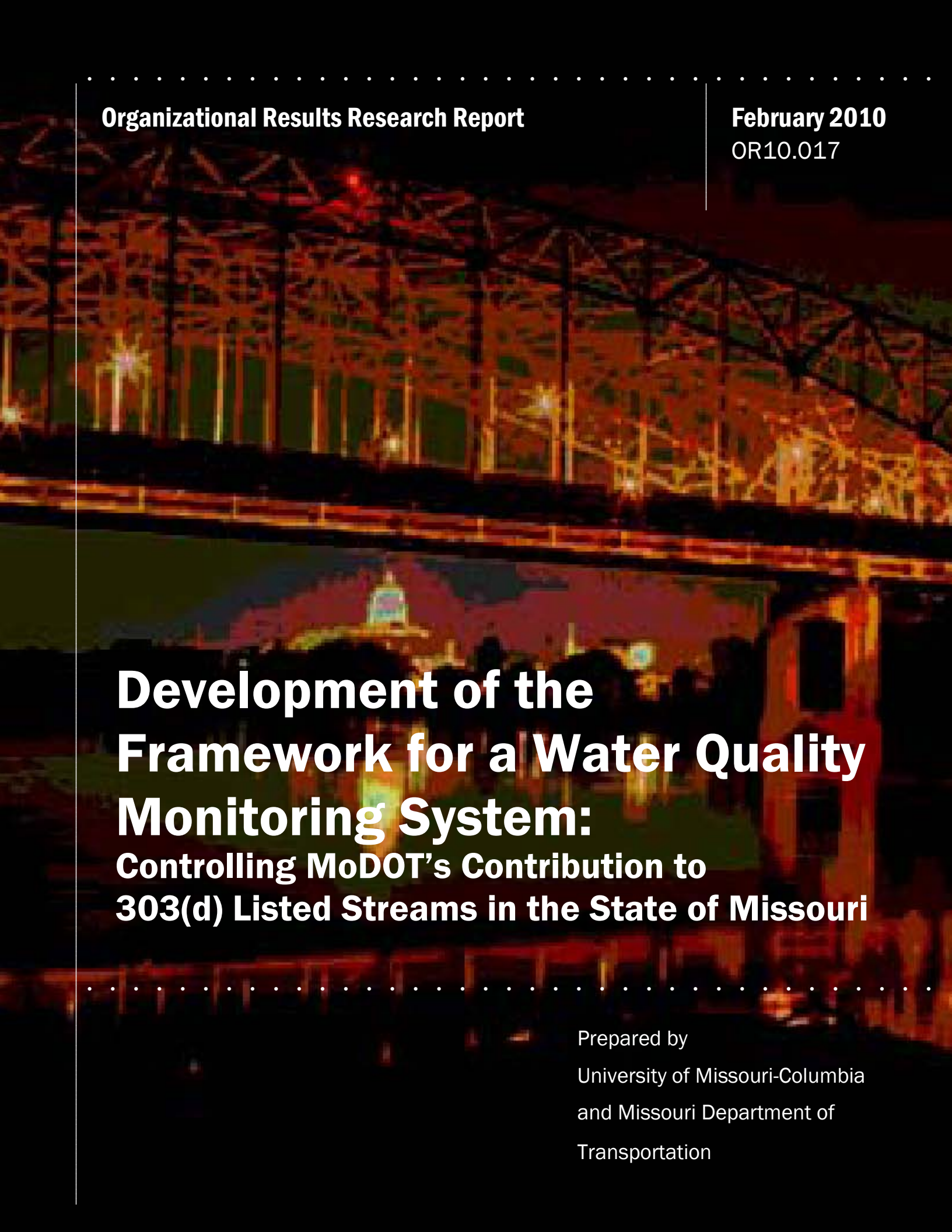

Organizational Results Research Report

February 2010
OR10.017

# Development of the Framework for a Water Quality Monitoring System:

## Controlling MoDOT's Contribution to 303(d) Listed Streams in the State of Missouri

Prepared by
University of Missouri-Columbia
and Missouri Department of
Transportation

**Final Report**
RI08-031

# Development of the Framework for a Water Quality Monitoring System:

## Controlling MoDOT's Contribution to 303(d) Listed Streams in the State of Missouri

Prepared for
Missouri Department of Transportation
Organizational Results

by

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## Executive Summary

Under the federal Clean Water Act, operators of municipal separate storm sewer systems (MS4s) are required to develop and implement storm water management plans to reduce pollutant loadings to the maximum extent possible, especially in water bodies listed on the Environmental Protection Agency's 303(d) list. The Missouri Department of Natural Resources (DNR) may in the near future require the Missouri Department of Transportation (MoDOT) to receive permits for discharges from the MS4s under its control. Placing monitoring programs at all the MS4 crossings statewide would result in significant costs to MoDOT. An approach was needed to avoid placing monitoring programs at locations where MoDOT activities have no environmental impact.

This project was conducted to provide MoDOT staff with an easy-to-use method utilizing existing analysis tools to identify whether a proposed project would, or potentially could, impact a 303(d) listed water body. This in turn, can guide MoDOT staff on where monitoring programs are necessary and avoid the costs of unnecessary placements.

By using ArcGIS and building a visual map with locations of the 303(d) listed water bodies, the Missouri road system, watershed boundaries, and other features, MoDOT staff can easily discern if the intended project/activity would cause, or potentially could cause, a contaminate to be added to a 303(d) listed water body.

Access software allows data collected regarding the water body to be stored in such a manner that meaningful reports can be generated. Items such as pH, water temperature, dissolved oxygen, conductivity, the X and Y coordinates (in point form), watershed, sub-watershed, county, town, etc. can all be collected and entered into the database allowing reports to be generated as needed. Additionally, Best Management Practices (BMPs) data (BMP type, spacing, baseline contaminant levels, and post BMP contaminant levels) can also be collected allowing a quantified evaluation regarding effectiveness of the BMPs being used.

Using ArcGIS and Access software to visualize and archive project data, allows a quick method to allocate department resources to the best practical benefit, and provides data to assess the effectiveness of any BMPs used, as well as providing a historical timeline of the levels of contaminants before, during, and after a project.

## TABLE OF CONTENTS

List of Figures ..... ii
List of Tables ..... ii
Introduction ..... 1
Objectives ..... 2
Present Conditions ..... 2
Technical Approach ..... 3
Results and Discussion (Evaluation) ..... 8
Conclusions ..... 22
Recommendations ..... 22
Implementation Plan ..... 23
Principal Investigator and Project Members ..... 23
Implementation Objective ..... 24
Affected Business Units and Principal Contact ..... 24
Implementation Period ..... 24
Funding ..... 24
Technology Transfer ..... 24
Procedure ..... 24
Budget ..... 25
Bibliography ..... 26
Appendix A: Work Plan
Appendix B: Creation of layers in ArcGIS for Missouri 303(d) listed streams
Appendix C: Creation of an Impaired Streams Field Sampling Report from the Access Database
Appendix D: Decision Flowchart for Use of Tools
Appendix E: Access Database Users Manual (draft)
Appendix F: 303(d) Listed Streams Shown in the Example ArcMap (Figure 3)

## List of Figures

Figure 1: Illustration of how the components of this project interrelate..... 2
Figure 2: State of Missouri 2002 303(d) listed streams and MDNR Regions (left; Harmil 2005) and MoDOT districts (right; MoDOT 2007) ..... 5
Figure 3: Example ArcMap of the approved Missouri 2008 303(d) listed stream locations that may be of concern to MoDOT ..... 10
Figure 4: Flowchart of the Use of the Decision Tool ..... 12
Figure 5: Form for Field Measurement..... 14
Figure 6: Form for BMP Measurement ..... 15
Figure 7: Screen short of the Microsoft Access generated Water Quality Impact Database (WQID) ..... 18

## List of Tables

Table 1 – Summary of Urban Runoff Pollutants ..... 19
Table 2 – Missouri 303(d) Pollutant Occurrence Table..... 19
Table 3 – Summary of the Top 6 303(d) Constituent Categories ..... 21
Table 4 – Project Budget delineated by Task and Month..... 25

## Introduction

The National Environmental Policy Act (NEPA) of 1969 mandates that for all federal actions with the potential to affect the environment, government agencies shall utilize a systematic interdisciplinary approach to minimize the impact of the proposed project on the environment. States utilizing federal monies to complete projects fall under this mandate. Therefore, the Missouri Department of Transportation (MoDOT), in addition to its primary function of "safe roads and efficient transportation" must also ensure they maintain environmental awareness in their activities.

The Environmental Protection Agency (EPA) publishes a listing, with states input, of the impaired water bodies in the United States, commonly referred to as the 303(d) list. States are required to monitor and ensure the activities of its inhabitants do not further degrade the listed water bodies. One method of regulating the amount of pollutants entering the water body is through permits. The Missouri Department of Natural Resources (DNR) issues permits to industries and municipalities that outline where and how much they may discharge into a particular waterway.

Phase II of the Clean Water Act (CWA) requires permitting of urban Municipal Separate Storm Sewer Systems (MS4s). It is under this portion of the CWA that DNR has indicated they may require MoDOT to monitor any water body to which MoDOT contributes to the impairment (inability for the water body to meet the standards set in the Clean Water Act). However, water bodies are listed for a variety of pollutants and MoDOT does not contribute to the impairment of all of the listed streams that cross its right-of-way (ROW). Additionally, it is not fiscally prudent for MoDOT to monitor every water body that crosses its ROW, when not all impairments are transportation related.

When MoDOT proposes an activity they can use ArcGIS to identify any water bodies the activity may cross or be in proximity to, once these water bodies are identified, MoDOT may look at the pollutant(s) for which the water body is impaired and if it is determined the proposed activity does not have the potential to impact the impaired water body then monitoring of such may not be necessary. On the other hand, if it is determined the proposed activity *may* impact the water body then data can be collected using a field data sheet to record/document any MoDOT generated pollutants. These field measurements would be stored on an Access database allowing archiving of the data; exact location, pollutants tested for, watersheds, county, date, etc. would all be stored for easy retrieval of this historical data. After field samples are taken and analyzed in the laboratory, a determination may be made as to the necessity of further monitoring. Lack of activity caused pollutants may allow MoDOT to successfully petition the Department of Natural Resources (DNR) to stop further monitoring for that activity.

If, after analysis, it is determined the activity does contribute pollutants to the impaired waters MoDOT may find it necessary to install more extensive storm water containment devices such as Best Management Practices (BMPs). Once these devices are installed, further sampling would be required to ensure the BMPs are working as intended. Monitoring/analysis would then determine whether the activity continues to contribute pollutants and the level of contribution. If the BMPs are successful and no further pollutants are leaving the site and entering the water

body then MoDOT may be able to say "…under these type of conditions, using these types of containments, we do not contribute activity related pollutants to the water bodies…". Using this historical data, MoDOT may then petition DNR to halt any further monitoring under similar circumstances thereby reducing unnecessary cost and reallocating the monies to other needed activities.

## Objectives

The primary objective of this project is to create a "Monitor and Response Decision Tool" for MoDOT which would address the federally mandated storm water management plant (SWMP) as it pertains to discharges to Water Quality Impaired Waters (Sections 3.1 and 5.1 of the current permit). The components that support that Decision Tool would include a water quality database (designed to meet Section 3.1.1.1), a GIS-based map of MoDOT and MDNR attributes (designed to meet Sections 3.1.1.2 and 3.1.2), a sampling and analysis plan (designed to meet Section 5.1.2), and training materials (designed to meet section 5.1.3) that help to formalize the process of gathering data and making use of these resources in the decision making process. The efforts proposed to integrate all of these components is illustrated in Figure 1 and further explained in the next section.

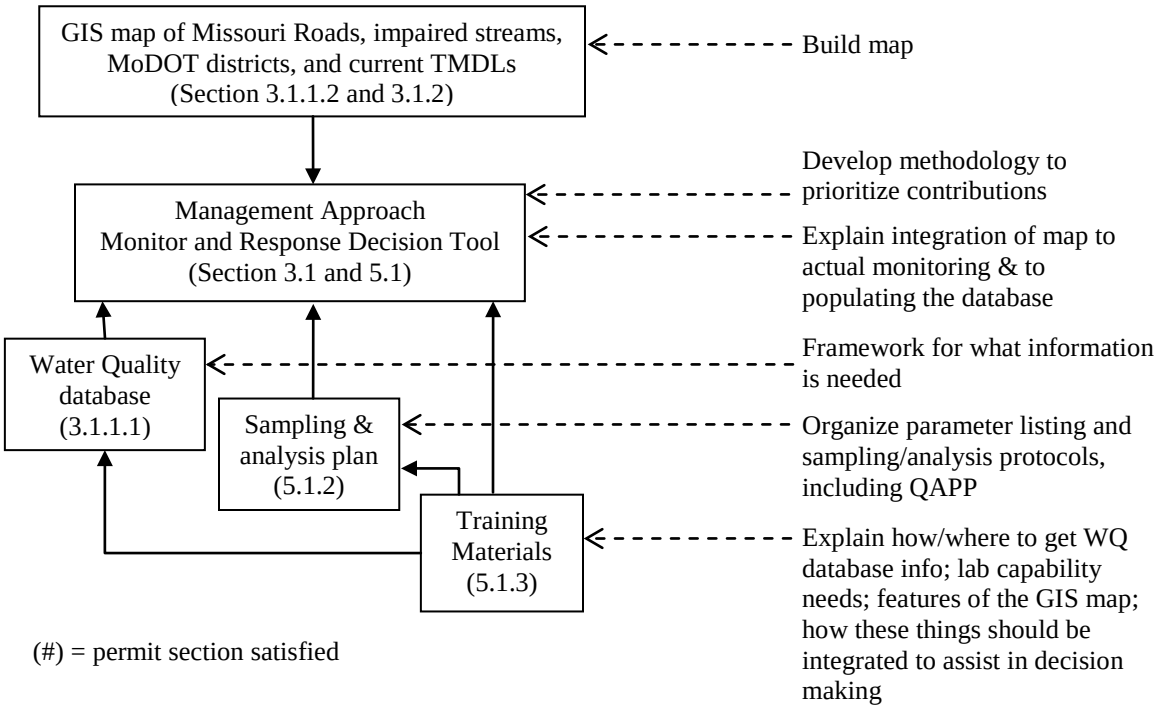



**Figure 1: Illustration of how the components of this project interrelate**

## Present Conditions

The Missouri Department of Transportation's MS4 (Municipal Separate Storm Sewer System) permit (MO-R040063) was renewed in June 2008. In this permit, according to the Missouri Department of Natural Resources (MDNR 2008b), MoDOT is mandated to incorporate into their

overall SWMP a specific plan for monitoring storm water flowing into 303(d) listed stream segments and that SWMP must be put into public notice. This mandated monitoring plan will be a challenge to complete by 2012 so that the permit may be renewed in 2013. The project proposed here (considered a phase I) would be to provide assistance to MoDOT in setting up a framework for the protocols needed to sample and monitor what its contributions are to 303(d) listed stream segments in the State of Missouri. The completed monitoring plan, federally mandated under the current NPDES MS4 permitting structure, would provide a basis for informed decision making on how to incorporate water quality improvements in the most cost-effective manner. A sound monitoring plan would also provide valuable information on the performance of the various pollution control features employed by MoDOT while identifying where the major concerns in the system are so that maintenance priorities may be set. Because additional phases are needed in order to complete the monitoring plan, Phase I is intended to provide a good foundation for MoDOT staff to continue with its efforts to sample and analyze water quality in the development and implementation of the mandated SWMP monitoring plan.

MDNR (2008a) is in the process of developing TMDL (Total Maximum Daily Load) limits for all streams listed as 303(d) waters (i.e., not meeting the federal Clean Water Act's water quality standards). TMDL development uses a watershed approach to identifying pollutant causes of the water quality impairments that warrant 303(d) listing. The pollutants most recently considered here in the State of Missouri include metals (lead, zinc), volatile and nonvolatile suspended solids, nutrients and high organics content (that deplete oxygen in the water while promoting eutrophication), fecal coliform, and chloride. These TMDLs are finalized and approved by the U.S. Environmental Protection Agency (EPA). Most permittees are municipalities that only need to concern themselves with the TMDLs of the specific streams that are adjacent to them. MoDOT, in contrast, essentially has to address in some form every TMDL proposed by the state because they potentially contribute to every stream segment of the state during runoff situations such as rain events.

## Technical Approach

a. Develop a report indicating the Total Maximum Daily Load (TMDL) limits for all streams listed as 303(d) waters (i.e., not meeting the federal Clean Water Act's water quality standards) located in Missouri that MoDOT could potentially contribute during runoff situations.

Our approach to this requirement will be the development of a Geographical Information System (GIS) based map with at least the following layers:

- 303(d) waters in the State of Missouri,
- TMDL status for each impaired stream segment (including permit in lieu of TMDL)
- each TMDL parameter,
- pollutants of interest and pollutants implicated where there is no TMDL
- MDNR regions,
- MoDOT districts,
- MoDOT roadways/right-of-way

Figure 2 shows two of the layers we intend to incorporate in the map. This map would allow MoDOT to query streams at a district level and determine whether there are 303(d) water quality

concerns that may affect project/activity planning and management in that district. As part of this project, a comparison of the TMDL listed parameters to the more likely contaminants generated by MoDOT activities allows for prioritization of potential MoDOT impacts. Certain chemical parameters that may be listed will not come from MoDOT activities and therefore the priority of concern placed on that water's quality is lower.

The functionality of the GIS map will be based on the ability to look at TMDL concerns within a specific MoDOT district. Of the seven major functions of the GIS we are most interested in 3; storage (of spatial and attribute data), query (finding specific features based on location or attribute data), and analysis (to relate data across multiple layers to determine conditions and trends). This map will allow overlay of districts on top of 303(d) listed streams on top of right-of-ways within districts with the ability to call up pollutants of concern. Ultimately, layers for MoDOT activities and existing/proposed BMPs will also be added to the map and provide greater correlation of potential MoDOT contributions (or lack of) to stream impairment (Shamsi 2002).

The tasks listed for this requirement include:

- Gather Map layer information
- Incorporation of the layers into a functional map
- Preparation of a report on the functionality of the GIS map

### b. Development of the foundation for a standard management study approach to monitoring and responding to water quality concerns.

Phase I, the development of a foundation for a SWMP monitoring plan, should include the **framework** for a water quality database that identifies parameters of concern at various locations (determined from TMDL listings) and MoDOT's contributions (determined from appropriate sampling and analytical work). This database and the monitoring plan itself must include decisions on and development of protocols for sampling (including sampling locations) and preservation, forms and procedures for shipping and chain-of-custody, sampling receipt and storage procedures, appropriate analytical techniques for pollutants and associated safety procedures, and training materials for MoDOT personnel to be able to implement the plan. Additionally, the laboratory facilities that MoDOT uses will need to be evaluated as to their capability to conduct the analysis while satisfying approved EPA quality control and/or quality assurance of the sample collection and analysis results (Law et. al 2008).

It is not the within the scope of this Phase 1 project to actually do water quality sampling and analysis. Instead, the project management team will provide an explanation of step-wise implementation of the monitoring program over such a range of sites/locations (where to start, efforts to test protocols, how to proceed through adding sites to the program).

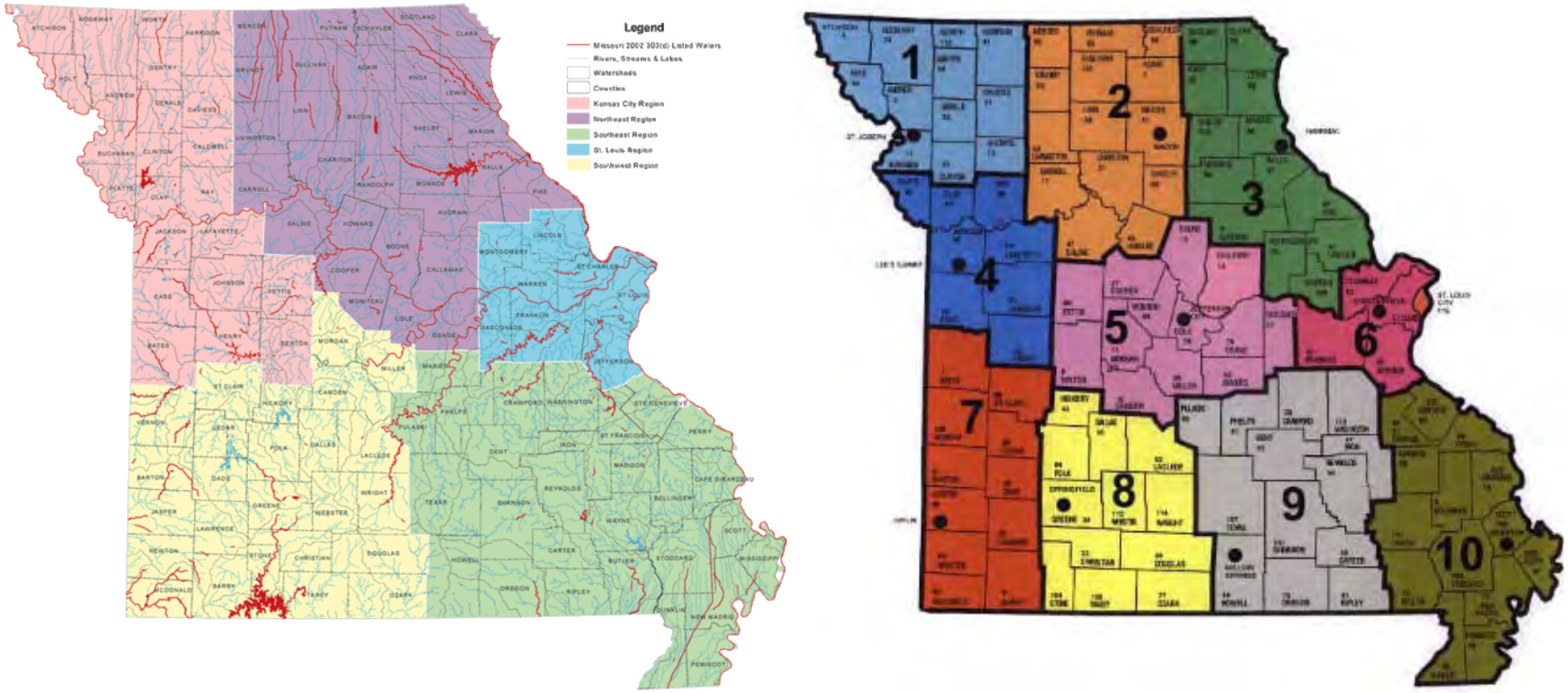



Figure 2: State of Missouri 2002 303(d) listed streams and MDNR Regions (left; Harmil 2005) and MoDOT districts (right; MoDOT 2007)

A **Monitor and Response Decision Tool** is the tangible product of our efforts to satisfy this requirement and will be designed to address questions like: what information needs to be input into the tool? What are the variables for decision making? What is the threshold of concerns that warrants making a decision? Successful development of such a tool will require repeated consultation with MoDOT personnel involved in dissemination of this type of resource to its districts. The tool would then be better designed to allow the MoDOT decision maker to answer questions such as:

- is there a need to monitor? if so, what protocols should be followed?
- who should do the monitoring?
- how will the results of monitoring be used by the department?
- do all outfalls need monitoring? if not, what criteria should be used to determine which to monitor?

The results of this project or of answers found from the decision tool have the potential of altering activity management choices based on TMDL and 303(d) concerns. The goal of this tool will be to help MoDOT personnel affirm or discount the need to monitor (Granato et. al 2003). Appendix Figure 1 provides a draft flowchart of how the decision tool might be used.

The specific tasks listed for this requirement include:

- Development of a protocol for utilizing the GIS map
- Development of a protocol for reviewing the Water Quality Impact Database, which will be developed as part of this project
- Development of a manual that explains the decision criteria suggested for pinpointing MoDOT's contribution to stream impairment
- Preparation of a report on the features of the decision tool

### c. Develop database template to include where water quality impacts occur and what MoDOT's contribution is at each of these occurrences.

The pollutants most recently considered here in the State of Missouri TMDLs include metals (lead, zinc), volatile and nonvolatile suspended solids, nutrients and high organics content (that deplete oxygen in the water while promoting eutrophication), fecal coliform, and chloride (MDNR 2008a). Of these that are listed, the parameters most likely associated with MoDOT operation and maintenance are erosion/sediment, petroleum, and salts/conductivity/total dissolved solids (TDS), or rather chlorides.

To start to address this requirement both a literature review and a MoDOT personnel survey need to be conducted. The two efforts are expected to yield a more complete listing of pollutants that might come from roadways, construction activities, maintenance lots, and any other common MoDOT activities.

The survey and literature review should also begin to list BMPs that are in place or that could be implemented. The "International Stormwater BMP Database" (BMPDB 2007) provides existing data on the removal efficiencies of several BMPs on various pollutants. This information will be used to estimate water quality impacts and provide a basis for field verification when potential impacts exceed a threshold of concern and such verification is feasible within the scope of management of an activity.

The main focus of the researchers working on this requirement will be the development of a structured **Water Quality Impact Database (WQID)**, which would include more common DOT activities and their associated constituents, some of the BMPs that are in place, their reported efficiencies, and highlights of pollutants of concern that overlap MoDOT activities and the 303(d) listings. This project will provide MoDOT with the template for a "living" database that should be updated as new water quality data is gathered. Interactions of this database with the GIS map will increase the usefulness of the Management and Response Decision Tool.

The tasks listed for this requirement include:

- A literature review and summary of pollutants of concern to not only general stream impairment, but also to Departments of Transportation (DOTs) throughout the country
- A literature review and summary of DOT activities that may yield pollutants and of efforts to reduce pollutant concentrations
- A literature review of storm water best management practices (BMPs) and their associated removal efficiencies
- Development of the template for storing water quality data and beginning to populate the database
- Preparation of a report on the structure of and data input into the database

### d. Develop a sampling and analysis plan, for determining MoDOT contributions to 303(d) listed streams.

The storm water quality sampling and analysis monitoring plan itself must include protocols for sampling (including sampling locations) and preservation, forms and procedures for shipping and chain-of-custody, sampling receipt and storage procedures, appropriate analytical techniques for pollutants and associated safety procedures. This plan will be based on both EPA protocols for monitoring, assessment, and reporting of water quality data (U.S.EPA 2008) and guidance documents published by the Federal Highway Administration (Granato et al. 2003). Additionally, guidance will be provided on how to evaluate the capabilities of lab resources to fulfill monitoring needs.

Building of the literature review conducted to develop the water quality database, efforts to meet this requirement will include evaluating and summarizing more effective storm water management strategies used by other state agencies by listing advantages and disadvantages of their efforts and suggesting ways to adjust the strategies to better fit conditions in various areas within the State of Missouri based on regions designated by the Department of Natural Resources and the districts of MoDOT.

The purpose of the plan is to test/verify contributions (or lack of) to the impairment of a 303(d) listed stream. In addition to the plan itself, we are proposing, as part of the training, to provide guidance on how a MoDOT decision maker may more easily identify an area or condition which stands out as a more likely MoDOT contribution to stream impairment and therefore warrants monitoring. Cost effective decision making will depend on this ability to focus resources on confirming suspicions of specific contributions rather than broadly monitoring all potential contributions.

The tasks listed for this requirement include:

- Translation of FHWA and EPA protocols for sampling and analysis of water quality pollutants of concern specific to MoDOT activities
- Preparation of worksheets and checklists to assist with water quality sampling and analysis decision making

### e. Develop training materials for the proposed monitoring strategy.

To fulfill this requirement, the development of several training modules is proposed. Training on maintaining and updating the GIS map would involve incorporation of the GIS map into existing MoDOT infrastructure, and consideration of the best methods for accessing the information by MoDOT personnel, particularly in the districts. The map itself will suggest which districts would be most affected by monitoring concerns due to 303(d) listings and therefore who the training should be targeting. Maintaining and updating the Water Quality Impact Database training module will include a discussion of where existing water quality data may be gathered and how both existing and developed data should be input into the database. Use of the Monitor and Response Decision Tool to prioritize monitoring efforts is the third suggested training module. This module should include a discussion on the methodology for evaluating TMDL data to determine the need for sampling and analysis. It is suspected that there will be minimal overlap between 303(d) listed concerns and MoDOT contributions. This training and the associated Decision Tool will help to confirm this suspicion. Training on the use of the tool will involve interpretation of GIS map results and the Water Quality Impact Database in order to help in the decision on whether or not there is a need to monitor.

The mode of delivery of the training (on-line versus face-to-face) will depend on the technical level of the information being presented. This decision will be made through consultation with MoDOT personnel. District representatives will most likely be receiving training, which will likely vary according to the district and the parameter of concern. Checklists and worksheets will be developed and provided to representatives as part of the training effort.

The specific tasks expected to fulfill this requirement include:

- Development of a training module on GIS map maintenance (likely in the form of a guidance document)
- Development of a training module on Water Quality Impact Database maintenance (likely in the form of a user's manual)
- Development of a training module on use of the Monitor and Response Decision Tool (included in the above mentioned user's manual)
- Pilot testing of these training modules on MoDOT personnel (upon request of MoDOT)
- Development of a report on Implementation Suggestions (to be included in the final report)

## Results and Discussion (Evaluation)

The Technical Approach lists the deliverables for this project in terms of items a. through e. The following discussion will highlight the accomplishments for each of these items and demonstrate some of the resources that have been developed as part of this project.

### a. ArcMAP Functionality

This section of the report details the design and purpose of the ArcGIS map used in conjunction with the contaminant database to serve as a decision making tool for water quality monitoring of MoDOT facilities as it relates to the 303(d) list of streams in the state of Missouri. This interactive ArcGIS map will serve as a visual output of the results and comparisons received/made from the information stored in the database. The GIS map will have two main functions, (1) to display the existing and gathered data in useable and informative ways and (2) to provide a basis for modeling potential hazards and proposed mitigation efforts.

(1) **Display of existing and gathered data is the primary function of this map**. Using existing map data such as the 2008 303(d) list of impaired streams and the location and functions of the various MoDOT facilities the map will be able to output the location of "overlapping" data. This has been tested with the limited amount of data currently acquired and has shown great promise in being able to locate with color coded polylines and zones the areas where a MoDOT facility may be directly impacting an impaired water body (Fig. 3). Some of the steps used in creation of the current ArcGIS map can be seen in the Appendix of this report. In addition to the preexisting data, new data gathered from site visits, visual inspections, and water sampling will allow for greater detail and certainty of the displayed information and allow for more efficient use of future sampling and monitoring. This gathered data, especially information on the water quality of the site runoff material, will greatly help with the second function of the map, the modeling.

(2) Providing a basis for **modeling of water quality and the movement of constituents** is the secondary function of the ArcGIS map being created. Once sufficient data is collected from the areas of concern the map could then be used to help simulate a wide range of events allowing for prediction of movement of constituents and their impact on the surrounding water quality. This would allow for the simulated testing of mitigation devices like BMPs and also allow for modelers to possibly determine potential problem areas from seasonal activities such as snow melt and construction runoff.

Figure 3 is the result of an effort to take the approved 2008 303(d) listing and to query stream segments that lists the contaminant as either chloride, sediment, toxicity, or unknown. Once these segments were isolated they were coded and then pulled from a Missouri streams map. This information was then overlain on  a Missouri County map.  The resulting layered map now provides some indication of where MoDOT should concentrate their monitoring efforts and why.

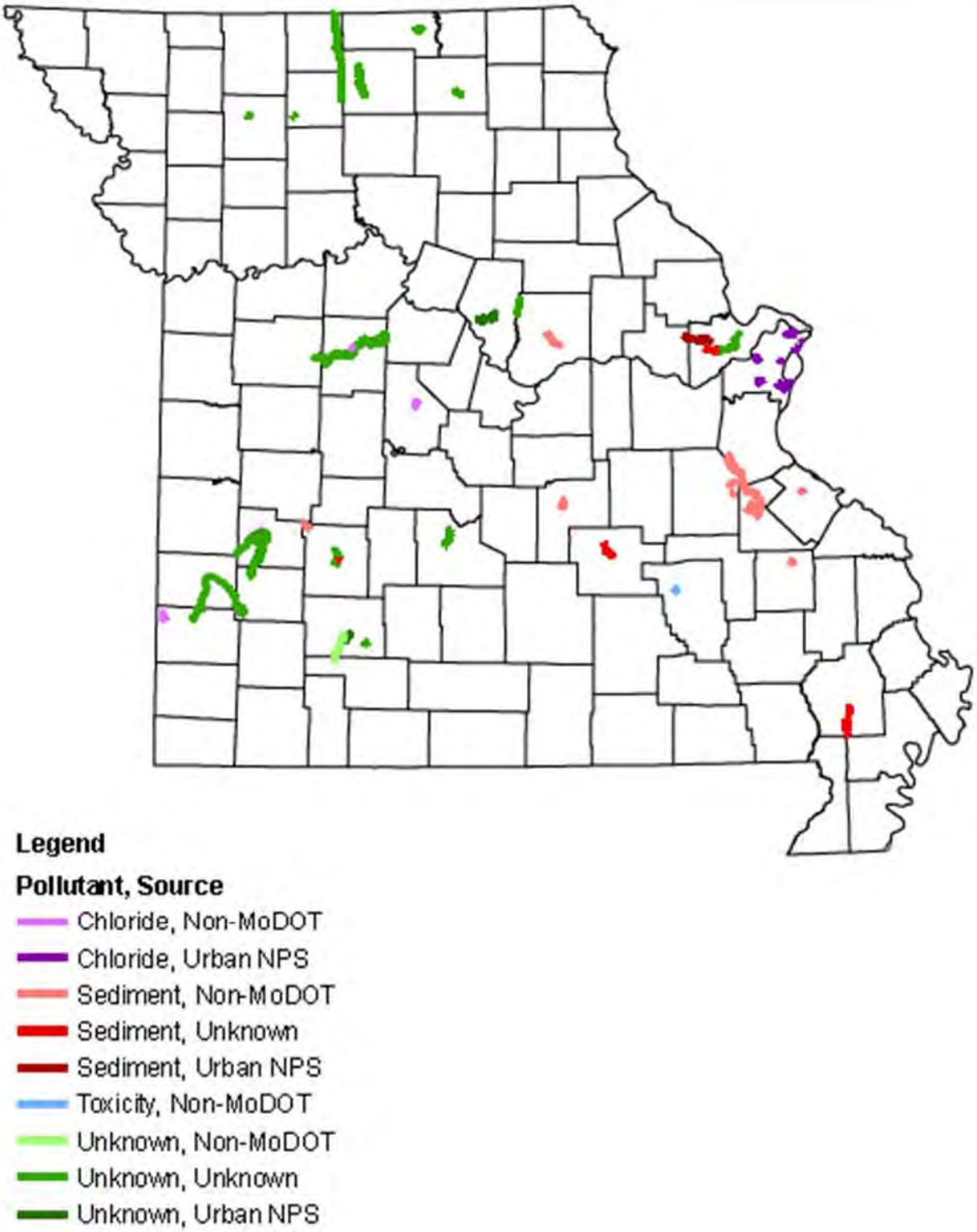



Figure 3: Example ArcMap of the approved Missouri 2008 303(d) listed stream locations that may be of concern to MoDOT *(a listing of these specific streams is located in Appendix F)*

Figure 3 also shows three source types as found in the 2008 303(d) list. They are known, non-MoDOT sources (like mines or poultry facilities), unknown (EPA/MDNR have not yet determined a source), and urban nonpoint source (NPS; as declared by EPA/MDNR). It is recommended that MoDOT consider the urban NPS looking forward.

### b. Monitor & Response Decision Tool

As shown in Figure 4 and re-illustrated in Appendix D, the Monitor & Response Decision Tool is more actually use of the Water Quality Impact Database (WQID) to interface with the ArcGIS map to visually allow for decisions to be made about the need to monitor water quality before, during, and after the completion of various MoDOT activities or as part of specific MoDOT activities.

## Using Microsoft Access to Archive Data, Provide Output for ArcGIS, and Generate Reports Regarding Project/Activity Information and Field Measurements, Pollutants by Impaired Streams, and BMPs

The purpose of this MoDOT Access database is to store relevant data regarding the activity as well as any field measurements taken pertaining to the impaired water body. User input data is stored in the tables section of the program. ArcGIS data is generated automatically with the user exporting the data, in Excel, for use. Additionally, reports can be generated listing the information needed by MoDOT personnel.

There are four sections to the MoDOT Access database: 1) tables, 2) queries, 3) forms, and 4) reports. The tables section has the information from the 303(d) list, the counties in the state of Missouri, the pollutants, the BMPs, and the units of measurement. These data are "pre-loaded;" if the user requires additional data not already on the list they may do so by opening the desired table in "Design View" and adding the necessary data. All input data is stored in the various tables.

There is currently only one query; this is for storing the ArcGIS data for later export (into Excel). The data stored in this query lists the X and Y coordinates in point format, the pollutant, and the amount of pollutant in the sample taken on site.

The forms section has two separate forms for data input, which is stored in the respective table. The first form is for project/activity/field measurements, and the second is for information regarding the use of BMPs. The project/activity/field measurements form has been discussed previously. The BMPs form is used to list the activity name, describe the BMPs being used, and the effectiveness of the BMPs by comparing a base line measurement from the impaired stream to a second measurement from the same impaired stream at the same location. If the BMPs are working there should be minimal change between the two measurements.

Three reports are currently available; the first is for the project/activity/field measurements, the second is for the BMPs, and the third is a report listing the impaired streams and the pollutants for which these water bodies are impaired.

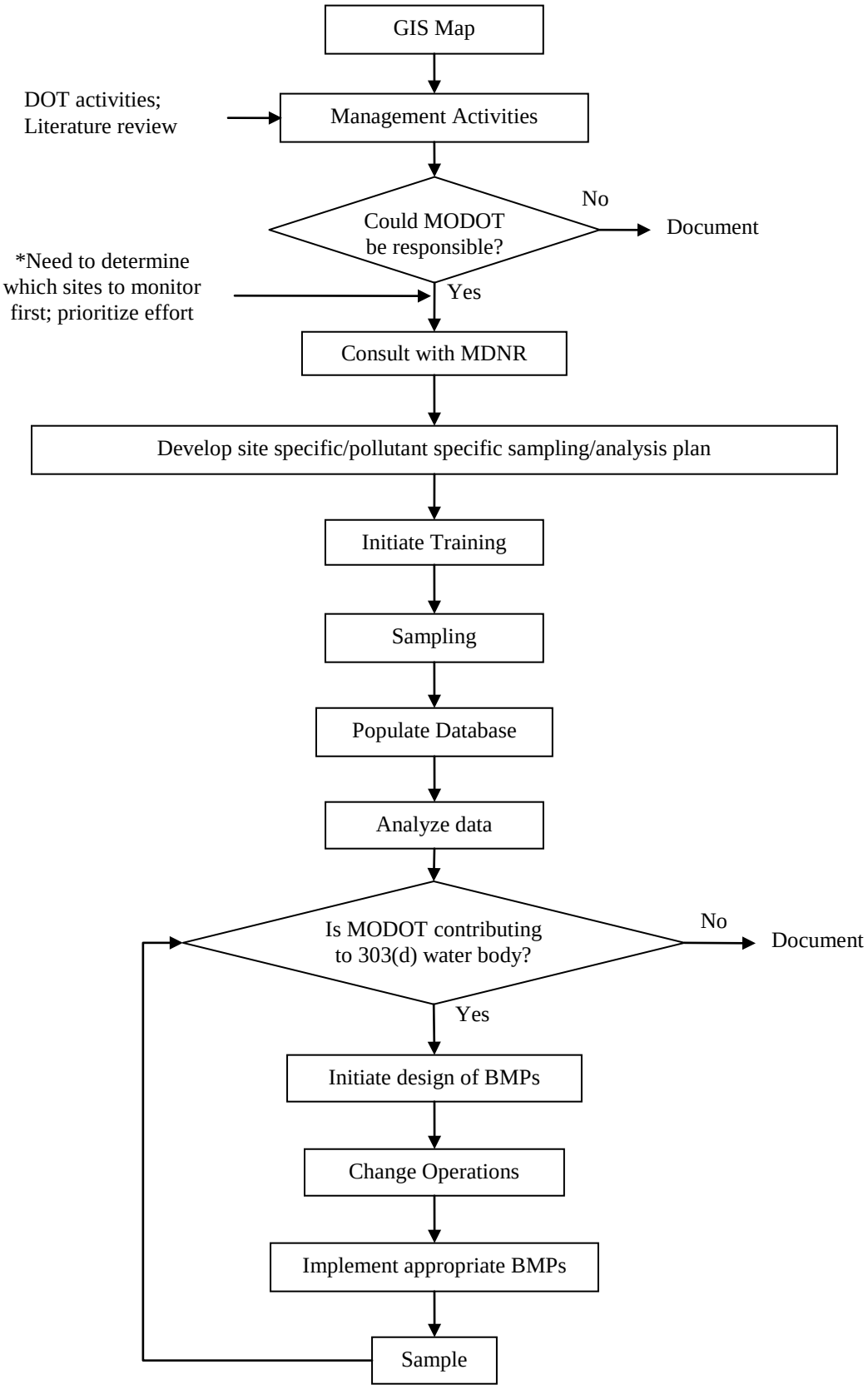



Figure 4: Flowchart of the Decision Tool

### c. Water Quality Impact Database (WQID)

**To start using the Access program**

After the program is open, there will be a blank sheet in the center of the screen and a column of ALL ACCESS OBJECTS on the left. The ALL ACCESS OBJECTS consists of Tables, Queries, Forms, and Reports. By using these objects, the data can be stored and retrieved in a meaningful manner.

**FORMS**

There are two forms available for data input, 1) Field Measurements and 2) BMP Measurements.

Field Measurements

To input data into the Field Measurements Form, click on Field Measurements in the ALL ACCESS OBJECTS column. This form is laid out in the same manner as the Activity/Field Data sheet to simplify data entry.

The activity data and the field data will be completed at different times, with the project/activity data being completed first. The top section, Activity Data, should be completed by someone familiar with the activity specifics: Name of the activity, location of the activity, etc. Once this data is entered it is stored in the Field Measurements Table. If there are more projects to be entered the user should click on the "Add Record" button located at the bottom of the form. Once the user has entered all project data, the "Close Form" icon should be pressed. After the field employee completes the field measurements on site and the laboratory results are returned to MoDOT, the rest of the form for the specified project can be completed. The user can simply tab through the records by using the "Next/Previous" buttons located at the bottom of the form. One must be very cautious inputting the data, e.g. Activity1 is not the same as Activity I.

To aid the user in inputting the data, drop down lists have been added for the water body identification number (WBID), County, Parameter testing for, and lab result units.

BMP Measurements

The BMP Measurements form aids MoDOT in evaluating the control measures which are in place. This information may be obtained from the comment section. Recall this section is to be used to record any important site specific information. The BMP Measurements form has inputs for the project/activity name, results of a baseline sample of the water body, the type of BMP being used, the spacing of the BMPs, the post BMP measurement of the water body, and the WBID. The WBID is a pull down list.

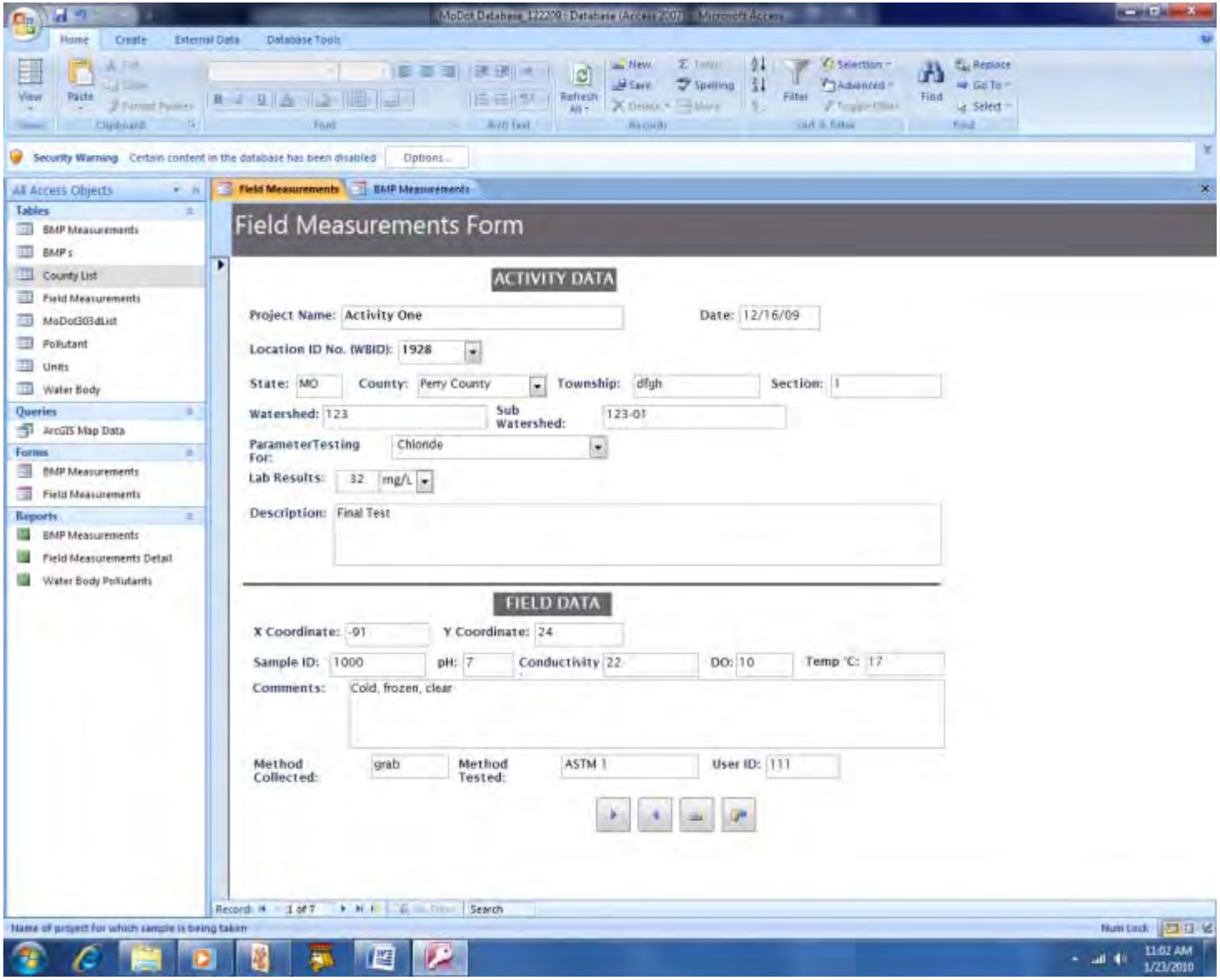
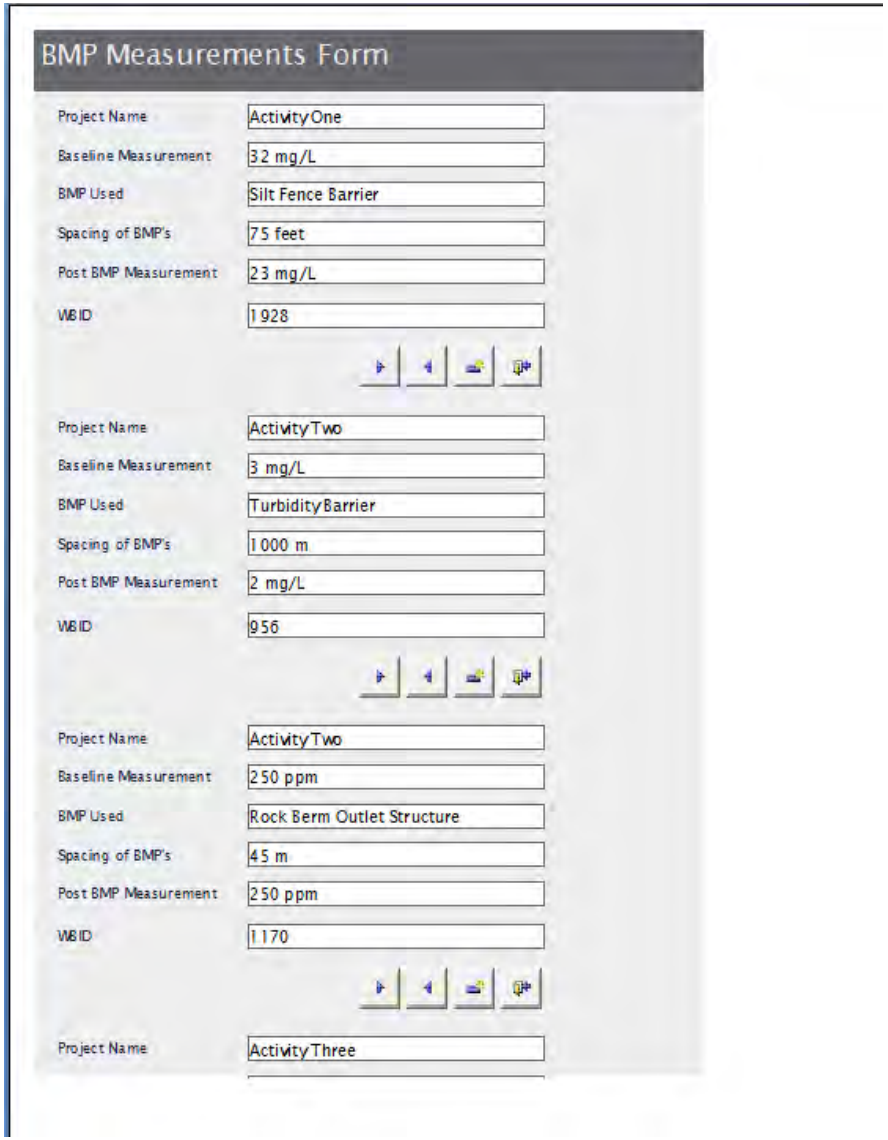



Figure 5: Form for Field Measurements



BMP Measurements Form

| | |
|---|---|
| Project Name | ActivityOne |
| Baseline Measurement | 32 mg/L |
| BMP Used | Silt Fence Barrier |
| Spacing of BMP's | 75 feet |
| Post BMP Measurement | 23 mg/L |
| WBID | 1928 |

| | |
|---|---|
| Project Name | ActivityTwo |
| Baseline Measurement | 3 mg/L |
| BMP Used | TurbidityBarrier |
| Spacing of BMP's | 1000 m |
| Post BMP Measurement | 2 mg/L |
| WBID | 956 |

| | |
|---|---|
| Project Name | ActivityTwo |
| Baseline Measurement | 250 ppm |
| BMP Used | Rock Berm Outlet Structure |
| Spacing of BMP's | 45 m |
| Post BMP Measurement | 250 ppm |
| WBID | 1170 |

| | |
|---|---|
| Project Name | ActivityThree |

Figure 6: Form for the BMP Measurement

## REPORTS

Three reports are currently available: BMP Measurements, Filed Measurements Detail, and Water Body Pollutant.

BMP MEASUREMENTS

The BMP Measurements report displays the project/activity related BMPs in an easily readable columnar format.

Field Measurements Detail

The Field Measurement Detail report displays all project/activity information in the familiar Project/activity/field Measurement Data sheet format.

Water Body Pollutant

The Water Body Pollutant report lists the impaired stream segments, by WBID and the pollutants which make these segments impaired. This information provides MoDOT staff with a quick method to see why a particular water body is listed on the EPA 303(d) list and whether the activity may contribute to the impairment.

## QUERIES

ArcGIS Map Data

The ArcGiS Map Data collects the needed information to be used in mapping data collection points and the pollutant levels at the specified location. The query lists the X and Y coordinates (in point form), the pollutant tested for, and the results of the test. This data may be exported in Excel spreadsheet format.

Exporting the data, via Excel, to ArcGIS :

1. Open the query "ArcGIS Map Data"
2. In the main ACCESS toolbar click on "External Data"
3. In the Export section click on Excel. An export dialog box will pop-up
4. In the "File Name" section enter the desired destination location for the Excel file, or click on "Browse" to find the desired file destination. The file format should say "Excel workbook (*.xlsx)"
5. Click "Close"

These data are now ready to be uploaded for ArcGIS.

## TABLES

In the ALL ACCESS OBJECTS column, there are several tables. Some of these tables only store data, others are used to provide the information for the pull down lists, and the MoDOT 303(d) table feeds the information to the rest.

Data collectors

The BMP Measurements and Field Measurements Table only store the inputted data. They should not require any outside manipulation.

Pull Down Information

The BMPs, County List, Pollutant, and Units Tables are pre-loaded with the information used in the pull down menus accessed in the Forms. The only reason one may need to manipulate these tables would be to add additional choices to the list, e.g. a type of BMP being used that is not already on the BMPs table.

EPA 303(d) List Information

The MoDOT 303(d)List Table lists the EPA's 303(d) List. This table will need to be updated every time the 303(d) List is published (usually every two years). This current 303(d) list information can be downloaded from:

http://www.dnr.mo.gov/env/wpp/docs/2006final-epa-list.pdf

This data is in PDF format and as such will require Adobe Acrobat Pro to convert it to Excel. Once the pdf is saved on a local computer, open the file using Adobe Acrobat Pro, then export the file in Excel format.

Once the 303(d) List is in Excel format, the column heading needs to be compared with the column heading of the MoDOT 303(d)List Table in Access. These column headings must be the same; if they are not, edit the column heading of the Excel file so the headings match.

Now the new 303(d) list is ready to be uploaded to Access.

1. Open Access (enable option)
2. On main toolbar click "external data"
3. On Import section click on Excel
4. Under file name: Enter the location of the Excel 303(d) List or click Browse to find the file location
5. Click on "append a copy of the record to the table"
6. Select the "MoDOT303(d)List" table from the pull down menu
7. The Import Wizard window will pop up, if not already selected, click on "show workbook"
8. Click "Next" twice
9. Ensure MoDOT303(d)List is showing in the "Import to Table" window
10. Click "Finish"

The MoDOT 303(d) List Table should now be loaded with the new data. Once this table is loaded, the Water Body table should also have the new data, as the MoDOT 303(d) List Table "feeds" the Water Body Table.

The database is now ready to be used with the current EPA 303(d) list data.

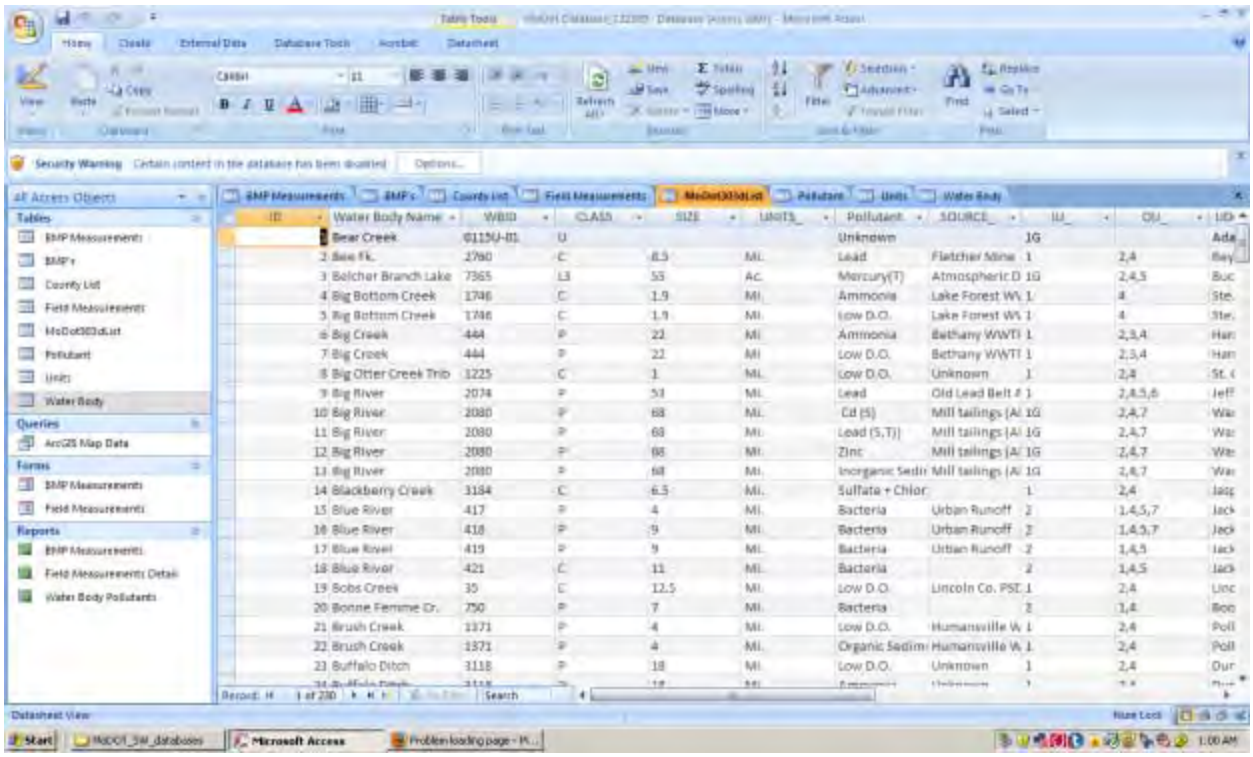


Figure 7: Screen shot of the Microsoft Access generated Water Quality Impact Database (WQID)

### d. Sampling and Analysis Plan

This section provides an overview of the background information gathered as to the hazards and risks posed by the identified constituents of concern for the water quality monitoring system, these constituents being: sediments, chlorides, and petroleum. When looking at highway runoff the Federal Highway Administration established in their Constituents of Highway Runoff, State-of-the-Art Report that "highway runoff characteristics are similar to that of urban runoff and may exert significant shock pollution loads on receiving water." (Gupta et al. 1981) Under this assumption we can look at the typical constituents in urban runoff, as shown in Table 1, and determine from that list where MoDOT's facilities and highways may be impacting waters listed on the 303(d) list. The decision to focus only on three constituents was made because of the frequency of MoDOT activities that would contribute to increased amounts of that constituent as well as feasibility of monitoring and control. Using the most up to date version of the 2004/2006 303(d) list we see that many constituents outside of the three used in this project already have defined sources. A ranking of the 303(d) list pollutants can be seen in Table 2.

Table 1: Summary of Urban Runoff Pollutants (EPA 1993)

| Category | Parameters | Possible Sources | Effects |
|---|---|---|---|
| Sediments | Organic & Inorganic | Construction Sites | Tubidity |
| | Total suspended solids | Urban/agricultural runoff | Habitat alteration |
| | Turbidity | CSOs | Recreational and aesthetic loss |
| | Dissolved solids | Landfills, septic fields | Contaminant transport |
| | | | Navigation/hydrology |
| | | | Bank erosion |
| Nutrients | Nitrate | Urban/agricultural runoff | Surface Waters |
| | Nitrite | Landfills, septic fields | Algal blooms |
| | Ammonia | Atmospheric deposition | Ammonia toxicity |
| | Organic nitrogen | Erosion | Ground Water |
| | Phosphate | | Nitrate toxicity |
| | Total phosphorous | | |
| Pathogens | Total coliforms | Urban/agriculural runoff | Ear/intestinal infections |
| | Fecal coliforms | Septic Systems | Shelfish bed closure |
| | Fecal streptococci | Illicit sanitary connections | Recreation/aesthetic loss |
| | Viruses | CSOs | |
| | *E. Coli* | Boat discharges | |
| | Enterococcus | Domestic/wild animals | |
| Organic enrichment | Biochemical oxygen demand (BOD) | Urban/agricultural runoff | Dissolved oxygen depletion |
| | Chemical oxygen demand (COD) | CSOs | Odors |
| | Total organic carbon (TOC) | Landfills, septic systems | Fish kills |
| | Dissolved oxygen | | |
| Toxic pollutants | Toxic trace metals | Urban/agricultural runoff | Bioaccumulation in food chain |
| | Toxic organics | Pesticides/herbicides | organisms and potential toxicity |
| | | Underground storage tanks | to humans and other organisms |
| | | Hazardous waste sites | |
| | | Landfills | |
| | | Illegal oil disposal | |
| | | Idustrial discharges | |
| Salts | Sodium chloride | Urban runoff | Vehicular corrosion |
| | | Snowmelt | Contamination of drinking water |
| | | | Harmful to salt-intolerant plants |

Table 2: Missouri 303(d) Pollutant Occurrence Table

| Missouri 303(d) List Pollutant | # of Occurrences | Percentage of Total Occurrences | Missouri 303(d) List Ranking of Occurrence |
|---|---|---|---|
| Ammonia | 7 | 3.07% | 7 |
| Atrazine | 1 | 0.44% | 12 |
| Bacteria | 40 | 17.54% | 3 |
| Chloride | 14 | 6.14% | 6 |
| Color | 2 | 0.88% | 9 |
| FC, E.Coli | 1 | 0.44% | 13 |
| Fish Trauma | 1 | 0.44% | 14 |
| Heavy Metals | 53 | 23.25% | 2 |
| Low DO | 66 | 28.95% | 1 |
| Nutrients | 4 | 1.75% | 8 |
| pH | 2 | 0.88% | 10 |
| Sediment | 17 | 7.46% | 5 |
| Sulfate | 2 | 0.88% | 11 |
| Temperature | 1 | 0.44% | 15 |
| Unknown | 18 | 7.89% | 4 |

*NOTE: Heavy metals, although listed as separate metals on the 303(d) list are combined for this evaluation.

**Sediments**

Sediments are a general term given to the various forms of solids transported in runoff. These sediments, or solids, are broken down into two different groups, total suspended solids (TSS) and total dissolved solids (TDS). The major concern of TDS in this study will be with the Chlorides/Salts explained later, thus no further discussion of TDS will be made in this section. This constituent covers a wide variety of materials both organic and inorganic that are put into suspension with runoff water from storm events. These materials may include clays, silts, dissolved minerals, or even parking lot debris (Murphy 2007). This excess material entering the water body can have ill effects on aquatic life as well as creating a more turbid body of water. Suspended solids interfere with the transmission of light in a body of water and can also disrupt the growth rate of fish (Viessman and Hammer 2005). Increased amounts of TSS can also raise the temperature of the water body as the solid particles absorb more heat thus also affecting the amount of dissolved oxygen in the body of water. Over time solids can settle out of suspension (KDW 1997a). This siltation provides both a problem and a solution to a high sediment load. The problem is that this siltation may close up the water body reducing reservoirs, ponds, and lakes into marshes and wetlands. If the location and timing of the siltation can be controlled through the use of Best Management Practices (BMPs) such as detention ponds, bio filters, or other media filters then the amount of sediments transmitted to the receiving body can be reduced in most cases quite effectively (BMPDB 2008b). When looking at the Missouri 303(d) list of impaired waters sediments are listed on 17 different waterways. Several methods may be employed to determine suspended solids or the turbidity that it causes. Turbidity is measured using Standard Methods (STM) 2130 and solids are to use STM2540. EPA Method 0160.2 will also define how to determine TSS in a sample.

**Chlorides/Salts**

Chlorides, or salts, are the combination of chlorine (Cl) with some other metal such as sodium (Na) or Calcium (Ca). While chlorides are not usually harmful to humans, high concentrations are detrimental to aquatic life and can contaminate drinking water supplies. Chlorides are also corrosive to metals, which makes industry use difficult for waters high in chlorides concentration and also causes vehicle corrosion. (KDW 1997b, EPA 1993) Salts are predominately used to combat icing of roads in the winter months. The widespread use of salts for deicing allows for them to be washed off into receiving water bodies especially during the spring snowmelt and rainstorms. (EPA 1993) Chlorides are the biggest concern for this project due to their extensive use by MoDOT to prevent and control icing of highways and the vast amount of salt storage facilities across the state. Chlorides total 12 of the listed waterways on the 303(d) list, 10 of which have no listed source. Once the salts are dissolved into the runoff or receiving stream there is no easy solution to remove them except through expensive desalination processes usually involving reverse osmosis, thus proper storage of deicing salts and conservative use for deicing are the best practices for controlling chloride contamination. (EPA 1993) Detection of chlorides in the water is typically done using Ion Chromatography (IC). (KDW 1997b) The process for conducting IC analysis is listed under STM 4110. One could also use conductivity as measured of dissolved salts in the water using STM 2510. EPA Method 300.0 provides guidance for the determination of dissolved anions such as chloride in water.

**Petroleum**

Petroleum products and their constituents are in certain quantities very harmful to humans and aquatic life alike. Petroleum products such as fuels are the primary concern for MoDOT due to the storage of them at the various maintenance facilities across the state. Fuels contain hydrocarbons as well as heavy metals that are regulated by EPA. For example in the state of Texas fuel stations are required to monitor runoff for the individual hydrocarbons weekly, with the total petroleum hydrocarbons being less than 15mg/L (1). Looking at the 303(d) list all listings of heavy metals such as lead, zinc, and cadmium have listed sources none of which are attributed to urban runoff or non-point sources. Also, we find that there are no hydrocarbon pollutants listed as well. The World Health Organization recommends in their *Guidelines for Drinking Water* that only spills should be considered for monitoring. (2) Several BMPs listed in Geosyntec Consultants & Wright Water Engineers, Inc., *Overview of Performance by BMP Category and Pollutant Type* show good performance in the reduction of metals and EPA's *Handbook: Urban Runoff Pollution Prevention and Control Planning* suggests that media filter BMPs such as sand filter do well and the removal of metals as well as suspended. The listed Standard Method for the detection of metals is an atomic absorption test, STM 3110. As can be seen from Table 1 petroleum is not listed as a typical pollutant in highway or urban runoff and none of its subsequent parameters (heavy metals, hydrocarbons) are listed on the 303(d) or already have a defined source. **This information helps support the need only for the monitoring of accidental spills or leaks and does not seem to warrant constant monitoring.**

Table 3: Summary of Top 6 303(d) Constituent Categories

| Category | Constituents | Missouri 303(d) List | MoDOT Concern | Standard Method | EPA Method |
|---|---|---|---|---|---|
| Low DO | - | 1 | Largest 303(d) contributor, many known sources, too many to monitor with too many contributing factors | - | - |
| Heavy Metals | Lead, Zinc, Cadmium, Mercury, Manganese, Nickel | 2 | Concern only if leak or spill of petroleum is found. All known sources accounted for and mercury is mostly atmospheric deposits. | STM 3110 | EPA 0200.0 |
| Bacteria | - | 3 | Majority of MoDOT activities do not contribute to bacterial load | - | - |
| Unknown | - | 4 | Can't determine what contribution if any MoDOT has with unknown sources or pollutants | - | - |
| Sediment | Inorganic & Organic Sediment | 5 | Large concern for MoDOT construction projects and permanent structures due to runoff | STM 2130, 2540 | EPA 0160.2 |
| Chloride | | 6 | Large concern for MoDOT due to extensive use of de-icing salts | STM 4110, 2510 | EPA 0300.0 |

Results of the testing at selected sites are submitted with the annual MS4 report. As an example of how the requirements may be agreed upon, samples would be expected to be taken at least 4 times a year of which 3 are base flow samples and 1 is a storm event sample.

### e. Training Materials for monitoring

Appendices B and C include instructions for the creation of the GIS layers when the 303(d) lists are updated and of an impaired stream field sampling report, respectively. These are some of the materials that have been organized to assist MoDOT with the implementation of this project. Appendix E is a user's manual for navigating through the Access database. The research group is also working toward a video screen capture of navigating the Access database.

## Conclusions

a. ArcMAP Functionality - By utilizing ArcGIS to quickly visualize the location of any impaired waterbody in relation to its activities, MoDOT will be able to allocate resources optimally.

b. Monitor & Response Decision Tool – The format developed for the WQID allows for project and maintenance activities to be linked to concerns about water quality in the area of the MoDOT activity. From this information determination of a priority list of monitoring needs becomes much more efficient.

c. Water Quality Impact Database (WQID) - will allow easy transition from field notes into electronic format which will allow easily generated reports listing all the MoDOT required data.

d. Sampling and Analysis Plan – A number of protocols are established for the sampling and analysis of water quality parameters. The frequency and location of sites to be monitored requires additional negotiation with the Water Quality Staff at the Missouri Department of Natural Resources. However, with the tools developed in this project, MoDOT has already been proactive in considering the framework that fosters the most efficient use of their resources.

e. Training Materials for monitoring – Guidance documents for organizing the ArcMap, and for using the forms are included in the appendices, along with a user's manual for the Water Quality Impact Database. The University of Missouri is also working on a video tutorial. The materials are intended for use by whoever is assigned the task of coordinating this storm water monitoring effort. Assistance with actual training sessions for district staff expected to conduct field measurements or any other MoDOT staff associated with the effort may be provided by the project team upon request from MoDOT.

## Recommendations

a. ArcMAP Functionality – Updates to the 303(d) list portion of the map should be done as soon as the new list is approved and circulated. Environmental and Historic Preservation staff may have to prompt the CADD personnel to make these changes to the database.

b. Monitor & Response Decision Tool – The need for monitoring should be determined by the MS4 coordinator for MoDOT. Updates to the database and map can then be prompted by this person to meet permit requirements.

c. Water Quality Impact Database (WQID) – Have MoDOT District personnel make use of the field sampling forms to collect samples and record pertinent field conditions at the time of the sampling. Staff in Jefferson City may then be responsible for analyzing the samples and uploading the analytical results into the database. It would be most efficient if the staff from the District had a way to complete an online form whose contents would populate the appropriate sections of the database based on the field observations and activities. Modifications to the database that allow a specific site to be the linkage between all of the data generated may be the best approach to how to query information.

d. Sampling and Analysis Plan – Based on TMDL review determine the needs for monitoring in the various Districts. Once a need is identified meet with MDNR staff to negotiate the most appropriate and effective monitoring plan.

e. Training Materials for monitoring – Pilot testing of the training materials in MoDOT personnel was envisioned when this project was proposed, but not done since the need to monitor is still to be determined. After the determination is made on when and where to monitor, MoDOT should either do internal training of staff using the project team as technical question support or ask the University of Missouri (MU) team to provide the training. The 'piloting' referred to here is designed to provide the MU team feedback so that the training materials may be improved to better fit the needs and culture of how things are done at MoDOT.

## Implementation Plan

Implementation includes the following tasks:

1. Development of an on-line form similar to what is currently used for updates to the maintenance database.
2. Review TMDLs to identify whether MoDOT installations are specifically identified.
3. Follow the guidance document to create the layers needed to illustrate the areas of concern around the State and therefore which Districts would be most affected by the need to monitor and where they should start.
4. Prepare field sampling forms for each of the areas of greatest concern.
5. Train field staff on sampling as well as documentation of activities.
6. Have District staff sample each of the areas to formulate a baseline of water quality data. Provide training as needed.
7. Based on sample analysis results prepare a draft proposal for monitoring that may be used as a starting point for negotiations with MDNR.

## Principal Investigator and Project Members

*(List all names, their title and responsibility for each.)*

***Dr. E. C. Inniss***, Ph.D., Assistant Professor – the principle investigator (PI) in charge of the overall management of the project and the lead on the development of the database components

***Dr. K. Trauth***, Ph.D., P.E., Associate Professor – co-PI and the lead on the development of the GIS map

***Dr. R.E. Reed***, Ph.D., P.E., Research Assistant Professor – co-PI and the lead on development of the decision tool and associated training materials.
***Dan David***, B.S., Master of Science student – worked on the Microsoft Access database framework and interface for the ArcGIS
***Matthew Wheeler***, undergraduate research student – worked on ArcGIS maps

## Implementation Objective

The objective of implementation of the framework developed in the project is to establish the protocols with which MoDOT will determine the need for monitoring water quality in order to meet MS4 permit requirements. This objective is also illustrated in Appendix D.

## Affected Business Units and Principal Contact (PC)

Environmental and Historic Preservation Division,
PC: William B. Carter (William.B.Carter@modot.mo.gov)

## Implementation Period

The implementation of the use of these tools depends greatly on the regulatory requirements for monitoring as promulgated by the Missouri Department of Natural Resources. In preparation for the permit renewal application the implementation period could start as soon as May 2010 and go at least until the submission of the next permit renewal application in early 2013. According to the Phase II General permit (MO-RO4000), renewal applications are due by 180 days before the expiration date, which is June 12, 2013 (MDNR 2008b).

## Funding

**To be determined,** but funds in the budget to support this effort will likely be from a split between the Design Division, the Maintenance Division, and the Construction Division.

## Technology Transfer

Appendices B, C, and E include guidance documents and a user's manual. Video tutorials may also be prepared by the University of Missouri to help users learn how to navigate the system. Training sessions may be proposed that allow MoDOT staff to ask questions and get feedback from MU researchers.

## Procedure

To be determined based on efforts placed in the implementation plan and subsequent discussions with MDNR on the need for monitoring.

**Budget** for the project that is being reported here.

Table 4 – Project Budget delineated by Task and by Month

| | | | TASK 1 - TMDL Report | | TASK 2 - Monitor and Response Decision Tool | | TASK 3 - Water Quality Impact Database | | TASK 4 - Sampling and Analysis Plan | | TASK 5 - Training Materials | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Approximate Completion and Billing Date | | | Jun-09 | | Dec-09 | | Sep-09 | | Nov-09 | | Dec-09 | | | |
| Name | Labor Category | Rate | Hours | Dollars | Hours | Dollars | Hours | Dollars | Hours | Dollars | Hours | Dollars | Hours | Dollars |
| **Direct Labor** | | | | | | | | | | | | | | |
| Inniss | Principal Investigator | $ 46.25 | 6 | $ 278 | 30 | $ 1,388 | 25 | $ 1,156 | 15 | $ 694 | 20 | $ 925 | 96 | $ 4,440 |
| Trauth | Professional | $ 50.53 | 57 | $ 2,880 | 7 | $ 354 | 0 | $ - | 0 | $ - | 8 | $ 404 | 72 | $ 3,638 |
| Reed | Professional | $ 46.00 | 0 | $ - | 57 | $ 2,622 | 0 | $ - | 0 | $ - | 15 | $ 690 | 72 | $ 3,312 |
| Graduate Student | Research Assistant | $ 17.58 | 60 | $ 1,055 | 300 | $ 5,274 | 250 | $ 4,395 | 150 | $ 2,637 | 200 | $ 3,516 | 960 | $ 16,877 |
| Undergrad Student | Research Assistant | - | 160 | $ 500 | - | $ - | - | $ - | - | $ - | - | $ - | - | $ 500 |
| **Direct Labor Total** | | | 283 | $ 4,713 | 394 | $ 9,637 | 275 | $ 5,551 | 165 | $ 3,331 | 243 | $ 5,535 | 1200 | $ 28,767 |
| **Direct Expenses** | | | | | | | | | | | | | | |
| Travel | | | | $ - | | $ 50 | | $ - | | $ - | | $ 100 | | $ 150 |
| Supplies | | | | $ 18 | | $ 18 | | $ 18 | | $ 18 | | $ 18 | | $ 90 |
| **Total Direct Expenses** | | | | $ 18 | | $ 68 | | $ 18 | | $ 18 | | $ 118 | | $ 240 |
| **Overhead** (on Direct Labor & Expenses) | | 36.60% | | $ 1,731 | | $ 3,552 | | $ 2,038 | | $ 1,226 | | $ 2,069 | | $ 10,617 |
| **Direct and Overhead Total** | | | | $ 6,462 | | $ 13,257 | | $ 7,608 | | $ 4,574 | | $ 7,722 | | $ 39,624 |
| **Indirect Expenses** | | | | | | | | | | | | | | |
| Tuition | | | | $ - | | $ - | | $ - | | $ - | | $ - | | $ 5,377 |
| **Total Indirect Expenses** | | | | $ - | | $ - | | $ - | | $ - | | $ - | | $ 5,377 |
| **TOTAL COSTS** | | | 283 | $ 6,462 | 394 | $ 13,257 | 275 | $ 7,608 | 165 | $ 4,574 | 243 | $ 7,722 | 1200 | $ 45,001 |
| | | | | | | | | | | | | | | |
| PROJECTED EXPENDITURES BY MONTH | | | | | | | | | | | | | | |
| | | Oct 08 | Nov 08 | Dec 08 | Jan 09 | Feb 09 | Mar 09 | Apr 09 | May 09 | Jun 09 | Jul 09 | Aug 09 | Sep 09 | Oct 09 |
| TOTAL ($) | | 0 | 0 | 0 | 4,396 | 1,820 | 1,820 | 4,354 | 4,352 | 1,708 | 1,708 | 6,806 | 6,284 | 6,284 |
| | | | | | | | | | | | | | | |
| | | Nov 09 | Dec 09 | Jan 10 | Feb 10 | Mar 10 | Apr 10 | May 10 | Apr 10 | May 10 | Jun 10 | Jul 10 | Aug 10 | TOTAL |
| | | 2,672 | 2,797 | 0 | | | | | | | | | | 45,000 |

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# Appendix A - Work Plan

Table A-1 – 2009 Schedule of tasks and milestones in for project "Development of the Framework for a Water Quality Monitoring System: Controlling MoDOT's Contribution to 303(d) listed streams in the State of Missouri"

| **Task/Milestones** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **a. TMDL Report** | | | | | | | | | | | | |
| Gather map layer information | | | | | | | | | | | | |
| Develop layers into functional map | | | | | | | | | | | | |
| Report on map functionality | | | | | | | | | | | | |
| **b. Monitor & Response Decision Tool** | | | | | | | | | | | | |
| Develop protocol for GIS map review | | | | | | | | | | | | |
| Develop protocol for WQID review | | | | | | | | | | | | |
| Explanation of decision criteria for pinpointing MoDOT contribution | | | | | | | | | | | | |
| Report on features of tool | | | | | | | | | | | | |
| **c. Water Quality Impact Database (WQID)** | | | | | | | | | | | | |
| Literature review of pollutants of concern | | | | | | | | | | | | |
| Literature review of other DOT efforts | | | | | | | | | | | | |
| Literature review of BMPs and removals | | | | | | | | | | | | |
| Template for storing WQ data | | | | | | | | | | | | |
| Report on the structure of the database | | | | | | | | | | | | |
| **d. Sampling and Analysis Plan** | | | | | | | | | | | | |
| Protocols based on FHWA/EPA resources | | | | | | | | | | | | |
| Worksheets/checklists development | | | | | | | | | | | | |
| **e. Training Materials for monitoring** | | | | | | | | | | | | |
| GIS map maintenance module | | | | | | | | | | | | |
| WQID maintenance module | | | | | | | | | | | | |
| Use of Monitor and Response Decision Tool | | | | | | | | | | | | |
| Pilot testing of training modules | | | | | | | | | | | | |
| Implementation Suggestions | | | | | | | | | | | | |
| **Quarterly Updates** | | | | | | | | | | | | |
| **Final Report Draft** | | | | | | | | | | | | |
| **Final Report** | | | | | | | | | | | | |

# Appendix B

Creation of layers in ArcGIS for Missouri 303(d) listed streams

A. **Acquiring and Converting the 303d List**

a. Often, a pre-prepared GIS Map of the 303d listed waterways in Missouri may be downloaded from http://msdis.missouri.edu. There is a several month delay, however, between the release of a new 303d list and the posting of a map to MSDIS. As there may be a desire to perform analysis before the MSDIS map is posted, instructions are provided here for the preparation for ArcGIS of the 303d list.

   i. If such a map is available, use the symbology options of ArcGIS to hide irrelevant 303d waterways, such as those contaminated with substance that are not possibly of MoDOT origin. Skip to section (E).

b. If a pre-prepared map is not available, a PDF of the 303d list can be found at the Missouri DNR website at http://www.dnr.mo.gov/env/wpp/waterquality/303d.htm.

c. The table in the PDF needs to be exported to Microsoft Excel with Adobe Acrobat Professional.

   i. In Excel, make a copy of all rows. For the original set, add a field and assign IDs in the format ####U for Upstream. For the second set, assign each row an ID in the format ####D for Downstream.

   ii. Add a field “UorD” and assign value “U” for the original set and “D” for the second set.

   iii. Create 2 new columns called Lat and Long. For the original set copy coordinates from Up lat/Up long fields, for downstream set copy coordinates from Down lat/ Down long.

   iv. Use the Data->Sort command in excel to sort by ID# to pair up U and D records. Be **very** careful to sort the whole row, not just the ID# field.

   v. Irrelevant entries may be deleted, although any records of disinterest can be hidden in ArcGIS.

   vi. Make sure all field names are less than 13 characters and have no spaces or special symbols. This is critical or you will encounter errors later.

   vii. Save the spreadsheet as a DBF4.

B. **Importing the list into ArcGIS**

a. Import the DBF into ArcGIS using "Add XY Data."

b. Make sure to set the coordinate system to WGS 1984 datum and select the appropriate Longitude (X) and Latitude (Y) fields.

c. Ensure the reasonableness of the display and projection by comparing the points with an NHD (National Hydrologic Dataset) layer. NHD data can be downloaded from the Natural Resources Conservation Service Geospatial Data Gateway at http://datagateway.nrcs.usda.gov/

## C. Displaying the Data

a. Use the "Unique Values, Many Fields" option in the symbology menu to give meaning to the data points.

   i. This author suggests using color to represent pollutant and shape to indicate source. Care must be taken to apply the formatting rules in an appropriate order.

   ii. The result is a map showing the upstream start points and downstream end points for each segment of 303d listed waterway. This map is very useful for an initial assessment of the general location or nature of 303d listed waterways.

## D. Converting the points to polylines.

a. If desired, the points layer can be use to clip the NHD layer to that the 303d stream are represented by actual polylines showing the stream segment, instead of simple points. This can very useful for analysis and display. Use the ArcGIS polygon editing tools to manually trim down a copy of the NHD layer to just the 303d listed waterways. Data about each waterway may be copied from the point layer to the newly created 303d waterway polyline layer.

## E. Adding other data

a. Additional data may now be added. Suggested data includes:

   i. Digital Elevation Model. 60m DEM can be downloaded from http://msdis.missouri.edu

   ii. 12 digit watershed boundary dataset. This can be downloaded from datagateway.nrcs.usda.gov

   iii. MoDOT sheds, roadways, districts etc.

## F. Importing Monitoring data from Access

Outline: Export the data table in Access as an XLS file. Use Microsoft Excel to resave the table as a DBF4 file. Use the “add XY data” feature of ArcGIS to import the data file, making sure to set the coordinate system to WGS 1984 datum and select the appropriate Longitude (X) and Latitude (Y) fields.

## G. Assessing possible MoDOT contributions to 303d waterways

It is now a much more straightforward task to determine by inspection those regions of MoDOT activity most likely to impact a 303d listed region. With the DEM data, 12 digit watersheds, 303d data, and MoDOT maps all overlain, an analyst can easily see areas of concern in which MoDOT activity is upstream of 303d site. ArcGIS permits the filtering of 303d sites by pollutant and identified sources, allowing MoDOT to focus monitoring and environmental protection efforts.

# Appendix C

## Creation of an Impaired Streams Field Sampling Report from the Access Database

The **MoDOT Impaired Streams Field Sampling Report** (hereafter called the report) is divided into two separate parts. The first section, **Project Data** is meant to be filled out by someone in the administration of the project/activity as this individual will have the necessary information to completely and accurately fill out this section. The **Field Data** is meant to be completed by the employee who is actually on site at the sampling location.

Completing the project/activity data should be straightforward; each field on the report is labeled with the required information needed:

**Project Name:**
This is the name MoDOT will assign to the given project/activity.

**Date:**
The date MoDOT feels will reflect on the project/activity; the start date, the date of the water sample, etc.

**Location ID No. (WBID):**
The EPA assigned number belonging to a particular impaired water body segment

**State, County, Township, Section:**
Information obtained from the state

**Parameter Testing For:**
This is the pollutant the water sample will be testing for; TDS, Chlorides, bacteria, etc.
Laboratory Results: After the water sample has been sent to an independent laboratory and tested, the results of the test should be entered in this field.

**Watershed, Sub-Watershed**:
Information obtained from the state

**Description:**
This space is for any identifying remarks about the project/activity; length of project/activity, contractors on site, special concerns with the project/activity, etc.

The Field Data section of the report is completed in much the same manner. The only difference being the information used will be supplied from the readout of a field data instrument.

**X and Y coordinate:**
These data are obtained with a portable (hand held) Global Positioning System (GPS). The location should be recorded at the actual site of where the water body sampling/tests are being conducted. The user needs to confirm the output data from the GPS in point format, <u>not</u> degrees, min, sec.

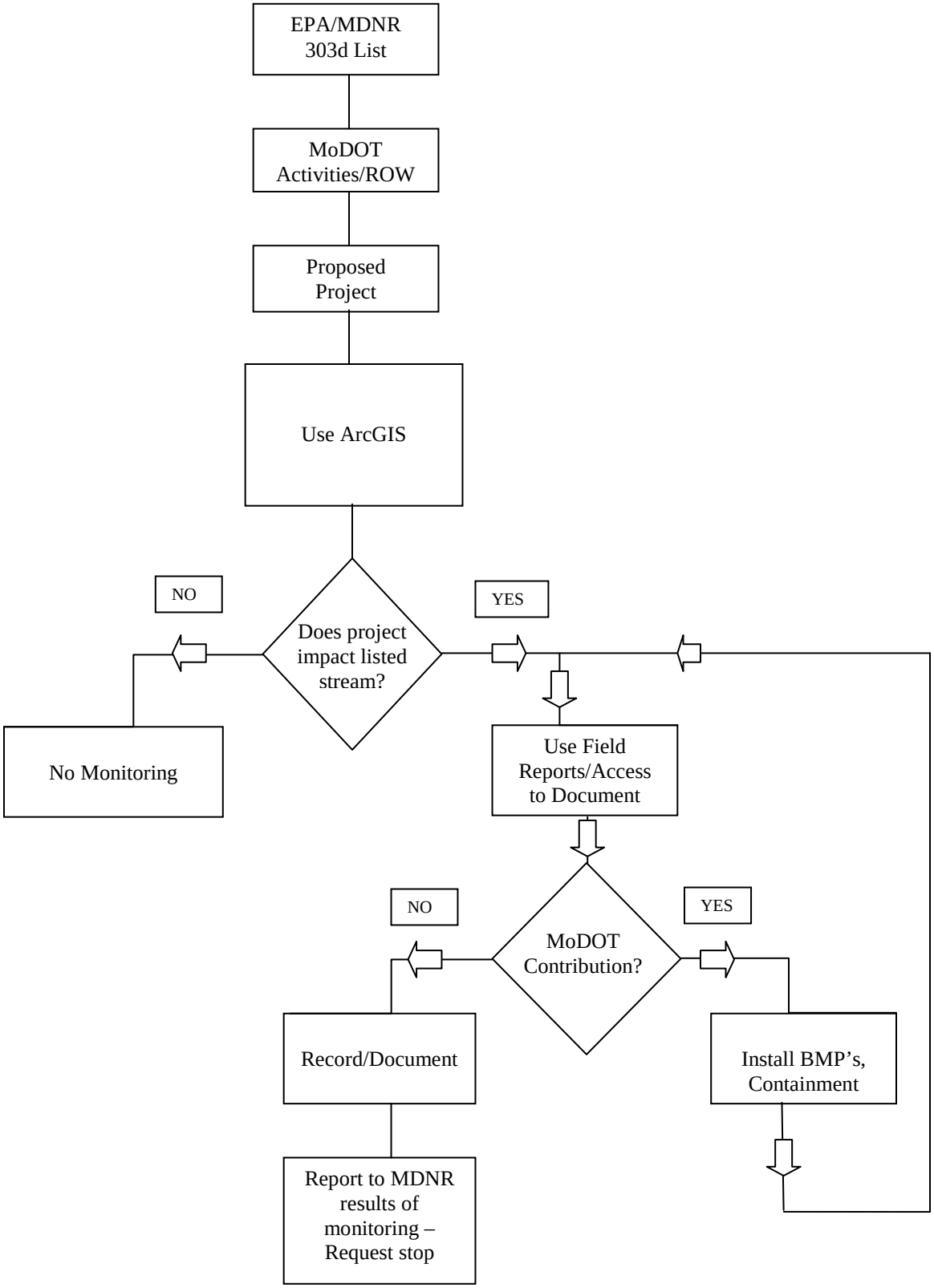
**Sample ID:** This Identification number will be the unique label the user puts on the sample. This number will be used to track the sample through testing at an independent laboratory, and will keep the sample with a particular project/water body.

**pH, Conductivity, Dissolved Oxygen (DO), Temperature in degrees Celsius**:
This data will be obtained using field instruments, the tests should be performed on the actual water body being sampled.

**Comments:**
This field should be used by the field technician to report any field conditions, soil type, weather conditions, and any other information of interest.

**User ID, Signature:**
This information ties the field report to the employee taking the test. This will ensure the correct person can be contacted if a question arises regarding the location, sample, or conditions at the site.

# **Appendix D –** Decision Flowchart for Use of Tools



## **Appendix E –** Access Database Users Manual (draft)

# Water Quality Impact Database (WQID)

Draft Access Manual

RI08-031

**Development of the Framework for a Water Quality Monitoring System: Controlling MoDOT's Contribution to 303(d) listed streams in the State of Missouri**

Prepared for
Missouri Department of Transportation
Organizational Results

by

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January 2010

RI08-031

# Access Database Manual
## Table of Contents


1. Introduction .....3

2. Starting the Access program .....4

3. Forms .....7
   - BMP Measurements
   - Field Data Sheet
   - Field Measurements

4. Reports .....12
   - BMP Measurements
   - Field Measurements Detail
   - Water Body Pollutants

5. Queries .....15
   - ArcGIS Map Data

6. Tables .....16
   - BMP Measurements
   - BMPs
   - County List
   - Field Measurements
   - EPA303(d)List
   - Pollutant
   - Units
   - Water Body

7. Exporting the Data, via Excel, to ArcGIS .....22

8. Importing the EPA303(d)List .....26

# INTRODUCTION

## USING ACCESS TO ARCHIVE DATA, PROVIDE OUTPUT FOR ArcGIS, AND GENERATE REPORTS REGARDING PROJECT/ACTIVITY INFORMATION and FIELD MEASUREMENTS, POLLUTANTS BY IMPAIRED STREAMS, and BMPS

The purpose of this MoDOT Access database is to store relevant data regarding the project/activity as well as any field measurements taken pertaining to the impaired water body. User input data is stored in the tables section of the program. ArcGIS data is generated automatically with the user exporting the data, in Excel, for use. Additionally, reports can be generated listing the information needed by MoDOT personnel.

There are four sections to the MoDOT Access database: 1) tables, 2) queries, 3) forms, and 4) reports. The tables section has the information from the 303(d) list, the counties in the state of Missouri, the pollutants, the BMPs, and the units of measurement. These data are "pre-loaded;" if the user requires additional data not already on the list they may do so by opening the desired table in "Design View" and adding the necessary data. All input data is stored in the various tables.

There is currently only one query; this is for storing the ArcGIS data for later export (into Excel). The data stored in this query lists the X and Y coordinates in point format, the pollutant, and the amount of pollutant in the sample taken on site.

The forms section has two separate forms for data input, which is stored in the respective table. The first form is for project/activity/field measurements, and the second is for information regarding the use of BMPs. The project/activity/field measurements form has been discussed previously. The BMPs form is used to list the project/activity name, describe the BMPs being used, and the effectiveness of the BMPs by comparing a base line measurement from the impaired stream to a second measurement from the same impaired stream at the same location. If the BMPs are working there should be minimal change between the two measurements.

Three reports are currently available; the first is for the project/activity/field measurements, the second is for the BMPs, and the third is a report listing the impaired streams and the pollutants for which these water bodies are impaired.

# STARTING THE ACCESS PROGRAM

After clicking the icon to open Microsoft Access, the user will need to click on the options button located below the menu bar.

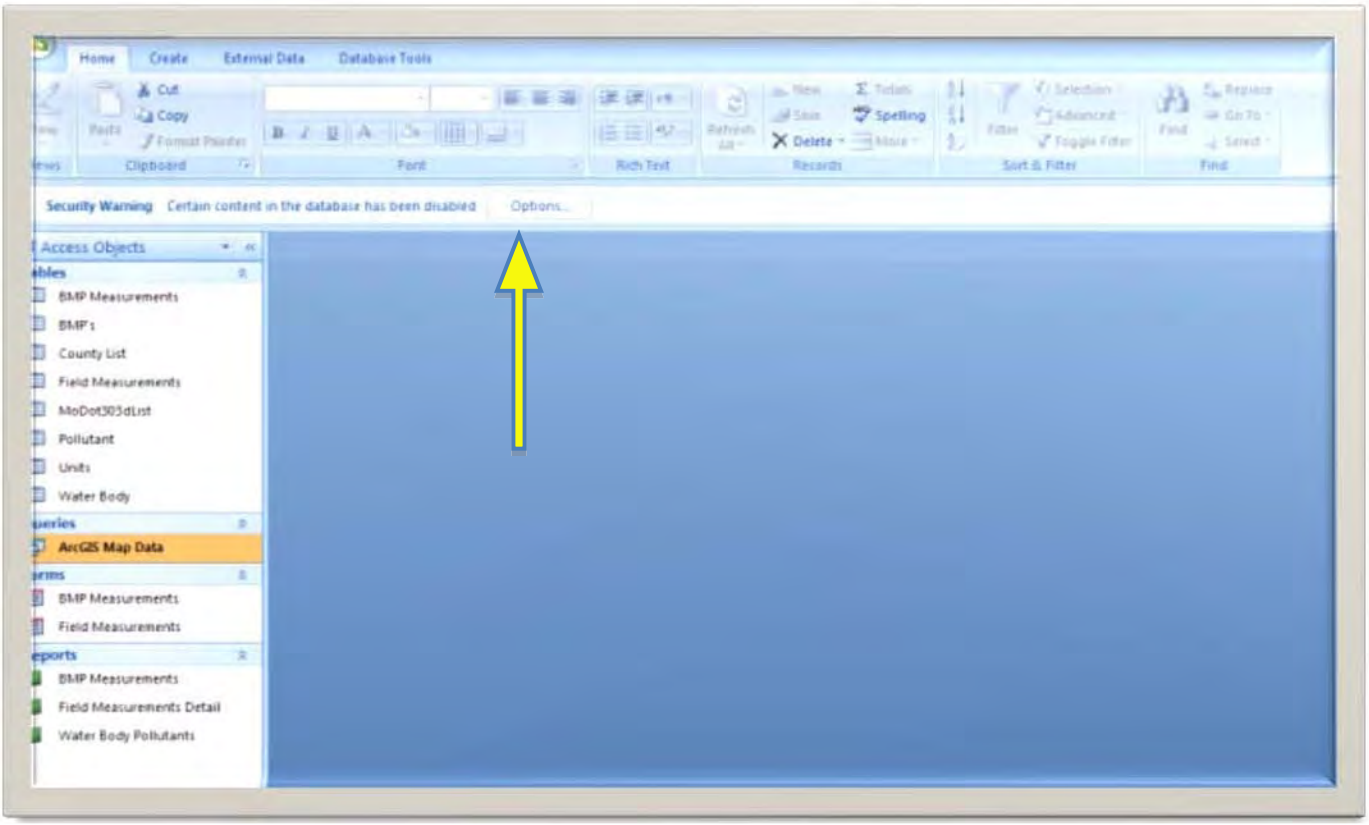



Figure 1

When the Security Alert box appears, click on “Enable this content”, this will enable all the features in Access.

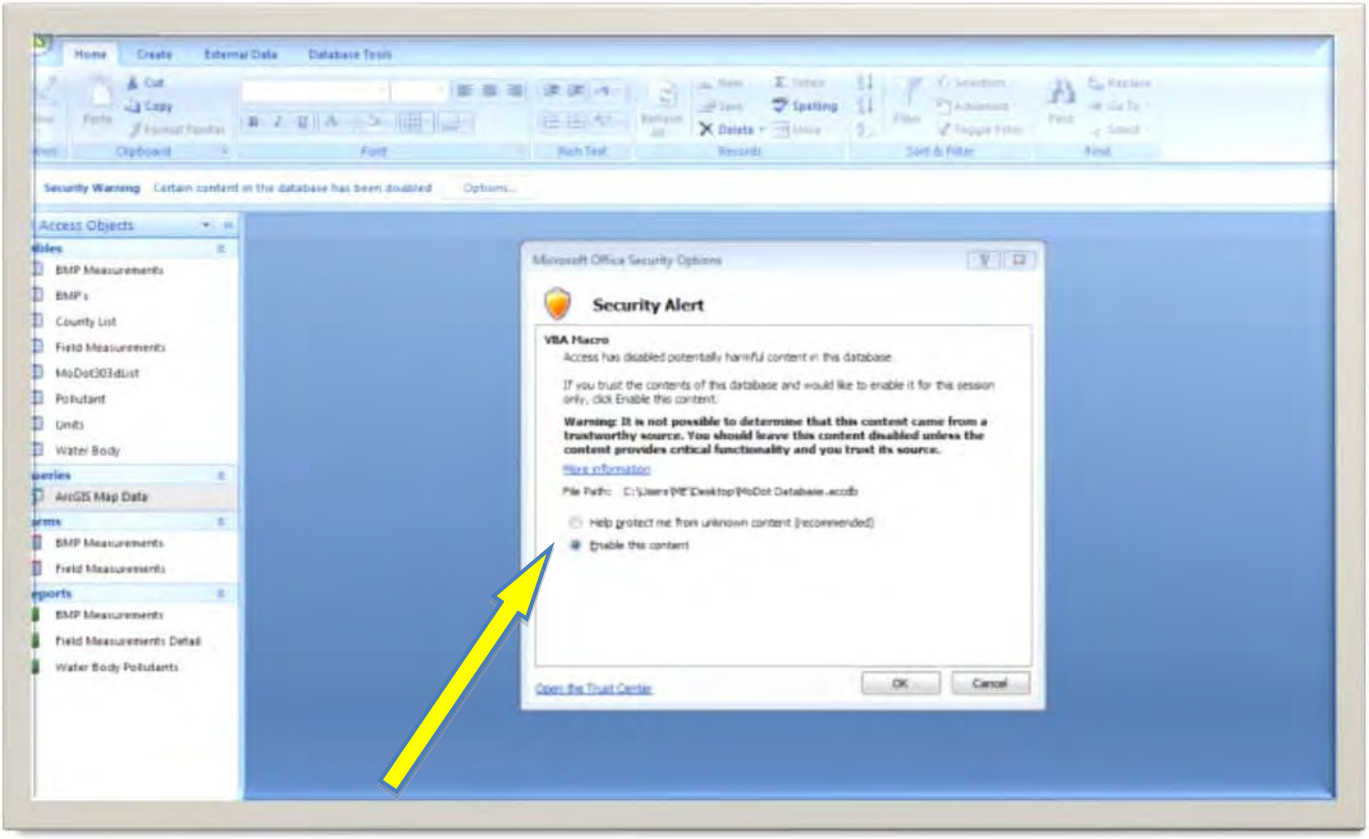



Figure 2

After the program is open, there will be a blank sheet in the center of the screen and a column of ALL ACCESS OBJECTS on the left. The ALL ACCESS OBJECTS consists of Tables, Queries, Forms, and Reports. By using these objects, the data can be stored and retrieved in a meaningful manner.

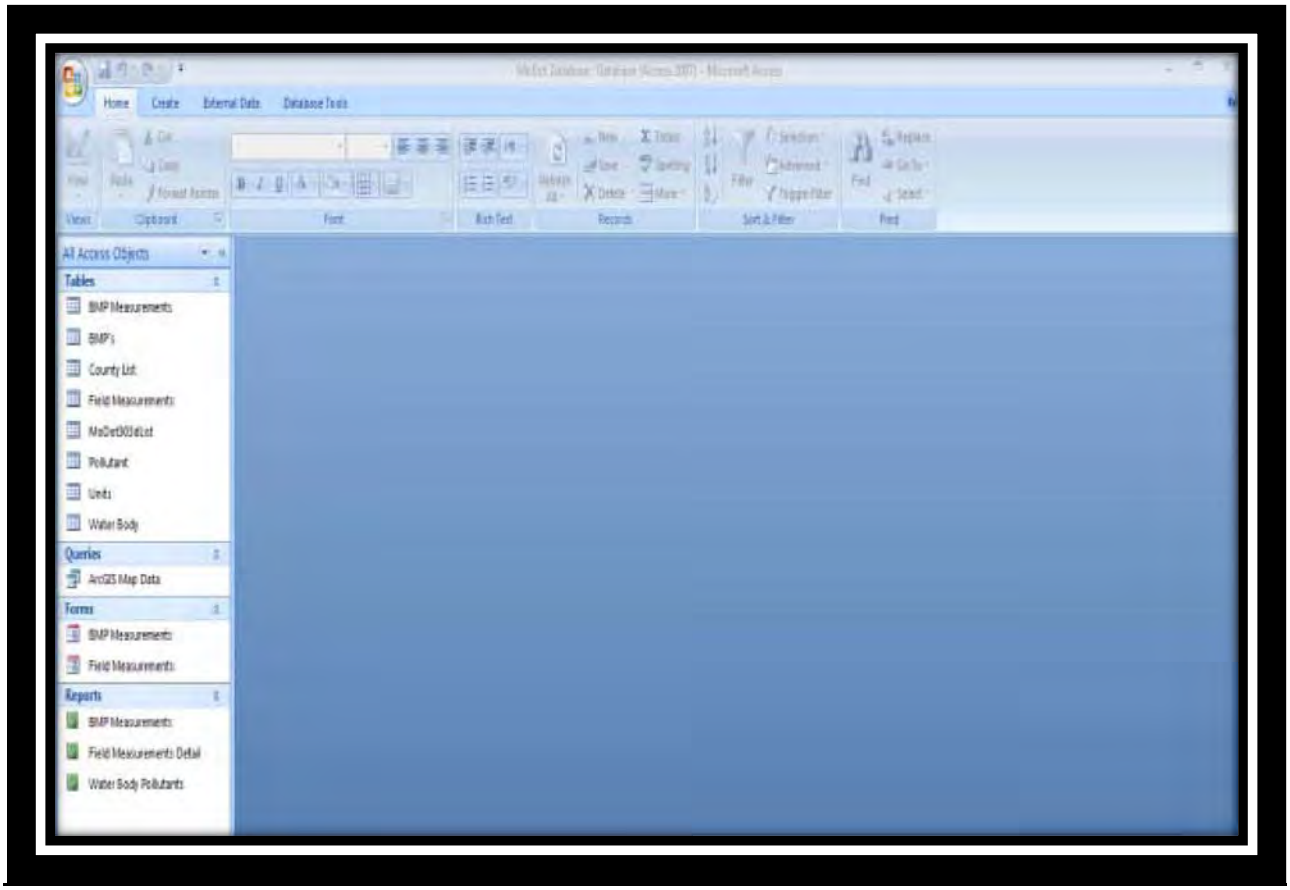



Figure 3

# FORMS

There are two forms available for data input, 1) BMP Measurements and 2) Field Measurements.

## BMP MEASUREMENTS

The BMP Measurements form aids MoDOT in evaluating the control measures which are in place. This information may be obtained from the comment section. Recall this section is to be used to record any important site specific information. The BMP Measurements form has inputs for the project/activity name, results of a baseline sample of the water body, the type of BMP being used, the spacing of the BMPs, the post BMP measurement of the water body, and the water body identification number (WBID). The WBID and the BMP used are pull down lists.

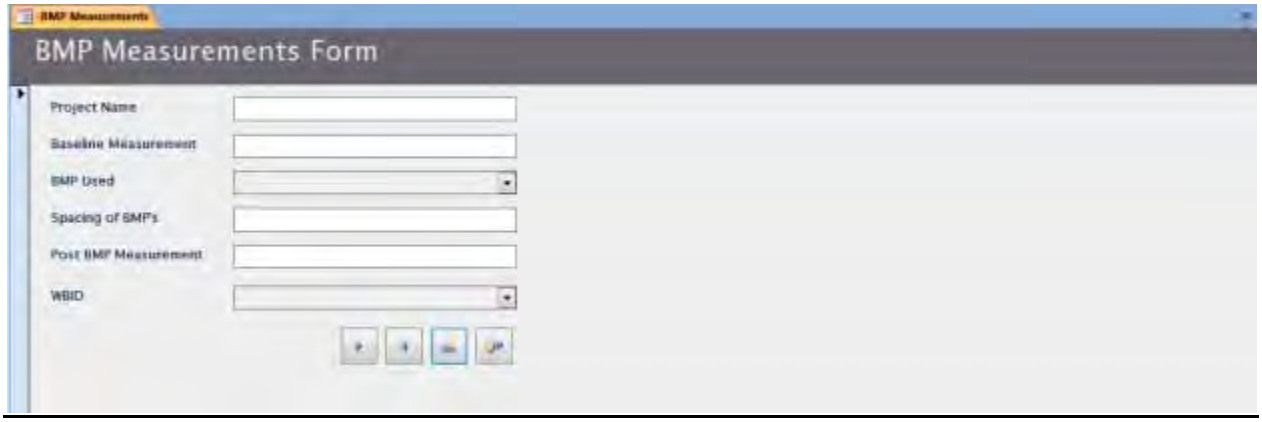



Figure 4

BMP Measurement Form with sample data filled in

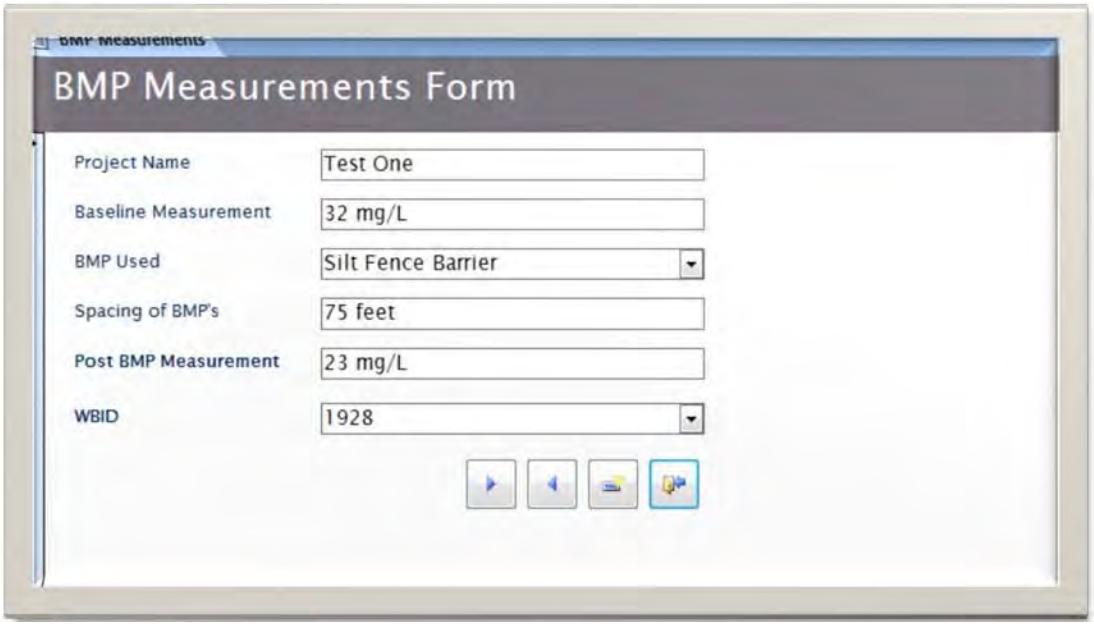



Figure 5

# Field Measurements

To input data into the Field Measurements Form, click on Field Measurements in the ALL ACCESS OBJECTS column. This form is laid out in the same manner as the Activity/Field Data sheet to simplify data entry.

The activity data and the field data will be completed at different times, with the project/activity data being completed first. The top section, Activity Data, should be completed by someone familiar with the activity specifics: Name of the activity, location of the activity, etc. Once this data is entered it is stored in the Field Measurements Table. If there are more activities to be entered the user should click on the "Add Record" button located at the bottom of the form. Once the user has entered all project/activity data, the "Close Form" icon should be pressed. After the field employee completes the field measurements on site and the laboratory results are returned to MoDOT, the rest of the form for the specified activity can be completed. The user can simply tab through the records by using the "Next/Previous" buttons located at the bottom of the form. **The naming convention for activities should be consistent in order to avoid confusion over the activity being referenced.** An Arabic one and a Roman numeral one, for instance Activity 1 versus Activity I, is seen by the database as separate activities. Such discrepancies in naming should be avoided whenever possible.

To aid the user in inputting the data, drop down lists have been added for the WBID, County, Parameter testing for, and lab result units.

Field Data Sheet (Screen Display of the Blank Field Measurements Form)

# Field Measurements Form

## ACTIVITY DATA

Activity Name: Date:

Location ID No. (WBID):

State: County: Township: Section:

Watershed: Sub Watershed:

ParameterTesting For:

Lab Results:

Description:

## FIELD DATA

X Coordinate: Y Coordinate:

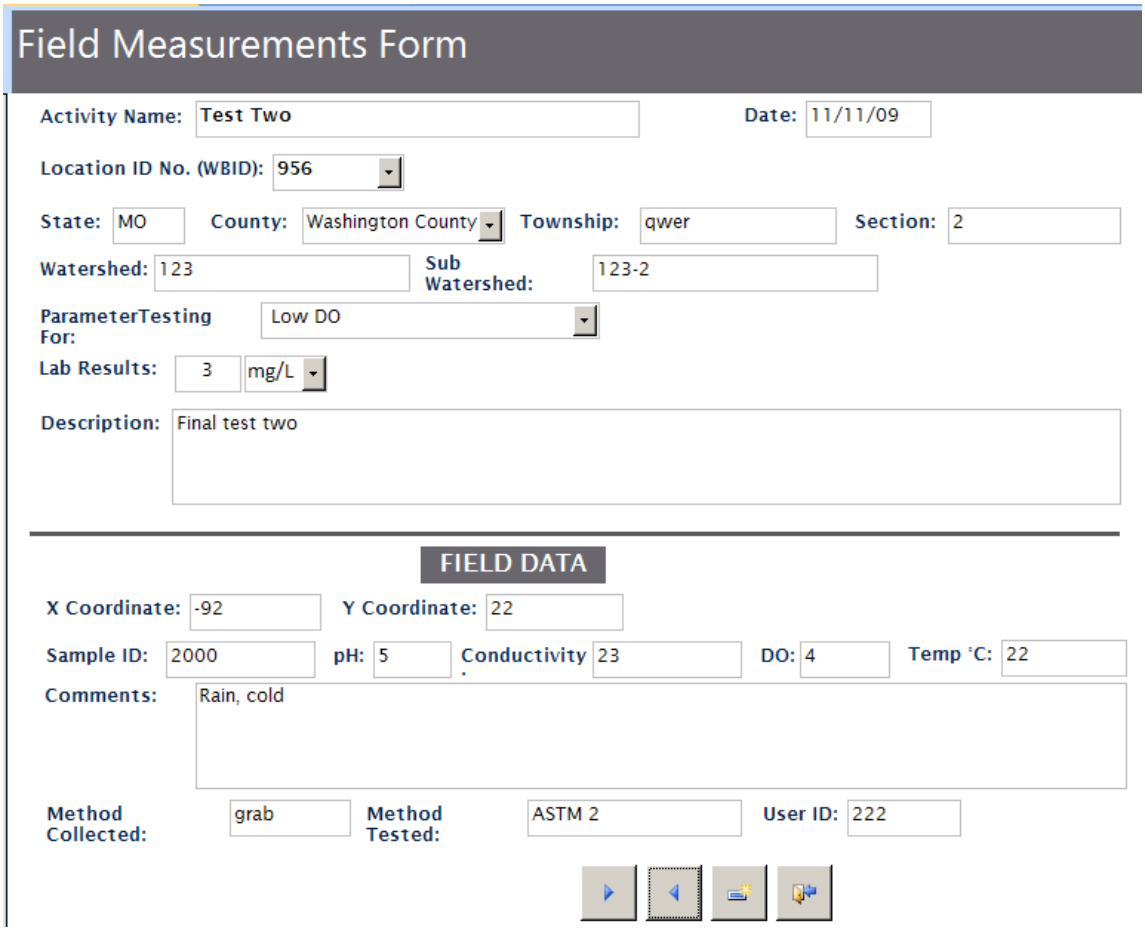
Sample ID: pH: Conductivity: DO: Temp °C:

Comments:

Method Collected: Method Tested: User ID:

Figure 6

Field Measurement Form with sample data filled in



Field Measurements Form

Activity Name: Test Two
Date: 11/11/09
Location ID No. (WBID): 956
State: MO
County: Washington County
Township: qwer
Section: 2
Watershed: 123
Sub Watershed: 123-2
ParameterTesting For: Low DO
Lab Results: 3 mg/L
Description: Final test two

FIELD DATA

X Coordinate: -92
Y Coordinate: 22
Sample ID: 2000
pH: 5
Conductivity 23
DO: 4
Temp °C: 22
Comments: Rain, cold
Method Collected: grab
Method Tested: ASTM 2
User ID: 222

Figure 7

# REPORTS

Three reports are currently available: BMP Measurements, Filed Measurements Detail, and Water Body Pollutant.

## BMP MEASUREMENTS

The BMP Measurements report displays the project/activity related BMPs in an easily readable columnar format.

### BMP Measurements

| Activity Name | WBID | Baseline Measurement | BMP Used | Spacing of BMP's | Post BMP Measuremen |
|---|---|---|---|---|---|
| **Activity Four** | | | | | |
| | 1317 | 220 ppm | Rock Barrier for Culverts and Sediment | 50 ft | 200 ppm |
| **Activity One** | | | | | |
| | 1928 | 32 mg/L | Silt Fence Barrier | 75 feet | 23 mg/L |
| **Activity Three** | | | | | |
| | 1008 | 23 ppm | Sediment Containment Filter Bag | 25 ft | 12 ppm |
| | 7020 | 43 ppm | Rock Barrier Check Structure | 10 ft | 40 ppm |
| **Activity Two** | | | | | |
| | 1170 | 250 ppm | Rock Berm Outlet Structure | 45 m | 250 ppm |
| | 956 | 3 mg/L | Turbidity Barrier | 1000 m | 2 mg/L |

Monday, February 01, 2010 Page 1 of 1

Figure 8

# Field Measurements Detail

The Field Measurement Detail report displays all project/activity information in the familiar Project/activity/field Measurement Data sheet format.

## Field Measurements Report

**Activity Name: Test Four**

**WBID: 1317** Sample Date: 12/12/09 **User ID: 333**

State: MO County: Lincoln County Township: mnbv Section: 4

Watershed: 567 Sub Watershed: 567-1

Parameter: Atrazine Laboratory Results: 220ppm

Description: Final Test...if all goes well

X Coordinate: -98 Y Coordinate: 22

Sample ID: 7000 pH: 3 Conductivity: 22 DO: 3 Temp Deg C: 16

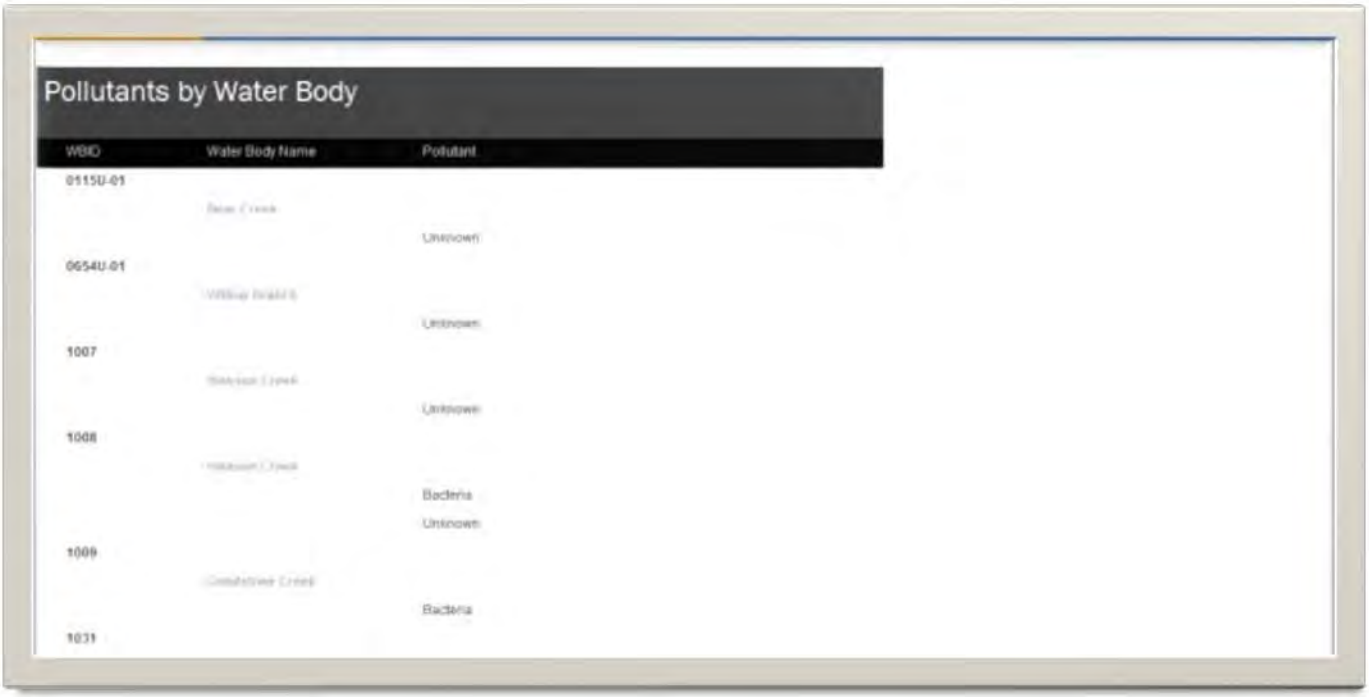
Method Collected: grab Method Tested: ASTM 3

Comments: Calm, clear

Figure 9

# Water Body Pollutant

The Water Body Pollutant report lists the impaired stream segments, by WBID and the pollutants that make these segments impaired. This information provides MoDOT staff with a quick method to see why a particular water body is listed on the EPA 303(d) list and whether the project/activity may contribute to the impairment.



Pollutants by Water Body

| WBID | Water Body Name | Pollutant |
|---|---|---|
| 0115U-01 | | |
| | [illegible] | |
| | | Unknown |
| 0654U-01 | | |
| | [illegible] | |
| | | Unknown |
| 1007 | | |
| | [illegible] | |
| | | Unknown |
| 1008 | | |
| | [illegible] | |
| | | Bacteria |
| | | Unknown |
| 1009 | | |
| | [illegible] | |
| | | Bacteria |
| 1031 | | |

Figure 10

# QUERIES

## ArcGIS Map Data

The ArcGiS Map Data collects the needed information to be used in mapping data collection points and the pollutant levels at the specified location. The query lists the X and Y coordinates (in point form), the pollutant tested for, and the results of the test. This data may be exported in Excel spreadsheet format to upload into ArcGIS.

| X Coordinate | Y Coordinate | Parameter | Result | Units |
|---|---|---|---|---|
| -91 | 24 | Chloride | 32 | mg/L |
| -92 | 22 | Low DO | 3 | mg/L |
| -89 | 20 | Nutrients | 43 | ppm |
| -91 | 24 | Chloride | 23 | mg/L |
| -89 | 21 | Inorganic Sediment | 250 | ppm |
| -88 | 20 | Organic Sediment | 23 | ppm |
| -98 | 22 | Atrazine | 220 | ppm |

Figure 11

# TABLES

In the ALL ACCESS OBJECTS column, there are several tables. Some of these tables only store data, others are used to provide the information for the pull down lists, and the MoDOT303(d) table feeds the information to the rest.

## DATA COLLECTORS

The BMP Measurements and Field Measurements Table only store the inputted data. They should not require any outside manipulation.

| ID | Baseline Measurement | BMP Used | Spacing of BMP's | Post BMP Measurement | WBID | Project Nam | Add New Field |
|---|---|---|---|---|---|---|---|
| 9 | 32 mg/L | Silt Fence Barrier | 75 feet | 23 mg/L | 1928 | Test One | |
| 10 | 3 mg/L | Turbidity Barrier | 1000 m | 2 mg/L | 956 | Test Two | |
| 11 | 250 ppm | Rock Berm Outlet Structure | 45 m | 250 ppm | 1170 | Test Two | |
| 12 | 43 ppm | Rock Barrier Check Structure | 10 ft | 40 ppm | 7020 | Test Three | |
| 13 | 23 ppm | Sediment Containment Filter Bag | 25 ft | 12 ppm | 1008 | Test Three | |
| 14 | 220 ppm | Rock Barrier for Culverts and Sedim | 50 ft | 200 ppm | 1317 | Test Four | |
| (New) | | | | | | | |

Figure 12

(Partial table)

| Sample ID | Project Name | WBID | Sample Date | User ID | X Coordinate | Y Coordinate | Temp Deg C | pH | Conductivity | DO | Parameter | Re |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1000 | Test One | 1928 | 12/16/09 | 111 | -91 | 24 | 17 | 7 | 22 | 10 | Chloride | |
| 2000 | Test Two | 956 | 11/11/09 | 222 | -92 | 22 | 22 | 5 | 23 | 4 | Low DO | |
| 3000 | Test Three | 7020 | 10/10/09 | 333 | -89 | 20 | 23 | 6 | 34 | 7 | Nutrients | |
| 4000 | Test One | 1928 | 12/30/09 | 444 | -91 | 24 | 15 | 6.8 | 20 | 7 | Chloride | |
| 5000 | Test Two | 1170 | 12/15/09 | 111 | -89 | 21 | 20 | 6 | 23 | 9 | Inorganic Sediment | |
| 6000 | Test Three | 1008 | 11/10/09 | 222 | -88 | 20 | 12 | 4 | 11 | 21 | Organic Sediment | |
| 7000 | Test Four | 1317 | 12/12/09 | 333 | -98 | 22 | 16 | 3 | 22 | 3 | Atrazine | |

Figure 13

# PULL DOWN INFORMATION

The BMPs, County List, Pollutant, and Units Tables are pre-loaded with the information used in the pull down menus accessed in the Forms. The only reason one may need to manipulate these tables would be to add additional choices to the list, e.g. a type of BMP being used that is not already on the BMPs table. The Water Body Table is loaded from the EPA303(d)List.

BMP's Table

BMP's

| ID | BMP's | Add New Field |
|---|---|---|
| 5 | Rock Berm Outlet Structure | |
| 6 | Riser Pipe Outlet Structure | |
| 7 | Rock Barrier for Culverts and Sediment Containment Systems | |
| 8 | Sediment Containment System Surface Skimmer | |
| 9 | Sediment Containment Filter Bag | |
| 10 | Sediment Containment System for Road Medians | |
| 11 | Single chamber Sediment Containment System | |
| 12 | Double-Chamber Sediment Containment system | |
| 13 | Bale Barrier | |
| 14 | Silt Fence Barrier | |
| 15 | Continuous Barrier | |
| 16 | Geosynthetic Barrier | |
| 17 | Turbidity Barrier | |
| 18 | Water-Filler Barrier | |
| 19 | Bale Barrier Around Area Drains | |
| 20 | Rock Barrier Around Area Drains | |
| 21 | Curb Inlet Division Berm | |
| 22 | Rock Barrier for Curb Inlets | |
| 23 | Curb and Gutter Sediment Containment Systems | |
| 24 | Inlet Insert Sediment Containment System | |
| 25 | Bale-Barrier Check Structure | |
| 26 | Geosynthetic Check Structure | |
| 27 | Rock Barrier Check Structure | |
| 28 | Vehicle Tracking Pad | |
| (New) | | |

Figure 14

County List Table

| ID | COUNTY | Add New Field |
|---|---|---|
| 1 | Adair County | |
| 2 | Andrew Count | |
| 3 | Atchison Coun | |
| 4 | Audrain Count | |
| 5 | Barry County | |
| 6 | Barton County | |
| 7 | Bates County | |
| 8 | Benton County | |
| 9 | Bollinger Coun | |
| 10 | Boone County | |
| 11 | Buchanan Cour | |
| 12 | Butler County | |
| 13 | Caldwell Coun | |
| 14 | Callaway Coun | |
| 15 | Camden Count | |
| 16 | Cape Girardeau | |
| 17 | Carroll County | |
| 18 | Carter County | |
| 19 | Cass County | |
| 20 | Cedar County | |
| 21 | Chariton Count | |
| 22 | Christian Coun | |
| 23 | Clark County | |
| 24 | Clay County | |
| 25 | Clinton County | |
| 26 | Cole County | |
| 27 | Cooper County | |
| 28 | Crawford Coun | |
| 29 | Dade County | |
| 30 | Dallas County | |

Figure 15

Pollutant Table

| Pollutant ID | Pollutant | Add New Field |
|---|---|---|
| 1 | Unknown | |
| 2 | Cadmium | |
| 3 | Lead | |
| 4 | Mercury | |
| 5 | Zinc | |
| 6 | Low DO | |
| 7 | Inorganic Sediment | |
| 8 | Organic Sediment | |
| 9 | Chloride | |
| 10 | Nutrients | |
| 11 | Ammonia | |
| 12 | Atrazine | |
| 13 | Bacteria | |
| 14 | Color | |

Figure 16

Units Table

| ID | Units | Add New Field |
|---|---|---|
| 1 | mg/L | |
| 2 | ug/L | |
| 3 | ng/L | |
| 4 | ppm | |
| 5 | ppb | |
| 6 | NA | |
| (New) | | |

Figure 17

Water Body Table

Water Body

| ID | WBID | Water Body Name | Add New Field |
|---|---|---|---|
| 1 | 0115U-01 | Bear Creek | |
| 2 | 2760 | Bee Fk. | |
| 3 | 7365 | Belcher Branch Lake | |
| 5 | 1746 | Big Bottom Creek | |
| 7 | 444 | Big Creek | |
| 8 | 1225 | Big Otter Creek Trib | |
| 9 | 2074 | Big River | |
| 13 | 2080 | Big River | |
| 14 | 3184 | Blackberry Creek | |
| 15 | 417 | Blue River | |
| 16 | 418 | Blue River | |
| 17 | 419 | Blue River | |
| 18 | 421 | Blue River | |
| 19 | 35 | Bobs Creek | |
| 20 | 750 | Bonne Femme Cr. | |
| 21 | 1371 | Brush Creek | |
| 24 | 3118 | Buffalo Ditch | |
| 25 | 1865 | Burgher Branch | |
| 26 | 7057 | Busch WQ Lake 35 | |
| 27 | 3234 | Capps Creek | |
| 28 | 3245U-01 | Cave Spring Branch | |
| 29 | 743 | Cedar Creek, Trib. | |
| 31 | 3203 | Center Creek | |
| 32 | 640 | Chariton River | |
| 33 | 1333 | Clear Creek | |
| 34 | 1336 | Clear Creek | |
| 35 | 3238 | Clear Creek | |
| 36 | 3239 | Clear Creek | |
| 38 | 935 | Clear Fork | |
| 39 | 7326 | Clearwater Lake | |

FIGURE 18

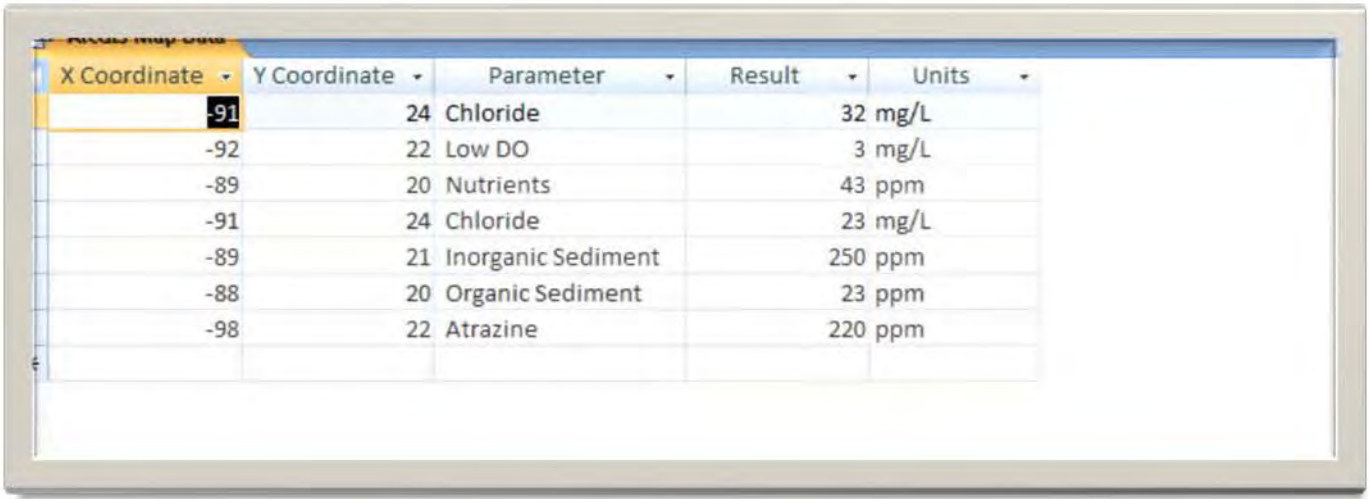
EPA303(D)LIST TABLE

| ID | Water Body Name | WBID | CLASS | SIZE | UNITS_ | Pollutant | SOURCE_ | IU_ | OU_ | UDCOUNTY | F11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Bear Creek | 0115U-01 | U | | | Unknown | | 1G | | Adair | |
| 2 | Bee Fk. | 2760 | C | 8.5 | Mi. | Lead | Fletcher Mine | 1 | 2,4 | Reynolds | |
| 3 | Belcher Branch Lake | 7365 | L3 | 55 | Ac. | Mercury(T) | Atmospheric D | 1G | 2,4,5 | Buchanan | |
| 4 | Big Bottom Creek | 1746 | C | 1.9 | Mi. | Ammonia | Lake Forest W\ | 1 | 4 | Ste. Genevieve | |
| 5 | Big Bottom Creek | 1746 | C | 1.9 | Mi. | Low D.O. | Lake Forest W\ | 1 | 4 | Ste. Genevieve | |
| 6 | Big Creek | 444 | P | 22 | Mi | Ammonia | Bethany WWT | 1 | 2,3,4 | Harrison | |
| 7 | Big Creek | 444 | P | 22 | Mi | Low D.O. | Bethany WWT | 1 | 2,3,4 | Harrison | |
| 8 | Big Otter Creek Trib | 1225 | C | 1 | Mi. | Low D.O. | Unknown | 1 | 2,4 | St. Clair/Henry | |
| 9 | Big River | 2074 | P | 53 | Mi. | Lead | Old Lead Belt A | 1 | 2,4,5,6 | Jefferson | |
| 10 | Big River | 2080 | P | 68 | Mi. | Cd (S) | Mill tailings (Al | 1G | 2,4,7 | Washington/Je | |
| 11 | Big River | 2080 | P | 68 | Mi. | Lead (S,T)) | Mill tailings (Al | 1G | 2,4,7 | Washington/Je | |
| 12 | Big River | 2080 | P | 68 | Mi. | Zinc | Mill tailings (Al | 1G | 2,4,7 | Washington/Je | |
| 13 | Big River | 2080 | P | 68 | Mi. | Inorganic Sedi | Mill tailings (Al | 1G | 2,4,7 | Washington/Je | |
| 14 | Blackberry Creek | 3184 | C | 6.5 | Mi. | Sulfate + Chlor | | 1 | 2,4 | Jasper | |
| 15 | Blue River | 417 | P | 4 | Mi. | Bacteria | Urban Runoff | 2 | 1,4,5,7 | Jackson | |
| 16 | Blue River | 418 | P | 9 | Mi. | Bacteria | Urban Runoff | 2 | 1,4,5,7 | Jackson | |
| 17 | Blue River | 419 | P | 9 | Mi. | Bacteria | Urban Runoff | 2 | 1,4,5 | Jackson | |
| 18 | Blue River | 421 | C | 11 | Mi. | Bacteria | | 2 | 1,4,5 | Jackson | |
| 19 | Bobs Creek | 35 | C | 12.5 | Mi. | Low D.O. | Lincoln Co. PSC | 1 | 2,4 | Lincoln | |
| 20 | Bonne Femme Cr. | 750 | P | 7 | Mi. | Bacteria | | 2 | 1,4 | Boone | |
| 21 | Brush Creek | 1371 | P | 4 | Mi. | Low D.O. | Humansville W | 1 | 2,4 | Polk/St. Clair | |
| 22 | Brush Creek | 1371 | P | 4 | Mi. | Organic Sedim | Humansville W | 1 | 2,4 | Polk/St. Clair | |
| 23 | Buffalo Ditch | 3118 | P | 18 | Mi. | Low D.O. | Unknown | 1 | 2,4 | Dunklin | |
| 24 | Buffalo Ditch | 3118 | P | 18 | Mi. | Ammonia | Unknown | 1 | 2,4 | Dunklin | |
| 25 | Burgher Branch | 1865 | C | 2 | Mi. | Low D.O. | | 1 | 4 | Phelps | |
| 26 | Busch WQ Lake 35 | 7057 | L3 | 51 | Ac. | Mercury | | 1 | 2,4 | St. Charles | |
| 27 | Capps Creek | 3234 | P | 4 | Mi. | Bacteria | Rural NPS | 2 | 1,3,4,5,6 | Barry | |
| 28 | Cave Spring Branch | 3245U-01 | U | | Mi. | Nutrients | Simmons Ind. | | | McDonald | |
| 29 | Cedar Creek, Trib. | 743 | C | 1.5 | Mi. | Low D.O. | | 1 | 2,4 | Callaway | |
| 30 | Center Creek | 3203 | P | 26 | Mi. | Cadmium (W,S | Tri-State AML | 1 | | Jasper | |

Figure 19

# EXPORTING THE DATA, VIA EXCEL, TO ArcGIS

6. Open the query “ArcGIS Map Data”



| X Coordinate | Y Coordinate | Parameter | Result | Units |
|---|---|---|---|---|
| -91 | 24 | Chloride | 32 | mg/L |
| -92 | 22 | Low DO | 3 | mg/L |
| -89 | 20 | Nutrients | 43 | ppm |
| -91 | 24 | Chloride | 23 | mg/L |
| -89 | 21 | Inorganic Sediment | 250 | ppm |
| -88 | 20 | Organic Sediment | 23 | ppm |
| -98 | 22 | Atrazine | 220 | ppm |

Figure 20

7. In the main ACCESS toolbar click on “External Data”

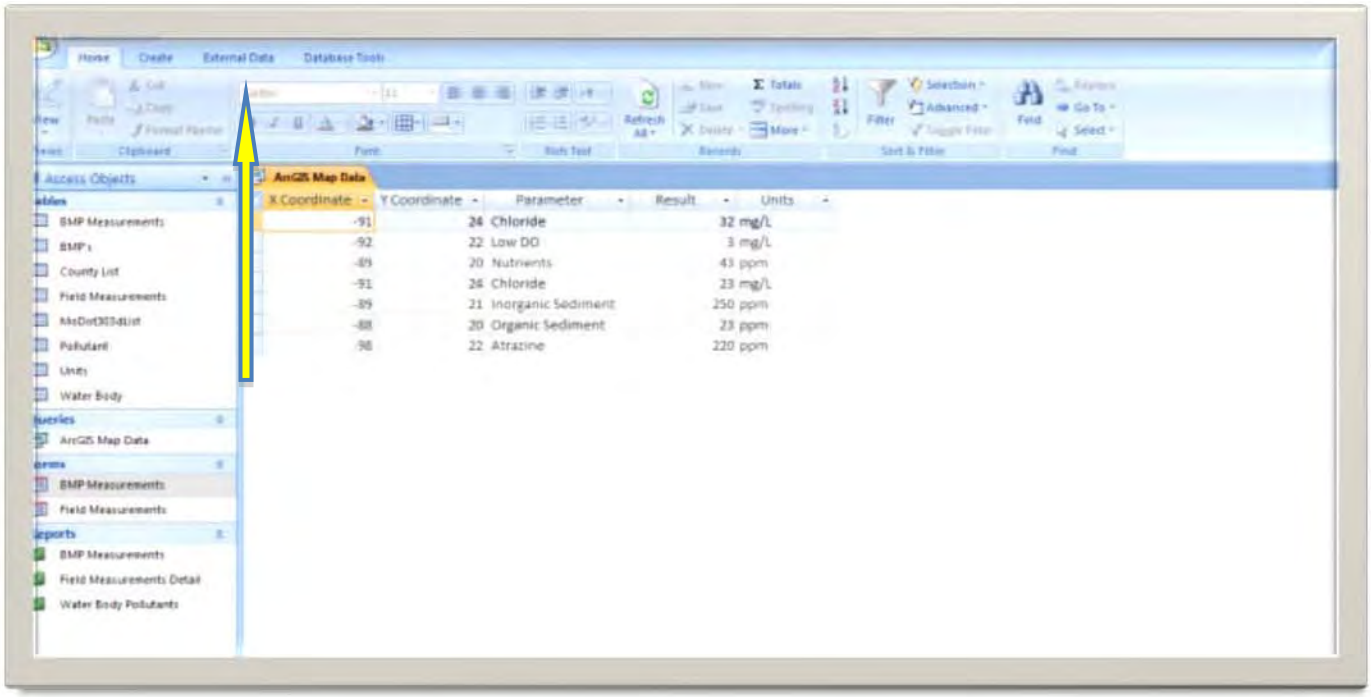


Figure 21

8. In the Export section click on Excel.

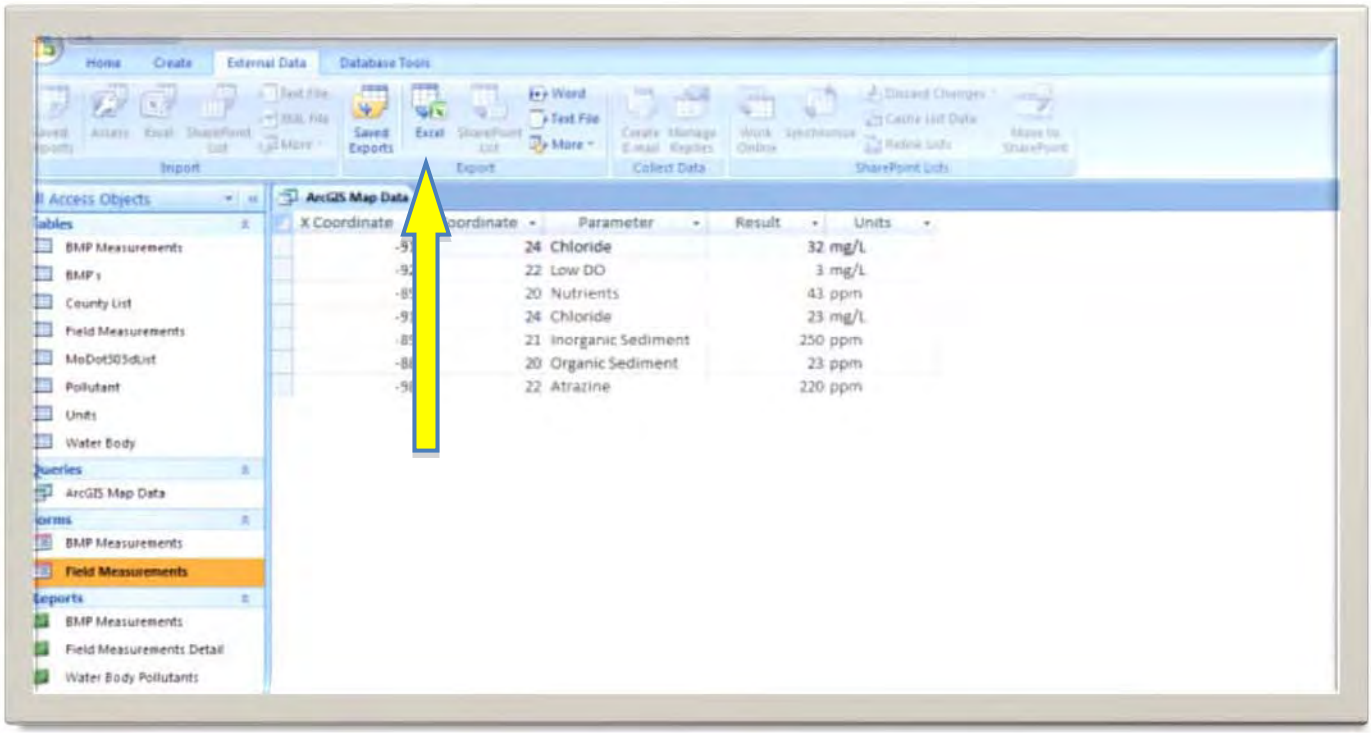



Figure 22

An export dialog box will pop-up

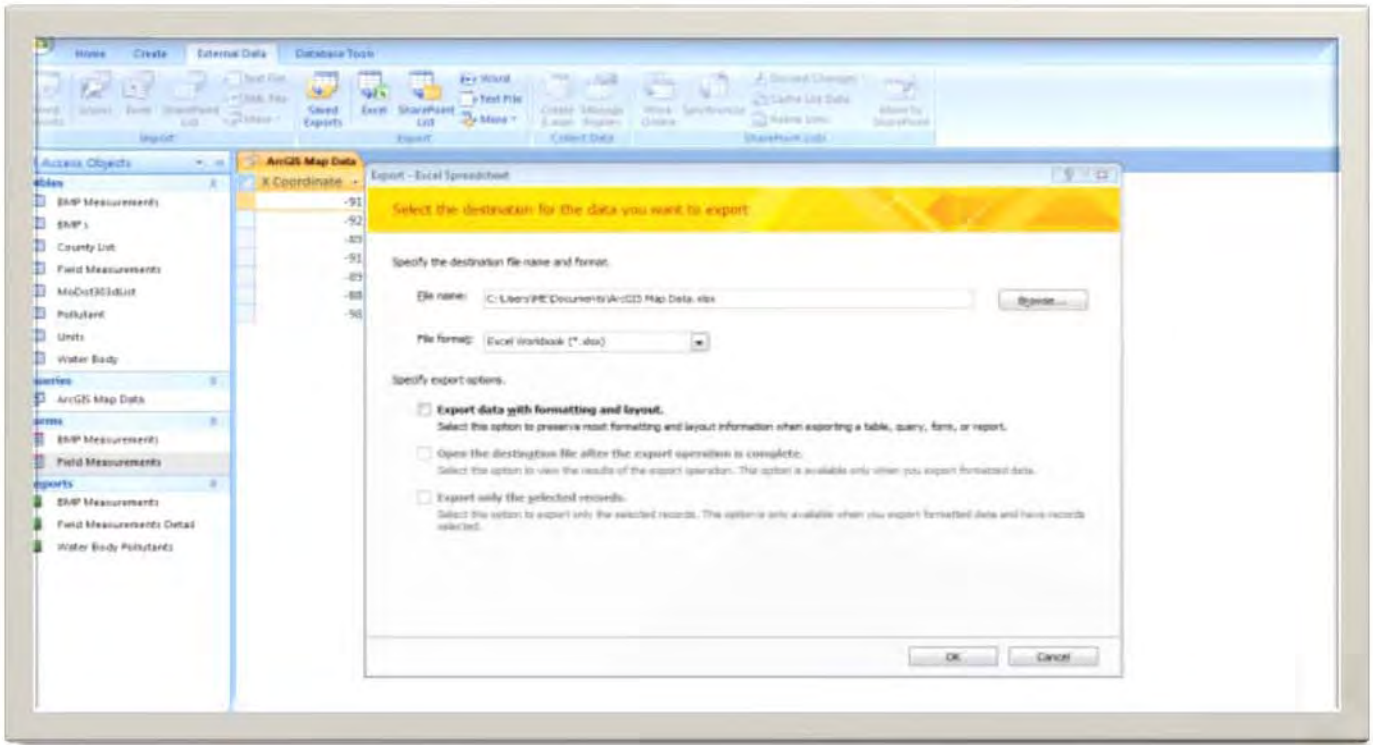



Figure 23

9. In the “File Name” section enter the desired destination location for the Excel file, or click on “Browse” to find the desired file destination. The file format should say “Excel workbook (*.xlsx)”

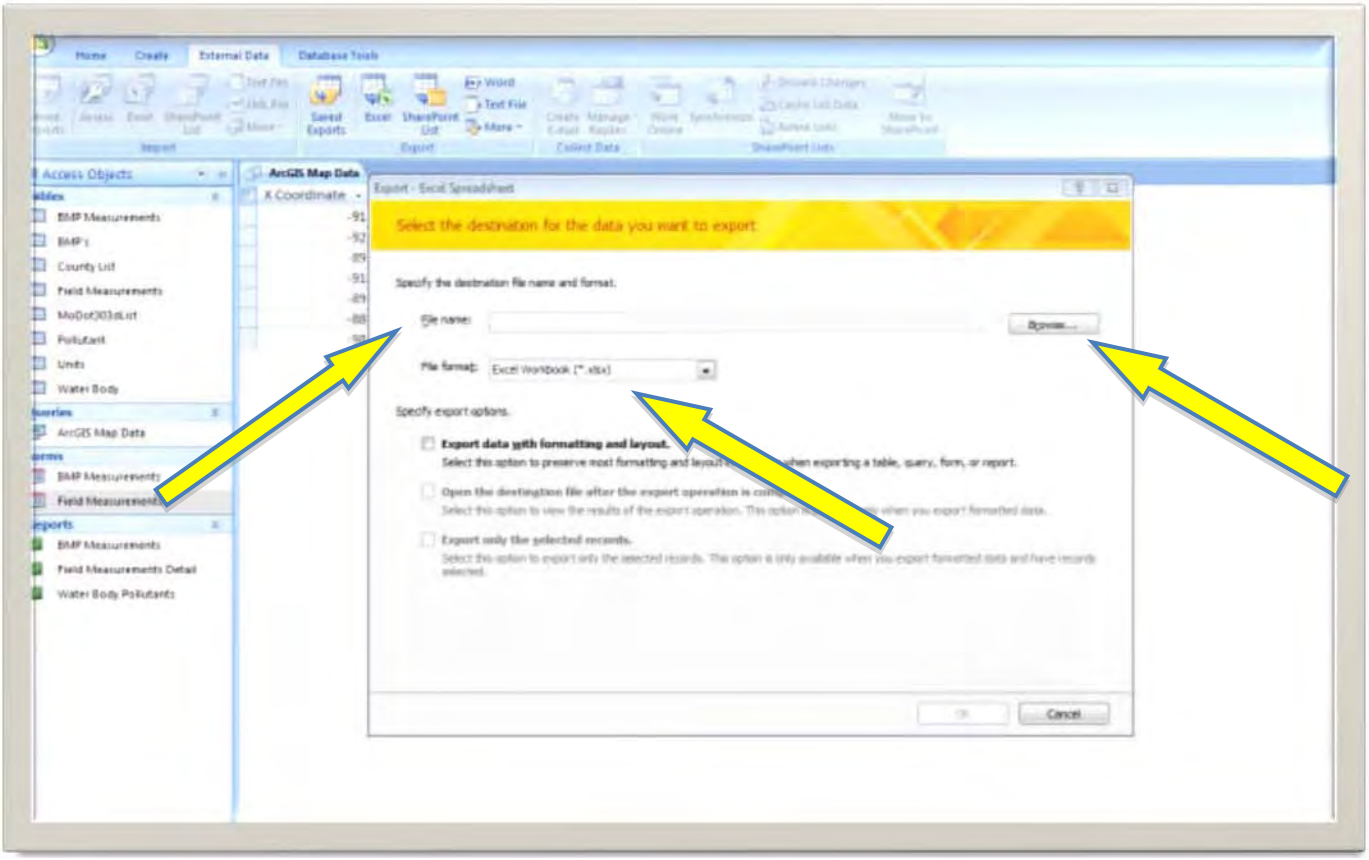



Figure 24

10. Click “Close”

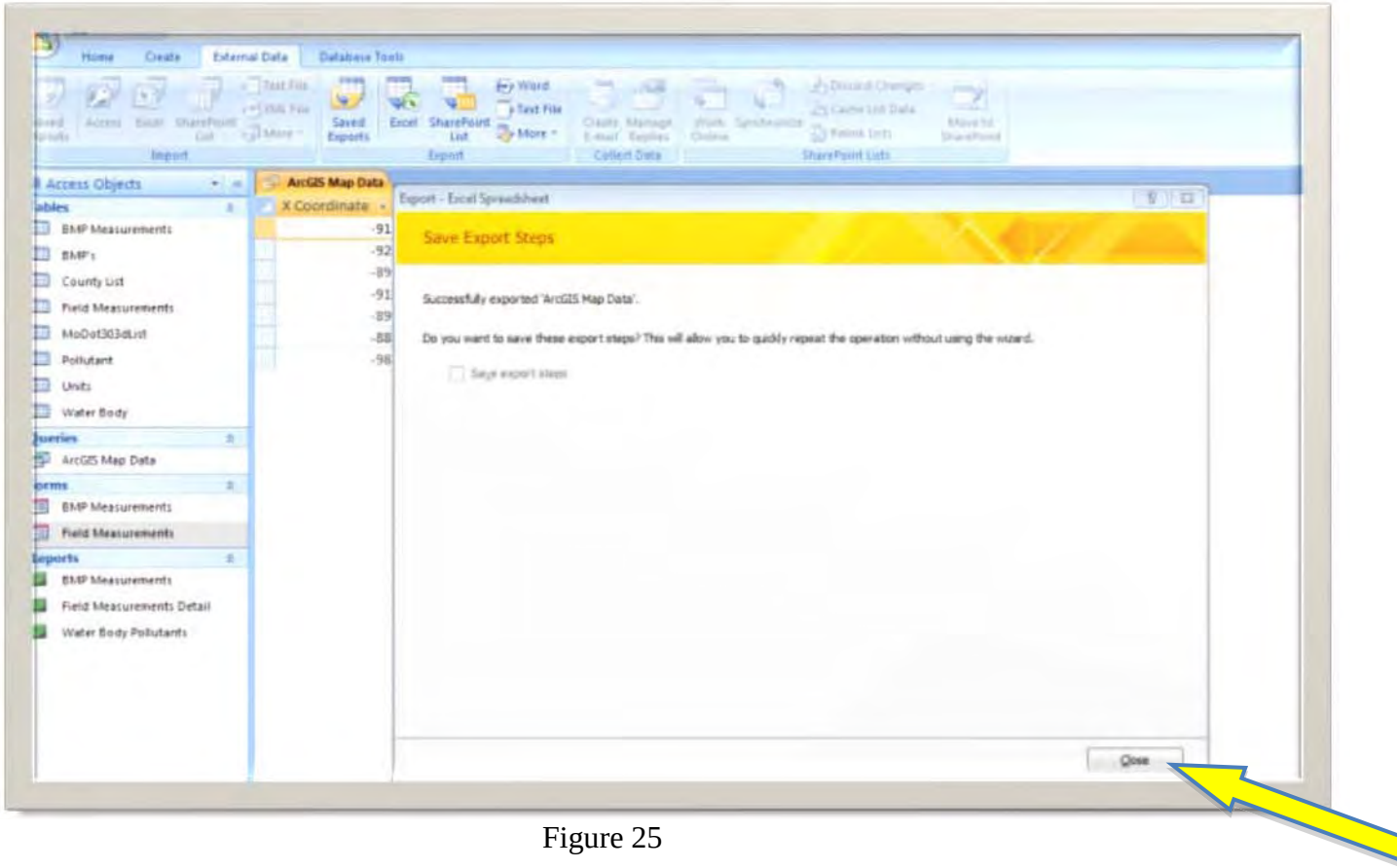



Figure 25

These data are now ready to be uploaded for ArcGIS.

# IMPORTING THE EPA 303(d)LIST

## EPA303(D) LIST INFORMATION

The MoDOT303(d)List Table list the EPA's 303(d) List. This table will need to be updated every time the 303(d) List is published (usually every two years). This current 303(d) list information can be downloaded from:

http://www.dnr.mo.gov/env/wpp/waterquality/303d.htm

Click on Final 2008 Missouri 303(d) List PDF

NOTE:

This data is in PDF format and as such will require Adobe Acrobat 9.0 Pro to convert it to Excel. Once the pdf is saved on a local computer, open the file using Adobe Acrobat 9.0 Pro, then export the file in Excel (xlxs) format.

Once the 303(d) List is in Excel format, the column heading needs to be compared with the column heading of the MoDOT303(d)List Table in Access. These column headings must be the same; if they are not, edit the column heading of the Excel file so the headings match.
Now the new 303(d) list is ready to be uploaded to Access.

1. Open Access (enable option)

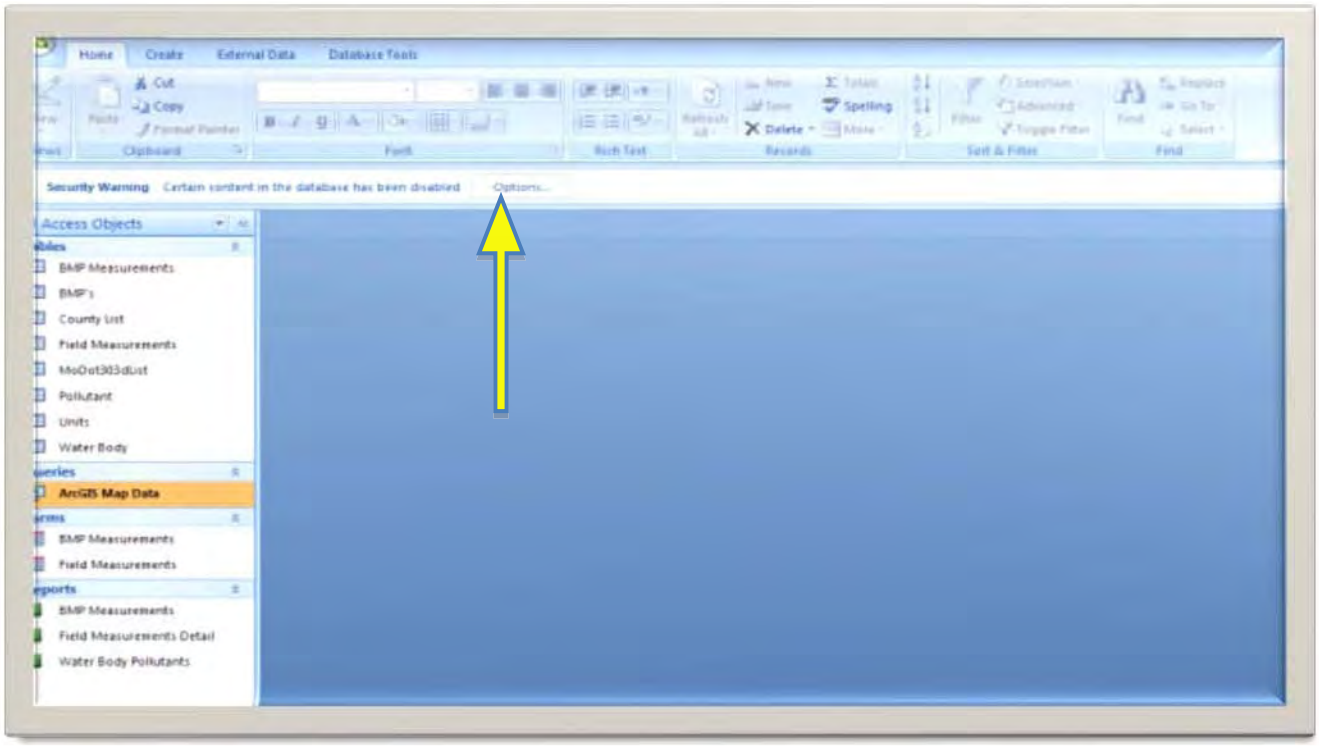



Figure 26

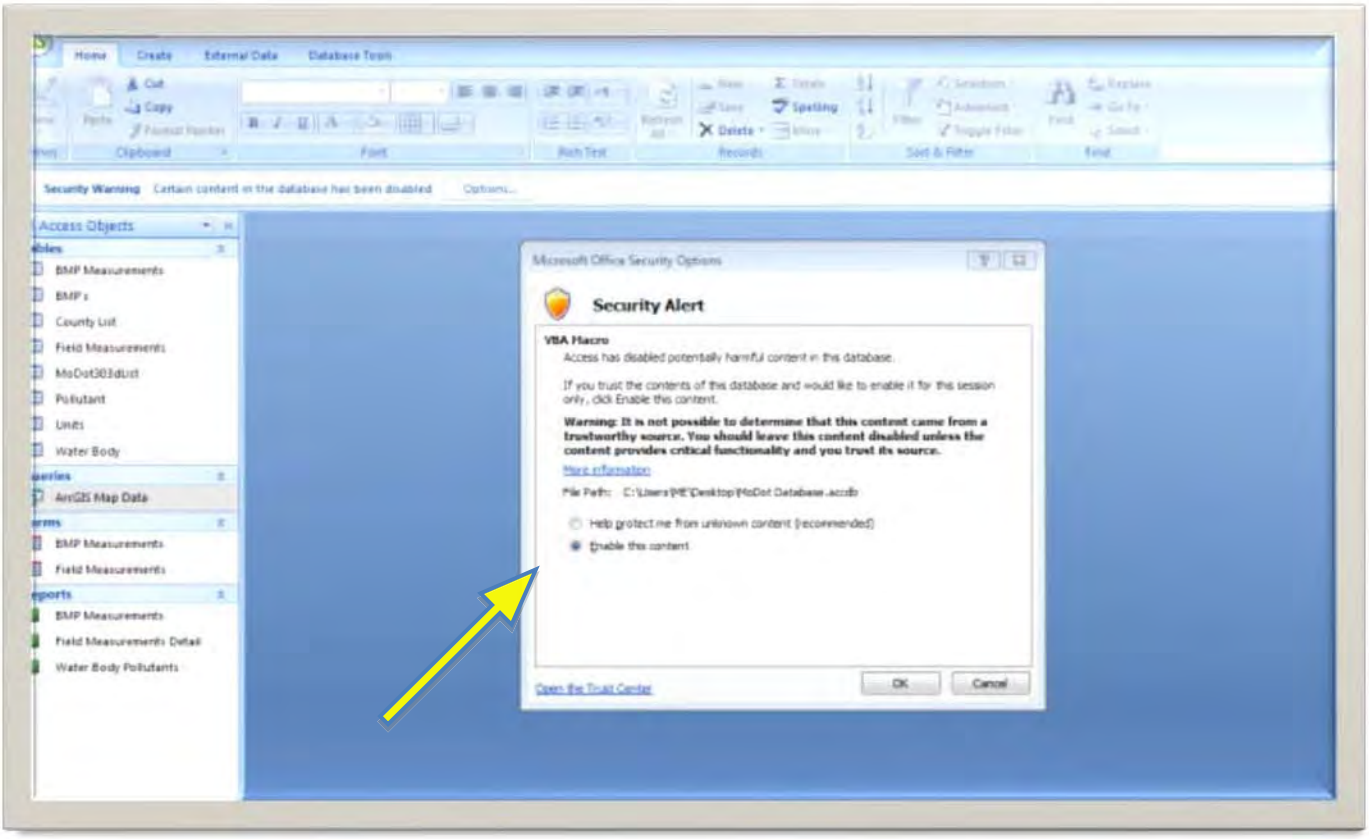

Home
Create
External Data
Database Tools
Security Warning
Certain content in the database has been disabled
Options...
Access Objects
BMP Measurements
BMPs
County List
Field Measurements
MoDot303dList
Pollutant
Units
Water Body
ArcGIS Map Data
BMP Measurements
Field Measurements
BMP Measurements
Field Measurements Detail
Water Body Pollutants
Microsoft Office Security Options
Security Alert
VBA Macro
Access has disabled potentially harmful content in this database.
If you trust the contents of this database and would like to enable it for this session only, click Enable this content.
Warning: It is not possible to determine that this content came from a trustworthy source. You should leave this content disabled unless the content provides critical functionality and you trust its source.
More information
Help protect me from unknown content (recommended)
Enable this content
Open the Trust Center
OK
Cancel

Figure 27

2. On main toolbar click “external data”

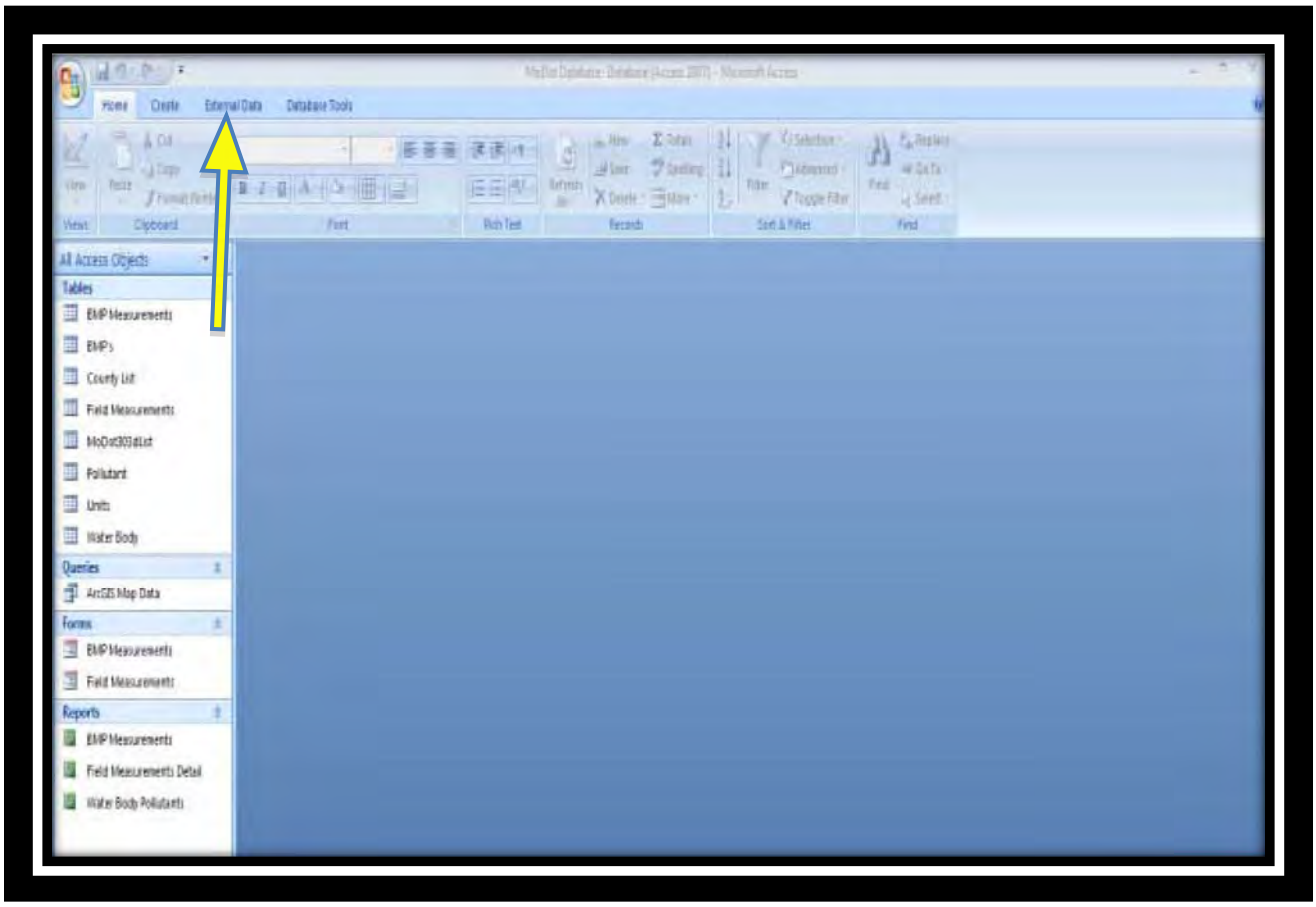



Figure 28

3. On Import section click on Excel

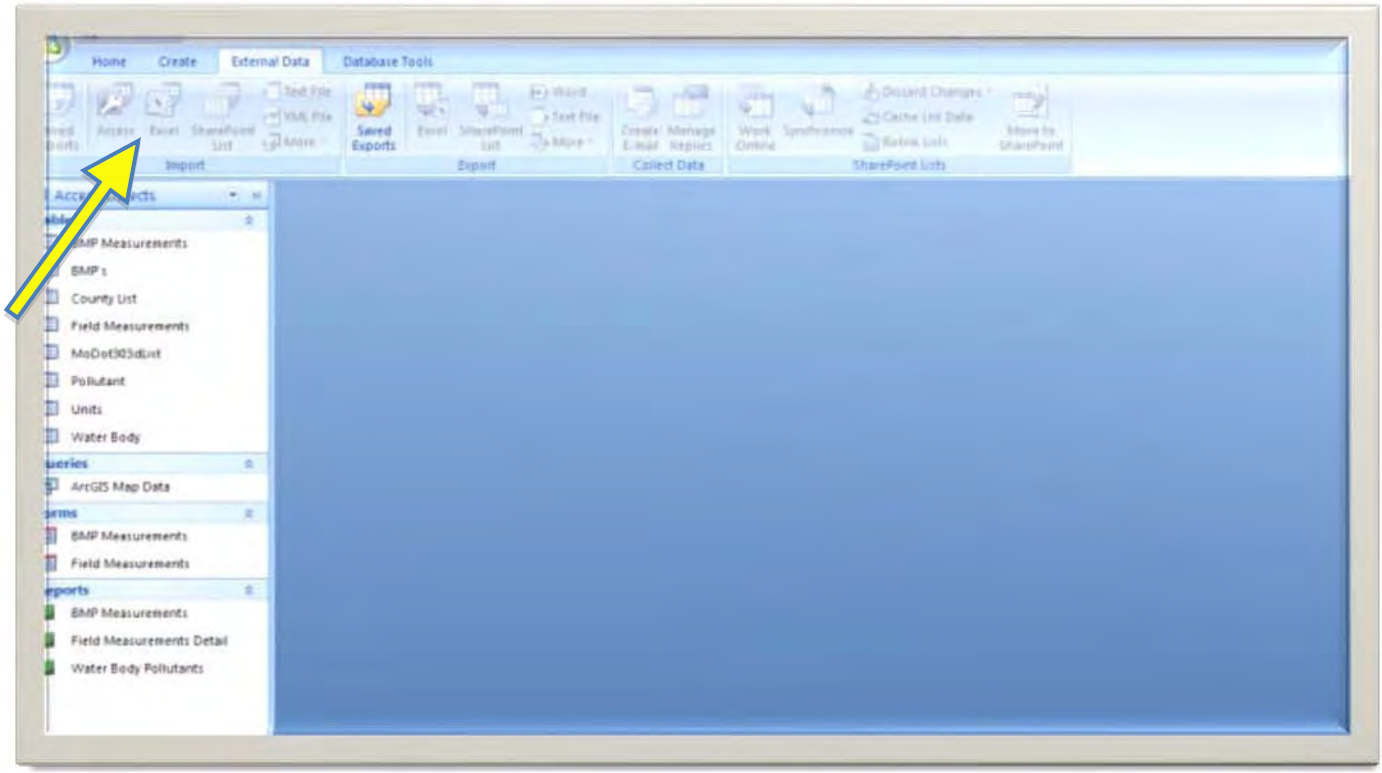



Figure 29

The Get External Data Pop-Up Menu will be displayed

4. Under file name: Enter the location of the Excel 303(d) List or click Browse to find the file location

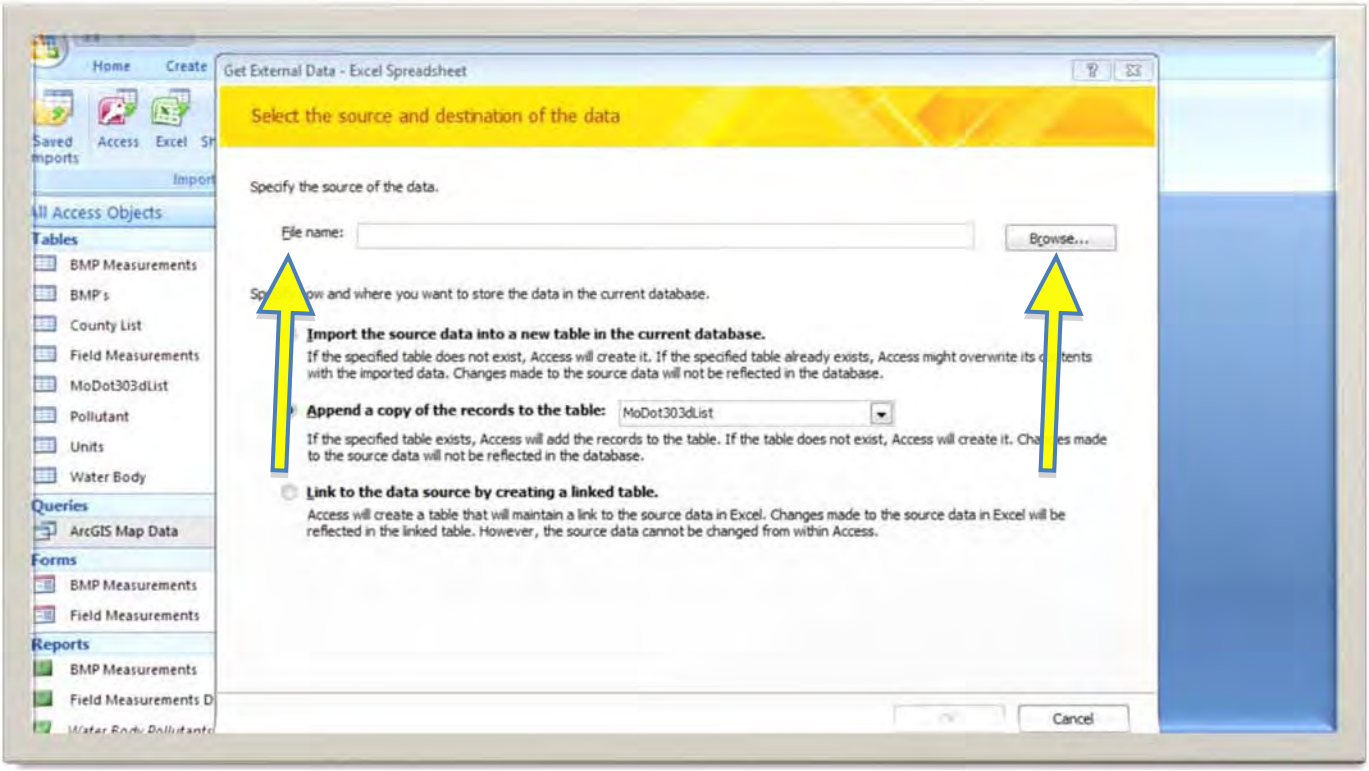



Figure 30

5. Click on “append a copy of the record to the table” and

6. Select the “MoDOT303(d)List” table from the pull down menu

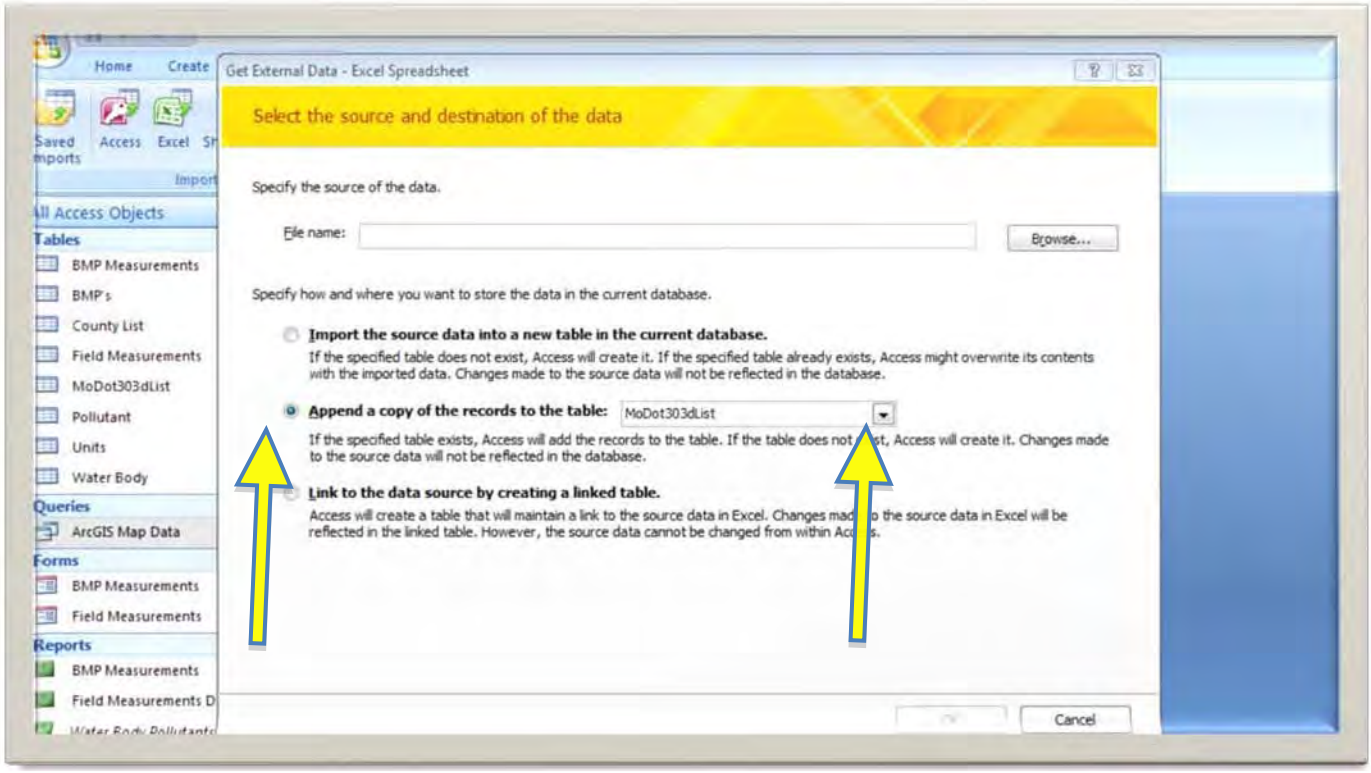



Figure 31

7. The Import Wizard window will pop up, if not already selected, click on “show workbook”

8. Click “Next”

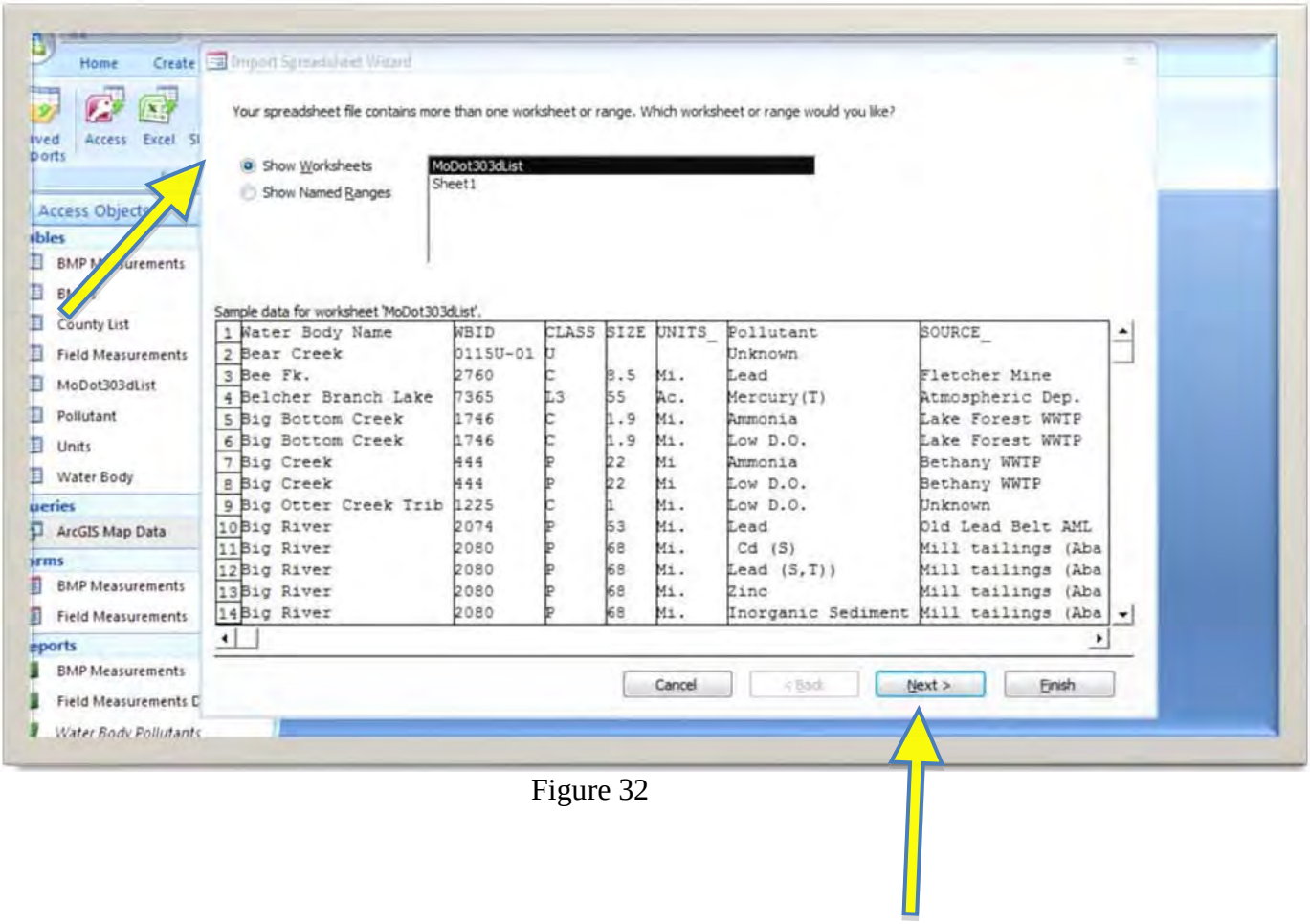
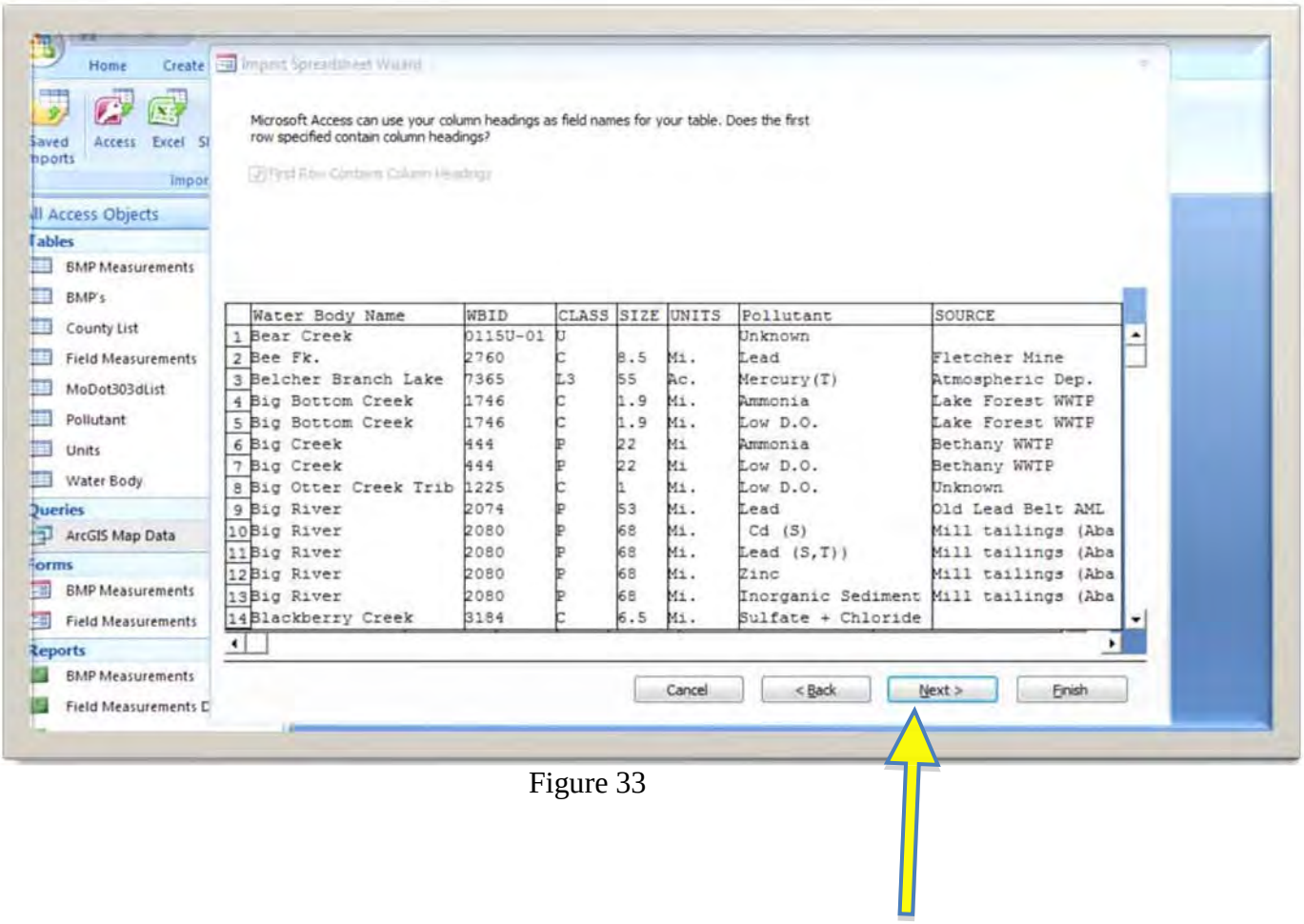



Figure 32

9. Click “Next”




| | Water Body Name | WBID | CLASS | SIZE | UNITS | Pollutant | SOURCE |
|---|---|---|---|---|---|---|---|
| 1 | Bear Creek | 0115U-01 | U | | | Unknown | |
| 2 | Bee Fk. | 2760 | C | 8.5 | Mi. | Lead | Fletcher Mine |
| 3 | Belcher Branch Lake | 7365 | L3 | 55 | Ac. | Mercury(T) | Atmospheric Dep. |
| 4 | Big Bottom Creek | 1746 | C | 1.9 | Mi. | Ammonia | Lake Forest WWTP |
| 5 | Big Bottom Creek | 1746 | C | 1.9 | Mi. | Low D.O. | Lake Forest WWTP |
| 6 | Big Creek | 444 | P | 22 | Mi | Ammonia | Bethany WWTP |
| 7 | Big Creek | 444 | P | 22 | Mi | Low D.O. | Bethany WWTP |
| 8 | Big Otter Creek Trib | 1225 | C | 1 | Mi. | Low D.O. | Unknown |
| 9 | Big River | 2074 | P | 53 | Mi. | Lead | Old Lead Belt AML |
| 10 | Big River | 2080 | P | 68 | Mi. | Cd (S) | Mill tailings (Aba |
| 11 | Big River | 2080 | P | 68 | Mi. | Lead (S,T)) | Mill tailings (Aba |
| 12 | Big River | 2080 | P | 68 | Mi. | Zinc | Mill tailings (Aba |
| 13 | Big River | 2080 | P | 68 | Mi. | Inorganic Sediment | Mill tailings (Aba |
| 14 | Blackberry Creek | 3184 | C | 6.5 | Mi. | Sulfate + Chloride | |

Figure 33

10. Ensure MoDOT303(d)List is showing in the “Import to Table” window

11. Click “Finish”

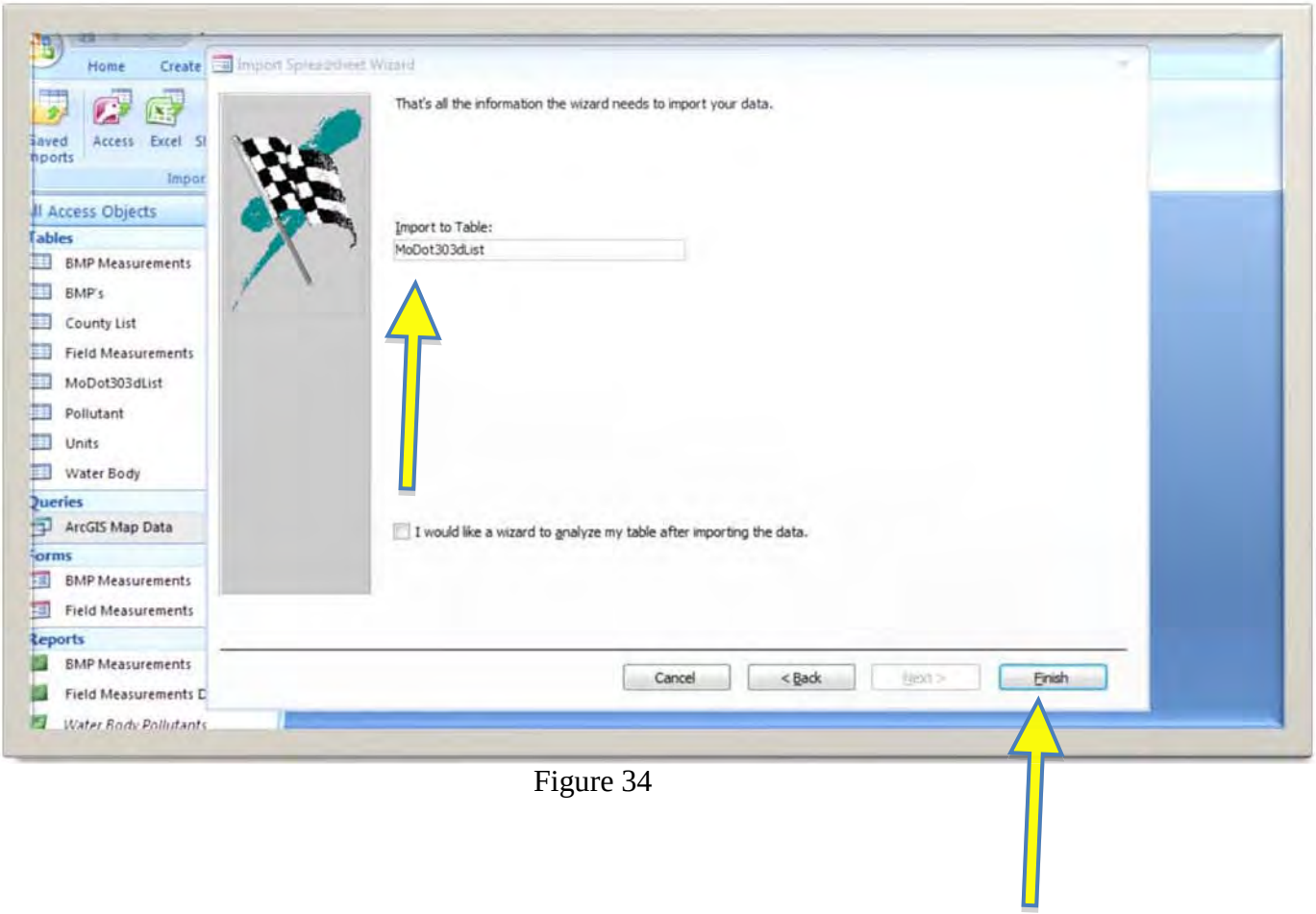



Figure 34

The MoDOT303(d)List Table should now be loaded with the new data. Once this table is loaded, the Water Body table should also have the new data, as the MoDOT303(d)List Table “feeds” the Water Body Table.

The database is now ready to be used with the current EPA 303(d) list data.

# Appendix F

## 303(d) Listed Streams Shown in the Example ArcMap (Figure 3)

| WBID (ID#) | WATERBODY | POLLUTANT | COUNTY | Source |
|---|---|---|---|---|
| 853 | Muddy Cr. | Chloride | Pettis | Non-MoDOT |
| 959 | Straight Fk. | Chloride | Morgan | Non-MoDOT |
| 3184 | Blackberry Cr. | Chloride | Jasper | Non-MoDOT |
| 1703 | Creve Coeur Cr. | Chloride | St. Louis | Urban NPS |
| 1706 | Coldwater Cr. | Chloride | St. Louis | Urban NPS |
| 1708 | Watkins Cr. | Chloride | St. Louis | Urban NPS |
| 1709 | Maline Cr. | Chloride | St. Louis | Urban NPS |
| 1711 | R. des Peres | Chloride | St. Louis | Urban NPS |
| 1712 | Gravois Cr. | Chloride | St. Louis | Urban NPS |
| 2184 | Grand Glaize Cr. | Chloride | St. Louis | Urban NPS |
| 1711U-01 | R. des Peres | Chloride | St. Louis | Urban NPS |
| 710 | Stinson Cr. | Organic Sediment | Callaway | Non-MoDOT |
| 1371 | Brush Cr. | Organic Sediment | Polk/St. Clair | Non-MoDOT |
| 1529 | L. Beaver Cr. | Inorganic Sediment | Phelps | Non-MoDOT |
| 1746 | Big Bottom Cr. | Organic Sediment | Ste. Genevieve | Non-MoDOT |
| 2080 | Big R. | Inorganic Sediment | St. Francois/Jefferson | Non-MoDOT |
| 2120 | Shibboleth Cr. | Inorganic Sediment | Washington | Non-MoDOT |
| 2128 | Pond Cr., Trib | Inorganic Sediment | Washington | Non-MoDOT |
| 2168 | Flat River Cr. | Sediment | St. Francois | Non-MoDOT |
| 2170 | Shaw Branch | Inorganic Sediment | St. Francois | Non-MoDOT |
| 2863 | Village Cr. | Inorganic Sediment | Madison | Non-MoDOT |
| 3105 | Lat. #2 Main Ditch | Inorganic Sediment | Stoddard | Unknown |
| 3708 | Spring Branch | Organic Sediment | Dent | Unknown |
| 218 | Peruque Cr. | Inorganic Sediment | St. Charles | Urban NPS |
| 2760 | Bee Fk. | Toxicity | Reynolds | Non-MoDOT |
| 2375 | Wilson Cr. | Unknown | Greene | Non-MoDOT |
| 221 | Dardenne Cr. | Unknown | St. Charles | Unknown |
| 442 | Hickory Cr. | Unknown | Daviess | Unknown |
| 589 | Hickory Cr., Trib | Unknown | Grundy | Unknown |
| 613 | W. Fk. Locust Cr. | Unknown | Sullivan/Linn | Unknown |
| 623 | W. Fk. Medicine Cr. | Unknown | Mercer/Grundy | Unknown |
| 652 | Sandy Cr. | Unknown | Putnam | Unknown |
| 737 | Cedar Cr. | Unknown | Callaway | Unknown |
| 1145 | Dry Auglaize Cr. | Unknown | Laclede | Unknown |
| 1344 | Cedar Cr. | Unknown | Cedar | Unknown |
| 1348 | Horse Cr. | Unknown | Cedar | Unknown |
| 1444 | Piper Cr. | Unknown | Polk | Unknown |
| 2373 | Pearson Cr. | Unknown | Greene | Unknown |
| 3188 | N. Fk. Spring R. | Unknown | Dade/Jasper | Unknown |
| 0115U-01 | Bear Cr. | Unknown | Adair | Unknown |
| 1008 | Hinkson Cr. | Unknown | Boone | Urban NPS |
| 3374 | Jordan Cr. | Unknown | Greene | Urban NPS |

Missouri Department of Transportation
Organizational Results
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innovation@modot.mo.gov