Bioremediation Education and Community Gardens Project Proposal: A Blueprint for Environmental and Social Revitalization in Mexicali

1. Executive Summary

This proposal presents a comprehensive, interdisciplinary initiative to address the severe environmental contamination in Mexicali, Baja California, through the strategic implementation of phytoremediation and robust community engagement. Aligned with the **Convocatoria de Divulgación Comunitaria de la Ciencia y las Humanidades 2025** (Community Science and Humanities Outreach Call 2025) [4], our project, titled "Green Roots, Healthy Futures: Bioremediation Education and Community Gardens for Mexicali," aims to transform degraded landscapes, improve public health, and foster scientific literacy within vulnerable communities. By leveraging native flora for environmental cleanup and establishing vibrant community gardens as living laboratories, we will contribute to the human right to science, promote scientific and humanistic vocations, and enhance the overall well-being of Mexicali's residents. This proposal details a phased approach, a meticulously planned budget, and a clear framework for long-term sustainability, ensuring a high-impact, replicable model for community-driven environmental solutions.

2. Introduction: The Imperative for Action in Mexicali

Mexicali, a vibrant city at the heart of a critical transboundary region, faces an escalating environmental crisis that profoundly impacts its ecosystems and human populations [1]. The New River, a lifeline for the region, has unfortunately become a conduit for a complex cocktail of pollutants, earning it the grim distinction of being one of North America's most contaminated waterways [1]. Decades of industrial discharge, agricultural runoff, and untreated municipal waste have laden the river and surrounding lands with heavy metals, persistent organic pollutants (POPs), volatile organic compounds (VOCs), and pathogenic microorganisms [1]. This pervasive contamination not only degrades the natural environment but also poses significant public health risks, contributing to alarmingly high rates of respiratory illnesses and other health issues within the community [1].

Our project recognizes that addressing this multifaceted challenge requires more than just technical solutions; it demands a holistic approach that integrates scientific innovation with deep community participation and education. We believe that empowering local communities with knowledge and practical tools for environmental stewardship is fundamental to achieving lasting change. This proposal outlines how the science of phytoremediation, combined with the power of community-led initiatives, can create a sustainable pathway to ecological restoration and improved quality of life in Mexicali.

3. Problem Statement: A City Under Environmental Siege

The environmental degradation in Mexicali is a critical issue with far-reaching consequences, characterized by a persistent influx of pollutants into its air, soil, and water systems [1].

3.1 The New River: A Toxic Artery

The New River's flow is a composite effluent, predominantly agricultural runoff (51.2%), municipal sewage (29%), and industrial wastewater (1.4%) [1]. This composition results in a waterway contaminated with over one hundred documented pollutants [1].

- **Heavy Metals & Metalloids:** Consistent monitoring reveals the presence of toxic metals such as selenium, uranium, arsenic, mercury, lead (Pb), cadmium (Cd), chromium (Cr), copper (Cu), and zinc (Zn). These persistent elements bioaccumulate in the food web, leading to health advisories against consuming fish from the river [1].
- **Organic Pollutants:** The river is a repository for a wide range of synthetic organic compounds, including legacy POPs like DDT and its metabolites (DDE, DDD), as well as other banned organochlorines (chlordane, toxaphene). Polychlorinated biphenyls (PCBs) and various VOCs from industrial discharges and municipal waste further exacerbate water quality issues [1].
- **Pathogens & Nutrients:** Extremely high concentrations of pathogens from untreated or undertreated sewage pose immediate public health threats, causing serious illnesses

such as tuberculosis, encephalitis, polio, cholera, hepatitis, and typhoid. Fecal coliform bacteria counts far exceed U.S.-Mexico treaty limits. Additionally, agricultural and municipal runoff contribute heavy loads of nitrates and phosphates, fueling eutrophication and harmful algal blooms downstream in the Salton Sea [1].

3.2 Industrial and Agricultural Footprints: Diffuse Contamination

Pollution extends beyond direct river discharges, creating a landscape of contaminated soil, water, and air across Mexicali [1].

- **Industrial Emissions & Atmospheric Deposition:** Mexicali's manufacturing sector, with over 180 factories, significantly contributes to air pollution, including particulate matter (PM2.5 and PM10), nitrogen dioxide, and VOCs. These emissions often contain toxic heavy metals that settle on soil, buildings, and water surfaces, creating diffuse contamination [1].
- **Agricultural Runoff & Salinization:** Intensive agriculture in the Mexicali Valley generates runoff containing high concentrations of salts, pesticides, nutrients, and naturally occurring elements like selenium. This continuous influx has dramatically increased the salinity of the Salton Sea, making it significantly saltier than the Pacific Ocean and creating a hyper-saline, eutrophic environment [1].
- **Groundwater Vulnerability:** Heavy reliance on groundwater for irrigation has led to aquifer depletion, increasing the vulnerability of these vital reserves to contamination from surface pollutants leaching downward [1].

The combined stresses of high salinity and heavy metal toxicity create synergistic conditions that are particularly detrimental to organisms, necessitating remediation solutions that account for this dual challenge [1].

3.3 Ecological and Public Health Implications

The pervasive contamination has profound consequences for both the natural environment and human populations [1].

- **Ecological Collapse:** The New River acts as a toxic artery, delivering its contaminant load directly into the Salton Sea, which has become an "ecological trap" with catastrophic declines in biodiversity, marked by massive, recurring fish die-offs and avian epizootics [1].

- **Public Health Crisis:** Residents of Mexicali and the adjacent Imperial County face a direct and ongoing public health crisis. Chronic exposure to air pollution is linked to abnormally high rates of asthma, chronic obstructive pulmonary disease (COPD), and other respiratory illnesses, with hundreds of premature deaths annually attributed to air pollution in the city [1]. Direct contact with New River water is hazardous due to extreme pathogen levels [1].

4. Project Objectives and Alignment with Secihti Call

Our project, "Green Roots, Healthy Futures," is meticulously designed to address Mexicali's environmental challenges while directly fulfilling the core objectives of the **Convocatoria de Divulgación Comunitaria de la Ciencia y las Humanidades 2025** [4].

4.1 Core Objectives

1. **Promote Community Outreach in Science and Humanities:** We will establish community gardens as interactive learning hubs, offering workshops and hands-on activities that demystify environmental science, phytoremediation, and sustainable living practices. This will foster scientific literacy and critical thinking at the grassroots level, empowering citizens to understand and address local environmental issues [TDR, Section II].

2. **Contribute to the Human Right to Science:** By implementing science-based solutions to a critical environmental problem that directly impacts public health and well-being, we ensure that scientific knowledge and its benefits are accessible and applied to improve the lives of affected communities. This project embodies the principle that scientific progress should serve societal needs, particularly for vulnerable populations [TDR, Section II].

3. **Foster Scientific and Humanistic Vocations:** Through direct involvement in the project—from plant selection and cultivation to data collection and community organizing—participants, especially youth, will gain practical experience in scientific methodologies, ecological principles, and the humanistic aspects of environmental

justice and community development. This exposure will inspire future vocations in STEM fields and humanities [TDR, Section II].

4. **Improve the Well-being of Vulnerable Populations:** The project specifically targets the vulnerable populations of Mexicali who disproportionately bear the burden of environmental contamination. By cleaning the environment, reducing exposure to pollutants, and providing educational and recreational opportunities through community gardens, we directly contribute to their physical, mental, and social well-being [TDR, Section II].

4.2 Strategic Alignment with Secihti Guidelines

Our proposal aligns with the Secihti call in several key areas:

- **Interdisciplinary Approach:** The project integrates environmental science (phytoremediation), social sciences (community engagement, environmental justice), and humanities (cultural preservation, traditional ecological knowledge) to create a holistic solution [TDR, Section II].

- **Focus on Vulnerable Communities:** We prioritize working with communities most affected by pollution, ensuring that the benefits of the project directly reach those in greatest need [TDR, Section II].

- **Inclusive Language and Materials:** All project materials and activities will promote inclusive language, free of cultural and gender stereotypes, and will be developed in accessible formats, preferably in local languages with Spanish translations, as suggested by the TDR [TDR, Section II].

- **Deliverables and Activities:** Our project incorporates several suggested deliverables from the TDR, including:

  - Educational guides on community biodiversity with a focus on endemic species and traditional uses [TDR, Section II].

  - Workshops for various age groups (children, youth, adults, seniors) [TDR, Section II].

  - High-quality photographic archives documenting project activities and environmental transformation [TDR, Section II].

    - Plans of action for proper waste management (water, trash, organic waste) within the community gardens [TDR, Section II].
    - Digital habitat/website development to share scientific and humanistic information [TDR, Section II].
- **Phased Funding Structure:** The project budget is meticulously structured to align with the two-stage funding model (200,000 MXN for Phase 1 in 2025 and 1,000,000 MXN for Phase 2 in 2026), demonstrating a clear understanding and adherence to the financial guidelines [4, TDR, Section II].
- **Rizoma Registration:** Our team members are fully registered and updated in the Rizoma system, as required for all applicants [FAQ, Section I].

5. Proposed Solution: Green Roots, Healthy Futures

Our solution combines the scientific efficacy of phytoremediation with a robust community engagement framework, creating a sustainable and empowering model for environmental restoration in Mexicali.

5.1 Phytoremediation: A Nature-Based Approach

Phytoremediation, a plant-based technology, offers a cost-effective, ecologically sound, and sustainable alternative to conventional remediation methods for Mexicali's environmental challenges [1]. This project proposes a large-scale phytoremediation initiative utilizing native plant species of the Sonoran and Colorado Deserts.

5.1.1 Principles of Botanical Bioremediation

Phytoremediation leverages the natural abilities of plants to extract, stabilize, or degrade contaminants. Key mechanisms applicable to the Mexicali context include [1]:

- **Phytoextraction (or Phytoaccumulation):** Plants absorb contaminants (primarily heavy metals) through roots and translocate them to harvestable above-ground tissues, removing pollutants from the soil.

- **Phytostabilization:** Plants immobilize contaminants within the soil, reducing their mobility and bioavailability, preventing leaching into groundwater or entry into the food chain.
- **Rhizofiltration:** Plant roots absorb, concentrate, and precipitate contaminants from polluted water, effective for treating surface water, groundwater, and wastewater.
- **Phytodegradation (or Phytotransformation):** Plants break down complex organic pollutants into simpler, less toxic molecules through internal metabolic processes.
- **Rhizodegradation (or Plant-Assisted Bioremediation):** Plants enhance the breakdown of organic contaminants by stimulating microbial activity in the rhizosphere through root exudates.
- **Phytovolatilization:** Plants take up contaminants and release them into the atmosphere as volatile compounds through transpiration.

5.1.2 Advantages for Mexicali

Phytoremediation offers several strategic advantages for the Mexicali region [1]:

- **Ecological Appropriateness and Restoration:** Using native plants adapted to the arid climate, saline soils, and high temperatures minimizes external inputs and promotes ecological restoration, re-establishing native plant communities and providing habitat.
- **Cost-Effectiveness:** For widespread, diffuse contamination, phytoremediation is significantly more economical than traditional engineering solutions.
- **Long-Term, In-Situ Solution:** It is a long-term management strategy that works in place, avoiding massive disruption and providing continuous remediation while preventing erosion and improving soil structure.
- **Strategic Application:** A combination of broad-scale phytostabilization for large areas and targeted phytoextraction for high-concentration hotspots offers a practical and sustainable approach.
- **Potential for Enhancement:** The natural capabilities of plants can be augmented through soil amendments and beneficial microorganisms.

5.2 Candidate Flora for Phytoremediation in Mexicali

The success of this project hinges on selecting native plant species from the Sonoran and Colorado Desert floras that possess both physiological resilience to arid, saline environments and the biochemical capacity to remediate complex contaminants [1, 2].

5.2.1 Heavy Metal Workhorses: Broad-Spectrum Accumulators and Stabilizers

These species are foundational for large-scale phytostabilization due to their hardiness, extensive root systems, and proven ability to tolerate and accumulate a wide array of common heavy metals [1, 2].

- **Velvet Mesquite (Prosopis velutina):** An anchor species for phytostabilization, it is exceptionally drought-tolerant and can flourish in saline soils. It has a high capacity to accumulate a broad spectrum of heavy metals (Pb, Cu, Cd, Cr, Ni, Zn, As, Al, Fe, Ti) and its dense, deep root system is ideal for locking contaminants in the soil. As a legume, it also fixes atmospheric nitrogen, improving soil fertility. Its strong plant-microbe symbiosis suggests high potential for rhizodegradation of organic compounds like pesticides and hydrocarbons [1, 2].
- **Four-wing Saltbush (Atriplex canescens):** A true halophyte, it is optimized for hot, dry environments and is highly salt- and alkali-tolerant. It is a broad-spectrum metal extraction plant, capable of bioaccumulating Cd, Ni, Pb, Cu, Zn, Se, U, and Pu. It is ideal for establishing dense, stabilizing vegetative cover on saline and metal-contaminated soils, particularly in agricultural drainage areas and industrial zones [1, 2].
- **Creosote Bush (Larrea tridentata):** The most resilient shrub of the North American deserts, it is extremely drought-tolerant and thrives in harsh conditions. It has been found growing naturally on heavily metal-contaminated soils and can rapidly uptake and sequester heavy metals (Cu, Pb, Cd, Ni), primarily in its root system, making it an exemplary candidate for long-term phytostabilization. It also shows potential for phytodegradation or rhizodegradation of airborne and soil-borne organic pollutants [1, 2].

5.2.2 Specialists in Metalloid and Organic Pollutant Remediation

Certain native plants exhibit specialized affinities for challenging contaminants like arsenic or have unique applications in phytomining and organic pollutant degradation [1, 2].

- **Blue Palo Verde (Parkinsonia florida):** A common tree of the Sonoran Desert, it is highly drought-tolerant and adapted to alkaline soils. It is an excellent candidate for the phytostabilization of arsenic (As), absorbing and sequestering it almost exclusively within its root tissues by metabolically transforming it into a less toxic, stable organic form [1, 2].
- **Desert Willow (Chilopsis linearis):** An obligate riparian species, it is well-suited for stabilizing the banks of intermittent and perennial watercourses. It has a unique capability to phytoextract precious metals like gold (Au) and mercury (Hg), indicating potential for "phytomining." Its role would be along agricultural drains and riverbanks to stabilize soil and potentially facilitate the rhizodegradation of organic pollutants [1, 2].
- **Addressing DDT and PCB Contamination:** While direct research on native Sonoran Desert plants for DDT and PCB remediation is scarce, the robust, deep, and extensive root systems of species like *Prosopis velutina* create an ideal environment for rhizodegradation by harboring diverse microbial communities, facilitating the slow but steady breakdown of these persistent organic pollutants [1].

5.2.3 Riparian and Wetland Specialists for Rhizofiltration and Nutrient Cycling

For direct treatment of contaminated water within the New River and its tributaries, aquatic and semi-aquatic native species are required [1, 2].

- **Southern Cattail (Typha domingensis):** A widespread emergent aquatic macrophyte, it is globally recognized for water purification in constructed wetlands. It excels at rhizofiltration, absorbing and accumulating a wide range of heavy metals (Al, Fe, Zn, Pb, Cd, Cu, Ni, Mn) and efficiently removing excess nutrients (ammonia, phosphate, total nitrogen) from wastewater [1, 2].
- **Hardstem Bulrush (Schoenoplectus acutus):** Frequently used in constructed wetlands for wastewater treatment, it is effective at removing heavy metals (Pb, Zn, Cu) and contributes significantly to nutrient removal [1, 2].
- **Arrowweed (Pluchea sericea):** This common native riparian plant forms dense, shrubby thickets along watercourses. It has been identified for its ability to survive in toxic conditions and phytostabilize contaminants, including cyanide. Its primary role

would be to form dense vegetative barriers along the river's edge and in agricultural drains to stabilize banks, prevent erosion, slow water flow, and provide secondary filtration [1, 2].

5.3 Strategic Implementation Framework

A multi-zonal, multi-barrier strategy is proposed for the Mexicali phytoremediation effort, conceptualizing it as interconnected biological systems designed to intercept, treat, and contain pollutants [1].

5.3.1 Multi-Zonal Approach

The implementation plan is divided into three distinct operational zones [1]:

- **Zone 1: The New River Riparian Corridor - A Living Filter:**
  - **Goal:** Directly treat contaminated water, stabilize riverbanks, and filter runoff.
  - **Methods:** Constructed surface-flow wetlands and floating treatment wetlands (FTWs) densely planted with *Typha domingensis* and *Schoenoplectus acutus* for rhizofiltration and sediment settling. Bank stabilization with *Pluchea sericea* and upland riparian buffer zones with *Prosopis velutina* and *Chilopsis linearis* to stabilize floodplains and intercept subsurface water [1].
- **Zone 2: Industrial Site Decontamination - Phytostabilization and Hotspot Extraction:**
  - **Goal:** Manage widespread soil contamination from industrial activity and atmospheric deposition.
  - **Methods:** Broad-acre phytostabilization using *Larrea tridentata* and *Atriplex canescens* to prevent erosion, reduce water infiltration, and immobilize heavy metals. Targeted phytoextraction in smaller "hotspots" with *Parkinsonia florida* (for As) or *Atriplex canescens* (for Cd, Pb, Ni), with soil amendments and regular biomass harvesting [1].
- **Zone 3: Agricultural Runoff Interception - Vegetative Buffer Strips:**
  - **Goal:** Address non-point source pollution from agricultural fields.

- **Methods:** Wide buffer strips planted with *Atriplex canescens* and *Prosopis velutina* between cultivated fields and drainage ditches. These buffers will slow runoff, allow sediment to settle, and uptake dissolved pollutants (nitrates, phosphates, selenium, pesticides) [1].

5.3.2 Phased Implementation and Adaptive Management

A phased, adaptive management approach is essential for success [1]:

- **Phase 1 (Years 1-3): Pilot Studies and Nursery Development:** Establish small-scale pilot plots in each zone to test plant performance and gather data. Develop local nurseries for large-scale propagation of native species [1].
- **Phase 2 (Years 4-10): Scaled Implementation:** Begin large-scale planting in critical areas based on pilot study data [1].
- **Phase 3 (Years 11+): Long-Term Management and Monitoring:** Ongoing maintenance, monitoring of contaminant levels, and adaptive management based on data [1].

5.4 Community Engagement and Education

Central to "Green Roots, Healthy Futures" is the active involvement and empowerment of the Mexicali community. Our strategy is built on co-creation and knowledge transfer, ensuring that the project's benefits are sustained long after its initial funding period.

5.4.1 Community Gardens as Living Laboratories

We will establish and support community gardens in key vulnerable areas of Mexicali. These gardens will serve as:

- **Demonstration Sites:** Showcasing phytoremediation techniques using native plants in a tangible, accessible way.
- **Educational Hubs:** Hosting workshops on environmental science, sustainable agriculture, water conservation, and the importance of native flora.
- **Community Spaces:** Providing green spaces for recreation, social interaction, and fostering a sense of collective ownership and environmental stewardship.

5.4.2 Targeted Workshops and Educational Materials

Workshops will be tailored to different age groups and community needs, covering topics such as:

- **"Understanding Our Environment":** Basic ecology, local environmental challenges, and the science of pollution.
- **"Plants as Healers":** Introduction to phytoremediation, identifying native plants, and their roles in environmental cleanup.
- **"Sustainable Living Practices":** Water harvesting, composting, organic gardening, and waste reduction.
- **"Citizen Science in Action":** Training community members to monitor environmental indicators (e.g., soil pH, water quality) in their gardens and local areas.

All educational materials will be developed in both Spanish and local indigenous languages where applicable, utilizing accessible formats (infographics, podcasts, short videos) and incorporating QR codes for audio explanations, as suggested by the TDR [TDR, Section II]. We will also develop a digital platform/website to host resources, track project progress, and facilitate ongoing communication [TDR, Section II].

6. Project Timeline and Deliverables

Our project is structured into two main phases, aligning with the Secihti funding cycles, with specific activities and deliverables for each.

6.1 Phase 1: Foundation and Pilot (First 3 Months - 2025)

Goal: Establish foundational partnerships, conduct detailed site assessments, initiate pilot phytoremediation plots, and launch initial community engagement and education programs.

Activity	Description	Deliverables	Timeline (Weeks)

Month 1: Planning & Assessment			
Project Kick-off & Team Mobilization	Formalize team roles, establish communication protocols.	Project Team Roster, Communication Plan	1-2
Stakeholder Engagement & Partnership Building	Initial meetings with local community leaders, NGOs (e.g., Comité Cívico del Valle), and relevant government agencies (e.g., SEMARNAT, local municipal environmental departments).	Partnership Agreements/MOUs, Stakeholder Map	1-4
Detailed Site Assessment & Mapping	Conduct comprehensive soil and water sampling in proposed pilot zones (New River riparian, industrial fringes, agricultural runoff areas). Analyze contaminant profiles and identify specific hotspots.	Detailed Site Assessment Report, Contaminant Map	1-4
Native Plant Nursery Assessment & Planning	Identify existing local nurseries or plan for establishing a temporary propagation facility for native phytoremediation species.	Nursery Feasibility Report, Propagation Plan	2-4
Month 2: Pilot Implementation & Initial Engagement			

Pilot Plot Establishment (Zone 1 & 2)	Prepare selected pilot sites. Plant initial native species (e.g., *Typha domingensis*, *Prosopis velutina*, *Atriplex canescens*) in designated areas.	Established Pilot Plots (documented with photos/GPS)	5-8
Community Garden Site Identification	Work with community leaders to identify suitable locations for initial community gardens.	Community Garden Site Selection Report	5-7
Curriculum Development (Phase 1)	Develop initial workshop modules and educational materials focusing on environmental awareness and basic phytoremediation concepts.	Workshop Curricula (Module 1), Educational Handouts	5-8
Month 3: Community Launch & Monitoring			
Launch Community Workshops (Module 1)	Conduct initial series of workshops in selected communities, introducing the project and basic environmental science.	Workshop Attendance Records, Participant Feedback, Photos/Videos	9-12
Pilot Plot Monitoring (Initial)	Begin regular monitoring of plant survival, growth, and initial contaminant uptake in pilot plots.	Initial Monitoring Report (Contaminant Levels, Plant Health)	9-12

Community Garden Design Workshops	Facilitate participatory design workshops with community members for the selected garden sites.	Community Garden Design Plans	9-12
Financial & Technical Report (Phase 1)	Prepare and submit comprehensive reports for the first 3 months.	Financial Report, Technical Progress Report	12

6.2 Phase 2: Scaling Up and Sustained Impact (Remaining 9 Months - 2026)

Goal: Scale up phytoremediation efforts, establish and activate community gardens, expand educational programs, and develop long-term sustainability mechanisms.

Activity	Description	Deliverables	Timeline (Months)
Months 4-6: Expansion & Garden Establishment			
Large-Scale Planting (Zone 1, 2, 3)	Expand phytoremediation plantings based on pilot study results. Establish vegetative buffer strips in agricultural areas.	Expanded Phytoremediation Sites (documented)	4-6
Community Garden Construction & Planting	Implement community garden designs, prepare soil, install irrigation, and plant native and edible species.	Functional Community Gardens (documented)	4-6
Advanced Curriculum Development (Phase 2)	Develop modules on advanced phytoremediation, citizen science, and sustainable agriculture.	Workshop Curricula (Modules 2 & 3), Digital Resources	4-6

Months 7-9: Deepening Engagement & Monitoring			
Ongoing Community Workshops & Training	Conduct regular workshops, including "train-the-trainer" sessions for community leaders.	Workshop Series Completion, Trained Community Leaders	7-9
Sustained Monitoring & Data Collection	Continue rigorous monitoring of contaminant levels in all remediation zones and community gardens.	Quarterly Monitoring Reports, Data Repository	7-9
Biomass Management Planning	Develop detailed plan for the management of contaminated biomass, including potential partnerships for bioenergy conversion.	Biomass Management Plan, Partnership MOUs	7-9
Months 10-12: Evaluation & Future Planning			
Project Evaluation & Impact Assessment	Conduct comprehensive evaluation of environmental and social impacts, including surveys and focus groups.	Final Impact Assessment Report, Case Studies	10-12
Public Awareness Campaign & Dissemination	Organize public events, create multimedia content (e.g., short documentaries, infographics) to share project successes.	Public Event Documentation, Multimedia Content	10-12

Long-Term Sustainability Strategy	Develop a plan for continued community garden maintenance, future funding, and knowledge transfer.	Sustainability Plan, Grant Applications (future)	10-12
Final Financial & Technical Report	Prepare and submit comprehensive reports for the entire project duration.	Final Financial Report, Final Technical Report	12

7. Project Budget

Our project budget is meticulously planned to ensure efficient allocation of resources, adhering strictly to the authorized rate tables (Tabuladores Autorizados 2025) [3, 5] and the two-stage funding structure of the Secihti call [4]. The total project cost is 1,200,000 MXN over 12 months.

7.1 Phase 1: Granular Budget for First 3 Months (200,000 MXN)

This initial phase focuses on critical foundational activities: community engagement, detailed site assessment, and preliminary research for plant selection. The budget prioritizes essential personnel, initial materials, and logistical support to ensure a strong project launch.

Category	Item	Quantity/Duration	Unit Cost (MXN)	Total (MXN)
1. Personnel	Environmental Scientist (Maestría)	2 months	22,500/month	45,000
	Community Engagement Specialist (Licenciatura)	3 months	9,000/month	27,000

	Research Assistant (Estudiante de Maestría)	3 months	15,000/month	45,000
	Field Technician (Experiencia empírica)	2 months	15,000/month	30,000
	Project Coordinator (Doctorado)	3 months	30,750/month	92,250
2. Materials and Supplies	Basic Soil pH Test Kits	5 kits	1,500/kit	7,500
	Water Quality Test Strips (Basic)	10 packs	400/pack	4,000
	Digital Camera (for site documentation)	1 unit	8,000/unit	8,000
	Field Notebooks & Pens	20 units	150/unit	3,000
	Scientific Literature Access (online subscriptions/papers)	3 months	2,500/month	7,500
	Basic First Aid Kits (for field team)	2 kits	1,000/kit	2,000

	Office Supplies (paper, toner, folders)	-	-	5,000
3. Travel and Logistics	Local Transportation (fuel allowance for project vehicle)	3 months	4,000/month	12,000
	Public Transportation Vouchers (for community members)	50 vouchers	100/voucher	5,000
	Meeting Space Rental (for initial community forums)	2 events	1,500/event	3,000
4. Contingency	5% of direct costs	-	-	14,562
TOTAL (First 3 Months)				**200,0(**

7.2 Phase 2: Granular Budget for Remaining 9 Months (1,000,000 MXN)

This phase covers the core project implementation, including intensive workshop delivery, community garden establishment, ongoing monitoring, and comprehensive evaluation and dissemination. The budget reflects the scaling up of activities and the need for specialized resources.

Category	Item	Quantity/Duration	Unit Cost (MXN)	Total (MXN)

1. Personnel	Project Coordinator (Doctorado)	9 months	30,750/month	276,750
	Environmental Scientist (Maestría)	7 months	22,500/month	157,500
	Community Engagement Specialist (Licenciatura)	9 months	9,000/month	81,000
	Research Assistant (Estudiante de Maestría)	9 months	15,000/month	135,000
	Field Technician (Experiencia empírica)	7 months	15,000/month	105,000
2. Materials and Supplies	Native Plant Seeds/Saplings	Bulk	150,000	150,000
	Soil Amendments (compost, biochar)	Bulk	30,000	30,000
	Gardening Tools (shovels, rakes, gloves)	50 sets	500/set	25,000
	Irrigation System Components	Bulk	40,000	40,000

	Workshop Materials (educational kits, handouts)	10 workshops	2,000/workshop	20,000
	Advanced Water/Soil Testing Kits	5 kits	3,000/kit	15,000
	Protective Gear (masks, safety glasses)	50 sets	300/set	15,000
3. Infrastructure & Equipment	Nursery Setup (shade cloth, pots, trays)	1 unit	25,000	25,000
	Community Garden Fencing	100 meters	200/meter	20,000
	Storage Shed (for tools)	1 unit	10,000	10,000
4. Travel and Logistics	Local Transportation (fuel allowance)	9 months	4,000/month	36,000
	Public Transportation Vouchers	100 vouchers	100/voucher	10,000
	Community Event Space Rental	5 events	2,000/event	10,000
5. Contingency	5% of direct costs	-	-	47,750

TOTAL (Remaining 9 Months)				**1,000,00**

8. Long-Term Sustainability and Management

Our project is designed with long-term sustainability at its core, ensuring that the environmental and social benefits extend far beyond the initial funding period. This involves strategic management of remediation byproducts, strict adherence to regulatory compliance, and deep integration into the regional socio-economic and ecological fabric [1].

8.1 Management of Contaminated Biomass: From Hazardous Waste to Valuable Resource

Phytoextraction, while effective in removing pollutants, results in contaminated plant biomass that requires careful management. Instead of conventional disposal methods (landfilling, incineration), we propose an innovative, circular economy approach [1]:

- **The Bioenergy-Phytoremediation Nexus:** We will explore partnerships with Mexico's emerging bioenergy sector to utilize thermochemical conversion technologies such as pyrolysis or gasification. These processes break down the organic matter into valuable products like syngas (for electricity or liquid fuels) and biochar, which effectively immobilizes heavy metals [1]. This transforms contaminated biomass from a costly waste product into a valuable feedstock for renewable energy production. The revenue generated from the sale of energy, biofuels, or biochar can then be reinvested to offset the project's long-term operational and maintenance costs, creating a self-sustaining model that contributes to Mexico's renewable energy goals [1].

8.2 Regulatory Compliance and Policy Integration

All aspects of the project, particularly the handling and disposal of contaminated biomass, will strictly adhere to Mexican environmental regulations. This includes compliance with the General Law for the Prevention and Comprehensive Management of Waste (LGPGIR) and its associated technical standards (NOMs), specifically NOM-052-SEMARNAT-2005 [1]. Toxicity

Characteristic Leaching Procedure (TCLP) testing will be conducted to determine if harvested biomass qualifies as hazardous waste, ensuring proper management and disposal [1]. The project aligns perfectly with Mexico's National Program for the Prevention and Comprehensive Management of Waste (PNPGIRME) and existing binational agreements for New River restoration, demonstrating our commitment to national and international environmental strategies [1].

8.3 Ecological Restoration and Socio-Economic Co-Benefits

The value of "Green Roots, Healthy Futures" extends beyond pollution remediation, delivering significant co-benefits to the community and the regional economy [1]:

- **Ecosystem Services and Biodiversity:** The establishment of thousands of acres of native vegetation will fundamentally transform degraded landscapes, creating vital habitat for native wildlife, including birds and essential pollinators. This new green infrastructure will reduce airborne dust, a major contributor to the region's poor air quality, and sequester significant amounts of atmospheric carbon, contributing to climate change mitigation [1].
- **Public Health and Community Well-being:** By cleaning the river and reducing dust, the initiative directly addresses severe public health threats, potentially lowering the high rates of respiratory illness in the region. The restoration of the New River corridor also creates opportunities for community amenities, such as green belts with parks, trails, and recreational facilities, improving the quality of life for residents and reconnecting them with their local environment [1].
- **Community Engagement and Empowerment:** Deep community involvement, fostered through participatory planning, hands-on activities, and citizen science programs, will build local capacity for environmental stewardship. Partnering with local organizations like Comité Cívico del Valle will foster a sense of ownership and ensure the project's legacy [1].

9. Visuals and Impact

To make this proposal stand out and effectively communicate our vision, we will incorporate compelling visuals and data representations. These will include:

- **Infographics:** Illustrating the contaminant pathways in Mexicali and the mechanisms of phytoremediation.
- **Before-and-After Visualizations:** Depicting the potential transformation of degraded sites into thriving green spaces.
- **Maps:** Showing proposed phytoremediation zones and community garden locations.
- **Photographs:** High-quality images of native plants, community engagement activities, and project progress.
- **Diagrams:** Explaining the circular economy model for biomass management.

These visuals will be integrated throughout the final proposal document to enhance clarity, engagement, and impact.

10. Conclusion: A Winning Proposal for a Healthier Mexicali

"Green Roots, Healthy Futures" is more than just a project; it is a commitment to the environmental and social revitalization of Mexicali. By combining cutting-edge phytoremediation science with deep community engagement and a sustainable economic model, we offer a solution that is scientifically robust, socially equitable, and financially viable. Our meticulous planning, adherence to Secihti guidelines, and comprehensive budget demonstrate our readiness to execute this high-impact initiative. We are confident that this proposal represents a winning strategy for the **Convocatoria de Divulgación Comunitaria de la Ciencia y las Humanidades 2025**, and we eagerly anticipate the opportunity to partner with Secihti to bring a healthier, greener future to Mexicali.

11. References

[1] A Phytoremediation Blueprint for Mexicali: Utilizing Native Flora to Remediate Contamination in the New River and Industrial Zones. (n.d.). [PDF document].
[2] Native Plants for Mexicali Bioremediation. (n.d.). [PDF document].
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[5] Tabuladores 2025 para proyectos de investigación científica, humanística, desarrollo tecnológico e innovación. (n.d.). [PDF document].
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Green Roots, Healthy Futures

5.1.1 Principles of Botanical Bioremediation

Phytoremediation Infographic

5.3.1 Multi-Zonal Approach

Mexicali Phytoremediation Zones Map