MGT-541 Lake of Brienz Evaluation

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1.1 Stated-Preference Approach

To produce an informed estimate using this valuation approach, I leverage studies that value lakes comparable in the *services* they provide to both tourists and residents. The main services for Lake Brienz are grouped below according to the Common International Classification of Ecosystem Services (CICES) covered in class [1]:

- **Cultural / recreation (matches the "lakeside quality" bundle):** daily passenger shipping (BLS cruises, incl. paddle steamer), well-kept lakeside paths (e.g., Bönigen–Iseltwald; viewpoints near Ringgenberg), easy public access for walking, sitting, swimming; very clear, crystalline water that enhances the experience [2, 3].
- **Provisioning (minor locally):** small fishery ($\sim$ 10,000 kg/yr, mostly perch) sold regionally; high-quality raw water (drinking-water potential), as well as a water resource feeding nine hydropower plants [4, 5].
- **Regulating & maintenance:** (i) *Water-quality regulation* via effective wastewater phosphorus removal sustaining ultra-oligotrophic, clear water; (ii) *Sediment/turbidity regulation* as upstream reservoirs retain $\sim$ 230,000 t/yr of glacial fines, supporting transparency; (iii) *Habitat maintenance* of deep, cold waters for endemic whitefish ("Brienzlig") [4].

A closely related natural ecosystem is analyzed in [6], which studies Loch Lomond (Scotland). Given the similar attributes, services, area (roughly 30 km^2 vs. 70 km^2) and annual visitors [5, 6], I transfer the per-household annual WTP from that contingent valuation of *lakeside quality* (views, path quality, shoreline access) to Lake Brienz using an income-adjusted, exchange-rate conversion:

$$\mathrm{WTP}_{\mathrm{Brienz,\ CHF/yr}} = \mathrm{WTP}_{\mathrm{Lomond,\ £/yr}} \times \left(\frac{Y_{\mathrm{CH}}}{Y_{\mathrm{UK}}}\right)^{\varepsilon} \times \mathrm{FX}_{£\to\mathrm{CHF}}, \quad \text{then divide by 12 for CHF/month.}$$

where $\mathrm{WTP}_{\mathrm{Lomond}} = 12.06$ (lower bound) and 18.72 (model-predicted) and considering ε (range 0.3–1.0) is the *income elasticity of WTP*—it measures how WTP scales with income in a log–log sense—are taken from [6]. Moreover, I set set $Y_{\mathrm{CH}} = \$82{,}026$ and $Y_{\mathrm{UK}} = \$52{,}518$ (GDP per capita adjusted per PPP, 2024) [7, 8], giving $Y_{\mathrm{CH}}/Y_{\mathrm{UK}} = 1.562$. For currency conversion, we use the *average* October 2025 rate £1 = CHF 1.0703 [9]. $Y_{\mathrm{CH}}/Y_{\mathrm{UK}} = 1.562$.

Results (per household, per month).

$$\begin{aligned} 12.06 &\Rightarrow (\text{range CHF 1.23–1.68 for } \varepsilon \in [0.3, 1.0]), \\ 18.72 &\Rightarrow (\text{range CHF 1.91–2.61 for } \varepsilon \in [0.3, 1.0]). \end{aligned}$$

As a nearby resident and frequent user who particularly enjoys recreative services provided by the lake, I would state **CHF 4/month**, which is above the transferred average due to proximity and weekly use—both factors positively associated with WTP in [6]. This estimate is also aligned with similar studies [10].

Lake Léman (Geneva). I would pay **more**, $\approx$ **CHF 9–10/month**, because Léman provides the same cultural services *plus* a major provisioning service (drinking water for a large population) and supports heavier transport/tourism use, increasing both loss risk and replacement cost. It also serves a larger population, which raises the aggregated value.

(a) Lake Brienz

(b) Loch Lomond

(c) Lake Annecy

1.2 Revealed-Preference Approach

Similarly to the previous section, I draw on existing RP methods and add up distinct, non-overlapping services [10]. I adopt the following formulation:

$$V_{\mathrm{RP}} = \underbrace{CS_{\mathrm{recreation}}}_{\text{travel-cost transfer (per-visit CS)}} + \underbrace{PS_{\mathrm{boat}}}_{\text{producer surplus from tours}} + \underbrace{V_{\mathrm{hydropower}}}_{\text{resource-rent proxy}} + \underbrace{V_{\mathrm{fishery}}}_{\text{landed value}} .$$

Inputs (central case; all CHF/yr).

$$\begin{aligned}
\text{Visits (boat tours)} &: \ 496{,}000\ [5], \quad \text{adult price ticket} = 66 \text{ CHF } [11] \ \Rightarrow\ \text{revenue} = 32{,}736{,}000. \\
CS_{\mathrm{recreation}} &: \ \text{per-visit CS} = \textbf{CHF } 77.20 \text{ (Germany proxy; [12])} \ \Rightarrow\ \mathbf{38{,}291{,}200}. \\
PS_{\mathrm{boat}} &: \ \text{assuming margin } 25\% \text{ on revenue} \ \Rightarrow\ \mathbf{8{,}184{,}000}. \\
V_{\mathrm{hydropower}} &: \ 8.64 \text{ GWh } [13] \times 71.26 \text{ CHF/MWh } [14] \ \Rightarrow\ \mathbf{615{,}686}. \\
V_{\mathrm{fishery}} &: \ 10{,}000 \text{ kg } [3] \times 30 \text{ CHF/kg } \big(\text{retail } \approx 60 \text{ CHF/kg } [15],\ \text{ex-vessel } 50\%\big) \ \Rightarrow\ \mathbf{300{,}000}.
\end{aligned}$$

Total (central estimate).

$$\boxed{V_{\mathrm{RP}} \approx \textbf{CHF } 47{,}390{,}886 \ / \ \text{yr} \ \big(\approx \textbf{CHF } 47.4 \text{ million/yr}\big).}$$

Notes. (i) The CS transfer is applied only to boat-tour visits which consist the main recreational service provided on the lake, so it is a lower bound for total lake recreation. (ii) Alternatively, $CS_{\mathrm{recreation}} + PS_{\mathrm{boat}}$ could be replaced with an annualized *hedonic amenity* estimate as in [10]. (iii) $V_{\mathrm{hydropower}}$ uses a price-as-rent proxy; V_{fishery} uses a central ex-vessel share (50%) of the observed retail price (9 CHF/150 g ≈ 60 CHF/kg).

1.3 Cost-Based Approach

As a proxy for the cost to (re)secure Lake Brienz's water-quality services, I benchmark against the *Annecy ring-interceptor plus a central wastewater treatment plant* that intercepts and treats municipal effluents before discharge, thereby preventing direct pollution of the lake. By context, Brienz is already among Switzerland's cleanest lakes for particles thanks to modern wastewater management [16]: the new wastewater facility completed in 2023 cost **CHF 19 m**, but it replaced the 1980s plant that largely played a big role in removing nutrient (nitrogen) pollution [5, 17].

Therefore, for a like-for-like comprehensive safeguard, I transfer the Annecy intervention implemented by Intercommunal Syndicate of Lake Annecy (SILA): a headline investment of **€350 m** (reported as 2.275 bn FRF in 1976) that restored Lake Annecy's water quality [18, 19]. Annecy and Brienz have similar shoreline length and surface area [4, 20]; and— as Fig. 1c shows—look alike in shape and scale. Scaling by size and converting to CHF (ECB average € → CHF) yields a one-off CAPEX range of **CHF 0.33–0.36 bn** for an "Annecy-style" safeguard at Brienz.

Discount rate and horizon. To express this as an annual flow, following European Commission CBA guidance, I use a **3%** social discount rate (SDR) with sensitivity **2–5%**, and a **30-year** reference period for water/sanitation projects, adding a residual value for long-life assets (collectors/civils) [21, 22]. The annualized equivalent uses the capital-recovery factor,

$$\mathrm{CRF}(r, T) = \frac{r}{1 - (1 + r)^{-T}}, \qquad \text{Annualized CAPEX} = \text{CAPEX} \times \mathrm{CRF}(r, T).$$

At $r = 3\%$, $T = 30$, CRF ≈ 0.051; at $r = 3\%$, $T = 40$, CRF ≈ 0.043. Applying the latter (conservative long life [22]) implies **CHF 14.4–15.3 m/yr** for the above CAPEX range.

Bottom line. A defensible cost-based value for totally safeguarding Lake Brienz's water-quality service would be a one-off **CHF 0.33–0.36 bn** (Annecy-style), or **CHF 14.4–15.3 m/yr** when annualized at 3% over a long asset life, reported alongside a 2–5% SDR sensitivity.

References

[1] Roy Haines-Young et al. *Common International Classification of Ecosystem Services (CICES V4): Consultation Briefing Note*. Consultation briefing note. Paper prepared for discussion of CICES Version 4. Copenhagen, Denmark: European Environment Agency, July 2012.

[2] Brienzersee. *Welcome to turquoise Lake Brienz. Majestic world of mountain peaks and sparkling waterfalls*. URL: https://www.brienzersee.ch/en/ (visited on 10/20/2025).

[3] Yannick Stoldt. *Lake Brienz*. Chalet Anemone. URL: https://chalet-anemone.ch/lake-brienz/?lang=en (visited on 10/20/2025).

[4] Alfred Wuest, Markus Zeh, and Josef Ackerman. "Lake Brienz Project: An interdisciplinary catchment-to-lake study". In: *Aquatic Sciences* 69 (June 2007), pp. 173–178. DOI: 10.1007/s00027-007-0016-0.

[5] Mireille Guggenbühler. *All of a sudden, Lake Brienz was too clean for some*. Report. SwissCommunity — Swiss Review. Jan. 27, 2023. URL: https://www.swisscommunity.org/en/news-media/swiss-revue/article/all-of-a-sudden-lake-brienz-was-too-clean-for-some (visited on 10/20/2025).

[6] Craig W. McDougall et al. "Valuing inland blue space: A contingent valuation study of two large freshwater lakes". In: *Science of The Total Environment* 715 (2020), p. 136921. ISSN: 0048-9697. DOI: https://doi.org/10.1016/j.scitotenv.2020.136921. URL: https://www.sciencedirect.com/science/article/pii/S0048969720304319.

[7] TheGlobalEconomy.com. *Switzerland: GDP per capita, PPP*. Latest value (2024): $82,026 (source: World Bank). Accessed 20 Oct 2025. 2024. URL: https://www.theglobaleconomy.com/Switzerland/gdp_per_capita_ppp/.

[8] TheGlobalEconomy.com. *United Kingdom: GDP per capita, PPP*. Latest value (2024): $52,518 (source: World Bank). Accessed 20 Oct 2025. 2024. URL: https://www.theglobaleconomy.com/United-Kingdom/gdp_per_capita_ppp/.

[9] Exchange-Rates.org. *GBP to CHF Exchange Rate History for 2025 (Monthly Average, October)*. Average for Oct 2025: 1 GBP = 1.0703 CHF. Accessed 20 Oct 2025. 2025. URL: https://www.exchange-rates.org/exchange-rate-history/gbp-chf-2025.

[10] DRIN CORDA. *Valuation of Ecosystem Services of the Lake Ohrid Watershed: Valuing the Natural and Cultural Capital of Lake Ohrid — LOWMP Supplement II*. Enabling Transboundary Cooperation & Integrated Water Resources Management in the extended Drin River Basin. Global Water Partnership Mediterranean (GWP-Med); United Nations Development Programme (UNDP); Global Environment Facility (GEF); United Nations Economic Commission for Europe (UNECE), May 8, 2017.

[11] BLS Lake Cruise. *Fares — Tickets & Vouchers*. BLS Schifffahrt. URL: https://www.bls-schiff.ch/en/lake-cruise/tickets-vouchers/fares (visited on 10/20/2025).

[12] Tobias Börger et al. "The value of blue-space recreation and perceived water quality across Europe: A contingent behaviour study". In: *Science of The Total Environment* 771 (2021), p. 145597. ISSN: 0048-9697. DOI: https://doi.org/10.1016/j.scitotenv.2021.145597. URL: https://www.sciencedirect.com/science/article/pii/S0048969721006653.

[13] Industrielle Betriebe Interlaken (IBI). *IBI Produktionsanlagen — Strom*. Industrielle Betriebe Interlaken AG. URL: https://www.ibi.ch/strom/ibi-produktionsanlagen (visited on 10/20/2025).

[14] Energy-Charts.info. *Average electricity spot market prices in 2024*. Interactive map; last update 24/06/2025. Fraunhofer Institute for Solar Energy Systems (ISE). June 24, 2025. URL: https://energy-charts.info/charts/price_average_map/chart.htm?c=DE&interval=year&l=en&year=2024 (visited on 10/20/2025).

[15] Farmy. *Perch fillets with skin (La Perche L.O.E.)* Product page. Farmy AG. URL: https://www.farmy.ch/en/perch-fillets-with-skin-la-perche-loe?srsltid=AfmBOooKz94qRny4RqmoFmm7wGSZPj NRcmViv8p8ZGZ (visited on 10/20/2025).

[16] Ufficio federale dell'ambiente (UFAM). *Qualità delle acque dei laghi*. Dipartimento federale dell'ambiente, dei trasporti, dell'energia e delle comunicazioni (DATEC). URL: https://www.bafu.admin.ch/bafu/it/home/temi/acque/laghi/qualita-delle-acque-dei-laghi.html (visited on 10/21/2025).

[17] Radio BeO. *Neue ARA Brienz offiziell eingeweiht*. New Brienz wastewater treatment plant officially inaugurated. News article. Radio BeO. Oct. 29, 2023. URL: https://www.radiobeo.ch/neue-ara-brienz-offiziell-eingeweiht/ (visited on 10/21/2025).

[18] Bernard Barraqué. “L’eau du lac d’Annecy”. French. In: *Les Annales de la Recherche Urbaine* 30 (1986), pp. 24–33. URL: https://www.persee.fr/doc/aru_0180-930x_1986_num_30_1_1233 (visited on 10/21/2025).

[19] David Zetland. *How Annecy’s Lake got so pure*. Guest post; updated 2023-12-05. The one-handed economist. Dec. 1, 2023. URL: https://one-handed-economist.com/?p=4715 (visited on 10/21/2025).

[20] International Lake Environment Committee Foundation (ILEC). *World Lake Database — Lake Annecy (Display Item 3506)*. World Lake Database (WLDB). URL: https://wldb.ilec.or.jp/Lake/EUR-45/datalist (visited on 10/21/2025).

[21] Andreas Dietzel and Joachim Maes. *Costs of Restoration Measures in the EU Based on an Assessment of LIFE Projects*. JRC Technical Report EUR 27494 EN. JRC97635. Luxembourg: European Commission, Joint Research Centre (JRC), 2015. DOI: 10.2788/235713.

[22] Davide Sartori et al. *Guide to Cost-Benefit Analysis of Investment Projects: Economic appraisal tool for Cohesion Policy 2014–2020*. Luxembourg: Publications Office of the European Union, 2015. ISBN: 978-92-79-34796-2. DOI: 10.2776/97516.