AUTODESK UNIVERSITY

Big Innovyze for Small Town in Brazil

CES502779 - Caarapó, MS, Brazil

Fernando Figueiredo | Schettini, BIM Consultant
Ryan Brown | Innovyze, System Engineer
Newton Caxeta | PARS, Technical Specialist
Raírio Mota | Pro System, Civil 3D Instructor
Matheus Barros | UnB, BIM Manager

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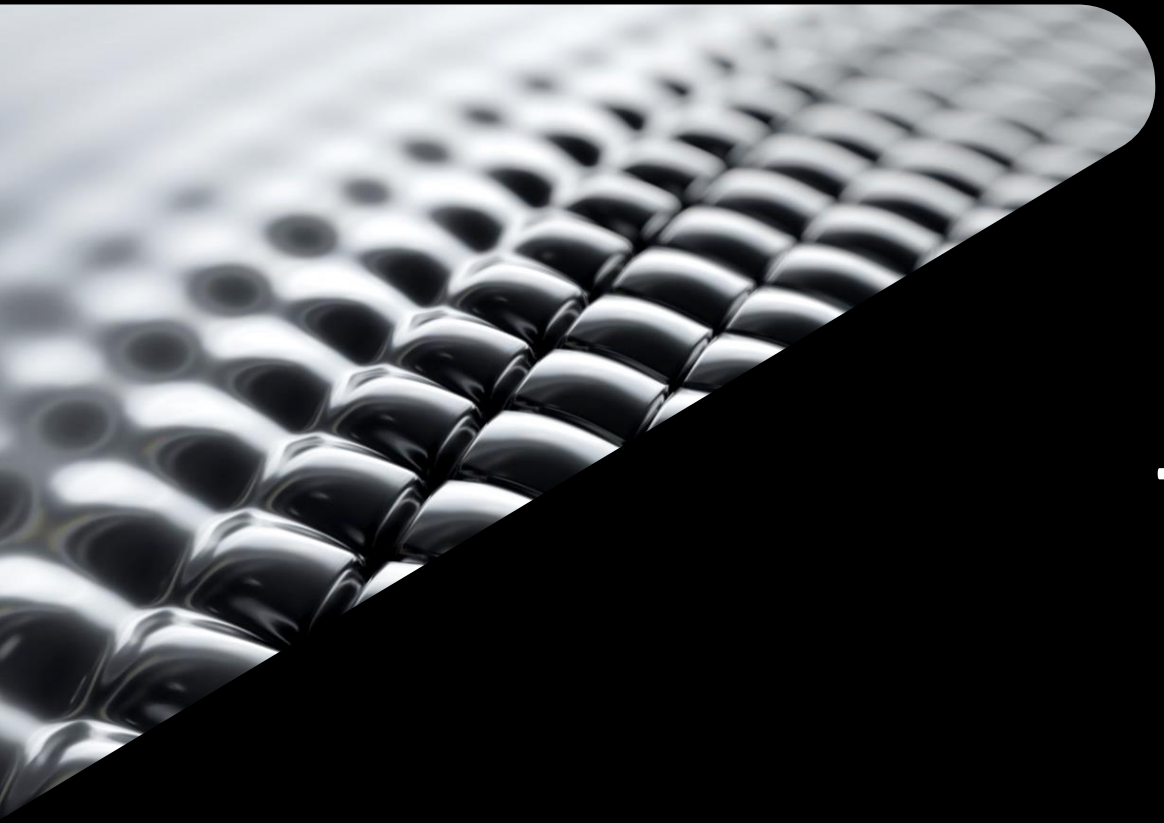
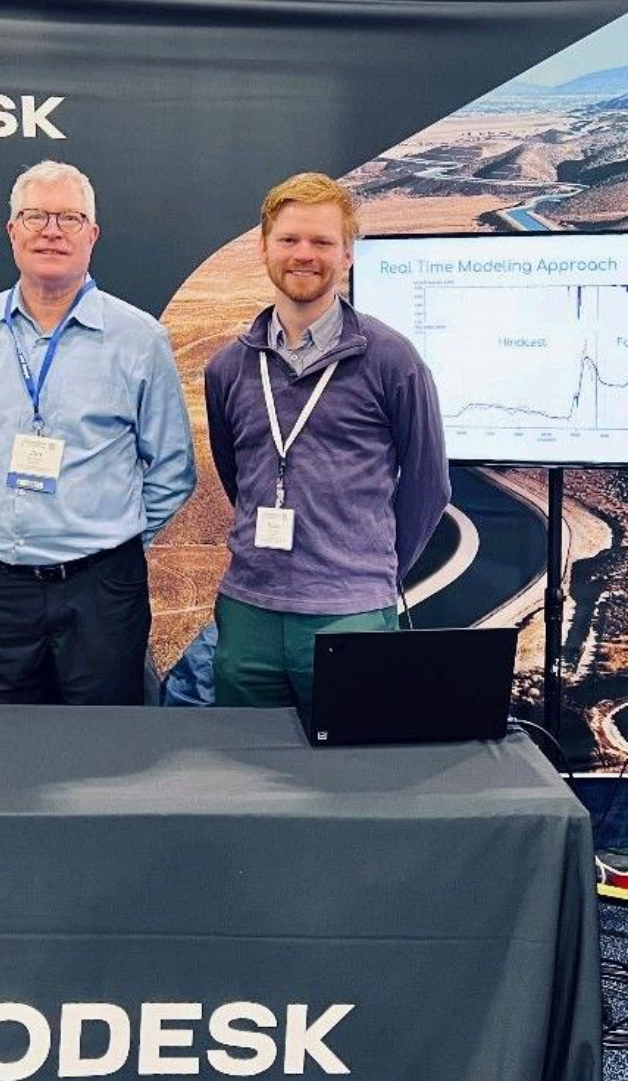


Team Members

Fernando L. S. Figueiredo, M.E.

Schettini ENGENHARIA

- Civil Engineering Consultant at Schettini Engineering;
- BIM Specialist at Vertrio;
- Bachelor's Degree in Civil Engineering at UCDB/MS, Brazil;
- Master's Degree in BIM Management for Infrastructure, Civil Engineering and GIS at Zigurat Global Institute/BCN, Spain;
- Experience with urban infrastructure projects, working from conception to budget management and construction planning.



Ryan F. Brown, M.S.

- Systems Engineer at Innovyze, an Autodesk Company;
- Bachelor’s Degree in Biosystems Engineering-Natural Resources/Environmental at Clemson University;
- Master’s Degree in Biological and Agricultural Engineering at North Carolina State University;
- Experience with riverine and floodplain analysis and FEMA permitting, stormwater master planning, drainage design, stormwater management, and sanitary sewer analysis.

Newton Rossi Caxeta, M.E.

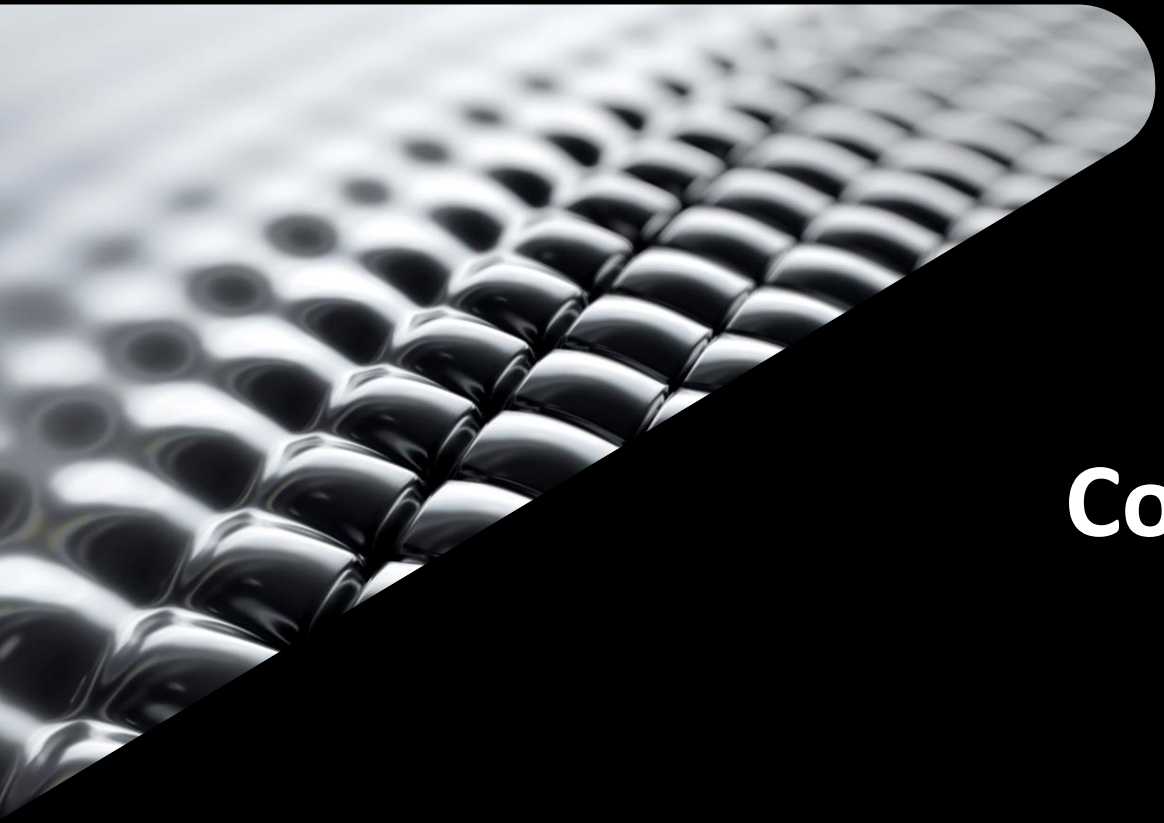
- Technical Sales Specialist at PARS;
- Bachelor’s Degree in Civil Engineering at FAAP/SP, Brazil;
- Associate’s Degree in Building Construction at FATEC/SP, Brazil;
- Master’s Degree in BIM: Design Infrastructure at PUC/SP, Brazil;
- Experience with Sanitation System (pump station, treatment station and water/sewage system).

Raírio dos Santos Mota, M.E.

- Autodesk Civil 3D Certified Instructor at Pro Systems ATC;
- Bachelor’s Degree student in Civil Engineering at UEFS/BA, Brazil;
  - Researching the theme “BIM for Urban and Road Infrastructure”.
- Associate’s Degree in Building Technician at IFBA/BA, Brazil;
- Experience in Urban and Transportation Infrastructure designs;
- BIM Technical at RCM Projects.

Matheus Lima de Barros, M.S.E.

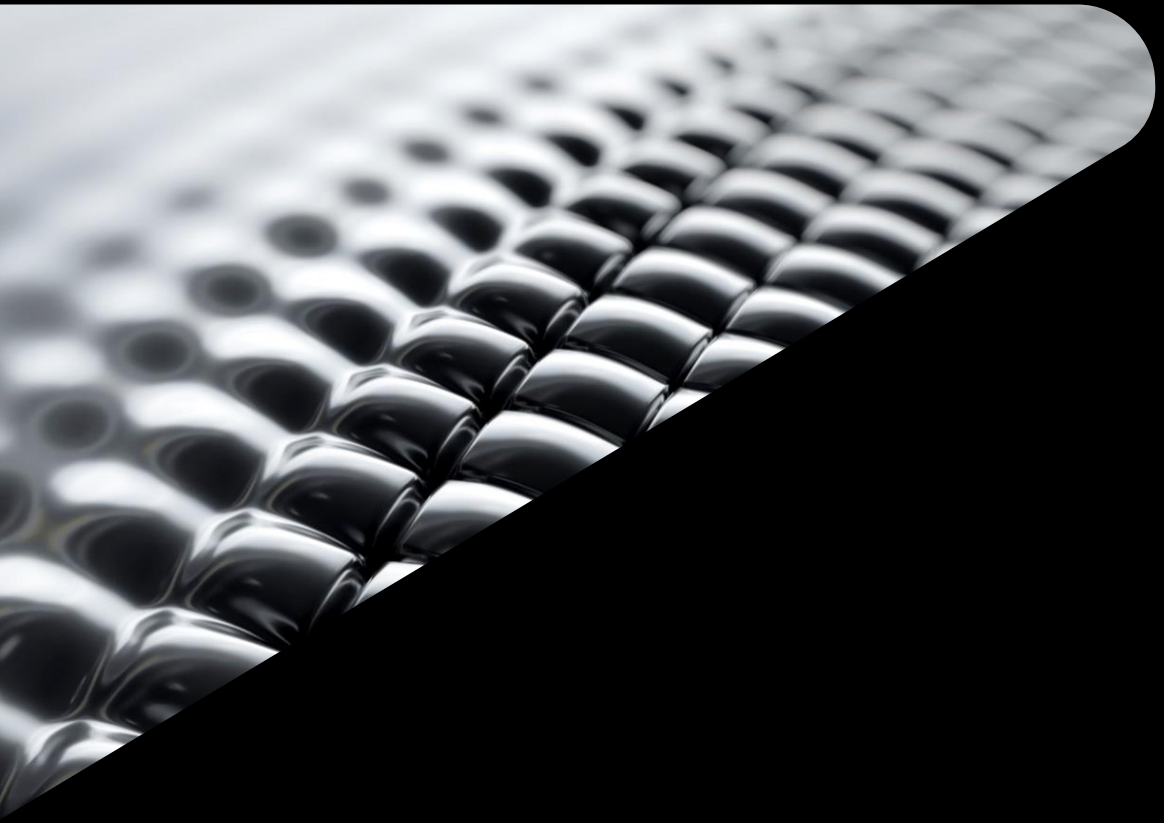
- Bachelor’s Degree in Civil Engineering and Master’s Degree in Geotechnical Engineering at UnB/BSB, Brazil;
- Master’s Degree in BIM Management at Zigurat Global Institute/BCN, Spain;
- Member of the research group GEOFLUXO, where we develops research on BIM GIS Integration;
- Experience with Urban Land Development and Transportation Infrastructure Design at RHUMB;
- Content Creator at Build Lab Academy by FF Solutions.



Contextualization

Caarapó, Mato Grosso do Sul, Brazil

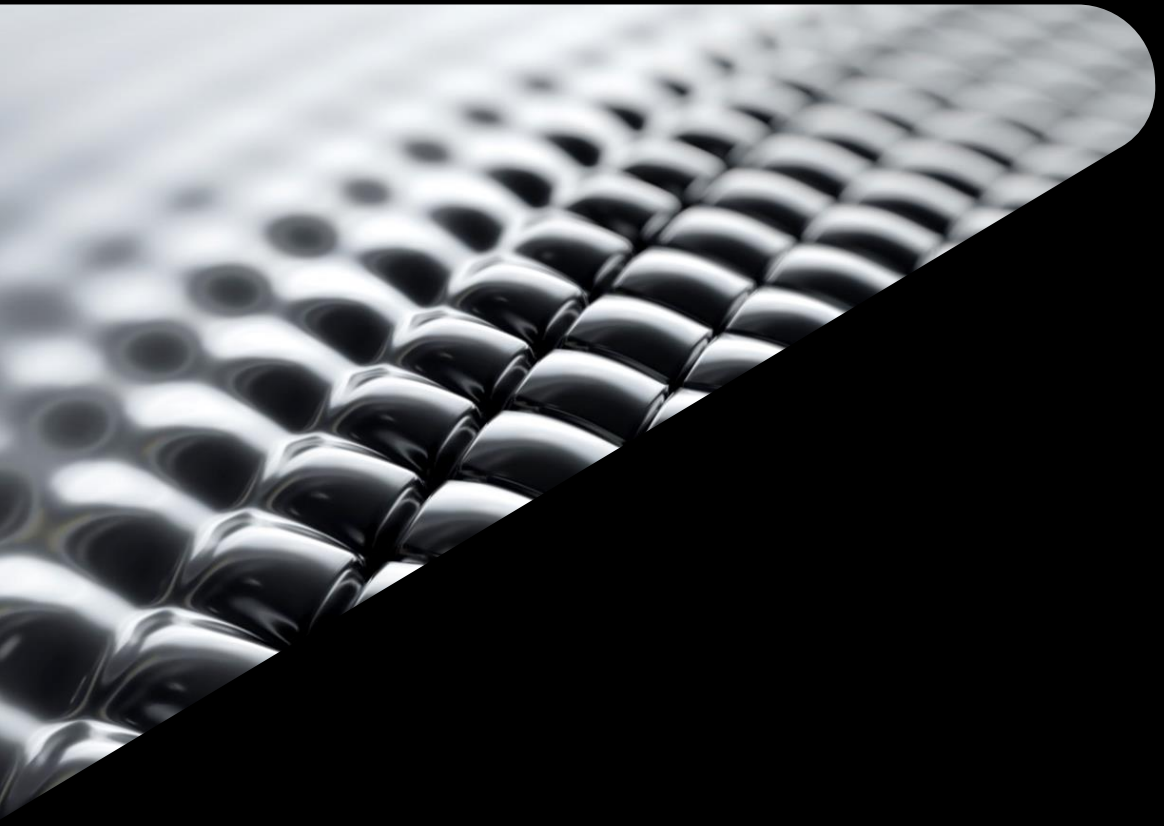
- Ayrton Senna Park built in 1977 is the only tourist attraction;
- Impoundment of the Diego Cuê stream, and its dam lake was used as a space for recreation and socialization;
- In 2015 an atypical event, caused a partial overtopping fail;
- In 2017 a project using traditional methodologies (2D) was delivered to the city.



Challenges

Sparse public resources call for more conscious decisions

- City with less than 30,000 inhabitants;
- Difficulties of a small town;
  - Innovating in public management;
  - Obtaining new technologies and methodologies.
- Urban infrastructure required:
  - Urban drainage network;
  - Water supply network;
  - Basic sanitation network;
  - Management of underground assets.

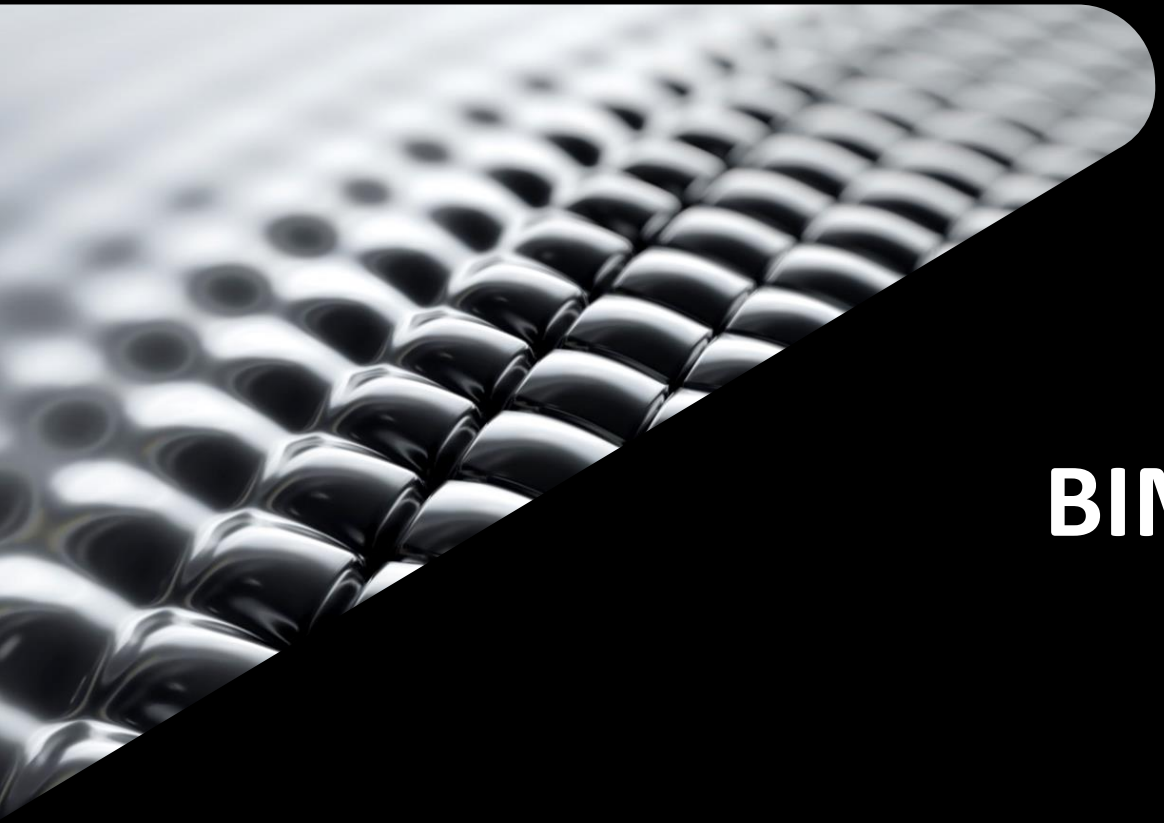


Solutions

Autodesk Ecosystem

AEC Collection | Innovyze | Unity

- We will present individual use and interoperability of the following solutions:
  - Autodesk Docs;
  - Autodesk Infraworks;
  - Autodesk Recap;
  - Autodesk Revit;
  - Autodesk Civil 3D;
  - Autodesk Navisworks;
  - Innovyze Infoworks ICM;
  - Unity Reflect.
- For documentation management and mapping of BIM processes, we used the following tools:
  - Bizagi;
  - Plannerly.

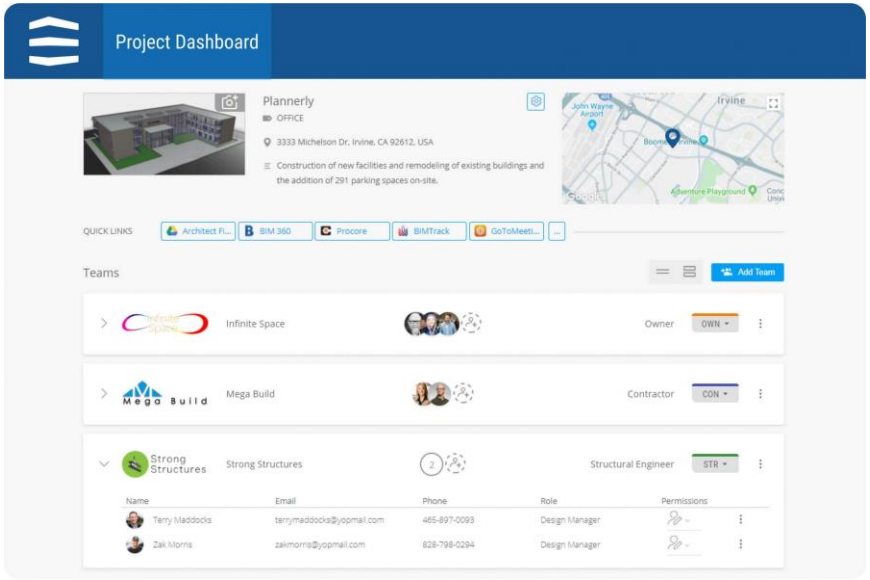


BIM Management

BIM Management – Plannerly

- User-Friendly Platform;
  - Web Solution (no installation needed);
  - Real-time Collaborative Work;
  - BIM Documents;
  - Plan and Scope Modules.

- Definition of BIM Execution Plan (BEP):
  - ISO 19650 Template.
  - Complemented with the Project Information: Start Date / End Date, Scope, Appointing Party Requirements and Available Data.



plannerly

BIM Management – BEP Strategy

People

- BIM Uses;
- Team Members;
- BIM Roles;
- Responsibility Matrix.

Processes

- Workflows;
- Project Milestones;
- Project Meetings;
- Project Standards;
- Model Quality Control;
- Deliverables.

Technology

- Software Versions;
- Common Data Environment (CDE);
- File Formats;
- Hardware.

BIM Management – BIM Uses and BIM Roles

- BIM Uses by Succar.
  - Description, Priority and Life Cycle Phase;
  - BIM Uses: Conceptualization, Surveying, Laser Scanning, Design Authoring, Design Reviews, 3D Coordination, Clash Detection, Disaster Planning, Risk and Hazard Assessment, 2D Documentation, 3D Detailing, Augmented Reality Simulation (AR).
- BIM Roles:
  - BIM Coordinator - Fernando
  - BIM Modeler – Raírio
  - BIM Analysts – Newton and Ryan
  - BIM Manager - Matheus

BIM Use	Description	Priority (High/Med/Low)	Plan/ Design/ Construct/ Operate			
			P	D	C	O
Conceptualization	Conceptualization is a Model Use allowing the initial investigation of design possibilities and spatial requirements. Conceptualization occur during the Conceptual Design sub-phase and may utilize specialized Spatial Analysis Tools.	Med	x			
Surveying	A Model Use where 3D models are used to establish the dimensional relationships, including horizontal distances, elevations, directions, and angles, on the earth's surface. Surveying is typically used to locate property boundaries, generating maps and establishing construction layout.	Low	X	X		
Laser Scanning	A Model Use representing the process of rapid generation of Point Cloud data of as-built structures, terrain and vegetation using a fixed, mobile or airborne 3D Laser Scanner.	Low	X	X		
Design Authoring	A Model Use representing the process of developing Generative Models or Parametric Models for design exploration, design communication and design iteration purposes. Design authoring is a key BIM activity leading to model-based 2D Documentation, 3D Detailing and other model-based deliverables.	Med		X		
Design Reviews	Review of the Design Model, defined as an object-based 3D model generated by the Design Team (individually or as a group) for the purposes of design analysis .	Low		X		

plannerly

BIM Management – Software

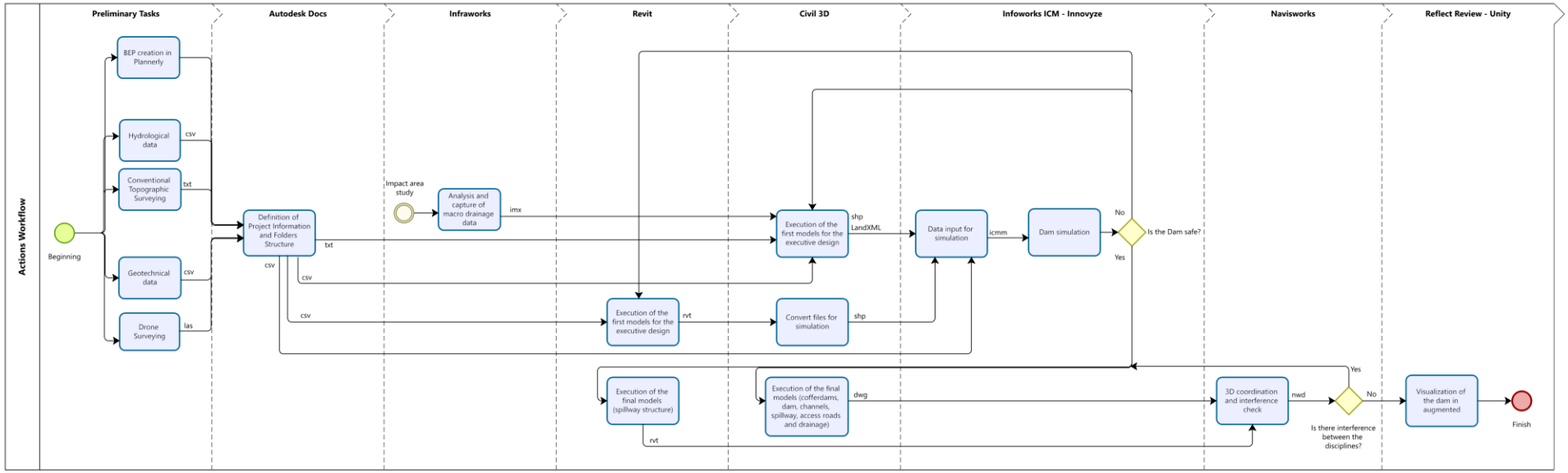
- For each software from Autodesk, Innovyze and Unity:
  - Discipline, Use and Version.
- Interoperability;
  - Format Tests allowed the Definition of the Workflow.

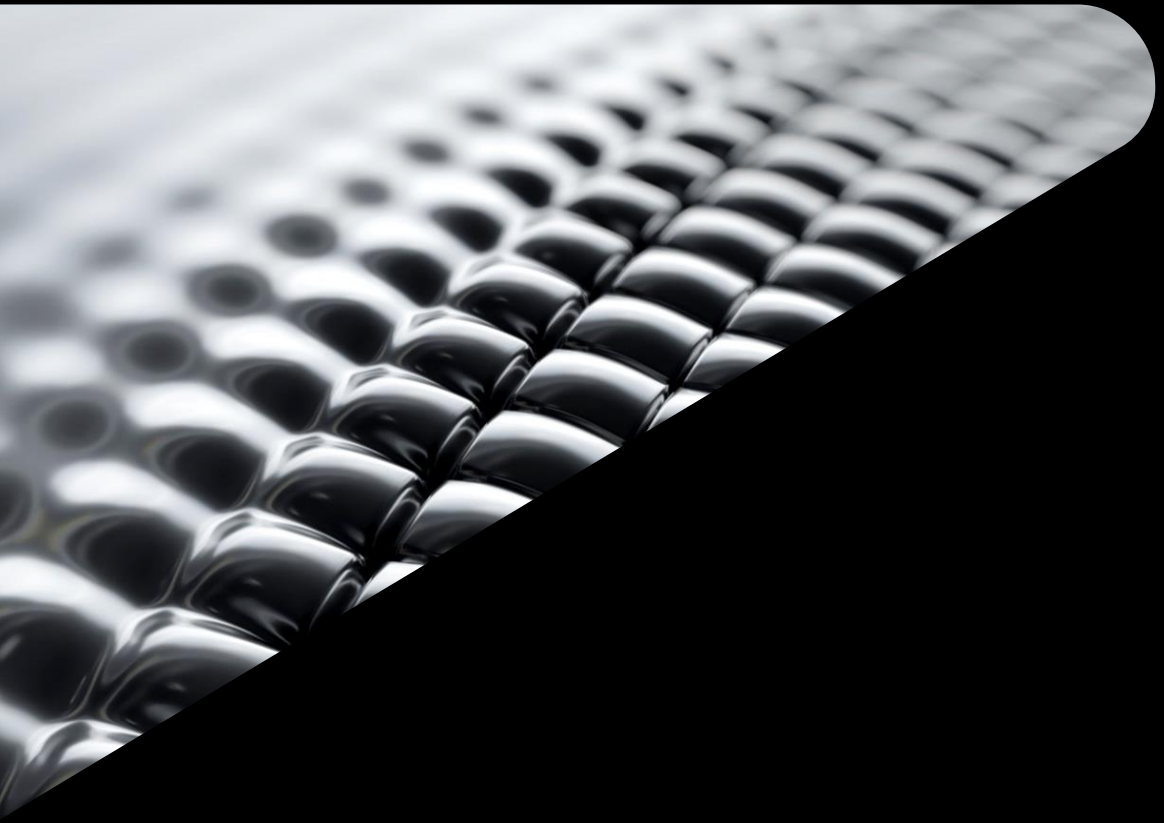
DISCIPLINE	USE	SOFTWARE	VERSION	ICON
All	BIM Management Platform	Plannerly	Always Current	
Common Data Environment (CDE)	File Sharing	Autodesk Construction Cloud	Always Current	AUTODESK CONSTRUCTION CLOUD
Topography	Design	Autodesk Recap Pro	2023	
Geometry	Design	Autodesk Civil 3D	2023	
Earthmoving	Design	Autodesk Civil 3D	2023	
Drainage Systems	Design	Autodesk Civil 3D	2023	
Structures	Design	Autodesk Revit	2022	
Reservoir Simulations	Design	Innovyze InfoWorks ICM	2023.0	
All	Visualization	Autodesk Infraworks	2023	
All	Visualization	Unity Reflect View	2023	unity Reflect
All	Coordination	Autodesk Navisworks	2023	
All	Coordination	Autodesk Construction Cloud	Always Current	AUTODESK CONSTRUCTION CLOUD

plannerly

Solutions Workflow

Workflow





Preliminary Tasks and CDE

Initial data

- Hydrologic Data;
  - INMET;
  - Pluviometric station 2254000;
  - 1974 to 2009.

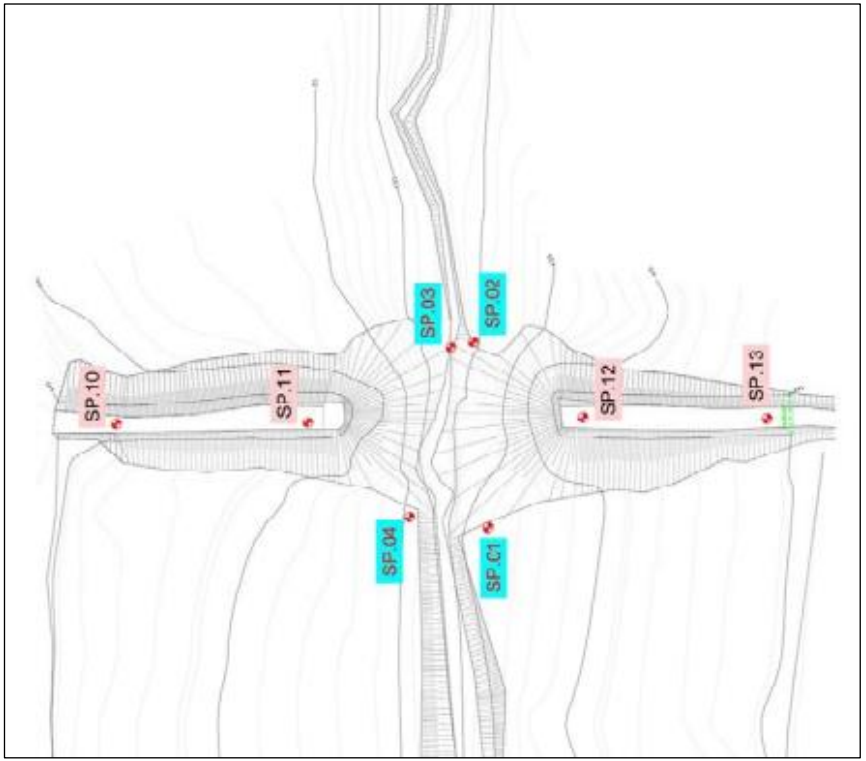
laxima	Total	DiaMaxima	NumDiasDeChuva	MaximaStatus	TotalStatus	NumDiasDeChuvaStat
	106,9			0	1	
32,4	133,8	11		1	1	
44,9	167,8	29	8	3	3	
11,8	18,6	22	3	3	3	
53,9	137,3	20	5	1	1	
3,5	5,2	7	3	1	1	
9,9	24,4	4	4	1	1	
8,5	19,4	13	4	1	1	
40,7	72,9	7	2	1	1	
32,3	129	29	10	1	1	
39,1	150,4	20	11	3	3	
34	144,7	7	9	1	1	
88,8	283,6	17	8	3	3	
38,9	133,5	27	7	1	1	
19,4	53,5	6	4	1	1	
3,6	3,7	26	2	1	1	
0	0	1	0	1	1	
15,7	25	3	3	1	1	
9,2	15,7	1	3	2	2	
40,2	63,7	23	4	1	1	
17,4	31,4	20		2	2	
34,9	116,4	13	6	2	2	
53,1	164,6	12	10	1	1	
20,1	75,5	18	7	1	1	
42	124,9	29	5	1	1	
80	186,3	18	6	1	1	

Initial data

- Conventional Topographic Surveying;
  - Equipment: GPS RTK;
  - Coordinate System: SIRGAS UTM 21S;
  - Standard: Class I. (NBR 13.133/94).

Initial data

- Geotechnical Data;
  - For this design it was realized two types of geotechnical survey:
    - Hand Auger;
    - Standard Penetration Test (SPT).



Initial data

- Drone Surveying;
  - Equipment: eBee X with camera S.O.D.A.;
  - Collecting terrain information quickly, efficiently and accurately is critical for the first step of the design.

Docs

MS_018 - CAARAPÓ

Arquivos
Revisões
Transmissões
Problemas
Relatórios
Membros
Ponte
Configurações

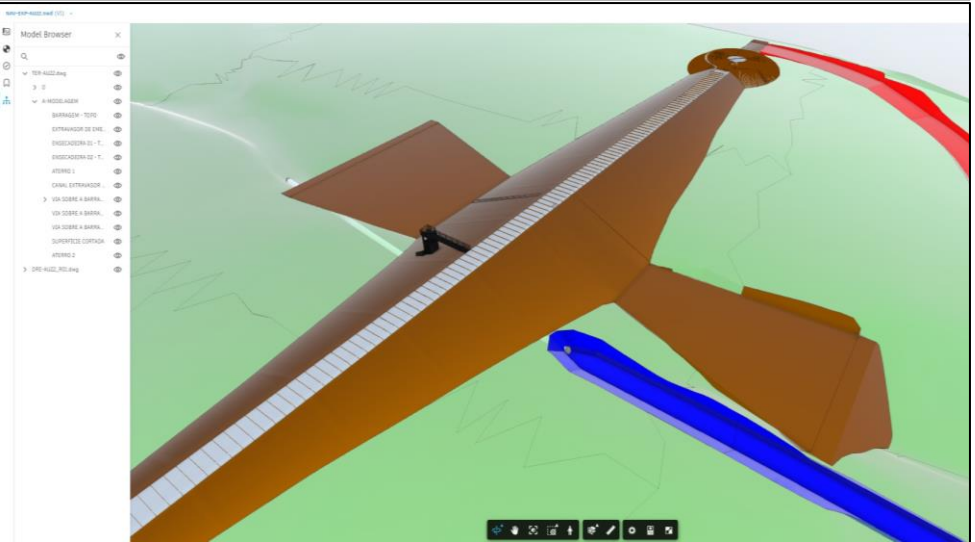
Files

Folders | Holding area

Project Files
- BEP
- DWG's
- ESTRUTURAL
- GEOTECNIA
- HANDOUT
- IMAGENS
- JAZIDAS
- MACCAFFERI
- MEMORIAL
- MODELAGEM
  - DWG
  - FBX
  - ICMM
  - IDSX
  - IFC
  - IMX
  - NWC
  - NWD
  - PDF
  - RVT
  - SHP

Upload files

Name	Description	Version	Synced with Bridge	Markup	Size	Last updated	Updated by	Review status
DWG	--	--		--	--	Jun 24, 2022 8:26 P...	Rairio dos Sa...	--
FBX	--	--		--	--	Jun 24, 2022 10:10 ...	Fernando Sch...	--
ICMM	--	--		--	--	Jul 5, 2022 7:51 AM	Newton Caxeta	--
IDSX	--	--		--	--	Jun 29, 2022 9:33 ...	Newton Caxeta	--
IFC	--	--		--	--	Jul 28, 2022 2:01 PM	Rairio dos Sa...	--
IMX	--	--		--	--	Jun 24, 2022 10:10 ...	Fernando Sch...	--
NWC	--	--		--	--	Jul 28, 2022 12:01 ...	Newton Caxeta	--
NWD	--	--		--	--	Aug 4, 2022 2:06 PM	Newton Caxeta	--
PDF	--	--		--	--	Jun 29, 2022 9:10 A...	Newton Caxeta	--
RVT	--	--		--	--	Jul 28, 2022 12:34 ...	Rairio dos Sa...	--
SHP	--	--		--	--	Jun 30, 2022 3:46 ...	Newton Caxeta	--
TXT	--	--		--	--	Jun 29, 2022 12:14 ...	Newton Caxeta	--
XML	--	--		--	--	Jun 24, 2022 8:26 P...	Rairio dos Sa...	--
AU2022-1W.iwm		V1		--	136 B	Jul 27, 2022 10:20 ...	Rairio dos Sa...	



MS_018 - CAARAPÓ

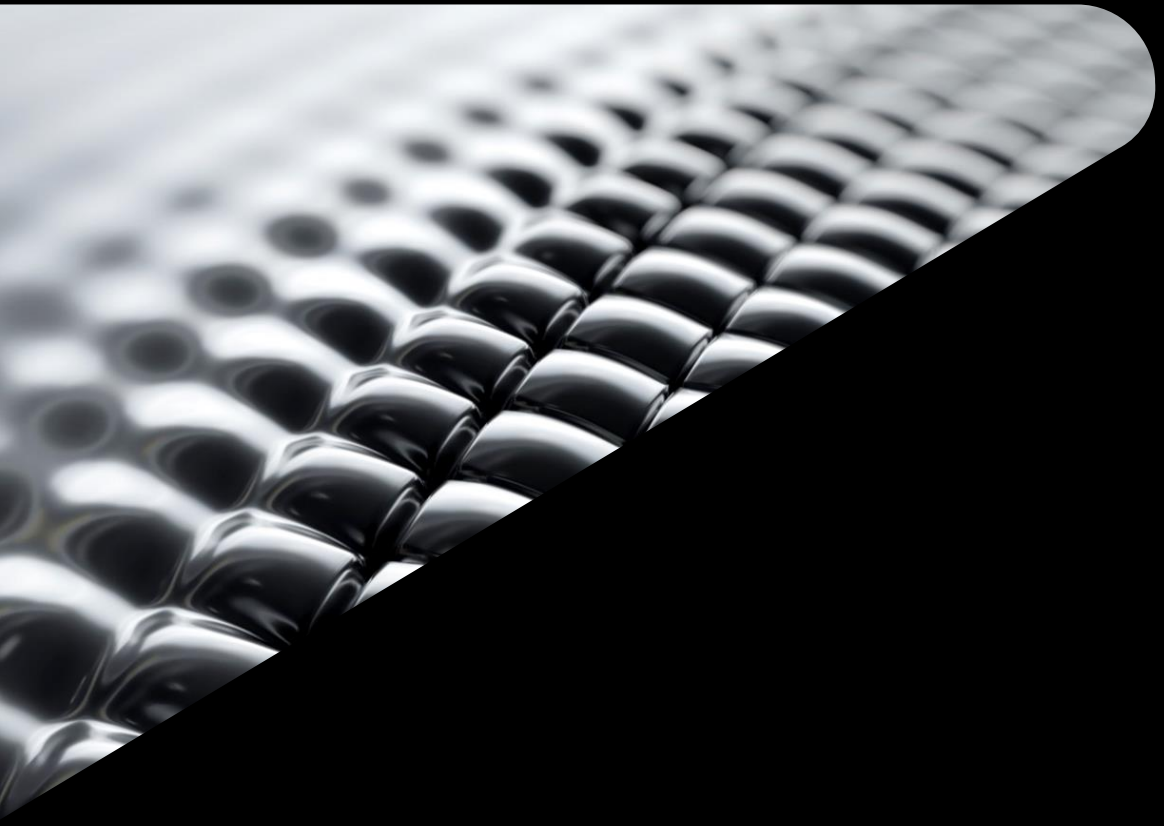
Files

Folders | Holding area

Project Files
- BEP
- DWG's
- ESTRUTURAL
- GEOTECNIA
- HANDOUT
- IMAGENS
  - 17-01-2...
  - 26-01-2...
  - Fotos G...
  - VOO - 2...
- JAZIDAS
- MACCAFFERI
- MEMORIAL
- MODELAGEM
- PDF's
- PRESENTATI...
  - Fernando
  - Matheus
  - Newton
  - Rairio
  - Ryan
  - Softwar...
  - Videos
- TOPOGRAFIA
- WORKFLOW

Upload files

Name	Description	Version	Synced with Bridge	Markup
(09) Caarapó Erosão - Bueiro de De...		V1		
(09) Caarapó Erosão - Bueiro de De...		V1		
536-SCH-BAR-CAA-MC-001-R00_M...		V1		
Boca de Jusante - 3D.dwg		V1		
Boca de Jusante.dwg		V1		
Caixa Vertedora - 3D.dwg		V1		
Caixa Vertedora - Grade - 01.skb		V1		--
Caixa Vertedora - Grade - 01.skp		V1		
Caixa Vertedora - Grade.dwg		V1		
Caixa Vertedora - Grade.skb		V1		--
Caixa Vertedora - Grade.skp		V1		
Canal - 3D.dwg		V1		
Croqui - Bueiro de Descarga de fun...		V1		
Croqui ARMADURA.dwg		V1		
Dissipador - 3D.dwg		V1		
Laje - 3D.dwg		V1		
planilha-consumo-solda.xls		V1		--
Solda da Grade.xlsx		V1		--



Modeling and Design

Civil 3D and Revit

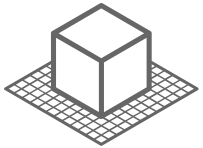
Modeling

Initial steps in Civil 3D modeling

- All modeling was based on existing 2D designs;
  - Use of external references (XREF) from 2D.
- Use of Country Kit Brazil: templates based on DNIT and SANEAMENTO.

Topographic data

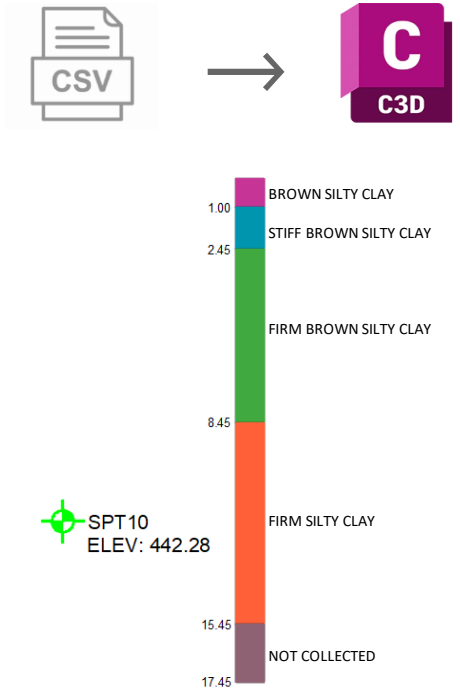
Civil 3D



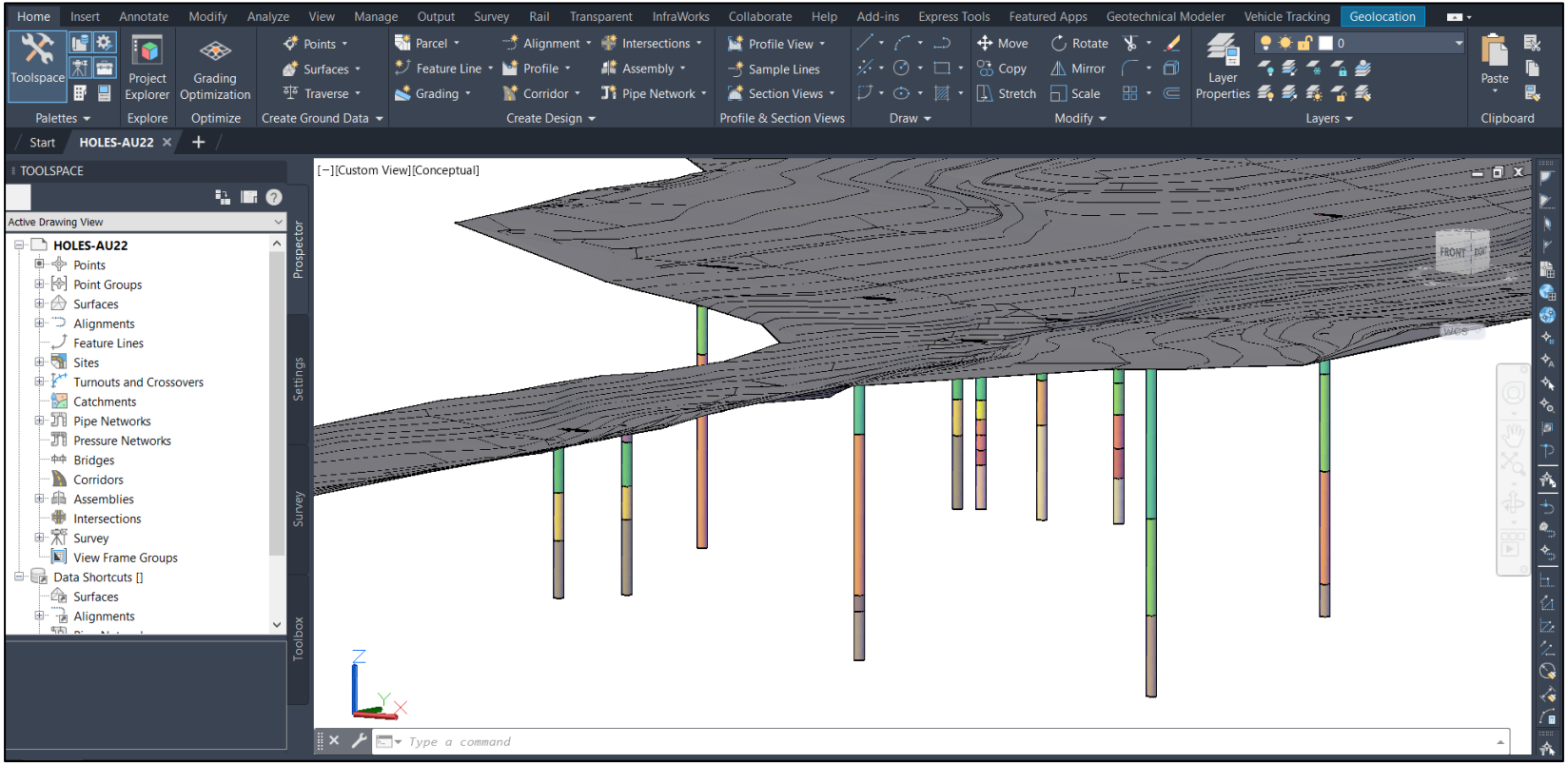
Existing ground surface

Geotechnical Data

- Geotechnical Modeler (GM) in Civil 3D 2023;
  - Data Preparation: Multiple Sheets Files;
    - Hand Auger;
    - Standard Penetration Tests (SPT).
  - Autodesk Sample Files as a Start;
  - Field Data in CSV file.
- Visualizations:
  - 2D Profile with Geological Description (sticklogs);
  - 3D Borehole View.



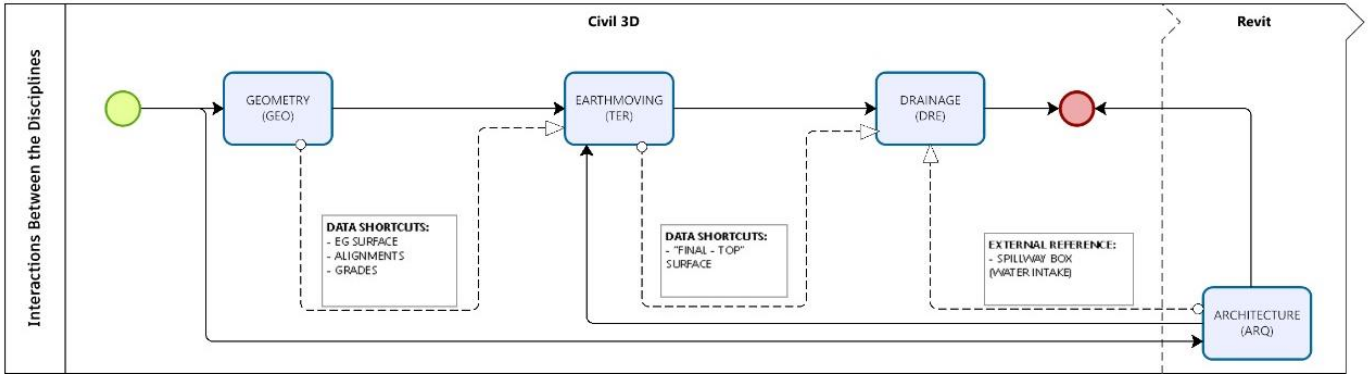
Geotechnical Data



Civil 3D and Revit modeling

- Design organized in 04 disciplines:
  - Geometry (GEO);
  - Earthmoving (TER);
  - Drainage (DRE);
  - Architecture (ARQ).

- Data Shortcuts were used between the disciplines.
  - GEO:
    - Existing ground surface;
    - Alignments;
    - Grades TER.
  - TER "FINAL - TOPO" surface DRE.



Civil 3D and Revit modeling

Description of the 4 disciplines

1 - GEO: alignments and longitudinal profiles:

- Cofferdams 01 and 02;
- Dam;
- Overflow channel;
- Emergency spillway;
- Access roads.

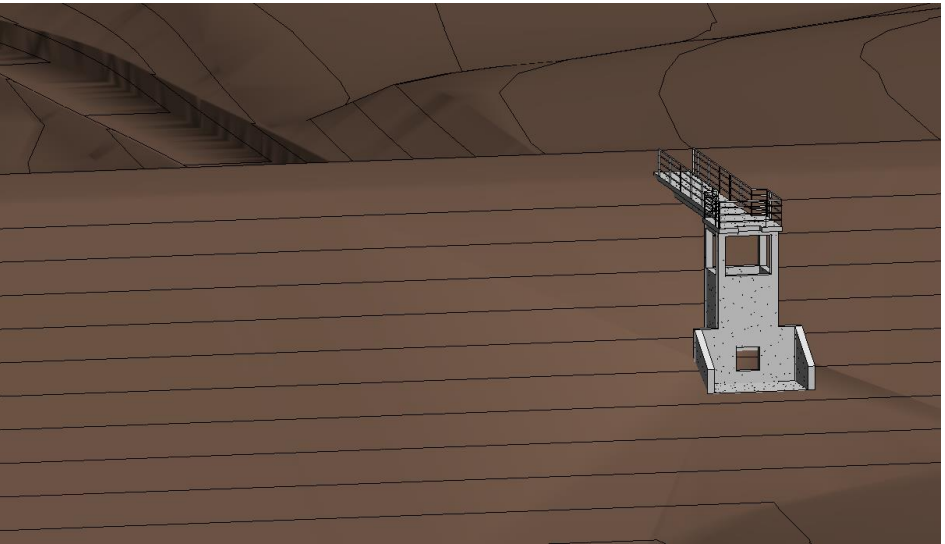
3 - DRE: pipes and structures:

- A Null Structure was used for the connection between the pipes.
  - Location of the connection according to the 2D design

2 - TER: assemblies, corridors and design surfaces:

- Corridors from GEO;
- Embankments;
- **“FINAL - TOPO" surface;**
  - Top links from corridors;
  - Gradings surfaces from embankments.

4 - ARQ: modeling the spillway structure in Revit.



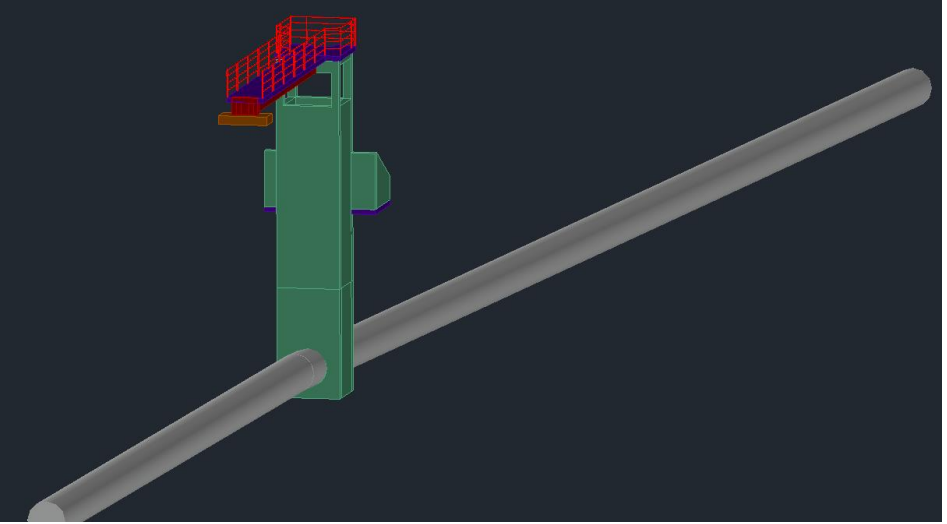
Civil 3D and Revit modeling

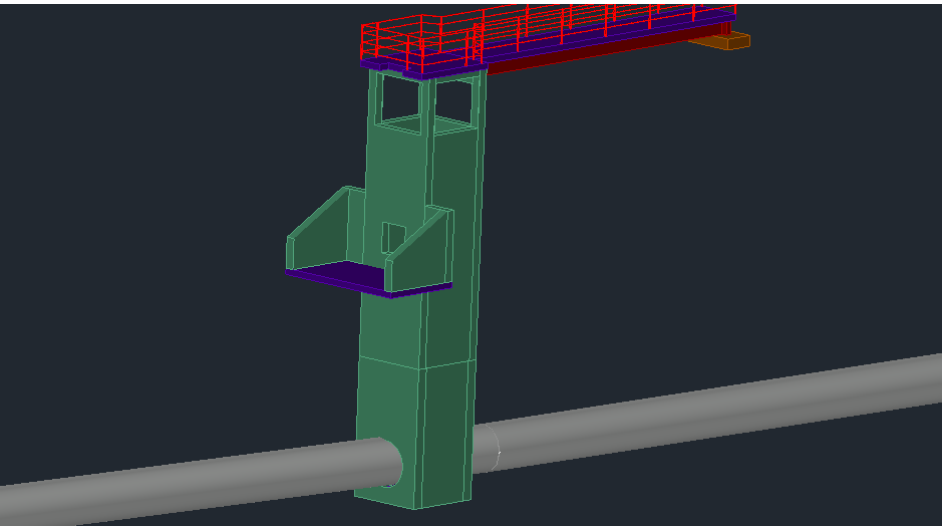
Interoperability between Civil 3D and Revit

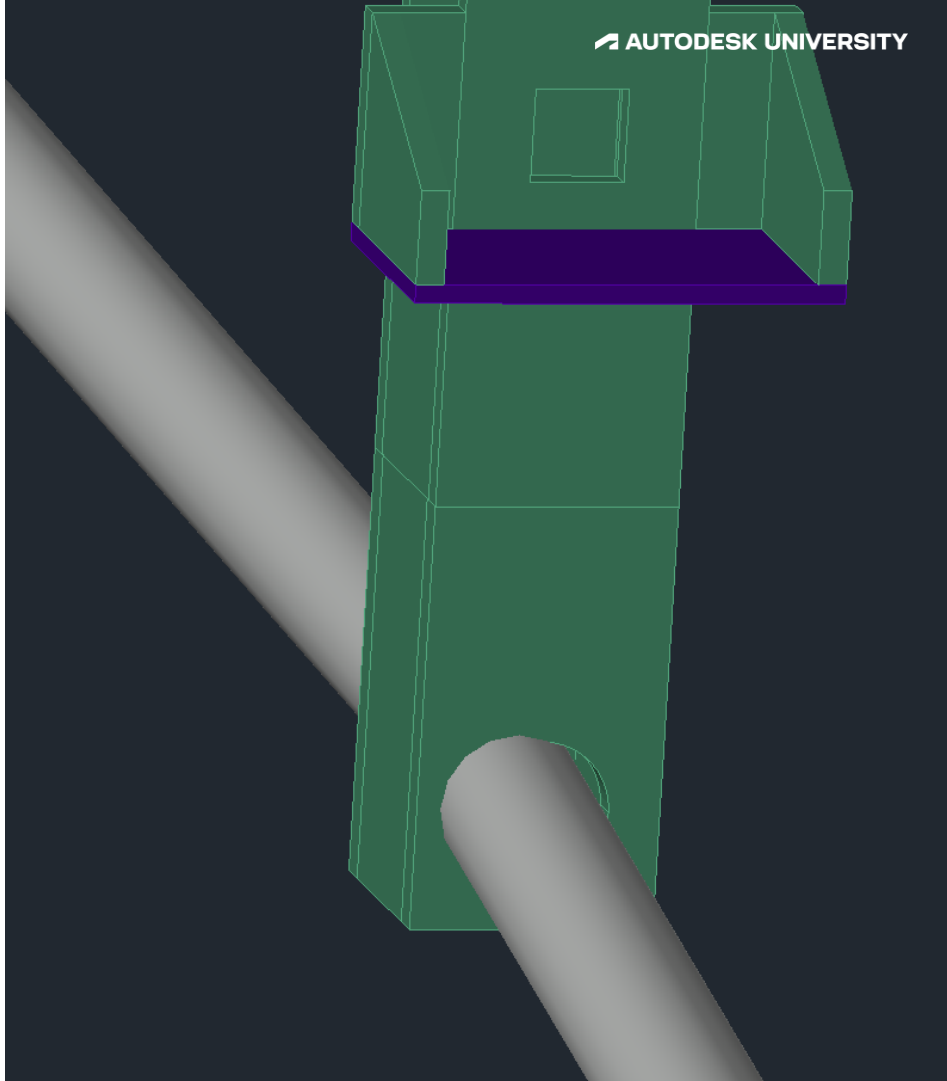
- Share Reference Point and Desktop Connector;
  - Michael Hurtado (Autodesk University 2019, Las Vegas).

C3D 2023 ⟷ AUTODESK CONSTRUCTION CLOUD™ ⟷ 2022

- Verified incompatibility between the pipe and spillway structure.
  - Correction made by changing the location of the Null Structure.



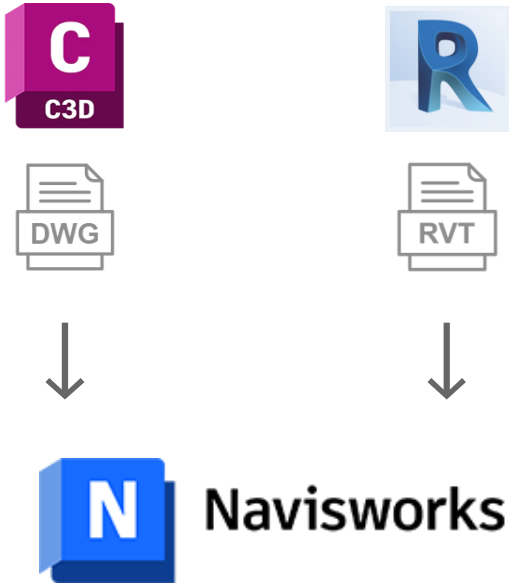




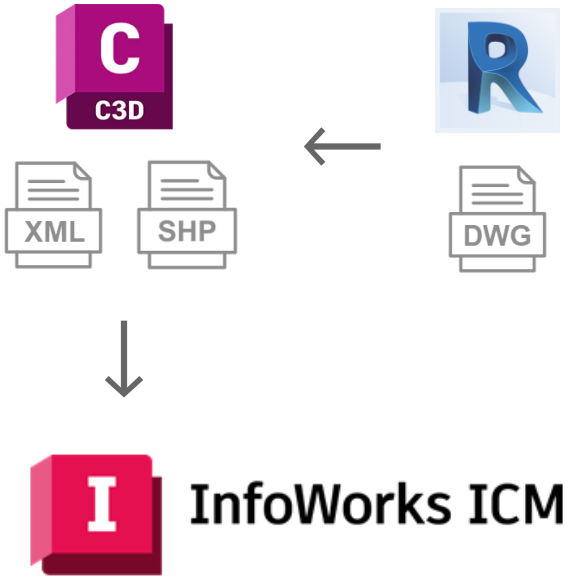
Exported Products

Civil 3D and Revit to Navisworks and InfoWorks ICM

Interference checks through Navisworks

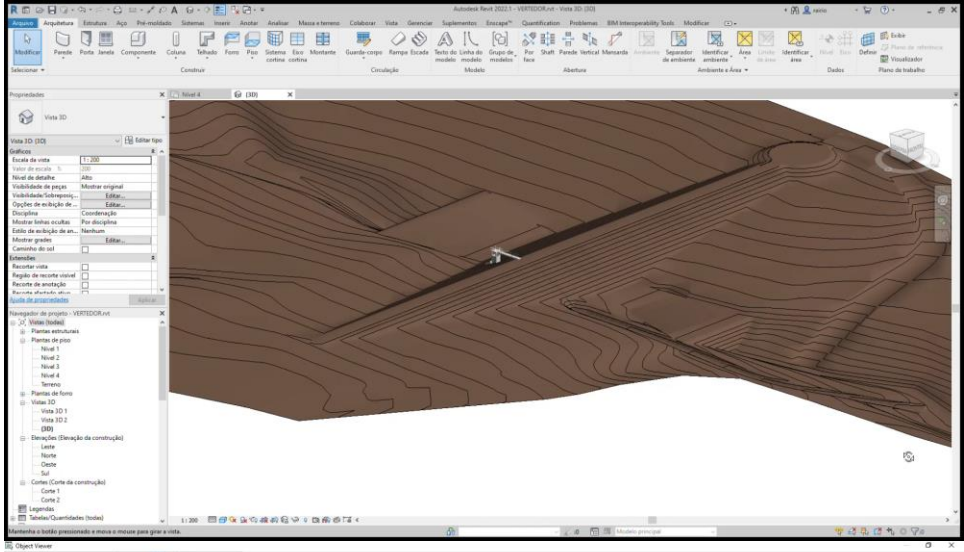


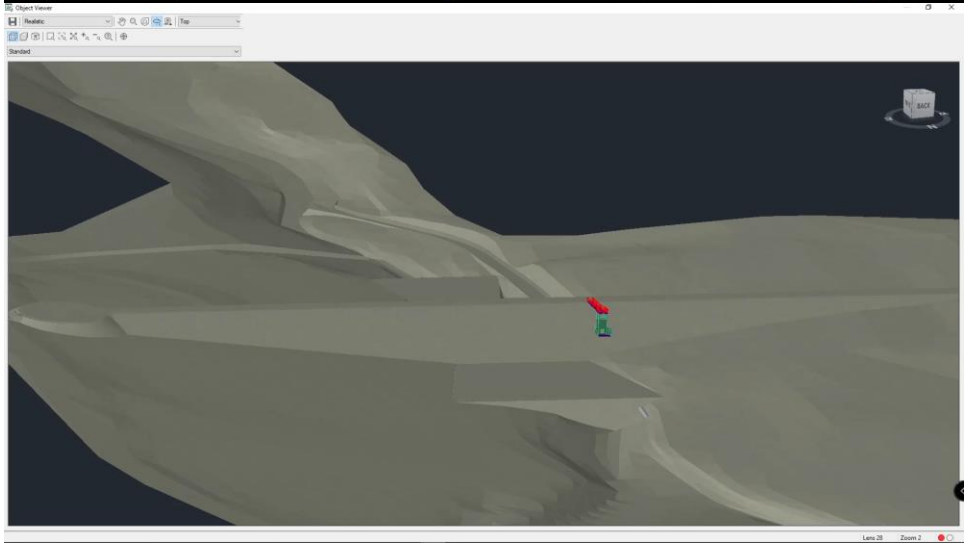
Simulations of normal operation and dam failure in InfoWorks ICM

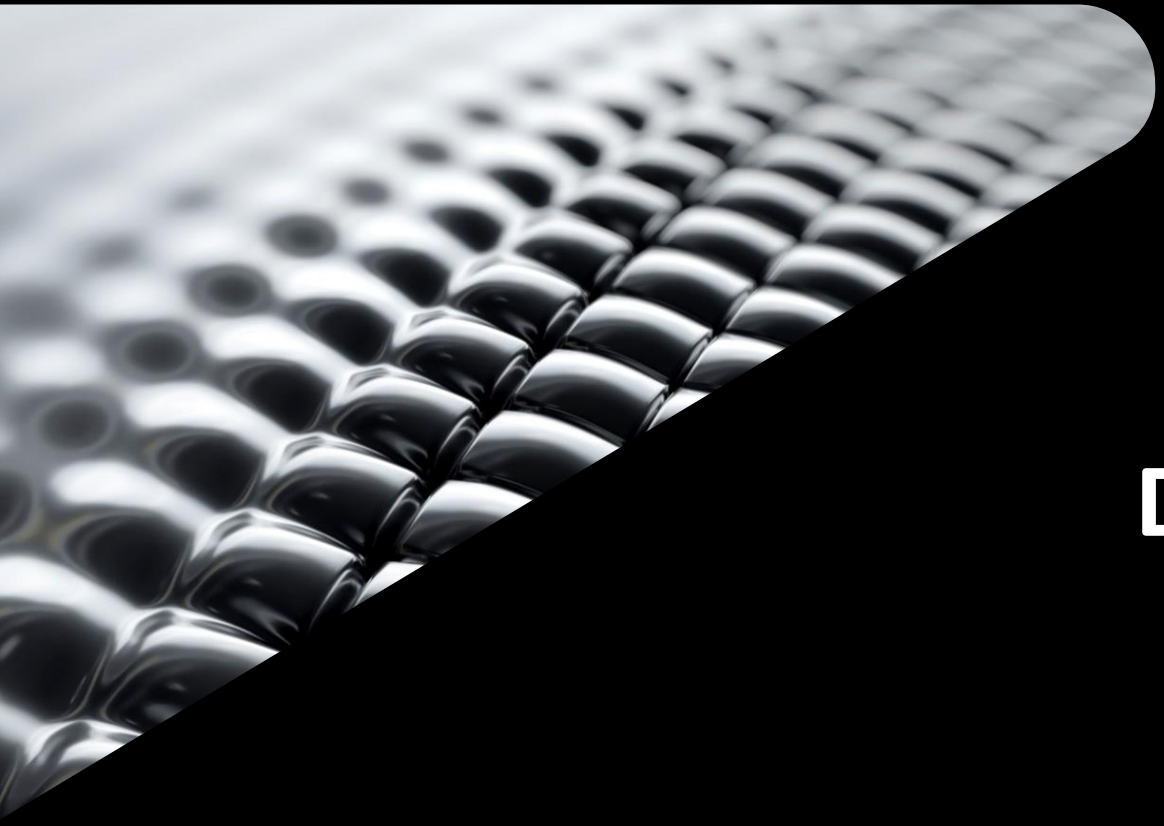


Modeling Results

- After the simulations were completed, the executive projects were prepared;
- Differences and inconsistencies between the 2D design and the Civil 3D and Revit modeling were verified:
  - Slope lengths of the cofferdams and channels;
  - Position of the beginning of the pipe;
  - Location of connection between pipes;
    - Less errors and rework in the construction phase;
    - More savings in the final cost of the project.





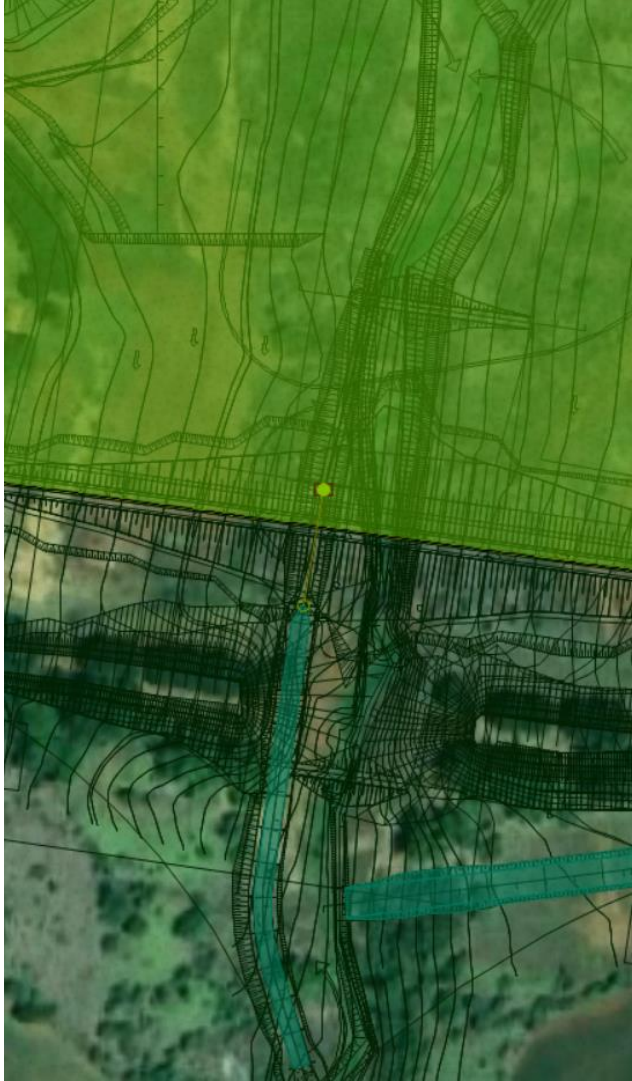


Dam Simulation

Innovyze Infoworks ICM

InfoWorks ICM – Dam Break Analysis

- Data Inputs:
  - Surfaces via LandXML from Civil 3D and Infraworks;
  - Shapefile export from Civil 3D for Context;
  - Hydrological Inflow Data.
- Model Build:
  - Existing surface combined with Infraworks surface and imported to ICM;
  - Dam represented with a base linear structure;
  - Outlet structure represented with a sluice gate for the inlet;
  - Main spillway and overflow spillway represented with mesh level zones.



Normal Day Operation

- With a base flow, the dam operates normally with no issues.

InfoWorks ICM – Dam Break Analysis

- Four different simulations:
  - Fail Geotechnically
    - Full;
    - Partial.
  - Fail at Overtopping
    - Full;
    - Partial.
- Using design flow, dam did not overtop;
  - Design flow was augmented to force a condition where the dam would overtop.
- None of the simulations showed catastrophic downstream impacts.

Fails Geotechnically

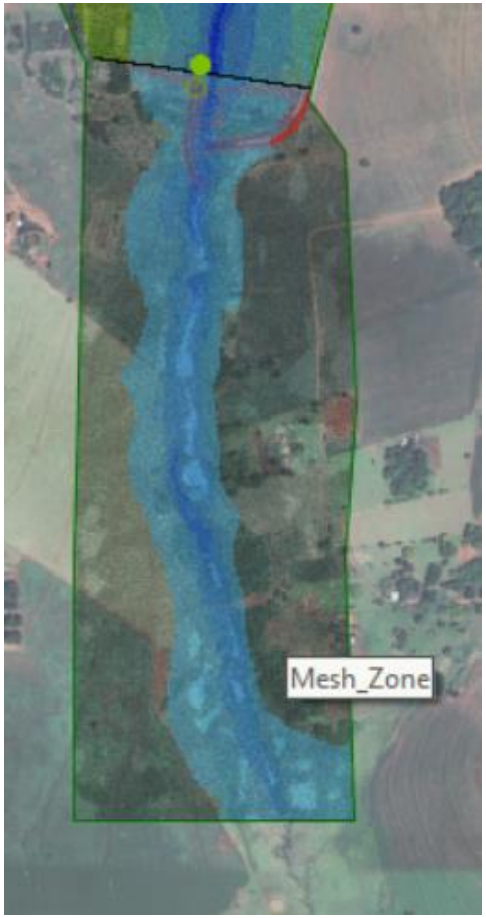
Partial Failure

Full Dam Failure

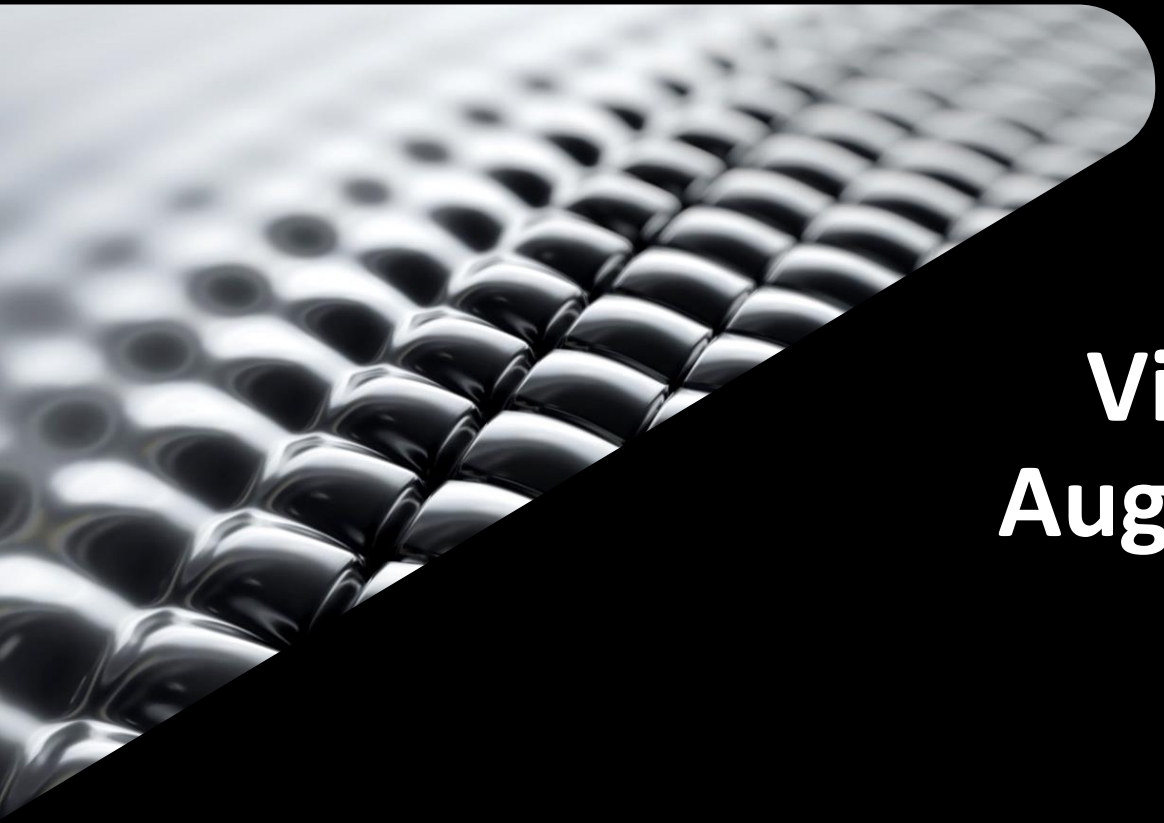
Fails by Overtopping

Partial Failure

Full Dam Failure




Live Demo!

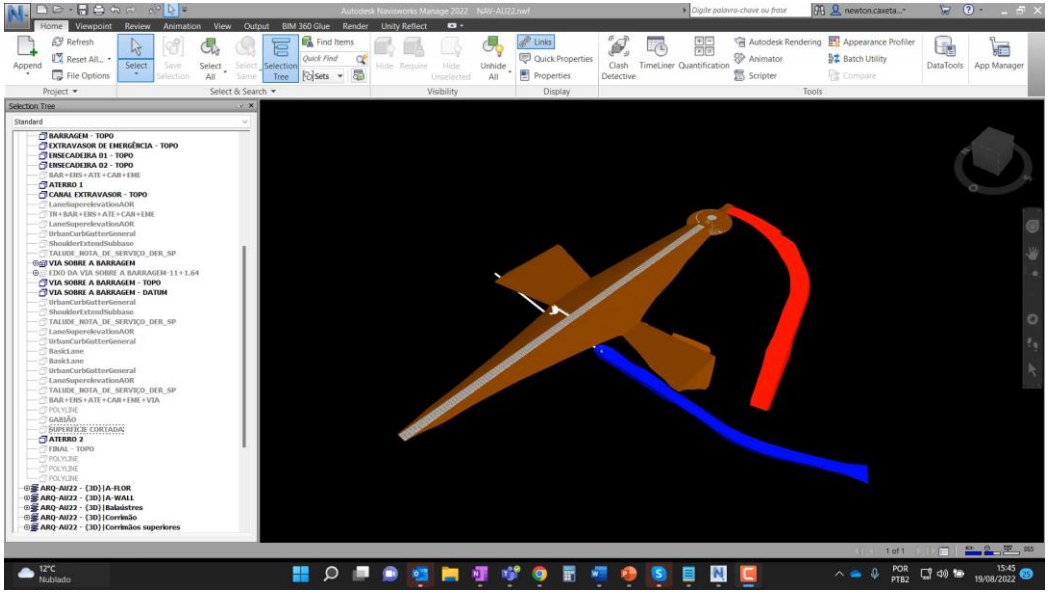


Visualization and Augmented Reality

Navisworks and Unity Reflect

3D Coordination and Interference Check

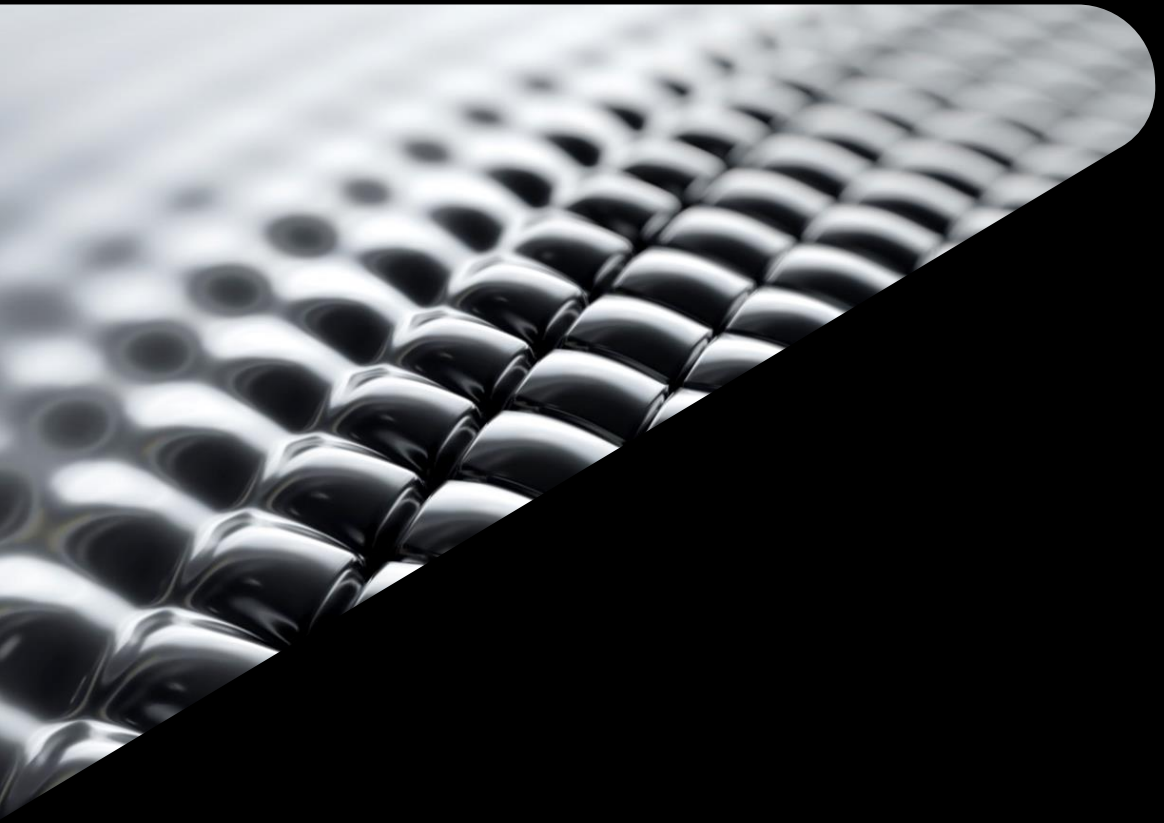
- Clash detection between the disciplines;
- Union of the Autodesk Solutions (Revit and Civil 3D);
- Interoperability between Autodesk and Unity Solutions is through .rvt and .nwd files.



Augmented reality

- Union between stakeholders and technical people;
- Benefits for using these workflow:
  - 3D model with viewing from all angles;
  - Augmented reality with smartphone or any other device;
  - Existing Added Value.

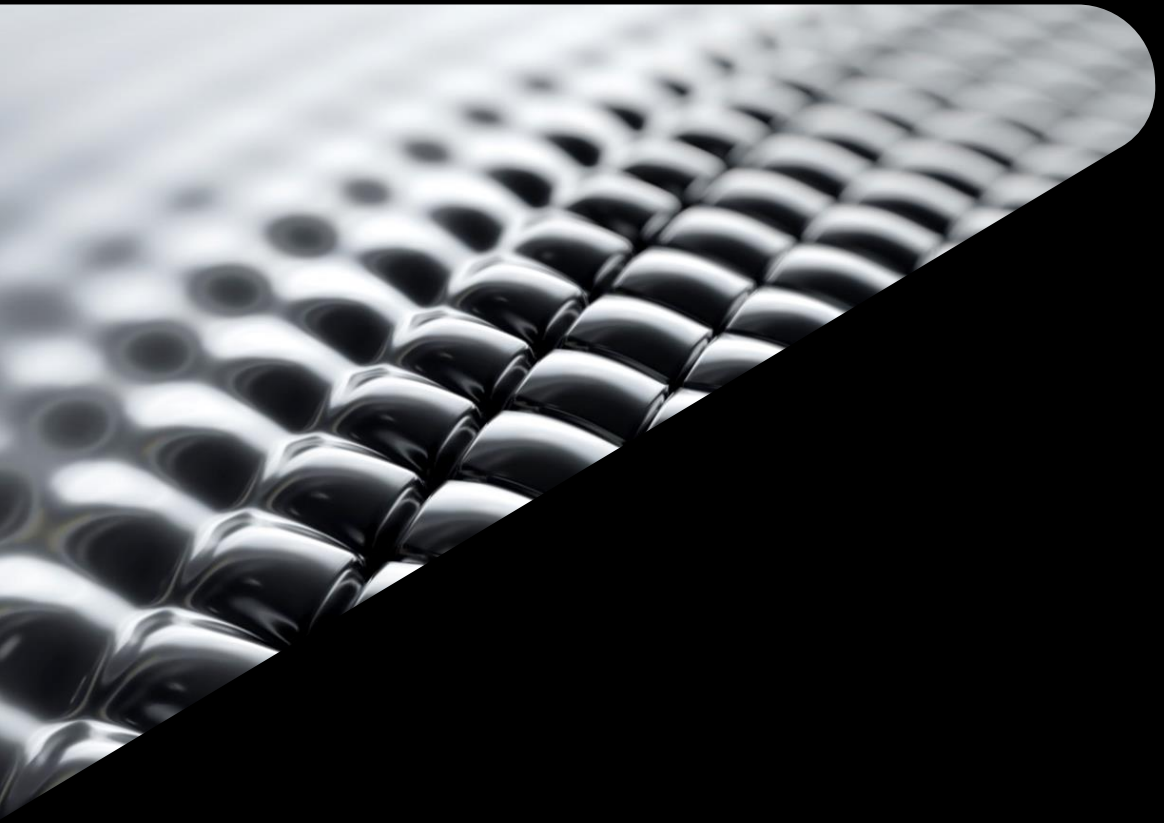
*the augmented reality scale in the video is 1:100



Results

Results and Analyzes

- BIM processes and documentation enabled more consistent decisions;
- In the modeling process, it was possible to locate inconsistencies in the 2D designs and correct them according to the documentation produced;
- Interoperability between Revit and Civil 3D;
- Interoperability between Civil 3D and Infoworks ICM;
- Interoperability between Navisworks and Unity Reflect.



Next Actions

Drainage, Sewer, Water, Assets

- Finally, we would like to list the next projects that will be developed using the Autodesk Software Ecosystem:
  - Drainage Network;
  - Sewerage system;
  - water network.

- And the most important part of this new proposal is how to use Info360 Asset to manage these mentioned assets, including the monitoring of the dam.