# NATURAL AND NATURE-BASED INFRASTRUCTURE SYSTEMS MAKING TIMELY PROGRESS

## NEED FOR DESCRIPTIVE METHODS, MANUALS, AND STANDARDS



CONSERVATION INTERNATIONAL

Emily Corwin, P.E., M.ASCE
Director of Nature-based Engine

# WHERE WE WORK

Starting with our first project in Bolivia more than 30 years ago, Conservation International has helped support 1,200 protected areas across 77 countries, protecting more than 601 million hectares (1.485 billion acres) of land and sea. With offices in 30 countries worldwide, Conservation International's reach has never been broader, but our mission remains the same: to protect nature for the benefit of us all.

HOW CAN WE MOVE FORWARD WITHOUT BEING HELD BACK?"|

"JUMP START RESILIENCE WITH IMMEDIATE ACTIONS" |

"CURRENTLY HAVE 1000'S OF *(RELATIVELY SMALL)* SINGLE-PURPOSE INDEPENDENT PROJECTS" |

"HOW DO WE MOVE TOWARDS A SYSTEMS APPROACH?"| "NON-LINEAR CHALLENGES NEED NON-LINEAR SOLUTIONS" |

"SCREAM FOR HELP FOR GUIDANCE & TOOLS" |

"MOST AVAILABLE GUIDANCE IS OLD & OUTDATED"

GIVEN THE LACK OF ACCEPTED NORMS AND STANDARDS FOR NATURAL INFRASTRUCTURE DESIGN AND ENGINEERING,

HOW MIGHT WE INCREASE THE EXPERIENCE, FAMILIARITY AND, CONSEQUENTLY, CONFIDENCE OF ENGINEERS, DEVELOPERS, INDUSTRY, AND GOVERNMENTS

SO THEY CAN DESIGN AND BUILD NATURAL INFRASTRUCTURE PROJECTS THAT PROTECT, MANAGE, AND RESTORE NATURE FOR COMMUNITIES AND FUTURE GENERATIONS

# 21ST CENTURY ENGINEERING GUIDELINES FOR OUR 21ST CENTURY CHALLENGES



CONSERVATION INTERNATIONAL

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By 2050, nearly 20% of the world’s population will be at risk of floods


By 2050, up to 5.7 billion people will live in water-scarce areas.

# sustainable & resilient

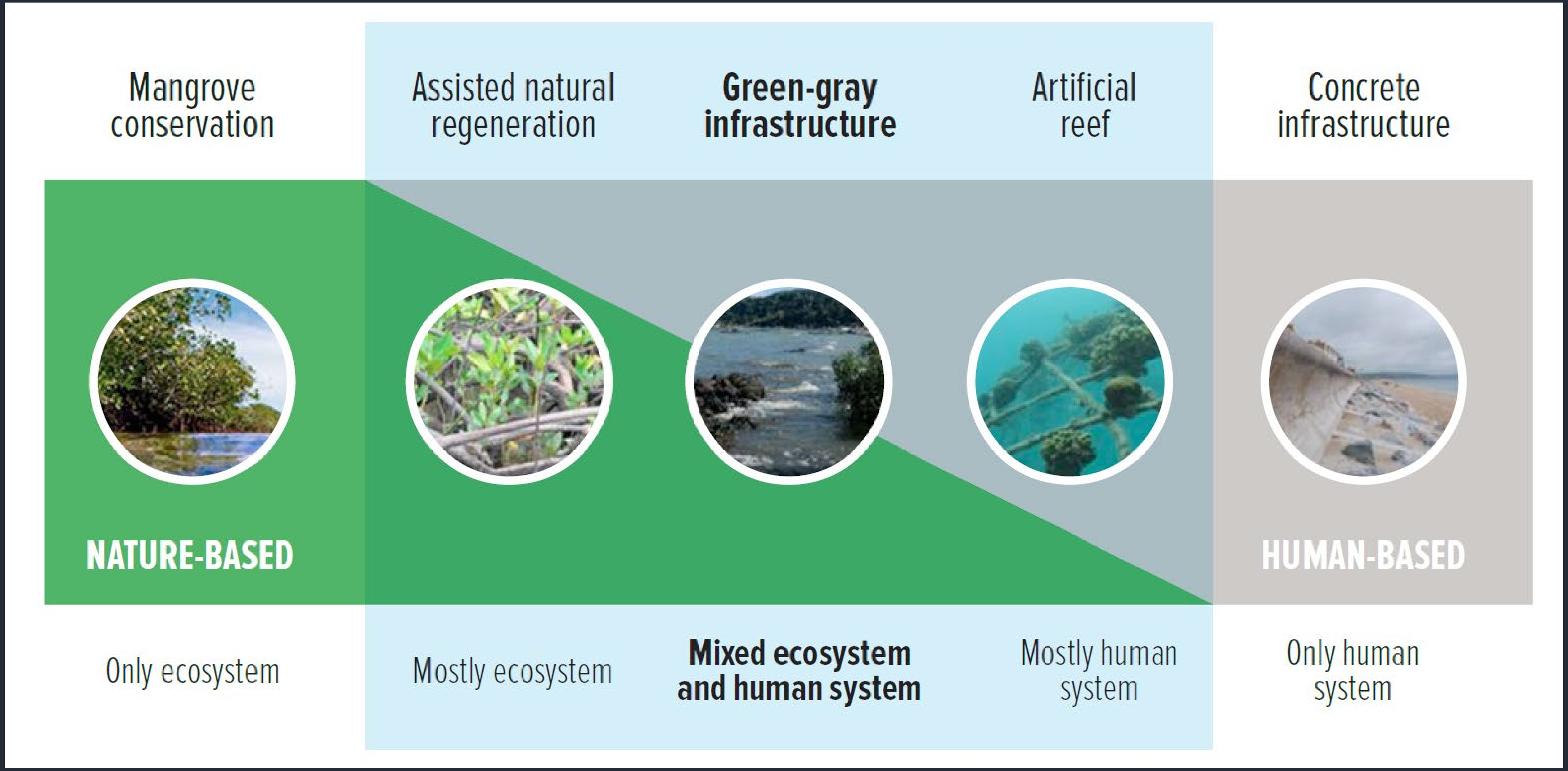
Infrastructure costs are expected to account for up to 80% of total climate change adaptation spending globally – estimated at USD 150 billion to USD 450 billion per year in 2050.


Nature-based infrastructure can be up to **50% cheaper** than traditional gray infrastructure and provide **28% better value for money**.
**Replacing just 11%** of current global infrastructure needs with nature-based infrastructure **could save USD 248 billion each year**.

# A RANGE OF POTENTIAL SOLUTIONS

Green-gray – or hybrid - infrastructure draws upon the best of our engineering achievements to create hybrid solutions along this spectrum

In our most built environments a gray-only solution, like sea walls, may be most appropriate – and on the other end of the spectrum, a purely green spectrum, a purely green solution, like mangrove restoration, may be best.



# OUR GOAL

Fundamentally transform the engineering and construction industry to design and build with nature – to create the next generation of climate resilient infrastructure.

Key barriers:

1. Engineers, developers, industry, and governments lack experience, familiarity and, consequently, confidence in the reliability and application of green-gray approaches;

2. Technical knowledge and data needed to standardize reliable green-gray solutions is not broadly or equitably available;

3. Most infrastructure policies and regulations do not currently incentivize green-gray solutions; and

4. Real and perceived risks constrain investments in developing economies despite significant opportunities for achieving social, economic, and climate mitigation and adaptation objectives at a competitive cost.

# WHAT ARE WE TALKING ABOUT?

## Generically ….

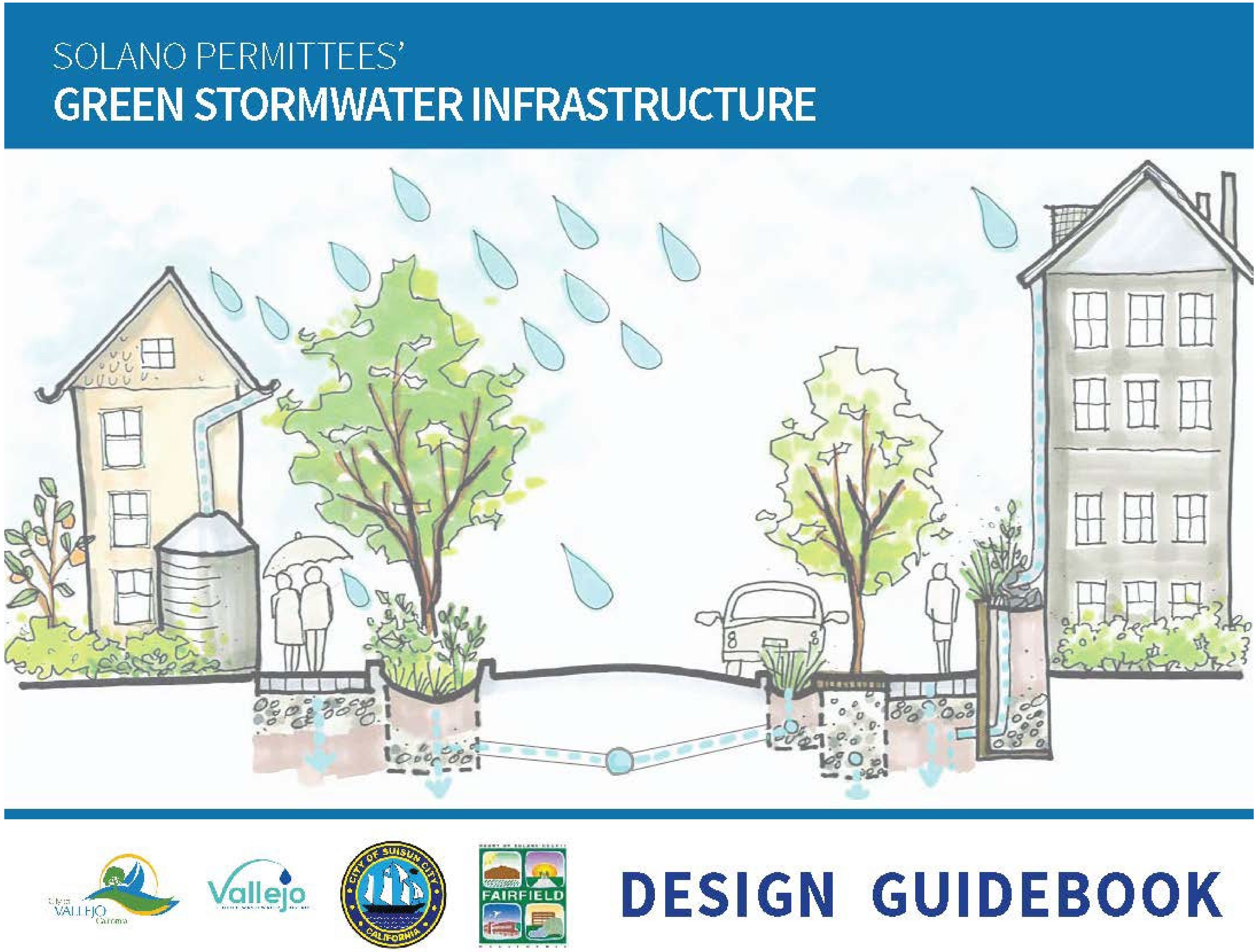
1. Description of the approach
   - *e.g., purpose, benefits, and constraints*
2. General design principles
   - *e.g., sizing, operation and maintenance requirements, costs*

**DESCRIPTIVE METHODS**

3. Design Detail(s)
   - *usually drawn in AutoCAD*
4. Design Specification
   - *word document with detailed instructions to the builder*

**STANDARDS**

# ENGINEERING DESIGN GUIDELINES EXAMPLE



# ENGINEERING DESIGN GUIDELINES EXAMPLE

## 2. Green Stormwater Infrastructure Types

### GREEN STORMWATER INFRASTRUCTURE CLASSIFICATIONS

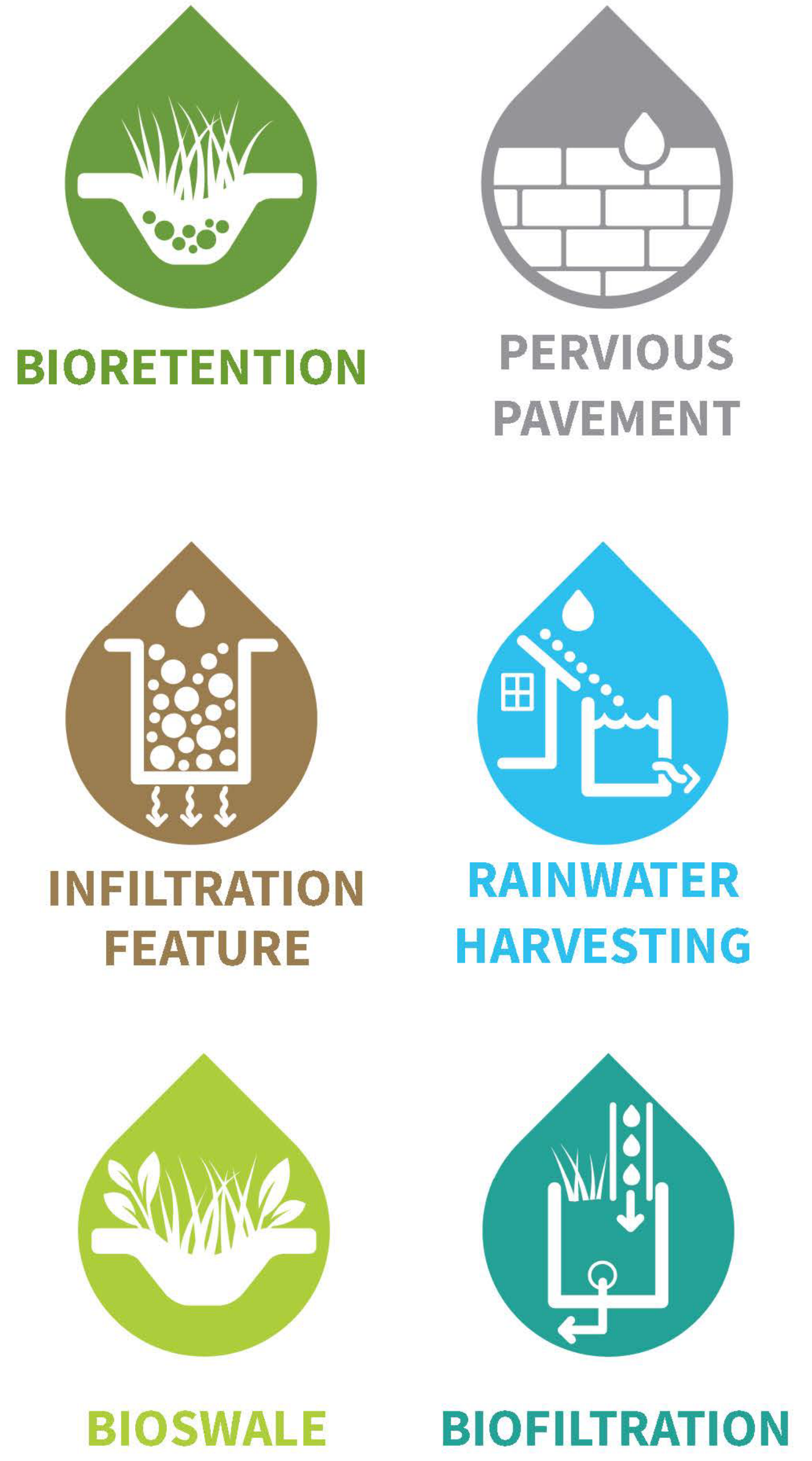
For the purposes of organizing and presenting information, this Design Guidebook classifies green stormwater infrastructure structures into six categories. Any existing or proposed green stormwater infrastructure feature can be identified as one of these six types: a bioretention feature, an infiltration feature, pervious pavement, rainwater harvesting, a bioswale or a biofiltration feature.

There are other common terms associated with green stormwater infrastructure, like "curb cuts", that are specific design elements that can be associated with many different green stormwater infrastructure types. Another example is the term "rain garden", which is a type of bioretention where stormwater can infiltrate into the subsurface soils. Biofiltration is another type of bioretention with an impermeable or concrete liner with an underdrain (pervious) pipe.

These definitions are consistent throughout the Solano Permittees' green stormwater infrastructure programs, including within the Green Infrastructure Plans and pollutant load models.

Several of these Green Stormwater Infrastructure strategies can be combined into a treatment train to meet stormwater requirements and project goals, depending on what is best suited for a particular project and site. In this context, treatment train refers to GSI in series so overflow, for example, from a biofiltration may flow into a bioretention which may flow into a bioswale. Throughout this Design Guidebook the icons to the right are used to identify different types of Green Stormwater Infrastructure as they are represented within right-of-way improvements or parking lots (Chapter 3) or specific design details (Chapter 4).

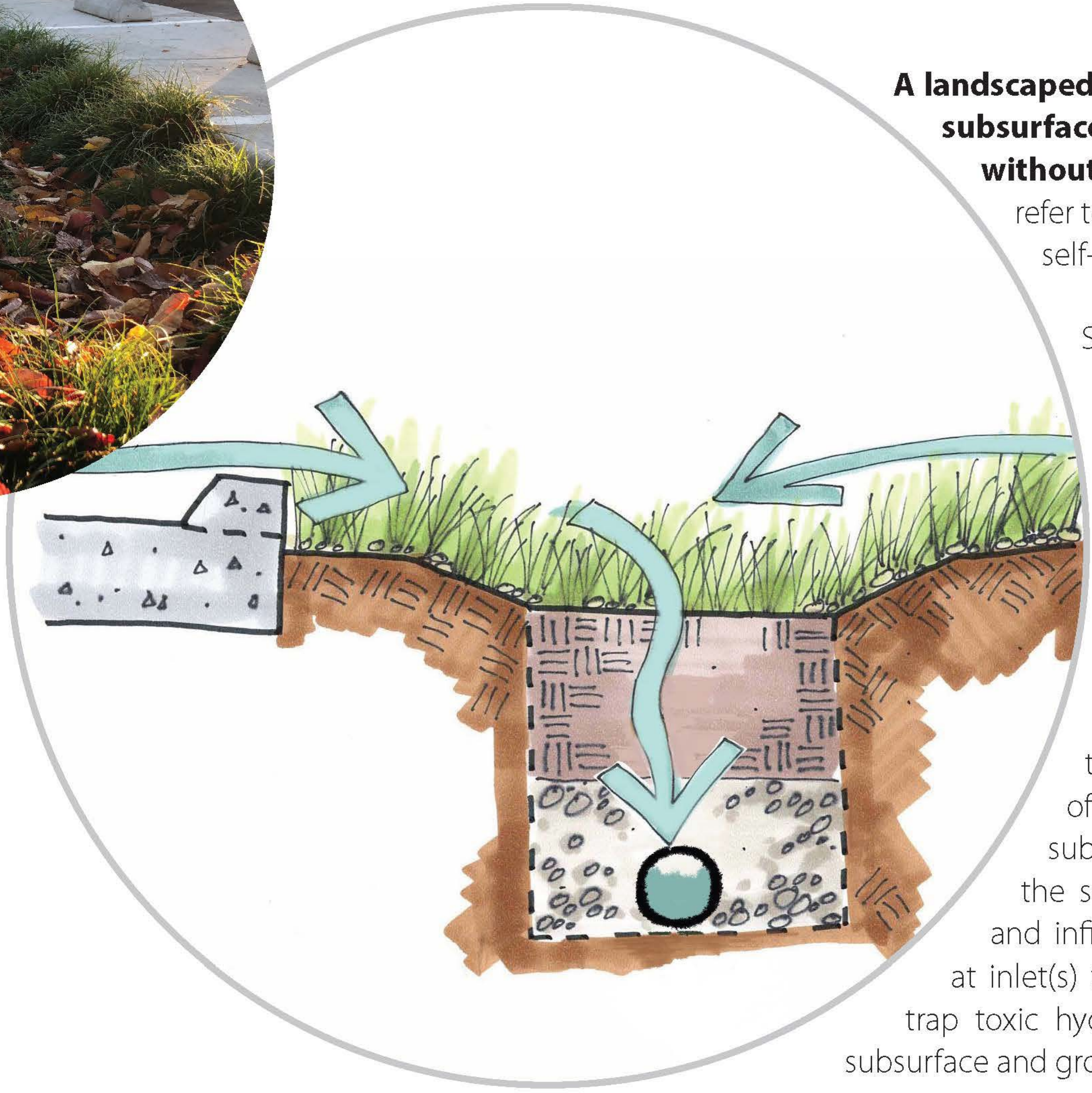
> Bioswales and pervious pavements will have limited applicability towards meeting a Regulated Project's stormwater requirements, and are recommended to "treat" impervious area at a 2:1 ratio of pervious to impervious surface..



# ENGINEERING DESIGN GUIDELINES EXAMPLE

## 2. Green Stormwater Infrastructure Types

### BIORETENTION



**A landscaped feature that allows for infiltration into subsurface soils and can be constructed with or without side walls.** Other common terms used to refer to bioretention features include rain gardens, self-retaining areas, or biofilters.

Stormwater typically is designed to pond up to 6 inches prior to outflow via a surface outlet (e.g., curb cut) or a piped overflow (e.g., overflow inlet and/ or underdrain). Bioretention features may or may not include a perforated underdrain. Bioretention structures are constructed with a specialized soil media ideally 18-24 inches in depth to enhance biogeochemical processes to retain and transform pollutants, and infiltrate at a rate of 5 inches per hour. A rock or aggregate subsurface reservoir can be included under the soil media to enhance stormwater storage and infiltration. A settling forebay can be located at inlet(s) to remove sediment. Bioretention features trap toxic hydrocarbons and asbestos before reaching subsurface and groundwater supplies.

# ENGINEERING DESIGN GUIDELINES EXAMPLE

## 3. Streetscape and Project Design Guidelines


### Design Considerations

Stormwater curb extension sizing should allow for safe overflow during large storm events to minimize flooding into the roadway, which can create hazards for street users.

Plants in curb extensions should not grow taller than 24 inches above the sidewalk grade to maintain sight clearance in the right of way.

Curb extensions are typically recessed 1-2 feet from the outside edge of the right-most travel lane, though width may be adjusted based on site specific considerations.

The angle of the curb extension where it joins the original curb should be angled between 30 to 60 degrees to allow for mechanical street sweeping.

Inlets and outlets should be designed to avoid vehicle and bicycle wheels entering the openings.

A pre-settling zone, or energy dissipation area, should be incorporated at any locations where high energy flows are expected to enter the GSI.

While ensuring that emergency responders maintain adequate access, stormwater curb extensions can be located in areas where on-street parking is already prohibited, such as near fire hydrants or driveway setbacks.

# ENGINEERING DESIGN GUIDELINES EXAMPLE

## 4. Green Stormwater Infrastructure Standard Specification and Design Details

PURPOSE:

BIORETENTION BASINS CONTROL PEAK FLOWS AND VOLUMES OF STORMWATER RUNOFF BY PROVIDING SURFACE, SUBSURFACE STORAGE AND INFILTRATION INTO NATIVE SOIL. WATER IS ALSO TREATED AS IT FILTERS THROUGH THE BIORETENTION SOIL.

DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT PLAN AND SECTION DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. FACILITY AREA, PONDING DEPTH, BIORETENTION SOIL DEPTH, AND AGGREGATE STORAGE DEPTH MUST BE SIZED TO MEET PROJECT HYDROLOGIC PERFORMANCE GOALS.
3. PONDING AND BIORETENTION SOIL DRAWDOWN TIME (I.E., TIME FOR MAXIMUM SURFACE PONDING TO DRAIN THROUGH THE BIORETENTION SOIL AFTER THE END OF A STORM) RECOMMENDATIONS:
   - 3 - 12 HOUR PONDING AND BIORETENTION SOIL DRAWDOWN (TYPICAL)
   - 24 HOUR MAXIMUM PONDING AND BIORETENTION SOIL DRAWDOWN
4. FACILITY DRAWDOWN TIME (I.E. TIME FOR SURFACE PONDING TO DRAIN THROUGH THE ENTIRE SECTION INCLUDING AGGREGATE STORAGE AFTER THE END OF A STORM) REQUIREMENTS:
   - 48 HOUR MAXIMUM FACILITY DRAWDOWN (I.E. ORFICE CONTROLLED SYSTEM OR EXTENDED STORAGE DEPTH WITHIN INFILTRATION SYSTEM).
5. THE FOLLOWING GUIDELINES APPLY TO RIGHT-OF-WAY APPLICATIONS:
   - BULB OUT CURB TRANSITIONS SHALL CONFORM TO CITY STANDARDS.
   - WHEN FACILITY CONSTRUCTION IMPACTS EXISTING SIDEWALK, ALL SAW CUTS MUST ADHERE TO CITY REQUIREMENTS. SAW CUTS SHOULD BE ALONG SCORE LINES AND ANY DISTURBED SIDEWALK FLAGS SHOULD BE REPLACED IN THEIR ENTIRETY.
   - DESIGNER TO SPECIFY TRANSITION OF PLANTER TO TOP OF CURB ELEVATION BETWEEN CURB CUTS OR CONTINUOUS 6 INCH REVEAL AT CURB EDGE.
6. UP TO TWO PLANTERS MAY BE CONNECTED IN SERIES, IN LIEU OF MULTIPLE INLETS, PROVIDED THE CONNECTION IS A TRENCH DRAIN OR EQUAL SURFACE CONVEYANCE AND IS ADEQUATELY SIZED TO CONVEY FLOWS.
7. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT CITY ASSET PROTECTION STANDARDS AND OTHER UTILITY PROVIDERS REQUIREMENTS.

| RELATED SPECIFICATIONS | CSI NO. |
|---|---|
| **BIORETENTION:**<br>- BIORETENTION SOIL MIX<br>- AGGREGATE STORAGE<br>- MULCH<br>- STREAMBED COBBLES | 33 47 27 |

| RELATED COMPONENTS | | | |
|---|---|---|---|
| UNDERDRAINS: | 2.0 | - | 2.1 |
| INLETS: | 3.0 | - | 3.2 |
| OUTLETS: | 4.0 | - | 4.3 |

DESIGNER CHECKLIST
(MUST SPECIFY, AS APPLICABLE):

- ☐ FACILITY WIDTH, LENGTH, SLOPES (INCLUDING SIDE, CROSS, AND LONGITUDINAL), AND SHAPE
- ☐ DEPTH OF BIORETENTION SOIL
- ☐ DEPTH AND TYPE OF GRAVEL STORAGE, IF ANY
- ☐ PLANTER SURFACE ELEVATION (TOP OF BIORETENTION SOIL) AT UPSLOPE AND DOWNSLOPE ENDS OF FACILITY
- ☐ CONTROL POINTS AT EVERY CORNER OF FACILITY AND POINT OF TANGENCY
- ☐ DIMENSIONS AND DISTANCE TO EVERY INLET, OUTLET, SIDEWALK NOTCH, ETC.
- ☐ ELEVATIONS OF EVERY INLET, OUTLET, STRUCTURE RIM AND INVERT, AND SIDEWALK NOTCH
- ☐ TYPE AND DESIGN OF FACILITY COMPONENTS (E.G., EDGE TREATMENTS, INLETS/GUTTER MODIFICATIONS, UTILITY CROSSINGS, LINER, AND PLANTING DETAILS)

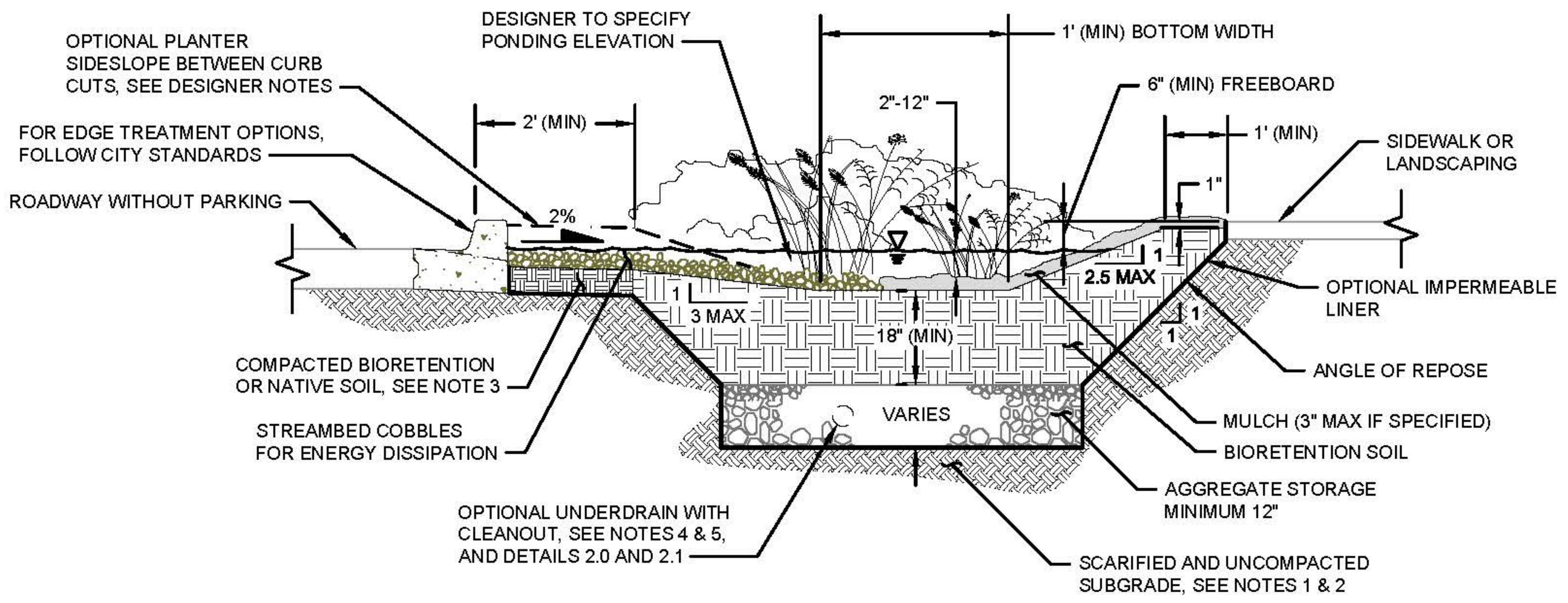
LAYOUT REQUIREMENTS:

1. FOR RIGHT-OF-WAY APPLICATIONS, REFER TO THE CITY STANDARD ACCESSIBILITY REQUIREMENTS FOR CONSTRUCTION OF COURTESY STRIP, THROUGHWAY, PARKING SPACE AND ACCESSIBLE PATH REQUIREMENTS.
2. LOCATE CURB CUTS AND GUTTER MODIFICATIONS TO AVOID CONFLICTS WITH ACCESSIBILITY REQUIREMENTS (E.G., LOCATE OUTSIDE OF CROSSWALKS).

NOT FOR CONSTRUCTION

| BIORETENTION & BIOINFILTRATION BASINS<br>DESIGNER NOTES | 1.0 |
|---|---|

## 4. Green Stormwater Infrastructure Standard Specification and Design Details



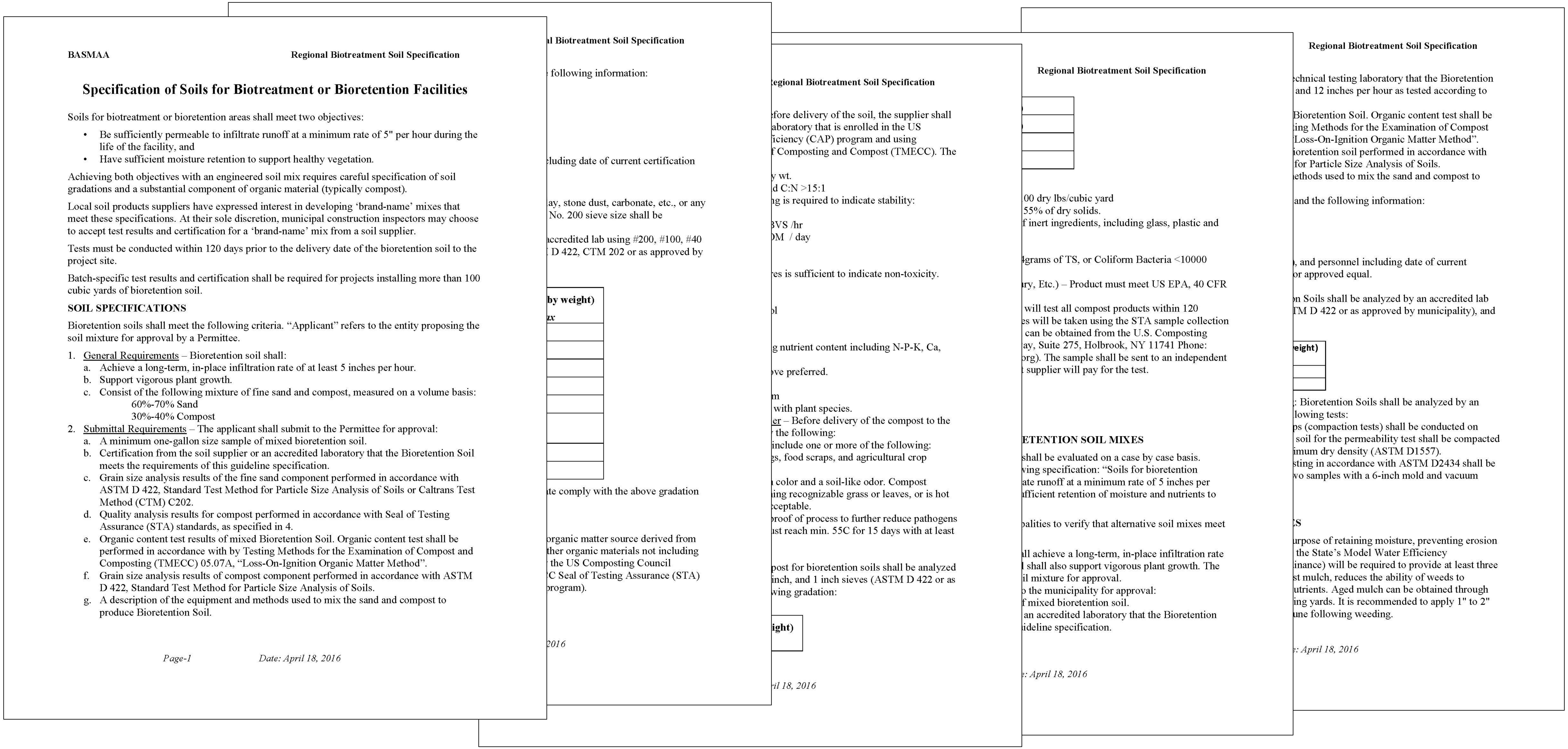

CONSTRUCTION NOTES:

1. AVOID COMPACTION OF EXISTING SUBGRADE BELOW BASIN.
2. SCARIFY SUBGRADE TO A DEPTH OF 3 INCHES (MIN) IMMEDIATELY PRIOR TO PLACEMENT OF AGGREGATE STORAGE AND BIORETENTION SOIL MATERIALS.
3. COMPACT BIORETENTION SOIL IMMEDIATELY BEHIND CURB TO 90% OF MAXIMUM DENSITY PER STANDARD PROCTOR TEST (ASTM D698).
4. UNDERDRAIN REQUIRED FOR ALL FACILITIES WITH IMPERMEABLE LINER.
5. PROVIDE ONE CLEANOUT PER PLANTER (MIN) FOR FACILITIES WITH UNDERDRAINS. CLEANOUT MUST CONSIST OF A VERTICAL, RIGID, NON-PERFORATED PVC PIPE, WITH A MINIMUM DIAMETER OF 4-INCHES AND A WATERTIGHT CAP.
6. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT CITY STANDARDS. COORDINATE WITH ENGINEER IN THE EVENT OF UTILITY CROSSING AND UTILITY CONFLICTS.

NOT FOR CONSTRUCTION

| BIORETENTION & BIOINFILTRATION BASINS<br>ROADSIDE SECTION | 1.1 |
|---|---|

# ENGINEERING DESIGN GUIDELINES EXAMPLE



BASMAA — Regional Biotreatment Soil Specification

## Specification of Soils for Biotreatment or Bioretention Facilities

Soils for biotreatment or bioretention areas shall meet two objectives:

- Be sufficiently permeable to infiltrate runoff at a minimum rate of 5" per hour during the life of the facility, and
- Have sufficient moisture retention to support healthy vegetation.

Achieving both objectives with an engineered soil mix requires careful specification of soil gradations and a substantial component of organic material (typically compost).

Local soil products suppliers have expressed interest in developing 'brand-name' mixes that meet these specifications. At their sole discretion, municipal construction inspectors may choose to accept test results and certification for a 'brand-name' mix from a soil supplier.

Tests must be conducted within 120 days prior to the delivery date of the bioretention soil to the project site.

Batch-specific test results and certification shall be required for projects installing more than 100 cubic yards of bioretention soil.

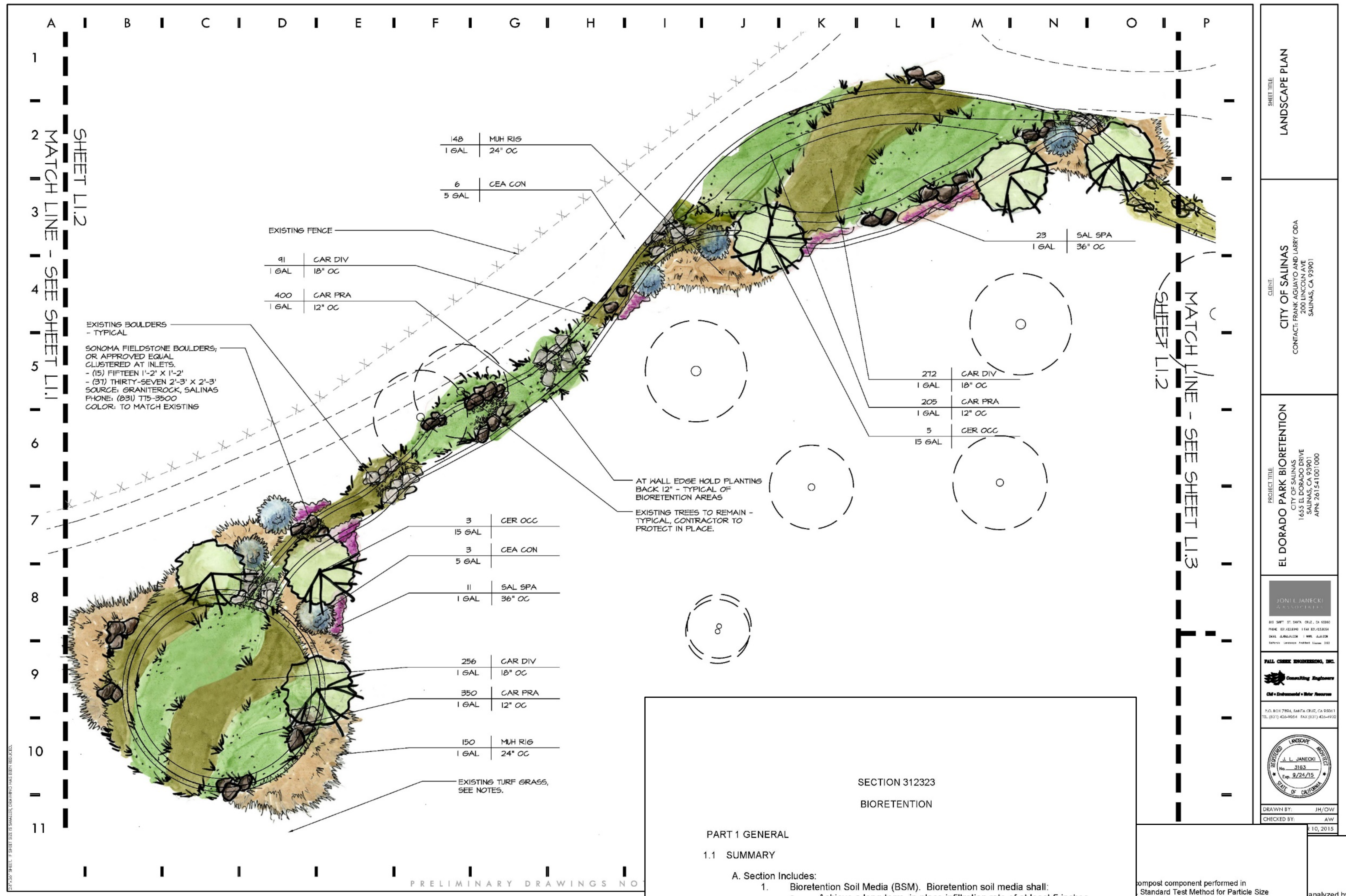
**SOIL SPECIFICATIONS**

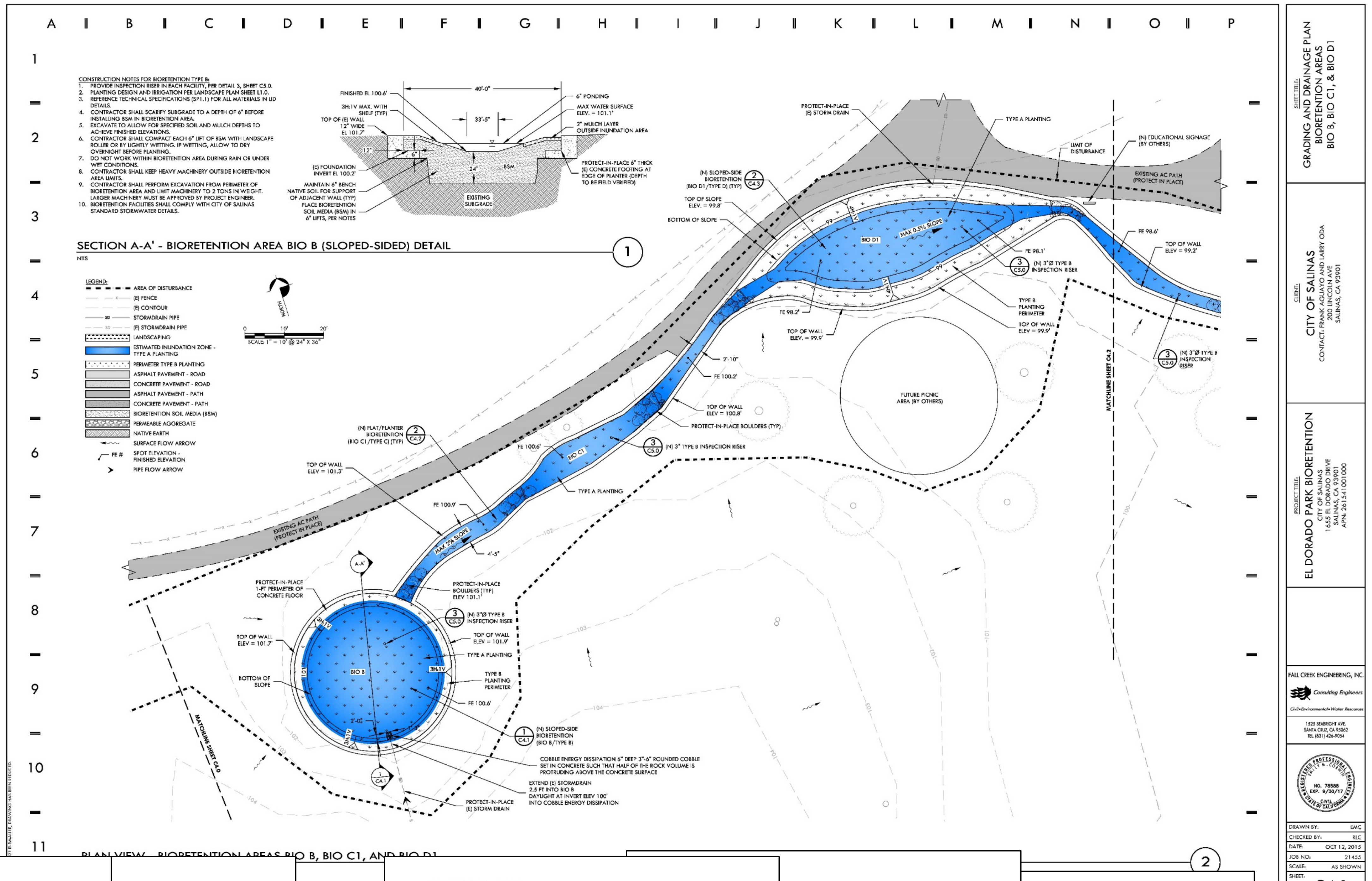
Bioretention soils shall meet the following criteria. "Applicant" refers to the entity proposing the soil mixture for approval by a Permittee.

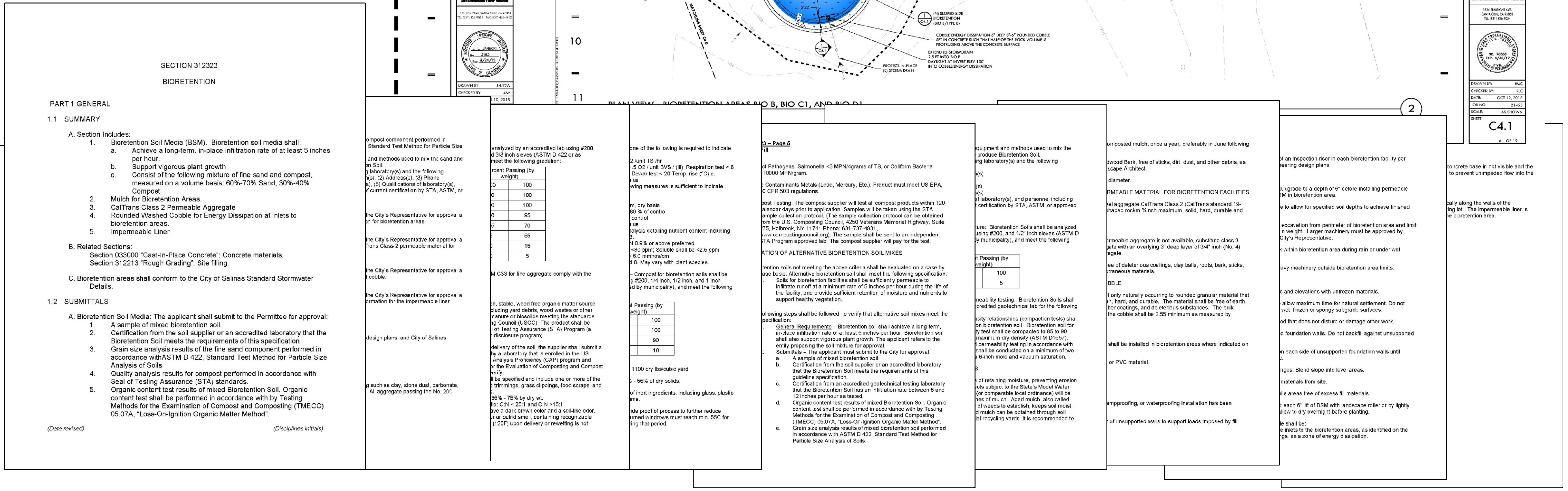
1. General Requirements – Bioretention soil shall:
   a. Achieve a long-term, in-place infiltration rate of at least 5 inches per hour.
   b. Support vigorous plant growth.
   c. Consist of the following mixture of fine sand and compost, measured on a volume basis:
      60%-70% Sand
      30%-40% Compost
2. Submittal Requirements – The applicant shall submit to the Permittee for approval:
   a. A minimum one-gallon size sample of mixed bioretention soil.
   b. Certification from the soil supplier or an accredited laboratory that the Bioretention Soil meets the requirements of this guideline specification.
   c. Grain size analysis results of the fine sand component performed in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils or Caltrans Test Method (CTM) C202.
   d. Quality analysis results for compost performed in accordance with Seal of Testing Assurance (STA) standards, as specified in 4.
   e. Organic content test results of mixed Bioretention Soil. Organic content test shall be performed in accordance with by Testing Methods for the Examination of Compost and Composting (TMECC) 05.07A, "Loss-On-Ignition Organic Matter Method".
   f. Grain size analysis results of compost component performed in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils.
   g. A description of the equipment and methods used to mix the sand and compost to produce Bioretention Soil.

*Page-1* *Date: April 18, 2016*

# ENGINEERING DESIGN GUIDELINES EXAMPLE



SECTION 312323

BIORETENTION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Bioretention Soil Media (BSM). Bioretention soil media shall:
   a. Achieve a long-term, in-place infiltration rate of at least 5 inches per hour.
   b. Support vigorous plant growth
   c. Consist of the following mixture of fine sand and compost, measured on a volume basis: 60%-70% Sand, 30%-40% Compost
2. Mulch for Bioretention Areas.
3. CalTrans Class 2 Permeable Aggregate
4. Rounded Washed Cobble for Energy Dissipation at inlets to bioretention areas.
5. Impermeable Liner

B. Related Sections:
Section 033000 "Cast-In-Place Concrete": Concrete materials.
Section 312213 "Rough Grading": Site filling.

C. Bioretention areas shall conform to the City of Salinas Standard Stormwater Details.

1.2 SUBMITTALS

A. Bioretention Soil Media: The applicant shall submit to the Permittee for approval:
1. A sample of mixed bioretention soil.
2. Certification from the soil supplier or an accredited laboratory that the Bioretention Soil meets the requirements of this specification.
3. Grain size analysis results of the fine sand component performed in accordance withASTM D 422, Standard Test Method for Particle Size Analysis of Soils.
4. Quality analysis results for compost performed in accordance with Seal of Testing Assurance (STA) standards.
5. Organic content test results of mixed Bioretention Soil. Organic content test shall be performed in accordance with by Testing Methods for the Examination of Compost and Composting (TMECC) 05.07A, "Loss-On-Ignition Organic Matter Method".

(Date revised) (Disciplines initials)

# THERE ARE FEW ACCEPTED ENGINEERING STANDARDS FOR NATURE-BASED INFRASTRUCTURE SOLUTIONS – BUT THERE ARE – MANY GUIDES AND RESOURCES THAT GIVE US ENOUGH INFORMATION TO BEGIN …

EWN Engineering With Nature ®

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# International Guidelines on Natural and Nature-Based Features for Flood Risk Management

Available now!


CONSERVATION INTERNATIONAL

AECOM

BECHTEL

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FEBA
Friends of Ecosystem-based Adaptation

IUCN

The Nature Conservancy

the Natural Infrastructure Initiative

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THE UNIVERSITY OF MELBOURNE

Faculty of Architecture, Building and Planning

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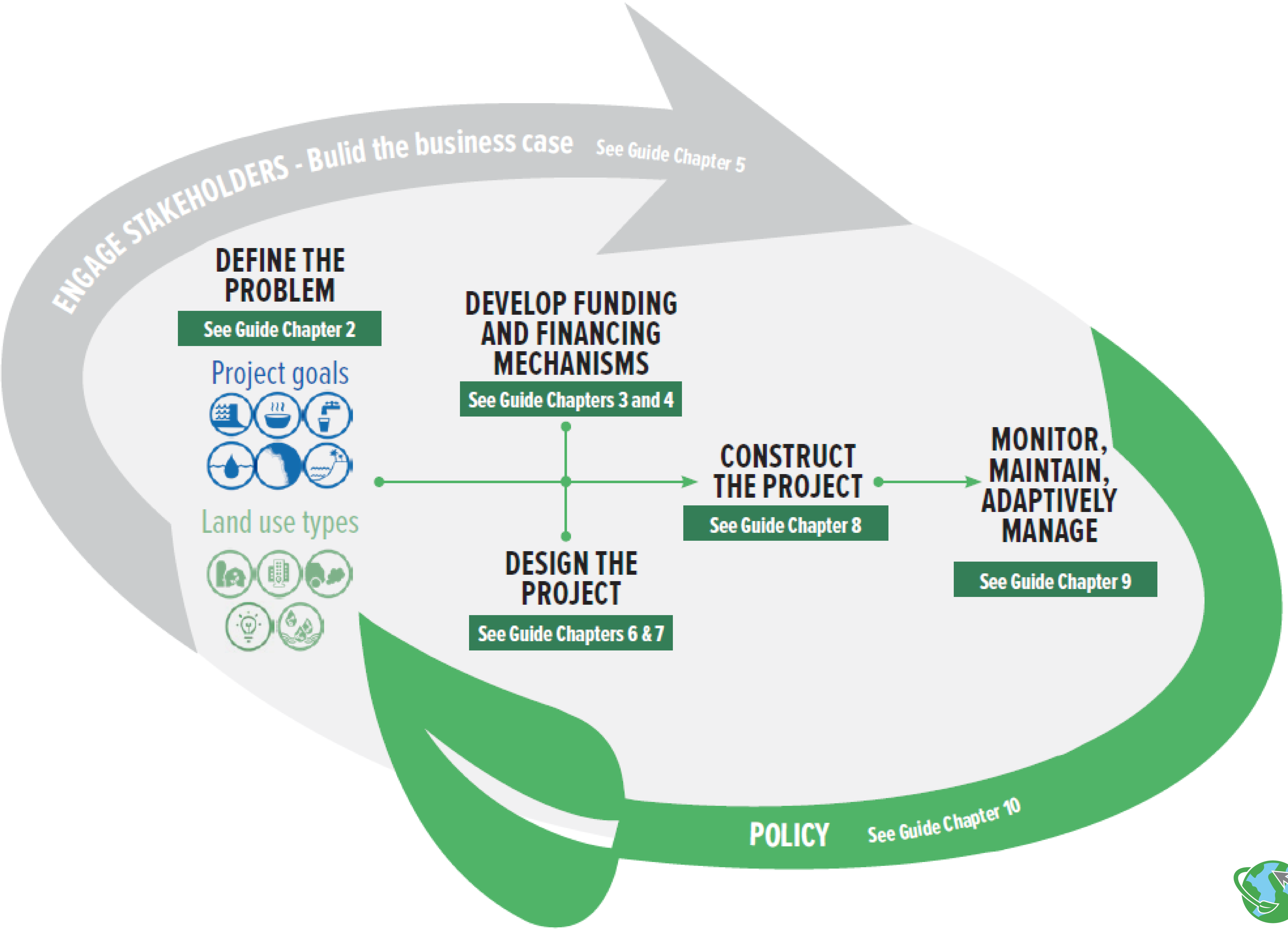


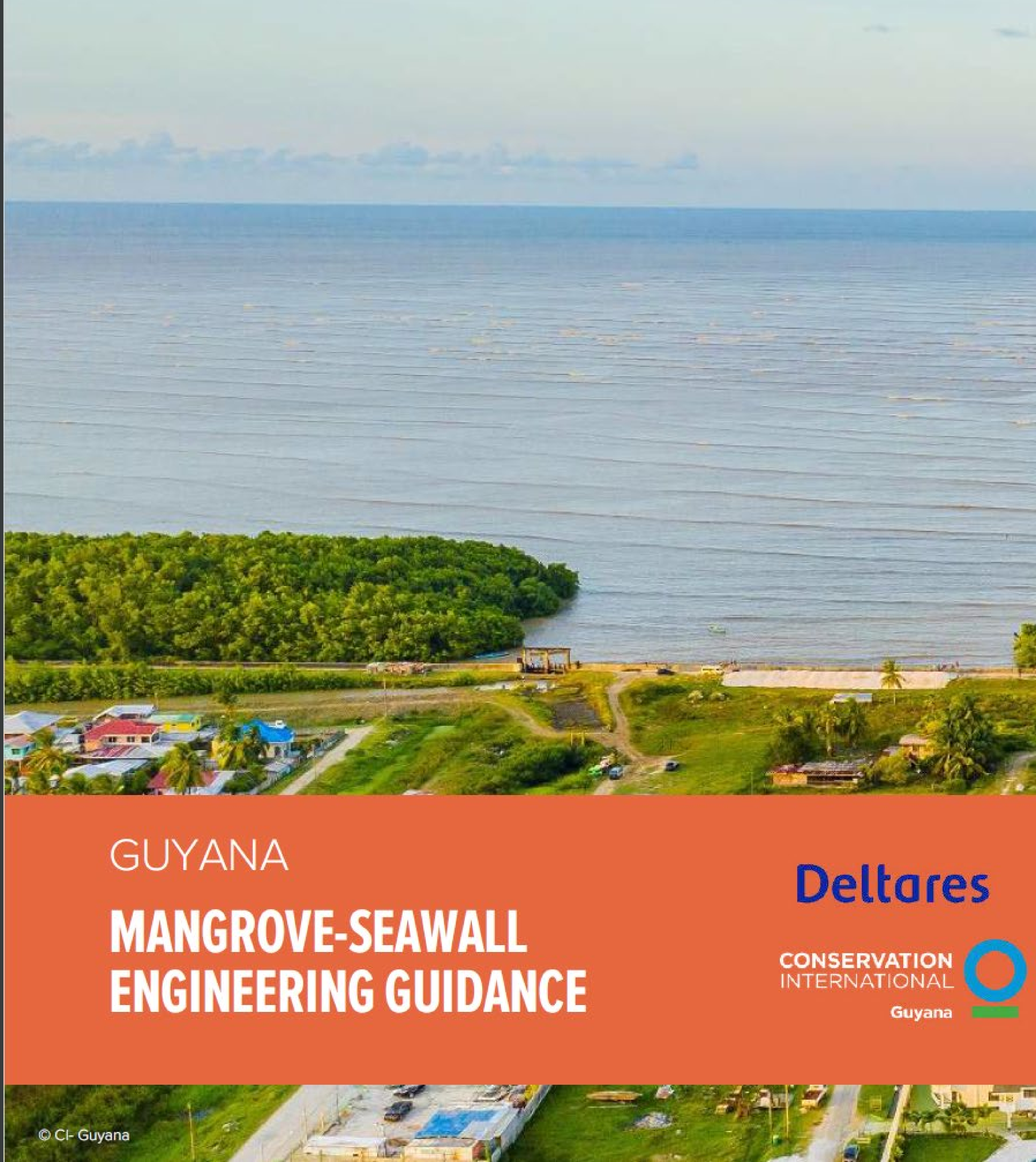

GREEN GRAY Community of Practice

## SCIENCE & ENGINEERING

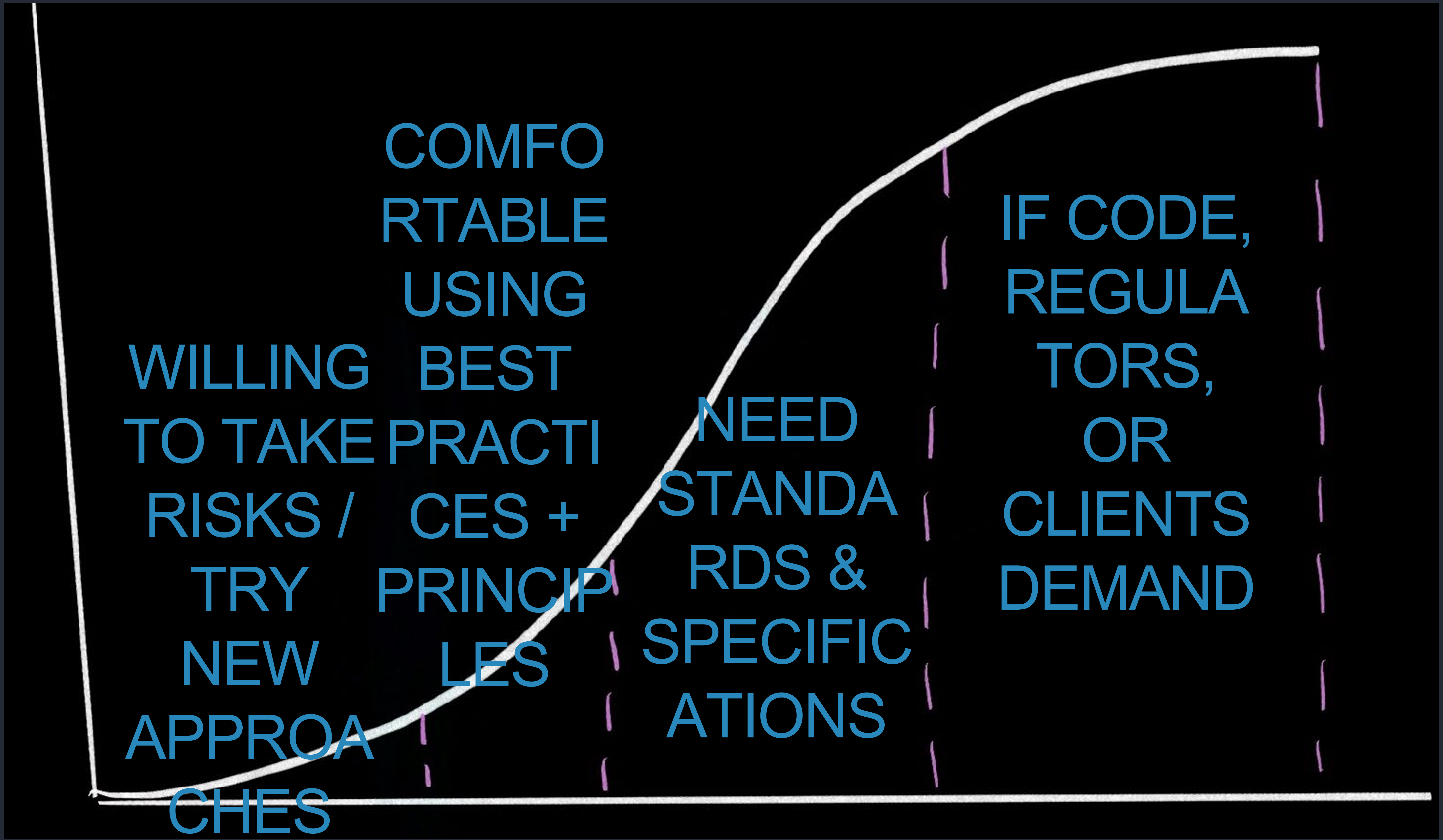
Develop concise, scientific green-gray engineering guidance for mangroves + seawalls

- Guyana specific
- General version

Database review of Engineering Resources available on our green-gray community website…



# WHAT LEVEL OF GUIDANCE DO ENGINEERS NEED?



# DOING

# KNOWING THAT:

1. OFTEN THE COMPLEXITY OF NATURE-BASED SOLUTIONS REQUIRES FLEXIBLE DESIGN APPROACHES– VERSUS RIGID STANDARDS

2. COMPETENT ENGINEERS – WILL TAKE RISKS AND INNOVATE & APPLY AND IMPROVE UPON BEST PRACTICES

# LEARN BY DOING … HOW?

# THE CURRENT APPROACH TO EVIDENCE-BASED DECISION MAKING FOR NATURE-BASED SOLUTIONS IS AT BEST – PROJECT, REGION, OR PROBLEM SPECIFIC.

# AT WORST - IT IS NON-EXISTENT OR PROPRIETARY.

REGULAR MONITORING OF INFRASTRUCTURE PERFORMANCE AND IMPACTS IS NECESSARY TO GENERATE DATA, WHICH SHOULD BE AVAILABLE TO ALL STAKEHOLDERS.

# 10. EVIDENCE-BASED DECISION-MAKING

The planning and management of infrastructure throughout the lifecycle should be informed by key performance indicators that should promote the collection of data, including data that is disaggregated by stakeholder groups. Regular monitoring of infrastructure performance and impacts is necessary to generate data, which should be made available to all stakeholders.

# Monitoring

- Monitoring the performance and impacts of infrastructure enables continuous improvement in service delivery and sustainability.
- Pre- and post-project data on all stages of the lifecycle should be identified and defined, collected, managed, analysed and fed back to decision makers and stakeholders.
- In addition to economic and financial data, adequate resources should be allocated to collection of data relating to environmental and social sustainability factors, including spatial and disaggregated data - at international, national, local and project levels.

# Data Sharing

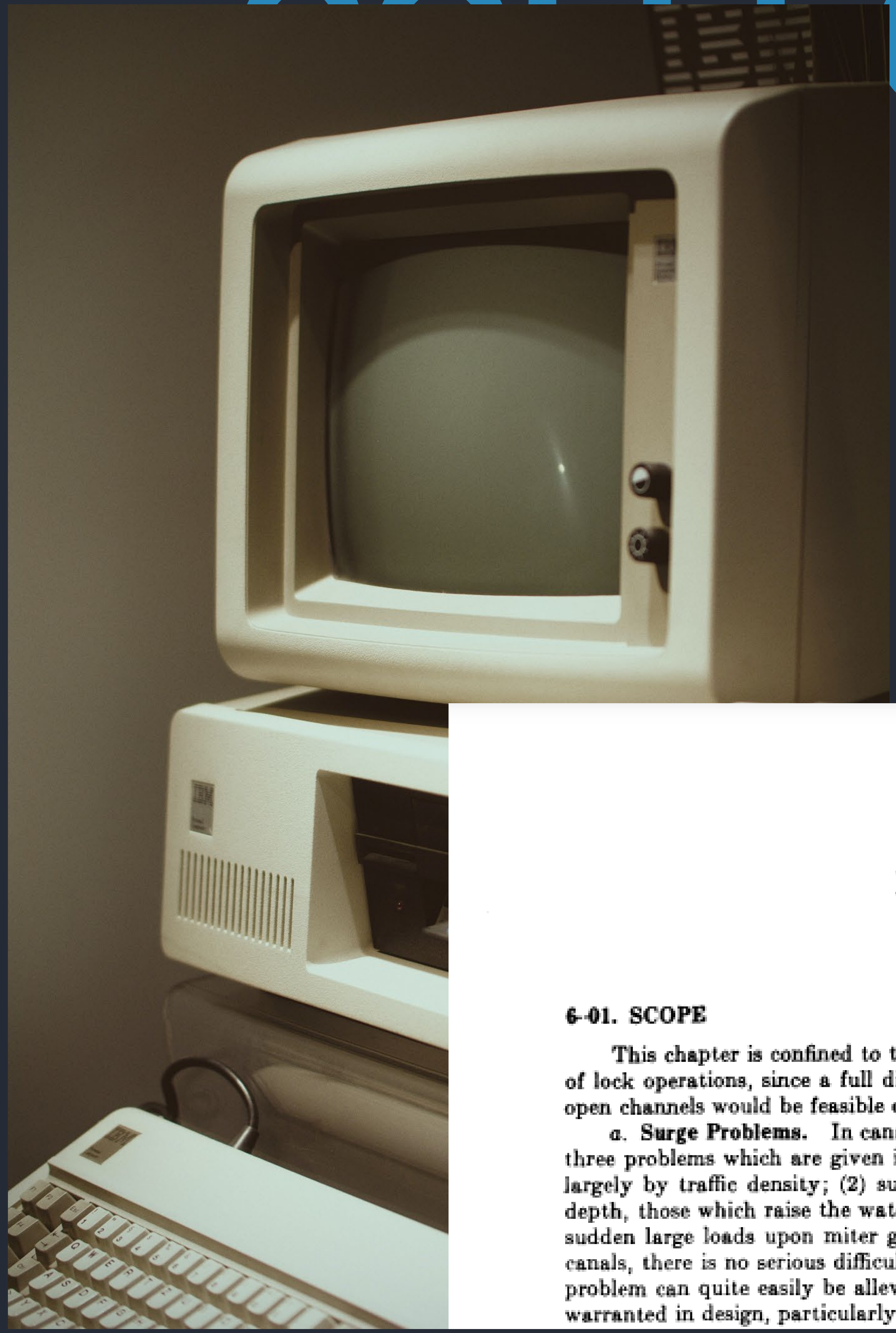
- Effective monitoring requires data management and storage capacity that allows for continuity of data gathering, storage and sharing across different project and lifecycle phases and with different stakeholder groups.

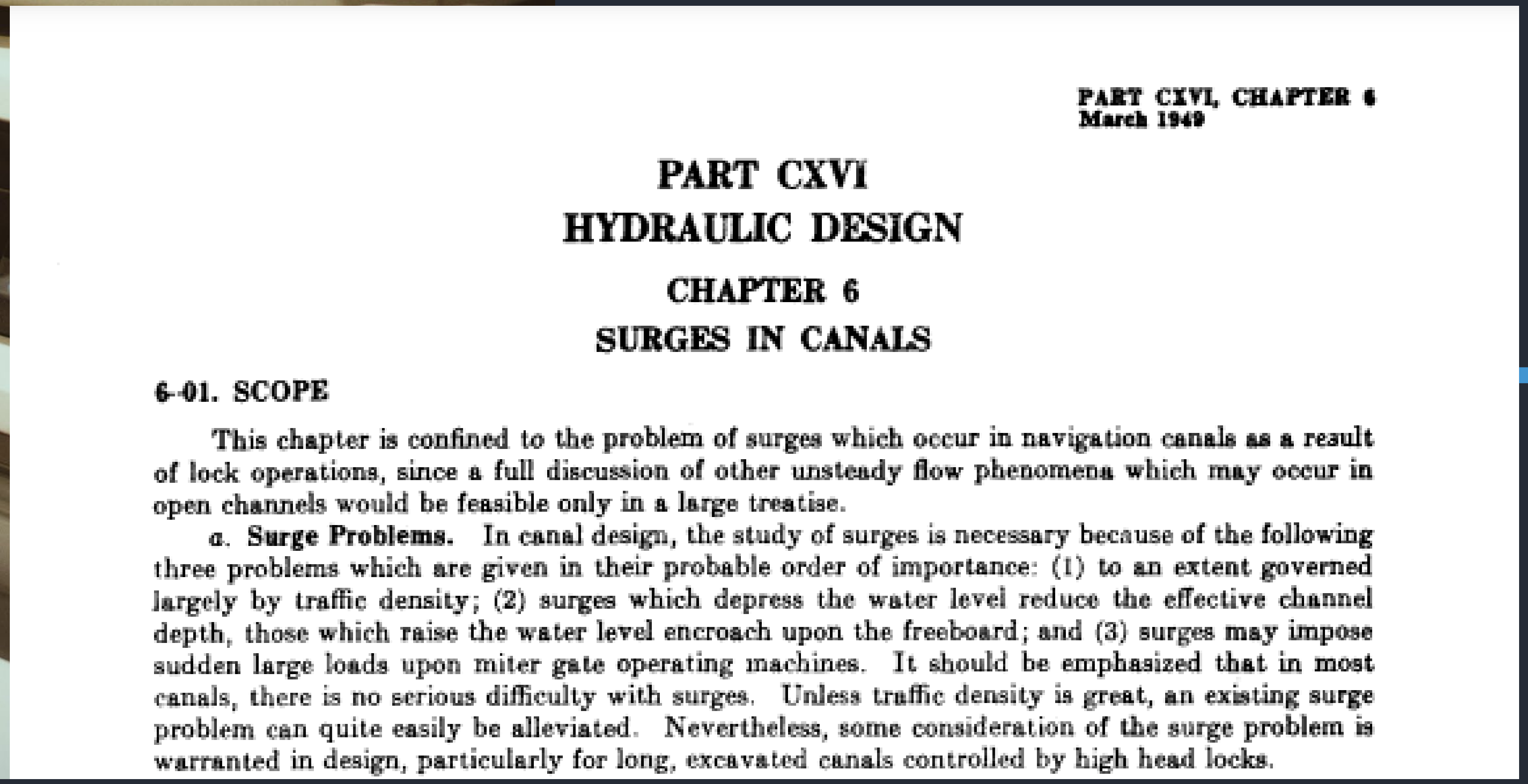
- Governments should engage in partnerships with the private sector, academia and civil society to ensure that relevant data are defined, measured, collected, analysed and synthesised in ways that are useful for decision makers and the public.

# WE CAN...

# COLLABORATE ACROSS DISCIPLINES AND GEOGRAPHIES TO DESIGN A TRUSTED MODERN DATA SHARING PLATFORM FOR USERS TO INPUT TECHNICAL KNOWLEDGE AND DATA ABOUT NATURAL INFRASTRUCTURE PROJECTS.

# DESIGN A PLATFORM THAT LEVERAGES MODERN COMPUTING & DATA COLLECTION TECHNOLOGY





PART CXVI, CHAPTER 6
March 1949

PART CXVI

HYDRAULIC DESIGN

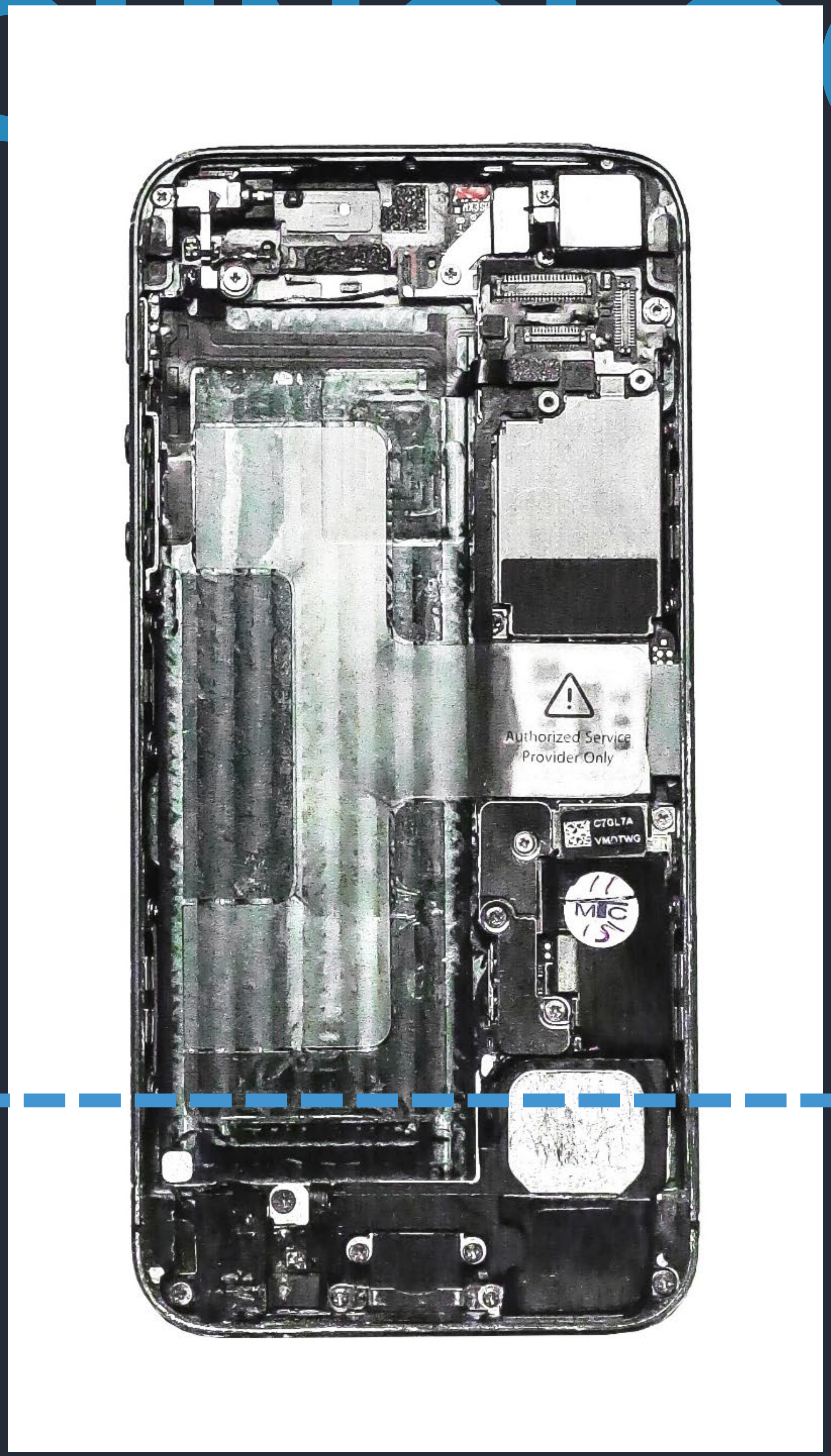
CHAPTER 6

SURGES IN CANALS

**6-01. SCOPE**

This chapter is confined to the problem of surges which occur in navigation canals as a result of lock operations, since a full discussion of other unsteady flow phenomena which may occur in open channels would be feasible only in a large treatise.

*a.* **Surge Problems.** In canal design, the study of surges is necessary because of the following three problems which are given in their probable order of importance: (1) to an extent governed largely by traffic density; (2) surges which depress the water level reduce the effective channel depth, those which raise the water level encroach upon the freeboard; and (3) surges may impose sudden large loads upon miter gate operating machines. It should be emphasized that in most canals, there is no serious difficulty with surges. Unless traffic density is great, an existing surge problem can quite easily be alleviated. Nevertheless, some consideration of the surge problem is warranted in design, particularly for long, excavated canals controlled by high head locks.

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INTERNATIONAL STORMWATER BMP DATABASE

HOME ABOUT CONNECT

Urban Stormwater BMP Database | DOT Portal to BMP Database | Urban BMP Cost Database | National Stormwater Quality Database | Agricultural BMP Database | Stream Restoration Database

# International Stormwater BMP Database

The International Stormwater Best Management Practices Database (BMPDB) is a repository of BMP field studies and related web tools, performance summaries, and monitoring guidance. Initiated over 25 years ago, the original focus was urban stormwater BMPs (stormwater control measures). Through the support of long-term partners, the project has expanded to develop additional resources related to both urban and agricultural runoff, treatment and management. Separate databases are accessible on this site for urban stormwater BMP performance, agricultural BMPs, stream restoration BMPs, and urban runoff quality characterization (National Stormwater Quality Runoff Database). Special resources have also been developed for Department of Transportation users through the DOT Portal. All of these resources can be accessed through this website, with the most developed tools available for urban stormwater BMPs.

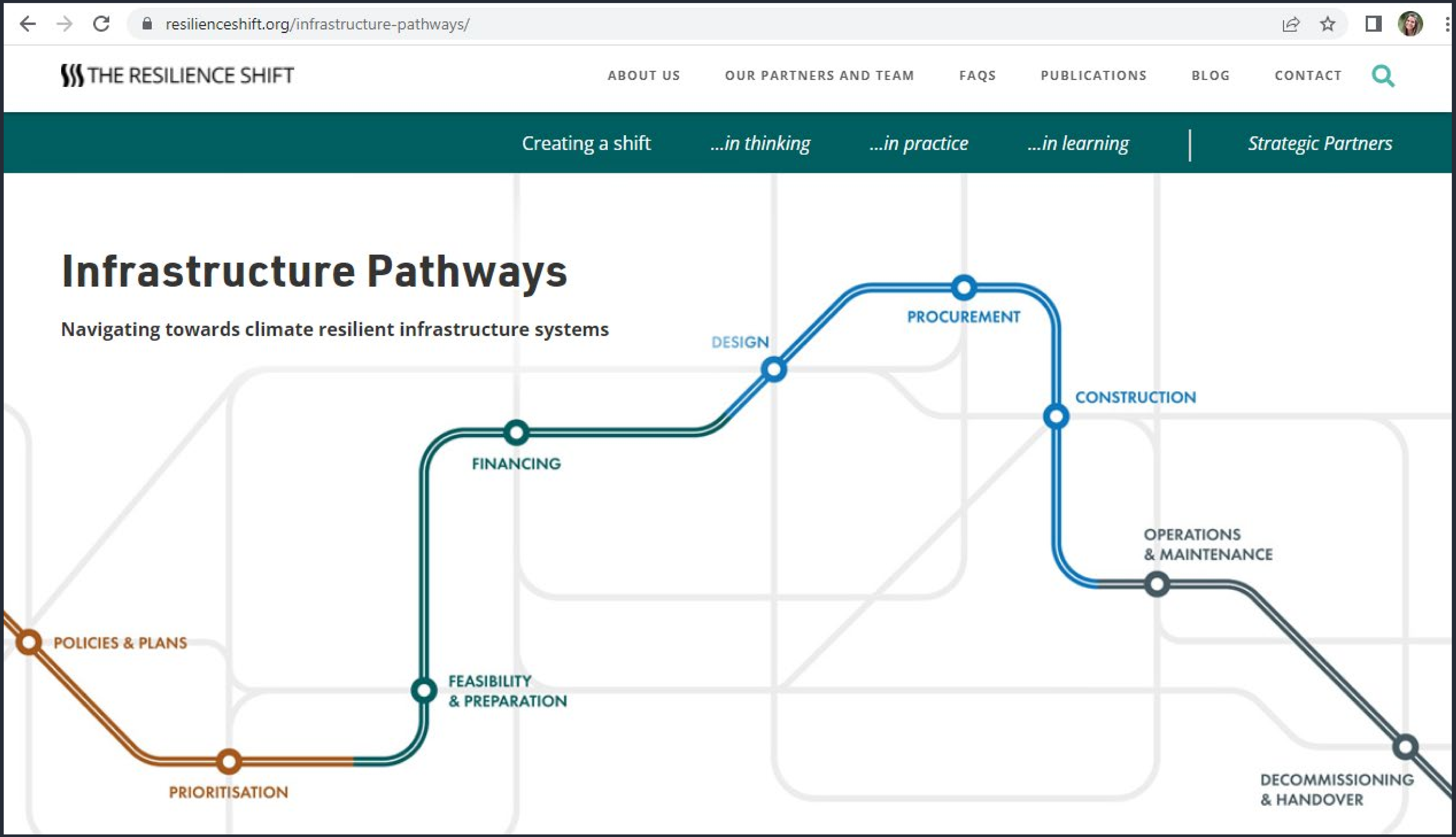
To be placed on a contact list for project updates, contact us.

### What's New

2020 Urban BMP Database Performance Summary

2020 Agricultural BMP Database Summary

Update to Stream Restoration Crediting Guidance 2021, (in progress)


resilienceshift.org/infrastructure-pathways/
THE RESILIENCE SHIFT
ABOUT US
OUR PARTNERS AND TEAM
FAQS
PUBLICATIONS
BLOG
CONTACT
Creating a shift
...in thinking
...in practice
...in learning
Strategic Partners
Infrastructure Pathways
Navigating towards climate resilient infrastructure systems
POLICIES & PLANS
PRIORITISATION
FEASIBILITY
& PREPARATION
FINANCING
DESIGN
PROCUREMENT
CONSTRUCTION
OPERATIONS
& MAINTENANCE
DECOMMISSIONING
& HANDOVER

# BUILD AND IMPLEMENT A SYSTEM
# BY-AND-FOR USERS
# TO INPUT KNOWLEDGE AND DATA

*technology + performance + cost*

# & INFORM DESCRIPTIVE METHODS

# PRIMARY & SECONDARY USERS

## 1˚ – ENGINEERS:

*performance data, design details, specifications, costs*

## 2˚ - INVESTORS, POLICY MAKERS, & FUNDERS: *case studies, project pipeline*

**“WE NEED FRAMEWORKS TO BE INSPIRATIONAL” |**

**“TO HELP PEOPLE IMAGINE WHAT IT IS**

# MANAGE, MAINTAIN, AND LEARN

*from successes and failures*

# NATURAL INFRASTRUCTURE ENGINEERING

*(web)* **HUB**

*Closing and shortening the feedback loop*
*between discovery, application, and advancing practice*

PRE-COMPETITIVE COLLABORATION

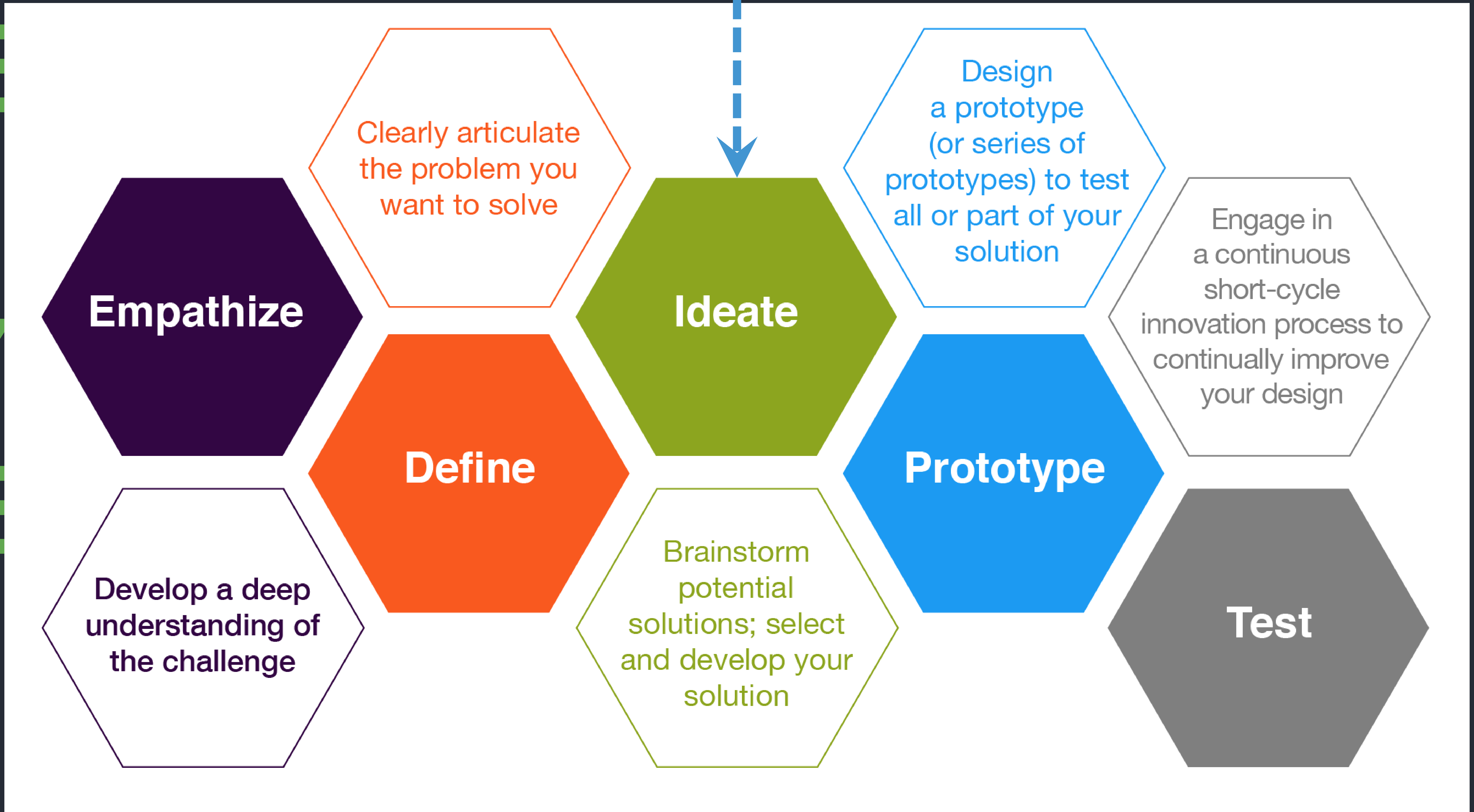
**By drawing on multidisciplinary expertise and collaborative outputs we can ensure the inclusion of diverse perspectives ... to create fertile ground for innovation and new partnerships within and across sectors.**

PRACTICAL GUIDE TO IMPLMENTING
GREEN-GRAY INFRASTRUCTUE

# NEXT STEPS:

WE ARE HERE

1. CONVENE
2. IDEATE
3. PROTOTY
4. TEST / ITE



HOW DO WE FUND IMPLEMENTATION AND LONG-TERM MAINTENANCE OF SUCH A HUB? WHO LEADS THE DESIGN AND IMPLEMENTATION? WHO HOSTS – MONITORS AND MAINTAINS - THE PLATFORM?

# PROS/CONS OF DIFFERENT SECTORS/ACTORS *(stereotypes)*

**PRIVATE SECTOR:** *global network to spread knowledge, proprietary*

**NON-PROFIT:** *non-propietary data sharing, grant dependent*

**ACADEMIA:** *region/location specific, grant-based dependencies*

**GOVT (LOCAL, NATIONAL, INTL'):** *bureaucratic, slow, trusted*

*something new ... ?*

HOW COULD WE REQUIRE OR INCENTIVIZE INPUTS BACK INTO THIS TYPE OF "MODERN ENGINEERING GUIDELINE"? THROUGH PERMITS, REIMBURSEMENTS, OR REWARDS? POSSIBLE TO ENABLE CITIZEN SCIENCE INPUTS?

# NATURAL INFRASTRUCTURE ENGINEERING HUB

*A pathway to address barriers and increase global implementation of natural infrastructure*

# ANNEX

# GREEN-GRAY INFRASTRUCTURE FUNDING & FINANCING PLAYBOOK

## Available for review now! (Sharing links)

By end-of-day Monday May 23rd, please:

(1) provide your comments in 'suggesting' mode, and

(2) add your name to the list of contributors

A Playbook to guide players & define the plays and strategies to accelerate green-gray infrastructure implementation

https://docs.google.com/document/d/1siyWhXiUXfLUXkTev9BON_osbAbgp0sj/edit?usp=sharing&ouid=110777601449852950557&rtpof=true&sd=true

GREEN GRAY Community of Practice

# NATURE-BASED COASTAL RESILIENCE

Case-based Learning Series
from the Global Green-Gray Community of Practice

*The Global Green-Gray Community of Practice cordially invites you to learn with us every month from practitioners around the world working to innovate sustainable and resilient coastal green-gray infrastructure solutions.*

*We will alternate every session between the Asia-Pacific and Americas and hope you will join us!*

GREEN GRAY
Community of Practice

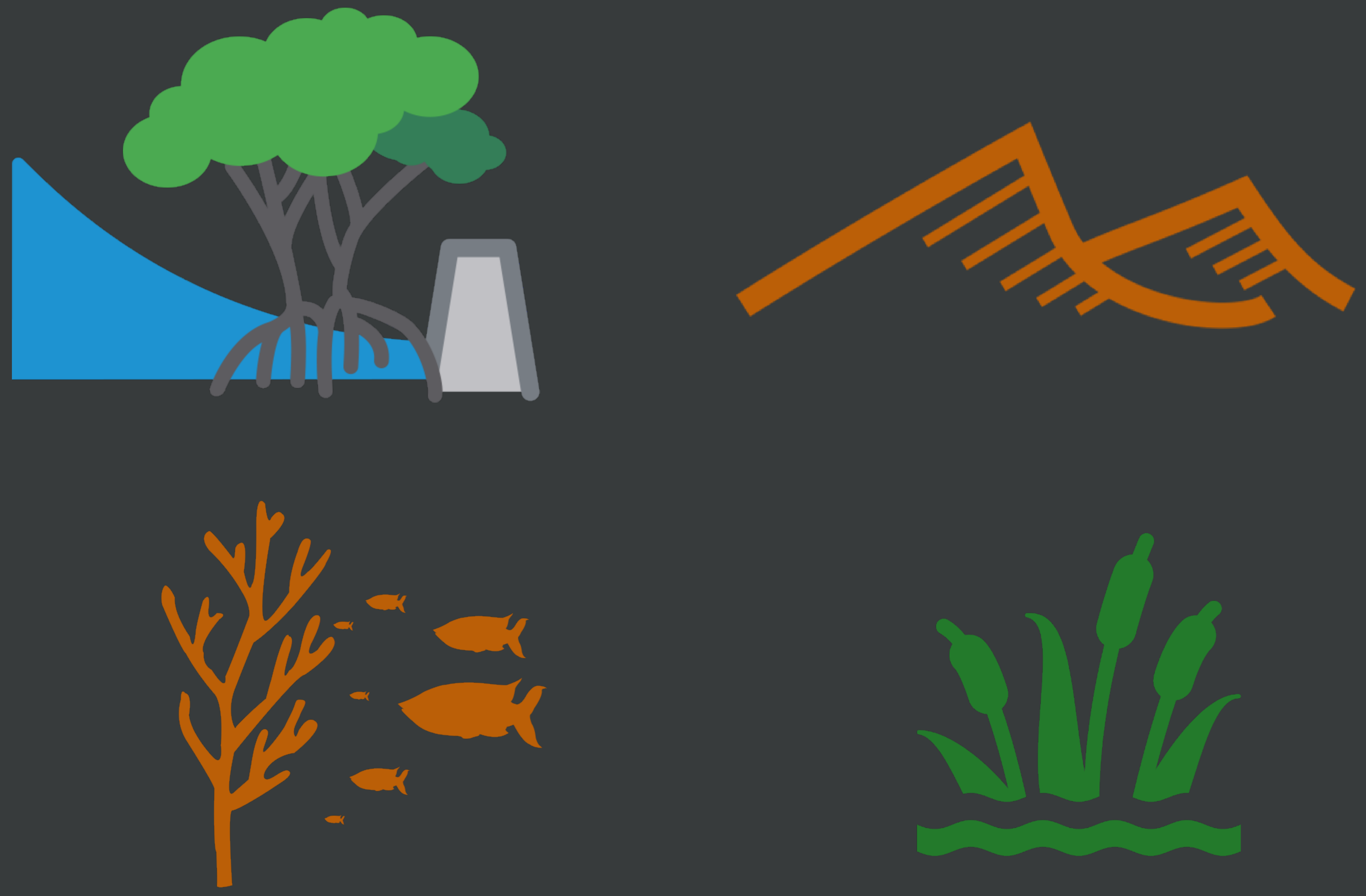
# COASTAL GREEN-GRAY COST-BENEFIT ANALYSIS TOOL

## First Technical Advisory Group Meeting May 27th (Sharing Invite)

De-mystifying ecosystem benefit values to inform design

Open-source | country or region specific | excel-based

Coastal infrastructure + ecosystems



Moving forward in Mexico & North Brazil Shelf!

GREEN GRAY Community of Practice

# Useful Resources / Further Reading



**Measurement**

- Inter-American Development Bank – Common set of aligned SSI
- Five-step process for strategic performance indicator development
- The World Bank – Resilience rating system Methodology for Building and Tracking Resilience to Climate Change
- Institute for Sustainable Infrastructure - The Envision framework

**Monitoring**

- ASCE – Climate-resilient Infrastructure: Adaptive Design and Risk Management
- Climate ADAPT - Use of remote sensing in climate change adaptation
- Monitoring of weather impacts on infrastructure networks using the internet of things
- UNDP – Five approaches to build functional early warning systems

**Data Sharing**

- The FAIR guiding principles for open data
- GFDRR – Open Data for Resilience Initiative
- The World Bank – Open Government Data Toolkit
- Geospatial Risk and Resilience Assessment Platform - GRRASP
- Analysis of the cascade effects in supply networks – software tool CAESAR