The city perspective.
Lessons from Dublin
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Dublin City Council
CSGN – The city perspective. Lessons from Dublin

Topics covered in Presentation

• Introduction to Dublin
• Greater Dublin Strategic Drainage Study 2005
• Water Framework Directive 2010
• City Development Plan 2011-2017 (requirements for Green Infrastructure)
• Suds Philosophy
• Source of our ideas
• Practical examples from Dublin and elsewhere
• Green roofs
Introducing Dublin - The City Now

City Population in 2006
506,211
(+2% from 2002)

Greater Dublin Area
Population in 2006
1.66 m

39% of national population lives in Greater Dublin Area
A Sustainable City
Integrate the Six Themes

- Economic
- Social
- Environmental
- Cultural
- Movement
- Urban Form & Spatial
Achievements of Last 15 Years

- Temple Bar Cultural Quarter
- Dublin Bikes
- Fatima Rejuvenation
- Grand Canal Dock
- Port Tunnel
- O Connell Street
- LAB and NEIC
- T21 & LUAS
- Fr Collins Park / New Areas
People Living in the City Centre

Investing in community leisure and recreation

Fostering a creative & SMART economy

Investing in the city’s infrastructure
Develop Cruise Tourism
WELCOME FOR RECENT VISITORS TO DUBLIN
Strong City Identity
Greater Dublin Strategic Drainage Study

Phase 1
Initial Planning
2001

Phase 2
Modelling
2002-2003

Phase 3
Options
2003-2004

2011 Development

2031 Development

Drainage Policies for Dublin Region

Initial Strategy Review

Final Strategy Report
March 2005
Greater Dublin Strategic Drainage Study

Drainage Policies

New Development
Stormwater Management, SuDS
Construction Inspection

Environmental Management
Water Framework Directive
Sustainable Drainage Systems
CSOs

Climate Change
Rising Sea Water Levels
Increased Rainfall Intensities

Inflow / Infiltration / Exfiltration

Basements
GDSDS Policies & Resilience:

1: Over All Policy
2: New Development
3: Environmental Management
4: Infiltration–Exfiltration
5: Climate Change
6: Basements
OBJECTIVES OF IMPLEMENTING SuDS POLICY

- REDUCE PEAK RUN-OFF FROM NEW DEVELOPMENT
- IMPROVE QUALITY OF RUN-OFF
- ASSIST IN ACHIEVING OBJECTIVES OF WATER FRAMEWORK DIRECTIVE, (ie. ALL WATERS TO BE OF GOOD ECOLOGICAL STATUS)
- IMPROVE BIODIVERSITY
IMPLEMENTATION OF SuDS POLICY

- EMBEDDED AS POLICY OBJECTIVE IN DEVELOPMENT PLANS OF LOCAL AUTHORITIES IN GREATER DUBLIN AREA

- CODE OF PRACTICE FOR ALL DRAINAGE WORKS IN SEVEN LOCAL AUTHORITIES

- INSERT CONDITION IN ALL GRANTS OF PLANNING PERMISSION REQUIRING COMPLIANCE WITH CODE OF PRACTICE
"New Development Policy, Technical Guidance Document".

• All new development shall incorporate SuDS facilities
EU policy instruments for protecting our water resources

**EU Environmental Legislation**
- Water Framework Directive
- Urban Waste Water Directive
- Nitrates Directive

**EU Research Programmes**

**Financial incentives (±/−)**
- New EU Agricultural Policy
- EU Funding Instruments
- Water pricing reflecting cost recovery
Environmental objective “surface waters”

Impact
- No or minimal
- Slight
- Moderate
- Major
- Severe

Ecological status
- HIGH
- GOOD
- MODERATE
- POOR
- BAD

Non-deterioration
Restoration
Ambitious and binding on objectives, flexible on tools

- Legally binding and enforceable on environmental objectives
- Flexible on paths/tools to achieve these objectives, thus open to, and encouraging, innovation
• Plan and Programme of measures adopted in July 2010 – Incorporated into Development Plan

• Dublin City co-ordinates 12 Local Authorities and 33 Public Bodies
Requirement for Green Infrastructure
WHAT's NEW?

• CORE STRATEGY (6 Year & Long-Term)
• SUSTAINABLE DUBLIN

• ECONOMIC RECOVERY (Action Plan, Creative Alliance, 4 LAs)
• GREEN INFRASTRUCTURE (Strategic, Multi-Functional)
• PUBLIC REALM, GOOD ARCHITECTURE (New Guiding Principles Chapter 16)
• COMPACT, CONNECTED CITY, LOW-RISE, TALL BUILDINGS IN LIMITED AREAS
• SUSTAINABLE NEIGHBOURHOODS (Phasing / Community Audits)

• MONITORING & IMPLEMENTATION (18 Indicators, Annual Report)

• NEW COMMUNICATAION – (Web, Blogs, My City Interactive Display)
Expanding the City Core
Dublin Bay
Strategic Environmental Assessment (SEA)

- Prepared in parallel with Development Plan
- Affords High level protection to the environment

Habitats Directive Assessment (Appropriate Assessment) (AA)

- Scientific assessment of potential impacts of the Development Plan on Natura 2000 Sites (Dublin Bay)
Hydrological Cycle - managing the entire cycle is the goal
The SUDS concept

The management train

- Evaporation
- Conveyance
- Discharge
- Source control
- Site control
- Regional control
- Infiltration
- Prevention
- Conveyance
- Receiving water

Amenity and Bio-diversity

Quantity Quality
Traditional Surface Water Drainage

- Drainage design has been extremely simple using a rational method to size pipes to ensure that surface water is removed as quickly as possible to ensure flooding does not take place.

- Unfortunately this philosophy is flawed as, in transferring the surface water downstream, it provides the potential for flooding of other areas.

- In addition the pollution in the wash-off from the urban environment is conveyed into the natural environment.
SuDS can be summarised as offering a “total” solution to rainwater management while traditional drainage can be considered as only providing a “collection and disposal” approach.

The philosophy of SuDS is to try and replicate the natural drainage that would have occurred prior to development.

SuDS control flooding by reducing the peak flow during a storm event.

SuDS increase the morphology, biodiversity and enhanced landscape fit.

There is no unique solution and each situation has to be evaluated on its own merits and suitable SuDS solutions picked for that particular location.
The SUDS concept

The management train

Conveyance

Source control

Prevention

Conveyance

Evaporation

Discharge

Site control

Discharge

Regional control

Infiltration

Receiving water

Quantity

Quality

Amenity and Bio-diversity

SUDS
Disconnectivity
Instead of being directly connected to stormwater infrastructure, rain leaders are “disconnected” and allowed to discharge across a lawn or into a rain garden, swale or infiltration bed.
Green Roofs
Roofing systems specially designed to grow vegetation, normally consisting of a special waterproof and root repellant membrane, drainage system, filter cloth, lightweight growing medium, and plants.
Porous Pavements
A type of pavement that allows rain or snowmelt to pass through it. Can be specialized asphalt or concrete, dry-laid interlocking pavers, or other materials.

Sidewalks & Walkways

Driveways & Patios
Bioretention and Urban Streetscape (Portland, OR)
Rainwater Harvesting
Putting rainwater to work for garden or houseplant watering, for washing the car, or even for flushing toilets.
Infiltration Planters
Another way to integrate landscape with architecture is to build planters that also manage stormwater.

Portland, OR
Dry Wells: don’t need much space
The SUDS concept

The management train

Site control

Conveyance

Evaporation

Discharge

Source control

Prevention

Conveyance

Receiving water

Infiltration

Regional control

Amenity and Bio-diversity

Quantity

Quality

SUDS
Infiltration Systems
Any system designed to promote stormwater infiltration into groundwater. Include basins, trenches, drywells, stone beds beneath pervious pavement, etc.
Open Swales
Vegetated swales can replace curbs, gutters, and pipes in the stormwater conveyance system. The swales provide filtration of stormwater runoff and reduce piping and infrastructure costs.
Bioretention Areas
Stormwater directed to these shallow topographic depressions in the landscape is filtered, stored, and infiltrated into the ground using specialized vegetation and soils.
The SUDS concept

The management train

Conveyance
Evaporation
Discharge
Source control
Prevention
Conveyance
Site control
Regional control
Receiving water

Infiltration

Amenity and Bio-diversity
Quantity
Quality

SUDS

CIRIA
Wet Detention Pond: last component in BMP Treatment Train

1. Runoff from 30mm of rainfall is detained in the pond for flood control, erosion control, and treatment by algal and vegetative uptake, solids setting, and adsorption.

2. The runoff from the first 30mm of rainfall is detained above a permanent pool (with a wet season hydraulic residence time of 14 to 28 days) for treatment.

3. Storage recovery of runoff from 30mm of rainfall is required in 48 to 72 hours.

Notes:
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3. Storage recovery of runoff from 30mm of rainfall is required in 48 to 72 hours.
Caw Burn, Scotland
Integrated Stormwater Planning Helps

Regeneration: the Toronto Waterfront Regeneration Trust.
EXAMPLES OF SUSTAINABLE DRAINAGE SYSTEMS

Practical examples from Dublin and elsewhere
City West, Dublin
Aiken’s Village, Sandyford, Dublin
Belarmine, Sandyford, Dublin
Downstream Defender®
"Hydrodynamic Vortex Separator"
Downstream Defender – An Integrated SuDS approach
Cherrywood, Dublin
Livingston, Scotland
Combination of Wetland and Infiltration
Augustenborg, Malmö, Sweden

- Inner-city suburb in Malmö, CSO and flooding problems
- In 2001 Augustenborg was disconnected from the existing combined sewer and drained by means of an open stormwater system. Stormwater is now led through a complex arrangement of green roofs, swales, channels, ponds and small wetlands.
Development of Integrated Constructed Wetlands (ICW) Systems
Basic ICW hydraulic model

- Precipitation
  \[ \text{Interception} + \text{Evapo-transpiration} \]
  \[ \text{Influent} \]
  + Impeded seepage/infiltration
  \[ \text{Effluent} \]

Multi-celled with sequential flow
ICW in Tolka Valley Park, Dublin
ICW, Tolka Valley Park

River Tolka

INLET

CELL 1

CELL 2

LAKE

OUTLET

CELL 2
ICW Landscaped into Park
Green Roofs
Green Roof Hydrology

- Rainfall
  - Evapotranspiration
  - Interception by plants
  - Infiltration and storage
- Substrate
- Plants
- Drainage layer
- Runoff

Comparison between conventional roof and green roof:
- Conventional roof:
  - Peak runoff
  - Total runoff volume
- Green roof:
  - Runoff is delayed
  - Peak runoff and total runoff volume reduced
Living Walls
Why do we need Green Roofs & Living Walls?

• By 2100, 20% increased rainfall
• By 2100, 1.5 - 2°C warmer winter
• Existing surface water and combined drainage systems overloaded
• Increased flooding
Benefits:

- Less Runoff
- Pollution removal
- Carbon sequestration
- Less solar absorption
- Energy savings
- Habitat creation
- Rare species conservation
- Thermal regulation
- Amenity & biodiversity provision
• Carbon Emissions:
  - Carbon sequestration properties.
  - USA experiment: 660gCm² captured in green roof system (above ground, soil and below ground biomass).
  - 3000ha of green roof capturing 18,000 metric tonnes of Carbon

• Energy:
  - Traditional roof solar reflection: 5-10%
  - Green roof solar reflection: 20%
  - Reduce winter heating demands by 10%
  - Reduce electricity consumption by 5-10%.
  - Can be combined with photovoltaic panels
Habitat Creation

In London:

- Increase notable spiders
- Black Redstart numbers increasing
- Increase in rare and scarce species of invertebrates – bees, beetles and butterflies
UK Example of Retrofit Green Roof – Ethelred Housing Estate, Lambeth

- Estate considered for demolition in the early 1990s
- Tenant Management Organisation opposed demolition
- Various refurbishment works required – including roofing repairs
- Tenants proposed green roof
- 6000 m² – largest green roof retrofit in Europe
- No additional land take
Impact of Green Roof Legislation in Linz

Area without green roof regulations before 1985

Area with green roof regulations after 1985
CSO Program Implementation
- Philadelphia

Unique facilities, such as a 13.5-foot inflatable rubber dam being installed near the historic Fairmount Water Works along the Schuylkill River, will help achieve water quality improvements while restoring urban stream habitats and protecting biological resources.
Dublin Flood Initiative

**Drainage**
- GDSDS: Greater Dublin Strategic Drainage Study
- Regional Study: good practice guidelines, codes of practice

**Dams**
- DCCFP: Dublin Coastal Flooding Protection Proj.
- Strategic Review: dam improvements, operational GLs for: DCC water supply, ESB power supply

**Coastal**
- Strategic Study: new defences, flood atlas, forecast system

**Rivers**
- CFRAMs: Catchment Flood Risk Assessment & Management
- 3 Catchment Studies: modelling, multi criteria assessment, flood mapping

**Pluvial**
- FRC: Flood Resilient City
- City wide study: meteorology, indexing, flood mapping, adaptive works, codes of practice, emergency response
Context - Parallels with UK Pluvial Practice

FRC Programme Elements Relevant to Pluvial Flooding ↔ Emerging UK SWMP and Pluvial Flooding Practice

**Awareness**
- 1D/2D flood modelling and integrated mapping
  - Integrated flood forecasting and warning
  - 3D urban exceedance model
- Flood partnerships framework and flood awareness and information

**Avoidance**
- Spatial planning and flood resilience
  - Water sensitive urban design

**Alleviation**
- ‘Streets as Streams and Roads as Rivers’
- Flood alleviation techniques in urban areas
  - Structural and non-structural means

**Assistance**
- Civil flood assistance plan
- Flood information management system
  - Flood resilience in the community
  - Flood response management

**Risk Assessment**
- Staged approach/future scenarios
- Map and communicate risk

**Implementation**
- Action plan

**Preparation**
- Establish SWMP partnership

**Options**
- Planning policies / improved resilience
- Source control, SUDS, storage etc
- Overland flow management, maintenance
- Temporary defences, SUDS, etc
- Weather warning / improved resilience etc

Context - Parallels with UK Pluvial Practice
Option Appraisal

The ‘FAB-Plus’ test

Looking for multiple wins:

- **Flood Risk Mitigation** .....a ‘given’
- **Amenity Enhancement**
- **Biodiversity Opportunity**
- **- Plus**.....
- Carbon reduction /sequestration
- Waste re-use
- Potential for **Regeneration Uplift**
- **Recreational** enhancement
- ........and others?

Consultants Jacobs – as part of EU Flood Resilient Cities Project
Dublin City Promoting SuDS in Ireland
The website is to promote and facilitate the use of SuDS
- Tools for Developers and Planners
- Guidance on SuDS
- References for more information
- Provide a common view for all stakeholders
Specific Site Guidance

Simple short report (with unique ref. identifier) advising on appropriate SuDS for a site, based on:

- Soil type
- Type of development
- Size
- Contaminated land
- Scarce water resources
- Groundwater depth
- Drainage ownership
- Greenfield / Brownfield
- Aquifer vulnerability
Irish SuDS: Guidance and Tools
www.irishsuds.com
How to Use the Stormwater Storage Assessment Tool:

1. Use the map tools to pan and zoom to your desired map location.
2. Select the information (i) tool and click on your map location.
3. Fill in the name and location of your site and correct the form default values as necessary.
4. Press "Calculate" to complete the calculated values on the form.
5. Amend any entry fields and press "Recalculate" to change the calculated values. Repeat this step as many times as required.
6. Press "Report" to produce a site report with a unique reference provided by this website to confirm your use of the tool.
## Stormwater Storage Assessment Tool

- **Site name:** Daily
- **Site location:** Dublin
- **Site coordinates:** -6.504365, 53.536100 -6.488047, 53.591121

### Site characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Automatic values</th>
<th>Editable values</th>
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<tbody>
<tr>
<td>Area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed % of Impermeable Area (50-100%)</td>
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<td></td>
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<tr>
<td>% of Impermeable Area Required Treatment</td>
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<tr>
<td>Soil Type (based on FSR)</td>
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</tr>
<tr>
<td>Hydrological Region</td>
<td>Dublin Region</td>
<td>Dublin Region</td>
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<tr>
<td>Average Annual Rainfall</td>
<td>874</td>
<td>874</td>
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<tr>
<td>M5-60 Rainfall Depth</td>
<td>17</td>
<td>17</td>
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<tr>
<td>&quot;r&quot; Ratio M5-60/M5-2 day</td>
<td>0.3</td>
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<tr>
<td>Climate Change Increase</td>
<td>1.1</td>
<td>1.1</td>
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### Discharge rate limits

<table>
<thead>
<tr>
<th>Year</th>
<th>1:1 year</th>
<th>1:30 year</th>
<th>1:100 year</th>
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<tbody>
<tr>
<td>l/s</td>
<td>5 (5)</td>
<td>13 (6)</td>
<td>16 (6)</td>
</tr>
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</table>

### Volumetric requirements

<table>
<thead>
<tr>
<th>Type of Storage</th>
<th>Treatment Storage</th>
<th>Long Term Storage</th>
<th>Attenuation Storage</th>
<th>Interception Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirement</td>
<td>120 (120) m³</td>
<td>201 (0) m³</td>
<td>247 (534) m³</td>
<td>40 (40) m³</td>
</tr>
</tbody>
</table>

*Values in brackets are calculated for the case when long-term storage is not used.*
Green solutions at the heart of Dublin City Development
Thank you for your attention

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Dublin City Council