Comparison of water conservation potentials with greywater reuse and with the segregated human urine collection in a multifamily residential building
The residential water consumption can represent 50% of the total amount of water used in urban areas (GONÇALVES & JORDÃO, 2006).

In São Paulo, it reaches up to 84% (GONÇALVES & JORDÃO, 2006)

Minas Gerais → 83% (PENNA et al., 2000)

And in Vitória that percentual is of 85% (RODRIGUES, 2005)

Percentage that points out the importance of adopting water conservation measures in residential buildings.
Objective

To check out the impact of the greywater reuse system implanted in a building on drinking water conservation and wastewater flow.

In addition, to evaluate the water conservation potential and the wastewater reduction in this building, with the implantation of alternative sanitation system, such as human urine management.
The building is located at Praia do Canto, Vitória – ES - Brazil;

It is a high middle class multi-family residential building;

The occupation began in July 2007;

One of the first buildings with the reuse of light greywater in Vitoria.

The building has 17 apartment floors (1 per floor)

Pilotis floor (utility + leisure area)

Lobby

The greywater treatment plant is located in the Underground
Characteristics of the monitored building

Existing water conservation measures in the building.

The building has some conservation water measures, like:

- **Rational water use**
  - Toilet with an attached water reservoir.
  - Faucet sink aerators
  - Individual hydrometers

- **Alternate source**
  - Greywater reuse for flushing toilet

---

**Actions on the water demand**

**Actions on the water supply**
The types of consumed water in the building are what follows:

- **PW** – potable water
- **RW** – recycled water

**Total water** – **TW**

- **PW** – Used in apartments and in the collective areas in the condominium.
- **RW** – Used only in the apartments for toilet flushing.
The types of wastewater produced in the building are what follows:

- **BW** – black water
- **GW_{dark}** – dark greywater
- **GW_{light}** – light greywater
- **GW_{light-net}** – light greywater discharged into the municipal sewage system
- **GW_{light-total}** – total of light greywater production

Sewage discharged into the municipal system except the amount that is recycled.
Water consumption and wastewater production readings was obtained from water and wastewater meters installed in the building.

This monitoring was carried out daily starting at 8:00 am, by reading all the meters installed in the building.

Daily measurements  Every day at 8:00 AM

Population – checked with the doorman.
**Water meters:** hydrometers
Water consumption (AP, AC light)

**Wastewater meters:**
*Parshall* flume + hydrometer
Wastewater (AC light – total, AN, AC dark)
### Monitoring

#### Water Consumption

<table>
<thead>
<tr>
<th></th>
<th>TW</th>
<th>PW</th>
<th>RW</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
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<td></td>
<td></td>
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<tr>
<td>Jul</td>
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<td>Jan</td>
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</tbody>
</table>

#### Sewage Production

<table>
<thead>
<tr>
<th></th>
<th>SE Total</th>
<th>SE Net</th>
<th>BW</th>
<th>GW dark</th>
<th>GW light – net</th>
<th>GW light– total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td></td>
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<td>Jul</td>
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<td>Ago</td>
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<td>Jan</td>
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</tr>
</tbody>
</table>

- **180 days**
- **88 days**
- **11 days**
- **10 days**
After that was calculated the per capita water consumption indicators.

And the wastewater production indicators.
Scenarios was simulated to evaluate the water conservation potential and wastewater reduction with the implantation of alternative sanitation systems, such as human urine management.
Scenario simulation

**Scenario 1** – real studied building (greywater reuse for flushing toilet)

Greywater reuse for flushing toilets.
Scenario simulation

**Scenario 2** – Conventional building without water recycling

By using the real scenario data, but without considering the water recycling.
Scenario simulations

Scenario 3 – Building which uses greywater recycling to toilet flushing, to water the garden and to wash impermeable areas.

Greywater reuse for:

- Toilet flushings
- Cleaning of impermeable areas
- Garden watering
Scenario simulations

**Scenario 4a** – building with urine diversion, with subsequent collection, storage and potential reuse of the urine in agriculture. Use of the urine diversion toilets.
Scenario simulations

**Scenario 4b** – scenario 4a + greywater recycling for toilet flushing.

- **Greywater recycling to:**
  - Double flush Urine diversion toilet (0.1\(\ell\) for urine, 4\(\ell\) for faeces)
  - Urine tank

[www.ccb.se/downloads/gebers_bk.ppt](http://www.ccb.se/downloads/gebers_bk.ppt)
For the calculations of the scenarios, were used:

✓ the per capita indicators calculated in the water consumption characterization stage in the actual building;

✓ The per capita indicators calculated in the wastewater production characterization stage in the actual building;

✓ frequency and time data of the equipments usage;

✓ Some equipments flows; and

✓ urine and faeces volume.
Water consumption distribution

(Volume m³/d; participation %)

<table>
<thead>
<tr>
<th>RW</th>
<th>PW</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,86; 11%</td>
<td>14,62; 89%</td>
</tr>
</tbody>
</table>

**RW**
Consumed only at the apartments!
That corresponds the water consumption for toilet flushing
11% → That corresponds the water consumption for toilet flushing in relation to total water consumption.

\[ 11\% \approx 9\% \] smaller than expected

### INTRODUCTION

#### OBJECTIVE

#### METHODOLOGY

#### RESULTS AND DISCUSSION

#### CONCLUSION

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Place</th>
<th>Type of construction</th>
<th>Toilet water consumption in relation to the overall water consumption (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>This research</td>
<td>2011</td>
<td>Vitória</td>
<td>Multi-family</td>
<td>11</td>
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<tr>
<td>Barreto</td>
<td>2008</td>
<td>São Paulo</td>
<td>House</td>
<td>20</td>
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<tr>
<td>Agostini</td>
<td>2009</td>
<td>Vitória</td>
<td>Multi-family</td>
<td>20</td>
</tr>
<tr>
<td>Oliveira</td>
<td>2007</td>
<td>São Paulo</td>
<td>Multi-family</td>
<td>20</td>
</tr>
<tr>
<td>Cheung et al.</td>
<td>2009</td>
<td>Florianópolis, SC</td>
<td>Multi-family</td>
<td>21</td>
</tr>
</tbody>
</table>
Per capita water consumption indicators

<table>
<thead>
<tr>
<th>Author</th>
<th>Place</th>
<th>Type of construction</th>
<th>( I_{PW} ) (ℓ/pers.d)</th>
<th>( I_{RW} ) (ℓ/pers.d)</th>
<th>( I_{TW} ) (ℓ/pers.d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>This research</td>
<td>Vitória - ES</td>
<td>Multi-family with greywater reuse</td>
<td>247</td>
<td>31</td>
<td>278</td>
</tr>
<tr>
<td>Agostini (2009)</td>
<td>Vitória - ES</td>
<td>Multi-family with greywater reuse</td>
<td>182</td>
<td>54</td>
<td>236</td>
</tr>
<tr>
<td>Macintyre (1986)</td>
<td>Project reference</td>
<td>Apartaments</td>
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<td>200</td>
</tr>
</tbody>
</table>

The per capita potable water indicator was higher than the expected.

The per capita recycled water indicator was inferior than the expected.
Distribution of wastewater production

(Volume m³/d; participation %)

- BW
- GW dark
- GW light - Net
- GW light - reused

- GW light (provision)
  - 3.12, 22%
  - 9; 64%
- GW light (provision)
  - 1.98, 14%
  - 1.9; 13%
- GW light (provision)
  - 7.1; 51%
<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Place</th>
<th>Type of building</th>
<th>$I_{GW\ light}$ (ℓ/pers.d)</th>
<th>$I_{GW\ dark}$ (ℓ/pers.d)</th>
<th>$I_{BW}$ (ℓ/pers.d)</th>
<th>$I_{SW\ Net}$ (ℓ/pers.d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>This research</td>
<td>2011</td>
<td>Vitória – ES, Brazil</td>
<td>Multi-family with water reuse</td>
<td>152</td>
<td>53</td>
<td>33</td>
<td>216</td>
</tr>
<tr>
<td>Valentina</td>
<td>2009</td>
<td>Vitória – ES, Brazil</td>
<td>Multi-family with water reuse</td>
<td>195</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Provision and demand of light greywater

Provision: GW_light -total production average → 169 ℓ/pers.d (provision)

Demand: RW consumption average → 25 ℓ/pers.d (demand)

Production ≈ 7 times superior than the consumption

10 Monitored days
### Scenarios

<table>
<thead>
<tr>
<th>Identification</th>
<th>Description</th>
<th>PW Reduction (%)</th>
<th>TW demand reduction (%)</th>
<th>Reduction $SW_{Net}$ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario 1</td>
<td>Actual situation with the water reuse for toilet flushing.</td>
<td>10</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Scenario 2</td>
<td>Conventional, comparison base</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Scenario 3</td>
<td>Water reuse for flushing, garden watering and cleaning of impermeable areas</td>
<td><strong>16</strong></td>
<td>0</td>
<td><strong>16</strong></td>
</tr>
</tbody>
</table>

16% of potable water could be obtained if the recycled water were used for flushing toilets, garden watering and cleaning of impermeable areas.

Better optimization of water provision
The replacement of the existing toilets by the urine diversion toilets would result in a saving of 8% of water consumption and a reduction of 9% of the wastewater discharged into the collecting net, turning possible the storage of 0.06 m³ of urine a day.

**Better performance in terms of rational water usage.**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Description</th>
<th>PW Reduction (%)</th>
<th>TW demand reduction (%)</th>
<th>Reduction $SW_{Net}$ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4a</td>
<td>Urine diversion toilet and urine storage with potential usage in agriculture.</td>
<td>8</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>4b</td>
<td>4a + water reuse for toilet flushing</td>
<td>10</td>
<td>8</td>
<td>11</td>
</tr>
</tbody>
</table>
It was noticed that a saving of potable water around 11% can be obtained through the light greywater reuse for toilet flushing, based on 180 monitoring days.

Those percentages could be higher if the water reuse were used for different non-potables ends, like garden watering and cleaning of impermeable areas, car washing and also for laundrying.

Since only 21% of the light greywater production is reused, the other 79% are sent to the collecting net.
Thank you !!!

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