Culvert Design Process

Hydrology

↓

Site Assessment

↓

Alignment and Profile

↓

Bed and Banks

↓

Structure

↓

Sediment Mobility & Stability

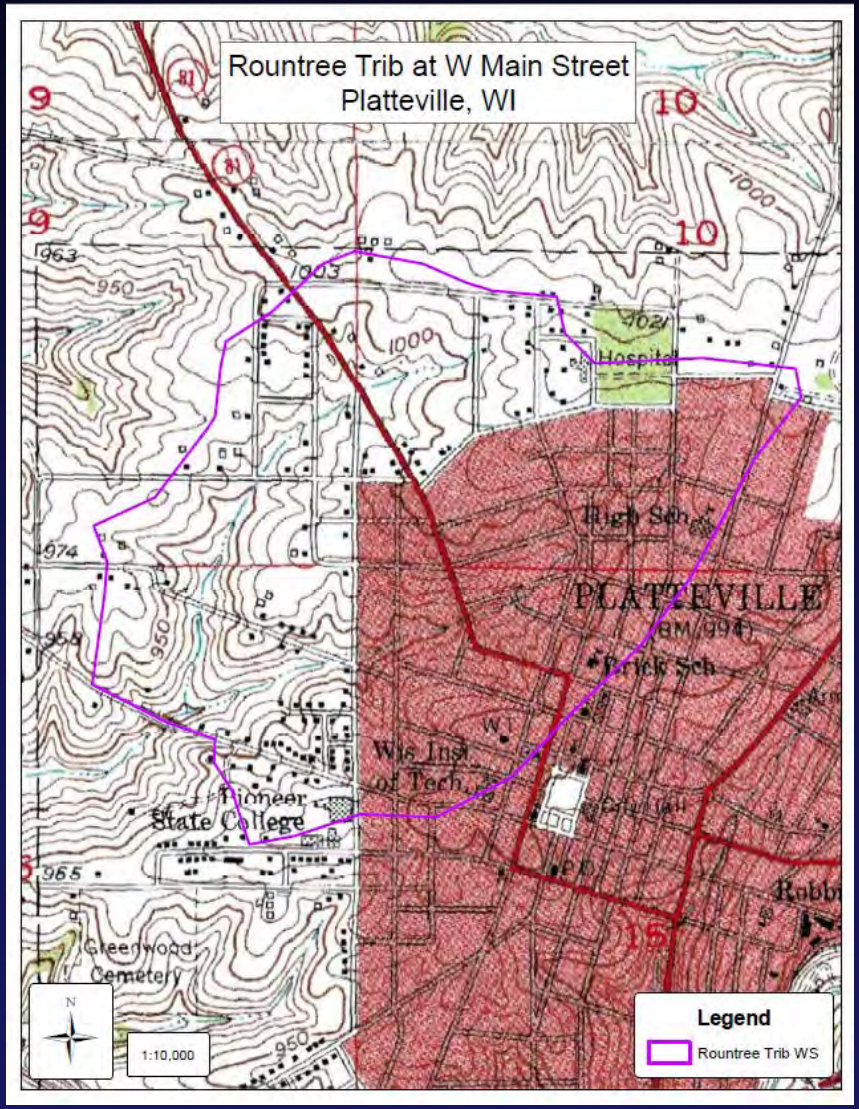
Site assessment

- Initial Site Assessment
- Field Survey
- Site Check-list
- Reference Reach

Initial site assessment

Use existing information

- Maps
- Aerial photos
- GIS layers
- Local experts: resource and transportation agencies



Initial site assessment

ID important concerns and survey requirements

- Passage: other potential barriers to check/verify
- Road considerations:
  - right-of-way,
  - types of vehicle use,
  - maintenance problems,
- Channel morphology:
  - possible downstream headcuts,
  - upstream sediment sources and transport,
  - reference reach,
  - impacts of the crossing

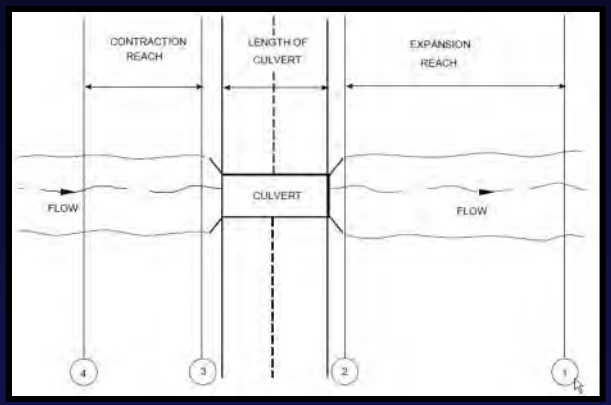
Initial site assessment

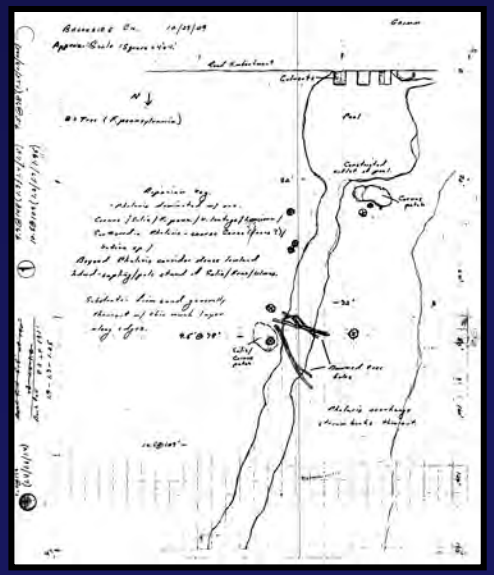
Develop preliminary objectives

- Passage:
  - fish,
  - other aquatic sp,
  - terrestrial
- Road design standards:
  - vehicle size and load,
  - speed,
  - safety,
  - maintenance
- Channel morphology:
  - alignment,
  - restoration

Field survey

- Benchmark
- Stream profile
- Stream x-sec (2 up, 2 dn)
- Road profile (and x-sec)
- Plan view sketch, or
- Topo survey w/total station
- Reference reach
- Geotechnical investigation





Alignment

Also fish passage, utility, R-of-W and reference reach concerns

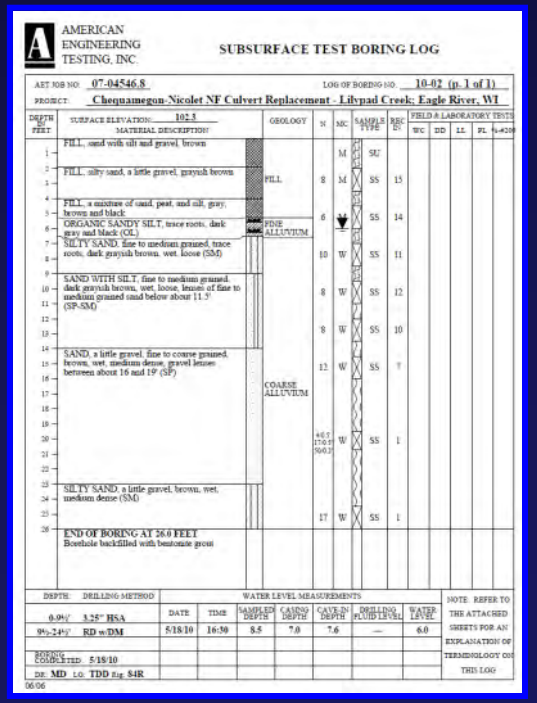
Fish passage, sediment, safety, channel restoration, historic concerns

Preliminary geotechnical investigation

- Characterizes material below the channel.
- Identifies subsurface conditions that may require further geotechnical analysis.
  - Clay soils
  - Organic-rich material
  - Saturated material
  - Bedrock
- Needed for design of structure and foundation.

Geotechnical investigation for soils

- Soil auger-portable or hand shovel: describe materials
- Drive probe: estimate density and thickness of units
- Soil borings: identify types and bearing capacity of subsurface units



AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE TEST BORING LOG

AET JOB NO: 07-04546.8 LOG OF BORING NO: 10-02 (p. 1 of 1)

PROJECT: Chequamegon-Nicolet NF Culvert Replacement - Lilypad Creek; Eagle River, WI

SURFACE ELEVATION: 102.5

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN	FIELD & LABORATORY TESTS WC	DD	LL	PL	#200
1	FILL, sand with silt and gravel, brown			M	SU						
3	FILL, silty sand, a little gravel, grayish brown	FILL	8	M	SS	15					
4	FILL, a mixture of sand, peat, and silt, gray, brown and black										
5	ORGANIC SANDY SILT, trace roots, dark gray and black (OL)	FINE ALLUVIUM	6		SS	14					
7	SILTY SAND, fine to medium grained, trace roots, dark grayish brown, wet, loose (SM)		10	W	SS	11					
10	SAND WITH SILT, fine to medium grained, dark grayish brown, wet, loose, lenses of fine to medium grained sand below about 11.5' (SP-SM)		8	W	SS	12					
13			9	W	SS	10					
15	SAND, a little gravel, fine to coarse grained, brown, wet, medium dense, gravel lenses between about 16 and 19' (SP)	COARSE ALLUVIUM	12	W	SS	7					
20			44-7 17-9 50-3	W	SS	1					
24	SILTY SAND, a little gravel, brown, wet, medium dense (SM)		17	W	SS	1					
26	END OF BORING AT 26.0 FEET Borehole backfilled with bentonite grout										

DEPTH	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
0-9½'	3.25" HSA	5/18/10	16:50	8.5	7.0	7.6	—	6.0
9½-24½'	RD w/DM							

BORING COMPLETED: 5/18/10

DR: MD LG: TDD Rig: SIR

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

06/06

Selection of reference reach

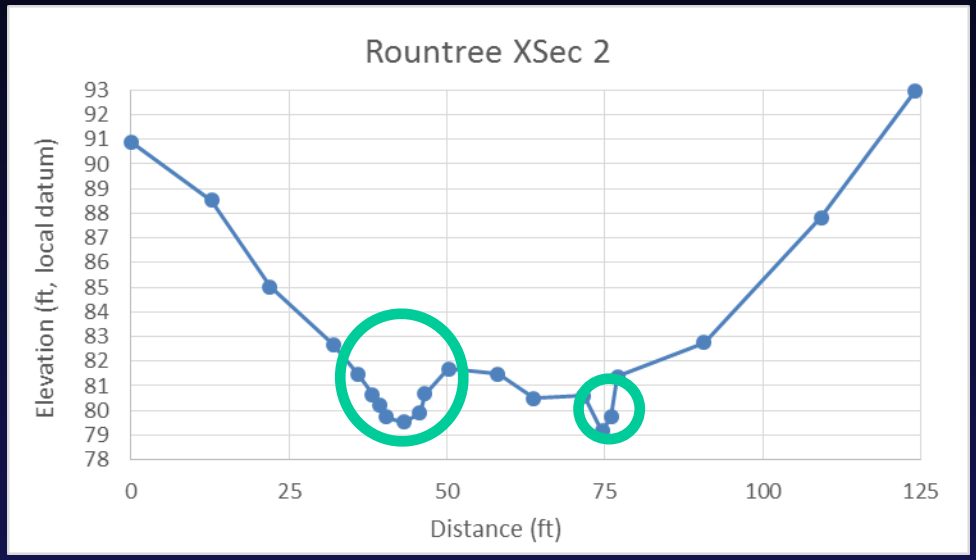
- Represents project channel
  - Primarily selected by project gradient
- Provides “input” to stream simulation
- Out of the influence of existing crossing
- Try to avoid very complex channels

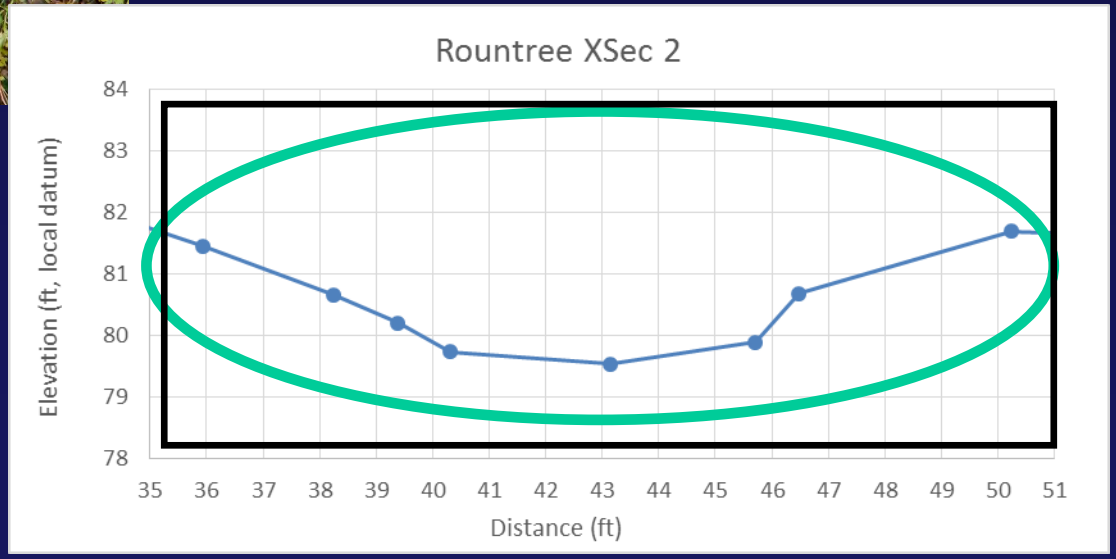
Reference reach measurements

- Pattern (site sketch, profile survey)
- Variability/controlling structures (site sketch, key pieces measurements)
- Slope (profile survey)
- Dimensions (cross-section survey, bankfull measurements)
- Substrate (pebble count)
- Photos/video

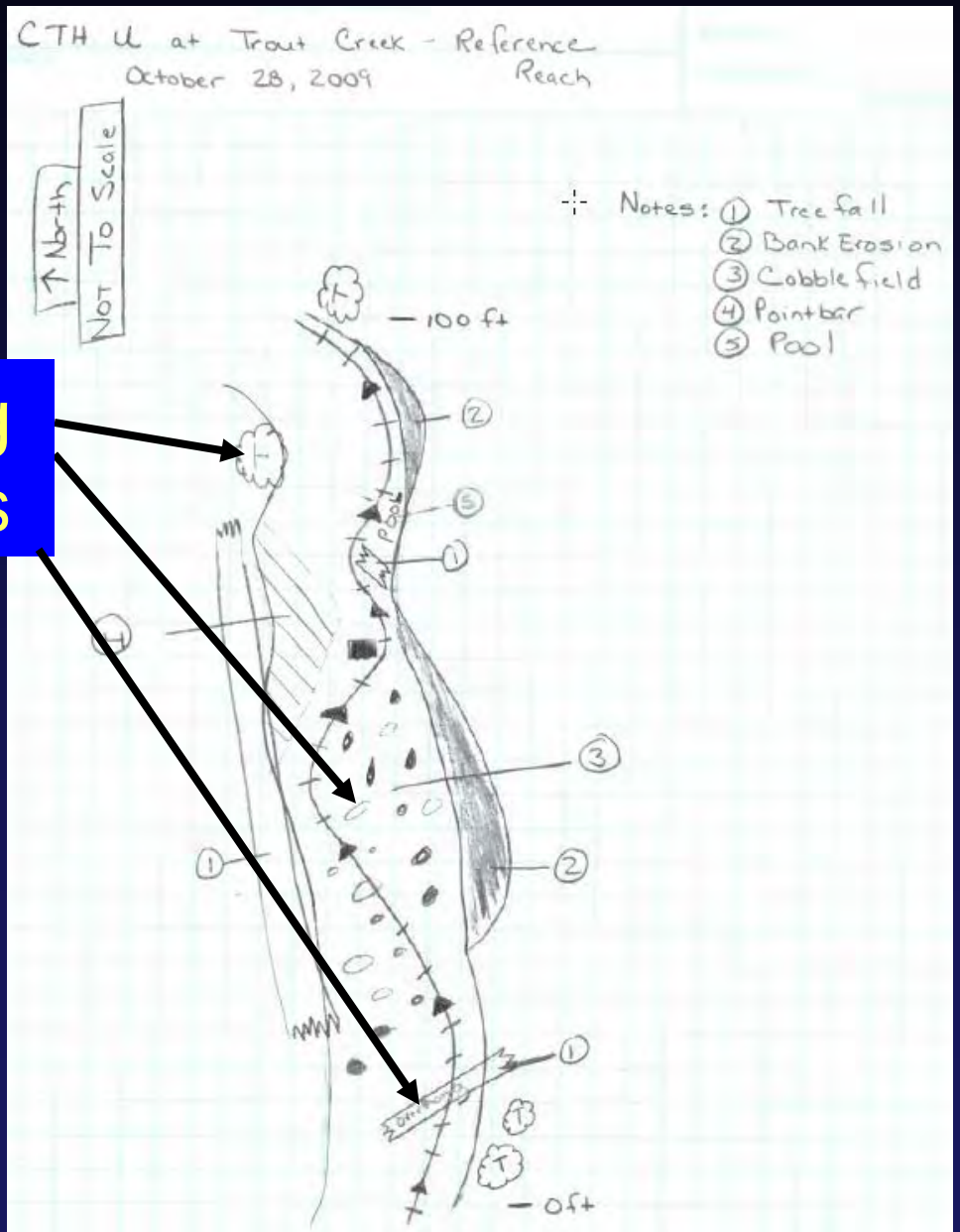
Selecting a reference reach for bankfull width measurements

Cross-sections



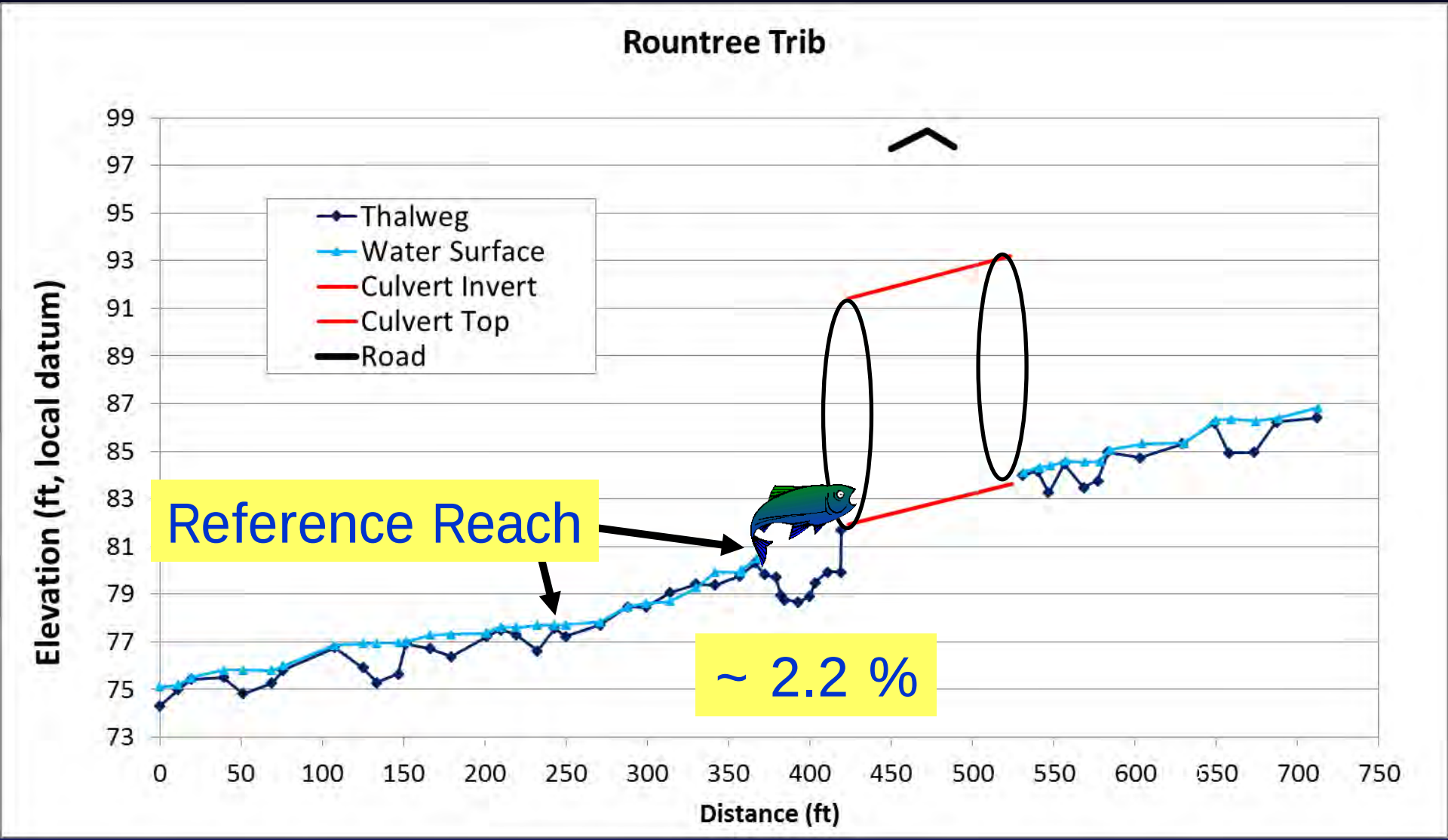


Site sketch



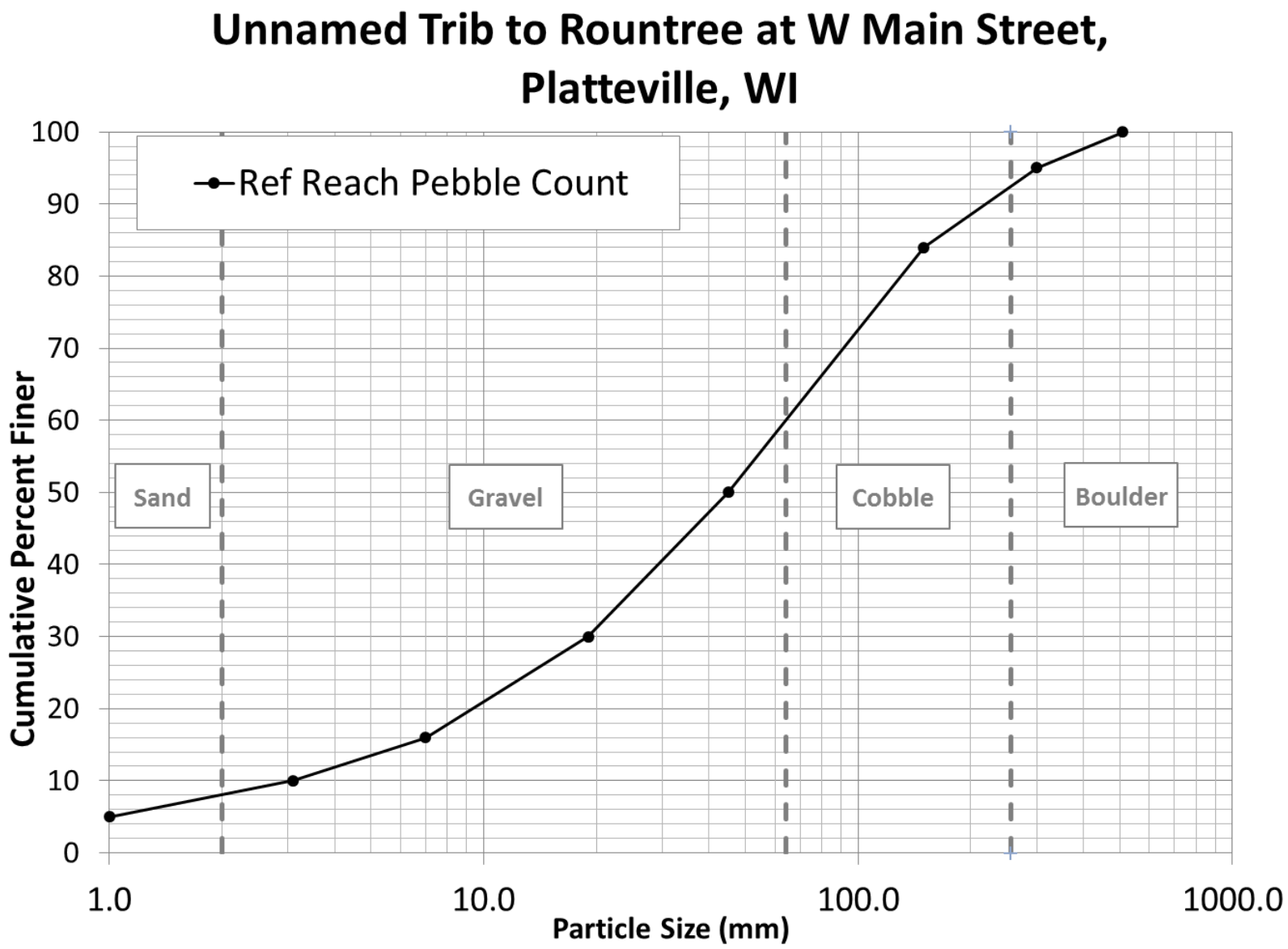
Controlling structures

Profile


Rountree Trib
Thalweg
Water Surface
Culvert Invert
Culvert Top
Road
Elevation (ft, local datum)
99
97
95
93
91
89
87
85
83
81
79
77
75
73
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
Distance (ft)
Reference Reach
~ 2.2 %

Pebble-count

Rountree Trib. pebble count



Channel materials: Key pieces

- Measure the largest particles making up key hydraulic features
- Measure between 10 to 25 particles
- Measure the particles, A, B and C dimensions
- Describe the shape and roundness of the particles measured

Site check list

Road/Stream Site Assessment Checklist

Action	Notes
Stream Characteristics	
Reference reach	
• Cross-sections	
• Bankfull width	
• Substrate	
• Slope/ gradient	
• Roughness elements, key pieces	
Crossing Impacts	
• braiding or bank erosion	
• Up or downstream aggradation or scour	
Channel shape and sinuosity	
Floodplain characteristics (width, soil, veg)	
Fish and aquatic resources	
Public use and navigation	
Road Characteristics	
• Alignment (vertical & horizontal)	
• Field indicators of problems (overtopping, debris, scour, etc.)	
• Elevations (low point)	
• Surface drainage	
• Ditch drainage	
• Surfacing	
• Available cover	
• Right-of-way (ROW) width	
• Adjacent land ownership & structures	
• Ave Daily Traffic (ADT)	
Structure Design	
Road alignment (vertical & horizontal)	
Detour	
Structure	
• Site feasibility for a culvert or bridge	
• Shape	
• Material	
• Height/Width	
• Length	
• Fill cover depth	
• Embankment slope	
• Inlet type (projecting/mitered/headwalls)	
• Elevation	
• Alignment	
• Slope	
• Hydraulic capacity check	
Substrate	
• Size class distribution	
• Roughness elements, grade controls	
• Grade control	
• Stream banks	
• Bed shape	
• Volume by size class	
• Mobility/stability check	
• Transitions	
Permitting	
DNR/COE permits & timing restrictions	
FWS migratory bird nesting	
Real estate needs	
FEMA Floodplain mapping	
Other local permits	
Construction	
Site survey	
Traffic control	
Utilities	
Land ownership	
Wetlands & floodplain	
Equipment specifications (type, size, capability)	
Excavation (materials placement, unsuitable)	
Backfill	
• Material specifications	
• Compaction	
Erosion control	
• Diverting surface drainage from site	
• Dewatering	
• Recover organisms	
• Stream diversion & maintaining flow	
○ Flow volumes	
• Ditch flow	
• Silt fencing	
• Riprap specifications	
• Seed mixture and rate	
• Mulch/erosion control blanket	
Final site plan	
Monitoring plan	

Exercise 3, Site Assessment