

ARTERIES PROJECT

Emergency & Long Term Waterbody
Response Planning

CoastalReVitalization (CReV) L.L.C.

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PURPOSE

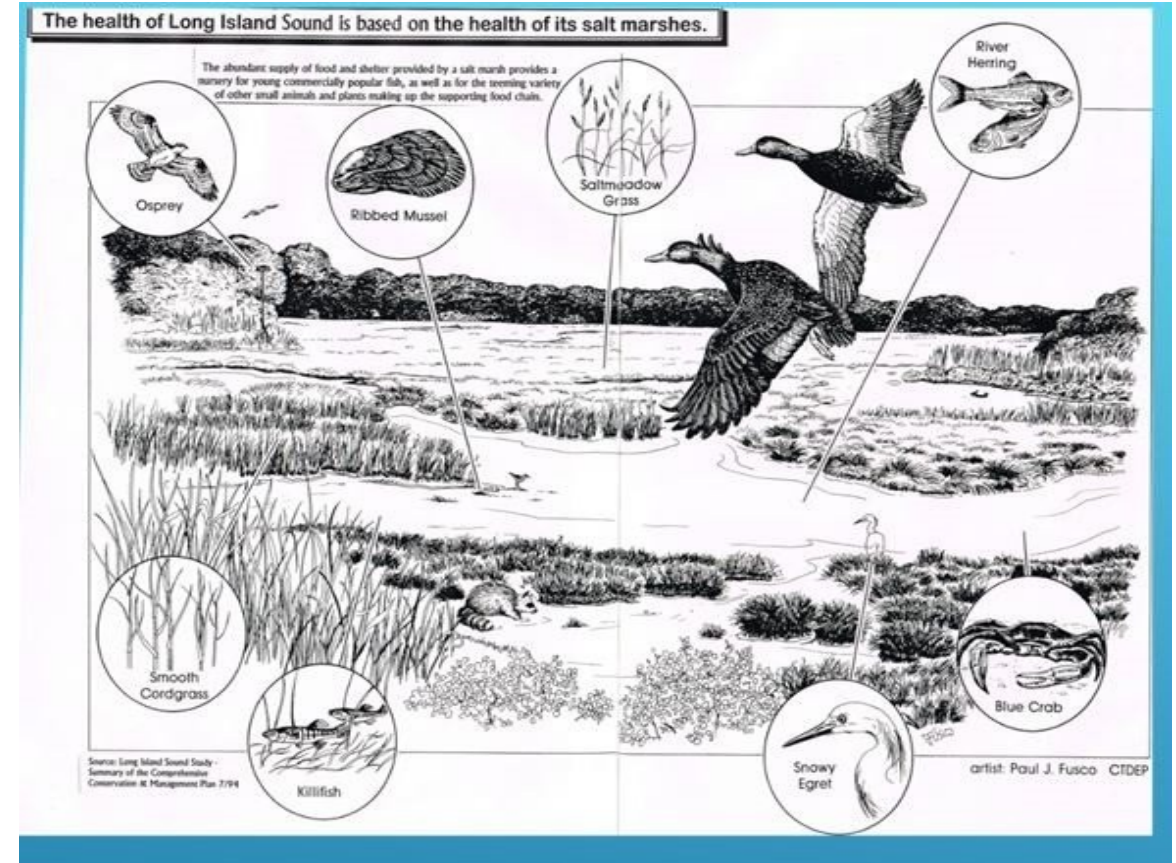
What This Program Does

The premise, in one sentence.

Long Island Sound's feeder streams — its “arteries” — are occluded by a century of piped runoff, while more than 90% of the Sound's salt marshes have been removed. This program recovers those runoff deposits by amphibious suction dredging and re-uses the clean yield as the base material to rebuild marsh, barrier islands, and stabilized stream banks.

Three outcomes at the same time:

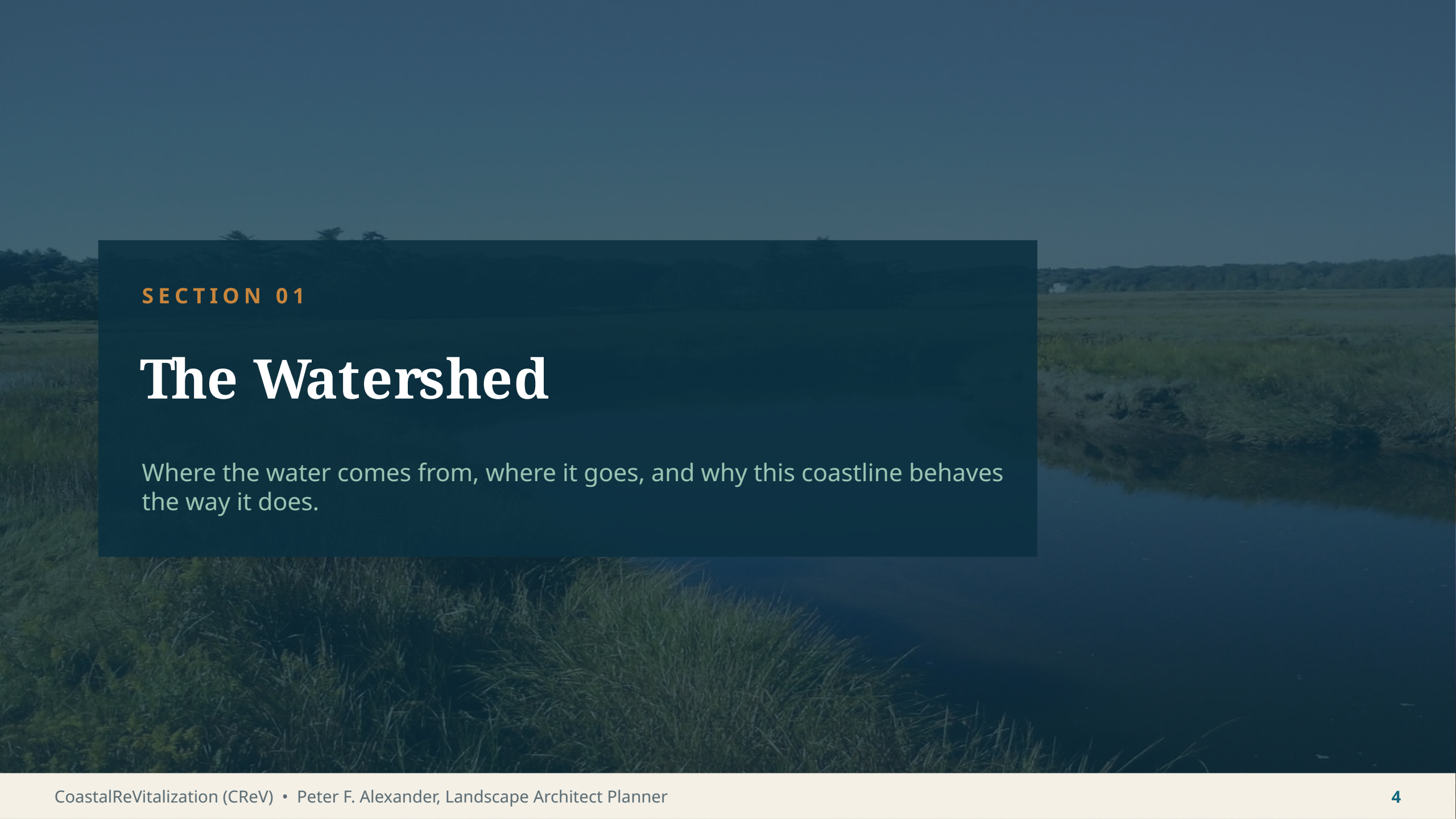
- Restored stream capacity — flood and drought attenuation
- Rebuilt salt marsh — carbon storage, habitat, wave diffusion
- Tested, cleansed material — toxins identified and treated, not relocated



The health of Long Island Sound is based on the health of its salt marshes.

How This Deck Is Organised

- | | | |
|----|--------------------------|--|
| 01 | The Watershed | Long Island Sound, Greenwich, and the Byram River system |
| 02 | The Problem | Occluded arteries, paved runoff, and lost salt marsh |
| 03 | The Method | Amphibious dredging, dewatering, and marsh reconstruction |
| 04 | The Equipment | Watermaster V, transport, boom, tree spade, sawmill, vessel, skiff |
| 05 | The Sites | Greenwich Harbor, Byram River parks, pilot marsh drawings |
| 06 | Delivery Sequence | How a project moves from first look to five-year master plan |



SECTION 01

The Watershed

Where the water comes from, where it goes, and why this coastline behaves the way it does.

Long Island Sound — A Watershed With a Unique Orientation



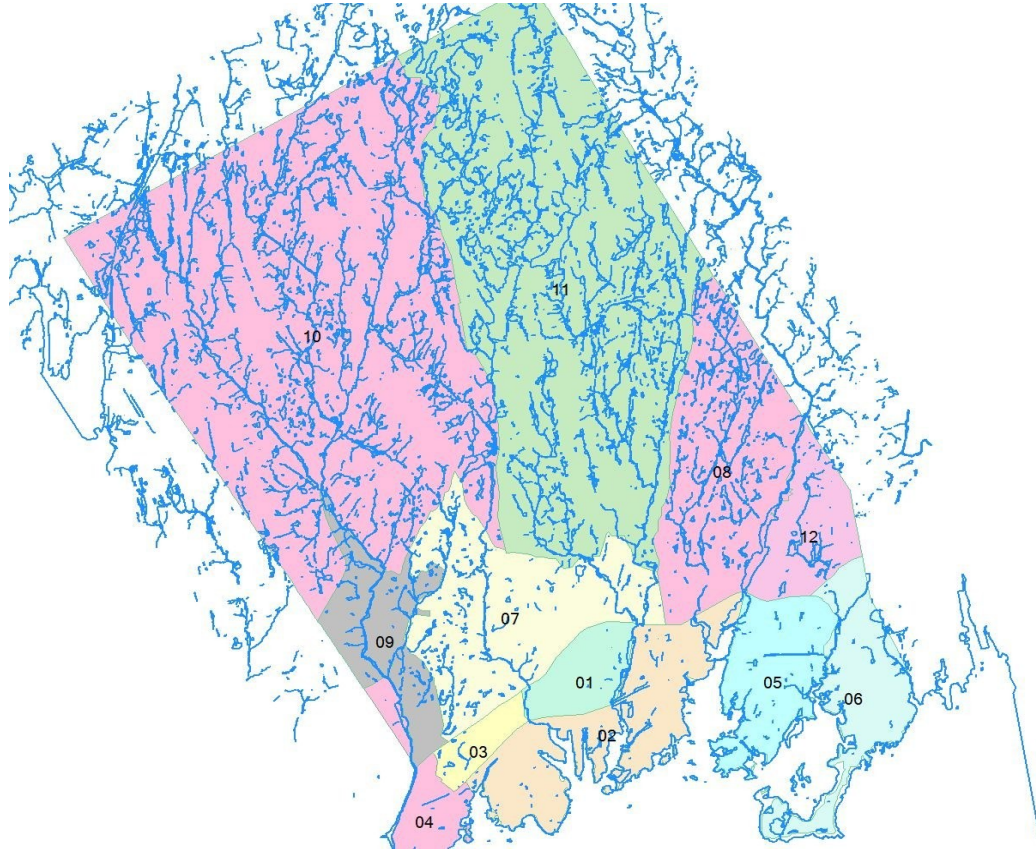
Sound watershed, Canada to the New York / Connecticut border.

North-south valleys feeding an east-west waterbody.

The Sound is fed by north-south valleys that drain into an east-west oriented waterbody. That geometry gives it a sun angle no other estuary on this coast receives, and a myriad of species thrive on it.

- Roughly 90% of tidal input arrives from the Atlantic Ocean; the remainder enters through Throgs Neck.
- A metaigneous border and a 150-mile small-particulate barrier island — Long Island — enclose the system.
- The Connecticut portion of the watershed essentially ends at the New York / Connecticut border.
- Water quality is compromised by pollution from populated areas: fresh meets salt, and everything upstream arrives here.

Town of Greenwich, CT — 54,000 Acres of Mixed Terrain



Greenwich watersheds with significant arteries and wetland setbacks.

The map that drives the work plan.

54,000 acres of mixed terrain comprise the Town of Greenwich. Colour separates each sub-watershed; the blue lines are the arteries — the streams that carry every acre of runoff to the Sound.

Basic understanding of the sub-watershed is critical to long-term flood planning. Work is prioritised artery by artery, not parcel by parcel:

Byram • Greenwich • Bruce • Rivercob • Old Greenwich

The pilot corridor: Port Chester, New York to Stamford, Connecticut — a five-year-term master plan project.

Long Island Sound Revitalization Training — Site Key

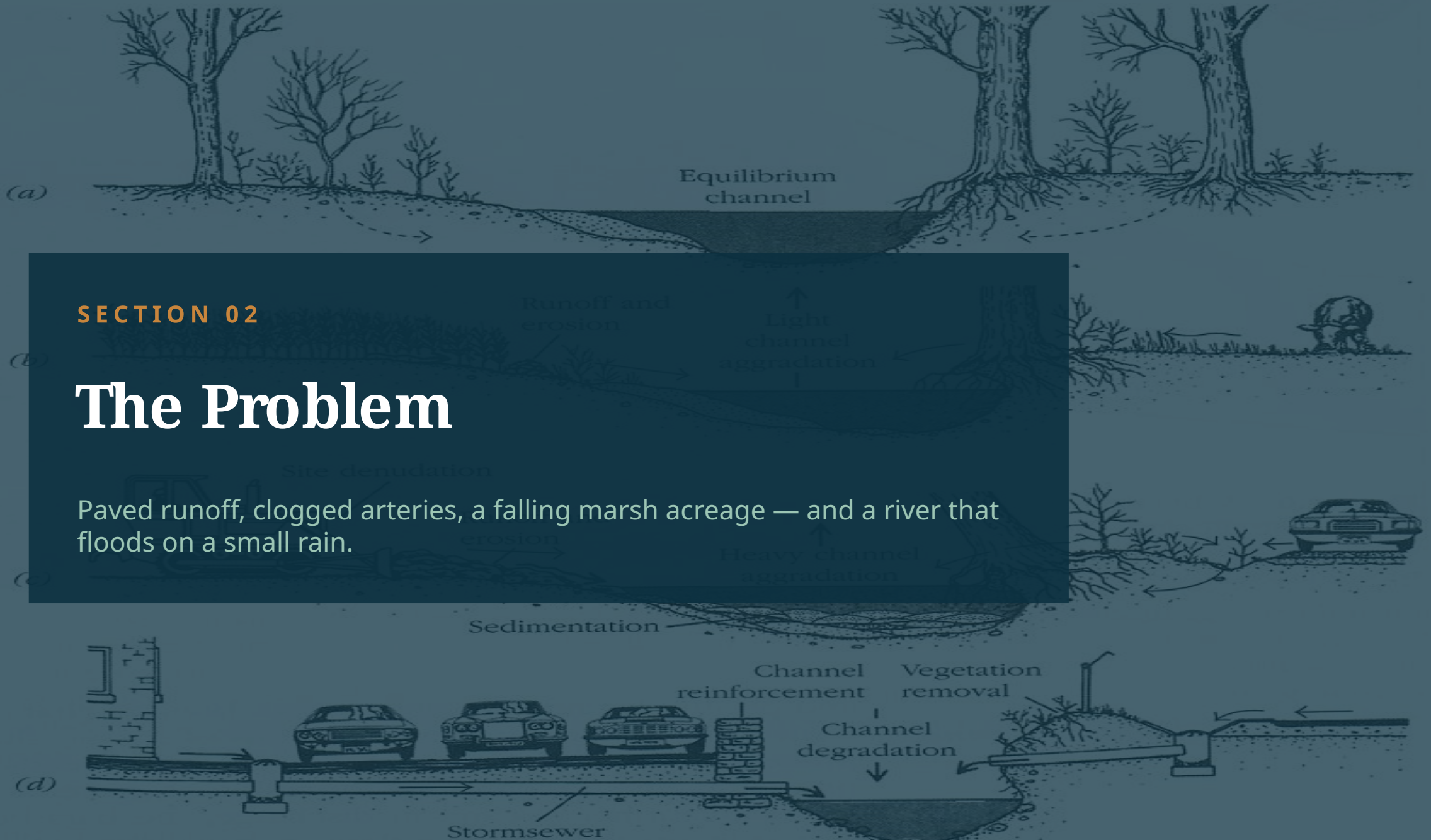
- | | | |
|---|-------------------------------|---|
| 1 | School | Artery restoration — youth training potential site. |
| 2 | Dam | Modern improvements for anadromous & diadromous fish; bank planting for migratory avian & insect species — staging area. |
| 3 | Occluded stream | Artery cleansing method site. |
| 4 | Fresh water marsh | Artery cleansing method site. |
| 5 | Compromised salt marsh | Artery cleansing method site. Sites 3–5 hold centuries of heavy minerals that changed the course of history, plus 20th and 21st century chemicals that are easily identifiable and treatable. |
| 6 | Long Island Sound | Tidal influenced waterway. The Connecticut watershed essentially ends at the New York / Connecticut border. |

Located and analysed with precise location software and modern bathymetry to map silt accumulation, supported by the Neurological Physician Testing System for health analysis.

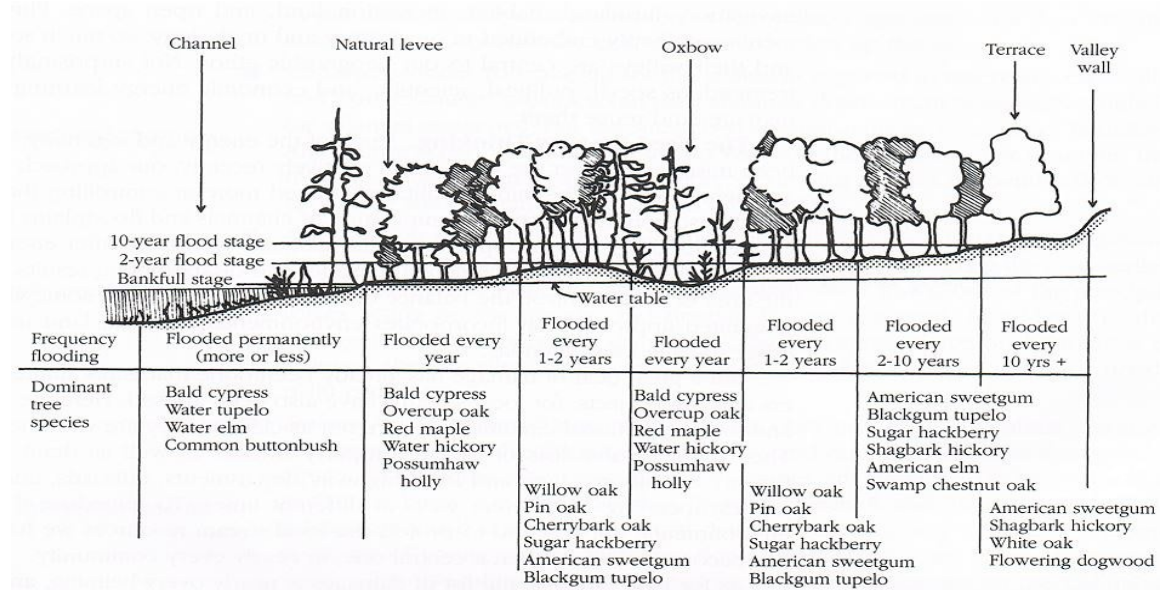
SECTION 02

The Problem

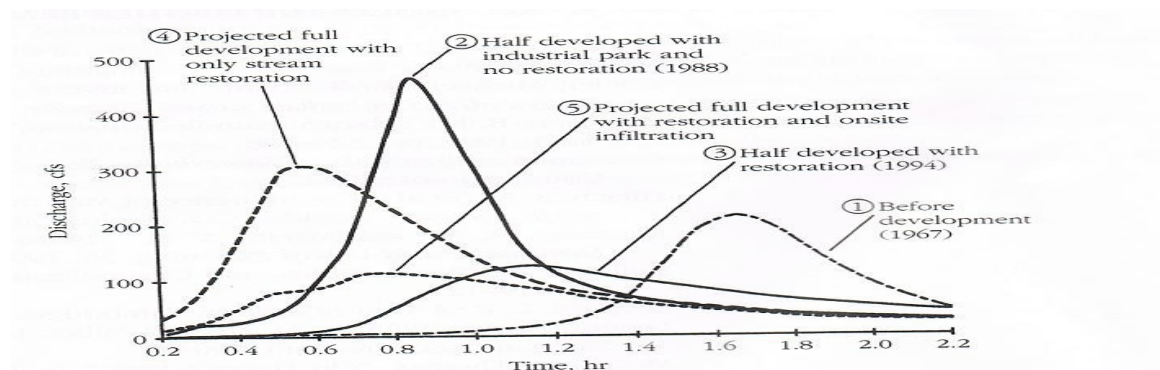
Paved runoff, clogged arteries, a falling marsh acreage — and a river that floods on a small rain.



Change With No Change — Roads to Ruin



Flood-plain zonation: channel, natural levee, oxbow, terrace, valley wall.



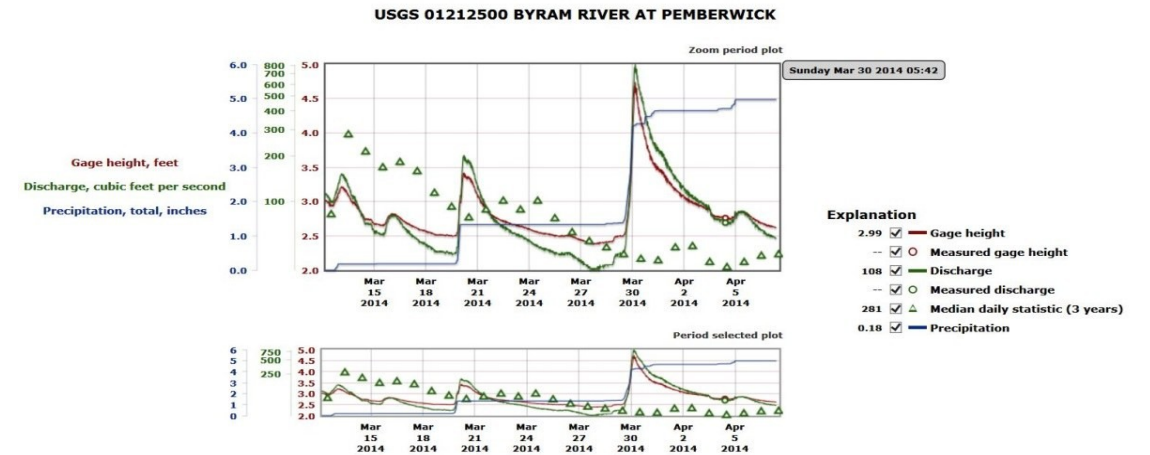
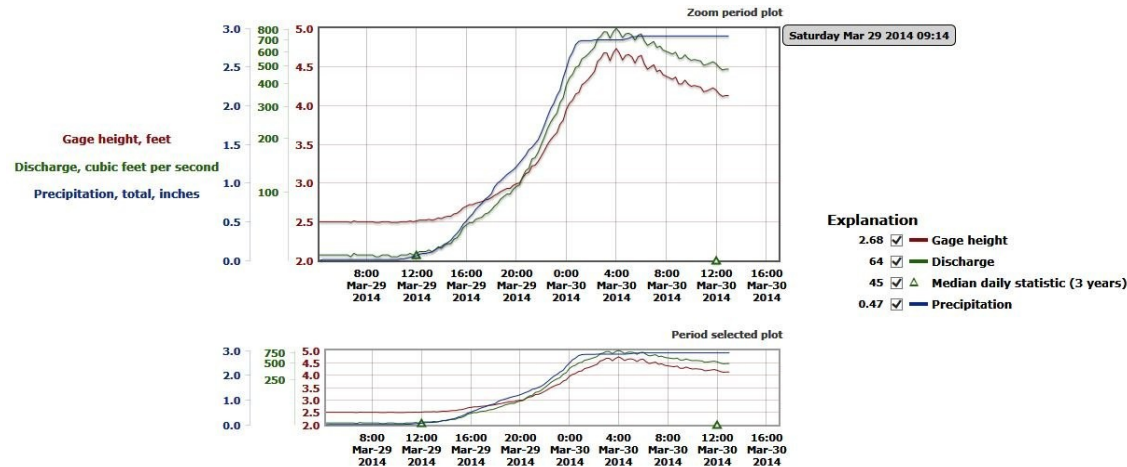
A tiny amount of rain now creates flood conditions.

The increase in roadway area has dramatically changed both the amount and the speed of runoff. Small amounts of rain now cause flooding at the local level, and the quality of life for a wide variety of species — humans included — has suffered for it.

The discharge curves at left tell the story: full development with only stream restoration spikes hardest and fastest; development combined with infiltration and restoration flattens the same storm into a manageable curve.

Permeable paving and the slowing of runoff can be carried out with very little disruption.

Byram River Drama — Height, Volume, Rainfall



USGS gauge, Byram River at Pemberwick: top line river height, middle volume of flow, bottom rainfall.

Bottom line: a tiny amount of rain creates flood conditions — and it drains away just as fast.

The rain stops, and less than an hour later river height and volume drop. That flashiness is the signature of a piped, paved watershed with no storage left in it. Detention, retention and infiltration are what convert that spike back into base flow — which is also the answer to drought, not only to flood.

Long Island Sound's Treasure — And Its Critical Loss



Compromised salt marsh, Long Island Sound.

Over 90% of the Sound's salt marshes were removed.

The remaining acreage is at a critical stage from a combination of rising Sound levels and increased stormwater volume. All marshes, at all elevations, are critical for ecological survival.

One acre of salt marsh absorbs up to 400% more CO₂ than an acre of our New England forest.

Priority for salt marsh restoration is air and water cleansing and habitat restoration — with storm, Sound-level variant and hurricane protection by wave diffusion, and recreational and educational opportunity alongside it.

The background image shows a marsh restoration project. In the center, an excavator is working in a muddy area. To the right, a large plume of water or sediment is being discharged into the air. The foreground is filled with green marsh vegetation and a body of water.

SECTION 03

The Method

Recover the runoff deposits. Test them. Dewater them. Rebuild the marsh with them.

From Storm Log Line to Mean High Water

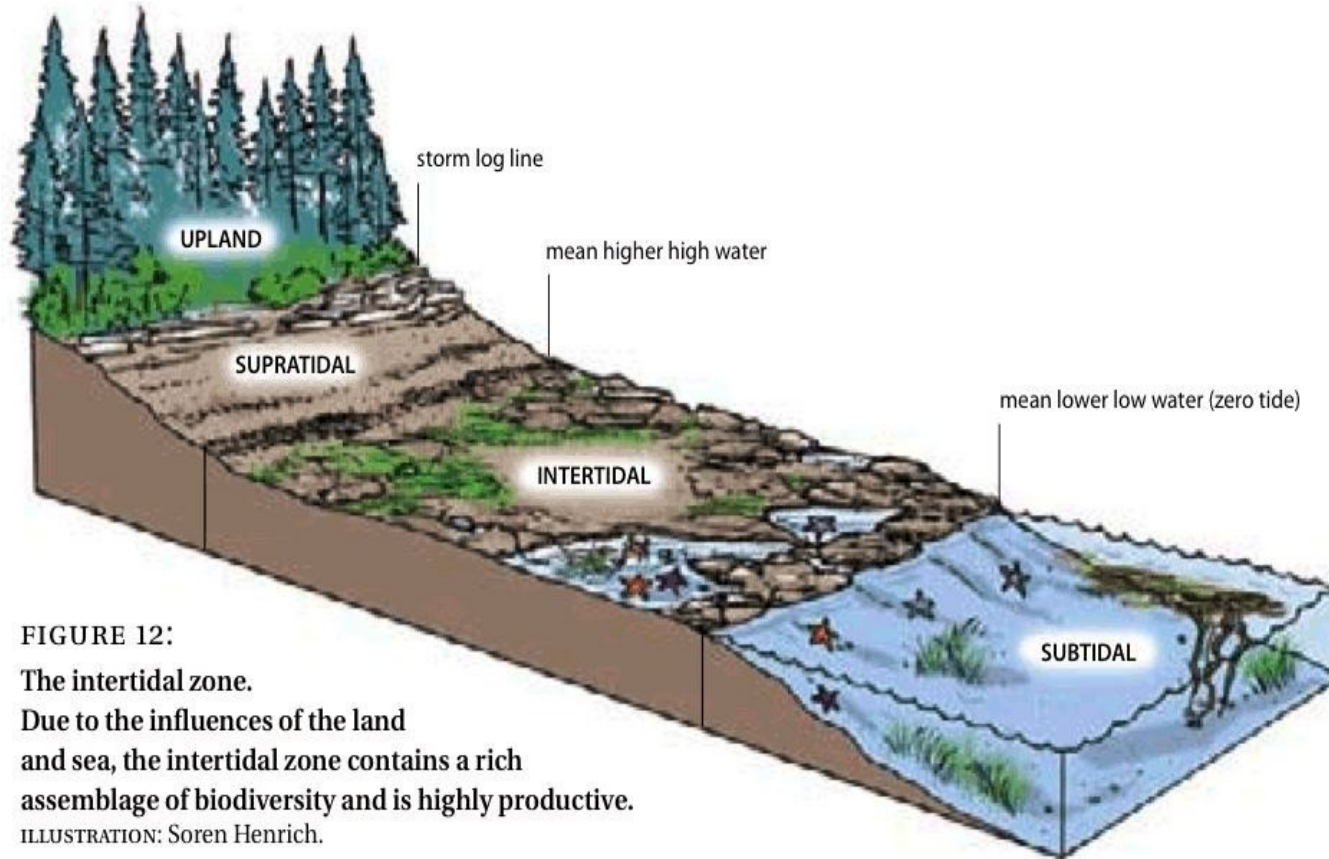


FIGURE 12:

The intertidal zone.

Due to the influences of the land and sea, the intertidal zone contains a rich assemblage of biodiversity and is highly productive.

ILLUSTRATION: Soren Henrich.

The intertidal zone — upland, supratidal, intertidal, subtidal. Illustration: Soren Henrich.

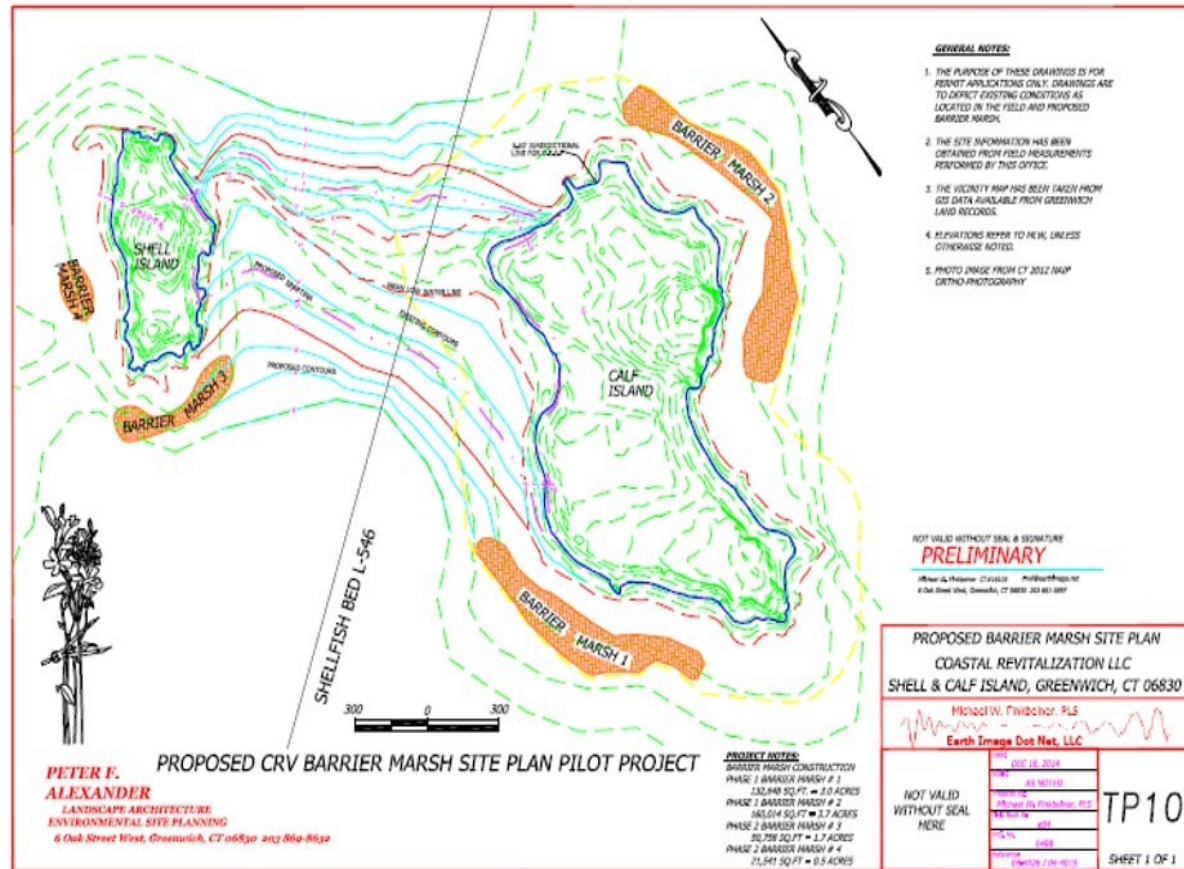
Thank you, Soren Henrich.

The illustration is thorough and clear: from log line to mean high water, it shows the cleansing and runoff performed by natural factors. Because of the influences of both land and sea, the intertidal zone contains a rich assemblage of biodiversity and is highly productive.

Storm log line.

100-year-old trees dominate our forests, and wetlands compromised by paved runoff have clogged the Sound watershed's arteries. Harvested selectively for marsh reconstruction, those trees contribute vertical storm log lines set under mean high water.

Barrier Marsh / Shellfish Protection Plan



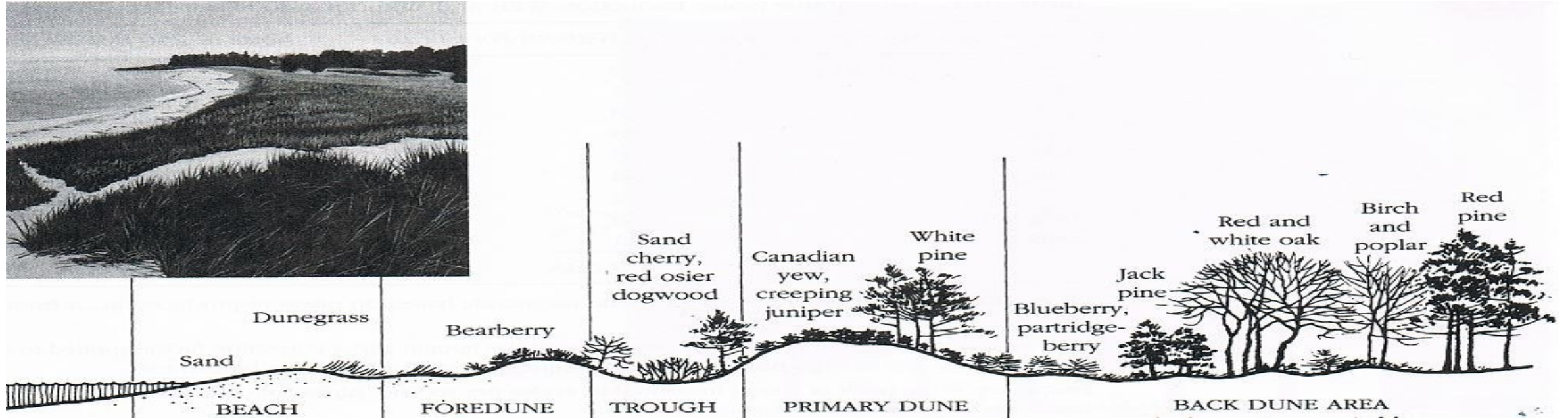
Proposed CReV barrier marsh site plan — Shell & Calf Island, Greenwich, CT.

Clean dewatered dredge material, placed accurately.

The ability to use clean, dewatered dredge material — transported in biodegradable units and placed accurately and strategically — will dramatically and rapidly improve the potential of both islands for storm protection and for marsh and shellfish bed recovery.

Ecological diversity is achieved by grade change: the section model replicates the best outcome possible for storm, tidal and wind effects on the shoreline, and each elevation band supports a different community.

Shoreline Stability Model — The Section Behind the Islands



Beach, foredune, trough, primary dune, back dune ridge — grade change producing ecological diversity.

This section is the model used to design the future of the proposed barrier isles. Attention is grabbed by sudden events — hurricanes and “super storms” — but large waterbody and coastal interface changes go on daily. Tidal action, accretion and erosion affected by runoff can all be planned for, enhanced or deterred.

Dewatering Through Geotextiles — Then Placement



Geotextile dewatering bed



Filled biodegradable tube



Dump trailer — dewatering on board



High-capacity transport trailer

Concept: use existing, proven suction dredging, dewater through geotextiles, then place strategically.

Dewatering can be done on dump trailers, and the resulting clean material placed exactly where it is needed — including offshore locations — to provide the base for barrier islands and marshlands. Skiff-delivered textile tubes carry the material the last distance to the marsh or island edge.

Toxic yield is separated from clean yield at source. Clean yield is repurposed on site for retention berms planted with native species friendly to migratory species; larger stone recovered from the stream is used to stabilise the stream bottom and banks.

Three Dams on the Byram River — Risk and Opportunity



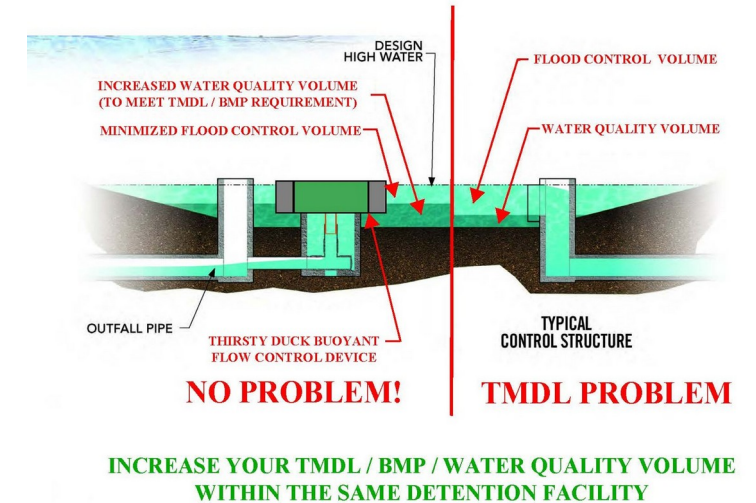
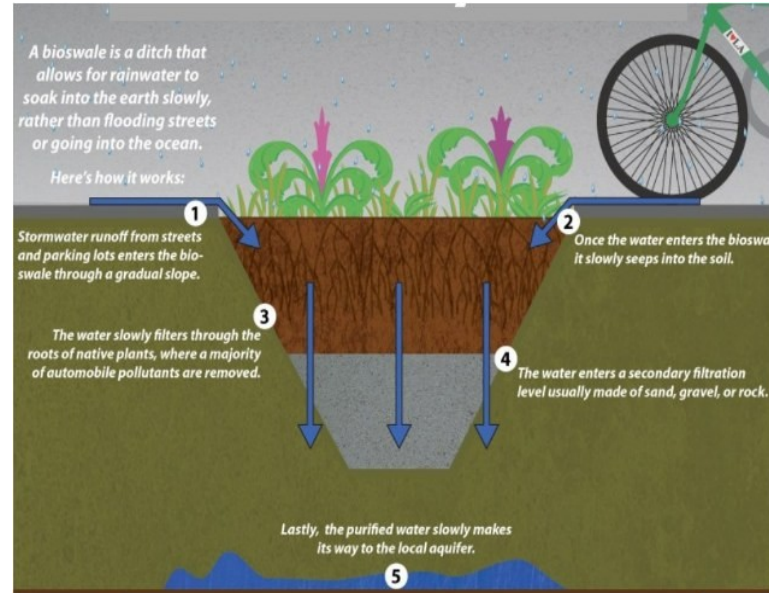
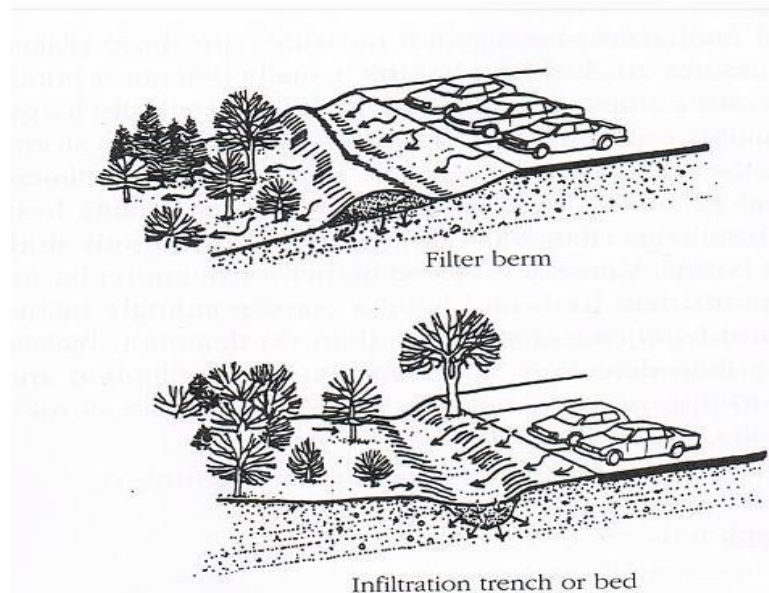
Existing dam with proposed anadromous / diadromous access channel indicated.

New England dams — from beavers to settlers to industry — provided critical fresh water, while species requiring salt water lost their run.

Three dams on the Byram River exist today and offer great potential to improve safety and to repair an environment that was compromised until the plant closed — before modern toxic chemicals were invented.

1. Floating siphon system for material transfer.
2. Detention, retention and infiltration made critical by extreme weather events.
3. Blast-yield buttress area — recent and future New England projects require blasting; that blast yield is tested radon-free and combined into the works.
4. Anadromous and diadromous access channel, using Jersey barriers to stabilise the fish channel sides.

Filter Berms, Infiltration Beds and Bioswales



Filter berm & infiltration trench | bioswale operation | water-quality volume within the same detention facility

Cleaning of water can occur simultaneously with control of it.

Drainage system overloads get attention by flooding, but the same structures can be made to treat what they carry. A bioswale lets rainwater soak into the earth slowly rather than flooding streets; filter berms and infiltration beds do the same at the edge of paved areas; and increasing the water-quality volume inside an existing detention facility resolves the TMDL problem without new land.

SECTION 04

The Equipment

One amphibious machine, a transport chain, and the tools that let it work anywhere in the watershed.

Watermaster V — Amphibious, Multi-Function, Self-Propelled



Highway-transportable: the machine walks on and off its own trailer.

10 ft

maximum width — gentle access & egress

24 in

hydraulic cutter head, engineered in Finland

10 in

discharge line

1,000 cy/hr

yield, pumped up to one mile

4 in

rock size capability

200 ft+

working range for sensitive areas

General suction dredging for silt, sand, mud, sludge and gravel — with the ability to treat toxins and purify runoff.

It walks in and out of streams under its own power, meets US highway transport standards, works in tight areas, and can distribute its own yield directly by siphon. Delivery to the marsh is by skiff-carried biodegradable textile tubes, and in some settings by floating pump systems with a one-mile range that can be augmented with additional floating or shore-bound pumps.

Reference: watermaster.na

What the Machine Itself Does (1–3)



1 — Works in tight areas

Beneath a masonry bridge arch: 10 ft width and self-propelled walking give access where barges and land plant cannot reach.



2 — Long term bank stabilization

Movax vibratory pile driver setting shore piling from the water, with the dredge working the same reach.



3 — Temporary stabilization by tree centre

Bank work staged so planted species take over long-term stabilization as they establish.

These two slides cover the Watermaster V alone. Transport, boom, sawmill, vessel and skiff are set out separately on the following slides.

What the Machine Itself Does (4–6)



4 — In and out of all areas

Amphibious walking access and egress: it enters and leaves the water under its own power, with no ramp, barge or crane.



5 — Power to distribute its own yield

Direct siphon discharge — up to 1,000 cubic yards per hour, pumped up to one mile from the cut.



6 — Meets US highway standards

Loads itself onto standard interstate equipment and walks back off at the next site.

Reference: watermaster.na — machine capability only; no support equipment shown on this slide.

Stream Cleaner — Prescribed Gear



Watermaster working a stream reach with support plant alongside.

Backhoe rake — 9 ft

Removes invasive vegetation from lake and stream by raking, without excavating the bed.

Piling driver bucket

Sets wood piles for storm log lines and bank works.

Movax vibratory pile driver

Post-storm piling borders and permanent shore stabilization.

Tree spade

Moves vegetation temporarily for access, then replants — and can revitalize plants suffering from silt-caused higher water-table elevation.

Cutter head — 24 in

General suction dredging of silt, sand, mud, sludge and gravel.

Transport, 65-Foot Boom and Lift



Stream Cleaner transport chain: tractor unit, 65-foot boom truck and low-bed trailer.

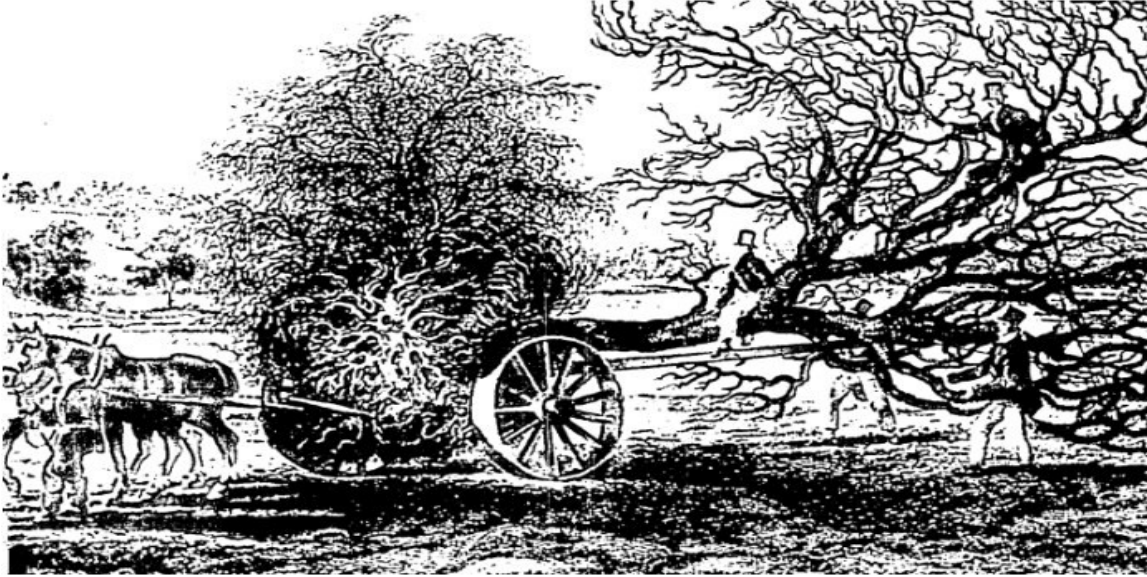
High-capacity trailer.

10 ft maximum for access and egress, with a highway transport tractor rated 1.5 tons at 65 ft — able to transfer either toxic or clean yield out of occluded streams, or cleanse and repurpose the yield on site for retention berms.

Scissor telescope boom — tractor with 65 ft boom.

Lifts combine the 25 ft Watermaster boom with a 65 ft boom truck and up to a 200 ft scissor lift, for long reaches and difficult terrain, and for materials unsuitable for suction. Boom / tractor — approximately \$200k.

Tree Mover and Lumber Processor



Selective harvesting — the practice this program returns to.

Harvested 100-year-old trees become the vertical storm log lines set under mean high water in the reconstructed marsh — nothing leaves the watershed.

5 — Tree mover / tree spade.

Provides access to limited spaces and replants or relocates as applicable. Temporarily moving vegetation, including trees, opens spatial access — and can revitalize plants suffering from silt-caused higher water-table elevation.

6 — Lumber processor / trailer sawmill.

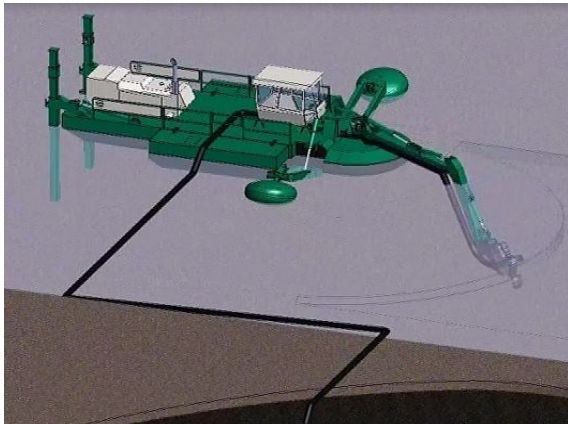
Tree harvesting to provide flood-amelioration swale and berm pilings. The Long Island Sound watershed's aging forests are both a threat and a blessing: natives, settlers and migratory species all thrived here, and we need to honour that by selective harvesting. Forest management provides safety and species protection for meadow-reliant species.

Project Vessel, Berths and Survey Skiff



7 — Staff berths on vessel: full galley and head.

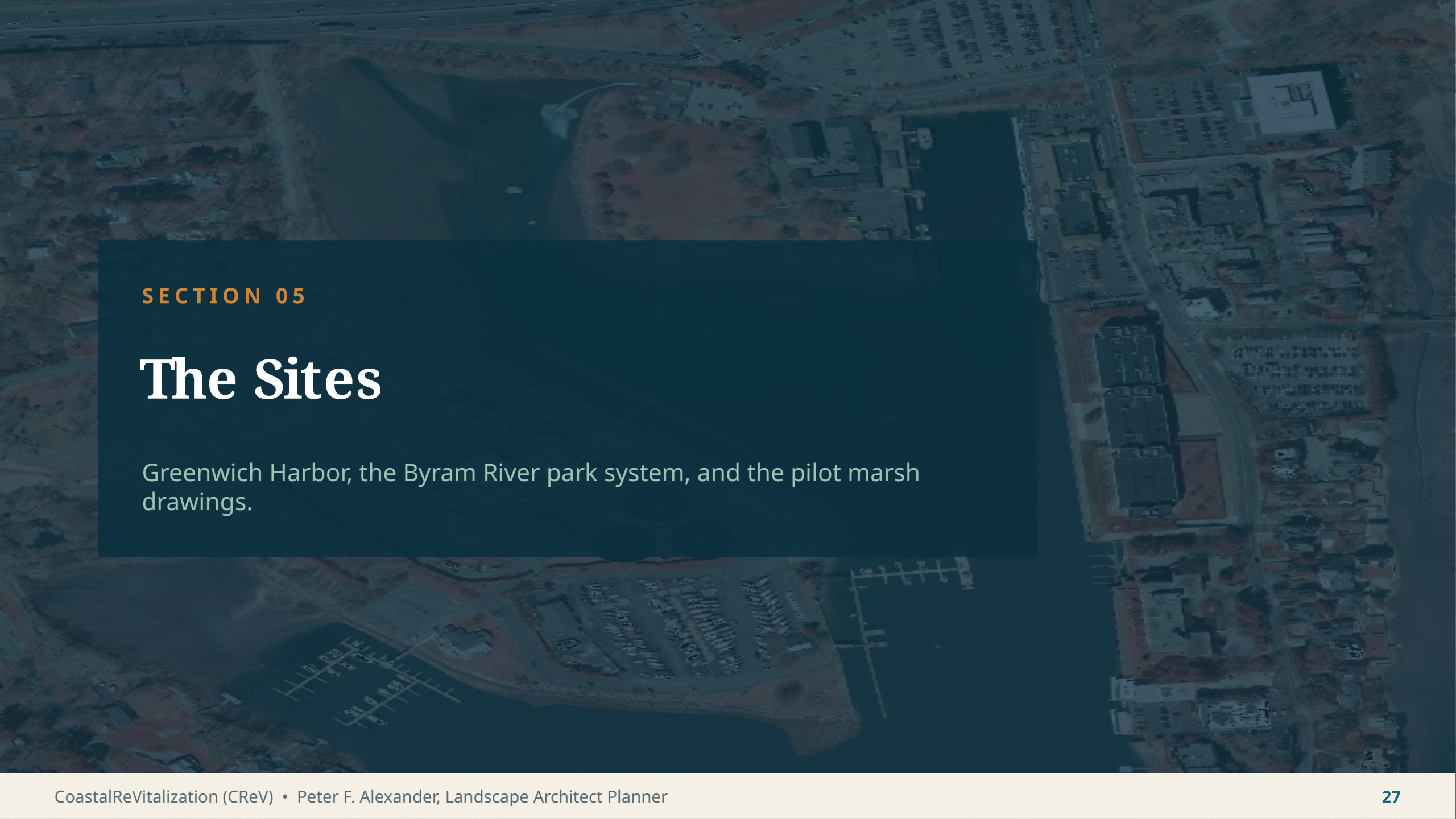
Site housing on or offshore with shoring ability, doubling as the corporate office and data-collection station for the duration of the works.



8 — Survey & launch skiff.

Shares capacity with the Watermaster to beach, receive and disperse supplies ashore for marsh and island restoration. Cutterhead pump at 1,000 cubic feet per hour with one-mile range; carries the biodegradable textile tubes to the placement point. Skiff and trailer travel with the crew.

Project vessel with full galley, head, cabin and berths | survey skiff | cutter head working the shore

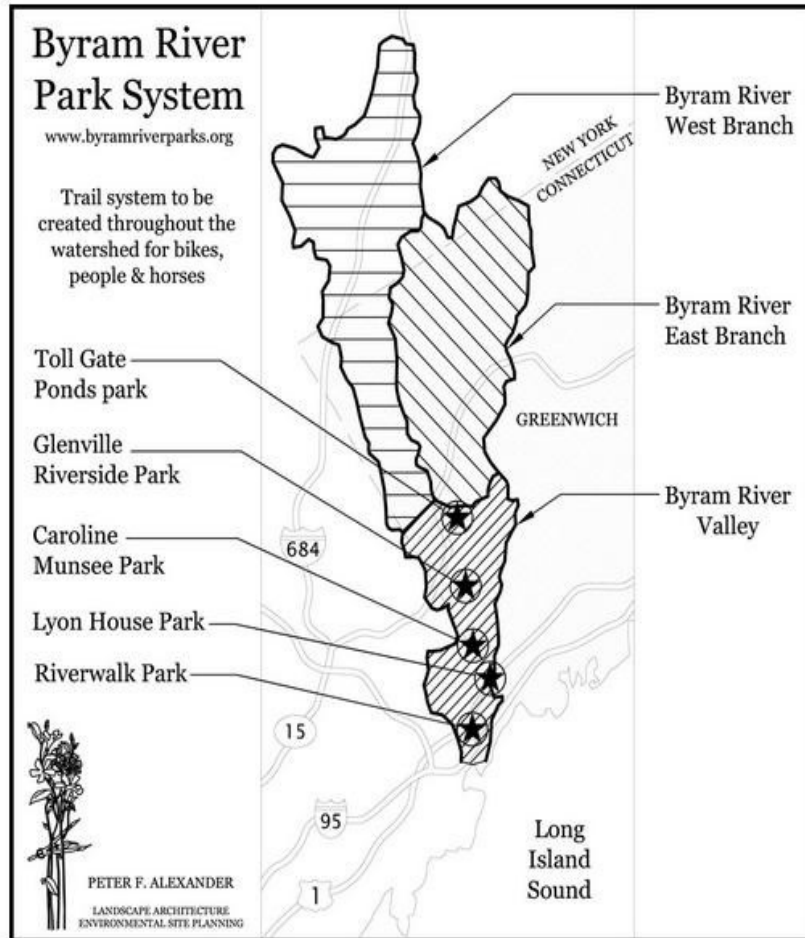


SECTION 05

The Sites

Greenwich Harbor, the Byram River park system, and the pilot marsh drawings.

Byram River Park System — Six Linked Parks



Trail system to be created throughout the watershed for bikers, people and horses.

Toll Gate Ponds Park

Pond restoration and silt trapping; over time siltation has filled the pond, raising the water table 2 ft to 3 ft in most cases.

Glenville Riverside Park

Riverside road walk on the Merritt Parkway alignment; riverbank access and planting.

Caroline Munsee Park

Silt-trapping streamway, deep-water fishing hole and recreation areas at the existing pond edge.

Lyon House Park

Thomas Lyon Homestead Park at the state line; the Byram River is the border between CT and NY.

Riverwalk Park

River walks and bicycle trails; dredge the river and use the material to build the trail system.

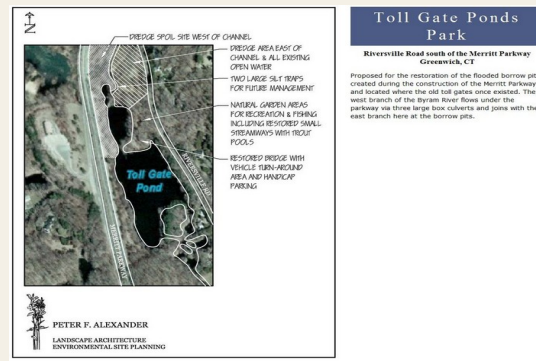
Byram River Valley

West and east branches feeding Long Island Sound at Port Chester / Greenwich.

Park Sites — Existing Conditions and Proposals



Toll Gate Pond — aerial



Toll Gate Ponds Park — restoration plan



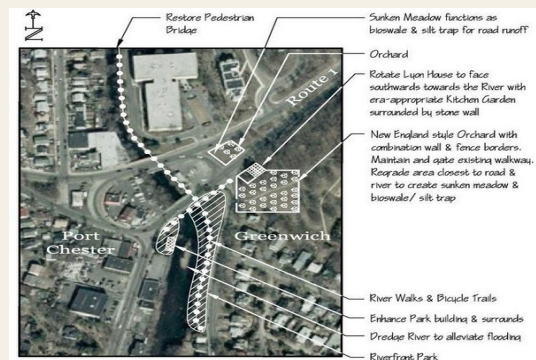
Glenville — aerial



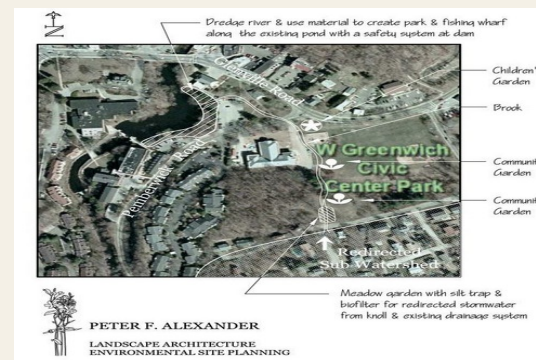
Caroline Pond — aerial



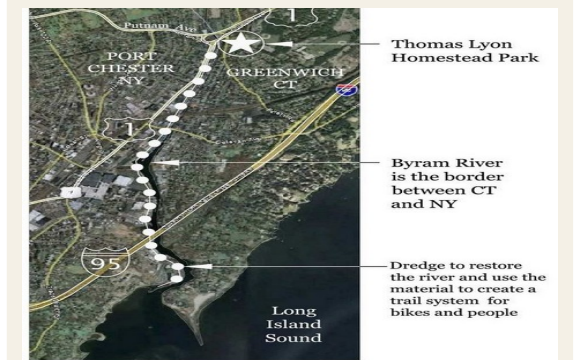
Caroline Pond — silt trapping streamway plan



Lyon / Port Chester — restoration plan



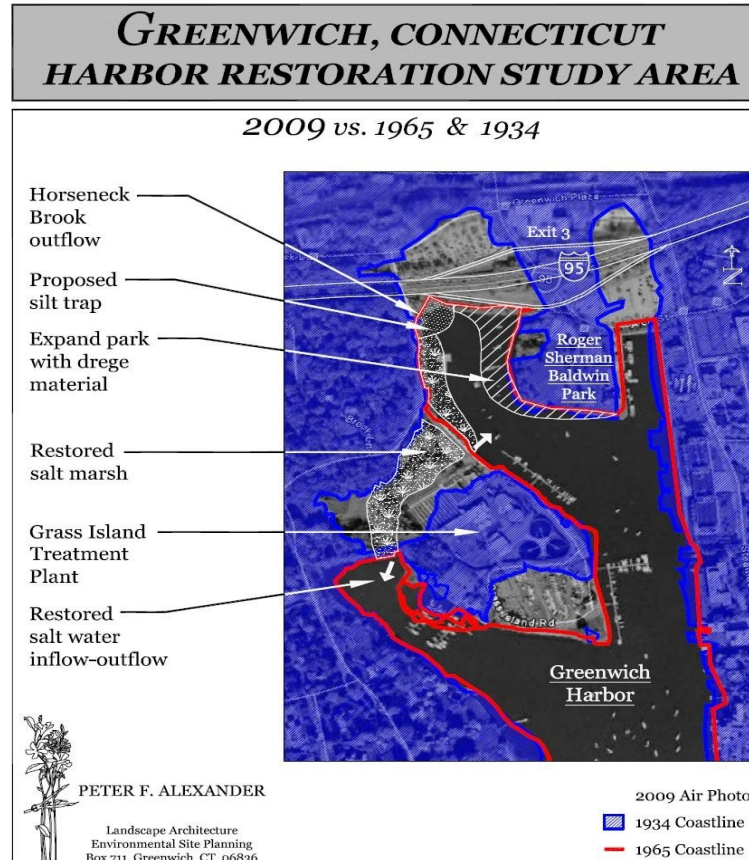
Greenwich Civic Center Park — meadow garden & silt trap



Riverwalk — state line to Long Island Sound

Each plan pairs a silt trap with a public amenity: restore the artery, and the park pays for its own maintenance in reduced downstream flooding.

Harbor Restoration Study Area — 2009 vs. 1965 & 1934



Study area keys

- Horseneck Brook outflow
- Proposed silt trap
- Expand park with deep dredge material
- Restored salt marsh
- Grass Island Treatment Plant
- Restored salt marsh with water inflow / outflow

Natural and human melding here has a now-understood history of more than 1,000 years. Native, settler and species activity can be precisely located with GIS and three-dimensional monitoring of harbor condition before, during and after.

Infrared aerial (left) and restoration study area overlay: 2009 coastline against 1934 and 1965.

2023 / 2024 / 2025 Harbor Improvements — Program

a **Test results analysis**

Analysis and storage in a climate-controlled, limited-access facility.

b **2012 test results**

Comparison study against the current sampling round.

c **Inner harbor master plan**

Based on (a) and (b), with State, Federal and local protocols.

d **Timeline & budget**

8/1/2023 start date. Test bidding to mirror USACE / CT DEEP, or provide duplicates to same. \$250,000 US with a \$25,000 retainer directly from the Town of Greenwich; all expenditures require joint approval post-retainer.

e **Routine maintenance & storm response**

Decrease channel occlusion through a silt trap system and restored salt marsh, with potential to use harbor yield in conjunction with the NFWF grant program to restore salt marshes.

Peter F. Alexander L.A., CT 470 / NY 989 — 12/26/2024

Submission Set — Existing, Sections and As-Built

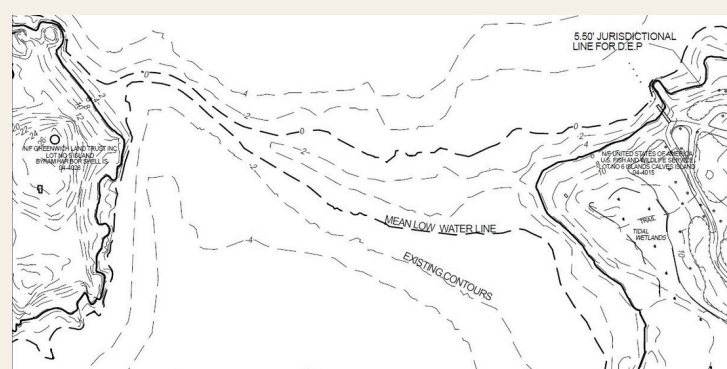
DRAWING LIST		
SHEET LIST	DRAWING TITLE	DATE
1	VICINITY MAP	12/26/2013
2	OVERVIEW SITE PLAN	12/26/2013
3	EXISTING CONDITIONS PLAN	12/26/2013
4	CROSS SECTIONS	12/26/2013
5	CROSS SECTIONS	12/26/2013
6	PROPOSED CONDITIONS SITE PLAN	12/26/2013
7	PROPOSED SECTIONS	12/26/2013
8	PROPOSED SECTIONS	12/26/2013
9	TITLE SHEET, GENERAL NOTES, & CONVERSION TABLE	12/26/2013

GENERAL NOTES:		
1.	THE PURPOSE OF THESE DRAWINGS IS FOR PERMIT APPLICATIONS ONLY. DRAWINGS ARE TO DEPICT EXISTING CONDITIONS AS LOCATED IN THE FIELD.	
2.	THE SITE INFORMATION HAS BEEN OBTAINED FROM FIELD MEASUREMENTS PERFORMED BY THIS OFFICE.	
3.	THE VICINITY MAP HAS BEEN TAKEN FROM GIS DATA AVAILABLE FROM GREENWICH LAND RECORDS.	
4.	ELEVATIONS REFER TO MLW, UNLESS OTHERWISE NOTED.	

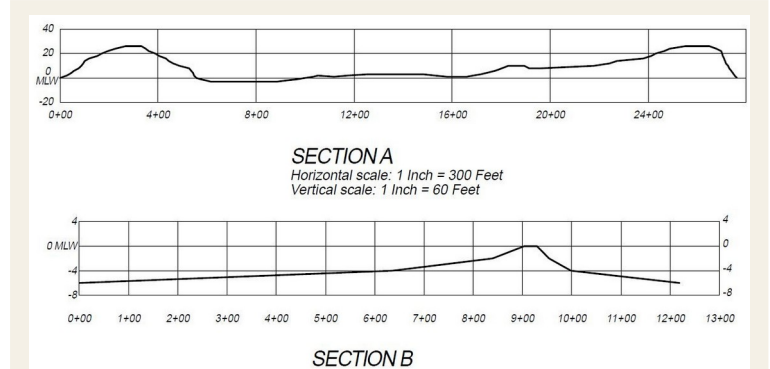
CONVERSION TABLE		
	NAVD 88	MLW
HIGHEST PREDICTED TIDE	+6.4 FT	+10.3 FT
CT COASTAL JURISDICTION LINE	+5.5 FT	+9.4 FT
MEAN HIGH WATER (MHW)	+3.35 FT	+7.25 FT
NAVD 1988	0.0 FT	3.9 FT
MEAN LOW WATER (MLW)	-3.9 FT	0.0 FT

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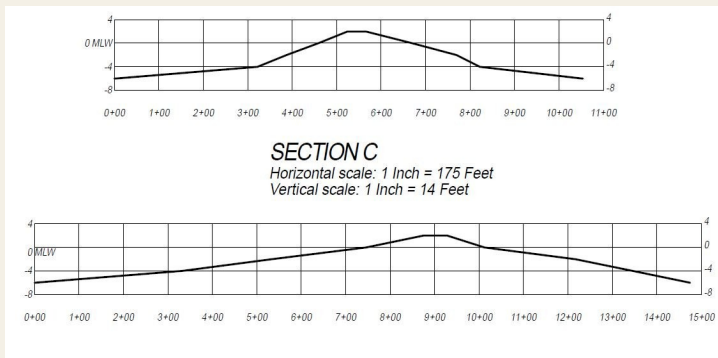
Submission key & drawing list



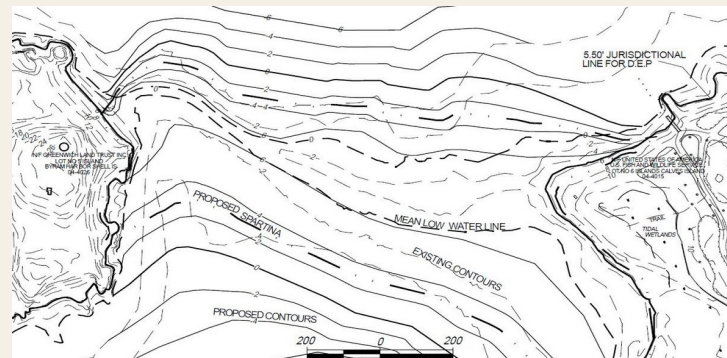
Existing contours



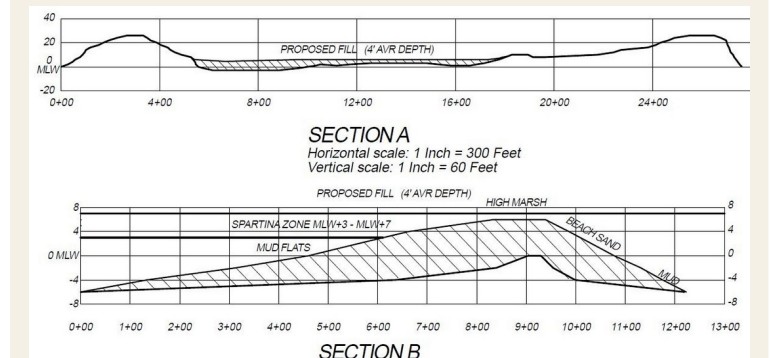
Existing sections A & B



Existing section C



Final phase — as-built contours



Final sections A, B, C & D

Sections locations, existing grade and as-built grade are drawn to the same horizontal and vertical scales so the placed volume is auditable against the permit.

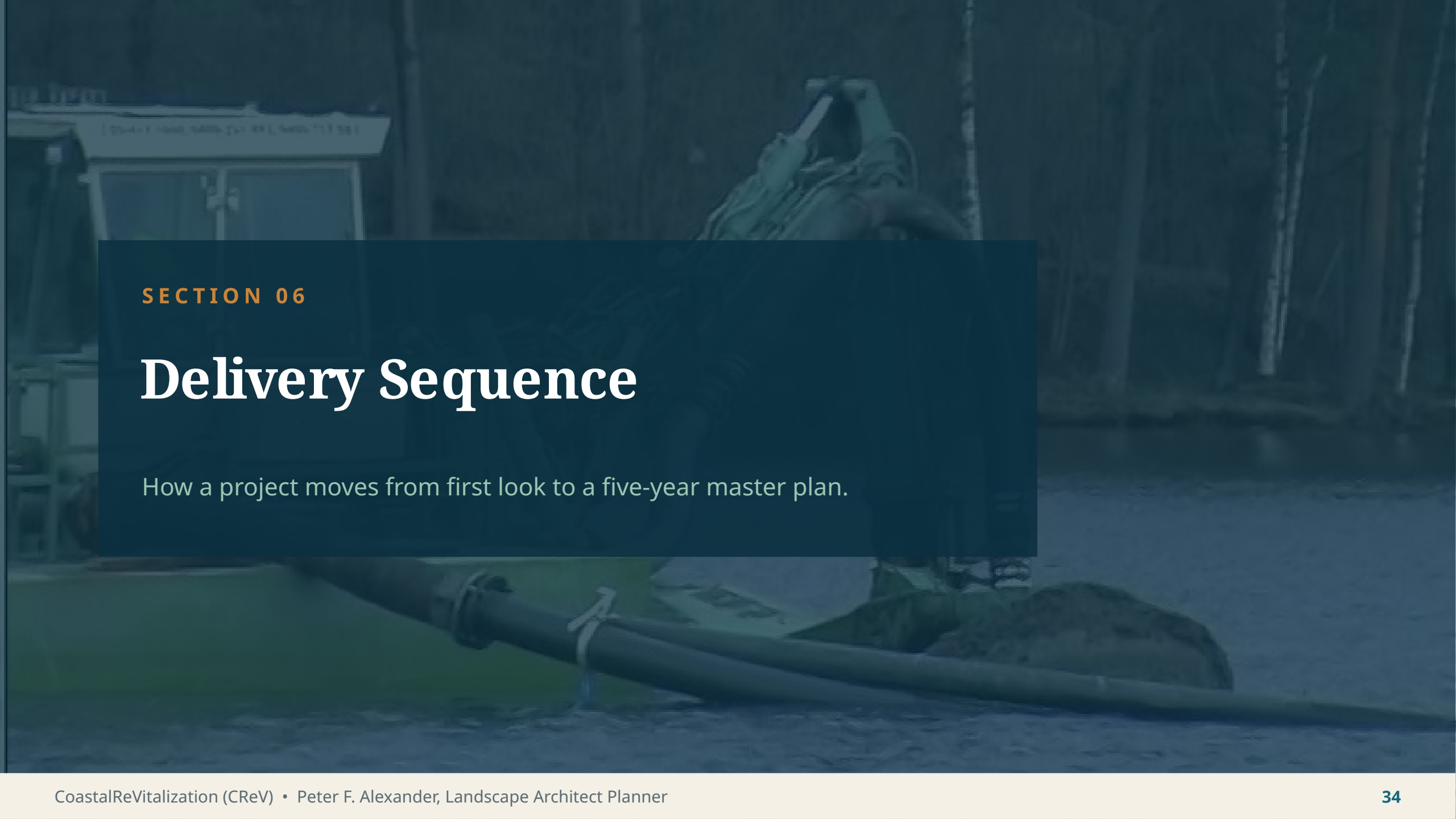
OUTCOME

The New England Lagoon



Tidal influenced waterway separating salt marsh areas — upland and transition zone behind.

“Lagoon” is commonly thought of as endemic to southern areas. The existence of tidal influenced waterways separating salt marsh areas can be profound for both ecological vitality and storm attenuation — and it is precisely what this coastline once had, and can have again.

The background image is a dark, blue-tinted photograph of a construction site. On the left, a white building with a flat roof is visible. In the center, a large crane with a long boom is positioned. The ground appears to be a mix of dirt and gravel. The overall scene is somewhat obscured by the dark overlay and the text boxes.

SECTION 06

Delivery Sequence

How a project moves from first look to a five-year master plan.

SEQUENCE

From First Look to Five-Year Master Plan

Step 1	Satellite assessment	Digital site review at no cost; site visit within 100 miles of a studio at pre-determined travel cost.
Step 2	Master plan & budget preview	Issued 12 hours after digital review and site visit.
Step 3	Bathymetry & testing	Precise location software and modern bathymetry locate silt accumulation; toxin and health analysis by Dr. Judy Gao. Results stored in a climate-controlled, limited-access facility.
Step 4	Pilot works	Artery cleansing at the occluded stream, fresh water marsh and compromised salt marsh sites; dewatering and strategic placement.
Step 5	Maintenance & storm response	Silt trap system plus restored salt marsh reduce channel occlusion permanently; monitoring before, during and after with GIS in three dimensions.

Revitalization, Not Relocation

Fifty years of wetlands regulation have succeeded remarkably. Centuries of dealing with floods and droughts have never been safer or easier to manage. What remains is to clear the arteries, test what comes out of them, and put the clean yield back to work as marsh.

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