Chapter 7

Summary of Evaluations for Treated Water Recharge/Reuse

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SUMMARY OF EVALUATIONS FOR TREATED WATER RECHARGE / REUSE

7.1 INTRODUCTION AND SCREENING OF TECHNOLOGIES

Centralized wastewater processes include treated water recharge facilities designed to minimize the impacts on nearby surface waters and/or groundwater. Potential impacts of large treated water recharge flows include groundwater mounding and an increase in pollutant concentrations in receiving water bodies.

Currently, the WWTF uses sand infiltration beds as the sole means of treated water recharge. Treated water from the WWTF is recharged to a total of four sand infiltration beds, on a rotating basis, covering approximately four acres, north of the WWTF. The facilities are described in detail in the 1999 NAR.

This Chapter identifies and screens treated water recharge technologies for more detailed evaluation and summarizes the evaluations completed to find a feasible recharge site.

7.2 TECHNOLOGY SUMMARY

A detailed description of the various treated water recharge technologies is provided in Appendix P with a summary of their advantages and disadvantages. The following text summarizes this description.

Sand infiltration beds (similar to the existing sand infiltration beds at the WWTF) are a simple and reliable treated water recharge technology with relatively low operating costs.

Subsurface infiltration facilities (similar to large septic system leaching systems) are simple and reliable. These facilities are constructed below ground and therefore have minimal visual

impacts, reduced potential for odors, and can provide secondary use of the land. Treated water recharge in subsurface infiltration facilities has higher land area requirements. Subsurface infiltration facilities are not easily cleaned. Therefore, the life of the facilities will be dependent on the quality of the effluent.

Spray irrigation is a simple and reliable treated water recharge technology. It can provide additional nitrogen uptake and removal. Significant additional treatment is required if the irrigation is in a public area.

Treated water recharge through well injection has relatively low land requirements and relatively low construction costs. Well injection has the potential of plugging at the injection point due to build-up of fine solids and biofouling, and would require chlorination. This method does provide a means of treated water recharge at multiple potential sites with minimal land requirements; however, MassDEP's resistance to support and permit of this technology eliminates it from further consideration.

Treated water recharge through wick well is a variation of well injection and has similar advantages and disadvantages. It is attaining limited regulatory acceptance, and more complete acceptance is contingent on long-term demonstration of effectiveness.

Wetland restoration and nitrogen attenuation concepts are being evaluated on Cape Cod and include evaluation and modeling of very site-specific considerations. If they prove to be feasible and acceptable to the regulatory community, they could provide low-cost methods to recharge highly treated water, recharge impacted portions of the watershed, and attenuate nitrogen in the groundwater. These systems are very site specific and should be considered where applicable.

Discharge through an ocean outfall is not allowed by the Massachusetts Ocean Sanctuaries Act, however, this alternative will remain under consideration if no other acceptable site is identified with sufficient capacity to handle the Town's needs.

The main characteristics of these technologies are summarized on Table 7-1 with respect to the standard set of criteria used to screen technologies in Chapters 5 and 6.

The following treated water recharge technologies are recommended for further evaluation:

- Continued use (and expansion) of existing sand infiltration beds at the WWTF site.
- Sand infiltration beds.
- Subsurface infiltration.
- Spray irrigation.
- Wetland restoration (only for appropriate sites)

7.3 PRELIMINARY SITE EVALUATIONS

A. **Introduction.** Several sites were considered for treated water recharge. Using the Town's GIS system, site visits and discussions with Town officials, 15 sites, ten of which were Town owned, were identified. Each of these sites is identified in Table 7-2. This table summarizes some of the major physical features and site specific criteria to be used to evaluate each site.

The sites were then ranked based on this initial analysis to determine the top candidate sites for further evaluation. The summary of this evaluation is presented in Table 7-3. The results of this analysis were reviewed with the Town's Technical Advisory Group (TAG) and six sites were identified for detailed evaluation. The TAG recommended that privately owned sites be removed from consideration and only focus on Town owned properties. In addition, several other sites were ruled out for consideration for further evaluation based on site conditions, proximity to wetlands or proximity to sensitive receptors. As a result, although not identified as one of the original Top 6 sites, the Airport site was moved ahead of several other sites based on site accessibility, size, and recommendations from the Town. Therefore, the sites retained for further evaluation include:

- Site 1 (WWTF or Treatment Plant North)
- Site 2 (Volunteer Park)
- Site 4 (Chatham Airport)
- Site 7 (Chatham High School)
- Site 9 (Chatham Seaside Links Golf Course)
- Site 10 (Hamden Place)

Sites are shown on Figure 2-5.

Each site was considered for each of the recommended disposal technologies, except ocean outfall. Application of technologies for each site was then based on the results of subsurface investigations, TAG input and considerations of location, capacity, feasibility and general acceptance. The following technologies were evaluated for each site:

- Site 1 – Use of existing sand infiltration beds, and either new sand infiltration beds or subsurface leaching facilities.
- Site 2 – Subsurface leaching facilities.
- Site 4 – Subsurface leaching facilities and/or sand infiltration beds.
- Site 7 – Subsurface leaching facilities.
- Site 9 – Subsurface leaching facilities and/or spray irrigation.
- Site 10 – Subsurface leaching facilities.

In most cases, the use of sand infiltration beds was not considered based on site location and existing and/or abutting land use. In those areas, only facilities located below grade would be considered. Only Site 1, the location of the existing sand infiltration beds operated as part of the existing WWTF, is considered a viable location for open sand beds. Because of the MassDEP Interim Guidelines on Reclaimed Water, only Site 9 (the golf course) was considered for spray irrigation. There is the possibility of considering its use at Site 1, however, the limited recharge capacity spray irrigation would offer at this site is less favorable than the other two technologies.

B. **Wastewater Treatment Issues and Requirements for Treated Water Recharge at New Remote Sites.** If the Town considers developing new treated water recharge sites, potential future recharge limitations must be considered.

1. Treated water that is recharged into subsurface leaching facilities must have low suspended solids to avoid plugging the soil infiltration system which would require costly repairs. Effluent filtration would reduce this potential.

2. Treated water recharges upgradient of freshwater ponds and lakes would need phosphorus removal to avoid the creation of a phosphorus plume that could migrate to the freshwater body and cause eutrophication. The Otis Air Force Base wastewater treatment facility discharge, and the eutrophication of Ashumet Pond in Falmouth and Mashpee is a recent Cape Cod example of this issue. This case study is described in the 2003 report by the U.S.

Geological Survey entitled *"Reactive-Transport Simulation of Phosphorus in the Sewage Plume at the Massachusetts Military Reservation, Cape Cod, Massachusetts."*

3. Treated water recharge into Zone II areas (drinking water supply areas) will need to meet the MassDEP *"Interim Guidelines on Reclaimed Water."* Effluent limits for this type of discharge would need to meet the following treatment and design standards:

- pH: 6 to 9
- BOD concentration: $\leq$30 mg/L
- Turbidity: <5 Nephelometric turbidity units (NTU)
- Fecal coliform content: <200 colonies/100 ml
- TSS concentration: $\leq$10 mg/L
- TN concentration: <10 mg/L

These standards are typically met by the addition of filtration facilities and disinfection.

Treated water recharge in a Zone II area with less than a two-year travel time to a public water supply would need to meet the following more stringent treatment and design standards:

- pH: 6 to 9
- BOD concentration: $\leq$10 mg/L
- Turbidity: $\leq$2 NTU
- Fecal coliform content: median of no detectable colonies/100 ml and no single sample to exceed 14 colonies/100 ml
- TSS concentration: $\leq$5 mg/L
- TN concentration: <10 mg/L

These standards are typically met by microfiltration and disinfection.

It is noted that MassDEP is currently revising this guidance to become new regulations.

These requirements and issues would need to be considered if other sites are considered in the future.

C. **Development and Comparison of Conceptual Designs.** A conceptual design was developed for each of the recommended sites and technologies, and the basis for these are provided below:

1. **Infiltration Beds.** Conceptual designs for sand infiltration beds were developed in accordance with the following guidance documents:

- *Guides for the Design of Wastewater Treatment Works, NEIWPCC*
- *Guidelines for the Design, Construction, Operation, and Maintenance of Small Sewage Treatment Facilities with Land Disposal* by the MassDEP
- *Interim Guidelines on Reclaimed Water* by the MassDEP

The following additional considerations were also used to develop the conceptual designs:

- Available areas were divided into cells (approximately 200 feet by 200 feet, where possible) in order to provide flexibility for operation and maintenance.
- Cell areas would be graded flat during construction and be separated by berms.
- Treated water flow would be pumped from the WWTF or small cluster wastewater treatment system through the transport force main, into header pipes, and then into individual bed influent pipes.
- The header pipes would control areas of use, while the bed influent pipes would control flow to individual cells.
- Splashing would be prevented through the use of an end splash guard and pad. Pumping is only required at the WWTF.
- Header pipes and bed pipes are valved, allowing for individual cell use. Cell areas require 4 feet of clean sand for the infiltration surface. The site would contain access roads along the berms and the site area would be fenced.

2. **Subsurface Infiltration Facilities.** Conceptual designs for subsurface infiltration facilities were developed in accordance with the following guidance documents:

- *Guides for the Design of Wastewater Treatment Works, NEIWPCC*
- *Title 5 Pressure Distribution Guidance* from MassDEP.
- *Interim Guidelines on Reclaimed Water* by the MassDEP.

The following additional considerations were also used to develop the conceptual designs:

- Treated water flow from any cluster WWTF or the Chatham WWTF would be filtered.
- If the treated water recharge is up gradient of a fresh water body and phosphorus removal is needed, the phosphorous would be precipitated and removed with the addition of a metal salt (alum, ferrous sulfate, etc) before the filter.
- The filtered effluent would be pumped from the treatment facility through the transport force main, and into a wet well and pump station located at the site.
- The effluent would be re-pumped through header piping, center manifold piping, and distribution piping in the infiltration cells. The header pipes control areas of use, while the center manifolds control the flow to individual cells.
- Infiltration areas are divided into cells (approximately 200 feet by 200 feet, where possible) in order to provide flexibility for operation and maintenance.
- Flows discharge from the distribution pipes located approximately 8 feet on center.
- Pumping is required at both the treatment facility and the site.
- Header pipes and center manifolds are valved, allowing for individual cell use, periodic high-rate dosing, and the ability for cells to dry out between doses.

3. **Spray Irrigation Facilities.** Conceptual designs were investigated for spray irrigation facilities in accordance with the following guidance documents:

- *Interim Guidelines on Reclaimed Water* by the MassDEP.
- *Guides for the Design of Wastewater Treatment Works, NEIWPCC.*

The following additional considerations were also used to develop the conceptual designs:

- Microfiltration at the WWTF.
- Transmission piping to the site.
- Booster pumping to increase irrigation pressures.
- Hydraulic loading rate of 2 inches per acre per week.
- Nozzle spacing of 60 to 100 feet.
- Nominal nozzle pressure of 30 psi.

Based on these designs, preliminary layouts and capacities were developed.

USGS modeling of the potential treated water recharges were developed to investigate mounding impacts and potential groundwater recharge sites were developed to further investigate mounding impacts and the location where the treated water would surface.

7.4 FURTHER EVALUATIONS OF TREATED WATER RECHARGE SITES

A. **Introduction**. Following the recommendations of the preliminary evaluation as described in Section 7.3 of available sites for treated water recharge in Chatham, additional study was performed and documented as part of the "Treated Water Recharge Site Evaluations – Final Report", dated June 2007. A copy of this report is included in Appendix F.

The report documented the findings of field investigations at the six potential sites in Chatham, Sites 1, 2, 4, 7, 9, and 10.

B. **Conclusions and Recommendations of the Report.** Each site evaluated has the potential to serve as a treated water recharge site. This is a result of the presence of similar medium to course grain sands seen at each site. At each site, similar loading rates were assigned, based on the comparable percolation rates observed. In accordance with MassDEP guidance that relates loading rate to percolation test infiltration rate, loading rates of 5 gpd/sf and 2.5 gpd/sf were assigned to each site for sand beds or leaching fields, respectively. The various sites do have limitations; however, they are primarily a function of the available acreage.

A clay layer is known to exist across most of the Town. This clay layer was encountered in the Airport (Site 4) borings (45 to 50 feet) and in the Volunteer Park (Site 2) boring (55 feet). A clay layer underlying the receiving aquifer at a relatively shallow depth can also limit the infiltration capacity of sites because of mounding. Greater mounding results when there is less aquifer thickness to disperse the water. Depth to clay at the Airport and Volunteer Park was assigned to be 8 feet and 5 feet below the water table, respectively. The available aquifer depth (the distance between the water table and the clay layer) has a significant affect on the mounding. However, using the recharge rates derived from the available infiltration area, mounding did not eliminate any site from further consideration. Mounding heights ranged from 4 feet at the golf course (Site 9) (low rate of recharge) to 25 feet at the Airport and 30 feet at

Volunteer Park (shallow clay layer). However, even in the case of the Airport and Volunteer Park, background groundwater levels are sufficiently deep that adverse impacts due to this mounding do not occur.

Each site has the potential to serve as a treated water recharge site. There are capacity limitations at each site, but all the sites can be considered to be available as a possible destination for either a portion of the flow from the existing treatment plant or the flow from a local, neighborhood satellite plant. Sites located within Zone II's of the Town's drinking water supply are considered less favorable because of the added restrictions of the MassDEP "Interim Guidelines for Reclaimed Water Use", which imposes stricter permitting and treatment requirements. Therefore it is advantageous to the Town to stay out of these areas from both a water supply protection and cost perspective.

Because of the favorable conditions at Site 1, the Town chose to perform additional study at this site to investigate the possibility of increasing the allowable recharge rate to greater than 5 gpd/sf.

7.5 USGS MODELING EFFORTS

Beginning in 2004 the Town of Chatham began work with the United States Geologic Survey (USGS) to perform groundwater modeling of Chatham relative to various recharge alternatives as described above. As part of these efforts, the modeling was also used to evaluate the effects of various treated water recharge scenarios on the groundwater at the existing landfill.

A Technical Memorandum, dated July 11, 2005 and included in Appendix D, identifies these efforts and summarizes the findings.

As a result of these efforts, it was demonstrated that any of the proposed recharge scenarios would not result in the capture of any groundwater under the landfill (a potential landfill plume) by Indian Hill Well.

Additional USGS modeling evaluations were made for groupings of the 6 sites (combined flows of 1.5 mgd flow or greater) to further evaluate potential mounding at the sites and where the treated water recharged at the sites would ultimately move with the groundwater system.

Particle track figures illustrating this modeled transport for each site and scenario are contained in Appendix G. There are two groups of figures: figures depicting treated water / groundwater flow with Indian Hill well turned off (6/23/04 figures), and figures depicting this flow with Indian Hill well turned on (7/28/04 figures). A table at the end of this appendix summarizes estimates of the number of flow particles and flow volume that would surface at the various surface water resources and public water supply wells.

This preliminary groundwater modeling indicated that recharge at the existing treatment facility and Site 1 (located to the north of the treatment facility) would contribute the least amount of treated water flow to the Town's sensitive coastal estuaries. It was also understood that recharge at the WWTF and Site 1 would involve the lowest costs to construct and operate recharge facilities because these two sites are the closest to the WWTF.

7.6 FURTHER EVALUATION OF SITE 1

Following the site evaluations and the USGS modeling efforts, the Town proceeded with additional infiltration loading tests at Site 1. The tests were performed in the summer of 2006 and a copy of the report is included in Appendix E.

The field testing at Site 1 indicated observed loading rates of 300 to 460 gpd/sf. The observed loading rates lead to a design loading rate of 30 gpd/sf using the USEPA procedures to allow an order of magnitude safety factor on the clean-water observed rates. The design rate of 30 gpd/sf was recommended to MassDEP for further considerations.

MassDEP requested further localized modeling of the affects of three loading rates on surrounding areas, and in the spring of 2007 additional modeling was performed. A copy of the "Findings of Groundwater Modeling for Treated Water Recharge at Existing WWTF Site and Site No. 1 – Technical Memorandum", dated June 2007 is included in Appendix G.

This memorandum determined that no impacts would occur within the three alternative design loading rates of 15 gpd/sf, 30 gpd/sf, and 45 gpd/sf. The design loading rate of 30 gpd/sf was recommended as the one to use for new infiltration bed sizing at the WWTF site and at Site 1 based on the hydraulic load test work and the USEPA design criteria. This 30 gpd/sf design loading rate indicates the need for 200,000 sf of bed area for the projected Town-wide maximum

month flow of 3.1 mgd (discussed in Chapter 2). This bed area is also based on the need to have 100% redundant bed area that can be taken off line at the maximum month condition for remediation or repairs. This projected bed area can be located on the existing site and on Site 1; therefore, there is not a need to use any of the other potential recharge sites.

7.7 WATER REUSE CONSIDERATIONS

A. **Introduction**. Two water reuse alternatives and their associated treatment requirements were considered for the treated water:

1. Further treatment of the water with microfiltration, and the transmission of the water to town lands (and possibly private lands) for spray irrigation.

2. Further treatment requirements for the recharge into Zone II areas as required by MassDEP.

These two alternatives are discussed below.

B. **Spray Irrigation Reuse.** Much interest has been expressed in Chatham on the possible reuse of the treated water for spray irrigation of public lands and private properties. It was expressed that this alternative could save money because it would make productive use of what could be considered a waste product. Also, several applications of this technology in Florida and the western states were used as an example of how the technology could be used on Cape Cod.

As discussed earlier in this chapter, this alternative would require the following components beyond the ENR treatment facilities already envisioned for the WWTF upgrade:

- Microfiltration would be provided by advanced membrane materials. This process is similar to a reverse osmosis process that can be used to desalinate sea water and produce a pure water product, except that it has a lower membrane pore size and lower capital and O&M costs. It is effective at removing various pathogen cysts that may not be removed by the ENR facilities. This process would be required by MassDEP if the spray irrigation was to occur in a public place without restrictive site controls. The process would be installed and operated in a building at the WWTF.

- UV disinfection to the highest performance level would be required for further disinfection of the water.
- Storage facilities would be needed to store the treated water that is produced at the plant so that it could be available for the time when all users on the line wanted to irrigate. This type of storage is typically provided in an elevated storage tank similar to the two tanks used by the Water Department to store and provide pressurized drinking water across the Town.
- Dedicated treated water transmission pipes to convey the water to the spray irrigation sites.
- Booster pump station(s) would be needed if the storage facilities were not elevated. These pumps could be located at each irrigation site to ensure sufficient pressure for the site or at the non-elevated storage tank to pressurize the whole system.
- Site controls at the irrigation sites as required by MassDEP permits. These permits would also require sampling and groundwater monitoring at the site.
- Irrigation facilities at the sites.

It is noted that these facilities would not reduce any of the treated water recharge facilities at the WWTF, because the WWTF recharge facilities would be sized for the times when no one is irrigating, but the wastewater flow continues to the WWTF.

There is precedent for this type of irrigation at golf courses in Massachusetts when the treatment plant is located at (or very near to) the golf course. The closest example is the Town of Yarmouth seven-hole portion of the Bay Berry Hills golf course that is constructed on the capped Yarmouth landfill. The treatment facility already had a large elevated storage facility when the landfill cap and golf course was planned and designed. This site also uses Town drinking water for irrigation.

There is no precedent for the irrigation on other Town or private properties that are accessible by the public.

Capital costs for a 1.0 mgd (700 gpm) treatment and distribution system to extend from the WWTF to the Chatham golf course at Main Street and Chatham Bars Avenue are conceptually summarized as follows:

- Microfiltration facility, including building, feed pumps, membranes, backwash facilities, and finished water pump station is estimated at $3,500,000.
- An elevated storage tank is estimated at $1,500,000.
- The disinfection facility and electrical power feed is estimated at $500,000.
- Transmission force main piping is estimated at $150 per linear foot installed (approximately 4 miles) for a total of $3,200,000.
- Contingency costs are estimated at 25 percent for $2,100,000.
- The irrigation facilities at the individual properties would be provided and funded by the property owner.
- Design, fiscal, legal, permitting, and engineering costs are estimated at 15 percent for $1,200,000.

These components would total approximately $12 million. It is believed that individual irrigation well and booster pump systems could be installed at the irrigation sites for less capital cost than this total cost. It is noted that the golf course already has its own irrigation well and system.

This type of system is not considered feasible for Chatham at this time. It could be added to the ENR process at a later time if water shortages warranted the additional costs.

C. **Treatment Requirements for Recharge to a Zone II Area.** As identified earlier in this chapter, MassDEP requires additional treatment requirements for recharge to a Zone II area as part of their *"Interim Guidelines on Reclaimed Water."* These requirements typically lead to the addition of filtration facilities and disinfection facilities. A portion of the WWTF site is in the Zone II area for the Indian Hill well. The ENR process envisioned for the WWTF upgrade includes filtration facilities, and disinfection would need to be added to meet the requirements.

As discussed earlier in this report:

- MassDEP is planning to rewrite/revise the *"Interim Guidelines on Reclaimed Water"* document to a new set of reclaimed water reuse regulations. The content and impact of these regulations is not yet known.
- The Indian Hill well has been off-line for several years due to contamination unrelated to wastewater disposal. Although contaminant levels have generally been

below drinking water standards and thus the well has DEPs approval for use, the Town made a policy decision not to use the well until it is free of contaminants, except in an emergency. Indian Hill well remains an integral part of the Town's potable water supply.

- Additional consideration on the public health threat related to the recharge of treated water includes:
  - Recharge through the sand infiltration beds and groundwater travel through the aquifer will remove any bacterial pathogens through the natural filtration abilities of the soil. This has been well documented by George Heufelder of the Barnstable County Health and Environment Department in septic system evaluations.
  - Viruses become inactive after six months to one year of travel time in the groundwater.

Groundwater modeling as summarized in Appendix G indicates that no recharge water will flow to any public drinking water wells (with Indian Hill well off) for the Phase 1 or Phase 2 flow condition. If the Indian Hill well was restarted in the future, a portion of the recharged water could flow to the well as illustrated in Appendix Q, Figures 1 and 2. The percentage of treated water flow indicated by the groundwater modeling is four (4) and eight (8) percent for the 1.3 mgd and 1.9 mgd flows, respectively. The travel time associated with this possible flow to the Indian Hill well is greater than 10 years, in the 10- to 100-year range.

These considerations indicate that disinfection facilities should not be installed at this time, especially considering the fact that MassDEP will promulgate new reuse regulations in the future. Disinfection could be added in the future when the Indian Hill well is restarted and/or disinfection is required by MassDEP.