The combination of the two literature searches, field and laboratory, should provide a reasonable basis for estimation of changes in microbiota concentrations that may be expected during ASR storage of treated surface water. The laboratory investigations indicate a range of attenuation rates for pathogenic bacteria, typically 1 to 30 days per log cycle at temperatures exceeding 20oC, which are reasonably representative of Florida conditions. Exact attenuation mechanisms and their interrelationships will require further research. However, it seems clear that natural attenuation of microbiota occurs during ASR storage, as simulated under laboratory conditions.

Controlled conditions in the laboratory approximate those in the field; however, they cannot replicate the heterogeneity and complexity of natural aquifer systems. Natural geochemical processes; seasonal variations in salinity; ambient, naturally occurring microbiota in the aquifer; nutrient sources; oxidation-reduction reactions; and other factors that are difficult to replicate in the laboratory can have a significant effect upon water quality changes during ASR storage, including microbiota concentrations. For these reasons, field investigations cannot be controlled as carefully as those conducted in the laboratory, reflecting varying climatological conditions, site-specific geology and mineralogy, surrounding land use effects upon recharge water quality, and other factors. Field investigations are more costly to perform and come from a broad array of data sources under widely differing conditions. Nevertheless, they provide a valuable, independent source of information on this subject.

Further ASR field investigations are needed to confirm the results of the laboratory literature search. These should be conducted under field conditions matching those proposed for the Comprehensive Everglades Restoration Program (CERP) in Florida, and other sites. Until such time as field investigations can be conducted in ASR wells that are recharging treated surface water containing microbiota, and data sets can be developed at multiple sites for comparison, we can only rely upon field and laboratory literature search results such as those presented in this web site. The currently planned three ASR demonstration projects for the CERP will not be obtaining this data as currently planned, since they will be recharging water that has been treated to meet all drinking water standards, including those for microbiota. Either those projects can be modified to recharge with treated surface water containing microbiota, or new projects could be authorized that obtain such data at other sites.

A suggested approach for moving forward with ASR investigations is as follows:

1. Identify indicator pathogenic microbiota that are pertinent to proposed ASR operations in Florida, and associated ranges of temperature and salinity conditions.

2. From the literature searches, estimate a reasonable range of attenuation rates (expressed in days/log cycle) for all of these indicator microbiota, without biasing the results with obvious outlier data. A suggested approach would be to select the middle quartile of all the data sets.

3. Select the upper end of this middle quartile range and determine the number of days per log cycle attenuation rate that encompasses all pathogenic bacteria deemed to be of concern.

4. Select the number of log cycles of microbiota attenuation that is deemed necessary to adequately protect groundwater quality and public health, based upon available data for naturally

occurring concentrations of these pathogenic microbiota in source waters during representative recharge periods. Tentatively, it is suggested that three log cycle attenuation should be ample.

5. Calculate the travel time radius around each ASR well by multiplying the number of log cycles of attenuation by the number of days required for each log cycle, in steps 3 and 4 above. For example, 30 days per log cycle times 3 log cycles would suggest the need for a 90-day travel time radius around an ASR well, within which natural treatment processes would be deemed to occur.

6. Estimate the radius associated with recharge for the target travel time, at the recharge flow rate for the well. For example, a 5-million gallon per day (MGD) well recharging for 90 days would have a treatment radius associated with a storage volume of 450 million gallons (MG). If the aquifer is 400 feet thick, and has an estimated bulk porosity of 20 percent, the theoretical treatment radius would be 489 feet. To account for aquifer heterogeneity and anisotropy, this distance could be increased by approximately 50 percent, yielding a ZOD of about 750 feet.

7. Measure compliance with primary standards for microbiota at a radial distance of 750 feet from the ASR well.

8. Seek Florida Department of Environmental Protection (FDEP) authorization for proposed testing, and measurement of compliance at the edge of a ZOD at the estimated radius. The U.S. Environmental Protection Agency (EPA) has already authorized such testing for the Comprehensive Everglades Restoration Program (CERP).

Information is requested regarding additional sources of information regarding the fate of microbiota during ASR storage, or related processes in which water moves through an aquifer from a well or sinkhole. Information from either field or laboratory investigations would be of value. Such information should be sent to the following address:

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Information provided will be evaluated by a panel comprised of representatives of several state and federal agencies. At such time as the peer review is completed satisfactorily, the information will be added to this web site.