Amendment – Flora and Fauna Assessment:

'Responsible water management by beneficially reusing recycled water from the Selwyn Wastewater Treatment Plant'. Response to draft conditions for DA 23/2747

Introduction

As a result of the 2020 wildfire in the central parts of Kosciuszko National Park (KNP), Selwyn Snow Resort (SSR) lost most of the infrastructure associated with visitor facilities and resort operations. Since that event the company has rebuilt the resort including staff accommodation, operation centre, guest facilities, augmented the water supply, upgraded the snowmaking infrastructure and completed the sewage treatment plant (STP). Prior to the wildfire, the resort used to have a wastewater pump out system to accommodate grey water and effluent management. However, with the advent of the new STP, several options were considered to deal with treated wastewater, with the preference to:

> *recycle for reticulation in resort snowmaking operations following dilution with freshwater from Clear Creek and storage in the former quarry dam at the top of the resort. A variation to this proposal is the hybrid arrangement for partial reuse for reticulation of resort facilities (i.e., toilets) and the manufacture of snow using treated effluent.*

Several dilution and water quality studies were conducted as part of the original assessment following discussions among Department of Planning (DoP), National Parks and Wildlife Service (NPWS) and Environment Protection Authority (EPA). In February 2023 the author of this amendment also contributed an ecological assessment that appraised threatened entities under the *Biodiversity Conservation Act 2016* (BC Act), the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the *Fisheries Management Act 1994* (FM 1994). The author understands that a 'conditional approval' was granted to SSR for a limited operation during the 2023 snowseason, but several issues needed to be addressed before a longer-term approval would be granted by DoP and supported by EPA and NPWS. One of those elements for further assessment, this amendment, included a review of two threatened entities following the consideration of additional information from an updated dilution study to account for direct application impacts not addressed in the original flora and fauna report. NPWS have also requested a Vegetation Monitoring Program be established and conducted annually as part of the request for further information. The author understands that SSR intend to prepare and conduct that component prior to the 2024 snowseason.

The approach to this amendment has been to address the issues raised by NPWS in a correspondence email to DoP (15/11/2023) and shared by DoP with SRR (20/11/2023). The original flora and fauna assessment report is referenced as part of this amendment, and the author assumes the reader will have knowledge or access to the original document, except where new discussion or previous information has been reiterated for the purpose of the amendment.

Proposal Adjustment

At the time the flora and fauna assessment was conducted, discharged treated effluent was assumed to meet state and national licence conditions, standards and guidelines pertaining to the receiving environment and human health. A major premise to the appraisal was the inclusion of recycled water into snowmaking and discharge across the slopes during the snowseason. With the lack of targeted field survey time and effort to account for the presence or absence of threatened entities, most of the discussion pertained to the overlap of species based on 'assumed' presence, knowledge of relevant habitat and behaviour of those entities, and discharge as part of snowmaking operations including timing, reticulation areas and assumed consequences for increased concentrations of nutrients into Clear Creek and absorption into soils. Some of the discussion scenarios expanded on the circumstances where nutrients were above the conditioned thresholds, accumulation of nutrients in the soil, and as a result of catastrophic failure (unmanaged discharge).

The correspondence by NPWS on 20/11/2023 stated that '*…it is not clear where the Flora and Fauna Report considers direct application and we note that the report was prepared based on the original dilution study which has since been updated to consider direct application*.' The author of the report and this amendment agrees that the line of discussion was based on snowmaking application and not direct irrigation following the snowseason or when the snowseason was curtailed to a shorter period than expected. This is an important element to reconcile as some of the species such as threatened reptiles, if present, may still be in brumation during the winter snowseason, but less likely after all snowmelt has taken place or aroused earlier due to warmer weather.

Matters to Reconcile

NPWS have used 'internal species experts' to streamline the amendments to reconcile for a longer-term approval. This has precluded the need for additional survey work but requires the report to address the entities identified by NPWS where direct application may result in impacts to alpine she-oak skink (*Cyclodomorphus praealtus*) and broad-toothed rat (*Mastacomys fuscus*). A third threatened entity, alpine tree frog (*Litoria verreauxii alpina*) was also listed but NPWS experts concluded that the presence of this species was unlikely and that amendment and future monitoring for this species was not required.

The three above mentioned threatened species and the threatened ecological community *Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions* were four threatened entities identified by the author in the original flora and fauna assessment that were filtered from a table of 30 threatened candidates (p. 14) for consideration against criteria in the Test of Significance (ToS). The table of candidates were in turn appraised from 72 entities filtered from a database literature review.

The amendment has only addressed the request by NPWS for the species and activity of concern, though the author recognises the brevity of the assessment to detect the presence, or refute with more confidence the absence, of threatened flora and fauna possibly occurring in the area. The author also recognises the major ecological upheaval and recovery following the 2020 wildfire upon the landscape in and around SSR and the affects this will have on threatened species in the area.

Alpine She-oak Skink (*Cyclodomorphus praealtus*)

For the original assessment, rudimentary surveys were conducted for alpine she-oak skink (and mountain skink *Liopholis montana*), but a single survey effort that also focused on other entities across a large area was never going to be adequate to discount the presence of this threatened reptile. Though no records are published for this species in or adjacent to SSR, habitat elements including a mix of optimum and sub-optimum opportunities were identified, though most in a post-fire stage of recovery. Nevertheless, discussion on impacts assumed presence with most impact discounted due to snowmaking discharge and species behavioural activity occurring at different times. This was considered 'direct impact'. The two key elements being considered were potential nutrients and toxins. Further discussion identified the possibility of nutrient accumulation and the potential consequence of habitat change due to the diverse range of introduced plant species increasing in biomass compared to native flora (secondary impacts). To reiterate, the circumstances were based on supplementary snowmaking during the snow season, and incidents if nutrients and toxins were not managed to prescribed levels as proposed for recycled water discharge.

On the premise that reticulation discharge may also occur outside of the snowseason but not discharged as snowmaking per se (but discharged across the same areas and using the same infrastructure), the proposal may subsequently overlap with alpine she-oak skink activity when this species in not in brumation. There is not a lot of literature on the interaction of reptiles and nutrients (e.g., nitrogen and phosphorus) and metals (e.g., aluminium, boron and cadmium). However, reptiles can absorb elements and compounds through the skin and therefore toxins cannot be totally excluded from harm to any reptile species, particularly if concentrations are high. That said, non-threatened reptiles that are exposed to many nutrients including chlorinated water in built-up landscapes, would suggest a degree of resistance and persistence by animals in these environments, and a sensitivity not overly apparent to have attracted major studies of these interactions. The same may or may not be true for metals such as boron and cadmium that can be toxic in certain concentrations to vertebrates including people. Some reptile keepers use tap water that can include fluoride, chlorine and chloramines, along with the metals that leach from holding tanks and pipes. The general consensus within the herpetological fraternity (and assumed veterinarian professionals) is to refrain from this practice, but many people continue and there's little to suggest there are dire consequences. That said, the previous discussion does not justify any abandonment of concern for direct nutrient exposure to reptiles, but rather communicates a degree of uncertainty and that the author believes the risk of harm to alpine she-oak skink (and other reptile species) due to direct exposure to reticulation when the discharge recycled water parameters are being met, is likely to be low. It also communicates a statement of uncertainty that if the discharge parameters are above prescription levels including a catastrophic discharge that in the unlikely event would circumvent all the operational procedures that are designed to prevent discharge beyond acceptable levels, then the outcome of direct impact is also unknown.

Notwithstanding doubt about the impact of nutrients and toxins on reptiles, NPWS main concern from direct application of the effluent recycling scheme upon alpine she-oak skink is an increase in non-native vegetation cover, weed density and weed species. The author also raised this in the original flora and fauna assessment (p. 22 - 23) for residual accumulation or catastrophic failure during snowmaking reticulation where '*the consequence of increased nutrients to the environment could be expressed in a greater composition and density of introduced species*.' An increase in non-native species cover and density could result in habitat change that does not support alpine she-oak skink or diminish the existing opportunities and potential life-cycle requirements to persist at SSR. The interpretation of diminished opportunities and requirements inferred to other ecological changes such

as prey availability and abundance. Habitat change could have significant impact upon alpine she-oak skink where the species prefers tree-less or very lightly treed areas that contain tussock grasses, low heath or a combination or both. These habitat elements (as reported in the original assessment) are present at SSR, with habitat opportunity least commensurate at the top of the resort where slope grooming and other operation activities are most intense, but generally improves further down respective slopes where there is also a greater occurrence of native species.

The concern for an increase in distribution, abundance and structure of introduced flora and subsequent habitat change emanates from the high representation of exotic species already present across the ski slopes that includes noxious weeds such as **Hypericum perforatum*, **Achillea millefolium* and **Leucanthemum x superbum*, but also the highly invasive introduced perennial grasses of **Dactylis glomerata*, **Holcus lanatus*, **Phleum pratense*, **Anthoxanthum odoratum*, **Agrostis capillaris*, **Festuca stolonifera* and **Festuca arundinaceae*. These and many other introduced species are known to be responsive to an increase in nutrients and can alter the ground cover structure and stratum to a more dense and taller vegetation layer compared to native tussocks with inter-tussock spacing that is favoured by alpine she-oak skink.

Detrimental impacts upon alpine she-oak skink are premised on the species being present at SSR and assumes that any nutrients from recycled water reticulation are absorbed into the soil, are available in a form that can be used by plants, and of a concentration that is beneficial to such plants that enhances growth and biomass beyond the background levels currently available across the area. However, whether thresholds of nutrient availability and uptake results in an increase in cover, density and distribution of introduced plants, can only be addressed through a peer reviewed monitoring regime. The STP Dilution Study by Advisian identified a 'Sewage Treatment Plant Receiving Environment Monitoring Program' which focused on the receiving environment of water and soil. Although these two receiving environments are still an appropriate monitoring medium to identify nutrient and toxin concentrations and accumulations overtime against discharge parameters, NPWS have identified that a separate monitoring program needs to be established to see if the said concentrations and accumulations (if any), are responsible for an increase in introduced species, independent of the prescribed discharge parameters being exceeded. The author understands that SRR will prepare (or have prepared on its behalf) a Vegetation Monitoring Program to the satisfaction of NPWS. This was communicated in the same correspondence dated 20/11/2023 by NPWS that required the amendments to the flora and fauna report. The author understands that the report and initial fieldwork will be furnished by SRR to NPWS prior to the effluent recycling scheme becoming operational in 2024.

To account for the update to Table 1 (p.15) and Appendix 3 – Test of Significance against criteria 'C' (p.38) as it pertains to alpine she-oak skink, the paragraphs are now to be read as:

> *During the winter snow season when recycled effluent is reticulated to supplement snow making across SSR, alpine she-oak skink is unlikely to be directly impacted by diluted effluent dispersal as discharge and snowmelt would occur before the species arouse from brumation. However, there may be a direct application of the scheme and interaction with alpine she-oak skink if reticulation were to occur independent of snow making such as at the end of the snowseason when there was no snow on the ground and animals had aroused from brumation and active across or adjacent to discharge areas. The consequences of such direct interaction are unknown, but general reference to reptile exposure to pollutants in a range of domestic and urban environments does not rally a major concern in the literature by reptile*

keepers and professional herpetologists. However, the consequences for increased nutrients in an environment where introduced plants are prevalent is better understood. An increase in nutrients may result in an increase in introduced plant cover and density, and possibly an increase in introduced flora. This has ramifications for habitat change, particularly for ground dwelling species such as alpine she-oak skink. An increase in nutrients that results in a change in vegetation structure and stratum, and subsequently habitat change to the detriment of threatened species, is difficult to evaluate against natural and/or existing background levels unless subjected to a peer reviewed vegetation monitoring program. As part of a conditional approval, a long term vegetation monitoring program will be established to monitor weeds that may flourish in response to nutrients that may emanate from the effluent recycling scheme, that in turn may impact on habitat critical to alpine she-oak skink. A vegetation monitoring program will be in addition to the monitoring of water and soils as part of the discharge receiving environments.

Broad-toothed Rat (*Mastacomys fuscus*)

Detection of broad-toothed rat is relatively easy in the field by the presence of unique scats, being grass-fibrous textured with occasional graminoid seeds, and olive-green when fresh and paling to straw-yellow when older and desiccated. The characteristic scat means that the species do not need to be observed or trapped to indicate presence. Broad-toothed rat also use runways that are easily identifiable when surveying for this species through ground vegetation and low-heath.

Broad-toothed rat was detected in a previous assessment by the author that was part of post-fire infrastructure reconstruction within SSR. Several relatively fresh scats were found approximately 70 m south of the pump house on Clear Creek in 2020. The vegetation was in a very early phase of post-fire regeneration, but the recording was very important to account for the survivorship of animal(s) after an extremely intense wildfire. The species was again detected for this proposal approximately 50 m downstream from the bottom of Race Course ski slope. Three years after the January 2020 wildfire, much of the graminoid vegetation aligning Clear Creek, along adjacent drainage lines and across floodplain areas, had attained pre-fire heights. In some fire-affected woodland vegetation, grasses were very dense and high (1.5 m to 2 m including the culms and inflorescence), though these areas are less allied to broad-toothed rat habitat. To reiterate, broad-toothed rat live in a complex of runways through dense vegetation of wet grass, sedge, or heath, and under the snow in winter. Sheltering nests of grass are built in the understorey or under logs, where two or three pups are born in summer. Food is mostly gathered at night in summer and autumn, and during the early evening in winter. The diet consists almost solely of grasses and sedges, supplemented by seeds and moss spore cases.

In the flora and fauna assessment, the author suggested it was unlikely that any faulting effluent treatment and subsequent dispersal would have a toxic impact upon any mammal species because of the dispersed nature of the process, but doubt was still communicated in the report (p.36) due to the lack of relevant literature. However, terrestrial fauna impact, if any, is most likely through a consequence of habitat change. Unmanaged or faulting effluent processes may increase nutrients in the environment (p.11 and p.36). Most introduced species and native ruderals would take advantage of extra nutrients leached into the soil, however, there may also be some thresholds where excess nutrification could impact vegetation through changes in soil biota and pH values.

There is uncertainty as to direct impacts upon broad-toothed rat, as it is for alpine she-oak skink, by nutrients and toxins associated with recycled effluent discharge water. However, for the same reasons pertinent to alpine she-oak skink addressed above, NPWS consider the greatest risk to broad-toothed rat from the effluent recycling scheme is an increase in non-native vegetation cover, weed density and weed species. This is consistent with the author's opinion as per p.11. In the original report, the appraisal of potential impacts upon biota was premised on recycled effluent water being released during the winter snowseason to supplement snowmaking capacity, and subsequent interactions of known or potential occurrence of threatened entities within the irrigation area and/or receiving environment. Because broad-toothed rat does not hibernate during winter with foraging tending to be subniveal and overall movements less active during the snowseason, the appraisal considered the species' interaction and habitats in relation to the snowmaking irrigated area and downslope drainage. The receiving areas were groomed slopes that are consider negligible broad-toothed rat habitat as the vegetation tends to be slashed during summer and the snow compacted in winter by oversnow machines. As a consequence potential habitat is removed, and without structure, the subnivean space cannot form and provide winter cover. In contrast, the adjacent woodland and riparian vegetation provides enough elevated ground vegetation including shrubs and large graminoid tussocks (e.g., *Carex appressa*, *Poa helmsii* and *Poa labillardierei*) to maintain a network of space and thoroughfares underneath the snow. In this latter habitat, broad-toothed rat may be present and influences of excess nutrients were discussed in this context.

The interaction between broad-toothed rat and direct impacts (i.e., exposure to nutrients and toxins) and secondary impacts (i.e., risk of nutrients entering the soil and increasing the biomass of introduce plants and possibly invoke habitat change), was discussed in the context of the treated effluent being recycled and delivered as part of winter snowmaking. However, the circumstance of delivery now includes potential reticulation during winter when there is no existing snow cover, or at the end of the season in the absence of snow, but also at a time when many threatened entities such as broad-toothed rat are active within or adjacent to the discharge environment. In this scenario, as it was discussed for alpine she-oak skink, there is no change to the uncertainty as to how nutrients and toxins may harm broad-toothed rat. However, where reticulation is not part of any snowpack and subsequent snowmelt, the risk of direct application to the receiving environment during the warmer months could result in increased nutrients that favour introduced plant species. To reiterate what was stated above, this is premised on the species being present and assumes that any nutrients from recycled water reticulation are absorbed into the soil, are available in a form that can be used by plants, and of a concentration that is beneficial to such plants that enhances growth and biomass beyond the background levels currently available across the slopes and adjacent areas. However, whether thresholds of nutrient availability and uptake results in an increase in cover, density and distribution of introduced plants, can only be addressed through a peer reviewed monitoring regime. As part of a longer-term approval for the proposed work, a Vegetation Monitoring Program will be prepared where a report and initial fieldwork will be furnished by SRR to NPWS prior to the effluent recycling scheme becoming operational in 2024.

Therefore, to account for the update to Table 1 (p.15) and Appendix 3 – Test of Significance against criteria 'C' (p.38) as it pertains to broad-toothed rat, the paragraphs are now to be read as:

> *During the winter snow season when recycled effluent is reticulated to supplement snow making across SSR, there is a degree of uncertainty to how any nutrients and toxins would affect, including harm, broad-toothed rat. Unlike many threatened entities in the Selwyn area that hibernate, brumate or migrate for winter, broad-toothed remain active, albeit less so than during*

the non-winter months and often in the subnivean space that is formed between the snowpack and the ground. For most areas at SSR, broad-toothed rat habitat is allied to native vegetation areas adjacent to the ski slopes as the slopes are slashed in summer and compressed by snow grooming in winter, which precludes habitat opportunity in these areas.

However, there may be a direct application of the scheme and interaction with broad-toothed rat if reticulation were to occur independent of snow making such as at the end of the snowseason when there was no snow on the ground. Broad-toothed rat is unlikely to occupy the ski slopes that are manipulated in both winter (i.e., snow grooming) and summer (i.e., slashing), but the areas adjacent that may also be occupied by broad-toothed rat may receive reticulated spray and run-off. If that is the case, then the consequences of such direct interaction with nutrients and toxins is still uncertain in the non-snow season as it is if reticulated as part of supplementary snowmaking in winter. That said, the consequences for increased nutrients in an environment where introduced plants are prevalent is better understood. An increase in nutrients may result in an increase in introduced plant cover and density, and possibly an increase in introduced flora. This has ramifications for habitat change, particularly for ground dwelling species such as broad-toothed rat. An increase in nutrients that results in a change in vegetation structure and stratum, and subsequently habitat change to the detriment of threatened species, is difficult to evaluate against natural and/or existing background levels unless subjected to a peer reviewed vegetation monitoring program (as requested by NPWS). The methodology including stratification for such a monitoring program would need to consider reference or control sites, the effects (or implications) of the post-fire vegetation, and representation of habitat and niche likely to be occupied by broad-toothed rat compared to those areas allied to alpine she-oak skink.

This amendment now considers direct application of diluted recycled treated effluent water if discharged during non-snowmaking operations across the ski slopes at SSR, both during and after the winter season. The amendment has focused on the risk of an increase in weed density and distribution and subsequent impact to habitat allied to alpine she-oak skink and broad-toothed rat; the former assumed present and the latter detected by the author for the current and a previous assessment. A pending Vegetation Monitoring Program will be established to identify if discharged recycled water is responsible for a change in weed presence with potential consequences for habitat change.

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