Appendix C

Technical Memorandum on findings of USGS Modeling for Effluent Recharge Alternatives and Effects on a Landfill Plume, July 2005, and Preliminary USGS Particle Track Figures 1-7

Technical Memorandum on findings of USGS Modeling for Effluent Recharge Alternatives and Effects on a Landfill Plume, July 2005

Stearns & Wheler, LLC
Environmental Engineers and Scientists

TECHNICAL MEMORANDUM

To: Brian Dudley, MADEP SERO
Ronald Lyberger, MADEP Boston
Eduard Eichner, CCC
Thomas Cambareri, CCC

From: Nathan C. Weeks, P.E.
T. Lawrence Hineline, LSP
J. Jefferson Gregg, P.E.

Copy: Steven Hallem, MADEP Boston
Donald Walter, USGS
David Ellis, DEP, SERO, DSW
Robert A. Duncanson, Ph.D., Town of Chatham

Date: July 11, 2005

Re: Town of Chatham CWMP
Findings of USGS Modeling for Effluent Recharge Alternatives and Effects on the Landfill Plume
S&W No. 70098

Introduction and Purpose

On December 16, 2004, we met with Donald Walter of the United States Geologic Survey (USGS) to review the preliminary findings of USGS modeling services provided to the Town of Chatham (Town) through Barnstable County and the Cape Cod Commission (CCC). At that meeting, we reviewed the services being offered by the CCC and USGS and how these services could develop valuable information for the Chatham Comprehensive Wastewater Management Planning (CWMP) project. At that meeting, there was interest in using the USGS regional groundwater model to evaluate the possible effects of potential effluent recharges on the groundwater system under or downgradient of the Town's capped landfill (landfill plume).

The purpose of this memorandum is to summarize the findings of the groundwater modeling completed to evaluate possible effects on the landfill plume.

Background

In November 1987, the Massachusetts Department of Environmental Protection (MADEP) issued an Administrative Consent Order to the Town requiring that the effluent recharge from the Chatham Wastewater Treatment Facility (WWTF) be limited to 100,000 gallons per day (gpd) on an average annual basis. This limit was identified to minimize the risk of groundwater mounding at the site that

could cause effluent migration to public water supply wells or could cause the landfill plume to migrate toward public drinking supply wells. In September 1998, this limit was increased to 150,000 gpd on an average annual basis due to revised modeling results as summarized in the February 1995 Report by Metcalf & Eddy. The location of the existing WWTF and the landfill are illustrated on the attached Figure 1.

It is noted that a plume of impacted groundwater has never been delineated for the landfill, and that the 1996 Comprehensive Site Assessment completed for the subsequent capping of the landfill indicated minimal impacts to the groundwater system from the landfill. Even with the minimal impacts, the landfill was capped, and the effluent recharge at the existing WWTF was limited to less than 150,000 gpd.

Comprehensive Wastewater Management Planning (CWMP) in Chatham

The Town's CWMP project was started in 1997 to evaluate and provide a comprehensive strategy for wastewater treatment and recharge issues for the next 20 years. One task of the CWMP project was to resolve concerns that effluent recharge could cause a potential landfill plume to migrate toward a public drinking water supply well. That resolution would be needed if increased effluent recharge were to be proposed at or near the WWTF site.

The Town's CWMP has taken several years while nitrogen limits of the Town's estuaries have been developed by the Massachusetts Estuaries Project. Now that total nitrogen limits are close to being finalized, the Town is proceeding efficiently to evaluate various wastewater management scenarios. The Town expects that expanded wastewater collection and treatment, and effluent recharge, will be needed to meet the proposed nitrogen limits. As a result, the Town has begun groundwater investigations and modeling to evaluate candidate sites for new potential effluent recharge locations.

The potential effluent recharge sites being evaluated by the Town are illustrated in Figure 1.

USGS Modeling Utilized by the Chatham CWMP

Barnstable County, through its Wastewater Implementation Committee (WIC) and the Cape Cod Commission (CCC), has offered free groundwater modeling services by the USGS for the towns on Cape Cod. These services are the modeling and evaluation of potential effluent recharge scenarios being considered for CWMP projects or new groundwater withdrawals for water supply projects.

The USGS regional groundwater model (as described in *USGS Scientific Investigations Report 2004-5181* by D.A. Walter and A.T. Whealan entitled "Simulated Water Sources and Effects of Pumping on Surface and Ground Water, Sagamore and Monomoy Flow Lenses, Cape Cod, Massachusetts") has been used to evaluate these potential effluent recharge scenarios in Chatham.

The following effluent recharge evaluations have been performed to calculate the route that the treated effluent travels through the groundwater system and the potential mounding that might occur at a recharge site. The route that the effluent travels is illustrated by a "particle tracking" component of the

groundwater model, and the mounding is illustrated by groundwater contours showing the calculated increase in water table elevation (mounding) or decrease.

The following evaluations were performed for potential future effluent recharge near the landfill:

- Scenario C1
  - 0.7 million gallons per day (mgd) at the existing WWTF beds
  - 0.8 mgd at Site 1
- Scenario C2
  - 0.4 mgd at the WWTF beds
  - 1.1 mgd at Site 1
- Scenario C3
  - 0.6 mgd at the WWTF beds
  - 0.9 mgd at Site 2

The wastewater flows considered are all average annual flow estimates based on a well-treated effluent and the available land area at the site.

Three modeling rounds were conducted:

1. The first modeling round was completed in June 2004 and simulated the future effluent recharge scenarios and future water supply pumping without the Indian Hill Well pumping. It is noted that the Indian Hill Well has been shut down for several years due to contamination problems not related to of the WWTF or the landfill.

2. The second modeling round was completed in July 2004 and simulated the future scenarios with the Indian Hill Well pumping at its rated capacity.

3. The third modeling round was completed in early 2005 and simulated the particle tracks (landfill plume) coming from the capped landfill and solid waste management site for each of the future effluent recharge scenarios with the Indian Hill Well pumping.

Summary of Findings on the Effects of Potential Effluent Discharges on the Landfill Plume

1. Existing Conditions. The existing conditions are illustrated in Figure 2 and include the following hydrogeologic withdrawals and recharges:
   - Existing (2003) water supply pumping.
   - Existing groundwater recharge of 0.1 mgd at the Chatham WWTF.
   - Septic tank groundwater recharge of the remaining town wastewater flows.

   As seen in Figure 2, the landfill plume flows south to Nantucket Sound with an estimated travel time of 10 to 50 years. The plume may be shifted slightly to the east by the existing 0.1 mgd effluent recharge as compared to a no-effluent recharge condition.

2. Scenario C1. Scenario C1 illustrated in Figure 3 is the alternative of 0.7 mgd effluent recharge at the WWTF beds and 0.8 mgd effluent recharge at Site #1 north of the WWTF site. The following

observations are made from the results of this modeled scenario that has Indian Hill Well not pumping:

- Nearly all the effluent flows south through the Cockle Cove Creek, Taylor Pond, and Sulfur Springs watersheds, with travel times of 50 years or greater.
- A few particle tracks leave the main group and lead to Goose Pond, Muddy Creek, Crow's Pond, Oyster Pond, and the Training Field Wells.
- No particle tracks lead to Indian Hill Well. (This well is not pumping in this model run.)
- No particle tracks go to any of the other public water supply wells due to groundwater elevations and distance to the wells.
- A 6-foot mound is created above the current groundwater elevation at the WWTF site and at Site #1. This mounding will increase the average elevation of Goose Pond located north of the WWTF site by 1-foot. This is within the natural water level fluctuations observed for this pond.

The following observations are made from the results of this scenario with Indian Hill well pumping (Figure 4).

- The particle tracks are very similar for this model run as for the run illustrated in Figure 3, except that many particle tracks are captured by the Indian Hill Well.
- The mounding at the WWTF site is reduced by approximately 1-foot compared with Figure 3, and the elevation of Goose Pond does not appear to be affected.
- Approximately 5-feet of drawdown occurs at Indian Hill Well, which lowers the elevation of several ponds in the vicinity of Indian Hill Well.

The following observations are made from the results of the landfill particle tracks for this scenario (Figure 5):

- The particle tracks are pushed further to the east as compared with the existing conditions (Figure 2) now entering the upper portion of the Bucks Creek / Sulphur Springs system.
- The landfill particle tracks do not flow to Indian Hill Well.

In summary, this modeling indicates that the landfill plume would be shifted to the east but it would not flow to Indian Hill Well or to any other water supply under the C1 effluent recharge scenario.

3. Scenario C2. Scenario C2 is the alternative of 0.4 mgd effluent recharge at the existing WWTF beds and 1.1 mgd effluent recharge at Site #1. As depicted in Figures 6, 7 and 8, this scenario has very similar particle tracks for the effluent and the landfill plume, and has very similar groundwater elevation changes as Scenario C1 (Figures 3, 4, and 5).

4. Scenario C3. Scenario C3 is the alternative of 0.6 mgd effluent recharge at the existing WWTF beds and 0.9 mgd effluent recharge at Site #2 through subsurface leaching facilities. The following observations are made from the results of this scenario (Figures 9, 10 and 11):

   - More effluent particle tracks are pushed to the east as compared to scenarios C1 or C2.
   - The landfill plume becomes squeezed between the effluent recharge at the WWTF beds and the effluent recharge at Site #2.
   - Similar to the existing conditions, the landfill particle tracks flow toward the lower portion of Bucks Creek and Nantucket Sound.

Conclusions and Summary

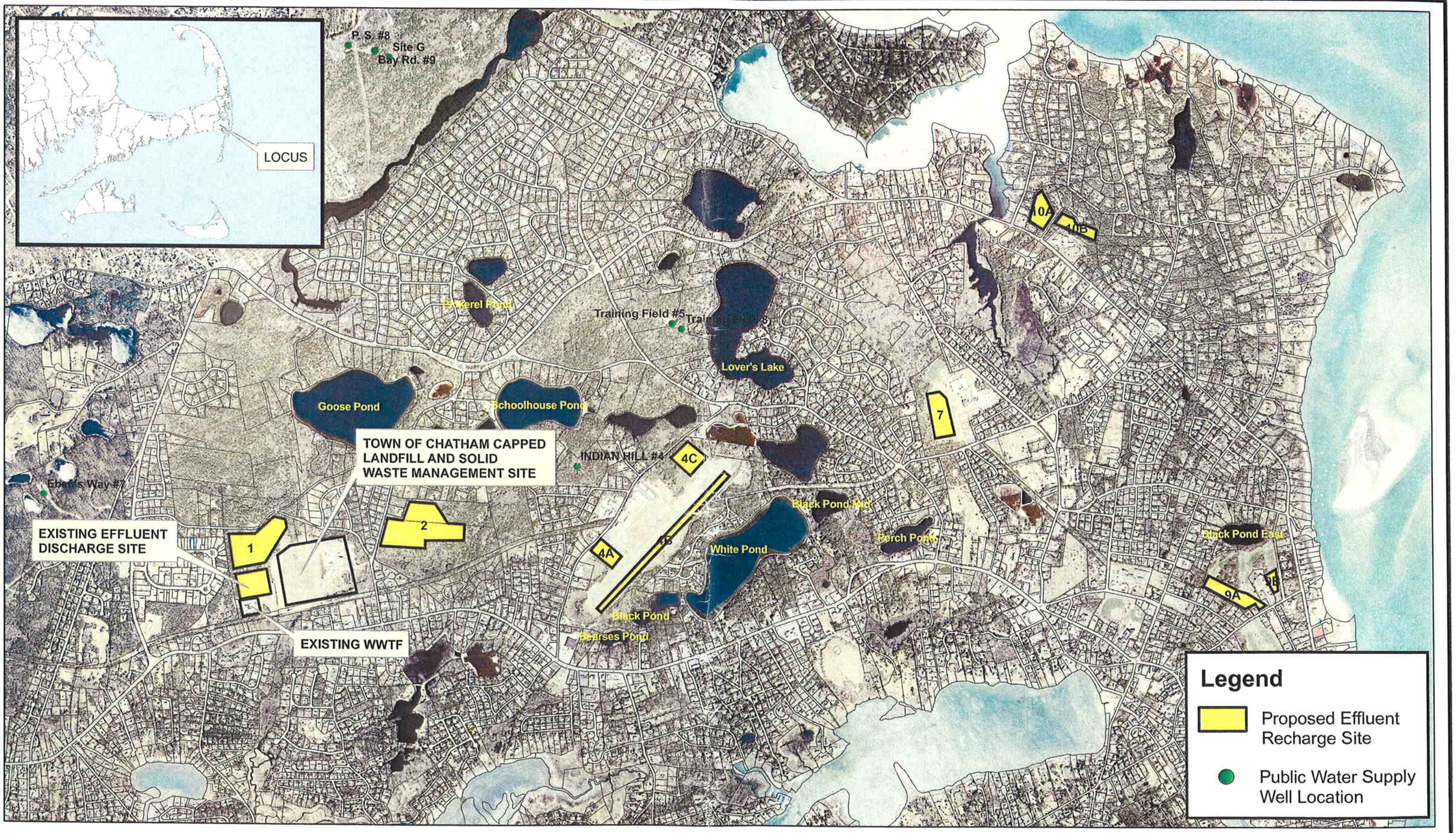
The modeling to date indicates that the modeled effluent recharge flows at the existing WWTF, Site #1, and Site #2, do not result in the capture of any landfill plume by Indian Hill Well.

Additional effluent recharge modeling has been initiated for Site Nos. 4, 7, 9 and 10 as illustrated on Figure 1. These recharge alternatives are not expected to have any effect on the landfill plume.

The modeling results presented here support the conclusion that, under three likely effluent recharge scenarios, a plume originating from the capped landfill will not impact Indian Hill well, or any other municipal supply well. Please review these findings and inform Robert A. Duncanson, Ph.D., Chatham Director of Health and the Environment, or Stearns & Wheler, if you have concerns on this issue, or you believe additional modeling or evaluation is needed.

Additional effluent modeling will continue as part of the CWMP to find the most suitable and cost effective treated effluent recharge site. We hope to complete the modeling by October 2005, which is the planned completion date of the free modeling services. The findings of the USGS modeling services will be summarized in the Comprehensive Wastewater Management Plan and Environmental Impact Report.

We look forward to receiving your comments on this Technical Memo and the resolution of this landfill plume issue. If you do not concur with the findings as summarized in this technical memorandum, we will need your comments by mid August so that we can complete additional modeling to address those comments.



Data Source: Mass GIS .5 meter Orthophoto (2001)

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FIGURE 1

POTENTIAL EFFLUENT RECHARGE SITES

TOWN OF CHATHAM CWMP

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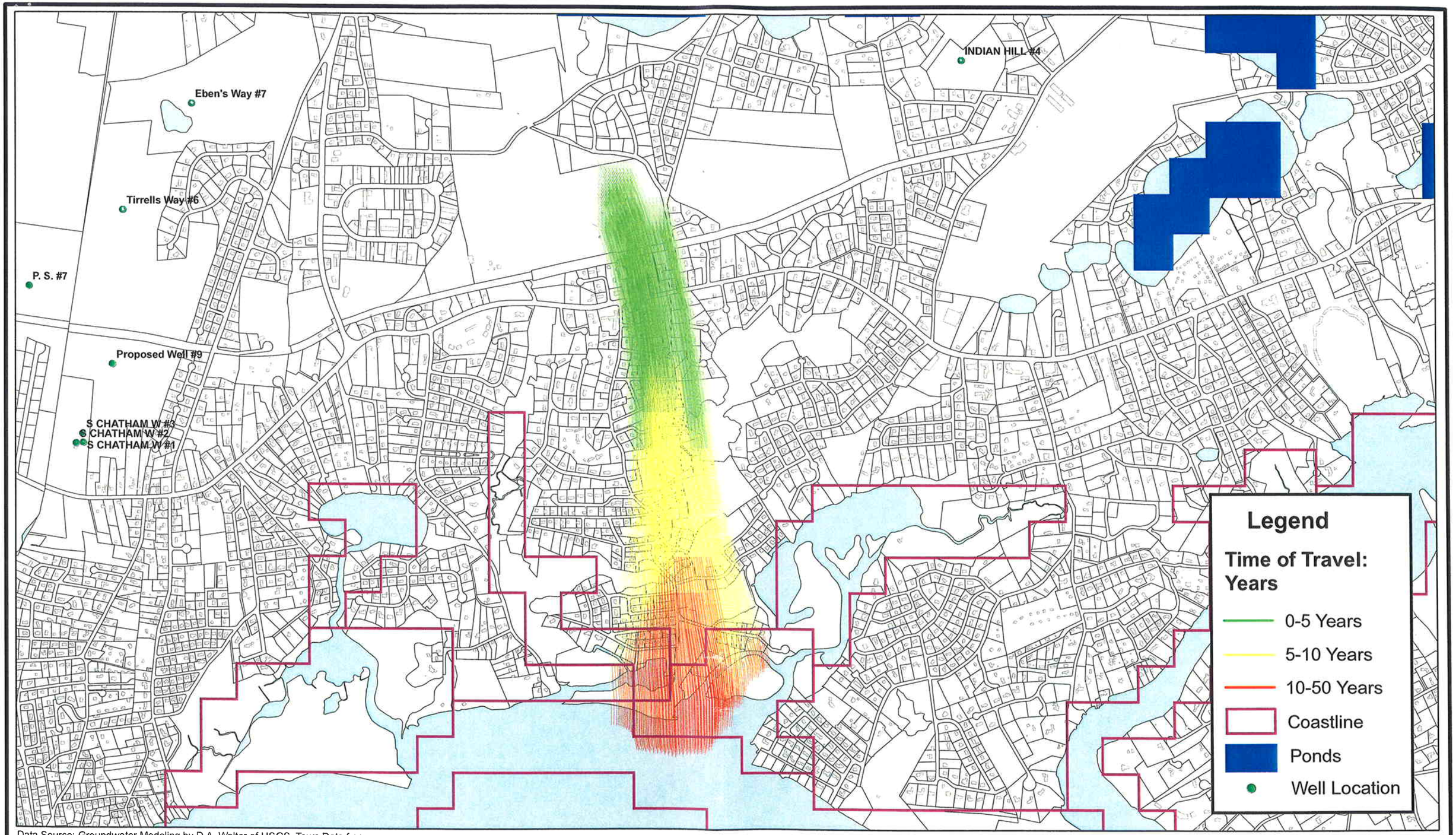

Data Source: Groundwater Modeling by D.A. Walter of USGS. Town Data from Town of Chatham GIS Department.

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Scale: 1 inch = 1000'

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FIGURE 2

PARTICLE TRACKS FROM CHATHAM LANDFILL FOR EXISTING CONDITIONS

TOWN OF CHATHAM CWMP

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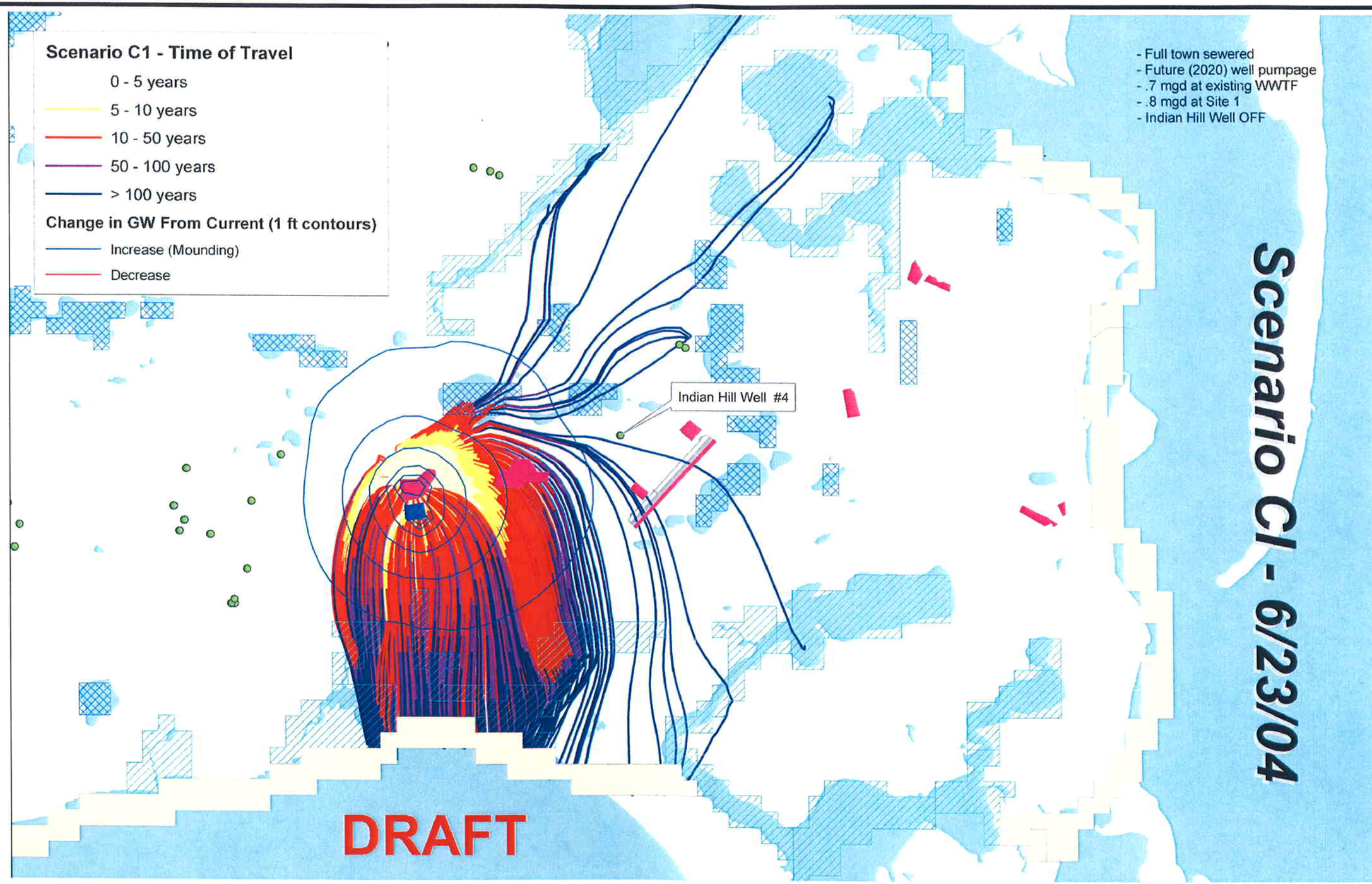

Data Source: Groundwater Modeling by D.A. Walter of USGS. GIS Map Produced by Cape Cod Commision.

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FIGURE 3
SCENARIO C1: EFFLUENT PARTICLE TRACKS WITH INDIAN HILL WELL NOT PUMPING
TOWN OF CHATHAM CWMP

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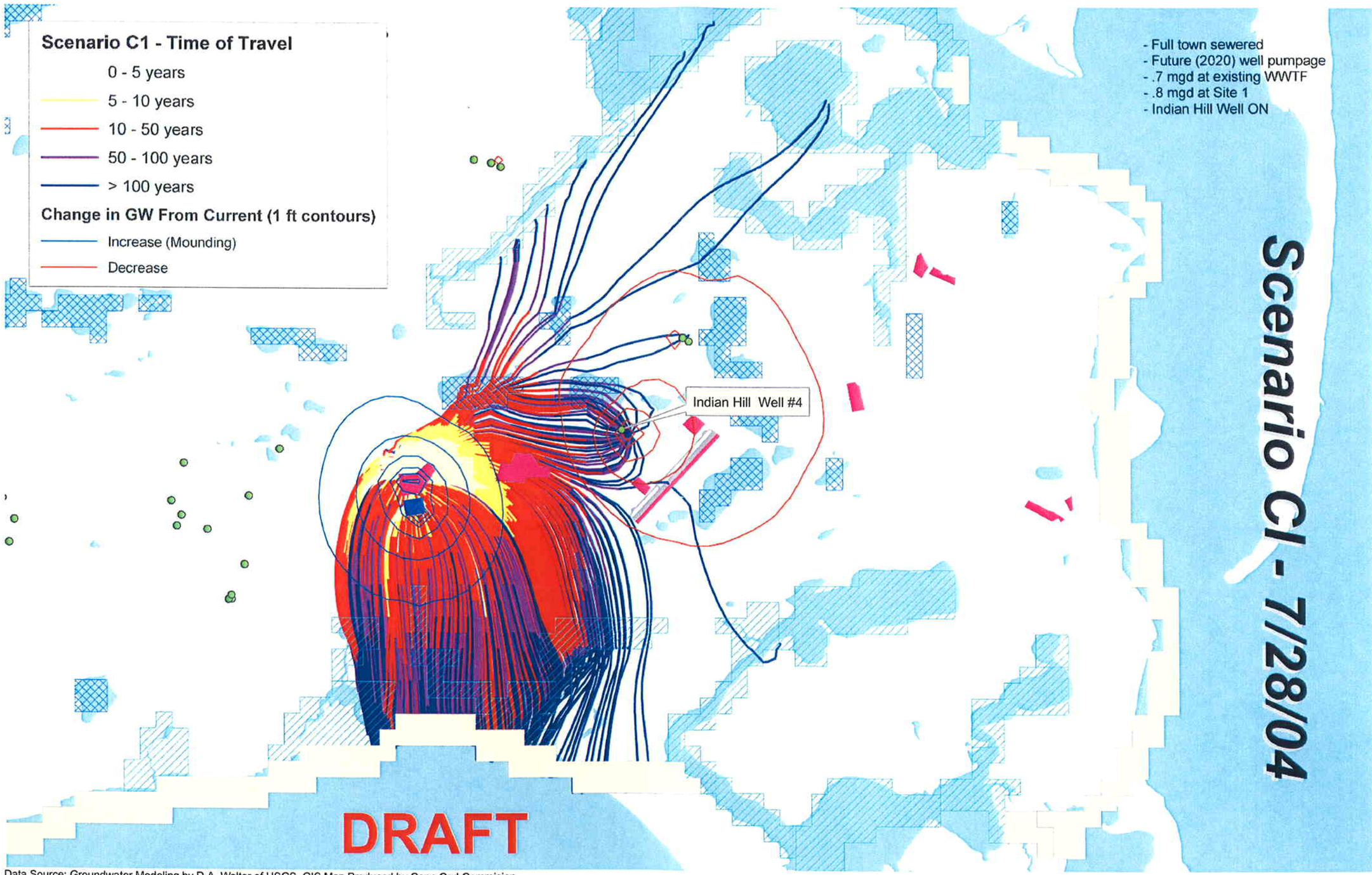

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FIGURE 4

SCENARIO C1: EFFLUENT PARTICLE TRACKS WITH INDIAN HILL WELL PUMPING

TOWN OF CHATHAM CWMP

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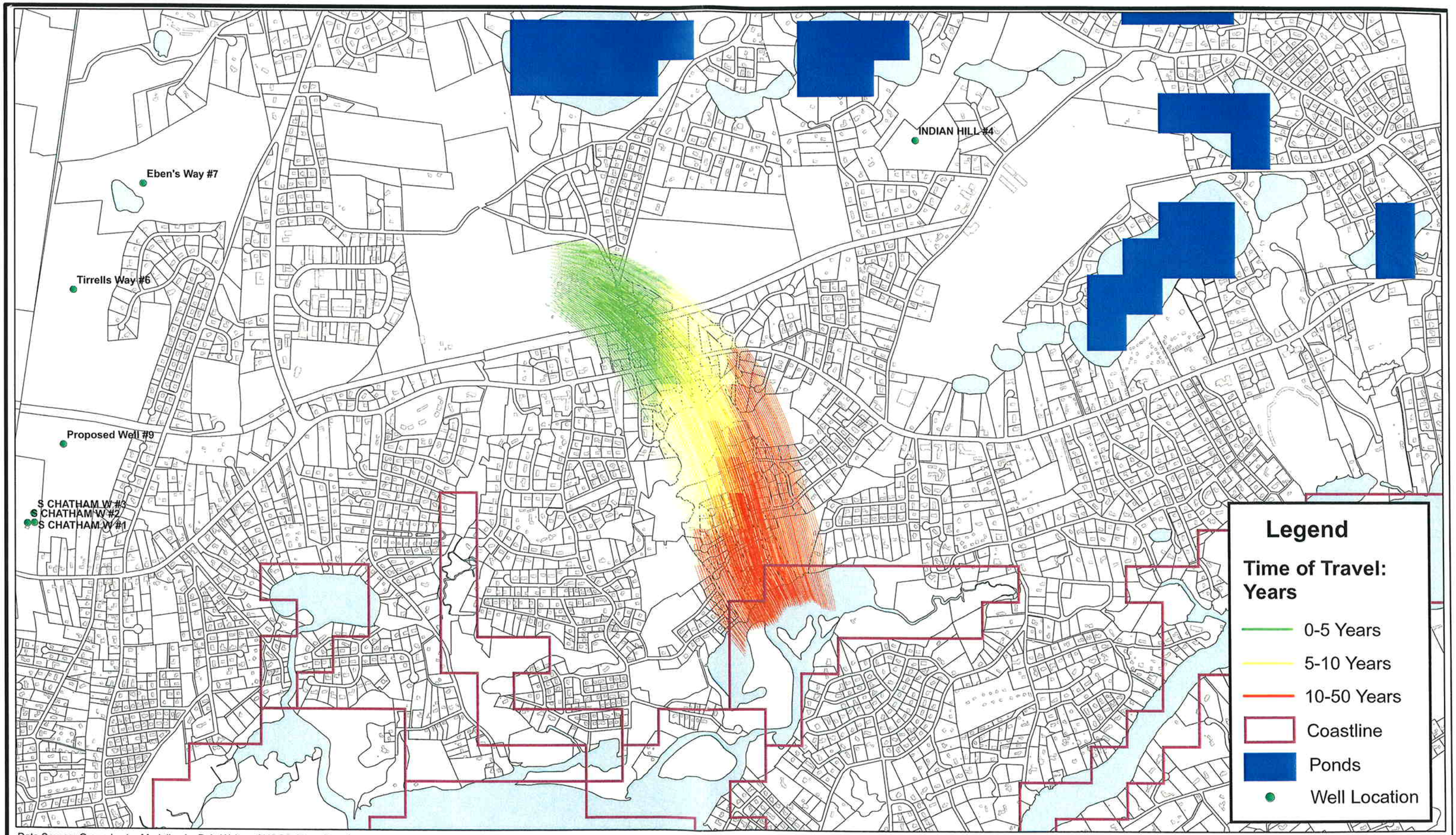

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FIGURE 5

SCENARIO C1: LANDFILL PARTICLE TRACKS WITH INDIAN HILL WELL PUMPING

TOWN OF CHATHAM CWMP

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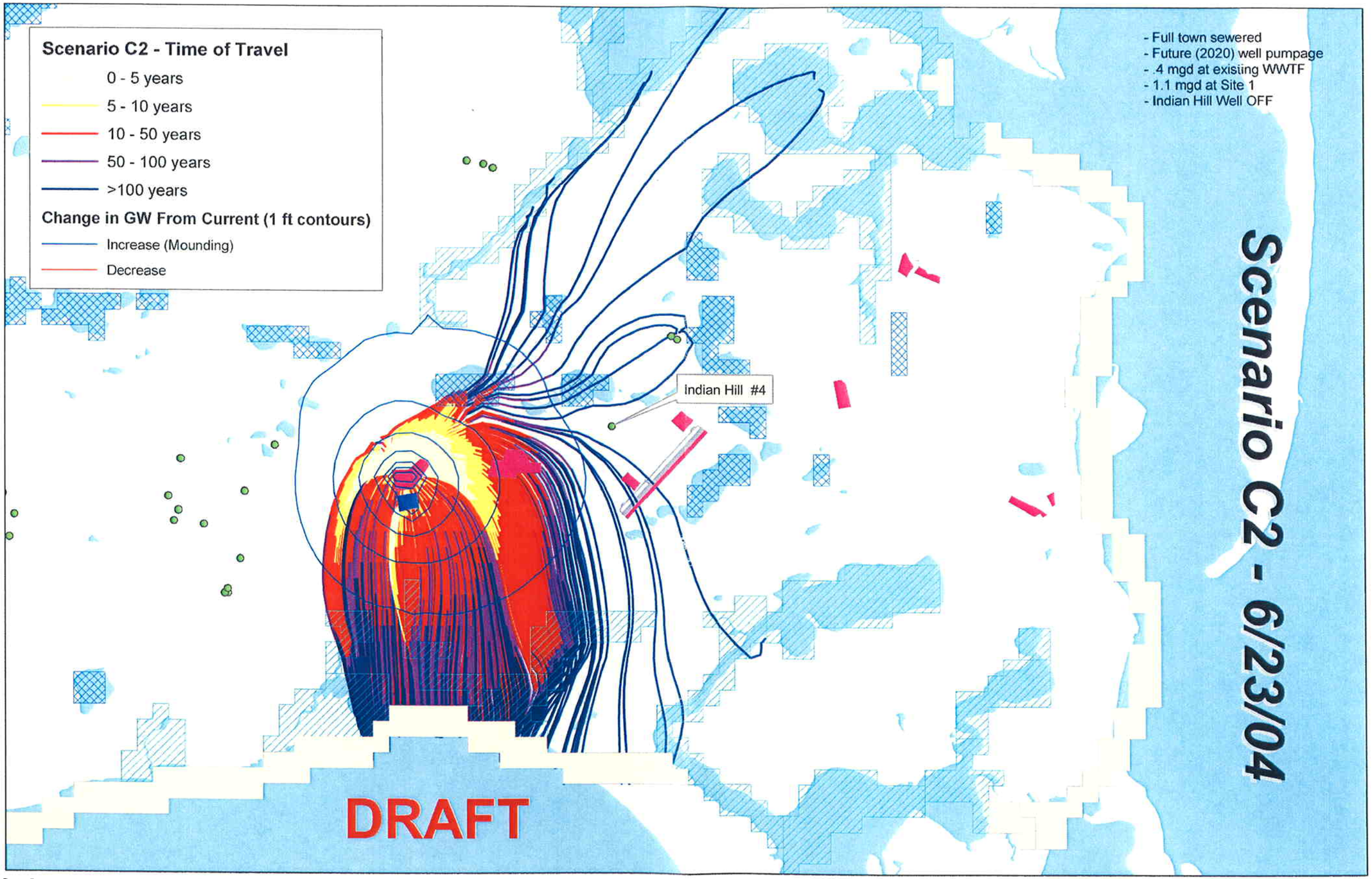

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FIGURE 6

SCENARIO C2: EFFLUENT PARTICLE TRACKS WITH INDIAN HILL WELL NOT PUMPING

TOWN OF CHATHAM CWMP

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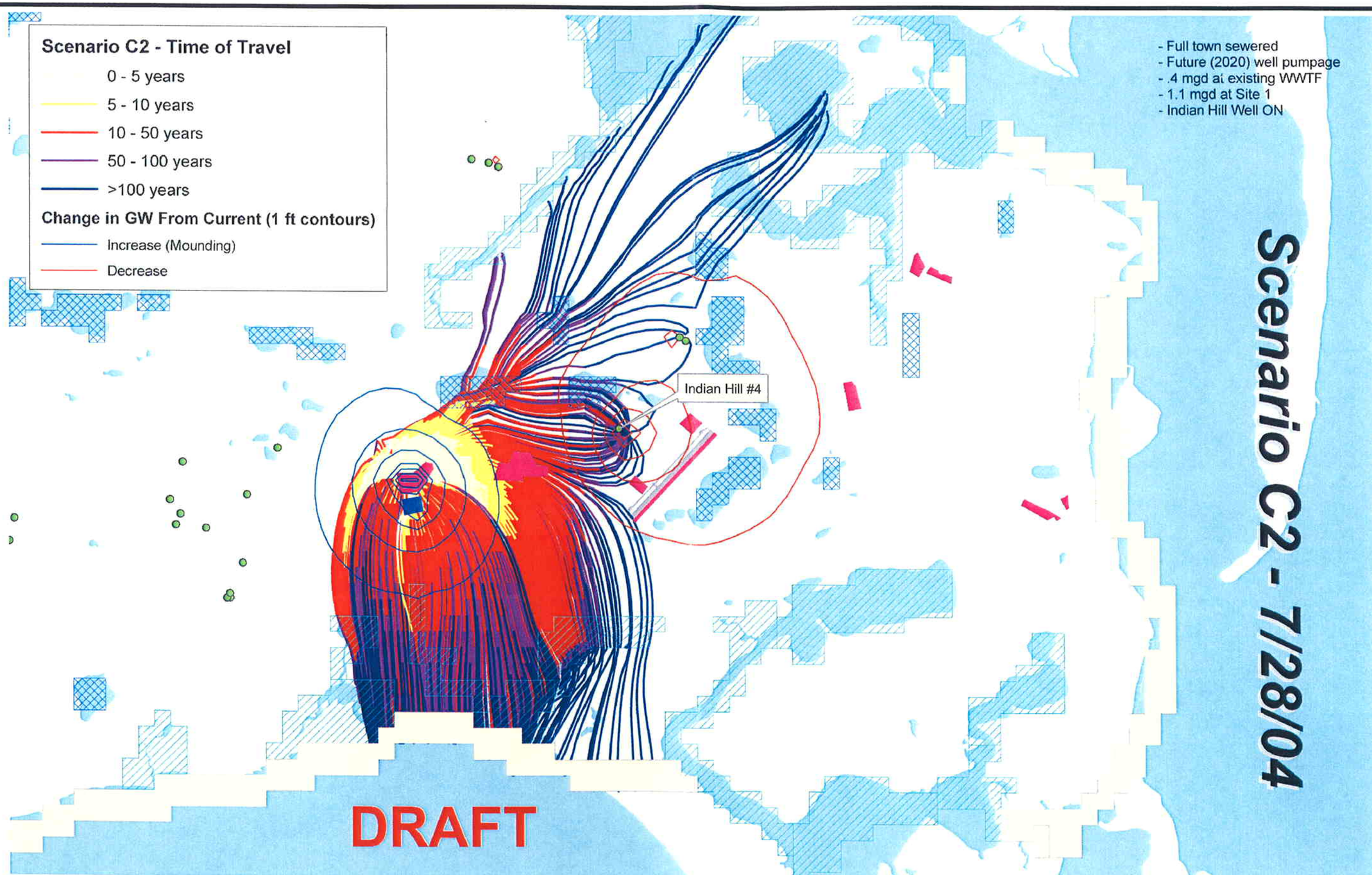

Data Source: Groundwater Modeling by D.A. Walter of USGS. GIS Map Produced by Cape Cod Commision.

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FIGURE 7
SCENARIO C2: EFFLUENT PARTICLE TRACKS WITH INDIAN HILL WELL PUMPING
TOWN OF CHATHAM CWMP

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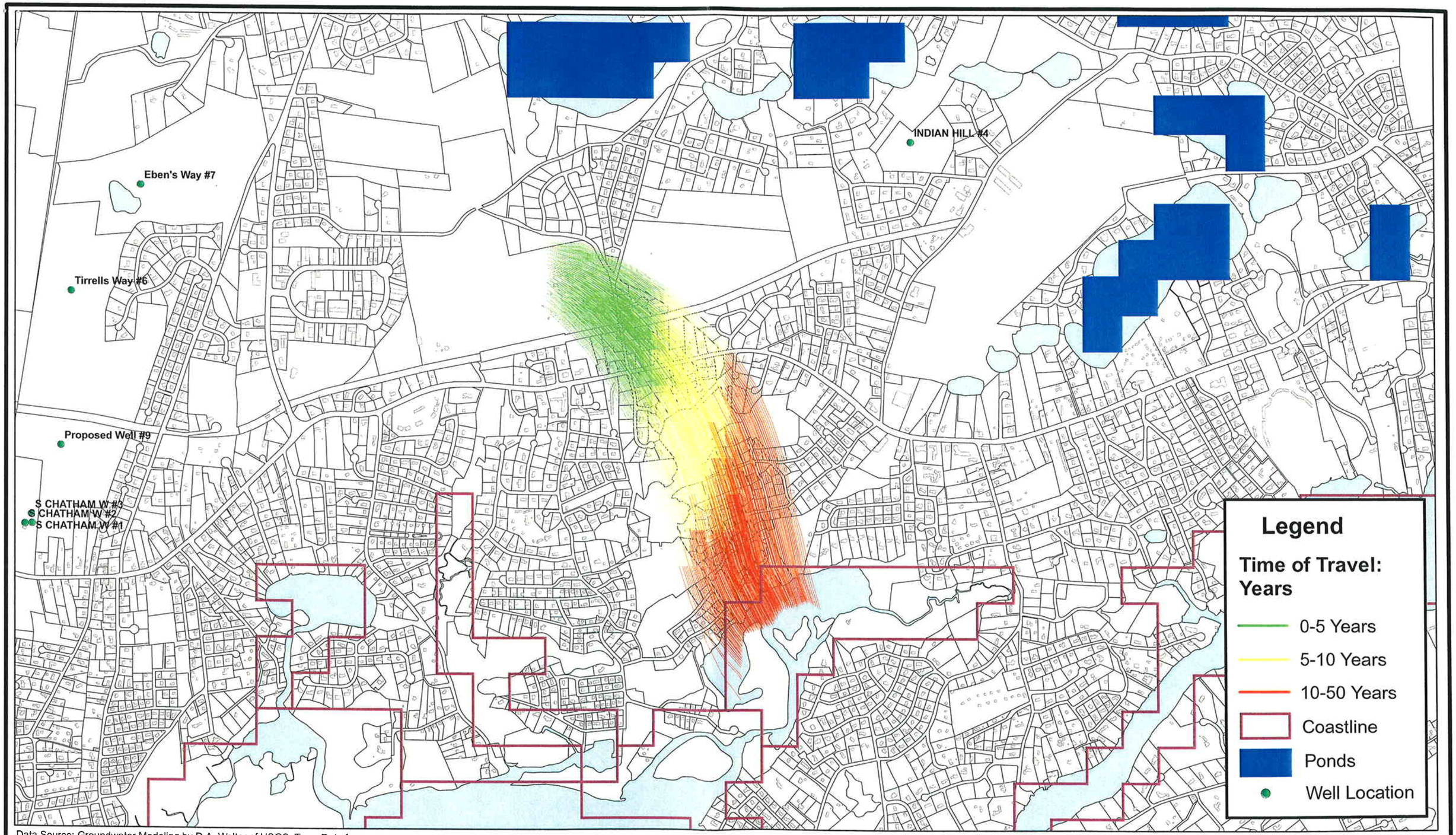

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Scale: 1 inch = 1000'

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FIGURE 8

SCENARIO C2: LANDFILL PARTICLE TRACKS WITH INDIAN HILL WELL PUMPING

TOWN OF CHATHAM CWMP

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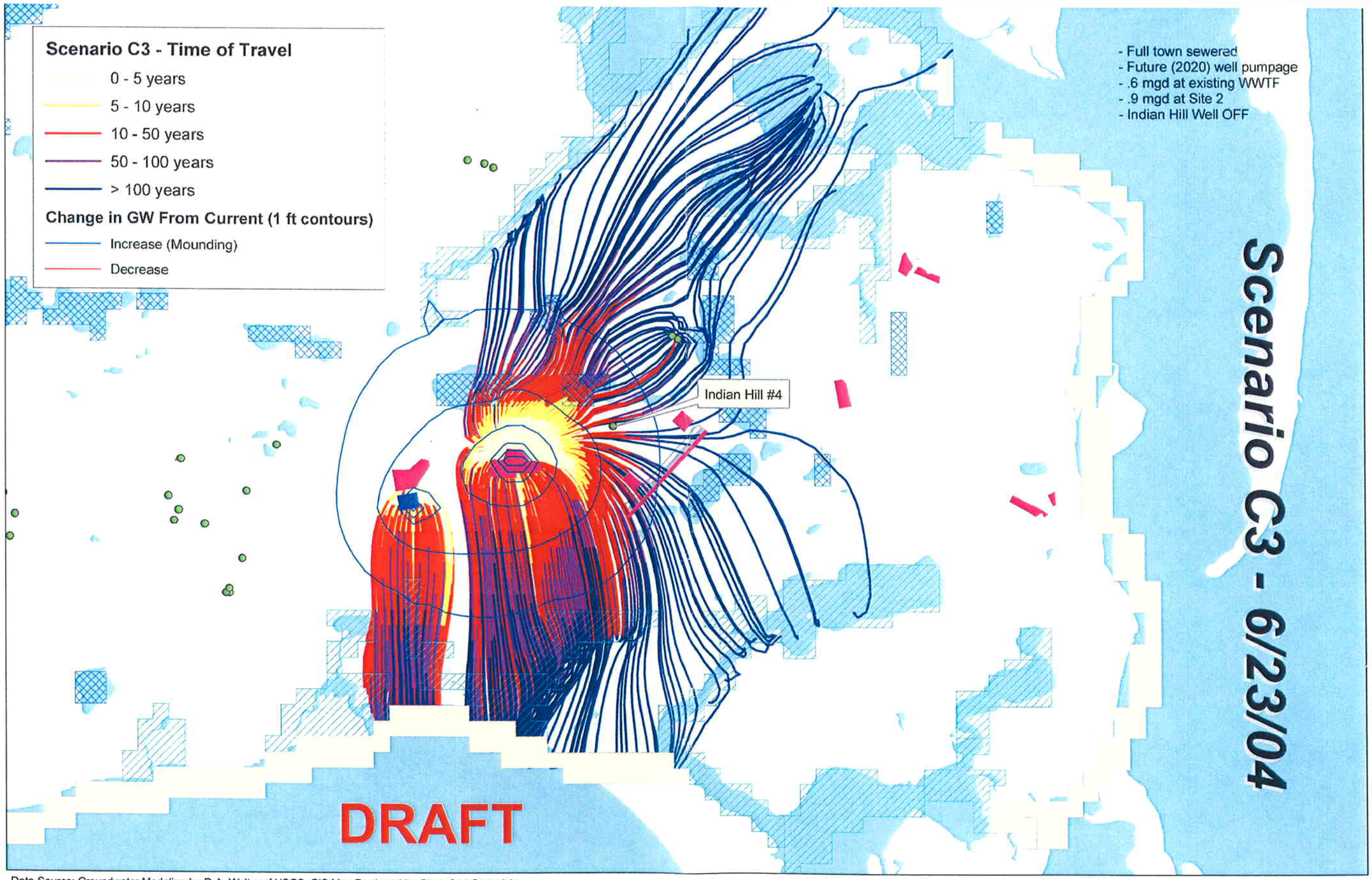

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FIGURE 9

SCENARIO C3: EFFLUENT PARTICLE TRACKS WITH INDIAN HILL WELL NOT PUMPING

TOWN OF CHATHAM CWMP

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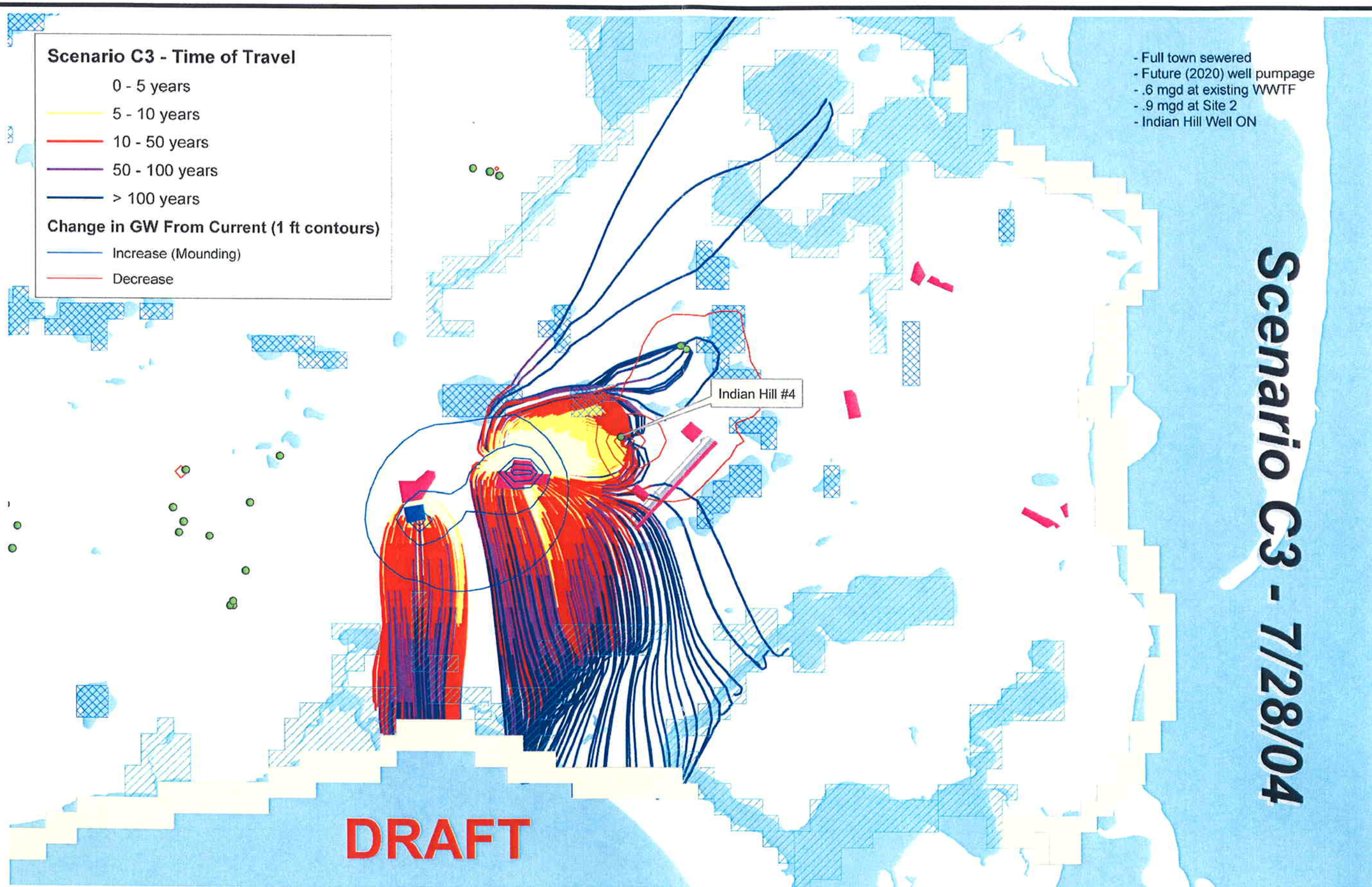

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FIGURE 10

SCENARIO C3: EFFLUENT PARTICLE TRACKS WITH INDIAN HILL WELL PUMPING

TOWN OF CHATHAM CWMP

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FIGURE 11

SCENARIO C3: LANDFILL PARTICLE TRACKS WITH INDIAN HILL WELL PUMPING

TOWN OF CHATHAM CWMP

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