AFTER-USE PLAN OF UNGURI PEAT PRODUCTION SITE

(PROJECT NR 23/4345)

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INTRODUCTION

SIA Unguri (aaddress Cēsu nov., Raiskuma parish, "Ungursalas", LV-4146, Latvia, registry code 49503002863) owns mining permit AP23ZD0044 (previously 8/45; permit number in information system KS-16807; valid until 13.03.2036) for peat production on Unguri peat production site. The peat production site will not be completely exhausted by the current validity end of the licence Unguri peat production site is in Cēsu county on territory of Raiskuma parish, on cadastrial units 42740100128, 42740100151, 42740100152, 42740100156, 42740100158, 42820100041, 42820100056, 42820100057 and 42820100061. Total area of site is 483.16 ha (permit area) and rental area is 559.07 ha.

Unguri site is completely prepared for peat production, drainage network, roads and fields are established. In Unguri peat production site, milled and block peat is produced. The main work phases for milled peat are milling, harrowing, and collecting peat with vacuum harvesters. Collected peat is stored in stockpiles. Block peat is produced by cutting peat with extraction cutting box. Peat blocks are left drying on the surface of the field overwinter. When block peat is dried to required moisture content, peat blocks are stored on wooden pallets and covered. Peat production period lasts usually from May to September.

This document, the after-use plan, was made according to the requirements in the mining permit AP23ZD0044, Gauja Nature Area protection plan (2023-2035) and Steiger Engineering fieldwork (07 – 09.11.2022) results. The purpose of this after-use plan is to assess the after-use possibilities in Unguri peat production site, and preferably re-create suitable conditions for the regeneration of the mire communities thus supporting the protection goals of Gauja Nature Area protection plan. The owner of the mining permit and the lessee of the land (i.e. the company SIA Unguri) is obliged to reclaim the Unguri peat production site and cover the related costs. The after-use of mining areas, including peat production areas, is based on the legislation in force in the Republic of Latvia. The engineering of after-use should be done as part of technical after-use project and must include detailed survey of ground height and modelling of water flow and estimations of groundwater level heigh after restoration.

1. THE AFTER-USE DIRECTION AND THE CURRENT SITUATION

Unguri peat production site (483.16 ha) cadastral units (42740100128, 42740100151, 42740100152, 42740100156, 42740100158, 42820100041, 42820100056, 42820100057 and 42820100061) belong to the state. The surrounding cadastral units are mainly state owned in the western edge of the Unguri peat production area and cadastral units covered with peatlands in natural state which are located east from the Unguri peat production site. Rest of the cadastral units surrounding the Unguri peat production site are privately owned. The ownership of the surrounding areas is important to prepare mitigation measures when raising the water levels on restoration areas to not harm valuable forest and agricultural lands on private units. Unguri peat production area is surrounded by peatland (mostly near-natural; including peatland forests) and forest ecosystems (dominated by *Betula pubescens, Picea abies,* and *Pinus sylvestris*) and lake Ungurs from the north. The peat production site and surrounding areas are articulated due to many mineral islands in the area.

The peat production method also affects the reclamation planning of the site. In the Unguri peat production site, currently block-cutting (about 30 % of area) and peat milling (about 60 % of area) are used (figure 1). Block-cut areas are mainly in the edges of the Unguri peat production site where peat layer is shallower (figure 2). It is possible that due to market situation and labor availability, the proportions between the peat extraction techniques can change. After peat milling, relatively flat areas will be left with field ditches (figure 3) whereas after block-cutting trenches that are bordered with baulks (where peat stacks are put to dry) are left. The application after-use option, incl. its success also somewhat depends on the peat production method. For example, several studies confirm, that the peatland vegetation recovery is more rapid in block-cut areas (especially in trenches) than in milled areas (Lavoie & Rochefort, 1996; Lavoie et al. 2003; Triisberg et al. 2011).

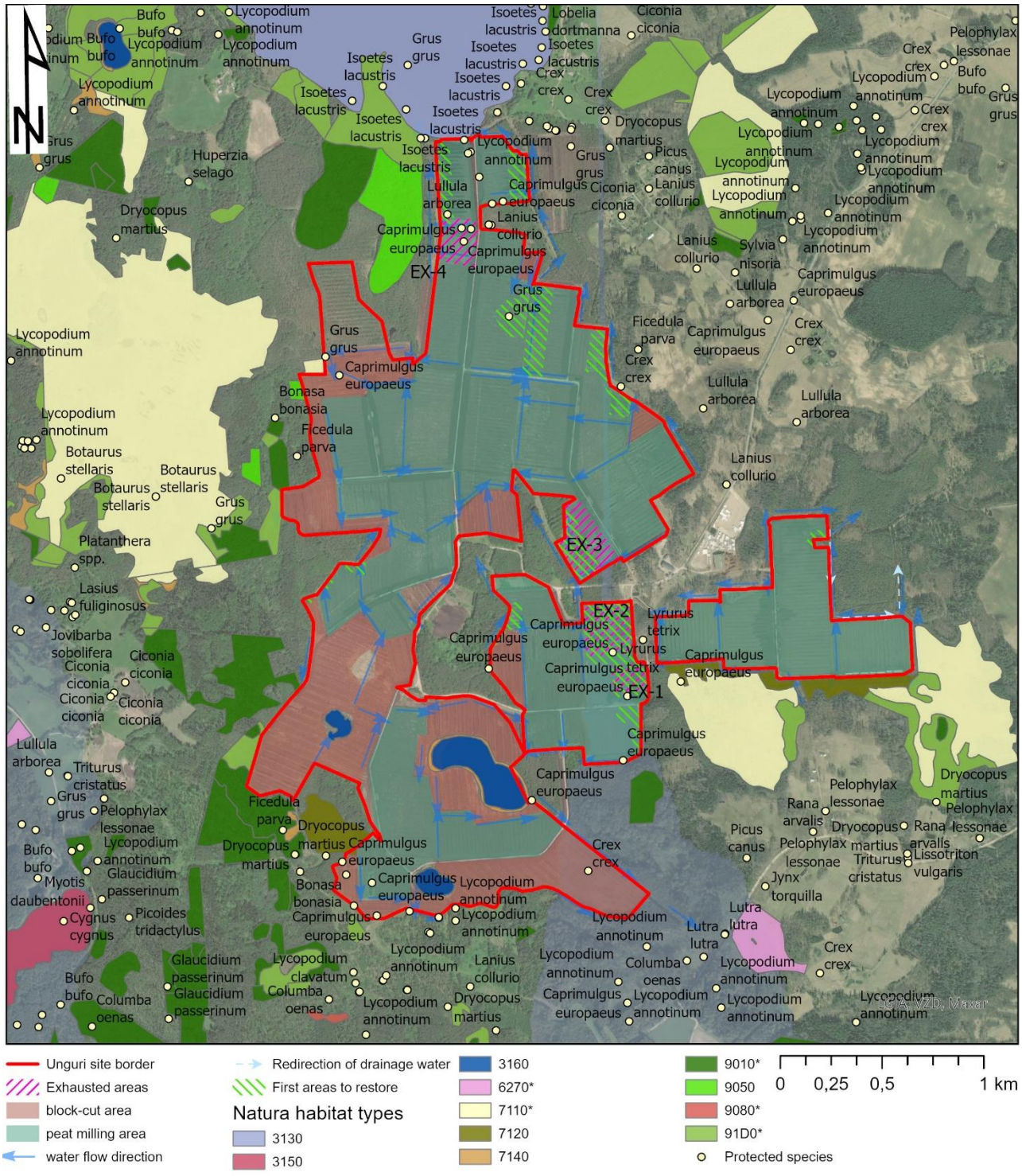

Figure 1. Existing situation in Unguri peat production area

Figure 2. Example of block-cutting in the western part of the Unguri peat production area (STEIGER Engineering, 08.11.2022)

Figure 3. Example of peat milling area in the eastern part of the Unguri peat production area (STEIGER Engineering, 07.11.2022)

During the preparation of the after-use plan, any protected species, and habitats on and site should be considered. There are several locations of *Lycopodium annotinum* around the Unguri peat production area, which typically grows in (drained) peatland forests. Several protected bird species have been registered in the Unguri peat production area (*Lullula arborea*, *Crex crex*, *Lyrurus tetrix, Grus grus*, *Bonasa bonasia* and *Caprimulgus europeaus*). *L. arborea, C. crex* and *G. grus* are species often found in open habitats. *B. bonasia* and *L. tetrix* use open habitats near forests for lekking grounds, and nests in dense spruce-mixed forests (*B. bonasia*) and or primarily deciduous forests (*L. tetrix*). *C. europeaus* is species often inhabiting drainage impacted peatland forests. In lake Ungurs, several locations of *Isoetes lacustris* and *Lobelia dortmanna* have also been registered. Those water plants grow in mildly acidic nutrient-poor lakes with sandy or rocky bottom. The habitats of these species should be considered during planning of restoration.

The environmental permit AP23ZD0044 and the lease agreement of the cadastral units of Unguri peat production site do not indicate the desired after-use direction of the site. General directions for peat production site after-use are restoration of peatlands, afforestation, establishment of a water body, or agricultural crop cultivation. More specific after-uses are also possible. According to the law "Par zemes dzīlēm" §86, the direction of the after-use should be agreed with the local municipality. SIA Unguri has agreed with the local municipality to restore the mire habitats ("Par zemes dzīlēm" §91.1) in Unguri peat production site. This reclamation direction is also supported by the Nature Conservation Agency (Dabas aizsardzības pārvalde, DAP) in its 22.09.2022 letter no 3.15/5173/2022-N to SIA Unguri, according to which the after-use to mire habitats should be prioritized in Unguri peat production site if it is technically feasible.

There are four parts of the Unguri peat production site where revegetation has already started, with approximate total area of about 16 ha (figure 1):

- EX-1 (figure 4; area about 2,5 ha): no suitable water body for measuring pH and electrical conductivity (EC). Not mowed. EX-1 is dominated by grass layer (*Eriophorum vaginatum, Calamagrostis canescens, Juncus conglomeratus, Carex spp*.), whereas small spots of brown mosses (*Warnstorfia exannulata*, *Pleurozium schreberi*) are also present.

Surrounded by birches (*B. pubescens*), spruces (*P abies*), and pines (*P. sylvestris*) and willows (*Salix spp*.).

- EX-2 (figure 5; area about 6,3 ha): no suitable water body for measuring pH and EC. Species present in the grass and herb layer: *C. canescens, Carex spp*., *J. conglomeratus, Fragaria vesca, Pilosella spp.,* brown mosses *Polytrichum strictum* and *W. exannulata*, few small *P. sylvestris* young trees are present. Area is mown.
- EX-3 (figure 6; area about 6,7 ha): pH 4,3; EC 64µS/cm. In the shrub layer Salix spp., Pinus sylvestris (few young trees). In the grass layer *C. canescens*, *J. conglomeratus, E. vaginatum*, *Phegopteris connectilis*, *Carex spp*. In the moss layer *P. strictum, Polytrhicum commune*, and *P. schreberi*. Area is mown.
- EX-4 (figure 7; area about 4,2 ha): no suitable water body for measuring pH and EC. From the tree-layer *B. pubescens* and *P. sylvestris*, grass layer: *E. vaginatum, C. canescens, J. conglomeratus, Carex spp*. Area is not mown.

Figure 4. Exhausted area EX-1 in the Unguri peat production area (STEIGER Engineering, 07.11.2022)

These areas can be broadly divided into two, nutrient poorer areas dominated by *E. vaginatum* (EX-1 and EX-4) and more nutrient rich areas

dominated by other herbs and grasses (EX-2 and EX-3). Exhausted areas with vegetation were relatively wet during the field work in autumn, 2023. Raising the water level to be close to the peat surface throughout the year would support the development of bog or transitional mire vegetation in EX-1 and EX-4 and minerotrophic mire vegetation in EX-2 and EX-3.

Figure 5. Exhausted area EX-2 in the Unguri peat production area (STEIGER Engineering, 07.11.2022)

During the peatland restoration, suitable conditions are created for the development of biodiversity by creating growth conditions for plants characteristic of peatlands and providing habitats for animals. Peat decomposition is reduced through higher groundwater levels, and with the development of plant cover, prerequisites are created for carbon sequestration in the peatland area, restored peat areas are also reservoirs of fresh water, and as the water level rises, the fire hazard of the area decreases (Padur et al., 2017). The reduction of CO_2 emissions when creating suitable conditions for peatland recovery in peat production areas is confirmed by research conducted on peat production areas being restored in the Baltic States (Järveoja et al., 2016; Purre et al., 2019), where it is particularly important to ensure the rapid development of vegetation in the area, which, together with the high water

level, creates the conditions for the formation of peat and for carbon accumulation (Järveoja et al., 2016; Purre et al., 2019).

Figure 6. Exhausted area EX-3 in the Unguri peat production area (STEIGER Engineering, 08.11.2022)

Generally, afforestation is suitable for areas where the residual peat layer is thin and can be plowed through with mineral soil. In the case of afforestation, the mineralization of peat continues and the fire hazard of the area can be mitigated by recovery of a swamp forest with a high groundwater level. As in the Unguri peat production site mire habitats are preferred, then the wet peatland forest habitats are proposed, that do not need drainage and management. To increase biological diversity, the spread of different native trees (mainly birch and pine) is necessary, which are also present in the surrounding areas of Unguri peat production site, while wet peatland forests provide gathering areas for locals (Padur et al., 2017). Infrastructure suitable for forest accessibility (road network) has already been created for peat production areas. Tree species suitable for wet conditions should be chosen, which allows to create a natural look for the area and prevent excessive peat decomposition and in future, peat and carbon accumulation also.

Figure 7. Exhausted area EX-4 in the Unguri peat production area (STEIGER Engineering, 07.11.2022)

When creating suitable conditions for the peatland restoration, either for treeless or treed peatland habitats, the water level is raised close to the peat surface, and when the ditches are closed, the water level may also rise in the areas bordering the area to be restored. Unguri peat production area borders partly with private lands. To avoid restoration and after-use related to the raising the water level in the peat production area on the surrounding privately-owned properties used for forestry and agriculture, it is necessary to agree with the landowners in need of mitigating measures (e.g. peat dams) during the preparation of the technical after-use project.

2. PROPSED TYPES OF AFTER-USE AND WORKS TO BE CARRIED OUT

Unguri peat production site must be reclaimed in accordance with the law "Par zemes dzīlēm" §14 (8) and the land rental agreement after the exhaustion of the peat layer or before the end of the validity of the mining permit. According to the §2 of the "Par zemes dzīlēm", the purpose of the law is to ensure the complex, rational, environmentally friendly, and sustainable use of the land resources. This is supported by the complete use of the peat reserves in areas which have already being impacted by the peat extraction, and the restoration of mire habitats after the exhaustion of the peat reserves in one location.

The reclamation works carried out according to the technical after-use project are accepted by the reception committee for reclamation works. Although some smaller parts of the peat production site are close to exhaustion and vegetation is developing there, the rest of the peat production site would be exhausted between less than 5 year or up to 40 years based on available peat depth on the fields and average layer of extracted peat each year (figure 8). The exhaustion period of the peat production site depends mainly on geological conditions determining the peat depth, climate conditions determining the amount of peat that could be extracted each year, and market situation, so approximate values are given in figure 8.

SIA Unguri is prepared to prepare the technical after-use project for whole Unguri peat production site and apply it to exhausted production fields stepwise. Still, it must be kept in mind, that generally it is not reasonable to make a detailed technical engineering for after-use in parts of the peatland, where there is currently several meters of peat left and decades until the application about the after-use. The restoration techniques and methods improve in time and with shallower residual peat layer the knowledge about the underlying peat physio-chemical composition is more detailed. In those areas, the technical engineering of the after-use could be generally left in broader scale in the project and specified in the later stages. This means, that with temporal development of knowledgebase about residual peat layer and other environmental conditions on site, and the increasing scientific knowledge about

restoration techniques and methods, the technical after-use project should be reviewed from time to time and updated if necessary.

Unguri peat production site it is recommended to reclaimed into a restored peatland and a wet peatland forest (figure 9), which is supported by the sapropel layer under large parts of the peat production site, surrounding landscape and vegetation. The restoration of peatland habitats also supports the protection goals of Gauja National Park. There are two general approaches for the restoration of mire habitats in extracted peatlands: rewetting (for all mire ecosystems) and moss-layer-transfer technique (Rochefort et al., 2003), which is developed especially for restoring bog habitats and Sphagnum layer in suitable conditions. In the whole Unguri peat production site, the residual peat layer will be well-decomposed, when the peat layer is close to exhaustion. So, the residual layer would be relatively nutrient rich, and therefore not suitable for application moss-layer-transfer technique (Rochefort et al., 2003; Purre et al. 2020), which also includes application of *Sphagnum* diaspores and covering them with straw mulch in addition to raising of the water level. So the general rewetting approach should be chosen in the Unguri case. The moss-layer-transfer technique could be considered to areas where for any cause remains layer of weakly decomposed peat or *Sphagnum* peat (e.g. on the road edges) to increase the speed of vegetation development in such areas.

The mire habitats dived generally into three types: fens (generally more nutrient rich and dominated by grasses and brown mosses), transitional mires (mixed between two main types, developmental stage) and bogs (nutrient-poor, dominated by *Sphagnum* layer) depending on their nutrient status, hydrology, and vegetation. Due to physiochemical properties of the residual peat layer on site, the restoration of bog habitats is not reasonably achievable as the bog peat layers have been removed, but the residual peat properties support the development of transitional mire vegetation. The open (not treed) peatland areas that will be developing after restoration will develop firstly in the direction of 7140 (Transitional mires and quaking bogs; about 370 ha) and wet peatland forest in the direction of natura habitat type 9080 (Fennoscandian deciduous swamp woods; about 50 ha) or in the southern part 91D0 (bog woodland, transitional mire type, about 30 ha). Through natural succession transitional mire vegetation developing after restoration activities, will be eventually succeeding into bog communities. The distribution of the suggested after-use types within Unguri peat production site depends on the underlying relief of the peat base (including mineral islands, where tree layer will eventually develop), surrounding habitats, locations of existing protected species within area and

vegetation already growing on the site among other considerations. For the peatland restoration approximately 20-30 cm of residual peat layer should be left to support the growth of peatland specific species.

In the transitional mire and quaking bog habitat type, development in the direction of transitional mire development can be supported by raising the water level in the area. In this habitat type tree layer is absent or scarce (in the bush layer several species of *Salix, Betula humilis* and *Frangula alnus*), and the grass layer dominates with species such as *Carex spp., Calamagrostis spp., E. vaginatum, Trichophorum alpinum, Dryopteris cristata, Andromeda polifolia, Potentilla palustris* and *Menyanthes trifoliata*. In hummocks also grows *Oxycoccus palustris, Empetrum nigrum* and *Calluna vulgaris*. In the open transitional mires, *Sphagnum spp*. dominate the moss layer, but to a smaller extent brown mosses are also present. In natura habitat type 9080, main tree species in the region are *Alnus glutinosa* with *B. pubescens, Alnus incana* and *Salix spp.* Several *Carex* species are present in the grass- and herb layer, and mosaic moss layer consists of brown mosses and *Sphagnum*. In the southern part of the peat production site where supporting the development of bog woodland is proposed, *P. sylvestris* should be planted with smaller proportion of *B. pubescens*. In this habitat type bushes (e.g. *Salix cinerea*, *Betula humilis*, *Betula nana* and *Frangula alnus*). Grass layer in this type is well developed with *Carex spp*. *Calamagrostis spp, Phragmites australis* and several herb species (*P. palustris*, *M. trifoliata*, *Thelypteris palustris*, *O. palustris*), and later in the mire development also *E. vaginatum* and typical bog shrubs (*Ledum palustre*, *Vaccinium uliginosum, A. polifolia*). In the moss layer *Sphagnum* grows in hummocks and between the hummocks several brown mosses can be present (*Pleurozium schreberi, Hylocomnium splendens* and *Dicranum spp*.).

Some area can also serve double purpose as in the “Monitoring and mitigation plan of Unguri peat production site” (OÜ Inseneribüroo STEIGER, work no 23/4345) the areas suggested to use as a sedimentation field can be also considered as restored peatfields at a same time, as the groundwater level and vegetation developing in the sedimentation fields is similar to pristine peatlands. The constant water flowthrough from the sedimentation field supports the rapid revegetation of the sedimentation field and provides habitats for species preferring wetter habitats. There are no further restoration works needed after the construction and vegetation development of the sedimentation field.

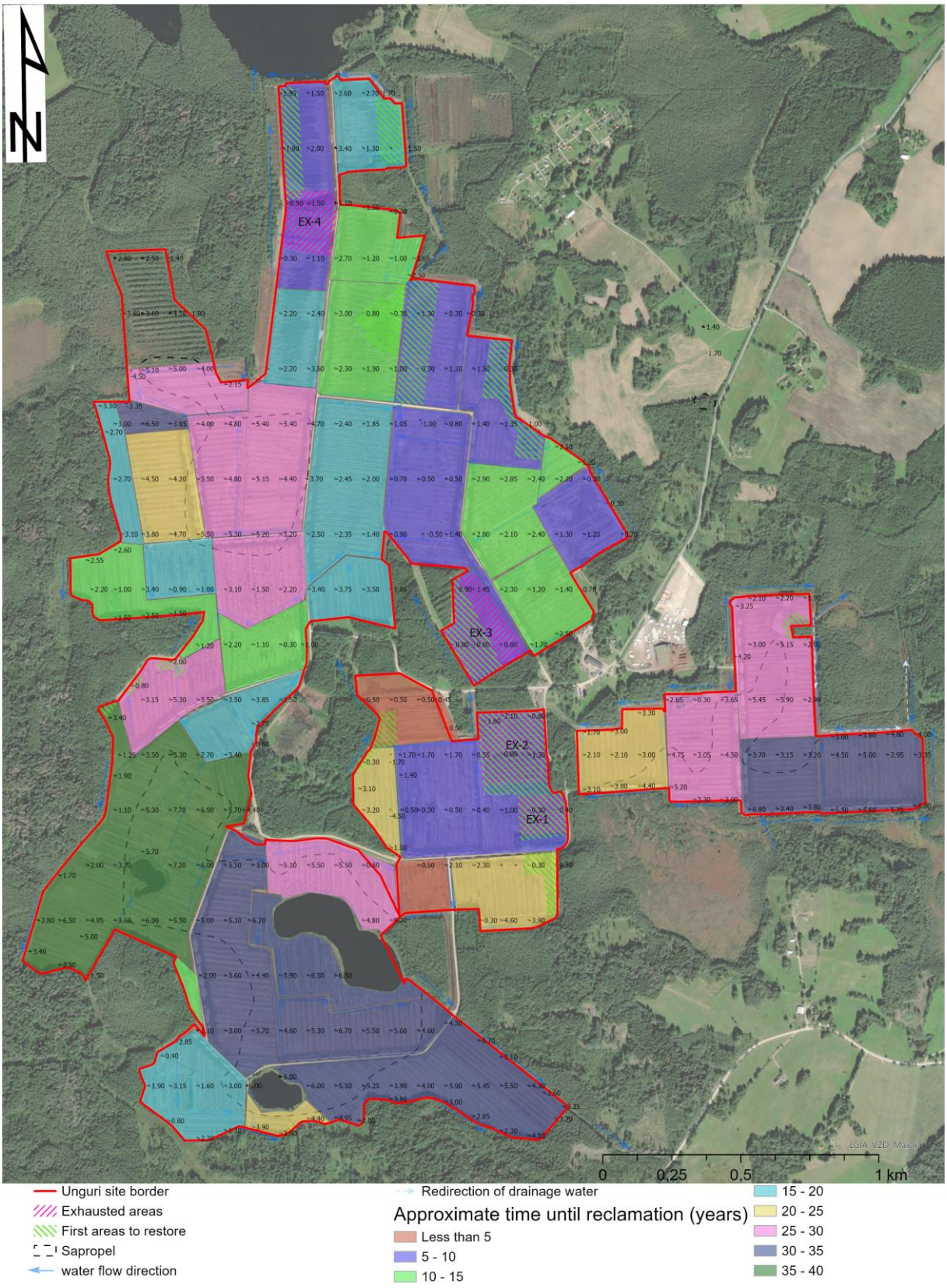

Figure 8. Unguri peat production site approximate time until after-use and peat depth according to the geological survey points

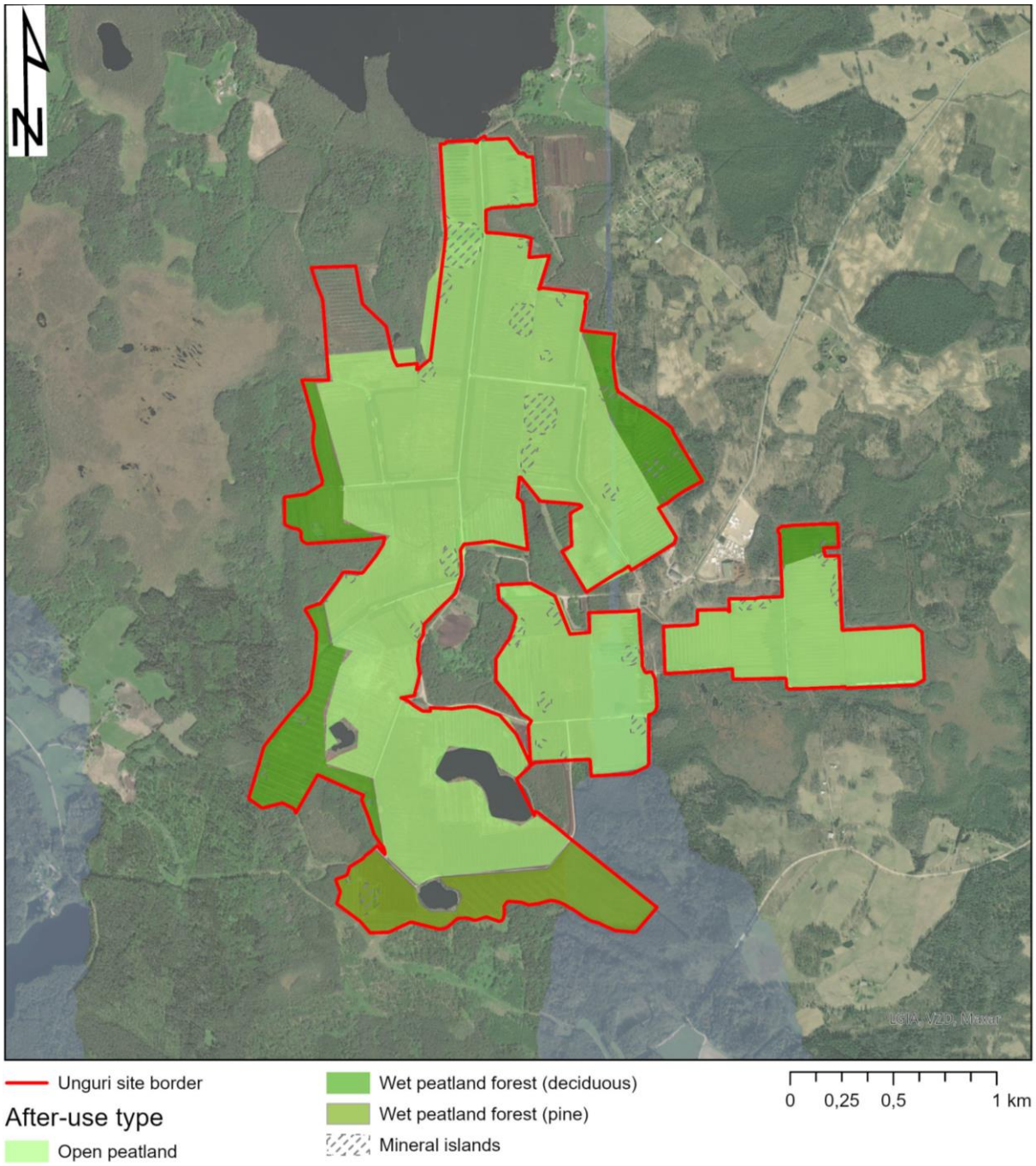

Figure 9. Suggested Unguri peat production site after-use types

In the final phase of excavation, peat production must ensure as flat peat surface as possible to simplify restoration work and reduce restoration costs. Also, the banks of block-cutting areas should be reprofiled into gentle slopes (exact angle determined in the technical after-use project). The prerequisite for peatland restoration is raising the water level close to the peat surface, which ensures suitable conditions for the development of the vegetation characteristic to peatlands. To raise the groundwater level, dams and peat walls must be built according to the technical after-use project of the peat production site. For

outflows, water level regulators should be constructed, so it is possible to either close or open them to drain excess water during the extreme flooding seasons. The amount and location of water regulators are determined in the technical after-use project.

The raising of the groundwater level and construction of dams must be carried out as soon as possible after the peat fields are exhausted to prevent further mineralization of the peat. In this case it is not necessary to strip the surface of the peat layer (mineralized layer). After the end of production activities, everything artificial from the peat production area needs to be removed to restore the natural appearance of the land affected by mining. Concrete plates will be removed. Also, connectivity with the surrounding area should be created by reprofiling any peat dams between the pristine and restoration parts of the Unguri bog and encourage dispersal of peatland species to the restoration site from the surrounding areas. This is supported by at least partly closing the collector ditches and removing the peat walls from the edges of the peat production site which are used as a mitigation measure. The homogenous conditions on site are also supported by filling in the field ditches where enough residual peat is left, this also supports the vegetation recovery and restoration success in the site.

Since the residual peat is well decomposed in the 0.2 – 0.3 m lower part, and there is mineral soil nearby, the area has nutrient-rich conditions after the area is exhausted, in which the spread of mineral soil plant communities is possible. These conditions are not suitable for restoring bog species, but support the development of transitional mire species and habitats. When restoring the peat production site to peatland, a uniform and close to the peat layer water regime is created and this helps the spread of peatland species. Transitional mire plants can grow from seeds in residual peat upon regeneration of suitable conditions (high water level), spread to the area from the surrounding areas, and the spread of these plants can be encouraged by sowing plants (hay) collected from near-natural mire ecosystems (e.g. wet meadows) into the restored area (Middleton and others, 2006).

Because Unguri peat production site is surrounded by a natural peatland area on many sides, and peatland specific vegetation is also present surrounding the remnant bog pools, then the natural spread of plants characteristic of mires from the preserved natural areas to the restored area is likely, and additional planting of plants may not be necessary, or is necessary on a small scale. The

need for biological restoration, the volume and the species used are determined in the technical after-use project.

Reclamation of the drainage system from supporting wet peatland forest is not needed. The water regime suitable for peatland forests occurs on parts with a higher mineral relief to develop natural peatland borders, provide habitats for peatland forest species and mitigate impacts of rewetting to bordering land-owners. For the partial afforestation of the Unguri peat production area, it is expedient to use B*. pubescens* and *A. glutinosa* as the main tree species in deciduous wet peatland forest (about 50 ha) and *P. sylvestris* as a main species in pine dominated wet peatland forest (about 30 ha). The results of afforestation of milled peatlands so far have been most successful when both tree species (*Betula* and *Pinus sylvestris*) are used together, so the other species in both cases should be used as secondary species. Birch compensates for pine's sensitivity to night frosts, the frequency of which is higher in open peat production areas than in surrounding landscape. The exact planting scheme and ratio of tree species must be resolved with the technical after-use project. To ensure rapid development of wet peatland forest, use of seedlings is suggested. The establishment of wet peatland forests reduces the CO_2 emissions and fire hazard of the area caused by the decomposition of peat in the afforested area, but it still allows for economic interest to manage the forest sustainably (including gathering areas for locals) and provides habitats for species characteristic of peatland forests. Since there is currently no experience of establishing and managing forests with high water levels in milled peatlands, the more precise conditions for afforestation and the target forest communities must be defined during the preparation of the technical after-use project in these areas.

After the restoration works, it is important to monitor the water levels and the development of the vegetation in the area to assess the success of the restoration work and the need for additional work. A complete solution for the restoration of the peat production area and monitoring is developed during the preparation of the technical after-use project. To analyze the effect of restoration work, the monitoring should start one year before the application of peatland restoration activities. All final works and technical solutions related to the restoration are defined in the technical after-use project.

3. SUMMARY

In the Unguri peat production site is recommended to restore the peat production area into an open peatland (transitional mire) and wet peatland forest (dominated by birch and black alder; or in southern part dominated by pine). These restoration directions support the biodiversity and carbon accumulation, fit into surrounding landscape and consider the local conditions. The restoration works should be carried out stepwise, as soon as peat fields with sufficient size have been exhausted to avoid the mineralization of the topmost residual peat layer, and reduce atmospheric CO_2 emissions from these sites.

The local stakeholders such are bordering landowners, DAP, and the local government should be cooperated with during the preparation of the technical after-use project. The technical after-use project must include detailed survey of ground height and modelling of water flow and estimations of groundwater level height after restoration. Monitoring suggestions should also be given in technical after-use project.

4. USED LITERATURE

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