

Exxon Valdez Oil Spill
Gulf Ecosystem Monitoring and Research Project Final Report

Graphical Information System (GIS) Map of Water Quality Monitoring Sites
Across the Gulf of Alaska

Project 030607
Final Report

Will Schlein

GIS/Internet Specialist
Cook Inlet Keeper
P.O. Box 3269
Homer, AK 99603

May 2004

The *Exxon Valdez* Oil Spill Trustee Council administers all programs and activities free from discrimination based on race, color, national origin, age, sex, religion, marital status, pregnancy, parenthood, or disability.

The Council administers all programs and activities in compliance with Title VI of the Civil Rights Act of 1964, Section 504 of the Rehabilitation Act of 1973, Title II of the Americans with Disabilities Act of 1990, the Age Discrimination Act of 1975, and Title IX of the Education Amendments of 1972. If you believe you have been discriminated against in any program, activity, or facility, or if you desire further information, please write to: EVOS Trustee Council, 441 West 5th Avenue, Suite 500, Anchorage, Alaska 99501-2340; or O.E.O. U.S. Department of the Interior, Washington, D.C. 20240.

Exxon Valdez Oil Spill
Gulf Ecosystem Monitoring and Research Project Final Report

Graphical Information System (GIS) Map of Water Quality Monitoring Sites
Across the Gulf of Alaska

Project 030607
Final Report

Will Schlein

GIS/Internet Specialist
Cook Inlet Keeper
P.O. Box 3269
Homer, AK 99603

May 2004

Graphical Information System (GIS) Map of Water Quality Monitoring Sites Across the Gulf of Alaska

Project G-030607 Final Report

Study History: Project G-030607 addresses the task of building a central database of water monitoring sites throughout the Gulf of Alaska. The project was funded from October 2002 – September 2003. To obtain data from as many groups as possible an extension was asked for and granted through September 2004.

Abstract: Cook Inlet Keeper has synthesized existing data to create a comprehensive Geographic Information Systems (GIS) map and database of monitoring sites across the Gulf of Alaska. This map was published in hardcopy and linked to CIIMMS and STORET, through which the map and data can be easily updated and made available to monitoring entities as well as policy-makers, scientists, and the general public. This map and the accompanying data will serve as a lasting tool for the restoration and protection of the Gulf of Alaska's resources by coordinating diverse monitoring efforts and establishing a framework into which information about current and future monitoring programs can be entered.

Key Words: water quality monitoring, database, GIS, map, STORET, CIIMMS, physical, chemical, biological

Project Data: Data is available at the Cook Inlet Keeper Website (www.inletkeeper.org), the CIIMMS website (<http://info.dec.state.ak.us/ciimms/>), and through The EVOS library.

Citation: Schlein, W. 2004. Graphical Information System (GIS) Map of Water Quality Monitoring Sites Across the Gulf of Alaska, *Exxon Valdez* Oil Spill Restoration Project Final Report (Project G-030607), Cook Inlet Keeper, Homer, Alaska.

Table of Contents

EXECUTIVE SUMMARY	1
INTRODUCTION	4
OBJECTIVES	5
METHODS	5
RESULTS	6
DISCUSSION	11
CONCLUSION AND RECOMMENDATIONS	12
ACKNOWLEDGEMENTS	13
LITERATURE CITED	13

Table of Figures

Figure 1 - ArcMap 8.2 view.....	7
Figure 2 - ArcMap Query to Database.....	8
Figure 3 - Online Interface.....	9
Figure 4 - Online Query to database (Select with polygon)	9
Figure 5 - Online Query to database (Select with criteria).....	10
Figure 6 - ArcExplorer Freeware View	11

Graphical Information System (GIS) Map of Water Quality Monitoring Sites Across the Gulf of Alaska

EXECUTIVE SUMMARY

One of the biggest challenges in the world of data collection is the management of where data is collected. Toward that end Cook Inlet Keeper and the Alaska Department of Environmental Conservation have come together to create a central database of water quality monitoring site information in the EVOS area. This area can be easily expanded since the challenge is a universal one. Through this database collaboration can be fostered and monitoring funding used most efficiently.

To develop a user-friendly data management system for site entry, storage, analysis, retrieval, and accessibility requires the use of GIS (Graphical Information System), database, interactive internet software, and custom software. The system also needs to be dynamic to keep the data current through easy updates.

The overall goal of the project is to allow broad dissemination of site data. To this end, the information will migrate towards inclusion into STORET (short for STORage and RETrieval), the Environmental Protection Agency's (EPA) computerized environmental data system. The data is also available over the Internet through a network node via CIIMMS, Alaska's Cooperatively Implemented Information Management System. CIIMMS is a web-based system that provides access to a broad spectrum of timely data and analysis tools via the Internet. This map and the accompanying data will serve as a lasting tool for the restoration and protection of the Gulf of Alaska's resources by coordinating diverse monitoring efforts and establishing a framework into which information about current and future monitoring programs can be entered.

OBJECTIVES

1. Create a comprehensive GIS map that illustrates water quality monitoring sites in offshore, nearshore, Alaska Coastal Current, and watershed habitats of the Gulf of Alaska.
2. Make this map available to citizens, organizations, and agencies in formats to reach as many end users as possible

METHODS

This project involves the collection of existing data only. The data was synthesized, then presented on paper and digital maps using Geographic Information Systems software (ESRI's ArcView 8.2, and ArcExplorer) and custom interactive internet software developed by the Alaska Department of Environmental Conservation.

Cook Inlet Keeper's GIS Specialist identified agencies and groups with pertinent environmental monitoring data. He then gathered the following data about each monitoring program: location (latitude and longitude); entity conducting monitoring; type of data collected (physical, chemical, & biological); type of site (offshore, nearshore, stream, etc.); and status of monitoring (active or inactive). The data was processed using ArcView 8.2. Processing involved re-projecting all data into the same coordinate system, and creating a simple database (associated with the digital product) to record data source, type, dates, as well as other information about the monitoring program. Once data was processed, ArcView 8.2 together with additional data (such as shoreline, lake or stream, road, watershed locations) was used to create attractive, legible, 24" x 34" paper maps. ArcExplorer was used to assemble the data into a simple project that can be read by anyone with a modern PC. (ArcExplorer is available as a free download from www.esri.com). In addition, Keeper created a prototype CD with the GIS map and data which was supplied to the *Exxon Valdez* Oil Spill Trustee Council for the library.

RESULTS

At the conclusion of this stage of the project the following products are in place using data from the 32 nonprofit, government, and native agencies contacted. Over 4000 sites have been compiled from organizations conducting water quality monitoring in Alaska. A CD-ROM has been manufactured with the current data in various forms.

The data is available as an ArcMap project. This allows for the greatest search and query capabilities to be utilized. This data is available for use to the end users who have access to ArcMap software. A version of the data is also available on the CD-ROM as an ArcExplorer project. The free software to access this project is available for download from www.esri.com. It too allows for various layers to be turned on and off by the user. From the GIS maps the data points can be queried accessing the database to obtain the information collected about each monitoring site.

On the Cook Inlet Keeper website the data can be accessed as well. The ArcMap project, the ArcExplorer project and shapefiles can all be downloaded as compressed files. A link to ESRI's website is provided allowing anyone desiring to access the data via ArcExplorer to obtain the latest version of the free software necessary to view and work with this form of the database. The Keeper website also hosts the online form used by water quality monitoring entities to add their sites to the dynamic version of the map. CIIMMS has added the monitoring site data as layers to their online mapviewer utility program. This viewer was created to search and query this type of data to produce customized reports. The data on the CIIMMS site will also be exported to the EPA National STORET warehouse. A series of hardcopy maps has been produced summarizing the study area and database. Copies are being furnished to the EVOS library. A copy of the final CD-ROM was furnished for the library collection as well.

DISCUSSION

Creating this database has provided a major step in the process to allow better collaboration between water quality monitoring organizations. The database has already been used to provide background information to entities planning and providing background for management of current and future water monitoring programs. The project has provided a crucial link to migrating as much information to the EPA STORET system. STORET, the EPA's largest computerized environmental data system contains data on surface and ground water collected by federal, state and local agencies, Indian Tribes, volunteer groups, academics, and others. All 50 States, territories, and jurisdictions of the U.S. are represented in these systems. (EPA 2004) It is therefore a logical selection for a central repository for the database of water quality monitoring sites.

The challenge has been getting the data into STORET through a user-friendly data entry interface and then making them accessible on the Internet in a user-friendly format. There is no question that with enough time, money and training, most anyone could navigate through the multitude of entry forms in STORET to enter their data. But with state and federal budgets for water quality monitoring continuing to decline, volunteer collected data, through citizen based monitoring, have become more important in state monitoring programs (Mauger 2003). This project is one tool allowing site data to be centralized for wide dissemination.

CONCLUSION AND RECOMMENDATIONS

To develop an interactive water quality monitoring database and make it accessible on the web is a very complex and time-consuming process that requires collaboration of technological, financial, and human resources. To make a system functional and up to date requires a user interface which is easy to use and yet universal. Project 03607 has facilitated this. It also ties the database to the EPA's STORET allowing it to be widely disseminated. There is no way a project of this scale would ever work without the broad base cooperation and collaboration of agencies and organizations. This project has shown that it is possible to collaborate and cooperate to build such a system. It is important to recognize that a project of this nature, one that provides all of us invaluable information about our water resources, is a project that will never end, it must carry on into perpetuity. Therefore we must continue to develop a dynamic system capable of changing with technology and time. By maintaining such a system we will help facilitate a better understanding about threats to, and solutions for, water quality and habitat.

To be of use indefinitely the systems developed need to be easily updateable. This is now accomplished through a web-based form. Submittals of this form will be used to update the database to keep it current. Then, periodically the database will be replaced with the most up to date copy for end users. To allow the database to be updated in real-time will require additional programming. This function can be addressed in Phase II of the project

Graphical Information System (GIS) Map of Water Quality Monitoring Sites Across the Gulf of Alaska

INTRODUCTION

In February 2002, Keeper held the Second Annual Conference of water quality monitoring partner organizations and agencies at the Alaska Forum on the Environment in Anchorage. The groups represented included: Cook Inlet Keeper; Alaska Boreal Forest Council; Alaska Department of Environmental Conservation; Alaska Department of Fish and Game; Alaska Department of Natural Resources; Anchorage Waterways Council; Association of Village Council Presidents; Cooperatively Implemented Information Management System (CIIMMS); Chikaloon Village; Division of Governmental Coordination; *Exxon Valdez* Oil Spill Trustee Council; Homer, Upper Susitna and Wasilla Soil and Water Conservation Districts; Kenai Watershed Forum; Native American Fish and Wildlife Society; Native Village of Eklutna; Native Village of Elim; Port Graham/Nanwalek Watershed Council; Port Graham Village Council; Seldovia Village Tribe; Stebbins Community Association; University of Alaska Anchorage's Environment and Natural Resources Institute; U.S. Environmental Protection Agency; U.S. Fish and Wildlife Service; and U.S. Geological Survey.

Keeper facilitated a roundtable discussion during which participants expressed a need for a map showing all water quality monitoring sites across the Gulf of Alaska. All organizations and agencies present felt this map would be an important tool for the coordination of monitoring efforts and the protection of water quality.

In 1997, Cook Inlet Keeper created the first *Cook Inlet GIS Atlas* on CD-ROM. The Atlas contains a wealth of information on the region including marine mammal habitat, salmon streams, transportation routes, and property boundaries. Keeper conducted educational workshops with the Atlas in Native Villages around Cook Inlet, and made the CD-ROM available to schools, agencies, and organizations. Keeper's GIS Atlas has been widely used by schools, the Kenai Peninsula Borough, and other entities. Since the publication of the Atlas, Keeper has been successfully incorporating GIS into all of its programs. Keeper uses GIS maps to relay important watershed issues in engaging ways to the public, to help prioritize habitat in need of protection, and to aid in designing water quality monitoring programs.

With ongoing success at using GIS to protect the Cook Inlet watershed, Keeper is well prepared to synthesize information available from agencies and organizations to create a comprehensive GIS map showing water quality monitoring sites across the Gulf of Alaska. This map, which could easily be expanded to include statewide efforts, will provide a framework for consistent representation of Gulf of Alaska monitoring programs and help organizations and agencies understand their role in the monitoring of Alaska's public resources. In addition, the map will help organizations and agencies design their monitoring efforts so that they are as effective and efficient as possible and it will provide an opportunity to assess where water quality monitoring is needed.

This map and its data must be easily updated in order for this project to serve as a lasting tool for the restoration and protection of the Gulf of Alaska's resources. To fulfill this need, Cook Inlet Keeper will coordinate with the Alaska Department of Environmental Conservation to incorporate this GIS map and its data into the Cook Inlet Information Management and Monitoring System (CIIMMS) web site and ADEC's development of an interface with the EPA's National STORET (short for STORage and RETrieval)warehouse. This will provide an opportunity for the GIS data and map to show current and accurate information about water quality monitoring sites across the Gulf of Alaska.

This map and the accompanying data will serve as a lasting tool for the restoration and protection of the Gulf of Alaska's resources by coordinating diverse monitoring efforts and establishing a framework into which information about current and future monitoring programs can be entered.

With consistent, credible, and comprehensive monitoring across the Gulf of Alaska and beyond, organizations and agencies can work together to assess the state of water quality and ensure that public resources, such as sport and commercial fisheries and wildlife habitat, are protected now and into the future.

OBJECTIVES

1. Create a comprehensive GIS map that illustrates water quality monitoring sites in offshore, nearshore, Alaska Coastal Current, and watershed habitats of the Gulf of Alaska.
2. Make this map available to citizens, organizations, and agencies in formats to reach as many end users as possible

METHODS

This project involves the collection of existing data only. The data was synthesized, then presented on paper and digital maps using Geographic Information Systems software (Environment Systems Research Institute's ArcView 8.2, and ArcExplorer) and custom interactive internet software developed by the Alaska Department of Environmental Conservation.

Cook Inlet Keeper's GIS Specialist identified agencies and groups with pertinent environmental monitoring data. He then gathered the following data about each monitoring program: location (latitude and longitude); entity conducting monitoring; type of data collected (physical, chemical, & biological); type of site (offshore, nearshore, stream, etc.); and status of monitoring (active or inactive). The data was processed using ArcView 8.2. Processing involved re-projecting all data into the same coordinate system, and creating a simple database (associated with the digital product) to record data source, type, dates, as well as other information about the monitoring program. Once data was processed, ArcView 8.2 together with additional data (such as shoreline, lake or stream, road, watershed locations) was used to create attractive, legible, 24" x 34" paper maps. ArcExplorer will be used to assemble the data into a simple project that can be read by anyone with a modern PC. (ArcExplorer is available as a free download from

(www.esri.com). In addition, Keeper created a prototype CD with the GIS map and data which was supplied to the *Exxon Valdez* Oil Spill Trustee Council for the library.

RESULTS

At the conclusion of this stage of the project the following products are in place using data from the 32 nonprofit, government, and native agencies contacted. Over 4000 sites have been compiled from organizations conducting water quality monitoring in Alaska. A CD-ROM has been manufactured with the current data in various forms.

The data is available as an ArcMap project (Figure 1). This allows for the greatest search and query capabilities to be utilized. This data is available for use to the end users who have access to ArcMap software. A version of the data is also available on the CD-ROM as an ArcExplorer project. The free ESRI software to access this project is available at www.esri.com. It too allows for various layers to be turned on and off by the user. From the GIS maps the data points can be queried accessing the database to obtain the information collected about each monitoring site.

On the Cook Inlet Keeper website the data can be accessed as well. The ArcMap project, the ArcExplorer project, and Excel spreadsheets can all be downloaded as compressed files. A link to ESRI's website is provided allowing anyone desiring to access the data via ArcExplorer to obtain the latest version of the free software necessary to view and work with this form of the database. The Keeper website also hosts the online form used by water quality monitoring entities to add their sites to the dynamic version of the map. CIIMMS has added the monitoring site data as layers to their online mapviewer utility program. This viewer was created to search and query this type of data to produce customized reports. The data on the CIIMMS site will also be exported to the EPA National STORET warehouse. A series of hardcopy maps has been produced summarizing the study area and database. Copies are being furnished to the EVOS library. A copy of the final CD_ROM was furnished for the library collection as well.

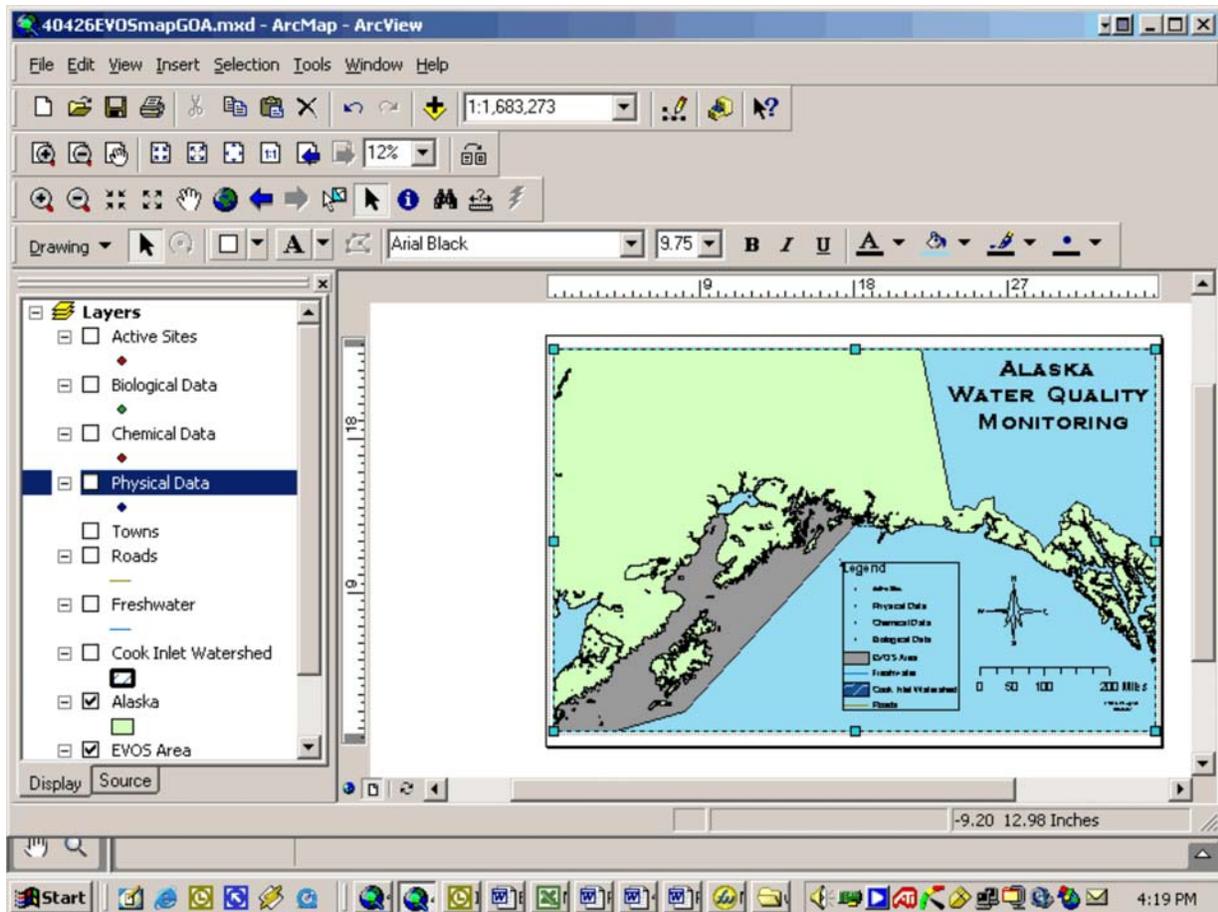


Figure 1 - ArcMap 8.2 view

In the ArcMap version the various layers can be toggled on and off to create custom views. One layer can be designated as the active layer. This feature is used to query the data. The query results are viewed in a window that opens automatically. (Figure 2) The map can also be zoomed in to a particular area of interest to provide more detail. Maps can be custom tailored to the end user and then exported in various graphic formats for printing and emailing.

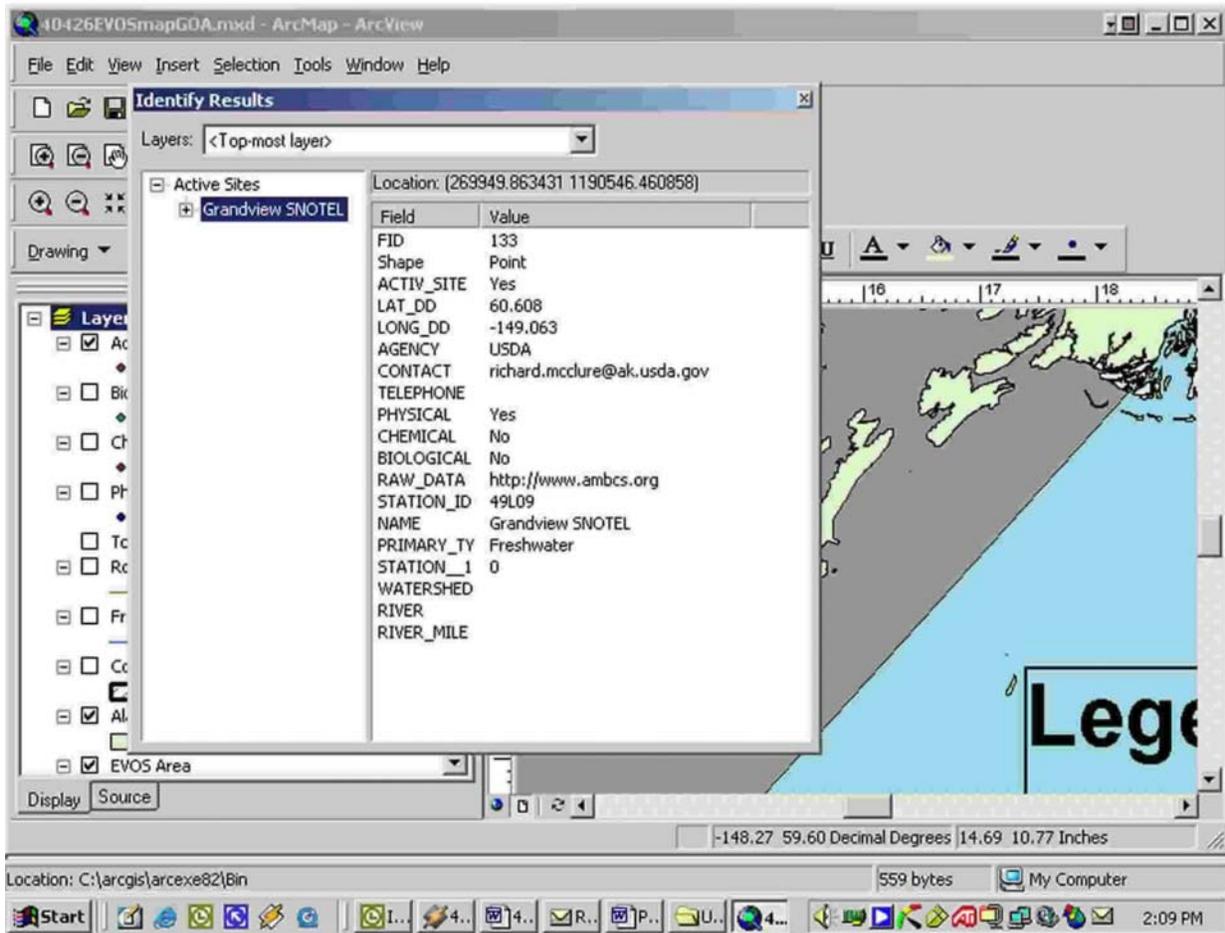


Figure 2 - ArcMap Query to Database

The custom software (Figure 3) created by Alaska's Cooperatively Implemented Information Management System (CIIMMS) available at <http://squid.dnr.state.ak.us/website/akstoret/viewer.htm> provides online access to the database. This software allows for the toggling on and off of the different layers and zoom features to be used (CIIMMS 2004). One layer can be designated as the active layer and can be queried using the various query functions provided. Monitoring sites can be selected by creating a polygon around the desired sites or using the convenient query tool and specifying the desired criteria. (Figures 4 and 5)

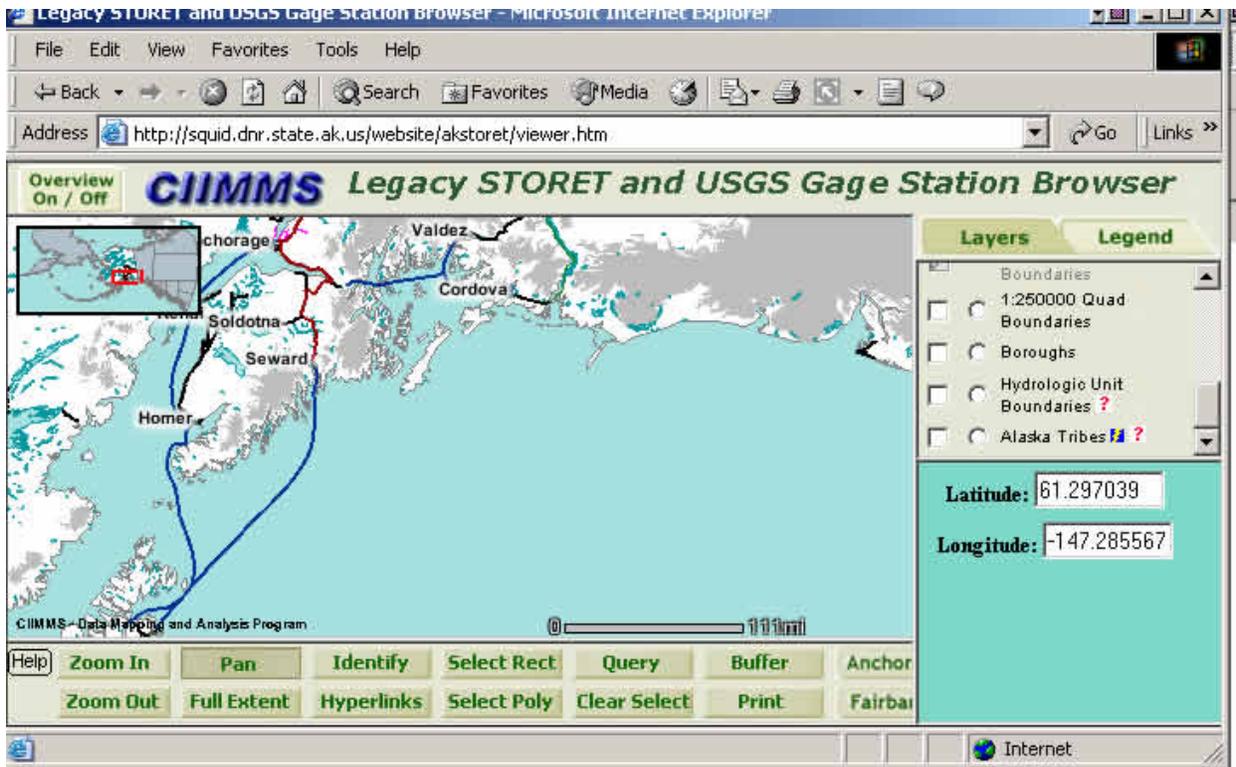


Figure 3 - Online Interface

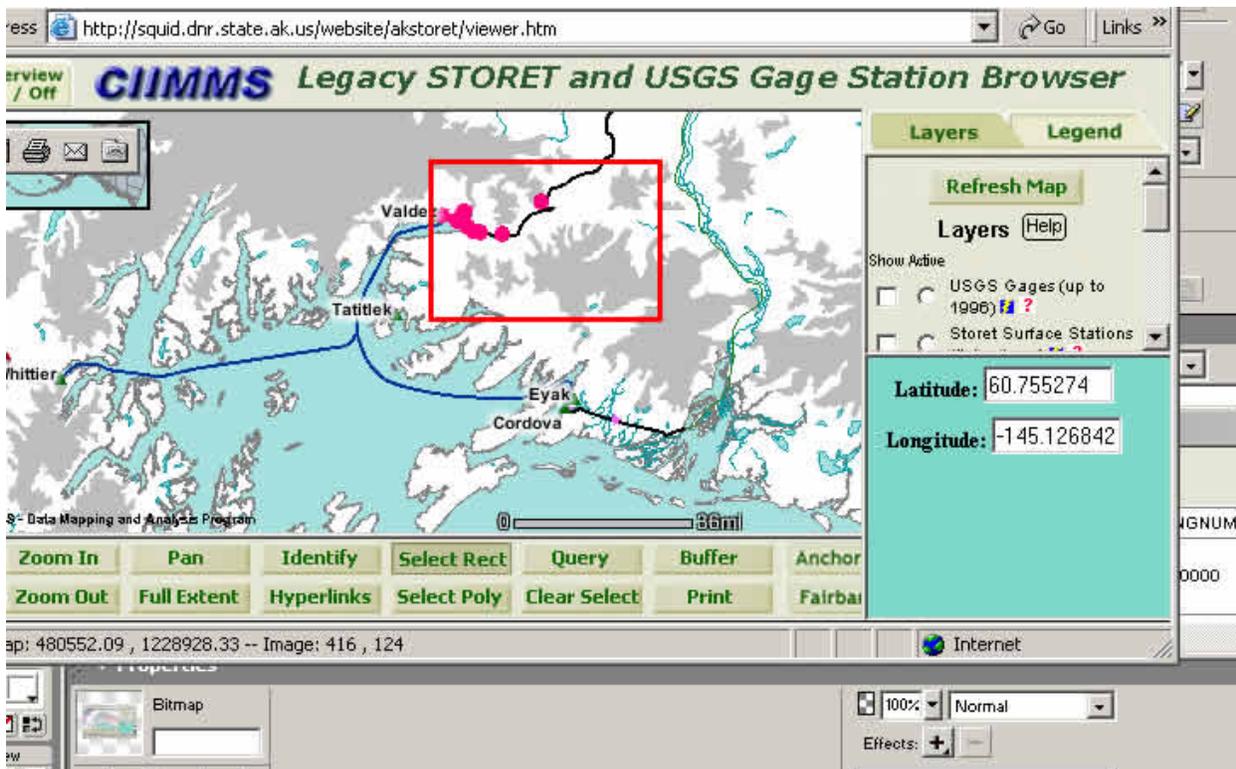


Figure 4 - Online Query to database (Select with polygon)



Figure 5 - Online Query to database (Select with criteria)

The ArcExplorer version of the map (Figure 6) can be accessed by anyone who obtains the free ArcExplorer software from ESRI. This software is available to download at www.esri.com. Using this software provides access to all of the data but cannot be used for all of the custom query functions available with ArcMap or through the CIIMMS website.

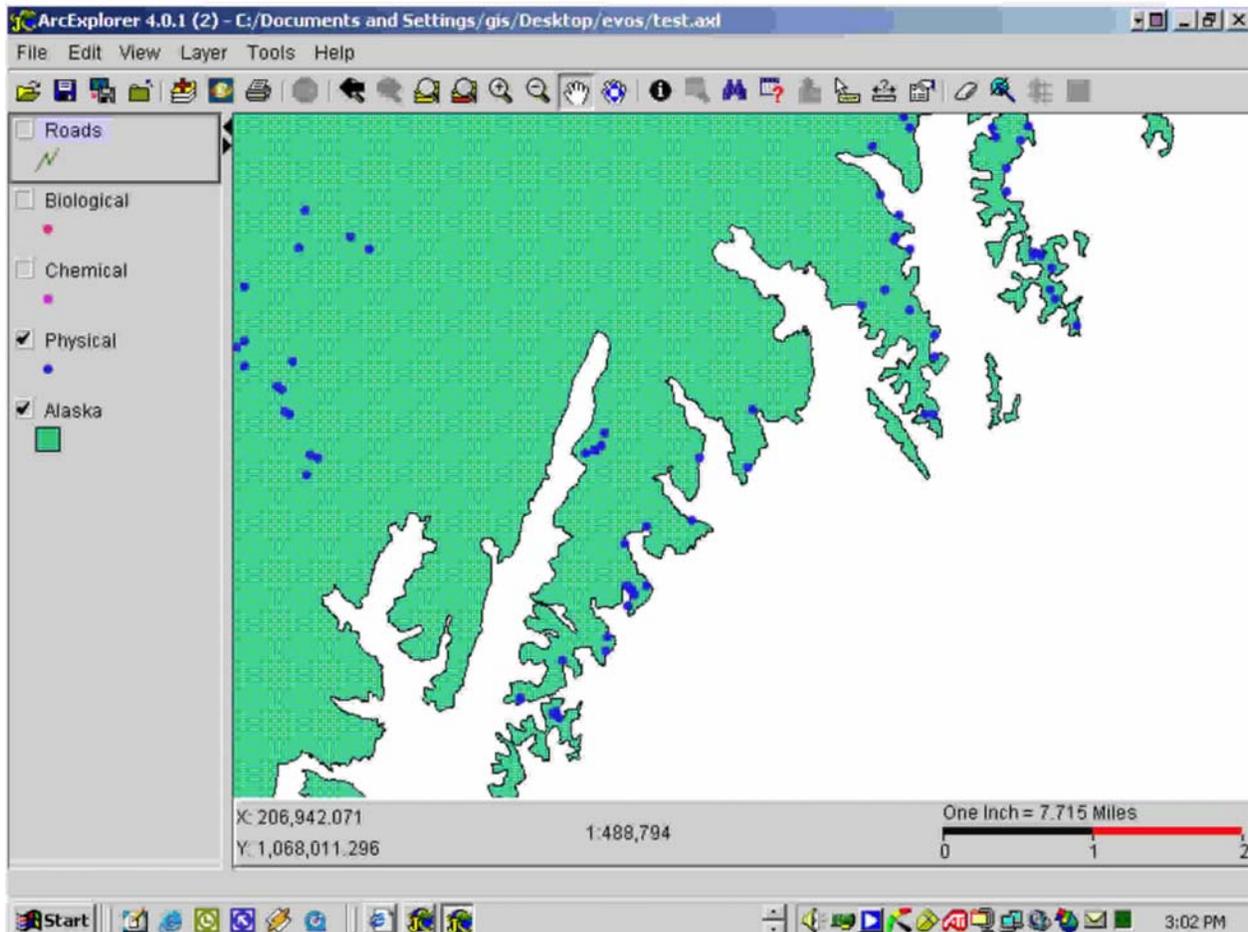


Figure 6 - ArcExplorer Freeware View

DISCUSSION

Creating this database has provided a major step in the process to allow better collaboration between water quality monitoring organizations. The database has already been used to provide background information to entities planning and providing background for management of current and future water monitoring programs. The project has provided a crucial link to migrating as much information to the EPA STORET system. STORET, the EPA's largest computerized environmental data system contains data on surface and ground water collected by federal, state and local agencies, Indian Tribes, volunteer groups, academics, and others. All 50 States, territories, and jurisdictions of the U.S. are represented in these systems. (EPA 2004) It is therefore a logical selection for a central repository for the database of water quality monitoring sites.

The challenge has been getting the data into STORET through a user-friendly data entry interface and then making them accessible on the Internet in a user-friendly format. There is no question that with enough time, money and training, most anyone could navigate through the multitude of entry forms in STORET to enter their data. But with

state and federal budgets for water quality monitoring continuing to decline, volunteer collected data, through citizen based monitoring, have become more important in state monitoring programs (Mauger 2003). This project is one tool allowing site data to be centralized for wide dissemination.

Using CIIMMS, Alaska's Cooperatively Implemented Information Management System, as an intermediate step has provided additional benefits. The data is then made accessible on the Internet through a network node via CIIMMS. CIIMMS is a logical choice for providing Internet access for this project since it was designed as a user-friendly web-based system made to provide access to a broad spectrum of timely data and analysis tools via the Internet.

CONCLUSION AND RECOMMENDATIONS

To develop an interactive water quality monitoring database and make it accessible on the web is a very complex and time-consuming process that requires collaboration of technological, financial, and human resources. To make a system functional and up to date requires a user interface which is easy to use yet universal. Project G-030607 is one tool developed to facilitate this. It also ties the database to the EPA's STORET allowing it to be widely disseminated. There is no way a project of this scale would ever work without the broad base cooperation and collaboration of agencies and organizations. This project has shown that it is possible to build such a system. This system can be easily expanded to encompass larger areas and other types of data. It is important to recognize that a project of this nature, one that provides all of us invaluable information about our water resources, is a project that will never end, it must carry on into perpetuity. Therefore we must continue to develop a dynamic system capable of changing with technology and time. By maintaining such a system we will help facilitate a better understanding about threats to, and solutions for, water quality and habitat.

To be of use indefinitely, the systems developed need to be easily updateable. This is now accomplished through a web-based form. Submittals of this form will be used to update the database to keep it current. Then, periodically, the database will be replaced with the most up to date copy for end users. To allow the database to be updated in real-time will require additional programming. This function can be addressed during the next phase of the project.

ACKNOWLEDGEMENTS

First and foremost, Cook Inlet Keeper must express its deepest appreciation to the staff of each organization that contributed to the database.

Special thanks goes to Russell Kunibe, Computer Programmer and Analyst with Alaska Department of Environmental Conservation and Carol Fries, Alaska Department of Natural Resources for their vision, skills, and collaborative efforts to make this project a reality!

Thanks to Mike Gracz for his work on this project.

Thanks to the Alaska Department of Environmental Conservation and the Alaska Department of Natural Resources for developing and hosting the CIIMMS Mapping Application

This project was made possible by the *Exxon Valdez* Oil Spill Trustees

LITERATURE CITED

CIIMMS [Homepage of CIIMMS: Alaska's Cooperatively Implemented Information Management System], [Online]. (2002, June 20 - last update). Available: <http://info.dec.state.ak.us/ciimms/> [2004, April 21].

Mauger, S. 2003. Effectiveness of Citizens' Environmental Monitoring Program, *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Project 02667), Cook Inlet Keeper, Homer, Alaska.

U. S. Environmental Protection Agency. 2004. [Homepage of About STORET], [Online]. (2004, April 6 - last update). Available: <http://www.epa.gov/storet/about.html> [2004, April 21]