COST Short Term Scientific Mission (STSM) TU1206- 32038

GLASGOW SUB SURFACE Project – Lessons and applications with particular reference to Urban Planning in Glasgow and the economic aspects

STSM Report to COST MC Chair

Identifying ways to realize cost savings for subsurface projects by improving the use of geological and subsurface data

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Host: Ms Gillian Dick, Glasgow City Council, UK

STSM report submitted to:

COST MC Chair (DR S.D Campbell)

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STSM reference details:

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STSM Applicant: dr. Tine Compernolle, Hasselt University, Belgium

STSM Topic: Valuing geological information – Lessons on how subsurface information is used in practice and how its value can be determined.

Host: Ms Gillian Dick, Glasgow City Council, UK

Acknowledgements

A large number of individuals have contributed to this short – term scientific mission (STSM), and made the STSM a very valuable collaboration between the City of Glasgow and Hasselt University. Particular thanks go to Ms Gillian Dick, Glasgow City Council, UK and Helen Bonsor, British Geological Survey for hosting the STSM. Dr Diarmad Campbell - BGS, David Hay – GCC and Hans de Beer – NGU are also thanked for their advice and support to the STSM, and for previous work which laid the foundation for the STSM application. Finally the author thanks the COST action for offering the opportunity granted by the STSM programme and for the financial contribution to the collaboration.

Contents

A. Rationale

Considering that one of the main objectives of the SUB-URBAN COST Action is to highlight the importance of introducing geological maps and subsurface information in urban planning activities, it is imperative that those operating at the planning level (decision makers, planners, developers, contactors, etc.) understand this importance, and the influence that geology has in planning, and the cost-benefits on using subsurface data more effectively in the planning process is evaluated.

To determine the value of geological information, a cost benefit analysis (CBA) can be performed. The value, or net benefit of subsurface information (SI) is equal to the benefit of using subsurface information minus the cost to obtain, collect, and use this information:

$$V(GI) = NB(SI) = B(SI) - C(SI) \quad (1)$$

With $V(SI)$ representing the value (or net benefit) of geological information, $B(SI)$ the benefit of using geological information and $C(SI)$ the cost of geological information.

The purpose of this STSM is to begin to trial the application of a cost-benefit analysis of subsurface data to Glasgow.

To value the benefit of geological data to reduce risks and uncertainties in development work, it is necessary to know the risks and associated costs of large projects that affected by taking into account geological information, and the risks and associated costs of these projects without taking into account geological information. The difference between these two costs can be considered as the benefit of using geological information.

The costs of using geological information include the costs to obtain, collect, manage, consult, and use subsurface information.

To determine who is willing to pay for subsurface information, it is necessary to know who is responsible at the different stages of the planning process for different actions, within the Action Programme of a site, and where the risk resides, if an unexpected and unwanted event occurs.

Analogously, a cost benefit analysis can be made to value the functions of the subsurface by comparing the cost and benefits of having and not having the subsurface to deliver that function.

This STSM will develop a methodological framework to assess the economic value of subsurface information. There is a clear immediate benefit of the STSM outputs to Working Group 2 subgroup reviewing and identifying best practice in Urban Planning and management across Europe. The evaluations and outputs of the STSM are highly relevant to the wider COST SUBURBAN Action as a whole.

B. Work carried out within the STSM

The STSM involved a 5 day visit to Glasgow from 11th - 15th January 2016. Meeting discussions over the week were centred on:

How geological and subsurface information is used within the Glasgow City Council to plan for the redevelopment of particular areas. It was discussed how improvements in the request for subsurface data and the use of subsurface data can result in possible cost savings during actual building processes and how these cost savings can be determined.

The work and outputs of this STSM will be of wide benefit to the COST Action and its participants, as well as to others outside of the Action, by:

• Facilitating knowledge exchange between key personnel in GCC to evaluate lessons learned from the Glasgow City Council and its links to urban planning and economics.
• Compare the issues regarding the use of geological data in adapting national urban planning legislation to allow for local and strategic planning of the subsurface
• Review the way in which costs and benefits of using subsurface data can be determined
• Provide the basis for engagement of a wider group of COST participants.

This STSM would co-ordinate currently independent work between COST participants to allow a benchmarking process to be piloted between different cities.

	Monday	Tuesday	Wednesday	Thursday	Friday
9:00 – 10:30		*Meeting on BIM model – architecture department*	Meeting with Ian Kelly on subsurface planning		
10:30 – 12:00	Arrival of Tine			Meeting with Gillian	
12:00 - 13:00	**Lunch**	**Lunch**	**Lunch**	**Lunch**	**Lunch**
13:00 – 15:00	Meeting with Gillian	Meeting with Donald Linn and Andrew Fallas	*Meeting with Helen Bonsor and Grontmij in Edingburgh, Lain Hall*		Departure
15:00 – 16:30		Visit Sighthill site			
Evening					

C. Lessons learned from the STSM

1. Subsurface challenges Glasgow

1.1 Subsidence – mining

Glasgow has an industrial past, and significant area of the city is underlain by bedrock geology which has been formerly mined. In some areas of the city, particularly along the centre of the River Clyde valley, the bedrock geology is overlain by significant thickness of unconsolidated deposits which somewhat mitigate the risk of subsidence from former mine working; however, the thickness of the superficial deposits and depth to rockhead and depth of mine workings is variable across the city, and across sites, and improved certainty and understanding of these ground conditions is needed to be front loaded into the Development Planning system when land is released for development – to improve forecasting of the potential risks at a site and likely construction costs, and the mitigation measures likely to be required to redevelop the site areas (e.g. grouting of mine workings).

1.2 Contaminated land and groundwater

As well as mining, Glasgow was once host to a significant amount of ship building and metal works industry. These former industries have resulted in significant amounts of contaminated soils and groundwater from buried waste and metal contamination. Brownfield sites often require significant remediation prior to redevelopment and construction of new housing or infrastructure at these sites. The contamination is highly variable and requires detailed knowledge within sites to ensure appropriate remediation and construction strategies are implemented. At a city-scale, there is a need to understand where the highest contamination exists, and how this spatially corresponds to Development Planning priorities for new housing and infrastructure, so that land which is least contaminated and complex can be prioritised for these development priorities.

1.3 Flooding – shallow groundwater and surface water flooding

Glasgow is characterised by shallow depth to groundwater across much of the city, within the unconfined and unconsolidated superficial aquifer units. Some of these units are in hydraulic connection to deeper bedrock aquifer as well. Flooding from shallow groundwater, as well as from surface water flooding and sewer leakage/over capacity during intense rainfall periods is a key issue which needs to be understood so that the Environment Regulator (SEPA – Scottish Environment Protection Agency) and the City Council can implement effective flood alleviation measures. Currently there is no urban groundwater monitoring network in Glasgow and very little existing groundwater datasets.

1.4 Difficulty in unlocking and derisking vacant and derelict Brownfield land in the city for redevelopment and regeneration

Despite clear priorities within the City Council Development Plan for Glasgow, of improving sustainability of the urban environment, quality of place and well-being, reducing emissions, increasing the connectiveness and compactness of Glasgow as a city – large numbers of Brownfield sites remain vacant and derelict within the city, due to the large uncertainty in ground conditions, and the high risk to developers. It is estimated 50% of Glasgow's population lives within 500m of vacant and derelict land, and from research done, there are spatial

correspondences to health, deprivation and well-being. Whilst the City Council has excellent Development Planning priorities for Brownfield redevelopment, and integrating these transformation areas into the wider Strategic Development Frameworks of the city, City Council lacks the use of subsurface data in the Development Planning process to understand and de-risk some of these sites for development to take place.

2. Dealing with subsurface challenges

To deal with the subsurface challenges, Glasgow City Council (GCC) is taking the necessary actions to

- Coordinate and improve the way that geological subsurface data is collected, managed, processed, and used in the most effective way within the Development Planning system – from the Call for Sites stage when land is identified for possible development, to Action Programming, and the pre-planning application stage, when responsibilities for any mitigation measures required at the site are identified and outlined between developers and the City Council; right through to the construction stages of development.
- Create first UK Subsurface Supplementary Planning Guidance to assist the appropriate mapping of relevant subsurface data through the different planning stages

2.1 To coordinate and improve the way that geological subsurface data is collected, managed, processed, and used

Geological subsurface data should be collected, managed, processed, and used in the most effective way so that the interaction between subsurface conditions and subsurface infrastructure is better understood and so that the correct restrictions are set on the right planning and correctly applied at the subsequent levels.

3. The Glasgow City Council (GCC)

3.1 Organizational structure

The Development and Regeneration Services (DRS) of the Glasgow City Council is responsible for maintaining, enhancing and growing Glasgow as a prime location for securing investment, development and regeneration. This involves the delivery of the following core services: business and the economy, housing investment and development, project management and design planning, services (including development management, building control and public safety, and property information and mapping), transport and environmental policy, service development and Corporate Services. Three major subdivisions are Planning and Building Control, Project Management and Design, and Service Development.

<table>
<tr><td colspan="3">Development and Regeneration Services</td></tr>
<tr><td>Planning and Building Control

- Development plan group
- Planning Neighbourhoods</td><td>Project Management and Design

- Architecture group
- Engineering groups
o geotechnical and land remediation
o civil and structural engineering</td><td>Service Development</td></tr>
</table>

	o mechanical engineering o Flood risk management	

Planning and building control supports DRS in terms of planning applications, it offers planning guidance, and draft development plans for the City of Glasgow. Furthermore, it aims to secure the health, safety, welfare and convenience of persons in and about buildings and others who may be affected by buildings or matters connected with buildings; to further the conservation of fuel and power; and to further the achievement of sustainable development

The Development Plan Group provides input to Glasgow Clyde Valley Strategic Development Plan including annual monitoring; it developed the Glasgow's proposed City Development Plan, the associated supplementary guidance and supporting documentation. It also provides strategic input to National Developments including potential High Speed Rail, Edinburgh Glasgow Improvement Plan, West Coast rail development, Metropolitan Strategic Drainage Plan and Central Scotland Green Network. It support the Development Management process by providing input/analysis on e.g. Transport Assessments, Travel Plans, Retail Impact Assessments, Housing Needs and Demand Assessment and Housing Land Supply. It provides planning input to the EU programme on subsurface planning. It develops Glasgow's Open Space Strategy.

Planning Neighbourhoods processes planning applications, advert applications, listed building applications and conservation area consents. The group are also provide pre application discussion and advice. It is responsible for forward planning including development and implementation of area-based regeneration/intervention strategies for the city's neighbourhoods with particular emphasis on key strategic areas such as the inner East End, the North, Easterhouse, Partick and Govan as well as local areas such as Drumchapel, Pollok and Toryglen. It supports the regeneration of local town centres such as Shawlands, Govan, Calton Barras and Parkhead. This includes delivery of funded regeneration programmes for these areas which includes delivery of Calton Barras Action Plan, Shawlands Town Centre Action Plan, Parkhead Townscape Heritage Initiative and Central Govan Action Plan and Townscape Heritage Initiative as well as an extensive programme of public realm works throughout the city's neighbourhoods. It protects and enhances the city's rich historic and environmental assets through expert guidance on Planning Applications, designation of Conservation areas, Tree Preservation Orders, tackling historic buildings which are at risk, and in interpretation and celebration of the city's built heritage. It provides design and landscape expertise into the Planning process.

Project management and design guides the management and design of specific regeneration projects in the City of Glasgow

The architecture group is responsible for the master planning and project management for Sighthill Transformational Regenerational Area which involves large scale remediation and infrastructure works to facilitate private investment into a new residential led development. It is also responsible for the construction and extension of facilities in support of the 20th Commonwealth Games.

The engineering group: **geotechnical and land remediation** provides geo-environmental investigations, design and construction input to the master planning and project management for Sighthill Transformational Regenerational Area and the construction of facilities in support of the 20th Commonwealth Games. Assessment of building warrant applications (relevant to the wider scope of this analysis)

The engineering group: civil and structural engineering provides civil and structural engineering design and construction inputs to the Council's capital programme including schools, care homes and sport facilities. Site surveys including the innovative laser scanning of buildings.

The engineering group: mechanical engineering provides mechanical engineering design and construction inputs to the Council's capital programme including schools, care homes and sport

facilities. Development of innovative low carbon and energy efficient solutions including building modelling and Combined Heat Power (CHP) engines linked to ground source heat pumps.

The engineering group: flood risk management is responsible for watercourse maintenance and inspection including direction of LES operatives to clear trash screens at the entrance to culverts on receipt of heavy rain warnings.

Service development aims to create a data management system that collects all subsurface information in a specified format and that sets out the guidelines on the provision, use and updates of trustworthiness subsurface information.

3.2 Steps that are taken when a site or neighbourhood is regenerated

Step 1. Planning and building control (the strategic level) plan the regeneration of specific sites and neighbourhoods. This unit sets out the different plots for a certain area: where to build schooling, housing, and leisure facilities.

Step 2. Project Management and Design (the project level) designs the buildings and layouts of a site and indicates where utility infrastructure is needed

Step 3. If the site needs remediation, a contract is procured to remediate the site. Procurement for excavations and soil or ground movement are made as well at this point.

4. Current Flow and use of subsurface data

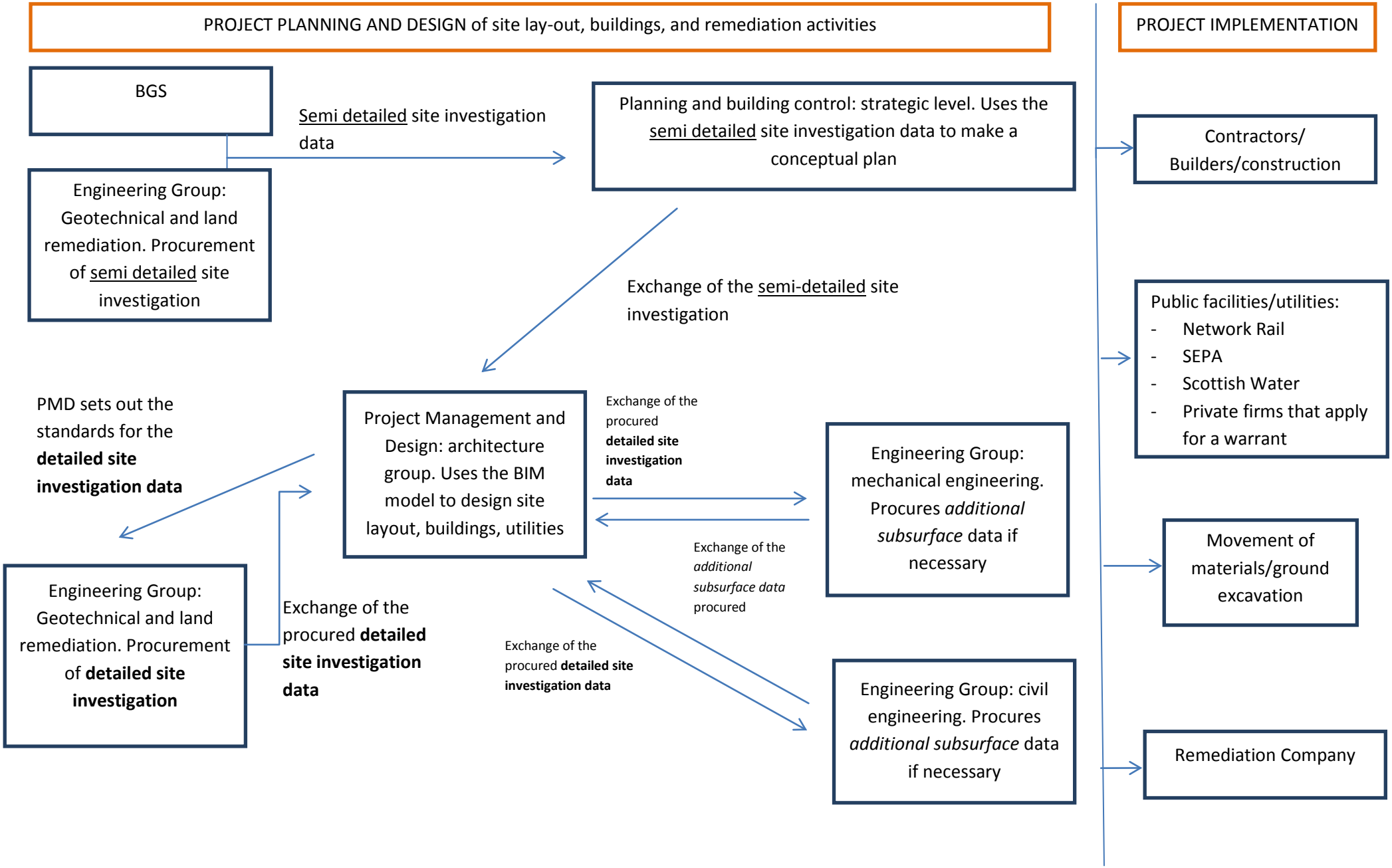
4.1 Traditional situation

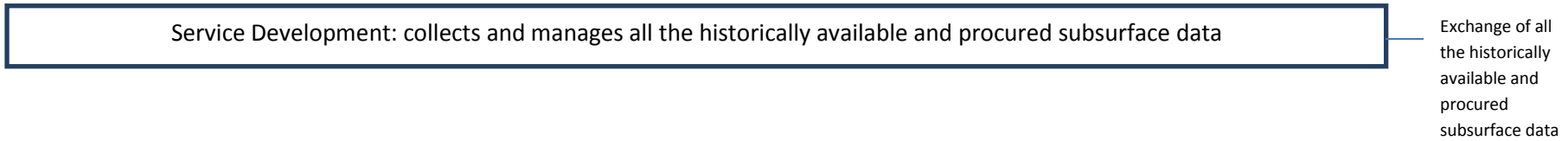
- There is no centralised pool or database of all subsurface data used and procured by GCC which any one council service can access and use. As a result, the Development Plan group can use at a strategic level to plan the City Development Plan (CDP) priorities within the city, and to prioritise the release and sorting of land. As a result, only a small percentage of the relevant and availale subsurface data to the Development plan process is used.
- Often the first request for susbsurface data is after planning permission/approval of a site for development when a contract has to be procured to remediate the site, site investigation is procured by the Engineering Group Geotechnical and Land remediation. Subsurface information is then delivered by private firms and the British Geological Survey. Often this is after the design of buildings and layout of a site has been decided, alongside the integrated infrastructure design (e.g. SMART infrastructure above and below ground)
- The format in which the data is delivered has traditionally been PDF-files, but it is now procured in standardised digital format (using the AGS standard) which is significantly increasing the accessibility of the data, and the ability of the council to use the data to inform the decisiion making processes about the design, and infrastructure at the sites.
- If the Engineering Groups Mechanical engineering and Civil engineering required subsurface information for the design of the utilities, they procured site investigations separately from the Engineering Group Geotechnical and Land remediation.

4.2 Current changes and objectives

- If site investigations are procured, the data are now delivered in a raw form so that it can be reused in the future
- More subsurface data is being requested upfront, and earlier in the planning process, and at pre-planning application stage. This enables better planning activities at a site, approopiate integration of SMART infrastructure above and below ground, and to realise these opportunities (such as Sustainable Drainage schemes, ground source heat schemes), and to optimise the layout of development at a site, according to below ground conditions.
- To have increased exchange the procured data between the different departments and engineering groups in the council
- To procure *additional subsurface data* more effectively (cost effectively) for subsurface work at a site in the development and construction works
- To create a central data management system to collect and manage all the historically available and procured subsurface data
- To exchange all the historically available and procured subsurface data with the contracted companies and public organizations

It is important to note, that despite increasing awareness of the economic value of better use of subsurface data with Glasgow City Council –both within the Strategic Development Planning process, and in the construction stages of realising re-development projects - there are still disconnects in this understanding in the council between council teams. It is envisaged the Supplementary Planning Guidance will act not only as an external document to developers, as to how subsurface data should be used at different stages of the planning process, but also initially, as an internal document to the Council to assist individuals and the different service teams to realise the different subsurface data held and procured by the City Council, when it is most effective to use and re-use this data in re-development and planning processes, and to cost-benefits.


PROJECT PLANNING AND DESIGN of site lay-out, buildings, and remediation activities
PROJECT IMPLEMENTATION
BGS
Semi detailed site investigation data
Planning and building control: strategic level. Uses the semi detailed site investigation data to make a conceptual plan
Contractors/ Builders/construction
Engineering Group: Geotechnical and land remediation. Procurement of semi detailed site investigation
Exchange of the semi-detailed site investigation
Public facilities/utilities:
- Network Rail
- SEPA
- Scottish Water
- Private firms that apply for a warrant
PMD sets out the standards for the detailed site investigation data
Project Management and Design: architecture group. Uses the BIM model to design site layout, buildings, utilities
Exchange of the procured detailed site investigation data
Engineering Group: mechanical engineering. Procures additional subsurface data if necessary
Exchange of the additional subsurface data procured
Movement of materials/ground excavation
Engineering Group: Geotechnical and land remediation. Procurement of detailed site investigation
Exchange of the procured detailed site investigation data
Exchange of the procured detailed site investigation data
Engineering Group: civil engineering. Procures additional subsurface data if necessary
Remediation Company


Service Development: collects and manages all the historically available and procured subsurface data
Exchange of all the historically available and procured subsurface data

5. Evidence of possible cost savings

5.1 Regeneration of the Sighthill site versus regeneration of the Common Wealth Games Site

- The timing of procuring site investigation:

Benefits of collecting and using semi-detailed subsurface data before the planning stage:

- to make the planning of the site lay-out more effective. At the Sighthill site, a school will be built on top of the contaminated area. In case semi-detailed subsurface data would have been used, one could have opted to put a park on top of the contamination. And housing is planned on top of a tunnel. This would have led to cost savings in building and cost savings in site investigation (20 000 pounds, assuming that masterplan is altered at an early stage following preliminary investigation).
- to seize subsurface opportunities such as the application of geothermal heating (not relevant for the Sighthill site because of the contamination). This can result in both economic and environmental benefits.

Benefits of collecting and using detailed subsurface data before the design stage:

- Less conservative and more effective designs of buildings: cost savings in building works
- Creates the opportunity to feed the data back to the planning stage and adapt the planning of the site lay-out

Costs of collecting and using semi-detailed subsurface data before the planning stage: subject to further study

Comment 1. Filling the tunnel because of the housing to be built on top resulted in an additional cost. However, it also resulted in a benefit: the avoided cost of maintaining the tunnel. Hence, the tunnel would have to be filled anyway, regardless of the activities on top of it.

Comment 2: it should be looked into what makes site investigation more effective: having one company doing both the conceptual and detailed site investigation, and/or a better timing of the site investigation. In my opinion, the timing of collecting data is more important than who the data collects. Interchangeability of data between companies is a prerequisite of course.

- The way subsurface data is delivered

Common Wealth Games Site: data was delivered in PDF

Sighthill site: data was delivered in raw form which has enabled

subsurface data to be used and re-used much more effectively and interchangeably by both the council and stakeholders and contractors on a site. It has also enabled the Council to develop an above-below ground Business Information Model (BIM) for Sighthill which facilitates this greater re-use and awareness of available data at a site by all council departments, and stakeholders. Benefits of making subsurface data reusable:

- To direct site investigation more effectively and to avoid unnecessary data collection, or duplication of data requests from develoeprs and consultancies, which will result in site investigation cost savings

Benefits of using and integrating the data within design software such as BIM

- Less conservative and more effective designs of buildings: cost savings in building works. The design will better address the actual site conditions. To integrate different types of data, to realise and harness subsurface opporunities, as well as the ground conditions for building design eg regarding the potential of geothermal heating. Benefit: to seize subsurface opportunities such as the application of geothermal heating
- To direct site investigations more effectively resulting in site investigation cost savings
- To design buildings and roads with less uncertainty resulting in project cost savings
- To seize subsurface opportunities

Costs of integrating data in a design software

- Specialized software
- Training of employees
- Change in data flow process

- The way in which site redevelopment is contracted/tendered by the Council appears to remain a difference to the availability and subsurface data at a site between all the different stakeholders, and consequently the cost-effectiveness of construction design. If one consultancy is contracted to do all the redevelopment, there is much clearer awareness of available above and below ground data, and better use of the data at the site to inform construction design. If many contractors undertaking the redevelopment and design work – the re-sue of data is more broken and limited.

- The way subsurface data is managed

The traditional situation for both the Sighthill site and Common Wealth Games site: no single, centralised internal data management system

Current developments and objectives: to create a central data management system

Benefits of having a central data management system:

- To make subsurface data more visible and accessible and therefore, reusable within the Council
- To make it possible to have a shared knoweldge base with developers, using above and below ground BIM data management models and system
- To make it possible to use the data within design process within BIM

Costs of having a central data management system: to be determined

- Using subsurface data at a strategic level

Cost of collecting subsurface data in case the question would be: we want an area for education, there are 5 potential sites, which site is most suitable with regards to subsurface conditions?

Between 7000 and 40 000 pounds per site, depending on specific site conditions. £7000 for a school on shallow boulder clay, with no contamination and minerally stable, to around £40,000 for a site with poor soils, shallow mineworkings and contamination problems. In general terms, it's rare for a school investigation to cost more than £20,000. The schools build in Glasgow tend to be 2 to 3 storey.

- Using subsurface data at project scale:

Consultancies working within major GCC projects estimate doubling of design costs are incurred by using above and below ground BIM to inform construction design and integrated of SMART infrastructure – but this leads to cost savings of 2 orders of magnitude greater at construction stage, by enabling optimum construction design to be identified quicker and reduced uncertainty in ground conditions.

D. Recommendations

1. Ways to identify and quantify cost savings in general

- Evaluate processes
    - Process of tendering
    - Process of site investigation
- Make flow diagrams between different departments and groups
- Describe benefits and costs
- Calculate benefits and costs
- Take into account hidden costs: quality for money?

2. Ways to save cost on site investigation

- Share subsurface data between groups and departments
- Make subsurface data interchangeable
- Ensure that subsurface data can be used in design software

3. Ways to save cost on projects

- Collect and use semi-detailed subsurface data at the planning and design stage for an effective design of the site lay-out
- Integrate different types of data to seize subsurface opportunities such as geothermal heating
- Collect and use detailed subsurface data before the final design stage to ensure that the design of buildings and roads fits the actual site conditions

E. Planners questions on economics

During the STMS to Glasgow and Oslo, the following questions with regards to the economic aspects of the subsurface, project appraisal, and the valuation of subsurface data (its collection, management, and use) were raised.

- How do I make a cost benefit analysis?
- What are the benefits of using subsurface info early in the planning process?
- How do I describe the benefits of using subsurface info early in the planning process?
- How do I describe the benefits of using subsurface info at a specific planning stage
- How do I quantify/monetize the benefits of using subsurface info early in the planning process?
- How do I quantify/monetize the benefits of using subsurface info at a specific planning stage?
- What are the costs of using subsurface info early in the planning process?
- How do I determine the costs of using subsurface info early in the planning process?
- How can I determine the value of the subsurface?
- How can I determine whether it is worthwhile to valorize the subsurface?
- How can I set priorities for subsurface use?
- How can I value the use of best available technologies to prevent unexpected events?
- How can I value the reuse of data?
- How can I calculate the costs that could have been avoided if subsurface data was used?
- How can I calculate the costs of investment postponement?

F. Confirmation by the host institution

Report noted with approval,

Ms Gillian Dick, Glasgow City Council, UK