Roinn Cumarsáide, Gníomhaithe ar son na hAeráide & Comhshaoil
Department of Communications, Climate Action & Environment

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

Research Programme
- Short Calls, Final Report -

For official use only
Date received: *Ref. No.:* *Interim report:*

Lead Applicant Name	Paul Quigley
Email	pquigley@gdgeo.com
Host Organisation name	Gavin and Doherty Geosolutions Ltd.
Project Title	Development of a Toolkit to Manage AGS data for Geotechnical Usage (TAGS)
Contract Number	2017-SC-062

Date: 31/05/2018

This report covers the period November 1st 2017 to May 31st 2018

2. Project information:

Final project report (*max **2500** words, excluding figures and headings*):

(i) *Progress* of objectives and scientific/engineering targets beyond the state of the art & *methods* used

The TAGS project is within the scope of the GSI Information programme, which helps to increase the accessibility and re-usability of geotechnical ground investigation data within the community (contractors, laboratories, clients, design and consultancies, etc.). Currently, AGS data is not available on the National Geotechnical Database to view or download. The TAGS project explored a variety of solutions to process AGS data and to support the reliable transfer and usage of site investigation data in Ireland. The project aimed to provide solutions for GSI to host AGS data files and to provide download link to the original AGS files as well as to develop a preliminary toolkit that will process borehole data from the National Geotechnical Borehole Database to AGS 4 data format.

A preliminary desk study was conducted to identify the common fields and distinctive fields between the GSI Oracle database and the AGS data format. The mapping from the AGS data format to the GSI Oracle database focused on the borehole information including mainly PROJ, LOCA and GEOL groups in the AGS 4.0 data format. A dictionary mapping the GSI Geotechnical Database to the AGS 4.0 data format was compiled and agreed with GSI.

Practical solutions to integrate the AGS data with the GSI Oracle database and to extract the GSI Geotechnical database into AGS 4.0 format files were proposed. Through the discussions with GSI, in order to input the AGS data files into the existing GSI Oracle database in the most straightforward manner and to also consider the new Corner Database, the TAGS project proposed that the GSI stores the donated AGS files (in their original formats) in the existing file container, e.g. Goldmine, and provides download link to the original files on the Geotechnical Online Viewer. The TAGS project simultaneously developed a AGS file writer tool to extract the borehole information from the GSI Oracle database into AGS 4.0 format files. The integration will be tested and implemented when the GSI new Geotechnical Online Map Viewer is available.

(ii) Implementation (please include any issues with timelines, milestones, management etc. or deviations from the original implementation plan)

Roinn Cumarsáide, Gníomhaithe ar son na hAeráide & Comhshaoil
Department of Communications, Climate Action & Environment

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

Publications to date: *Please use format below and provide a copy of the presentation.*

[Conference Publication] Zhang, L.; Quigley, P.; Trench, J.; Sheehy, M. (2018) TAGS: How the GSI is making AGS data available to the geotechnical community. Submitted to *Proceedings of CERI 2018*, 28th-30th August, 2018, University College Dublin, Dublin, Ireland.

The TAGS project has made good progress during the project span and there were no issues in relation to timelines or management. However, based on the outcomes of the feasibility study, there were a number of deviations from the original implementation plan as follows:

- Based on the initial feasibility study, the implementation plan has been verified to discard the original toolkit development for 'data-cleaning'. AGS data-cleaning often requires expert interventions and, therefore, an automated process could lead to potential problems with any of the existing 124 AGS4 groups (the total number is increasing by adding new user-defined groups) and unnecessary effort in justifying or re-projecting the AGS data without a data viewing software/platform. There are a number of currently available AGS data verification tools, such as AGS Checker and DataEntry from Keynetix.

- The tool development has been implemented using Python code instead of the originally proposed Matlab. Python is superior in terms of data manipulation and project progress presentation with its modules, packages and libraries of connecting to and extract data from Oracle database; data manipulation in Pandas, csv and numpy; data visualisation in matplotlib and Jupyter notebook which could be directly launched into HTML and PDF files as the project publications.

The project deliverables have been revised to reflect these changes, as outlined in the table below.

(iii) **Outputs** (please provide a short description *and* complete the table below)

The following are the main outputs of the TAGS project to date:

(1) A conference paper has been submitted and accepted for presentation in the Civil Engineering Research Association of Ireland 2018 (CERI 2018) conference to be held on 28th – 30th August 2018 in UCD, Ireland.
(2) A survey on the AGS data usage in Ireland has been designed and issued with the compiled contact details of the Ground Investigation contractors in Ireland.
(3) A GSI Geotechnical Database heading to AGS 4 data format heading dictionary has been compiled as the feasibility research on the tool development.
(4) A AGS writer Tool has been developed.

Task No.	Deliverable description	Planned delivery (as per proposal)	Expected delivery
T1	Survey on AGS data usage in Ireland to GI contractors	n/a	March 2018
T2	Compatibility review between GSI Oracle database and the AGS 4 data format	n/a	March 2018
T3	Software to generate AGS 4 files from the GSI database	n/a	May 2018
T4	Conference paper and presentation at CERI 2018	D6	May 2018

4. Data/outputs submitted with final report *(please list the documents, presentations, datasets etc. submitted with this report)*

a. CERI 2018 conference paper on the TAGS project.
b. A zip file for the TAGS AGS 4.0 Writer Tool

TAGS: How the GSI is making AGS data available to the geotechnical community

L. Zhang[1], P. Quigley[1], J. Trench[2] and M. Sheehy[2]
[1]Gavin and Doherty Geosolutions, Unit A2, Nutgrove Office Park, Dublin, D14 X627 Ireland
[2]Geological Survey of Ireland, Beggars Bush, Haddington Road, Dublin D04 K7X4, Ireland
email: lzhang@gdgeo.com, pquigley@gdgeo.com, james.trench@gsi.ie, michael.sheehy@gsi.ie

ABSTRACT: Previous ground investigation data is a valuable resource when evaluating geotechnical issues on existing or prospective sites. The Geological Survey of Ireland (GSI) has, over many years, compiled a geotechnical borehole database and provides access a short synopsis of the borehole records via their map viewers and also to numerous scanned copies of the original reports. Many recent ground investigations are compiled using the Association of Geotechnical and Geoenvironmental Specialists (AGS) common format for electronically organising geotechnical data in order to facilitate data sharing. This data format can be used by specialist software packages to allow for quick and efficient processing of the ground investigation information. The GSI funds research to develop the TAGS (Tool for AGS) project to create an interface between the existing GSI Geotechnical Database and the AGS format following demand from the geotechnical engineers. This paper describes why the AGS data format is valuable to geotechnical designers, how the information can be made available in AGS format via the GSI online viewer and suggests how the AGS format can be more widely used in Ireland.

KEY WORDS: AGS; GSI; Borehole Database; Geotechnical Online Viewer.

1 INTRODUCTION

The AGS data format was established in 1992 by Association of Geotechnical and Geoenvironmental Specialists (AGS) as a standard method for transferring data between industry organisations, which is independent of software, hardware or operating system. The AGS data format is widely used for ground investigations in Ireland and the UK with an increasing number of countries worldwide regularly using the format. However, the format is typically only used by ground engineering professionals and the Geological Survey of Ireland (GSI) uses alternative data formats for their software platforms to store and manage data. In order to enable data sharing capacity in the AGS format, the GSI commissioned Gavin and Doherty Geosolutions (GDG) to provide solutions for hosting and exporting AGS format data from the National Geotechnical Database (TAGS project). This paper presents an overview of data sharing in ground engineering, the survey results of the AGS data usage in Ireland, the solutions proposed by TAGS project on hosting and generating AGS files based on GSI database, and the impact as well as outlooks for the TAGS project.

2 BACKGROUND

Previous ground investigation (GI) data is a valuable resource when evaluating geotechnical issues on existing or prospective sites. Efficient, economical and reliable data transferring method plays a crucial role in modern geotechnical engineering practice and is demonstrated by the increasing adoption of Building Information Modelling (BIM) in civil engineering projects. The use of digital data could unlock the collaboration challenge between the clients, principal contractors and specialists (Smith, 2017). The speed of delivery of GI information and ability for end users to manipulate the data without a reduction in quality of the information is a key driver for the adoption of AGS data in geotechnical engineering. Chandler (2015) described a recent case study of the Silvertown tunnel project in London where the availability of previous ground investigation in AGS format resulted in a targeted ground investigation which saved the Client approximately £100,000 in ground investigation costs. The greater availability of digital logging tablets can result in quicker and more efficient data transfer between contractors and designers. The data can be stored in a BIM environment where modifications to a borehole database can be instantly transferred to 3D models, allowing for easier interpretation of the borehole findings. The use of the AGS format is particularly useful for larger projects and is ideally suited to linear infrastructure projects such as roads, rail, tunneling and drainage projects. Chandler (2015) outlined how the use of AGS data format for the HS2 project in the UK was streamlining the data flow between the production of the data by ground investigation contractors and the end users of the data (Figure 1) with an important validation buffer between the parties.

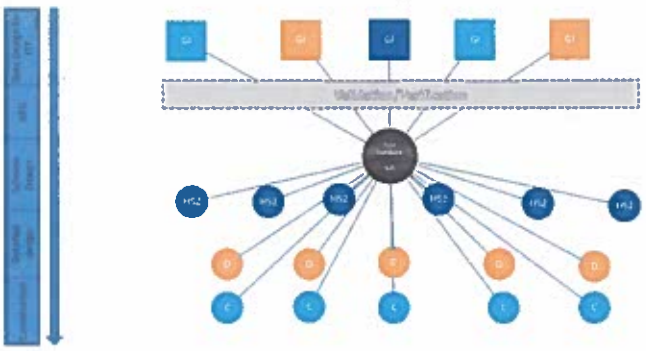

Figure 1. Management of data for HS2 (Chandler, 2015).

2.1 Development of AGS data format

During the 1980s there was a proliferation of software systems and data formats for site investigation. The need for standarised data transfer and storage of site investigation information was recognised and a Working Group was established in 1991 to develop the AGS data format. The AGS data has been developed over three decades from AGS 1 (03/92) (Bland, 2014) to AGS 4.0 and has become a prevailing data format for ground investigation data transfer. The ease of use of the AGS data files is dependent on the quality of the data entry. Technically, all AGS files should:

- Follow the AGS rules, and
- Be validated before publishing using readily available AGS file validation software.

There have been many problems with older files such as corrupted file and unvalidated data (Entwisle & Self, 2018). However, the quality of AGS data from Irish Contractors has improved with time although files are not always fully validated and some end-user corrections are often required, depending on software compatibility. A survey of ground engineering practitioners by the UK magazine 'Ground Engineering' suggested that 'Sharing and knowledge transfer' and 'Quality control' are the two most significant inhibitors towards using digital data (Figure 2).

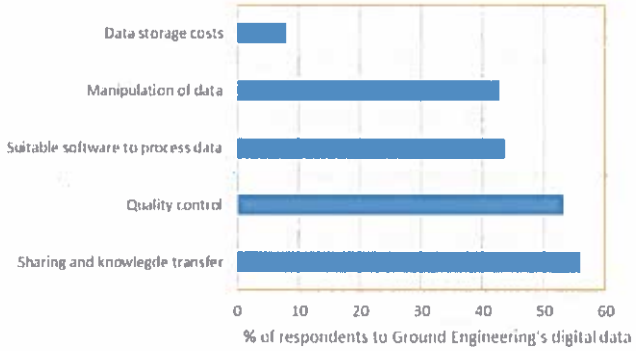

Figure 2. Results of digital data survey published by Ground Engineering (2017).

2.2 AGS data and the British Geological Survey

The British Geological Survey (BGS) has designed the relational database for the UK national geotechnical data based on the AGS industry standard for AGS 3.1 (BGS, 2017). AGS digital data transfer format can be quickly added without transcription errors compared to the traditional method of adding data from paper records. The BGS provides AGS data uploading, integration to the relational database, and downloading services (Figure 3). Data were originally typed into the database from paper records, a slow and laborious process, but now a majority added are from AGS digital data transfer format files, most notably from the Highways Agency Geotechnical Data Management System (HA GDMS). With an increasing drive towards asset management and extending the design life of asset portfolios, having an understanding of the ground conditions is a key component of what future maintenance may be required. The BGS connect and BGS AGS support were integrated in Keynetix Holebase SI, where Holebase SI users would be able to find and download mapping and AGS data held at the BGS using the mapping interface.

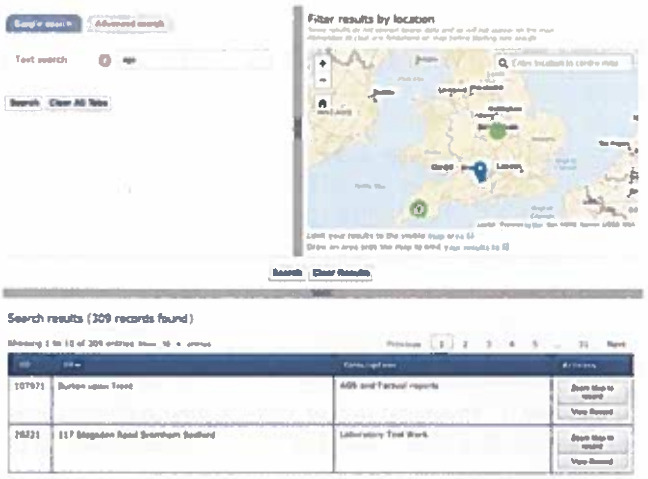

Figure 3. BGS provides download for AGS data files via Deposited Data Search.

2.3 Laboratory results and AGS

The AGS format is also used to capture laboratory results with data linked to the sample codes in the borehole logs. Some software packages have the facility to send and receiving Chain of Custodies and Laboratory Test Schedules between the designer and contractor, maintaining the fidelity of the AGS data format through the ground investigation phase. Geochemical data can be provided in AGS format and integrated into mapping software for identifying the locations of exceedances.

3 GSI NATIONAL BOREHOLE DATABASE

The GSI serves as a national earth science knowledge centre hosting a geotechnical borehole database and providing access to borehole records and original reports. The database holds approximately 135,000 borehole records, dating back over sixty years. The database is stored on an Oracle platform with a bespoke filing system. Data is manually entered into the database by the GSI. The red polygons outlining the ground investigation are generated by the GSI during the data entry process (Figure 4).

Figure 4. Extract from the GSI Borehole online map viewer.

The majority of the data stored on the database is collated from the Dublin region and it has been possible to generate

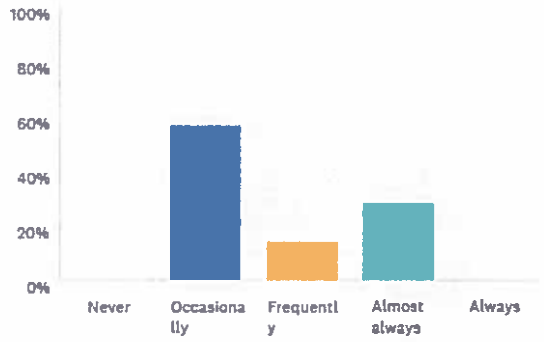

Figure 8. Frequency of GI contractors supplying AGS data as part of the GI contract.

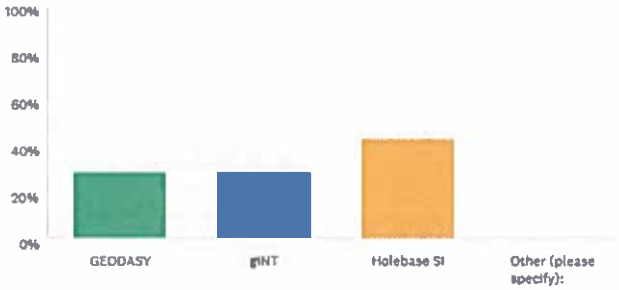

Figure 9. AGS data management software packages used by Irish GI contractors.

Similarly, five of the contractors manage the laboratory tests in AGS with AGS software packages, e.g. GEODASY and KeyLAB. However, only one of the contractors has scheduled laboratory tests in an AGS file from a consultant. The dominant approach to issue laboratory test schedule templates in Excel format and the test requirements are added by the client to the Excel Sheet. Compatibility issues were encountered while scheduling laboratory tests in AGS format, and one contractor developed a system by integrating KeyAGS and Excel for better performance.

All the of the contractors gave positive answers on their willingness to donate the AGS data files to GSI to improve the National Geotechnical Database, although only one of the contractors has donated AGS data files to GSI. Confidentiality and copyright of the data pose as the main concern from donating the data since the ground investigation data obtained by GI contracts should be considered the property of the Client.

Future improvements for GI data transfer and share in Ireland were proposed by training on AGS data file production, guidance on laboratory testing management using AGS data, workshop between contractors and consultants on the AGS data format usage. One contractor noted that integrating AGS more routinely into the GI workflow would ease fundamental issues such as Bill of Quantity measurements. The contractor was actively exploring using digital logging software in the field to improve how data is captured.

5 TAGS PROJECT

The TAGS project was commissioned and financially supported by GSI within the scope of the GSI Information programme to increase the accessibility and re-usability of geotechnical ground investigation data within the ground engineering community (contractors, laboratories, clients, design and consultancies, etc.). Two parallel implementations were carried out to enable GSI to host donated AGS files as well as to export AGS files from the GSI National Geotechnical Database.

5.1 AGS data file hosting on GSI database

Possible approaches to host AGS data files on the GSI database were explored. The donated AGS data files were proposed to be hosted on the GSI OnLine Document, Maps and InformatioN Explorer (GOLDMINE) and the meta data for the AGS data files would be used to populate the GSI Geotechnical Database with uniform resource locators (URLs) created and stored in the database as links with which the original AGS data files can be downloaded from the GSI Geotechnical Online Map Viewer (Figure 10). The file name of the donated AGS data would be hard-coded as a unique identifier on GOLDMINE.

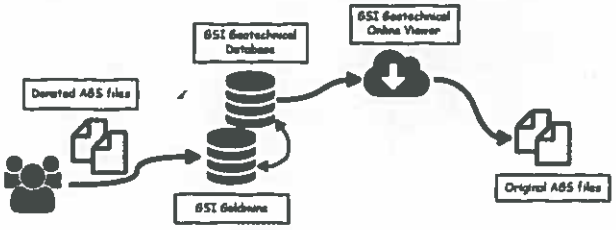

Figure 10. Flowchart illustration for hosting donated AGS data files in GSI database.

5.2 AGS 4.0 file export tool

The common practice of downloading and re-using the geotechnical investigation data stored on the GSI Geotechnical Database is by downloading the ground investigation report (Figure 11) including the borehole logs and laboratory tests in portable document format (PDF) and transferring the information manually to editable formats, e.g. Excel or AGS.

Figure 11. Ground investigation report example on the GSI Geotechnical Online Map Viewer.

The TAGS project developed a tool by querying the ground investigation data stored on the GSI Geotechnical Database, mapping the data into its corresponding fields in AGS 4.0 data format, and exporting the information into AGS 4.0 data files. The structure of a subset of the GSI Geotechnical Database

useful information on the depth to bedrock and 3D stratigraphy. GOLDMINE is a GSI repository of scanned documents, in particular old maps and ground investigation reports.

The GSI sought to explore how to provide AGS data to serve the ground engineering community and also to take advantage of the increasingly availability of digital data and streamline the population of the Irish National Geotechnical Database. The development of a Toolkit to manage AGS data for geotechnical usage (TAGS) project provided solutions for hosting AGS files to be viewed and downloaded in their original formats as well as developed an AGS 4.0 data file generation tool from the GSI Geotechnical Database which would enable downloading AGS 4.0 ground investigation file via GSI Online Map Viewer. A simplified AGS data flow in Ireland is illustrated in Figure 5.

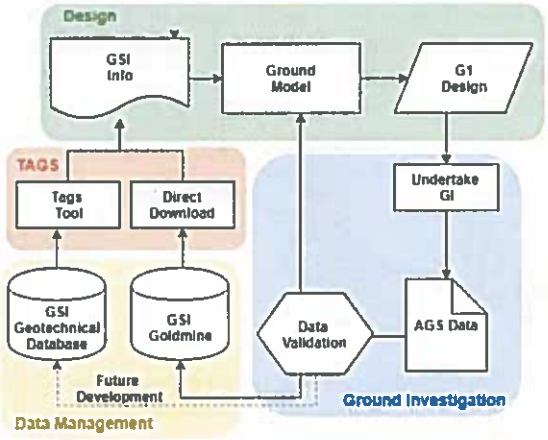

Figure 5. Simplified AGS data flow in Ireland.

4 SURVEY ON AGS USAGE IN IRELAND

The targeted audience of the survey on the AGS data usage in Ireland is GI contractors. The survey was structured with an emphasis on ground investigation data production and transfer by the Irish GI contractors in AGS formats. Informal discussions with leading ground investigation contractors and our experience processing AGS files resulted in the development of the survey. Illustrations of data transfer for ground investigations with Excel and with AGS laboratory test scheduling are presented in Figure 6 and Figure 7, respectively. Scheduling laboratory tests in AGS formats could be more efficient in the final AGS data production with fewer reformatting errors and compatibility issues. The compatibility issues with AGS files generated from different software packages was considered in the design of the survey by gathering the software information used by Irish GI contractors in AGS data production and management.

4.1 Survey structure

A survey on the AGS data usage in Ireland has been issued to the ground investigation contractors in Ireland. The current usage of AGS formatted ground investigation data by Irish GI contractors in Data Production, Data Management, Laboratory Test Scheduling, Data Supply, Data Donation to GSI during the process illustrated in Figure 6 and Figure 7 have been incorporated in the design of the survey.

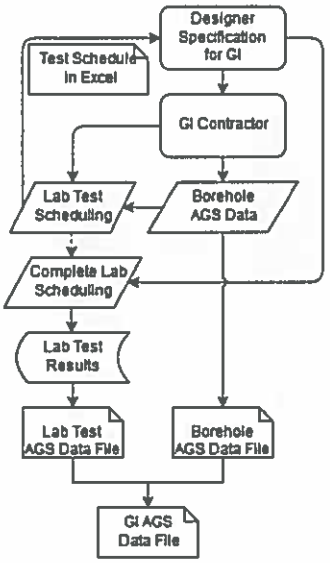

Figure 6. Data transfer for ground investigations without laboratory test scheduling in AGS data format.

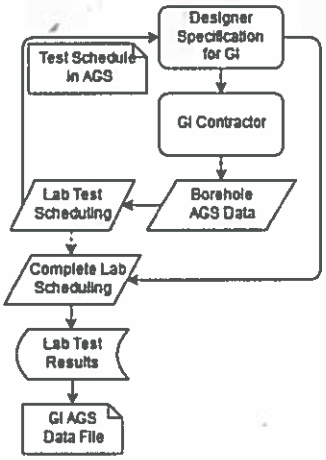

Figure 7. Data transfer for ground investigations with laboratory test scheduling in AGS data format.

4.2 Survey results

The survey was sent to 12 Irish GI contractors with seven completed survey results. Fortunately, the seven respondents represent some of the larger ground investigation firms and would account for a significant market share. The survey indicates that contractors issue AGS ground investigation data as part of the ground investigation contracts (Figure 8). Popular AGS data management software packages (Figure 9), including Holebase SI, KeyLab, GEODASY and gINT, are used in Ireland, of which 71.4 % are on ongoing maintenance contracts with the service provider and 28.6 % have the AGS data production software upgraded carried out before more than four years by the time of the survey.

Six of the seven contractors are able to provide the GI AGS data in AGS 4.0 formats, however the version of AGS data is usually defined by the end-users. Both AGS 4.0 and AGS 3.1 are prevalent at data production stage.

containing borehole information is presented in Figure 12. Nine tables from five schemas (sets of objects) were used to export AGS 4.0 formatted ground investigation (borehole) data. GDG compiled the data mapping from the GSI Geotechnical Database to the AGS 4.0 Data format for borehole logs. The mapping between the AGS groups and GSI database tables is listed in Table 1. Five AGS groups (PROJ, UNIT, ABBR, LOCA, GEOL) were populated based on the GSI database, and two groups (TRAN, TYPE) were hard-coded since the TRAN and TYPE information is not project-specific. The ABBR group in the AGS format was compiled from the LOOKUP tables. All of the FILE_FSET fields were hard-coded as blank for the current tool. 27 GSI database fields are matched to the 62 AGS 4.0 format fields within the five AGS groups for borehole log information.

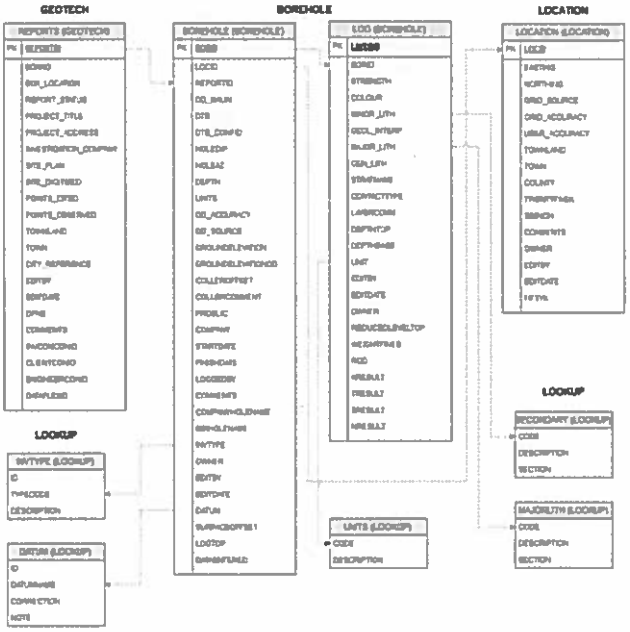

Figure 12. Relational tables for AGS 4.0 data file generation in GSI Geotechnical Database.

The GDG AGS 4.0 file generation tool was coded in Python 3 and can be hosted in the GSI Geotechnical Online Map Viewer (Figure 13**Error! Reference source not found.**) at the next upgrade.

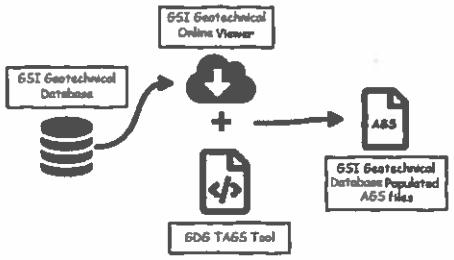

Figure 13. Illustration for hosing the TAGS tool on the Geotechnical Online Viewer.

Table 1. Mapping between AGS 4.0 groups and GSI database tables.

AGS 4.0 Group	AGS 4.0 field	GSI DB schema table	GSI DB field
PROJ	PROJ_ID	GEO.RPT	REPORTID
PROJ	PROJ_NAME	GEO.RPT	PROJECT_TITLE
PROJ	PROJ_LOC	GEO.RPT	PROJ_ADDRESS
PROJ	PROJ_CLNT	GEO.RPT	CLIENT_COMPANY
PROJ	PROJ_CONT	GEO.RPT	INVESTIGATING_COMPANY
PROJ	PROJ_ENG	GEO.RPT	CONSULTING_ENGINEER
PROJ	PROJ_MEMO	GEO.RPT	COMMENTS
UNIT	UNIT_UNIT	BH.BH	UNITS
UNIT	UNIT_DESC	LU.UNT	UNITS
LOCA	LOCA_ID	BH.BH	BORID
LOCA	LOCA_TYPE	BH.BH	INVTYPE
LOCA	LOCA_NATE	LOC.LOC	EASTING
LOCA	LOCA_NATN	LOC.LOC	NORTHING
LOCA	LOCA_GL	BH.BH	GROUDELEVATIONOD
LOCA	LOCA_REM	BH.BH	COMMENTS
LOCA	LOCA_FDEP	BH.BH	DEPTH
LOCA	LOCA_STAR	BH.BH	STARTDATE
LOCA	LOCA_PURP	BH.BH	OWNER
LOCA	LOCA_ENDD	BH.BH	FINISHDATE
LOCA	LOCA_DATM	BH.BH	DATUM
LOCA	LOCA_OFFS	BH.BH	SURFACEOFFSET
GEOL	LOCA_ID	BH.LOG	BORID
GEOL	GEOL_TOP	BH.LOG	DEPTHTOP
GEOL	GEOL_BASE	BH.LOG	DEPTHBASE
GEOL	GEOL_DESC	BH.LOG	LAYERCOMM
GEOL	GEOL_GEOL	BH.LOG	MAJOR_LITH
GEOL	GEOL_GEO2	BH.LOG	MINOR_LITH

where DB = database, GEO = GEOTECH, RPT = REPORTS, BH = BOREHOLE, LU = LOOKUP, UNT = UNITS, LOC = LOCATION

5.3 Impact of the TAGS project

The TAGS project explored the means to increase the accessibility and re-usability of geotechnical ground investigation data by hosting the donated AGS data files on the GSI GOLDMINE and providing the access for the borehole information stored in the National Geotechnical Database in AGS 4.0 data format. The TAGS survey results suggest that Irish GI contractors are generally willing to donate the AGS ground investigation data files to GSI. The AGS files will expand the coverage of the National Geotechnical Database quickly and reliably as well as increase the efficiency and quality of transferring and reusing the geotechnical investigation data.

By accessing and exporting from the GSI National Geotechnical Database, minor improvements were made to the database in terms of the comment fields and unit consistency. Line feed and cartridge returns were commonly used in the comments fields, such as GEO.RPT.COMMENTS, BH.BH.COMMENTS, and BH.LOG.LAYERCOMM, which poses difficulties in transferring these fields into the AGS format and had to be replaced throughout the GSI database. Some other issues were found, such as the unit case-inconsistency in BH.BH and in LU.UNT fields. The TAGS project provided an opportunity to check the GSI Geotechnical Database based on the AGS industry standard.

The ground investigation data held by the GSI is a valuable resource for the geotechnical industry. Transferring borehole data in AGS format allows the industry to share and re-use the

ground investigation data more efficiently and reliably. The AGS data can be loaded into a range of software packages leading to quicker test result plotting, two-dimensional cross-section logging and three-dimensional geological modelling which can be a subsurface component for BIM. It is noted that the responsibility for verifying the data, assessing the quality of the data sources and developing a suitable ground model will remain with the designer.

5.4 Quality constraints of the TAGS project

The GSI database has not been constructed based on the AGS industry standard and generating AGS format files from the information stored in the GSI database is not a straightforward step. An extensive mapping exercise was undertaken between the GSI database and the AGS format.

Within the available resources, the TAGS project managed to provide solutions for hosting the original AGS data files on the GSI GOLDMINE and to develop an AGS 4.0 data file generation tool from the GSI Geotechnical Database. The tool includes all the mandatory groups with the GEOL and LOCA groups for the borehole log information and is ready to be extended to include other AGS groups, particularly geotechnical tests.

6 FURTHER WORK

The TAGS project is a first step for widening the data sharing and re-usage of AGS data in Ireland. Further developments based on the TAGS project would benefit the community by reliable data sharing to a greater extent:

(1) Make the AGS data format more available for consultants for Irish projects. This involves advertising how this data format can be used to develop ground models and avoid or mitigate geohazards earlier in the design process. Feedback from contractors and the Geotechnical Society of Ireland suggests that the AGS format is underutilised.

(2) The tool developed by GDG will be tested and integrated on the GSI servers and the new online map viewer which enables the availability for the wider community to download AGS compatible data.

(3) The methodology could be reverse engineered for receiving AGS data files and populating the GSI Geotechnical Database. A series of protocols will be required to ensure that the AGS files provided to the GSI will be easily imported. These protocols would ideally follow the AGS 4.0 rules and be of benefit for all users.

(4) The LOOKUP tables of the GSI Geotechnical Database could be mapped to the AGS standard abbreviations in the generated AGS data files, providing greater alignment of the GSI generated AGS data with the AGS 4.0 abbreviation standard.

(5) Natural Language Processing could be used to analyse the layer comments for geological description and assign the standard AGS geology code in the generated AGS data files. At present, the AGS user will be required to define the geology codes within the AGS software package.

(6) Some limited information on geotechnical tests (in-situ and laboratory) are available in the GSI database. Future developments of the tool could incorporate this data for export in the AGS data files.

(7) Along with the ground investigation data sharing in AGS format, the tools and platforms developed would be open-sourced for generating end-user customised queries.

ACKNOWLEDGMENTS

We thank the Geological Survey of Ireland Research Programme for financially supporting the TAGS project and providing permission to publish these interim results. We are also grateful to the respondents to the survey which is useful for highlighting the current status of AGS data usage in Irish ground investigations.

REFERENCES

[1] BGS (2017) Geotechnical Data. [ONLINE] Available at http://www.bgs.ac.uk/services/ngdc/management/geology/geotechnical.html. [Accessed 1st May 2018].

[2] Chandler, R. (2015) AGS Data Format – Enabling BIM Modelling of the Sub-surface. One Day Seminar on Ground Investigation and Ground Characterization for Civil Engineering Projects. Association of Geotechnical and Geoenvironmental Specialists (Hong Kong).

[3] Bland, J. (2014) AGS Data Transfer Format. [ONLINE] Available at https://www.bgs.ac.uk/research/engineeringGeology/urbanGeoscience/Clyde/askNetwork/docs/Jackie_Bland_ASKNetwork2.pdf. [Accessed 1st May 2018].

[4] Entwisle, D. C. and Self, S. (2017) [ONLINE] available at http://nag-city.org/docs/NAG-CITY-Oslo-2C.pdf. [Accessed 1st May 2018].

[5] Smith, C. (2017) 'Digital Data – leveraging the benefits', Ground Engineering, December 2017, 28-29.