SOLUTIONS

H&B Solutions, LLC

37534 Oliver Drive
Selbyville, DE 19975

Tel: 410.292.4385

April 24, 2015

Maryland Department of the Environment
Oil Control Program
1800 Washington Blvd., Suite 620
Baltimore, MD 21230-1708

Attn: Mr. Chris Ralston, Administrator

Re: Groundwater Remediation
Proposed 2015 Action Plan – Response Letter
Case No. 1987-2534-KE
Chester River Hospital Center
100 Brown Street, Chestertown
Kent County, Maryland
Project No. 14004.00

Dear Chris:

This is in response to Maryland Department of the Environments (MDE's) letter dated March 27, 2015 regarding comments on the proposed 2015 Action Plan. The specific purpose of this Shore Regional Health Chester River Hospital Center (SRH-CRHC) response letter is to both address the MDE comments and to revise the 2015 Proposed Action Plan as required.

We believe both parties agree that at this stage in the groundwater remediation effort the MyCelx® Filter Treatment System alone is inadequate to fully remediate the site, especially in addressing the documented "smear zone" issue. The Pilot Study has successfully demonstrated that the use of Ivey-sol® surfactants and the Ivey-sol® Push-Pull process can safely liberate and recover residual liquid phase hydrocarbons (LPH) from the smear zone, as noted in your letter. Combining the MyCelx® Filter Treatment System with the Ivey-sol® Push Pull process in the study area has proven that the technologies together enhance the groundwater remediation effort.

Several appendices are enclosed which include the requested field notes and pictures as well as vendor confirmation that the MyCelx® Filter Treatment System has the appropriate hydraulic and treatment capacity to adequately process extracted groundwater continuously discharged through the pump and treat system, as well as during the Ivey-sol® push-pull extractions, without impairing the effectiveness of the process while continuing to meet Discharge Permit limits. In order to protect against any type of filter breakthrough, you will note, and the Technical Team agrees, that the vendor has recommended additional MyCelx® Emulsion Breaker (EB) Filters be installed after the MyCelx® Product Recovery Filters. It has also been determined by the equipment vendor that the surfactant will have no negative impact on removal efficiencies of the MyCelx® Filter Treatment System with these upgrades.

Notwithstanding the successful outcome of the Pilot Study, the Technical Team also clearly understands the need to address your comments, provide additional clarifications, and revise the Proposed 2015 Action Plan. We believe that the following will provide the additional supporting information and justification needed for MDE to approve the revised 2015 Action Plan. As per our recent discussions, this document shall serve as and become an addendum to the previous Plan submittal dated January 19, 2015.

Listed below is a short summary that captures the salient points included in this response letter followed by a more detailed technical discussion of the points raised and the revisions to the 2015 Action Plan:

Summary of Responses to Comments and 2015 Action Plan Revisions:

1. Each Priority Zone as identified in the proposed 2015 Action Plan will be addressed in succession from the highest Priority Zone #1 to the lowest Priority Zone #4.

2. The upgraded MyCelx® Filter product recovery system will be left on during the entire 2015 Action Plan process.

3. The MyCelx® Filter Treatment System will be used to support both the pump and treat system (hydraulic control) and the Ivey-sol® push-pull extractions.

4. Each push-pull event will start and end per the procedures outlined in the proposed 2015 Action Plan and will not be terminated until both the surfactant readings and the twenty-four (24) hour laboratory TPH-DRO readings are at or near limits of detection.

5. The observed mounding affect is a result of well construction and the introduction of Ivey-sol® during the push/injection phase of the process. The degree of mounding; however, is not critical to the process as rates of Ivey-sol® dispersion are associated with the soil types and Ivey-sol® published data. The dispersion rates selected in the Action Plan were confirmed based on a comparison of the soils characterized by the cross section and well logs.

6. Ivey-sol® dispersion rates are those defined on the exhibits included in the sections below as prepared by Ivey International per twenty-five (25) years of experience using this process in different soil types. As indicated above, the soil types onsite have been confirmed through examination of the cross sections and well logs and comparing them against the Ivey-sol® exhibits for determining dispersion rates to be used in the 2015 Action Plan.

7. Field data and related pictures demonstrate how the process of reading the surfactant field test works. Discussions that follow this summary section expand on the test protocols in more detail. Because the surfactant field test and lab tests for surfactants have very high levels of comparability, surfactant lab tests will not be used in 2015 procedures only in the field test. The Technical Team believes this will be a more accurate way to gauge effectiveness as lab tests take weeks for turnaround. Therefore, lab testing of surfactants is not recommended for use in guiding ongoing field activities.

8. The pictures also show the fouling on both the bag/MyCelx® filters associated with a biological film. The Technical Team believes this is associated with an increase in petroleum-consuming microbes in the groundwater table associated with the liberated material. (There was no physical evidence of clouding or particulate matter in the extracted water.) The details in the following section better define the needed frequency of bag filter replacements to address this observation which is keyed to the pressure readings on the MyCelx® Filter Treatment System. The bag filters will be changed as required based on pressure readings, in accordance with vendor specifications.

9. Sampling, laboratory testing, and reporting on a monthly and quarterly basis shall continue and include the following along with added sampling/reporting as noted below:
    - Monthly gauging of all monitoring and recovery wells.
    - Monthly sampling of eleven (11) targeted monitoring wells (MW-15, MW-16, MW-19, MW-20, MW-24, MW-33, MW-34, MW-35, MW-48, MW-49, and MW-50) for the presence of Total Petroleum Hydrocarbons – Diesel Rand Organics (TPH-DRO) using EPA Method 8015.
    - Quarterly sampling all monitoring and recovery wells for the presence of TPH-DRO using EPA Method 8015 and Volatile Organic Compounds (VOC's) including oxygenates, using EPA Method 8260B.
    - On a monthly basis, provide all laboratory and field testing results that was performed during the implementation of the Priority Zones. The number of samples cannot be estimated at this time as onsite field decisions will be the primary factor for demonstrating the presence/absence of surfactant at the injection or surrounding wells. Furthermore, the Technical Team will rely on field observations and rapid analysis of TPH-DRO for determining end points at a particular well.

10. The extraction pump rates shall be those associated with the two (2) pumps (5 gallons per minute (gpm) and 3 gpm) that fit the four inch (4") and two inch (2") wells respectively. The reported difference in the individual well withdrawal pumping rates in the Pilot Study is a reflection of the well characteristics in each (screening, fines at bottom of well, local hydro-geologic conditions, etc.). However, since we propose to run the pumps and extract liberated material and surfactants until we measure at or near non-detectable levels of TPH-DRO and surfactant using agreed upon test methods, the rate of extraction is not relevant to our objective which is simply to enhance current remediation efforts at the site.

11. The Priority Zone implementation plan will include identification of each Zone, the specific wells to be used, protocols to be followed, use of end point indicators, and discussion of the successions from Zone #1 through Zone #4.
    - The upgraded MyCelx® Filter Treatment System which serves as the hydraulic control for the groundwater remediation project will remain in operation at all times as part of the 2015 Action Plan.
    - In general the push-pull process will be initiated in Priority Zone #1 and once completed the process will be repeated in sequence in Priority Zone #2, then in Priority Zone #3, and then in Priority Zone #4.
    - The specific protocols to be used are those found in the 2015 Action Plan dated January 19, 2015.
    - A determination to move from Priority Zone #1 to Priority Zone #2 will be made using the results from daily TPH-DRO and field run surfactant tests such that when they measure non-detectable levels the extraction element of the process will be considered complete and the Technical Team will move on to the next Zone.

12. There was no measurable thickness of LPH sheen in any of the extraction wells. The sheen was barely visible to the eye. This is to modify any language in the Pilot Study report and 2015 Action Plan which may have used the term mass recovery. Since it was

not a measureable thickness we reported it as not present, but stand corrected per your March 27, 2015 letter and discussion of same.

13. The Technical Team agrees there is still residual LPH in and around the treated area because the wells are located within the footprint of the former LPH plume. The purpose of the proposed 2015 Action Plan is to provide a more robust implementation which would be necessary for sustained improvement in the groundwater remediation effectiveness.

14. Detailed field notes and pictures were collected by EBA and BrightFields. They documented the day-to-day activities as reflected in the Pilot Study report and interpretation of findings. The two (2) most important items discussed in more detail below are pictures of the microbiological fouling of the bag and MyCelx® filters and visuals of the field run surfactant tests which prove to be as reliable as the laboratory tests.

As requested by MDE our response follows the outline of the letter March 27, 2015 letter which is broken down into two (2) sections: Pilot Test Evaluation and Proposed 2015 Action Plan.

Responses to MDE Pilot Test Evaluation Comments:

1. Section 3.10 - General Observations and Discussion

a. Generally absent from this section is any discussion of the technical team's field notes and any photos collected during the pilot test. The report should provide more detail on what was observed during the periodic visual inspections and provide photo documentation if collected.

The Team of EBA and BrightFields took a significant amount of notes during each day of the Pilot Study as well as photos that document the day-to-day activities and capture any significant observations. Attachment A includes copies of the relevant field notes. Attachment B includes copies of the relevant pictures.

In addition to confirming the actual events for each day which were documented in the Pilot Study Report, the field notes describe some key findings and observations such as:

The field notes from EBA provide details on the following:

- Capturing of daily activities with time notations.
- Documentation of personnel onsite including members of the Technical Team, MDE, Clean Harbors, and Mr. Sipes.
- Documentation that gauging and sampling events was performed.
- Visual inspections of the influent tank for the presence of surfactant or liquid phase hydrocarbons.
- Documentation of surface tension field test results.
- Documentation of surface agitation field test results.
- Documentation of injection events.
- Documentation of extraction events with emphasis on having sufficient data to cease extraction efforts.
- Documentation that surfactant did not migrate south of Brown Street.

The field notes from BrightFields provide details on the following:

- Capturing of daily activities with time notations.
- Recording of gauging data from the monitoring wells.
- Recording of system checks and maintenance activities associated with the pump and treat system with emphasis on pressure readings, presence of sediment, and bio-fouling of filters.
- Documentation of injection events.
- Documentation of extraction events.
- Documentation of surface tension field test results.

b. *This section provides some general discussion on the presence of biological residue that required the bag filters and Mycelx filters to be replaced periodically during the extraction process. As this is a key observation from the pilot test and the frequent filter changes will be a critical component of the proposed actions for 2015, a more detailed discussion of the biological residue is needed throughout the report.*

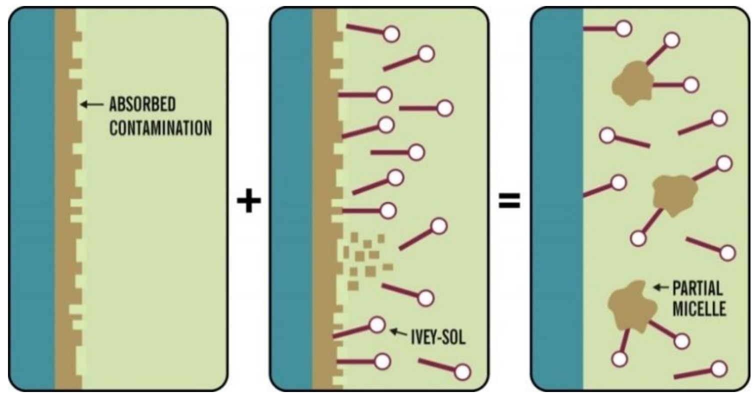
Provide further discussion of any observations in the pump and treat system during this pilot test that triggered the multiple replacements of the bag filters and the Mycelex filters, and discuss how the frequency of filter changes compared to normal operation and maintenance. The discussions should address the following:

i. *What exactly was observed that was determined to be "biological activity"? Any photos?*
A film appeared on the bag/MyCelx® filters during the extraction process. Since the extraction water was clear and had no evidence of particles or turbidity, it is assumed that TPH-DRO liberated was dissolved and became available for microbial action. Rapid growth of these microorganisms appeared on the surface area of the bag/MyCelx® filters much like the surface area on a trickling filter which became a good environment for microbial growth. Attachment B includes pictures of the growth on the bag/MyCelx® filters.

ii. *How was it determined that this observed activity was a result of the injection process?*
Prior to the injection process, this type of biological film never occurred and was never reported for the many years the MyCelx® Filter Treatment System was used. The only differing factor during the Pilot Study was that surfactants were injected and TPH-DRO was liberated.

iii. *Was the "biological activity" observed in any of the wells?*
No. There was no "biological activity" observed in any of the wells. However, the observation of filter biofouling should be interpreted as a positive observation when associated with the Ivey-sol® pilot applications. In fact, this was briefly discussed as a potential consequence of the Pilot Study application by the project team understanding that the Ivey-sol® would not only increase the "*physical-availability*" of the TPH-DRO for hydraulic recovery at the extraction wells, but also increase the "bio-availability" of the TPH-DRO (i.e., NAPL, sorbed, and/or dissolved) to the microbial population present in the sub-surface.

The mechanism of how Ivey-sol® increases the physical, biological, and chemical availability of contamination is shown below.



Biofouling of the filters, in and of itself, is easily resolved through treatment system monitoring and maintenance (i.e., bag filter change outs) schedule modifications to ensure the system operated within required specifications.

If biofouling of a well (i.e., IW, MW, RW) is observed, this is easily resolved at each well location, as it's not an uncommon occurrence for active in-situ site remediation projects. Biofouling can be resolved using one or more of the following approaches:

- Surge blocking of wells;
- Radial water jetting of wells; and/or
- Mild application of environmentally safe disinfectants (i.e., bleach) at wells.

In all likelihood, when the TPH-DRO has been reduced in each of the four (4) Priority Zones, the natural occurring bacteria will continue to mineralize residual contamination to non-detectable levels. That natural process is termed "*Natural Attenuation"* or MNA "*Monitored Natural Attenuation"* where all active remediation efforts are ceased, including the shutdown of pumping wells, with periodic groundwater monitoring at monitoring well locations being undertaken until pre-set targets have been realized. MNA has a history of being effective at sites during the final phase of remediation. To the extent it may be necessary BrightFields during the 2015 Action Plan implementation will use mild application of environmentally safe disinfectants to control any unwanted biofouling in the wells and on the bag filters.

iv. Other than creating a need for frequent bag filter changes, are there are any other implications for the proposed remediation plan (positive or negative)?
As discussed above, the fact that there is biological activity associated with the push-pull process is a positive outcome. From a physical standpoint, other than a more frequent change of bag filters and careful monitoring of the pressure gauges on the filters, there is no other implication of the proposed remediation plan.

c. *Discuss why different pumping rates were used for some of the extraction wells (i.e. MW -22 at 5 gallons per minute [gpm], MW-40 at 5 gpm, MW-41 at 3.5 gpm, and MW-42 at 1 gpm).*
There were only two (2) sizes of pumps used during the push-pull process. One that fit the four inch (4") well (5 gpm) and one that fit the two inch (2") well (3 gpm). The difference in reported rates is related to the well characteristics themselves and variables such as well screening, the amount of fines, when the well was last developed/redeveloped, the hydrogeologic characteristics, etc.

The Technical Team believes that wells having different rates of extraction are not critical to the cleanup plan. The more important outcome is that the extractions continue until levels of TPH-DRO and surfactant are at or near non-detectable levels. This will then indicate that all of the liberated material and surfactant has been extracted and the next step in the push-pull process can proceed.

d. *In its report of observation included in Appendix C, MDE noted that a reduced surface tension was observed in the pump and treat system recovery wells on several dates, which would indicate the presence of surfactant. However, this observation was not clearly discussed in the report, and must be included in the revised report.*
We agree that the presence of surfactant was the reason for reduced surface tension which was observed in the pump and treat recovery wells on several dates. The observation of Ivey-sol® surfactant influenced groundwater, and associated contaminant recovery, through surface tension testing during injection and recovery 'Push-Pull' pilot scale testing, allowed management of injection and recovery pumping process. It provided an empirical means to observe break through times, residence times, diffusion radii, and significant recovery of injection fluids. It also acted as a surrogate for observing site specific contamination, indicating optimal sample collection points for TPH-DRO recovery calculations.

Ivey International, Inc. has documented that the greatest concentrations of contaminants released during injections of Ivey-sol®, into the subsurface, are consistently correlated with the presence of surfactant influenced groundwater, and is a reliable means through which to document to the stakeholders that full recovery of Ivey-sol®, and it's concomitant enhanced contaminant (TPH-DRO) recovery, has performed as expected.

e. *Provide a description of the quality of the extracted water (e.g. were LPH observed? Was emulsified oil present? Was bio-fouling present?). Present any photos that may have been taken.*
There was no physical evidence of clouding or particulate matter in the extracted water. Also, there was no measurable thickness of LPH sheen in any if the extraction wells. The sheen was barely visible to the eye. This is to modify any language in the Pilot Study Report and 2015 Action Plan which may have used the term mass recovery. Since it was not a measureable thickness we reported it as not present, but stand corrected per your March 27, 2015 letter and discussion of same.

As also stated above, the Technical Team believes the fouling of the bag/MyCelx® filters is associated with an increase in petroleum-consuming microbes in the water table associated with the liberated material. Item "1.b." above describes the biofouling observations and provides the significance of this observation relative to the cleanup of the “smear zone” and overall site remediation. The bag filters will be changed as necessary using vendor equipment specifications that identify acceptable pressure readings to assure proper operations. When pressure readings drop below recommended operating levels, the bag filters will be replaced as often as necessary.

f. *Were volumes of liquids extracted from each well determined? If so, please provide details.*
Yes. Volumes of liquid extracted from each well were determined as noted in Attachment C – Volume Extraction Sheet.

g. *Page 12, paragraph 3 - The text states that "it was important to note that there was no free product associated with the liberation of material from the soils ... " LPH sheens were noted in several wells on several dates as documented in the MDE report of observations (Appendix C). Additionally, Appendix D, Table 1, denotes detections of sheen in several wells during the pilot. However, the table does not present a "Depth to Product" column, which is common practice within the industry. Note that an LPH sheen is a positive detection of free-phase LPH at a thickness that cannot be discretely measured by an interface probe. Therefore, it is misleading to state that LPH were not observed at any time during the pilot test and that there was no measured depth to product. The text and table must be corrected to acknowledge this.*
As noted in Item “1.e.” above, we agree that the LPH sheens, although not measurable in thickness was an indication that free-phase LPH was present. The appropriate table has been corrected to acknowledge this and is included as Attachment C – Revised Appendix D - Table 1 - Pilot Study Data Summary During Field Activities to this letter.

2. Section 4 - Presentation of Results

a. *Table 1 - This paragraph suggests that mounding occurred in the injection wells. Looking at the data presented in Appendix D, Table 1 and the cross sections presented in Appendix G, it appears that at least in the case of MW-42 and MW-22 that the observed mounding appears to be a factor of well construction. The highest measured elevations, taken about 30 minutes after the injection commenced, were about 5.5 feet above the elevation of the well screen and the observed mound appeared to dissipate within approximately one hour after the injections. Further there was approximately 5 feet of screen above the water table in each of these wells prior to the injection commencing. Actual mounding may have been limited to approximately 5 feet and for a limited distance from the well and a limited duration.*

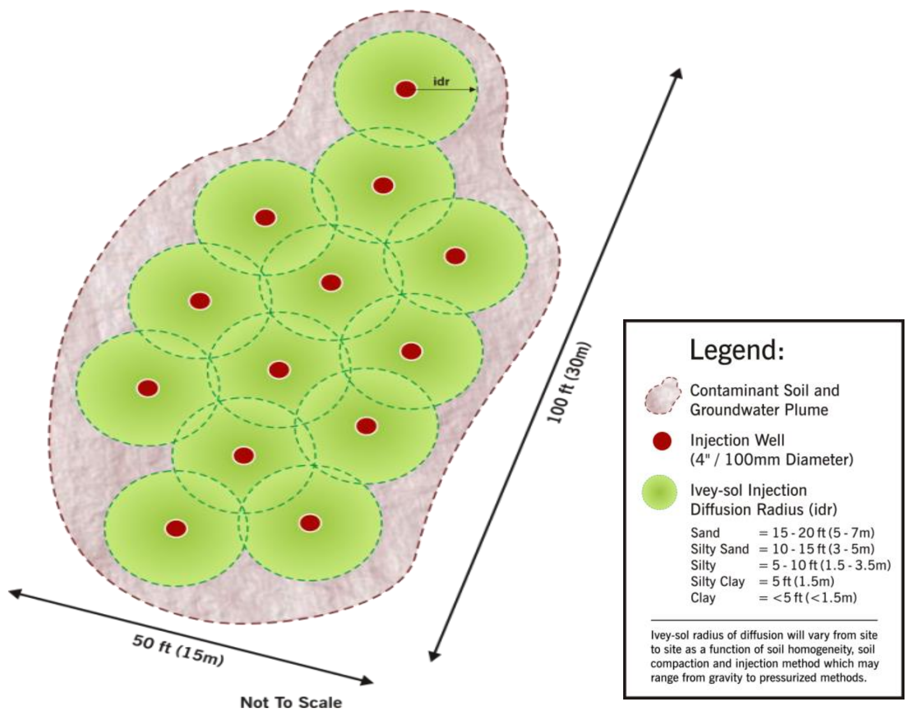
Because the 2015 Action Plan places emphasis on mounding as a success factor for delivering the surfactant, provide a more detailed discussion of the observed mounding. The discussion should include, at a minimum, the following:

i. *Duration of the mounding;*
ii. *Whether mounding was a factor of well construction (i .e. screen depths); and*
iii. *Whether mounding was observed in adjacent wells and at what distances.*

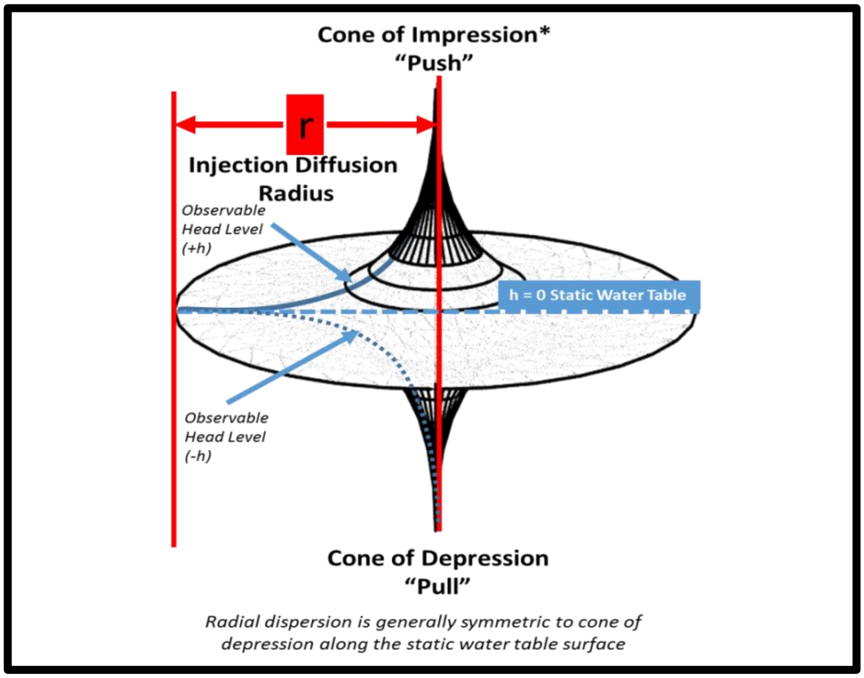
Also note that as discussed above, it is misleading to make the statement, "At no time was liquid phase hydrocarbons detected during site activities." LPH sheens were detected on several occasions in several wells and in the bag filters of the pump and treat system. It is more accurate to state that at no time were measurable LPH detected.

The application of the Ivey-sol® surfactant technology has been used at in-situ remediation sites since 1993. Although not all of their case studies are cited on Ivey International's web-site, including the several in-situ push-pull applications, a twenty-five (25) year body of knowledge helped to underpin the design and deployment of the pilot scale application completed in July-August 2014. As the pilot-scale data demonstrated, the Ivey-sol® push-pull application was effective in liberating TPH-DRO and increasing removal efficiencies. The illustration below speaks to the application approach and positive observations which can be measured and validated in the field scale.

IVEY-SOL INJECTION DIFFUSION RADIUS



A more technical validation would involve hydraulic monitoring for the standard Injection Diffusion Radius (IDR) of Ivey-sol® for Push-Pull Injection and Recovery in a Single Well Utilizing near-by Monitoring Wells. An Ivey-sol® solution injection volume (Q – which can be increased or decreased to modify IDR) will flow with an increased hydraulic conductivity (K) based on surface tension reductions (i.e. from 73 dynes to < 30 dynes), and have a corresponding lower viscosity than that which are incorporated into the standard K values for groundwater flow, which are the basis of modeling drawdown (a generalized symmetry exists with respect to the cone of impression "*Push*" and the cone of depression "*Pull*" at the static water table surface).



Under the generalized radial dispersion model, if Q and K are constant, at a monitoring well within the Injection Diffusion Radius, one can record and document the following to assure hydraulic recovery:

i. During "Push" event the change in head levels $(+\Delta\,\mathrm{h})$ is positive, a rise in the groundwater table;
ii. During "Pull" event the change in head levels $(-\Delta\,\mathrm{h})$ is negative, a drop in the groundwater table;
iii. Before, during and after each event, the static groundwater table can be monitored for head levels;
iv. To hydraulically ensure that recovery "Pull" events successfully recover all injection fluids, one would want to ensure that the following equation is satisfied in monitoring wells within the injection diffusion radius: $|-\Delta\,\mathrm{h}|$ + C > $|+\Delta\,\mathrm{h}|$ where C is a safety factor based on hydrogeologic factors which deviate from this generalized model.

Radial Dispersion (generalized homogenous-isotropic assumption)
Where porosity, permeability, and thickness are uniform in a homogeneous, isotropic medium, distribution of injection liquid will be in a radial direction. The dip of the receiving bed, which influences the hydraulic gradient of the reservoir, can be disregarded when calculating injection fluid displacement, if the dip of the beds is of a low order. Assuming uniformity in a bed receiving a fluid, radial distance of displacement can be calculated by using the following equation:

$$r = \sqrt{\frac{Q}{\pi \Phi h}}$$

Where:
r = radial distance of fluid front from well (length)
Q = cumulative volume of fluid injected (volume)
Φ = porosity of receiving formation
h = thickness of formation (length)
Vv = volume of voids (volume)
Vt = total volume

Reference: Texas Department of Water Resources, April 1983 – Underground Injection Control

b. *Table 3 - There is little discussion on the formula used or the assumptions made to derive the calculated radii of influence for the extraction wells.*
   i. *Is the formula meant to be used when a steady state is reached with regard to the pumping rate and the head change, and was this considered to have been achieved?*
   ii. *Provide justification for the 20 feet per day value used for the permeability term.*
   iii. *How were the pumping rates for each well incorporated into the radius of influence calculations?*
   iv. *How did the gauging data from adjacent wells align with the calculated radii of influence?*
   v. *A table summarizing each extraction event for each well that includes the following information would be useful in the discussion: duration of the extraction event, the pumping rate, the total gallons pumped, and the total hydraulic head change.*
   vi. *Note that the terms Radius of Influence and Capture Zone are not interchangeable terms. Actual capture zone limits are typically less than that of the radius of influence. Figure 3 uses the term capture zone to portray the calculated radii of influences over the extraction wells, which is misleading.*

   Yes, the formula is used when a steady state is reached with regard to the pumping rate and the head change. The radius of influence is defined by the radial distance from the center of a well bore to the point where there is no lowering of the water table or potentiometric surface. Therefore, a steady state is considered to have been achieved.

   The continued use of twenty feet (20') per day with regards to permeability (also referred to as hydraulic conductivity or K) was based upon an email dated December 18, 2013 authored by Earth Data, Inc. and sent to Mr. Chris Ralston and Ms. Susan Bull of MDE that addressed how groundwater velocity was determined. The justification has been copied below:

   > "The hydraulic conductivity, K, for silty sand , in which the monitoring wells are screened is estimated to be twenty feet per day 20'/day (Johnston, 1973)."

Dupuit Forcheimer equation for radial Flow to a well or point source excavation in an unconfined aquifer is given by:

$$R_0 = \exp(\frac{\pi K(H^2 - h_w^2)}{Q} + \ln(r_w))$$

Using the above equation, the pumping rates for each well were incorporated into the radius of influence calculation.

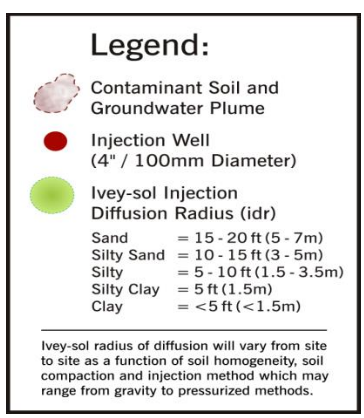
A table summarizing each extraction event is now included as Attachment C – Volume Extraction Sheet.

We agree the Radius of Influence and Capture Zone terms are not interchangeable. The shape of the capture zone depends on the natural hydraulic gradient as well as the pumping rate and transmissivity, whereas the drawdown of influence depends largely on the pumping rate and transmissivity alone.

3. Section 5 - Discussion of Remedial Effectiveness

a. *Section 5.1.B - The following statement is made, "By achieving a groundwater table mounding on the order of five feet to ten feet in the vicinity of each monitoring well indicated we can target residual TPH-DRO in the unsaturated (vadose) zone onsite if and as required." As commented on previously, the well construction details and gauging data from neighboring wells should be incorporated into this argument. It is not clear that there was anything more than highly localized and short lived "mounding" in the injection well as the slug of surfactant dissipated into the formation. From the data presented, there does not appear to be a way to substantiate just how far into the formation the injected material drained.*

The observed mounding affect is a result of well construction and the introduction of Ivey-sol® during the push/injection phase of the process. The degree of mounding; however, is not the only factor that characterizes the degree to which Ivey-sol® will disperse. Obviously the greater the mounding affect the greater the dispersion rate. But based on Ivey Internationals use of the Ivey-sol® process throughout the world, the field experience with dispersion rates is expected to be more reliable than other methods of modeling/predictions and consistent with the exhibit below.



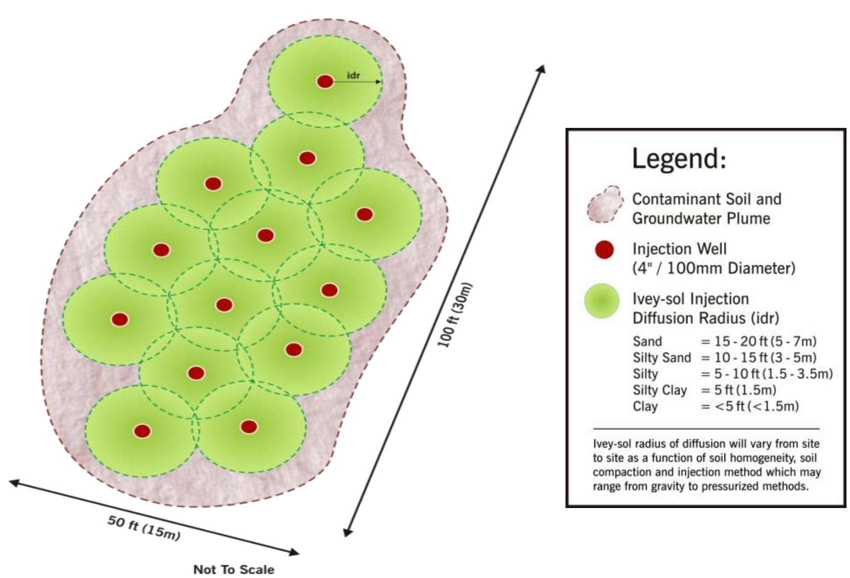
This chart was created to reflect dispersion rates on a twenty-four (24) hour basis. Where the 2015 Action Plan reflects twenty feet to thirty feet (20'-30') it was based on the expected dispersion over a forty-eight (48) hour period.

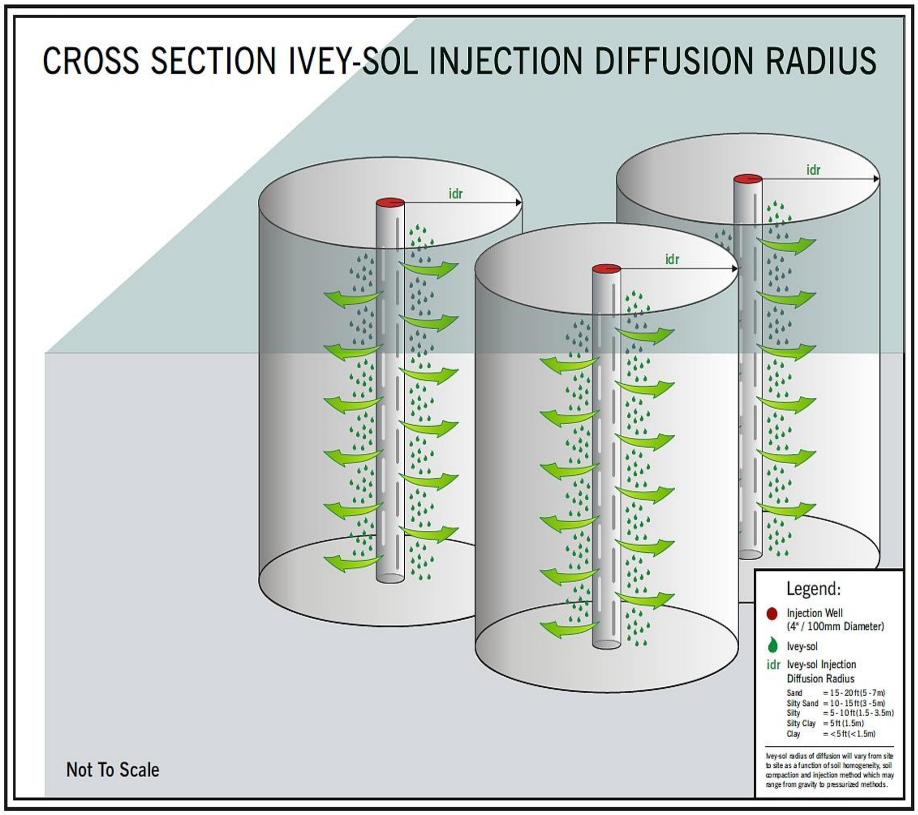
Specifically, based on the following discussion and more integrated explanation of the Ivey-sol® experience combined with the results of the Pilot Study, the Technical Team can confirm that a twenty-five foot (25') injection radius is appropriate to use for the four inch (4") diameter wells and a twenty foot (20') injection radius for the two inch (2") diameter wells.

Appendix D, Figure 2 of the Pilot Test Evaluation Report and 2015 Action Plan represents the radius of influence during the Ivey-sol® injection following a twenty-four (24) hour residence time. The figure shows a radius of ten to fifteen feet (10-15') from the injection well. This is consistent with the information presented in the Ivey-sol® literature (Cross Section Ivey-Sol Injection Diffusion Radius) for sands are fifteen to twenty feet (15-20') and silty sands are ten to fifteen feet (10-15'). This is also consistent with Appendix I of the 2014 Action Plan which stated "We understand that the soils at the site are sands and silty sands. Based upon extensive Ivey-sol® experience on various site with similar soils and utilizing four inch (4") diameter Injection Wells (IW) that the injection diffusion radius would likely be between ten and twenty feet (10'-20')."

Additionally, the extent an Ivey-sol® injection diffuses out can be evaluated in the field by obtaining pre-injection groundwater table elevations (water level meter) at the injection well and nearby monitoring wells. At the time of injecting at an injection well a known volume 'X' of Ivey-sol® and water, local mounding of the groundwater table will occur. By monitoring the groundwater table elevation at the nearby monitoring wells you can verify if the injected volume is expressing an influence at the monitoring wells where you would measure a rise in the groundwater table elevation. This vertical elevation, plus measuring the straight line distance between the injection well and monitoring wells you can verify site specific Injection Diffusion Radius (IDR). The image below shows a mean compilation of expected IDR for different site geology.

IVEY-SOL INJECTION DIFFUSION RADIUS





Appendix D, Figure 3 of the Pilot Test Evaluation Report and 2015 Action Plan represents the capture zone during extraction. It also emphasizes that at no time was the Ivey-sol® surfactant outside the limits of the extraction wells. Even with an increased residence time (twenty-four (24) to forty-eight (48) hours), the radius of influence during injection would still be less than half the radius during extraction. Again, this provides reassurance that the Ivey-sol® surfactant would remain within the limits of control imposed by the extraction wells. Finally, utilizing the formula associated with construction dewatering was most appropriate based upon the field data collected during the pilot study.

Appendix F, Figure 1 of the Pilot Test Evaluation Report and 2015 Action Plan represents the overview of Priority Zones 1-4. For four inch (4”) diameter wells, a twenty-five foot (25’) injection radius was used and for two inch (2”) diameter wells, a twenty foot (20’) injection radius was used. Overlapping of aquifer zones is one the keys to success for site cleanup and is clearly demonstrated in Priority Zones 1, 2, and 3.

In summary, Ivey-sol® long history with injections and extractions performed in a twenty-four (24) hour period in silty sand soils indicated a radius of ten to fifteen feet (10-15’) as representative of the injection diffusion radius. In the 2015 Action Plan we are proposing the residence time be forty-eight (48) hours which supports the use of twenty-five feet (25’) radius as an IDR for the for inch (4”) wells and a twenty foot (20’) IDR for the two inch (2”) wells.

b. *Section 5.1.C - These calculations may broadly indicate a percent change in the TPH-DRO concentrations during the push-pull events per well, which is not the same as mass recovery. The term "percent mass recovery" is a misleading term for this calculation as presented in the text. A more accurate term would be percent concentration increase. The discussion is not based on actual mass recovered, which would be measured in units of mass, but is based on percent differences between contaminant concentrations at various points in time. The discussion is meant to demonstrate that the application of Ivey-sol increased the amount of petroleum hydrocarbons available to be recovered relative to the amount present in the well prior to the pilot test, which is appropriate. It is more accurate to discuss the data in terms of increases in concentration of contaminants, TPH-DRO in this case, than it is to create an unnecessary metric. A more appropriate presentation would be to show the TPH-DRO concentration changes in each well over time and in relation to the push-pull events.*

   At a minimum, a true discussion of mass recovery would take into account the concentration of TPH-DRO and the volume of liquids pumped to derive a mass recovery. In order to demonstrate that the Ivey-sol had some relative impact over previous mass recovery efforts, one would need to know the mass recovery absent the influence of Ivey-sol. These comments are not presented to suggest that additional work or analysis needs to be conducted by the Hospital, but merely to point out that the "Mass Recovery" discussion is not technically accurate.

   Following our meeting with you on April 2, 2015 we agree that "Mass Recovery" was not the most appropriate terminology to use in our discussion of observed removal efficiencies from the push-pull process. Moving forward we will identify recovery rates in terms of pre push-pull, during, and post concentrations.

c. *Section 5.1.D - Further explanation is needed for this section. The objective of these comments or observations is not clear.*

   This section was attempting to show the percent increase in removal efficiencies associated with before and after laboratory testing of TPH-DRO associated with the push-pull events. The numbers reported are not what is important, but that there was a measurable and significant increase associated with liberated TPH-DRO levels measured in the extracted water.

4. *Section 6 - Recommendations for Additional implementation*

a. *Bullet 2 - Recall that the purpose of the pilot test was more a demonstration than a true remedial scale implementation, which is what was proposed in the plan for 2015. There is still residual LPH in and around the treated area because the wells are located within the footprint of the former LPH plume. A more robust implementation, as proposed for 2015, would be necessary for sustained improvement.*

   The Technical Team agrees addressing the comments provided by MDE and making the necessary revisions to the 2015 Action Plan as described above have significantly enhanced the groundwater remediation approach for the next phase of the project. We have very high expectation that the use of surfactant to liberate sorbed residual hydrocarbons (in this case TPH-DRO) and combining the MyCelx® Filter Treatment System hydraulic control with the extraction component of the Ivey-sol® process, offers the opportunity to significantly enhance removal efficiencies.

Responses to MDE Comments and 2015 Required Action Plan Revisions:

1. ***Section 7.3 Protocol 2***

   Hydraulic Controls to Remain in Place. The Department agrees that the pump and treat treatment system should remain in operation to provide hydraulic control during the proposed work. However, there appears to be a conflict between this protocol and the second bullet under Section 7.7A. The Department needs confirmation that the pump and treat remediation system will remain on during the proposed push-pull events.

   As referenced above in several sections, the upgraded MyCelx® Filter Product Recovery System shall remain in full operation during the entire 2015 Action Plan. The recovery wells to be used are the same wells that have been used for the last five (5) years and no change is recommended.

   It is not clear from the various discussions in the report which wells will be running during the proposed activities. Through verbal communications with your consultant, it was suggested that the pump and treat system recovery wells used may vary depending on the treatment zone that is being addressed. Provide appropriate clarification on how the pump and treat system will be operating during the proposed push-pull activities. If needed, also provide revised or additional figures.

   In addition to the recovery wells which will remain on at all times, the extraction wells in Priority Zone #1 will be connected to the MyCelx® Filter Product Recovery System during the Ivey-sol® push-pull process and continue until the water from the extractions reaches at or near non-detect levels for TPH-DRO and surfactants. Once the push-pull event for Priority Zone #1 has been completed these extraction wells will be disconnected and the extraction wells to be used in Priority Zone #2 will be connected. This process will continue sequentially through all four (4) Priority Zones until the 2015 Action Plan has been completed. All of the extraction wells have been correctly identified for each Priority Zone in the original 2015 Action Plan with the one exception that the Department has specified. Only MW-20 can be used for this purpose in Priority Zone #4.

2. ***Section 7.4 Protocol 3***

   Extractions to be Removed Through Pump and Treat. Although the Department may agree that the pump and treat system is a good means to process the extracted material, additional information is needed in order to approve the use of the system to handle the additional proposed waste water. The following information will be needed before the plan can be approved:

   a. *In reading the manufacturer's information on their website and the Brightfields, Inc. discussion of the system (Appendix E), it seems as though the filters work on both a molecular size mechanism and a surface attraction mechanism. The Hospital must provide manufacturer's documentation that the Mycelx filters will operate adequately to filter the recovered groundwater, oil, and surfactant mixture that is proposed. Alternatively, a controlled treatment demonstration may be required.*

      MyCelx® representatives reviewed the pilot test report and discussed the proposed operations associated with the 2015 Action Plan with BrightFields, Inc. and Ivey International, Inc. Based on their review, MyCelx® recommends the addition of an emulsion breaker filter into the treatment train. The emulsion breaker filter will be added in series after the existing MyCelx® product recovery filter, and is capable of capturing oil droplets down to one (1) micron in size.

MyCelx® provided a letter, included as Attachment D which states the revised system is capable of treating up to 360 gallons per minute (gpm) of extracted groundwater to meet our discharge limits.

b. *Provide a piping and instrumentation diagram for the treatment system including which wells are attached to it. The diagram should indicate all components of the system, various ratings, etc. so that the Department can evaluate the system capabilities more thoroughly.*
The as-built/diagram included in Attachment D shows the major equipment and piping of the existing treatment system. While the pumps in the six (6) monitoring wells have the ability to instantaneously pump approximately 115 gpm, the average combined flow from these wells from June through December 2014 was approximately fifty-five (55) gpm. In January 2015, the wet well pump was replaced. This pump is controlled by the level in the wet well tank, operating to empty the tank on a cycling basis. Should the level in the wet well exceed the high level, all groundwater pumps are automatically shut-off.

The wet well pump can operate up to 300 gpm at twenty feet (20') total dynamic head (TDH). Flow from the wet well pump is split between two identical treatment trains (in parallel) that consist of two bag filters and a MyCelx® product recovery filter. Flow through the treatment train is limited by the MyCelx® filter; each filter is capable of treating up to 180 gpm.

The proposed treatment system for the 2015 Action Plan would include up to sixty (60) gpm of flow from extraction wells entering the wet well. Based on recent system performance, the wet well pump can accommodate this additional flow. As mentioned above, the proposed treatment train would also include the addition of a MyCelx® emulsion breaker filter in series after the MyCelx® product recovery filter. Each MyCelx® emulsion breaker filter is limited to effectively treating 160 gpm, with a combined treatment capacity of 320 gpm, significantly higher than the capacity of the wet well pump.

c. *Provide a summary table showing the system influent and effluent concentration data, total gallons of water pumped, flow rates, and system runtimes over the last two years. If this data is not available, that will need to be noted.*
Data summary table has been provided in Attachment E.

d. *If approved, what is the anticipated additional monthly discharge during the time that the pump and treat system will be used to filter water from the proposed push-pull events?*
It is anticipated the maximum additional monthly discharge would occur during the Ivey-sol® push-pull applications within Priority Zone #1. At this time, we are estimating a maximum of two (2) events per week. In reviewing the well construction of the eight (8) monitoring wells involved, all are four inch (4") in diameter with exception of MW-47 that is two inches (2"). For estimation purposes, approximately

1,335 gallons (12,015 gal/ 9 MWs) were extracted from each four inch (4") well during each extraction event throughout the Pilot Study.

The estimated additional monthly discharge is as follows:

- *8 wells x 2 extraction events per week x 4 weeks per month x 1,335 gallon per event = 85,440 gallons per month.
  *Note – It is understood that if 25,000 gpd is exceeded the discharge monitoring requirements will increase from one (1) time per month to two (2) times per month in accordance with the Discharge Permit requirements.

3. Section 7.7 Priority Zone Implementation Plan

a. *Section 7.7.A - The text proposes several modifications to the pilot study procedures. The following comments are made in response to the modifications:*

   i. *Number 1 - The only concern with the residence time increase would be for MW-20, which is discussed further below.*
      The Technical Team agrees and as modified above, Priority Zone #4 will only use MW-20 for injection and extraction and the residence time for Ivey-sol® will be limited to twenty-four (24) hours per event.

   ii. *Number 2 - This modification seems to contradict other statements made throughout this report. The Department does not approve turning off the system and relying on only the push-pull process for hydraulic control.*
      To confirm, and as amended herein, the existing MyCelx® Filter Treatment System and recovery wells that provide the hydraulic control for the project will be left in operation for the full duration of the 2015 Action Plan.

   iii. *Number 3 - Because the Mycelx filters did not filter the additional material extracted during the pilot test as this text alludes, the Department has concerns about whether the filters will provide adequate treatment to achieve effluent with part per billion (ppb) range petroleum hydrocarbons when exposed to the surfactants. This concern was discussed above.*
      See Item "2 – Section 7.4 Protocol 3" above. As further documented in Attachment D, MyCelx® Emulsion Filters will be added after the MyCelx® Product Recovery Filters. It is also indicated in the vendor letter that surfactants are not expected to negatively impact the performance of the upgraded MyCelx® Filter Recovery System.

b. *Section 7.7.B - At this time, the Department will not permit treatment of any of the wells in Priority Zone #4 with the following exceptions: MW -20 may be utilized but only with a 24-hour residence time and with the pump and treat system fully operational.*
   Understood and agreed as noted above it Item "2.a.i".

4. ***Section 7.8 Post Injection Extraction Monitoring and Sampling***
The two bullets appear to state the same requirements for monthly and quarterly sampling. However, the proposed analyses do not include TPH-GRO, which was included in Section 6.3. Please clearly propose which analyses will be included and at what frequency.
As previously stated above, sampling, laboratory testing, and reporting on a monthly and quarterly basis shall continue and include the following along with added sampling/reporting as noted below:
    - Monthly gauging of all monitoring and recovery wells.
    - Monthly sampling of eleven (11) targeted monitoring wells (MW-15, MW-16, MW-19, MW-20, MW-24, MW-33, MW-34, MW-35, MW-48, MW-49, and MW-50) for the presence of Total Petroleum Hydrocarbons – Diesel Rand Organics (TPH-DRO) using EPA Method 8015.
    - Quarterly sampling all monitoring and recovery wells for the presence of TPH-DRO using EPA Method 8015 and Volatile Organic Compounds (VOC's) including oxygenates, using EPA Method 8260B.

We look forward to working with MDE on the 2015 Action Plan and to the planned kick-off meetings with the Town.

Sincerely,

H&B Solutions, LLC

Dane S. Bauer
Member

Enclosures

Cc: Mr. Kenneth Kozel, Shore Regional Health (w/ enclosures)
Mayor Chris Cerino (w/ enclosures)
Mr. Michael Forlini (w/ enclosures)
Mr. Michael Powell, Esq. (w/ enclosures)
Mr. Horacio Tablada (w/ enclosures)