

## Memorandum

To George Meservey, Director of Planning & Community Development  
Michael Domenica, PE, Program Manager

CC Betsy Shreve, AICP, AECOM Project Director  
Mark Owen, PG, AECOM

Subject **Town of Orleans, MA**  
**Water Quality and Wastewater Planning**  
**Task Number 8.1.1.C – Downtown Area Groundwater Discharge Sites**  
**Technical Memorandum - Summary of Alternative Groundwater Discharge**  
**Locations - Final**

Project Number 60476644

From Thomas Parece, P.E., AECOM Project Manager

Date February 14, 2017

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Approvals	Date	Signature / Initials
George Meservey, Orleans, MA Director of Planning & Community Development		
Michael Domenica, PE, Water Resources Associates, Program Manager		

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### 1. Background

This Technical Memorandum documents a summary of alternative groundwater discharge locations to be considered for the proposed Downtown Area Wastewater Treatment Facility (WWTF) in November 2016. An assessment of potential locations, including use of a decision-support system to record ratings of sites based on established criteria, formed the basis for preliminary selection. Select data from each location will be used to assist in evaluating which site(s) may be further evaluated for the Downtown Area wastewater treatment facility groundwater discharge.

### 2. Introduction

The focus of this technical memorandum is to provide a summary of the preliminary evaluation of possible groundwater discharge locations for the Downtown Area wastewater treatment facility using existing available information.

### 3. Background

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### 4. Introduction

The focus of this technical memorandum is to provide a summary of the preliminary evaluation of possible groundwater discharge locations for the Downtown Area wastewater treatment facility using existing available information.

### 5. Possible Groundwater Discharge Sites Considered for Characterization and Evaluation

Six (6) potential locations for groundwater discharge of wastewater treatment facility effluent were considered including:

- Overland Way (Parcels 1/1A);
- Route 6 Interchange (Exit 12 Cloverleaf);
- Thayer Property (Orleans Market Place);
- Old Colony Apartments (Old Colony Way);
- Hole in One Restaurant Parking (Cranberry Highway); and
- Depot Square (Old Colony Way).

The six locations are shown on Figure 1.

Limited information (subsurface soils, depth to groundwater, underground utilities, etc.) was available for most sites. This lack of information needs to be considered when reviewing the results below. Obtaining adequate information will be part of a more detailed future hydrogeologic evaluation conducted if a discharge is proposed for a site based on this preliminary screening step. Information produced will define the size, capacity and layout of the site, as well as additional design factors. The information is used in assessing the locations against the Site Suitability Criteria presented in Section 5.

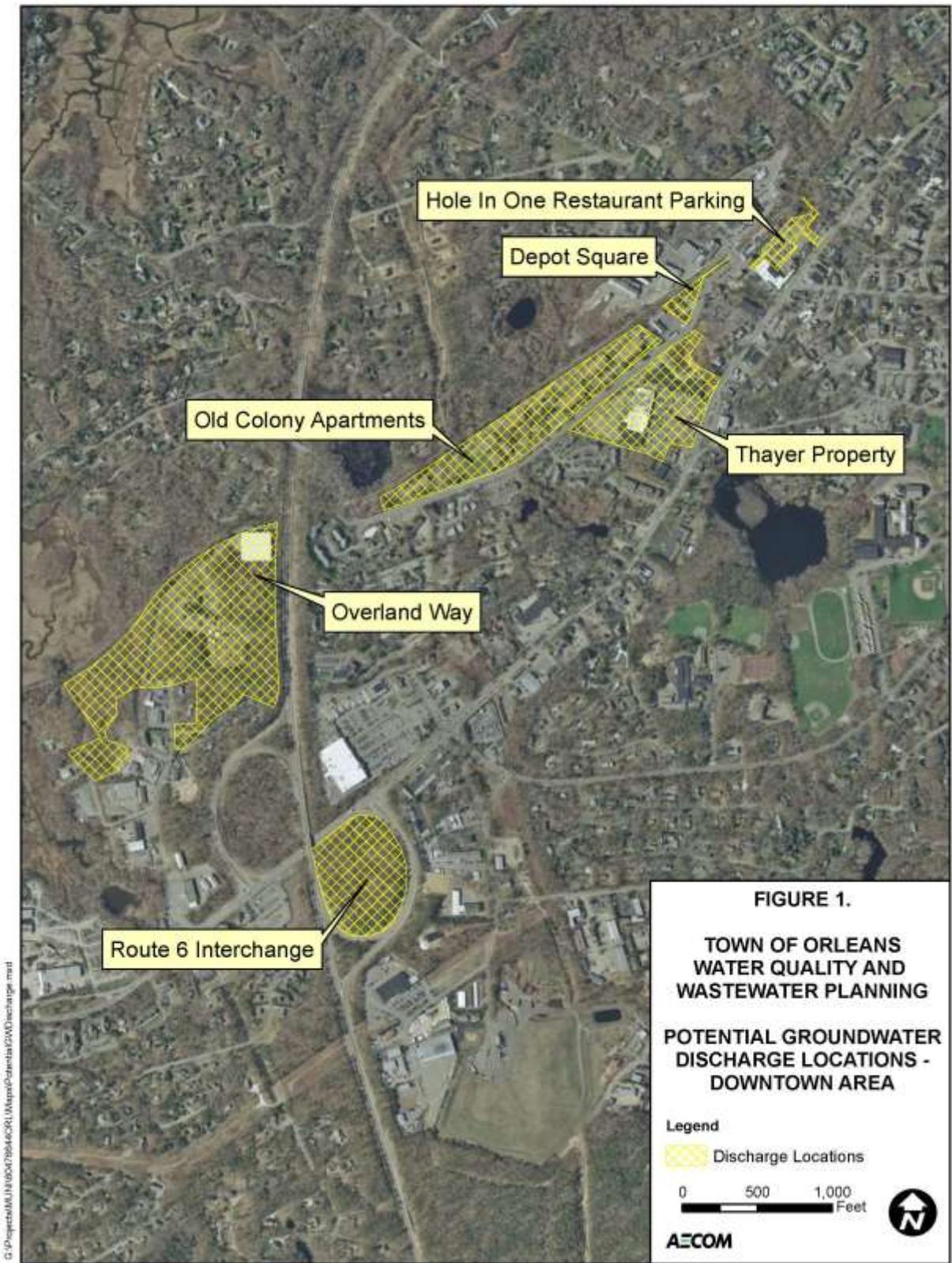
Information reviewed regarding possible groundwater discharge sites follows.

#### A. Overland Way (Sites 1/1A)

The Overland Way (former Tri Town Septage Treatment Facility) site is located on a 26-acre site on Overland Road, in the Town of Orleans (Figure 1). Site 1/1A located in the northeast corner of the site.

The former Tri Town Septage Treatment Facility was built in 1980 to serve the towns of Orleans, Brewster and Eastham by receiving septage from these as well as other Cape Cod towns. The facility was owned and operated by the Orleans-Brewster-Eastham Groundwater Protection District (the Tri-Town District).

In order to meet the anticipated flows and effluent limit for nitrogen (10 mg/l), the existing Tri-Town Septage Treatment Facility would have needed significant repairs and upgrades which were estimated at \$5,140,000 in 2012. The agreement between the three towns co-owning and operating the facility was due to expire in May 2015. In addition, the National Pollutant Discharge Elimination System (NPDES) permit for the wastewater disposal was scheduled to expire in December 2016.



Due to the high rehabilitation cost to bring the septage treatment facility up to current effluent standards, the Tri-Town District decided in June 2016 to decommission and demolish the treatment facility. At present, a new facility is proposed to be constructed at this same site to treat the wastewater flow from the Downtown Area and, potentially, the septage from local towns.

The Overland Way site is the most studied and understood of the possible groundwater discharge selected sites. Several USGS reports have documented the Tri Town wastewater treatment facility discharge and its lack of impacts on Namskaket Marsh. The reports are referenced at the end of this technical memorandum.

The Tri Town facility was permitted to discharge 45,000 gallons per day (gpd), but generally discharged less than 30,000 gpd through eight open bed discharge lagoons.

Disposal facilities at this site could consist of open sand beds, subsurface leaching trenches, or wicks. The discharge method selected would be based on the results of the hydrogeologic evaluation.

#### **B. Route 6 Interchange (Exit 12 Cloverleaf)**

The Route 6 Interchange (Exit 12 Cloverleaf) site is located in the Little Namskaket watershed. The area within the cloverleaf is approximately 8.75 acres and is owned by MassDOT. The Town has requested site access from MassDOT to conduct a hydrogeological evaluation of the site as a discharge location.

A disposal facility on this site would consist of subsurface leaching trenches or wicks. The discharge method selected would be based on the results of the hydrogeologic evaluation and the final agreement with MassDOT.

The elevation of the proposed discharge is approximately 80 to 100 feet above mean sea level (msl). The depth to groundwater is expected to be in excess of 60 feet. Groundwater below the site flows in a northerly direction towards Little Namskaket Marsh. The upper reaches of Little Namskaket Marsh are approximately 4,000 feet to the north-northwest of the proposed discharge. Soils underlying the site are mapped as outwash sands and gravel.

At this time, the Town is seeking an agreement with MassDOT to allow a hydrogeologic evaluation at the site.

#### **C. Thayer Property (Orleans Market Place)**

The Thayer Property (Orleans Market Place) is located at 136 (Route 6A). The site consists of several retail stores, restaurants, and parking area. The groundwater discharge would likely be limited to subsurface leaching trenches installed under portions of the parking areas.

Limited subsurface data was available at the local Health Department. Records indicate the following:

- Test pit data at four locations in the northwest corner of the parking lot behind staples along Old Colony Way;
- No test/soil boring data available;
- The soils to a depth of 11 to 12 feet to are described as a sandy loam (silty sand). Below 12 feet is a primarily a loose, fine, clean sand. These soils as well as those to and below the water table will need to be further investigated and evaluated across the site;
- There was no percolation test data;
- No groundwater was incurred at the test pit locations. The elevation of the site is around 65 feet msl. Based on the site elevation of approximately 65 feet and an approximate the water table elevation of 10 feet. The water table is estimated at around 55 feet below the ground surface;

Based on square footage of existing parking lot, it is estimated that the location has the potential for a 135,000 gpd groundwater discharge provided that the underlying soils are suitable.

A hydrogeologic evaluation of the site for an increased groundwater discharge was performed by the owner. Documentation of the evaluation was submitted to MassDEP. In a letter dated August 19, 2016, MassDEP requested additional information to assist with their evaluation of the permit request. If additional discharge is approved by MassDEP, the reports will be reviewed and evaluated as part of the site evaluation process.

#### **D. Old Colony Apartments (Old Colony Way)**

The Old Colony Apartment Complex is located adjacent to the Thayer property on the opposite side of Old Colony Way (Figure 1). The site consists of several apartment buildings, several parking areas, and open space where the existing subsurface groundwater discharge is located.

The folder containing data on the groundwater discharge investigations was not available at the time of the Health Department visit.

Including the existing discharge area, there is approximately 40,000 sq. ft. available for a groundwater discharge. This does not include parking areas located throughout the property which could potentially be utilized for subsurface groundwater discharge. Based on the 40,000 sq. ft. area only, the site could potentially discharge 80,000 gpd, provided the underlying soils are favorable.

The most likely method of groundwater discharge would be subsurface leaching trenches at the apartment complexes existing discharge site with additional potential subsurface leaching trenches discharges under existing parking areas.

#### **E. Hole in One Restaurant Parking (Cranberry Highway)**

The Hole in One Restaurant is located at 98 Cranberry Highway (Route 6A). The shopping complex includes the Hole in One restaurant and several retail stores which share a common parking lot. The shared parking area behind the restaurant could provide area for subsurface leaching trenches for the Downtown Area wastewater treatment facility discharge.

The Board of Health records were reviewed for the business known as Hole in One Restaurant. Details are as follows:

- Test pit data was available from several locations;
- Test boring data at four locations was available, however, there is no data for the top 15 feet of test borings as these soils were not logged;
- The soils at depth (particularly below 15 feet) contain a fine to medium clean sand, with layers of finer sands, silts and clays. These finer soils do not appear to be contiguous, but would need to be further investigated and evaluated across the site;
- There was no percolation test data to review; and
- The test borings were drilled to a depth of around 27 to 29 feet. No groundwater was incurred. Based on the site elevation of approximately 50 feet and an approximate the water table elevation of 10 feet, the water table is estimated at around 40 feet below the ground surface.

Based on the square footage of existing parking lot, it is estimated that the location has the potential to discharge up to 50,000 gpd provided the underlying soils are favorable. However, poor soils located below the available records of 27 to 29 feet could greatly reduce the discharge estimate; and offsets and/or underground utilities could also reduce the estimated discharge rate.

**F. Depot Square (Old Colony Way)**

Depot Square is a small town owned property located at the corner of Old Colony Way and Main Street. The site is used as a park containing picnic areas, a bike path, open space and a small parking lot. Subsurface leaching trenches could be located under the parking areas and portions of the open space.

The Board of Health records were reviewed for the site. Select details are as follows:

- Test pit were conducted at four locations;
- Percolation tests were performed at two of the test pit locations;
- Soil borings were not performed;
- The soils excavated from the test pits were described as being mixed at most test pit locations, consisting of layers of sands and loamy sands. It is not clear if these finer soils are contiguous, and would need to be further investigated and evaluated across the site;
- Soils below 11 to 12 feet are unknown and could influence the amount of discharge; and
- The depth to groundwater is approximately 40 feet assuming a ground elevation of 50 feet and a water table elevation of 10 feet.

Groundwater discharge area (triangular in shape) could potentially be 24,000 sq. ft. with a capacity up to 48,000 gpd if underlying soils are found to be favorable for that amount of discharge.

**6. Groundwater Modeling Evaluation**

This section documents the preliminary groundwater modeling results simulating groundwater flow from potential discharge locations for the proposed Downtown Area Wastewater Treatment Facility. A summary of the modeling method, conceptual model of the aquifer, model design and updates, changes to the model input parameters and model calibration are summarized in Technical Memorandum "Task Number 8.1.1A – Downtown Area Groundwater Discharge Flow Paths Deliverable 8.1.1.A Summary Parcels 1/1A Flow Paths" dated October 2016. The predictive simulations are summarized below.

**A. Predictive Simulations**

The calibrated USGS groundwater flow model was used to simulate several groundwater discharge scenarios in order to predict groundwater flow from the discharge sites.

Six separate discharge scenarios were simulated using the groundwater flow model. The scenarios simulated discharges from the six Downtown Area discharge the sites being considered. Each scenario simulation the discharge under the average ambient water table conditions described above. Scenarios simulated maximum discharge rates as described above (between 48,000 and 200,000 gpd) through subsurface leaching trenches.

The simulated paths of groundwater flow were illustrated by using the groundwater model particle tracking module. The down gradient extent of the particle traces illustrate where groundwater discharges to a surface water. The simulation results with particle traces are provided in Attachment A.

The model scenarios simulated are summarized below:

- **Overland Way** – A model simulations was performed at a discharge rate of 200,000 gpd. Through particle traces, the model simulation indicates that groundwater flows from Site 1/1A on Overland Way north and west. A majority of the discharge flows under the Namskaket and Little Namskaket Creek marshes directly into Cape Cod Bay. A few particle traces terminate in the creeks and marshes of the Namskaket Creek Watersheds indicating that a portion of the flow discharges into these areas, However, It should be noted that a majority of the flow enters the watersheds relatively close to where the Creeks discharge to Cape Cod Bay where the tidal flux is greatest.
- **Route 6 Interchange** –As with Overland Way, a discharge scenario of 200,000 gpd was simulated. The model simulation indicates that the discharge flows to the north and west of the site. As with the Overland Way simulation, a majority of the discharge flows under Namskaket and Little Namskaket Creeks directly into Cape Cod Bay with a portion of the flow discharging into the Namskaket Creeks near Cape Cod Bay.
- **Old Colony Apartments** – A discharge scenario of 80,000 gpd from the Old Colony Apartments existing discharge area was simulated. The flow paths indicate that discharge from the site would flow northerly under Boat Meadow and the northern portion of Little Namskaket Creek to Cape Cod Bay. Almost all flow paths terminate in Cape Cod Bay indicating that a majority of the flow will discharge into Cape Cod Bay. A small portion of the discharge could enter one or both of the watersheds.
- **Thayer Property (Orleans Market Place)** – Based on the size of the parking area at Orleans Market Place, a discharge scenario of 135,000 gpd was simulated. The model results indicate that most of the groundwater would discharge to Rock Harbor Creek. A few particle traces flow under the Rock Harbor Watershed to Cape Cod Bay, Boat Meadow River, and Town Cove. The site is located in both the Rock Harbor and Boat Meadow River Watersheds and is located very close to the divide between Boat Meadow River and Town Cove Watersheds. As a result, the discharge flows to each.
- **Depot Square** – The model scenario performed for Depot Square simulated a discharge of 48,000 gpd. Depot Square is located directly downgradient of the Thayer property within the Rock Harbor River Watershed but has a total flow of just over a third of The Thayer Property scenario. The simulated discharge pattern shows the discharge emerging in Rock Harbor Creek, Cape Cod Bay and at the outlet of Boat Meadow Harbor.
- **Hole In One Restaurant** – In this scenario, a groundwater discharge of 50,000 gpd was simulated. The Hole in One Restaurant parking lot is located in the Town Cove Watershed. As a result, a majority of the particle traces terminate in Town Cove. A portion of the flow may also discharge into Boat Meadow River.

## **B. Results of Groundwater Modeling Predictive Simulations**

Flow from the six potential groundwater discharge sites was simulated using a slightly modified version of the USGS Monomoy Lens groundwater Model. Using the groundwater model's particle tracking module, flow paths were used to estimate the path of the wastewater treatment facility's discharge from the discharge location, through the groundwater, and eventually to where it discharges to surface waters. Results of the simulations are included in Attachment A.

Table 1 summarizes the watersheds where the wastewater treatment facility flow from the discharge site scenarios emerges. The quantity of flow and amount of nitrate that discharges into each of the watersheds would require additional groundwater model runs.

According to Town records and the particle traces, at least one property that may have a private well is located downgradient of each of the sites. If the any of the wells is a drinking water or irrigation supply well, the Town should consider connecting the property to the public water supply.

**Table 1 - Summary of Groundwater Discharge Model Scenarios  
 Discharge Location of Modeled Particle Traces**

Discharge Location	Estimated Discharge Rate (gpd)	Cape Cod Bay	Namskaket Creek	Little Namskaket Creek	Rock Harbor	Boat Meadow River	Town Cove (Nauset Marsh)
Parcel 1/1A	200,000	X	X	X			
Route 6, Exit 12	200,000	X	X	X			
Old Colony Apts.	80,000	X		X	X		
Thayer Property	135,000	X			X	X	X
Depot Square	48,000				X	X	
Hole in One Rest.	50,000				X	X	X

If any of the sites above is selected for consideration as a discharge location, a detailed hydrogeologic evaluation would be completed as required by MassDEP. The evaluation would require additional subsurface investigations, data analysis, model updates, model calibration, and model simulations. As part of evaluation, the USGS groundwater model would be updated to incorporate local and regional hydrogeologic conditions. At that time, the quantity of flow and amount of nitrate discharging into each watershed could more accurately be estimated.

**7. Site Suitability Criteria and Analysis**

**A. Site Selection Matrix**

A Site Selection Matrix was developed for objective evaluation of selected discharge sites. The Matrix includes criteria for Site Suitability, Permitting, Project Evaluation and Other/Overriding Considerations. These criteria address environmental, land use and implementation features of the proposed demonstration locations. Permitting criteria assess regulatory requirements and potential conflicts related to the proposed demonstration locations. Other/Overriding Considerations refer to other superseding issues that may support or possibly prevent a demonstration at a given site.

The site selection screening is preliminary and based on existing available information. Data would need to be substantiated prior to the final site selection. The Site Selection Matrix includes the following criteria:

**Site Suitability**

- Property Ownership – Town owned, open space, privately owned, developed, undeveloped,
- Distance from wastewater treatment facility – The length of the force main and route it would follow must be installed significantly affecting overall costs.
- Ease of Access/Use of Property – Whether the discharge area is in an open area, under an existing parking lot, or in a developed area can affect the size and cost of the discharge area as well as installation and maintenance costs.
- Site Topography - Significant changes in elevation may affect construction and monitoring.
- Present Use of Site – Developed sites may be difficult to gain an easement agreement or right-of-way for a groundwater discharge.
- Depth to Groundwater - Deeper water table increases costs and may affect feasibility.

- Potential Use of Site – Sites that are zoned or slated for future development may be more difficult to get permission to access and can impact the purchase price of parcel or alter the value of Town owned land.
- Subsurface Soils Profile – Finer, lower transitivity soils (silt and clay) between the ground surface and 20 feet or so below the groundwater table can limit the amount of groundwater that can be discharged as well as the method of discharge (open bed, subsurface, wick, etc.).
- Area Available for Groundwater Discharge – Smaller discharge areas limit the amount of groundwater discharge potentially requiring discharge infrastructure at several locations.
- Downgradient Water Use – Public water supply or potable water supply wells are located nearby or down gradient.

**Permitting**

- Potential for Watershed/Estuary Impacts - Distance from surface water and wetland resource areas/ water use considerations.
- Potential Impacts to an ACEC.
- Presence of Rare and Endangered species.

**Project Evaluation**

- Watershed total maximum daily load (TMDL) – Discharging to a watershed with a nitrate total maximum daily load may require higher treatment levels at the wastewater treatment facility significantly increasing capitol and O&M costs.
- Conclusion of Previous Studies – The quality and conclusion of previous studies can impact the tasks necessary to perform the required MassDEP Hydrogeologic Evaluation.
- Required Effluent Discharge Quality – Site specific and surrounding conditions can impact required wastewater treatment facility discharge quality such as disinfection, nitrate levels, etc.
- Groundwater Discharge Method(s) – Capital and O&M costs for groundwater discharge methods vary. Site conditions can impact what discharge methods can be used.

**Other/Overriding Considerations**

- Community Acceptability
- Funding Potential

**B. Analysis**

AECOM collected site specific information, conducted site visits, and evaluated the potential performance effectiveness. A rating system was then developed to quantify how well each site met a specific criterion. The point-based system used is as follows:

- Good = 1 point
- Neutral = 0 points
- Poor = -1 point

A **good** rating (1) was assigned if the criterion could be met fully.

A **neutral** rating (0) was assigned if the criterion could be met in part, but there were some potential issues and/or difficulties.

A **poor** rating (-1) was assigned if the criterion could not be met.

A copy of the Matrix used to perform the analysis is provided in Attachment B.

## 8. Findings and Recommendations

The site suitability evaluation process (see Appendix B) resulted in the following total ratings and associated ranking of sites:

- Overland Way (Sites 1/1A) – 13 Points
- Route 6 Interchange (Exit 12 Cloverleaf) – 8 Points
- Depot Square (Old Colony Way) – 5 Points
- Old Colony Apartments (Old Colony Way) – 5 Points
- Thayer Property (Orleans Market Place) – 1 Points
- Hole in One Restaurant Parking (Cranberry Highway) – 1 Points

The advantages and disadvantages of Overland Way and the Route 6 Interchange, the top ranked sites are as follows:

### A. Overland Way

#### Site Advantages

- The property is owned by the Town.
- The discharge would be located on the same property as the proposed wastewater treatment facility.
- Based on existing data, there would be sufficient area for both the primary and reserve discharge areas at the site.
- The geology and hydrogeology of the site are well known and favorable for a groundwater discharge.
- The depth to groundwater is generally over 34 feet. Groundwater mounding from a discharge would likely not be an issue.
- The MassDEP is familiar with the site and has previously granted a Groundwater Discharge Permit (45,000 gpd) for the site.
- Based on preliminary groundwater model simulation, most if not all of the discharge would flow to watersheds that have not exceeded a total maximum daily load threshold.
- There is the option of either a subsurface, open bed, or wick discharge.
- The discharge could easily be monitored and maintained by wastewater treatment facility personnel.

#### Site Disadvantages

- Potentially some local opposition due to concern about discharge to Namskaket Marsh.

### B. Route 6 Interchange

#### Site Advantages

- There is sufficient area to discharge the projected demand of the proposed wastewater treatment facility.
- Mapped geology and hydrogeology appears to be favorable for a groundwater discharge.
- The depth to groundwater is estimated between 50 and 90 feet. Groundwater mounding from a discharge would likely not be an issue.

- Based on preliminary groundwater model runs, most if not all of the discharge would flow to watersheds that have not exceeded at total maximum daily load threshold.
- The site is located in an area with commercial facilities and few residences.

**Site Disadvantages**

- The property is not owned by the Town. MassDOT does not appear to be in favor of allowing a groundwater discharge at the site.
- The discharge would not be located at the same site as the proposed wastewater treatment facility.
- Ease of access to the site for operation and maintenance is presently not known
- The geology and hydrogeology of the site are not known and would require a hydrogeologic investigation.

**9. References**

Cape Cod Commission 1995, Orleans Water Table Mapping Project

Howes B., S. W. Kelley, J. S. Ramsey, R. Samimy, D. Schlezinger, E. Eichner (2012). Linked Watershed-Embayment Approach to Determine Critical Nitrogen Loading Thresholds for the Nauset Harbor Embayment System Towns of Orleans and Eastham, Massachusetts

Howes B., S. W. Kelley, J. S. Ramsey, R. Samimy, D. Schlezinger, E. Eichner (2006).

Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for Pleasant Bay, Chatham, Massachusetts. Massachusetts Estuaries Project, Massachusetts Department of Environmental Protection. Boston, MA.

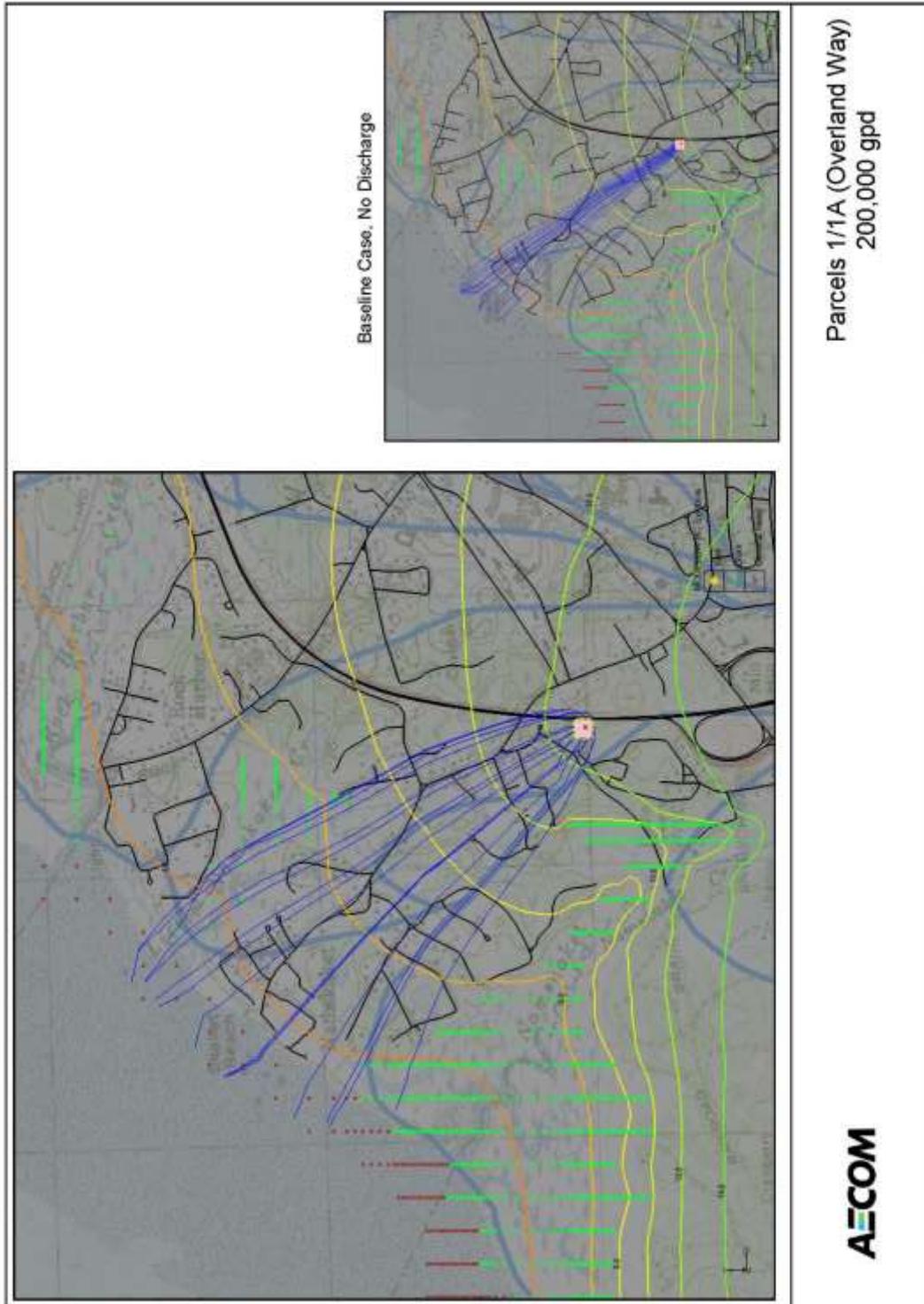
MT Environmental Restoration and GHD Inc., April 2015, Orleans landfill nitrate data evaluation report.

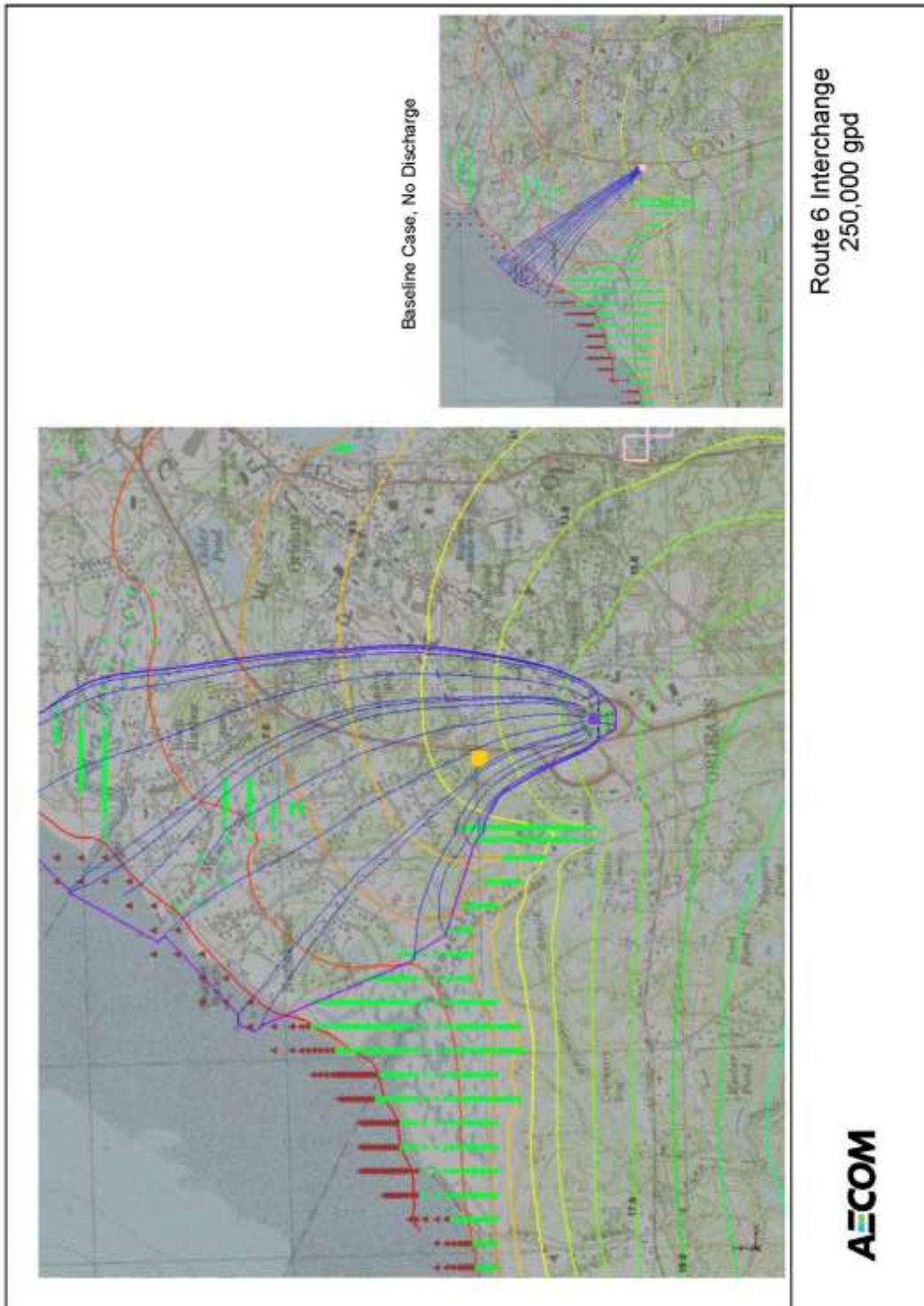
Walter, D.A., Masterson, J.P., and Hess, K.M., 2004, Ground-water recharge areas and travel times to pumped wells, ponds, streams, and coastal water bodies, Cape Cod, Massachusetts: U.S. Geological Survey Scientific Investigations Map I-2857, 1 sheet [<http://pubs.usgs.gov/sim/2004/2857/>].

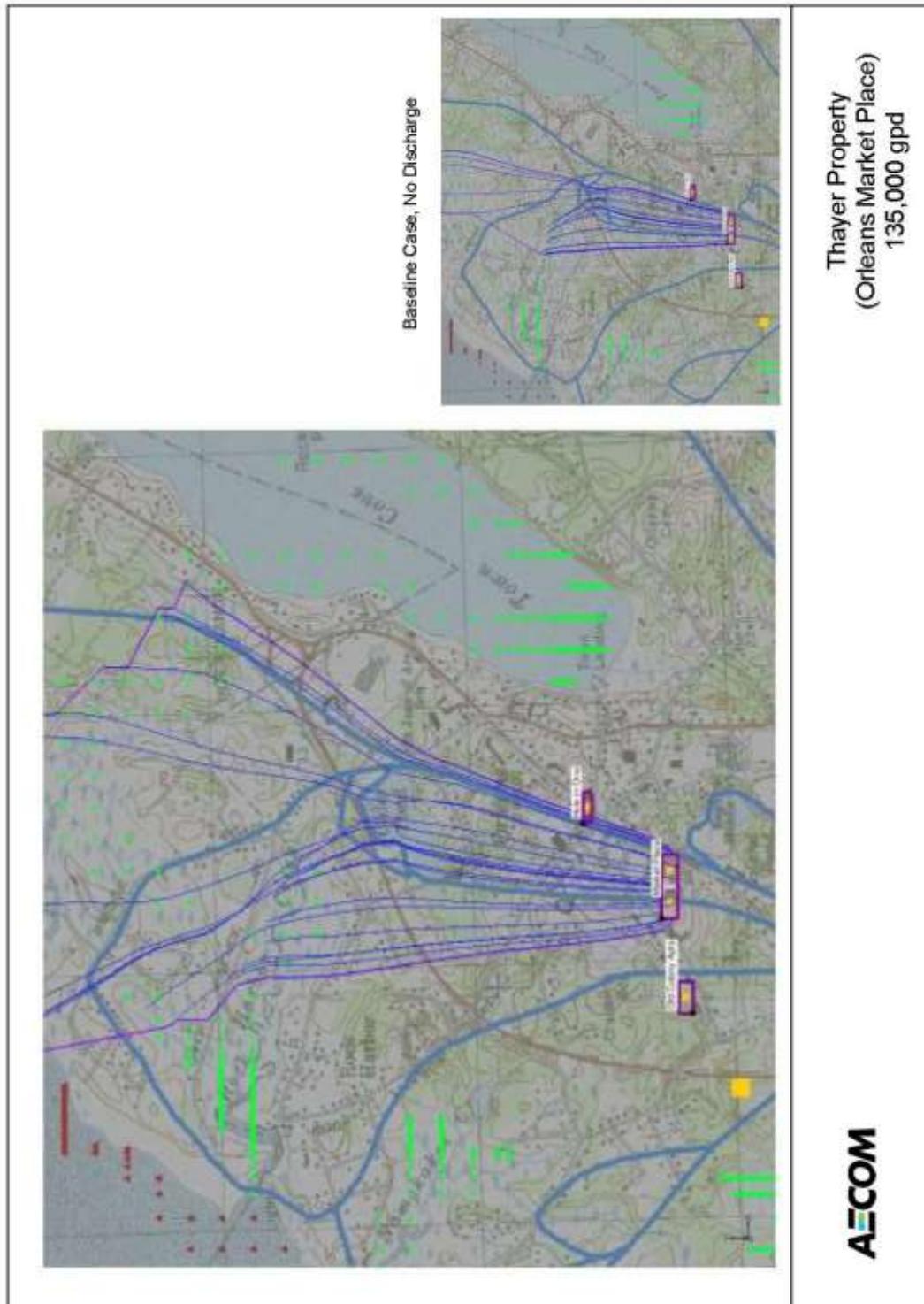
Weiskel, P.K., Barbaro, J.R., and DeSimone, L.A., 2016, Environmental Conditions in the Namskaket Marsh Area, Orleans, Massachusetts: A summary of Studies by the U.S. Geological Survey, 1989 – 2011: U.S. Geological Survey Scientific Investigations Report 2016-5122

Wright-Pierce, December 2010, Town of Orleans Comprehensive Wastewater Management Plan and Single Environmental Impact Report.

ATTACHMENT A



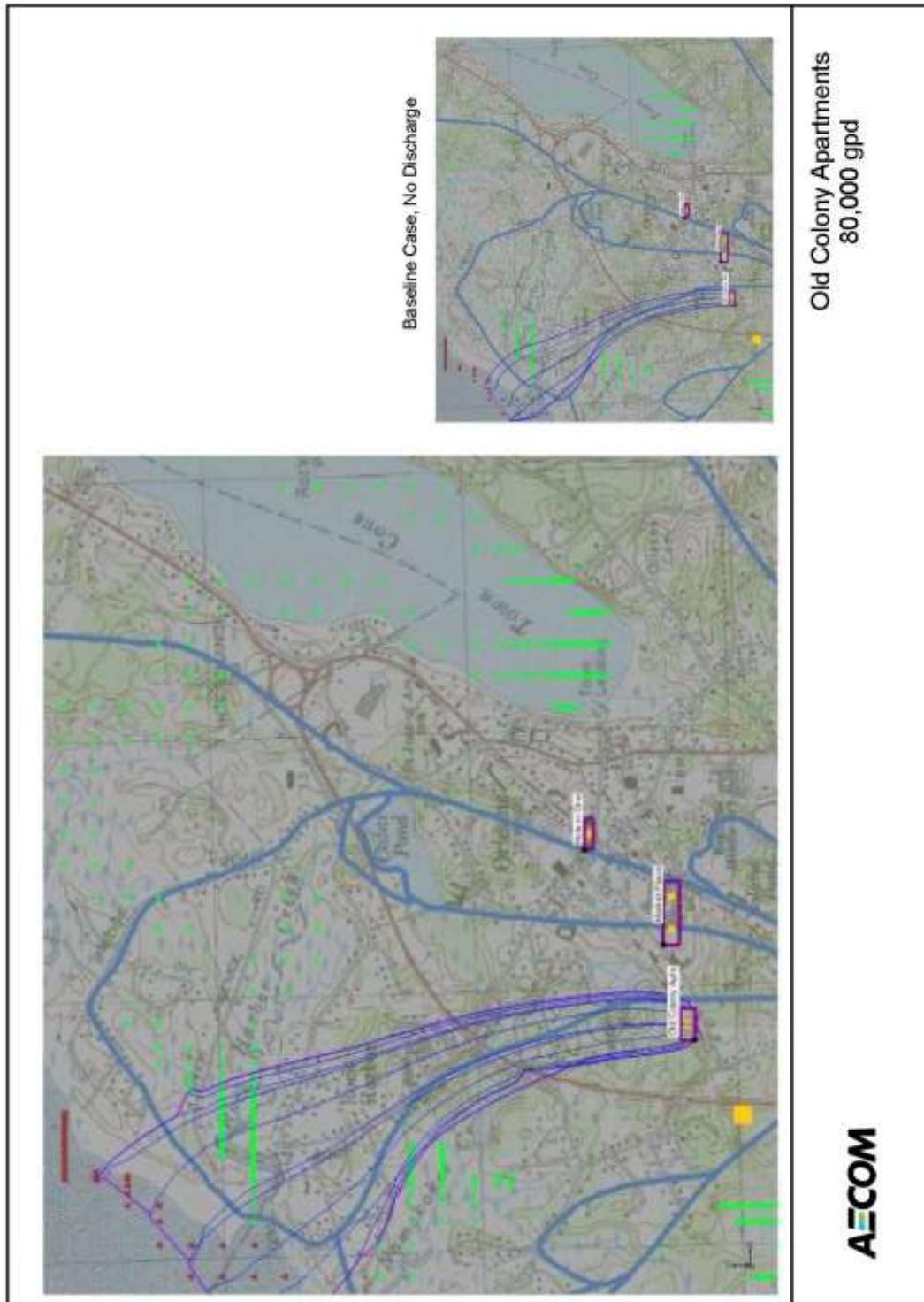


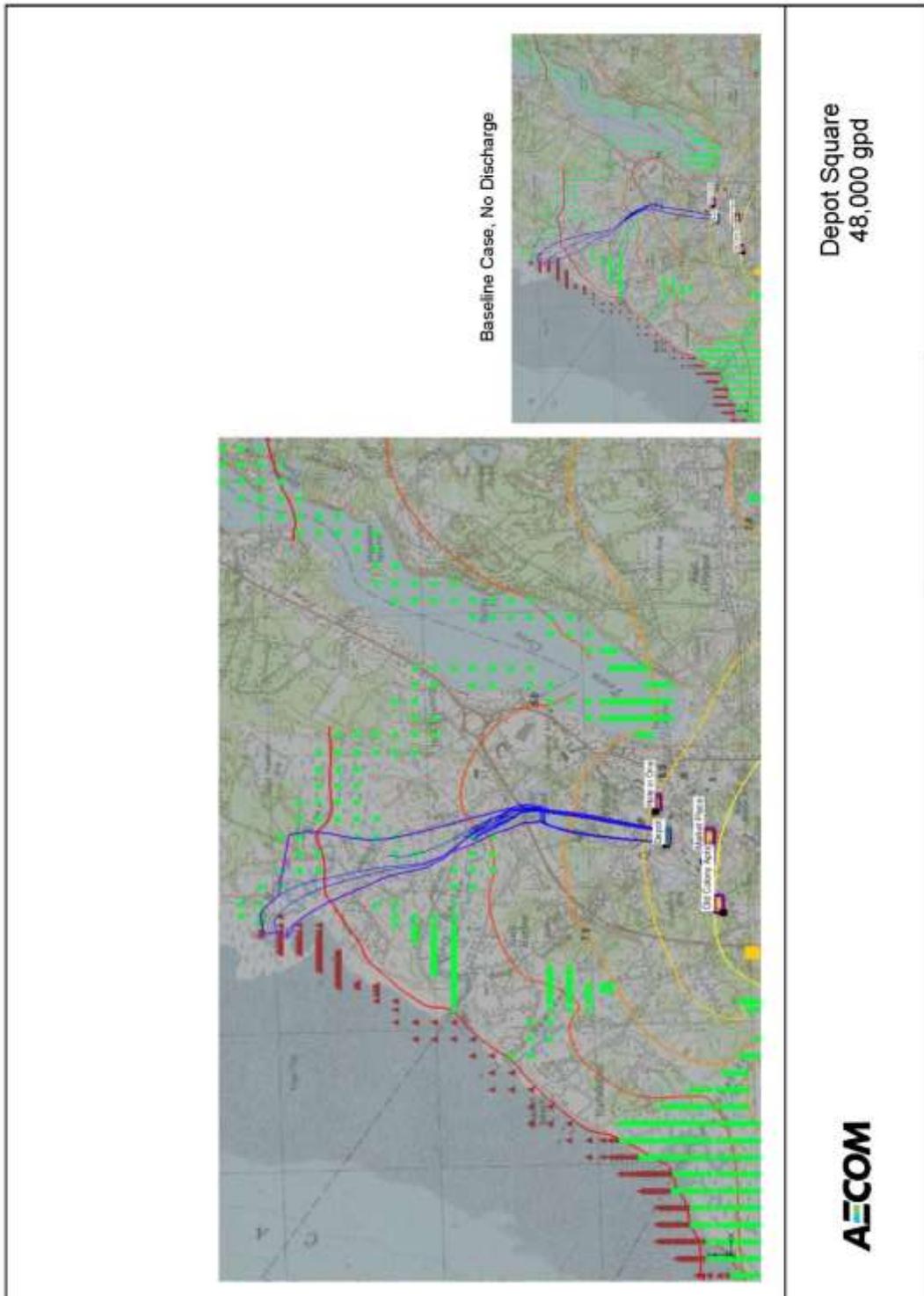


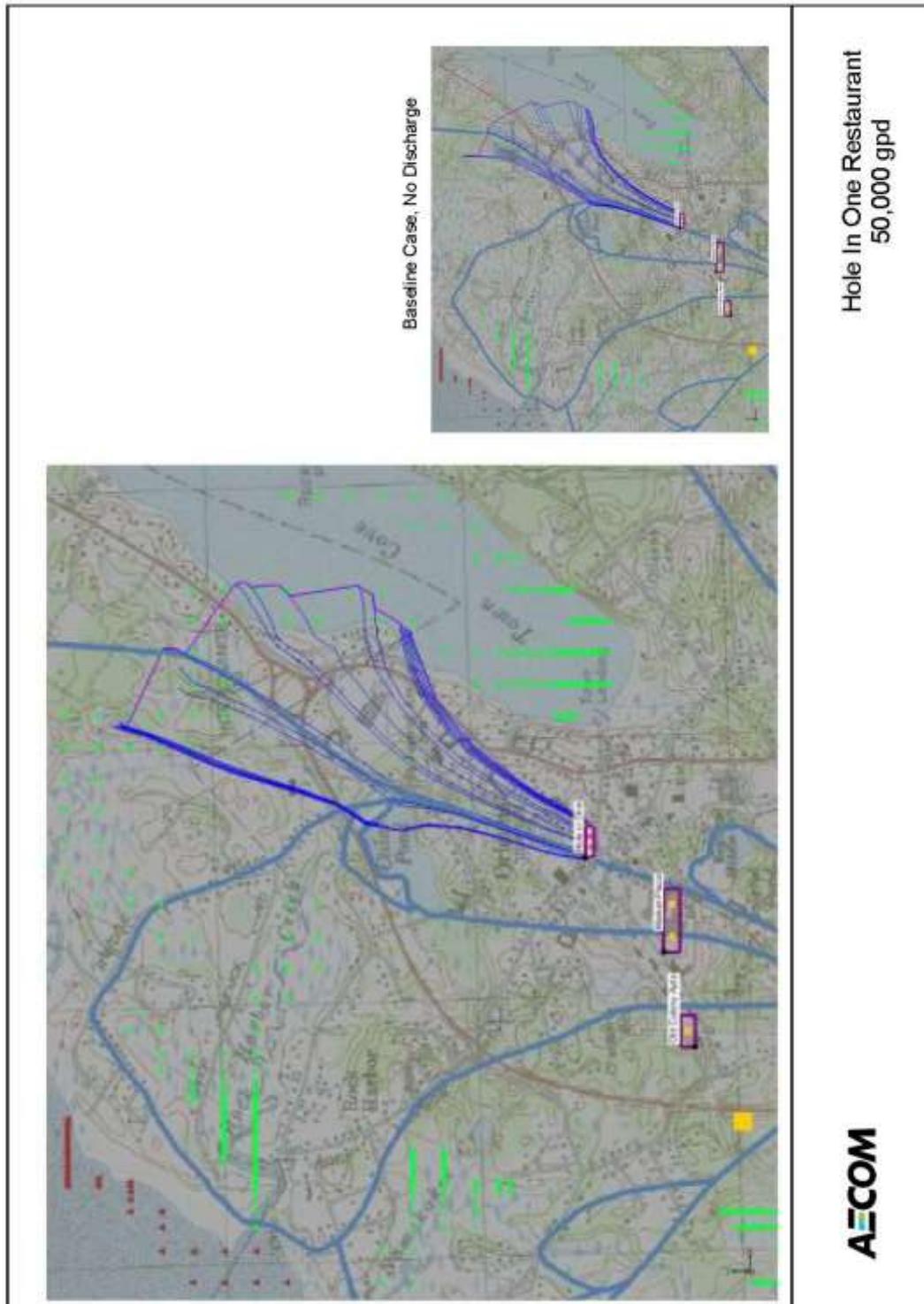
Baseline Case, No Discharge

Thayer Property  
(Orleans Market Place)  
135,000 gpd

**AECOM**







ATTACHMENT B

