



# Washington State Department of Transportation

## Monument Mapping Engine, 6.0.1

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The Monument Mapping Engine was released in 1999 and supports WSDOT's ongoing geodetic survey activities. It was upgraded in 2001, 2003, 2008, and 2010. In 2015 the application was rewritten to support ArcGIS 10.2/10.3, to use multiple map services, and to support the newly released ArcGIS JavaScript API. In 2016, 2017, and 2021 the servers supporting the application were upgraded to ArcGIS Server 10.3.1, 10.5.1, 10.7 and 10.9.1, respectively. Version 5.8.1 ran under ArcGIS Server 10.8.1. After each software upgrade the map documents used by the application for the map services were upgraded. The current version number of the application is 6.0.1 and was redeveloped using ESRI JavaScript API 4.28 and its interface modernized to match the 'button centric' ESRI web application look and feel. This version currently runs under ArcGIS Server 10.9.1 and is designed to run under ArcGIS Server 11.0 and 11.1.

The Mapping Engine uses scale dependent rendering with five different map services to display a variety of geographic features as one zooms into a specific survey station on the map. The map services provided are WSDOT Survey monuments, National Geodetic Survey (NGS) stations, Washington State Route mileposts, Washington County Boundaries, and the common WSDOT base map. When first started the application provides a statewide view with the location of WSDOT's geodetic survey monuments and National Geodetic Survey's HARN and CORS stations shown on top of WSDOT's general base map. Washington county boundaries and State Route mileposts are available as well. The user may select a WSDOT or NGS monument by clicking on the map to see details about the selected station. If a monument is found near the position clicked a pop-up window opens that shows information about the station and the user can then request the complete data sheet for the station from the pop-up window.

This application was originally developed in 1999 and has run, with updates, for 25 years. This application was taken off-line after 9-11, during that time 1.5 FTEs were required to answer email and phone calls for survey information. In the twelve-month period March 2019 to February 2020 the application received 3,842 unique sessions and in January 2020 had 296 unique users. Based on the cost of installing a monument, the time required to fulfill an in-person information request during 9-11, the number of visits to this site, and discussions with members of the professional Land Surveyors' Association of Washington; WSDOT estimates that the State has achieved over \$1.9 million in cost avoidance since the application was initially fielded in 1999.

( <https://www.wsdot.wa.gov/monument> )

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*This document is preliminary, has not undergone formal review or editing and is provided for informational purposes only.*

## **Washington State Department of Transportation (WSDOT) Monument Mapping Engine, version 6.0.1**

### **Background**

The Monument Mapping Engine was first fielded in 1999 as an out of the box ArcView IMS™ application to support WSDOT's survey activities. At the request of the Geodetic Survey Section, Geographic Services Office (now known as the GeoMetrix Office), the Information Technology Division redeveloped the application using ESRI's ArcIMS technology; to include support for Digital Raster Graphics (i.e., USGS 7.5' Topographic maps) and query functions. Development began March 20, 2001 and was completed on April 12, 2002. The application was ported with minimal changes in September 2008 to ArcIMS 9.2 and a new server, updated in 2010, and rewritten in 2014.

At the release of ArcGIS 10 by ESRI™ in 2010 the original image map service technology used by the Monument Mapping Engine application was removed from ArcIMS. This necessitated the fourth major upgrade of the application. In March 2011 the new Monument Mapping Engine, known as version 4.0, was released. This was the first version of this application to run as a native ArcGIS Server application.

In 2014 ArcGIS 10.2 and 10.3 was released. This release changed the way that maps services are published on the server (i.e., as a tiled service vs. an image service) and introduced a new ArcGIS JavaScript application programming interface (API). The recommended way that the application handled map services changed as well. In the past a single map service usually contained all the map layers needed for the application. At 10.2 it was recommended that each layer be its own map service, this allows the map services to be reusable and distributed across several servers.

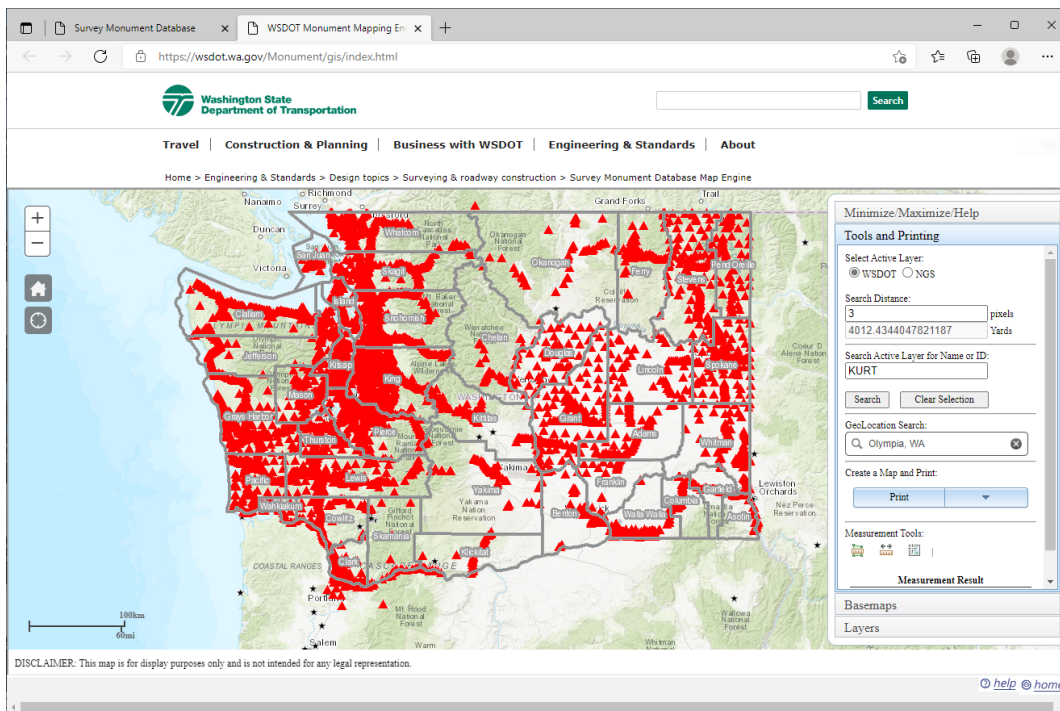
At version 5.0 of the Monument Mapping Engine multiple ArcGIS Map Services were used, these are located on several ArcGIS Servers and in ArcGIS Online The application utilized five feature services at a time and two supporting utility services (e.g., print and query). The application was based ESRI JavaScript API version 3.x and had major version changes in 2016, 2017, 9/2021, 2/2022 when the supporting JavaScript API, ArcGIS and Web servers were upgraded.

At version 6.0 the application was rewritten from scratch using ESRI's JavaScript API version 4.28. This was required because the version 3 API will reach end of life on July 1, 2024. All on-premises map services used by application were recreated as ArcGIS Pro map services (vs. ArcMap) and are running under ArcGIS Server 10.9.1. This version is fully supported under ArcGIS Server 11.0 and 11.1. The map service upgrade was required because ArcMap based map services will not be supported under ArcGIS Server 11.

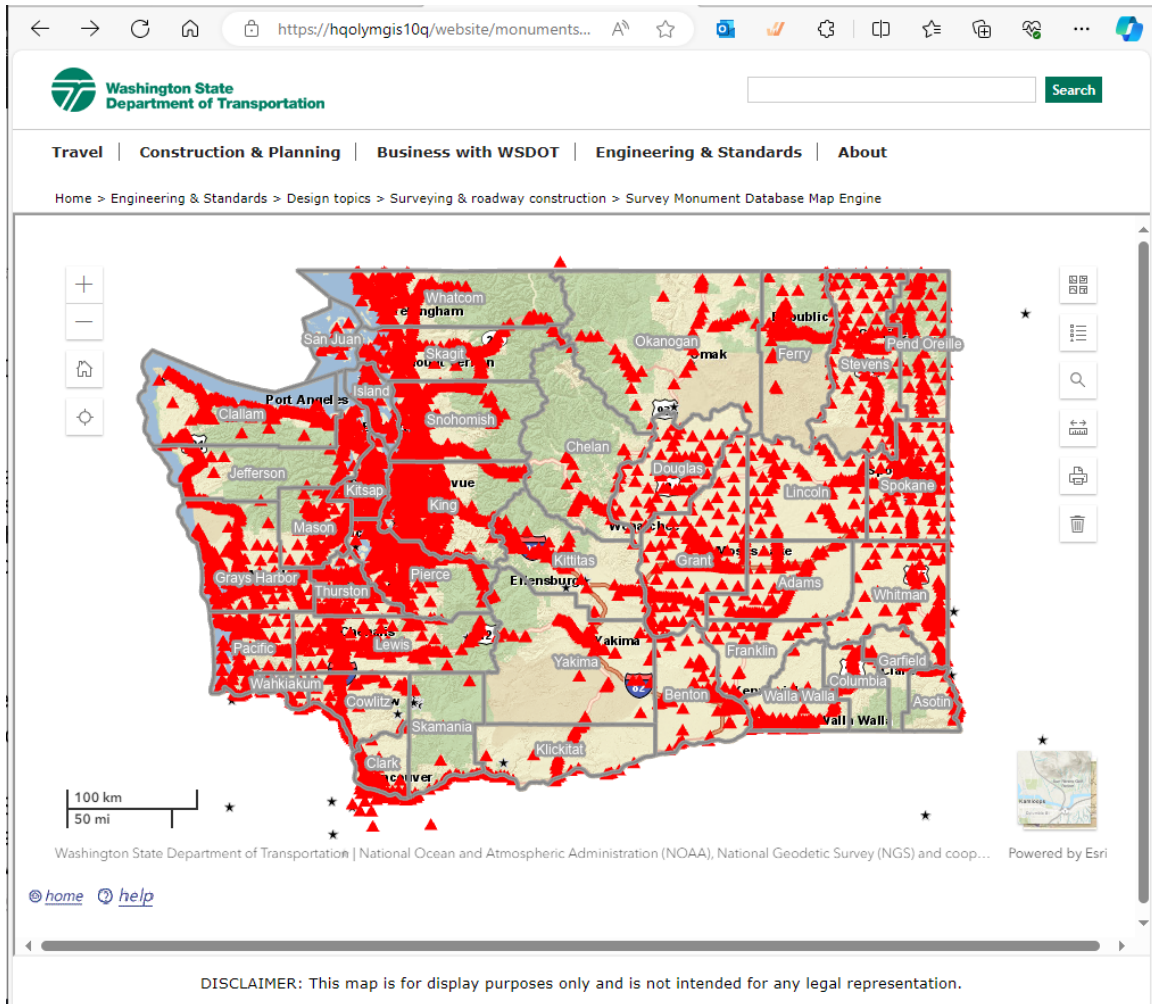
## Getting Around the Application

When started the application initially provides a statewide view that displays WSDOT's geodetic survey monuments, National Geodetic Survey's HARN and CORS stations, County boundaries on top of a WSDOT's standard base map (Figure 1a and 1b). Within the application red triangles indicate the location of survey monuments or stations maintained by the Washington State Department of Transportation. Blank and Gold symbols (e.g., circles, triangles, gold stars) show the location of National Geodetic Survey survey stations.

**Figure 1a. Initial seen when visiting the Monument Mapping Engine for version 5.7.2.**



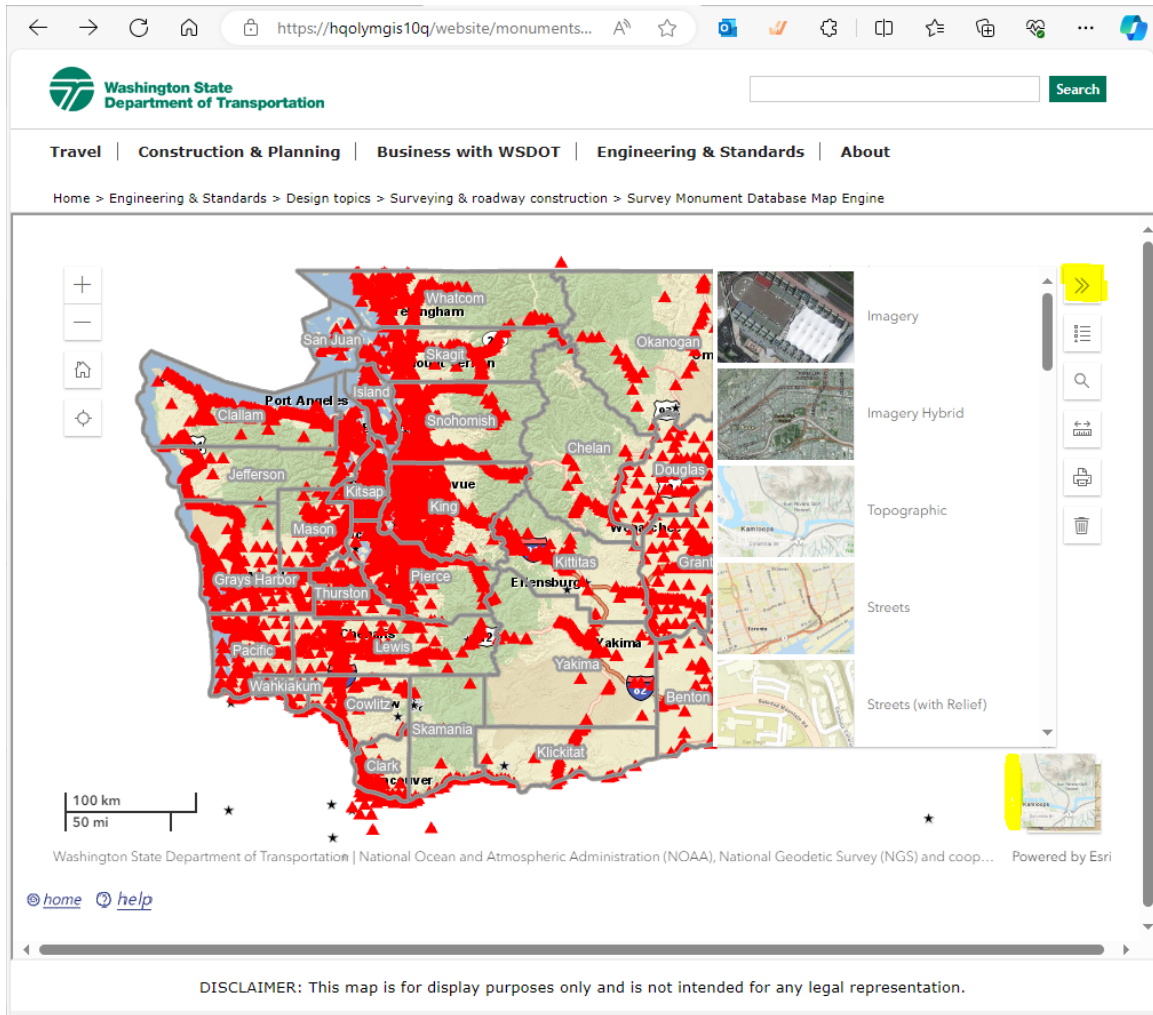
**Figure 1b. Initial screen seen when visiting the Monument Mapping Engine starting at version 6.0.1.**



In the past as one zoomed into the map past a scale of 1:250,000 the shaded relief map was replaced with a color 1:250,000 scale USGS topographic map. If you continued to zoom in past 1:50,000, the 1:24,000 scale USGS maps (a.k.a., 7.5-minute topographic quadrangles) turned on. At 1:12,000 and larger scales the topographic map was replaced with air photography from the Washington State Orthophoto Partnership.

At the version 6 release (and the prior version 5 releases) scale dependency is still used but the underlying base map does not change. As one zooms in past 1:250,000 scale the WSDOT State Highway Mile Post layer is turned On, while at scales larger than 1:100,000 the County layer is turned Off. There are two options to change to the basemap displayed. On the bottom right of the application is a 'Toggle basemap' tool that switches between the ESRI™ topographic map and WSDOT's custom basemap. There is also a "Select Basemap" tool. This tool provides access to a basemap gallery which has over 26 possible background maps, to include Imagery (Figure 2).

**Figure 2. The base map used as the backdrop for the application can be changed by the user with the ‘Select Basemap’ or ‘Toggle basemap’ Tools.**



Using the tools available (see Table 1) within the application the user can zoom into their area of interest and then interactively select a monument, print a map (Figure 4), measure distance between any points on the map and retrieve a site description/data sheet for a selected WSDOT geodetic monument or NGS survey station (Figure 5).

**Table 1. Tools available within the Monument Mapping Engine.**

**Help - WSDOT Monument Mapping Engine v6.0.1**

Mouse Operations:

- Identify - Double click on a survey station on the map to open a pop-up window containing a list of WSDOT or NGS survey monuments located "near" where you clicked. To open up a Data Sheet for a monument click on the **Data Sheet** link in the pop-up window. Identify works on the WSDT, NGS, and State Route Mile Post layers in the map.
- Panning - Clicking on the map and hold down the mouse key, then drag the map in the desired direction.

Left Side Toolbar Options:

- Zoom In - Clicking on [+] sign to zoom-in or use the scroll wheel on the mouse to zoom in or out.
- Zoom Out - Clicking on [-] sign to zoom-out or use the scroll wheel on the mouse to zoom in or out.
- Home Button - Click to go to the default map view for the map (i.e., Zoom to the State of Washington).
- Locate Button - Click to zoom to your current location. Location is determined by the GPS or cell phone towers if using a remote device or based on your computers IP address if connected to a network. This button is only displayed if your device is able to provide a location.

Right Side Toolbar Options:

- Basemap Gallery - Swap display of the Basemap to one of 27 options to include imagery and satellite maps.
- Legend - Display Legends for the layers currently displayed on the map.
- GeoLocation Search - Search for City, County Names or addresses using Esri's default GeoLocator OR search for WSDOT or NGS Station names.
- Measure - Provides capability for measuring distances on the map.
- Create Map and Print - Print your current view to a document. The map is created as a PDF document, PNG or JPG file and is opened in another tab. This can take up to 30 seconds to complete.
- Clear Selection - closes any open PopUps, clears current selections, and removes temporary graphics from the screen.
- Basemap Toggle - Swap display between the WSDOT Standard Basemap and ESRI's Topographic Basemap.

\*To view the WSDOT monument datasheets you must have an Adobe or PDF Reader installed on your device. If you don't have one installed, contact your local IT Help desk and ask to have one installed or visit the App Store on your device and download one.

For a full description of the Monument Mapping Engine read our [User Handout](#) (Adobe PDF File).

To get information on a station click on the map. A pop-up will be displayed showing information for all NGS and WSDOT stations 'close' to where you clicked. In the pop-up the number of stations found is shown in the top right (Figure 3). You can 'flip' the station cards by clicking on the less than/greater than icons. At the bottom of each card is a Data Sheet row, clicking on the 'View' hyperlink opens the data sheet for the selected station (Figure 4).

**Figure 3. Pop-up window showing data cards for five selected survey stations. Use the greater than/less than icons on the top of the pop-up to flip through the cards.**

WSDOT Station: 202-1

1 of 5

Monument ID	9312
Latitude (DD)	47.607155866
Longitude (DD)	-121.959983313
Horizontal Method	1
Vertical Method	4

Data Sheet View

**Figure 4. Example of a monument data sheet obtained using the application for survey monument G 259 RESET.**

**Washington State Department of Transportation**  
**Geographic Services**  
**SURVEY INFORMATION SYSTEM** Report of Survey Mark

<b>Designation:</b> G 259 RESET	<b>T.R.S.:</b> 17N, 2W, 11	<b>ACCOUNTS INFORMATION</b>		
<b>Monument ID:</b> 654	<b>Corner Code:</b>	<b>BOOK</b>	<b>PROJECT</b>	<b>INVOICE</b>
<b>NGS Pid:</b> SC2867	<b>State Route:</b>	55	PL4013	23-93028
<b>State:</b> WASHINGTON	<b>Mile Post:</b>	28	OL1905	23-93043
<b>County:</b> THURSTON	<b>Station:</b>	115	PL8013	23-97050
<b>Region:</b> OL	<b>Offset:</b>	94	MS3747	23-99045
<b>Nearest Town:</b> TUMWATER	<b>Owner:</b> GS	167	PN0013	23-00044
<b>USGS Quad:</b> MAYTOWN	<b>Bearing:</b> M	207-209	MS4357	23-01032
		233	MS5400	23-05032
		NA	MT0319	23-11026

TO REACH THE STATION FROM THE INTERSECTION OF SR 005 AND AIR INDUSTRIAL WAY IN TUMWATER, GO EASTERLY 1.13 MILES ALONG AIR INDUSTRIAL WAY TO THE INTERSECTION WITH CAPITAL BLVD (OLD HWY 099) TURN RIGHT AND GO SOUTHEASTERLY 0.62 MILES ALONG CAPITAL BLVD TO THE OLYMPIA AIRPORT - PORT OF OLYMPIA ADMINISTRATION BUILDING AND MARK ON RIGHT. IT IS LOCATED IN A GRASSY AREA BETWEEN THE FRONTAGE RD AND PARKING LOT FOR THE PORT OF OLYMPIA ADMINISTRATION OFFICES, 31.2 METERS @ 220 DEGREES FROM THE APPROXIMATE CENTERLINE OF OLD HWY 99, 61.2 METERS @ 310 DEGREES FROM THE APPROXIMATE CENTERLINE OF THE ENTRANCE TO OLYMPIA REGIONAL AIRPORT #7643, 1.0 METER @ 130 DEGREES FROM A WITNESS POST AND 37.6 METERS @ 165 DEGREES FROM TELEPHONE RISER # F75W1. THE MARK IS A NGS BRASS DISK SET INTO THE TOP OF A ROUND CONCRETE MONUMENT WHICH IS SET LEVEL WITH THE GROUND SURFACE.


Survey Control					
<b>Datum:</b> NAD 83/11		<b>Date:</b> 08/22/2013			
<b>Lat:</b> 46 58 32.986245 N		<b>Long:</b> 122 53 48.528527 W		<b>Ellips:</b> 37.624 (M)	<b>Geoid:</b> -21.291 (M)
<b>Washington State Plane Zone:</b> South					
<b>Northing</b>	<b>Easting</b>	<b>Scale</b>	<b>Comb Factor</b>	<b>Conv Angle</b>	
185336.784 (M) 608059.099 (USFt)	317665.167 (M) 1042206.469 (USFt)	0.99993783	0.99993193	-1 44 27.7	
<b>Ortho:</b>	<b>Date:</b> 08/01/1992	<b>Survey Info</b>	<b>Accuracy</b>	<b>Network</b>	<b>Method</b>
<b>Datum:</b> NAVD 88		Horizontal	2 CM	PRIMARY	GPS
<b>Elevation:</b> 58.915 (M) 193.290 (USFt)		Ellips	5 CM		GPS
		Ortho	1 CM	PRIMARY	DIFF LEVELS

In addition to zooming to a station, selecting it, and pulling up the station data sheet the user often needs to print a map to help them physically locate and find the station on the ground. The 'Print Tool' provides this capability and is located on the right side of the application main window.




zoom the map to that location. If there are several possible results, the top five hits will be shown, you would then click/select the one you want and be zoomed to its location.




The Measurement tool is available in the right-side tool area (  ). This tool is used to measure distances between two (or more points) on the map. This is often used to help us find a station in the field from a highly visible object shown in the imagery basemap (e.g., how far in Yards is the station IS3418 ‘east’ from the northeast corner of the 7-11 Store located at the intersection of Israel Road SW and Capital Boulevard, answer 28 yards).




A Print tool is available in the right-side tool area (  ). This tool is used to create a printable map of the currently displayed map. This map may be saved to PDF, PNG, or JPEG.





A Clear Select tool is available in the right-side tool area (  ). This tool is to Clear any currently selected stations, search results, etc. and will close any currently open Pop-ups.



A Toggle Basemap tool is available in the right-side tool area (  ). This tool will toggle or swap the current base map being displayed. On the load the default map shown is the WSDOT common base map. Clicking the toggle will swap the map to the ESRI Topographic map (i.e., the default map used previously with version 5.x of the application).

This application supports field use on small screen devices (Figure 5). On the left side of

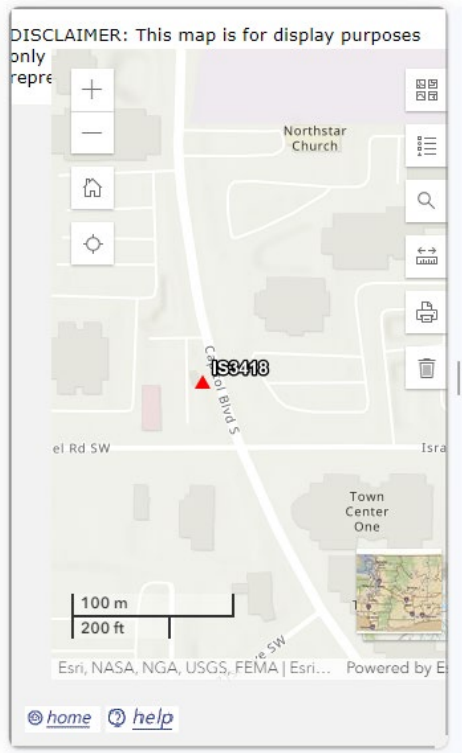


the application, you will find zoom in (  ) and out (  ) controls, return to Home

(  ) -full Washington State view, and Zoom to my GPS Location tools (  ).

When the Location tool is clicked the application zooms into your current location. Location is obtained from your devices GPS (if enabled), your wireless or cell network, or an estimated location is made based on your devices IP Address. \*This tool supports HTTPS, returned results are encrypted.

**Figure 5. Monument Mapping Engine application as seen on a small screen device**  
**Note - the WSDOT header bar is not displayed and small screen devices.**



Several benefits have been realized from making the survey information publicly available. Firstly, before the site was implemented WSDOT manually filled monument information<sup>1</sup> requests. Secondly, it has encouraged federal, state, city, and local surveyors to integrate our survey network into their projects. This assists WSDOT in maintaining the network, as local construction or maintenance activities are less likely to destroy a station.

Since the Monument Mapping Engine's release in 1999 it has received 1000 to 1500 unique pageviews per month. Based on the cost of installing a monument<sup>2</sup>, the number of site visits, and discussions with members of the professional Land Surveyors' Association of Washington, WSDOT estimates that the State has achieved over \$1.9 million in cost avoidance since 1999.

### **Current Environment**

The current ArcGIS production server has been migrated to the Azure Cloud using Lift and Shift methods. This new Azure virtual machine with two 2 Cores using Intel(R) Xeon(R) CPU E5-2667 v2 @3.30GHz and 8 GB RAM with 120 GB SSD. The

<sup>1</sup> After the September 11<sup>th</sup> terrorist attack, the Monument Mapping Engine was taken off-line for security review. While it was off-line, WSDOT personnel spent ½ to 1 FTE per day responding to phone requests for information.

<sup>2</sup> It costs between \$5000 and \$7000 to install and survey a monument into the geodetic network –depending on the accuracy requirements for the new station.

application now uses three ArcGIS map services for the main map and two external services found in ArcGIS Online. The maps generated by the services are delivered to the client as PDF, PNG, or JPEG color images. The applications HTML and JavaScript pages were developed from code samples obtained from ESRI™ and then extensively customized by WSDOT.

## **History Summary**

The modification made in the current January 2024, v6.0.1, release of the application is:

- Upgrade ArcGIS JavaScript API support from 3.39 to 4.23,
- Use all new widget tools and remove all DOJO web API calls,
- Upgrade to ArcGIS Server 10.9.1, and
- Update all services from ArcMap to ArcGIS map services

The modification made in the February 2022, v5.8.1, release of the application was:

- Upgrade ArcGIS JavaScript API support from 3.27 to 3.39 and
- Upgrade to ArcGIS Server 10.8.1.

The primary modification made in the November 2021, v5.7.2, release of the application was:

- Update interface to match the new look and feel of the WSDOT Intranet web pages.

The primary modifications made in the September 2021, v5.7.1, release of the application were:

- Upgrade ArcGIS JavaScript API support from 3.26 to 3.37 and
- Upgrade to ArcGIS Server 10.7.1.

The primary modifications made in the March 2021, v5.6.2, release of the application were:

- Upgrade ArcGIS JavaScript API support from 3.21 to 3.36.
- Move application to new server and update to support ArcGIS Server 10.6.1.
- Make County Boundaries on by default on initial load of the application.
- Add HTTPS support.

The primary modifications made in the June 2017, v5.0.3, release of the application were:

- Upgrade to ArcGIS Server Standard 10.4.1 and
- update map documents to support new ArcGIS ArcMap version.

The primary modifications made in the January 2016, v5.0.1, release of the application were:

- Upgrade to ArcGIS Server Standard 10.3.1 and
- Add Location button to interface (zoom to my GPS location).