Natural Resource Inventory Instructional Manual and Report Template

Town of Manchester, Connecticut

Part 1: Instructional Manual

Introduction to the Instructional Manual Purpose of the Manual The primary purpose of this instructional manual is to provide a standardized, repeatable methodology for conducting a comprehensive Natural Resource Inventory (NRI) for the town of Manchester, Connecticut. An NRI is a systematic collection, organization, and interpretation of information related to the natural and environmental systems within a defined geographic area. These systems include flora, fauna, water resources, soils, geological features, wetlands, forests, and ecological habitats. This manual is intended to function as both a technical guide and a procedural framework for inventory development. It establishes a consistent methodology that can be replicated across municipalities and environmental study areas to ensure scientific reliability, organizational clarity, and long-term usability. The inventory process outlined in this document supports conservation planning, environmental assessment, climate resilience initiatives, land-use decision-making, and sustainable resource management. An NRI serves as an environmental baseline. By documenting existing ecological conditions and spatial relationships, municipalities and environmental organizations can better identify sensitive habitats, evaluate development pressures, prioritize conservation efforts, and support informed planning decisions. In addition to planning applications, NRIs also function as educational resources that improve public understanding of local ecological systems and environmental challenges.

Important Note: Throughout this instruction manual, it is essential to keep in mind that some resources or datasets may not be readily available at the local level at this time. All data suggestions provided are intended as a starting point and may be supplemented or refined as additional information becomes accessible in the future. Flexibility and adaptability are key, and stakeholders should consider this an evolving process that will benefit from ongoing data collection and updates.

Scope of the Manual

This manual outlines the complete Natural Resource Inventory development process. The scope includes:

- Establishing the inventory framework and objectives
- Collecting and organizing GIS-based spatial datasets
- Conducting environmental and ecological classification
- Integrating field observations and scientific literature
- Mapping ecological systems and natural resources
- Developing narrative interpretations of environmental systems
- Preparing foundational inventory documentation and report structure

The procedures outlined in this manual are designed for use by:

- Environmental planners
- Conservation commissions
- Municipal land-use departments
- Conservation officers and land managers

The methodology is adaptable to multiple ecosystem types, including:

- Forest ecosystems
- Wetlands and riparian areas
- Grasslands and agricultural systems
- Watersheds and hydrological systems
- Urban ecological interfaces

This instructional manual is strictly focused on inventory creation and baseline ecological assessment. It does not include advanced GIS modeling, long-term database management systems, regulatory permitting procedures, or highly specialized environmental impact reporting requirements.

Chapter 1: Introduction

1.1 Establishing the Definition of a Natural Resource Inventory

A Natural Resource Inventory (NRI) is a GIS-based, science-driven baseline report that systematically identifies, maps, and interprets the natural, ecological, and environmental systems of a municipality or geographic region. It integrates spatial datasets, field observations, ecological classification methods, and scientific research into a unified environmental planning framework. An NRI functions as both a scientific reference document and a planning tool. Unlike a simple collection of maps or environmental datasets, a comprehensive NRI synthesizes ecological information into an organized interpretation system that supports conservation planning, land-use management, environmental protection, and climate adaptation initiatives. The inventory process combines: (Branford Conservation and Environment Commission, n.d.; Town of Canton, n.d.; Town of Salisbury, 2022)

- Geographic Information Systems (GIS)
- Remote sensing and spatial analysis
- State and federal environmental datasets
- Field observations and ecological surveys
- Scientific literature and regional environmental research
- Narrative ecological interpretation

The resulting inventory provides municipalities with a detailed understanding of their environmental assets, ecological vulnerabilities, and interconnected natural systems.

1.2 Purpose of the Natural Resource Inventory

The Natural Resource Inventory serves several core functions within municipal and environmental planning frameworks:

Planning and Decision-Making

The NRI provides municipalities with a scientific baseline for evaluating land-use decisions, conservation priorities, zoning considerations, and environmental management strategies. It helps identify environmentally sensitive areas and ecological constraints before development or infrastructure planning occurs.

Conservation and Ecological Protection

By identifying critical habitats, wetlands, wildlife corridors, forest systems, and watershed networks, the NRI supports the protection and long-term stewardship of natural resources. Climate resilience and adaptation The inventory assists municipalities in understanding environmental stressors such as flood risk, habitat fragmentation, heat island effects, invasive species pressures, and pollution impacts. This information supports climate adaptation planning and resilience initiatives.

Educational and Public Resource

The NRI also serves as an educational resource for community organizations, schools, conservation groups, and residents by Improving public understanding of local ecosystems and environmental systems.

1.3 Manchester-Specific NRI Framework

The proposed NR for Manchester should include analysis and mapping of:

- Watershed systems, particularly the Hockanum River watershed
- Forest ecosystems, including Manchester Town forest and fragmented upland forests
- Wetlands, including bogs, swamps, vernal pools, and regulated buffer areas
- Eco-type land classifications such as forest, wetland, agricultural, and developed land
- Wildlife habitats and ecological corridors
- Climate-related stressors and environmental contaminants
- Pollinator and pesticide-related ecological impacts, including neonicotinoid concerns

This systems-based structure recognizes that Manchester's environmental resources operate as interconnected ecological networks rather than isolated landscape features.

1.4 Vision Statement

Manchester's NRI reflects the town's unique environmental and historical identity. The town's mill history, river systems, forest landscapes, wetlands, and urban-natural interfaces collectively shape its ecological character and environmental significance. The vision of the NRI is to create a scientifically grounded, accessible, and policy-relevant environmental framework that supports:

- Long-term ecological sustainability
- Conservation planning
- Climate resilience
- Community education
- Responsible land-use management

The inventory is intended to guide future environmental stewardship while preserving the ecological systems that contribute to Manchester's environmental health and regional identity.

1.5 Methodology Overview

The methodology used in this NRI integrates GIS technology, environmental datasets, scientific literature, and field-based observations into a unified inventory system. Primary data sources include: (Connecticut Environmental Conditions Online [CT ECO], n.d.; Town of Manchester, n.d.; University of Connecticut Natural Resources Conservation Academy, n.d.)

State Data Sources

- Connecticut Department of Energy and Environmental Protection (CT EEP)
- Connecticut Environmental Conditions Online (CT ECO)

Federal Data Sources

- United States Geological Survey (USGS)
- Federal Emergency Management Agency (FEMA)
- United States Department of Agriculture (USDA)
- National Wetlands Inventory (NWI)

Local and Regional Sources

- Manchester GIS databases
- Regional planning organizations

- University of Connecticut (UConn) research
- Local conservation and watershed studies The inventory development process includes

The step by step development process for Manchester's NRI will include:

1. Collection of spatial datasets
2. GIS mapping
3. Ecological classification
4. Verification through field observations, where applicable
5. Narrative interpretation of environmental systems
6. Organize into a standardized NRI report structure

GIS serves as the primary analytical and organizational platform throughout the inventory process, enabling the integration of multiple ecological datasets into a cohesive spatial database.

Chapter 2: Physical Landscape

2.1 Introduction

The physical landscape forms the foundation upon which all ecological systems develop and interact. Geological structure, topography, elevation, and soil composition collectively influence hydrology, vegetation patterns, wildlife habitat distribution, land-use suitability, and long-term environmental stability. Understanding these physical characteristics is essential for interpreting the ecological structure of Manchester and identifying areas sensitive to development, erosion, flooding, or environmental degradation. This chapter examines Manchester's geological setting, topographic structure, and soil systems as core components of the NRI. The analysis establishes the environmental baseline necessary for evaluating land-use planning, agricultural potential, watershed function, infrastructure limitations, and conservation priorities. The physical landscape assessment integrates GIS-based spatial analysis with federal and state environmental datasets, particularly soil and geological mapping resources provided through the United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), Connecticut Environmental Conditions Online (CT ECO), and United States Geological Survey (USGS) (Friedland & Relyea, 2019; United States Geological Survey [USGS], n.d.).

2.2 Purpose

The purpose of this section is to characterize Manchester's regional geological setting and topographic structure in order to understand how underlying landforms influence ecological systems, hydrology, drainage patterns, vegetation communities, and land-use constraints. Geology and topography directly affect:

- Soil development
- Groundwater recharge
- Watershed structure
- Wetland formation
- Forest distribution
- Erosion susceptibility
- Development suitability

Understanding these systems provides critical context for all subsequent ecological analysis within the NRI.

2.3 Regional Geological Context

Manchester Connecticut, is located primarily within the Central Lowlands physiographic region of Connecticut, though portions of the surrounding landscape transition toward upland terrain associated with the Eastern and Western Highland systems. The Central Lowlands region is characterized by relatively lower elevations, sedimentary bedrock formations, river valleys, glacial deposits, and gently rolling terrain. This geological setting developed through a combination of: (CT ECO, n.d.; USGS, n.d.)

- Ancient tectonic activity
- Sedimentary basin formation
- Glacial advance and retreat
- Fluvial erosion and deposition

The region's glacial history significantly shaped Manchester's present-day landscape. Retreating glaciers deposited extensive till, sand, gravel, and stratified drift materials that continue to influence drainage characteristics, soil composition, and groundwater recharge potential. Key geological characteristics include:

- Glacial till uplands
- Stratified drift deposits
- River terraces
- Floodplain sediments
- Bedrock-controlled drainage systems

These features strongly influence the location of wetlands, stream corridors, forest composition, and development constraints throughout the municipality.

2.4 Topographic Characteristics

Manchester's topography consists primarily of gently rolling terrain interspersed with:

- River valleys
- Wetlands
- Forested uplands
- Urbanized lowland areas

Elevation changes are generally moderate, though localized slopes influence:

- Stormwater runoff
- Soil erosion potential
- Habitat connectivity
- Infrastructure development
- Flood susceptibility

The Hockanum River watershed serves as one of the town's primary hydrological and topographic organizing systems. Drainage patterns throughout the municipality are heavily influenced by glacial deposits and lowland basin morphology. Topographic variation contributes to the development of:

For Manchester-specific interpretation, the Hockanum River corridor should be treated as a central organizing feature for water resources and riparian habitat. Upland and forested systems should be evaluated in relation to Manchester Town Forest and other open-space parcels, while more developed central corridors should be assessed for impervious surface coverage, stormwater runoff, and flood vulnerability. Lowland drainage areas and wetland-associated landscapes should be mapped using CT ECO, CT DEEP, NWI, and municipal GIS layers before any field verification is conducted (CT ECO, n.d.; Town of Manchester, n.d.).

GIS-based elevation and slope analysis should be incorporated to identify environmentally sensitive terrain and areas susceptible to erosion or runoff impacts. Geospatial data relating to topography can be easily displayed on a map, and can help identify environmentally sensitive areas when evaluating planning and land use decisions.

2.5 Ecological Influence of Physical Landscape

Manchester's geology and topography directly shape ecological structure and environmental function. Physical landforms influence:

- Forest distribution patterns
- Soil drainage capacity
- Surface water movement
- Wetland occurrence
- Habitat fragmentation
- Wildlife corridor formation

For example:

- Poorly drained glacial depressions often support wetlands and vernal pools
- Well-drained upland soils support deciduous forest systems
- Floodplain deposits influence riparian vegetation and habitat diversity
- Sleeper slopes may limit development while preserving forest continuity

These interactions demonstrate that physical landscape systems form the structural basis for broader ecological processes throughout the municipality.

Chapter 3: Soils

3.1 Introduction

Soils are one of the most important components of the natural landscape because they integrate geological history, hydrology, vegetation, climate, and land-use processes. Soil composition and drainage characteristics influence ecological productivity, agricultural capability, groundwater recharge, wetland formation, erosion potential, and infrastructure suitability. : (Friedland & Relyea, 2019; United States Department of Agriculture Natural Resources Conservation Service [USDA NRCS], n.d.)This chapter inventories and classifies Manchester's soil systems to support:

- Land-use planning
- Agricultural preservation
- Wetland protection
- Stormwater management
- Ecological assessment
- Development suitability analysis

The soils assessment relies primarily on GIS-based analysis using federal and state environmental datasets, particularly the USDA Natural Resources Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO) (USDA NRCS, n.d.).

3.2 Soil Composition and Characteristics

Manchester contains a diverse range of soil systems formed primarily through glacial deposition and hydrological processes. Soil characteristics vary according to:

- Parent geological material
- Drainage conditions
- Elevation and slope
- Organic accumulation
- Historical land use

Major soil groupings within Manchester include:

- Glacial till soils
- Sandy and gravelly stratified drift soils
- Floodplain alluvial soils
- Hydric wetland soils
- Moderately well-drained upland soils

These soils influence:

- Vegetation communities
- Agricultural productivity
- Stormwater infiltration
- Septic suitability
- Development constraints
- Ecological resilience

3.3 Statewide Important Farmland Soils

Certain soils within Manchester are classified by the USDA as:

- Prime Farmland Soils
- Statewide Important Farmland Soils

These classifications are based on:

- Soil fertility
- Drainage capability
- Water availability
- Slope conditions
- Agricultural productivity potential

Preserving agricultural soils supports:

- Food system resilience
- Open space conservation
- Ecosystem services

- Sustainable land management

GIS analysis should identify and map:

- Prime farmland locations
- Agricultural capability classes
- Existing agricultural land use
- Development pressure areas affecting farmland resources

3.4 Hydric and Regulated Soils

Manchester contains hydric and regulated soils associated with wetlands and environmentally sensitive landscapes. Hydric soils:

- Form under prolonged saturated conditions
- Support wetland vegetation
- Indicate potential wetland boundaries
- Influence groundwater and surface water interaction These soils are essential for:
- Wetland delineation
- Flood mitigation
- Water quality protection
- Habitat conservation
- Infrastructure development
- Septic system installation
- Road construction
- Stormwater management systems

Mapping hydric and regulated soils is critical for identifying environmental constraints and conservation priorities.

Chapter 4: Water Resources

4.1 Introduction

Water resources are among the most critical components of Manchester's environmental system. Rivers, streams, wetlands, groundwater systems, and waterbodies collectively regulate hydrology, support biodiversity, influence water quality, reduce flooding impacts, and sustain both ecological and human communities. This chapter examines Manchester's water resource systems through a watershed-based framework that integrates hydrology, aquatic ecology, flood resilience, groundwater protection, and wetland conservation. The assessment identifies the relationships between surface water systems, groundwater recharge areas, ecological corridors, and environmental stressors affecting long-term watershed health. The Water Resources chapter supports: (Friedland & Relyea, 2019; CT ECO, n.d.)

- Watershed management planning
- Flood resilience and stormwater mitigation
- Wetland conservation
- Aquatic habitat protection
- Groundwater resource management
- Climate adaptation planning

- Water quality protection

This section relies heavily on GIS-based hydrological analysis and integrates state, federal, and municipal datasets, including CTDEEP hydrography layers, National Wetlands Inventory (NWI) data, FEMA floodplain mapping, and groundwater resource datasets (CT ECO, n.d.; Connecticut Department of Energy and Environmental Protection [CT DEEP], n.d.; Federal Emergency Management Agency [FEMA], n.d.; U.S. Fish and Wildlife Service, n.d.).

4.2 Watershed Systems and Drainage Basins

The purpose of this section is to identify and map Manchester's watershed systems and drainage basins in order to understand how water moves through the landscape and how hydrological systems influence ecological function, flooding, water quality, and land-use planning. Whether you mean local land use policy or state rules (or both). Watersheds are interconnected systems in which all surface water drains toward a common outlet such as a river, stream, lake, or wetland complex. Because environmental impacts travel throughout watersheds, watershed analysis serves as a foundational framework for understanding environmental health and resilience. Manchester is located primarily within the Hockanum River watershed system, which functions as one of the municipality's primary hydrological organizing features. Additional tributary systems and subwatersheds contribute to regional drainage networks throughout the town. Watershed systems influence:

- Surface water flow
- Floodplain development
- Sediment transport
- Nutrient movement
- Wetland formation
- Aquatic habitat connectivity
- Groundwater recharge

GIS-based watershed delineation should identify:

- Primary watershed boundaries
- Tributary drainage systems
- Surface runoff pathways
- Headwater stream systems
- Flood-prone drainage corridors

4.3 Watershed Stressors

Manchester's watersheds experience multiple environmental stressors associated with:

- Urban runoff
- Impervious surface expansion
- Stream channel modification
- Habitat fragmentation
- Pollutant loading
- Sedimentation
- Climate-driven flooding intensity

Understanding these stressors is essential for long-term watershed resilience planning and aquatic ecosystem protection.

4.4 Rivers and Streams

The purpose of this section is to inventory Manchester's rivers, streams, and aquatic corridors while evaluating flood resilience, stream connectivity, ecological condition, and infrastructure interactions. Rivers and streams provide:

- Surface water transport
- Wildlife movement corridors
- Aquatic habitat systems
- Flood storage and drainage functions
- Nutrient cycling

Hockanum River System

The Hockanum River is one of Manchester's most significant hydrological and ecological resources. The river and its tributaries influence:

- Floodplain dynamics
- Wetland distribution
- Riparian habitat connectivity
- Stormwater drainage
- Aquatic biodiversity

Riparian corridors associated with the Hockanum River serve as important ecological transition zones that support wildlife movement, vegetation diversity, and water quality protection. (Connecticut Department of Energy and Environmental Protection [CT DEEP], 2015)

Flood Resilience and Stream Stability

Flood resilience analysis should evaluate:

- FEMA floodplain areas
- Streambank erosion
- Channel stability
- Stormwater runoff impacts
- Flood storage capacity
- Culvert and crossing vulnerability

Climate-related increases in intense precipitation events may increase:

- Flash flooding
- Stream erosion
- Sediment transport
- Infrastructure stress
- Habitat degradation

GIS analysis should identify flood-prone areas and vulnerable infrastructure corridors.

Road-Stream Crossings and Aquatic Passage

Road-stream crossings significantly influence aquatic ecosystem connectivity and flood resilience. The inventory should evaluate:

- Culverts
- Bridges
- Undersized crossings
- Stream constrictions
- Fish and wildlife passage barriers Improperly designed crossings can:
- Restrict aquatic organism movement
- Increase localized flooding
- Accelerate erosion
- Alter stream hydrology
- Crossing locations
- Structural conditions
- Passage limitations
- Flood vulnerability
- Stream continuity impacts

Existing GIS datasets can help identify likely road-stream crossing locations, culverts, bridges, and stream intersections. However, structural condition, aquatic organism passage, localized erosion, and crossing capacity should be verified through future field assessment because these conditions may not be fully represented in public GIS layers (CT ECO, n.d.; CT DEEP, n.d.). This can be done in the future and be added to a preexisting NRI.

4.5 Groundwater and Aquifers

The purpose of this section is to identify and assess Manchester's groundwater resources, aquifer systems, recharge areas, and potential contamination stressors. Groundwater systems are essential for:

- Drinking water supply
- Stream baseflow maintenance
- Wetland hydrology
- Drought resilience

Aquifer Systems and Recharge

Aquifer capacity and recharge potential are influenced by:

- Soil permeability
- Surficial geology
- Stratified drift deposits
- Land cover
- Impervious surface development

Groundwater recharge areas should be mapped to identify environmentally sensitive zones that contribute to long-term water supply sustainability. GIS analysis should include:

- Aquifer boundaries
- Recharge zones
- Wellhead protection areas
- Stratified drift deposits

4.6 Groundwater Quality and Environmental

Stressors Groundwater quality may be affected by:

- Stormwater infiltration
- Urban pollutants
- Road salt
- Septic systems
- Industrial contaminants
- Agricultural runoff
- Pesticides and herbicides

Particular attention should be given to emerging contaminants such as neonicotinoid pesticides, which may affect:

- Aquatic ecosystems
- Pollinator health
- Surface water quality
- Groundwater integrity

Environmental stressor analysis should identify:

- Potential or known contamination sources
- Vulnerable recharge zones
- Areas of impaired water quality
- Long-term groundwater risks

4.7 Overview: Wetlands and Vernal Pool Systems

The purpose of this section is to identify and classify Manchester's wetlands, vernal pools, and regulated wetland buffer zones in order to support ecological conservation, flood mitigation, and water quality protection. Wetlands provide critical ecological functions including:

- Floodwater storage
- Groundwater recharge
- Water filtration
- Nutrient cycling
- Wildlife habitat
- Carbon storage

Wetland Types

Manchester contains multiple wetland systems including:

- Bogs
- Swamps

- Marshes
- Forested wetlands
- Vernal pools
- Riparian wetlands

These systems are influenced by:

- Hydric soils
- Groundwater interaction
- Surface water flooding
- Glacial landforms

Wetland complexes often function as biodiversity hotspots and ecological transition zones. Vernal Pools Vernal pools are seasonal wetlands that provide critical breeding habitat for amphibians and invertebrates. Because these systems often lack permanent fish populations, they support specialized ecological communities. Vernal pools are environmentally sensitive due to:

- Habitat fragmentation
- Hydrological disruption
- Development pressure
- Pollution inputs

Field verification may be necessary where GIS datasets do not fully capture seasonal wetland systems. are not entirely wetland, but they have critical functions, and in state law they are currently lumped under the authority of inland wetland agencies

4.8 Regulated Wetlands and Upland Review Areas

Connecticut wetland regulations include upland review areas extending approximately 100 feet beyond wetlands and watercourses boundaries in many municipal review processes (Town of Manchester Planning and Zoning Commission, 2014). These regulated buffer areas are important because activities outside wetlands may still influence:

- Hydrology
- Sedimentation
- Water quality
- Habitat integrity

Wetland mapping should incorporate:

- National Wetlands Inventory (NWI) datasets
- CT DEEP wetlands data
- Hydric soil overlays
- Municipal wetland mapping
- Field observations where applicable

Chapter 5: Biological Communities

5.1 Introduction

Biological communities represent the living ecological systems that occupy and interact within Manchester's landscape. These systems include forests, wetlands, grasslands, riparian corridors, wildlife habitats, and interconnected ecological networks that collectively support biodiversity, ecosystem stability, and environmental resilience. This chapter examines the composition, distribution, and ecological function of Manchester's biological communities through a landscape-scale ecological framework. The analysis focuses on eco-type mapping, upland forest systems, wildlife habitat distribution, biodiversity conservation, and ecological connectivity across municipal boundaries. Biological community assessment is essential for: (Friedland & Relyea, 2019; CT ECO, n.d.)

- Biodiversity conservation
- Habitat protection
- Wildlife corridor planning
- Climate resilience
- Ecological restoration
- Open space management
- Land-use planning

This chapter integrates ecological mapping, habitat classification systems, wildlife data, land cover analysis, and regional ecological research (CT ECO, n.d.; CT DEEP, n.d.).

5.2 Eco-Type Mapping and Ecological Land Classification

The purpose of this section is to classify and map Manchester's ecological landcover systems in order to understand the distribution, connectivity, and ecological function of the town's natural communities. Eco-type mapping organizes landscapes into ecological categories based on:

- Vegetation structure

which Manchester uses

- Hydrology
- Soil conditions
- Land cover
- Ecological function
- Human disturbance patterns

These classifications provide the foundation for ecological interpretation, biodiversity assessment, and conservation planning

Eco-Type Classification Systems

Manchester's ecological systems should be classified into broad eco-type categories including:

- Upland forests
- Wetlands
- Riparian corridors
- Shrublands
- Grasslands and open fields

- Agricultural land
- Urban green spaces
- Developed landscapes

Additional classifications may include:

- Early successional habitats
- Interior forest zones
- Fragmented forest systems
- Vernal pool-associated habitats
- Floodplain forests

Ecological Importance of Eco-Type Mapping

Eco-type mapping supports:

- Habitat conservation planning
- Wildlife corridor analysis
- Biodiversity assessment
- Climate adaptation planning
- Open space prioritization
- Environmental impact review

The classification process helps identify:

- Core habitat areas
- Fragmented ecosystems
- Ecological transition zones
- Areas vulnerable to development pressure
- Opportunities for habitat restoration

5.3 Upland Forest Systems

The purpose of this section is to identify and evaluate Manchester's upland forest systems. including forest core areas, interior forest habitat, and municipally protected forest lands. Upland forests provide:

- Biodiversity support

you propose this breakdown of categories? is it easier to fit into the spatial data sources you propose using? frequently within your proposed framework - consider consolidating within one section if appropriate

- Carbon sequestration
- Groundwater recharge
- Stormwater infiltration
- Habitat connectivity
- Climate regulation
- Soil stabilization

These forest systems are among the municipality's most ecologically valuable natural resources. Upland forests influence:

- Watershed health
- Carbon storage
- Pollinator habitat
- Temperature regulation
- Air quality
- Wildlife shelter and breeding habitat

These systems are especially important for maintaining ecological resilience under increasing climate and development pressures.

5.4 Town Forest and Forest Core Areas

Manchester contains important forest systems including municipally protected forest lands such as the Manchester Town Forest and associated upland forest corridors. Forest core areas are large, relatively unfragmented forest blocks that maintain:

- Interior habitat conditions
- Wildlife movement
- Ecological resilience
- Reduced edge disturbance

Forest fragmentation caused by roads, development, and utility corridors can:

- Reduce habitat quality
- Increase invasive species pressure
- Alter wildlife movement
- Increase edge effects
- Decrease biodiversity stability

Analysis should identify:

- Core forest areas
- Interior forest habitat
- Forest fragmentation zones
- Connectivity corridors
- Edge-to-interior ratios

5.5 Wildlife Habitat and Species Assessment

The purpose of this section is to identify wildlife habitats, species distribution patterns, and ecologically sensitive habitat areas throughout Manchester. Wildlife habitat assessment supports:

- Biodiversity conservation
- Habitat management
- Species protection
- Corridor planning
- Ecological restoration initiatives

Habitat Zones and Species Distribution Different ecological zones support different wildlife communities based on:

- Vegetation structure
- Water availability
- Habitat connectivity
- Human disturbance
- Food availability Examples include:
- Wetlands supporting amphibians and waterfowl
- Forest interiors supporting migratory birds and mammals
- Grasslands supporting pollinators and early successional species
- Riparian corridors supporting aquatic and semi-aquatic species

Preliminary habitat mapping may be completed using CT ECO land-cover data, aerial imagery, municipal open-space data, and CT DEEP biodiversity resources. Species presence, vernal pool condition, invasive species extent, and actual wildlife movement patterns should be treated as field-verification needs unless reliable local survey data already exists (CT ECO, n.d.; CT DEEP, n.d.).

Habitat mapping should identify:

- High biodiversity zones
- Critical breeding habitats
- Seasonal wildlife use areas
- Rare or sensitive habitat systems

5.6 Species of Greatest Conservation Need The inventory should identify species

considered:

- Threatened
- Endangered
- State-listed
- Species of Greatest Conservation Need (SGCN)

Species assessment should utilize:

- CT DEEP Natural Diversity Database information
- Regional wildlife studies
- Habitat suitability analysis
- Scientific literature and biodiversity datasets

Potential species groups may include:

- Amphibians
- Migratory birds
- Pollinators
- Reptiles
- Mammals
- Aquatic organisms

Special attention should be given to species vulnerable to:

- Habitat fragmentation
- Climate change
- Pollution exposure
- Wetland loss
- Pesticide contamination, including neonicotinoid impacts

5.6 Wildlife Corridors and Ecological Connectivity

The purpose of this section is to identify ecological corridors and habitat linkages that support wildlife movement within Manchester and across surrounding municipal boundaries. Wildlife corridors are essential for:

- Species migration
- Genetic diversity
- Seasonal movement
- Climate adaptation
- Habitat connectivity

Ecological connectivity becomes increasingly important as development fragments natural landscapes. Corridor Systems and Linkages Wildlife movement corridors may include:

- Forested stream corridors
- Riparian systems
- Wetland networks
- Interior forest connections
- Utility and open space corridors

Corridors linking Manchester to surrounding municipalities support:

- Regional biodiversity
- Landscape-scale ecological resilience
- Long-distance wildlife movement Analysis should identify:
- Habitat connectivity zones
- Fragmentation barriers
- Road crossing conflicts
- Corridor pinch points
- Regional ecological linkages

5.7 Ecological Fragmentation and Development

Pressure Habitat fragmentation may result from:

- Road construction
- Residential development
- Commercial expansion
- Utility infrastructure
- Impervious surface growth Fragmentation can:
- Isolate wildlife populations
- Reduce biodiversity

- Increase mortality risks
- Disrupt migration pathways
- Reduce ecosystem resilience

Chapter 6: Land Use and Community Character

6.1 Introduction

Land use and community character reflect the interaction between Manchester's natural systems, historical development patterns, cultural identity, and open space resources. The arrangement of developed areas, conservation lands, agricultural landscapes, parks, historic districts, and scenic corridors collectively shapes the municipality's environmental function and visual identity. This chapter examines the relationship between land use, conservation, agriculture, and historic landscape character within Manchester. The assessment focuses on open space systems, scenic and historic resources, and agricultural landscapes that contribute to ecological resilience, community identity, and long-term planning priorities. Understanding land use patterns is essential for: (Mansfield, Connecticut, 2023; Town of Manchester, n.d.)

- Conservation planning
- Open space management
- Historic preservation
- Scenic resource protection
- Agricultural sustainability
- Climate resilience
- Sustainable development planning

This chapter evaluates how natural and cultural landscapes contribute to Manchester's overall environmental and community structure.

6.2 Open Space and Conservation Lands

The purpose of this section is to identify and evaluate Manchester's open space systems, conservation lands, parks, and managed green spaces in order to support ecological conservation, recreation planning, and landscape connectivity. Open spaces provide:

- Habitat protection
- Recreational opportunities
- Flood mitigation
- Ecological connectivity
- Urban heat reduction
- Scenic and cultural value
- Climate resilience benefits

Protected open space systems are essential for maintaining ecological stability within increasingly developed landscapes.

Conservation Lands and Protected Areas

Manchester contains a variety of protected and semi-protected open space systems including:

- Municipal parks
- Conservation areas

- Forest preserves
- Watershed protection lands
- Recreational green spaces
- Land trust properties

These areas contribute to:
- Wildlife habitat preservation
- Public recreation access
- Forest and wetland conservation
- Ecological corridor continuity
- Water resource protection

Open space analysis should identify:

- Protected conservation parcels
- Publicly accessible green spaces
- Regional trail connections
- Ecologically significant open lands
- Areas vulnerable to fragmentation or development pressure

6.3 Land Trust Properties and Stewardship

Land trust properties play an important role in local conservation efforts by protecting environmentally sensitive landscapes and preserving undeveloped open space. These lands may include:

- Forested conservation easements
- Wetland protection areas
- Agricultural preservation parcels
- Wildlife habitat corridors
- Scenic landscapes

Conservation stewardship supports:

- Biodiversity protection
- Watershed resilience
- Public environmental education
- Long-term ecological sustainability

6.4 Historic and Scenic Resources

The purpose of this section is to document Manchester's historic landscapes, scenic resources, and culturally significant environmental features in order to preserve the municipality's historical identity and landscape character. Historic and scenic resources contribute to:

- Community identity
- Cultural heritage
- Tourism and recreation
- Educational value
- Environmental stewardship

- Landscape preservation

These systems demonstrate the relationship between Manchester's industrial history, river systems, transportation networks, and environmental development. Manchester? and if so, where is the property they manage?

Historic Landscapes and Cultural Resources

Manchester contains historically significant landscapes associated with:

- Industrial mill development
- River corridor settlement
- Agricultural land use
- Transportation infrastructure
- Historic residential districts

Particular emphasis should be placed on the Cheney Brothers Mill District and associated mill-era landscapes, which represent one of the town's most historically significant cultural resources. Historic resource analysis should identify:

- Historic districts
- Mill structures and industrial corridors
- Historic open spaces
- Cultural landscapes
- Historically significant waterways and transportation routes

Scenic Corridors and Natural Character

Scenic resources may include:

- River corridors
- Forested landscapes
- Historic streetscapes
- Open agricultural fields
- Ridgelines and upland views
- Greenway systems

The Hockanum River corridor functions as both an ecological and scenic resource that contributes significantly to Manchester's landscape identity. Scenic resource assessment should evaluate:

- Visual landscape continuity
- Development pressures affecting scenic character
- Opportunities for greenway preservation
- Public access and recreational visibility

Protecting scenic resources supports both environmental quality and community identity.

6.5 Agricultural Resources

The purpose of this section is to identify and assess Manchester's agricultural resources, productive farmland systems, and agricultural support landscapes. Agricultural lands contribute to:

- Local food systems

- Open space preservation
- Soil conservation
- Habitat diversity
- Cultural landscape character
- Economic sustainability

Even within suburbanizing municipalities, agricultural resources remain important components of environmental and community resilience. Active Farmland and Agricultural Land Use Agricultural resources within Manchester may include:

- Active farmland
- Nurseries and greenhouses
- Community agriculture
- Hayfields and pasture
- Orchards and specialty crop areas

Agricultural inventory efforts should identify:

- Existing active agricultural operations
- Preserved farmland
- Agricultural land-use trends
- Conversion pressures from development Maintaining agricultural land supports:
- Open landscape continuity
- Soil productivity preservation
- Pollinator habitat
- Sustainable land management

6.6 Soil Productivity and Agricultural Suitability

Agricultural productivity is closely tied to:

- Prime farmland soils
- Drainage conditions
- Water availability
- Slope characteristics
- Development pressures This section should evaluate:
- Prime farmland soils
- Statewide Important farmland soils
- Agricultural capability classifications
- Areas suitable for future agricultural preservation

Protecting productive soils helps preserve long-term agricultural potential and reduces the loss of ecologically valuable open landscapes.

Chapter 7: Climate and Emerging Environmental Issues

7.1 Introduction
Climate change and emerging environmental stressors are increasingly influencing the ecological stability, hydrology, biodiversity, and long-term resilience of municipalities throughout Connecticut. Changes in precipitation patterns, temperature regimes, land development, pollution, and habitat fragmentation are altering the structure and function of natural systems across Manchester. This chapter examines the environmental challenges and climate-related pressures affecting Manchester's ecosystems, water resources, biodiversity, and land-use systems. The analysis focuses on climate change patterns, invasive species, habitat fragmentation, pollution trends, and other emerging environmental concerns that may affect the municipality's long-term ecological health and resilience. Understanding these issues is essential for: (FEMA, n.d.; Friedland & Relyea, 2019; National Oceanic and Atmospheric Administration [NOAA], n.d.)

- Climate adaptation planning
- Environmental resilience strategies
- Conservation prioritization
- Watershed protection
- Biodiversity management
- Sustainable land-use planning
- Long-term ecological monitoring

This chapter serves as a forward-looking assessment that identifies environmental vulnerabilities and potential risks influencing Manchester's future environmental conditions.

7.2 Temperature Shifts and Seasonal Change
Regional climate trends throughout Connecticut indicate increasing average temperatures and changing seasonal conditions. Observed and projected impacts may include:

- Warmer annual temperatures
- Milder winters
- Increased frequency of extreme heat events
- Longer growing seasons
- Reduced snow cover duration
- Earlier spring onset

These temperature shifts influence:

- Forest composition
- Wildlife migration patterns
- Pollinator activity
- Invasive species expansion
- Water temperature and aquatic habitat conditions

Longer growing seasons may also alter agricultural systems and ecological timing relationships. (U.S. Global Change Research Program, 2023)

7.3 Altered Precipitation Patterns
Climate change is contributing to changes in precipitation intensity, timing, and seasonal distribution. Potential impacts include:

- Increased frequency of intense rainfall events
- Greater flood risk
- Stormwater management challenges
- Streambank erosion
- Wetland hydrological changes
- Drought periods between precipitation events

Hydrological systems such as the Hockanum River watershed may become increasingly vulnerable to:

- Flash flooding
- Sediment transport
- Infrastructure stress
- Aquatic habitat disruption

Changes in precipitation patterns may also affect groundwater recharge and wetland stability.

7.4 Ecological Impacts of Climate Change

Climate-related environmental shifts may influence:

- Habitat suitability
- Species distribution
- Forest health
- Pollinator populations
- Wetland hydrology
- Wildlife movement patterns

Sensitive ecosystems such as wetlands, vernal pools, and fragmented forest habitats may be particularly vulnerable to climate-related stress. Climate resilience planning should prioritize:

- Habitat connectivity
- Floodplain protection
- Forest conservation
- Wetland preservation
- Stormwater management improvements

7.5 Environmental Challenges and Ecological Stressors

The purpose of this section is to identify ongoing environmental challenges affecting Manchester's ecosystems, biodiversity, and natural resource systems. Environmental stressors may originate from:

- Development pressure
- Habitat fragmentation
- Pollution
- Invasive species
- Infrastructure expansion
- Climate-related disturbance

These pressures often interact and compound one another, reducing ecological resilience over time.

7.6 Habitat Fragmentation and Development Pressure

Habitat fragmentation occurs when continuous natural landscapes are divided by:

- Roads
- Residential development
- Commercial infrastructure
- Utility corridors
- Impervious surfaces Fragmentation can:
- Isolate wildlife populations
- Reduce biodiversity
- Increase edge effects
- Disrupt migration corridors
- Increase invasive species exposure
- Decrease ecological resilience

Development pressure may particularly affect:

- Forest core areas
- Wetland buffer zones
- Wildlife corridors
- Agricultural open spaces
- Riparian systems

Maintaining ecological connectivity is critical for long-term biodiversity conservation and climate adaptation.

7.7 Invasive Species

Invasive species represent a significant ecological challenge because they may outcompete native species, alter habitat structure, and disrupt ecological processes. Potential invasive species concerns may include:

- Invasive plants
- Forest pests
- Aquatic invasive organisms
- Non-native insects and pathogens Impacts may include:
- Reduced biodiversity
- Altered forest regeneration
- Habitat degradation
- Pollinator disruption
- Increased ecosystem instability

Environmental monitoring and management efforts should prioritize early detection and habitat restoration strategies where feasible.

7.8 Urbanization and Impervious Surface Expansion

Urban development increases impervious surface coverage through:

- Roads
- Parking lots
- Buildings

- Sidewalks and infrastructure Impervious surface expansion may:
- Increase stormwater runoff
- Reduce groundwater recharge
- Elevate flood risk
- Increase stream erosion
- Contribute to urban heat island effects
- Reduce habitat availability

Long-term land-use planning should evaluate opportunities to reduce environmental impacts associated with urbanization.

7.9 Pollution Trends and Environmental Contaminants

The purpose of this section is to assess long-term pollution trends and environmental contaminants affecting Manchester's ecosystems, water resources, and ecological health. Pollution sources may include:

- Stormwater runoff
- Industrial activity
- Roadway pollutants
- Agricultural chemicals
- Pesticides and herbicides
- Nutrient loading
- Atmospheric deposition

Understanding contaminant pathways is essential for protecting water quality and ecological integrity.

7.10 Surface Water and Groundwater Quality Water quality may be influenced by:

- Sediment transport
- Excess nutrients
- Urban runoff
- Road salt
- Chemical pollutants
- Septic system leakage
- Agricultural runoff Pollutants may affect:
- Aquatic biodiversity
- Drinking water quality
- Wetland systems
- Stream health
- Amphibian populations

Monitoring efforts should evaluate both surface water systems and groundwater recharge areas.

7.11 Pesticides and Emerging Contaminants

Particular attention should be given to emerging contaminants such as:

- pesticides
- Herbicides
- Industrial chemical residues

- Microplastics and urban contaminants

Neonicotinoids are of concern because they may:
- Affect pollinator populations
- Impact aquatic invertebrates
- Persist within soils and water systems
- Influence broader ecological food webs

Potential contamination pathways include:
- Stormwater transport
- Soil infiltration
- Agricultural runoff
- Urban landscape management practices

Long-term monitoring can help identify contaminant trends and ecological risks over time.

7.12 Environmental Monitoring and Resilience Planning

Long-term environmental monitoring supports:

- Climate adaptation planning
- Water quality protection
- Habitat conservation
- Pollution mitigation
- Ecosystem resilience assessment Monitoring efforts should prioritize:
- Watershed health
- Biodiversity indicators
- Flood-prone systems
- Sensitive habitats
- Groundwater recharge areas
- Pollinator and aquatic ecosystem health

Chapter 8: ArcGIS Development and Data Integration

8.1 Introduction

Geographic Information Systems (GIS) form the technical foundation of the Natural Resource Inventory (NRI). GIS allows environmental, ecological, hydrological, and land-use datasets to be integrated into a unified spatial framework that supports analysis, visualization, conservation planning, and public communication (CT ECO, n.d.; Town of Manchester, n.d.; University of Connecticut Natural Resources Conservation Academy, n.d.).

This chapter outlines the GIS architecture, data acquisition methods, ArcGIS workflow procedures, and StoryMap development process used to construct the Manchester Natural Resource Inventory. The chapter explains how federal, state, regional, and municipal datasets are combined to create an integrated environmental intelligence system capable of supporting ecological interpretation, planning decisions, and public engagement.

The ArcGIS framework allows the NRI to function as:

- A spatial environmental database
- An ecological interpretation system
- A planning and conservation tool
- A public education platform
- A climate resilience assessment framework

This chapter also establishes standardized GIS procedures to ensure consistency, reproducibility, and compatibility with municipal planning systems.

8.2 StoryMap Structure

The StoryMap should organize the NRI into thematic environmental sections including:

- Physical landscape
- Water resources
- Biological communities
- Land use and community character
- Climate and environmental stressors
- Conservation priorities

Each StoryMap section should include:

- Interactive maps
- Explanatory narrative text
- Layer visibility controls
- Ecological interpretation
- Photographs and visual references where applicable

The StoryMap serves both technical and public-facing purposes by making complex environmental information accessible to planners, conservation groups, and residents.

8.3 Beginner ArcGIS Workflow Overview

For a beginner user, the ArcGIS workflow should be completed in a simple sequence: identify the planning question, gather public data, create a web map, style and organize the layers, save the map, and then place the finished map into the StoryMap. The recommended beginner workflow is:

1. Define the purpose of the map. For example, decide whether the map will show wetlands, watersheds, soils, open space, floodplains, or ecological corridors.

2. Open ArcGIS Online and sign in through the school or organizational account.

3. Open Map Viewer and start a new map.

4. Choose a clear basemap, such as Topographic, Imagery Hybrid, or Streets, depending on the purpose of the map.

5. Add public data layers from trusted sources such as CT ECO, CT DEEP, FEMA, USDA NRCS, USGS, the National Wetlands Inventory, municipal GIS portals, or ArcGIS Living Atlas.

6. Rename each layer using plain language so the map is easy to understand.

7. Adjust layer colors, transparency, labels, pop-ups, and visibility settings.

8. Zoom to Manchester, Connecticut and save the map with a clear title, such as Manchester Wetlands and Watercourses Map.

9. Add a short summary and source notes in the map item details page.

10. Insert the completed web map into the ArcGIS StoryMap section where it supports the written narrative.

8.4 Accessing Public GIS Data

Public GIS data should be gathered from authoritative sources whenever possible. The following sources are recommended for the Manchester NRI: (CT ECO, n.d.; CT DEEP, n.d.; FEMA, n.d.; USDA NRCS, n.d.; USGS, n.d.)

- CT ECO: statewide natural resource and environmental datasets, including aquifer protection areas, drainage basins, contours, protected open space, water quality classifications, and other environmental layers.
- CT DEEP GIS Open Data: downloadable environmental data in formats such as Shapefile, File Geodatabase, KML, and CSV, with metadata and map service options.
- FEMA Flood Map Service Center or FEMA floodplain layers: flood hazard and floodplain information.
- USDA NRCS Web Soil Survey and SSURGO: soil classifications, hydric soils, prime farmland soils, drainage classes, and agricultural capability information.
- USGS: elevation, hydrography, topography, and geological datasets.
- National Wetlands Inventory: wetland classification data maintained by the U.S. Fish and Wildlife Service.
- ArcGIS Living Atlas: curated public GIS layers that can be added directly to web maps.
- Town of Manchester GIS or municipal records: parcels, zoning districts, parks, open space, public facilities, and local infrastructure layers when available.

Beginner data-access procedure:

1. Start with the question: What environmental feature am I trying to map?

2. Identify the most authoritative data source for that feature. For example, use NRCS for soils, FEMA for floodplains, CT ECO or CT DEEP for Connecticut environmental layers, and municipal GIS for local zoning or parcel data.

3. Download the data if a download option is available, or copy the web service URL if the site provides a map service.

4. Check the metadata before using the data. Metadata should identify the data source, date, scale, limitations, and update frequency.

5. Save downloaded files in a clearly labeled project folder, such as NRI_GIS_Data/Soils or NRI_GIS_Data/Wetlands.

6. Add the layer to ArcGIS Online or ArcGIS Pro.

7. Confirm that the layer displays in the correct location over Manchester.

8. Record the source, download date, and any limitations in a data-source log.

8.5 Adding Data to ArcGIS Online

ArcGIS Online can use public data in several ways. A beginner should use the simplest method that works for the dataset.

Option A: Add a public layer from ArcGIS Online or Living Atlas

1. Open the web map in Map Viewer.
2. Click Layers, then Add.
3. Choose Browse layers.
4. Search ArcGIS Online, Living Atlas, or the organization account.
5. Search for terms such as wetlands, flood hazard, land cover, soils, or Connecticut environmental data.
6. Review the layer owner and description to confirm that the source is authoritative.
7. Click Add to place the layer on the map.
8. Rename the layer and adjust the style if needed.

Option B: Add a layer from a web service URL

1. Open Map Viewer.
2. Open the Layers pane.
3. Choose Add layer from URL.
4. Paste the ArcGIS service, WMS, or other supported layer URL.
5. Select the correct service type if prompted.
6. Click Add to map.
7. Confirm that the layer appears in the correct location.

Option C: Upload a downloaded file

1. Download the public dataset from the source website.
2. If the dataset is a shapefile, keep all shapefile components together and compress them into one .zip file.
3. In ArcGIS Online, go to Content.
4. Choose New Item.
5. Upload the file.
6. Add a title, tags, summary, and source description.

7. Publish the file as a hosted feature layer if the account permissions allow it.

8. Add the new layer to the web map.

8.6 Basic ArcGIS Pro Workflow

If ArcGIS Pro is available through school or a municipal workstation, it can be used for more advanced organization and analysis. A beginner workflow is:

1. Open ArcGIS Pro and create a new project named Manchester NRI

2. Create folders for raw data, working data, maps, exports, and documentation.

3. Add a base map and set the project area to Manchester, Connecticut.

4. Add public data layers such as soils, wetlands, hydrology, open space, floodplains, and land cover.

5. Check each layer coordinate system and confirm that layers align properly.

6. Clip statewide datasets to the Manchester boundary when appropriate.

7. Symbolize each layer using clear and consistent colors.

8. Create map layouts for report figures.

9. Export maps as PNG or PDF files for the written report.

10. Document every dataset in the source log.

8.7 Recommended NRI Map Products

The ArcGIS work should produce a set of maps that directly support the NRI chapters. Recommended map products include:

- Regional location map
- Topography and elevation map
- Soils classification map
- Prime farmland and Statewide Important Farmland Soils map
- Hydric soils map
- Watershed and drainage basin map
- Rivers, streams, and waterbodies map
- FEMA floodplain map
- Wetlands and vernal pool screening map
- Land cover and eco-type map
- Forest core and fragmentation map
- Open space and conservation lands map
- Historic and scenic resources map
- Impervious surface and urbanization map
- Climate vulnerability or flood-risk screening map
- Conservation priority areas map

8.8 Data Management and Source Log

Every GIS layer used in the NRI should be documented in a simple source log. The source log should include:

- Layer name
- Source agency or organization
- Website or data portal
- Date accessed
- Data format
- Original geographic extent
- Whether the data was clipped or edited
- Known limitations
- Chapter or map where the layer is used

This log protects the credibility of the NRI by showing where the information came from and how it was used.

8.9 Quality Control Checklist

Before publishing the GIS maps or StoryMap, the following quality control steps should be completed:

- Confirm that all layers align correctly over Manchester.
- Confirm that the map legend is understandable to a non-technical reader.
- Remove duplicate or unused layers.
- Use consistent colors across related maps.
- Check that pop-ups do not show confusing field names.
- Add source notes for each public dataset.
- Confirm that sensitive species data is not displayed at a level of detail that could harm protected resources.
- Test the StoryMap on a different computer or browser.
- Confirm that all links work.
- Save a backup copy of all exported maps and source data notes.

8.10 Public Communication and StoryMap Publishing

The final StoryMap should be written for both technical and general audiences. Each section should include plain-language explanations, maps that can be understood without specialized GIS training, and short interpretation notes explaining why the mapped resources matter for Manchester.

Before publication, the StoryMap should be reviewed for:

- Accuracy of data sources
- Clarity of map legends
- Accessibility of language
- Consistent formatting
- Appropriate treatment of sensitive environmental data
- Alignment with municipal planning goals

Once reviewed, the StoryMap can serve as the public-facing version of the NRI and can be updated as new data becomes available.

Table 8.1: GIS Data Availability and Field Verification Needs

This distinction improves the credibility of the NRI by separating baseline GIS screening information from field-verified environmental conditions. Public GIS layers establish the initial spatial framework, while field collection improves accuracy, ecological interpretation, and long-term monitoring value.

Data likely requiring future field collection or field verification includes culvert condition assessments, vernal pool confirmation, invasive species mapping, wildlife corridor verification, species surveys, streambank erosion severity, habitat quality assessments, and localized stormwater infrastructure conditions. These items should be identified as recommended future work rather than presented as fully verified findings unless field data has already been collected.

Publicly available GIS data should be used for baseline mapping of soils, hydrology, floodplains, wetlands, land cover, zoning, parcels, open space, aerial imagery, and elevation. These datasets are available through sources such as CT ECO, CT DEEP, FEMA, USDA NRCS, USGS, ArcGIS Living Atlas, and the Town of Manchester GIS portal (CT ECO, n.d.; CT DEEP, n.d.; FEMA, n.d.; Town of Manchester, n.d.; USDA NRCS, n.d.; USGS, n.d.).

A key distinction in the Manchester NRI is the difference between GIS data that is already publicly available and environmental information that would require future field collection or verification. Public GIS layers provide the starting point for screening, mapping, and organizing the inventory; however, field-based observations are needed to confirm conditions that change over time or cannot be fully interpreted from mapped datasets alone.

8.11 Existing Public GIS Data vs. Future Data Collection Needs

Resource or Topic	Public GIS Data Available	Field Collection or Verification Needed
Soils and farmland soils	USDA NRCS Web Soil Survey, SSURGO, CT ECO	Usually not needed for baseline mapping; site-specific soil verification may be needed for development review.
Wetlands and watercourses	NWI, CT DEEP/CT ECO wetland and hydrography layers, municipal data where available	Field delineation and local verification are needed for regulatory accuracy and seasonal wetland conditions.
Floodplains and flood risk	FEMA Flood Map Service Center, CT ECO flood-related layers	Field or engineering review may be needed for localized drainage problems and storm impacts.
Parcels, zoning, parks, and open space	Town of Manchester GIS and municipal records	Verification may be needed for ownership changes, conservation restrictions, and public-access status.
Wildlife habitat and corridors	CT ECO land cover, CT DEEP Natural Diversity Database screening, aerial imagery	Species surveys, corridor use, habitat quality, and sensitive species information require careful field review.
Road-stream crossings and culverts	Hydrology layers, road layers, aerial imagery, and municipal infrastructure data when available	Culvert condition, aquatic passage, blockages, erosion, and crossing capacity require field assessment.

Invasive species and restoration needs	Limited public GIS data may exist regionally	Local field mapping is generally needed to confirm extent, severity, and restoration priorities.

Chapter 9: Recommendations and Stewardship

9.1 Introduction

The NRI is not a static document but a living planning tool designed to evolve alongside environmental conditions, scientific understanding, and municipal development patterns. This chapter outlines actionable recommendations for conservation, regulatory alignment, and long-term stewardship of Manchester's natural systems. The goal of this section is to translate ecological findings into practical planning and management strategies that support: (Mansfield, Connecticut, 2023; Town of Canton, n.d.; Town of Salisbury, 2022)

- Long-term environmental protection
- Sustainable land-use decisions
- Biodiversity conservation
- Watershed and climate resilience
- Alignment with municipal planning frameworks

Effective stewardship requires coordination between municipal agencies, conservation organizations, landowners, and regional partners.

9.2 Land Acquisition Priorities

Municipal or land trust acquisition should prioritize:

- Parcels adjacent to existing conservation land
- Unprotected forest interior habitats
- Floodplain areas with repeated inundation risk
- Ecological corridor pinch points
- High biodiversity hotspots identified in habitat assessments Acquisition strategies may include:
- Fee simple purchase
- Land swaps
- Partnership acquisitions with land trusts
- Open space set-asides during development approvals

9.3 Habitat Restoration Opportunities

Restoration should focus on: (Friedland & Relyea, 2019; Mansfield, Connecticut, 2023)

- Reconnecting fragmented forest patches
- Restoring degraded wetlands
- Reestablishing riparian buffers
- Removing invasive plant species
- Enhancing pollinator habitat in open fields

Restoration projects improve both ecological function and climate resilience. do you have citations or resources that led you to these recommendations?

9.4 Alignment with the Plan of Conservation and Development (POCD)

The NRI should directly support Manchester's Plan of Conservation and Development by:

- Identifying priority conservation areas
- Supporting open space acquisition goals
- Informing land-use allocation decisions
- Guiding sustainable growth patterns
- Supporting climate resilience objectives

The POCD and NRI should be used together to ensure:

- Ecological systems are considered in development planning
- Growth is directed away from sensitive areas
- Infrastructure aligns with environmental constraints

9.5 Alignment with Zoning Regulations

Zoning regulations should be informed by NRI findings to:

- Protect wetlands and buffer zones
- Limit development in flood-prone areas
- Preserve agricultural soils and open space
- Reduce fragmentation of forest systems
- Maintain wildlife corridor continuity

The NRI can help identify where zoning updates may be needed to:

- Reduce environmental risk
- Improve land-use compatibility
- Strengthen conservation outcomes

Environmental Review Applications The NRI should be used in:

- Subdivision review processes
- Site plan evaluations
- Environmental impact assessments
- Conservation commission decisions

This ensures consistent ecological consideration in municipal approvals.

9.6 Regular Updates and Adaptive Management

The purpose of this section is to establish the NRI as a ,.living document" that is continuously updated as environmental conditions and scientific data evolve. Environmental systems are dynamic, meaning:

- Land use changes over time
- Climate conditions shift
- Species distributions change
- New environmental threats emerge

Regular updates ensure the NRI remains accurate and relevant.

9.7 Annual Review

The NRI should undergo annual updates that incorporate:

- New land use changes
- Updated wetland or habitat data
- Invasive species survey results
- New conservation acquisitions
- Infrastructure expansions
- Flood or storm event impacts

Annual updates ensure the inventory reflects current conditions.

9.8 Ten-Year Comprehensive Update

A full NRI revision should occur every 10 years, including:

- Complete dataset updates (CTDEEP, USGS, FEMA, etc.)
- Revised eco-type classification
- Updated climate projections
- Expanded habitat and species assessments
- Re-evaluation of conservation priorities
- Integration of new scientific methods and datasets

This ensures long-term scientific and planning accuracy.

Monitoring and Data Continuity

To maintain continuity, Manchester should:

- Maintain a centralized GIS database
- Standardize data collection methods
- Document all dataset updates
- Track environmental change over time

This creates a long-term environmental monitoring framework.

9.9 Emerging Environmental Issues to Integrate

Future updates to the NRI should consider adding dedicated sections for:

Light Pollution

- Impacts on nocturnal wildlife
- Effects on migratory birds
- Ecological disruption in forest edges and open space systems Emerging Chemical Contaminants
- New pesticide formulations
- Industrial chemical byproducts
- Microplastics in soil and water systems Climate Extremes
- Increased heatwave frequency
- Severe storm intensification
- Drought-flood cycling impacts

Urban Environmental Stressors

- Heat island effects
- Air quality degradation
- Noise pollution impacts on wildlife

9.10 Framework Expansion Strategy

When new environmental issues emerge, the NRI should:

- Add dedicated thematic chapters or subsections
- Integrate new datasets into GIS systems
- Update mapping and analysis procedures
- Revise conservation priorities accordingly

This ensures the NRI remains scientifically current and policy-relevant.

9.11 Adaptive Stewardship Philosophy The NRI should be treated as:

- A continuously improving scientific system
- A decision-support tool for planning
- A long-term environmental monitoring framework
- A living document reflecting ecological change

This adaptive approach ensures that Manchester's environmental planning remains responsive to future ecological and climate conditions.

Conclusion

This Instructional Manual establishes a standardized and repeatable framework for developing a comprehensive NRI for the Town of Manchester, Connecticut. It is designed to translate environmental data into an organized system for understanding ecological conditions, guiding land-use decisions, and supporting long-term conservation and planning efforts. The manual demonstrates that an NRI is not simply a collection of maps or datasets, but an integrated environmental intelligence system. By combining ecological classification, watershed analysis, habitat assessment, land-use interpretation, and climate evaluation, the NRI provides a unified structure for understanding how natural and human systems interact across the Through its step-by-step methodology, this manual ensures that users can move from raw environmental data to meaningful ecological interpretation. It standardizes the process of data collection, GIS integration, eco-type classification, and spatial analysis so that results remain consistent, reproducible, and applicable across time. The inclusion of regulatory alignment with the Plan of Conservation and Development (POCD) and zoning frameworks ensures that the NRI directly supports municipal decision-making. At the same time, its adaptive structure allows it to evolve in response to new environmental challenges, scientific advancements, and emerging ecological stressors. Ultimately, this manual positions the NRI as a living planning document, one that supports conservation stewardship, strengthens climate resilience, and enhances the town's ability to make informed, science-based land-use decisions. By maintaining and updating this framework over time, Manchester can ensure that its environmental planning remains proactive, data-driven, and responsive to both ecological change and community needs

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Part 2: Natural Resource Inventory Report Template

Front Matter

Title Page

Include:

- Project title
- Municipality name
- Date of completion
- Town seal or municipal logo
- Lead organizations and contributors

Executive Summary

Provide a concise overview of:

- Major natural resources
- Significant ecological systems
- Key environmental findings
- Primary conservation concerns
- Major planning implications

Glossary of Terms

Define technical terminology used throughout the inventory, including:

- Natural Resource Inventory (NRI)
- Geographic Information Systems (GIS)
- Spatial dataset
- Eco-types
- Watershed
- Vernal pool
- Riparian corridor
- Habitat fragmentation

Acknowledgments

Recognize contributions from:

- Conservation Commission
- Municipal departments
- Regional planning agencies

- Research institutions
- Community organizations
- Scientific and technical advisors

Benchmark Reference Frameworks

The structure and organization of this NRI should be informed by established Connecticut Natural Resource Inventories, including: that it may be worth having the template as a separate document

- Branford NRI: resilience and floodplain-focused StoryMap framework
- Salisbury NRI (2022): detailed ecological narrative structure
- Canton NRI: policy-integrated ecological classification framework
- Colebrook NRI: simplified rural ecological inventory model

These reference inventories demonstrate that a modern NRI is not simply a map collection, but a layered ecological interpretation system integrating:

- GIS analysis
- Scientific narrative
- Environmental planning
- Policy relevance
- Conservation strategy.

Chapter 2 Template Structure Chapter 3 Template Structure

3.1 Introduction

- Importance of soils within ecological systems
- Relationship between soils and land-use planning

3.2 Soil Composition and Characteristics

- Soil formation processes
- Major soil groupings
- Ecological and hydrological influence

3.3 Statewide Important Farmland Soils

- Agricultural soil classifications
- Preservation importance
- Agricultural capability mapping

3.4 Hydric and Regulated Soils

- Wetland-associated soils
- Environmental constraints
- Conservation importance

Recommended Maps and Figures

- Soil classification map
- Prime farmland soils map
- Hydric soils map

- Soil drainage classification map
- Development suitability overlay
- Erosion susceptibility map Recommended GIS Data Sources
- NRCS SSURGO
- USDA Web Soil Survey
- CT ECO
- FEMA floodplain layers
- Municipal GIS data
- USGS elevation datasets

Chapter 4 Template Structure

4.1 Introduction

- Importance of water resources
- Relationship between hydrology and ecology
- Watershed planning framework

4.2 Watershed Systems and Drainage Basins

- Watershed boundaries
- Drainage patterns
- Hydrological connectivity
- Watershed stressors

4.3 Rivers and Streams

- Hockanum River system
- Flood resilience
- Stream stability
- Road-stream crossing inventory
- Aquatic passage analysis

4.4 Groundwater and Aquifers

- Aquifer systems
- Recharge areas
- Groundwater quality
- Contamination stressors
- Neonicotinoid and pollutant analysis

4.5 Wetlands and Vernal Pool Systems

- Wetland classifications
- Vernal pools
- Hydric systems
- Upland review areas
- Wetland conservation importance

Recommended Maps and Figures

- Watershed boundaries map
- Stream and river network map
- FEMA floodplain map
- Road-stream crossing inventory map
- Aquifer recharge map
- Wetland classification map
- Vernal pool distribution map
- Upland review area buffer map Recommended GIS Data Sources
- CT DEEP Hydrography
- CT ECO
- National Wetlands Inventory (NWI)
- FEMA Flood Insurance Rate Maps
- USGS hydrology datasets
- Municipal stormwater infrastructure datasets

Chapter 5 Template Structure

5.1 Introduction

- Importance of biological communities
- Biodiversity and ecosystem resilience
- Ecological planning framework

5.2 Eco-Type Mapping and Ecological Land Classification

- Land cover classification
- Ecological system categories
- Habitat distribution analysis
- Ecological interpretation

5.3 Upland Forest Systems

- Forest core analysis
- Town Forest systems
- Forest fragmentation
- Ecological functions

5.4 Wildlife Habitat and Species Assessment

- Habitat zone analysis
- Species distribution
- Species of Greatest Conservation Need
- Biodiversity considerations

5.5 Wildlife Corridors and Ecological Connectivity

- Corridor systems
- Habitat linkages

- Fragmentation impacts
- Regional ecological connectivity

Recommended Data Sources

- CT ECO land cover datasets
- CT DEEP Natural Diversity Database
- National Land Cover Database (NLCD)
- Municipal open space records
- Forest canopy datasets
- Wildlife habitat studies
- Regional ecological corridor research

Chapter 6 Template Structure

6.1 Introduction

- Relationship between land use andcommunity character
- Importance of conservation and cultural landscapes
- Planning and sustainability relevance

6.2 Open Space and Conservation Lands

- Parks and green spaces
- Conservation lands
- Land trust properties
- Ecological and recreational value

6.3 Historic and Scenic Resources

- Historic districts
- Cheney Brothers Mill District
- Scenic river corridors
- Cultural landscape preservation

6.4 Agricultural Resources

- Active farmland
- Nurseries and agricultural operations
- Soil productivity
- Agricultural preservation considerations

Recommended Maps and Figures

- Open space and conservation land map
- Park and recreation map
- Historic district map
- Scenic corridor map
- Agricultural land-use map
- Prime farmland soils map

- Land use classification map

Recommended Data Sources

- Municipal open space records
- Local land trust data
- CT DEEP land-use datasets
- Historical society archives
- NRCS farmland soil classifications
- Municipal planning and zoning records
- Agricultural land-use records

Chapter 7 Template Structure

7.1 Introduction

- Overview of climate and environmental stressors
- Relationship between climate change and ecological systems
- Long-term environmental resilience considerations

7.2 Climate Change and Regional Environmental Shifts

- Temperature change trends
- Altered precipitation patterns
- Seasonal and hydrological changes
- Ecological impacts of climate change

7.3 Environmental Challenges and Ecological Stressors

- Habitat fragmentation
- Development pressure
- Invasive species
- Urbanization impacts

7.4 Pollution Trends and Environmental Contaminants

- Surface and groundwater quality
- Pollution pathways
- Pesticides and neonicotinoids
- Long-term contaminant concerns
- Environmental monitoring priorities Recommended Maps and Figures
- Flood vulnerability map
- Habitat fragmentation map
- Impervious surface coverage map
- Climate-sensitive habitat map
- Pollution source vulnerability map
- Groundwater contamination risk map
- Invasive species distribution map

Recommended Data Sources

- NOAA climate datasets
- FEMA floodplain data
- CT DEEP environmental monitoring data
- Watershed and hydrology studies
- Municipal land-use records
- Environmental contaminant studies
- Regional climate adaptation reports

Chapter 8 Template Structure

8.1 Introduction

- Purpose of GIS within the NRI
- Relationship between spatial data, ecological analysis, and public communication
- Overview of ArcGIS Online, ArcGIS Pro, and StoryMap use

8.2 StoryMap Structure

- Recommended thematic sections
- Interactive map requirements
- Narrative and visual content requirements
- Public-facing communication goals

8.3 Beginner ArcGIS Workflow

- Starting a web map
- Selecting a basemap
- Adding public data layers
- Renaming, styling, and organizing layers
- Saving and documenting map items

8.4 Accessing Public GIS Data

- CT ECO data download and map services
- CT DEEP GIS Open Data
- FEMA floodplain data
- USDA NRCS soils data
- USGS elevation and hydrology data
- National Wetlands Inventory data
- ArcGIS Living Atlas public layers

8.5 Recommended Maps and Figures

- StoryMap structure diagram
- GIS workflow diagram
- Data source inventory table
- Example ArcGIS layer organization screenshot
- Map quality-control checklist

8.6 Recommended Data Sources

- ArcGIS Online and ArcGIS Living Atlas
- CT ECO
- CT DEEP GIS Open Data
- Town of Manchester GIS or municipal records
- FEMA Flood Map Service Center
- USDA NRCS Web Soil Survey and SSURGO
- USGS National Map and hydrology datasets
- U.S. Fish and Wildlife Service National Wetlands Inventory

Chapter 9 Template Structure

9.1 Introduction

- Purpose of stewardship and recommendations
- NRI as a living planning tool

9.2 Action Items

- Conservation easements
- Land acquisition priorities
- Habitat restoration strategies

9.3 Regulatory Alignment

- POCD integration
- Zoning regulation alignment
- Planning and development review applications

9.4 Regular Updates

- Annual review process
- Ten-year comprehensive update
- Data continuity and monitoring

9.5 Expanding the Framework

- Light pollution
- Emerging contaminants
- Climate extremes
- Urban environmental stressors
- Adaptive management approach

References and Public Data Resources

The NRI should include direct links to the public data resources used to support mapping, analysis, and citations. Recommended starting resources include:

- ArcGIS Online Help: Add layers to maps and add layers from URL.
- ArcGIS StoryMaps Help: Create a story and add web maps or web scenes.

- ArcGIS Living Atlas of the World: Curated public data layers that can be added directly to maps.
- CT ECO Data Download: Connecticut environmental and natural resource GIS layers.
- CT DEEP GIS Open Data: Downloadable Connecticut environmental GIS data and map services.
- FEMA Flood Map Service Center: Flood hazard and floodplain mapping.
- USDA NRCS Web Soil Survey and SSURGO: Soil and farmland classification data.
- USGS National Map: Elevation, hydrography, and topographic datasets.
- U.S. Fish and Wildlife Service National Wetlands Inventory: Wetland classification data.