THE EMBEDDED ARTIST PROJECT

2008-2010

SLOW CLEANUP: CIVIC EXPERIMENTS IN PHYTOREMEDIATION

2010-2012

A Special Project of:

The School of The Art Institute of Chicago
+
The City of Chicago
+
Frances Whitehead, Artist / Professor

THE EMBEDDED ARTIST PROJECT: 2008-2010 | SLOW CLEANUP:CIVIC EXPERIMENTS IN PHYTOREMEDIATION: 2010-2012

ACKNOWLEDGMENTS

The SLOW Cleanup Project Team would like to acknowledge the generosity of the organizations and individuals who made the Embedded Artist Project and the SLOW Cleanup Project possible. We appreciate their spirit of adventure and creative collaboration:

+ **Kevin Carroll**, Chicago Department of Transportation
+ **Paul Coffey**, Vice Provost, SAIC
+ **Chicago State University**, USTEP Program Participants
+ **Kathleen Dickhut**, Deputy Commissioner, Chicago Department of Housing & Economic Development
+ **Eddie's Food and Liquor Market**
+ **Greencorp Chicago** Staff & Trainees
+ **Matthew Guilford**, Former Innovation Program Director, Chicago Department of Innovation & Technology
+ **Michelle Harris**, Alderman, 8th Ward, Chicago
+ **Dan Hatch**, Architect
+ **Ben Helphand**, NeighborSpace
+ **Dr. Karel Jacobs**, CSU Professor of Urban Forestry
+ **Dr. Leroy Jones**, Principal Investigator, USTEP Program
+ **Barbara Koenen**, Project Manager, Chicago Department of Cultural Affairs and Special Events
+ **Suzanne Malec-Mckenna**, Fomer Commissioner, Chicago Department of Environment
+ **Dr. Walter Massey**, President, SAIC
+ **Douglas Pancoast**, Until Architecture
+ **Brendan M. Peterson**, Tecnica Environmental Services, Inc.
+ **Sandra Peterson**, President Cottage Grove Heights Community Coalition
+ **Judy Pollock**, Bird Conservation, Audubon Chicago Region
+ **Prairie Moon Nursery**, Winona, Minnesota
+ **Conner & Kelsay Shaw**, Possibility Place Nursery
+ **Dr. Elyssa Tenney**, Provost, SAIC
+ **Michael Thompson**, Chicago Honey Co-op
+ **Dr. Lisa Wainwright**, Dean of Faculty

Book Design: by SAIC Alumnus, DJ Catrow, Loudmouth Design Co.

Cover Photo: Michelle Litvin Photography

ABOUT THIS REPORT

This report serves as final report for the **SAIC City Modeling Grant** funded by the **Chicago Department of Environment ComEd Grant Fund** No. 009-929-0722005-0005. The work of this grant was begun two years earlier through an inter-institutional experimental program **The Embedded Artist Project**, which serves as the framework engagement for all that follows.

CONTENTS

APPENDIX

+ A digital appendix of supporting documentation accompanies this Final Grant Report to the City of Chicago.
+ This documentation is not included in all printed copies of the report due to copyright and confidentiality obligations.

ILLUSTRATIONS

+ All diagrams, illustrations, and photographs are prepared by Frances Whitehead and the Chicago Brownfield staff from publicly available data, unless otherwise noted.

EMBEDDED ARTIST PROJECT
INTER-INSTITUTIONAL COLLABORATION

The Embedded Artist Project (EAP), a two year pilot running from August 2008-August 2010, was a joint effort by the **City of Chicago** Departments of Planning, Environment, Innovation & Technology, and Cultural Affairs, and the **School of the Art Institute of Chicago**, to increase local government's ability to creatively address major systemic issues by embedding practicing artists in City departments at the management level.

Initiated by SAIC faculty **Frances Whitehead** and managed by the CDoIT Innovation Program, the EAP pilot has led directly to further investigations and collaborations between SAIC and the City of Chicago, including the work funded by the ComEd SAIC City Modeling Grant for which this document serves as final report and documentation.

These joint investigations between SAIC and the City of Chicago were begun during the Mayoral administration of **Richard M. Daley** and have continued into the administration of **Mayor Rahm Emanuel**. Plans to extend the ideas described in this report are expected to inform further collaborative efforts between SAIC and the City of Chicago in the coming years.

01 COLLABORATION

EMBEDDED ARTIST PROJECT AIMS

Innovation

▶ Utilize the innovation capacity of artists for civic innovation

▶ Provide new thinking early in program development process

Knowledge Transfer

▶ Link academic research, methodologies and discourses (*including theories and practices of innovation, creativity, knowledge production, and sustainability*) to benefit the City

Civic Engagement

▶ Pilot new forms of partnering with underutilized Chicago Institutions, "knowledge assets," and communities of practice

▶ Explore the potential of "Civic Experiments" and "Participatory Research" in partnered projects

TIMELINE OF PLACEMENTS + FUNDING SOURCE

August 2008–April 2009 (SAIC Funded)

Frances Whitehead
- Department of Planning
- Sustainable Division
- CMAP 2040 Food Plan Work Group

August 2008–August 2010 (SAIC Funded)

Adelheid Mers
- Department of Innovation and Technology
- Digital Excellence Action Agenda

April 2009–August 2010 (SAIC Funded)

Frances Whitehead
- Department of Environment
- Urban Management and Brownfields Redevelopment Division (UMBR)
- Abandoned Service Station Program

August 2010–August 2012 (DOE 929 GRANT)

Frances Whitehead
- Department of Environment
- Urban Management and Brownfields Redevelopment Division (UMBR)
- Abandoned Service Station Program

PROJECT INTERNS

Summer 2008–Spring 2009

Lia Roussett
- SAIC MFA Student, 2040 Food Plan

Summer 2009–Summer 2010

Nancy Fleischman
- SAIC MFA Student, DoE Brownfields

Spring 2011

Ivan Martinez
- SAIC MFA Student, Site Modeling

Summer 2011

Andrew Barco, Marissa Benedict, Craig Butterworth, Sarah Floyd, Hellen Ascoli
- SAIC MFA Students, Field Trials

Spring 2012–Summer 2012

Kim Harty
- SAIC MFA Student, File Archive Organization

Summer 2012

Meghan Quinn
- SAIC Alumna Site Typologies Graphics

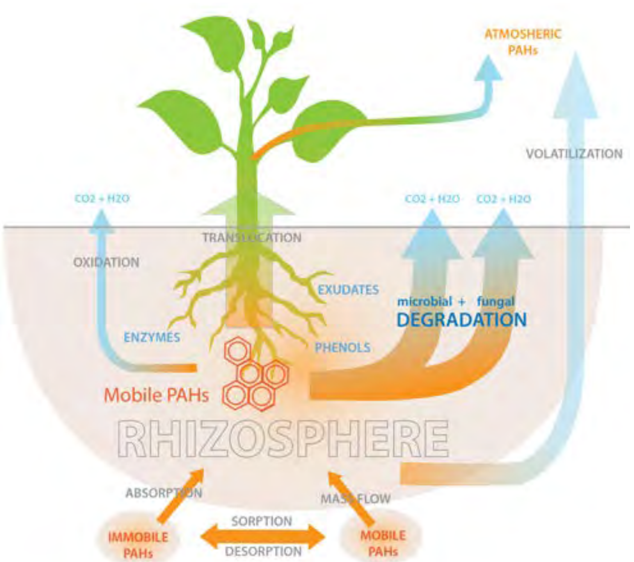
Emily Adamson

Janyne Little
- Purdue University Students, Lab Trials

Arthi Puri

Rani Iyer
- West Lafayette H.S. Students, Lab Trials

EMBEDDED ARTIST EA SAIC + CITY OF CHICAGO



Phytoremediation processes for petroleum

SUSTAINABLE BROWNFIELDS REMEDIATION PLAN – SLOW CLEANUP

RESEARCH DIRECTIVE

Suzanne Malec-Mckenna,
Former Commissioner of the Environment
Commissioner Malec-Mckenna directed the UMBR Project Team to investigate the following questions:

Theory:
What is a cutting-edge, sustainable brownfield cleanup?
How can Chicago move beyond the "state of the science" and "state of the practice"?

Practice:
How can UMBR Staff gain direct experience with alternative and/or bio-remediation processes?
What do we need to know?

Sites:
What can be done with Chicago's 400+ Abandoned Service Station Properties (ABNSS)?
Is this a candidate for "Asset-based Planning?"

PROJECT TEAM

Urban Management and Brownfields Redevelopment (UMBR) + Research Collaborators

Kimberly Worthington
- Deputy Commissioner, UMBR

David S. Graham
- P.G., Environmental Engineer III UMBR

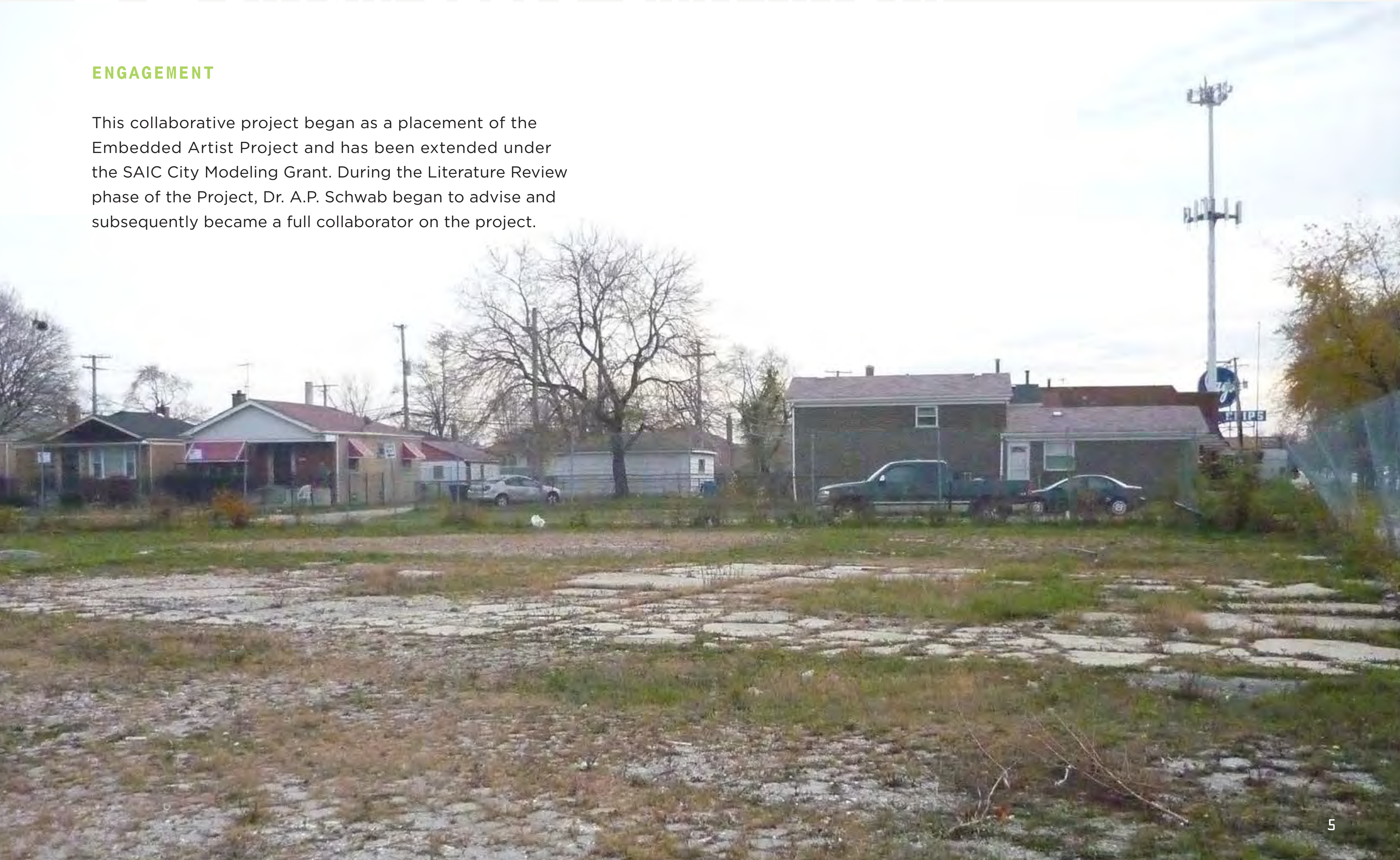
Frances Whitehead
- CDoE Embedded Artist
- Professor, School of the Art Institute of Chicago

Dr. Arthur Paul Schwab
- Professor, Phytoremediation Soil Science Texas A&M University (since 7. 2012)
- Purdue University (until 7. 2012)

02 BROWNFIELDS INNOVATION

ENGAGEMENT

This collaborative project began as a placement of the Embedded Artist Project and has been extended under the SAIC City Modeling Grant. During the Literature Review phase of the Project, Dr. A.P. Schwab began to advise and subsequently became a full collaborator on the project.



slow CLEAN-UP

Civic Experiments with Phytoremediation

Phyto-remediation Sites

Hydrology

City Boundary

0 2.5 5 10 Miles

Slow Cleanup - Frances Whitehead for Embedded Artist Project 10.18.09

PROJECT OVERVIEW:

SLOW Cleanup is a whole systems approach to site remediation designed to increase the net benefits from plant based phytoremediation processes. Piloting the use of ornamental, flowering, and fruiting plants, along with the typical agronomic plants most associated with phytoremediation, this enhanced cleanup program aims to increase the plant palette and site preparation methods for this alternative approach.

Working together with academic, community, and conservation partners, the City of Chicago has established Field Trial test plots of 80 previously untested plant species in Summer 2011 and a parallel Lab Trial at Purdue University of the same species. New remediative landscape typologies (swatches) can be modeled using the new plant remediator species from these trials. These designs might be executed on the small ABNSS parcels or any other hydrocarbon impacted site.

PROJECT AIMS/GOALS

New Values, New Models, New Practices, New Knowledge

- Move remediation from an "environmental" model (greener cleanup) to a fully "sustainable" model
- Extend current hydrocarbon phytoremediation science and soil conservation methods
- Design, execute, and assess a City of Chicago directed phytoremediation program
- Demonstrate "asset-based" planning. Leverage under-utilized assets such as time, land, citizen/partner participation
- Capture knowledge - recommend new "best practices", disseminate information

"INTERIM USE" CONCEPT - "TIME" IS AN ASSET

SCENARIOS	SMALL MINIMAL INTERVENTION TEMPORARY	MEDIUM → INTERIM	LARGE MAXIMAL INTERNVENTION PERMANENT
TIME FRAME FOR REMEDIATION (ESTIMATE)	FAST TURN AROUND 1-3 YEARS	SHORT TERM 3-5 YEARS	MEDIUM TERM 3-5 YEARS
TIME FRAME FOR NET BENEFITS (ESTIMATE)	SHORT TERM 3 YEARS	MEDIUM TERM 5-10 YEARS	10 YEARS INDEFINITE
TOXINS AND SOIL	SHALLOW EVENLY DISPERSED	DIRTY SITE WITH UNEVEN DISTRIBUTION OF TOXINS	MULTIPLE HOT SPOTS AND DEPTH OF TOXINS -PLUMES LIKELY
PLANT TYPE	ANNUAL PLANTS, AGRONOMIC SPECIES, KNOWN REMEDIATORS	WOODY SHRUBS, PERENNIALS, PRAIRIE FORBS, LIKELY REMEDIATORS	SPECIAL PLANTING FEATURES REFLECTS LONG TERM
ECOLOGIC, ECONOMIC, SOCIO-CULTURAL OPPORTUNITIES	ECONOMIC FOCUSED, LIKELY TO BE RE-DEVELOPED	MORE POTENTIAL FOR VISUAL INTEREST AND SOCIO CULTURAL	EXCELLENT PROGRAM POTENTIAL GREATEST ENVIRO BENEFITS
COST TO INSTALL	LESS EXPENSIVE	MEDIUM COST	EXPENSIVE
MAINTENANCE	"CROP" APPROACH REQUIRES ANNUAL RESEEDING	NEEDS CARE TO ESTABLISH LESS CARE TO MAINTAIN	LONG TERM MAINTENANCE LESSENS WITH MATURITY
TOTAL COSTS AND TIME	**LEAST**	→	**MOST**

03 CONCEPT

CONCEPT DESIGN – KEY ELEMENTS

After a thorough literature review on petroleum phytoremediation science and practice, a program concept was devised that foregrounded the following elements:

"Interim Use" repurposes petroleum contaminated properties

- Likens process to "SLOW Food" movement- alternative to "fast cheap easy" approach
- Embraces "time" as an asset and cultural value
- Small parcels well suited as test sites for 5-10 approaches to "phytoscapes".

Onsite soil re-use prevents sending soil to landfill

- An alternative to "dig and dump" methods
- Recycle site asphalt and concrete pavement
- Turns site gravel into native soils with organic amendments

"Net Benefits" model for Brownfields

- Integrates "tangible" and "intangible" benefits – integrates qualitative and quantitative approaches
- Based on the UN "4 pillar" model of Sustainability adds more value(s)
- Adds community participation into the usual economic/environmental remediation criteria
- Demonstrates economic potential of enhancing habitat, ornamental, and social improvements
- Designed Civic Experiment- Public Research Concept- participatory outreach
- 3 Scales of intervention relates to complexity and budget

"Un-development"- flip the script

- Unlike the industry standard of "fast cheap easy" this concept asserts that additional uncharted costs are incurred by leaving sites partially paved
- If ABNSS sites were fully "undeveloped" and restored to productive green infrastructure, the petroleum would naturally "attenuate"
- In urban areas with little or no re-develoment pressure, the most economical strategy is to see these sites as a land-bank (as assets), which can be optimized if fully "un-developed"

DESIGN SCENARIOS

Interim Use Design Schemes are categorized, based on cost, amount of work required to install plants, duration of site maintenance and level of ongoing monitoring and evaluation.

(SMALL) 2 to 3 year Time Frame / Lowest Cost and Impact:

- Minimal site preparation – limited concrete/ asphalt removal and onsite maintenance
- Low cost plant installation and ongoing maintenance – vigor based plant selection
- Minimal site improvements

(MEDIUM) 3 to 6 year Time Frame / Moderate Cost and Impact:

- Site preparation – Removal or amendment of concrete and engineered fill (gravel, etc)
- Varied horticultural plant installation and seasonal plant maintenance
- Limited aesthetic site improvements (fencing and education signage)
- Annual monitoring of soil remediation

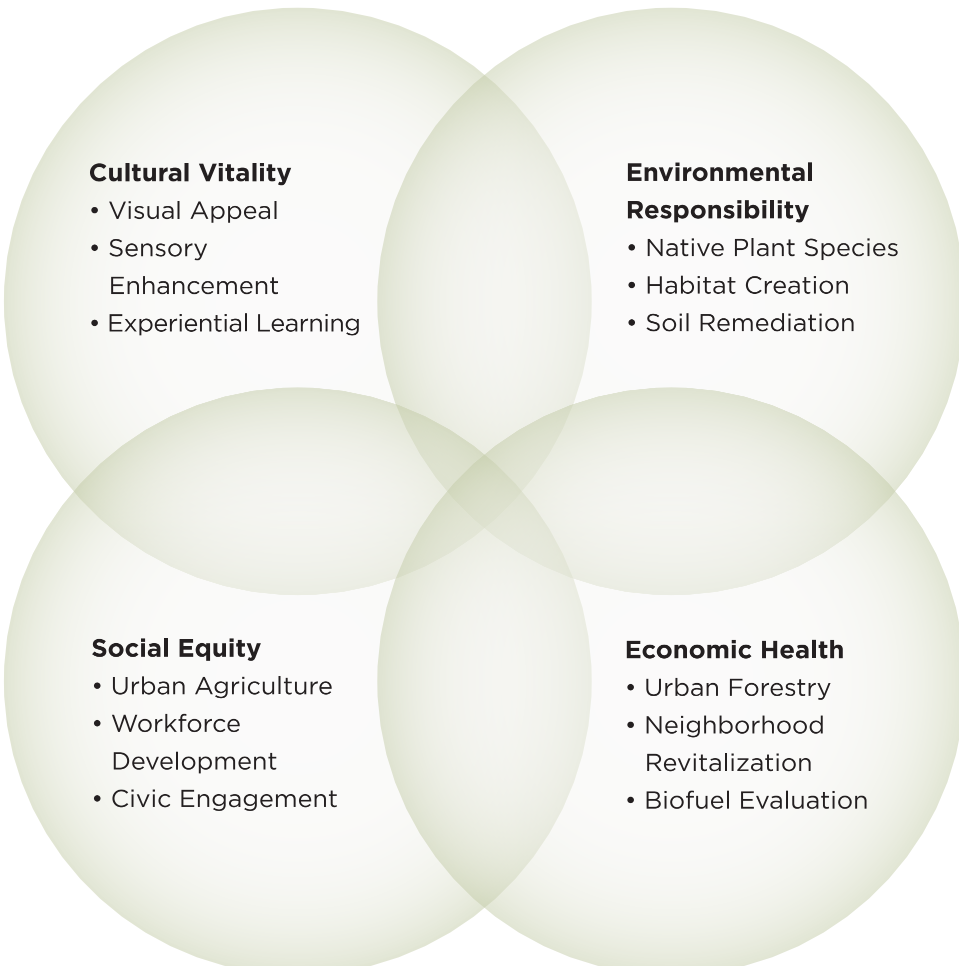
(LARGE) 6 to 10 year Time Frame / Highest Cost and Impact:

- Extensive removal of historic structures and intensive soil preparation
- Plant installation varied, including long-term fruiting plants and trees
- Aesthetic site improvements (ornamental fencing, land contouring, educational features)
- Detailed evaluation and site monitoring

[CONCEPT]

DESIGNED PLANTINGS

Can be developed to illustrate the 4 pillar model of sustainability to include:



CHALLENGES TO THE NET BENEFITS APPROACH:

- Need to improve understanding / knowledge of natural processes
- Different from “standard” engineering practices
- Takes longer to achieve target habitat than an “engineered” vegetative cover
- Requires the use of professionals not typically consulted (paradigm shift)
- Requires site-specific planning and design considerations not usually considered

Bruce R Pluta, US EPA Region 3, 2009

Enhanced Phyto Project - "Universe of Costs"

Estimated Per Site Cost by Scope	SMALL		MEDIUM		LARGE	
	2 to 3 Year Time Frame		3 to 6 Year Time Frame		6 to 10 Year Time Frame	
	Lowest Impact		Moderate Impact		Highest Impact	
Proposed Tasks	no maintenance	w/ maintenance	no maintenance	w/ maintenance	no maintenance	w/ maintenance
Work By DOE						
Site Evaluation	$ 10,000.00	$ 10,000.00	$ 15,000.00	$ 15,000.00	$ 25,000.00	$ 25,000.00
Site Preparation	$ 25,000.00	$ 25,000.00	$ 55,000.00	$ 55,000.00	$ 90,000.00	$ 90,000.00
Installation	$ 25,000.00	$ 25,000.00	$ 60,000.00	$ 60,000.00	$ 80,000.00	$ 80,000.00
Annual Monitoring	$ 30,000.00	$ 30,000.00	$ 50,000.00	$ 50,000.00	$ 135,000.00	$ 135,000.00
Work by DOE or Partners						
First Year Maintenance		$ 15,000.00		$ 15,000.00		$ 20,000.00
Ongoing Maintenance		$ 10,000.00		$ 50,000.00		$ 90,000.00
Per Site / Per Scenario	$ 90,000.00	$ 115,000.00	$ 180,000.00	$ 245,000.00	$ 330,000.00	$ 440,000.00

Proposed Site Concepts and likely cost range for each concept type

Concept		Range of costs -- low to high					
Agronomic plants	S	$ 90,000.00	$ 115,000.00				
Gridded cement	S	$ 90,000.00	$ 115,000.00				
Biofuels	S - M	$ 90,000.00	$ 115,000.00	$ 180,000.00	$ 245,000.00		
Fragrance	S - M	$ 90,000.00	$ 115,000.00	$ 180,000.00	$ 245,000.00		
Bird thicket (allees)	M			$ 180,000.00	$ 245,000.00		
Prairie perennials	M			$ 180,000.00	$ 245,000.00		
Bosque	M			$ 180,000.00	$ 245,000.00		
Pollinator scape	M - L			$ 180,000.00	$ 245,000.00		
Test plots	M - L			$ 180,000.00	$ 245,000.00	$ 330,000.00	440,000.00
Winter color (mounds)	L		Range of costs -- low to high			$ 330,000.00	440,000.00
Fruiting/ urban ag	L					$ 330,000.00	440,000.00
					Range of costs -- low to high		

4 low impact sites	$ 360,000.00	$ 230,000.00				
	5 medium impact sites		$ 900,000.00	$ 1,225,000.00		
				3 high impact sites	$ 660,000.00	$ 880,000.00

Costs if all typologies Executed	All 11 low end	All 11 high end
	$ 360,000.00	$ 230,000.00
	$ 900,000.00	$ 1,225,000.00
	$ 660,000.00	$ 880,000.00
	$ 1,920,000.00	$ 2,335,000.00

STATE OF THE SCIENCE — FINDINGS

Technology literature review

- Hydrocarbon remediation is the product of microbial activity enhanced by root exudates
- Phenolic root exudates are suspected to be contributors to the process
- No semi-volatile hydrocarbon uptake offers many unexplored opportunities for urban agriculture and habitat
- Most plants with vigorous root structures are likely to remediate

"Known and Suspected Remediator" database created

- 100+ species from 200+ studies were reviewed by Dr. Paul Schwab from publicly available data
- Known hydrocarbon remediators were revealed to be limited to a few agronomic plants, especially grasses and monocots
- Non-agronomic plants including ornamental, habitat, fruit bearing and prairie forbs remain largely untested

Existing studies of native flowering prairie forbs, shrubs, trees

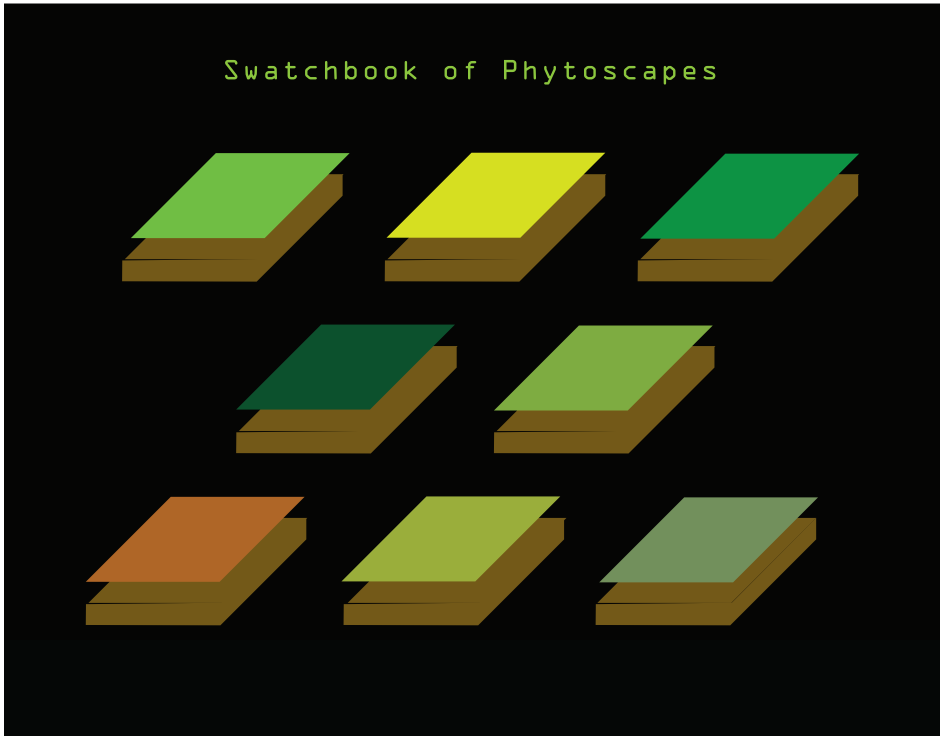
- Clayton Rugh, 2003 Study in River Rouge, Michigan
  + Preliminary results not conclusive but promising
  + Limited species similar in scope to our study

- David Tsao, 2009 Study of PAH tolerance for British Petroleum
  + Tested tolerance not remediation

STATE OF THE DISCOURSE — FINDINGS

Multi-criteria, values-based planning

- Planners are trending towards a "systemic" understanding, which differentiates sustainable from "greener" clean-up models.
- Many organizations are considering *two* criteria or values such as:
  + Aesthetics effecting socio-cultural outcomes
  + Habitat improvement affects social and biologic outcomes
  + Aesthetics and habitat can reverse negative perceptions around site reuse that affects economics of the site and redevelopment in the vicinity
- No one has connected all these aspects in one program concept

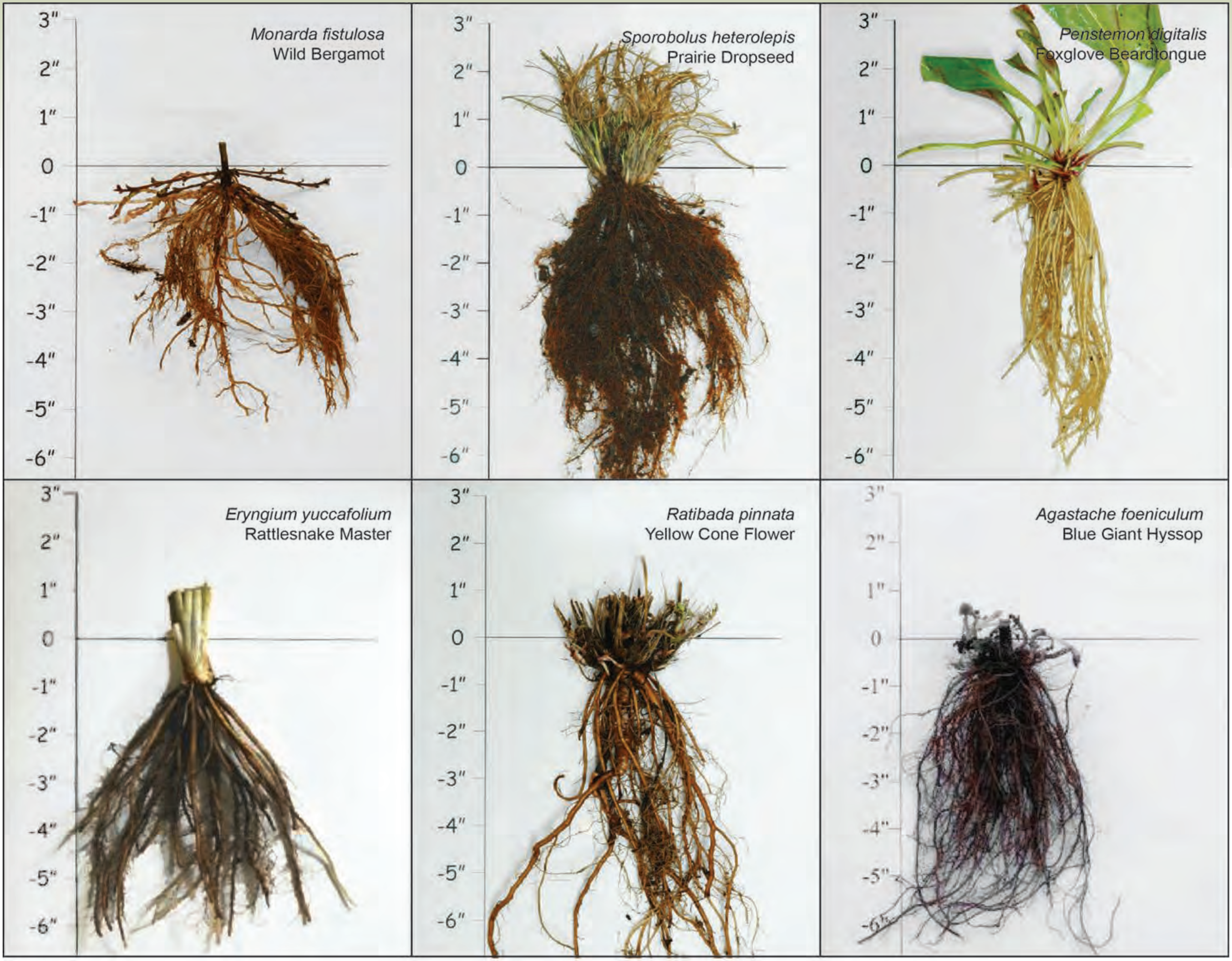


Land use typologies need to be expanded for new urban functions

- Few available land use typologies have been used as basis for remediation site design
- Current thinking privileges large parcels but habitat patches and green corridors are equally important
- Small parcels on prominent corners can have big impacts on human and animal communities

SWATCH BOOK

Ecological	Land Use Planning	Vernacular	Other
Upland Forest	Yards / Greens	Thicket	Phytoscape
Oak Woodland	Gardens / Courts	Big Hedge	Urban Wild
Wetland	Parks	Lawn	Bird Scape
Riparian	Frontages	Woods	Intermediate Landscape
Edge Condition	Athletic Fields	Tree Lot	Linear Landscape
Prairie	Open Space	Bird Gardens	Artscape
Grassland	Evergreen	Forest Margins	Moundscape
Dune Complex	Ornamental	Flower Garden	Locus Amenus
Savanna	Fruiting	High Fence	Allees for Vistas
Wooded Community	Urban / Rural/ Suburban	Low Fence	5 Senses Landscape
Shrubland	Conduit	High Wall	Grove / Bosque
Corridors	Strips / Edges	Low Wall	Orchard
Greenways	Pocket Wilderness	Hedges	Fruiting Shrubs
Edgeland	Urban Ecosystem	Gates	Flowering Shrubs
Bird Rest Stops	Wooded Ancient	Used by the Public	Briar Patch
Intermediate Patch	Wooded Estate Land	Used by Animals	Phenoscape(Climate)
Interstitial Areas	Wooded Secondary	Ball Fields / Courts	Bugscape (Bees)
Dispersed Unwooded	Commons	Walk / Path	Biofuel Zone
Nucleated Unwooded	Central Square	Farmers Markets	Botanic Garden
Habitat	Wet and Waste Unwooded	Memorials	Meadow
Nut And Fruiting Plants	Unsettled Open Land	Parkway	Research Landscape



PHOTOS courtesy of Prairie Moon Nursery

Root masses of prairie forbs

PLANT DATABASE

New "Candidates Remediator" Plant Species Database created

- 475 species were assembled, listed and assessed by multiple native plant and horticulture specialists
- Evaluation criteria included: appearance, vigor, availability, root morphology, prior study, phenolic content, habitat enhancement, alkalinity tolerance, net benefits

Root Typology Photo Archive reviewed

- Scaled photographs of all major native plant species supported the plant species assessment
- Provided *pro bono* by Prairie Moon Nursery, Winona, Minnesota

New Likely Remediator Plant Species selected for study

- 80 species of largely native trees, shrubs and perennial forbs were selected for study
- Grasses excluded from study as "known remediators" except 3 species as a cross reference
- Species were selected to produce the 10 site typologies under consideration

NATIVE "LIKELY REMEDIATOR" SPECIES TESTED

TREES

	SCIENTIFIC NAME	COMMON NAME
1	*Amelanchier arboria*	Downy Serviceberry
2	*Amelanchier laevia*	Shad Bush
3	*Asimina triloba*	Paw Paw
4	*Cercis canadensis*	Redbud
5	*Crataegus crus gali*	Hawthorn
6	*Diospyros virginiana*	American Persimmon
7	*Hamamelis virginiana*	Witch Hazel
8	*Juglans nigra*	Nut Tree (Walnut)
9	*Juniperus communis*	Common Juniper
10	*Malus domestica*	Edible Apple
11	*Malus iowensis*	Prarie Crab
12	*Prunus cerasus*	Edible Cherries (Sour)
13	*Prunus americana*	Wild Plum
14	*Prunus serotina*	Black Cherry
15	*Quercus bicolor*	White Oak
16	*Quercus muelenberghi*	Chiquapin Oak
17	*Syringa vulgaris Sarah Sands*	Common Lilac

SHRUBS

	SCIENTIFIC NAME	COMMON NAME
1	*Amorpha canescens*	Lead Plant-Ironwood
2	*Amorpha fruticosa*	False Indigo, Indigobush
3	*Aronia melanocarpa*	Black Chokeberry
4	*Cephalanthus occidentalis*	Buttonbush
5	*Cornus alba "Buds yellow"*	Yellow Twig Dogwood
6	*Cornus drummondii*	Rough-leaved Dogwood
7	*Cornus stolonifera C.sericea*	Red-osier Dogwood
8	*Corylus americana*	American Hazelnut
9	*Diervilla lonicera*	Dwarf Bush Honeysuckle
10	*Forsythia spp. X intermedia*	Forsythia Northern Gold
11	*Physocarpus opulifolius*	Common Ninebark
12	*Rhus aromatica*	Fragrant Sumac
13	*Ribes americana*	Wild Black Currant
14	*Rosa blanda*	Early Wild Rose
15	*Salix humulis*	Prairie Willow
16	*Sambucus canadensis*	Elderberry
17	*Viburnum dentatum*	Arrowhead Viburnum

FORBS

	SCIENTIFIC NAME	COMMON NAME
1	*Achillea sp.*	Yarrow
2	*Agastache foeniculum*	Lavender Blue Giant Hyssop
3	*Agastache nepetoides*	Yellow Giant Hyssop
4	*Andropogon gerardii*	Big Bluestem
5	*Andropogon scoparius*	Little Bluestem
6	*Asclepias syriaca*	Common Milkweed
7	*Asclepias tuberosa*	Butterfly Plant
8	*Asclepias verticillata*	Whorled Milkweed
9	*Aster ericoides*	Heath Aster
10	*Aster laevis*	Smooth Blue Aster
12	*Aster novae-angliae*	New England
13	*Baptisia australis*	Blue Wild False Indigo
14	*Cirsium discolor*	Pasture Thistle
15	*Echinacea pallida*	Pale Purple Coneflower
16	*Echinacea purpurea*	Purple Coneflower
17	*Eryngium yuccifolium*	Rattlesnake Master
18	*Eupatorium maculatum*	Joe Pye Weed
19	*Eupatorium perfoliatum*	Boneset
20	*Eurphorbia*	Which One?
21	*Geum triflorum*	Prairie Smoke
22	*Helianthus giganteus*	Tall Sunflower
23	*Helianthus mollis*	Downy Sunflower
24	*Helianthus rigidus*	Prairie Sunflower
25	*Helianthus tuberosus*	Jerusalem Artichoke
26	*Heuchera richardson*	Alum Root
27	*Liatris aspera*	Rough Blazing Star
28	*Liatris pycnostachya*	Prairie Blazing Star
29	*Monarda fistulosa*	Wild Bergamot (Bee Balm)
30	*Monarda punctata*	Horse Mint
31	*Nepeta cataria*	Catnip
32	*Oenothera missoriensis*	Evening Primrose
33	*Penstemon digitalis*	Foxglove Beardtongue
34	*Petalostemum purpureum*	Purple Prairie Clover
35	*Physostegia virginiana*	Obedient Plant
36	*Ratibada pinnata*	Yellow Coneflower
37	*Rudbeckia subtomentosa*	Sweet Black-eyed Susan
38	*Rudbeckia triloba*	Brown-eyed Susan
39	*Salvia azurea var. pitcherii*	Pitchers Sage

	SCIENTIFIC NAME	COMMON NAME
40	*Sanguisorba canadensis*	American Burnet
41	*Silphium integrifolium*	Rosin Weed
42	*Silphium terebinthinaceum*	Prairie Dock
43	*Silphum laciniatum*	Compass Plant
44	*Solidago missouriensis*	Missouri Goldenrod
45	*solidago ohioensis*	Ohio
46	*solidago speciosa*	Showy
47	*Sporobolus heterolepis*	Prairie Dropseed
48	*Verbena hastata*	Blue Vervain
49	*Verbena stricta*	Hoary Vervain
50	*Vernonia fasciculata*	Ironweed
51	*Veronicastrum virginicum*	Culver's Root

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SITE DATABASE ANALYSIS

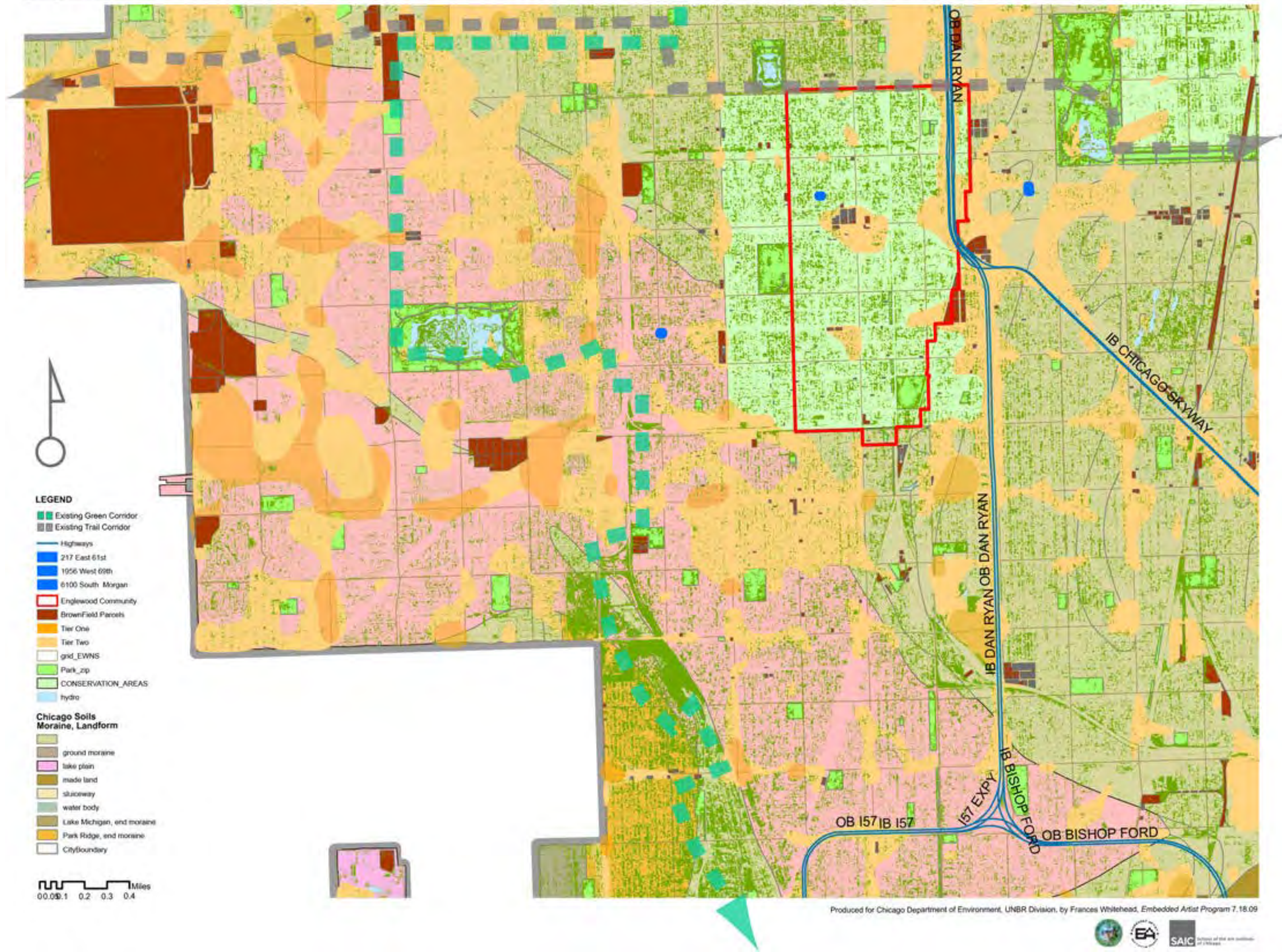
Abandoned Service Station Inventory Review

- 400 City controlled sites were assessed as candidate sites for the program
- Criteria for selection included: geotechnical, community, location, geographic distribution in city, soils, contaminant types and locations, important adjacencies, documentation, and relationship to partners and neighborhoods

Final Site Selection

- Contextual GIS Mapping studies were performed to identify opportunities and adjacencies for potential remediative landscapes
- Partnerships and potentials were assessed from these adjacencies
- 25 sites were selected for in-depth soil and contamination review
- 10 candidate sites were identified as suitable for the program

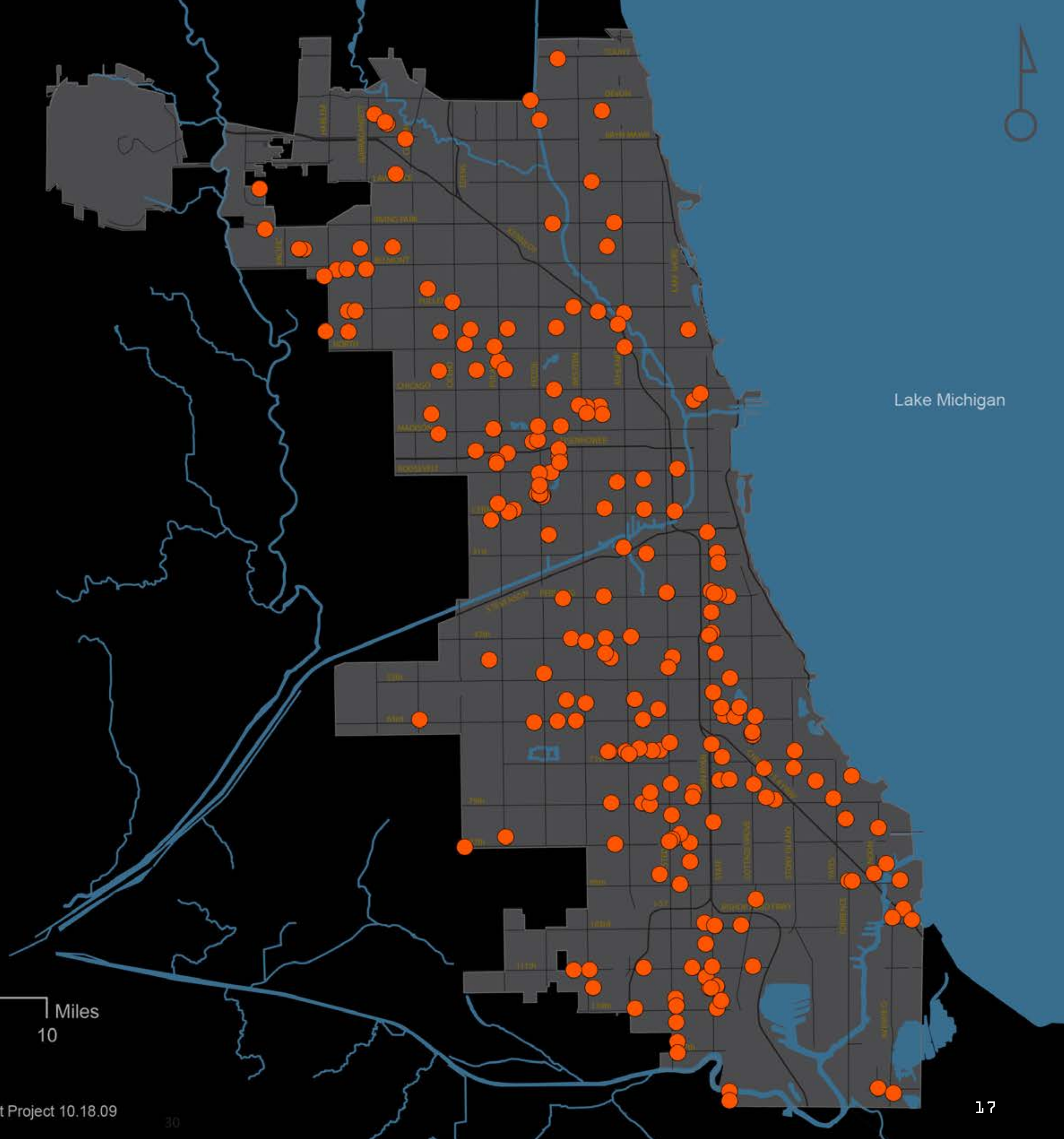
Phytoremediation Site Selection Study for Abandoned Gas Station 1.2 Heat Island + Green Corridor + Urban Ag Potential for Englewood Area



Produced for Chicago Department of Environment, UNBR Division, by Frances Whitehead, *Embedded Artist Program* 7.18.09

slow
CLEAN-UP

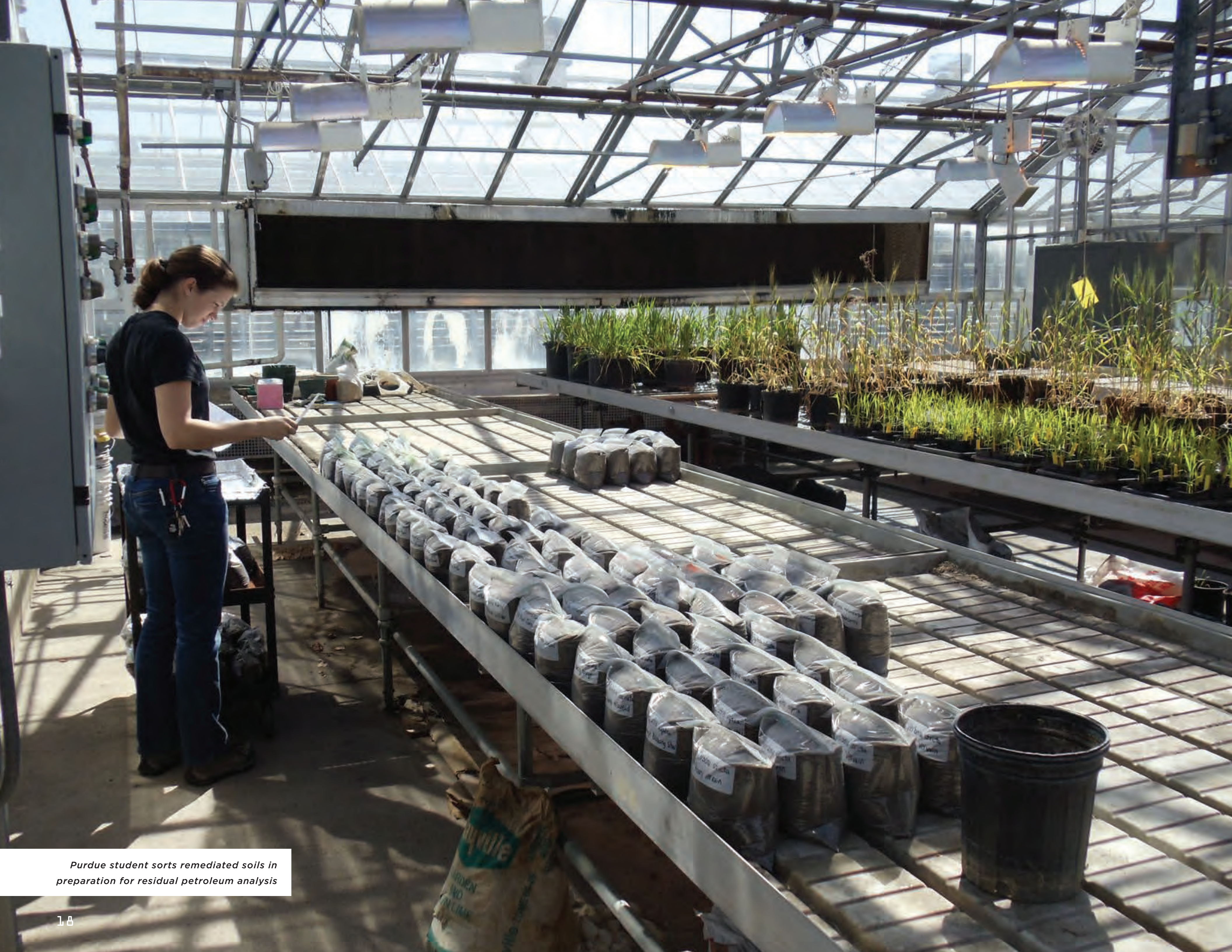
Abandoned
Service Stations
in Chicago, 2009



- Abandoned Service Stations
- Hydrology
- City Boundary

0 2.5 5 10 Miles

Slow Cleanup - Frances Whitehead for Embedded Artist Project 10.18.09



Purdue student sorts remediated soils in preparation for residual petroleum analysis

TECHNOLOGY + METHODOLOGY RESEARCH

KEY ELEMENTS

The Phytoremediation Plant Trials has five components:

1. The controlled lab trial to test actual petroleum dissipation per species
2. A complementary field trail to test plant vigor and adaptability
3. An experimental site soil preparation method
4. A community engagement and visitor informed site design
5. An educationally focused field trails installation process

1) LAB TRIALS – PROOF OF THE CONCEPT

Structure of the Lab Trials

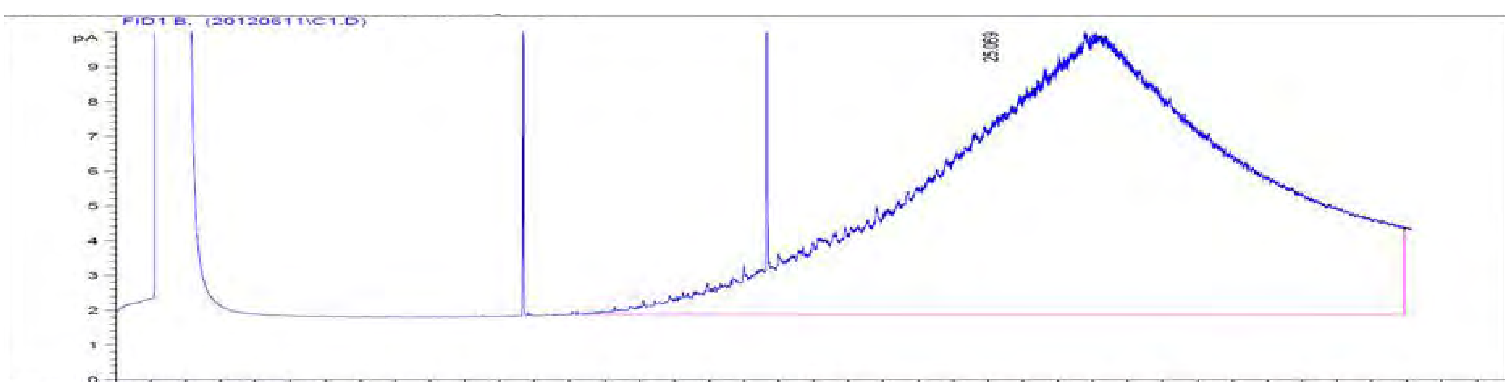
A greenhouse study was initiated in the summer of 2011 to test a broad array of plant species that had not been evaluated previously for phytoremediation potential. The species were chosen to fulfill a number of roles in horticultural/urban agriculture landscapes. A limited number of species that had been tested previously (e.g., big bluestem, little bluestem, purple coneflower, tall sunflower) were included to verify that the experiment was executed successfully.

- ▶ 80 plant species grown in soils treated with motor oil as a surrogate for petroleum hydrocarbons (TPH - Total Petroleum Hydrocarbons)
- ▶ The soil used was an agricultural soil from Indiana
- ▶ Target concentration: 4000mg TPH/kg soil
- ▶ 1.6 kg of soil added to greenhouse pots
- ▶ Plants placed in the soils
- ▶ After seven months of watering and fertilization, pots sacrificed
- ▶ Soils exhaustively extracted with dichloromethane
- ▶ TPH determined by gas chromatography with flame ionization detection

Benchmark soil samples were:

+ contaminated soil kept dry and cool for the duration of the experiment;
+ unplanted soil treated in the same way as planted soils (placed in pot, watered, fertilized)

GRAPH courtesy of A.P. Schwab

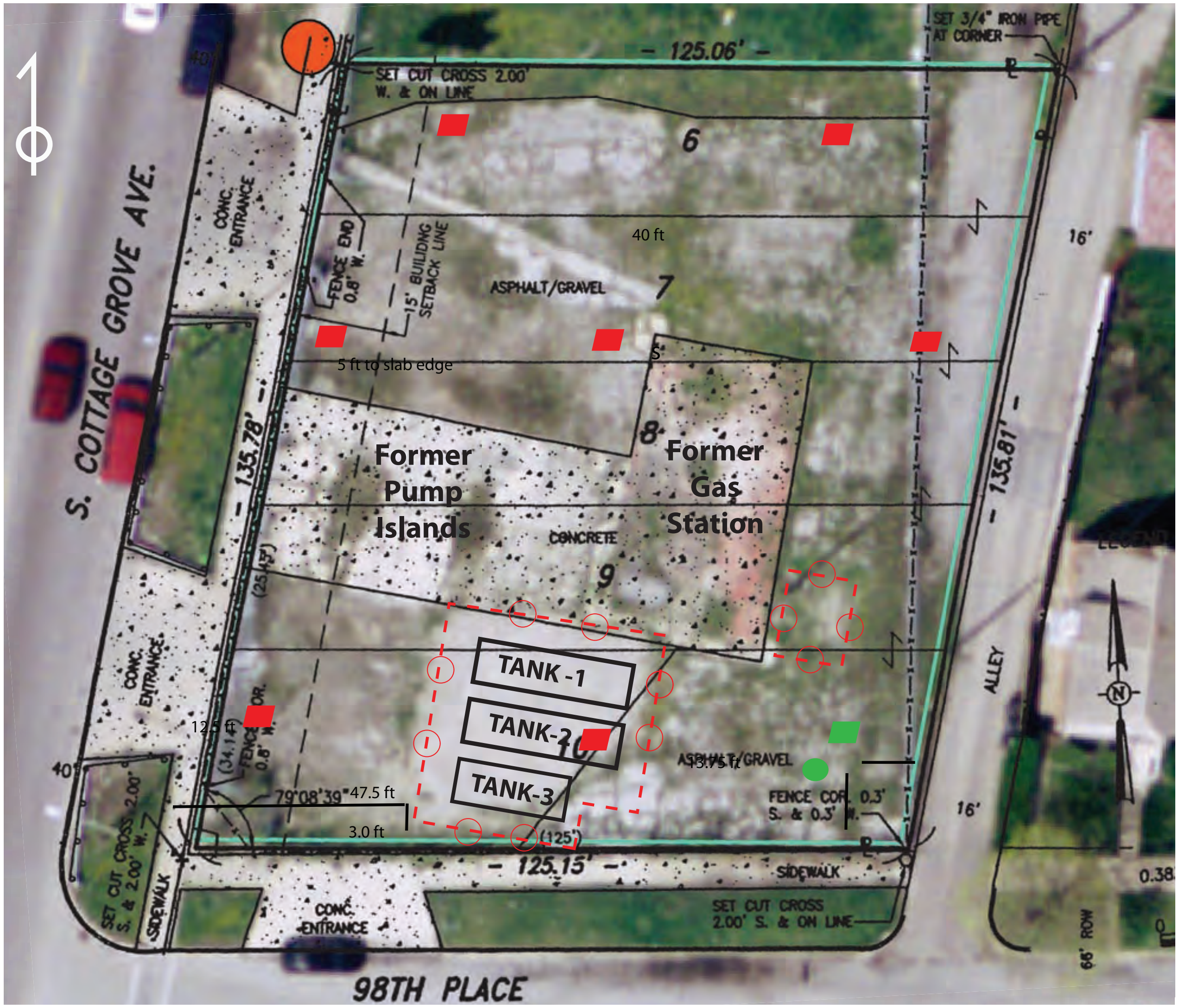


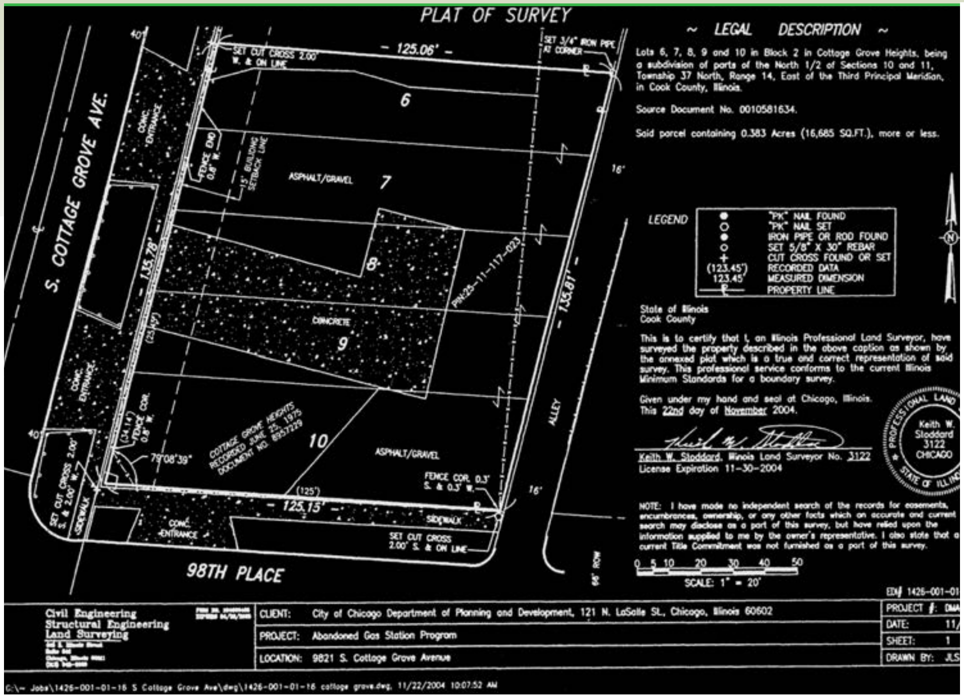
Gas chromatogram of a soil extract

2) FIELD TRIALS – SITE CONDITIONS

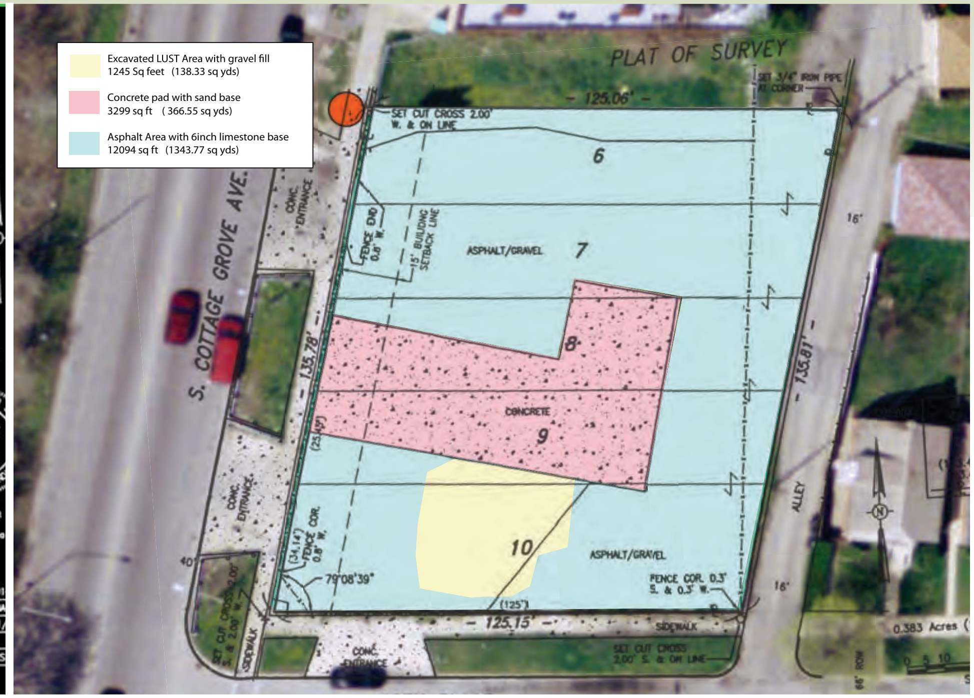
The Cottage Grove Heights Laboratory Garden
98th Street and South Cottage Grove Avenue
Abandoned Service Station
PIN: 25-11-117-023-0000

A large 5 parcel abandoned gas station property adjacent to Chicago State University (CSU) in the Cottage Grove Heights neighborhood of the 6th ward in south Chicago was selected for the Field Trials. Selection criteria for this site included its adjacency to CSU, the existence of native silty clay soils on site, and the geotechnical and regulatory status of the site. Many soil borings and site measurements had been conducted over the last decade providing background data including data that supported the Phase1, Phase2 and NFR letter that constituted the site dossier. The site had been remediated to meet industrial/commercial TACO standards, and thus provided the opportunity to use phytoremediation to move the site soils towards residential standards.

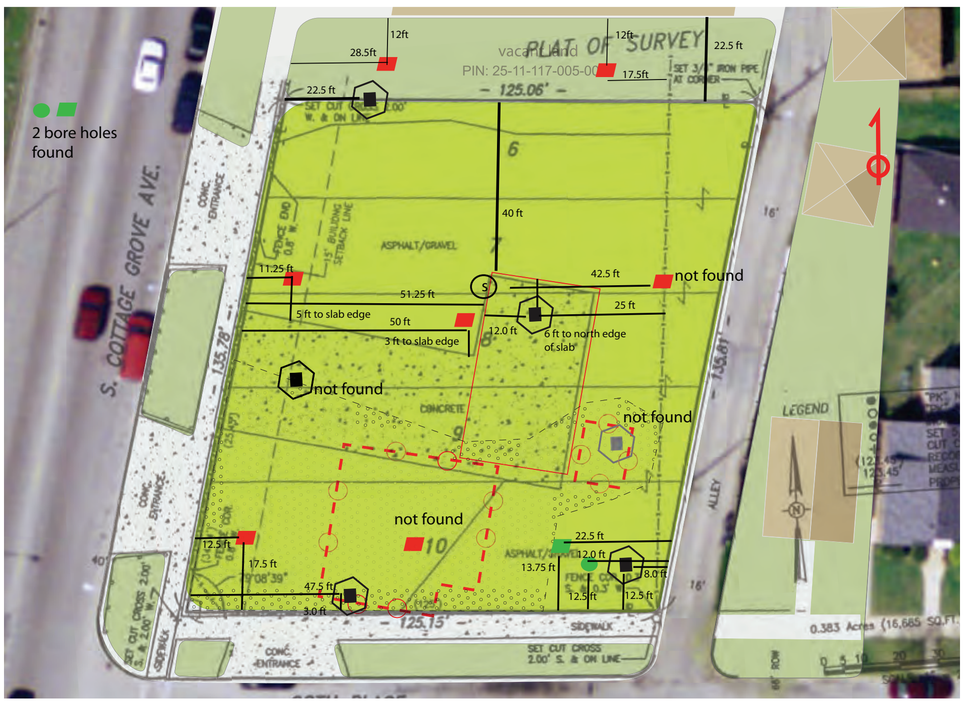




PLAT OF SURVEY
~ LEGAL DESCRIPTION ~
Lots 6, 7, 8, 9 and 10 in Block 2 in Cottage Grove Heights, being a subdivision of parts of the North 1/2 of Sections 10 and 11, Township 37 North, Range 14, East of the Third Principal Meridian, in Cook County, Illinois.
Source Document No. 0010581634.
Said parcel containing 0.383 Acres (16,685 SQ.FT.), more or less.
LEGEND
"PK" NAIL FOUND
"PK" NAIL SET
IRON PIPE OR ROD FOUND
SET 5/8" X 30" REBAR
CUT CROSS FOUND OR SET
(123.45') RECORDED DATA
123.45' MEASURED DIMENSION
PROPERTY LINE
State of Illinois
Cook County
This is to certify that I, an Illinois Professional Land Surveyor, have surveyed the property described in the above caption as shown by the annexed plat which is a true and correct representation of said survey. This professional service conforms to the current Illinois Minimum Standards for a boundary survey.
Given under my hand and seal at Chicago, Illinois. This 22nd day of November 2004.
Keith W. Stoddard, Illinois Land Surveyor No. 3122
License Expiration 11-30-2004
Keith W. Stoddard 3122 CHICAGO
NOTE: I have made no independent search of the records for easements, encumbrances, ownership, or any other facts which an accurate and current search may disclose as a part of this survey, but have relied upon the information supplied to me by the owner's representative. I also state that a current Title Commitment was not furnished as a part of this survey.
SCALE: 1" = 20'
S. COTTAGE GROVE AVE.
98TH PLACE
ALLEY
125.06'
125.15'
135.78'
135.81'
ASPHALT/GRAVEL
CONCRETE
CLIENT: City of Chicago Department of Planning and Development, 121 N. LaSalle St., Chicago, Illinois 60602
PROJECT: Abandoned Gas Station Program
LOCATION: 9821 S. Cottage Grove Avenue
Civil Engineering
Structural Engineering
Land Surveying



Excavated LUST Area with gravel fill
1245 Sq feet (138.33 sq yds)
Concrete pad with sand base
3299 sq ft (366.55 sq yds)
Asphalt Area with 6inch limestone base
12094 sq ft (1343.77 sq yds)
PLAT OF SURVEY
S. COTTAGE GROVE AVE.
ASPHALT/GRAVEL
CONCRETE
125.06'
125.15'
0.383 Acres



2 bore holes found
vacant land
PIN: 25-11-117-005-00
PLAT OF SURVEY
not found
not found
not found
not found
12ft
28.5ft
22.5 ft
17.5ft
40 ft
11.25 ft
51.25 ft
42.5 ft
25 ft
5 ft to slab edge
50 ft
3 ft to slab edge
12.0 ft
6 ft to north edge of slab
22.5 ft
12.5 ft
17.5 ft
47.5 ft
3.0 ft
13.75 ft
8.0 ft
S. COTTAGE GROVE AVE.
LEGEND
0.383 Acres (16,685 SQ.FT.)

This Parcel not part of project
PLAT OF SURVEY
Leave these 2 parcels as gravel
Prepare soil on these 3 parcels
S. COTTAGE GROVE AVE.
98TH PLACE
0.383 Acres (16,685 SQ.FT.)
9821-15 South

3) SOIL PREPARATION METHOD

Soil Amendments Specifications

The principal aims of the in-situ soil preparation was:

- Keep all non-recyclable materials on site and out of landfills
- Identify a mechanical method for turning the hard-packed gravel layer into the soils under neath to at least 30inches in depth
- Turn an equivalent volume of organic matter (compost) into the top 12inches of soil, based on the onsite volume of gravel, sand, or excavation stone

Free petroleum lens in soil

Existing Conditions and Planting Soil Requirements

Working in concert with Dr. AP Schwab and the environmental team from Technica Environmental, soil and gravel volumes at the field trials site on South Cottage Grove were sampled and calculated.

- 3 types of site conditions, typical for ABNSS properties in Chicago, were observed:
  - **1)** 75% of the site contained 6 inches of crushed limestone base under 3 inches of asphalt
  - **2)** 20% of the areas contained concrete pavement over a sand base rather than crushed stone, including a building foundation artifact
  - **3)** 5% of the site was a tank excavation where the underground gasoline storage tank (UST) had been removed. In this area, native soils were returned to the excavation and the tank volume was replaced with a stone mixture - typical of this application
- Lenses of free petroleum were observed, along with petroleum odor, once the pavement was removed during the soil preparation process
- Sitewide, first succession plant species had built up topsoil to a depth of 3 inches in most areas

Typical soils on gas station sites

3) SOIL PREPARATION METHOD CONTINUED

Soil Preparation Methodology

The following steps were employed at the Cottage Grove Heights Laboratory Garden to prepare the soil. The entire process was executed in three 8 hour work days.

Step 1 – Day 1

- Using hydraulic excavator and skid steer equipment remove, transport and recycle 200 tons of concrete surface pavement from the site and all subsurface concrete foundations
- Saw cut concrete/asphalt pavement along property line as necessary to facilitate clean removal
- Remove and store existing chain link fence for re-installation
- Load out, transport and dispose (at sub-title D landfill) 220 tons of asphalt

Step 2 – Day 2

- Using a front end loader, excavate gravel from UST area and mix with subjacent soil at approximate 1:1
- Ratio and backfill within UST excavation
- Scrape and stockpile gravel at north end of site for later use
- Received initial truckloads of compost and begin spreading on north end of site

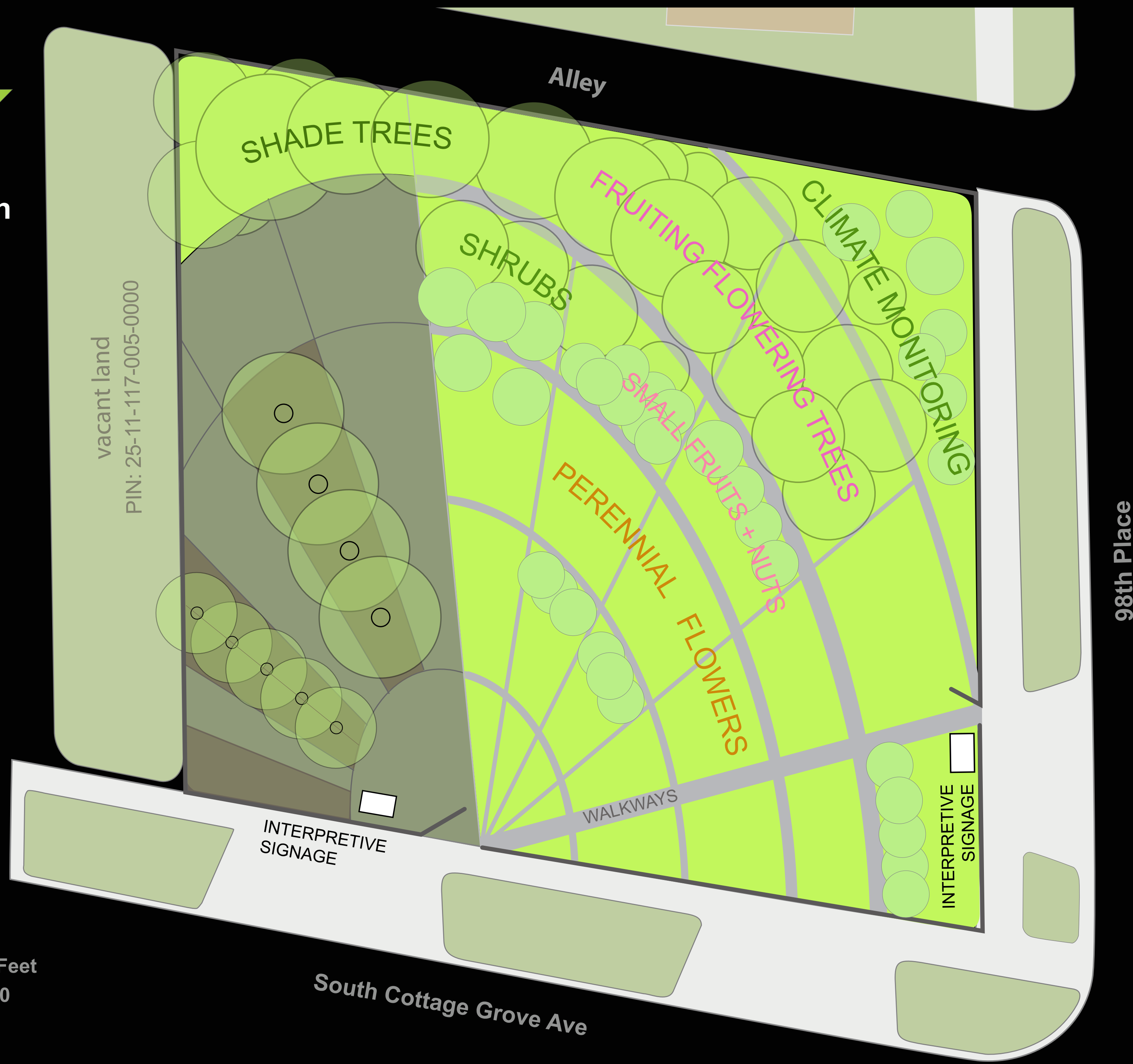
Step 3 – Day 3

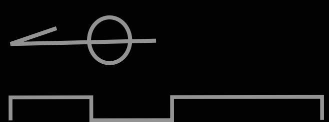
- Using the Wirtgen 2400 soil stabilizer, mix existing site surface gravel and soil to depth of approximately 20 inches below grade (maximum depth of tilling blades)
- Uniformly spread compost throughout site and make a second pass with the Wirtgen 2400 to re-mix to depth of approximately 15 inches, producing the required 30 inches turned depth
- Continue to receive truckloads of compost synchronized to stay ahead and clear of Wirtgen 2400 tilling
- Re-spread stockpiled gravel uniformly throughout lots 6&7
- Re-install removed existing fence without footers as a temporary fence awaiting new black iron fencing


TECNICA

slow CLEAN-UP

Phytoremediation Test Plots

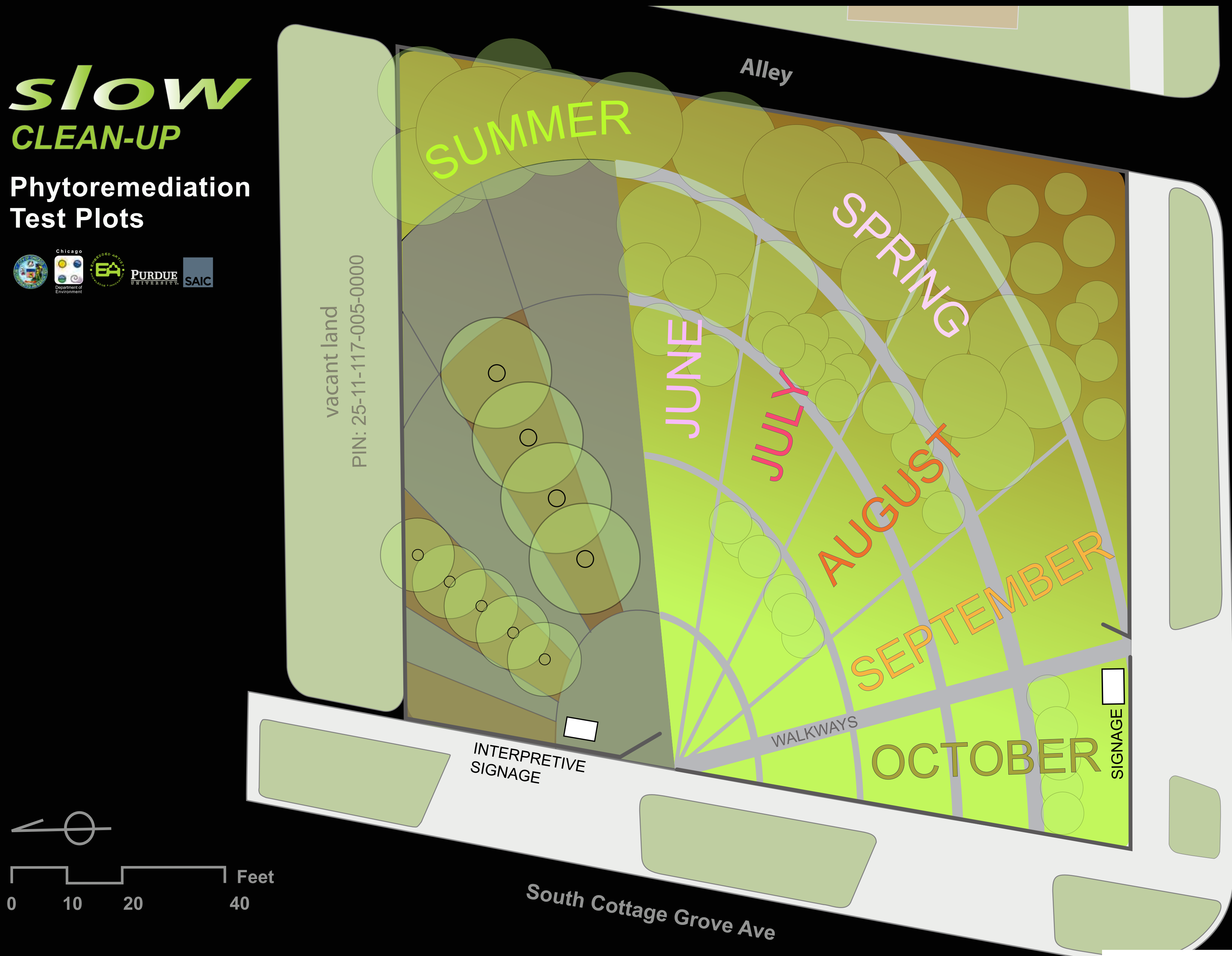




Site design – plant types

slow CLEAN-UP

Phytoremediation Test Plots



Site design – bloom sequence

4) COMMUNITY ENGAGEMENT AND SITE DESIGN

Local Participation

Development of the 98th Street and South Cottage Grove field trials site has been conducted in conversation with the *Cottage Grove Heights Community Coalition* (CGHCC), through President, Sandra M. Patterson and the Board of Directors

- The CGHCC named the site the *Cottage Grove Heights Laboratory Garden*, creating a new concept, of community garden and identifying that they were playing the role of "host" for the Laboratory Garden.
- 8th Ward Alderman, Michelle A. Harris, has funded an ornamental fence to surround the site, increasing its visual appeal and value to the community

Field Trials *(lab gardens)* Design

The site design for the prototypic Community Laboratory Garden utilizes a dramatic radial grid, centered on the main streetscape. This design device provides a grid structure for the scientific plant Field Trials and also privileges visual access and legibility for the community and site visitors. A reversal of the "power dynamics" associated with such grand geometric space plans, the site design concept integrates technology, aesthetics, community engagement, and passive economic benefit through design, while contributing to overall greenspace for the city and its inhabitants.

- Site design is a radial grid for visual interest and legibility from outside the site fence
- The radial grid also references the gridded organization of conventional test plots but is oriented towards both the passive viewer, and the scientific observer, while remaining accessible to tending
- The grid and maintenance walks are edged for a tidy look in contrast to the dense plantings
- Perennial plugs were planted 1 foot on center for ease of future observations and calculations
- Site design laid out by plant type as well as bloom time to visualize seasonality
- Social engagement, community outreach, participatory research, and job training programs were considered in the design of site, along with appearance and legibility
- Site fencing and signage add interpretation and visuals to be completed Fall 2012

The planting process

Greencorp horticulture trainees

4) COMMUNITY ENGAGEMENT AND SITE DESIGN CONTINUED

- The Field Trials soil preparation was followed by a conventional site grading, layout and planting
- Plants used for the Field Trials were the 80 test species referenced above in Section 5
- Field Trials may or may not remediate the test site. The primary purpose is to test soil prep methods, plant vigor, hydrocarbon tolerance of plants, ornamental appeal, and adaptability to soil as amended
- The Field Trials woody plants were planted in Spring 2011 and the perennial forbs were planted Summer 2011 by the groups described below

5) FIELD TRIAL INSTALLATION

Educational Programming in Horticulture, Site Specific Sculptural Practices, Urban Soil Science
Four groups of students and trainees were involved in the planting and analysis of the Field Trials Site and the Lab Trials

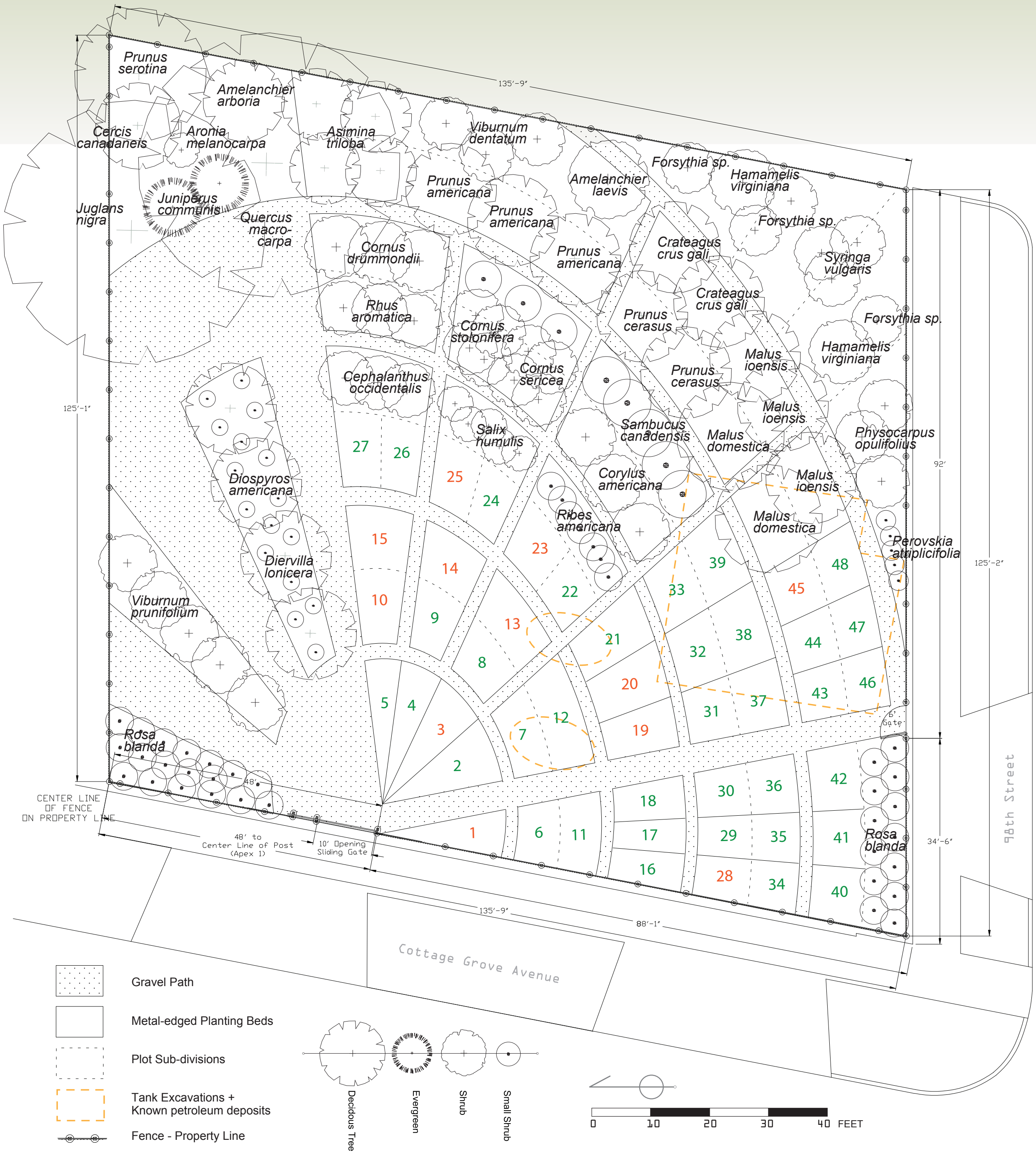
1) Site Planting and Detailing

- **Greencorp Chicago**, Chicago's community landscaping and job training program executed the majority of the site landscaping tasks.
  - The trainees installed all large woody shrubs and trees, many of the perennial forb plugs and installed the gravel walkways on site.
  - The installation was overseen by Greencorp professional staff horticulturists
  - This extensive "in kind" contribution of labor and expertise is not reflected in the project budget, (see page 11) and would add additional cost to a project where such in-kind support was not available
- **School of the Art Institute of Chicago** students and faculty installed the "sculptural" elements of the build-out
  - This included detailing the metal edging grid, fine tuning the soil grade, and the use of planting gigs for the plant spacing
  - SAIC students planted the most visually precise portions of the perennial forb plugs and contributed to on-site design finalization
  - Several SAIC graduate student interns have conducted site plant count monitoring through August 2012, the Grant period

2) Site and Soil Analysis

- **Chicago State University** students conducted initial site soil analysis in 2010 and 2011 under the supervision of Dr. Karel Jacob
  - Students participated via the Urban Science, Technology, Engineering, Mathematics Talent Expansion Program (USTEP) Program
- **Purdue University** Soil Science students conducted all aspects of the phytoremediation plant lab trials under the supervision of Dr. AP Schwab
  - In the Schwab lab and greenhouses, students assisted with regular plant assessments, plant and soil extraction and analysis

FINAL PLANTING LAYOUT



Plot #	Scientific Name	Common Name
1	*Heuchera richardsonii*	Alum Root
2	*Ruellia humulis*	Wild petunia
3	*Eryngium yuccifolium*	Rattlesnake Master
4	*Geum triflorum*	Prairie Smoke
5	*Zizia aptera*	Golden alexander
6	*Petalostemum purpureum*	Purple Prairie Clover
7	*Eurphorbia corollata*	Large flowering spurge
8	*Salvia azurea var. pitcherii*	Pitchers sage
9	*Veronicastrum virginicum*	Culver's Root
10	*Penstemon digitalis*	Foxglove Beardtongue
11	*Aster ericoides*	Heath Aster
12	*Liatris pycnostachya*	Prairie blazing star
13	*Monarda punctata*	Horse Mint
14	*Ratibada pinnata*	Yellow Coneflower
15	*Echinacea pallida*	Pale purple coneflower
16	*Aster laevis*	Smooth Blue Aster
17	*Helianthus mollis*	Downy Sunflower
18	*Helianthus giganteus*	Tall Sunflower
19	*Nepeta cataria*	Catnip
20	*Monarda fistulosa*	wild bergamot (bee balm)
21	*Verbena hastata*	Blue Vervain
22	*Sanguisorba canadensis*	American burnet
23	*Oenothera biennis*	Evening Primrose
24	*Asclepias syriaca*	Common milkweed
25	*Achillea sp.*	Yarrow
26	*Echinacea purpurea*	Purple Coneflower
27	*Geranium maculatum*	Wild geranium
28	*Sporobolus heterolepis*	Prairie Dropseed
29	*Schizachyrium scoparium*	Little Bluestem
30	*Andropogon gerardii*	Big Bluestem
31	*Eupatorium maculatum*	Joe Pye Weed
32	*Vernonia fasciculata*	Ironweed
33	*Asclepias incaranata*	Swamp milkweed
34	*Rudbeckia triloba*	Brown-eyed Susan
35	*Solidago speciosa*	Showy goldenrod
36	*Rudbeckia subtomentosa*	Sweet Black-Eyed Susan
37	*Silphium laciniatum*	Compass Plant
38	*Eupatorium perfoliatum*	Boneset
39	*Verbena stricta*	Hoary Vervain
40	*Liatris aspera*	Rough blazing star
41	*Aster novae-angliae*	New EnglandAster
42	*Solidago ohioensis*	Ohio Goldenrod
43	*Silphium terebinthinaceum*	Prairie Dock
44	*Kuhnia eupatoriodes*	False Boneset
45	*Agastache foeniculum*	Blue Giant Hyssop
46	*Silphium integrifolium deamii*	Rosin Weed
47	*Physostegia virginiana*	Obedient Plant
48	*Agastache nepetoides*	Yellow Giant Hyssop

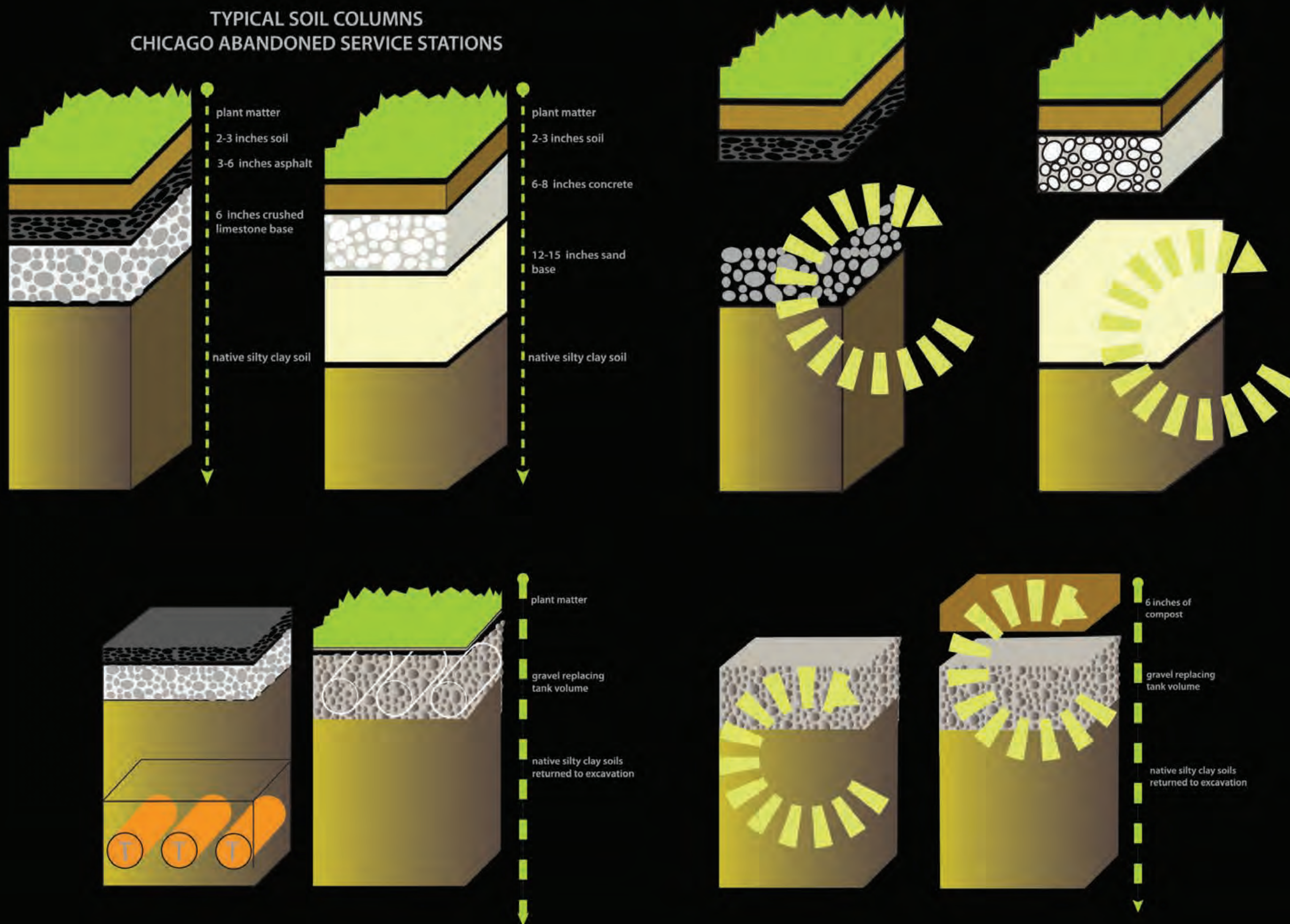
Species in Lab and Field Trials

New Petroleum Remediators Species

Installation 2011

NEW SOIL PREP METHODS KEEP ALL MATERIALS ON SITE

TYPICAL SOIL COLUMNS
CHICAGO ABANDONED SERVICE STATIONS



07 NEW KNOWLEDGE

INNOVATION + KNOWLEDGE OUTCOMES

THREE YEARS AHEAD OF THE NATIONAL (EPA) MODEL

- The SLOW Cleanup Phyto remediation Program has conceptualized, trialled and built a pilot site concerning innovative brownfields approach
- Interim Use Concept and Asset-based planning is fully developed and implemented in Chicago
- Alternative in situ soil prep methods replace "dig and dump" practices
- Connections to urban agriculture and soil building, including management of bio-availability add value to the work undertaken since 2010 at UMBR
- Based on this productive Team partnership, we expect additional fruiting plant studies to be undertaken with Dr. AP Schwab in the near future

NEW SOIL PREPARATION METHODS

1) Successful in-situ soil turning with the Wirtgen 2400 Soil Stabilizer

- The soil stabilizer executed the work easily with immediate and dramatic results, including the large gravel and stone as well as compost turning
- The soil stabilizer proved adequately agile to move easily around the site despite its large size
- Smaller sites would be more difficult to till with this machine and also the mobilization fee would make it prohibitive to use it for single parcel sites as individual events, although bundling several sites into one day's work may well be feasible if they are geographically close to each other
- Some delays resulted from the discovery of pipes and artifacts left on site that should have been removed with the LUSTs

2) Lessons Learned

- Remove accumulated top soil from top of pavement first before beginning. Incremental volume of this soil will contaminate the pavement intended for recycling rendering it unrecyclable. Such contaminated pavement is then disposed of in a landfill not kept on site or recycled
- Given the agility and power of the Wirtgen 2400, it is easy to overtill the soil and dissipate the compost, which should remain in the top foot of soil
- Keep it simple. The agility of the Wirtgen can also lead to overconfidence in the staging and maneuvering on site
- Simple and uniform soil processing all over the site is recommended due to staging issue, avoid treating areas with unique methods








PHOTOS: courtesy of Forestryimages.org

NEW REMEDIATOR SPECIES IDENTIFIED

1) Conclusive Plant Findings *(see table 1)*

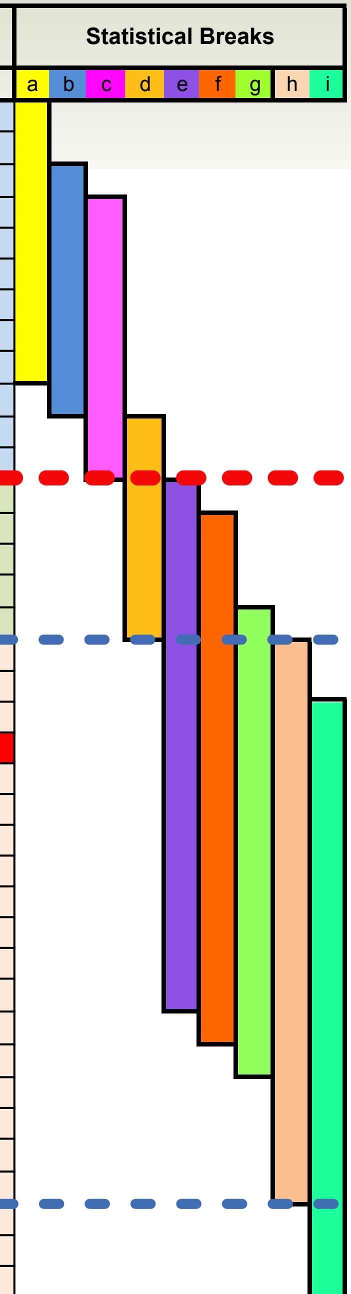
- The greenhouse trial was successful despite a number of obstacles
- We observed significant degradation of the petroleum hydrocarbons, and new remediator species emerged.
- Twelve (12) species have been found to enhance dissipation relative to natural attenuation (absence of plants in identical soil, tended identically for the duration of the trial period)

i. Purple coneflower, *Echinacea purpurEa*
ii. Blue giant hyssop, *Agastache foeniculum*
iii. Horse mint, *Monarda punctata*
iv. Rattlesnake master, *Eryngium yuccifolium*
v. Alum root, *Huechera richarsonii*
vi. Yellow coneflower, *Ratibada pinnata*
vii. Wild bergamot, *Monarda fistulosa*
viii. Prairie dropseed, *Sporobolus heterolepis*
ix. Yarrow, *Achilllea sp.*
x. Catnip, *Nepeta cataria*
xi. Foxglove beardtongue, *Penstemon digitalis*
xii. Evening primrose, *Oenothera biennis*

- Of these, the only species tested previously was Purple coneflower, *Echinacea purpura*
- These additional remediator species extend the horticultural and habitat potentials of remediation sites

TABLE 1 — Prarie Forb Final TPH Dissipation Results 8.2012

Species	Species	Total Petroleum Hydrocarbons	Dissipation
Common Name	Latin name	mg/kg	%
Purple Coneflower	*Echinacea purpurea*	1003 a	72.5 a
Blue Giant Hyssop	*Agastache foeniculum*	1049 a	71.1 a
Horse Mint	*Monarda punctata*	1142 ab	68.7 ab
Rattlesnake Master	*Eryngium yuccifolium*	1234 abc	66.1 abc
Alum Root	*Huechera richarsonii*	1240 abc	66.0 abc
Yellow Coneflower	*Ratibada pinnata*	1283 abc	64.8 abc
Wild Bergamot	*Monarda fistulosa*	1396 abc	61.7 abc
Prairie Dropseed	*Sporobolus heterolepis*	1432 abc	60.8 abc
Yarrow	*Achilllea sp.*	1436 abc	60.6 abc
Catnip	*Nepeta cataria*	1598 bc	56.2 bc
Foxglove Beardtongue	*Penstemon digitalis*	1695 cd	53.5 cd
Evening Primrose	*Oenothera biennis*	1697 d	53.4 cd
Brown-eyed Susan	*Rudbekia triloba*	2033 d	44.2 de
Prairie smoke	*Geum triflorum*	2050 de	43.8 def
Obedient Plant	*Physostegia virginiana*	2088 de	42.7 def
Ohio goldenrod	*solidago ohioensis*	2089 de	42.7 def
Black-eyed susan	*Rudbeckia subtomentosa*	2113 def	42.0 defg
Purple prairie clover	*Petalostemum purpureum*	2254 efg	38.1 efgh
Prairie petunia	*Ruellia humulis*	2267 efg	37.8 efgh
Heath Aster	*Aster ericoides*	2343 efgh	35.7 efghi
Unplanted		**2362 efgh**	**35.2 efghi**
Rough Blazing Star	*Liatris aspera*	2409 efgh	33.9 efghi
Yellow Giant Hyssop	*Agastache nepetoides*	2421 efgh	33.6 efghi
Common milkweed	*Asclepias syriaca*	2460 efgh	32.5 efghi
Prairie dock	*Silphium terebinthinaceum*	2461 efgh	32.5 efghi
Culver's root	*Veronicastrum virginicum*	2473 efgh	32.1 efghi
Big bluestem	*Andropogon gerardii*	2489 efgh	31.7 efghi
Golden Alexander	*Zizia aptera*	2491 efgh	31.6 efghi
Hoary Vervain	*Verbena stricta*	2496 efgh	31.5 efghi
Prairie Blazing Star	*Liatris pycnostachya*	2595 fgh	28.8 fghi
Compass plant	*Silphium laciniatum*	2647 fgh	27.4 ghi
Pitchers Sage	*Salvia azurea var. pitcherii*	2678 gh	26.5 hi
Swamp Milkweed	*Asclepias incaranata*	2688 gh	26.2 hi
New England Aster	*Aster novae-angliae*	2751 gh	24.5 hi
Tall Sunflower	*Helianthus giganteus*	2770 gh	24.0 hi
False boneset	*Kuhnia eupatoriodes*	2823 h	22.5 i
Flowering Spurge	*Eurphorbia Corollata*	2867 h	21.3 i
Downy Sunflower	*Helianthus mollis*	2882 h	20.9 i
Control		**3644 i**	**--**



Statistically Equivalent Best Remediators

Likely Remediators. Merits further study.

Species appear to impede remediation. Merits further study.

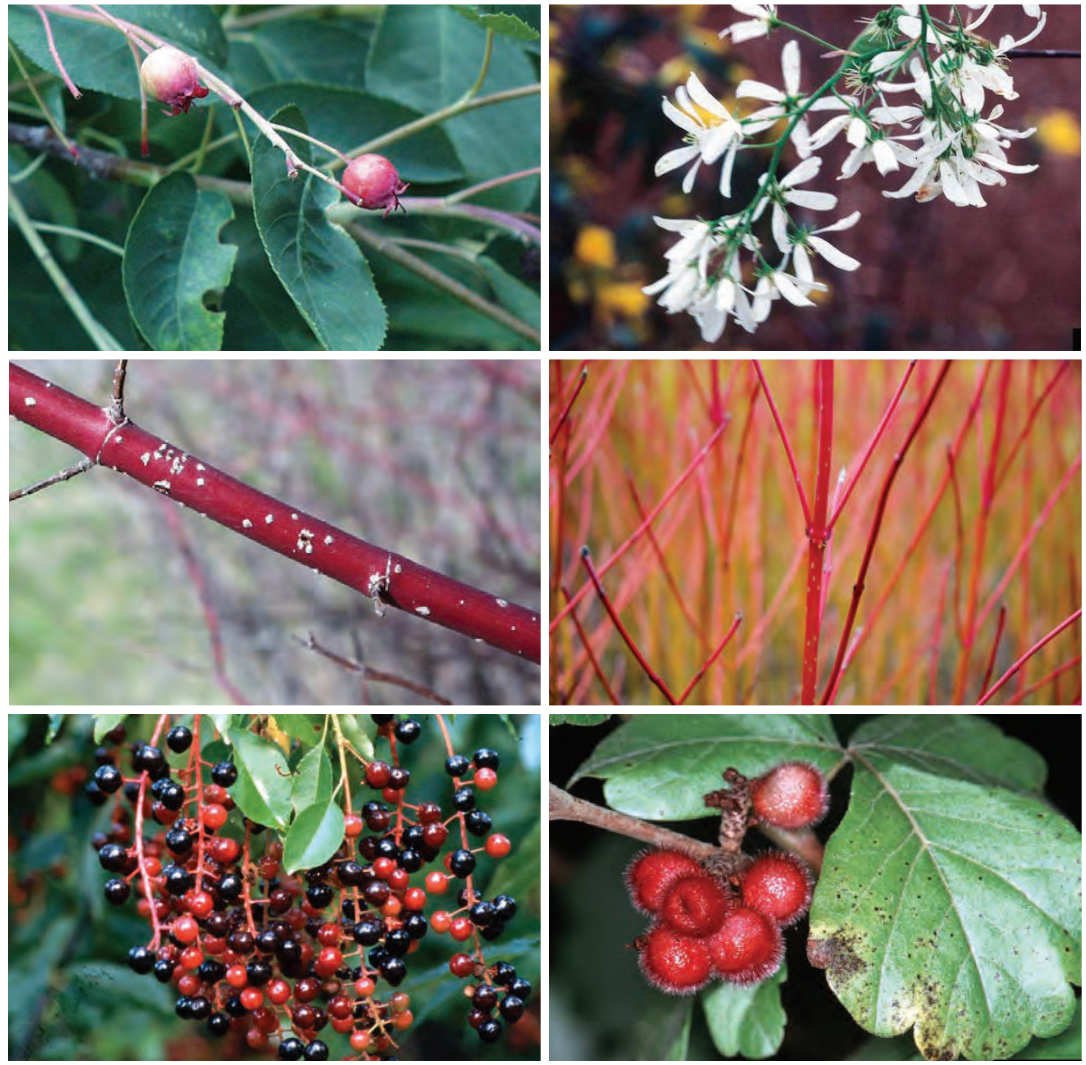
CHART: F. Whitehead based on A.P. Schwab's data

2) Plant Findings Needing Further Study
(see table 2)

- Sourcing adequate small specimens for such a large number of species proved very complex. Consequently, not all species had adequate specimens for reliable statistical sampling.
- Because only one pot of some species was available, a statistical analysis of the TPH is yet not possible on all species in the Field Trials
- Promising species from this portion of the study include:

+ Black cherry
+ Red-osier dogwood
+ Downy serviceberry
+ Fragrant sumac

- All of the deciduous species in the single specimen group went into winter dormancy very early in the experiment, and the roots were not actively growing. We would expect all of these species to show greater dissipation of TPH if they were growing while active and in a fully replicated experiment. For these species, further study is warranted
- Research was also inconclusive on edibles and woody shrubs trees due to plant availability at testing time
- Challenges included high greenhouse summer heat and frequent handling immediately prior to planting. Many of the plant species being tested responded poorly to being transplanted from peat to soil in the heat of the summer. Some of the species, being deciduous, dropped their leaves early in the experiment and, even though healthy and viable, had not regained their leaves by the time we harvested the soils



PHOTOS courtesy of Forestryimages.org

TABLE 2 — Woody Plants Preliminary Findings 8.2012

Residual total petroleum hydrocarbons (TPH) and dissipation of TPH in soils for plant species with single replications.
The dissipation calculation is based on the original TPH concentration of 3644 mg/kg.
Highlighted species exhibit results (without replication) greater than "Unplanted" control of 35.2% / 2362 mg/kg TPH

Species	Species	TPH	Dissipation
Common name	**Latin name**	**mg/kg**	**%**
Black cherry	*Prunus serotina*	2106	42
Red-osier dogwood	*Cornus stolonifera C. sericea*	2165	41
Downy serviceberry	*Amelanchier arborea*	2211	39
Fragrant sumac	*Rhus aromatica*	2270	38
Walnut	*Juglans nigra*	2423	34
Early wild rose	*Rosa blanda*	2439	33
Wild plum	*Prunus americana*	2444	33
Witch hazel	*Hamamelis virginiana*	2467	32
Elderberry	*Sambucus canadensis*	2538	30
Black chokeberry	*Aronia melanocarpa*	2587	29
Dwarf bush honeyscuckle	*Diervilla lonicera*	2612	28
Button bush	*Cephalanthus occidentalis*	2622	28
False indigo	*Amorpha fruticosa*	2637	28
Prairie willow	*Salix humulis*	2707	26
American hazelnut	*Corylus americana*	2690	26
Chinquapin oak	*Quercus muelenberghi*	2738	25
Redbud	*Cercis canadensis*	2768	24
Wild black currant	*Ribes americana*	2771	24
Lead plant	*Amorpha canescens*	2796	23
Prairie crab	*Malus ioensis*	2802	23
Paw paw	*Asimina triloba*	2982	18
Blackhaw viburnum	*Viburnum prunifolium*	3031	17
Arrowhead viburnum	*Viburnum dentatum*	3121	14
Common ninebark	*Physocarpus opulifolius*	3132	14
American persimmon	*Diospyros virginiana*	3302	9
White oak	*Quercus bicolor*	3466	5
Common juniper	*Juniper communis*	3496	4

Single Observation Equivalent to or Better than Unplanted Control

F. Whitehead based on A.P. Schwab's data

New Site Designs and Typologies

1) Swatchbook of Phytoscapes

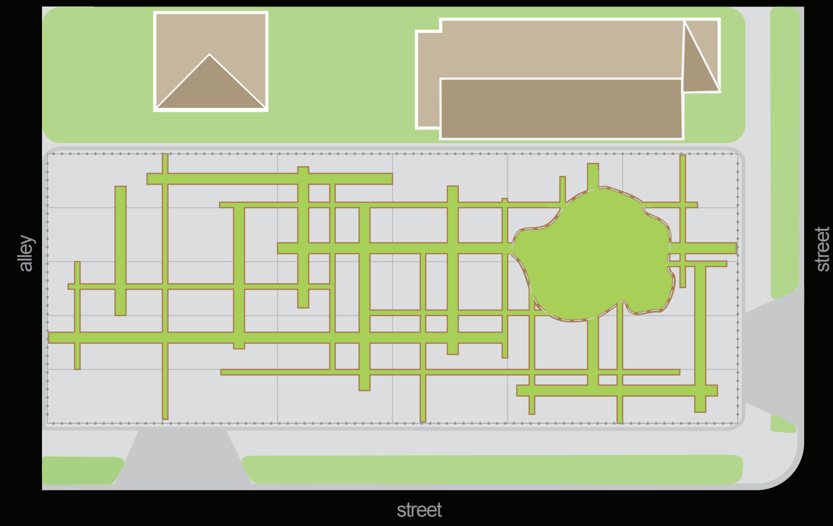
Based on the Summer 2012 results of the Schwab Lab Trials additional site design typologies (swatches) are possible. Design Criteria used to conceptualize the Swatchbook include:

- Maximize the urban landscape design potentials of the particular new remediator species characteristics, height, color, bloom, etc.
- Considerations are given to multiple human and non-human user groups including citizens, students, birds, pollenators
- Varied spatial approaches to the basic challenge that phytoremediation sites require a very dense planting
- Designs address the need for public visibility and safety and participation with visual permeability beyond the required site fences
- Each “swatch” balances aesthetics, “cues to care” and technological approaches
- Emerging discourses on future land uses addressed include: urban agriculture, arbor-culture, biofuel production, and civic engagement
- Examples of each scale design typology (Small, Medium, Large) are modeled based on preliminary new remediator results and above criteria

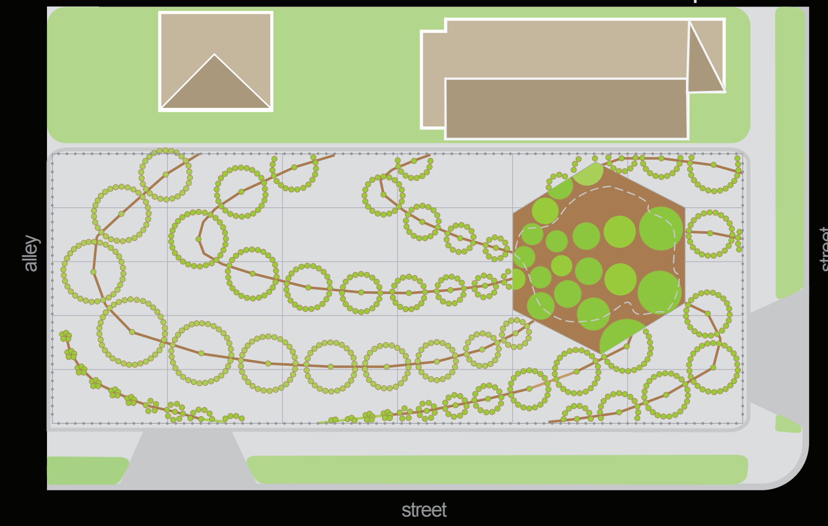
SWATCHBOOK Landscape Typologies From New Petroleum Remediator Species - See Illustrations on following pages.

SCALE	TYPOLOGY	DESCRIPTION
SMALL 1	Crack garden/ Seeded biofuel	Gridded sawcut removal of concrete emerging from the tank excavation area, is inter-planted with known, annual, monocot remediator, *Switchgrass or Big Bluestem*, to be harvested as biofuel experiment annually
SMALL 2	Crack Garden/ Cored Crop Circles	Leaving concrete in place, cores are created in decorative patterns, removed and planted with vigorous rooted, perennial, remediators such as Prairie Dropseed (*Sporobolus heterolepis)*
MEDIUM 1	Mixed Pollinators	Perennial forb species identified from Lab Trials are sorted by height into 3 perennial “mixes” and planted in large decorative swathes on prepared soil with concrete removed
MEDIUM 2	Winter Color	Red Osier dogwood forms the basis of a checked grid for striking winter color. Alternate green “checks” can be planted with any other species, such as *Rhus aromatica*, *Sporobolus heterolepis, Huechera richardsonii*
MEDIUM 3	Quincunx Bosque	*Amelanchier arborea*, or any small tree, is under-planted with short and medium perennial mixes along diagonal sightlines. Effective on prominent corners where two sight lines are available
LARGE 1	Fruit-scape	Edible fruit trees and shrubs, planted in orchard style *allees* are under-planted with perennial mixes, which should clean petroleum prior to the appearance of fruit (requires an additional fruiting plant study)
LARGE 2	Community Laboratory Garden	A radial grid, oriented towards the main streetscape makes legible the civic experiment, providing visual access and participation. Plants can be sited by height or bloom time to support a variety of types of programming.
LARGE 3	Bird-scape	*Prunus serotina* (black cherry) forms the basis of a bird-friendly “layered” landscape, under-planted with tall and short shrubs, *Amelanchier, Rhus aromatic*, alongside grasses and seed producers such as *Sporobolus heterolepis, Rudbekia triloba* and *Ratibada pinnata*

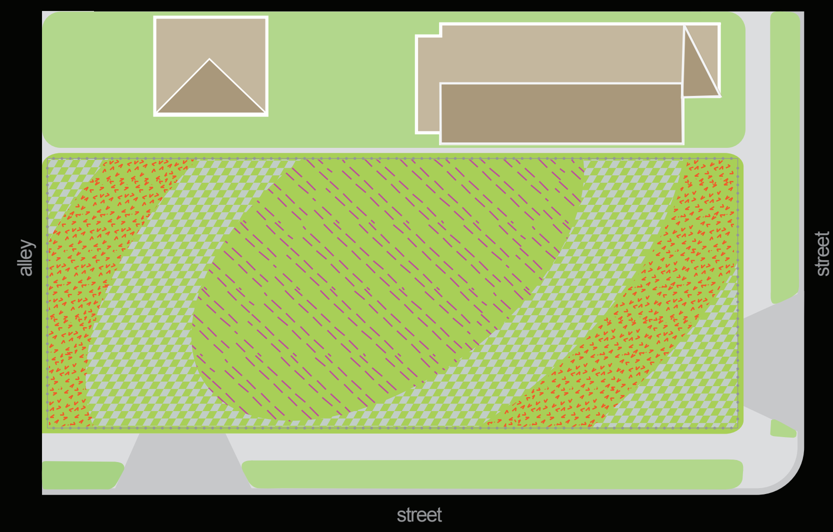
SMALL 1 - Crack Garden / Seeded Biofuel



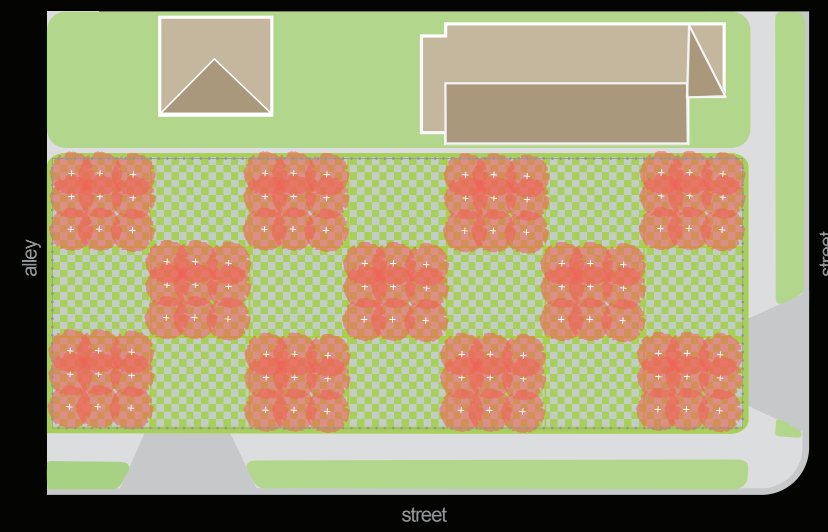
SMALL 2 - Crack Garden / Cored Crop Circles

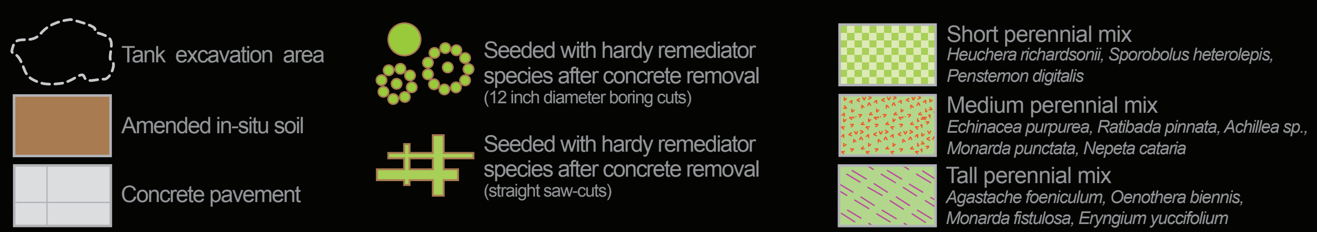


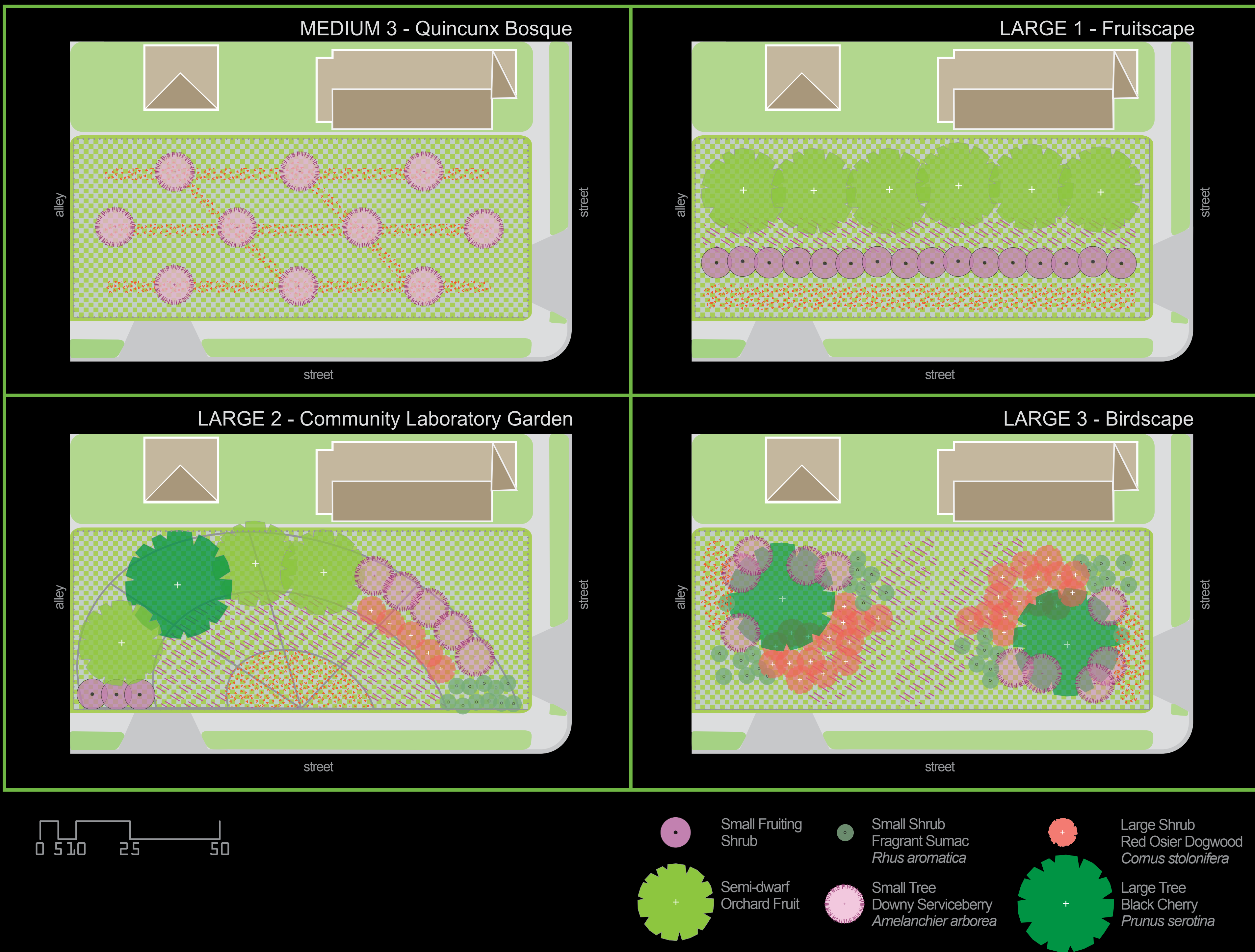
MEDIUM 1 - Mixed Pollinators



MEDIUM 2 - Winter Color






MEDIUM 3 - Quincunx Bosque
LARGE 1 - Fruitscape
LARGE 2 - Community Laboratory Garden
LARGE 3 - Birdscape
alley
street
street
0 5 10 25 50
Small Fruiting Shrub
Small Shrub
Fragrant Sumac
Rhus aromatica
Large Shrub
Red Osier Dogwood
Cornus stolonifera
Semi-dwarf Orchard Fruit
Small Tree
Downy Serviceberry
Amelanchier arborea
Large Tree
Black Cherry
Prunus serotina

Eryngium yuccifolium plugs ready for planting

08 RECOMMENDATIONS

PHYTOREMEDIATION RECOMMENDATIONS

Although the value of phytoremediation is well-recognized, scientific investigations on the subject has become more of a niche rather than focused research efforts. The excitement that it once enjoyed, that included large, well-funded projects, has subsided. The decreased enthusiasm for phytoremediation is a product of success and economics:

a) Plant species have been identified for nearly every remediation target, whether organic or inorganic

b) The misconception exists that phytoremediation is easy and requires very little expertise to successfully execute challenging remediation projects

c) Compared to more heavily engineered projects or even "dig, haul, and landfill", the opportunity for profit is small; thus, despite the high probability for success, it is not an attractive alternative for private companies

d) Phytoremediation is slow compared to many of the existing remediation solutions

As a result, focused applications (such as this project) are faced with the promise that phytoremediation should be successful combined with a lack of details about how to execute the project. This is particularly true if the project envisions using plant species that have not been tested previously.

1) Soil and Site Conditions

- Carefully consider fill material for tank excavation—restore native soils as appropriate to ensure flexibility in site re-use into the future
- Remove and recycle all pavement when tanks are removed to promote natural attenuation
- Consider quantity and type of pavement on site to assess practicality
- Develop a range of soil treatment equipment uses similar to Wirtgen 2400 for different scaled sites
- Avoid soil compaction by excessive use of soil prep and grading equipment
- Don't create an overly complex site staging as complexities evolve with typical site contingencies
- Develop "Decision Trees" for the above scenarios
- Georeference soil borings and clean up measures so that future monitoring is more accurate

2) Plants and Designs

- Be sure landscape personnel implementing design understand that phytoremediation is not conventional landscape design and that design may differ from standard practices in density and type
- Use phytoremediation only on sites with adequate soils.
- Integrate Phytoremediation Planning into Soil Re-use and Land-use Programs as they evolve
- Establish a soil recycling facility in vicinity (Chicago) to facilitate the above
- Consider adjacencies to other natural and green space corridors and patches as described in the Chicago Wildlife Plan
- Consider plant and labor availability in site design decisions
- Consider drainage and porosity of site soils with site design and plant selection

3) Implementation Budget

- The direct costs of labor, material, equipment, and plant materials are significantly lower than originally predicted for a "Large" typology
- However, the "in-kind" costs, including: City Staff, A.P. Schwab Lab, Greencorp trainee labor, and SAIC student labor could easily double the cost of such a complex installation if it were procured exclusively from commercial vendors
- Conversely, if a systemic assessment method were established that was capable of tracking social and intangible value added, the over all "cost" of the project would likely reflect the "net-benefits" gained
- The direct cost of implementing this type of remediation/revitalization effort compared to the untracked costs of leaving site partially un-developed needs further study

4) Socio-Cultural

- Due to the dynamic nature of City government, establishing firm partnerships and stewardship plans prior to implementation is crucial
- Choose site designs based on adjacent partners, aesthetic preferences and site locations to ensure community participation and to enhance social capital and value from all types of projects
- Fencing and signage may improve public perception of sites even without ongoing tending

ASSESSMENT RECOMMENDATIONS

Assessment of the SLOW Cleanup Remediation Program Concept is impossible until implementation of new typologies is undertaken and appropriate assessment measures are developed. To fully understand the potentials of whole systems integrative approaches we recommend the following:

- Integrative assessment models such as Life Cycle Assessment should be developed in relation to different site typologies, costs and criteria
- Dynamic Modeling and Participatory Assessment should be considered as a reflection of contemporary best community practices
- Assessment of the innovation outcomes could be developed for future use as other academic and cultural partnerships evolve
- Publication of scientific results will be assessed via the "peer to peer review" process utilized by academic and scholarly research institutions and publications. We anticipate publications on the scientific trials and findings within the next two academic year cycles (2012-2014)

KNOWLEDGE AND INNOVATION RECOMMENDATIONS

- Partnerships with local academic institutions interested in civic engagement and noncommercial perspectives may benefit city initiatives by bringing new perspectives earlier in the process
- Research questions and new implementation methods that are beneficial to cities may have little commercial value but contribute greatly to social, cultural and environmental conditions and capitals
- Important non-commercial research leader ship can be accomplished through innovative partnerships between unlikely partners committed to systemic approaches and the public good.

Greencorp tree planting


PHOTO: Steve Juras

09 NEXT STEPS

EXTENSIONS

Several extensions are underway of the inter-institutional collaboration, ideas related to the use of artists in planning efforts, and further initiatives to extend the phytoremediation studies. These include:

Several opportunities exist to integrate the SLOW Cleanup findings into City Planning efforts:

- Connect to Chicago Public School Science and Service Learning around plant indicators and remediators for CPS garden sites
- Department of Cultural Affairs and Special Events (DCASE) and SAIC are discussing how to collaborate on the DCASE initiative to "integrate arts and culture into planning" citywide
- Department of Housing and Economic Development (DHED) and SAIC are discussing ways to integrate these approaches into the Green Healthy Neighborhood (GHN) landuse strategy for Englewood, West Englewood, Washington Park, and Woodlawn, to establish several phyto test sites
- Partnering with NeighborSpace and the City, evolve a multi-community program to site phyto "swatch" sites throughout the city, in relation to appropriate neighborhoods, stakeholders, and institutions

Funding opportunities being explored by SAIC + DHED-Planning + DCASE include:

- Current grant opportunities are under consideration to establish sites in GHN Area
- Field Museum Staff or Forest Service staff could provide required sociological components of Grants as required
- This development could move the project to a LCA assessment model as described above
- Federal Grant opportunities through the NEA, including Our Town Grants, are being investigated. We anticipate applying in the next funding cycle for work in Englewood

Phytoremediation at Big Marsh Calumet

- The SLOW Cleanup Team (CDoE UMBR + Frances Whitehead, SAIC + Dr. AP Schwab, Purdue University) were awarded a grant in 2010 by the USDA, *Urban and Community Forestry Program* in the amount of $193,595
- The Project Title: *Use of Trees and other Vegetation in the Remediation of Brownfields: Big Marsh Property of Lake Calumet Area*
- This successful grant application demonstrates the funding potential for this whole systems approach at other types of sites in the Chicago Area

Further Plant Species Petroleum Remediation Studies

- Conversations have begun with Dr. AP Schwab concerning further analysis and publication of Lab and Field Trial Results
- Additional avenues will be sought to execute a replicated study of both woody species and edibles fruit species left inconclusive by this study
- A extensive fruiting plant study is expected to begin in Fall 2013-2016 under Dr. Schwab at Texas A&M University, with Field Trials in Chicago
- Schwab, Graham and Whitehead will begin publication of scientific results in 2013

10 DISSEMINATION

The COLLABORATION, PROJECTS, AND OUTCOMES will be published as opportunities arise and data is analyzed. We anticipate a *SLOW Cleanup* website to be developed in the future. To date, findings have been presented at the following multi-disciplinary conferences and publications:

- Ingram, Mrill. *Sculpting Solutions: Art-Science Collaborations in Sustainability*, VENV: Environment: Science and Policy for Sustainable Development, July/Aug 2012, Vol 54 No. 4, pages 24-35. http://www.environmentmagazine.org/Archives/Back%20Issues/2012/July-August%202012/sculpting-abstract.html

- Newcombe, Jodi. The Art of the Eco-City, Working with Artists to Further Urban Sustainability. Report for the City of Melbourne, International Case Study 3, page 17-18, April 2012. http://www.carbonarts.org/projects/the-art-of-the-eco-city/

- Ingram, Mrill, The Diplomacy of Art: what ecological artists offer environmental politics, Art, Science and Geographical Imaginaries (4): Practice and Publics. Royal Geographers Conference, London, 2012. http://www.rgs.org/HomePage.htm,

- Ingram, Mrill. Politics of Art and Alchemy at an Abandoned Gas Station, Chicago, Inhabiting the Micro Panel, American Association of Geographers, Feb 2012, NYC. http://www.aag.org/cs/annualmeeting/program

- Whitehead, Frances. 51 Declarations for the Future: A Manifesto for Artists + NOTES on the Manifesto" Opening essay for The New Earthwork: Art, Action, Agency," ISC Press, (2012). Edited by Twylene Moyer and Glenn Harper. fig. pg 16-20. http://sculpture.gostorego.com/new-earth-works.html

- Whitehead, Frances, What Do Artists Know?, Princeton University School of Architecture magazine, Pidgin, Vol 12 (Spring 2012). http://www.pidgin-magazine.net/

- Whitehead, Frances; Graham, David S.; Schwab, AP. Integrating Aesthetics and Technology in the Remediation of Soils at Abandoned Gas Stations. US EPA Sustainable Remediation 2011 Conference, June 1-3, 2011, University of Massachusetts, Amherst. http://www.umass.edu/tei/conferences/SustainableRemediation/

- Whitehead, Frances, The Embedded Artist as New Knowledge Producer, College Art Association 2011 Conference, Panel: Artmaking as New Knowledge: Research, Practice, Production, organized by Derek Conrad and Soraya Murray, UCDS. http://conference.collegeart.org/2011/

- Englestad, Janeil, Make Art with Purpose, Interview, Project Page 2011. http://www.makeartwithpurpose.net/projects.php?id=15&tp=0

- Art- Science: Collaboration, Bodies, Environments: Case Study 2011- ongoing. http://artscience.arizona.edu/research_site_slow-cleanup.html

- Whitehead, Frances, Post- Normal Cultural Heritage, Welsh College of Architecture, Cardiff, Wales, Symposium -The Post- industrial City, Invited participant funded by British Council, 2011.

- Whitehead, Frances; Atha, Christine. Complexity and Engagement: Art and Design in the Post Industrial, MADE- Materials, Architecture, Design, Environment, Welsh School of Architecture Publication, Volume 6, 2010, p.42-51, fig. http://cardiff.ac.uk/archi/made.php

- Whitehead, Frances; Matthew Guillford. "Climate Change : Culture Change Innovation and Agency from the Knowledge of Artists", Research and Creativity: Next Claiming Creativity - Art education in cultural transition, European League of Institutes of Art Annual Conference, Columbia College, Chicago, April 2010. http://eliaartschools.wordpress.com/category/claiming-creativity/

- Ise, Claudine. ART:21 Blog Frances Whitehead, Embedded Artist, feature on recent public works, 2010. http://blog.art21.org/2010/08/24/frances-whitehead-embedded-artist/

APPENDIX

A digital appendix of supporting documentation accompanies this Final Grant Report to the City of Chicago. This documentation is not included in all printed copies of the Report due to copyright and confidentiality obligations.

code name	original vial+cap	soil wt	2nd vial+cap	2nd vial+dcr extract	gas vial+cap	gas vial+extract+spike	position on tray
G2	14.90	4.99	14.97	35.17	2.51	4.76	C4
G2-2	14.91	4.95	15.05	35.60	2.49	4.57	C5
G3	15.09	5.00	15.01	34.71	2.55	4.65	C6
G4	14.96	4.95	15.07	34.95	2.50	4.32	C7
G5	14.97	5.14	15.03	34.59	2.58	4.55	C8
G6	15.01	5.13	15.15	34.49	2.52	4.83	C9
G7	14.96	5.00	14.99	34.09	2.53	4.81	C10
G8	14.98	5.08	14.95	34.45	2.50	4.56	
APS 4/10 NOTE: New Tetracosane 4/10 0.0748g /25mL							
G9	14.96	4.92	14.68	37.13	2.55	4.60	
G10	15.00	5.01	14.65	37.54	2.55	4.67	
G11	14.93	5.03	14.67	34.26	2.50	4.48	
G12	14.69	5.03	14.83	35.03	2.50	4.77	
G12-2	14.86	5.08	14.85	36.93	2.56	4.62	
H1	14.68	5.06	14.96	37.86	2.54	4.56	
H2	14.82	4.99	14.63	37.21	2.51	4.50	
H3	14.62	5.02	14.80	37.36	2.52	4.99	
H4	14.84	4.99	14.64	36.73	2.49	4.29	
I1	14.72	5.00	14.64	37.02	2.56	4.38	
I2	14.66	5.00	14.96	38.18	2.62	4.37	
I3	14.82	5.04	14.58	37.14	2.55	4.55	
I4	14.79	5.00	14.80	36.05	2.55	4.57	
J1	14.82	5.02	14.65	37.83	2.50	4.76	

code name	original vial+cap	soil wt	2nd vial+cap	2nd vial+dcr extract	gas vial+cap	gas vial+extract+spike	position on tray
JI-2	14.86	4.99	14.76	37.75	2.52	5.02	E6
BLK-2	14.78	—	14.71	40.77	2.52	4.51	E7
EA 4/10 → APS 4/11 cal dispensing 13.322							
J2	14.80	5.11	14.63	36.80	2.54	4.52	E8
J2-2	14.65	4.95	14.72	37.08	2.51	4.58	E9
J3	14.78	4.92	14.81	36.24	2.56	4.46	E10
J4	14.93	4.98	14.88	38.03	2.56	4.55	F1
K1	14.97	5.02	14.77	36.92	2.49	4.74	F2
K2	14.86	5.00	14.67	37.38	2.50	4.49	F3
K3	15.01	5.02	14.54	37.28	2.53	4.56	F4
K4	14.04	4.99	14.71	37.51	2.51	4.46	F5
L1	14.79	5.02	14.66	37.36	2.50	4.42	F6
L2	14.77	5.00	14.80	37.57	2.52	4.59	F7
L3	14.58	5.04	14.83	36.96	2.52	4.55	F8
L4	14.67	5.01	14.84	37.45	2.56	4.67	F9
M1	14.71	5.00	14.89	38.25	2.51	4.51	F10
M2	14.64	4.96	14.76	37.78	2.54	4.71	G1
M2-2	14.85	5.01	14.72	37.71	2.50	4.38	G2
BLK-4	14.77	—	14.76	40.64	2.57	4.73	G3
M3	14.73	5.01					
M4	14.65	5.03					
N1	14.82	5.00					
N2	14.76	4.99					
N3	14.69	5.01					
N4	14.78	5.01					

Schwab Lab, notebook, 2012