The Geospatial Solutions Network™

2004 NSDI Cooperative Agreement Program Proposal

Category 5: Establishing Framework Data Services using the OGC Web Feature Service Specification

Final Project Report

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Project Information

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Project Narrative

GeoLeaders is pleased to provide the following Final Report for the 2004 CAP Grant Program, Category 5: Establishing Framework Data Services using the OGC Web Feature Services Specification (The Project).

The Project proposed to establish a reference implementation of a reliable and efficient Web Feature Service to deliver selected Framework Layers via the Internet, and will define a methodology for easily configuring and deploying interoperable Web Feature Services for Framework Data Themes and the National Map by implementing a new GML 3.0 Level 0 Profile of GML for WFS implementations (GML 3.0 Level 0 Profile is now referred to as GML for Simple Features Profile - Compliance Level 1 (GMLSF-1)). The Project goal was to help realize and demonstrate the full benefits of leveraging spatial data infrastructures with standards-based data services architectures, and to allow for testing and evaluation of the GMLSF-1 that enables the deployment of truly interoperable Web Feature Services by providing for the operational use of WFS based Framework Data Services by multi-vendor desktop and applications development environments. These elements are vital to providing a strong foundation for further NSDI development activities for the Framework Data Themes using WFS and GML.

The Project proposed to focus on the implementation of a CubeWerx CubeSERV Web Feature Server using GMLSF-1 that is coordinated with the current efforts of the OGC and the USGS to define GML profiles for the Framework Data Themes of the National Map. The Project will specifically address the National Hydrography Dataset (NHD) as the subject Framework Data Theme.

The Project proposed to support national, state and regional GIS infrastructure objectives by accomplishing the following objectives.

- Enable a reliable online access to an existing archive of the Nation's digital geographic information through development and deployment of an online operational WFS capability for the Hydrography Framework Data layer (NHD/WFS). The NHD/WFS will serve as an operational reference implementation of OGC Web Feature Service (WFS) Version 1.0. that can be reused by other organizations at all levels of government. The Project will demonstrate the WFS capability by developing and deploying a WFS client to test the functionality of the deployed Web Feature Service.

- 'Lower the bar' for implementing WFS for Framework Data Theme(s) by employing a constrained GML 3.0 Profile, and by coordinating with the current OGC collaboration with the USGS to define GML Application Schemas for the Framework Data Themes. This will further the use of GML and WFS for future implementations and will translate to lower implementation costs and flexibility of underlying vendor platforms, making implementation easier for any organization interested in improving interoperability by implementing the WFS interface, thereby enhancing the NSDI. The resulting implementation will serve as a general reference implementation of an OGC Web Feature Server (WFS) Specification based on the GMLSF-1 Specification enabling faster

deployments of interoperable data services based on open OGC compliant WFS specifications for state, local and private organizations that may also want leverage WFS to sharing data independently and to support a collaborative National Map program.

- Define methods used to configure Framework Data services on legacy data, and make available to the community to assist in broader uptake. It is anticipated that the proposed Project will define the techniques to simplify the task of configuring Framework Data Services using WFS that will find their way into other widely available commercial software implementations. The WFS NHD will be based on the Framework Data model defined in the draft INCITS Project 1574-D, Geographic information - Framework Data Content Standard, public review draft version (TBD). The INCITS-L1 multi-part standard and the implementation will be modified by the end of the project to reflect the final INCITS-L1 multi-part standards when published.

- In conjunction with the USGS and EPA, define general query and maintenance level Use Cases that detail the end user requirements of the NHD WFS. These Use Cases will provide the specific context and objectives for the client demonstrations, as well as define more advanced capabilities required to integrate WFS with other web service initiatives upon which these organizations rely to perform core business functions. This may include specific identification of requirements and issues between OGC standards and WSDL, SOAP, and EBRIM.

- Develop a collaborative NSDI implementation methodology that can be repeated for implementing and supporting reliable, standards-based online spatial data service for other Framework Data categories. Combined with the registration of these services within the FGDC-compliant metadata catalog of the GOS Portal, these benefits will lead to faster deployments of interoperable data services based on the OGC WFS specifications.

- Generate feedback on the proposed OGC draft standard for GML Level 0 Profile, comment and reference on the draft ANSI Framework Standards, and input to the OGC Web Feature Service (WFS) specification.

Through meeting these objectives, the Project has achieved a critical milestone in the usefulness of GML which will enhance the NSDI and provide major ongoing benefits. Through this Project, the FGDC directly impacted and accelerated the release of the OGC GMLSF-1 Specification. The new GMLSF-1 standard will enable future implementations to more readily release interoperable, standards-compliant services and software products. In addition, the project also defined a repeatable implementation methodology and identified critical improvements required to tools to support more efficient implementations of GMLSF-1 based WFS services.

Project Status

Final Completed Tasks

Following the Mid-Term report the following activities were completed for the Category 5 project:

Development & Implementation

- Reviewed recent modifications/enhancements to Hydro & Transportation UML Models & Created Final GMLSF-1 based profiles for each.
- Performed final Hydro & Base Transportation data migration to CubeSTOR using final GMLSF-1 based schemas.
- Developed and Reviewed with EPA the Use Cases for Navigation/Viewing & Transaction/Analysis Workflows
- Performance of Validation Testing of the NHD WFS Implementation through Client to Server request/response testing and verification
- Discussed status of XML Transaction Files used to maintain GeoDatabase implementations. It was determined that these are still in development by the USGS and that the use of the GML profiles developed for the project can be leveraged by the USGS. Further development and collaboration with the USGS is required to enable use of XML/GML Transaction Files to maintain consistency and integrity of the Framework Theme WFS implementation using the same transaction applied to the ESRI GeoDatabase production systems.

Demonstration

- At September 22, 2005 meeting of the FGDC Geospatial Applications & Interoperability Work Group, demonstrated an Integrated OGC-Based workflow using WMS/WFS and following the Use Cases defined which illustrated rudimentary WFS integration with EPA Environmental Information Exchange workflow.
- Demonstrated access by Multi-Vendor Desktop Support including Gaia and the CarbonArc Extension for ArcGIS. Access to the WFS implementation can be achieved with any client application which supports the WFS Specification.
- Demonstrated implementation & use of Binary XML Encoding of GML, however implementation of the server side and Carbon Tools products were based on different Binary XML Encodings; and therefore, require additional development and collaboration is to recognize the performance benefits.

- Demonstrated functional use of XML Transaction Files (WFS-T) to maintain consistency and integrity of CubeSTOR implementation.

Status of the NHD WFS Service

- The NHD WFS is now running operational with a final load of the NHD database as provided by USGS, and using a validated GMLSF-1 Schema which supports the Framework Data Theme UML Model for Hydrography. The service is available @ http://nhd.cubewerx.com/cwwrs/cwwrs.cgi?request=GetCapabilities .

- Implementation includes a limited set of Transportation Theme data. Additional development and collaboration with USGS is required to enable all Base Transportation data.

- NHD WFS is registered on the Geospatial One-Stop Portal @ www.geodata.gov .

- Delivery of CubeWerx based implementation is pending consideration of an alternate proposal to continue hosting the implementation within the context of enabling additional operational Framework Data Theme Web Features Services.

Completed Tasks Prior to Mid-Term Report

- Defined early iterations of GMLSF-1 Schemas for Hydro & Base Transportation from Framework UML Models. Documented as .xsd files and posted to the FGDC project portal (http://www.fgdc.gov/framework/dotproject/index.php?). Used .xsd GML 3 Application Schema generated from UGAS and .xmi file as input.

- To help facilitate more rapid GML Schema generation, attempted to semi automate the process of generating GMLSF-1 Schemas by generating a SQL schema directly from the UML Model, which subsequently could be used to generate the GMLSF-1 Schema. Evaluated approximately 10 tools including Magic Draw, Umbrello, Master Modeler. Consistently could not read UML/XMI files. In cases where it could read, there was still not enough information to successfully create a SQL Schema. As a result, the GMLSF-1 schemas were generated manually.

- Mapped Properties from shape files to GMLSF-1 schemas and validated schemas by loading small sample into CubeSTOR from NHD shape files from GeoDatabase to validate that the WFS generates a valid GMLSF-1 Schema for fulfilling a DescribeFeatureType requests.

- Developed CubeWerx GMLSF-1 Schema Validator (v0.0.1/2) for GMLSF-1s to be used against all Framework Schemas in Category 5 projects. Successful response from the GMLSF-1 Schema Validator is an HTML which defines the features and their source in a more easily readable form. GML Schema Validator is available at http://www.pvretano.com/cwg3l0 .

- Revised the OGC Simple Features Profile Specification, (previously called GML 3.0 Level 0 Profile for WFS. Revisions continue based on recommendations from WFS working group. Will be posted before the next OGC Technical Committee meeting where should become and adopted profile (June 13, 2005; St. John's, NF)

- Compared Framework Reference Model w/ GeoDatabase Definition using Schema Dump of NHD GeoDatabase

- Performed pre-final validation of GMLSF-1 for NHD & Base Transport Framework Themes. Both NHD and Base Transportation validate successfully using CubeWerx SF-GML Schema Validator (v0.0.1/2).

- Procured, configured the Linux Server with Oracle DB, CubeSTOR, and CubeWerx WFS. The NHD WFS is currently operational behind firewall, and was exposed at http://nhd.cubewerx.com in May, 2005.

- Requested and received FGDC Compliant Metadata for the NHD, which will be loaded into OGC Catalog Server 2.0 Compliant Web Registry Server

- Coordination with EPA CDX & Environmental Exchange Network Pilot Project. Reviewed EPA Pilot Project plan and requirements. Project Collaboration and Use Case review June 2, 2005

Methodology, Issues & Lessons Learned

Through the Project, the geoLeaders team has demonstrated the viability of WFS in meeting key objectives of an NSDI based on open standards-based web services. The Project identified several project and technology related issues which impacted the level of effort required for implementing standards-based online spatial data services, and the effectiveness of the implementation for supporting operational applications.

Implementation Methodology

The general implementation methodology included the following steps and milestones:

- Utilization of Framework Data UML Models defined by draft INCITS Project 1574-D
- Interactive/Semi-Automatic Generation of GMLSF-1 from UML Models
- Mapping of Source Data Schemas into Framework Model Based Database Design
- Migration and Loading of Data into Framework Model Defined Database
- Validation of the GMLSF-1 using WFS
- Testing and Demonstration of the WFS using multiple client applications

Issues & Lessons Learned

The overall efficiency of project execution was impacted considerably by an extended project timeline attributable to several factors including accommodation of Framework Data Theme UML Model revisions, limitations of current products to support required workflows, and issues related to project coordination and scheduling of non-dedicated resources. Below the issues related to the Implementation Methodology and Functional Limitations of the WFS capability are discussed in more detail.

A. Implementation Methodology: The Implementation Methodology defined above required multiple iterations due to the following issues:

1. Stability of UML Models and Framework Data Theme
   - Anticipated this issue, but burden was compounded by multiple revisions and the issues detailed below.

2. Stability of GML for Simple Features Specification
   - Required revisions to the GML schemas a number of times to comply with the evolving GMLSF specification.

3. Utilization of UML Models in Generating GMLSF-1
   - Existing UML Modeling tools were lacking in end to end capability due to the complexity of GML
   - Attempted to use multiple products including Rational Rose, Enterprise Architect, Umbrello, Magic Draw, and others, but all were inadequate.

- Attempted to automate process; however, ran into XMI inconsistencies when trying to create SQL tables.
- Ideally, WFS would have generated the GML Profiles directly.
- Not enough detailed information was provided in XMI files to successfully generate SQL.

4. Mapping from Source to Target Schemas
   - NHD data had poor data dictionaries/metadata that complicated process
   - Needed closer collaboration with Framework Working Groups for Validation of UML interpretation and GMLSF-1 profiles.
   - Product Limitations/Inconsistencies generating Normalized Schema Definitions & GMLSF-1 for WFS. Use of most products and tools result in Non-Normative Schema Definition as there is significant loss of data/definitions in translation.

B. Functional Limitations: From a perspective of supporting Production Applications, the following standards-based product/technology limitations also limit the overall usefulness and effectiveness of the implementation:

1. Competing Binary XML Standards on Server and Client side applications
   - While CubeWerx and Carbon Project's CarbonArc Extension of ArcGIS (CarbonArc) both supported Binary XML, their implementations are non-compliant thereby limiting our ability to demonstrate the performance gains of Binary XML encodings.

2. Limited support the OGC Filter Specification in Client Applications
   - While the CubeWerx based WFS implementation supports the OGC Filter Specification, client applications such as CarbonArc have only limited support.
   - This is a critical function required to limit queries against large spatial databases enabled with WFS

3. Limited Support for WFS Transactions
   - While WFS Transactions were accomplished and demonstrated, this is currently limited to point features within CarbonArc.
   - Production use will require support for complex geometries.
   - Demonstrated capability using WFS Transaction Formats is directly applicable to USGS efforts to define XML transactions to maintain ESRI GeoDatabase implementations.
   - Invoking and tracking history of interactive and batch updates using GML is possible but was not adequately demonstrated in the GAI meeting presentation.

4. Support for Analytical Processing and Topological Data Structures
   - There is a current lack of understanding and support for consideration of analytical requirements which rely of topological data structure such as those required for Dynamic Segmentation.
   - While the UML Models and resulting WFS read into ArcGIS using CarbonArc include the necessary attributes to perform simple Event Modeling; currently WFS

displayed features are not treated the same as features display from shape or coverage files.
- This was a particularly important capability of a HND WFS based solution to support the needs of the EPA who currently makes extensive use of Event Tables.

5. Integration of Data Discovery into Standards-Based Workflows
   - The NHD WFS is registered at the GOS Portal site; however is not easily accessed or displayed within the GOS Portal viewer, nor is a user able to discover and utilize the WFS directly within a disparate application such as ESRI ArcGIS using the CarbonArc Extension.
   - This is a critical, yet overlooked capability which will continue to limit the usability of standards-based data services.

While these factors negatively impacted the project budget, delivery schedule, and functional achievement, they also highlight those areas where further investments are required and justified to enable more rapid deployments of standards-based web feature services and spatial data infrastructures which can robustly support production applications.

Recommendations

The geoLeaders Team believes that it has a unique vision for helping the Federal Government realize the benefits of OGC Web Services & interoperability; and therefore its' significant investments in OGC over the years. Through the 2004 CAP Grant Category 5 Project we have demonstrated the viability of GML as a capable standard for enabling a web services based spatial data infrastructure using the GML for Simple Features Specification. However, many challenges still exist to achieve useful implementations and to overcome factors limiting the overall success of OGC Standards-Based Spatial Data Infrastructures. The primary recommendations resulting from the Project include the following:

1. Establish Operational OGC Framework Data Theme Web Services
   - Based on an assessment of other Category 5 efforts, there is still a significant effort required to finalize and validate GMLSF-1 based profiles for other Framework Data Themes. Until this is accomplished in a complete and validated form, WFS implementations will continue to fall short of enabling interoperability.
   - Availability of Framework Data Theme Web Services will provide a robust 'platform' around which future CAP Grant Program initiatives can then focus on deeper issues of achieving effective multi-vendor interoperability and collaboration using OGC standards-based web services.
   - Availability of Framework Data Theme Web Services will encourage vendors to increase the priority of incorporating support for OGC standards into their products which ultimately impacts the level of interoperability achieved.
   - Availability of Operational Framework Data Services will serve to encourage similar investments and collaboration among other Federal, State, Local and commercial entities.

2. Enhancement of Tools to generate GMLSF
   - The current UGAS Open Source Tool currently Generates GML but not GMLSF-1.
   - Enhancement of this tool to support GMLSF-1 is estimated to require only a modest investment which would provide excellent and ongoing value in the development of standards-based spatial data services.
   - Wide availability of an enhanced UGAS Open Source Tool would significantly accelerate and help normalize future implementations of WFS services.

3. Incorporation of Full Support for GML/WFS within Legacy Platforms
   - While the intent of standards-based interoperability is vendor agnostic, technologies such as the CarbonArc Extension represent a needed bridge between broadly used legacy investments such as ArcGIS and new investments in standards-based spatial data services.
   - Use of Third-Party Extension versus built in vendor support forces and ensures better adherence to standards.
   - Will highlight the degree of vendor 'lock-in' and real cost represented by current proprietary implementations; but will also present new possibilities to make future

SDI investments which optimize flexibility, choice, and capability through the use of standards-based web services.

- Once a core set of operational, standards-based spatial data services are established for the Framework Data Themes, and a new level of flexibility and choice ensue, we believe that this will then spur rejuvenated interest by the vendor community to invest more aggressively in ensuring support for consensus-based standards.
- Need API for interfacing Spatial Data Infrastructure components such as WFS and WMS services, with other SDI components such as the GOS Portal to build-in data discovery capabilities directly into production applications.

4. Define & Establish Broader Requirements and Capabilities
   - Additional strategic investments are required to define and establish more advanced capabilities including the integration of WFS with operational applications including other web service initiatives upon which users rely to perform core business functions using WSDL, SOAP, and EBRIM for example.
   - There is a particular need and opportunity to do so within the context of EPA Environmental Information Exchange Network projects.
   - Investigate implications and challenges of deploying web services Security Framework which will enable deployment of operational WFS within a Federated Network required to address inter-enterprise data sharing and collaboration.

5. Investment in Cartographic Quality Style Layer Descriptors for Framework Data Themes
   - Needed to move beyond elementary state of cartographic quality found in OGC based demonstrations, test beds and applications.
   - Leveraging OGC standard for SLDs has real implications and value for applications such as Emergency Mapping Symbology where there is a need for multi-vendor support and collaboration based on cartographic display.

6. Leverage the GML for Simple Features Specification to Support Gazetteers
   - By defining a UML Model and GMLSF-1 which supports the requirements of a Gazetteer application, implementations of Gazetteer databases and applications can be decoupled leading to more efficient and reusable implementations.

7. Significant Increase in Priority, Investment and Leadership
   - As directed by OMB mandate, and evident from ongoing interoperability challenges, the Federal Government and tax payers have the most to gain from increased interoperability through OGC standards-based web services.
   - Therefore, overall we believe that investment in OGC standards-based spatial data infrastructures should be of higher priority and warrant more significant investment, particularly in consideration of the expenditures made in popular yet proprietary software, and their architectures and databases; the costs associated with ‘stove pipe’ implementations; and the potential savings which OMB has identified.
   - The Federal Government unlike State, Local or commercial entities is in a key leadership position in ensuring the adoption of OGC standards, and needs to be more aggressive in this role, so as to not be marginalized by the ease of ‘de-facto’ standards.

- That part of the OGC community which is most committed to advancing the success of OGC Consensus-Based Standards needs more significant 'buy-in' from the Federal Government and therefore, Federal Government implementation should invest in and leverage existing and advanced SCOTS products. Failure to do so *discourages* further development of open standards-based capabilities and competition in the commercial market; and reinforces the continued use of 'de-facto' standards and dominance of single vendor architectures.

Project Budget/Cost Analysis

GeoLeaders delivered a total project value of $153,544 or $213,694 versus a proposed value of $153,119 based on billed and incurred costs respectively. The GeoLeaders Team effort significantly exceeded the allocated project budget of $74,204, ultimately providing a more significant In-Kind project contribution of $97,505 or $139,466 versus the proposed $78,915, again based on billed and incurred costs respectively. Significant cost over-runs were related to an under estimation of the following:

- Development costs associated with the definition of the GMLSF-1 based profiles and schemas due to inadequacy of current tools; and general support provided to the Category 5 group by Peter Vretanos,
- Implementation costs due to multiple iterations required to load and validate the multiple revisions of the Framework Data Theme Schemas,
- Project management due to extended project time period, level of coordination required, and time required for documentation and reporting
- Travel due to higher airfare than anticipated and higher hotel costs in Washington, DC area due to vacancy shortage during September 22, 2005 demonstration.

These over budget items were offset slightly by overall expenditures which were less than budgeted for Hardware and Software, primarily due to agreement by Oracle to provide an evaluation license for the project period. However, part of these savings was also reallocated to upgrade the hardware memory and storage beyond what the original budget would have provided.

The Project Budget/Cost Summary, Project Costs Details and Original Budget Worksheet for this Project are included below. In addition to the costs incurred to date, the geoLeaders Team will also provide shipping to deliver the preconfigured server to a USGS site.

Budget/Cost Summary

2004 FGDC CAP Grant Program Category 5 Budget/Cost SUMMARY			
PROJECT VALUE			
Proposed Project Value:			$ 153,119
Estimated Total Project Value Delivered:			$ 213,694
Project Value Using Hours Billed:			$ 153,544
Difference Billed versus Proposed Project Value:			$ 425
Difference Delivered versus Proposed Project Value:			$ 60,575
IN-KIND CONTRIBUTIONS			
Proposed In-Kind:			$ 78,915
Actual In-Kind Using Hours Billed:			$ 97,505
Actual In-Kind Using Hours Incurred:			$ 139,466
Additional In-Kind using Billed Services versus Proposed:			$ 18,590
Additional In-Kind using Incurred Services versus Proposed:			$ 60,551
PROJECT COSTS			
Total Project Budget:			$ 74,204
Total Project Cost using Burdened Labor Billed:			$ 87,587
Total Project Cost using Burdened Labor Incurred:			$ 141,133
Total Project Loss Based on Billed Burdened Hours:			$ (13,383)
Total Estimated Project Loss Based on Incurred Burdened Hours:			$ (53,547)
SERVICES			
Cost Proposed Labor Hours with In-Kind Discount:	448		$ 58,660
Burdened Cost Billed Labor Hours:	460		$ 73,913
Burdened Cost Incurred Labor Hours:	793		$ 127,459
Total Direct Cost Labor:			$ 51,750
Total Indirect Cost Labor:			$ 22,163
Fderal Share Indirect Cost Labor:			$ 6,910
Difference Billed versus Proposed:			$ (15,253)
Difference Incurred versus Proposed:			$ (68,799)
EQUIPMENT			
Equipmemnt Budget:			$ 10,994
Actual Equipmemnt Costs:			$ 7,230
Difference:			$ 3,764
TRAVEL			
Travel Budget:			$ 4,550
Actual Travel Costs:			$ 6,444
Difference:			$ (1,894)

Cost Details

2004 FGDC CAP Grant Program Category 5 Budget/Cost Details

GeoLeaders Project Team Services	Actual Hours	Budget Hours	Charged Hours	Burdened Rate	Actual Total Value	Total Value Hours Billed	Proposed Value	Actual 30% In-Kind	Proposed 30% In-Kind	Proposed Cost	Burdened Cost of Labor Billed (Fixed Price)	Estimated Burdened Cost Incurred	Over Budget Cost	Bottom Line In-Kind Contribution Value
Architecture (Design, Coordination, Documentation)	64	48	48	$ 225	$ 14,400	$ 10,800	$ 10,800	$ 4,320	$ 3,240	$ 7,560	$ 7,713	$ 10,284	$ 153	$ 6,840
Development (Definition WFS/GML Level 0 Profile for Data Theme(	256	96	96	$ 175	$ 44,800	$ 16,800	$ 16,800	$ 13,440	$ 5,040	$ 11,760	$ 15,425	$ 41,134	$ 3,665	$ 33,040
Implementation (Configuration/Load/Testing w/ Data Theme(s) &	296	184	180	$ 175	$ 51,800	$ 31,500	$ 32,200	$ 15,540	$ 9,660	$ 22,540	$ 28,922	$ 47,561	$ 6,382	$ 29,260
Project Management (Coordination/Presentation/Documentation)	177	120	136	$ 200	$ 35,450	$ 27,200	$ 24,000	$ 10,635	$ 7,200	$ 16,800	$ 21,852	$ 28,481	$ 5,052	$ 18,650
	793.25	**448**	**460**	**Total**	**$ 146,450**	**$ 86,300**	**$ 83,800**	**$ 43,935**	**$ 25,140**	**$ 58,660**	**$ 73,913**	**$ 127,459**	**$ 15,253**	**$ 87,790**

Equipment					Actual Value	Actual Value	Proposed Value	Actual In-Kind	Proposed In-Kind	Proposed Cost	Actual Cost	Actual Cost	Over Budget Cost	In-Kind Value Contribution
Dual 3.0 Ghz Intel Processor, 4 GB RAM (Included Shipping of Server)					$ 7,230	$ 7,230	$ 4,500	$ -	$ -	$ 4,500	$ 7,230	$ 7,230	$ -	$ -
Oracle 8i (v8.1.7) or 9i (v9.2.0) (Extended Demonstration License)					$ 4,995	$ 4,995	$ 4,995	$ 4,995	$ -	$ 4,995	$ -	$ -	$ -	$ 4,995
Red Hat Enterprise Linux AS, Standard Edition (Included with Server)					$ -	$ -	$ 1,499	$ -	$ -	$ 1,499	$ -	$ -	$ -	$ -
CubeSTOR v4.x, CubeSERV WFS v4.x (1 Yr. Limited License &					$ 41,580	$ 41,580	$ 41,580	$ 41,580	$ 41,580	$ -	$ -	$ -	$ -	$ 41,580
CadCorp Map Viewer & Map Manager (1 Seat License for Demo)					$ -	$ -	$ 1,200	$ -	$ 1,200	$ -	$ -	$ -	$ -	$ -
Carbon Tools Version 1.1 (1 Seat Development Toolkit)					$ 995	$ 995	$ 4,995	$ 995	$ 4,995	$ -	$ -	$ -	$ -	$ 995
				Total	**$ 54,800**	**$ 54,800**	**$ 58,769**	**$ 47,570**	**$ 47,775**	**$ 10,994**	**$ 7,230**	**$ 7,230**	**$ (3,764)**	**$ 47,570**

Partner Contributions					Actual Value	Actual Value	Proposed Value	Actual In-Kind	Proposed In-Kind	Proposed Cost	Actual Cost	Actual Cost	Over Budget Cost	In-Kind Value Contribution
EPA Project Support 10% Time (Estimated, Env. Info Exchange Project Team Use Case Review)					$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ -	$ -	$ -	$ -	$ 6,000
				Total	**$ 6,000**	**$ 6,000**	**$ 6,000**	**$ 6,000**	**$ 6,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 6,000**

Travel					Actual Value	Actual Value	Proposed Value	Actual In-Kind	Proposed In-Kind	Proposed Cost	Actual Cost	Actual Cost	Over Budget Cost	In-Kind Value Contribution
Travel (Exceeded Estimate Due to Excessive Hotel Costs/Availabilty)					$ 6,444	$ 6,444	$ 4,550	$ -		$ 4,550	$ 6,444	$ 6,444	$ 1,894	$ (1,894)
				Total	**$ 6,444**	**$ 6,444**	**$ 4,550**	**$ -**	**$ -**	**$ 4,550**	**$ 6,444**	**$ 6,444**	**$ 1,894**	**$ (1,894)**

	Actual Project Value	Total Value w/ Hours Billed	Proposed Project Value	Actual In-Kind Top Line	Proposed In-Kind	Proposed Cost	Fixed Price Cost w/ Burdened Labor	Burdened Cost Incurred	Over Budget Cost	Bottom Line In-Kind Value
TOTALS:	**$213,694**	**$153,544**	**$ 153,119**	**$ 97,505**	**$78,915**	**$ 74,204**	**$87,587**	**$141,133**	**$13,383**	**$ 139,466**

Original Budget Worksheet

2004 FGDC CAP Grant Program Category 5 Costs

GeoLeaders Project Team Services	Hours	Rate	Total	30% In-Kind	Cost
Architecture (Design, Coordination, Documentation)	48	$ 225	$ 10,800	$ 3,240	$ 7,560
Development (Definition WFS/GML Level 0 Profile for Data Theme(s))	96	$ 175	$ 16,800	$ 5,040	$ 11,760
Implementation (Configuration/Load/Testing w/ Data Theme(s) & Client)	184	$ 175	$ 32,200	$ 9,660	$ 22,540
Project Management (Coordination/Presentation/Documentation)	120	$ 200	$ 24,000	$ 7,200	$ 16,800
		Total	$ 83,800	$ 25,140	$ 58,660

Equipment			Total	In-Kind	Cost
Dual 3.0 Ghz Intel Processor, 4 GB RAM			$ 4,500	$ -	$ 4,500
Oracle 8i (v8.1.7) or 9i (v9.2.0)			$ 4,995	$ -	$ 4,995
Red Hat Enterprise Linux AS, Standard Edition			$ 1,499	$ -	$ 1,499
CubeSTOR v4.x, CubeSERV WFS v4.x (1 Yr. Limited License & Support)			$ 41,580	$ 41,580	$ -
CadCorp Map Viewer & Map Manager (1 Seat License for Demo)			$ 1,200	$ 1,200	$ -
Carbon Tools Version 1.1 (1 Seat Development Toolkit)			$ 4,995	$ 4,995	$ -
		Total	$ 58,769	$ 47,775	$ 10,994

Partner Contributions			Total	In-Kind	Cost
EPA Project Support 10% Time			$ 6,000	$ 6,000	$ -
		Total	$ 6,000	$ 6,000	$ -

Travel			Total	In-Kind	Cost
Travel (Five Round Trips & Expenses 17 Days @ $150)		Total	$ 4,550	$ -	$ 4,550

TOTALS			**$153,119**	**$ 78,915**	**$ 74,204**

Conclusion

The final deliverables include the following set of documents and references resulting from the Project which are posted at the FGDC Portal.

- 2004 CAP Grant Program Category 5 Final Report
- 2004 CAP Grant Program Category 5 Mid-Term Report
- 2004 CAP Grant Program Category 5 Use Case Documentation
- OGC GML for Simple Features Specification (GMLSF)
- GMLSF Profile for the National Hydrography Dataset in .xsd format
- 2004 CAP Grant Program Category 5 GAI Meeting Presentation in .ppt format
- Link to GML Validator @ http://www.pvretano.com/cwg3l0
- Link to GOS Portal @ www.geodata.gov Search on 'NHD WFS'
- Current Link to National Hydrography Dataset Web Feature Services @ http://nhd.cubewerx.com/cwwrs/cwwrs.cgi?request=GetCapabilities

GeoLeaders is grateful for the opportunity to have worked with the FGDC on the 2004 CAP Grant Program. We hope that as a direct result of the Project's success that we can proceed to work on some of the above recommendations to help the FGDC realize its' goals for the NSDI and to improve adoption of OGC standards-based web services for meeting operational requirements.