Sections


FDE


Benefits of
Modular
Precast Dam
Construction

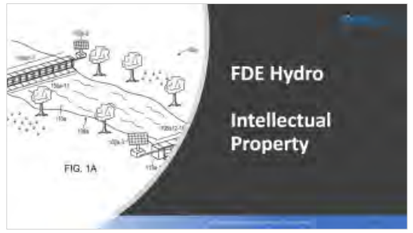


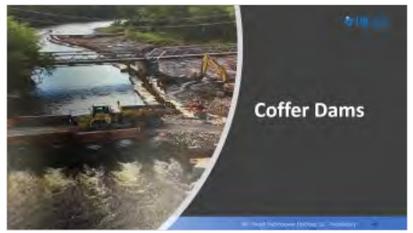
FIG. 1A
FDE Hydro
Intellectual
Property


French Dam
Test with
Research and
Funding from:
U.S. Department of Energy's Water Power
Technologies Office (DOE WPTO)
supported by Oak Ridge National
Laboratory (ORNL)


Water Stop


Linkage and
Bolts

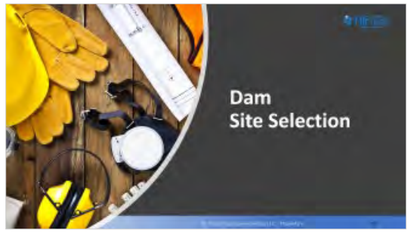

Rock Bolts

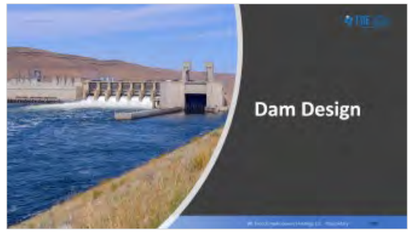

Coffer Dams


Precast
Structures


Designing
Modular
Precast
Dams and Powerhouses


Precast
Finishes


Dam
Site Selection


Dam Design


Site Prep
Coffer Dam and Dry working area
Access to work area


EPC to Commissioning

FDE | FRENCH DEVELOPMENT ENTERPRISES

MODULAR HYDRO SOLUTIONS

Means and Methods Overview of Precast Hydro

Concept to Commissioning

NDA & Patents

The following information is being provided to you or your company under NDA with:

W.L. French Hydropower Holdings LLC d/b/a FDE Hydro

INFORMATION CONTAINED HEREIN APPLY TO WL FRENCH HYDROPOWER HOLDINGS "FAMILY OF PATENTS"

FORWARD LOOKING STATEMENT: THIS PRESENTATION CONTAINS FORWARD-LOOKING STATEMENTS WITHIN THE MEANING OF THE PRIVATE SECURITIES LITIGATION REFORM ACT OF 1995. FORWARD-LOOKING STATEMENTS ARE OFTEN, BUT NOT ALWAYS, IDENTIFIED USING WORDS SUCH AS "ANTICIPATE", "BELIEVE", "EXPECT", "PLAN", "INTEND", "PROJECT", "MAY", "WILL", "SHOULD", "COULD", OR SIMILAR WORDS SUGGESTING FUTURE OUTCOMES OR OUTLOOKS. THERE ARE NUMEROUS RISKS AND MARKET CONDITIONS THAT MAY CAUSE THE OUTCOME TO DIFFER SUBSTANTIALLY FOR THAT SUGGESTED BELOW. THESE FORWARD-LOOKING STATEMENTS INCLUDE, BUT ARE NOT LIMITED TO, STATEMENTS OF EXPECTATIONS OF OR ASSUMPTIONS ABOUT STRATEGIC ACTIONS, OBJECTIVES, EXPECTATIONS, INTENTIONS, ENERGY MARKET CONDITIONS, PRODUCT PRODUCTION RATES, FINANCIAL AND OPERATIONAL PERFORMANCE, REVENUE AND EARNINGS GROWTH AND PROFITABILITY AND EARNINGS RESULTS.

Return to Summary

FDE FRENCH DEVELOPMENT ENTERPRISES
MODULAR HYDRO SOLUTIONS

Benefits of Modular Precast Dam Construction

Benefits of Modular Precast

FDE PATENTED TECHNOLOGIES

Modular Precast Concrete Civil Structures (Multiple System Configurations)

9 Patents US, CANADA, BRAZIL and EUROPE FDE Hydro has **exclusive rights to all North America**

$1.6 M US Department of Energy Grant for French Dam Proof of Concept rapidly deployable hydropower asset.

BENEFITS DEMONSTRATED Project Risk Lowered

Civil Construction Cost Reduction	**60%**
Dam Longevity **2X** Improvement	**100 yrs.**
Project Construction Time Reduction	**43%**
Reduces total labor force & hazardous labor force hours	**60%**
Lessens Construction Liability Window	**40% less time on site**
Reduce Environmental Exposure and Impact	**40% less time on site**
Reduce Climate-Induced cost overruns	**Controlled Environment**
Predictable Civil Construction Means and Methods	**Stakeholder Risk Reduction**

SUPPLY CHAIN Outstanding business relationships

- Tier 1 Precast Concrete Manufacturers
- Tier 1 Civil Engineering Firms
- Modular Hydro Turbines and System Interconnects
- Top project partners CM'S , GC'S & Hydro Developers

Modular Precast Hydro Applications

- Small to Medium Head Dams (New, Rehab and Refurb)
- Modular Pumped Storage
- Water Resource Management
- Fish Passages
- Secure Microgrids

FUTURE MANDATE FOR MODULAR

US GOVERNMENT AGENCIES: USACE, DOE, BUREAU OF RECLAMATION, FEMA, EPA

W.L. French Hydropower Holdings LLC.

W.L. French Hydropower Holdings LLC d/b/a FDE Hydro,

Holds 9 Active Patents on Modular Precast Solutions protecting unique Civil structures for hydropower and water structures.

The Patents cover all shapes and sizes of precast

With Application to:

- Dam Impoundments
- Precast Modular Powerhouses
- Conduits
- Modular Fish Passage w/ Merck Animal Health’s Hyper InfusiO2n Solutions
- Modular Pump Storage Hydro (m-PSH)
- Hydro micro-Grids

Precast vs CIP

Trading CIP with Precast

Why you should use precast technology on your next large-scale construction project

W.L. French Precast, Modular Construction for Water Impoundment Infrastructure

White Paper 2017 Precast, Modular Construction for Water Impoundment Infrastructure

100 Reasons for Precast (slide 69 discusses life)

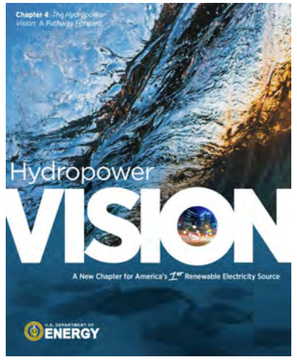
100 Reasons for Precast

Hydropower Vision Road Map

DOE Water Power Technologies Office

Scalable Modular Civil

Water Power Technologies Office Hydropower Vision Chapter 4: The Hydropower Vision Roadmap: A Pathway Forward JULY 21, 2016
<click to open>



4.1 Technology Advancement
Action 4.1.1.2 Develop scalable modular civil structure designs.
Pages 356-364
<click to open>

FDE Hydro addresses all

ACTION 4.1.1: *Develop Next-Generation Hydropower Technologies.*

ACTION 4.1.1: Develop Next-Generation Hydropower Technologies
The next generation of hydropower and PSH technologies must be able to realize high efficiencies and enhanced performance, while minimizing environmental footprint and lowering capital costs.

Deliverable: New designs and approaches that will allow developers to tap into previously unrealized potential, while making hydropower more competitive with other generation resources.

Impact: Reduced costs and higher reliability.

Key Objectives: Optimization, Growth

Growth Sectors Addressed: Upgrades, NPD, Conduits, NSD, PSH

Timeframe: All actions in this area could commence immediately and simultaneously. Research is already underway by DOE in standard and modular designs (4.1.1.1 and 4.1.1.2), and components manufactured using advanced techniques and materials (4.1.1.3) already exist, but additional applications should continue to be explored. Research and development efforts in new design philosophies (4.1.1.4) will be ongoing and evolving to adapt to new markets, regulatory actions, and unrealized potential. While closed-loop PSH plants already exist, there are opportunities to explore non-conventional designs at perhaps smaller scales (4.1.1.5).

Action	Deliverable	Impact
Action 4.1.1.1 Standardize equipment components.	Standard equipment components that can be mass produced and assembled in a variety of packaged designs.	Reduced costs, expanded manufacturing capabilities, increased industry collaboration.
Action 4.1.1.2 Develop scalable modular civil structure designs.	Modular civil structure designs, manufacturing and implementation plans, database describing performance characteristics of modular designs.	Reduced construction costs, reduced lead time on project construction.
Action 4.1.1.3 Implement additive manufacturing techniques and advanced materials.	Stronger and lighter hydropower components that are more resistant to corrosion and that can be manufactured and installed quickly.	Faster production of turbine components, lower project and maintenance costs.
Action 4.1.1.4 Explore alternative hydropower design philosophies.	Cost-benefit studies and technical reports documenting the feasibility of new design philosophies.	Reduced capital costs, potential deployment at previously unfeasible sites.
Action 4.1.1.5 Demonstrate potential and feasibility of innovative closed-loop PSH design concepts.	Reports and feasibility studies of innovative closed-loop PSH technologies, such as distributed closed-loop PSH systems.	Greater grid flexibility and storage capacity as a result of increased development of PSH.

eration Hydropower Technologies

357

Page 358
ACTION 4.1.1.2: Develop scalable modular civil structure designs.

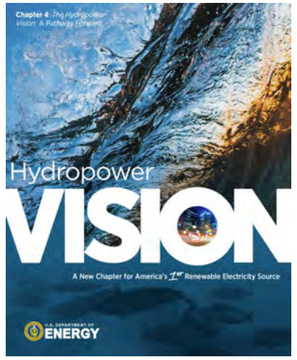
The term “modular” refers to precast, pre-assembled, and/or standardized civil structure components that would otherwise be site-customized in traditional hydropower design approaches. Development and implementation of innovative modular hydraulic structure and foundation concepts have the potential to transform existing designs and streamline construction to reduce overall costs. One goal of this action is to be able to initially develop projects under a least-cost methodology. After a project is on-line and generating revenue, the project owner could then further customize the equipment and operating features to suit their particular needs. For example, a developer may decide to install a turbine-generator unit at a non-powered dam that does not utilize the dam’s full hydroelectric potential. Once the project begins generating revenue, the developer can, through a license amendment or during relicensing, add an additional unit and generate more electricity using modular civil structures with minimal infrastructure costs.

Hydropower Vision Road Map

DOE Water Power Technologies Office

Fish passages & enhanced environmental performance

Water Power Technologies Office Hydropower Vision Chapter 4: The Hydropower Vision Roadmap: A Pathway Forward JULY 21, 2016
<click to open>



FDE Hydro addresses

4.1 Technology Advancement
ACTION 4.1.2: Enhance Environmental Performance of New and Existing Hydropower Technologies.
Pages 356-364
<click to open>

ACTION 4.1.2: Enhance Environmental Performance of New and Existing Hydropower Technologies

ACTION 4.1.2: Enhance Environmental Performance of New and Existing Hydropower Technologies
Environmental performance (e.g., fish survival rates, water quality) of hydropower and PSH technologies is a significant concern of all parties and should thus be evaluated and, when necessary, modified to ensure continual improvement.

Deliverables: Methodologies and metrics to measure environmental performance of hydropower components that are applied during development, deployment, and evaluation of hydropower technologies.

Impact: Improved environmental performance due to adaptations of hydropower technology in response to environmental performance findings; acceptance and support from the stakeholder community for individual facilities or projects, resulting in increased deployment of new hydropower technologies.

Key Objectives: Optimization, Growth, Sustainability

Growth Sectors Addressed: Upgrades, NPD, Conduits, NSD, PSH

Timeframe: Actions to assess environmental performance through the development of methodologies (4.1.2.1) and biologically-based designs and evaluation techniques (4.1.2.2) are underway. Findings from the assessments can sequentially be used to identify potential modifications for specific technologies to enhance their environmental performance (4.1.2.3). Baseline studies of environmental metrics (4.1.2.4) are already being performed, but these will be refined with the deliverables from 4.1.2.1 and 4.1.2.2. The existing fleet could be continuously modernized with the latest enhancement technologies to ensure environmental sustainability of hydropower projects (4.1.2.5).

Action	Deliverable	Impact
Action 4.1.2.1 Develop metrics, monitoring, and measurement methodologies for environmental stressors.	Metrics and testing methodologies for environmental stressors.	Improved characterization and quantification of environmental stressors.
Action 4.1.2.2 Develop and apply biologically-based design and evaluation techniques for hydropower components and associated water control facilities.	Biologically-based design and evaluation techniques for hydropower.	Greater prediction and evaluation of environmental performance of hydropower components and associated water control facilities.
Action 4.1.2.3 Apply environmental performance findings within an adaptive management process to prompt modifications to given hydropower technology.	Application of environmental performance findings to drive improvements in hydropower structures and operations.	Improved environmental performance of hydropower technologies.
Action 4.1.2.4 Compare environmental metrics before and after upgrades, new environmental requirements, or deployments at select example facilities to validate and communicate environmental performance improvements.	Comparisons of environmental performance for baseline and post-construction conditions.	Improved documentation and communication of environmental performance.
Action 4.1.2.5 Ensure that enhancing environmental performance is addressed within hydropower fleet modernization efforts.	Comparisons of environmental performance for baseline and post-construction conditions.	Improved documentation and communication of environmental performance.

Page 361
ACTION 4.1.2.5: Ensure that enhancing environmental performance is addressed within hydropower fleet modernization efforts.

Hydropower industry and researchers regularly carry out R&D efforts to develop innovative technologies that meet environmental objectives. This research takes into account factors such as environmental regulations, changing operating modes, and the effects of climate change. As hydropower owners and operators modernize facilities, equipment, and components, they can help ensure continued environmental compliance and stewardship at existing hydropower facilities by implementing the best available technologies to monitor and mitigate environmental impacts. Even as they do so, owners and operators must also consider the costs of such technologies and the effect of those costs on the viability of hydropower production at the facility. This is particularly important for older facilities that are at or near their relicensing periods, or that may have been designed under less stringent environmental protection regimes.

US Army Corps of Engineers Vision of Civil work 2020

FDE FRENCH DEVELOPMENT ENTERPRISES
MODULAR HYDRO SOLUTIONS

USACE Vision Civil work 2020		FDE Hydro Modular Precast Solution		
USACE Revolution 2020.pdf		Material	Design	Construction
Accelerating Project Delivery	Utilize innovative materials, construction practices, and design procedures. Expedite delivery of quality projects to improve performance, resilience, and reduce life cycle costs.	High quality precast materials with proven life and resiliency. Reduces maintenance and **life cycles costs**. Fabricated in a factory-controlled setting with quality inspection throughout the process.	Automated design methodology (Telka's software for precast) defines internal rebar structure, embedded hardpoints and structural connections. Design software plans staging, crane lifts, and	**Precast modules reduce the time in the water** Reduce or eliminated on site rebar or form construction. Fabricate the precast modules while prepping the site.
Transform Project Financing and Budgeting	Expand risk-informed decision making to the entire project life cycle to guide decisions and implement solutions faster. Improve acquisition by streamlining review and award processes, incorporating risk-based approaches, and encouraging alternative contract methods. Encourage all levels of the agency to delegate decision-making to streamline efforts and expedite project delivery. Implement recommendations to improve the Continuing Authorities Program by delegating decisions, increasing flexibilities, and streamlining delivery. Refine proposals to streamline and delegate Project Partnership Agreements and implement recommendations in 2020.	Reduce or eliminate fabrication risk Incoming material is received and inspected All precast concrete batch mixtures are exactly the same mixture and content per spec. Final produced modules our inspected at the factory prior to shipment to site, documentation available for agencies review prior to final build.	Complete design is reviewed before in factory fabrication begins. Use of materials will be optimized to reduce waste and control purchasing. Designs incorporate next generation means and methods	Significantly reduce risk from weather events. Full team coordination of module delivery, stage, crane lifts and final placements. All material (modules, linkages, seals) are coordinated for delivery to align with staging plan. Schedule process will streamline delivery. Modules Installed and bar coded for project coordination and production goals
Improve Permitting and Regulatory Reform	Provide training and tools and remove administrative barriers to further encourage our partners to take leadership roles with the completion of authorized studies and construction projects.	Automated mixing of material in the factory monitored by QA. Reduced the need for highly skilled labor in the field.	Precast moves highly trained teams out of the fields and to the factory	Lower risk construction

The French Modular Civil Solution was called by a Major Research Director
"A Disruptive Technology and the biggest innovation in water infrastructure and hydro power in 50-years"

Low Impact Hydropower Institute (LIHI)

Design your next project with LIHI in mind

Jan. 7, 2022 the Executive Directory review FDE Hydro's approach and commented.

> "Prospective research and development projects, such as the designs offered by French Development Enterprises LLC (FDE), have great potential to provide the new technologies we need to enable new hydropower development at existing dams. Innovative construction methods that can minimize the footprint and time of dam reconstruction, when necessary, will also reduce adverse environmental impacts."

Each design project is unique and will require individual approval by LIHI but stating with innovative technology such as FDE Hydro's modular precast solution is the future.

LIHI French Dam Letter 2022

Return to Summary

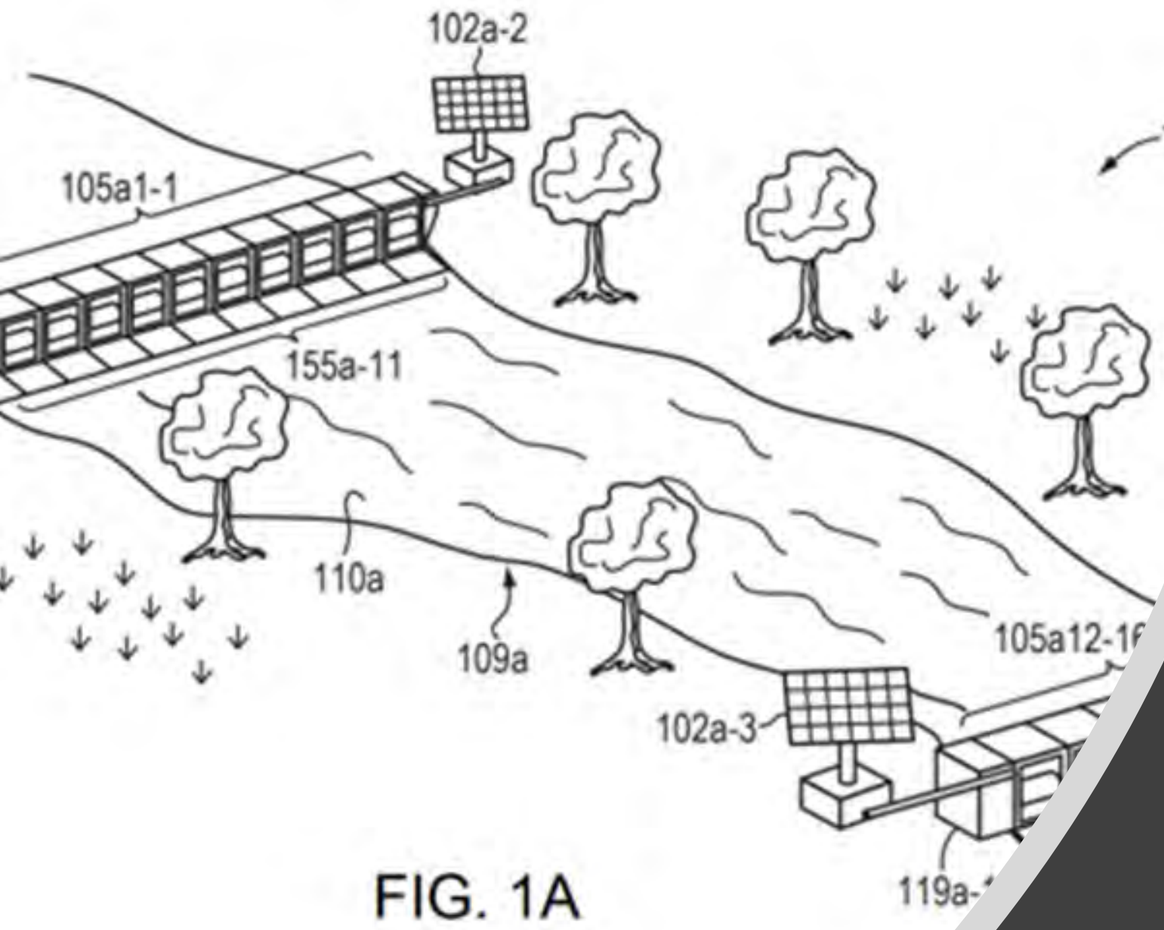
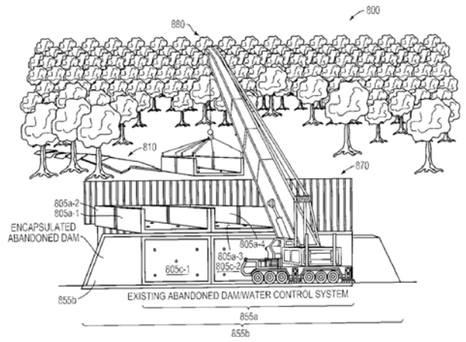


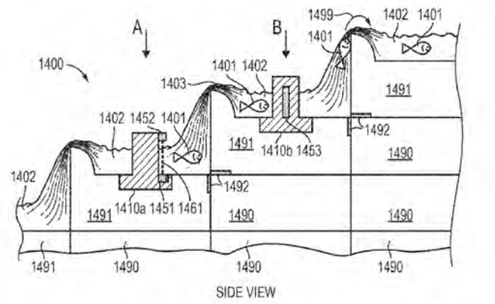
FIG. 1A

FDE Hydro

Intellectual Property

FDE Hydro IP Summary





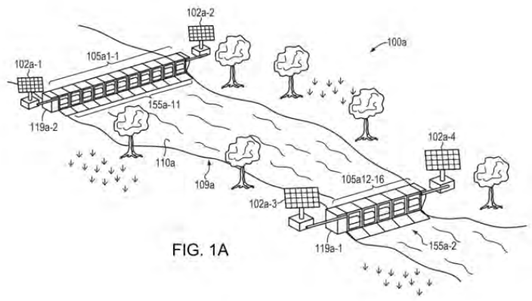
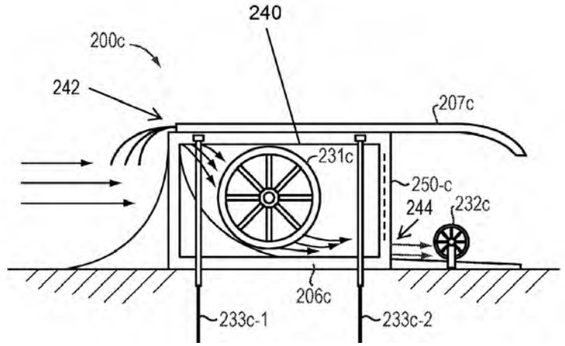


FIG. 1A



US PATENT – *"INTELLIGENT" HYDROELECTRIC DAM WITH POWER STORAGE (New Dams)*

CANADA PATENT – *RENEWABLE ENERGY SYSTEMS*

US PATENT – *"INTELLIGENT" HYDROELECTRIC DAM WITH POWER STORAGE (Powerhouse & Retrofit)*

US PATENT – *PRECAST DAM STRUCTURE WITH FLOWPATH*

US PATENT – *AQUATIC ANIMAL PASSAGE WITH COUNTER*

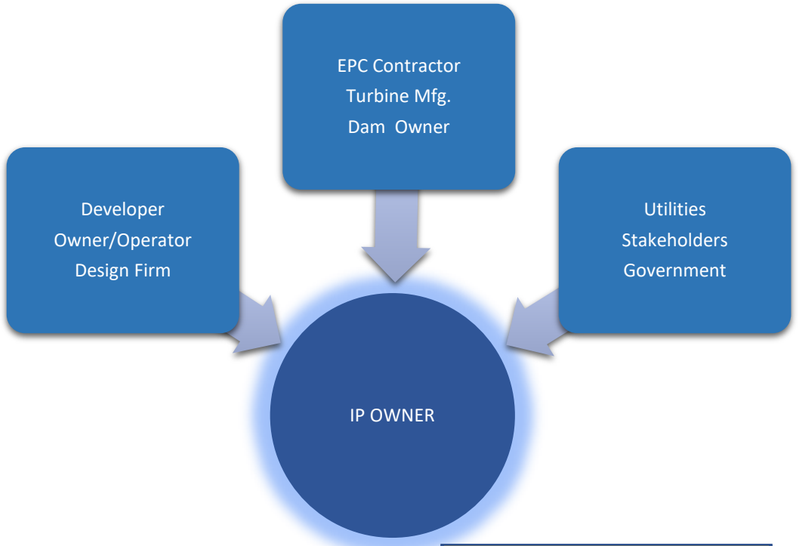
US PATENT ALLOWED – *MODULAR PRECAST PUMPED STORAGE HYDRO SYSTEM FOR POWER GENERATION*

CANADA PATENT – *RENEWABLE ENERGY SYSTEM – HYDRO*

BRAZIL PATENT – *RENEWABLE ENERGY SYSTEMS - HYDRO*

EUROPE PATENT PENDING – *"INTELLIGENT" HYDROELECTRIC DAM WITH POWER STORAGE*

DESIGNATED COUNTRIES: ALBANIA, AUSTRIA, BELGIUM, BULGARIA, CROATIA, CYPRUS, CZECH REPUBLIC, DENMARK, ESTONIA, FINLAND, FRANCE, GERMANY, GREECE, HUNGARY, ICELAND, IRELAND, ITALY, LATVIA, LIECHTENSTEIN, LITHUANIA, LUXEMBOURG, MACEDONIA, MALTA, MONACO, NETHERLANDS, NORWAY, POLAND, PORTUGAL, ROMANIA, SAN MARINO, SERBIA, SLOVAKIA, SLOVENIA, SPAIN, SWEDEN, SWITZERLAND, TURKEY, UK

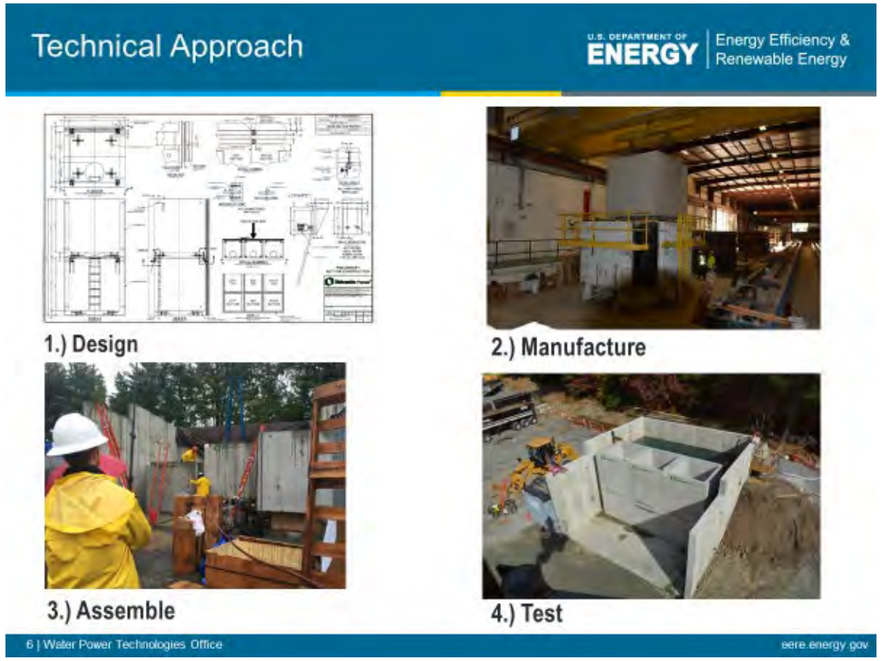


Return to Summary

French Dam Test with Research and Funding from:

U.S. Department of Energy's Water Power Technologies Office (DOE WPTO) supported by Oak Ridge National Laboratory (ORNL)

French Modular Impoundment FY17



French Dam Reports

French Dam - Working Platform Linkage @ Layout Information

French Dam - Civil Water Infrastructure Solutions

FDE Consultant Review

U.S. DOE peer review

Reports and Articles

Article from Concrete Technology Magazine 2017

(see report section of sharepoint)_

2017 Concrete Technology Magazine

FDE DOE Final Report (see report section of sharepoint)_

French Modular Impoundment

Deliverable 6.4: Final Cost and Performance Evaluation

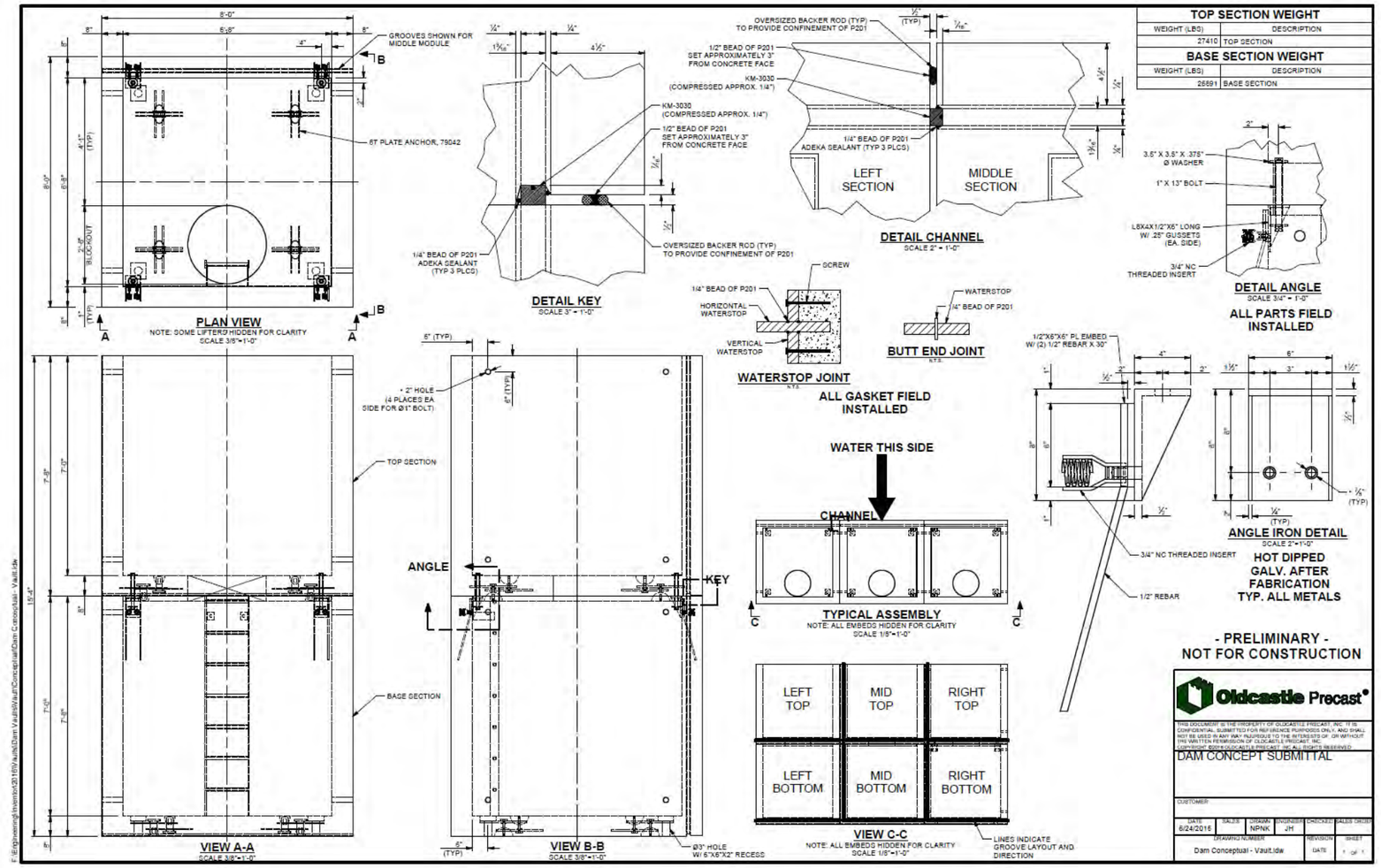
DOE Award: DE-EE0007244

Project Period: 12/01/15 – 12/31/16

FDE - DOE Final Report

Drawing of French Dam

with Linkages and Waterstop



French Dam Module Fabrication

Any Size / Any Shape

Interlocking keyways and water stop seating channels molded into module at fabrication

Openings and Man access portals formed in the molding process

Reinforcing bar sized and spacing to accommodate specific application

Concrete strength (PSI) can be tailored to the site and application specification

Work Platform Linkage Layout

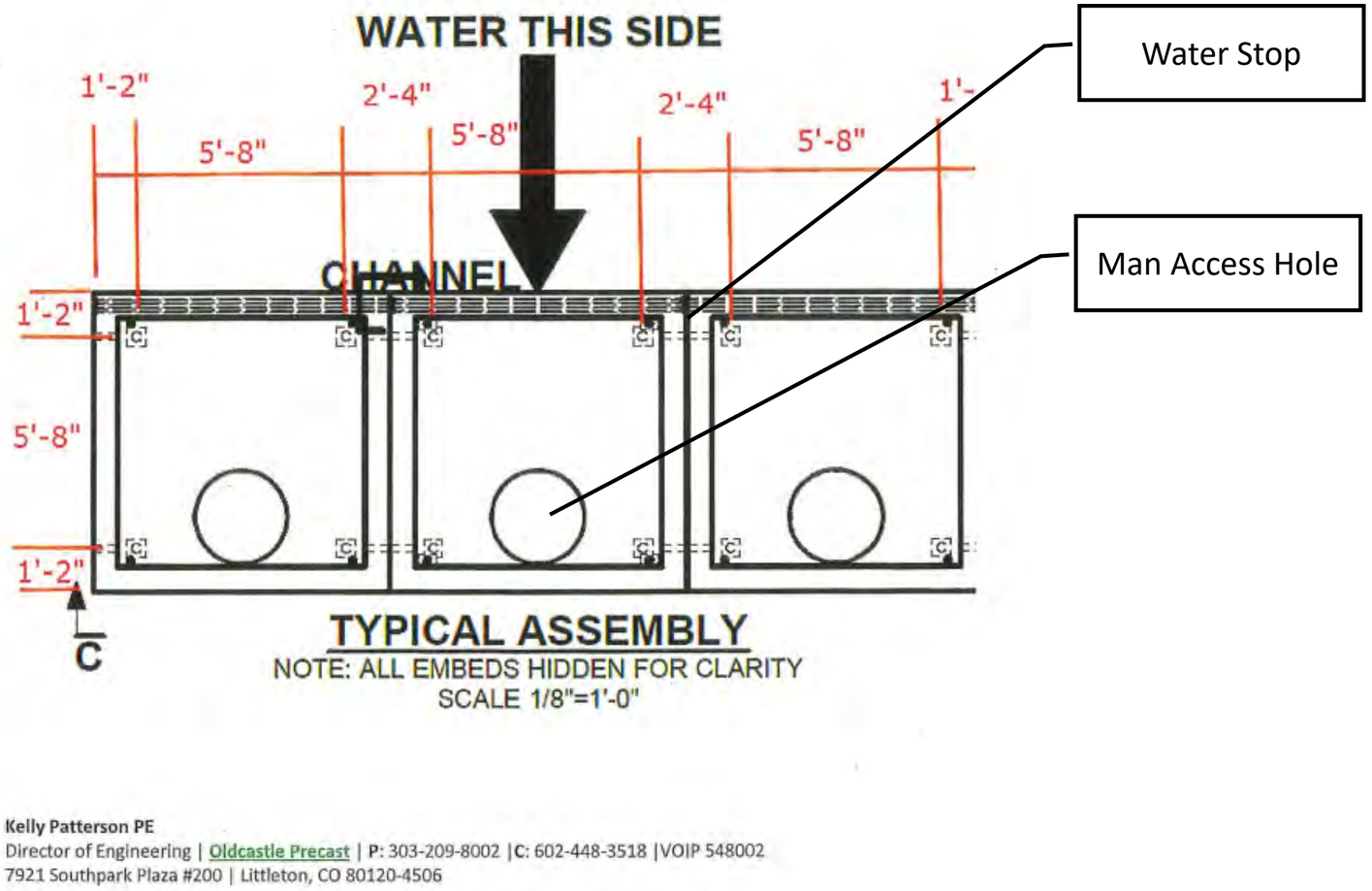
Top-down view of French Dam

Layout of the work platform

Linkage bolts positions are in the red dimensions and are within 1/16 inch of true position determined using a Total Station.

Layout the work platform using a Total Station

A total station is **an optical surveying instrument that uses electronics to calculate angles and distances**. It combines the functions of a theodolite with that of a transit level and electronic distance meter (EDM).



Kelly Patterson PE
Director of Engineering | Oldcastle Precast | P: 303-209-8002 |C: 602-448-3518 |VOIP 548002
7921 Southpark Plaza #200 | Littleton, CO 80120-4506

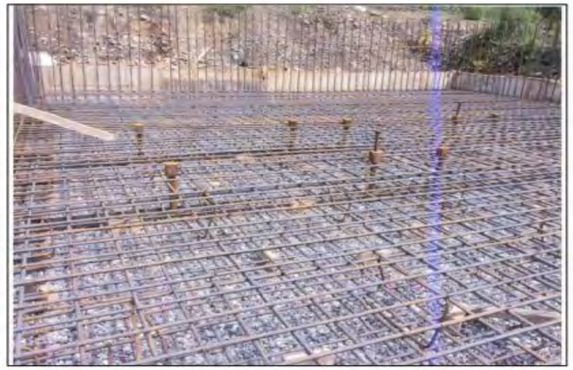
Work Platform Hardware

Custom hardware precision fabricated by recognized machining center
Bolts sized site specific requirements, and engineer identified standards

Assembly Starts with Strong Working Platform

1

2



3

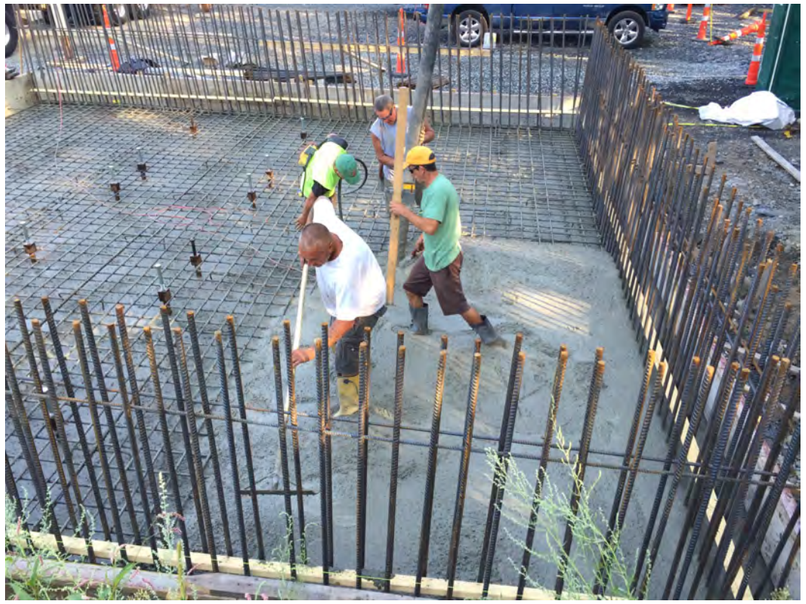
4

5

6

1. PRE–FABRICATED UNDER SLAB LINKAGE
2. WORKING SLAB FORMED WITH UNDER SLAB LINKAGE SET IN PLACE USING GPS
3. REINFORCING ROD IS PLACED AND READY FOR CONCRETE
4. CONCRETE SLAB BEING POURED AND FINISHED
5. WORKING SLAB COMPLETE WITH BOLT LINKAGE IN PLACE
6. AT FINAL REVIEW BEFORE PRECAST MODULAR INSTALLATION. ALL BOLT LINKAGE WAS "DEAD ON"

Videos of Working Platform Pour



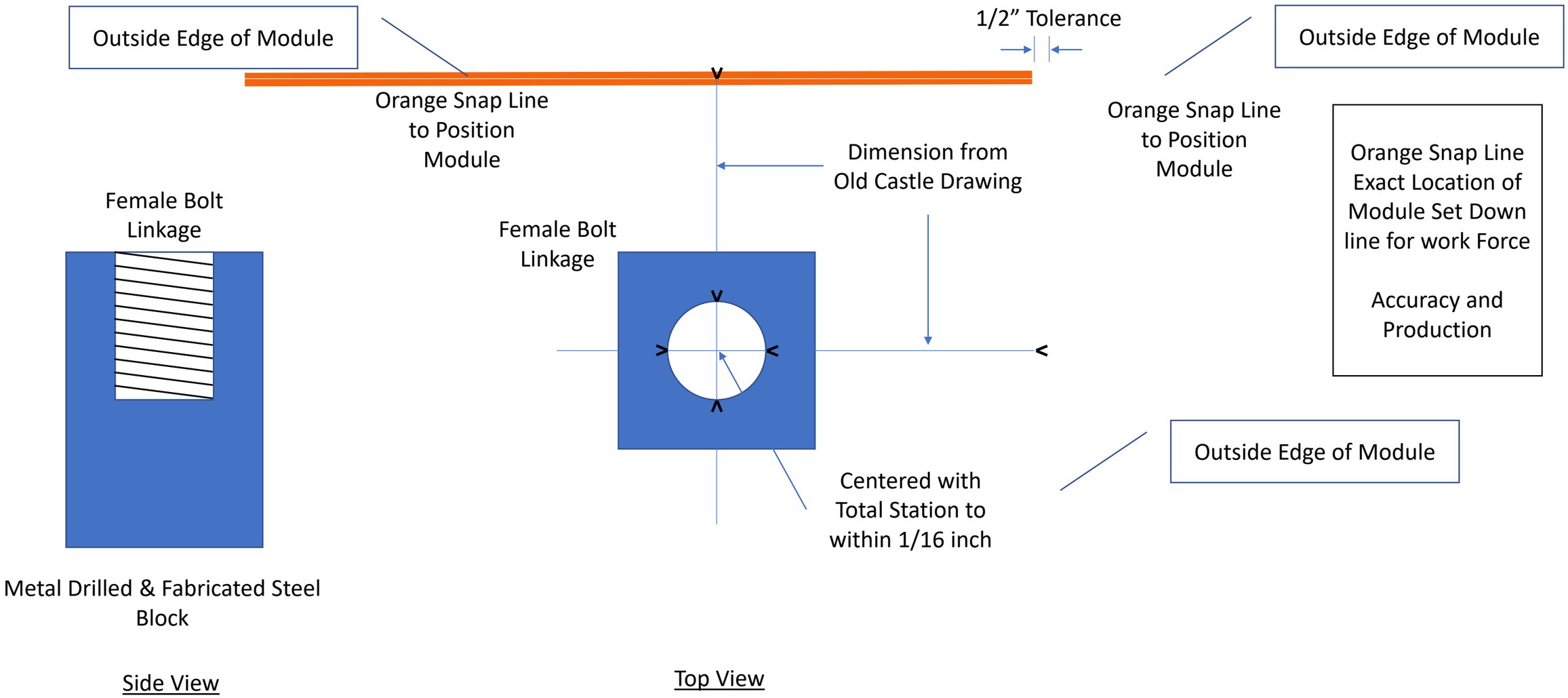
Please watch our videos on the web page just below this presentation

Video 1 start of Platform Pour

Video 2 continue Platform Pour

Video 3 Continue of Platform Pour

Bolt Position
(Not to Scale)



Precast Module Layout is Critical

French Dam Test

Assembled in 3.5 hours in Extreme Weather

French Dam Test

1

2

3

4

5

6

1.) TEST TANK – WORKING SLAB
2.) OFF LOADING DAM MODULES
3.) STAGING DAM MODULES – READY FOR DEPLOYMENT
4.) FRENCH DAM DOWN STREAM VIEW
5.) FRENCH DAM UP STREAM VIEW – HOLDING 30,000 GALLONS
6.) FRENCH DAM HOLDING 30,000 GALLONS – WINTER CONDITIONS

French Dam Test, Decommissioning

Reconfigure the French Dam to Horizontal Dam and Levee Configuration

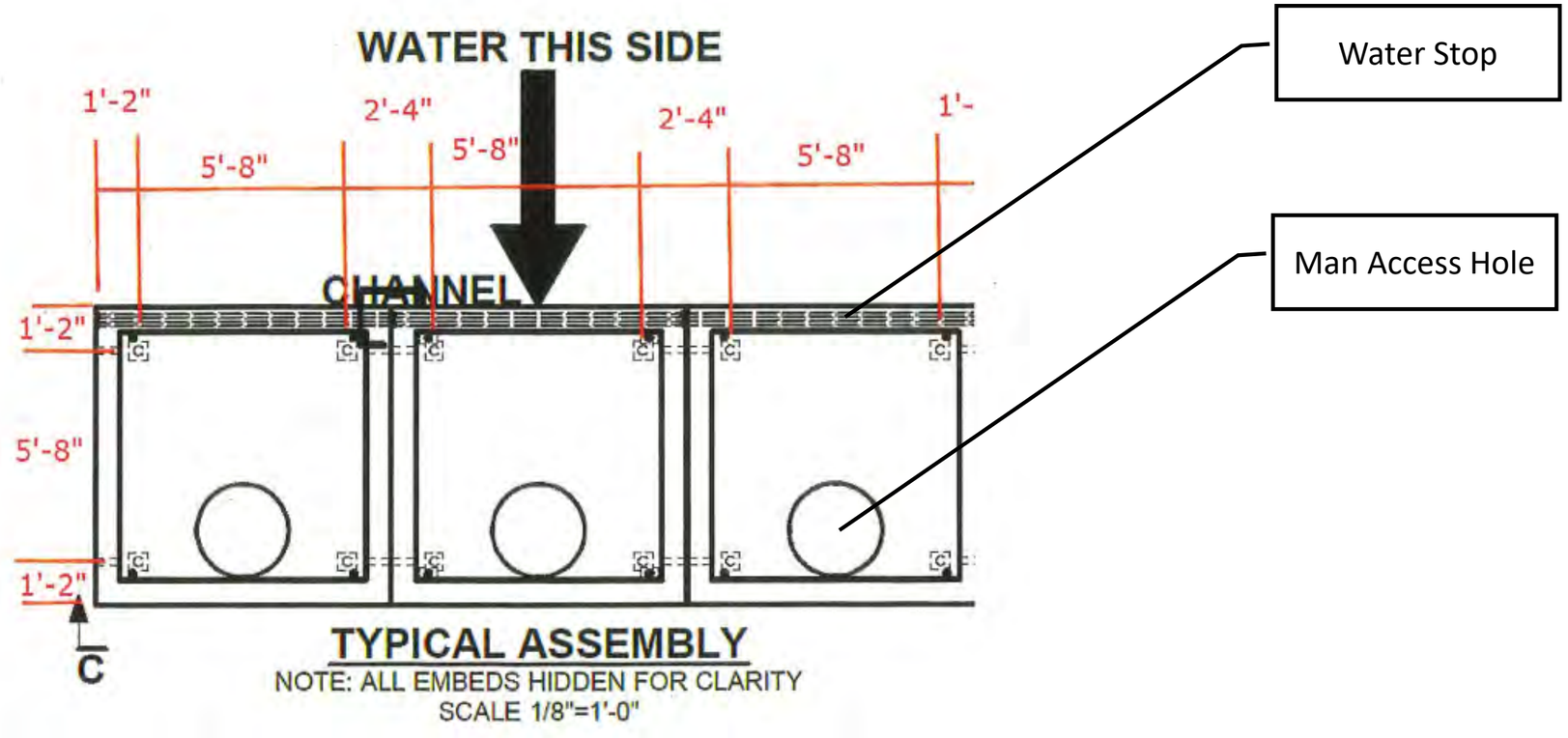
Decommissioned from test configuration in 1.5 hours

Return to Summary

Water Stop

Water Stop Positioned on Waterside of Dam

Top-down view of French Dam



TYPICAL ASSEMBLY

NOTE: ALL EMBEDS HIDDEN FOR CLARITY

SCALE 1/8"=1'-0"

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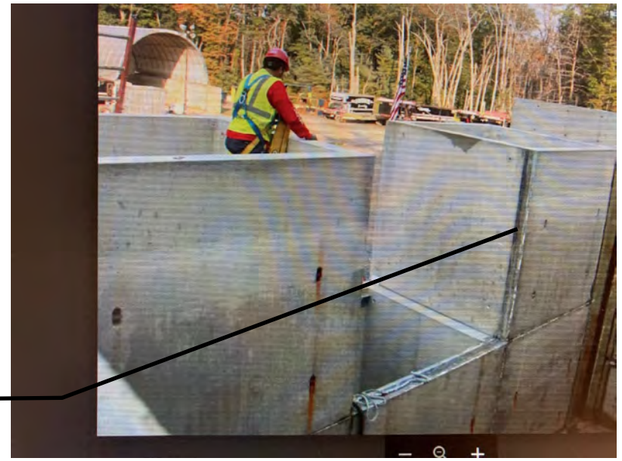
7921 Southpark Plaza #200 | Littleton, CO 80120-4506

Precast Water Stop Keyway

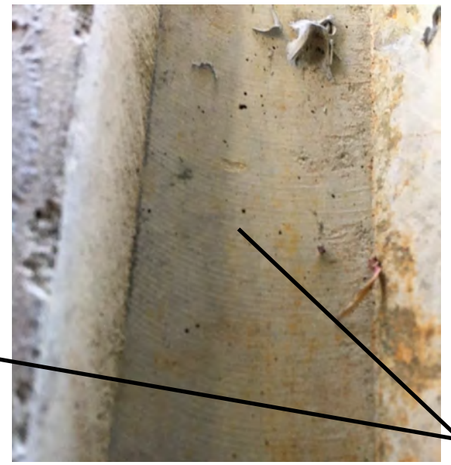
Slots in precast modules to accommodate water stop

Slots designed into precast modules to accommodate water stop

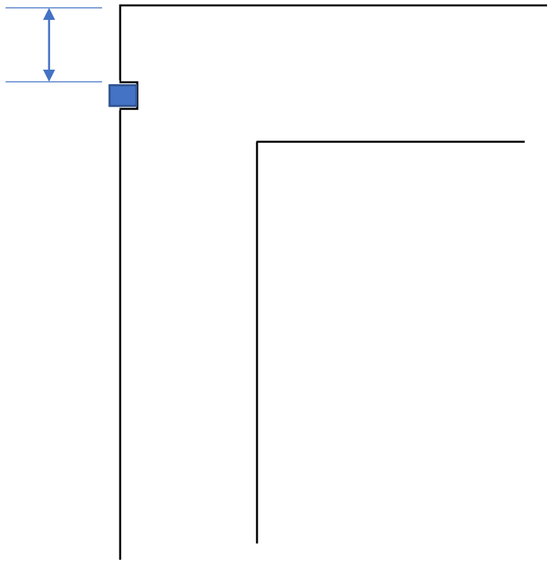


Horizontal and Vertical slots in precast modules to accommodate water stop

Design of Expandable Water Stop



Critical dimension to prevent cracking during seal expansion



Slots designed into precast modules to accommodate water stop

Detail of French Dam Water Stop Keyways, and Water Stop

Return to Summary

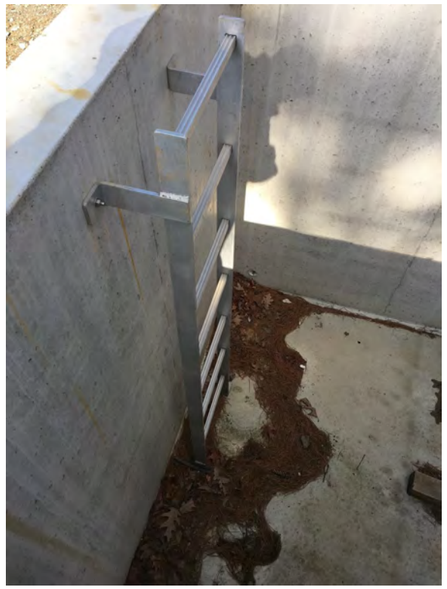
Linkage and Bolts

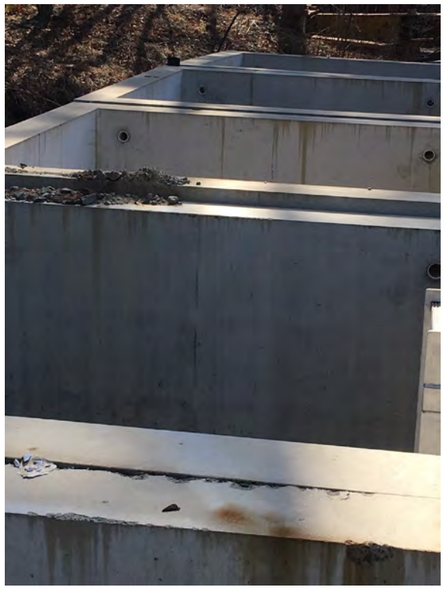
Details of French Dam Modules & Linkage

Module Position Marked on Work platform
To improve assembly

Internal connections to link upper modules

Internal equipment installed in factory





Video French Dam Module & Linkage

Please watch our videos on the web page just below this presentation

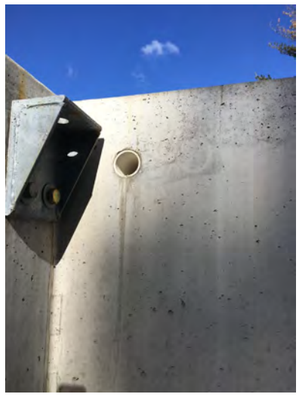
Detail of the French Dam

Module formed to receive square shim

Module formed with integrated lift points

Horizontal linkage holes formed at factory

Access formed in module at factory



Linkage approach to connecting precast modules

Size and strength determined by site requirements

Standard Precast connection to be sized based on site and project spec

Horizontal keyway for waterstop

Heavy duty integrated linkage

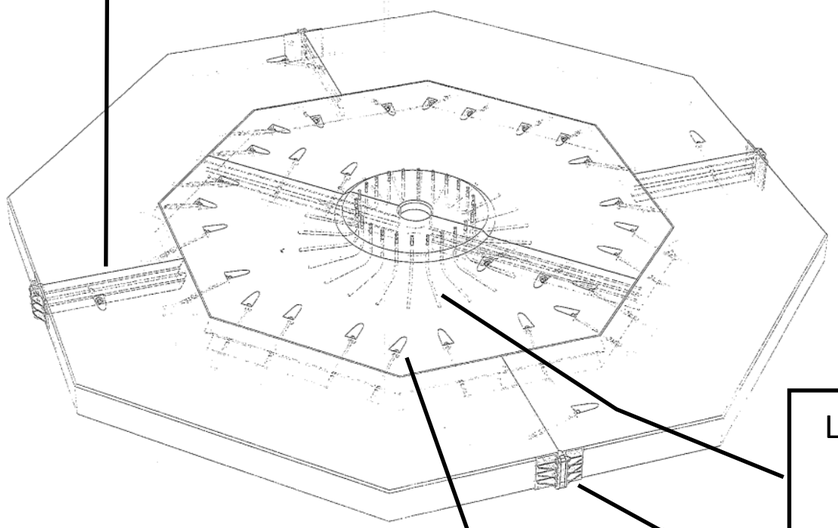
4.5 inch keyway for molded in the module for assembly

Heavy duty dowel pins

Cast-in-Place to precast column or beam

Heavy Gage Linkage
Connecting precision precast modules

Heavy Gage Linkage's Structural web embedded deep into the precast to hold linkages



Very tight tolerances between modular elements

Linkages designed with shims to allow for tight tolerances

L-shaped bolts embedded deep into the precast to hold equipment

Radial Bolts Connecting center precast to outer elements

Heavy Gage Linkage Connecting large precast

Prestress Cables

Size and Strength based on design requirements

Prestress Cables maybe incorporated into Precast to increase tensile strength

Return to Summary

Rock Bolts

Create Designs to Connect with the Site Bed Rock

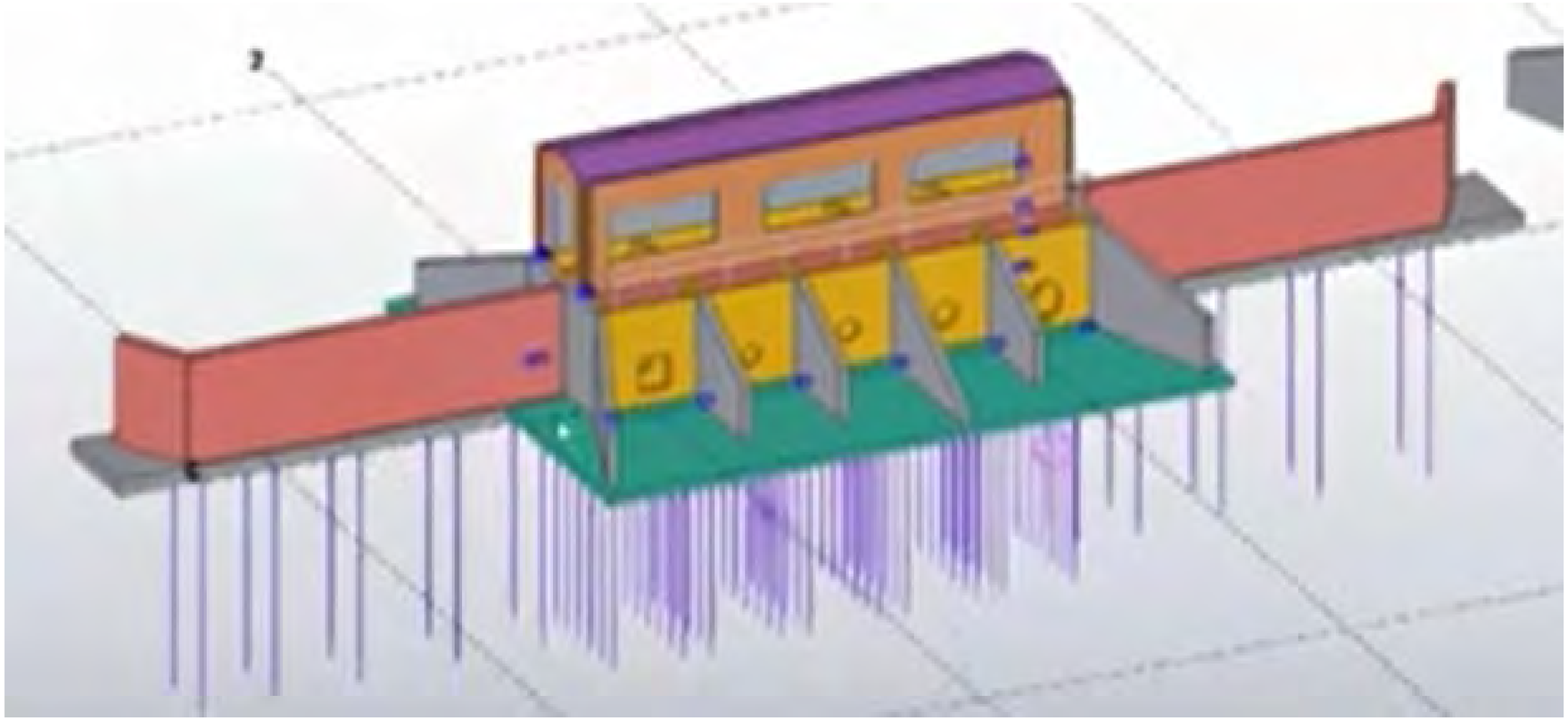
Rock Bolts to anchor dam’s work platform and abutments to site bedrock

Powerhouse and Rock bolts

Design Dam and Powerhouse with Solid attachment to Bedrock

Rock Bolt attachments designed to exceed gravitational load of the mass of CIP dam

Rock Bolts attachments also applied through abutments horizontally to adjacent rock



Return to Summary

Coffer Dams

Coffer Dams

Circular Type Cellular Cofferdam

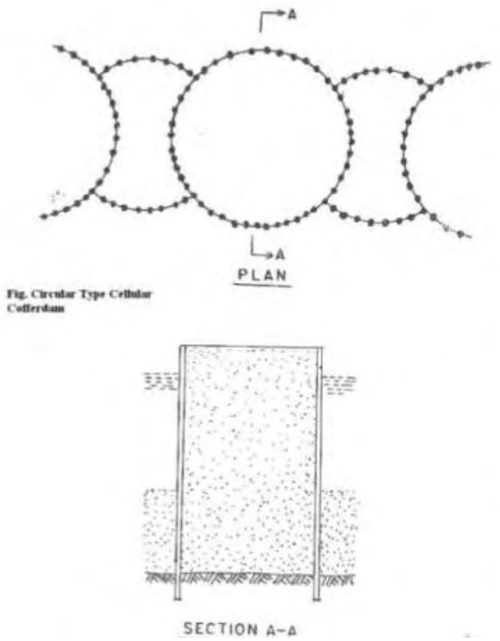
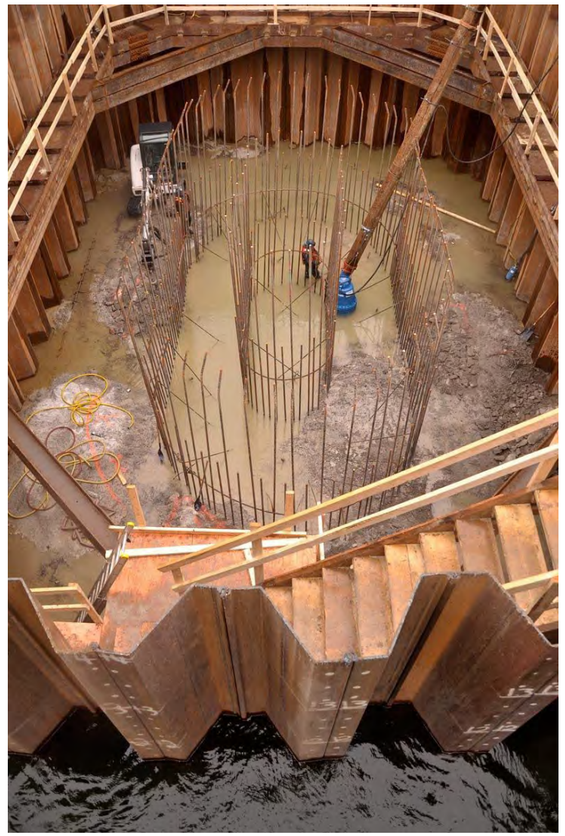


Fig. Circular Type Cellular Cofferdam

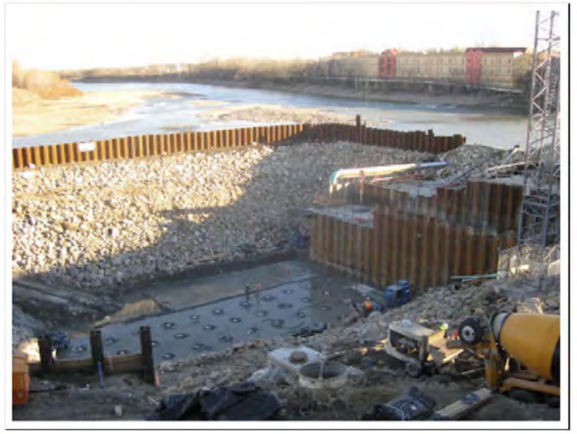
Braced Cofferdam



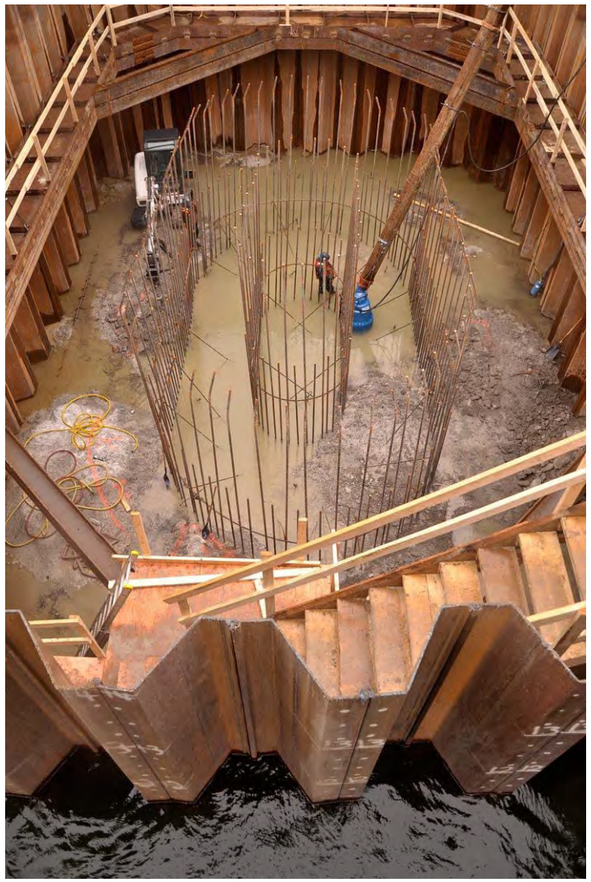
Ref: What Is Cofferdam | Different Types Of Cofferdam | Its Uses (civilengineeringweb.com)

Coffer Dam Allowing work in the Dry

Water Control Reduce Project Risk Exposure
Well designed coffer dams provide protection



Coffer Dams Continued



Return to Summary

Precast Structures

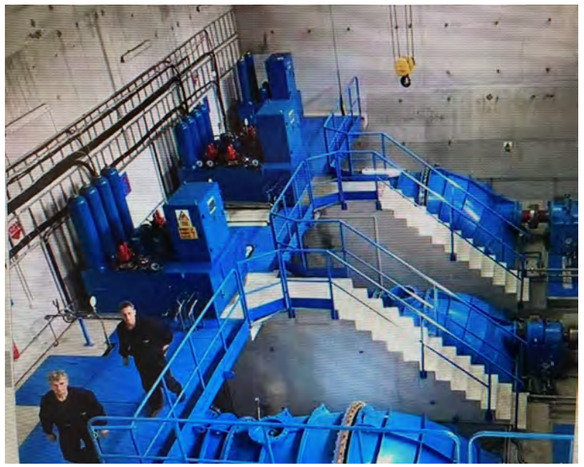
Modules may be removed for future enhancements

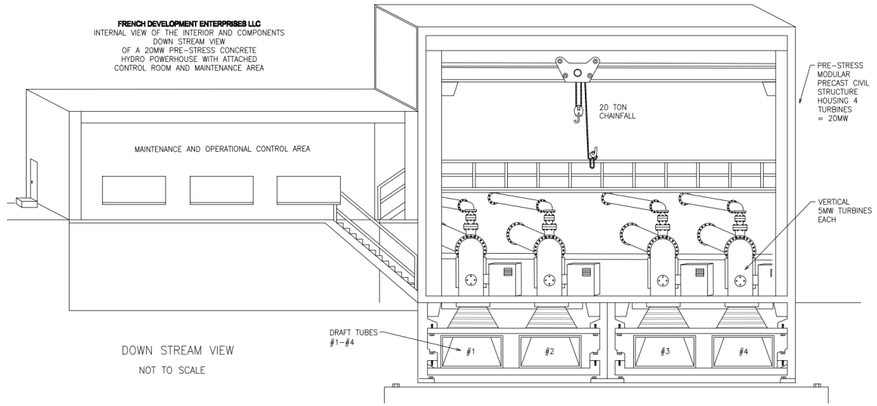
Future addition of power modules for Turbines

President of FDE Hydro
Chris Bencal

And

Consultant Will Fay

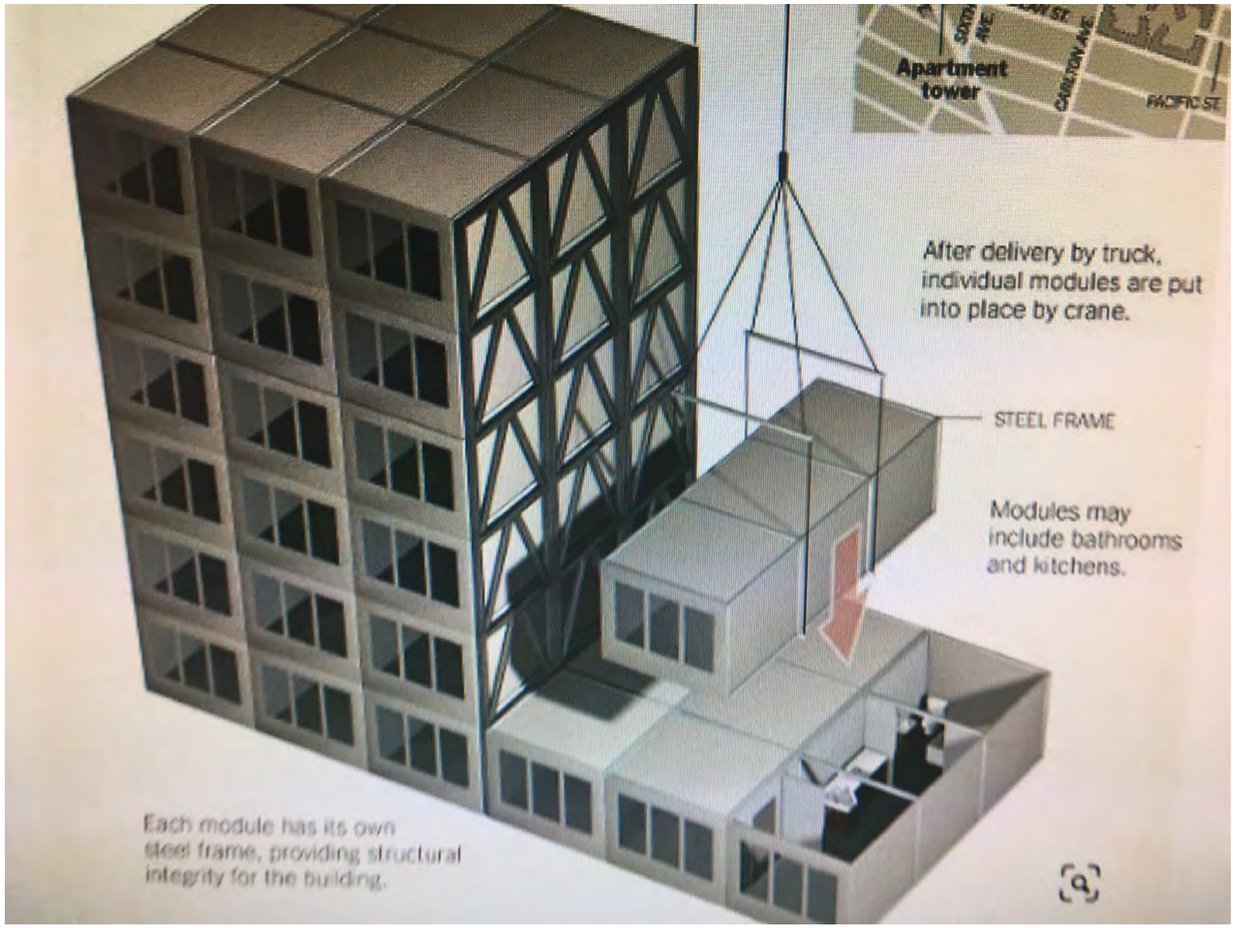




WL French Precast Installation Experience

Large Scale installation

Short Video on Positioning precast modules
https://www.youtube.com/watch?v=MiLtQVGWpHE



Precast Structures

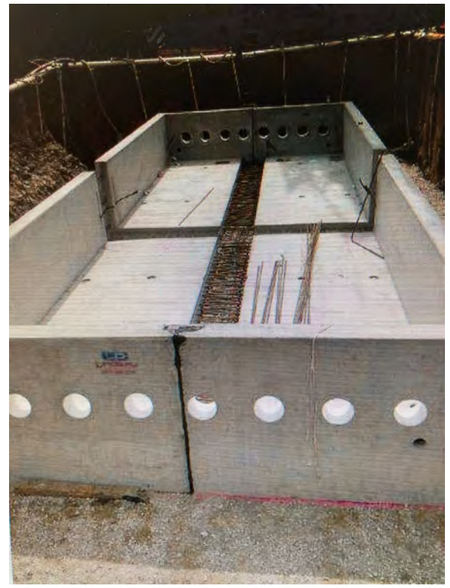
Tail way

Large Scale Powerhouse

Large Scale Powerhouse

Pass Through

Lower bay



Transporting Precast Using the Correct Equipment

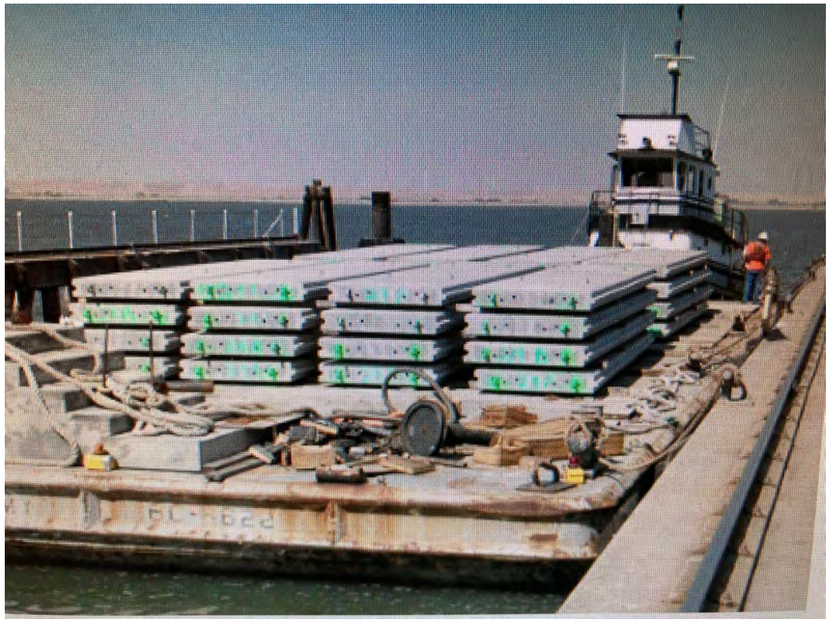
Precast lifting tool and grapple

Perform kick and swing studies

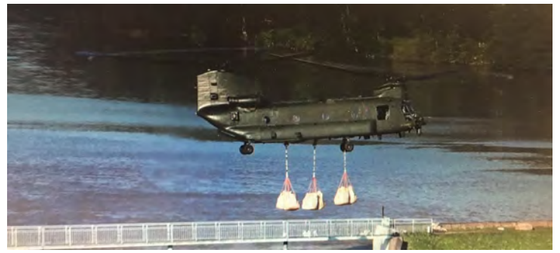
Transport based on weight restrictions of States

Barge & Helo transportation maybe an option

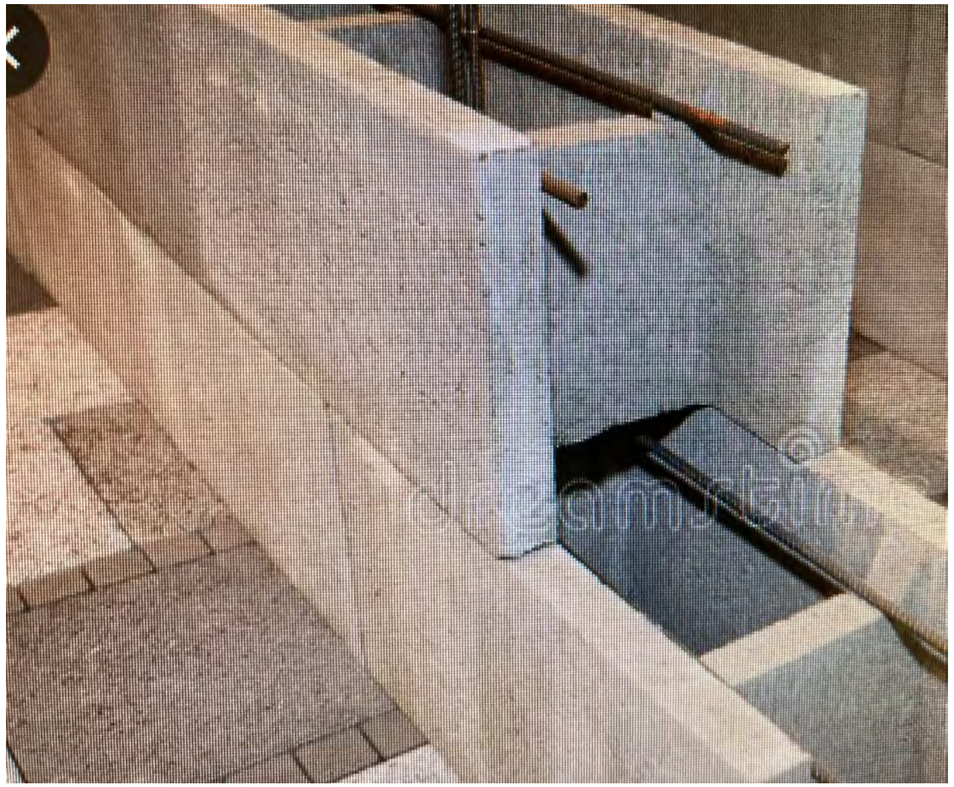
Barge transport



Helicopter transport



Precast Wall Systems



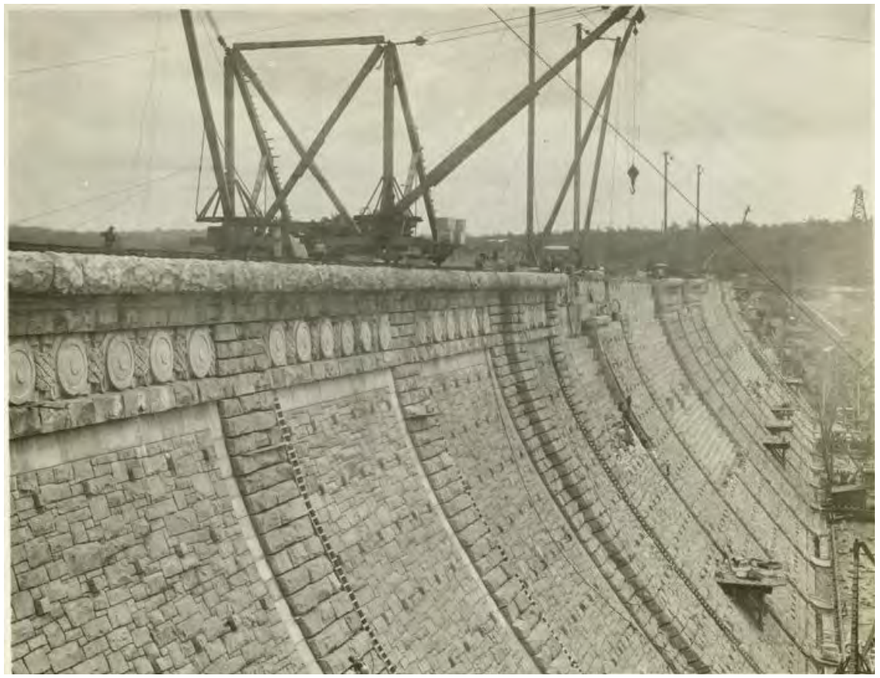
Return to Summary

Designing Modular Precast

Dams and Powerhouses

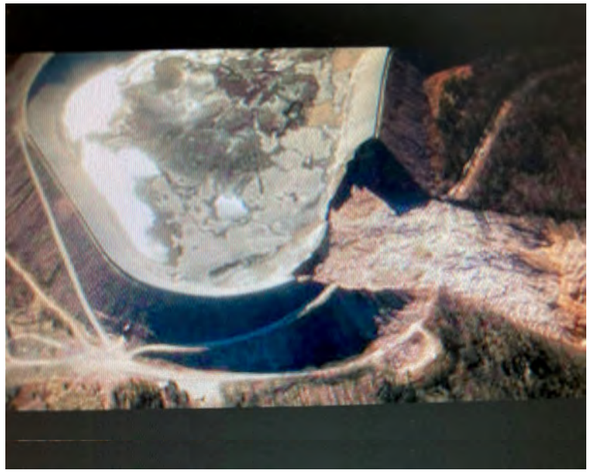
Historical consideration of Dam Construction

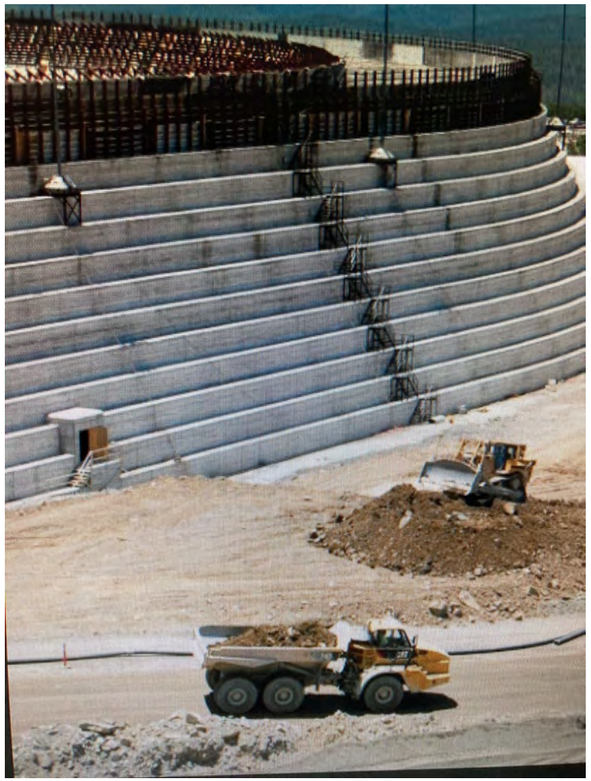
Granite blocks where the material of choice.



Designing in Water
Consider the Power of Water

Side Blow out and Repair Pump Storage System

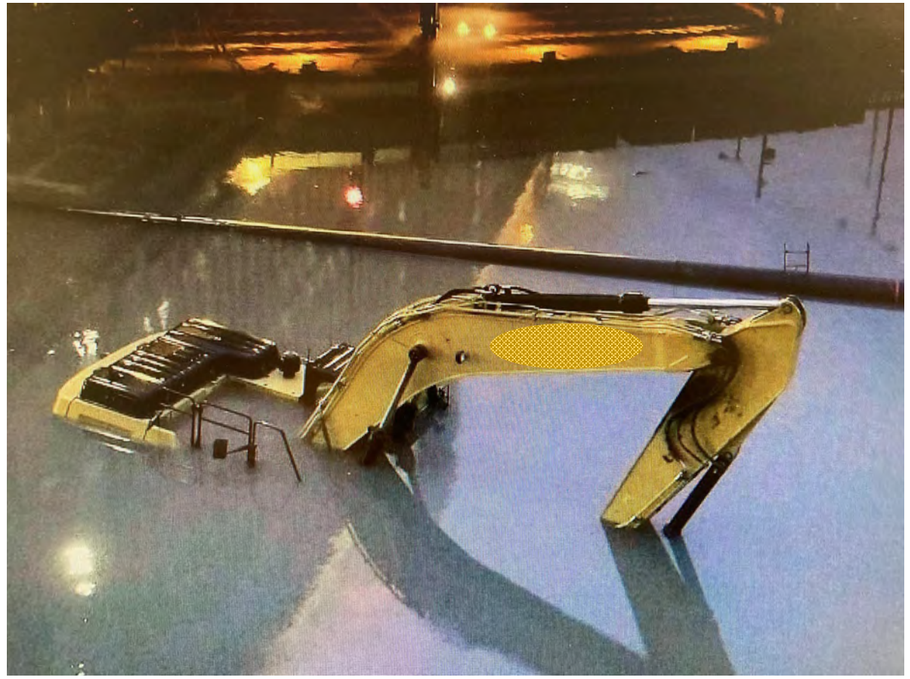




Inadequate Coffer Dams design and installation

may result failure and cost overruns / project delays.

Coffer dam failure



Coffer dam over topped by storm

French Dam Design Options Support Creation of:

Dam Impoundments; New, Repair and Retro Fit (new dam in front of existing)

Water Control dams

Precast Modular Powerhouses at non-powered dams

Run of the river Hydropower modular /scalable spill way and powerhouse application

Conduit hydropower facilities

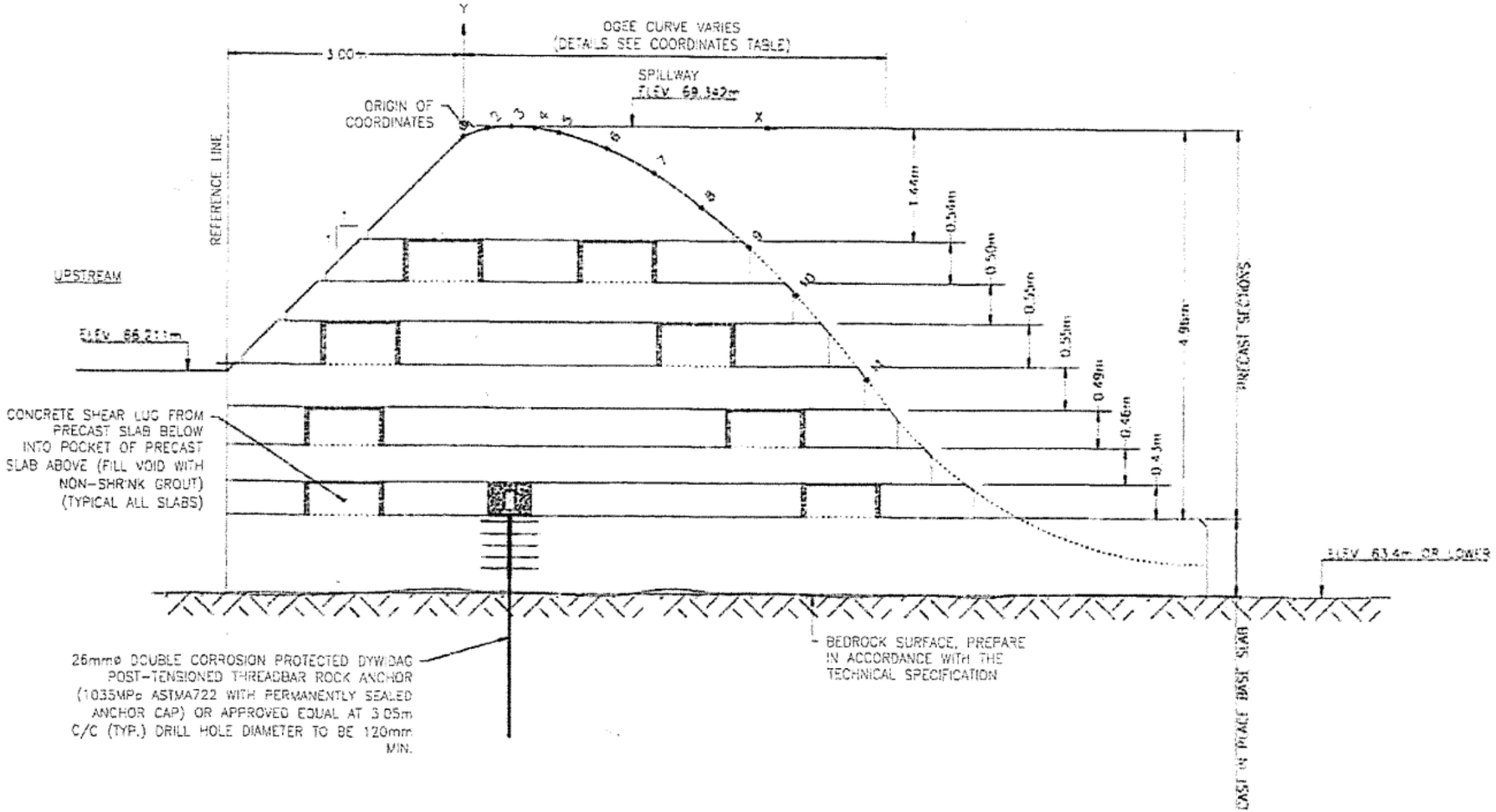
Modular Fish Passage w/ Merck Animal Health's Hyper InfusiO2n Solutions

Modular Pump Storage Hydro (m-PSH)

Resilient and secured hydro powered modular / scalable micro-Grids

All FDE Hydro water infrastructure solutions are US and Canadian Patents Protected

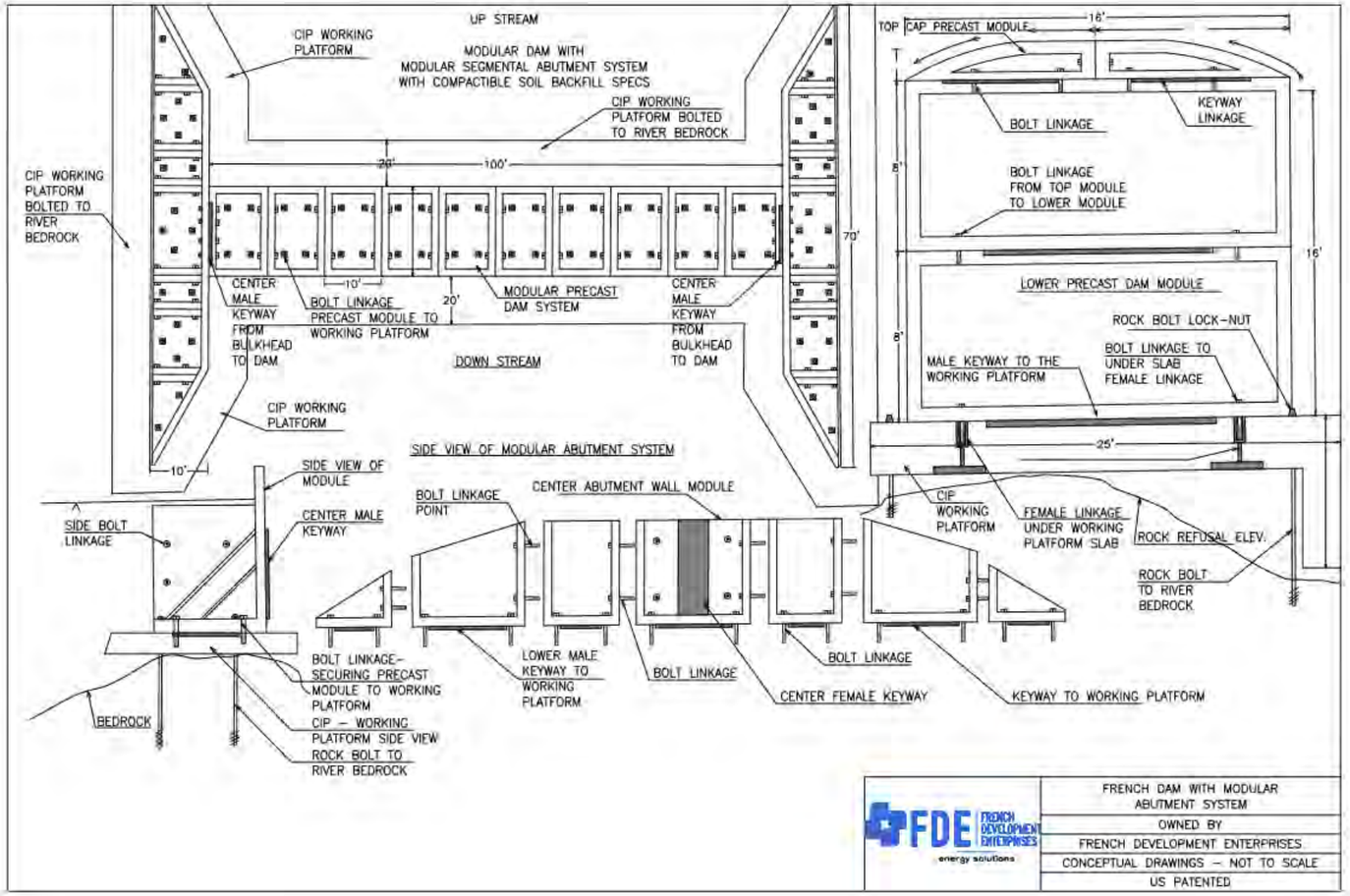
Example of Precast Dam Design



Abutment System I
Modular Precast

Precast may be any size and any shape

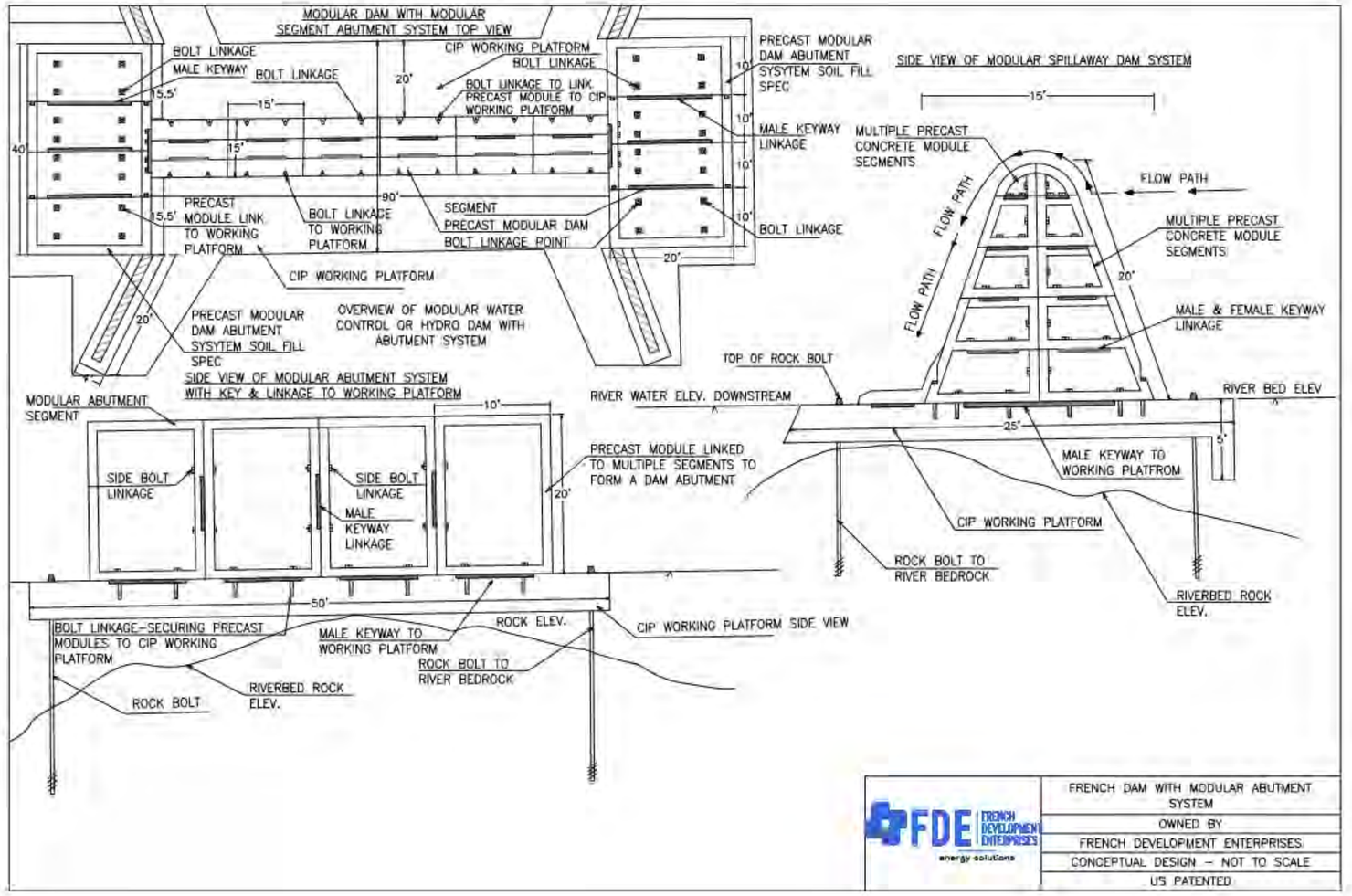
Image below is an example of Cast-in-Place bulkhead which may be easily replaced with modular precast as detailed in the drawing to the right.



Abutment System II

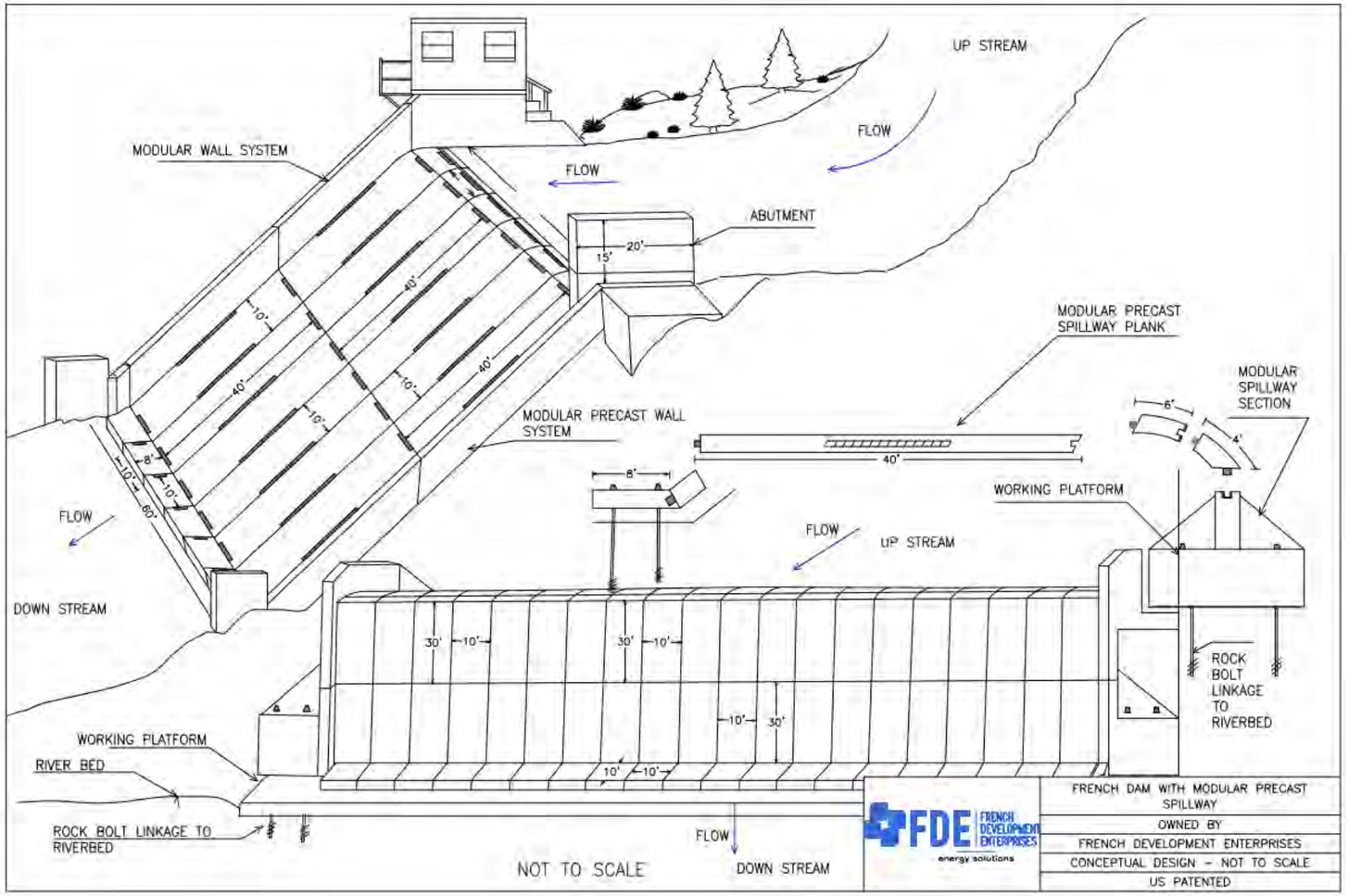
Modular Precast

Precast may be any size and any shape



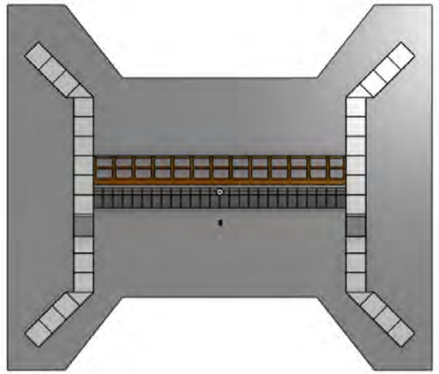
Spillway & Abutment
Modular Precast

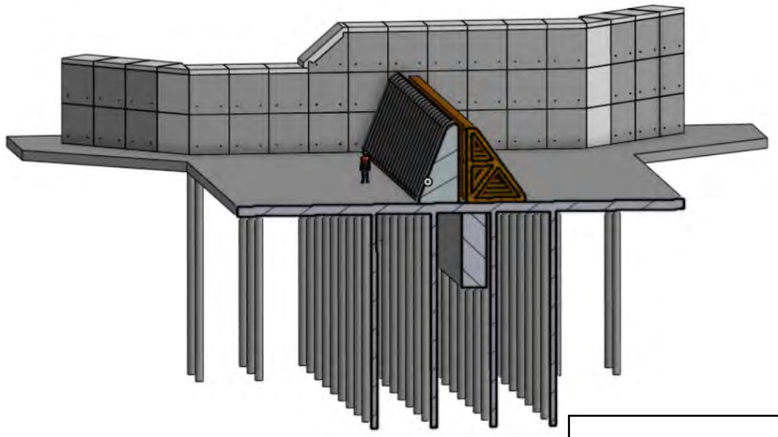
Precast may be any size and any shape

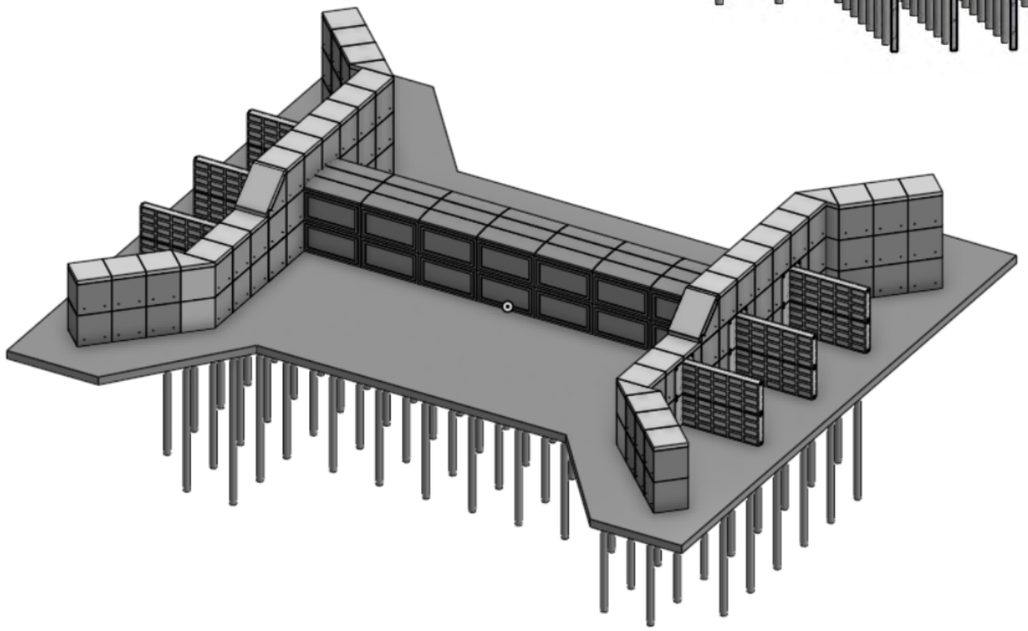


Conceptual Abutment Dam Any Size, Any Shape

CAD Precast Modules

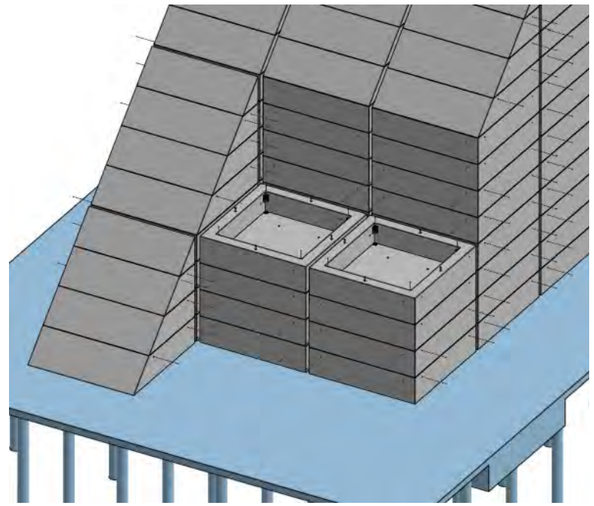


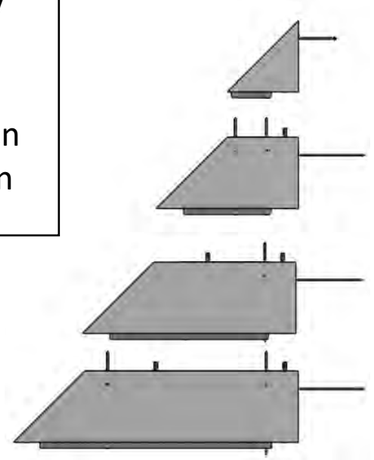


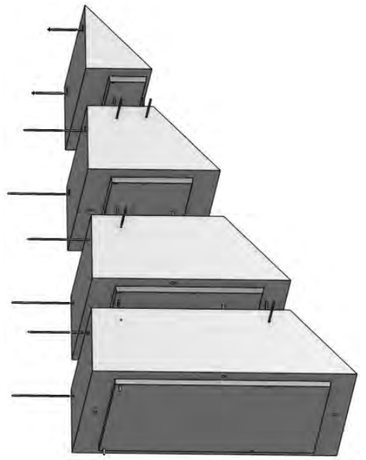


Modular precast dam scalable design for any Height x Flow

Configurations based on site specific information



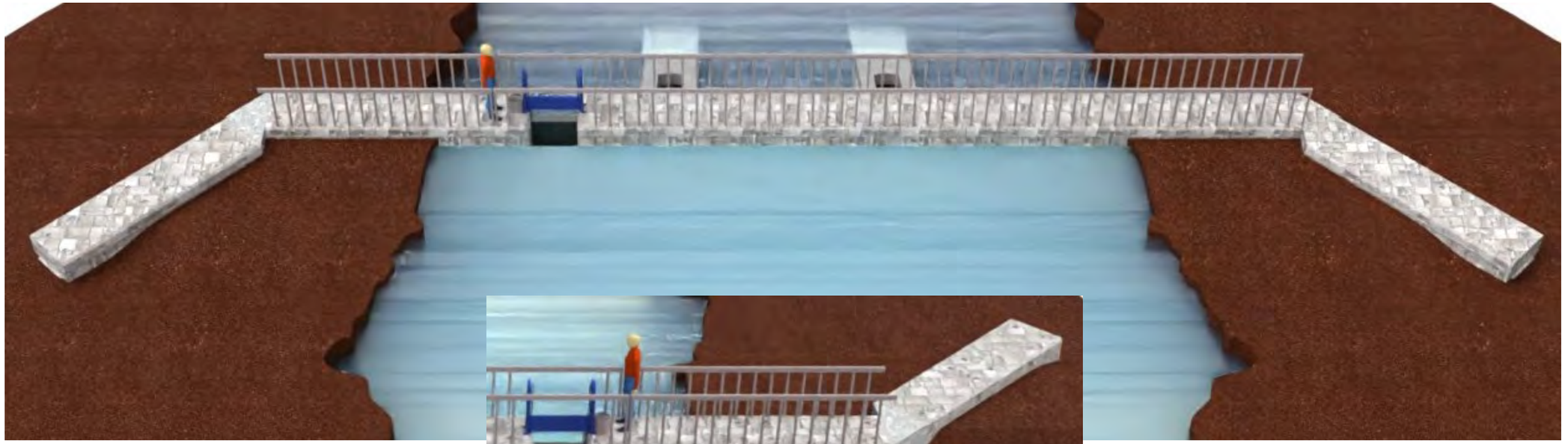




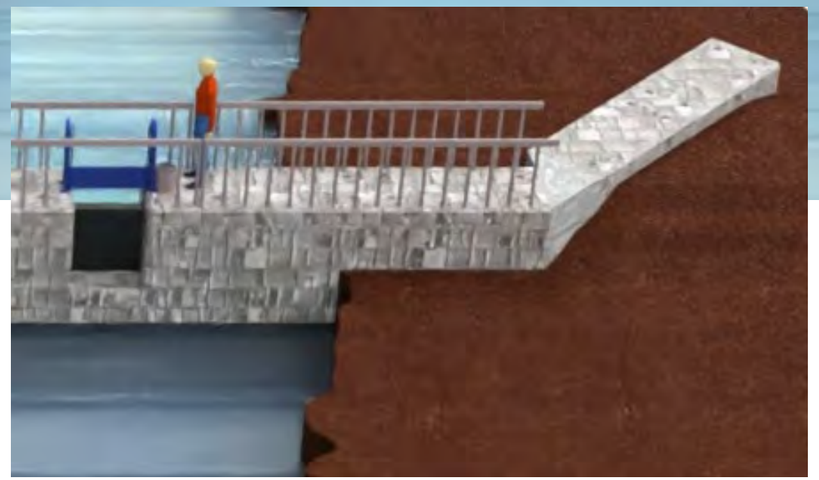
Conceptual Abutment Dam

CAD Rendering

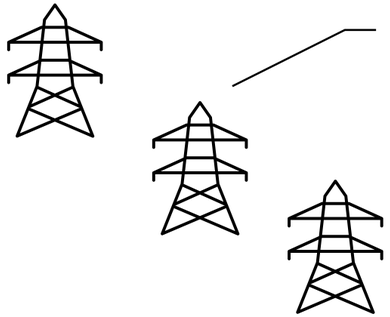
FLOW



FLOW



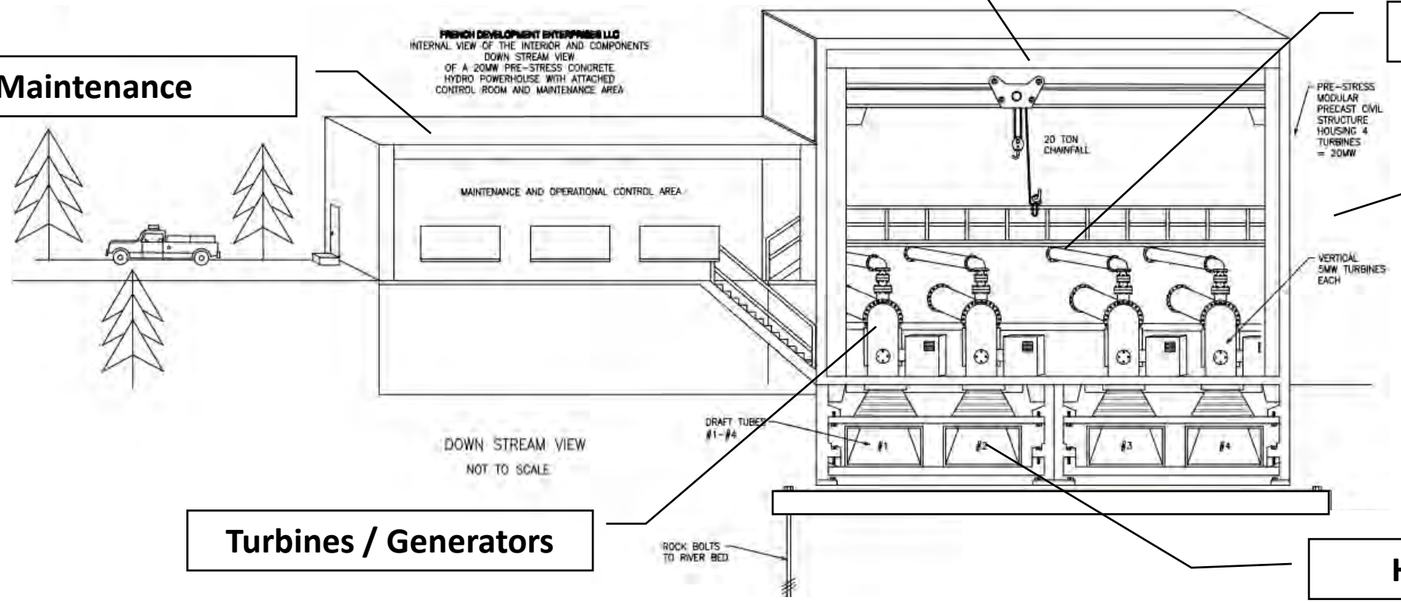
Modular Precast Powerhouse, Elements to consider



Electrical systems

Automation

Maintenance



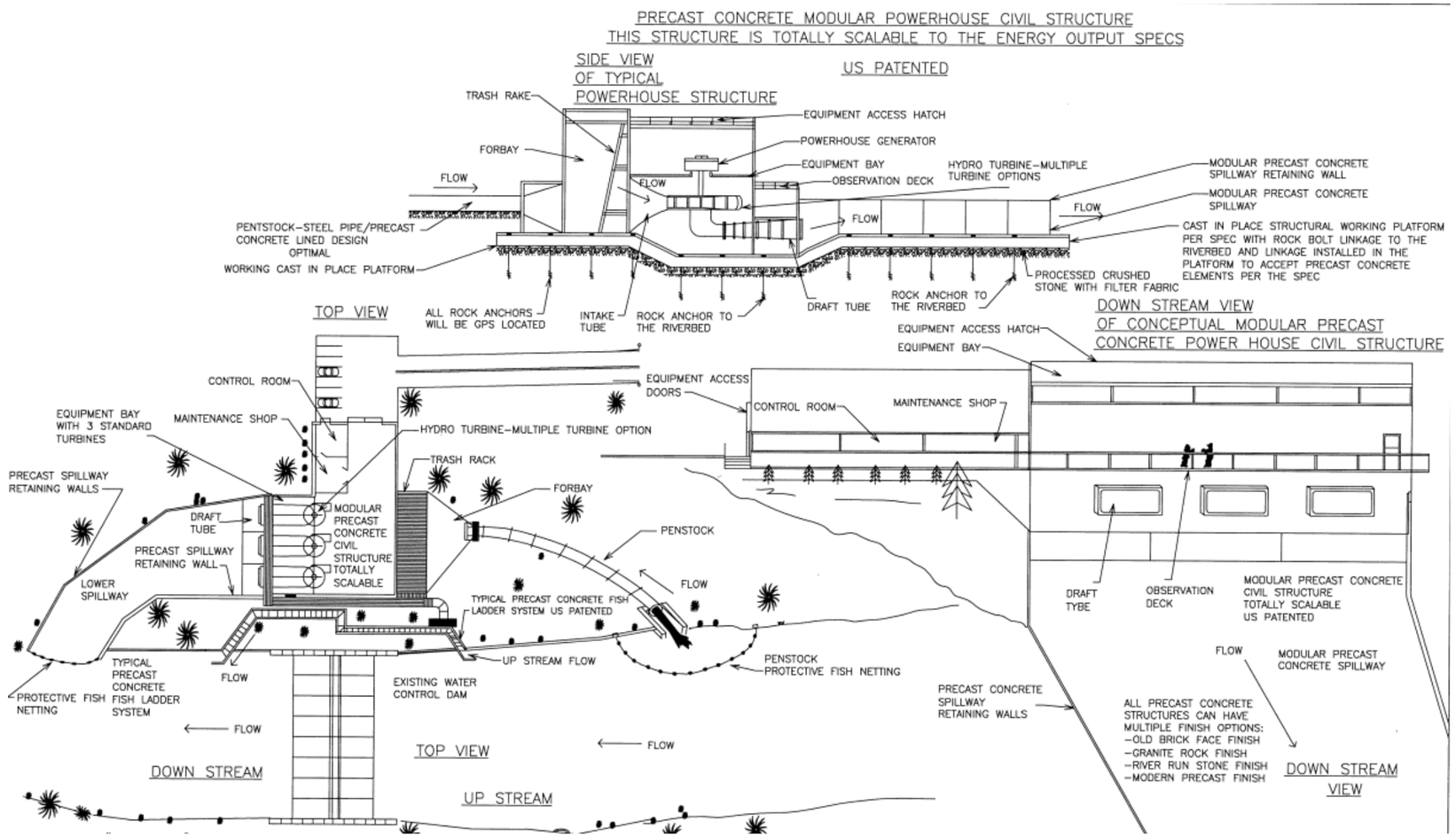
Mechanical systems

Shut-off valve

Turbines / Generators

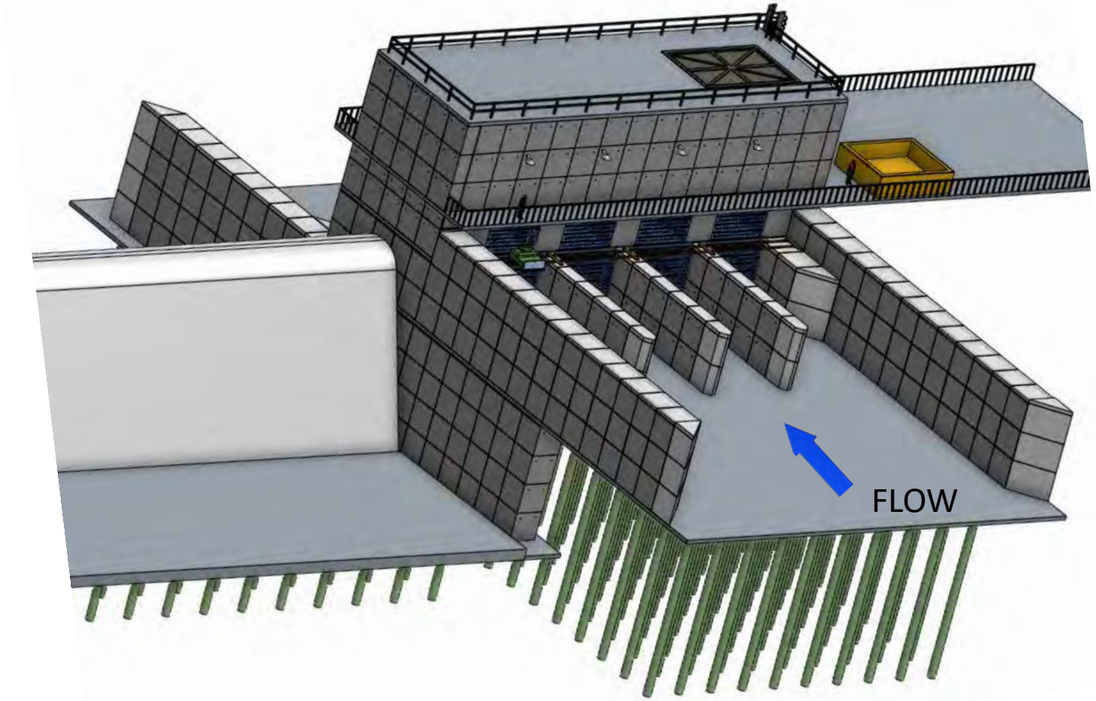
Hydraulic steel structure

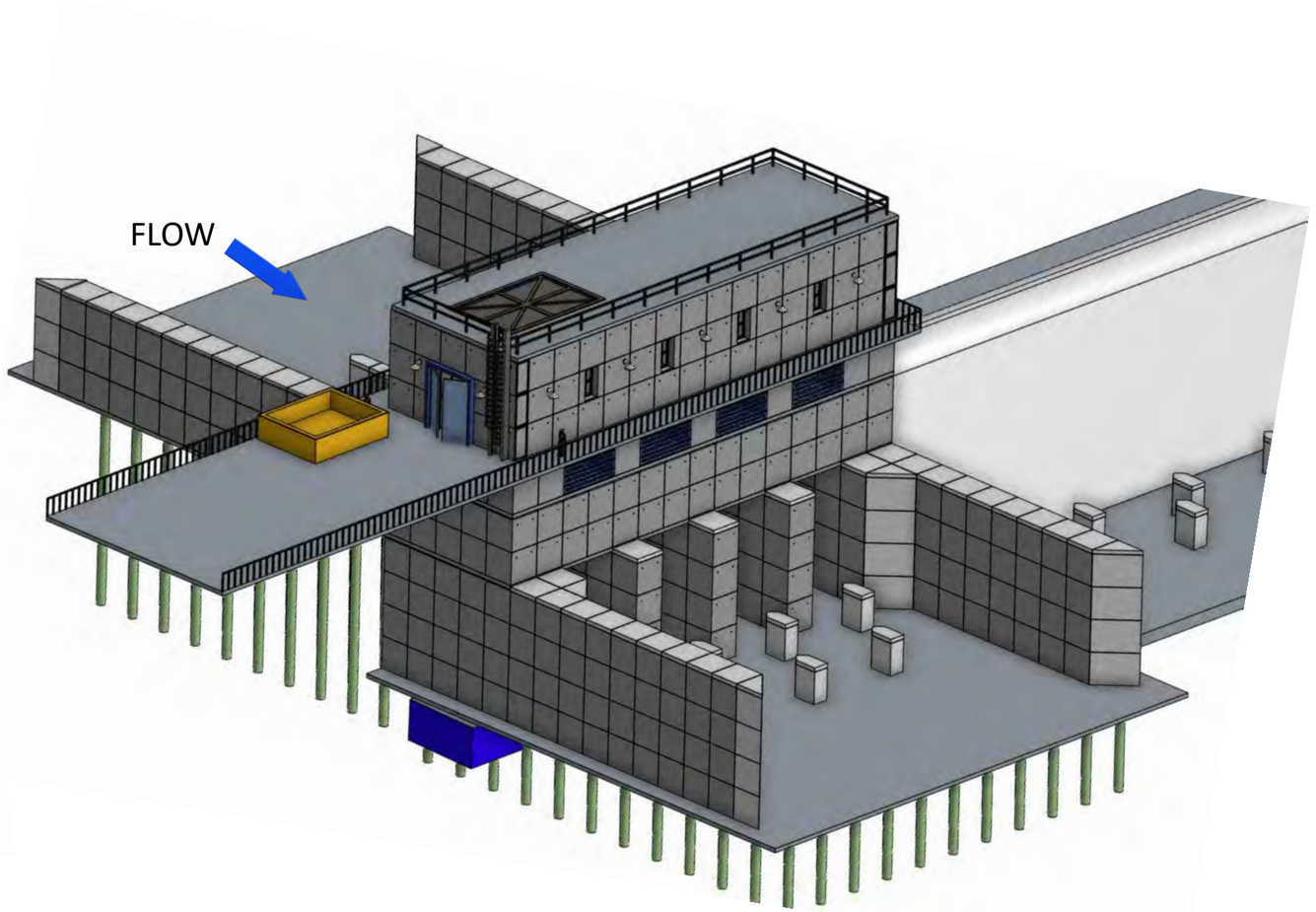
Design of Precast Powerhouse



Small and Medium Head Powerhouse

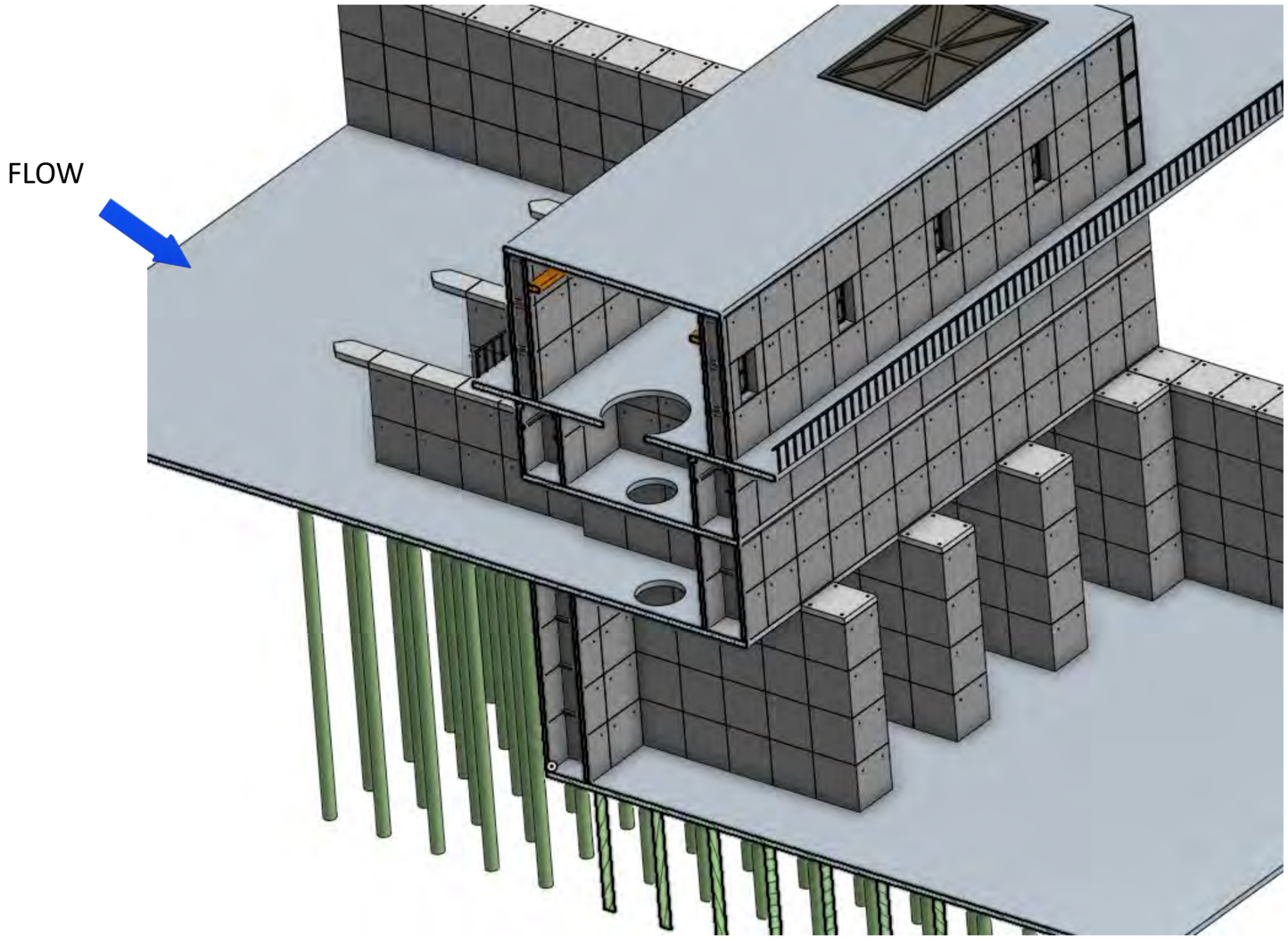
CAD Precast Modules





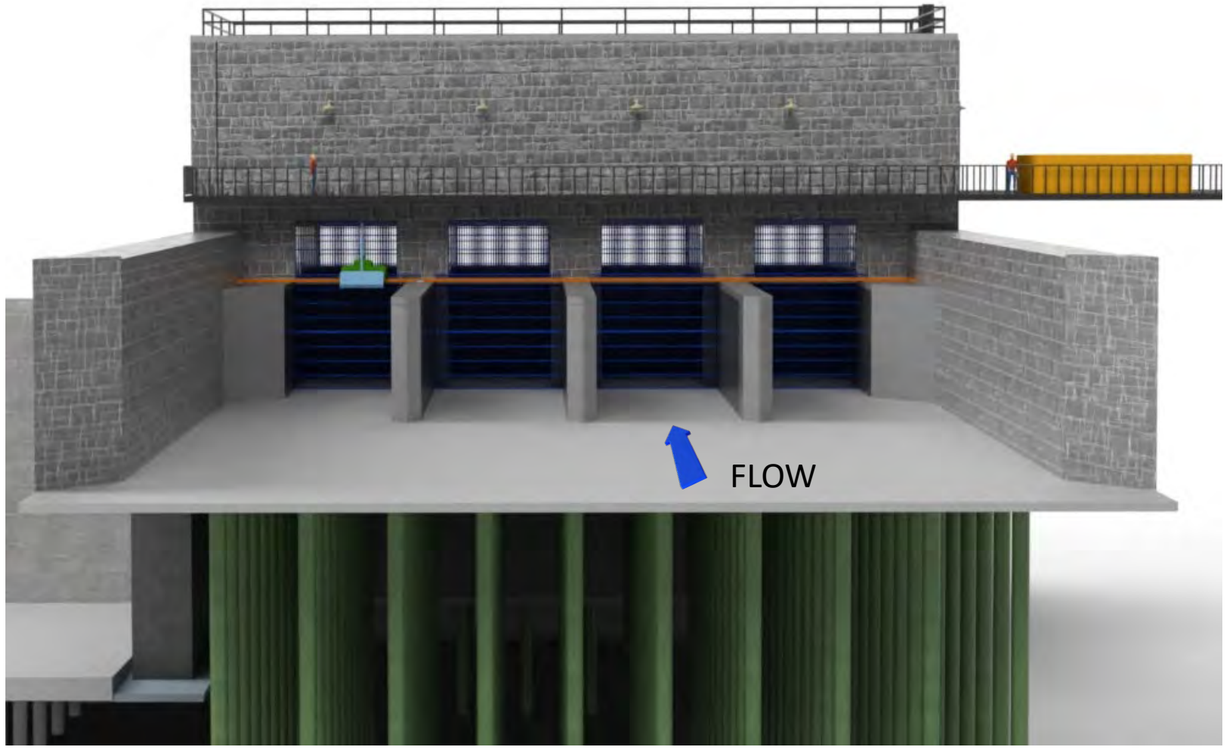
Powerhouse – Section Through Turbine Bay

CAD Precast Modules



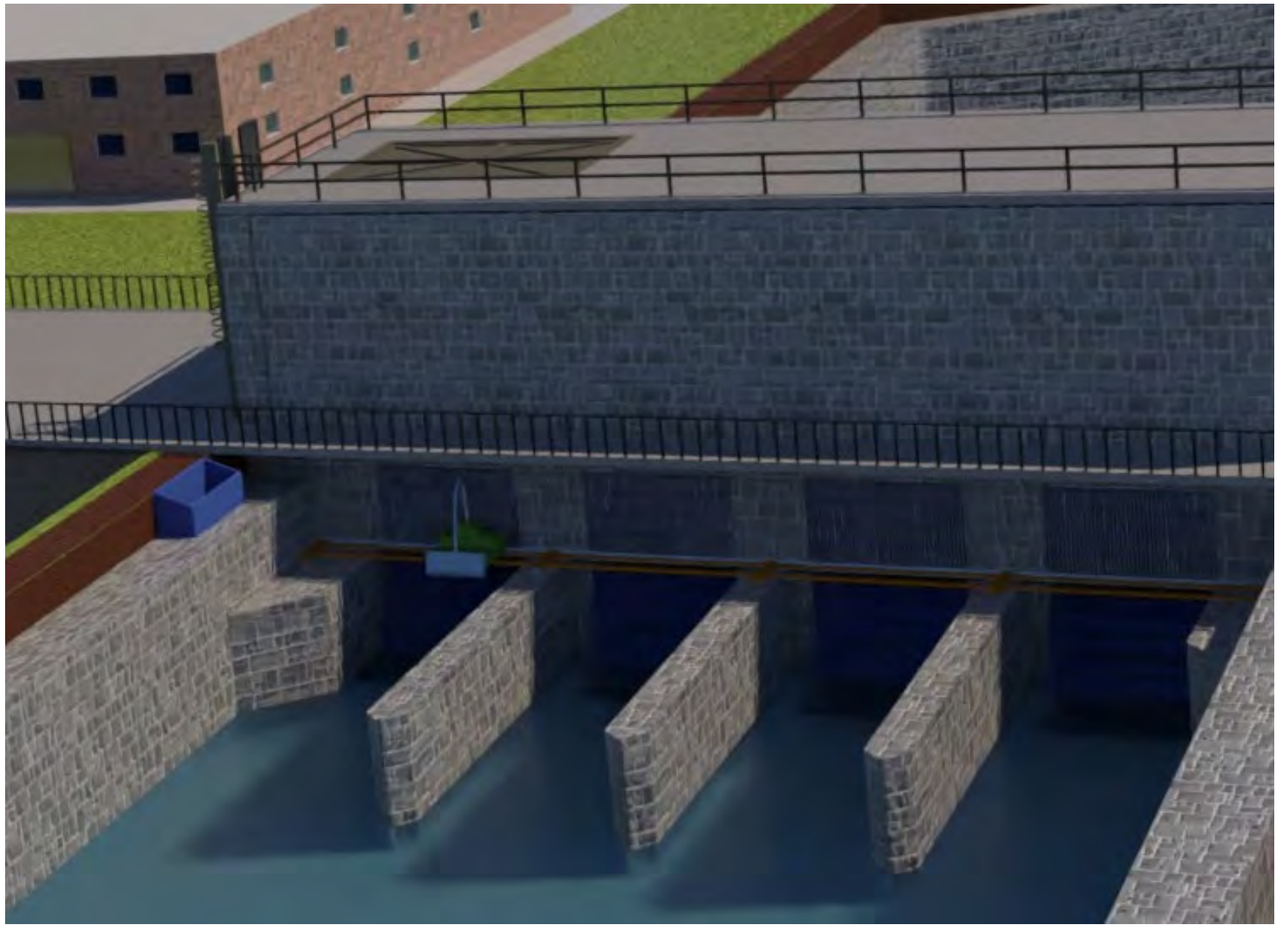
Turbine Powerhouse Architectural Precast Finish

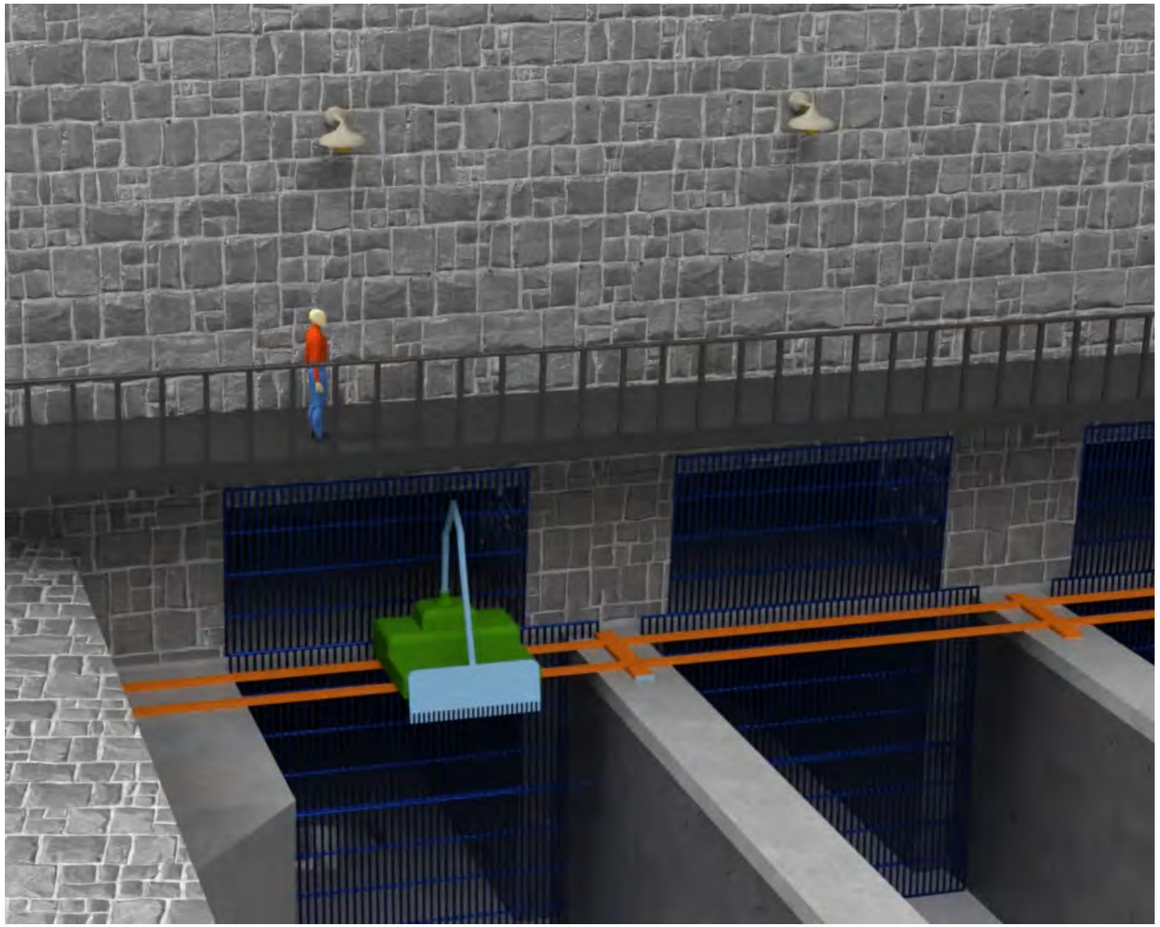
CAD Rendering



Turbine Powerhouse Architectural Precast Finish

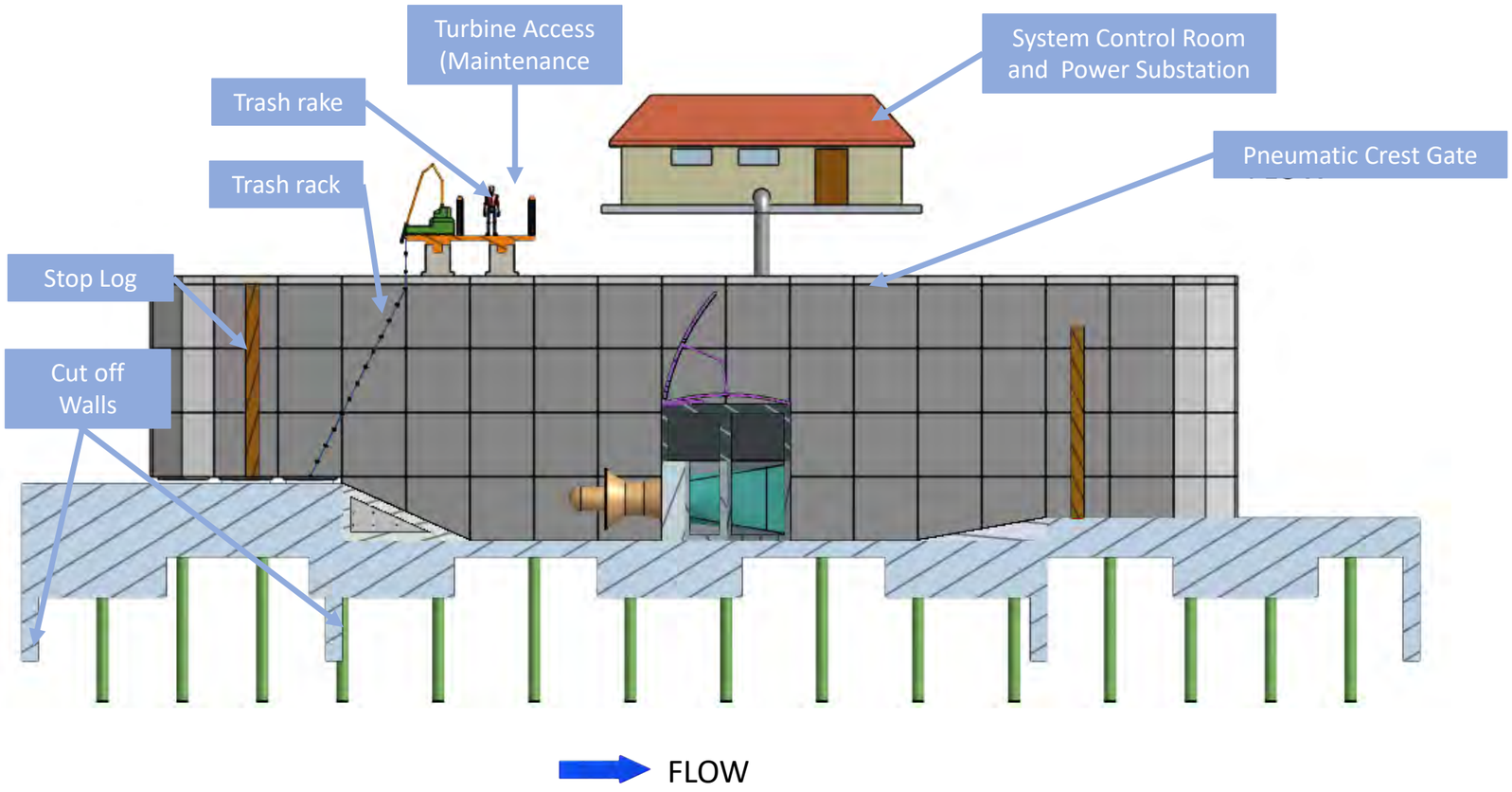
CAD Rendering

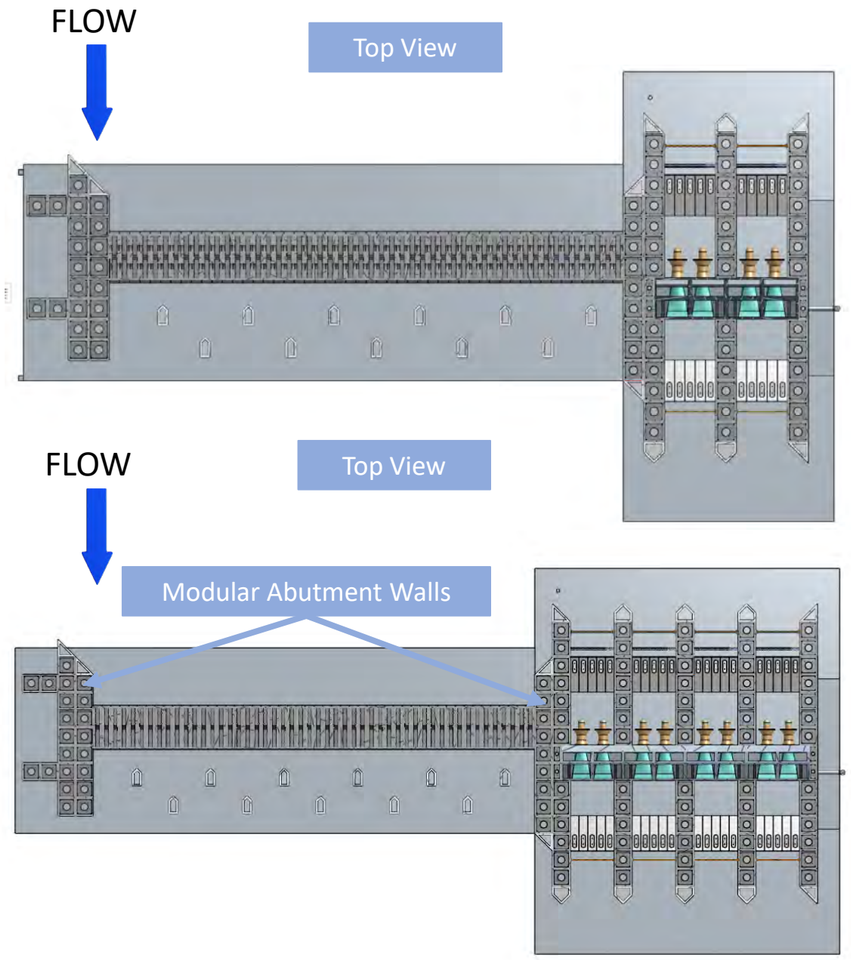




Channel Style Powerhouse – Scalable

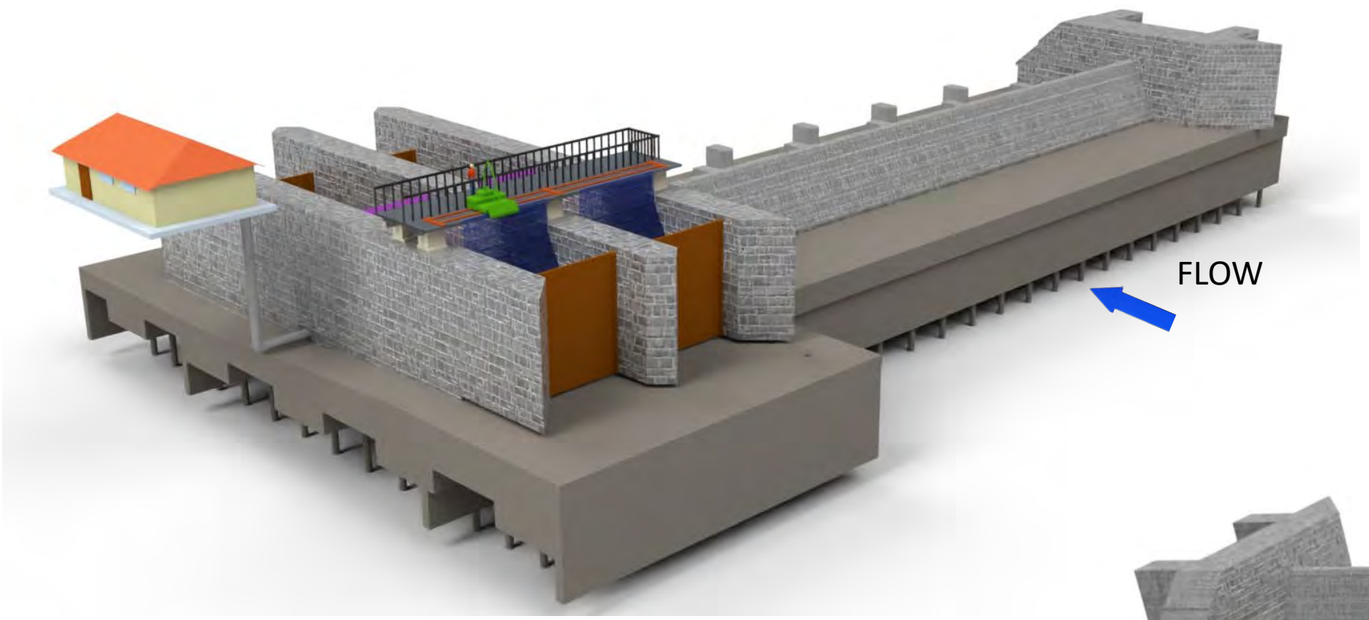
CAD Precast Modules

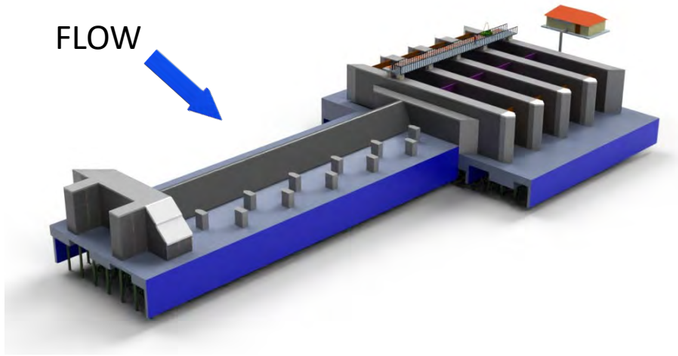


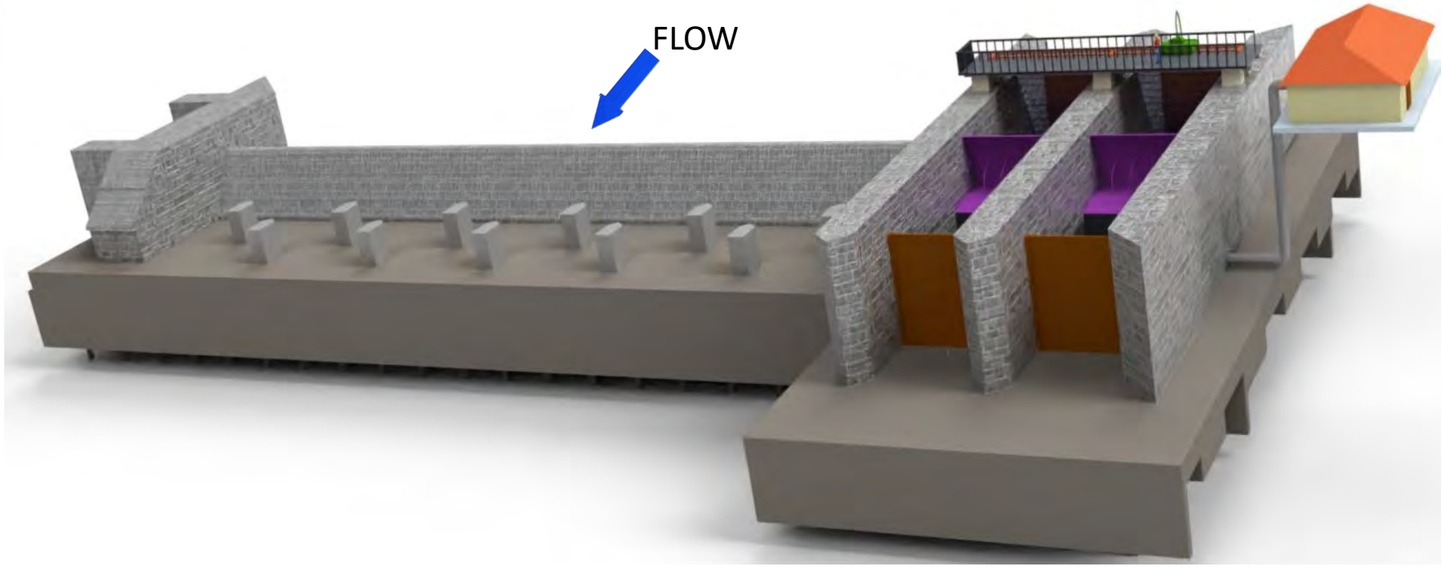


Channel Style Powerhouse – Scalable

CAD Rendering



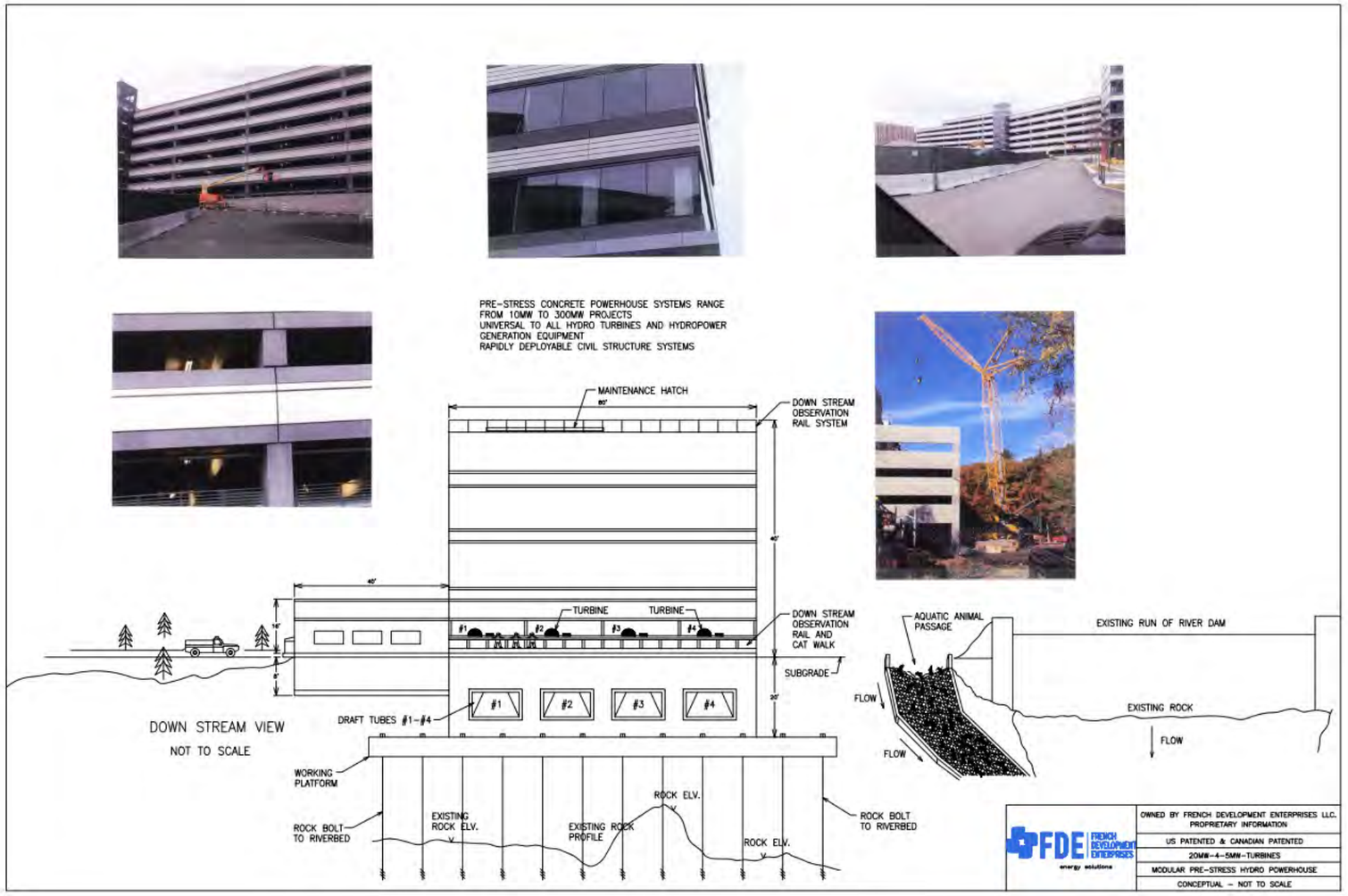




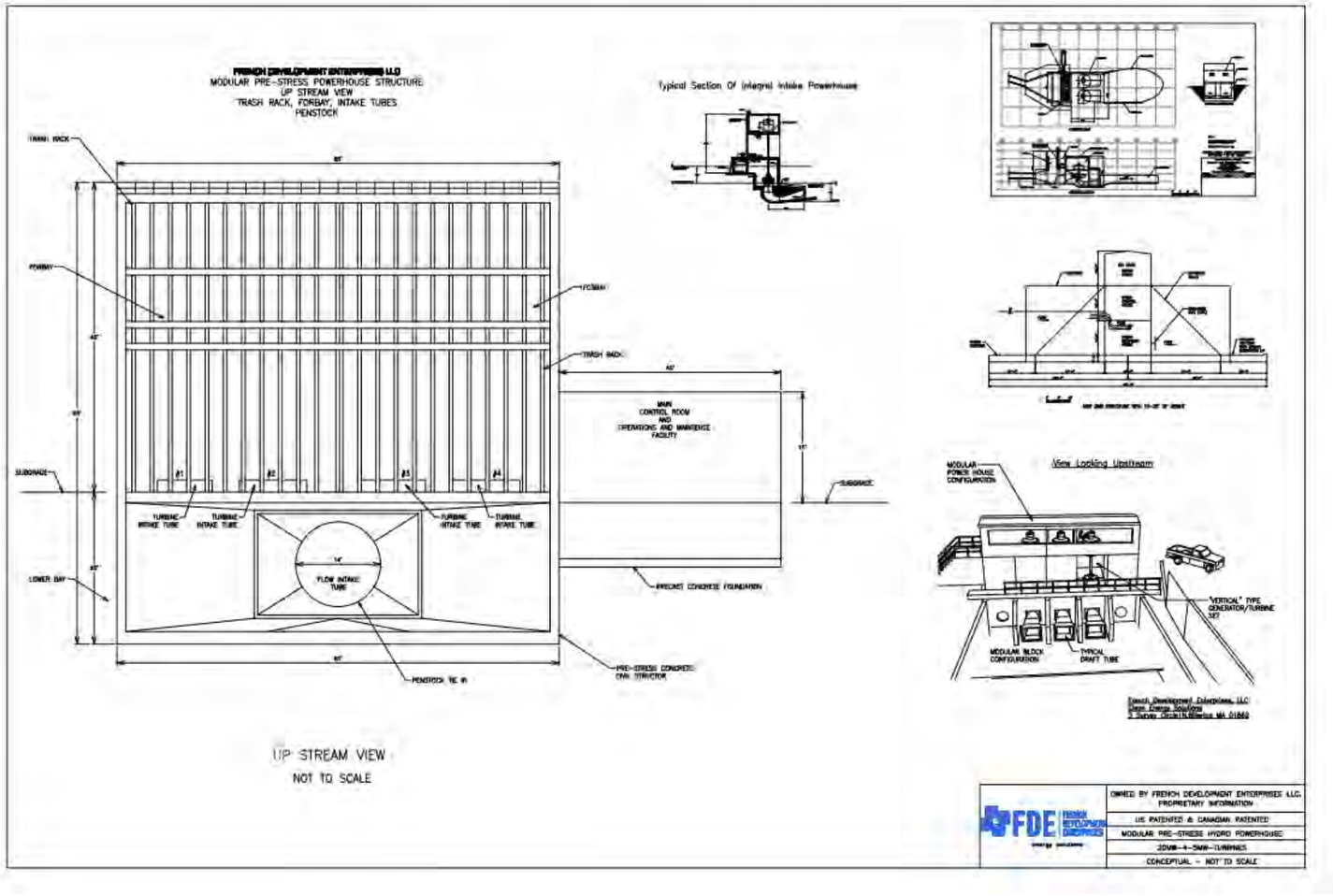
Scalable modular precast channels for any Height x Flow

Configurations based on site specific information

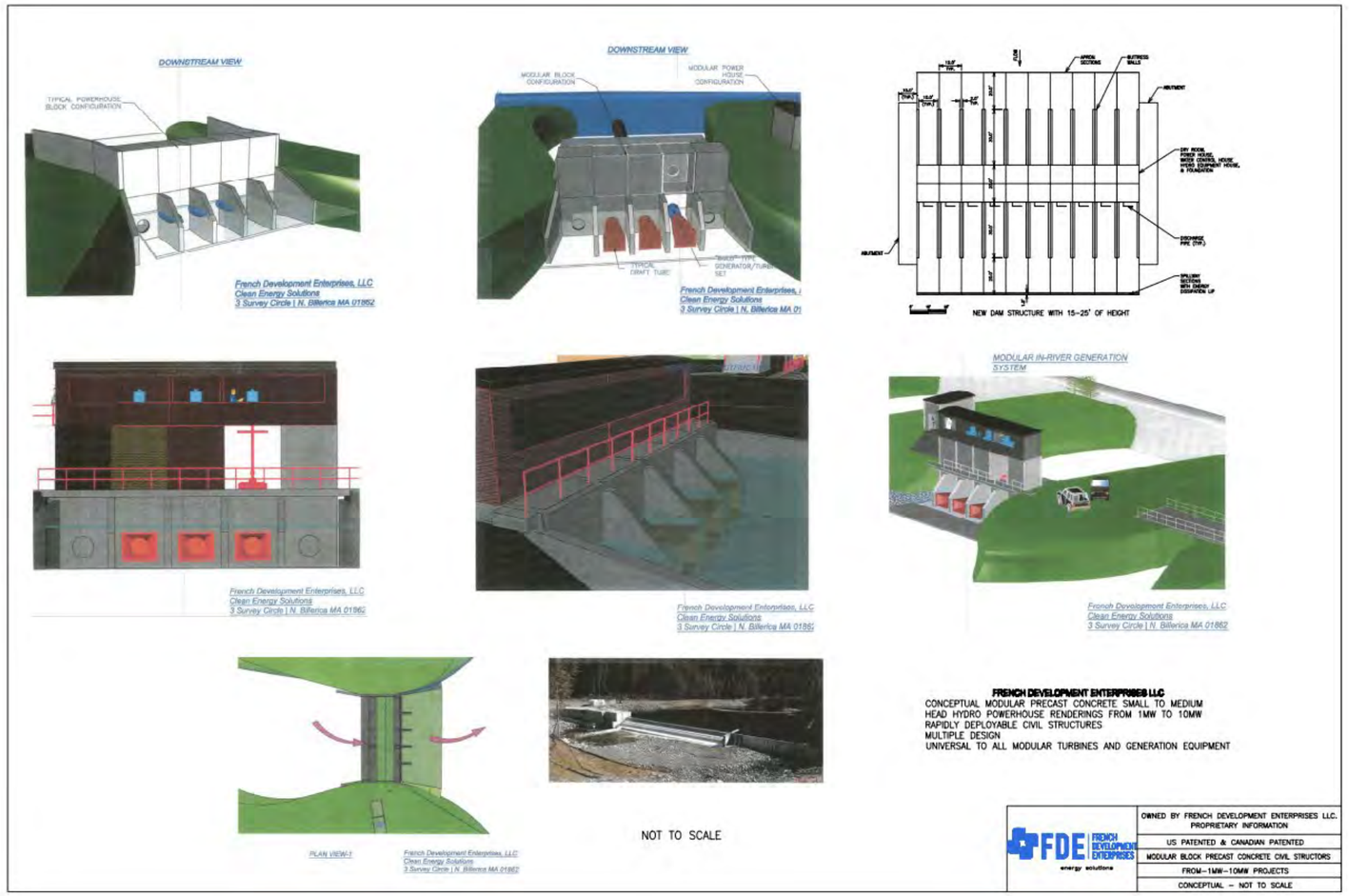
Powerhouse, Precast can be Scaled



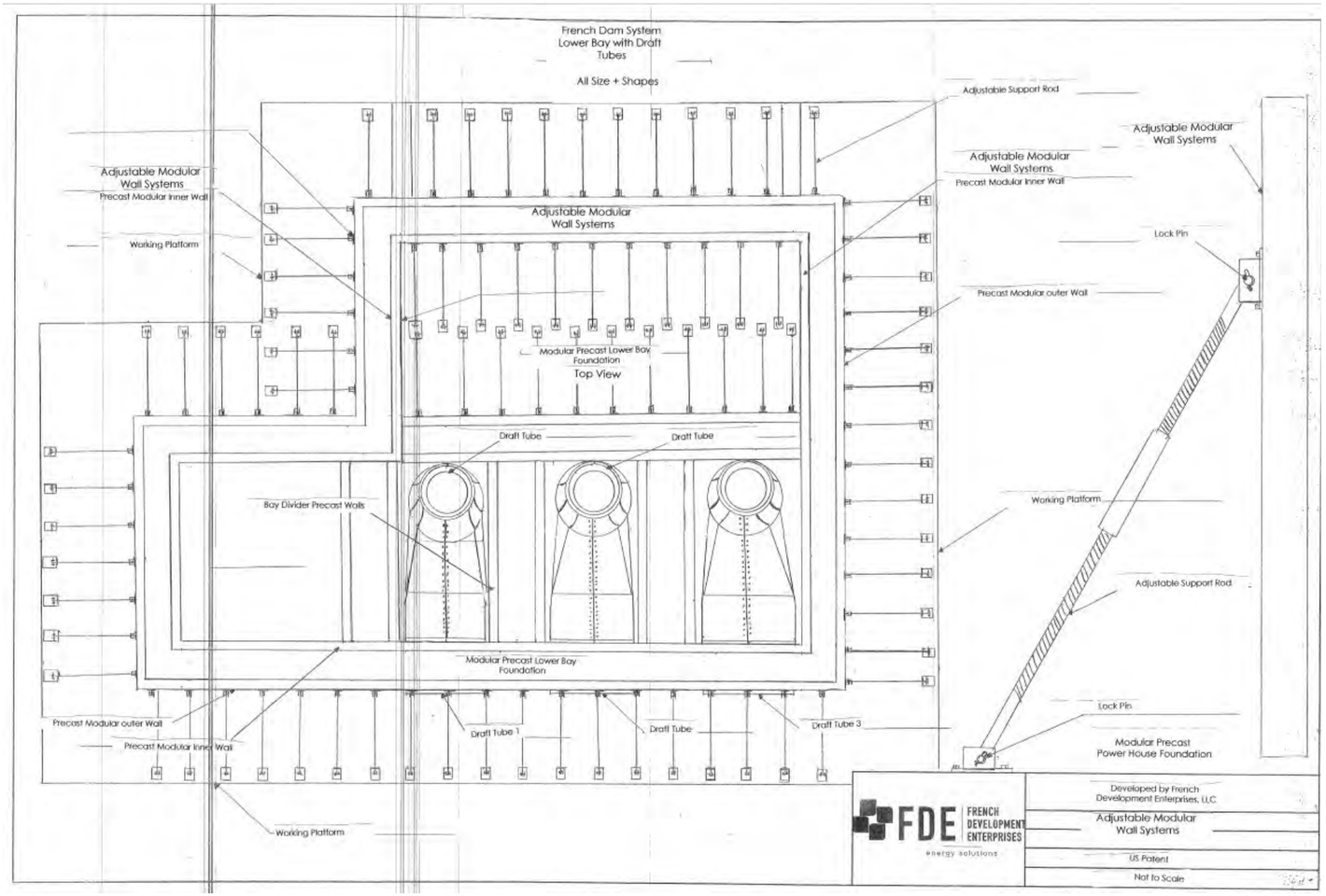
Powerhouse


MODULAR PRE-STRESS POWERHOUSE STRUCTURE
UP STREAM VIEW
TRASH RACK, FORBAY, INTAKE TUBES
PENSTOCK
Typical Section Of Integral Intake Powerhouse
TRASH RACK
FORBAY
MAIN
CONTROL ROOM
AND
OPERATIONS AND MAINTENCE
FACILITY
SUBGRADE
TURBINE
INTAKE TUBE
FLOW INTAKE
TUBE
LOWER BAY
PRE-STRESS CONCRETE
FOUNDATION
PENSTOCK TIE IN
PRE-STRESS CONCRETE
DRAFT TUBE
View Looking Upstream
MODULAR
POWER HOUSE
CONFIGURATION
"VERTICAL" TYPE
GENERATOR/TURBINE
SET
MODULAR BLOCK
CONFIGURATION
TYPICAL
DRAFT TUBE
UP STREAM VIEW
NOT TO SCALE
OWNED BY FRENCH DEVELOPMENT ENTERPRISES LLC.
PROPRIETARY INFORMATION
US PATENTED & CANADIAN PATENTED
MODULAR PRE-STRESS HYDRO POWERHOUSE
CONCEPTUAL - NOT TO SCALE

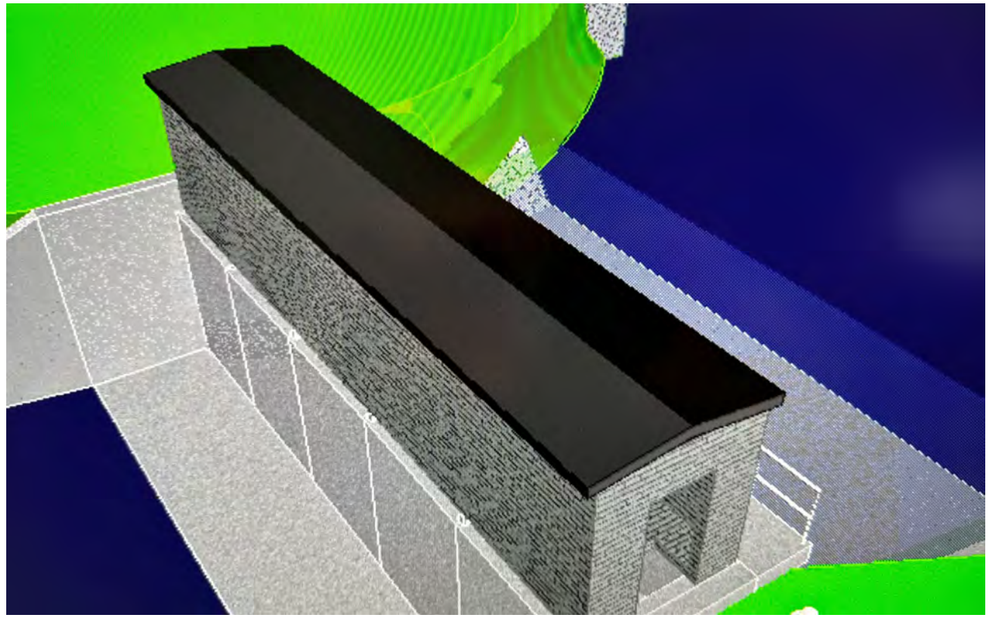
Powerhouse


DOWNSTREAM VIEW
TYPICAL POWERHOUSE BLOCK CONFIGURATION
French Development Enterprises, LLC
Clean Energy Solutions
3 Survey Circle | N. Billerica MA 01862
DOWNSTREAM VIEW
MODULAR BLOCK CONFIGURATION
MODULAR POWER HOUSE CONFIGURATION
TYPICAL DRAFT TUBE
French Development Enterprises, LLC
Clean Energy Solutions
3 Survey Circle | N. Billerica MA 01862
NEW DAM STRUCTURE WITH 15-25' OF HEIGHT
French Development Enterprises, LLC
Clean Energy Solutions
3 Survey Circle | N. Billerica MA 01862
French Development Enterprises, LLC
Clean Energy Solutions
3 Survey Circle | N. Billerica MA 01862
MODULAR IN-RIVER GENERATION SYSTEM
French Development Enterprises, LLC
Clean Energy Solutions
3 Survey Circle | N. Billerica MA 01862
PLAN VIEW-1
French Development Enterprises, LLC
Clean Energy Solutions
3 Survey Circle | N. Billerica MA 01862
NOT TO SCALE
FRENCH DEVELOPMENT ENTERPRISES LLC
CONCEPTUAL MODULAR PRECAST CONCRETE SMALL TO MEDIUM HEAD HYDRO POWERHOUSE RENDERINGS FROM 1MW TO 10MW
RAPIDLY DEPLOYABLE CIVIL STRUCTURES
MULTIPLE DESIGN
UNIVERSAL TO ALL MODULAR TURBINES AND GENERATION EQUIPMENT
FDE FRENCH DEVELOPMENT ENTERPRISES energy solutions
OWNED BY FRENCH DEVELOPMENT ENTERPRISES LLC.
PROPRIETARY INFORMATION
US PATENTED & CANADIAN PATENTED
MODULAR BLOCK PRECAST CONCRETE CIVIL STRUCTORS
FROM-1MW-10MW PROJECTS
CONCEPTUAL – NOT TO SCALE

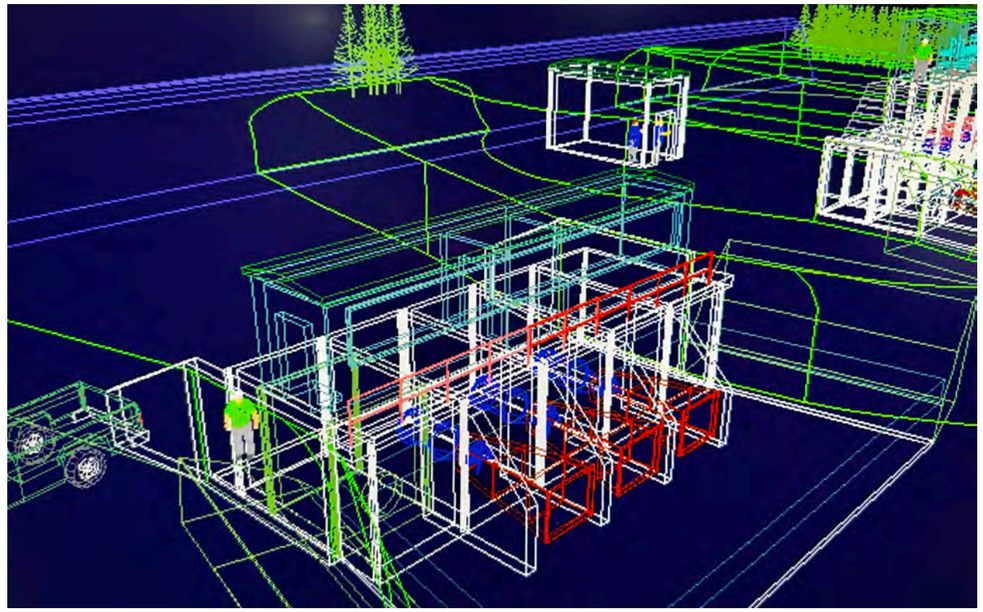
Adjustable Wall System



Powerhouse Videos



3D model of Powerhouse design



Wire frame of Powerhouse design

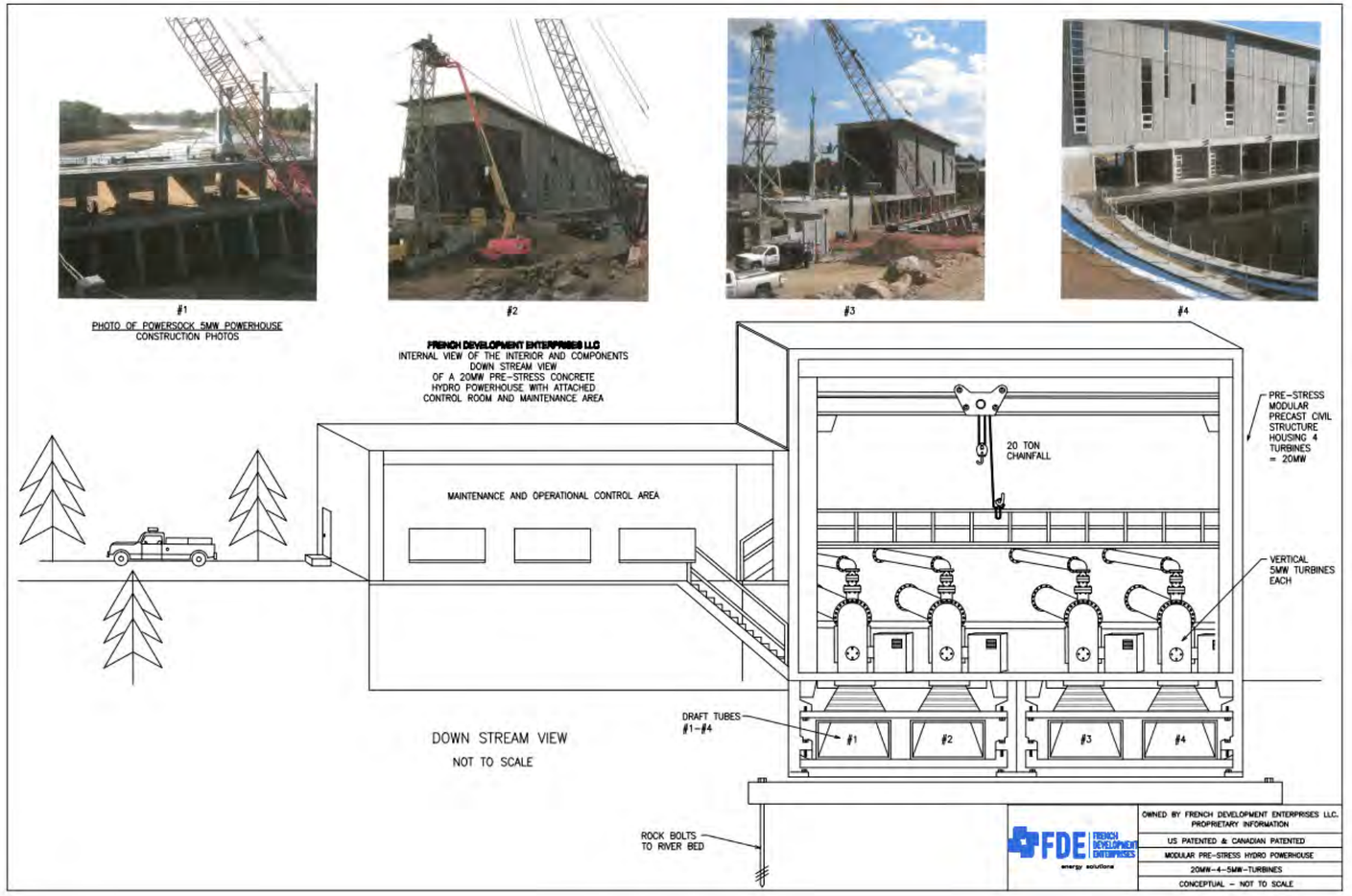
Please watch our videos on the web page just below this presentation

Powerhouse Images using Precast Concrete

Powerhouse was constructed in 2011-2012

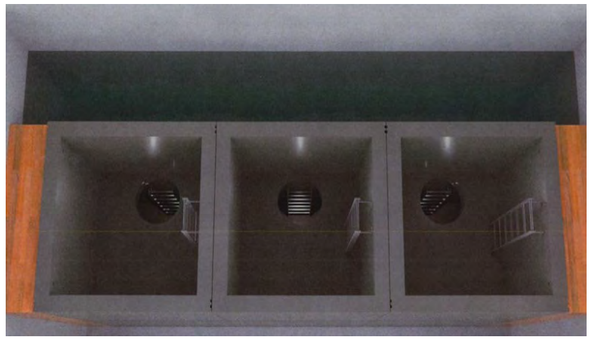
- Bottom is cast-in-place
- Upper structure constructed using precast

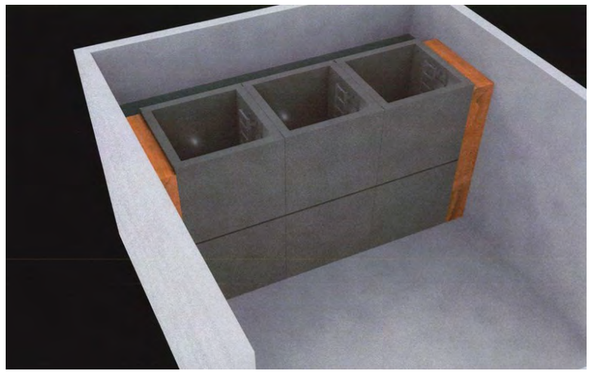
Powerhouse


#1
#2
#3
#4
PHOTO OF POWERSOCK 5MW POWERHOUSE
CONSTRUCTION PHOTOS
FRENCH DEVELOPMENT ENTERPRISES LLC
INTERNAL VIEW OF THE INTERIOR AND COMPONENTS
DOWN STREAM VIEW
OF A 20MW PRE-STRESS CONCRETE
HYDRO POWERHOUSE WITH ATTACHED
CONTROL ROOM AND MAINTENANCE AREA
MAINTENANCE AND OPERATIONAL CONTROL AREA
20 TON
CHAINFALL
PRE-STRESS
MODULAR
PRECAST CIVIL
STRUCTURE
HOUSING 4
TURBINES
= 20MW
VERTICAL
5MW TURBINES
EACH
DRAFT TUBES
#1-#4
#1
#2
#3
#4
DOWN STREAM VIEW
NOT TO SCALE
ROCK BOLTS
TO RIVER BED
FDE
FRENCH
DEVELOPMENT
ENTERPRISES
energy solutions
OWNED BY FRENCH DEVELOPMENT ENTERPRISES LLC.
PROPRIETARY INFORMATION
US PATENTED & CANADIAN PATENTED
MODULAR PRE-STRESS HYDRO POWERHOUSE
20MW-4-5MW-TURBINES
CONCEPTUAL – NOT TO SCALE

Modular Precast is Universal to all Modular Turbines

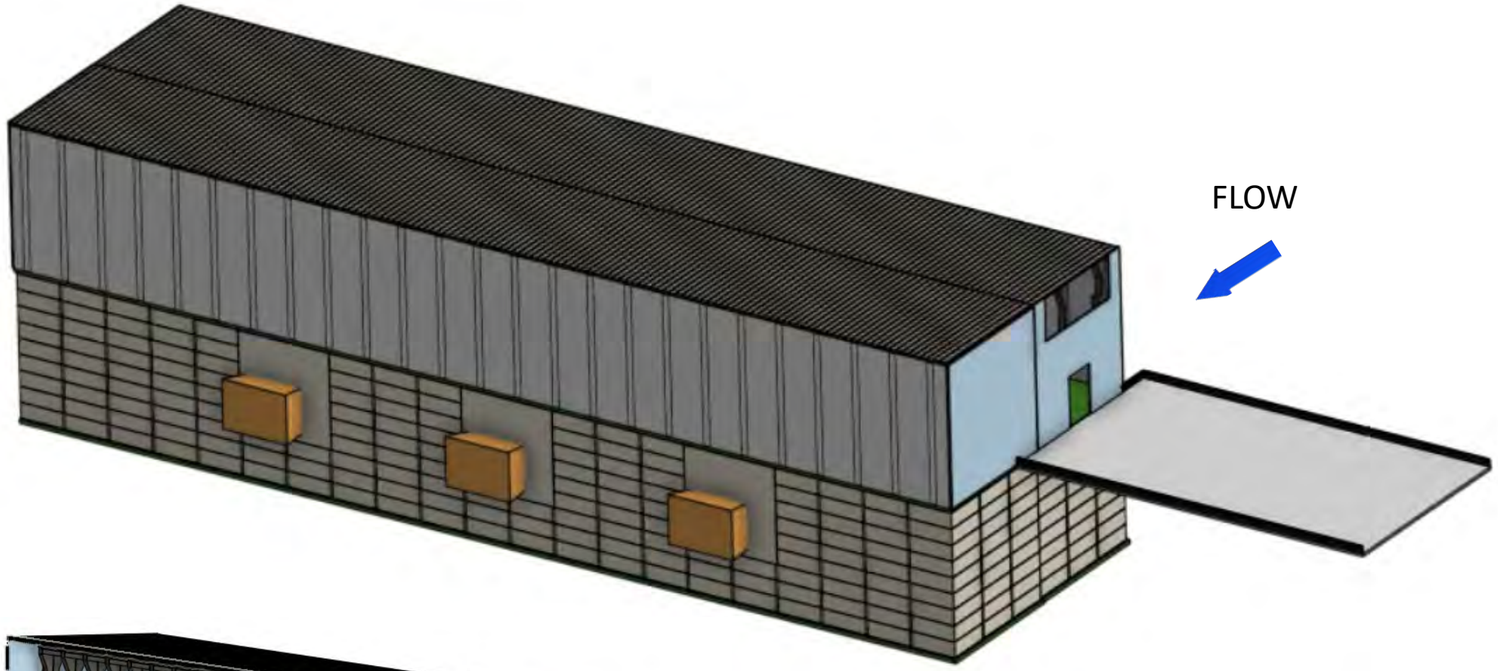
The modular powerhouses can be configured to accept many families of turbine, generator and pump combinations.

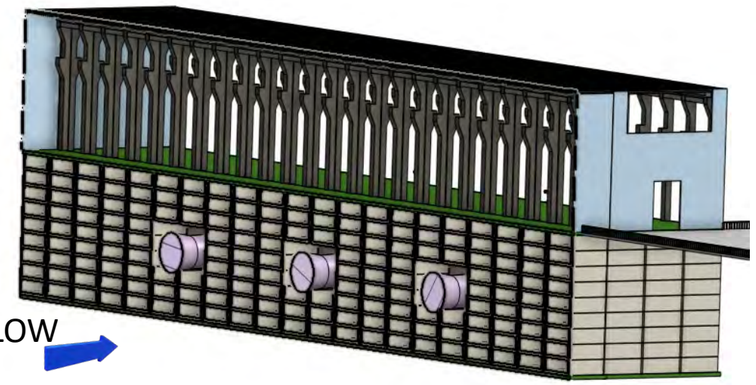




Large Powerhouse Dam (500 to 2000MW)

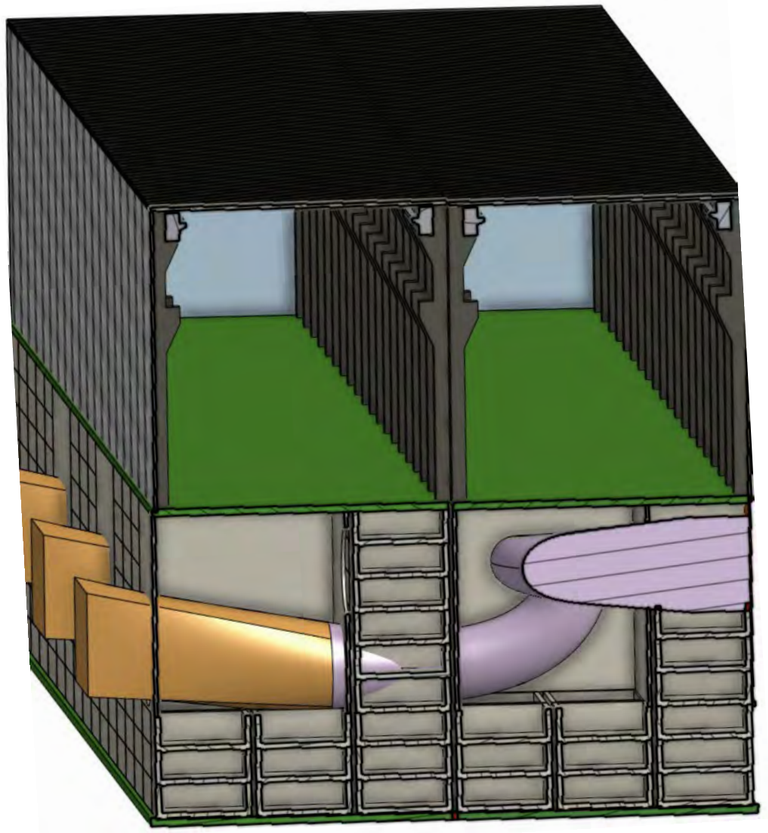
CAD Precast Modules



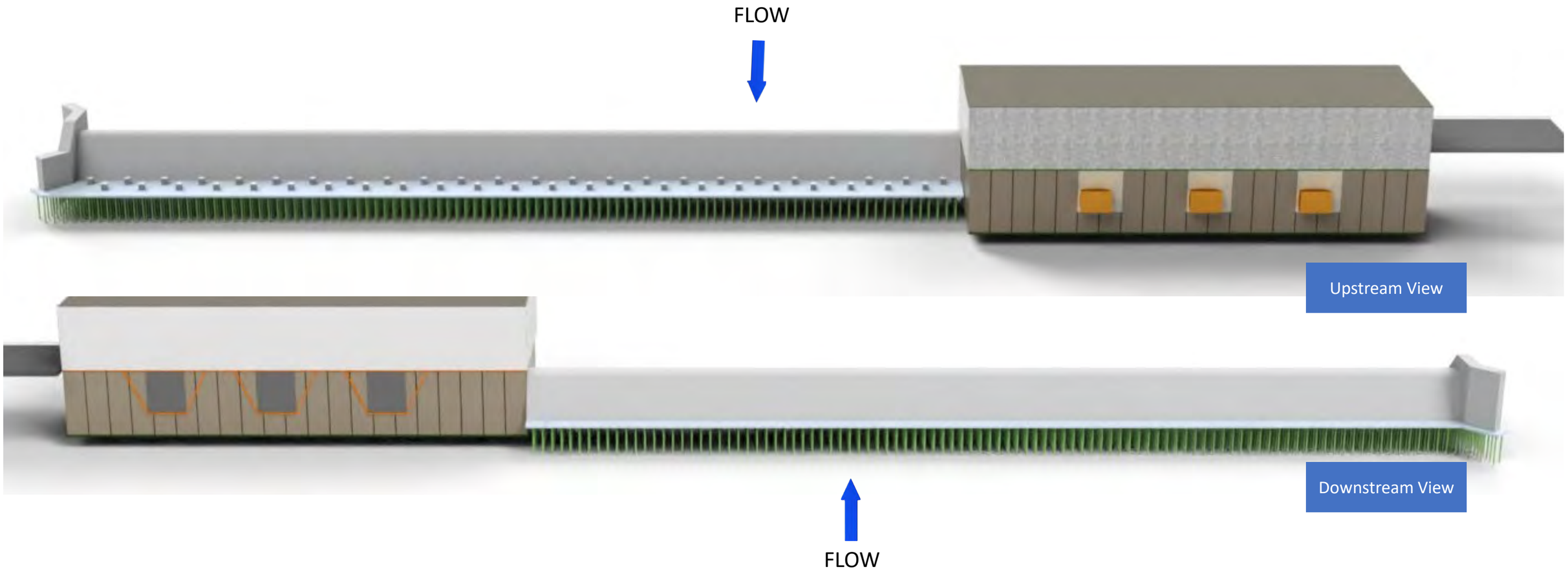


Scalable modular precast for any
Height x Flow

Configurations based on site specific information

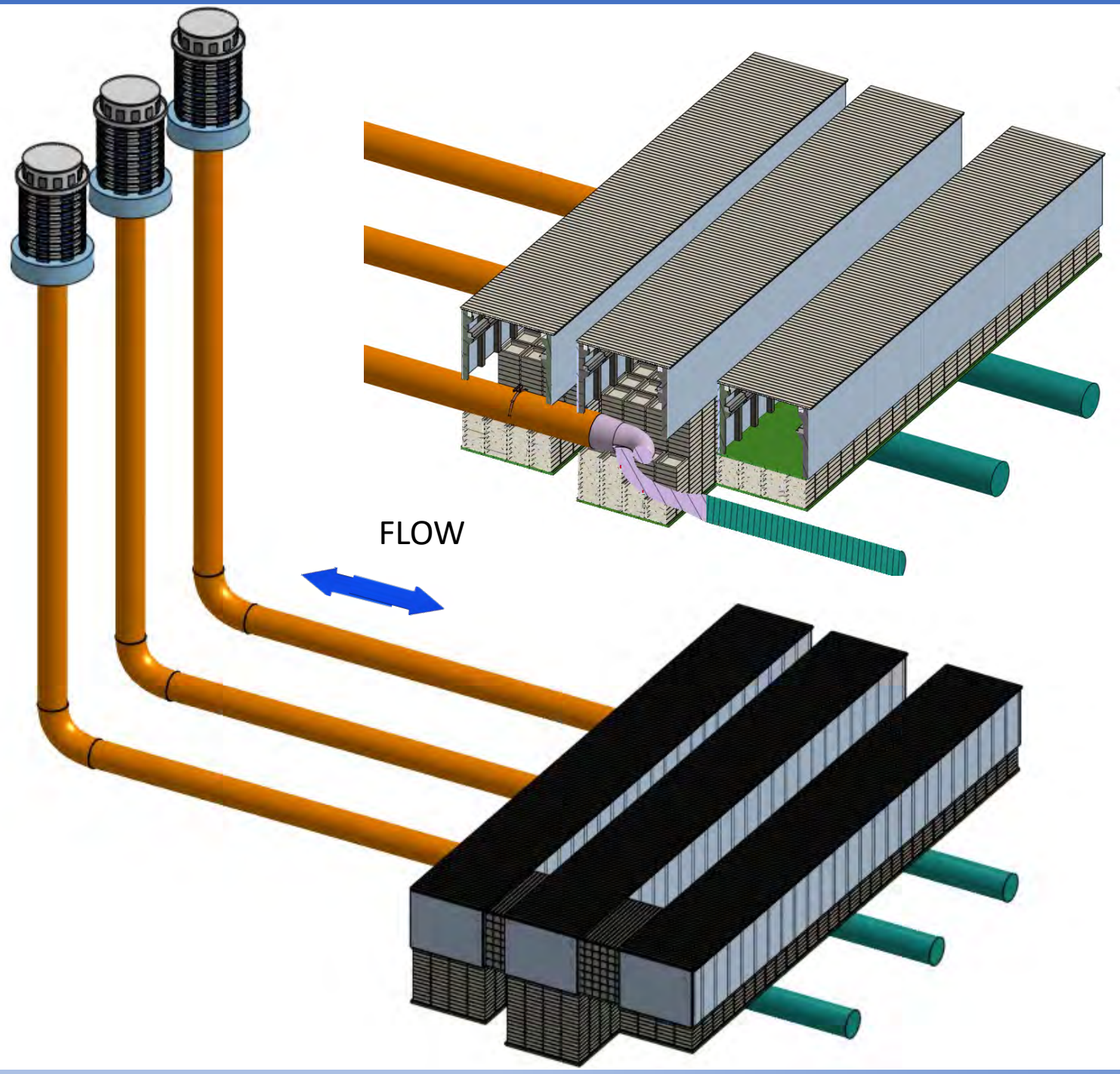


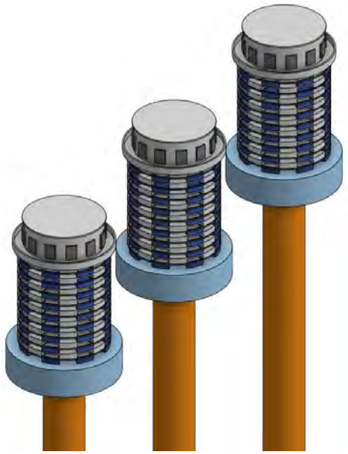
Large Powerhouse Dam
CAD Rendering

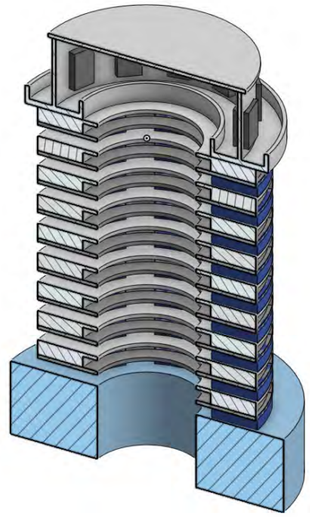


Pump Storage Hydro

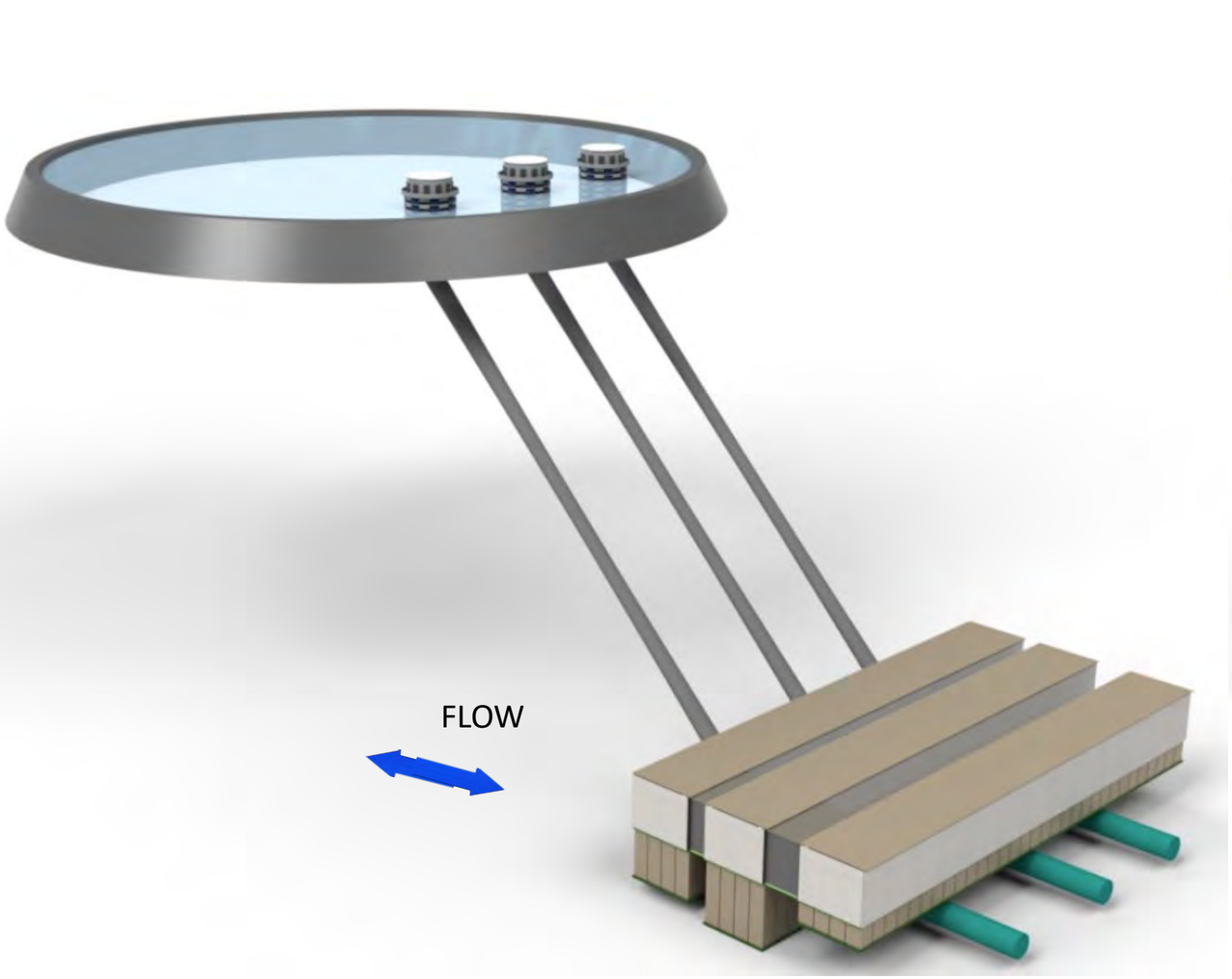
CAD Precast Modules

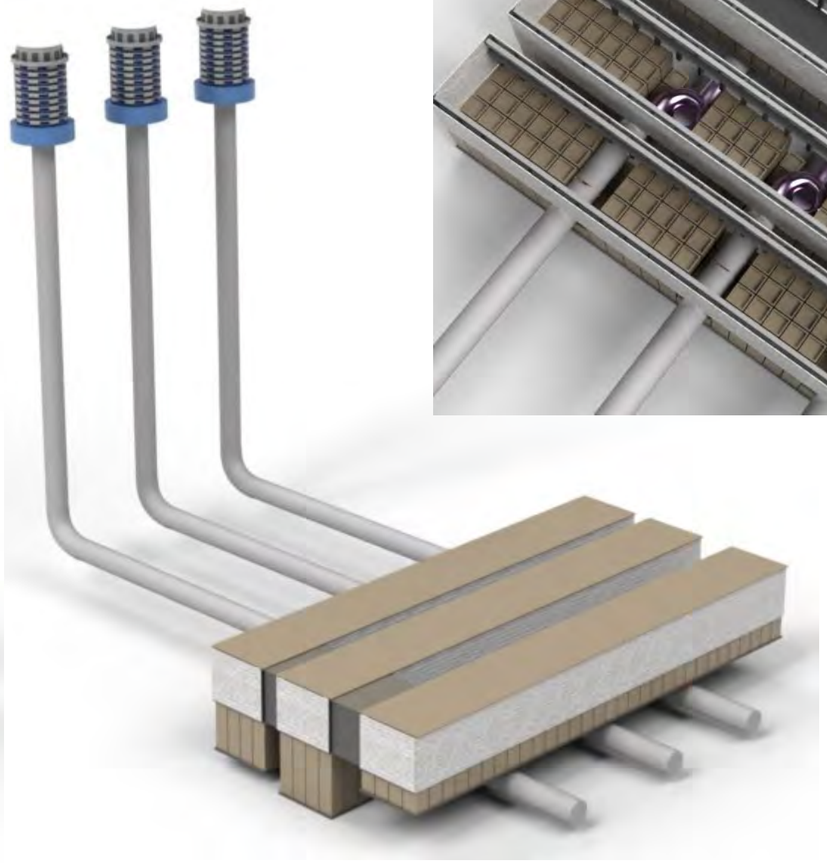


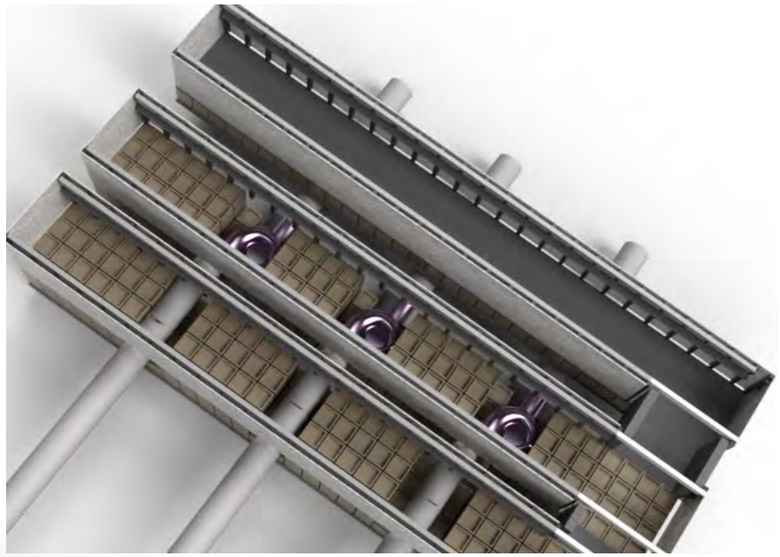




Pump Storage Hydro
CAD Rendering



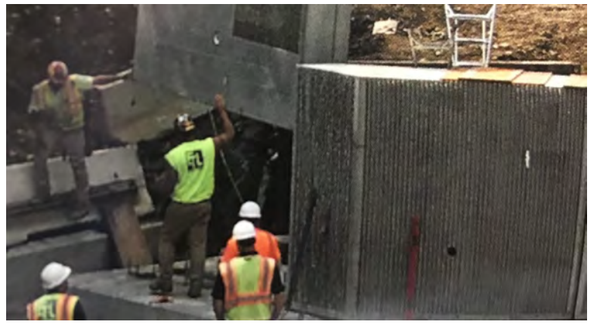




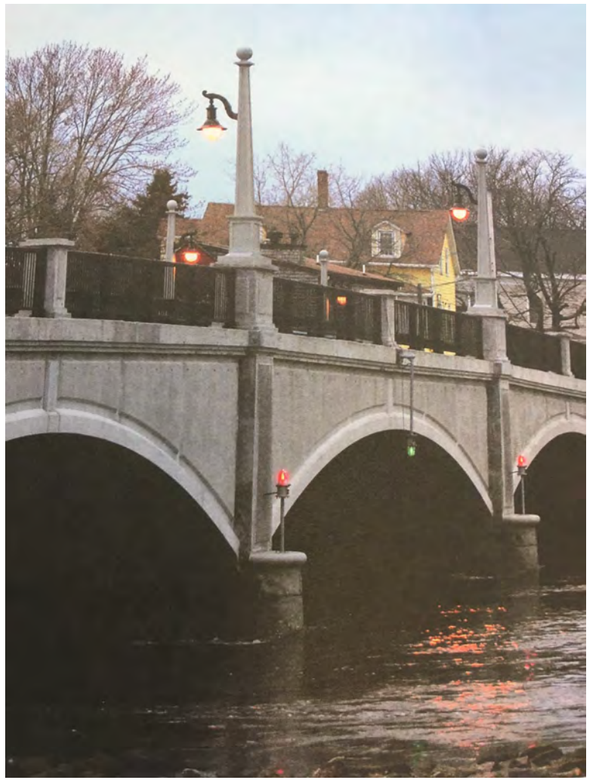
Return to Summary

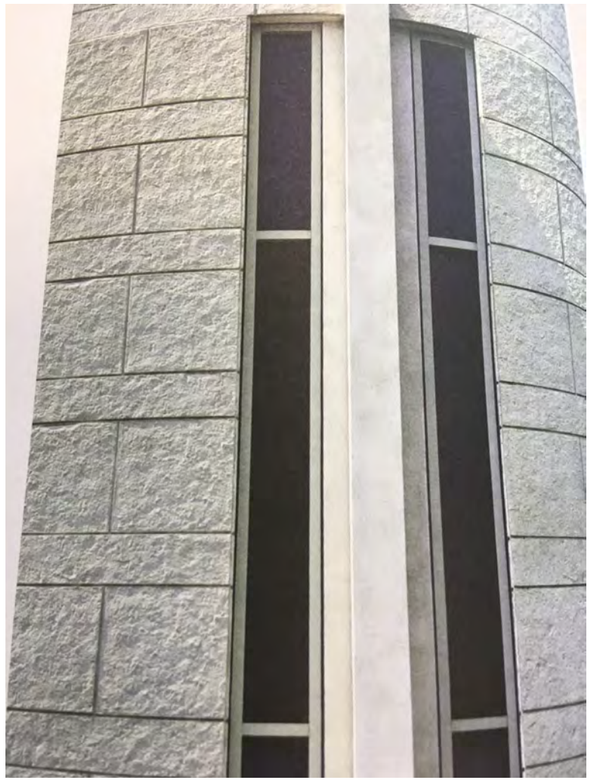
Precast Finishes

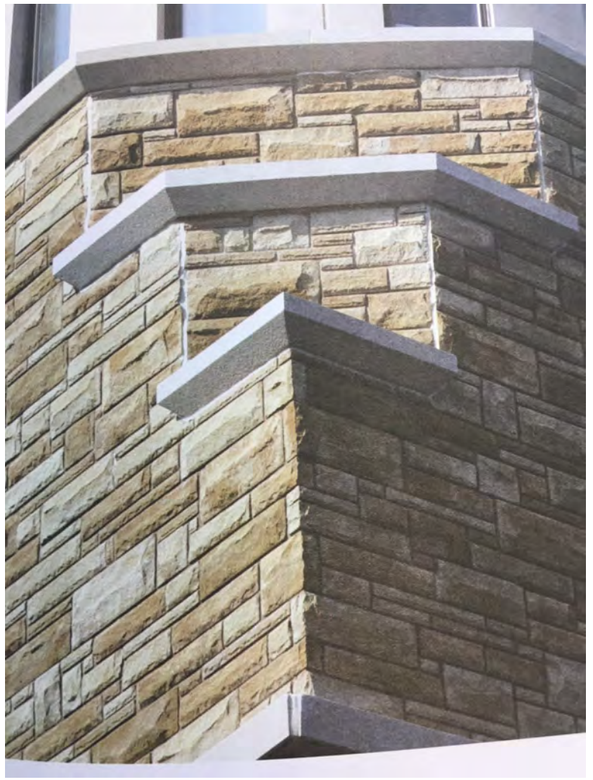
Precast Finishes



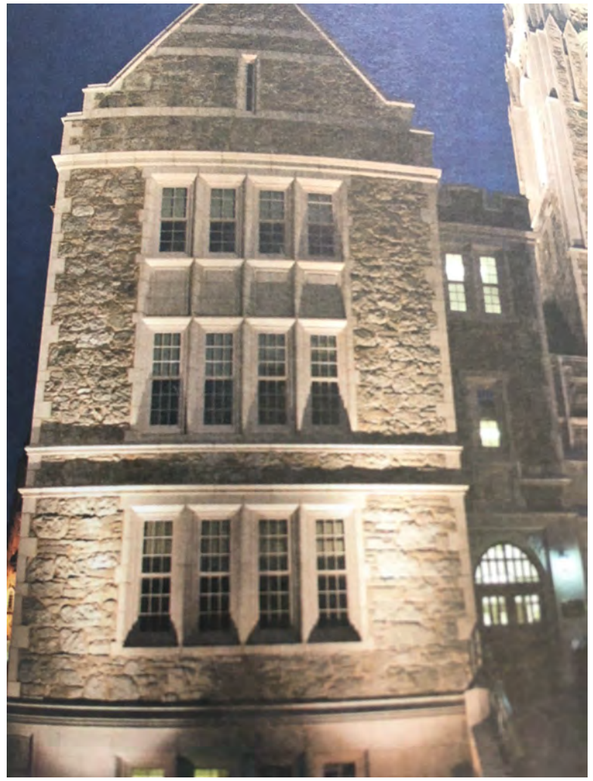
Advances in Precast Finishes

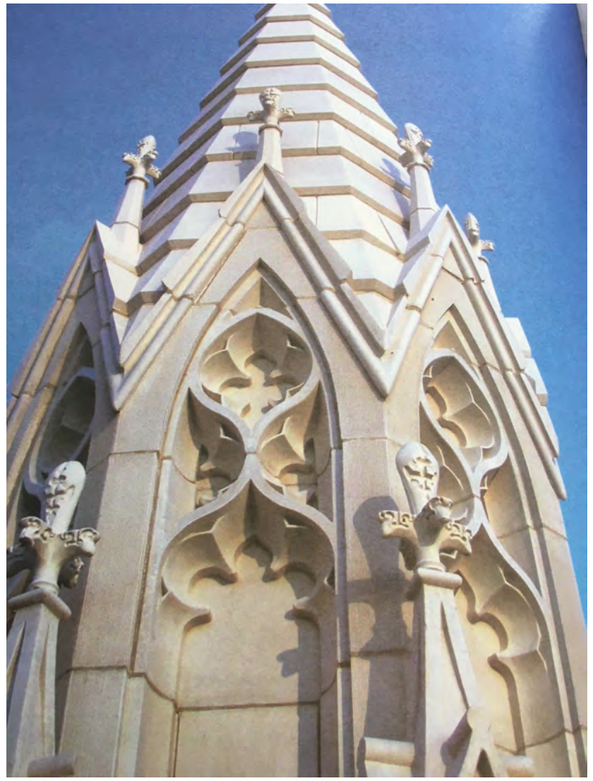






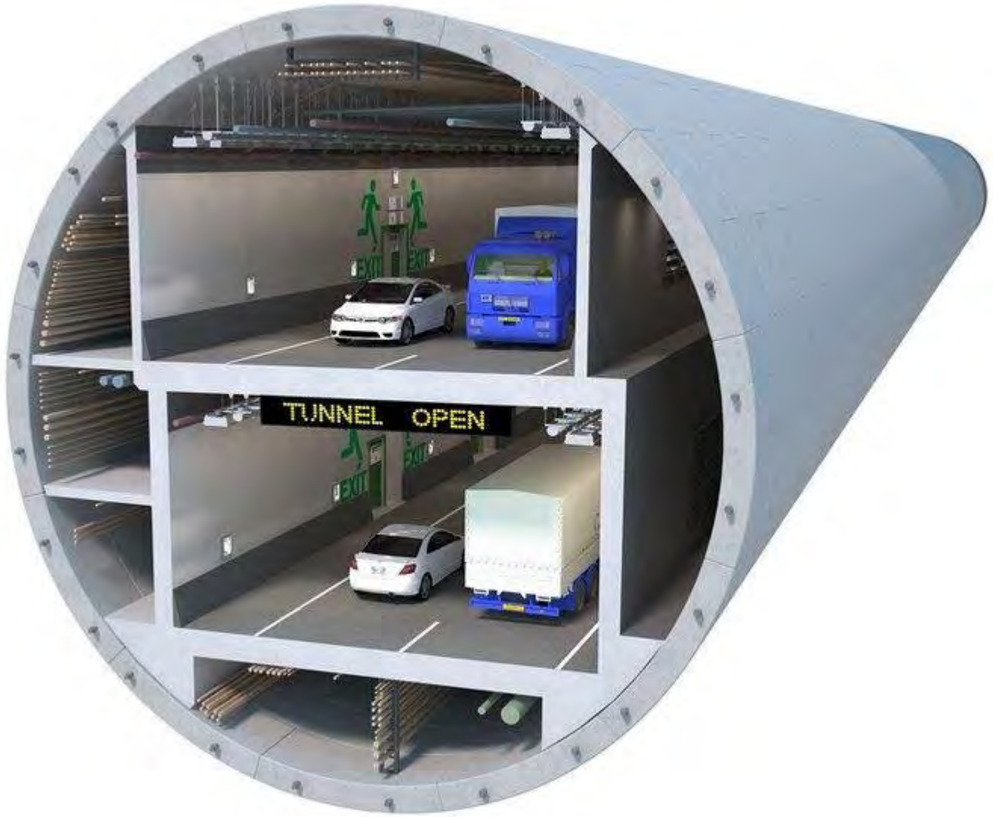
Advances in Precast Finishes Creating Fantastic Buildings





Precast in Tunnel Construction

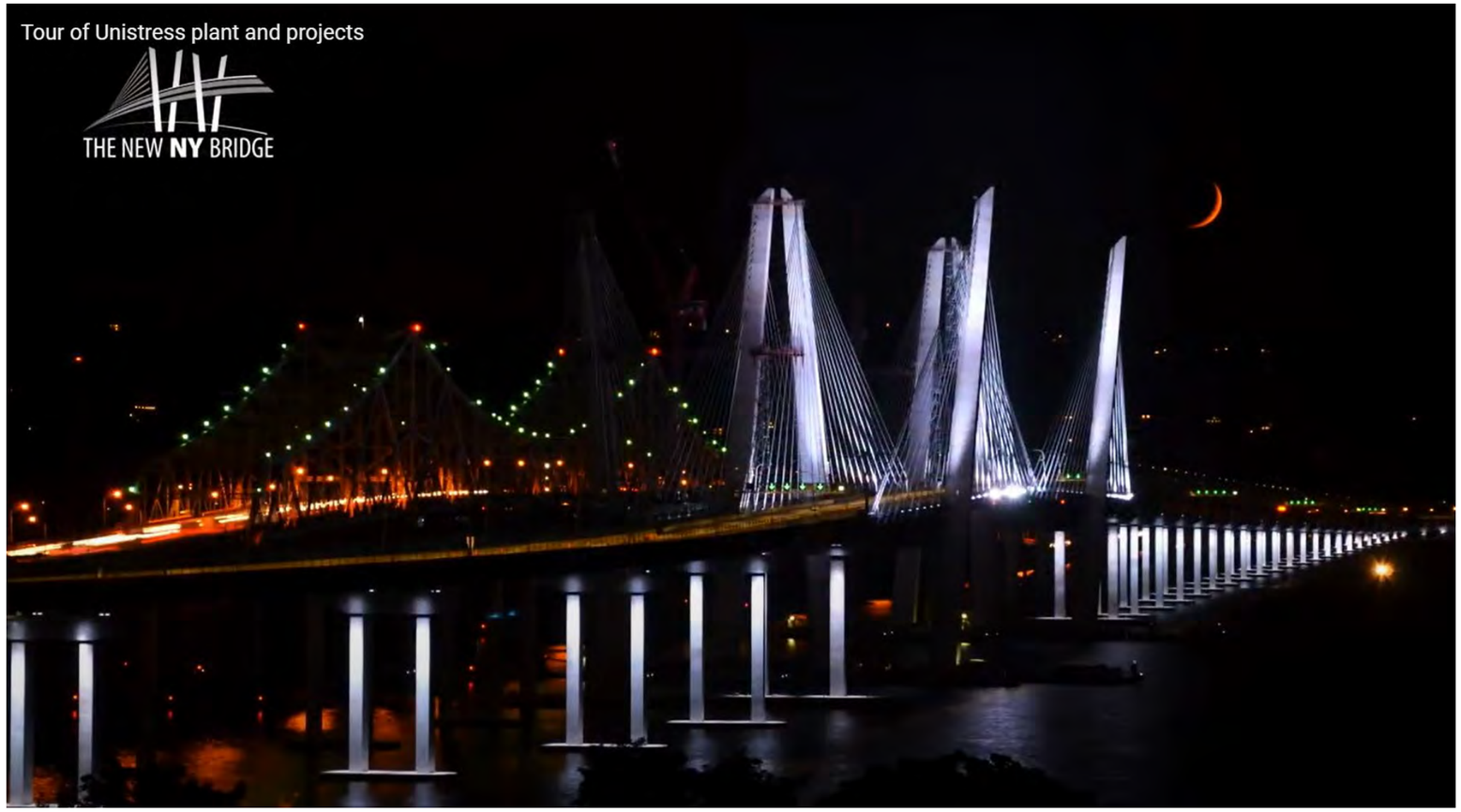
Applications to large water conduits and Penstocks



Large Scale Precast Facility at Work

Tour of Unistress plant and project
<click below to start video>

[Unistress Plant and Project]



Ref: https://www.unistresscorp.com/

Return to Summary

Dam
Site Selection

FDE Modular Civil Solution Advantages

Top utility executives' priorities when building a new energy asset

Lower risk to all stakeholders

Much quicker Return on Investment (ROI)

Newest innovation in materials, equipment and construction means and methods

Modular precast provides 100-year service life (longer than other energy assets)

Environmental, Social and Governance (ESG) solution

Features Hydro provides others do not (black start, energy on demand, flexibility to the grid, load following) hydropower is considered the most resilient and efficient energy source

Modular precast concrete water solutions reduce major risk reduction for project stake holders

Modular precast hydro power's Capacity Factor (3x other needed renewables)

Modular Hydro power can be constructed at lower cost, below other renewable energy assets

Site Selection Should Consider Project Requirements
Project phase considerations and solutions

New

New Dam

New Pump Storage Impoundment

Power Non-power Dam

Run of the river

Retro-Fit

Replace leaving dam in place (minimal disruption to silt and pollution)

Repair

Repair existing Non-power Dam (or replace)

Repair existing Powered Dam (or replace) impoundment, spillway or powerhouse

Mine tailing impoundment, with precast water cut walls with wick drain and lower elevation

Improve

Powered dam to higher power level

Smart sustainability and resilient, adjustable hydraulic operated spillway.

Modular upgrades, adding future power and dam control features

Fish passage to greater number of passage lower turn backs

Site Evaluation

Site Evaluations must be conducted by Licensed Professional and should consider

Engineering Survey / Geological Survey

Hydrologist Survey and River parameters

Site access / Heavy equipment / Platforms and work areas

Laydown area / Staging area / Barge movement

Licensing/ Permitting

FERC “Licensing”

Bureau of Reclamation “Lease of Power Privilege”

EPA (State and Federal)

Others

Return to Summary

Dam Design

Designing Precast Dams and Powerhouses Software Specifically for Modular Precast

Tekla Software

Developed for Design of Modular Precast Units for Dams Powerhouses Conduits Interconnected Switch Rooms

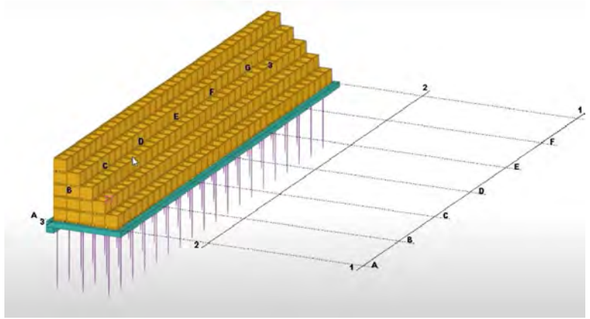
A short review of Tekla functionality for utility precast can be found here:

[YouTube Video of Tekla Software in action]

Large Dam

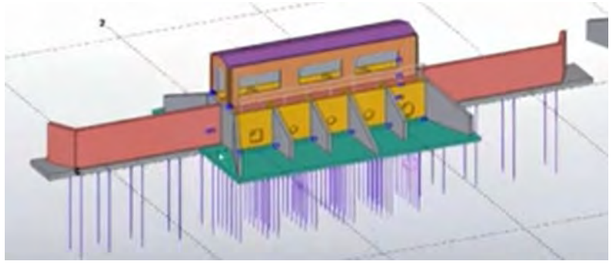
[French Modular Dam designed using Tekla Software]

Play the video by simply clicking on the link. Sometimes due to internet connection speed, the resolution quality can be somewhat low. If this is the case, download the video to your desktop and then play it from there. For any questions regarding the Tekla Structures software contact Bill French Sr.

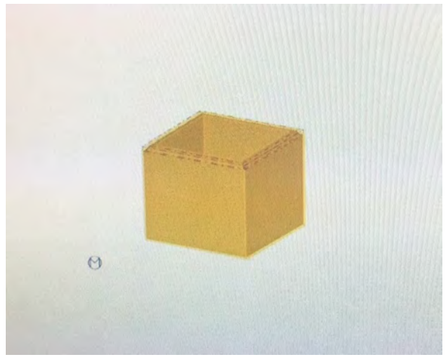


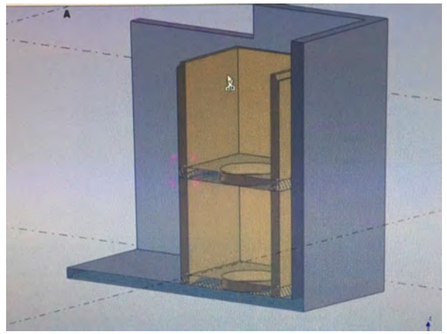
Powerhouse

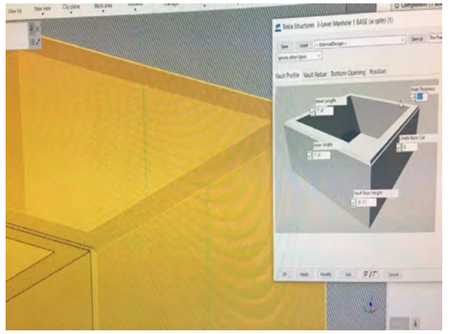
[French Modular Hydro-Powerhouse]

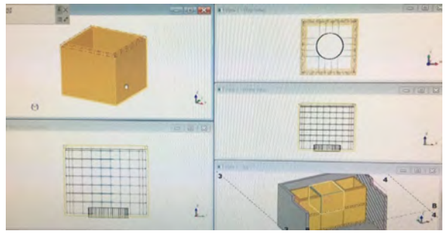


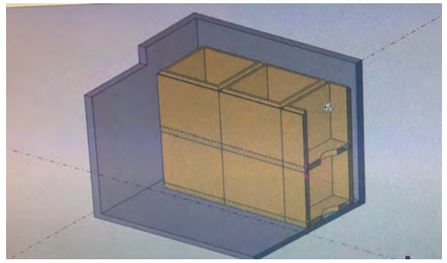
Modular Precast Design

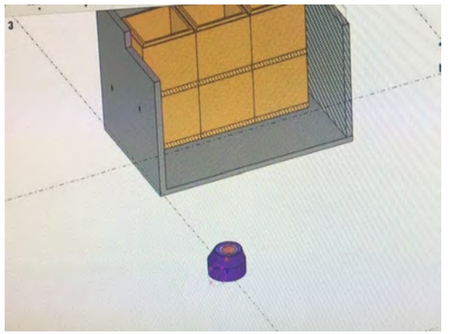




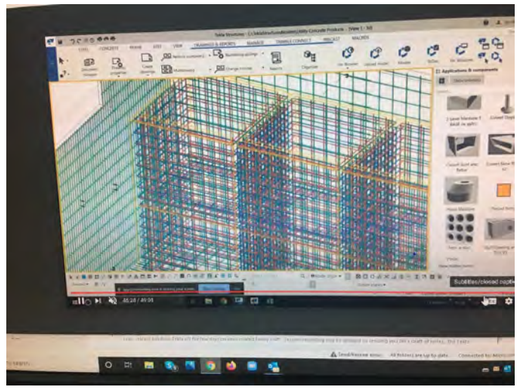


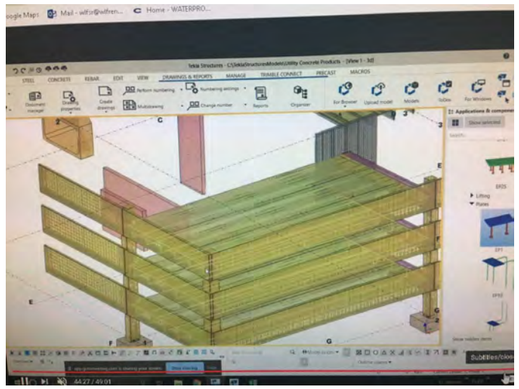


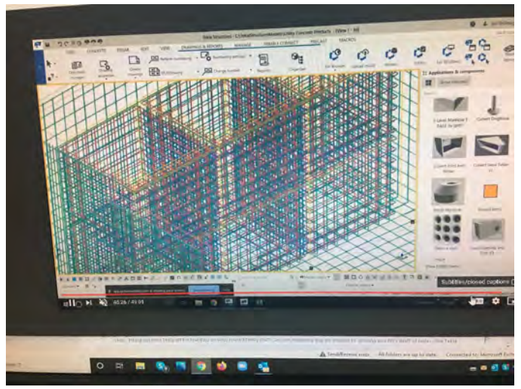


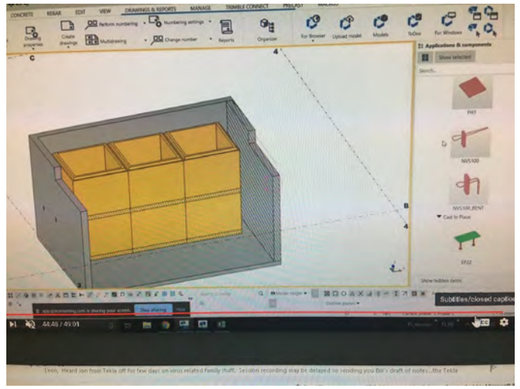


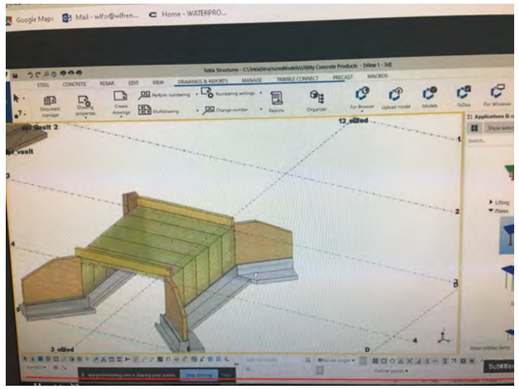
Including Design of
Rebar Structures, Crane Lifts and Assembly

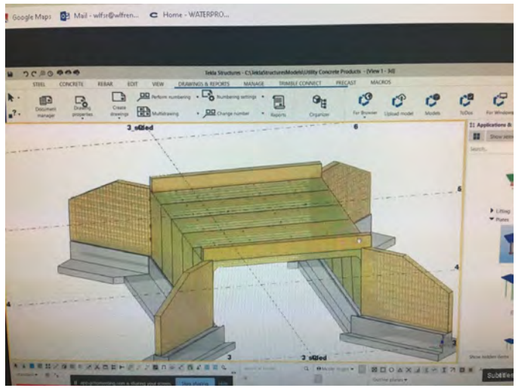


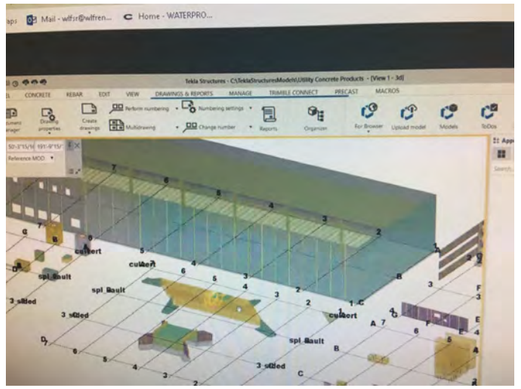








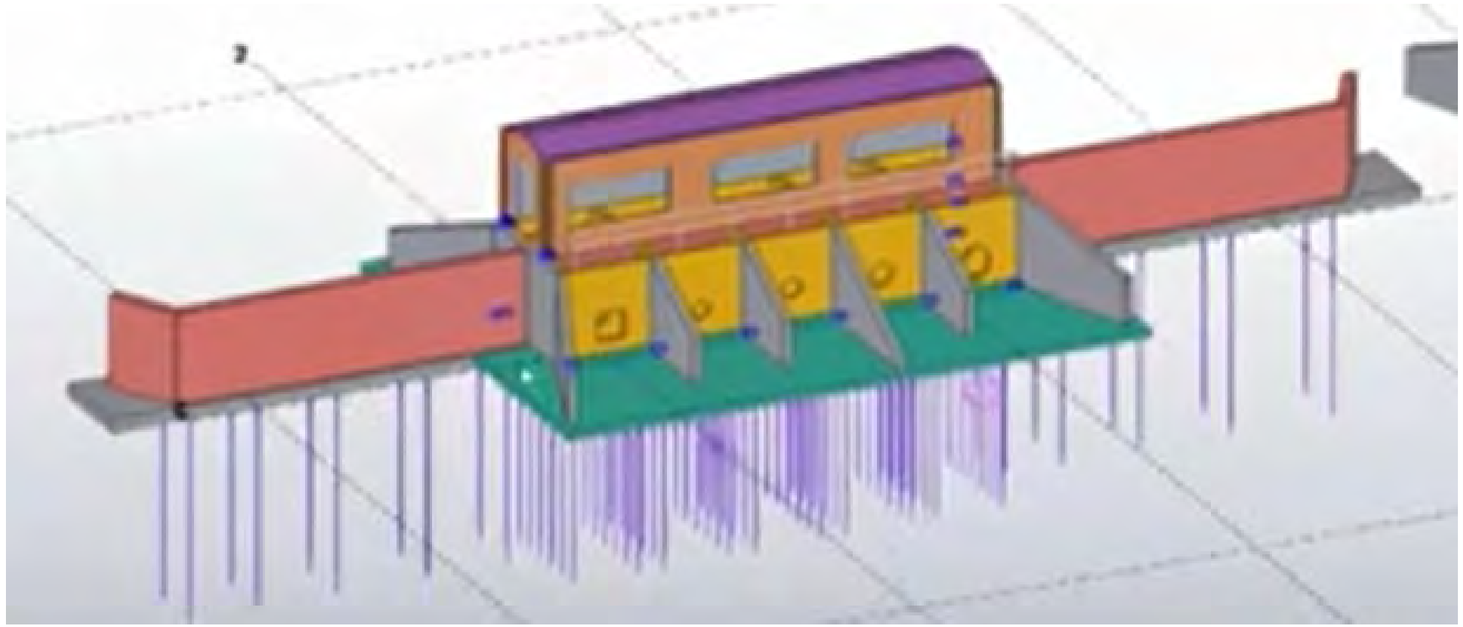




Create Designs to Connect with the Site Bed Rock

Rock Bolts to anchor dam’s work platform and abutments to site bedrock

Powerhouse and Rock bolts



Power Interconnect

Powered Dams required:

Power interconnects,
Transmission lines
Switching stations

Design should consider:

Construction Staging Area
Crane lifts
Material

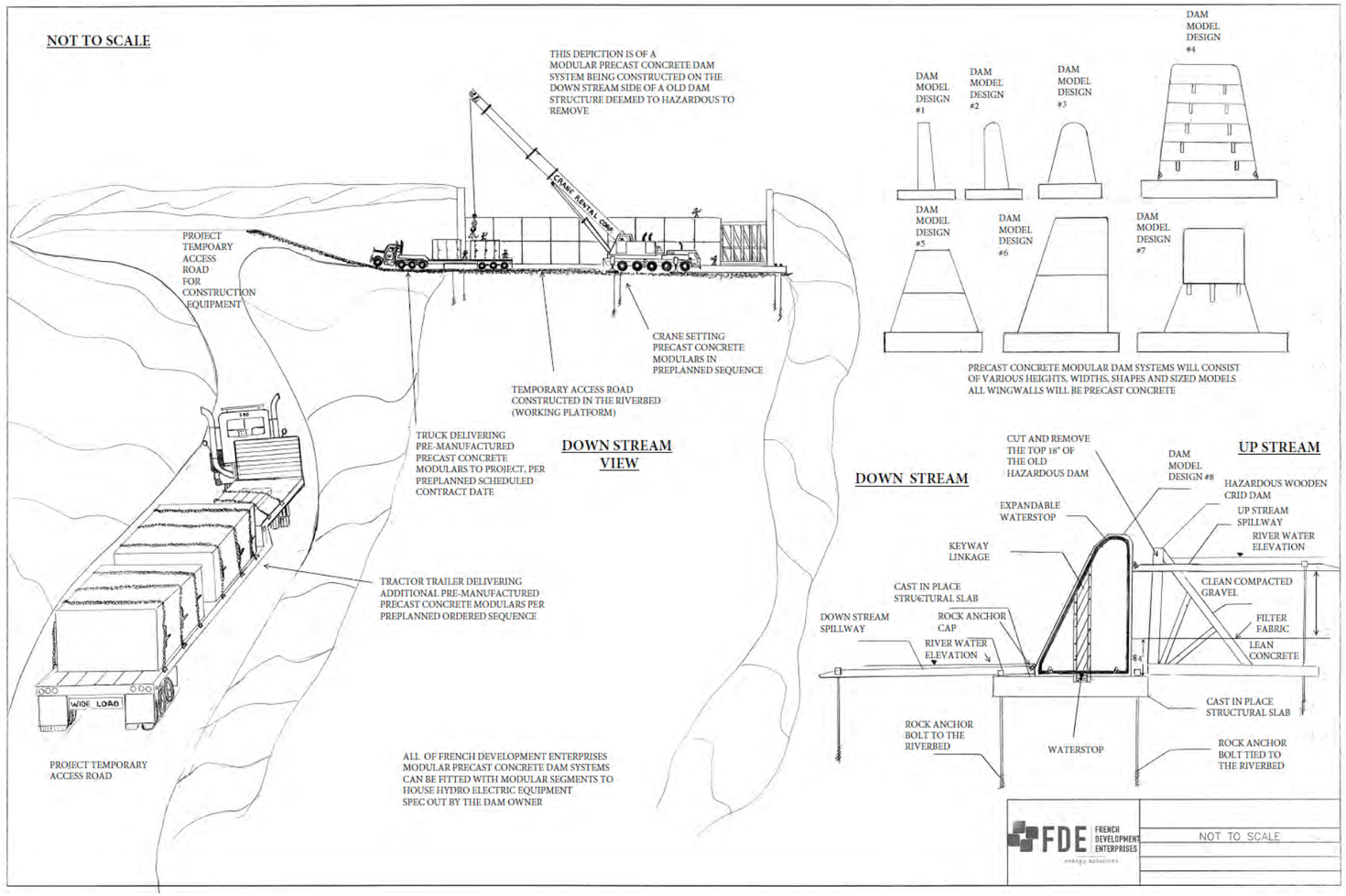
Low Environmental Impact
Road Access and Crane pad

Modular Precast Solution requires less time to construct.

Less time in river and at site

Less overall construction equipment over life of development job.

Access roads and Crane pads will be constructed of local stone to reduce the impact to site during and after construction.



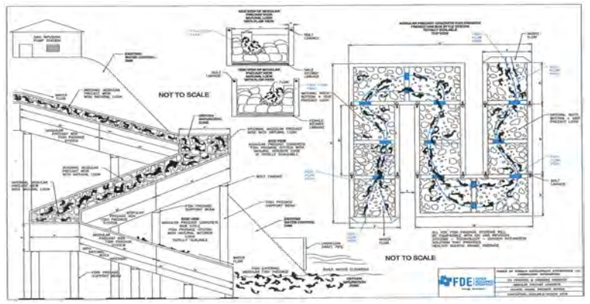
Modular Designed Dams and Powerhouses
Are Fish Friendly with Advanced Modular Fish Passage

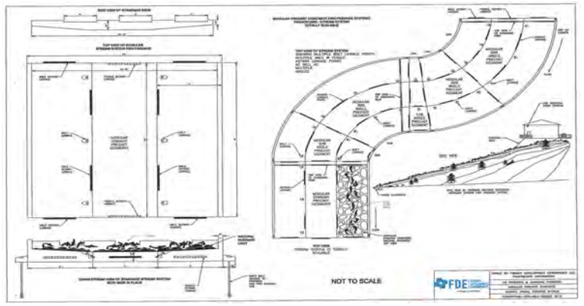
Fish Passage is a primary environmental concerns for dams

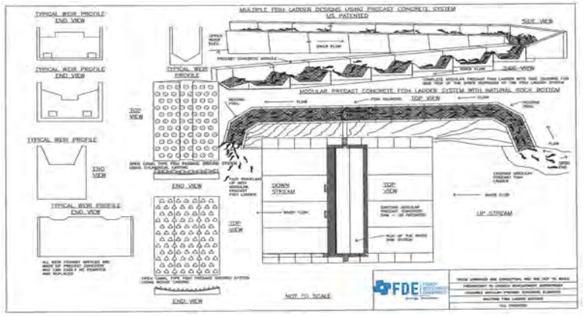
FDE Hydro patents cover pre-cast modular fish ladder and in partnership with Biomark™ we offer a solution to this key environmental challenge.

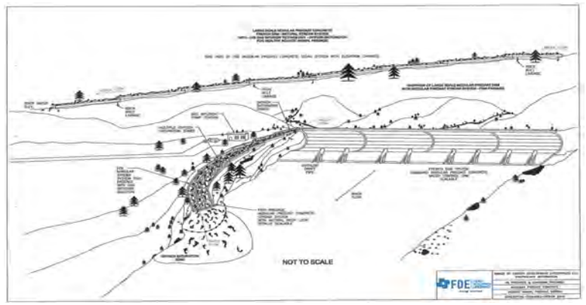
System ready for testing and deployment –Plug and Play

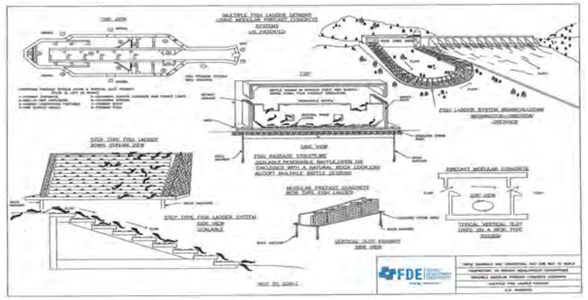
Fish ladder designed by aquatic engineers (Huntsman Marine Institute) Biomark™ containerized HyperInfusiO_2n™ Unit

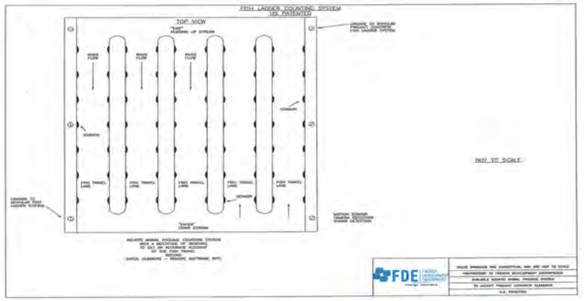






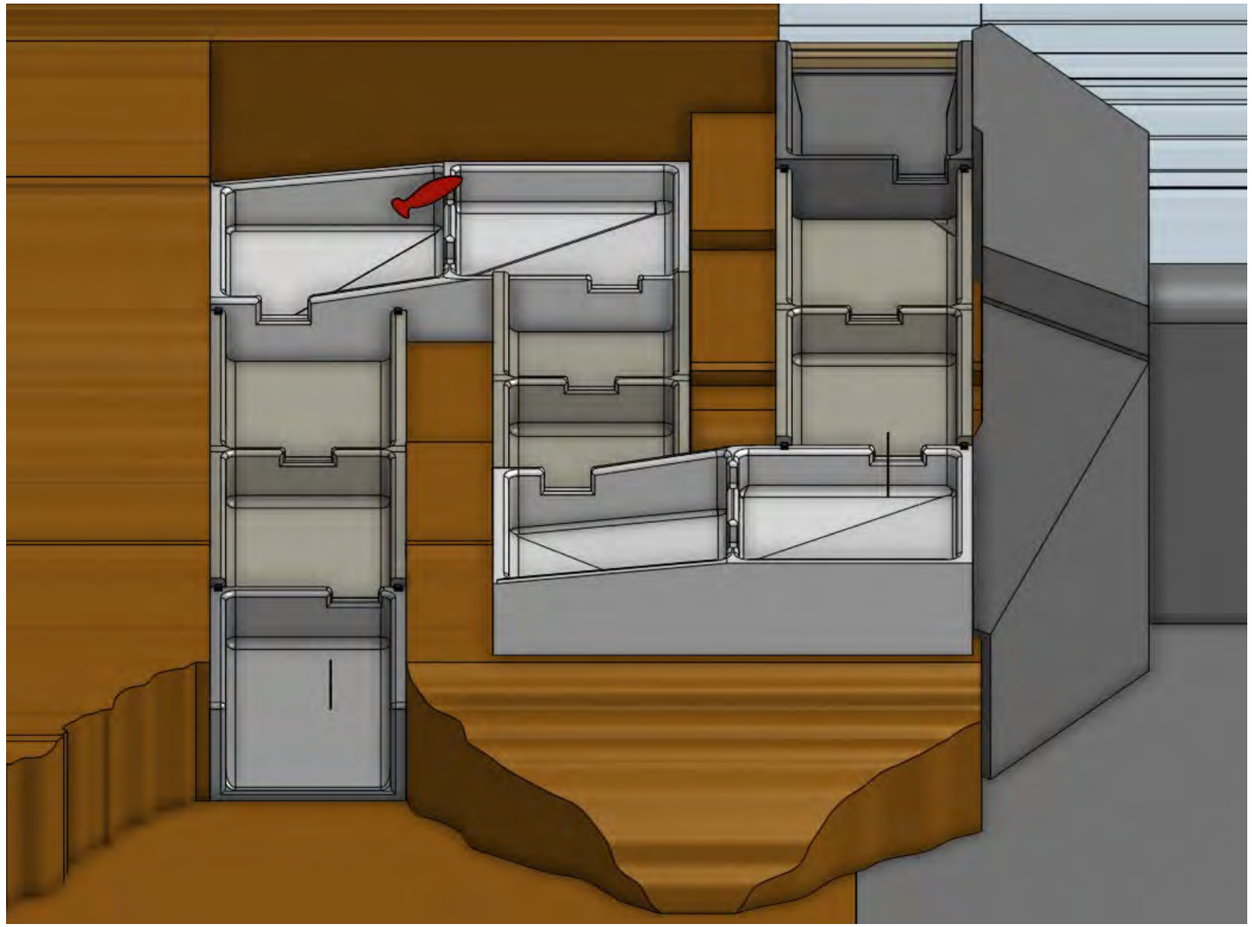


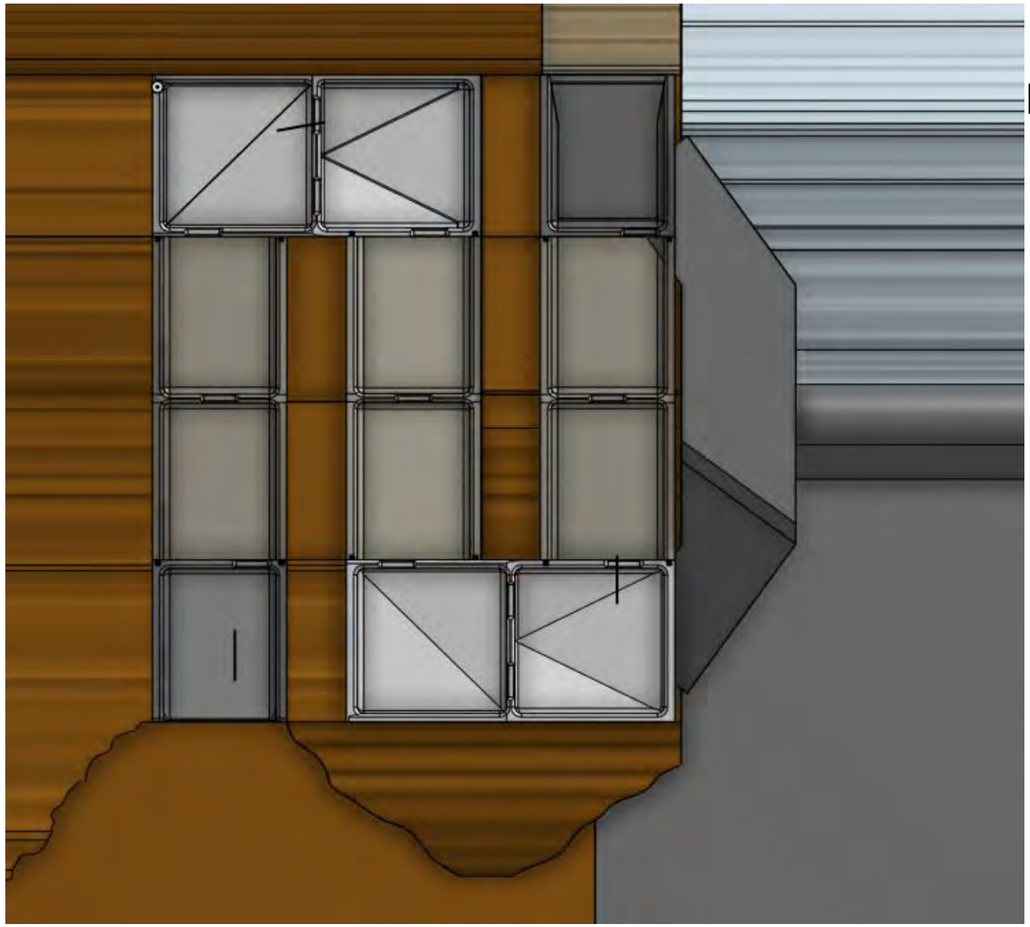




Fishway – Pool & Weir

CAD Precast Modules





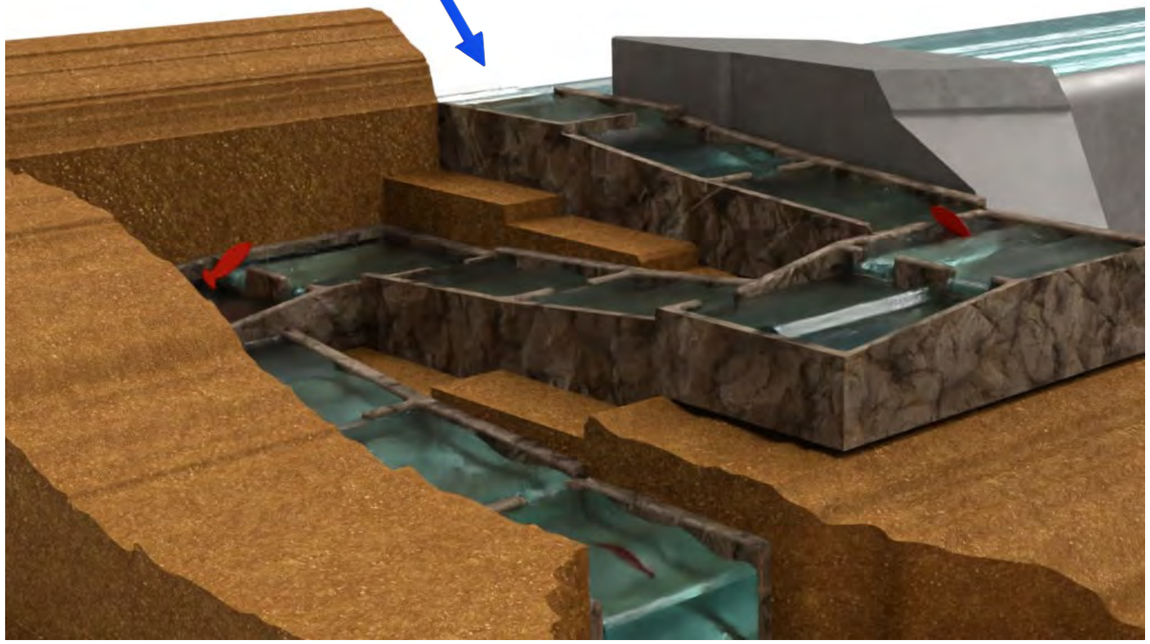
Sloped modular blocks designed according to USFWS specs

Fishways – Pool & Weir

CAD Rendering

FLOW

FLOW



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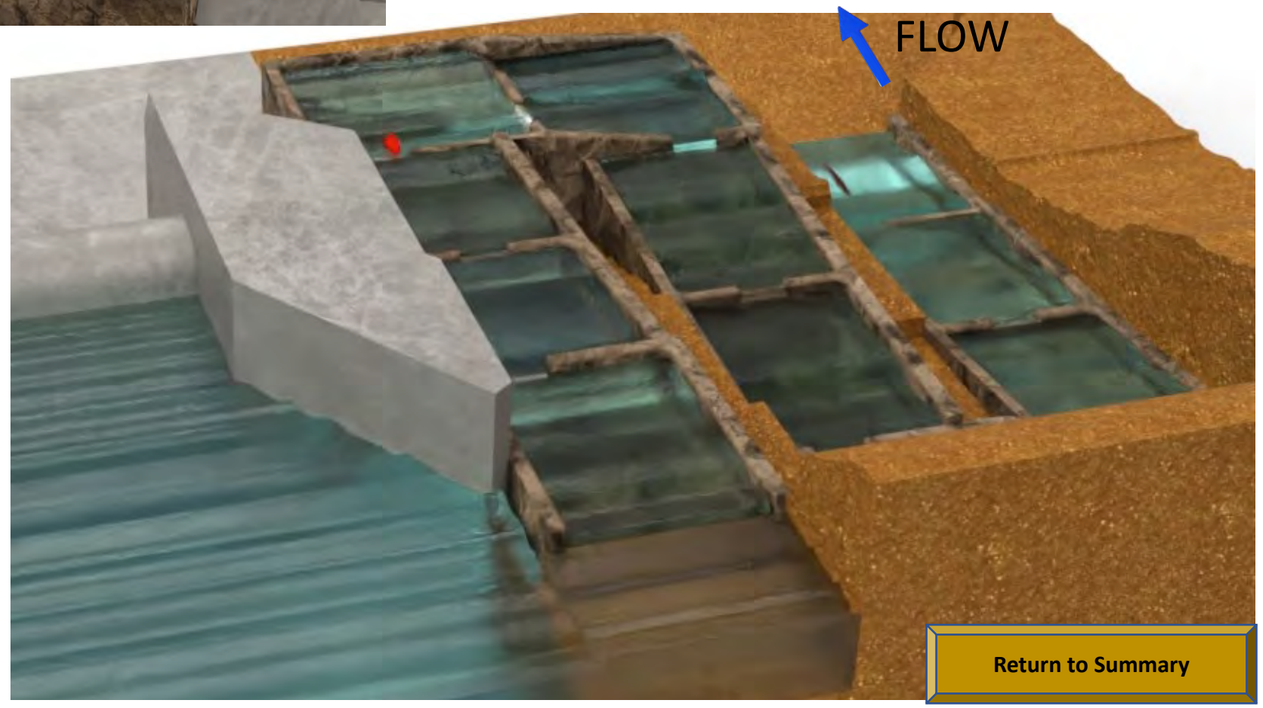

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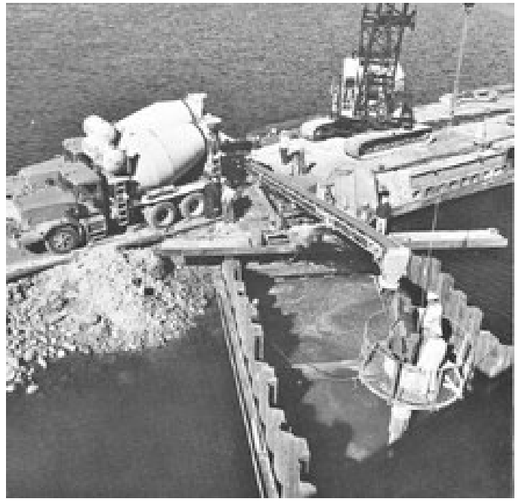
Site Prep

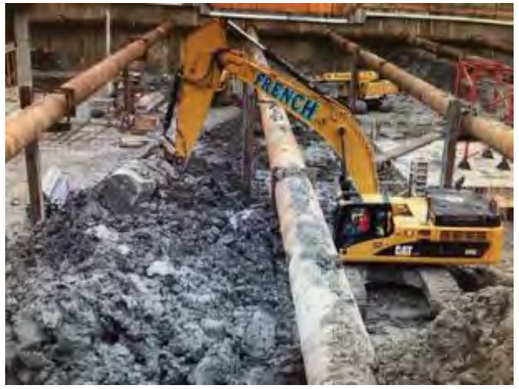
Coffer Dam and Dry working area

Access to work area

WL French +50 years history Heavy Civil

WL French +50 years history Heavy Civil cont.



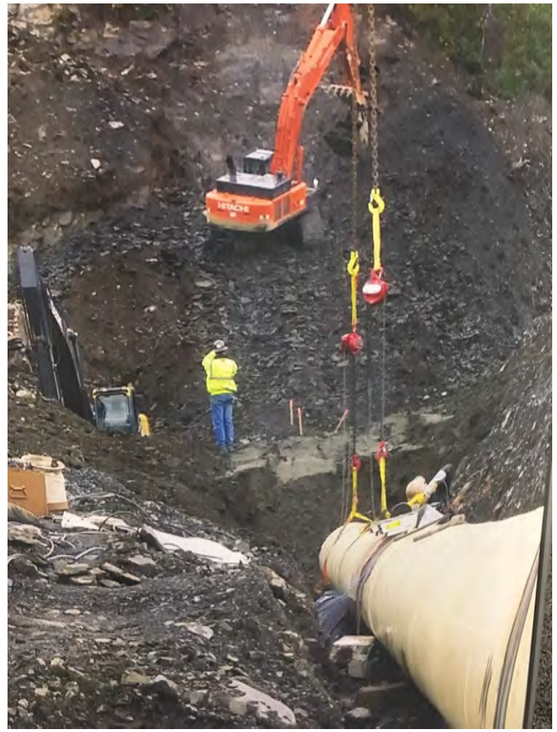


Site Prep, Water control and Access to Work Area

Coffer Dam in the river (Pilings) and next to the river (Berm)

Providing a Dry working area

Access to work area

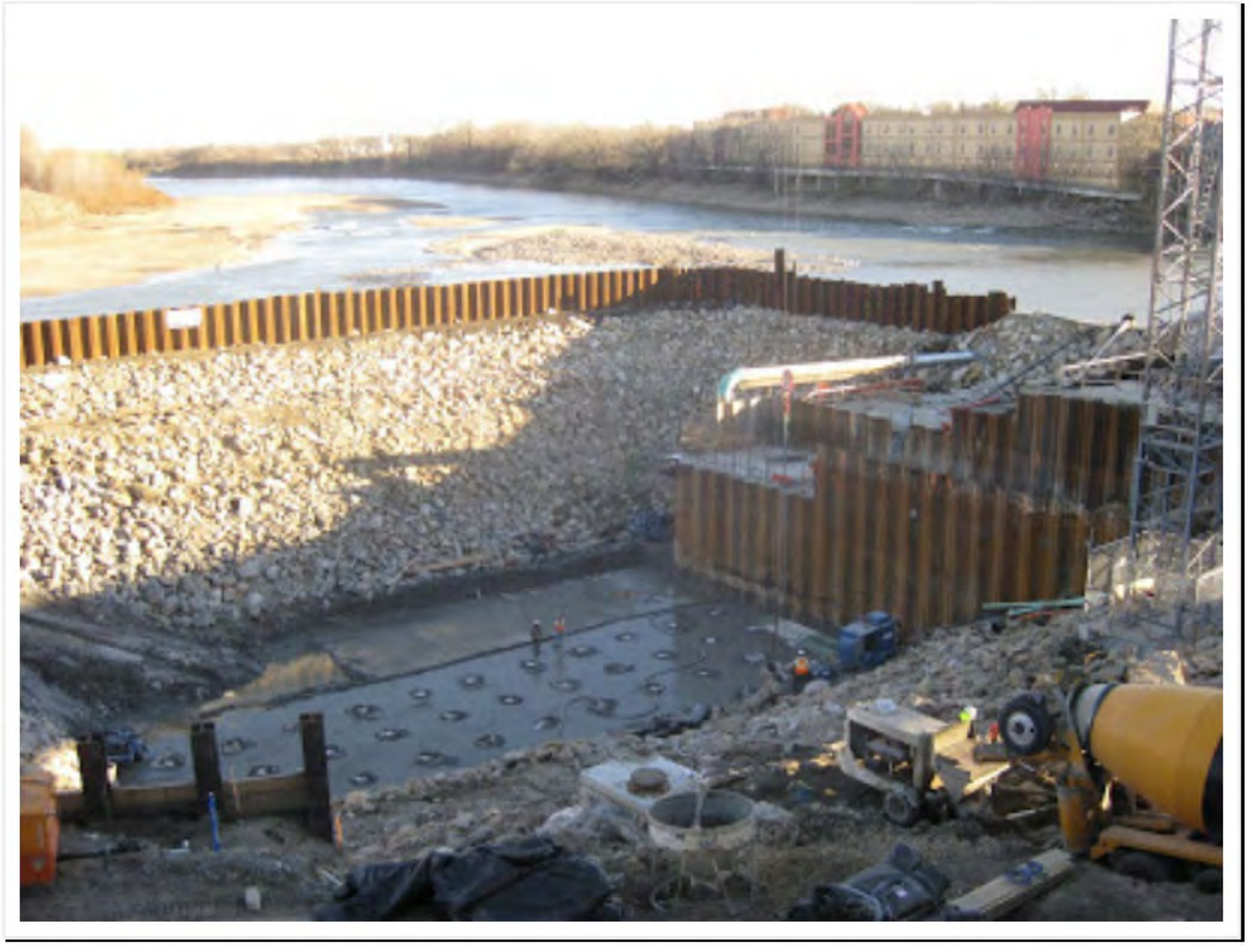


Coffer Dam around CIP work platform

Layout the work platform using a Total Station

A total station is **an optical surveying instrument that uses electronics to calculate angles and distances**. It combines the functions of a theodolite with that of a transit level and electronic distance meter (EDM).

Rock bolts shown in a grid pattern



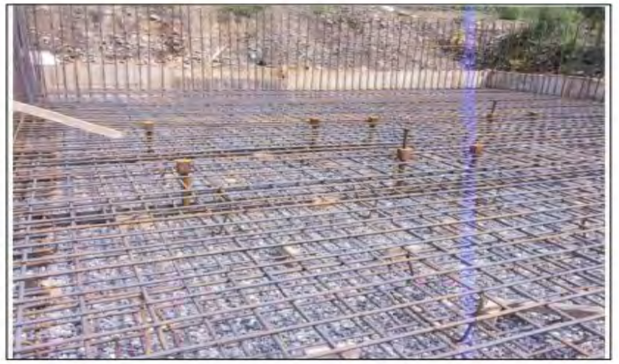
Reference 1: https://www.engineersupply.com/total-stations.aspx

Preparing for Work Platform

French Dam Work Platform

1

2



3

4

5

6

1. PRE–FABRICATED UNDER SLAB LINKAGE
2. WORKING SLAB FORMED WITH UNDER SLAB LINKAGE SET IN PLACE USING GPS
3. REINFORCING ROD IS PLACED AND READY FOR CONCRETE
4. CONCRETE SLAB BEING POURED AND FINISHED
5. WORKING SLAB COMPLETE WITH BOLT LINKAGE IN PLACE
6. AT FINAL REVIEW BEFORE PRECAST MODULAR INSTALLATION. ALL BOLT LINKAGE WAS "DEAD ON"

Precast Module Layout is Critical

Modular Controlled and Predictable Production Sequence

Precast working Platform Module

Positioning Modules

Staging Precast prior to Assembly

Assembly of Modules

Construction of the Precast Modules can be completed
- Wind Swept Rain
- Heavy Down pours
- Minimal crew and crane operators
  (Test site was completed in 3 ½ hours in rain)

For CIP construction these conditions would have sent the crew home with pay
- No work complete (schedule delay)
- Cost over run

Weather can affect a site for days to weeks

Return to Summary

EPC to Commissioning

Return to Summary