

Indian Carry Stream Crossing Project Moultonborough, NH

Team Members: Daniel Page (PM), Casey Hughes, Joseph Yurczyk
Project Advisor: Kenneth Flesher P.E.
Project Sponsor: Joseph Lowery (Indian Carry Landowners Association)

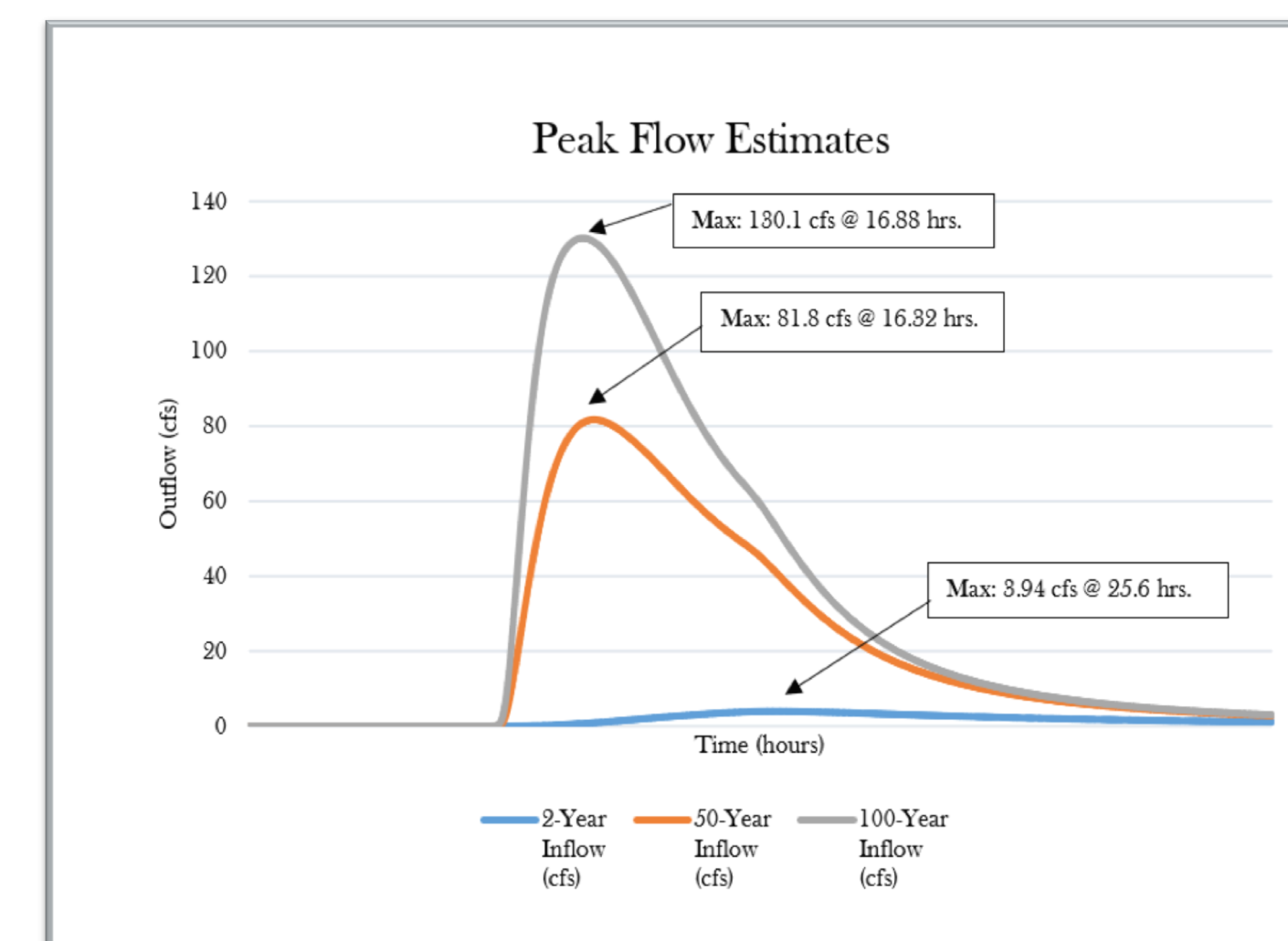
Introduction

Indian Carry Crossing is located in Moultonborough, NH. The crossing connects Indian Carry Stream with runoff from Red Hill and Wakondah Pond through dual 42" culverts. The property is owned and maintained by the Indian Carry Landowners Association. The team was tasked with developing alternative design solutions to replace the existing culverts. The goal of the project is to provide the landowners with a technical report that includes information regarding the project to aid the decision-making process. This report will include a recommendation on what the team concluded as the best design solution.



Hydrology/Hydraulics

To properly size the culverts, an estimated peak flow was calculated. Using both USGS StreamStats and HydroCAD, both the watershed and peak flows were determined. Based on the USGS StreamStats Report of the site, it was estimated that the contributing drainage area is 1.6 mi² (1,024 acres). While the StreamStats Report provided the 2-, 50-, and 100-year peak flows a model of the watershed was developed in HydroCAD to achieve a more accurate estimation. The model was developed by breaking up the drainage areas into subcatchments, reaches, and ponds represented as nodes. To determine the max velocities for each design solution, the peak flows estimated by HydroCAD were used. The importance of a hydraulic study is to make sure the culvert design will be adequate and not allow for the flow to overtop the roadway. In addition, excessive velocities could cause erosion downstream. The velocities found in the design comparison chart were used to design for the rock outlet protection. With these velocities the culvert designs were evaluated to ensure the size was adequate, as well as compare the different material alternatives with open bottom alternatives.



Design	Name	Velocity (fps)		
		2-Year Flow	50-Year Flow	100-Year Flow
1	ADS N-12	4.53	9.72	13.53
2	ADS StormTech	4.37	6.50	8.11
3	Concrete Box Culvert	4.06	6.03	6.44

Permitting

There are multiple permits that could apply to the project, and the prerequisites have unique limitations that must be considered. Thus, the design alternatives of the new stream crossing have different permitting requirements. Each permit, though related to culvert repair and replacement, address a specific scope of work and design alternatives were created to reflect the requirements of each permit. It was important early in the project to provide design solutions for a wide range of work and at varying levels of permitting requirements. This was done to provide the landowners association with a wide range of options when it comes time to permit the work.

Potential Permits:

- NH DES "RR-1: Culvert Replacement or Repair"
- NH DES Standard Dredge and Fill Permit
 - Wetlands Bureau Stream Crossing Worksheet

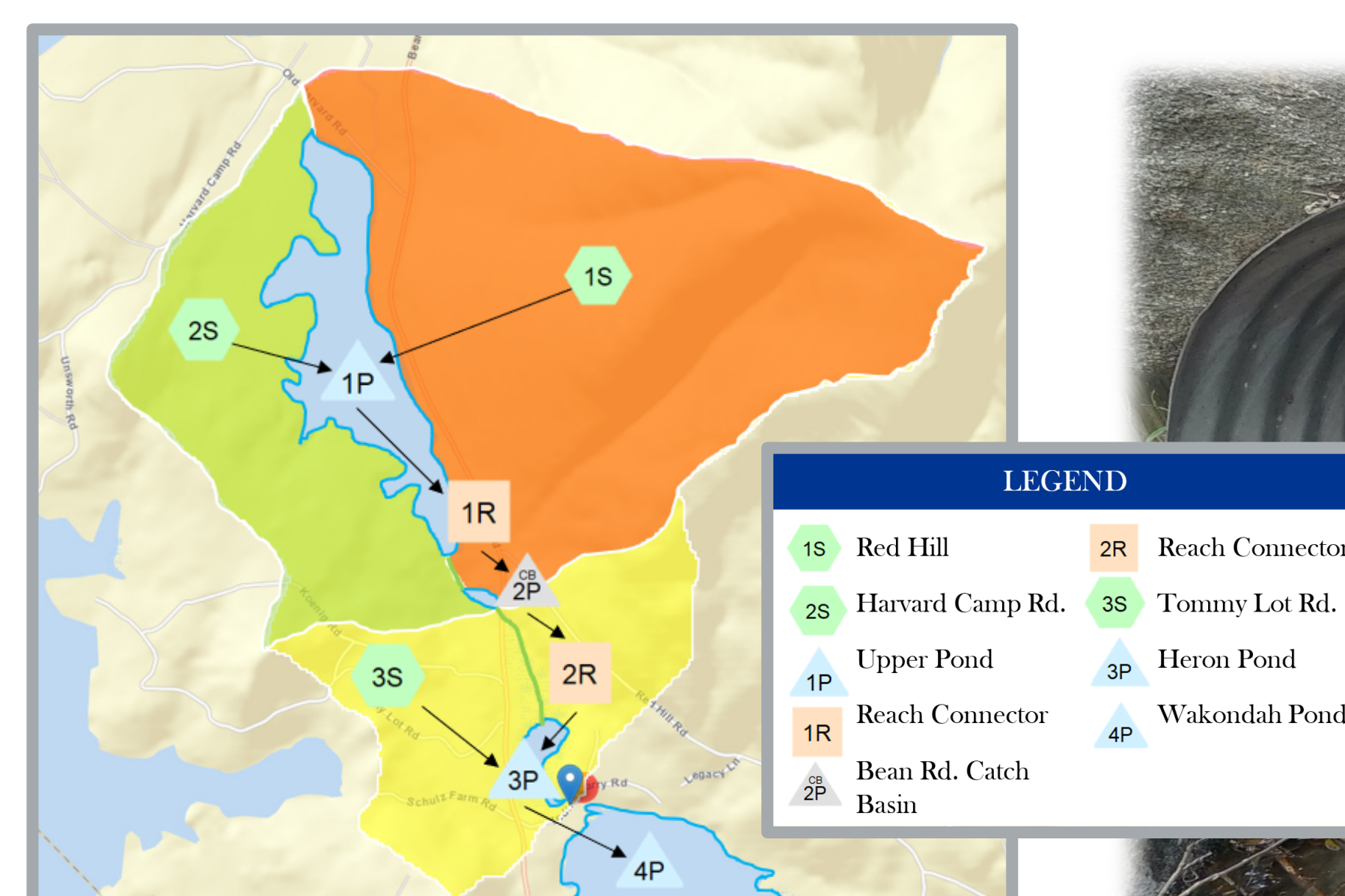
Materials

Protection against corrosion was seen as the point of concern when selecting a culvert material. The current corrugated metal pipes are showing severe signs of corrosion. With this material failure the potential design solutions that were developed included a range of materials that resist corrosion at various price points. The team investigated various materials including CMP, coated CMP, plastic, and concrete. Below is a brief comparison of the materials researched.

	Material Comparison		
	Coated CMP	Plastic	Concrete
Estimated Service Life	75+ years	75+ years	50+ years
Manning's	0.012	0.012	0.024
Corrosion Protection	Varies with coating	Inert Material	Varies with coating

Existing Conditions

- Twin 42" culverts
 - Already showing signs of failure
 - Corrosion, Warping, Partial Collapse
- Wood Guardrail
 - Partially retaining embankment material
 - Gravel road
 - Loose stone headwall
 - Beaver Activity



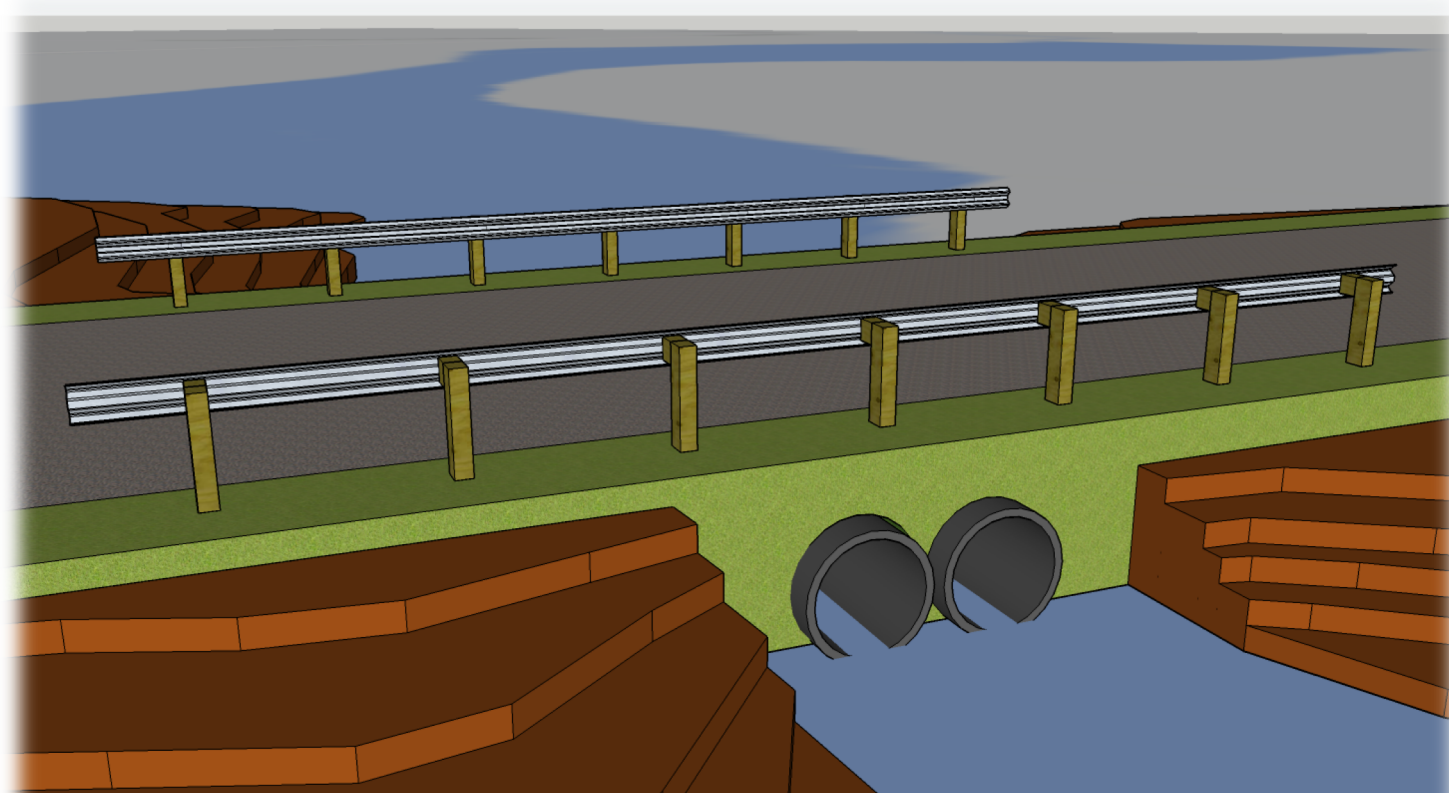
Contributing Watershed



Design 1: Dual 42" Plastic Culverts

Design 1 provides the Landowners Association with a cost effective, low maintenance, and accessible stream crossing option. This design is very similar to the existing structure but features upgraded pipe materials. In terms of permitting, this design solution may be the most practical option. The design was created to fit within the bounds of the RR-1 permit which limits to only replace "in-kind". This was done to give the landowners a design option that could be completed in the interim to replace the existing culvert in the short-term while the landowners developed a plan to fund a more permanent and long-term solution.

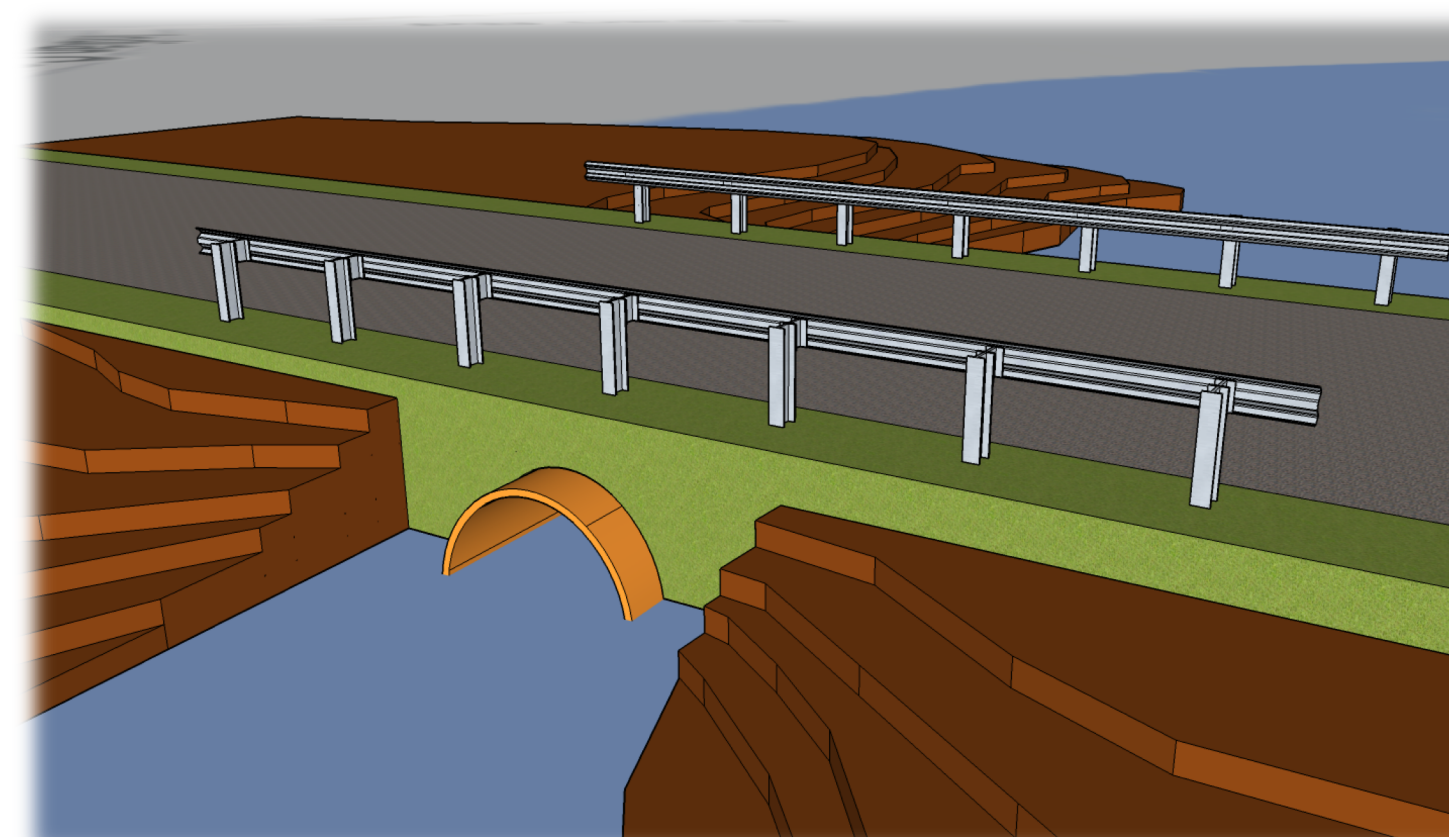
Item	Description
Pipe	ADS: Two 42" N12 Plastic Corrugated Pipe
Outlet Protection	26' x 10.5' Riprap pad w/ 18" stone
Debris Control	non-structural annual maintenance
Guardrail	Wood Post w/ Steel Guardrail
Roadway	Graded Gravel
Headwall	Stone
Embankment	Vegetative Stabilization



Design 2: StormTech Pipe-Arch Culvert

Design 2 is another cost effective and low maintenance design alternative for the Landowners Association. This design is an open bottom crossing with a plastic arch set on concrete footings. The open bottom channel allows for a lower velocity on the tail end compared to Design 1. Due to its inert material, corrosion will not impact the structure like the existing culverts. Permitting for this design requires the Standard Wetlands Dredge and Fill Permit accompanied by the stream crossing worksheet provided by the Wetlands Bureau. **Design 2 is the team's recommended design as it provides an open bottom crossing that is cost effective, low maintenance, and has a high expected service life.**

Item	Description
Arch Culvert	ADS: Stormtech MC-3500 Chamber
Outlet Protection	26' x 10.5' Riprap pad w/ 18" stone
Debris Control	non-structural annual maintenance
Guardrail	Steel Post w/ Steel Guardrail
Roadway	Graded Gravel
Headwall	Stone
Embankment	Vegetative Stabilization



Design 3: Concrete Box Culvert

Design 3 features a pre-cast concrete box to provide an open bottom stream crossing. This design would be the most expensive of the options but would have the longest service life. It would be permitted under the Standard Wetlands Dredge and Fill Permit with the Stream Crossing Worksheet. A precast option was recommended early in the project as the long term, open bottom, solution but as the design developed, concerns about cost effectiveness, construction, and permitting emerged. As other open bottom crossings were developed, the concrete option became less viable. This design was completed so comparisons could be made between pipe, arch, and box culverts as well as their respective materials.

Item	Description
Box Culvert	Michie: 4' x 4' Box Section
Outlet Protection	26' x 10.5' Riprap pad w/ 18" stone
Debris Control	non-structural annual maintenance
Guardrail	Steel Post w/ Steel Guardrail
Roadway	Graded Gravel
Headwall	Precast Wing Walls
Embankment	Vegetative Stabilization

