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Development of Bilateral Data Transferability in the Virginia Department of Transportation's Geotechnical Database Management System Framework

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Supplementary Notes

Abstract

An Internet-based, spatiotemporal Geotechnical Database Management System (GDBMS) Framework was designed, developed, and implemented at the Virginia Department of Transportation (VDOT) in 2002 to retrieve, manage, archive, and analyze geotechnical data using a distributed Geographical Information System methodology.

As the use rate of the GDBMS Framework grew, VDOT engineers recognized that additional engineering analysis and design functionalities could be incorporated. In response, five geotechnical engineering applications (DRIVEN, RSS, LPILE Plus, SHAFT, and GALENA) that are used to calculate slope stability, pile, and shaft capacity were identified. An Analysis and Design Module (ADM) for these five applications was developed and implemented in 2004.

In 2005, additional automated file upload capability (Bilateral Data Transferability, BDT) was developed and implemented to allow VDOT engineers and geologists to upload completed geotechnical data files, with a pre-screening and QA/QC check prior to the final posting on the GDBMS server. This BDT module was implemented based on the latest gINT geotechnical data template and library used at VDOT. In addition, a new functionality to export dynamically generated fence diagrams into MicroStation in a DXF format was developed and implemented in GDBMS.

FINAL CONTRACT REPORT

DEVELOPMENT OF BILATERAL DATA TRANSFERABILITY IN THE VIRGINIA DEPARTMENT OF TRANSPORTATION'S GEOTECHNICAL DATABASE MANAGEMENT SYSTEM FRAMEWORK

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ABSTRACT

An Internet-based, spatiotemporal Geotechnical Database Management System (GDBMS) Framework was designed, developed, and implemented at the Virginia Department of Transportation (VDOT) in 2002 to retrieve, manage, archive, and analyze geotechnical data using a distributed Geographical Information System methodology.

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INTRODUCTION

In 2001, the Geotechnical Research Advisory Committee (GRAC) of the Virginia Transportation Research Council (VTRC) identified a need to implement an Internet-based, spatiotemporal Geotechnical Database Management System (GDBMS) Framework using a distributed Geographical Information System (GIS) methodology for data management, archiving, retrieval, and analysis. Subsequently, a feasibility study was conducted by Ishibashi and Yoon to identify a number of GDBMS implementation alternatives.[1] The GIS-based approach was recommended as the most viable implementation model in terms of ease of use, cost-effectiveness, flexibility, and future expandability.

After the initial feasibility study, a demonstration pilot of the GDBMS Framework implementation was carried out for the Third Hampton Roads Crossing Project (HR3X). The main goal of the HR3X pilot study was to design, develop, and implement a practical Internet-based GDBMS Framework for accessing and utilizing geotechnical data. In 2003, the GDBMS Framework was further developed and scaled up to facilitate a statewide model, and subsequently the Woodrow Wilson Bridge and Route 1 Interchange site was added as a second project module.[2] Implemented statewide, the Internet-accessible, GIS-based GDBMS Framework has been actively used and recognized by VDOT engineers as an effective and efficient tool to manage geotechnical data.

Initial conceptualization of the GDBMS Framework was to facilitate geotechnical data archival, access, and retrieval. As the rate of utilization of the GDBMS Framework grew, VDOT engineers recognized that additional analysis and design functionalities could be incorporated. In response, five geotechnical engineering software applications (DRIVEN, RSS, LPILE Plus, SHAFT and GALENA) that are frequently used to calculate slope stability, shaft, and pile capacity were identified. Analysis and Design Module (ADM) functionality for these five applications was designed, developed, and implemented to the GDBMS Framework in 2004.[3]

ADM was designed to automatically extract, filter, translate, and generate input data sets inside the GDBMS Framework when a borehole site is selected. Thus, ADM allows VDOT engineers to perform specific analysis and design calculations by automatically generating input

data sets. In addition to the ADM module development, a powerful data search algorithm, *GDBMS Borehole Search Rabbit*, was implemented. This new search algorithm provides hierarchical and partial search capabilities based on GDBMS site module, VDOT project number, source-level gINT project file, and borehole designation. Once a borehole data search is completed, VDOT engineers can directly access particular site data in various formats, such as the original legacy data format, translated standard data format, gINT and Excel files of translated standard data format, and borehole data log and laboratory results.

In 2005, additional automated file upload capability (Bilateral Data Transferability, BDT) functionality was developed and implemented to allow VDOT geologists to upload completed geotechnical gINT data files to the GDBMS server, with a pre-screening and QA/QC validity check prior to the final posting. This BDT module was implemented based on the latest geotechnical gINT data template and library used by VDOT. In addition, new functionality to export dynamically generated fence diagrams into MicroStation in a DXF format was developed and implemented.

PURPOSE AND SCOPE

The purpose of this project was to develop and implement an automated upload capability in the existing GDBMS Framework. In addition to designing the required mechanism of uploading geotechnical data files, special attention was given to providing several layers of data verification and final data certification as a means of QA/QC when the data were uploaded by an engineer or a geologist in a VDOT district office.

Three key implementation issues were targeted during this project.

(1) development of an automated upload capability (BDT) for gINT project files, with a pre-screening and QA/QC check prior to the final posting to the statewide GDBMS Framework

(2) development and update of the GDBMS Framework with the mainstream gINT library that VDOT geologists and consultants are currently using

(3) development of functionality to export a dynamically generated fence diagram into MicroStation in a DXF format.

METHODS

VDOT GDBMS Framework source codes were revised and updated to add the Bilateral Data Transferability Module based on an adaptive translative engine for the VDOT gINT data template and library. Separate source codes were developed and implemented to facilitate translation and creation of a dynamically generated fence diagram into MicroStation in a DXF format.

The key conceptualization of the BDT Module was to provide VDOT engineers and geologists a fully functional, user-friendly, rugged, flexible yet expandable data upload tool. In addition to designing the required mechanism of uploading geotechnical data files, special attention was given to providing several layers of data verification and final data certification as a means of QA/QC when the data were uploaded by an engineer or a geologist in a VDOT district office.

The quality and value of any data are solely judged by their correctness and accuracy. It is equally true that once any incorrect and inaccurate data are introduced to a database management system, the data quality and accuracy on the whole will suffer greatly. It will also be extremely difficult to remove the data.

The initial screening and verification of data in the form of QA/QC is a critical issue when any kind of user data upload functionality is provided to a system. The BDT implementation carried out in this study addressed critical QA/QC issues during the upload process. Components of the BDT QA/QC fully use the adaptive translative filter implementation in the GDBMS Framework. The schematic flowchart of BDT processes is shown in Figure 1.

RESULTS

The Internet-based, spatiotemporal Geotechnical Database with the BDT Module can be accessed at http://matrix2/website/index.html inside VDOT. The entire database is mirrored for outside access at http://gis.virginiadot.org/ (GDBMS Framework). For security reasons, BDT functionality is available only on the internal VDOT network.

Key components of the BDT implementation in the GDBMS Framework environment are shown in Figures 2 through 5.

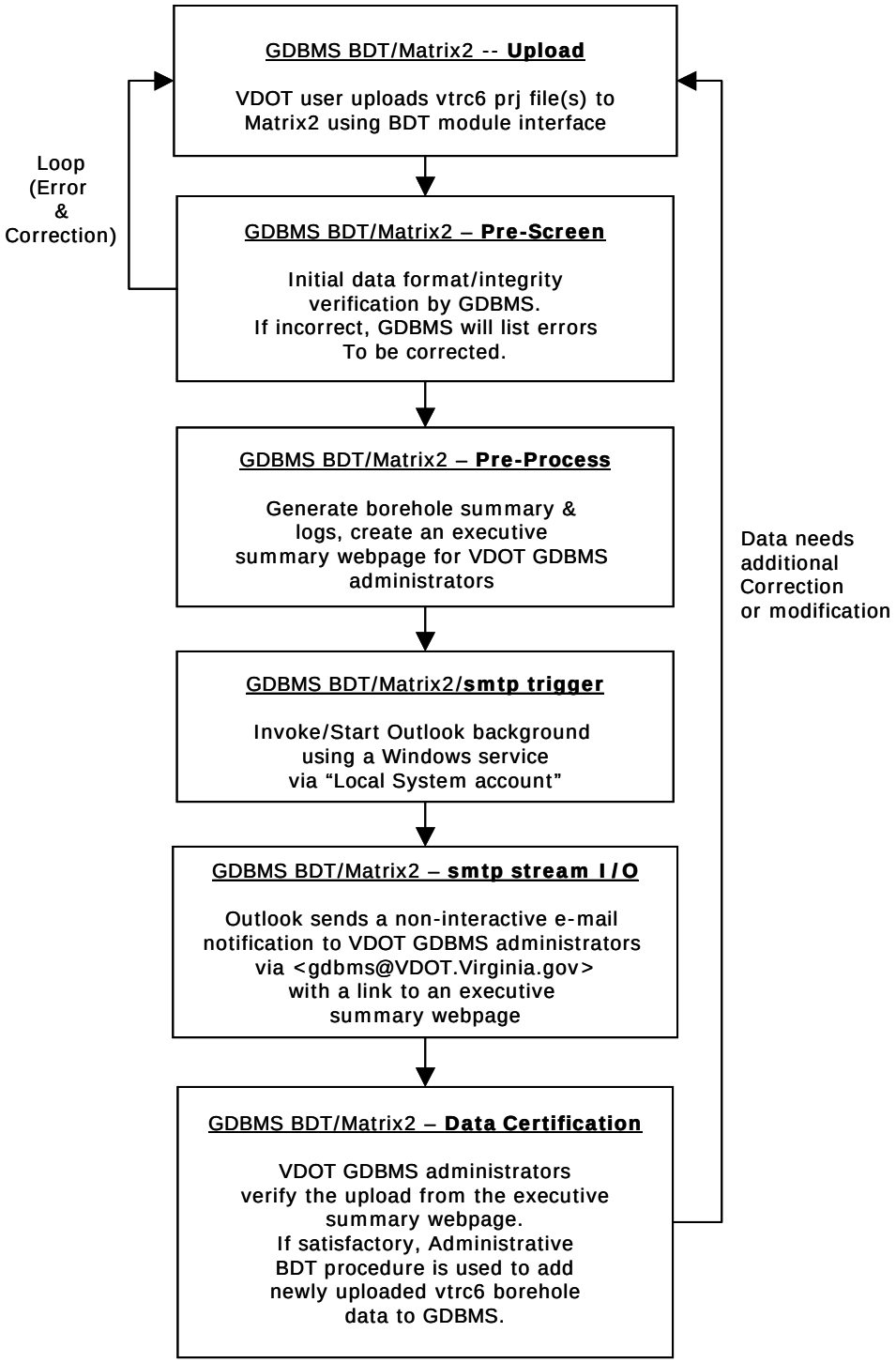

Figure 1. Schematic Flowchart of Bilateral Data Transferability in GDBMS Framework

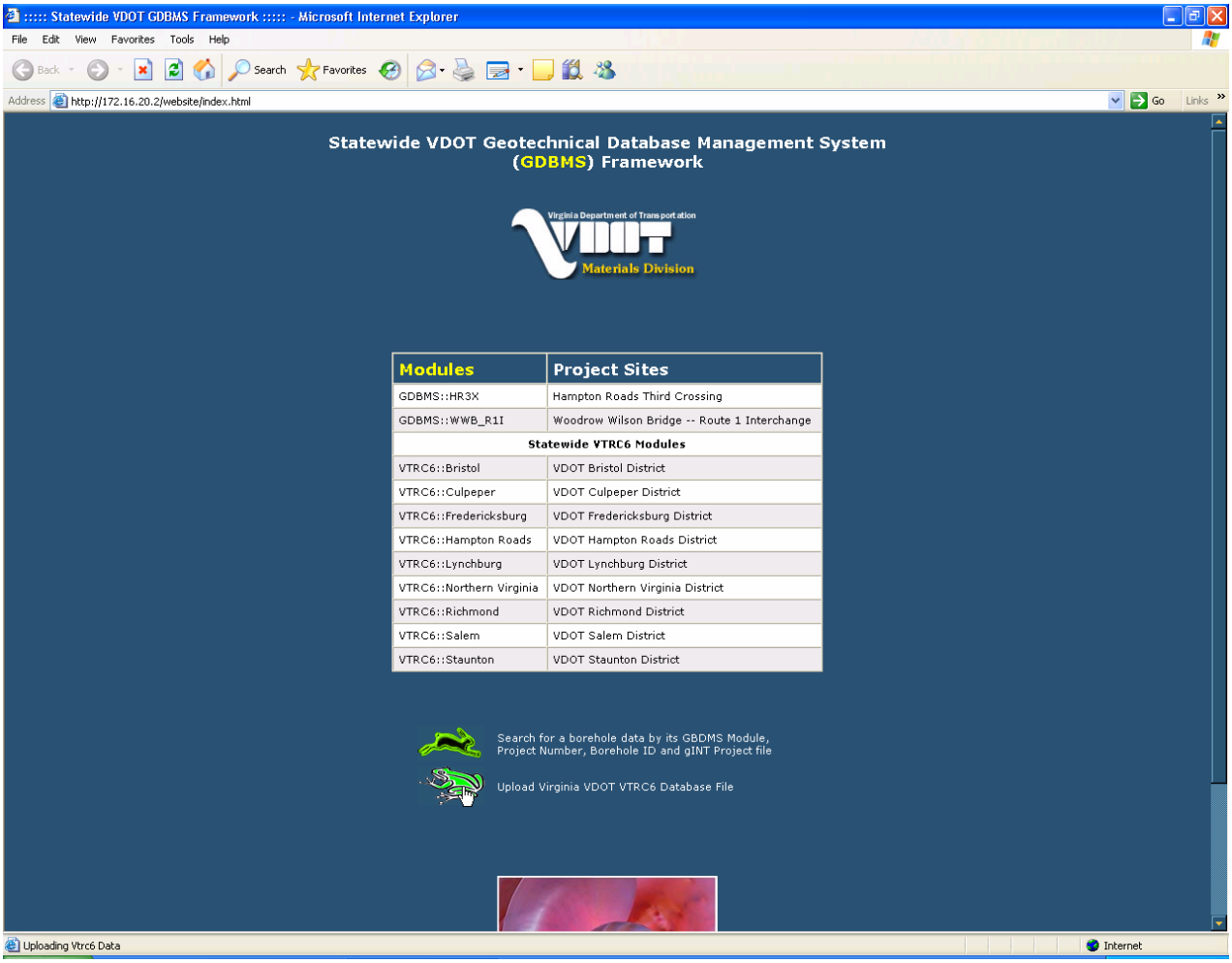

Figure 2. Bilateral Data Transferability Upload Links

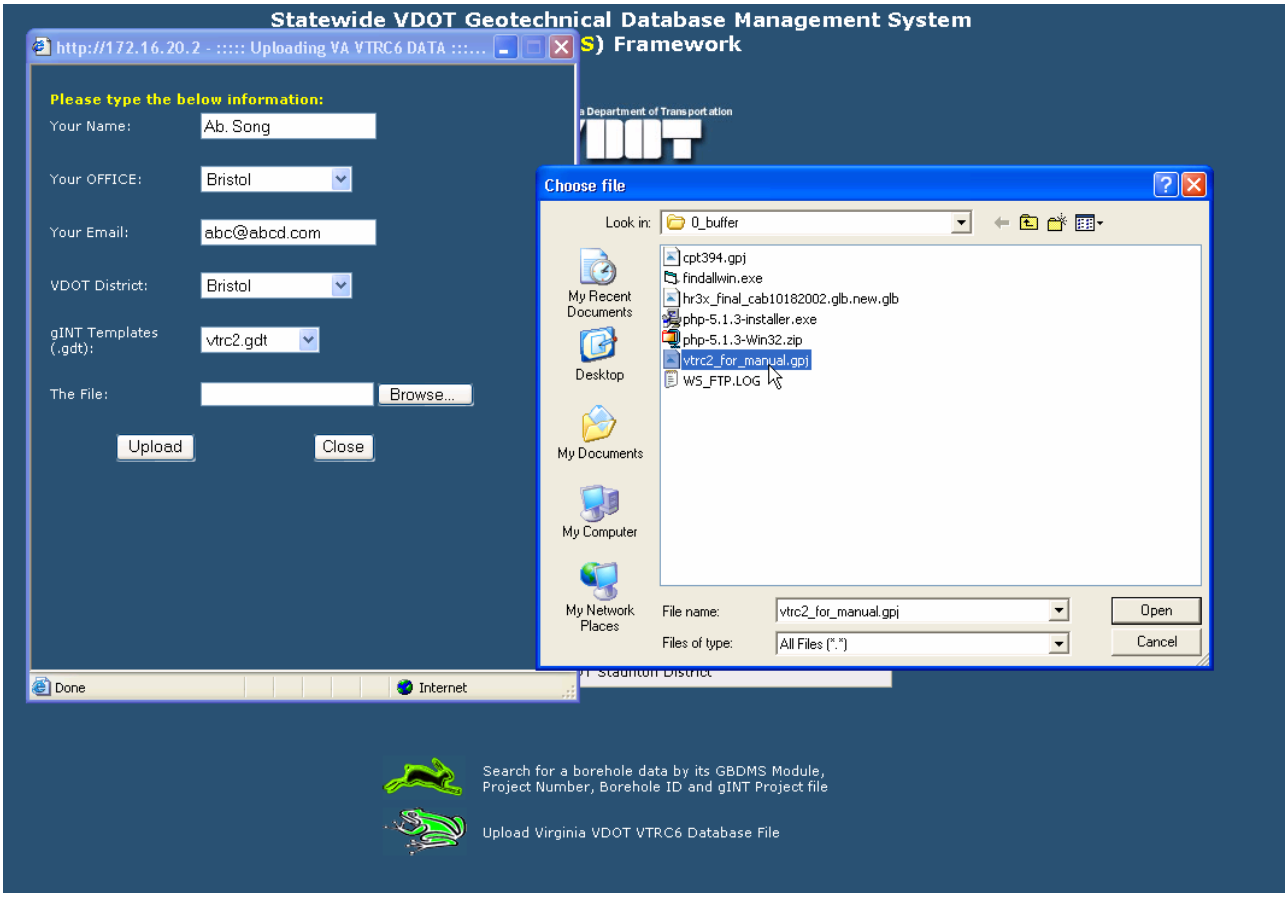

Figure 3. Upload File Selection Dialog Screen

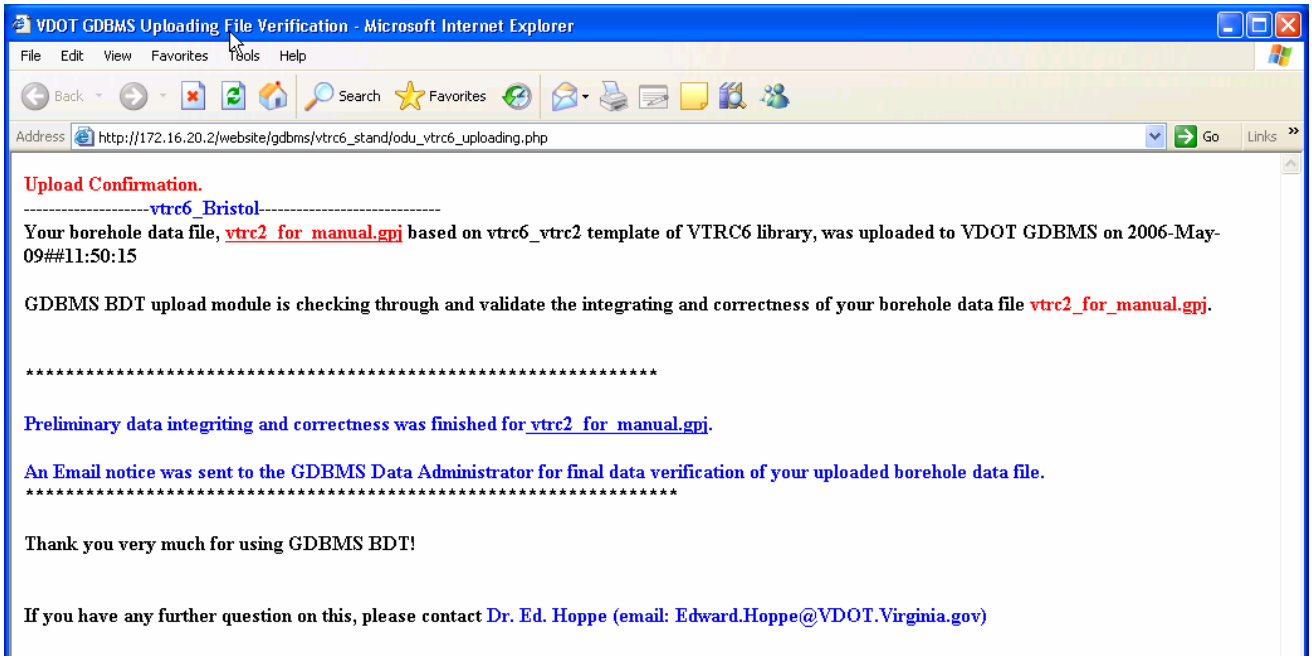

Figure 4. Example Confirmation Screen Following a Successful Data Validity Check

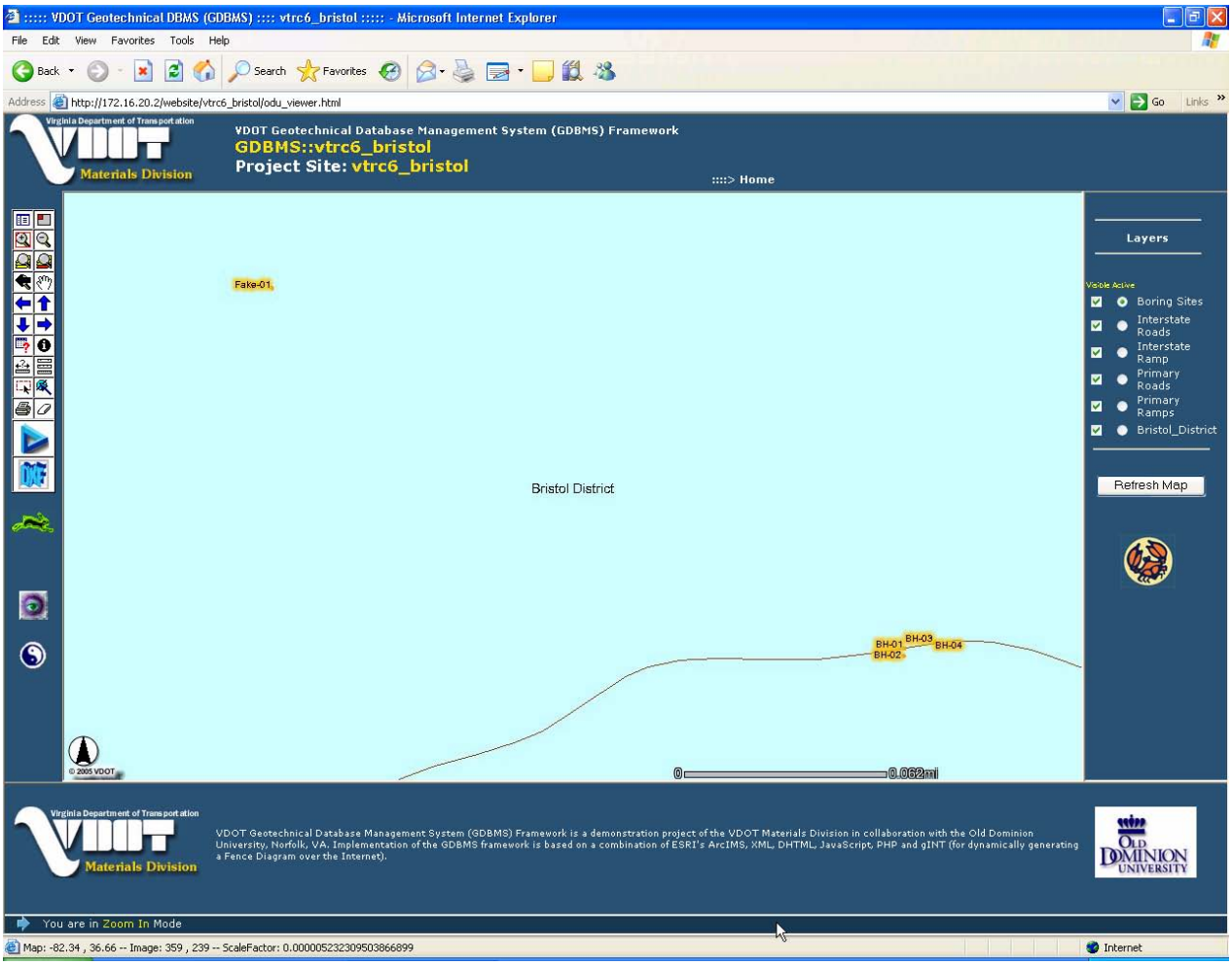

Figure 5. Plan View of New Borehole Locations

CONCLUSIONS

- *An automated file upload capability with QA/QC data verification was developed and implemented in the VDOT Geotechnical Database. Compared to a previously used procedure of manual data entry by IT personnel, this BDT implementation provides VDOT engineers and geologists with an effective tool to manage the geotechnical data.*

- *New functionality to transfer dynamically generated borehole fence diagrams to MicroStation for further processing was developed and implemented.*

RECOMMENDATION

1. *VDOT's Materials Division should use the BDT functionality for all new geotechnical data postings to the GDBMS Framework.*

BENEFITS AND COSTS ASSESSMENT

The BDT implementation will result in more efficient and streamlined geotechnical data management at VDOT. Manual tasks, previously delegated to the IT support personnel, have now been automated. It is estimated that 2 hours of labor will be saved per each new borehole data element that needs to be verified, added, and incorporated in the GDBMS Framework. A typical construction project includes approximately 10 boreholes.

ACKNOWLEDGMENTS

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