ARCADIS Design & Consultancy for natural and built assets

# City of Fitchburg, Massachusetts

## STORMWATER MANAGEMENT MANUAL

### Operations and Maintenance for Municipal Facilities

June 2021


# CONTENTS

# TABLES



# APPENDICES

# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AST | Aboveground Storage Tank |
| BMP | Best Management Practice |
| CWA | United States Environmental Protection Agency's Clean Water Act |
| DEP | Massachusetts Department of Environmental Protection |
| DPW | Department of Public Works |
| EPA | United States Environmental Protection Agency |
| IDDE | Illicit Discharge Detection and Elimination |
| MCM | Minimum Control Measure |
| MS4 | Municipal Separate Storm Sewer System |
| MSDS | Material Safety Data Sheet |
| NPDES | National Pollutant Discharge Elimination System |
| NOI | Notice of Intent |
| SWPPP | Stormwater Pollution Prevention Plan |
| SPCC | Spill Prevention, Control and Countermeasure |
| TMDL | Total Maximum Daily Load |
| TSS | Total Suspended Solids |
| UST | Underground Storage Tank |
| WQS | Water Quality Standards |

# 1 INTRODUCTION

As part of the National Pollutant Discharge Elimination System (NPDES) General Permit for small Municipal separate storm sewer system (MS4) Permit the City of Fitchburg (City) has adopted pollution prevention and good housekeeping controls intended to ensure that municipal operations and activities conducted at municipally-owned facilities do not contribute to stormwater pollution. In most urbanized areas such as Fitchburg, stormwater is conveyed through a system of catch basins and pipes commonly referred to as a stormwater drainage system. Stormwater pollution can be conveyed through the stormwater drainage system and affects the quality of the City's surface waters including North Nashua River, Falulah Brook, Baker Brook, Flag Brook, and Whitman River.

These good housekeeping controls, referred to as best management practices (BMPs), are standard operating procedures for municipal personnel and for use at all municipal-owned facilities. These BMPs are intended to serve as guidance for properly conducting municipal-wide operations such as street sweeping, cleaning out catch basins, and general maintenance of the stormwater drainage system, and municipal-owned facilities including vehicle maintenance, vehicle washing, lawn care, and materials management.

## 1.1 Manual Purpose and Scope

The purpose of the Stormwater Management Manual (Manual) is to provide standard operating procedures for typical municipal facility operations and activities to reduce and eliminate contamination that may enter Municipal facilities' stormwater drainage systems. These standard operating procedures are referred to as best management practices (BMPs) in this manual and this manual is intended to fulfill the MS4 Permit requirements for Operation and Maintenance (O&M) Plans and Stormwater Pollution Prevention Plans (SWPPPs) for permittee owned facilities.

The BMPs in this Manual were selected based on a review and inventory of operations and activities at municipal-controlled facilities. The BMPs are intended to provide straightforward and up-to-date procedures for municipal personnel to follow in conducting their day-to-day activities. The Manual should be reviewed annually and periodically revised whenever operations and/or activities at these facilities change or in response to regulatory or permit changes.

### 1.1.1 Organization of Manual

The Stormwater Management Manual is organized into the following sections:

- Section 1: Provides an overview of the Manual's purpose and content, as well as watersheds and water quality overviews.

- Section 2: Provides a listing of municipal leasees'/site users' responsibilities to adhere to permit regulations.

- Section 3: Provides BMP fact sheets for operations and activities conducted at municipal-controlled facilities. These BMP fact sheets are intended to be used as guidance that include suggested BMPs, inspection procedures and maintenance procedures. Each BMP fact sheet includes a list of targeted facilities and operations, and pollutant constituents. These fact sheets are simple (two to three pages) and are intended to be copied and distributed as necessary to facility personnel, and/or contractors who work on-site.

- Appendix A: Identifies BMP activities relevant to specific Municipal properties and facilities that have been inspected as part of the good housekeeping work. This Appendix also lists the Pollution Prevention Team for facilities requiring a formal Stormwater SWPPP.

- Appendix B: Includes stormwater system maps for the specific Municipalfacilities inspected. Attributes including stormwater drainage system components (drain manholes, catch basins and gravity mains) and, if applicable, discharge points (stormwater outfalls) are shown for each inspected facility. Maps should be made available to necessary facility personnel and contractors who work on-site.

- Appendix C: Provides a blank sign-in sheet for use at future training sessions.

- Appendix D: Good Housekeeping Inspection Form. The Good Housekeeping Inspection Form should be used at each facility on an annual basis. It serves as a checklist for facility managers to ensure that BMPs are being properly implemented and that if any new activities are being conducted, additional BMPs are implemented.

- Appendix E: Municipal Standard Operating Procedures (SOP) for catch basin cleaning, street sweeping, and winter maintenance.

- Appendix F: Municipal Structural Best Management Practices (BMP)

### 1.1.2 Manual Updates

The Stormwater Management Manual should be reviewed and updated on an annual basis after the Good Housekeeping Inspection Form (Appendix D) is completed for the various Municipal facilities. If during any Municipal facility inspections, additional activities are identified, additional BMPs should be placed in this Manual. In addition, BMPs should be revised based on updated procedures and protocols adopted by the City, or in response to regulatory changes or permit conditions.

## 1.2 Stormwater Pollutants and Impacts on Water Quality

Pollutant impacts to the receiving surface waters of Municipal facilities can be attributable, to an extent, to contaminated runoff that enters the facilities' stormwater drainage systems and discharges through outfalls.

### 1.2.1 Watersheds and Pollutants of Concern

Receiving surface waters and pollutants of concern for the City of Fitchburg are listed in Table 1-1. Additionally, Total Maximum Daily Loads (TMDLs) established for the area have been noted. TMDLs are regulatory limits established for pollutants to surface waters in order to maintain water quality standards.

Municipal separate storm sewer system (MS4) outfalls that are covered by the NPDES permit and are located at municipal facilities are provided on the stormwater system maps found in Appendix B. These maps also provide details on the layout of the stormwater drainage system, including catch basins, manholes, and pipes. These maps provide important information to guide actions described in this Manual.

**Table 1. City of Fitchburg, MA Receiving Waters**

| Receiving Waterbody and Segment ID | Surface Water Class | TMDL Category | Impairment |
|---|---|---|---|
| Baker Brook (MA81-62) | Class B | Category 5 | E. Coli |
| Baker Pond | Class B | Category 3 | Insufficient Information |
| Falulah Brook (MA81-63) | Class B | Category 5 | E. Coli |
| Flag Brook (MA81-10) | Class B | Category 2 | Not Assessed |
| Goodfellow Pond | Class A | Category 3 | Insufficient Information |
| Greenes Pond | Class B | Category 3 | Insufficient Information |
| Lowell Reservoir (MA81074) | Class A | Category 3 | Insufficient Information |
| McTaggarts Pond | Class B | Category 3 | Insufficient Information |
| Mirror Lake (MA81084) | Class B | Category 3 | Insufficient Information |
| Monoosnuc Brook (MA91-13) | Class B | Category 5 | E. Coli |
| North Nashua River (MA81-01) | Class B | Category 5 | E. Coli |
| North Nashua River (MA81-02) | Class B | Category 5 | Ambient Bioassays -- Chronic Aquatic Toxicity, Aquatic Macroinvertebrate Bioassessments, E. Coli |
| Notown Reservoir (MA81092) | Class A | Category 3 | Insufficient Information |
| Overlook Reservoir | Class A | Category 3 | Insufficient Information |
| Pearl Hill Brook (MA81-80) | Class B | Category 5 | Enterococcus |
| Phillips Brook (MA81-12) | Class B | Category 2 | Not Assessed |
| Sand Brook | Class B | Category 3 | Insufficient Information |
| Sawmill Pond (MA81118) | Class B | Category 4c | Non-Native Aquatic Plants |

| Receiving Waterbody and Segment ID | Surface Water Class | TMDL Category | Impairment |
|---|---|---|---|
| Scott Reservoir (MA81119) | Class A | Category 3 | Insufficient Information |
| Shea Brook | Class B | Category 3 | Insufficient Information |
| Sheldon Brook | Class B | Category 3 | Insufficient Information |
| Snows Millpond (MA81127) | Class B | Category 3 | Insufficient Information |
| Summond Pond | Class B | Category 3 | Insufficient Information |
| Whitman River (MA81-11) | Class B | Category 2 | Not Assessed |
| Wymans Brook | Class B | Category 3 | Insufficient Information |

### 1.2.2 Pollutant Impacts on Water Quality

Typical pollutants, including environmental effects and sources, found in stormwater runoff include the following:

Sediment

- Sediment is often viewed as the largest pollutant load associated with stormwater runoff in an urban setting. The loadings have been shown to be exceptionally high in the case of construction activity.
- Sediment is associated with numerous impacts in surface waters, including increased turbidity, effects on aquatic and benthic habitat and reduction in capacity of impoundments.
- A number of other pollutants often attach to, and are carried by, sediment particles.

Nutrients

- The nutrients most often identified in stormwater runoff are phosphorous and nitrogen.
- In surface waters, these nutrient loads can lead to heavy algae growth, eutrophication and low dissolved oxygen levels. Nutrients enter the stormwater drainage system in a variety of ways, including landscaping practices in parks and recreation areas, leaks from sanitary sewers or septic systems, and animal wastes.

Organic Matter

- Various forms of organic matter may be carried by stormwater in urban areas. Decomposition of this material by organisms in surface waters results in depleted oxygen levels.
- Low levels of dissolved oxygen severely impact water quality and life within surface waters.
- Sources of organic matter include garbage and yard waste.

Bacteria (Pathogens)

- High bacteria levels may be found in stormwater runoff as a result of garbage, pet waste, and illegal connections from sanitary sewers or leaking septic systems.

- The impacts of bacteria on surface waters may affect recreational uses and aquatic life as well as impose health risks.

Oil and Grease

- Numerous activities produce oil, grease and lubricating agents that are readily transported by stormwater.
- The intensity of activities, including vehicle traffic, maintenance and fueling activities, leaks and spills, and manufacturing processes within an urban setting contribute heavily to the level of these pollutants present in adjacent surface waters.

Heavy Metals

- Heavy metals such as copper, lead, zinc, arsenic, chromium and cadmium may be typically found in urban stormwater runoff.
- Metals in stormwater may be toxic to some aquatic life and may accumulate in aquatic animals.
- Sources of metals in stormwater may include automobiles, paints, preservatives, motor oil, and various urban activities.

Temperature

- Stormwater runoff increases in temperature as it flows over impervious surfaces. In addition, water stored in shallow, unshaded ponds and impoundments can increase in temperature.
- Removal of natural vegetation (such as tree canopy) opens up water bodies to direct solar radiation.
- Elevated water temperatures can impact a water body's ability to support certain fish and other aquatic organisms.

Pesticides and Herbicides

- Pesticides and herbicides in stormwater runoff can be toxic, even at low concentrations, to aquatic life and the birds that feed on them.

Trash and Debris

- Trash and debris including floatables, plant debris, animal wastes, street litter and other material may contain pollutants including metals, pesticides, bacteria and other toxins.
- Trash and debris can harbor bacteria, vectors, and low dissolved oxygen concentrations in surface waters affecting aquatic life.

Vectors

- Vectors including mosquitoes and rodents can frequent in standing waters, including drainage structures, and eventually live and reproduce in such structures resulting in disease spread and a local nuisance.

# 2 CITY OF FITCHBURG STORMWATER MANAGEMENT POLICY

The City of Fitchburg recognizes and is in full agreement with the Clean Water Act's National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges from Small Municipal Separate Storm Sewer Systems. The City's approach and detailed implementation schedule is provided in the Stormwater Management Plan. A copy is available at the Department of Public Works or on the City's Stormwater Management webpage.

## 2.1 Other Related Policies and Protocols

The municipality's current documented policies and protocols that are applicable to good housekeeping and pollution prevention include the following:

- Illicit Discharge Detection and Elimination Plan
- Stormwater Bylaw
- Stormwater Management Rules and Regulations
- Catch Basin Inspection and Cleaning Standard Operating Procedures (SOP)
- Snow Removal and De-Icing SOP
- Street Sweeting SOP

In addition, the DPW has the following guidance document for Vehicle Maintenance and Storage and Spill Prevention and Response: DPW's "*Spill Prevention, Control, and Countermeasure Plan (SPCC) Plan"*. These documents supplement the above referenced BMPs for further information. The most recent versions of these documents reside with the DPW. The Department of Public Works can be contacted on how to receive a copy of any one of these.

## 2.2 Requirements of Leases

The following is an example language that can be inserted into Municipal leases:

"The City of Fitchburg has submitted a Notice of Intent (NOI) to the Massachusetts DEP and EPA to obtain coverage under the NPDES Small MS4 General Permit. A copy of the NOI is available for review. In order to comply with the Permit requirements, the City has developed Best Management Practices (BMPs) that parties leasing Municipal owned properties must adhere to. These BMPs contain pollution prevention and source control techniques to minimize the impact of those activities upon dry-weather urban runoff, stormwater runoff, and receiving water quality.

Activities performed at the facility leased shall conform to the Permit and BMPs, and must be performed as described within all applicable BMPs. The lessee shall fully understand the BMPs applicable to activities conducted at the facility leased prior to conducting them and maintain copies of the BMPs at the leased facility throughout the agreement duration.

Evaluation (or cost) of activities performed at the facility leased may be conducted by the City to verify compliance with BMP requirement and may be required through lessor self-evaluation as determined by the City."

## 2.3 Requirements of Contractors on Municipal Property

The following is example language that can be inserted into municipal field program contracts:

“The City of Fitchburg has submitted a Notice of Intent (NOI) to the Massachusetts DEP and EPA to obtain coverage under the NPDES Small MS4 General Permit. A copy of the NOI is available for review. In order to comply with Permit requirements, the City has developed Best Management Practices (BMPs) that parties conducting the municipal activities must adhere to. These BMPs apply to any party conducting municipal activities and contain pollution prevention and source control techniques to minimize the impact of those activities upon dry-weather urban runoff, stormwater runoff, and receiving water quality.

Work performed under this CONTRACT shall conform to the Permit requirements and BMPs, and must be performed as described within all applicable BMPs. The CONTRACTOR shall fully understand the BMPs applicable to activities that are being conducted under this CONTRACT prior to conducting them and maintain copies of the BMPs throughout the CONTRACT duration. The applicable BMPs are included as Exhibit ___ of this CONTRACT.

Evaluation of activities subject to BMPs performed under this CONTRACT may be conducted to verify compliance with BMP requirements and may be required through CONTRACTOR self-evaluation as determined by the City.”

# 3 BEST MANAGEMENT PRACTICES

Guidance on good housekeeping best management practices (BMPs) to be performed at muncipal facilities is presented using the fact sheets provided in this section. Each of the fact sheets provides a description of the practice, the pollution prevention approach, suggested practices, inspection procedures and maintenance procedures. In addition, the targeted facilities, operations and pollutant constituents are identified. All of the suggested BMPs do not need to be implemented for the targeted facilities and operations. The BMPs that reduce an influx of pollutants to the stormwater drainage system to the maximum extent practicable should be considered for implementation.

Implemented BMPs should be reviewed annually for effectiveness using the Good Housekeeping Inspection Form provided in Appendix D, and adjusted as necessary.

## 3.1 Fueling Operations and Petroleum Tank Storage

### Purpose and Approach

Vehicle fueling operations can impact water quality if stormwater runoff from areas with these activities occurring within them becomes polluted by components of the fuel. Spills and leaks that occur during vehicle and equipment fueling can contribute hydrocarbons, oil and grease, as well as heavy metals to stormwater runoff. It only takes 1 gallon of oil to contaminate 1 million gallons of drinking water. Similarly, activities and leaks from petroleum storage tanks have the potential to contaminate stormwater runoff.

In the Inspection Matrix Fueling Operations and Petroleum Tank Storage are separate inspection forms.

### Best Management Practices (BMPs)

*General Practices*

- Store fluids in labeled, plastic or metal container with a lid.
- Place flammables in a fire safe cabinet.
- Place drip pans under leaking vehicles, valves, spigots, and pumps.
- Routinely check for leaking vehicles.
- Do not conduct any vehicle maintenance near catch basins.
- Vehicle maintenance should be done in covered facility.

*Fueling*

- Ensure that all fueling activities are not conducted near catch basins or that procedures are in place to control any spills.
- Fuel storage tanks should be placed in impervious surfaces with no cracks or gaps; secondary containment is recommended.
- Provide barriers such as posts, guard rails, or bollards where tanks are exposed to prevent collision damage with vehicles.

Targeted Facilities and Operations

- All Fleet Vehicle and Equipment Operations
- All Facilities with petroleum storage tanks.

Targeted Constituents

- Sediment
- Nutrients
- Trash
- Metals
- Oil & Grease
- Hydrocarbons

Reference

- “California Stormwater Quality Association Municipal BMP Handbook”

- Post signs at the fuel dispenser or fuel island warning vehicle owners / operators against “topping off” of vehicle fuel tanks.
- Label drains within the facility boundary by paint/stencil (or equivalent) to indicate whether they flow to the sanitary sewer, to a catch basin, or into a dry well.

*Petroleum Storage Tanks*

- Ensure that outdoor storage areas are covered with a roof.
- Clearly tag or label valves and restrict access to valves.
- Provide secondary containment for all ASTs and portable containers of petroleum containing liquids.
- Place drip pans, absorbent materials, and/or secondary containment measures beneath all mounted container taps.
- Maintain spill kits that are clearly marked and located near all locations where loading and unloading of USTs or ASTs occur.
- Keep drums and other containers in good condition. Replace when drums and other containers when leaks, corrosion, or deterioration is identified.
- Label new or secondary containers with the product name and hazards.
- Keep SPCC Plan up-to-date and implement accordingly.
- Clean up spill and leaks that occur during loading and unloading operations promptly and dispose of materials properly.
- Drums are stored indoors and in an area with secondary containment free of materials that may damage drums.

## Inspection Procedures

*Fueling*

- Identify locations of floor drains and catch basins and know where they discharge to. Floor drains should be connected to the sanitary sewer system and catch basins should be connected to the stormwater drainage system.
- Regularly inspect vehicles and equipment for leaks and repair immediately.
- Inspect fuel storage tank foundations, connections, coatings, tank walls and piping system. Look for corrosion, leaks, cracks, scratches and other physical damage that may weaken the tank or container system.
- Inspect fueling areas, catch basin inserts, containment areas and drip pans on a regular schedule.

*Petroleum Storage Tanks*

- Regularly inspect stormwater collection structures for petroleum sheen before draining. When sheen is detected, water should be removed and disposed of properly via sanitary contractor.
- Regularly Inspect storage areas for Spills and leaks.

## Maintenance Procedures

- Sweep the maintenance area on a regular basis to collect loose particles. Wipe up spills with rags and other absorbent material immediately. Do not hose down the area to a catch basin.

- Keep ample supplies of spill cleanup materials on-site. Clean up spills immediately.
- Properly train employees, leases/site users, hired contractors and any other personnel working with vehicles on fueling and handling oil and waste oil.

## 3.2 Vehicle Washing


### Purpose and Approach

Wash water from vehicle and equipment cleaning activities performed outdoors or in areas where wash water flows onto the ground can contribute toxic hydrocarbons and other organic compounds, oils and greases, nutrients, phosphates, heavy metals, and suspended solids to stormwater runoff. It is important to be responsible with soap and detergents used during washing to ensure phosphates and other contaminants do not enter water bodies. Most soap products contain phosphates that can increase algae growth and degrade surface water quality.

Targeted Facilities and Operations

- All Fleet Vehicle and Equipment Operations

Targeted Constituents

- Sediment
- Nutrients
- Trash
- Metals
- Oil & Grease
- Organics

Reference

- "California Stormwater Quality Association Municipal BMP Handbook"

### Best Management Practices (BMPs)

*General*

- Use biodegradable, phosphate-free detergents for washing vehicles as appropriate.
- Mark the area clearly as a wash area.
- Post signs stating that washing is only allowed in wash area and that discharges to the stormwater drainage system are prohibited. Facility employees should know where catch basins are.
- Provide a trash container in wash area. Vacuum floor mats or shake them into trash.
- Those that use facility to wash vehicles (e.g., students) should be informed of proper washing protocols.

*Vehicle and Equipment Cleaning*

- Install sumps or drain lines to collect wash water or construction of a berm around the designated area and grading of the area to collect wash water as well as prevent stormwater run-on.
- Consider washing vehicles and equipment inside the building if washing/cleaning must occur on-site.
- If washing must occur on-site and outdoors:
  - Use designated paved wash areas. Designated wash areas must be well marked with signs indicating where and how washing must be done. This area must be covered or bermed.

    to collect the wash water and graded to direct the wash water to a treatment or disposal facility, or washing must take place on a grassed area.

  - Cover the wash area when not in use to prevent contact with rain water.
  - Cover and protect catch basins during washing.
- Use hoses with nozzles that automatically turn off when left unattended. Use high-pressure, low-volume sprays.
- Perform pressure cleaning and steam cleaning off-site to avoid generating runoff with high pollutant concentrations. If done on-site, no pressure cleaning and steam cleaning should be done in areas designated as wellhead protection areas for public water supply.

*Disposal*

- Filter and recycle wash water if possible.

## Inspection Procedures

- Inspect floor drain systems regularly; use only those that discharge to a sanitary sewer.
- Inspect nearby catch basins annually.

## Maintenance Procedures

- Maintain a map of on-site stormwater drainage system locations to avoid discharges to the stormwater drainage system.
- Take precautions against excess use and spillage of detergents.
- Clean vehicles only where wastes can be captured for proper disposal, such as a commercial vehicle wash station.

## 3.3 Vehicle and Equipment Maintenance

### Purpose and Approach

Vehicle repair and service (e.g., parts cleaning and fueling), replacement of fluids (e.g., oil change), and outdoor equipment storage and parking (dripping engines) can impact water quality if stormwater runoff from areas with these activities occurring on them becomes polluted by a variety of contaminants. Spills and leaks that occur during vehicle and equipment fueling can contribute hydrocarbons, oil and grease, as well as heavy metals to stormwater runoff. It only takes 1 gallon of oil to contaminate 1 million gallons of drinking water.

### Best Management Practices (BMPs)

- General Practices
- Fueling
- Vehicle Maintenance
- Disposal
- Used Oil

*General Practices*

- Store fluids in labeled, plastic or metal container with a lid.
- Place flammables in a fire safe cabinet.
- Place drip pans under leaking vehicles, valves, spigots, and pumps.
- Routinely check for leaking vehicles.
- Do not conduct any vehicle maintenance near catch basins.
- Vehicle maintenance should be done in covered facility.

Targeted Facilities and Operations

- All Fleet Vehicle and Equipment Operations

Targeted Constituents

- Sediment
- Nutrients
- Trash
- Metals
- Oil & Grease
- Hydrocarbons

Reference

- “California Stormwater Quality Association Municipal BMP Handbook”

*Vehicle Maintenance*

- Provide a designated area for vehicle maintenance on an impervious surface.
- Keep equipment clean; don't allow excessive build-up of oil and grease.
- If possible, perform all vehicle fluid removal or changing inside or under cover:
  - Keep a drip pan under the vehicle while you unclip hoses, unscrew filters or remove other parts.
  - Promptly transfer used fluids to the proper waste or recycling drums. Don't leave drip pans or other open containers lying around.
  - Keep drip pans or containers under vehicles or equipment that might drip during repairs.
  - Do not change motor oil or perform equipment maintenance in non-appropriate areas.
- If temporary work is being conducted outside, use a tarp, ground cloth or drip pan beneath the vehicle or equipment to capture all spills and drips.

*Disposal*

- Fluids should be recycled or properly disposed.
- Full pans should be dumped into 55-gallon drums.
- Drain fluids from out-of-service vehicles.
- Dispose of debris including oil filters, oil cans, rags, and clean-up supplies.
- Vehicle fluids should never be dumped down catch basins.
- Interior floor drains should discharge to holding tanks or be sealed.

*Used Oil*

- Recycle used oil.
- Do not mix wastes with used oil.

## Inspection Procedures

- Identify locations of floor drains and catch basins and know where they discharge to. Floor drains should be connected to the sanitary sewer system and catch basins should be connected to the stormwater drainage system.
- Regularly inspect vehicles and equipment for leaks and repair immediately.
- Inspect fuel storage tank foundations, connections, coatings, tank walls and piping system. Look for corrosion, leaks, cracks, scratches and other physical damage that may weaken the tank or container system.
- Inspect fueling areas, catch basin inserts, containment areas and drip pans on a regular schedule.

## Maintenance Procedures

- Sweep the maintenance area on a regular basis to collect loose particles. Wipe up spills with rags and other absorbent material immediately. Do not hose down the area to a catch basin

- Keep ample supplies of spill cleanup materials on-site.  Clean up spills immediately.
- Properly train employees, leases/site users, hired contractors and any other personnel working with vehicles on fueling and handling oil and waste oil

## 3.4 Building and Grounds Maintenance

### Purpose and Approach

Typical building maintenance includes cleaning operations, such as outside pressure washing of buildup and repairs. Implement applicable suggested BMPs to reduce the influx of pollutants to the stormwater drainage system to the maximum extent practicable.

Nutrient loads generated by lawns can be significant, which is why it is important to monitor which chemicals (if any) are applied to lawns and also use products that are safe for the environment. Pesticide runoff can contribute pollutants that contaminate drinking water supplies and are toxic to both humans and aquatic organisms.

It is important to reduce pesticides, herbicides, fertilizers, and lawn debris from entering surface and ground water supplies by washing and cleaning up with as little water as possible, following good landscape management practices, preventing and cleaning up spills immediately, keeping debris from entering the stormwater drainage systems, and maintaining the stormwater collection system.

### Best Management Practices (BMPs)

*Landscaping Activities*

- Reduce or discontinue the use of chemicals (insecticide, herbicide, or fertilizer) on lawns
- Do not apply any chemicals (insecticide, herbicide, or fertilizer) directly to surface waters, unless the application is approved and permitted by the state.
- Use mulch or other erosion control measures on exposed soils.
- Check irrigation schedules so pesticides will not be washed away and to minimize non-stormwater discharge.
- Place temporarily stockpiled material away from watercourses and drain inlets, and berm or cover stockpiles to prevent material releases to the stormwater drainage system.
- Use hand or mechanical weeding where practical.

Targeted Facilities and Operations

- All Municipal Facilities

Targeted Constituents

- Sediment
- Nutrients
- Trash
- Metals
- Bacteria
- Oil & Grease
- Organics
- Low Dissolved Oxygen

Reference

- “Mass Highway Stormwater Handbook”
- “Massachusetts Stormwater Handbook, Vol. 2, Chapter 1”
- “California Stormwater Quality Association Municipal BMP Handbook”

- Employ mowing techniques to maintain a healthy lawn and minimize chemical use—no more than 1” of lawn should be removed from each mowing (grasses kept at 2.5” to 3.0” high are more heat resistant than close-cropped grass).Keep mower blades sharp and leave clippings in place after mowing.
- Do not allow clippings to collect or be raked or swept onto catch basin grates.
- Water plants in the early morning.

### *Fertilizer and Pesticide Management*

- Follow manufacturers’ recommendations and label directions.
- Do not apply insecticides within 100 feet of surface waters such as lakes, ponds, wetlands, and streams.
- Use less toxic pesticides that will do the job, whenever possible and use the minimum amount needed. Avoid use of copper-based pesticides if possible.
- Do not use pesticides if rain is expected.
- Do not mix or prepare pesticides for application near catch basins.
- Calibrate fertilizer distributors to avoid excessive application.
- Apply pesticides only when wind speeds are low.
- Work fertilizers into the soil rather than dumping or broadcasting them onto the surface.
- Irrigate slowly to prevent runoff and then only as much as is needed.
- Dispose of empty pesticide containers according to the instructions on the container label.
- Use up the pesticides. Rinse containers and use rinse water as product. Dispose of unused pesticide as hazardous waste.
- Implement storage requirements for pesticide products with guidance from the local fire department and the Massachusetts Department of Agricultural Resources.
- Provide secondary containment for pesticides.

### *Debris Removal*

- Compost or mulch yard waste to be used as mulch and topsoil.
- Sweep up yard debris instead of hosing down.
- Clean pavement and sidewalk if fertilizer is spilled on these surfaces before applying irrigation water.
- Do not leave yard waste in the street or sweep it into catch basins or streams.

### *Pressure Washing of Buildings, Rooftops and Other Large Objects*

- In situations where soaps or detergents are used and the surrounding area is paved, pressure washers must use a waste/water collection device that enables collection of wash water and associated solids. A sump pump, wet vacuum or similarly effective device must be used to collect the runoff and loose materials. The collected runoff and solids must be disposed of properly.
- If soaps or detergents are not used and the surrounding area is paved, wash water runoff does not have to be collected, but must be screened. Pressure washers must use filter fabric or some other type of screen on the ground and/or in the catch basin to trap the particles in wash water runoff.

- If you are pressure washing on a grassed area (with or without soap), runoff must be dispersed as sheet flow as much as possible, rather than as a concentrated stream. The wash runoff must remain on the grass and not drain to pavement. Ensure that this practice does not kill grass.

*Building Repair, Remodeling and Construction*

- Do not dump any toxic substance or liquid waste on the pavement, the ground or toward a catch basin.
- Use ground or drop cloths underneath outdoor painting, scraping and sandblasting work, and properly dispose of collected material daily.
- Use a ground cloth or oversized tub for activities such as paint mixing and tool cleaning.
- Clean paint brushes and tools covered with water-based paints in sinks connected to sanitary sewers or in portable containers that can be dumped into a sanitary sewer drain. Brushes and tools covered with non-water-based paints, finishes or other materials must be cleaned in a manner that enables collection of used solvents (e.g., paint thinner, turpentine, etc.) for recycling or proper disposal. Use a catch basin cover, filter fabric or other similarly effective runoff control mechanism if dust, grit, wash water or other pollutants may escape the work area and enter a catch basin. The containment device(s) must be in place at the beginning of the workday and accumulated dirty runoff and solids must be collected and disposed of before removing the containment device(s) at the end of the work day. When pressure-washing to remove paint, collect wash water and dispose of it properly, as outlined above.
- If you need to de-water an excavation site, you may need to filter the water before discharging to a catch basin or off-site. In this case, you should direct the water through hay bales and filter fabric or use other sediment filters or traps.
- Store toxic material under cover with secondary containment during precipitation events and when not in use. A cover would include tarps or other temporary cover material.

## Inspection Procedures

*Building Maintenance*

- Sweep paved areas regularly to collect loose particles and wipe up spills with rags and other absorbent materials immediately. Do not hose down the area to a catch basin.

*Grounds Maintenance*

- Minimize excess watering and repair leaks in the irrigation system as soon as they are observed.
- Inspect and remove accumulated debris from grounds.
- Routinely monitor lawns to identify problems during their early stages.
- Identify nutrient/water needs of plants.
- Inspect for problems by testing soils.

## Maintenance Procedures

*Grounds Maintenance*

- Sweep paved areas regularly to collect loose particles.
- Wipe up spills with rags and other absorbent materials immediately.

- Do not hose down the area to catch basins.
- Keep mower blades sharp.
- Do not sweep yard waste, debris, clippings, etc. into catch basins or surface waters.

## 3.5 Fire Training and Hose Flushing

### Purpose and Approach

Fire training and hose/hydrant flushing requires certain procedures in order to prevent pollutants from entering the surrounding stormwater system. Training and cleaning fire equipment requires the use of chemicals that can be collected by runoff and distributed into adjacent waterways. This must be prevented along with hose and hydrant flushing activities collecting pollutants and being discharged into the drainage system.

### Best Management Practices (BMPs)

- If possible, conduct training at a designated facility built and engineering for training activities.
- Sweep, vacuum or use any other dry-cleaning method on pavement to clean up debris and sediment before flushing or training.
- Direct hydrant or hose flushing flows to landscaped or green areas when possible and without causing erosion or damage to the landscape.
- Use haybales, filter socks or other filtration devices at all stormwater structures during all activities.
- When using foam, block storm drain inlets with plastic sheeting and sandbags to divert flow to sanitary system (with DPW approval).
- Limit use of straight streams and fog streams during training.
- Conduct vehicle and equipment cleaning indoors or at a facility that is connected to the sanitary sewer system.
- Use biodegradable, phosphate-free detergents (if needed) when cleaning.
- Conduct all maintenance and repair of fire vehicles and equipment indoors when applicable.

### Inspection Procedures

- Inspect training or flushing site for petroleum leaks or spills prior to flushing or fire training activities
- Inspect vehicles prior to going to training site to ensure there are no leaks
- Check that spill kit is fully stocked and on site.
- Locate all drainage structures and stormwater conveyances on site.
- Check for MSDS's for fire fighting chemicals.

Targeted Facilities and Operations

- All Municipal Facilities
- All Fleet Vehicle and Equipment Operations

Targeted Constituents

- Sediment
- Nutrients
- Trash
- Metals
- Oil & Grease

Reference

- "California Stormwater Quality Association Municipal BMP Handbook"

## Maintenance Procedures

- Repair any leaks on vehicles or equipment before going to training or flushing site.
- Routinely clean fire vehicles and equipment in a designed wash area to eliminate chemicals, gas, or any other pollutants from traveling to the training site. See Section 3.3 Vehicle and Equipment Maintenance for more BMPs.
- When on site, properly install filtration devices or barriers for stormwater structures.
- Update MSDS's for each vehicle for fire fighting chemicals.
- If a chemical spill or leak is reported on site, use the spill kit that is on site and proper clean up procedures. Properly dispose of waste and report to the DPW.

## 3.6 Outdoor Waste Management & Disposal

### Purpose and Approach

Waste management entails the selection of the individual products, the correct use and storage of the product, and the proper disposal of associated waste(s). It is important to be responsible with common chemicals and solvents including paints, cleaners, and automotive products to reduce contamination to stormwater runoff.

Targeted Facilities and Operations

- All Municipal Facilities
- All Fleet Vehicle and Equipment Operations

Targeted Constituents

- Sediment
- Nutrients
- Trash
- Metals
- Oil & Grease
- Organics
- Low Dissolved Oxygen

Reference

- "California Stormwater Quality Association Municipal BMP Handbook"

### Best Management Practices (BMPs)

*Materials Maintenance*

- Routine cleaning of workspaces
- Proper collection/disposal of waste
- Product selection
- Product use and storage
- Routine vehicle and equipment maintenance and inspection
- Employee training

*Materials Inventory*

- Identify all hazardous and non-hazardous substances by reviewing purchase orders and conducting a walk-through of the facility.
- Compile Material Safety Data Sheets (MSDSs) for all chemicals. These should be readily accessible to all facility employees.
- Label all containers of significant materials that include cleaners, fuels and other hazards.
- Identify handling, storage and disposal requirements of all chemicals.
- Use environmentally friendly or non-hazardous substitutes when appropriate that include, but are not limited to, $H_2Orange_2$, Orange Thunder and Simple Green®.
- Keep hazardous materials and waste off the ground.
- Provide secondary containment, when appropriate.
- All drums and containers should be in good condition and properly labeled.
- Loose materials/stockpiles should be covered with tarps or placed in shelter.

*Solid Waste Management*

- Trash storage bins, dumpsters and disposal areas should be clean and free of debris, especially those located near catch basins.
- Dumpsters should be maintained in good condition and securely closed at all times.
- Clean up equipment and materials.

- Dispose of solid waste within local, state and federal laws.
- Temporary trash storage should be inspected weekly before being emptied by waste management contractor.
- Debris piles, including sweeping, construction and wood debris should be covered. Covers should be inspected weekly before waste is removed off-site. Compost yard debris does not need to be covered.

### Inspection Procedures

- Inspect dumpsters and trash containers for leaks and make sure they are covered.
- Inspect material storage sheds (inside and outside) to verify items are not exposed to precipitation and are covered or in enclosed areas.
- Inspect stormwater discharge locations and on-site stormwater drainage infrastructure (e.g., catch basins) for contaminants, soil staining and plugged discharge lines.
- Physical on-site verification of sealed floor drains (or redirected to sanitary sewer).

### Maintenance Procedures

- Repair or replace any leaking/defective containers and replace label as necessary
- Maintain caps and/or covers on containers
- Maintain aisle space for inspection of products/wastes
- Routinely clean work spaces
- Properly collect/dispose of waste
- Routinely maintain and inspect vehicles and equipment
- Train employees, leases/site users, hired contractors and any other personnel performing materials management activities routinely and when new products enter the facility on proper use, storage, disposal and safety concerns. Material Safety Data Sheets (MSDSs) should be reviewed and readily accessible in central facility location
- Review any Spill Prevention, Control and Countermeasure (SPCC) Plans in place for a specific facility for petroleum products.

## 3.7 Outdoor Material Storage

### Purpose and Approach

It is necessary to use certain methods when storing raw or finished materials outside on a side to ensure stormwater runoff does not become contaminated and then enter the drainage system. Materials may be stored in containers, on platforms or pads, in bins or boxes, or in piles. Storage areas that are exposed to rainfall and direct runoff can contribute pollutants to stormwater when solid materials wash off or materials dissolve into the runoff.

### Best Management Practices (BMPs)

In order to ensure proper outdoor material storage, it is important to use the following practices:

- Properly label each outdoor storage bin or area.
- Create a berm around storage areas to contain any potential spills or leaks.
- Keep storage areas away from stormwater drainage structures.
- Ensure all liquids stored outside on a paved impervious surface are stored with a secondary containment mechanism.
- All chemical, drums, or bagged materials should also be placed on secondary containment.
- Cover treated wood products, other storage areas and/or bins with permanent or seasonal structures.
- Keep all storage areas secure to prevent vandalism and unauthorized access.

### Inspection Procedures

- Inspect all storage areas and bins routinely for spills or leaks.
- Inspect all secondary containment and structures that are used for cover and ensure there are no breaks or cracks.
- Check for properly labeled containers and storage areas.

Targeted Facilities and Operations

- All Municipal Facilities
- All Fleet Vehicle and Equipment Operations

Targeted Constituents

- Sediment
- Nutrients
- Trash
- Oil & Grease
- Organics
- Low Dissolved Oxygen

Reference

- “Massachusetts Stormwater Handbook, Vol. 2, Chapter

- Inspect spill kit and confirm all components are fully stocked.
- Identify the location of all stormwater drainage structures and ensure stored materials are not in the surrounding area.

### Maintenance Procedures

- Repair or replace any leaking or defective containers and replace labels or signage as necessary.
- Ensure spill skit is readily available and stocked.
- If spills or leaks have occurred, use a spill kit and proper clean up equipment and properly dispose of any materials or waste.
- Repair or replace any damaged secondary containment or structures used for cover.
- Regularly sweep and clean up any litter in or around the storage areas.

## 3.8 Painting & Equipment Loading/Disposal

### Purpose and Approach

Containing paint and debris is essential on a work site so that the chemicals can be properly disposed of and not pollute the surrounding area. Properly maintaining and cleaning all painting equipment is also necessary to ensure chemicals are not being spilt or distributed on site.

### Best Management Practices (BMPs)

It is important to use the following practices and control measures to prevent paint and other chemicals from entering the stormwater system:

- Store paints, coatings, and solvents in a covered and well-ventilated area. Keep containers closed in storage area when not in use. Refer to Section 3.13 Hazardous Material Storage for more BMPs for storage.
- Remove excess paint from spent barrels and cans to allow residual paint to dry.
- Properly dispose of spent barrels and cans as solid waste once residual paint is dry.
- When possible select water-based latex paints, they emit fewer chemicals and lower levels of chemical vapor.
- Contain painting activities and use other methods such as drop cloths, tarps, etc. under the painting/work area to contain any paint chips, drips, or spills.
- Install filtration devices or barriers to prevent chemicals, paint residue, or any other pollutants from entering the stormwater system.
- Wash all painting equipment in an approved wash area or wash rack. Refer to Section 3.2 Vehicle Washing for more BMPs.
- Use dry cleaning methods to clean up hardened paint residue and properly dispose as a solid waste.

Targeted Facilities and Operations

- All Municipal Facilities
- All Fleet Vehicle and Equipment Operations

Targeted Constituents

- Sediment
- Nutrients
- Trash
- Metals
- Oil & Grease

Reference

- “Massachusetts Stormwater Handbook, Vol. 2, Chapter

## Inspection Procedures

- Inspect storage area for any leaks or spills.
- Identify the location of all stormwater drainage structures where painting is being completed.
- Inspect all structures for paint residue or chemical sheen.
- Inspect vents and air circulation in ventilated storage area.

## Maintenance Procedures

- Repair or replace any leaking paint containers in the storage area.
- Routinely clean all paint equipment and repair any leaks or defects.
- Remove paint chips from drainage structures if any have collected.
- Update all MSDSs and keep on painting site.

## 3.9 Outdoor Vehicle and Equipment Storage

### Purpose and Approach

Vehicles and equipment stored outdoors such as fleet parking can be a potential source of pollution during rain events. Vehicle and other equipment such as snow-blowers or lawnmowers can contain oils, coolants, and fuel which have the potential to leak from the vehicle or equipment. If these items are stored outdoors, leaks have the potential to be introduced to the stormwater system by surface runoff caused by rainfall. Note that this section pertains only to outdoor storage of vehicles and equipment, and that the maintenance of such vehicles and equipment is covered under Section 3.3 Vehicle and Equipment Maintenance.

### Best Management Practices (BMPs)

In order to ensure proper outdoor storage for vehicles and equipment, it is important to use the following practices:

- Fleet parking area and surrounding storage area(s) should be kept neat and orderly.
- Provide trash receptables in parking area(s) and maintain signage indicating “No Littering”
- Store vehicles and equipment prone to leaking under cover.
- Drain fluids from long-term inactive, decommissioned, and wrecked vehicles and equipment as soon as possible.
- Use drip pans or other spill/leak containment where fluid draining cannot be conducted.
- Clean spills/leaks promptly and dispose of properly.
- Use dry cleaning methods (sweeping/vacuuming) to remove debris from impervious parking area(s).

### Inspection Procedures

- Regularly inspect vehicle and equipment and storage area(s) for signs of leaks/spills.
- Regularly inspect stormwater collection structures for petroleum sheen before draining. When sheen is detected, water should be removed and disposed of properly via sanitary contractor.

Targeted Facilities and Operations

- All Fleet Vehicle and Equipment Operations

Targeted Constituents

- Sediment
- Nutrients
- Trash
- Oil & Grease
- Organics
- Low Dissolved Oxygen

Reference

- “Massachusetts Stormwater Handbook, Vol. 2, Chapter 1”

## Maintenance Procedures

- Regularly perform dry cleaning methods (sweeping/vacuuming) for impervious surfaces that vehicles and equipment are stored on.
- Keep storage and parking area(s) clean and orderly.
- Utilize spill/leak prevention and containment for stored vehicles and clean any spills/leaks promptly with proper disposal.
- Provide trash receptacles in the parking and storage area(s).

## 3.10 Salt/Sand and Salt Brine/Calcium Chloride Storage

### Purpose and Approach

Proper road sand/salt application and storage is necessary to prevent contamination to surface and ground water supplies. Salts are very soluble—once in contact with water there is no way to remove salt. The major reasons for keeping salt covered and controlling use are that salt:

- Kills vegetation
- Corrodes infrastructure
- Blocks catch basins, swales, and other drainage structures
- Increases sedimentation to streams and rivers
- Even small quantities (5% road salt) contain phosphorus, nitrogen, copper, and cyanide

Pollutants often attach to sand particles and excessive sand washed into the stormwater drainage system can clog catch basins. In order to ensure proper sand/salt management, it is important to address the following items:

- Proper Storage
- Proper Use
- Proper Removal
- Proper Disposal

### Best Management Practices (BMPs)

*Proper Storage*

Storage facilities for sand/salt mixtures should have the following key elements:

- Covered structure on impervious surface
- Drainage should be diverted away from storage facility
- Sand/salt handling should be done within storage facility
- Should not be located in a water supply watershed or within 100 year floodplain

Targeted Facilities and Operations

- All Municipal Facilities
- Facility Access Roads and Parking Lots

Targeted Constituents

- Sediment
- Nutrients
- Trash
- Metals
- Oil & Grease
- Organics
- Low Dissolved Oxygen

Reference

- “Mass Highway Stormwater Handbook”
- “Massachusetts Stormwater Handbook, Vol. 2, Chapter 1”
- “California Stormwater Quality Association Municipal BMP Handbook”

*Proper Use*

- Establish a low salt area near any water bodies or residential areas.
- When feasible, use higher percentage of sand in sand/salt mixture.
- Regulate the amount of road salt applied to prevent over-salting of motorways and increasing runoff concentrations.
- Vary the amount of salt applied to reflect site-specific characteristics, such as road width and design, traffic concentration and proximity to surface waters.
- Provide calibration devices for spreaders in trucks to aid maintenance workers in the proper application of road salts.
- Establish air temperature and snow depth conditions favorable for successful use of salt.
- Use alternative materials, such as sand or gravel, in especially sensitive areas.
- Use alternative products such as Magic Salt.

*Proper Removal*

- Street sweeping of facility access roads and parking lots in spring and fall.
- Catch basin cleaning once per year.

*Proper Disposal*

Disposal of sand/salt mixtures should never be done in the following areas:

- Wetlands or surface waters
- Stormwater drainage system
- Well locations and public drinking supplies

Dispose of sand/salt mixtures at appropriate disposal sites:

- Locate disposal sites adjacent to or on pervious surface in upland areas away from water resources and wells.
- Maintain the disposal site with silt fence and other barriers on the downgradient side of the site.

*Salt Brine and Calcium Storage*

- Store brine and liquid deicers in well maintained and clearly labeled storage tanks.
- Immediately repair spills and leaks from storage tank fittings, valves and pumps.
- For tanks located outside, utilize secondary containment (double walled tanks or containment dikes) with 110-125% of the capacity of the largest tank.
- House storage tanks and mixing equipment inside protective barriers (bollards, jersey barriers, etc).
- Use drain or inlet covers to prevent collection of accidental deicer spills/leaks from entering the storm system.
- Keep MSDS on site and accessible.

## Inspection Procedures

- Inspect salt storage shed for leaks on a regular basis, including fall and spring.
- Inspect salt application equipment, including calibration equipment and spreaders.
- Inspect salt regularly for lumping or water contamination.
- Inspect surface areas for evidence of runoff – salt stains in ground near and around the salt storage shed, loading area or down slope.
- Inspect for excessive amounts of salt on roads.
- Perform regular scheduled inspection and maintenance of Salt Brine and Calcium storage tanks and fittings, valves, and pumps.

## Maintenance Procedures

- Service trucks and calibrated spreaders regularly to ensure accurate, efficient distribution of salt.
- Educate and train operators on hazards of over-salting to roads and environment at the beginning of the snow season as part of meetings with supervisor and drivers.
- Repair salt storage shed leaks.
- Perform regularly scheduled maintenance on Salt Brine and Calcium storage tanks and accessories (valves, fittings and pumps), and immediately repair leaking or dripping connection on tanks.

## 3.11 Material Stockpiles

### Purpose and Approach

Stockpiled materials such as snow, soil, gravel, and mulch represent a source of pollution during rain events. When stored unprotected outdoors, material stockpiles are exposed to precipitation. When the eroded material enters the stormwater system, the sediment can quickly fill the sumps of catch basin structures. The eroded material is also a surface that pollutants can adhere too and then enter the drainage system, leading to pollution in the waterways and environment.

### Best Management Practices (BMPs)

In order to ensure proper material stockpile management, it is important to use the following practices:

- Store materials indoors whenever possible.
- When planning a location for a stockpile, use a relatively level site away from slopes, water features, and stormwater drainage structures.
- Store outdoor stockpiles under a covered area or use tarps for cover.
- Implement erosion control systems at storage site perimeter. Common practices include sediment basins, silt fences, or grass filter strips.
- Install berms, curbing and/or grading to prevent precipitation run-on into stockpile areas.
- Use catch basin filter inserts for catch basins located near outdoor material stockpiles.

*Snow Dump/Stockpile:*

- Select snow storage sites before snow season begins. These sites should be on a pervious surface and away from stormwater features and wells.
- Place silt fence or sediment barrier as down grade side of site to collect any sediment from meltwater.
- Clean up and properly dispose of litter and sediment after snow season is over.

.

Targeted Facilities and Operations

- All Fleet Vehicle and Equipment Operations

Targeted Constituents

- Sediment
- Nutrients
- Trash
- Oil & Grease
- Organics
- Low Dissolved Oxygen

Reference

- “Massachusetts Stormwater Handbook, Vol. 2, Chapter 1”

## Inspection Procedures

- Inspect all material stockpiles for proper cover.
- Inspect the condition of all erosion control structures
- Identify the location of all stormwater drainage structures and ensure stockpiles are not in the surrounding area.

## Maintenance Procedures

- Regularly sweep and clean up any eroded material in stockpile storage area.
- For snow storage areas, clean up litter and collected sediment from snow melt at the end of the snow season.
- Remove debris from catch basin filter inserts.
- Repair or replace any damaged tarps, structures used for cover, or erosion control systems.
- Move any stockpiles that have been placed within the vicinity of any drainage structures.

## 3.12 Hazardous Material Storage

### Purpose and Approach

It is important to properly store hazardous materials (including antifreeze, paints, solvents, and cleaners) to prevent them from contaminating stormwater runoff. Hazardous materials include:

- Cleaning agents: solvents and drain cleaners
- Vehicle maintenance fluids: motor oil, gasoline, antifreeze, degreasers, and radiator flush
- Water treatment chemicals
- Paints

### Best Management Practices (BMPs)

In order to ensure proper hazardous material storage, it is important to address the following items:

- Loading / Unloading
- Container storage
- Maintenance
- Disposal

*Loading / Unloading*

- All facilities should have proper procedures in place for loading and/or unloading hazardous materials received, especially areas located near catch basins.
- Do not conduct loading and unloading of exposed hazards during wet weather, whenever possible.
- If feasible, load and unload all materials and equipment in covered areas, such as building overhangs at loading docks.
- Load / unload only at designated loading areas.
- Use drip pans underneath hose and pipe connections and other leak-prone spots during liquid transfer operations, and when making and breaking connections.

*Container Storage*

- Keep containers away from high traffic areas

Targeted Facilities and Operations

- All Fleet Vehicle and Equipment Operations

Targeted Constituents

- Sediment
- Nutrients
- Trash
- Metals
- Oil & Grease
- Organics
- Low Dissolved Oxygen

Reference

- “Massachusetts Stormwater Handbook, Vol. 2, Chapter 1”
- “California Stormwater Quality Association Municipal BMP Handbook”

- When possible, store indoors. If stored outdoors, cover all containers and drums or place under shelter.
- Place containers in a designated area that is paved, free of cracks and gaps, and impervious in order to contain leaks and spills. The area should also be covered. Store containers on pallets.
- Provide secondary containment for hazardous materials and waste placed outdoors.
- Log inventory and supply MSDSs for all stored materials.
- Chemicals should be kept in original labeled containers. Containers should not be glass.
- Containers should not be overfilled. Install overfill protection on storage tanks/drums.
- Properly stack containers and drums.
- Storage areas should be enclosed, clean and organized.
- Minimize storage on-site. Lock storage areas and provide warning signs.
- Contractors should be trained on delivery and storage practices.
- Segregate reactive/incompatible materials (such as chlorine and ammonia).
- Place drip pans under container spout.

*Maintenance*

- Routinely inspect storage spaces and containers for leaks and cracks.
- Train maintenance personnel, employees, leases/site users, hired contractors and any other personnel working with hazardous materials for spill cleanup.

*Disposal*

- Properly dispose of hazardous materials.
- Recycle when possible.

## Inspection Procedures

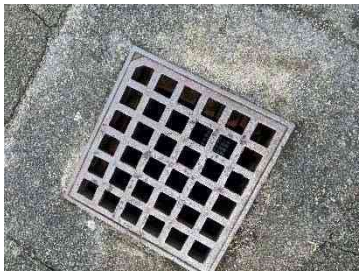
- Check loading and unloading equipment regularly for leaks, including valves, pumps, flanges and connections
- Look for dust or fumes during loading or unloading operations
- Inspect storage areas regularly for leaks or spills
- Conduct routine inspections and check for external corrosion of material containers
- Check for structural failure, spills and overfills due to operator error or failure of piping system
- Check for leaks or spills during pumping of liquids or gases from truck or rail car to a storage facility or vice versa
- Visually inspect new tank or container installations for loose fittings, poor welding and improper or poorly fitted gaskets
- Inspect tank foundations, connections, coatings, tank walls and piping system. Look for corrosion, leaks, cracks, scratches and other physical damage that may weaken the tank or container system.

- Replace containers that are leaking, corroded or otherwise deteriorating with ones in good condition. If the liquid chemicals are corrosive, containers made of compatible materials must be used instead of metal drums.
- Label new or secondary containers with the product name and hazards

### Maintenance Procedures

- Conduct regular inspections and make repairs as necessary. The frequency of repairs will depend on the age of the facility.
- Check loading and unloading equipment regularly for leaks.
- Sweep area regularly with dry broom.
- Conduct major clean-out of loading and unloading area and any sumps prior to October 1 of each year.
- Repair or replace any leaking/defective containers and replace labels as necessary.
- Maintain caps and/or covers on containers.
- Maintain aisle space for inspection of products/wastes.
- Train employees, leases/site users, hired contractors and any other personnel working with hazardous materials on proper procedures when new hazardous materials are used.

## 3.13 Catch Basin Cleaning



### Purpose and Approach

It is important to remove sediments that hall collected in the sumps of catch basins. Sediments can have a high concentration of pollutants including metals and hydrocarbons. These sediments can also clog downstream drainage systems and transport pollutants to nearby water bodies.

### Best Management Practices (BMPs)

- Provide this BMP sheet to any catch basin cleaning contractor who will work on-site.
- EPA recommends to clean basins when solids reach one-third the depth from the basin bottom to the invert of the lowest pipe into or out of the basin.
- Target cleaning for early Spring or late Fall.
- Clean structures prior to rainy season.
- Clean manually or with equipment (i.e., bucket loaders).
- Properly dispose of catch basin material (MADEP and EPA requires chemical analysis to determine if substance is hazardous waste).
- Repair damaged catch basins including outlet traps.
- Install hoods if catch basins do not have them.
- Install outlet traps if catch basins do not have them.
- Inform employees that catch basins are part of the stormwater collection system and not the septic system.
- Maintain a log of cleaning activities. Information should include amount of cleanings removed and areas with heavily filled basins.

### Inspection Procedures

- Inspect catch basins, grates and ditches at least twice per year (best times are before the start and before the end of the rainy season).
- Inspections should be incorporated during yearly routine cleaning.

Targeted Facilities and Operations

- All Municipal Facilities
- Facility Access Roads and Parking Lots

Targeted Constituents

- Sediment
- Nutrients
- Trash
- Metals
- Oil & Grease
- Organics
- Low Dissolved Oxygen

Reference

- “California Stormwater Quality Association Municipal BMP Handbook”

### Maintenance Procedures

- Clean catch basins annually. Catch basins should be checked for sediment levels in sump, in accordance with the inspection schedule discussed above. Those in areas that accumulate a significant amount of sediment should be cleaned more frequently.
- During catch basin repairs, any missing hoods should be replaced.

## 3.14 Pavement Maintenance

### Purpose and Approach

Pavement cleaning and repairs are essential components towards keeping municipal lots and roadways safe for travel and functional. However, if debris continually collects on paved surfaces and it not properly removed, it can collect pollutants and enter the drainage system with stormwater runoff. Also, while conducting pavement repair, it is important that the chemicals used do not enter the stormwater system and pollute the waterways.

### Best Management Practices (BMPs)

The following items should be addressed to help prevent pollutants from entering the drainage system during pavement maintenance:

- Schedule regular sweeping to remove sediment and debris from paved surfaces.
- Keep work sites clean and orderly and remove debris from construction in a timely fashion.
- Use dry cleaning methods for spills and leaks on site and properly dispose of waste after clean-up is complete.
- Load and transfer hot bituminous material away from stormwater structures and watercourses.
- Cover and seal nearby stormwater catch basins, inlets, and manholes before applying seal coat, slurry seal, etc.

### Inspection Procedures

- Locate all stormwater structures that are surrounding or along the path of construction.
- Check to see that there is a fully stocked spill kit on site.

### Maintenance Procedures

- Sweep and properly dispose of any sediment during regular scheduled cleaning and post-construction.
- Use a spill kit for any leaks or spills on site and properly dispose of waste.
- For sweeping or pavement construction, cover and seal stormwater structures surrounding the site.

Targeted Facilities and Operations

- All Municipal Facilities
- Facility Access Roads and Parking Lots

Targeted Constituents

- Sediment
- Nutrients
- Trash
- Metals
- Bacteria
- Oil & Grease
- Organics
- Low Dissolved Oxygen

Reference

- “California Stormwater Quality Association Municipal BMP Handbook”

## 3.15 Street and Parking Lot Sweeping

### Purpose and Approach

Street and parking lot sweeping includes self-propelled equipment to remove sediment from paved surfaces that can enter catch basins or receiving waters. Sweeping is most effective for removing coarse particles, leaves, and trash. Regularly sweeping reduces catch basin cleaning.

### Best Management Practices (BMPs)

- Implementation
- Sweeper Operation and Maintenance

*Implementation*

- Provide this sheet to any sweeping contractors that will work on-site.
- Prioritize by sweeping the dirtiest roadways more frequently.
- Sweep before rain events to prevent particles and pollutants from entering runoff.
- Sweep as early in the spring as possible (after snowmelt).
- Sweep in June (after trees drop seeds and flowers) to prevent phosphorus-laden runoff.
- Any visible sediment should be swept up (including sand/salt mixtures and granular material).
- Control the number of points where vehicles leave the site to allow sweeping to be focused on certain areas.
- Sweep up the smallest particles feasible.
- Sweep in pattern to keep spilled material from being pushed into catch basins.
- Before sweeping, manually rake sand from turf areas on surfaces to be swept.
- Properly dispose of sweepings as a solid waste (dumpsters). If possible, recycle fall leaf sweepings by composting.
- Maintain a log of sweeping activities. Information should include amount of sweepings removed and heavily sedimented areas.

*Sweeper Operation and Maintenance*

- Adjust broom frequently to maximize efficiency of sweeping operations.

Targeted Facilities and Operations

- Facility Access Roads and Parking Lots

Targeted Constituents

- Sediment
- Nutrients
- Trash
- Metals
- Oil & Grease
- Organics
- Low Dissolved Oxygen

Reference

- “Massachusetts Stormwater Handbook, Vol. 2, Chapter 1”
- “California Stormwater Quality Association Municipal BMP Handbook”

- After sweeping is finished, properly dispose of sweeper wastes.
- Do not use kick brooms or sweeper attachments that tend to spread dirt.
- When unloading sweeper, make sure there is no dust or sediment release.

### Inspection Procedures

- Regularly inspect streets and Municipal parking lots for debris.

### Maintenance Procedures

- Adjust broom frequently to maximize efficiency of sweeping operations.
- After sweeping is finished, properly dispose of sweeper wastes. Street sweepings are regulated as solid waste by the Commonwealth of Massachusetts and can be used in a variety of ways, including as a landfill cover, compost additive, or as fill in a public way. (MassDEP Policy BWP-94.092).
- Do not use kick brooms or sweeper attachments that tend to spread dirt.
- When unloading sweeper, try to avoid dust or sediment release.
- Inspect sweepers to check that they are properly maintained and repaired.

## 3.16 Spill Prevention and Response


### Purpose and Approach

It is important to have a plan in place in the event a spill should occur so contaminants do not mix with stormwater runoff. A plan can be effective at reducing risk of contamination to surface and groundwater contamination—but only effective with personnel training, availability of cleanup supplies, and management ensures procedures are followed.

- Create a well thought out and implemented plan
- Post a response checklist in any hazardous waste storage area with contact information (including emergency phone numbers), and spill containment procedures
- Train employees, leases/site users, hired contractors and any other personnel working with spill prevention activities
- Regularly update plan, checklists, and contact information
- Regularly inspect spill potential areas
- Facilities with aboveground storage tanks (ASTs) and underground storage tanks (USTs) greater than 1,320 gallons and 42,000 gallons must have Spill Prevention Control & Countermeasure plans in place.

### Spill Prevention and Response Plan

An effective Spill Prevention and Response Plan should include the following:

- Description of the facilities, the address, activities and materials involved.
- Identification of key spill response personnel and hospital contacts.
- Identification of the potential spill areas or operations prone to spills/leaks.
- Identification of which areas should be or are bermed to contain spills/leaks
- Facility map identifying the key locations of areas, activities, materials, structural BMPs, etc.

<u>Targeted Facilities and Operations</u>

- Facility Access Roads and Parking Lots

<u>Targeted Constituents</u>

- Nutrients
- Metals
- Oil & Grease
- Hydrocarbons
- Organics

<u>Reference</u>

- “City of Fitchburg SPCC Plan
- “California Stormwater Quality Association Municipal BMP Handbook”

- Material handling procedures and safety measures for each kind of waste.
- Spill response procedures including:
  - Assessment of the site and potential impacts
  - Containment of the material
  - Notification of the proper personnel and evacuation procedures
  - Clean up of the site
  - Disposal of the waste material
  - Proper record keeping procedures
- Plan to protect all catch basins in the event of a spill.
- Descriptions of spill response equipment, including safety and cleanup equipment.

## Best Management Practices (BMPs)

*Spill/Leak Prevention*

- If possible, move material handling indoors, under cover, or away from catch basins or sensitive water bodies.
- Properly label all containers so that the contents are easily identifiable.
- Berm storage areas so that if a spill or leak occurs, the material is contained.
- Cover outside storage areas either with a permanent structure or with a seasonal one such as a tarp so that rain will not come into contact with the materials.
- Check containers (and any containment sumps) often for leaks and spills. Replace containers that are leaking, corroded, or otherwise deteriorating with containers in good condition. Collect all spilled liquids and properly dispose of them.
- Store, contain and transfer liquid materials in such a manner that if the container is ruptured or the contents spilled, they will not discharge, flow or be washed into the stormwater drainage system, surface waters, or groundwater.
- Place drip pans or absorbent materials beneath all mounted taps and at all potential drip and spill locations during the filling and unloading of containers. Any collected liquids or soiled absorbent materials should be reused/recycled or properly disposed of.

- Only transport the minimum amount of material needed for the daily activities and transfer materials between containers at a municipal yard where leaks and spill are easier to control.
- If paved, sweep and clean storage areas monthly, do not use water to hose down the area unless all of the water will be collected and disposed of properly (e.g., sanitary sewer)
- Install a spill control device (such as a tee section) in any catch basins that collect runoff from any storage areas if the materials stored are oil, gas, or other materials that separate from and float on water. This will allow for easier cleanup if a spill occurs.
- If necessary, protect catch basins while conducting field activities so that if a spill occurs, the material will be contained.
- Keep ample supplies of spill cleanup materials including Speedi Dry and absorbent boom pads on-site. Train all employees, leases/site users, hired contractors and any other personnel working with spill prevention activities on where materials are stored.

*Spill Clean Up*

- Small non-hazardous spills:
  - Use a rag, damp cloth or absorbent materials for general cleanup of liquids.
  - Use brooms or shovels for the general cleanup of dry materials
  - If water is used, it must be collected and properly disposed of. The wash water cannot be allowed to enter the stormwater drainage system.
  - Dispose of any waste materials properly.
  - Clean or dispose of any equipment used to clean up the spill properly.
- Large non-hazardous spills
  - Use absorbent materials for general cleanup of liquids.
  - Use brooms, shovels or street sweepers for the general cleanup of dry materials.
  - If water is used, it must be collected and properly disposed of. The wash water cannot be allowed to enter the stormwater drainage system.
  - Dispose of any waste materials properly.
  - Clean or dispose of any equipment used to clean up the spill properly.

- For hazardous or very large spills, the Fire Department and/or a private cleanup contractor may need to be contacted to assess the situation and conduct the cleanup and disposal of the materials. Keep spill contractor contact information available for all employees.
- Chemical cleanups of material can be achieved with the use of absorbents, gels, and foams.
- Remove the adsorbent materials promptly and dispose of according to regulations.
- If the spilled material is hazardous, then the used cleanup materials (rags) are also hazardous and must be sent to a certified laundry facility or disposed of as hazardous waste.

*Reporting*

- Report any spills immediately to key spill response personnel.
- Report spills in accordance with applicable reporting laws. Spills that pose an immediate threat to human health or the environment must be reported immediately.
- Federal regulations require that any oil spill into a water body or onto an adjoining shoreline be reported to the National Response Center (NRC) at 800-424-8802 (24 hour).
- After the spill has been contained and cleaned up, a detailed report about the incident should be generated and kept on file. The incident may also be used in briefing staff about proper procedures.

## Inspection Procedures

- Inspect secondary containment systems periodically to identify any operational problems.
- Inspect containers for leaks, areas near catch basins and stormwater outlets, and floor drains for indications of spills.

## Maintenance Procedures

- Protect drains with oil absorbent materials.
- Clean out catch basins on regular schedule (annually).
- Remove spilled salt from salt loading areas, including the facility's salt shed.

# APPENDIX A

## Facility Matrix and Pollution Prevention Team

# City of Fitchburg

## Pollution Prevention Team

Facility: Public Works Complex

| Name: | Title: |
|---|---|
| Nicolas Bosonetto | Commissioner of Public Works |
| Nick Erickson | Civil Engineer, Engineering Division |
| Jeffrey Murawski | Deputy Commissioner of Wastewater |
| | |
| | |

City of Fitchburg, Massachusetts
Operations and Maintenance Activities Inventory at Municipal Facilities

| BMPs | | | | BMP 1 | BMP 2 | BMP 3 | BMP 4 | BMP 5 | BMP 6 | BMP 7 | BMP 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Facility Activities** | **Category** | **SWPPP Required** | **Inspection Frequency** | **Fueling Activities** | **Vehicle Washing** | **Vehicle and Equipment Maintenance** | **Building and Grounds Maintenance** | **Fire Training and Hose Flushing** | **Outdoor Waste Management** | **Outdoor Material Storage** | **Painting and Equipment Loading/Disposal** |
| Airport Complex | City Building | | Annual | | X | X | X | | X | X | |
| Hosmer School | Schools | | Annual | | | | | | | | |
| Amiott Field | Parks | | Annual | | | | X | | | | |
| Bartley-Nolan Park | Parks | | Annual | | | | X | | X | | |
| Brigham Park | Parks | | Annual | | | | X | | | | |
| Caldwell Park | Parks | | Annual | | | | X | | X | | |
| Central Fire Station | Fire | | Annual | X | X | X | X | | X | | |
| Coggshall Park | Parks | | Annual | | | | X | | | | |
| City Hall (New) | City Building | | Annual | | | | X | | X | | |
| City Hall (Old) | City Building | | Annual | | | | | | | | |
| Crocker Elementary School | Schools | | Annual | | | | X | | X | | |
| Coolidge Park | Parks | | Annual | | | | X | | | | |
| Crocker Field | Parks | | Annual | X | | | X | | X | | |
| Daniels Park | Parks | | Annual | | | | | | | | |
| Crocker Playground | Parks | | Annual | | | | X | | | | |
| Crocker Playground - Spray Pad | Parks | | Annual | | | | X | | | | |
| Day Street Lot | Parking Garage/Lots | | Annual | | | | | | | | |
| Dean Hill Cemetery | Cemeteries | | Annual | | | | X | | X | | |
| East WWTF | Wastewater | | Annual | | X | X | X | | | | |
| Falulah Treatment Plant | Water | | Annual | X | X | X | X | | X | | |
| Rollstone/Laurel Schools | Schools | | Annual | | | | X | | | | |
| Fitchburg High School | Schools | | Annual | X | | | X | | X | | |
| FLLAC School | Schools | | Annual | | | | X | | X | | |
| Forest Hill Cemetery | Cemeteries | | Annual | X | | | X | | | | |
| Former Central Fire Station Lot | Parking Garage/Lots | | Annual | | | | | | | | |
| Gateway Park | Parks | | Annual | | | | X | | X | | |
| Goodrich Academy | EAST | | Annual | | | | X | | | | |
| Goodrich Playground | Parks | | Annual | | | | X | | X | | |
| Green Corners Park | Parks | | Annual | | | | X | | X | | |
| Howarth Park | Parks | | Annual | | | | X | | X | | |
| Harwell Cemetery | Cemeteries | | Annual | | | | X | | | | |
| Heritage Park | Parks | | Annual | | | | X | | | | |
| Lacava Pump Station | Water | | Annual | | | | X | | | | |
| Bird Sanctuary | Parks | | Annual | | | | X | | | | |
| Longsjo Middle School | Schools | | Annual | X | | | X | | X | | |
| Laurel Hill Cemetery | Cemeteries | | Annual | | | | X | | | | |
| Lowe Playground | Parks | | Annual | | | | X | | X | | |
| McKay Arts Academy | Schools | | Annual | | | | | | | | |
| Marshall PRV Station | Water | | Annual | | | | X | | | | |
| Main Street Parking Garage | Parking Garage/Lots | | Annual | | | | | | | | |
| Main Street Parking Lot (Mont) | Parking Garage/Lots | | Annual | | | | | | | | |
| Memorial Middle School | Schools | | Annual | X | | | X | | X | | |
| Montachusett Industrial Park Pump Station | Water | | Annual | | | | X | | | | |
| Monument Park | Parks | | Annual | | | | X | | X | | |
| Moran Field | Parks | | Annual | | | | X | | X | | |
| State Pool | Parks | | Annual | | | | X | | X | | |
| Oak Hill Fire Station | Fire | | Annual | | X | | X | | X | | |
| Nikitas Field | Parks | | Annual | | | | X | | | | |
| Oak Hill Pump Station | Water | | Annual | | | | X | | | | |
| Oak Hill Tank and Controls/Valve Building | Water | | Annual | | | | X | | | | |
| Overlook Storage Tank and Controls/Valve Building | Water | | Annual | | | | X | | | | |
| Parkhill Park | Parks | | Annual | | | | X | | | | |
| Phillips Playground | Parks | | Annual | | | | X | | X | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Police Station | City Building | | Annual | | | | X | | | | |
| Public Library | City Building | | Annual | X | | | X | | X | | |
| Public Works Complex | City Building | Yes | Quarterly | | X | X | X | | X | X | X |
| Putnam Street Parking Garage | Parking Garage/Lots | | Annual | | | | | | | | |
| Reingold Elementary School | Schools | | Annual | X | | | X | | X | | |
| Riverfront Park | Parks | | Annual | | | | X | | X | | |
| Sadie Quatrale Park | Parks | | Annual | | | | X | | | | |
| Scott Storage Tank and Controls/Valve Building | Water | | Annual | | | | X | | | | |
| Senior Center | City Building | | Annual | X | | | X | | X | | |
| South Fitch Playground | Parks | | Annual | | | | X | | | | |
| South Street Cemetery | Cemeteries | | Annual | | | | X | | | | |
| South Street Elementary School | Schools | | Annual | | | | | | | | |
| Summer Street Fire Station | Fire | | Annual | | X | | X | | X | | |
| Upper Common | Parks | | Annual | | | | X | | | | |
| West Fitchburg Steamline Trail Park | Parks | | Annual | | | | X | | | | |
| West Street Cemetery | Cemeteries | | Annual | | | | X | | X | | |
| West WWTF | Wastewater | | Annual | X | X | X | X | | X | | |
| Rindge Road Forest | Parks | | Annual | | | | X | | | | |
| Route 2 Forest | Parks | | Annual | | | | X | | | | |
| Brigham Park | Parks | | Annual | | | | X | | | | |
| Henry P. Dextraze Circle | Parks | | Annual | | | | X | | | | |
| Forest Park/Hill Rd Island | Parks | | Annual | | | | X | | | | |
| Pat Moran Park | Parks | | Annual | | | | X | | | | |
| St. Joseph's Park | Parks | | Annual | | | | X | | | | |
| Woods Haven | Parks | | Annual | | | | X | | | | |
| Putnam Park | Parks | | Annual | | | | x | | | | |

| BMPs | BMP 9 | BMP 10 | BMP 11 | BMP 12 | BMP 13 | BMP 14 | BMP 15 | BMP 16 | BMP 17 |
|---|---|---|---|---|---|---|---|---|---|
| **Facility Activities** | **Petroleum Tank Storage** | **Outdoor Vehicle and Equipment Storage** | **Salt and Sand Storage** | **Salt Brine and Calcium Storage** | **Material Stockpiles** | **Hazardous Material Storage** | **Catch Basin and Storm System** | **Pavement Maintenance** | **Structural BMP Maintenance** |
| Airport Complex | | | | | | X | | | |
| Hosmer School | | | | | | | | | |
| Amiott Field | | | | | X | | | | |
| Bartley-Nolan Park | | | | | X | | | | |
| Brigham Park | | | | | | | | | |
| Caldwell Park | | | | | X | | | | |
| Central Fire Station | X | | | | | X | X | | |
| Coggshall Park | | | | | | | | | |
| City Hall (New) | | | | | X | X | | | |
| City Hall (Old) | | | | | | | | | |
| Crocker Elementary School | | | | | | X | X | | |
| Coolidge Park | | | | | | | | | |
| Crocker Field | | | | | | X | X | | |
| Daniels Park | | | | | X | | | | |
| Crocker Playground | | | | | | | | | |
| Crocker Playground - Spray Pad | | | | | | | | | |
| Day Street Lot | | | | | | | X | | |
| Dean Hill Cemetery | | | | | X | | | | |
| East WWTF | | | | | X | X | | | |
| Falulah Treatment Plant | X | X | | | | X | X | | X |
| Rollstone/Laurel Schools | | | | | | | | | |
| Fitchburg High School | | | | | | | | | |
| FLLAC School | | | | | | | | | |
| Forest Hill Cemetery | | | | | X | | X | | |
| Former Central Fire Station Lot | | | | | | | | | |
| Gateway Park | | | | | X | | X | | |
| Goodrich Academy | | | | | | | | | |
| Goodrich Playground | | | | | X | | X | | |
| Green Corners Park | | | | | X | | | | |
| Howarth Park | | | | | X | | | | |
| Harwell Cemetery | | | | | | | | | |
| Heritage Park | | | | | | | | | |
| Lacava Pump Station | X | | | | | | | | |
| Bird Sanctuary | | | | | | | | | |
| Longsjo Middle School | | | | | | X | X | | |
| Laurel Hill Cemetery | | | | | | | | | |
| Lowe Playground | | | | | X | | | | |
| McKay Arts Academy | | | | | | | | | |
| Marshall PRV Station | | | | | | | | | |
| Main Street Parking Garage | | | | | | | | | |
| Main Street Parking Lot (Mont) | | | | | | | | | |
| Memorial Middle School | | | | | | X | X | | |
| Montachusett Industrial Park Pump Station | X | | | | | | | | |
| Monument Park | | | | | X | | | | |
| Moran Field | | | | | X | | | | |
| State Pool | | | | | | X | X | | |
| Oak Hill Fire Station | X | | | | | X | X | | |
| Nikitas Field | | | | | | | | | |
| Oak Hill Pump Station | | | | | | | | | |
| Oak Hill Tank and Controls/Valve Building | | | | | | | | | |
| Overlook Storage Tank and Controls/Valve Building | | | | | | | | | |
| Parkhill Park | | | | | | | | | |
| Phillips Playground | | | | | X | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Police Station | | | | | | | | | |
| Public Library | X | | | | | | X | | |
| Public Works Complex | | X | X | X | X | X | X | X | |
| Putnam Street Parking Garage | | | | | | | X | | |
| Reingold Elementary School | | | | | | X | X | | |
| Riverfront Park | | | | | X | | | | |
| Sadie Quatrale Park | | | | | X | | | | |
| Scott Storage Tank and Controls/Valve Building | | | | | | | | | |
| Senior Center | X | | | | | X | | | |
| South Fitch Playground | | | | | X | | | | |
| South Street Cemetery | | | | | X | | | | |
| South Street Elementary School | | | | | | | | | |
| Summer Street Fire Station | X | | | | | X | X | | |
| Upper Common | | | | | | | | | |
| West Fitchburg Steamline Trail Park | | | | | | | | | |
| West Street Cemetery | | | | | X | | | | |
| West WWTF | X | X | | | | X | X | | |
| Rindge Road Forest | | | | | | | | | |
| Route 2 Forest | | | | | | | | | |
| Brigham Park | | | | | | | | | |
| Henry P. Dextraze Circle | | | | | | | | | |
| Forest Park/Hill Rd Island | | | | | | | | | |
| Pat Moran Park | | | | | | | | | |
| St. Joseph's Park | | | | | | | | | |
| Woods Haven | | | | | | | | | |
| Putnam Park | | | | | | | | | |

# APPENDIX B

## Facility Maps


N

0 465 930 1,860 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

CITY OF FITCHBURG, MASSACHUSETTS

ARCADIS

# AIRPORT COMPLEX

Address: 563 Crawford Street


N

0 20 40 80 Feet

City Owned Parcel
Waterbody
Stormwater Pipe
Drain Manhole
Outfall
Catch Basin
Sanitary Sewer Pipe
Sanitary Sewer Manhole
Sanitary Sewer Regulator
Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# DEAN HILL CEMETERY

Address: 304 Caswell Road


N

0 150 300 600 Feet

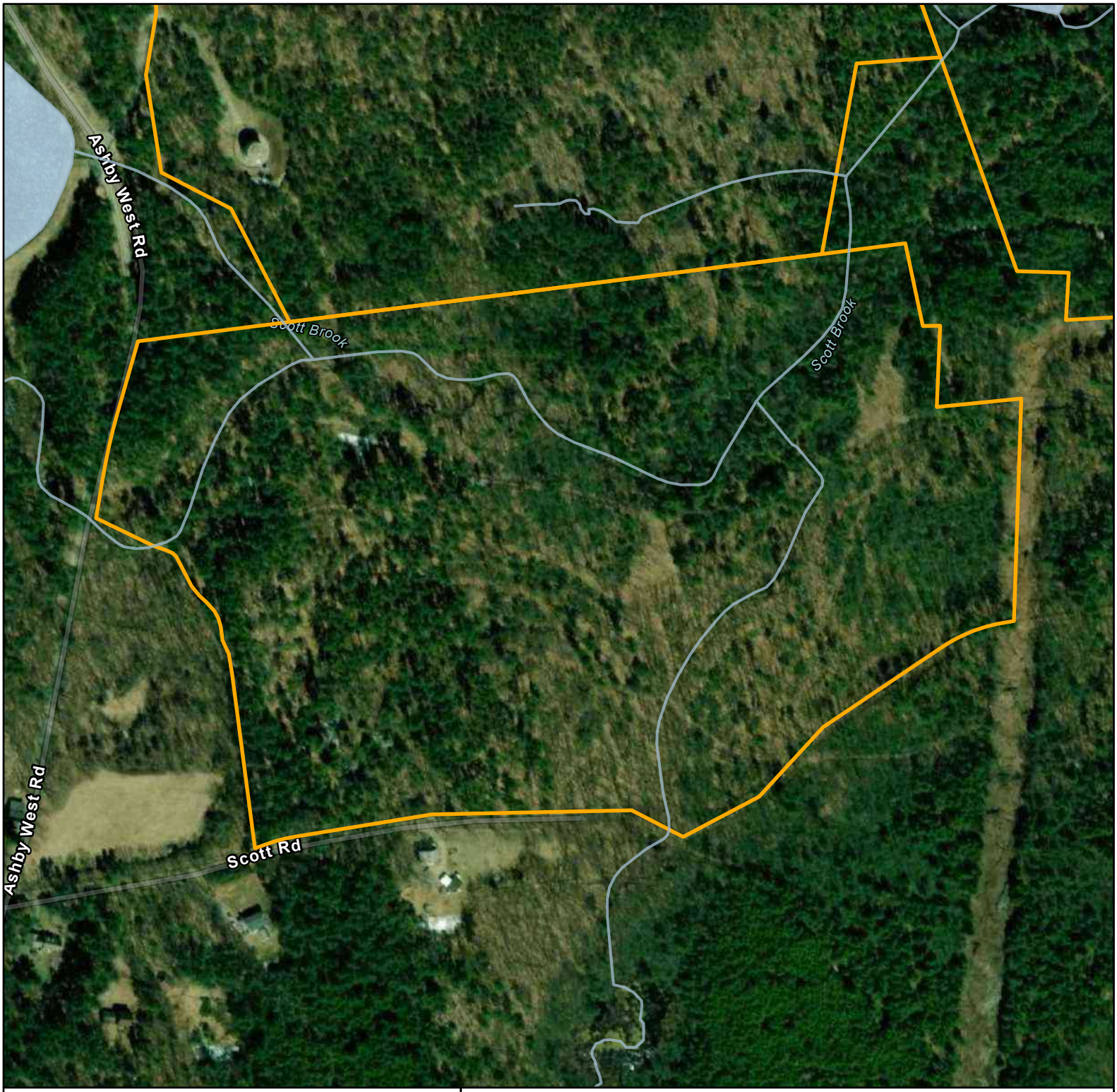
- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# FOREST HILL CEMETERY

Address: 115 Mt. Elam Road




N

0 165 330 660 Feet

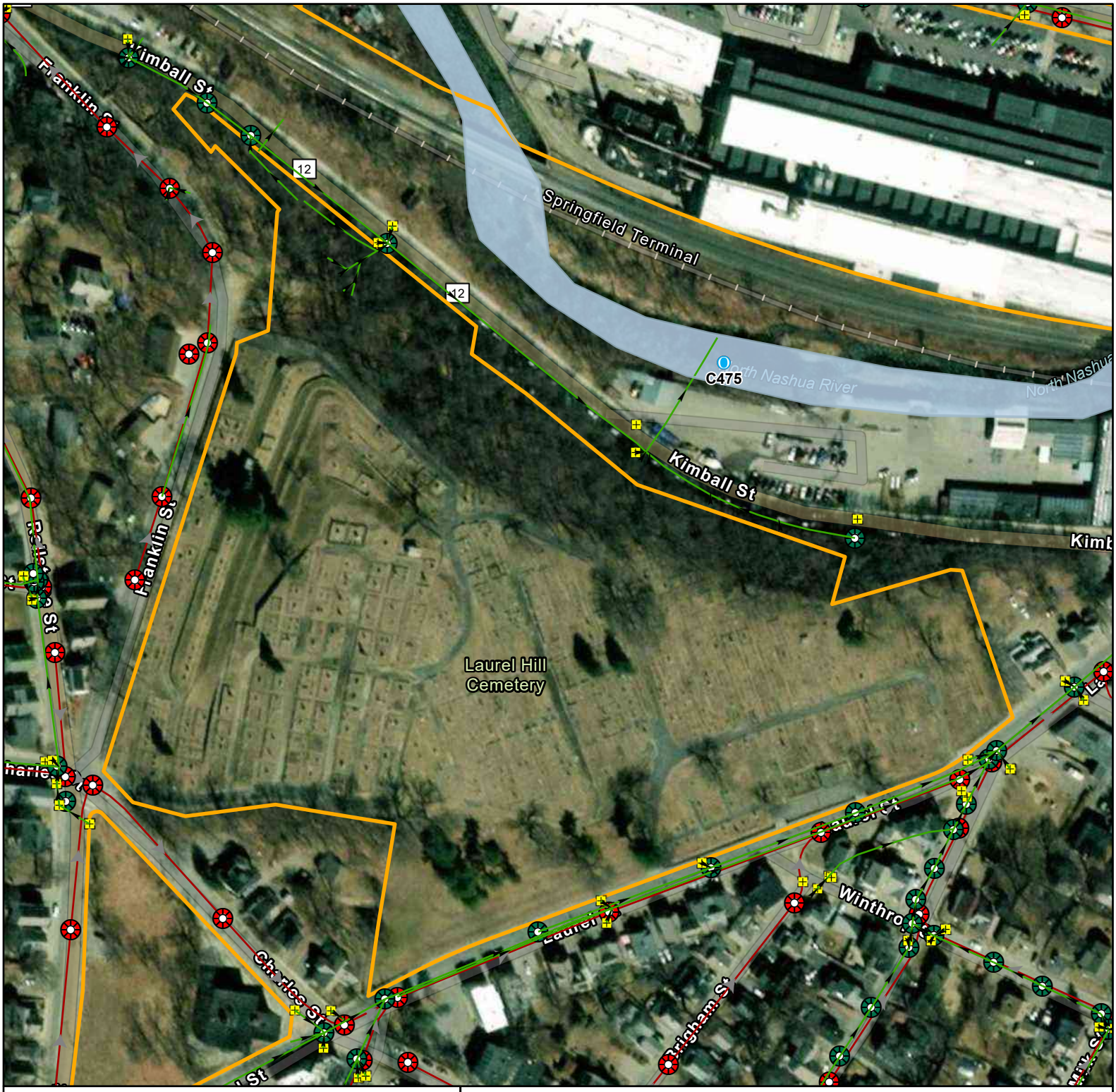
- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# HARWELL CEMETERY

Address: 299 Ashby West Road




N

0 90 180 360 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

CITY OF FITCHBURG, MASSACHUSETTS

ARCADIS

# LAUREL HILL CEMETERY

Address: 167 Laurel Street


N

0 25 50 100 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# SOUTH STREET CEMETERY

Address: South Street


N

Feet

0 5 10 20

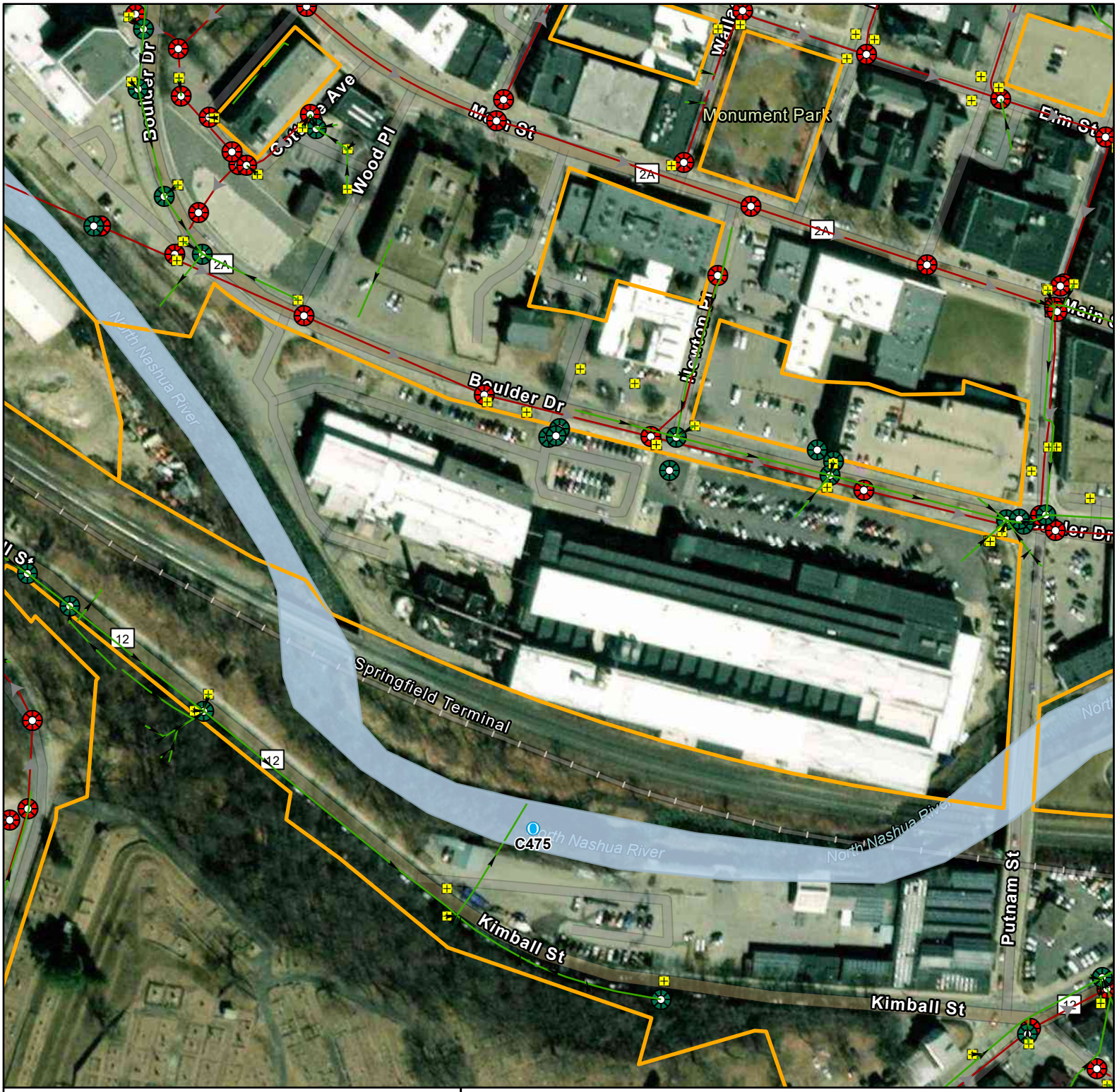
City Owned Parcel
Waterbody
Stormwater Pipe
Drain Manhole
Outfall
Catch Basin
Sanitary Sewer Pipe
Sanitary Sewer Manhole
Sanitary Sewer Regulator
Sanitary Sewer Cleanout

CITY OF FITCHBURG, MASSACHUSETTS

ARCADIS

# WEST STREET CEMETERY

Address: Main Street




N

0 95 190 380 Feet

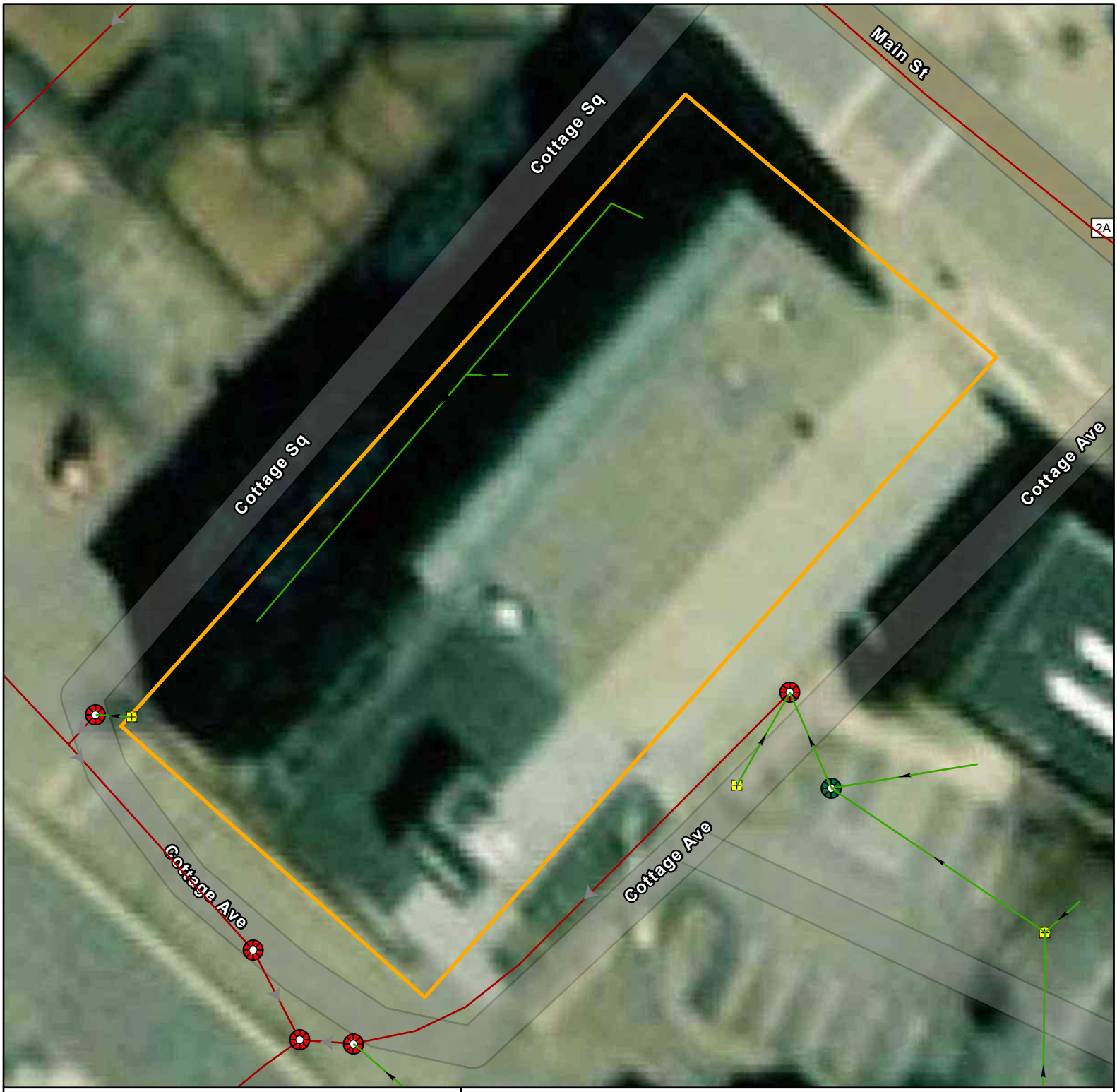
- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

**CITY OF FITCHBURG, MASSACHUSETTS**

ARCADIS

# CITY HALL (NEW)

Address: 166 Boulder Drive




N

0 12.5 25 50 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# CITY HALL (OLD)

Address: 718 Main Street


N

0 25 50 100 Feet

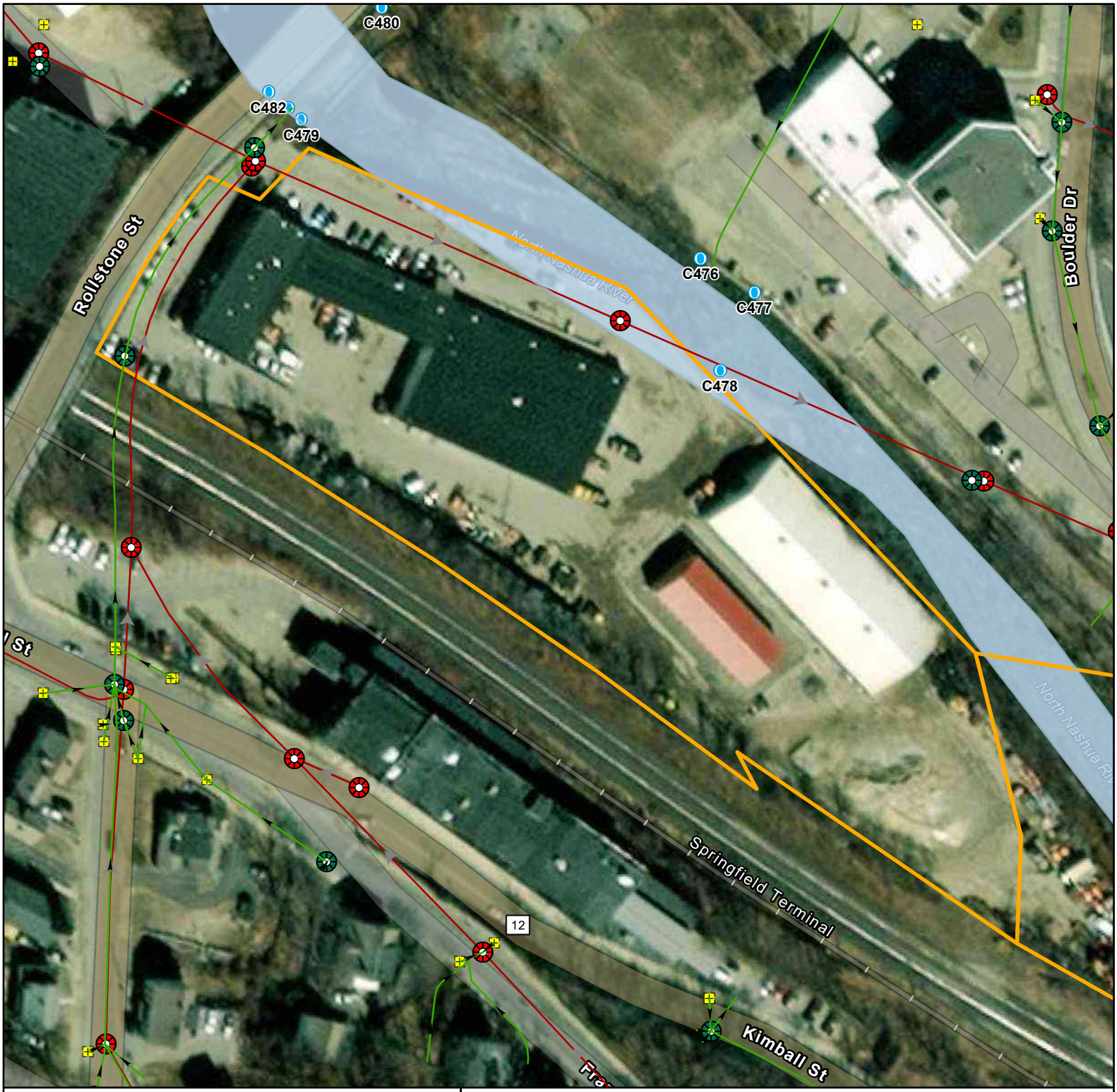
- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# POLICE STATION

Address: 20 Elm Street




N

0 50 100 200 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# PUBLIC WORKS COMPLEX

Address: 301 Broad Street


N

0 25 50 100 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# CENTRAL FIRE STATION

Address: 33 North Street


N

Feet
0 10 20 40

City Owned Parcel
Waterbody
Stormwater Pipe
Drain Manhole
Outfall
Catch Basin
Sanitary Sewer Pipe
Sanitary Sewer Manhole
Sanitary Sewer Regulator
Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# FORMER CENTRAL FIRE STATION LOT

Address: 28 Oliver Street


N

0 5 10 20 Feet

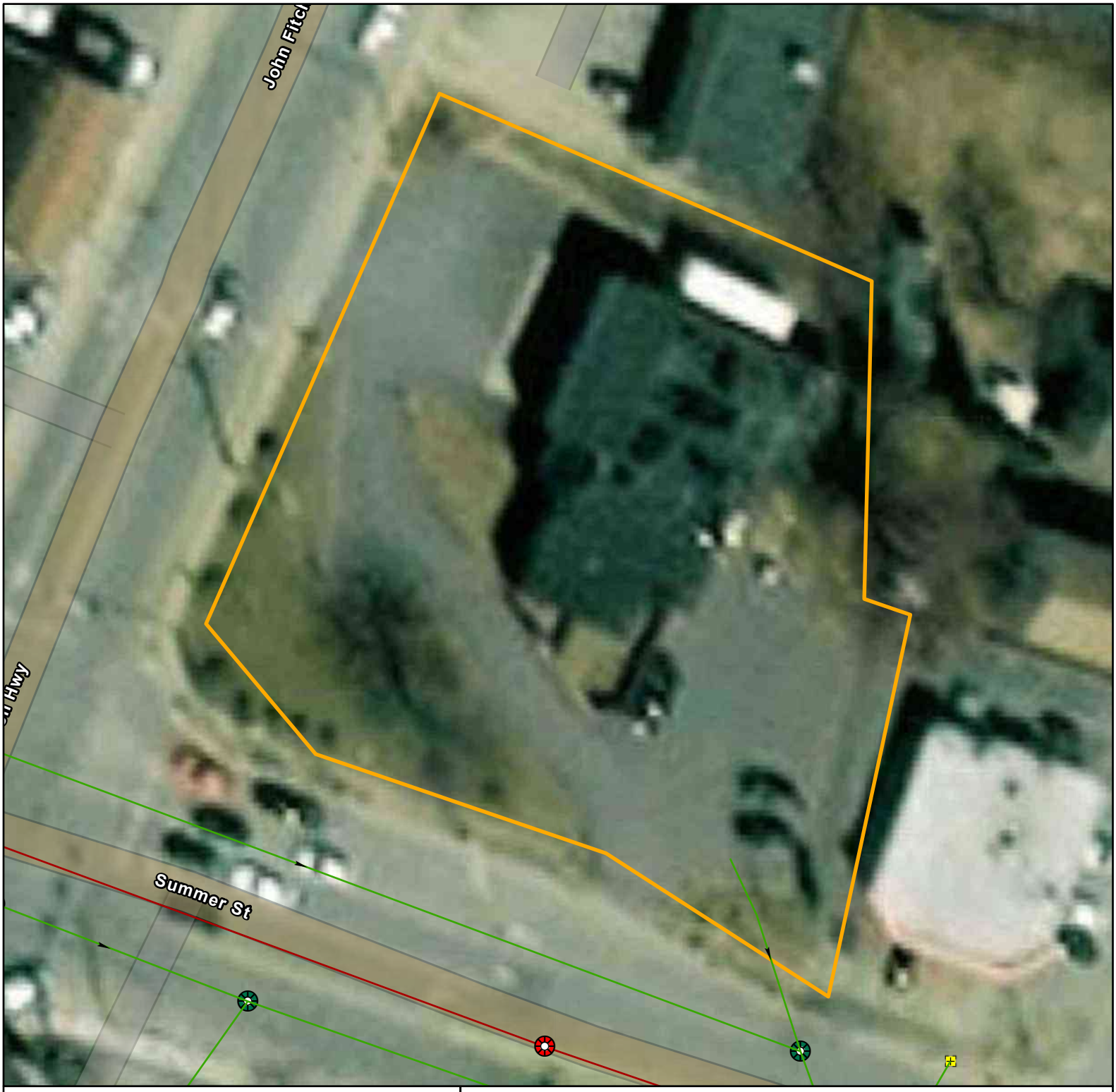
- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# OAK HILL FIRE STATION

Address: 234 Fairmount Street




N

0 15 30 60 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# SUMMER STREET FIRE STATION

Address: 42 John Fitch Highway


N

0 15 30 60 Feet

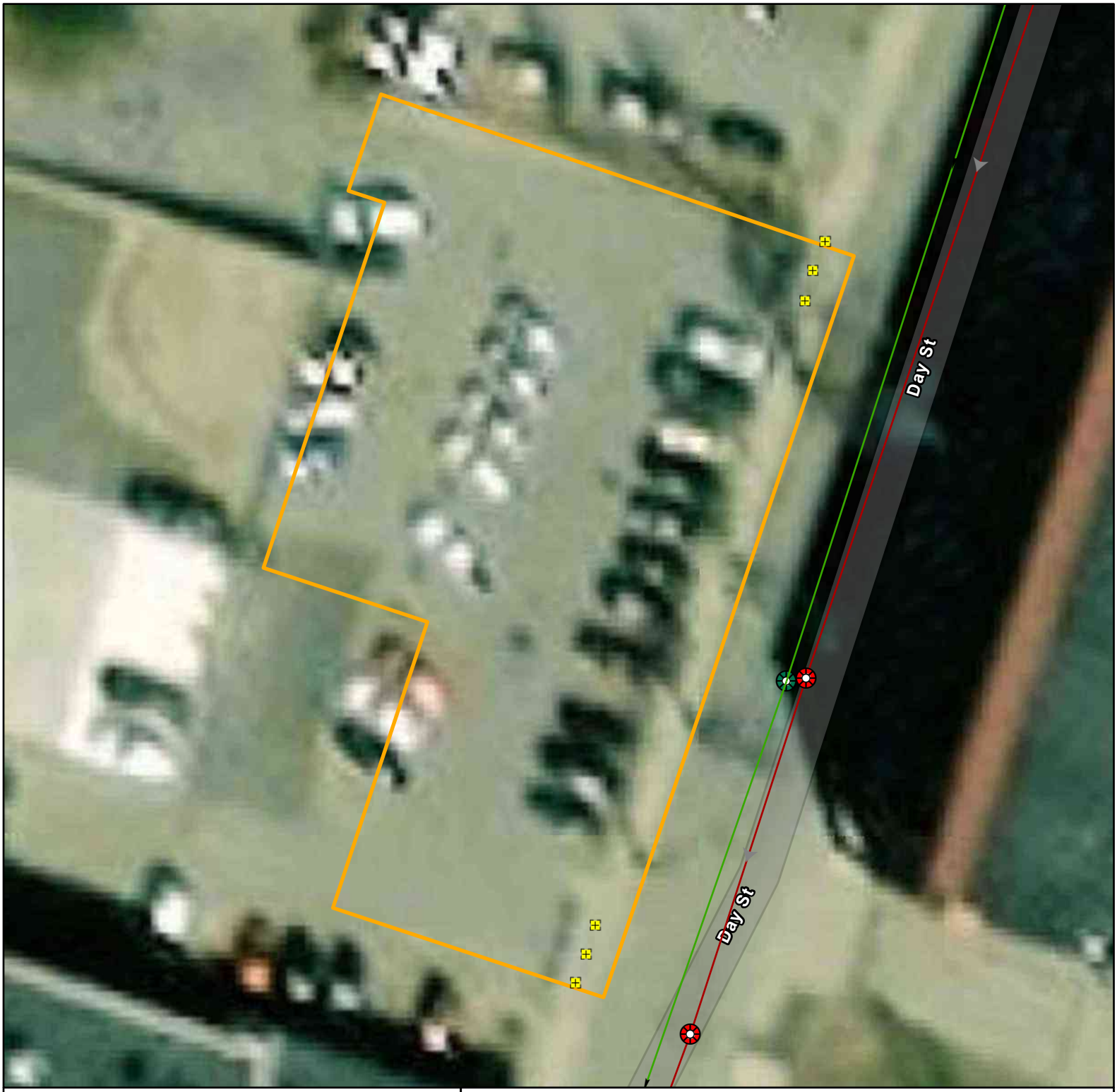
- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# PUBLIC LIBRARY

Address: 610 Main Street




N

0 12.5 25 50 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# DAY STREET LOT

Address: Day Street


N

0 50 100 200 Feet

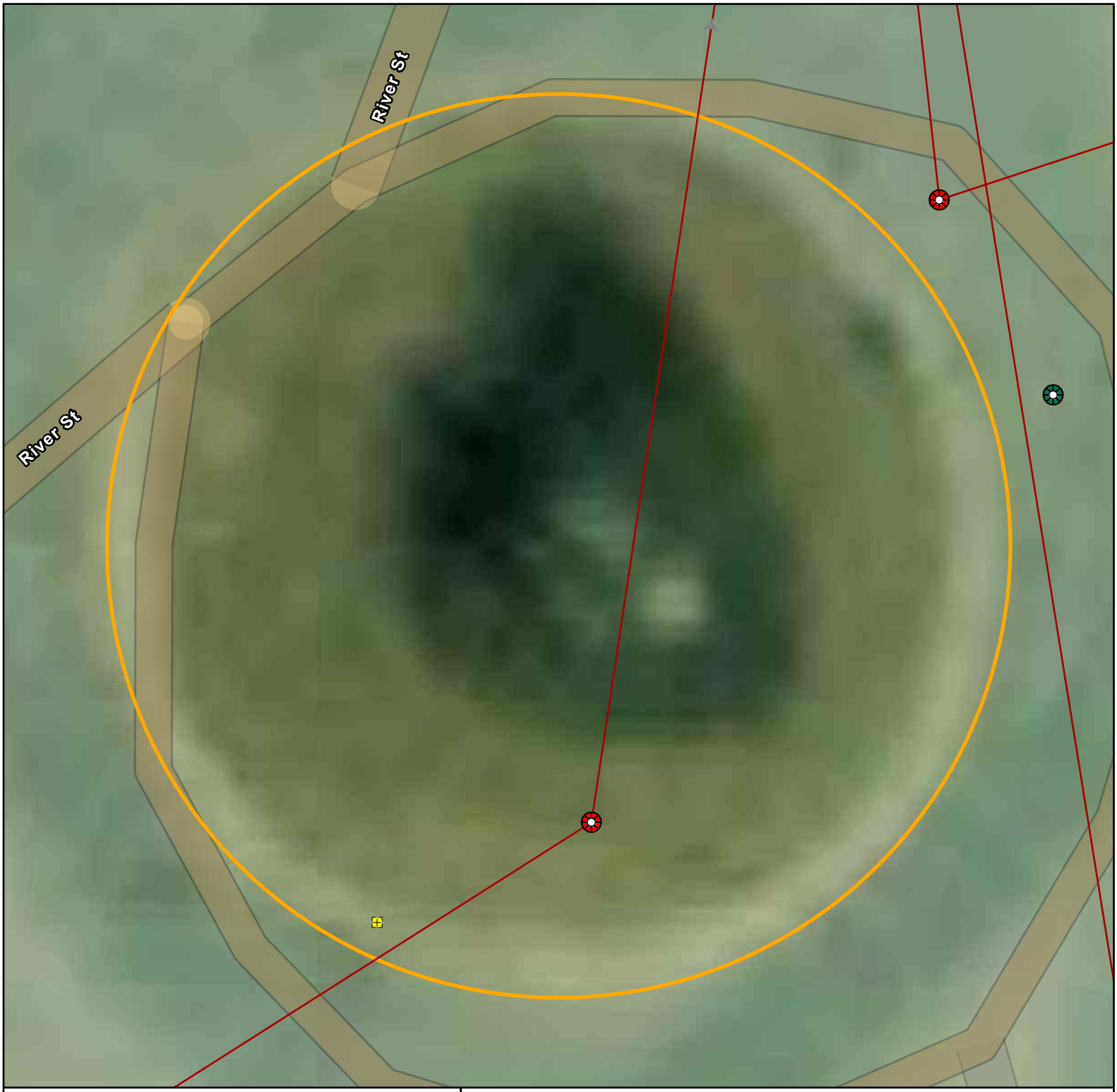
- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# FOREST PARK ISLAND

Address: Forest Park




N

0 5 10 20 Feet

City Owned Parcel
Waterbody
Stormwater Pipe
Drain Manhole
Outfall
Catch Basin
Sanitary Sewer Pipe
Sanitary Sewer Manhole
Sanitary Sewer Regulator
Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# HENRY P DEXTRAZE CIRCLE

Address: Daniels Street at River Street


N

0 20 40 80 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

CITY OF FITCHBURG, MASSACHUSETTS

ARCADIS

# MAIN STREET PARKING GARAGE

Address: Main & Mill Streets


N

0 12.5 25 50 Feet

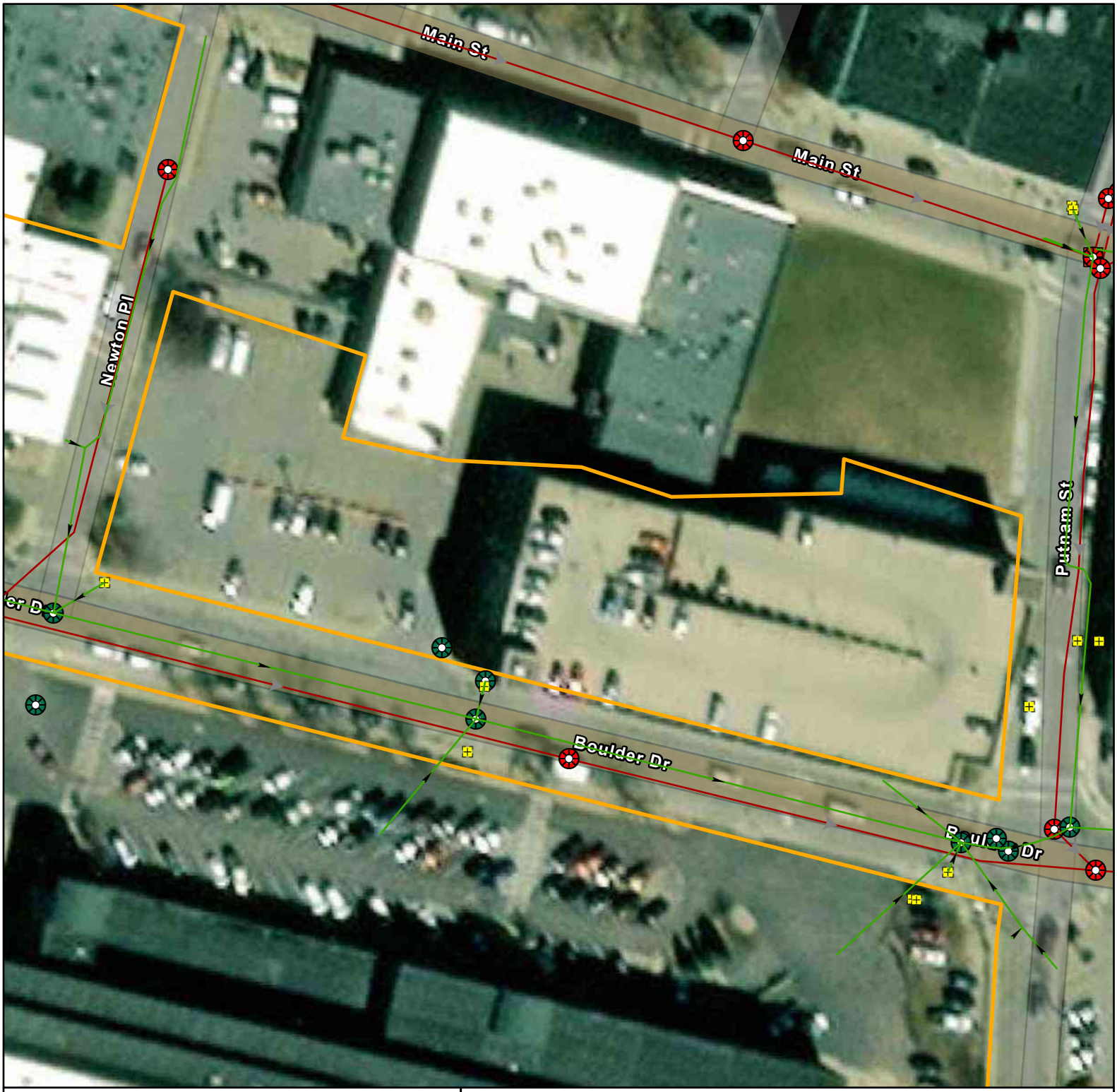
- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# PUTNAM PARK ISLAND

Address: Putnam Park




N

0 30 60 120 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# PUTNAM STREET PARKING GARAGE

Address: Putnam Street & Boulder Drive


N

0 25 50 100 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# AMIOT FIELD

Address: River Street, across from Broad


N

0 25 50 100 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# BABE DICONZA MEMORIAL PARK

Address: 32 Beekman Street


N

0 115 230 460 Feet

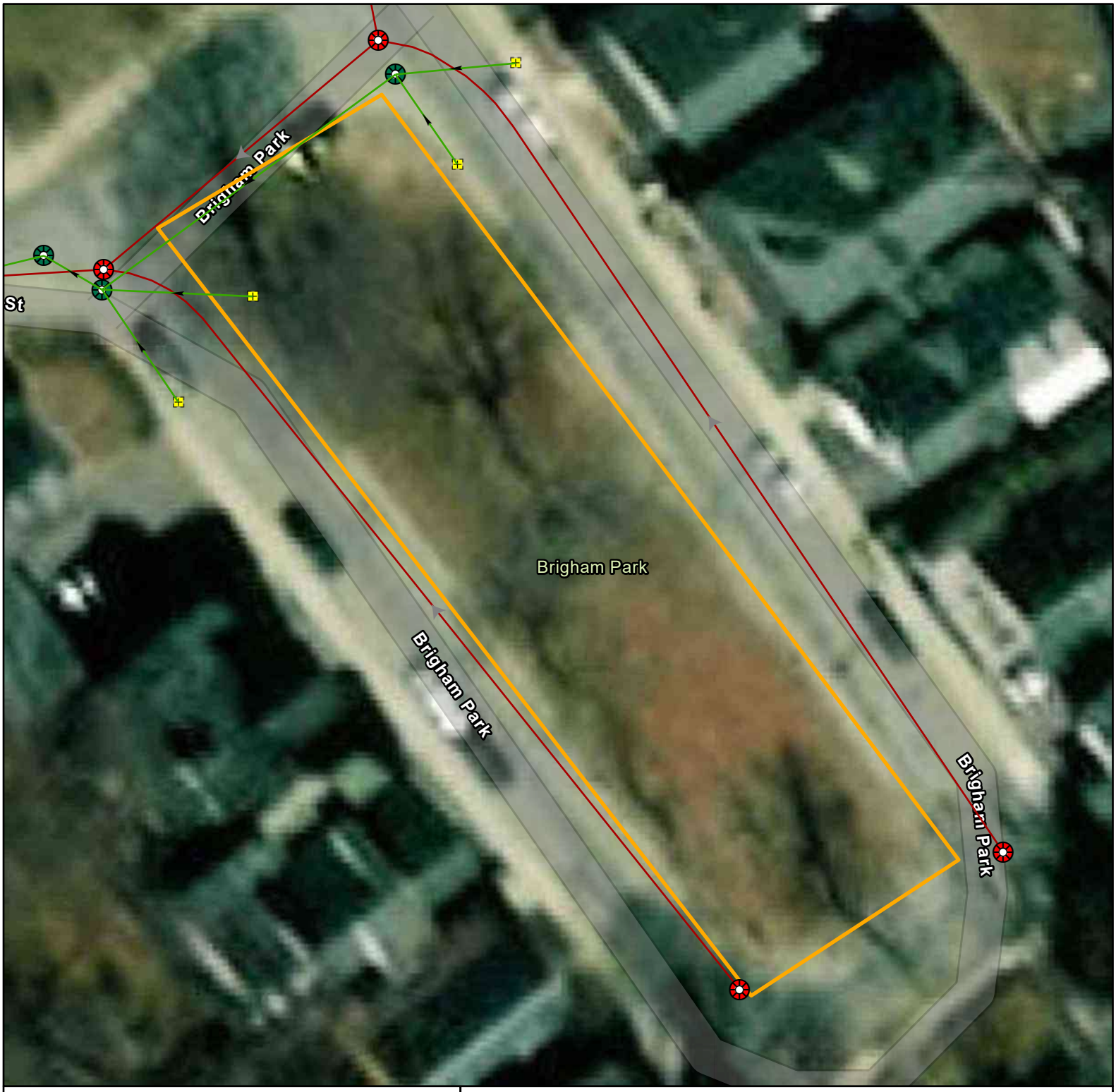
- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# BIRD SANCTUARY

Address: Ashburnham Hill Road




N

0 15 30 60 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

**CITY OF FITCHBURG, MASSACHUSETTS**

ARCADIS

# BRIGHAM PARK

Address: Brigham Park


N

0 25 50 100 Feet

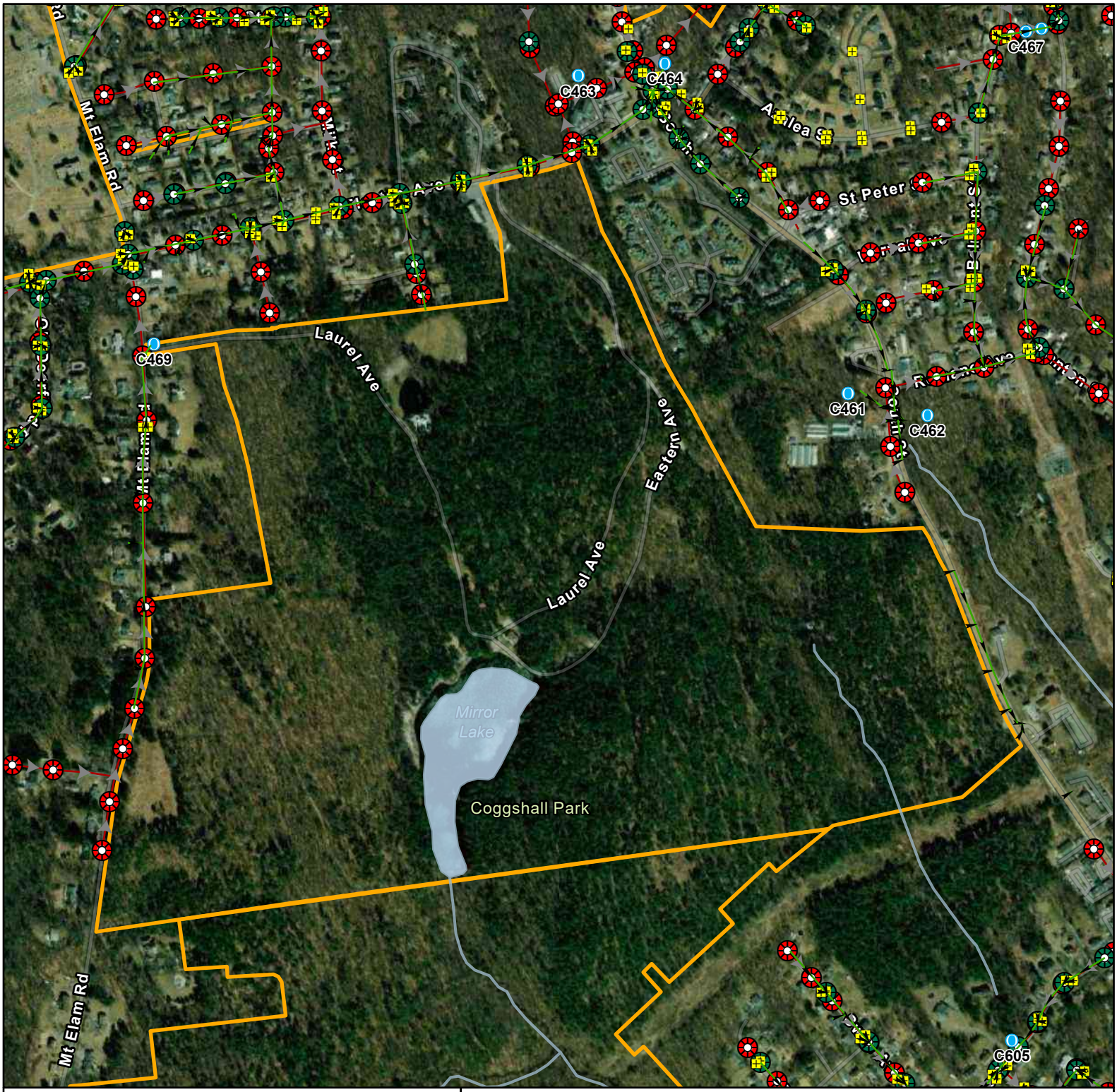
- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# CALDWELL PARK

Address: Main & Caldwell Streets




N

0 335 670 1,340 Feet

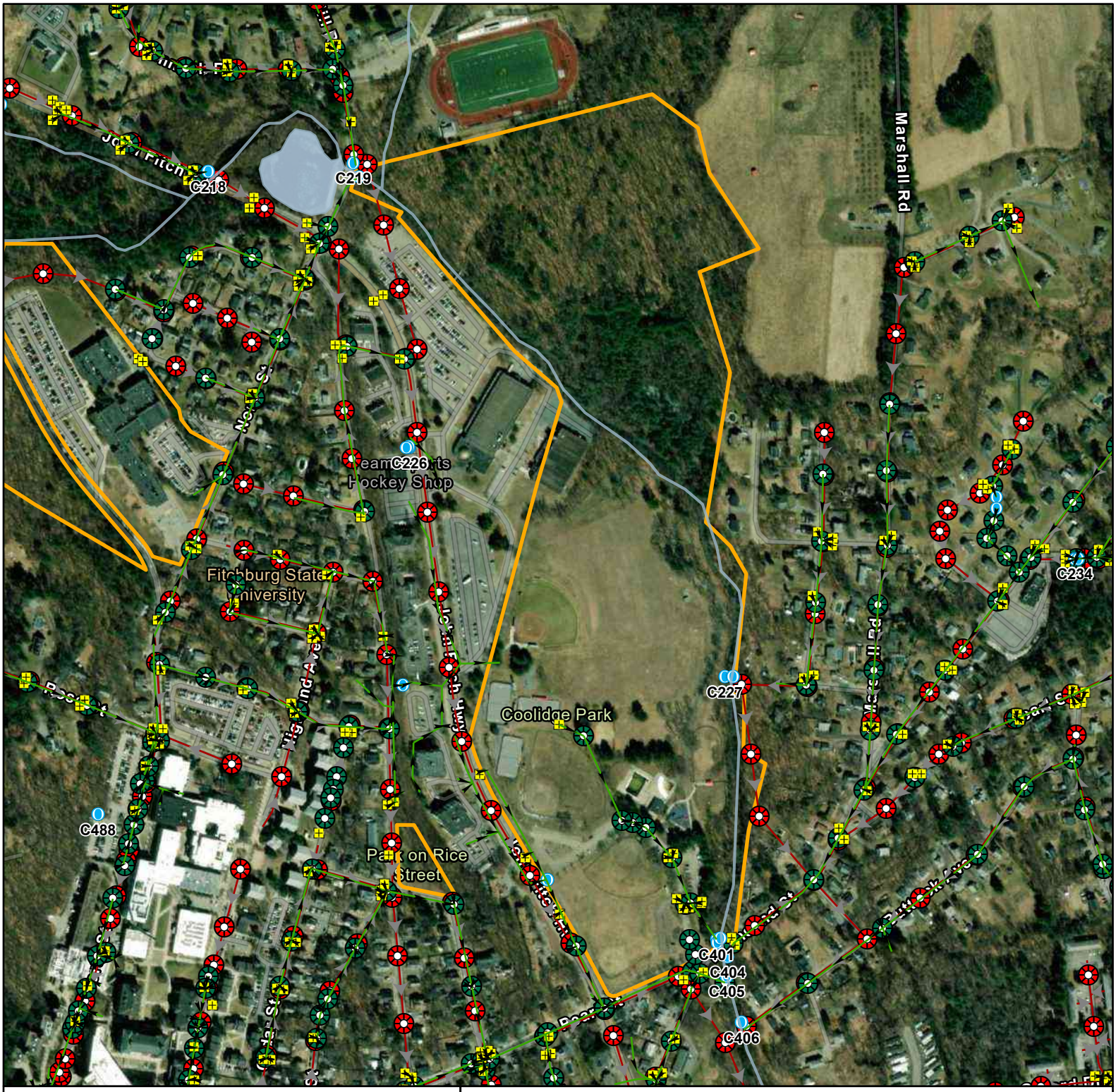
- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

**CITY OF FITCHBURG, MASSACHUSETTS**

ARCADIS

# COGGSHALL PARK

Address: 159 Electric Avenue




N

0 260 520 1,040 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# COOLIDGE PARK

Address: 198 Townsend Street


N

0 70 140 280 Feet

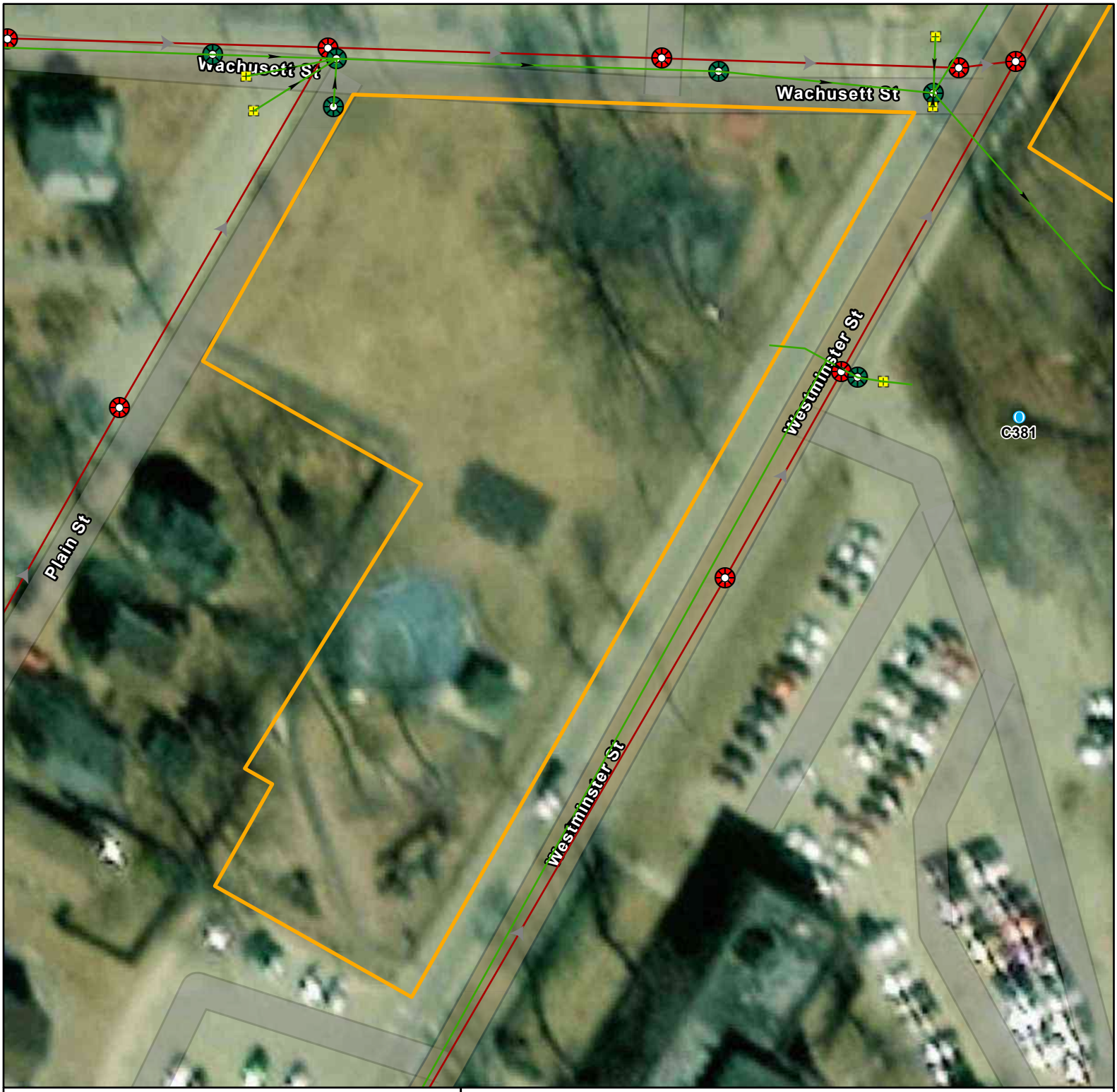
- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# CROCKER FIELD

Address: River & Broad Streets




N

0 25 50 100 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

**CITY OF FITCHBURG, MASSACHUSETTS**

ARCADIS

# CROCKER PLAYGROUND

Address: Westminster & Wachusett


N

0 10 20 40 Feet

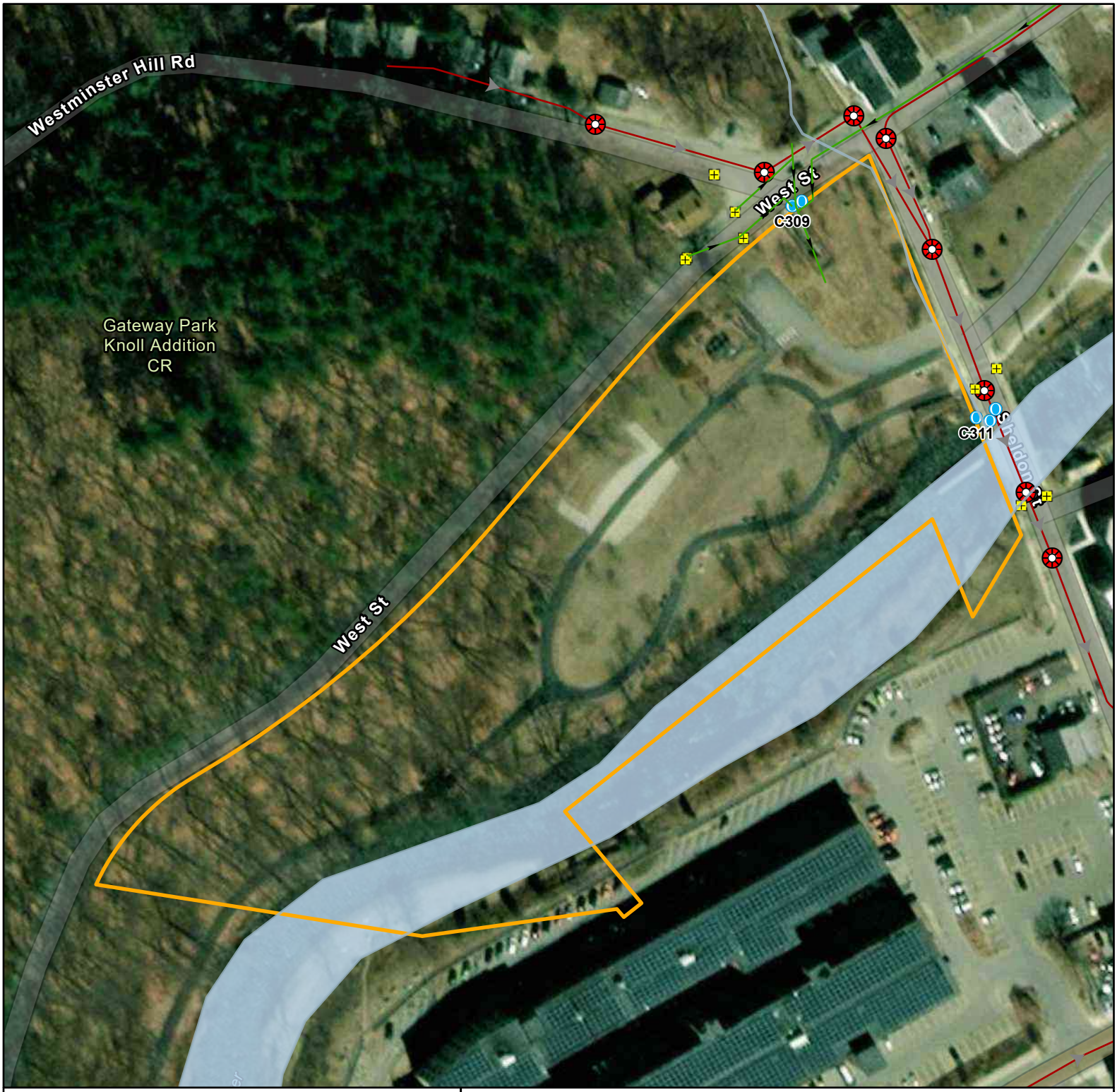
- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# DANIELS PARK

Address: Daniels & Fairmount Streets




N

0 65 130 260 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# GATEWAY PARK

Address: 19 Sheldon Street


N

0 35 70 140 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# GOODRICH PLAYGROUND

Address: Goodrich & Boutelle Streets


N

0 15 30 60 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# GREEN CORNERS PARK

Address: North & Willow Streets


N

0 15 30 60 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

CITY OF FITCHBURG, MASSACHUSETTS

ARCADIS

# HERITAGE PARK

Address: Boulder & Main Streets


N

0 37.5 75 150 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# HOWARTH PARK

Address: Rollstone & Laurel Streets


N

0 40 80 160 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# LOWE PLAYGROUND

Address: 174 Elm Street


N

0 15 30 60 Feet

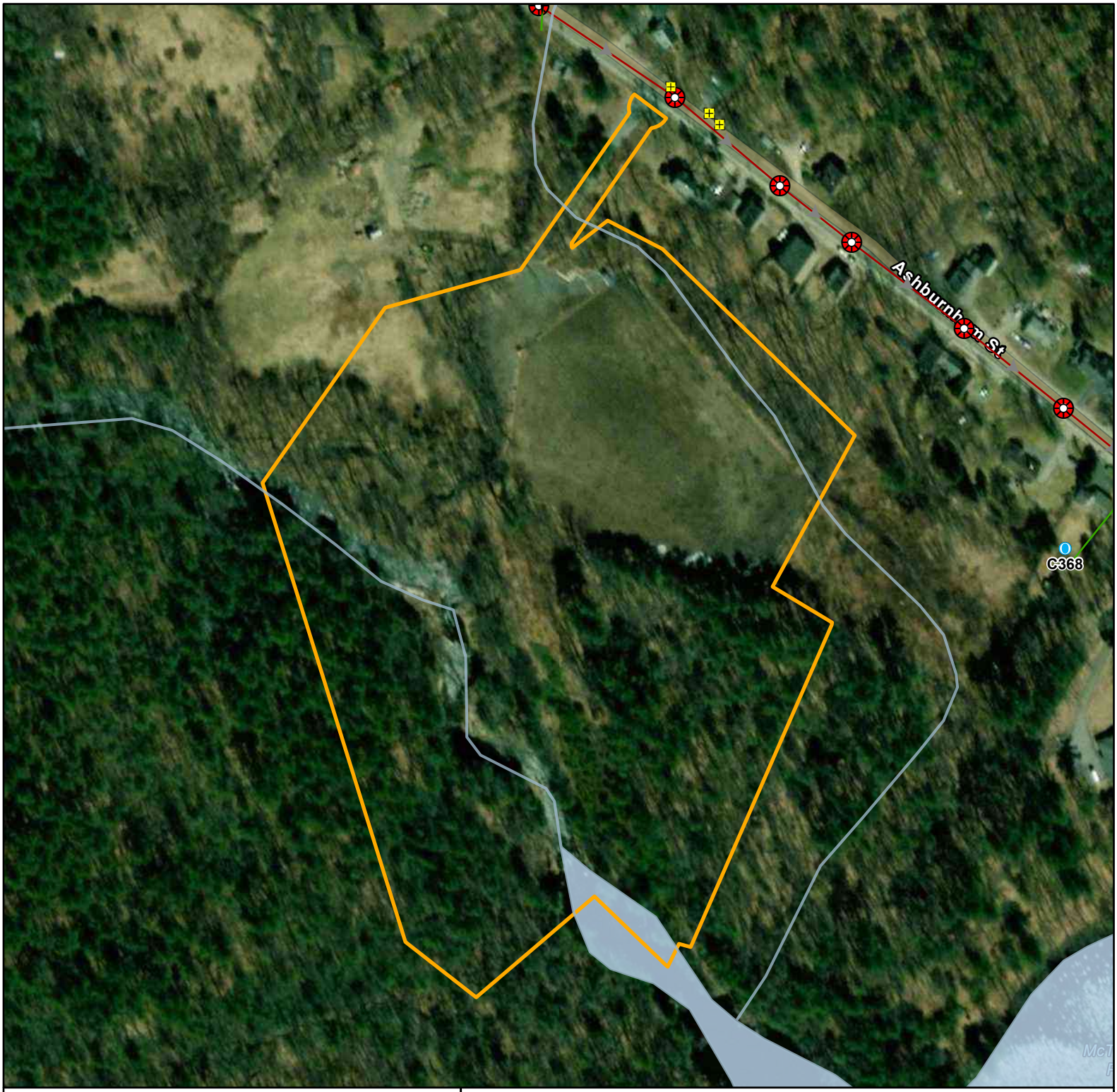
- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# MONUMENT PARK

Address: 597 Main Street




N

0 100 200 400 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# MORAN FIELD

Address: 445 Ashburnham Street


N

0 155 310 620 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# NIKITAS FIELD/PARKHILL PARK

Address: Rollstone Street & Franklin Road


N

0 12.5 25 50 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# PHILLIPS PLAYGROUND

Address: 842 Westminster Hill Road


N

0 105 210 420 Feet

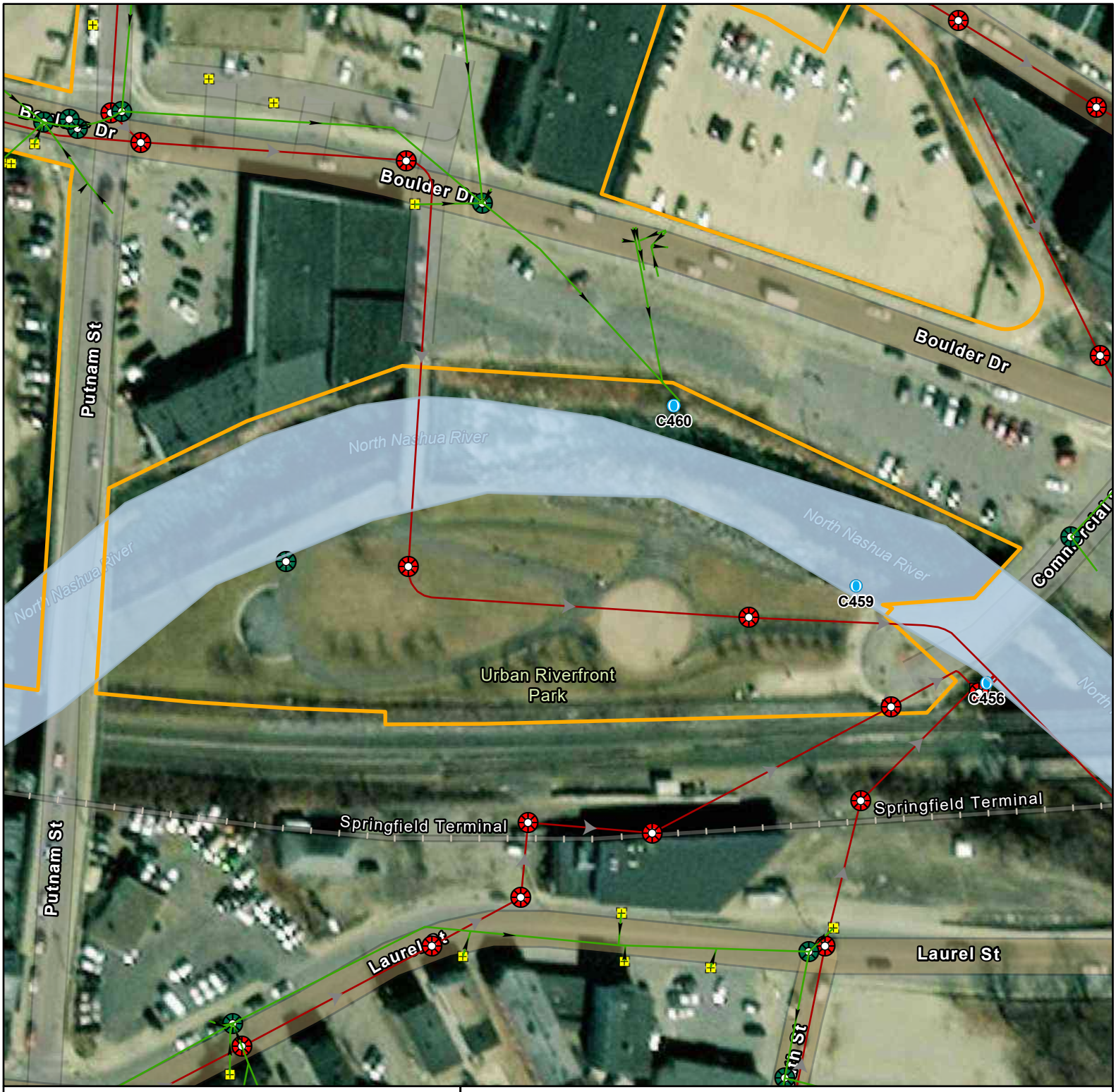
- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# RINGE ROAD FOREST

Address: Ringe Road




N

0 45 90 180 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

CITY OF FITCHBURG, MASSACHUSETTS

ARCADIS

# RIVERFRONT PARK

Address: 51 Commercial Street


N

0 205 410 820 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# ROUTE 2/FITCHBURG FOREST

Address: Route 2


N

0 15 30 60 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# SADIE QUATRALE PARK

Address: John T. Centrino Memorial Drive


N

0 105 210 420 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# SOUTH FITCH PLAYGROUND

Address: Abbot Avenue and Water Street

N

0 25 50 100 Feet

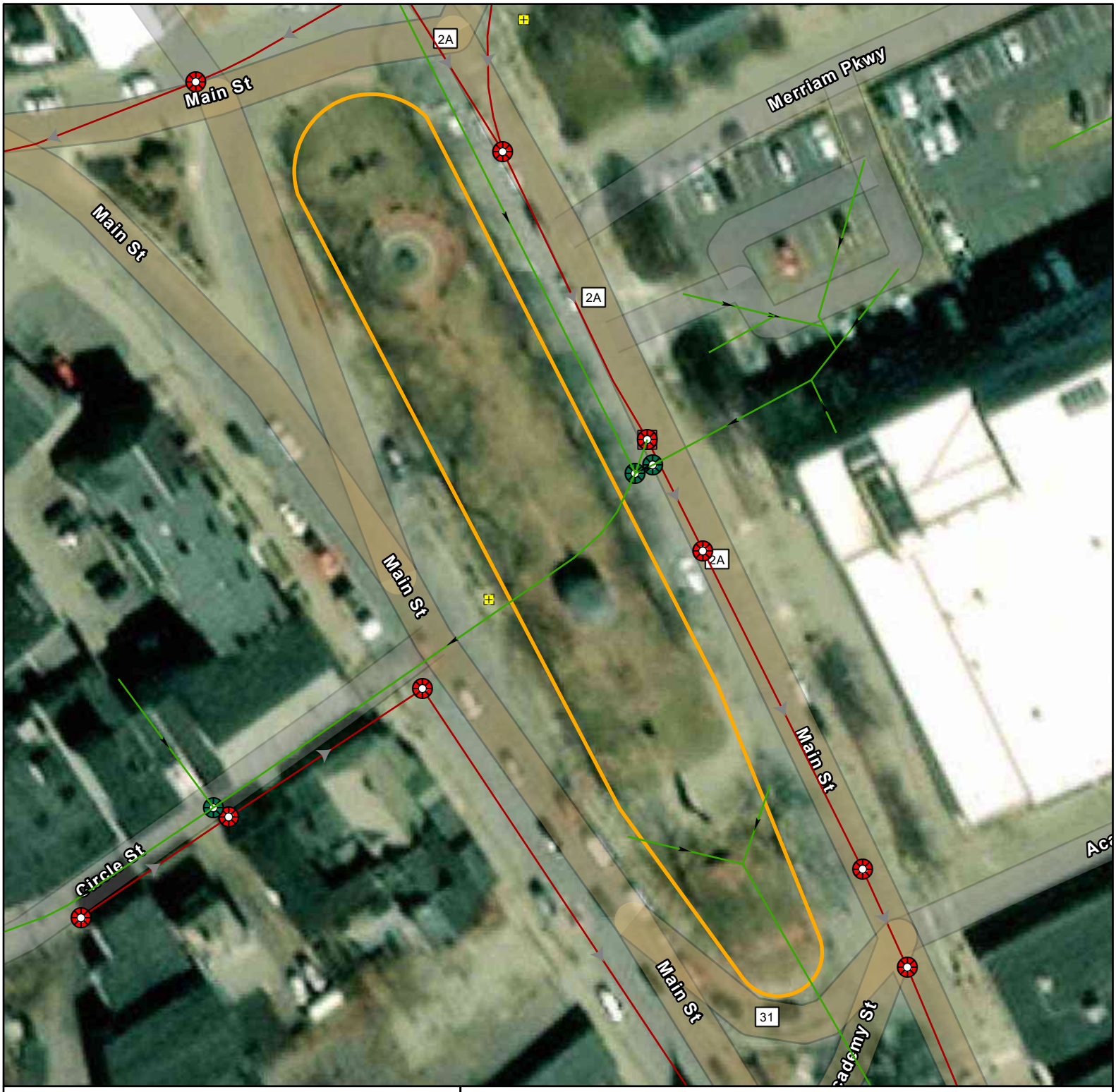
- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# STATE POOL

Address: Wanoosnoc Road




N

0 30 60 120 Feet

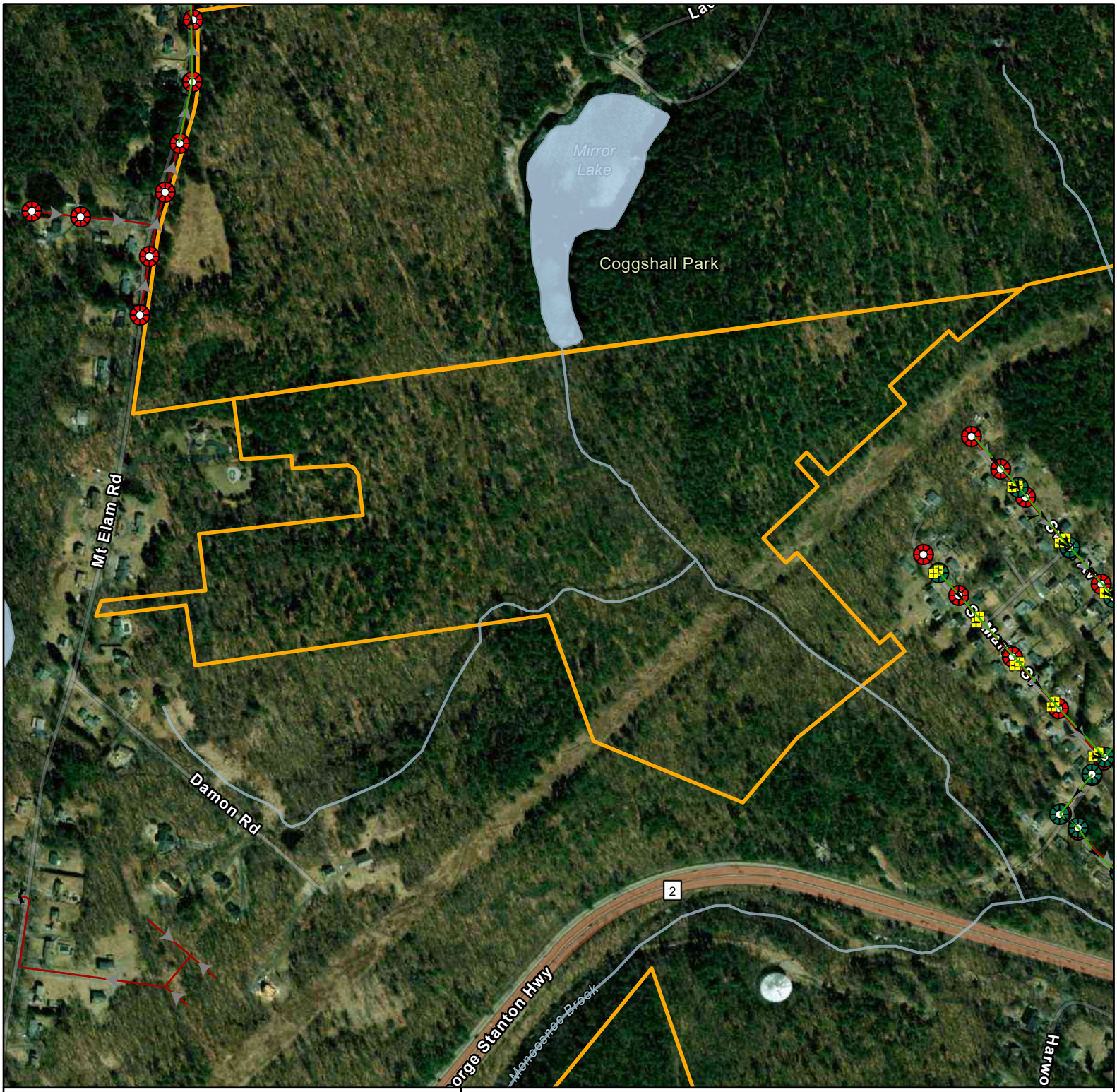
- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# UPPER COMMON

Address: 857 Main Street




N

0 275 550 1,100 Feet

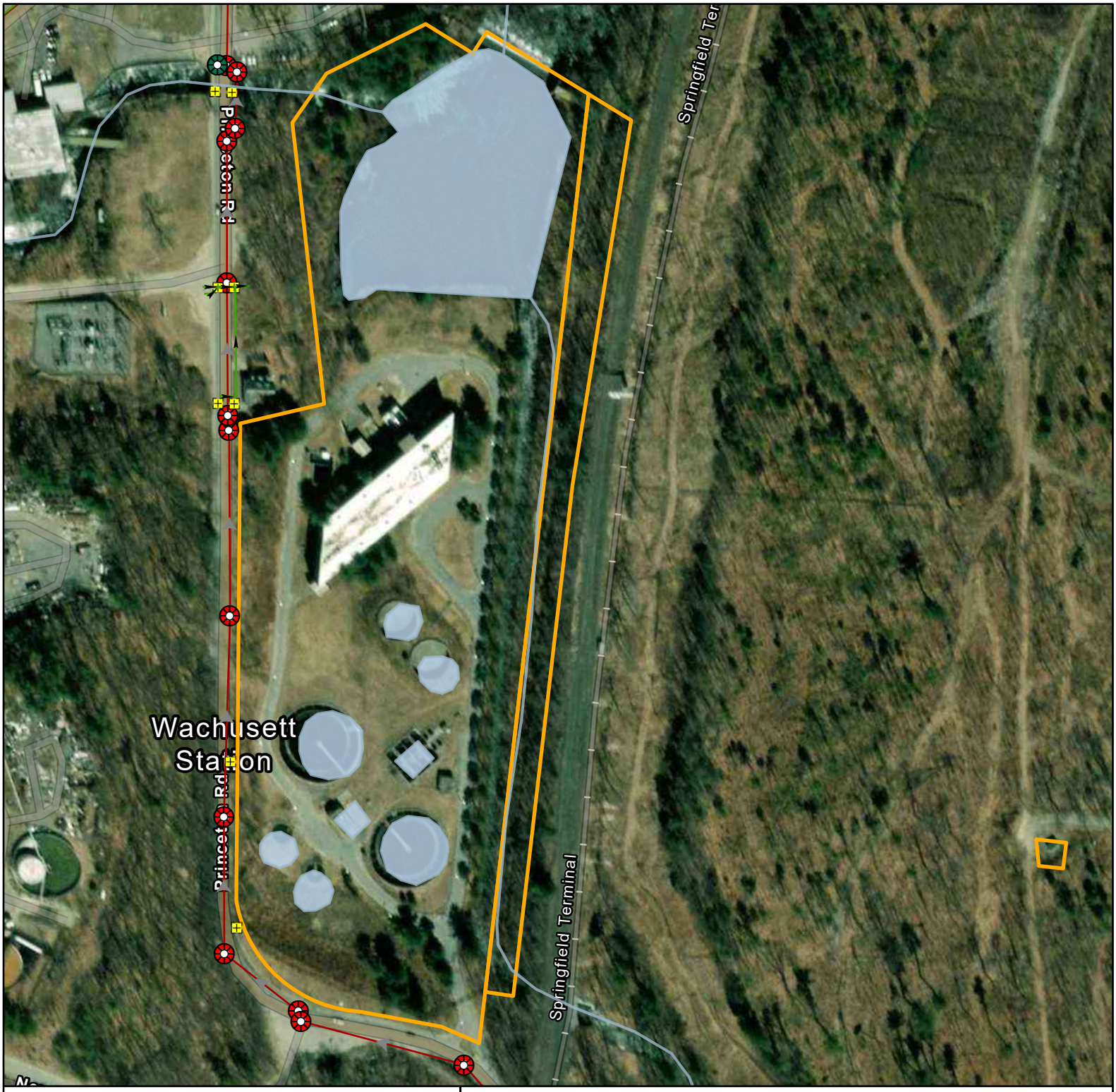
- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# VACANT PARCEL

Address: Mount Elam Road




N

0 115 230 460 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

CITY OF FITCHBURG, MASSACHUSETTS

ARCADIS

# WEST FITCHBURG STREAMLINE TRAIL

Address: 465 Westminster Street


N

0 30 60 120 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# WEST FITCHBURG STREAMLINE TRAIL PARK

Address: 465 Westminster Street


N

0 20 40 80 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# WOODS HAVEN

Address: Rice Street and Lincoln Street


N

0 100 200 400 Feet

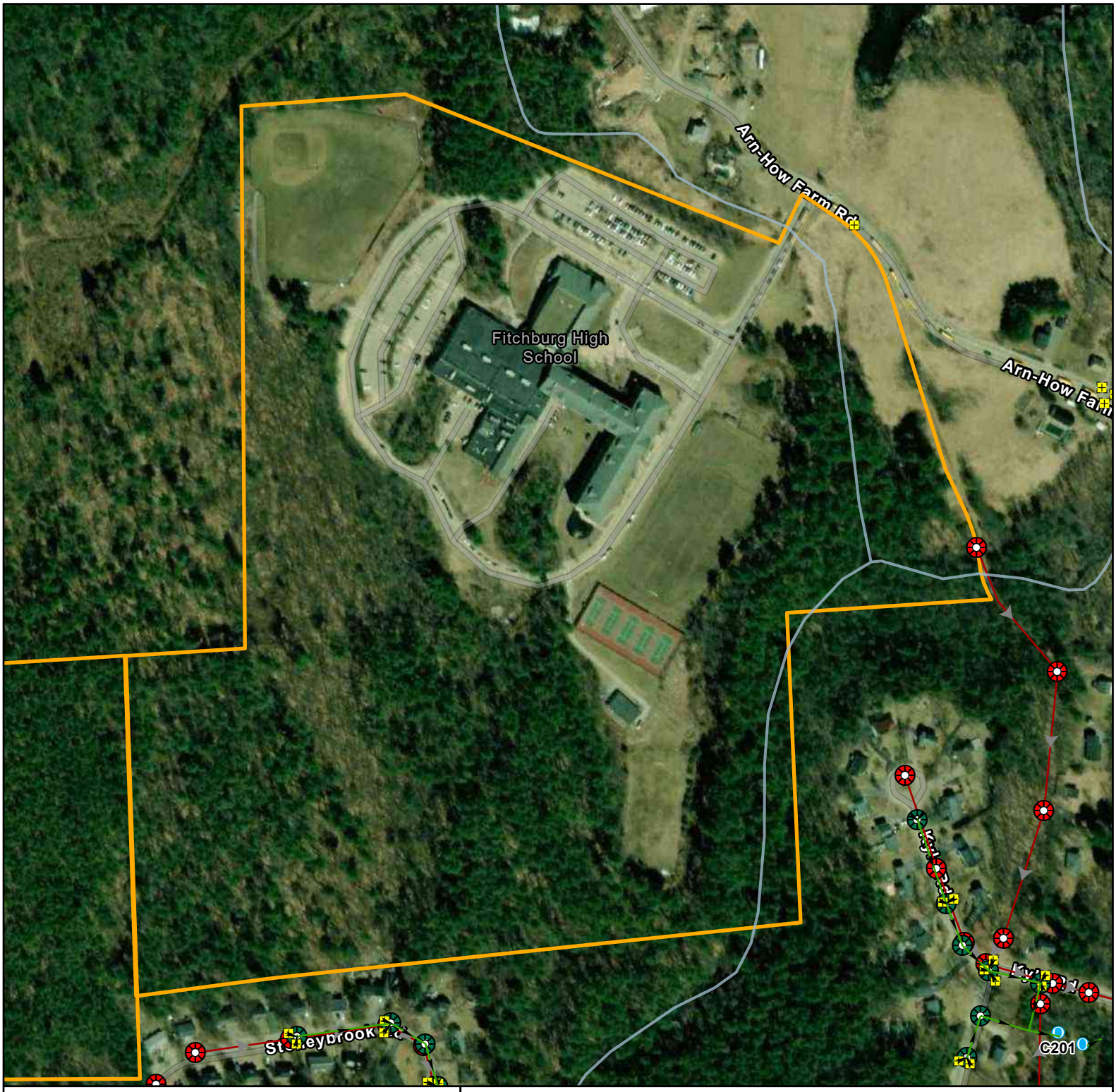
- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

CITY OF FITCHBURG, MASSACHUSETTS

ARCADIS

# CROCKER ELEMENTARY SCHOOL

Address: 200 Bigelow Road




N

0 165 330 660 Feet

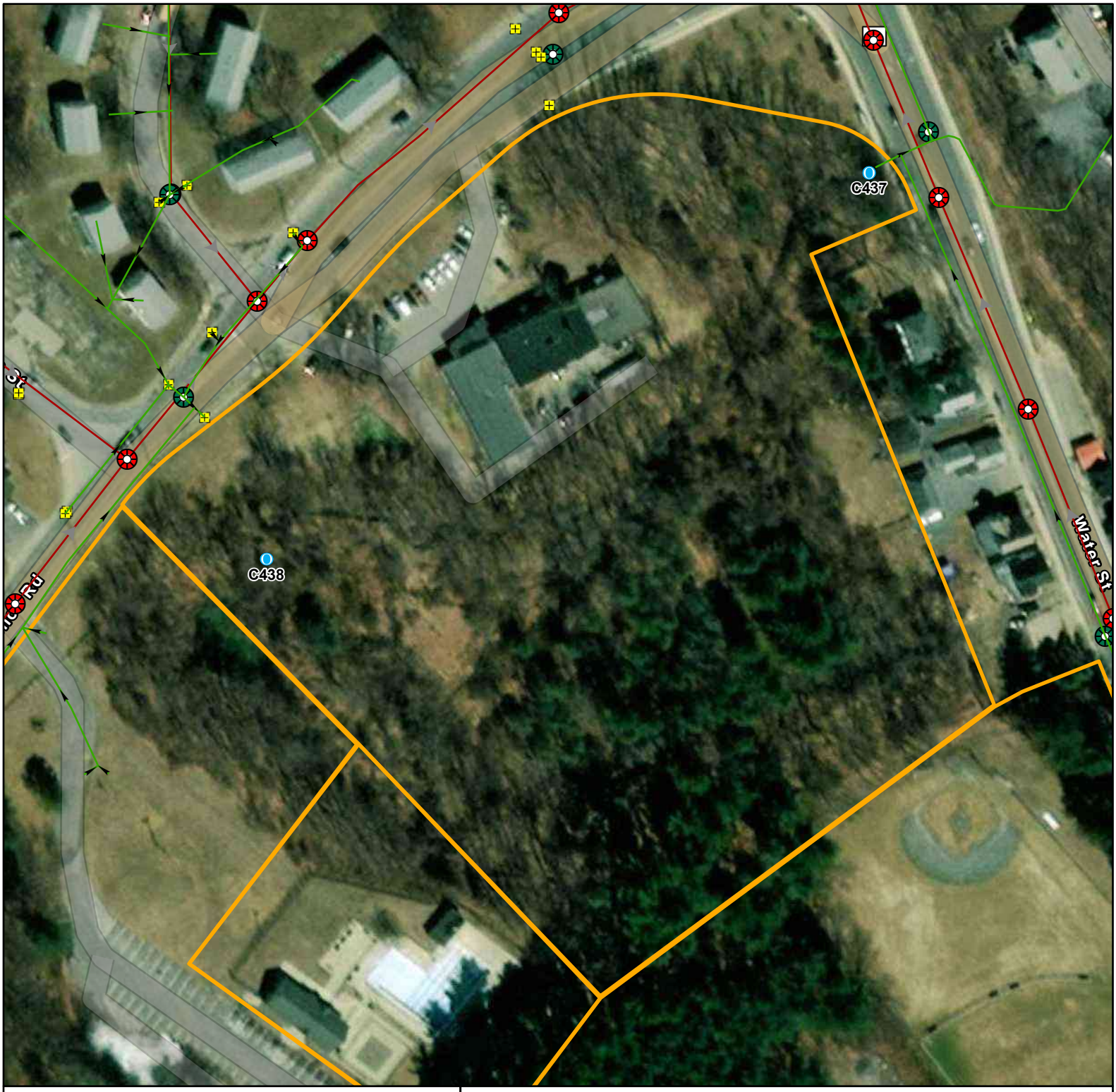
- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

CITY OF FITCHBURG, MASSACHUSETTS

ARCADIS

# FITCHBURG HIGH SCHOOL

Address: 140 Arn-How Farm Road




N

0 60 120 240 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

CITY OF FITCHBURG, MASSACHUSETTS

ARCADIS

# FLLAC SCHOOL

Address: 44 Wanoosnoc Road


N

0 15 30 60 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# GOODRICH ACADEMY

Address: 111 Goodrich Street


N

0 15 30 60 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# HOSMER SCHOOL

Address: 110 South Street


N

0 40 80 160 Feet

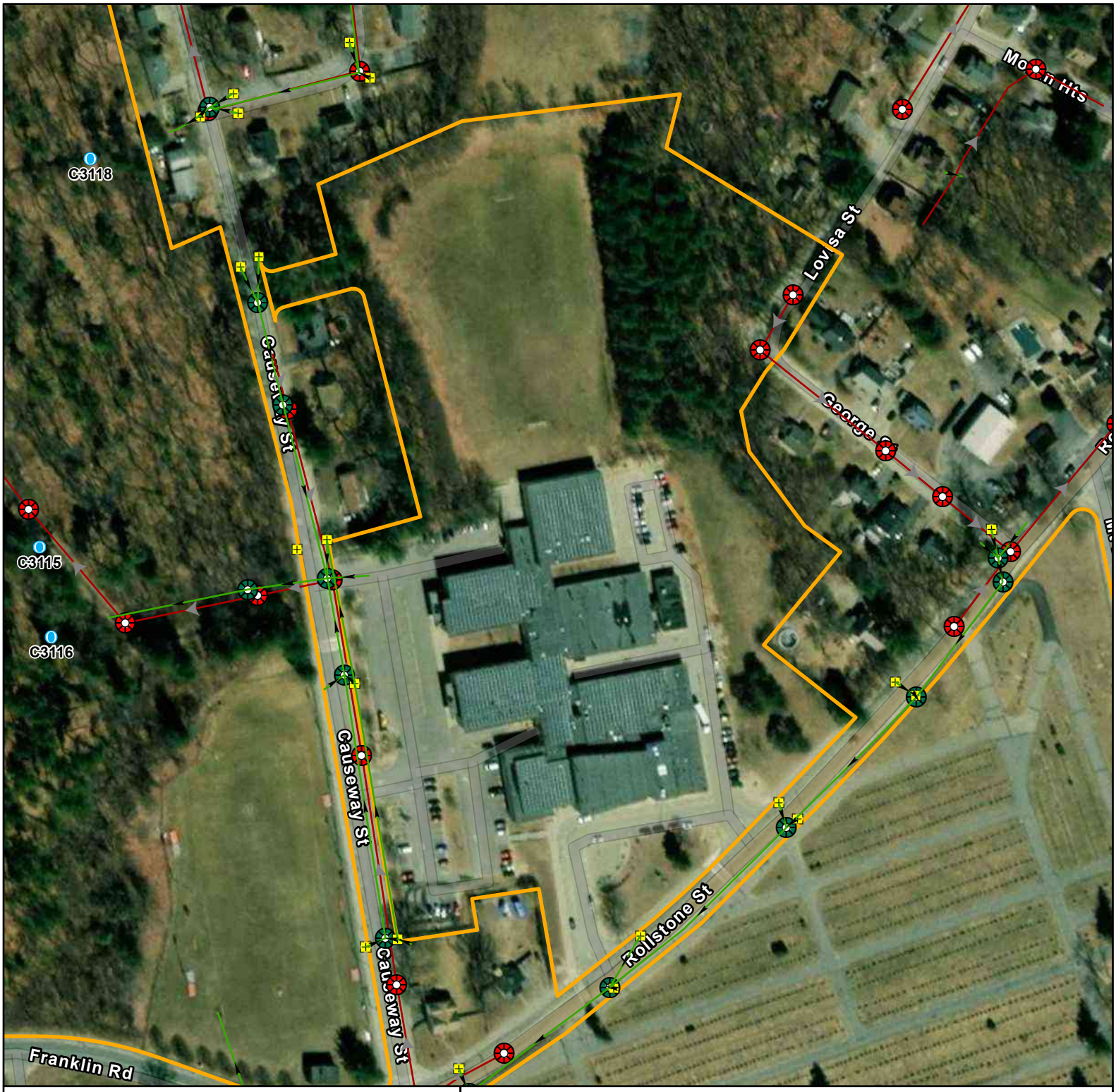
- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# LONGSJO MIDDLE SCHOOL

Address: 98 Academy Street




N

0 90 180 360 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# MEMORIAL MIDDLE SCHOOL

Address: 615 Rollstone Street


N

0 90 180 360 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# REINGOLD ELEMETARY SCHOOL

Address: 70 Reingold Avenue


N

0 35 70 140 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# ROLLSTONE/LAUREL SCHOOLS

Address: 260 Rollstone Street


N

0 75 150 300 Feet

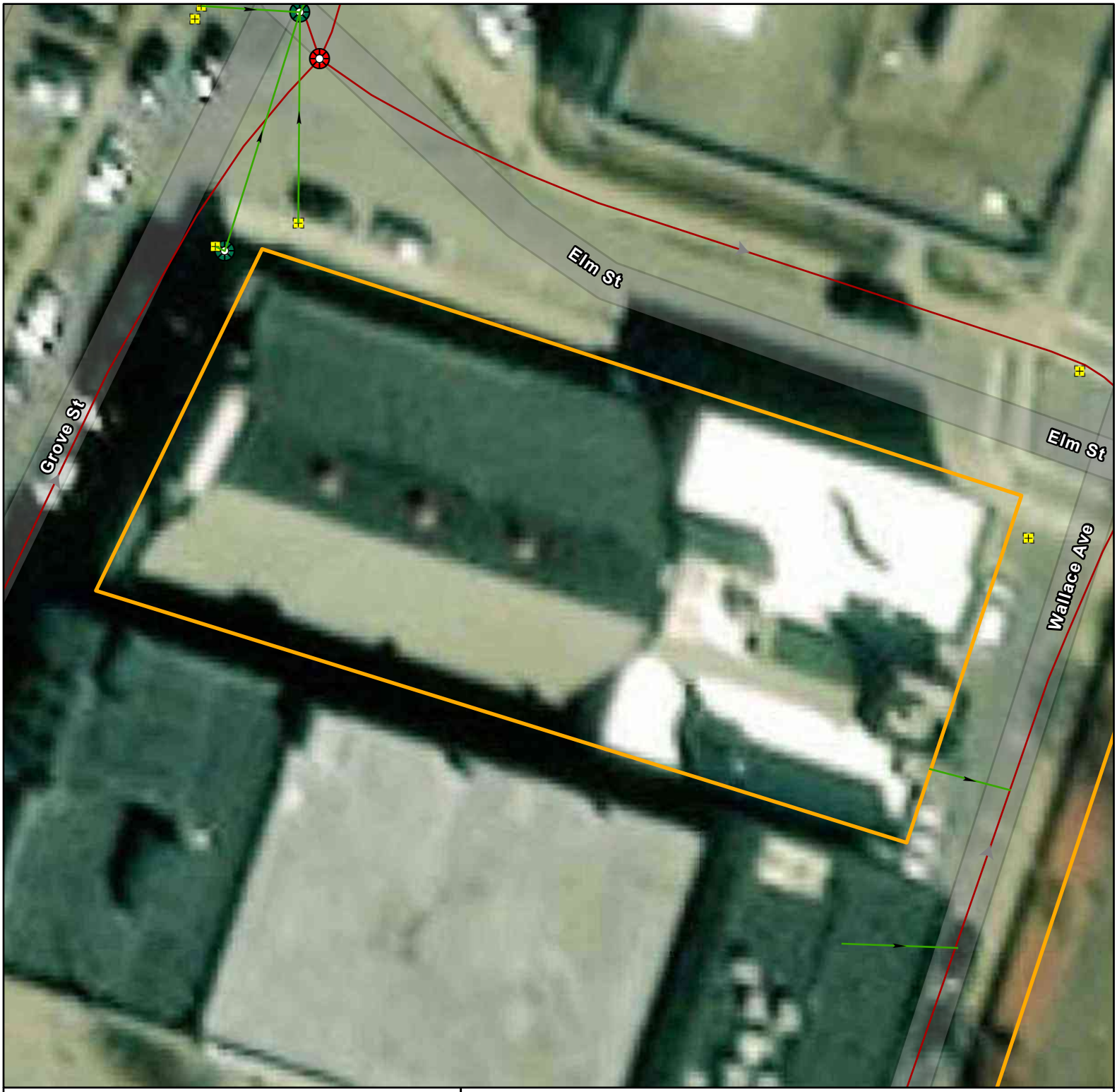
- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# SOUTH STREET ELEMETARY SCHOOL

Address: 376 South Street




N

0 15 30 60 Feet

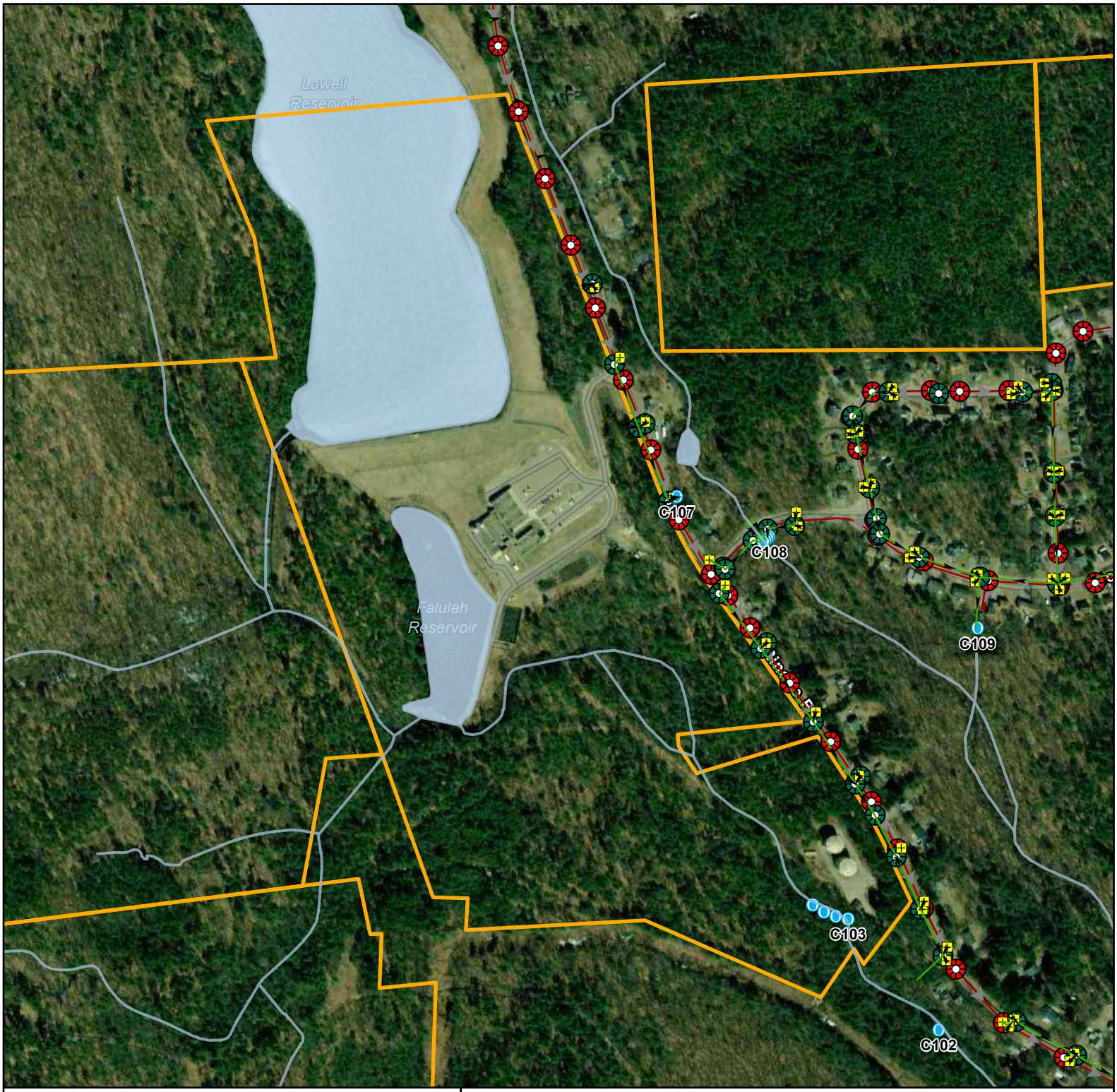
- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# SENIOR CENTER

Address: 14 Wallace Avenue




N

0 245 490 980 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# FALULAH TREATMENT PLANT / STORAGE TANKS

Address: 1200 Rindge Road


N

0 12.5 25 50 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# LACAVA PUMP STATION

Address: Great Wolf Drive

N

0 5 10 20 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# MARSHALL PRV STATION

Address: 120 Caldwell Street

N

0 5 10 20 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# MONTACHUSETT INDUSTRIAL PARK PUMP STATION

Address: 19 Industrial Road

N

0 3.75 7.5 15 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# OAK HILL PUMP STATION

Address: 1071 Franklin Road

N

0 15 30 60 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# OAK HILL TANK AND CONTROLS BUILDING

Address: End of Oak Leaf Road


N

0 190 380 760 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

**CITY OF FITCHBURG, MASSACHUSETTS**

ARCADIS

# OVERLOOK STORAGE TANK

Address: Flat Rock Road


N

0 155 310 620 Feet

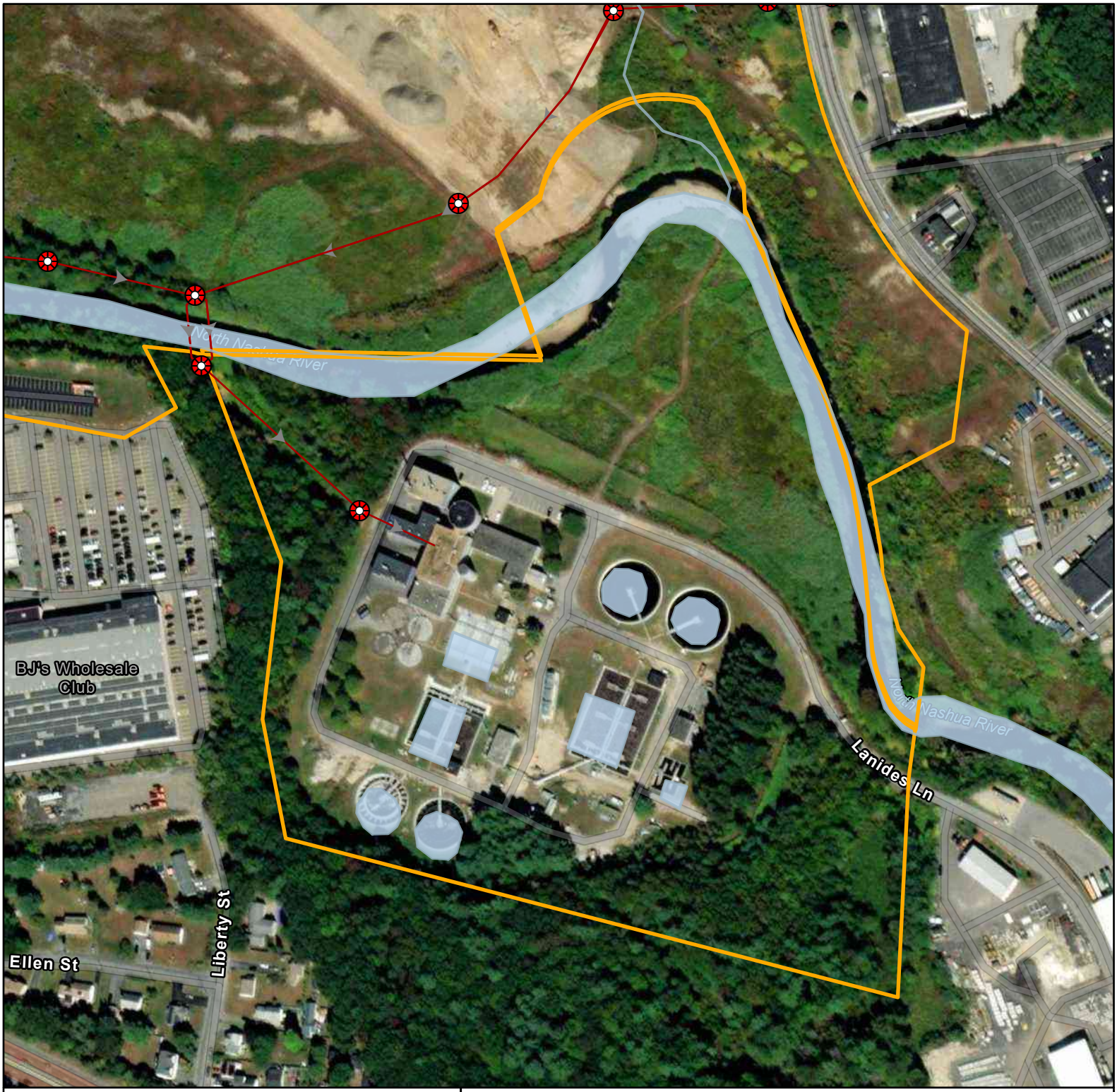
- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# SCOTT STORAGE TANK AND CONTROLS/VALVE BUILDING

Address: Ashby West Road




N

0 137.5 275 550 Feet

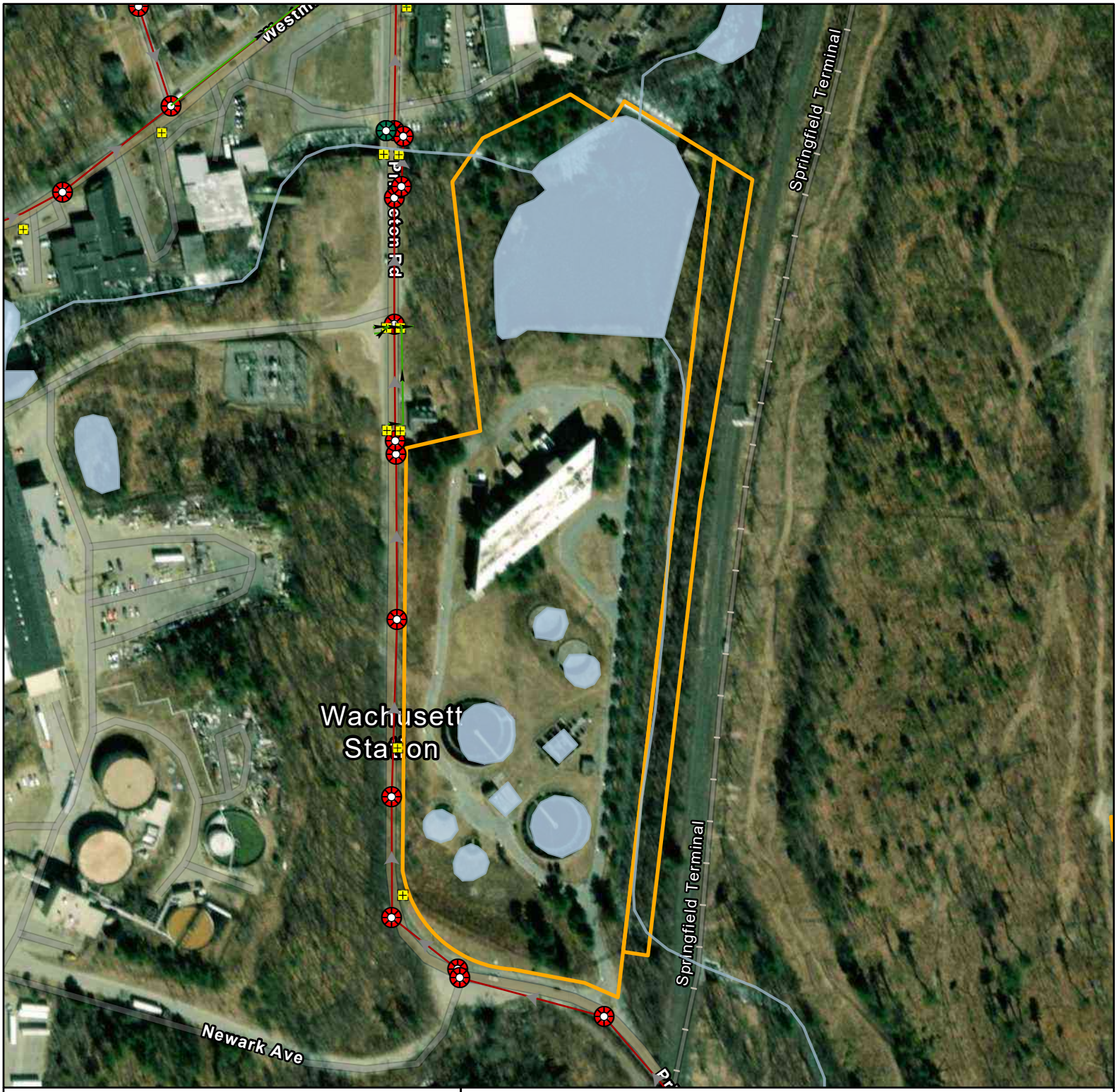
- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# EAST WWTF

Address: 24 Lanides Lane




N

0 130 260 520 Feet

- City Owned Parcel
- Waterbody
- Stormwater Pipe
- Drain Manhole
- Outfall
- Catch Basin
- Sanitary Sewer Pipe
- Sanitary Sewer Manhole
- Sanitary Sewer Regulator
- Sanitary Sewer Cleanout

ARCADIS

**CITY OF FITCHBURG, MASSACHUSETTS**

# WEST WWTF

Address: 230 Princeton Road

# APPENDIX C

## Training Sign in Sheet

**The City of Fitchburg**
**Municipal Facilities Good Housekeeping**
**Training & BMP Education Log**

**Facility Name _____**

Please print date, name and contact information. This will be kept as a record of stormwater training & education on site.

| DATE | NAME & ORGANIZATION | ADDRESS | TELEPHONE | E-MAIL | TRAINING TYPE / BMP SHEET NAME |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

# APPENDIX D

## Good Housekeeping Inspection Forms

# FACILITY SITE COMPLIANCE INSPECTION COVER SHEET

| | |
|---|---|
| **Facility Name:** | |
| **Address:** | |
| **Facility Type/Department:** | |
| **Inspection Date and Time:** | |
| **Inspector:** | |

| **Facility Contact Information:** | |
|---|---|
| **Name:** | |
| **Phone Number:** | (____) - ____ - _____ ex _____ |
| **Email:** | |

| **Facility Information:** | |
|---|---|
| **Site Description:** | |
| **Site Outfall(s):** | |
| **Receiving Water Body(ies):** | |
| **Spill Prevention Control and Countermeasures Plan?** | |
| **If Yes, Revision Date:** | |

# FACILITY SITE COMPLIANCE INSPECTION COVER SHEET

**Existing Structural BMPs:**

# FACILITY SITE COMPLIANCE INSPECTION CHECKLIST

**Facility Name:** _____ **Date:** _____

**Address:** _____ **Inspector:** _____

**Department:** _____ **Weather :** _____

| Question | Yes / No / N/A | If "YES", Describe Corrective Action |
|---|---|---|
| **General** | | |
| Is there evidence of litter and debris in parking lots and paved areas? | | |
| Is there evidence of a discharge, spill or leak on your site that has not been properly cleaned up? This includes dry sorbent materials that are not swept up. | | |
| Are any storm drains, catch basins or ditches showing evidence of clogging or excessive sediment build-up? | | |
| **Fueling Areas** | | |
| Are spill kits missing from fuel islands or do they need to be restocked? | | |
| Is there evidence of spills or leaks? | | |
| Are fuel hoses exposed where they may be run over by vehicles or heavy equipment? | | |
| **Vehicle and Equipment Maintenance Areas** | | |
| Are materials stored indoors or under cover? | | |
| Are maintenance activities being performed outside? | | |
| Are wastes being improperly stored (outside, not on secondary containment, near storm drains, etc)? | | |
| Are there leaks from any vehicles awaiting repair or decommisioning? | | |
| **Trash Storage Areas** | | |
| Are dumpsters uncovered? | | |
| Do dumpsters have holes, missing plugs, or showing evidence of leaking? | | |
| Are any waste storage containers cracked, leaking or damaged? | | |
| Are dumpsters located on pervious ground area or away from watercourse to storm drain structures? | | |
| Are universal wastes stored outdoors and not on secondary containment? | | |
| **Material Loading/Unloading and Storage Areas** | | |
| Are materials stored outside or not under cover? | | |
| Are there signs of leaks or spills from storage containers? | | |
| Are bulk hazardous materials/liquids stored outside and not in secondary containment? | | |
| Do any containment pallets need to be drained? Check for sheen prior to discharge. | | |
| Is there evidence of paint on the ground near loading areas or outdoor painting areas? | | |

# APPENDIX E

## Standard Operating Procedures

| | | |
|---|---|---|
| | **Standard Operating Procedures**<br>*City of Fitchburg, Massachusetts*<br>*Department of Public Works*<br>**Catch Basin Inspection and Cleaning** | **Issue Date:**<br>June 18, 2021 |

**APPROVED BY:**

_____

Director of Public Works

***Introduction***

Catch basins help minimize flooding and protect water quality by removing trash, sediment, decaying debris, and other solids from stormwater runoff. These materials are retained in a sump below the invert of the outlet pipe. Catch basin cleaning reduces foul odors, prevents clogs in the storm drain system, and reduces the loading of suspended solids, nutrients, and bacteria to receiving waters.

During regular cleaning and inspection procedures, data can be gathered related to the condition of the physical basin structure and its frame and grate and the quality of stormwater conveyed by the structure. Observations such as the following can indicate sources of pollution within the storm drain system:

- Oil sheen
- Discoloration
- Trash and debris

Both bacteria and petroleum can create a sheen on the water surface. The source of the sheen can be differentiated by disturbing it, such as with a pole. A sheen caused by an oil will remain intact and move in a swirl pattern; a sheen caused by bacteria or plant-based oils will separate or fracture and appear “blocky”. Bacterial and plant-based oil sheen is not a pollutant but should be noted.

Observations such as the following can indicate a potential connection of a sanitary sewer to the storm drain system, which is an illicit discharge.

- Indications of sanitary sewage, including fecal matter or sewage odors
- Foaming, such as from detergent
- Optical enhancers, fluorescent dye added to laundry detergent

Each catch basin should be cleaned and inspected annually at a minimum. Catch basins in high-use areas may require more frequent cleaning. Performing scheduled street sweeping will reduce the amount of sediment, debris, and organic matter entering the catch basins, ultimately reduce the frequency with which structures need to be cleaned.

***Cleaning Procedure***

Catch basin inspection cleaning procedures should address both the grate opening and the basin's sump. Document any and all observations about the condition of the catch basin structure and water quality on the Catch Basin Inspection Form (attached).

Catch basin inspection and cleaning procedures include the following:

1. Work upstream to downstream.
2. Clean sediment and trash off grate.
3. Visually inspect the outside of the grate.
4. Visually inspect the inside of the catch basin to determine cleaning needs.
5. Inspect catch basin for structural integrity.
6. Determine the most appropriate equipment and method for cleaning each catch basin.
    a. Manually use a shovel to remove accumulated sediments, or
    b. Use a bucket loader to remove accumulated sediments, or
    c. Use a high pressure washer to clean any remaining material out of catch basin while capturing the slurry with a vacuum.
    d. If necessary, after the catch basin is clean, use the Rodder/Jetter of the vacuum truck to clean downstream pipe and pull back sediment that might have entered downstream pipe.
7. If contamination is suspected, chemical analysis will be required to determine if the materials comply with the Massachusetts DEP Hazardous Waste Regulations, 310 CMR 30.000 (http://www.mass.gov/dep/service/regulations/310cmr30.pdf). Chemical analysis required will depend on suspected contaminants. Note the identification number of the catch basin on the sample label, and note sample collection on the Catch Basin Inspection Form.
8. Properly dispose of collected sediments. See following section for guidance. Collected sediments are brought to the DPW yard on Broad Street. A waste hauling/disposal contractor is hired and responsible for proper disposal of the sediments.
9. If illicit discharges are observed or suspected, notify the Department of Public Works.
10. At the end of each day, document location and number of catch basins cleaned, amount of waste collected, and disposal method for all screenings.
11. Report additional maintenance or repair needs to the Department of Public Works.

***Disposal of Screenings***

Catch basin cleanings from storm water-only drainage systems may be disposed at any landfill that is permitted by MassDEP to accept solid waste. MassDEP does not routinely require stormwater-only catch basin cleanings to be tested before disposal, unless there is evidence that they have been contaminated by a spill or some other means.

Screenings may need to be placed in a drying bed to allow water to evaporate before proper disposal. In this case, ensure that the screenings are managed to prevent pollution.

***Attachments***

1. Catch Basin Inspection Form

**Job No.:** _____ **City:** **FITCHBURG, MA**

**Inspector:** _____ **Date:** _____

## CATCH BASIN CLEANING INSPECTION FORM

| | | | |
|---|---|---|---|
| **Catch Basin I.D.** | _____ | **Final Discharge from Structure?** Yes ☐ No ☐<br>**If Yes, Discharge to Outfall No:**_____ | |
| **Catch Basin Label:** | **Stencil** ☐ **Ground Inset** ☐ **Sign** ☐ **None** ☐ **Other**_____ | | |
| **Basin Material:** | Concrete ☐<br>Corrugated metal ☐<br>Stone ☐<br>Brick ☐<br>Other: _____ ☐ | **Catch Basin Condition:** | Good ☐ Poor ☐<br>Fair ☐ Crumbling ☐ |
| **Pipe Material:** | Concrete ☐<br>HDPE ☐<br>PVC ☐<br>Clay Tile ☐<br>Other:_____ | **Pipe Measurements:** | Inlet Dia. (in): d= ____<br>Outlet Dia. (in): D= ____ |

**Required Maintenance/ Problems (check all that apply):**

- ☐ Tree Work Required
- ☐ New Grate is Required
- ☐ Pipe is Blocked
- ☐ Frame Maintenance is Required
- ☐ Remove Accumulated Sediment
- ☐ Pipe Maintenance is Required
- ☐ Basin Undermined or Bypassed
- ☐ Cannot Remove Cover
- ☐ Ditch Work
- ☐ Corrosion at Structure
- ☐ Erosion Around Structure
- ☐ Remove Trash & Debris
- ☐ Need Cement Around Grate

**Other:** _____

| **Catch Basin Grate Type:** | **Sediment Buildup Depth:** | **Description of Flow:** | **Street Name/ Structure Location:** |
|---|---|---|---|
| Bar: ☐<br>Cascade: ☐<br>Other:_____<br><br>Properly Aligned: Yes ☐<br>No ☐ | 0-6 (in): _____<br>6-12(in): _____<br>12-18 (in): _____<br>18-24 (in): _____<br>24 + (in): _____ | Heavy ☐<br>Moderate ☐<br>Slight ☐<br>Trickling ☐ | |

***If the outlet is submerged check yes and indicate approximate height of water above the outlet invert.** h above invert (in):___ Yes ☐ No ☐

☐ **Flow**
☐ **Standing Water**
**(check one or both)**

**Observations:**

Color:
Odor:

**Weather Conditions:** Dry > 24 hours ☐ Wet ☐

**Sample of Screenings Collected for Analysis?** Yes ☐ No ☐

**Comments:**

**Circle those present:**

| | |
|---|---|
| Foam | Oil Sheen |
| Sanitary Waste | Bacterial Sheen |
| Orange Staining | Floatables |
| Excessive sediment | Pet Waste |
| Other: _____ | Optical Enhancers |

# Standard Operating Procedures

*City of Fitchburg, Massachusetts*

*Department of Public Works*

## Sweeping Streets and Parking Lots

**Issue Date:**
June 18, 2021

**Approved by:**

_____

*Public Works Commissioner*

## Purpose of SOPs:

Procedures for the operation and maintenance of street sweepers, frequency of sweeping, disposal of debris, and recordkeeping to prevent pollution from entering the stormwater sewer systems.

## MA Small MS4 General Permit Requirement Summary:

**Part 2.3.7.a.iii.3.**

The permittee shall establish and implement procedures for sweeping and/or cleaning streets, and permittee-owned parking lots. All streets with the exception of rural uncurbed roads with no catch basins or high speed limited access highways shall be swept and/or cleaned a minimum of once per year in the spring (following winter activities such as sanding). The procedures shall also include more frequent sweeping of targeted areas determined by the permittee on the basis of pollutant load reduction potential, based on inspections, pollutant loads, catch basin cleaning or inspection results, land use, water quality limited or TMDL waters or other relevant factors as determined by the permittee. The permittee shall report in each annual report the number of miles cleaned or the volume or mass of material removed. For rural uncurbed roadways with no catch basins and limited access highways, the permittee shall either meet the minimum frequencies above, or develop and implement an inspection, documentation and targeted sweeping plan with two (2) years of the effective date of the permit, and submit such plan with its year one annual report.

**Part 2.3.a.iii.4.**

The permittee shall ensure proper storage of catch basin cleanings and street sweepings prior to disposal or reuse such that they do not discharge to receiving waters.

## Equipment Inventory:

The following is a list of street sweeping equipment:

| Equipment Number | Make | Description | Sweeper Speed (or other notes) |
|---|---|---|---|
| | | | |
| | | 4 sweepers | |
| | | Broom attachment to small machine | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

# Standard Operating Procedures

*City of Fitchburg, Massachusetts*

*Department of Public Works*

## Sweeping Streets and Parking Lots

**Issue Date:**
June 18, 2021

## Operations

1. Operate all sweepers and equipment according to the manufacturer's recommended settings, standards, and procedures.

2. While sweeping, drive between the optimal sweeping speed limit, as recorded in the equipment list above.

3. Sweeping will not take place during steady rain**.**

4. If spills occur or illegal discharges are seen, report to DPW Dispatch.

## Maintenance

1. Sweepers will be checked for leaks at least every 300 hours, while performing regular maintenance (i.e. oil change, etc.). Immediately contain and properly clean up any spills.

2. Regular preventative maintenance to prolong equipment use (such as greasing moving parts and minor adjustments) occur every 300 hours.

3. Parts are replaced as needed. Brushes are replaced when bristle length is less than 6 inches.

4. Equipment is washed at the DPW garage, located at 301 Broad Street, Fitchburg.

5. The left-over debris is scraped out from the hopper after approximately 15 debris dumps, or daily.

## Schedule

1. Street sweeping will primarily take place on a biannual basis between the months of April and June in the spring, and October and December in the fall. 2 sweepers out, 2 times per day. 1 Sweeper goes out on daily basis to clean up after complaints or problem areas at the bottom of the hills.

2. All streets with curbing and/or catch basins shall be swept a minimum of once per year in the spring (following winter activities such as sanding) and once per year in the fall. Streets are swept according to the street sweeping map and are scheduled on a rotating basis by Ward number, such that a different Ward is swept first each year. Two sweepers per shift with two shifts per day are scheduled for street sweeping during regular sweeping timeframes (fall and spring). Additionally, one sweeper is scheduled on a daily basis to address complaints and known problem areas, particularly in the hill areas of the City.

3. Priority roads and parking lots are identified on the basis of pollutant load reduction potential, based on inspections, pollutant loads, catch basin cleaning or inspection results, land use, impaired or TMDL waters or other relevant factors. These roads are swept a minimum of twice per year, and parking lots are swept a minimum of twice per year. Priority roads and parking areas include Main Street and the downtown area, are swept once per week. The areas at the bottom of hills are swept after heavy rainstorms.

   The list of priority roads and parking lots will be reassessed on an ongoing basis, but at least annually. Notifications from the See Click Fix system are followed-up on and addressed, as soon as possible, as appropriate.

4. The sweeping schedule is assessed once per year and updated as necessary.

5. A map of town roads and parking lots is on file at the Fitchburg DPW.

6. Events/activities that require special sweeping are *the 4th of July parade, Longsjo Bike Race, and the Civic Days Block Party.*

## Storage and Disposal

1. Temporary storage of solid sweeping debris is on an impervious surface or in a truck/dumpster that is protected from runoff. The storage location(s) is/are the DPW yard (designated area on pavement with concrete wall to secure the area).

2. Solid sweeping debris is brought to the landfill in Westminster (owned by City of Fitchburg) for permanent disposal. If applicable, solid sweeping debris from Fitchburg will be reused as landfill cover following the MassDEP Reuse and Disposal of Street Sweepings Policy. Debris is permanently disposed of daily.

3. Decant water is discharged to a catch basin at DPW.

4. Weighing process: The amount of solid sweeping debris is tracked by number of times the trucks are dumped. Each truck is dumped when the hopper is full. The volume of sweepings can be calculated from this information.

## Training

1. Employees are trained once per year on this procedure and the proper operation of equipment. Employees are also trained on stormwater pollution prevention, spill and response, and illicit discharge detection and elimination procedures.

## Record Keeping

1. Records are kept at the DPW in the Street Superintendent's office.

2. Volumes of debris are recorded daily after each sweeping.

3. The number of curb miles swept is calculated annually.

4. A list of employees implementing the SOPs and the completion of their training(s) can be found on file at the DPW.

## Revising the SOPs

1. These procedures are reviewed once per year and updated as needed.

| | | | |
|---|---|---|---|
| | **STANDARD OPERATING PROCEDURE**<br>**DEPARTMENT OF PUBLIC WORKS [OR OTHER]**<br>**PROGRAM:**<br>Snow Removal and De-Icing | **SOP NUMBER:** | **ISSUE DATE:**<br>June 18, 2021 |

**APPROVED BY:**

_____

Public Works Director [or other]

## MA SMALL MS4 PERMIT REQUIREMENT SUMMARY:

**Part 2.3.7.a.iii.5.**
The permittee shall establish and implement procedures for winter road maintenance including the use and storage of salt and sand; minimize the use of sodium chloride and other salts, and evaluate opportunities for use of alternative materials; and ensure that snow disposal activities do not result in disposal of snow into waters of the United States. For purposes of this MS4 Permit, salt shall mean any chloride-containing material used to treat paved surfaces for deicing, including sodium chloride, calcium chloride, magnesium chloride, and brine solutions.

## Personnel

A list of personnel responsible for snow and ice removal is on file at the Fitchburg DPW. Employees performing the procedures in this SOP shall attend yearly stormwater pollution prevention training.

## Equipment

The municipality owns and maintains ice control and snow removal equipment. Equipment maintenance shall be conducted regularly and consistent with best management practices for pollution prevention from Vehicles and Equipment maintenance activities. The wash bay/ designated vehicle washing area is located at the Fitchburg DPW.

**Plowing**
When conditions warrant, plows are installed on the larger trucks to move snow from the traveled roadway. Average time to install a plow is approximately **[*10*]** minutes. Smaller trucks are available for plowing of residential streets and clearing public lots.

**Sand/Salt Spreaders**
When conditions warrant, sand/salt spreaders are installed to spread a sand/salt mixture on the traveled roadway. Each sand/salt spreader is calibrated every 2 years and evaluated prior to the deicing season.

On Main Street, only Salt is spread on the traveled roadway.

## Materials

The major materials are used in snow and ice control are coarse sand and coarse salt. These materials are stockpiled in advance of an event and are immediately available when needed and stocks are replenished between events.

**Sand**

Sand is used as an abrasive for traction on slick roadways. Approximately *35,000 yd*$^3$ cubic yards are anticipated to be used per year and are mined from the "Airport Pit" (now owned by Fitchburg Redevelopment Authority) on Crawford Street prior to each deicing season. Sand is stored in a protected staging area until it can be mixed with salt located at the Fitchburg DPW Yard (301 Broad Street). Loading areas and yards are swept after the winter season to prevent sand build-up and run-off.

**Salt**

Salt is used to expedite the melting of snow and ice from the street surface and also to keep the ice from forming a bond to the street surface. Approximately 5,700 tons of rock salt are anticipated to be used per year and are ordered from Eastern Salt Company, Inc. 134 Middle Street, Suite 210 Lowell, MA 01852 or Eastern Salt Company, Inc. 37 Marginal Street Chelsea, MA 02150 prior to each deicing season. Salt is stored in the covered salt shed facility located at the DPW Yard (301 Broad Street)**.** Loading areas and yards are swept after the winter season to prevent salt build-up and run-off.

# Procedures

**Sand/Salt Application**

1. Whenever conditions warrant, sand/salt mixture is applied to the roadway prior to accumulation of snow to prevent compacted snow from bonding to the roadway surface. The Superintendent of Streets will instruct staff when sand/salt application is appropriate. Salting will not be done when pavement temperatures are above *32* degrees F.
2. Prior to sand/salt application, equipment will be checked to ensure proper working order and ensure proper calibration of equipment. All fluid levels will be checked and filled to proper levels, all lights must be in working order. A visual walk-around inspection of the truck or equipment must be made. Any repairs must be made and reported to a supervisor or mechanic before leaving the yard.
3. In general, the DPW follows the prioritized route or schedule included in Appendix 1 of the Snow and Ice Control Manual. Main roads are salted/sanded first. These main roads include: Electric Ave, Mt. Elam Rd, Oak Hill Rd, River St, Westminster St, Mechanic St, John Fitch Highway. Summer St, Water St.
4. Note that Main Street does not receive a salt/sand mixture, but rather only salt is applied.
5. Before parking any truck or equipment after use, all fluid levels will be checked and filled. All minor repairs will be done by the operator. Any repairs the operator cannot perform will be written up on the proper forms and turned in to Superintendent of Streets. The Superintendent will determine importance and will assign the repairs according to schedule. All sand/salt will be washed from equipment at the wash bay or designated wash area.

**Snow Plowing**

1. As the storm develops and **any snow has begun falling**, all of the drivers and available equipment will begin to plow their assigned routes.
2. Prior to plowing operations, equipment will be checked to ensure proper working order. All fluid levels will be checked and filled to proper levels, all lights must be in working order. A visual walk-around inspection

of the truck or equipment must be made. Any repairs must be made and reported to a supervisor or mechanic before leaving the yard.

3. Avoid plowing, pushing, blowing or storing excess snow, deicer, or other debris in or near creeks, watercourses or storm drainage systems.
4. Reduce plowing speed in sensitive areas (near creeks, wetlands or other water courses) to prevent snow and deicing materials from entering waterways.
5. Drivers are expected to plow at safe speeds.
6. Follow the prioritized route or schedule. This schedule is located in Appendix 1 of the Snow and Ice Control Manual. Main roads are plowed first.
7. Before parking any truck or equipment after use, all fluid levels will be checked and filled. Blades or bolts, which need replacing, will be taken care of unless told to do otherwise. Chains that need repairs will be repaired. All minor repairs will be done by the operator. Any repairs the operator cannot perform will be written up on the proper forms and turned in to the Superintendent of Streets. The Superintendent will determine importance and will assign the repairs according to schedule.

**Record Keeping and Documentation**

1. Maintain a master schedule of prioritized snow and sanding routes and the miles or roads plowed or sanded. These are included in the Snow and Ice Control Manual.
2. Keep copies of manufacturer's recommendations for equipment calibration, plowing speed and salt/sand application rates. These are kept on file at the DPW.
3. Keep records of the amounts of salt and sand applied per season. These are kept on file at the DPW.
4. Keep a list of all employees trained in the facility's Stormwater Pollution Prevention binder or computer file.

# Standard Operating Procedures

*City of Fitchburg, Massachusetts*

*Department of Public Works*

## MS4 Infrastructure Maintenance

**Issue Date:**
**July 2020**

**Approved by:**

_____

*Public Works Commissioner*

## Purpose of SOPs:

Procedures for the maintenance of MS4 infrastructure and reporting MS4 infrastructure defects and maintenance issues.

## MA Small MS4 General Permit Requirement Summary:

**Part 2.3.7.a.iii.1.**

The permittee shall establish within two (2) year of the effective date of the permit a written (hardcopy or electronic) program detailing the activities and procedures the permittee will implement so that the MS4 infrastructure is maintained in a timely manner to reduce the discharge of pollutants from the MS4. If the permittee has an existing program to maintain its MS4 infrastructure in a timely manner to reduce or eliminate the discharge of pollutants from theMS4, the permittee shall document the program in the SWMP.

## Operations & Inspection Programs

1. Catch basin cleaning: Annually, 1/3 of Town's catch basins are inspected and cleaned by a vendor in accordance with the DPW's schedule as required by the MS4. The schedule of catch basins to be cleaned is updated based on sediment levels observed. Through this cleaning work, any observed issues with catch basin frames, covers, and structures are reported to DPW. Sediment levels are also recorded and catch basins with high sediment levels are reported to the DPW.
2. Illicit Discharge Detection & Elimination Program: As inspectors are inspecting outfalls, manholes, catch basins, and assessing related infrastructure during inspections, observed infrastructure issues are documented and reported to the DPW.
3. Street Sweeping: Street sweeping occurs in accordance with the DPW's schedule and as required by the MS4 permit. Any issues found with the drainage structures during this work is reported to the DPW.
4. Good Housekeeping Program: Audits at municipal facilities were performed in 2020 and any issues with drainage at these facilities were reported to DPW. Additionally, municipal stormwater treatment BMPs were inventoried and mapped during this time period. These structures will be maintained in accordance with maintenance procedures outlined in the MA Stormwater Handbook, as funding allows. Issues with drainage structures on municipal sites will also be recorded and submitted to the DPW with the required annual or quarterly good housekeeping inspection.

## Maintenance and Repair

1. CCTV of pipes will be performed on an as-needed basis when any of the above inspection programs indicates a potential problem exists with drainage piping, and as funding allows.
2. The DPW typically sets aside funding for drainage system repairs in the annual DPW budget. The repair program also includes separate programmatic funds set aside for resetting and replacing frames and covers. Repair program work is prioritized and completed annually, with funds available.
3. Larger repair or replacement projects identified through the above inspection programs are prioritized and developed as capital contracts on an as-needed basis and as funding allows.

# Standard Operating Procedures

*City of Fitchburg, Massachusetts*

*Department of Public Works*

## MS4 Infrastructure Maintenance

**Issue Date:**
**July 2020**

## Schedule

1. A schedule will be put together on an as-needed basis and as funding allows for issues identified.

## Storage and Disposal

1. Temporary storage of solid debris removed from any drainage infrastructure is on an impervious surface or in a truck/dumpster that is protected from runoff. The storage location is ***INSERT STORAGE LOCATION***
2. Broken drainage structures will be temporarily help at…

## Training

1. Select municipal employees (e.g. facility managers, DPW foremen, etc.) will be trained on good housekeeping and inspection programs annually, as required by the MS4 permit, and as funding allows.

## Record Keeping

1. Records of drainage infrastructure maintenance and repairs are kept ***at the Fitchburg Department of Public Works.***

# APPENDIX F

## Structural BMPs

# City of Fitchburg, Massachusetts
# Stormwater Management Manual
# City-Owned Structural BMP Inventory

| SUBDIVISION NAME | STREET NAME | DETENTION POND ID |
|---|---|---|
| AIMEES WAY | AIMEES WAY | 1A |
| APPLE COUNTRY ESTATES | MACINTOSH LN | 1A |
| APPLE COUNTRY ESTATES | CORTLAND AVE | 1A |
| BEJAMIN ESTS | VICTORIA LN | 1B |
| BEJAMIN ESTS | VICTORIA LN | 1A |
| BEJAMIN ESTS | VICTORIA LN | 1A |
| BILOTTA WAY | BILOTTA WAY | 1B |
| BILOTTA WAY | BILOTTA WAY | 1A |
| BISHOP RD | BISHOP RD | 1A |
| CASTLE RD | CASTLE RD | 1A |
| DELOGE HGTS | WATTS WAY | 1A |
| DELOGE HGTS | TIBBETT CIRCLE | 1A |
| ETHIER ST | ETHIER ST | 1A |
| FAIRWAY HOMES | ARNHOW FARM RD | 1A |
| HEMLOCK DR | HEMLOCK DR | 1A |
| LEGION ST | LEGION ST | 1A |
| MT ELAM PEAK | GOODFELLOW DR | 1A |
| OAKLAND ST | OAKLAND ST | 1A |
| PARKER HILL ACRES | PARKER HILL DRIVE | 1A |

# City of Fitchburg, Massachusetts
# Stormwater Management Manual
# City-Owned Structural BMP Inventory

| SUBDIVISION NAME | STREET NAME | DETENTION POND ID |
|---|---|---|
| PARKER HILL ACRES | DOWNY CIRCLE | 1B |
| PARKER HILL ACRES | FLICKER DR | 1C |
| QUARRY LN | QUARRY LN | 1A |
| ROLLSTONE BRUCE HAZEL | ROLLSTONE ST | 1A |
| ROOSEVELT ST | ROOSEVELT ST | 1A |
| ROOSEVELT ST | ROOSEVELT ST | 1B |
| SKYVIEW DR | SKYVIEW DR | 1A |
| SOUTH ST CROSSING | MONTESION DR | 1A |
| STONEY BROOK VILLAGE | STONEYBROOK RD | 1A |
| WHALON ST | WHALON ST | 1A |
| WOODLAND ESTATES RINDGE RD | WOODLAND ESTATES RINDGE RD | 1A |

# Sediment Forebays

**Description:** A sediment forebay is a post-construction practice consisting of an excavated pit, bermed area, or cast structure combined with a weir, designed to slow incoming stormwater runoff and facilitating the gravity separation of suspended solids. This practice is different from a sediment trap used as a construction period BMP.

## Ability to meet specific standards

| Standard | Description |
|---|---|
| 2 - Peak Flow | Provides no peak flow attenuation |
| 3 - Recharge | Provides no groundwater recharge |
| 4 - TSS Removal | MassDEP requires a sediment forebay as pretreatment before stormwater is discharged to an extended dry detention basin, wet basin, constructed stormwater wetland or infiltration basin. No separate credit is given for the sediment forebay. For example, extended dry detention basins with sediment forebays receive a credit for 50% TSS removal. Wet basins and constructed stormwater wetlands with sediment forebays receive a credit for 80% TSS removal. When they provide pretreatment for other BMPs, sediment forebays receive a 25% TSS removal credit. |
| 5 - Higher Pollutant Loading | Recommended as a pretreatment BMP |
| 6 - Discharges near or to Critical Areas | Recommended as a pretreatment BMP |
| 7 - Redevelopment | Usually not suitable due to land use constraints |

## Advantages/Benefits:

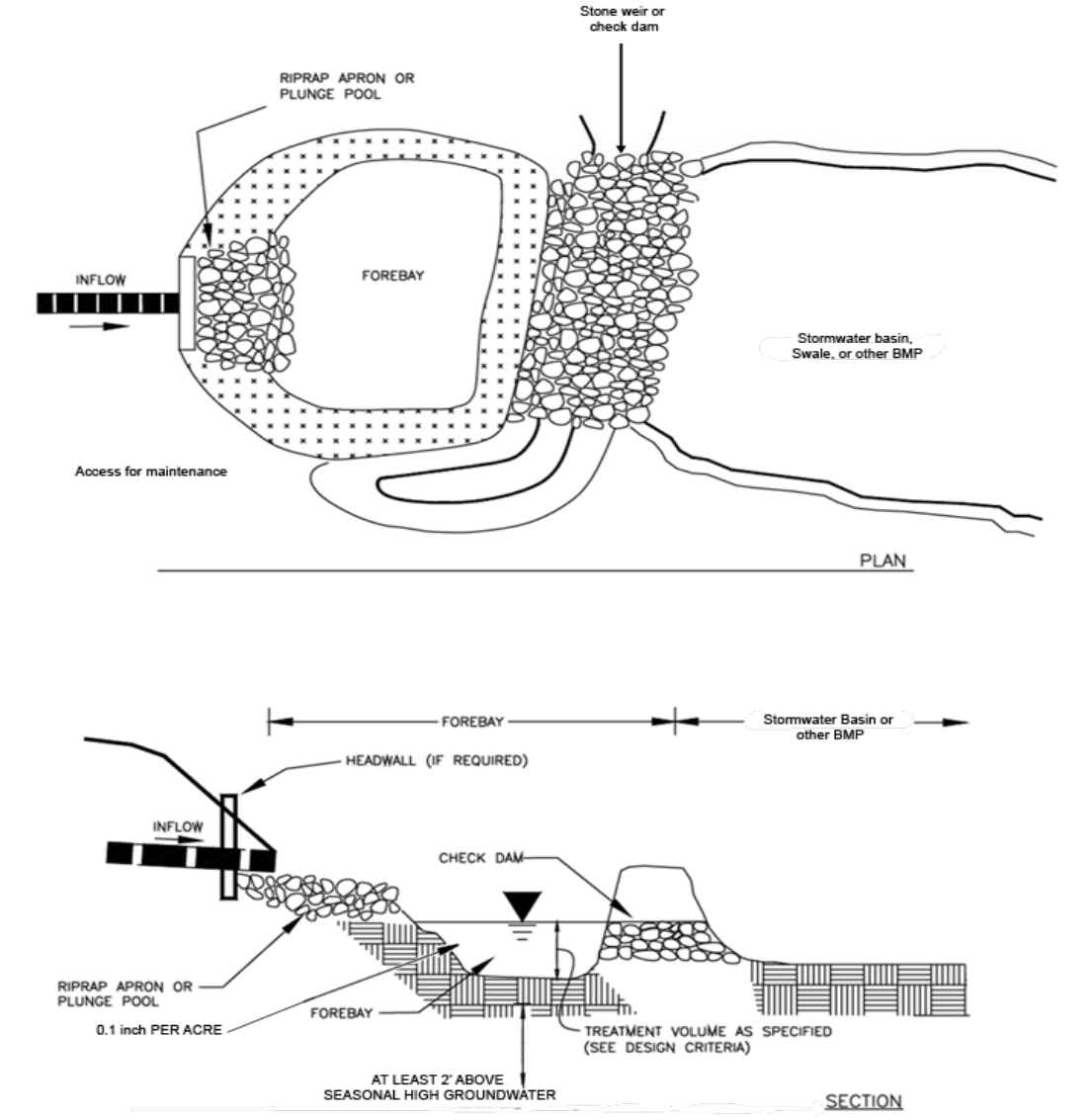
- Provides pretreatment of runoff before delivery to other BMPs.
- Slows velocities of incoming stormwater
- Easily accessed for sediment removal
- Longevity is high with proper maintenance
- Relatively inexpensive compared to other BMPs
- Greater detention time than proprietary separators

## Disadvantages/Limitations:

- Removes only coarse sediment fractions
- No removal of soluble pollutants
- Provides no recharge to groundwater
- No control of the volume of runoff
- Frequent maintenance is essential

## Pollutant Removal Efficiencies

- Total Suspended Solids (TSS) - 25%
- Nutrients (Nitrogen, phosphorus) - Insufficient data
- Metals (copper, lead, zinc, cadmium) - Insufficient data
- Pathogens (coliform, e coli) - Insufficient data




*adapted from the Vermont Stormwater Handbook*

## Maintenance

| Activity | Frequency |
|---|---|
| Inspect sediment forebays | Monthly |
| Clean sediment forebays | Four times per year and when sediment depth is between 3 to 6 feet. |

## Special Features

MassDEP requires a sediment forebay as pretreatment before discharging to a dry extended detention basin, wet basin, constructed stormwater wetland, or infiltration basin.

MassDEP uses the term sediment forebay for BMPs used to pretreat stormwater after construction is complete and the site is stabilized. MassDEP uses the term sediment trap to refer to BMPs used for erosion and sedimentation control during construction. For information on the design and construction of sediment traps used during construction, consult the Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas: A Guide for Planners, Designers and Municipal Officials.

# Sediment Forebays

### Design

Sediment forebays are typically on-line units, designed to slow stormwater runoff and settle out sediment.

At a minimum, size the volume of the sediment forebay to hold 0.1-inch/impervious acre to pretreat the water quality volume.

When routing the 2-year and 10-year storms through the sediment forebay, design the forebay to withstand anticipated velocities without scouring.

A typical forebay is excavated below grade with earthen sides and a stone check dam.

Design elevated embankments to meet applicable safety standards.

Stabilize earth slopes and bottoms using grass seed mixes recommended by the NRCS and capable of resisting the anticipated shearing forces associated with velocities to be routed through the forebay. Use only grasses. Using other vegetation will reduce the storage volume in the forebay. Make sure that the selected grasses are able to withstand periodic inundation under water, and drought- tolerant during the summer. MassDEP recommends using a mix of grasses rather than relying upon a single grass species.

Alternatively, the bottom floor may be stabilized with concrete or stone to aid maintenance. Concrete floors or pads, or any hard bottom floor, greatly facilitate the removal of accumulated sediment.

When the bottom floor is vegetated, it may be necessary to remove accumulated sediment by hand, along with re-seeding or re-sodding grasses removed during maintenance.

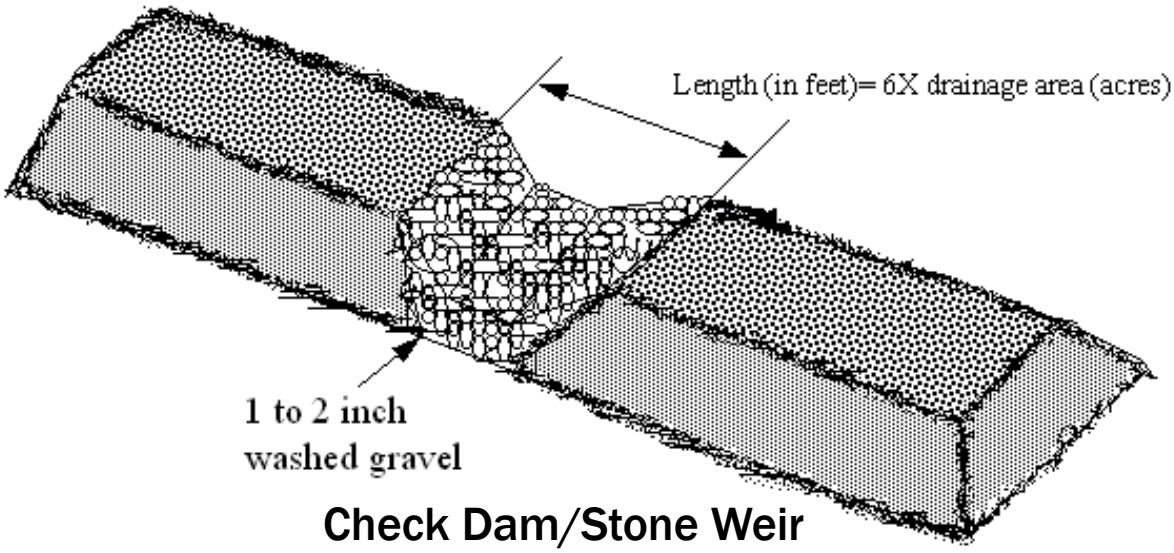
Design sediment forebays to make maintenance accessible and easy. If machinery is required to remove the sediment, carefully incorporate equipment access in the design. Sediment forebays may require excavation so concrete flooring may not always be appropriate.

Include sediment depth markers to simplify inspections. Sediment markers make it easy to determine when the sediment depth is between 3 and 6 feet and needs to be removed. Make the side slopes of sediment forebays no steeper than 3:1. Design the sediment forebay so that the discharge or outflow velocity can control the 2-year peak discharge without scour. Design the channel geometry to prevent erosion from the 2-year peak discharge.

Do not confuse post-construction sediment forebays with the sediment traps used as a construction-period control. Construction-period sediment control traps are sized larger than forebays, because there is a greater amount of suspended solids in construction period runoff. Construction-period sediment traps are sized based on drainage area and not impervious acre. Never use a construction-period sediment trap for post-construction drainage purposes unless it is first brought off-line, thoroughly cleaned (including check dam), and stabilized before being made re-operational.

Refer to the section of this chapter for information on the design of the check dam component of the sediment forebay. Set the minimum elevation of the check dam to hold a volume of 0.1-inch of runoff/ impervious acre. Check dam elevations may be uniform or they may contain a weir (e.g., when the top of the check dam is set to the 2-year or 10-year storm, and the bottom of the weir is set to the top of the 0.1-inch/impervious acre volume). When a weir is included in a stone berm, make sure that the weir is able to hold its shape. Fabric or wire may be required.

Unless part of a wet basin, post construction sediment forebays must be designed to dewater between storms. Set the bottom of the forebay at a minimum of 2 feet above seasonal high groundwater, and place pervious material on the bottom floor to facilitate dewatering between storms. For design purposes, use 72 hours to evaluate dewatering, using the storm that produces either the ½ inch or 1-inch of runoff (water quality volume) in a 24-hour period. A stone check dam can act as a filter berm, allowing water to percolate through the check dam. Depending on the head differential, a stone check dam may allow greater dewatering than an earthen berm.




Check Dam/Stone Weir

*MassDEP Stormwater Handbook, 1996*

## Maintenance

Sediments and associated pollutants are removed only when sediment forebays are actually cleaned out, so regular maintenance is essential. Frequently removing accumulated sediments will make it less likely that sediments will be resuspended. At a minimum, inspect sediment forebays monthly and clean them out at least four times per year. Stabilize the floor and sidewalls of the sediment forebay before making it operational, otherwise the practice will discharge excess amounts of suspended sediments. When mowing grasses, keep the grass height no greater than 6 inches. Set mower blades no lower than 3 to 4 inches. Check for signs of rilling and gullying and repair as needed. After removing the sediment, replace any vegetation damaged during the clean-out by either reseeding or re-sodding. When reseeding, incorporate practices such as hydroseeding with a tackifier, blanket, or similar practice to ensure that no scour occurs in the forebay, while the seeds germinate and develop roots.

# Vegetated Filter Strips

***Description***: Vegetated filter strips, also known as filter strips, grass buffer strips and grass filters, are uniformly graded vegetated surfaces (i.e., grass or close-growing native vegetation) that receive runoff from adjacent impervious areas. Vegetated filter strips typically treat sheet flow or small concentrated flows that can be distributed along the width of the strip using a level spreader. Vegetated filter strips are designed to slow runoff velocities, trap sediment, and promote infiltration, thereby reducing runoff volumes.

## Ability to meet specific standards

| Standard | Description |
|---|---|
| **2 - Peak Flow** | Provides some peak flow attenuation but usually not enough to achieve compliance with Standard 2 |
| **3 - Recharge** | No recharge credit |
| **4 - TSS Removal** | If greater than or equal to 25' and less than 50' wide, 10% TSS removal. If greater than or equal to 50' wide, 45% TSS removal. |
| **5 - Higher Pollutant Loading** | May be used as part of a pretreatment train if lined |
| **6 - Discharges near or to Critical Areas** | May be used as part of a pretreatment train if lined. May be used near cold-water fisheries. |
| **7 - Redevelopment** | Suitable for pretreatment or as a stand-alone practice if sufficient land is available. |

**Advantages/Benefits:**

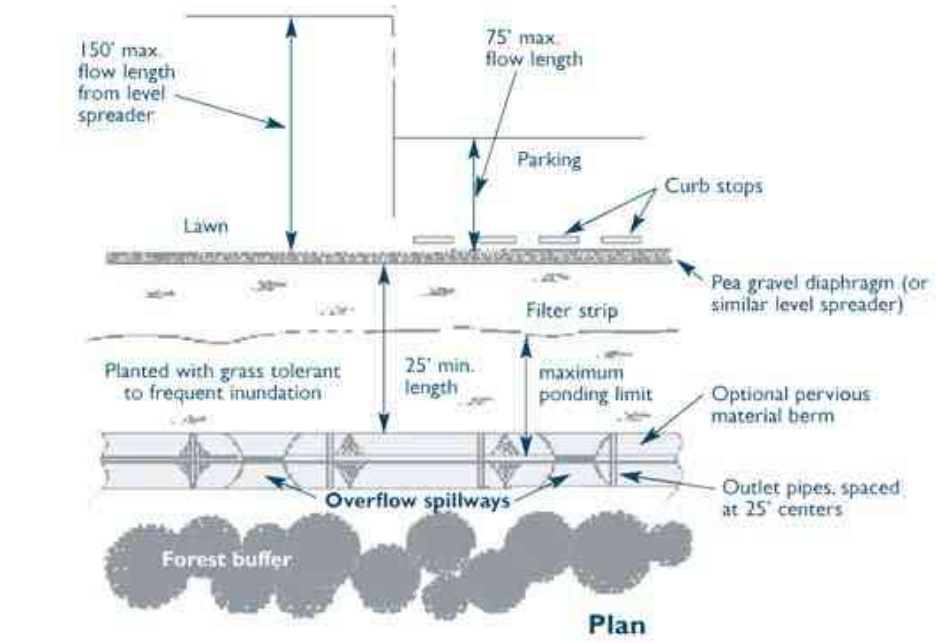
- Reduces runoff volumes and peak flows.
- Slows runoff velocities and removes sediment.
- Low maintenance requirements.
- Serves as an effective pretreatment for bioretention cells
- Can mimic natural hydrology
- Small filter strips may be used in certain urban settings.
- Ideal for residential settings and to treat runoff from small parking lots and roads.
- Can be used as part of runoff conveyance system in combination with other BMPs
- Little or no entrapment hazard for amphibians or other small creatures

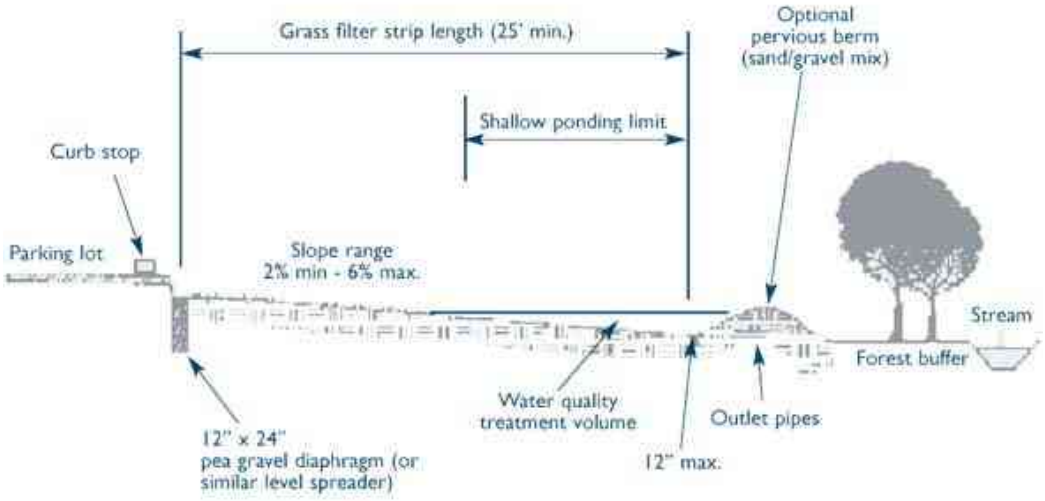
**Disadvantages/Limitations:**

- Variability in removal efficiencies, depending on design
- Little or no treatment is provided if the filter strip is short-circuited by concentrated flows.
- Often a poor retrofit option due to large land requirements.
- Effective only on drainage areas with gentle slopes (less than 6 percent).
- Improper grading can greatly diminish pollutant removal.

**Pollutant Removal Efficiencies**

| | |
|---|---|
| • TSS (if filter strip is 25 feet wide) | 10% assumed (Regulatory) |
| • TSS (if filter strip is 50 feet wide) | 45% assumed (Regulatory) |
| • Nutrients (Nitrogen, phosphorus) | Insufficient data |
| • Metals (copper, lead, zinc, cadmium) | Insufficient data |
| • Pathogens (coliform, e coli) | Insufficient data |




*adapted from the "Design of Stormwater Systems" 1996*

## Maintenance

| Activity | Frequency |
|---|---|
| Inspect the level spreader for sediment buildup and the vegetation for signs of erosion, bare spots, and overall health. | Every six months during the first year. Annually thereafter. |
| Regularly mow the grass. | As needed |
| Remove sediment from the toe of slope or level spreader and reseed bare spots. | As needed |

## Special Features

Include an impermeable liner and underdrain for discharges from Land Use with Higher Potential Pollutant Loads and for discharges within Zone IIs and Interim Wellhead Protection Areas; for discharges near or to other critical areas or in soils with rapid infiltration rates greater than 2.4 inches per hour.

# Vegetated Filter Strips

### Applicability

Vegetated filter strips are used to pretreat sheet flow from roads, highways, and small parking lots. In residential settings, they are useful in pretreating sheet flow from driveways. They provide effective pretreatment, especially when combined with bioretention areas and stream buffers. Urban areas can sometimes accommodate small filter strips depending on available land area, making them potential retrofit options in certain urban settings. Vegetated filter strips can also be used as side slopes of grass channels or water quality swales to enhance infiltration and remove sediment.

### Effectiveness

Variable TSS removal efficiencies have been reported for filter strips, depending on the size of the contributing drainage area, the width of the filter strip, the underlying parent soil, the land slope, the type of vegetation, how well the vegetation is established, and maintenance practices. Vegetated filter strips may remove nutrients and metals depending on the length and slope of the filter, soil permeability, size and characteristics of the drainage area, type of vegetative cover, and runoff velocity.

### Planning Considerations

Vegetated filter strips may be used as a stand-alone practice for redevelopments, only where other practices are not feasible. Vegetated filter strips can be designed to fit within the open space and rights of way that are available along roads and highways. Do not design vegetated filter strips to accept runoff from land uses with higher potential pollutant loads (LUHHPL) without a liner. Vegetated filter strips function best for drainage areas of one acre or less with gentle slopes.

### Design

Do not locate vegetated filter strips in soils with high clay content that have limited infiltration or in soils that cannot sustain grass cover.

The filter strip cannot extend more than 50 feet into a Buffer Zone to a wetland resource area.

The contributing drainage area to a vegetated filter strip is limited to one acre of less.

Design vegetated filter strips with slopes between 2 and 6 percent. Steeper slopes tend to create concentrated flows. Flatter slopes can cause ponding and create mosquito-breeding habitat.

Design the top and toe of the slope to be as flat as possible. Use a level spreader at the top of the slope to evenly distribute overland flows or concentrated runoff across the entire length of the filter strip. Many variations of level spreader designs may be used including level trenches, curbing and concrete weirs. The key to any level spreader design is creating a continuous overflow elevation along the entire width of the filter strip.

Velocity dissipation (e.g. by using riprap) may be required for concentrated flows.

Design the filter strip to drain within 24 hours after a storm. The design flow depth must not exceed 0.5 inches.

To recieve TSS removal credit, make the filter strip at least 25 feet long and generally as wide as the area draining to the strip. To prevent high-velocity concentrated flows, the length of the flow path must be limited to 75 feet if the filter strip handles runoff from impervious surfaces, and 150 feet if the filter strip handles runoff from pervious surfaces. The minimum width of the filter strip must be 20% of the length of the flow path or 8 feet, whichever is greater.

To prevent groundwater contamination, the filter strip must be constructed at least 2 feet above seasonal high groundwater and 2 to 4 feet above bedrock.

The filter strip must be planted with grasses that are relatively salt-tolerant. Select grasses to withstand high flow velocities under wet weather conditions.

A vegetated filter strip may be used as a qualifying pervious area for purposes of the LID Site Design Credits for disconnecting rooftop and nonroof top runoff.

### Construction

Proper grading is essential to establish sheet flow from the level spreader and throughout the filter strip.

Implement soil stabilization measures until permanent vegetation is established.

Protect the area to be used for the filter strip by using upstream sediment traps.

Use as much of the existing topsoil on the site as possible to enhance plant growth.

### Maintenance

Regular maintenance is critical for filter strips to be effective and to ensure that flow does not short-circuit the system. Conduct semi-annual inspections during the first year (and annually thereafter). Inspect the level spreader for sediment buildup and the vegetation for signs of erosion, bare spots, and overall health. Regular, frequent mowing of the grass is required. Remove sediment from the toe of slope or level spreader, and reseed bare spots as necessary. Periodically, remove sediment that accumulates near the top of the strip to maintain the appropriate slope and prevent formation of a "berm" that could impede the distribution of runoff as sheet flow.

When the filter strip is located in the buffer zone to a wetland resource area, the operation and maintenance plan must include strict measures to ensure that maintenance operations do not alter the wetland resource areas. Please note, filter strips are restricted to the outer 50 feet of the buffer zone.

### Cold Climate Considerations

In cold climates such as Massachusetts, the depth of soil media that serves as the planting bed must extend below the frost line to minimize the effects of freezing. Avoid using peat and compost media, which retain water and freeze during the winter, and become impermeable and ineffective.

### References:


Center for Watershed Protection, Stormwater Management Fact Sheet: Grassed Filter Strip, http://www.stormwatercenter.net/Assorted%20Fact%20Sheets/Tool6_Stormwater_Practices/Filtering%20Practice/Grassed%20Filter%20Strip.htm

Claytor, R.A. and T.R. Schueler. 1996. Design of Stormwater Filtering Systems. Center for Watershed Protection. Silver Spring, Maryland.

Connecticut Department of Environmental Protection. 2004. Connecticut Stormwater Quality Manual.

International Stormwater BMP Database, Biofilter – Grass Strip, http://www.bmpdatabase.org

Knox County, Stormwater Management Manual, Volume 2, Section 4.3.9, Filter Strip, Pp. 4-155 to 4-164, http://knoxcounty.org/stormwater/pdfs/vol2/4-3-9%20Filter%20Strip.pdf

Knoxville, City of, 2003, Knoxville BMP Manual Stormwater Treatment, Filter Strips and Swales, Practice No. ST – 05, http://www.ci.knoxville.tn.us/engineering/bmp_manual/ST-05.pdf

Maine Department of Environmental Protection. 2006, Maine Stormwater Best Management Practices Manual, Chapter 5, Pp. 5-1 to 5-18, http://www.maine.gov/dep/blwq//docstand/stormwater/stormwaterbmps/vol3/chapter5.pdf

Maryland Department of the Environment, 2000, Maryland Stormwater Design Manual, Volume I, Chapter 2, Unified Sizing Criteria, P. 2.39, http://www.mde.state.md.us/assets/document/chapter2.pdf

Massachusetts Highway Department. 2004. Storm Water Handbook for Highways and Bridges.

Metropolitan Council. 2001. Minnesota Urban Small Sites BMP Manual: Stormwater Best Management Practices for Cold Climates. Prepared by Barr Engineering Company. St. Paul, Minnesota.

New Jersey Department of Environmental Protection, 2004, Best Management Practice Manual, Chapter 9.10, Standard for Vegetated Filter Strip, Pp. 9.10-1 to 9.11-10, http://www.njstormwater.org/tier_A/pdf/NJ_SWBMP_9.10.pdf

New York State Department of Environmental Conservation (NYDEC). 2001. New York State Stormwater Management Design Manual. Prepared by Center for Watershed Protection. Albany, New York.

United States Environmental Protection Agency (EPA). 1999. Preliminary Data Summary of Urban Storm Water Best Management Practices. EPA 821-R99-012.

United States Environmental Protection Agency (EPA). 2002. National Menu of Best Management Practices for Stormwater Phase II. URL: http://www.epa.gov/npdes/menuofbmps/menu.htm, Last Modified January 24, 2002.

Virginia Department of Conservation and Recreation, Chapter 3, Minimum Standard 3.14, Vegetated Filter Strip, Pp. 3.14-1 to 3.14.-14, http://dcr.state.va.us/soil_&_water/documents/Chapter_3-14.pdf

Yu, S.L., S.L. Barnes, and V.W. Gerde, 993. Testing of Best Management Practices for Controlling Highway Runoff. Virginia Transportation Research Council, Charlottesville, VA.

# Bioretention Areas & Rain Gardens

***Description:*** Bioretention is a technique that uses soils, plants, and microbes to treat stormwater before it is infiltrated and/or discharged. Bioretention cells (also called rain gardens in residential applications) are shallow depressions filled with sandy soil topped with a thick layer of mulch and planted with dense native vegetation. Stormwater runoff is directed into the cell via piped or sheet flow. The runoff percolates through the soil media that acts as a filter.

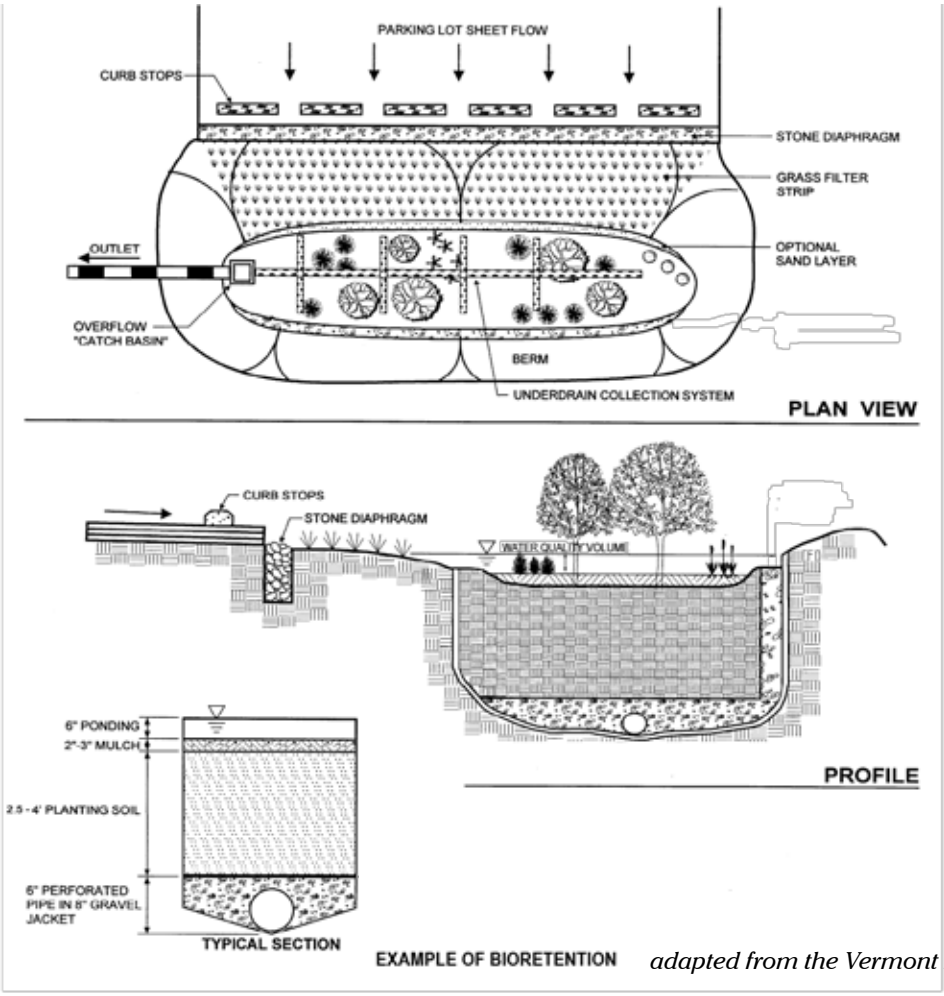
There are two types of bioretention cells: those that are designed solely as an organic filter filtering bioretention areas and those configured to recharge groundwater in addition to acting as a filter exfiltrating bioretention areas. A filtering bioretention area includes an impermeable liner and underdrain that intercepts the runoff before it reaches the water table so that it may be conveyed to a discharge outlet, other best management practices, or the municipal storm drain system. An exfiltrating bioretention area has an underdrain that is designed to enhance exfiltration of runoff into the groundwater.

## Ability to meet specific standards

| Standard | Description |
|---|---|
| **2 - Peak Flow** | N/A |
| **3 - Recharge** | An exfiltrating bioretention area provides groundwater recharge. |
| **4 - TSS Removal** | 90% TSS removal credit with adequate pretreatment |
| **5 - Higher Pollutant Loading** | Can be used for certain land uses with higher potential pollutant loads if lined and sealed until adequate pretreatment is provided. Adequate pretreatment must include 44% TSS removal prior to infiltration. For land uses that have the potential to generate runoff with high concentrations of oil and grease such as high intensity use parking lots and gas stations, adequate pretreatment may also include an oil grit separator, sand filter or equivalent. In lieu of an oil grit separator or sand filter, a filtering bioretention area also may be used as a pretreatment device for infiltration practices exfiltrating runoff from land uses with a potential to generate runoff with high concentrations of oil and grease. |
| **6 - Discharges near or to Critical Areas** | Good option for discharges near cold-water fisheries. Should not be used near bathing beaches and shellfish growing areas. |
| **7 - Redevelopment** | Suitable with appropriate pretreatment |

**Pollutant Removal Efficiencies**

- Total Suspended Solids (TSS) — 90% with vegetated filter strip or equivalent
- Total Nitrogen — 30% to 50% if soil media at least 30 inches
- Total Phosphorus — 30% to 90%
- Metals (copper, lead, zinc, cadmium) — 40% to 90%
- Pathogens (coliform, e coli) — Insufficient data




EXAMPLE OF BIORETENTION *adapted from the Vermont Stormwater Manual*

**Special Features:**

- Can be lined and sealed to prevent recharge where appropriate
- Adequate pretreatment is essential
- Not recommended in areas with steep slope
- Depth of soil media depends on type of vegetation that is proposed
- Soil media must be 30 inches deep to achieve removal of nitrogen

**Advantages/Benefits:**

- Can be designed to provide groundwater recharge and preserves the natural water balance of the site
- Can be designed to prevent recharge where appropriate
- Supplies shade, absorbs noise, and provides windbreaks
- Can remove other pollutants besides TSS including phosphorus, nitrogen and metals
- Can be used as a stormwater retrofit by modifying existing landscape or if a parking lot is being resurfaced
- Can be used on small lots with space constraints
- Small rain gardens are mosquito death traps
- Little or no hazard for amphibians or other small animals

**Disadvantages/Limitations:**

- Requires careful landscaping and maintenance
- Not suitable for large drainage areas

## Maintenance

| Activity | Frequency |
|---|---|
| Inspect and remove trash | Monthly |
| Mow | 2 to 12 times per year |
| Mulch | Annually |
| Fertilize | Annually |
| Remove dead vegetation | Annually |
| Prune | Annually |

# Bioretention Areas & Rain Gardens

*Not all bioretention cells are designed to exfiltrate. Only the infiltration requirements are applicable to bioretention cells intended to exfiltrate.*

## Applicability

Bioretention areas can provide excellent pollutant removal for the "first flush" of stormwater runoff. Properly designed and maintained cells remove suspended solids, metals, and nutrients, and can infiltrate an inch or more of rainfall. Distributed around a property, vegetated bioretention areas can enhance site aesthetics. In residential developments they are often described as "rain gardens" and marketed as property amenities. Routine maintenance is simple and can be handled by homeowners or conventional landscaping companies, with proper direction.

Bioretention systems can be applied to a wide range of commercial, residential, and industrial developments in many geologic conditions; they work well on small sites and on large sites divided into multiple small drainage areas. Bioretention systems are often well suited for ultra-urban settings where little pervious area exists. Although they require significant space (approximately 5% to 7% of the area that drains to them), they can be integrated into parking lots, parking lot islands, median strips, and traffic islands. Sites can be retrofitted with bioretention areas by replacing existing parking lot islands or by re-configuring a parking lot during resurfacing. On residential sites, they are commonly used for rooftop and driveway runoff.

## Effectiveness

Bioretention areas remove pollutants through filtration, microbe activity, and uptake by plants; contact with soil and roots provides water quality treatment better than conventional infiltration structures. Studies indicate that bioretention areas can remove from 80% to 90% of TSS. If properly designed and installed, bioretention areas remove phosphorus, nitrogen, metals, organics, and bacteria to varying degrees.

Bioretention areas help reduce stress in watersheds that experience severe low flows due to excessive impervious cover. Low-tech, decentralized bioretention areas are also less costly to design, install, and maintain than conventional stormwater technologies that treat runoff at the end of the pipe. Decentralized bioretention cells can also reduce the size of storm drain pipes, a major component of stormwater treatment costs. Bioretention areas enhance the landscape in a variety of ways: they improve the appearance of developed sites, provide windbreaks, absorb noise, provide wildlife habitat, and reduce the urban heat island effect.

## Planning Considerations

Filtering bioretention areas are designed with an impermeable liner and underdrain so that the stormwater may be transported to additional BMPs for treatment and/or discharge. Exfiltrating bioretention areas are designed so that following treatment by the bioretention area the stormwater may recharge the groundwater.

Both types of bioretention areas may be used to treat runoff from land uses with higher potential pollutant loads. However, exfiltrating bioretention areas may be used to treat runoff from land uses with higher potential pollutant loads, only if pretreatment has been provided to achieve TSS removal of at least 44%. If the land use has the potential to generate runoff with high concentrations of oil and grease, other types of pretreatment, i.e., a deep sump catch basin and oil grit separator or a sand filter, is required prior to discharge of runoff to an exfiltrating bioretention area. A filtering bioretention area may also be used as a pretreatment device for an exfiltrating bioretention area or other infiltration practice that exfiltrates runoff from land uses with a potential to generate runoff with high concentrations of oil and grease.

To receive 90% TSS removal credit, adequate pretreatment must be provided. If the flow is piped to the bioretention area a deep sump catch catch basin and sediment forebay should be used to provide pretreatment. For sheet flow, there are a number or pretreatment options. These options include:

- A vegetated filter strip, grass channel or water quality swale designed in accordance with the specifications set forth in Chapter 2.
- A grass and gravel combination. This should consist of at least 8 inches of gravel followed by 3 to 5 feet of sod. (source: North Carolina Stormwater Manual, 2007, http://h2o.enr.state.nc.us/su/documents/Ch12-Bioretention_001.pdf)
- Pea diaphragm combined with a vegetated filter strip specially designed to provide pretreatment for a bioretention area as set forth in the following table. (source: Georgia Stormwater Manual and Claytor and Schuler 1996)

**Dimensions for Filter Strip Designed Specially to Provide Pretreatment for Bioretention Area**

| Parameter | Impervious Area | | | | Pervious Areas (lawns, etc.) | | | |
|---|---|---|---|---|---|---|---|---|
| Maximum inflow approach length (feet) | 35 | | 75 | | 75 | | 100 | |
| Filter strip slope (max=6%) | <2% | >2% | <2% | >2% | <2% | >2% | <2% | >2% |
| Filter strip minimum length (feet) | 10 | 15 | 20 | 25 | 10 | 12 | 15 | 18 |

Bioretention areas must not be located on slopes greater than 20%. When the bioretention area is designed to exfiltrate, the design must ensure vertical separation of at least 2 feet from the seasonal high groundwater table to the bottom of the bioretention cell.

For residential rain gardens, pick a low spot on the property, and route water from a downspout or sump pump into it. It is best to choose a location with full sun, but if that is not possible, make sure it gets at least a half-day of sunlight.

Do not excavate an extensive rain garden under large trees. Digging up shallow feeder roots can weaken or kill a tree. If the tree is not a species that prefers moisture, the additional groundwater could damage it. Size the bioretention area using the methodology set forth in Volume 3.

## Design

Size the bioretention area to be 5% to 7% of the area draining to it. Determine the infiltrative capacity of the underlying native soil by performing a soil evaluation in accordance with Volume 3. Do not use a standard septic system (i.e., Title 5) percolation test to determine soil permeability.

The depth of the soil media must be between 2 and 4 feet. This range reflects the fact that most of the pollutant removal occurs within the first 2 feet of soil and that excavations deeper than 4 feet become expensive. The depth selected should accommodate the vegetation. If the minimum depth is used, only shallow rooted plants and grasses my be used. If there is a Total Maximum Daily Load that requires nitrogen to be removed from the stormwater dischrges, the bioretention area should have a soil media with a depth of at least 30 inches, because nitrogen removal takes place 30 inches below the ground surface. If trees and shrubs are to be planted, the soil media should be at least 3 feet.

Size the cells (based on void space and ponding area) at a minimum to capture and treat the required water quality volume (the first 0.5 inch or 1 inch of runoff) if intended to be used for water quality treatment (Stormwater Standard No. 4), the required recharge volume if used for recharge (Stormwater Standard No. 3), or the larger of the two volumes if used to achieve compliance with both Stormwater Standards 3 and 4.

Cover the bottom of the excavation with coarse gravel, over pea gravel, over sand. Earlier designs used filter fabric as a bottom blanket, but more recent experiences show that filter fabric is prone to clogging. Consequently, do not use fabric filters or sand curtains. Use the Engineered Soil Mix below.

*Engineered Soil Mix for Bioretention Systems Designed to Exfiltrate*

- The soil mix for bioretention areas should be a mixture of sand compost and soil.
  - o 40 % sand,
  - o 20-30% topsoil, and
  - o 30-40% compost.

- The soil mix must be uniform, free of stones, stumps, roots or similar objects larger than 2 inches. Clay content should not exceed 5%.
- Soil pH should generally be between 5.5-6.5, a range that is optimal for microbial activity and adsorption of nitrogen, phosphorus, and other pollutants.
- Use soils with 1.5% to 3% organic content and maximum 500-ppm soluble salts.
- The sand component should be gravelly sand that meets ASTM D 422.

| **Sieve Size** | **Percent Passing** |
|---|---|
| 2-inch | 100 |
| ¾-inch | 70-100 |
| ¼-inch | 50-80 |
| U.S. No. 40 | 15-40 |
| U.S. No. 200 | 0-3 |

- The topsoil component shall be a sandy loam, loamy sand or loam texture.
- The compost component must be processed from yard waste in accordance with MassDEP Guidelines (see http://www.mass.gov/dep/recycle/reduce/leafguid.doc). The compost shall not contain biosolids.

On-site soil mixing or placement is not allowed if soil is saturated or subject to water within 48 hours. Cover and store soil to prevent wetting or saturation.

Test soil for fertility and micro-nutrients and, only if necessary, amend mixture to create optimum conditions for plant establishment and early growth.

Grade the area to allow a ponding depth of 6 to 8 inches; depending on site conditions, more or less ponding may be appropriate.

Cover the soil with 2 to 3 inches of fine-shredded hardwood mulch.

The planting plan shall include a mix of herbaceous perennials, shrubs, and (if conditions permit) understory trees that can tolerate intermittent ponding, occasional saline conditions due to road salt, and extended dry periods. A list of plants that are suitable for bioretention areas can be found at the end of this section. To avoid a monoculture, it is a good practice to include one tree or shrub per 50 square feet of bioretention area, and at least 3 species each of herbaceous perennials and shrubs. Invasive and exotic species are prohibited. The planting plan should also meet any applicable local landscaping requirements.

All exfiltrating bioretention areas must be designed to drain within 72 hours. However, rain gardens are typically designed to drain water within a day and are thus unlikely to breed mosquitoes.

Bioretention cells, including rain gardens, require pretreatment, such as a vegetated filter strip. A stone or pea gravel diaphragm or, even better, a concrete level spreader upstream of a filter strip will enhance sheet flow and sediment removal.
Bioretention cells can be dosed with sheet flow, a surface inlet, or pipe flow. When using a surface inlet, first direct the flow to a sediment forebay. Alternatively, piped flow may be introduced to the bioretention system via an underdrain.

For bioretention cells dosed via sheet flow or surface inlets, include a ponding area to allow water to pond and be stored temporarily while stormwater is exfiltrating through the cell. Where bioretention areas are adjacent to parking areas, allow three inches of freeboard above the ponding depth to prevent flooding.

Most bioretention cells have an overflow drain that allows ponded water above the selected ponding depth to be dosed to an underdrain. If the bioretention system is designed to exfiltrate, the underdrain is not connected to an outlet, but instead terminates in the bioretention cell. If the bioretention area is not designed to exfiltrate, the underdrain is connected to an outlet for discharge or conveyance to additional best management practices.

## Construction

During construction, avoid excessively compacting soils around the bioretention areas and accumulating silt around the drain field. To minimize sediment loading in the treatment area, direct runoff to the bioretention area only from areas that are stabilized; always divert construction runoff elsewhere.

To avoid compaction of the parent material, work from the edge of the area proposed as the location of an exfiltrationg bioretention cell. Never direct runoff to the cell until the cell and the contributing drainage areas are fully stabilized.

Place planting soils in 1-foot to 2-foot lifts and compact them with minimal pressure until the desired elevation is reached. Some engineers suggest flooding the cell between each lift placement in lieu of compaction.

## Maintenance

Premature failure of bioretention areas is a significant issue caused by lack of regular maintenance. Ensuring long-term maintenance involves sustained public education and deed restrictions or covenants for privately owned cells. Bioretention areas require careful attention while plants are being established

**Bioretention Maintenance Schedule**

| *Activity* | *Time of Year* | *Frequency* |
|---|---|---|
| Inspect & remove trash | Year round | Monthly |
| Mulch | Spring | Annually |
| Remove dead vegetation | Fall or Spring | Annually |
| Replace dead vegetation | Spring | Annually |
| Prune | Spring or Fall | Annually |
| Replace entire media & all vegetation | Late Spring/early Summer | As needed* |

** Paying careful attention to pretreatment and operation & maintenance can extend the life of the soil media*

and seasonal landscaping maintenance thereafter.

In many cases, a landscaping contractor working elsewhere on the site can complete maintenance tasks. Inspect pretreatment devices and bioretention cells regularly for sediment build-up, structural damage, and standing water.

Inspect soil and repair eroded areas monthly. Re-mulch void areas as needed. Remove litter and debris monthly. Treat diseased vegetation as needed. Remove and replace dead vegetation twice per year (spring and fall).

Proper selection of plant species and support during establishment of vegetation should minimize—if not eliminate—the need for fertilizers and pesticides. Remove invasive species as needed to prevent these species from spreading into the bioretention area. Replace mulch every two years, in the early spring. Upon failure, excavate bioretention area, scarify bottom and sides, replace filter fabric and soil, replant, and mulch. A summary of maintenance activities can be found on the previous page.

Because the soil medium filters contaminants from runoff, the cation exchange capacity of the soil media will eventually be exhausted. When the cation exchange capacity of the soil media decreases, change the soil media to prevent contaminants from migrating to the groundwater, or from being discharged via an underdrain outlet. Using small shrubs and plants instead of larger trees will make it easier to replace the media with clean material when needed.

Plant maintenance is critical. Concentrated salts in roadway runoff may kill plants, necessitating removal of dead vegetation each spring and replanting. The operation and maintenance plan must include measures to make sure the plants are maintained. This is particularly true in residential subdivisions, where the operation and maintenance plan may assign each homeowner the legal responsibility to maintain a bioretention cell or rain garden on his or her property. Including the requirement in the property deed for new subdivisions may alert residential property owners to their legal responsibilities regarding the bioretention cells constructed on their lot.

## Cold Climate Considerations

Never store snow in bioretention areas. The Operation and Maintenance plan must specify where on-site snow will be stored. All snow dumps must comply with MassDEP's guidance. When bioretention areas are located along roads, care must be taken during plowing operations to prevent snow from being plowed into the bioretention areas. If snow is plowed into the cells, runoff may bypass the cell and drain into downgradient wetlands without first receiving the required water quality treatment, and without recharging the groundwater.

## References

Center for Watershed Protection, 2000, Bioretention as a Water Quality Best Management Practice, Article 110 from Watershed Protection Techniques; http://www.cwp.org/Downloads/ELC_PWP110.pdf

Federal Highway Administration , YEAR, Bioretention Fact Sheet, http://www.fhwa.dot.gov/environment/

Low Impact Development Center, 2003, Drainage – Bioretention Specification, http://www.lowimpactdevelopment.org/epa03/biospec.htm

Prince Georges County, 2002, Bioretention Manual, http://www.goprincegeorgescounty.com/der/bioretention.asp

Puget Sound Action Team, 2005, Low Impact Development, Pp. 174 - 184 http://www.psat.wa.gov/Publications/LID_tech_manual05/LID_manual2005.pdf

U.S. Environmental Protection Agency, 1999, Stormwater Technology Fact Sheet, Bioretention, EPA 832-F-99-012, http://www.epa.gov/owm/mtb/biortn.pdf

U.S. Environmental Protection Agency, 2005, National Management Measures to Control Nonpoint Source Pollution from Urban Areas, Publication Number EPA 841-B-05-004, Pp. 5-29 http://www.epa.gov/nps/urbanmm/

University of North Carolina, www.bae.ncsu.edu/topic/bioretention www.bae.ncsu.edu/stormwater/PublicationFiles/DesigningRainGardens2001.pdf

# Plant Species Suitable for Use in Bioretention - Herbaceous Species

| Species | Moisture Regime | | Tolerance | | | | | | Morphology | | | General Characteristics | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Scientific Name* Common Name | Indicator Status | Habitat | Ponding (days) | Salt | Oil/ Grease | Metals | Insects/ Disease | Exposure | Form | Height | Root System | Native | Wildlife | |
| *Agrostis alba* redtop | FAC | Mesic-Xeric | 1-2 | H | - | H | H | Shade | Grass | 2-3' | Fiberous Shallow | Yes | High | - |
| *Andropogon gerardi* bluejoint | FAC | Dry Mesic-Mesic | 1-2 | - | - | - | - | Sun | Grass | 2-3' | Fiberous Shallow | Yes | High | - |
| *Andropogon virginicus* broomsedge | - | Wet meadow | 1-2 | L | - | | | Full sun | Grass | 1-3' | | Yes | High | Tolerant of fluctuating water levels and drought. |
| *Carex vulpinoidea* fox sedge | OBL | Freshwater marsh | 2-4 | L | - | | | Sun to partial sun | Grass | 2-3.5' | Rhizome | Yes | High | - |
| *Chelone glabra* | | | | | | | | | | | | | | |
| *Deschampsia caespitosa* tufted hairgrass | FACW | Mesic to wet Mesic | 2-4 | H | - | H | H | Sun | Grass | 2-3' | Fiberous Shallow | Yes | High | May become invasive. |
| *Glyceria striata* fowl mannagrass, nerved mannagrass | OBL | Freshwater marsh, seeps | 1-2 | L | - | | | Partial shade to full shade | Grass | 2-4' | Rhizome | Yes | High | - |
| *Hedera helix* English Ivy | FACU | Mesic | 1-2 | - | - | - | H | Sun | Evergreen ground cover | - | Fiberous Shallow | No | Low | - |
| *Hibiscus palustris* | | | | | | | | | | | | | | |
| *Iris kaempferi* | | | | | | | | | | | | | | |

H High Tolerance
M Medium Tolerance
L Low Tolerance

FACU Facultative Upland - Usually occur in non-wetlands, however, occasionally found in wetlands.
FAC Facultative - Equally likely to occur in wetlands and non-wetlands.
FACW Facultative Wetland - Usually occur in wetlands, however, occasionally found in non-wetlands.
OBL Obligate Wetland - Occur almost always in wetlands

***Adapted from the Prince George's County Design Manual & the Center for Watershed Protection for the use of bioretention in Stormwater Management***

# Plant Species Suitable for Use in Bioretention - Herbaceous Species

| Species | Moisture Regime | | Tolerance | | | | | | Morphology | | | General Characteristics | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Scientific Name* Common Name | Indicator Status | Habitat | Ponding (days) | Salt | Oil/ Grease | Metals | Insects/ Disease | Exposure | Form | Height | Root System | Native | Wildlife | |
| *Lobelia siphilitica* | | | | | | | | | | | | | | |
| *Lotus Corniculatus* birdsfoot-trefoil | FAC | Mesic-Xeric | 1-2 | H | L | H | H | Sun | Grass | 2-3' | Fiberous Shallow | Yes | High | Member of the legume family. |
| *Onoclea sensibilis* sensitive fern, beadfern | FACW | | | | | | | Shade | | 1-3.5' | | | H | |
| *Pachysandra terminalis* Japanese pachysandra | FACU | Mesic | 1-2 | - | - | - | M | Shade | Evergreen ground cover | - | Fiberous Shallow | No | Low | - |
| *Panicum virgatum* switch grass | FAC to FACU | Mesic | 2-4 | H | - | - | H | Sun or Shade | Grass | 4-5' | Fiberous Shallow | Yes | High | Can spread fast and reach height of 6' |
| *Vinca major* large periwinkle | FACU | Mesic | 1-2 | - | - | - | H | Shade | Evergreen ground cover | - | Fiberous Shallow | No | Low | Sensitive to soil compaction and pH changes. |
| *Vinca minor* common periwinkle | FACU | Mesic | 1-2 | - | - | - | H | Shade | Evergreen ground cover | - | Fiberous Shallow | No | Low | - |
| Indian grass | | | | | | | | | | | | | | |
| Little bluestem | | | | | | | | | | | | | | |
| Deer tongue | | | | | | | | | | | | | | |
| Green coneflower | | | | | | | | | | | | | | |

H High Tolerance
M Medium Tolerance
L Low Tolerance

FACU Facultative Upland - Usually occur in non-wetlands, however, occasionally found in wetlands.
FAC Facultative - Equally likely to occur in wetlands and non-wetlands.
FACW Facultative Wetland - Usually occur in wetlands, however, occasionally found in non-wetlands.
OBL Obligate Wetland - Occur almost always in wetlands

***Adapted from the Prince George's County Design Manual & the Center for Watershed Protection for the use of bioretention in Stormwater Management***

## Plant Species Suitable for Use in Bioretention - Herbaceous Species

| Species | Moisture Regime | | Tolerance | | | | | | Morphology | | | General Characteristics | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Scientific Name* Common Name | Indicator Status | Habitat | Ponding (days) | Salt | Oil/ Grease | Metals | Insects/ Disease | Exposure | Form | Height | Root System | Native | Wildlife | |
| *Aronia arbutifolia (Pyrus arbutifolia)* red chokeberry | FACW | Mesic | 1-2 | H | – | H | M | Sun to partial sun | Deciduous shrub | 6-12' | – | Yes | High | Good bank stabilizer. Tolerates drought. |
| *Clethra alnifolia* sweet pepperbush | FAC | Mesic to wet Mesic | 2-4 | H | – | – | H | Sun to partial sun | Ovoid shrub | 6-12' | Shallow | Yes | Med | Coastal plain species. |
| *Cornus Stolonifera (Cornus sericea)* red osier dogwood | FACW | Mesic-Hydric | 2-4 | H | H | H | M | Sun or shade | Arching, spreading shrub | 8-10' | Shallow | Yes | High | Needs more consistent moisture levels. |
| *Cornus amomum* silky dogwood | FAC | Mesic | 1-2 | L | – | – | M | Sun to partial sun | Broad-leaved | 6-12' | – | Yes | High | Good bank stabilizer |
| *Euonymous europaeus* spindle-tree | FAC | Mesic | 1-2 | M | M | M | M | Sun to partial sun | Upright dense oval shrub | 10-12' | Shallow | No | No | – |
| *Hamamelis virginiana* witch hazel | FAC | Mesic | 2-4 | M | M | M | M | Sun or shade | Vase-like compact shrub | 4-6' | Shallow | Yes | Low | – |
| *Hypericum densiflorum* common St. John's wort | FAC | Mesic | 2-4 | H | M | M | H | Sun | Ovoid shrub | 3-6' | Shallow | Yes | Med | – |
| *Ilex glabra* inkberry | FACW | Mesic to wet Mesic | 2-4 | H | H | – | H | Sun to partial sun | Upright dense shrub | 6-12' | Shallow | Yes | High | Coastal plain species. |
| *Ilex verticillata* winterberry | FACW | Mesic to wet Mesic | 2-4 | L | M | – | H | Sun to partial sun | Spreading shrub | 6-12' | Shallow | Yes | High | – |

H High Tolerance
M Medium Tolerance
L Low Tolerance

FACU Facultative Upland - Usually occur in non-wetlands, however, occasionally found in wetlands.
FAC Facultative - Equally likely to occur in non-wetlands and wetlands.
FACW Facultative Wetland - Usually occur in wetlands, however, occasionally found in non-wetlands.
OBL Obligate Wetland - Almost always occur in wetlands.

***Adapted from the Prince George's County Design Manual & the Center for Watershed Protection for the use of bioretention in Stormwater Management***

# Plant Species Suitable for Use in Bioretention - Herbaceous Species

| Species | Moisture Regime | | Tolerance | | | | | | Morphology | | | General Characteristics | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Scientific Name* Common Name | Indicator Status | Habitat | Ponding (days) | Salt | Oil/ Grease | Metals | Insects/ Disease | Exposure | Form | Height | Root System | Native | Wildlife | |
| *Itea virginica* tassel-white, Virginia sweetspire | OBL | Mesic | 1-2 | M | – | – | M | Sun or shade | Broad-leaved, deciduous shrub | 6-12' | – | Yes | Low | – |
| *Juniperus communis "compressa"* common juniper | FAC | Dry Mesic-Mesic | 1-2 | M | H | H | M-H | Sun | Mounded shrub | 3-6' | Deep taproot | No | High | Evergreen |
| *Juniperus horizontalis "Bar Harbor"* creeping juniper | FAC | Dry Mesic-Mesic | 1-2 | M | H | H | M-H | Sun | Matted shrub | 0-3' | Deep taproot | No | High | Evergreen |
| *Lindera benzoin* spicebush | FACW | Mesic to wet Mesic | 2-4 | H | – | – | H | Sun | Upright shrub | 6-12' | Deep | Yes | High | – |
| *Myrica pennsylvanica* bayberry | FAC | Mesic | 2-4 | H | M | M | H | Sun to partial sun | Rounded, compact shrub | 6-8' | Shallow | Yes | High | Coastal plain species. |
| *Physocarpus opulifolius* ninebark | FAC | Dry Mesic to wet Mesic | 2-4 | M | – | – | H | Sun | Upright shrub | 6-12' | Shallow | Yes | Med | May be difficult to locate. |
| *Viburnum cassinoides* northern wild raisin | FACW | Mesic | 2-4 | H | H | H | H | Sun to partial sun | Rounded, compacted shrub | 6-8' | Shallow | Yes | High | – |
| *Viburnum dentatum* arrow-wood | FAC | Mesic to wet | 2-4 | H | H | H | H | Sun to partial sun | Upright, multi-stemmed shrub | 8-10' | Shallow | Yes | High | – |
| *Viburnum lentago* nannyberry | FAC | Mesic | 2-4 | H | H | H | H | Sun to partial sun | Upright, mlti-stemmed shrub | 8-10' | Shallow | Yes | High | – |

H High Tolerance
M Medium Tolerance
L Low Tolerance

FACU Facultative Upland - Usually occur in non-wetlands, however, occasionally found in wetlands.
FAC Facultative - Equally likely to occur in non-wetlands and wetlands.
FACW Facultative Wetland - Usually occur in wetlands, however, occasionally found in non-wetlands.
OBL Obligate Wetland - Almost always occur in wetlands.

***Adapted from the Prince George's County Design Manual & the Center for Watershed Protection for the use of bioretention in Stormwater Management***

# Plant Species Suitable for Use in Bioretention - Herbaceous Species

| Species | Moisture Regime | | Tolerance | | | | | | Morphology | | | General Characteristics | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Scientific Name* Common Name | Indicator Status | Habitat | Ponding (days) | Salt | Oil/ Grease | Metals | Insects/ Disease | Exposure | Form | Height | Root System | Native | Wildlife | |
| *Acer rubrum* red maple | FAC | Mesic-Hydric | 4-6 | H | H | H | H | Partial sun | Single to multi-stem tree | 50-70' | Shallow | Yes | High | - |
| *Amelanchier canadensis* shadbush | FAC | Mesic | 2-4 | H | M | - | H | Partial sun | Single to multi-stem tree | 35-50' | Shallow | Yes | High | Not recommended for full sun. |
| *Betula nigra* river birch | FACW | Mesic-Hydric | 4-6 | - | M | M | H | Partial sun | Single to multi-stem tree | 50-75' | Shallow | Yes | High | Not susceptible to bronze birch borer. |
| *Betula populifolia* gray birch | FAC | Xeric-Hydric | 4-6 | H | H | M | H | Partial sun | Single to multi-stem tree | 35-50' | Shallow to deep | No | High | Native to New England area. |
| *Fraxinus americana* white ash | FAC | Mesic | 2-4 | M | H | H | H | Sun | Large tree | 50-80' | Deep | Yes | Low | - |
| *Fraxinus Pennsylvanica* green ash | FACW | Mesic | 4-6 | M | H | H | H | Partial sun | Large tree | 40-65' | Shallow to deep | Yes | Low | - |
| *Ginko biloba* Maidenhair tree | FAC | Mesic | 2-4 | H | H | H | H | Sun | Large tree | 50-80' | Shallow to deep | No | Low | Avoid female species-offensive odor from fruit. |
| *Gleditsia triacanthos* honeylocust | FAC | Mesic | 2-4 | H | M | - | M | Sun | Small caopied large tree | 50-75' | Shallow to deep variable taproot | Yes | Low | Select thornless variety. |
| *Juniperus virginiana* eastern red cedar | FACU | Mesic-Xeric | 2-4 | H | H | - | H | Sun | Dense single stem tree | 50-75' | Taproot | Yes | Very high | Evergreen |
| *Liquidambar styraciflua* sweet gum | FAC | Mesic | 4-6 | H | H | H | M | Sun | Large tree | 50-70' | Deep taproot | Yes | High | Edge and perimeter; fruit is a maintenance problem. |
| *Nyssa sylvatica* black gum | FACW | Mesic-Hydric | 4-6 | H | H | H | H | Sun | Large tree | 40-70' | Shallow to deep taproot | Yes | High | - |

H High Tolerance
M Medium Tolerance
L Low Tolerance

FACU Facultative Upland - Usually occur in non-wetlands, however, occasionally found in wetlands.
FAC Facultative - Equally likely to occur in non-wetlands and wetlands.
FACW Facultative Wetland - Usually occur in wetlands, however, occasionally found in non-wetlands.
OBL Obligate Wetland - Almost always occur in wetlands.

***Adapted from the Prince George's County Design Manual & the Center for Watershed Protection for the use of bioretention in Stormwater Management***

# Plant Species Suitable for Use in Bioretention - Herbaceous Species

| Species | Moisture Regime | | Tolerance | | | | | | Morphology | | | General Characteristics | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Scientific Name* Common Name | Indicator Status | Habitat | Ponding (days) | Salt | Oil/ Grease | Metals | Insects/ Disease | Exposure | Form | Height | Root System | Native | Wildlife | |
| *Platanus acerifolia* London plane-tree | FACW | Mesic | 2-4 | H | – | – | M | Sun | Large tree | 70-80' | Shallow | No | Low | Tree roots can heave sidewalks. |
| *Platanus occidentalis* sycamore | FACW | Mesic-Hydric | 4-6 | M | M | M | M | Sun | Large tree | 70-80' | Shallow | Yes | Med | Edge and perimeter; fruit is a maintennance problem; tree is also prone to windthrow. |
| *Populus deltoides* eastern cottonnwood | FAC | Xeric-Mesic | 4-6 | H | H | H | L | Sun | Large tree with spreading branches | 75-100' | Shallow | Yes | High | Short lived. |
| *Quercus bicolor* Swamp white oak | FACW | Mesic to wet Mesic | 4-6 | H | – | H | H | Sun to partial sun | Large tree | 75-100' | Shallow | Yes | High | One of the faster growing oaks. |
| *Quercus coccinea* scarlet oak | FAC | Mesic | 1-2 | H | M | M | M | Sun | Large tree | 50-75' | Shallow to deep | Yes | High | – |
| *Quercus macrocarpa* bur oak | FAC | Mesic to wet Mesic | 2-4 | H | H | H | M | Sun | Large spreading tree | 75-100' | Taproot | No | High | Native to Midwest. |
| *Quercus palustris* pin oak | FACW | Mesic-Hydric | 4-6 | H | H | H | M | Sun | Large tree | 60-80' | Shallow to deep taproot | Yes | High | – |
| *Quercus phellos* willow oak | FACW | Mesic to wet Mesic | 4-6 | H | – | – | H | Sun | Large tree | 55-75' | Shallow | Yes | High | Fast growing oak. |
| *Quercus rubra* red oak | FAC | Mesic | 2-4 | M | H | M | M | Sun to partial sun | Large spreading tree | 60-80' | Deep taproot | Yes | High | – |
| *Quercus shumardii* Shumard's red oak | FAC | Mesic | 2-4 | H | H | H | M | Sun to partial sun | Large spreading tree | 60-80' | Deep taproot | No | High | Native to Southeast. |

H High Tolerance
M Medium Tolerance
L Low Tolerance

FACU Facultative Upland - Usually occur in non-wetlands, however, occasionally found in wetlands.
FAC Facultative - Equally likely to occur in non-wetlands and wetlands.
FACW Facultative Wetland - Usually occur in wetlands, however, occasionally found in non-wetlands.
OBL Obligate Wetland - Almost always occur in wetlands.

***Adapted from the Prince George's County Design Manual & the Center for Watershed Protection for the use of bioretention in Stormwater Management***

## Plant Species Suitable for Use in Bioretention - Herbaceous Species

| Species | Moisture Regime | | Tolerance | | | | | | Morphology | | | General Characteristics | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Scientific Name* Common Name | Indicator Status | Habitat | Ponding (days) | Salt | Oil/ Grease | Metals | Insects/ Disease | Exposure | Form | Height | Root System | Native | Wildlife | |
| *Sophora japonica* Japanese pagoda tree | FAC | Mesic | 1-2 | M | M | _ | M | Sun | Shade tree | 40-70' | Shallow | No | Low | Fruit stains sidewalk. |
| *Taxodium distichum* bald cypress | FACW | Mesic-Hydric | 4-6 | _ | _ | M | H | Sun to partial sun | Typically single stem tree | 75-100' | Shallow | Yes | Low | Not well documented for planting in urban areas. |
| *Thuja occidentalis* arborvitae | FACW | Mesic to wet Mesic | 2-4 | M | M | M | H | Sun to partial sun | Dense single stem tree | 50-75' | Shallow | No | Low | Evergreen |
| *Zelkova serrata* Japanese zelkova | FACU | Mesic | 1-2 | M | M | _ | H | Sun | Dense shade tree | 60-70' | Shallow | No | Low | Branches can split easily in storms. |

H High Tolerance
M Medium Tolerance
L Low Tolerance

FACU Facultative Upland - Usually occur in non-wetlands, however, occasionally found in wetlands.
FAC Facultative - Equally likely to occur in non-wetlands and wetlands.
FACW Facultative Wetland - Usually occur in wetlands, however, occasionally found in non-wetlands.
OBL Obligate Wetland - Almost always occur in wetlands.

***Adapted from the Prince George's County Design Manual & the Center for Watershed Protection for the use of bioretention in Stormwater Management***

# Extended Dry Detention Basin

***Description***: Extended dry detention basins are modified conventional dry detention basins, designed to hold stormwater for at least 24 hours to allow solids to settle and to reduce local and downstream flooding. Extended dry detention basins may be designed with either a fixed or adjustable outflow device. Pretreatment is a fundamental design component of an extended dry detention basin to reduce the potential for clogging. Other components such as a micropool or shallow marsh may be added to enhance pollutant removal.

## Ability to meet specific standards

| Standard | Description |
|---|---|
| **2 - Peak Flow** | With proper design can provide peak flow attenuation. |
| **3 - Recharge** | Provides no groundwater recharge. |
| **4 - TSS Removal** | When combined with sediment forebay provides 50% TSS removal. |
| **5 - Higher Pollutant Loading** | May be used as treatment BMP provided basin bottom is lined and sealed. For some land uses with higher potential pollutant loads, may also need oil grit separator, sand filter, lined bioretention area, or equivalent prior to discharge to extended dry detention basin. |
| **6 - Discharges near or to Critical Areas** | Shall not be used for discharges near or to critical areas |
| **7 - Redevelopment** | Existing dry detention basins may be retrofitted to become extended dry detention basins |

**Advantages/Benefits:**

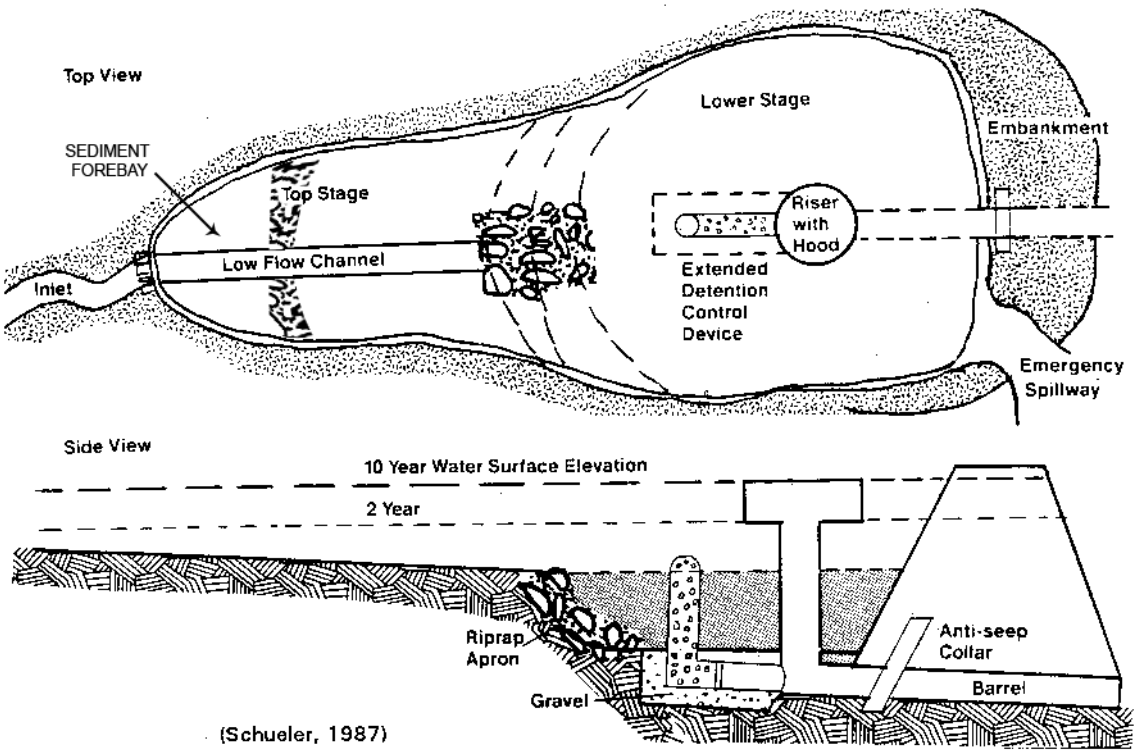
- Least costly BMP that controls both stormwater quantity and quality.
- Good retrofitting option for existing basins.
- Can remove significant levels of sediment and absorbed pollutants.
- Potential for beneficial terrestrial and aquatic habitat.
- Less potential for hazards than deeper permanent pools.

**Disadvantages/Limitations:**

- Infiltration and groundwater recharge is negligible, resulting in minimal runoff volume reduction.
- Removal of soluble pollutants is minimal.
- Requires relatively large land area.
- Moderate to high maintenance requirements.
- Potential contributor to downstream warming.
- Sediment can be resuspended after large storms if not removed.

**Pollutant Removal Efficiencies**

- Total Suspended Solids (TSS) 50% provided it is combined with sediment forebay or equivalent
- Total Nitrogen 15% to 50%
- Total Phosphorus 10% to 30%
- Metals (copper, lead, zinc, cadmium) 30% to 50%
- Pathogens (coliform, e coli) Less than 10%




## Maintenance

*adapted from Controlling Urban Runoff, Schueler 1987*

| Activity | Frequency |
|---|---|
| Inspect extended dry detention basins | At least twice a year and during and after major storms. |
| Examine the outlet structure for evidence of clogging or outflow release velocities that are greater than design flow. | At least twice a year. |
| Mow the upper-stage, side slopes, embankment, and emergency spillway. | At least twice a year. |
| Remove trash and debris. | At least twice a year. |
| Remove sediment from the basin. | At least once every 5 years. |

## Special Features

Design extended dry detention basins with two distinct stages; stage one should have the capacity to regulate peak flow rates of large, infrequent storms (10, 25, or 100-year recurrence intervals). Design the lower stages of the basin to detain the 2-year storm for at least 24 hours to remove pollutants from the runoff

## LID Alternatives

Bioretention Areas
Decentralized stormwater management system that directs stormwater runoff from different sections of the site to small bioretention areas distributed throughout the site.

# Extended Dry Detention Basin

## Applicability

Generally, extended dry detention basins are not practical if the contributing watershed area is less than ten acres. MassDEP recommends four acres of drainage area for each acre-foot of storage in the basin. Extended dry detention basins can be used at residential, commercial and industrial sites.

Because they have a limited capability for removing soluble pollutants, extended dry detention basins are more suitable for commercial applications where there are high loadings of sediment, metals and hydrocarbons. Do not use extended dry detention basins by themselves in low-density residential areas, where soluble nutrients from pesticides and fertilizers may be a concern. Combine extended dry detention basins with a shallow marsh system or other BMPs for more efficient pollutant removal.

Existing dry detention basins can be retrofitted as extended dry detention basins at a relatively low cost by simply modifying the outlet structure. Because of the land requirements, extended dry detention basins are not feasible at sites where land costs or space is at a premium. Investigate soils, depth to bedrock, and depth to water table before designing an extended dry detention basin for a site.

Sites where bedrock is close to the surface can significantly increase excavation costs and make extended dry detention basins infeasible. If on-site soils are relatively impermeable, such as soil group D (as defined by the NRCS), problems with standing water may arise. In this case, using a wet basin may be more appropriate. A water table within two feet of the bottom of the extended dry detention basin can also create problems with standing water. On the other hand, if soils are highly permeable, such as well-drained sandy and gravelly soils (NRCS Soil Group A), it will be difficult to establish the shallow marsh component in the basin.

## Effectiveness

The primary pollutant removal mechanism in extended dry detention basins is settling; therefore, the degree of pollutant removal depends on whether the pollutant is in the particulate or dissolved form. Expect limited removal for soluble pollutants, but high removal rates for particulate pollutants. Enhanced removal of soluble pollutants in the lower stage of the basin can occur by natural biological removal processes if it is maintained as a shallow wetland. The degree of removal by such wetlands depends on the wetland's size in relation to its loading. When designed properly, extended dry detention basins are effective in reducing pollutant loads and controlling post-development peak discharge rates. Extended dry detention basins may be used to meet Stormwater Management Standards 2 and 4. However extended dry detention basins do little to reduce post-development increases in runoff volume or maintain recharge.

## Planning Considerations

Check the soils, depth to bedrock and depth to water table before designing an extended dry detention basin. Where bedrock is close to the surface, high excavation costs may make extended dry detention basins infeasible. If soils on-site are relatively impermeable, or the water table is within two feet of the bottom of the basin, the basin may experience problems with standing water. If soils are highly permeable, it will be difficult to establish a shallow marsh component in the basin, unless a liner is used. Maximum depth of the extended dry detention basin may range from 3 to 12 feet. The depth of the basin may be limited by groundwater conditions or by soils.

Construct extended dry detention basins above the normal groundwater elevation (i.e. the bottom of the basin should not intercept groundwater). If runoff is from a land use with a higher potential pollutant load, provide adequate pretreatment and a greater separation between the bottom of the basin and the seasonal high groundwater table.

To be effective in reducing peak runoff rates, the extended dry detention basin is ordinarily located where it can intercept most of the runoff from the site, usually at the lowest elevation of the site where freshwater wetlands are frequently found. Like all other best management practices, extended dry detention basins may not be constructed in wetland resource areas other than isolated land subject to flooding, bordering land subject to flooding, land subject to coastal storm flowage and riverfront areas. Select a location that will not adversely affect wetland resource areas but will still provide the peak rate attenuation required by Standard 2. Embankments, or dams, created to store more than 15 acre-feet, or that are more than 6 feet high, are under the jurisdiction of the state Office of Dam Safety and are subject to regulation.

## Design

*[See the following document for complete design references: Design of Stormwater Pond Systems. 1996. Schueler. Center for Watershed Protection.]*

Extended dry detention basin design must accommodate large, infrequent storm events for runoff quantity control, as well as small, frequent storm events for runoff quality control. Typically, the first flush of runoff contains the highest concentrations of pollutants. Consequently, design the extended dry detention basin to maximize the detention time for the most frequent storms. Routing calculations for a range of storms should provide the designer with the optimal basin size.

Generally, most particulates settle within the first 12 hours of detention; however, finer particulates may require additional time to settle. The minimum detention time for the Water Quality Volume is 24-hours. The most traditional and easiest method for extended detention routing is the 24 hour brimfull draw down (Required Water Quality Volume/24 hours = Qavg). This sets the average discharge rate. An orifice is then sized based on a max Q = 2*Qavg, using the brimfull head (Qmax = (CA(2gh)1/2) where h is the head when the basin is full to the Required Water Quality Volume (WQv) elevation, g is acceleration due to gravity, A is the net opening area, and C is the orifice coefficient. The orifice coefficient is determined by consulting tables in standard references such as the Civil Engineering Reference Manual for the PE Exam, 10th Edition, by Michael R. Lindeburg, P.E., 2006.

The critical parameters in sizing an extended dry detention basin are storage capacity and the maximum rate of runoff released from the basin. To meet the requirements of Standard 2, design the storage volume to hold the pre-development peak flow.

To maximize sedimentation, design the extended dry detention basin to lengthen the flow path, thereby increasing detention time. To maximize the detention time, locate the inflow points as far from the outlet structure as possible. Long, narrow configurations with length to width ratios of 2:1 provide better removal efficiencies than small deep basins. Consider using internal berms and other baffles to minimize short-circuiting of flows and increase detention times.

Reducing inflow velocities lengthens detention times, enhances sedimentation of solids in incoming runoff, and minimizes the potential for resuspension of settled pollutants. Design all inflow points with riprap or other energy dissipators, such as a baffle below the inflow structure. MassDEP requires a sediment forebay to enhance the removal rates of particulates, decrease the velocity of incoming runoff, and reduce the potential for failure due to clogging.

Design sediment forebays for ease of maintenance. Hard bottom forebays make sediment removal easier. All forebays must be accessible for maintenance by heavy machinery, if necessary.

A low flow channel routes the last remaining runoff, dry weather flow and groundwater to the outlet, which should be installed in the upper stage of the basin to ensure that the extended dry detention basin dries out completely. The maximum flow velocity (which should be set at the 2-year peak discharge rate) depends on the nature of the material used to line the channel. Consider whether a pervious or impervious channel lining is most appropriate.

Pervious linings allow runoff to interact with soil and grass, thereby increasing the sorption of pollutants. Make design velocities in pervious low flow channels high enough to prevent sedimentation but low enough to prevent scouring and erosion.

Impervious channels are simple to construct, easy to maintain, and empty completely after a storm event. Runoff flows and differential settling can undermine impervious channels unless constructed and maintained properly. Locate the top of the impervious channel lining at or below the level of the adjacent grassed areas to ensure thorough drainage of these areas. When designing impervious channels, take into account settlement of the lining and the adjacent areas as well as the potential for frost impacts on the lining. Provide impervious lining with broken stone foundations and weep holes. Consider the potential for erosion or scour along the edges of the lining caused by bank-full velocities. Maintain a low outflow discharge rate at the downstream end of the impervious channel to ensure sufficient treatment of runoff, which backs up and overflows onto the grassed basin bottom.

Use low flow underdrains connected to the principal outlet structure or other downstream discharge point to promote thorough drying of the channel and the basin bottom. Take into account the depth of the

low flow channel when preparing the final bottom grading plan. Establish wetland vegetation in a shallow marsh component or on an aquatic bench in the lower stage of the extended dry detention basin to enhance removal of soluble nutrients, increase sediment trapping, prevent sediment resuspension, and provide wildlife and waterfowl habitat. Proper soils and surface depth or groundwater depth are needed to maintain wetland vegetation.

Make the side slopes of the extended dry detention basin no steeper than 3:1, and use intermittent benches to foster vegetative growth and provide for safety. Flatter slopes help to prevent bank erosion during larger storms, make routine bank maintenance tasks (such as mowing) easier, prevent animals from getting trapped, and allow easier access to the basin. Include a multi-stage outlet structure to provide an adequate level of water quality and flood control. To meet the water quantity control standards, use the required design storm runoff rates as the outlet release rates. For water quality control, the release rate will vary with the design storm selected. For extended dry detention basins with shallow marshes or permanent pools, place the lowest stage outlet at an elevation that will create a permanent pool of water.

The type of outlet structure needed will depend on factors such as the type of spillway, basin configuration and extended detention outflow rate. Design the outlet to control the outflow rate without clogging. Locate the outlet structure in the embankment for maintenance, access, safety and aesthetics. Design the outlet to facilitate maintenance; the vital parts of the structure must be accessible during normal maintenance and emergency situations. It also must contain a draw-down valve for complete detention basin draining within 24 hours.

To prevent scour at the outlet, use a flow transition structure, such as a lined apron or plunge pad, to absorb the initial impact of the flow and reduce the velocity to a level that will not erode the receiving channel or area. Design embankments and spillways in accordance with the state regulations for Dam Safety (302 CMR 10.00). All extended dry detention basins must have an emergency spillway capable of bypassing runoff from large storms without damaging the impounding structure.

Provide a public or private right-of-way access for maintenance that is at least 15 feet wide with a maximum slope of 5:1. Make sure this access extends to the forebay, safety bench, and outflow structure, and never crosses the emergency spillway, unless the spillway has been designed for that purpose. Use vegetative buffers around the perimeter of the basin for erosion control and additional sediment and nutrient removal.

## Maintenance

Inspect extended dry detention basins at least once per year to ensure that the basins are operating as intended. Inspect extended dry detention basins during and after major storms to determine if the basin is meeting the expected detention times. Examine the outlet structure for evidence of clogging or outflow release velocities that are greater than design flow. Potential problems that should be checked include: subsidence, erosion, cracking or tree growth on the embankment; damage to the emergency spillway; sediment accumulation around the outlet; inadequacy of the inlet/outlet channel erosion control measures; changes in the condition of the pilot channel; and erosion within the basin and banks. Make any necessary repairs immediately. During inspections, note any changes to the extended dry detention basin or the contributing watershed, because these could affect basin performance.

Mow the upper-stage, side slopes, embankment, and emergency spillway at least twice per year. Also remove trash and debris at this time. Remove sediment from the extended dry detention basin as necessary, but at least once every 5 years. Providing an on-site sediment disposal area will reduce the overall sediment removal costs.

# Wet Basins (formerly wet retention ponds)

***Description***: Wet basins use a permanent pool of water as the primary mechanism to treat stormwater. The pool allows sediments to settle (including fine sediments) and removes soluble pollutants. Wet basins must have additional dry storage capacity to control peak discharge rates. Wet basins have a moderate to high capacity to remove most urban pollutants, depending on how large the volume of the permanent pool is in relation to the runoff from the surrounding watershed.

## Ability to meet specific standards

| Standard | Description |
|---|---|
| **2 - Peak Flow** | Can be designed to provide peak flow attenuation. |
| **3 - Recharge** | Provides no groundwater recharge. |
| **4 - TSS Removal** | 80% TSS removal credit when combined with sediment forebay as pretreatment. |
| **5 - Higher Pollutant Loading** | May be used as treatment BMP provided basin bottom is lined and sealed. For some land uses with higher potential pollutant load, may require pretreatment by oil grit separator, sand filter or equivalent prior to discharge to wet basin |
| **6 - Discharges near or to Critical Areas** | Do not use for discharges to cold-water fisheries |
| **7 - Redevelopment** | Not usually suitable. |

**Advantages/Benefits:**

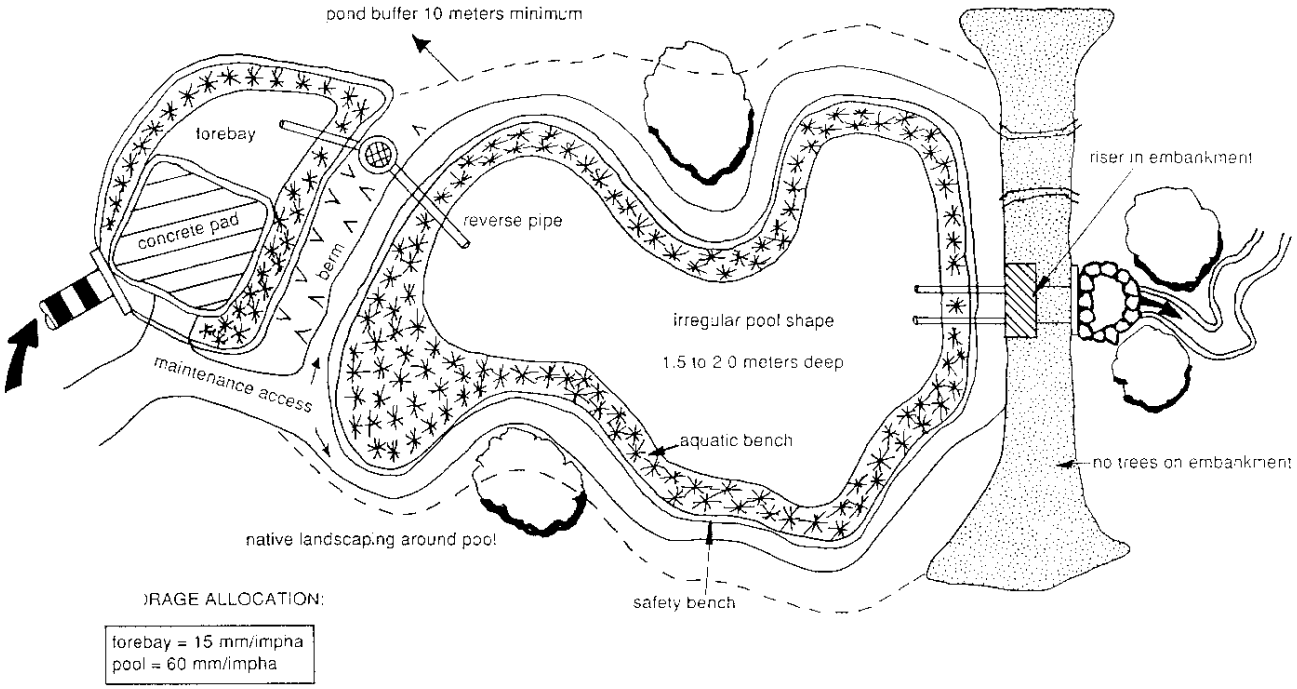
- Capable of removing both solid and soluble pollutants
- Capable of removing nutrients and metals
- Aesthetically pleasing BMP.
- Can increase adjacent property values when properly planned and sited.
- Sediment generally needs to be removed less frequently than for other BMPs.
- Can be used in retrofits

**Disadvantages/Limitations:**

- More costly than extended dry detention basins.
- Larger storage volumes for the permanent pool and flood control require more land area.
- Infiltration and groundwater recharge is minimal, so runoff volume control is negligible.
- Moderate to high maintenance requirements.
- Can be used to treat runoff from land uses with higher potential pollutant loads if bottom is lined and sealed.
- Invasive species control required

**Pollutant Removal Efficiencies**

| | |
|---|---|
| • Total Suspended Solids (TSS) | 80% with sediment forebay |
| • Total Nitrogen | 10% to 50% |
| • Total Phosphorus | 30% to 70% |
| • Metals (copper, lead, zinc, cadmium) | 30% to 75% |
| • Pathogens (coliform, e coli) | 40% to 90% |




*adapted from Schueler, 1992*

## Maintenance

| Activity | Frequency |
|---|---|
| Inspect wet basins to ensure they are operating as designed | At least once a year. |
| Mow the upper-stage, side slopes, embankment and emergency spillway. | At least twice a year. |
| Check the sediment forebay for accumulated sediment, trash, and debris and remove it. | At least twice a year. |
| Remove sediment from the basin. | As necessary, and at least once every 10 years |

## Special Features

MassDEP requires a sediment forebay as pretreatment to a wet basin.

**LID Alternative**

1. Design measures to reduce impervious areas, shrinking the size of the wet basin
2. Use if LID site design credits for the water quality volume requirement (Stormwater Standard 4)
3. Decentralized Stormwater Management System that uses vegetative filter strips to direct stormwater runoff to BMPs located throughout the site

# Wet Basins

A wet basin may be created by constructing an embankment or excavating a pit. The primary component of a wet basin is the deep, permanent pool, but other components, such as a shallow marsh, may be added to the design *(see basin/ wetland design in constructed wetlands section)*. MassDEP requires a sediment forebay as pretreatment to a wet basin. The sediment forebay plus the wet basin collectively are credited with an 80% TSS removal rate.

The basic operation of a wet basin allows incoming stormwater to displace the water present in the pool. This stormwater remains until displaced by runoff from another storm event. Increased retention time allows particulates, including fine sediments, to settle out of the water column. The permanent pool also serves to protect deposited sediments from resuspending during large storm events. Another advantage of wet basins is the biological activity of algae and fringe wetland vegetation, which reduces the concentration of soluble pollutants. Wet basins may be designed with a multi-stage outlet structure to control peak rate discharges from different design storms. When properly designed and maintained, wet basins can add recreation, open space, fire protection, wildlife habitat, and aesthetic values to a property.

### Applicability

Generally, dry weather base flow and/or large contributing drainage areas are required to maintain pool elevations. The minimum contributing drainage area must be at least 20 acres, but not more than one square mile. Sites with less than 20 acres of contributing drainage area may be suitable only if sufficient groundwater flow is available. Use wet basins at residential, commercial and industrial sites. Because wet basins remove soluble pollutants, they are ideal for sites where nutrient loadings are expected to be high. In such instances, source controls must also be implemented to further reduce nutrient loadings.

Investigate soils, depth to bedrock, and depth to water table before designing a wet basin. At sites where bedrock is close to the surface, high excavation costs may make wet ponds infeasible. If the soils on site are relatively permeable or well drained, such as a soil type in Hydrologic Group A (as defined by the Natural Resource Conservation Service), it will be difficult to maintain a permanent pool. In this situation, it may be necessary to line the bottom of the wet pond to reduce infiltration. Designing wet basins for multiple storms will provide peak rate control. In such instances, design the upper stages of wet basins to provide temporary storage of larger storms (i.e., 10, 25, and 100-year 24-hr. storms). Wet basins are generally ineffective in controlling the post-development increase in runoff volume, although some infiltration does occur, as well as evaporation in summer months.

### Planning Considerations

Evaluate soils and depth to bedrock before designing a wet basin. At sites where bedrock is close to the surface, high excavation costs may make wet basins infeasible. If the soils are permeable (A and B soils), heavy drawdown of the basin may occur during dry periods. In these situations, compact the basin soils or install a liner at the bottom of the basin to minimize the potential for drawdown. Specifications for basin materials include (in order of decreasing costs):

- 6-inch clay
- Polyvinyl liner
- Bentonite
- 6 inches of silt loam or finer material

To be effective in reducing peak runoff rates, locate the basin where it can intercept most of the runoff from the site, typically a low elevation that is near freshwater wetlands. Like all stormwater best management practices, wet basins must not be constructed in wetland resource areas other than isolated land subject to flooding, bordering land subject to flooding, land subject to coastal storm flowage, and riverfront area. Select a location that can accommodate the need to attenuate peak discharge rates without adversely impacting nearby wetland resources.

It is preferable to create the wet basin by excavating a pit below the grade of land. When this is not feasible, an earthern embankment can be created. Embankments or dams created to store more than 15 acre-feet, or that are more than 6 feet high, are under the jurisdiction of the Massachusetts Department of Conservation and Recreation (DCR) Office of Dam Safety and must be constructed, inspected, and maintained according to DCR guidelines.

## Design

*See the following for complete design references:*
*Wet Extended Detention Pond Design: Step by Step Design. 1995. Claytor.*

Volume and geometry are the critical parameters in a wet basin design; the relationship of the volume in the permanent pool to the contributing runoff volume directly affects pollutant removal rates. Generally, bigger is better; however, after a certain threshold level, increasing the pool size results in only marginal increases in pollutant removal. The permanent pool must be sized at a minimum to hold twice the water quality volume (this is equivalent to a VB/VR of 2) when a wet basin is designed to provide peak rate attenuation in addition to water quality treatment. The peak rate volume is an additional volume above the permanent pool. The permanent pool volume must not be counted as part of the volume devoted to storage associated with peak rate attenuation. When designing a wet basin to also accommodate peak rate attenuation, a multiple stage outlet must be included as part of the design.

Make the minimum contributing drainage area at least 20 acres, but no more than one square mile. Sites with less than ten acres of contributing drainage area may be suitable if sufficient groundwater flow is available to maintain the permanent wet pool.

Pool depth is an important design factor, especially for sediment deposition. Use an average pool depth of 3 to 6 feet. Settling column studies and modeling analyses show that shallow basins remove more solids than deeper ones. However, resuspension of settled materials by wind action might be a problem in shallow basins that are less than two feet deep. Depths greater than eight feet may cause thermal stratification. Stratified pools tend to become anoxic (low or no oxygen) more often than shallower ponds. If possible, vary depths throughout the basin.

Providing deeper pools can provide fish habitat. It may be advantageous to introduce fish to the wet basins to reduce mosquito breeding. When designing wet basins to support fish, a fisheries biologist should be consulted. Fish habitat features may include trees to provide shading over the deeper depths. Selection of trees should be done carefully to avoid embankment or sidewall failure.

Use intermittent benches around the perimeter of the basin for safety and to promote vegetation. Design the safety bench to be at least ten feet wide and above normal pool elevations. Make the aquatic bench at least ten feet wide and maintain depths of 12 to 18 inches at normal elevations to support aquatic vegetation. Shallow depths near the inlet will concentrate sediment deposition in a smaller, more accessible area. Deeper depths near the outlet will yield cooler bottom water discharges that may mitigate downstream thermal effects.

Use a minimum pool surface area of 0.25 acres. Enhance the performance of the wet basin by enlarging the surface area to increase volume, instead of deepening the pool, although this increases water temperatures and evaporation rates. The original design of wet basin depths and volumes should take into account the gradual accumulation of sediment. Accumulating sediment in the pool will decrease storage volume and reduce pollutant removal efficiency.

| Wet Basin Design Criteria | |
|---|---|
| Factor | Criteria |
| Maximum Drainage area | ≥20 acres unless sufficient groundwater flow |
| Permanent Pool Volume | ≥2 x WQv (equivalent to Vb/Vr ratio of 2) |
| Minimum Pool Surface Area | ≥0.25 acres |
| Minimum Length to Width Ratio | ≥3:1 |
| Mean Permanent Pool Depth | 3 to 6 feet |
| Maximum Permanent Pool Depth | 8 feet |
| Maximum Pool Slopes | ≤3H:1V |
| Maximum Safety & Aquatic Bench Slopes | ≤2H:1V |
| Perimeter Accessway Width | ≥15 feet |
| Perimeter Vegetative Buffer | ≥25 feet |
| Sediment Forebay | Required (not included in wet basin sizing) |
| Pool Drain (for maintenance purposes) | Required maximum pool drain time: 40 hours |

MassDEP requires a sediment forebay to pretreat stormwater before it enters the wet basin. Forebays trap sediment before the runoff enters the primary pool, effectively enhancing removal rates and minimizing long-term operation and maintenance problems. Removing sediment from the forebay is easier and less costly than from the wet basin pool, so design sediment forebays for ease of

maintenance. Hard bottom forebays make sediment removal easier. Make forebays accessible by heavy machinery to faciltate maintenance.

To avoid reducing the pollutant removal capability and to maximize travel distance, locate the inflow points as far from the outlet structure as possible. To maximize stormwater contact and retention time in the pool, use a length to width ratio of at least 3:1.

Set the invert elevation of the inlet pipe at or below the surface of the permanent pool, preferably within one foot of the pool. Pipes discharging above the pool can erode the banks and side slopes. Design all inflow points with riprap or other energy dissipators to reduce inflow velocities.

Establish wetland vegetation on the aquatic bench to enhance the removal of soluble nutrients, facilitate sediment trapping, prevent sediment resuspension, provide wildlife and waterfowl habitat, and conceal trash and debris that may accumulate near the outlet. Six to eighteen inches of water depth are needed for wetland vegetation growth.

Make the slopes of the pools no steeper than 3:1. Flatter slopes help to prevent bank erosion during larger storms and facilitate routine bank maintenance tasks, such as mowing. Flat slopes also provide for public safety, and allow easier access. In addition, design the sides of the pool that extend below the safety and aquatic benches to the bottom of the pool at a slope that will remain stable, usually no steeper than 2:1 (horizontal to vertical).

Design the invert of the wet basin outlet pipe to convey stormwater from approximately one foot below the pool surface and to discharge into the riser in the pond embankment. To prevent clogging, install trash racks or hoods on the riser.

To facilitate access for maintenance, install the riser within the embankment. Place anti-seep collars or filter and drainage diaphragms on the outlet barrel to prevent seepage and pipe failure. Make the vital parts of the structure accessible to maintenance personnel during normal and emergency conditions. Install a bottom drainpipe to allow complete draining of the wet basin in case of emergencies or for routine maintenance.

Fit both the outlet pipe and the bottom drain pipe with adjustable valves at the outer end of the outlet to permit adjustment of the detention time, if necessary.

To prevent scour at the outlet, install a flow transition structure, such as a lined apron or plunge pad, to absorb the initial impact of the flow and reduce the velocity to a level that will not erode the receiving channel or area.

Design embankments and spillways to conform with DCR Dam Safety regulations, if applicable. All wet basins must have an emergency spillway capable of bypassing runoff from large storms without damaging the impounding structure.

Provide an access way for maintenance, with a minimum width of 15 feet and a maximum slope of 15%, by public or private right-of-way. Equipment that will be used for maintenance must be capable of using this access-way. This access should extend to the forebay, safety bench, and outflow structure and should never cross the emergency spillway, unless the spillway has been designed for that purpose. Place vegetative buffers around the perimeter of the wet basin to control erosion and remove additional sediment and nutrients. The vegetative buffer must be at least 33 feet (10 meters). Vegetation must be designed to prevent the introduction of invasive species.

## Maintenance

Inspect wet basins at least once per year to ensure they are operating as designed. Inspect the outlet structure for evidence of clogging or excessive outflow releases. Potential problems to check include: subsidence, erosion, cracking or tree growth on the embankment, damage to the emergency spillway, sediment accumulation around the outlet, inadequacy of the inlet/outlet channel erosion control measures, changes in the condition of the pilot channel, erosion within the basin and banks, and the emergence of invasive species. Make any necessary repairs immediately. During inspections, note any changes to the wet basin or the contributing watershed area because these may affect basin performance. At least twice a year, mow the upper-stage, side slopes, embankment and emergency spillway. At this time, also check the sediment forebay for accumulated material, sediment, trash, and debris and remove it. Remove sediment from the basin as necessary, and at least once every 10 years. Providing an on on-site sediment disposal area will reduce the overall sediment removal costs.

## References

Galli, J. 1990, Thermal Impacts Associated with Urbanization and Stormwater Best Management Practices. Prepared for the Maryland Department of Environment, Baltimore, MD, by the Metropolitan Council of Governments, Washington, D.C.

# Infiltration Basins

***Description***: Infiltration basins are stormwater runoff impoundments that are constructed over permeable soils. Pretreatment is critical for effective performance of infiltration basins. Runoff from the design storm is stored until it exfiltrates through the soil of the basin floor.

## Ability to meet specific standards

| Standard | Description |
|---|---|
| **2 - Peak Flow** | Can be designed to provide peak flow attenuation. |
| **3 - Recharge** | Provides groundwater recharge. |
| **4 - TSS Removal** | 80% TSS removal, with adequate pretreatment |
| **5 - Higher Pollutant Loading** | May be used if 44% of TSS is removed with a pretreatment BMP prior to infiltration. For some land uses with higher potential pollutant loads, use an oil grit separator, sand filter or equivalent for pretreatment prior to discharge to the infiltration basin. Infiltration must be done in compliance with 314 CMR 5.00 |
| **6 - Discharges near or to Critical Areas** | Highly recommended, especially for discharges near cold-water fisheries. Requires 44% removal of TSS prior to discharge to infiltration basin |
| **7 - Redevelopment** | Typically not an option due to land area constraints |

**Advantages/Benefits:**

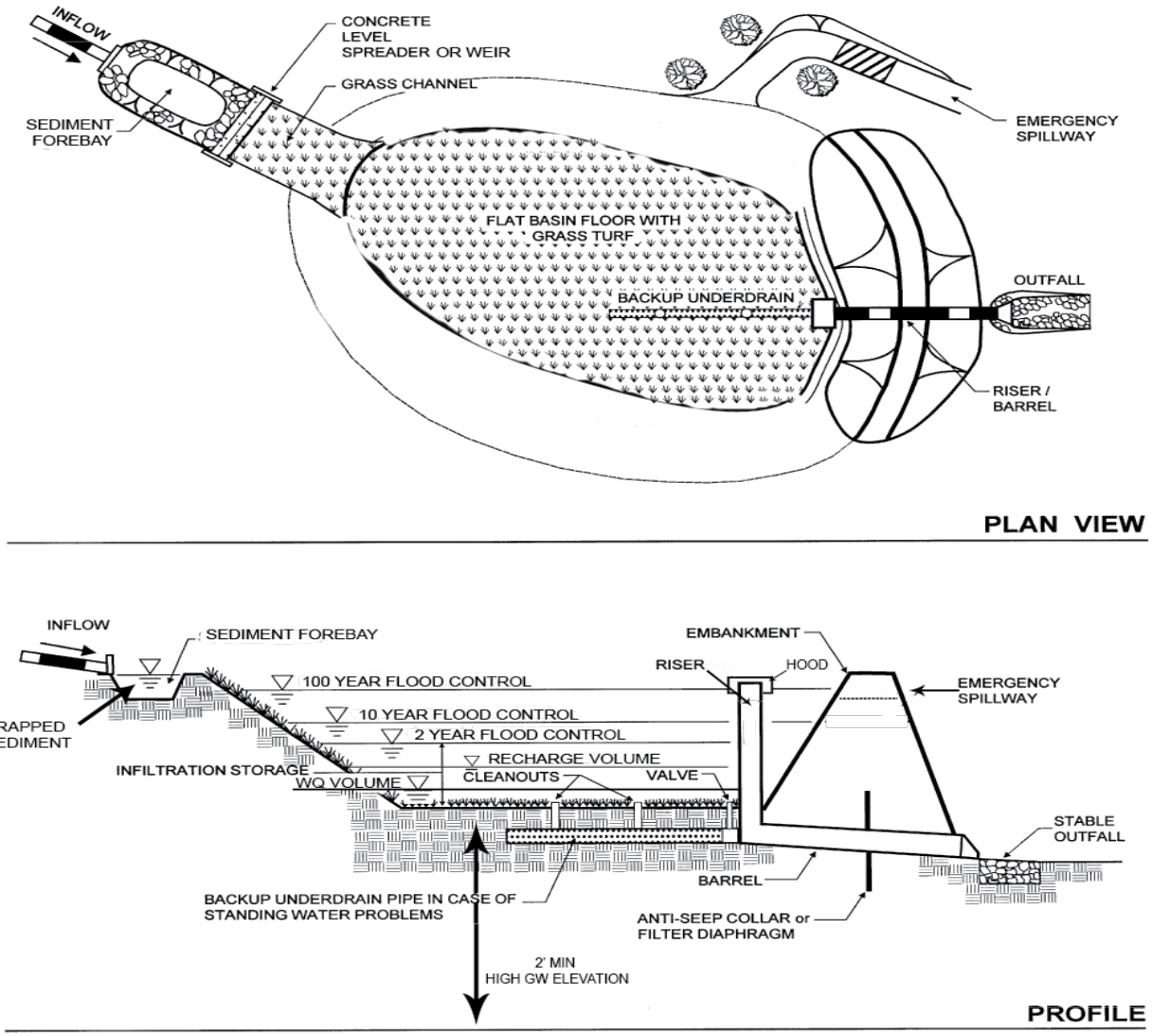
- Provides groundwater recharge.
- Reduces local flooding.
- Preserves the natural water balance of the site.
- Can be used for larger sites than infiltration trenches or structures.

**Disadvantages/Limitations:**

- High failure rates due to improper siting, inadequate pretreatment, poor design and lack of maintenance.
- Restricted to fairly small drainage areas.
- Not appropriate for treating significant loads of sediment and other pollutants.
- Requires frequent maintenance.
- Can serve as a “regional” stormwater treatment facility

**Pollutant Removal Efficiencies**

| | |
|---|---|
| • Total Suspended Solids (TSS) | 80% with pretreatment |
| • Total Nitrogen | 50% to 60% |
| • Total Phosphorus | 60% to 70% |
| • Metals (copper, lead, zinc, cadmium) | 85% to 90% |
| • Pathogens (coliform, e coli) | 90% |




*adapted from the Vermont Stormwater Manual*

## Maintenance

| Activity | Frequency |
|---|---|
| Preventative maintenance | Twice a year |
| Inspect to ensure proper functioning | After every major storm during first 3 months of operation and twice a year thereafter and when there are discharges through the high outlet orifice. |
| Mow the buffer area, side slopes, and basin bottom if grassed floor; rake if stone bottom; remove trash and debris; remove grass clippings and accumulated organic matter | Twice a year |
| Inspect and clean pretreatment devices | Every other month recommended and at least twice a year and after every major storm event. |

**Special Features:** High failure rate without adequate pretreatment and regular maintenance.

**LID Alternative:** Reduce impervious surfaces. Bioretention areas

# Infiltration Basins

*The following are variations of the infiltration basin design.*

### Full Exfiltration Basin Systems

These basin systems are sized to provide storage and exfiltration of the required recharge volume and treatment of the required water quality volume. They also attenuate peak discharges. Designs typically include an emergency overflow channel to discharge runoff volumes in excess of the design storm.

### Partial or Off-line Exfiltration Basin Systems

Partial basin systems exfiltrate a portion of the runoff (usually the first flush or the first half inch), with the remaining runoff being directed to other BMPs. Flow splitters or weirs divert flows containing the first flush into the infiltration basin. This design is useful at sites where exfiltration cannot be achieved by downstream detention BMPs because of site condition limitations.

### Applicability

The suitability of infiltration basins at a given site is restricted by several factors, including soils, slope, depth to water table, depth to bedrock, the presence of an impermeable layer, contributing watershed area, proximity to wells, surface waters, and foundations. Generally, infiltration basins are suitable at sites with gentle slopes, permeable soils, relatively deep bedrock and groundwater levels, and a contributing watershed area of approximately 2 to 15 acres. Table IB.1 presents the recommended site criteria for infiltration basins.

Pollution prevention and pretreatment are particularly important at sites where infiltration basins are located. A pollution prevention program that separates contaminated and uncontaminated runoff is essential. Uncontaminated runoff can be infiltrated directly, while contaminated runoff must be collected and pretreated using an appropriate combination of BMPs and then rerouted to the infiltration basin. This approach allows uncontaminated stormwater to be infiltrated during and immediately after the storm and permits the infiltration of contaminated stormwater after an appropriate detention time. The Pollution Prevention and Source Control Plan required by Stormwater Standard 4 must take these factors into account. For land uses with higher potential pollutant loads, provide a bypass to divert contaminated stormwater from the infiltration basin in storms larger than the design storm.

| **Table IB.1 - Site Criteria for Infiltration Basins** |
|---|
| 1. The contributing drainage area to any individual infiltration basin should be restricted to 15 acres or less. |
| 2. The minimum depth to the seasonal high water table, bedrock, and/or impermeable layer should be 2 ft. from the bottom of the basin. |
| 3. The minimum infiltration rate is 0.17 inches per hour. Infiltration basins must be sized in accordance with the procedures set forth in Volume 3. |
| 4. One soil sample for every 5000 ft. of basin area is recommended, with a minimum of three samples for each infiltration basin. Samples should be taken at the actual location of the proposed infiltration basin so that any localized soil conditions are detected. |
| 5. Infiltration basins should not be used at sites where soil have 30% or greater clay content, or 40% or greater silt clay content. |
| 6. Infiltration basins should not be placed over fill materials. |
| 7. The following setback requirements should apply to infiltration basin installations:<br>• Distance from any slope greater than 15% - Minimum of 50 ft.<br>• Distance from any soil absorption system- Minimum of 50 ft.<br>• Distance from any private well - Minimum of 100 ft., additional setback distance may be required depending on hydrogeological conditions.<br>• Distance from any public groundwater drinking supply wells - Zone I radius, additional setback distance may be required depending on hydrogeological conditions.<br>• Distance from any surface drinking water supply - Zone A<br>• Distance from any surface water of the commonwealth (other than surface water supplies and their tributaries) - Minimum of 50 ft.<br>• Distance from any building foundations including slab foundations without basements - Minimum of 10 ft. downslope and 100 ft. upslope. |

Prior to pretreatment, implement the pollution prevention and source control program specified in the Pollution Prevention and Source Control Plan to reduce the concentration of pollutants in the discharge. Program components include careful management of snow and deicing chemicals, fertilizers, herbicides, and pest control. The Plan must prohibit snow disposal in the basin and include measures to prevent runoff of stockpiled snow from entering the basin. Stockpiled snow contains concentrations of sand and deicing chemicals. At industrial sites, keep raw materials and wastes from being exposed to precipitation. Select pretreatment BMPs that remove coarse sediments, oil and grease, and floatable organic and inorganic materials, and soluble pollutants.

## Effectiveness

Infiltration basins are highly effective treatment systems that remove many contaminants, including TSS. However, infiltration basins are not intended to remove coarse particulate pollutants. Use a pretreatment device to remove them before they enter the basin. The pollutant removal efficiency of the basin depends on how much runoff is exfiltrated by the basin.

Infiltration basins can be made to control peak discharges by incorporating additional stages in the design. To do this, design the riser outlet structure or weir with multiple orifices, with the lowest orifice set to achieve storage of the full recharge volume required by Standard 3. Design the upper orifices using the same procedures as extended detention basins. The basins can also be designed to achieve exfiltration of storms greater than the required recharge volume. However, in such cases, make sure the soils are permeable enough to allow the basin to exfiltrate the entire volume in a 72-hour period. This may necessitate increasing the size of the floor area of the basin. Generally, it is not economically feasible to provide storage for large infrequent storms, such as the 100-year 24-hour storm.

## Planning Considerations

Carefully evaluate sites before planning infiltration basins, including investigating soils, depth to bedrock, and depth to water table. Suitable parent soils should have a minimum infiltration rate of 0.17 inches per hour. Infiltration basis must be sized in accordance with the procedures set forth in Volume 3. The slopes of the contributing drainage area for the infiltration basin must be less than 5%.

## Design

Infiltration basins are highly effective treatment and disposal systems when designed properly. The first step before design is providing source control and implementing pollution prevention measures to minimize sediment and other contaminants in runoff discharged to the infiltration basin. Next, consider the appropriate pretreatment BMPs.

Design pretreatment BMPs to pretreat runoff before stormwater reaches the infiltration basin. For Critical Areas, land uses with potentially higher pollutant loads, and soils with rapid infiltration rates (greater than 2.4 inches/hour), pretreatment must remove at least 44% of the TSS. Proponents may comply with this requirement by proposing two pretreatment BMPs capable of removing 25% TSS. However, the issuing authorities (i.e., Conservation Commissions or MassDEP) may require additional pretreatment for other constituents beyond TSS for land uses with higher potential pollutant loads. If the land use has the potential to generate stormwater runoff with high concentrations of oil and grease, treatment by an oil grit separator or equivalent is required before discharge to the infiltration basin.

For discharges from areas other than Critical Areas, land uses with potentially higher pollutant loads, and soils with rapid infiltration rates, MassDEP also requires some TSS pretreatment. Common pretreatment for infiltration basins includes aggressive street sweeping, deep sump catch basins, oil/grit separators, vegetated filter strips, water quality swales, or sediment forebays. Fully stabilize all land surfaces contributing drainage to the infiltration practice after construction is complete to reduce the amount of sediment in runoff that flows to the pretreatment devices.

Always investigate site conditions. Infiltration basins must have a minimum separation from seasonal high groundwater of at least 2 feet. Greater separation is necessary for bedrock. If there is bedrock on the site, conduct an analysis to determine the appropriate vertical separation. The greater the distance from the bottom of the basin media to the seasonal high groundwater elevation, the less likely the basin will fail to drain in the 72-hour period following precipitation.

Determine soil infiltration rates using samples collected at the proposed location of the basin. Take one soil boring or dig one test pit for every 5,000 feet

of basin area, with a minimum of three borings for each infiltration basin. Conduct the borings or test pits in the layer where infiltration is proposed. For example, if the A and B horizons are to be removed and the infiltration will be through the C horizon, conduct the borings or test pits through the C horizon. MassDEP requires that borings be at least 20 feet deep or extend to the depth of the limiting layer.

For each bore hole or test pit, evaluate the saturated hydraulic conductivity of the soil, depth to seasonal high groundwater, NRCS soil textural class, NRCS Hydrologic Soil Group, and the presence of fill materials in accordance with Volume 3. Never locate infiltration basins above fill. Never locate infiltration basins in Hydrologic Soil Group "D" soils. The minimum acceptable final soil infiltration rate is 0.17 inches per hour. Design the infiltration basin based on the soil evaluation set forth in Volume 3.

If the proposed basin is determined to be in Hydrologic Soil Group "C" soils, incorporate measures in the design to reduce the potential for clogging, such as providing more pretreatment or greater media depth to provide additional storage. Never use the results of a Title 5 percolation test to estimate a saturated hydraulic conductivity rate, because it tends to greatly overestimate the rate that water will infiltrate into the subsurface.

Estimate seasonal high groundwater based on soil mottles or through direct observation when borings are conducted in April or May, when groundwater levels are likely to be highest. If it is difficult to determine the seasonal high groundwater elevation from the borings or test pits, then use the Frimpter method developed by the USGS (Massachusetts/ Rhode Island District Office) to estimate seasonal high groundwater. After estimating the seasonal high groundwater using the Frimpter method, re-examine the bore holes or test pits to determine if there are any field indicators that corroborate the Frimpter method estimate.

Stabilize inlet channels to prevent incoming flow velocities from reaching erosive levels, which can scour the basin floor. Riprap is an excellent inlet stabilizer. Design the riprap so it terminates in a broad apron, thereby distributing runoff more evenly over the basin surface to promote better infiltration.

At a minimum, size the basin to hold the required recharge volume. Determine the required recharge volume using either the static or dynamic methods set forth in Volume 3. Remember that the required storage volume of an infiltration basin is the sum of the quantity of runoff entering the basin from the contributing area and the precipitation directly entering the basin. Include one foot of freeboard above the total of the required recharge volume and the direct precipitation volume to account for design uncertainty. When applying the dynamic method to size the basin, use only the bottom of the basin (i.e., do not include side wall exfiltration) for the effective infiltration area.

Design the infiltration basin to exfiltrate in no less than 72 hours. Consider only the basin floor as the effective infiltration area when determining whether the basin meets this requirement.

Design the basin floor to be as flat as possible to provide uniform ponding and exfiltration of the runoff. Design the basin floor to have as close to a 0% slope as possible. In no case shall the longitudinal slope exceed 1%. Enhanced deposition of sediment in low areas may clog the surface soils, resulting in reduced infiltration and wet areas. Design the side slopes of the basin to be no steeper than 3:1 (horizontal: vertical) to allow for proper vegetative stabilization, easier mowing, easier access, and better public safety.

For basins with a 1% longitudinal slope, it will be necessary to incorporate cells into the design, making sure that the depth of ponded water does not exceed 2 feet, because sloped basin floors cause water to move downhill, thereby decreasing the likelihood of infiltration. Make lateral slopes flat (i.e., 0% slope).

After the basin floor is shaped, place soil additives on the basin floor to amend the soil. The soil additives shall include compost, properly aged to kill any seed stock contained within the compost. Do not put biosolids in the compost. Mix native soils that were excavated from the A or B horizons to create the basin with the compost, and then scarify the native

materials and compost into the parent material using a chisel plow or rotary device to a depth of 12 inches. Immediately after constructing the basin, stabilize its bottom and side slopes with a dense turf of water-tolerant grass. Use low-maintenance, rapidly germinating grasses, such as fescues. The selected grasses must be capable of surviving in both wet and dry conditions. Do not use sod, which can prevent roots from directly contacting the underlying soil. During the first two months, inspect the newly established vegetation several times to determine if any remedial actions (e.g., reseeding, irrigating) are necessary.

Never plant trees or shrubs within the basin or on the impounding embankments as they increase the chance of basin failure due to root decay or subsurface disturbance. The root penetration and thatch formation of the turf helps to maintain and may even enhance the original infiltration capacity. Soluble nutrients are taken up by the turf for growth, improving the pollutant removal capacity. Dense turf will impede soil erosion and scouring of the basin floor.

In place of turf, use a basin liner of 6 to 12 inches of fill material, such as coarse sand. Clean and replace this material as needed. Do not use loose stone, riprap, and other irregular materials requiring hand removal of debris and weeds.

Design embankments and spillways to conform to the regulatory guidelines of the state's Office of Dam Safety (302 CMR 10.00). Design infiltration basins to be below surrounding grade to avoid issues related to potential embankment failure. All infiltration basins must have an emergency spillway capable of bypassing runoff from large storms without damage to the impounding structure. Design the emergency spillway to divert the storm associated with brimful conditions without impinging upon the structural integrity of the basin. The brimful condition could be the required recharge volume or a design storm (such as the 2-year, 10-year, or 100-year storm if the basin is designed to provide peak rate attenuation in addition to exfiltration). The storm associated with the brimful conditions should not include the one foot of freeboard required to account for design uncertainty. Design the emergency spillway to shunt water toward a location where the water will not damage wetlands or buildings. A common error is to direct the spillway runoff toward an adjoining property not owned by an applicant. If the emergency spillway is designed to drain the emergency overflow toward an adjoining property, obtain a drainage easement and submit it to the Conservation Commission as part of the Wetlands NOI submission. Place vegetative buffers around the perimeter of the basin for erosion control and additional sediment and nutrient removal.

***Monitoring wells:*** Install one monitoring well in the basin floor per every 5,000 square feet of basin floor. Make sure the monitoring well(s) extend 20 feet beneath the basin floor or to the limiting layer, whichever is higher.

***Access:*** Include access in the basin design. The area at the top of the basin must provide unimpeded vehicular access around the entire basin perimeter. The access area shall be no less than 15 feet.

***Inlet Structures:*** Place inlet structures at one longitudinal end of the basin, to maximize the flow path from the inlet to the overflow outlet. A common error is to design multiple inlet points around the entire basin perimeter.

***Outlet structures:*** Infiltration basins must include an overflow outlet in addition to an emergency spillway. Whether using a single orifice or multiple orifices in the design, at a minimum, set the lowest orifice at or above the required recharge volume.

***Drawdown device:*** Include a device to draw the basin down for maintenance purposes. If the basin includes multiple cells, include a drawdown device for each cell.

***Fences:*** Do not place fences around basins located in Riverfront Areas, as required by 310 CMR 10.58(4)(d)1.d. to avoid impeding wildlife movement. In such cases, consider including a safety bench as part of the design.

## Construction

Prior to construction, rope or fence off the area selected for the infiltration basin. Never allow construction equipment to drive across the area intended to serve as the infiltration basin.

Never use infiltration basins as temporary sediment traps for construction activities.

To limit smearing or compacting soils, never construct the basin in winter or when it is raining. Use light earth-moving equipment to excavate the infiltration basin because heavy equipment compacts the soils beneath the basin floor and side slopes and reduces infiltration capacity. Because some compaction of soils is inevitable during construction, add the required soil amendments and deeply till the basin floor with a rotary tiller or a disc harrow to a depth of 12 inches to restore infiltration rates after final grading.

Use proper erosion/sediment control during construction. Immediately following basin construction, stabilize the floor and side slopes of the basin with a dense turf of water-tolerant grass. Use low maintenance, rapidly germinating grasses, such as fescues. Do not sod the basin floor or side slopes. After the basin is completed, keep the basin roped or fenced off while construction proceeds on other parts of the site. Never direct construction period drainage to the infiltration basin. After construction is completed, do not direct runoff into the basin until the bottom and side slopes are fully stabilized.

## Maintenance

Infiltration basins are prone to clogging and failure, so it is imperative to develop and implement aggressive maintenance plans and schedules. Installing the required pretreatment BMPs will significantly reduce maintenance requirements for the basin.

The Operation and Maintenance Plan required by Standard 9 must include inspections and preventive maintenance at least twice a year, and after every time drainage discharges through the high outlet orifice. The Plan must require inspecting the pretreatment BMPs in accordance with the minimal requirements specified for those practices and after every major storm event. A major storm event is defined as a storm that is equal to or greater than the 2-year, 24-hour storm (generally 2.9 to 3.6 inches in a 24-hour period, depending in geographic location in Massachusetts).

Once the basin is in use, inspect it after every major storm for the first few months to ensure it is stabilized and functioning properly and if necessary take corrective action. Note how long water remains standing in the basin after a storm; standing water within the basin 48 to 72 hours after a storm indicates that the infiltration capacity may have been overestimated. If the ponding is due to clogging, immediately address the reasons for the clogging (such as upland sediment erosion, excessive compaction of soils, or low spots).
Thereafter, inspect the infiltration basin at least twice per year. Important items to check during the inspection include:

- Signs of differential settlement,
- Cracking,
- Erosion,
- Leakage in the embankments
- Tree growth on the embankments
- Condition of riprap,
- Sediment accumulation and
- The health of the turf.

At least twice a year, mow the buffer area, side slopes, and basin bottom. Remove grass clippings and accumulated organic matter to prevent an impervious organic mat from forming. Remove trash and debris at the same time. Use deep tilling to break up clogged surfaces, and revegetate immediately.

Remove sediment from the basin as necessary, but wait until the floor of the basin is thoroughly dry. Use light equipment to remove the top layer so as to not compact the underlying soil. Deeply till the remaining soil, and revegetate as soon as possible. Inspect and clean pretreatment devices associated with basins at least twice a year, and ideally every other month.

## References:

Center for Watershed Protection, http://www.stormwatercenter.net/Manual_Builder/Construction%20Specifications/Infiltration%20Trench%20Specifications.htm

Center for Watershed Protection, http://www.stormwatercenter.net/Manual_Builder/Performance%20Criteria/Infiltration.htm

Center for Watershed Protection, Stormwater Management Fact Sheet, Infiltration Basin, http://www.stormwatercenter.net/Assorted%20Fact%20Sheets/Tool6_Stormwater_Practices/Infiltration%20Practice/Infiltration%20Basin.htm

Ferguson, B.K., 1994. Stormwater Infiltration. CRC Press, Ann Arbor, MI.

Galli, J. 1992. Analysis of Urban BMP Performance and Longevity in Prince George's County, Maryland. Metropolitan Washington Council of Governments, Washington, DC.

Maryland Department of the Environment, 2000, Maryland Stormwater Design Manual, Appendix B-2, Construction Specifications for Infiltration Practices, http://www.mde.state.md.us/assets/document/appendixb2.pdf

Pitt, R., et al. 1994, Potential Groundwater Contamination from Intentional and Nonintentional Stormwater Infiltration, EPA/600/R-94/051, Risk Reduction Engineering Laboratory, U.S. EPA, Cincinnati, OH

Schroeder, R.A., 1995, Potential For Chemical Transport Beneath a Storm-Runoff Recharge (Retention) Basin for an Industrial Catchment in Fresno, CA, USGS Water-Resource Investigations Report 93-4140.

Wisconsin Department of Natural Resources, 2004, Conservation Practice Standard 1003, Infiltration Basin, http://www.dnr.state.wi.us/org/water/wm/nps/stormwater/technote.htm

Winiarski, T. Bedell, J.P., Delolme, C., and Perrodin, Y., 2006, The impact of stormwater on a soil profile in an infiltration basin, Hydrogeology Journal (2006) 14: 1244–1251

Arcadis U.S., Inc.

500 Edgewater Drive

Suite 511

Wakefield, Massachusetts  01880

Tel 781 224 4488

Fax

www.arcadis.com