STORMWATER MANAGEMENT IN SENSITIVE URBAN DEVELOPMENT

Dr Andrzej Listowski
CONTEXT

- INTRODUCTION TO SYDNEY OLYMPIC PARK
- INTEGRATED WATER CONCEPT
- URBAN STORMWATER; planning, design & management
- RESULTS, ISSUES, CHALLENGES
- CONCLUSION
The Place
it’s about access

Sydney Olympic Park is located only 14 kilometres west of Sydney CBD and some 8 kilometres east of Parramatta.
TOTAL AREA 640ha

NEARLY 2/3 or (425ha) OF THE SITE IS PARKLAND.

~105ha REMEDIATED LANDFILL

SPORTING COMPLEX

RESIDENTIAL AREA

COMMERCIAL FACILITIES

FUTURE EXPANSION

MODEL DEVELOPMENT
A complete operational unit of deployable set of components, products, functions and specifications AND how these components, products, functions integrate and support each other.
STORMWATER INFRASTRUCTURE - CONCEPTS

- Major/Minor system approach for design
- Stormwater pollution control devices and water quality control pond in each catchment
- Where possible, ‘soft’ environmental designs used
- Large storage in brickpit

CATCHMENT AREAS
Olympic Village, Carpark, Newington Wetlands
Western Catchment, SIAC
Eastern Catchment
Brickpit
Newington Storage
Dry year harvest 142ML
Median year harvest 346 ML
Irrigation Demand
Dry year 665ML
Median Year 395 ML
Wet year 240 ML

Eastern WQCP
Dry year harvest 97ML
Median Year Harvest 107ML
Operational Demand
Irrigation 25 - 65 ML

Northern Water Feature
Dry year harvest 135 ML
Media year harvest 158 ML
Irrigation Demand
Dry year 186ML
Median Year 111ML
Wet year 68 ML

Brickpit Storage 300ML
Stormwater run-off 76ML
Stormwater transfer 140-350ML

Urban Core, Public Space
Irrigated area 23 Ha
Demand dry year 395 Mi
Median 143 Mi
Wet 125 ML

Southern WQCP
Dry year harvest 67ML
Median Year Harvest 86ML
Operational Demand
Irrigation 12 - 36 ML

LEGEND:
- Flow Directions
- Existing Stormwater Mains
- Proposed Stormwater Mains
- Catchment Boundary
- Proposed Stormwater Rising Mains

NOTES:
Approximate Network
Subject to change in
detail design stage.
Secondary Mains not shown
<table>
<thead>
<tr>
<th>SYSTEM ELEMENTS</th>
<th>No’s/Area</th>
<th>POLLUTANTS REMOVAL</th>
<th>ASSESSMENT CRITERIA</th>
<th>PERFORMANCE INDICATOR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ROOF WATER COLLECTION</strong></td>
<td>40,000m²</td>
<td>NA</td>
<td></td>
<td>COLLECTED VOLUME</td>
</tr>
<tr>
<td><strong>SOURCE CONTROL (SILT, GREASE, LITTER, TP, TN, SS, )</strong></td>
<td>Each facility</td>
<td>√</td>
<td></td>
<td>COLLECTED MASS</td>
</tr>
<tr>
<td><strong>S/W DRAINAGE INFRASTRUCTURE</strong></td>
<td>Pipe, pits, culverts,</td>
<td>√</td>
<td></td>
<td>COLLECTED MASS</td>
</tr>
<tr>
<td><strong>S/W SYSTEM POLLUION CONTROL</strong></td>
<td></td>
<td></td>
<td></td>
<td>(kg/unit/y)</td>
</tr>
<tr>
<td>S/W TREATMENT &amp; CONTROL - GPT’S</td>
<td>26 CDS+14 Pits+12 Booms</td>
<td>~70T</td>
<td>COLLECTED MASS</td>
<td></td>
</tr>
<tr>
<td>S/W TREATMENT &amp; CONTROL - BUFFER STRIPS/SWALES</td>
<td>3,600m²</td>
<td>√</td>
<td>COLLECTED MASS</td>
<td></td>
</tr>
<tr>
<td>S/W TREATMENT &amp; CONTROL - PONDS &amp; WETLANDS</td>
<td>28</td>
<td>√</td>
<td>COLLECTED MASS</td>
<td></td>
</tr>
<tr>
<td><strong>S/W TREATMENT &amp; CONTROL – LANDSCAPE INFILTRATION</strong></td>
<td>50,000m²</td>
<td>√</td>
<td>COLLECTED MASS</td>
<td></td>
</tr>
<tr>
<td><strong>S/W USAGE (DIRECTLY FROM STORAGES, PONDS, WETLANDS)</strong></td>
<td>320ML/y</td>
<td>√</td>
<td>COLLECTED MASS</td>
<td>(ML/y)</td>
</tr>
<tr>
<td><strong>S/W USAGE (RECYCLED WATER SUPPLY)</strong></td>
<td>455ML/y</td>
<td>√</td>
<td></td>
<td>(ML/y)</td>
</tr>
<tr>
<td><strong>TOTAL S/W RUNOFF (IMPERVIOUS SURF.)</strong></td>
<td>~1920ML/y</td>
<td>√</td>
<td></td>
<td>(ML/y)</td>
</tr>
<tr>
<td><strong>S/W RUNOFF TO ENVIRONMENT</strong></td>
<td>~6000ML/y</td>
<td>√</td>
<td></td>
<td>(ML/y)</td>
</tr>
<tr>
<td><strong>RAINFALL (AVERAGE ANNUAL)</strong></td>
<td>870mm/y</td>
<td>NA</td>
<td></td>
<td>(ML/y)</td>
</tr>
</tbody>
</table>
THE WSUD CONCEPT EVALUATION

**Water sources**
Stormwater rainfall/ runoff
(Roof, Allotment, Road)
Potable water
Sewage
Recycled water

**Water Users**
Water Quality (potable-non potable)
Water uses (types, time, technique)
Water demand management
Water conservation practices

**Pollution Retention**
Source control, system control, discharge control
Pollutant traps (gross, suspended, dissolved)
Biofiltration, Soils, Surfaces
On site Treatment, On site Reuse

**Receiving Waters**
No net export of pollutants to waters
Water Balance (Quality & Quantity)
Impact on Aquatic Ecology
Water Pollution Reduction Plans

**Water retention methods**
Permeable surfaces
Land contours & topography
Landscape & Vegetation
Storage tanks, ponds & wetlands

**Water Conveyance Methods**
Pipes, drains, swales, trenches
Pressure and gravity systems
Water retention and storages
Multiple water supply systems
STORMWATER TREATMENT DESIGN ISSUES

STORMWATER TREATMENT SHOULD BE CONSIDERED AS A CONTINUATION OF PHYSICAL, CHEMICAL AND BIOLOGICAL PROCESSES OPERATING UNDER SPECIFIC CONDITIONS

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>TREATMENT Method</th>
<th>TREATMENT Sequencing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Pollutants $d_{pa}&gt;5\text{mm}$</td>
<td>Screening</td>
<td>Removal of <strong>Gross Pollutants</strong></td>
</tr>
<tr>
<td>Medium Pollutants $5\text{mm} \text{ to 0.1mm}$</td>
<td>Sedimentation</td>
<td>Removal of <strong>Coarse Materials</strong></td>
</tr>
<tr>
<td>Fine Pollutants $0.1\text{mm} \text{ to 0.01mm}$</td>
<td>Sedimentation/ Flocculation</td>
<td>Removal of <strong>Fine Materials</strong></td>
</tr>
<tr>
<td>Colloidal Pollutants $0.01\text{mm} \text{ to 0.005mm}$</td>
<td>Adsorption</td>
<td>Removal of <strong>soluble Contaminants</strong></td>
</tr>
<tr>
<td>Dissolved Pollutants $d_{pa}&lt;0.005\text{ mm}$</td>
<td>Biodegradation /</td>
<td></td>
</tr>
</tbody>
</table>

Other factors: concentration, density, solubility, hydrodynamics, temperature, etc
## Stormwater Resources – Availability and Reuse Potential

<table>
<thead>
<tr>
<th>Year</th>
<th>Rainfall (mm/y)</th>
<th>Potential Annual Yield (ML)</th>
<th>Reused Volume (ML)</th>
<th>Diversion Reuse Ratio (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/01-31/12/2001</td>
<td>872.6</td>
<td>1396.16</td>
<td>125</td>
<td>9.0%</td>
</tr>
<tr>
<td>1/01-31/12/2002</td>
<td>585.4</td>
<td>936.64</td>
<td>276</td>
<td>29.5%</td>
</tr>
<tr>
<td>1/01-31/12/2003</td>
<td>1033.7</td>
<td>1653.92</td>
<td>350</td>
<td>21.1%</td>
</tr>
<tr>
<td>1/01-31/12/2004</td>
<td>758.4</td>
<td>1213.44</td>
<td>665</td>
<td>54.8%</td>
</tr>
<tr>
<td>1/01-31/12/2005</td>
<td>706.4</td>
<td>1130.24</td>
<td>125</td>
<td>11.0%</td>
</tr>
<tr>
<td>1/01-31/12/2006</td>
<td>741.6</td>
<td>1186.56</td>
<td>384</td>
<td>32.3%</td>
</tr>
<tr>
<td>1/01-31/12/2007</td>
<td>1333.24</td>
<td>2133.184</td>
<td>346</td>
<td>16.2%</td>
</tr>
<tr>
<td>1/01-31/12/2008</td>
<td>1212.8</td>
<td>1940.48</td>
<td>618</td>
<td>31.8%</td>
</tr>
<tr>
<td>1/01-31/12/2009</td>
<td>745.2</td>
<td>1192.32</td>
<td>702</td>
<td>58.9%</td>
</tr>
<tr>
<td>1/01-31/12/2010</td>
<td>956.8</td>
<td>1530.88</td>
<td>590</td>
<td>38.6%</td>
</tr>
<tr>
<td>1/01-31/12/2011</td>
<td>527.53</td>
<td>844.048</td>
<td>518</td>
<td>61.4%</td>
</tr>
<tr>
<td><strong>AVERAGE</strong></td>
<td><strong>861</strong></td>
<td><strong>1378</strong></td>
<td><strong>427</strong></td>
<td><strong>33.15%</strong></td>
</tr>
</tbody>
</table>

### Stormwater Quality and Pollution Load Calculation - daily & annual

<table>
<thead>
<tr>
<th>Unit</th>
<th>Range</th>
<th>Mean Range</th>
<th>Mean (kg/day)</th>
<th>(kg/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP</td>
<td>mg/L</td>
<td>0.049 – 2.14</td>
<td>0.32</td>
<td>0.37</td>
</tr>
<tr>
<td>TN</td>
<td>mg/L</td>
<td>0.5 – 12.6</td>
<td>2.51</td>
<td>2.94</td>
</tr>
<tr>
<td>Nitrate</td>
<td>mg/L</td>
<td>0.1 – 6.2</td>
<td>0.79</td>
<td>0.92</td>
</tr>
<tr>
<td>BOD5</td>
<td>mg/L</td>
<td>3.0 - 73.0</td>
<td>14.80</td>
<td>17.31</td>
</tr>
<tr>
<td>pH</td>
<td>na</td>
<td>6.7 – 8.5</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>TDS</td>
<td>mg/L</td>
<td>44 - 208</td>
<td>95.67</td>
<td>111.92</td>
</tr>
<tr>
<td>TSS</td>
<td>mg/L</td>
<td>13 – 1622</td>
<td>145.21</td>
<td>169.88</td>
</tr>
<tr>
<td>Turbidity</td>
<td>NTU</td>
<td>12 – 34</td>
<td>20.20</td>
<td>23.63</td>
</tr>
<tr>
<td>Cadmium</td>
<td>mg/L</td>
<td>0.2 - 46</td>
<td>3.03</td>
<td>3.54</td>
</tr>
<tr>
<td>Copper</td>
<td>mg/L</td>
<td>0.005 – 0.56</td>
<td>0.05</td>
<td>0.06</td>
</tr>
<tr>
<td>Iron</td>
<td>mg/L</td>
<td>2.4 – 7.3</td>
<td>4.19</td>
<td>4.90</td>
</tr>
<tr>
<td>Lead</td>
<td>mg/L</td>
<td>0.007 – 2.04</td>
<td>0.12</td>
<td>0.14</td>
</tr>
<tr>
<td>Manganese</td>
<td>mg/L</td>
<td>0.04 – 0.11</td>
<td>0.07</td>
<td>0.08</td>
</tr>
</tbody>
</table>
Annual Rainfall

Financial Year

- Annual Rainfall (mm)
- Days Rained Annually
- Linear (Annual Rainfall (mm))
- Linear (Days Rained Annually)
# Case Study - Stormwater Environmental Impact Control

## Pollutant Loading Limits

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>kg/ha/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS</td>
<td>250</td>
</tr>
<tr>
<td>COD</td>
<td>70</td>
</tr>
<tr>
<td>BOD</td>
<td>36</td>
</tr>
<tr>
<td>TN</td>
<td>10</td>
</tr>
<tr>
<td>TP</td>
<td>1.5</td>
</tr>
</tbody>
</table>

## Average annual pollutant export reduction

- **Runoff**: 60%
- **SS**: 90%
- **TP**: 90% red.
- **TN**: 80% red.
- **BOD**: 90% red.
STORMWATER OPERATIONS

- Domestic plastics (food packaging, chip packs, straws...) 30% - 21 000 kg
- Industrial packaging (polystyrene, foam) 12% - 9 000 kg
- Metals (aluminium, steel cans) 3% - 2 000 kg
- Plastic bottles, containers, 20% - 14 500 kg
- Paper (cigarette butts, magazines, boxes) 13% - 8 800 kg
- Sediment 1% - 600 kg
- Organic 18% - 12 500 kg
- Other - medical supplies, oil, glass 4% - 2 500 kg

TOTAL - 71 000 kg/y
- 40 GPT’s
- 24 Silt, O&G Pits
- 12 Boom gates on Cr’s

Total annual M&O cost ~$130k/y
Wetlands M&O cost ~ $140k/y
Stormwater harvesting ~ $60k/y
**UNDERSTANDING OF URBAN STORMWATER SYSTEM - CONCEPTUALISATION & IMPLEMENTATION PROCESS**

**STEP 1**
- Catchment Definition
  - Catchment definition: topography, hydrology, land uses, urbanisation, activity, etc
  - Receiving waters ecosystem characterisation
  - Rainfall and runoff; relation to urbanisation
  - Pollutants characterisation; types, sources, quality, quantity

**STEP 2**
- S/Water System Needs
  - Performance objectives and stormwater system requirements
  - Strategies, performance standards, criteria & design requirements (mandatory, planning, systemic, functional & operational priority)
  - Treatment technologies, mechanisms, method and processes
  - Capital costs, maintenance and operational resources

**STEP 3**
- Performance Assessment
  - Technical performance evaluation; data, quality, quantity, efficiency...
  - Economic performance; LCA, CBA, land value
  - Environmental benefits; ie, habitat enhancement, pollution reduction, water saving
  - Social benefits; ie aesthetics, recreation,
In the interests of minimising costs, water utilities will choose a traditional water/wastewater system which tends to equalise average and marginal costs across system components.

Traditionally, water utilities don’t have to pay any compensation for any costs that the third party water reuse, sewer mining, stormwater harvesting operation impose.

The inclusion of these costs could have a significant influence in any financial comparison of reuse versus conventional water supply and wastewater schemes.

Encourage proper economic, social and environmental evaluation of alternative water supply, sewerage and drainage schemes.
WATER CYCLE SYSTEM
CONCLUSIONS

♦ Planning, design and management of stormwater systems requires innovative approaches to meet operational challenges and high level environmental expectations.

♦ Demonstrated confidence in integrated water cycle & stormwater role in securing future urban water supply.

♦ Wider understanding of environmental benefits, but urgent need to quantify M&O LC cost.

♦ Implementation of a large scale integrated water cycle stormwater schemes is depending on LCA economic incentives.
Thank you

Any

andrzej.listowski@sopa.nsw.gov.au
02-97147404 or 0407948795