Chemical Storage & Contamination

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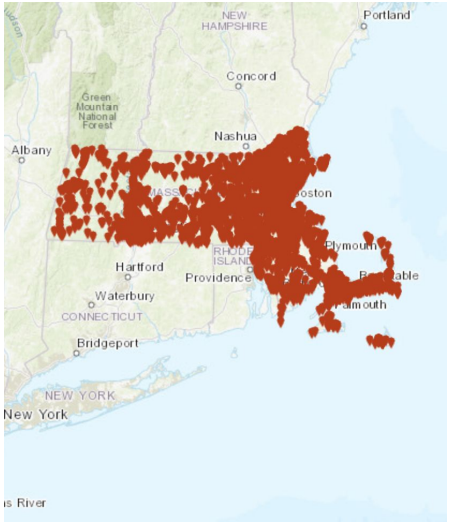
The Problem


NEW HAMPSHIRE
Portland
Concord
Green Mountain National Forest
Nashua
Albany
Boston
Plymouth
Hartford
Providence
Waterbury
CONNECTICUT
Bridgeport
NEW YORK
New York


DANGER
CHEMICAL SPILL
NO ENTRY


CAUTION
CHEMICAL
STORAGE AREA

The Problem

- Bhopal Disaster in India → led to the passage of the 1986 Emergency Planning and Community Right-to-Know Act.

- Love Canal (1978)
  - Brief History
    - 1940s/50s → Hooker Chemical Corporations
  - Cause and Effect
  - EPA Involvement
  - Today: Impacts of the Love Canal
    - “Many residents in the area, which was deemed safe by authorities, claim to be facing health problems” (2018, PBS)

The Problem

- Hazardous Materials Processing regulation (527 CMR 33)
  - Implementation and Reasoning
    - Fire and explosion in Danvers, MA (2006)
      - CSB Investigation and Recommendation
    - Middleton Chemical Plant Explosion, MA (2005)
- Conservation Law Foundation vs. Exxon (Mystic River)
  - Failing to protect fuel storage tank farm from climate change

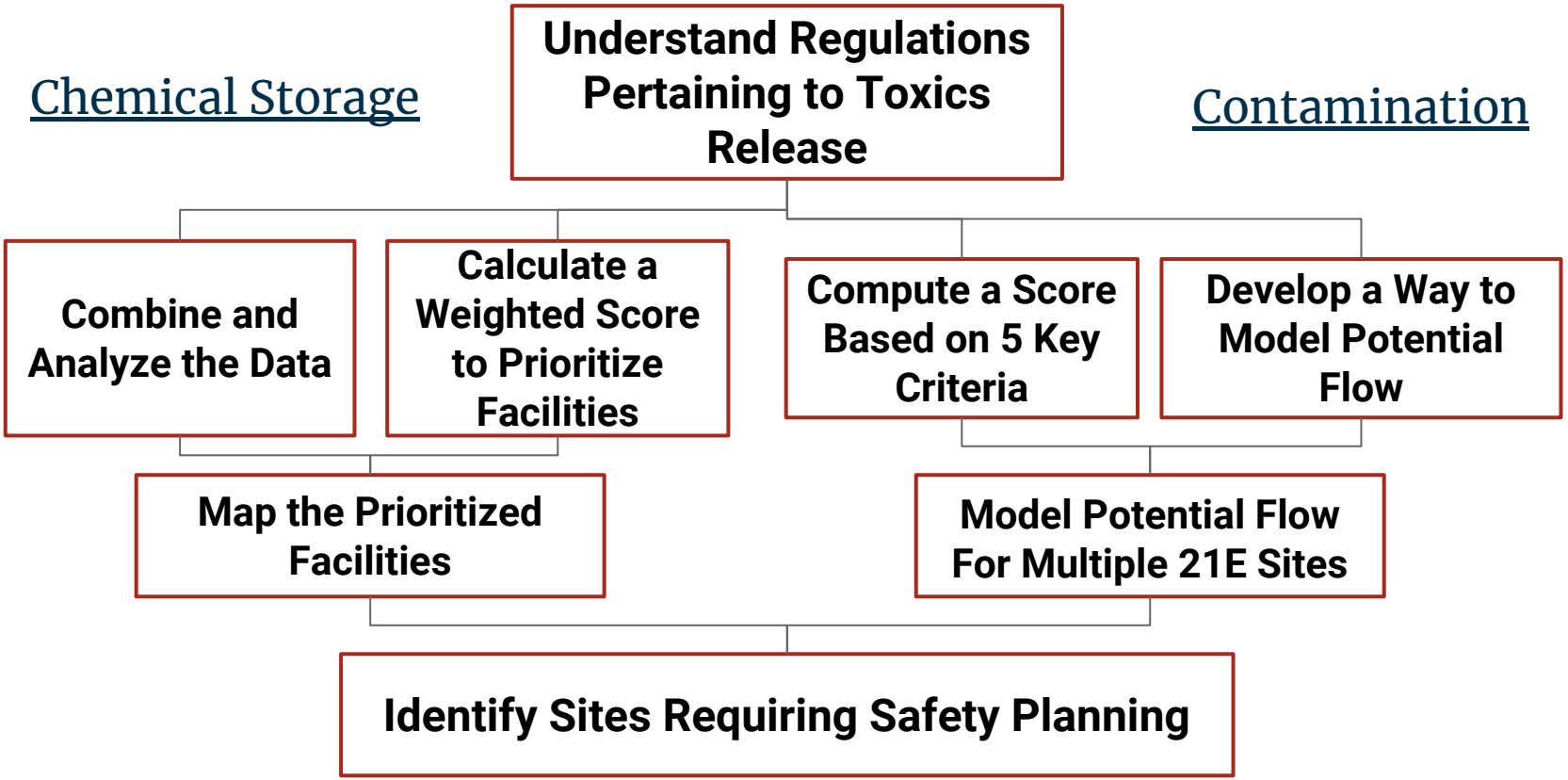
Objectives

~ Ranking facilities will help prioritize emergency preparedness efforts

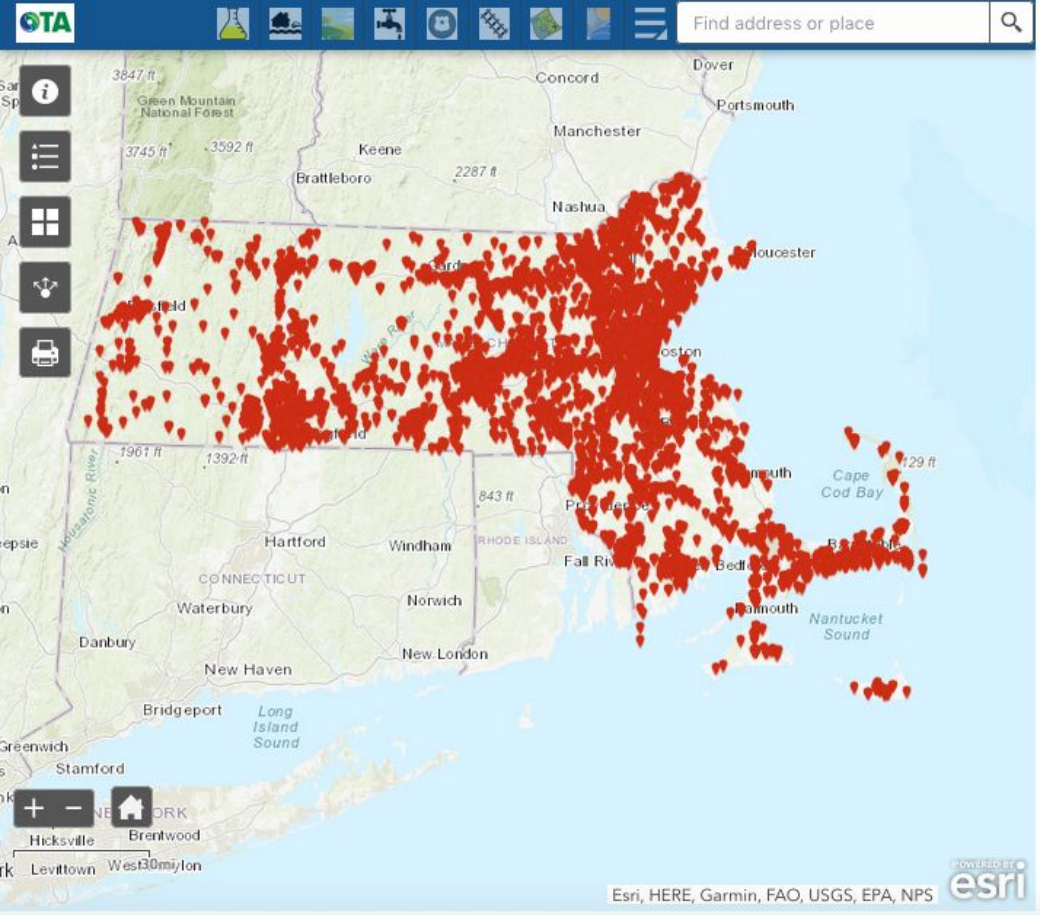
~ We can utilize maps and flow models to prevent dangerous contamination

~ Watershed associations, fire departments, and planning agencies can use these tools to better design safety planning

Strategy


Chemical Storage
Understand Regulations Pertaining to Toxics Release
Contamination
Combine and Analyze the Data
Calculate a Weighted Score to Prioritize Facilities
Compute a Score Based on 5 Key Criteria
Develop a Way to Model Potential Flow
Map the Prioritized Facilities
Model Potential Flow For Multiple 21E Sites
Identify Sites Requiring Safety Planning

Chemical Storage



Red dots = Tier II facilities

<u>Data Included</u>
Environmental Justice Boundaries
Sites with chemicals (Chapter 21E, Tier II, etc.)
Administrative boundaries

https://mass-eoeea.maps.arcgis.com/apps/webappviewer/index.html?id=485fe2bea40f49d3944a58ed368a7b4d

Map of Massachusetts Toxics Users and Vulnerability Climate Factors

Explanation of the Data

EPA List of Lists

- CERCLA RQ
- EPCRA:
  - EHS Section 304 RQ
  - Section 313

(taken from epa.gov)

Both include:

1. Type of chemical

2. CAS Code

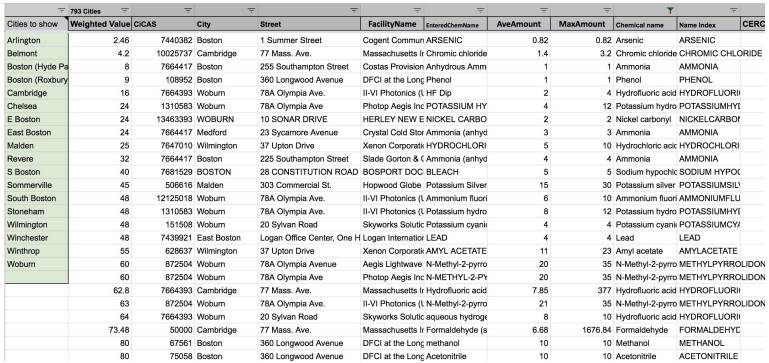
Tier II Data

- Facilities
- Street Address
- Average Quantity

(from Tiffany Skogstrom)

Devising a scoring system

- Combined data by matching chemical information with the City data using the CAS code



793 Cities										
Cities to show	Weighted Value	CiCAS	City	Street	FacilityName	EnteredChemName	AveAmount	MaxAmount	Chemical name	Name Index	CERC
Arlington	2.46	7440382	Boston	1 Summer Street	Cogent Commun	ARSENIC	0.82	0.82	Arsenic	ARSENIC	
Belmont	4.2	10025737	Cambridge	77 Mass. Ave.	Massachusetts Ir	Chromic chloride	1.4	3.2	Chromic chloride	CHROMIC CHLORIDE	
Boston (Hyde Pa	8	7664417	Boston	255 Southampton Street	Costas Provision	Anhydrous Amm	1	1	Ammonia	AMMONIA	
Boston (Roxbury	9	108952	Boston	360 Longwood Avenue	DFCI at the Long	Phenol	1	1	Phenol	PHENOL	
Cambridge	16	7664393	Woburn	78A Olympia Ave.	II-VI Photonics (U	HF Dip	2	4	Hydrofluoric acid	HYDROFLUORI	
Chelsea	24	1310583	Woburn	78A Olympia Ave	Photop Aegis Inc	POTASSIUM HY	4	12	Potassium hydro	POTASSIUMHYI	
E Boston	24	13463393	WOBURN	10 SONAR DRIVE	HERLEY NEW E	NICKEL CARBO	2	2	Nickel carbonyl	NICKELCARBOI	
East Boston	24	7664417	Medford	23 Sycamore Avenue	Crystal Cold Stor	Ammonia (anhyd	3	3	Ammonia	AMMONIA	
Malden	25	7647010	Wilmington	37 Upton Drive	Xenon Corporati	HYDROCHLORI	5	10	Hydrochloric acic	HYDROCHLORI	
Revere	32	7664417	Boston	225 Southampton Street	Slade Gorton & (	Ammonia (anhyd	4	4	Ammonia	AMMONIA	
S Boston	40	7681529	BOSTON	28 CONSTITUTION ROAD	BOSPORT DOC	BLEACH	5	5	Sodium hypochlc	SODIUM HYPOC	
Sommerville	45	506616	Malden	303 Commercial St.	Hopwood Globe	Potassium Silver	15	30	Potassium silver	POTASSIUMSILI	
South Boston	48	12125018	Woburn	78A Olympia Ave.	II-VI Photonics (U	Ammonium fluori	6	10	Ammonium fluori	AMMONIUMFLU	
Stoneham	48	1310583	Woburn	78A Olympia Ave.	II-VI Photonics (U	Potassium hydro	8	12	Potassium hydro	POTASSIUMHYI	
Wilmington	48	151508	Woburn	20 Sylvan Road	Skyworks Solutic	Potassium cyanic	4	4	Potassium cyanic	POTASSIUMCYA	
Winchester	48	7439921	East Boston	Logan Office Center, One H	Logan Internatior	LEAD	4	4	Lead	LEAD	
Winthrop	55	628637	Wilmington	37 Upton Drive	Xenon Corporati	AMYL ACETATE	11	23	Amyl acetate	AMYLACETATE	
Woburn	60	872504	Woburn	78A Olympia Avenue	Aegis Lightwave	N-Methyl-2-pyrro	20	35	N-Methyl-2-pyrro	METHYLPYRROLIDON	
	60	872504	Woburn	78A Olympia Ave	Photop Aegis Inc	N-METHYL-2-PY	20	35	N-Methyl-2-pyrro	METHYLPYRROLIDON	
	62.8	7664393	Cambridge	77 Mass. Ave.	Massachusetts Ir	Hydrofluoric acid	7.85	377	Hydrofluoric acid	HYDROFLUORI	
	63	872504	Woburn	78A Olympia Ave.	II-VI Photonics (U	N-Methyl-2-pyrro	21	35	N-Methyl-2-pyrro	METHYLPYRROLIDON	
	64	7664393	Woburn	20 Sylvan Road	Skyworks Solutic	aqueous hydroge	8	10	Hydrofluoric acid	HYDROFLUORI	
	73.48	50000	Cambridge	77 Mass. Ave.	Massachusetts Ir	Formaldehyde (s	6.68	1676.84	Formaldehyde	FORMALDEHYI	
	80	67561	Boston	360 Longwood Avenue	DFCI at the Long	methanol	10	10	Methanol	METHANOL	
	80	75058	Boston	360 Longwood Avenue	DFCI at the Long	Acetonitrile	10	10	Acetonitrile	ACETONITRILE	

- Give each data point a weighted value:

Final Weight: [Reportable Quantity Weight + 3 if its a 313] * Average Quantity of Chemical

Reportable Quantity	10	100	500	1000	5000	10000
Weighted Value	9	8	7	6	5	3

Devising a scoring system

- Sorted by weighted value and the selected cities within the Mystic River Watershed
- Removed solids that were less likely to be impacted during an emergency

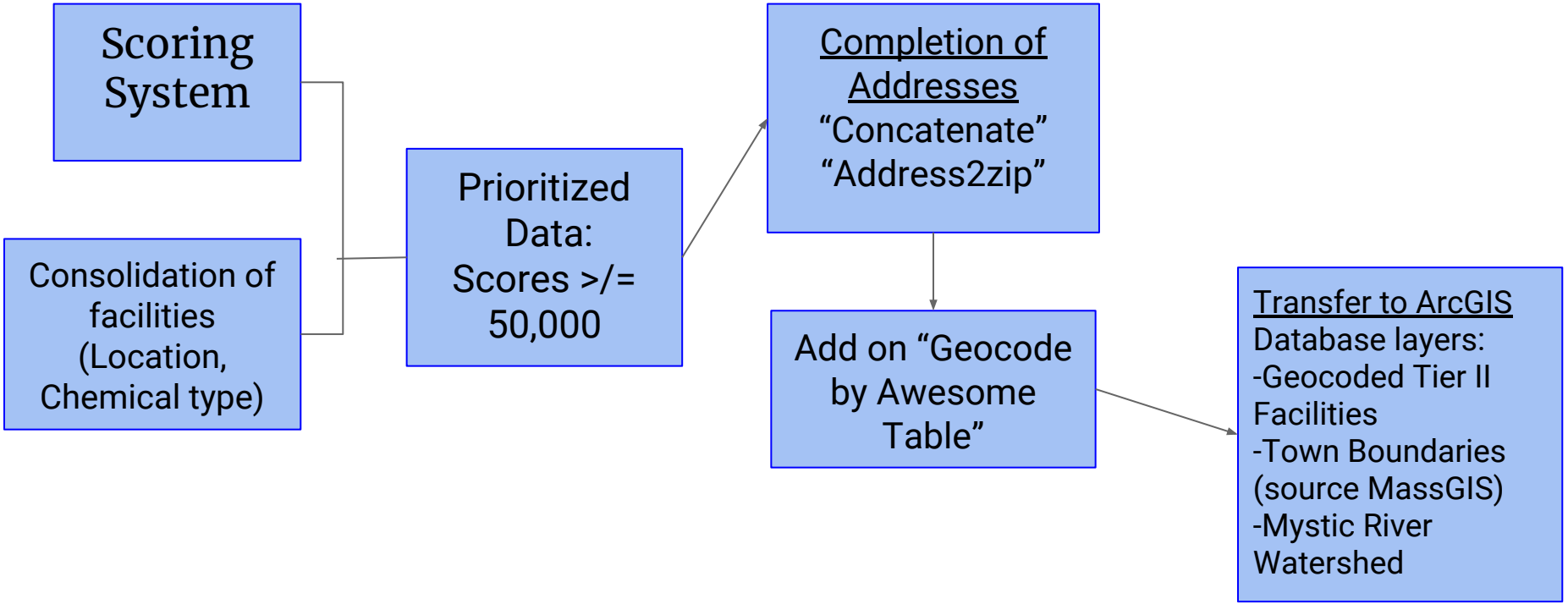
7664417	Revere	135 American Legion Highw	New England Co	Anhydrous Amm	35000	
7664939	Boston	2 Frontage Road	AMTRAK Southa	BATTERIES, WE	40000	
7664939	Cambridge	265 First Street	Kendall Green E	SULFURIC ACID	40005	
4098719	Wilmington	730 Main Street	DSM Coating Re	ISOPHORONE D	36065	
1336216	Cambridge	265 First Street	Kendall Green E	Ammonium Hydr	60348	
7439921	BURLINGTON	12 BLANCHARD BLVD	Burlington Switc	LEAD	30536	
7439921	Everett	69 Norman Street	Duncan Galvaniz	Lead	31000	
7647010	Everett	69 Norman Street	The Duncan Gro	HYDROCHLORI	74968	
7664939	Woburn	485 Wildwood Avenue	Tighe Warehousi	BATTERY ACID	42619	
7439921	Woburn	74 Commerce Way	Woburn, MA PCS	Lead	32400	
1344281	Woburn	316 New Boston St.	New England Re	ALUMINUM OXI	138270	
7439921	Boston	25 Dorchester Avenue	US Postal Servic	Lead	49535	
7439921	BOSTON	28 CONSTITUTION ROAD	BOSPORT DOC	LEAD BATTERIE	50000	
7440666	Everett	69 Norman Street	Duncan Galvaniz	Zinc	700000	
7439921	CAMBRIDGE	250 BENT ST	AT&T - MA3456	LEAD	545153	
30080	Medford	Packard Avenue	Tufts University	Carbon Monoxid	30	
98000	Boston	32A Drydock Ave	Boston Ship Rep	Unleaded gasolir	0	
112243	Woburn	316 New Boston St.	New England Re	Epikure 3234 Cu	475	
641758	Malden	960 Eastern Avenue	Ace-Lon Corpora	Ethyl Alcohol	0	
987655	Boston	45 Gerard Street	Boston HERC - S	Automatic Transr	800	
1317391	Boston	32A Drydock Ave	Boston Ship Rep	Cuprous Oxide	6000	
2494895	Wilmington	25 Industrial Way	Crystal Warehou	Apses	59004	
2634335	Wilmington	25 Industrial Way	Crystal Warehou	IJX 782-1	32454	
5964352	BOSTON	28 CONSTITUTION ROAD	BOSPORT DOC	TILEX CLEANER	5	
7328974	Woburn	316 New Boston St.	New England Re	Epon 1031	1000	
7550358	Cambridge	225 Binney Street	Biogen, Inc. - Ca	Lithium Bromide	11998	

Priority Chemicals

Chemical Name	CERCLA RQ
Ammonium Hydroxide	1000
Aqueous Ammonia	100
Lead acid (battery acid)	10
Chlorine - any forms	10
Cyanide - any forms	1
Hychloric acid	5000
Lead acid (battery acid)	10
Methylethylketone	5000

Chemical Name	CERCLA RQ
Nitric Acid	1000
Phenols	1000
Potassium cyanide	10
Potassium Hydroxide	1000
Sodium Hydroxide	1000
Styrene monomer	100
Sulfuric Acid	1000
Toluene	1000

Geocoding on Google Sheets



Contaminated Sites

Methods - Mapping

Data Layers Used:

1. Elevation and Shaded Relief (MassGIS)
2. Hydrography (MassGIS)
3. Watershed Boundaries (MassGIS)
4. 21 E sites (Katelyn)

Workflow:

1. Used sites to select the watershed boundary
2. Clipped elevation data to watershed boundary
3. Ranked sites based five key attributes to determine how dangerous they are
4. Ran Fill, Flow Direction, and Flow accumulation algorithms on elevation data
5. Created Maps showing flow accumulation for top 5 worst sites

Methods-Mapping

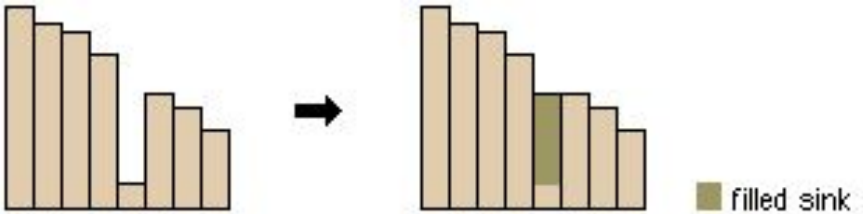
- Score was computed based on 5 attributes
- Each attribute was either a zero or a one
- Room for improvement, coefficients

Open_site + ARS + AEPMM + Critical_Exp_Pathway + Imm_Hazard

0.5*Open_Site + 0.75*ARS + 1.25*AEPMM + 2.0*Critical_Exp_Pathway + 1.2*Imm_Hazard + Other Variables?

Methods-Mapping

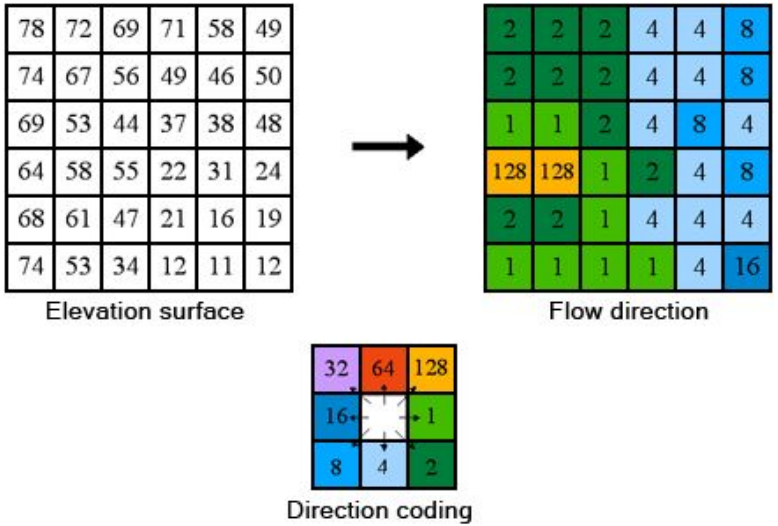
How Fill Works:



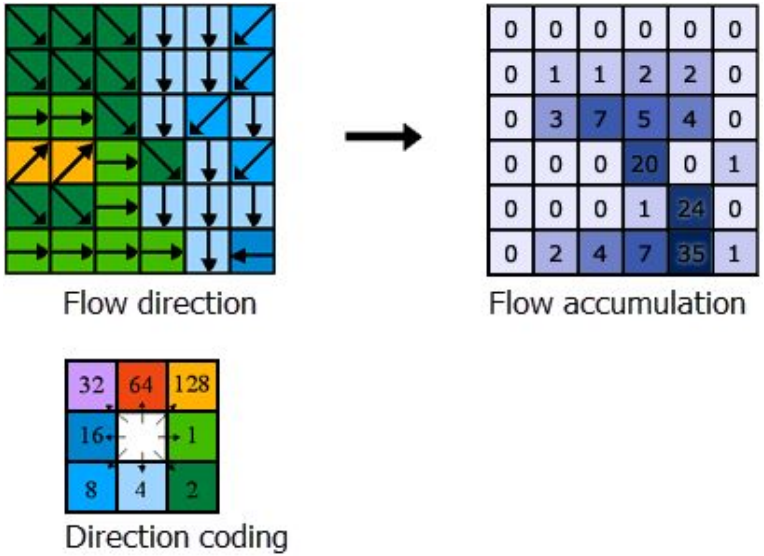
without this nothing will work

Methods-Mapping

How Flow Direction Works:



How Flow Accumulation Works:



Results

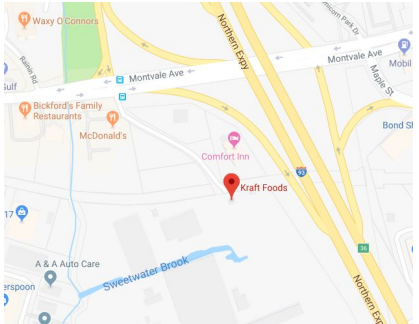
Results- Chemical Storage

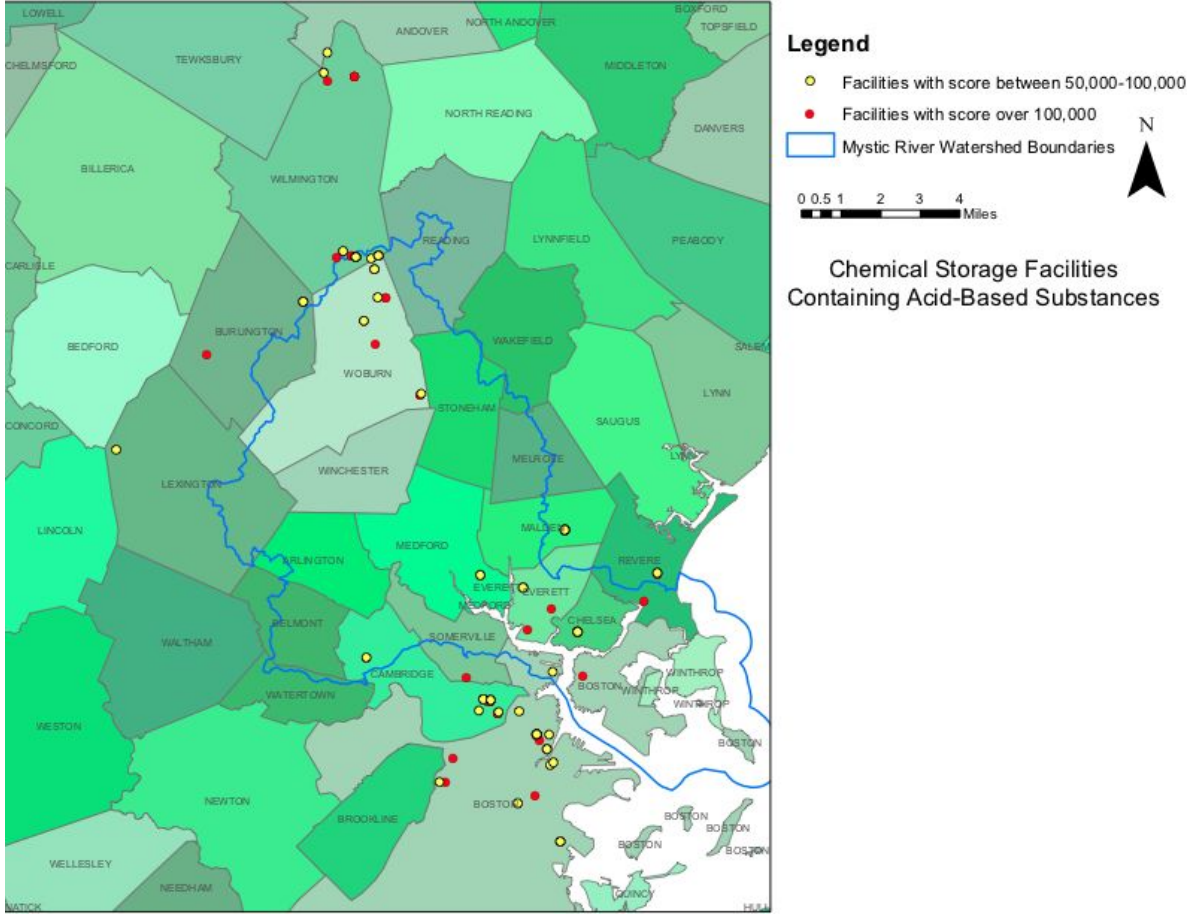
- Chemical Storage Catalogue 1 (scores between 50,000-100,000)
- Chemical Storage Catalogue 2 (scores over 100,000)
- Most common chemical on final list: sulfuric acid, aerosol form (23 facilities)

Marshalls Woburn Distribution Center
Score: 2,228,580
Chemicals: lead, battery acid

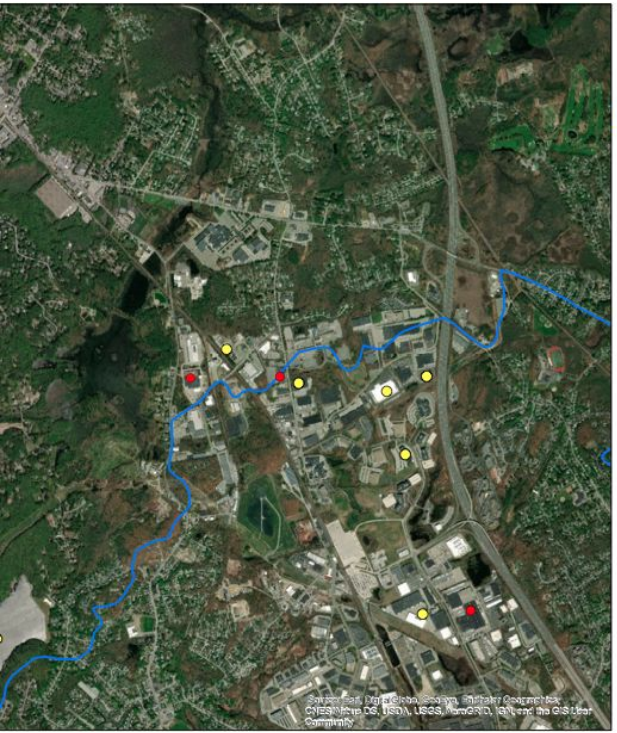
NITCO Materials Handling Solutions
Score: 1,813,020
Chemicals: battery acid

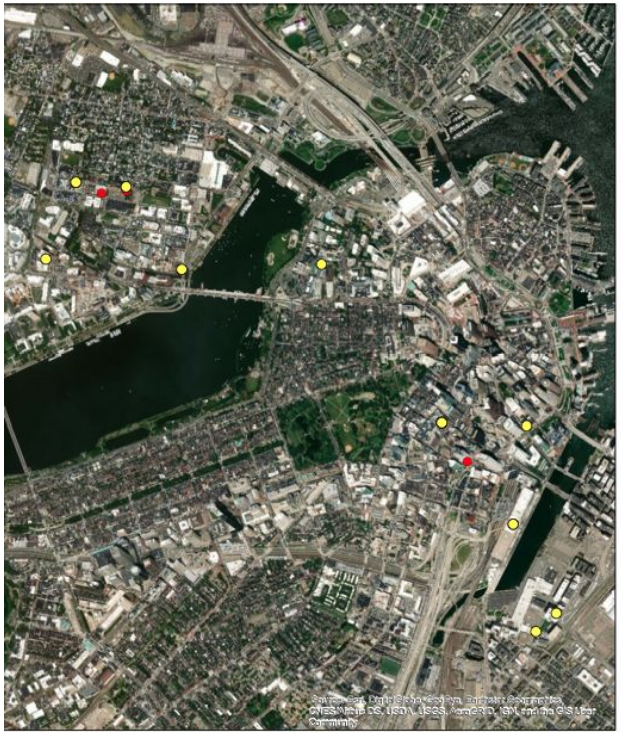
Kraft Heinz Company
Score: 1,291,242
Chemicals: sulfuric acid





Chemical Storage Facilities in Mystic River Watershed

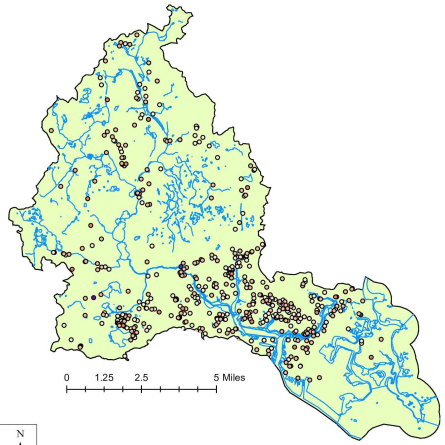




Focused Clusters of Facilities

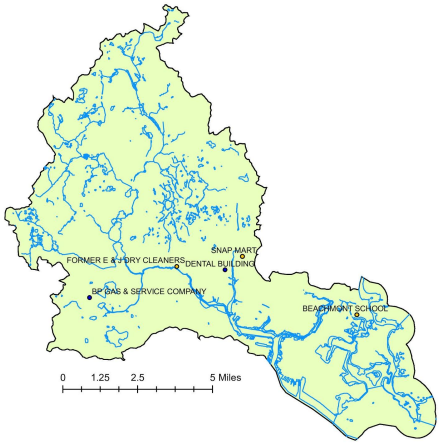
Results-Contamination

21E Sites in the Mystic Watershed



Projection: Lambert Conformal Conic
Map Source: Boston University, March 2019
Shapefile Source: MassGIS Data Layers,
Shapefiles for: Massachusetts
Retrieved March 1, 2019, from MassGIS:
https://www.mass.gov/service-details/massgis-data-layers

Worst 5 Sites in the Mystic Watershed



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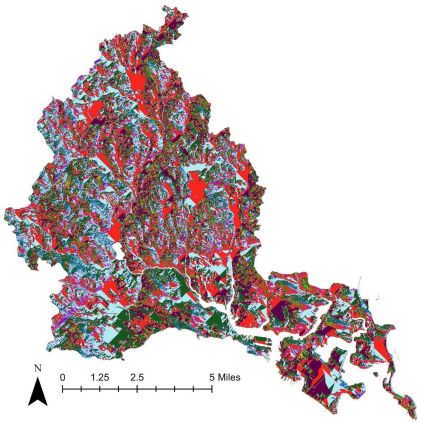
Flow Direction for Mystic Watershed



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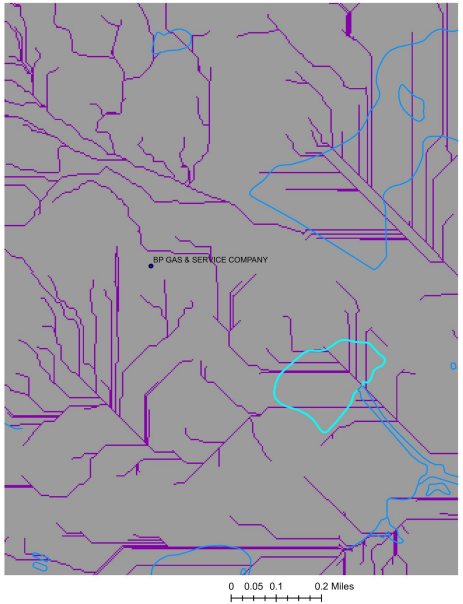
BP Gas

BP Gas Flood Path



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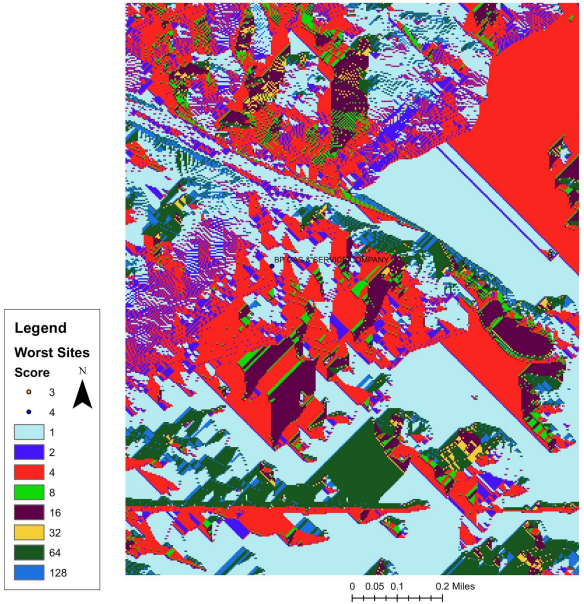
BP Gas Flow Direction



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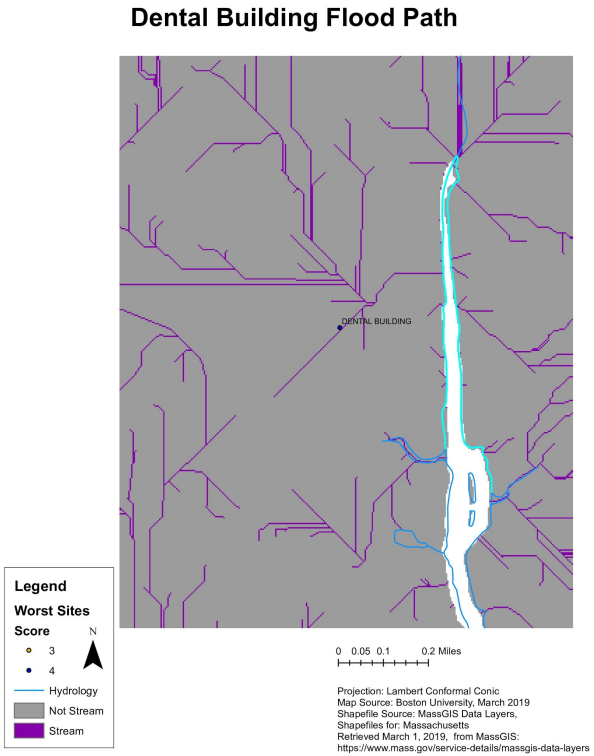
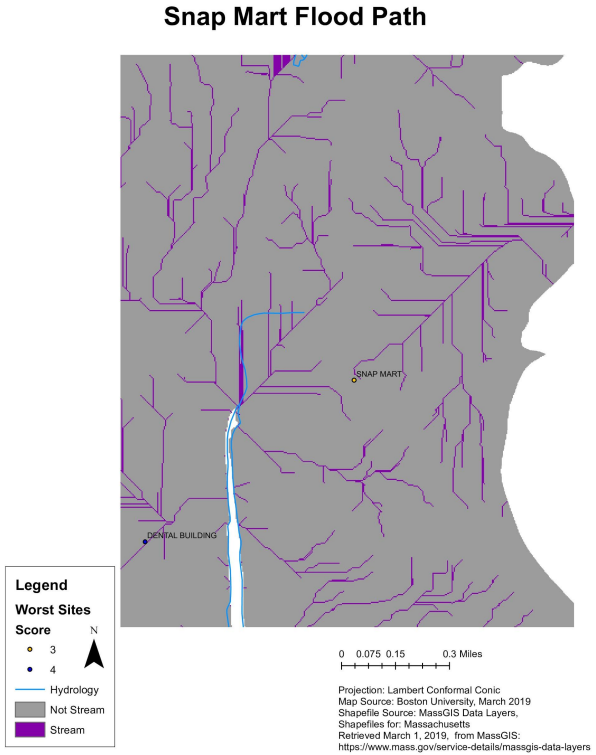
Dental Building



SnapMart


Snap Mart Flood Path
SNAP MART
DENTAL BUILDING
Legend
Worst Sites
Score
3
4
Hydrology
Not Stream
Stream
N
0 0.075 0.15 0.3 Miles
Projection: Lambert Conformal Conic
Map Source: Boston University, March 2019
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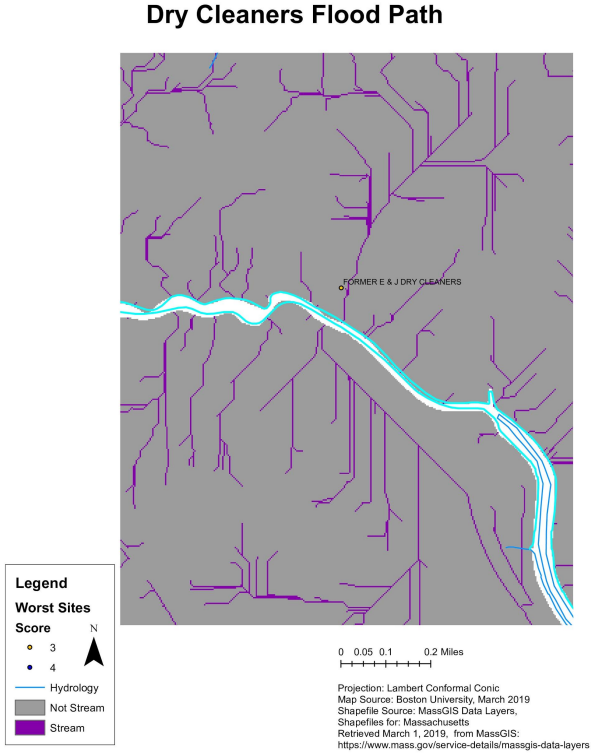
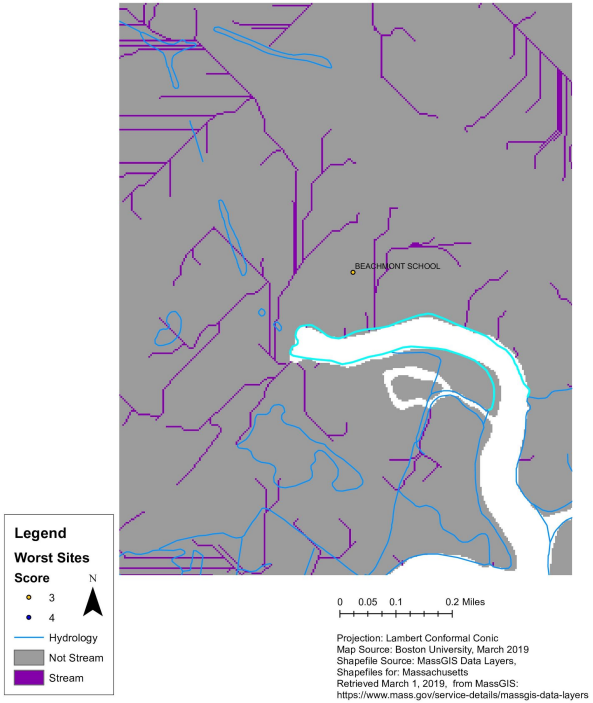
https://www.mass.gov/service-details/massgis-data-layers

Dry Cleaners

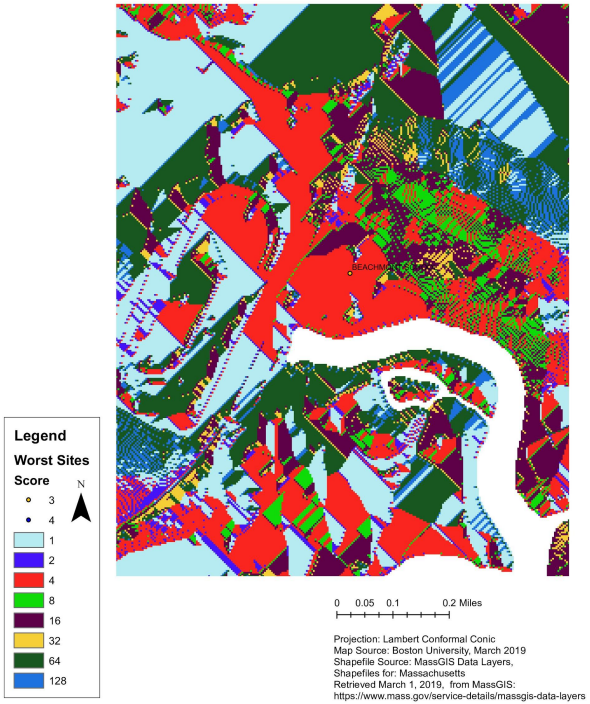


Beaumont School

Beachmont School Flood Path

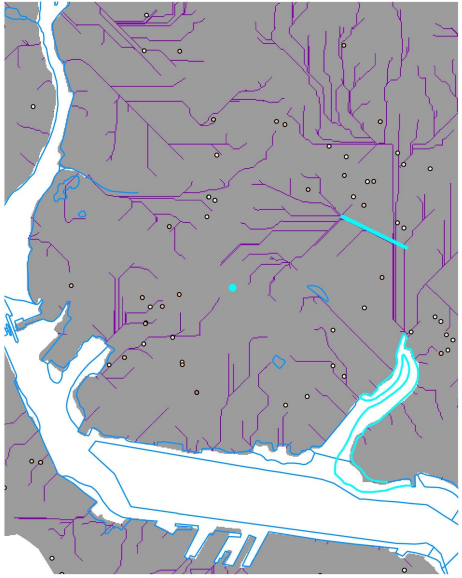


Beachmont School Flow Direction

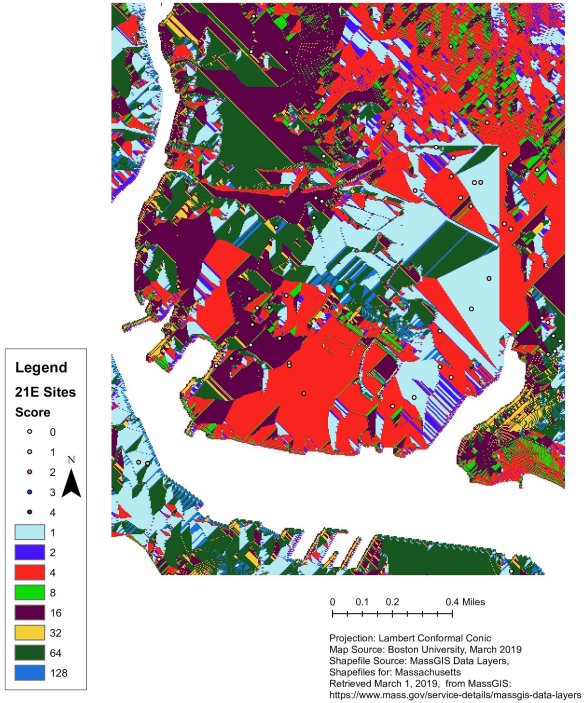


ExxonMobile

ExxonMobile Flood Path



ExxonMobile Flow Direction



Further Goals

Chemical Storage Project

- Refine scoring system
- Explore data without weighted scores (ex. Petroleum, Hydraulic Acid, Propane, Diesel)
- Create prioritized data for other chemicals
- Map prioritized data onto FEMA flooding map → locate facilities in areas vulnerable to flooding

Contamination Project

- Refine Scoring system
- Buffer (200m, 100m, 50m)