Annex C Australian Grayling Species Impact Assessment

TASMANIAN IRRIGATION –

Sassafras – Wesley Vale Irrigation Scheme Augmentation, Tasmania

Australian Grayling (*Prototroctes maraena*)

Species Impact Assessment

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ABN 59123488639

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Author (s):	Jakob Fries Dr Luke Finley	
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Contact:	Elgin Associates Pty Ltd ABN 59123488639 28 Letitia St, North Hobart, TAS, 7000 Telephone: +61 417 598807 www.elgin.com.au	

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ABBREVIATIONS

IBRAa	Interim Biogeographic Regionalisation for Australia
ML	Megalitre
TI	Tasmanian Irrigation Pty Ltd
WC	Water Crossing
SWIS	Sassafras – Wesley Vale Irrigation Scheme
SWISA	Sassafras – Wesley Vale Irrigation Scheme Augmentation

1 PROJECT INTRODUCTION

1.1 SPECIES BIOLOGY AND THREATS

The Australian Grayling (*Prototroctes maraena*) is a diadromous species, native to southern New South Wales, Victoria and Tasmania (Backhouse *et al*. 2008a). Australian Grayling are a freshwater inhabitant, requiring migration between fresh and marine/estuarine environments in order for populations to remain viable. It is biologically necessary for individuals to complete a diadromous migration to complete their lifecycle (Berra 1982, Berra *et al*. 1987, McDowall 1996). Adult Grayling are typically found in deep, slow flowing pools (Bishop and Bell, 1978a), clear gravel-bottomed streams with both pools and riffles (Berra 1982) and in some instances in turbid waters (Jackson and Koehn 1988).

Adults are resident in freshwater streams and migrate to downstream reaches close to estuaries to spawn. Spawning migrations typically occur in autumn-winter, coinciding with increased river flows. Adults typically migrate downstream to within a few km's of estuaries (Koster *et al* 2013, Amtstaetter 2015) in early to mid-May for spawning (Koster *et al*, 2013). Koster *et al* 2013 observed spawning migrations to occur 1-4 weeks before eggs were detected in lower river reaches and estuaries. Rapid downstream migrations have also been observed from late March to late April over distances between 15 and 30 km triggered by controlled environmental flow releases (Koster *et al* 2013, Amtstaetter *et al* 2016, Koster *et al* 2017). After spawning in lower freshwater reaches, demersal eggs are dispersed into estuaries where eggs are larvae can spend up to 4-6 months in marine waters before migrating back to freshwaters (Berra 1982, Crook *et al* 2006, Koster *et al*. 2020). Upstream migration of juveniles from estuaries into the lower reaches of rivers has been observed from September to December with peak abundances between late October and Early November (Koster *et al*. 2020). Recruitment and upstream migration of juveniles has been strongly linked to streamflow cues (Koster *et al*. 2020). Exact timings are likely to be spatially variable and may be different in Tasmania.

Individuals typically reach 300mm in total length (Berra & Cadwallader 1983, Stead 1903, Mcdowall 1996) and may live up to five years (Berra & Cadwallader 1983). Adult individuals typically occupy restricted reaches of streams (<1km) (Dawson and Koster 2018). Their preferred habitats are moderate to fast-flowing glides or runs, though they have been observed to use slower-flowing habitats at night (Dawson and Koster 2018). Grayling are anecdotally known to be fast swimmers, able to dart away from danger very quickly (Blackhouse *et al* 2008). The species has been described as 'salmoniform' in physiology and appearance resembling some salmonid species from European and North American continents. Grayling are slender fish with a small head and rounded snout. Their colour varies from silvery with an olive-grey back and whitish belly to olive-green or brownish on the back, with clear to greyish fins. The species is often confused with various species of mullet Australian Smelt. The species typically produces between 25,000 and 68,000 eggs per individual per year (Berra 1982, 1984). Eggs are less than 1mm in diameter, demersal and non-adhesive (McDowall 1976, Jackson & Koehn 1988, Berra 1982, Backhouse *et al*. 2008b, DCCEEW 2024).

The major threats to the Australian Grayling include barriers to fish passage, and introduced species such as Brown Trout (*Salmo trutta*) and Rainbow Trout (*Oncorhynchus mykiss*), and Redfin Perch (*Perca fluviatilis*). Fish passage barriers such as weirs, dams, culverts and bunds prevent upstream migration of juveniles to suitable habitats in upstream reaches of streams and creeks. Introduced species have resulted in high levels of predation, competition for resources and introduction of pathogens (Cadwallader 1996; Jackson & Koehn 1988; Humphries & Walker 2013; Jarvis *et al*. 2019, Backhouse *et al*. 2008a, Knott 1973). Several threatening human activities have been outlined in the national recovery plan for Australian Grayling by Backhouse *et al*. (2008a). These include:

- Constructing barriers to fish movement/migration – barriers include culverts, weirs, dams, barrages, areas of unsuitable habitat (e.g. excessive turbulence, artificially raised water temperatures).

- Reduction in/alteration of river flows (particularly during migration periods – Autum/winter for spawning and summer for recruitment), through water extraction.
- Removal/degradation of riparian vegetation/habitat.
- Removal of snags, woody debris, rocks from potential habitat. Where this is unavoidable (e.g. for protection of assets such as bridges), alternative suitable habitat should be created as a compensation or offset.
- Events leading to increased siltation or sedimentation, such as works on riverbank and floodplain.
- Release of potential predators/competitors (such as stocking for recreational angling) in areas where important populations occur or where habitat works are occurring to increase population size and security.
- Pesticide and fertiliser run-off changing nutrient regimes leading to algae blooms, reduction in dissolved oxygen, increasing sedimentation rates etc.

A number of management practices have also been identified to aid conservation of Australian Grayling:

- Maintenance or restoration of flow regimes (especially winter flows) in coastal rivers to meet the habitat and spawning requirements of Australian Grayling.
- Removal of artificial barriers or provision of fish passage (of a type suitable for negotiation by Australian Grayling) past barriers on coastal rivers and streams.
- Maintenance and restoration of river channel structure and instream habitat quality.
- Maintenance or restoration of quality and width of riparian vegetation at levels necessary to maintain stream temperature and light regimes, maintain input of organic materials, and filter surface runoff under heavy rainfall conditions.
- Management of catchment vegetation clearing and planting (e.g. of pine or eucalypt plantations) to avoid negative effects on catchment water yields and flow patterns, in catchments where Australian Grayling occur.
- Manage water quality where Australian Grayling occurs to maintain waters free of significant levels of nutrient, sediment, pesticide, and other pollutants, consistent with the ANZECC guidelines for water quality (ANZECC 2000).
- Continuing to prohibit fishing for the species, through education, regulation and enforcement, at least until there is recovery to sustainable levels.
- Management of fish stockings to avoid any potential impacts on Australian Grayling.
- Continue to limit the Tasmanian recreational whitebaiting season to selected rivers for a short open season.

1.2 Regional Presence

Australian Grayling has been recorded in catchments throughout the north, west, and east of Tasmania (McDowall 1976; Backhouse *et al*. 2008b; TSS 2019). It is known to be widely distributed and was prolific throughout these areas prior to European colonisation (Backhouse *et al*. 2008b; DCCEEW 2024). The Mersey catchment is known to be a remaining stronghold of the species, with several recorded observations in recent surveys (Threatened Species Scientific Committee 2021). There have also been several recordings of the species within the Sassafras/Wesley Vale area (Atlas of Living Australia 2024) which are illustrated in Figure 1.

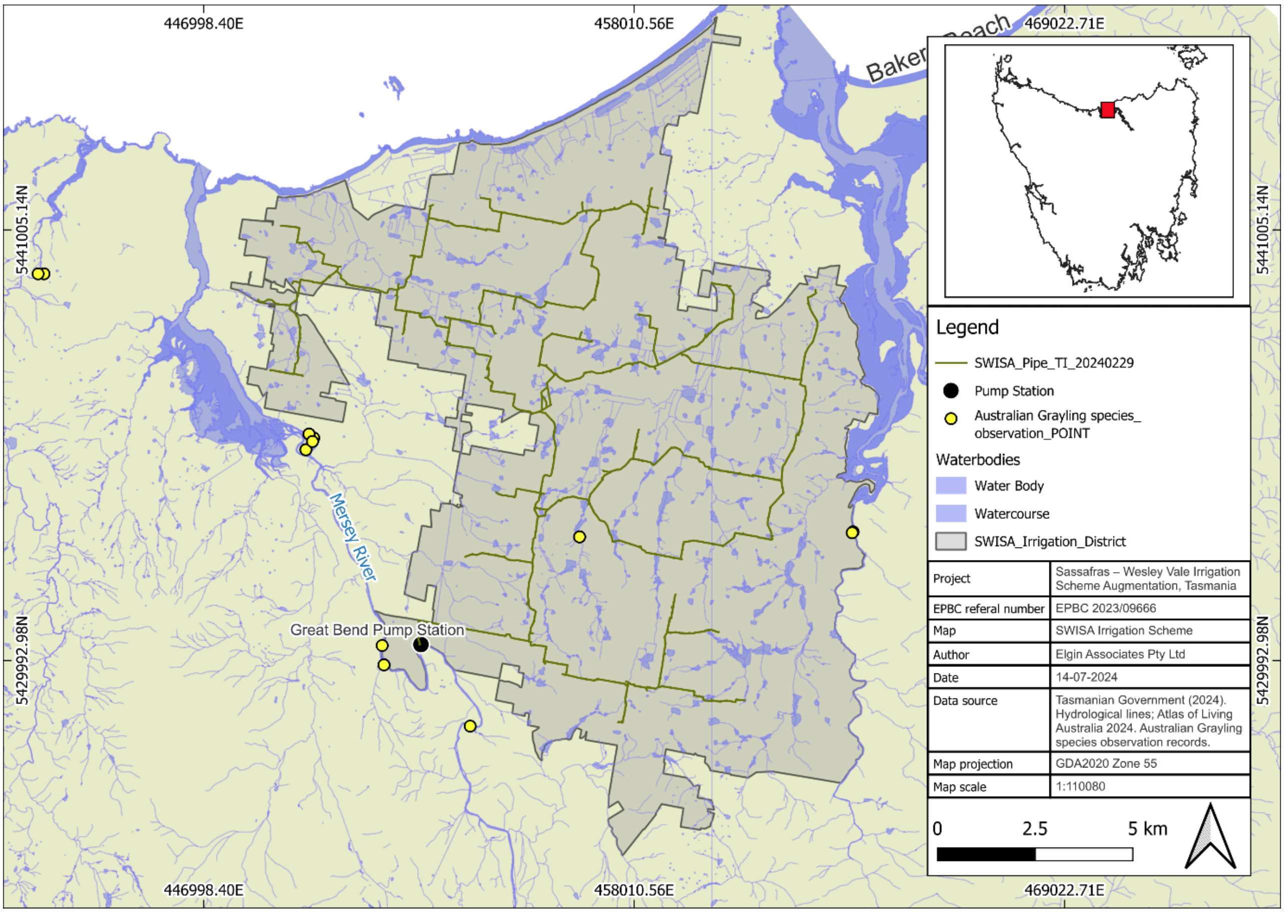


Figure 1. Site map for Tas Irrigation SWISA augmentation and Mersey River, Great Bend Pump Station. Map includes recorded observations of Australian Grayling (P. maraena).

2 [redacted] MERSEY RIVER - ASSESSMENT 1

2.1 SITE DETAILS

The Mersey River is approximately 147km in length upstream of tidal influence. The river flows northward from the central plateau, discharging into the Bass Strait at Devonport (Figure 2). There are two major dams on the river, the most downstream, Parangana Dam located approximately 92.5km upstream from the point of tidal influence. In this report, all references to the Mersey River refer to the river below Parangana Dam. As this structure is impassable to fish, the river above this dam is not considered in assessment of impacts to the Australian Grayling. The river is relatively free from anthropogenic in-stream structures that my form barriers to fish passage below Parangana Dam. The catchment is comprised of agricultural, forestry, and conservation/other land uses. These comprise approximately 26%, 30% and 44% respectively (Department of Natural Resources and Environment Tasmania, 2023). Annual rainfall ranges from 860mm in the lower floodplain to 2020mm in the highlands (DPIPWE 2020). Grazing and dairy are the major agricultural uses (DPIPWE 2020). While much of the floodplain is cleared for agriculture, established riparian vegetation is present along most of the river.

[redacted].

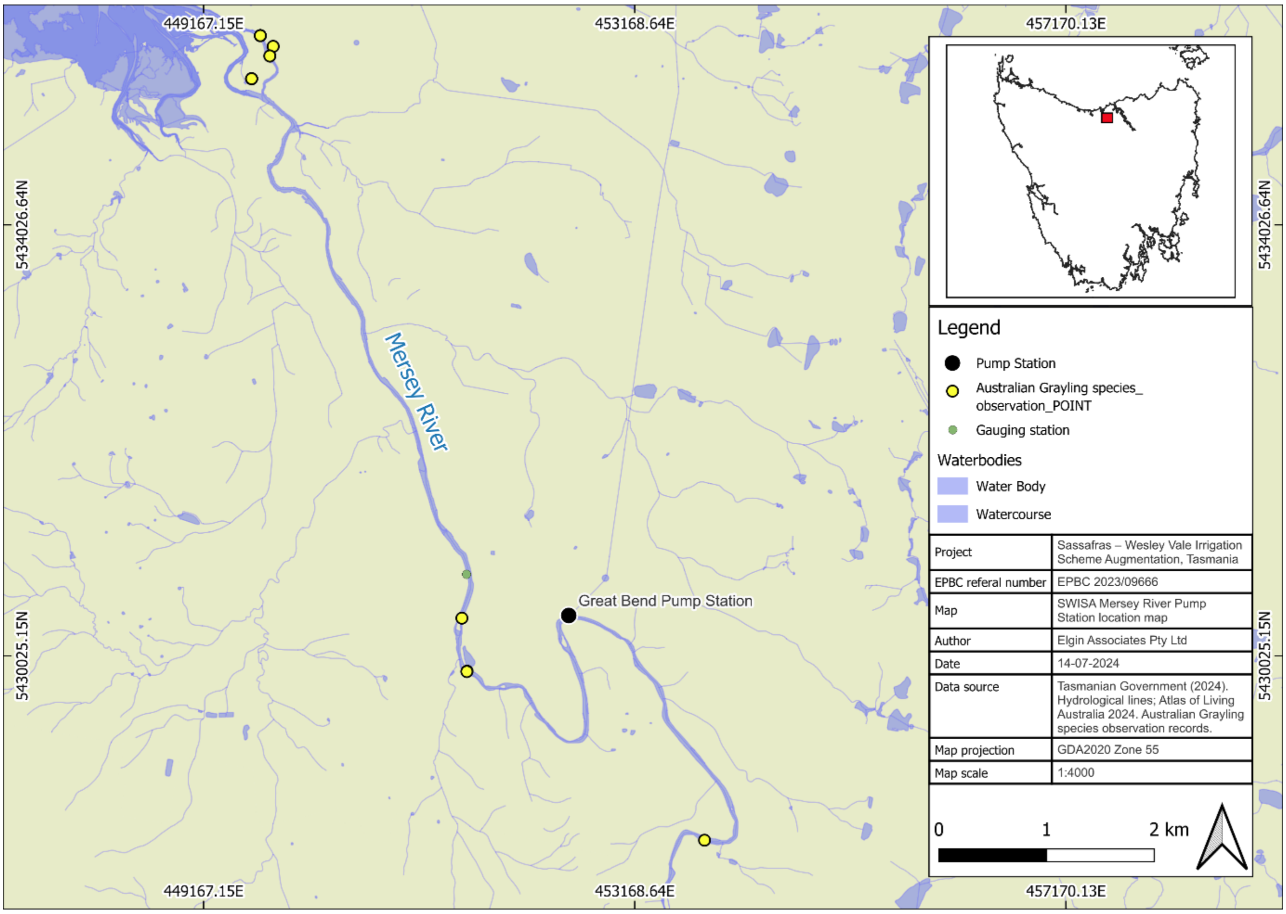


Figure 2. Site map for Mersey River, Great Bend Pump Station. Map includes recorded observations of Australian Grayling (P. maraena).

2.1.1 SPECIES PRESENCE

The species has been recorded within the vicinity, both upstream and downstream from [redacted] (Figure 2). It is likely that the impact site forms suitable habitat for residence of adult Grayling. It is also highly likely that both adults and juveniles migrate through [redacted] during spawning and recruitment migrations. It is unknown whether spawning occurs upstream from the site, and whether Australian Grayling eggs are likely to be dispersed through the site.

2.1.2 SITE SURVEY

Initial GIS assessment of the watercourse was conducted to determine if anthropogenic physical barriers existed downstream of [redacted] the Mersey River. Two barriers were identified – a major weir at the tidal interface, and a temporary earth coffer dam [redacted] The major weir located downstream is situated on an anabranch of the river and therefore would not prevent fish passage upstream. There have been several recordings of Australian Grayling both upstream and downstream from the site (Figure 1). It is therefore be assumed that the species is present within the river [redacted]

A site survey was conducted to assess the impact of [redacted] on fish passage and to assess entrainment and mortality risk on 22/08/2024. No surveys were conducted to determine the presence of Australian Grayling as it was assumed the species is present within the river reach due to recent observations. The [redacted] is situated is densely vegetated on upstream and downstream sides with remnant vegetation. The opposite ([redacted]) bank is also vegetated with a ~16m wide strip of native riparian vegetation. This is comprised mostly of invasive willow (*Salix spp.*) trees (Figure 3).

[redacted]

[redacted]

2.1.3 POTENTIAL IMPACTS TO AUSTRALIAN GRAYLING

Potential impacts resulting from the proposed actions can be classified as temporary and on-going. These represent the construction of infrastructure and operation of the irrigation scheme respectively.

2.2 TEMPORARY IMPACTS

2.2.1 CONSTRUCTION OF IN-STREAM STRUCTURES

The construction of the pump-house upgrade could present a number of risks to the species by way of impacts to water quality if works are not managed effectively. Construction will include installation of new intake structures inside both pump wells, and installation of a new screen on the pump well faces. No additional structures will be installed in the waterway outside of the existing pump wells. It is unlikely that construction will result in any direct interactions with individual Australian Grayling as they are highly mobile and likely able to move away from disturbance and human activity (Threatened Species Scientific Committee 2021). As the construction site is situated within a fast-flowing section of run habitat, fish will be facilitated in moving either upstream or downstream with entrainment or trapping within the works site highly unlikely to occur. It is also unlikely that construction disturbance would impact spawning and recruitment migrations within the reach. Individuals migrating may encounter construction works but will easily be able to avoid disturbance due to the wide stream profile at the site.

Construction will not involve the use of machinery within the waterway or any excavation of streambed material. Where earthworks are required to stabilise the streambank at the site, sediment mobilisation is a risk. Sediment mobilisation may result in temporary movement of individuals and may disturb feeding behaviours while visibility is reduced. However, suspended sediment levels resulting from construction operations are unlikely to exceed levels experienced regularly within the reach during rainfall events.

2.2.2 Avoidance And Mitigation – Construction Environmental Management Plan (CEMP)

Controls may be used to avoid impacts from construction operations and mostly relate to the timing of operations relative to migrations, and maintenance of suitable water quality parameters (Table 1).

Table 1. Environment Protection Requirements (EPR) for Australian grayling during construction phase of the Mersey River Pump Station.

EPR	Mitigation measures	Responsibility	Reference documents
1	Construction of in-stream structures or any other major in-stream works must not occur during peak migration periods. This includes downstream spawning migrations from March to April, and recruitment migrations from November to January.	TI Project Manager	
2	During construction, sediment pollution must be minimised at the site using sediment management according to best practice principles. For example, where machinery is used in or adjacent to a waterway that causes sediment mobilisation, appropriate use of silt curtains is required.	Contractor, TI Environment Team	
3	Where construction operations are predicted to, or result in mobilisation of sediment, a water quality monitoring plan must be implemented to ensure suspended sediment and turbidity remain within Default Guideline Values for Aquatic Ecosystems of the Mersey Catchment (Environment Protection Authority, 2021).	TI Environment Team	Default Guideline Values for Aquatic Ecosystems of the Mersey Catchment (Environment Protection Authority, 2021)
4	If instream excavation or construction of instream structures is required, a separate impact risk assessment must be conducted by a suitably qualified fish passage specialist.	TI Environment Team, suitably qualified aquatic ecologist	

2.2.3 IMPACT RISK ASSESSMENT

The assessment of impacts resulting from the construction phase of the project is detailed in Table 2. In assessing the impact of various aspects of construction and relevant life-stages of Australian Grayling, consideration was given to the controls detailed above in Section 2.2.2. The assessment assumes that all avoidance and mitigation controls as detailed in this report are implemented in full. Where controls are modified or are not implemented in full, an additional impact risk assessment should be conducted. The assessment determined the risk of impact to Australian Grayling resulting from construction activities of the SWISA project in the Mersey River to be low for all life stages.

Table 2. Impact risk assessment for construction activities of the SWISA project in relation to Australian Grayling (P. maraena). Refer to Appendix 1 for risk assessment matrix and consequence description.

	Likelihood	Consequence	Pre-Control Risk rating	Consideration of Prescribed Controls	Post Control Risk rating
Disturbance from works within waterway					
Resident Adult	Highly Unlikely	Minor	Low	Assessed with relevant controls in place	Low
Migrating Adult	Highly Unlikely	Minor	Low	Assessed with relevant controls in place	Low
Migrating Juvenile	Unlikely	Moderate	Low	Assessed with relevant controls in place	Low
Short Term Impacts to Water quality					
Resident Adult	Highly Unlikely	Moderate	Low	Assessed with relevant controls in place	Low
Migrating Adult					
Migrating Juvenile					

2.3 RESIDUAL IMPACTS

Australian Grayling are likely to interact with [redacted] in the Mersey River on an ongoing basis. These interactions include:

- the structure's presence in the waterway and implications for fish passage
- entrainment and mortality of fish during water extraction
- changes to flow regime resulting from water extraction
- changes to flow regime resulting from water releases from Parangana Dam [redacted]

The likelihood, avoidance, and mitigation of each of these interactions is addressed below.

2.3.1 FISH PASSAGE

Australian Grayling require unimpeded passage through upper, middle, and lower reaches of the Mersey River in order to complete migrations to and from marine environments. These migrations occur during autumn-winter for spawning (downstream migration), and during summer for juvenile recruitment (upstream migration). Downstream spawning migrations typically coincide with increased flows. Migration of juveniles upstream typically coincides with low-flow conditions experienced during summer.

Barriers to fish passage are caused by physical in-stream structures that create a hydraulic drop, or increased water velocities. These are typically control structures such as dams, weirs, bunds or culverts. Barriers may also be caused by physiochemical changes that prevent movement, these can include anoxic or hypoxic conditions, elevated or decreased water temperatures, sounds/pressure changes, or other chemical changes e.g. salinity (Moore *et al*. 2022).

[redacted] does not constitute a control structure. However, intrusion of large structures into a waterway may result in hydraulic conditions that present a barrier to migration. Therefore, the relative intrusion of the pump station into the waterway has been assessed for its' potential impact(s) on fish passage.

The pump station extends ~5.3m from the high bank into the main channel during average flow conditions, with the extent of intrusion is approximately 2m. This constitutes a 6.9% intrusion into the main channel. Bathymetry assessment of the site identifies the main channel as indicated in Figure 5. Bathymetry at [redacted], Mersey River, Tasmania.. During average and high-flow conditions, the channel width extends ~36m, with the pump structure protruding ~5.3m into the channel.

[redacted]

During high flow conditions there will remain a continuous zone of low-velocity water on the opposite side of the channel. This is facilitated by the structurally complex vegetated streambank. It is therefore unlikely that the structure would impact fish passage for even smaller individuals. Therefore, both upstream and downstream migration would be unimpeded during high flow conditions.

During low flow conditions the channel is likely to be reduced in width. However, bathymetry of the site shows the low-flow channel to be located within the middle of the river channel, and dispersed across approximately 10m (Figure 5. Bathymetry at [redacted] Mersey River, Tasmania.). Therefore, the structure will not protrude further as a proportion of channel width due to the steep gradient sloping away from the pump intake. Due to the separation of the low-flow channel from the intake structure, it is unlikely that fish would be directed closer to the pump intake even during low-flow conditions. Australian Grayling will therefore not be impeded in both upstream and downstream migration past the structure under low flow conditions.

In summary, it is unlikely that the structure presents an ongoing risk to fish passage in its planned configuration, during low or high flow river conditions.

2.3.2 WATER EXTRACTION – DIRECT ENTRAINMENT AND MORTALITY

Entrainment and mortality of fish can occur at pump intakes where hydraulic conditions are such that fish are unable to exit intake structures, are entrained in screens, or directly killed through intake into pumps. The quantity and size of fish lost directly through extraction intakes can vary widely (Boys *et al.*, 2021). Variation is dependent on abundance of fish, physiological traits such as swim speeds, behavioural traits such as schooling or use of refuge structure, and importantly on the hydraulic conditions of the intake structure or screens. Native fish losses directly resulting from extraction (i.e. offtake entrainment) have been observed as high as 887 juvenile or adult fish per ML (Boys *et al.*, 2021).

There is a paucity of information specific to Australian Grayling swimming abilities and losses resulting from extraction. Two observations made for the species suggest different swimming abilities. Bishop and Bell (1987b) noted that the presence of mature Australian Grayling in torrential water immediately below the Tallowa Dam (NSW) outlet suggests that adults can swim against water velocities of at least 2-4 m/s. However, Koster and Raadik (2010) found Grayling were unable to successfully pass through structures with 1.2-2.5 m/s velocities. Koster *et al.* (2020) observed abundances of juveniles migrating upstream to be highly variable. Abundances ranged between 12 (Barwon Ck) and ~500 (Bunyip Ck) per 24-hour period in Victoria. Without further information specific to the Mersey River population, particularly for juvenile size classes, it is not possible to estimate mortality resulting from water extraction at [redacted] Therefore, a conservative approach has been taken in assessing the likelihood of entrainment and mortality.

Australian Grayling will have the potential to interact with the pump intakes during residency as adults and during migrations as described in Section 2.3.1. A risk matrix has been used to determine the likelihood of mortality resulting from interaction with the pump intake (Table 3). Individuals most at risk of entrainment are juveniles migrating upstream. This is due to their physiological characteristics and hydraulic conditions at the time of migration which create a higher risk of entrainment and mortality. Juveniles have reduced swimming abilities, and their smaller body size is closer to that of screen openings. Additionally, this migration occurs when river flows are low and the channel is (relatively) closer to the extraction point. Therefore, migrating juveniles are more likely to pass closer the pump – compared to high river flow periods.

The assessment of mortality risks in Table 3 is presented for each life stage of Australian Grayling. This report details operational controls and design specifications that are site-specific and aim avoid and/or mitigate impacts for all life history stages.

Table 3. Risk assessment for entrainment and mortality of P. maraena resulting from extraction intake structures. All group characteristics are measured in relative terms due to the unquantifiable nature of the species with currently available information

Risk factor	**Group characteristic**	**Reference**	**Resultant risk of entrainment or mortality**
Resident			
Abundance	Low	Berra 1982, Bishop and Bell 1978a	Low
Size of individuals	Medium-Large (>80mm SL)	Bishop and Bell 1978a, Koster *et al* 2020	Low
Swimming ability	Strong	Bishop and Bell 1978b	Low
Behavioural trait	daily migrations past pump intake site.	Dawson and Koster 2018	Low

Risk factor	Group characteristic	Reference	Resultant risk of entrainment or mortality
Hydraulic conditions	Present during all river flow conditions	Dawson and Koster 2018	Low
Migrating Adult			
Abundance	Low	Berra 1982	Low
Size of individuals	Large (>150mm SL)	Bishop and Bell 1978a	Low
Swimming ability	Strong	Bishop and Bell 1978b	Low
Behavioural trait	Migration during autumn-winter	Dawson and Koster 2018	Low
Hydraulic conditions	During high and peak flow conditions	Dawson and Koster 2018	Low
Migrating Juvenile			
Abundance	High	Berra 1982	High
Size of individuals	Small (<80mm SL)	Bishop and Bell 1978a	High
Swimming ability	Poor	Cahoon et al. 2018 (for *Thymallus arcticus*, a morphologically and physiologically comparable species)	High
Behavioural trait	Upstream migration during summer	Koster *et al*. 2020	Medium
Hydraulic conditions	During low/intermediate-flow conditions	Koster *et al*. 2020	High
Egg/Larval			
Abundance	unknown		High
Size of individuals	~<10mm		High
Swimming ability	Poor/Nil		High
Behavioural trait	Washed downstream after spawning	Koster *et al*. 2017	Medium
Hydraulic conditions	During high-flow conditions	Koster *et al*. 2017	Medium

Several design principles have been adapted following Boys *et al*. (2012, 2021) and Boys (2021) to reduce the risk of entrainment and mortality of Australian Grayling resulting from pump intakes. These design principles have been used in similar ecological and hydraulic conditions and have been shown to reduce mortality by up to 90% (Boys *et al*. 2021). Principles include:

1. Where practical, fish screens should be installed as close to the entrance of a diversion intake as possible (i.e. within or adjacent to the main river channel), which negates the need for a fish bypass.

2. Intake screens should be orientated so that the predominant length of screen face is as parallel to the river flow as possible.
3. The screen should be installed with adequate clearance between the screen and the bottom of the riverbed to prevent entrainment of sediment and benthic aquatic organisms.
4. Where installation of the screen at the intake entrance is not feasible or desirable, the screen may be located within the diversion channel downstream of the entrance and any water control structure. When this occurs, an effective bypass system may be required to safely and quickly transport fish back to the river.
5. If located within a diversion channel, the screen should be adequately angled so that sweeping velocity exceeds approach velocity, which will direct fish towards a fish bypass. Typically, this is achieved by ensuring the screen has a maximum angle of 45 degrees relative to the direction of the intake flow (i.e. is closer to parallel than perpendicular to the predominant channel flow. At a 45-degree angle, the approach velocity is about equal to the sweeping velocity. At some sites, screen angle options may be constrained by site-specific channel geometry and hydraulic conditions.

It is difficult to assess an appropriate screen size for protection of Australian Grayling as the has been an absence of research into screen applications for the species. Therefore, a cautious approach has been applied here. Following the risk assessment (Table 5) and determination of size classes and life stages most at risk, screen specifications were aimed at avoiding mortality to individuals less than 60mm in length. To avoid entrainment and mortality of the at-risk size classes, it is recommended that a fish screen is installed on the outer face of the pump wells to prevent entrainment. The pump screen should be sized so that approach velocities are no greater than 0.1m/s (measured as described in Boys *et al*. (2012, 2021) and Boys (2021). It was noted that the orientation of the pump well open face where screens are to be installed is parallel to the direction of river flow. This orientation will assist in providing greater sweeping velocities across the screen, further reducing the risk of entrainment and mortality (Boys *et al*. 2012, 2021, Boys, 2021). Based on the information available and reviewed herein, the screen sizing and design as described above should prevent the intake of Australian Grayling, and therefore likely to prevent entrainment of other native fish species present within the Mersey River.

2.3.3 FLOW REGIME MODIFICATIONS

The [redacted] There are existing '*cease to take*' rules outlined in the NRE water management plan that will apply to the scheme. These include *cease to take* limits where river flow is less than 195 ML/day during Dec-May, and 260 ML/day during November. Refer to the Sassafras Wesley Vale Irrigation Scheme Augmentation – Hydrologic Modelling for detailed staged restrictions. During these periods, when *cease to take* flow limits have been reached, extraction will only occur when water is released from Parangan Dam for the purposes of extraction. Volumes extracted will not exceed release volumes.

Because the [redacted] is located in the downstream reach of the system, the potential for extraction to modify flow the flow regime is greatly reduced. [redacted] will only impact the river below the site (~9km). [redacted] will utilise timed water releases from Parangana Dam when *cease to take* rules are in effect. The potential for extraction and releases to impact spawning and recruitment migrations is assessed below.

Flow regime modifications can impact Australian Grayling in several ways. Flow regimes can directly impact the ability for individuals to complete daily and life-cycle migrations by creating barriers to fish passage when flow rates are significantly reduced. They can also impact migrations indirectly by changing natural seasonal variations and patterns that species rely on as migration cues (Koster *et al*. 2013, 2018, 2020). Impacts to fish passage resulting from extraction are unlikely to occur due to the downstream location of the pump station within the Mersey River. However, impacts to migrations resulting from changes to seasonal flow regimes are a potential risk.

Thirty (30) years of flow rate data[1] were analysed for flow patterns to assess likely and possible impacts to Australian Grayling resulting from [redacted]. The data set included daily average flow rates (ML/day) from 01/01/1994 – 01/01/2024. Average annual flow was 486,280 ML/yr (Min: 161,048.5 ML, max: 1,143,701.9 ML). Monthly mean flows are presented in Figure 6 and illustrate the typical seasonal flow regime of the Mersey River. Mean daily flow rates peak in August at approximately 3,400 ML/day. February and March typically record the lowest daily flow rates at approximately 350 ML/day. Mean monthly totals follow the same pattern of variation with figures presented in Table 4.

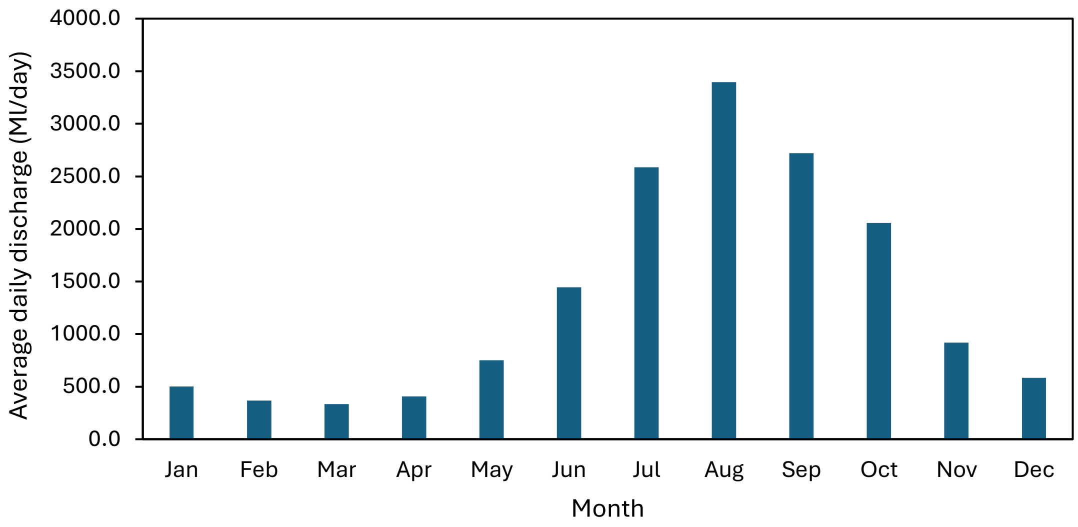


Figure 6. Monthly average daily discharge in the Mersey River at gauging station 447 from 1994 to 2024. Data source: Water Data Portal: v2024.1.67, Department of Natural Resources and Environment Tasmania. Accessed on 22/06/2024.

Table 4. Monthly Average daily discharge and monthly average discharge in the Mersey River at gauging station 447 from 1994 to 2024. Data source: Water Data Portal: v2024.1.67, Department of Natural Resources and Environment Tasmania. Accessed on 22/0

Month	Average daily discharge (ML/day)	Average monthly total discharge (ML)
Jan	502.0	473924.0
Feb	367.5	307191.3
Mar	332.9	303570.8
Apr	407.1	362708.4
May	751.3	691985.8
Jun	1446.8	1286228.7
Jul	2586.8	2364338.4

[1] Data were sourced from Gauging station 447 from the Water Data Portal: v2024.1.67, Department of Natural Resources and Environment Tasmania. https://portal.wrt.tas.gov.au/

Aug	3396.0	3110703.8
Sep	2721.0	2446196.6
Oct	2056.2	1908191.0
Nov	917.4	811006.4
Dec	585.2	536003.2

A flow duration curve (FDC) has been used to assess flow characteristics and possible impacts resulting from extraction. The FDC in Figure 7 shows flows in the Mersey River has a large degree of variation. The median flow from the most recent 30 years of data is approximately 680 ML/day. Approximately 80% of the time, flows were between ~300-3000 ML/day. The consistent slope of the FDC over a wide range of flow rates indicates that the moderate flows in the river are maintained by groundwater discharge (DPIPWE, 2020). River flows have been altered since construction of Parangana Dam, with the impact of this is shown in Figure 9. The occurrence of extreme low-flow conditions (<200 ML/day) have increased since construction of the Dam. However, environmental flow releases at this lower end since 1999 have assisted in reducing this impact. The reduction in incidence of flows has been skewed toward higher flows, indicating a ‘dampening’ of the natural hydrograph. This has essentially resulted in a more uniform hydrograph with less variability in flow rates, particularly less high flow events.

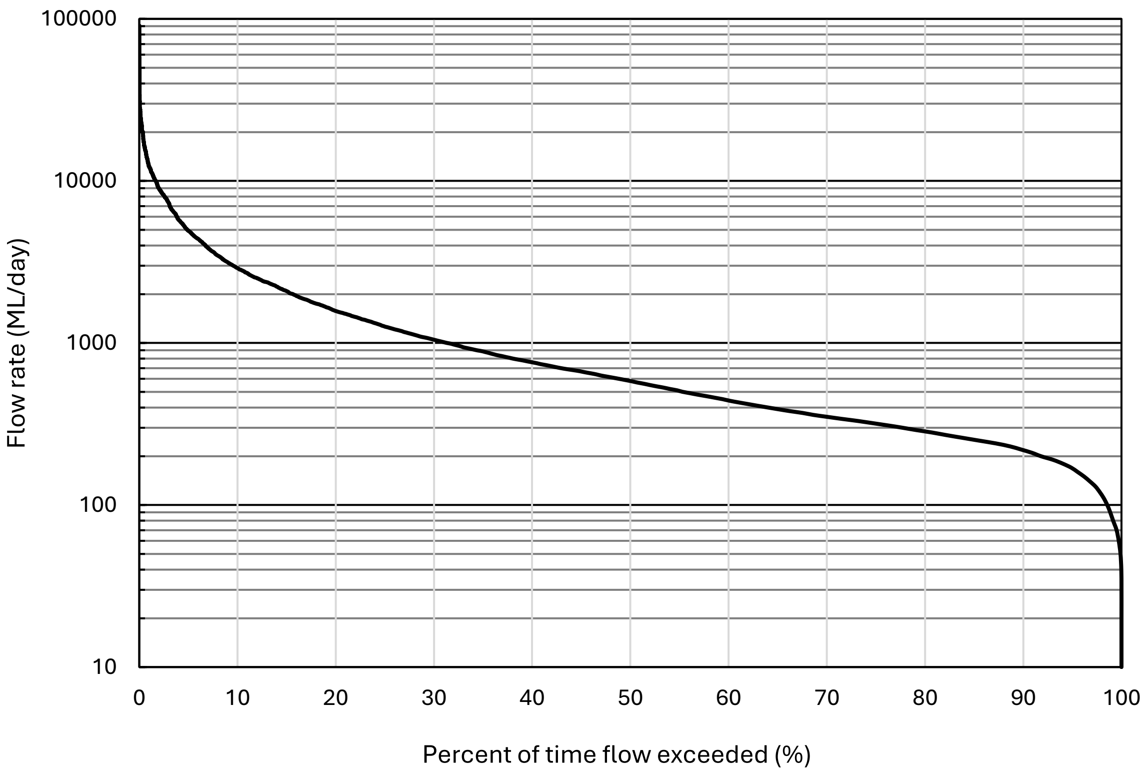


Figure 7. Flow duration curve for the Mersey River at gauging station 447 from 1994 to 2024. Data source: Water Data Portal: v2024.1.67, Department of Natural Resources and Environment Tasmania. Accessed on 22/06/2024.

Flow duration curves were modelled for the Mersey River under expected irrigation scheme uptake scenarios in Sassafras Wesley Vale Irrigation Scheme Augmentation – Hydrologic Modelling Report (Wright, 2024). Modelling indicated the proposed fully sold irrigation scheme would result in the Mersey River entering *cease to take* conditions (i.e. low flows) in fewer instances than under the existing SWIS scheme (Figure 8). This was due to the use of timed releases from Parangana Dam to supplement extraction for the SWISA scheme.

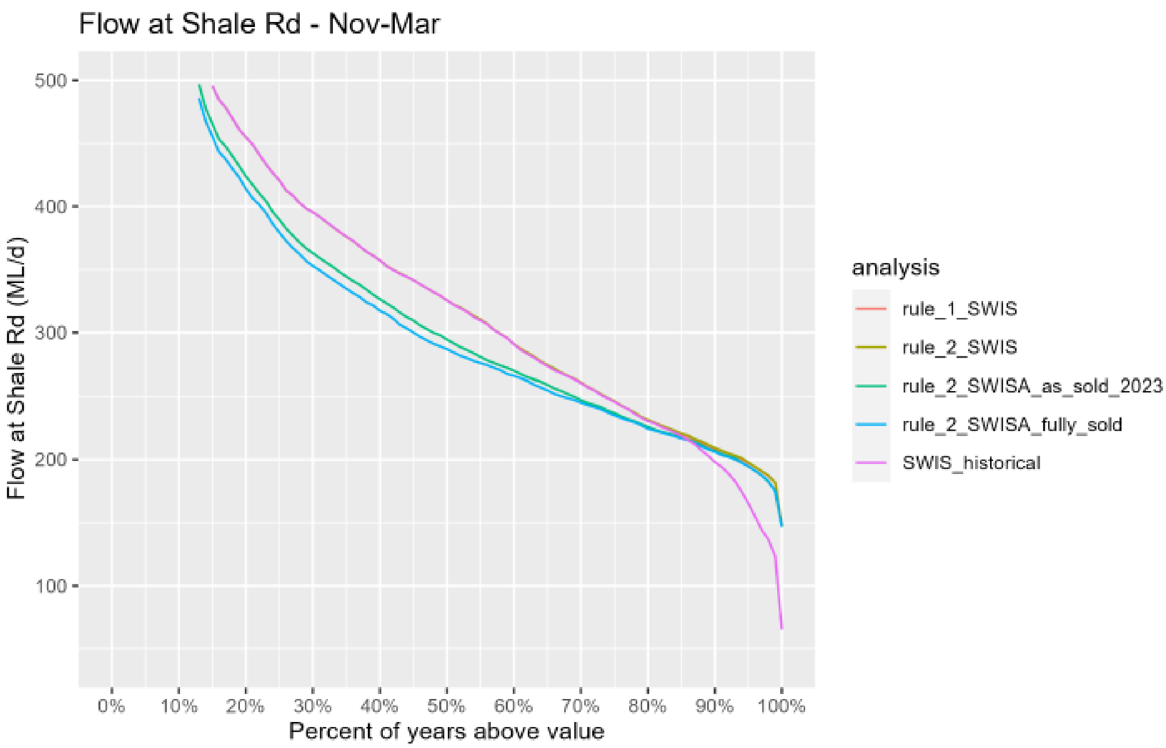


Figure 8. Modelled flow duration curves of the Mersey River under SWIS and SWISA scenarios as presented in (Tasmanian Irrigation, 2024).

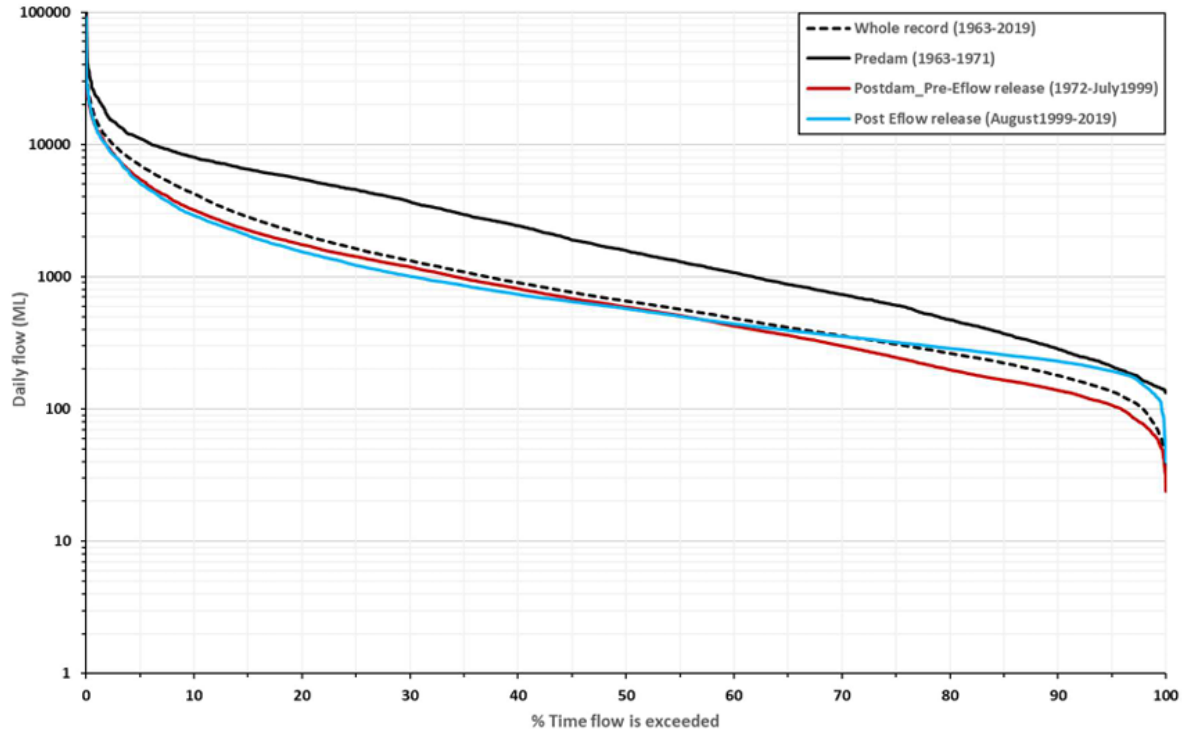


Figure 9. Flow duration curves of the Mersey River pre and post construction of Parangana Dam as presented in (DPIPWE, 2020).

To assess the potential impact of extraction on the flow regime, a 'typical' year was selected from the last ten years of data. The selected year was 2018, with an annual discharge of 473,062 ML. Additionally, a 'low discharge' year was selected to assess potential impacts under more adverse environmental conditions. The 'low discharge' year selected was 2008, with an annual discharge of 234,560 ML. This is nearly half of the discharge in 2018. Daily flow rates (ML/day) were plotted to determine periods where flow regimes were most likely to be important for migration cues (Figure 10). Whilst migration of Australian Grayling has not been measured in the Mersey River specifically, it can be inferred from similar populations in Tasmania and Victoria. Known migration cues for the species are small increases in flow during summer and larger increases in flow during Autumn-Winter (Koster *et al*. 2013, 2018, 2020).

Flow related migration cues are likely to occur during periods where median daily flow rates are greater than ~800ML/day. Maximum daily offtake is 105 ML, therefore the risk of alteration of flow regime is likely to be substantially lower during this period than during the summer migration period. Median daily flows during the summer migration period of a typical year are ~260 ML/day. The risk of overextraction during this period is lowered due to the imposition of *cease to take* limits in the Mersey River Catchment management plan and due to the use of timed releases from Parangana Dam. However, timed releases can have implications for migration cues (Koster *et al*. 2016).

During low rainfall and low-flow years such as illustrated in Figure 11, migration cues are substantially reduced in frequency and duration. It is important during these periods that adequate flow is maintained in the river to facilitate migrations. As previously noted, timed releases will be used to supply water for offtake. These events are almost exclusively likely to occur during summer months, when river flows are lowest. The migration most at risk is the upstream migration of juveniles from the estuary mouth. This migration is triggered by small flow increases during this period. Where releases from Parangana dam are used to supply offtake water at [redacted], the flow regime below the pump station should not be impacted. The pump station is located ~9km upstream from the point of tidal influence, and therefore impacts on juveniles entering the lower freshwater reach are not likely.

However, where unsupplemented water extraction coincides with small increases in flow during otherwise low-flow periods (such as those illustrated in Figure 10 & Figure 11) disruption to migrations is possible. Unsupplemented extraction has the potential to dampen the small flow cues used by Australian Grayling on their recruitment migration. It is therefore recommended that an adaptive management approach is used, whereby flow regimes are monitored directly above the pump station and compared with data from gauge 447 to determine the degree to which summer migration flow cues are impacted by unsupplemented extraction. Where flow cues are individually and cumulatively reduced by 10% or more, a re-assessment of flow regime impacts is undertaken. Where this occurs, protocols for managing impacts on summer flow cues should be developed and implemented.

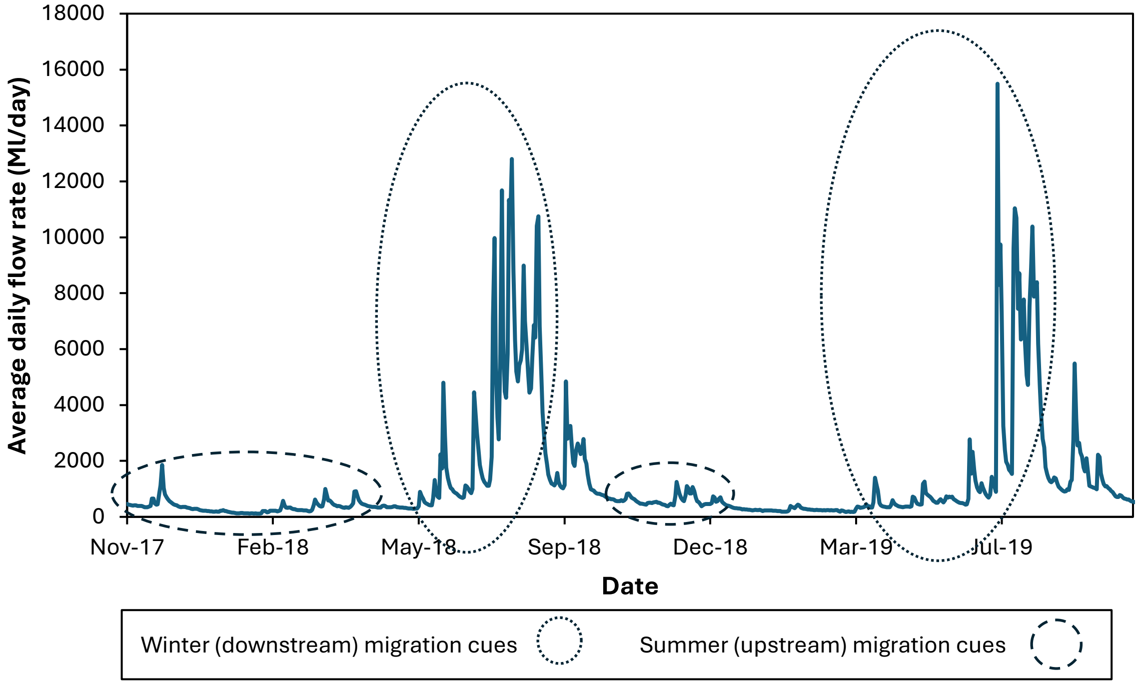


Figure 10. Mersey River 2018-19 flow regime illustrating 'typical year' with migratory flow cues for downstream spawning migrations, and upstream recruitment migrations. Data source: Gauge 447: Water Data Portal: v2024.1.67, Department of Natural Resources

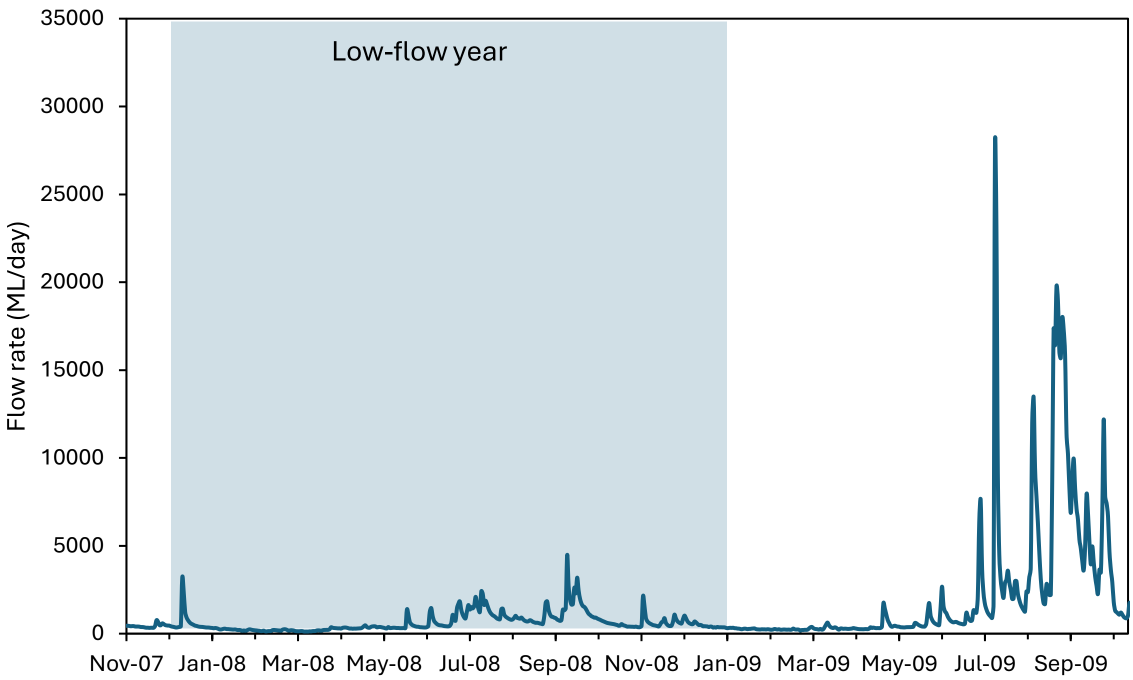


Figure 11. Mersey River 2008-09 flow regime illustrating 'low flow year' with reduced migratory cues. Data source: Gauge 447: Water Data Portal: v2024.1.67, Department of Natural Resources and Environment Tasmania. Accessed on 22/06/2024. 2008 annual di

2.3.4 COLD WATER POLLUTION

The SWISA irrigation scheme proposes to use supplemented flows released from Lake Parangana during *cease to take* conditions. Water released from Lake Parangana via the Parangana Dam mini-hydro may pose a cold-water pollution risk to Australian Grayling in the Mersey River. Cold water pollution occurs when hypolimnetic water from thermally stratified reservoirs is released into waterways and aquatic environments. Cold water pollution has significant direct acute and residual effects on a number of native Australian fish species (Parisi *et al*., 2022, Lugg and Copeland, 2014). In particular, cold-water pollution has been observed to be lethal to eggs and larvae of Murray Cod (*Maccullochella peelii peelii)* (Todd *et al*, 2005). It can directly interfere with larval and juvenile development through sub-lethal impacts on growth and physiology (Michie *et al*., 2020a, 2020b) and interfere with spawning cues through dampening of natural seasonal temperature signatures (Lugg and Copeland, 2014). It is also known to have significant impacts on ecological functioning of freshwater ecosystems (ANZECC 2000, Lugg and Copeland 2014), and therefore likely to result in lasting indirect impacts to native fish. Further, cold water pollution can also form a barrier to fish migration (Pollino *et al*., 2004).

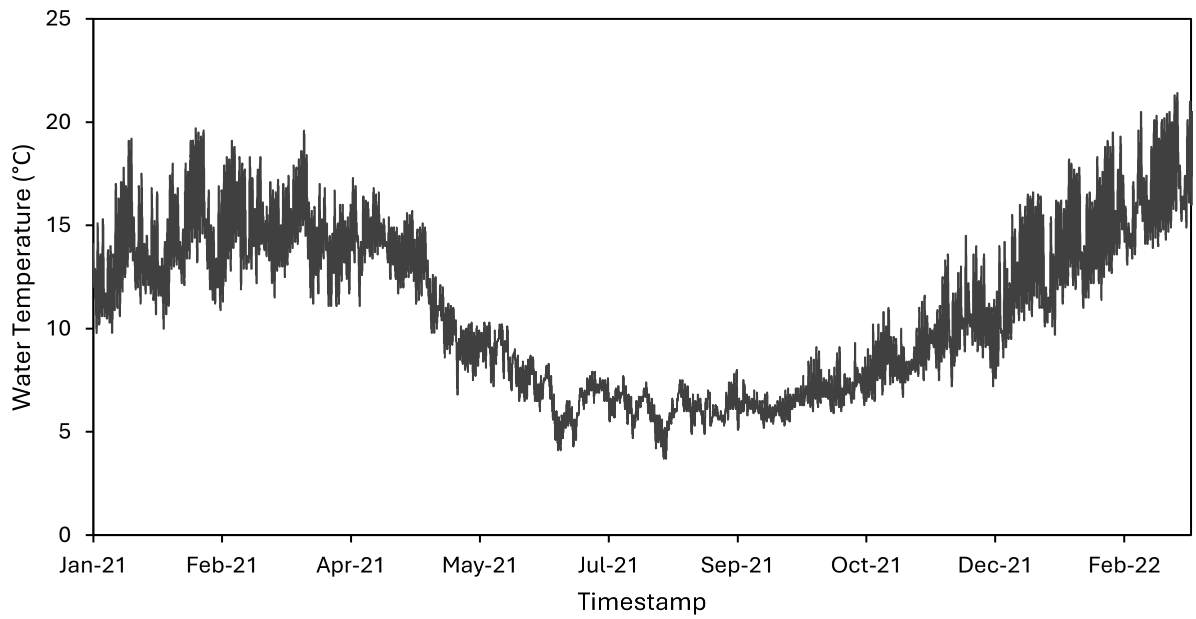
Thermal stratification is known to occur in Lake Parangana during summer and autumn (Hydro Tasmania 2011). Temperatures in the lake can vary by approximately 16 degrees in autumn (Hydro Tasmania 2011). It is important to note that environmental releases from Lake Parangana are currently used to supplement environmental flows in the Mersey River. Any assessment of impacts should be treated separately to the existing operations of Hydro Tasmania. It is not clear from available data whether release water from Parangana Dam has resulted in cold water pollution in the Mersey River. The existing availability of water quality data for release waters from Parangana Dam has limited the assessment of potential impacts of the SWISA scheme. It is recommended that further assessment of physiochemical parameters, particularly temperature in release water from Parangana dam is undertaken. A risk assessment was conducted on potential cold-water pollution resulting from the additional releases relating to the SWISA scheme. Additionally, an adaptive management approach has been recommended below.

Cold water pollution can be mitigated through use of thermal curtains, selective withdrawal capabilities and operational strategies such as appropriately timed releases (Michie *et al*., 2020c, Sherman *et al*., 2007). In this instance, it is not possible to recommend an appropriate mitigation until further assessment is undertaken.

To assess the potential risk of cold-water pollution resulting from increased releases from Parangana Dam for the purposes of SWISA extraction, the existing thermal regime and variation in the Mersey River was investigated. The Liena gauge was used to assess instantaneous water temperature data downstream of the dam. This gauge is the closest gauge downstream of the dam, approximately 9km downstream of the dam and ~74 km upstream [redacted] downstream of Parangan dam. Water temperature data collected at the Leina station should therefore provide a representative illustration of variability river temperature within the vicinity downstream of the dam. However, due to limited data availability and the distance to the pump station location, it is not possible to assess how these effects might flow through to reaches further downstream.

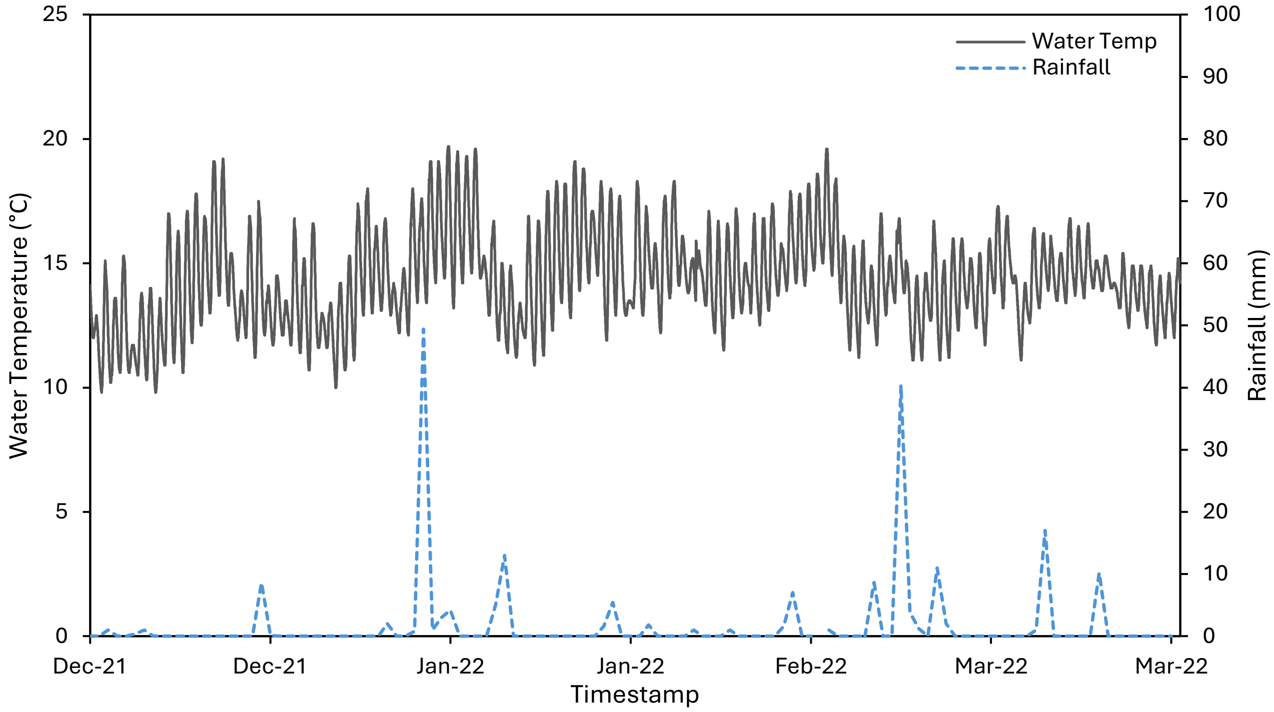
Instantaneous water temperature data was first investigated to determine seasonal and inter-annual variability. Data from the four most recent years indicated that summer temperatures were highly variable compared to winter temperatures. The greatest variations typically occurred in Jan-Feb, and the lowest variations in July-Aug, for example monthly mean ranges were 4.7 and 2.1 for January and July 2021 respectively. However, daily mean variability was considerably greater, e.g. 11.2-19.7 (range of 8.2) in January 2021 and 3.7-7.5 (3.8 range) in July 2021. This indicated a system that currently experiences a highly variable thermal regime, during summer, with a stable regime in winter.

Figure 12. Instantaneous water temperature data from the Mersey River below Parangana dam 2021-22. Water temperature data derived from Liena monitoring station (Station number 60.1) © Hydro Tasmania (Hydro-electric Corporation).



Changes in water temperature during the summer period were typically in the form of depressed temperatures over a period of 1-3 days, then resumption of temperatures closer to the monthly average for longer periods of 2-4 days. Instantaneous water temperature data was overlayed with rainfall data from the region to investigate whether these patterns were related to releases from Parangana dam (Figure 13). As there are no rainfall gauges upstream from Liena and downstream from Parangana dam or nearby to the dam, the nearest gauge to Liena was used. It should be noted that because there were no suitably located gauges, this analysis has a high level of uncertainty and low confidence.

Figure 13. Instantaneous water temperature data and daily rainfall from the Mersey River below Parangana dam during summer 2021-22. Water temperature data derived from Liena monitoring station (Station number 60.1) © Hydro Tasmania (Hydro-electric Corporation), rainfall data derived from Lorinna Gauge (091055 – Bureau of Meteorology: IDCJAC0009 reference: 113303153).



There were no apparent linkages between variations in water temperature and rainfall occurrence or volume during summer periods. Figure 13 illustrates an example of summer water temperatures and rainfall in 2021-22. In some instances, temperature was varied by approximately 7-10 degrees for periods of days or multiple hours.

Records for releases from Parangan dam were sourced from Hydro Tasmania to identify if temperature variability could be linked to dam releases. This assessment determined that releases from Parangana dam are unlikely to impact water temperatures in the Mersey River downstream of the dam and reaching the Liena gauge. Preliminary analysis showed no correlation between release volumes at Parangana, and flow volumes recorded at Liena. This is likely due to the significant difference in volumes. In most instances, flow at Liena was in the order of 10-100 times that of water released from Parangana dam (Figure 14). Additionally, there was no apparent relationship between the timing of depressed water temperatures at Liena, and water releases at Parangana Dam. Parangana Dam releases were largely consistent with little variance, providing a base flow to the river. These preliminary analyses indicate that there is no discernible impact of water released from Parangana dam on water temperatures at Liena in the Mersey River. It should be noted that while no relationship was evident from current data, future release volumes under the SWISA scheme are higher than current release volumes. This may result in greater impact on downstream water temperatures compared to the current state, but it is impossible to predict this without actual monitoring data from temperature and flow sensors once the SWISA project commences.

There remains a potential that under very low flows, where the no-take threshold for SWISA is reached and release waters are used to supplement flows, release volumes may almost equal natural flows. Under these circumstances, the potential for adverse impacts on water temperatures are more likely. As above, it is not possible to quantify the likelihood or magnitude of this impact without actual monitoring data once the scheme commences. Ongoing monitoring and adaptive management will be required to mitigate this remaining risk. It is therefore recommended that ongoing monitoring of temperature and flow regime of the

Mersey River is monitored to determine whether significant changes result from the SWISA scheme and impact the species under a range of environmental conditions e.g. drought.

Figure 14. Hourly flow/discharge rates at Parangana dam (release waters) and Liena (river flow) from the Mersey River below Parangana dam from January 2021 to August 2021. Water flow data derived from Liena monitoring station (Station number 60.1) © Hydro Tasmania (Hydro-electric Corporation), and provided by Hydro Tasmania for Parangana Dam.

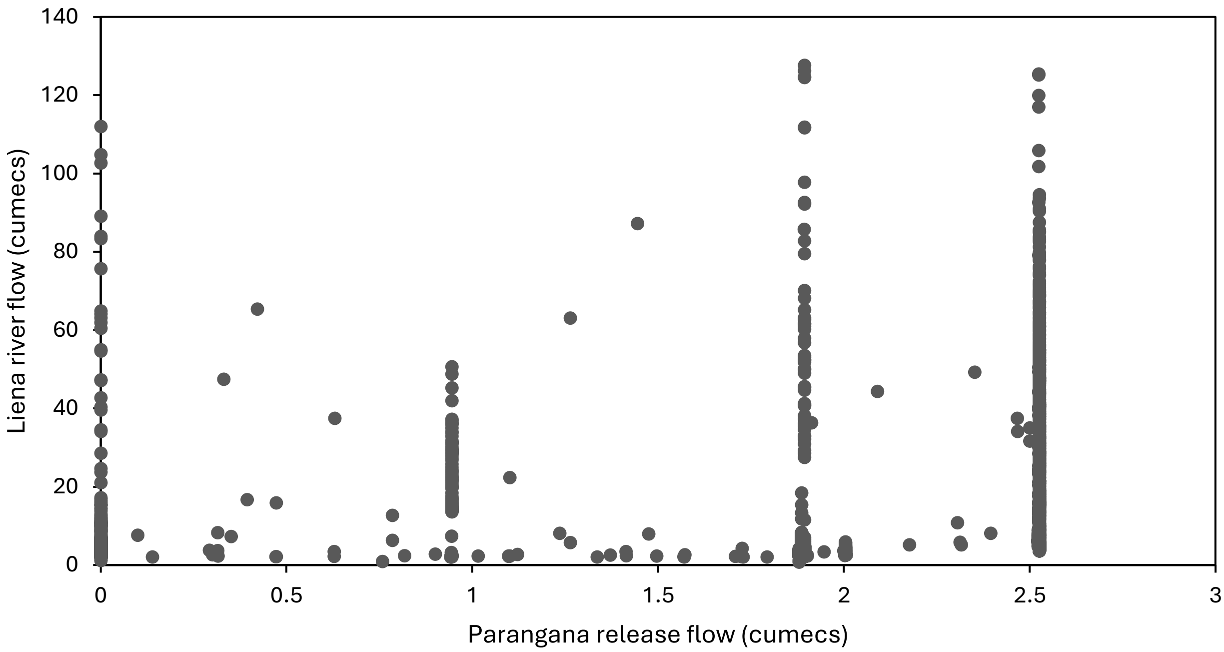
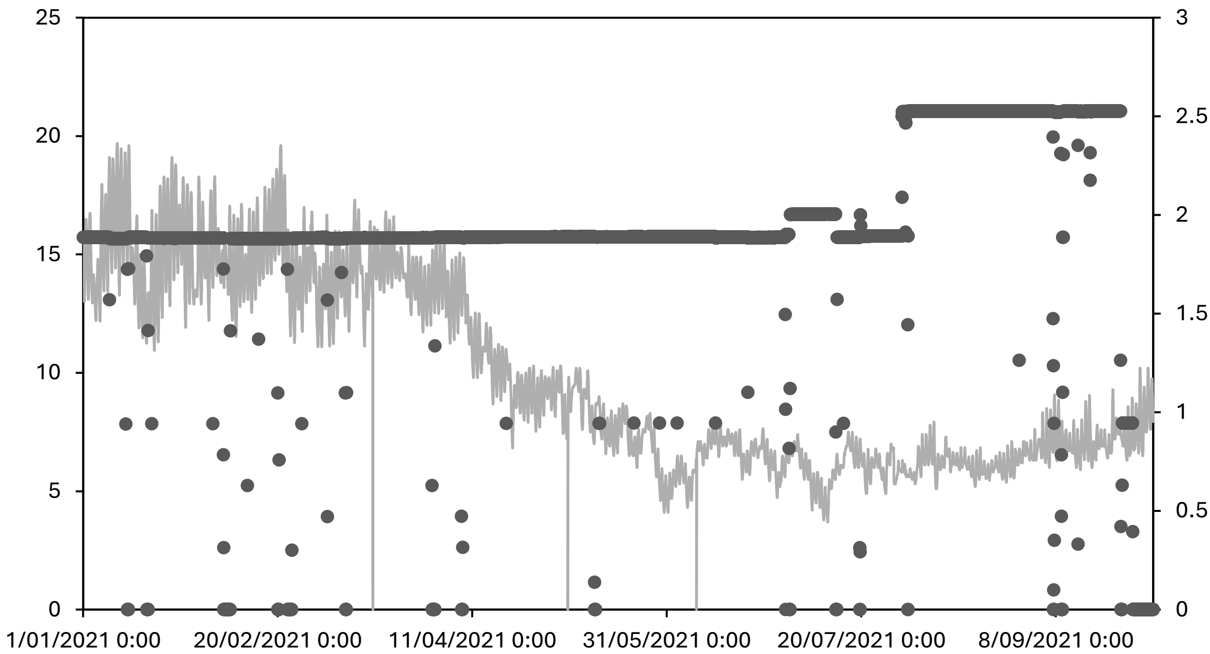


Figure 15. Hourly flow/discharge rates at Parangana dam (release waters) and instantaneous water temperature data at Liena, Mersey River below Parangana dam from January 2021 to August 2021. Water temperature data derived from Liena monitoring station (Station number 60.1) © Hydro Tasmania (Hydro-electric Corporation), and provided by Hydro Tasmania for Parangana Dam.



2.4 AVOIDANCE AND MITIGATION OPERATIONAL ENVIRONMENTAL MANAGEMENT PLAN (OEMP)

Fish passage: To avoid and mitigate impacts to fish passage during low-flow conditions (particularly of juveniles migrating upstream) several controls on extraction are to be included in the OEMP. These include:

- That extraction is managed such that water depth adjacent to the pump house is not reduced to <0.2m.
- That extraction is managed such that water flow below or adjacent to the pump house is not reduced to <195 ML/day during Dec-May, and <260 ML/day during November.
- That the river channel adjacent to the pump station is monitored to ensure the low flow channel is not diverted to, or modified to be within 2.5m of the pump intake.
- Where the low-flow channel is changed because of natural processes or otherwise, so that is realigned within 2.5m of the pump intake, remedial works be completed to restore the low-flow channel to an adequate distance from the intake structure.

Pump intake entrainment: Avoidance and mitigation of impacts resulting from direct entrainment and mortality of individuals will be ensured through intake structure design.

- The intake structure will utilise a screen at the outer southern face of each pump well, with the screen oriented parallel to the direction of stream flow.
- The screens will be constructed so that approach velocities (as measured in Boys *et al*. 2012, 2021, and Boys 2021) will not exceed 0.1m/s.
- Screen orientation and mesh size must ensure that sweeping velocities remain higher than approach velocities during all operational conditions.
- Where screens that do not meet the above specifications are used at the outer pump well faces, screens that achieve <0.1m/s approach velocities must be installed within the pump well.
- Where screens are installed within the pump wells, unless monitoring determines that Australian Grayling are not entrained within the pump wells at any time, additional design requirements are specified below:
    - The pump wells must either:
        - include a bypass opening on both the upstream and downstream side to allow exit of fish from the pump well in the direction of stream-flow, or
        - include the use of operational procedures to allow entrained fish to exit the pump well. These must include at a minimum, pump shut-downs for at least 20 minutes every 6hrs of operation during the months of September to December.
- Operation of screens will be monitored to ensure correct operation as designed and that approach velocities remain below 0.1m/s.
- Screens will be regularly inspected to ensure they are free from damage.
- The river channel adjacent to the pump house must be regularly monitored to ensure the low flow channel remains >1m from the intake structure.
- Where a diversion channel is constructed to facilitate water extraction, the diversion channel must remain 0.2m higher than the low-flow channel. The diversion channel must include a bypass channel to allow individuals to return to the low-flow channel in the direction of flow.
- Where the low-flow channel is changed as a result of natural processes or otherwise, so that the above conditions are not met, remedial works are conducted to restore the above conditions.

Flow regimes: Avoidance and mitigation of impacts resulting from alteration of flow regimes within the Mersey River will be achieved through the following conditions:

- Extraction is limited to within the existing framework specified in the Mersey Water Management Plan (DPIWE, 2005) and in (NRE, 2023).
- No-take trigger limits of 195ML/day during Dec-May, and 260ML/day during November are adhered to.
- Where timed releases from Parangana dam are used to supplement flow for extraction:
    - Water quality parameters of release water must comply with Default Guideline Values as specified in Environment Protection Authority (2021).
    - Flow rates within the reaches below the dam must be regularly monitored to ensure that the incidence of *cease to take* thresholds as specified in (DPIWE, 2005) and in (NRE, 2023) does not increase because of SWISA operations.
    - Quantitative monitoring of the Australian Grayling population in the Mersey River is conducted at least every two years.
    - Were declines in abundance and distribution of Australian Grayling in the Mersey River and lower catchment are observed, and it is determined that any potential interaction with the operation of the SWISA scheme, and observed declines exists:
        - Assessment is conducted to determine whether operation and mitigation measures are appropriate.
- Adaptive management for impacts to migration cues:
    - Where extraction occurs during September to December, flow regimes are monitored daily to determine the degree to which summer migration flow cues are impacted by unsupplemented extraction.
    - Monitoring of data is assessed annually.
    - Where flow cues (peak instantaneous flow rate and total volume of non-base-flow discharge event are individually and cumulatively reduced by 10% or more, an assessment of flow regime impacts on summer migration of Australian Grayling is undertaken within 6 months.
    - The assessment must develop protocols for managing impacts on summer flow cues.
    - Management responses must be implemented within 6 months.

Cold Water Pollution: Avoidance and mitigation of impacts resulting from cold-water pollution.

- Where timed releases from Parangana dam are used to supplement flow for extraction for the SWISA scheme:
    - Water quality within the reaches below the dam must be monitored regularly to ensure that values remain within Default Guideline Values as specified in Environment Protection Authority (2021).
    - Releases from Parangana dam for the purposes of extraction for the SWISA scheme do not significantly change the natural seasonal thermal regime of the Mersey River.
    - Water released from Parangana dam for the purposes of extraction for the SWISA scheme does not cause a reduction in water temperatures of greater than 10 degrees Celsius at any point downstream of the dam.
    - Where monitoring determines a significant impact on the thermal regime of the Mersey River, operational or design mitigations must be implemented to mitigate the impact.
- Monitoring of water quality and temperature should be conducted at the point of release from Parangana Dam, and stratified downstream to [redacted] to detect the extent, if any, of cold-water pollution resulting from timed supplemental releases for the SWISA irrigation scheme.
    - Monitoring of water temperatures must be:
        - Monitored continuously within <1km downstream of Parangana Dam in the main river channel.
        - Monitored continuously at [redacted] within the main river channel.

  - Monitored continuously at the existing Liena Gauge.
- Monitoring should be conducted for at least 2 years continuously prior to commencement of operation of the scheme, and two years following commencement of operation of the scheme. Continued monitoring after 2 years post commencement can be reevaluated once a suitable data set exists to inform a review of risks associated with cold water pollution – nominally six (6) release events each in winter and summer.

2.5 RESIDUAL IMPACT RISK ASSESSMENT

The assessment of ongoing impacts resulting from the operational phase of the project is detailed in Table 5. In assessing the impact of various aspects of construction and relevant life-stages of Australian Grayling, consideration was given to the recommended controls. The assessment assumes that all avoidance and mitigation controls as detailed in this report are implemented in full. Where controls are modified or are not implemented in full, a review of this impact risk assessment should be conducted.

The assessment of flow regime impacts on migrating juveniles has been assessed as high with consideration given to the recommendation of an adaptive management strategy. The rating of high was determined due to the likelihood being 'possible', and a consequence of 'major', primarily because it is not known what the uptake and demand of extracted water will be. Further information derived from flow monitoring and/or assessment will enable the likelihood to be refined based on real data. This approach will also allow for controls to be developed and implemented that aim lower the likelihood of occurrence, such that the risk rating is lowered to a more acceptable level. It should also be understood that as uptake of the scheme changes over time, the likelihood of occurrence will change. Adaptive management will allow operators to continue to assess and mitigate risks accordingly.

Cold water pollution from dam water releases have not been fully assessed, a provisional assessment of cold-water pollution risks was undertaken, with a final risk rating pending further investigation to be conducted upon commencement and operation of the Project. Consequently, it was not possible to determine a risk rating for this impact until the scheme is in operation.

Table 5. Impact risk assessment for operational activities of the SWISA project in relation to Australian Grayling (P. maraena). Refer to appendix 1 for risk assessment matrix and consequence description.

	Likelihood	Consequence	Pre-Control Risk rating	Consideration of Prescribed Controls	Post Control Risk rating
Entrainment and mortality					
Resident Adult	Highly Unlikely	Moderate	Low	Assessed with relevant controls in place	Low
Migrating Adult	Highly Unlikely	Moderate	Low	Assessed with relevant controls in place	Low
Migrating Juvenile	Unlikely	Moderate	Low	Assessed with relevant controls in place	Low
Larval	Possible	Moderate	Medium	Assessed with relevant controls in place	Low
Fish passage					
Resident Adult	Highly Unlikely	Moderate	Low	Assessed with relevant controls in place	Low
Migrating Adult	Highly Unlikely	Moderate	Low	Assessed with relevant controls in place	Low
Migrating Juvenile	Unlikely	High	Medium	Assessed with relevant controls in place	Low
Flow regime					

Migrating Adult	Highly Unlikely	High	Low	Assessed with relevant controls in place	Low
Migrating Juvenile	Possible	Major	High	Assessed with adaptive management	Low
Cold water pollution					
All life stages	Unlikely	Major	High	Assessed with adaptive management – Ongoing monitoring and adaptive management responses are provided to ensure impacts are mitigated as they are identified.	Medium

2.6 SPECIFIC IMPACT CRITERIA

Specific impact criteria for activities detailed in Assessment 1 are summarised in Table 6. Detailed descriptions of each criterion are provided below.

Table 6. Significant impact criteria and likelihood of impact for Assessment 1 – Mersey River Pump Station, for impacts on Australian Grayling (P. maraena).

Significant impact criteria	Likelihood
Lead to a long-term decrease in the size of an important population of a species.	Unlikely
Reduce the area of occupancy of an important population.	Unlikely
Fragment an existing important population into two or more populations.	Highly unlikely
Adversely affect habitat critical to the survival of the species.	Unlikely
Disrupt the breeding cycle of an important population.	Unlikely
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat.	Highly unlikely
Introduce disease that may cause the species to decline.	Highly unlikely
Interfere substantially with the recovery of a species.	Highly unlikely

2.6.1 LEAD TO A LONG-TERM DECREASE IN THE SIZE OF AN IMPORTANT POPULATION OF A SPECIES.

The Project is not expected to result in a long-term decrease in the size or viability of the Australian Grayling population in the Mersey River. The primary risks associated with the project include temporary impacts from construction works, and ongoing impacts from operation of the irrigation infrastructure, and resulting modifications to flow regimes.

Temporary impacts resulting from construction activities of the SWISA project in the Mersey River were determined to be of low risk to all life stages of Australian Grayling. Impacts on water quality and direct disturbance were considered the only mechanisms by which impacts were likely to occur during construction. Both were considered to be low risk and are unlikely to result in a long-term decrease in the size of the Mersey River population.

Four ongoing impacts were considered to have a possible interaction with the population of Australian Grayling in the Mersey River and lower catchment: fish passage, direct entrainment and mortality from pump intake structures, flow regime changes, and cold-water pollution.

Fish passage was assessed as low for most life stages, and medium for juvenile and larval stages respectively. Based on the low risk assessed herein, it is unlikely that these factors would result in a long-term decrease in the size or distribution of the Mersey River Australian Grayling population.

Both flow regime changes and cold-water pollution were provisionally assessed, with risk ratings being contingent on further information. It is not possible to predict the likely or potential impact resulting from changes to flow regime and possible cold-water pollution before operation of the scheme commences. It has therefore been recommended in Section 2.4 that active monitoring and adaptive management strategies are implemented to better understand these impacts and risk profiles.

2.6.2 REDUCE THE AREA OF OCCUPANCY OF AN IMPORTANT POPULATION.

The Project is not expected to impact the area of occupancy of the Australian Grayling population in the Mersey River. The primary risks associated with the project that have the potential to impact the accessibility of habitat within the lower Mersey River catchment are fish passage and cold-water pollution. Impacts to fish passage resulting from the Project were assessed as low risk for adult Australian Grayling. The risk to migrating juveniles was assessed as medium due to a high consequence rating. Impacts to fish passage in the lower reaches of a catchment could have significant impacts on the area of riverine habitat available to the species. However, the likelihood was determined to be 'unlikely' where controls specified in section 2.4 are implemented.

Cold water pollution (if present) may act as a barrier fish passage, effectively reducing the area of available riverine habitat. A provisional assessment of cold-water pollution risks was undertaken, with a final risk rating pending further investigation to be conducted upon commencement and operation of the Project. It was not possible to determine a risk rating for this impact until the scheme is in operation. Monitoring and adaptive management requirements have been detailed in Section 2.4 to reduce the risk of cold-water pollution resulting from the Project. Therefore, it is not expected that this would result in a reduction in the area of occupancy of Australian Grayling in the Lower Mersey River catchment.

2.6.3 FRAGMENT AN EXISTING IMPORTANT POPULATION INTO TWO OR MORE POPULATIONS.

The Project is not expected to result in fragmentation of the Australian Grayling population in the Mersey River. Australian Grayling are diadromous and require migration between marine and freshwater environments. Barriers to fish passage and migration would result in exclusion and a subsequent reduction in available habitat, rather than fragmentation. Section 2.6.2 details the assessment of this impact.

2.6.4 ADVERSELY AFFECT HABITAT CRITICAL TO THE SURVIVAL OF THE SPECIES.

The Project is not expected to adversely impact habitat critical to the survival of Australian Grayling in the Lower Mersey River catchment. The primary risks associated with the project that have the potential to impact the quality of habitat within the lower Mersey River catchment are direct alteration of habitat at the [redacted] during construction/modification of the existing pump station infrastructure and ongoing impacts from cold-water pollution.

The assessment of construction activities of the SWISA project in the Mersey River determined the risk of impact to be low for all life stages of Australian Grayling. Impacts on water quality and direct disturbance were considered the only mechanisms by which impacts were likely to occur during construction. Both of these impacts were considered to be low risk to adversely impacting the species directly or habitat that is critical to survival of the species.

A provisional assessment of cold-water pollution risks was undertaken, with a final risk rating pending further investigation to be conducted upon commencement and operation of the Project. It was not possible to determine a risk rating for this impact until the scheme is in operation. Monitoring and adaptive management requirements have been detailed herein to reduce the likelihood of cold-water pollution risks resulting from the Project. Therefore, it is not expected that this would result in an adverse impact (above existing) on habitat used by Australian Grayling in the Lower Mersey River catchment.

In addition, the species is widely distributed across Tasmania and Victoria. This distribution is largely out of scope of the SWISA scheme and unaffected. Therefore, any remnant habitat within the impact area could not be considered to be critical to the survival of the species.

2.6.5 DISRUPT THE BREEDING CYCLE OF AN IMPORTANT POPULATION.

The Project is not expected to result in a significant disruption to breeding cycles of the Australian Grayling population in the lower Mersey River catchment. Australian Grayling are a diadromous species and therefore require migrations between marine and freshwaters. This assessment included a specific focus on several possible impacts resulting from the project that may interact with migrations and breeding cycles of Australian Grayling in the Mersey River. The primary risks associated with the project include temporary impacts from construction works, and ongoing impacts from operation of the irrigation infrastructure, and resulting modifications to flow regimes.

Temporary impacts resulting from construction activities of the SWISA project in the Mersey River were determined to be of low risk to all life stages of Australian Grayling. Impacts on water quality and direct disturbance were considered the only mechanisms by which impacts were likely to occur during construction. Both were considered to be low risk and are unlikely to result in a disruption to the breeding cycle of Australian Grayling in the Lower Mersey River Catchment.

Three ongoing impacts were considered to have a possible interaction with the breeding cycle of Australian Grayling in the Lower Mersey River Catchment: fish passage, flow regime changes, cold water pollution. Fish passage was assessed as low for most life stages, and medium for Juveniles. Fish passage impacts on Juveniles were assessed as medium risk as fish connectivity would significantly impact many individuals in this life stage. The consequences of a barrier to fish passage in the downstream reaches of the catchment are significant. The likelihood of this occurring was determined to be low, and several controls have been detailed in this report to further minimise the potential for any fish passage impacts to be realised. Ongoing monitoring will assist in preventing any significant impacts resulting from fish passage barriers.

Both flow regime changes and cold-water pollution were provisionally assessed, with risk ratings being contingent on further information. Both of these impacts have the potential to significantly disrupt breeding cycles by altering natural migration cues and physically impacting eggs and larvae of Australian Grayling. However, it was not possible to predict the likely or potential impact resulting from both cold-water pollution and flow regime changes before operation of the scheme has commenced. It has therefore been recommended that active monitoring and adaptive management strategies are implemented to better understand these impacts and risk profiles. Modify, destroy, remove, isolate, or decrease the availability of quality of habitat to the extent that the species is likely to decline.

2.6.6 RESULT IN INVASIVE SPECIES THAT ARE HARMFUL TO A VULNERABLE SPECIES BECOMING ESTABLISHED IN THE VULNERABLE SPECIES HABITAT.

No introduction or translocation of invasive species is anticipated to occur as a result of this project.

2.6.7 INTRODUCE DISEASE THAT MAY CAUSE THE SPECIES TO DECLINE.

No introduction or transmission of disease or pathogen is anticipated to occur as a result of this project.

2.6.8 INTERFERE SUBSTANTIALLY WITH THE RECOVERY OF A SPECIES.

In general, recovery actions for the species include removal of barriers to migration, increases in environmental flows, restoration of natural flow regimes, restoration of streambanks and riparian vegetation, reducing predatory invasive species, and improvement of water quality. This assessment undertaken for this project determined that project activities were unlikely to result in significant changes to streambanks and riparian vegetation, barriers to migration, and prevalence of predatory invasive species. However, it was not possible to confidently determine the likely impacts of the project on flow regimes and water quality, to the extent that these changes would impact breeding cycles and habitat quality for Australian Grayling in the Mersey River. It is not possible to assess these impacts until operations commence. Adaptive management strategies have been developed that will ensure impacts resulting from changes to flow regimes and water quality will be identified and mitigated/avoided through operational settings.

3 – SWISA IRRIGATION NETWORK - ASSESSMENT 2

3.1 SITE DETAILS

The SWISA pipeline network and irrigation district covers approximately 20,000ha and involves installation of approximately 102km of pipe (Figure 16). The area is comprised mostly of non-forest agricultural land with some small patches of remnant native vegetation. The major agriculture type is livestock grazing.

The works to install the pipeline will require excavation along the pipeline route, including across waterways. The majority of the pipeline will be installed via trenching, with some selected sites using Horizontal Directional Drilling (HDD). The irrigation infrastructure will allow an additional 106 ML/day of water to be used for irrigation, facilitating changes and intensification of agriculture in the district. There are two mechanisms by which Australian Grayling (*P. maraena*) may be impacted by the irrigation network: 1) direct impacts resulting from construction of the pipeline through waterways, and 2) indirect impacts resulting from changes to hydrology in the irrigation district.

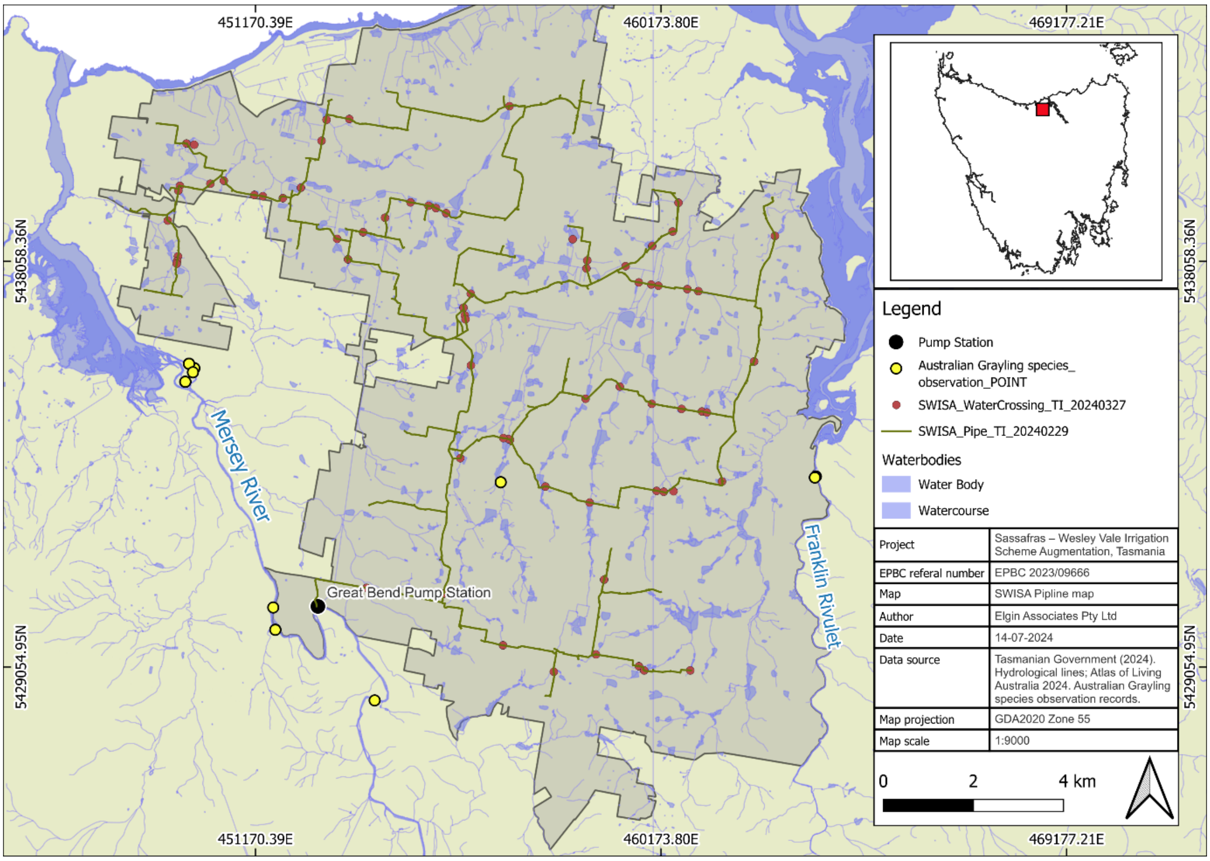


Figure 16. SWISA Irrigation district and proposed pipeline with waterway crossings.

3.1.1 SPECIES PRESENCE

Australian Grayling have been recorded within the irrigation district in Panatana Rivulet (Atlas of Living Australia, 2024). It has also been recorded in Franklin Rivulet, adjacent to the Eastern boundary of the district (Figure 16). While it is likely that the irrigation area forms suitable habitat for residence of adult Grayling, it is also highly likely that their distribution is limited to larger streams and rivers, such as the Panatana Rivulet.

3.1.2 SITE SURVEY

A preliminary desktop GIS assessment was used to identify and prioritise likely habitat for Australian Grayling in the irrigation network area using the criteria in Table 7. This assessment was completed in accordance with Survey guidelines for Australia's threatened fish (DSEWPaC, 2011) included identification of likely barriers to fish passage, riparian vegetation and suitable habitat, likely permanence or water bodies, and recorded observations. A prioritisation was then conducted on each proposed waterway crossing using the above below criteria:

Table 7. Habitat prioritisation criteria for SWISA pipeline crossing assessment

Criterion	Categories	Analysis
Riparian vegetation	Present, absent	Riparian vegetation is an indicator of aquatic ecological health, providing food sources and suitable hydrological conditions. • Does the water body within the vicinity of the proposed crossing have visible native riparian vegetation cover along the majority of streambank?
Presence of downstream barriers	Yes, no, AND passable, not passable	Australian Grayling a diadromous and require migration within freshwater reaches and between fresh and salt water. The presence, passability and number of barriers in the waterway is an indicator of the likelihood of presence in and utilisation of the waterway. • Are there any known barriers to fish passage downstream from the site?
Water body permanence	Permanent, semi-permanent, ephemeral	Australian Grayling require permanent flowing water, or access to suitable refuge habitat. • Does the waterbody appear permanent or ephemeral?
Recorded observations	Yes, no	Previous recorded observations indicate likely contemporary presence. • Have there been any recorded observations of the species in any attached waterway?
Accessible refuge habitat	Yes, no	Where waterbodies are ephemeral, access to suitable refuge habitat may increase the likelihood of presence. • For waterbodies that are possibly ephemeral, are there connected and accessible refuges present?

The prioritisation identified all crossing sites to be upstream from at least one fish passage barrier, with some sites upstream from multiple barriers. In general, streams and watercourses within the irrigation district were found to be heavily impacted and modified. Most had significant removal of riparian vegetation, re-alignment, straightening and multiple small dams. Panatana Rivulet is the major water course likely to be impacted by irrigation network crossings and has a number of potential barriers. However, there has been an observation of Australian Grayling upstream of these barriers, within the irrigation network area. This observation upstream of several barriers indicated that many of the potential barriers identified might be passable under certain flow conditions. This usually occurs during down-out conditions where water levels exceed bank levels, and the entire structure is inundated. It was therefore concluded that on-ground inspection to inform a prioritisation study should be used to confirm likely presence of Australian Grayling. The prioritisation was used to determine where to conduct electrofishing surveys.

3.1.3 SITE PRIORITISATION INSPECTIONS

The following methodology was used to determine whether on-ground verification was required to determine likelihood of Australian Grayling presence in waterways with proposed pipeline crossings.

Analysis of criteria and categorisation of sites was conducted using GIS and aerial imagery. Each proposed crossing site was identified, and the extent of the waterway defined according to stream classification. A waterway was considered to be a contiguous and discrete waterway where stream classification remained the same or lower that the classification at the crossing site. An increase in classification level indicated a separate watercourse. The analysis and categorisation were then conducted for each discrete waterway on which a proposed crossing was located.

3.1.4 RIPARIAN VEGETATION PRESENCE

Aerial imagery was reviewed, and riparian vegetation was assigned **Yes** or **No**. Riparian vegetation is complex to define from aerial imagery alone, so the following criteria were used:

- Presence of continuous vegetation along the banks of the river upstream or downstream of the pipeline crossing point.
- Obvious fencing of waterways or roadside easements was assumed to promote bankside vegetation.

3.1.5 PRESENCE OF DOWNSTREAM BARRIERS

Downstream barriers (as defined in section 2.3.1) were assessed using aerial imagery. Where there was any visible indication of a barrier (e.g. road crossing), a potential barrier was recorded.

3.1.6 PERMANENCE

Water Permanence was inferred from aerial photographs using a range of sources, including ListMap, Google Earth historic imagery, and using Google Street View - where available. Water Permanence was assigned Perennial (permanent) where water was visible in all imagery and/or waterway classification was greater than or equal to a River or Stream. Ephemeral was assigned to waterways that did not display water in all imagery.

3.1.7 CONNECTIVITY TO RECORDED OBSERVATIONS

Connectivity to recorded observations of Grayling was assessed as the presence of existing populations indicates suitable habitat and flow conditions, and the possibility of dispersal of the species into nearby areas. A waterway was considered to be connected to recorded Grayling observations where the observation occurred on the same waterway, or a separate discrete waterway that is directly connected to the crossed waterway, or connected through another nearby waterway of greater stream classification. Where a potential barrier was located between the waterway and the recorded observation, this was considered **not connected**.

3.1.8 ACCESSIBLE REFUGE HABITAT

Accessible refuge habitat included larger bodies of water that were more likely to be permanent, e.g. larger water impoundments, larger rivers, lakes, wetlands. Where refuge was identified on the same waterway, and there was no potential barrier between the crossing site and the refuge, this criterion was determined in the affirmative.

3.2 PRIORITISATION

Crossing waterways were prioritised for on-ground verification or excluded from further investigation according to a series of criteria analyses. Initially, any waterway that was determined to be highly ephemeral e.g. a drainage line that is only actively flowing during runoff events, was excluded from further analysis as these do not constitute suitable waterways for fish habitation. Criteria were then used to determine whether to exclude waterways or whether an on-ground verification survey is required or not. The criteria were analysed following the below methods:

- Waterway is unsuitable for Australian Grayling where:
    - Permanence = semi-permanent, or ephemeral, and

  - Accessible refuge habitat = **no**
- On-ground verification surveys were required where:
  - The crossing waterway (as defined above) is **connected to a recorded observation**,

Or, the below criteria were met:

  - Riparian vegetation presence =**present, and**
  - Presence of downstream barriers = **no,**

or

  - Riparian vegetation presence = **yes, and**
  - downstream barriers were present but required fish passage assessment.

The above methodology is consistent with the first principle of recommended survey techniques for EPBC Act listed fish, which is to identify target species including through consideration of habitat suitability. Where a waterway was determined unsuitable using the above analysis, and therefore not prioritised for on-ground verification and surveys, fish surveys were not conducted.

3.2.1 VERIFICATION

On-ground verification included habitat surveys, water quality assessments and fish passage assessments (Table 8) to further exclude or confirm likelihood of Australian Grayling presence. Verification surveys were conducted on 01/08/2024.

Table 8. Criteria used for on-ground verification of waterway suitability for Australian Grayling.

Criterion	Categories	Analysis
Suitable habitat	Suitable, not suitable	Suitable habitat for Australian Graylin constitutes flowing water, riffles, runs, glides, slow-moving deep pools, gravel and cobble bed material and adequate water quality. • Does the water body constitute suitable habitat?
Water quality	Suitable, not suitable	Suitable water quality meets the guidelines specified in (Environment Protection Authority, 2021) or site-specific criteria. • Does the water quality meet or exceed guidelines or criteria?
Fish passage	Passable under all conditions, passable under high flows, passable only under down-out conditions	Passability is dependent on multiple factors, some of these include flow velocities, drop height, culvert specifications (e.g. length, diameter, fall). • What is the passability of the barrier?

3.2.2 SUITABLE HABITAT

Suitable habitat for Australian Graylin constitutes flowing water, riffles, runs, glides, slow-moving deep pools, gravel and cobble bed material and adequate water quality. Refer also to Section 1.1 for a full description of the species.

3.2.3 WATER QUALITY

Four water quality parameters that are most critical and immediately measurable were recorded at sites that required water quality assessment. These parameters included: temperature, dissolved oxygen, electrical conductivity (indicates salinity), and pH. The suitable ranges for each of these parameters within the catchment are detailed in (Environment Protection Authority, 2021). A hand-held YSI ProDSS (calibrated on 31/07/24) was used to measure water quality parameters.

3.2.4 FISH PASSAGE

Fish passage assessments were conducted according to Moore *et al*. 2022. The irrigation area includes many fish barriers, but these have not been detailed here. Only waterway crossings that were selected as requiring a site inspection in the prioritisation process were further assessed for fish passage.

3.2.5 ON-GROUND VERIFICATION SURVEY RESULTS

The results of on-ground verification surveys are detailed below (Table 9). These results have been used to direct fish sampling efforts, and exclude waterways from the possibility of Australian Grayling presence. Where HDD has been confirmed as the crossing methodology, these waterway crossing sites do not require further survey via electro fishing. However, any site(s) where Australian Grayling are confirmed via electro fishing surveys, then HDD will be required.

Table 9. Results of on-ground verification of waterway suitability for Australian Grayling and determination of fish survey requirements.

Water Crossing Identifier	Species present	Suitability	Requires fish survey	Comments
[redacted]		No	No	
[redacted]		Yes	Yes	^HDD methodology confirmed so fish survey only required if this changes
[redacted]		Yes	Yes	^HDD methodology confirmed so fish survey only required if this changes
[redacted]		No	No	
[redacted]	Y	No	Yes	Trench method. Fish survey required.
[redacted]	Y	No	Yes	Trench method. Fish survey required.
[redacted]		No	No	
[redacted]		No	No	
[redacted]		No	No	
[redacted]		Yes	Yes	^HDD methodology confirmed so fish survey only required if this changes
[redacted]	Y	Yes	Yes	^HDD methodology confirmed so fish survey only required if this changes
[redacted]	Y	No	Yes	Trench method. Fish survey required.
[redacted]		No	No	
[redacted]		No	No	
[redacted]		Yes	Yes	Trench method but possibly changing alignment to remove water crossings. Suitable but connectivity is unlikely, multiple DS barriers. Minimal suitable habitat US. Requires additional DS barrier survey.

^Note: If HDD is not undertaken, then a fish survey will be required prior to any site works. If the fish survey identifies fish are present, HDD method should be reinstated. Where fish are not present, normal trenching methodology can be used.

3.3 FISH SURVEY

Fish sampling included the use of electrofishing to detect the presence of Australian Grayling within each prioritised waterway. Five crossings were confirmed as requiring electrofishing surveys to determine the presence (or absence) of the species at each site.

The use of electrofishing is consistent with DCCEEW guidelines for listed freshwater fish species. This is due to its success rates for catching fish, coupled with the fact that, when used correctly, the technique is non-lethal, and fish can be photographed/measured and returned to their habitats alive (DSEWPaC 2011). Electrofishing causes fish to swim out of complex habitats towards the anode, making it more likely to catch cryptic or well-hidden fish than compared with netting (Poos *et al.* 2007).

3.3.1 FISH SURVEY METHOD

Electrofishing surveys of the five sites were completed on 23rd October and 21st November 2024. Three electrofishing sites were selected per waterway, one nearby site for each crossing(s) and two downstream sites to confirm whether the species was present in the waterway, in addition to the crossing site(s). A total of nine electrofishing surveys were completed (Table 10; Appendix 2).

Table 10. Electrofishing site codes with relevant waterway and crossing (WC) and water quality results.

			Water Quality Parameters				
Water Crossing #	Waterway	Electrofishing Site Code	Temperature	DO (mg/l)	DO (%)	EC	pH
[redacted]	[redacted]	22-001	11.7	4.58	42.3	414.4	6.93
		22-002	12.4	2.64	24.8	421.7	6.44
		22-003	13.6	1.14	11	402.8	6.93
[redacted]	[redacted]	27-001	17.8	7.62	80.3	222.7	7.01
		27-002	16.9	6.48	67.1	217.5	6.44
		27-003	18.2	8.49	94.9	270.8	7.22
[redacted]	[redacted]	74-001	18.9	7.62	82.2	300.3	6.7
		74-002	18.56	8.18	87.5	305.5	7.11
		74-003	19.29	7.21	70.2	304.2	6.79

Electrofishing surveys were conducted under IFS Permits [redacted]. A team of three scientists completed the surveys, including (i) the electrofisher operator, using a SmithRoot LR20B backpack electrofisher and (ii) an in-water field assistant, collecting fish with a 300mm net and (iii) an off-water field assistant, carrying equipment and field notes.

At each electrofishing site, a start point was designated downstream of the site with the survey proceeding upstream through the waterway. The site was sampled for 1200 seconds of shock time (as recorded on the electrofisher unit) in bursts, as continual shocking can push fish ahead of the samplers. The survey time was restricted at [redacted] due to waterway accessibility and [redacted] due to lack of suitable habitat. One [redacted] was not sampled due to low dissolved oxygen levels (<20%), deemed unsuitable water quality conditions for Australian Grayling (Table 10).

The electro-fisher was deployed with the anode close to the surface so that fish moved higher in the water column to maximise likelihood of catch, attracting fish within the zone of electrical influence (typically less than 3 metres). Captured fish were immediately placed into a bucket filled with freshwater until the survey time elapsed, where each individual was identified to species level and immediately returned to the waterway. All attempts were made to minimise the length of time fish spent in the bucket. Where an off-water assistant was available, fish were immediately identified, measured and released downstream while electrofishing continued.

3.3.2 EQUIPMENT & SETTINGS

Electrofishing sampling equipment included -

- SmithRoot LR20B backpack electrofisher
- Net for assistant (300mm flat lower edge, 3mm mesh)

Electrofishing settings are listed in Table 11 below. Initial voltages and duty cycle were based on the Electrical Conductivity of the waterway. The default settings listed below are guideline values only and were appropriately modified by electrofisher operator in response to behavioural changes in fish observed during the survey. Voltages were estimated low initially to minimise the likelihood of "fish burn". Voltage also changed in response to battery charge level and water depth.

Table 11. Electrofishing default settings utilised for the Australian Grayling fish survey

Electrical Conductivity (uS/cm)	Voltage (V)	Duty Cycle	Frequency Range (Hz)
<150	250-300	10	Corresponds to fish size - • Small species: 10-40 • Large species (e.g. salmonoids): 40-60
150-500	200-250	10-20	
500-800	150-200	10-30	

3.3.3 FISH SURVEY RESULTS

The Australian Grayling (*Prototroctes maraena*) was not identified at any of the surveyed waterways. Photos from the field survey are presented below (Photos 1-8).

[redacted]

[redacted]

Physio-chemical observations collected at each electrofishing survey site (water temperature, dissolved oxygen, redox, turbidity, flow, electrical conductivity), habitat observations and records of all fish species detected are provided in attachments 2 and 3. All waterways had suitable habitat conditions but a number of sites do not have suitable water quality for Australian Grayling (Table 10).

Although no Australian Grayling were observed at any of the sites during this study, previous records of the species have found it to occur in Panatana Rivulet. It is therefore possible that the sampling methodology was not entirely effective, either due to limited spatial or temporal scope or limitations of the electrofishing method. It is therefore suggested that further investigation is undertaken for Panatana Rivulet to exclude the presence of the species from this waterway at present. As this waterway exhibited the best habitat and water quality conditions, it holds the highest likelihood of the species presence. It is highly unlikely that the species occurs in the other waterways investigated ([redacted]). Further investigations in [redacted] may seek to utilise more passive sampling methods that are effective over a greater spatial and temporal scale. These may include fyke netting during migration periods, or eDNA.

3.4 IMPACTS TO AUSTRALIAN GRAYLING

Potential impacts resulting from the proposed actions can be classified as temporary and on-going. These represent the construction of pipeline infrastructure and operation of the irrigation scheme respectively.

3.4.1 TEMPORARY IMPACTS

Construction of the irrigation pipeline involves excavation along the pipeline route, including across waterways. The majority of the pipeline will be installed via trenching, with some selected sites using Horizontal Directional Drilling (HDD). In some areas, vegetation will be cleared to provide access to machinery. In all instances, infrastructure, once installed, will not protrude into waterways, and no in-stream structures will remain following completion of works. Where HDD is used, impacts to the waterway are likely to be negligible as no disturbance or structures will occur or be installed within the waterway. However, some specific requirements for this method have been outlined in Section 3.5 that aim to avoid any possible impacts.

Where a section of waterway was found to contain Australian Grayling, it was recommended that HDD be used to minimise impacts to habitat. Where HDD was decided to not be used, and trenching used instead, strict protocols have been developed to avoid impacts to Australian Grayling (Section 3.5). Risks posed by this activity include barriers to migration, habitat disturbance or degradation, and changes in water quality. Each of these risks are assessed in Table 12. Operational controls provide a good method for mitigating impacts and the assessment has been conducted assuming all controls are adhered to.

Table 12. Impact risk assessment for construction of SWISA pipeline infrastructure using trenching in relation to Australian Grayling (P. maraena). Refer to appendix 1 for risk assessment matrix and consequence description.

	Likelihood	Consequence	Pre-Control Risk rating	Consideration of Prescribed Controls	Post Control Risk rating
Disturbance from trenching within waterway (temporary)					
Resident Adult	Unlikely	Minor	Low	Assessed with relevant controls in place. HDD at all crossings with confirmed Australian Grayling observations	Low
Migrating Adult	Unlikely	Minor	Low		Low
Migrating Juvenile	Unlikely	Moderate	Low		Low
Short term impacts to water quality (temporary)					
Resident Adult	Unlikely	Moderate	Low	Assessed with relevant controls in place. HDD at all crossings with confirmed Australian Grayling observations	Low
Migrating Adult					
Migrating Juvenile					

3.5 AVOIDANCE AND MITIGATION – CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN (CEMP)

Horizontal Directional Drilling procedure – applies where pipeline infrastructure is installed using HDD in waterways where Australian Grayling have been confirmed or are likely to be present.

- Pipelines must be installed an appropriate depth below the stream bed to prevent exposure of the pipe in the future as the streambed erodes. The highest point of pipe or casement must be at least 1m below bed level.
- Where vehicle or machinery access across the waterway is required, it should be ensured that excessive disturbance of the stream bed and banks do not result from activities.
- Any disturbance should not cause erosion or suspension of sediment.
- No temporary structures are to be erected within the waterway that may constitute a barrier to fish passage for more than 24hrs.

Trenching procedure – applies where pipeline infrastructure is installed using trenching in waterways where Australian Grayling have been confirmed or are likely to be present.

- Pipelines must be installed an appropriate depth below the stream bed to prevent exposure of the pipe in the future as the streambed erodes. This may require that where the streambed is found to be constituted by erosive material, a greater depth is necessary. The highest point of pipe or casement must be at least 1m below bed level.
- Where vehicle or machinery access across the waterway is required, it should be ensured that excessive disturbance of the stream bed and banks do not result from activities.
- Installation of pipelines through waterways with Australian Grayling present only occurs during low-flow conditions between the months of January to April.
- Bed composition and profile must be returned to pre-works conditions.
- Any scour protection installed in the bed of a waterway must be installed at a minimum of 30cm below bed-level and covered with bed material that is naturally present within the same waterway.
- Any engineered erosion control materials such as geotextile products are installed so that they will not be exposed to, or enter the waterway under extreme weather conditions or over time as a result of erosion.
- Backfill material used within the bed and banks of a waterway must:
    - be obtained locally and replicate material existing within the waterway.
    - be free of contamination including but not limited to acid sulphate soils, heavy metals, hydrocarbons.
- Where riparian vegetation is removed or disturbed, revegetation is conducted within 6 months of completion of works.
- Where trenching occurs in perennial waterways, or during any flow conditions other than cease to flow, the below requirements must be met:
    - Temporary diversion, damning or obstruction of water flows must occur for a maximum of 7 days.
    - Any temporary coffer dams constructed in the waterway use material that is free from contamination as described above.
    - All coffer dam material is removed from the waterway following construction except where it meets the criteria for appropriate back-fill material as described above and does not alter the profile of the waterway.

A **Water Quality Management Plan** is prepared and implemented during construction works.

An example of a framework for daily water quality monitoring of downstream and released water from any diversion or in-stream works at water crossings where Australian Grayling have been confirmed or are assumed to be present based on the prioritisation, including:

- Appropriate monitoring sites selected as follows:
  - Upstream:
    - Located upstream of all watercourse crossing works and potential sedimentation inputs from the site
    - Downstream of any confluences with significant creeks, streams or rivers
    - Not to be undertaken less than 10m or further than 200 m upstream from the site.
  - Downstream:
    - Located downstream of all construction sediment inputs (from both point and diffuse sources)
    - Upstream of any confluences with significant creeks, streams or rivers
    - Not be undertaken less than 20m or further than 100 m downstream of the construction site.
  - Monitoring to be undertaken by a suitably qualified person and is to be conducted in accordance with the following:
    1. Daily readings start at least one day prior to construction commencing.
    2. Minimum three upstream and downstream readings taken daily once construction has commenced:
    - Prior to the commencement of daily works
    - During daily works
    - At the completion of daily works
    - At any other time that there is a visible change in turbidity downstream resultant from site activities.
  - All WQ readings to be checked against the SWISA Turbidity Management Framework and actions taken as necessary.
    - Where parameters exceed those specified in the WQMP or CEMP, works must immediately be ceased, and appropriate remedial action taken until parameters meet the above requirements.
  - A sediment curtain is installed downstream of the works to reduce the impacts of sediment disturbance.
  - Sediment traps, bags, or basins are used during dewatering or where otherwise necessary to mitigate discharge of highly turbid water back to the waterway.

Longer Term Controls

An inspection of the crossing is carried out after at least 12 months, and within 24months of completion of works during low-flow conditions to ensure that:

- Revegetation is likely to be successful
- No significant erosion of the bed and banks is occurring as a result of the works
- No infrastructure installed under or adjacent to the waterway has been exposed as a result of erosion.

Where works have resulted in a change to hydrology, an appropriately qualified specialist is engaged and remedial works conducted (if appropriate) to ensure no ecological impacts that may impact Australian Grayling occur.

3.5.1 RESIDUAL IMPACTS

Residual impacts that may result from the irrigation scheme relate to the use of water, changes in agricultural practices resulting from water access, and hydrological impacts to the catchment. There are no residual impacts anticipated to result from pipeline infrastructure, as these will not protrude into waterways. However, some risks are associated with increased use of irrigation water in the catchment, and resulting changes to agricultural practices. These have been assessed below and risks identified in Table 13.

Table 13. Impact risk assessment for ongoing operation of the SWISA scheme in relation to Australian Grayling (P. maraena). Refer to appendix 1 for risk assessment matrix and consequence description.

Life stage	Likelihood	Consequence	Pre-Control Risk rating	Consideration of Prescribed Controls	Post Control Risk rating
Barriers to fish passage and channel morphology					
All life stages	Possible	Moderate	Medium	Assessed with relevant controls in place. Use of FarmWAP's to manage agricultural practices.	Low
Flow regime modifications					
All life stages	Unlikely	Moderate	Low	Assessed with relevant controls in place. Use of FarmWAP's to manage agricultural practices.	Low
Removal and degradation of riparian vegetation					
All life stages	Possible	Moderate	Medium	Assessed with relevant controls in place. Use of FarmWAP's to manage agricultural practices.	Low
Changes to water quality					
All life stages	Possible	High	Medium	Assessed with relevant controls in place. Use of FarmWAP's to manage agricultural practices.	Low

3.5.2 WATER DISTRIBUTION AND LAND USE CHANGE

Irrigation schemes provide access to additional water that would otherwise limit agricultural practices and land use. Providing access to additional water is likely to result in a shift in management practices and allow for some degree of intensification of agriculture within the scheme area. The impacts of these changes on aquatic ecosystems are highly varied, often unpredictable and dependent on a multitude of both economic, agronomic, practical, and ecological factors.

To assess the potential cumulative impact of the scheme on Australian Grayling It is necessary to understand the ecological requirements of the species, the current state of ecosystems and the presence of the species within the irrigation district. Changes to ecological functioning can then be predicted from likely agricultural changes. It is important to note however, that it is not possible to predict future interactions between the variables in this assessment.

3.5.3 SPECIES HABITAT REQUIREMENTS

Australian Grayling are a freshwater inhabitant, requiring migration between fresh and marine/estuarine environments in order for populations to remain viable. It is biologically necessary for individuals to complete a diadromous migration to complete their lifecycle (Berra 1982, Berra *et al*. 1987, McDowall 1996). Adult

Grayling are typically found in deep, slow flowing pools (Bishop and Bell, 1978a), clear gravel-bottomed streams with both pools and riffles (Berra 1982) and in some instances in turbid waters (Jackson and Koehn 1988).

3.5.4 WATERWAYS WITHIN SWISA IRRIGATION AREA

The Sassafras-Wesleyvale irrigation district is characterised by highly modified waterways, little to no riparian vegetation, and extensive agriculture. The current state of waterways within the district could be accurately described as 'highly degraded'. This state has resulted from:

- Declines in condition of channel morphology through direct and indirect measures e.g. channel straightening and bank erosion respectively.
- Removal and degradation of riparian vegetation
- Degradation water quality including nutrient, sediment, and pesticide pollution from agricultural activities.
- Changes to sediment regimes from erosion, construction of dams and runoff from agriculture.
- Changes to stream bed composition from increased sedimentation.
- Altered hydrological regimes e.g. changes from seasonal to more permanent flows, construction of dams and straightening of channels.
- Construction of barriers to fish passage including road crossings, culverts, and dams.

Cumulatively, these factors have contributed to the widespread degradation of aquatic ecosystem health in the irrigation area. It is likely that further intensification of agricultural operations resulting from the SWISA irrigation scheme will result in further declines to aquatic ecosystem health via some of the above mechanisms. However, it is not possible to quantify the extent of this impact. Several of the impact mechanisms can be mitigated or avoided through agricultural management practices.

3.5.5 BARRIERS TO FISH PASSAGE AND CHANNEL MORPHOLOGY

Construction of dams, weirs, culverts, road crossings and other structures that are barriers to fish passage is one of the most serious and significant risks to Australian Grayling broadly, and specifically in the SWISA scheme area. Despite the high number of barriers already existing on waterways in the area, some evidence of Australian Grayling presence above these barriers indicates that the species has been able to navigate under some flow conditions. Further construction of barriers is likely to result in significant impacts to the species where it is present. However, it is not anticipated that the scheme will result in construction of any additional on-stream dams, as existing water storage infrastructure will be utilised (Pinion 2023: Att 34 SWISA Hydrology Considerations report V2). Similarly, changes to channel morphology are unlikely to result directly or indirectly from the scheme as these modifications have largely already taken place historically.

3.5.6 FLOW REGIME MODIFICATIONS

The likely impact(s) of the scheme on flow regimes are detailed in Att 34 SWISA Hydrology Considerations report V2 (Pinion 2023). This report notes that regional hydrological effects will be indiscernible due to uptake and usage patterns. The report further states that agricultural practices generally used in the scheme area result in less than 10% of un-utilised (uncontrolled) water, i.e. water that is not evaporated or transpired through the plant water use process, and is discharged into the environment through runoff and deep drainage. This water was quantified as a 2% increase in the uncontrolled water within the scheme area. This quantum of change is significantly less than natural interannual variation, and therefore unlikely to result in further degradation of aquatic ecosystems in the scheme area.

3.5.7 REMOVAL AND DEGRADATION OF RIPARIAN VEGETATION

The removal of any riparian vegetation within or adjacent to waterways should be avoided wherever possible. Pinion (2023) state that no material land clearing will result from construction or operations.

3.5.8 POTENTIAL CHANGES TO WATER QUALITY

The application of additional irrigation water to the area has the potential to impact water quality.

Water Quality Monitoring was reviewed by Pinion (2023), who concluded the following:

- Existing water monitoring in area – existing water quality monitoring has not shown any significant impact from the operation of SWIS.
- Will be continued with opportunity to review and add water quality monitoring sites for SWISA.
- Significant 'baseline' data pre-SWISA exists providing sound background for management and proactive identification of issues through ongoing water quality monitoring.

Note: in order to assess changes to water quality and sedimentation, the SWISA project would benefit from a review of water quality data (where available) and the preparation of an updated Water Quality Monitoring Plan.

3.6 AVOIDANCE AND MITIGATION OPERATIONAL ENVIRONMENTAL MANAGEMENT PLAN (OEMP) AND RESIDUAL IMPACT RISK ASSESSMENT

Tasmanian Irrigation have advised that the continued use of and further development of Farm WAP's will be used to avoid and mitigate any residual impacts resulting from the application of irrigation water through the SWISA scheme. An OEMP is being prepared by Tasmanian Irrigation and partners for the purpose of managing environmental impacts once SWISA is constructed and implemented. Specific controls for mitigating potential impacts to Australian Grayling from the application of irrigation water will be integrated into Farm WAP's. Current requirements include:

- Protect key aquatic habitat sites from physical or biological disturbance by:
  - Precluding installation of instream barriers,
  - Precluding heavy machinery use within 5m of habitat sites, and
  - Retaining and enhancing native vegetation cover in and around habitat sites.
- Protect key aquatic habitat sites from contaminated runoff and changes in hydrology by:
  - Precluding chemical spraying within 5m of aquatic habitat,
  - Precluding fertiliser application within 5m of aquatic habitat,
  - Using only biocides endorsed by the Australian Pesticides and Veterinary Medicines Authority,
  - Identifying erodible soils around aquatic habitats and developing and implementing erosion and sediment control measures consistent with accepted protocols, and
  - Preventing changes to drainage patterns or surface flows around aquatic habitat sites.

In addition to the current requirements, additional requirements are provided below to mitigate and potential impacts resulting from the SWISA scheme in the future. These include:

- Facilitating the restoration and conservation of aquatic habitats by:
  - Restoring natural riparian and aquatic vegetation where works are undertaken in these areas. For example, where remediation is conducted following streambank erosion.
  - Removing in-stream barriers to fish passage where existing barriers are upgraded, repaired or become redundant. For example, removal of pipe culverts and replacement with bed-level or other crossings that do not constitute a barrier to fish passage.

3.7 SPECIFIC IMPACT CRITERIA

Specific impact criteria for activities detailed in Assessment 1 (Section 3) are summarised in Table 6. Detailed descriptions of each criterion are provided below.

Table 14. Significant impact criteria and likelihood of impact for Assessment 2 – SWISA irrigation area, for impacts on Australian Grayling (P. maraena).

Significant impact criteria	Likelihood
Lead to a long-term decrease in the size of an important population of a species.	Unlikely
Reduce the area of occupancy of an important population.	Unlikely
Fragment an existing important population into two or more populations.	Highly unlikely
Adversely affect habitat critical to the survival of the species.	Unlikely
Disrupt the breeding cycle of an important population.	Highly unlikely
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat.	Highly unlikely
Introduce disease that may cause the species to decline.	Highly unlikely
Interfere substantially with the recovery of a species.	Unlikely

3.7.1 LEAD TO A LONG-TERM DECREASE IN THE SIZE OF AN IMPORTANT POPULATION OF A SPECIES.

The Project is not expected to result in a long-term decrease in the size or viability of the Australian Grayling population in the SWISA irrigation district. The primary risks associated with the project include temporary impacts from construction works, and ongoing impacts from operation of the irrigation infrastructure, and resulting modifications to flow regimes. These impacts are addressed in previous sections of this report.

3.7.2 REDUCE THE AREA OF OCCUPANCY OF AN IMPORTANT POPULATION.

The Project is not expected to impact the area of occupancy of the Australian Grayling population in the SWISA irrigation district. The primary risks associated with the project that have the potential to impact the accessibility of habitat within the catchment are fish passage and water quality. Impacts to fish passage resulting from the Project were assessed as low risk for all life stages due to the requirements to preclude construction of any fish barriers, and remediate existing barriers where possible.

Degradation of water quality is likely to reduce the available habitat for occupancy, migration and feeding of the species. However, there is no existing ‘important population’ in the irrigation district. Rare occurrences of the species are restricted to few waterways and the species was not recorded during fish sampling in this study. Additionally, requirements detailed in FarmWAP’s will avoid and mitigate degradation of water quality within the irrigation district and any adjoining waterways in the catchment.

3.7.3 FRAGMENT AN EXISTING IMPORTANT POPULATION INTO TWO OR MORE POPULATIONS.

The Project is not expected to result in fragmentation of the Australian Grayling population in the SWISA irrigation district. Australian Grayling are diadromous and require migration between marine and freshwater environments. Barriers to fish passage and migration would result in exclusion and a subsequent reduction in available habitat, rather than fragmentation.

3.7.4 ADVERSELY AFFECT HABITAT CRITICAL TO THE SURVIVAL OF THE SPECIES.

The Project is not expected to adversely impact habitat critical to the survival of Australian Grayling in the SWISA irrigation district and Lower Mersey River catchment. As the existing habitat in the area is already severely degraded. This has resulted in there being no existing ‘habitat critical to the survival of the species in the impact area’.

3.7.5 DISRUPT THE BREEDING CYCLE OF AN IMPORTANT POPULATION.

The Project is not expected to result in a significant disruption to breeding cycles of the Australian Grayling population in the SWISA irrigation district or lower Mersey River catchment. Australian Grayling are a diadromous species and therefore require migrations between marine and freshwaters. This assessment included a specific focus on several possible impacts resulting from the project that may interact with migrations and breeding cycles of Australian Grayling. The primary risks associated with the project include temporary impacts in the Mersey River from construction works, and ongoing impacts from operation of the irrigation infrastructure, and resulting modifications to flow regimes.

Temporary impacts resulting from construction activities of the SWISA project in the Mersey River were determined to be of low risk to all life stages of Australian Grayling. Impacts on water quality and direct disturbance were considered the only mechanisms by which impacts were likely to occur during construction. Both were considered to be low risk and are unlikely to result in a disruption to the breeding cycle of Australian Grayling in the Lower Mersey River Catchment.

3.7.6 RESULT IN INVASIVE SPECIES THAT ARE HARMFUL TO A VULNERABLE SPECIES BECOMING ESTABLISHED IN THE VULNERABLE SPECIES HABITAT.

No introduction or translocation of invasive species is anticipated to occur as a result of this project.

3.7.7 INTRODUCE DISEASE THAT MAY CAUSE THE SPECIES TO DECLINE.

No introduction or transmission of disease or pathogen is anticipated to occur as a result of this project.

3.7.8 INTERFERE SUBSTANTIALLY WITH THE RECOVERY OF A SPECIES.

In general, recovery actions for the species include removal of barriers to migration, increases in environmental flows, restoration of natural flow regimes, restoration of streambanks and riparian vegetation, reducing predatory invasive species, and improvement of water quality. This assessment undertaken for this project determined that project activities were unlikely to result in significant changes to streambanks and riparian vegetation, barriers to migration, and prevalence of predatory invasive species. Additionally, requirements have been included in FarmWAP's that will ensure the preservation of habitat, preclusion of additional barriers to fish passage, maintenance of suitable water quality, and restoration of habitat. This project therefore will be unlikely to interfere substantially with the recovery of the species.

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5 LIMITATIONS

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5.1 APPENDIX 1

Table A 1. Risk rating matrix for impact assessment on Australian Grayling (P. maraena).

Likelihood	Consequence				
	Minor	Moderate	High	Major	Critical
Highly likely (>90%)	Medium	High	High	Severe	Severe
Likely (>70%)	Low	Medium	High	High	Severe
Possible (>50%)	Low	Medium	Medium	High	Severe
Unlikely (<30%)	Low	Low	Medium	High	High
Highly unlikely (<10%)	Low	Low	Low	Medium	High

Table A 2. Consequences of impacts to Australian Grayling (P. maraena) resulting from activities in the Mersey River and SWISA irrigation district.

Consequence rating	Implications for Australian Grayling in Tasmania
Minor	Impacts are highly spatially and temporally restricted (within a localised part of a reach and occurs over days) - small number of individuals impacted
Moderate	Impacts are spatially and temporally restricted (within a reach and occurs within a single season) - small number of individuals impacted
High	Impacts are spatially dispersed throughout the ecosystem and will occur over multiple seasons.
Major	Impacts are spatially dispersed throughout the ecosystem and will occur over multiple years.
Critical	Impacts are spatially widespread throughout the region encompassing multiple ecosystems and are permanent.