Girty's Run Flood Control Alternatives Analysis

Team: RRDA Consulting
4/15/19

RRDA
RAIN, RAIN, DRAIN AWAY

Our Team

- Benjamin Grunauer ➔ Water Resources
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- Angela Urban ➔ Transportation
- Liam Gillen-Hughes ➔ Geotechnical
- Nick Panchik ➔ Construction Management
- Dylan Margolis ➔ Construction Management

Agenda

- Problem Statement
- Approach & Project Scope
- Watershed Study & Overview
- Alternatives Analysis
- Recommendations
- Summary
- Q&A

What’s the Problem?


High Water Level
IVAN
September 18th, 2004


Reserve Township
Millvale
Pittsburgh PPG Aqu
19
I-279 HOV
LAWRENCEVILLE
Mattress Factory Museum
STRIP DISTRICT
279
NORTH OAKLAND
ttsburgh
Pittsburgh
376
376
Schenley


North Ave
Seavey Rd
Evergreen Rd
North Ave
Friday
Mr. Smalls Thea
Millvale
illvale
Community Lib
Allegheny
RDEN
28
40th St Bridge
Mt Troy Rd

Event/Date	Description
1930s-40s	Major Flooding
1936	21’ above flood stage
1937	~10’ above flood stage
1972	7 day rainfall; Allegheny River back-up
1973-74	Army Corps “flood control project”
2004	100-year hurricane
2007	25-year storm 2-hour rainfall Army Corps dredging of Girty’s Run
2018	12 day rainfall > 0.01”

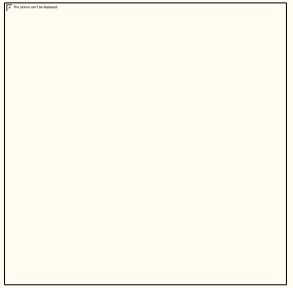
Girty's Run Watershed Ordinances

- Millvale's Annual Budget
  - $2,000 towards stormwater management
  - $50,000 towards engineering
- Millvale 2015 Floodplain Ordinance
  - Restricts new construction in the floodplain
- Upstream Stormwater Ordinances
  - Ross & Shaler Townships
  - New developments must collect 110% of rainwater

Approach & Project Scope

Client: Girty's Run Watershed Association & Millvale Community

- Watershed Study
  - Hydrology, Water Resources, & Hydraulics
- Alternatives Analysis
  - Via discussions, research, meetings, & field visits
  - Preliminary Engineering and Design
- Summary Report & Recommendations



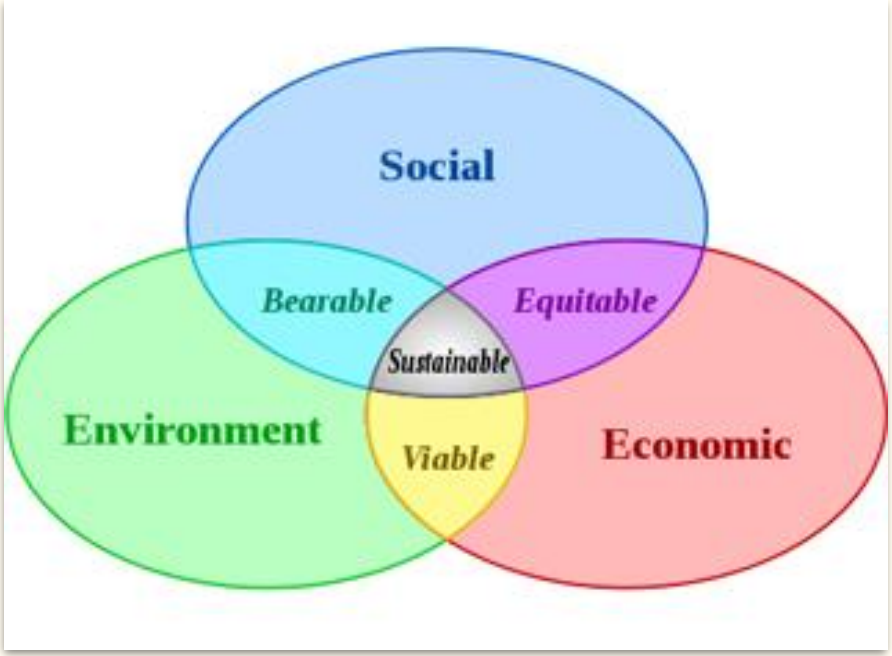
Alternatives Analysis Criteria

Evaluated alternatives based on:

- Project Cost
- Public Approval
- Constructability
- Maintenance & Risk
- Flood Mitigation
- Sustainability

Incorporating Sustainability

- Three pillars of Sustainability
  - Environmental
  - Social
  - Economic



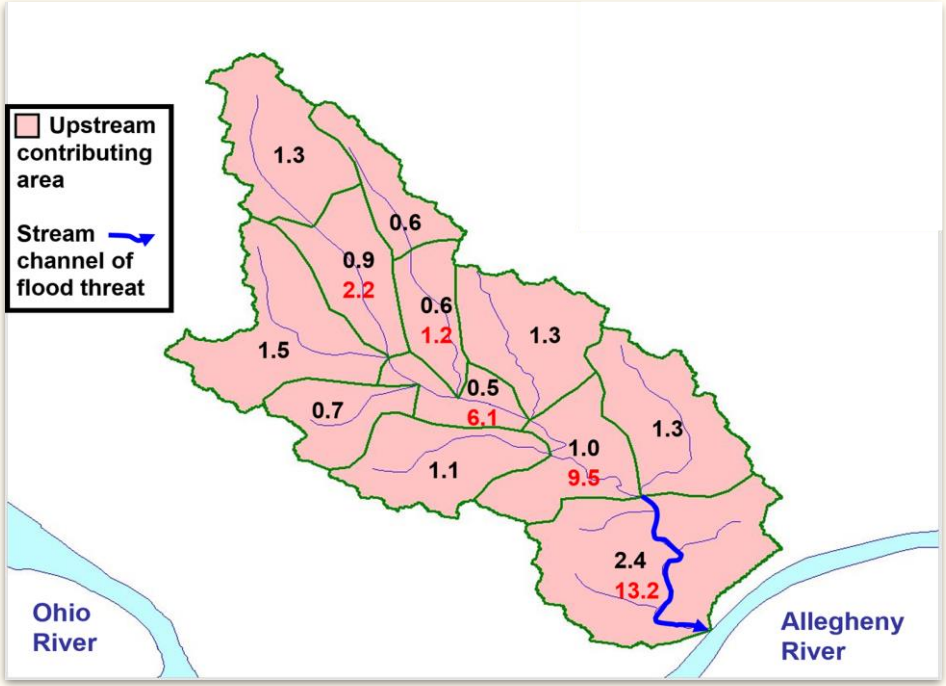
Watershed Study & Overview

Girty's Run & Tributaries

Girty's Run Watershed

Total Watershed Drainage Area (mi^2)	13.2
Mean Annual Precipitation (in)	38
Mean Annual Temperature (^oF)	51

Land Cover	
Open Water	0.03%
Low Intensity Residential	27.09%
Commercial	13.26%
Decidious Forest	21.36%
Evergreen Forest	0.07%
Mixed Forest	0.08%
Urban Development	38.11%



Focus: Millvale is in flood threatened area

~75% of watershed is built-up and impervious

Topography of Millvale Area

- Highest point: 910 ft msl
- Downtown Millvale: 700 ft msl

- Deep Valley
- Steep Walls
- Vulnerable Position

- Upstream conditions are similar

*Contour Density Map created with ArcGIS

Watershed Soil Conditions

- Numerous types of soil
- 75% of applicable area was rated:
  - Poor drainage conditions
  - Susceptible to erosion
  - Weak loading capability
- Complications for earthmoving activities
  - Projects would need a foreign source

Field Investigations

- **Surveyed channel surroundings**
- **Evaluated channel conditions**
- **Gathered public opinion from businesses and residents**

Multiple investigations during late January & early February

Right: Example of channel emerging from under buildings

Top: Beginning of Girty's Run ~6mi upstream

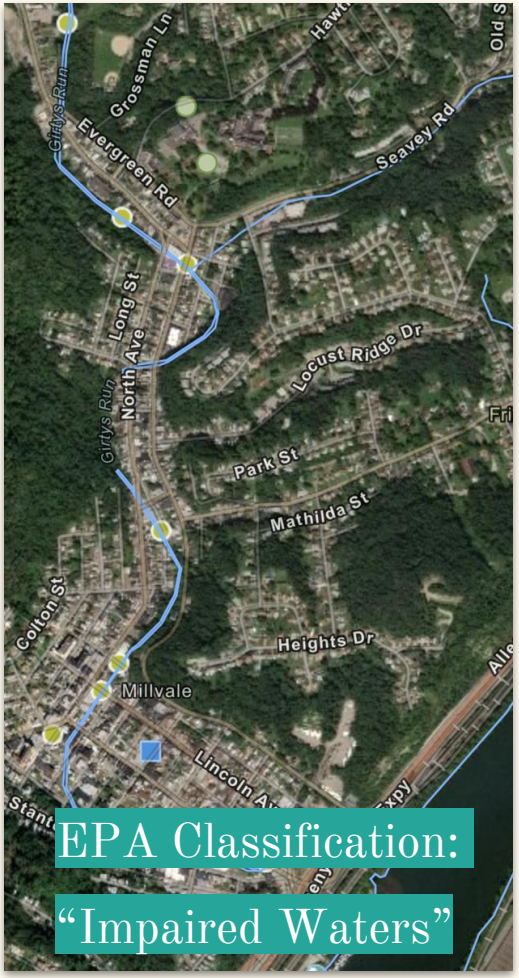
Right: Girty's Run outlet into Allegheny River

Left: Channel section through Millvale

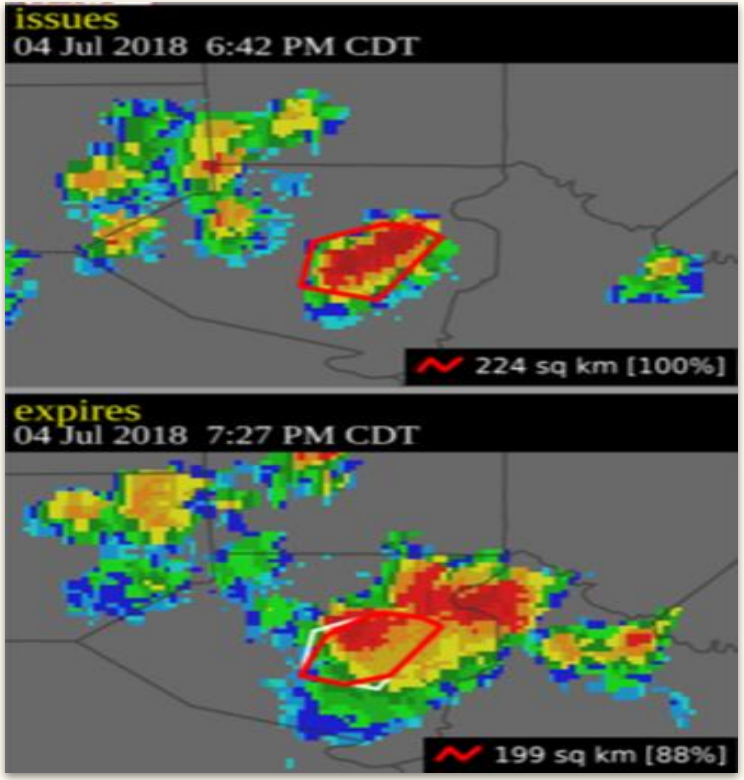
Right: Failed wall in channel

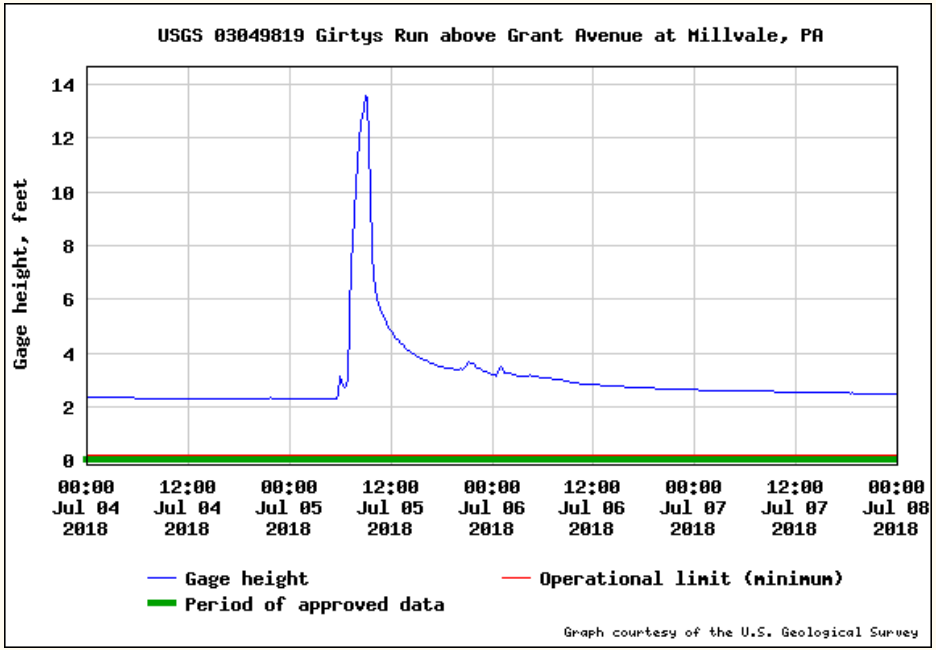
Girty's Run & Millvale

- Sewer/Storm Outfalls (Green Circles)
  - 5 surveyed in central Millvale
  - 563 total in Girty's Run Watershed
- Green Stormwater Infrastructure
  - 39 Rain Barrels
  - 2 Water Cisterns (Blue Boxes)
  - 2 Major Rain Gardens
  - 2 Major Bioswales



Recent Media Attention: *July 4th-5th, 2018 Storm*

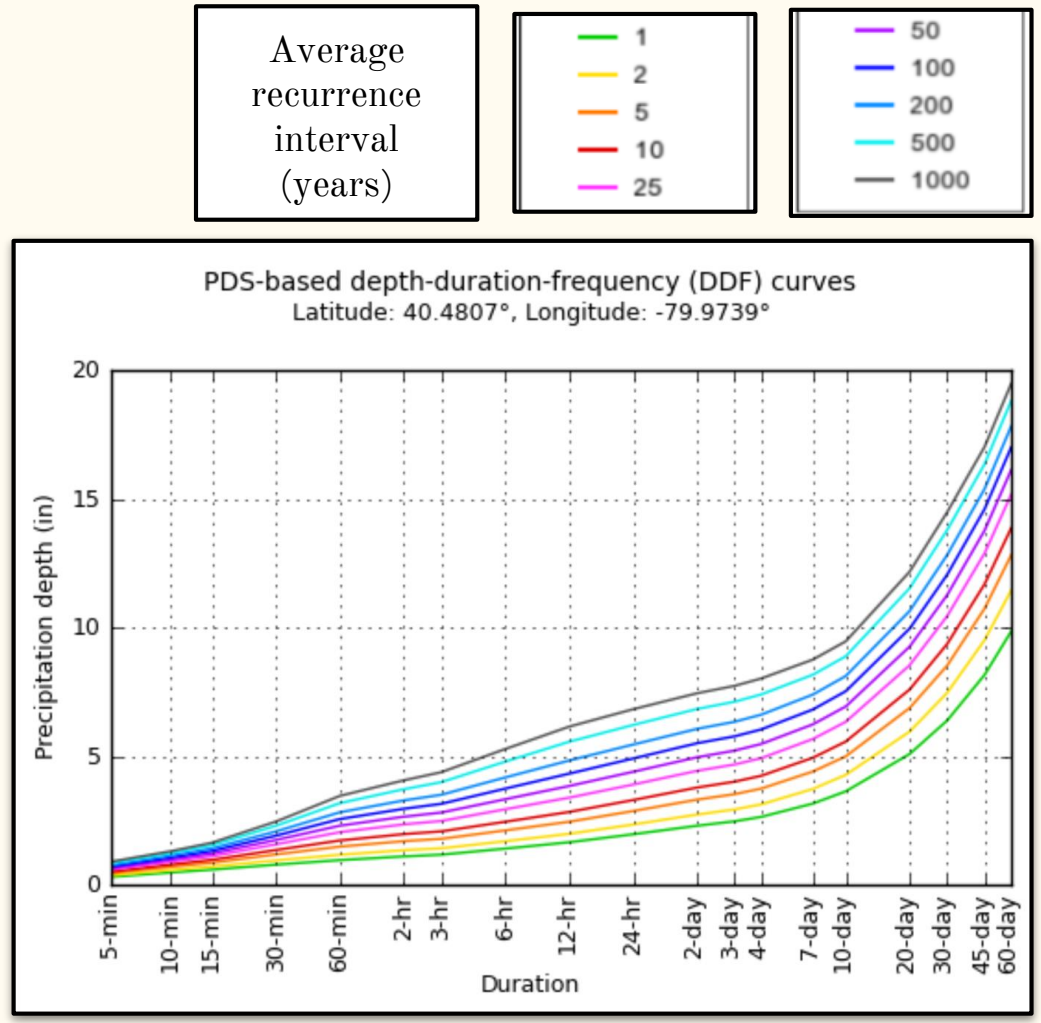




- Storm cells can be isolated and amorphous
- Flash flooding occurred in Millvale

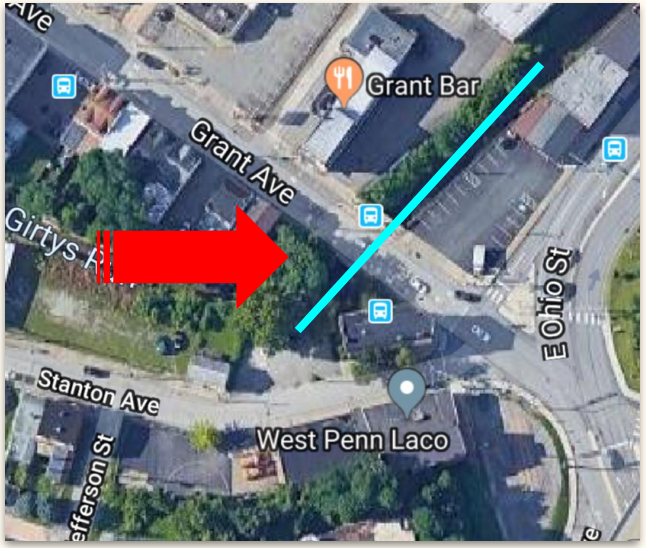
Storm Data

- Limited precipitation data
  - No reliable rain gages within the watershed
  - RADAR only
- Area is particularly sensitive
  - Storm curve density
- Increased intensity over time due to climate variability
  - 2018 - record rainfall



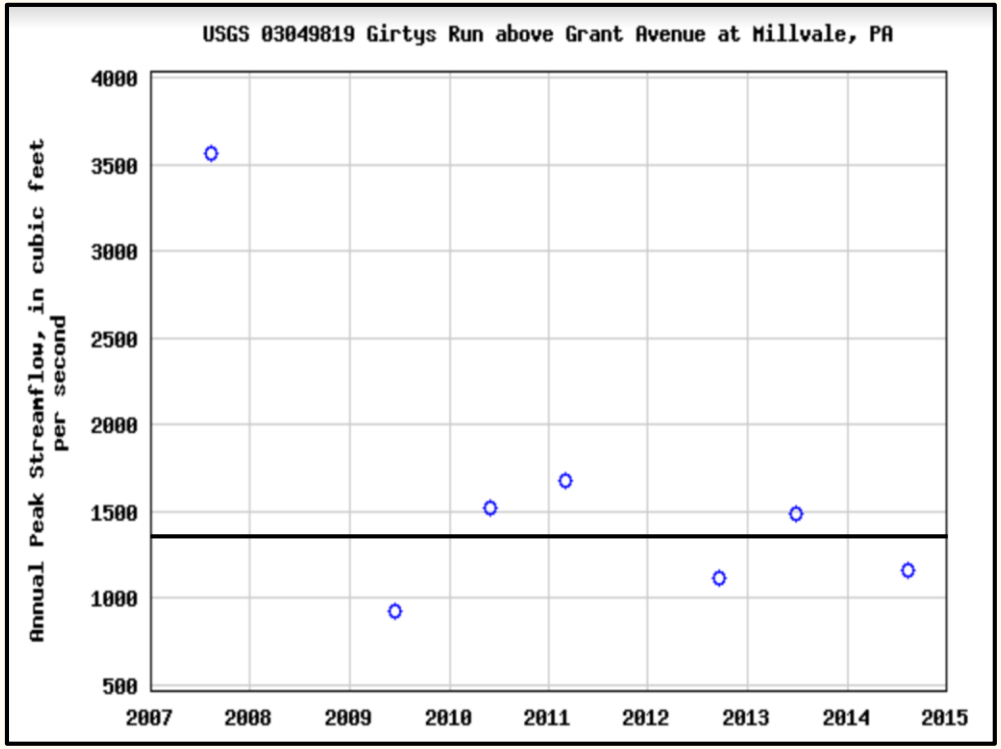
Girty's Run Stage & Flow

- Staff gauge begins at the bottom of the channel (1.5 ft below streambed)
  - Gauge height is indicative to "levels of action"
    - Different from the exact water height
  - Grant Avenue Bridge
    - Right after Route 28 interchange



Girty's Run Gauge Height:	8 ft	11 ft	14 ft	18 ft
Flooding Stage:	Action Stage	Flood Stage	Moderate Flood Stage	Major Flood Stage
Flow Rate:	N/A	1400 cfs	2400 cfs	3500 cfs

Storms & Flooding



- Girty's Run overflows at 1400 cfs
  - (BLACK LINE - see figure)
- Overflows have occurred almost yearly within the past decade

<u>Storms of concern</u>

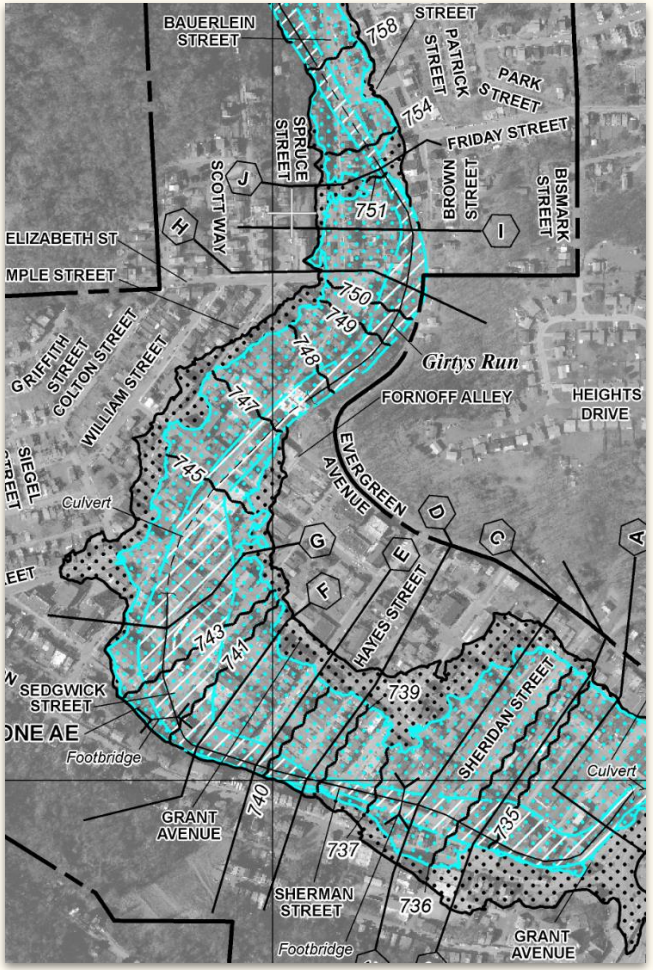
Short duration, high intensity

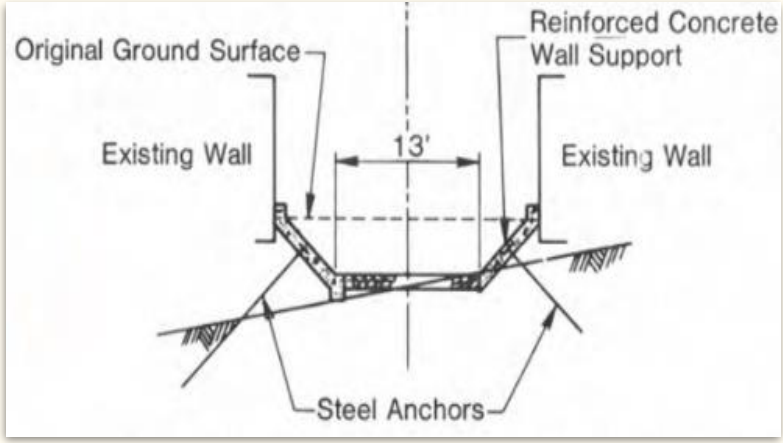
Ex: 2.5" over 1 hour

Typical Channel & Floodplain

- Composite Trapezoidal & Rectangular Channel
- 1.75 miles through Millvale
- Width: **25 ft** | Height: **11 ft**
  - Negligible refuse
  - In-Situ average of 1.5ft of sediment & rock
    - Reduces cross section - accounted for in hydraulic analysis
- Channel Roughness: **0.041** (Manning's Coefficient)
- Channel Slope: **41 ft per mile** (Elevation Change)

(Derived from Army Corps, USGS, & Field Survey)



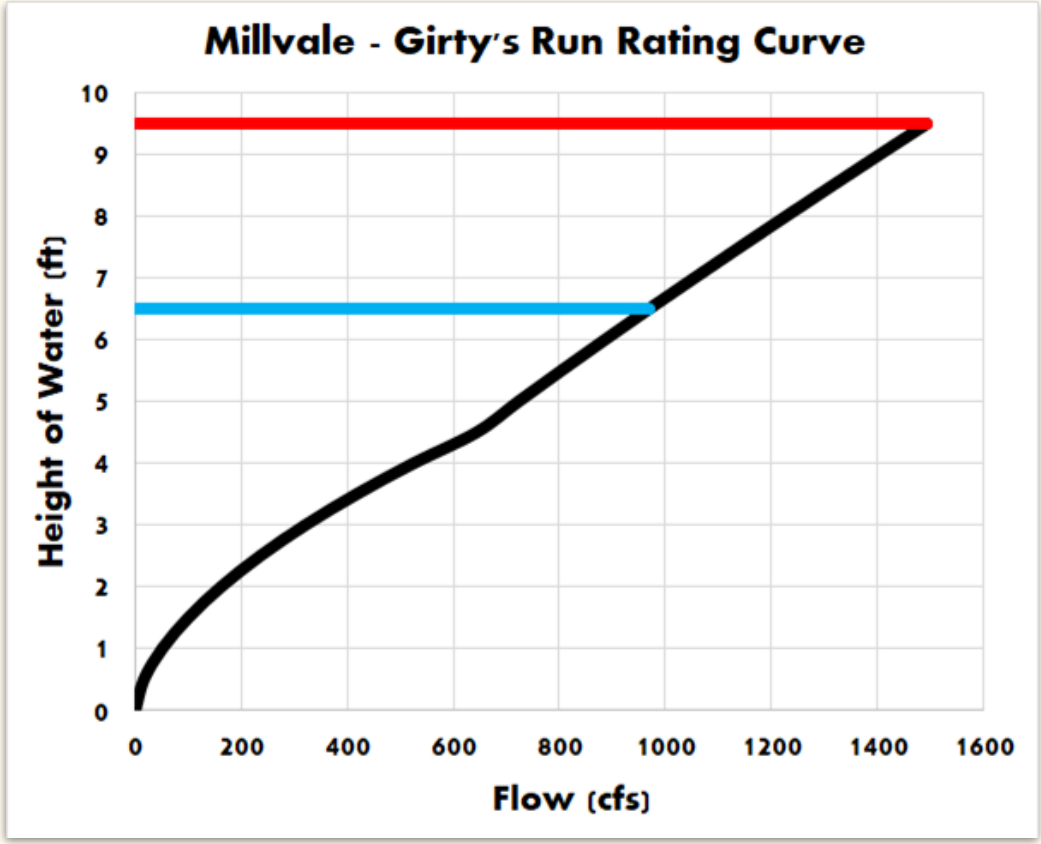


$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

Actual Water Depth:

Action Stage:

Flood Stage:



Current Conditions

Current Conditions

- Channel improvement completion (1980)
  - Deepened channel
  - Added gabions
- With no action
  - Channel Walls Failing
  - Channel continuously filling with sediment
- Decreased capacity of channel
  - Increased severity of floods
  - Increased frequency of floods

No Action

Damages, Cleanup, & Economic Analysis

Cost Analysis completed based on Army Corps' Report

- 100 year flood event
  - Hurricane Ivan (2004)
    - Estimated cost of $14.3 million
      - About 400 private homes affected
      - About 200 businesses affected
- 25 year flood event
  - Estimated Cost - $7.8 million
- Average Annual Damages in Millvale is $1.94 million

Alternatives Analysis

Alternatives

1. Upstream Detention Basin
2. Channel Widening
3. Diversion Channel
4. Full Channel Dredging
5. Reservoir/Dam Structure
6. Maintenance & Management Plan Upgrades
7. Green Street Initiatives

Alternatives

1. **Upstream Detention Basin**
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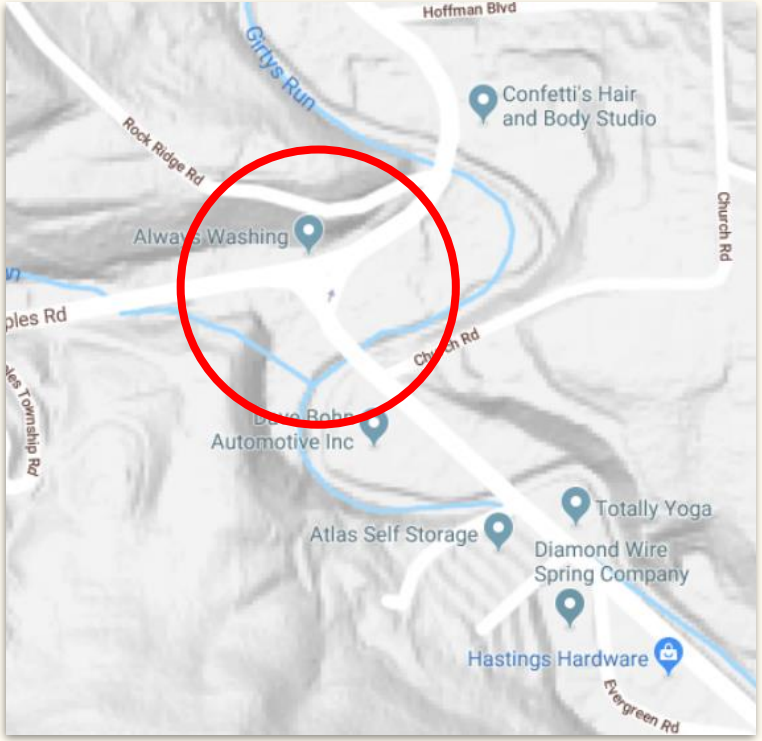
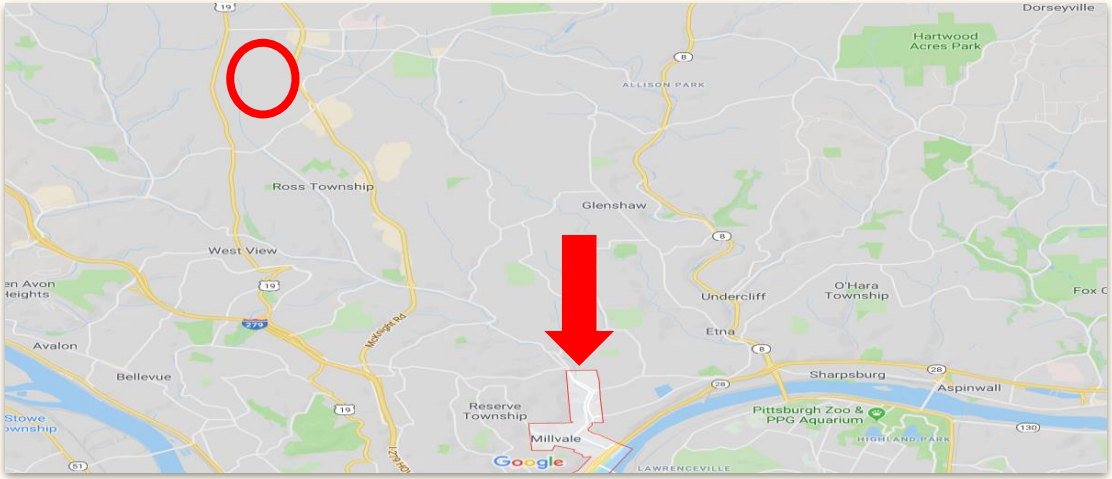
Upstream Detention Basin

- Ross & Shaler Townships, North Hills Area
- Detention Pond(s) near Babcock Blvd
  - Large singular or series of system(s)
  - Contains critical points near Girty's run
- Presence of large cliffs
  - Excess of 70 feet
  - Not feasible to place detention ponds



Upstream Detention Basin

- Ross Township has a new land development plan
  - 6 miles upstream of Millvale
    - Roughly 7.2 acres of development



Upstream Detention Basin

- Designing in accordance with the Pennsylvania Stormwater BMP Manual
  - Using the rational formula
  - 2 year storm event

$Q_{Post} = (1.18 \text{ in/hr})*(0.9)*(7.2 \text{ acres}) - Q_{Pre}$

$Q_{Post} = 6 \text{ cfs}$

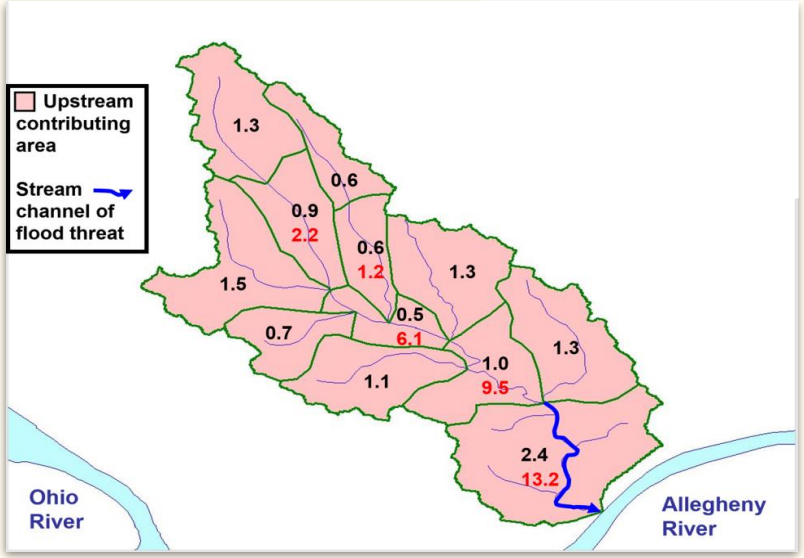
- Impactful peak discharge reduction requires much larger catchment area

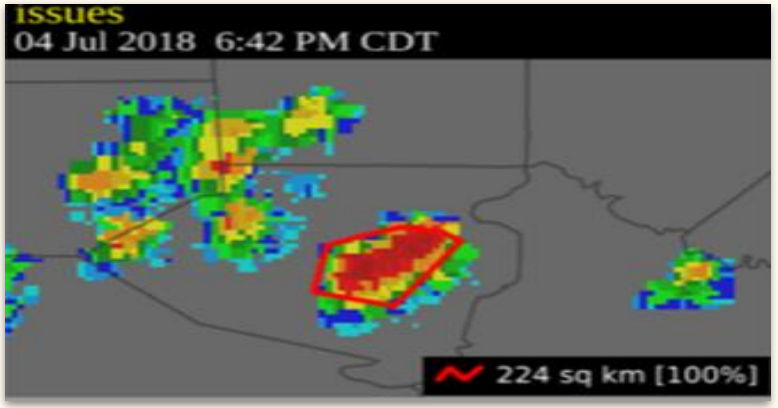
$$Q = C\,i\,A$$

Q = Peak runoff rate (cubic feet/sec)
i = Rainfall intensity (inches/hour)
A = Area in acres
C = Runoff coefficient (dependent on surface type)

Upstream Detention Basin

- Using entire stream segment of 1.3 mi^2
- Q_{Post} = (1.18 in/hr)*(0.6)*(832 acres)
  - 590 cfs
  - 25% reduction
- Issue to acquire land
- USDA rated soil conditions poorly for development
- Millvale is prone to isolated high intensity storms
  - Missing catchment area
- Total Cost Estimate: $1.6 Million





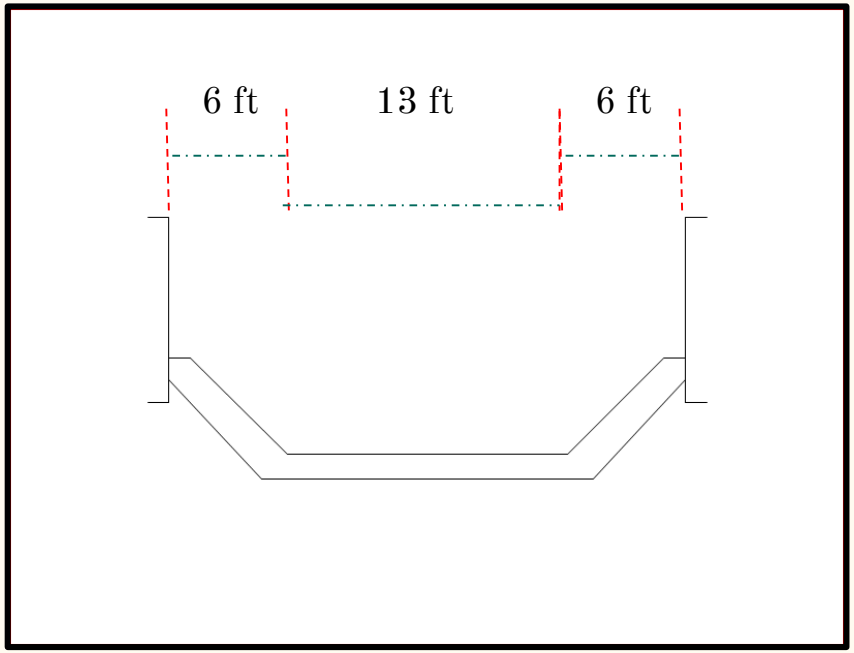
Alternatives

1. Upstream Detention Basin
2. **Channel Widening**
3. Diversion Channel
4. Full Channel Dredging
5. Reservoir/Dam Structure
6. Maintenance & Management Plan Upgrades
7. Green Street Initiatives

Channel Widening

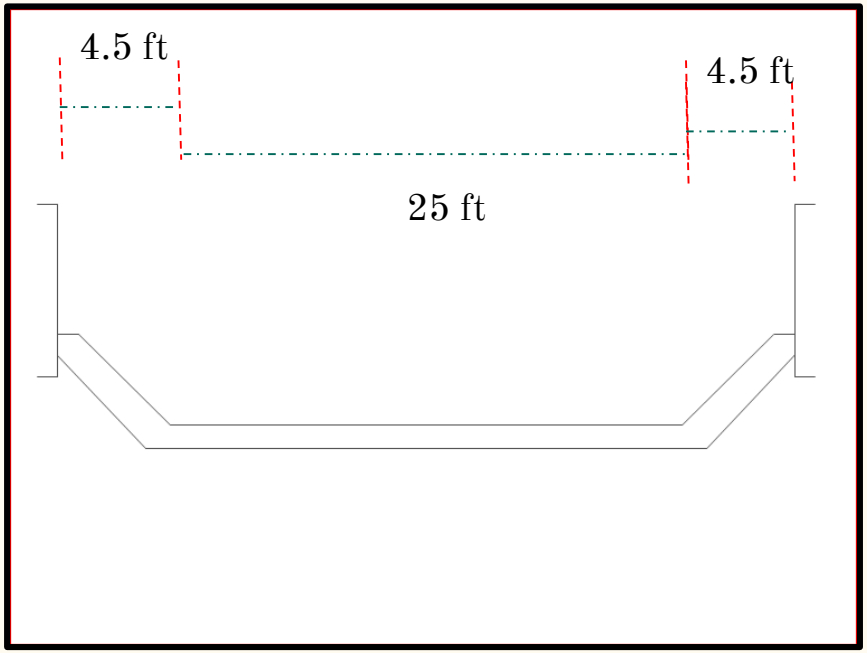
- Used Manning's Equation to design new channel width
  - Capacity of 2,400 cfs (moderate flood stage)
  - Same Water Depth of 9.5 ft
- Calculated a new width of 34 ft
  - Average 9 ft increase in width throughout Millvale
- Channel shape remains same
  - Trapezoidal and rectangular

Improved Channel Design (1980)



Total Width = 25 ft

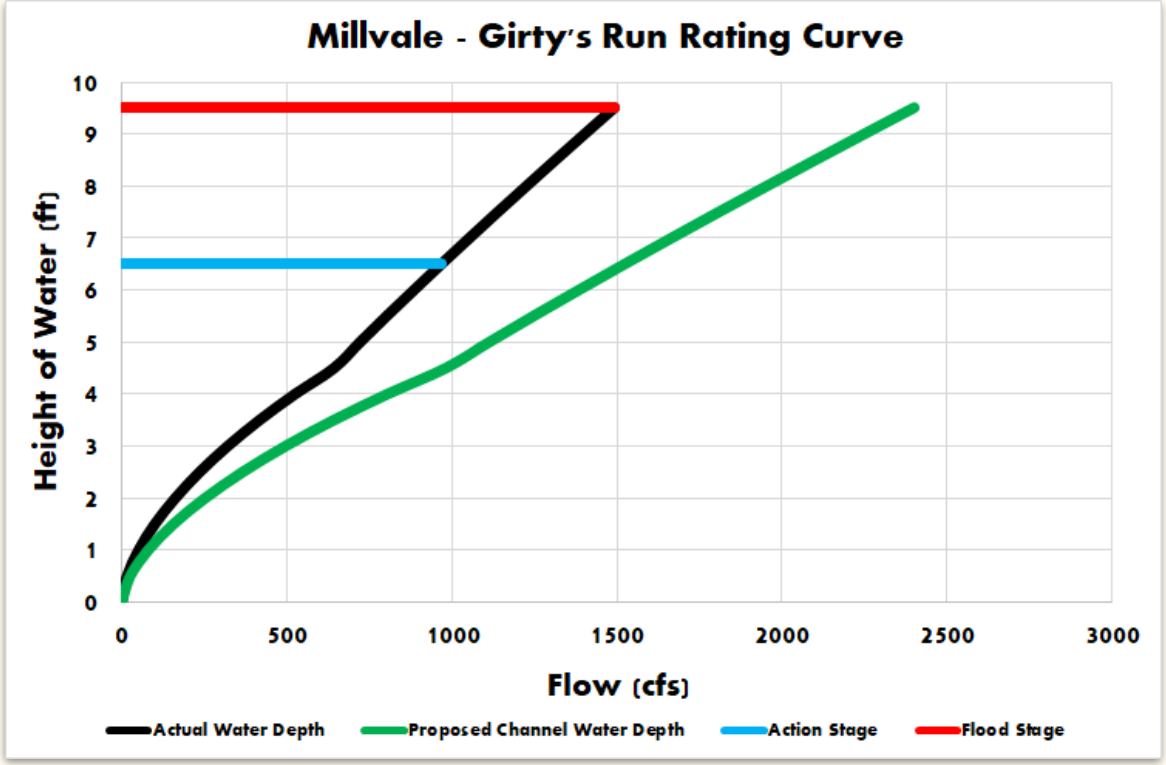
Proposed Design



Total Width = 34 ft

Hydraulics of Widened Channel

- Flood Stage (9.5ft)
  - Before: 1400 cfs
  - After: 2400 cfs
    - 71% Increase
- Action Stage (6.5 ft)
  - Before: 1000 cfs
  - After: 1500 cfs
    - 50% increase



Channel Widening Cost Analysis

- Required Property Acquisition
  - Total: **$8 Million** to purchase necessary properties
- Culvert Widening
  - 12 culverts would need to be widened along the channel
  - Similar PennDOT projects cost about $850,000 per culvert
  - Total: **$10.2 Million**
- Approximately 1,200 ft underground
  - Road reconstruction cost estimated at **$125,000**
  - Cost of earth work **$3 Million**
- **Total Cost: $21 Million**
  - Using the Average Annual damages of $1.94 million

Channel Widening

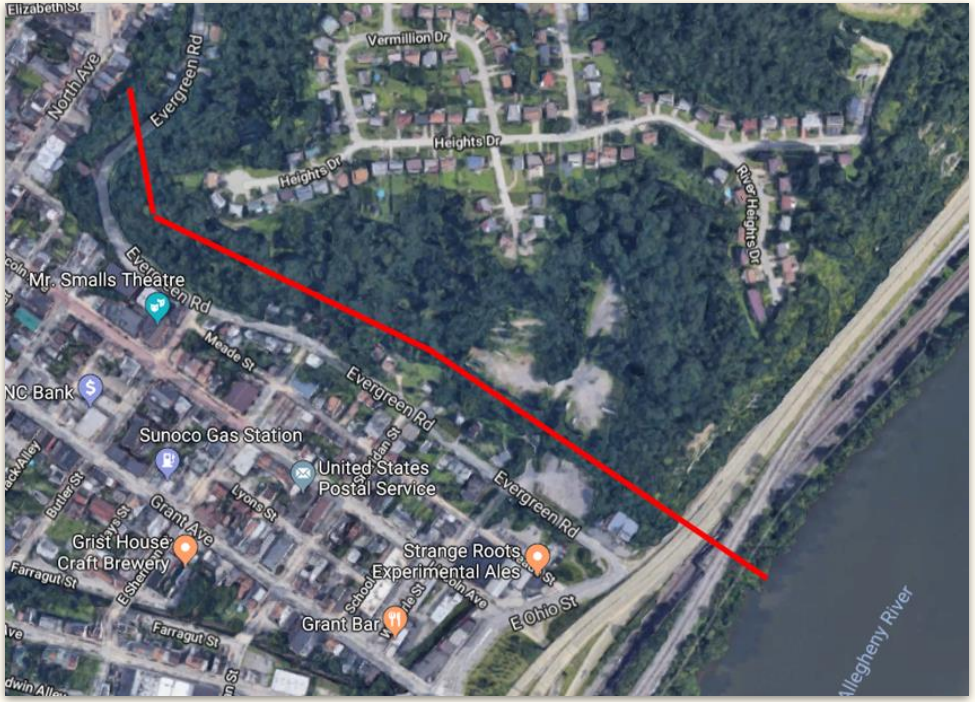
- Future Work
  - Utility Relocation
  - Negatively Impact Millvale during construction
    - Construction would be lengthy
    - Many roadways would be closed during construction
  - Public opinion
    - Eminent Domain

Alternatives

1. Upstream Detention Basin
2. Channel Widening
3. **Diversion Channel**
4. Full Channel Dredging
5. Reservoir/Dam Structure
6. Maintenance & Management Plan Upgrades
7. Green Street Initiatives

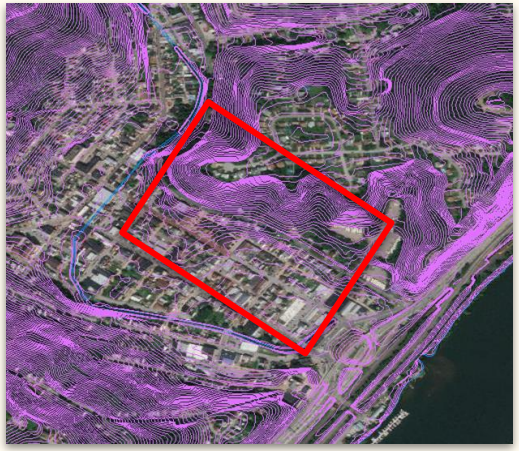
Diversion Channel

- Location(NE Border along Evergreen Rd): Pictured
  - Channel is located in open wooded area
  - Property purchases are minimal
- Channel Design
  - Additional Capacity: 1,000 cfs
  - 9 ft wide
  - 9.5 ft deep
  - 2,400 ft long
  - Concrete walls



Diversion Channel

- Topography Concern
  - Construction of the channel would require extreme earthwork
  - Slope stability concerns - erosive soil
  - Elevation along hillside ranges from 800 to 910 ft
  - Ideal elevation for diversion channel is 745 ft



Box Culvert Diversion Channel

- Specifications
  - Under Evergreen Rd at the same elevation of the existing channel
  - 9 ft wide by 9.5 ft deep
  - 3,200 ft in length
- Constructability concerns
  - Excavation of a minimum of 55 ft of soil
  - Highway Closure

Box Culvert Diversion Channel Cost

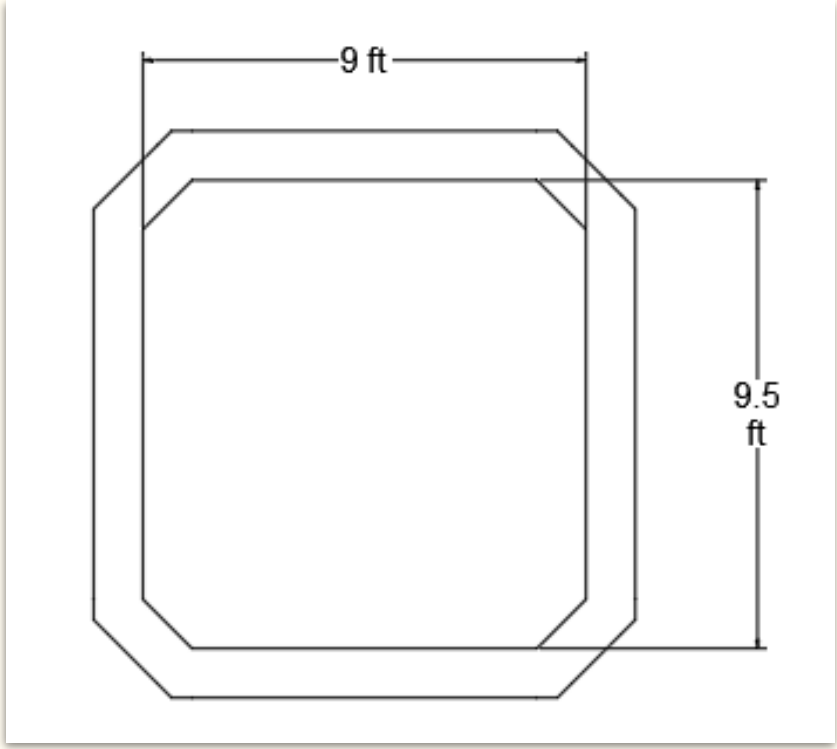
Road Demolition - $320,000

Excavation and Backfill- $53 million

Box Culvert - $5.4 million

Road Construction - $2.5 million

TOTAL COST - $61.2 million



Alternatives

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Full Channel Dredging

- Methods
  - Cutterhead pipeline dredges
  - Mechanical dredges
- Resulting in increased channel capacity
  - Average of 2.5 feet of sediment build up
  - Stage height increase of 1.5 feet
  - Additional 350 cfs of capacity during flood stage

Breakdown of Dredging Costs

Extent of Dredging	Volume of Silt (ft^3)	Dredging	Dewatering/Disposal	Cost
Entire Channel	45,000	$1,900,000	$100,000	$2,000,000
Upstream Half	18,650	$650,000	$40,000	$690,000
Downstream Half	26,250	$900,000	$50,000	$950,000

*Based on a complete dredging of the channel performed in 2007

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Reservoir/Dam Structure

- Designed by Army Corps of Engineers in 1970
  - Location: Intersection of Evergreen Rd and Babcock Blvd
  - Height: 115 ft Length: 1000 ft
  - Earthen Dam
  - Create a lake of 100 acres
    - Providing 3140 ac-ft of Storage
    - Provide flood mitigation
- Issues
    - Residences and commercial structures
    - Highway relocation

Alternatives

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6. **Maintenance & Management Plan Upgrades**
7. Green Street Initiatives

Maintenance & Management Plan Upgrades

Comprehensive Watershed Survey

- Numerous field surveys with equipment
- Additional rain gauge implementation

Emergency Management

- Upgraded warning system
- Flood detour route

Annual Maintenance Plan

- Localized Dredging
- Routine channel structure inspections and repairs

Upgraded Flood Warning System Plan

- Siren System already in place
  - One Siren - use precautions
  - Two Sirens - floods occuring
- Connect system to staff gauge and send warnings to locations (0.5 ft prior)
  - Continuous staff gauge sensor

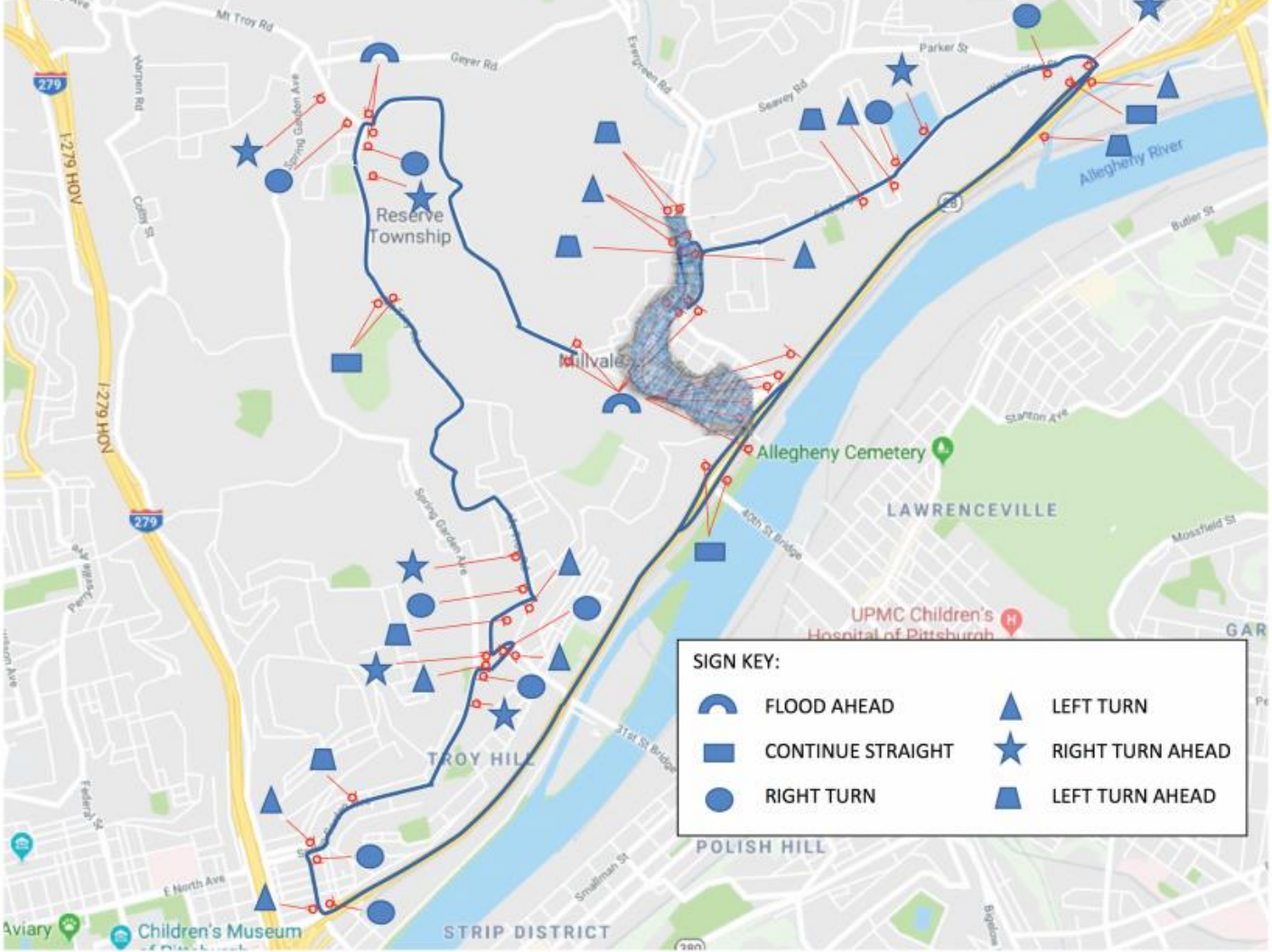
Gauge Height (ft)	11	15.8	16	18	18.6	21
Water Location	Gazebo Garden	Lincoln Ave	Grant St bridge deck	top of staff gauge	upper parking lot	line on Grant St (Hurricane Ivan)

Flood Detour

- Allow safe travels around Millvale
- Sign Type
  - Variable
  - Temporary
    - Signs placed during emergency management plan

Trip Duration

- 22 min - 35 min
  - Depending on time of day

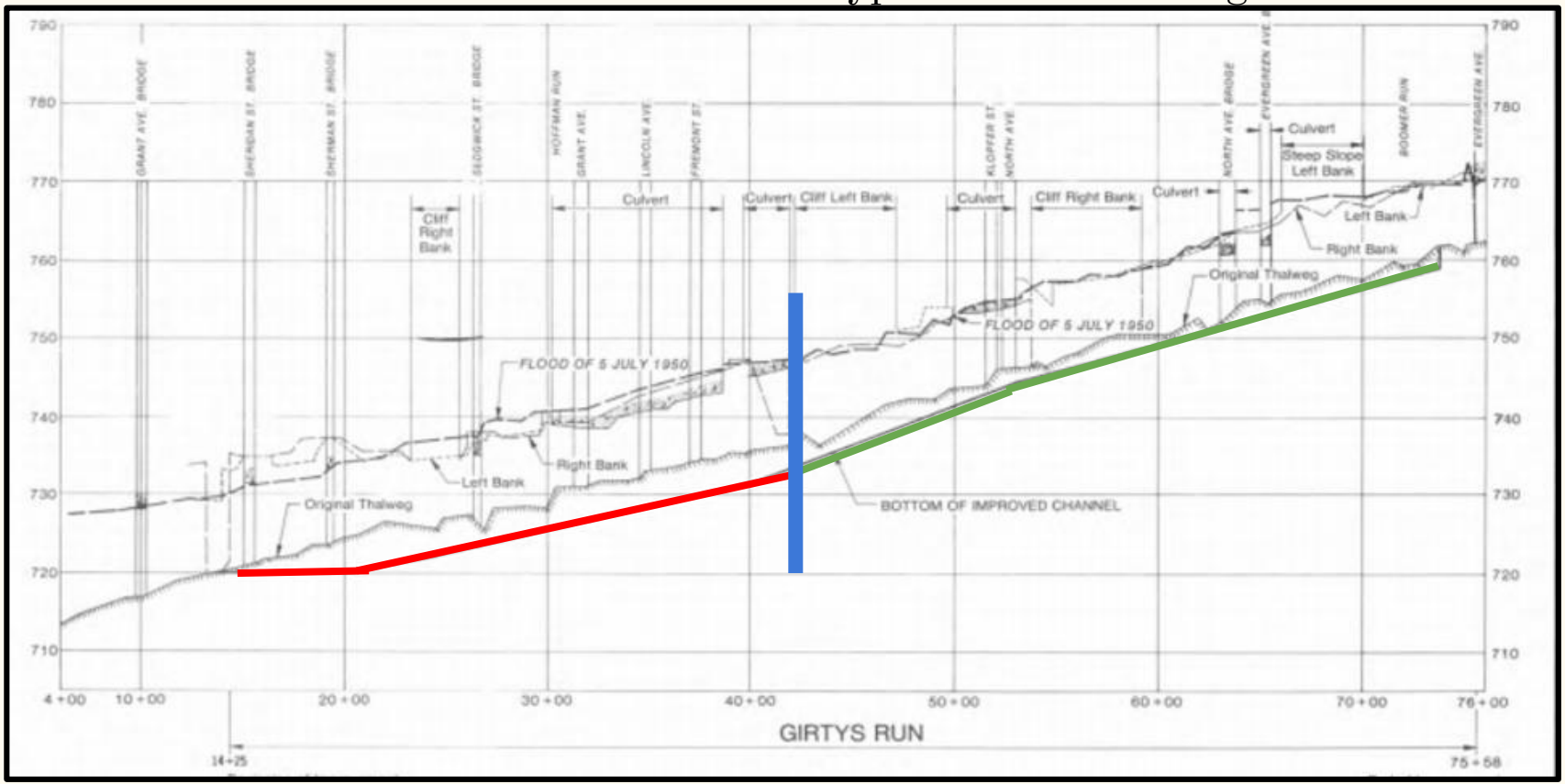


Repairs

- Field Identified areas of concern

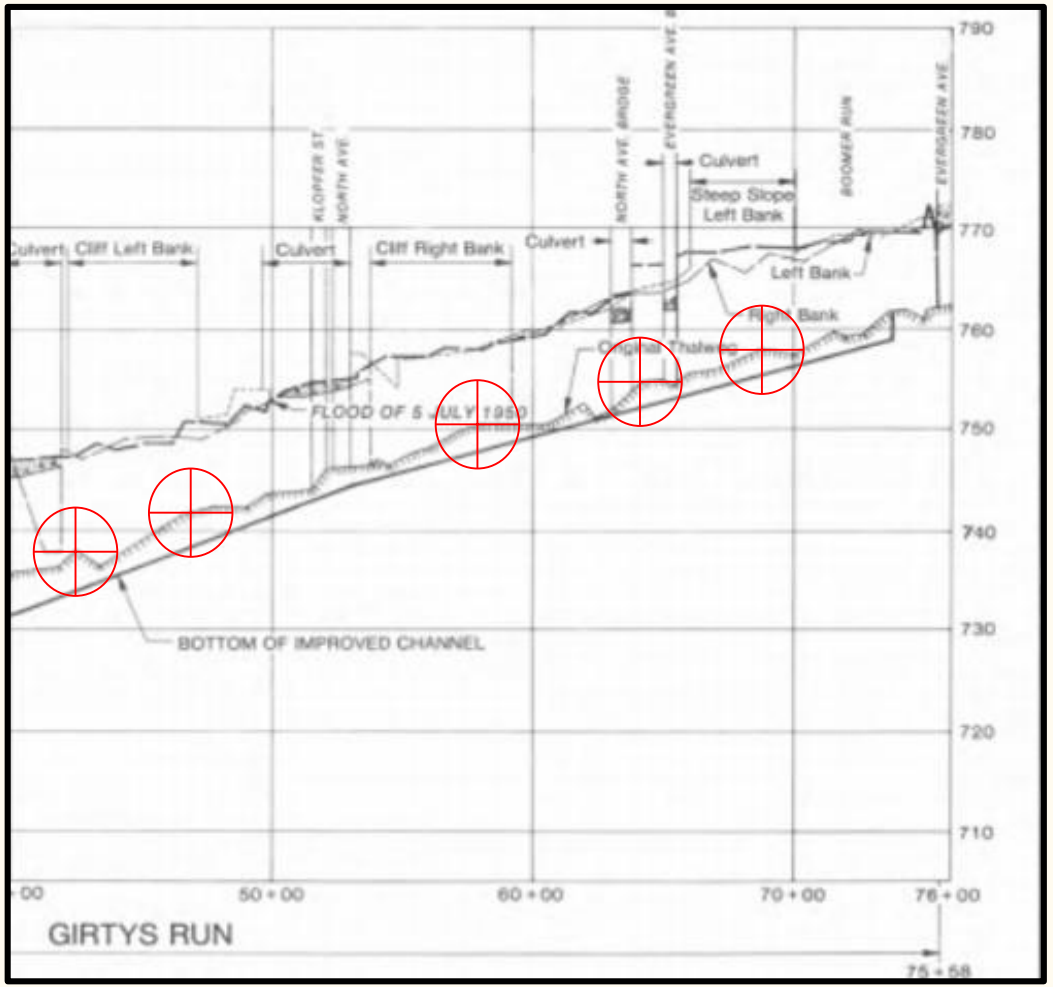
Localized Dredging

- Target heavy sediment areas to reduce buildup
  - Bypasses maneuvering costs



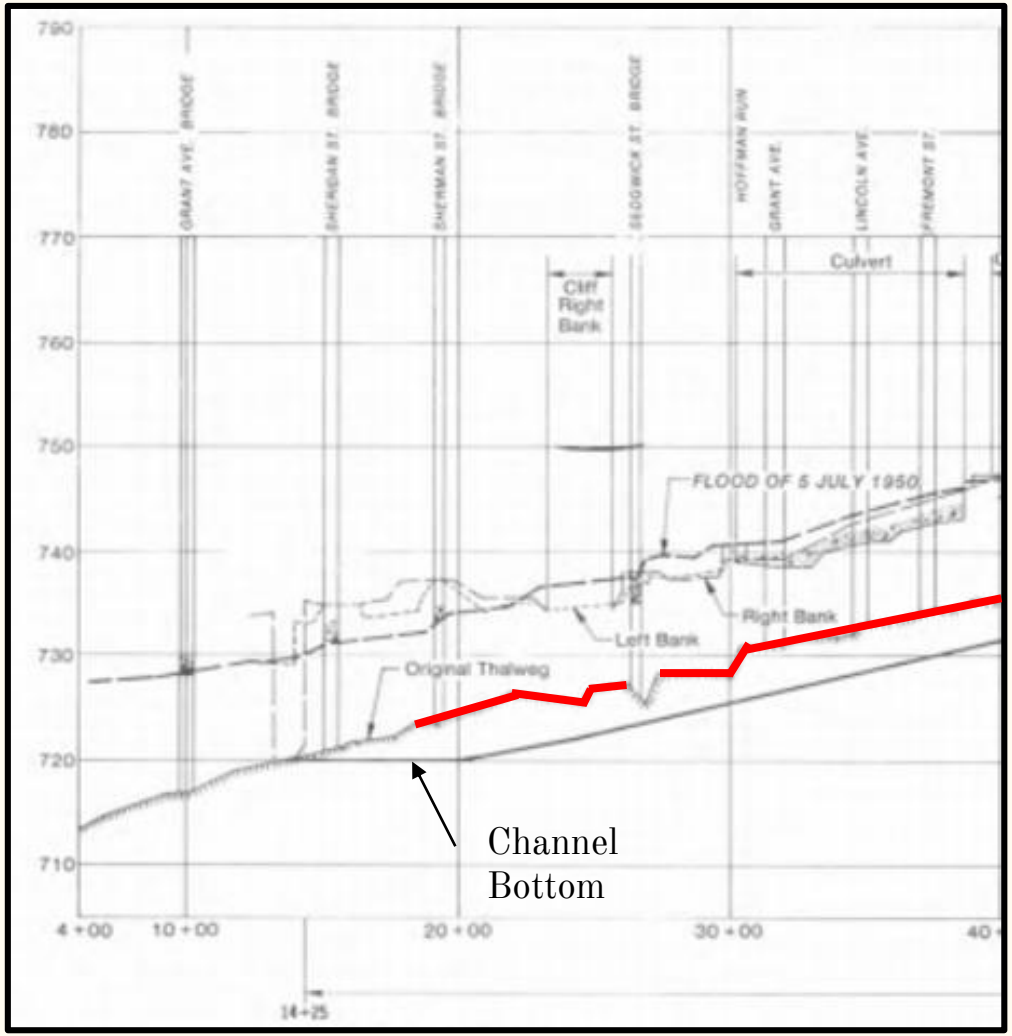
Upstream

- From Evergreen Ave to 50 ft before Freemont St
- 18,750 ft^3 of silt accumulated
- Average silt build-up of 1 ft
- Several areas warrant concern



Downstream

- 20 ft before Freemont St to Sheridan St
- 26,250 ft^3 of silt accumulated
- Average silt build-up of 2 ft
- Primary target for dredging



Maintenance & Management Plan Budget

- One time
  - Signs - Total Cost of $3,900
  - Watershed survey - $1,000
  - Gauge sensor $4,000
- Recurring
  - Dredging
    - 2,500 cu ft per year
    - $140,000
  - Repairs
    - $2,000 to fix 100 sq ft area
  - Inspection
    - $1,000
- **Total Annual Budget: $143,000 per year**

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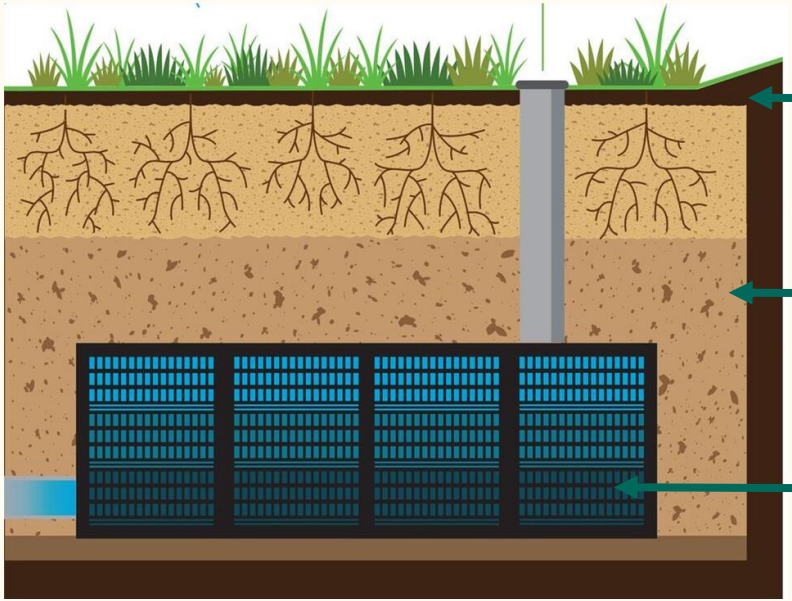
7. **Green Street Initiatives**

What Are Green Streets?

- Wide variety of green infrastructure:
    - Street Trees
    - Rain Gardens and Bioswales
    - Permeable Pavement
- Impervious Surface Reduction
- Improved Sidewalk Drainage

What is Green Infrastructure?



- Vegetation
- Soil
- Engineered Systems

→

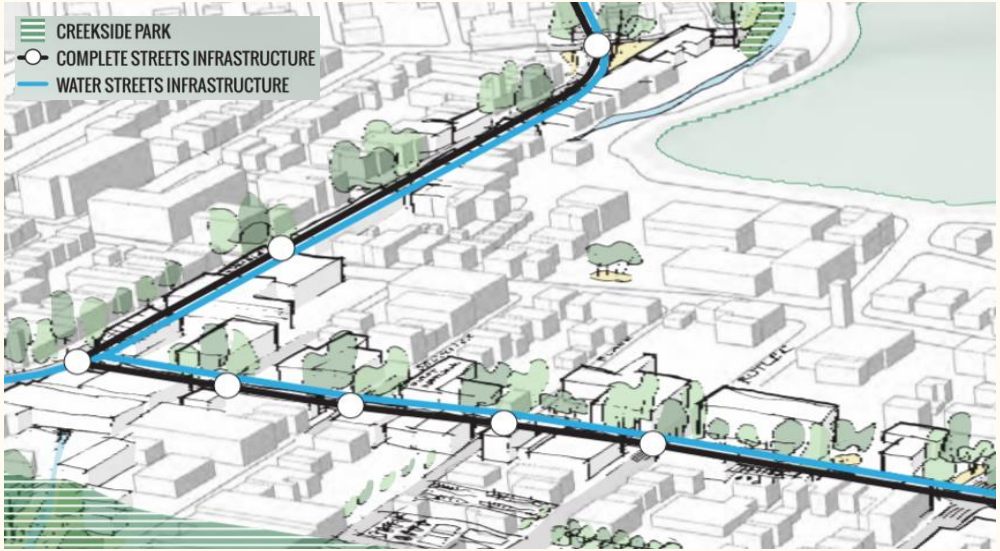
- Reduce peak stormwater flows
- Slow, filter, & cleanse runoff
- Increase Infiltration

Case Study: Etna Borough

- Etna Green StreetScape
  - 2 Street Phases
  - 1 Rain Garden
- Completed 2016-2017
- Manages ~1.25 acres of impervious surface area
- Manages 16.8 MG/yr of runoff

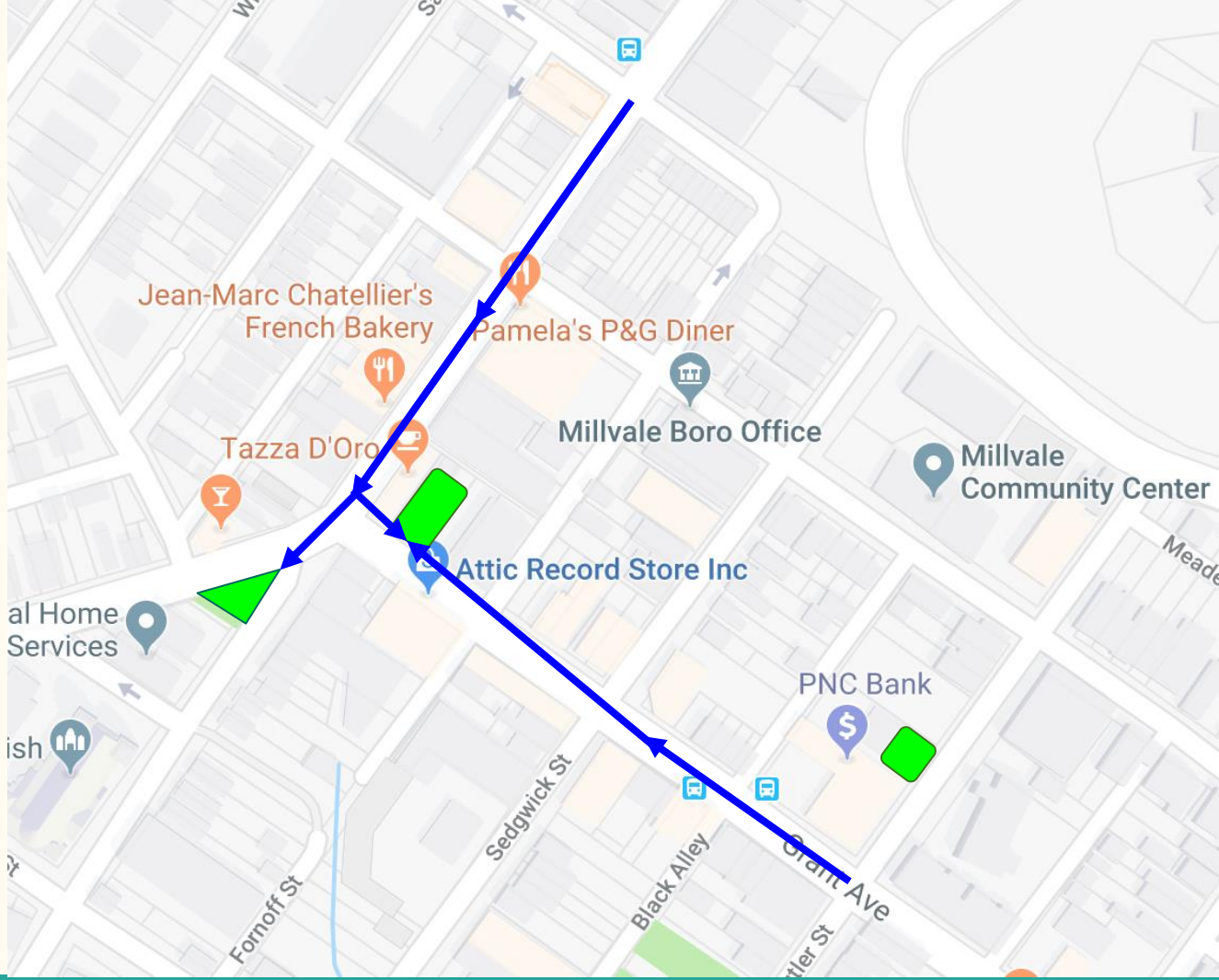
Millvale Green Streets Plan: 2015

- 2015 EcoDistrict Pivot Plan
- Incorporated Complete Streets, Green Stormwater Infrastructure, and Creekside Park



Green Streets

- North Ave. & Grant Ave.
- Main Business Corridor
- Existing Green Spaces

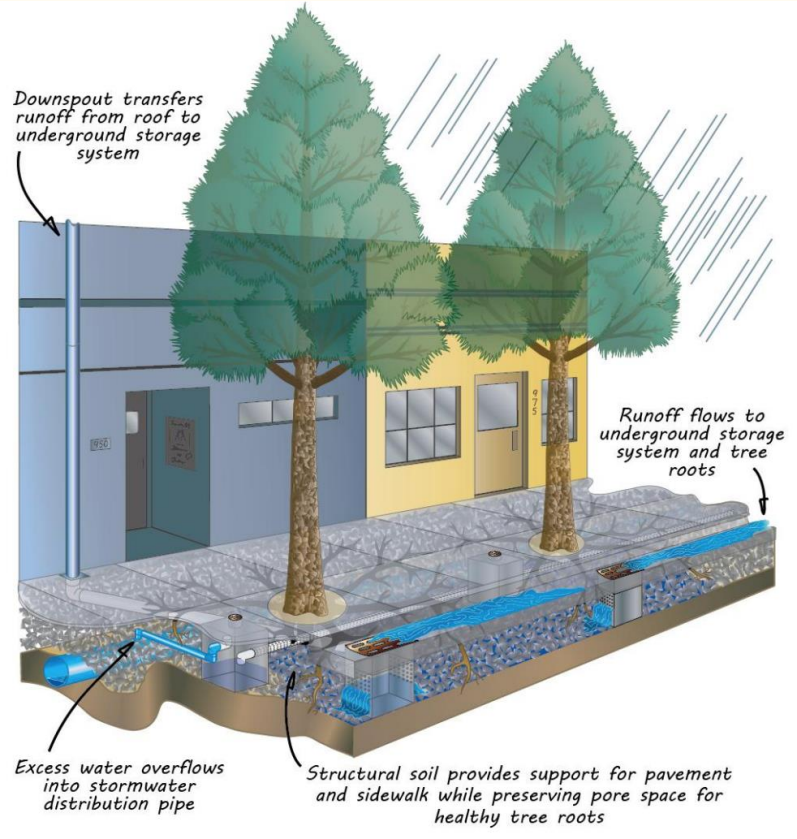


Current Street Conditions

- Grant Ave:
  - Street Width = 32 ft
  - Sidewalk Width = 9 ft
- North Ave:
  - Street Width = 32.5 ft
  - Sidewalk Width = 9 ft
- Single Pour Concrete Sidewalks
- ADA Compliant Crosswalks

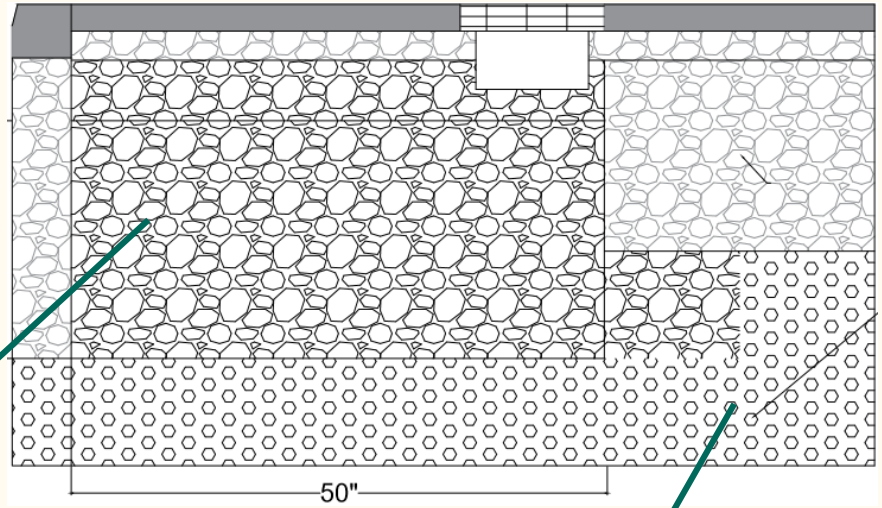
Green Streets Alternative

- Improved Sidewalk Drain Network
- Street Trees
- Downspout Disconnections
- Rain Gardens



Sidewalk Drainage Cross Section

- Cross-section runs whole length
  - Drainage slope: 0.004 ft/ft
  - 4 ft buffer to building facade
- Sidewalk slopes 2% to drain
- CU Structural Soil, R-Tanks, and Impermeable Geotextile Membrane

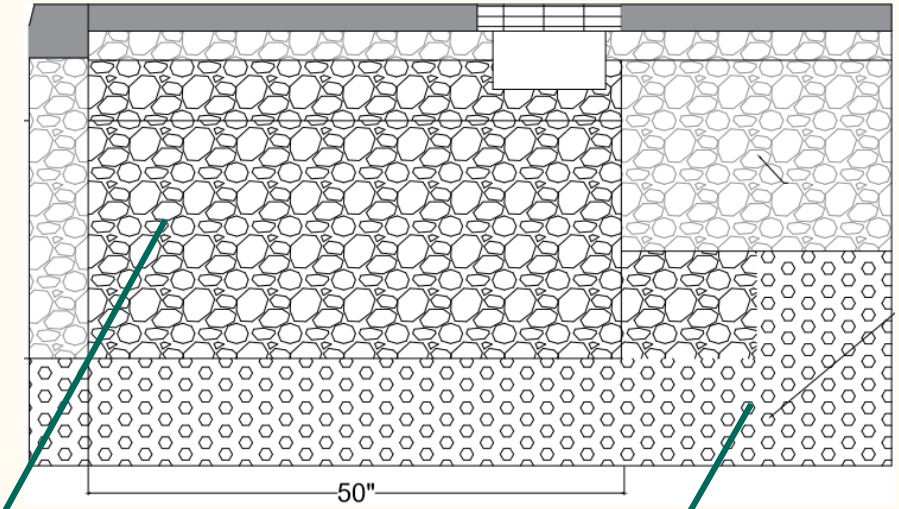


CU Structural Soil

Modular Plastic Stormwater Units (R-Tanks)

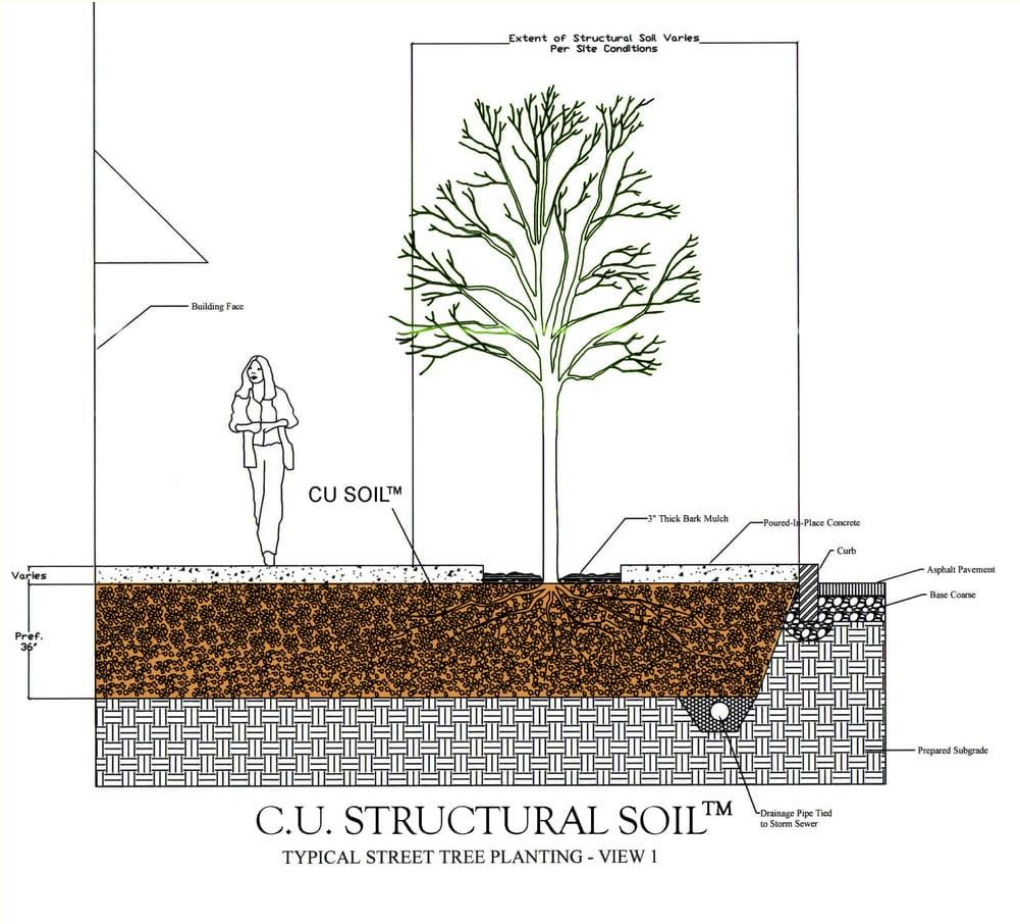
Sidewalk Drainage Cross Section

- Total 40” Depth
  - 6” Sidewalk Layer/Drain Opening
  - 18” CU Structural Soil
  - 10” Bottom Stormwater Units
  - Impermeable Geotextile Membrane surrounding



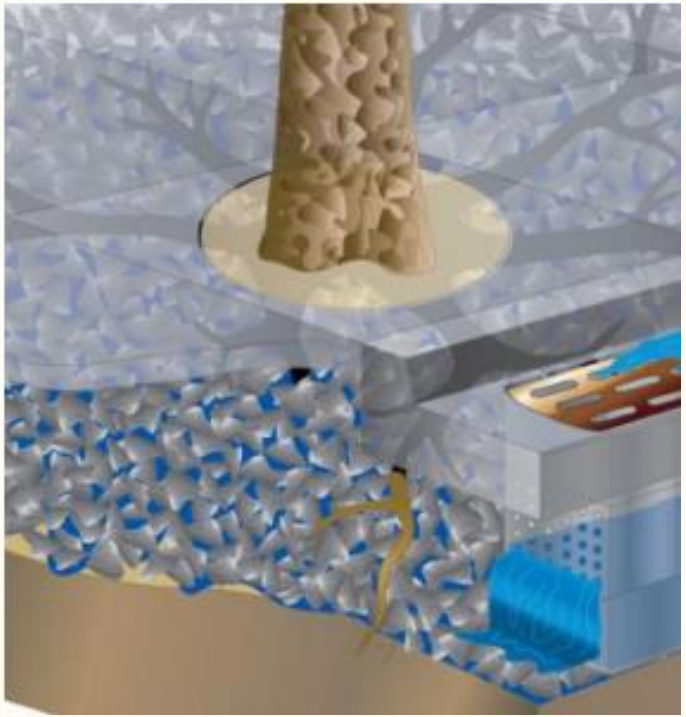
Street Trees

- Spacing Guidelines
  - 25 ft from intersection
  - 20 ft or more between trees
  - Standard Tree Well = 4 ft x6ft
- 40 ft between trees
- 40 Tree Wells Total



CU Structural Soil

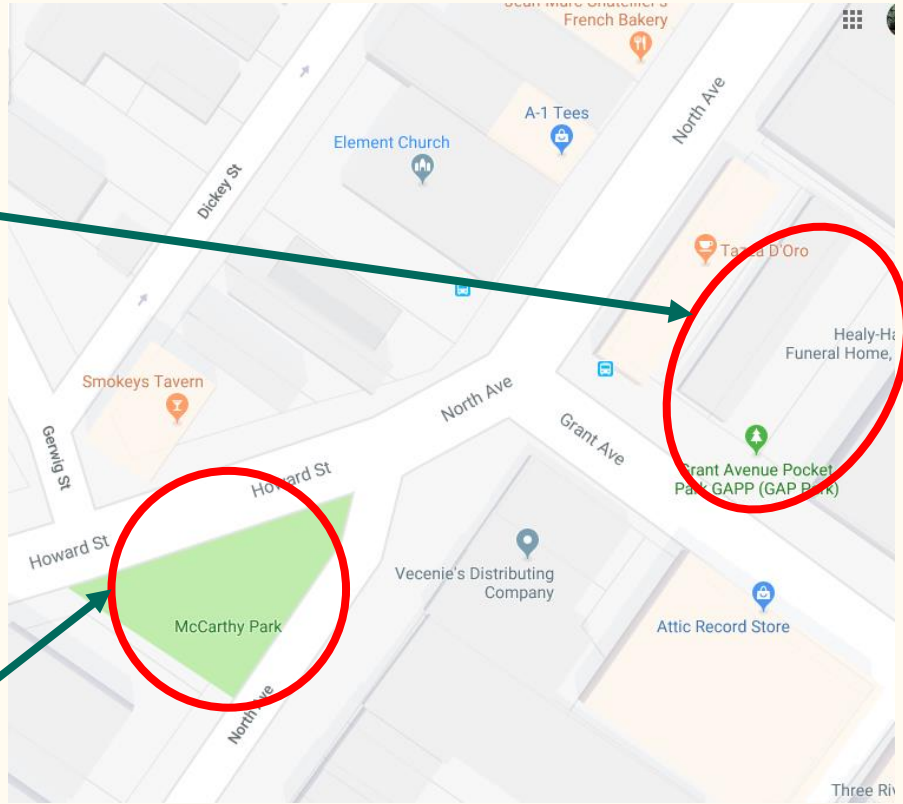
- Gravel Soil Mix to support tree growth and provide sub-base for pavements
- Highly porous to accommodate root growth and water infiltration
- Can be compacted to meet load-bearing requirements



Rain Garden Locations

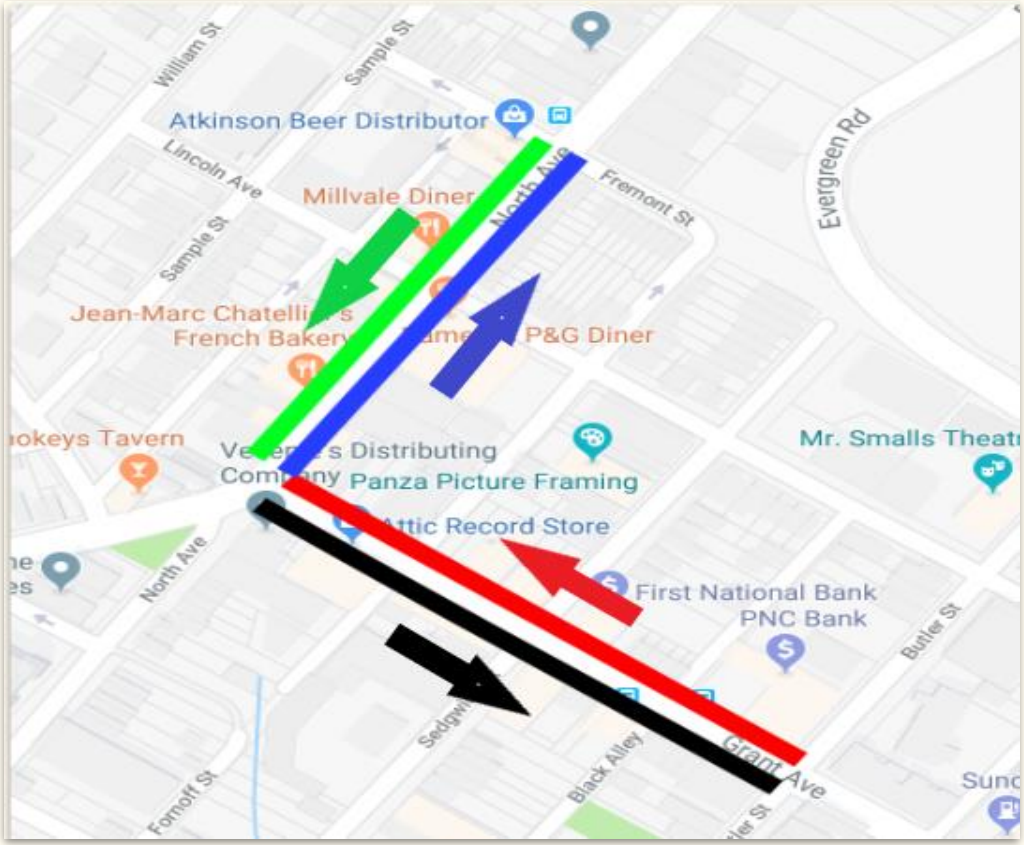
Grant Ave. Pocket Park

McCarthy Park

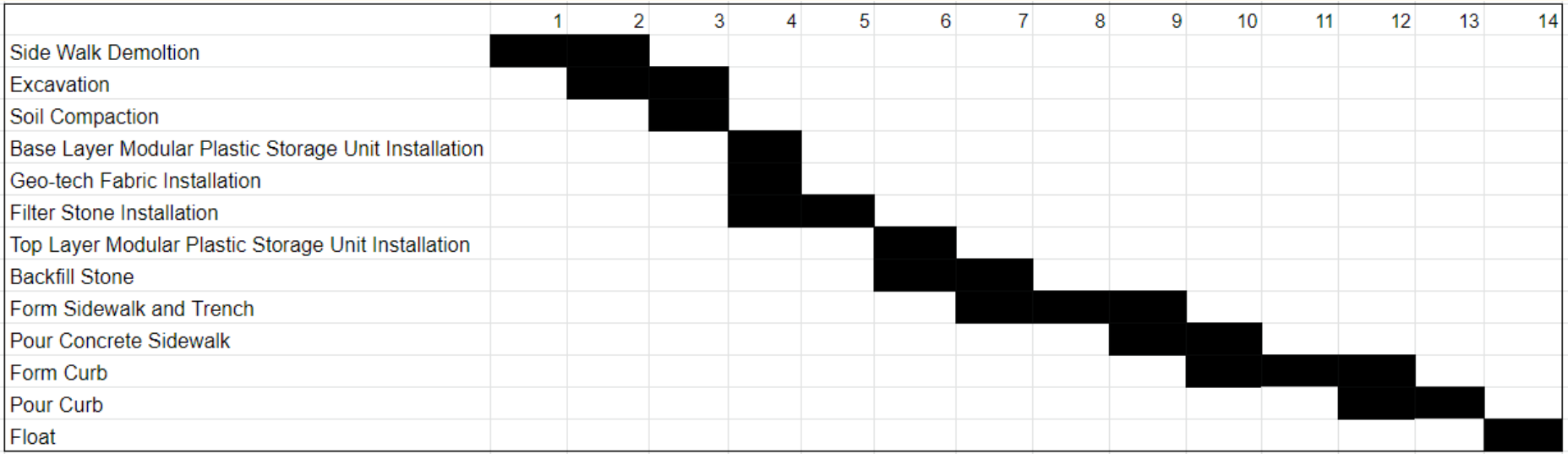


Green Street Alternative Construction

- Phase 1 (RED)
  - Westbound on Grant Ave.
- Phase 2 (BLUE)
  - NorthBound on North Ave.
- Phase 3 (GREEN)
  - Southbound on North Ave.
- Phase 4 (BLACK)
  - Eastbound on Grant Ave.



Phase Schedule



- Crews will work on a tight timeline completing work behind each other
- Phase Duration: 2 weeks
- Total Project Duration: 8 weeks

Detour Routes

- 2 travel lanes and 2 parking lanes
- Closed parking lane on side closest to construction
  - Staging area
- Closed travel lane on side closest to construction
  - Temporary walkway for pedestrians
  - Barrier protection

Phase 1 & 4 - Blue

Phase 2- Black

Phase 3- Red

Project Estimate

$475,000

Etna Green
Streetscape Phase 1

- 4,776 ft^2 of sidewalk
- 12 street trees
- 2,300 ft^3 underground storage
- 3,900 ft^2 pervious pavers

$950,000

Millvale Green
Streets

- 9,040 ft^2 of sidewalk
- 40 street trees
- 4,400 ft^3 excavation and underground storage
- 2 Rain Gardens

Project Funding

- Etna Streetscape funded by…
  - PA DEP Growing Greener grant
    - PA state funds for addressing environmental concerns
  - US EPA Section 319 grant
    - Nonpoint source management program for the Clean Water Act
  - 3 Rivers Wet Weather grant
    - Non-profit environmental organization

pennsylvania DEPARTMENT OF ENVIRONMENTAL PROTECTION

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

3 Rivers Wet Weather
Improving our region's water quality

Borough of Millvale PENNSYLVANIA

Analysis Comparison

Alternatives

1. No Action
2. Upstream Detention Basin
3. Channel Widening
4. Diversion Channel
5. Full Channel Dredging
6. Reservoir/Dam Structure
7. Maintenance & Management Plan Upgrades
8. Green Street Initiatives

No.	ALTERNATIVES	Total Project Estimate	Public Approval	Constructability	Maintenance & Risk	Sustainability	Flooding Mitigation	OVERALL RANKING
1	No Action							7
2	Upstream Detention Basin							6
3	Channel Widening							5
4	Diversion Channel							8
5	Full Channel Dredging							3
6	Reservoir & Dam							4
7	Maintenance & Management Plan Upgrades							1
8	Green Street Initatives							2

2: Positive

1: Neutral

0: Negative

WORST

BEST

Recommendations

Our Top Alternatives:

1. **Maintenance & Management Plan Upgrades**
2. **Green Street Initiatives**
3. **Full Channel Dredging**

- Final Report will be submitted to GRWA & Millvale Community
- Utilize our analysis to make decisions on future projects that mitigate flooding

Thank you!

Zaheen Hussain - Millvale Sustainability Coordinator

Donna Pearson & Alexis Boytim - Girty's Run Watershed Association

John Darnley - National Weather Service

Sara Woida, Patricia Kitchen, & Joe Delucia - US Army Corps of Engineers

Werner Loehlein & John Sebastian - Faculty Mentor

Questions?

RRDA

RAIN, RAIN, DRAIN AWAY