Dear Professor Cloke

Thank you very much for taking the time to review our manuscript.

We implemented all suggested changes to the manuscript. As requested, the changes were marked in red. For ease of viewing the complete sentences were marked, rather than just the changed sections. The detailed list of adaptations may be found below.

We hope that the changes to the manuscript are to your full satisfaction and are very much looking forward to your decision.

Kind regards

Dr. Anne-Marie Kurth

Changes to the manuscript

- general grammar check (not marked in red)

- p. 1094, line 1: clarification of sentence: “In this study, we investigated whether river restoration was successful in re-establishing groundwater-surface water interactions in a degraded urban stream.”

- p. 1094, line 4: addition of information: “Restoration measures included morphological changes to the river bed, such as the installation of gravel islands and spur dykes, as well as the planting of site specific riparian vegetation.”

- p. 1094, line 7: omission of term “(near-)natural”: “Standard Distributed Temperature Sensing (DTS) and novel active and passive DTS approaches were employed to study groundwater-surface water interactions in two reference streams and an experimental reach of an urban stream before and after its restoration.”

- p. 1094, line 7: clarification of sentence: “Radon-222 analyses were utilised to validate the losing stream conditions of the urban stream in the experimental reach.”

- p. 1095, line 2: clarification of sentence: “This includes the recreation of a natural river morphology and the provision of habitats for native flora and fauna, while maintaining groundwater-surface water interactions.”

- p. 1095, line 7: references updated: “The latter, in particular, is of paramount importance with regard to the natural functioning of streams: the interaction between groundwater and surface water controls the availability of nutrients in the hyporheic zone (Fuller and Harvey

2000; Gooseff et al. 2002; Butturini et al. 2003), impacts water temperature (Bencala 2005; Hannah et al. 2009; Norman and Cardenas 2014) and quality (Boulton et al. 1998; Findlay 1995; Fuller and Harvey 2000; Trauth et al. 2015), and, thus, influences ecosystem functioning (Boulton et al. 1998; Malard et al. 2002; Thorp et al. 2006) and health (Wondzell 2011). ”

- p. 1095, line 11: removal of “worldwide”: “Many river restoration efforts focus on the re-establishment of longitudinal and lateral connectivity and appearance, rather than vertical connectivity (Mendiondo 2008; Filoso and Palmer 2011; Sudduth et al. 2011; Kurth and Schirmer 2014), a fact that might explain the often cited failure of river restoration with respect to ecosystem functioning (Louhi et al. 2011; Sudduth et al. 2011; Violin et al. 2011).”

- p. 1095, line 29: clarification and rephrasing of sentence: “We define hydrogeological success as an increase in vertical connectivity along the restored reach of the stream. This will be indicated by an increase in groundwater-surface water interactions, provided that groundwater and surface water were connected prior to anthropogenic interference. Ideally, a spatial variability in high and low exchange rates will be reached for the benefit of the aquatic ecosystems.”

- p. 1096, line 8: rephrasing of sentence: “Additionally, hydrogeological conditions were investigated in the vicinity of the restored stream reach, and losing stream conditions verified with Radon-222 analyses.”

- p. 1096, line 15: correction of “improves”, clarification of sentence: “Thus, we tested the hypothesis that the vertical connectivity, and therefore groundwater-surface water interactions, indeed improve after river restoration. We conclude with an outlook on the application of the described DTS measurement approach and recommendations for restoration practise based on our insights.”

- p. 1096, line 23: line break inserted; clarification of information: “The Urbach and the Röthenbach, thereby, are reference streams to evaluate whether the restoration of the Chriesbach recreated conditions resembling either a natural or a near-natural stream. ‘Natural’ and ‘near-natural’ thereby refers to the streams’ morphology and the groundwater-surface water interactions. Both parameters were tested prior to site selection following guidelines by the Swiss Federal Office for the Environment and by manually evaluating the temperature distribution in the streams, respectively.”

- p. 1096, line 25: clarification of sentence: “In spite of upstream hydropower production and the installation of stone crib walls as flood protection measures in the meadows, the Urbach has maintained its natural river morphology due to the extensive intermediate catchment between study site and the retaining lake of the hydropower production plant. Hence, it was selected as a reference for presumably natural groundwater-surface water interactions.”

- p. 1097, line 3: clarification of sentence: “Although having been lowered and straightened led to a rather uniform stream width, the Röthenbach still has a naturally varying water depth and flow velocities. The stream is impacted by diffuse manure inflow into the stream, by discharge of warm water from power production in a nearby sawmill and by a significant drawdown due to water abstraction in the surrounding areas in summer.”

- p. 1097, line 7: clarification of sentence: “Nevertheless, due to initial investigations of the water temperature distribution in the stream, groundwater-surface water interactions in the Röthenbach were assumed to be near-natural in winter.”

- p. 1097, line 9: addition of figure 2: “Hence, between 2006 and 2014, 900 m of the Chriesbach were restored: the channel was widened, shores levelled, and water depth and width varied (Fig. 2).”

- p. 1097, line 16: addition of information: “The study site of the Chriesbach investigated in this study was restored in the autumn and winter of 2013/2014.”

- p. 1097, line 25: clarification of sentence: “The DTS instrument then analyses the energy and the time of arrival of the elastically and inelastically backscattered photons, the so called Stokes and Anti-Stokes signal, and calculates the temperature for each section, e.g. every meter, of the glass fibre.”

- p. 1098, line 1: addition of reference: “It is generally assumed that the temperature of the fibre-optic cable equals the surrounding temperature (Tyler et al. 2009), e.g. the surface water temperature.“

- p. 1098, line 10: rephrasing of sentence: “In active measurements, on the other hand, the metal components of the fibre-optic cable, e.g. copper or steel wires, are heated by applying an electrical current through them (Read et al. 2014).”

- p. 1098, line 12: moving of cooling rate calculation to experimental section; clarification of sentence: “To avoid possible correlations between the temperature of the fibre-optic cable and the cooling rate of the fibre-optic cable in a way that warmer sections of the cable heat up more strongly, the cooling rate was investigated in the temperature range of 15.9 °C to 16.1 °C in steps of 0.1 °C”; addition of information: “Both active and passive DTS measurements were employed in this study.”

- p. 1098, line 24: reference to description of experimental procedure of radon measurements

- p. 1099, section 2.4, figure 1: we decided to keep the colour of the marking, as it is the easiest to read

- p. 1099, line 4: addition of information: “Both instruments were calibrated with the same procedure, including constantly stirred ice and a hot water baths and dispersion, slope and offset corrections. Additionally, post-measurement drift- and offset correction were applied.”

- p. 1099, line 9: addition of information: “Hobo TidbiTs® measurement intervals were matched to the DTS measurement integration time, i.e. 3 or 15 minutes.”

- p. 1099, line 15: clarification of information: “All measurements in the Urbach and the Röthenbach were passive measurements. At the Chriesbach site measurements were passive before (2013) and after restoration (2014), and active after restoration (2014).”

- p. 1099, line 20: addition of information: “The PAB approach is a new method for the detection of groundwater-surface water interactions in losing stream conditions (Kurth 2015). The periodic heating of the buried fibre-optic cable provides an insight into the spatial distribution of surface water infiltration into and groundwater exfiltration out of the stream bed.”

- p. 1099, line 24: addition of heating parameter: “During active measurements, the metal components of the fibre-optic cable were heated with a current of 10 A (2.48 W/m) for 30 minutes twice a day.”

- p. 1099, line 28: addition of figure 6: “Measurements in the Urbach were performed with the fibre-optic cable being passed through three areas: a side channel (cable sections 140 m to 188

m), a drainage ditch draining the surrounding meadows (cable sections 194 m to 266 m), and the main channel of the Urbach (cable sections 269 m to 327 m) (Fig. 4)."

- p. 1100, line 2: rephrasing of sentence: "The drainage ditch was measured to provide insight into the local groundwater temperature, as it was assumed that it was mainly fed by groundwater that day."

- p. 1100, line 4: rephrasing of sentence: "At the Chriesbach site, groundwater temperature and the groundwater level were measured every 15 minutes with an temperature logger (STS Switzerland®) situated in in around 3 m depth of a piezometer situated next to the investigated reach of the stream."

- p. 1100, line 5: addition of figure 3: "For passive measurements at the Urbach, the Röthenbach and the Chriesbach prior to its restoration, the fibre-optic cables were fixed on the streambed; for passive (P) and active (A) measurements at the Chriesbach after restoration the fibre-optic cable was buried (B) with a plough at a depth of about 0.4 m within the streambed (PAB approach) (Fig. 3)."; "At the Chriesbach site, groundwater temperature and the groundwater level were measured every 15 minutes with an temperature logger (STS Switzerland®) situated in around 3 m depth of a piezometer situated next to the investigated reach of the stream (Fig. 3)."

- p. 1100, line 10: addition of information: "Groundwater samples were also taken from piezometers at the restored site with a Gardena® jet pump with a pumping rate of 0.9 L/s. [...] Samples were taken early in the morning to prevent warming and degassing of the samples in the tubing. The tubing was checked for bubble formation prior to sampling."

- p. 1100, line 18: definition of the term "temperature profile": "Hereby, the term temperature profile describes the longitudinal temperature distribution along the investigated section of the stream."

- p. 1102, line 16: unit changed from °C to K: "The heating of the fibre-optic cable caused a rise in cable temperatures of between 1.3 °C and 1.6 K, depending on the initial temperature of the cable."

- p. 1102, line 25: addition of information: "Radon-222 activities in the Chriesbach ranged between 0 Bqm^{-3} and 1103 Bqm^{-3}. In the nearby piezometers Radon-222 activities were significantly higher with values ranging between 3482 Bqm^{-3} and 5037 Bqm^{-3}. Sample 5.1 had the highest Radon-222 activity of all surface water samples. However, this result could not be verified in a second sampling campaign."

- p. 1103, line 14: addition of information: "These effects are always localised and are either detected during regular cable checks or, at the latest, during removal of the fibre-optic cable."

- p. 1104, line 10: clarification of sentence: "In case of the Chriesbach, the results indicate that there was no groundwater upwelling in the investigated section of the stream, as the surface water temperature of the Chriesbach was ca. 2 K below the groundwater temperature and strongly varied with the daily temperature fluctuations."

- p. 1105, line 15: addition of information: "As the fibre-optic cable was only inserted in one of the gravel islands no conclusions may be drawn as to the surface water downwelling in the other gravel islands."

- p. 1105, line 17: splitting of sentence: "Success evaluations in river restoration are increasingly being employed to test whether restoration measures were successful in

improving conditions for the ecosystem. Hydrogeological success, which influences ecological success as well, however, is not routinely investigated."

- p. 1105, line 20 ff: reduction of enthusiasm; addition of information: "We therefore examined hydrogeological success, i.e. groundwater-surface water interactions, before and after the restoration of an urban stream and compared results to streams in natural and near-natural conditions. Results indicated that in the Chriesbach, groundwater-surface water interactions after restoration increased due to the installation of gravel islands. Additional analyses of the data in the future may allow estimates of the actual flux sizes of surface water downwelling into the gravel islands."

- p. 1105, line 25: removal of superfluous information: "Although our results were site specific, it may be assumed that the installation of gravel islands, riffle-pool sequences and other in-stream structures generally improve groundwater-surface water interactions."

- p. 1108: addition of reference: "KURTH, A.-M., 2015. Investigation of Groundwater-Surface Water Interactions with Distributed Temperature Sensing (DTS). Ph.D. thesis, University of Neuchâtel."

- p. 1111, table 1: exchange of "further away" to "2.5 m away"

- p. 1113 ff: removal of shading from figures 5 - 9 (former figures 2 – 6)

- p. 1113 ff.: increasing of font size for better legibility (figures 5 – 9)

- p. 1115, figure 7: blacking-out of irrelevant data