**Supplemental material**

This supplemental material describes the design and costing of the rainwater harvesting and supply systems. Figure 1 shows the basic elements of the system and the associated Tables 1-4 show the specific dimensions and capacities of each infrastructure item. The tables give an overview of the type of infrastructure modifications for a specific option. The last column of Tables 1-4 indicates the changes required to the infrastructure under the alternative storage options ‘drinking water tank’ and ‘reservoir’. For the reservoir storage options, no rainwater pumping is required, because it is assumed that the ground level reservoir can be filled by gravity drainage.

Table 5-7 give an overview of the capital expenditure. Table 8 shows the operational costs for the existing storage and drinking water reservoir alternative. Finally, Table 9 shows the operational cost for the reservoir storage option. Lower operational costs for reservoir storage are a result of reduced pumping expenses due to discharge by gravity.

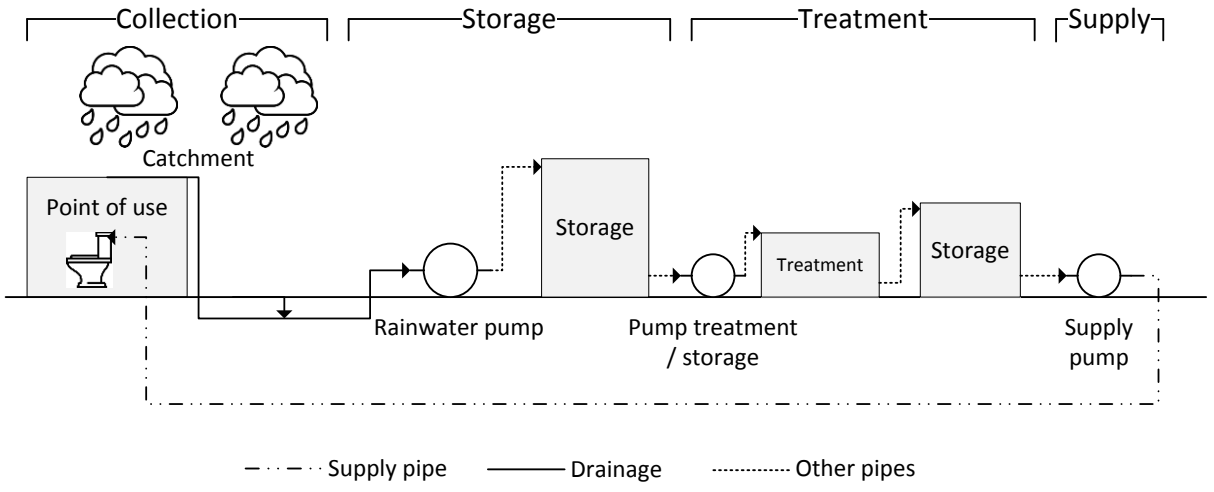


**Figure 1:** Overview of rainwater harvesting and supply system, distinguished into the different infrastructure elements.

**Table 1:** Option I – Schiphol wide supply - dimensions of the rainwater harvesting and supply system

| **Item** | **Dimensions** | |
|---|---|---|
| | Existing storage | Difference to drinking water tank and reservoirs alt. |
| | **Collection** | |
| Pipes | Existing drainage system - no modification | |
| Rainwater pump | 2000m3/h | N/A for reservoir option |
| | **Storage** | |
| Storage | 14600$m^3$ (7300$m^3$ new & 7300$m^3$ existing remediation costs incurred) | Reservoir and tank options: no use of existing storage cap. 14600$m^3$ |
| | **Treatment** | |
| Rapid sand filtration | 110$m^3$/h | |
| Pump treatment and storage | 120$m^3$/h | |
| Storage | 200$m^3$ | |
| | **Supply** | |
| Supply pump | 160$m^3$/h | |
| Supply pipe | 14km (100mm PVC) | |
| Point of use | 1080 public and non-public toilets, 2340 hotel toilets,175 office toilets, 11 cooling installations | |

**Table 2:** Option II – Supply of Centre terminal by roof runoff - dimensions

| **Item** | **Dimensions** | |
|---|---|---|
| | Existing storage | Difference to drinking water tank and reservoirs alternative |
| | **Collection** | |
| Pipes | Modification to existing drainage 3km 250mm PVC pipe to separate from current drainage system | |
| | **Storage** | |
| Rainwater pump | 1400$m^3$/h | NA for reservoir option |
| Storage | 7300$m^3$ – remediation costs incurred | Reservoir and tank options: no use of existing storage cap. 7300$m^3$ |
| | **Treatment** | |
| Rapid sand filtration | 110$m^3$/h | |
| Pump treatment and storage | 120$m^3$/h | |
| Storage | 200$m^3$ | |
| | **Supply** | |
| Supply pump | 160$m^3$/h | |
| Supply pipe | 3km (100mm PVC) | |
| Point of use | 1080 public and non-public toilets of toilets and 940 hotel toilets, 100 office toilets and 8 cooling installations | |

**Table 3:** Option III - Supply of Centre terminal by roof, paved landside and paved airside runoff - dimensions

| Item | Dimensions | |
|---|---|---|
| | Existing storage | Difference to drinking water tank and reservoirs alternative |
| | **Collection** | |
| Collection | Existing drainage system no modification | |
| | **Storage** | |
| Rainwater pump | 1400$m^3$/h | N/A for reservoir option |
| Storage | 7300$m^3$ – remediation costs incurred | Reservoir and tank options: no use of existing storage cap. 7300$m^3$ |
| | **Treatment** | |
| Rapid sand filtration | 110$m^3$/h | |
| Pump treatment and storage | 120$m^3$/h | |
| Storage | 200$m^3$ | |
| | **Supply** | |
| Supply pump | 160$m^3$/h | |
| Supply pipe | 3km (100mm PVC) | |
| Point of use | 1080 public and non-public toilets of toilets and 940 hotel toilets, 100 office toilets and 8 cooling installations | |

**Table 4:** Option III - Supply of firefighting by roof and paved landside and paved airside runoff in North - dimensions

| **Item** | **Dimensions** | |
|---|---|---|
| | Existing storage | Difference to drinking water tank and reservoirs alternative |
| | **Collection** | |
| Collection | Existing drainage system no modification | |
| | **Storage** | |
| Rainwater pump and housing | $400m^3/h$ | N/A for reservoir option |
| Storage | $4000m^3$ – existing storage no remediation cost incurred | Reservoir and tank options: no use of existing storage cap. $4000m^3$ |
| | **Treatment** | |
| Rapid sand filtration | N/A | |
| Pump treatment and storage | N/A | |
| Storage | N/A | |
| | **Supply** | |
| Supply pump | N/A - existing firefighting equipment is used | |
| Supply pipe | | |
| Point of use | | |

**Table 5.** Capital costs for the existing storage options 1(DHV 2015) 2 overview internal report Schiphol, 3 (RIONED 2015), 4 experience based, 5(Hicks 2008).

| | | | Existing storage | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref** | **Item** | **Unit cost** | **Option I** | | **Option II** | | **Option III** | | **Option IV** | | | |
| | Collection infrastructure | | € - | 0% | € 450,000 | 10% | € - | 0% | € - | 0% | | |
| 3 | Collection infrastructure | €150/m | € - | 0% | € 450,000 | 10% | € - | 0% | € - | 0% | | |
| | Storage | | € 4,290,000 | 38% | € 470,000 | 11% | € 640,000 | 16% | € 140,000 | 100% | | |
| 1 | Storage | | € 3,650,000 | 32% | € - | 0% | € - | 0% | € - | 0% | | |
| 2 | Remediation existing storage | 7300m3 | € 40,000 | 0% | € 40,000 | 1% | € 40,000 | 1% | € - | 0% | | |
| 1 | Rainwater pumps | € - | € 600,000 | 5% | € 430,000 | 10% | € 600,000 | 15% | € 140,000 | 100% | | |
| | Treatment | | € 357,000 | 3% | € 357,000 | 8% | € 357,000 | 9% | € - | 0% | | |
| 1 | Sandfiltration pumps | | € 57,000 | 1% | € 57,000 | 1% | € 57,000 | 1% | € - | 0% | | |
| 1 | Rapid sand filtration | | € 200,000 | 2% | € 200,000 | 5% | € 200,000 | 5% | € - | 0% | | |
| 1 | Buffer tank | 200m3 | € 100,000 | 1% | € 100,000 | 2% | € 100,000 | 2% | € - | 0% | | |
| | Supply | | € 6,684,000 | 59% | € 3,078,000 | 71% | € 3,078,000 | 76% | € - | 0% | | |
| 4 | Supply pipes | €60/m | € 840,000 | 7% | € 180,000 | 4% | € 180,000 | 4% | € - | 0% | | |
| 5 | Building and appliances | €2000/ connection | € 5,774,000 | 51% | € 2,828,000 | 65% | € 2,828,000 | 69% | € - | 0% | | |
| 1 | Supply pumps | | € 70,000 | 1% | € 70,000 | 2% | € 70,000 | 2% | € - | 0% | | |
| | Sum including 15% contingency | | € 13,030,650 | | € 5,008,250 | | € 4,686,250 | | € 161,000 | | | |

**Table 6.** Capital costs for the concrete drinking water tank options 1(DHV 2015) 2 overview internal report Schiphol, 3 (RIONED 2015), 4 experience based, 5(Hicks 2008).

| | | | Concrete drinking water tank | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref** | **Item** | **Unit costs** | **Option I** | | **Option II** | | | **Option III** | | | **Option IV** | | |
| | **Collection infrastructure** | | **€** | **-** | **0%** | **€** | **450,000** | **6%** | **€** | **-** | **0%** | **€** | **-** | **0%** |
| 3 | Collection infrastructure | €150/m | € | - | 0% | € | 450,000 | 6% | € | - | 0% | € | - | 0% |
| | **Storage** | | **€** | **7,600,000** | **52%** | **€** | **4,080,00** | **51%** | **€** | **4,250,000** | **55%** | **€** | **2,340,000** | **100%** |
| 1 | Storage | | € | 7,000,000 | 48% | € | 3,650,000 | 46% | € | 3,650,000 | 47% | € | 140,000 | 100% |
| 2 | Remediation existing storage | 7300m3 | € | - | 0% | € | - | 0% | € | - | 0% | € | - | 0% |
| 1 | Rainwater pumps | | € | 600,000 | 4% | € | 430,000 | 5% | € | 600,000 | 8% | € | 140,000 | 6% |
| | **Treatment** | | **€** | **357,000** | **2%** | **€** | **357,000** | **4%** | **€** | **357,000** | **5%** | **€** | **-** | **0%** |
| 1 | Sand filtration pumps | | € | 57,000 | 0% | € | 57,000 | 1% | € | 57,000 | 1% | € | - | 0% |
| 1 | Rapid sand filtration | | € | 200,000 | 1% | € | 200,000 | 3% | € | 200,000 | 3% | € | - | 0% |
| 1 | Buffer tank | 200m3 | € | 100,000 | 1% | € | 100,000 | 1% | € | 100,000 | 1% | € | - | 0% |
| | **Supply** | | **€** | **6,684,000** | **46%** | **€** | **3,078,000** | **39%** | **€** | **3,078,000** | **40%** | **€** | **-** | **0%** |
| 4 | Supply pipes | €60/m | € | 840,000 | 6% | € | 180,000 | 2% | € | 180,000 | 2% | € | - | 0% |
| 5 | Building and appliances | €2000/ connection | € | 5,774,000 | 39% | € | 2,828,000 | 36% | € | 2,828,000 | 37% | € | - | 0% |
| 1 | Supply pumps | | € | 70,000 | 0% | € | 70,000 | 1% | € | 70,000 | 1% | € | - | 0% |
| | Sum incl. 15% contingency | | € | 16,837,150 | | € | 9,159,750 | | € | 8,837,750 | | € | 2,691,000 | |

**Table 7.** Capital costs for the reservoir storage options 1(DHV 2015) 2 overview internal report Schiphol, 3 (RIONED 2015), 4 experience based, 5(Hicks 2008).

| | | | Reservoir storage option | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref** | **Item** | **Unit costs** | **Option I** | | **Option II** | | **Option III** | | **Option IV** | | | |
| | **Collection** | | **€ -** | **0%** | **€ 450,000** | **10%** | **€ -** | **0%** | **€ -** | **0%** | | |
| 3 | Collection infrastructure | €150/m | € - | 0% | € 450,000 | 10% | € - | 0% | € - | 0% | | |
| | **Storage** | | **€ 800,000** | **10%** | **€ 500,000** | **11%** | **€ 500,000** | **13%** | **€ 300,000** | **100%** | | |
| 1 | Storage | | € 800,000 | 10% | € 500,000 | 11% | € 500,000 | 13% | € 300,000 | 100% | | |
| 2 | Remediation existing storage | 7300m3 | € - | 0% | € - | 0% | € - | 0% | € - | 0% | | |
| 1 | Rainwater pumps | | € - | 0% | € - | 0% | € - | 0% | € - | 0% | | |
| | **Treatment** | | **€ 357,000** | **5%** | **€ 357,000** | **8%** | **€ 357,000** | **9%** | **€ -** | **0%** | | |
| 1 | Sand filtration pumps | | € 57,000 | 1% | € 57,000 | 1% | € 57,000 | 1% | € - | 0% | | |
| 1 | Rapid sand filtration | | € 200,000 | 3% | € 200,000 | 5% | € 200,000 | 5% | € - | 0% | | |
| 1 | Buffer tank | 200m3 | € 100,000 | 1% | € 100,000 | 2% | € 100,000 | 3% | € - | 0% | | |
| | **Supply** | | **€ 6,684,000** | **85%** | **€ 3,078,000** | **70%** | **€ 3,078,000** | **78%** | **€ -** | **0%** | | |
| 4 | Supply pipes | €60/m | € 840,000 | 11% | € 180,000 | 4% | € 180,000 | 5% | € - | 0% | | |
| 5 | Building and appliances | €2000/ connection | € 5,774,000 | 74% | € 2,828,000 | 64% | € 2,828,000 | 72% | € - | 0% | | |
| 1 | Supply pumps | | € 70,000 | 1% | € 70,000 | 2% | € 70,000 | 2% | € - | 0% | | |
| | Sum incl. 15% contingency | | € 9,017,150 | | € 5,042,750 | | € 4,525,250 | | € 345,000 | | | |

**Table 8:** Operational costs for the existing storage options and drinking water storage tank option

| Item | Costs |
|---|---|
| **I Supply of all connections** | |
| Total annually | **€ €82,440.00** |
| Every 5 years – cleaning tank | €119,440.00 |
| **II Supply of Central zone terminal from roof only** | |
| Total annually | **€45,410.96** |
| Every 5 years – cleaning tank | €64,160.96 |
| **III Supply of Central terminal from roof and paved catchments** | |
| Total annually | **€77,731.92** |
| Every 5 years – cleaning tank | €96,481.92 |
| **IV. Supply of firefighting** | |
| Total annually | **€10,852.35** |
| Every 5 years – cleaning tank | €20,852.35 |

**Table 9:** Operational costs for the reservoir option

| Item | Costs |
|---|---|
| **I Supply of all connections** | |
| Total annually | **€ 40,440.00** |
| Every 5 years – cleaning tank | € 77,440.00 |
| **II Supply of Central zone terminal from roof only** | |
| Total annually | **€ 13,843.31** |
| Every 5 years – cleaning tank | € 32,593.31 |
| **III Supply of Central terminal from roof and paved catchments** | |
| Total annually | **€ 35,731.92** |
| Every 5 years – cleaning tank | € 54,481.92 |
| **IV. Supply of firefighting** | |
| Total annually | **€ 1,052.35** |
| Every 5 years – cleaning tank | € 11,052.35 |

## References


Hicks B (2008) A Cost-benefit Analysis of Rainwater Harvesting at Commercial Facilities in Arlington County, VA. Virginia, Master projects Nicholas School of the Environment and Earth Sciences Duke University.

RHDHV (2015) Coststandard calculator. Royal HaskoningDHV, Amersfoort, The Netherlands

RIONED (2015) www.rioned.com Leidraad riolering. National centre of expertise in sewer management and urban drainage in the Netherlands. Accessed 4 March 2015