European Cooperation in the field of Scientific and Technical Research - COST -

Brussels, 21 November 2012

TU1206

MEMORANDUM OF UNDERSTANDING

Subject:	Memorandum of Understanding for the implementation of a European Concerted Research Action designated as COST Action TU1206: SUB-URBAN - A European network to improve understanding and use of the ground beneath our cities

Delegations will find attached the Memorandum of Understanding for COST Action as approved by the COST Committee of Senior Officials (CSO) at its 186th meeting on 20 - 21 November 2012.

MEMORANDUM OF UNDERSTANDING
For the implementation of a European Concerted Research Action designated as

COST Action TU1206
SUB-URBAN - A EUROPEAN NETWORK TO IMPROVE UNDERSTANDING AND USE OF THE GROUND BENEATH OUR CITIES

The Parties to this Memorandum of Understanding, declaring their common intention to participate in the concerted Action referred to above and described in the technical Annex to the Memorandum, have reached the following understanding:

1. The Action will be carried out in accordance with the provisions of document COST 4154/11 "Rules and Procedures for Implementing COST Actions", or in any new document amending or replacing it, the contents of which the Parties are fully aware of.

2. The main objective of the Action is to provide a long-needed contribution to greater interaction and networking between experts who develop urban subsurface knowledge and those who can benefit most from it - urban decision-makers, practitioners and researchers.

3. The economic dimension of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at EUR 32 million in 2012 prices.

4. The Memorandum of Understanding will take effect on being accepted by at least five Parties.

5. The Memorandum of Understanding will remain in force for a period of 4 years, calculated from the date of the first meeting of the Management Committee, unless the duration of the Action is modified according to the provisions of Chapter V of the document referred to in Point 1 above.

A. ABSTRACT AND KEYWORDS

Increasing urbanisation throughout the world challenges the sustainable development and resilience of cities. Despite this, the importance of the ground beneath cities is under-recognised and often overlooked. The main aim of the Action is to provide a long-needed contribution to greater interaction and networking, and so transform the relationship between experts who develop urban subsurface knowledge and those who can benefit most from it - urban decision makers, practitioners and the wider research community. The Action will establish a network to co-ordinate, integrate and accelerate the world-leading research into modelling the subsurface taking place in European institutions and to develop a Toolbox to enable subsurface knowledge to be widely disseminated. Thus, to maximise the economic, social and environmental benefits of urban subsurface resources and ecosystem services on which cities depend, the Action will:

- Draw together collective research capabilities in 3D/4D characterisation, prediction and visualisation of the subsurface;
- Deliver this in appropriate forms;
- Provide training and continuing support and advice to better inform and empower decision makers and other end-users;
- Foster development of policy which reflects the importance of the urban subsurface;
- Recommend the basis for improved availability, initial use and re-use of subsurface data.

A.2 Keywords: Subsurface, city, 3D/4D modelling, urban sustainability and ecosystem services, geology and groundwater

B. BACKGROUND

B.1 General background

Cities worldwide are recognised as vital engines for economic growth. Europe's population is already substantially urbanised and by 2050 it is estimated that two-thirds of the world's population will live in urban areas (UN-HABITAT, 2012). As populations grow, sustainable development - a

pattern of growth in which resource use aims to meet human needs while preserving the environment for present and future generations (The Brundtland Commission 1987) - is increasingly threatened. In contrast to the attention given to the visible (above ground) expressions of cities, there is a marked lack of appreciation of the importance of the subsurface amongst those who plan, develop and manage cities. This is manifested in a lack of co-ordinated policy on the subsurface. For example, the subsurface is not explicitly acknowledged in the evolving Joint Programming Initiative 'Urban Europe' (http://www.jpi-urbaneurope.eu). As a result, the area beneath our cities is used inefficiently at best and unsustainably at worst; safeguarding of subsurface ecosystem services lacks robustness and conflicting uses of the subsurface are largely unaddressed. The underground as a spatial asset needs to be clearly understood by urban decision-makers if it is to achieve its full potential in adapting cities to the many challenges that will be faced in the coming decades.

Explosive growth of cities, coupled with the demand for improved liveability and environmental protection, is creating a strong demand for new underground infrastructure. Conflicts with prior uses (often of lesser value) and unappreciated impacts on other underground resources often make use of underground space in cities suboptimal. This frequently occurs because the basic resources provided by the underground, i.e. space, materials, water and energy, are considered without any vision for their future uses collectively, and of the subsurface as a whole. For example, unanticipated disruption of groundwater flows can cause wells to dry up, cause ingress of pollutants, damage to sites of historical interest or cause flooding of existing subsurface developments. For underground space to remain a societal asset, it is necessary to plan and manage its use, just like any other asset, as has been pioneered for example in Helsinki and St Petersburg, where subsurface urban development has been integrated into the land-use planning system. If this is not done, the greatest benefits of underground space will prove to be short-lived and the subsurface will eventually cease to be an effective instrument for the support, redirection and sustainable development of urban areas (ITACUS, White Paper, 2010).

To achieve maximum effectiveness, planning for urban areas must go beyond the conventional two-dimensional (2D) arrangements of surface facilities and consider the full three-dimensional interactions between the built environment, both above and below ground, its supporting infrastructure and subsurface space. A key barrier to progress is the inadequate way in which knowledge about the subsurface is made available to urban decision makers. Recent advances in technology and computer software have completely revolutionised the way in which the subsurface can be interpreted, visualised and analysed, and delivered, with a move from 2D representation to 3D and 4D. These advances have been adopted, and in many cases initiated, by Geological Survey

Organisations (GSOs) and other researchers in Europe. However, the research proceeds independently, resulting in a lack of common purpose, duplication of effort and dissipation of impact. Currently, experts engaged in the Action can continue to fund their research, but do not have the additional funding available to allow their effective interaction and coordination, other than on a limited and ad hoc basis. Thus, COST is the most appropriate framework to bring together the groups of experts, to integrate their research, and their approach to the delivery of subsurface knowledge, to enable them to engage with and recognise fully the needs of decision makers, and to facilitate mutual interchange of methodologies, ideas and advances in understanding.

B.2 Current state of knowledge

Historically, research into ways that geological and associated subsurface information could be used in engineering, planning and development, concentrated on how it could be presented in the form of maps and reports. Whilst such methods provided useful, localised information, this was hard to keep up-to-date, and to integrate with other forms of knowledge used by decision-makers. GSOs are both the main holders of subsurface data throughout Europe, and providers of knowledge derived from these. They have been addressing the transition from traditional 2D to 3D geological modelling (also referred to as 3D geological mapping). Together with some other European institutions, GSOs are carrying out pioneering, high-quality independent scientific research on subsurface and are preparing multi-scalar and multi-attributed digital models. These synthesise and visualise data in 2D (GIS), 3D (deterministic, attributed, geological framework models and stochastic, voxellated property models), and 4D (predictive time series models, e.g. of groundwater movement), with representations of uncertainty.

Although subsurface models for a few European conurbations are used to provide information to guide local policy (e.g. in Hamburg, Rotterdam and St Petersburg), or for targeted and ad hoc decision making (e.g. in Glasgow), this approach is as yet underused. There is no connection between these city examples and no effective coordination of approach, or of the knowledge that underlies them, on broader levels. Similarly, there is relatively little progress towards integrating above and below ground information as the basis for whole system environmental models, with the exception of some good, but isolated, examples. CityGML is a common information model that allows users to share virtual 3D city and landscape models for sophisticated analysis and display tasks. However, this and other, above ground modelling techniques, e.g. Building Information Modelling (BIM), pay limited regard, as yet, to the subsurface. The international LIFE06 project "Integrating Geological Information in City Management to Prevent Environmental Risks

(GeoInforM)", did, though, consider subsurface conditions when developing a geological Atlas and risk management system for St Petersburg. Experts from Germany and Finland who made major contributions to that project are participants in this Action.
Some similar research is taking place outside Europe, most notably, urban subsurface 3D modelling in mainland China, although access to this research is restricted. Initiatives are at an early stage in some other Asian cities, e.g. Singapore, Hong Kong - which may provide a valuable link to organisations in mainland China, Dhakar City and Abu Dhabi. In North America, limited access to third party subsurface data hinders progress, although 3D modelling for the Big Dig tunnelling project in Boston is a marked exception. There is considerable potential, therefore, for mutual benefit in networking outside Europe, particularly with experts in developing nations.

B.3 Reasons for the Action

The development of any big city is likely to require an intensive use of the subsurface for its infrastructure: underground transport, tunnels, sewers and other services, foundations, underground parking and storage, as well as for exploitation of groundwater and heat resource and waste disposal. All these activities have significant effects on the environment and insufficient account for local geological peculiarities may lead to problems, like groundwater pollution and damage to underground facilities (GeoInforM, 2008). It is only relatively recently that the need for governments and their policy makers to develop co-ordinated planning guidelines for the development and use of underground space has become widely acknowledged (e.g. Hidden aspects of urban planning- surface and underground development - COST Action C7, 2002). In the UK, the Urban Futures research project (http://www.urban-futures.org/), has developed a tool to help urban designers analyse the resiliency of their sustainability solutions. This Action will enable the implementation of practical measures in support of it, aided by participation of an expert from the Urban Futures project.
Many of the more recent advances in data handling, Geographical Information Systems (GIS), 3D modelling software and 3D visualisation that allow improved ways of representing and using subsurface information have been pioneered by GSOs and other researchers, working independently, across Europe. However, to persuade planners and policy makers to use subsurface information when making decisions it is essential that this knowledge is provided in a form compatible with their needs and the systems that they already use for above surface planning. Yet, there is little progress towards unifying and integrating above and below ground information as the basis for genuinely volumetric urban planning and whole system environmental modelling. The

INSPIRE Directive (2007/2/EC) will make environmental spatial information, including subsurface data, more available between public sector organisations and with the public, but does not directly address 3D/4D models. It is not, though, the lack of subsurface data which is the main problem - they are abundant in urban areas. It is, though, their availability and integration. To achieve maximum economic and societal benefits, subsurface data need to be assembled efficiently, re-used effectively by key experts, and delivered appropriately to match the specific needs and capabilities of decision-makers. By doing so, conflicting use of the subsurface can be resolved and critical subsurface ecosystem services safeguarded.

B.4 Complementarity with other research programmes

There are no directly relevant and ongoing ESF Research Network programmes or Eureka projects. Interreg III, IVb programmes such as SAWA, MARE, and FRC have issues related to subsurface properties, though subsurface issues tend to be secondary. Other programmes are dealing with individual benefits, such as ecosystem services and flooding.. CityChlor is a transnational cooperation project that aims to improve the quality and minimize the pollution of soil and groundwater. The Action will provide information on groundwater modelling to complement this and the recently completed COST Action C22 - Urban Flood Management, and will collaborate with COST Actions TU0801 and TU 0902 (see Section E.3).

C. OBJECTIVES AND BENEFITS

C.1 Aim

The main objective of the Action is to provide a long-needed contribution to greater interaction and networking between experts who develop urban subsurface knowledge and those who can benefit most from it - urban decision-makers, practitioners (private consultants and contractors) and the wider research community by establishing a network to co-ordinate, integrate and accelerate the world-leading research into modelling the subsurface taking place in European institutions, and by developing a Toolbox to enable the knowledge to be widely disseminated and more easily incorporated in urban policy and planning.

C.2 Objectives

In addition to the main objective (Section C.1), the secondary objectives are to:

- Co-ordinate and share current world-leading research and knowledge about the subsurface in a minimum of 11 GSOs and 7 European research institutions, and to work together with a minimum of 12 City-partners to understand how they would use this subsurface knowledge;
- Accelerate the uptake of subsurface modelling workflows by GSOs and researchers and the development of tools to support urban subsurface decision-making;
- Inform policy- and decision-makers from the City-partners, and demonstrate to them, the importance of the subsurface and of using subsurface knowledge at an early stage in urban decision making;
- Transform delivery and impact of subsurface data and knowledge to enable policy makers to make better informed decisions for a range of key subsurface issues and to incorporate these in urban policies.

The above objectives will be achieved by developing and delivering: (1) Tools to enable free flow and use of subsurface data and knowledge; (2) Subsurface information in digital formats compatible with above ground city initiatives (e.g. CityGML); (3) A working example of at least one city model integrating subsurface and above ground knowledge and establishing protocols to enable this to be undertaken elsewhere and (4) A Toolbox and training package comprising a range of good practice for collection, interpretation and use of subsurface data, with potential to influence European policy, and be applicable to Non-COST countries.

C.3 How networking within the Action will yield the objectives?

The participation in all stages of the Action by the City-partners with expertise in planning and policy will be vital in ensuring clear exchange and clarification of their needs with GSOs and other researchers. The objectives will be achieved by establishing networking in three main areas: (1) Co-operation between the GSOs and researchers so that those actively engaged in 3D/4D modelling of the subsurface can exchange knowledge, develop good practice (techniques, workflows), and share these with other partners at earlier stages in their development of these capabilities; (2) Building

relationships between the GSOs and researchers, on the one hand, and the current and potential end users of subsurface knowledge, and particularly City-partners, on the other, to establish and test the content of the Toolbox and prepare at least one integrated city model, and (3) Promoting the importance, and appropriate use, of subsurface knowledge to the wider community of experts and potential end users and responding to their feedback.

C.4 Potential impact of the Action

In terms of the drive for economic growth and sustainability, use of the subsurface will become increasingly important for 'occupancy' (accommodation, leisure, car parking, shopping etc.), storage and transport. Social, economic and other benefits will therefore include: (1) Closer working between experts and policy makers leading to a unified approach to the subsurface and better informed and defensible decision making by planners and developers, supported by provision of guidance and improved knowledge availability, and appropriate, interoperable decision-support tools; (2) Improved stewardship of subsurface ecosystem services; (3) Cost benefit and reduced delays in construction and development deriving from more effective ground investigation, construction, and related risk management, and (4) Improved policy (within Europe) related to the subsurface.

Scientific impact of the Action is also expected to be high, as it will provide a unique opportunity to integrate a large number of data acquisition and modelling techniques to develop a new co-ordinated approach to understanding and utilising the subsurface. Benefits will include: (A) Accelerated achievement of capability in subsurface modelling and data management; (B) Providing the data, platform, and momentum, to integrate subsurface and above ground urban models; (C) Promotion of city-scale models to enable better understanding of subsurface processes (e.g. related to ground source heat, surface-groundwater interaction, flooding and distribution of urban pollutants) and (D) Publications in high impact journals and other published forms of the research outputs.

C.5 Target groups/end users

Subsurface experts of various disciplines need to present their expertise in a more integrated way. The Action will seek to bridge the different 'cultures' between different groups (e.g. geologists and

urban planners think about, and use, information differently) so that they acquire a common understanding about the use of subsurface knowledge. The partners will make the findings of the Action available to a wide range of policy makers. The City-partners, the key end users of the Action, were directly involved in its preparation; other urban policy- and decision-makers will also be important end users (see Section H.1).

D. SCIENTIFIC PROGRAMME

D.1 Scientific focus

Collating and interpreting subsurface data is a complex task requiring specialist scientific knowledge and skills in which European researchers are at the forefront globally. The scientific programme will transform delivery and impact of this research. A key innovation will be in providing both the data, and a decision-making platform that will combine subsurface and above ground modelling in 3D. As a result, fully integrated subsurface-surface assessment will become possible and volumetric, rather than just spatial, subsurface planning and management achievable. Subject to the Management Committee's confirmation, the Action will focus on at least one major city in each partner country and will co-ordinate four main research tasks relating to the use of the subsurface in these.

Task 1 Review and collate the existing research.

The initial priority will be to assess current capabilities in the management and modelling of subsurface data by GSOs and other researchers, and to assess the related needs of City-partners by compiling inventories of:

- Existing management of subsurface data and legislation and practice related to the sharing of, and access to, these (including key geotechnical and groundwater data);
- Methodologies and workflows related to, and applications of, urban subsurface 3D /4D modelling - the representation of subsurface conditions depends fundamentally on the comprehensive availability, and quality, of input data;
- City-scale 3D/4D models and their uses, with case studies relating to specific needs of City-partners;
- Interactions between GSOs, researchers and urban decision-makers;

- Relevant EU directives and design codes, such as INSPIRE - an infrastructure for spatial information in Europe to support Community environmental policies, and EUROCODE 7 - the world's first geotechnical design code to share a common philosophy with the design methodology for structures.

The inventories will be summarised in a 'state-of-the-art' report which will form a milestone to inform the remainder of the Action.

Task 2 Evaluate and produce good practice workflows and tools for developing subsurface 3D/4D geological models and for incorporating subsurface information and knowledge in integrated urban modelling.

- Accelerate development of optimal workflows and of 3D multi-scalar geological models and related outputs on a range of urban scales;
- Identify appropriate techniques and methods applicable and relevant to differing urban subsurface scenarios and needs in partner countries, this will involve working closely with the City-partners to further determine their needs;
- Assess how the work can be made interoperable with above ground models. This work is being carried out in several different ways in partner countries and elsewhere.

Conclusions will be delivered as a summary of recommended good practice workflows and tools. Following the evaluation, a prototype example of an integrated above ground/subsurface city model will be made available.

Task 3 Preparation and testing of Toolbox and proposals for legislative guidelines

The Toolbox will comprise a fit-for-purpose suite of recommended methodologies, good practice, guidance, and case studies to enable the free flow of key subsurface data and knowledge, and delivered to all those engaged in subsurface issues to enable improved urban planning and sustainable development.

- The Toolbox will be tested by representative City-partners;
- It will be developed as a free access source of knowledge, relevant to the needs of both researchers (e.g. GSOs) and urban policy- and decision-makers. Open source software will be recommended where available.

The detailed content and structure of the Toolbox will be defined by WG3. It will be delivered as a web-based system accompanied by a summary document describing its use.

Task 4 Communication and dissemination of the Toolbox and findings to the target audience
This will make best use of interactive and mobile web services and interactive tools, visualisation, delivery via electronic newsletters, i-publications and other publishing media, workshops, presentations at conferences and collaboration with other COST Actions, culminating in a major conference at the project end.

- All City-partners will provide feedback on the use of the Toolbox under real conditions, and modifications will be made to it as appropriate and feasible;
- The partners will particularly disseminate the findings of the Action to policy makers.

D.2 Scientific work plan methods and means

The work plan is designed to be sufficiently flexible to allow amendment and enhancement at the implementation stage following the advice of the MC. The Action will create and maintain an Action Website (see section H). Table 1 shows a preliminary list of topics to be addressed. These will be considered and revised by the MC with topics allocated to WGs for them to plan in detail; the list is probably not yet complete, and is certainly not prescriptive.
Tasks 1 and 2 will require workshops, work-visits and interchange of staff, including short-term scientific missions (STSMs), to share collective urban subsurface skills, methodologies and technical capability, with the aim of rapidly bringing all partners to comparable levels of capability and common understanding - GSOs, researchers, and city decision-makers (policy makers, planners, managers, regulators, and consultants and contractors who work on their behalf).

- A series of workshops throughout the duration of the Action will allow interchange of knowledge and exploration of new ideas. Each workshop will concentrate on a specific aspect of the scientific programme and involve appropriate researchers and end-users of the research. The details of the workshops will be established by the MC and WG chairs following the Action ‘kick off’ meeting.
- STSMs will enable researchers to visit different institutions (including those of planning and policy makers). They will enhance inter-disciplinary capability, for example, by enabling researchers to acquire new skills (particularly Early-Stage Researchers), to advise on specific technical issues and to understand user requirements.

Contact will be made with complementary research programmes in Europe and beyond. These include: CityGML, originally developed in Germany but now used elsewhere; the UK-funded Mapping the Underworld and Urban Futures projects.

The Toolbox to be prepared as part of task 3 will comprise an organized collection of components such as recommended methodologies and workflows, case studies, reference documents, reader lists, external web sites and other supporting materials, guidance documents and best practice documents. The topics and stages to be covered are likely to reflect, for the most part, those listed in Table 1. The content will be defined by WG3. The workflows will describe the various elements of the process from the initial acquisition and management of subsurface data, through their re-use in 3D/4D modelling to incorporation of outputs from the modelling into planning and policy. Subsurface planning will usually need a combination of approaches, including possible adaption of policies, new types of planning and information. A range of tools will be provided to allow flexibility in use. The types of tools needed, and the way in which they are combined, will vary from country to country.

Task 4 will be overseen by WG4 and will include, as an important element, the preparation and maintenance of the Action website and web services for delivery of output. The Action includes participants with wide experience in editing and publishing scientific books and papers. A milestone will be a major international conference in the final year of the Action to provide an opportunity to showcase its outputs and findings to a wider audience.

Data		Specifications
		Online capture
		Data management
		Data delivery
		Data re-use
3D Model development		Workflows for main modelling softwares and different city scenarios
		Deterministic modelling
		Stochastic modelling
		Model uncertainty
Knowledge development	Model attribution	Physical properties e.g. hydraulic conductivity, aquifers
		Chemical properties
	4D process/time-series modelling	Groundwater, historical and predictive time series models for aquifer protection, sustainable drainage, effects of climate change

Knowledge Use		City case-studies
		Visualisation
		Monitoring
Knowledge delivery and integration	Subsurface/above ground linkage	Building Information modelling (BIM) and CityGML
		Buried infrastructure
		Archaeological/cultural assets
	Incorporation in Decision making tools	Volumetric planning
		Ecosystem services stewardship
		Aquifer vulnerability/groundwater protection
		Thermal and other mineral resource extraction and storage
		Ground stability and foundation conditions
		Risk management in development/construction
		Protection of cultural heritage
		Hazard identification and risk management
		Burial of services and development of subsurface infrastructure, including underground transport, storage and waste disposal

Table 1. Preliminary list of subsurface topics for inventory, evaluation and inclusion in Toolbox

E. ORGANISATION

E.1 Coordination and organisation

The Action will be carried out by a network of experts from COST countries and non-COST countries. The organisation of the Action will follow the usual procedures according to the COST regulations (doc. COST 4159/10). Its implementation will be co-ordinated by a Management Committee and four Working Groups. A website manager will support delivery of the Action's outputs.

E.2 Working Groups

The Action will be taken forward through four interacting Working Groups (WGs), reflecting, but not precisely mirroring the tasks of the scientific programme above. Each WG will be chaired by a

lead partner, appointed where possible from different institutions/countries. The composition of WGs will reflect the breadth of skills and gender balance available to the Action. The WG chairs will manage group meetings and co-ordinate activities, including the production of deliverables.

WG1 Compile inventories of existing methods, practices and case studies

WG1 will establish the 'status quo' (baseline) and provide a state-of-the art report comparing current practice and use. The report will also consider the requirements of the City-partners, and highlight national and local variations.

WG2 Evaluation and integration of techniques

WG2 will identify good practice in 3D and 4D mapping/modelling and related workflows to achieve comprehensive representation of subsurface variability of properties and their integration with other forms of data, e.g. buried infrastructure and time-series data. Following evaluation, WG2 will also assess, and encourage research into new methods for providing subsurface information in forms relevant to the needs of the City-partners, for providing subsurface information in digital formats. These should complement current above ground initiatives in 3D city visualisation and representation. This will lead to at least one full-scale city example (chosen by WG in collaboration with MC). WG1 and WG2 members will include experts in subsurface data management, 3D deterministic and stochastic modelling of the subsurface, 4D subsurface process modelling (groundwater, thermal), buried infrastructure, and City-partners with expertise in city planning and management, and construction.

WG3 Preparation of guidelines and a Toolbox

WG3 will manage the overall content and development of the Toolbox using material provided by WG1 and WG2. The Toolbox will be tested by representative City-partners. It is anticipated that some members from WG1 & WG2 will serve on WG3 to sure continuity of knowledge between the WGs and during the workshops. Guidelines will be prepared in forms appropriate for both researchers/experts on the subsurface and its various properties and for non-geoscientist end-users, e.g. urban policy makers, planners, managers and regulators.

WG4 Dissemination and training

WG4 will advise on the delivery of web content and usage, web services, 3D web interrogation tools and usage, and consider best use of interactive web site. City-partners will provide feedback on the use of the Toolbox. WG4 will include experts with experience in delivering web services and training packages.

E.3 Liaison and interaction with other research programmes

Contact has been made with participants from TU0801 and those involved in the development of CityGML; representatives will be invited to relevant workshops and to contribute to WGs. The output of other related EU projects and COST Actions, as detailed in section B3, will be monitored and topics of mutual interest will be explored with the relevant researchers.
Non-COST countries: Output from the Action will be relevant to The United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), which is seeking to address the sustainable development of urban areas. A representative from ESCAP will be invited to relevant workshops and the final conference.

E.4 Gender balance and involvement of early-stage researchers

The gender balance and involvement of Early-Stage Researchers has already been take into consideration when planning the Action and inviting experts to join the Action. Gender balance will be considered for the nomination of experts in various positions within the Action (such as Chair/Vice Chair, Chairs of the WGs etc.) and WGs will be encouraged to make further contacts with leading and young female researchers in order to promote participation in the Action. Computerised 3D modelling is by its nature a scientific field that attracts the attention of Early-Stage Researchers and in which they are quick to absorb and develop new ideas, and many of its leading exponents in GSOs are women, so gender balance and Early Stage Researcher involvement can be addressed in parallel.

F. TIMETABLE

The Action will take place over four years. Following a kick off meeting in Year 1, the MC will review the overall plan of the Action, establish a core group and take decisions on WG leaders, membership of WGs and the first year's STSMs.

	Year 1				Year 2				Year 3				Year 4			
	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4
Establish MC and WGs	**X**															
MC meetings			**X**		**X**		**X**		**X**		**X**		**X**		**X**	
WG meetings			**X**		**X**		**X**		**X**		**X**		**X**		**X**	
Develop & Launch website (WG4)	→	◇														
Maintain website (WG4)		←	–	–	–	–	–	–	–	–	–	–	–	–	–	→
Workshops (minimum)			**X**				**X**				**X**					
STSMs (at least 4 per year)		←	–	–	–	–	–	–	–	–	–	–	–	–	→	
Release of 'State of the Art' web-based report (WG1)						◇										
Release of combined subsurface & above ground city model WG2)												◇				
Release of 'Toolbox' (WG3)														◇		
Release of trial 'Toolbox' (WG3)												◇				
Final conference (WG4)															◇	

Table 2. Timetable of the COST Action

Various activities will take place during the same event (e.g. MC meetings, seminars and workshops, and WG meetings) to promote cross-fertilisation of ideas and to save travel costs. The work programme will take place in phases; an initial establishment phase followed by four phases according with the tasks identified in section D.1. The MC will monitor and review progress, amending the plan as necessary.

G. ECONOMIC DIMENSION

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest: DE, DK, FI, IE, NL, NO, SE, UK. On the basis of national estimates, the economic dimension of the activities to be carried out under the Action has been estimated at 32 Million € for the total duration of the Action. This estimate is valid under the

assumption that all the countries mentioned above but no other countries will participate in the Action. Any departure from this will change the total cost accordingly.

H. DISSEMINATION PLAN

H.1 Who?

Target Audience:

1. Researchers participating in the COST Action;
2. City/municipality policy and decision-makers (both as expert partners and end users) and others tasked with planning and managing our cities;
3. Water Companies responsible for drinking water, sewerage and drainage network;
4. Local, national and European authorities as providers of policy and legislation;
5. The wider research community, to build further on the Action's outputs;
6. Practitioners (consultants and contractors) within the private sector, both as end users and data providers;
7. The general public will benefit from the Action, but are not seen as a primary target audience. However, as in the UN Habitat World Urban Campaign ‘Better City, Better Life’, it is important to engage the public at large in the global movement to face the task of climate change adaption.

H.2 What?

The Action will develop a communication strategy at an early stage (led by WG4) and will use a variety of methods to disseminate the information appropriately to different target groups. As an indication, the methods will include:
An Action website containing:

- General information (all audiences);

- Examples of 3D visualisations and online 3D interrogation tools (all audiences);
- 'Join us' page, enabling others to become involved in the Action or to follow its progress (primarily audiences 2,3,4,5 & 6);
- Password-protected area allowing interchange of information dedicated to participants in the Action (audiences 1 & 2);
- The electronic subsurface ‘Toolbox’ (primarily audiences 1,2,3,4 & 6).

Publications:

- State-of-the art reports (audiences 1,2,3,5 & 6);
- Case study reports (audiences 1-6);
- Guidelines, manuals, interim and final reports (primarily audiences 1,2,3,5 & 6);
- Articles in peer-reviewed scientific and technical journals (primarily audiences 1,2,5 & 6);
- Articles in Professional and Trade journals (audiences 2,3 & 6);
- Articles in popular press, radio, TV in participant countries (primarily audience 7, but applicable to all).

Events:

- Workshops (primarily audiences 1,2,3,5 & 6);
- Final conference (audiences 1-6);
- Contributions to national and international conferences and symposia (primarily audiences 3, 5 & 6).

Media communication:

- Press releases (primarily audiences 4,5 & 6);

- Email announcements (all audiences);
- Electronic newsletter (for those that have indicated interest via website).

H.3 How?

Dissemination activities will take place in all phases of the Action. Individual WGs will be responsible for their outputs, but the dissemination of these will be co-ordinated and overseen by WG4. Dissemination will embrace a variety of techniques according to audience. The best use will be made of electronic communication e.g. via the web (web services, on-line interrogation tools etc.), mobile technology, email and Voice Over Internet protocol (VOIP) for communication between participants and interested parties.
Workshops will promote face-to-face contact between experts and end users and STSMs will enable detailed interchange between experts, particularly aimed at Early-Stage Researchers. Each STSM will produce a report and/or presentation at a workshop.
A major international conference (and Webinar) towards the project end will enable the message from the Action to be delivered to a wide audience. The 'Toolbox' of methodologies, good practice, guidance, and case studies will be available as an i-publication hosted on the Action website with a supporting summary document describing its use, and it will also be made available to participants at the final conference.