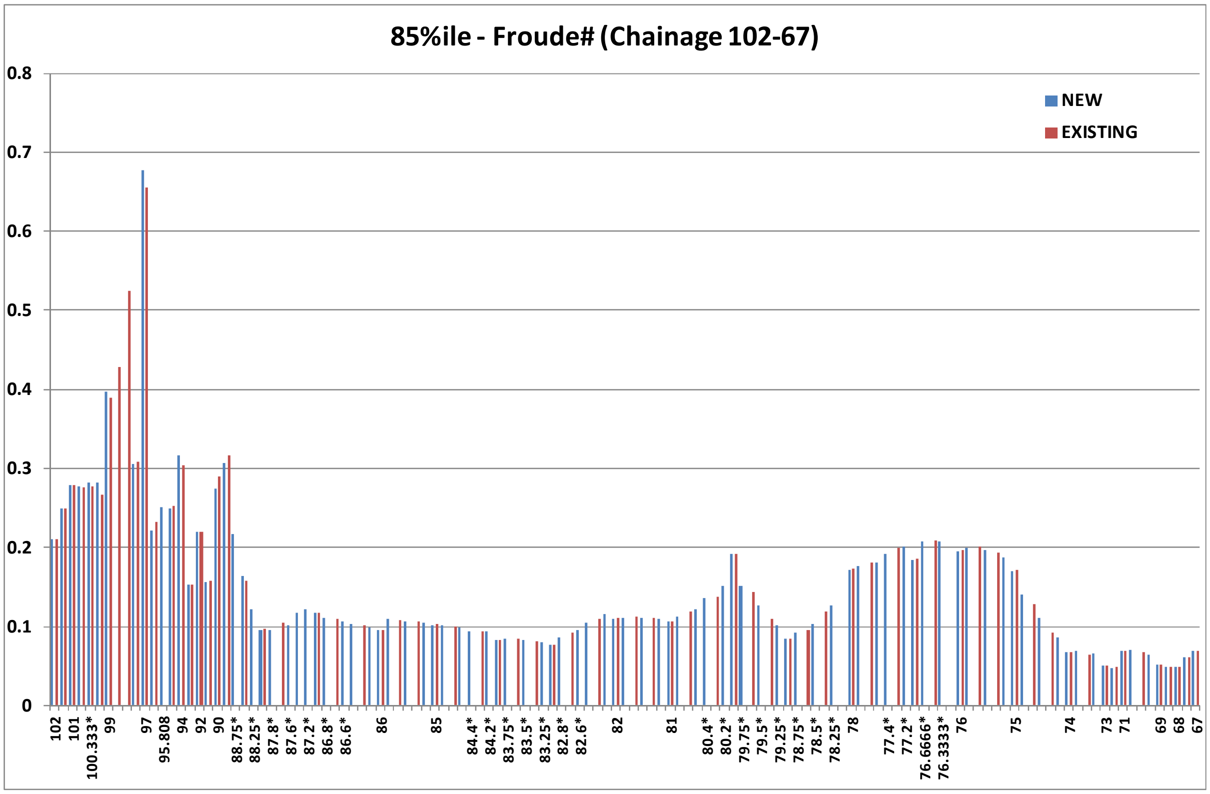

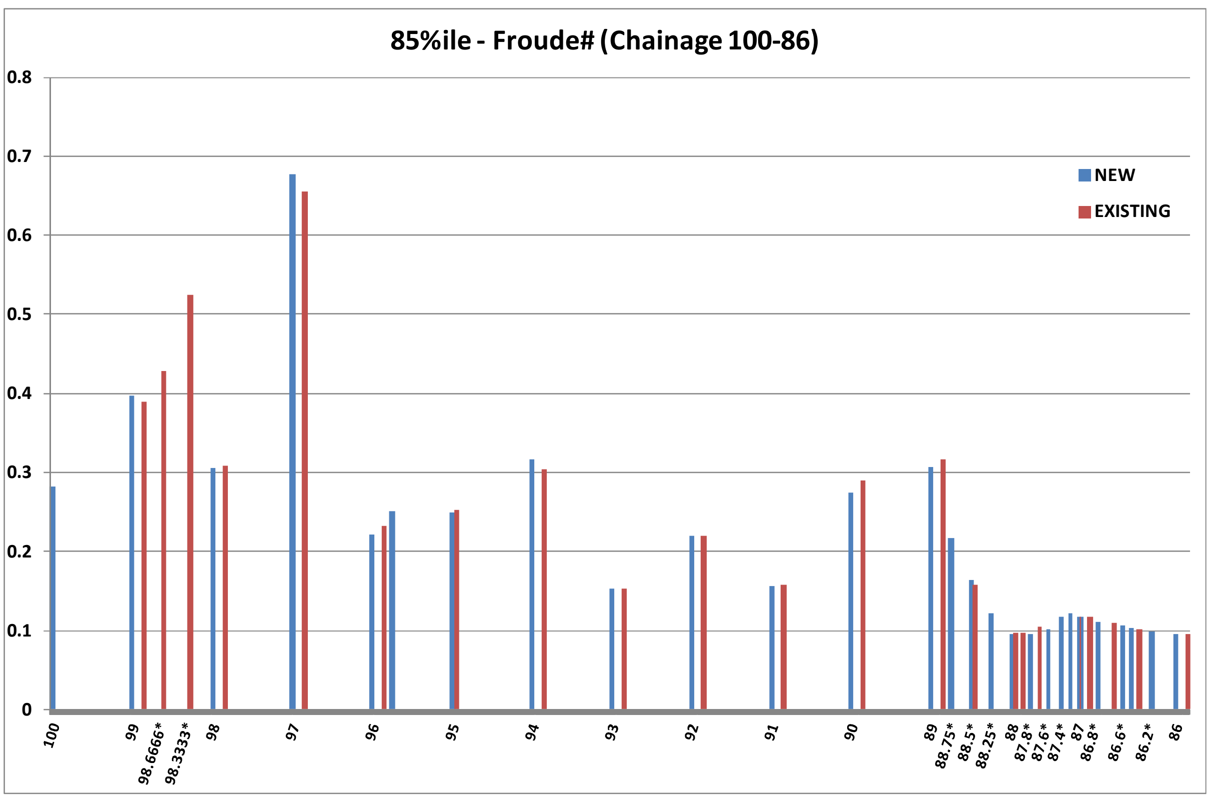

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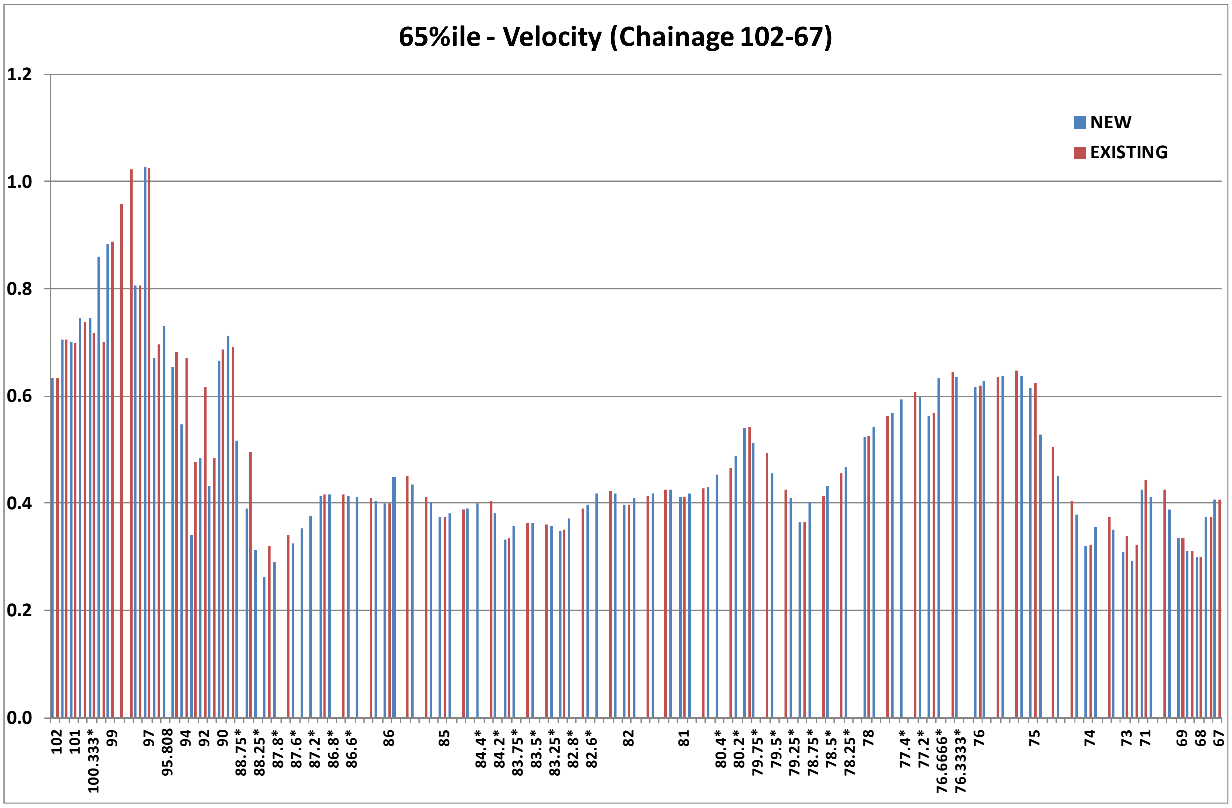

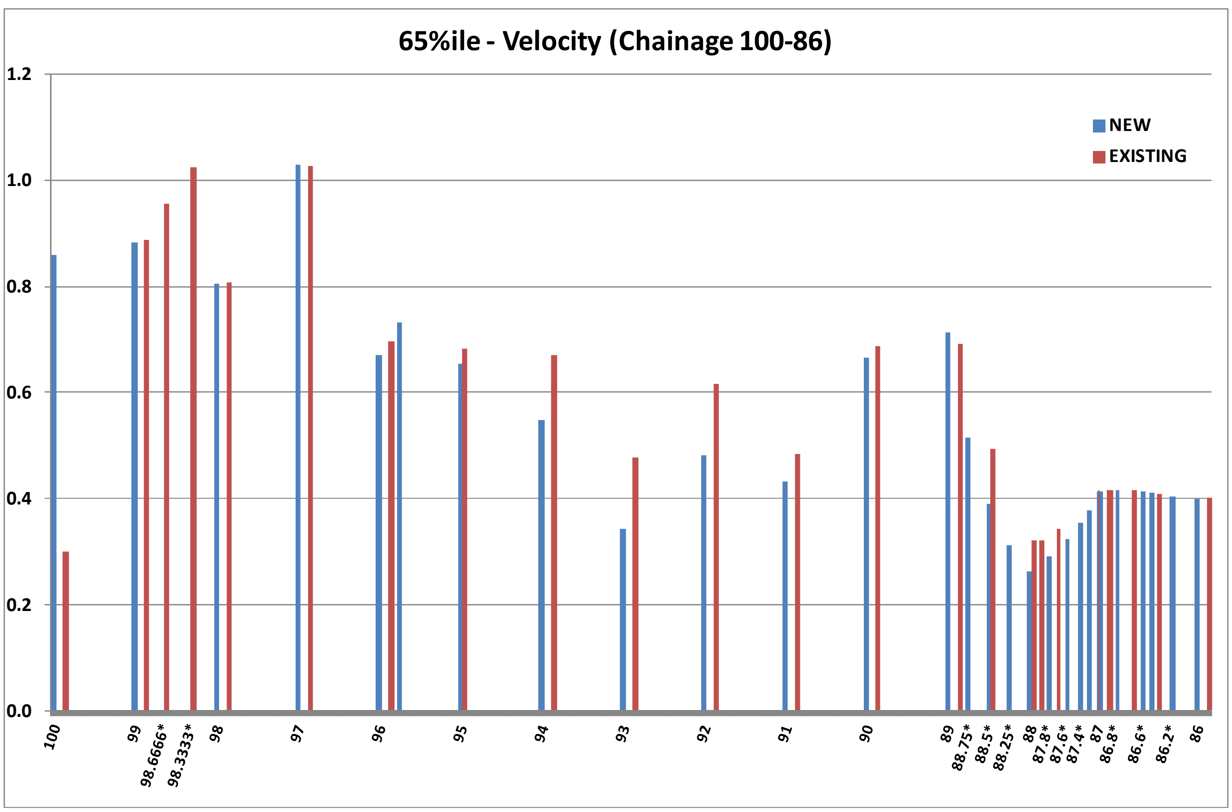

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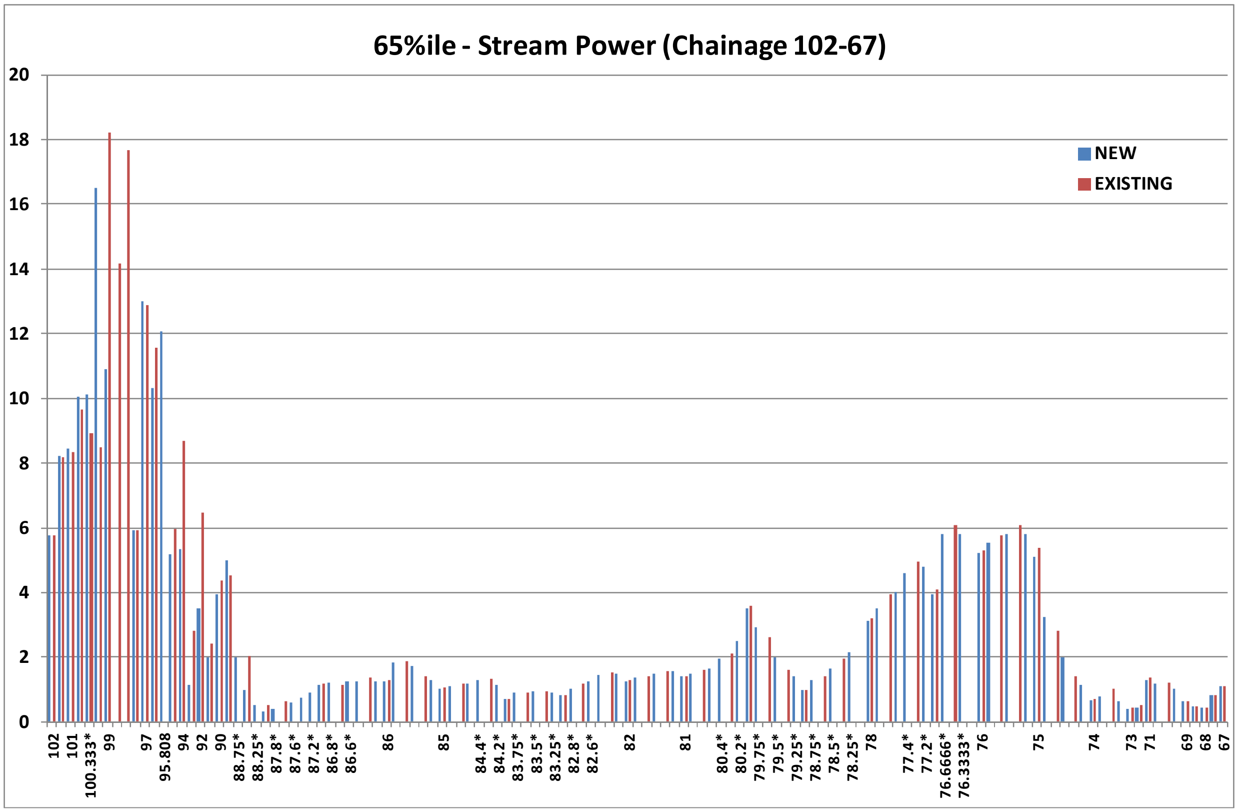

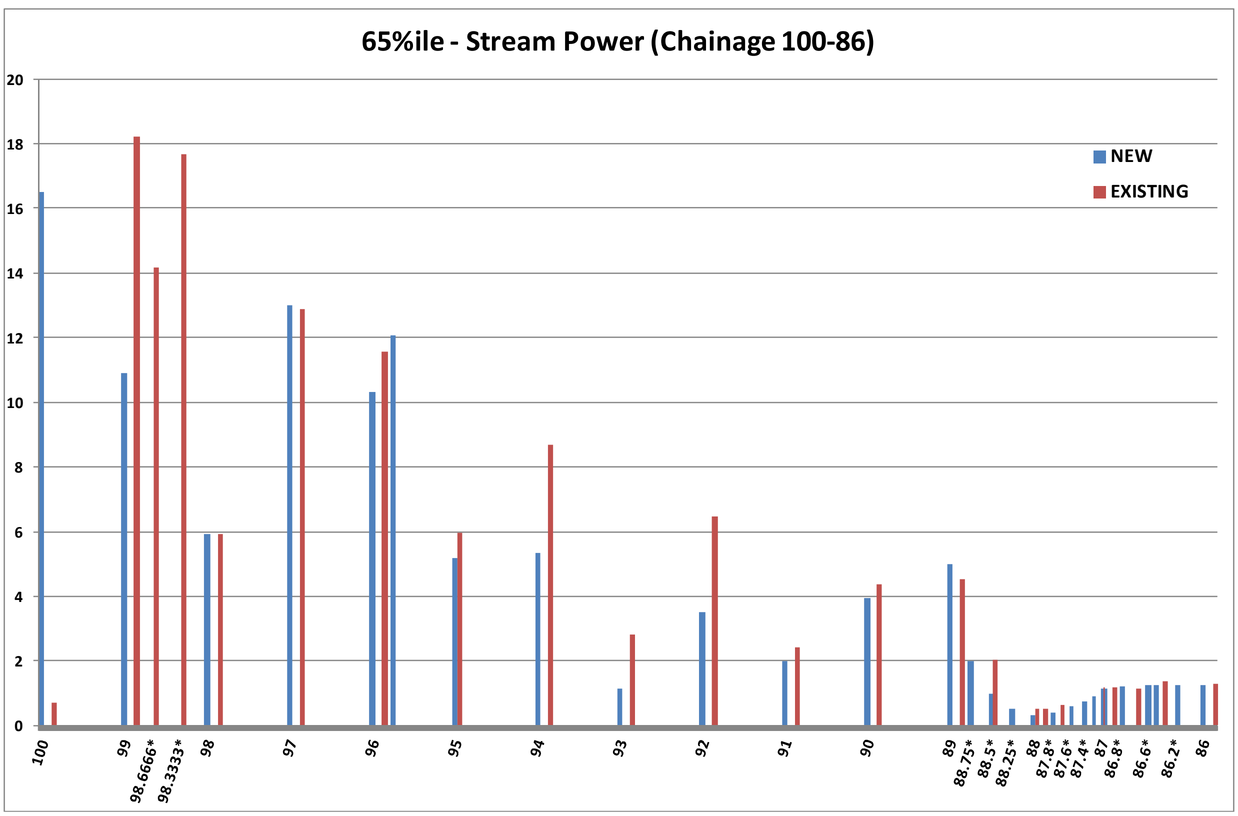

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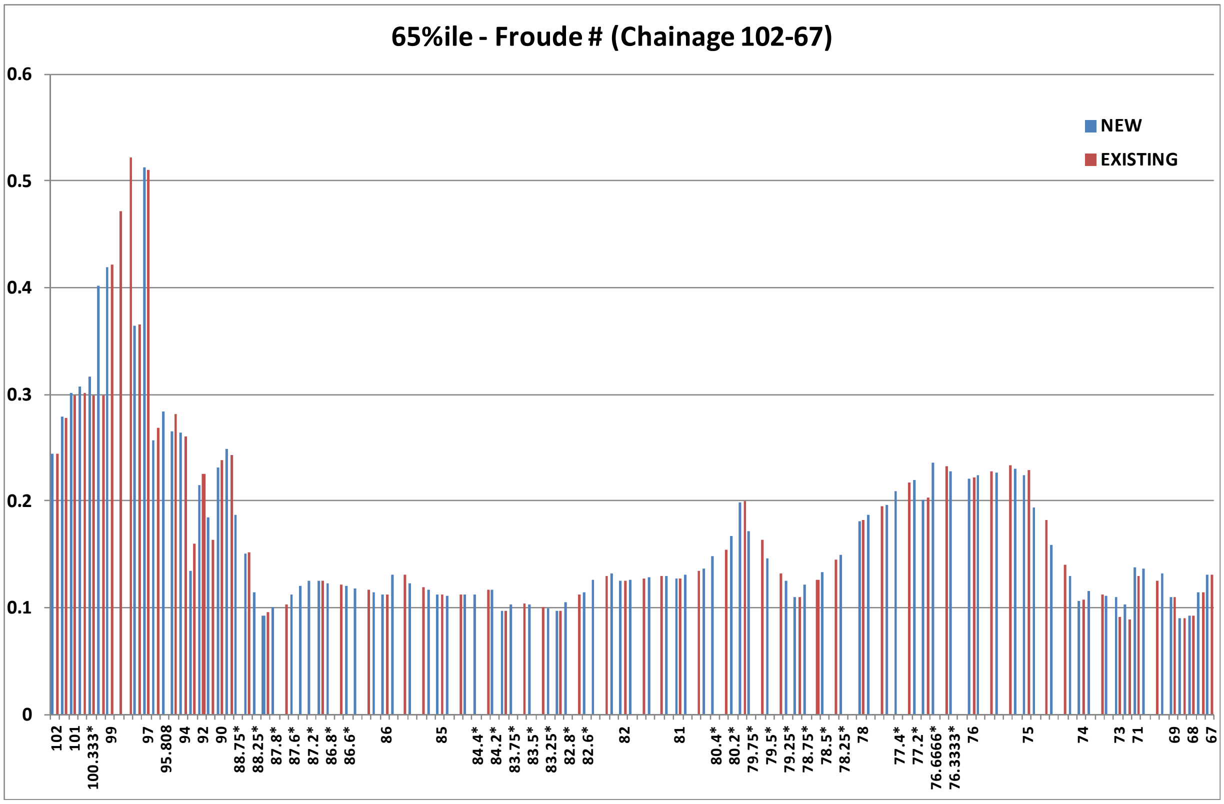

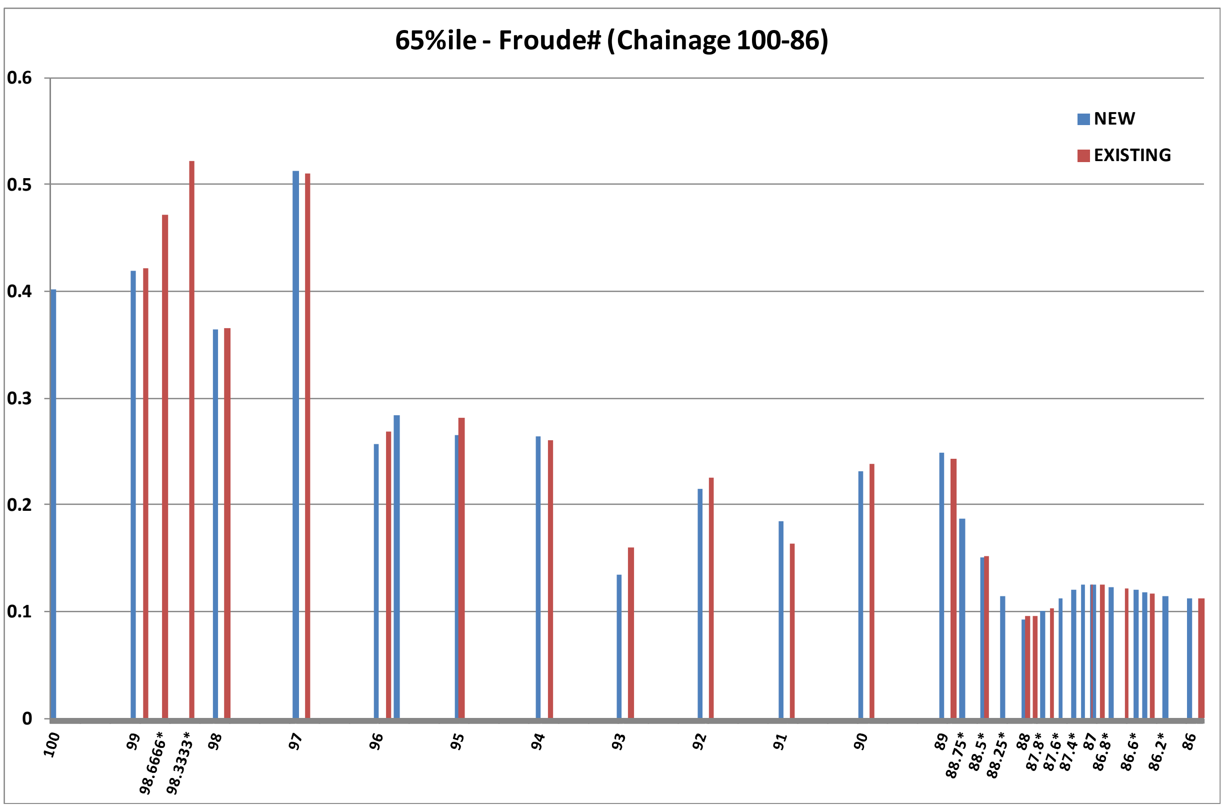

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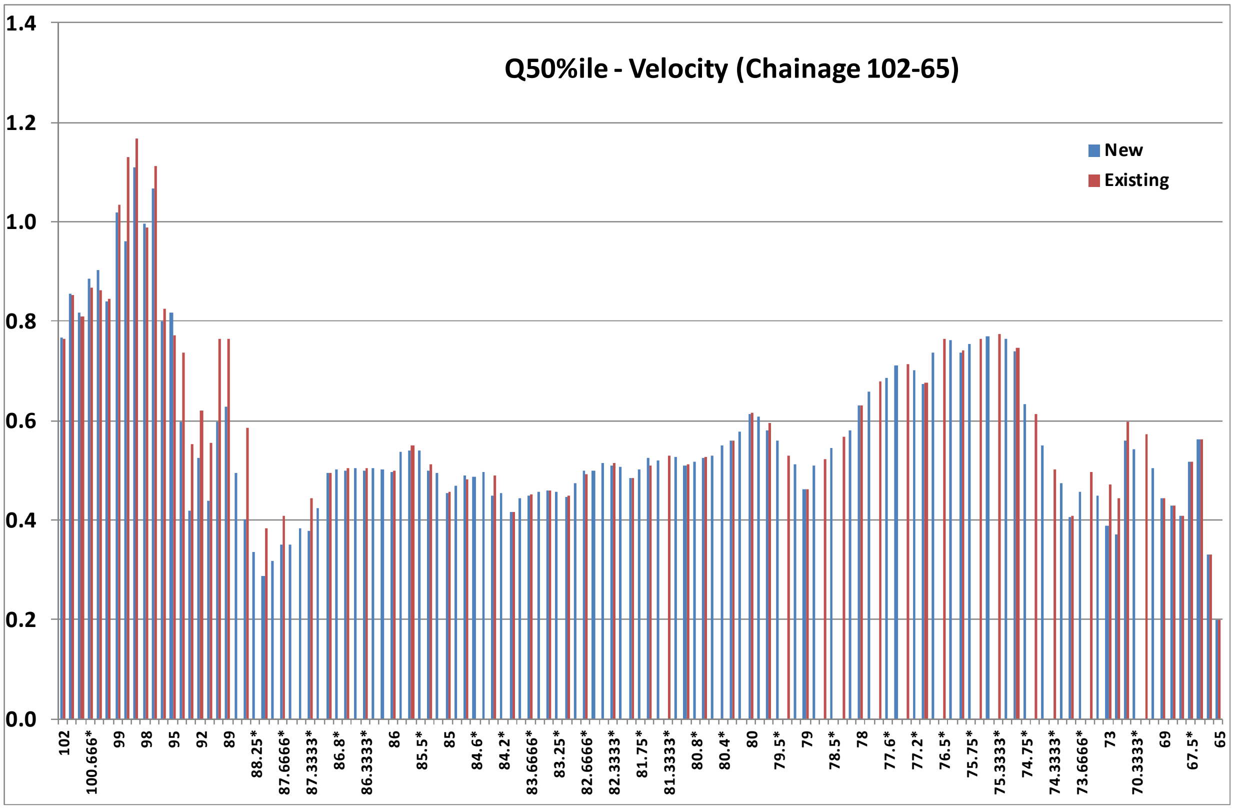

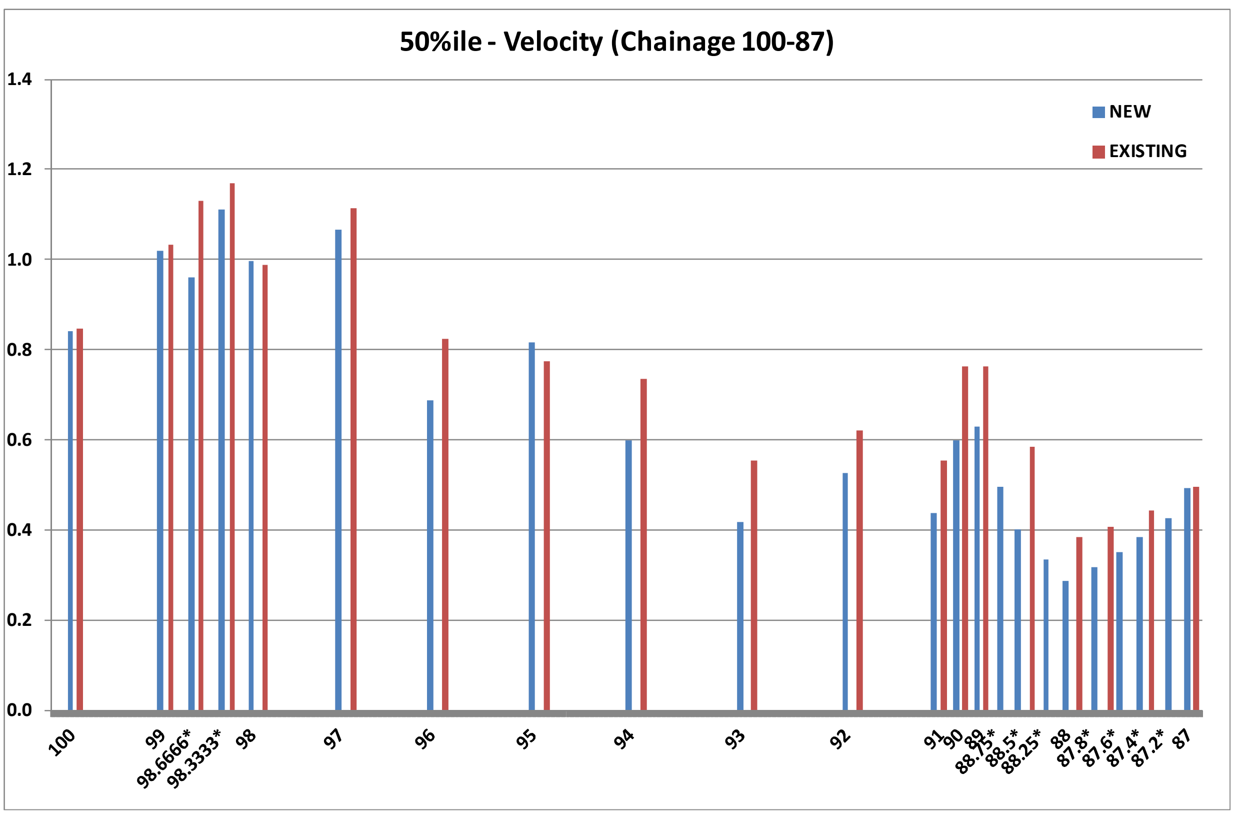

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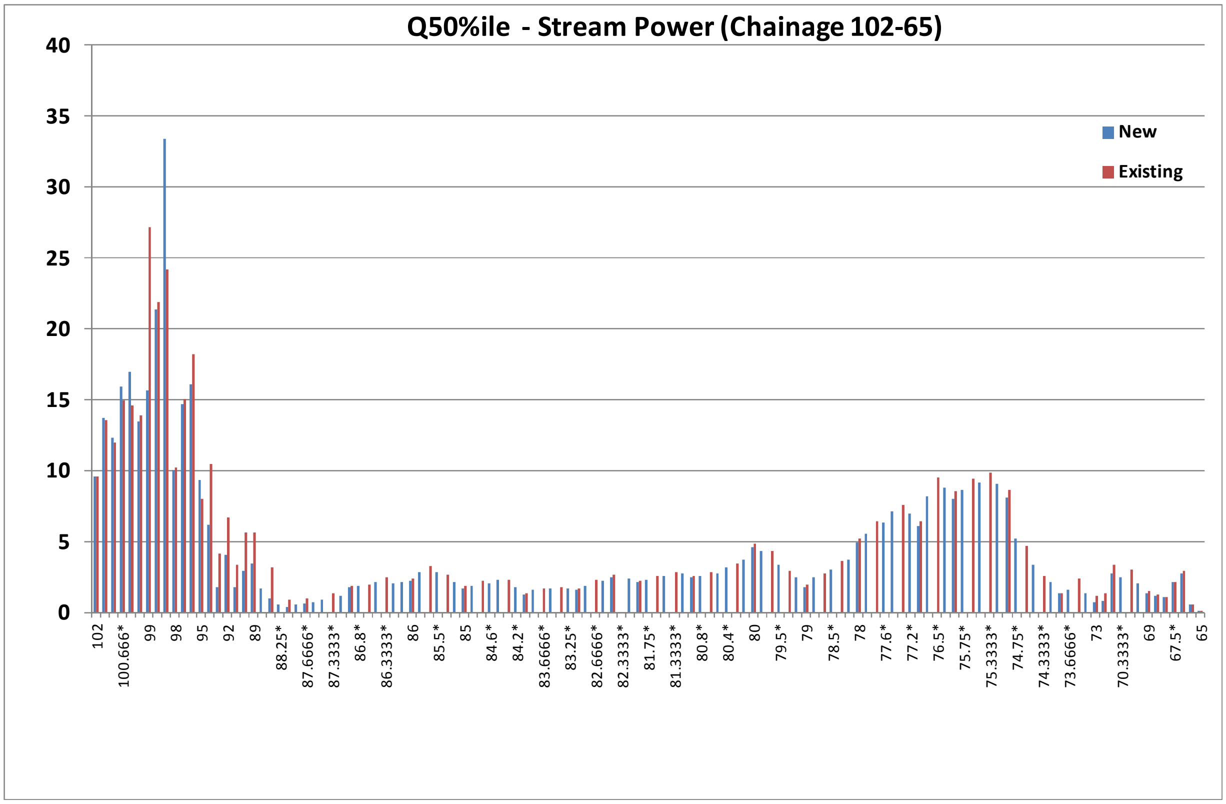

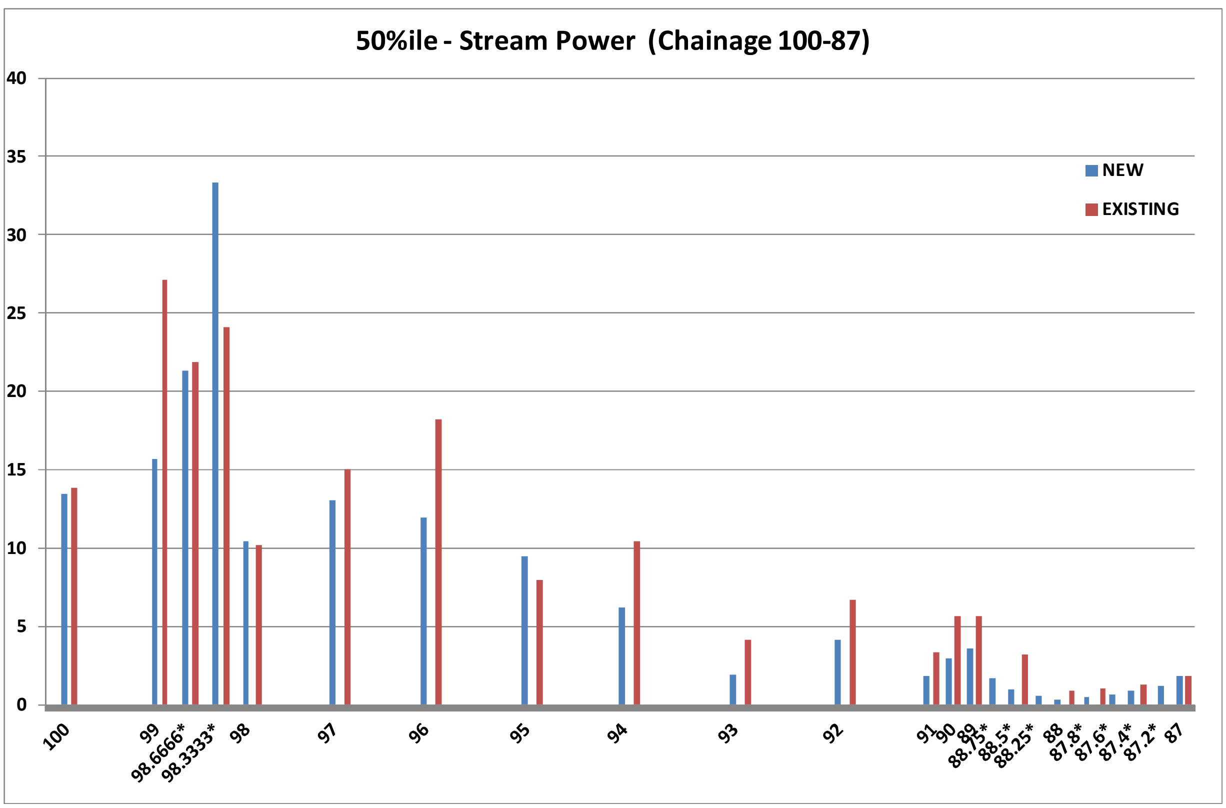

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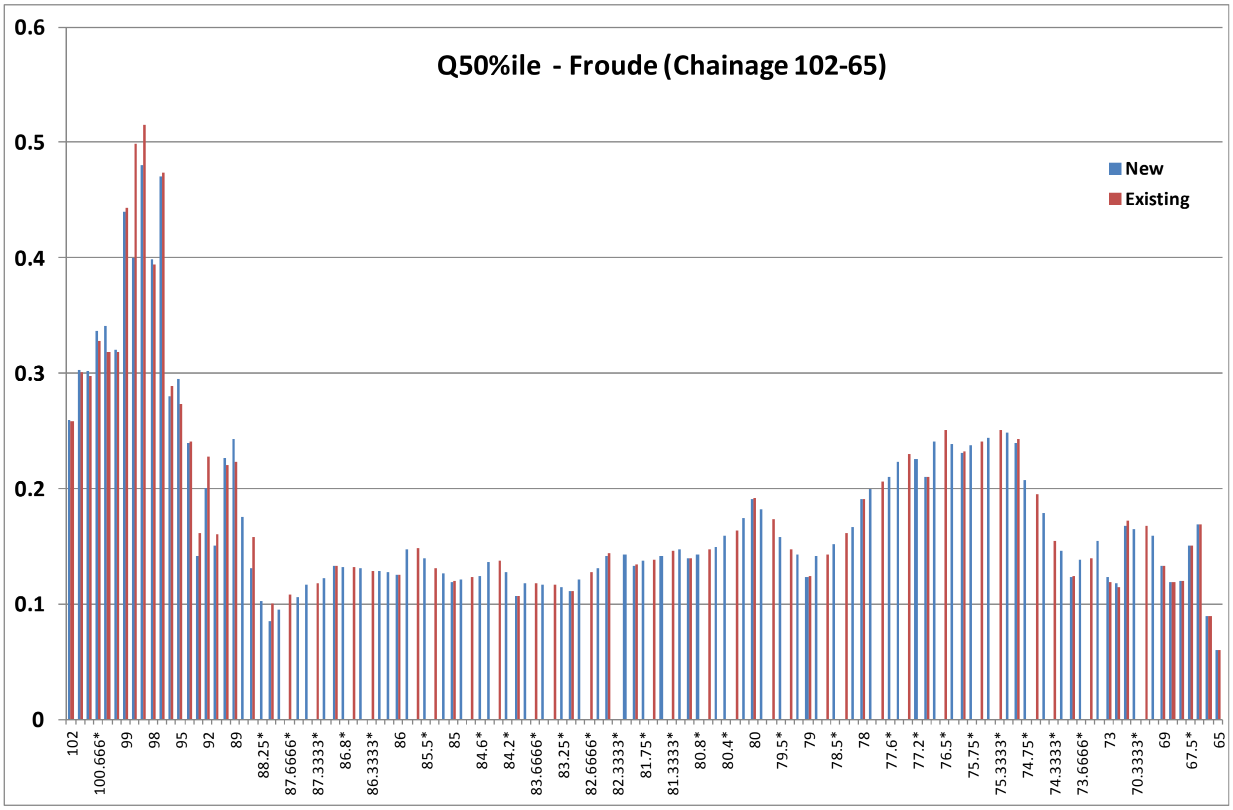

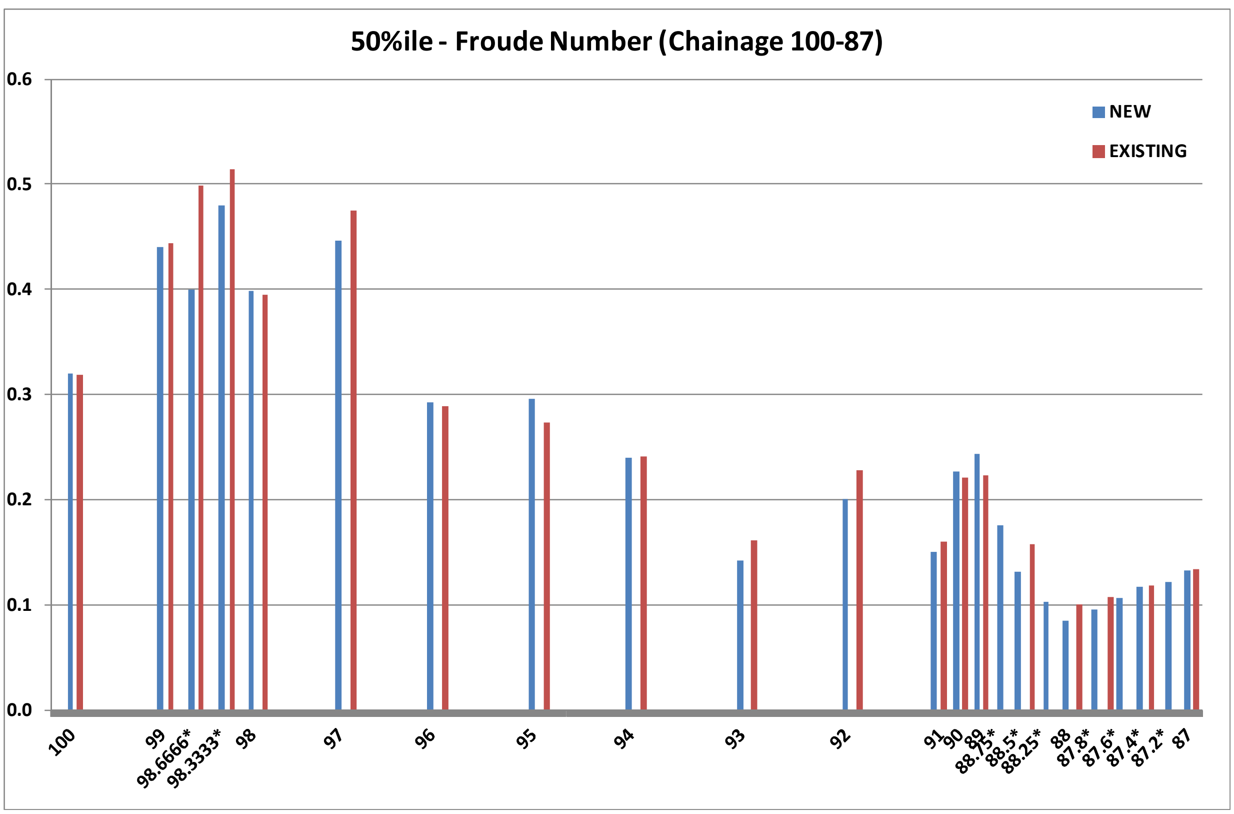

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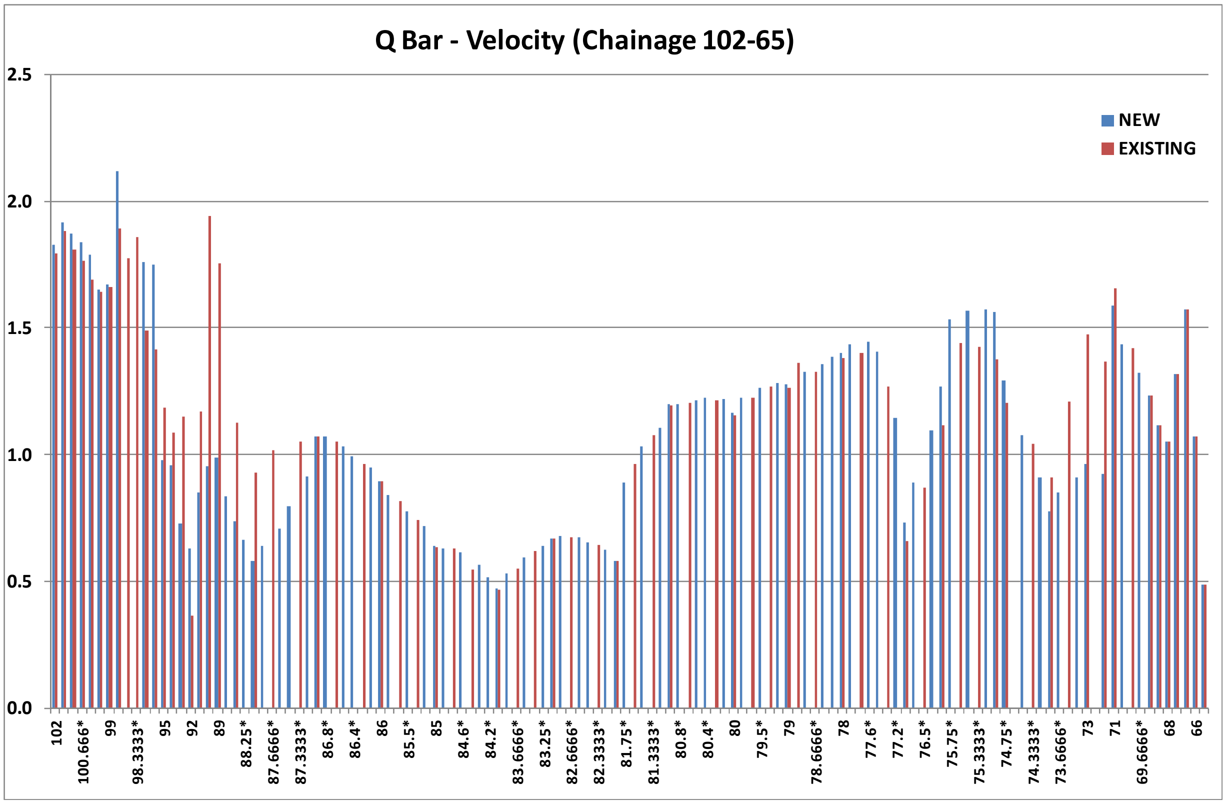


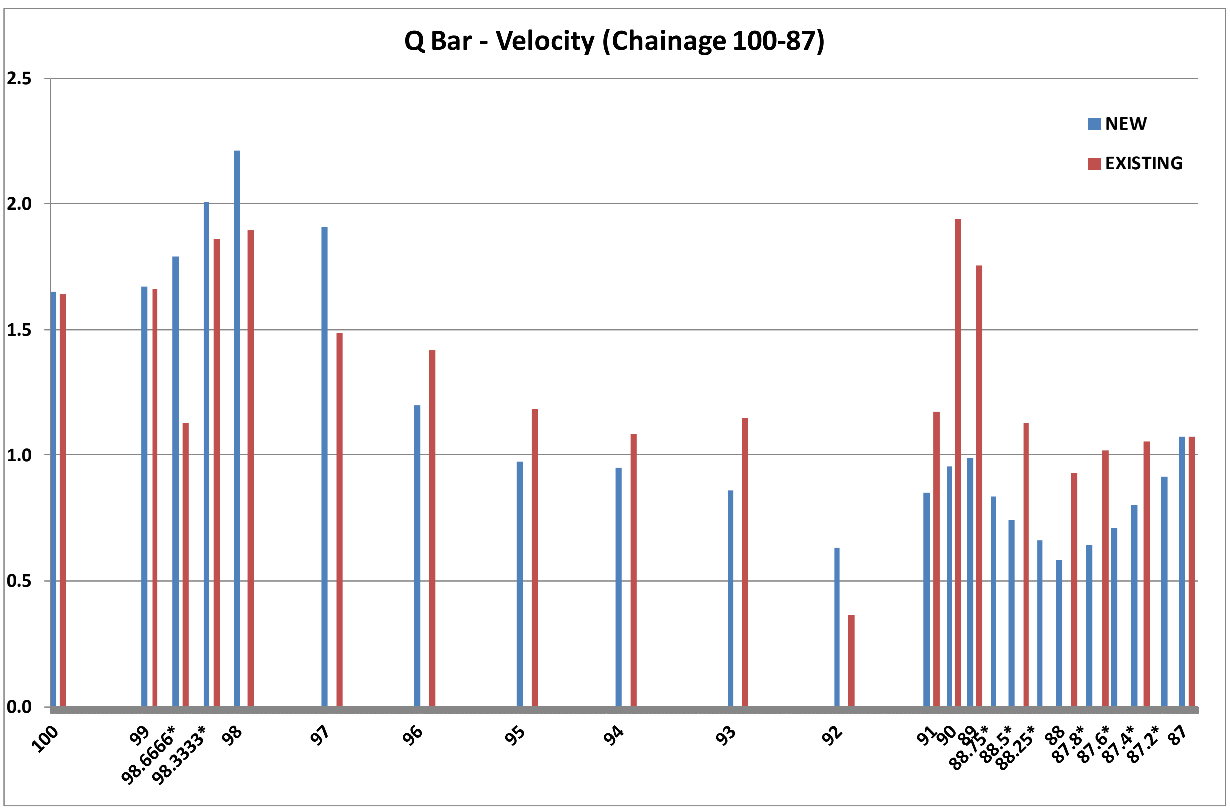
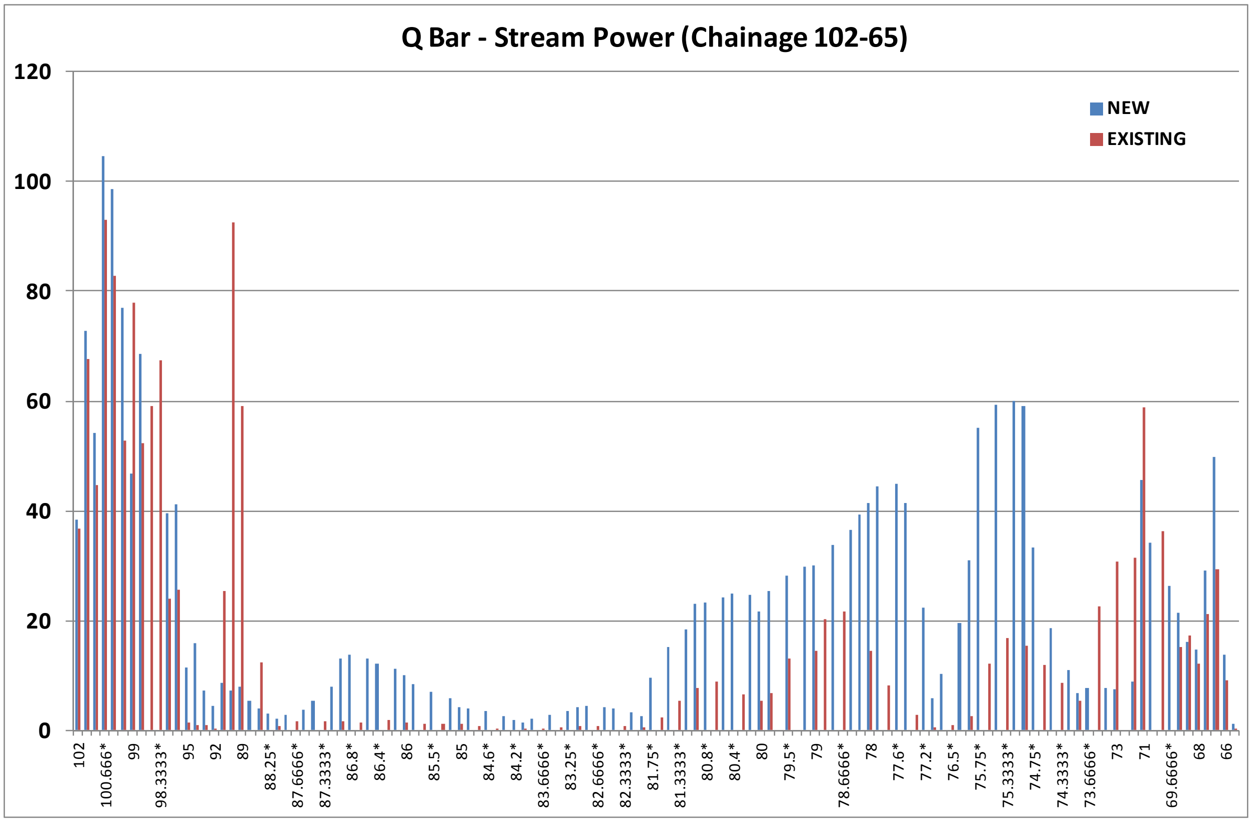


Figure 13(a) and (b)



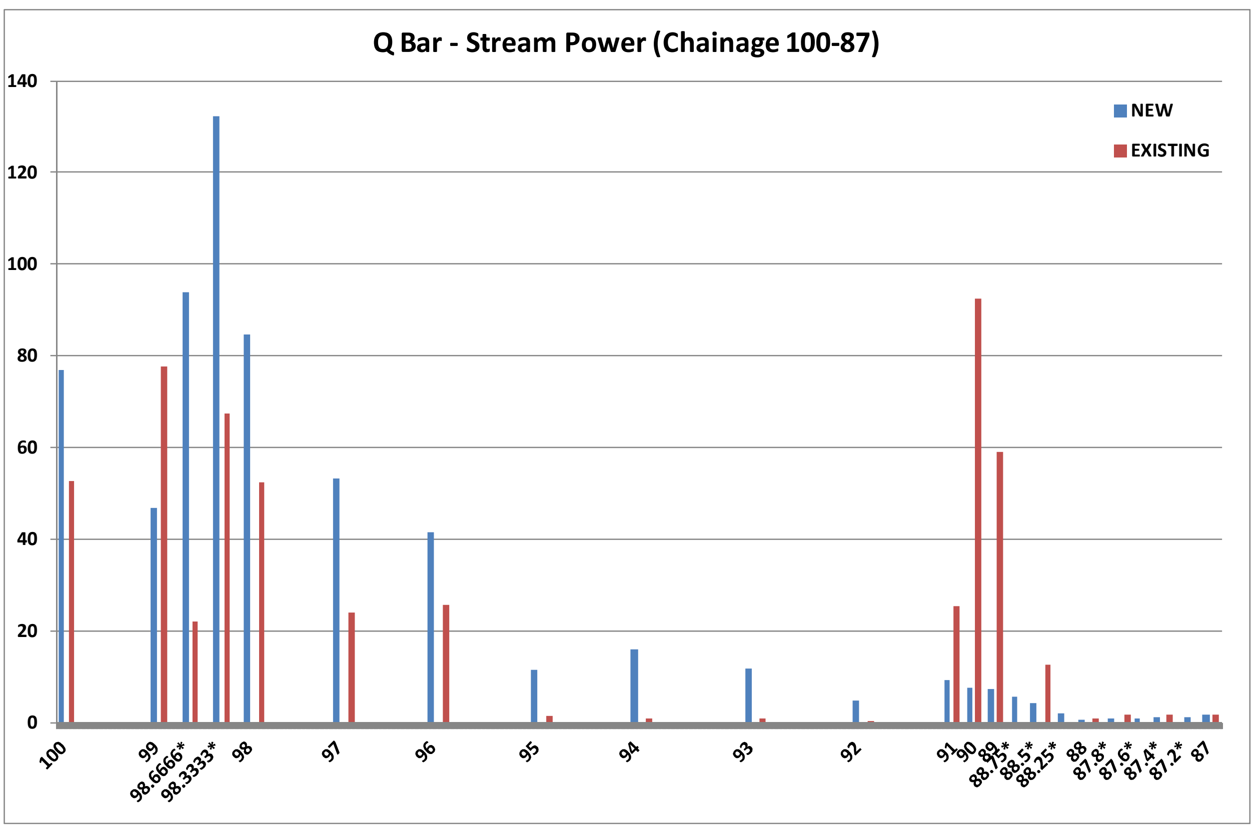
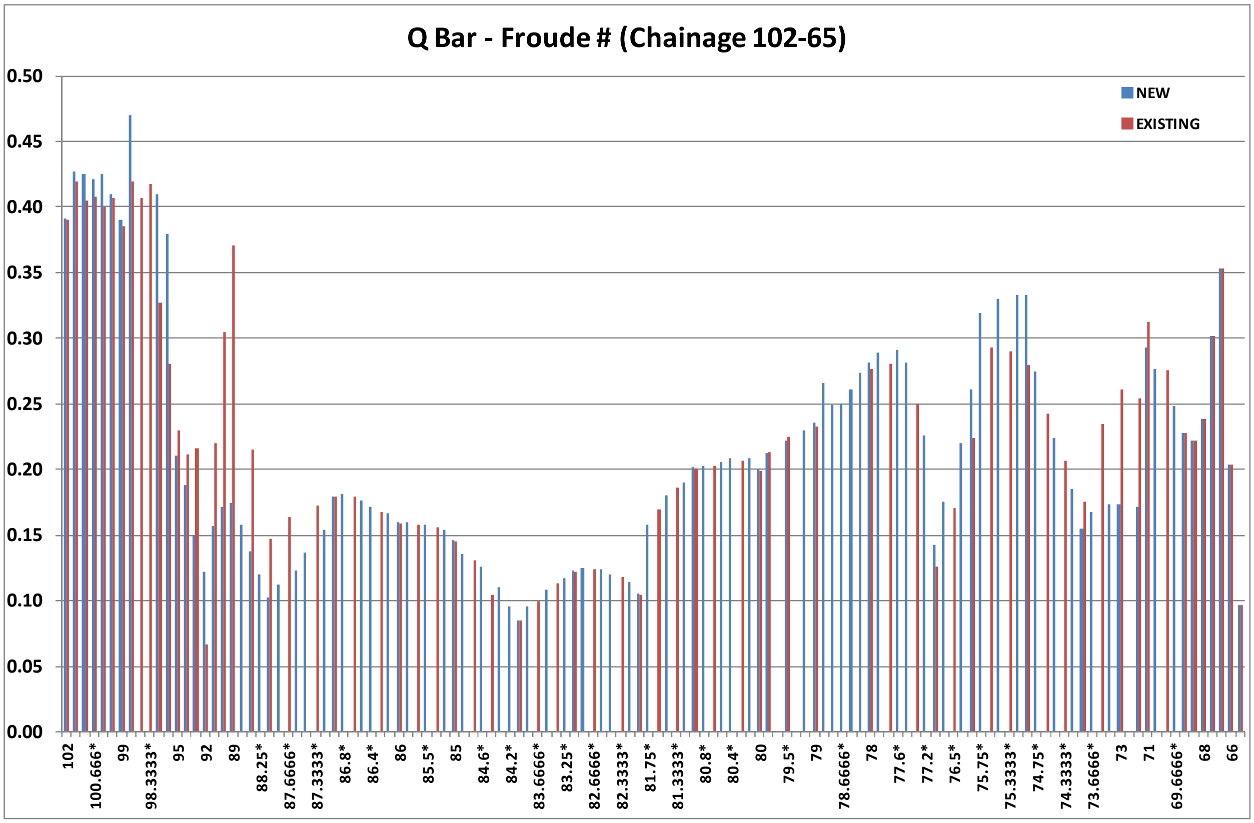


Figure 14(a) and (b)



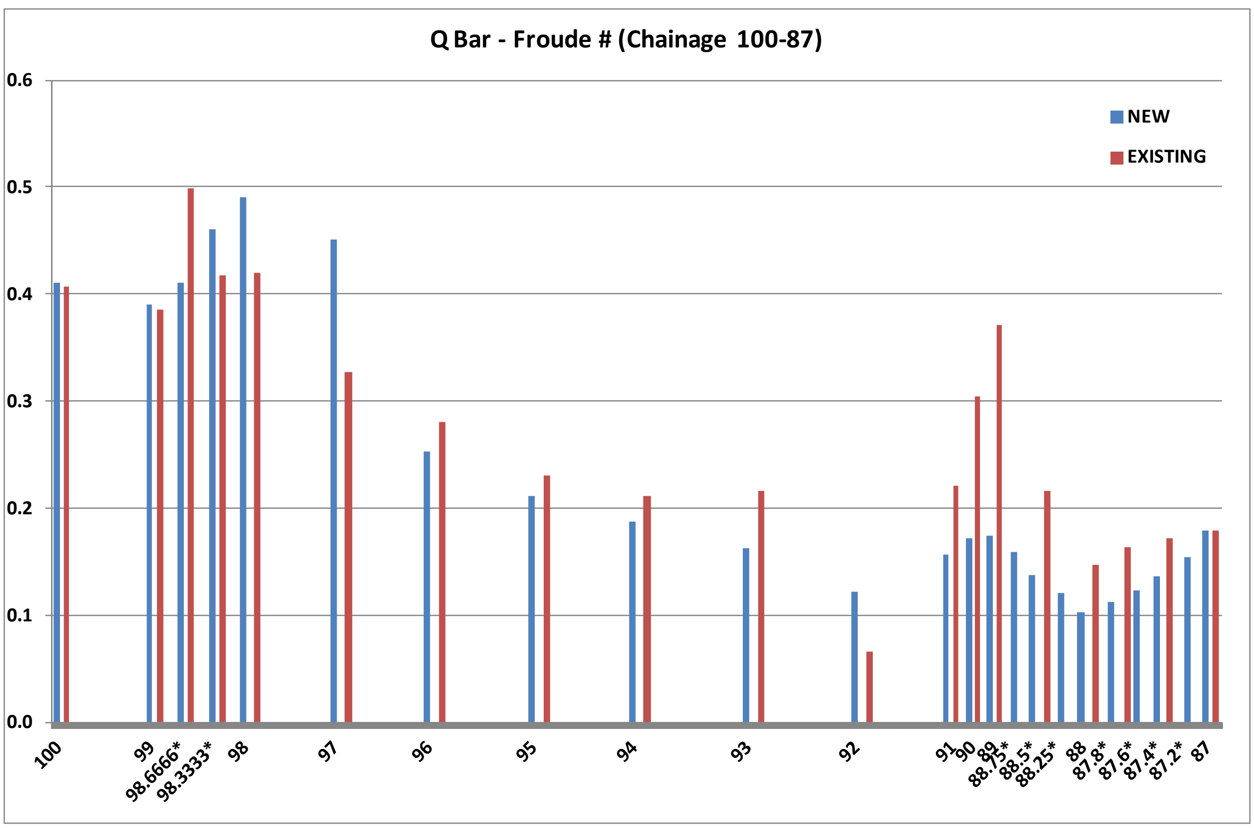


Figure 15(a) and (b)

APPENDIX F

Extracts from the ‘Interpretation Manual of European Union Habitats’

Interpretation Manual of European Union Habitats – 3140 Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.
1) Lakes and pools with waters fairly rich in dissolved bases (pH often 6-7) (21.12) or with mostly blue to greenish, very clear, waters poor (to moderate) in nutrients, base-rich (pH often >7.5) (21.15). The bottom of these unpolluted water bodies are covered with charophyte, *Chara* and *Nitella*, algal carpets. In the Boreal region this habitat type includes small calcareous-rich oligomesotrophic gyttja pools with dense *Chara* (dominating species is *C. strigosa*) carpets, often surrounded by various eutrophic fens and pine bogs. **2)** Plants: *Chara spp., Nitella spp.*
3) Corresponding Categories Nordic classification : "633 Långskottsvegetation med kransalger", "6421 *Littorella uniflora-Chara* spp. -typ"

Interpretation Manual of European Union Habitats – 3180*Turloughs
1) Temporary lakes principally filled by subterranean waters and particular to karstic limestone areas. Most flood in the autumn and then dry up between April and July. However, some may flood at any time of the year after heavy rainfall and dry out again in a few days; others, close to the sea, may be affected by the tide in summer. These lakes fill and empty at particular places. The soils are quite variable, including limestone bedrock, marls, peat, clay and humus, while aquatic conditions range from ultra oligotrophic to eutrophic. The vegetation mainly belongs to the alliance *Lolio-Potentillion anserinae* Tx. 1947, but also to the *Caricion davallianae* Klika 1934. **2)** Plants: *Cinclidotus fontinaloides, Fontinalis antipyretica* (Bryophyta). Animals: *Tanymastix stagnalis* (wet phase) and the beetles *Agonum lugens*, *A. livens, Badister meridionalis, Blethisa multipunctata* and *Pelophila borealis* (dry phase).
The Status of EU Protected Habitats and Species in Ireland (NPWS 2008) - Typical species
Typical Species : **Bryophytes and algae:** *Cinclidotus fontinaloides, Drepanocladus revolvens, Fontinalis antipyretica, Oedogonium sp.* **Angiosperms:** **Dicots:** *Salix repens, Polygonum amphibium, Polygonum persicaria, Rumex crispus, Ranunculus flammula, Ranunculus repens, Rorippa amphibia, *Rorippa islandica, Rorippa palustris, Filipendula ulmaria, Potentilla anserina, Potentilla reptans, Trifolium repens. Lotus corniculatus, Rhamnus cathartica, Frangula alnus, *Viola persicifolia, Hydrocotyle vulgaris, Apium inundatum, Menyanthes trifoliata, Galium boreale, Galium palustre, Myosotis scorpioides, *Callitriche palustris, Mentha aquatica, Mentha arvensis, *Limosella aquatica, Veronica scutellata, Littorella uniflora, Achillea ptarmica, Cirsium dissectum, Leontodon autumnalis, Taraxacum palustre.* **Monocots:** *Baldellia ranunculoides, Alisma plantago-aquatica, Potamogeton natans, Potamogeton polygonifolius, Juncus bulbosu, Glyceria fluitans, Agrostis stolonifera, Phalaris arundinacea, Molinia caerulea, Eleocharis palustris, Schoenus nigricans, Carex flacca, Carex viridula, Carex hirta, Carex hostiana, Carex nigra, Carex panicea.* **Aquatic invertebrates:Plathyhelminthes, Turbellaria:** *Polycelis nigra;* **Mollusca:** *Lymnaea palustris, Lymnaea peregra, Bithynia tentaculata;* **Crustacea, Cladocera:** *Alona affinis, Chydorus sphaericus, Daphnia spp. (D. obtusa, D.longispina, D. pulex, and D. magna), *Eurycercus glacialis, Simocephalus vetulus;* **Crustacea, Copepoda; Crustacea, Ostracoda; Crustacea, Amphipoda:** *Gammarus spp., Asellus aquaticus; Insecta, Ephemeroptera: Cloeon simile;* **Insecta, Odonata:** **Lestes dryas, Sympetrum sanguineum;* **Insecta, Heteroptera:** *Notonecta spp.;* **Insecta, Trichoptera:** *Family Limnephilidae;* **Insecta, Coleoptera:** *Colymbetes fuscus, Rhantus frontalis; Ilybius fuliginosus, Agabus bipustulatus, Agabus labiatus, Agabus nebulosus, Laccophilus minutus, Porhydrus lineatus, Hygrotus impressopunctatus, Hygrotus inaequalis, Hygrotus quinquelineatus, *Graptodytes bilineatus, Hydroporus erythrocephalus, Hydroporus palustris, Hydroporus planus, Hydrobius fuscipes, Helophorus brevipalpis, Helophorus flavipes, Helophorus grandis, Helophorus minutus, Anacaena lutescens, Ochthebius minimus, Dryops spp. (D. luridus and D. similaris).* **Terrrestrial invertebrates:Lepidoptera:** *Paraponyx stratiotata, Bactra furfurana, Deltote uncula;* **Coleoptera, Staphylinidae:** *Platystethus nodifrons,Philonthus furcifer ,* **Colopetera, Carabidae:** *Pterostichus crenatus, Pterostichus strenuus, Pelophila borealis and Chlaenius nigricornis;* **Diptera:** *Clusiodes caledonica, Zabrachia minutissima, Pherbellia nana,*

Colobaea distincta.

Interpretation Manual of European Union Habitats – 3260 Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation
1) Water courses of plain to montane levels, with submerged or floating vegetation of the *Ranunculion fluitantis* and *Callitricho-Batrachion* (low water level during summer) or aquatic mosses. **2)** Plants: *Ranunculus saniculifolius*, *R. trichophyllus*, *R. fluitans*, *R. peltatus*, *R. penicillatus* ssp. *penicillatus*, *R. penicillatus* ssp. *pseudofluitantis*, *R. aquatilis*, *Myriophyllum* spp., *Callitriche* spp., *Sium erectum*, *Zannichellia palustris*, *Potamogeton* spp., *Fontinalis antipyretica*.
3) Corresponding Categories German classification : "23010101 naturnahes, kalkreiches Epi-/Metarhithral", "23010201 naturnahes, kalkarmes Epi-/Metarhithral", "23010301 naturnahes, kalkreiches Hyporhithral", "23010401 naturnahes, kalkarmes Hyporhithral", "23020101 naturnahes Epipotamal", "23010201 naturnahes Metapotamal", "23010301 naturnahes Hypopotamal" (mit flutenden Macrophyten, P138). Nordic classification : "6621 *Myriophyllum alterniflorum-Potamogeton alpinus-Fontinalis antipyretica*-typ". **4)** This habitat is sometimes associated with *Butomus umbellatus* bank communities. It is important to take this point into account in the process of site selection. **5) Sjörs, H. (1967).** *Nordisk växtgeografi. 2 uppl*. Svenska Bokförlaget Bonniers, Stockholm, 240 pp.
The Status of EU Protected Habitats and Species in Ireland (NPWS 2008) - Typical species
Typical Species : *R. trichophyllus, R. peltatus, R. penicillatus, R. aquatilis, Myriophyllum spp., Callitriche spp., Sium erectum, Zannichellia palustris, Potamogeton spp., Fontinalis antipyretica.*

Interpretation Manual of European Union Habitats – 7220 Petrifying springs with tufa formation (Cratoneurion)
1) Hard water springs with active formation of travertine or tufa. These formations are found in such diverse environments as forests or open countryside. They are generally small (point or linear formations) and dominated by bryophytes (*Cratoneurion commutati*). **2)** Plants: *Arabis soyeri, Cochlearia pyrenaica (in sites with heavy metals), Pinguicula vulgaris, Saxifraga aizoides. Mosses: Catoscopium nigritum, Cratoneuron commutatum, C. commutatum var. falcatum, C. filicinum, Eucladium verticillatum, Gymnostomum recurvirostrum. In the Boreal region also Carex appropinquata, Epilobium davuricum, Juncus triglumis, Drepanocladus vernicosus, Philonotis calcarea, Scorpidium revolvens, S.cossoni, Cratoneuron decipiens, Bryum pseudotriquetum.*
3) Corresponding Categories United Kingdom classification: "M37 *Cratoneuron commutatum-Festuca rubra* spring community" and "M38 *Cratoneuron commutatum-Carex nigra* spring community". German classification: "220102 kalkreiche Sicker- und Sumpfquelle", "220302 kalkreiche Sturzquelle", "220402 kalkreiche, temporäre Sicker- und Stumpfquelle", "220502 kalkreiche, temporäre Sturzquelle". Nordic classification: "3521 *Philonotis*-typ" and "3522 *Cratoneuron*-typ".
4) Can form complexes with transition mires, fens, chasmophytic communities of cold and humid environments and heaths and calcareous grassland (*Festuco-Brometalia*). In order to preserve this habitat of very limited expanse in the field, it is essential to preserve its surroundings and the whole hydrological system concerned.

Interpretation Manual of European Union Habitats – 6410 Molinia meadows on calcareous, peaty or clayey-siltladen soils (Molinion caeruleae)
1) Molinia meadows of plain to montane levels, on more or less wet nutrient poor soils (nitrogen, phosphorus). They stem from extensive management, sometimes with a mowing late in the year or, they correspond to a deteriorated stage of draining peat bogs. Sub-types : 37.311: on neutro-alkaline to calcareous soils with a fluctuating water table, relatively rich in species (Eu-molinion). The soil is sometimes peaty and becomes dry in summer. 37.312: on more acid soils of the Junco-Molinion (Juncion acutiflori) except species-poor meadows or on degraded peaty soils.

2) Plants: 37.311 - *Molinia coerulea, Dianthus superbus, Selinum carvifolia, Cirsium tuberosum, Colchicum autumnale, Inula salicina, Silaum silaus, Sanguisorba officinalis, Serratula tinctoria, Tetragonolobus maritimus;* 37.312 - *Viola persiciflora, V. palustris, Galium uliginosum, Cirsium dissectum, Crepis paludosa, Luzula multiflora, Juncus conglomeratus, Ophioglossum vulgatum, Inula britannica, Lotus uliginosus, Dianthus deltoides, Potentilla erecta, P. anglica, Carex pallescens.*
3) Corresponding Categories United Kingdom classification : "M26 - Molinia caerulea-Crepis paludosa fen meadow" and "M24 - Molinia caerula-Cirisum dissectum fen meadow type" ("M23 - Juncus effusus/acutiflorus-Galium palustre rush pasture" and "M25 - Molinia caerulea-Potentilla erecta mire" are excluded).
4) In some regions, these grasslands are in close contact with Nardetalia communities. For the Molinia meadows of river valleys, a transition toward Cnidion dubii alliance is observed.
The Status of EU Protected Habitats and Species in Ireland (NPWS 2008) - Typical species
Typical species : *Agrostis spp., Carex echinata, Carex nigra, Carex hostiana, Carex panicea, Carex pulicaris,Holcus lanatus, Angelica sylvestris, Caltha palustris, Cardamine pratensis, Cirsium dissectum, Cirsium palustre, Filipendula ulmaria, Juncus acutiflorus, Juncus articulatus, Juncus conglomeratus, Juncus effusus, Lotus pedunculatus, Lychnis flos-cuculi, Lythrum salicaria, Molinia caerulea, Myosotis laxa, Orchidaeae spp., Potentilla anglica, Potentilla erecta, Ranunculus repens, Ranunculus flammula, Senecio aquaticus, Succisa pratensis, Pseudoscleropodium purum, Thuidium tamariscinum, Hylocomium splendens, Carex pallescens, Carum verticillatum, Sisyrinchium bermudiana, Wahlenbergia hederacea.*