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StreamStats

A National Web Site for Streamflow Statistics and Basin Characteristics

By Kernell Ries, Peter Steeves, and Alan Rea

Need for Streamflow Statistics

- Water resources planning, management, and permitting
- Instream flow determinations for pollution and habitat
- Design and permitting of facilities such as wastewater-treatment plants, hydropower plants, and water-supply reservoirs
- Design of structures such as roads, bridges, culverts, dams, locks, and levees

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Problems in Providing Statistics

- Published streamflow statistics for data-collection stations are scattered among hundreds of reports nationally
- Many publications are out of date and/or out of print
- Labor cost for information requests is high
- Streamflow statistics are not available everywhere they are needed

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Regression Equations

- Used to estimate streamflow statistics for ungaged sites
- Relate streamflow statistics to measured basin characteristics
- Developed by all 48 USGS districts on a State-by-State basis through the cooperative program
- Often not used because efforts needed to determine basin characteristics is very high
- Users often measure basin characteristics inaccurately

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Example Basin Characteristics

- Regression equations take the form:

$$Q_{100} = 0.471 A^{0.715} E^{0.827} SH^{0.472}$$

- Drainage area is used in nearly all equations
- Other common variables include:
  - Basin slope, relief, or mean elevation
  - Precipitation (mean annual; 2-year, 24-hour)
  - Stream length or slope
  - Land use (forest area, wetland and water areas)
  - Basin shape or orientation
  - Soils or surficial geology

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Manually Determining Basin Characteristics

- A 10-square mile basin takes about 24 hours once you have the proper materials
- The required time increases exponentially with increasing watershed area because of the increasing dendritic patterns and logistical problems when matching between map sheets
- The manual process is not completely repeatable
- The error introduced by determining basin characteristics probably is as large as the uncertainty in the regression models

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The Massachusetts Streamstats Web Application -

- Provides published streamflow statistics, basin characteristics, and other information for data-collection stations
- Provides estimates of streamflow statistics, basin characteristics, and other information for user-selected points on ungaged streams

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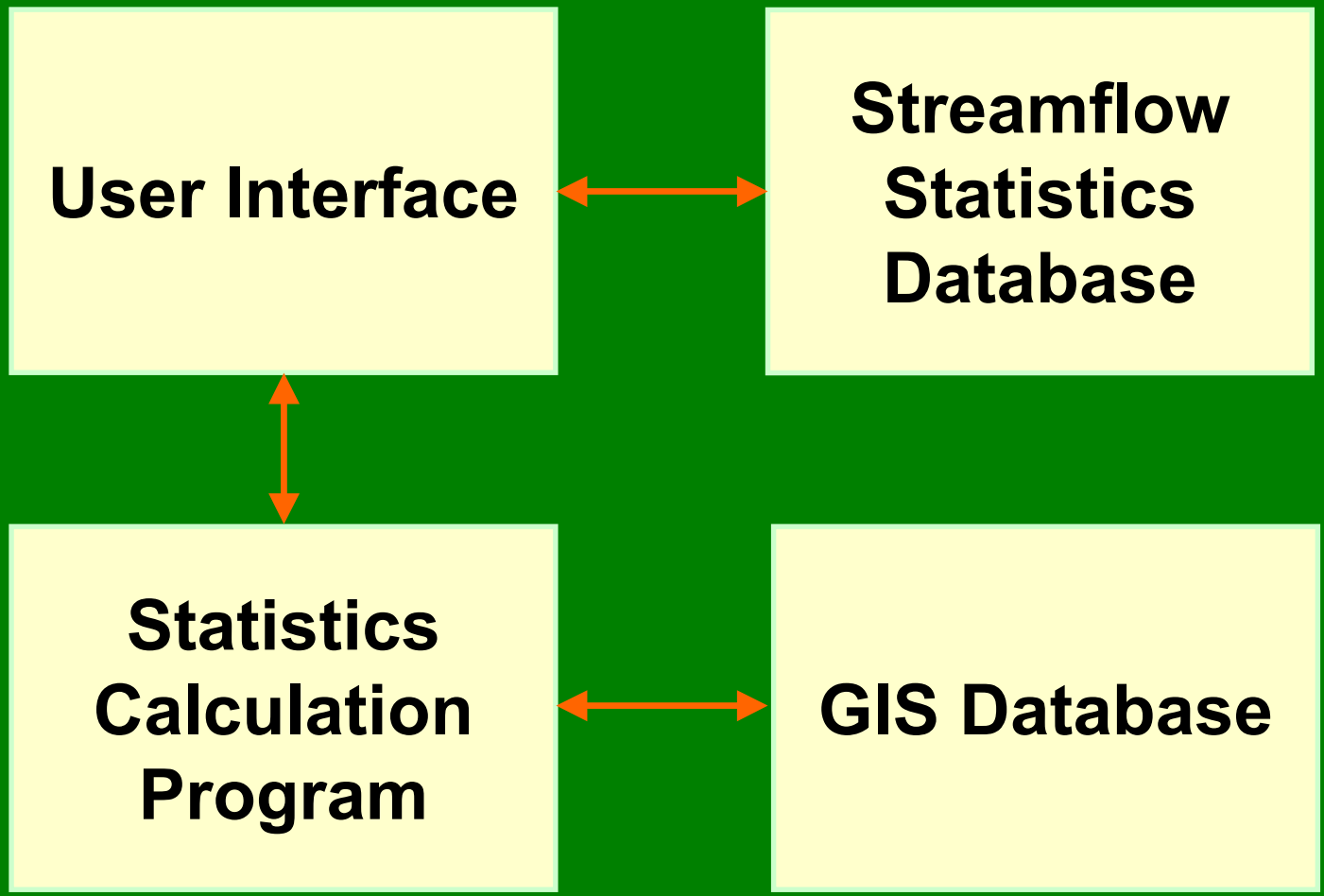
Web Application Components



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User Interface

- Interacts with users to enable site selection
- Displays maps
- Allows adding/subtracting map layers
- Allows zooming and panning to places of interest
- Displays results in a separate output window

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Statistics Database Includes

- Previously published streamflow statistics for data-collection stations
- Descriptive information, such as station name and number, coordinates, period of record
- Basin characteristics, such as drainage area, total stream length, mean basin slope

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GIS Database Includes

- All data layers needed to solve the regression equations
- Other data layers needed to locate sites of interest, such as state and town boundaries, streams, and roads
- Digital topographic maps (DRG's) for detailed selection

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Statistics Calculation Program

- Determines drainage boundaries and measures basin characteristics for user-selected sites
- Solves regression equations to obtain estimated streamflow statistics and provides prediction intervals as estimates of errors
- Delivers basin characteristics, streamflow statistics, prediction intervals, and maps of user-defined basins back to user interface

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Data Layers for Defining Drainage Boundaries

- Hydrography – networked, centerlined, reach coded; derived from 1:24,000 topographic maps
- Elevation grids (DEM) – unaltered and drainage enforced - 1:24,000
- Sub-basin boundaries - from delineations on 1:24,000 topographic maps

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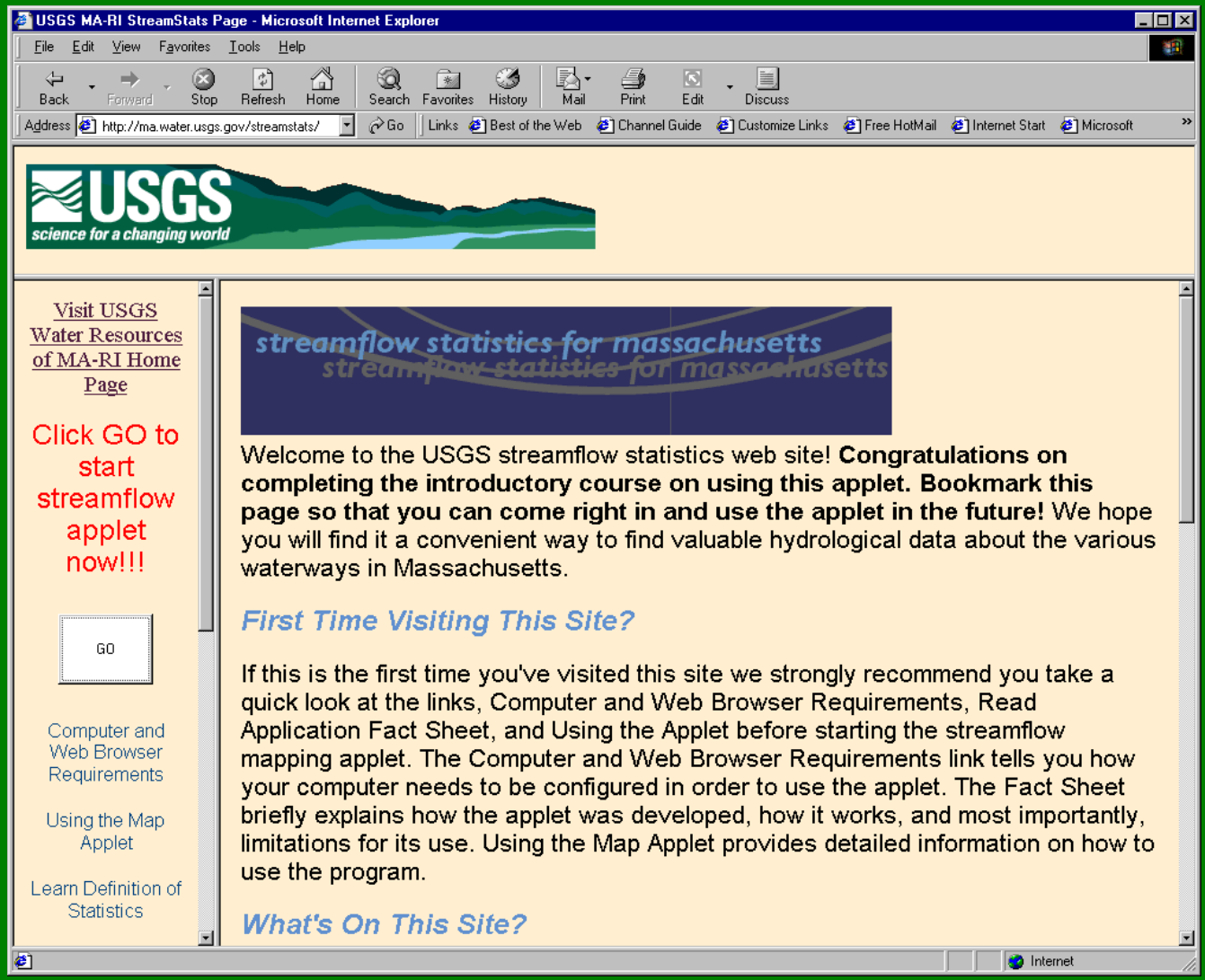
Web Application Home Page

http://ma.water.usgs.gov/streamstats



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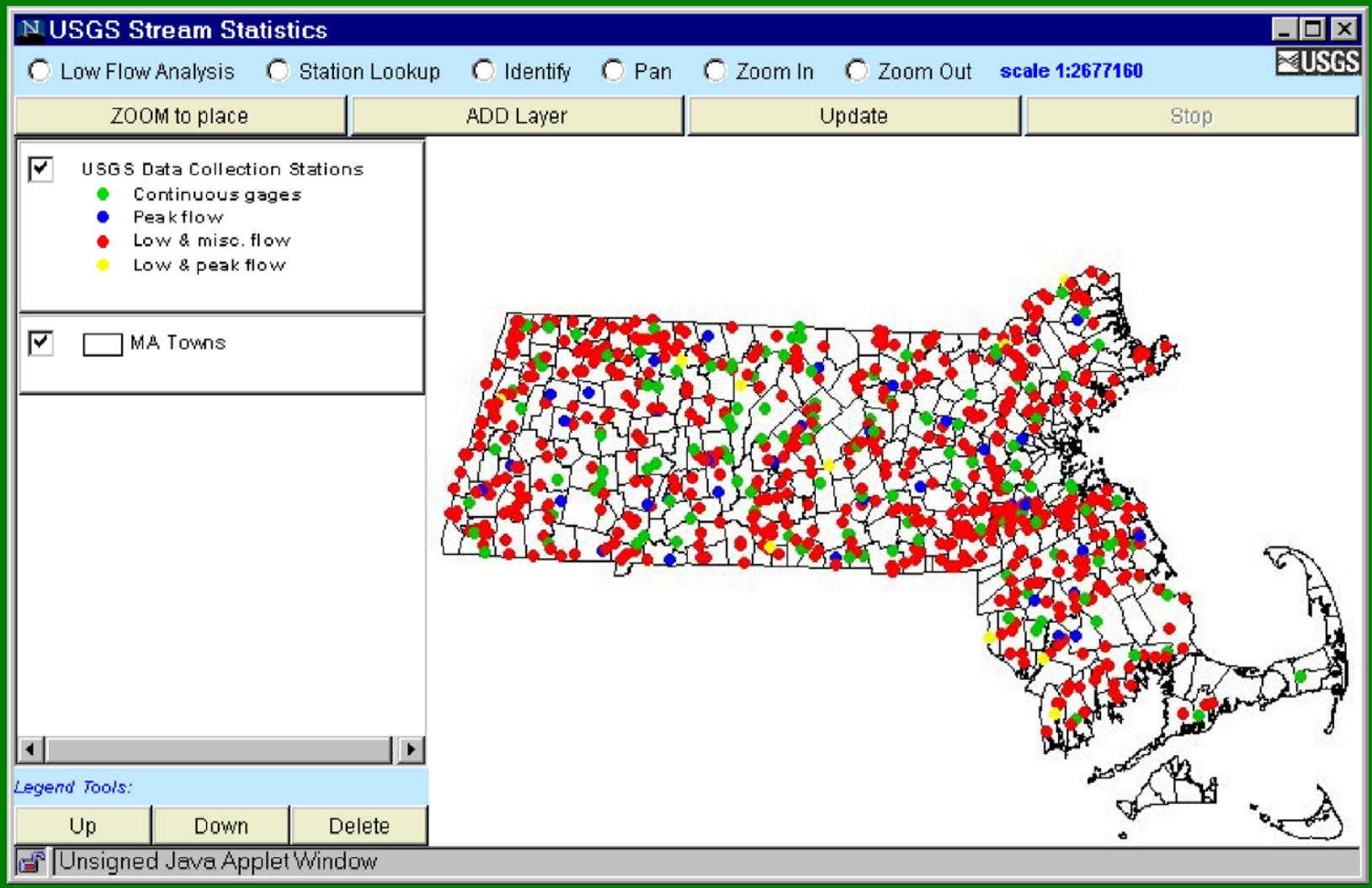
User Interface at Startup



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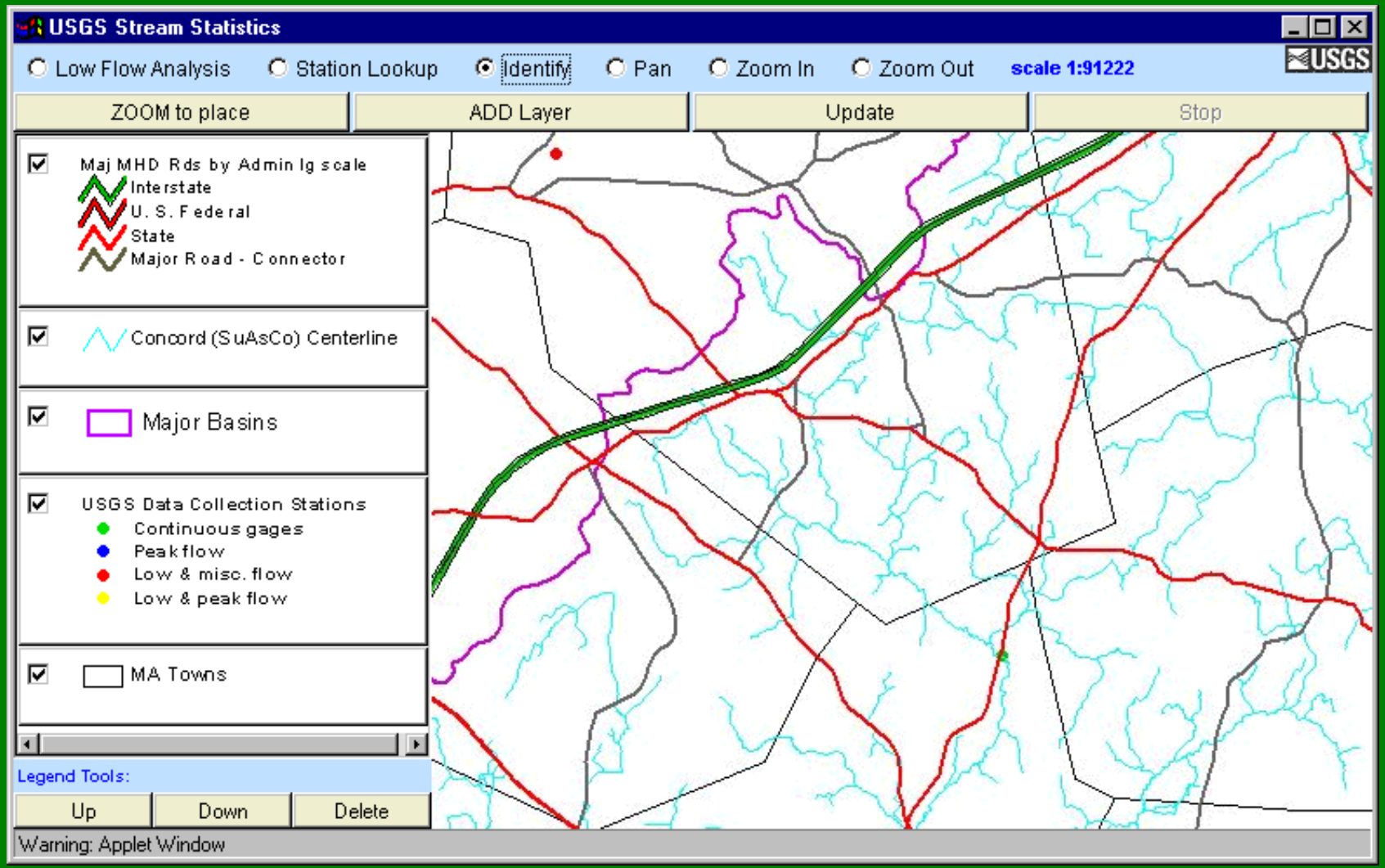
Zoom In and Add Map Layers



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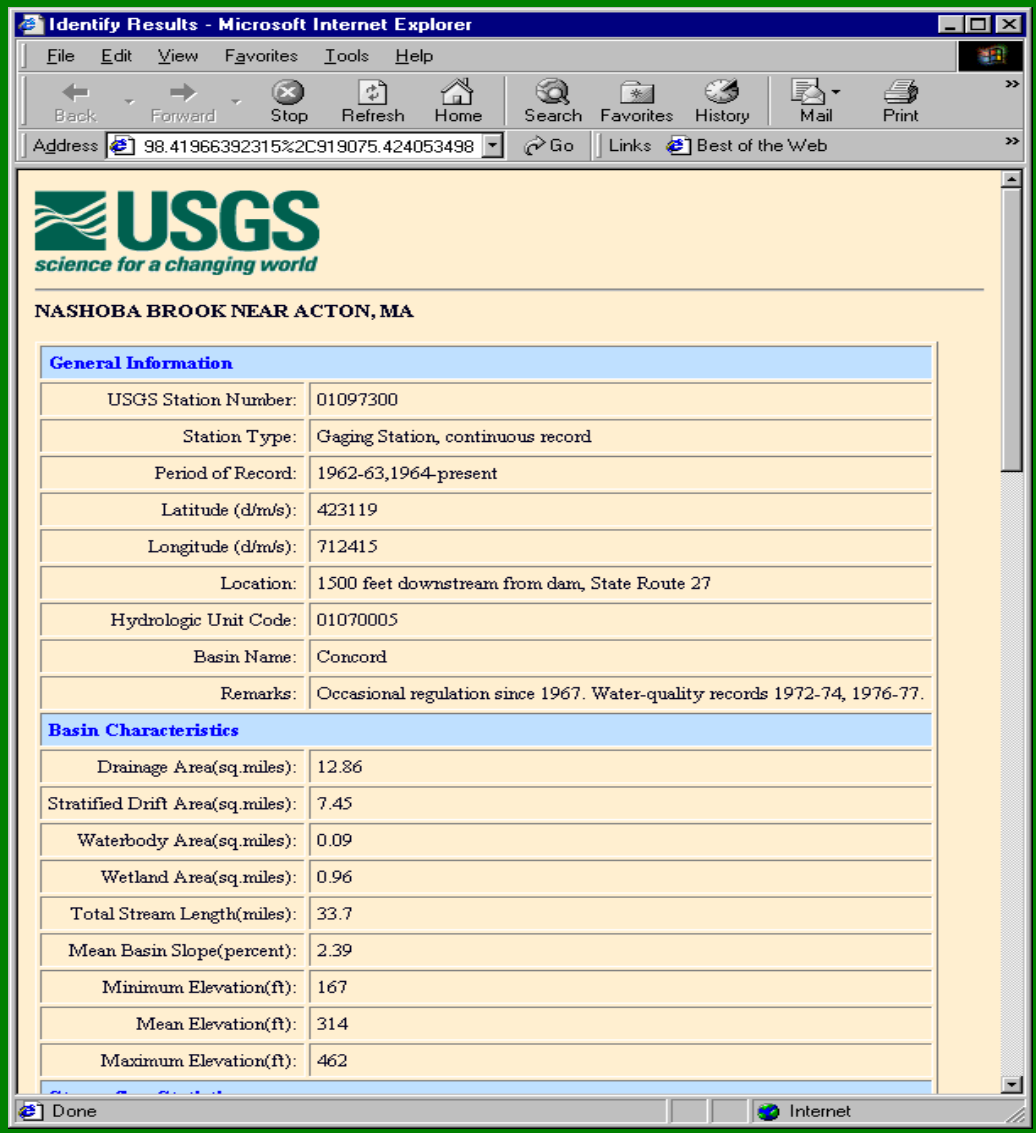
Example Output from Database



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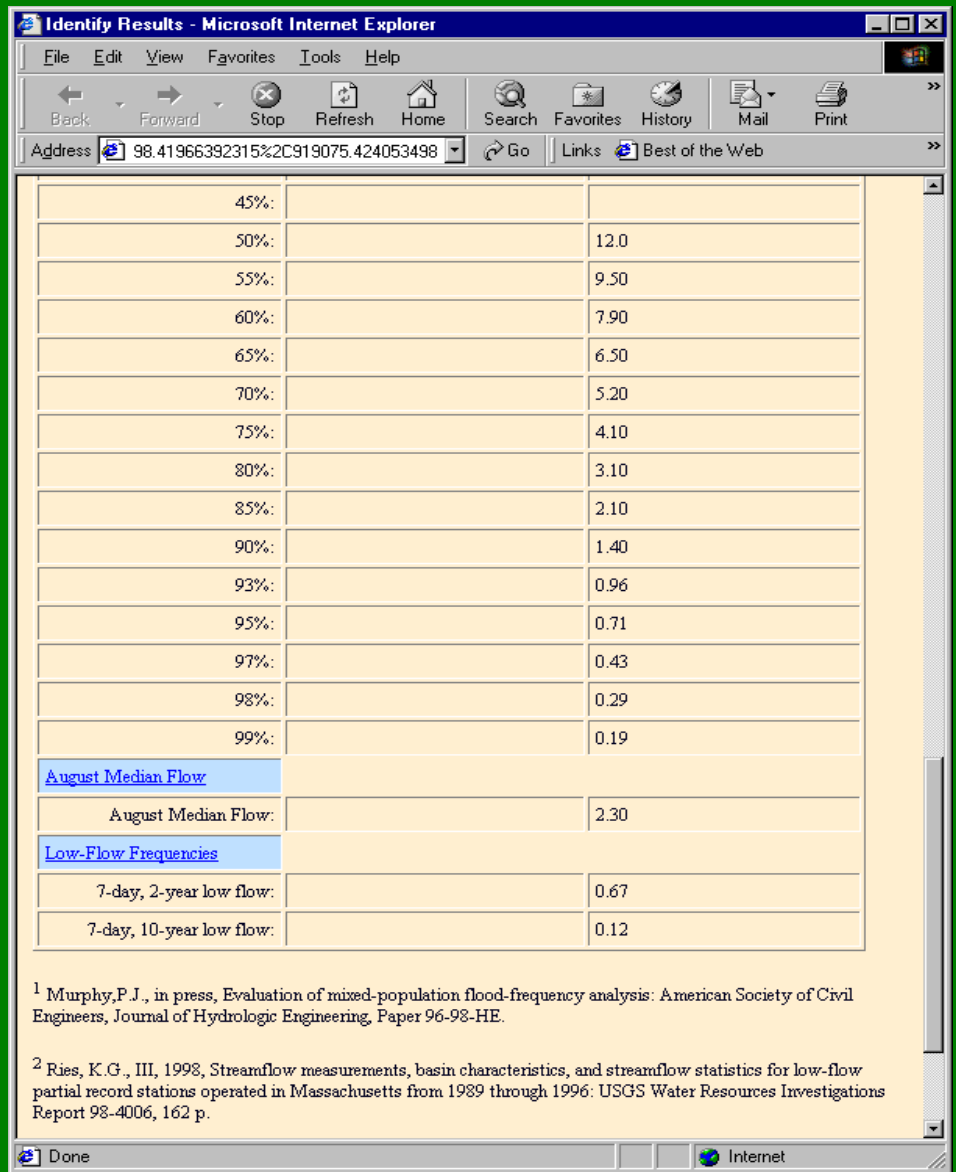
Example Output from Database,

cont'd



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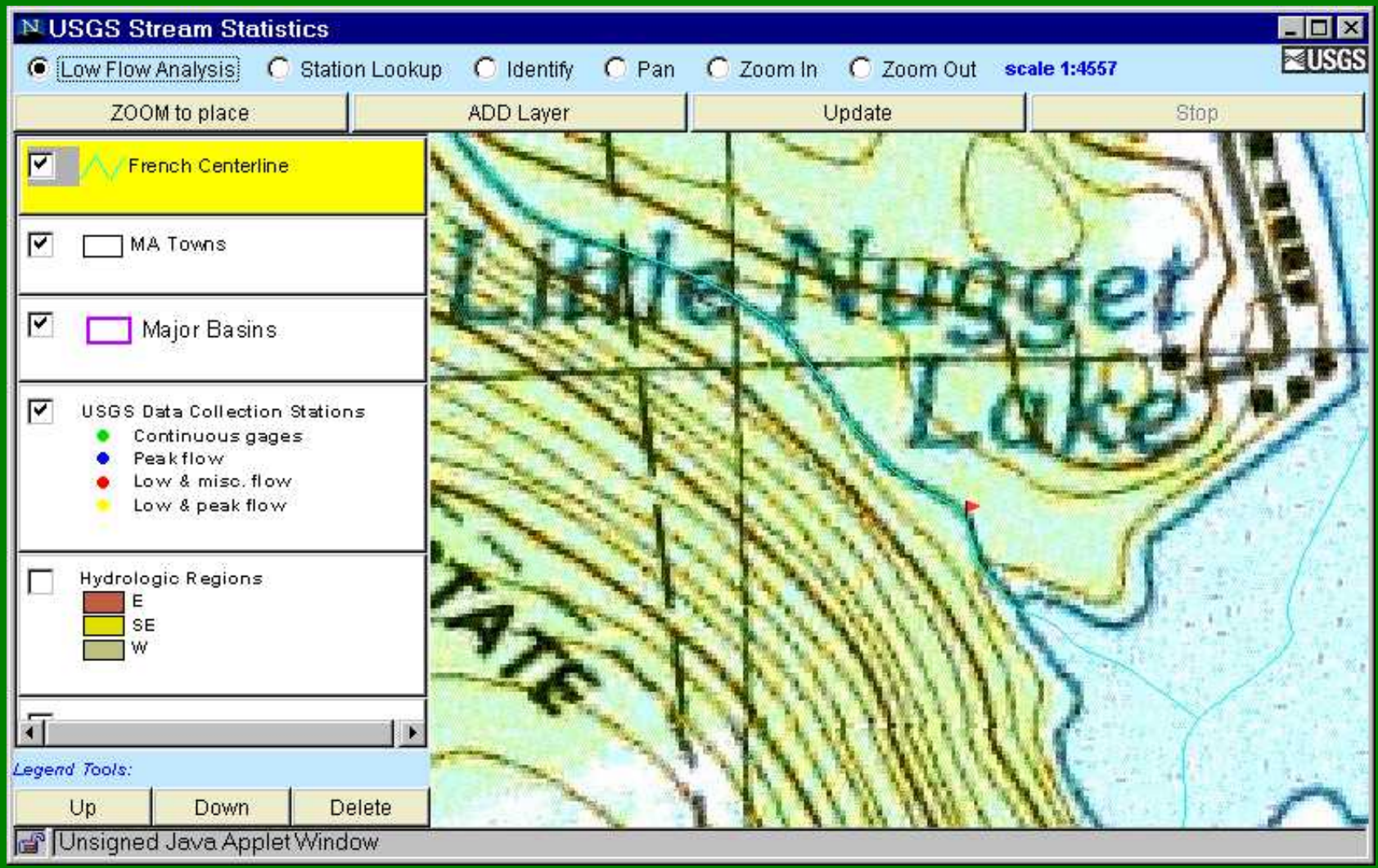
Site Selection for Low-Flow Analysis



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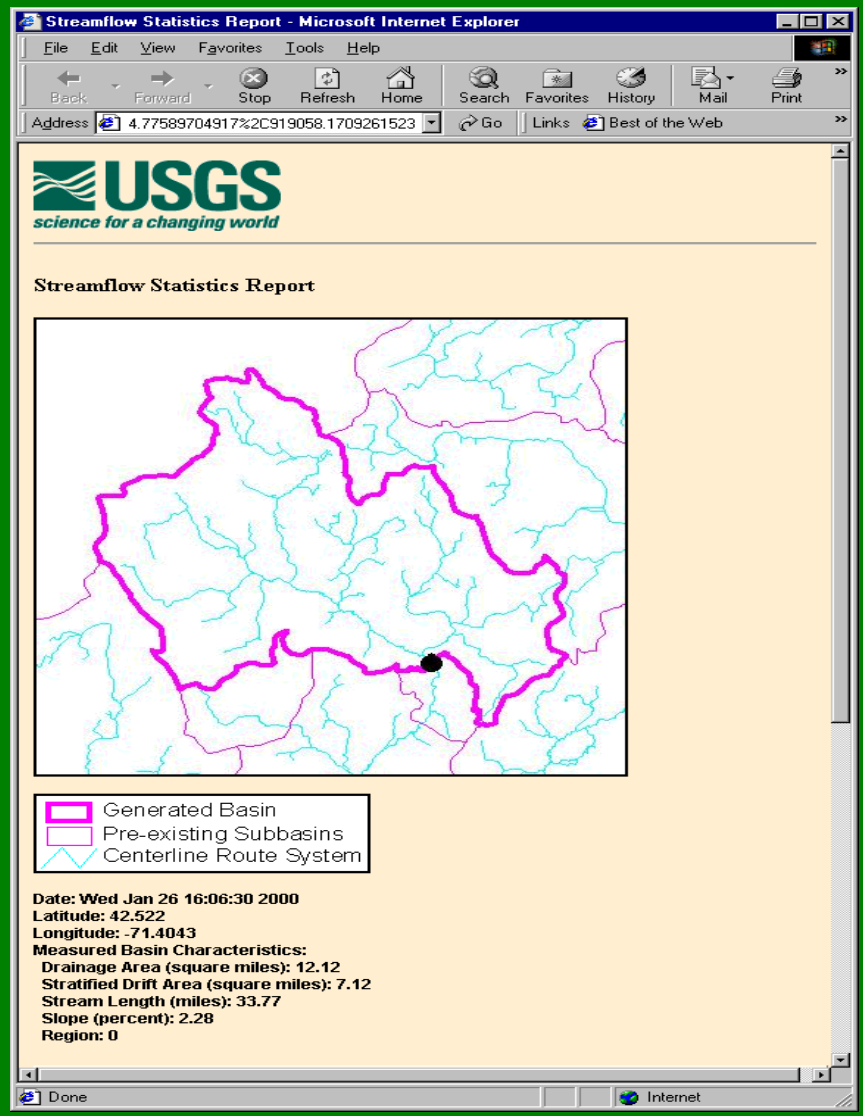
Example Output for Ungaged Sites



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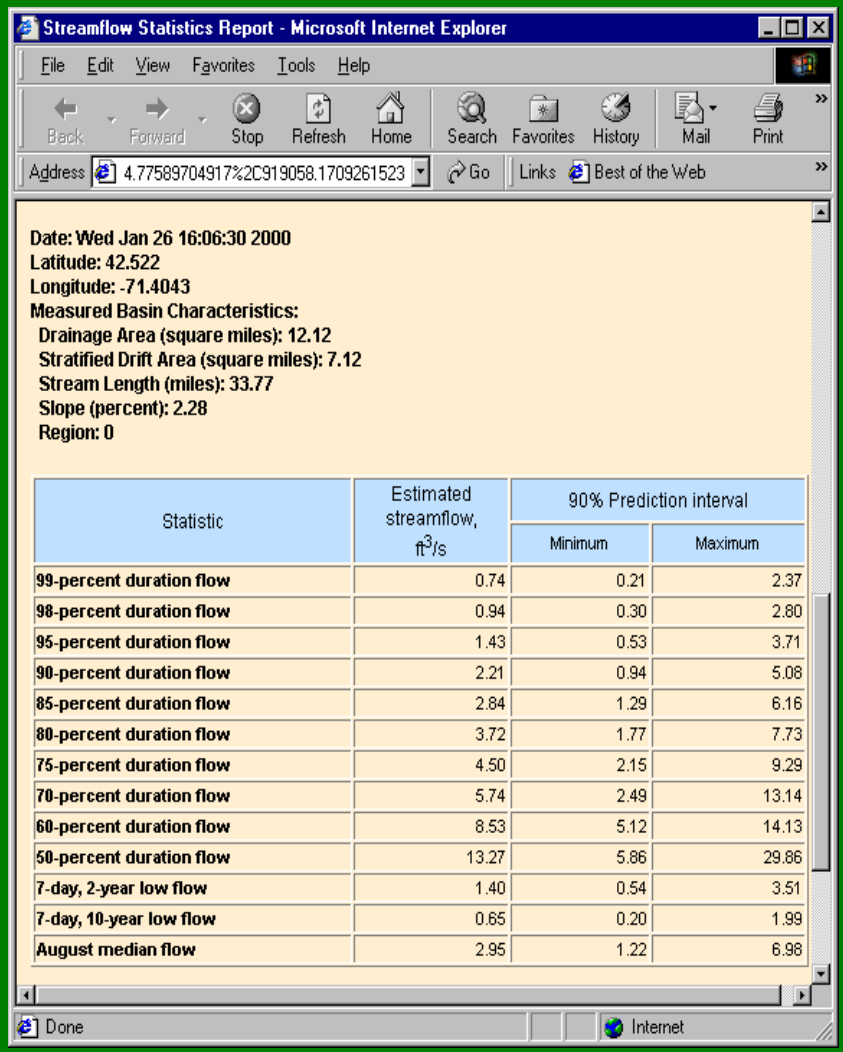
Example Output for Ungaged Sites, cont'd



Date: Wed Jan 26 16:06:30 2000
Latitude: 42.522
Longitude: -71.4043
Measured Basin Characteristics:
Drainage Area (square miles): 12.12
Stratified Drift Area (square miles): 7.12
Stream Length (miles): 33.77
Slope (percent): 2.28
Region: 0

Statistic	Estimated streamflow, ft^3/s	90% Prediction interval	
		Minimum	Maximum
99-percent duration flow	0.74	0.21	2.37
98-percent duration flow	0.94	0.30	2.80
95-percent duration flow	1.43	0.53	3.71
90-percent duration flow	2.21	0.94	5.08
85-percent duration flow	2.84	1.29	6.16
80-percent duration flow	3.72	1.77	7.73
75-percent duration flow	4.50	2.15	9.29
70-percent duration flow	5.74	2.49	13.14
60-percent duration flow	8.53	5.12	14.13
50-percent duration flow	13.27	5.86	29.86
7-day, 2-year low flow	1.40	0.54	3.51
7-day, 10-year low flow	0.65	0.20	1.99
August median flow	2.95	1.22	6.98

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Benefits to Users

- Published statistics are readily available
- The process for ungaged sites takes a fraction of the time required by manual methods - usually less than 15 minutes
- Large collections of maps, equipment, and software are not necessary
- The process is reproducible
- Little or no additional error is introduced in the accuracy of the low flow estimates.
- Only basic understanding of hydrology, computer science, geographic analysis is needed

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Benefits to USGS

- Reduced costs for handling information requests
- Consistent information delivery
- Fulfills goals of USGS Strategic Plan and National Streamflow Information Program
- Application is expandable, and could be used to deliver other types of data for user-defined locations or areas (water quality, water use, ground water, biological, geological)

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Status of Streamstats

- The application was announced to the public in January, 2001, and has gotten substantial press coverage
- The State of Massachusetts is requiring use of Streamstats to estimate natural streamflow for locations of all new water withdrawals in excess of 100,000 gpd, and for NPDES permits
- Many USGS district offices have inquired about developing similar applications.

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Developing a National Application

- $160,000 in FY2001 gross funds are available to begin developing a national application
- The development team will consist of employees from the Water and Mapping disciplines, and consultants
- Work is currently in the design phase
- A prototype is planned for completion by Fall 2001

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Objectives

- Develop a generic national web application that can provide streamflow statistics for data-collection stations and for ungaged sites
- Implement the application in selected test areas, evaluate its performance, and make any necessary changes
- Provide guidance to districts for implementing the application

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Tasks

- Determine hardware, software, and digital map data requirements
- Develop a generic user interface
- Develop a national streamflow statistics database
- Develop standardized data preparation methods
- Modify or develop new programs for measuring basin characteristics and solving regression equations
- Assemble national and regional GIS data
- Compile regression equations

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User Interface Development

- The interface will be developed in coordination with NWIS-Web, Gateway to the Earth, and other web-mapping efforts
- The interface will use Visual Basic programming and ArcIMS software
- A consultant will help develop the interface
- Desktop and web-based versions will be developed

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User Interface Development, cont'd

- More selection functionality will be added to the prototype (select by street address, coordinates, etc.)
- More analysis functionality will be added in the future (drainage-area ratio estimates, additional databases, etc.)

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Stream Information Database Development

- The database will be built using Access
- It will contain fields for all streamflow and basin characteristics that are currently available, and it will allow new characteristics to be added
- Data will be entered by districts using data entry forms
- The database will likely replace the defunct Basin Characteristics file

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GIS Database Development

- A list of required basin characteristics will be compiled and GIS methods for measuring them will be determined
- National data layers will be used whenever possible
- Data layers developed by NWS for solving National Flood Frequency Program equations will be obtained and tested
- Additional data layers will be obtained from districts and other sources
- Data architecture and naming conventions will be standardized

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Required National Data Layers

- National Elevation Dataset (NED-H) –Elevation-derived hydrologic grids at 1:24,000 scale
- National Hydrography Dataset (NHD) – Centerlined, networked streams at 1:24,000-scale, where available; at 1:100,000 scale elsewhere
- Watershed Boundary Dataset (WBD) – Drainage basin boundaries developed by NRCS, or State layers where WBD is not available
- Digital Raster Graphics (DRG) – Topographic maps, obtained by linking to Terraserver

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GIS Application for Measuring Basin Characteristics

- GIS methods for measuring the basin characteristics will be standardized
- Programming will automate measurement of the basin characteristics and solving equations
- A desktop version will be developed initially, followed by a Web version
- Some development work may be done through the CRADA between USGS and ESRI

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Data Storage and Server Requirements

- Linkages will be established to existing databases, such as Terraserver
- Hardware and software requirements for prototype will be evaluated
- Long term, NatWeb will provide hardware for server and data storage

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Regression Equations

- NFF software contains all peak-flow equations, and is being modified to be the equation-solving engine for the national Web application
- Urban equations will not be included
- Districts will need to provide equations for other streamflow statistics, which will then be entered into NFF
- Programming will be needed to allow transfer of information among NFF, the GIS program, and the user interface

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Selection of Test Areas

- Test areas are not yet chosen, but preference will be given to districts in the Arkansas-White-Red basin because of availability of NED-H data
- Test areas should encompass at least one entire HUC, with multiple States and hydrologic regions
- All GIS data needed to compute basin characteristics should be available
- Local districts or cooperators will provide labor to populate the streamflow statistics database and test the application

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Testing the Prototype

- Comparisons will be made between basin characteristics and streamflow statistics obtained using the application to those determined for stations used to develop the regression equations
- If differences in bias and accuracy are found, adjustments will be made to GIS procedures or regression coefficients, if possible
- Some areas may require new regression equations

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National Implementation

- The application will be implemented on a state-by-state basis as GIS data become available and districts verify the accuracy of the results
- Headquarters staff will maintain the application, prepare guidance, and provide assistance to the districts for implementing the application
- Computations for individual states will be made available to the public only after the district evaluations are complete

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District Responsibilities

- Provide OSW with all equations to be programmed into the application
- Populate the streamflow statistics database
- Develop any necessary GIS data
- Test results and gain OSW acceptance before equations will be provided to public
- Use GIS data layers to measure basin characteristics used to develop any new regression equations

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Conclusions

- A national web application for serving stream information will aid decision-makers at all levels of government and in private industry
- Savings in manpower compared to traditional manual techniques will be substantial and accuracy will be increased
- A prototype national application should be completed by Fall 2001
- Assistance from districts will be needed to complete full implementation

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