

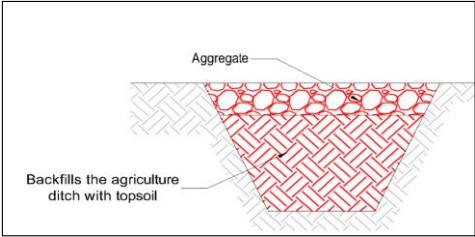


# Feasibility study, baseline studies and detailed designs for wetland rehabilitation in the city of Kigali

## Action sheet

<b>Action 5.N</b>	Name	Blocking of surface and subsurface drains		
	Action target	Water filtration, Biodiversity		
	Wetland	Nyabugogo		
<b>Location (map) N06 - N07 - N08</b>		<b>Photos / examples</b>		
		  		
<b>Characteristics</b>	<b>Rough cost estimate</b>	<b>Priority</b>	<b>Objectives</b>	
N06: backfill the agricultural drains with approximately 22 000 m3	117 500 USD	3 - Long-term 2050	<ul style="list-style-type: none"> <li>- Limit the lowering of the groundwater</li> <li>- Increase the residence time of the water in the wetland</li> <li>- Homogenise the wetland ground</li> <li>- Enhance the storage capacity of the wetland</li> <li>- Reduce the water quantity and velocity downstream</li> </ul>	
N07: backfill the agricultural drains with approximately 20 000 m3	87 300 USD	3 - Long-term 2050		
N08: backfill the agricultural drains with approximately 1 12 000 m3	2 800 USD	1 - Short-term 2025		
<b>Comments</b>				
<b>Maintenance need</b>	No needs			
<b>Management monitoring</b>	No needs			

## Feasibility study, baseline studies and detailed designs for wetland rehabilitation in the city of Kigali

### Action sheet

<b>Action 6.N</b>	Name	Planting of native plant species adapted to the wetland environment
	Action target	Biodiversity
	Wetland	Nyabugogo

Location (map) N06- N07



Photos / examples



Characteristics	Rough cost estimate	Priority	Objectives
N06 Surface : 404 800 m <sup>2</sup>	1 416 800 US Dollar	3 - Long-term 2050	<p>This action aims at recovering a herbaceous cover on all these surfaces, composed of a characteristic flora of wetlands and typical of Rwandan wetlands. For that, the first step consists in a preparation of the ground, with a decompacting of the ground in place on the first 15 centimeters in order to reactivate the seed bank and to support the rooting. The second step consists of planting with native species typical of local wetlands, such as Indian pennywort (<i>Centella asiatica</i>), Urugaga (<i>Cyperus dives</i>), Urukanganga/Epiphytic flatsedge (<i>Cyperus latifolius</i>), Carolina dichondra (<i>Dichondra micrantha</i>), Ubwungu/Heartleaf drymary (<i>Drymaria cordata</i>), Urufunzo/Papyrus (<i>Cyperus papyrus</i>), Umuberanya/Southern Cattail (<i>Typha domingensis</i>), Carex mildbraediana, Urukirakenja/Jointed flatsedge (<i>Cyperus articulatus</i>), Umujangaja/winged sedge (<i>Cyperus denudatus</i>), Carolina dichondra (<i>Dichondra micrantha</i>), Urujenone (<i>Enhydra fluctuans</i>), Gutwikumwe/Floating pennywort (<i>Hydrocotyle ranunculoides</i>), Ubusuna/Common rush (<i>Juncus effusus</i>), Urukembagufa/Cut grass (<i>Leersia hexandra</i>), Ikirogora (<i>Brillantaisia cicutricosa</i>), Umuzigangore (<i>Ludwigia abyssinica</i>), Igorogonzo/Watersmart weed (<i>Persicaria decipiens</i>), Igorogonzo/Watersmart weed (<i>Persicaria pulchra</i>), Urutaretare/ (<i>Pycreus macrostachys</i>).</p>
N07 Surface : 148 900 m <sup>2</sup>	521 200 US Dollar	3 - Long-term 2050	<p>The plantings will aim to adapt the location of the species according to their need for water and the water conditions of the soil, in order to favour their development. The seedlings must come from a local source, which is necessary both ecologically and economically: ecologically, because the plants present in a given territory necessarily have the appropriate genetics for that land and are therefore adapted to local conditions, and economically, because local actors are more in demand than foreign suppliers.</p> <p>The planting will take place in December, once the rainy season is over. The clods will be installed in a hole made with a tiller, a planter or a pickaxe and carefully positioned in the hole thus made. Before planting, the plants will be soaked in water before installation and then packed in the soil. The plants in cups will be distributed by spots at a rate of 2 plants per m<sup>2</sup>. All plants supplied by the landscaper shall be of the species and variety requested, free of wounds and pest attacks. They shall be separated by destination compartment and by species to facilitate distribution and verification. The plants must be replanted as soon as possible after delivery.</p>
<b>Comments</b>			
<b>Maintenance need</b>	Annual management by mowing in August, before the rainy season.		
<b>Management monitoring</b>	Monitoring the evolution of the vegetation twice a year, during the dry seasons, by botanical expert, over 30 years (n+1, n+2, n+3, n+5, n+7, n+10, n+15, n+20, n+25, n+30).		

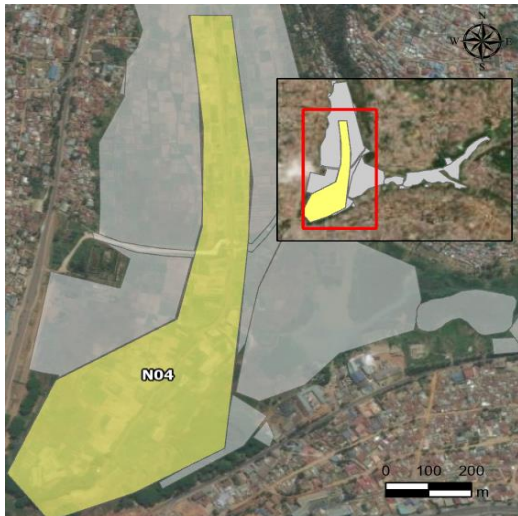
# Feasibility study, baseline studies and detailed designs for wetland rehabilitation in the city of Kigali

## Action sheet

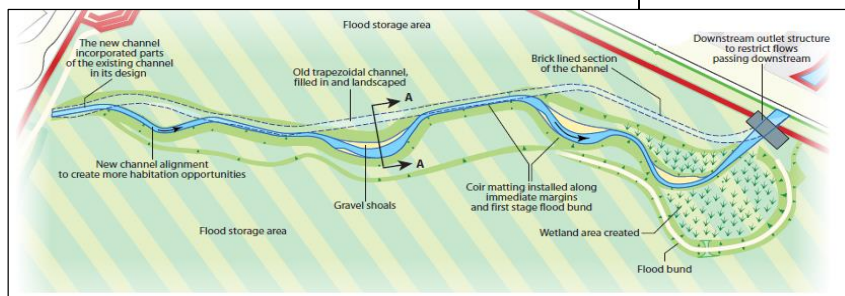
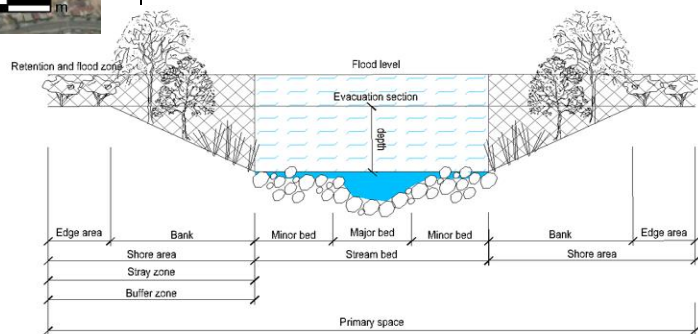
**Action 7.N**

Name	Re-profiling of the river with the creation of meanders and banks with different levels
Action target	Water filtration, Biodiversity
Wetland	Nyabugogo

**Location (map) N04**



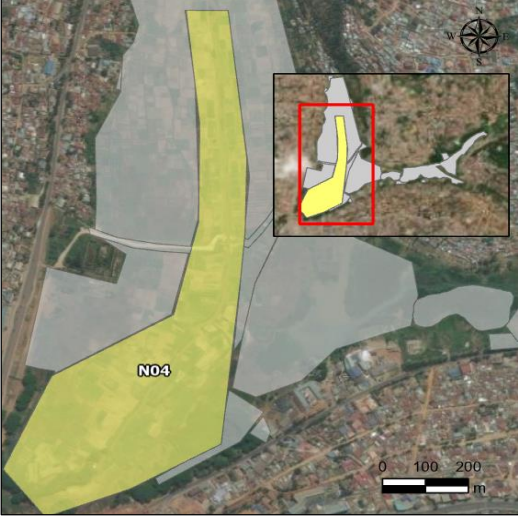

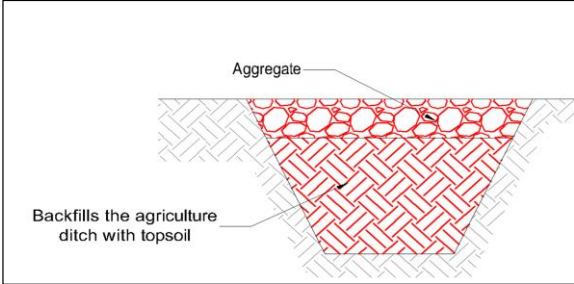
**Photos / examples**



Characteristics	Rough cost estimate	Priority	Objectives
N04 : Creation of meander and banks along 1 600 m	1 673 500 USD	2 - Medium-term 2035	<ul style="list-style-type: none"> <li>- Improve the water quality and decrease the water quantity flowing downstream (slowing the flow)</li> <li>- Improve the biodiversity</li> <li>- Promote recreational area</li> </ul>
<b>Comments</b>			
<b>Maintenance need</b>	Needs to be defined according to the monitoring management report		
<b>Management monitoring</b>	<p>The work will be the subject of a technical file of the works carried out with the plans of the built installations. A follow-up of the profile of the restored banks and the minor bed will be carried out 6 months after the end of the work and then the year that follows. The frequency will be adapted according to the possible disorders observed and the results of this follow-up.</p> <p>On the basis of the technical file, the following will be identified</p> <ul style="list-style-type: none"> <li>- Possible movements, departures or contributions of blocks;</li> <li>- All possible traces of erosion, scouring on the resumed zones as well as on the transition zones and the zones peripheral to the development not impacted by the works.</li> </ul> <p>All the elements of this follow-up will be recorded in a report. In conclusion, recommendations will be made on possible rework, the frequency of monitoring, and on future developments.</p>		

## Feasibility study, baseline studies and detailed designs for wetland rehabilitation in the city of Kigali

### Action sheet

<b>Action 8.N</b>	Name	Recharge of the river bed with aggregate		
	Action target	Water filtration, Biodiversity		
	Wetland	Nyabugogo		
<b>Location (map) N04</b>		<b>Photos / examples</b>		
				
				
<b>Characteristics</b>	<b>Rough cost estimate</b>	<b>Priority</b>	<b>Objectives</b>	
N04: filling the watercourse with aggregates of different diameter and topsoil	928 900 USD	2 - Medium-term 2035		
<b>Comments</b>				
<b>Maintenance need</b>	Needs to be defined according to the monitoring management report			
<b>Management monitoring</b>	<p>The work will be the subject of a technical file of the works carried out with the plans of the built installations. A follow-up of the profile of the restored banks and the minor bed will be carried out 6 months after the end of the work and then the year that follows. The frequency will be adapted according to the possible disorders observed and the results of this follow-up.</p> <p>On the basis of the technical file, the following will be identified</p> <ul style="list-style-type: none"> <li>- Possible movements, departures or contributions of blocks;</li> <li>- All possible traces of erosion, scouring on the resumed zones as well as on the transition zones and the zones peripheral to the development not impacted by the works.</li> </ul> <p>All the elements of this follow-up will be recorded in a report. In conclusion, recommendations will be made on possible rework, the frequency of monitoring, and on future developments.</p>			

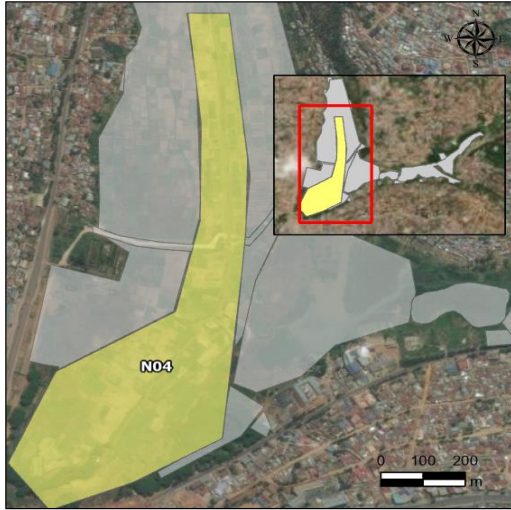
## Feasibility study, baseline studies and detailed designs for wetland rehabilitation in the city of Kigali

### Action sheet

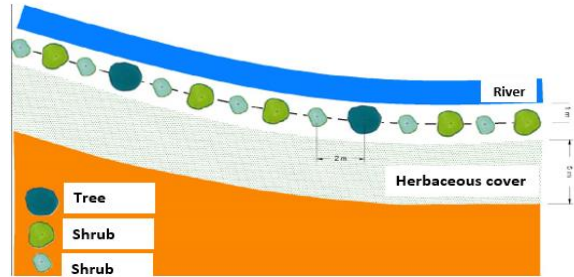
**Action  
9.N**

Name	Planting the banks with native plant species
Action target	Biodiversity
Wetland	Nyabugogo

Location (map) N04



Photos / examples



Characteristics

Rough cost estimate

Priority

Objectives

N04

Surface : 260 400 m<sup>2</sup>

911 400 US Dollar

2 - Medium-term 2035

This action aims at recovering a herbaceous cover composed of a flora characteristic of wetlands and typical of Rwandan wetlands on all the banks and edges of the main rivers. To do this, the first step consists of soil preparation, with decompaction of the soil in place on the first 15 centimeters to reactivate the seed bank and promote rooting. The second step consists of planting native species typical of local wetlands, matching the water requirements of these species with the water conditions of the soil or the frequency of overflowing of the stream (depending on the stream levels). The species planted could be : Indian pennywort (*Centella asiatica*), Urugaga (*Cyperus dives*), Urukanganga/Epiphytic flatsedge (*Cyperus latifolius*), Carolina dichondra (*Dichondra micrantha*), Ubwungu/Heartleaf drymary (*Drymaria cordata*), Urufunzo/Papyrus (*Cyperus papyrus*), Umuberanya/Southern Cattail (*Typha domingensis*), *Carex mildbraediana*, Urukirakenja/Joined flatsedge (*Cyperus articulatus*), Umujangaja/winged sedge (*Cyperus denudatus*), Carolina dichondra (*Dichondra micrantha*), Urujenone (*Enhydra fluctuans*), Gutwikumwe/Floating pennywort (*Hydrocotyle ranunculoides*), Ubusuna/Common rush (*Juncus effusus*), Urukembagufa/Cut grass (*Leersia hexandra*), Ikirogora (*Brillantaisia cicatricosa*), Umuzigangore (*Ludwigia abyssinica*), Igorogonzo/Watersmart weed (*Persicaria decipiens*), Igorogonzo/Watersmart weed (*Persicaria pulchra*), Urutaretare/ (*Pycneus macrostachys*).

In addition, on the banks, it will be possible to plant shrub or tree species, adapted to wetlands, in order to form a ripisilve along the stream. This

			<p>will stabilize the banks and strengthen the ecological corridor. This riparian buffer will be created on one side of the stream only, in order to maintain sufficient light and facilitate stream maintenance.</p> <p>The plants must come from a local source, which is necessary both ecologically and economically: ecologically, because the plants present in a given territory necessarily have the appropriate genetics for that land and are therefore adapted to local conditions, and economically, because local actors are more in demand than foreign suppliers.</p> <p>The planting will take place in December, once the rainy season is over.</p> <p>For the herbaceous species, the clods will be installed in a hole made with a rototiller, a planter or a pickaxe and carefully positioned in the hole thus made. Before being planted, the plants will be soaked in water before being installed, then tamped into the soil. The plants in the cups will be distributed in patches at a rate of 2 plants per m<sup>2</sup>.</p> <p>For trees and shrubs, plants shall be placed in a hole at least 40 cm deep and staked.</p> <p>All plants supplied by the landscaper must be of the species and variety requested, free of wounds and pest attacks. They shall be separated by destination compartment and species for ease of distribution and verification. Plants shall be replanted as soon as possible after delivery.</p>
<b>Comments</b>			
<b>Maintenance need</b>	<p>Annual management by mowing in August, before the rainy season.</p> <p>Maintenance of the rypisilve every year : removal of dead wood, pruning as needed, ...</p>		
<b>Management monitoring</b>	<p>Monitoring the evolution of the vegetation twice a year, during the dry seasons, by botanical expert, over 30 years (n+1, n+2, n+3, n+5, n+7, n+10, n+15, n+20, n+25, n+30).</p>		

## Feasibility study, baseline studies and detailed designs for wetland rehabilitation in the city of Kigali

### Action sheet

<b>Action 10.N</b>	Name	Possible development of recreational activities: Nyabugogo Wetland Centre
	Action target	Landscape / Recreational activities
	Wetland	Nyabugogo

### Location / photos examples



Characteristics	Rough cost estimate	Priority	Objectives
<b>N05 : NYABUGOGO WETLAND CENTRE</b>			
<b>Package 1 - Allowing access and delimitating spaces:</b> <ul style="list-style-type: none"> <li>- Pedestrian/cycling circuits 4m wide (3km linear)</li> <li>- Benches every 500m (10x)</li> <li>- Accessible pedestrian bridge</li> <li>- Solar light poles every 20m (150x)</li> <li>- Planting of native species (3km linear)</li> <li>- Interpretation trail (natural habitat awareness signage)</li> </ul>	<b>USD 750 000,00</b>  <b>RWF 765 622 500,00</b>	<b>1 - Short-term 2025</b>	To create an attractive wetland centre with multiple uses: nature preservation, walking, food, etc. Economic activities managed by private operators are included in the programme in order to contribute to the sustainability and durability of investments.
<b>Package 2 : Economic activities (attracting private actors)</b> <ul style="list-style-type: none"> <li>- Playgrounds (3x)</li> <li>- Cafe/restaurant</li> <li>- Events /market hall</li> <li>- Visitor centre point with gift shop</li> <li>- Toilets</li> <li>- Lighting</li> <li>- Bike rental kiosk</li> <li>- Picnic tables</li> </ul>	<b>USD 550 000,00</b>  <b>RWF 561 456 500,00</b>	<b>2 - Medium-term 2035</b>	
<b>Package 3 : Boosting attractiveness and quality of spaces</b> <ul style="list-style-type: none"> <li>- Water activities</li> <li>- Bird watching decks (2x)</li> <li>- Outdoor gym circuits (5x)</li> <li>- Landscaped areas (1000m2 planted with native species)</li> </ul>	<b>USD 250 000,00</b>  <b>RWF 255 207 500,00</b>	<b>3 - Long-term 2050</b>	
<b>Comments</b>	See detailed plan provided in annex		
<b>Maintenance need</b>	Annual for equipments and infrastructures and quarterly for green spaces with nature evolution		
<b>Management monitoring</b>	Involvement of private operators for the day-to-day management of certain facilities (restaurant/cafe, bike rental kiosk, etc). Involvement of public players (site cleanliness, waste collection and management, etc.), to manage and enforce contracts, ensure coordination for the management of the site (internal regulations) and ensure security of the site		

## Feasibility study, baseline studies and detailed designs for wetland rehabilitation in the city of Kigali

### Action sheet

<b>Action 11.N</b>	Name	Riprap at the outlet of urban discharge
	Action target	Flood control / Water filtration
	Wetland	Nyabugogo

Location (map) N01 - N02 - N03



Photos / examples



Characteristics	Rough cost estimate	Priority	Objectives
N01 Number of riprap : 4 Volume : 200 m3	9 000 US Dollar	2 - Medium-term 2035	<p>This action consists of placing boulders just at the outlet of the urban drains, in order to break the incoming flow and improve the diffusion of water towards the downstream wetland and other hydraulic outlets. These riprap will be made of stones of size between 200 and 1000 mm, depending on the flow of water arriving and the speed of flow, so that they can ensure their anti-erosion role. For each riprap, it will be used stones of different dimensions so that the small stones occupy the empty spaces between the larger stones. They will be placed one on top of the other, so as to form a homogeneous entity and in phase with the width of the drains.</p> <p>The installation of the riprap will take place in dry periods, outside of rainy periods.</p>
N02 Number of riprap : 1 Volume : 50 m3	2 250 US Dollar	2 - Medium-term 2035	
N03 Number of riprap : 5 Volume : 250 m3	11 250 US Dollar	1 - Short-term 2025	
<b>Maintenance need</b>	/		
<b>Management monitoring</b>	Visual inspection of riprap twice a year and removal of any waste or plant debris that may be present.		

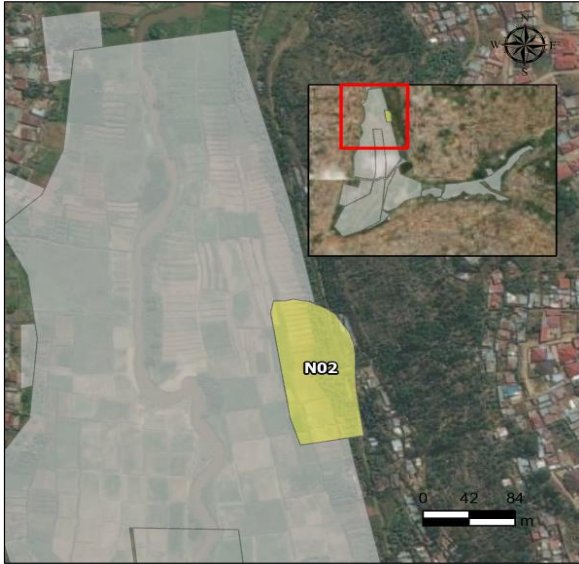


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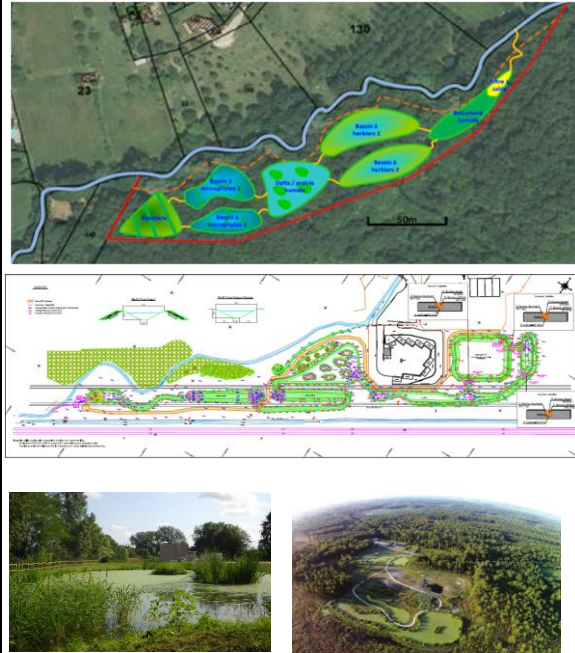
### Action sheet

<b>Action 12-N</b>	Name	Creation of a constructed wetland - buffer zone
	Action target	Biodiversity and Water Quality
	Wetland	Nyabugogo

Location (map) N02



Photos / examples




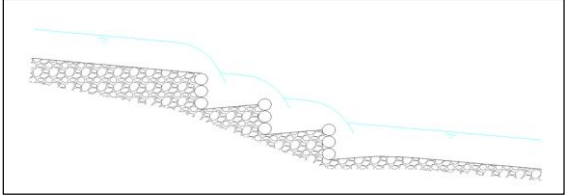


Characteristics	Rough cost estimate	Priority	Objectives
N 02 Total surface : 9 000 m <sup>2</sup>	166 500 US Dollar	2 - Medium-term 2035	<p>The design approach of the buffer wetland leaves an important part to the study of the contributing watershed in order to know precisely the characteristics of the incoming effluents and of the contributing watershed (flow rate, surface of the watershed, quality, frequency of feeding...). This ecological engineering project is based on different components such as hydraulics, purification, wetlands ecology and plant engineering.</p> <p>In summary, the creation of a wetland buffer zone is carried out in 3 stages</p> <ul style="list-style-type: none"> <li>- Feasibility study to identify the environmental issues and take them into account in the design: topographic surveys, soil studies, hydraulic studies of the watershed...</li> <li>- Design study including: execution plans of the wetland buffer zone compartments, ecological engineering design, hydraulic sizing of the works and integration of educational supports...</li> <li>- Works and follow-up of the construction site requiring the intervention of qualified partners for the realization of the civil engineering (earthworks to create the various compartments, the overflows...), ecological engineering (choice of materials, planting of the vegetable species...) and a qualified site manager.</li> </ul> <p>A safety margin of 0.30m (minimum difference between the highest water level and the top of the compartment crest) is provided for during periods of maximum compartment filling. To achieve this objective, overflows will be installed at the top of the compartment crest.</p>

<b>Comments</b>	<ul style="list-style-type: none"> <li>- The wetland buffer cannot be effective if it collects untreated wastewater.</li> <li>- Maximum depth of the compartments fixed at 1,20m</li> </ul>
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<p><b>Maintenance need</b></p>	<p>Annual management by mowing in August, before the rainy season</p> <p>A wetland buffer reproduces, on a smaller scale, mechanisms that occur naturally in the natural environment. The evolution of the habitats and the sustainability of the objectives targeted by the wetland buffer (purification, biodiversity, education, etc.) are directly linked to the quality of its management from the moment it is put in water.</p> <p>The management of the buffer wetland leads to be vigilant on the following hydraulic phenomena</p> <ul style="list-style-type: none"> <li>- Creation of hydraulic plugs at the level of the hydraulic structures that can lead to overflows (loading of the system) and a reduction in the residence time.</li> <li>- Reduction of the residence time and the treatment capacity of the system by short-circuits and filling of the volume of the basins.</li> <li>- Risk of invasive plants or plant dieback.</li> </ul> <p>A management plan also has the following objectives</p> <ul style="list-style-type: none"> <li>- Ensure the cutting of plants with export of green waste</li> <li>- Maintain a high level of biodiversity in the water compartments by applying a differentiated vegetation management method.</li> <li>- <u>To perpetuate the landscape quality of the site and its potential to welcome the public.</u></li> </ul>
<p><b>Management monitoring</b></p>	<p>Monitoring of the evolution of vegetation and hydraulics twice a year, during dry and rainy seasons, by an expert in ecological engineering, for 30 years (n+1, n+2, n+3, n+5, n+7, n+10, n+15, n+20, n+25, n+30)</p>

## Feasibility study, baseline studies and detailed designs for wetland rehabilitation in the city of Kigali

### Action sheet

<b>Action 13.N</b>	Name	Re-profiling of the hydraulic outlets from the discharge		
	Action target	Water filtration, Biodiversity		
	Wetland	Nyabugogo		
<b>Location (map) N03</b>		<b>Photos / examples</b>		
		  		
<b>Characteristics</b>	<b>Rough cost estimate</b>	<b>Priority</b>	<b>Objectives</b>	
N03: Riprap at the outlet with creation of different river bed ground level over 350 m	8 000 USD	1 - Short-term 2025		
<b>Comments</b>				
<b>Maintenance need</b>				
<ul style="list-style-type: none"> <li>- Maintenance of the outlets (provent from solid waste accumulation): twice per year (including one before the rainy season)</li> <li>- Other needs to be defined according to the management monitoring report</li> </ul>				
<b>Management monitoring</b>				
<p>The work will be the subject of a technical file of the works carried out with the plans of the built installations. A follow-up of the profile of the restored banks and the minor bed will be carried out 6 months after the end of the work and then the year that follows. The frequency will be adapted according to the possible disorders observed and the results of this follow-up.</p> <p>On the basis of the technical file, the following will be identified</p> <ul style="list-style-type: none"> <li>- Possible movements, departures or contributions of blocks;</li> <li>- All possible traces of erosion, scouring on the resumed zones as well as on the transition zones and the zones peripheral to the development not impacted by the works.</li> </ul> <p>All the elements of this follow-up will be recorded in a report. In conclusion, recommendations will be made on possible rework, the frequency of monitoring, and on future developments.</p>				

## Feasibility study, baseline studies and detailed designs for wetland rehabilitation in the city of Kigali

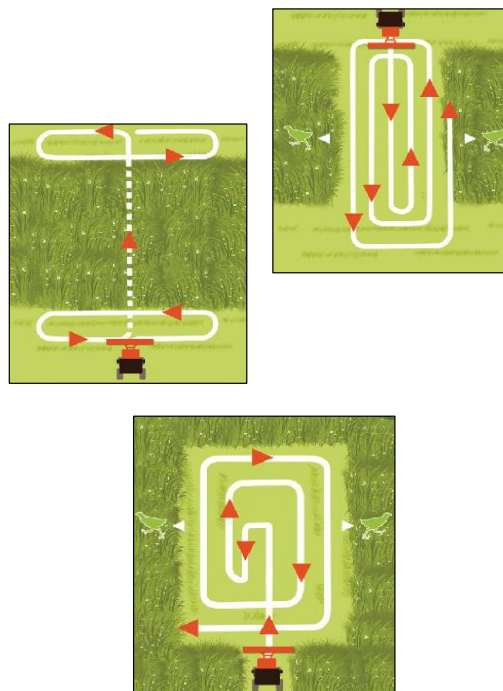
### Action sheet

<b>Action 14.N</b>	Name	Differentiated management according to natural habitats
	Action target	Biodiversity
	Wetland	Nyabugogo

Location (map) N08 - N09



Photos / examples



Characteristics	Rough cost estimate	Priority	Objectives
N08 Surface : 19 500 m <sup>2</sup>	19 500 US Dollar	1 - Short-term 2025	<p>Herbaceous habitats will be managed by annual mowing. Mowing will be mechanized or manual, in dry periods to facilitate access, promote reseeding and limit impacts on wildlife. They will be carried out at a minimum height of 10 cm, and centrifugal so as to push the fauna towards the refuge zones of the non mowed sectors (in accordance with the mowing principle illustrated in the diagrams above). The refuge zones, corresponding to the non mowed areas, will represent approximately 5% of the mowed surface. The speed of the self-propelled mowing machines will be moderate to allow time for insects and other fauna to move. Mowing residues will be systematically exported to limit soil eutrophication and the development of nitrophilic vegetation.</p>
N09 Surface : 11 900 m <sup>2</sup>	11 900 US Dollar	1 - Short-term 2025	<p>For low herbaceous formations, management by grazing as an alternative to differentiated mowing may be considered, if there is an opportunity for a territorial agricultural project in the medium to long term. The necessary conditions are: sufficiently dry soil, a grazing period limited to about 3 months and a stocking rate limited to 0.5 to 0.8 LU per hectare. Eco-grazing can be implemented after an initial period of management by mowing to establish the cover. Chemical weeding and the use of phytosanitary products is prohibited.</p> <p>As for the shrub and tree environments, management consists of selective clearing and removal of the shoots of any invasive species by manual or mechanical removal of the feet (with export).</p>
<b>Comments</b>			
<b>Maintenance need</b>	/		
<b>Management monitoring</b>	Annual botanical monitoring, during the dry seasons, by botanical expert, over 30 years (n+1, n+2, n+3, n+5, n+7, n+10, n+15, n+20, n+25, n+30) to identify the development and evolution of plant formations, in order to adapt the objectives and methods of maintenance, in particular the frequency of mowing, and to perpetuate the most suitable hygrophilous formations.		

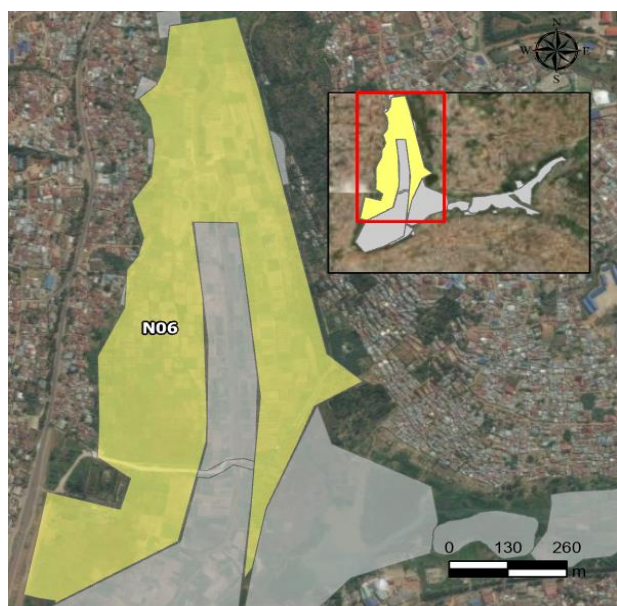
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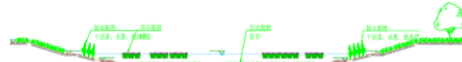
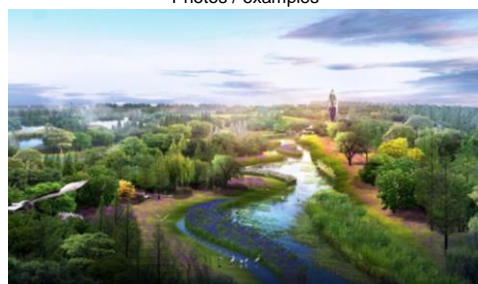
**Action  
18.N**

Name	Creation of a depression disconnected from the river
Action target	Biodiversity and Water Quality
Wetland	Nyabugogo

Location (map) N06



Photos / examples



Characteristics	Rough cost estimate	Priority	Objectives
N06  One quarter of the total area developed for the creation of depressions Surface : 100 000 m <sup>2</sup>	800 000 US Dollar	2 - Medium-term 2035	<p>Before carrying out the earthworks, a design study phase will be necessary to refine the works to be carried out. These studies will make it possible to respect the following principles:</p> <ul style="list-style-type: none"> <li>- The arrival of water from urban drains must be accompanied by riprap to limit erosion in the depression;</li> <li>- The "project elevation" (longitudinal profile) must be determined on the basis of a good knowledge of the level of the river and of the water table (and its variations);</li> <li>- The slopes of the banks must be as low as possible;</li> <li>- The arm/depression can be materialized by multiple basins;</li> <li>- The recreation will not be uniform;</li> <li>- Excessive excavation may result in lowering of the water table (drainage). It can also cause a pollution of the water table by feeding with water of bad quality.</li> </ul> <p>These earthworks will have for objective to respect the criteria specified above. The use of mechanical shovel, bulldozer is necessary. The work must be carried out in such a way as to limit the compaction of the land: use machines with good bearing capacity ("marsh" shovels), avoid driving with the machines on the talweg, decompact the soil at the end of the work... The period of execution of the work is largely conditioned by hydraulic constraints (low water). It is important to underline the importance of the quality of the company and the project management in this type of work.</p> <p>It is advisable to choose companies that have already carried out this type of work, and to provide for very regular monitoring of the site by an ecologist.</p> <p>A safety margin of 0.30 m (minimum difference between the highest water level and the top of the compartment crest) is</p>
<b>Comments</b>	<ul style="list-style-type: none"> <li>- The depression cannot be effective if it collects untreated wastewater.</li> <li>- Maximum depth of the compartments fixed at 1,20m</li> </ul>		
<b>Maintenance need</b>	<p>Annual management by mowing in August, before the rainy season</p> <p>The management of depression to be vigilant on the following hydraulic phenomena</p> <ul style="list-style-type: none"> <li>- Creation of hydraulic plugs at the level of hydraulic structures that can lead to overflows (loading of the system) and a reduction in residence time.</li> <li>- Reduction of the residence time and the treatment capacity of the system by short circuits and the filling of the volume of the basins.</li> <li>- Risk of invasive plants or plant dieback.</li> </ul> <p>A management plan also aims to</p> <ul style="list-style-type: none"> <li>- Ensure the cutting of plants with export of green waste</li> <li>- Maintain a high level of biodiversity in the water compartments by applying a differentiated vegetation management method.</li> <li>- Perpetuate the landscape quality of the site and its potential to welcome the public.</li> </ul>		

<b>Management monitoring</b>	Monitoring of the evolution of vegetation and hydraulics twice a year, during dry and rainy seasons, by an expert in ecological engineering, for 30 years (n+1, n+2, n+3, n+5, n+7, n+10, n+15, n+20, n+25, n+30)
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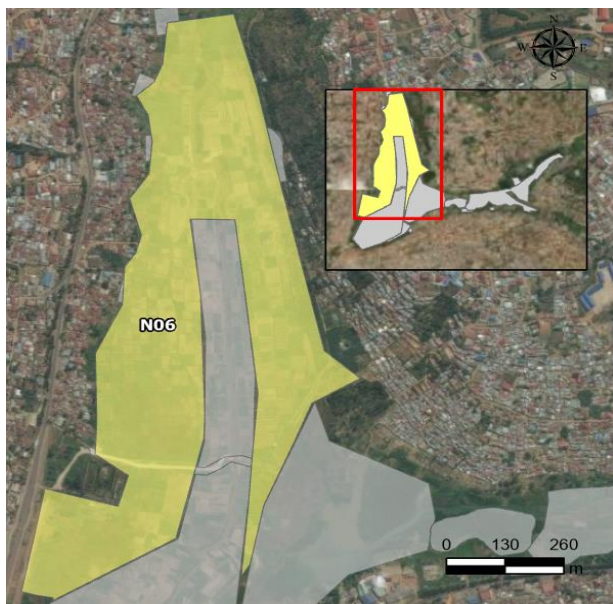
## Feasibility study, baseline studies and detailed designs for wetland rehabilitation in the city of Kigali

### Action sheet

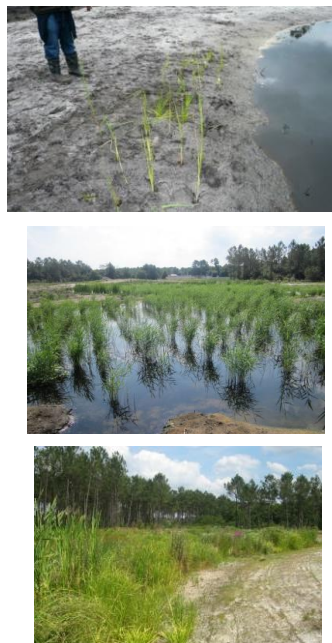
**Action  
19-N**

Name	Diversification of natural habitats typical of wetlands
Action target	Biodiversity
Wetland	Nyabugogo

Location (map) N06



Photos / examples



Characteristics	Rough cost estimate	Priority	Objectives
N06  One quarter of the total area developed for the creation of depressions. Therefore, the area to be vegetated is the same. Surface : 100 000 m <sup>2</sup>	400 000 US Dollar	3 - Long-term 2050	<p>This action aims at recovering a herbaceous cover composed of a flora characteristic of wetlands and typical of Rwandan wetlands on all the depressions up to the banks. To do this, the first step consists in preparing the soil, with decompacting the soil in place on the first 15 centimeters to reactivate the seed bank and promote rooting. The second step is to plant native species typical of local wetlands, matching the water needs of these species with the water conditions of the soil. Indeed, in order to accelerate the vegetation, it will be interesting to plant semi-aquatic and aquatic plants: sedges, reeds...In time, the planted plants will be more or less completed/replaced progressively by species spontaneously colonizing the site. The zones regularly in water will generally be well colonized by natural vegetation; it is thus little useful to sow them.</p> <p>This will involve proposing an adapted plant life with the following plant species: <i>Centella asiatica</i> (<i>Centella asiatica</i>), <i>Urugaga</i> (<i>Cyperus dives</i>), <i>Urukanganga/Cyperus latifolius</i> (<i>Cyperus latifolius</i>), <i>Carolina Dichondra</i> (<i>Dichondra micrantha</i>), <i>Ubwungu/ Drymaria cordata</i> (<i>Drymaria cordata</i>), <i>Urufunzo/Papyrus</i> (<i>Cyperus papyrus</i>), <i>Umuberanya/Southern cattail</i> (<i>Typha domingensis</i>), <i>Carex mildbraediana</i>, <i>Urukirakenja/Cyperus articulatus</i>, <i>Umujangaja/Cyperus denudatus</i>, <i>Dichondra Carolina</i> (<i>Dichondra micrantha</i>), <i>Urujenone</i> (<i>Enhydra fluctuans</i>), <i>Gutwikumwe/ Hydrocotyle ranunculoides</i>, <i>Ubusuna/ Common rush</i> (<i>Juncus effusus</i>), <i>Urukembagufa/ Cutting grass</i> (<i>Leersia hexandra</i>), <i>Ikirogora</i> (<i>Brillantaisia cicatricosa</i>), <i>Umuzigangore</i> (<i>Ludwigia abyssinica</i>), <i>Igorogonzo/Water weed</i> (<i>Persicaria decipiens</i>).</p>
<b>Comments</b>	<p>"- Developments must be carried out outside of rainy periods to avoid soil compaction and degradation caused by erosion (uprooting of plantations, seeds washed away by runoff...) - It is imperative to carry out the revegetation as soon as the earthworks are completed at the favourable period in order to avoid the proliferation of invasive species and erosion by runoff</p>		
<b>Maintenance need</b>	<p>"- Annual management by mowing in August, before the rainy season - Ensure the cutting of plants with export of green waste</p>		
<b>Management monitoring</b>	<p>Monitoring the evolution of the vegetation twice a year, during the dry seasons, by botanical expert, over 30 years (n+1, n+2, n+3, n+5, n+7, n+10, n+15, n+20, n+25, n+30).</p>		

**Feasibility study, baseline studies and detailed designs  
for wetland rehabilitation in the city of Kigali**

**Action sheet**

<b>Action 20-N</b>	Name	Stream protection zone with a vegetated riparian buffer
	Action target	Biodiversity and Water Quality
	Wetland	Nyabugogo

**Location (map) N04**



**Photos / examples**



Characteristics	Rough cost estimate	Priority	Objectives
<p align="center"><b>N04</b></p> <p>Vegetated buffer strip of approximately 25m wide on each side of the watercourse, i.e. an area of approximately : 75 000m<sup>2</sup> for a total of 1 500m</p>	281 300 US Dollar	2 - Medium-term 2035	<p>In order to limit the transfer of pollutants to the watercourse via runoff, vegetated buffer strips are positioned between agricultural plots and the watercourse network. In this action sheet, a vegetated buffer strip is defined as any vegetated surface that intercepts diffuse or concentrated surface runoff and therefore reduces the transfer of pollutants and/or sediments. These vegetated buffer strips are translated as grassy strips, permanent grasslands, fallow land, hedges, woods or copses.</p> <p>Their implementation requires :</p> <ul style="list-style-type: none"> <li>- Tillage to level and decompact the land;</li> <li>- Revegetation, which is either seeding of grassland or planting of shrubs/trees;</li> <li>- A choice of local plant species.</li> </ul> <p>This vegetated buffer strip, whose width will have to be refined according to the intercepted watershed, will also be a support for the migration of animal species.</p>
<b>Comments</b>	Developments must be carried out outside of rainy periods to avoid soil compaction and degradation caused by erosion (uprooting of plantations, seeds washed away by runoff...)		
<b>Maintenance need</b>	Annual management by mowing in August, before the rainy season		
<b>Management monitoring</b>	Monitoring the evolution of the vegetation twice a year, during the dry seasons, by botanical expert, over 30 years (n+1, n+2, n+3, n+5, n+7, n+10, n+15, n+20, n+25, n+30).		



## Feasibility study, baseline studies and detailed designs for wetland rehabilitation in the city of Kigali

### Action sheet

<b>Action 24.N</b>	Name	Protection and conservation of typical wetland habitats
	Action target	Biodiversity
	Wetland	Nyabugogo

Location (map) N08 - N09



Photos / examples



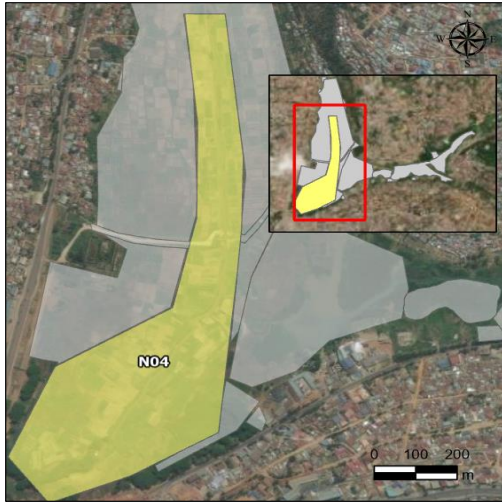
Characteristics	Rough cost estimate	Priority	Objectives
N08 Linear of fences : 650 ml	65 000 US Dollar	1 - Short-term 2025	<p>This action aims to protect the wetlands of good plant quality and the most biologically sensitive (breeding grounds for heritage fauna, protected plant species, ...). For this, several solutions are proposed:</p> <ul style="list-style-type: none"> <li>- the installation of fences or wooden barriers, positioned all around the area of interest, in order to prohibit any pedestrian or vehicle access (except for maintenance). These protective elements must be well integrated into the landscape, so wooden elements are recommended. Awareness signs may also be installed.</li> <li>- the classification of the zone of interest in a protection zoning (reserves, protected areas, ..), allowing to limit the uses to those favorable to the maintenance of the fauna and the present flora. The classification in protection zoning induces administrative procedures but proves to be a very relevant tool to guarantee the durability of the area and the actions carried out, and to maintain quality habitats.</li> </ul> <p>In addition, thorough biological monitoring must be carried out on these areas by experts in ecology or environmental associations. The objective of this monitoring is to identify the fauna and flora issues in these areas, to follow the evolution of the habitats and to propose and adapt the management modalities in order to enhance the environment. This monitoring must be carried out at all times of the year, with more frequent visits during the period of activity of the fauna and development of the flora, and carried out according to a precise protocol repeated over several years.</p>
N09 Linear of fences : 550 ml	55 000 US Dollar	1 - Short-term 2025	
<b>Comments</b>			
<b>Maintenance need</b>	/		
<b>Management monitoring</b>	Annual verification of the state of deterioration of the fences.		

# Feasibility study, baseline studies and detailed designs for wetland rehabilitation in the city of Kigali

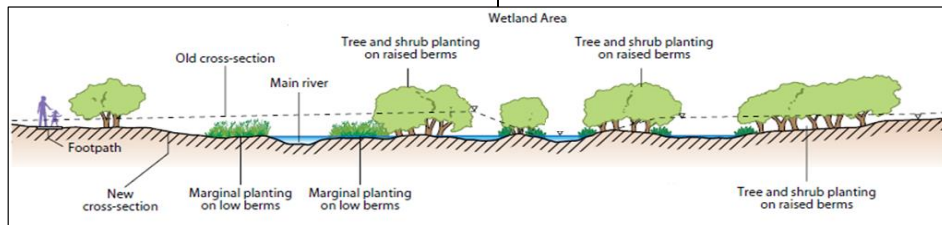
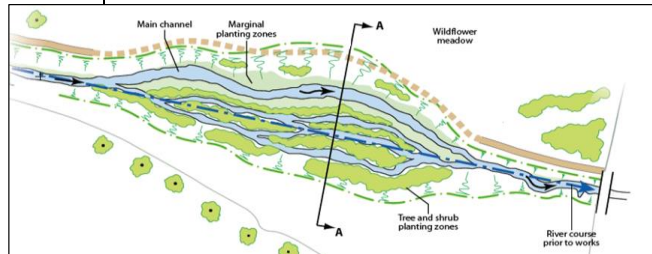
## Action sheet

<b>Action 26.N</b>	Name	Creation of a delta before the confluence of the Nyabugogo river
	Action target	Flood mitigation, Biodiversity
	Wetland	Nyabugogo

### Location (map) - N04



### Photos / examples



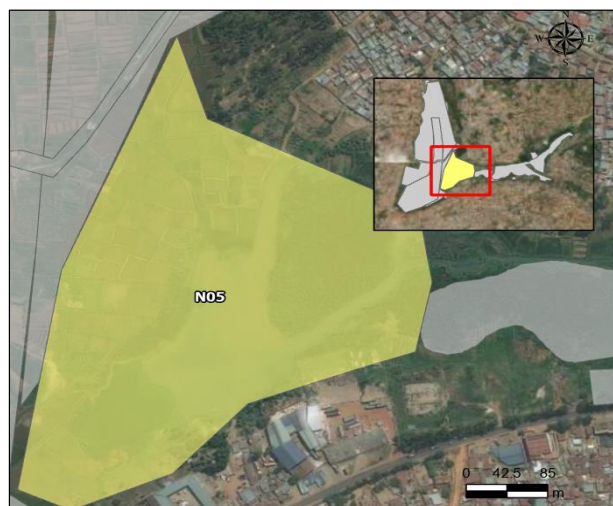
Characteristics	Rough cost estimate	Priority	Objectives
<p>N04</p> <p>Length of watercourse to be repositioned in the thalweg : 220 m</p>	85 100 USD	2 - Medium-term 2035	<p>Before carrying out the earthworks, a design study phase will be necessary to refine the work to be carried out. These studies will make it possible to ensure that the water level is respected in order to create lentic and lotic zones:</p> <ul style="list-style-type: none"> <li>- The "project grade" (longitudinal profile) must be determined based on a good knowledge of the current slope of the river, the natural terrain and the water table (and its variations);</li> <li>- The recreation will not be uniform to create different flow facies.</li> </ul> <p>The use of mechanical shovel, bulldozer is necessary. The work will have to be carried out in such a way as to limit soil compaction: use machines with good bearing capacity ("marsh" shovels), avoid driving with machines on the talweg, decompact the soil at the end of the work....</p> <p>The period of execution of the work is largely conditioned by the hydraulic constraints (low water). It is important to underline the importance of the quality of the company and the project management in this type of work.</p> <p>It is advisable to choose companies that have already carried out this type of work, and to provide for very regular monitoring of the site by an ecologist.</p>
<b>Comments</b>			
<b>Maintenance need</b>	<p>Annual management by mowing in August, before the rainy season</p> <p>The management of the new minor bed must be vigilant on the following hydraulic phenomena:</p> <ul style="list-style-type: none"> <li>- Creation of hydraulic plugs at the level of the flows;</li> <li>- Departure of boulders positioned in the minor bed;</li> <li>- Presence of erosion of the banks and the bottom of the watercourse.</li> </ul> <p>A management plan also aims to ensure the cutting of vegetation with export of green waste</p>		
<b>Management monitoring</b>	<p>Monitoring of the evolution of vegetation and hydraulics twice a year, during dry and rainy seasons, by an expert in ecological engineering, for 30 years (n+1, n+2, n+3, n+5, n+7, n+10, n+15, n+20, n+25, n+30)</p>		

## Feasibility study, baseline studies and detailed designs for wetland rehabilitation in the city of Kigali

### Action sheet

<b>Action 27</b>	Name	Management to limit the expansion of the water hyacinth
	Action target	Biodiversity
	Wetland	Nyabugogo

#### Location (map) N05





#### Photos / examples



Characteristics	Rough cost estimate	Priority	Objectives
<p style="text-align: center;">N05</p> <p>Area to be treated : 19 800 m<sup>2</sup></p>	<p>316 800 US Dollar</p>	<p>2 - Medium-term 2035</p>	<p>The vegetative multiplication of the water hyacinth is very fast when the conditions are met (temperature higher than 18°C) : it is done by the production of stolons at the base of the leaves. The biomass of the herbariums can reach 300 tons per hectare.</p> <p>In order to fight against the expansion of the water jascinth, the chosen solution is the mechanical pulling up. This technique consists in pulling out the feet of the water jascinth, and to bring them back to the banks on zones of deposits, where cloths of jutes were beforehand laid out.</p> <p>This technique requires heavy equipment:</p> <ul style="list-style-type: none"> <li>- boats with digging forks or cutting bars, dredging machines in order to detach and pull out the water jascinth plants.</li> <li>- push boats or conveyor belts to collect the plants and transport them to the bank.</li> </ul> <p>The intervention must take place just after the end of the rainy period.</p> <p>The temporary storage of the uprooted plants is important because it allows a significant reduction in the volume of plant debris that will then have to be incinerated or transported to appropriate channels (landfill). It must be done in an area sheltered from strong winds to avoid any risk of dissemination, where access to animals is reduced and a flat area to avoid any risk of runoff in case of heavy rain. The evacuation of the site will be carried out by machines adapted to the low bearing capacity of the soil.</p> <p>In addition, it will be advisable not to leave any pieces or cuttings of water jascinth on the treated zones (wetland and aquatic zone), any remainder of grubbing residues will have to be collected using landing nets. The equipment will also be cleaned well after the work.</p> <p>A second intervention must take place approximately 45 days after the first intervention, with the objective of controlling the uprooting of the plants and their possible recovery following the first intervention, and uprooting the remaining plants.</p>
<b>Comments</b>	<p>- The existing water supply pipelines implemented into the wetland will be included and considered during the further studies and works</p>		
<b>Maintenance need</b>	<p>Based on the results of the monitoring, repeat the action each year to limit the expansion of the water jascinth.</p>		
<b>Management monitoring</b>	<p>Annual monitoring by an expert botanist of the treated area and of the deposition zones to control the evolution of the water jascinth populations and thus adapt the actions to limit its expansion.</p>		

## Feasibility study, baseline studies and detailed designs for wetland rehabilitation in the city of Kigali

### Action sheet

<b>Action 28.N</b>	Name	Pedestrian path to connect both sides of the wetlands		
	Action target	Transportation, Recreational		
	Wetland	Nyabugogo		
<b>Location (map) N11</b>		<b>Photos / examples</b>		
				
<b>Characteristics</b>	<b>Rough cost estimate</b>	<b>Priority</b>	<b>Objectives</b>	
N11: Creation of a pedestrian path over 660 m	607 200 USD	2 - Medium-term 2035		
<b>Comments</b>	- The existing water supply pipelines crossing the wetland at the level of the planned pedestrian path will be included and considered during the further studies and works			
<b>Maintenance need</b>	Ensure cleanliness on a weekly basis			
<b>Management monitoring</b>				