Program Information: **Montgomery County, Maryland**
Program Title: **Integration of GIS Web Services with the 311 Call Center**
Program Category: **# 14 – Information Technology**

1. Abstract

Montgomery County's Department of Technology Services, Geographic Information Systems (DTS-GIS) team has successfully met the stringent requirements set forth by the County's brand new consolidated Call Center (MC311) system design and development team. This latest successful leveraging of GIS capabilities for the County's new customer service initiative is another example of the power and utility of such technology. GIS, with its vast collection of data layers coupled with recent advances in web services technologies, has made the vision of MC311 possible and on its way to provide state of art customer service to County residents.

2. The Problem / Need for the Program

The County has a long history of providing responsive government services to its residents. A major focus of the current administration is to improve service delivery to County residents. One of the initiatives resulting from this commitment is to provide "One Number (311) to reach the County." Having a single telephone number simplifies the process by which residents are asked to contact the County for services and information. A consolidated 311 Call Center with knowledgeable call takers can indeed provide a one-stop shop for County residents and constituents.

In 2009, the County implemented Siebel's Customer Relationship Management (CRM) system. The new system will increase responsiveness to service requests while providing improved visibility into the status of those requests. For example, residents will be able to quickly request services or information regarding pothole repairs, snow removal, zoning violations, stray animals, trash pickup, etc…

The County's GIS integrates with the CRM system using a Master Centerline Address Database (MCAD). This is vital to the overall success of the CRM implementation. MC311 required a very fast intranet application that connects data from several departments with the county's ArcSDE geodatabase environment, allowing customer service representatives to enter an address and verify if the property or address exists. In addition, MC311 wanted to minimize the average time it takes to complete a service request.

3. Description of the Program

The County leveraged ESRI's *ArcGIS Server*, a comprehensive platform for delivering full-featured enterprise GIS applications that are centrally managed and support multiple users. *ArcGIS Server* is the first GIS product to directly allow for the utilization of Services Oriented Architecture (SOA). The web services developed by DTS-GIS directly integrates the enterprise geodatabases with Siebel's CRM system. The county's *ArcGIS Server* implementation leverages an impressive enterprise geodatabase. DTS-GIS integrates two Oracle databases operating within a Storage Area Network (SAN).

The GIS integration uses a total of four SOAP/XML Web services. Three web services provide geocoding by street address/intersection/or highway exit, which forces a valid street address to be used, and uses point-in-polygon spatial analysis functionality to automatically populate required fields

within Siebel from about 40 polygon layers. If the input address is not inside Montgomery County, the caller can be so advised. Once an address is successfully geocoded, a wealth of polygon memberships can be determined for this address (Figure 1). For example, which council member district (and who is his/her council member), which transportation depot that will handle the reported pothole repair, which school (service area) that his/her child will be assigned to or is attending, which zip code area (and post offices) that provide US Mail service for his/her new home or which day(s) of the week trash or recyclables are to be picked up.

	A	B	C	D	E	F	G	H	I
		Latest edit: 11-24-2009		GIS Data Layers for MC311 Call Center					
		Source Agency	Data Layer Type	Data Layer Name	Sensitive	Data Maintained By	Update Frequency	POC	Avail for soft launch 1/3/2010
1		MCFRS	Polygon	Fire Battalions	No	DTS-GIS	as needed	Ierley	Available
2		MCFRS	Polygon	Volunteer Fire Corporation Areas	No	DTS-GIS	as needed	Ierley	Available
3		MCFRS	Polygon	Fire Station Response Areas	No	DTS-GIS	as needed	Ierley	Available
4		PD	Polygon	Police Districts	No	DTS-GIS	as needed	Vandeyar	Available
5		PD	Polygon	Police Beats	No	DTS-GIS	as needed	Vandeyar	Available
6		DEP	Polygon	Watershed Map	No	DEP	annually	Vicky Wan	Available
7		DEP	Polygon	SPA Map	No	DEP	as needed	Vicky Wan	Available
8		DEP-SWS	Polygon	Service Areas	No	DEP-SWS	quarterly	Angie Braun	Available
9		DEP-SWS	Polygon	Trash Routes	No	DEP-SWS	quarterly	Angie Braun	Available
10		DEP-SWS	Polygon	Recycle Routes	No	DEP-SWS	quarterly	Angie Braun	Available
11		DEP-SWS	Polygon	Yard Trim Routes	No	DEP-SWS	quarterly	Angie Braun	Available
12		DOT	Polygon	Neighborhood Snow Plow Routes	No	DOT Hwy Services	annually	Barb Selbst	Available
13		DOT	Polygon	Depots	No	DOT Hwy Services	annually	Barb Selbst	Available
14		DOT	Polygon	Dispatch Regions	No	DOT Hwy Services	annually	Howard	Available
15		DOT	Polygon	Leaf Collection Schedule	No	DOT Hwy Services	annually	Howard	Available
16		DOT	Polygon	Parking Enforcement Areas	No	DOT Prkng Services	as needed	Salan/Souders	Not Available
17		MNCPPC	Polygon	MNCPPC Planner Map	No	MNCPPC	annually	DeBose	Available
18		ZAH	Polygon	Parcel Zoning Map	No	MNCPPC	annually	DeBose	Available
19		Census Bureau	Polygon	Census Tract Boundaries	No	DTS-GIS	10 years	Lian Chen	Available
20		CCL	Polygon	Council Member's Name	No	DTS-GIS	as needed	Lian Chen	Available
21		BOE	Polygon	Councilmanic Districts	No	DTS-GIS	10 years	Lian Chen	Available
22		BOE	Polygon	Election Districts	No	DTS-GIS	10 years	Lian Chen	Available
23		BOE	Polygon	State Legislative Districts	No	DTS-GIS	10 years	Lian Chen	Available
24		BOE	Polygon	School Board Districts	No	DTS-GIS	10 years	Lian Chen	Available
25		CEX	Polygon	Regional Service Centers	No	DTS-GIS	as needed	Sadler	Available
26		ADC	Polygon	ADC Map Grid	No	DTS-GIS	as needed	Taormino	Available
27		DTS	Polygon	Municipalities	No	DTS-GIS	as needed	Lian Chen	Available

Figure 1 – 27 of the 40 polygon ("district") layers that are available for the MC311 Call Center application. Layers 7, 8, and 14 needed are obtained from the operating Departments. The rest are part of the enterprise GIS database.

The fourth web service provides places of interest (PLOI) search, such as libraries, schools, hospitals, and bus stops, by address, category and radius (Figure 2).

	A	B	C	D	E	F	G	H	I
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		Source Agency	Data Layer Type	Data Layer Name	Sensitive	Data Maintained By	Update Frequency	POC	Avail for soft launch 1/3/2010
1		MCFRS	Point	FIRE STATIONS	No	DTS-GIS	quarterly	Ierley	Available
2		PD	Point	POLICE FACILITIES	No	DTS-GIS	quarterly	Vandeyar	Available
3		HHS	Point	HHS FACILITIES	No	DTS-GIS	as needed	Taormino	Available
4		HHS	Point	SENIOR CENTERS	No	DTS-GIS	as needed	Taormino	Available
5		DTS	Point	HOSPITALS	No	DTS-GIS	as needed	Taormino	Available
6		MCPL	Point	LIBRARIES	No	DTS-GIS	as needed	Taormino	Available
7		DLC	Point	LIQUOR STORE	No	DTS-GIS	as needed	Sadler	Available
8		Finance	Point	MC GOVERNMENT Facilities	No	DTS-GIS	as needed	Taormino	Available
9		DEP	Point	DEP Assets (stormwater facilities)	No	DEP	annually	Vicky Wan	Available
10		DOT	Point	PARK AND RIDE LOTS	No	DTS-GIS	as needed	Salan/Souders	Available
11		DOT	Point	PARKING GARAGES AND LOTS	No	DTS-GIS	as needed	Salan/Souders	Available
12		DOT	Point	Street Lights	No	DOT Traffic	monthly	Shoemaker	Available
13		DOT	Point	Bus Stops	No	DOT Transit	as needed	Matt Yeh	Available
14		BOE	Point	POLLING PLACES	No	DTS-GIS	annually	Bernard	Available
15		DOR	Point	RECREATION CENTERS	No	DTS-GIS	as needed	Taormino	Available
16		DOR	Point	SWIMMING POOLS	No	DTS-GIS	as needed	Taormino	Available
17		DOR	Point	GOLF COURSES	No	DTS-GIS	as needed	Taormino	Available
18		CEX	Point	REGIONAL SERVICES CENTERS	No	DTS-GIS	as needed	Taormino	Available
19		MCPS	Point	ELEMENTARY SCHOOLS	No	MCPL	annually	Salamon	Available
20		MCPS	Point	MIDDLE SCHOOLS	No	MCPL	annually	Salamon	Available
21		MCPS	Point	HIGH SCHOOLS	No	MCPL	annually	Salamon	Available
22		MNCPPC	Point	PARK FACILITIES	No	MNCPPC	as needed	DeBose	Available
23		WSSC	Point	Hydrants	No	DTS-GIS	quarterly	Pedro Flores	Available
24		MWATA	Point	METRO STATIONS	No	DTS-GIS	as needed	Ed Wills	Available
25		MWATA	Point	MARC TRAIN STATION	No	DTS-GIS	as needed	Ed Wills	Available
1		DTS	Line	Street Centerlines (for 'roadway ownership' queries)	No	DTS-GIS	annually	Barb Selbst	Available

Figure 2 – 25 point ("places of interest") layers are available to MC311 application so that call takers can answer questions such as what are the libraries close to my home or the elementary school that my child is going to attend. One line ("Street Centerlines") layer supports the street address based geocoding.

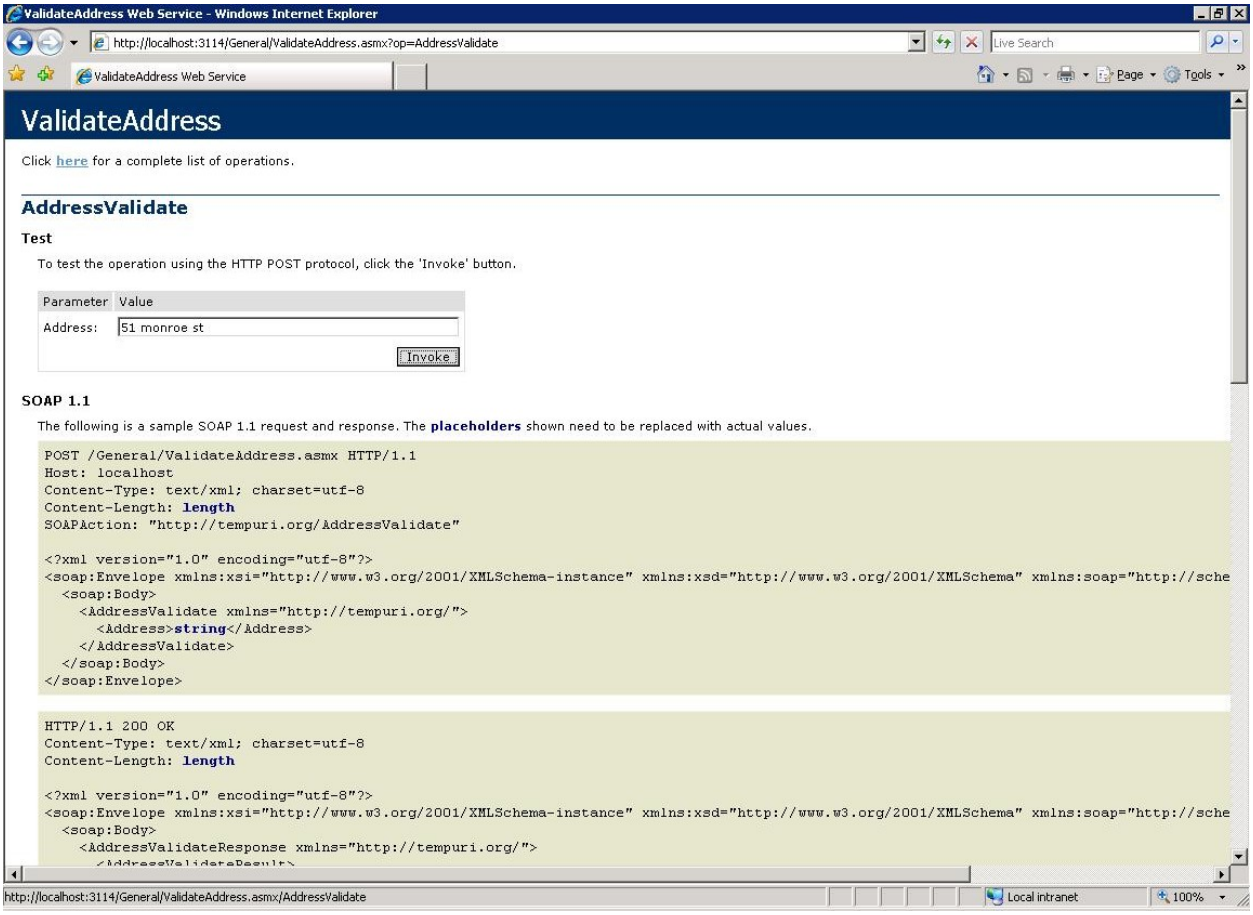

Figure 3 – The "Validate Address" SOAP service. The data being transmitted from Siebel (via a call taker's key-in) is the street address provided by the caller.

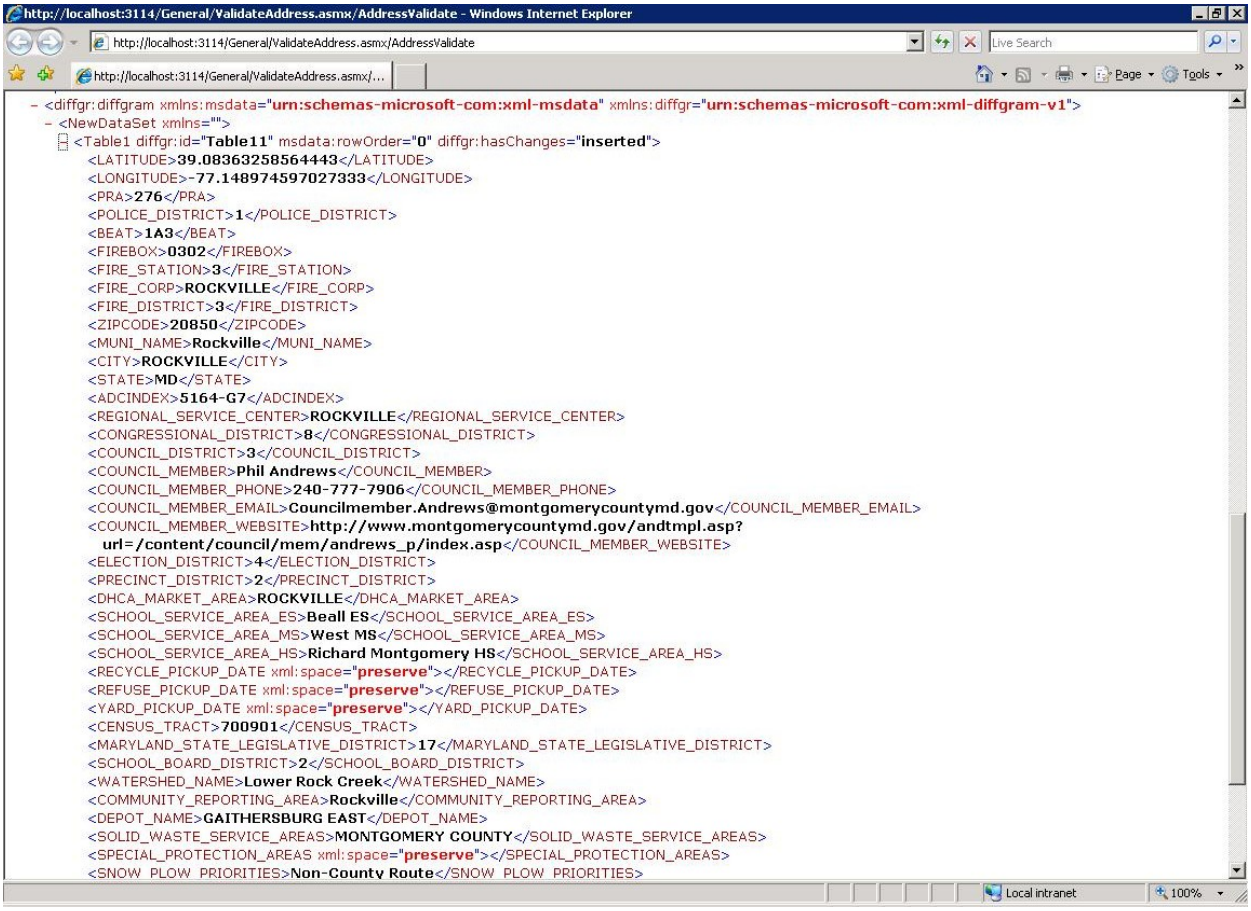

Figure 4 – Once an input address is validated, a wealth of polygon membership information (those shown in black and bold) is being returned to the Siebel query via the GIS Web service.

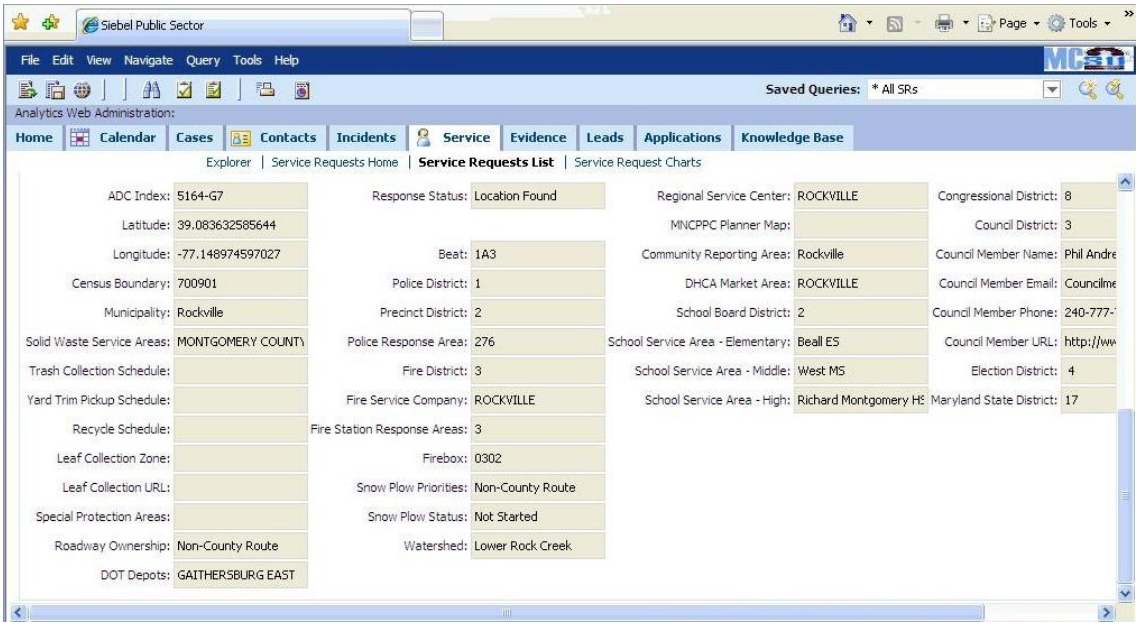

Figure 5 – Siebel receives the polygon membership information from the GIS Web service and presents the information to the Call Taker. The polygon membership information enables the call taker to answer questions, to route calls, or to consult the knowledge database for more specialized topics. MC311 analysts can use these polygon codes to separate and tally calls/cases, prepare statistics, etc. The Latitude and Longitude coordinate

values of the validated address are also shown (2nd and 3rd entries, left most column). When displayed in map form, these X, Y pairs will reveal patterns of calls, such as multiple reports for the same pothole, increased housing complaints in a neighborhood, or high numbers of unresolved cases in a district. The power and breadth of the GIS capability is evident here.

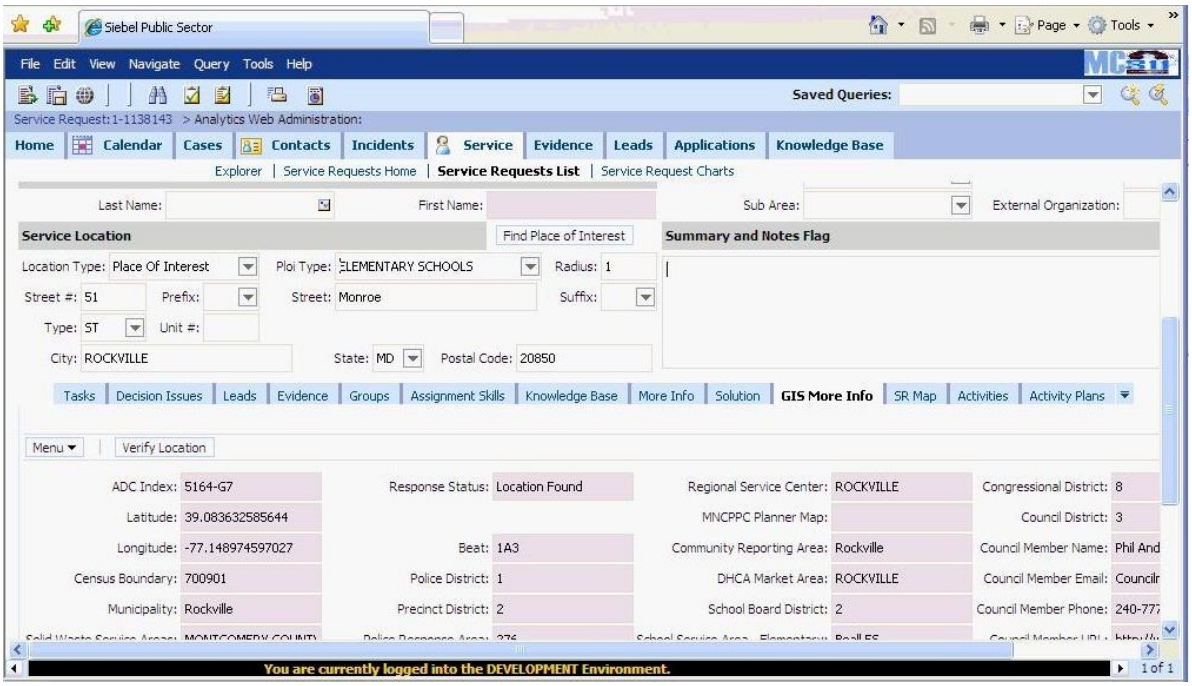

Figure 6 - Once the address is validated, the call taker can answer further question from the caller such as the elementary school(s) near a home. The call taker uses the "Find Place of Interest" dialog box (top, middle of the screen print) to select the category of places of interest (such as Elementary Schools), and specify a search radius (in mile).

System Tuning

Extensive tuning on the *ArcGIS Server* and database server tiers provided sub 2-second response time with 200 concurrent users. The application can be scaled to support additional capacity.

1. Database tuning:

A series of tests revealed the following web service performance statistics. To determine polygon membership of a validated address via the point in polygon determination logic takes about 15 seconds if the logic is to drill through 40 individual polygon layers. With this approach, the GIS Web service simply accesses the needed polygon layers being centrally maintained in the enterprise GIS database. A (very impressive) 0.5 seconds response time is taken for the SOAP service if it is to drill through 35 static polygon (school/council/election etc) layers combined into a single dataset and 5 non-static layers (snow/recycle etc) separately. The non-static polygon layers are updated by the business departments (DOT, DEP, etc.) frequently. With this hybrid approach, the GIS analyst needs to spatially combine (a GIS Geo-processing capability) the 35 static polygon layers into one. Each tiny new polygon in the combined set carries the IDs for the 35 input polygons (council district, zipcode, depot area, etc.)

2. ArcGIS Server tuning:

The ESRI default SOC instances are minimum of 1 and maximum of 2. With these default settings, the responses are less than desirable. Working closely with the technical staff of ESRI, the County has increased the minimum SOC instances to be 20 and maximum to be 25. This new setting produced very stable SOC connections to handle concurrent Siebel application requests.

With these *ArcGIS Server* tuning experiments, the County has achieved the following improvement on responses. The statistics below clearly show that these GIS web services can handle multiple concurrent user requests.

The impact of tuning to the average response time to a single request (in seconds):

# of concurrent users	before tuning	after tuning
20	2.03	0.78
40	3.72	0.86
60	4.65	0.97
100	5.78	1.52
200	7.86	1.89
600	11.01	4.39

For the best combination between database and *ArcGIS Server*, the GIS web services can handle 100 concurrent user requests with about 1.5 second response. This level of performance has exceeded the CRM's program requirements with flying colors.

Beyond serving MC311, these GIS web services can be integrated into other County Department's applications that require similar GIS intelligence. They no longer need to consult extensively with paper maps to get questions answered and tasks planned.

Adding Maps to the MC311 System

An additional application was developed using *ArcGIS Server* and will provide an interactive map within the Siebel CRM interface to plot service calls (Figure 7). This application will allow MC311 staff members to better manage their daily work flow by quickly displaying where existing calls have been recorded as new ones are being entered. This will greatly assist the staff in grouping calls so repeat tickets are not generated for the same problem. This implementation will also give the County a vastly improved method to target its existing resources and cut down on redundancy.

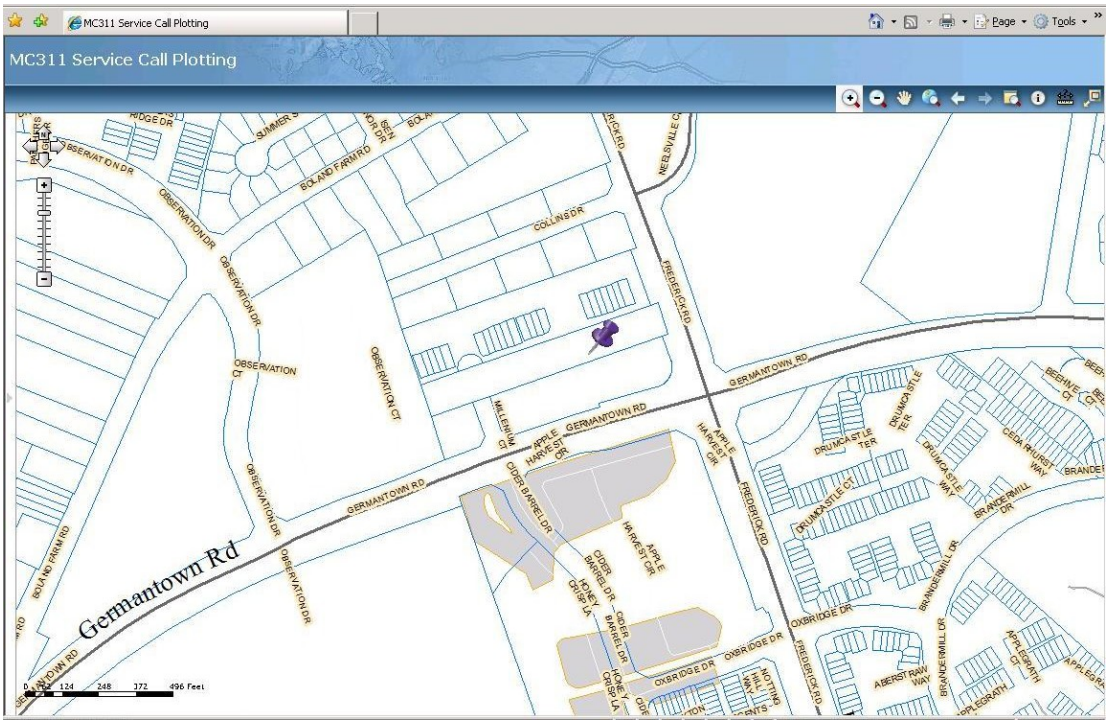

Figure 7 – Mapping the calls. The pin is placed at the X, Y coordinates returned by the "Locate Address" Web service.

This mapping application can be used to track service calls by departments, service types and time histories. It will be useful to help the County to better deploy its resources.

4. Use of Technology

ESRI's *ArcGIS Server 9.3* Web application development platform and ArcGIS Desktop software were used in developing the four GIS Web services to be consumed by the Siebel CRM calls. GIS enterprise database was built (and is being maintained) on Oracle and augmented by the ESRI SDE middleware.

Reusability of the Web services - The use of SOAP/XML Web services means that this functionality can be used in other applications as well, with no modification. For example, the County's Department of Housing and Community Affairs (DHCA) has an application that tells case workers which ADC map page and grid a particular address falls in. This information will help an inspector in planning his/her daily inspection trip(s). The same geocoding SOAP/XML Web service can be used in this scenario.

5. The Cost of the Program

A dedicated server machine ($15,000) was allocated by the DTS Server Team for providing the GIS Web services. A dedicated *ArcGIS Server* license ($16,322) was purchased from ESRI. ArcGIS Desktop was part of the GIS software repertoire used by the DTS-GIS team. The GIS systems administrator has spent about 50 hours in setting up the virtual machine (VM) and the physical servers. (The VM server will act as backup.) The GIS analyst has spent about 200 hours on the project. The total labor cost is estimated at $12,500.

6. The Results / Success of the Program

The *ArcGIS Server* based GIS Web services being successfully implemented with Siebel's CRM has allowed the County to better manage and accurately facilitate calls and determine how they were resolved. The County has also seen an overall increase in management efficiency. For example, the Department of General Services, Department of Transportations, Department of Environmental Protection, and the Police Department's Animal Care and Control unit, etc... can now better target their resources, improve communications in fielding calls, and provide better responses to problems.

7. Worthiness of an Award

DTS-GIS is proud to be able to support the MC311 Call Center application with its vast collection of polygon, line, and point GIS data layers. No additional GIS data development cost was incurred during this program. The database tuning and SOC instance tuning experience described in this document should serve as an invaluable guide for jurisdictions contemplating adopting similar GIS Web services initiatives.