Accelerated Innovation Deployment (AID) Demonstration Project:

White Swan Bridge Replacement

Final Report
January 20, 2016

Submitted By: *Ohkay Owingeh Tribe*

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

ACCELERATED INNOVATION DEPLOYMENT (AID) DEMONSTRATION GRANTS

The Accelerated Innovation Deployment (AID) program is one aspect of the multi-faceted Technology and Innovation Deployment Program (TIDP) approach, which provides funding and other resources to offset the risk of trying an innovation. The AID Demonstration funds are available for any project eligible for assistance under title 23, United States Code. Projects eligible for funding shall include proven innovative practices or technologies such as those included in the EDC initiative. Innovations may include infrastructure and non-infrastructure strategies or activities, which the award recipient intends to implement and adopt as a significant improvement from their conventional practice.

The Federal Highway Administration (FHWA) Accelerated Innovation Deployment (AID) Demonstration grant program, which is administered through the FHWA Center for Accelerating Innovation (CAI), provides incentive funding and other resources for eligible entities to offset the risk of trying an innovation and to accelerate the implementation and adoption of that innovation in highway transportation.

Projects deemed eligible for funding included proven innovative practices or technologies, including infrastructure and non-infrastructure strategies or activities, which the applicant or subrecipient intends to implement and adopt as a significant improvement from their conventional practice. The AID Demonstration funds were available for any project eligible for assistance under title 23, United States Code.

Entities eligible to apply included State departments of transportation (DOT), Federal Land Management Agencies, and tribal governments as well as metropolitan planning organizations (MPOs) and local governments which applied through the State DOT as subrecipients.

REPORT SCOPE AND ORGANIZATION

This report documents the AID demonstration grant award for White Swan Bridge Replacement Project*)* using GRS/IBS and Precast Bridge Superstructure. The report presents details relevant to the employed project innovation(s), the overarching TIDP goals, performance metrics measurement and analysis, lessons learned, and the status of activities related to adoption of Force Account Work as conventional practice by the Ohkay Owingeh Planning Department. Ohkay Owingeh is located in North Central New Mexico. (*As applicable* - Technology transfer activities that took place to disseminate the project results are also discussed.)

PROJECT OVERVIEW

PROJECT OVERVIEW

Ohkay Owingeh sought funding to accelerate construction of a small, two-lane bridge within their community. The Every Day Counts (EDC) initiative promoted an accelerated bridge construction schedule through the use of a Geosynthetic Reinforced Soil (GRS) abutments and Pre-fabricated Bridge Elements and Systems (PBES). It is with these technologies that Ohkay Owingeh designed a new structure for the replacement of the White Swan Bridge. AID funding was be used for the pre-fabrication of the superstructure and construction of the GRS abutments. Since these technologies were successfully deployed, both will be proposed on future projects.

The White Swan Bridge (Bridge No. M210) in Ohkay is located approximately one mile north of NM Hwy 74 on White Swan Road within Ohkay Owingeh. The bridge is over one of the largest drainage basins in Ohkay Owingeh, and has experienced flooding on several occasions. The bridge was comprised of a batter of four 4 ft x 10 ft. precast box culverts. Two of the four joints of the spans were separated to approximately one and one half inch gap.

The existing bridge had a skew from the drainage flow pattern that created sediment deposit at the inlet and caused flooding. The bridge skew created operational concerns from both directions at the approaches and were difficult to negotiate at the posted speed of 25mph. The site distance to the north was limited to approximately 200 ft. and did not meet minimum AASHTO requirements. The bridge and approach geometry contributed to the bridge railings being struck on numerous occasions.

To compound the issues with the bridge, there were two irrigation ditches in the immediate vicinity of the bridge on the north and southeast side. These ditches had an impact on the type of bridge construction that can be accomplished.

The design for the White Swan Bridge replacement project accomplished the following goals:

- Straightened the roadway and bridge geometry,
- Replaced the existing box culverts with a single span precast bridge superstructure,
- Extended the existing irrigation facilities outside of the safety zone,
- Added a sidewalk for pedestrian access across the bridge, and
- Realigned the approaches to increase the overall safety and function of the bridge.

Ohkay Owingeh expected to realize many of the documented benefits of GRS and PBES. We anticipated both cost and time savings by using these technologies. Conventional construction would need significant closure time and specialized equipment. The bridge was easy to build with common equipment and local staff from the Pueblo's crew. Specifically the GRS technology provided employment opportunities to qualified tribal members and helped increase the skill level of those employees.

Ohkay Owingeh personnel have successfully previously completed construction of two related projects. The first was reconstruction of a 0.9 mile roadway that was experiencing severe flooding, the second was replacement of an irrigation crossing with the installation of a culvert pipe and cast in place concrete headwalls. The personnel skill level is fitting for the installation of the GRS-IBS system. The use of conventional cast in place abutment construction would eliminate the opportunity for force account work, due to its complexity with reinforcement and means and methods of construction. The use of GRS will allow a short time frame for construction and will provide the opportunity to move to the superstructure prior the start of the monsoonal flows the arroyo experienced.

Performance goals and measures for this project:

Goal: Reduction of construction time

Measure: Length of construction time measured in days.
(Measurement at beginning and end of construction starting with mobilization and ending with approval of final construction) We will compare this with traditional construction techniques for similar type bridges.

Goal: Reduce project cost

Measure: Total cost of design, fabrication, delivery and construction will be compared with original estimate for cast in place construction.

Goal: Ensure Pueblo crew has appropriate training for construction

Measure: In person or web training session provided to crew prior to construction.

LESSONS LEARNED

Through this project, the road maintenance staff from Ohkay Owingeh gained valuable insights with regard to the use of GRS/IBS systems for bridge crossings. The following were some of the lessons learned:

- Don't be afraid to use your resources at FHWA their knowledge of this process is very helpful with the construction planning and construction process for GRS/IBS
- Clearly understand your critical materials, and schedule their delivery early to avoid delays
- The use of smooth, uniform block is much better than using split face block due to their unevenness in construction.
- Study and planning ahead of the days' work is key to production
- If it looks right the first time, check to make sure before moving on
- Safety, Safety, Safety!!

PROJECT DETAILS

BACKGROUND

The White Swan Bridge (Bridge No. M210) in Ohkay is located approximately one mile north of NM Hwy 74 on White Swan Road within Ohkay Owingeh. The bridge is over one of the largest drainage basins in Ohkay Owingeh, and has experienced flooding on several occasions. The bridge was comprised of a batter of four 4 ft x 10 ft. precast box culverts. Two of the four joints of the spans were separated to approximately one and one half inch gap. The existing bridge had experienced severe failure and had a sufficiency rating of 65.8.

The existing bridge had a skew from the drainage flow pattern that created sediment deposit at the inlet and caused flooding. The bridge skew created operational concerns from both directions at the approaches and were difficult to negotiate at the posted speed of 25mph. The site distance to the north was limited to approximately 200 ft. and did not meet minimum AASHTO requirements. The bridge and approach geometry contributed to the bridge railings being struck on numerous occasions.

To compound the issues with the bridge, there were two irrigation ditches in the immediate vicinity of the bridge on the north and southeast side. These ditches had an impact on the type of bridge construction that can be accomplished.

The replacement of the bridge allowed for geometric changes to increase site distance, allow for construction of the bridge abutments parallel to the flow of runoff, and allowed for removal of hazards from within the clear zone.

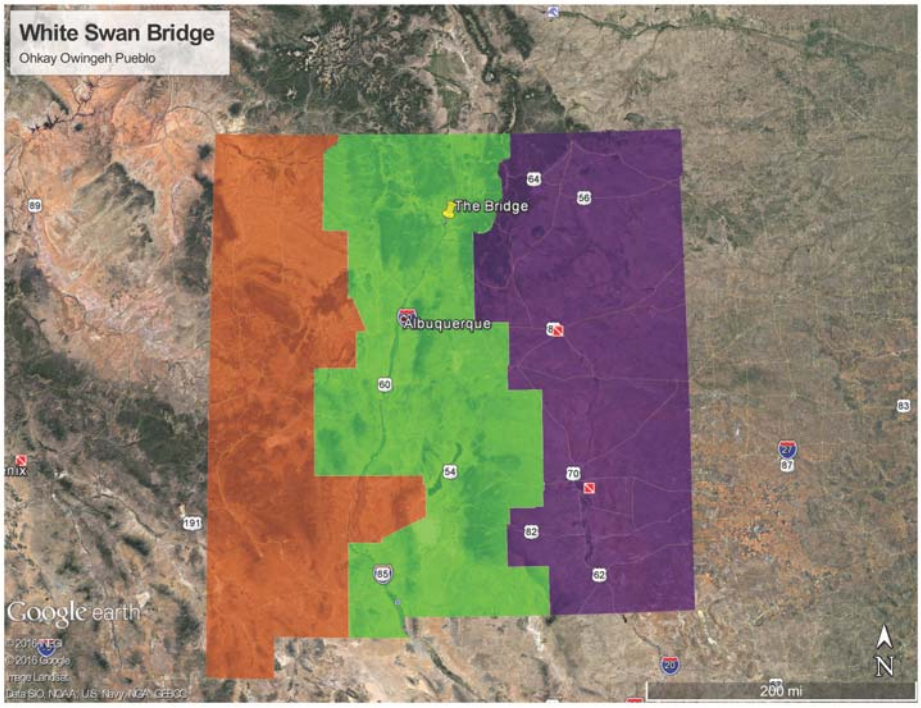


Figure 1. Map. Project area location.

Figure 2. Map. Project regional location.

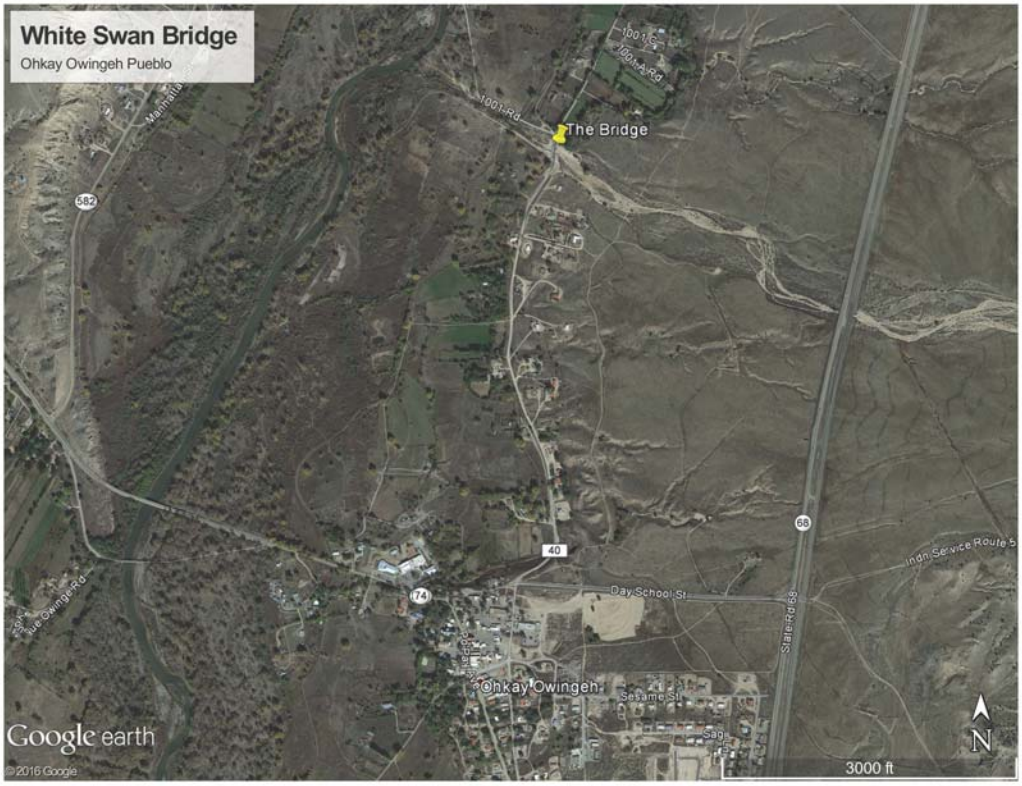


Figure 3. Map. Project local location.

PROJECT DESCRIPTION

The design for the White Swan Bridge replacement project accomplished the following goals:

- Straightened the roadway and bridge geometry,
- Replaced the existing box culverts with a single span precast bridge superstructure,
- Extended the existing irrigation facilities outside of the safety zone,
- Added a sidewalk for pedestrian access across the bridge, and
- Realigned the approaches to increase the overall safety and function of the bridge.
- Allowed for a shorter construction duration versus conventional construction
- GRS/IBS provided an opportunity to Ohkay Owingeh to construct the bridge with their own work force, and gain valuable experience in this type of work.
- Provided for employment opportunities and professional growth for staff from within the pueblo.

Ohkay Owingeh expected to realize many of the documented benefits of GRS and PBES. We experienced both cost and time savings by using these technologies. Conventional construction would need significant closure time and specialized equipment. Using the Design Engineer during the construction phase for Construction Management and Inspection also provided efficiency in the installation since issues could be resolved on-site rather than coordinating with a third party for clarification/direction. The bridge design allowed us to build with common equipment and local staff from the Pueblo's crew. Specifically the GRS technology provided employment opportunities to qualified tribal members and helped increase the skill level of those employees.

Ohkay Owingeh personnel had successfully previously completed construction of two related projects. The first was reconstruction of a 0.9 mile roadway that was experiencing severe flooding, the second was replacement of an irrigation crossing with the installation of a culvert pipe and cast in place concrete headwalls. The personnel skill level was fitting for the installation of the GRS-IBS system. The use of conventional cast in place abutment construction would have eliminated the opportunity for force account work, due to its complexity with reinforcement and means and methods of construction. The use of GRS accommodated a short time frame for construction and provided the opportunity to move to the superstructure prior the start of the monsoonal flows the arroyo historically experienced.

Performance goals and measures for this project:

Goal: <u>Reduction of construction time</u>

Measure: Length of construction time measured in days.

Result: The construction was accomplished within a 2-month period which was less than the 4 1/2-month period that would be required under conventional construction methods.

Goal: Reduce project cost

Measure: Total cost of design, fabrication, delivery and construction will be compared with original estimate for cast in place construction.
The construction means and methods undertaken by the crew allowed for recycling of materials such as base course, and the concrete foundation for the existing box culvert crossing which reduced the need for import of new materials and reduced the overall construction cost of the project.

Result: The GRS/IBS bridge system cost less than half of a conventional bridge. In addition, the labor cost utilizing the Ohkay Owingeh Road Crew resulted in approximately half the estimated labor cost using an outside contractor to build the GRS-IBS Bridge System.

Goal: Ensure Pueblo crew has appropriate training for construction

Measure: In person or web training session provided to crew prior to construction.

Result: The Pueblo's Civil Engineer, the Road Crew, and Planning Manager attended the GRS demonstration at the Kaw Nation, OK in 2014.
The Road Crew and Planning Manager attended training at FHWA in Denver at the beginning of 2015 for GRS/IBS.
In 2013, the Road Crew completed the Road Scholar Program – "Plan Reading".
Crew Members have a CDL and have completed the Heavy Equipment Operators Training Course.
The Construction Team read and studied the Interim Guidelines prior to starting construction.
The Construction Team watched the EDC GRS-IBS you tube Video prior to starting construction..
The Crane company used for the movement of the superstructure came out a day early and provided training and crane certification for the construction team.

DATA COLLECTION AND ANALYSIS

Performance measures consistent with the project goals were jointly established for this project by Ohkay Owingeh and FHWA to qualify, not to quantify, the effectiveness of the innovation to inform the AID Demonstration program in working toward best practices, programmatic performance measures, and future decision making guidelines.

Data was collected to determine the impact of using GRS/IBS on the White Swan Bridge Replacement Project to increase safety, and monitor schedule, cost, quality and demonstrate the ability to:

- Achieve a safer environment for the traveling public and workers
- Reduce overall project delivery time and associated costs
- Reduce life cycle costs through producing a high-quality project
- Reduce impacts to the traveling public and project abutters
- Satisfy the needs and desires of our customers

This section discusses how Ohkay Owingeh established baseline criteria, monitored and recorded data during the implementation of the innovation, and analyzed and assessed the results for each of the performance measures related to these focus areas.

SAFETY

Ohkay Owingeh is always concerned with the safety of both the workers delivering the project and the users of our infrastructure during construction.

There were no incidents or injuries to workers and inspectors during construction. We believe this is primarily due to the fact that daily safety meetings were conducted at the beginning of the workday that addressed the work process for the day and kept awareness as a forefront in the construction process. Even when sub-contractors were brought in for installation of the bridge beams and paving, a pre-installation safety meeting was held with all present to make sure that all involved understood the process of installation was to be undertaken and the proper means for communication during that process.

SCHEDULE

Streamlining the project delivery process results in earlier overall project completion. This in turn provides greater service to our end users sooner. The use of GRS/IBS allowed for a reduction of construction time by approximately 2 ½ months over the method traditionally employed by Ohkay Owingeh to deliver a comparable project. Since the pueblo usually utilizes a design/bid/build process. However, by making use of GRS/IBS for this project, not only were we were able to realize a savings of 2 ½ months, the roadway was not closed for a longer duration. White Swan Road is an arterial roadway that also serves the community north of Ohkay

Owingeh. The detour route utilized for the project created an additional 3-mile route for those residents north of the bridge, thus the impact to those was also minimized.

There is also a financial component of time. With few exceptions the purchasing power of today's money is greater than the purchasing power of the same amount in the future due to the effects of inflation; materials, fuel, labor, equipment, and supplies will generally cost more in the future than they do today.

COST

A traditional project of similar scope and scale delivered using our traditional methods was estimated to cost $1,000,000.00. The Design Engineer estimated that the use of GRS/IBS would result in a cost of $484,726.00. The as-built construction cost was $419,331.26 which resulted in a savings of $580,668.74 over conventional methods.

QUALITY

As previously discussed, using traditional project delivery techniques Ohkay Owingeh would have utilized a design, bid, build system. However, through the use of this innovation we were able to utilize force account work for the installation which allowed direct purchase of materials from material suppliers without markup, closer coordination in the project schedule, and allowed a shorter construction schedule while meeting or exceeding the quality of construction. This method of construction allowed for a higher level of quality control, in depth knowledge of the construction means and methods, and a fuller understanding of the bridge construction for future maintenance requirements, simply because the same crew that will maintain the bridge also constructed it. There was a fully vested interest in the quality of construction.

USER COSTS

Generally, the three categories of user costs used in an economic/life cycle cost analysis are vehicle operating costs (VOC), delay costs, and safety-related costs/crash costs.
The impacts to the road users, though often underrepresented, are not to be neglected. Generally, user costs are categorized by delay costs, vehicle operating costs, and safety-related costs which incorporate numerous factors including fuel usage, vehicle emissions, distance traveled, point-to-point travel time, accelerated degradation of detour facilities, decreased levels of service along detour routes, and the viability of alternate routes for non-motorized users.

Since this bridge also serves a community outside of the boundaries of the pueblo, quantifying life cycle costs, vehicle operating costs, etc is a complex process and was not developed for this project. What is key is that by the use of GRS/IBS impacts to adjacent residents and businesses were lessened.

RECOMMENDATIONS AND IMPLEMENTATION

RECOMMENDATIONS

Ohkay Owingeh determined from the results of our data analysis and sense of satisfaction from the facility users that the use of a Force Account construction method in conjunction with GRS/IBS for the White Swan Bridge Replacement Process was successful. We propose adopting more Force Account construction methods into our standard operating procedures where applicable.

We believe that there are some areas of the GRS/IBS manual that need more detail. For example the process and method for installation of the foundation system was not completely clear, and if FHWA staff had not been present for the first installation, this could have caused much confusion and delay. Some of means and methods of construction should be shared as a guide for use by future installers.

STATUS OF IMPLEMENTATION AND ADOPTION

Since the completion of the White Swan Bridge Replacement using Force Account construction, Ohkay Owingeh has undertaken discussion with FHWA staff to identify what future projects that are identified in the Pueblo's TIP could use the same construction method.

Figure 4. Photo. Project area before.

Figure 5. Photo. Project area after.

TECHNOLOGY TRANSFER

Ohkay Owingeh shared two powerpoint presentations on lessons learned and successes from the use of this program. The Power Point presentation is attached.

September 15, 2015-FHWA-Every Day Counts (EDC)- "Geosynthetic Reinforced Soil-Integrated Bridge System (GRS-IBS)". The audience was State DOT Personnel.

September 30, 2015- FLH Innovation Office- "Design and Build your own GRS-IBS".
The audience was Federal Land Management Agencies, local counties, and other Tribal Nations.

OHKAY OWINGEH

WHITE SWAN BRIDGE

GRS-IBS BRIDGE SYSTEM

Project Overview

- White Swan Bridge is located in a residential neighborhood of Ohkay Owingeh
- Skew was the major reason for flooding
- White Swan Bridge is over one of the largest drainage basins in Ohkay Owingeh

White Swan Bridge Prior to Construction

Project Overview

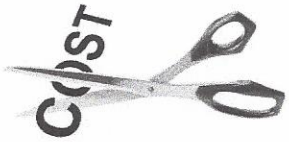
- The Bridge had a sufficiency rating of 65.80 based on the bridge evaluation performed by BIA in February 2010.
- Although the sufficiency rating would normally justify funding for rehab; the Tribal Council was unanimously in favor of installing the GRS/IBS Bridge System to ensure longevity of the bridge

Project Cost

- $200,000 - Accelerated Innovation Deployment (AID) Demonstration Grant- FHWA (Contact: Victoria Peters)
- $284,706 - FHWA Bridge Replacement Program
- $484,706 - Total Project Budget
- $65,374.74 - Project Balance
- $419,331.26 - Total Project Cost (13% under budget)

Cost Savings – Construction

- Conventional Bridge - $1,000,000 (overall engineers estimate)
- GRS/IBS Bridge System - $419,331.26
- Total Cost Savings - $580,668.74



Cost Savings
Personnel – Forced Account

- $105,000 - Estimated Contractual Cost for outside contractor to build the GRS-IBS Bridge System
- $52,103 - Ohkay Owingeh Road Crew actual labor costs for forced account
- **$52,897** - Total labor cost savings by utilizing forced account

Why Did Ohkay Owingeh Consider the GRS-IBS?

- The Tribal Council wanted a bridge replacement to ensure a long-term solution for the safety of roadway users
- Reduction of Construction Time - The GRS-IBS bridge system was completed in a two month period versus a 4 ½ month timeframe for a conventional bridge
- Reduce Project Costs - The GRS-IBS bridge system cost was less than half of a conventional bridge

FUNDING

- Through collaboration with FHWA, the Pueblo worked with the EDC Exchange to apply for the AID Demonstration grant
- Through collaboration with our Tribal Transportation Program (TTP) Coordinator, we were able to apply for the FHWA bridge program and partner the two grants to complete the project

SCOUR ANALYSIS

We performed the evaluation to determine whether there was a potential for live-bed or clear water scour and determined that if there was scour occurring it was Live Bed Scour.

SCOUR ANALYSIS

- It was further determined that it was contraction scour and computed that a minimum of 1 foot of scour protection was needed at the bridge Abutments
- The floor of the existing box culverts was left in place and concrete cloth added to the exposed areas

Abutment and Superstructure Design

- SUPERSTRUCTURE- The existing bridge had four 4'x10' culverts in a battery. During design when the scour analysis was conducted, we determined that there would be sediment deposit more so than scour at the location of the bridge.
- It was determined that a single span bridge would be more appropriate to allow the water to flow more freely under the bridge and minimize settlement deposit.
- ABUTMENTS- The GRS abutments allowed us to maximize the effectiveness of the installation of the bridge superstructure.
- The abutments used required less excavation than using a conventional cast-in-place abutment and footing system, and also eliminated the need for building a concrete beam seat.

Building the Abutments - GRS

Beam Installation - IBS

Beam Installation

Project Completed!

Grand Opening was held August 5, 2015

Training

- The Pueblo's Civil Engineer, the Road Crew, and Planning Manager attended the GRS demonstration at the Kaw Nation, OK in 2014
- The Road Crew and Planning Manager attended a training at FHWA in Denver at the beginning of 2015 for GRS/IBS
- In 2013, the Road Crew completed the Road Scholar Program - "Plan Reading"
- Crew Members have a CDL and have completed the Heavy Equipment Operators Training Course

Planning, Design and Construction Tips

- Keep FHWA TTP Coordinator and Engineer involved even before applying for the AID demonstration grant for a GRS/IBS Bridge System.
- The FHWA Engineer has completed several of the bridge systems and will provide valuable input in the design.
- Coordinate exchanges with neighboring Tribes!
- Get excited about utilizing your existing crew! The Project will be a success and will build capacity in your program!

Lessons Learned

- Order pre-cast concrete beams well in advance! The beams were ordered two months prior to scheduled installation and were delivered five weeks late. This cost a significant increase in the cost of the cranes (change order was $9,200) and also caused a longer than necessary road closure

Goals Were Met - Success!!!

- The overall long term goal is to provide safe roads for all roadway users
- The installation of the GRS-IBS bridge system has allowed Ohkay Owingeh a long-term solution for safety on the White Swan Bridge.
- Our Road Crew has valuable skills and our program has built capacity in our program