Estonia

River Valgejõgi: Kotka dam

Country	Estonia
River	Valgejõgi
Site	Kotka dam
Type of sea trout populations	Mixed population
Temporal scale of the restoration	Long term
Spatial scale of the restoration site	One site
Responsible organisation	NA
Duration of the project	1 years
Geographical location WGS84	N 59° 32.431' E 25° 44.3145'
Total budget	Alt. 1. 390 456 € (artificial rapid) Alt 2. 72 600 € (full dam removal)

General information

The Kotka dam is located 9 km from the river mouth on the river Valgejõgi (N 59° 32.4269' E 25° 44.3151'; Figure 1). The river is 89.5 km long and has a catchment area of 451.5 km^2, elevation at the source is 107 m. Valgejõgi had poor water quality in the past; presently it is classified as very good. The river has mixed (there is natural reproduction and supplementary juvenile releases are carried out) Atlantic salmon and sea trout populations. The Atlantic salmon population is considered to be in

a precarious state and natural reproduction occurs predominantly in areas below Kotka dam. The status of trout is also poor; however resident trout occur throughout the watershed. River lamprey and vimba bream populations occur only below the Kotka dam. Resident protected species are grayling and European bullhead. Those species are absent only on the uppermost 20 km part of the river. Historically there were at least eight mills on the lower and middle part of river. All of them had a negative effect to the previously mentioned fish species. Presently most of the dams are gone and one natural like fish pass was built in 2014 to the upper part (76.8 km from the sea) of the river. The Kotka and Nõmmevski dams are the last remaining man-made migration hindrances and are primary factors affecting the abundance of migratory fish. Salmonid parr density is monitored in the most relevant parts of the river since 2016. Therefore, any change in salmonid parr densities after the dam removal would be observed and documented. There is also a 1.3 m high natural waterfall 100 m downstream of the Nõmmeveski dam, however, at least some salmon and sea trout are known to be able to pass it. Consequently, at present, salmon and sea trout need to pass three obstacles (2 dams and the waterfall) to reach the best and largest spawning areas. The long-term objective is to ease the migration past the dams so that the fish only have to strain themselves to pass the natural waterfall.

The Kotka dam is the lowermost migration obstacle. It was built in 1950 and operated as hydroelectric power station (HEP) until 1960. Later it provided water for a fish farm. Wooden parts of the dam broke in 2016 and it was not restored. The dam has no water permit, and it is not culturally valuable. Original height of the dam was 3.5 m and at present the remaining height is 1.1 m. For salmonids, the dam is considered as difficult to pass, although some salmon and trout are able to overcome it. For other species, such as European sculpin and lamprey, it is unpassable.

Planning phase

Kotka dam is a major limiting factor for Atlantic salmon and sea trout populations. Of all spawning areas in river Valgejõgi, 90 % are located upstream the dam. Therefore, Kotka dam is nationally a high priority migration obstacle that should be made passable. The dam no longer has any function and there are no plans to restore it. Negotiations to buy the dam from its private owner by the Estonian Ministry of Environment are ongoing. State ownership of the dam enables the planning for the most optimal long-term solution. Full removal of the dam is therefore realistic and technically relatively easy. The site has good access, and the dam is located on a flat landscape. Dam removal is the most certain way to enable all fish species and other aquatic fauna to move freely across the site. It also does not require any future maintenance. Through procurement, hydro engineering companies Eesti Veeprojekt OÜ and Inseneribüroo Urmas Nugin OÜ were hired to compose two alternative solutions for the dam. Preliminary environmental impact assessment (PEIA) for all alternatives was carried out by AS Maves. It was concluded that environmental impact assessment (EIA) is not necessary to prepare as the objective is to improve the environment.

First alternative is to remove the remaining dam constructions. Upstream from the present dam location a 73 m long artificial rapid with 1.1 height would be built. The rapid would provide free passage and serve as spawning and rearing area for salmon, trout, grayling and lamprey (Figure 2). This alternative would provide free passage for all aquatic fauna. Major drawback of this alternative is the high estimated cost, 390 456 euros.

Second alternative is to remove the remaining dam construction and to enforce the riverbanks at the immediate vicinity of the dam site (Figure 3). The calculated cost of this alternative is 72 600 euros. This alternative is considerably cheaper and favoured by the future implementers (Estonian Ministry

of the Environment). It is difficult to predict how riverbank erosion will change the appearance of the river upstream of the dam and that is the biggest concern of this alternative.

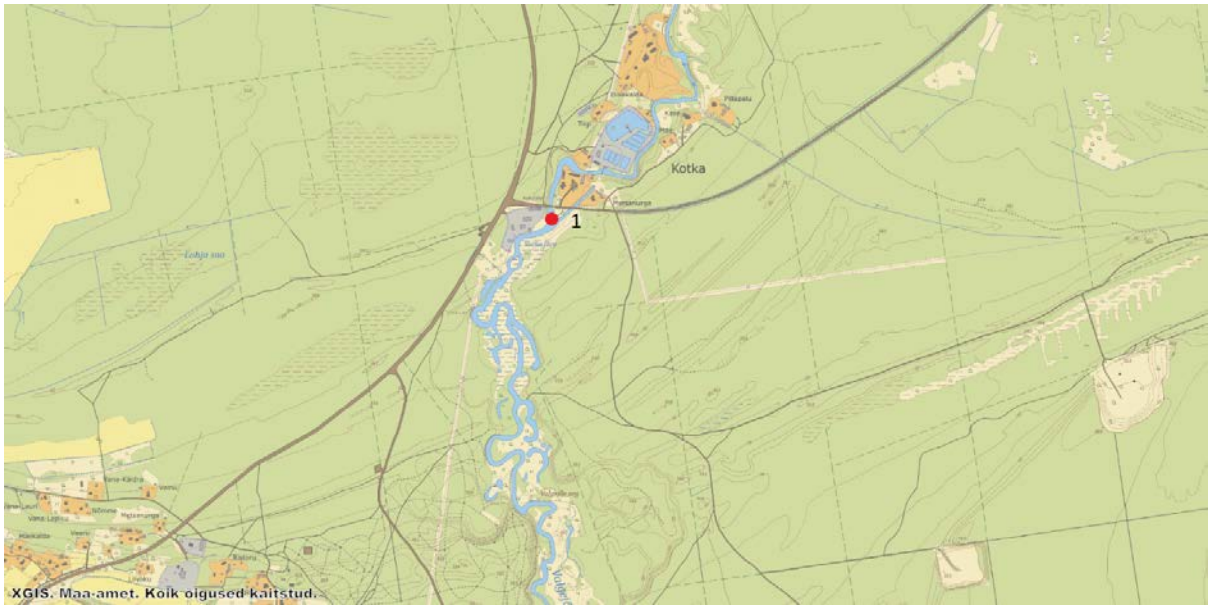

Figure 1. River Valgejõgi. 1. Kotka dam. Source: www.maaamet.ee.

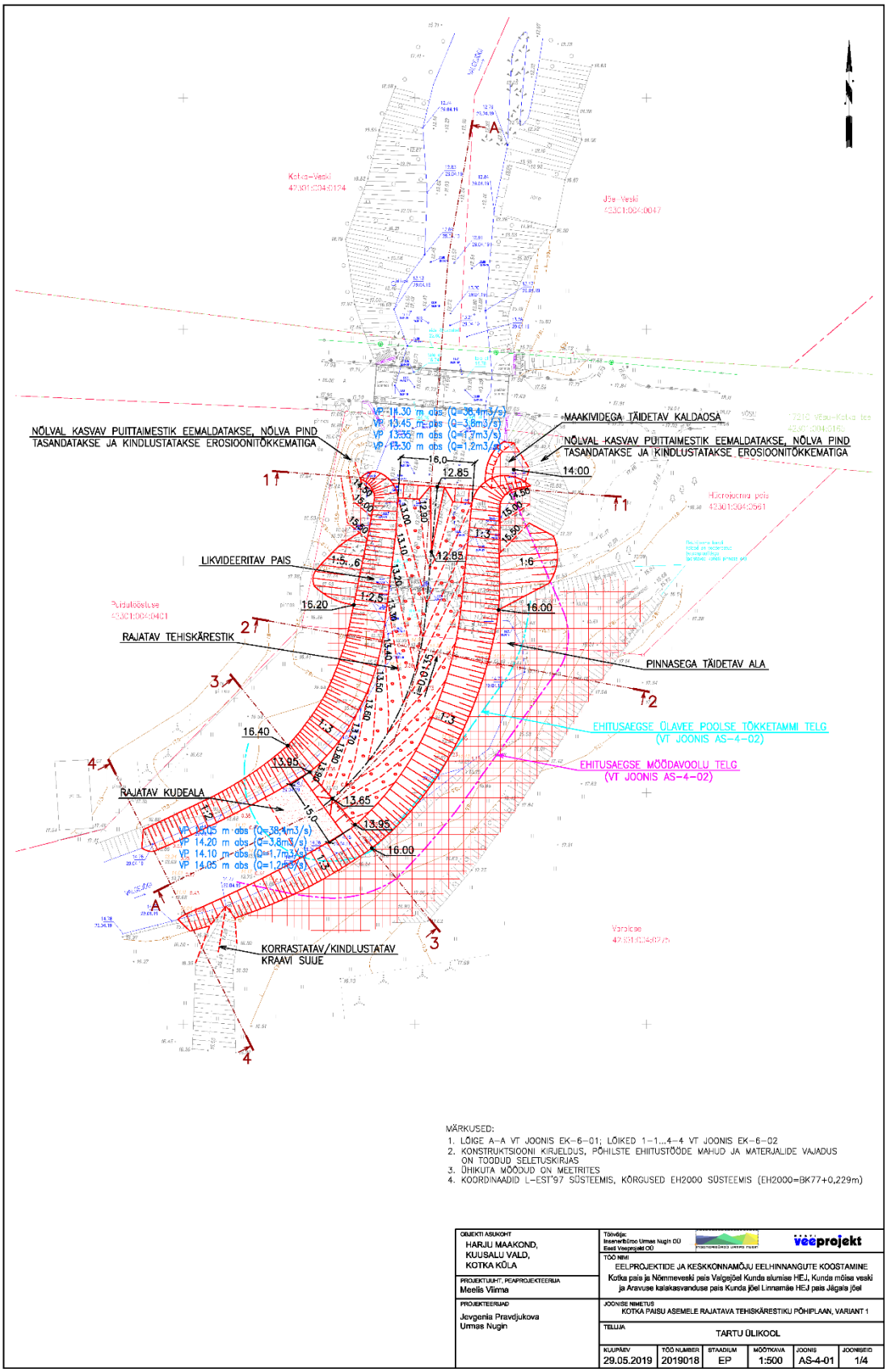

Figure 2. Design drawing (top view) of the first dam removal alternative for Kotka dam.

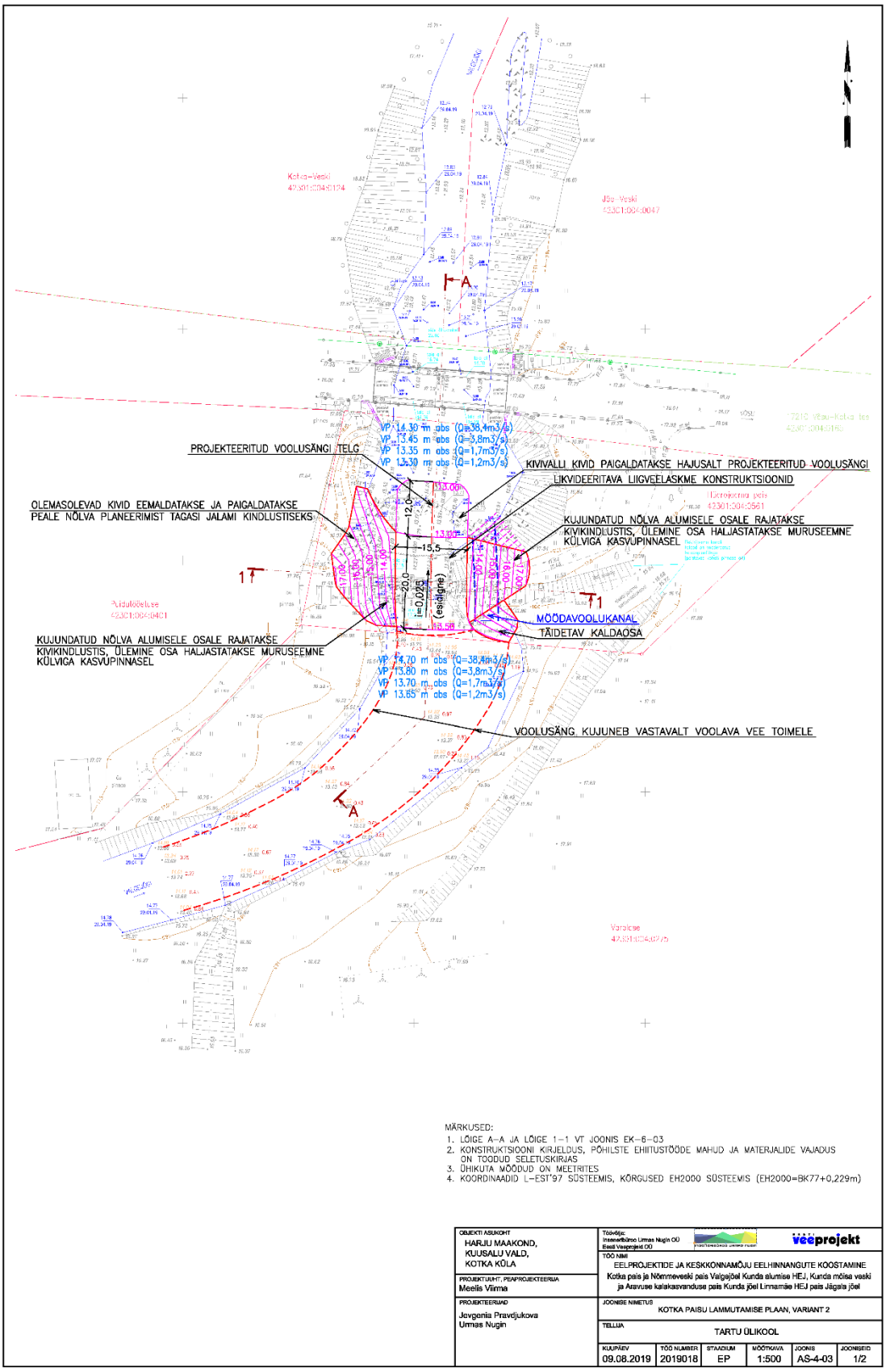

Figure 3. Design drawing (top view) of the second dam removal alternative for Kotka dam.

River Valgejõgi: Nõmmeveski dam

Country	Estonia
River	Valgejõgi
Site	Nõmmeveski dam
Type of sea trout populations	Mixed population
Temporal scale of the restoration	Long term
Spatial scale of the restoration site	One site
Responsible organisation	NA
Duration of the project	1 years
Geographical location	N 59° 30.4228’ E 25° 47.2926’
Total budget	Alt. 1. 223 344 € (artificial rapid)

General information

The Nõmmeveski dam is located 20.2 km from the river mouth on the river Valgejõgi (N 59° 30.4209’ E 25° 47.2936’; Figure 4). The river Valgejõgi is 89.5 km long, has a catchment area of 451.5 km^2 and elevation at the source is 107 m. The river had water quality issues in the past; however presently water quality is classified as very good. The river has mixed (there is natural reproduction and supplementary juvenile releases are carried out) Atlantic salmon and sea trout populations. River lamprey and vimba bream also ascend to the river. Resident protected species are grayling and European bullhead. Historically there were at least eight mills on the river and all of them had a negative effect to the fish fauna. Most of the dams are gone and one natural like fish pass was built in

2014 to the upper part (76.8 km from the sea) of the river. The Kotka and Nõmmevski dams are the last remaining man-made migration hindrances on river Valgejõgi. Salmonid parr density is monitored in the most relevant parts of the river since 2016. Therefore, any change in salmonid parr densities after the dam removal can be observed and documented. There is also a 1.3 m high natural waterfall downstream of the Nõmmeveski dam, however, it is known that at least some salmon and sea trout can pass it. Salmon and sea trout need to pass three difficult obstacles (2 dams and the waterfall) to reach the best and largest spawning areas. The long-term objective is to ease migration past the dams so that the fish only have to strain themselves to pass the natural fall.

Planning phase

The Nõmmeveski dam is the second man made obstacle from the river mouth and it is considered a high priority migration obstacle (Photo 2). There is a 1.3 m high natural waterfall located 100 m downstream of the dam and some salmon and sea trout can pass it. About 75 % for the potential spawning areas for Atlantic salmon and about 80 % of the potential spawning areas for sea tout are located upstream of the site. The dam was built in 1924 and it operated as a hydropower station (HEP) until 1964. The wooden parts of the dam broke in 2010 and it was not restored because it has no water permit. The original height is not known, but the present height is 1 m. The dam is considered difficult to pass for salmon and sea trout and it is considered unpassable for European sculpin and lamprey.

There are no plans to restore the dam to its original height. Side walls of the dam and the pillar in the middle of the river function as a bridge foundation. The bridge is in everyday use, and no actions are currently planned for it. Negotiations to buy the dam from its private owner by the Estonian Ministry of Environment are ongoing. State ownership of the dam would enable planning for the most optimal solution to improve fish passage.

It is not possible to lower the water level more than 0.2 m without threatening the structural stability of the side walls and the pillar. It was decided during the early planning phase that nothing would be done to the bridge. Building a new bridge would increase the cost of the project unreasonably high. Through procurement hydro engineering companies Eesti Veeprojekt OÜ and Inseneribüroo Urmas Nugin OÜ were hired to compose one alternative solution for the dam. Preliminary environmental impact assessment (PEIA) for one alternative was carried out by AS Maves. It was concluded that environmental impact assessment (EIA) is not necessary to prepare as the objective of the work is to improve the environment.

One alternative was made. Two cuttings will be made at the base of the dam openings. The new openings would lower the water level by 0.2 m. A 32 m long artificial rapid with a 4 % slope downstream of the dam base would be built. The rapid would provide free passage (Figure 5). This alternative would meet the set environment objectives. Calculated cost of this alternative is 223 344 euros.

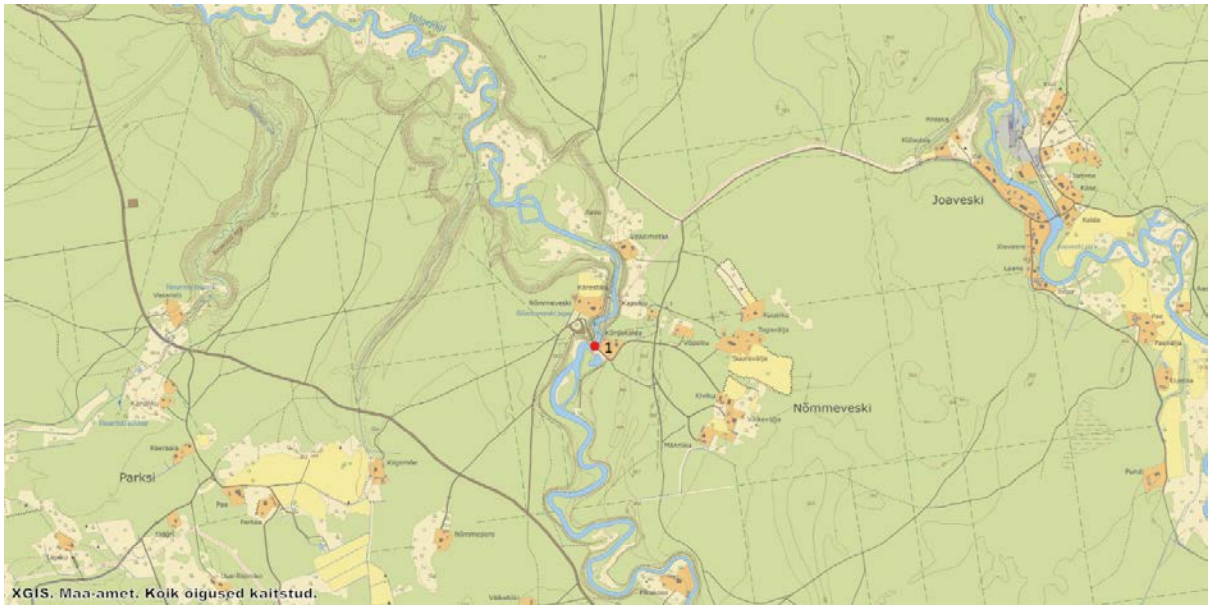

Figure 4. River Valgejõgi. 1. Nõmmeveski dam. Source: www.maaamet.ee.

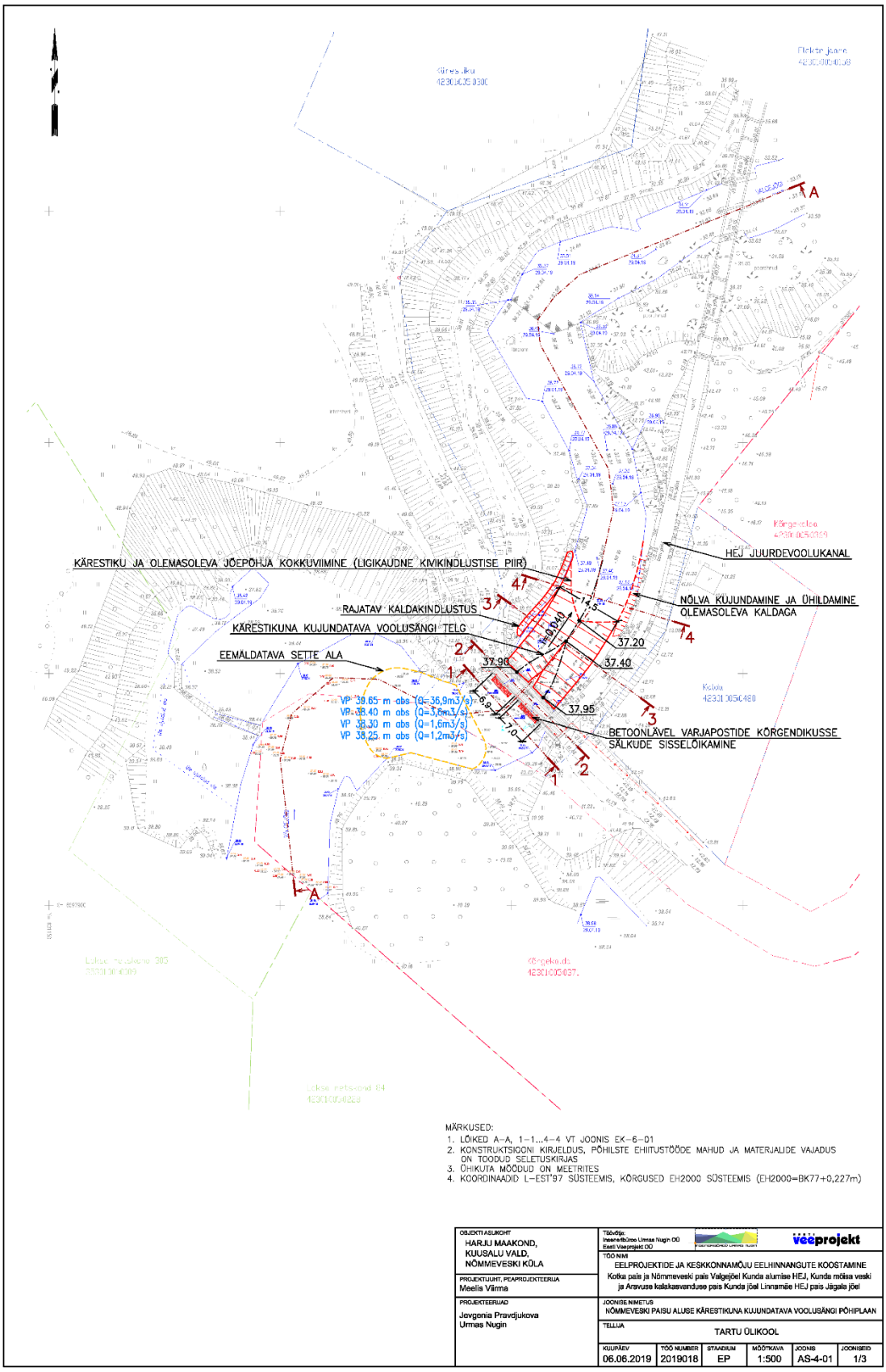

Figure 5. Design drawing (top view) of the dam hight alteration solution for Nõmmeveski dam.

River Kunda: Kunda lower hydroelectric power station (dam)

Country	Estonia
River	Kunda
Site	Kunda lower HEP
Type of sea trout populations	Original population
Temporal scale of the restoration	Long term
Spatial scale of the restoration site	One site
Responsible organisation	NA
Duration of the project	2 years
Geographical location	N 59° 30.1740′ E 26° 32.5186′
Total budget	Alt. 1. 2 587 667 € (bypass next to the dam)

General information

The Kunda lower hydroelectric power station (HEP) is located 2.3 km from the river mouth Kunda river (N 59° 30.1740′ E 26° 32.5186′; Figure 6). The river is 82.2 km long and has a catchment area of 535.9 km^2. The elevation at the source is 90 m. Water quality of the river is classified as good. The river has wild native Atlantic salmon population that spawns only on the lower 2.3 km long part of the river. Salmon parr density below the dam is very high, however it comprises only about 10 % of the river's total potential spawning areas. In addition, sea trout, river lamprey and vimba bream also ascend to the lower part of river. For those species over 90 % of the suitable spawning areas are also located upstream of the dam. Resident trout, grayling and European bullhead exist throughout the watershed.

Salmon and trout parr abundance is regularly monitored only on the lower accessible part of the river. There are no fish releases done in the river and all fish populations are wild and native. The Kunda HEP is one of three dams close to each other on the lower part of the river. All those dams are unpassable migration obstacles and most of the potential spawning areas for salmon and sea trout are located upstream from all three of them.

Planning phase

The Kunda lower HEP is the lowest dam on the river (Figure 7) and it is a complete migration obstacle for all fish. The planned solution must provide passage to all fish fauna, also those that are not good swimmers, e.g., sculpin. The dam was built in 1893 and operated as a hydropower station until 1971. The dam was restored and operated from 2000 to 2007. Its original height was 10.5 m, now it is 8.5 m. Wooden parts of the dam are missing and the HEP is not operational. The dam was designated as culturally valuable in 2008. Negotiations to buy the dam from private owners by the Estonian Ministry of Environment are ongoing. State ownership of the dam enables to plan for the most optimal compromise between the environment and cultural values. The dam is located in as steep valley and space for a passage solution is very limited. During early planning phase it became evident that at least partial removal of the dam is unavoidable for a viable passage solution. Through procurement a hydro engineering companies Eesti Veeprojekt OÜ and Inseneribüroo Urmas Nugin OÜ were hired to compose 3 alternative solutions for the dam. Preliminary environmental impact assessment (PEIA) for one alternative was carried out by AS Maves. It was concluded that environmental impact assessment (EIA) is not necessary to prepare as the objective of the planned works is to improve the environment.

In the **first alternative** the limestone wall on the left side on the dam would be demolished and new river channel with a 3.5 % slope would be built to left from the concrete dam. Rest of the dam remains intact. Water level will be lowered to pre-dam level. To keep the left side of the valley stable, a 110 m long and up to 10 m high concrete wall would be built (Figure 8). A 14 m long and 1.5 m wide bridge will be built across the new river channel. The bridge connects the remaining dam with the opposite river side. The calculated cost of this alternative is 2 587 667 euros. This alternative retains most of the cultural values and provides free passage to all fish and aquatic life.

Second alternative is to remove the main concrete body of the dam and lower the water level to the original height. A 100 long rapid with a 3.5% slope would replace the dam and impounded lake area (Figure 9). Only the turbine building on the right side of the river would remain. This alternative would retain cultural values only partially and would restore the river to its original state. The calculated cost of this alternative is 1 038 147 euros. The remaining turbine building needs regular maintenance.

Third alternative is to remove all parts (including the turbine building) of the dam and restore the river and the valley close to its original state (Figure 10). Riverine conditions would be similar to the second alternative. In this case cultural values would not be preserved. Calculated cost of this alternative is 1 125 234 euros.

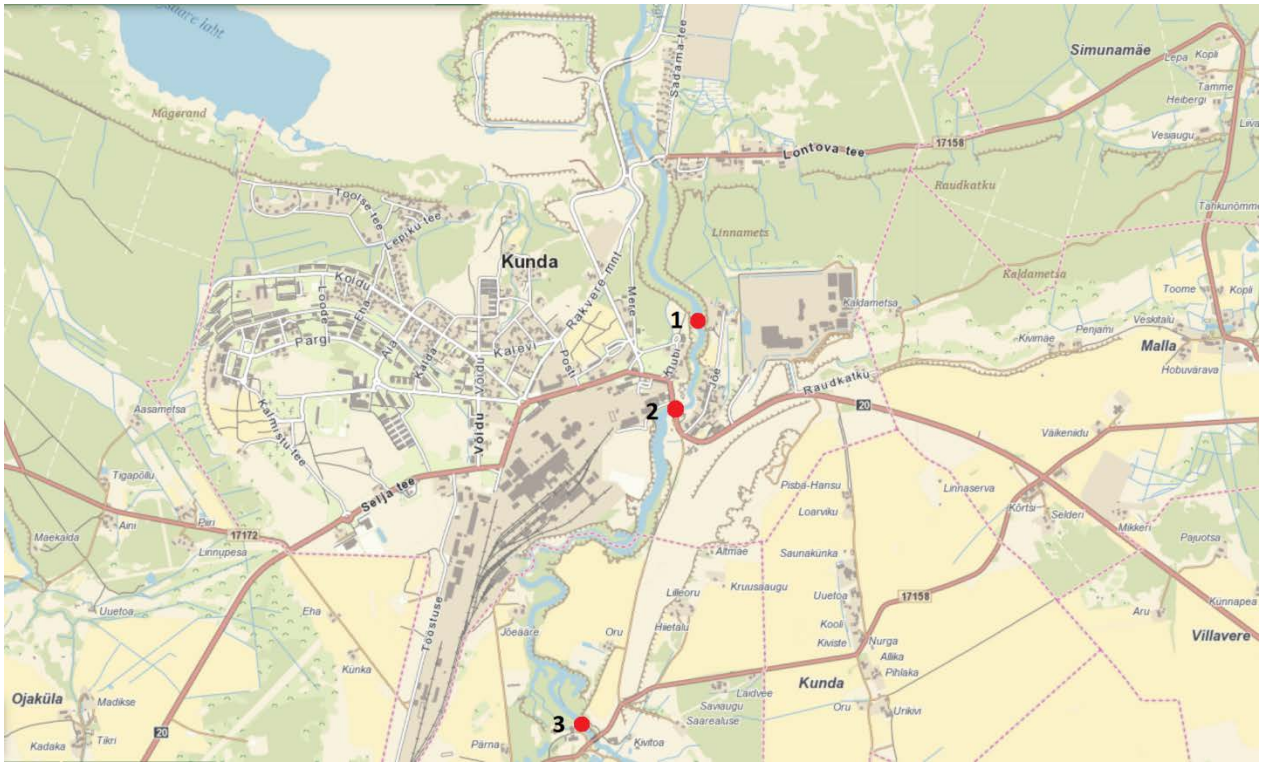

Figure 6. Migration obstacles on the lower part of river Kunda. 1. Kunda lower HEP, 2. Kunda second and 3. Kunda manor mill Source: www.maaamet.ee.

Figure 7. Kunda HEP is the lowermost migration obstacle on river Kunda. Most potential sea trout spawning areas are located upstream of the dam. Photo credit: Martin Kesler.

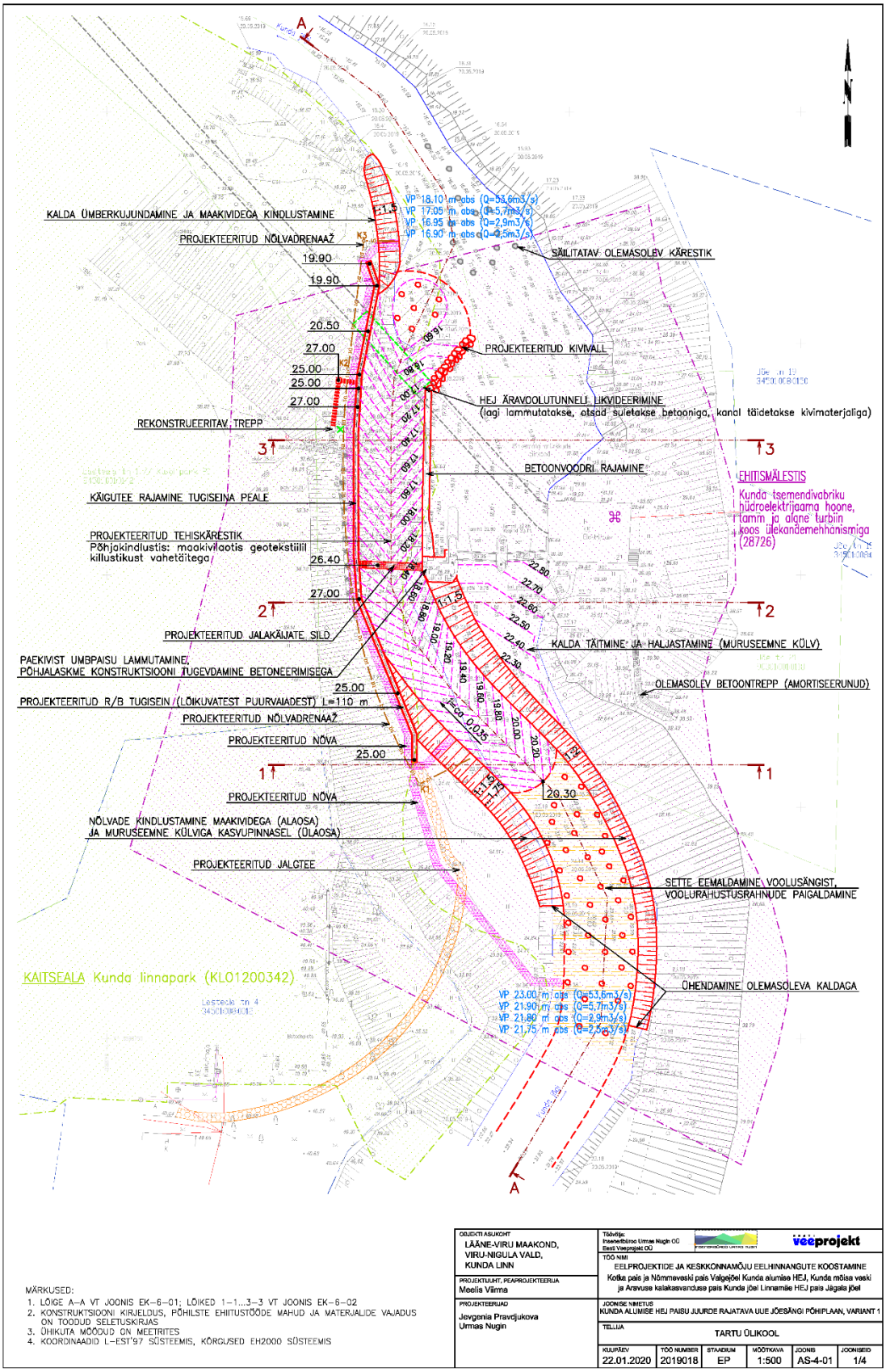

Figure 8. Design drawing (top view) of the first alternative solution for Kunda lower HEP dam.

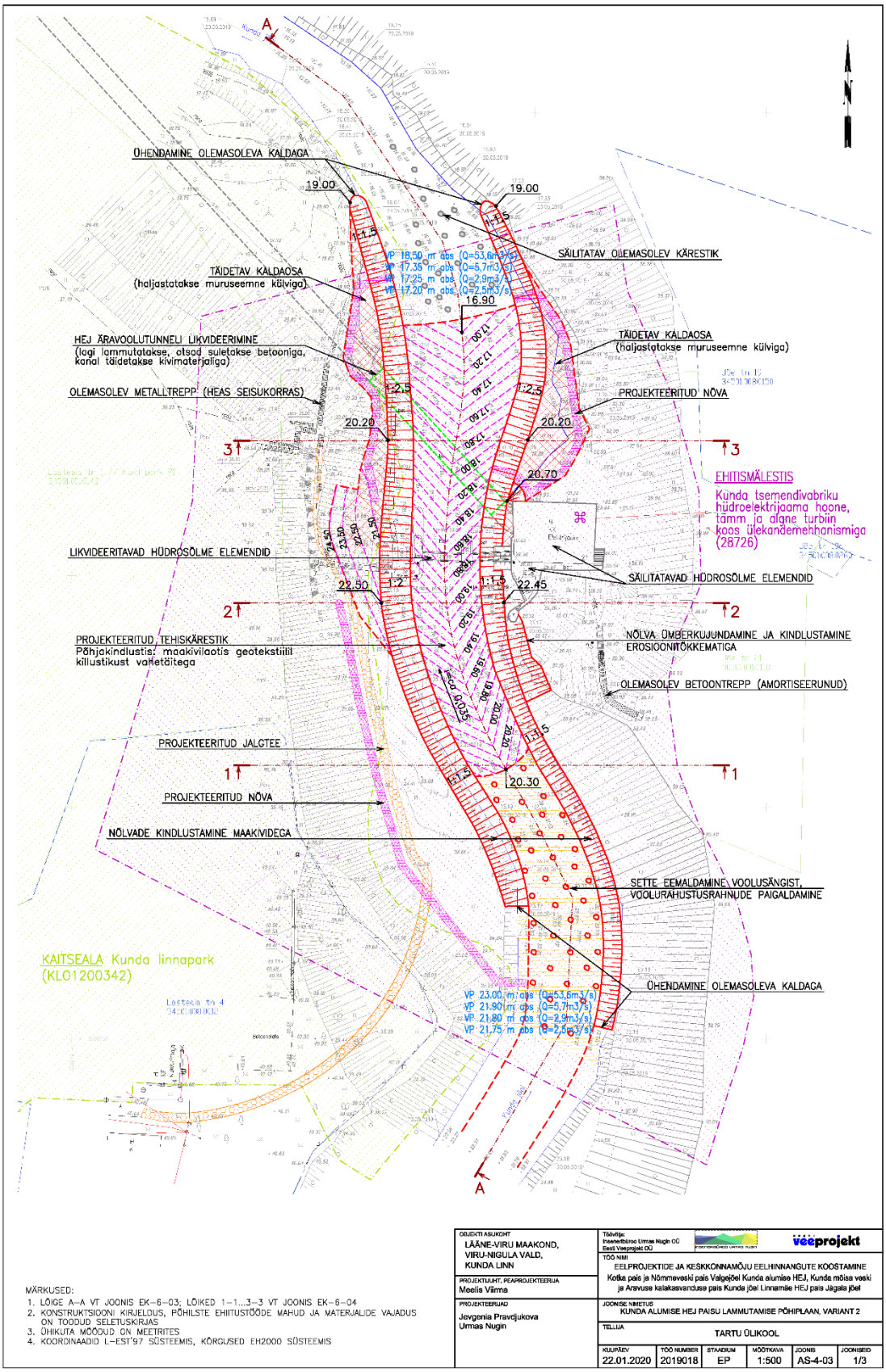

Figure 9. Design drawing (top view) of the second alternative solution for Kunda lower HEP dam.

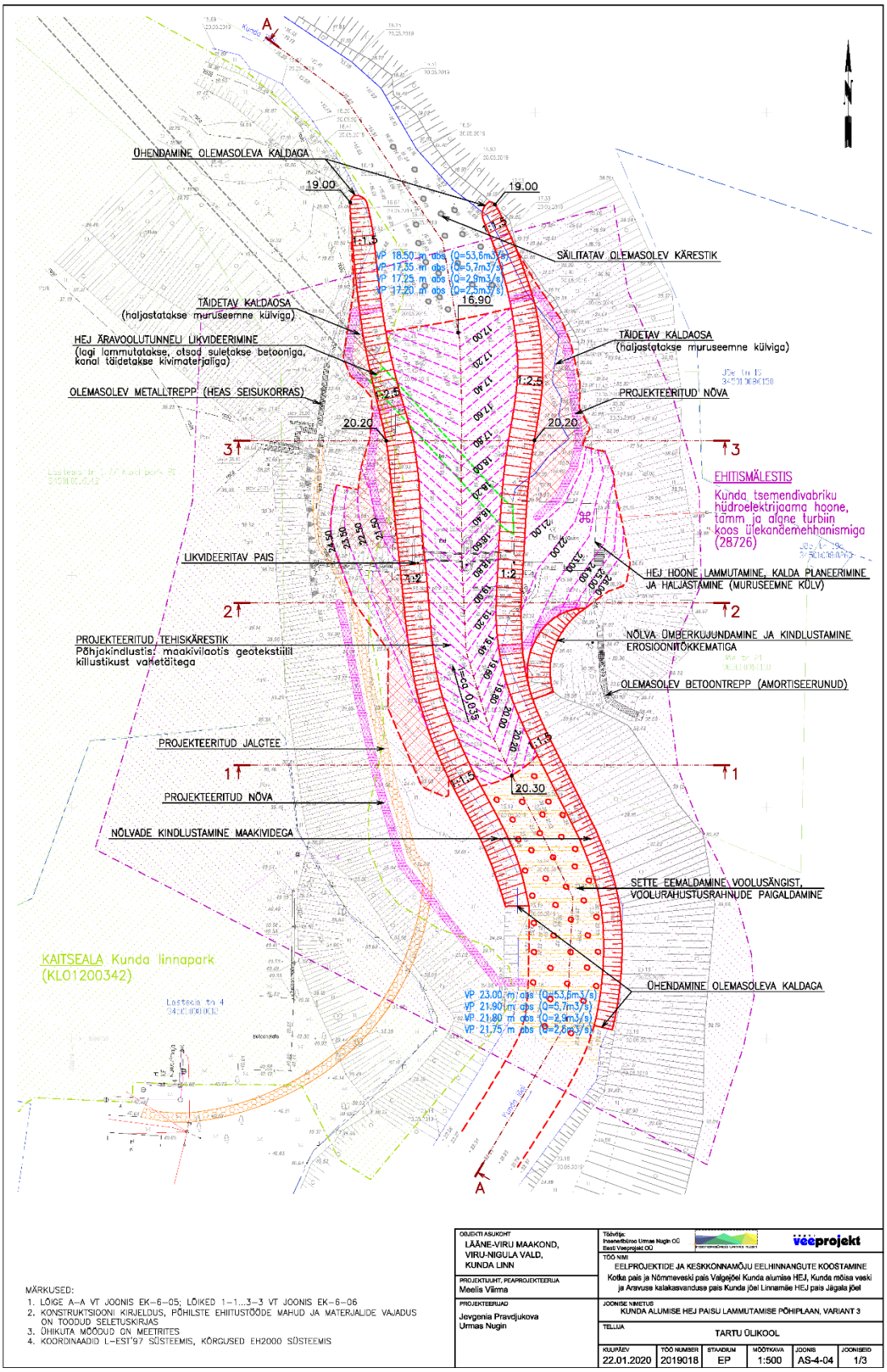

Figure 10. Design drawing (top view) of the third alternative solution for Kunda lower HEP dam.

River Kunda: Kunda manor mill dam

Country	Estonia
River	Kunda
Site	Kunda manor mill
Type of sea trout populations	Original population
Temporal scale of the restoration	Long term
Spatial scale of the restoration site	One site
Responsible organisation	NA
Duration of the project	1 years
Geographical location	N 59° 29.1197’ E 26° 31.8685’
Total budget	104 148 € (full dam removal)

General information

The Kunda manor mill dam is the third obstacle from the sea, 5.5 km from the river mouth (N 59° 29.1191’ E 26° 31.8662’; Figure 6). Kunda river is 82.2 km long and has a catchment area of 535.9 km^2. The elevation at the source is 90 m. Water quality of the river is classified as good. The river has wild native Atlantic salmon population that spawns only on the lower 2.3 long river section. Salmon parr density on that section is high; however, it comprises only 10 % of the rivers potential spawning areas. In addition, sea trout, river lamprey and vimba bream also ascend to the lower part of river but over 90 % of the suitable spawning areas are located upstream of the dam. Resident trout, grayling and European bullhead exist throughout the watershed. There are no fish releases done in the river and all fish populations are considered wild and native.

Planning phase

The Kunda manor mill was built in 1870. Its original height was 2.7 m. The wan is in ruins and remaining height is 1.7 m. It is still a definite migration obstacle. The dam has no longer any function, does not have water permit, and it is not identified as culturally valuable. Negotiations to buy the dam from private owners by the Estonian Ministry of Environment are ongoing. State ownership of the dam enables implementation of the most optimal solution. The dam is in a steep valley and space for a passage solution around the dam is very limited. During the planning phase it became evident that removing the dam is most sensible. Through procurement hydro engineering companies Eesti Veeprojekt OÜ and Inseneribüroo Urmas Nugin OÜ were hired to compose (one solution) for the dam removal plan. Preliminary environmental impact assessment (PEIA) for one alternative was carried out by AS Maves. It was concluded that environmental impact assessment (EIA) is not necessary to prepare as the objective of the planned work is to improve the environment.

The only prepared solution is to remove all remaining parts of the dam, enforce the riverbanks at the immediate vicinity of the dam. The deep pool below the dam would be filled with gravel and boulders (Figure 11). Calculated cost of the dam removal is 104 148 euros.

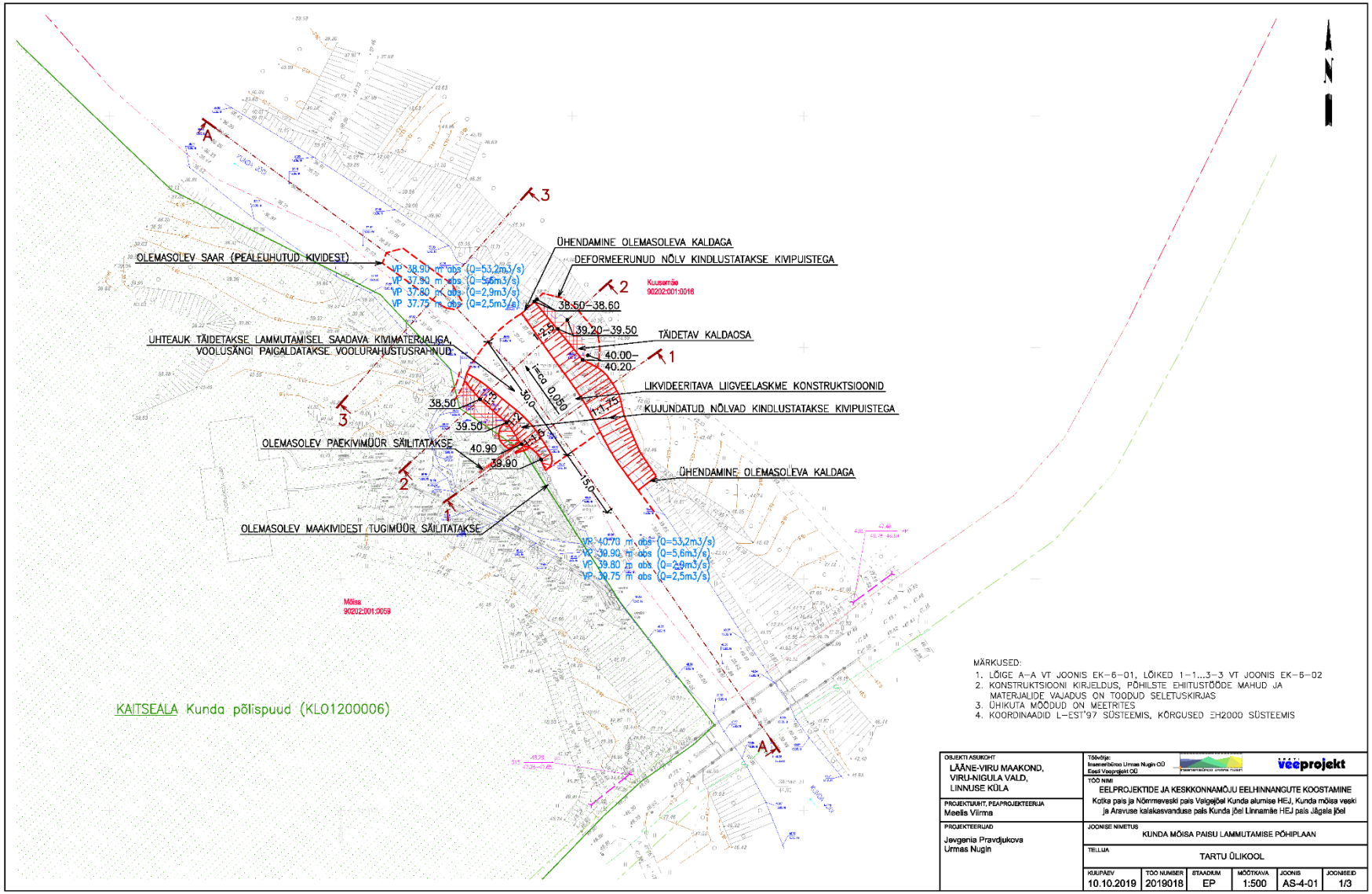

Figure 11. Design drawing (top view) of the produced solution for Kunda manor mill dam.

River Kunda: Aravuse fish farm dam

Country	Estonia
River	Kunda
Site	Aravuse dam
Type of sea trout populations	Original population
Temporal scale of the restoration	Long term
Spatial scale of the restoration site	One site
Responsible organisation	NA
Duration of the project	1 years
Geographical location	N 59° 14.0251’ E 26° 39.3879’
Total budget	182 820 € (natural like pass)

General information

The Kunda river is 82.2 km long, has a catchment area of 535.9 km^2. The elevation at the source is 90 m. Water quality of the river is classified as good. The river has wild native Atlantic salmon and sea trout populations. River lamprey and vimba bream also ascend to the river. Resident protected species are grayling and European bullhead. The lower part of the river has three dams and all of them had a negative effect to the previously mentioned fish species. The Aravuse dam is located on the upper part of the river. It is part the water supply system for a fish farm. It is the fourth and uppermost obstacle of the river (50 km from the sea, N 59° 14.0233’ E 26° 39.3918’; Figure 12). The precise size of the spawning areas upstream of the dam is not known, however the upper 30 km long river section

holds resident native trout population, and it has valuable spawning areas to sea trout and river lamprey. Abundance of resident trout in the upper part of the river is not regularly monitored.

Planning phase

The Aravuse dam was built in 1970 as part of water supply of a fish farm. Its height is 1.5 m high and has no fish pass. During the planning phase it became evident that it is not possible to remove the dam and a fish pass is needed. The dam has a water permit, and it requires the owner to provide fish passage in near future. Through procurement hydro engineering companies Eesti Veeprojekt OÜ and Inseneribüroo Urmas Nugin OÜ were hired to compose one solution for the dam removal. Preliminary environmental impact assessment (PEIA) for one alternative was carried out by AS Maves. It was concluded that environmental impact assessment (EIA) is not necessary to prepare as the objective of the planned work is to improve the environment.

One solution was produced. A natural-like fish pass would be built to the right side of the dam. The upper entrance is located between the bridge and the dam on the right side and the lower entrance is planned to be built as close to the base of the dam as possible. The width of the planned pass is 1.2 m, depth is 1 m, and length is 130 m (Figure 13). The pass will have two resting pools without gradient and overall slope of the pass is 1.45 %. The pass channel will be covered by geotextile which would be covered by gravel and boulders to imitate natural rapid. Calculated cost of the fish pass is 182 820 euros.

Figure 12. Location of Aravuse dam on upper river Kunda. Source: www.maaamet.ee.

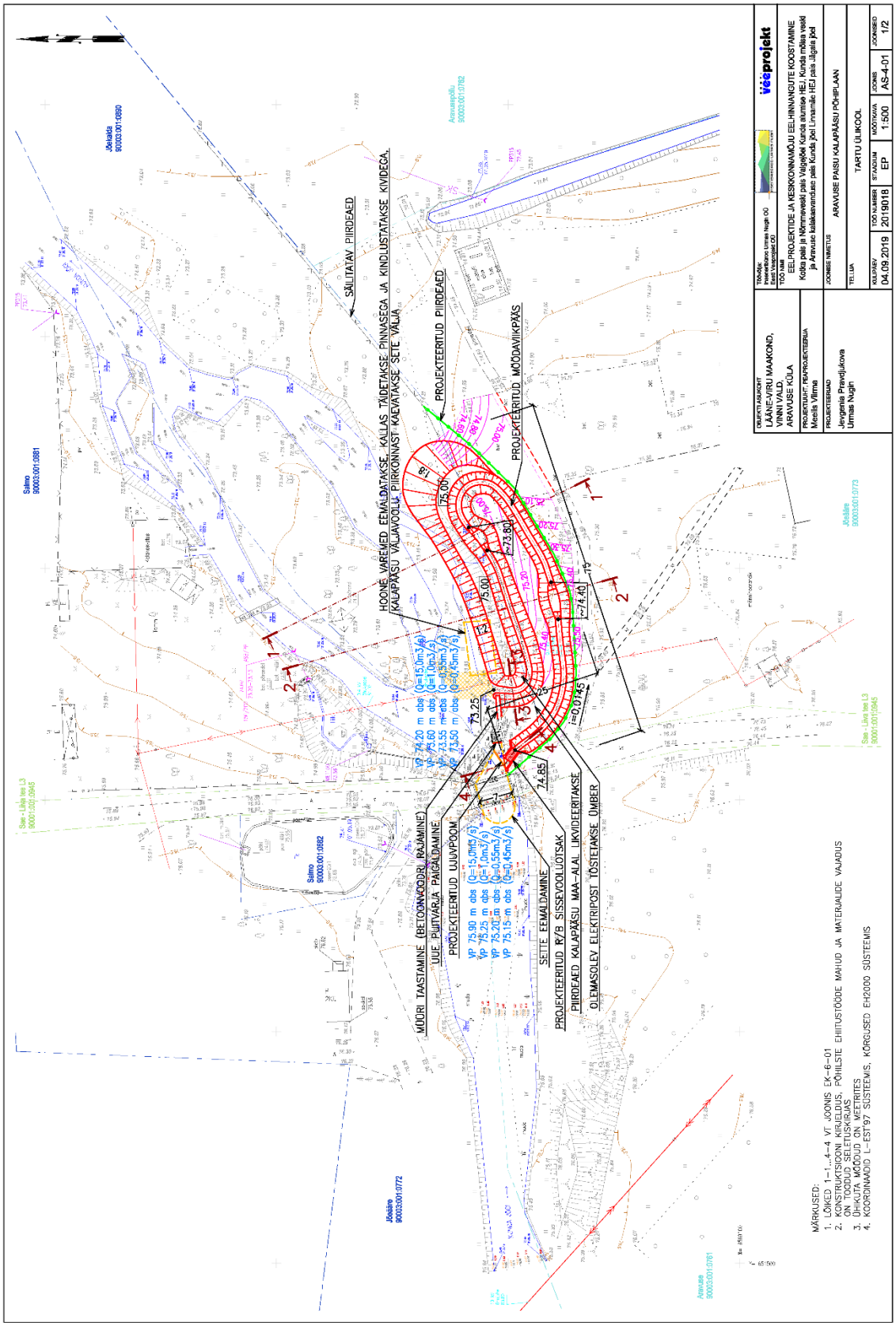

Figure 13. Design drawing (top view) of the produced solution for Kunda Aravuse fish farm dam.

River Jägala: Linnamäe hydropower station (dam)

Country	Estonia
River	Jägala
Site	Linnamäe HEP
Type of sea trout populations	Original population
Temporal scale of the restoration	Long term
Spatial scale of the restoration site	One site
Responsible organisation	NA
Duration of the project	2 years
Geographical location	N 59° 14.0251’ E 26° 39.3879’
Total budget	Alt. 1. 6 777 045 € (natural like pass)

General information

The river Jägala is 119 km long, has a catchment area of 1481 km^2 and elevation at the source is 82 m. Water quality of the river is classified as satisfactory and it has improved considerably during past two decades. The river has a natural 8 m high waterfall 4.3 km from the sea. Historically Atlantic salmon, sea trout, anadromous whitefish, vimba bream and river lamprey populations existed downstream of the fall. When Linnamäe HEP was built 1.3 km from the river mouth (N 59° 27.9322’ E 25° 9.352’; Figure 14), access to spawning areas of all mentioned anadromous species was blocked. As a result, anadromous fish populations disappeared from above the dam. Atlantic salmon smolts are regularly stocked to compensate for the loss of the natural population and some adults ascend the river. The

Linnamäe HEP was built in 1924. Its height is 11 m (Figure 15). A primitive technical fish pass was also planned but was never fully built. The dam was partially demolished in 1941 and was restored to its present state in 2002.

River Jägala from the waterfall to the sea is a Natura 2000 area, and the achievement of a good ecological status is first priority. This necessitates the restoration of the riverine habitat and fish fauna. The original parts of the Linnamäe HEP were declared as culturally valuable in 2016 and therefore a demolition of the dam became in conflict with the cultural values. The HEP has a temporary water permit. Yet the owners have an obligation to provide fish passage.

Planning phase

During the planning phase it became evident that natural and cultural values are conflicting, and a compromise is needed. Three passage solutions were compiled with the primary objective to restore the riverine habitat and ensure free fish passage with a high certainty. Cultural values were deemed secondary and may be renounced to some extent. Through procurement hydro engineering companies Eesti Veeprojekt OÜ and Inseneribüroo Urmas Nugin OÜ were hired to compose three solutions for the dam removal. Preliminary environmental impact assessments (PEIA) for the solutions were carried out by AS Maves. It was concluded that environmental impact assessment (EIA) is not necessary to prepare as the objective of the planned work is to improve the environment.

Construction of a fish pass next to the dam was deemed to be insufficient to recover fish populations. Two thirds of the historical spawning and rearing areas are destroyed by the impounded lake. The dam is located in a steep valley and available space for the fish pass is limited. Therefore, only solutions that end water impoundment would ensure the recovery of anadromous fish populations. That became the basis of all alternatives.

In the first alternative a 30 m long part of the dam on the left bank would be demolished, rest of the dam would remain intact. Water level will be lowered to pre dam level and new river channel to the left from the dam would be built. New river channel would be 200 m long and would have a slope of 1.45 %. To keep the left side of the valley stable, a 200 m long and up to 12.8 m high concrete wall would be built (Figure 16). A new bridge would connect the remaining dam with the opposite riverbank. The calculated cost of this alternative is 6 777 045 euros. This alternative retains most of the cultural values at the dam and provides free passage to all fish and aquatic life.

Second alternative is to remove the main concrete body of the dam and lower the water level to the original height. A 130 m long rapid with a 1.65 % slope would replace the dam and impounded lake area (Figure 17). Only the turbine building on the right side of the river would remain. This alternative would retain cultural values only partially and would restore the river close to its original state. The calculated cost of this alternative is 2 169 750 euros. The remaining turbine building needs maintenance and that cost is not included.

Third alternative is to remove all parts (including the turbine building) of the dam and restore the river and the valley close to its original state. Riverine conditions would be identical to the second alternative. In this case cultural values would not be preserved (Figure 18). Calculated cost of this alternative is 2 391 246 euros.

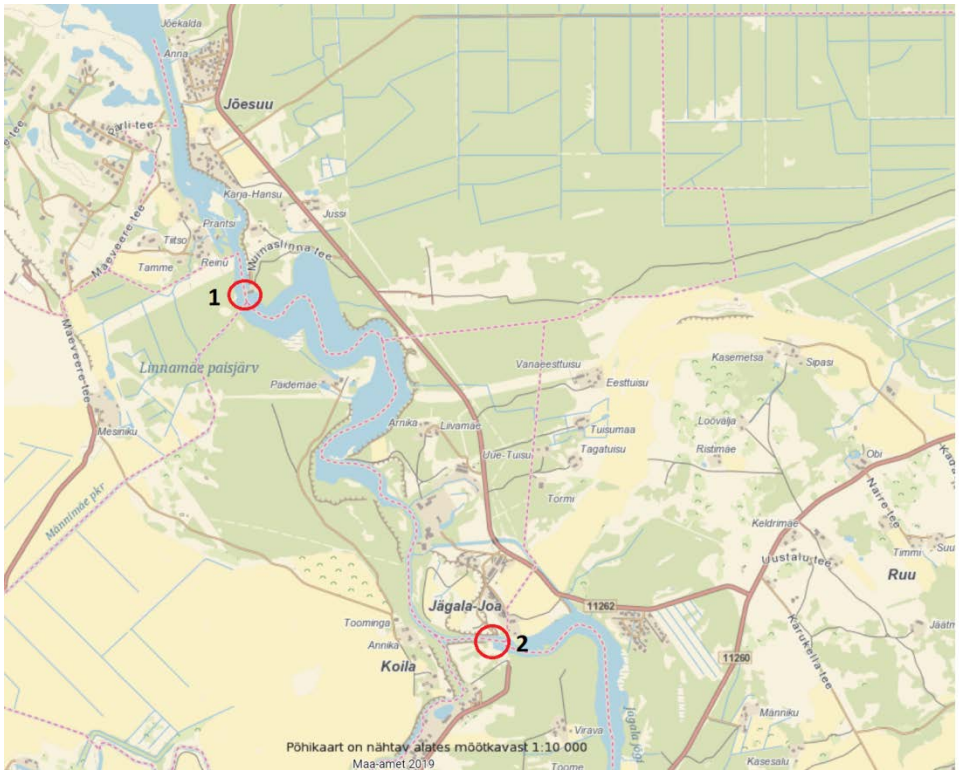

Figure 14. Indicates the location of the Linnamäe hydroelectric power station and 2 indicates the location of the Jägala-Joa waterfall. Source: www.maaamet.ee.

Figure 15. Construction of a Linnamäe HEP to river Jägala resulted is the loss of all anadromous fish populations in 1920s. Photo credit: Martin Kesler.

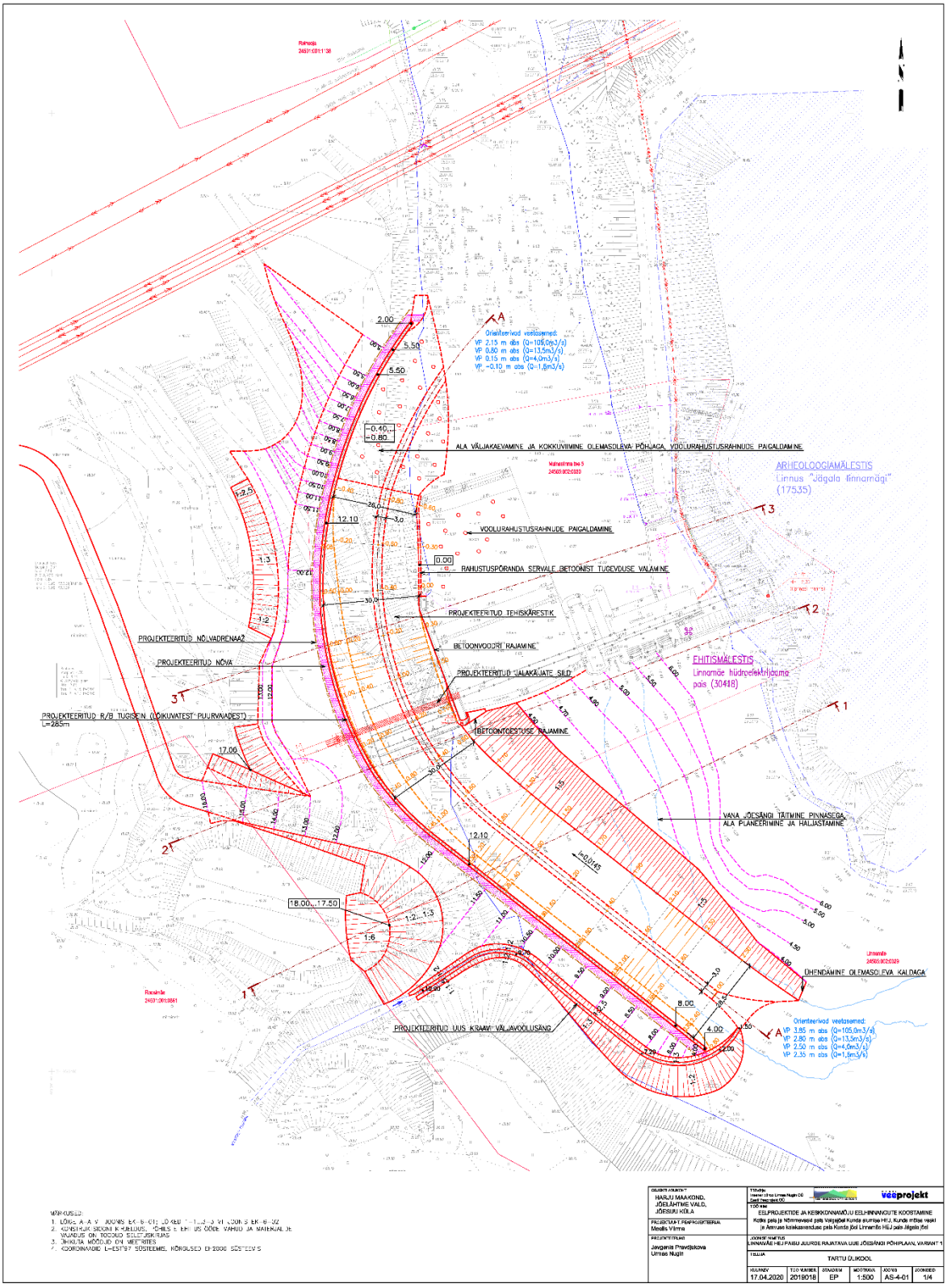

Figure 16. Design drawing (top view) of the first alternative solution for Linnamäe hydropower station dam.

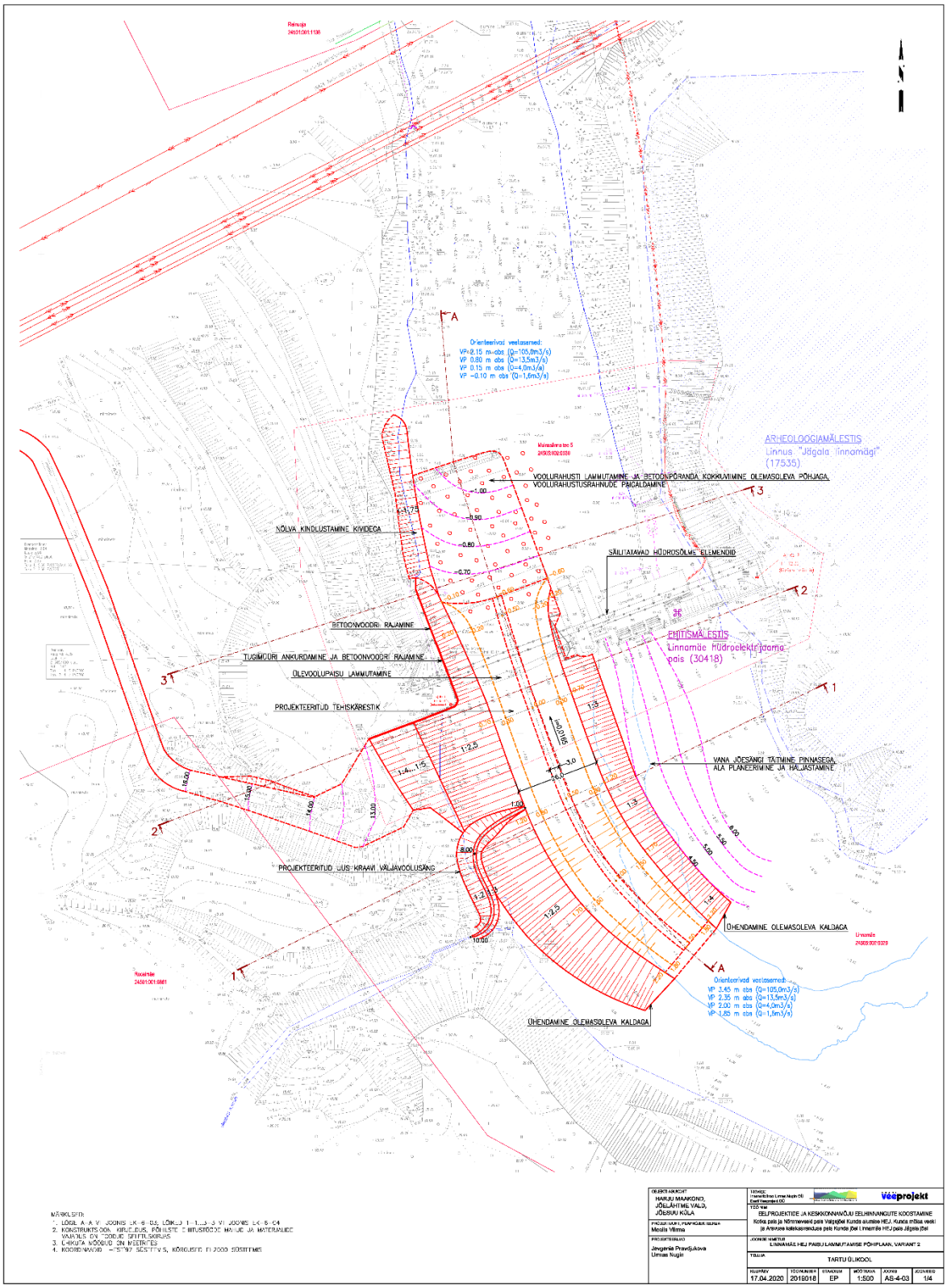

Figure 17. Design drawing (top view) of the second alternative solution for Linnamäe hydropower station dam.

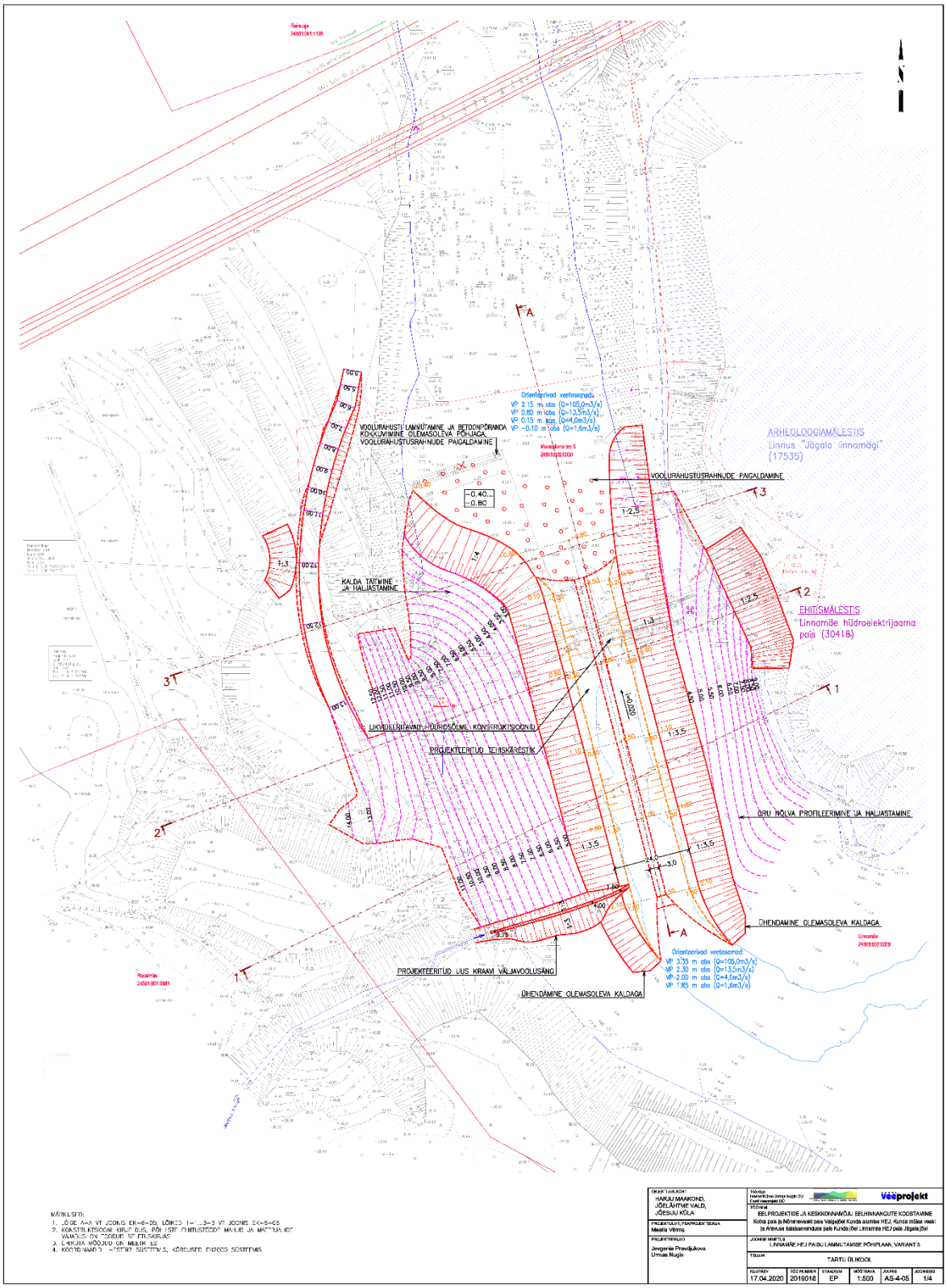

Figure 18. Design drawing (top view) of the third alternative solution for Linnamäe hydropower station dam.