Cities of Tomorrow R&D Programme – Vertical 5 City in Nature (CoT V5)

1st Grant Call Briefing

20 Feb 2023

CoT V5 – Launch of 1st Grant Call

- The first grant call for Vertical 5 – City in Nature (under the Cities of Tomorrow R&D Programme) (CoT V5) has been launched as of **6 February 2023**.

- We invite interested researchers to submit suitable full proposals for potential funding support under **5 Call Topics:**

    1) Tree-Root Anchorage and Non-Destructive Testing Development for Constrained Urban Planting Spaces
    2) The Ectomycorrhizal-Microbial-Soil Nutrition Axis in Improving Growth of Dipterocarps in Urban and Forested Areas
    3) Enhancing Low Maintenance and Resilient Naturalistic Landscapes along Roads and within Housing Estates
    4) Landscape and Well-being
    5) Assessment of Nutrient Dynamics in Ecosystems in Singapore

- Interested parties are strongly encouraged to form research teams that collaborate across public research institutes and the private sector (including industry), and support translation of research outcomes to real-world applications.

Schedule

4.00pm	Overview of CoT V5 1st Grant Call – *by* ***CoT Directorate*** • Overview of the Cities of Tomorrow R&D Programme – Vertical 5 City in Nature (CoT V5) • Grant call eligibility & funding criteria • Review process • Instruction for submission of proposals • Q&A on grant call processes
4.30pm	Call Topic 1 – *by* ***NParks*** "Tree-Root Anchorage and Non-Destructive Testing Development for Constrained Urban Planting Spaces"
4.45pm	Call Topic 2 – *by* ***NParks*** "The Ectomycorrhizal-Microbial-Soil Nutrition Axis in Improving Growth of Dipterocarps in Urban and Forested Areas"
5pm	Call Topic 3 – *by* ***NParks*** "Enhancing Low Maintenance and Resilient Naturalistic Landscapes along Roads and within Housing Estates"

Schedule

5.15pm	Call Topic 4 – by ***HDB*** "Landscape and Well-being"
5.30pm	Call Topic 5 – by ***NParks*** "Assessment of Nutrient Dynamics in Ecosystems in Singapore"
5.45pm	Final Q&A *Note: A short Q&A timeslot will be allocated during the presentation of each Call Topic (strictly capped at 15mins each). This final Q&A session will be dedicated for any additional questions that have not yet been addressed earlier.*
6pm	End

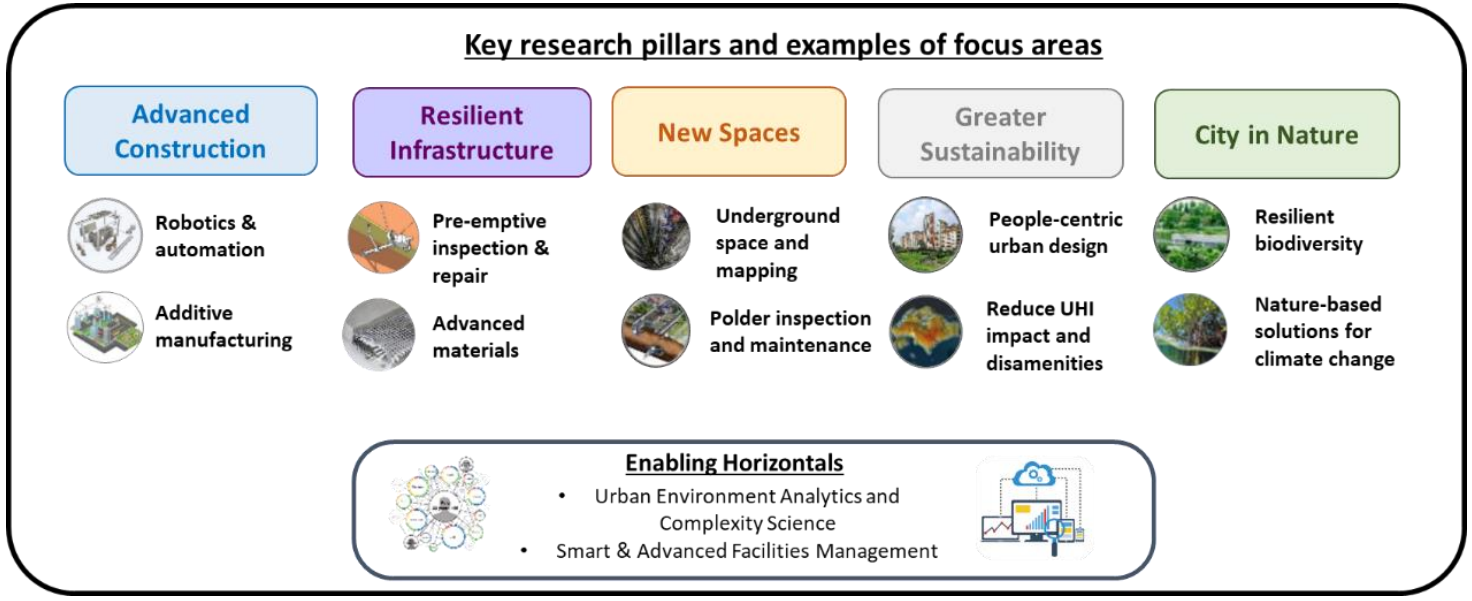
Overview of the Cities of Tomorrow R&D Programme – Vertical 5 City in Nature (CoT V5)

Cities of Tomorrow R&D Programme

- Launched in 2017, the Cities of Tomorrow (CoT) R&D programme is MND's flagship R&D programme under the Urban Solutions and Sustainability (USS) domain

- The vision of CoT is to establish Singapore as a highly liveable, sustainable and resilient city of the future, and as a vibrant urban solutions hub

- In RIE2025, CoT comprises 5 key verticals and 2 enabling horizontals, including the new Vertical 5 on City in Nature



Vertical 5 – City in Nature *(under Cities of Tomorrow R&D programmme)*

- New NRF-funded Funding Initiative (FI), and 5th research vertical under CoT R&D Programme, totaling $17.9M to support a 5-year programme under the USS domain under RIE2025
  - Led by NParks as Implementing Agency

- Multi-stakeholder research programme which seeks to provide scientific foundation to support Singapore's transformation into a City in Nature

- Aims to enhance:
  - Climate resilience – by improving ecosystem capacity to adapt and respond to disturbances brought about by climate change (e.g., higher temperatures, inland flooding due to extreme rainfall events) using nature based solutions
  - Ecological resilience – by adopting an evidence-based approach to plan, design and monitor biodiversity conservation outcomes more effectively
  - Social resilience – by gaining a better understanding of how dimensions and detailing of landscape elements affect mental and physical health, which allows more effective planning and design of public spaces towards enhanced health outcomes and social cohesion

Vertical 5 – City in Nature *(under Cities of Tomorrow R&D programmme)*

- 4 research themes, in support of the FI's overall outcomes of enhancing climate, ecological and social resilience:

1 Safe, productive, and multifunctional urban greenery

To develop new solutions to improve urban greenery operations and management, and its integration with the built environment

2 Biodiversity monitoring to improve adaptive management of urban biodiversity

To develop tools and techniques to improve the efficiency of biodiversity monitoring

3 Managing human-nature relationships

To improve our understanding of human-nature relationships, so as to inform policies and solutions that further enhance the physical and mental well-being benefits of urban nature

4 Nature-based solutions for inland climate change adaptation

To inform the planning and design of blue-green infrastructure for the provision of climate-related ecosystem services

Grant Call Eligibility & Funding Criteria

Grant Call Eligibility

- All Singapore-based Institutions of Higher Learning (IHLs), companies, company-affiliated research laboratories or institutions and not-for-profit entities are eligible to participate in the call.

- The Lead PI who leads the Research must be based in Singapore. Collaboration with foreign organisations and experts in the capacity of Co-Investigator (Co-I), or as Collaborator is allowed.

- All funding awarded must be used to carry out the research work in Singapore, unless expressly approved by the grantor.

- Grant applicants are strongly encouraged to collaborate with industry partners to develop innovative solutions that can address the call objectives and demonstrate strong potential for real-world application within and beyond Singapore.

- R&D proposals already funded by other government agencies will not be considered. R&D proposals with similar scope, which are currently under evaluation by other funding initiatives, will not be considered until the results from the other funding initiatives are finalised. Lead PIs, Co-Is, and Collaborators will need to declare other funding sources as well as participation in other funding initiatives during application.

Grant Call Eligibility

Additional notes for private sector entities

- Funding for private sector entities would be conditional on collaboration with a public research performer for:
  - Research projects with a total project budget more than S$500,000;
  - Test-bedding/demonstration/scale-up projects with a total project budget more than S$2.0mil.

- For projects funding non-Singaporean entities (i.e., companies registered in Singapore with less than 30% local shareholding, determined by the ultimate individual ownership), a Singapore Technology Licensing Office (STLO) must be appointed regardless of the involvement of public research performer.

Funding Criteria

Direct Costs*

- Supportable direct costs are incremental cost required to execute the programme; can be classified into the following cost categories:-
  - Expenditure on manpower (EOM);
  - Equipment;
  - Other Operating Expenses (OOE); and
  - Overseas Travel

Indirect Costs (i.e. "overheads")

- Costs that are incurred for common or joint objectives and therefore cannot be identified readily and specifically with a particular sponsored research project, but;
- Contribute to the ability of the Institutions to support such research projects (e.g., providing research space, research administration and utilities), and not through the actual performance of activities under the sponsored projects.

** Please refer to the Annex D of the Grant Call info sheets for the list of non-fundable direct costs of research.*

Funding Criteria

Singapore-based IHLs/public research institutes	• Lead PI or Co-I will qualify for:
	  • **[Direct costs] 100%** of the approved qualifying direct costs of a project;
	  • **[Indirect costs] 30%** of the total qualifying approved direct costs of a project.

Singapore-based private sector entities (incl. not-for-profit organisations)	• Lead PI or Co-I will qualify for:
	  • **[Direct costs] Up to 70%** of the approved qualifying direct costs of a project
	  • 30% for all non-Singaporean entities (incl. non-Singaporean not-for-profits);
	  • 50% for Singapore Large Local Enterprises (LLEs);
	  • 70% for Singapore Small Medium Enterprises (SMEs), start-ups and not-for-profits.

Overseas organisations	• **Not** permitted to receive, directly or indirectly, any part of the funding, whether in cash or in the form of assets acquired using the funding or otherwise unless expressly approved by the grantor. • Exception: **Travel expenses** for Visiting Professors/Experts (e.g., overseas-based Co-Is and Collaborators) **to come over to Singapore**, which should be identified and budgeted for upfront in the Other Operating Expenses vote to be incurred by the Host Institution.

Funding Criteria

Additional notes on Collaborators

- Collaborators are **not** permitted to receive, directly or indirectly, any part of the funding, whether in cash or in the form of assets acquired using the funding or otherwise unless expressly approved by the grantor.

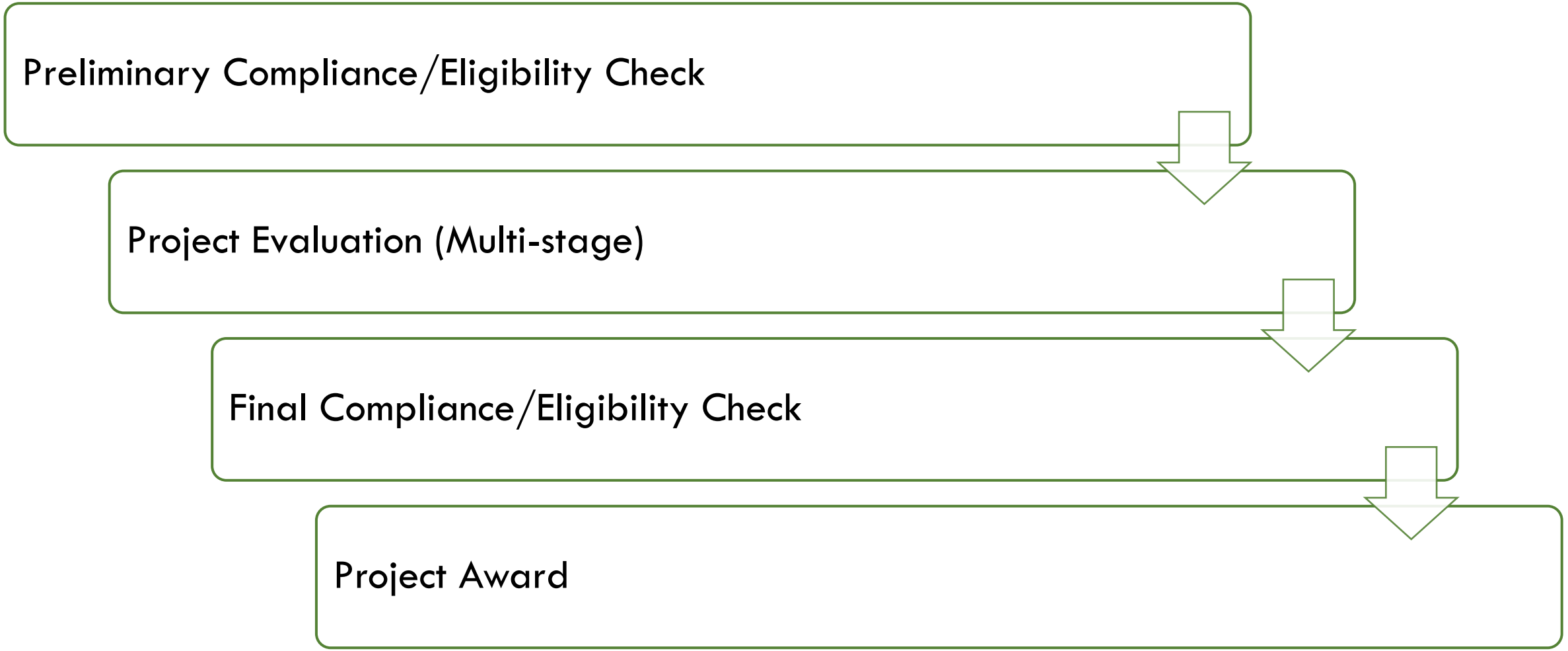
Additional notes on funded assets

- All assets acquired using the funding must be located in Singapore and maintained within the control of the grantees.

Please refer to the Grant Call info sheets for detailed information on the guidelines for the grant call.

Review Process

Review Process – at a glance



Evaluation of Proposals

Evaluation of proposals will include:

1. Technical Peer Review

Proposals will be subject to a round of technical peer review by domain experts* with relevant expertise, to ensure excellent science in proposals.

2. Project Evaluation Panel

Shortlisted applicants will be invited to present their proposals to a Project Evaluation Panel, consisting of relevant agency representatives, the Programme Director, and other external experts (where relevant).

Successful applicants will be informed by the CoT Directorate on the award of the grant. The CoT Directorate's decision on project and funding support will be final.

** Research teams applying for the grant call are invited to recommend potential suitable peer reviewers for the CoT Evaluation Committee's consideration, as part of the proposal submission process. The final decision on the peer reviewers will be decided by the Evaluation Committee.*

Evaluation Criteria

Criteria

Potential Contribution to CoT Objectives

- Relevance of proposed research in contributing to objectives/targets stated for the CoT Call Topic.

Potential for Breakthrough and Innovation

- Quality and significance of proposed research, including value for money, and the potential for breakthrough/innovation to advance knowledge and understanding within its own field or across different fields.

Potential for Application and Deployment in Singapore and Commercialisation/Export

- Potential for application of research outcomes in Singapore by a public agency and potential for solutions to be replicated in Singapore beyond a single site/project.
- Feasibility for commercialisation/export in areas where Singapore has a competitive advantage.

Execution Strength and Technical Competency of Research Team

- Quality of plans for execution and delivery of the research programme and goals, including the appropriateness of the proposed milestones and deliverables (specific to evaluation of full proposal applications)
- Quality, significance, and relevance of the recent research record of the Lead PI and Co-Is and the strength of the applicant group, including likely synergy in delivering research and potential for international leadership.

Instructions for Submissions of Proposals

Overview of Timeline

FOR APPLICANTS & INTERESTED PARTIES (SGT, UTC +08:00)	
Grant Call Opens (for 8 weeks)	6 February 2023, 2.00pm
Virtual Briefing for CoT V5 1st Grant Call	20 February 2023, 4.00pm
Grant Call Closes (Proposal Submission Deadline)	31 March 2023, 2.00pm

FOR SHORTLISTED APPLICANTS ONLY	
Notification of shortlisted applicants	May 2023*
Presentation to Project Evaluation Panel	June 2023*

FOR SUCCESSFUL AWARDEEES ONLY	
Approval and Letter of Award	August 2023 onwards*

** Timings are indicative; shortlisted/successful applicants will be notified accordingly.*

Grant Call Details

Grant call information and relevant documents at:

- CoT V5 1st Grant Call website
- IGMS

Application only through IGMS:

- See section on "Application Guidelines". All funded proposals should follow the prevailing Research Grant Terms and Conditions and NR Fund Guide.

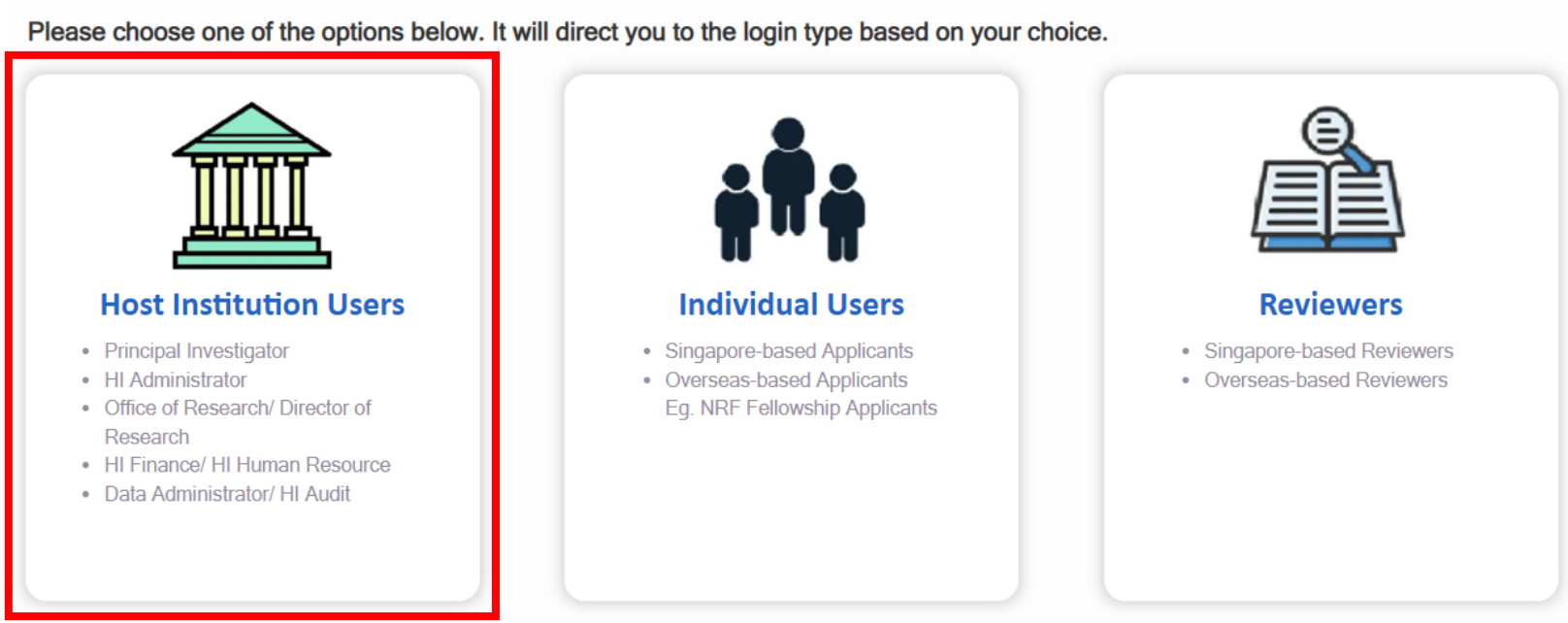
- The application will only be considered valid if the submission of the full proposal is completed in IGMS, including endorsement by the Director of Research (also in IGMS) by the proposal submission deadline (**31 March 2023, 2.00pm**).
  - A copy of the application should also be sent via email to the CoT Directorate (CoTV5@nparks.gov.sg) after this.

- E-mail or walk-in applications will not be accepted.

- Late submissions will not be considered. Incomplete submissions may also be rejected. Applicants are advised not to submit their application at the last minute in case of technical errors with the IGMS website.

- The following slides outline steps for "Using IGMS" and "Full Proposal Submission".

Application Guidelines



Using IGMS:

<u>Key details for first time users</u>

- Under the landing page, select the **"Host Institution Users"** option. This option will lead you to "Login with Singpass (Logging in as Business User)". Login or register using your Singpass.
- **Authorise ORCID ID** before any grant application.
- Fill up mandatory fields.
- Update user profile.

Application Guidelines

Full Proposal Submission:

- Login to the system using the "Host Institution Users" option and subsequently, via "Login with Singpass (Logging in as Business User").

- Click on grant call topic of interest under “Open Opportunities” and click “Apply”.

For detailed steps, please refer to:

- Quick guide for Potential Applicants; and
- Help guide for Potential Applicants

(also available on the IGMS “Training Guides” page: https://researchgrant.gov.sg/Pages/TrainingGuides.aspx)

Contact Information

- For **general information**, please refer to the Grant Call FAQs document in either:
  - CoT V5 1st Grant Call website
  - Under "Related Documents" under the grant call topic of interest on IGMS

- For transparency, no verbal enquiries will be entertained. However, if you require clarification, please email the CoT Directorate at CoTV5@nparks.gov.sg. Answers to all received queries will also be reflected in the Grant Call FAQs document (see above), which will be updated periodically to ensure that all applicants have equal access to additional information.

- For any queries on the **use of IGMS**, please contact the IGMS helpdesk.
  Tel No: (65) 6556 8807 or (65) 6556 6971
  E-mail: helpdesk@researchgrant.gov.sg

Q&A on Grant Call Processes

Call Topics for CoT V5 1st Grant Call

1st Grant Call: Topic 1
CoT_V5_GC2023_01

R&D Theme 1 - Safe, productive & multifunctional urban greenery

Call Topic: Tree-Root Anchorage and Non-Destructive Testing Development for Constrained Urban Planting Spaces

Budget: S$ 3.5 Mil
Duration of Project: up to 5 years
Lead Agency: NParks

Call Topic:

Tree-Root Anchorage and Non-Destructive Testing Development for Constrained Urban Planting Spaces

Background	In Singapore, the majority of the urban trees are planted in constrained urban planting spaces. These constrained planting spaces are commonly located at the ground level and increasingly also at the skyrise/rooftop level. In those locations, the available soil volumes for tree roots are often framed and limited by urban structures such as walkways/pavements, kerbs, drainage features, and parapet walls. Mature tree rooting architectures in these constrained planting spaces as well as tree root interactions with urban structures and/or other trees remain relatively unexplored. This project will provide information on tree root architecture, interactions with urban structures as well as the associated root anchorage strengths that can be inferred from non-destructive testing.

Call Topic:

Tree-Root Anchorage and Non-Destructive Testing Development for Constrained Urban Planting Spaces

Objectives	(a) Acquire 3D models of the coarse root architecture of the 10 most widely planted tree species of various girth sizes in planting spaces of differing constraints and conditions found at the different urban settings (e.g., roadside and skyrise). (b) Field testing to perform multi-directional non-destructive/destructive testing to determine the service and ultimate load/deformation behaviour of trees or stands under different conditions and root damage. (c) Use data from the field test and numerical modelling to investigate the effects of different site conditions, urban structures, and root damage on load/deformation behaviour. (d) Identify threshold criteria for non-destructive testing (static or dynamic testing). (e) For large trees (girth size of $\geq$ 1.0 m), develop and prototype accurate, non-destructive, and productive testing protocols and equipment for assessing the overall structural condition of the tree in terms of bending and rotational resistance/stiffness for at least 2 orthogonal directions. (f) The protocols and equipment should be appropriate for deployment to test trees located in the various urban spaces including roadside and skyrise gardens. *Projects are encouraged to further build upon the above-mentioned objectives, and/or propose additional research objectives.*

Call Topic:

Tree-Root Anchorage and Non-Destructive Testing Development for Constrained Urban Planting Spaces

Technical Deliverables	<u>Phase I</u> (a) Tree rooting architectures under different constraints and conditions (b) Load/deformation behaviour of urban trees of different species, sizes, modes of tree failure and planting space characteristics (static and dynamic) (c) Numerical models that accurately depict field conditions (d) Threshold values of static or dynamic moduli for development of future field-testing protocols <u>Phase II</u> (a) Prototyping of the non-destructive testing (NDT) protocols and equipment (b) Testing of the developed NDT protocols and equipment (c) Enhancements and verifications to the NParks Tree Structural Model Plus (TSM+) *Projects are encouraged to further build upon the above-mentioned deliverables, and/or propose additional deliverables.*

Call Topic:

Tree-Root Anchorage and Non-Destructive Testing Development for Constrained Urban Planting Spaces

Impact Outcomes	*In relation to the overall aims and key research themes of CoT V5, this project should look towards contributing to the following impact outcomes:* (a) Develop more efficient and accurate non-destructive testing (NDT) protocols, to be used by NParks and other tree managers to directly assess tree-root anchorage. (b) Enhance existing NParks Tree Structural Model Plus (TSM+) to better depict tree root anchorage conditions and predict tree failure risk in urban settings. (c) Contribute towards ongoing efforts to reduce annual incidences of tree failures by 20% by 2030.

Agencies Involved:

Tree-Root Anchorage and Non-Destructive Testing Development for Constrained Urban Planting Spaces

Role	Agency
Lead	National Parks Board
Member	JTC Corporation
Member	Housing & Development Board
Member	PUB, Singapore's national water agency

Q&A on Call Topic 1

1st Grant Call: Topic 2
CoT_V5_GC2023_02

R&D Theme 1 - Safe, productive & multifunctional urban greenery

Call Topic: The Ectomycorrhizal-Microbial-Soil Nutrition Axis in Improving Growth of Dipterocarps in Urban and Forested Areas

Budget: S$ 1.5 Mil
Duration of Project: up to 3 years
Lead Agency: NParks

Call Topic:

The Ectomycorrhizal-Microbial-Soil Nutrition Axis in Improving Growth of Dipterocarps in Urban and Forested Areas

Background	• Dipterocarps are dominant trees of the native lowland forests of South-East Asia and the health of the Dipterocarps are critical to the resilience and persistence of our natural capital within the nature reserves. • Dipterocarps form a symbiotic relationship with ectomycorrhizal fungi in the soil that promotes better growth and enhances the resilience of the trees against drought stress and pathogenic incursions. • However, studies on the species diversity of ectomycorrhizal fungi in tropical soils, as well as biotic and abiotic factors that affect the symbiotic relationship between the ectomycorrhizal fungi and Dipterocarps are scarce. • An in-depth understanding of Dipterocarp-ectomycorrhizal fungi physiology, soil biogeochemistry, and the functional ecology of the associated soil microbes will be vital to ensure the continued growth and health of Dipterocarps. • The study will contribute immensely to the current state of knowledge on the restoration of the native forests, which are a major component of the region's natural capital providing key ecosystem services.

Call Topic:

The Ectomycorrhizal-Microbial-Soil Nutrition Axis in Improving Growth of Dipterocarps in Urban and Forested Areas

Objectives	(a) Profile soil microbial diversity and mycorrhizal compositions associated with Dipterocarps in forested and urban areas (parks and roadside). (b) Identify beneficial microbial species and how biotic and abiotic conditions regulate their abundance and prevalence. (c) Study the effect/benefit of priming soil using identified microbes on Dipterocarp growth in forested and urban areas. (d) Establish methodologies and guidelines to introduce and optimise the microbial communities in soil for improved growth of Dipterocarps in forested and urban areas. *Projects are encouraged to further build upon the above-mentioned objectives, and/or propose additional research objectives.*

Call Topic:

The Ectomycorrhizal-Microbial-Soil Nutrition Axis in Improving Growth of Dipterocarps in Urban and Forested Areas

Technical Deliverables	(a) Establish a non-species-specific palette of soil microbial and mycorrhizal compositions that will support and improve growth of dipterocarps in tropical forests and urban areas. (b) Develop methodologies and best practice guidelines to introduce and optimise the microbial communities in soil for improved growth of Dipterocarps in forested and urban areas. *Projects are encouraged to further build upon the above-mentioned deliverables, and/or propose additional deliverables.*

Call Topic:

The Ectomycorrhizal-Microbial-Soil Nutrition Axis in Improving Growth of Dipterocarps in Urban and Forested Areas

Impact Outcomes	*In relation to the overall aims and key research themes of CoT V5, this project should look towards contributing to the following impact outcomes:* (a) Increase knowledge on enhancing the growth of the Dipterocarp trees in forested and urban areas, so as to improve the ability to conduct restoration of Dipterocarps in forested areas and to introduce them as urban trees. (b) Increase the number of Dipterocarp species established in urban areas by 15% (corresponding to 15 new species). (c) Enhance the biodiversity and conservation of Dipterocarps as a keystone species in Singapore.

Agencies Involved:

The Ectomycorrhizal-Microbial-Soil Nutrition Axis in Improving Growth of Dipterocarps in Urban and Forested Areas

Role	Agency
Lead	NParks

Q&A on Call Topic 2

1st Grant Call: Topic 3
CoT_V5_GC2023_03

R&D Theme 1 - Safe, productive & multifunctional urban greenery

Call Topic: Enhancing Low Maintenance and Resilient Naturalistic Landscapes along Roads and within Housing Estates

Budget: S$ 0.65 Mil
Duration of Project: up to 3 years
Lead Agency: NParks

Call Topic:

Enhancing Low Maintenance and Resilient Naturalistic Landscapes along Roads and within Housing Estates

Background	• A key strategy to transform Singapore into a City in Nature is the restoration of nature into the built environment. To achieve this, agencies such as the National Parks Board (NParks) and the Housing and Development Board (HDB) are increasingly adopting a more naturalistic planting approach for our streetscapes, parks and greenery spaces. • Naturalistic landscapes, such as Nature Ways, are often implemented using a multi-tiered structure of diverse and native trees and shrubs to mimic the natural environment. Aside from enhancing the ecological connectivity of our green spaces, naturalistic landscapes also benefit the soil and encourage biodiversity to thrive within the local neighbourhood. By allowing green spaces to grow naturally, there could also be reduced maintenance interventions and requirements. However, the naturalistic planting approach and its benefits in the local context have not been studied in depth and documented. Moreover, there could be opportunities to enhance the existing naturalistic planting schemes. • In addition, with the increased potential for human-wildlife interactions as we implement more naturalistic landscapes, there is also a need to better understand the public's perception towards naturalistic landscapes.

Call Topic:

Enhancing Low Maintenance and Resilient Naturalistic Landscapes along Roads and within Housing Estates

Objectives	(a) Study and document existing naturalistic planting schemes and examine their maintenance requirements, biodiversity benefits, hydrological performance, and nutrient cycling benefits. (b) Develop new naturalistic planting schemes for low maintenance and resilient naturalistic landscapes along roads, parks and greenery spaces. (c) Analyse the costs and benefits of the maintenance requirements of conventional planting schemes with naturalistic planting schemes. (d) Understand public perception towards naturalistic planting schemes. *Projects are encouraged to further build upon the above-mentioned objectives, and/or propose additional research objectives.*

Call Topic:

Enhancing Low Maintenance and Resilient Naturalistic Landscapes along Roads and within Housing Estates

Technical Deliverables	(a) Documentation on existing naturalistic planting schemes, and their maintenance requirements, biodiversity benefits, hydrological performance, and nutrient cycling benefits. (b) Establish and enhance low maintenance naturalistic planting schemes that support biodiversity and enhance hydrological performance and nutrient cycling. (c) Cost benefit analysis of naturalistic landscapes against conventional planting schemes. (d) Analysis of public perception towards naturalistic planting schemes. *Projects are encouraged to further build upon the above-mentioned deliverables, and/or propose additional deliverables.*

Call Topic:

Enhancing Low Maintenance and Resilient Naturalistic Landscapes along Roads and within Housing Estates

Impact Outcomes	*In relation to the overall aims and key research themes of CoT V5, this project should look towards contributing to the following impact outcomes:* (a) Develop enhanced naturalistic planting schemes that reduce maintenance/cost requirements of green spaces by 20%, due to reduced attrition rate of plants and reduced maintenance interventions (e.g., watering, weeding). (b) Increase biodiversity in the neighbourhood (e.g., birds and butterflies) through more informed design and selection of plant species, contributing to ecological resilience. (c) Improve hydrological performance of green spaces (infiltration, runoff, storage), resulting in increased moisture retention and reduced stormwater runoff. (d) Boost nutrient cycling in green spaces (in terms of nutrient content & organic matter), which will improve soil health and reduce resource input (e.g., fertilizer application). (e) Contribute towards more sustainable landscapes in Singapore.

Agencies Involved:

Enhancing Low Maintenance and Resilient Naturalistic Landscapes along Roads and within Housing Estates

Role	Agency
Lead	NParks
Member	Housing & Development Board

Q&A on Call Topic 3

1st Grant Call: Topic 4
CoT_V5_GC2023_04

R&D Theme 3 - Managing human-nature relationships

Call Topic: Landscape and Well-being

Budget: S$ 2.0 Mil
Duration of Project: up to 3 years
Lead Agency: HDB

Call Topic:

Landscape and Well-being

Background	• The beneficial effects of urban green spaces on the health of urban dwellers are increasingly documented worldwide. A conceptual framework, the "Positive Health Effects of the Natural Outdoor Environment" formulated in the context of the EU 7th Framework project, posited that people's well-being interacts mutually with four key domains in the physical environment - Human Habitat/ Ecosystem, State of Green Spaces, Policies & Programs and Human Agency or Behavior (Lawrence and Forbat, 2019). However despite the growing scientific evidence, there is very little practical knowledge on how to design and manage urban green spaces to be effective in health promotion. Research needs to move beyond documenting benefits to generate evidence-based insights that will inform the formulation of guidelines for designing landscapes that are more restorative. This is especially important in the context of high-density, high-rise environments in which majority of Singaporeans reside, where there are higher risks of poor mental health (Larcombre et al., 2019). • The research aims to address the question: Which are the physical attributes of landscapes that enhances the mental well-being of users? The landscape in question refers to the outdoor environment inclusive of both hardscape and softscape components which are direct consequence of design and planning. Landscape quality is broadly defined by attributes such as landform, vegetation, furniture, built structures, water elements, character, views, vistas, building density, etc. The research will focus on public landscape spaces such as precinct gardens and common greens to understand how user's experiential exposure to the space with different attributes affects his mental well-being.

Call Topic:
Landscape and Well-being

Objectives	(a) Identify objective ways to measure and quantify effects of landscape on mental well-being (b) Identify attributes of the landscape quality which have positive effects on mental well-being (c) Determine causality between identified attributes of landscape quality and mental well-being (d) Validate the correlation between better mental well-being and optimised landscape typologies through the development of landscape prototypes and on-site experiments (e) Formulate guidelines for the design of public space urban landscapes that promotes health and well-being (f) Assess the relevant baselines based on current landscape provisions and quantify the improvements to mental well-being through the adoption of the new guidelines *Projects are encouraged to further build upon the above-mentioned objectives, and/or propose additional research objectives.*

Call Topic:
Landscape and Well-being

Technical Deliverables	(a) Develop guidelines for the design of public urban landscapes that promote mental well-being, while balancing cost implementation, and maintenance considerations. *Projects are encouraged to further build upon the above-mentioned deliverables, and/or propose additional deliverables.*

Call Topic:
Landscape and Well-being

Impact Outcomes	*In relation to the overall aims and key research themes of CoT V5, this project should look towards contributing to the following impact outcomes:* (a) Improve design outcomes for public urban landscapes to promote well-being, while balancing cost, implementation, and maintenance considerations. The resulting guidelines will be operationalised and integrated into HDB's development processes and norms, namely via HDB's Biophilic Town Framework, with the principles and strategies adopted and implemented in new developments. The guidelines can also be adopted by other agencies, e.g., NParks in parks and green space design, and JTC in commercial sites.

Agencies Involved:

Landscape and Well-being

Role	Agency
Lead	Housing & Development Board
Member	National Parks Board

Q&A on Call Topic 4

1st Grant Call: Topic 5
CoT_V5_GC2023_05

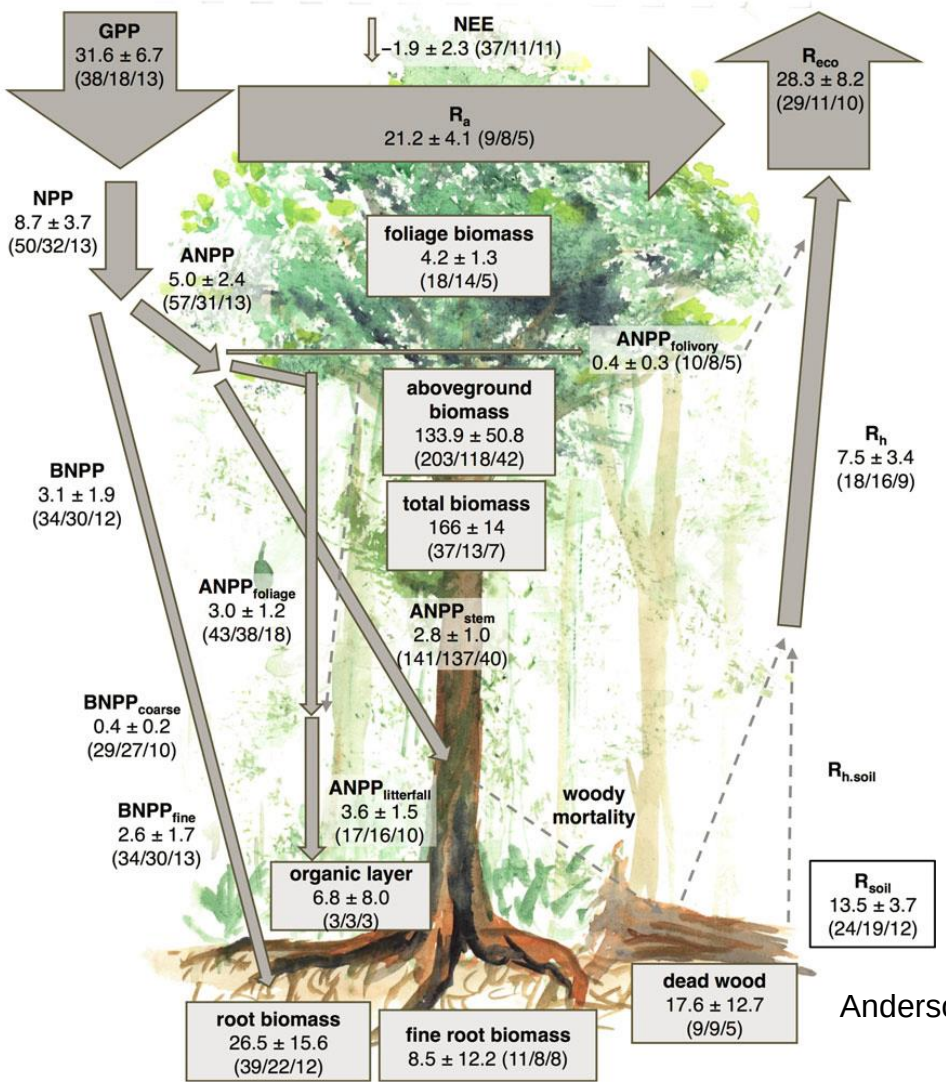
R&D Theme 4 - Nature-based solutions for inland climate change adaptation

Call Topic: Assessment Of Nutrient Dynamics in Ecosystems in Singapore

Budget: S$ 1.82 Mil
Duration of Project: up to 3 years
Lead Agency: NParks

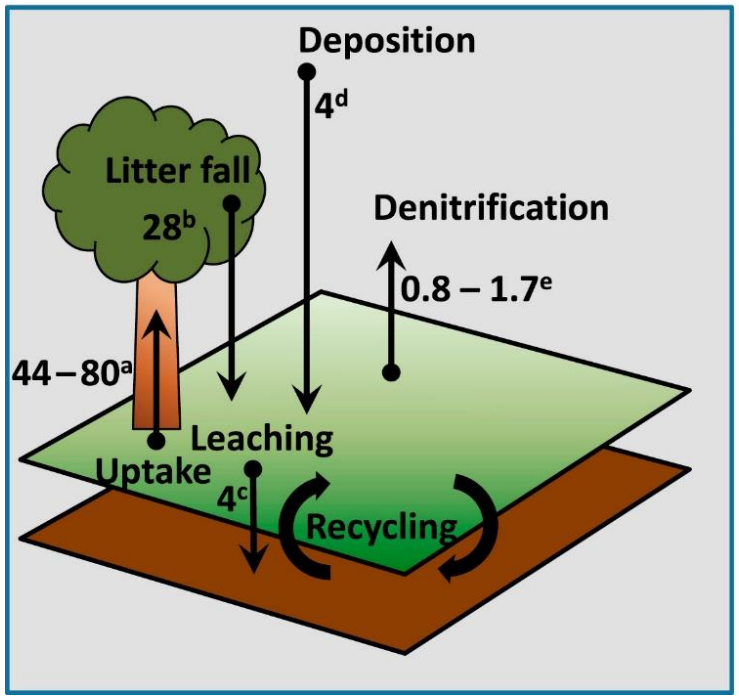
Call Topic:
Assessment of Nutrient Dynamics in Ecosystems in Singapore

Background

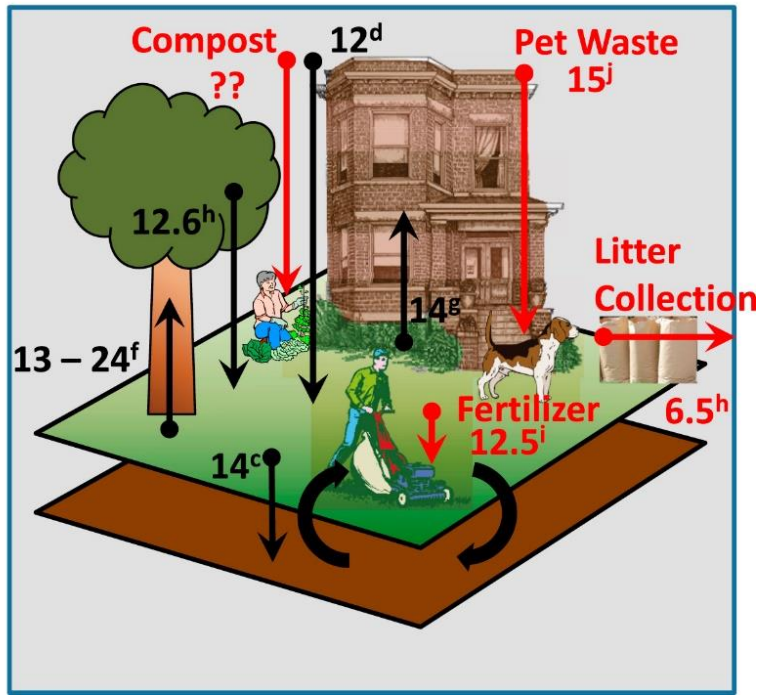


Anderson-Teixeira et al. (2016) *Global Change Biology* 22: 1690

Rural Forest N Cycling



Urban N Cycling



Templer et al. (2015) Environmental Pollution 197: 256

Call Topic:
Assessment of Nutrient Dynamics in Ecosystems in Singapore

Objectives	(a) Develop a cost-effective long-term monitoring system for key terrestrial C, N, and P fluxes associated with net primary production (both aboveground, i.e., canopy and coarse wood, as well as belowground, i.e., fine and coarse roots), decomposition and nutrient returns to the soil from trees. (b) Determine and compare baseline rates of these nutrient fluxes: i. Across major forest types: primary forest (as reference baseline) against native-dominated and exotic-dominated secondary forests ii. Between forest and urban greenspaces (c) Assess the effects of City in Nature interventions on these fluxes, specifically: i. Weeding of invasive species and reforestation versus control ii. Naturalistic, high-density/diversity plantings versus typical planting schemes *Projects are encouraged to further build upon the above-mentioned objectives, and/or propose additional research objectives.*

Vegetation categories			Sites to consider	References for specific locations
Forest	Primary forest		BTNR	Lum & Ngo (2021) Biol Conserv 254: 108847
			CCNR	Wong et al. (1994) Gardens' Bulletin 46: 37
			SBG Rain Forest	Turner et al. (1996) Conserv Biol 10: 1229
			Nee Soon Swamp Forest	Chong et al. (2021) J Veg Sci 32: e13072
	Secondary vegetation	Native-dominated	CCNR	Wong et al. (1994) Gardens' Bulletin 46: 37
		Exotic-dominated	Bukit Batok Nature Park, Thomson Nature Park, Windsor Nature Park	Neo et al. (2017) Appl Veg Sci 20: 692 Lai et al. (2021) Appl Veg Sci 24: e12548
Urban greenspaces	Parks		Bishan-Ang Mo Kio Park	See Trees.SG website for locations, species of trees in these sites
			Jurong Lake Gardens	
			SBG (Tyersall/Gallop)	
			Yishun Dipterocarp Arboretum	
	Streetscapes		Nature Ways (see Chong et al. (2014) Biol Conserv 171: 299 for potential control sites)	

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Technical Deliverables	(a) Set-up protocols for long-term monitoring of net primary production and decomposition in forests and urban greenspaces. i. This should include the microenvironmental covariates of these processes, e.g., soil temperature, pH, etc., that would be required for accurate modelling and prediction of these rates in other sites or under different scenarios. ii. The number of study sites and sampling strategy should also be explicitly described in the proposal, as the level and robustness of replication will contribute towards the assessment and ranking of proposals. (b) Estimates of nutrient return rates from decomposition, mineralisation/mobilisation, and fixation of C, N and P in forest and urban greenspaces, including raw data from the duration of monitoring in the project and the modelling or calculations (e.g., in the form of programming scripts, where possible in the R programming language) used to derive these estimates. *Projects are encouraged to further build upon the above-mentioned deliverables, and/or propose additional deliverables.*

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Technical Deliverables	(c) Final report with literature review, integrated results of comparisons between forest and greenspace types, and recommendations for forest and urban greenery management. This should include: i. An evaluation of the effects of current approaches on nutrient cycling; ii. Relevant suggestions that would improve the health and resilience of greenery and forest ecosystems, and; iii. Which monitoring methodology to adopt that is most cost-effective in Singapore's context for assessing future refinements in management approaches. (d) Publications in top scientific journals of relevant fields. (e) Workshops for handing over and knowledge transfer. *Projects are encouraged to further build upon the above-mentioned deliverables, and/or propose additional deliverables.*

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Impact Outcomes	*In relation to the overall aims and key research themes of CoT V5, this project should look towards contributing to the following impact outcomes:* (a) Identify indicators of C, N, and P cycling and protocols suitable for use by public agencies involved in landscaping and greenery management, such as NParks and HDB, as well as the environmental and horticultural sector for long-term monitoring in the context of urban greenery. (b) Establish the evidence base for how City in Nature interventions, specifically the weeding of invasive species, reforestation, and naturalistic, high-diversity, high-density plantings, have improved carbon sequestration and nutrient control. This will serve as the baseline for future refinements of management interventions to further improve these ecosystem services provided by greenery in Singapore.

Agencies Involved:

Assessment of Nutrient Dynamics in Ecosystems in Singapore

Role	Agency
Lead	National Parks Board
Member	Housing & Development Board

Q&A on Call Topic 5

Final Q&A

Thank You

For further enquiries, please contact: CoTV5@nparks.gov.sg