FLOW
FOR LOVE OF WATER

Protecting the Common Waters of the Great Lakes Basin
Through Public Trust Solutions

April 21, 2017

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VIA Electronic Submission

RE: NESTLÉ WATERS NORTH AMERICA'S ("NWNA" OR "NESTLÉ")) APPLICATION FOR PW-101, OSCEOLA COUNTY, MICHIGAN "WHITE PINE SPRINGS" TO INCREASE PUMPING FROM 150 GALLONS PER MINUTE ("GPM") TO 400 GPM, PURSUANT TO SECTION 17, SAFE DRINKING WATER ACT ("SDWA"), MCL 325.1017; SECTION 32723, GREAT LAKES PRESERVATION ACT ("GLPA"), MCL 324.32723, AND OTHER APPLICATION COMMON LAW AND STATUTORY REQUIREMENTS

Dear Director Grether and Supervisor Gamble:

For Love of Water ("FLOW") submits this Report, together with Appendix 1[1] (Legal Requirements and Standards), Appendix 2[2] (Evaluation of Hydrogeological), and Appendix 3[3] (Ecological Impacts), for the purpose of providing scientific hydrological, hydrogeological and environmental information, expert scientific

[1] James Olson, J.D., LL.M.,is President and Legal Advisor to FLOW, Traverse City, Michigan. He is senior principal, law firm of Olson, Bzdok & Howard, P.C., also in Traverse City, Michigan. Mr. Olson has a B.A. in Business, Michigan State University, J.D., Michigan State University College of Law (formerly Detroit College of Law), and LL.M. in water and environmental law, University of Michigan. He was lead council in the trial and reported decisions in *Michigan Citizens for Water Conservation v. Nestlé Waters* (2001-2009). He submits this specific legal comment on behalf of FLOW. www.flowforwater.org. Olson, Summary of Legal Requirements and Standards and Selected Statutory Provisions, FLOW, April 21, 2017) ("FLOW Legal Report" or **Appendix 1**).

[2] David Hyndman, PhD, Evaluation of Proposed Increase in Pumping of PW-101 to 400 gpm by Nestlé Waters North America ("NWNA"): Osceola Site, Osceola County, Michigan (April 21, 2017) ("Hyndman Report" or **Appendix 2**).

[3] Mark Luttenton, PhD, Ecological Impacts to Surface Water Features Due to Groundwater Pumping from PW-101 Site in Osceola County, Michigan (April 21, 2017) ("Luttenton Report" or **Appendix 3**).

opinions, legal analysis, and conclusions regarding the required determinations by the Michigan Department of Environmental Quality ("DEQ" or the "Department") in the above-referenced matter.

A. INTRODUCTION

1. Overview

The Applicant Nestlé Waters ("Nestlé") seeks permission to increase pumping from 150 gallons per minute ("gpm") (or 216,000 gallons per day ("gpd")) to 400 gpm from its existing large-volume water well PW-101 that DEQ approved in 2007 and again in 2009. Nestlé's current permit request for an additional 250 gpm or 358,000 gpd more water would cumulatively total 400 gpm or 576,000 gpd or 210 million gallons a year. In order to increase its pumping by 167 percent, Nestlé must demonstrate from an evaluation of existing conditions and effects that there is a "reasonable basis for a determination" that there will be no adverse resource impact, no violation of groundwater law standards, and no likely impairment of the creeks, streams, and wetlands, habitat, fish, or other environmental impacts. As evaluated below, Nestlé's application falls far short of the high-bar legal and technical standards for a permit in this matter, and that the application should be denied.

FLOW retained hydrogeological and aquatic impact experts to conduct a thorough and independent review of the application and supporting reports and computer model. Based on this review, it is abundantly clear that the Nestlé did not sufficiently evaluate *existing* hydrogeological and environmental conditions, and actual and predicted effects and impacts to form a reasonable basis for the DEQ to approve its application. In addition, based on the actual conditions at the proposed increase of 250 gpm and total removal of 576,000 gpd from the headwater springs of Chippewa and Twin Creeks, there will be substantial effects and impacts to the streams, fishery, habitat, wetlands, and environment contrary to the legal standards that must be satisfied.

Because Nestlé wants to bottle and sell "spring water," it is required by U.S. Food and Drug Administration ("FDA") to demonstrate a direct hydraulic and hydrogeological connection with a spring that flows to the surface of the earth, forming creeks, wetlands, and streams. [4] As a result, the location required by Nestlé's marketing desire necessarily means that for every gallon removed for "spring water," a gallon is removed from the flow of the connected spring, seeps, creeks and streams and reduced from the normal levels of wetlands.[5] Nestlé requests permission to pump continuously, 24 hours/7 days/week, for as long as it desires, forcing a new "steady state" condition on the headwaters/groundwater/surface water/wetlands complex.

This means it will be permanently affected and changed by the subtraction of 576,000 gallons a day.[6] As a result, Nestlé's proposed removal of water from the connected springs, seeps, wetlands, creeks and lakes will be or are likely to cause significant effects, and in turn impair, unreasonably harm, and adversely impact water, aquatic resources, brown and brook trout and habitat, wetlands, the interconnected ecosystem.[7] It will also significantly diminish the water available for other users in the watershed and the natural conditions for brook

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[4] 21 C.F.R. 165.10(a) (2) (VI). "There shall be a natural force causing the water to flow to the surface through a natural orifice. The location of the spring shall be identified…Spring collected with the use of an external force (well/pumping) shall be from the same underground stratum as the spring, as shown by a measurable hydraulic connection using a hydrogeological valid method between the bore hole and the natural spring."

[5] DEQ Executive Summary, Nestlé Ice Mountain Voluntary Petition for Determination of "No Adverse Impact Under MCLA 324.32724 (repealed), February 2, 2007 (hereinafter "DEQ 2007 Executive Summary").

[6] *Id.* "If spring water is collected with use of an external force, water must continue to flow naturally to the surface of the earth through the spring's natural orifice."

[7] Pumping may have already or will at these increased rates of pumping stop the flow of water from some of the springs, which violates 21 C.F.R. 165.10. *Id.*

and brown trout in the stream system.

None of this should be surprising given the hydrogeology, precipitation, glacial till or mixture of sand, gravel, and clayey materials in Michigan's Lower Peninsula. Michigan's groundwater is replenished from seasonal rains and snowmelt in early spring. In dry years or seasons, normally May through mid-September (now exacerbated by climate change) the flow and levels of springs, creeks, streams, lakes, and wetlands are significantly diminished, sometimes by as much as 50 percent. Similarly, artificial or human removal of groundwater reduces flows and levels. When water removals exceed 100,000 gpd and are not returned to the groundwater or streams, significant effects and harms occur. The effects and harm is even greater during drier months or drier years.

In *Michigan Citizens for Water Conservation v. Nestlé,* involving removals from 200 to 400 gpm at the Sanctuary Springs, approximately 25 miles south of the springs and streams involved in this matter, the Michigan Court of Appeals recognized that even moderate withdrawals cause undue harm in unsuitable locations like headwater streams and wetlands.[8]

The Court of Appeals in the *Michigan Citizens for Water Conservation ("MCWC") v. Nestlé* is instructive for the determinations to be made in this matter.

First, the court affirmed the trial court's ruling that pumping at 200 gpm had caused significant effects on flow and levels and substantial harm,[9] and would also do so at 400 gpm; the court affirmed a significant drop in flows and levels – 24.5 to 28 percent, in summer months as much as 35 percent, with corresponding drops in stream, lake and wetland levels of two to six inches or more.

Second, the court ruled that a removal of gpm for marketing "spring water" bottled water constituted an unreasonable use under Michigan groundwater law, and an impairment of water and water resources in violation of the Michigan Environmental Protection Act ("MEPA"), Part 17, NREPA.[10]

Third, the court affirmed trial court injunction, but remanded the case to the trial court to modify the injunction to allow for fair participation of all users in the watershed and to assure adequate water in the stream.[11]

Fourth, the court found as part of the common law reasonable use test that headwater springs, streams, and lakes are not a suitable location for high-volume pumping for bottled water, that adequate water must be maintained in the stream under all conditions, and that there is a preference for on-tract or in-watershed use of water, not diversion and export for the convenience of bottled water.[12]

Fifth, after the Court of Appeals remanded the *MCWC v. Nestlé* case to the trial court, the parties with the help of experts stipulated to a modification of the injunction to strictly control pumping rates when they exceeded stated criteria in gpm or inches of flows and levels, respectively, tied to continuous monitoring during pumping

[8] *Michigan Citizens for Water Conservation v. Nestlé*, 269 Mich. App.25, 709 N.W.2d 174 (2005) (hereinafter "MCWC"), the court noted that large water removals are not considered suitable for the headwaters of small creeks and streams. *Id.*at 44-48.

[9] *Id.*

[10] Michigan Environmental Protection Act ("MEPA"), Part 17, NREPA, MCL 324.1701 *et seq*.

[11] *MCWC v Nestlé*, 269 Mich App at 61-69, 71.

[12] *Id.* at 75.

of the effects on the stream segment and lakes.[13] If flows or levels dropped below the criteria, pumping is correspondingly reduced or shut down. The order also imposes a limit on the maximum rate of withdrawals during summer months (150 gpm) and winter months (225 gpm).[14]

Sixth, the court affirmed the observation of the trial court that Nestlé's hydrogeology expert was a "company man,"[15] because he doubled groundwater recharge from 9 to 10 inches to 18 inches in the model just above the three large-volume wells; this understated effects on groundwater, stream, lakes, and wetlands. Average precipitation in north central Michigan averages 32 to 33 inches. Approximately 25 to 30 percent of this ends up in groundwater (recharge), the base flow of streams in dry periods. This means recharge is only eight to 10 inches a year.[16]

As often happens in large volume water removal cases, there are two ways to determine effects on flows and levels. One is to conduct extensive monitoring before, during, and after pumping and removal; this requires direct measurement and observation, and is considered far superior to groundwater models. Two is to construct a groundwater model to estimate effects. As with any computer model, the design, parameters, and assumptions, and calibrations may or may not reflect or predict reality—depending on use of existing data, verified assumptions or parameters backed by actual or existing soil and hydrological conditions, such as precipitation, recharge, springs, headwaters, proper stream reaches, or wetlands.[17] Existing conditions are also essential for determinations of effects and impacts, especially with models. If one cannot compare or "match" model calibrations and predictions with existing or actual conditions, the model is not reliable or credible.[18]

Based on the detailed analysis below, Nestlé's application for 250 gpm or 356,000 gpd with the cumulative water request for 400 gpm or 576,000 gpd should be denied. This massive permanent removal of water from PW-101 and this sensitive, cold headwater complex will result in significant diminishment of flows and levels of these water bodies and impair the water, fish, and other aquatic and natural resources. Further, DEQ should impose measures, similar to the 2009 amended stipulated order in *MCWC v. Nestlé*, on the currently approved 150 gpm to assure that pumping will be limited to follow the seasons, cycles, and unpredicted effects of climate change, and the use of continuous monitoring and pumping records.[19]

B. PROCEDURAL BACKGROUND OF NESTLÉ'S PERMITS, REGISTRATIONS, APPROVALS, AND CURRENT APPLICATION UNDER SECTION 1017 SDWA.

1. The Original Permit to Withdraw 150 gpm, February 2, 2007

[13] Amended and Final Stipulated Order, July 6, 2009, pp. 2-4 (**See Appendix 1, Exhibit 1**); *MCWC v Nestlé* (Mecosta County Circuit Court, On Remand).

[14] As a practical matter, under the order, Nestlé can remove on average only 125 or so gpm in summer months, and around 225 gpm in winter months.

[15] *MCWC v Nestlé*, Trial Court Opinion, Mecosta Cir. Ct. no. 01-14563-CE, Nov. 25, 2003, p. 10.

[16] More recently, droughts or extreme swings from climate change have reduced groundwater recharge and flows and levels even more. The same consultant (S.S. Papadopulos & Associates ("SSPA") in the instant case constructed Nestlé's groundwater model discredited in the *MCWC v Nestlé* case. For example, the SSP model puts 14 inches of recharge to base groundwater, overstating amount of water in the system and understating or masking effects on flow and levels and impacts. Recharge to groundwater from precipitation is nine to 10 inches in northern or this north central Michigan area.

[17] Section 17(3) of the SDWA and Section 32723(6)(b) of the GLPA recognize the importance of information and evaluation of existing conditions, to assure better reliability of predicted effects.

[18] See **Appendix 2**, pp.2-3.

[19] MCL 324.1710(4)(b) Safe Drinking Water Act ("SDWA").

Nestlé obtained a permit in February, 2007, for the original 150 gpm by requesting full review and approval under the "voluntary" application provisions of Section 32724 (*now repealed*) of the Great Lakes Preservation Act ("GLPA"), a less rigorous process than a permit application under Section 17 of the SDWA and Section 32723 of the GLPA. Section 32724 (now repealed) required only a showing of "no adverse resource impact," defined as adverse impact to functional fish populations. Although requested to consider violations of the MEPA[20] Part 17, NREPA, and standards under state wetlands and inland lakes and streams law,[21] DEQ carefully limited its approval based on impacts to fish populations as narrowly defined under the GLPA, and made clear that other approvals or standards must be obtained to withdraw 150 gpm from PW-101 for bottled water.[22]

The DEQ found that every gallon removed for spring water was a gallon removed from the creeks.[23] Relying on the requested level, the DEQ evaluated stream flows and the effect on stream flows based on flow estimates for Twin and Chippewa Creeks. It determined that Twin and Chippewa Creeks are designated cold water trout streams, found a similar cold water trout stream, (Pine River) that had a flow gauging station with a drainage area of 58.9 square miles above the station. Using the ratio of the gauged flow of 9.6 cubic feet per second ("cfs") per the upstream area of 58.9 miles of Pine River, the DEQ estimated the flow at the ungauged point on Chippewa Creek with a 2.9 square mile drainage area at 0.5 cfs (225 gpm), and Twin Creek with a 16.7 square mile drainage area at 2.7 cfs (1,215 gpm).[24] The DEQ noted actual flow measurements in the right location can better determine flows and levels; actual measurements before, during, and after pumping over an adequate period of time can better determine the actual relationship between flows, levels, and effects of pumping. The DEQ also found that Twin and Chippewa Creeks had numerous brown and brook trout and other fish species that are characteristic of a cold water trout stream.[25] Nestlé then submitted a few selected flow monitoring results for measurement stations, including SF1, SF9, SF16, and SF17; the DEQ correlated these with the Pine River flows, and adjusted flows upward to 4.4 cfs (1,760 gpm) for Twin Creek and 3.8 cfs (1,710 gpm) for Chippewa Creek. Even after adjusting upward for flows that are not identified as 50% Index flows (*i.e.*, more flows than exist during drier summer month), the DEQ determined that PW-101 should be limited to 220 gpm to prevent adverse impacts to trout populations; and, again even using higher than actual low based flows, the DEQ limited pumping to 260 gpm.[26]

With more accurate date and verified stream measurements from all the data, including those during pumping, the observations and estimates would show that the cfs or gpm for the two creeks are much lower.[27] Dr. Luttenton, FLOW's expert for this report, noted in 2007 and 2008 that Nestlé's experts avoided "adverse resource impacts" by "selecting specific [monitoring] sites with flow regimes" that represent the least impacts," that "the most sensitive sites have been excluded from the analysis."[28]

DEQ approved a 150 gpm maximum withdrawal rate from PW-101 to comply with the narrow "adverse

[20] Part 17, NREPA, MCL 324.1701 *et seq*. See **Appendix 1**, Specific Legal Requirements and Standards applicable to Nestlé application, pp.4-5.
[21] MCL 324.301 et seq. (Wetlands); MCL 324.301 et seq.(Inland Lakes and Streams).
[22] DEQ 2007 Executive Summary.
[23] *Id.*
[24] One (1) cfs equals 448 gallons per minute (gpm). For ease of math, the number is rounded to 450 gpm.
[25] DEQ 150 gpm determination, pp. 3-4.
[26] *Id.* at 4.
[27] **Appendix 2**, p. 3.
[28] Luttenton, Mark, PhD, Comments on "Proposal for Determination on Nestlé Waters North America's Petition for Voluntary determination under MCL 324.3724, Exhibit 2, Letter from James Olson, Attorney for MCWC to DEQ, January 7, 2007. See also discussion under scientific analysis sections, **Appendix 2**, pp.5-6; **Appendix 3**, p 4-5.

resource impact" standard, defined as "decreasing the flow of a stream" that "functionally impaired" "characteristic fish populations." However, DEQ qualified its determination by acknowledging it did not consider other laws[29] and that its decision was based on the information that had been submitted by Nestlé. The DEQ emphasized that "The determination in question is a very limited one,"[30] is limited to impairment of functional fish populations, and not considerations of other effects on environment, water, natural resources, or other uses, and the DEQ did not consider other laws that would affect Nestlé's ability to obtain approval.[31] Similarly, the DEQ admitted that it relied only on the application information submitted by Nestlé, and that the information was insufficient to determine and does not account for such environmental and water or other resource impacts.[32]

As a result of the above, the DEQ emphatically stated that for bottled water Nestlé would have to obtain "specific permits from DEQ…under the Michigan Safe Drinking Water Act." Further, Nestlé applied for and obtained "water source" approval under the SDWA on March 27, 2009.[33] However, Nestlé's permit for 150 gpm for bottled water would equal 356,000 gpd, which was subject to Section 17, SDWA, in effect on February 28, 2006,[34] and subject to amendments to Section 17 for more than 200,000 gpd, effective as of July 9, 2008.

To date, Nestlé has never applied for a permit under or complied with Section 17 SDWA bottled water requirements and Section 32723 GLPA standards as part of its request in 2007 and for water source approval in 2009 that require the filing of sufficient information on existing hydrologic, hydrological and environmental conditions, public notice and comment, and determinations based on far more rigorous statutory and common law standards than the voluntary application, less rigorous, and more lenient approval under Section 32724.

2. The April 16, 2015 Registration ID#3908-20154-32 for the first increase of 100 gpm, totaling 250 gpm.

To comply with an increase in pumping from PW-101 from the 150 gpm to 250 gpm, Nestlé submitted information for 100 gpm only under the Water Withdrawal Assessment Tool ("WWAT"), Section 327106a.[35] Although this increased withdrawals from PW-101 by 216,000 gpd, or total of 356,000 gpd, Nestlé did not submit an application for this increase as required by Section 17(3) and (4) of the SDWA. Other than the assessment tool, there was and has been no application for the 100 gpm increase registered under the WWAT on April 16, 2015.

3. The January 5, 2016 Registration ID#4125-201512-31 and Site Specific Review (SSR) Letter for second increase of 250 gpm, totaling 400 gpm.

Nestlé filed for a registration under the WWAT for a 250 gpm increase, totaling 400 gpm, or 576,000 gpd in late 2015. The WWAT rejected the registration because it would result in "adverse resource impacts" to a Category D Coldwater stream, and required a site specific review under Section 32706c.[36] Nestlé submitted additional information and the DEQ passed the registration for the increase of 250 gpm on January 5, 2016; DEQ changed the withdrawal to Category A (no adverse resource impact) by overriding the rejection by the

[29] **Appendix 1**, p. 1-4.
[30] *Id.* at 6.
[31] *Id.* at 8, 10.
[32] *Id.* at 8-9.
[33] Nestlé Application under Section 17, SDWA, July 2016, Attachment A-1.
[34] Section 17(10), MCL 325.1017(10).
[35] MCL 324.32706a.
[36] MCL 32706a(2). Site-Specific Review Report, Dec. 4, 2015.

assessment tool as Category D. Nestlé's additional information represented more available water from its model, hence overstated flows and understated effects, to avoid showing "adverse resource impact" or impact to functional fish populations.

4. **The October 2016 Application for Water Source Approval under Section 17 SDWA**.

Nestlé submitted an application in 2016 for water source approval pursuant to Section 17 SDWA to increase permitted withdrawals by 250 gpm from PW-101 (from 150 gpm to 400 gpm). As noted above, Nestlé has never requested approval under Section 17 for the original 150 gpm, even though the permit approved in 2007 and water source approval in 2009 involved more than 200,000 gpd. Nestlé has withdrawn and pumped at a capacity of 150 gpm since the water source approval in 2009.

In late October 2016 just five days before the close of the public comment period, MLive journalist Garret Ellison alerted the public that public comments on Nestlé's application were due on November 3, 2016. Because the DEQ had not issued sufficient public notice and provide for a 45-day public comment period, the public comment period was extended to December 3, 2016, and because of public outcry, lack of sufficient public notice, and complexity of subject matter, extended two additional times to March 3, 2017 and April 21, 2017.

On December 16, 2016, FLOW filed a third written comment to DEQ that requested the Department to clarify whether Nestlé's application for its water withdrawal approvals or registrations exceeding 200,000 gpd must comply with Section 17(3) and (4) of the SDWA and Section 32723 of the GLPA. FLOW also pointed out that the 100-gpm increase by Nestlé approved in 2007 and 2009, the 100 gpm increase in 2015 under the WWAT, and site specific review ("SSR") approval on January 5, 2016 were not valid, and these exceeded 200,000 gpd, and, therefore, did not comply with the bottled water provisions of Section 17 SDWA and Section 32723 of the GLPA.[37]

On January 17, 2017, DEQ Heidi Grether sent a reply letter to FLOW, and agreed that Section 17(3) and 17(4) SDWA and the standards of Section 32723 GLPA would be applied to the Nestlé application. Although Director Grether advised that the prior approvals were not invalid, she noted that all prior approvals were conditional on compliance with the information, determination, and the requirements and standards of Section 17 and Section 32723. The Director also stated that no new application, public notice or 45-day comment period were necessary, because all previous permits, approvals are not final until determinations are made as required by Section 17 and the standards of Section 32723.[38]

On April 12, 2017, the DEQ noticed and hosted a public hearing at Ferris State University, Big Rapids, Michigan, in the evening that was attended by over 500 affected or concerned citizens. One hundred speakers made three-minute public comments included affected landowners and fishermen/women, including representatives of residents of Detroit and Flint, who decried the injustice and grossly disproportionate and contradictory state law and policy that allowed Nestlé to pay a $200 application fee to export overtime billions of bottles of water and receive billions of dollars in revenue, while city residents paid over $200 a month for their family, which they cannot afford; these residents also decried the injustice compounded by the fact that they were forced to buy bottled water because of the unsafe lead water in Flint and tens of thousands of water-shutoffs in Detroit. A few speakers supported the Nestlé application because it paid taxes and provided jobs. The DEQ hearing moderator stressed that the Nestlé application will be decided based on the science, facts, and legal requirements and standards of Section 17 SDWA, Section 32723, and other applicable legal

[37] The letters from FLOW to the DEQ, dated November 3, 2016 and December 16, 2016, are incorporated by reference and made a part of the record of public comment.

[38] The DEQ Jan. 17, 2017 letter is made a part of the record in this matter.

standards.[39]

C. THE FACTS AND CIRCUMSTANCES REGARDING SUFFICIENCY OF INFORMATION, EXISTING CONDITIONS, EFFECTS, IMPACTS AND/OR IMPAIRMENT

As noted above, Section 17(3) and Section 32723 both require submission of the essential hydrogeological data and information and likely adverse impact or impairment of wetlands, seeps, springs, and headwater creeks, fish, aquatic life, habitat and other natural resources. The facts that follow set forth the material facts and circumstances relevant to the Nestlé application for withdrawing 400 gpm for its bottled operations in Stanwood, Michigan. The facts are divided into (1) background facts and description of the proposal, (2) lack of information and evaluation of existing conditions and effects; (3) the hydrologic and ecological setting, (4) impacts on streams, aquatic organisms, and ecosystems.

1. Background Facts on Nestlé's Proposed Substantial Removal of Water from the Headwater Springs, Wetlands, and Creeks

The Applicant Nestlé wants to pump 400 gpm, 576,000 gpd, or 210 million gallons a year from PW-101, high-volume water well permitted for 150 gpm in 2001. The 400 gpm total would increase the production and removal of water from the headwater springs, seeps, creeks, and wetlands by 250 gpm or 358,000 gpd.

To place this proposal into proper perspective, it is important to look at the context of Nestlé's proposal. The proposed removal of water will serve, via pipeline and truck transfer, Nestlé's bottled water plant operation in Stanwood, Michigan. The operation packages groundwater into various labels, including its "Ice Mountain" brand, which is labelled "spring water," and its Nestlé Life brand, which is groundwater. The bottled water is treated, packaged, and shipped in various size plastic containers, or in tanker trucks to other Nestlé bottled water or packaged water container plants. Several groundwater "water sources" supply the Stanwood plant:

(1) groundwater wells at the plant (300 gpm or more);
(2) the Sanctuary Springs, headwaters of the West Branch, Little Muskegon, in Mecosta County (100 gpm to 225 gpm as limited by a circuit court consent order);
(3) City of Evart municipal community wells dedicated to private use of Nestlé; and
(4) the existing PW-101 well (150 gpm).

As a result, Nestlé has other water sources, current and available or as alternatives, and the spring water from PW-101 is not essential for continued production at its Stanwood plant and trucking facility.

For Nestlé to sell "spring water," it must comply with FDA regulations that require Nestlé to demonstrate that the bottled water comes from a spring.[40] To show that it comes from a "spring" as defined by FDA, Nestlé must demonstrate a hydrologic connection between the continuing removals of groundwater by a high-volume well and nearby springs and surface waters or creeks. In other words, it must show that for every gallon of groundwater removed, there is approximately one gallon that no longer flows from a spring. Nestlé represents that the proposed withdrawal is for "spring water," presumably its Ice Mountain brand.

[39] See Legal Requirements and Standards, **Appendix 1,** pp.2-5.
[40] 21 C.F.R. 165.10, *supra* note 4.

2. Lack of Information and Evaluation Regarding Existing Conditions and Effects and/or Predicted Effects

FLOW requested Dave Hyndman, PhD, hydrogeology expert, and Mark Luttenton, PhD, stream and wetland expert, to conduct a full and independent evaluation of the Nestlé Application, and all information attached or subsequently submitted by Nestlé and its consultants (SSPA, Golder, etc.), As a result, Dr. Hyndman prepared a report, *Evaluation of the Proposed Increase in Pumping of PW-101 of 250 gpm to 400 gpm by Nestlé Waters North America: Osceola Site, Osceola County, Michigan*.[41] Dr. Luttenton prepared a report, *Ecological Impacts to Surface Water Features Due to Groundwater Pumping from PW-101 Site in Osceola County, Michigan*.[42]

Dr. Hyndman and Dr. Luttenton have extensive experience and expertise in addressing the issues, requirements, and standards related to the Nestlé application in this matter. Both evaluated, researched, prepared reports, and testified for the prevailing party, Michigan Citizens for Water Conservation, in the *MCWC v Nestlé* case, which involved a very similar proposal permitted by DEQ for Nestlé to pump 400 gpm from groundwater at Sanctuary Springs, Mecosta County, approximately 25 miles south of the Osceola Site. Both trial court and Court of Appeals in that case, found significant effects on flows and levels and substantial harm and adverse ecological impacts to stream, lakes, and wetlands, relying more on their testimony, as well as the late Barbara Madsen, Ph.D., and not accepting the effect and impact testimony of Nestlé's experts—mostly the same consultants who have been hired by Nestlé to assist the company in obtaining the permit from the DEQ in this matter.

Nestlé's Application and supporting information is based on a groundwater model prepared by SSPA. It is not based upon actual water, soil, and climate measurements.[43] Existing monitoring results on flows and levels from SF and SG locations are not used, except for selected data.[44] The SF and SG locations where flows were measured are located more than ½ mile downstream, apparently to avoid data from upstream that would show significant effects.[45]

The area consists of a primarily unsaturated groundwater recharge zone with heterogeneous soils. Nestlé makes assumptions or relies on calibrations in the SSPA model that only *assume* recharge to groundwater from annual precipitation is 14 inches, when as noted above it is closer to nine or 10 inches.

Further, the SSPA groundwater model assumes or calibrates low conductivity soils to minimize effects on wetlands and streams, rather than collect soil profiles and other existing data or conditions at the site.[46]

Dr. Hyndman's evaluation found that:

a. Nestlé or Nestlé Waters North America ("NWNA") application does not fully evaluate the

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[41] **Appendix 2**.
[42] **Appendix 3**.
[43] **Appendix 2**, pp.3-4
[44] *Id.*
[45] **Appendix 3**, p. 3.
[46] **Appendix 2**, p.4.

existing hydrologic, hydrogeological, or other physical and environmental conditions because: (1) Data collected between 2001 and the onset of pumping in 2009 do not appear to be used or evaluated; (2) The seven or eight years of data on the effects of pumping at 150 gpm when pumping started in 2009 have not been used or evaluated.[47]

For example, there are significant variations in the water level and streamflow data presented, and there has been no effort to tie those variations to changes in precipitation or pumping since 2009. Streamflow measurements have been lower since pumping started in 2009, but not evaluated, and the SSPA groundwater model did not evaluate the relationship between predicted streamflows and pumping, and did not compare the model to drops in stream flows in the last seven or eight years. Failure to collect or use local continuous weather data fails to provide a basis to evaluate the existing conditions in relation to existing pumping.

b. The data provided by NWNA are insufficient for the DEQ to fully assess the effects and impacts of past pumping or to provide an adequate or reasonable baseline for identification of future or predicted effects and impacts.[48]

Critical data bases were either not recorded or not submitted in NWNA reports and/or attachments, including (1) continuously monitored streamflow; (2) all pump test and pumping data for PW-101; (3) wetland water levels; and (4) local weather information.

Further, monthly streamflow measurements are insufficient to adequately evaluate or determine Index Flow in summer months (Q50 exceedance), In addition, based on information provided it is not possible to determine when pumping began, shut-down, and when pumping rates varied.

ECT measured wetland levels, but this existing data is not presented in the reports, the SSPA model, or used to compare or correlate the model's predicted effects. Moreover, wetland and water levels have not been continuously monitored with electronic transducer devices, a standard requirement to establish an adequate or reasonable basis to show or evaluate existing hydrologic and environmental conditions and functions or effects and predicted effects.

c. The NWNA reports and submissions do not provide adequate information about predicted effects of the proposed increase of 250 gpm or total 400 gpm.[49]

(1) The Golder Report appears to rely almost entirely on the SSPA groundwater model to predict hydrologic effects. Models are useful to assess potential effects, but only if the predicted effects are measured for reliability by comparing these predictions with existing data and conditions. The reliability of the model is not established. For example, there is a mismatch between measured groundwater levels and model predictions; the difference or "residual" is so great that the model predictions of water levels are not reliable; in the area near "White Pine Springs" groundwater levels are 1.4 and 3.6 feet above the measured values, which mask the predicted effects of 0.5 to 1 feet drop in levels from pumping. This will also affect simulated

[47] **Appendix 2,** pp. 1-2.
[48] **Appendix 2**, p. 2.
[49] **Appendix 2,** pp. 2-3.

flows, also masking effects of pumping.

(2) Confidence in the groundwater model from effects of existing pumping is not adequately established to determine effects and impacts. The model simulated the impact of only a short 10-day period based on the pump test in 2001. No other assessment of effects of pumping exists. SSPA's groundwater model did not even report the predicted effects at a rate of 150 gpm at PW-101.

(3) The effects of model uncertainties are not sufficiently addressed. For example, there is no attempt to analyze the wide discrepancy in the simulated model water levels and measured water levels, as noted above.

(4) The effects of variability in recharge over a long period of time were not considered or evaluated. Recharge varies from season to season and year to year, as much as a factor of two in this region of Michigan.[50] Lower recharge leads to lower stream flows levels; on the other hand, a lack of consideration of this variability would overstate water levels and understate effects and impacts.

d. The NWNA application does not provide a reasonable basis to determine the effects or impacts of the proposed pumping increase of 250 gpm or the total of 400 gpm. There are unsupported assumptions without existing or real measurements that permeate the SSPA ECT reports filed by NWNA. SSPA and ECT reports, taken together, show that their assessment minimizes effects on streamflows and wetlands.

(1) SSPA created a "low-conductivity" (barrier) soil or sediment zone between wetlands and streams. Such a barrier artificially limits the predicted flows and accrual effects.

(2) SSPA limited the period in the model to January 2001 to December 2002. This leads to a calibration in the model that supports the low conductivity barriers, but there pumping and streamflow data exist from then until 2016. Use of this time period or low conductivity are not supported by any existing data or conditions, therefore, merely artificial and unreliable assumptions.

(3) SSPA's groundwater model uses recharge estimates that are flawed because the reported recharge (Holtschlag 1997) do not represent the actual recharge in the Evart or surrounding areas of Michigan;

(4) SSPA's model states that their estimate is even 25 percent higher than the flawed reliance on Holtschlag.

(5) The groundwater draw-down contours across the site and area round PW-101 are not accurate, and therefore should not be relied on for evaluating effects and impacts on wetlands.

(6) ECT assumptions that wetlands B, C, and D are not connected to the aquifer are wrong. This assumption is inserted to mask the predicted effects that these wetlands will be significantly affected—1 foot drop in level. Wetland levels will drop even more, given the overstated assumptions about groundwater levels noted in b. above.

e. The NWNA application, models, and reports do not explicitly evaluate both individual and cumulative effects and impacts from the proposed increase of 250 gpm and total of 400 gpm pumping.

Neither the Golder report nor SSPA report and model evaluate the individual cumulative effects, predicted effects, or impacts of pumping at 400 gpm, the combined effects and

[50] **Appendix 2**, p. 4.

impacts of 150 gpm plus 250 gpm.[51] For example, Table 2, SSPA report, presents only changes in flow relative to the increase from 150 gpm to 400 gpm; and Figure 19 shows groundwater drawdown contours for only the 150 to 400 gpm increase. In turn, the simulated effects of the increase are all that is relied on by ECT in its impacts report. Moreover, SSPA simulated effects for both 150 gpm and 400 gpm, but subtracted one form the other to present only the incremental effects of pumping. Limiting the effects and impacts to the increment of 250 gpm does not address evaluate effects and total or cumulative effects and impacts from the entire proposed 400 gpm or loss of 576,000 gpd.[52]

Dr. Luttenton also found that the information submitted and evaluated is insufficient for DEQ to make a determination of effects, impacts, harms, and impairment in this matter:[53]

(1) The data is insufficient to determine there is no impact or impairment of fish communities because NWNA's consultants reduced survey locations and periods, fish data provided cover all of 2003 to 2016, rather than evaluate changes over time, including pumping from 2009 to present, and little baseline data was measured or collected before pumping started.[54]

(2) The date for invertebrate communities is also insufficient because invertebrate data from 2003 to 2016 is lumped together, the number of survey sites are limited and there is little information or data before pumping.[55]

(3) Data assessing existing conditions and impacts related to existing physical conditions are insufficient because the data is again lumped together, stream flow measurements methods are uncertain,[56] Further, the flow measurement meter does not meet USGS standards, and the calculated drop in water level of 0.01 feet uniformly over the region masks impacts, especially headwater segments not measured where existing flows are much lower and effects and impacts will be much greater.[57]

(4) No data are shown upstream from measurement locations or in surrounding seeps and unnamed small creeks.[58]

(5) Data for wetlands are insufficient because the wetland assessment was done in the spring with higher water levels from show melt and during plant dormancy. Golder report also notes that ECT did not perform specific search for

[51] The reports note the 400 gpm rate used in the WWAT registration that was rejected. There is no explanation why the current application under Section 17 SDWA with the mandatory evaluation requirements and standards of Section 32723 GLPA did not evaluate these individual and cumulative effects and impacts.

[52] As noted above, even with overstated groundwater and streamflows, DEQ limited pumping under Section 32724 GLPA to prevent "adverse resource impacts" to fish populations at 220 gpm for Chippewa Creek. This in itself demonstrates under assumptions favorable to NWNA that neither the 250 gpm nor 400 gpm can be approved; indeed; and if the assumptions and manipulations of the data and model are corrected, significant effects and impacts are likely at 150 gpm under the original PW-101 approval in 2007 (GLPA) and 2009 (SDWA). Of course, this is precisely why the entire total from 0 to 400 gpm must be evaluated, and why the original 150 gpm must still be applied for and approved for under the requirements and standards of Section 17(3) SDWA and Section 32723 GLPA. The current application fails to do this.

[53] **Appendix 2**, pp. 3-4.

[54] *Id.* at p. 3.

[55] *Id.*

[56] *Id.*

[57] *Id.*

[58] *Id.* at p. 4.

species, which could have been done throughout the growing season.[59]
(6) ECT looked at very limited search for species, and did not conduct a systematic search for specific species.[60]

3. Hydrological effects and ecological impacts on springs, creeks, wetlands, fish, habitat, and aquatic resources.

Dr. Hyndman and Dr. Luttenton have more fully described their findings and conclusions in their reports However, their findings are summarized as follows:

a. Effects on Flows and Levels on Streams, Wetlands.[61]

(1) Dr. Hyndman found and concluded that there will be more significant effects following the increase in pumping to 250 gpm.[62] SSPA Groundwater Report already shows significant effects on lower streamflows, compared to a period in 2002 to 2003.
(2) Dr. Luttenton found that there will be significant drops in seeps, springs, upstream segments in the 1.0 foot groundwater drop predicted by SSPA model; this will result in reduced flows and shorten the length and periods of flow;[63] this will cause a reduction invertebrate communities, reduced ecological function, reduced fish habitat, spawning, fish movement, and survival.[64]
(3) Dr. Hyndman found there will be a cumulative reduction in index flows near 15 percent at SF-6, Weir 6, and SF-8, and Weir 5, reductions of index flows near 15 percent at SF-11, sF-9, sF-16, and SF-13, and more dramatic significant seasonal effects for wetlands.[65] "Submerged Wetland H is likely to be permanently lost.
(4) Dr. Hyndman concludes that all of the above effects will be significantly greater at the cumulative drawdown at 400 gpm, and that the effects during low precipitation months, June through mid-September, would be even greater.
(5) When the deficiencies and wrong assumptions regarding recharge, low-conductivity barriers between wetlands and streams that are likely not there, and streamflow is related to pumping rates, and measurements adjusted for seasonal and cyclical low precipitation or drought, including effects from climate change, the effects will be very significant.[66]

Dr. Hyndman and Dr. Luttenton's evaluations have also found that (1) that monitoring or measurement locations were set farther downstream to minimize data showing effects; (2) the SSPA groundwater model understates effects; and (3) there will be significant effects on stream flows and levels as a result of the increased 250 gpm and total of 400 gpm pumping and removal of water from the groundwater and watershed.[67]

4. Impacts on Streams, Aquatic Organisms, Fish and Ecosystem.

[59] *Id.*
[60] *Id.*
[61] For ease of reference, Stream Flow Measuring and Monitoring Locations are shown in attached **Appendices 4** and **5**.
[62] **Appendix 2**, p. 5.
[63] **Appendix 3**, pp. 4-5.
[64] *Id.*
[65] **Appendix 2,** p.5.
[66] *Id.* at 5.
[67] See **Appendix 2**, p. 4; **Appendix 3**, p. 5.

As described above, Dr. Luttenton found overall that there will be significant adverse impacts to flows, levels, habitat, spawning, fish migration and survival, significant impacts on invertebrates, and on wetland water levels and plant species and functions. More specifically, Dr. Luttenton found:

(1) Upper Chippewa Creek is a cold-water trout stream. For Upper Chippewa Creek (above impoundments) (monitoring locations SF-8 and SG-5 (SSPA Fig. 9, Golder Fig. 3.8), monitoring records show a general decrease in discharge to streams;[68] invertebrate changes and impacts have already occurred between 2003 and 2015,[69] pumping has and will exceed natural fluctuations, which will cause impairment and significantly harm and reduce aquatic resources and the condition of surface water features.[70]

(2) In Lower Chippewa Creek, Luttenton reviewed SF-16, SF-17, SF-18, and SF-19. For SF-18, and for a small tributary called Posted Creek, data was excluded; no data is recorded for SF-19, an unnamed tributary creek. Only discharge streamflows, but no physical or ecological data was provided for SF-17. Water flowing from SF-7 is colder and likely buffers warmer temperatures noted for SF-16. Since SF-17 and SF-18 are within even SSPA's model prediction drop of 6 inches, reducing the water table and flows in this region or segment will cause significant diminishment of cold water flows and cold water fish species. Since SF-17 is within the 6-inch to 2-foot range for predicted drops in water table, lack of information on temperature and conditions is serious, especially because the stream segment above SF-18 support a significant juvenile brook trout population.[71]

(3) Fish communities have been monitored between 2003 and 2015 at SF-16.[72]Again the data has been lumped together, and not evaluated for changes. However, some data between 2000 and 2004, and in 2006, and in 2016, brook trout and brown trout populations have been significantly diminished;[73] Posted Creek and this segment of Chippewa are an important fishery, including spawning.[74]

(4) The 2006 report shows brown trout reproduce,[75] and their populations have also dropped significantly. Drops in water table and effects will substantially adversely impact fish reproduction and survival for trout.[76]

(5) While invertebrate data is similarly averaged between 2003 and 2015, three key invertebrates (Brachycentrus, Glssosoma, Leidostomitidae) are no longer present.[77] Stream habitat will be significantly impacted. Any drop in water level from drops in streamflow in this region and upstream will substantially reduce invertebrate populations.[78]

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[68] **Appendix 3**, p. 5.

[69] *Id.*, pp. 5-6.

[70] *Id.*, p. 6.

[71] *Id.*, p. 6. It is emphasized that the lack of baseline data and averaging or lumping of data, the failure or selective use of data by NWNA consultants means there is not sufficient information to evaluate effects and impacts as required by SDWA Sec. 17(3) and Sec. 32723 GLPA.

[72] See **Appendix 4**, Golder Fig, 3.8, AEM report, Table 1.

[73] See **Appendix 3**, pp. 7-8, Fig. F2.

[74] **Appendix 3**, p. 7.

[75] *Id.*, p. 8.

[76] *Id.*, p. 8.

[77] *Id.*

[78] *Id.*, p. 9.

(6) In Twin Creeks, data was collected at SF-1, SF-2, Sf-11, SF-10, and SF-13.[79] However, data is incomplete and sporadic, and at weirs 2 and 4 there are no measurements for August, the low or base flow month. Again, all data is lumped or thrown together and average, so as presented not evaluation of impacts can be made. However, stream depths are low (1.0 feet), upstream locations are 4 to 6 inches deep; and this is in area predicted by model for drop in groundwater of 1 foot.[80]

(7) Temperatures in Twin Creek, such as SF 5-5-6, have increased from 12 degrees C in 2003 to 17 degree C in 2013 to 2015, and temperatures at SF-6 have increased to 15 degree C.[81] The upper area between SF-1 and SF-9 is a cold water refuge for trout. The reduction of water table and reduction in flow of cold water will cause a significant decrease in trout species.

(8) While again, fish community data was averaged, Luttenton found the number of fish species declined from 14 to 9 between 2003 and 2015. At SF-9 the brown trout population from 34 to 12; from 2000 to 2016.[82] Brook trout population has dropped from 10 to 5 at SF-6. Brook trout are most abundant in cold water unnamed reaches below seeps; the proposed pumping will cause increase in water temperature, drops in flows and change habitat, and substantially impact adversely trout populations and the viability and functionality trout in the stream.[83] A drop in water level in seeps, upper reaches and Twin Creek will substantially alter the gravel substrate and habitat for spawning and reduce invertebrates and the trout fishery.[84]

(9) Twin Creek invertebrate populations have declined, while one increased, similar to Chippewa Creek.[85]

(10) Pumping has caused and will cause a drop in water level at seeps, weirs, and upper reaches of both creeks, which will loss or change in plant communities, and allow introduction of invasive species.[86]

(11) Wetland habitat will be substantially impaired and adversely impacted. Reduced water levels in the 16 wetlands evaluated will cause loss of habitat required for an amphibians and reptiles that depend on this habitat.[87]

D. THE NESTLÉ APPLICATION DOES NOT COMPLY WITH LEGAL REQUIREMENTS OF SECTIONS 1017(3) AND (4) OF THE SDWA.

Section 17 of the SDWA demands a thorough evaluation of existing conditions, effects, and predicted effects based on those existing conditions. Section 17 also demands that the applicant's information and evaluation provides a "reasonable basis for determination" by DEQ that the standards of Section 17 of the SDWA and Section 32723 of the GLPA have been met. "Only if"[88] these requirements have been established, can a determination be made to approve the requested permit. For the reasons stated below, the permit must be denied for lack of

[79] **Appendix 4**.
[80] *Id.* at 10.
[81] *Id.*
[82] *Id.* at 11.
[83] *Id.* at 11-13.
[84] *Id.* at 15-16.
[85] *Id.* at 14.
[86] *Id.* at 16.
[87] *Id.* at 18.
[88] Section 17(4) SDWA.

sufficient information and evaluation for DEQ to make such a determination, and because the permit does not otherwise meet the requirements and standards of Section 17 and Section 32723.

1. Section 17(3) requires Nestlé to "submit an application… containing an evaluation of *environmental, hydrological and hydrogeological conditions that exist* and the predicted effects of the intended withdrawal that *provides a reasonable basis for the determination…"* Section 17(4), as recognized by the Department in its July 17, 2017 letter, authorizes an approval only if the proposed use will meets the applicable standards in Section 32723" of the WWA. Section 32723(2) requires an "evaluation of the *existing hydrologic and hydrogeological conditions*" and "detailed" preventative measures and how they will be implemented to protect flow regimes, aquifers, creeks, wetlands, and other water courses.[89]

   DEQ has already determined that information is incomplete to continue review of the application. DEQ's February 14, 2017 letter to Nestlé identifies 21 items involving the hydrogeological and groundwater study, streams, wetlands that are needed for it to review the application. FLOW's hydrogeologist expert Dr. David Hyndman, freshwater and wetland expert Dr. Mark Luttenton, and hydrogeologist and wetlands expert Dr. Grobbel have all identified critical data and information that must be collected and/or made available before any determination by DEQ can be made on Nestlé's application as required by these legal requirements and standards.

   Dr. Hyndman found that the Nestlé application is based almost entirely on the SSPA groundwater model, and that evaluations of effects and impacts were based on the model, not existing conditions, monitoring, measurements data. Models in themselves are less reliable than existing conditions and effects on hydrogeology and the environment. When models are used the assumptions and calibrations or calculated features like groundwater levels, drawn-down, stream flows and levels, and soil characterization must be compared with real data and measurements of existing conditions. As pointed out by Dr. Hyndman, Nestlé model makes gross assumptions about soils, low-conductivity between wetlands and streams, but they are not matched to actual soil profile characterization, data, or conditions. Nestlé assumed or the model put in low-conductivity, because the model calibration required the feature to conform to flows and level predictions from pumping. In turn, recharge of 14 inches of groundwater was overstated n the model because that amount of water was required for consistency with the model's targets for effects on flows and levels. Once again, SSPA did not conduct an evaluation of local weather and recharge conditions—the 14 inches of recharge in the model does not match the 9 to 10 inches of recharge characteristic of this region of Michigan. As noted earlier in this report, Nestlé's groundwater expert in the *MCWC v. Nestlé* case, 30 miles to the south, did the same thing when he doubled recharge in the model to 18 inches in the area just above the wellfield. Dr. Hyndman found that Nestlé consultants also ignored or were selective with what stream flow data they had, and that in any event the consultants have not shown actual pumping data in connection with flows, which is standard protocol for understanding and evaluating existing conditions, effects, and to properly predict effects in the future.

   Dr. Hyndman concluded that the insufficient information and lack of proper evaluation of existing conditions, effects of pumping on flows and levels, and the omission of wetland

[89] See **Appendix 1**, pp. 2-3, 5-6, 7-8.

and flow records fail to provide DEQ with a reasonable basis for determination of effects and impacts, existing and future.

Dr. Luttenton, similarly, found that Nestlé's submission of information and data was insufficient for DEQ to make a determination of effects, impacts, and impairment in this matter. Existing conditions lacked data and what data there was on flows, wetlands; fish surveys were lumped or averaged, and not evaluated or compared from one year to another. Stream flow measurements were taken at locations, such as SF-16 through SF-19, or SF-10,[90] far enough downstream that minimized the effects of pumping in the model; even these locations showed significant reduction of flows that would cause impairment or significant harm to cold-water conditions, fish, habitat, reproduction, and invertebrates. If information or conditions were accurately measured and represented, Dr. Luttenton, the effects and impacts in this case will be even greater than those that are shown by Nestlé's model estimates and supposed impacts.

Based on this stunning lack of information, especially insufficient gathering of data and evaluation of critical existing conditions and effects or impacts, Dr. Luttenton concluded that there is no reasonable basis for DEQ to make the determinations on conditions, pumping, effects and impacts that are required.

Further, as determined by Dr. Hyndman, the Nestlé and SSPA model and effort at predictions from pumping is limited to the 250 gpm (358,000 gpd) increase, did not include the originally permitted 150 gpm (216,000 gpd), and did not address individual and cumulative impacts at 400 gpm.

For these and the other reasons noted in Hyndman and Luttenton reports, the application for the proposed 250 gpm increase must be denied, because it does not comply with the evaluation of "existing conditions" or "conditions that exist" requirement, and there is no adequate or reasonable basis for determinations required of DEQ by Section 17(3) and Section 32723(2).

2. Further, the application should be denied because there is a substantial lack of information critical for evaluation and review. Section 17(4) of the SDWA authorizes an approval "only if the proposed use will meets *the applicable standard in Section 32723*" of the GLPA. Until this information has been submitted, it necessarily follows that Nestlé has not met and cannot meet the standards under Section 17 and Section 32723, and the application on the record of this proceeding should be denied.

3. The original permit for 150 gpm or 216,000 gpd has never been permitted as required by law. As described in Section B.1. of this report, Nestlé filed a voluntary application under Section 32724, for a narrow determination of "no adverse resource impact" to "characteristic fish populations" before the water assessment tool was in place. The DEQ approved the voluntary request for no adverse impact in 2007, but explicitly stated this did not satisfy and Nestlé would have to obtain any other permits and approvals. Final approval came in 2008, and the permit under Section 17 SDWA was not obtained until 2009. At all relevant times, Section 17 requires a permit for bottled water withdrawals exceeding 200,000 gpd. The original 150 gpm totaled 216,000 gpd and required a permit under Sections 17(3) and (4). Moreover, the DEQ made a

[90] **Appendix 4**.

determination under Section 32724 (now repealed) but has not issued a permit under Section 17 and Section 32723 the GLPA.

As a result, Nestlé's permit for 150 gpm from PW-101 is contrary to and not in compliance with law; Nestlé has pumped at a capacity of 150 gpm from 2009 to the present without a valid permit under Section 17 and Section 32723. The application in the instant matter does not address or evaluate the original 150 gpm, only an increment of 250 gpm, and therefore the current level of pumping by Nestlé is contrary to law for lack of required permits.

4. Nestlé's application must conduct an evaluation on existing or other information under Section 17 and Section 32723(6)(b) of individual and cumulative impacts.[91] As established by Dr. Hyndman, the application in this matter does not address the total or cumulative impacts of pumping 400 gpm or a total of 575,000 gpd from PW-101. Moreover, the application does not address individual and cumulative impacts of the original 150 gpm coupled with the additional 100 gpm, totaling 358,000 gpd. The application must be denied because it does not address or show no cumulative adverse impacts, effects, harm, or impairment as required by Section 17 and Section 32723, as well as Section 17(5), MEPA, MCL 324.1705(2).[92]

5. Nestlé registered its 100 gpm increase from 150 gpm to 250 gpm in 2015 under the WWAT. The DEQ's 2015 approval pursuant to the WWAT is contrary to law, because the cumulative total of the requested 100 gpm increase exceeded 200,000 gallons per day, and should have been submitted and should have complied with Section 17 of the SDWA and Section 32723 of the MWWA, not the WWAT. Section 17 SDWA requires an application under the SDWA where the quantity exceeds 200,000 gpd. The 150 gpm permitted for PW-101 in 2001 and 100 gpm registered under the WWAT totaled 250 gpm, which totals 360,000 gpd. Nestlé failed to comply with the procedural informational, public notice, and public comment requirements of Sections 17 and/or Section 32723, and is therefore contrary to or not in compliance with law. Nestlé has pumped hundreds of thousands of gallons from PW-101 since 2009 to the present date without obtaining the permit required under Section 17.

6. The DEQ site specific review ("SSR") on January 15, 2016 pursuant to Section 32706(c) of the WWAT is also contrary to or not in compliance with law, because it exceeded 200,000 gpd and was governed by Section 17 of the SDWA and Section 32723 of the GLPA for the reasons described in paragraph 2(a) above. While the DEQ casts the approval as conditional or not final, it was clearly contrary to law and should be set aside. In the alternative, Nestlé should be notified that both previous approvals in 2015 and January are not yet in compliance with law, not final, and cannot be relied upon to continue pumping or diverting water for bottled water operations unless it has shown and the DEQ determines Nestlé has complied with and met the procedural and informational requirements and standards in Section 17 and Section 32723.

E. NESTLÉ'S APPLICATION DOES NOT COMPLY WITH THE APPLICABLE LEGAL STANDARDS OF SECTION 17(4) SDWA AND SECTION 32723 GLPA BECAUSE THE PROPOSED 250 GPM AND CUMULATIVE 400 GPM OR TOTAL REMOVAL OF 576,000 GPD

[91] **Appendix 1**, p. 8.
[92] *Id.* at 3-4.

WILL OR IS LIKELY TO CAUSE ADVERSE IMPACTS, SUBSTANTIAL AND UNREASONABLE HARM, UNACCEPTABLE AQUATIC IMPACTS, AND IMPAIRMENT OF CREEKS, WETLANDS, AND ASSOCIATED HABITAT, FISH AND WILDLIFE, AND ASSOCIATED ENVIRONMENT.

1. Nestlé has failed to comply with Section 17(3) and (4) "only if" requirements and the standards and requirements of Section 32723 of the GLPA.

As demonstrated above, Nestlé failed to comply with the "existing conditions" and evaluation requirements of Section 17(3).

In addition, the information relied on so far by DEQ has been submitted by Nestlé and its consultants. Section 32723(6)(b) requires that information regarding existing environmental, hydrological, and hydrogeological conditions) shall be "gathered by the Department," not just the information supplied by the applicant. The DEQ has not gathered independent data or information of such existing conditions essential to its determination, therefore the application must be denied, unless the DEQ gathers information in conjunction with other information and scientific evaluations through the public comment and hearing process. Based on this additional information, including this FLOW report, and the evaluations and opinions of Dr. Hyndman and Dr. Luttenton, and others,[93] the permit must be denied.

Further, as noted in Section D.4. above, Nestlé's application fails to address the individual and cumulative effects of the total of 400 gpm, and the original 150 gpm. Accordingly, the application should be denied because it is contrary to Section 17(3) and (4) and Section 32723(60(b).

Nestlé has not established that the proposed application is "in compliance with all local, state, and federal laws. Section 32723(6)(c). Nestlé has not shown that the proposed removal of 250 gpm or 400 gpm and transport to the trucking station in Evart will comply with the Osceola Township zoning ordinance. In fact, the Township Planning Commission denied Nestlé's request for a special use permit on April 19, 2017.[94]

Nestlé has not established that it has "consulted with local governmental officials and interested community members." The DEQ has consulted and is consulting with the tribes protected by relevant treaty property rights in fishing and hunting. However, the State of Michigan and Nestlé have not adequately conducted a consultation process with local officials or interested members of the township, landowner, riparian owners, and fishermen/women and outdoors persons, or other interested persons or organizations.

Nestlé has not submitted measures based on existing conditions and effects, including future effects (climate change and weather, other users entitled to a fair participation) to prevent hydrologic individual and cumulative effects and impacts. Section 17((4(b), 17(5) SDWA; Section 32723(8) GLPA.[95] As noted above, nothing has been done to address cumulative effects and impacts. Nestlé has not submitted measures to prevent effects and impacts, and for DEQ to control and prevent adverse or unlawful impacts, unreasonable use, or impairment under other laws in the future.

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[93] Grobbel, Ph.D., Report I and Report II, submitted by Great Lakes Environmental Law Center ("GLELC").

[94] Matheny, Keith. "Permit denial won't end Nestle water plant's bid for more water." Detroit Free Press, April 19, 2017 http://www.freep.com/story/news/local/michigan/2017/04/19/nestle-groundwater-michigan-great-lakes/100663218/

[95] **Appendix 1**, p. 2.

2. **The Nestlé application fails to demonstrate a reasonable basis that it will not violate the standards of Section 32723 of the GLPA.**

a. **The Application and information does not establish that there will be no violation of common law standards as required by Section 32723.**

Section 32723(6)(d) requires that "The proposed use is "reasonable under common law principles of water law in Michigan." Those common law principles involve protection of all groundwater and riparian users and the natural streams, wetlands, and aquatic resources and uses. There are two controlling cases or legal precedents under the common law of water:

1. *Schenk v City of Ann Arbor*, 196 Mich 75, 84, 163 NW 109 (1917).[96] In Schenk the Michigan Supreme Court ruled under the correlative rights/reasonable user standard for groundwater extractions, that a landowner cannot withdraw and transfer or divert water off-tract for sale to distant consumers, in competition with other neighboring water users, unless it is shown that there will be no interference with a neighbors well or "no material diminishment" of the flow or level of a marsh, swamp, spring, stream or lake. This rule does not prohibit all off-tract transfers for sale elsewhere, only those transfers in quantities that materially diminish water and natural features. Of course, the non-diminishment standard does not apply to on-tract uses, such as farming, drinking water, or other uses that benefit the overlying tract; the on-tract standard is a reasonable use or no unreasonable harm rule.

2. *Michigan Citizens for Water Conservation v Nestlé Waters*, 269 Mich App 25, 67, 709 NW2d 174 (2005) ("MCWC").[97] Despite binding Supreme Court precedent in *Schenk*, the Court of Appeals created and applied a new "reasonable use balancing test" for groundwater withdrawals and transfers that are hydro geologically connected to surface waters. The Court laid down a water law standard with three principles and six factors to determine whether a proposed use is reasonable. The three factors are: (1) "fair participation" for all or users – private and public—of the water course-- a "proper balance" to preserve as many uses by all affected persons or uses of the common water source;[98] (2) the law protects a use "only if it is itself reasonable" as determined by the circumstances—all groundwater or riparian users are entitled to an adequate supply of water for a reasonable use;[99] and (3) the law will only address unreasonable harms; i.e., under the circumstances.[100]

To determine whether a use is reasonable or unlawful, the court lists a set of six factors to evaluate an existing or proposed withdrawal or use:[101] (1) traditional groundwater uses, riparian uses, or public rights and uses are preferred over artificial off-tract uses; (2) the location must be suitable, including the size and nature of the stream or other water features; (3) extent and amount of the harm, including the nature of and effect on diminishment of water course or other uses, aquatic and natural resources, and environment; (4) nature of benefits such as private or public; (5) necessity and duration of the water use; (6) other factors that bear on reasonableness.

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[96] *Id.* at 2.
[97] **Appendix 1**, pp. 2-3.
[98] 269 Mich App at 71; FLOW **Appendix** 1, p. 2.
[99] *Id*.
[100] *Id*.
[101] *Id*. at 71-72; **Appendix 1**, pp. 2-13.

The court in *MCWC v Nestlé* applied these principles and factors to a 400 gpm withdrawal 576,000 gpd and an on-going 200 gpm withdrawal 358,000 gpd that was diverted to the bottling plant in Stanwood. In doing so, the court made findings applicable to large-volume water withdrawals for bottled water near or within headwater springs, creeks, streams, lakes, and wetlands.[102]

- Traditional or natural riparian or groundwater users prevail against extraction for bottled water, an artificial use.[103]
- Further, landowners who use riparian streams, lakes, or groundwater in connection with or to benefit their land are preferred over users, like Nestlé, that ship water away.[104]
- Large volume groundwater extractions connected to headwater streams are not well suited for headwater creek locations, because modest rates of pumping can have dramatic consequences. [105]
- Groundwater extraction by companies like Nestlé for "spring water" do not need to maintain high-levels of pumping, such as 250 to 400 gpm, because they have multiple water sources or can develop additional water sources elsewhere; on the other hand, competing water users that need or use water in connection with their land require adequate water.[106]
- A bottled water user like Nestlé is in a better position to spread the costs by reduction in use, and it is unjust to deplete stream flow and place burden of harms on riparian landowners.[107]

Nestlé's proposed 250 gpm increase and total 400 gpm withdrawal for "spring water" bottled water undoubtedly will result in significant effects on flows and levels of Twin and Chippewa Creek, especially upstream of the monitoring locations. These effects will also drop flows from seeps, through weirs, and in wetlands. As a result, 250 gpm or 400 gpm continuous pumping as applied for by Nestlé will cause adverse impacts, significant harm to the creeks and streams and wetlands, and impair their physical condition, such as size and cold-water, and their fishery, habitat, invertebrates, and spawning.

In addition, the 400 gpm is strikingly similar to the 200 gpm and permitted 400 gpm spring water withdrawal for bottled water in the headwaters at Sanctuary Springs, stream and lakes, and adjacent wetlands found to be unlawful, unreasonable, and subject to an injunction to maintain adequate water in the stream and lakes for riparian uses and protection of flows, levels, and the environment from impairment.

The traditional riparian and groundwater users downstream and near PW-101 have a fair participation in use of water, which has not been evaluated; these users riparian and groundwater uses prevail or are preferred to Nestlé's off-tract transfer of water for sale. Large

[102] FLOW Comment on Michigan Legal Requirements and Standards and Statutory Provisions Applicable to Water Withdrawals for Bottled Water in Excess of 200,000 Gallons Per Day, James Olson, April 12, 2017; **Appendix 1**, pp. 2.
[103] *MCWC,* 269 Mich. App. at 75.
[104] *Id.* at 75.
[105] *Id.* at 76.
[106] *Id.* at 77-78
[107] A bottled water user like Nestlé is in a better position to spread the costs by reduction in use, and it is unjust to deplete stream flow and place burden of harms on riparian landowners. *Id.* at 78-79.

volumes of groundwater removed as "spring water" for sale elsewhere to satisfy FDA regulations and for convenience for others are not necessary and not preferred; moreover these large volume withdrawals for "spring water" have been found by the court of appeals to be not in a suitable location. Nestlé has substantial other water sources and can locate other water resources for its Stanwood Plant; the plant has other spring water sources, and a substantial portion of its production does not involve spring water. Nestlé is in a better position to continue its operation without the substantial harm and impact from significant effects of the proposed withdrawal. Further, subject to imposition by DEQ of required measures to prevent effects and impacts from its current 150 gpm withdrawal and compliance with Section 17 SDWA, Nestlé may be able to show it can continue to remove some water from PW-101, but that remains to be seen, and again is not essential or necessary to its plant operation. While Nestlé provides jobs and pays taxes, those are related to the plant and Mecosta County, not Osceola County or Osceola Township; in fact those jobs and taxes will continue whether the White Springs large volume transfers are made or not. Moreover, it should be noted that Nestlé receives hundreds of millions of revenues off its water withdrawn from Michigan, and stipulated in the *MCWC v. Nestlé* case that its sole purpose is for private gain and profit.

For these reasons and based on the facts presented above, the proposed permit for 250 gpm and total of 400 gpm must be denied, because it violates Michigan common law water standards under both *Schenk* and *MCWC v Nestlé.*

3. Nestlé's proposed conduct to increase pumping to 250 gpm and total of 400 gpm will or is likely to impair water, water and aquatic resources, fish, fish habitat for brook and brown trout in cold-water streams, and adjacent wetlands in violation of Part 17, NREPA (Michigan Environmental Protection Act).[108]

Section 17(9) SDWA requires that the "applicability of other laws is not affected providing for protection of natural resources or the environment" shall not be affected. Section 32723(6)(f) prohibits a permit or withdrawal that will result in the violation of "Michigan water law or Michigan common law duties."[109]

The Michigan Environmental Protection Act, Part 17, NREPA constitutes other Michigan water law and statutory standards and duties that protect the natural resources and environment.[110] The MEPA applies to permit, application, licensing or other proceedings for approval before the DEQ.[111] The applicable standards under MEPA are as follows: i. no likely impairment of water or natural resources or public trust in the water and natural resources; ii. the state has an affirmative duty to adequately consider and determine that there will be no likely degradation or impairment; iii. There are three separate standards to determine whether MEPA has been violated: a) a violation of a pollution or impairment standard, such as the Inland Lakes and Streams Act[112] and Wetlands Protection Act;[113] b) use of a standard such as

[108] MCL 324.1701 *et seq*.
[109] **Appendix 1,** pp.5-9.
[110] **Appendix 1**, pp. 3-4.
[111] Section 1705(2), MCL 324.1705; *Ray v. Mason County Drain Comm'r*, 393 Mich 294 (1975); *State Highway Comm'n v. Vanderkloot*, 392 Mich 159, 167-168, 184-187, 220 NW2d 416 (1974); *Genesco v. MDEQ*, 250 Mich App 45, 645 NW2d 319 (2002); *Buggs v. MPSC* (Mich App unpublished opinion, Jan 23, 2015 p. 5; 2015 WL 159795).
[112] MCL 324.30101 et seq.
[113] MCL 324.30301 et seq.

no impairment of water, riparian rights, or public trust in water or fish or other resources under ILSA, or no unacceptable aquatic impacts under WPA; c) based on the facts and circumstances it is shown there will or is not likely to be impairment of water, water resources, or public trust.[114]

Based on the lack of information and evaluation of existing conditions, the Nestlé Application must be denied, because the DEQ has no reasonable basis to make a determination regarding violation of the MEPA standards.

Further, the facts show, based on Hyndman, Luttenton findings and expert opinions described above and in their reports, together with other findings and opinions,[115] that there will be interference and impairment of streams, fish, riparian uses, and public trust in fishery, that would violate the standard in ILSA; there will undoubtedly be unacceptable impacts to aquatic resources that would violate the standard in Section 30311 of the WPA.

Finally, based on the facts and circumstances, there will be or is likely an impairment and significant harm or degradation of the seeps, cold-water seeps and segments of creeks, an impairment of fish, fishery, habitat, invertebrates, the condition, size, and nature of the streams and wetlands; there will be likely impairment of wetland plants, functions, and water levels that will alter and degrade or dry up or reduce the size of wetlands. As a result, there is a likely impairment of water, water resources, and natural resources and the public trust in fish in violation of the MEPA.

CONCLUSION

Based on the foregoing facts, including Appendices 1, 2, and 3, the Nestlé application in this matter must be denied.

(1) There is no reasonable basis for DEQ to make the determinations required by Section 17, Section 32723, the common law, and MEPA;
(2) The application does not satisfy the information and proofs or elements required by Section 17, including lack of cumulative impact evaluation, local and community consultation, non-compliance with the township zoning;
(3) There are or will be actual or likely significant effects on the hydrology, hydrogeology, and environment for the off-tract transfer for bottled water from this headwater groundwater/surface water system, including material diminishment of flows and levels under common law of water use in *Schenk v. City of Ann Arbor;*
(4) The proposed withdrawal for off-tract transfer for bottled water constitutes an unreasonable use under *MCWC v. Nestlé* ;
(5) The proposed withdrawal and transfer for bottled water will or likely to impair the surface water streams, ponds, creeks, fish and other aquatic resources, and public trust in fish in violation of the Part 17, NREPA, MEPA.

A POSTSCRIPT ON THE VALUE OF WATER AND PEOPLE IN MICHIGAN AND THE GREAT LAKES

While Michigan passed the Great Lakes Compact and related water withdrawal laws, including

[114] *Nemeth v Abonmarche*, 457 Mich 16 (1998).at 35-36; *MCWC*, 269 Mich. App. at 88-89; **Appendix 1**, p. 4.
[115] Grobbel Report, GLELC Comment.

the bottled water provisions in Section 17 of the Safe Drinking Water Act and Section 32723 of the Great Lakes Preservation Act, these laws were not a wholesale license for water commodification of the Great Lakes or Michigan's esteemed lakes, streams, creeks, rivers, wetlands and diverse ecosystems for fishing, hunting and recreation. In fact, these laws, together with the common law and other environmental statutes, impose stringent standards and informational requirements. Michigan and the DEQ must hold these laws and applicants to the highest standards given regional and global water scarcity issues, large-scale operations to extract and divert water from the Great Lakes and other water bodies, and harmful impacts to these waters and water resources that belong to the public. Anything less will open the raceway for loss of our valued water, quality of life, and jobs and economy that depend on them.

Even in those narrow circumstances where bottled water withdrawals are allowed – both from public water supplies of our towns and cities or from groundwater that forms the headwaters of our creeks, streams, and wetlands, Michigan, its citizens, communities and businesses must take pause. It is time to reevaluate bottled water, as policy and law. The gross imbalance and disproportionate treatment between our residents in Flint whose water has been poisoned with lead and those in Detroit whose water is shutoff because they and their families cannot afford it must be addressed; Nestlé and other bottled water applicants pay a small application fee of only $200, when the people in our cities struggle to pay $200 a month for the water they are entitled to as a human right.

Our water and hydrosphere are all connected. Municipal water and spring water come from the same source. Water comes from streams and lakes, including the Great Lakes, those that use it or seek to sell it our subject to a paramount human right and public trust in water that prohibits privatization, commodification, impairment or private subsidies for a few over residents who depend on water for livelihood, sustenance, and survival. It is time for Michigan, the DEQ and Legislature, and residents to strengthen our human and constitutional right, and uphold our duties and responsibilities to secure the sustainability of water.

Sincerely yours,

James Olson
President and Law and Policy Advisor
FLOW (For Love of Water)

Encs.

Electronic cc: Attorney General William Schuette
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APPENDIX 1, FLOW REPORT

SUMMARY OF MICHIGAN LEGAL REQUIREMENTS AND STANDARDS AND SELECTED STATUTORY PROVISIONS APPLICABLE TO WATER WITHDRAWALS FOR BOTTLED WATER IN EXCESS OF 200,000 GPD

April 21, 2017

Report prepared by:

James M. Olson, J.D., LL.M.

President and Founder of FLOW

I. Summary of Michigan Legal Requirements and Standards

Section 17 of the Safe Drinking Water Act ("SDWA") imposes specific requirements and standards for a permit for proposals in excess of 200,000 gallons of water per day. Specifically, in addition to the requirements and standards in Section 17, Section 17(4) mandates that the Department of Environmental Quality ("Department") "shall only approve" a permit if the Department "determines both" of the following requirements: (a) the application establishes the applicable standards contained in Section 32723 of the Great Lakes Preservation Act ("GLPA") or Water Withdrawal Law and (b) measures are imposed to prevent or address hydrologic effects commensurate with the nature and extent of the withdrawal.

The following list summarizes the requirements and standards under both Section 17 and Section 32723:

a. Section 17(3) of the SDWA requires that the applicant must provide sufficient information containing an "evaluation of environmental, hydrological, and hydrogeological conditions that exist and the predicted effects" that "provides a reasonable basis for the determination" of the requirements and standards of Section 17 of the SDWA and Section 32723 of the GLPA. (Emphasis added).
b. Similarly, Section 32723(2) of the GLPA requires that the application shall contain "information described in section 32706c" (Site Specific Review proposal) and an "evaluation of existing hydrological and hydrogeological conditions." (Emphasis added).
c. Under Section 32723(6)(b), the information must consider both "individual" and "cumulative" adverse resource impacts.
d. The Department must base its review and determination on information (existing environmental, hydrological, and hydrogeological conditions) "gathered by the department," not just the information submitted by the applicant. *Id*.
e. Under Section 17(4)(b) and 17(5), the applicant must provide information on measures to prevent hydrologic individual and cumulative effects and impacts, such as diminishment of flows and levels of streams, lakes, or wetlands.
f. Further, the applicant "shall consult with local government officials and interested community members." Section 17(5). (Emphasis added).
g. Under Section 32723(6)(c), the withdrawal must be implemented "in compliance with all applicable local, state, and federal laws." (Emphasis added).
h. Under Section 32723(6)(d), the Department must determine that the proposed use is "reasonable under common law principles of water law in Michigan." (Emphasis added).

i. Section 17(9) of the SDWA and Section 32723 of the GLPA do not alter common law water rights or the "applicability of other laws providing for the protection of natural resources or the environment." In this regard, the Department must determine that the proposed withdrawal "will not violate public or private rights and limitations imposed by Michigan water law or other Michigan common law duties." (Emphasis added).

Common law principles include the following:

a. The withdrawal or removal will not materially interfere with other water uses or materially diminish flows and levels of streams, lakes, or wetlands where the withdrawn water is transferred off-track or out of the source watershed. *Schenk v. City of Ann Arbor*, 196 Mich. 75, 84, 163 N.W. 109 (1917) (following the "no material diminishment" "reasonable user" rule for off-tract transfer and sale of water in the Eastern United States. *Meeker v. City of East Orange*, 77 N.J.L. 623, 636-639, 74 A. 379 (1909); *Smith v. City of Brooklyn*, 160 N.Y. 357, 54 N.E. 787 (1899); *Collens v. New Canaan Water Co.*, 234 A. 2d 825 (Conn. 1967)).

b. However, in *Michigan Citizens for Water Conservation v. Nestlé Waters North America, Inc.*, 269 Mich. App. 25, 67, 69-71, 709 N.W.2d 174 (2005) ("*MCWC*"), the Court of Appeals ignored the binding standard for "off-tract" transfers in *Schenk* in favor of a "reasonable use balancing test" ("RUBT") for all groundwater uses, on-tract or off-tract. The Court laid down three primary principles with six factors to determine whether a proposed use is lawful under the RUBT.

c. The three principles are:

    i. There should be a "fair participation" for all users – private and public – of the water course; hence, there must be a "proper balance" to preserve as many uses by all affected persons or uses of the common water source. *MCWC*, 269 Mich. App. at 69-71, 79.

    ii. The law protects a use "only" if it is "itself reasonable" as determined by the circumstances—all groundwater or riparian users are entitled to an adequate supply of water for a reasonable use. *Id*.

    iii. The law will only address unreasonable harms; i.e., under the circumstances and six-factor test, below, the interference is substantial. *Id*.

d. The six factors are:

    i. The purpose of the use. Traditional groundwater uses, riparian uses, or public rights and uses are preferred over artificial off-tract uses such as large-volume water off-tract diversions or consumptive uses for sale of water. *MCWC*, 269 Mich. App. at 71-72; *Thompson v. Enz*, 379 Mich. 667, 686, 154 N.W.2d 473 (1967).

ii. The suitability of the use to the location, including nature and size of stream, lake, wetlands, and amount of water. *MCWC*, 269 Mich. App. at 71.

iii. The extent and amount of the harm, including the nature of and effect on diminishment of water course or other uses, aquatic and natural resources, and environmental conditions; *Id.; People v. Hulbert*, 131 Mich. 156, 170, 91 N.W. 211 (1902); *Enz*, 379 Mich. at 686.

iv. The nature of benefits such as private or public. *MCWC*, 269 Mich. App. at 71-72.

v. The necessity, duration, and amount of the water use. *Id*; *Hulbert*, 131 Mich. at 170.

vi. Any other factor that may bear on the reasonableness of a use. *Hulbert*, 131 Mich. at 170.

e. In addition, the applicant, like Nestlé in this matter, must bear the burden at all times to assure there is adequate water in a stream, wetland, or lake for continued use and enjoyment by others. *MCWC*, 269 Mich. App. at 71, 78-79.

f. The Michigan Supreme Court has not decided which rule applies for off-tract sale of groundwater, the "reasonable user" standard in *Schenk* or the "RUBT" in *MCWC*. In any event, the *MCWC* court disfavored Nestlé's artificial off-tract diversion for private bottled water sales that diminished or caused harm to riparian streams and lakes. *MCWC*, 269 Mich. App. at 75-76.

Standards and Requirements of Other Applicable Water and Environmental Laws include the following:

a. Part 17, NREPA, MCL 324.1701, *et seq*. ("Michigan Environmental Protection Act" or "MEPA") applies to governmental agencies.

i. No likely impairment of water, natural resources, or the public trust, section 1703(1), MCL 324.1703(1), except where applicant demonstrates no feasible and prudent alternative location, manner, quantity or levels of pumping. *Id*.; MCL 324.1705(2). *Ray v. Mason County Drain Comm'r*, 393 Mich. 294 (1975); *Nemeth v. Abonmarche,* 457 Mich. 16 (1998).

ii. The state has an affirmative duty to prevent and minimize environmental degradation, *Ray,* 393 Mich. at 294, and to consider and determine whether the withdrawal and transfer of water is likely to impair the water, natural resources, or public trust in those resources; if there are such likely effects, the permit must be denied. Section 1705(2); MCL 324.1705(2). The duty to consider impacts and feasible and prudent alternatives applies to permit proceedings before state agencies. *State Highway Comm'n v. Vanderkloot*, 392 Mich. 159, 167-168, 184-187, 220 N.W. 2d 416 (1974); *Genesco, Inc. v. MDEQ*, 250 Mich. App. 45, 645 N.W. 2d 319 (2002); *Buggs v. MPSC* (Mich. App. unpublished opinion, Jan 23, 2015 p. 5; 2015 WL 159795).

iii. The determination of "likely pollution or impairment of water and natural resources" turns on the facts and circumstances; the determination is not limited to actual degradation, but "likely" or "probable" damage. *Nemeth*, 457 Mich. at 25. There are three separate grounds for finding "likely pollution or impairment:"

(1) Whether there has been a violation of a pollution or water standard. *Nemeth*, 457 Mich. at 35-36; *MCWC*, 269 Mich. App. at 88-89.

(2) Even if there is no violation of a pollution standard, "likely pollution or impairment" can be determined through the "aid" of other water and environment statutes, such as the Inland Lakes and Streams Act, MCL 324.30101 *et seq*., and Wetlands Protection Act, MCL 30301 *et seq.; MCWC*, 269 Mich. App. at 88.

(3) Whether based on sufficient facts and information there is "likely pollution or impairment." *Ray*, 393 Mich. at 294*; Nemeth*, 457 Mich. at 25; *MCWC*, 269 Mich. App. at 88.

II. Selected Applicable Provisions from the Safe Drinking Water Act Statutory Requirements and Standards, MCL 325.1001 *et seq*.

A. Section 2 of the SDWA, MCL 325.1002: "Definitions"

As used in this act:

(a) "Bottled drinking water" means water that is ultimately sold, provided, or offered for human consumption in a closed container.

(b) "Capacity assessment" means an evaluation of the technical, financial, and managerial capability of a community supply or nontransient noncommunity water supply to comply and maintain compliance with all requirements of this act and the rules promulgated under this act.

(c) "Community supply" means a public water supply that provides year-round service to not fewer than 15 living units or which regularly provides year-round service to not fewer than 25 residents.

* * *

(k) "Noncommunity supply" means a public water supply that is not a community supply, but that has not less than 15 service connections or that serves not fewer than 25 individuals on an average daily basis for not less than 60 days per year.

B. Section 17 of the SDWA, MCL 325.1017: "Bottled Drinking Water"

(1) A person engaged in producing bottled drinking water shall utilize a water source meeting the requirements of this section and the requirements otherwise provided in this act.

* * *

(3) A person who proposes to engage in producing bottled **drinking water** from a new or increased large quantity withdrawal of more than 200,000 gallons of water per day from the **waters** of the state or that will result in an intrabasin transfer of more than 100,000 gallons per day average over any 90-day period *shall submit* an application to the department in a form *required* by the department *containing an evaluation of environmental, hydrological, and hydrogeological conditions that exist and the predicted effects* of the intended withdrawal *that provides a reasonable basis for the determination* under this section to be made.

(4) The department *shall only approve* an application under subsection (3) if the department *determines both* of the following:

   (a) The proposed use *will meet the applicable standard provided in section 32723* of the natural resources and environmental protection act, 1994 PA 451, MCL 324.32723.

   (b) The person will undertake activities, if needed, to *address hydrologic impacts commensurate with the nature and extent of the withdrawal*. These activities may include those *related to the stream flow regime,* ***water*** *quality, and aquifer protection*.

(5) Before proposing activities under subsection (4)(b), the person proposing to engage in producing bottled drinking water *shall consult with local government officials and interested community members.*

(6) Before making the determination under subsection (4), the department shall provide public notice and an opportunity for public comment of not less than 45 days.

(7) If the person proposing to engage in producing bottled drinking water under subsection (3) *does not have a permit under section 4, the person shall request a determination under subsection (4) when that person applies for a permit under section 4.*

* * *

(9) This section shall not be construed as affecting, intending to affect, or in any way altering or interfering with common law **water** rights or the applicability of other laws providing for the protection of natural resources or the environment.

(10) * * *

(11) As used in this section, “compact”, “intrabasin transfer”, “new or increased large quantity withdrawal”, and “waters of the state” mean those terms as they are defined in section 32701 of the natural resources and environmental protection act, 1994 PA 451, MCL 324.32701.

(Emphasis Added)

III. The Great Lakes Preservation Act, MCL 324.32701 *et seq*. (hereafter "GLPA"), including Section 32723 standards that are made applicable by Section 17(3) of the Safe Drinking Water Act, supra.

A. Section 32701 of the GLPA, MCL 324.32701: "Definitions"

As used in this part:

(a) "Adverse resource impact" means any of the following:

* * *

(*ii*) Beginning February 1, 2009, subject to subparagraph (*vi*), decreasing the flow of a cold river system by part of the index flow as follows:

(A) For a cold stream, the withdrawal will result in a 3% or more reduction in the density of thriving fish populations as determined by the thriving fish curve.

* * *

(k) "Consumptive use" means that portion of water withdrawn or withheld from the Great Lakes basin and assumed to be lost or otherwise not returned to the Great Lakes basin due to evaporation, incorporation into products or agricultural products, use as part of the packaging of products or agricultural products, or other processes. Consumptive use includes a withdrawal of waters of the Great Lakes basin that is packaged within the Great Lakes basin in a container of 5.7 gallons (20 liters) or less and is bottled drinking water as defined in the food code, 2005 recommendations of the food and drug administration of the United States public health service.

* * *

(p) "Diversion" means a transfer of water from the Great Lakes basin into another watershed, or from the watershed of 1 of the Great Lakes into that of another by any means of transfer, including, but not limited to, a pipeline, canal, tunnel, aqueduct, channel, modification of the direction of a water course, tanker ship, tanker truck, or rail tanker but does not apply to water that is used in the Great Lakes basin or a Great Lake watershed to manufacture or produce a product that is then transferred out of the Great Lakes basin or watershed. Diverted has a corresponding meaning. Diversion includes a transfer of water withdrawn from the waters of the Great Lakes basin that is removed from the Great Lakes basin in a container greater than 5.7 gallons (20 liters), but does not include any of the following:

(*i*) A consumptive use.

* * *

(x) “Index flow” means the 50% exceedance flow for the lowest summer flow month of the flow regime, for the applicable stream reach, as determined over the period of record or extrapolated from analyses of the United States geological survey flow gauges in Michigan. Beginning on October 1, 2008, index flow shall be calculated as of that date.

(y) “Intrabasin transfer” means a diversion of water from the source watershed of a Great Lake prior to its use to the watershed of another Great Lake.

* * *

(cc) “New or increased large quantity withdrawal” means a new water withdrawal of over 100,000 gallons of water per day average in any consecutive 30-day period or an increase of over 100,000 gallons of water per day average in any consecutive 30-day period beyond the baseline capacity of a withdrawal.

(dd) “New or increased withdrawal capacity” means new or additional water withdrawal capacity to supply a common distribution system that is an increase from the person's baseline capacity. New or increased capacity does not include maintenance or replacement of existing withdrawal capacity.

* * *

(ff) “Preventative measure” means an action affecting a stream or river that prevents an adverse resource impact by diminishing the effect of a withdrawal on stream or river flow or the temperature regime of the stream or river.

* * *

(kk) “Source watershed” means the watershed from which a withdrawal originates… with a preference for returning water to the watershed of the direct tributary from which it was withdrawn.

(*ll*) “Stream” means a flowing body of water with a drainage area of less than 80 square miles.

(mm) “Stream reach” means a segment of a stream or river.

* * *

(tt) “Zone A withdrawal” means the following:

(*i*) For a cold river system, as follows:

(A) For a cold stream, less than a 1% reduction in the density of thriving fish populations as determined by the thriving fish curve.

(B) For a cold small river, less than 50% of the withdrawal that would result in an adverse resource impact.

* * *

(ww) "Zone D withdrawal" means, beginning February 1, 2009, a withdrawal that is likely to cause an adverse resource impact.

B. Section 32723 of the GLPA, MCL 324.32723: Statutory Legal Requirements and Standards.

(1) Except as provided in subsection (13), the following persons shall obtain a water withdrawal permit prior to making the withdrawal:

*** * ***

(d) A person who proposes to develop a new or increased withdrawal capacity that will result in an intrabasin transfer of more than 100,000 gallons per day average over any 90-day period.

(2) A person shall apply for a water withdrawal permit under this section by submitting an application to the department containing *the information described in section 32706c(1)(a) to (e) and an evaluation of existing hydrological and hydrogeological conditions.* If the applicant proposes to undertake a preventative measure along with the withdrawal, the property owner shall provide the department with *a detailed description of the preventative measure and relevant information as to how the preventative measure will be implemented*….

(3) An application submitted under subsection (2) is considered to be administratively complete effective 30 days after it is received by the department unless the department notifies the applicant, in writing, during this 30-day period that the application is not administratively complete…. If the department determines that the application is not administratively complete, the notification shall specify the information necessary to make the application administratively complete. If the department notifies the applicant as provided in this subsection, the 30-day period is tolled until the applicant submits to the department the specified information….

* * *

(6) The department shall issue a water withdrawal permit under subsection … if *all* of the following conditions are met:

(a) All water withdrawn, less any consumptive use, is returned, either naturally or after use, to the source watershed.

(b) The withdrawal will be implemented so as to ensure that the proposal will result in no *individual or cumulative* adverse resource impacts. *Cumulative adverse* *resource impacts* under this subdivision *shall be evaluated* by the department based upon available *information gathered by the department*.

(c) Subject to section 32726, the withdrawal will be implemented so as to ensure that it is in compliance with all applicable local, state, and federal laws ….

(d) The proposed use is *reasonable under common law* principles of water law in Michigan.

* * *

(f) The department determines that the proposed withdrawal *will not violate public or private rights and limitations imposed by Michigan water law or other Michigan common law duties.*

* * *

(8) In reviewing a proposed preventative measure, the department *shall consider the effect of the preventative measure on preventing an adverse resource impact by diminishing the effect of the withdrawal on stream or river flow or the temperature regime* of the stream or river. If the department approves a preventative measure in conjunction with a water withdrawal permit under this section, the *department shall enter into a legally enforceable implementation schedule* for completion of the preventative measure.

* * *

(Emphasis added)

Exhibit 1

Exhibit 1

STATE OF MICHIGAN

IN THE CIRCUIT COURT FOR MECOSTA COUNTY

MICHIGAN CITIZENS FOR WATER CONSERVATION, a Michigan nonprofit corporation; R.J. DOYLE AND BARBARA DOYLE, husband and wife; and JEFFREY R. SAPP AND SHELLY M. SAPP, husband and wife,

Plaintiffs,

v

NESTLÉ WATERS NORTH AMERICA INC., a Delaware corporation; and DONALD PATRICK BOLLMAN AND NANCY GALE BOLLMAN, husband and wife, a/k/a Pat Bollman Enterprises,

Defendants.

______________________________/

Case No. 01-14563-CE

Honorable Susan H. Grant

AMENDED AND FINAL STIPULATED ORDER

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______________________________/

At a session of said Court held in the Courthouse in the City of Big Rapids, Michigan, this 6th day of July, 2009.

PRESENT: Honorable Susan H. Grant
Circuit Court Judge, acting by assignment

This matter having come before the Court pursuant to paragraph V.B. of the Stipulated Order on Remand dated January 25, 2006; and the hearing pursuant to said paragraph V.B. having commenced July 6, 2009; and the parties having compromised and settled all of their claims, rights and obligations in this litigation; and the Court being fully advised in the premises;

NOW, THEREFORE, IT IS ORDERED THAT THE STIPULATED ORDER ON REMAND IS AMENDED PURSUANT TO STIPULATION OF THE PARTIES TO NOW BE A FINAL ORDER WHICH READS IN ITS ENTIRETY AS FOLLOWS:

I. **Groundwater Claim – Injunction.**

A. The following levels of water extraction by Nestlé Waters North America Inc. ("NWNA") from the Sanctuary Springs location are deemed to meet the criteria discussed in the Court of Appeals Opinion (Part III), 269 Mich App 25, 53-82, and are hereby permitted:

	Period	Maximum Average Withdrawal Rate
1.	January 1 – March 15:	275* gpm monthly average (as defined below)
2.	March 16 – April 15:	225 gpm monthly average (as defined below)
3.	April 16 – May 15:	225 gpm monthly average (as defined below)
4.	May 16 – May 31:	175 gpm monthly average (as defined below)

5. June 1 – August 31: The maximum average withdrawal rate during the June 1 – August 31 period is limited by the following stage and flow criteria:

	Stage at SG-Doyle	Maximum Average Withdrawal Rate
a.	if less than 959.9' amsl (2 consecutive weekly readings)	50 gpm bi-weekly average
b.	if 959.9' amsl – 960.0' amsl	100 gpm bi-weekly average, subject to flow criterion (i) below
c.	if 960.01' amsl – 960.2' amsl	125 gpm bi-weekly average, subject to flow criteria (i), (ii) and (iii) below
d.	if greater than 960.2' amsl	175 gpm bi-weekly average, subject to flow criteria in (i), (ii), (iii), and (iv) below
	Flow at SG-102 (M-20 Bridge)	
i.	if 925 gpm or below (2 consecutive weekly readings)	50 gpm bi-weekly average
ii.	if 926 gpm – 975 gpm	100 gpm bi-weekly average
iii.	if 976 gpm – 1150 gpm	125 gpm bi-weekly average
iv.	if 1151 gpm – 1250 gpm	150 gpm bi-weekly average
v.	if greater than 1250 gpm	175 gpm bi-weekly average

6.	September 1 – September 15:	175 gpm monthly average (as defined below)
7.	September 16 – October 31:	210 gpm monthly average (as defined below)
8.	November 1 – December 31:	275* gpm monthly average (as defined below)

*If and to the extent that NWNA's actual average water extraction for the period June 1 through August 31 in any year is less than 150 gpm, the maximum water extraction level for the following November 1 through March 15 time period shall be increased (up to, but not more than 290 gpm), to make up the gallons not extracted during June 1 through August 31. For example, if the actual average extraction for the period June 1 through August 31, 2009 were 135 gpm, the water extraction level for November 1, 2009 to March 15, 2010 would be 285 gpm monthly average.

"Monthly average" as used above means the average for the calendar month, or for a period less than one calendar month, the average for such time period. "Bi-weekly" as used above means every two weeks beginning with the first day of the specified time period. "SG-Doyle" as used above means the staff gauge currently located in Dead Stream near the Doyle residence. "SG-102" as used above means the monitoring location at the south side of the M-20 bridge at the Dead Stream.

As to the June 1-August 31 time period, if a weekly reading of stage or flow indicates that a reduced pumping limitation or increased pumping limitation is to take effect, such changed limitation shall take effect beginning on the third business day following the reading, unless the reporting of the applicable reading was delayed pursuant to the last sentence of paragraph III.B.2. below. If the reporting of the reading was delayed pursuant to the last sentence of paragraph III.B.2., the changed limitation shall take effect on the next business day following the reporting and shall remain in effect for at least 7 days (i.e., no subsequent change shall take effect prior to the expiration of 7 days).

B. Levels of water extraction by NWNA from the Sanctuary Springs location in excess of those set forth in paragraph A above shall be deemed to interfere with the riparian rights of Plaintiffs in violation of the principles and criteria set forth in the November 29, 2005 Court of Appeals Opinion, and are hereby enjoined.

II. **MEPA Claim.**

A. The levels of water extraction from the Sanctuary Springs location set forth in paragraph I.A. above are deemed not likely to pollute, impair or destroy the air, water or other natural resources in violation of the Michigan Environmental Protection Act ("MEPA"), MCL 324.1701(1), and are hereby permitted.

B. Levels of water extraction by NWNA from the Sanctuary Springs location in excess of those set forth in paragraph I.A. above are deemed likely to impair the water or other natural resources in violation of MEPA, and are hereby enjoined.

III. **Additional Provisions.**

A. NWNA shall measure and record the stage and flow of Dead Stream at the M-20 Bridge (SG-102/SG-106) and the stage of Dead Stream at SG-Doyle at a weekly frequency during the period May 16 – August 31. During the remainder of the year, the monitoring frequency for SG-102/SG-106, SG-Doyle, SG-103 (Cole Creek) and SW-Gilbert/SW-101 (Gilbert Creek) shall be at the same frequency as for the "every four weeks" monitoring events in the Revised Monitoring Plan dated May 12, 2006, unless otherwise agreed by the parties. NWNA shall advise Plaintiffs' designated representative of the dates and times of measuring such monitoring data and Plaintiffs shall have the opportunity to have their designated representative present to observe and/or inspect NWNA's measuring and/or to take comparative measurements.

B. NWNA shall furnish monitoring data to Plaintiffs' designated representative within three business days following the monitoring event, and the monitoring data so furnished may be made publicly available. NWNA shall furnish pumping data to Plaintiffs' designated representative on the following basis:

1. Raw data for NWNA's daily total pumping volumes from the Sanctuary Springs location shall be furnished on a weekly basis, within two business days following the end of the week.

2. Reports of (a) NWNA's daily average pumping volume for each well at the Sanctuary Springs location (in gpm), (b) NWNA's total daily average pumping volume from all wells at the Sanctuary Springs location (in gpm), and (c) NWNA's average pumping volume from all wells at the Sanctuary Springs location (in gpm) during the applicable monthly or bi-weekly period pursuant to paragraph I.A. above, shall be furnished within four business days following the end of the applicable monthly or bi-weekly period.

3. Except as otherwise expressly provided in this Amended and Final Stipulated Order, the monitoring, exchange, and verification of monitoring, precipitation, and pumping data shall comply with the Revised Monitoring Program and the Plans and Procedures to Ensure Continuing Compliance, both dated May 12, 2006, unless otherwise agreed by the parties.

All of the foregoing time periods for furnishing data are subject to reasonable extensions or exceptions (as applicable under the circumstances pertaining to the furnishing of the respective data) for weather; power outages; hunting restrictions on monitoring data measurement at the Sanctuary; malfunction of meters, computers and/or computer software; or other natural causes not within the reasonable control of NWNA.

C. NWNA shall reimburse to Plaintiffs their costs in obtaining expert review of the monitoring data up to $10,000 per year for 22 years, beginning in 2006. Thereafter, all monitoring data shall be provided monthly to an expert designated by MCWC or its successors and such designated expert shall have the right to be present, inspect, take comparative measurements, and receive the monitoring data as provided in paragraphs III.A. and III.B. above; provided, however, that if MCWC or its successors is dissolved or has notified NWNA that it no longer wants to receive such data, it shall be made available to Ferris State University, or other public library in Mecosta County willing to receive and maintain the information.

IV. **Enforcement.**

A. If any party violates any of the provisions of this Final Amended Stipulated Order, any party may seek to enforce such provision by motion filed in the Circuit Court for Mecosta County, Michigan, as provided by law, seeking relief including but not limited to injunctive or other equitable relief; reduction of maximum average withdrawal rates in a subsequent period(s) to offset any previous withdrawals in violation of this Order; ancillary damages; contempt; or other sanctions. Any plaintiff who prevails shall be awarded their reasonable attorney fees and costs in obtaining enforcement of this Order. The trial court retains jurisdiction for purposes of enforcing this Order.

B. It is expressly stipulated and agreed that MCWC has standing in this action, as a matter of fact and law, and that such standing shall continue necessarily as part of its right to enforce this Amended and Final Stipulated Order. Further, it is expressly stipulated and agreed as a matter of fact and law that MCWC or its successor organization shall have the legal standing and the right to enforce the terms of this Amended and Final Stipulated Order under the Michigan Environmental Protection Act, MCL 324.1701 *et seq*. It is also stipulated and agreed as a matter of fact that (1) MCWC has members who are riparian land owners or members of the public who specifically use and enjoy the Dead Stream and/or Thompson Lake for viewing, boating, kayaking, canoeing, or other recreation (it being understood, however, that there is no right of public access to either Thompson Lake or the Dead Stream); (2) any reduction of flows and levels of Dead Stream or the levels of Thompson Lake due to a violation of the terms and provisions of this Amended and Final Stipulated Order would directly and actually injure or interfere with such uses and enjoyment; and (3) such injury and interference will be redressed by enforcement of the terms and provisions of this Amended and Final Stipulated Order. Accordingly, MCWC, as representative of the interests of these members, has distinct and special interests unique from the public at large to maintain a civil action to enforce the terms and provisions of this Amended and Final Stipulated Order as provided in paragraph A above.

V. **Amendment of Injunction.** The injunction set forth herein modifies, supersedes and fully replaces the injunction in the Stipulated Order on Remand dated January 25, 2006.

VI. **Binding Effect.** The provisions of this Order shall be binding upon and shall inure to the benefit of the parties and their respective heirs, executors, representatives, successors and assigns.

VII. **Recording.** A copy of this Order may be recorded by either party with the Register of Deeds for Mecosta County, Michigan, as provided by law, and indexed with reference both to NWNA's interest in the Sanctuary Springs property and to the Doyle property and the Sapp property.

VIII. **MCR 2.602(A)(3) Last Order.** This Amended and Final Stipulated Order resolves the last pending claim and closes the case, and this being a complete compromise and settlement of all claims in this litigation, no appeals shall be filed by either party.

IT IS SO ORDERED.

Dated: July 6, 2009

Honorable Susan H. Grant P33079
Circuit Court Judge, acting by assignment

We consent to the entry of this Order amending the Stipulated Order on Remand dated January 25, 2006:

Plaintiffs Michigan Citizens For Water Conservation, a Michigan nonprofit corporation; R.J. Doyle and Barbara Doyle, husband and wife; Jeffrey R. Sapp and Shelly M. Sapp, husband and wife

By: ______________________________

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APPENDIX 2, FLOW REPORT

EVALUATION OF THE PROPOSED INCREASE IN PUMPING OF PW-101 TO 400 GPM BY NESTLE WATERS NORTH AMERICA (NWNA): WHITE-CEDAR-OSCEOLA SITE, OSCEOLA COUNTY, MICHIGAN

April 21, 2017

Report prepared by:
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Prepared for and in partnership with FLOW (For Love of Water)

This report addresses the hydrologic and hydrogeological aspects of the recent request by NWNA for expansion of their pumping at PW-101 to 400 gpm from its current 150 gpm permitted capacity. The analysis presented here is based on a review of documents provided by NWNA and their contracting partners.[1] The documents frequently referred to below are:

- Golder Report: *Section 17 Of Michigan Safe Drinking Water Act: Application Information Package,* with Appendices, Figures, Attachments, prepared by Golder Associates Inc.
- SSPA Report: *Evaluation of Groundwater and Surface Water Conditions in the Vicinity of Well PW-101, Osceola County, Michigan*, prepared by S.S. Papadopulos & Associates, Inc. with attachments and other referenced information.
- ECT Report: *White Pine Springs Evart, Michigan Assessment of Wetland Effects,* prepared by Environmental Consulting & Technology, Inc., including attached or referenced information.

Although voluminous, the NWNA application is deficient in four important categories, described below.

1. **The NWNA application does not fully evaluate the existing hydrologic, hydrogeological, or other physical and environmental conditions.**
    a. **Data collected between 2001 and the onset of pumping in 2009 do not appear to have been evaluated, nor have the seven years of data since pumping at 150 gpm began.**
    There are significant variations in the water level and streamflow data presented, and there has been no apparent effort to ascribe those variations to either changes in precipitation or pumping (since 2009). Streamflows at measurement locations have been significantly lower since the onset of high-capacity withdrawals in 2009 (see Figures 6-9, SSPA report), however the model has not been used to evaluate the linkage between this change and pumping despite its capability to do so. The extent to which these flows have been affected or impacted by pumping is not examined nor is it discussed in either the SSPA or Golder reports.
    b. **The data provided are insufficient for the public or the DEQ to fully assess the effects and impacts of either past pumping or to provide an adequate baseline or basis for identification of future or predicted effects and impacts.**
    The following critical datasets were either not recorded or not provided in any of the reports or attachments/appendices: 1) continuously monitored streamflow, 2) pumping data from PW-101, 3) wetland water levels, or 4) local meteorological information. Further, monthly streamflow measurements are insufficient to accurately determine Q50 exceedance flows (the index flow in this case) in the lowest flow month (here August). With the information provided it is not possible

[1] The review is based on information and data disclosed and submitted to MDEQ

to determine when pumping actually began, presumably sometime in 2009, nor was any information about shut-down periods of the pump, or pump flow rate variability provided. Wetland water levels were measured as part of the ECT assessment, but they are not presented in any form. Nor does it appear that levels have been continuously monitored with a pressure transducer, which is required to provide an adequate or reasonable baseline for both hydrologic and ecological existing conditions and functions, and to evaluate and assess the effects and impacts of current or requested future pumping. Finally, without presented local meteorological data, there is no context for the variability in any of the presented datasets, nor do any of the reports analyze this variability in light of the stated effects of pumping.

2. **The NWNA application does not provide adequate or sufficient information about the predicted effects of their requested pumping.**

   The NWNA application for pumping as summarized in the Golder report appears to rely almost entirely on modeling work done by SSPA for its hydrologic impacts. While models are useful tools to assess the potential impacts of expanded pumping, their use requires adequate demonstration of their predictive capability relative to measured data. That standard is not met in this case for three main reasons:

   a. **Confidence in groundwater model predictions of the pre-pumping conditions of the system is not adequately established.**

      The mismatch between measured groundwater levels and model predictions greatly exceeds the simulated effects of pumping [SSPA report]. This difference, called a residual, was used to calibrate the model. Nevertheless, even after calibration residuals in key areas were large. For example, in the area near White Pine Springs, model simulated values are between 1.4 and 3.6 feet above measured values. These residuals significantly exceed predicted drawdowns of approximately 0.5-1 foot at this location. Besides reducing confidence in model predictions, such differences will systematically affect simulated seep flows into Twin Creek, particularly at Wiers 1 to 4.

   b. **Confidence in groundwater model predictions of effects of existing pumping within the system is not adequately established.**

      Although the model was used to simulate the impacts of a relatively short duration 10-day pump test in 2001, no other assessment of the effects of existing pumping at PW-101 is presented. As part of their report effort SSPA created a model with 150 gpm pumping at PW-101, but does not report results from this model. Thus the performance of this model in terms of capturing the impacts of real-world pumping is unclear.

   c. **The effects of model uncertainties are insufficiently addressed.**

      The uncertainty assessment method presented in the SSPA report is incapable of providing a comprehensive view of how model uncertainty affects prediction confidence. For instance, there is no discussion or analysis of how simulated water table residuals (discussed in point 2a above) impact streamflow predictions. The most important aspect of uncertainty analysis is bracketing a range of potential effects, and this was not done in the SSPA report.

d. **The effects of recharge variability through time are not considered.** Recharge varies considerably from year-to-year, by as much as a factor of two in this region [*Kendall 2009*]. As seen in the water level data, periods of low recharge can lead to lower water levels, and thus lower stream flows. It is during these times, not average years, where hydrologic effects are most significant. The SSPA report does not address how pumping at 400 gpm would affect flows in low-flow years. Thus the impacts of pumping during these most critical times cannot be determined from this model.

3. **The NWNA application does not provide a reasonable basis to determine the effects or impacts of pumping.**

A set of unsupported assumptions throughout the SSPA and ECT reports work collectively to minimize the simulated and estimated effects of pumping on both wetlands and stream flows.

a. **The creation by SSPA of a low-conductivity sediment zone beneath both Twin and Chippewa Creeks is unsupported by evidence**.
Nor is a feature such as this common in the region. This low-conductivity which would artificially limit the influence of the pumping on the flow in those streams, effectively creating a barrier underneath the streams.

b. **The calibration period selected, from January 2001 to December 2002 is unnecessarily short**.
Furthermore it appears to be a period of both relatively low water levels and stream flows. This selection will lead the automated parameter calibration routine to produce results that are consistent with the low-conductivity zonation, but are physically unsupported and otherwise unjustified. With a more neutral selection of streamflow calibration targets, the actual streamflow impacts are likely higher than those predicted by SSPA's modeling efforts.

c. **SSPA uses a recharge estimate [*Holtschlag 1997*] that is flawed for this region.**
For instance it inputs greater recharge under forested areas than in more open land covers. This runs counter to a large body of literature and scientific studies that demonstrate the opposite.

d. **SSPA's calibrated recharge value is significantly higher than other estimates for this region.**
SSPA states that their estimate is roughly 25% higher than in Holtschlag [*1997*], at approximately 14 inches per year. In an analysis from the Dr. Anthony Kendall [*Kendall 2009*], the approximate average recharge in the immediate proximity of

the well (within a ¼ section) is 9.8 inches. This discrepancy would lead to significant overestimates of groundwater resources in the area.

e. **The head contours drawn by Arcadis in the vicinity of wetlands B, C, and D is not supported**.
There are substantial deviations in the manually-drawn contours that, if properly constructed, would be due to topography, variation in geologic materials, or otherwise justified by observation data as presented.

f. **The assumption by ECT that wetlands B, C, and D are disconnected from the aquifer is unjustified.**
The water table according to Arcadis' head contours is just 2 feet below the wetlands, well within both measurement uncertainties and inter- and intra-annual variability in water levels. This is particularly problematic given the sparseness of water level measurements in the immediate proximity to those wetlands. These three wetlands are near the 1 foot predicted drawdown contour for the 250 gpm pumping increase, and therefore will likely be significantly affected by an increase in pumping.

4. **The NWNA application does not explicitly consider both the individual and cumulative effects or impacts of their proposed pumping.**

The NWNA application does not address the cumulative effects of pumping at the proposed 400 gpm rate, but rather solely discusses the effects of the increase in pumping from 150 to 400 gpm. Neither the Golder report nor the SSPA report address cumulative impacts of pumping at 400 gpm, except to note that the 400 gpm rate was used in the WWAT. Rather in Table 2 of the SSPA report, they present changes in flow relative to the initial 150 gpm permit. Similarly, Figure 19 of the same report presents drawdown contours for only the 150 to 400 gpm increment. This is the complete basis for the hydrologic effects of pumping wetlands as presented in the ECT report.

SSPA conducted the simulations for both pumping rates (150 and 400 gpm) and then subtracted one from the other to present the incremental effects of pumping. Thus it would have been trivial for that report to also include the cumulative impacts (and to evaluate the already-observed impacts of pumping at 150 gpm, as discussed above in point 1a).

Not including the cumulative effects of 400 gpm pumping obscures the total impact that this pumping rate would have on the hydrology surrounding PW-101.

Findings of Hydrologic Effects and Adverse Resource Impacts

1. **A more neutral analysis would likely find--for an average year—more significant effects of the following for the incremental 250 gpm increase:**
   - **a.** Cumulative reductions of index flows of greater than 15% at SF-6, Weir 6, SF-8, and Weir 5.
   - **b.** Cumulative reductions of index flows near 15% at SF-11, SF-9, SF-16, and SF-13

c. Significant effects on seasonal wetland flooding will likely occur, on both seasonal and average levels, at Wetlands A, B, C, D, G, H, R, and CC. In the ECT report this discussed this several times, as for Wetland H: "Under worst case, surface inundation in Wetland H could be permanently lost, with soil saturation to the surface occurring only seasonally..."

2. **All of these effects will be significantly greater than presented by NWNA when cumulative drawdown due to 400 gpm pumping is considered.**
3. **The effects and adverse resource impacts during low precipitation years or months, such as commonly occur during June through Mid-September, would be even greater.**

The extent to which streamflows and water levels would be affected by low precipitation (and groundwater recharge) periods was not examined in the Golder or SSPA reports.

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Curriculum Vitae

CURRICULUM VITAE

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EDUCATION:

Ph.D.	Stanford University	Geological & Environmental Sciences Dept.	Hydrogeology	1995
M.S.	Stanford University	Applied Earth Sciences Dept.	Hydrogeology	1993
B.S.	University of Arizona	Hydrology and Water Resources Dept.	Hydrology	1989

PROFESSIONAL EXPERIENCE:

Chair	Michigan State University, Dept. of Geological Sciences	2010 – present
Professor	Michigan State University, Dept. of Geological Sciences	2008 – present
Associate Professor	Michigan State University, Dept. of Geological Sciences	2000 - 2008
Assistant Professor	Michigan State University, Dept. of Geological Sciences	1995 - 2000
Hydrologist	United States Geological Survey, Water Resources Div.	1988 - 1992

EDITOR POSITIONS:

Ground Water (Associate Editor)	1997 - 2011
Water Resources Research (Associate Editor)	2000 - 02 & 04 - 05

AWARDS:

Chair, Consortium of Universities for Hydrologic Sciences Board	2016
CIC Department Executive Officer Fellow	2011
Coauthor on Best Paper Award, Center for Water Science, MSU	2008
Elected Fellow, Geological Society of America	2006
Darcy Distinguished Lecturer, National Ground Water Association	2002
Team member – NGWA Outstanding Remediation of the Year Project Award	2002
Ronald W. Wilson Teaching Award	2001
Editors Citation for Excellence in Refereeing for Water Resources Research	2000
Lilly Fellow, Michigan State University	1997
Superior Performance Award, U. S. Geological Survey	1989
Special Achievement Award, U. S. Geological Survey	1988

PROFESSIONAL AFFILIATIONS:

Geological Society of America
American Geophysical Union
National Ground Water Association
American Association for the Advancement of Science

BOOKS:

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17. R. L. Van Dam, *Eustice, B., **D. W. Hyndman**, W. W. Wood, C. T. Simmons, 2014, *Electrical Imaging and Fluid Modeling of Transient Free Convection in a Shallow Water-Table Aquifer*, Water Resources Research, 50, DOI:10.1002/2013WR013673.

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20. Basso, B., †A. D. Kendall, and **D. W. Hyndman,** 2013, *The Future of Agriculture Over the Ogallala Aquifer - Solutions to Grow Crops More Efficiently with Limited Water*. Earth's Future, 1: 39–41, DOI:10.1002/2013EF000107.
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23. *Martin, S.L., D.B. Hayes, D.T. Rutledge, and **D.W. Hyndman**, 2011, *The land-use legacy effect: Adding temporal context to lake chemistry*. Limnology and Oceanography 56(6) 2362-2370, DOI: 10.4319/lo.2011.56.6.2362.
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26. Wiley, M. J., **D.W. Hyndman**, B. C. Pijanowski, †A. D. Kendall, C. Riseng, E. S. Rutherford, S.T. Cheng, M.L. Carlson, J.A. Tyler, R.J. Stevenson, P.J. Steen, P.L. Richards, P.W. Seelbach, and J.M. Koches, 2010. *A Multi-Modeling Approach to Evaluating Climate and Land Use Change Impacts in a Great Lakes Tributary River Basin*, Hydrobiologia, DOI: 10.1007/s10750-010-0239-2.
27. Liu, G., J.J. Butler, Jr., G.C. Bohling, E. Reboulet, S. Knobbe, and **D.W. Hyndman**, 2009, *A New Method for High-Resolution Characterization of Hydraulic Conductivity*, DOI:10.1029/2009WR008319, Water Resources Research.
28. Hu, B.X., M.M. Meerschaert, W. Barrash, **D.W. Hyndman**, *C. He, *X. Li, and *L. Guo, 2009, *Examining the influence of heterogeneous porosity fields on conservative solute transport*, Journal of Contaminant Hydrology, DOI: 10.1016/j.jconhyd.2009.06.001.
29. Van Dam, R. L., C. T. Simmons, **D.W. Hyndman**, and W. W. Wood, 2009, *Natural free convection in porous media: First field documentation in groundwater*, Geophysical Research Letters, 36, L11403, DOI:10.1029/2008GL036906.
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31. **Hyndman, D.W.**, 2009, *Potential Impacts of Climate Changes on Natural Hazards and Water Resources*, *in* Decision Support for Natural Disasters and Intentional Threats to Water Security, T. Illangasekare and J. Barich Eds., Springer, pp. 63-80.

32. *Jayawickreme, D. H., R. L. Van Dam, and **D.W. Hyndman**, 2008, *Subsurface Imaging of Vegetation, Climate, and Root-Zone Moisture Interactions*, Geophysical Research Letters, 35, L18404, DOI:10.1029/2008GL034690.
33. Wiley, M., B. Pijanowski, R. Stevenson, P. Seelbach, P. Richards, C. Riseng, **D. Hyndman**, and J. Koches, 2008, Integrated Modeling of the Muskegon River: Ecological Risk Assessment in a Great Lakes Watershed. In *"Wetland and Water Resource Modeling and Assessment: A Watershed Perspective",* CRC Press.
34. Stevenson, R. J., M. J. Wiley, S. H. Gage, V. L. Lougheed, C. M. Riseng, P. Bonnell, T. M. Burton, R. A. Hough, **D.W. Hyndman**, J. K. Koches, D. T. Long, B. C. Pijanowski, J. Qi, A. D. Steinman, and D. G. Uzarski, 2008, Watershed Science: Essential, Complex, Multidisciplinary and Collaborative. In *"Wetland and Water Resource Modeling and Assessment: A Watershed Perspective",* CRC Press.
35. Pijanowski, B., D. K. Ray, *A. D. Kendall, *J. M. Duckles, and **D. W. Hyndman**, 2007. *Using backcast land-use change and groundwater travel-time models to generate land-use legacy maps for watershed management*. *Ecology and Society* **12**(2): 25.
36. **Hyndman, D.W.**, *A. D. Kendall, and *N. R.H. Welty, 2007, *Evaluating Temporal and Spatial Variations in Recharge and Streamflow Using the Integrated Landscape Hydrology Model (ILHM)*, AGU Monograph, Subsurface Hydrology: Data Integration for Properties and Processes, DOI: 10.1029/171gm11, p. 121-142.
37. Singha, K., **D.W. Hyndman.**, and F.D. Day-Lewis, 2007, *Introduction*, Subsurface Hydrology: Data Integration for Properties and Processes, American Geophysical Union, Geophysical Monograph Series Volume 171, p. 1-5, DOI: 10.1029/170GM01.
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41. *Bennett, G. L., G. S. Weissmann, G. S. Baker, and **D. W. Hyndman**, 2006, *Regional-scale assessment of a sequence bounding paleosol on fluvial fans using ground penetrating radar, eastern San Joaquin Valley, California.*, GSA Bulletin, 118, p. 724–732; DOI: 10.1130/B25774.1.
42. Illangasekare, T., S. W. Tyler, T. P. Clement, K. G. Villholth, A. P. G. R. L. Perera, J. Obeysekera, A. Gunatilaka, C. R. Panabokke, **D. W. Hyndman**, K. J. Cunningham, J. J. Kaluarachchi, W. W.-G. Yeh, M. T. van Genuchten, K. Jensen. 2006, *Impacts of the 2004 tsunami on groundwater resources in Sri Lanka,* Water Resour. Res., 42, W05201, DOI:10.1029/2006WR004876.
43. Zhao, X., R. B. Wallace, **D. W. Hyndman**, M. Dybas, and T. C. Voice, 2005, *Heterogeneity of Chlorinated Hydrocarbon Sorption Properties in a Sandy Aquifer*, Journal of Contaminant Hydrology, 78(4):327-42.
44. Phanikumar, M. S., **D. W. Hyndman**, X. Zhao, and M. Dybas, 2005, *A Three-Dimensional Model of Microbial Transport and Biodegradation at the Schoolcraft, Michigan Site*, Water Resources Research, 41, W05011, DOI:10.1029/2004WR003376.
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46. *Biteman, S.E., **D.W. Hyndman**, M.S. Phanikumar, and G.S. Weissmann, 2004, *Integration of Sedimentologic and Hydrogeologic Properties for Improved Transport Simulations*, In Aquifer Characterization, J.S. Bridge and D.W. Hyndman eds., SEPM Special Publication 80.
47. Bridge, J. S. and **D.W. Hyndman**, 2004, *Preface: Aquifer Characterization*, SEPM Special Publication 80.
48. **Hyndman, D. W.**, and J. Tronicke, 2004, *Hydrogeophysical Case Studies at the Local Scale: the Saturated Zone: Chapter 13*, Hydrogeophysics, Kluwer Press.
49. Haack, S.K, *L.R. Fogarty, *T.G. West, *E.W. Alm, *J.T. McGuire, D.T. Long, **D.W. Hyndman**, and L. J. Forney. 2004, *Spatial and Temporal Changes In Microbial Community Structure Associated With Recharge-Influenced Chemical Gradients In A Contaminated Aquifer*, Environmental Microbiology, 6(5), 438-448, DOI:10.1111/j.1462-2920.2003.00563.x.
50. Phanikumar, M.S., and **D.W. Hyndman**, 2003, *Interactions Between Sorption and Biodegradation: Exploring bioavailability and pulsed nutrient injection*, Water Resources Research, 39 (5), 1122, DOI: 10.1029/2002WR001761.
51. *Wayland, K.G., D.T. Long, **D.W. Hyndman, ***S. Woodhams, and B.C. Pijanowski, 2003, *Identifying Relationships between Baseflow Geochemistry and Land Use with Synoptic Sampling and R-Mode Factor Analysis*, Journal of Environmental Quality, (32), 180-190.
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53. Phanikumar, M.S., **D.W. Hyndman**, and C.S. Criddle, 2002, *Subsurface Biocurtain Design Using Reactive Transport Models,* Groundwater Monitoring and Remediation, 22, no. 3, 113-123.
54. Phanikumar, M.S., **D.W. Hyndman**, D. Wiggert, M.J. Dybas, M.E. Witt, and C.S. Criddle, 2002, *Simulation of Microbial Transport and Carbon Tetrachloride Biodegradation in Intermittently-fed Aquifer Columns*, Water Resources Research, 38 (4), 4-1 to 4-13.
55. *Wayland, K.G, **D.W. Hyndman**, *D.F. Boutt, B.C. Pijanowski, D.T. Long, 2002, *Modeling The Impact Of Historical Land Uses On Surface Water Quality Using Ground Water Flow And Solute Transport Models*, Lakes and Reservoirs, (7), 189-199.
56. *McGuire, J. T., D. T. Long, M. J. Klug, S. K. Haack, and **D. W. Hyndman**, 2002, *Evaluating the Behavior of Oxygen, Nitrate, and Sulfate During Recharge and Quantifying Reduction Rates in a Contaminated Aquifer*, Environmental Science and Technology**,** (36), 2693-2700.
57. Webb, R.H., *J.B. Blainey, and **D.W. Hyndman**, 2002*, Paleoflood hydrology of the Paria River, southern Utah and northern Arizona, USA*, in House, P.K.,Webb, R.H., Baker, V.R., and D.R. Levish, Ancient floods and modern hazards, principles and applications of paleoflood hydrology: Washington, DC, American Geophysical Union, Water Science and Application Series, v. 5, 295-310.
58. *Boutt, D. F., **D.W. Hyndman**, B.C. Pijanowski, and D.T. Long, 2001, *Modeling Impacts of Land Use on Groundwater and Surface Water Quality*, Ground Water, 39 (1), 24-34.
59. **Hyndman, D. W**., M. J. Dybas, L. Forney, R. Heine, T. Mayotte, M.S. Phanikumar, G. Tatara, J. Tiedje, T. Voice, R. Wallace, D. Wiggert, X. Zhao and C. S. Criddle, 2000, *Hydraulic Characterization and Design of a Full-Scale Biocurtain*, Ground Water, 38(3), p. 462-474.
60. **Hyndman, D. W.**, J. M. Harris, and S. M. Gorelick, 2000, *Inferring the relationship between seismic slowness and hydraulic conductivity in heterogeneous aquifers*, Water Resources Research, 36(8), 2121-2132.

61. *McGuire, J. T., *E. W. Smith, D. T. Long, **D. W. Hyndman**, S. K. Haack, M. J. Klug and M. A. Velbel, 2000, *Temporal variations in parameters reflecting terminal-electron-accepting processes in an aquifer contaminated with waste fuel and chlorinated solvents*, Chemical Geology, 169(3-4), 471-485.
62. **Hyndman, D. W.**, 1998, *Geophysical and Tracer Characterization Methods:* Chapter 11, Groundwater Engineering Handbook, **CRC Press, 11-1 – 11-29**.
63. **Hyndman, D. W.**, and S. M. Gorelick, 1996, *Estimating lithologic and transport properties in three dimensions using seismic and tracer data*, Water Resources Research, 32(9), 2659-2670.
64. **Hyndman, D. W.**, and J. M. Harris, 1996, *Traveltime inversion for the geometry of aquifer lithologies*, Geophysics, 61(6).
65. **Hyndman, D. W.**, J. M. Harris, and S. M. Gorelick, 1994, *Coupled seismic and tracer test inversion for aquifer property characterization*, Water Resources Research, 30(7), pp. 1965-1977.

Publications In-review (* Indicates Student Author, [†] Indicates Postdoc Author)

1. **D. W. Hyndman,** [†]T. Xu, *J. Deines, G. Cao, *R. Nagelkirk, A. Viña, W. McConnell, B. Basso, [†]A. Kendall, S. Li, L. Luo, F. Lupi, J. Winkler, Wu Yang, C. Zheng, J. Liu, *A systems approach to assess changes to water availability in a megacity,* Geophysical Research Letters.
2. W. W. Wood and **D. W. Hyndman**, *An Important Missing Source of Atmospheric Carbon Dioxide*, PLOS One.

Selected Outside Committee Positions and Lectureships

Committee to Review Groundwater Issues at the Fukushima Nuclear Plant, Japan	2016
Board of Directors, Consortium of Univ. for Hydrological Sciences (***Chair, 2016***)	2013-
National Science Foundation, EPSCOR Reverse Site Visit Committee	2015
U.S. – Israel Binational Science Foundation, Panel Member	2015
Co-Organized AGU Chapman conference of ~90 in Valencia, Spain	2015
Co-Organized NOVCARE meeting of ~100 in Lawrence, Kansas	2015
National Science Foundation, Integrated Earth Systems Panel	2014 & 15
National Science Foundation EAR/SEP Division, **Committee of Visitors, Chair**	2014
Scientists and Engineers Division Awards Committee, National GW Association	2012-14
Scientific Advisory Board, DOE LBNL, Sustainable Science SFA	2011-14
American Geophysical Union, Hydrogeophysics Committee	2004-15
National Science Foundation, Reverse Site Visit Committee	2013
Field Research Executive Committee, Department of Energy SBR	2011-12
External Advisory Board Member, SoilCAM European Union Project	2008-12
Hanford Integrated Vadose-Groundwater Assessment Expert Panel	2012
National Science Foundation EAR/SEP Division, Committee of Visitors	2011
Co-Organized NOVCARE meeting of ~100 in Cape Cod, MA	2011
National Science Foundation Climate and Water Sustainability Review Panel	2010

Committee of Visitors, Review Climate and Environmental Sciences Division, DOE	2010
Co-Organized NOVCARE meeting of 140 in Leipzig Germany	2009
Provided Invited Testimony to a Subcommittee of the US House of Representatives	2007
Co-Organized SEG Hydrogeophysics Workshop in Vancouver, Canada	2006
National Science Foundation, Carbon and Water Review Panel	2006
Department of Energy Review Panel	2006
Darcy Lecturer Selection Committee (chair, 2005)	2003-05
Accreditation Review Expert, Center for Hydrogeology, Neuchâtel, Switzerland	2004
Distinguished Lecturer, Presented one week unpaid short course in Novi Sad, Serbia	2004
Scientific Advisory Committee, MODFLOW 2004 Conference, Carlsbad, Czech Republic	2004
Consortium of Universities for Hydrological Sciences, Board Member	2002-04
Technical Committee, MODFLOW 2003 Conference, Golden Colorado	2003
NATO Hydrogeophysics ASI workshop, Invited presentation, Trest, Czech Republic	2003
Panel Participant (Complexity vs. Simplicity in models), Golden, Colorado	2003
Darcy Distinguished Lecturer – NGWA (59 invited lectures in 11 countries)	2002

SELECTED UNIVERSITY COMMITTEE POSITIONS

Water Science Committee, elected	2014-2016
Water Science Curriculum Committee	2014-
College of Natural Science Connected Math Committee	2011-
Program Advisory Group, Environmental Science and Policy Program	2004-08, 11-15
Department of Geological Sciences Advisory Committee (Chair 2005-06)	2002-06, 09-10
Graduate Director, Dept. of Geological Sciences	2008-09
Unsaturated Zone Hydrology Search Committee, Crop and Soil Sci. & Geol. Sci. Depts.	2006-08
Hydroecology Search Committee, Agricultural Engineering Dept.	2006-08
Executive Committee, Water Science Center	2004-11
Academic Council / Faculty Council Representative	2006
All University Award Committee	2004-05
College of Natural Sciences Position Management Committee	2004
Teaching Award Committee, Center for Integrative Studies (Chair, 2004-05)	2003-05
College of Natural Sciences Deans Advisory Committee (Vice Chair, 2004-05)	2003-05
Center for Integrative Studies in General Science Advisory Committee	2002-06

Graduate Students and Postdocs Advised

Postdocs:

Anthony Kendall, started 2009

Sherry Martin, started May 2011

Tianfang Xu, started 2016

Agustin Brenna, started May 2012 – (now faculty Universidad Nacional Autónoma de México)

Lisi Pei, started 2015 – (now research scientist with NOAA GLERL lab)

PhD Students:

Chanse Ford, started summer 2016

Sam Smidt, May **2017**

Jill Deines, received University Distinguished Fellowship - anticipated graduation August **2017**

Alex Kuhl, received CNS fellowship - anticipated graduation December **2017**

Erin Haacker, received University Distinguished Fellowship - anticipated graduation May **2017**

Travis Dahl, anticipated graduation May **2018**

Mine Dogan (now *Research Assistant Professor, Clemson University)*, **August 2013** - co-advised with Remke van Dam

Anthony Kendall (*Senior Research Associate, Michigan State Univ.)*, **May 2009**

Dush Jayawickreme (now *Faculty, Southern Connecticut State Univ.)*, **August 2008**

M.S. Students:

Xiao Liu, anticipated graduation August **2017**

Austin Parish, anticipated graduation August **2017**

Kayla Cotterman, **2016** (*US Army Corps of Engineering, Vicksburg MS*)

Emily Luscz (*Global Resource Engineering, Denver, CO*), **2013,** *Modeling Nutrient Loading to Watersheds in the Great Lakes Basin: A Detailed Source Model at the Regional Scale*

Chris May (*Golder, Seattle, WA*), **2009**, *Evaluating the Effects of Current and Past Land Cover on Sediment and Nutrient Transport*

Nick Welty (*ARCADIS, MI*), **2005**, *Exploring relationships between land use and ecohydrology using multivariate statistics and process-based models*

Peter Lepczyk (*Global Remediation Technologies, Traverse City, MI*), **2005**, *Laboratory and numerical simulations of three-dimensional microbial transport and biodegradation*

John Moss (*The Hartford*), **2004**, *Quantifying the specific conductivity of contaminated groundwater using ground penetrating radar at the former Wurtsmith Air Force Base, Oscoda, Michigan*

Mike Brennan (*ARCADIS*), **2004**, *Effect of small-scale heterogeneities on tracer transport*

Brian Lipinski (*Chevron*), **2002**, *Estimating natural attenuation rates for a chlorinated hydrocarbon plume in a glacio-fluvial aquifer, Schoolcraft, Michigan*

Chris Hoard (*USGS*), **2002**, *The influence of detailed aquifer characterization on groundwater flow and transport models at Schoolcraft, Michigan*

David Boutt (*p, Univ. Massachusetts*), **1999**, *Interpreting the impacts of land use on water quality using groundwater flow and transport simulations in the Grand Traverse Bay watershed* – Univ. Mass., Associate Processor

Ken Ewers (*GREDELL Engineering Resources*), **1997**, *Three-dimensional groundwater flow and contaminant transport in medium scale highly heterogeneous environments*

M.A. Students:

Sandra Treccani (*WA DEQ*), **1998**

SELECTED EXTRAMURAL GRANTS (PI is underlined)

Active:

1. Quantifying human and climate impacts on wetland ecosystems in the Lower Mekong River Basin, Jiaguo Qi, David Hyndman, David Kramer, Yadu Pokhrel, Peilei Fan, Joe Messina, Jinhua Zhao, Bill McConnell, **$2,173,112**, NASA-IDS - National Aeronautics and Space Administration. 2017-2020.
2. Quantifying how Global Change and Land Use Legacies Affect Ecosystem Processes at the Land Water Interface across the Great Lakes Basin, Laura Bourgeau-Chavez, David Hyndman (MSU-PI), William Currie, Deborah Goldberg, Kenneth Elgersma, Anthony Kendall, Jason Martina, Sherry Martin, Nancy H.F. French, Bruno Basso, **$1,500,000 ($509,439 to MSU)**, NASA-IDS - National Aeronautics and Space Administration. 2017-2020.
3. INFEWS/T3: Rethinking Dams: Innovative hydropower solutions to achieve sustainable food and energy production, and sustainable communities, Moran, Emilio; Hyndman, David; Moore, Nathan; Pokhrel, Yadu; Urquhart, Gerald; Mueller, Norbert; Lu, Dengsheng; Lopez, Maria, **$2,618,490**, National Science Foundation, 2017-2020.
4. Developing and promoting water-, nutrient-, and climate-smart technologies to help agricultural systems adapt to climate and societal changes, B. Basso, D. Hyndman, J. Zhao, J. Parker, J. Andresen, P. Robertson, A. Kendall, J. Rice, **$4,900,000,** USDA - National Institute of Food and Agriculture, 2015-2020.
5. WSC Category 3: Toward Sustainability of the High Plains Aquifer Region: Coupled Landscape, Atmosphere, and Socioeconomic Systems (CLASS), David Hyndman, Co-PI's: Drs. A. Kendall, N. Moore, J. Zhao, S. Zhong, B. Basso, and W. Wood (MSU), and J. Butler, and D. Whittemore (Kansas Geological Survey), $1,474,353 (**$1,224,157** to MSU), **National Science Foundation**, 2010-2017.
6. Forecasting and Evaluating Vulnerability of Watersheds to Climate Change, Extreme Events, and Algal Blooms, Stevenson, Robert; Hyndman, David; Moore, Nathan; Qi, Jiaguo, **Environmental Protection Agency**, **$749,801,** 2012-2017**.**
7. Baseline Environmental Assessment of the Upper AuSable and Manistee River Watersheds, David Hyndman, **$146,378**, **Anglers of the AuSable**, 2011-2017.

Completed:

Linking Remote Sensing and Process-Based Models to Better Understand the Influence of Land Use and Climate Changes on Great Lakes Coastal Wetlands, Co-PI with L. Bourgeau - Chavez (Michigan Tech Research Institute), D. Goldberg, N. French, and W. Currie (Univ. of Michigan). **NASA,** $1,567,696 (**$449,953** to MSU), 2010-2015.

Implications of Climate Change and Biofuel Development for Great Lakes Regional Water Quality and Quantity, **USGS-NIWR**, A. Thompson, R. Jackson, K. Karthikeyan (Univ. Wisconsin) David W. Hyndman, and A. Kendall (MSU), M. Fienen (USGS), B. Lepore (Ball State), $247,563 (**$110,027** in direct costs to MSU), 2010-2015.

Quantifying the Impacts of Projected Climate Changes on the Grand Traverse Bay Region: An Adaptive Management Framework, Hyndman, David; Stevenson, Robert; Rose, Joan; Norris, Patricia; Dreelin, Erin, **Seagrant** via Univ. of Michigan, **$149,974**, 2012-2015

Ecohydrologic Evaluation of Removing the Higgins Lake-Level Control Structure, Hyndman, David, **DNR Fisheries Division**, **$64,660,** 2012-2015**.**

Predicting the Impacts of Climate Change on Agricultural Yields and Water Resources in the Maumee River Watershed, David Hyndman, and Anthony Kendall, **$30,000**, **Great Lakes Regional Integrated Sciences and Assessments Center, NOAA**, 2011-2014

Identifying Land Use Tipping Points That Threaten Great Lakes Ecosystems, David Hyndman and Jan Stevenson, **$47,788**, **National Oceanic and Atmospheric Association**, 2011-2014.

WSC Category 1: Learning from Adaptable Water Systems, S. Gasteyer, **J. Rose**, D. Hyndman, R. J. Stevenson, J. Winkler, **National Science Foundation**, **$149,657**, 2010-2014.

Modeling Support for the St. Joseph and Maumee Watersheds, David Hyndman and Anthony Kendall, Army Corps of Engineers, 2012-2014, **$14,363**.

Nutrient management models to constrain harmful algal blooms, Co-PI with R. J. Stevenson, and J. Qi, **EPA-GLRI**, **$499,954** to MSU, 2010-2013.

Multi-scale Monitoring and Modeling of Land Use and Climate Change Impacts on the Terrestrial Hydrologic Cycle: Implications for the Great Lakes Basin, David Hyndman, Anthony Kendall, and Remke van Dam, **National Science Foundation**, **$243,552**, 2009-2013.

Study of the Jordan River Watershed and Deltaic Deposits, David Hyndman, Remke van Dam, and Warren Wood, **Friends of the Jordan River, $160,000**, 2007-2012.

Acquisition of an Electrical Resistivity System to Monitor Hydrologic Impacts of Climate and Land Use Changes and to Image Subsurface Transport and Density Driven Flow, Remke van Dam and David Hyndman, **National Science Foundation, $53,253**, 2009-2011

Novel Methods for Subsurface Characterization and Monitoring, Remke van Dam and David Hyndman, **$29,994**, **Army Research Office**, 2011.

SGER: Documenting the Transient Nature of Natural Free Convection in Groundwater, David Hyndman and Remke van Dam, **National Science Foundation, $49,116**, 2009-2011.

High-resolution Dynamic Mapping of Transport Pathways: Providing New Insights into Subsurface Processes, Collaborative Proposal, David Hyndman and Remke van Dam (MSU); Jim Butler, G Bohling and G. Liu (U. Kansas); C Zheng and G Tick (U Alabama), **National Science Foundation, $450,000** ($166,959 – to MSU), 2008-2012.

Quantifying the Impact of Land Use and Climate Change on Groundwater/Surface Water Interactions in Regional Great Lakes Watersheds, David Hyndman, Bryan C. Pijanowski, and Phanikumar S. Mantha, **National Science Foundation**, **$490,000,** 2003-2008.

USGS Natural Resources Integrated Information System, Co-PI with Bartholic, J. ; L. Wolfson, S. Batie, M.D.; Kaplowitz; S. Seedang, and R.J. Stevenson, **USGS**, **$184,670**, 2007-2011.

The role of historic climate variations and land transformation on human and ecological health in large watersheds that drain to Lake Michigan, David Hyndman, Merritt R. Turetsky, Joan B. Rose, Jeffrey A. Andresen, Julie A. Winkler, Bryan C. Pijanowski, Sabrina McCormick, **$144,378, MSU Water Science Center,** 2006-2010.

Fish Recruitment at the Interface of the Great Lakes and their Watersheds, **Great Lakes Fisheries Trust**, Co-PI with R. J. Stevenson, D. Long, B. Pijanowski, T. Burton and other PI's at U of M and GVSU**, ~$1,550,000**, 2004-2008.

Developing Relations Among Human Activities, Stressors, and Stream Ecosystem Responses and Linkage in Integrated Regional, Multi-Stressor Models, Co-PI with: R. J. Stevenson, M. J. Wiley, B. Pijanowski, and P. Seelbach, **Environmental Protection Agency**, **$748,527**, 2003-2007.

A Collaborative Approach to Understanding the Dynamics of the Muskegon Watershed: A Comprehensive Model, Risk Assessment and Tools for Use in Management, **Great Lakes Fisheries Trust**, Co-PI with B. Pijanowski, M. Wiley and other Co-PI's at U of M**, $1,273,006**, 2001-2007.

Evaluation of Remediation in Schoolcraft Plumes G and F Contaminated with Chlorinated Solvents and Metals, **Michigan Department of Environmental Quality**, Co PI with M. Dybas, D. Wiggert, T. Voice, C. Lastoskie, X. Zhao, S. Hashsham, and J. Tiedje, **$2,833,000**, 2000-2002.

Understanding and Modeling Hydrogeological, Microbiological, and Geochemical Processes that Control Groundwater Redox, **National Science Foundation**, Co-PI with D. Long, M. Klug, M. Velbel, and S. Haack (USGS/MSU), **$462,000**, 1997-2001.

Optimal Water Quality Sampling Design to Assess the Environmental Impacts of Land Use Intensity and Change, **Michigan Great Lakes Protection Fund**, D. Hyndman, B. Pijanowski, S. Haack (USGS/MSU), and D. Long, **$220,000**, 1999-2000.

Use of In-situ Bioaugmentation to Remediate an Aquifer Contaminated with Carbon Tetrachloride - Phase III, **Michigan Department of Environmental Quality,** Co-PI with C. Criddle, L. Forney, D. Wiggert, R. Wallace, T. Voice, and J. Tiedje, with consulting from The Traverse Group and EFX Systems, **$2,496,000**, 1996-1999.

The Influence of Land-use on Biogeochemical Indicators: Dynamic Models for Watershed Management, **Michigan Great Lakes Protection Fund**, Co-PI with B. Pijanowski, S. Haack (USGS/MSU), and D. Long, **$181,000,** 1998-1999.

The Influence of Land Use Change on Biogeochemical Indicators and Great Lakes Loadings: Data for Watershed Management**, Michigan Great Lakes Protection Fund**, Co-PI with B. Pijanowski, S. Haack (USGS/MSU), and D. Long, **$151,000,** 1997-1998.

Ecological Impacts to Surface Water Features due to Groundwater Pumping From PW-101 Site in Osceola County Michigan

April 21, 2017

Report prepared by:

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Background:

I have conducted an initial review of the currently available information submitted to date in the record of the Michigan Department of Environmental Quality on the application filed for approvals by Nestle Waters for PW-101 (Golder Associates, July 2016, http://www.michigan.gov/deq/0,4561,7-135-3313-399187--,00.html), regarding the ecological conditions of Chippewa Creek, Twin Creek (Fig. 1), other streams in the immediate area, and adjacent wetlands, reviewed photos of the sites and made a visit to the area. The Record I have reviewed consists of the information in the Application Information Package, July 2016 which included general plant community surveys, fish community surveys, aquatic invertebrate surveys, data for various physical parameters related to various water features. In addition, I have reviewed portions of the REPORT IN SUPPORT OF APPLICATION FOR DETERMINATION OF NO ADVERSE RESOURCE IMPACT dated August, 2006. Finally, I visited accessible sites on February 19, 2017. Review of the Record and the site visit were conducted in consideration of the harms caused or that are likely to be caused by Nestlé's pumping rates, and the potential need to limit those rates in light of the available record or due to the lack of information available in the prepared reports.

Based on my analysis to date, my opinion is that the water withdrawal by Nestlé's PW-101 will, or is very likely to cause environmental impacts to the surface water resources in the region. In addition, my opinion is that during low flow and low water level conditions, there is inadequate water in the Chippewa Creek, Twin Creek, and other surface water features, to prevent probable impairment, degradation, or harm to the aquatic and ecological system, including fish and fish habitat..

In sum, the significant artificial decrease in flows and water levels due to loss of water via pumping exceeds the natural fluctuation of the system and has, will or is likely to cause impairment or significant harm to these aquatic resources and the ecological condition of Chippewa Creek, Twin Creek, and other surface water and wetland features (Fig. 1). Decreased water levels will result in aquatic habitats being exposed, shifts in wetland plant communities, loss of available aquatic habitats and associated aquatic organisms, and a decrease in the value and quality of other remaining aquatic habitat. Also, the decrease in water levels has, will or is likely to cause harm to the chemical and physical condition of the water and aquatic resources, further impairing and degrading habitat and these conditions.

In my opinion, it is essential to preserve and maintain the natural hydrologic condition of the system, including the natural range of flows and water levels, to protect these systems and limit the adverse environmental impacts to the systems, because these conditions provide a migratory route between adjoining systems, provide spawning and nursery habitat, and support fish production in the form of invertebrate prey. Preserving and maintaining the natural range of flows and levels will prevent degradation, minimize impairment, and retain the integrity of this ecosystem's structure and function.

Analysis:

(I) General Comments on the Data Record

In general, the data provided in the reports included in the application is incomplete, and is generally insufficient to determine that there will be no negative impacts due to increased pumping.

A. The available data for assessing conditions and impacts to **fish communities** are insufficient due to the fact that:
1. The number of survey locations has been reduced between earlier and later survey periods.
2. The fish community and population data provided in the 2016 document appear to be the sum of all data from 2003 to 2015, consequently it is not possible to determine if changes have occurred.
3. There appears to be no or very limited baseline data collected prior to groundwater withdrawal.

B. The available data for assessing conditions and impacts to **invertebrate communities** are insufficient due to the fact that:
1. The invertebrate community and population data provided in the 2016 document appear to be a sum of all data from 2003 to 2015. Thus, other than for some obvious changes, it is impossible to determine if changes have occurred since pumping has begun.
2. There number of survey sites is insufficient to determine broad changes in macroinvertebrate communities.
3. There appears to be very limited baseline data collected prior to groundwater pumping.

C. The available data assessing conditions and impacts to **physical conditions** are insufficient due to the fact that:
1. The physical depth is presented as an average of data from between 2008 through 2015 or 2013 through 2015.
2. It is unclear what instruments were used to determine flow in stream segments. The report submitted by SS Papadopulos does not provide a methods section. Golder (2016) indicated that an electromagnetic flow meter was used to measure flow which may not comply with USGS standards.
3. The report submitted by AEM provided the flow meter used but has no additional methods and presents no results. The flow meter employed by AEM does not meet the data quality standards identified by the USGS as specified under Sec. 32706d.
3. The estimated change in water level of -0.01 ft has been applied uniformly in discussion of the impacts across stream segments and has led the authors of the application to the conclusion that impact throughout the system will be minimal. Applying this calculated value to all stream segments, particularly headwater segments makes an unreasonable assumption particularly for locations predicted to experience a decrease of the water table.

D. The available data assessing conditions and impacts to **seeps and springs** are insufficient due to the fact that:
1. No data are provided on communities found associated specifically with this habitat which may include a number of rare plant and/or animal species.

E. The available data assessing conditions and impacts to **wetlands** are insufficient due to the fact that:
1. As noted in Golder (2016), ECT conducted wetland assessments in the spring of 2016. Obviously, wetland water levels will generally be higher during spring runoff. The site specific photos provided in ECT (2016) support this fact. ECT (2016) notes they developed a list of species based on plants that could be identified in the dead or dormant state. Last, with regard to T&E species, Golder (2016) notes that ECT did not perform any search for specific species. Although this was a reference to the three identified T&E species, I must assume that this statement applies to all T&E species that may be present due to the habitat, but have not yet been reported from Osceola County.
2. The data that are available regarding plant species and communities are not provided.
3. There appears to be no pre-pumping data for the area.

F. The available data assessing impacts to Threatened and Endangered Species are insufficient due to the fact that:
1. The applicants consider a very limited number of species and it appears that no effort was made to conduct a systematic search for these species.
2. It appears that no effort was made to conduct a systematic search for any threatened or endangered species.

(II) Specific Comments on the Data Record and Impacts

A. Overall Impacts

My opinion, based on the data record provided in the 2016 application and attached reports, is that the increased removal of water by Nestle from this groundwater formation will, or is very likely to cause harm to the ecology of the associated surface water features, including streams, seep habitats, and wetlands. The additional removal of water from the aquifer is predicted to produce a cone of depression ranging from 3 ft at the center of the cone to 0.5 ft. at the margin. A number of seeps and springs to the west and south, including Northern Boomerang Springs, and seeps 1-4 fall within the zone defined as the 1 ft zone of depression. In addition, approximately 1,400 ft of the East Branch Twin Creek falls within this zone. All of the remaining monitoring area, including most of East Branch Twin Creek south of Nine Mile Rd, Northern Ridge Spring, Southern Boomerang Springs, White Pine Springs Chippewa Springs and Chippewa Creek above Decker Pond, Decker Springs, and a portion of Posted Creek are within the 0.5 ft. zone of depression. Depressing the groundwater table adjacent to or beneath these surface water features will not only reduce flow, but will shorten the length of flow. That is, water emerges from a seep at some elevation determined by the level of the groundwater table. If the groundwater table drops by 1 ft., a spring or seep should emerge at an altered rate or at a lower elevation depending on the geology. The new point of emergence of the seep will be determined by the slope. When the slope is steeper, a greater portion of the stream will be retained. In contrast, a longer slope will reduce the length of a stream segment. Shorter stream segments will significantly modify the structure and function of these streams, including, reduction in invertebrate communities, reduced ecological function, reduced fish spawning habitat, and reduced fish nursery areas. Thus, these changes will cause **significant diminishment** or impairment of these water resources and their functions, including habitat, fish spawning, fish movement, and fish survival.

B. Upper Chippewa Creek (above impoundments):

1. Physical Conditions.
This stream segment is listed as a perennial stream and includes monitoring locations SF-8 and SG-5, and weirs 5 and 10 associated with Chippewa Springs and weirs 7, 8, and 9 associated with Decker Springs.

Flow data at SF-8 (SSPA Fig 9) is provided only for the period between 2001 and 2009, and for weir 5 (SSPA Fig 9), data were provided only for the period between 2001 and 2010. There are no data provided for weirs 7, 8, 9, and 10. Likewise, AEM (2016) provides no flow data. Thus, the record is incomplete. None the less, the majority of flow measurements taken at weir 5 during 2009 and 2010 show a general decrease in discharge in this area (SSPA Fig 9). Temperature data (AEM Table 3) were collected only 3 times (n=3) and depth was measured 9 times (n=9) at these locations between 2008 and 2015. On average, depth was measured once per year and it is unclear if there were differences among years. Temperature collected using temperature loggers is reported only as average, maximum, and minimum for only July and August 2015 (AEM Table 4). It is unclear if there are differences among years based on this report.

2. Invertebrate Communities.
Invertebrate data appears to be the sum of all collections made between 2003 and 2015. Thus, it is not possible to determine differences among years. However, data obtained for SF8 due to a request for additional information indicate that changes have occurred between 2003 and 2015.

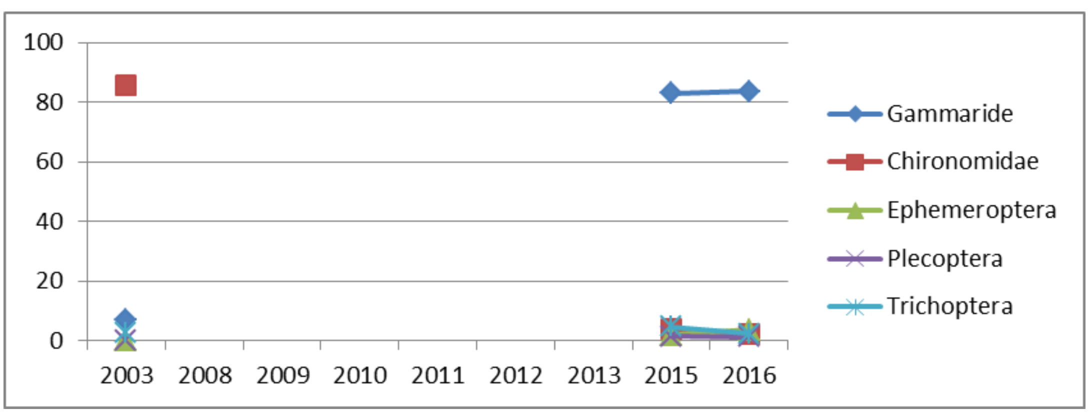


Figure F1. Relative abundance of important macroinvertebrates collected at SF8 between 2003 and 2016.

During 2003, Chironomidae was the dominant invertebrate group. Data for 2015 and 2016 clearly show that Chironomidae have decreased and Gammaride have increased substantially (Fig. F1).

It is unclear why samples were not collected between 2008 and 2014. None the less, because these surface water features, including Chippewa Springs and Decker Springs, are between the 1 ft. and 0.5 ft. cone of depression, the artificial decrease in water levels due to loss of water via pumping exceeds the natural fluctuation and has, will or is likely to cause impairment or significant harm and diminishment to the aquatic resources and ecological condition of the surface water features. Lowering the water table and reducing flow will impair the structure and function of these systems especially in stream segments where the sediments are exposed due to reduced water depth.

C. Lower Chippewa Creek (below impoundments):

1. Physical Conditions.
This stream segment is identified as a cold water trout stream and includes monitoring locations SF-16 and SF-17. SF-16 and SF-17 appear to be the sites used to estimate median and index flows. Monitoring location SF-19 is located on an unnamed tributary; no data are reported for this location. Any available results from an addition monitoring location, SF-18 which appears to be located on a stream segment designated as Posted Creek in a previous report, have been excluded from this report. Other than discharge, there appears to be no other physical (or biological) data reported for SF-17.

In 2003 temperatures at SF-17 did not exceed 20 ^{o}C. Indeed, in 2003 and 2004, temperatures at SF-17 do not appear to exceed 18 ^{o}C. During the same period, temperature at SF-16 averaged 19.3 ^{o}C. At SF-16, average temperature measured during surveys from 2008 to 2015 was 19.6 ^{o}C. Although there are no data for SF-17 during the later monitoring period, it appears that groundwater reaching Chippewa Creek in the region near SF-17 likely buffers warmer temperatures observed at SF-16 providing a constant supply of cold water to stream segments below SF-16. Consequently, this hydrologic feature likely provides a thermal refuge for trout within this section of the Chippewa Creek system. Reducing flow and the water table within this region will cause a significant diminishment of the resource, particularly cold water fish species.

Given the fact the Groundwater Basin of SF-17 (which includes SF-18) is directly within the area predicted to experience between a 0.5 ft. and 2 ft. drop in the water table, the lack of information is notable. Particularly given that the stream segment above SF-18 was previously found to support a significant juvenile brook trout population (see below).

Physical parameters were monitored at SF-16. The data provided are averages of depth and temperature calculated from discrete measurements taken between 2008 and 2015; for depth, n=63, and for temperature, n=21. Interestingly, average depth at SR-16 is only 6 inches. However, because the data are presented as averages it is not possible to determine if changes have occurred during the monitoring period. Similarly, average temperature (Table 3) does not provide the data needed to evaluate potential impacts. This is particularly true if daily fluctuations are relatively large. In addition, all of the data presented were collected after pumping began, and thus, there appears to be limited baseline data. Their observed data connected with before, during and after the pump test in connection with the application for the original 150 gpm for PW-101 in 2000-2001 does not appear to be used to compare against subsequent monitoring observations and data. Moreover, actual observed changes from monitoring data during years of pumping should be evaluated.

2. Fish Communities.
Fish communities have been monitored between 2003 and 2015 at SF-16 (AEM Table 1). Again, the data appear to be a sum of all fish collected during the monitoring period, thus, it is generally not possible to determine changes that may have occurred during that period.

However, based on the information provided in the 2016 report and the 2006 report, there are clear differences and it appears that the fish community may have already changed. Comparing data collected between 2000 and 2004 (KME 2006) with data reported in 2016, there were fewer fish species reported from Chippewa Creek in the 2016 report. The species not reported in the 2016 report include central mudminnow, bluegill, and brook trout. In 2006, brown and/or brook trout were observed to be present at <u>all sample locations except SF-8 and SF8-1</u>. The presence of brook trout in Chippewa Creek was noted in Table 3 and in Fig. 6. However, Table 7 provides no specific number of brook trout at SF-16. Section 4.2.1 notes a 6.5 in. brook trout collected in Chippewa Creek at SF-18. Table 1 (AEM 2016) provides a summary of the number of individuals of each fish species collected in Chippewa Creek (excluding SF-18) from 2003 to 2015; but no value is reported for brook trout which makes it appear that brook trout have not been present in Chippewa Creek since 2003. Similarly, there is no mention of brook trout in the fish community description suggesting that brook trout have not been present previously which directly contradicts statements provided in earlier reports.

A significantly large number of brook trout were collected in Posted Creek (27) during 2003, but no data are provided for this sample location in the 2016 report. The average size of brook trout collected in Posted Creek in 2003 was 101 mm (approximately 4 in.) indicating that this stream segment supports juvenile brook trout and is an important nursery area for this species.

Brown trout were reported to be most abundant at SF-18 and Posted Creek locations whereas a smaller population was reported at SF-16 (KME 2006). When considering brown trout populations at just SF-16, the data show that the annual abundance of brown trout at this location is, on average, lower than during 2003. The data provided due to requests for additional information clearly indicates that brown trout have decreased in abundance (Fig. F2).

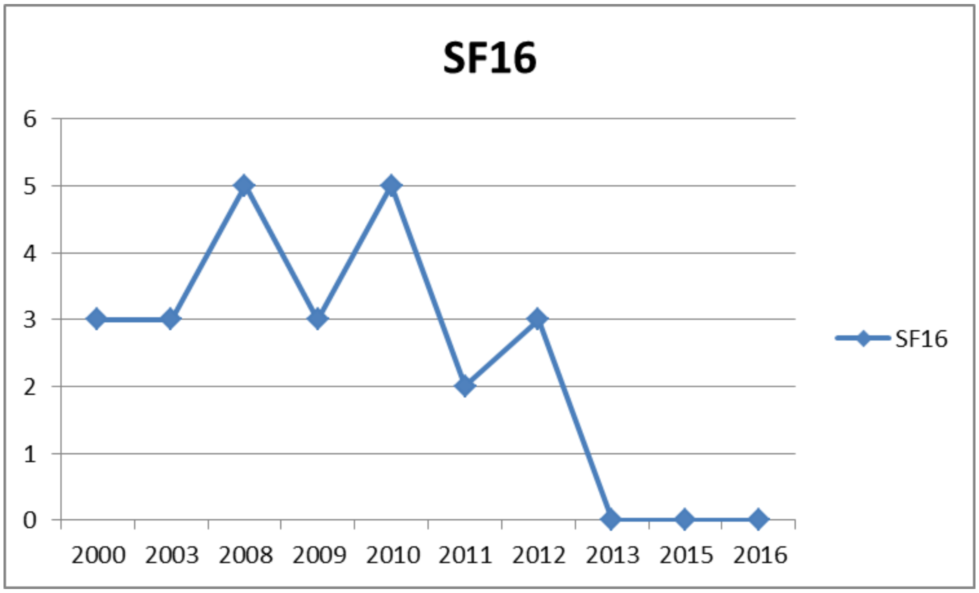


Figure F2. Abundance of brown trout at SF16 between 2000 and 2016.

A size-frequency distribution figure was included in the 2006 report but not in the 2016 report. The 2006 report concluded that the majority of brown trout collected in Chippewa Creek were juvenile fish (as was the case for brook trout collected in Posted Creek), and thus, these stream sections appear to serve as nursery habitat for trout populations. The portion of a fish life cycle that is most ignored is the period that includes spawning and juvenile development. There is no other time that a fish is more vulnerable, yet, because we typically do not observe fish during this period, the importance of this phase of the fish cycle has not been acknowledged. The loss of refuge and nursery habitat currently provided in various streams segments under current or previously existing conditions will have a substantial negative impact on fish reproduction and survival.

3. Invertebrate Communities.
The invertebrate community serves as an important food resource for fish in aquatic ecosystems. They also link aquatic and terrestrial habitats, with aquatic insects supplementing the terrestrial food web. Invertebrate data appears to be a sum of all collections between 2003 and 2015; consequently it is not possible to determine if changes have occurred over the study period. However, there are some clear differences in the data reported in 2006 and that reported in 2016. In 2003 (reported in 2006 report), three Trichoptera, including Brachycentrus, Glossosoma, and Lepidostomatidae were reported from sites in Chippewa Creek, however, these three groups are now absent from the Chippewa Creek sites.

Based on data obtained through requests for additional information, it is clear that changes have occurred between 2003 and subsequent sample dates. Taxonomic groups that accounted for approximately 50% of the community in 2003 generally accounted for <10% after 2011. Mayflies increased in percent abundance from 2012 to 2016 due to a single taxon (Fig. F3).

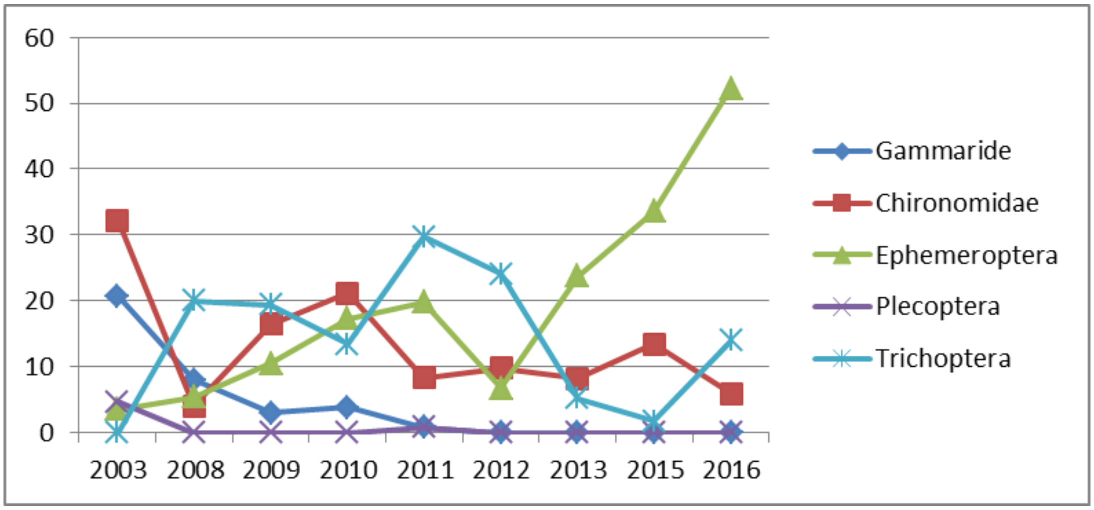


Figure F3. Relative abundance for dominant macroinvertebrate taxa collected at SF16.

Finally, the methods used to survey for mussel populations are not sufficient to detect exiting mussel populations.

4. Stream Habitat

General observations show that Chippewa Creek sediments are generally composed of sand and organic material, with some woody debris (Figs. 2 and 3). This condition was noted in the KME (2006) report. Although there is a focus on flow and temperature as it relates to fish and invertebrate communities, habitat is a critical component that supports aquatic communities. Steam sediments, particularly gravel of various sizes, provide crucial habitat for algae, insects, and fish. For algae and insects, gravel provides a solid point of attachment for growth and development. For fish, gravel is the primary substrate used for spawning. Given the apparent limited quantities of gravel available within Chippewa Creek, any drop in water level that exposes submerged gravel substrate or reduces water depth over gravel would reduce invertebrate production and decrease fish spawning. In addition, changes in groundwater flow that alters zones of discharge into the stream channel will impact fish spawning.

Assuming that it is appropriate to apply the proposed -0.01 ft. decrease in water depth calculated from index site flow to all sections of Chippewa Creek, there are still projected impacts. Based on this assumption, the impacts to Chippewa Creek are projected to be a reduction in channel width but increased water depth. First, this projection ignores the proposed drop in the water table below some segments of Chippewa Creek. Second, the projected increase in depth at other sites assumes that the stream flows occurring during pumping will be adequate to down-cut through the existing stream channel. However, there is no evidence provided to support this claim.

D. Twin Creek:

1. Physical Conditions.
This stream segment is identified as a water trout stream and includes monitoring locations SF-1, SF-2, SF-11, SF-9, SF-10 and SF-13 (Fig 3.8). However, additional sites are identified in other figures and a number of sites are identified in the 2006 report that have been excluded in the 2016 report. Data for weirs 2, 3, 4, and 6 were included, but individual data sets vary in length.

Flow data for only two monitoring weirs (weir 2 and 4) extends past 2010 and only one (weir 4) extends past 2014. Since 2010, it appears that flow at weir 2 and weir 4 regularly falls below the annual median flow. There are no data indicating August median flow.

Temperature and water depth data suffer from the same issues as noted for Chippewa Creek. All reported values are an average of the entire data set. Thus, it is not possible to determine if changes have occurred since 2008 (AEM 2016). It is notable that the average depth at the upstream locations is between 0.3 and 0.5 ft. The depth at SF-9 is greatest, averaging 1.0 ft. A section of East Branch Twin Creek falls between the 0.5 ft and 1.0 ft. cone of depression. Given that most of the East Branch Twin Creek averages 0.3 ft. deep, the drop in water table will, or is very likely to cause significant diminishment. In addition, the White Pine Springs are near the 1.0 ft cone of depression. This group of springs accounts for approximately 40% of the flow at SF-6, a site that averages 0.3 ft. The 2016 report indicates that flow from this group of springs is relatively consistent but acknowledges that there is variation related to long-term climatic factors. Flow from this spring complex also fluctuates due to stochastic factors, including migration of seeps.

While the temperature data is more complete for SF-1, SF-6, and SF-9 than for other sites, the data provided only extends back to January 2013. Averaging temperatures across years reduces resolution and eliminates the opportunity to compare across years. This is particularly concerning at SF-1 and SF-9 where maximum temperatures in July and August exceed 24 ^oC. In addition, looking at the different tables with temperature data indicates there are some inconsistencies and the proposed level of impact by the applicant may be influenced by those inconsistencies. Further, comparing data from 2013-2015 to data from August 2003 and 2004 suggests that maximum temperatures may have already increased at SF-1, SF-5, SF-9, and SF-16. In 2003 temperatures at SF-1 (Average = 18.3 ^oC), SF-9 (Average = 17.1 ^oC) did not exceed 20 ^oC. In 2004, temperatures at SF-9 appear to just exceed 20 ^oC. Data from July and August 2013 through 2015 shows that temperatures at SF-1 and SF-9 reached maximums over 24 ^oC (AEM 2016; SSPA 2016). During August 2003, temperatures at SF-5 averaged 11.2 ^oC. Similarly, during the 2013 to the 2015 period, data for SF-5-5-6 show that maximum temperatures exceeded 17 ^oC.

Temperatures recorded at SF-6 during 2013 through 2015 show that temperatures now regularly approach and exceed 15 ^oC. However, the area associated with seeps 1-4

(White Cedar Springs) still provides the most constant supply of cold water to the Twin Creek system between SF-1 and SF-9. Consequently, this hydrologic feature becomes the major thermal refuge for trout within this section of the Twin Creek system. Reducing flow and the water table within this region will cause a significant diminishment of the resource, particularly cold water fish species.

2. Fish Communities.
A total of 9 fish species were identified from surveys conducted on Twin Creek. This is a decrease from 14 species reported in surveys conducted in 2000, 2003, and 2004. However, because fish community data is presented as a composite of surveys from 2003 to 2015, it is impossible to determine when these changes in the community have occurred. In addition, there appears to be several inconsistencies in the data provided in as part of NWNA applications. For example, comparing the data provided in the 2016 report to data provided in the 2006 report leads to numerous questions about how the data have been tabulated.

Yearly fish survey data provided following a request for additional information indicates that brown trout abundances have sharply declined since 2003 (Fig. F4).

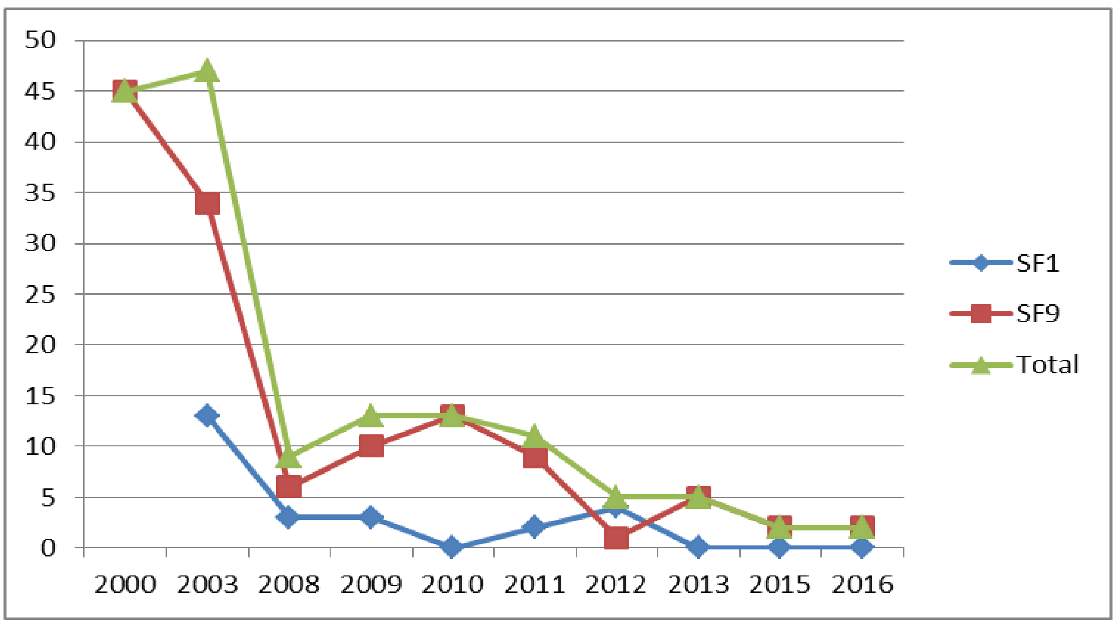


Figure F4. Brown trout abundances at SF1 and SF9 during 2000 to 2016.

There are similar questions regarding how the data for brook trout have been tabulated. It appears that there are several inconsistencies in this data set as well.

Brook trout abundances appear to fluctuate in the main stem of Twin Creek. Abundance peaked at 6 in 2008 and 2009, decreased to 2 in 2011, increased to 6 again in 2013, and has remained at 3 for the past two years. Brook trout were rarely found at SF1.

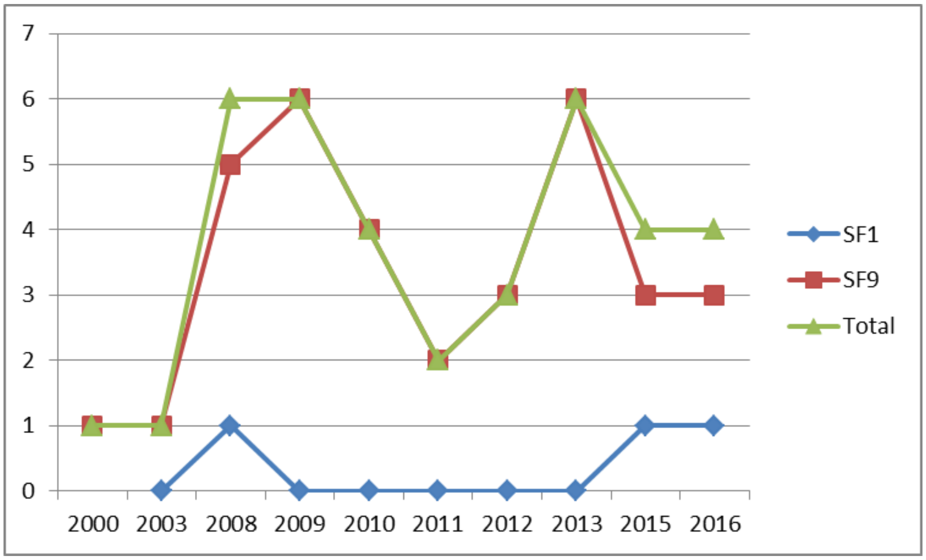


Figure F5. Abundance of brook trout at SF1 and SF9 between 2000 and 2016.

In comparison, brook trout abundances reached maximum density at SF5 and SF5-6 during 2003 and 2011, and minimum densities in 2009, 2013, and 2015 (Fig. F6). The 2006 report noted that brook trout were generally most abundant in headwater sections and these populations were dominated by juveniles. Thus, the presence of seeps positively influences brook trout. In addition, there was a significant brook trout population present at SF-11 (KME 2006).

However, comparing among years indicates that brook trout abundances tend to fluctuate between SF5 and SF5-6, and SF9, with different stream segments being alternately important. This suggests that stream segments associated with seeps and springs and main stem segments are both import for brook trout populations.

Similarly, most of the brown trout collected during surveys of Twin Creek sites were juveniles, but the presence of seeps and springs was less important. A substantial brown trout population was also present at SF-11 in 2000 and 2003. The lack of data for SF-11 in the 2016 report is obvious. None the less, these headwater stream segments are critical to sustaining viable brook trout populations and for supporting brown trout populations.

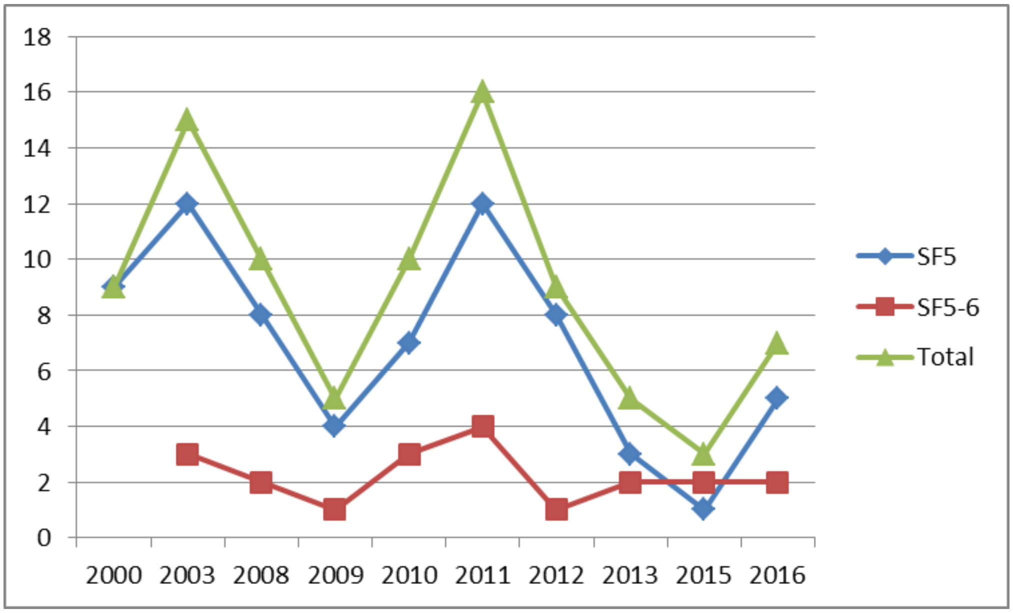


Figure F6. Abundance of brook trout at SF5 and SF5-6 between 2000 and 2016.

It is my opinion, based on the information available in the 2016 report and data provided following the request for additional information, changes in the Twin Creek fish community have occurred since 2003. This change is likely due in part as a result of the pumping. This includes a reduction in the number of fish species present in Twin Creek and it likely includes reductions in the abundance of important species. It is my further opinion that increased pumping will cause additional diminishment of the fish community in Twin Creek, specifically, the reduction of juvenile trout, and generally, the natural resource in total.

3. Invertebrate Communities.

As with Chippewa Creek, invertebrate data appears to be a sum of all collections between 2003 and 2015; consequently it is not possible to determine if changes have occurred over the study period. However, there are some clear differences in the data reported in 2006 and that reported in 2016. In 2003 (reported in 2006 report), at least two Trichoptera were reported from sites in Twin Creek that are now absent at the Twin Creek sites resulting in a loss of biodiversity.

Data received following requests for additional information clearly show that macroinvertebrate communities have changed between 2003 and 2016. The most obvious change is the large increase in the relative abundance of Gammaridae at both SF1 and SF9 (Fig. F7, Fig. F8).

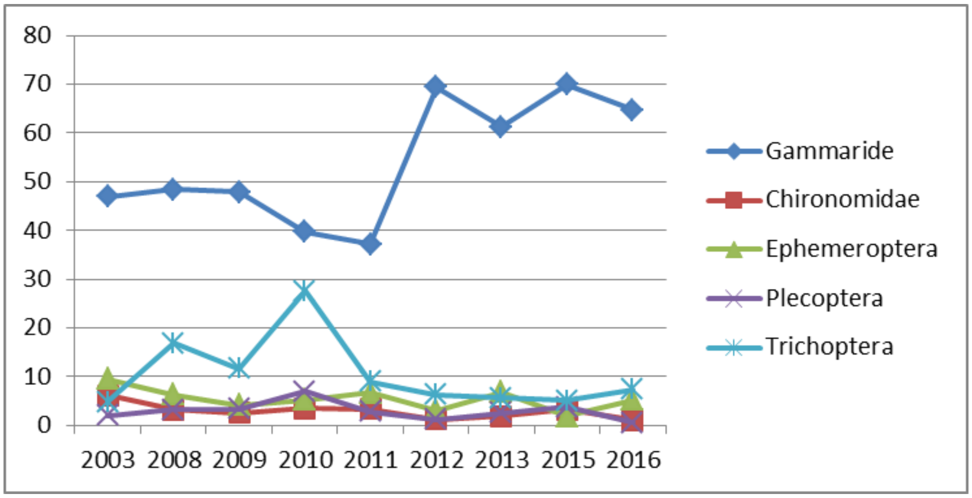


Figure F7. Relative abundance of important macroinvertebrate groups collected at SF1 between 2003 and 2016.

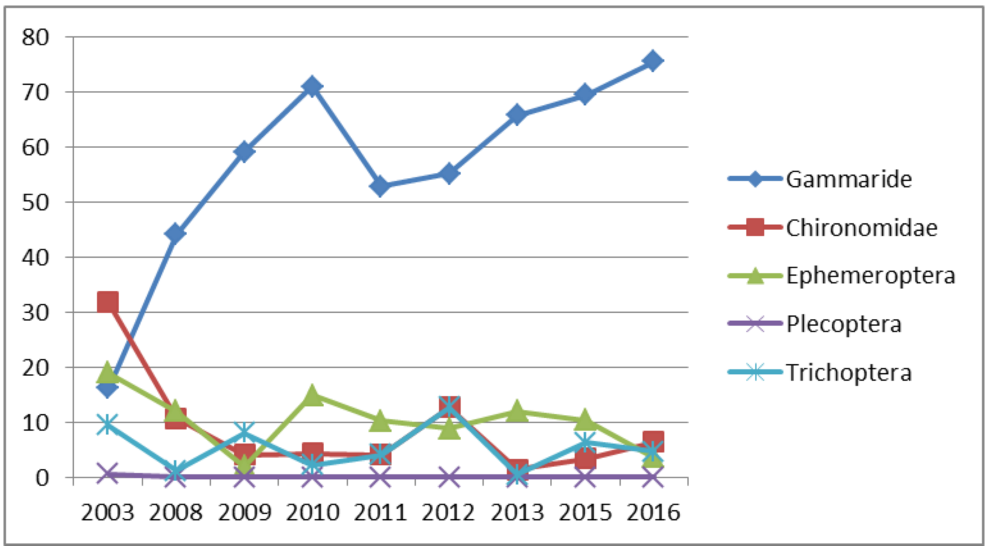


Figure F8. Relative abundance of important macroinvertebrate groups collected at SF9 between 2003 and 2016.

Similarly, changes have occurred at sample sites at upstream sites. Substantial change is evident at both SF5 and SF5-6 (Fig. F9, Fig. F10). At SF5, Gammaridae becomes the dominant taxa nearly doubling in relative abundance between 2003 and 2016. Changes at SF5-6 are much more variable than at SF5. Clearly, the dominant group in 2003 (Chironomidae) declines and various groups become more or less important during subsequent years.

Finally, the methods employed to evaluate mollusk populations are inadequate because kick-net sampling for this group of organisms is not an accepted methodology.

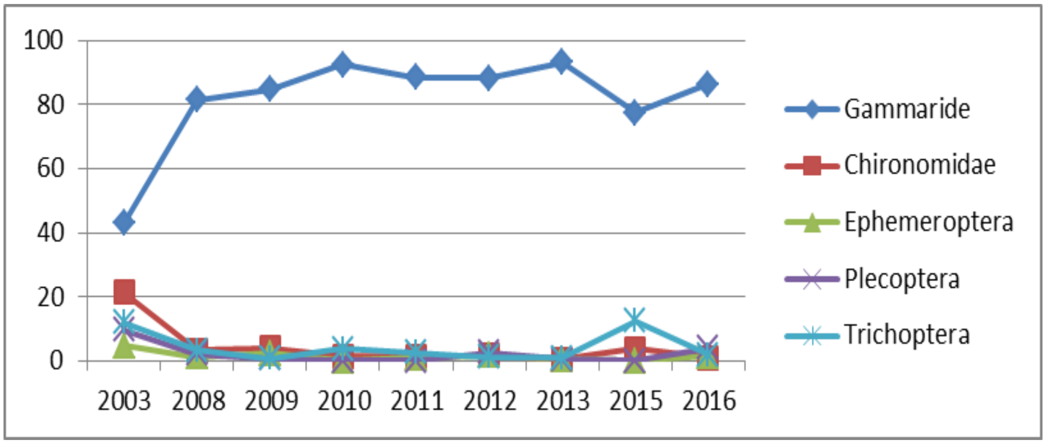


Figure F9. Relative abundance of important macroinvertebrate groups collected at SF5 between 2003 and 2016.

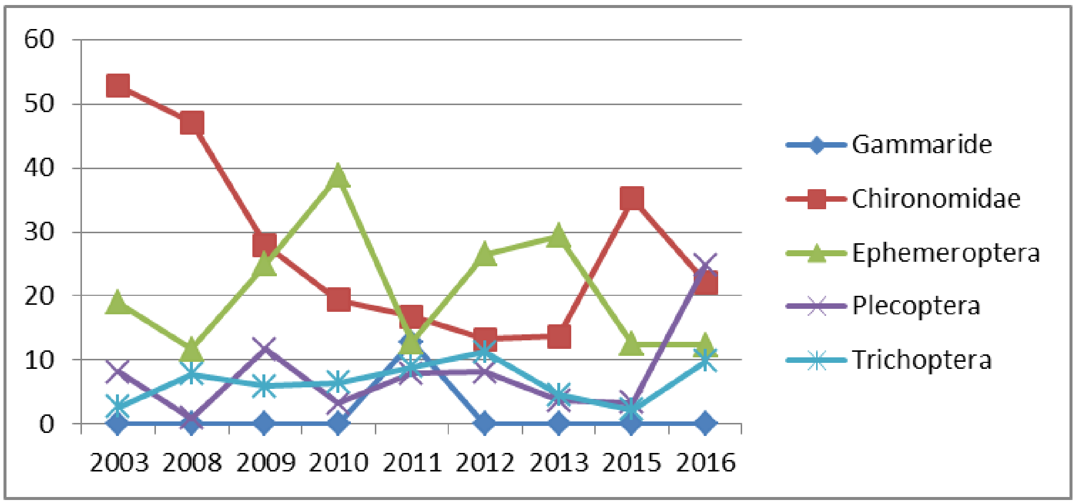


Figure F10. Relative abundance of important macroinvertebrate groups collected at SF5-6 between 2003 and 2016.

4. Stream Habitat

As is the case for Chippewa Creek, general observations show that Twin Creek sediments are generally composed of sand and organic material, with some woody debris (Figs. 4, 6, 9) as was noted in previous reports (KME 2006). As noted above, gravel of various sizes provide crucial habitat for algae, insects, and fish. Gravel provides a solid point of attachment for growth and development of algae and insects and is the primary substrate used by fish for spawning. Any drop in water level in Twin Creek that exposes submerged gravel substrate or reduces water depth over gravel would reduce invertebrate production and decrease fish spawning. In addition, changes in groundwater flow that alters zones of discharge into the stream channel will impact fish spawning.

Even assuming the accuracy of the proposed -0.01 ft. change in water depth calculated from index site flow, applying this estimated change to all sections of Twin Creek appears based on the assumption that the impacts due to reduced flow will be equally distributed across the system. Based on this assumption, the impacts to Twin Creek are projected to be a reduction in channel width but increased water depth. As noted for Chippewa Creek, this projection ignores the proposed drop in the water table below some segments of Twin Creek. This is important in Twin Creek given that large sections of Twin Creek are within the projected cone of depression. Second, the projected increase in depth at other sites assumes that the stream flows occurring during pumping will be adequate to down-cut through the existing stream channel. However, there is no evidence provided to support this claim.

E. Seeps:

Seeps and springs provide a unique set of ecological conditions which support a similarly unique biological community. However, there is no delineation of seep/spring plant communities provided in the report. Indeed, it appears that there was no attempt to determine actual plant community composition for this report given the fact that surveys were conducted in April; photos included in the report confirm that surveys were conducted before the flora had emerged (ECT 2016). It is unclear if this is the case for surveys conducted in previous years which are noted in this report. The 2006 report similarly lacks any indication that community composition was determined at that time as well. The 2016 report does refer to vegetation data collected during 2004, but that data is not included in the 2016 report.

Pumping has caused, or will very likely cause a decrease in flow from the springs/seeps in the vicinity of PW-101. This fact has been established by a pump test conducted at the site as early in 2001 (SSPA 2016). The empirical data indicates that changes in the flow from seeps and vents were “significant” based on direct measurements. The reduction in flow due to pumping will clearly impact the unique plant community, associated with the seeps/springs/vents that are associated with the aquifer, particularly at higher elevations. Pumping will drop the water table, resulting in a permanent decrease in water levels that eventually will cause groundwater flow to move down-slope, i.e., groundwater discharge will occur at a lower elevation, causing the adjacent wetland to migrate. Loss of flow thru the soils and associated biological communities will significantly shift and impair these unique communities. The report also concludes that a lower water table will cause plant communities to shift locations and may potentially be replaced by other more common communities and/or invasive species. Other groups of organisms that need to be considered are insects and other animals, such as *Neohermes concolor*, *Stenelmis douglasensis*, *Somatochlora hineana*, and *Sistrurus catenatus*, among others, which are known to be associated with these types or habitats; these other organisms are not mentioned in the Golder (2016), ECT (2016), or AEM (2016) reports.

F. Wetland Habitats:

Decreased water levels will also influence and impair adjacent wetland communities in two ways. First, every reference on wetland ecology highlights the importance of water level fluctuations with community structure. Indeed these communities are often dependent on the natural cycle of water level change among seasons. However, reducing water levels with increased pumping will lower the minimum and maximum water levels realized during annual cycles, and ultimately impair the wetland communities. Even short-term shifts in water levels have or will significantly impact these communities. At low water levels, plant communities are altered, exposed sediments release nutrients, and peat that has been accumulating over a long period is exposed to oxygen and begins to decompose. It is the combination of flow and peat accumulation that in part, helps maintain the existing plant community.

Only 16 wetlands, a small fraction of the total number that are within the area impacted by the cone of depression, were evaluated for this proposal. Of the 16 evaluated, 8 (half) were concluded to be connected to the spring aquifer. There is no reference to the remaining wetlands. Of the 8 that are identified as being connected to the aquifer, monitoring has been inconsistent as indicated in Golder (2016), for example: Wetland A - monitored since 2001; Wetland CC – unclear; Wetland FF- has not been monitored; Wetland OO and PP – have not been monitored; Wetland G – monitored since 2001; Wetland H – apparently has been monitored indirectly via well MW-4U; Wetland R, a 150 acre system – data collection has focused on a small area.

ECT (2016) provides a general discussion of the conditions within each wetland unit, noting general hydrologic conditions and select species. Although the report does note that changes may occur within a number of wetlands due to changes in the water table, the report dismisses most of the potential impacts. This is particularly true with regard to invasive species. For example, ECT (2016) makes no mention of an invasive cattail in the area, but populations of this cattail are apparent in some ECT photos, I have confirmed the wide-spread occurrence of this plant throughout the area (Fig. 11).

The information provided in regard to endangered species was limited to species noted to occur in Osceola Co. by MNFI. The available reports (ECT 2016 dismisses any potential impact to Vasey's Rush on the premise that wetland changes due to pumping will be minimal and appropriate habitat is not present in the areas that are perceived to be impacted by pumping and GW draw-down. However, no species-specific searches were conducted (Golder 2016), so the actual extent of the species is unknown. Similarly, other E&T species may be present but have not been reported to MNFI. Thus, drawing any conclusion of no or limited impact on E&T plants species without a complete floral assessment is premature and unreasonable.

The report (2016) suggests that reduced water levels in some wetlands may be a benefit to Northern long-eared bats due to growth of trees in areas that had previously been too wet. However, U.S. Fish and Wildlife notes that summer roosting habitat is not a limitation for Northern long-eared bats, so the assumed addition of trees in the region will have no benefit for this species. However, the loss of stream and wetland habitat may impact Northern long-eared bats due to a decrease in available aquatic insects, particularly caddisflies, which are known to be an important component of this species diet.

The potential impacts on other groups of T&E organisms have also been given very limited, thus insufficient consideration. For example, there are no data detailing amphibian or reptile populations. Clearly, decreased water levels in wetlands due to pumping will reduce critical habitat required for amphibians and reptiles that use these habitat types.

G. Threatened and Endangered Species:

Based on the information provided, there is a clear indication that there has been relatively little effort made to locate and identify threatened and endangered species. Specifically, amphibians and reptiles, wetland plants, mussels, and organisms associated with seep habitats. Consequently, there is no basis to determine if impacts will occur due to an increase in pumping.

H. Conclusion:

Based on the information, data, and circumstances, I have reviewed to date, and my expertise in limnology, aquatic ecology, stream ecology, wetland systems and aquatic resources, it is my opinion that Twin Creek and Chippewa Creek, and the adjacent seeps and wetlands have been and will, or are likely to be impaired if pumping continues. The aquatic communities clearly respond to and are impacted by reductions in water flow and depth due to pumping and some changes in fish and invertebrate communities have occurred since 2006 (Malcolm Pirnie 2006, Golder 2016). The proposal to increase pumping will have a significant negative impact on these aquatic communities, including brook trout and other fish populations, limiting fish migratory movements, and diminishing their overall contribution to the fishery in the associated stream segments. These changes will occur because reduced water flow and depths will alter and impair critical habitat elements (e.g., migratory pathways), community composition, physical-chemical components, and also creates a harsher environment due to artificially reduced water levels (Figs. 5, 7, 8, 10). The data are currently insufficient to draw informed conclusions about impacts to threatened and endangered species.

In addition, a recent analysis of impacts (Hyndman) on stream flow, the projected cone of depression, and the predictions of impacts provided by NWNA concluded that those predictions do not accurately reflect actual conditions. Furthermore, the impacts to stream flows and the cone of depression may be more extreme than reported by NWNA. Consequently, the impacts to the biological communities, particularly representative fish populations, the invertebrate communities, and wetland and seep communities will be more sever and will result is a much greater diminishment of the resource.

Figure 1. General area around PW-101.

Figure 2. Chippewa Creek at 90^{th,} illustrating sand and organic sediments. Photo taken Feb 19, 2017 during snow-melt due to warm weather. (M. Luttenton)

Figure 3. Chippewa Creek at 95th (SF-16), illustrating heavily embedded sediments. Photo taken Feb 19, 2017 during snow-melt due to warm weather. (M. Luttenton)

Figure 4. Twin Creek at 100th (SF-10), illustrating embedded gravel. Photo taken Feb 19, 2017 during snow-melt due to warm weather. (M. Luttenton)

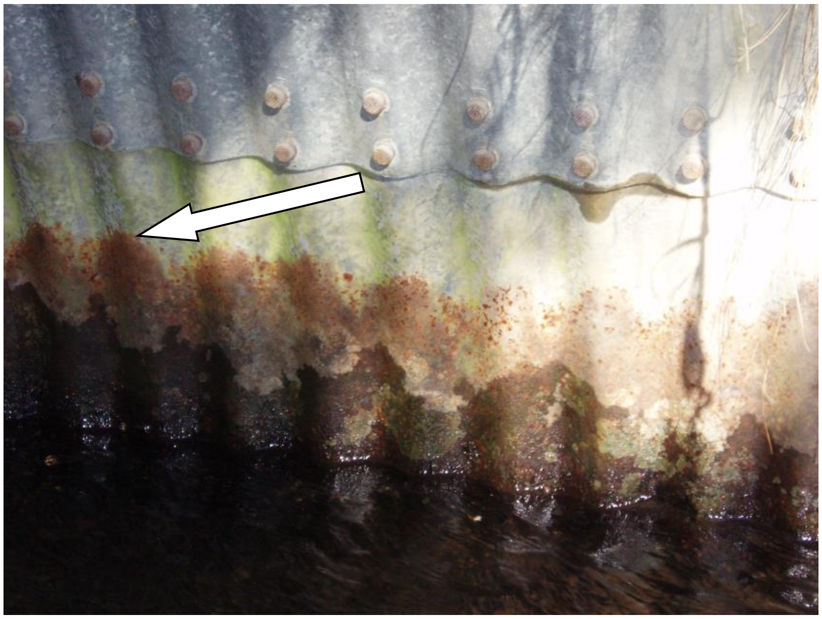


Figure 5. Twin Creek at 100th (SF-10), showing previous high water mark. Photo taken Feb 19, 2017 during snow-melt due to warm weather. (M. Luttenton).

Figure 6. E. Twin Creek at Nine Mile Road, illustrating organic sediments. Photo taken Feb 19, 2017 during snow-melt due to warm weather. (M. Luttenton)

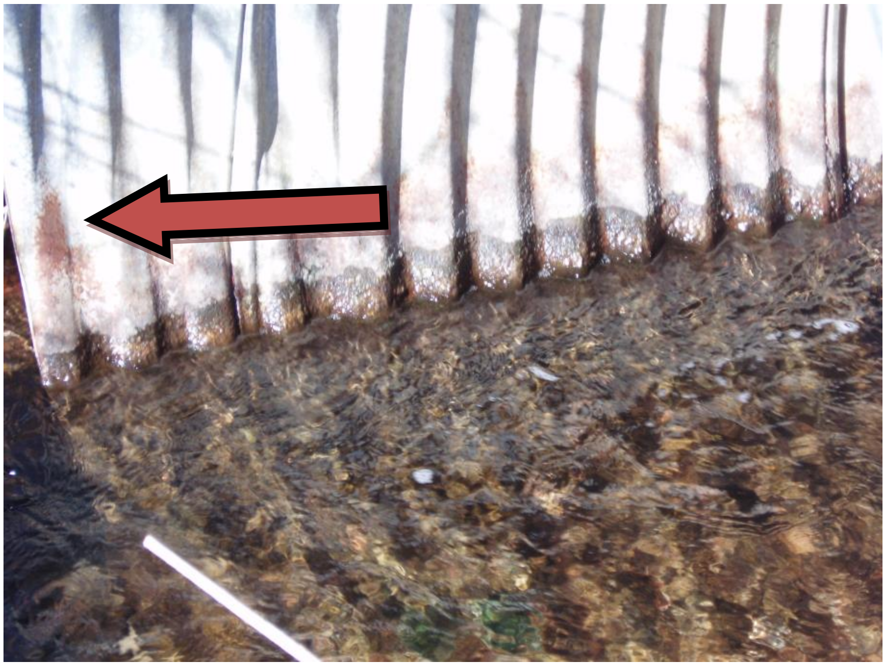


Figure 7. Downstream end of culvert on E. Twin Creek at Nine Mile Road, showing previous high water marks. Photo taken on Feb. 19, 2017 during snow-melt due to warm weather. (M. Luttenton)

Figure 8. Downstream end of culvert on Twin Creek at 110th, showing previous high water mark. Photo taken Feb 19, 2017 during snow-melt due to warm weather. (M. Luttenton)

Figure 9. Downstream end of culvert on Twin Creek at 8 Mile Road, showing sand and embedded gravel sediments. Photo taken Feb 19, 2017 during snow-melt due to warm weather. (M. Luttenton)

Figure 10. Downstream end of culvert on Twin Creek at 8 Mile Road, showing previous high water mark. Photo taken Feb 19, 2017 during snow-melt due to warm weather. (M. Luttenton)

Figure 11. Flower heads of Narrow Leaf Cattail at Decker Pond. Photo taken Feb 19, 2017 during snow-melt due to warm weather. (M. Luttenton)

I reserve the right to revise this report as additional information is made available. My Curriculum Vitae is attached below (pp. 25-43).

Mark R. Luttenton, Ph.D.

Curriculum Vitae

CURRICULUM VITAE
Mark R. Luttenton, Ph.D.

email: luttentm@gvsu.edu

The Graduate School
Department of Biology and
Annis Water Resources Institute
Grand Valley State University
Allendale, Michigan 49401

phone: 616-331-7105

I. EDUCATION:

Ph.D. Bowling Green State University, 1989
Emphasis: Aquatic Ecology

M.S. University of Wisconsin - La Crosse, 1982
Emphasis: Aquatic Biology

B.S. Central Michigan University, 1977
Major: Biology
Minor: Chemistry

II. RESEARCH INTERESTS:

Algal Community Ecology	Trophic Interactions	Great Lakes Fungal Diversity
Invasive Species	Stream Ecology	Aquatic Plant Communities
Whirling Disease	Avian Schistosomiasis	Wetland Ecology

III. PROFESSIONAL APPOINTMENTS:

1. Academic Appointments and Teaching:

Associate Dean of the Graduate School, Winter 2016 ;
Grand Valley State University, Allendale, MI

Interim Director, Annis Water Resources Institute, Fall 2011;
Grand Valley State University, Allendale, MI

Professor of Biology, 2006 - present;
Grand Valley State University, Allendale, MI.

Acting Department Chair, Winter 2005;
Biology Department, Grand Valley State University, Allendale, MI.

External Examiner, 2003 – 2004;
University of the West Indies, St. Augustine, Trinidad.

Graduate Program Coordinator, 2002 – 2016;
Biology Department, Grand Valley State University, Allendale, MI.

Associate Research Scientist, 2000 - present;
Water Resources Institute, Grand Valley State University, Allendale, Michigan.

Adjunct Graduate Faculty, 1998 - 2001;
Iowa State University, Ames, Iowa.

Research Fellow, 1996 - 2000;
Cooperative Institute for Limnology and Ecosystem Research
University of Michigan, Ann Arbor, Michigan.

Visiting Research Scientist, 1996 - 1998;
National Oceanographic and Atmospheric Administration,
Great Lakes Environmental Research Laboratory Ann Arbor, Michigan.

Associate Professor of Biology, 1995 - 2006;
Grand Valley State University, Allendale, Michigan.

Faculty, Latin American Studies, 1993 - present;
Grand Valley State University, Allendale, Michigan.

Senior Faculty, Summer 1993;
School for Field Studies, Beverly, Massachusetts.

Adjunct Graduate Faculty, 1993 - 1999;
Central Michigan University, Mt. Pleasant, Michigan.

Research Associate, 1990 - 1994;
Water Resources Institute, Grand Valley State University, Allendale, Michigan.

Assistant Professor of Biology, 1989 - 1995;
Grand Valley State University, Allendale, Michigan.

Instructor, Winter 1989;
Department of Natural Science, Findlay College, Findlay, Ohio.

Lecturer, Winter 1988;
Biology Department, East Carolina University, Greenville, North Carolina.

2. <u>Summer Field Teaching Positions</u>:

Freshwater Biology, Summer 2007;
Hancock Biological Station
Murray State University, Murray KY

Tropical Conservation Biology, 1992 - 1996;
Course taught in Belize, Central America.
Grand Valley State University, Allendale, MI.

Ecology of Tropical Rivers, Summer 1993;
Course taught in Belize, Central America.
School for Field Studies, Beverly, MA.

3. Recent Courses Taught:

Stream Ecology	Limnology	Freshwater Algae
Fisheries Biology	Wetland Ecology	Introductory Biology II
Aquatic Invertebrates	Environmental Science	

IV. RESEARCH FUNDING (since 1989):

2015:
Luttenton, M. (PI)
Title: Fine Scale Regulation and Bioenergetics of Brook Trout in Cedar Creek, Kent, Co., MI.
Funding Agencies: National Trout Unlimited, Schrems West Michigan Trout Unlimited, GVSU.
Amount:$52,298, Funded (4/15-8/16)

2013:
Cichewcz, R. (Principal), M. Luttenton, (Co-PI), S. Mooberry, (Co-PI), L. Du (Co-PI), A. Risinger (Co-PI), A. Miller(Co-PI).
Title: Sourcing Bioactive Secondary Metabolites from Great Lakes Fungi.
Funding Agency: National Institute of Health
Amount: $2,729,657, Funded (6/2014 – 12/2018)

Luttenton, M. (PI)
Title: Response of Brook Trout to Habitat Restoration in the Au Sable River.
Funding Agencies: Anglers of the Au Sable, Mason-Griffith Chapter of Trout Unlimited, Headwaters Chapter of Trout Unlimited, Patagonia Foundation
Amount: $25,869, Funded (9/2013 – 7/15)

2012:
Luttenton, M. (PI)
Title: Muskegon River Juvenile Steelhead Survival and Production – Supplemental Funding
Funding Agency: Michigan Department of Natural Resources - Fisheries Div.
Amount: $25,346, Funded (5/12-6/15)

Luttenton, M. (PI)
Title: Au Sable River Brown Trout Habitat use and Movement.
Funding Agency: Michigan Department of Natural Resources – Fisheries Div.
Amount: $45,580, Funded (5/13 - 9/14)

Luttenton, M. (PI)
Title: Au Sable River Brown Trout Habitat use and Movement.
Funding Agency: Anglers of the Au Sable
Amount: $50,172, Funded (5/12 – 5/13)

Luttenton, M. (PI)
Title: Au Sable River Brown Trout Habitat use and Movement.
Funding Agency: Mason-Griffith Chapter of Trout Unlimited
Amount: $3250, Funded (5/12 – 12/14)

Luttenton, M. (PI)
Title: Au Sable River Brown Trout Habitat use and Movement.

Funding Agency: Headwaters Chapter of Trout Unlimited
Amount: $3250, Funded (5/12 – 12/14)

2010:
Luttenton, M. (PI)
Title: Muskegon River Juvenile Steelhead Survival and Production.
Funding Agency: Michigan Department of Natural Resources and Environment, Fisheries Div.
Amount: $127,000, Funded (3/11 – 1/15)

2007:
Luttenton, M. (PI)
Title: Survival of Brown Trout Strains Across a North-South Gradient in Lake Michigan: Application of Molecular Methods in Fisheries Management.
Funding Agency: Research and Development Office, Grand Valley State University
Amount: $2,900.00, Funded

Luttenton, M. (PI)
Title: Population dynamics of *Corbicula* near the Eckert Power Station.
Funding Agency: Lansing Board of Water and Light
Amount: $1,200.00, Funded

2006:
Luttenton, M. (PI)
Title: Muskegon Lake Aquatic Plant Community Assessment.
Funding Agency: Timberland RCD
Amount: $7,758.00, Funded

2004:
Luttenton, M. (PI), A. Steinman and R. Rediske (Co-PIs)
Title: Water Quality Monitoring of White Lake.
Funding Agency: Michigan Department of Environmental Quality
Amount: $53,340.00, Funded

2002:
Uzarski, D. (Co-PI), M. Luttenton (Co-PI).
Title: Distribution and Abundance of Unionid Clams in the White River System.
Funding Agency: US Forest Service
Amount: $8000.00, Funded

Luttenton, M. (PI)
Title: Restoration of Aquatic Plant Communities in Muskegon Lake.
Funding Agency: Muskegon County NRCS
Amount: $9000.00, Funded

Nikitin, A., M. Luttenton (Co-Investigators)
Title: Genetic Structure of Brown Trout Populations in the Rogue River.
Funding Agency: GVSU Research and Development Office
Amount $3000.00, Funded

Luttenton, M. (PI)
Title: Algae as Indicators of Land Use in Three Watersheds in Trinidad
Funding Agency: Annis Water Resources Institute Grant
Amount: $2500.00, Funded

2000:
Luttenton, M. (PI)
Title: Distribution and Abundance of Zebra Mussels in the Muskegon River and their relationship to the Croton Dam impoundment.
Funding Agency: Grand Valley State University, Research Grant-in-Aid
Amount: $3000.00, Funded

Luttenton, M. (PI)
Title: Muskegon River Invertebrate Communities and the Potential Effects of Zebra Mussels on Invertebrates below Croton Dam.
Funding Agency: R. B. Annis Water Resources Institute, Grand Valley State University
Amount: $4960.00, Funded

1995:
Luttenton, M. (PI)
Title: Distribution and Abundance of Aquatic Macrophytes in Muskegon Lake and White Lake.
Funding Agency: Muskegon County Soil Conservation District
Amount: $7620.00

Luttenton, M. (PI)
Title: Citizens Outreach Project - Supplemental Funding.
Funding Agency: North American Lake Management Society, funding provided by EPA
Amount: $8000.00, Funded
(Proposal Author and Project Coordinator, funds awarded to NALMS, Michigan Chapter)

1994:
Luttenton, M. (PI)
Title: Citizens Outreach Project.
Funding Agency: North American Lake Management Society, with funding provided by the EPA
Amount: $26,000.00, Funded
(Project Coordinator, funds awarded to NALMS, Michigan Chapter)

Luttenton, M. (PI)
Title: Bear Creek Restoration Project. (Funding Renewal)
Funding Agency: Environmental Protection Agency
Amount: $25,000.00, Funded

1993:
Luttenton, M. (PI)
Title: Bear Creek Restoration Project.
Funding Agency: Environmental Protection Agency
Amount: $28,000.00, Funded

1992:
Luttenton, M. (PI)
Title: Project to Improve Education in Aquatic Sciences.

Funding Agency: National Science Foundation, ILI Program
Amount: $28,000.00, Funded

<u>1991</u>:
Luttenton, M. (PI)
Title: Dietary Analysis of Lake Michigan Yellow Perch.
Funding Agency: University of Michigan, R/V Laurentian Fund for Research
Amount: $9,000.00, Funded

Luttenton, M., D. Lodge (Co-PIs)
Title: Structuring Forces in the Littoral Zone of North Temperate Lakes. (Funding Renewal)
Funding Agency: National Science Foundation, ROA Program
Amount: $14,482.00, Funded

Luttenton, M. (PI)
Title: Genetic Structure of the Pere Marquette River Run Chinook Population.
Funding Agency: Ludington Charter Boat Association
Amount: $3,000.00, Funded

<u>1990</u>:
Luttenton, M., D. Lodge (Co-PIs)
Structuring Forces in the Littoral Zone of North Temperate Lakes. (Co-PI, Dr. David Lodge)
Funding Agency: National Science Foundation, ROA Program
Amount: $25,000.00, Funded

<u>1989</u>:
Luttenton, M. (PI)
Genetic Structure of Lake Michigan Chinook Salmon Populations.
Funding Agency: Research and Development Center, Grand Valley State University
Amount: $6,000.00, Funded

V. <u>SOCIETY MEMBERSHIPS</u>:

International Association of Great Lakes Research
International Society for Diatom Research
Society for Freshwater Science
American Fisheries Society

VI. <u>SOCIETY SERVICE AND COMMITTEES</u>:

2015 –Present: Executive Director Review Committee.
2012 – 2015: Publication Committee, Society for Freshwater Science.
2012 – 2015: Finance Committee, Society for Freshwater Science.
2012 – 2015: Long Range Planning Committee, Chair, Society for Freshwater Science.
2011 – 2012: Long Range Planning Committee, Society for Freshwater Science.
2010 – Present: Salmonid Technical Committee, North Central Division of the American Fisheries Society.
2008 – 2009: Local Arrangements Committee Chair, North American Benthological Society Annual Conference, Grand Rapids, MI, May 2009.
2005 – Present: American Fisheries Society - Michigan Chapter, Rivers and Streams Advisory Committee.

2000 – 2001: Annual Conference Program Committee North American Benthological Society.
1996: Upper Great Lakes Region Grant Evaluation and Planning Committee ,North American Lake Management Society - EPA Citizen Education Program.
1996: Session Organizer: Human Migration and Environmental Change: for, Conference On The Americas, Continents On The Move: Latin Americans At Home and Abroad. Annual Meeting, Latin American Studies Program, Grand Valley State University. March 16, 1996.
1995 – 1996: Past President, North American Lake Management Society, Michigan Chapter.
1995 – 1999: Program Advisor, Special Science Programs, American Institute of Biological Sciences.
1994 – 1994: President, North American Lake Management Society, Michigan Chapter.
1993 – 1994: President Elect, North American Lake Management Society, Michigan Chapter.
1992 – 1993: Program Committee Chair, North American Lake Management Society, Michigan Chapter.
1983 – 1984: Executive Committee, Oklahoma Society of Electron Microscopy.

VII. ACADEMIC COMMITTEES (since 2000):

2014 – 2015: University Strategic Positioning Committee
2013 – Present: Student Life Funding Board
2011 – 2012: McNair Scholars Selection Committee
2008 – Present: New Programs Council
2007 – 2014: Goldwater Fellowship Nominee Selection Committee
2005 – 2011: Presidential Graduate Research Award Selection Committee, Grand Valley State University.
2004 – Present: Graduate Council Policy Subcommittee, Grand Valley State University.
2004 – Present: CLAS Representative to the Graduate Council, Grand Valley State University. (Council Chair 2007 – present)
2003 – Present: Graduate Program Coordinator, Biology Department, Grand Valley State University.
2000 – 2010: Advisory Board, Regional Science and Math Center, Grand Valley State University.

VIII. EDITORIAL REFEREE AND REVIEWER:

1. Journals:

Archiv Fur Hydrobiologie
Ecology
Aquatic Ecology
Biotropica
Freshwater Biology
Journal of Great Lakes Research
Journal of the North American Lake Management Society
Journal of the North American Benthological Society
Journal of Phycology
Northeastern Naturalist
Genetica

2. Books:

Arms, K. Environmental Science, 2nd. ed. Saunders Publ.
Bond, C. Biology of Fishes, 2nd. ed. Saunders Publ.
Nalepa, T., editor. Zebra Mussels: Biology, Impacts, and Controls.

3. Grant Proposals:

National Science Foundation, Ecology Section

U.S. Fish and Wildlife Service Great Lakes Fish and Wildlife Restoration Act (GLFWRA) funding

Salton-Kenndy Grant Program, National Marine Fisheries Service, National Oceanographic and Atmospheric Administration

Maryland Sea Grant

IX. INVITED PRESENTATIONS AND SEMINARS:

Luttenton, M. The Grayling Hatchery Controversy. The Fishing Club, Wa Wa Sum Biological Field Station, Grayling, MI. (May 7, 2016)

Luttenton, M. Habitat Use by Au Sable River Brown Trout. The Fishing Club, Wa Wa Sum Biological Field Station, Grayling, MI. (May 2, 2015)

Zawacki, M. and M. Luttenton. Determining Cryptic Species of Tubifex tubifex and the Relationship to Whirling Disease in Michigan Rivers. Annis Water Resources Institute Summer Intern Seminar Series, (July 28, 2014)

Luttenton, M. Au Sable River Brown Trout Movement and Habitat Use. Challenge Chapter of Trout Unlimited, Pontiac, MI. (September 10, 2013)

Luttenton, M. Seasonal Movement of Au Sable River Brown Trout. Elliot Donnelley Chapter of Trout Unlimited, Chicago, IL. (May 7, 2013)

Luttenton, M. Tracking Au Sable River Brown Trout. Mason-Griffith Founders Chapter of Trout Unlimited, Grayling, MI. (February 2, 2013)

Luttenton, M. 2004. Habitat Assessments – Muskegon Lake and White Lake. Workshop on Restoring Fish and Wildlife in Michigan's Areas of Concern, Sponsored by Great Lakes Commission, Monroe, MI.

Luttenton, M. 1996. How Can We Improve Lake Management in Michigan? Annual Spring Conference, North American Lake Management Society - Michigan Chapter, Michigan State University.

Luttenton, M. 1996. Encouraging Science-Based Lake Management: What Is Needed In A Comprehensive Lake Management Plan? Annual Spring Conference, North American Lake Management Society - Michigan Chapter, Michigan State University.

Luttenton, M. 1995. Distribution and Abundance of Aquatic Macrophytes in Muskegon Lake. Muskegon Lake Public Action Committee.

Luttenton, M. 1995. Distribution and Abundance of Aquatic Macrophytes in White Lake. White Lake Public Action Committee.

Luttenton, M. 1995. EPA - North American Lake Management Society Outreach Grant – What Have We Accomplished. Annual Fall Conference, North American Lake Management Society - Michigan Chapter, Higgins Lake, Michigan.

Luttenton, M. 1994. Managing inland lake fish communities. Michigan Lakes and Streams Association Annual Conference, Boyne, Michigan.

Luttenton, M. 1994. Managing Michigan's inland lakes: Issues workshop. Conference on Michigan's High Quality Lakes, sponsored by the North American Lake Management Society, Michigan Chapter, Traverse City, Michigan.

Luttenton, M. 1993. Conservation of subtropical river systems: Social, economic, and biological considerations. Sigma Xi Society, Grand Valley State University Chapter.

Luttenton, M. 1993. Belize, Central America: The cost of progress. Hispanic Heritage Forum. Latin American Studies Program, Grand Valley State University.

Luttenton, M. 1993. Tropical change: The good, the bad, the ethical. Symposium on Ethics, Grand Valley State University.

Luttenton, M. 1993. Ecotourism, considering the impacts. West Michigan Tourism Council, Grand Rapids, Michigan.

Luttenton, M. 1993. Algal community dynamics. School for Field Studies, Beverly, Massachusetts.

Luttenton, M. 1993. Foreign invaders: Potential impacts of zebra mussels on the Great Lakes. Michigan Audubon Society Annual Meeting, Holland, Michigan.

Luttenton, M. 1992. The Water Resources Institute and the concern for freshwater. Rogue River Watershed Council, Belmont, Michigan.

Luttenton, M. 1992. Genetics of Lake Michigan chinook: Ecological considerations. Grand Haven Charter Boat Association, Grand Haven, Michigan.

Luttenton, M. 1992. Lake Michigan chinook populations: Where do we go from here? Ludington Charter Boat Association, Ludington, Michigan.

Luttenton, M. 1991. History and ecology of the Lake Michigan salmonid fishery. Michigan Off-shore Fishing Club, Lansing, Michigan.

Luttenton, M. 1991. Science education and the aquatic sciences. West Shore Area Math and Science Meeting, West Shore Community College, Ludington, Michigan.

Luttenton, M. 1991. Population genetics of Lake Michigan chinook salmon. Ludington Charter Boat Association, Ludington, Michigan.

Luttenton, M. 1991. Relationship between bacterial kidney disease and the genetic structure of Chinook populations. Grand Haven Charter Boat Association, Grand Haven, Michigan.

Luttenton, M. 1990. Water quality of the Grand River. Conference on Surface Water Quality of Urban and Rural Environments. Soil and Water Conservation Society, Grand Rapids, Michigan.

Luttenton, M. 1990. Ecological history of the Laurentian Great Lakes. Audubon Society, Holland Chapter, Holland, Michigan.

Luttenton, M. 1988. Experimental manipulations of factors affecting attached algal communities. Department of Biology, East Carolina University, Greenville, North Carolina.

Luttenton, M., J. B. Vansteenburg, and R. G. Rada. 1984. Phycoperiphyton in selected reaches of the Upper Mississippi River: A comparison of community structure, diversity, and productivity. 17th Annual Mississippi River Research Consortium, La Crosse, Wisconsin.

X. PRESENTED PAPERS:

Dean, E. and M. Luttenton. 2016. Seasonal fish migration supplements a trophic level in a coastal Lake Michigan stream. Society for Freshwater Science Annual Meeting, Sacramento, CA (May 21-26).

Zaparzynski, G., J. Wegner, and M. Luttenton. 2016. Evaluating foraging habits, and estimating prey consumption and growth of brook trout in a coolwater Michigan stream. Society for Freshwater Science Annual Meeting, Sacramento, CA (May 21-26).

Wegner, J., G. Zaparzynski, and M. Luttenton. 2016. Summertime movement and microhabitat use by brook trout in a small Michigan stream. Society for Freshwater Science Annual Meeting, Sacramento, CA (May 21-26).

Dean, E. and M. Luttenton. 2016. Seasonal Fish Migration Supplements the Energy Budget in a Coastal Lake Michigan Stream. 76th Midwest Fish and Wildlife Conference, Grand Rapids, MI.

Kuzniar, Z. R. VanKirk, E. Snyder, and M. Luttenton. 2015. Adult Rainbow Trout Habitat Selection in the Henry's Fork of the Snake River, Idaho. Society for Freshwater Science Annual Meeting, Milwaukee, WI. (May 17-21).

Giordano, B. and M. Luttenton. 2014. Diel and Seasonal Movement of Brown Trout in the Au Sable River System, MI. Society for Freshwater Science Annual Meeting, Portland, OR.

Swanson, N., A. Wieten, T. Foster, and M. Luttenton. 2012. Juvenile Steelhead in the Muskegon River: Analysis of Larval Drift and Juvenile Diet. The American Fisheries Society Annual Meeting, St. Paul, MN.

Baisch, D., A. Nikitin, and M. Luttenton. 2012. Origin of Great Lakes brown trout, Salmo trutta: A phylogeographic analysis using mtDNA sequence variation. The American Fisheries Society Annual Meeting, St. Paul, MN.

Albrecht, N., M. Luttenton. 2012. Growth, Survival, and Production of Juvenile Steelhead in the Muskegon River. American Fisheries Society Michigan Chapter, Marinette, WI.

Conte, M.S. M. Luttenton, M. Holtgren and S. Ogren. 2008. Larval sturgeon as potential prey for juvenile brown trout and rainbow trout in the Big Manistee River, MI. Michigan Chapter of the American Fisheries Society, Annual meeting, Sault Ste. Marie, MI. (March 4-5)

Luttenton, M. 2006. Temporal dynamics in wetland habitats and the implementation of management strategies. International Symposium: Wetlands 2006. Association of State Wetland Managers, Traverse City, Michigan.

Luttenton, M., N. Godby, E. Rutherford, and A. Bosch. 2006. Changes in benthic macroinvertebrates in an impounded Michigan river following the introduction of zebra mussels and a large flow event. North American Bentholigcal Society, Anchorage, Alaska.

Jermalowicz-Jones, J.L. and M.R. Luttenton. 2006. Groundwater and sediment nutrient influences on submersed aquatic macrophyte growth in White Lake, Muskegon County, Michigan. Midwest Aquatic Plant Management Society, Grand Rapids, Michigan.

Luttenton, M., N. Godby, E. Rutherford, and S. Vankampen. 2005. The introduction of zebra mussels into an impounded Michigan river: Effects on benthic macroinvertebrates. Midwest Fish and Wildlife Conference, Grand Rapids, Michigan.

Jermalowicz-Jones, J.L. and M.R. Luttenton. 2005. Influence of groundwater and sediment nutrients on submersed aquatic macrophyte growth in White Lake, Muskegon County, Michigan. North American Lake Management Society, University of Wisconsin, Madison, Wisconsin.

Hunt, S. W. S. P. Hendricks, and M. R. Luttenton. 2005. Biomonitoring and environmental conditions in the Little River basin, western Kentucky, USA. Kentucky Academy of Science.

Luttenton, M. R. and M. Horgan. 1997. Genetic identity of three Michigan walleye populations. Michigan Academy of Science, Arts, and Letters, Calvin College, Grand Rapids, Michigan.

Martindill, S. W., A. J. Davies, and M. Luttenton. 1993. Histopathological and parasitological analyses of fishes from a polluted stretch of the Grand River, Michigan. International Symposium on Pollution and the Environment, Royal Microscopical Society, University of Plymouth, United Kingdom.

Luttenton, M. 1989. Response of a lentic periphyton community to varying nutrient ratios, concentrations, and disturbance frequency. North American Benthological Society, University of Guelph, Guelph, Ontario.

Rosemond, A. D. and M. Luttenton. 1989. The effects of snail grazing on an epiphytic algal community. North American Benthological Society, University of Guelph, Guelph, Ontario.

Luttenton, M. 1988. Physiognomy of attached algal communities exposed to controlled disturbance. Ecological Society of America, University of California, Davis, California.

Luttenton, M. 1988. Theoretical response of algal populations in multivariate space. Periphyton Consortium, University of Louisville, Louisville, Kentucky.

Luttenton, M. and R. L. Lowe. 1987. Partitioning of diatom taxa along resource gradients. Ninth North American Diatom Symposium, Treehaven Field Station, University of Wisconsin-Stevens Point, Stevens Point, Wisconsin.

Luttenton, M. and R. L. Lowe. 1987. Response of periphyton communities to varying nutrient ratios and concentrations. North American Benthological Society, Orono, Maine.

Luttenton, M. and R. L. Lowe. 1987. A test of resource competition theory using periphyton communities. American Society of Limnology and Oceanography, Madison, Wisconsin.

Luttenton, M. 1984. Application of scanning electron microscopy to periphyton community ecology. Northwest Ohio Society of Electron Microscopy, Bowling Green, Ohio. (Co-best paper Award)

Luttenton, M. and R. G. Rada. 1984. Community structure and accrual of phycoperiphyton in Pool No. 5, Upper Mississippi River. North American Benthological Society, Raleigh, North Carolina.

Luttenton, M. and L. A. Pfiester. 1983. External cell morphology and a proposed mechanism for cell division of an unusual freshwater diatom. Oklahoma Academy of Science, Oral Roberts University, Tulsa, Oklahoma.

Luttenton, M. and L. A. Pfiester. 1983. The fine structure of *Rhizosolenia eriensis* H. L. Smith. Seventh North American Diatom Symposium, Barneby Center, Ohio State University.

Luttenton, M. and L. A. Pfiester. 1983. Cell wall morphology of a common freshwater diatom. Second Annual Midwest Botany Graduate Student Meeting, University of Oklahoma, Norman, Oklahoma.

Luttenton, M. 1982. A comparison of community structure of phycoperiphyton on artificial and natural substrates with notes on community ecology. Oklahoma Academy of Science, Chickshaw, Oklahoma.

Luttenton, M. 1982. A study of the phycoperiphyton on glass slide substrates with a comparison to natural substrate communities. Fifteenth Annual Mississippi River Research Consortium, La Crosse, Wisconsin.

Luttenton, M. 1981. A preliminary survey of the diatom flora of the Upper Mississippi River, with notes on community structure. Sixth North American Diatom Symposium, Central Michigan University Biological Station.

Douglas, C. B. and M. Luttenton. 1981. Science materials for the inner-city, middle school student. Michigan Association of Middle School Educators Annual Meeting, Southfield, Michigan.

XI. POSTER PRESENTATIONS:

Wegner, J., G. Zaparzynski and M. Luttenton. 2016. Brook Trout Movement, Behavioral Thermoregulation, and Habitat Use in a Disturbed Michigan Stream System. 76th Midwest Fish and Wildlife Conference, Grand Rapids, MI.

Zaparzynski, G., J. Wegner and M. Luttenton. 2016. Quantifying the Selectivity of Brook Trout Toward Available Prey Items in a Small Michigan Stream. 76th Midwest Fish and Wildlife Conference, Grand Rapids, MI.

Luttenton, M. and N. Albrecht. 2015. Summer survival of age-0 steelhead in the Muskegon River, MI. Midwest Fish and Wildlife Conference, Indianapolis, IN.

Dean, E. and M. Luttenton. 2015. Comparing energy density of three common food items in a Great Lakes coastal river system. Society for Freshwater Science Annual Meeting, Milwaukee, MI,

Gaskill, J., A. Russell, M. Luttenton and M. Woller-Skar.2015. Aquatic derived microcystin accumulation in livers of the terrestrial common cormorant (*Phalacrocorax carbo*), Saginaw Bay, Lake Huron. Society for Freshwater Science Annual Meeting, Milwaukee, WI.

Woller-Skar, M., A. Russell and M. Luttenton. 2015. Field measurements of microcystin in the mayfly *Hexagenia limbata* during emergence; Implications for toxin transfer and persistence. Society for Freshwater Science Annual Meeting, Milwaukee, WI.

Dean, E. and M. Luttenton. 2015. Comparing energy density of three common food items in a Great Lakes coastal river system. Society for Freshwater Science Annual Meeting, Milwaukee, WI.

Woller-Skar, M., A. Russell and Luttenton, M. 2014. Microcystin in little brown bats (*Myotis lucifugus*) following consumption of adult mayflies of the genus *Hexagenia*. Society for Freshwater Science Annual Meeting, Portland, OR.

Giordano, B., M. Luttenton and S. Sendek. 2014. Summer daily movement and season movement of brown trout in the Au Sable River system. Annual Meeting, American Fisheries Society Michigan Chapter, Holland, MI.

Giordano, B., M. Luttenton and S. Sendek. 2013. The movement and habitat use of brown trout in the Au Sable River, MI: A radio telemetry study. Wild Trout Symposium, Yellowstone National Park.

Giordano, B. and M. Luttenton. 2013. The effectiveness of utilizing volunteers for a large scale telemetry study on brown trout in the Au Sable River, MI. Annual Meeting, American Fisheries Society Michigan Chapter, Gaylord, MI.

Zuiderveen, G., T. Evans and M. Luttenton. 2012. Geographic distribution of native and invasive haplotypes of *Phragmites australis* along Michigan's West Coast. Botanical Society of America/American Society of Plant Taxonomists, Columbus, OH. (July).

Foster, T. H. and M. Luttenton. 2011. Zebras and bugs: How the zebra mussel invasion has affected macroinvertebrate communities in the Muskegon River. Society for Freshwater Science Annual Meeting, Louisville, KY. May 20-24.

Swanson, N., A. Wieten and M. Luttenton. 2011. Larval steelhead densities in the Muskegon River, Michigan. Midwest Fish and Wildlife Conference, Des Moines, IA.

Conte, M.S. M. Luttenton, M. Holtgren and S. Ogren. 2008. Potential brown and rainbow trout predation on larval lake sturgeon in the Big Manistee River, MI. North American Benthological Society 56th annual meeting, Salt Lake City, UT, May 25 – 30.

Trumble, A. F. and M. Luttenton. 2005. The Effect of Zebra Mussels on Algal Community Structure in an Impounded River System. North American Benthological Society, New Orleans, LA.

Luttenton, M., N. Godby, E. Rutherford and S. Vankampen. 2005. Changes in benthic invertebrate communities during the introduction of zebra mussels into an impounded Michigan river. North American Benthological Society, New Orleans, LA.

Tiano, T., A. Nikitin and M. Luttenton. 2004. Genetic structure of brown trout populations in the Rogue River, Kent Co, MI. American Fisheries Society, Madison, WI.

Luttenton, M. R. and C. Baisden. 1999. The effects of substratum size on changes in periphyton due to disturbance. Fourteenth North American Diatom Symposium, Pingree Park, CO.

Luttenton, M. R. and T. N. Luttenton. 1997. The algal flora of Australian Pine Marsh. Seventh Symposium on the Natural History of the Bahamas, Bahamian Field Station, San Salvador, Bahamas.

Luttenton, M., M. Horgan and D. Lodge. 1996. Response of littoral periphyton to grazing by crayfish and snails. Phycological Society of America, University of California, Santa Cruz, California.

Luttenton, M., M. Horgan and D. Lodge. 1994. Littoral periphyton response to grazing by crayfish and snails. Ecological Society of America, University of Tennessee, Knoxville, Tennessee.

Luttenton, M. 1991. Dynamics of nearshore Lake Michigan benthic communities. North American Benthological Society, College of Santa Fe, Santa Fe, New Mexico.

Luttenton, M. 1991. Impact of the Grand River Discharge on adjacent Lake Michigan benthic communities. International Association of Great Lakes Research, University of Buffalo, Buffalo, New York.

Horgan, M. and M. Luttenton. 1991. Population genetics of three Michigan walleye populations. International Association of Great Lakes Research, University of Buffalo, Buffalo, New York.

Luttenton, M. 1988. The effects of controlled disturbance on a lentic periphyton community. Phycological Society of America, Asilomar Conference Center, Pacific Grove, California.

Luttenton, M. and R. L. Lowe. 1988. Response of periphyton communities to disturbance. American Society of Limnology and Oceanography, University of Colorado, Boulder, Colorado.

Luttenton, M. 1987. Effects of wave action on periphyton communities. Ninth North American Diatom Symposium, Treehaven Field Station, University of Wisconsin-Stevens Point, Stevens Point, Wisconsin.

Luttenton, M. and R. G. Rada. 1986. Microdistributional patterns of epiphyte communities exposed to varying disturbance. North American Benthological Society, University of Kansas, Lawrence Kansas.

XII. <u>REVIEWED PUBLICATIONS</u>:

Zuiderveen, G. H., T. Evans, T. Schmidt and M. Luttenton. Geographic distribution of native and invasive haplotypes of *Phragmites australis* along Michigan's west coast. Michigan Botanist. (accepted)

Woller-Skar, M. M., D. Jones M. Luttenton and A. Russell. 2015. Microcystin detected in little brown bats (*Myotis lucifugus*). American Midland Naturalist 174:331-334.

Gillett, N., M. Luttenton and A. Steinman. 2015. Spatial and temporal dynamics of phytoplankton communities in a Great Lake's drowned river-mouth lake (Mona Lake, USA). Journal of Limnology 74:453-466.

S. S. Johnson, M. R. Luttenton and A. G. Nikitin. 2009. Genetic variation at the *ND-1* locus among North American wild and hatchery brown trout (*Salmo trutta*). Journal of Great Lakes Research 35:163-167.

Steinman, A. D., M. Ogdahl and M. R. Luttenton. 2009. An analysis of internal phosphorus loading in White Lake, Michigan. In: F. R. Miranda and L. M. Bernard, eds., Lake Pollution Research Progress, pg. 311-325. Nova Science Publications, NY.

Hendricks, S. P. and M. R. Luttenton. 2007. Benthic algal taxa (exclusive of diatoms) of the Little River basin, western Kentucky, 2000-2003. Journal of the Kentucky Academy of Science 68:31-36.

Tiano, T. J., C. M. Willis, A. A. Noble, M. R. Luttenton and A. G. Nikitin. 2007. Genetic identification of hatchery stocks of brown trout (*Salmo trutta*) using mitochondrial DNA polymorphism. North American Journal of Fisheries Management 27:965-970.

Hendricks, S. P., M. R. Luttenton and S. W. Hunt. 2006. Benthic diatom species list and environmental conditions in the Little River basin, western Kentucky, USA. Journal of the Kentucky Academy of Science 67:22-38.

Luttenton, M. and R.L. Lowe. 2006. Response of a lentic periphyton community to nutrient enrichment at low N:P ratios. Journal of Phycology 42:1007-1015.

Luttenton, M and C. Baisden**.** 2006. The relationships among disturbance, substratum size, and periphyton community structure. Hydrobiologia. 561:111-117.

Steinman, A, R. Rediske, R. Denning, L. Nemeth, X. Chu, D. Uzarski, B. Biddanda and M. Luttenton. 2006. An environmental assessment of an impacted, urbanized watershed: the Mona Lake Watershed, Michigan. Arch. Hydrobiol. 166:117-144.

Steinman, A.D., M. Luttenton, and K.E. Havens. 2004. Sustainability of surface and subsurface water resources: case studies from Florida and Michigan. Water Res. Update 127:100-107.

Alverson A., G. W. Courtney and M. Luttenton. 2001. Microhabitat and feeding characteristics of larval net-winged midges (Diptera: Blephariceridae: Blepharicera) from the southern Appalachian Mountains. Journal of the North American Benthological Society 20:564-581.

Pothoven, S., G. Fahenestiel, H. Vanderploeg and M. Luttenton. 2000. Population dynamics of *Mysis relicta* in southeastern Lake Michigan, 1995-1998. Journal of Great Lakes Research 26: 357-365.

Luttenton, M. R., M. J. Horgan and D. M. Lodge. 1998. Effects of three Orconectes crayfishes on epilithic microalgae: a laboratory experiment. Crustaceana 71:845-855.

Luttenton, M. R. and T. N. Luttenton. 1998. Algal flora of a small freshwater marsh, San Salvador, Bahamas. Proceedings of the Seventh Symposium on the Natural History of the Bahamas.

Luttenton, M. R., L. A. Pfiester and P. Timpano. 1986. Morphology and growth habit of *Terpsinoe musica* Ehr. (Bacillariophyceae). Castanea 51:175-182.

Luttenton, M. R. and R. G. Rada. 1986. The effects of disturbance on the architectural complexity of epiphytic communities in a reach of the Upper Mississippi River. Journal of Phycology 22:320-326.

Luttenton, M. R., J. B. Vansteenburg and R. G. Rada. 1986. Phycoperiphyton in selected reaches of the Upper Mississippi River: a comparison of community structure, diversity, and productivity. Hydrobiologia 136:31-45.

Vansteenburg, J. B., M. R. Luttenton and R. G. Rada. 1984. A floristic analysis of the attached diatoms of selected areas of the Upper Mississippi River. Proc. Iowa Acad. Sci. 91:52-56.

XIII. BOOKS:

Luttenton, M. R. Aquatic Resources of the Great Lakes Region. Great Lakes Regional Series, The University of Michigan Press. (contract awarded, manuscript in preparation)

Racle, F., M. R. Luttenton, and S. Heaney. 1993. Great Lakes Regional Environmental Issues Manual. Saunders College Publishing Co.

XIV. UNREFEREED PUBLICATIONS:

Luttenton, M. 2016. Summary of movement and habitat used by tagged brook trout in the Main Branch and North Banch Au Sable River during summer 2014. Final Report. Submitted to the Anglers of the Au Sable.

Luttenton, M., N. Albrecht, T. Foster, and N. Swanson. 2015. Muskegon River Juvenile steelhead survival and production. Final report submitted to the Michigan Department of Natural Resources, Fisheries Division, Project No. 231709/00.

Luttenton, M. and B. Giordano. 2015. Au Sable headwaters trout telemetry project. Final Report. Submitted to the Michigan Department of Natural Resources, Fisheries Division.

Luttenton, M. R., A. Steinman and R. Rediske. 2007. White Lake Water Quality Assessment Final Report. Submitted to The Michigan Department of Environmental Quality. 121 pg.

Steinman, A, R. Rediske, R. Denning, L. Nemeth, X. Chu, D. Uzarski, B. Biddanda and M. Luttenton. 2003. Preliminary watershed assessment: Mona Lake watershed. Annis Water Resources Institute, Muskegon, MI. Publication No. MR-2003-114.

Luttenton, M. R. 2002. Distribution and Abundance of Unionid Clams in the White River System. Prepared for U.S. Forest Service.

Luttenton, M. R. 2001. Final report for 2000: Cedar River physical-chemical analysis, habitat assessment, benthic macroinvertebrate monitoring, and algal community monitoring. Prepared for Shanty Creek Resort and Friends of the Cedar River.

Luttenton, M. R. 1996. The burden of facts and the joy of discovery. Grand Valley Review, vol. XV, pp. 40-43.

Luttenton, M. 1996. Distribution and Abundance of Aquatic Macrophytes in White Lake. Project Report, submitted to, Muskegon County Soil Conservation District.

Luttenton, M. 1995. Distribution and Abundance of Aquatic Macrophytes in Muskegon Lake. Project Report, submitted to, Muskegon County Soil Conservation District.

Luttenton, M. and R. David. 1994. Bear Creek Restoration Project Report. Publ. #MR-94-9, Water Resources Institute, Grand Valley State University, Allendale, Michigan.

Luttenton, M. 1993. Spatial and temporal dynamics of nearshore and offshore Lake Michigan invertebrate communities near Grand Haven, Michigan. Publ. #WR-93-9, Water Resources Institute, Grand Valley State University, Allendale, Michigan.

Martindill, S., M. Luttenton and A. Davies. 1993. Investigation on the prevalence of tumors and parasites in fishes from the Grand River. Publ. #WR-93-4, Water Resources Institute, Grand Valley State University, Allendale, Michigan.

Krueger, T., R. David and M. Luttenton. 1991. Zebra mussels: the threat to inland lakes. The Michigan Riparian, May Issue.

Luttenton, M. 1991. Project Report: Preliminary survey of genetic variation in Lake Michigan chinook salmon populations. Submitted to the Fisheries Division, Michigan Department of Natural Resources.

Bruursema, J. and M. Luttenton. 1990. Grand River Report: the present quality of the Grand River. Publ. #MR-90-70.

XV. <u>AWARDS</u>:

2007 Nominee for U.S. Professors of the Year
Sponsored by The Carnegie Foundation for the Advancement of Teaching and Council for Advancement and Support of Education

2007 Nominee for Michigan Distinguished Professor Award
Presented by: The Michigan Council of University Presidents

Outstanding Educator Award, 2006
Presented by: Grand Valley State University Alumni Association

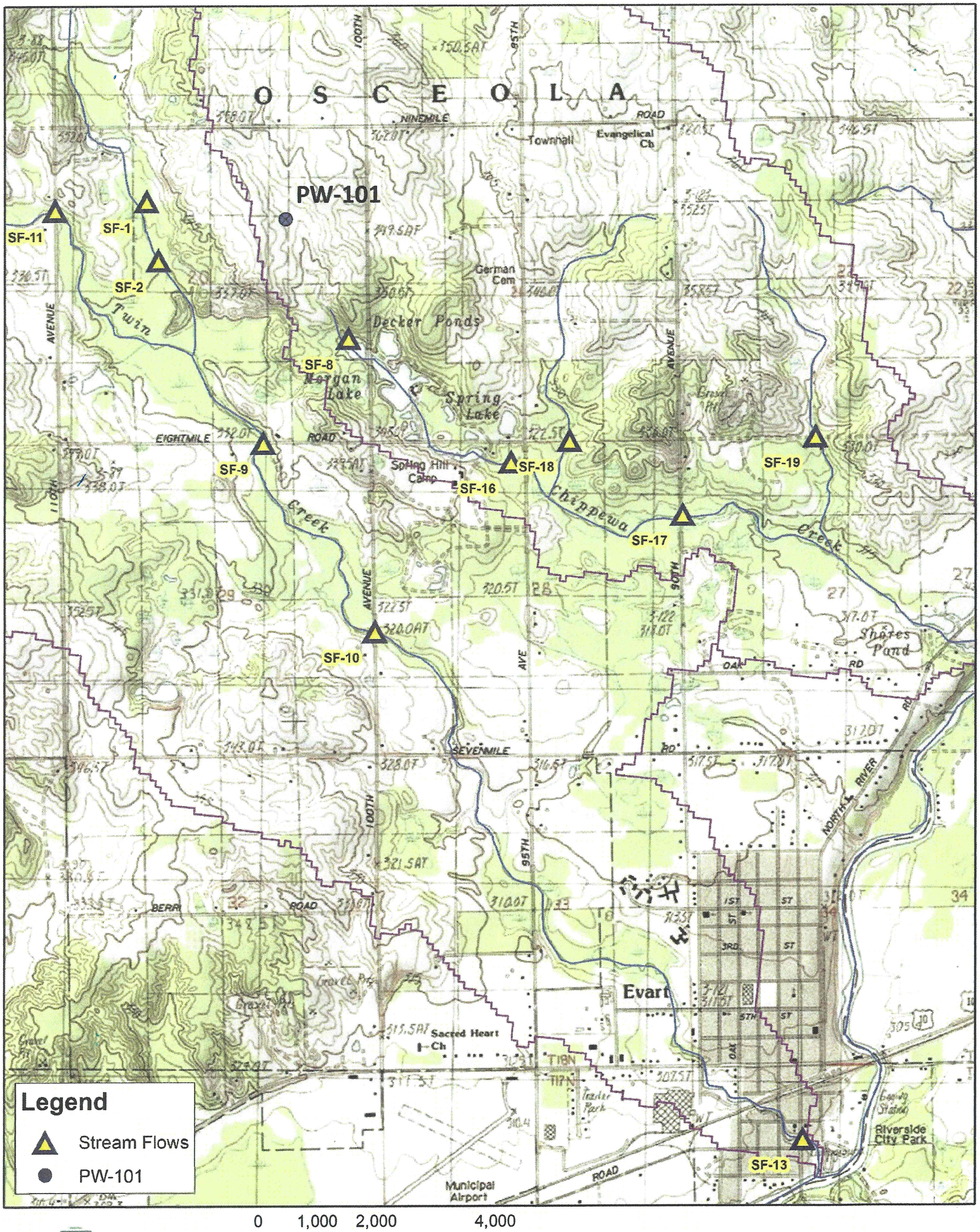
C. R. Evenson Conservation Professional Award, 2005.
Presented by: West Michigan Chapter of Trout Unlimited

Aquinas College Mentoring Program Certificate of Merit, 1995.

APPENDIX 4, FLOW REPORT

GOLDER ASSOCIATES
STREAM FLOWS OF MONITORING LOCATIONS
WHITE PINE SPRINGS, OSCEOLA COUNTY, MI

April 21, 2017



Golder Associates

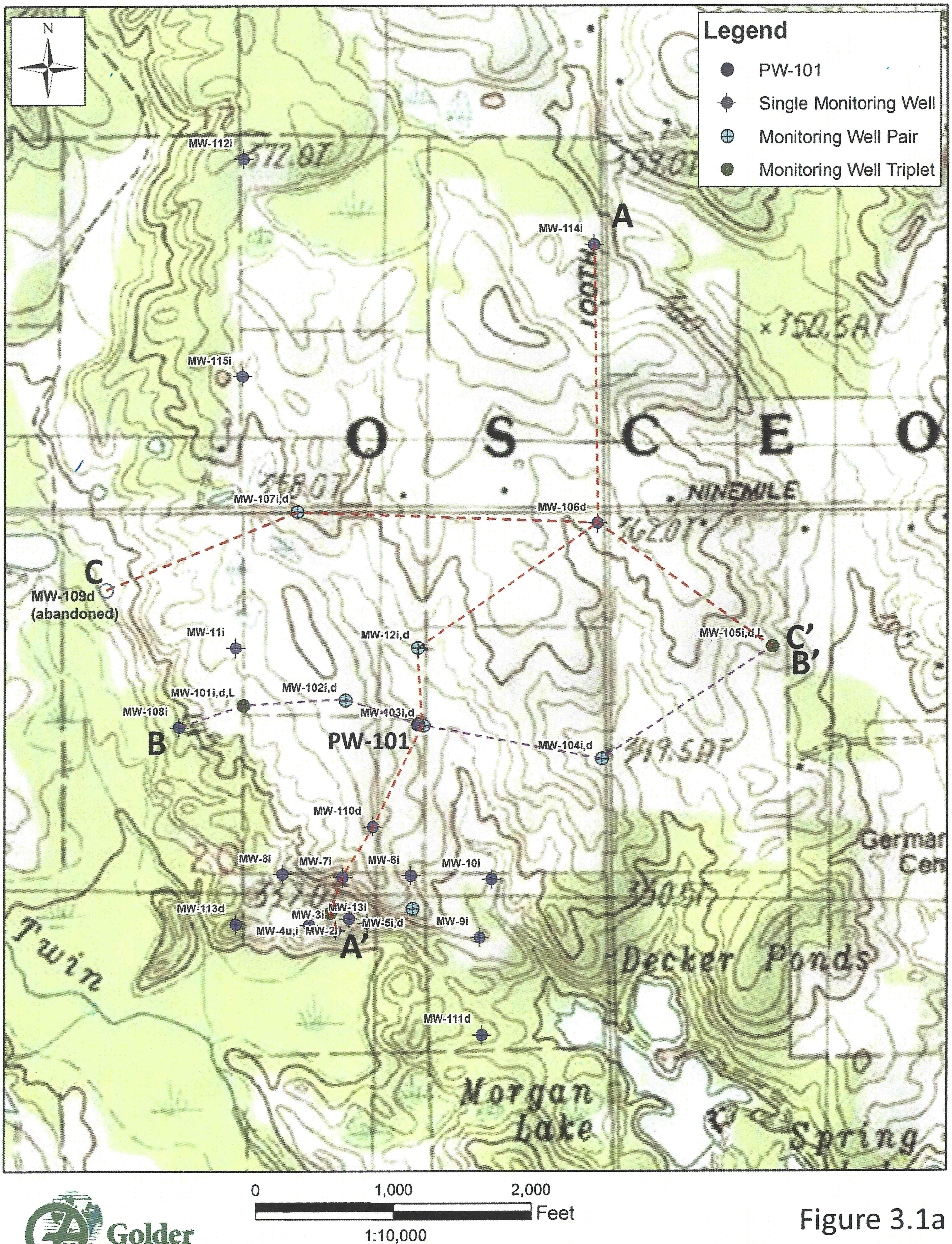
Figure 3.8

Stream Flow Monitoring Locations
White Pine Springs, Osceola County, MI

APPENDIX 5, FLOW REPORT

GOLDER ASSOCIATES
LOCATION MAPS OF MONITORING WELLS AND CROSS SECTIONS
WHITE PINE SPRINGS, OSCEOLA COUNTY, MI

April 21, 2017

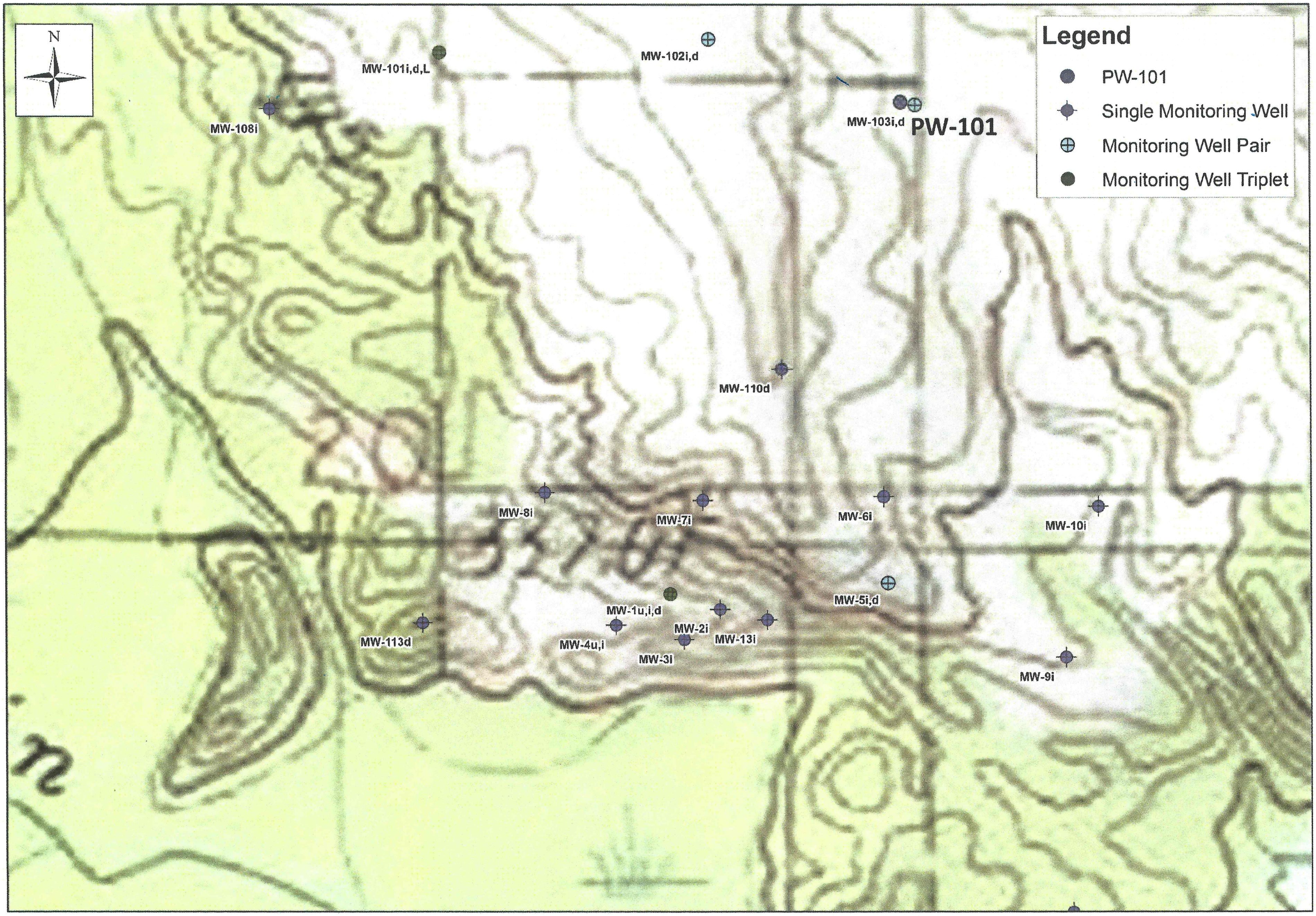


Golder Associates

Figure 3.1a

Location Map of Monitoring Wells and Cross Sections

White Pine Springs, Osceola County, MI



Golder Associates

Figure 3.1b

Location Map of Monitoring Wells, Detail
White Pine Springs, Osceola County, MI