New Jersey Department of Environmental Protection
Science Advisory Board

FINAL REPORT

RESPONSE TO CHARGE QUESTIONS ON THE IMPACT TO GROUND WATER SOIL REMEDIATION STANDARDS GUIDANCE

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October 20, 2011

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October 20, 2011

SAB IGWSRS REVIEW GROUP MEMBERS
Dr. Robert J. Lippencott, Chair
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NOTICE

EXECUTIVE SUMMARY

The Science Advisory Board (SAB) was asked to perform a peer review of the site-specific Impact to Ground Water Soil Remediation Standards (IGWSRS) Guidance framework to determine whether "associated assumptions and methodology reflect accurate and comprehensive information to guide the Licensed Site Remediation Professional (LSRP) in the evaluation of potential impacts associated with the impact to ground water pathway". Specifically, NJDEP Site Remediation Program (SRP) staff asked that the IGWSRS framework be evaluated for usability and scientific validity. The review and report was completed by the SAB IGWSRS Review Group. A report was initially prepared by the SAB IGWSRS Review Group and sent to the SAB for deliberation and comment, and then to the SRP for review and comment. The SAB approved this final report, which addresses review comments provided by the SAB members and SRP staff, based on the recommendations from the SAB IGWSRS Review Group.

The purpose of this report is to provide technical peer review comments and recommendations that are intended for use by the NJDEP staff and interested party stakeholders with a high degree of technical background regarding the NJDEP IGWSRS Guidance.

The SAB IGWSRS Review Group reviewed the IGWSRS Guidance and framework, supporting documentation provided by NJDEP, as well as several other references including the United States Environmental Protection Agency soil screening levels guidance, NJDEP's IGWSRS basis and background documentation, related NJDEP statutes and regulations, and scientific literature. The IGWSRS Guidance was found to provide a more sophisticated method for determining numerical IGWSRS than previous standards and provides options to adopt default values or develop site-specific IGWSRS. The fundamental concept of the IGWSRS Guidance framework (from simple/conservative to complex/refined) is technically appropriate, and it allows some flexibility for site-specific application. However, for a number of fairly common contaminants, the IGWSRS represent much lower values for remediation standards than the criteria formerly used in New Jersey prior to 2008. The IGWSRS default values, and optional site-specific values generated by the user, appear to be overly conservative for a number of contaminants from a scientific perspective. In addition, risk management options (similar to those used for other soil remediation standards to control potential exposure risks) are virtually absent. The framework was found to be inflexible in several ways and complicated to follow. Using the framework to develop site-specific IGWSRS can be time consuming and may increase investigation and remediation costs with no apparent value added for protection of human health and the environment.

The issues of conservative assumptions, and the degree to which exposure assumptions are realistic or reasonable as required by New Jersey statutes, represented challenging, albeit necessary, aspects of this review. A comprehensive evaluation of these issues is understood to be beyond the scope of the charge question. However, a meticulous effort was made to provide comments and recommendations to the extent practicable to address issues of conservative, realistic and reasonable assumptions in the IGWSRS Guidance.

The report includes many recommendations to improve the overall organization and usability of the IGWSRS framework. Specific suggestions for allowing the user flexibility in generating site-specific IGWSRS criteria are provided, which should help stream-line and improve the accuracy of the process for LSRP use. Some of the more important recommendations include:

- Cross-Bureau Coordination
  - In developing the IGWSRS, it is important to consider concerns within the agency that are currently not part of the IGWSRS Guidance, such as the nexus with the saturated zone, SRP Guidance, laboratory regulations, etc.

- Simplify the Process
  - While additional flexibility is recommended, the entire IGWSRS process should be simplified for the NJDEP and other stakeholders.

- Risk Management
  - The current IGWSRS methodology is heavily dependent on a risk calculation that assumes a future exposure (via drinking water) and does not incorporate risk management decisions that could modify the calculated IGWSRS to reflect actual and/or reasonable potential site-specific exposure scenarios.
  - Provide for the use of "Risk Management Decisions-making", e.g., consideration of institutional and engineering controls.
  - Allow for greater use of site-specific data and apply conservative assumptions about potential future impacts only when warranted (e.g., new or recent discharges).

- Organization
  - Re-organize the guidance into one document and present more streamlined version of the process with details in appendices to make it more decision-based and user-friendly.
  - Add a decision-based flow chart or navigation scheme to guide users through the process.

Additional important recommendations are provided in the Conclusions and Recommendations (Section 5) of this report.

ABBREVIATIONS, ACRONYMS AND DEFINITIONS

AOC - Area of Concern
AT123D - Ground water fate and transport model.
B&B - NJDEP Soil Remediation Standards Basis and Background documents (2004 and 2007).
CEA - Ground Water Classification Exception Area
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act
Contingent Samples/Analyses – additional sample collection and/or chemical analyses and associated extraction procedures that are required based on initial sample analytical results and that are made necessary by the IGWSRS Guidance.
DAF - Dilution Attenuation Factor
EP - Equilibrium Partition equation
FAQ - Frequently Asked Questions
Foc – fraction of organic carbon
IGWSCC - Impact to Ground Water Soil Cleanup Criteria (1999)
IGWSRS - Impact to Ground Water Soil Remediation Standards
IGWSRS - Impact to Ground Water Soil Screening Levels
IGWSRG - Impact to Ground Water Soil Remediation Goals; performance-based narrative or numerical remediation goal generally for sites that are undergoing active or passive ground water remediation (i.e., impact to ground water is documented as a former or current condition as opposed to a future potential risk based on site ground water data).
Kd - soil-water partition coefficient
Koc - organic carbon partition coefficient
LSRP - Licensed Site Remediation Professional
NJAC - New Jersey Administrative Code
NJSA - New Jersey Statutory Authority
PQL – Practical Quantitation Limit
QA/QC - Quality Assurance/Quality Control
RCRA - Resource Conservation and Recovery Act
SAB - NJ Science Advisory Board
SCC - Soil Cleanup Criteria
SESOIL - Vadose zone soil leaching model
SPLP - Synthetic Precipitation Leachate Procedure
SRG - Soil Remediation Goal
SRP - NJDEP Site Remediation Program
SRRA - Site Remediation Reform Act
SSL - Soil Screening Level
SW-846 - USEPA solid waste program technical methods
TRSR - Technical Regulations for Site Remediation (NJAC 7:26E)
USEPA - United States Environmental Protection Agency
VOC - Volatile Organic Compounds
ZHE - Zero Headspace Extraction

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FINAL REPORT

RESPONSE TO CHARGE QUESTIONS ON THE IMPACT TO GROUND WATER SOIL REMEDIATION STANDARDS GUIDANCE

October 20, 2011

1.0 INTRODUCTION

The SAB was charged with review of the NJDEP's *Impact to Ground Water Soil Remediation Standards Guidance* (IGWSRS Guidance), which was issued and became effective in 2008 and early 2009.

The NJDEP requires the use of the IGWSRS Guidance for investigation and remediation of sites subject to compliance under the NJDEP's Site Remediation Program (SRP). There are an estimated 20,000 cases in the SRP, virtually all of which require implementation of the IGWSRS Guidance.

The NJDEP adopted Remediation Standards rules in 2008 (NJAC 7:26D; amended 2009) which provide soil remediation standards (SRS) for direct contact exposure scenarios. The rule does not establish minimum standards for the IGW pathway, but requires these standards be developed on a site-by-site basis, pursuant to the Department's authority under NJAC 7:26D 1.1 (b) and NJSA 58:10B-12a, using the IGWSRS Guidance posted on the NJDEP website. The IGWSRS differs from the direct contact SRS in that it is designed to protect ground water quality from leaching of contaminants from the overlying soil. Therefore, site conditions can meet the direct contact SRS, but fail to meet the IGWSRS. The 2008 Remediation Standards and IGWSRS Guidance supersede the former remediation criteria (i.e., Impact to Ground Water Soil Cleanup Criteria [IGWSCC]) that had previously been in place for over 10 years.

The SAB was asked to provide a peer review of the framework and inherent assumptions and methodology of the IGWSRS Guidance for general scientific validity, completeness, accuracy and usability by New Jersey's Licensed Site Remediation Professionals (LSRP). The SAB was also asked to address a specific issue involving determination of IGWSRS regarding contaminated sites undergoing remedial action, which is not addressed in the guidance.

The charge questions also referred to related issues including New Jersey's statutory requirements, criticism by the regulated community regarding IGWSRS values being overly conservative, and a note indicating that there is an historical misunderstanding and misapplication of the impact to ground water pathway evaluation.

The charge questions as originally proposed to the SAB are provided in Attachment 1.

The purpose of this report is to provide technical peer review comments and recommendations that are intended for use by the NJDEP staff and interested party stakeholders with a high degree of technical background regarding the NJDEP IGWSRS Guidance.

The review and report was completed by the SAB IGWSRS Review Group. A report was initially prepared by the SAB IGWSRS Review Group and sent to the SAB for deliberation and comment, and then to the SRP for review and comment. Based on the recommendations from the SAB IGWSRS Review Group, the SAB approved this final report, which addresses review comments provided by the SAB members and SRP staff.

The IGWSRS Review Group performed a review of the IGWSRS framework and guidance documents provided on the NJDEP website. In addition, several other references were consulted for this review including the USEPA soil screening levels guidance, NJDEP's IGWSRS basis and background document, related NJDEP statutes and regulations, and scientific literature (see References). As part of this review of the IGWSRS Guidance, SAB members met with NJDEP Site Remediation Program (SRP) staff scientists in December 2010 and again in January 2011to discuss the associated technical issues. The working sessions facilitated a more focused discussion of the details and underlying concepts and assumptions of the methodology, formulas and selection of default values in the equations and models.

The SAB evaluated the IGWSRS Guidance based on the following general categories that were used to guide the review:

- Organization
- Transparency
- Flexibility
- Completeness
- Accuracy

The issues of conservative assumptions, redundancy and the degree to which exposure assumptions are realistic or reasonable required by New Jersey statutes, represented challenging, albeit necessary, aspects of this review. Developing IGWSSL and SRS requires making assumptions that are both numerical and conceptual (i.e., non-numerical), and that are expected to include some reasonable level of conservatism to provide a margin of safety. The NJDEP was instructed by the Legislature in S-1070 amendments (1993) to avoid using redundant conservative assumptions. According to the current SRRA (2009 amendments to Section 35 of P.L.1993, c.139 [NJAS 58:10B-12]), the NJDEP is to develop site-specific remediation standards based upon reasonable assumptions of exposure scenarios, avoiding the use of redundant conservative assumptions by the use of parameters that provide an adequate margin of safety, and which avoid the use of unrealistic conservative exposure parameters. A comprehensive evaluation of these issues is understood to be beyond the scope of the charge question. Notwithstanding, a meticulous effort was made to provide comments and recommendations to address these aspects of assumptions in the IGWSRS Guidance, which was required to complete this review. It should be noted that IGWSSL calculated from conservative default literature values and assumptions are generally considered to be less accurate than those developed using site-specific data. However, less accurate does not necessarily mean less stringent, as the default

SSLs are based on multiple conservative assumptions and values to account for the uncertainty of limited site-specific data.

2.0 SUMMARY OF FINDINGS

The IGWSRS Guidance provides a good degree of relatively accurate guidance and helpful spreadsheet calculators. Some of the assumptions and aspects of the methodology are too limiting and prescriptive. Also, some of the current available scientific information and existing methods should be added to the guidance to provide the kind of flexibility needed for use by an LSRP. A brief summary of findings and recommendations is included below; more detailed information is provided in following sections.

- Overview of Major Concepts and Considerations in IGWSRS
  - Limited to Unsaturated Zone.
  - SRS back-calculated from Ground Water Quality Standards (GWQS).
  - Intended to protect from future ground water impacts (i.e., predictive).

- Organization
  - Organization is not user-friendly, due in part to lack of a decision-based procedure, absence of a decision tree or flow chart, and hidden, unclear or unaddressed ramifications to various associated rules and guidance.
  - Process seems overly complex for many sites that would otherwise be considered as a low or minimal risk.
  - Modifications to guidance through FAQs may create uncertainty (e.g., numerous unscheduled changes to guidance without a phase-in period for existing projects) and is potentially inconsistent with guidance development requirements under SRRA.
  - Redundant information present throughout the guidance could be eliminated through re-organization of the document.

- Transparency
  - Not transparent in some important areas including technical basis, source references, spreadsheet calculation formulas.
  - References not included (e.g., literature values in Chemical Properties table, Basis and Background documentation [current form is incomplete and not readily available], formulas in calculation spreadsheets).

- Flexibility
  - Relatively inflexible and prescriptive.
  - Incorporate more technically applicable tools (e.g., greater use of site-specific data, flexibility in sample analytical methods (e.g., freezing of soil samples for volatile and/or non-volatile organics analysis to increase hold times).
  - Allow SPLP for VOCs, bench test methods (e.g., column studies).
  - Provide for risk management options to allow for site-specific exposure scenario assumptions that are realistic and reasonable.
  - Include risk assessment options, which are allowed under NJSA 58:10B-12.35.f. (Notwithstanding any limit or potential conflict in New Jersey's statutes, risk assessment is a technically viable approach to establishing remediation standards and should be available for evaluation of the IGW pathway.)

- Consider options for setting preliminary IGW soil remediation goals (IGWSRG), e.g., for sites with confirmed impacts to ground water.
- Expand performance-based, observed conditions approach using site-specific monitoring data for IGW pathway assessment and model validation/calibration.

- Completeness
  - Incomplete; does not include guidance on some important issues (such as those listed below).
  - Should include guidance for saturated zone soils since the behavior of contaminants in unsaturated and saturated subsurface soils may be closely related.
  - Current guidance does not meet SRRA requirements for use by the LSRP, which requires interested party review.
  - Update to expand options including:
    - Using available analytical methods for site-specific Kd for all contaminants (SPLP for VOCs, bench/batch tests, column studies, etc.).
    - IGW site remediation goals (as opposed to "standards" to provide a performance standard approach, e.g., for sites with active remediation or monitoring).
    - Allow for the use of site-specific risk assessment.
    - Incorporate risk management decision-making analogous to current methods for addressing contaminants in soil above direct contact soil remediation standards (e.g., institutional and/or engineering controls to manage potential exposure).
  - Coordinate with remediation permits and associated institutional and engineering controls (soil and ground water).

- Accuracy
  - Some IGWSRS (especially for VOCs) suffer from cumulative conservative assumptions (conceptual and numerical).
  - Conservative assumptions are reasonable where data are absent or limited, but overly conservative and unreasonable where site-specific data are available.
  - Include options to use alternative values with, or in place of, default conservative values from peer-reviewed literature or databases.
  - Expand use of site-specific soil and/or ground water data to generate more realistic IGWSRS when the data are available.
  - Incorporate methods to calibrate/validate predictive calculations and models.
  - Include options for IGWSRS or SRG where site conditions warrant more advanced evaluation (e.g., changes to GWQS, sites with long-term CEA, or where Class IIA GWQS do not apply, etc.).

3.0 OVERVIEW OF IGWSRS GUIDANCE DOCUMENTS

The IGWSRS Guidance (published on the NJDEP Webpage) is comprised of several documents, including an introductory document (recently deleted and changed to webpage introduction) and several technical documents focused on various site conditions and types of hazardous substances. Associated documents include several spreadsheet forms that function as interactive calculators for data input by the user. In addition, the IGWSRS guidance prescribes the use of specific modeling software (SESOIL and AT123D) with limitations. The model software must be purchased, and requires specialized training and experience. The IGWSRS Guidance is also modified through responses to frequently asked questions (FAQs) periodically posted on the NJDEP website.

The overall IGWSRS Guidance concept includes conservatively low default IGW soil screening levels that may be adopted as site-specific soil remediation standards (default IGWSRS). Depending on the contaminant, as well as on the site conditions, site-specific IGWSRS may be developed using other models and methodologies. The various additional documents, spreadsheets and models provide for input of site-specific data to allow further evaluation of contaminants that are above the default IGWSRS values. This general concept of having a simple/generic/more conservative approach then allowing the ability to develop a complex/site-specific/more refined approach to evaluation is appropriate. However, the IGWSRS Guidance documents and spreadsheets contain several restrictions and limitations that are not all clearly supported with defensible scientific basis and background information (i.e., not provided, incomplete or questionable).

4.0 DISCUSSION

4.1 Response to Primary Charge Question

General

Guidance for evaluating the IGW pathway and for developing site-specific IGWSRS is necessary. The USEPA SSL guidance is useful, but is overly simplistic and provides little information regarding more advanced evaluation necessary for establishing remediation standards. The USEPA methods for developing remediation standards for concerns identified through the IGWSSL process rely mostly on site-specific risk assessment procedures generally designed for relatively complex sites (e.g., subject to the CERCLA/NPL [Superfund], RCRA, NCP, etc.). Many sites subject to the NJDEP SRP requirements likely benefit from adapting the simpler USEPA SSL methods by addressing the IGW pathway through the process of elimination. However, a number of NJDEP SRP sites require a level of moderately complex evaluation that is somewhere between the SSL and a more formal risk assessment. The NJDEP IGWSRS Guidance provides methods and assumptions for addressing the IGW pathway that extend beyond the USEPA SSL process, but does not include risk management options or the option to use risk assessment.

Framework

The fundamental concept of the IGWSRS Guidance framework (from simple/conservative to complex/refined) is technically appropriate, and it allows flexibility for site-specific application. However, the technical basis and background information is not generally available and key references are missing or incomplete. For example, references are not included for the values listed in the Contaminant Properties Table on the IGWSRS website.

Organizationally, the framework is set out in several documents that are difficult to navigate and subject to change. For a first time viewer, the IGWSRS Guidance documents appear as a patchwork that is not user-friendly. Examples include, missing documents on the IGWSRS website, documents not presented in the proper order to facilitate decision-based navigation, and external updates via FAQs. The IGWSRS Guidance documents should be reorganized and combined to facilitate framework stability and method continuity, and to enhance usability. Any revised document should be made easy to navigate and dates of revisions documented. A decision-based flow chart should also be added to assist the user in navigating the process.

Methodology and Assumptions

Portions of the IGWSRS Guidance use the USEPA SSL guidance as a general basis for methods and assumptions. While many of the IGWSRS methods and assumptions are technically appropriate, not all are consistent with or included in the USEPA SSL guidance. Some of the IGWSRS assumptions violate the USEPA SSL model, are inappropriate when site-specific data are available, and when taken together, may be contrary to state law that limits the use of redundant or unrealistic conservative assumptions for the development of remediation standards. Note that the USEPA SSL guidance makes very clear that many simplifying conservative assumptions are used and that the resulting SSLs are not intended to be remediation standards, but are screening values to aid in refining the list of contaminants of concern for further review. Some of the method assumptions that contribute to overly conservative SSL and SRS values are listed and discussed below.

USEPA SSL method assumptions that contribute to conservative SSLs and SRS:

- Residential Land Use ("SSLs developed in accordance with this guidance are based on future residential land use assumptions and related exposure scenarios. Using this guidance for sites where residential land use assumptions do not apply could result in overly conservative screening levels; however, EPA recognizes that some parties responsible for sites with non-residential land use might still find benefit in using the SSLs as a tool to conduct a conservative initial screening." [USEPA, 1996; Emphasis Added]).
- Infinite source of contaminant mass (USEPA's SSL guidance notes that assuming an infinite mass can violate mass balance considerations especially for small sources).
- Potable use of shallow ground water near source investigation area.
- Adsorption of organic compounds strictly limited to soil organic carbon.
- Instantaneous and linear equilibrium soil/water partitioning.

NJDEP IGWSSL assumptions in addition to USEPA assumptions:

- Used as predictive model to protect against future potential impacts to ground water regardless of age of the discharge.
- Method and assumptions applied regardless of existing site-specific ground water quality.
- Single point compliance (i.e., precludes use of statistical analyses [mean, UCL]).
- Potable use of shallow ground water in source/investigation area.
- All SSLs and SRS are back-calculated from Class IIA GWQS only and do not provide for areas where they may not apply. The IGWSRS Guidance does not describe methods for developing IGWSRS using site-specific ground water quality criteria other than Class IIA GWQS.
- Limitations on use of available sample analytical technology and methods (e.g., SPLP for VOCs , extension of holding times for contingent analysis. Note that the NJDEP SRP rationale for omitting use of SPLP for VOCs is flawed due to incorrect assumptions regarding field sampling procedures.)
- Infinite source of contaminant mass with no allowance for mass-balance correction where warranted.
- Requires minimum of 3 samples per AOC for SPLP analysis, without flexibility for similar site-wide soil conditions that encompass multiple AOCs.
- Requires use and submission of NJDEP-provided spreadsheet calculators where fields and values are locked and cannot be changed by the data user (even when spreadsheet information is inaccurate compared to site data or conditions or results are illegible).
- No correction allowed for surface impermeable cap in ground water mixing zone dilution attenuation factor (DAF) calculation.

The IGWSRS Guidance, and supporting documents and information, includes discussion and rationale for many of the methods and assumptions. However, some of the rationale and requirements are not supported by a technical or scientific discussion, or are explained by reference to state laws and regulation and/or policies not in any laws or regulations.
In addition, there are implicit conceptual assumptions that add to the conservatism of the IGWSRS Guidance. These qualitative conservative assumptions include:

- assuming column or batch tests are "experimental" (i.e., unreliable);
- assuming that site-specific soil and ground water data are not related;
- taking a very limited view of historical and existing site-specific data usability; and
- applying the same conservative assumptions about of low-mobility substances to VOCs (e.g., assuming VOCs will migrate to the ground water after some long-term period into the future, when IGWSRS Guidance calculations, models and/or site-specific data demonstrate otherwise).

These are examples of assumptions inherent in the IGWSRS Guidance that are non-numeric and not easily accounted for when addressing the issue of redundant conservative assumptions. It should be noted that concern about future potential migration to ground water from soils may be valid for new discharges, but soil contamination at many remediation sites represents a legacy from past discharges that is now under metastable equilibrium conditions. The precautionary assumption in the IGWSRS that legacy soil contamination will mobilize to cause a future ground water impact is not warranted, and is inappropriate and overly conservative for many of these older sites. Thus, while site-specific data that may be used to confirm these legacy conditions are often available, they are not allowed to be considered under the current IGWSRS Guidance.

A fundamental issue that drives overly conservative IGWSRS for some of the carcinogenic substances is related to the back-calculation from the Class IIA GWQS. The Class IIA GWQS assume a 10^{-6} risk, which is a non-technical policy assumption that has no technical justification (Gallo, et al, 1995). The numerical GWQS are similar to drinking water standards that are established as health-based values or are based on practical quantitation limits (PQL). Another conservative assumption involves the method of Leachate Criterion calculation, which uses theoretical values that are, for some constituents, significantly lower than the GWQS values that are set at PQLs. This contradicts the statement in the Guidance that the higher of the health-based value or PQL is used for back-calculation of IGWSSL and IGWSRS. Thus, these additional conservative assumptions exacerbate the low IGWSSL and IGWSRS values generated by the method.

The sensitivity analyses of input terms in the EP, SPLP, DAF equations are oversimplified in the B&B because they do not address affects of simultaneous changes to key terms. For example, regarding the EP equation, changing the VOC organic carbon partition coefficient (Koc) value while maintaining a low value input for the fraction of soil organic carbon (Foc) shows little effect from changes to Koc. However, if Koc and Foc are both increased the effect is significant. Thus, the sensitivity analysis should consider the combined effects of changes to terms when evaluated together. (Note that the user cannot change the Koc values in the current spreadsheets.)

Application of the IGWSRS Guidance for all but very simple cases necessitates development of different IGWSRS for each Area of Concern (AOC) within a site. Many medium to large sites typically have 15 or more AOCs, although it is not uncommon for AOCs to number over 100 at larger sites. Thus, a larger site could conceivably have numerous IGWSRS for the same constituents where site-wide subsurface conditions are consistent. This seems overly and unnecessarily prescriptive and has the potential to cause needless use of resources with no environmental protection value-added. There should be an alternative option to evaluate AOCs

in groups or evaluate site-wide IGWSRS based on synoptic subsurface conditions and other factors.

Completeness

The IGWSRS Guidance is relatively comprehensive and useful for many sites, but incomplete in several respects:

- Use of risk assessment is not identified as an option;
- Application of risk management decision methods and guidance is not included (e.g., options for use of institutional and/or engineering controls, or monitoring).
- Calibration/Validation of IGWSRS calculations with observed conditions and site-specific data not addressed.
- Observed conditions analysis is limited (e.g., does not include many VOCs).
- Evaluation of IGW from saturated zone soils not addressed.
- Evaluation of IGW for areas undergoing remedial action not addressed.
- Identifications of nexus with other related NJDEP Guidance (remediation permits, technical impracticability) is missing or incomplete.

Accuracy

The IGWSRS Guidance promotes accuracy by allowing some use of site-specific data. However, the accuracy is limited by the method and assumptions regarding use of site-specific data in the following ways:

- Overreliance on literature values rather than site-specific data (e.g., use of site-specific Foc multiplied by a literature value for Koc to estimate Kd for VOCs is overly simplistic and produces values similar to the very conservative default screening levels for common soil types).
- Single point compliance and no provision for statistical methods (e.g., mean, 95%UCL).
- No adjustment for infinite mass source assumption.
- Use of cumulative conservative assumptions (conceptual and numerical).
- No procedure for validation or calibration of model (including predictive calculations in spreadsheets and SESOIL/AT123D in the IGWSRS Guidance).
- Limitations on use of USEPA analytical methods:
  - USEPA methods allow use of SPLP for VOCs, but it is not allowed by the NJDEP for no valid technical reason;
  - USEPA allows freezing of soils/sediments for extending sample analytical holding times for SVOCs beyond the current 14-day holding time, which is the holding time ascribed to preservation of the soils/sediments under cold (4 °C) conditions (USEPA, 1995, USEPA 2005b, USEPA 2008). Extending holding times is important for contingent analyses required by the NJDEP. However, this is not allowed by the NJDEP laboratory regulations, which require sample analysis or extraction within 14-days for SVOCs. It should be noted that the USEPA currently has no holding time requirement for analysis of PCBs (see SW846 Chapter 2; USEPA, 2008), but the NJDEP currently requires PCB analysis or extraction within 14-days. Thus, an LSRP that decides to employ judgment by implementing the USEPA methods for extending

holding times to comply with the NJDEP requirements runs the risk of having data rejected for no valid technical reason.)

Usability by LSRP

The IGWSRS Guidance is useful for sites that exhibit a relatively simple range of site conditions. However, its utility is adversely impacted by the organizational issues and technical limitations and omissions identified in this report. In addition, the guidance includes several references to the need for NJDEP review and approval that appear to contradict use by the LSRP without significant NJDEP review and approval. When taken together with the strict LSRP program requirements (e.g., report forms), the strict limitations of the IGWSRS will likely require site-specific review by the NJDEP for all but the simplest cases if there is even the slightest variance from the strictly limited set of conditions prescribed in the IGWSRS Guidance. It should also be noted that the LSRP's use and reliance on the IGWSRS Guidance is uncertain, since it was not developed with interested party review and input. Pursuant to SRRA, remediation standards guidance issued by the NJDEP for use by the LSRP must be developed through an interested party review process.

4.2 Additional Charge Questions

4.2.1 FAQ (Sites Undergoing Remedial Action for Ground Water Contamination)

The use of FAQs to address this topic is expedient, but inadequate for such a complex and important issue. Thus, these comments are intended to assist with addressing this issue using FAQ as a temporary measure. This issue and SAB comments are integral to comments and recommendations provided in the responses to the primary charge question and should be addressed with revisions to the guidance.

In framing the issue, the NJDEP notes that IGWSRS for VOCs are conservative and low regardless of the option used due to the high toxicity, mobility and solubility of VOCs. However, the limitations in the IGWSRS Guidance methodology and assumptions also contribute to the low IGWSRS for VOCs. The following comments and recommendations for changes to the guidance included in this report should be considered to address this issue (e.g., use of site-specific Kd for VOCs, observed conditions, etc.).

- The overall approach to address soil remediation for the IGW pathway in conjunction with the ground water remedy so that site soils and ground water are addressed in a holistic manner is appropriate.
- The evaluation on a "case-by-case" basis is assumed to mean site-specific basis and should be clarified to address if and when the LSRP should get input from the NJDEP.
- The Evaluation Criteria are reasonable, but should be revised after consideration of the SAB comments.
- This FAQ is too specific and should be revised to include more contaminants. Although this FAQ is specific to chlorinated VOCs because these cases have been the most problematic, other options are inadequate to address other classes of contaminants.
- Per the USEPA SSL Guidance, the methods and assumptions do not apply to areas where ground water impacts exist or may be reasonably expected (i.e., where soil contamination extends into the saturated zone).

- Using the term IGWSRS in the context of the proposed FAQ response is confusing and appears to be a circular reasoning. Rather than requiring IGWSRS for these sites, consider establishing preliminary IGW soil remediation goals (IGWSRG), consistent with the USEPA guidance, based on the methods noted below. One example of an IGWSRG would be evidence of decreasing contaminant mass, area, or concentrations in ground water over time in place of numeric IGWSRS, since this condition provides empirical site-specific evidence indicating the existing soil concentrations are not causing an increase in future impacts to ground water. Also, the guidance should incorporate development of IGWSRG that allows for consideration of current (potential, suspected or confirmed) impacts to ground water related to unsaturated and saturated soils because these subsurface zones are not compartmentalized in the environment.
- Methodology provided in the existing IGWSRS Guidance for petroleum mixtures may also be appropriate for other VOCs such as chlorinated solvents and should be considered to develop preliminary IGWSRG. While assumptions about biodegradation are more complex for chlorinated solvents, they are applicable at many sites (USEPA 1998, 1999). In addition, use of site-specific data that characterize ground water conditions (e.g., stabilized, decreasing area, mass) are valid indicators for IGW pathway evaluation.
- Technical limitations (e.g., technical impracticability) should be addressed or acknowledged (see petroleum mixtures guidance).
- Consider long-term remedial scenarios (e.g., some sites require a CEA for contaminated ground water [with or without ground water control/treatment] in perpetuity).
- Consider options for using engineering and/or institutional controls in development of IGWSRS or IGWSRG.
- Allow for alternative IGWSRS development methods, including options for performance-based standards (e.g., closure requirements linked to site monitoring data under remediation permits).
- Provide more flexibility in use of site-specific data, (e.g., development of site-specific Kd and/or Koc for VOCs using bench/batch tests (SPLP), treatability/column studies for all parameters, including VOCs).
- Incorporate mass transfer and de minimus quantities in evaluation (e.g., future use [no remediation], closure conditions [post-remediation]).
- Include the option of site-specific risk assessment and risk management decisions in the development of site-specific IGWSRS, which may be appropriate for sites that are more complex.
- **Table 1 -** References for data should be listed and using other sources of data should be an option.

4.2.2 FAQ Appendix A - Use of SESOIL to determine compliance

It is difficult to comment on the guidance suggested in "Appendix A Use of SESOIL to determine compliance" because it is incomplete (there are notes within the guidance which indicate "guidance not written") and the applicability and context is not clear. For example, it is not clear if the method is intended to be for all sites with a CEA or an option to address unsaturated soils containing elevated contaminant levels. In general, it should be revised after review and consideration of the comments and recommendations in this report. One overall concern is the reliance on a model and those associated default input restrictions in the IGWSRS Guidance that are not site-specific, instead of using site-specific data from ground water

characterization, which is inherently available by virtue of the CEA being issued. While some limited site-specific information can be input, there is currently no mechanism for model verification or calibration to confirm or make adjustments based on site-specific ground water monitoring data, and or spacio-temporal comparison of site-specific soil and ground water data. Also, this type of guidance should be an option rather than a requirement.

A related issue involves the applicability of IGWSRS for sites where a CEA is established, i.e., an area identified where ground water quality does not meet the GWQS. CEAs are generally established for periods longer than 5 years. A review of impacts to ground water from contaminants in unsaturated soil comparing three prominent soil models (including SESOIL) indicates the maximum concentrations of the more mobile contaminants (e.g., VOCs) in the ground water is reached within 5 years (Sanders, 1995). Experience with the SESOIL model is consistent with this general longevity of VOCs and subsurface soil types common in New Jersey for some sites but not for others. A lack of consistency in the duration VOCs existing in soils compared to model predictions suggests adsorption or other assumptions may be incorrect. Therefore, additional options should be included to use site-specific data in support of IGWSRS or IGWSRG, and/or to validate/calibrate/adjust predictive calculations (e.g., using monitoring data collected pursuant to CEA requirements).

4.3 Specific Technical Issues

4.3.1 Equilibrium Partition Assumptions

The method equations assume organic contaminants adhere only to organic carbon. For all organics but VOCs, the NJDEP allows determination of a site-specific Kd based on the ratio of total recoverable concentration data to the leachable concentrations based on the SPLP test. Omitting VOCs from SPLP is inconsistent with analytical techniques available in the existing USEPA analytical methods and underestimates the importance of site-specific partitioning data (vs. literature values) for evaluation of the IGW pathway and development of a site-specific Kd for VOCs.

The SPLP method for leaching of volatiles (USEPA SW-846 Method 1312) requires using up to 25-g of sample in a Zero Headspace Extractor (ZHE), which is designed to control loss of VOCs during extraction. A 25-g EnCore sampler, or equivalent coring device, can be used for collecting a sample for SPLP extraction for VOCs analysis. A 25-g aliquot can be collected in the field (separate from other 5-g sample aliquots required for standard total recoverable VOC analysis) using an EnCore-type device (consistent with SW-846 Method 5035a). Within 48 hours of collection the sample may be extracted per the SPLP method or extruded by the laboratory from the coring device into an empty sealed VOC vial and then preserved frozen at < - 7°C. The holding time for this preserved VOC sample is extended from 48 hours to 14 days from collection (SW-846 Method 5035a , *The Collection And Preservation Of Aqueous And Solid Samples for Volatile Organic Compound (VOC) Analysis).* The preserved 25-g sample aliquot may then be analyzed by the laboratory within 14 days from sample collection, at the discretion of the user (e.g., by the LSRP based on results from the total recoverable VOC analytical results).

In addition to standardized batch tests such as SPLP, the NJDEP should consider incorporating standard test procedures that have been developed for generating site-specific contaminant partition data, such as "Standard Test Method for Determining a Sorption Constant (Koc) for an

Organic Chemical in Soil and Sediments (ASTM, 2008). This is not the only reference and is intended only as an example of the kinds of technical methods that should be considered for inclusion as options in the IGWSRS Guidance.

During this review, the NJDEP SRP had indicated that test methods for developing Kd and Koc for VOCs are "experimental" and therefore impractical. However, the USEPA notes that "…many leach tests are available for application at hazardous waste sites, some of which may be appropriate in specific situations..." (USEPA, 1996). Therefore, the notion that such tests are not standardized, available, usable, etc., (and therefore not allowed) is a conservative assumption that is not technically valid.

VOCs are a primary issue due to conservative assumptions and calculations, although the default Kd for other substances are conservative based on the ranges from literature review (e.g., metals; USEPA 2005).

- Multiplying a literature-based (i.e., non-site-specific) Koc by Foc is a simplistic calculation to estimate Kd and includes conservative assumptions that are not consistent with scientific literature (Hoffman, 1995; Huang et al., 1997,1998; Morrisseya, et al., 1999; Silka, 1998; USEPA, 1993; Wang, et al., 2001; Weber, et al., 1992, 1996)) and with empirical data for many sites in New Jersey; while estimation of Kd may be a generally accepted standard approach used in many models, it is also a generally accepted practice to validate or calibrate a model and adjust input values as necessary. All models are estimates of reality, and should be selected and adjusted to the extent practicable fit the site, not forced to fit a scenario regardless of site conditions or data, especially when those data indicate the model or calculations may produce inaccurate IGWSRS.
- Assuming static, instantaneous equilibrium neglects sorption kinetics and associated partitioning behavior including:
  - Fickian sorption kinetics
  - Intra-particle (bi-phasic) sorption
  - Adsorption of VOC to non-organic soil fractions
  - Aging and weathering
  - Practical Irreversibility
- Effects of sorption kinetics and aggregate partitioning may be estimated using site-specific Kd for VOCs based on:
  - Historical/existing site data
  - SPLP for VOCs (e.g., the technique included in existing USEPA analytical methods uses zero head space extraction)
  - Column studies

4.3.2 Average and Mass

Development and/or application of IGWSRS based on single-point concentrations in soil without context of site characterization (e.g., spatial distribution, data mean, upper confidence limit [UCL], etc.) is inconsistent with conceptual behavior of contaminants in soil. While single-point compliance may be reasonable for initial default SSLs (e.g., where data are absent or limited), even a modest amount of site-specific data can facilitate reasonable average, UCL and mass estimates for developing IGWSRS and IGWSRG. Evaluation of contaminant concentration without considering limits to the mass can overestimate potential impacts to ground water and

thus generate overly conservative IGWSRS (USEPA, 1996). Use of common scientific assessment methods (e.g., statistical analysis) for site-specific data evaluation should be included to promote accuracy in developing IGWSRS or SRG. The IGWSRS should incorporate the use of statistical analytical methods for evaluation of soil data (e.g., area average concentrations, UCLs, mass estimates, etc.).

4.3.3 Contingent Analyses and Sample Holding Time

The IGWSRS Guidance necessitates additional sample collection and/or contingent sample analysis based on results of initial sample analysis. The requirement for evaluation of IGWSRS is also linked to initial soil sample analysis for EPH. Under current NJDEP laboratory rules (NJAC 7:18) sample analytical holding times for organic contaminants is 14-days from the time of collection. Thus, the IGWSRS Guidance creates an inherent requirement to expedite all organic analyses to meet holding times for contingent analyses. In other words, the EPH analysis and all other SVOC (ABNs and Pest/PCBs) analyses must be analyzed at the same time even though the results for the EPH analysis may indicate that additional testing of the sample for SVOCs is not warranted. The alternative to expediting analyses is re-mobilization and re-sampling. Both options drive up the costs and complexity of site remediation due mostly to antiquated and overly stringent NJDEP regulation that does not allow full use of the long-standing and well documented sample preservation techniques in existing analytical methods.

While sample holding times for metals analysis is reasonable (6 months), holding times for SVOCs (ABNs, PCBs/Pest) that undergo cold (4°C) sample preservation are 14 days or less, which seems unreasonably short considering sample handling includes constant refrigeration and these substances are known to resist decay. The scientific basis for the NJDEP's established holding times is uncertain. The current NJDEP requirements limit the options otherwise available under the USEPA methods that provide extension of holding times without sacrificing data quality.

A standard protocol for extending the holding time for extraction of a soil or sediment for SVOC analysis involves freezing of the sample to ≤ -20°C (see USEPA, 1995 and USEPA, 2005b). Samples may be held much longer than 14-days (in some cases up to a year or beyond) from sample collection to extraction if frozen in this manner to arrest holding time. Freezing samples to extend holding times is common practice in academic, government, contract labs, and industrial laboratories, and similar sample storage and handling methods are used to generate literature values that have formed the basis for remediation standards development by USEPA and NJDEP. Freezing of non-volatile organic sample will allow tests to be conducted in a rational, sequential manner whereby the results of one test (e.g., EPH analysis) may be fully evaluated before additional testing of the sample needs to be conducted for other SVOC analyses. This will save a great deal of unnecessary expense for these types of evaluations.

The NJDEP should allow extended holding times for SVOCs analyses (beyond the current 14 day limit, e.g. up to 1 year) if the sample is frozen to ≤ -20 °C within 14 days from collection, consistent with USEPA studies and protocols.

4.3.4 Validation/Calibration

Validation/calibration of predictive calculations and model assumptions is not addressed, but should be included as an option for evaluation of the calculations and model to assure the representation of site conditions is reasonably accurate. (This does not only apply to the SESOIL and AT123D models, but also to the EP, DAF and SPLP methods, which are used as predictive models in the guidance.) For example, site-specific, current and/or historical soil and/or ground water data can be used to calibrate/validate models that predict future potential impacts. The use of such data should be allowed to facilitate predictive calculations and model assumptions.

4.3.5 Alternative Back-Calculation Criteria

The IGWSRS Guidance methodology is based on back calculation of soil concentrations from health-based GWQS. However, the guidance does not allow flexibility to account for changes to GWQS, Interim Specific Standards, Class IIB/Class III ground water areas, surface water quality standards and associated ecological criteria where ground water receptors are surface waters, or sites where a CEA is established. The IGWSRS Guidance notes that use of ground water criteria other than the Class IIA GWQS may be established on a case-by case basis, but provides no methodology sites where the Class IIA GWQS do not apply (i.e., the ground water is not potable). A simple reference acknowledging a need for meeting with the NJDEP for development of IGWSRS where Class IIIA GWQS do not apply is not a substitute for guidance. Also, the GWQS are locked cells in the spreadsheet calculators and cannot be changed. Thus, the user is locked out from entering anything other than the Class IIA GWQS.

4.3.6 Saturated Zone

The IGWSRS Guidance applies to the unsaturated zone and does not provide guidance for IGWSRS development for the saturated zone (with or without known ground water contamination) beyond requiring vertical delineation to direct contact SRS. However, many sites exhibit conditions where contaminated soils extend into the water table and the same contaminants are present in the ground water at concentrations that exceed the GWQS. The saturated and unsaturated zones are not compartmentalized in the subsurface and should be considered together, especially for sites where contaminants have migrated to the saturated zone. Comments and recommendations including use of site-specific soil and ground water data elsewhere in this Report.

Clarify terms/concepts associated with the saturated zone, including:

- Saturated zone (e.g., includes capillary fringe, seasonal variation, etc.)
- Water table and the phrase “at the water table” (i.e., in or 6-inches above,etc.)

Provide options for site-specific IGWSRS or IGWSRG for the saturated zone using more advanced evaluation methods where site data are available. Consider adding:

- Performance standards based on GW monitoring data (rather than soil concentrations) to confirm protectiveness of remaining (post-remediation) soil concentrations.
- Correlation of historical/existing site soil/ground water data.
- Advanced site-specific Kd development (SPLP for VOCs, column studies, Bench/Pilot tests).
- Risk assessment/risk management approaches.

Development of IGWSRS for sites with confirmed impacts to ground water is a related issue that is addressed further below in the response to Additional Questions (FAQ) regarding sites undergoing long-term remediation of chlorinated solvents in ground water and sites with a CEA.

4.3.7 Required Spreadsheet Calculators

The spreadsheet calculators that are required to be submitted to the NJDEP by the LSRP are a practical and useful tool, but in some ways they are imprecise, inconsistent, and contain pre-entered values and fields that are locked and cannot be modified or corrected by the user. Inflexibility of calculation input parameters forces unrealistic modeling of site conditions; even when site-specific data may be used it is restricted to the point of potentially misrepresenting site conditions (e.g., underestimating or overestimating the potential for contaminant migration and impact to ground water). The spreadsheet calculators also contain undocumented and unexplained formulas that are not viewable to the user (e.g., LSRP). Thus, the calculators are a "black box." The terminology in the guidance text and spreadsheets is inconsistent, e.g., if no leaching from maximum soil concentration the text indicates that the IGW Pathway is no longer a concern, but the spreadsheet assigns a SRS value. In addition, the SRS value uses a rounded maximum value that is also rounded in the spreadsheet. Rounding values to significant figures is technically appropriate for comparison of data to standards. However, in the spreadsheet calculators, some rounded values are below the highest of the site data. This gives the mistaken impression that the maximum of the site data exceeds the IGWSRS assigned in the spreadsheet. Other minor issues (like locked column widths that make numbers illegible) are too numerous to list here. These are problematic issues since the spreadsheet calculators are required for LSRP-certified submissions and cannot be corrected by the LSRP. While some of these issues are addressed in the January 2011 FAQ, they should be rectified in updated spreadsheets.

Summary of recommended updates to the guidance text and spreadsheets:

- Make calculators more transparent (i.e., show formula details, provide access to B&B, reference literature values).
- Provide an explanation for rounding.
- Allow for corrections to be made to the spreadsheets.
- Allow for more flexibility of input terms (i.e., allow alternative literature values or more flexibility for input of site-specific data, especially for partition coefficients for all constituents including for VOCs; partition coefficents for VOCs are not included in the SPLP spreadsheet and should be added commensurate with allowance of SPLP methods for VOCs.)

4.3.8 Miscellaneous

Applicability of Guidance for Fill and Non-Soils

There is some concern that calculation assumptions intended for soils may not necessarily apply to fill or other soil-like solids. Therefore, the applicability of IGWSRS Guidance to non-soils, fill and historic fill should be clearly stated. Also methods to account for differences in soil vs. fill, etc. should be considered.

Comparison of IGWSRS to Prior NJDEP Criteria and IGWSRS Used by Other States

The default IGWSRS were compared to the former NJDEP SCC and analogous IGW soil criteria used in two other states (CT and MA). While the IGWSRS for some analytes are similar and some are higher, the NJDEP's default IGWSRS are much lower than the former NJDEP IGWSCC and the IGW soil criteria used by both CT and MA for a number of analytes listed in the guidance. VOCs appear to cause the biggest problem because additional evaluation using the options and assumptions in the IGWSRS guidance generally does not result in a significant change to the conservative default IGWSSL for these substances.

Contradictions Regarding Use of IGWSRS

The use of IGWSRS is unclear due to conflicting statements in 2004 B&B p. 20 and the TRSR (NJAC 7:26E-4.4). Clarify how IGWSRS may be used to trigger a ground water investigation.

Excerpts from B&B and TRSR:

> **2004 SRS B&B Document: Page 20 IGW Exp Pathway:** "…it is inappropriate to use IGW SRS to determine when a GW sample should be collected….the TRSR will be revised …."
>
> **7:26E-4.4 Remedial investigation of ground water**
> (a) A remedial investigation of ground water for an area of concern shall be conducted if:
> 1. A ground water sample previously collected from that area of concern contains a contaminant above the applicable ground water remediation standard;
> 2. A soil sample collected from that area of concern within two feet of the saturated zone or bedrock contains a contaminant above the applicable soil remediation standard;
> 3. A soil sample collected in the area of concern anywhere in the soil column contains a contaminant above the applicable soil remediation standard and the contaminant is not going to be actively remediated or removed.

A clear technical rationale is not provided in the IGWSRS Guidance or the B&B for why use of the IGWSRS for triggering a ground water investigation is inappropriate. As a result of the SAB review, the NJDEP has indicated that, for lower mobility contaminants, there is not necessarily a link between current soil quality and current ground water quality. The Technical Requirements detail when a ground water investigation is needed, and when to install a well (see NJAC 7:26E-3.7(a) and 4.4). The current regulatory triggers for a ground water investigation are generally based on solubility, soil texture and distance to the water table, and have been a long-standing, effective and accepted approach for deciding when a ground water investigation is warranted. However, the IGWSRS Guidance should include an option for use of existing and or historical soil and/or ground water data, or collection of soil and/or ground water samples, to evaluate whether the presence of elevated concentrations of more soluble constituents (e.g., VOCs) have affected ground water for certain scenarios. Examples of scenarios where this option may be appropriate include (but are not limited to): (1) sites with elevated concentrations of VOCs in soils that have existed for longer than the models predict they will migrate to ground water; (2) sites that have documented impacts to ground water; (3) sites that are undergoing ground water remediation; (4) sites that include institutional controls (e.g., CEA).

5.0 CONCLUSIONS AND RECOMMENDATIONS

The fundamental IGWSRS Guidance methodology of setting conservative default values and allowing use of site-specific data to evaluate sites with a variety of conditions and scenarios is a reasonable approach that generally follows the USEPA guidance. Additionally, the associated spreadsheet calculators facilitate development of refined IGWSRS by allowing limited input of site-specific data for less complex sites. However, the methodology is heavily dependent on a risk calculation with an assumed exposure and does not incorporate risk management decisions that could modify the calculated IGWSRS to reflect actual and/or reasonable potential site-specific exposure scenarios. The IGWSRS Guidance represents an adaptation of the quantitative aspects of USEPA's SSL guidance without the checks and balances of a risk management concept.

The IGWSRS Guidance includes additional concepts and restrictions over the USEPA SSL method, such as the principal of protection of future impacts, excluding or severely limiting the use of site-specific observed conditions data (e.g., ground water data), and other conservative limitations and assumptions discussed in the previous sections of this Report. Taken together with the conservative assumptions inherent in the USEPA method, these added assumptions and limitations result in unnecessarily low, conservative IGWSRS for some compounds (especially VOCs) regardless of which current IGWSRS site-specific option is used. The Guidance also unnecessarily complicates environmental sampling programs by applying antiquated and unsupported short analytical holding times (through nexus with laboratory regulations and other site remediation guidance) for contingent analyses required to comply with the guidance options.

Protecting ground water from leaching and/or migration of contaminants (i.e., impacts to ground water) is important. However, the IGWSRS Guidance represents a fairly narrow and precautionary approach to addressing the issue. While this Report is not intended to provide a comprehensive list of methods to address the issue, it does present a number of detailed examples that should be useful to guide revisions to the IGWSRS Guidance that will lead to a more usable, practical and technically-sound protocol for development of soil remediation standards.

It is critical to note that, while the SAB is recommending addition of options for flexibility, the entire process should be simplified for the NJDEP and other stakeholders. In that light, the NJDEP should consider use of a hierarchal approach, which should begin with use of current and/or historical site-specific data and then apply the evaluation tools that are available in the IGWSRS Guidance or its revisions, as necessary. The precautionary conservative assumption of potential future impacts to ground water should not be a default assumption for all sites, but should be applied sparingly, reserved primarily for limited scenarios (e.g., sites with very limited data and/or new discharges).

The following summary of recommendations is provided based on the review of the IGWSRS Guidance described above:

Fundamental Concepts, Methodology and Risk Assumptions:

- Incorporate risk management decision elements as modifiers to quantitative values for remedial decisions.

- Limit the precautionary conservative assumption of potential future impacts to ground water to only limited scenarios (e.g., sites with very limited data and/or new discharge areas).

- Include options for addressing the saturated zone using:
  - Remediation permits with performance standards based on ground water monitoring data (rather than soil concentrations) to "validate" protectiveness of remaining (post-remediation) soil concentrations.
  - Correlation of historical and/or existing site soil and/or ground water data.
  - Site-specific Kd (including for VOCs) using batch tests (e.g., SPLP), column studies, bench/pilot tests.
  - Risk assessment and risk management decision-making.

- Allow flexibility to account for back-calculation of IGWSRS to standards or criteria other than the GWQS to account for changes to GWQS, Interim Specific Standards, Class IIb/Class III ground water areas, surface water or ecological criteria, and sites where a CEA is established.

- Consider establishing preliminary IGW soil remediation goals (IGWSRG) for more complex sites, e.g., where ground water impacts are documented, where remediation is in progress or where institutional controls will be established for contaminated ground water (e.g., a CEA), etc.

- Provide guidance for options to use site-specific data for IGWSRS or SRG associated with remediation permits (e.g., deed notice and CEA requirements, engineering and/or institutional controls).

- Include methodology on the use of site-specific data that characterize ground water conditions (e.g., stabilized, decreasing area, mass) as indicators for soil IGW pathway evaluation.

- Allow for alternative IGWSRS development methods, including options for performance-based standards (e.g., closure requirements linked to site monitoring data under remediation permits).

Administrative/Usability:

- Re-organize the guidance into one document and present more streamlined version of the process, with details in appendices, to make it more decision-based and user-friendly.

- Add a decision-based flow chart or navigation scheme to assist users through the process.

- Revise and update the guidance to remove references to pre-approval by the NJDEP to the maximum extent possible, to make it consistent with the LSRP paradigm, and for use by the LSRP as guidance pursuant to the SRRA.

- In developing the IGWSRS, it is important to consider concerns within the NJDEP that are currently not part of the IGWSRS Guidance, such as the nexus with the saturated zone, other SRP Guidance, laboratory regulations, etc.

Technical/Detail:

- Clarify technical terms/concepts:
  - Saturated zone (e.g., includes capillary fringe, seasonal variation, etc.).
  - Define "at the water table" (e.g., immediately above the saturated zone, including capillary fringe, etc.).
  - Applicability of IGWSRS Guidance to non-soils, fill and historic fill.

- Allow use of site-specific, current and/or historical soil and/or ground water data to calibrate/validate models that predict future potential impacts.

- Provide flexibility to extend holding times for contingent analyses associated with implementing the IGWSRS Guidance pursuant to the available analytical methods.

- Summary of recommended updates to the guidance text and spreadsheets:
  - Make calculators more transparent (i.e., show formula details, provided access to B&B, reference literature values).
  - Provide an explanation for rounding values.
  - Allow user to correct values and fields that are locked in current spreadsheets.
  - Allow for more flexibility of input terms (i.e., allow alternative literature values or more flexibility for input of site-specific data, partition coefficients for all constituents including VOCs).

- Provide more flexibility in use of site-specific data, e.g., use of site soil and/or ground water data for development of site-specific Kd and/or Koc, use of SPLP for VOCs, bench test, treatability studies.

- Incorporate mass transfer and de minimus quantities in evaluation (e.g., future use [no remediation], closure conditions [post-remediation]).

- Include options for use of site-specific risk assessment.

- Include options for sampling ground water to address the IGW migration pathway for constituents that are not screened out by the IGWSSL process, consistent with USEPA methodology.

6.0 REFERENCES

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ATTACHMENT 1
Charge Questions

The SAB is requested to review and comment upon the following documents which are currently available:

1. The framework provided in the guidance document found at http://www.nj.gov/dep/srp/guidance/rs/igw_intro.htm. Comments are requested on the general scientific validity and usability of this document in supporting the legal requirement to develop the site specific IGWSRS.

2. The assumptions and methodology in development of the IGW Soil Screening Levels, found at http://www.nj.gov/dep/srp/guidance/rs/partition_equation.pdf

3. Additional technical documents as needed referenced in both of the above documents.

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Peer review of the Site-Specific Impact to Ground Water Soil Remediation Standards (IGWSRS) Framework: Do the IGWSRS framework and associated assumptions and methodology reflect accurate and comprehensive information to guide the Licensed Site Remediation Professional (LSRP) in the evaluation of potential impacts associated with the impact to ground water pathway?

State law requires determination of site-specific IGWSRS on each site. The IGW subcommittee, part of the Soil Standards effort, has developed a framework compatible with federal guidance (USEPA) involving screening levels for sites with little site specific data, and several other guidance documents and models for sites which do have site-specific data. Due to the low screening levels for several contaminants, and the fact that this pathway has been historically misunderstood and therefore erroneously applied, much criticism has been received from the regulated community.

Additional Questions for SAB:

1. The IGW Screening Levels/Default IGWSRS are conservative due to a variety of reasons. For most contaminants, use of site-specific data in conjunction with the other models and guidance lead to "higher" IGWSRS (and obviously lower associated remediation costs). However, for volatile organics, acceptable soil concentrations often remain low no matter which option is used. This is due to their high toxicity, mobility and solubility. In trying to resolve this issue in a somewhat practical manner, the IGW subcommittee has written up the following option to a frequently encountered condition. This is currently in the form of an FAQ proposed by the IGW subcommittee. The SAB is asked to comment on this option, and if possible suggest other procedures for determining site-specific remediation standards for volatile organic contaminants.

Frequently Asked Question

If I have a site that is highly contaminated with chlorinated solvents in the ground water and / or DNAPL, and ground water treatment/monitoring/attenuation will be ongoing for years, do I need to remove and / or treat soil contaminants exceeding the site-specific IGWSRS?

Summary

Remedial decisions for the IGW pathway at a site with high levels of chlorinated solvents in the ground water and / or DNAPL may be determined on a case by case basis. The soils remedy proposed for the IGW pathway may be assessed in conjunction with the ground water remedy so that site soils and ground water are addressed in a holistic manner. For example, if a site contains ground water that that will be treated or monitored for 10 years, soil remediation may be modified such that in 10 years soil contamination will meet site-specific IGWSRS. This option is mostly likely to be useful with coarser-grained soil textures such as sand and sandy loam, where elimination of these contaminants from the vadose zone may occur relatively quickly, and when contaminant concentrations are above default impact to groundwater screening levels, but still relatively low (i.e. well below their respective soil saturation limits). The SESOIL model may be used as a tool for this assessment (see draft Appendix A). The conditions that would enable such a decision are discussed below.

Evaluation criteria used to make site-specific decisions on remediation

Evaluation criteria and will include, but not be limited, to the following:

a. Receptor evaluation.
b. Remediation of highly contaminated soil. This includes removal of contaminant concentrations in the unsaturated zone soils above Csat pursuant to the Technical Requirements. Csat values for select chemicals are found in Table 2 below.
c. Free and residual product – removal, treatment or proposal to remove or remediate.
d. Whether an active ground water remediation is currently in place for the dissolved phase or active ground water remediation is proposed. Active groundwater remediation includes hydraulic control. If an active ground water remediation is underway, the effectiveness of the system needs to be evaluated.

Prior to case closure, compliance with the IGW pathway will have to be demonstrated through post-remedial soil sampling or some other mechanism

Guidelines for determining if soil is highly contaminated

Definition of highly contaminated is linked to free and/or residual product as well as contaminant concentrations in relation to their Csat values.

Guidelines for determination of presence of free or residual product

Pursuant to 7:26E-2.1(a)14 DNAPL chemicals are those that in their pure phase and at standard state conditions (20 degrees Celsius to 25 degrees Celsius and one atmosphere pressure) have densities greater than water. For these chemicals free and/or residual product shall be considered to be present if the contaminant is detected in ground water at concentrations equal to or greater than one percent of the water solubility of the contaminant if ground water contains only that organic contaminant. If a mixture of such contaminants is present, then the effective water solubility of the contaminant shall be estimated for this determination. Solubilities for select DNAPL chemicals are found below in Table 1.

Table 1.
Example Water Solubility for Select DNAPL Chemicals

	Chemical	*CAS Number*	*Water solubility mg/L*		*1% Solubility mg/L*
9	Tetrachloroethene (PCE) (Tetrachloroethylene)	127-18-4	2.00E+02	a	2.00
26	Chlorobenzene	108-90-7	4.72E+02	a	4.72
35	1,2-Dichloroethene (trans) (t-1,2-Dichloroethylene)	156-60-5	6.30E+03	a	63.00
60	Trichloroethene (TCE) (Trichloroethylene)	79-01-6	1.10E+03	a	11.00
64	1,1,2-Trichloroethane	79-00-5	4.42E+03	a	44.20
65	Bromomethane (Methyl bromide)	74-83-9	1.52E+04	a	152.00
66	2-Chlorophenol (o-Chlorophenol)	95-57-8	2.20E+04	a	220.00
76	1,1-Dichloroethane	75-34-3	5.06E+03	a	50.60
88	1,1,1-Trichloroethane	71-55-6	1.33E+03	a	13.30
89	1,2-Dichlorobenzene (o-Dichlorobenzene)	95-50-1	1.56E+02	a	1.56
109	1,2,4-Trichlorobenzene	120-82-1	3.00E+02	a	3.00
113	Chloroform	67-66-3	7.92E+03	a	79.20
117	Methylene chloride (Dichloromethane)	75-09-2	1.30E+04	a	130.00
119	1,2-Dichloroethane	107-06-2	8.52E+03	a	85.20
124	**1,3-Dichlorobenzene (m-Dichlorobenzene)**	541-73-1	**1.30E+02**	f	1.30
132	1,2-Dichloroethene (cis) (c-1,2-Dichloroethylene)	156-59-2	3.50E+03	a	35.00
133	Vinyl chloride	75-01-4	2.76E+03	a	27.60
135	1,1-Dichloroethene (1,1-Dichloroethylene)	75-35-4	2.25E+03	a	22.50
139	1,1,2,2-Tetrachloroethane	79-34-5	2.97E+03	a	29.70
142	Carbon tetrachloride	56-23-5	7.93E+02	a	7.93
144	Chloroethane	75-00-3	5.70E+03	f	57.00

Table 2.
Example C_{sat} Concentrations for select DNAPL Chemicals

Chemical	CAS Number	Water solubility mg/L		DEP Soil Saturation Limit (mg/kg)	Saturated Zone Csat (mg/kg)
Carbon tetrachloride	56-23-5	793	a	5.17E+02	4.61E+02
Chlorobenzene	108-90-7	472	a	2.88E+02	3.17E+02
Chloroethane	75-00-3	5700	f	1.29E+03	1.50E+03
1,2-Dichlorobenzene (o-Dichlorobenzene)	95-50-1	156	a	2.18E+02	2.29E+02
1,3-Dichlorobenzene (m-Dichlorobenzene)	541-73-1	130	f	2.06E+02	2.14E+02
1,4-Dichlorobenzene (p-Dichlorobenzene)	106-46-7	73.8	a	1.03E+02	1.08E+02
1,1-Dichloroethane	75-34-3	5060	a	1.24E+03	1.50E+03
1,2-Dichloroethane	107-06-2	8520	a	1.64E+03	2.28E+03
1,1-Dichloroethene (1,1-Dichloroethylene)	75-35-4	2250	a	8.99E+02	7.90E+02
1,2-Dichloroethene (cis) (c-1,2-Dichloroethylene)	156-59-2	3500	a	8.55E+02	1.07E+03
1,2-Dichloroethene (trans) (t-1,2-Dichloroethylene)	156-60-5	6300	a	1.92E+03	2.13E+03
Methylene chloride (Dichloromethane)	75-09-2	13000	a	2.44E+03	3.34E+03
1,1,2,2-Tetrachloroethane	79-34-5	2970	a	1.01E+03	1.25E+03
Tetrachloroethene (PCE) (Tetrachloroethylene)	127-18-4	200	a	1.11E+02	1.09E+02
1,2,4-Trichlorobenzene	120-82-1	300	a	1.12E+03	1.14E+03
1,1,1-Trichloroethane	71-55-6	1330	a	6.09E+02	6.03E+02
1,1,2-Trichloroethane	79-00-5	4420	a	1.14E+03	1.47E+03
Trichloroethene (TCE) (Trichloroethylene)	79-01-6	1100	a	5.90E+02	6.22E+02
Vinyl chloride	75-01-4	2760	a	8.94E+02	7.47E+02

Appendix A
"Use of SESOIL to determine compliance"

First, estimate how long the ground water remediation will take. To do so, utilize the Technical Requirements CEA process.

Second, determine whether soil contamination above IGWSRS will still be present in the unsaturated zone beyond the estimated timeframe of the groundwater remediation. To do so, utilize the SESOIL transport model as described in the Department's Impact to Ground Water Soil Remediation Standards guidance document. Alternate guidance for utilizing the SESOIL model to estimate the length of time for chlorinated volatile contaminants to be eliminated from soil must be followed. [NOTE: THIS GUIDANCE HAS NOT YET BEEN WRITTEN] A site-specific soil texture must be determined when using the SESOIL model for this purpose. As always, soil concentrations of the contaminant must be delineated. Furthermore, soil organic carbon contents must be determined for the soil profile, using the alternate guidance. The SESOIL model may not be used to estimate contaminant elimination time for capped sites. With the presence of a cap, groundwater recharge is eliminated, and volatilization of contaminant is inhibited, and contaminant may remain in the vadose zone for extended periods of time.

Relevant Definitions/Regulations

"**Free product**" means a separate phase material, present in concentrations greater than a contaminant's residual saturation point. This definition applies to solids, liquids, and semi-solids. The presence of free product shall be determined pursuant to the methodologies described in N.J.A.C. 7:26E-2.1(a)11.

"**Residual product**" means a separate phase material present in concentrations below a contaminant's residual saturation point, retained in soil or geologic matrix pore spaces or fractures by capillary forces. This definition applies to solids, liquids, and semi-solids. The presence of residual product shall be determined pursuant to the methodologies described in N.J.A.C. 7:26E-2.1(a)11.

"**Residual saturation point**" means the saturation point below which non-aqueous phase liquid becomes discontinuous and is immobilized by capillary forces, and fluid drainage will not occur.

N.J.A.C. 7:26E-2.1(a)14.i. For contaminants that in their pure phase and at standard state conditions (20 degrees Celsius to 25 degrees Celsius and one atmosphere pressure) have densities greater than water, free and/or residual product shall be considered to be present if the contaminant is detected in ground water at concentrations equal to or greater than one percent of the water solubility of the contaminant if ground water contains only that organic contaminant.

If a mixture of such contaminants is present, then the effective water solubility of the contaminant shall be estimated for this determination.

N.J.A.C. 7:26E-6.1(d) Free and/or residual product determined to be present pursuant to N.J.A.C. 7:26E- 2.1(a)11 shall be treated or removed when practicable, or contained when treatment or removal are not practicable. Likewise, natural ground water remediation for dissolved phase contamination may be implemented if it is determined by the Department that active ground water remediation for the dissolved phase is impracticable or not cost-effective. Decisions regarding the practicability of a remedial decision shall be made by the Department on a case by case basis. Natural remediation of free and/or residual product will not be allowed.