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Design report

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LOVIISA

AQUATIC PLANT CONTROL IN THE LOVIISA BAY AND THE LAI-VASILTA GUEST HARBOR

RAMBOLL

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Cover photo: City of Loviisa, aerial photo from the Loviisa river delta

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1. PROJECT DESCRIPTION

1.1 Project background and goals

Excessive growth of aquatic plants has been a problem near the Laivasilta guest harbor in Loviisa. Plants have been removed repeatedly over the years, last time in summer 2017 by mowing. An open waterfront clear of plants makes the harbor area more appealing and improves its scenic value.

The area covered in this design report is situated North from the Laivasilta guest harbor, in the Loviisa bay near the mouth of the Loviisa river.

Water depth on the delta is shallow, which enables plentiful growth of aquatic plants. Mowing the plants, however, keeps them away only temporarily. This report displays more long-term, economically and ecologically feasible ways to control the growth of aquatic plants.

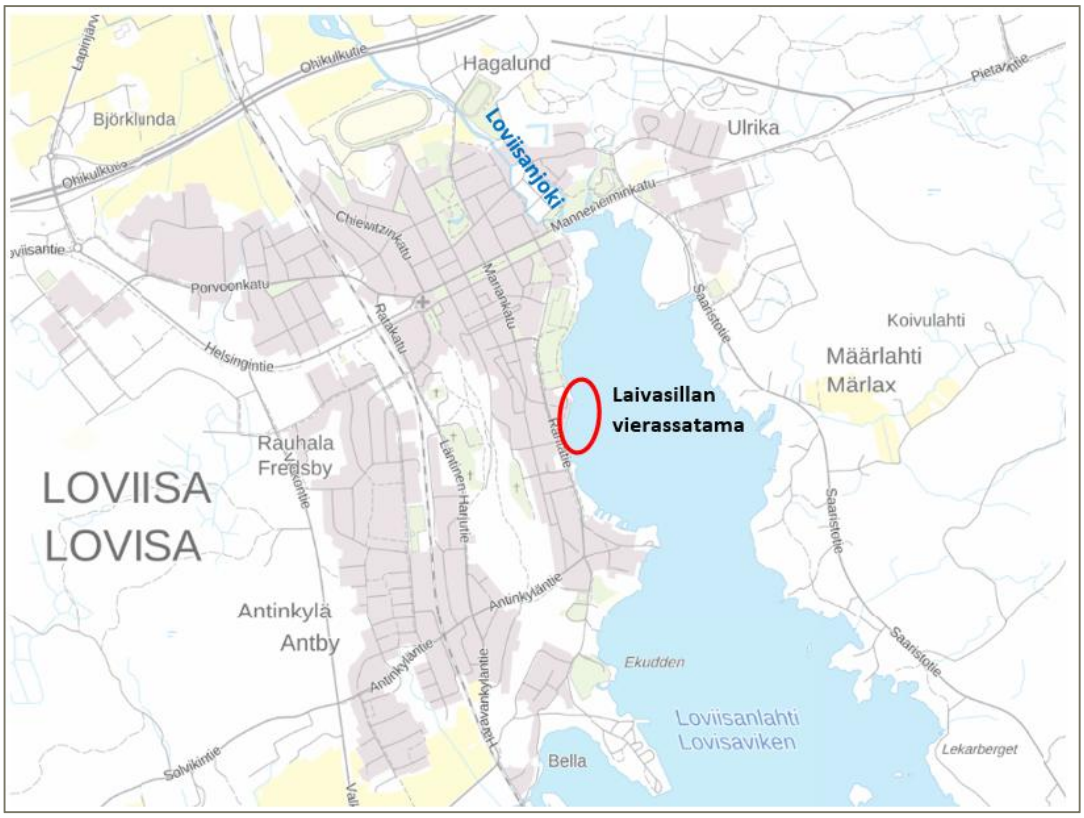


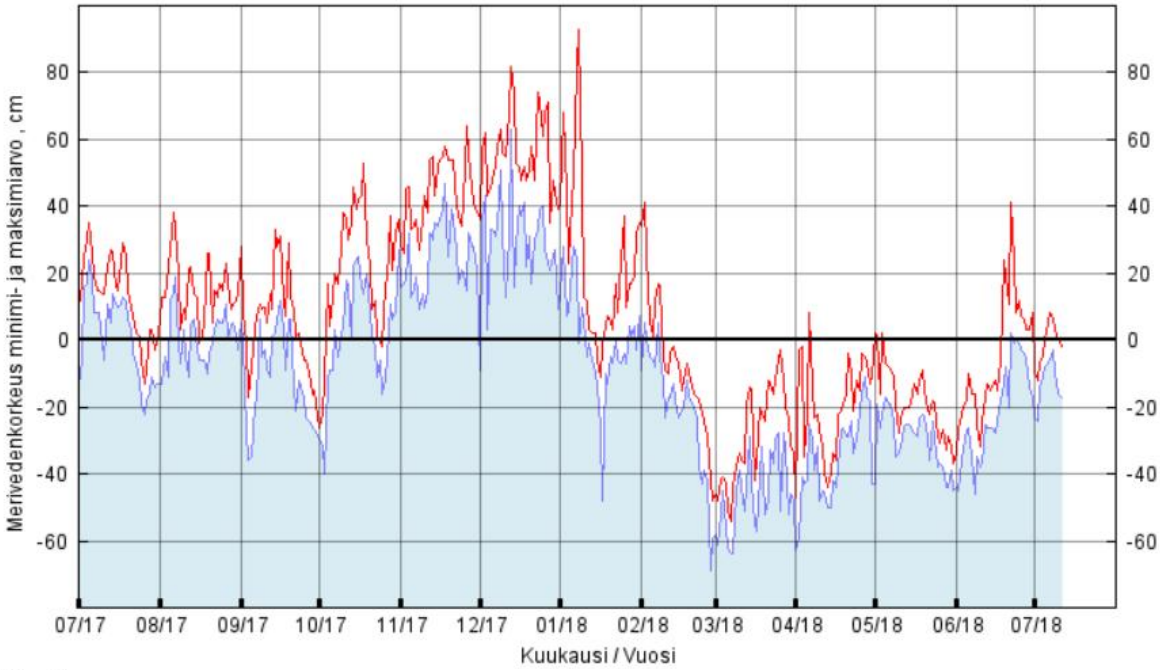
Image 1-1. The design area on a map.

1.2 The water system

According to the Finnish Meteorological Institute, theoretical mean sea level (MW) in Loviisa in the recent years has been about N60 -0,03 m. MHW (mean high water) level is about N60 +1,25 m. This year's lowest sea level in the summertime has been about N60 -0,2…-0,4 m. Image below (Image 1-2) shows the variation of sea level during last year. The red line represents the daily maximum observations and the blue line the daily minimums.

Water depths in the delta are displayed on a chart below (Kuva 1-3). In the project area the sea bottom is about N60 -0,6 m. The north side of the harbor has been dredged to the level N60 -1,8 m. If the project area were to be dredged with the mean low water in mind, excessive dredging of the delta area would be needed.

Porvoo



Hamina

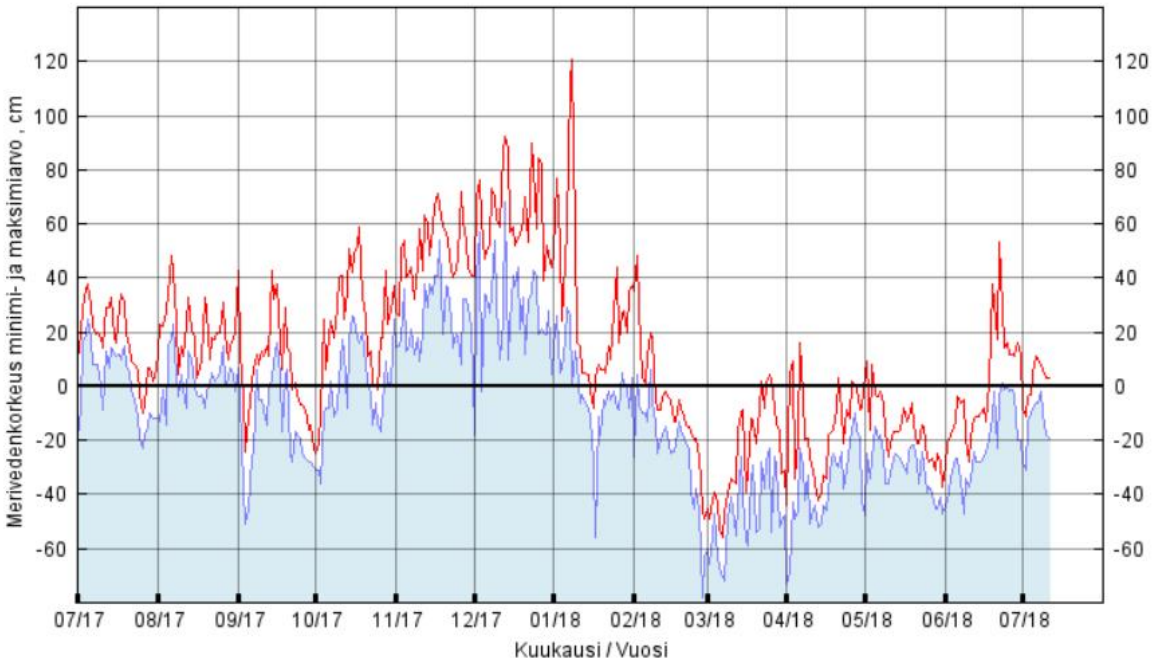
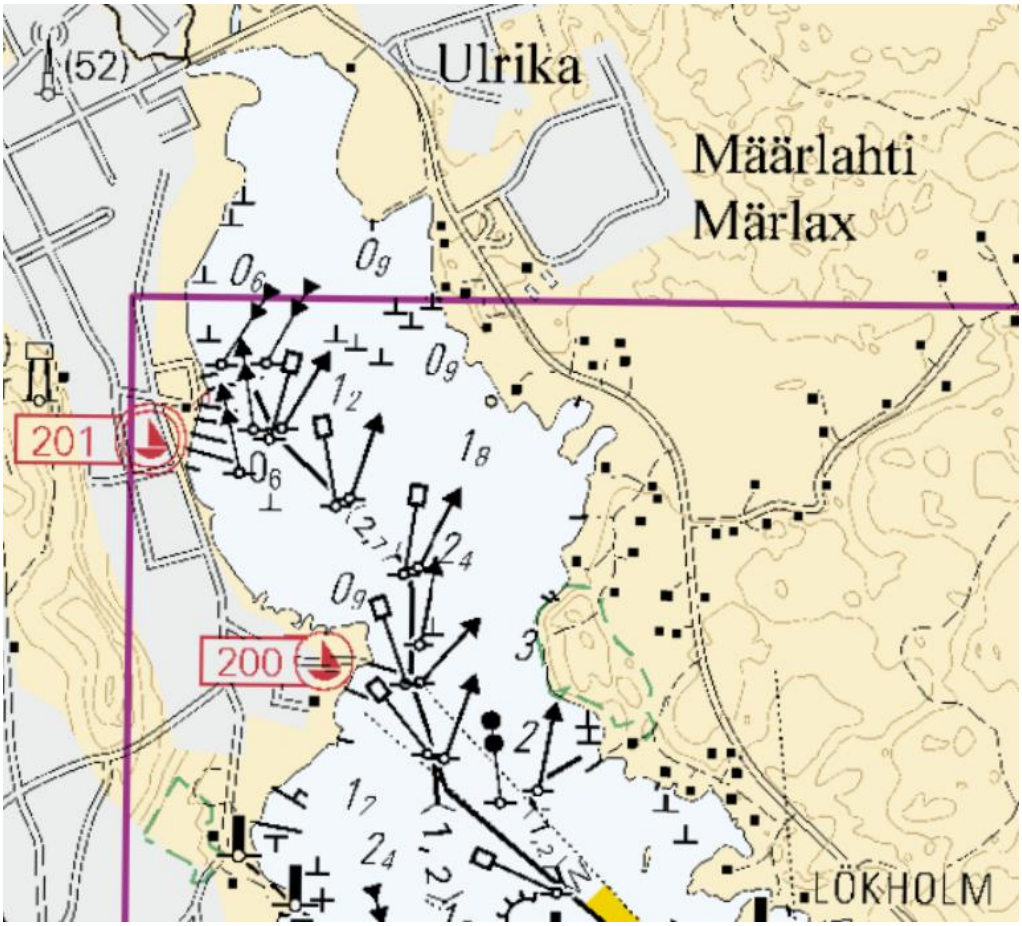


Image 1-2. Variation of sea level during the last year in two places near Loviisa (Finnish Meteorological Institute).



Kuva 1-3. Chart of Loviisa bay (Finnish Transport Agency).

Size of the Loviisa river catchment area (81.027) is 117 km^2 and 4 percent of the area is lakes (Image 1-4). Flow rate in Loviisa river varies a lot, which increases the washout of suspended solids. The ecological state of Loviisa bay is passable and the chemical state good. Loviisa river is a medium-sized river in region with clay soils and its ecological and chemical states are good. The river is naturally murky, and the water is eutrophic with high concentrations of phosphorus and nitrogen (Image 1-5).

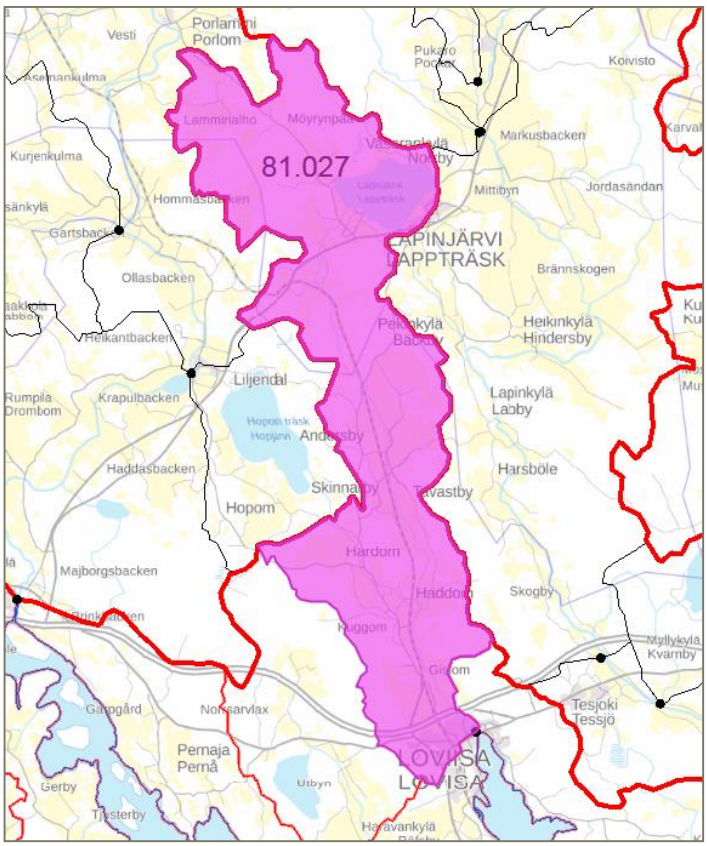


Image 1-4. Loviisa river catchment area (81.027).

Vedenlaadun havaintopiste Loviisanjoki 0,8, 1.1.2010-10.4.2018, n=32			
	Minimi	Maksimi	Keskiarvo
Alkaliniteetti mmol/l	0,26	0,84	0,53
Ammonium typpenä NH_4N µg/l	11	140	60
Biokemiallinen hapen kulutus BOD mg/l	0,8	5,3	1,4
Fosfaatti fosforina PO_4P µg/l	2,5	31	9,3
Hapen kyllästysaste kyll.%	67	91	77
Happi, liukoinen mg/l	6,5	11,9	9,8
Kemiallinen hapen kulutus mg/l	5	24	11
Kiintoaine, karkea mg/l	1	85	21
Kokonaisfosfori, suodattamaton µg/l	22	220	83
Kokonaistyppi, suodattamaton µg/l	590	2300	1304
pH	6,3	7,5	
Rauta, hajotus µg/l	860	5300	2244
Sameus FNU	4,6	155	45
Sähkönjohtavuus mS/m	6,5	30	16
Väriluku mg/l Pt	15	140	62

Image 1-5. Water quality in Loviisa river and location of the observation point (Finnish Environment Institute).

High nutrient levels in water and the shallow depth creates ideal circumstances for aquatic plants.

About 30 % of the Loviisanjoki catchment area is fields and about 70 % is forest. There are about 1200 scattered inhabitants in the area. The forest land is a source of considerable nutrient and suspended solid loading to the river. Most of the phosphorus loading comes from agriculture. Loading from sparsely populated area should be diminished too. Urban rainwater runoff from Loviisa city is discharged to the Loviisa bay, which effects the state of the bay.

2. RESTORATION OPTIONS IN THE CATCHMENT

2.1 Forestry and agriculture

NutrinFlow-project by Pro Agria, local farmers and city of Loviisa aims to improve the state of the Gulf of Finland by reducing nutrient loading from agriculture. The project is currently running in Hardombäcken's drainage network. Trees have been removed from the ditch banks. Flood plains, sedimentation basins and other structures to improve the state of fields and water systems have been built. A wetland plan has also been made for the catchment area (Erkkilä 2011) and some wetlands have already been built.

Reducing loading from the Loviisa river catchment helps to cut nutrient loading to Loviisa bay, which diminishes the growth of aquatic plants. Most of the loading seems to come from agriculture.

Water flow rate in Loviisa river varies a lot and river banks are susceptible to erosion. Recommended restoration options include for example riparian zones for agriculture and forestry, improving the fields' soil properties and controlling water flow velocities in the catchment.

Soil properties of fields can be improved by using gypsum, which is an industry side product. The method is being researched a lot (eg. SAVE-project) and has a potential to significantly reduce agriculture's phosphorus loading to the Baltic Sea.

Methods to cut loading from forestry include riparian zones and runoff control structures in drainage networks. Methods to stall water in the catchment area and cut maximum discharge in the river include sills, flood plains, weirs, brush dams, protection from erosion and restoring old streambeds.

2.2 Waste water from sparsely populated area and urban rainwater runoff

Waste water from sparsely populated area should be treated especially in households that have water pipes and sewers but lack a proper waste water treatment system. Loviisa's environmental guidelines state, that in houses near a river or a lake, at least 90 % of organic solids, 85 % of phosphorus and 40 % of nitrogen should be removed from the waste water. There are a lot of different techniques available for household waste water purification. The most common treatment methods dissipate organic matter and bound phosphorus.

Urban rainwater runoff transports solids, nutrients, metals, oils, hydrocarbons and microbes to water systems. Runoff can be controlled by slowing down its flow rate, stalling water in the head-waters and at the same time holding back contaminants and nutrients. There is a complete water system for urban rainwater runoff in Loviisa city and it is challenging to make changes to that. It is possible, however, to add runoff treatment systems to the existing infrastructure. These can be for example biofiltering areas or urban runoff basins, which also work as recreational areas in the city (for example image 2-6). Amount of runoff can be reduced by replacing unnecessary asphalt areas with more permeable materials or turn them into parks. Plowed snow contains a lot of contaminants, and it should be transported to a snow dump. Melting water should be treated before letting it back to a natural water system.

Urban runoff from Loviisa city is released to the Loviisa bay in many locations near the Laivasilta guest harbor (appendix 1, action 5). It is possible to treat runoff water on a sub-catchment scale by adding biofilters or basins to the existing infrastructure. On the north side of the guest harbor there is space for runoff treatment solutions (Image 2-1). Multiple solutions can form a runoff park. Suitable solutions to improve water quality include settling ponds for solid matter (also removes nutrients and metals) and biofiltration, filtering ponds and filtering depressions to remove soluble pollutants (image 2-6).

Aquatic plants near the runoff discharge point should be saved. Vegetation helps slow down the water flow and remove nutrients.

Image 2-1. Suggestion for urban runoff water purification. Vegetation near the shore is saved. There is space for a runoff park in the park area.

Image 2-6. Examples of urban runoff treatment solutions.

3. RESTORATION OPTIONS IN LOVIISA BAY

City of Loviisa uses the coordinate system ETRSGK26 (short form) and the height system N60. Actions are presented in N60, which is close to the theoretical mean sea level.

Actions on Loviisa bay are presented on a map in appendix 2.

3.1 Dredging

Dredging the delta area should be done with gentle slopes (at least 1:6). New open water areas are dredged to level N60 -0,5 m. If mowed areas need to be deepened by dredging, they are also dredged to level N60 -0,5 m. The area is ecologically important (birds and fish) and the aim of dredging is to increase diverse open water area.

As the Loviisa river runs towards the Loviisa bay, its flow rate slows down. Solid matter settles and piles up on the delta area. When done according to the plan, dredging divide the flow and scatters it to a wider area. This helps to keep the shore more open and plant-free. Water depth in the dredged area is mostly -0,6…-0,8 m. It is possible to make a small deeper area (level N60 -1,2 m) near the mowed areas to add diversity. Dredging to a deeper level in all areas would center the flow too much and cause overgrowth of aquatic weeds in other parts of the bay. A more scattered, diverse flow can keep the shore open and control vegetation even though the water depth remains shallow. The aim of the new dredging is to add new flow paths to the bay. If the dredging is expanded, it could make water murkier.

All dredging in the bay must be done with floating equipment. On the western shore a long boom excavator can be used during low water. March is ideal time for the work. Masses must be mapped and sampled for harmful substances and contaminants before dredging. The quality of the masses limits the options for dumping locations. Transport costs can increase unexpectedly, if masses have to be transported far. Clean masses can be dumped to the shore.

If dredged masses are dumped on land and they must be treated for example with lime, the maximum heap height is 0,5…1 m. The masses contain a lot of water and loosen while transported. Theoretically, 3 hectares of dumping area is needed, but the area must be specified with further planning. This report contains two possible locations for dumping sites. They must be high enough from the sea level so that flood water does not flush the masses back into the sea. Dried, compacted and plant covered masses stay in place.

Dredging of this scale requires a water permit from the Regional State Administrative Agency. The permit requires more detailed application plan with sediment depths and quality, mass amounts and impact assessment. The mowing areas must also be included in the application because they change flow routes in the delta area.

Dredging can cost over 0,5 million euros. Especially dumping and transporting can add unexpected costs.

Ruoppaukset, kustannukset			
	määrä	yks.kust	yhteensä
Uusi vesialue (kelluva kalusto)	3000 m^3ktr	14	42 000
Suiston ruoppaus (kelluva kalusto)	12 000 m^3ktr	14	168 000
Rantavyöhykkeen ruoppaus, 4 aluetta yht. (voi onnistua osittain kaivinkoneella aliveden aikaan)	7700 m^3ktr	12	92 400
kuljetusten ja mahdollisesti happamien maiden/haitta-aineita sisältävien massojen läjittämisen lisäkustannus (jos noin 1/2 massoista käsitellään)	12 000 m^3ktr	6	72 000
Työmaateiden rakentaminen	erä	20000	20 000
Avustavat työt, kuten raivaukset	1 erä	5 000	2 000
Rakennussuunnittelu ja vesiluvitus tutkimuksineen (mm. sedimentin paksuus ja haitta-ainemääritykset)	1 erä	20 000	20 000
Rakennuttaminen ja tarkkailu	1 erä	16 000	16 000
Yleiskustannukset ~17 %	erä		73 600
			506 000

3.2 Mowing

In addition to dredging, mowing aquatic plants increases the open water area. Mowing is a suitable method to reduce emersed weeds. Floating weeds also appear in the area. It is more complicated to mow them, because they often store a lot of nutrients in their roots. Therefore, it is crucial to mow in several consecutive years. Submersed weeds have not been spotted in the area. If they are found during mowing, they should be harvested in the third year.

Harvest areas presented in the report are directive, and further investigations of the flora are needed to specify them. The complete area is 8900 m^2. The planned areas for mowing are wavy and widen towards the seas. This way waves helps to keep the areas plant-free. To ensure more permanent results, mowing is done in three consecutive summers. A good time for mowing is from mid-July to mid-August, when the plants have most nutrients stored in roots. This weakens the flora and disturbs the fish and birds relatively little. Birds nest from April to July. The nesting birds bust be considered during further planning. In the first summer the weeds are mowed twice. Low sea level can limit the time of mowing.

Ideal equipment is a collecting and baling mower. The wet plant waste should be dumped far enough from the shoreline to prevent nutritious water from flowing back to the bay. Waste can also be composted or used as animal feed.

After three summers of mowing the plants are free to grow in the open water areas. The scattered flow keeps the “channels” open and plants help to take in solid materials. Mowing must be repeated later, when the weeds have grown too much and the scattered flow from the Loviisa river starts to center again. This will happen years after the first mowings, and the areas are again mowed in three consecutive summers. The dredged areas can also be maintained by mowing.

Estimated costs for mowing are under 40 000 euros.

Niitot, kustannukset			
	määrä	yks.kust	yhteensä
Suistoalueen niitot			
niitot 4 kertaa keräävällä kalustolla	0,9 ha	2000	7 200
raivausnuottaus 3. kesänä tarvittaessa	erä	2000	2 000
Mahdolliset puhdistuskaivut	2000 m^3ktr	12	24 000
Yleiskustannukset ~20 %	erä		6 600
			39 800

4. IMPACT ASSESSMENT

4.1 Impacts on the state of Loviisa river and Loviisa bay

Actions in the catchment area improves the scenic value of the environment and cut the loading to downstream waters. The suggested actions retain especially solid matter, which at the same time cuts nutrient loading.

Dredging and mowing in the Loviisa bay improve the scenery and increase open water area. The delta is ecologically significant and increased open water area gives birds and fish more suitable habitats. The actions also increase the deltas ability to take in nutrients.

4.2 Benefits of the actions in relation to the costs

Actions on forestry and agriculture could together bring a major improvement to the state of the whole water system. If actions were dispersed to the whole catchment area, the needed structures would be quite small scale and low-priced. Especially structures that slow down the flow rate and increase delay would help to cut the solid matter loading.

Mowing costs less than dredging, but the results of dredging lasts longer. The flow paths of the delta cannot be changed without dredging. To make significant change, it is recommended to dredge and mow the new flow paths.

5. PROPOSAL FOR SUPPLEMENTARY INVESTIGATIONS

The thickness and contaminant levels of the sediments must be determined for the water permit application plan. Dredging should be based on a detailed technical design plan based on fresh sediment thickness charts. The application must also include the dump sites for the masses.

To achieve significant changes in the catchment area, extensive restoration actions are needed in agricultural and forestry areas. It would be very important to reduce the direct load on the Loviisa River and Loviisa Bay. For example, piped dams can be implemented without specific plans if the contractor has experience in water restoration construction and the upper catchment area of the sites is not too large. Biofiltration of the urban rainwater runoff should be dimensioned on a case-by-case basis.