Quality Assurance Project Plan Guidance for Hydrologic Monitoring Studies

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Nonpoint Source Program support
Hydrologic Studies Unit
Michigan Department of Environmental Quality
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Contents

Purpose

All grantees receiving federal or state monies for the purpose of conducting hydrologic monitoring as part of their nonpoint source (NPS) project are required to prepare a quality assurance project plan (QAPP). This document is intended to provide guidance in the preparation of a hydrologic monitoring QAPP so that the grantee can complete the QAPP as efficiently as possible and with minimal revisions.

A QAPP is a written document that provides the framework for how environmental data will be collected to achieve specific project objectives and describes the procedures that will be implemented to obtain data of adequate quality. The QAPP must be prepared by the grantee or their consultant and approved by the Michigan Department of Environmental Quality (MDEQ), Water Bureau, prior to any data collection activities.

QAPP elements

The elements of a QAPP that reflect the U. S. Environmental Protection Agency's (EPA) requirements for such a document are presented here. The use of each element will vary depending upon the project. The elements fall into four main categories.

1. Project Management
2. Study Design
3. Data Acquisition
4. Data Analysis

The **Project Management** category includes some informational items basic to all projects.

- Title/Approval Page: (see attached)
- Responsible Parties: Identify key personnel and their contact information, organization, and responsibilities in the project.
- Documentation: Identify the expected distribution of project documents.

The **Study Design** component articulates the question or questions that the project intends to address and how the study is designed to address those questions.

- Problem Definition: Briefly explain the problem being addressed. This will often be copied from the grant application. The QAPP goals must reflect the funded project goals as described in the proposal and contract, unless specifically revised with the approval of the project administrator.
- Project Description: Describe the project in terms of what will be done and when each phase will occur.

The **Data Acquisition** category covers all aspects of data collected for the hydrologic study, whether by field monitoring or from external sources.

- Field Data: This item refers to collection of data such as river stage, precipitation, or a survey of the channel geometry. Identify the field data that will be collected and how it will be used. Describe the details of any planned monitoring, such as the locations of the monitors and the frequency of data collection. Include any techniques that will be used to ensure high quality data and provisions for dealing with unexpected changes such as site access. Where technical references are being followed that give detailed information on monitoring or data collection design, they may be referenced in place of extensive discussion (include a copy of the reference if not readily available).
- External Data Sources: This item refers to the collection of data assembled by others. Identify the sources of the data that will be collected for the hydrologic study, the details of planned data collection methods, and how the quality of the data will be evaluated and used. Where technical references are being followed, they may be referenced in place of extensive discussion (include a copy of the reference if not readily available).
- Data Verification: Describe the methods that will be used to validate and verify the data. Describe the calibration and relevant maintenance procedures for all field equipment, any replicate measurements that will be performed, and the procedures for checking data accuracy and completeness. Indicate who will review and make decisions regarding accepting, rejecting, or qualifying project data and how errors detected will be corrected and documented. Standard operating procedures may be cited and submitted in place of narrative.

The **Data Analysis** category covers the process of analyzing and reporting the project data.

- Analysis: Describe how the data will be analyzed. Describe how you will interpret and present your data (e.g. graphically, narrative, or tables). Identify the criteria that will be applied to test the significance of any statistical analysis. Describe how the calibration data, if any, will be selected. Technical references that will be followed that give detailed information may be referenced in place of extensive discussion (include a copy of the reference if not readily available).
- Reports: Identify the information that will be contained in the reports. Estimate the schedule of reporting.

When these elements are used together, they give the project participants a common reference point to ensure that the data they gather will be useful and of good quality. It is important to be sure that all of the participants understand the aspects of the QAPP that will be their responsibility.

Contact Dave Fongers, fongersd@michigan.gov or 517-373-0210 with questions or comments pertaining to this document. Contact Joe Rathbun, rathbunj@michigan.gov or 517-373-8868 with questions or comments relating to QAPPs in general.

Quality Assurance Project Plan for a Hydrologic Study of the Jewel River Watershed, Grant County

Grantee: MDEQ
MDEQ Tracking Code: 2007-0001

QAPP Prepared by: D. Fongers, HSU, MDEQ

Version 1
August 7, 2007

MDEQ Use Only	☐ **Approved** ☐ **Returned for Modifications**
	_____ Signature of NPS Unit Chief _____ Date

Table of Contents

This is a sample hydrologic monitoring QAPP. It is intended to help NPS grantees prepare their own hydrologic monitoring QAPP as efficiently as possible and with minimal revisions. The mention of trade names or commercial products does not constitute endorsement or recommendation for use.

1.0 Project Management

1.1 Responsible Parties

The Hydrologic Studies Unit (HSU) is the grant recipient. Staff of HSU will be conducting the monitoring study. Dave Fongers, HSU Environmental Engineer, is responsible for data collection, hydrologic modeling, and final reports. Ric Sorrell, HSU Chief, will provide project oversight and quality control review.

Table 1 - Contact Information for Key Personnel

Name	Responsibility	Address	Phone/e-mail
Dave Fongers	Data collection, hydrologic modeling, reports	HSU 525 West Allegan Lansing, MI 48909	517-373-0210 fongersd@michigan.gov
Ric Sorrell	Project oversight	HSU 525 West Allegan Lansing, MI 48909	517-335-3176 sorrell@michigan.gov

1.2 Documentation

This Quality Assurance Project Plan (QAPP) will be distributed to the MDEQ Nonpoint Source (NPS) QAPP coordinator and the Grant County Conservation District, which is the organization responsible for coordinating the Jewel River watershed plan. Draft reports of the hydrologic study will be provided to the NPS QAPP coordinator, the NPS project administrator, and the Grant County Conservation District. Final reports and data files will be kept in HSU files and made available to stakeholders and MDEQ.

2.0 Study Design

2.1 Problem Definition

The Jewel River watershed encompasses 75 square miles in Grant County (Figure 1). The Jewel River flows into Lake Michigan. The Grant County Conservation District is developing a watershed management plan. Stakeholders have reported increased flashiness and streambank erosion. An approved watershed management plan and an assessment of the cause(s) of erosion is required before implementing Best Management Practices (BMPs) targeted to erosion sites, if the BMPs are funded by an NPS grant administered by the MDEQ. This assessment will include the development of a hydrologic model. The project's goal is to help develop the sound watershed management plan, stormwater ordinances, and BMP recommendations needed to correct, enhance, and protect the Jewel River and its tributaries.

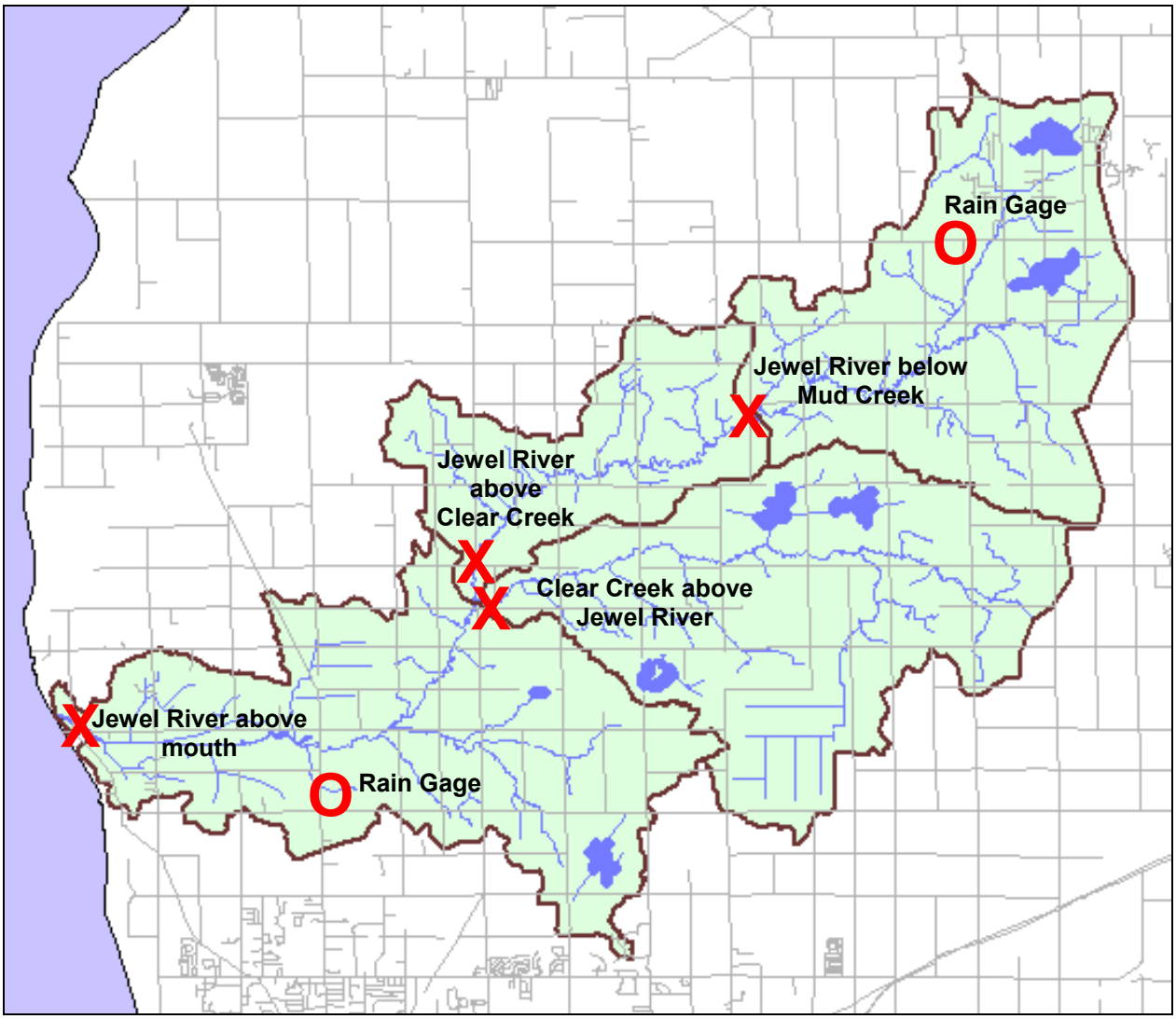

Figure 1: Jewel River Watershed Monitoring Sites

2.2 Project Description

The hydrologic study will provide stream flow and rainfall data that can be used to calibrate a hydrologic model. A hydrologic model is being developed by the HSU to help determine the effect of land use changes in the watershed on the Jewel River's flow regime and to provide design flows for streambank stabilization BMPs. Jewel River watershed stakeholders may combine this information with other determinants, such as open space preservation, to decide what locations are the most appropriate for wetland restoration, stormwater detention, in-stream BMPs, or upland BMPs. The communities within the watershed could use the information to help develop stormwater ordinances.

Specific tasks are as follows:

- Delineate watershed and subbasin boundaries
- Select monitoring locations
- Install and maintain monitoring equipment
- Measure flows for rating curves
- Calculate hydrologic model parameters
- Develop hydrologic model
- Calibrate model to monitoring data
- Document process and results

The stream monitoring will begin in the spring of 2008 and continue until several suitable rainfall events have occurred. Monitoring data will be reported shortly after the completion of the monitoring. We expect to complete the study by March 2009.

Stream flow monitoring sites will be selected to provide calibration points throughout the watershed. The sites are:

- near the mouth of the Jewel River
- on the Jewel River above its confluence with Clear Creek
- on Clear Creek above its confluence with the Jewel River
- on the Jewel River below its confluence with Mud Creek

Selection of specific sites will depend on accessibility for equipment placement and stream flow measurements.

3.0 Data Acquisition

3.1 Data Sources

- Topographic Maps: United States Geological Survey (USGS) Quadrangles
- Land Use: 1800 and 1978 GIS land use data
- Soils: NRCS soils data
- Precipitation: RGA rain gages with Rainlog dataloggers installed in the watershed for the duration of the monitoring study
- River Stage and Ambient Air Pressure: Solinst Levelogger Gold LT pressure transducers installed within the watershed for the duration of the monitoring study
- Flow measurements: Stream gaging equipment as described in the MDEQ LMWD Operating Procedure Admin-99-07 (appendix)
- Channel cross-sections: Surveys of channel cross-sections will be conducted if the rating curves need to be extended using hydraulic modeling. River slopes will be calculated based on surveys of typical water surfaces or USGS quadrangles. Values for the Manning's n parameter will be based on observed channel conditions and documented with photos.

3.2 Monitoring Procedure

Four Solinst Levelogger Gold LT pressure transducers will be installed at suitable locations to measure river stage in accordance with the goals of the project. In general, these monitors will be installed where corresponding flow measurements can be obtained, on the downstream side of culverts when located near a culvert, and where vandalism is unlikely. The pressure transducers will be located below the water surface at the lowest anticipated water elevation. A fifth pressure transducer will monitor ambient air pressure within the watershed. All pressure transducers will be set to record digital data every 30 minutes.

Rain gages will be placed at suitable locations in the watershed. Each rain gage will be installed on a flat surface in an area that is sufficiently open so that rainfall to the gage will not be obstructed. The rain gages will record every 1/100th inch of rainfall and the associated time.

The internal pressure transducer clocks and rain gage clocks will be set using the internal clock in the laptop computer that is used to program these monitors.

Flow measurements will be in accordance with the attached MDEQ LMWD Operating Procedure Admin-99-07 (Appendix).

3.3 Data Verification

Rain gages may be installed in pairs and, in that case, the paired data will be compared. Calibration of the rain gages will be checked if the paired gage totals are not within five percent. Rain gage calibration will be checked at least once per year.

River elevation monitoring data will be reviewed for reasonableness. Data from monitoring equipment that malfunctions will be discarded.

4.0 Data Analysis

4.1 Assessments and Response Actions

Questionable data will be reviewed with Mr. Ric Sorrell, HSU Chief.

All documents will pass through an internal HSU review.

4.2 Analysis

Graphs of the precipitation and river elevation data will be prepared and distributed to watershed stakeholders. The river elevation data for these graphs will be adjusted to a zero elevation datum based on our estimate of zero flow in the river channel.

Rating curves for each of the river elevation monitoring sites will be prepared. Rating curves will be developed following USGS Techniques of Water Resources Investigations, Book 3. There will be at least three well-spaced measured points on the rating curve that span the monitored stages. If the measured flows for the rating curve do not reasonably span the monitored stage data, the rating curve will be extended using the curve-shaping technique described on page 17 of USGS Techniques of Water Resources Investigations, Book 3, Chapter A-10.

Using the equations for the rating curves, the river flows will be calculated from the elevation data. Graphs of the precipitation and river flows will be prepared and distributed to watershed stakeholders.

The hydrologic model will be developed with the Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS). This model will use the Natural Resources Conservation Service (NRCS) curve number technique to calculate surface runoff volumes and peak flows as detailed in *Computing Flood Discharges for Small Ungaged Watersheds* (Sorrell, 2003). The design storms will be the 50 percent, and 4 percent chance (2- and 25-year), 24-hour storms of 2.28 and 4.48 inches respectively, to simulate channel-forming and flood flows.

The model will be calibrated to monitoring data for significant storm events, which, for calibration purposes, is defined as a storm where ratio of total precipitation, P, to potential maximum retention, S, exceeds 0.46. This requirement ensures that the entire watershed is contributing runoff. Engineering judgment will be used during the calibration process so that model parameters remain within realistic limits.

5.0 References

Sorrell, Richard C., P.E., *Computing Flood Discharges for Small Ungaged Watersheds,* October 2003, Michigan Department of Environmental Quality, https://www.michigan.gov/-/media/Project/Websites/egle/Documents/Programs/WRD/Hydrologic-Data/scs.pdf

USGS Techniques of Water Resources Investigations, Book 3: Applications of Hydraulics, Section A: Surface-water techniques, United States Geological Survey, United States Department of the Interior, https://pubs.usgs.gov/twri/

Appendix

DEPARTMENT OF ENVIRONMENTAL QUALITY	OPERATING PROCEDURE LAND AND WATER MANAGEMENT DIVISION	**NUMBER:** Admin-99-07 **PAGE:** 1 of 6
SUBJECT: Making Streamflow Measurements		**EFFECTIVE DATE:** 11/1/1999
SECTION AND/OR UNIT: Water Management Section Hydrologic Studies Unit	**APPROVAL SIGNATURE:** original signed by Hope Croskey **TITLE:** Chief, Water Management Section	**ALSO SEE:**

PURPOSE:

To establish a procedure for making streamflow measurements.

DEFINITIONS:

Streamflow:	The discharge that occurs in the natural channel of a stream
USGS:	United States Geologic Survey
HSU:	Hydrologic Studies Unit
CMD:	Current Meter Digitizer

FORMS USED: USGS Discharge Measurement Notes sheet (Form 9-275-F, Apr. 1993 and Form 9-275-G, Sept. 1995)

WHO	DOES WHAT
HSU STAFF	1. Checks-out a streamgaging equipment box from the HSU and verifies that meters are in good working order before leaving for the measurement site. An equipment list is included in Appendix A. 2. Arrives at site and picks a measurement section that is free of large rocks and heavy aquatic growth, and where the water is deep enough so that the current meter can be submerged to make a measurement. The measurement section should be in a straight reach of stream where the flow is relatively uniform and free of eddies, slack water, and excessive turbulence. Exceptions to these conditions should be noted on the USGS measurement form. 3. Measures the water level from the Reference Point and staff gage, if present. If a Reference Point has not yet been established, sets one on a permanent structure close to the measurement location. The hydraulic control for the current stage is described on the USGS measurement form. 4. Stretches a measuring tape or tag line across the width of the stream and uses the top-setting measuring rod to probe the bottom and to measure the approximate water depths across the section. Notes the distance of the left edge of water (LEW) and the right edge of water (REW) on the USGS measurement form (left and right are based on the observer looking downstream). Also notes whether the measurement will start from the LEW or the REW. 5. Decides where the measurements will start and stop and the spacing of the measurement locations, while performing step 4. Locations should be

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WHO	DOES WHAT
HSU STAFF (CONT'D)	chosen so that approximately 20-30 measurements are made across the stream and that no single measurement contains more than 10 per cent of the total flow. Locations do not need to be evenly spaced, but should be closer together in the areas of highest flow and can be farther apart in areas of lower flow.

6. Selects the standard meter, if the majority of the water depths are over 1.5 feet, or the pygmy meter, if depths are primarily less than 1.5 feet.

7. Spin tests the meter while still in the van or car. The measuring cups should spin for at least 30 seconds on the pygmy meter and for at least 90 seconds on the standard meter. They should slow down and come to a smooth stop.

8. Assembles the meter, the headphones or CMD, and the vane assembly (standard meter only) on the measuring rod as shown in Figure 1.

9. Begins the measurement starting at the LEW or the REW.

   a) Records the measurement location by noting the distance on the measuring tape that is stretched across the section.

   b) Holds the measuring rod and attached meter in the water at the measurement location, using the measurement tape as a guide. Rod is held vertically with the meter pointing upstream into the flow. Stands approximately two feet off to the side so that turbulence from the water hitting the leg doesn't influence the measurement.

   c) Measures water depth on the hexagonal main rod (there may or may not be any water depth at the LEW or the REW). If the velocity is such that the depth is higher on the upstream side of the rod than on the downstream side, uses the average of the two depths.

   d) Selects a measuring method:

      i) Uses the 0.6 method when using the pygmy meter and when using the standard meter in water depths less than 2.5 feet. When using the 0.6 method, sets the elevation on the smaller, round rod equal to the water depth measured on the main rod.

      Or

      ii) Uses the 0.2/0.8 method when using the standard meter where the water depth is greater than 2.5 feet. To make the 0.2 measurement, sets the smaller, round rod elevation to twice the water depth measured on the main rod. To make the 0.8 measurement, sets the

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WHO	DOES WHAT
HSU STAFF (CONT'D)	smaller, round rod elevation to half the water depth measured on the main rod. e) Makes the measurement using either the headphones or the CMD: i) Listens for "clicks" in the headphones. One click is equivalent to one revolution of the meter cups. When clicks are in a uniform pattern, indicating that the flow has stabilized, begins recording the number of clicks for a period of 40 to 70 seconds. Starts the stopwatch simultaneously with a click and counts this first click as "zero." Continues counting clicks and stops at a total number of revolutions equal to one of the column headings in the meter rating table. **Or** ii) Turns on the CMD and selects "1" if using the pygmy meter or "2" for the standard meter. Between 40 and 80 seconds after starting the measurement, the CMD will display the number of revolutions, the measurement time, and the velocity. f) Records the number of revolutions and the time duration of the measurement on the USGS measurement form. Also records the velocity, if the CMD was used. 10. Moves to the next measurement station and repeats steps 9a - 9f until reaching the opposite edge of the water. 11. Measures the water level from the Reference Point and staff gage again. 12. Records all of the information specified on the USGS measurement form (Form 9-275-F for the 0.2/0.8 method and 9-275-G for the 0.6 method). A completed, sample form is attached. 13. Disassembles meter from rod, cleans and dries it, sprays it with WD-40, then securely places items back in the streamgaging box, after completing the measurement.

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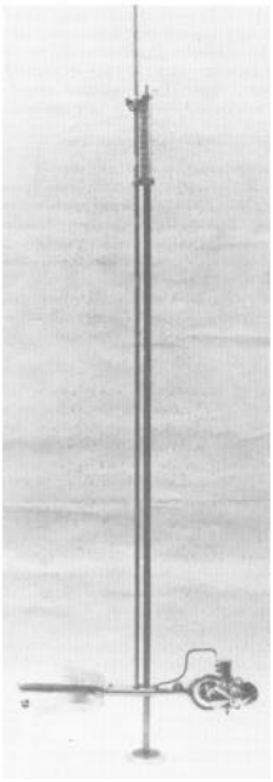
WHO	DOES WHAT

Figure 1. ***Rod and meter assembly***



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WHO	DOES WHAT

APPENDIX A

Basic Equipment List for Making a Streamflow Measurement

- Streamgaging equipment box from the HSU (this box should include the following):

  Standard and pygmy meters
  Stopwatch
  Headphones
  USGS Discharge Measurement Notes forms
  Clipboard
  Pencil
  Screw drivers
  Hammer
  Chisel
  Rating tables for meters
  3-in-1 oil and WD-40
  100-foot measuring tape
  300 foot tag line
  Two (2) stakes to attach measuring tape
  Folding tape measure
  Flashlight
  Insect repellant
  Electrical tape
  Rags
  Spray paint
  Q-tips

- Waders and/or hip boots
- Measuring rod
- First-aid kit
- County map book and/or USGS topographic map (Not HSU topo maps)

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WHO	DOES WHAT

SAMPLE, COMPLETED USGS MEASUREMENT NOTES SHEET