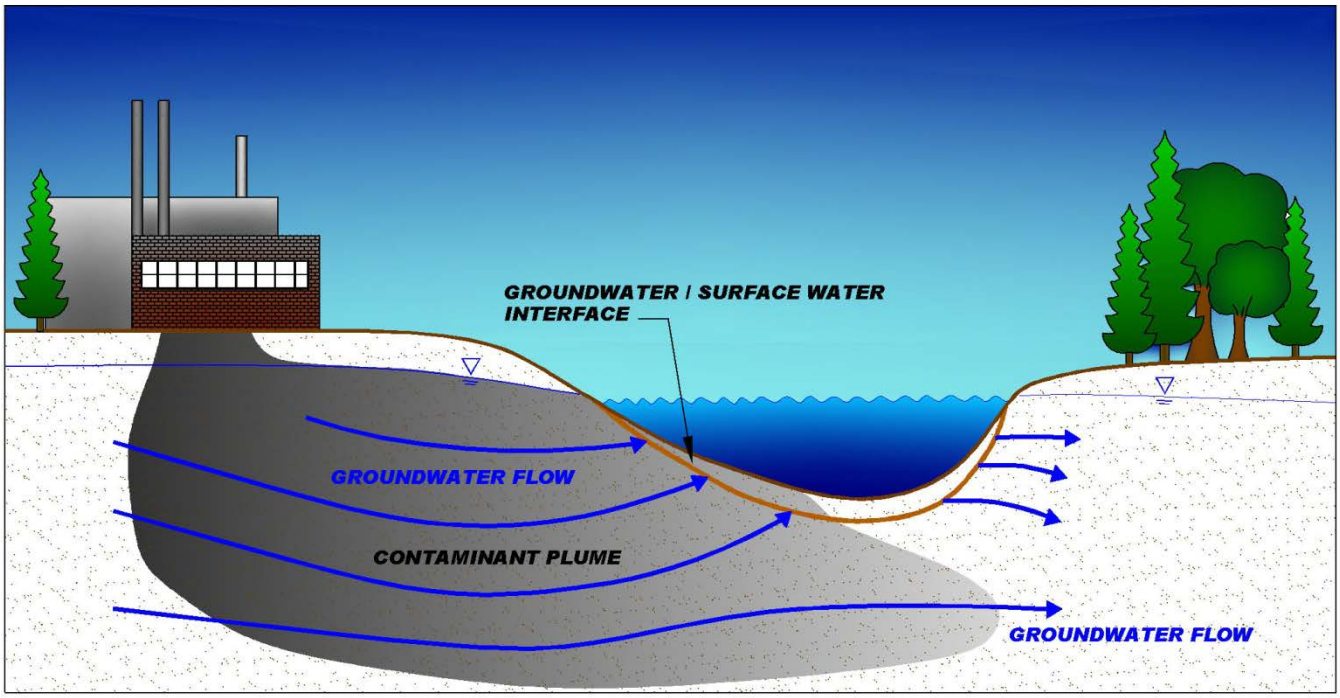
# *GROUNDWATER/SURFACE WATER INTERFACE PATHWAY COMPLIANCE OPTIONS*

## REMEDIATION AND REDEVELOPMENT DIVISION RESOURCE MATERIALS

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RRD-RESOURCE MATERIALS
June 2014

*In order to promote a consistent and informed approach for Michigan Department of Environmental Quality (MDEQ) staff, this document was developed to provide information to MDEQ staff and contractors on compliance options the groundwater/surface water (GSI) pathway.*

*This document is available as a technical reference to assist any party conducting investigations and assessing the GSI pathway to demonstrate compliance and support risk management decisions.*

*This document is explanatory and does not contain any regulatory requirements. It does not establish or affect the legal rights or obligations for the GSI pathway. It does not have the force or effect of law and is not legally binding on the public or the regulated community. Any regulatory decisions made by the MDEQ regarding GSI compliance will be made by applying the governing statutes and Administrative Rules to relevant facts.*

Approved: _____

Robert Wagner, Chief
Remediation and Redevelopment Division
June, 2014

**TABLE OF CONTENTS** **page no.**

## SUMMARY

This document is provided as a resource for environmental professionals interested in identifying compliance options for the groundwater/surface water interface (GSI) pathway. The GSI pathway plays a critical role in Michigan's environmental cleanup program due to complex hydrogeology across the state.

The first step in evaluating the GSI pathway is to develop a conceptual site model (CSM) with site specific investigative information, and then determine whether contaminated groundwater vents to a surface water body that is defined as waters of the state pursuant to Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act (NREPA), PA 451, 1994, as amended (Part 31). If it does not, the pathway is not relevant and no further GSI pathway investigation or monitoring is needed. If investigative activities indicate that the pathway is relevant, there are several options available for assessing and achieving compliance for contaminated venting groundwater.

After determining that the GSI pathway is relevant, an assessment of the contaminant concentrations will indicate whether the levels present exceed Michigan Water Quality Standards. If concentrations do exceed the Water Quality Standards, there are additional measures that may be taken to demonstrate compliance. These include collecting samples from GSI monitoring wells, requesting a variance, applying for mixing zone-based criteria, calculating site specific criteria, sampling alternative monitoring points, conducting an ecological assessment, completing a modeling assessment, performing a de minimis effect demonstration, requesting a technical impracticability waiver, and monitoring natural attenuation.

In cases where groundwater discharges to a storm sewer and the storm sewer in turn discharges to a surface water body, the point of compliance for the release under Part 201, Environmental Remediation, and Part 213, Leaking Underground Storage Tanks of the NREPA, PA 451, 1994, as amended (Part 201 and Part 213), is at the storm sewer outfall. However, this does not negate the obligations of municipal separate storm sewer (MS4) permit holders to eliminate illicit discharges or meet the requirements of the federal Clean Water Act (CWA). There are additional options referenced to assist with compliance for these conditions.

This document is not intended to comprehensively describe all details regarding the GSI pathway and options for achieving compliance. This document serves as a reference to help describe some of the methods and means for achieving compliance for the GSI pathway and to point to other resources that may be helpful.

## 1.0 INTRODUCTION

Glaciers advancing across the Michigan basin carved and shaped the landscape creating the Great Lakes and thousands of inland lakes, rivers, streams, and wetlands. The glaciers also deposited thick layers of unconsolidated drift where groundwater is present in numerous aquifers that are directly connected to surface water bodies. The groundwater/surface water interface (GSI) pathway defines this connection. The GSI is the location at which groundwater vents to a surface water body. Contaminant plumes resulting from releases of hazardous substances from thousands of sites across the state of Michigan migrate with groundwater and may pose a threat to surface water bodies. Characterization, evaluation, and management of contaminant plumes where the GSI pathway is relevant are statutorily required to ensure protection of waters of the state.

The scope of this document is to describe, in general terms:

- *GSI Pathway Relevancy*
- *Conceptual Site Model (CSM)*
- *Water Quality Standards*
- *Acute Toxicity Requirements*
- *Municipal Separate Storm Sewer Systems(MS4)*
- *Industry Standard for Impervious Storm Sewer*
- *GSI Pathway Compliance Options*

It is not the intent of this document to provide a detailed discussion of all GSI concepts or strategies. A list of selected definitions is provided in Appendix A. There is also a list of selected references, which provide a more thorough discussion of the concepts presented in this document, is presented in Appendix B. Statutory references in Appendix B provide regulatory requirements for the venting groundwater pathway.

## 2.0 GSI PATHWAY RELEVANCY

The GSI pathway is relevant when a remedial investigation or application of best professional judgment leads to the conclusion that a hazardous substance in groundwater can be reasonably expected to vent to surface waters of the state in concentrations that exceed the generic GSI criteria currently or in the future. The GSI pathway may be relevant for all land uses if there is a hydraulic connection between the groundwater and surface water. The Water Resources Division (WRD) of the MDEQ, is charged with determining whether a water body meets the criteria for being classified as surface waters of the state. Surface waters of the state include intermittent or ephemeral streams, creeks, brooks, ditches, drains and wetlands, including unregulated wetlands.

Some key elements in determining pathway relevancy include the following:

- There must be a hydraulic connection between the contaminated groundwater and surface water to have a groundwater/surface water interface. This includes an intermittent stream or water body that has flow until the groundwater table drops below the stream bottom. Intermittent streams are protected for acute and chronic risks at the GSI. An ephemeral stream or water body only has flow during periods of surface runoff (rain or snowmelt). By definition an ephemeral stream would not have a groundwater surface water interface.

- The hydraulic connection must transport contaminated groundwater to the surface water; a 'losing' surface water body would have a hydraulic connection with groundwater but would not transport contaminated groundwater to the surface water body.

- The designation of groundwater "not in an aquifer" does not eliminate the need to evaluate the GSI pathway. Groundwater "not in an aquifer" may be hydraulically connected to a surface water body and may vent or be reasonably expected to vent in concentrations that exceed generic GSI risk-based screening levels (RBSLs)/criteria (Appendix A).

- The applicable generic GSI RBSLs/criteria for all appropriate hazardous substances released or otherwise affected (reactions, breakdown byproducts, etc.) and appropriate water quality standards for physical characteristics are or could be exceeded in representative samples at GSI monitoring points.

- Contaminated groundwater is discharging into a separate storm sewer that discharges to a surface water body.

If the pathway for venting groundwater is determined to be not relevant, further evaluation is not necessary. The GSI pathway may be determined to be not relevant with supporting site conditions documentation that includes consideration of the statutory factors that may be used to demonstrate that there is no likelihood of exceeding GSI RBSLs/criteria in the groundwater contaminant plume at the point it vents to surface waters.

If investigative activities indicate that the pathway is relevant and groundwater is venting to surface water and the concentrations are below the generic GSI RBSLs/criteria and will remain below the GSI, no further action is needed. For the remaining circumstances where the pathway is relevant and contaminant concentrations exceed the generic GSI RBSLs/criteria, there are statutory options available to assess and achieve compliance for contaminated venting groundwater.

## 3.0 CONCEPTUAL SITE MODEL (CSM)

A CSM is a very powerful tool that can relay site specific information in a very expeditious and concise manner. A CSM is a written and/or an illustrative representation of the conditions and the physical, chemical and biological processes that control the transport of contaminants from areas with high concentrations of contaminants through environmental media to human and/or ecological receptors. The information depicted in the CSM can be used to demonstrate GSI pathway relevancy, show plume venting area, and depict the magnitude of the discharge so that all parties quickly understand the site conditions.

An accurate and complete CSM will evolve as information is gathered throughout the life of the project and should support scientific and technical interpretations and decisions for the site. Conditions at contaminated sites vary greatly from one site to another; therefore, the complexity of a CSM should be consistent with the complexity of the site.

The basic components of a CSM include, but may not be limited to the following:

- Site history including the process, products, and substances used.
- The extent of the area to be characterized.
- Identification of potential contaminants.

- Identification and characterization of areas where the release occurred or areas where the highest concentrations of contaminants exist.
- Delineation of potential migration pathways through environmental media such as groundwater, surface water, soil, sediment, biota, and air.
- Establishment of areas not contaminated by the release and the zones of highest contamination for each affected media.
- Identification of potential environmental receptors.

Complete and accurate CSMs pave the way for faster, easier, and better informed decisions when evaluating proposed and completed response actions related to releases of hazardous substances. The CSM also serves as the primary instrument to communicate effectively between all parties about the decision making process and final remedial outcomes.

## 4.0 WATER QUALITY STANDARDS

The MDEQ, WRD, has promulgated rules that establish water quality standards for hazardous substances pursuant to Part 31, Water Resources Protection (Part 31), of the NREPA, 1994 PA 451, as amended, that constitute generic GSI RBSLs/criteria. Water quality standards include chronic chemical-specific values that represent the most restrictive of the water quality values protective for aquatic life, human health, or wildlife; acute chemical-specific values protective of aquatic life; acute and chronic toxic units protective of aquatic life from groundwater toxicity testing; and standards for water quality characteristics such as pH, nutrients, or dissolved oxygen; and include physical characteristics such as, color, foam or sheens, taste, and odor. The chronic chemical-specific GSI criteria are listed in the RBSLs/criteria and the associated footnotes. Acute chemical-specific GSI RBSLs/criteria protective of aquatic life are included in the Part 31, Rule 57, Water Quality Values spreadsheet available from the MDEQ web page (Appendix B). In addition to the chemical-specific water quality standards, venting groundwater may not exceed 1.0 acute toxic units and venting groundwater may not cause or contribute to an exceedance of 1.0 chronic toxic units in the surface waters outside of any MDEQ approved mixing zone.

Generic chemical-specific GSI RBSLs/criteria may be based upon Tier I or Tier II water quality values depending on the amount of toxicity data available at the time that the water quality standards were developed. Tier I values represent a complete toxicity set, and Tier II values are based on a minimum toxicity data set. The Tier I or Tier II designation is indicated in the Part 31, Rule 57, Water Quality Values spreadsheet. Additional information on the toxicity data used to calculate a Tier 1 or Tier II water quality value for a hazardous substance is included in the Part 31 rules. Where the generic GSI criteria are based upon a Tier II value, additional mammalian or aquatic toxicity data to reduce the uncertainty factor would need to be generated to calculate Tier I values.

### 4.1 Applicable RBSLs/Criteria

If the GSI pathway is determined to be relevant, the GSI RBSLs/criteria are applicable. The designation “groundwater not in an aquifer” does not eliminate the need to evaluate the GSI pathway. Applicable RBSL/criteria apply to all appropriate hazardous substances released and appropriate water quality characteristics affected by the release. In cases where a target detection limit for a hazardous substance is greater than the risk-based GSI value, the target detection limit is substituted for the risk-based value as the RBSL/cleanup criterion. If the background groundwater concentration for a hazardous substance is greater than the risk-based GSI RBSL/criterion, the background concentration is substituted for the risk-based criterion as the RBSL/cleanup criterion. Background in groundwater means the concentration or level of a hazardous substance which exists in the groundwater at or

regionally proximate to a site that is not attributable to any release at or regionally proximate to the site. Background in groundwater may be determined on a facility-specific basis if proposed to be substituted for a cleanup criterion.

The GSI RBSLs/cleanup criteria include generic GSI RBSLs/criteria, mixing zone-based RBSLs/GSI criteria, and site-specific water quality standards to be used as GSI RBSLs/criteria. Development of mixing zone-based GSI RBSLs/criteria may be proposed if there is, or there is expected to be, an exceedance of generic RBSLs/criteria. The requirements for development of mixing zone-based GSI RBSLs/criteria are included in the MDEQ Procedure [To Be Determined].

Some generic chemical-specific GSI RBSLs/criteria are based upon the hardness or pH of the receiving waters. For these chemicals, representative site-specific surface water samples are collected for hardness or pH measurements and the values used as input to the criteria formulas. A spreadsheet is available to calculate these GSI and GSI protection RBSLs/criteria from the MDEQ-RRD webpage (Appendix B). To establish a value that can be used for evaluating the potential need for remedial activities, estimated hardness values of 50 milligrams per liter (mg/l) for the Upper Peninsula surface waters, 100 mg/l for northern Lower Peninsula surface waters, and 150 mg/l for southern Lower Peninsula surface waters may be used as input to the spreadsheet. To estimate a GSI criterion for pentachlorophenol, 7.0 standard units may be used to represent the pH of the receiving water. Final determination of compliance with RBSLs/criteria is based on RBSLs/criteria calculated with site-specific surface water hardness or pH values.

Compliance with the generic GSI RBSLs/criteria for ammonia is determined by multiplying the total ammonia-nitrogen concentration in the groundwater by a default value to represent unionized ammonia. The default value for unionized ammonia is based upon pH and temperature of the receiving waters. For the generic GSI RBSL/criterion the default for temperature depends upon the designation of coldwater surface waters. To determine compliance with the RBSLs/criteria, the designation of the receiving surface water must be identified. The Michigan Department of Natural Resources designates coldwater lakes and trout streams. Copies of the designations are available from the MDEQ district offices. If the surface water is not designated as coldwater, it is protected as warmwater. Representative site-specific surface water measurements may be collected for temperature or pH and the maximum values used rather than the default pH of 8 standard units and default surface water temperatures of 68˚F for coldwater and 85˚F for warmwater to estimate an alternative default value.

Some generic chemical-specific GSI criteria depend upon whether the surface water is protected as a drinking water source. The Great Lakes and their connecting waters are protected as a drinking water source. The Great Lakes connecting waters are defined as: the St. Mary's River, the Keweenaw waterway, the Detroit River, the St. Clair River, and Lake St. Clair. A listing of public water supply intakes on inland lakes and rivers is available from the MDEQ district offices.

## 4.2 Whole Effluent Toxicity (WET) Testing

The federal Clean Water Act's (CWAs) prohibition of the discharge of toxic pollutants in toxic amounts is incorporated into Part 31 Water Quality Standards. In addition to chemical-specific Water Quality Standards, venting groundwater may not exceed 1.0 acute toxic units, and may not cause or contribute to an exceedance of 1.0 chronic toxic units in the surface waters outside of any MDEQ approved mixing zone.

The WET refers to the aggregate toxic effect to aquatic organisms from all pollutants contained in a discharge (effluent). The United States Environmental Protection Agency (USEPA) WET aquatic toxicity test methods consist of exposing living aquatic organisms (plants, vertebrates, and

invertebrates) to various concentrations of aqueous samples to measure adverse (deleterious) effect on the specific test organisms' ability to survive, grow, and reproduce.

Data on the toxicity of individual hazardous substances to aquatic organisms are used in the development of the Part 31, Rule 57, Water Quality Standards. However, the chemical-specific toxicity values do not address additive or potentiation toxic effects of the compounds that could be present in a venting groundwater plume. Frequently the actual contaminant mixture is unknown or many discharge components are not analytically identifiable, which may not allow adequate assessment of the toxicity of the venting groundwater using chemical-specific criteria. WET testing may be an acceptable method to determine the collective effect of unknown components and contaminant mixtures. WET testing can be used to assess the potential risks associated with unknown components and contaminant mixtures and assist in determining when remediation may be necessary.

Site-specific factors influence the decision to conduct WET testing, and decisions are typically made on a case-by-case basis. WET Testing is most likely to be incorporated into monitoring programs when any of the following circumstances exist at a site with contaminated venting groundwater:

- The venting groundwater contains several chemicals whose toxicity is unknown;
- The venting groundwater contains a significant number of unknown/unidentified chemicals;
- The venting groundwater contains a number of chemicals known to be toxic to aquatic organisms, but may not exceed their individually toxicity limitations;
- The venting groundwater contains elevated concentrations of Total Dissolved Solids (TDS), or the chemical constituents of total dissolved solids (e.g., chlorides, sulfate);
- Adverse bio-survey findings; or
- The venting of groundwater contains a mixture of chemicals from multiple releases or areas of high contamination and the toxicity of the combined mixture cannot be predicted.

WET testing is only applicable for evaluating compliance of venting groundwater at the GSI. If GSI monitoring wells are relied upon for demonstrating compliance, then WET testing may be appropriate at those wells.

## 4.3 Site-Specific Criteria

Development of site-specific water quality standards for use as GSI criterion may be proposed for MDEQ approval. Aquatic life values may be modified on a site-specific basis to be more or less stringent to reflect local environmental conditions. Modifications may be derived using the USEPA recalculation procedure, water effect ratio procedures, or resident species procedure and the specific implementation provisions for recalculation and resident species of the Part 31, Rule 57, Water Quality Standards. Wildlife values may be modified on a site-specific basis to be more or less stringent to reflect local environmental conditions using appropriate site-specific adjustments to the methodology. Human health values may be modified on a site-specific basis to be more or less stringent to reflect local environmental conditions or local human exposure using appropriate site-specific adjustments to the methodology. Less stringent human health values must be protective of designated uses of the surface waters of the state and must be based on sound scientific rationale. Site-specific criteria may also include biological criteria.

If a Water Quality Standard has not been developed under Part 31 for a hazardous substance, then the necessary data for the MDEQ to establish a criterion under Part 31 is provided to the MDEQ and a Water Quality Standard developed prior to any authorization of the discharge, unless the MDEQ can establish criterion based upon comparison to a hazardous substance criterion with similar fate and toxicity, or can determine that a numerical criterion is not required to assure remedial action will be protective.

## 5.0 MUNICIPAL SEPARATE STORM SEWERS (MS4)

Under the federal CWA, MS4s are defined as a conveyance or system of conveyances owned by a state, city, town, or other public entity that discharges to waters of the United States (waters of the state) and is designed or used for collecting or conveying storm water. Regulated conveyance systems include roads with drains, municipal streets, catch basins, curbs, gutters, storm drains, piping, channels, ditches, tunnels, and conduits. Open drains used solely for conveyance of storm water may be considered part of a regulated conveyance system. A regulated conveyance system does not include combined sewer systems and publicly owned treatment works.

The CWA requires storm water discharges from certain types of urbanized areas that meet certain population thresholds to be permitted under the National Pollutant Discharge Elimination System (NPDES) program. A list and maps of MS4 communities is available from the MDEQ webpage (Appendix B).

The discharge of contaminants into a regulated municipal separate storm sewer system is an illicit discharge in accordance with Part 31 and the CWA. A contaminant plume containing concentrations of hazardous substances that comply with Part 201 and Part 213 may still be considered an illicit discharge in accordance with Part 31 and the CWA. MS4 permittees are required to detect, eliminate, and effectively prohibit illicit discharges into their MS4. The MDEQ, WRD, has included options to address illicit discharges that will help permittee's maintain compliance as part of their compliance assistance program. These options are available where illicit discharges of contaminated groundwater are occurring and for the party responsible for the illicit discharge and the MS4 permit holder to work on together.

Discharges from storm sewer systems that are not subject to MS4 regulations are required to comply with Part 31 and the CWA.

## 6.0 INDUSTRY STANDARD FOR IMPERVIOUS STORM SEWERS

Provisions to be considered in determining if the GSI pathway is relevant with regard to groundwater discharges to storm sewers reference the use of an "industry standard." The provision is based upon the concept that a sewer may be "impervious" to groundwater and groundwater seepage into the sewer is not reasonably expected to occur. The "industry standard" applies in determining if the sewer can be considered "impervious." The term "impervious" implies that the sewer is *impenetrable or prevents passage,* and the term applies to situations where a sewer is lined or constructed to be "impervious." Sewers are generally constructed of porous material with joints designed to allow leakage.

Migration of groundwater into a storm sewer can be prevented if the sewer is constructed to be impervious based on industry standard and shown to:

- Have been designed to prevent infiltration of water into (or out of) the sewer;

- Have a permeability that would prevent infiltration of groundwater into the sewer; typically less than $1x10^{-7}$ cm/sec, overall (including joints);

- Have a design life that is either the replacement time determined by the municipality or thirty years, whichever is longer; and

- Be compatible with the contamination such that the contamination will not significantly affect the permeability over the design life.

Supporting documentation including the above information and any supporting lines of evidence to demonstrate the "impervious" nature of sewer are critical for making this determination.

## 7.0 GSI PATHWAY COMPLIANCE OPTIONS

### 7.1 Generic GSI Criteria

Compliance may be demonstrated if contaminant concentrations are below the Generic GSI criteria, which are the Water Quality Standards, in GSI monitoring wells or alternative monitoring points.

### 7.2 Variances

The GSI statutory provisions include the option to request a variance from the surface water quality standards. Variance approval is achieved through the MDEQ, WRD, under Part 31. The information needed to request a variance from the surface Water Quality Standards is available for reference in R 323.1103.

Response activity plans have been approved that rely upon a variance to the mercury water quality standard where during evaluation, concentrations exceeded those determined as de minimus by the MDEQ Policy Number 09-014. In these instances, contaminated materials have been removed so that there is no longer a recognized source of mercury, and the level currently achievable has been demonstrated to be ten parts per trillion, or less.

### 7.3 Mixing Zones

Compliance with the GSI Pathway can be determined using mixing zone-based criteria. If samples from representative GSI sampling points exceed the generic GSI criteria or indicate that generic GSI criteria could be exceeded in the future, one option to pursue could be to obtain and comply with mixing zone-based GSI criteria.

A mixing zone is the allocated portion of the receiving surface water body where venting groundwater discharge is mixed with surface waters. The mixing zone is used to develop mixing zone-based criterion.

It may be advantageous to request calculation of preliminary mixing zone-based GSI criteria which will allow the results to be factored into the selection and design of a remedy. Sufficient information from the investigation will need to be available to process a request for preliminary mixing zone-based criteria. Information necessary to process a request to develop mixing zone-based criteria is included in the MDEQ Procedure [To be determined].

## 7.4 Alternative Monitoring Points

Alternative monitoring points may be used to demonstrate compliance with the GSI Pathway for comparison of data to Water Quality Standards, mixing zone-based GSI criteria, or site specific criteria. Alternative monitoring points are designed to allow for the collection of samples representative of the venting groundwater before it mixes with surface water. Alternative monitoring points are physically placed in locations where the contaminated groundwater vents to the surface water body before mixing with surface water. For example, a contaminant plume may be discharging to the surface water body some distance from the shoreline as opposed to directly venting along the shore due to regional groundwater flow paths, and alternative monitoring points could be used to collect samples at the location where the contaminated groundwater is actually venting to the surface water body. The vertical location of this venting (and the appropriate depth for sampling) is variable and will be influenced by the type of water body into which the discharge is occurring, as well as local hydrologic and geologic conditions. Specialized sampling devices may be used to collect representative samples. Tools available to locate areas of contaminated groundwater discharge are identified in the USEPA publications (Appendix B).

Characterization of the area where the contaminated groundwater is venting is critical to determining that the alternative monitoring points are being located in the areas that are reasonably representative of the higher concentrations of hazardous substances venting to the surface water. This characterization includes a description of the substrate and geology, and the spatial and temporal variability of the discharge, as well as the magnitude.

Sentinel monitoring points (including monitoring points upland of the surface water body in the appropriate flow path(s)) are used in conjunction with the alternative monitoring points for a period as needed to assure that any potential exceedance of an applicable surface water quality standard can be identified with sufficient notice to allow for additional response activity or corrective action, if needed, so that the exceedance can be appropriately addressed before discharging, and contingencies can be implemented.

Alternative monitoring points may be used to demonstrate that there is no need to take additional response activity to address the GSI pathway. This is done through notification to the MDEQ with a request for approval.

## 7.5 Ecological Assessment

The GSI statutory provisions allow the use of ecological assessments to evaluate and to determine compliance with the GSI pathway using scientifically valid methods. The USEPA has developed comprehensive guidance on ecological assessments that can be relied upon (Appendix B). Ecological assessments are typically site–specific and staff of the MDEQ, are available to assist with the development of a proposal for this type of assessment, upon request.

## 7.6 Modeling Assessment

Modeling may be used to determine compliance with the GSI pathway when a scientifically valid method uses calibrated and verified site-specific field measured data. The scientifically valid method may be demonstrated by the use of a method generally recognized as an acceptable means to model venting groundwater plumes. More innovative methods can be proposed as long as the method is scientifically justifiable for the intended purpose. Representative site-specific data of adequate quality

are used to calibrate and verify the model that shows compliance with the appropriate criteria for any modeling process. Additional information regarding the application of models (including calibration and verification) is available in the *Groundwater Modeling Resource Materials* document (Appendix B).

## 7.7 De Minimis Effect Demonstration

The GSI statutory provisions allow for the demonstration of a "de minimis effect" on surface waters of the state in determining if a response activity is necessary to address the GSI pathway. This provision is based upon the concept that some discharges to surface waters may be so small or of such short duration as to have no or little effect on the surface water. While the term de minimis is not defined by statute or rule, an applicable definition of de minimis effect would be *insignificant or of no concern*. Best professional judgment, multiple lines of evidence, and applicable or relevant appropriate requirements (ARARs) are used to support this determination.

A conceptual site model (CSM) and other data necessary to determine the mass flow of the contaminants and the expected maximum contaminant concentrations at the GSI is an excellent approach to documenting the site conditions and providing the lines of evidence for the demonstration. Plume characterization data is similar to that collected for a mixing zone request, including the low flow conditions of the receiving water. De minimis determinations rely on the concentrations and mass flow of contaminants entering the surface water, in conjunction with the expected duration of the discharge. The existing conditions of an already degraded surface water body do not serve as a line of evidence for determining whether a contribution is de minimis.

The de minimis concept is not applicable in situations where bioaccumulative chemicals of concern (BCC) identified in the water quality standards are being evaluated. Part 31 provisions have requirements to lower the discharge levels for BCC's whenever a discharge is occurring. An exception to this is mercury where the MDEQ policy 09-014 acknowledges that the mercury contribution from the GSI pathway is significantly lower than mercury from more widespread atmospheric deposition.

The de minimis effect concept is not applicable in situations where the relevant GSI criteria may be significantly higher than the risk-based water quality standards as a result of target detection limits not being available to measure the hazardous substance at concentrations at or below RBSLs/criteria. In these cases, when concentrations are detected, the evaluation based upon the risk-based water quality standard would not normally support a de minimis effect determination. Conversely, in instances where compliance with the GSI pathway would be based on the target detection limit rather than the risk-based Water Quality Standards, and there are no detectable concentrations, compliance has been met without the need for a de minimis determination.

In situations where the concentrations exceed a Water Quality Standard based upon acute effects to aquatic organisms, a de minimis determination would normally be inconsistent with a de minimis effect on surface waters.

De minimis determinations account for all Water Quality Standards including the physical properties and aesthetics of the GSI discharge.

Examples of de minimis demonstrations include:

- Mercury when concentrations met conditions outlined in the MDEQ Policy Number 09-014.
- A situation that included numerous contaminants above generic criteria in GSI monitoring wells. The MDEQ review included a review of the extensive available groundwater concentrations of the contaminants of concern. The analysis indicated there was no reasonable potential for

concentrations to exceed water quality standards for the venting groundwater. In conjunction with the reasonable potential analysis, the following were considered in determining that the on-going contaminant plume venting from the facility would have only a de minimus effect on the surface water:

- The location where the groundwater vents is a concrete channel;
- The thorough characterization of the site conditions and well developed CSM;
- The existing site-wide removal of contaminated materials; and
- The existing groundwater flow paths and remaining contaminated materials including:
  **(a)** The integrity of an adjacent dam and the likelihood that it remains in place, and
  **(b)** The proposed restrictions for the area to avoid changes in flow conditions.

The MDEQ has disapproved de minimus determinations in situations where it was determined that the GSI pathway was not relevant, the compliance point was not properly located, or site characterization was incomplete to support the determination.

## 7.8 Technical Impracticability (TI) Waivers

The GSI statutory provisions include the option for a TI waiver request for cases where areas of highest concentrations of soil and/or groundwater contamination have been controlled and compliance with GSI RBSLs/criteria remains unachievable. Technically impracticable means the inability to achieve certain remedial requirements and is based upon engineering feasibility and reliability, cost effectiveness, and risk-based considerations.

In certain situations, remediation of contaminated groundwater to GSI RBSLs/criteria may be technically impracticable from an engineering perspective. This may be due to site-specific characteristics contributing to complex site conditions that may limit the effectiveness of subsurface remediation. Factors such as the nature of the release, chemical properties, contaminant distribution, geology, and aquifer hydraulics or a combination of these may critically limit the potential to achieve GSI RBSLs/criteria in some situations.

Site characterization data plays a significant role in determining appropriate groundwater treatment options. If site characterization data is limited and the selected treatment method is not sufficiently effective, a TI waiver may be a GSI management option. A clearly focused collection of site characterization and data analysis could present sufficient information to define the most critical limitations to meeting GSI RBSLs/criteria.

A TI waiver request is made in writing to the MDEQ and includes lines of evidence, data, and analysis necessary for the MDEQ to determine that compliance with GSI RBSLs/criteria is unachievable.

TI waiver requests typically include the specific compounds that are subject to waiver request, conceptual site model, the spatial area of the GSI over which the waiver will apply, the release locations or areas with high contaminant concentrations that have been identified and will be or have been contained, any ongoing response actions, and a demonstration that no other remedial technologies could reliably achieve GSI criteria within a reasonable timeframe, and estimate of costs.

## 7.9 Natural Attenuation

The GSI statutory provisions include an evaluation of the contaminant plume for natural attenuation when assessing the need for response activities. There are a number of hazardous substances that naturally degrade in the environment over time. This is often demonstrated by monitoring the trends of contaminant concentrations over time and analyzing for daughter products and other geochemical indicator parameters. The MDEQ *Monitored Natural Attenuation Resource Materials* [currently under development] document may be used as a reference for developing plans to use this approach as a remedial strategy. ASTM International, the Interstate Technology and Regulatory Council (ITRC), and the USEPA have published several reference documents that may be used to guide a natural attenuation demonstration. Appendix B lists some of these reference documents.

## 7.10 Use Attainability Analysis (Wetlands)

The GSI statutory provisions protect wetlands for the groundwater to surface water pathway for all of the uses that apply to that wetland as specified by reference to Part 31. Part 31 regulates wetlands as defined surface waters of the state, and lists the designated uses for which they are protected. This list includes, but is not limited, to the following uses: agriculture, navigation, industrial water supply, warm-water fishery, other indigenous aquatic biota, partial body contact, recreation, and fish consumption.

Venting groundwater discharges resulting in water quality that impairs one or more designated uses of a wetland may be allowed if a use attainability analysis (UAA) shows that those designated uses are not or cannot be attained. A UAA is a structured scientific assessment of the factors affecting the attainment of designated uses. The factors to be considered in such an analysis include the physical, chemical, biological, and economic use removal criteria described in the water quality standards regulation by the USEPA. A UAA clearly shows or demonstrates why those designated uses are not attainable or cannot be attained. The analysis is submitted to the MDEQ for approval.

Wetlands not regulated by Part 303, Wetlands Protection, of the NREPA, 1994 PA 451, as amended, are considered waters of the state by Part 31 and are subject to GSI compliance statutory provisions.

## 7.11 Storm Water Sewer Sampling

Sampling at the storm sewer outfall (point of discharge) to surface water may be performed to demonstrate compliance with Part 201 and Part 213. Samples collected from the storm sewer, not the receiving surface water, are collected during dry weather or low flow periods to ensure that water collected represents the contaminated groundwater discharging into the sewer, not surface water runoff. Representative samples collected within the storm sewer that are considered upstream and downstream of the groundwater contaminant plume may also be used to determine if there are other contributions from other hazardous substance releases.

Authorization from the owner or operator of the storm sewer system should be obtained prior to sampling in the storm sewer system.

Appendix C provides a checklist for reference purposes when evaluating contaminated groundwater discharging to storm sewers.

## 7.12 MDEQ Submittals

Throughout the Part 201 GSI statutory provisions, there are references to when response activity may be self-implemented, when the MDEQ must be provided notices, and when submittals must be provided to the MDEQ for approval. Tables summarizing these provisions for ease of reference are included in Appendix D.

# Appendix A

## DEFINITIONS

GSI: Groundwater Surface Water Interface that is the location at which groundwater vents to a surface water body.

GSI Monitoring Well: A vertical well installed in the saturated zone as as practicable to surface water with a screened interval or intervals that are representative of the groundwater venting to the surface water.

GSI RBSLs/Criteria: The water quality standards for surface waters developed by the MDEQ pursuant to Part 31.

Mixing Zone: A mixing zone is the portion of a surface water body in which venting groundwater is mixed with the receiving water.

NPDES Permit: National Pollutant Discharge Elimination System (NPDES) permit issued pursuant to Part 31.

# Appendix B

## REFERENCES


ASTM. 2008. *Standard Guide for Developing Conceptual Site Models for Contaminated Sites.* ASTM E1689-95 (Reapproved 2008). ASTM International, West Conshohocken, PA. www.astm.org (http://www.astm.org/Standards/E1689.htm).

ASTM. 2009. *Standard Guide for Risk-Based Corrective Action for Protection of Ecological Resources.* ASTM E2205/E 2205M-02 (Reapproved 2009). ASTM International, West Conshohocken, PA. www.astm.org (http:// www.astm.org/Standards/E2205.htm).

**Water Quality Standards**
http://www.michigan.gov/documents/deq/wb-swas-rules-part4_254149_7.pdf

**Rule 57 Water Quality Values Spreadsheet**
www.michigan.gov/documents/deq/wb-swas-rule57_210455_7.xls

**MDEQ Designated Use Information**
Designated uses are specified in R 323.1100

WATER QUALITY AND POLLUTION CONTROL IN MICHIGAN
SECTIONS 303(d), 305(b), AND 314 INTEGRATED REPORT
A primary objective of the integrated report is to describe attainment status of Michigan's surface waters relative to the designated uses specified in Michigan's water quality standards.
Chapter 4 provides information regarding how the designated uses are assessed; a narrative of the assessment for the Great Lakes, Inland Lakes and reservoirs, rivers, and wetlands are included in following chapters; additional information for specific surface water bodies are contained in the appendix.
http://www.michigan.gov/deq/0,4561,7-135-3313_3686_3728-12711--,00.html

**GSI and GSI Protection Calculator**
www.michigan.gov/documents/deq/deq-rrd-GSICriteriaForFootnoteGCalulator_487674_7.xls

**Municipal Separate Storm Sewer Systems (MS4) Communities**

http://www.michigan.gov/deq/0,4561,7-135-3313_3682_3716-24366--,00.html

**Alternative Monitoring Sampling Devices**
**Ecological Risk Assessments**

USEPA ECO Update/Ground Water Forum Issue Paper "Evaluating Ground-Water/Surface-Water Transition Zones in Ecological Risk Assessments" July 2008 Publication 9285.6-17 EPA-540-R-06-072.

**Technical Impracticability**

Guidance for Evaluating the Technical Impracticability of Groundwater Restoration; USEPA September 1993; Directive 9234.2-25.

**Use Attainability Analysis**

http://water.epa.gov/scitech/swguidance/standards/uses/uaa/

**Natural Attenuation**

ASTM. 2010. *Standard Guide for Remediation of Ground Water by Natural Attenuation at Petroleum Release Sites.* ASTM E1943-98(2010) ASTM International, West Conshohocken, PA. www.astm.org (http:// www.astm.org/Standards/E1943.htm).

ITRC. *Natural Attenuation of Chlorinated Solvents in Groundwater: Principles and Practices*. September 1999. www.itrc.org

USEPA. *Performance Monitoring of MNA Remedies for VOCs in Groundwater*. April 2004. Publication EPA-600-R-04-027.

USEPA. *Monitored Natural Attenuation of MTBE as a Risk Management Option at Leaking Underground Storage Tank Sites*. January 2005. Publication EPA-600-R-04-179.

USEPA. *Natural Attenuation of the Lead Scavengers 1,2-Dibromoethane (EDB) and 1,2-Dichloroethane (1,2-DCA) at Motor Fuel Release Sites and Implications for Risk Management*. September 2008. Publication EPA-600-R-08-107.

USEPA. *Site Characterization to Support Use of Monitored Natural Attenuation for Remediation of Inorganic Contaminants in Ground Water.* November 2008. Publication EPA-600-R-08-114.

USEPA. *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water*. September 1998. Publication EPA-600-R-98-128.

**Response Activity Providing for Venting Groundwater**

Section 324.20120e, Part 201, Environmental Remediation, Natural Resources and Environmental Protection Act (NREPA), PA 451, 1994, as amended.

http://legislature.mi.gov/doc.aspx?mcl-324-20120e

Section 324.21304a, Part 213, Environmental Remediation, Natural Resources and Environmental Protection Act (NREPA), PA 451, 1994, as amended.

http://legislature.mi.gov/doc.aspx?mcl-324-21304a

# Appendix C

## STORM SEWER SAMPLING CHECKLIST

This checklist provides items that are useful when evaluating if contaminated groundwater is discharging from a site into storm sewers. Samples collected from the storm sewer are expected to be representative of contaminated groundwater discharging to the sewer.

This checklist has been prepared assuming that a complete conceptual site model (CSM) of the site and the release has been prepared and that a groundwater contaminant plume intersects a pervious storm sewer either continuously or seasonally due to water table fluctuations.

| | YES | NO |
|---|---|---|
| Has authorization to collect samples from the storm sewers from the owner of the system been obtained? | | |
| Have you made arrangements to provide data to the owner of the storm sewer system? | | |
| Have all of storm sewers that may be impacted by the contaminant plume been located?<br>*This information is available from storm sewer system maps and/or as-built drawings of storm sewer infrastructure; public works personnel and facility staff; and, field inspections be performed.* | | |
| Are the storm sewer and sanitary sewer combined or separated?<br>*Combined sanitary and storm sewers are otherwise regulated under the NPDES program.* | | |
| Do you know the age and physical condition of the storm sewers?<br>*Downpipe cameras can be used to complete a visual inspection of the storm sewer and identify if/where groundwater discharges are entering the storm sewer, and to identify possible sampling locations.* | | |
| Do you know where the storm sewers discharge?<br>*Does the storm sewer discharge to a surface water of the state, or to a separate storm sewer system and then to a surface water of the state? Part 31 defines a surface water of the state, as "a Great Lake and their connecting waters, all inland lakes, rivers, streams and wetlands."* | | |
| Do you understand the hydraulic connection between the storm sewer, groundwater and the contaminant plume?<br>*What variability is there in the groundwater elevation? Would a large storm event cause an increase in groundwater elevation and increase the discharge of the contaminant plume into the storm sewer, or could it reverse the flow causing water to flow out of the storm sewer and into the formation?* | | |
| Where will you collect your samples?<br>*Have you identified where the discharge is entering the storm sewer? Is this location near a catch basin or manhole, allowing sampling? Will you collect samples up-gradient and down-gradient of the discharge to identify if there are other releases contributing to the contaminant load? Will you sample at the end of the pipe, prior to discharge to waters of the state?* | | |

# STORM SEWER SAMPLING CHECKLIST

| |
|---|
| When will you collect your samples?<br>*Storm sewer samples must be representative of the contaminated groundwater plume entering the storm sewer, not surface runoff entering the storm sewer.* ***Therefore****, sampling events will need to be scheduled with weather events taken into consideration.* |
| How often will you collect your samples?<br>*Although it is standard to collect quarterly monitoring well samples to track seasonal trends in contaminant concentrations and groundwater elevations, this is not the case for sampling storm sewers. It is important that you identify a sampling schedule for your site (e.g. weekly, monthly, quarterly, etc) with supporting reasoning behind it. Your sampling schedule should be flexible to accommodate storm events and other activities that may affect storm runoff and/or discharge into the storm sewer.* |
| How will you sample the storm sewer? Grab samples or automatic samplers?<br>*The sample must be collected from the storm sewer at the point of groundwater discharge into the storm sewer or at a down gradient location from this discharge, or at the end of the pipe. A sample can't be collected in ambient waters after the storm water discharges into waters of the state (e.g. at the end of pipe with river or lake water mixing up into the pipe). Grab samples may be necessary for certain pollutants which cannot be collected using automated samplers due to cross-contamination concerns, these include: bacteria, oil and grease, and volatile organic compounds (VOCs). It is also important to collect a grab sample in the container it will be analyzed from and not to collect in one bottle and then distribute into lab containers. It is also important to not dip the bottle into any sediment collected on the bottom or side of the storm sewer and to minimize volatilization from the sample as much as possible.* |
| What Quality Control Procedures will you utilize during sampling and how will you accomplish this?<br>*It is important that the samples collected are valid and representative of the groundwater discharging into the storm sewer. Therefore, it is important that you abide by sample preservation, hold times, duplicate samples, and blank samples.* |

# Appendix D

## SELF-IMPLEMENTATION PROVISIONS

| Section 20120e Compliance Method | Response Activity Plan Required | | Statute Reference(s) |
|---|---|---|---|
| | Liable Party | Non-liable Party | |
| **GENERIC GSI CRITERIA** | | | |
| Evaluation | No | No | Subsection (5) (a) allows for a person to undertake evaluation activities without a response activity plan that include alternative monitoring points, an ecological demonstration, or a modeling demonstration. However, a notice is required from a liable party only if the conclusion of the evaluation is that no additional response activity is needed. |
| GSI Wells | No | No | Subsection (5) (b) allows for a person to use GSI monitoring wells to demonstrate compliance with generic criteria without a response activity plan. Note this includes sensitive environments. |
| Alternative Monitoring Points (excluding sensitive environments) | No | No | Subsection (5) (c) allows for response activity to include monitoring from an alternative monitoring point to demonstrate compliance with generic criteria without a response activity plan. A notice of alternative monitoring points is required. However, subsection (6) requires a response activity plan if a sensitive environment is present. |
| Ecological Demonstration (excluding sensitive environments) | Not Applicable | No | Subsection (5) (d) allows non-liable parties to conduct response activity that rely on an ecological demonstration to demonstrate compliance with generic criteria without a response activity plan. Note that subsection (9) requires sentinel wells. However, subsection (6) requires a response activity plan if a sensitive environment is present. |
| Modeling Demonstration (excluding sensitive environments) | Not Applicable | No | Subsection (5) (d) allows non-liable parties to conduct response activity that rely on a modeling demonstration to demonstrate compliance with generic criteria without a response activity plan. Note that subsection (10) requires field measurements. However, subsection (6) requires a response activity plan if a sensitive environment is present. |
| Sensitive Environments (AMPs, ED, MD only) | Yes | Yes | Subsection (6) requires a person to submit a response activity plan for any response activity relying on monitoring from alternative monitoring points, an ecological demonstration, or modeling demonstration to demonstrate compliance with generic criteria where a sensitive environment is applicable. Sensitive environments are listed in subsection (6) and include surface waters protected for coldwater fisheries. Note that a plan is not required if GSI wells are used to demonstrate compliance for sensitive environments. |

| Section 20120e Compliance Method | Response Activity Plan Required | Statute Reference(s) |
|---|---|---|

| | Liable Party | Non-liable Party | |
|---|---|---|---|
| **NON-GENERIC GSI CRITERIA** | | | |
| Variance | Yes | Yes | Subsection (7) requires a person to submit a response activity plan for any response activity relying on compliance methods other than generic criteria (e.g. variance, mixing zone, site specific, ecological, modeling). Only compliance with generic criteria is excluded. |
| Mixing-zone | Yes | Yes | |
| Site-specific | Yes | Yes | |
| Ecological Demonstration | Yes | Yes | |
| Modeling Demonstration | Yes | Yes | |

| **REQUIRED MDEQ NOTICES** | | | | |
|---|---|---|---|---|
| Liable Party | Non-liable Party | Timeframe | Statute Reference | |
| Yes | Yes | 7 days | Section 20120e(13)(a) | A person implementing a response activity is required to submit a notice to the MDEQ within 7 days of obtaining knowledge that there is an acute toxicity criterion exceedance at a GSI compliance monitoring point. |
| Yes | Yes | 30 days | Section 20120e(5)(c) | A person is required to submit a notice of alternative monitoring points to the MDEQ 30 days prior to relying on those alternative monitoring points. |
| Yes | Yes | 90 days | Section 20120e(14) | A person is required to submit a notice to the MDEQ if evaluations determine that venting groundwater has no effect or a de minimis effect on a surface water body. The MDEQ may disapprove the determination within 90 days after receipt of the determination. |
| Yes | No | None | Section 20120e(5)(a) | A person liable under Section 20126 is required to notify the department and request approval if evaluations determine that additional response activity is not required and are based on alternative monitoring points, an ecological demonstration, a modeling demonstration, or de minimis determination. |
| Yes | No | 30 days | Section 20120e(13)(b) | Within 30 days of the date of the acute toxicity notification, a person liable under Section 20126 is required to submit a notice of intent to the MDEQ if proposing an alternative monitoring point, ecological demonstration, modeling demonstration, site-specific criterion, or mixing-zone criterion to address acute toxicity exceedance. |