S T A T E O F M I C H I G A N

BOARD OF COMMISSIONERS OF THE COUNTY OF ALLEGAN

WATER STUDY WORKGROUP—AUTHORIZE GROUNDWATER STUDY PHASE II PROJECT/RESERVE WATER PROJECT FUNDS

WHEREAS, results from an Ottawa County study demonstrated water availability issues and potential impact for Allegan County; and

WHEREAS, on December 12, 2019, the Board of Commissioners (Board) authorized Public Health to proceed to gather a complete project scope on the groundwater study for the County of Allegan; and

WHEREAS, on March 12, 2020, the Board approved the Groundwater Study Phase I Proposal from Hydrosimulatics, Inc. in an amount not to exceed $150,000; and

WHEREAS, in February 2021, Hydrosimulatics, Inc. produced and presented the Groundwater Study Phase I to the Board, which included recommended next steps; and

WHEREAS, on March 25, 2021, the Board approved the County Administrator's recommendation that a work group be convened to review the data and form recommendations for next steps; and

WHEREAS, on May 13, 2021, as the next step, the Board accepted the Public Health's Water Study Workgroup Report; and

WHEREAS, on May 27, 2021, the Board accepted the Water Study Group Memorandum from the County Administrator which further vetted the workgroup's tasks and deliverables; and

WHEREAS, on June 10, 2021, the Board established the Water Study Workgroup; and

WHEREAS, on March 23, 2022, the workgroup held its first meeting; and

WHEREAS, on May 4, 2022, the workgroup recommended to the Board to accept the Screening-Level Modeling, Risk Analysis, and Ranking Proposal (Groundwater Study Phase II Project) from Hydrosimulatics, Inc. for screening level modeling of contaminated sites; and

WHEREAS, on June 1, 2022, the workgroup voted to recommend the implementation of monitoring wells in conjunction with the Michigan Geological Survey/Western Michigan for the initial build of four wells (approximately $15,000 of ARPA with blended funding) and a plan to implement approximately twenty more wells with blended funding (estimated total of approximately $100,000); and

WHEREAS, on June 1, 2022, the workgroup reviewed funding models for overall anticipated project plans and is recommending the Board appropriate three million dollars ($3,000,000.00) for the purpose of ground water studies, monitoring wells, potential water quality and availability improvements all towards the development of a short and long term plan for the protection of Allegan County water supply.

THEREFORE BE IT RESOLVED that the Board accepts the Groundwater Study Phase II Project from Hydrosimulatics, Inc. for approximately $110,000, as presented; and

BE IT FURTHER RESOLVED, that the total project cost will be funded from the American Rescue Plan Act Fund (ARPA); and

BE IT FURTHER RESOLVED, the County Administrator is authorized to negotiate contracts for services for the Phase II study (Hydrosymulatics, Inc.) and up to 24 monitoring wells(Michigan Geological Survey/Western Michigan); and

BE IT FURTHER RESOLVED, the Board reserves $3,000,000.00 of ARPA funds for water related projects including those authorized in this resolution; and

BE IT FINALLY RESOLVED, the County Administrator is authorized to sign any necessary documents on behalf of the County and the Executive Director of Finance is authorized to perform the necessary budget adjustments to complete this action.

ALLEGAN COUNTY
REQUEST FOR ACTION FORM

Completed RFA form must be attached to a work order request through the Track-It System. If you have any questions regarding this process, please contact Administration @ ext. 2633.

RFA#: 213-285

Date:

Board Approval: All contracts $10K and under and budgeted ongoing renewals to County Administrator; new contracts over $10K require Board discussion.

Request Type: Contract

Department Requesting: Health

Submitted By: Randy Rapp on Behalf of the Ground Water Study Ad-Hoc Work Group

Contact Information: rrapp@allegancounty.org & 4706

Parties:

Hydrosimulatics, Inc.: This is the company that produced and presented the ground water study to the Board of Commissioners on February of 2021.

Duration: ~ 6 months

Amount: $107,000.00

Purpose:

The proposed project will enable the County to rank and prioritize sites of environmental concern across its entire site portfolio – from high-risk sites requiring "immediate" action (e.g., oversight, groundwater sampling and analysis, and possible remediation), to low risk sites that can be addressed later (perhaps years in the future), or everything in between. The project will also provide additional information regarding source water areas (or "well-watersheds") of critical public water supply wells in the County (Type I community supply wells).

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Allegan County Groundwater Study - Proposed Next Step: SCREENING-LEVEL MODELING, RISK ANALYSIS, AND RANKING

A Project Proposal
By
Hydrosimulatics INC

May 4, 2022

MOTIVATION

A Ground Water Study Work Ad-Hoc Group was established to systematically review the Final Report from the (Phase 1) Allegan County Groundwater Study. The Phase 1 study analyzed existing regional groundwater data to better understand the groundwater conditions across the County and implications for management – both in terms of water quantity (availability and use) and water quality ("background" groundwater chemical concentrations and potential "point" sources of pollution). The Work Group is to assist in determining current and future water demands and sustainability of water supply relative to growth trends, and how to improve water quality and maintain the quantity required for human and agricultural use.

The Phase 1 Study inventoried and mapped about 250 known or potential sites of groundwater contamination in nearly all parts of the County, including PFAS sites, EGLE Sites of Environmental Concern, and Leaky Underground Storage Tanks, or LUSTs. Dozens of oil and gas wells and over 40 landfills / waste handlers were also identified as potential sources of contamination. The prevalence of sites raises concerns over the safe or sustainable use of groundwater for water supply within the County.

OBJECTIVE

The proposed project will enable to County to rank and prioritize sites of environmental concern across its entire site portfolio – from high-risk sites requiring "immediate" action (e.g., oversight, groundwater sampling and analysis, and possible remediation), to low risk sites that can be addressed later (perhaps years in the future), or everything in between.

The project will also provide additional information regarding source water areas (or "well-watersheds") of critical public water supply wells in the County (Type I community supply wells).

EXPECTED OUTCOMES

The deliverables of this project (maps of pollution site impact areas, source water areas of critical groundwater receptors, a countywide aquifer vulnerability map, and risk rankings) can be used to guide long-term planning relative to groundwater use and growth trends, allowing the county to answer questions such as:

- Which critical groundwater receptors are threatened by known or potential sources of groundwater pollution because of proximity to a pollution impact area?
- Which receptors are most vulnerable because of aquifer and soil properties?
- Which ones require "immediate attention" or close monitoring?
- Which ones might have an issue sometime later in the future?
- Which areas being considered for future development face water supply issues because of impaired water quality?
- What are the time-scales involved?

The deliverables can also be used as leverage to secure additional funding (e.g., from the State of Michigan or federal agencies) to perform further groundwater analysis (detailed sampling and 3D flow modeling) and/or remediation (pollution cleanup).

SCOPE OF WORK

The proposed work first involves, for all sites of environmental concern, using novel techniques for spatial interpolation of water levels and screening-level flow model simulation, combined with particle tracking techniques (forward tracing of flow-paths), to delineate potential pollution impact areas. Time-of-travel envelopes for different periods of time will be delineated to assist with the ranking and prioritization analysis.

Hydrosimulatics INC. will take advantage of previous work completed over the years related to realtime interactive, big data-enabled modeling, visualization, and analysis to perform rapid data-driven and process-based flow modeling in ways previously impractical (see Appendix A2 for more details).

A similar technique (backward tracing of flow-paths from wells) will be used to delineate source water areas / WellHead Protection Areas (WHPAs), under different assumed travel times, for all Type 1 wells with WHPAs not yet completed by the State of Michigan (see more details in Specific Tasks).

Then, Hydrosimulatics INC. will perform a countywide assessment of aquifer vulnerability by intelligently combining spatial data / maps from Phase 1 (and elsewhere, as needed) into a countywide map of how sensitivity to surface pollution changes across space.

Finally, Hydrosimulatics INC. will work with the Ground Water Study Ad-Hoc Work Group (and outside experts, if deemed necessary) to develop and apply a Risk Ranking System across the entire portfolio of sites of environmental concern - based on the flow-tracking analyses, aquifer vulnerability mapping, and other contributing factors.

Hydrosimulatics INC. will document all methodology, findings, spatial data / map products, and the final rankings into a complete Final Report.

POTENTIAL LINK TO DSS

The delineated impact areas, estimated source water areas, aquifer vulnerability maps, and site rankings will be saved as GIS-based spatial data files, which can then be integrated into a realtime interactive DSS - Decision Support System (i.e., a database, mapping, and analysis system).

It is also possible for Hydrosimulatics INC. to program tools for realtime interactive flow tracing (backward or forward) and realtime interactive aquifer sensitivity analysis into a DSS, so that users can apply them to new sites or at existing sites as more data becomes available.

SPECIFIC TASKS

Task 1- Identify Potential Impact Areas of Sites of Environmental Concern

Hydrosimulatics INC. will apply forward flow tracking techniques to identify the potential downstream impact/influence areas of all (about 300) sites of environmental concern in the County. This includes all PFAS sites, EGLE Sites of Environmental Concern, and Leaky Underground Storage Tanks, or LUSTs.

The first step at each site is using spatial interpolation and screening level flow model simulation to delineate local groundwater flow patterns (in 2D).

The countywide and subregional ("quadrants") maps generated in the Phase 1 Study cannot be used for this analysis because particle tracking (see next) is too sensitive to local variability that is "smoothed out" during countywide analysis and visualization. Instead, the analysis will require zooming in to each site area (or areas with clusters of closely grouped sites) to use map detailed local flow patterns using the subset of water level data available in the area and a fine model grid (high resolution).

We will apply both the data-driven (spatial interpolation of water levels) and process-based (simulated water levels) approaches to all sites and compare the resulting water level patterns. This is done to make full use of the existing data and available modeling technologies; by comparing the two approaches, one ca can quickly tell or know how to improve. See Appendix Section A2 for more details on methodology.

With a delineation of flow patterns, "particles" are then released or placed at their starting point (expected source of contamination) and flow paths are traced over time (see Graphic 1 in Appendix A1 for an example).

Note that, although flow pattern delineation and particle tracking are listed as separate subtasks, some sites will require "back and forth" or iteration between flow characterization and transport of particles. (Detail of flow patterns that can be fine-tuned are best seen when particle tracking takes place.)

Hydrosimulatics INC. will program the software used for this project so that final impact areas are automatically converted into a GIS-shapefile format, allowing for coping with hundreds of data layers and aggregating them into one data layer with different sub-features (sites and time-of-travel envelopes). The GIS-formatted files can then be integrated into a realtime interactive DSS or any other GIS-based software (as part of a separate proposed project by Hydrosimulatics INC.).

Data used in spatial interpolation analysis:

- Static Water Levels from water wells (from Phase 1, but this time the most current/complete dataset will be used)
- hydraulic conductivity estimates, which helps to control groundwater speed and water table configuration (from phase 1); and
- porosity estimates, which controls seepage velocity of contaminants (using best estimate based on geology).

Data used in screening-level process-based modeling:

- land surface topography represented with 10m Digital Elevation Model – to represent the aquifer top;
- bedrock top surface interpolated from bedrock elevation information in Wellogic records – to compute aquifer thickness;
- hydraulic conductivity estimates from Phase 1;
- natural (mean long-term) recharge from Phase 1; and
- porosity estimates.

See Appendix A2 for more details on how data are used to enable rapid data-driven or process-based delineation of flow patterns.

Task 2 – Delineate Source Water Areas for Important Receptors Lacking WHPAs

At the time of the Phase 1 study, there were 126 active Type 1 Wells identified within Allegan County. Currently, the State of Michigan GIS Portal includes 62 WellHead Protection Areas (WHPAs), or the source water area or well-watershed of the wells, located within the County.

Hydrosimulatics INC. will apply backward flow tracking techniques to delineate WHPAs for all Type 1 community supply wells that currently lack a delineation (64 at this time).

The process for backward flow tracking is similar to forward tracking: delineation the 2D local flow patterns (see details in Task 1) by data-driven (spatial interpolation approaches) and screening-level process-based flow modeling; place particles at their starting position; and trace out the flow-path over time (this time, moving backward in time). See Graphic 2 in Appendix A1 for an example.

Hydrosimulatics INC. will program the software used for this project so that final source water areas / WHPAs are automatically converted into a GIS-shapefile format, allowing for coping with dozens of data layers and aggregating them into one data layer with different sub-features (sites and time-of-travel envelopes). The GIS-formatted files can then be integrated into a realtime interactive DSS or any other GIS-based software.

Data used in this analysis: See Task 1

Task 3 – Map Aquifer Vulnerability / Sensitivity to Pollution

The impact area and source water area delineations described in Tasks 1 and 2 describe the travel times and areas of interest *assuming* the surface contaminant has successfully made it into the aquifer system. However, contamination at the surface must first pass through the unsaturated zone before it gets into the aquifer. Depending on the soil and other hydrogeological conditions, it can be very difficult (or sometimes, practically impossible) for the contamination to make it to the aquifer. For example, in places where the aquifer is confined or overlain by thick deposits of low permeability materials such as clay or silt, it can take a very long time (or practically "forever") for the contaminant to get into the aquifer.

Therefore, Hydrosimulatics INC. proposes to assess and map aquifer vulnerability or sensitivity to surface pollution so that this critical information can be used in the overall Risk Ranking analysis (see Task 4).

The specific method under consideration is the DRASTIC method, which combines maps of depth to water table (D), recharge (R), aquifer media (A), soil media (S), topography (T), impact of vadose zone (I), and hydraulic conductivity (C)[1] and use relative 'importance' weightings for the different parameters to create a single map of the aquifer sensitivity to pollution (see Graphics 3 and 4 in Appendix A1).

[1] From Barbulescu (2020):
"The depth to water table (D) [m] is the thickness of the layer crossed by the pollutant before reaching the aquifer. The aquifer vulnerability is inverse proportional to the depth to the water table.
The net recharge (R) [mm/year] represents the volume of infiltrated water that reaches the aquifer.
The contamination possibility increases if the net recharge increases.
The aquifer media (A) consists of different types of rocks serving as an aquifer.
The upper part of the vadose zone, with intense biological activity, is defined to be the soil media (S).
The topography (T) (%) is defined by the terrain slope, together with its variation. A low slope

Task 4 – Develop and Apply a Risk Ranking System with Allegan County

In this task, Hydrosimulatics INC. will develop integrated overlays of impact zone maps, WHPA maps, wells/receptors, and sites of environmental concern, and perform integrated qualitative assessment to create a Risk Ranking System to be applied across the entire site portfolio.

As part of this Task, Hydrosimulatics INC. will work present the findings from Tasks 1-3 to the Work Group and incorporate feedback in the development of the Risk Ranking System.

The overall risk of a site will be based on a number of factors, including:

- the occurrence of critical groundwater receptors (both human and ecological) within or near the impact areas (time-of-travel envelopes) generated in Task 1; sites that have receptors that are within the shorter-term impact areas will be ranked at a higher risk.
- the degree of overlap / proximity of Type 1 WHPAs with the impact areas, for different travel times; risk is higher when sites have impact areas that overlap with WHPA of major supply wells (especially for shorter time-of-travel envelopes).
- the aquifer vulnerability to surface contamination (Task 3); the risk is higher for sites in areas where the aquifer vulnerability is high.
- contaminant loading (if information is available), or how the amount (mass) of a pollutant that is discharged over a period of timing; sites with stronger loadings (lots of mass released quickly) have higher risk.
- Perspectives on human health risk, including applicable health-based criterion of particular contaminants (if available); risk is higher for sites with concentrations exceeding health guidelines.

Task 5 – Documentation

Hydrosimulatics INC. will document all methodology, findings, spatial data / map products, and the final rankings into a complete Final Report.

BUDGET AND SCHEDULE

A detailed budget, including expected outcomes or Deliverables for all subtasks, in presented in the Table 1 below. The total cost of the project is estimated to be $107,000.

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will determine a small surface flow and a high pollution risk.
The vadose zone's impact (I)—The unsaturated or discontinuously saturated layer situated above the water table is called vadose. The pollutant's transfer is influenced by the vadose zone's lithology. The aquifer hydraulic conductivity (C) is the aquifer materials' capacity to leave the water to pass through it. The aquifer vulnerability is low for reduced hydraulic conductivities."

Table 2 presents the proposed Project Schedule. A total Project Duration of 6 months (183 calendar days from NTP) is expected.

The proposed tasks will be completed sequentially (i.e., the first 91 days from NTP will be used to complete Task 1, then the next 16 days will be used to complete Task 2, and so on).

Once Tasks 1-3 are completed – estimated at 137 days (4.5 months) from NTP – Hydrosimulatics will present a formal presentation of findings to the Work Group and solicit feedback for the development of a Risk Ranking System. At this time, draft copies of all Deliverables for Tasks 1-3 will be provided (final copies will be included in the Final Report).

Once all Tasks are completed (estimated at 183 days or 6 months from NTP) Hydrosimulatics will present a formal presentation to the Work Group and Allegan County Board of Commissioners. A Final Report including all final versions of maps/tables/etc. generated for this Project will be provided at this time.

Throughout the project, Hydrosimulatics INC. will provide updates of project progress to the Work Group during their bi-weekly meetings.

Table 1: Proposed Project Budget & Deliverables.

SCREENING-LEVEL MODELING, RISK ANALYSIS, AND RANKING			
1	**Identify Potential Impact Ares of Sites of Environmental Concern**		**$60,000**
Task	Description	Deliverable	Cost
1.1	Download and process latest Static Water Level data from Wellogic	--	$1,000
1.2	Delineate local flow patterns for all Sites of Environmental Concern using the data-driven approach (spatial interpolation of water levels): -- EGLE Sites of Environmental Concern (250) --PFAS sites (3) -- Landfills and Waste Handlers (40)	Flow pattern maps (2D)	$34,000
1.3	Delineate local flow patterns for all Sites of Environmental Concern using the process-based approach		
1.4	Screening level calibration: comparison of process-based model with water levels (interpolated map and/or a graphical comparison of simulated and observed water levels		
1.5	Perform forward particle tracking from source areas to delineate impact areas -- 2 year time-of-travel envelopes -- 10 year time-of-travel envelopes --20 year time-of-travel envelopes	Impact area maps with locations of critical groundwater receptors	$20,000
1.6	Automate conversion of impact areas into GIS-shapefile, allowing for coping with hundreds of data layers and aggregating them into one (	Impact area GIS files	$5,000
2	**Delineate Source Water Areas for Important Receptors**		**$12,000**
2.1	Delineate local flow patterns for all identified Type 1 wells requiring WHPA delineation (64) using the data-driven approach (spatial interpolation of water levels)	Flow pattern maps (2D)	$7,000
2.2	Delineate local flow patterns for all identified Type 1 wells requiring WHPA delineation		
2.3	Screening level calibration: comparison of process based model with water levels (interpolated map and/or a graphical comparison of simulated and observed water levels		
2.4	Perform backward particle tracking to delineate WHPAs for Type 1 Wells identified in Task 2.1	WHPAs / Source water areas	$4,000
2.5	Automate conversion of impact areas into GIS-shapefile, allowing for coping with hundreds of data layers and aggregating them into one (	WHPA GIS files	$1,000
3	**Map Aquifer Vulnerability / Sensitivity to Surface Pollution**		**$15,000**
3.1	Compile, process and prepare soil spatial layers to combine with Depth to Water Table, Net Recharge, Topography, and Hydraulic Conductivity layers from Phase 1	--	$2,000

3.2	Assign Rating and Weighting for each Layers	--	$2,000
3.3	Program and apply DRASTIC method integration	--	$3,000
3.4	Iterate (Refine Weighting and Rating) to a final or “best estimate” map of aquifer vulnerability	Countywide aquifer sensitivity map	$7,000
3.5	Create GIS Data layers with attributes	GIS Data Layer	$1,000
4	**Develop and Apply Risk Ranking System with Allegan County**		**$13,000**
4.1	Develop integrated overlays of impact zone maps, WHPA maps, wells/receptors, sites of concerns, and vulnerability maps	Integrated overlays (maps)	$4,000
4.2	Integrated qualitative assessment		$2,000
4.3	Present ranking methods to task force and seek feedback		--
4.4	Finalize ranking methodology	Write-up of criteria	$2,000
4.5	Apply final ranking methodology to develop final Ranking List for complete portfolio of sites of environmental concern	Tables and maps	$4,000
4.6	Create GIS shapefile of sites of different priority-levels	GIS Shapefiles	$1,000
5	**Documentation**		**$7,000**
5.1	Prepare of a Final Technical Report, including all maps and final Rankings	Final Report	$6,000
5.2	Presentation to Allegan County Board of Commissioners	--	$1,000

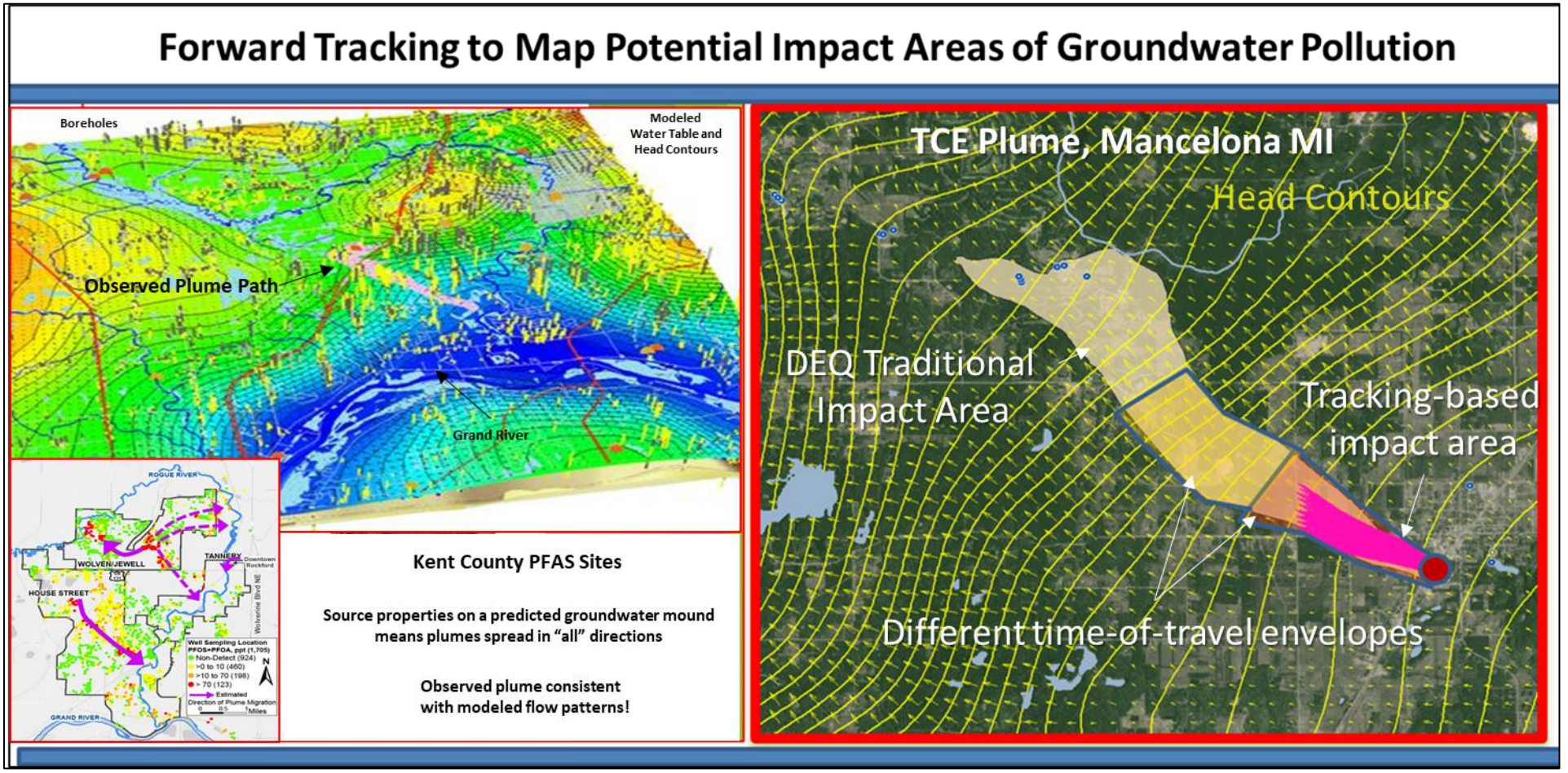
*Although flow pattern delineation and particle tracking are listed as separate tasks, some sites will require "back and forth" or iteration between flow characterization and transport of particles. (Detail of flow patterns that can be fine-tuned are best seen when particle tracking takes place).

Table 2: Proposed Project Schedule

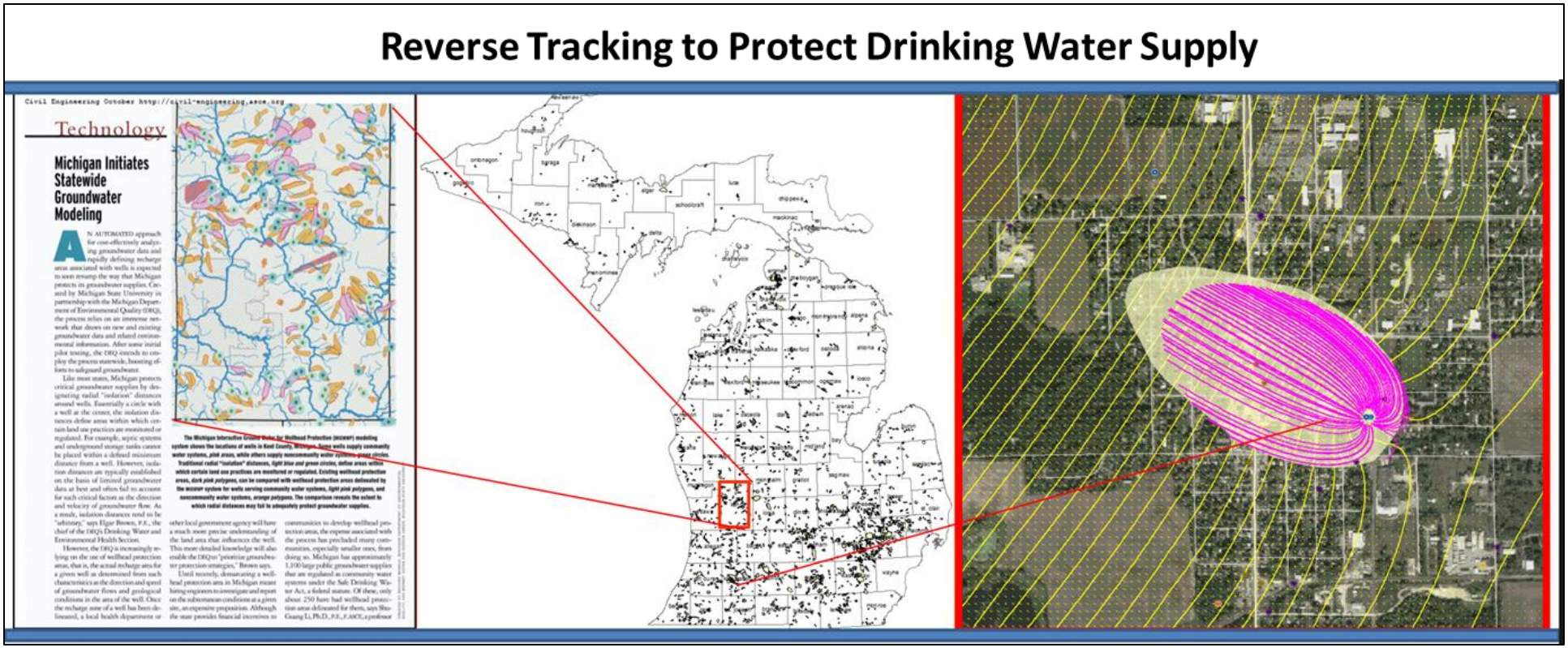
Task	Time to complete (calendar days from NTP)	Comments
Task 1	91	Task 1 - Identify Potential Impact Ares of Sites of Environmental Concern
Task 2	107	Task 2 - Delineate Source Water Areas for Type I Community Wells
Task 3	137	Task 3 - Map Aquifer Vulnerability / Sensitivity to Surface Pollution Presentation to GW Work Group; Deliverables for Tasks 1, 2, and 3 made available to Allegan County Payment for Tasks 1-3 sent to Hydrosimulatics INC
Task 4	167	Task 4 – Develop and Apply a Risk Ranking System
Task 5	183	Task 5 - Documentation and Final Presentation Remaining payments sent to Hydrosimulatics INC

* Note that Task 4 – Developing a Risk Ranking System with Allegan County – may take longer than expected depending on quickly the Work Group can provide feedback to Hydrosimulatics regarding factors that should be considered in the ranking analysis.

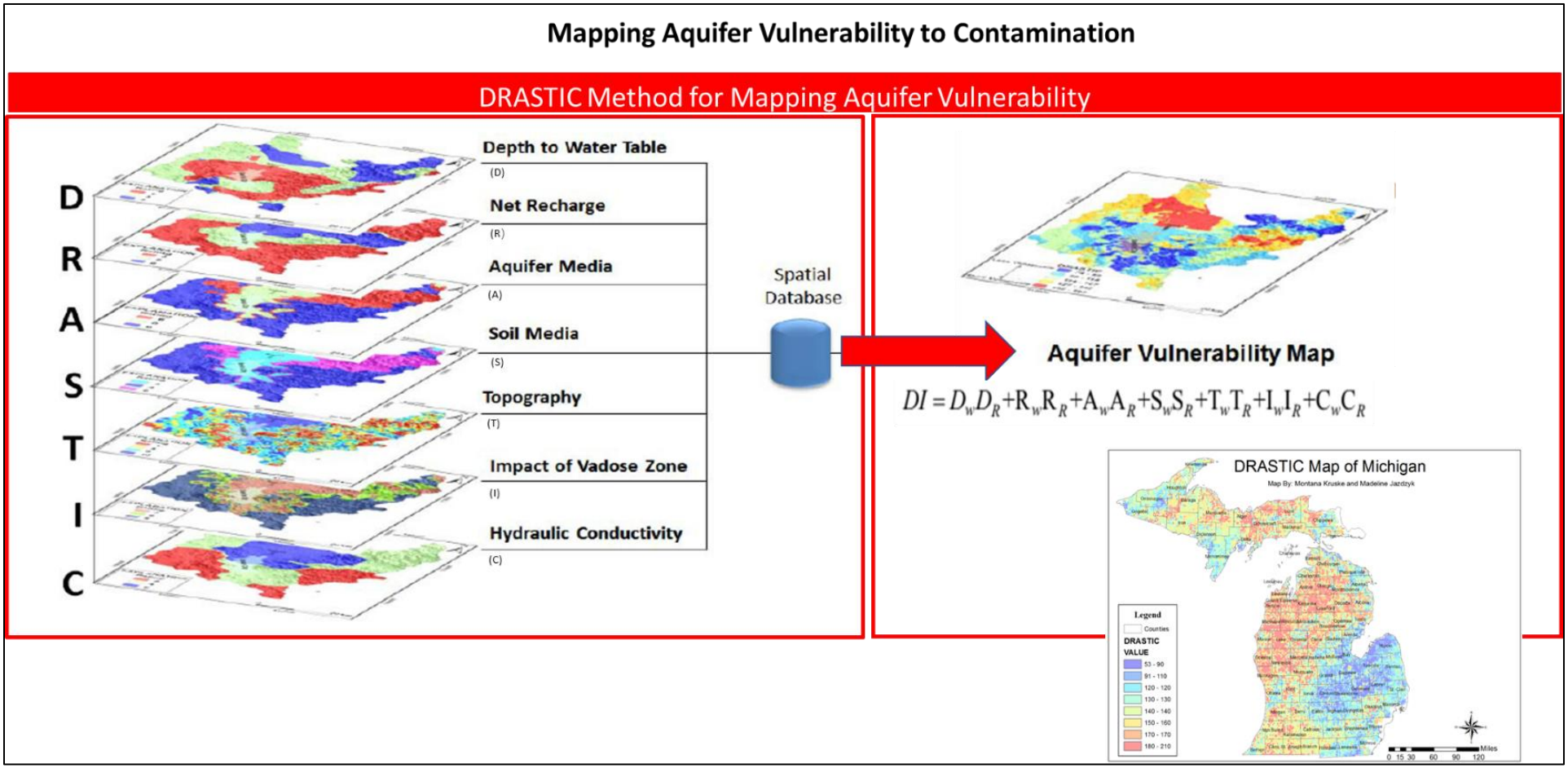
Appendix A1 – SUPPORTING GRAPHICS



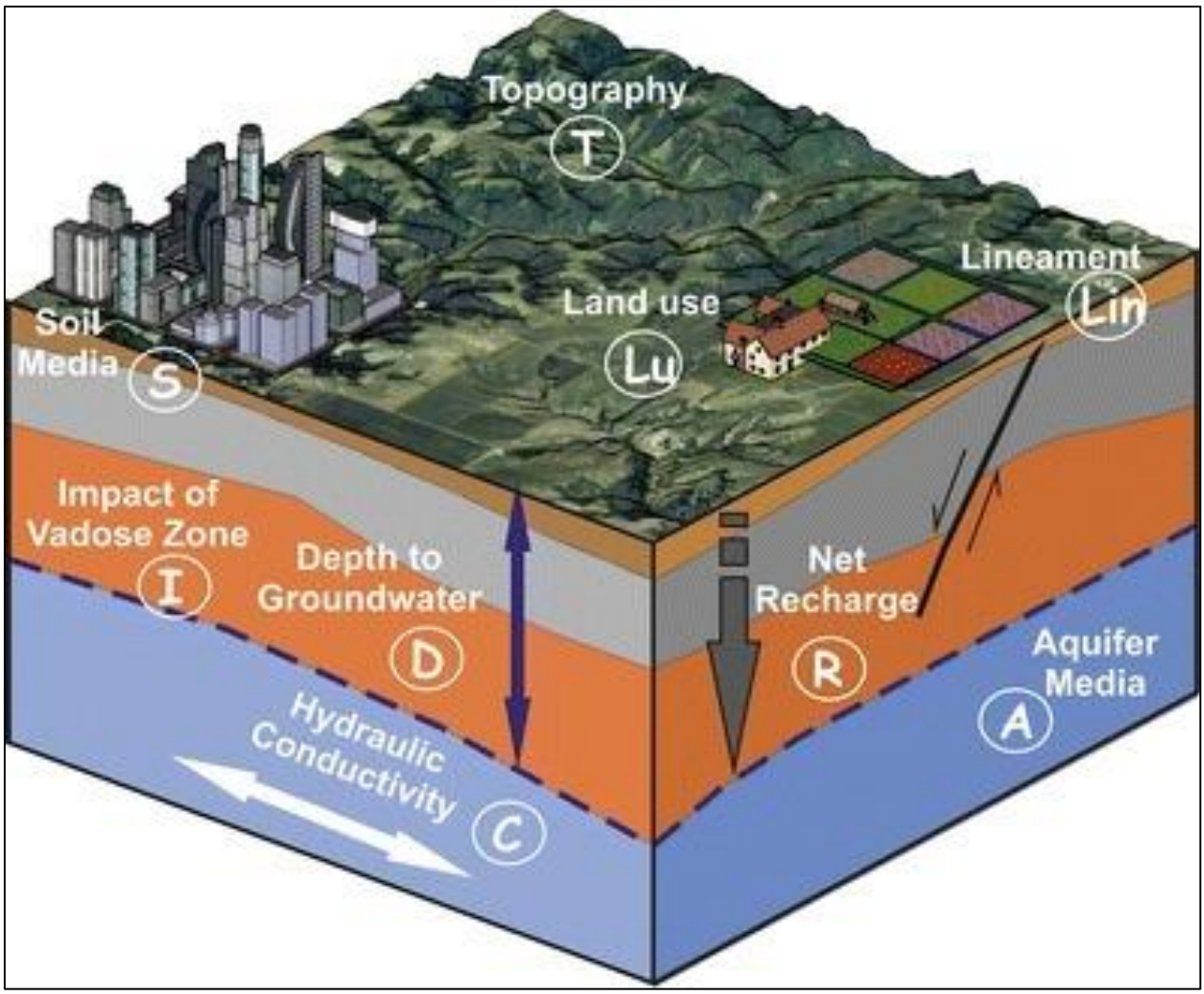
Graphic 1: Examples of applying the forward flow tracking technique to identify potential impact areas downstream from a potential groundwater contamination source. Left: Kent County PFAS study area; Right: TCE plume, Mancelona MI. Hydrosimulatics INC. will perform forward flow tracking for all known potential contamination sites in the county. These initial delineations can be used rank and prioritize sites, design optimal monitoring networks and emergency-response systems for the county and its townships.



Graphic 2: Example of applying the backward flow tracking technique to delineate source water areas for different public supply wells in Michigan. These initial delineations can be used to rank and prioritize sites, and to design optimal monitoring networks for the county and its townships. The technology has been used for delineation of source water protection areas (SWPAs) of more than 1,000 major public community wells by the State of Michigan (a task that would cost over $30,000,000 using traditional hydrogeological field investigations). At sites across the state, our model results match well with traditional site-specific investigations (sometimes our delineations are more accurate in some areas where more data is available for that site).



Graphic 3: Conceptual representation of the DRASTIC method for mapping aquifer vulnerability, or how aquifer sensitivity to pollution changes across space. This approach uses weighted averaging of different spatial layers that affect how easy it is for a pollutant to enter and spread in an aquifer system. Different weightings can be explored to look at range of management options for the county and its townships. The DRASTIC method is commonly used in the environmental community as a way to map aquifer vulnerability. Image source: https://www.researchgate.net/figure/Methodology-flowchart-for-DRASTIC-method_fig2_265977431 .



Graphic 4: Conceptual diagram of the DRASTIC approach for calculating aquifer vulnerability to surface pollution. In short, DRASTIC is all about vertical "time" to the aquifer and receptors of interest through the vadose zone and perhaps confining layers (in the case of confined aquifer). Image source: https://link.springer.com/article/10.1007/s10040-012-0947-y.

Appendix A2 – METHODOLOGY FOR FLOW TRACKING

Innovative use of "Big Data"

In recent years, the Hydrosimulatics INC. team has developed a number of innovative uses of large spatial datasets for understanding groundwater conditions across multiple scales, using both data-driven modeling techniques and process-based simulation. Of particular relevance to this proposed project are the various applications of water well data analysis. Although many practitioners insist that water well data from drillers might be too crude to be useful, recent experience in Ottawa County and systematic analysis shows that, when properly processed, these data can be extremely effective as starting point or screening-level evaluation, and can even be used for calibration of simulations of large, complex groundwater system (see Abbas, 2011, Sampath et al. 2016, 2016; Curtis et al. 2018; 2019; Liao et al. 2019 – full citations are provided below). In fact, extensive comparative analyses show that a large number of noisy measurements are much more useful than a limited number of precise measurements in delineating large groundwater systems.

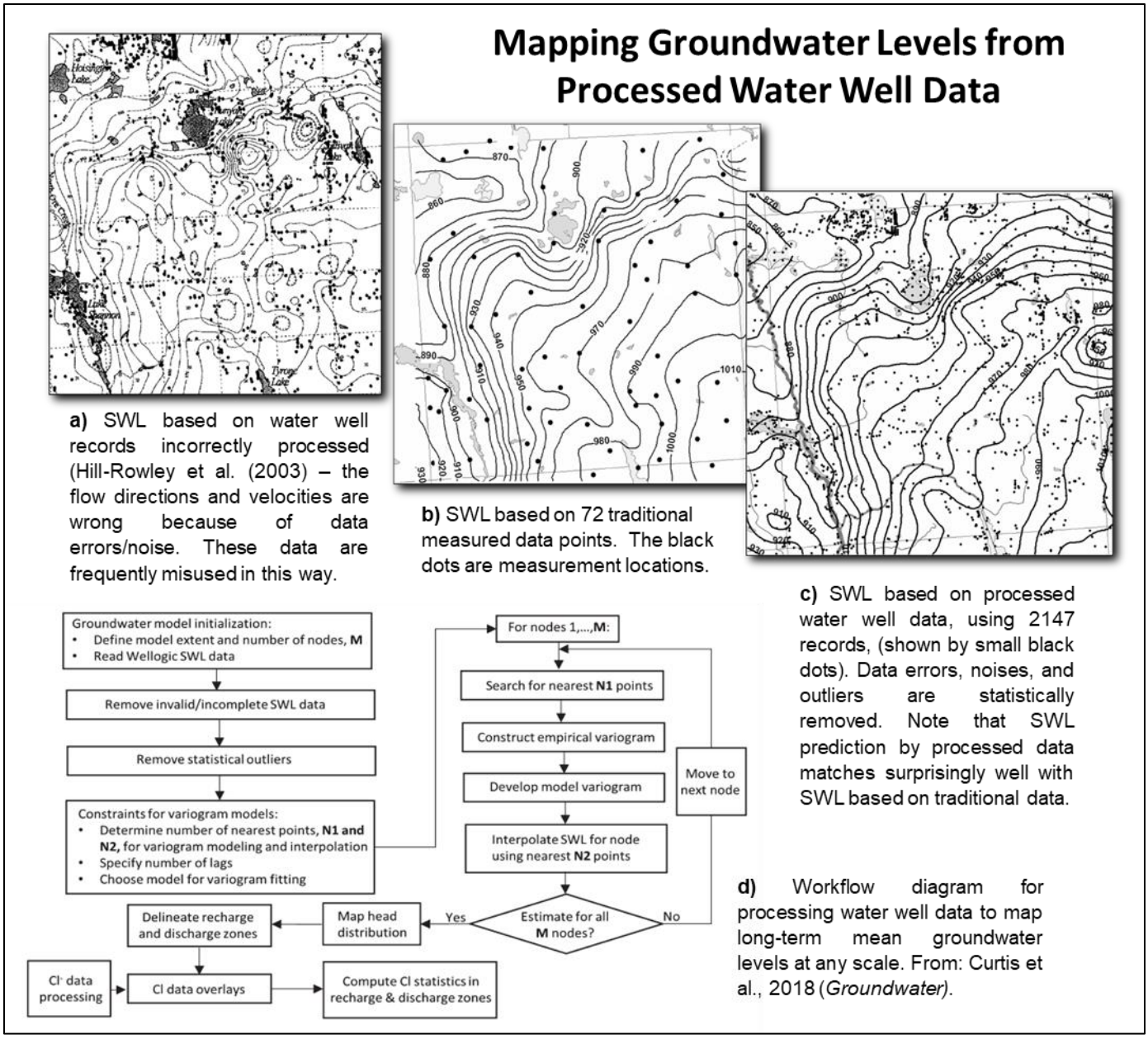
The American Society of Civil Engineers' Civil Engineering Magazine recognized Michigan's innovative use of water well records for cost effective resources management (2009 October Issue). These innovations also won "the '2009 Michigan Department of Environmental Quality (MDEQ) Director's Award", the First Place in the "2009 Michigan American Water Works Association (AWWA) 'Fresh Idea' Competition", and the Third Place in the "2009 National AWWA 'Fresh Idea' Competition". James Cleland, Chief of the MDEQ's Water Bureau, calls the contribution a "breakthrough the barriers" type of research that "will revolutionize how the DEQ evaluates groundwater in the years to come".

Steps to Filtering Water Well Records (for Spatial Interpolation)

The approach to using water well records follows a three-step filtering procedure:

1. Remove "black/white" errors. This step removes data values that are clearly wrong using a simple GIS-based query analysis.
2. Remove statistical outliers. This step performs a moving window statistical data analysis and identifies and removes data values that deviate significantly from local trends based on a predefined criterion (e.g., outside three standard deviations).
3. Remove "gray" errors. This step attempts to remove "randomly" distributed data noises representing errors caused by inaccurate well location, seasonal variability, inconsistencies, measurement uncertainty, and "driller variability". This is achieved using an advanced "moving window, non-stationary multiscale Kriging technique". This filtering technique, using a location dependent variogram, enables removing noise in complex datasets in the presence of strongly non-stationary spatial trends.

An example comparison of using traditional water level data and Static Water Level (SWL) data is shown in Graphic 5.



Graphic 5: Comparison of static water level (SWL) distribution based on traditional data and free water well records, Tyrone Township, Livingston County, Michigan; and a workflow diagram of the water well processing scheme. Hydrosimulatics INC. will apply the data processing scheme to map groundwater levels for sites or clusters of sites where sufficient water level data is available for spatial interpolation.

Prior Demonstrations and Applications

The data-driven and approach has been applied over the past decade for cost-effective, efficient characterization of groundwater flow system across the state of Michigan. Specific applications include:

i) delineation of source water protection areas (SWPAs) of more than 3,000 public major community wells by the State of Michigan – a task that would traditionally cost $36,00 for one site

ii) delineation of source water protection areas of 250 valuable groundwater-dependent-ecosystems supporting rare and endangered species by USFWS (see Abbas, 2011; Sampath et al. 2015, 2016);

iii) evaluation of upwelling of deep brines into shallow aquifers in 33 counties across Michigan by USDA, including detailed analysis in Ottawa County, Michigan (see Lusch et al., 2018, Curtis et al., 2018, 2019; Liao et al., 2020).

Relevant Publications

Abbas H (2011). Prairie Fen Hydrology. PhD Dissertation, Michigan State University, East Lansing.

Curtis, Z.K., Li, S.G., Liao, H.S. and Lusch, D., 2018. Data-driven approach for analyzing hydrogeology and groundwater quality across multiple scales. *Groundwater*, *56*(3), pp.377-398.

Liao, H.S., Curtis, Z.K., Sampath, P.V. and Li, S.G., 2020. Simulation of Flow in a Complex Aquifer System Subjected to Long-Term Well Network Growth. *Groundwater*, *58*(2), pp.301-322.

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Data-enabled Process-based Flow Modeling

At the heart of the MAGNET software to be used for this project is a wide-ranging storehouse of pre-processed "BIG" spatial framework data needed to conceptualize and calibrate numerical groundwater flow and transport models. The MAGNET modeling tools are built on / integrated with / live-linked to the preprocessed BIG DATA to allow extremely quick modeling of groundwater conditions in the surficial aquifer layer critical to water resources and groundwater-dependent ecosystems.

Aquifer Top

The top surface of a surficial aquifer model in MAGNET is the spatially variable land surface, represented by preprocessed Digital Elevation Models (DEMs). Ten-meter resolution DEM data is available for Allegan County from the USGS National Elevation Dataset (NED).

Aquifer Bottom

The bottom boundary is represented with a spatially variable surface representing the top of the bedrock unit underlying the unconsolidated sediments. A 500m data layer and a 1 km data layer has been created for the State of Michigan that will be used for process-based modeling involved with this project.

Hydraulic Conductivity

The ease with which groundwater flows through the subsurface (hydraulic conductivity) will be represented with a spatially variable 2D data-layer available for the State of Michigan. This data layer was generated by interpolating estimates of K from records in the Wellogic database, public water supply and U.S. Geological Society aquifer-tests, and aquifer properties reported in literature.

Aquifer Recharge

Infiltration of precipitation to the water table (groundwater recharge) is represented with a spatially variable 2D recharge input to the top-most cells in the groundwater model. For this project, a recharge raster layer is available (1609 m resolution) is available, generated following empirical methods presented in Holtschlag (1997) involving observed stream flow hydrographs and information related to land use, soil conditions, and watershed characteristics.

Surface Sources / Sinks of Water

In instances where the groundwater head exceeds the land surface elevation, groundwater can leave the aquifer as a sink of water (i.e., groundwater is lost as surface seepage). This approach automatically captures the exchange of groundwater to surface water bodies as part of the robust solution process, as the surface water stages (elevations) are embedded in the high-resolution DEM datasets available on the MAGNET server.

Allegan County Ground Water Study Ad-Hoc Work Group

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WATER STUDY WORKGROUP – AGENDA

Wednesday, May 4, 2022 – 2PM
Human Services Building, Karl Zimmerman Room
3255 122nd Avenue, Allegan, MI 49010
Virtual Meeting Options – Connectivity Instructions

2PM **CALL TO ORDER**:
ROLL CALL:
Present in Person: Ric Curtis, Dean Kapenga, Tom Kunetz
Present via Zoom: Zach Curtis, Brian Talsma, Johan Shagonaby
Absent: Kraai, Sweeris, Elgin, Drozd
PUBLIC PARTICIPATION: Michael Frederick
PRESENTATIONS: Proposal by Hydrosimulatics (Dr. Zach Curtis) for SCREENING-LEVELMODELING, RISK ANALYSIS, AND RANKING (Final Proposal Attached)
COMMUNICATIONS:

DISCUSSION ITEMS:

1. **Ground Water Study Next Steps: Formal Proposal for the** SCREENING-LEVEL MODELING, RISK ANALYSIS, AND RANKING **(Dr. Zach Curtis):**
   a. Dr. Curtis presented the formal proposal for screening level modeling of contaminated sites. 290 sites will be studied. 64 receptor sites will be included. Not included are 62 receptor sites already included in a state WHPA. Study will take about 6 months to complete. This will be called "Phase 2." Work Group to be updated regularly during progress.
   b. MOTION made: To recommend to the Allegan County Board of Commissioners that the Proposal submitted by Hydrosimulatics Inc. be accepted. (Unanimous approval, Dr. Curtis abstained)
   c. Suggestion made to inform EGLE of Hydrosimulatic's screening level study, as they may have input or be able to use resultant output of study for enforcement activities with regard to contaminated sites. ACTION: Scott Jones to contact EGLE and see if a representative can attend next Work Group meeting.
   d. Kapenga requested that the Board of Commissioners be informed of how much funding the Work Group anticipates being required in the near term and long term in response to this group's charge. ACTION: Rapp will prepare a report to BOC informing them of need for funds for the screening level study plus the DSS recommended in the Phase 1 study, approx.. $300,000 required in 2022. Long term funding cannot be estimated as the Work Group does not yet have sufficient understanding of future needs, but will address this later.
2. **Growth Trends for Allegan County:**
   a. **Presentation by Lakeshore Advantage:**
   Not present. Will attend the May 18, 2022 meeting
   b. **Presentation by State of Michigan (pending):** Not present.

3. **Proposed Recommendation to Board of Commissioners for Lobbyist (Pending results of BOC action):**
    a. Kapenga informed Work Group that the BOC has retained Midwest Strategy as their lobbyist for primarily broadband and water issues.
    b. MOTION made: To approve the Recommendation to the Board of Commissioners that Midwest Strategies be used to search for and secure state and federal funding for water-related projects. (Copy of Recommendation attached.)
    c. Kapenga reminded Work Group that the County may have access to ARP funds. It would be prudent to start considering now what water-related projects may benefit from these funds and inform the BOC so that they can plan for requesting funds. Work Group agreed to keep this in mind and revisit when more progress is made and group has a better understanding of the magnitude of work that may be required.
    d. Z. Curtis suggested that the Work Group invite Pat S? from Ottowa County to speak to the group about Ottowa's experiences with respect to contaminated site remediation and costs.
    e.
4. **Big Picture Framing Questions from the Work Group:**
    a. Kunetz requested group to think about overall framing questions that the group should be asking with respect to our charge. These questions help identify to the group what information is needed to in order for the group to make decisions, and therefore will guide our activities.
    b. Framing Questions are attached. This list can be modified as new questions are identified.

PUBLIC PARTICIPATION: Mike Frederick, lobbyist for Michigan Ground Water Association offered suggestions on the framing questions. He offered his services to the County as a lobbyist should the County need them.

ADJOURNMENT: 3:30 p.m. Next Meeting scheduled for Wednesday, May 18, 2022, at 2PM (Karl Zimmerman Room, Human Services Building)

Workgroup Tasks and Deliverables:

1. Review the final Allegan County Groundwater Study, conducted by Hydrosimulatics, Inc. and submitted to the Board on March 25, 2021.
2. Provide regular updates to the Board and a final written summary of observations and recommendations of the workgroup, within one-year of the appointment of its members, relative to the study content (and any other aspects of Allegan County's current and future state relative to water quality, including recommendations for how the County (as a geographic area) should proceed with next steps (if any) and provide particular focus on Hydrosimulatics, Inc. recommendation to pursue an interactive Decision Support System. All recommendations must be specific as to the management/oversight model, funding, root need/issue to be addressed and expected results of any next steps to be considered.
3. The Allegan County Health Department will participate in the discussions of the work group and will provide administrative support, guidance and expertise.
4. As an ad-hoc workgroup, the work of the group will be considered complete upon the delivery of item number 2 above.

ALLEGAN COUNTY
REQUEST FOR ACTION FORM

Completed RFA form must be attached to a work order request through the Track-It System. If you have any questions regarding this process, please contact Administration @ ext. 2633.

RFA#: 214-007

Date:

Board Approval: Items historically done on a periodic basis or Proclamations, directly to Board for action; Political positions require Board discussion.

Request Type	Routine Items
Department Requesting	Health
Submitted By	Randy Rapp on behalf of the Ground Water Study Ad-Hoc Work Group
Contact Information	rrapp@allegancounty.org & 4706

Description

The GROUND WATER STUDY AD-HOC WORK GROUP requests the Board of Commissioners to appropriate an amount, not to exceed, of three million dollars ($3,000,000.00) for the purpose of ground water studies and potential improvements for the advancement of ground water knowledge and protection in Allegan County. (see attached motion)

GROUND WATER STUDY AD-HOC WORK GROUP

MOTION AT THE JUNE 1, 2022 MEETING

MOTION: The GROUND WATER STUDY AD-HOC WORK GROUP requests the Board of Commissioners to appropriate an amount, not to exceed, of three million dollars ($3,000,000.00) for the purpose of ground water studies and potential improvements for the advancement of ground water knowledge and protection in Allegan County.

Motion made by: Doug Sweeris

Seconded by: John "Ric" Curtis

Vote:

Dean Kapenga, yes
Doug Sweeris, yes
Ric Curtis, yes
Tom Kunetz, yes
Chad Kraai, yes
Brian Talsma, yes
Erick Elgin, yes

Zachary Curtis absent
Jay Drozd absent
John Shagonaby absent

Breakdown:

Phase II Study (Hydrosimulatics)	$110,000 +/-
Monitoring	$100,000 +/-
DSS	$200,000 +/-
Total:	$500,000

Quick Fix/Improvements:

Local Unit Reports
Individual Well replacement Grants
Implement Study Correcting

Total:	$2,500,000 +/-
Grand Total:	$3,000,000 +/-