UNC CHARLOTTE
The WILLIAM STATES LEE COLLEGE of ENGINEERING

Senior Design Project Description

Company Name	*Orano Federal Services*	**Date Submitted**	*11/16/2018*
Project Title	*Optimization and Partial Demonstration of a Mercury Treatment Process* **(ORANO_HG)**	**Planned Starting Semester**	*Spring 2019*

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills:

Discipline	Number	Discipline	Number
Mechanical	4	Electrical	
Computer		Systems	
Other ( )			

Company and Project Overview:

Headquartered in Washington, D.C., Orano USA is a leading technology and services provider for decommissioning shutdown nuclear energy facilities, used fuel management, federal site cleanup and closure, and the sale of uranium, conversion, and enrichment services to the U.S. commercial and federal markets. With its parent company Orano, Orano USA has more than 30 years' experience in decontaminating and dismantling nuclear facilities, and more than 50 years' experience securely transporting and storing used nuclear fuel (UNF). Prior to a global rebranding in January 2018, Orano USA was AREVA Nuclear Materials.

The Orano Federal Services business – formerly AREVA Federal Services (AFS) – combines the capabilities, technologies and resources from multiple Orano companies to serve the United States Department of Energy (DOE) and its subcontractors in all phases of the nuclear fuel cycle. Orano Federal Services provides key services as an active member in various projects that support DOE's five strategic services**:** Environmental Management (EM)**,** Nuclear Energy (NE)**,** Office of Science (SC)**,** Office of Energy Efficiency & Renewable Energy (EERE), and National Nuclear Security Administration (NNSA)**.** Orano Federal Services currently is a contract team member of the following significant projects: the High Burnup (HBU) Demonstration Project; the Atlas railcar designed to ship UNF in transportation casks; the Yucca Mountain repository program (dormant); the Tank Operations Contract (TOC) at Hanford; et al. In anticipation of the need for several sites to cleanup mercury contaminated soils and facilities, Orano is proposing the use of mercury treatment process currently implemented in France to cleanup a sandy soil site contaminated with mercury. This project would start with the process utilized in France and examine the impact of change of soil type from a sand-based to a clay-based material and then optimize the operation of the process by potentially varying strainer size, water wash rates, equipment size, etc. An overview of this treatment process is shown below.

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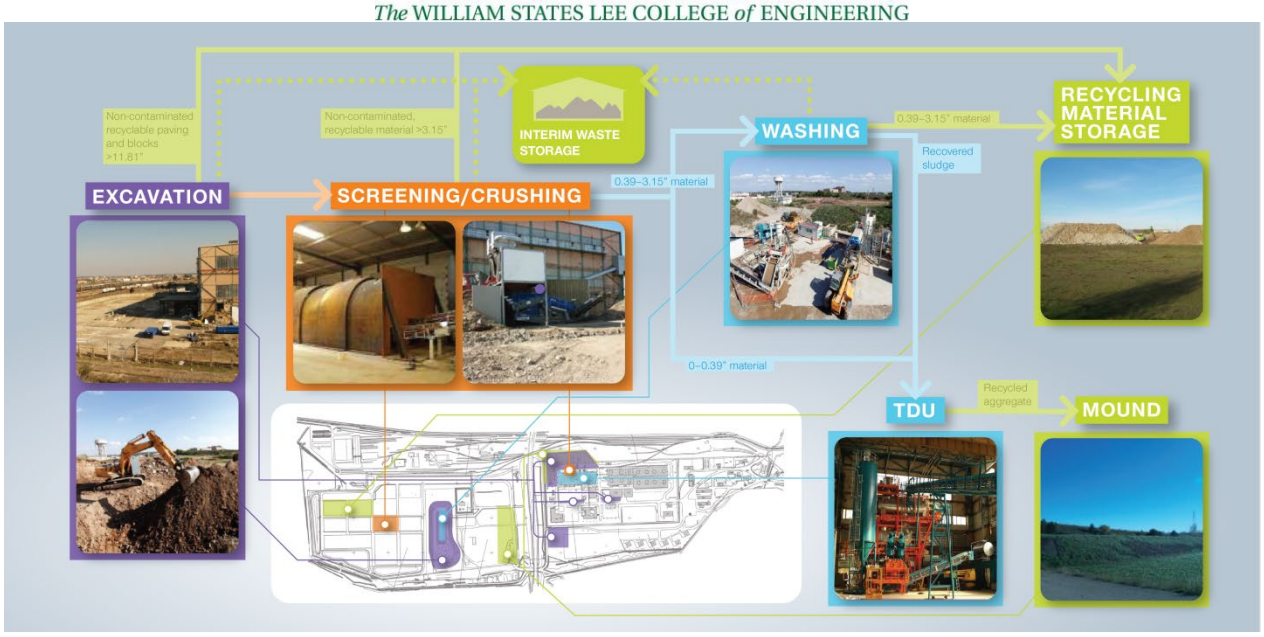
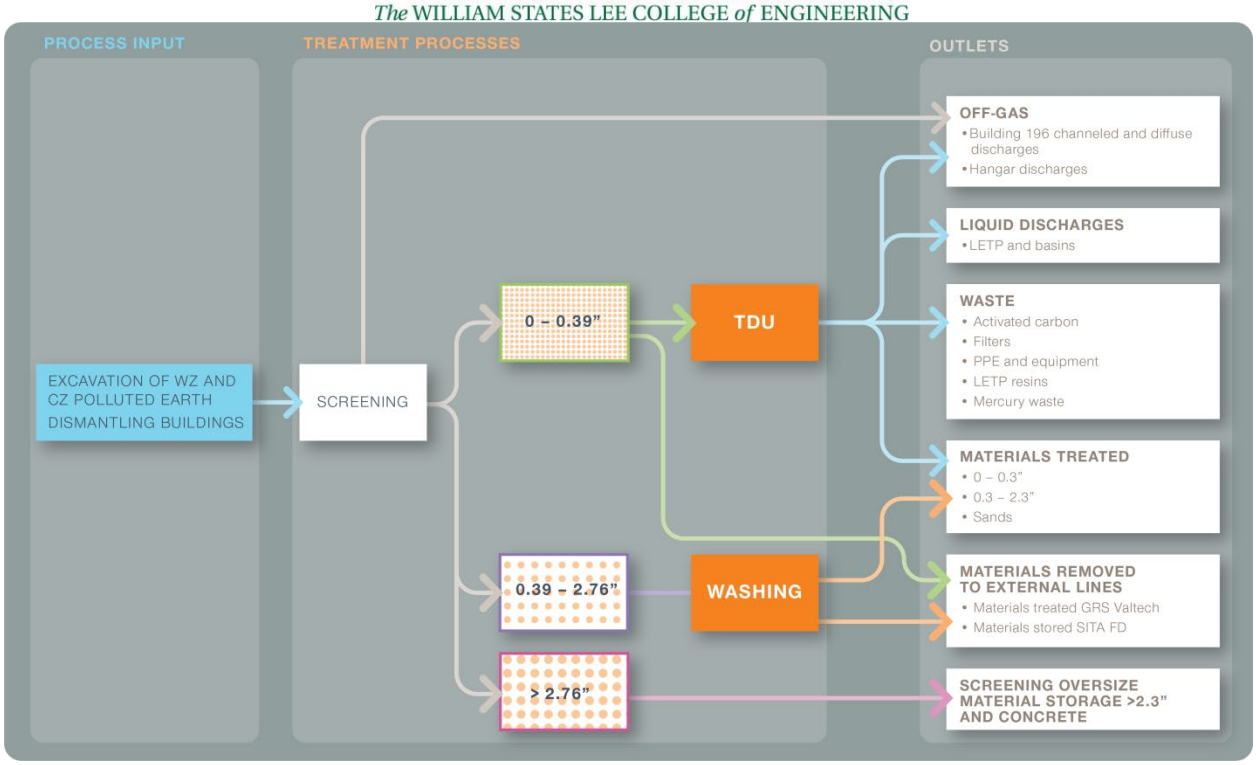


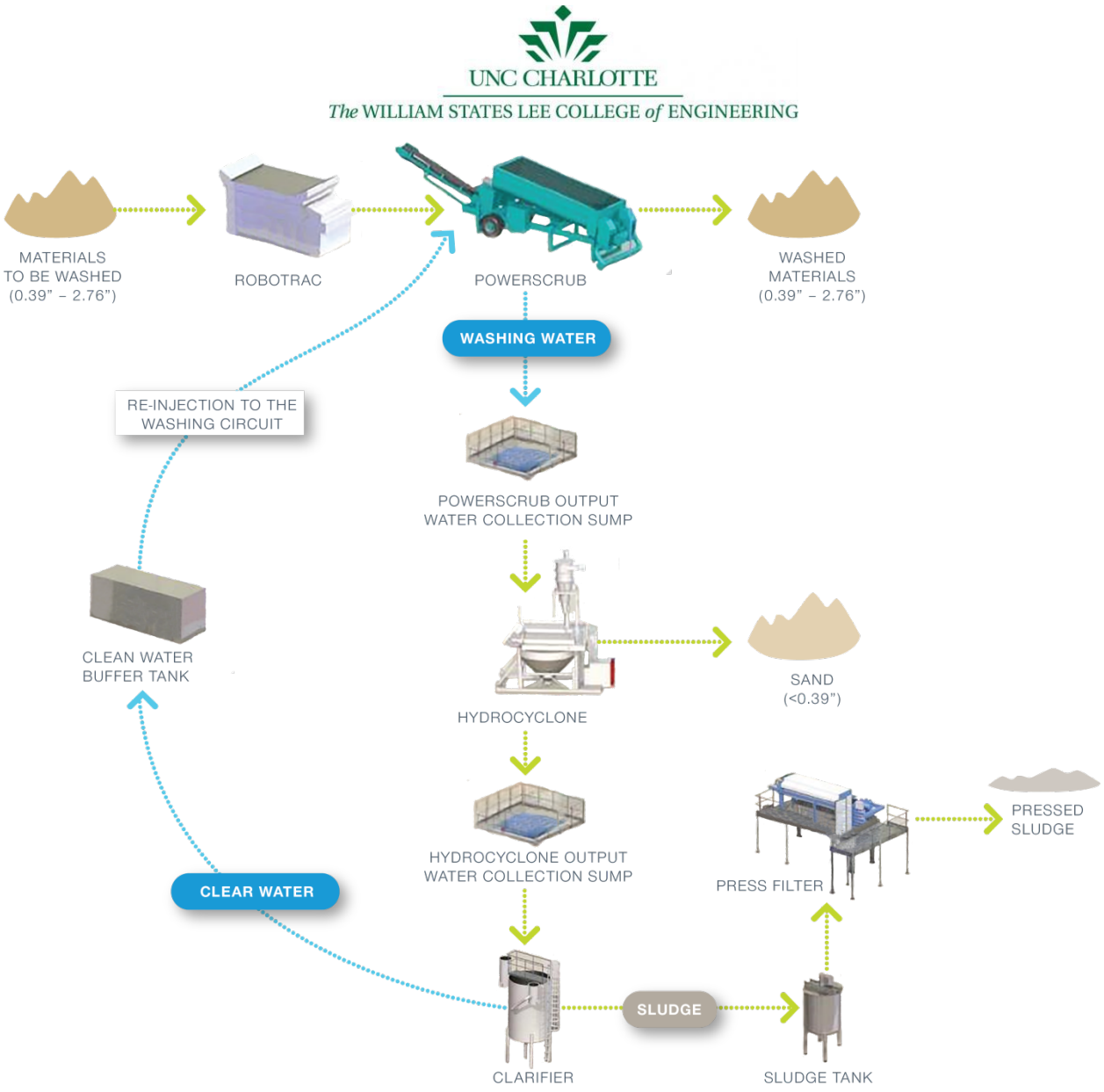
Project Requirements:

This project will examine the impact to the above outlined mercury separation and treatment process of changing the input material from a Hg contaminated sand-based soil to a Hg contaminated clay-based soil. However, no mercury is anticipated to be required to perform this project. In addition to examining the impact to the process as a result of changing the soil type, this project will also examine the ability to optimize the process to operate it more efficiently, potentially through the changing of strainer sizes, equipment sizes, equipment operating regimes (e.g., number of revolutions per second of the hydrocyclone), flow rates, etc.

A simplified process flow diagram is shown below. It shows that currently Hg contaminated sand-based soil is first crushed and then screened through a strainer which separates the soil into three differently sized streams: fines which are transferred to a thermal destruction unit (TDU), medium-sized materials which are transferred to a washing unit, and over-sized materials which are transferred to a storage unit. One of the first activities of this project would be to establish if clay-based soils are separable into comparable sized categories of materials or if an alternative categorization of materials is needed and/or a modification to the strainer would be a better alternative.

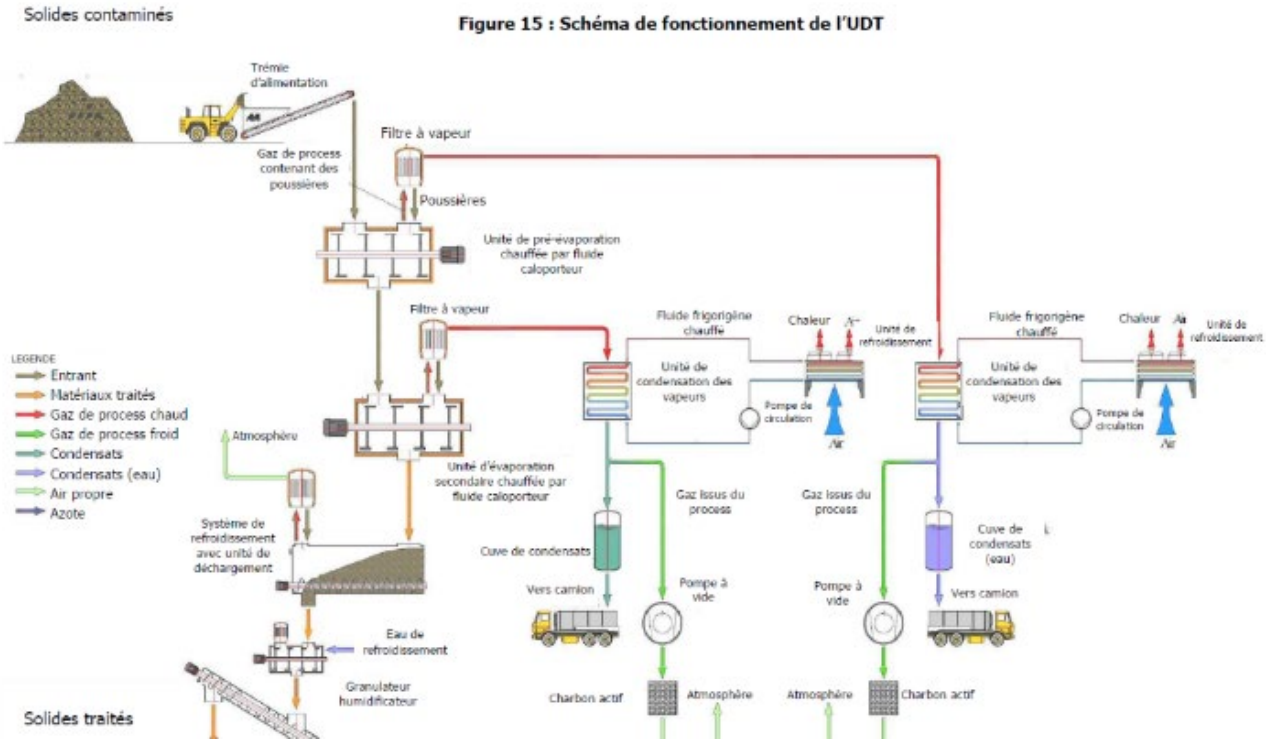


The medium-sized materials are transferred to a washing unit as shown in the figure below. A power scrubber is utilized to remove the mercury from these materials and produces two separate streams: a stream of washed materials with no mercury contamination and a stream of washing water containing mercury. The mercury contaminated washing water is transferred to a hydrocyclone that will perform a further separation resulting two more streams: a mercury contaminated washing water stream and a stream of washed materials free of mercury contamination. The washing water is now sent to a clarifier that separates the mercury contaminated material from the washing water, letting the clarified water to return to the power scrubber to repeat the cycle and sending the mercury contaminated material, which is in a sludge form, to a press filter. The press filter will separate the mercury contaminated material from any remaining liquid. The mercury contaminated material will be subsequently pressed into a solid in the shape and size of a hockey puck. This project would attempt to optimize the operation of this portion of the treatment by examining the impact of water usage, water spray rate, water spray distribution (nozzle types), rotation rate of hydrocyclone, and operation of clarifier to: improve throughput rate and minimize mercury leakage to the recycled washing fluid and to the non-contaminated waste streams.



The fines are transferred to the TDU that processes the fines as shown in the figure below. The fines enter a pre-evaporation unit that operates at a temperature sufficient to evaporate, as steam, the liquid mixed with the fines. The fines are then sent to a second evaporation unit operating at a higher temperature that results in releasing the mercury from the fines into the off-gas stream. The fines from this second evaporation unit are free of mercury contamination and can be recycled for general use. The off-gases from the first evaporation unit (primarily steam) are condensed and the produced clean water reutilized. The off-gases from the second evaporation unit are condensed and the produced mercury collected and removed from the process for later disposition. This project would attempt to optimize the operation of this portion of the treatment by examining the impact of variations in operating temperature of the evaporators to the clay-based soil that would enter this portion of the process and potentially modifying flow rates to improve the overall throughput rate and to minimize the mercury leakage to the non-contaminated output streams (water condensates and fines).

Figure 15 : Schéma de fonctionnement de l'UDT



Expected Deliverables/Results:

- Tests that examine the impact to the front end of the process (e.g., strainer/screen size separations) of changing from a sand-based contaminated soil to a clay-based contaminated soil. Potentially using a surrogate material for mercury (would need to be identified) to verify the effectiveness of the subsequent mercury separation processes.
- A report documenting the tests and the potential modifications to the process to account for the change in soil type and any optimizations to the process that can be made to improve processing times and/or mercury leakage to "clean" outputs.

Disposition of Deliverables at the End of the Project:

Work product is displayed at the last Expo and then results and any developed materials handed over to Orano following the Expo.

List here any specific skills, requirements, specific courses, knowledge needed or suggested (If none please state none):

- Experience with mechanical and/or chemical separation processes
- Experience with industrial processes and optimization of such processes
- Experience with laboratory testing processes