



## **Environment and Natural Resources Trust Fund (ENRTF)**

### **M.L. 2019 ENRTF Work Plan (Main Document)**

**Today's Date:** June 27, 2019

**Date of Next Status Update Report:**

**Date of Work Plan Approval:**

**Project Completion Date:** June 30, 2021

**Does this submission include an amendment request?** No.

**PROJECT TITLE:** Minerals and Water Research

**Project Manager:** Rolf Weberg

**Organization:** Regents of the University of Minnesota

**College/Department/Division:** University of Minnesota-Duluth, Natural Resources Research Institute

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**Web Address:** <https://www.d.umn.edu/>

**Location:** Duluth, MN

**Total Project Budget:** \$883,000.00

**Amount Spent:** \$0

**Balance:** \$0

**Legal Citation:** M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 3 (r)

**Appropriation Language:** \$883,000 the first year is to the Board of Regents of the University of Minnesota for academic and applied research through MnDRIVE at the Natural Resources Research Institute to develop and demonstrate technologies that enhance long-term Minnesota mineral opportunities. Of this amount:

- (1) \$300,000 is to support continued applied research to advance new technologies to improve water quality;
- (2) \$275,000 is to initiate the characterization of western Mesabi iron resources and development of next-generation Minnesota iron products;
- (3) \$158,000 is to develop emerging hydrometallurgy technology to support high-value mineral product development in Minnesota; and

(4) \$150,000 is to support efforts of the Natural Resources Research Institute to accelerate demonstration of high-capacity, cost-effective energy storage using Minnesota's historical auxiliary mine lands.

This research must be conducted in consultation with the Minerals Coordinating Committee established under Minnesota Statutes, section 93.0015.

## **I. PROJECT STATEMENT:**

The Mineral and Water Research project expands on the 2016 Legislative appropriation to accelerate applied research led by NRRI to advance economic and environmental opportunities & solutions associated with Minnesota's water and mineral resources in consultation with the Minerals Coordination Committee. Project outcomes are critical to the continued delivery of knowledge and solutions focused on Minnesota/regional challenges while also engaging key partners and collaborators and leveraging federal and industry funding.

The associated sub-projects were identified via continual broad consultation with Minnesota stakeholders, refined in legislative discussions and submitted as bills which were passed into this appropriation. Each sub-project has been designed, consistent with the final level of funding, to either deliver a final result or provide a significant step forward within the biennium timing.

There are 4 sub-projects, each focused on a specific aspect of Minnesota's mineral and water resources:

- Field demonstration of sulfate reduction technology targeting municipal water treatment facilities to provide affordable alternatives to water treatment
- Initiation of a new, long term effort to define technologies to utilize Minnesota's vast oxidized iron ore deposits to support Minnesota's future iron industry
- Define potential hydrometallurgy technologies that can afford differentiating opportunities for Minnesota mineral deposits
- Define renewable energy storage opportunities utilizing Minnesota's unique geology and water resources, including Minnesota's auxiliary mine lands.

This appropriation is to NRRI – Rolf Weberg is responsible for project outcomes, expenditures, and reporting responsibilities. Rolf Weberg serves as the sole point of contact for the project.

## **II. OVERALL PROJECT STATUS UPDATES:**

**First Update March 1, 2020**

**Second Update September 1, 2020**

**Third Update March 1, 2021**

**Final Report between project end (June 30) and September 30, 2021**

### **III. SUBPROJECTS AND OUTCOMES:**

#### **SUBPROJECT 1: Mobile Water Treatment Demonstration System for Sulfate Reduction**

**Description:** Minnesota is globally unique in its need for a portfolio of viable approaches to reduce wastewater sulfate concentrations significantly below drinking water standards (250ppm) in wild rice regions. One technology - reverse osmosis - can reduce concentrations to 10ppm or lower, but at operating costs that provide significant financial challenges to municipalities and industry while producing significant waste-sludge disposal issues. We propose to build a flexible, mobile demonstration system to scale up and demonstrate a treatment process based on chemical precipitation for deployment at municipal wastewater treatment facilities.

The design will be flexible to accommodate/add other developing water treatment technologies that address other water challenges in Minnesota such as excess phosphorus and nitrogen. This mobile system will support a chemical precipitation process capable of reducing sulfate concentrations from ~100 ppm to < 10 ppm and will contain a real-time monitoring laboratory to evaluate its performance and operation. Test operation will be conducted at the NRRI with synthetic or wastewater collected from facilities prior to the deployment. The mobile treatment system will be deployed at two municipal wastewater treatment plants to test and refine the chemical treatment system on site. Each will run for a duration of 1-3 months at least two seasons (summer and cold season). Treatment system performance will be evaluated through water chemistry, operational parameters, and waste management.

#### **SUBPROJECT 1 ENRTF BUDGET: \$300,000**

<b>Outcome</b>	<b>Completion Date</b>
1. Design, assemble and commission a trailer-based mobile treatment system for in-the-field demonstration	6/30/2020
2. Deploy trailer-based system to two (2) wastewater treatment facilities for on-site testing including assessment of process efficacy, performance and economics.	6/30/2021

3. Project partner outreach will be ongoing throughout the 2-year term.	6/30/2021
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**First Update March 1, 2020**

**Second Update September 1, 2020**

**Third Update March 1, 2021**

**Final Report between project end (June 30) and September 30, 2021**

## **SUBPROJECT 2: Western Mesabi Iron Resource Futures**

**Description:** This research will determine characteristics of iron formations to enable production of iron products from under-utilized/ under-valued ores, specifically oxidized and mixed oxidized/taconite ores. The process to recover magnetite from taconite ores was developed in response to the depletion of Minnesota’s “natural” iron ore (produced from natural oxidation processes). Magnetite existing in taconite ores can be converted to hematite and/or goethite by a process called oxidation. However, today’s operations avoid mining and processing oxidized iron ores. Furthermore, the taconite resources of the Mesabi Range are finite and the demand for blast furnace pellets is declining. The western Mesabi contains significant resources of oxidized and mixed oxidized / taconite ore. The purpose of this study is to initiate a long-term characterization program of the oxidized ores of the Western Mesabi Range to provide basis for future iron industry development in Minnesota.

Summing up in a “bigger picture” view vs. LCCMR goals, as indicated above, the state of Minnesota invested in development of the taconite process at the University of Minnesota. This project seeks to initiate a similar long-term effort to prepare for the state’s future iron industry. To begin, systematic characterization of these more complex, future iron resources is expected to offer insights to how to best responsibly utilize iron mineral resources that are currently considered overburden, waste or spent resources. Extension and/or development of process technologies to allow use of these resources will be pursued to take advantage of this new knowledge and deliver improvements in efficiency and yield with an intended overall reduction in energy and water impacts. Continued production of feedstock for the blast furnace market coupled with participation in the electric arc furnace market provides a more resilient position for Minnesota’s iron industry and brings more economic benefit to the state

Implementation of the characterization effort will require prioritization of geological sites and sampling approaches will be determined on the basis of material accessibility and collaboration with industry partners. Collaborative efforts will involve on-site visitation, laboratory work and group evaluation. Important characteristics to be assessed include mineralogy, liberation size, and chemical & thermal properties of the ores.

**SUBPROJECT 2 ENRTF BUDGET: \$275,000**

Outcome	Completion Date
1. Determine the characteristics and variability of concentrate produced from the Western Mesabi Iron Range.	6/30/2021
2. Identify alternative production methods and product types that will need to be developed for the future of the Western Mesabi Iron Range.	6/30/2021
3. Project partner outreach will be ongoing throughout the 2-year term.	6/30/2021

**First Update March 1, 2020****Second Update September 1, 2020****Third Update March 1, 2021****Final Report between project end (June 30) and September 30, 2021**

## **SUBPROJECT 3: Develop emerging hydrometallurgy technologies**

**Description:** This research project will identify and evaluate emerging hydrometallurgical technologies with applications for processing Minnesota mineral and waste resources leading to the design of a bench- and pilot-scale hydrometallurgical research facility at UMN. Recent advances in hydrometallurgical processing offers unique capability to individually extract high value metal products from Minnesota mineral resources and mineral-based waste materials at high purity, reduced energy consumption and closed loop water cycling systems. Such capability should also allow collection of metallic by-products currently left unmanaged for enhanced economic and environmental benefit to Minnesota. . Implementation of hydrometallurgical processing may ultimately enable enhancement of a circular economy approach for metallic resources and waste streams.

The project will directly engage industry and engineering collaborators across the state in the identification and evaluation of the relevance of current and emerging hydrometallurgical technologies to Minnesota mineral resources and waste materials. This includes benchmarking of current North American hydrometallurgical processing research capabilities and applicability to Minnesota resources. Travel to state collaborator locations will be included in both activities. Research results will be employed to develop a capital, equipment and process plan, as well as a government and industry funding strategy. The results of this study will provide the foundation for the concept and design development for a unique, industry-valued hydrometallurgical research facility at the NRRI Coleraine Laboratory.

**SUBPROJECT 3 ENRTF BUDGET: \$158,000**

Outcome	Completion Date
1. Review and identify current hydrometallurgical technologies that can be utilized to process known Minnesota mineral resources and waste resources.	12/31/2020
2. Define an industry-valued hydrometallurgical facility; deliver a capital, equipment, and process plan including conceptual design, propose a funding strategy for obtaining federal assistance, and propose a plan to build such a facility at the NRRI Coleraine Laboratory.	06/30/2021
3. Project partner outreach will be ongoing throughout the 2-year term.	6/30/2021

**First Update March 1, 2020****Second Update September 1, 2020****Third Update March 1, 2021****Final Report between project end (June 30) and September 30, 2021****SUBPROJECT 4: Accelerate high capacity/low cost energy storage options for Minnesota**

**Description:** This research aims to develop an understanding of Minnesota-relevant technologies that allow high-capacity, low-cost energy storage (>40 MW) with a significant duration of electrical release (durations exceeding 4 to 6 h) that will support efficient integration of renewable energy sources into the grid. This will involve an examination of both conventional and emerging technologies applied to unique circumstances in Minnesota, including utilization of auxiliary mine lands that are currently unproductive. This effort will engage industry partners, the Minnesota power industry and other collaborators in evaluation of technologies and potential match with industry needs. Some of these activities will involve site visits and technology presentations. The documented results of the study will allow decision makers to better define Minnesota's energy storage strategy, understand what is logistically and economically feasible for Minnesota and identify specific locations where technology installations could be implemented

**SUBPROJECT 4 ENRTF BUDGET: \$150,000**

Outcome	Completion Date
1. Conduct a review of various technologies that allow high duration energy storage at greater than 40 MW capacity to be attained at low system capital and operating costs	8/31/2020
2. Identify logistically and economically feasible locations within the state where the technologies can be located that minimizes new distribution costs for the electricity	6/30/2021
3. Project partner outreach will be ongoing throughout the 2-year term.	6/30/2021

**First Update March 1, 2020**

**Second Update September 1, 2020**

**Third Update March 1, 2021**

**Final Report between project end (June 30) and September 30, 2021**

## IV. DISSEMINATION:

In addition to LCCMR reporting requirements, overall project deliverables and research results will be disseminated via multiple outlets including:

- Web-based presentations to engage stakeholders including cognizant local, state, and federal government agency representatives and key industry partners.
- Workshop for wastewater treatment plant operators and regulators (eg MPCA) to disseminate the results of pilot testing.
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The Minnesota Environment and Natural Resources Trust Fund (ENRTF) will be acknowledged through use of the trust fund logo or attribution language on project print and electronic media, publications, signage, and other communications per the [ENRTF Acknowledgement Guidelines](#).

## V. ADDITIONAL BUDGET INFORMATION:

### A. Personnel and Capital Expenditures

**Explanation of Capital Expenditures Greater Than \$5,000:** N/A

**Total Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation:**

Enter Total Estimated Personnel Hours for entire duration of project: 16,500	Divide total personnel hours by 2,080 hours in 1 yr = TOTAL FTE: 4.0
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**Total Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation:**

Enter Total Estimated Contract Personnel Hours for entire duration of project: 1,000	Divide total contract hours by 2,080 hours in 1 yr = TOTAL FTE: 0.25
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## VI. PROJECT PARTNERS:

### A. Partners outside of project manager's organization receiving ENRTF funding

Subproject 1: *Mobile Water Treatment Demonstration System for Sulfate Reduction*

- External partners have not been confirmed to date, but will include two wastewater treatment plant operators.

Subproject 3: *Develop emerging hydrometallurgy technologies*

- External consulting expertise (to be determined) in hydrometallurgical processing will be contracted.

Subproject 4: *Accelerate high capacity/low cost energy storage options for Minnesota*

- The project will utilize external expertise/consultants (to be determined) for the evaluation of unique geological formations specific to Minnesota's Southeast region.

### B. Partners outside of project manager's organization NOT receiving ENRTF funding

## VII. LONG-TERM- IMPLEMENTATION AND FUNDING:

Innovative, integrated solutions are required to help Minnesota's natural resource-based industries evolve and thrive while also maintaining commitments to the environment and our communities. This project will have long-term impacts on the creation of new understanding and the delivery of working systems concerning stewardship of Minnesota water resources,



definition of future, diversified mineral opportunities and potential use of Minnesota auxiliary mine lands for renewable energy storage. These delivery points are consistent with the state's goals concerning energy & carbon reduction, environmental stewardship, industry growth opportunities and community support & development. This work will leverage long-term relationships and public & private funding opportunities.

## **VIII. REPORTING REQUIREMENTS:**

- Project status update reports will be submitted March 1 and September 1 each year of the project
- A final report and associated products will be submitted between June 30 and September 30, 2021

**Attachment A:****Environment and Natural Resources Trust Fund****M.L. 2019 Budget Spreadsheet****Legal Citation:** M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 3 (r)**Sub-project Manager:** George Hudak**Sub-project Title:** Develop emerging hydrometallurgy technologies (sub-project #3)**Organization:** Natural Resources Research Institute, University of Minnesota Duluth**Sub-project Budget:** \$158,000**Project Length and Completion Date:** 2 years, June 30, 2021**Today's Date:** 7/15/2019

<b>ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET</b>	<b>Budget</b>	<b>Amount Spent</b>	<b>Balance</b>
<b>BUDGET ITEM</b>			
<b>Personnel (Wages and Benefits)</b>	\$ 128,978	\$ -	\$ 128,978
George Hudak, NRRI Research Director: \$17,499 (74% salary, 26% fringe), 5% FTE for 2 years			
Academic P&A (in aggregate): 7 NRRI staff members est. total: \$111,479 (74% salary, 26% fringe), 37% Total FTE over 2 years			
<b>Professional/Technical/Service Contracts</b>			
TBD Mineral processing expertise to assist in the evaluation of hydrometallurgical technologies and applications to MN mineral resources and waste materials. Purchasing and/or bidding of project services will comply with Minnesota Statutes pertaining to purchasing, procurement and contracting as well as the UMN Purchasing Goods and Services Admin. Policy.	\$ 19,022	\$ -	\$ 19,022
<b>Travel expenses in Minnesota</b>			
Estimated travel within MN to engage industry and engineering collaborators. Five trips planned per year, estimated at \$1,000/trip based on three NRRI project participants per meeting.	\$ 10,000	\$ -	\$ 10,000
<b>Other</b>			
	\$ -	\$ -	\$ -
<b>COLUMN TOTAL</b>	\$ 158,000	\$ -	\$ 158,000

<b>OTHER FUNDS CONTRIBUTED TO THE PROJECT</b>	<b>Status (secured or pending)</b>	<b>Budget</b>	<b>Spent</b>	<b>Balance</b>
<b>Non-State:</b>		\$ -	\$ -	\$ -
<b>State:</b>		\$ -	\$ -	\$ -
<b>In kind:</b>		\$ -	\$ -	\$ -

<b>PAST AND CURRENT ENRTF APPROPRIATIONS</b>	<b>Amount legally obligated but not yet spent</b>	<b>Budget</b>	<b>Spent</b>	<b>Balance</b>
<b>Current appropriation:</b>		\$ -	\$ -	\$ -
<b>Past appropriations:</b>		\$ -	\$ -	\$ -

**Attachment A:****Environment and Natural Resources Trust Fund****M.L. 2019 Budget Spreadsheet**

Legal Citation: M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 3 (r)

Sub-project Manager: Donald Fosnacht

Sub-project Title: Accelerate High Capacity/Low Cost Energy Storage Options (sub-project #4)

Organization: Natural Resources Research Institute, University of Minnesota Duluth

Sub-project Budget: \$150,000

Project Length and Completion Date: 2 years, June 30, 2021

Today's Date: 7/15/2019



ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Budget	Amount Spent	Balance
<b>BUDGET ITEM</b>			
<b>Personnel (Wages and Benefits)</b>	\$ 121,000	\$ -	\$ 121,000
Donald Fosnacht, NRRI Research Director: \$60,566 (74% salary, 26% fringe), 13% FTE for 2 years			
Academic P&A (in aggregate): 2 NRRI staff members est. total: \$28,754 (74% salary, 26% fringe), 10.7% FTE for 2 years			
Civil Service (in aggregate): 2 NRRI staff members est. total \$31,680 (77% salary, 23% fringe), 26.7% FTE for 2 years			
<b>Professional/Technical/Service Contracts</b>			
Consultation services to evaluate unique geological formations in the Southeast part of the state that can be used for energy storage. Purchasing and/or bidding of project services will comply with Minnesota Statutes pertaining to purchasing, procurement and contracting as well as the UMN Purchasing Goods and Services Admin. Policy.	\$ 25,000	\$ -	\$ 25,000
<b>Travel expenses in Minnesota</b>			
Estimate travel to MN energy-sector partners and project collaborators to conduct the technical review of technologies. Costs will include mileage, lodging and allowable meals.	\$ 4,000	\$ -	\$ 4,000
<b>Other</b>			
	\$ -	\$ -	\$ -
<b>COLUMN TOTAL</b>	\$ 150,000	\$ -	\$ 150,000

OTHER FUNDS CONTRIBUTED TO THE PROJECT	Status (secured or pending)	Budget	Spent	Balance
<b>Non-State:</b>		\$ -	\$ -	\$ -
<b>State:</b>		\$ -	\$ -	\$ -
<b>In kind:</b>		\$ -	\$ -	\$ -

PAST AND CURRENT ENRTF APPROPRIATIONS	Amount legally obligated but not yet spent	Budget	Spent	Balance
<b>Current appropriation:</b>		\$ -	\$ -	\$ -
<b>Past appropriations:</b>		\$ -	\$ -	\$ -

**Attachment A:****Environment and Natural Resources Trust Fund****M.L. 2019 Budget Spreadsheet****Legal Citation:** M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 3 (r)**Sub-project Manager:** Rod Johnson**Sub-project Title:** Western Mesabi Iron Resource Futures (sub project #2)**Organization:** Natural Resources Research Institute, University of Minnesota Duluth**Sub-project Budget:** \$275,000**Project Length and Completion Date:** 2 years, June 30, 2021**Today's Date:** 7/15/2019

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Budget	Amount Spent	Balance
<b>BUDGET ITEM</b>			
<b>Personnel (Wages and Benefits)</b>	\$ 235,431	\$ -	\$ 235,431
Rod Johnson, NRRI Endowed Taconite Chair: \$46,787 (74% salary, 26% fringe), 15% FTE for 2 years			
7 Academic P&A: NRRI researchers & project manager est. total: \$78,294 (74% salary, 26% fringe), 36% Total FTE over 2 years			
2 Civil Service technicians: Lab techs est. total: \$110,350 (74% salary, 26% fringe), 85% Total FTE over 2 years			
<b>Professional/Technical/Service Contracts</b>			
Lab services for chemical and thermal analyses of production samples.	\$ 34,569	\$ -	\$ 34,569
<b>Equipment/Tools/Supplies</b>			
Lab supplies to include sampling tools and lab analyses	\$ 1,000	\$ -	\$ 1,000
<b>Travel expenses in Minnesota</b>			
Estimated monthly MN travel in coordination with industry partners to geological sites to determine sampling approaches and materials accessibility. with industry and University partners. Costs to include mileage, lodging, and allowable meals.	\$ 4,000	\$ -	\$ 4,000
<b>Other</b>			
		\$ -	\$ -
<b>COLUMN TOTAL</b>	\$ 275,000	\$ -	\$ 275,000

OTHER FUNDS CONTRIBUTED TO THE PROJECT	Status (secured or pending)	Budget	Spent	Balance
<b>Non-State:</b>		\$ -	\$ -	\$ -
<b>State:</b>		\$ -	\$ -	\$ -
<b>In kind:</b>		\$ -	\$ -	\$ -

PAST AND CURRENT ENRTF APPROPRIATIONS	Amount legally obligated but not yet spent	Budget	Spent	Balance
<b>Current appropriation:</b>		\$ -	\$ -	\$ -
<b>Past appropriations:</b>		\$ -	\$ -	\$ -

## Attachment A:

## Environment and Natural Resources Trust Fund

## M.L. 2019 Budget Spreadsheet

Legal Citation: M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 3 (r)

Sub-project Manager: Lucinda Johnson

Sub-project Title: Mobile Water Treatment Demonstration System for Sulfate Reduction (sub project #1)

Organization: Natural Resources Research Institute, University of Minnesota Duluth

Sub-project Budget: \$300,000

Project Length and Completion Date: 2 years, June 30, 2021

Today's Date: 7/15/2019



ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Budget	Amount Spent	Balance
<b>BUDGET ITEM</b>			
<b>Personnel (Wages and Benefits)</b>	\$ 234,050	\$ -	\$ 234,050
Lucinda Johnson, NRRI Research Director: \$4,410 (74% salary, 26% fringe); 1% FTE for 2 years			
Academic P&A (in aggregate): 6 staff members est. total: \$102,282 (74% salary, 26% fringe), 43.4% FTE Year 1, 34.3% FTE Year 2			
Civil Service (in aggregate): 6 staff members est. total: \$108,663 (77% salary, 23% fringe), 55% FTE Year 1, 80% FTE Year 2			
Undergraduate student: \$18,695 (100% salary, 0% fringe); 20% FTE Academic Year 1 & 2, 56.8% FTE Summer Year 1 & 2			
<b>Professional/Technical/Service Contracts</b>			
PRO-Senthil-Consulting for pilot system construction. Purchasing and/or bidding of project services will comply with Minnesota Statutes pertaining to purchasing, procurement and contracting as well as the UMN Purchasing Goods and Services Admin. Policy.	\$ 5,950	\$ -	\$ 5,950
<b>Equipment/Tools/Supplies</b>			
Plasticware, reactor material, electrode, and DNA preparation materials for field sampling, water quality analyses. Sonde components to measure pH, conductivity, turbidity, temperature, flow.	\$ 42,000	\$ -	\$ 42,000
<b>Travel expenses in Minnesota</b>			
Sample collection and field testing for costs including mileage, lodging and allowable meals.	\$ 12,000	\$ -	\$ 12,000
<b>Other</b>			
External lab analysis	\$ 6,000	\$ -	\$ 6,000
<b>COLUMN TOTAL</b>	\$ 300,000	\$ -	\$ 300,000

OTHER FUNDS CONTRIBUTED TO THE PROJECT	Status (secured or pending)	Budget	Spent	Balance
<b>Non-State:</b>		\$ -	\$ -	\$ -
<b>State:</b>		\$ -	\$ -	\$ -
<b>In kind:</b>		\$ -	\$ -	\$ -

PAST AND CURRENT ENRTF APPROPRIATIONS	Amount legally obligated but not yet spent	Budget	Spent	Balance
<b>Current appropriation:</b>		\$ -	\$ -	\$ -
<b>Past appropriations:</b>		\$ -	\$ -	\$ -

