

Chapter 6: Water Management

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Glossary of Terms

Abstraction	The removal or diversion of water from the natural water environment.
AOD (Above Ordnance Datum)	The system used by Ordnance Survey in Great Britain as the basis for deriving altitude on maps.
Catchment	An area of land within which water flows to a particular location.
CAR licence	A licence for activities affecting the water environment, issued by SEPA under The Water Environmental (Controlled Activities) (Scotland) Regulations 2011 (as amended).
Compensation Flow / Compensation release	Water released from a dam to maintain a flow of water down a watercourse.
Discharge	The release of water or other substances into the natural water environment.
Drawdown	The lowering of water level in a reservoir.
EIA	Environmental Impact Assessment – the process of undertaking a series of specialist environmental studies in order to identify and describe potentially significant effects of a proposed development.
EIA Report	Reports in detail the findings of the EIA.
FDC (Flow Duration Curve)	A plot illustrating the percentage of time that the flow in a watercourse exceeds a given rate.
Generating Mode	Transferring water from the upper reservoir to the lower reservoir during the operation of The Proposed Development
GWh	Gigawatt hours – a unit of energy equivalent to a steady power of 1 gigawatt (1 million kilowatts) running for one hour.
Level duration	The period of time during which the reservoir (upper or lower) is at a particular water level.
LFT (Lochaber Fisheries Trust)	Charitable organisation undertaking monitoring and protection of populations of native wild fish in Lochaber region.
Lochaber District Salmon Fishing Board (DSFB)	Statutory body with responsibility for salmon and sea-trout fishery protection and enhancement in the Lochaber region.
Mm ³	Million cubic meters.
MW	Megawatt – a unit of power equal to one million watts
Pumping mode	Transferring water from the lower reservoir to the upper reservoir during the operation of The Proposed Development.
Q95	The predicted minimum flow of water in m ³ /s for 95% of the time in a given month.
Residual Catchment	The area of catchment downstream of the dam which would not be affected by The Proposed Development.
Scoping Opinion	The written opinion of the determining authority as to the scope and level of detail of information to be provided in an EIA report.
SEPA (Scottish Environment Protection Agency)	A non-departmental public body tasked with the protection of the environment and human health in Scotland.
Scottish Canals	The British Waterways Board, operating as Scottish Canals – Public body with statutory duty for the operation and maintenance of waterways in Scotland.
Section 36	Section 36 of The Electricity Act (1989) for an electricity generating station with an output greater than 50 megawatts (MW).
Spill event	The flow of additional water downstream of the dam when the upper reservoir has reached capacity.
Stakeholders	Organisations and individuals who can affect or may be affected by The Proposed Development.
Standing By	No water transfer taking place between the reservoirs of The Proposed Development.

SW (Scottish Water)	Publically-owned company responsible for water supply and treatment of waste water in Scotland.
Water Framework Directive	Directive 2000/60/EC establishing a framework for the Community action in the field of water policy.

6 Water Management

6.1 Introduction

6.1.1 The Proposed Development broadly comprises a system to transfer water between Loch Lochy (lower reservoir) and a new reservoir created by enlarging the existing Loch a' Choire Ghlais (upper reservoir). This Chapter presents a summary of the baseline hydrological conditions and a review of the water management strategy for The Proposed Development. Details of The Proposed Development are included in Chapter 3: Description of Development, and an assessment of potential effects on the water environment (hydrology and hydrogeology) are described in Chapter 14: Geology and Water Environment.

6.2 Scope of Assessment

6.2.1 The scope of the assessment has been determined through a review of the Scoping Opinion and consultation with stakeholders.

6.2.2 Scoping responses received relevant to Water Management are summarised in Table 6.1.

Table 6.1: Key Issues From Consultation

Consultee	Summary Response	Comment/Action Taken
Scottish Environment Protection Agency (SEPA)	Request inclusion of a map showing engineering works within and near the water environment	Addressed in Chapter 10 (Terrestrial Ecology) and Chapter 14 (Geology and Water Environment) (and supporting Technical Appendices).
	If water abstraction proposed, a table of volumes and timings of groundwater abstraction and related mitigation measures should be provided.	Abstraction and discharge rates between the lower and upper reservoirs are described in Section 6.7. See also Chapter 14 (Geology and Water Environment).
Scottish Water (SW)	The EIA should include an assessment of the potential impacts on water abstraction locations within the vicinity.	This is included as a confidential appendix to Chapter 14 (Geology and Water Environment).
Lochaber Fisheries Trust (LFT)	The effect of fluctuating water levels in Loch Lochy on fish spawning and foraging activity should be assessed. Request that EIA includes detailed modelling of changes in loch levels and assesses the impact this will have on loch margin habitats.	Water fluctuations in Loch Lochy are discussed in this Chapter. Potential effects on fish, including assessment on fish spawning and foraging habitat, are addressed in Chapter 13 (Fish). It is not possible to construct accurate Loch Lochy level duration information at this stage as the operation of the scheme would be in response to future electricity markets.

Consultee	Summary Response	Comment/Action Taken
	Request a proposal on how water flows into River Lochy are to be managed when the scheme is in operation.	Discussed in Section 6.4. Full details cannot be provided at this stage. SSE request a similar Condition of Consent to that attached to the Section 36 Consent for The Consented Development, which states: <i>Prior to the Commencement of Development, the Company must submit details of any proposed modifications to the Mucomir Barrage and Power Station for approval in writing by the Planning Authority, who must consult SEPA. Details must include the proposed means of regulating flows into the River Lochy and details of any modifications proposed to the existing fish passage arrangements. The approved modifications must be implemented prior to the operation of the pumped storage hydroelectric generating station unless otherwise agreed in writing with the Planning Authority.</i>
Lochaber District Salmon Fishing Board (DSFB)	The EIA should include specific details on how flow management will be managed at Mucomir Barrage. What structure and mechanism will be left in place at Mucomir Barrage to manage flow and will this form part of the planning application / CAR licence?	Discussed in Section 6.4. See above response.
	What fish passage arrangements will be put in place at Mucomir Barrage?	Discussed in Section 6.4. See above response.
	The delivery of water downstream of Loch Lochy has created serious environmental problems in the River Lochy. The increase in loch fluctuation could make this situation more acute. How is the EIA going to address this problem?	Discussed in Section 6.4. See above response.
	How will the potential impacts on the salmon rod fishery business downstream on the River Lochy be addressed? Unnatural fluctuations in river levels can be highly detrimental to the success of rod fishery. This is the largest salmon fishery in West of Scotland and a major contributor to local economy.	Discussed in Section 6.4. See above response.
	How will the risk of rapid water level fluctuation on the large salmon farm on Loch Lochy run by Marine Harvest be assessed. Have Marine Harvest been consulted?	Marine Harvest has been consulted during the EIA process (see Chapter 4 (EIA Approach, Scoping and Consultation)).
	How will rapid fluctuations be managed with regard to delicate water level management of the Caledonian Canal and traffic using it. Have the British Waterways been consulted?	Scottish Canals has been consulted during the EIA process. - see Chapter 4 (EIA Approach, Scoping and Consultation). Loch Lochy level fluctuations discussed in this Chapter.
	How are the changes in fish habitat and food availability within the loch margins being assessed?	This has been assessed in Chapter 13 (Fish).

Consultee	Summary Response	Comment/Action Taken
Scottish Canals	Request consideration of potential impacts at Mucomir, Loch Lochy water levels, and impacts on boat moorings at Loch Lochy, Laggan and Gairloch and on a proposed small scale hydro power scheme at Banavie.	Scottish Canals has been consulted during the EIA process - see Chapter 4 (EIA Approach, Scoping and Consultation). Loch level fluctuations and operation of Mucomir discussed in this Chapter. Potential impacts on boat moorings considered in Chapter 19 (Land Use and Recreation). In relation to the proposed small scale hydro scheme at Banavie, existing CAR licence requirements and water management strategy is discussed in Sections 6.3 and 6.4. Ultimately the total volume of water passed through Mucomir barrage in a year would remain unchanged.

6.3 Overview of Development and Existing Conditions

- 6.3.1 During the period 1815 to 1825 the Caledonian Canal Company constructed a canal system linking the lochs of the Great Glen to provide a waterway between the east and west coasts of Scotland. The link between Loch Lochy and Loch Linnhe had lock gates and embankments constructed in the bed of the River Lochy at the west end of Loch Lochy, thus blocking the river flow. To provide a new outlet, the Mucomir Cut was excavated between Loch Lochy and the River Spean bypassing the canal works. In the 1960's, the North of Scotland Hydro-Electric Board constructed Mucomir Power Station and associated barrage structure at the downstream end of the Cut.
- 6.3.2 The nominal maximum installed generation capacity of The Proposed Development would be up to 1500 MW, this corresponds to a maximum flow between the reservoirs of approximately 425 m³/s.
- 6.3.3 The maximum energy storage of The Proposed Development would be up to 30 GWh, which corresponds to a useable water storage volume of 26 Mm³ (million cubic metres) in each of the two reservoirs.
- 6.3.4 The new dam and upper reservoir would inundate the existing Loch a' Choire Ghlais and impound the Allt a' Choire Ghlais at this location. The new dam would incorporate a spillway, a spillway discharge channel, and dam drawdown and compensation water release facilities. This is illustrated in Figure 3.3: Indicative Layout of Dam.
- 6.3.5 The lower reservoir is formed by Loch Lochy. Loch Lochy has a drainage area of approximately 377.5 km² (including the Arkaig catchment), is approximately 16 km long and has a surface area of 17.5 km².
- 6.3.6 The water level in Loch Lochy is currently controlled by SSE Generation Ltd (SSE) at its existing hydroelectric power station at Mucomir (Gairloch). Water is released from here through turbines to the River Spean (which then flows into the River Lochy just downstream of Mucomir); there are also floodgates to discharge larger flows as required. These activities are covered by a CAR licence.
- 6.3.7 The existing CAR licence for Mucomir Power Station (CAR/L/1010015 v2) requires that a compensation water volume of not less than 340,957 m³/day (3.95 m³/s average) is released from the Mucomir Barrage, except in conditions where the level of Loch Lochy

drops below the Caledonian Canal minimum operating level, in which case the flow shall be equal to the inflow to Loch Lochy if this is less.

- 6.3.8 Loch Lochy also forms part of the Caledonian Canal which joins the loch at Gairloch and at Laggan locks. To that end Scottish Canals hold a CAR Licence for operation of the canal downstream of the Gairloch Locks.
- 6.3.9 The minimum navigable Loch Lochy level for the Caledonian Canal is 28.65 m AOD, whilst the spillway gates at Mucomir (Gairloch) begin operation at 30.33 m AOD. This gives a current maximum possible operating range for Loch Lochy of 1.68 m¹, which corresponds to a volume in excess of the 26 Mm³ required by The Proposed Development to store 30GWh of energy.
- 6.3.10 A CAR licence (CAR/L/1108419) was obtained by SSE in 2013 for the consented 600 MW Coire Glas Pumped Storage Scheme. This licence incorporates the requirements of the existing Mucomir Power Station CAR licence and the proposed 600 MW scheme into a single licence. A request will be submitted to SEPA to modify this licence to provide for the requirements of The Proposed Development (up to 1500 MW).
- 6.3.11 The catchment of the River Lochy just downstream of the existing Mucomir Barrage at Camisky is approximately 1,213 km², of which approximately 377.5 km² (~31%) is upstream of Mucomir Barrage and therefore can be considered to be the proportion of the overall surface water catchment which could be influenced by The Proposed Development.

6.4 Water Management and Pumped Storage Hydro

- 6.4.1 The aim of any water management strategy for a pumped storage hydro scheme is to ensure that the plant is able to operate in any mode at any time for as long as possible. From a water transfer perspective, this can be one of three principle conditions:
- Pumping mode - Transferring water from the lower reservoir to the upper reservoir;
 - Generating Mode - Transferring water from the upper reservoir to the lower reservoir; and
 - Standing By - i.e. no water transfer taking place.
- 6.4.2 The operation of The Proposed Development would take priority over the operation of Mucomir Power Station. Mucomir Power Station would be managed to ensure that the operation of The Proposed Development was not constrained by Loch Lochy levels. Ultimately the total volume of water passed through the barrage in a year would remain unchanged.
- 6.4.3 As part of the construction of The Proposed Development, Mucomir Power Station would be modified and a new operating regime determined. This would include obtaining all necessary consents and relicensing. It is possible, although to be determined at a later stage, that this modification may involve partially or completely decommissioning Mucomir as a power station and operating it solely as a regulating barrage and fish pass.

¹ Corresponding to a volume in excess of the 26 Mm³ required by The Proposed Development to store 30 GWh of energy

- 6.4.4 Modifications to Mucomir Barrage would generally comprise measures to allow more control of water level in Loch Lochy. When changes in flow were required these would be implemented gradually at rates to be agreed.
- 6.4.5 It is not intended to manage Loch Lochy outwith the existing level range imposed by the (Gairloch) spillway and the sill levels of the first locks at Gairloch and Laggan, although variation in Loch Lochy level within these limits is expected to be more frequent. It is not possible to construct accurate Loch Lochy level duration information at this stage as the operation of The Proposed Development would be in response to future electricity markets. Similarly, it is not possible to predict the level duration characteristic for the upper reservoir behind the new dam, which would vary by up to 64 m between approximately 494 mOD and 558 mOD.
- 6.4.6 Detailed water level and discharge predictions are not possible at this time, due to the reasons given above, and the Applicant would welcome a similar Condition of Consent to that attached to the Section 36 Consent for The Consented Development. That condition stated:

Prior to the Commencement of Development, the Company must submit details of any proposed modifications to the Mucomir Barrage and Power Station for approval in writing by the Planning Authority, who must consult SEPA. Details must include the proposed means of regulating flows into the River Lochy and details of any modifications proposed to the existing fish passage arrangements. The approved modifications must be implemented prior to the operation of the pumped storage hydroelectric generating station unless otherwise agreed in writing with the Planning Authority.

6.5 Compensation Flow in Allt a'Choire Ghlais

- 6.5.1 Compensation flow would be released at the foot of the upper dam. This is proposed as a constant Q95 compensation release for the catchment interrupted by the dam, as shown in Table 6.2: this would be confirmed and agreed as part of the revised CAR licence application.

Table 6.2: Proposed Compensation Flow

Catchment	OS NGR	Catchment (km ²)	Compensation flow (Litres/second)
Coire Glas Dam	NN 236 956	3.05	17

- 6.5.2 As this compensation flow would be fed from a relatively large storage volume it is proposed that it be a constant flow, even when natural conditions would drop below Q95.

6.6 Residual Flow in Allt a'Choire Ghlais below Dam

- 6.6.1 In addition to the compensation release described in Section 6.5, the extent to which the characteristics of the Allt a' Choire Ghlais return towards a natural shaped Flow Duration Curve [FDC] below the dam depends upon the size of the residual catchment between the dam and the reference point. By the top of the falls at Kilfinnan (approximate grid reference NN 270 966) at 2.75 km downstream, the impounded catchment represents approximately 30% of the total natural catchment to that point.

6.6.2 Although the dam would be fitted with a spillway for reservoir safety reasons, the small catchment and the large water abstraction capability make it extremely unlikely that the upper reservoir would reach spillway level. The residual flow regime downstream of the dam would therefore ordinarily be unaffected by spill events from the dam.

6.6.3 The Proposed Development would be designed with control systems which would prevent pumping once the upper reservoir is full. The spillway would therefore be designed to pass the naturally occurring extreme flood event (which would have occurred with or without The Proposed Development being present) required for reservoir safety reasons to ensure dam structure.

6.7 Abstraction and Discharge Rates and Volumes

6.7.1 The Proposed Development would both abstract and discharge water between the upper and lower reservoirs dependent upon operating mode. These flow rates are shown in Table 6.3.

Table 6.3: Proposed Abstraction and Discharge Flows

Location	OS NGR	Maximum Discharge (m ³ /s)	Maximum Abstraction (m ³ /s)
Lower Reservoir	NN 255 933	425	425
Upper Reservoir	NN 236 955	425	425

6.7.2 The maximum volume that could be transferred between the upper and lower reservoirs by the operation of The Proposed Development is 26 Mm³. Based upon an installed generation capacity of 1500 MW this would take 17-28 hours continuous operation at maximum output. This represents the maximum single transfer of water which The Proposed Development could physically perform.

6.7.3 This case results in a rate of change of level in Loch Lochy due to The Proposed Development of around 0.06 – 0.1 m/hour within the parameters discussed in Section 6.3 above.

6.7.4 An indicative maximum operational draw down of approximately 64 m is anticipated within the upper reservoir. For the purposes of assessment within this EIA Report, the assumed maximum water level within the upper reservoir would be 558.1 m OD and the assumed minimum water level would be 494 m OD. The upper reservoir rate of change of level would be on average between around 2 – 4 m/hour. These levels would be subject to detailed design.

6.7.5 The Proposed Development would be operated as a closed system, which means no water would be transferred outside the catchment.