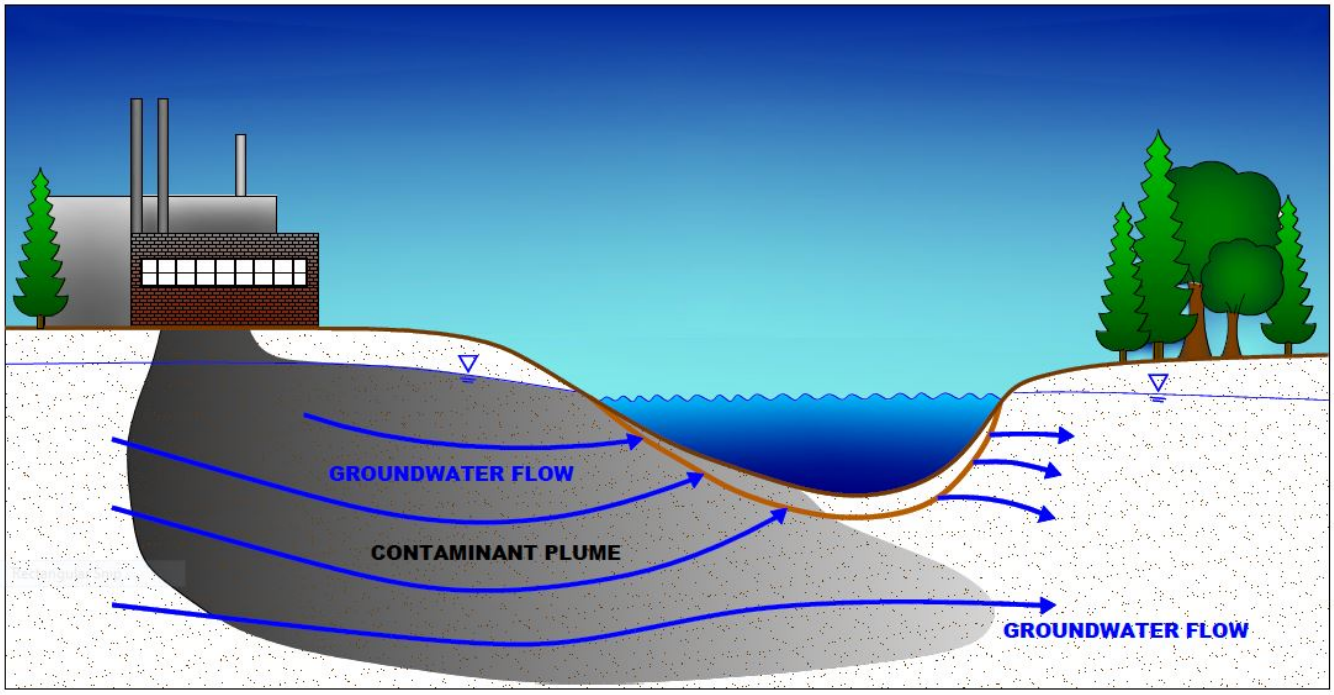
GROUNDWATER-SURFACE WATER INTERFACE PATHWAY COMPLIANCE OPTIONS

REMEDIATION AND REDEVELOPMENT DIVISION RESOURCE MATERIALS



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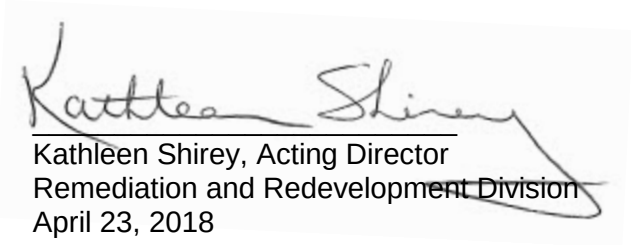
In order to promote a consistent and informed approach for Michigan Department of Environmental Quality (MDEQ) staff, this document was developed to provide information to MDEQ staff and contractors on compliance options the groundwater/surface water (GSI) pathway.

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: 

Kathleen Shirey, Acting Director
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April 23, 2018

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1.0 INTRODUCTION

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.

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 enters (vents) to a surface water body[1]. 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 surface waters of the state.

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

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

This document is not intended to comprehensively describe all concepts or strategies 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. A list of selected definitions is provided in Appendix A. 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 CONCEPTUAL SITE MODEL (CSM)

Site characterization sufficient to provide a clear understanding of the site 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 is necessary for making risk based decisions at sites with environmental contamination. The organization of this information into a readily understandable written and/or pictorial representation of site conditions and processes is a conceptual site model (CSM). It is very useful to have an adequate CSM developed and utilized for site decisions such as outlined in the ASTM Standard Guide for Development of Conceptual Site Models (See Appendix B).

A CSM is a very powerful tool that can relay site specific information in a very expeditious and concise manner. 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

[1] MCL 324.20120e(23)(c)

understand the site conditions. The CSM is also useful for identifying any data gaps and evaluating the potential effect they may have on final site decisions.

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 pathway for the site.

The CSM for each site will be unique. The CSM could be developed using existing site data, or it may require new data collection to adequately characterize and understand the risks at the GSI. The surface water body hydrogeological complexity and the potential risks to waters of the state posed by a site will determine the precision and amount of data necessary to complete the CSM.

The CSM may consist of a tabulated historical summary of contaminant concentrations in soil, groundwater and pore water; and groundwater and surface water elevations. Additional details may be provided in written format describing the site history (if available), source area(s) and the identification of site contaminants and applicable pathways. Descriptions of data collection methods and field screening procedures utilized with supporting documentation in the form of lithological boring logs, hydrographs illustrating groundwater flow conditions and interactions with surface water, geological cross sections, plan view maps identifying the source area(s), groundwater flow direction and contaminant distribution, current and future structures, property boundaries, surrounding land use and any other relevant field observations are all considered important components of a complete CSM for evaluating the GSI pathway.

Complete and accurate CSMs pave the way for faster, easier, and better informed decisions when evaluating proposed and completed response activities or corrective action 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.

3.0 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[2] in concentrations that exceed the generic GSI criteria currently or in the future (See 4.0 Water Quality Standards for further information on generic GSI criteria)[3]. 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. 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.

[2] See Appendix A definitions
[3] Section 20120e(3) of the NREPA

- 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 (See Appendix A).
- The applicable generic GSI RBSLs/criteria for all appropriate hazardous substances released or otherwise affected (reactions, breakdown byproducts, etc.) and appropriate WQS 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[4] that may be used to demonstrate that there will not be an exceedance of GSI RBSLs/criteria at the point the groundwater contaminant plume vents to surface waters. For the remaining circumstances where the pathway is relevant and contaminant concentrations exceed the generic GSI RBSLs/criteria, there are statutory options[5] available to assess and achieve compliance for contaminated venting groundwater [See 7.0 Compliance Options].

4.0 WATER QUALITY STANDARDS (WQS)

The MDEQ has promulgated rules that establish WQS for hazardous substances pursuant to Part 31, Water Resources Protection (Part 31), of NREPA. The WQS are the generic GSI RBSLs/criteria. The surface WQS establish water quality requirements applicable to the surface waters of the state that protect the public health and welfare, enhance and maintain the quality of water, and protect the state's natural resources. All surface waters of the state are designated and protected for the following uses: agriculture, navigation, industrial water supply, warmwater fishery, other indigenous aquatic life and wildlife, partial body contact recreation, and fish consumption[6]. Additional designated uses, including total body contact, coldwater fisheries, public water supply sources, etc., are listed in the Part 31 WQS Rules.

WQS 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; 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 (See WQS Part 31, Part 4 Rules Appendix B). The current chronic chemical-specific GSI criteria are listed in the RBSLs/criteria tables and the associated footnotes. Acute chemical-specific GSI RBSLs/criteria protective of aquatic life are included in the Part 31, Part 4 Rule 57, Water Quality Values spreadsheet available from the MDEQ web page (See Appendix B). Note that the Rule 57 values are updated periodically and the most current values are applicable criteria. In addition to the chemical-specific WQS, a discharge may not exceed 1.0 acute toxic units at the GSI 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 allocated mixing zone[7].

[4] Section 20120e(3)of NREPA
[5] Section 20120e of NREPA
[6] R 323.1100 Designated uses
[7] R 323.1219(1) Whole effluent toxicity

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 WQS were developed. Tier I values represent a complete toxicity set, and Tier II values are based on at least 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 Generic RBSLs/Criteria

If the GSI pathway is determined to be relevant, the generic GSI RBSLs/criteria are applicable. 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/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/ 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.

GSI RBSLs/criteria include generic GSI RBSLs/criteria, mixing zone-based RBSLs/GSI criteria, and site-specific 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. If this option is selected for demonstration of compliance, the requirements for calculation of mixing zone-based GSI RBSLs/criteria are included in the MDEQ Procedure [RRD-32]. See further discussion 7.3 Mixing zones, and 4.3 Site-specific criteria.

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 (See 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 these generic GSI RBSLs/criteria is based on RBSLs/criteria calculated with site-specific surface water hardness or pH values. Available public sources of surface water quality may be used for site-specific determinations.

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

Consistent with the federal Clean Water Act's (CWA) prohibition of the discharge of toxic pollutants in toxic amounts, in addition to chemical-specific WQS the Part 31 WQS do not allow a discharge to exceed 1.0 acute toxic units, and to cause or contribute to an exceedance of 1.0 chronic toxic units in the surface waters outside of any MDEQ allocated mixing zone.

WET refers to the aggregate toxic effect to aquatic organisms from all pollutants contained in a discharge (effluent). The United States Environmental Protection Agency (US EPA) 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, WQS. 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 at the GSI contains several chemicals whose toxicity is unknown;
- The venting groundwater at the GSI contains a significant number of unknown/unidentified chemicals;
- The venting groundwater at the GSI contains a number of chemicals known to be toxic to aquatic organisms, but may not exceed their individually toxicity limitations;
- The venting groundwater at the GSI 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 at the GSI 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 a person may elect to use WET testing at those wells.

4.3 Site-Specific Criteria Development

Development of numeric or nonnumeric site-specific GSI criterion may be proposed for MDEQ approval. Numeric site-specific WQS may be developed under provisions of the Part 31 rules:

- 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 US EPA recalculation procedure, water effect ratio procedures, or resident species procedure and the specific implementation provisions for recalculation and resident species.[8]
- 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.[9]
- 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.[10]

Site-specific criteria may also include biological criteria. The site-specific criteria provisions of Part 201[11] may allow other proposals, including nonnumeric criteria, if the proposed criteria, in comparison the generic criteria (WQS), better reflect best available information concerning the toxicity or exposure risk posed by the hazardous substance.

If a generic criteria (WQS) has not been developed under Part 31 for a hazardous substance that is present in venting groundwater, then when the necessary data for the MDEQ to establish a criterion under Part 31 is available a WQS will be developed, unless the MDEQ can:

- Establish criterion based upon comparison to a hazardous substance criterion with similar fate and toxicity,
- Determine that a numerical criterion is not required to assure remedial action will be protective,
- Or it is otherwise demonstrated that nonnumeric site-specific criteria is appropriate through a modeling demonstration and/or an ecological demonstration.

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 MS4 requirements apply to medium or large cities and can apply to other entities such as MDOT (See Appendix B).

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

[8] R 323.1057(2)(r)-Toxic substances
[9] R 323.1057(3)(n)
[10] R 323.1057(4)(h)
[11] Section 20120a(2) and 20120b of NREPA

(NPDES) program. A list and maps of MS4 communities is available from the MDEQ webpage (See 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 has developed options to address illicit discharges that will help MS4 permittee's maintain compliance as part of their compliance assistance program (See Appendix C). The party responsible for the illicit discharge and the MS4 permit holder will need to work together to implement an available option. The options available to MS4 permittees where illicit discharges of contaminated groundwater are occurring include:

- Eliminate the infiltration into the MS4 sewer; options include lining the storm sewer, lowering the water table in the area of the storm sewer, or moving the storm sewer.
- Require an NPDES permit be obtained for discharge via the storm sewer.
- Require treatment of the contaminated groundwater to uncontaminated levels prior to discharge to the storm sewer.
- Develop a plan to eliminate the illicit discharge as part of the Illicit Discharge Elimination Program; including a reasonable period of time for pollutant concentrations to be reduced.

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 SEWERS

Provisions to be considered in determining if the GSI pathway is relevant with regard to groundwater discharges to sewers include the use of an "industry standard" in determining if a sewer may be considered impervious.[12] 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. Suggested lines-of-evidence include showing the sewers:

- 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 other supporting lines-of-evidence to demonstrate the "impervious" nature of sewer are critical for making this determination. (See 7.12 Groundwater Venting to Sewers for discussion of options when the pathway is relevant.)

[12] Section 20120e(3)(h) & (19) of NREPA

7.0 GSI PATHWAY COMPLIANCE OPTIONS

The GSI statutory provisions provide for two basic approaches in determining compliance for the GSI pathway. This includes direct measurement of contamination in venting groundwater using various methods and locations; and indirect methods that use a lines-of-evidence approach to demonstrate the venting groundwater does not require remediation.

Pursuant to Part 201, all compliance options must assure protection of public health, safety, welfare and the environment and attain a degree of cleanup and control of the environmental contamination addressed that complies will all applicable or relevant and appropriate requirements of state and federal environmental law[13].

Options to demonstrate compliance may be used singularly or in combination. The following summarizes these options.

7.1 Generic GSI Criteria

Compliance may be demonstrated if groundwater contaminant concentrations are below the Generic GSI criteria, which are the WQS, in GSI monitoring wells or alternative monitoring points and there are no existing unacceptable water quality characteristics, such as nutrients, or dissolved oxygen or physical characteristics. Compliance with generic GSI criteria prior to entering a storm sewer, or at the storm sewer outfall, may demonstrate compliance for Part 201 or Part 213. However, 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 (see 5.0 Municipal Separate Storm Sewers and 7.12 Storm Water Sewer Sampling).

7.2 Variances

The GSI statutory provisions include the option to request a variance from the surface WQS. MDEQ approval of a variance is described in Part 31[14]. The information needed to request a variance is available from the Part 31 WQS rules. A WQS variance applies only to the person requesting the variance and only to the pollutant or pollutants specified in the variance. The variance does not modify the surface WQS for the water body as a whole, or apply to other water bodies.

A WQS variance may be granted if demonstrated to the MDEQ that attaining the WQS is not feasible for several reasons. The most applicable to venting groundwater is that human-caused conditions or sources of pollution prevent the attainment of the WQS and cannot be remedied or more environmental damage would occur in correcting the conditions or sources of pollution than would occur by leaving the conditions or sources in place. Any request for a variance is required to show that the variance requested conforms to antidegradation demonstration requirements and characterize the extent of any increased risk to human health and the environment associated with granting the variance compared with compliance with WQS without the variance in a way that enables the MDEQ to conclude that the increased risk is consistent with the protection of the public health, safety, and welfare and environment.

Issuance of a WQS variance requires public notice of the preliminary variance decision including notification of the other Great Lakes states. The variance decision will contain all conditions needed to implement the variance, including, at a minimum:

[13] Section 20118(3) of NREPA
[14] Section 20120e(1)(b) of NREPA; R 323.1103-Variances

- Compliance with an effluent limitation that at the time the variance is granted represents the level currently achievable.
- Reasonable progress is made toward attaining the WQS. If the variance is approved for any bioaccumulative chemicals of concern (BCC), implementation of a pollutant minimization program consistent with Part 31 provisions.
- The duration of a WQS variance cannot exceed 5 years[15]. A variance may be renewed. As part of a renewal request the requester will need to again demonstrate that attaining WQS is not feasible based on the rule requirements.

Response activity plans have been approved that rely upon a variance to the mercury WQS where during evaluation concentrations exceeded those determined as de minimis 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, natural attenuation is expected to allow progress toward achieving the WQS, 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 GSI criteria.

Exposures in mixing zones cannot result in deleterious effects to the populations of aquatic life and wildlife. The mixing zone cannot prevent the passage of fish or fish food organisms in a manner that would result in adverse effects on the immediate or future populations of the fish or fish food organisms. The area of the mixing zone must be minimized. Devices for rapid mixing, dilution, and dispersion are encouraged where practical[16], but are often not practical for venting groundwater.

As a minimum restriction, the final acute value for aquatic life must not be exceeded when developing mixing zone-based GSI criteria, unless the MDEQ determines or it is demonstrated to the MDEQ that a level higher is acceptable in accordance with the mixing zone rule provisions. An acute mixing zone is allowed under specific rule provisions[17].

For Part 213 corrective action a request for calculation of mixing zone-based GSI criteria should be submitted to the MDEQ independent of and prior to the submittal a Final Assessment Report (FAR) or Closure Report to allow the resulting criteria to be factored into the corrective action necessary to address the pathway.

For Part 201 response activities, a request for calculation of mixing zone-based GSI criteria should be submitted to the MDEQ independent of and prior to a NFA Report. It may be advantageous to request calculation of mixing zone-based GSI criteria early in the remedy evaluation to allow the resulting criteria to be used as part of the compliance assessment of the pathway.

[15] R 323.1103(1)(e)-Variances
[16] R 323.1082(1)-Mixing zones
[17] R 323.1082(7)

Sufficient information will need to be available to process a request for mixing zone-based criteria. The information necessary to process a request to calculate mixing zone-based criteria is included in the MDEQ Procedure [RRD-32].

7.4 Site-Specific Criteria

Compliance may be demonstrated using MDEQ approved site-specific criteria (see 4.3 Site-specific criteria for discussion on development). Approved site-specific criteria may be used in the development of mixing zone-based criteria. Biological criteria may be used as site-specific criteria.

7.5 Alternative Monitoring Points

Alternative monitoring points are an option to demonstrate compliance with the GSI Pathway for comparison of data to Surface WQSs, mixing zone-based GSI criteria, or site specific criteria in lieu of data collected from conventional upland vertical monitor wells. They are designed to allow for the collection of samples representative of the venting groundwater at the GSI.

Alternative monitoring points are physically placed in locations where the contaminated groundwater vents to the surface water body. 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.

Prior to installing any alternative monitoring points in surface waters, applicable permit requirements need to be evaluated. Part 301, Inland Lakes & Streams, Part 303, Wetlands Protection, Part 325, Great Lake Submerged Lands of NREPA, may have applicable permitting requirements, along with Part 404 of the CWA.

Characterization of the area where the contaminated groundwater is venting is critical to determining that the alternative monitoring points are located in the areas that are reasonably representative of the higher concentrations of hazardous substances venting to the surface water. Alternative samples from points or devices that are clearly installed within venting groundwater area can be used for determining compliance with GSI criteria. Alternative samples collected from the transition zone between groundwater and surface water will need additional documentation.

Documentation that the alternative samples are representative of venting groundwater in the transition zone through an evaluation of hydraulic head conditions and of the water sample geochemistry (e.g., static water levels, temperature, dissolved oxygen, conductivity, etc.) are appropriate. Static water levels higher than the elevation of the surface water body are indicators of conditions where groundwater vents to the surface water. Typical geochemical ranges or thresholds are not readily available. A site-specific lines-of-evidence proposal would be appropriate to support the determination that the sampling location is representative of the venting groundwater.

Documentation of the venting area also includes the characterization of the substrate and geology, and the spatial and temporal variability of the discharge, as well as the magnitude. 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.

Additionally, the transition zone represents a unique and important ecosystem that exists between surface water and the underlying groundwater and must be considered to assure protection of public

health, safety, welfare and the environment[18]. Before alternative samples collected from the transition zone can be used for determining compliance, an evaluation of the potential impacts of venting groundwater on surface water protected designated uses is necessary. Indigenous aquatic life (aquatic biota) is a protected designated use for all surface waters of the state. Because of the important ecological role of the transition zone discharge areas, venting groundwater could result in adverse ecological impacts to aquatic biota utilizing those areas. To assure protection of the environment, specifically aquatic biota, subsurface sampling depths should include an assessment of where in the transition zone aquatic biota occur or utilize the area. Sampling locations should be located so the results demonstrate that there would be no direct or indirect effect on the biota.

Specialized sampling devices may be used to collect representative samples. Tools available to locate areas of contaminated groundwater discharge are identified in US EPA publications (See Appendix B).

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 WQS 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. Appendix D provides a summary of when alternative monitoring points may be self-implemented, when the MDEQ must be provided notices, and when submittals must be made to the MDEQ for approval.

7.6 Ecological Assessment

The GSI statutory provisions allow the use of an ecological demonstration to evaluate and to determine compliance with the GSI pathway using scientifically valid methods. An ecological demonstration consists of an ecological assessment using multiple lines of evidence to evaluate the likelihood that adverse ecological effects may occur or are occurring as a result of exposure of aquatic life and/or wildlife to contaminants from venting groundwater.

Ecological assessments generally are conducted to understand why and how organisms behave, survive and reproduce, to assess the ecosystem health and determine its sustainability. There are different ways of conducting ecological assessments in terms of approaches and levels of biological organization examined. Regardless of the complexity of rigorousness of the assessment, all start with descriptions of species presence, abundance, interactions, ecological structure or processes, contaminant levels, and possible adverse effects. All involve inventories of the status of species, populations, communities or ecosystems, as well as changes and trends in species and ecosystem health and abnormalities. To be most effective, information on trends over space and time provide the necessary background for appropriate ecological assessment and management.

Ecological assessments will need to evaluate the potential impacts of venting groundwater on surface water protected designated uses. To appropriate assess the GSI pathway, an ecological assessment can only evaluate and determine compliance for ecological (i.e., aquatic life and/or wildlife) driven GSI criterion. In determining whether an ecological assessment is appropriate for the conditions at a facility, consideration must be given to the designated uses and available GSI criteria protective of the

[18] Section 20118(3) of NREPA

designated uses[19]. Water quality standards for most hazardous substances are developed to be protective for aquatic life, human health and wildlife, and the most sensitive of these values represent the generic GSI criterion[20]. An ecological assessment should only be conducted when the GSI criterion is based on an aquatic life or wildlife value and the concentration in venting groundwater does not exceed the human health value. Examples of the necessary considerations to determine if an ecological demonstration is appropriate follow:

- The contaminant exceeded is arsenic, the arsenic GSI generic criterion is based on human health; an *ecological* assessment would not address the potential human health-risk and would not demonstrate compliance for the pathway.
- The contaminant exceeded is trichloroethylene (TCE), the TCE GSI generic criterion of 200 is based on aquatic life, the water quality value for human health is 370; if contaminant concentrations exceed 370 an ecological assessment would not demonstrate compliance with the pathway since the surface water must be protected for all designated uses.

Indigenous aquatic life (aquatic biota) is a protected designated use for all surface waters of the state. Because the GSI pathway addresses venting groundwater, the transition zone between groundwater and surface water represents a critical part of an ecological assessment. Biota inhabiting, or otherwise dependent on, the transition zone may be adversely affected by contaminated groundwater discharging through the transition zone into overlying surface waters. Ecological risks to the transition zone are characterized after collection and analysis of physical, chemical, and ecological data have been completed. The risks can be characterized using the lines-of-evidence approach commonly used in ecological risk assessments.

Prior to initiating an ecological assessment, necessary permit requirements should be evaluated.

The US EPA has developed comprehensive guidance on ecological assessments that can be relied upon (Appendix B). Other approaches can be proposed. Ecological assessments are based upon site–specific physical, chemical and ecological data. Staff of the MDEQ is available to assist with the development of a proposal for this type of assessment, upon request.

7.7 Modeling Assessment

Modeling may be used to determine compliance with the GSI pathway when a generally recognized and 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. Innovative methods can be proposed as long as the method is scientifically justifiable for the intended purpose. Representative site-specific field data are used to calibrate and verify the model. As in most cases with models, the level of effort needs to be commensurate with the objective of the model. Additional information regarding the application of models (including calibration and verification) is available in the Groundwater Modeling Resource Materials document (See Appendix B).

7.8 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 effect or little effect on the surface water. While the term de minimis is not

[19] Discussion regarding surface water designated uses in included in Section 4.0
[20] Reference to the current spreadsheet of water quality values is included in Appendix B

defined by statute or rule, an applicable definition of de minimis effect would be *insignificant or of no concern*. Best professional judgment, lines-of-evidence, and applicable or relevant appropriate requirements (ARARs) regarding protection of surface waters may be 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 acceptable 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 surface WQS establish levels to protect the public health and welfare, enhance and maintain the quality of water, and protect the state's natural resources. These protections along with the designated uses of all surface waters are part of the site-specific analysis of whether the venting groundwater will have no effect or only a de minimis effect on surface waters. Specific WQS provisions may affect the determination as follows:

- Part 31 provisions set expectations that bioaccumulative chemicals of concern (BCCs) concentrations will be reduced whenever a discharge is occurring. Therefore, a de minimis effect determination may not be possible in situations where BCCs identified in the WQS are being evaluated. 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.
- A de minimis effect determination may not be applicable in situations where the relevant GSI criteria is significantly higher than the risk-based WQS 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 WQS 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 WQS, 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 WQS at the GSI based upon acute effects to aquatic organisms, a de minimis determination would normally be inconsistent with a de minimis effect determination (See 4.0 WQS and 7.6 Alternative Monitoring Locations for related discussion on surface waters designated use protection for aquatic life).
- De minimis determinations account for all surface WQS including the physical properties and aesthetics at the GSI.

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 WQS for the venting groundwater. In conjunction with the reasonable potential analysis, the following were considered in determining that the on-going contaminant plume venting would have only a de minimis 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 minimis determinations in situations where it was determined that the GSI pathway was not relevant, the GSI was not properly located, or site characterization was incomplete to support the determination.

7.9 Technical Impracticability (TI) Waivers

Technically impracticable means the inability to achieve certain remedial requirements and is based upon engineering feasibility and reliability, cost effectiveness, and risk-based considerations. 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.

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. The DEQ considers technical impracticability guidance published by the US EPA to be relevant in a TI waiver determination (see Appendix B).

In some cases a TI waiver may be considered an option prior to remedy implementation when supported adequately by detailed site characterization and data analysis or robust CSM that define the most critical limitations to meeting GSI RBSLs.

A TI waiver request includes lines-of-evidence, data, and analysis to demonstrate to 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 where 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 activities or corrective action, and a demonstration that no other remedial technologies could reliably achieve GSI criteria within a reasonable timeframe, and estimate of costs.

7.10 Natural Attenuation

The GSI statutory provisions provide that natural attenuation of hazardous substances upgradient of the GSI is an acceptable form of remediation and may be relied upon in lieu of any active remediation of the groundwater. Numerous hazardous substances naturally attenuate in the environment over time. The attenuation is generally demonstrated by monitoring the trends of contaminant concentrations over time and analyzing for breakdown or daughter products and other geochemical indicator parameters. The MDEQ *Monitored Natural Attenuation Resource Materials* 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 US EPA have published numerous reference documents that may be used to guide a natural attenuation demonstration. A list of some of these reference documents is provided in Appendix B.

7.11 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, (see Appendix A) and contains the designated uses for which they are protected. The designated uses include, but are not limited, to the following: agriculture, navigation, industrial water supply, warm-water fishery, other indigenous aquatic biota, partial body contact, recreation, and fish consumption. Designated uses are specified in R 323.1100 (See Appendix B).

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 WQS regulation by the US EPA. A UAA clearly shows or demonstrates why those designated uses are not attainable or cannot be attained. The analysis requires US EPA and MDEQ 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.

7.12 Groundwater Venting to Sewers

The GSI statutory provisions allow several options to demonstrate compliance with Part 201 or Part 213 for the situation where the GSI pathway is relevant and a groundwater contamination plume enters a sewer that discharges to surface water.

If the plume enters a separate sanitary sewer or combined sanitary storm sewer the discharge is regulated by Part 31 NPDES permits, not Part 201 or Part 213.

The GSI pathway may be determined not to be relevant by demonstrating a storm sewer is sufficiently tight to prevent inflow where the venting groundwater intersects the sewer or that the sewer is otherwise impervious based on industry standards (see 6.0 Industry Standard for Impervious Storm Sewers for additional discussion).

In cases where groundwater discharges to a storm sewer and the storm sewer in turn discharges to a surface water body, the compliance point under Part 201 and Part 213 is at the storm sewer outfall. However, this does not negate the obligations of MS4 permit holders to eliminate illicit discharges or meet the requirements of the CWA. (See 5.0 Municipal Separate Storm Sewer Systems for options to assist with compliance for these conditions.) When the plume enters a separate storm sewer options to demonstrate compliance for Part 201 and Part 213 include:

- The use of groundwater monitoring wells.
- Mixing zone-based criteria developed that account for the mixing that occurs in the receiving surface water.
- Natural attenuation that occurs in storm sewer system prior to the outfall to surface waters.
- A de minimis determination.
- Monitoring performed within the storm sewer at a location where the plume enters the storm sewer; downstream from where the plume enters but upstream of the outfall to surface waters; or at the outfall to the receiving surface waters.

Sampling at the storm sewer outfall (point of discharge) to surface water may 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 discharges from the groundwater plume 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 assess the concentration and volume of contamination that might be entering from the plume and 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 E provides a checklist for reference purposes when evaluating contaminated groundwater discharging to storm sewers.

7.13 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. MDEQ denial of a response activity plan containing a proposal for alternative monitoring points, an ecological demonstration, or modeling demonstration, or any combination, scientific or technical dispute may be appealed to Response Activity Review Panel.

Appendix A

DEFINITIONS

GSI[1]: Groundwater Surface Water Interface that is the location at which groundwater enters a surface water body.

GSI Monitoring Well[2]: A vertical well installed in the saturated zone as close as practicable to surface water with a screened interval or intervals that are representative of the groundwater venting to the surface water.

Generic GSI RBSLs/Criteria[3]: The water quality standards for surface waters developed by the MDEQ pursuant to Part 31.

Mixing Zone[4]: 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.

Source: For purposes of this document source is not used as defined by Part 201, rather it means a hazardous substance or combination of hazardous substances in a quantity or concentration that acts as a reservoir that sustains and/or increases contamination within a single environmental media or from one media to another media through dispersion, migration or any other physical, chemical, or biological process. Source includes non-aqueous phase liquids (NAPL) and other highly concentrated areas of contamination such as residual NAPL.

Surface Waters of the State[5]: Includes all of the following, but does not include drainage ways and ponds used solely for wastewater conveyance, treatment or control:

- The Great Lakes and their connecting waters.
- All inland lakes.
- Rivers.
- Streams.
- Impoundments.
- Open drains.
- Wetlands.
- Other surface bodies of water within the confines of the state.

Surface water[6] means all of the following, but does not include groundwater or an enclosed sewer, other utility line, storm water retention basin, or drainage ditch:

- The Great Lakes and their connecting waters.
- All inland lakes.
- Rivers.
- Streams.
- Impoundments.

Surface water[7] does not include:

- Groundwater.
- Hyporheic zone water.
- Water in enclosed sewers.
- Water in drainage ways and ponds used solely for wastewater or storm water conveyance, treatment or control.
- Water in subgrade utility runs and utility lines and permeable fill in and around them.

[1] Section 20120e(23)(c) of NREPA
[2] Section 20120e(23)(d) of NREPA
[3] Section 20120a(1)(a), Section 21303(j) and Section 21304a(5)(b) of NREPA
[4] Section 3109(3)(a) of NREPA & R 323.1044(b) [Part 31 definition of mixing zone]
[5] R 323.1044(u) [Part 31 rule definition]
[6] Section 21303(m) of NREPA
[7] Section 20120e(23)(g) of NREPA

Appendix B

REFERENCES

Conceptual Site Models:

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/Standards/E1689.htm

Water Quality Standards: Part 31, Part 4 Rules, R 323.1041 to R 323.1117

http://dmbinternet.state.mi.us/DMB/ORRDocs/AdminCode/302_10280_AdminCode.pdf

Rule 57 Water Quality Values Spreadsheet

http://www.michigan.gov/deq/0,4561,7-135-3313_3681_3686_3728-11383--,00.html

MDEQ Designated Use Information

Designated uses are specified in R 323.1100 [Water Quality Standards: Part 31, Part 4 Rules page 67]

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 document's appendix.
http://www.michigan.gov/deq/0,4561,7-135-3313_3686_3728-12711--,00.html

GSI and GSI Protection Calculator

http://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

Variances

Provisions for granting a variance are specified in R 323.1103

Alternative Monitoring Sampling Devices
Ecological Risk Assessments

US EPA 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.

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. https://www.astm.org/Standards/E2205.htm

US EPA *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* June 1997 Publication 9285 7.25 EPA 540-R-97-006

USEPA. 1992. Framework for Ecological Risk Assessment. EPA/630/R-92/001

USEPA. 1998. Guidelines for Ecological Risk Assessment. EPA/30/R-95/002F

REFERENCES CONTINUED

Groundwater Modeling

GROUNDWATER MODELING, REMEDIATION AND REDEVELOPMENT DIVISION RESOURCE MATERIALS February 2014
http://www.michigan.gov/documents/deq/deq-rrd-GroundwaterModelingGuidance_447643_7.pdf

Mass Flow and Mass Discharge

ITRC, Technology Overview *Use and Measurements of Mass Flux and Mass Discharge*. August 2010

Technical Impracticability

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

Use Attainability Analysis

https://www.epa.gov/wqs-tech/use-attainability-analysis-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/Standards/E1943.htm.

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

U.S. EPA, "*How to Evaluate Alternative Technologies for Underground Storage Tank Site: A Guide for Corrective Action Plan Reviewers*", EPA510-R-04-002, Solid Waste and Emergency Response 5401G, May 2004 (www.epa.gov/oust/pubs/tums.htm)

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

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

US EPA. *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.

US EPA. *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.

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

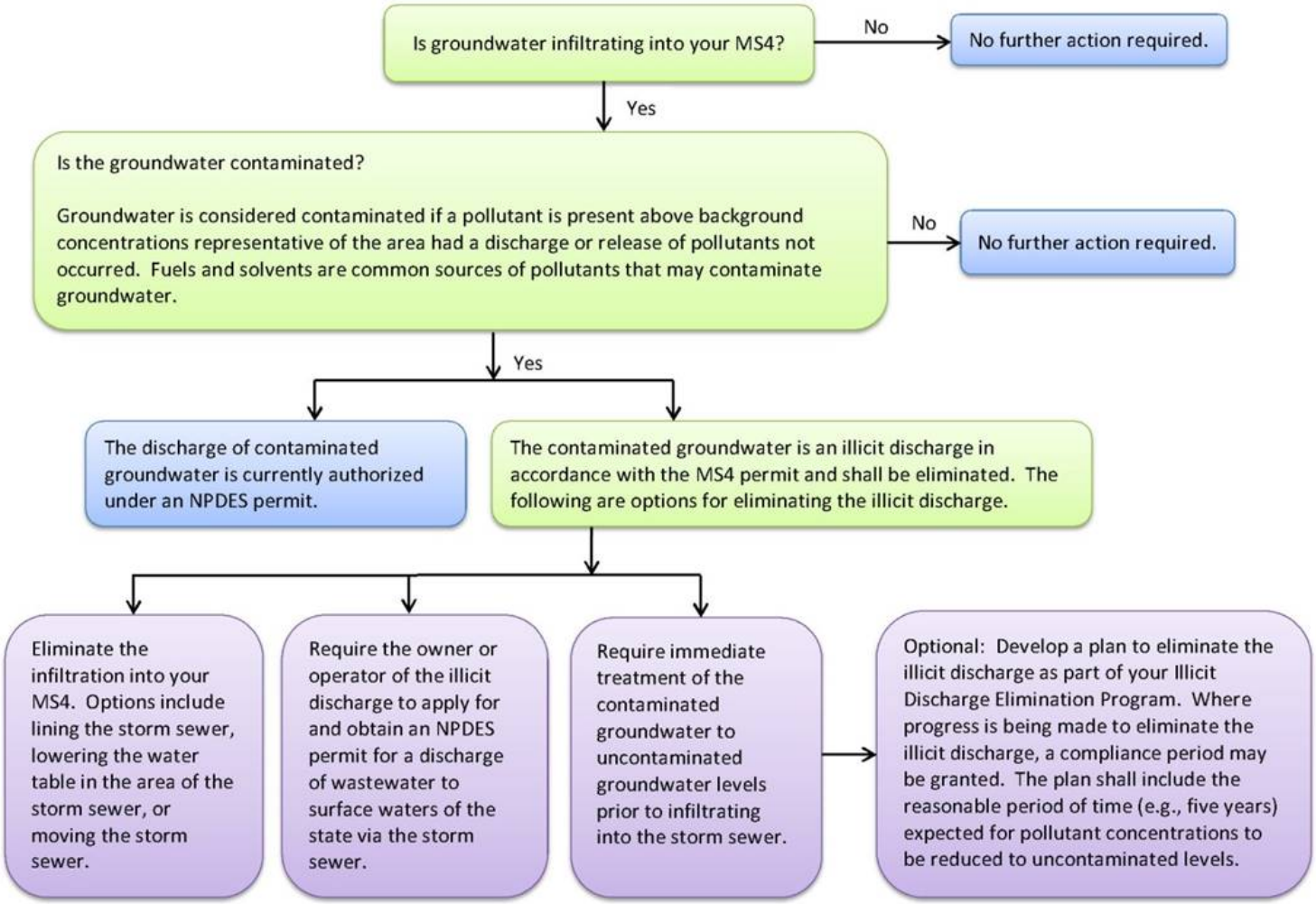
Response Activity Providing for Venting Groundwater

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

Options for Eliminating an Illicit Discharge of Contaminated Groundwater into your MS4



Appendix D

SELF-IMPLEMENTATION PROVISIONS

Section 20120e Compliance Method	Response Activity Plan (RAP)[1] 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 RAP 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 RAP. 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 RAP. A notice of alternative monitoring points is required. However, subsection (6) requires a RAP 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 RAP. Note that subsection (9) requires sentinel wells. However, subsection (6) requires a RAP 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 RAP. Note that subsection (10) requires field measurements. However, subsection (6) requires a RAP if a sensitive environment is present.
Sensitive Environments (AMPs, ED, MD only)	Yes	Yes	Subsection (6) requires a person to submit a RAP 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.

[1] For the purposes of this document "RAP" represents a Response Activity Plan, not the traditional acronym for Remedial Action Plan.

SELF-IMPLEMENTATION PROVISIONS CONTINUED

Section 20120e Compliance Method	Response Activity Plan (RAP) Required		Statute Reference(s)
	Liable Party	Non-liable Party	
NON-GENERIC GSI CRITERIA			
Variance	Yes	Yes	Subsection (7) requires a person to submit a RAP 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.

Appendix E

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 an adequate CSM to assess the pathway 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? *This information is available from storm sewer system maps and/or as-built drawings of storm sewer infrastructure; public works personnel and facility staff. Field inspections may be performed to verify locations of infrastructure.*		
Are the storm sewer and sanitary sewer combined or separated? *Combined sanitary and storm sewers are otherwise regulated under the NPDES program.*		
Do you know the age and physical condition of the storm sewers? *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? *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? *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? *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 CONTINUED

When will you collect your samples? *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? *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? *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? *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.*