

# **EVALUATION OF ROCK REINFORCEMENT AT BARRON MTN., WOODSTOCK, NH.**

**Phase I – Completed**

**Phase II – Pooled Fund Study**

**New York DOT**

**Connecticut DOT**

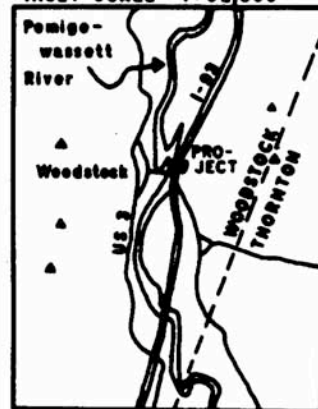
**New Hampshire DOT**

72°

# PROJECT LOCATION MAP Woodstock, New Hampshire

45°

INSET SCALE - 1:62,500



44°

43°

VERMONT

Connecticut

GRAFTON

Plymouth\*

BELKNAP

MERRIMACK

Concord\*

Manchester

CHESHIRE

HILLSBORO

MASSACHUSETTS

COOS

Berlin\*

MAINE

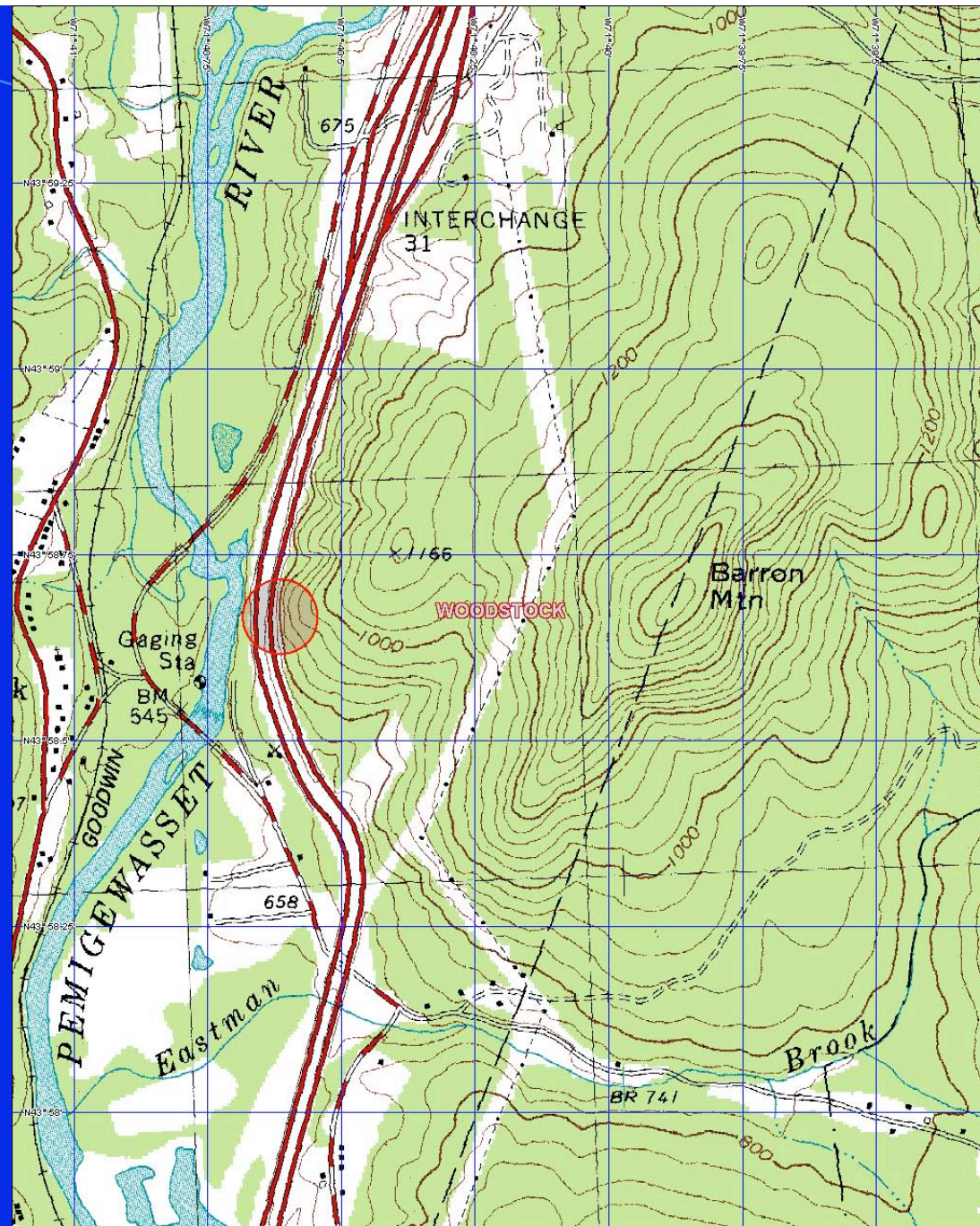
45°

44°

43°

Fig. 1

# PROJECT LOCATION MAP



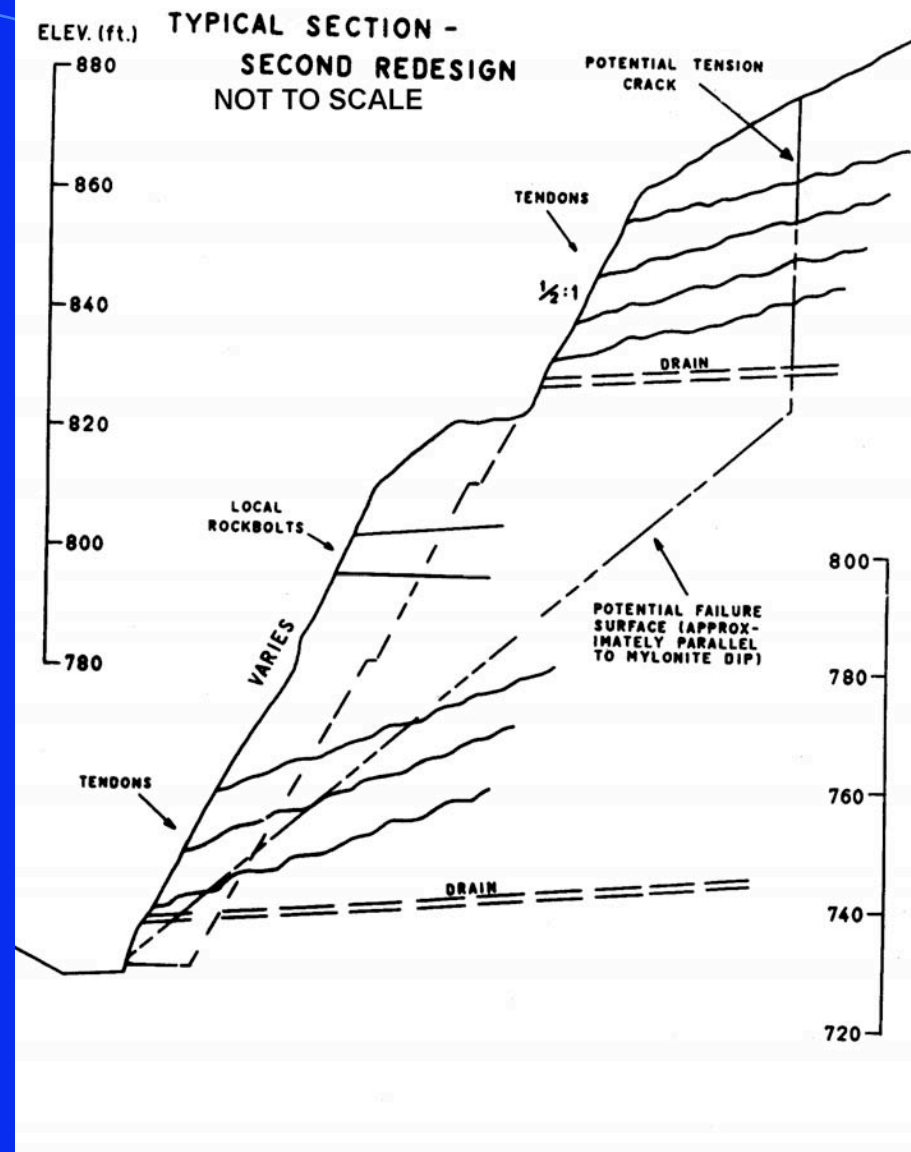
3-D TopoQuads Copyright © 1999 DeLorme Yarmouth, ME 04096 Source Data: USGS 350 ft Scale: 1:12,900 Detail: 14:0 Datum: WGS84





**East View of Rock Cut Along I-93 NB**





**Cross Section of Barron Mtn. Rock Cut**



**Pre-stressed Rock Bolts**





**Passive Tendons**

# **Rock Reinforcement Evaluation – Phase 1**

- **Assessment of Corrosion Potential**
  - **Ground water**
  - **Weathered rock**
- **Assessment of Rock Reinforcement**  
(Nondestructive Testing performed on 22 rock bolts and 20 tendons)
  - **Electrochemical Tests (half cell potential, polarization current)**
  - **Mechanical Tests (impact, ultrasonic)**





## DATA ACQUISITION (NDT)











## **PHASE 1 Findings**

- **Corrosive Environment**
- **30% of sampled rock bolts loss of pre-stress**
- **10 to 15% loss of cross section**
- **Tendons better condition than rock bolts**
- **Quality of cements grout along tendons more consistent than resin grout along rock bolts**
- **Remaining service life of rock bolts 15 years and tendon 20 years**

## **Rock Reinforcement Evaluation – Phase 2**

- **Invasive Testing (verify the results of NDT)**
  - **Lift-off tests**
  - **Physical, chemical and metallurgical testing of steel and grout samples retrieved from exhumed reinforcements (5 bolts, 2 tendons)**
- **GRANIT integrity test (type of NDT impact)**
- **Additional NDT testing on other elements**



## **Phase 2 Work Schedule**

- **GRANIT Test**
- **Scaling**
- **Drilling replacement holes**
- **Assemble and install rock reinforcement**
- **Grout**
- **Lift-off Test**
- **NDT testing of rock reinforcement above slide area**
- **Over-coring & exhuming bolts and tendons**
- **Testing retrieved reinforcement and recovered grout**



## GRANIT NDT TESTING









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**Scaling Loose Rock**





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**REMOVAL OF UNSTABLE BLOCK**





7 10 2004





7.10.2004





7 10 2004







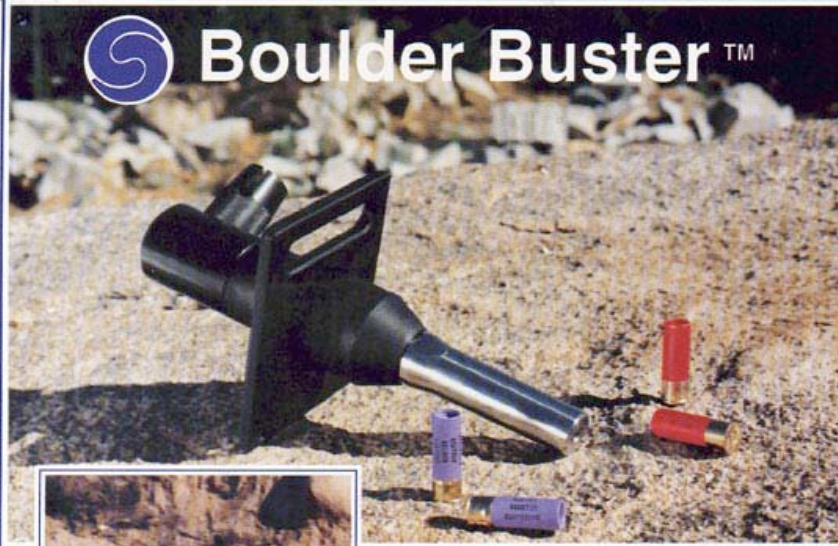


**Portion of Rock Bolt**





# Boulder Buster™



## The better solution in rock breaking.

The Boulder Buster™ is a compact, cost effective and portable piece of equipment which is extremely useful in the splitting and breaking of rocks, boulders as well as the demolition of concrete structures. The sheer convenience of operation and low operating costs make the Boulder Buster™ the first choice in standby rock breaking equipment.

### Advantages

- Safe and simple to operate
- Energy efficient
- No damage to structures and equipment
- Very low concussion
- Insignificant toxic gasses
- Low velocity fly rock and very little scatter
- No blasting licence required
- Light-weight and compact
- Cost effective

### Applications

- Secondary breaking in mines and quarries
- Civil construction
- Demolition
- Site clearing
- Swimming pool excavations
- Trench digging
- Farming operations
- Dimensional stone dressing and sizing

# BOULDER BUSTER





## **Drilling Holes for Replacement Bolts and Tendons**









6 10 2004





2004 10 5





2004 10 7





**Preparing Tendons**









**Preparing Rock Bolts**





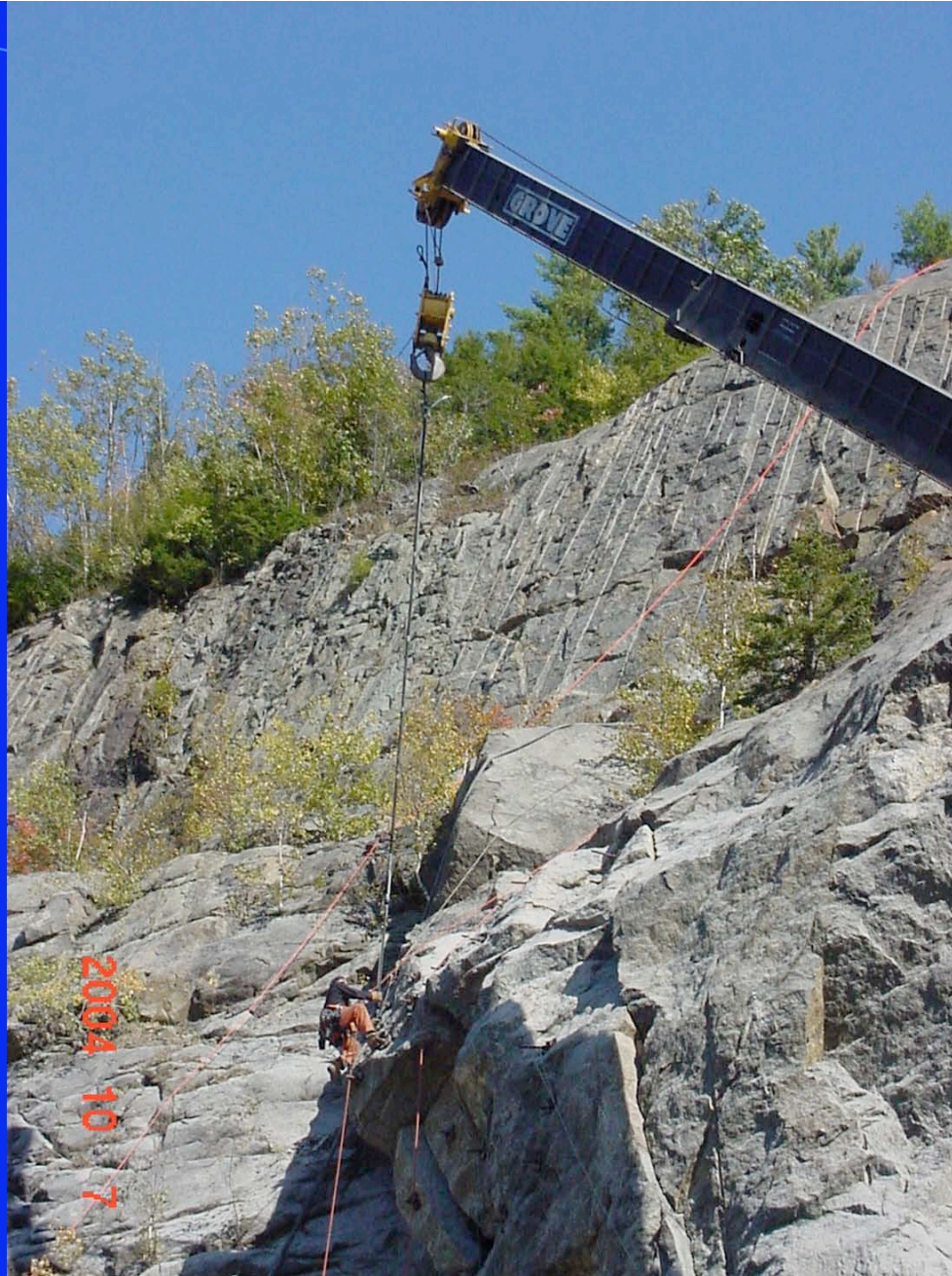
**Installing Rock Tendons**





2004 10 7





**Installing Rock Bolt**





2004 10 7





**NDT Testing above slide area**





**Lift-off Test on Existing Bolts**





**Proof Test on New Rock Bolts**





**Drill Rig for Over-coring Rock Reinforcement**





**Drill Casing and Diamond Bit**





**Over-coring**













**Recovered Rock Bolt**





**Resin Grout on Rock Bolt**





**Recovered Resin Grout**





**Corroded Rock Bolt**



# **Acknowledgment**

- **Researcher - McMahon & Mann Consulting Engineers, P.C., Buffalo, NY**
- **NDT GRANIT Integrity System – AMEC Group Ltd., United Kingdom**
- **Rock Bolt Specialty Contractor – JANOD Contractors, Quebec, Canada**









2004 10 12





2004 10 13