



Stream Depletion through the SGMA Lens— Michigan Water Withdrawal Screening Tool and Assessment Process

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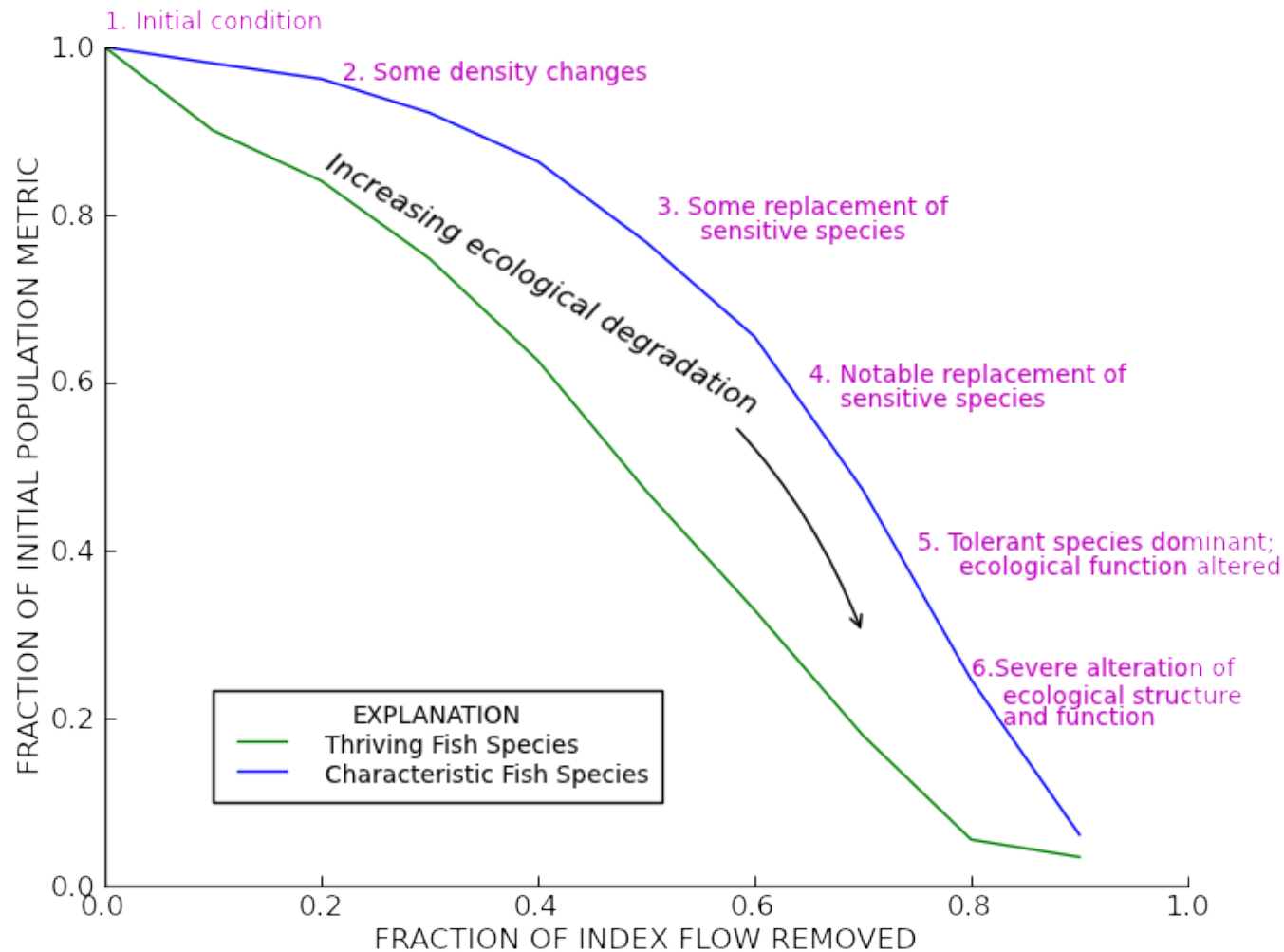
*Workshop on Stream Depletion through the SGMA Lens— Practical
Solutions for a Complex Problem, Groundwater Resources Association
of California, August 29, 2017, Sacramento, California*

Some Contrasts

- Michigan
 - Riparian rights
 - Only one undesired condition in water-withdrawal legislation: streamflow depletion
 - Statewide legislation and screening with local user groups formed as needed
 - Only few local or county groundwater flow models available
 - Legislation assumes good conditions in 2008 does not require mitigation
- California
 - Appropriative rights
 - Six sustainability indicators
 - Local planning for groundwater management under SGMA within statewide framework
 - Regional groundwater models in many areas
 - Adjudicated basins and basins that may require mitigation to meet sustainability targets

Motivation

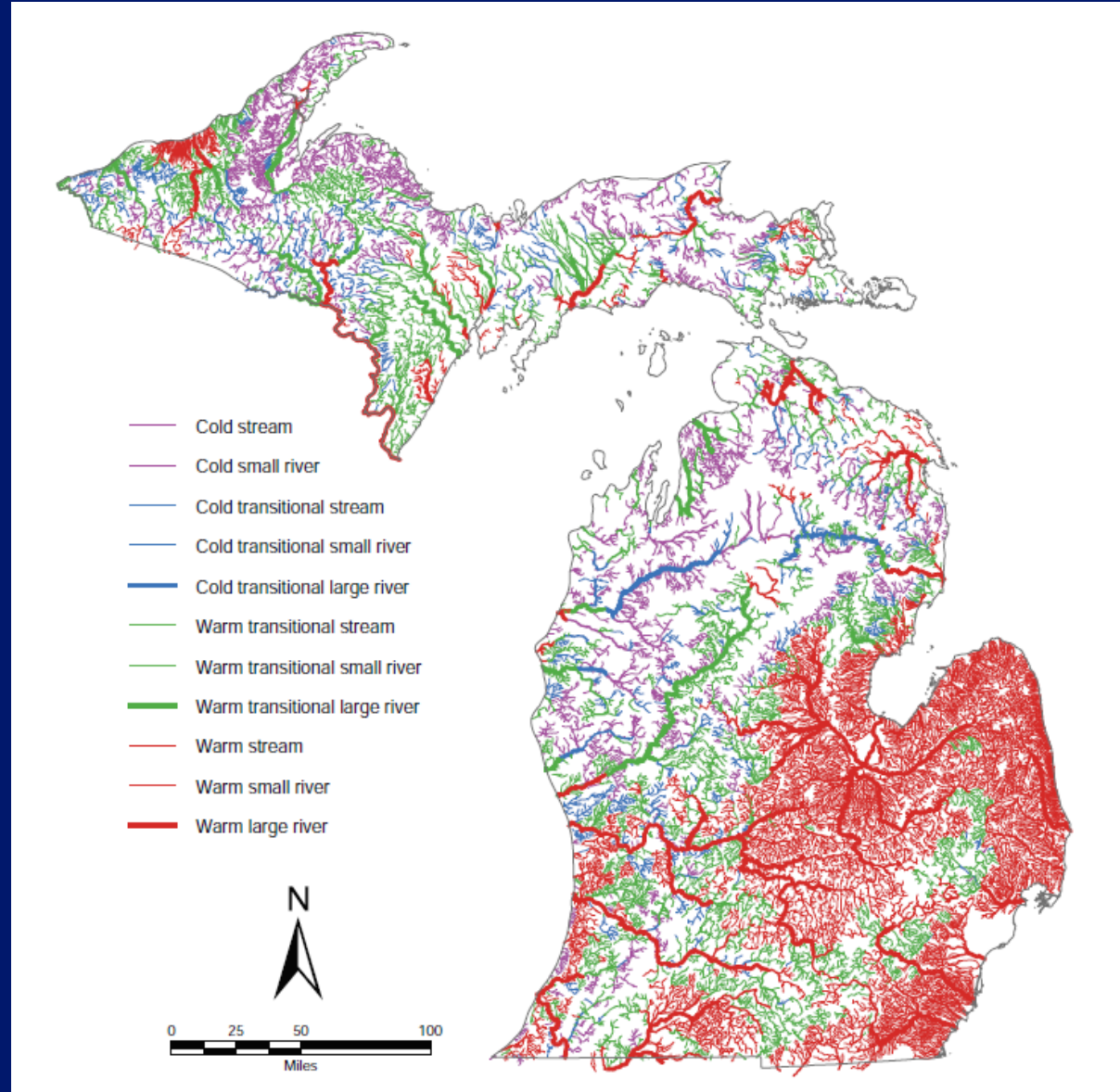
- Great Lakes-St. Lawrence River Basin Water Resources Compact, 2008
 - ... Withdrawals overall will not result in significant impacts to the Waters and Water Dependent Natural Resources of the Basin, determined on the basis of significant impacts to the physical, chemical, and biological integrity of Source Watersheds
- Michigan implementation (2008 Public Act 190): each of the 8 Great Lakes States committed to implement the Compact



Adapted from: Davies, S.P. and Jackson, S.K., 2006, The biological condition gradient—a descriptive model for interpreting change in aquatic ecosystems: Ecological Applications, v. 16, no. 4, p. 1251-1266, doi: 10.1890/1051-0761(2006)016[1251:TBCGAD]2.0.CO;2.

Preserve the
geography of
surface-
water flow

11 classes
based on
flow and
temperature



SIZE CLASSES

STREAM

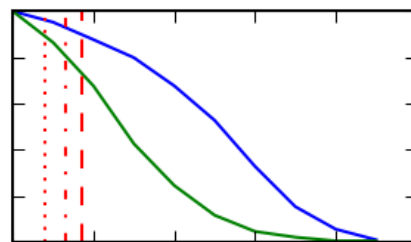
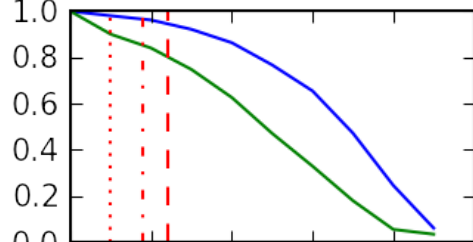
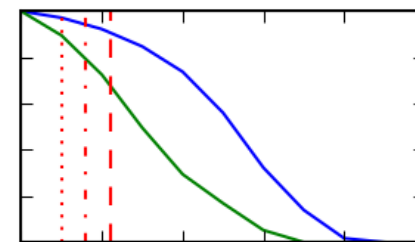
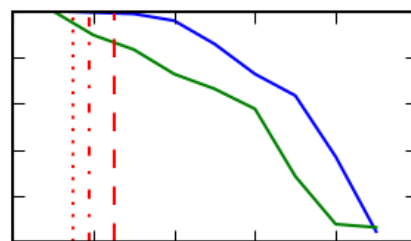
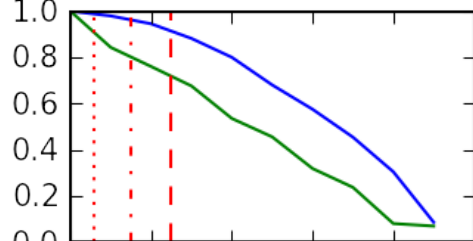
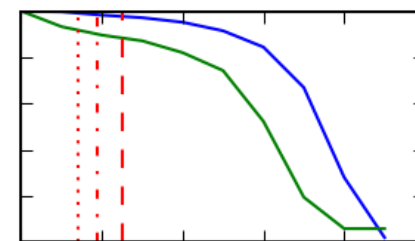
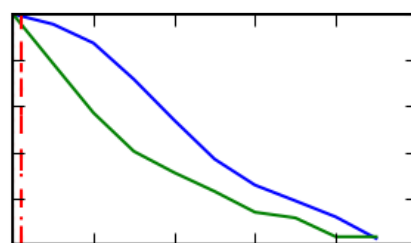
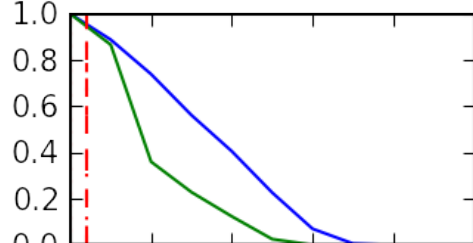
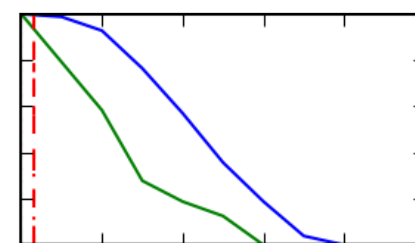
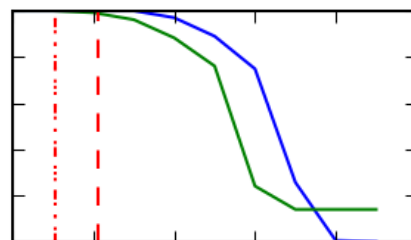
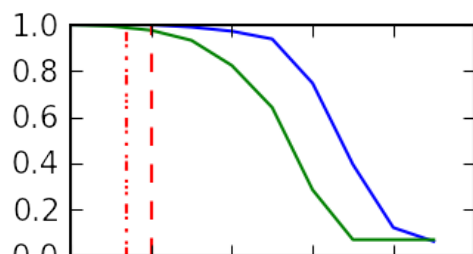
SMALL RIVER

LARGE RIVER

EXPLANATION

- Thriving Fish Species
- Characteristic Fish Species
- A-Line
- B-Line
- C-Line

FRACTION OF INITIAL POPULATION METRIC



FRACTION OF INDEX FLOW REMOVED

WARM
TRANSITIONAL
COLD

TEMPERATURE CLASSES

Approach

- When legislation was developed, there were no regional groundwater flow models to base decisions
- State had recently compiled groundwater information into a Groundwater Inventory and Map repository
- Many wells are installed every year
 - High capacity well > 70 gallons/minute, 0.31 acre-foot/day
- Statewide screening tool for high capacity wells
 - Allow registration of withdrawals less likely to cause adverse impact
 - Require analysis for withdrawals that might cause adverse impact: withdraw enough to move watershed to D zone
 - Analytical solution for streamflow depletion – companion equation for drawdown

Screening Tool: Analytical solution

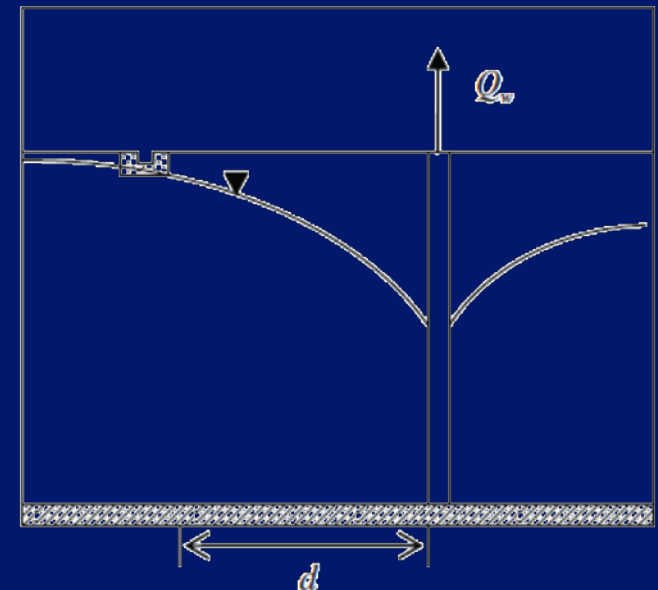
- Requires: distance from well to stream (d), transmissivity (T), storativity (S), streambed conductance (λ).

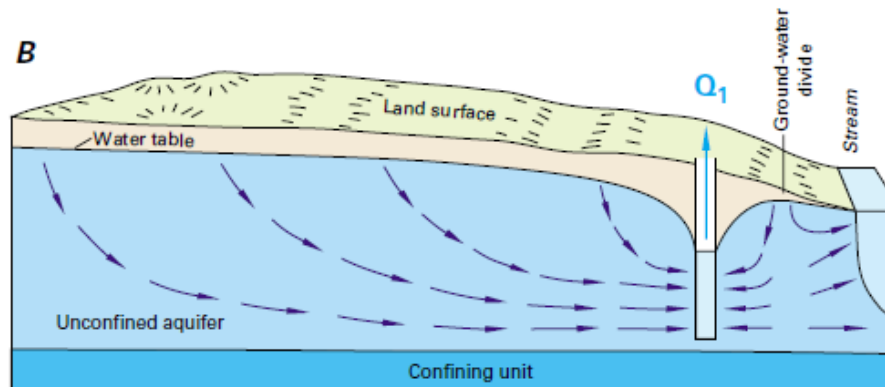
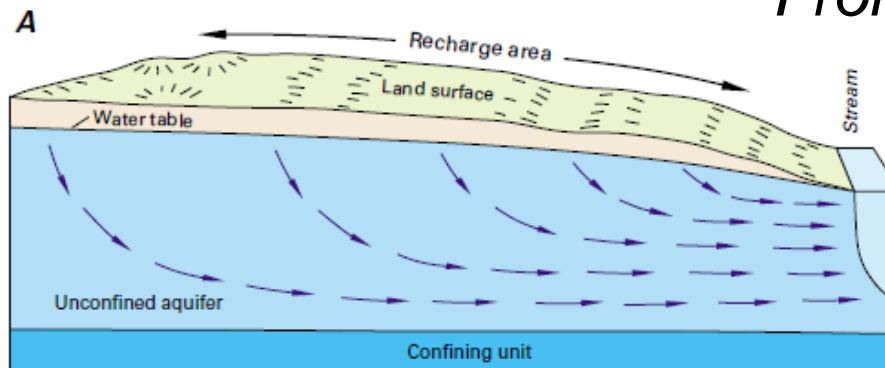
$$Q_s = Q_w \left[\operatorname{erfc} \left(\sqrt{\frac{d^2 S}{4 T t}} \right) - \exp \left(\frac{\lambda^2 t}{4 S T} + \frac{\lambda d}{2 T} \right) \operatorname{erfc} \left(\sqrt{\frac{\lambda^2 t}{4 S T}} + \sqrt{\frac{d^2 S}{4 T t}} \right) \right]$$

- S -> typical of leaky aquifer, 0.01 for glacial
- T -> from Michigan Groundwater Inventory and Map. For glacial deposits based on water-well records and glacial landforms; for bedrock based on aquifer-test analysis. Median value from 1000 m grid used for each watershed.
- d -> from web-based mapping tool
- t -> time: 5 years of pumping
- λ -> streambed conductance, estimated from T

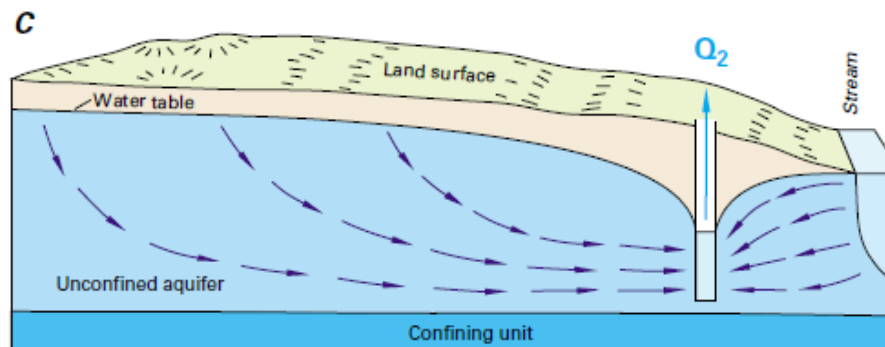
Assumptions

- Aquifer in connection with stream
- Pumping does not change recharge or stream stage
- No boundaries
- Streambed resistance is considered
- Uniform aquifer properties
- Horizontal flow
- Water to well from storage (drawdown) or stream



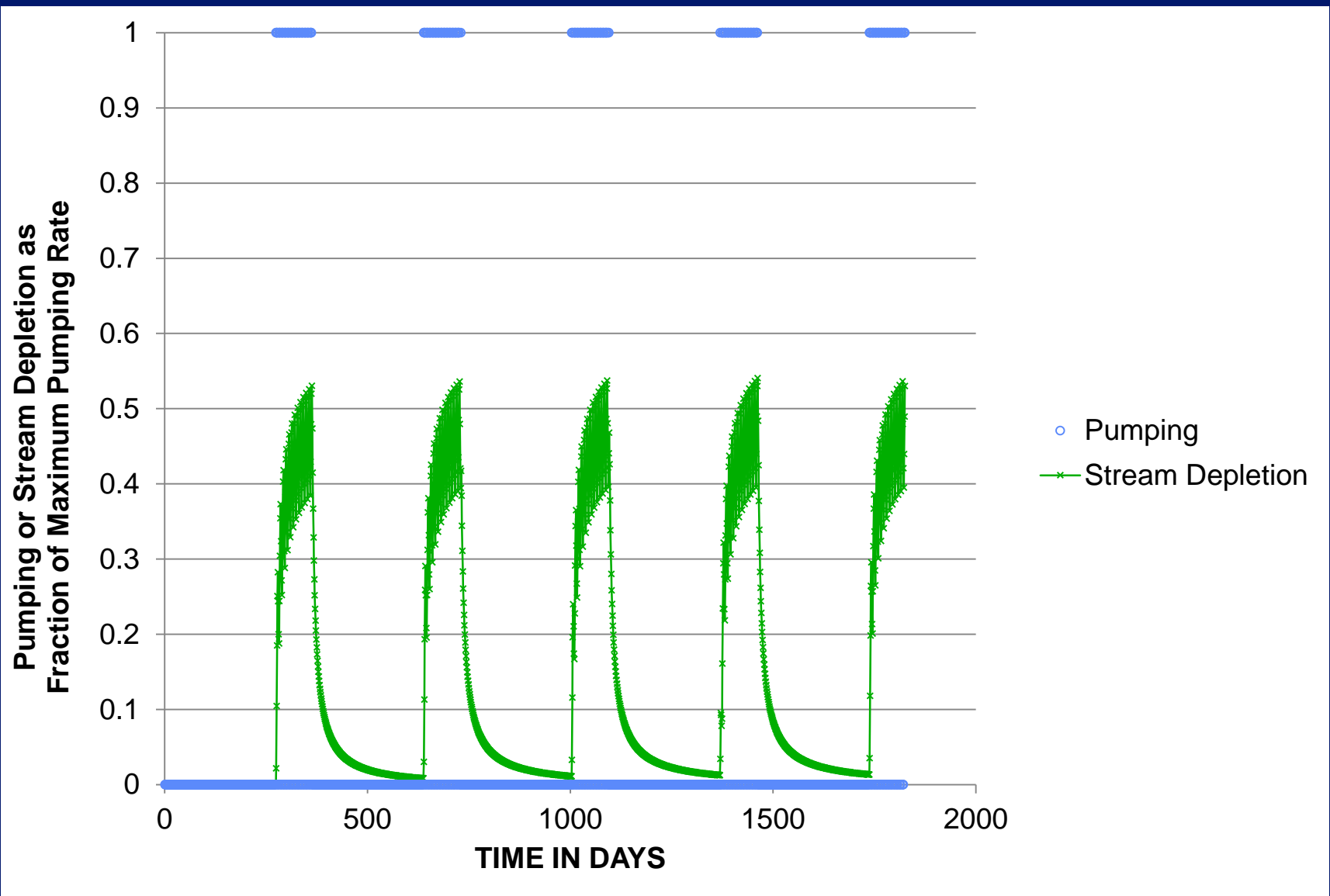


Capture water that would have discharged to the stream




Induce flow from the stream to the well

Figure 13. Effects of pumping from a hypothetical ground-water system that discharges to a stream. (Modified from Heath, 1983.)




← → http://www.deq.state.mi.us/wwat/{S(ev1rfwz0kqqvpthyl1jdv0r)}/default.aspx

DEQ: WWAT-Home Page



Michigan's Water Withdrawal Assessment Tool

Department of Environmental Quality



MICHIGAN.GOV
Michigan's
Official
Web Site

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Welcome

The Water Withdrawal Assessment Tool (WWAT) is designed to estimate the likely impact of a water withdrawal on nearby streams and rivers. Use of the WWAT is required of anyone proposing to make a new or increased large quantity withdrawal from the waters of the state, including all groundwater and surface water sources, prior to beginning the withdrawal. You must use the WWAT to determine if a proposed withdrawal is likely to cause an Adverse Resource Impact, and to register the withdrawal. The results page provides a quick link to submitting a registration. A registration is valid for 18 months; the withdrawal capacity must be installed within that 18 months or the registration becomes void.

[Start](#)

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Basemaps

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Image courtesy of USGS, State of Michigan, Earthstar Geographics

To evaluate a proposed withdrawal, first locate where the withdrawal will be placed on the map. Next click the "New Withdrawal" button below. Then click on the map where the withdrawal will be located.

Legend

Map Layers

Find a Location


About the Tool

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Image courtesy of USGS, State of Michigan, Earthstar Geographics


[←](#)
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[http://www.deq.state.mi.us/wwat/{S\(ev1nrfwz0kqqvpthyl1jdv0n\)}/Depletion_GW.aspx?dist_strings=833.707824901586,2157.47834536021,2995.01858](http://www.deq.state.mi.us/wwat/{S(ev1nrfwz0kqqvpthyl1jdv0n)}/Depletion_GW.aspx?dist_strings=833.707824901586,2157.47834536021,2995.01858)
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DEQ: WWAT-Withdrawal R... x



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Water withdrawal screening results

ARI Zone Graph



Result: Zone D

The proposed withdrawal has failed the screening process.

You must request a site specific review below in order to begin using this withdrawal.

The graph above illustrates the estimated impact of the proposed withdrawal on the affected stream, and its potential for causing an adverse resource impact (ARI).

Results:

The proposed withdrawal has failed the screening process. The projected impact of the withdrawal lies within 'Zone D' and is likely to cause an adverse resource impact.

Registration:

A large quantity withdrawal (LQW) with a capacity of 70 or more GPM must be registered before the withdrawal can begin. To register this withdrawal as you just entered it, use the button at the right.

A registration must be verified within 18 months by installation of the withdrawal. A registration that does not match actual installation, or that has not been installed within 18 months becomes void.

Stream Classification: Cold transitional stream

[Learn more...](#)

Site-Specific Review

[Rerun](#)

[Administrator](#)

[View Report](#)

DISCLAIMER: The Water Withdrawal Assessment Tool is designed to estimate the likely impact of a proposed water withdrawal on nearby streams. It is not an indication of how much groundwater may be available for your use. The quantity and quality of groundwater varies greatly with depth and location. You should consult with a water resources professional or a local well driller about groundwater availability at your location.

