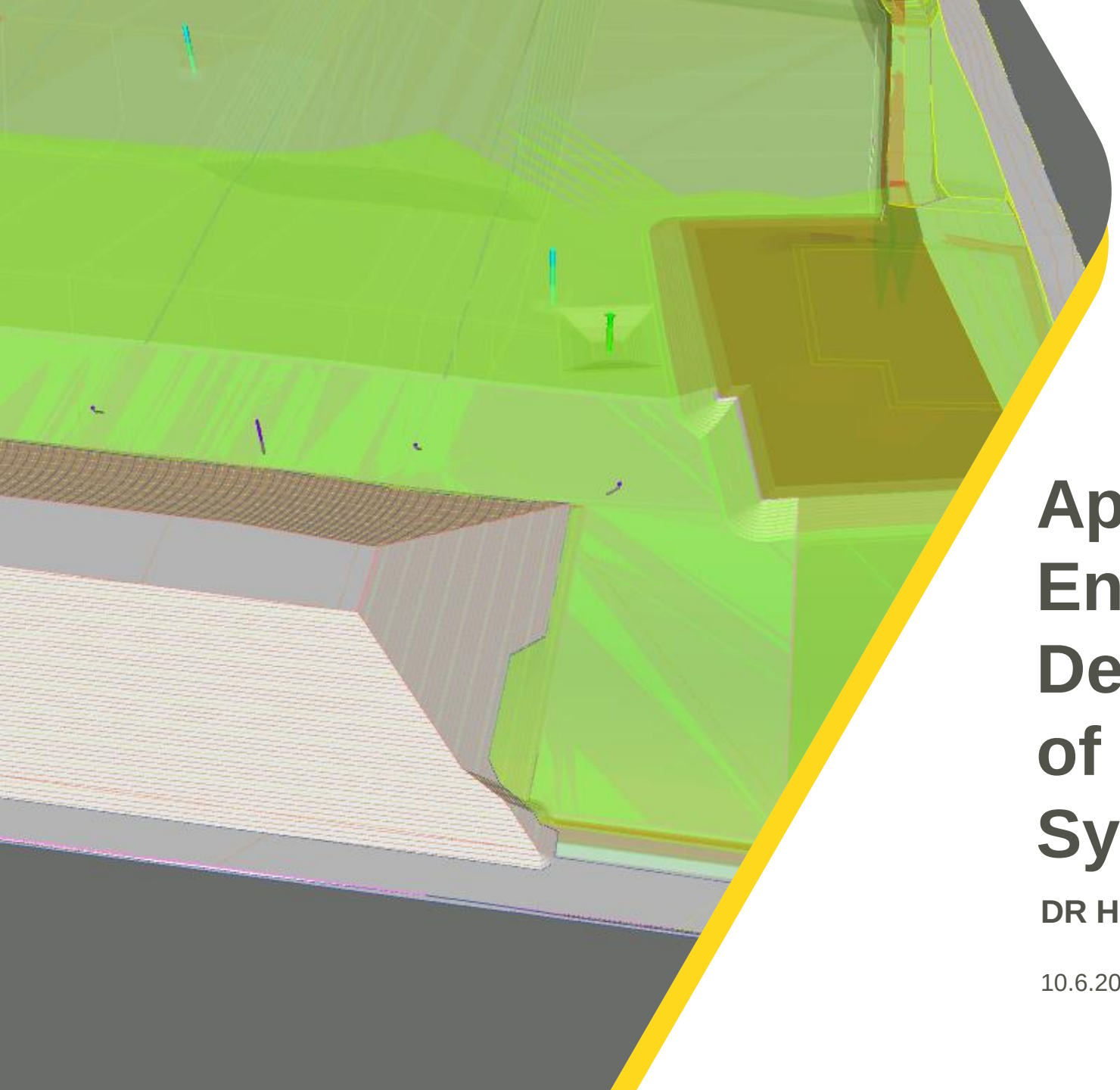

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Application of Digital Engineering in the Design and Construction of Complex Containment Systems

DR HOSSEIN GHIASINEJAD

10.6.2021

AGENDA

- The Project an introduction
- Cap and Contain Approach to Create Value
- Project Construction Constraints
- Digital Solution Provided
- Outcomes and Lessons Learned

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Cap and Contain Approach to Create Value

A Contaminated Site

REMEDIATION METHOD CONFORMING WITH FUTURE LAND USE

With the urban growth of cities and development of new infrastructures the need to deal with contaminated site is more and more frequent and required. Contaminated site pose significant risks of impact future land users through different exposure pathways that vary on the type of contaminant and the source of contamination.

Remediation will be a complex problem to solve when:

- There are multiple CoPC
- The CoPC have different exposure pathways
- The proposed final land intended use is industrial commercial or residential

Cap and Contain Solution

CHANGING A LIABILITY INTO AN ASSET

In our case study there where 4 CoPC with 3 different exposure pathways. The RAP indicated that for the intended use a Cap and Contained solution was required due to the level of contamination and the depth of impacted soils.

The Cap and Contain remediation system was require to:

- Prevent lateral migration of contaminated water and soil gases
- Provide a wicking barrier against contaminant capillary raise to the surface
- Provide a Soil Gas Protection System for VHC
- To reduce stormwater infiltration into the capillary break layer
- Manage groundwater level below the capillary break layer

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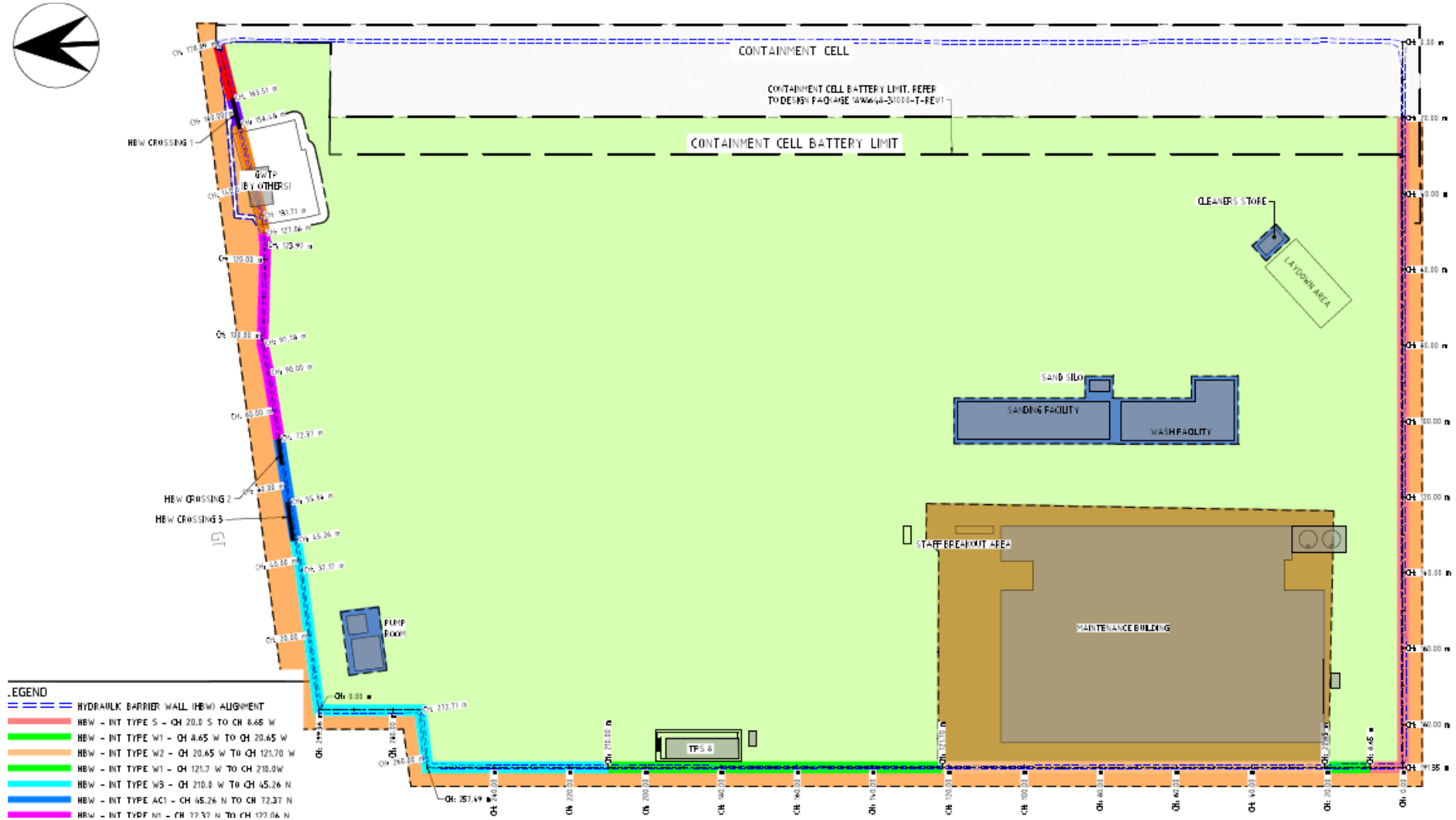
Remediation System Design

Remediation System Design

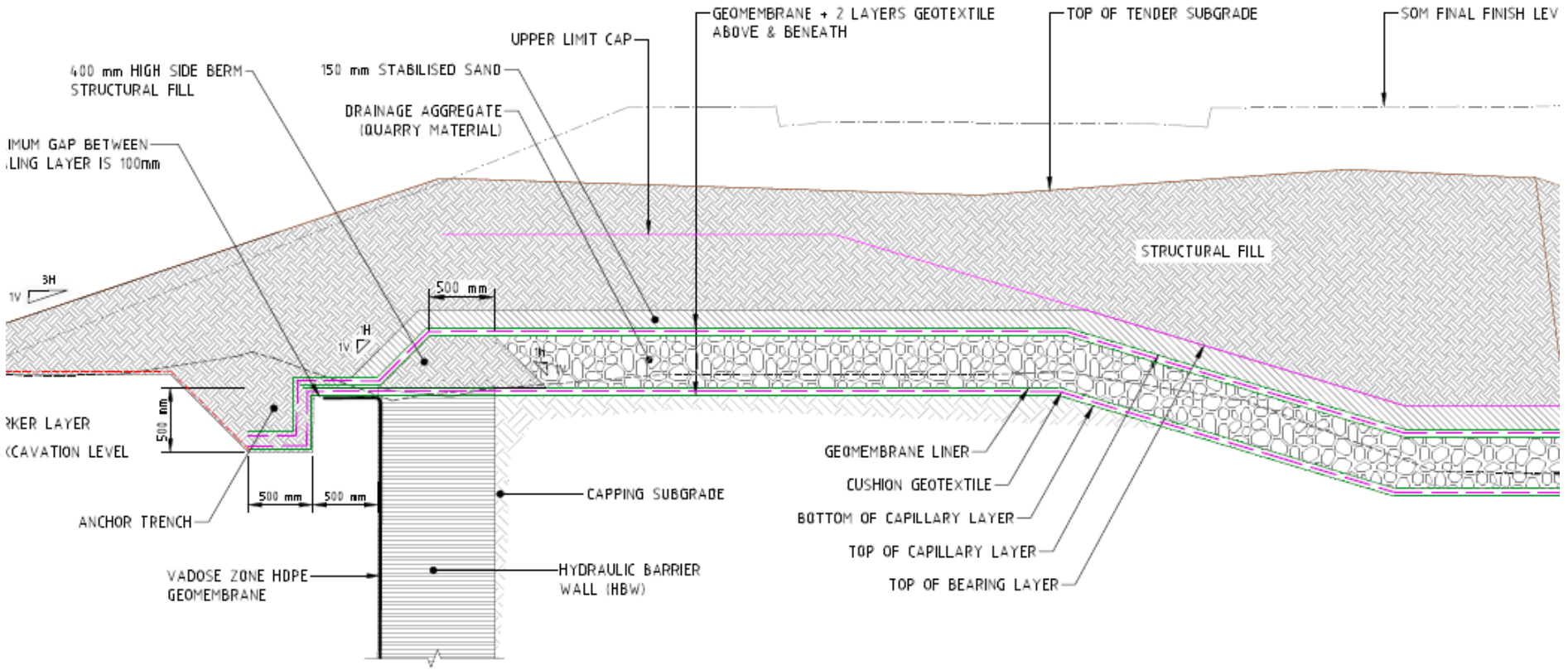
A HUGE ENGINEERING EFFORT

- The design of the Remediation System required contribution from different disciplines: Geotechnical (GI), Environmental, Ground water, Process and Mechanical engineers in addition to Soil Gas Intrusion and Air Quality dispersion modellers.
- Due to the client design requirement and interface with multiple stakeholder it lead to preparation of a significant amount design drawings and details (up too 200 sheets of drawings)
- This level of design complexity is unusual for this type of civil design (landfills and remediation systems).
- Standard earthmoving contractor are not used to deal with contaminated soils and such level of complexity in earthworks and geosynthetic installation leading to expensive and slow construction process.

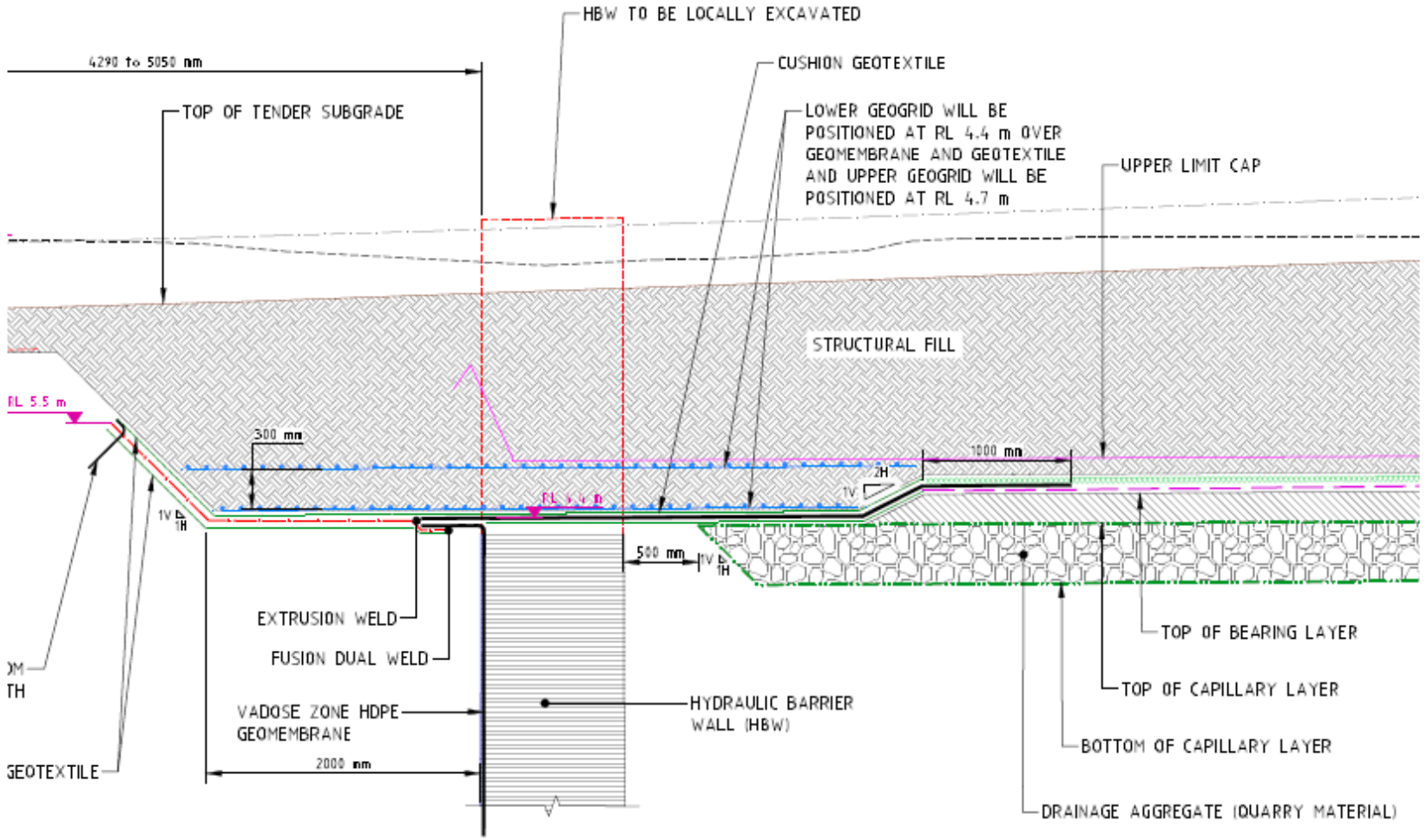
Remediation System – Multiple Capping System



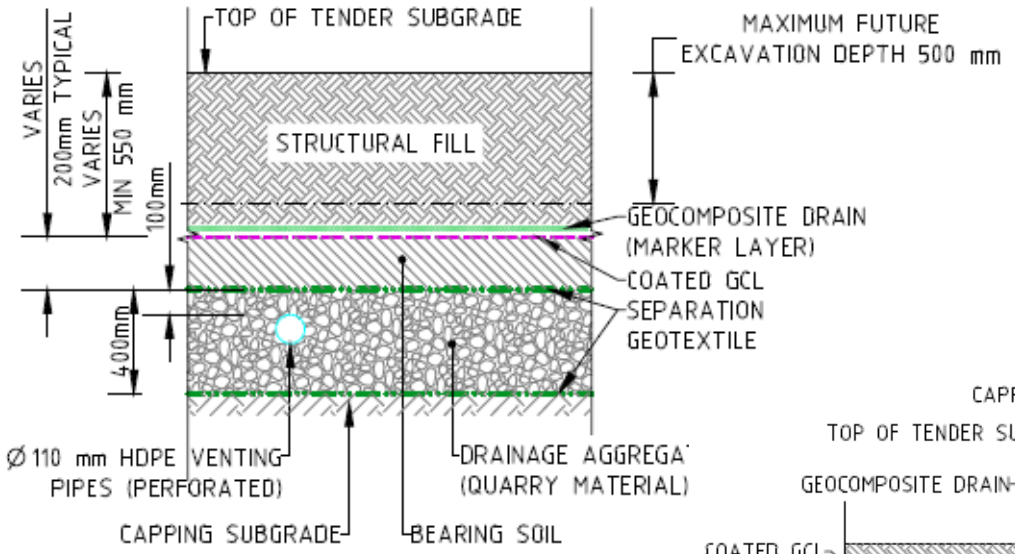
Remediation System – Capping and Containment Integration



Remediation System – Capping and Containment Integration

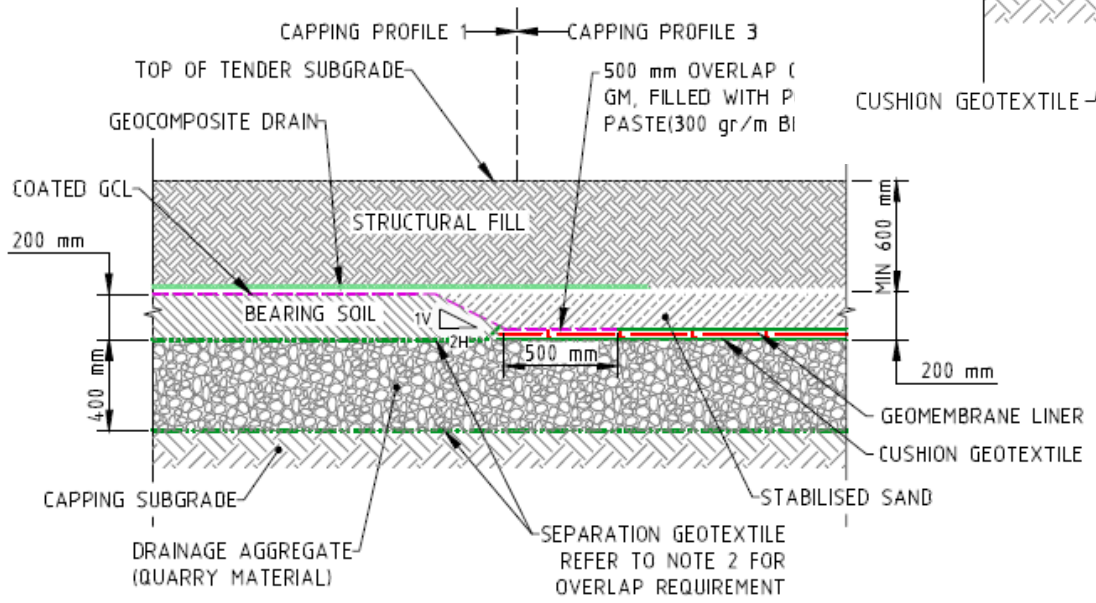


Remediation System – Integration between Cap Types

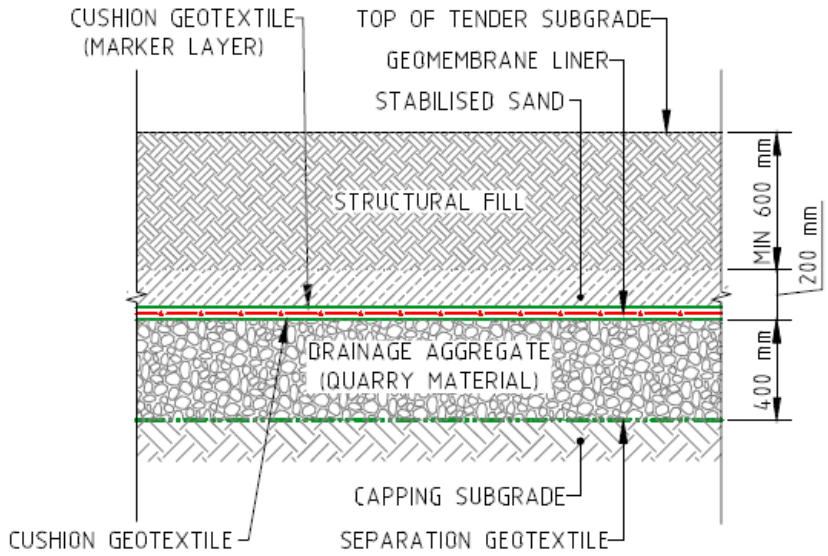


TYPICAL DETAIL - CAPPING PROFILE 1

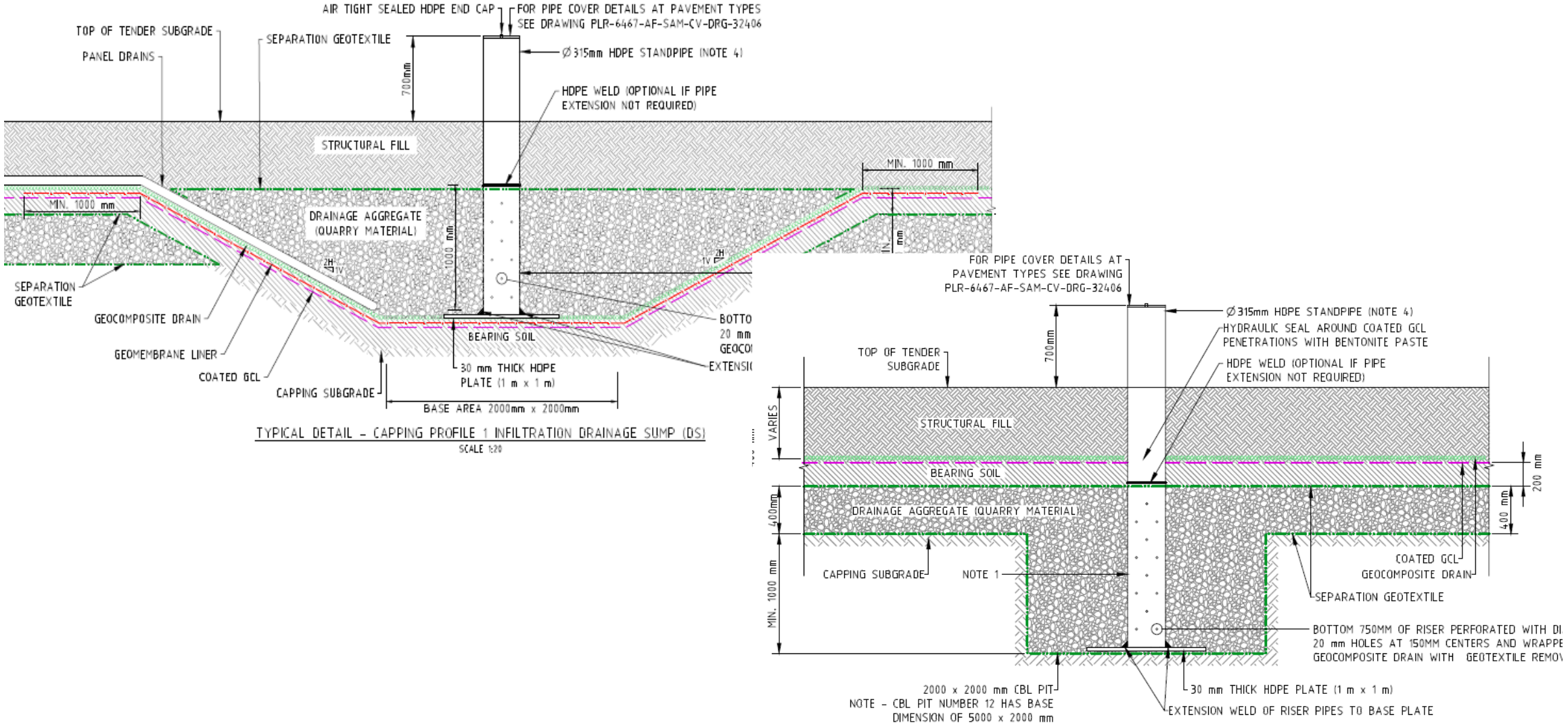
SCALE 1:20



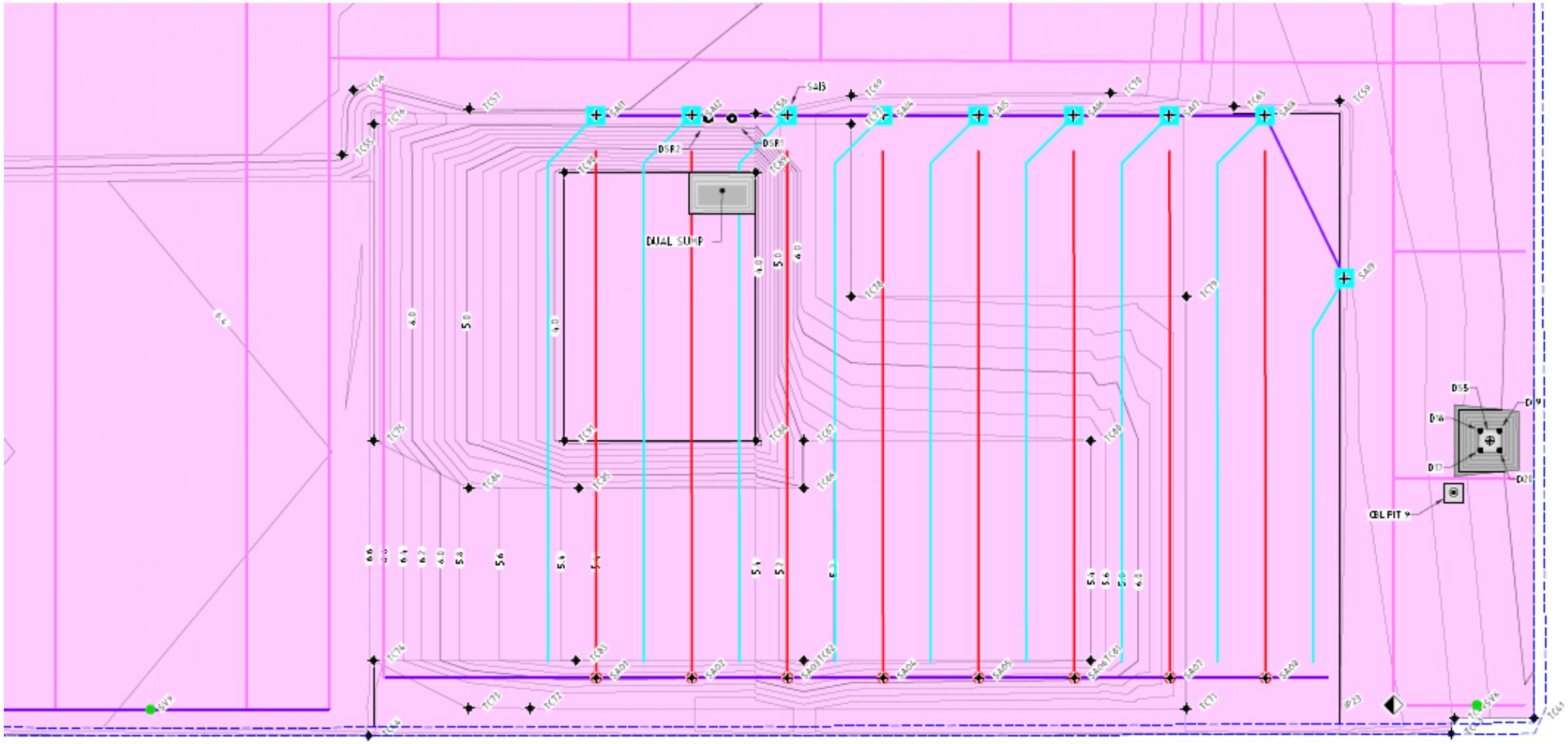
TYPICAL CAPPING INTERFACE DETAIL - PROFILE 1 AND 3



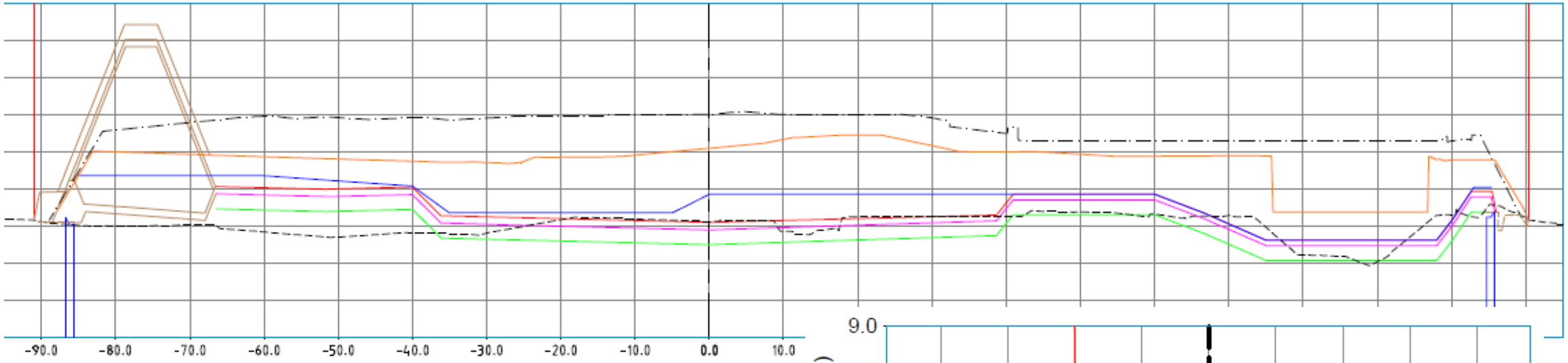
Remediation System – GW Pits and Infiltration Sumps

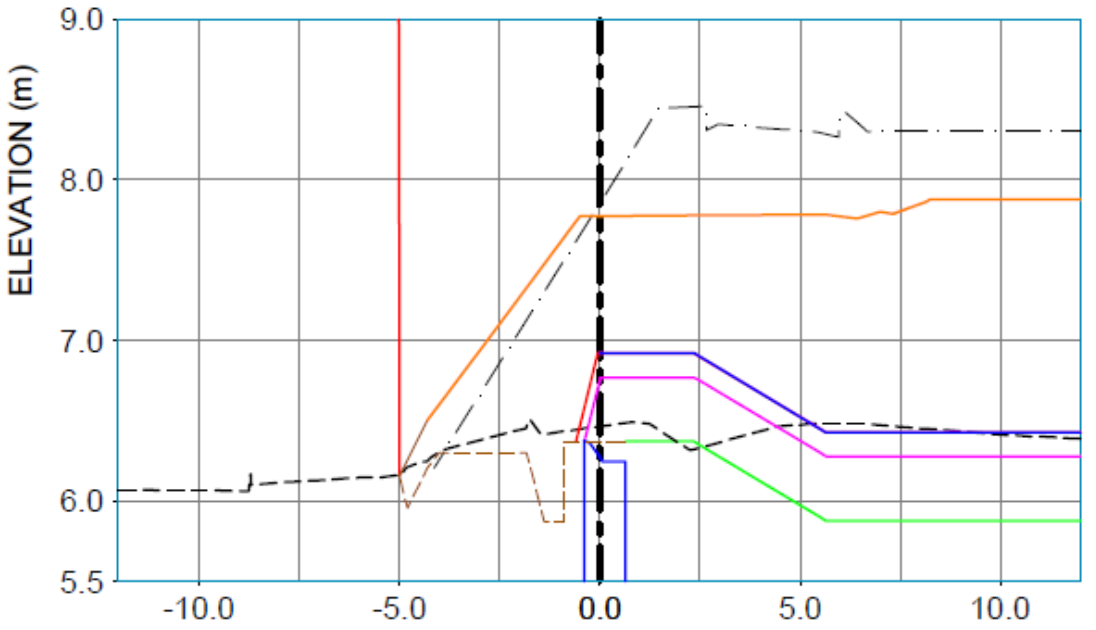


Remediation System – Soil Gas Protection System



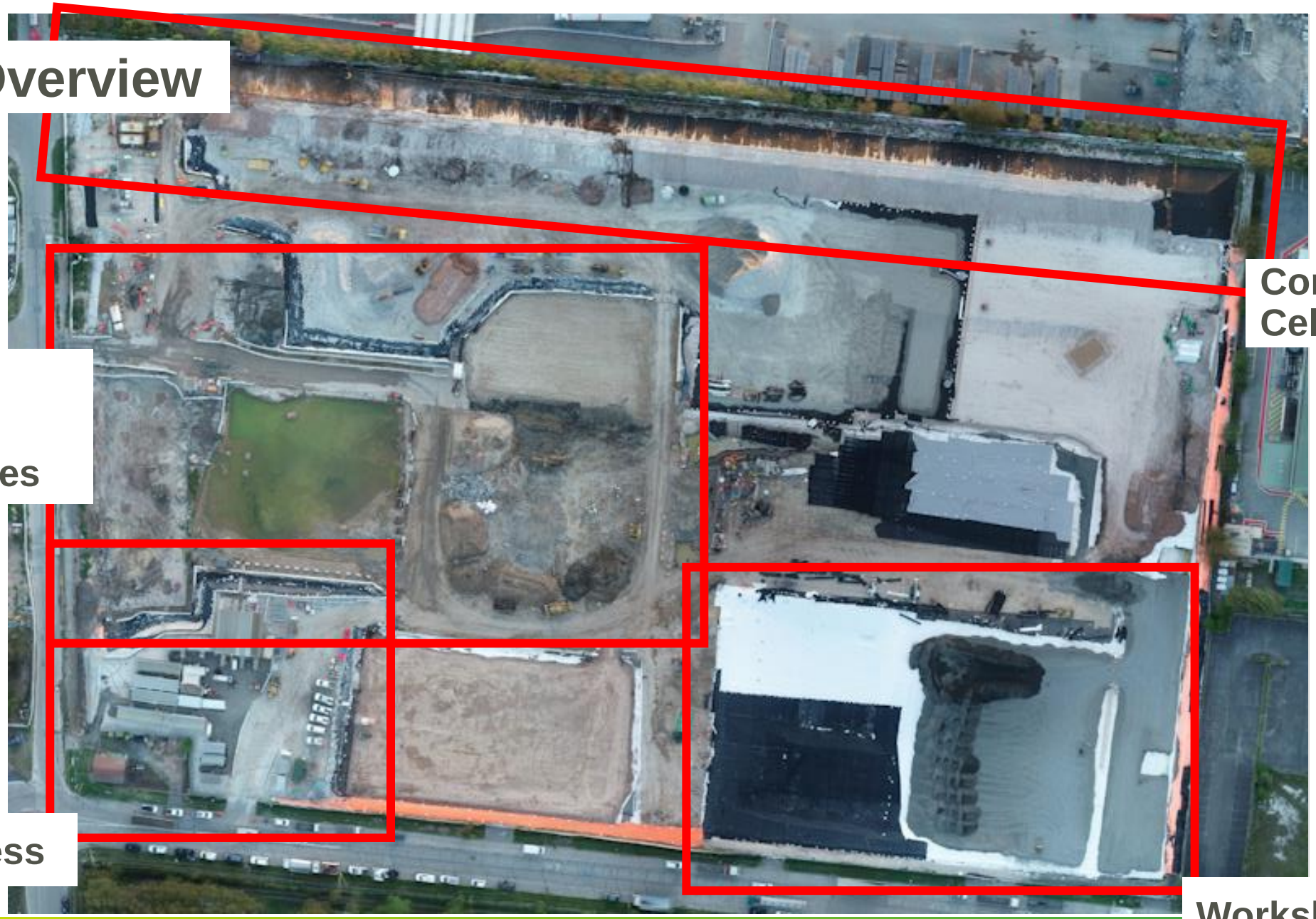
Remediation System – How to support the construction





Construction Constraints

Site Overview



Containment Cell

Second Access Stockpiles

Site Access

Workshop

Construction Sequencing

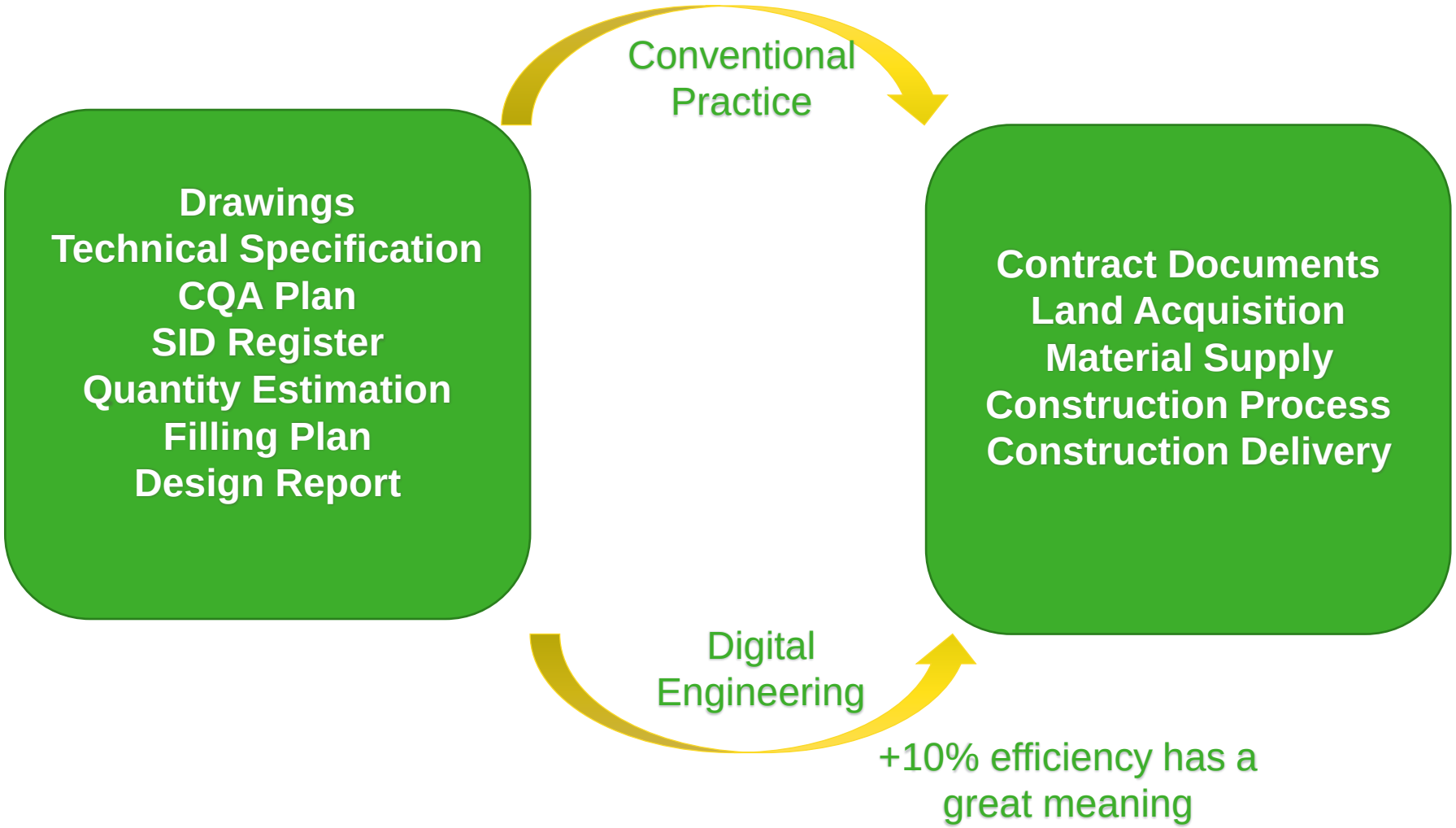
Construction Sequencing

Construction Sequencing

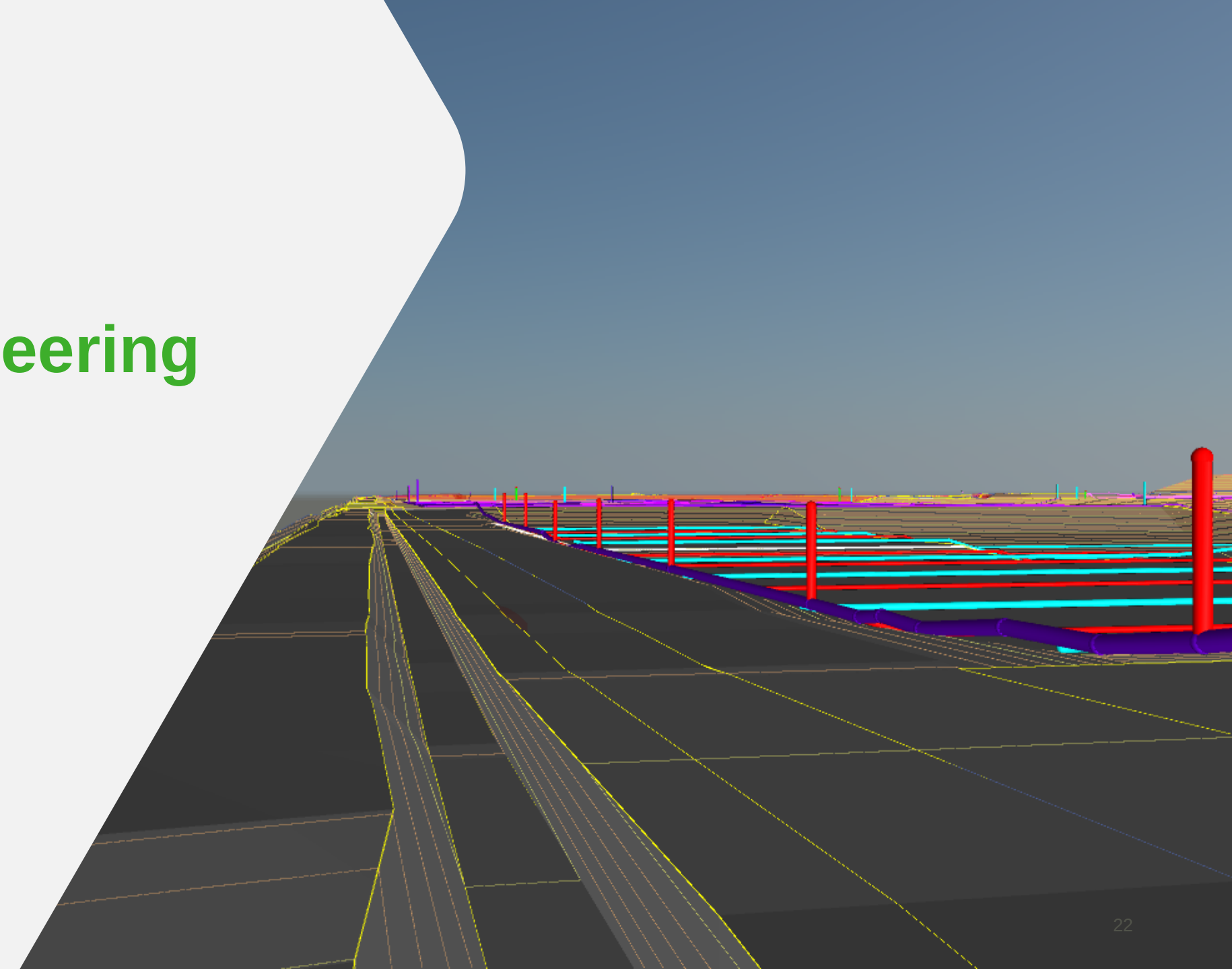
Health and Safety

Design to Construction Transition

AN OPPORTUNITY TO CREATE VALUE



Digital Engineering Solution

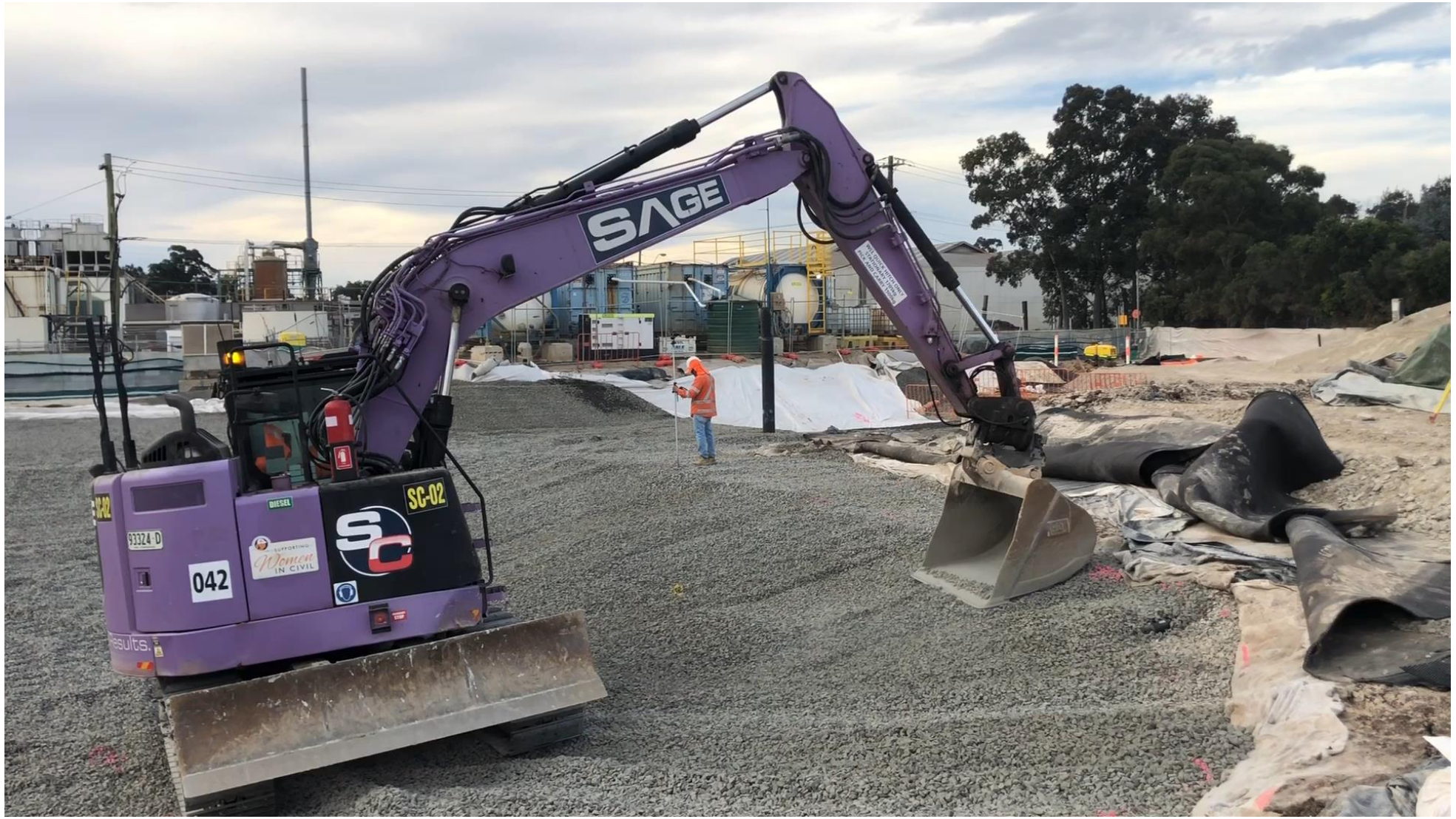


GPS/GRSS Antenna is mounted on the boom

GPS/GRSS Antenna is mounted on the counter weight

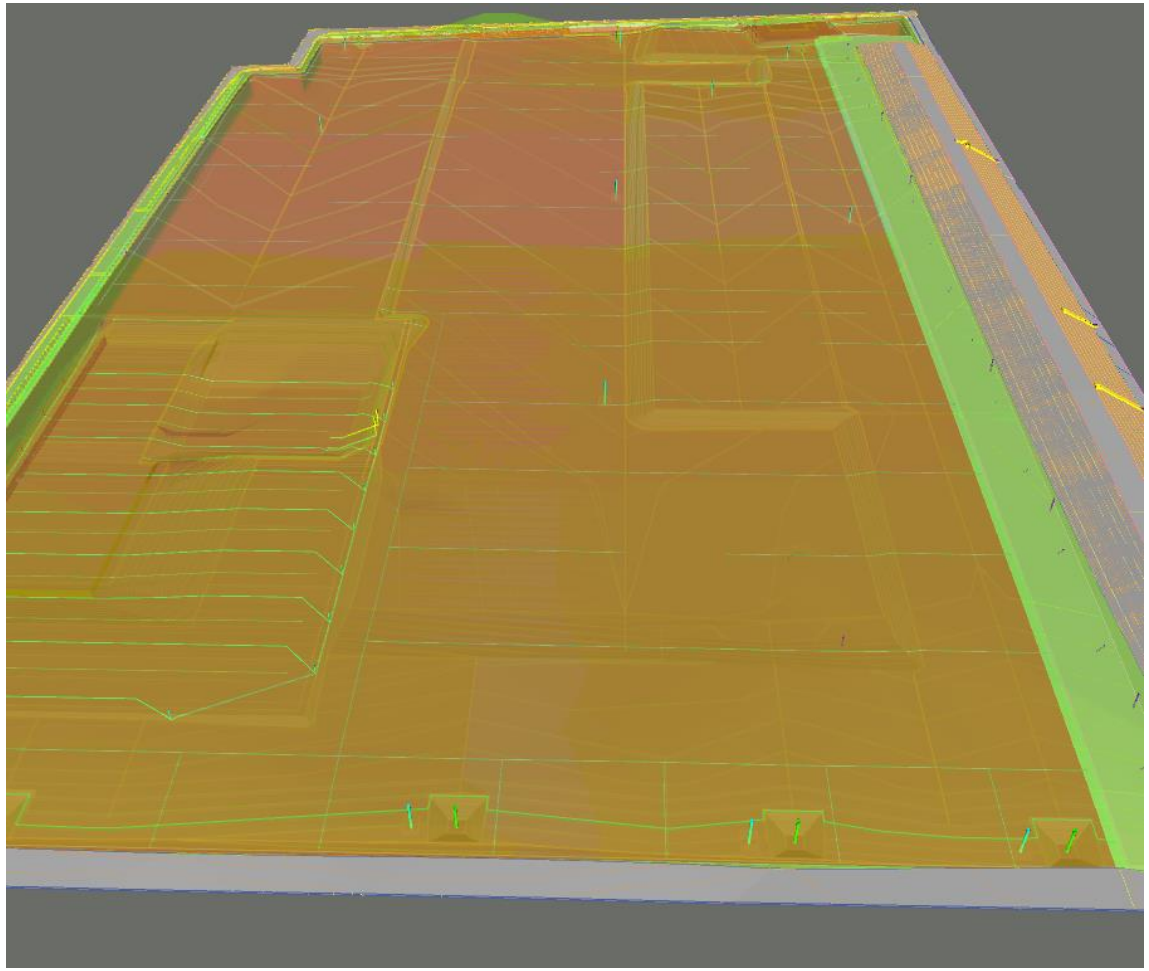
The designed surface is loaded to the equipment system.

GPS Equipped Excavator in action



A federated model for the Remediation System

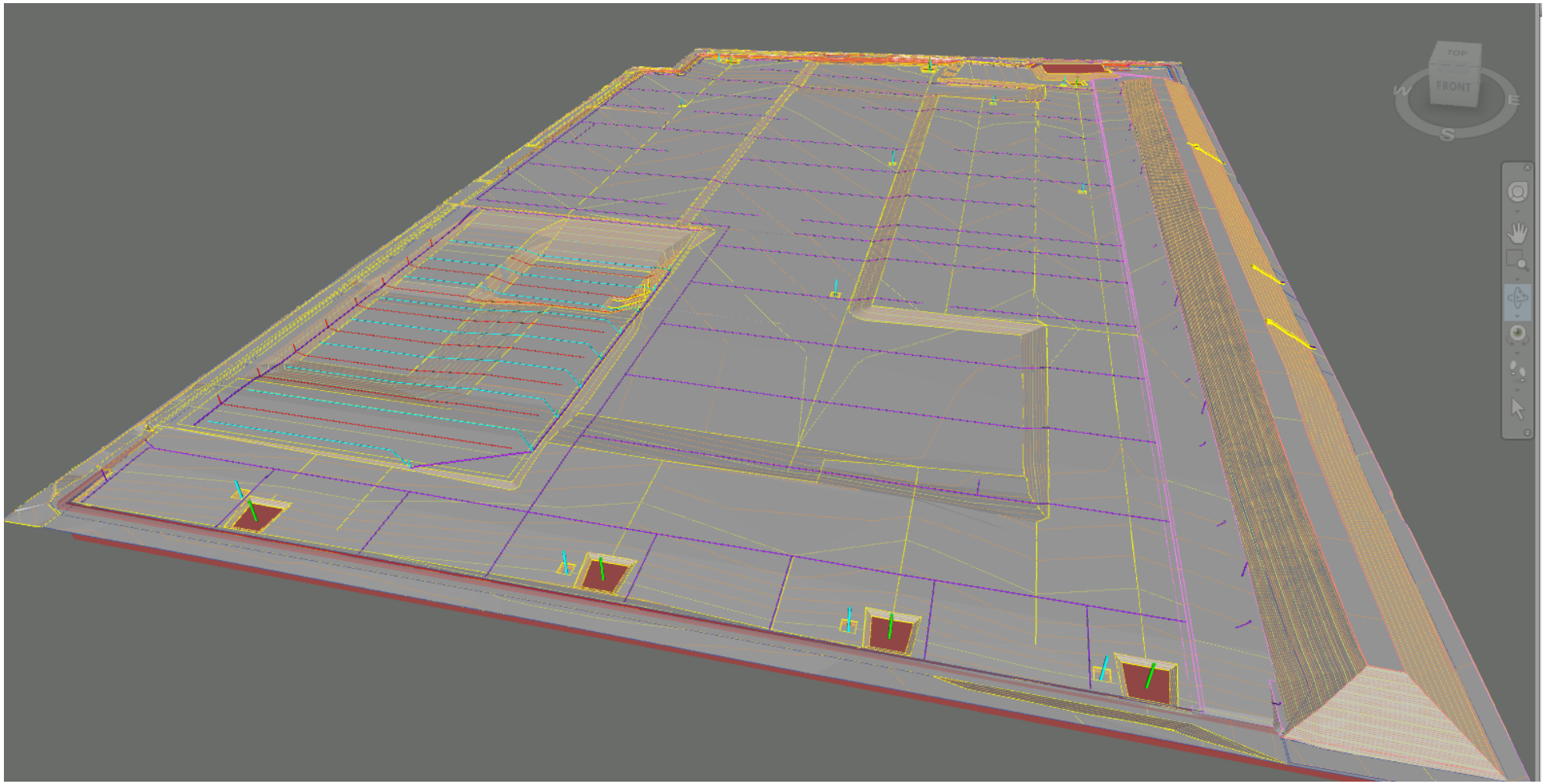
A ONE TO ONE DIGITAL MODEL OF THE PROJECT



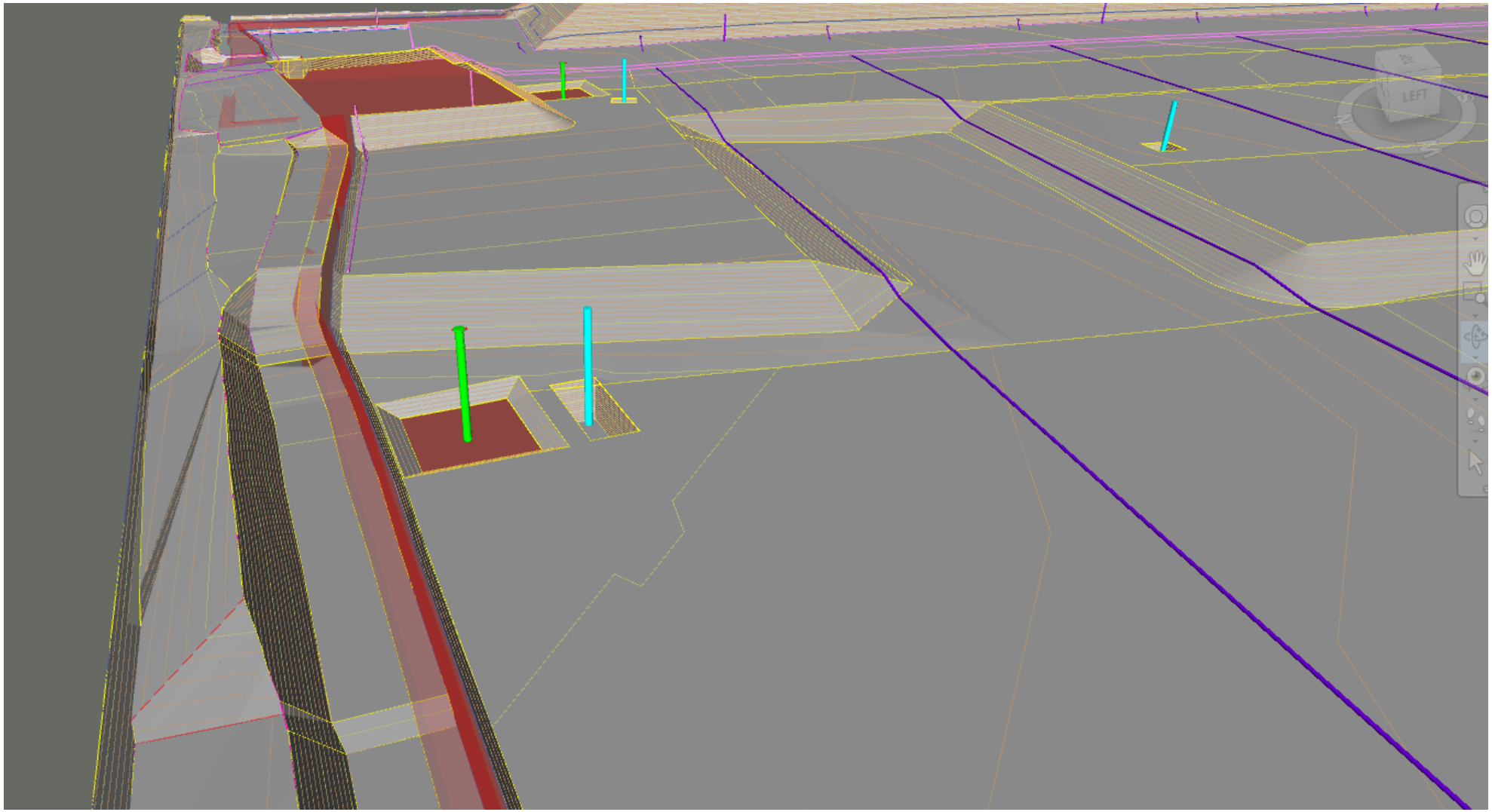
A combination BIM, CIVIL 3D, NAVIS WORKS and REVIT softwares were used to produce a full 3D model of the remediation system to include all the remediation elements including all Cap Type transition details, all pipeworks and their protrusions through the capping and integration details of the Capping system with Hydraulic Barrier.

The containment cell was also fully modelled.

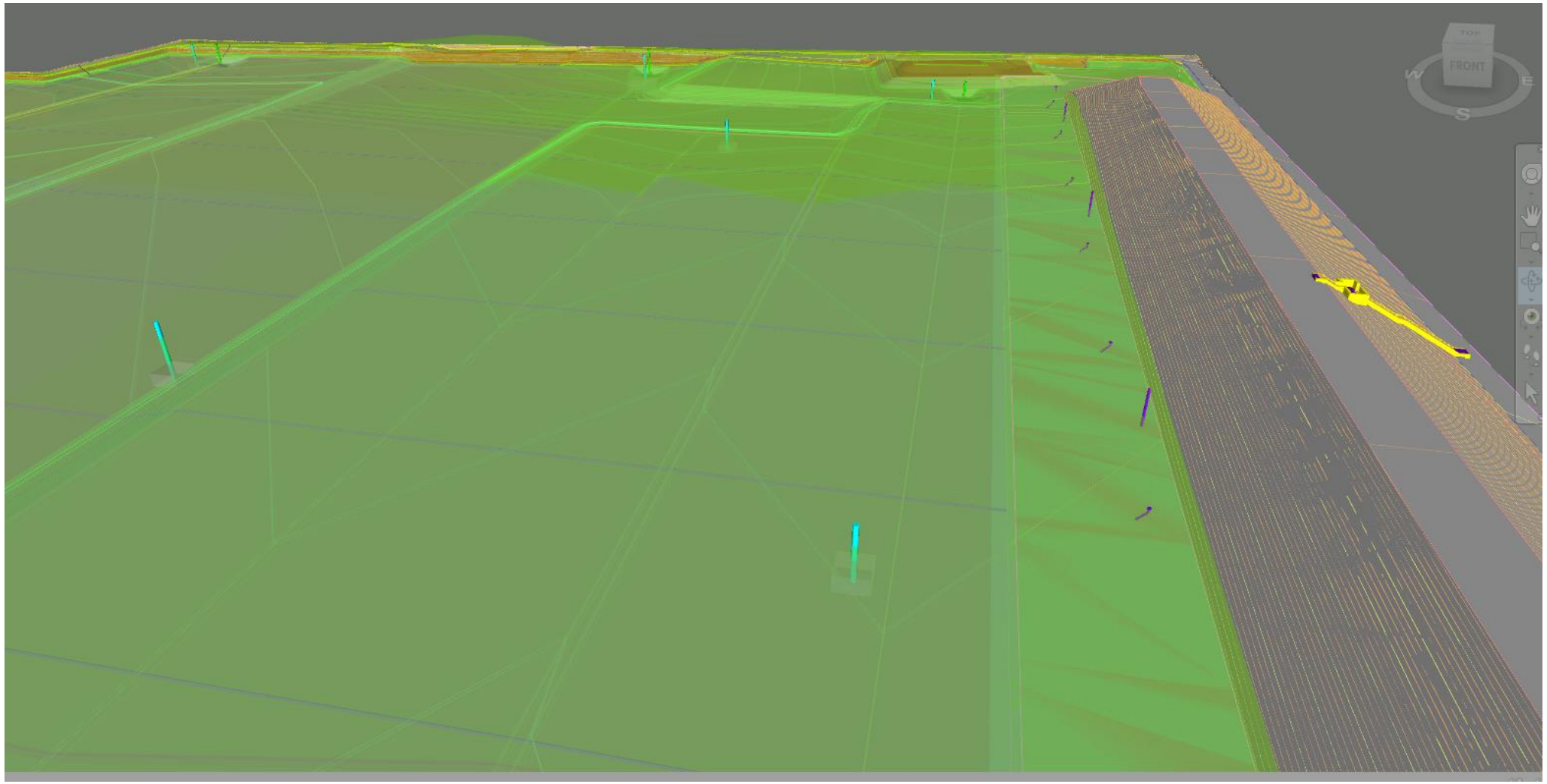
3D digital inclusive model



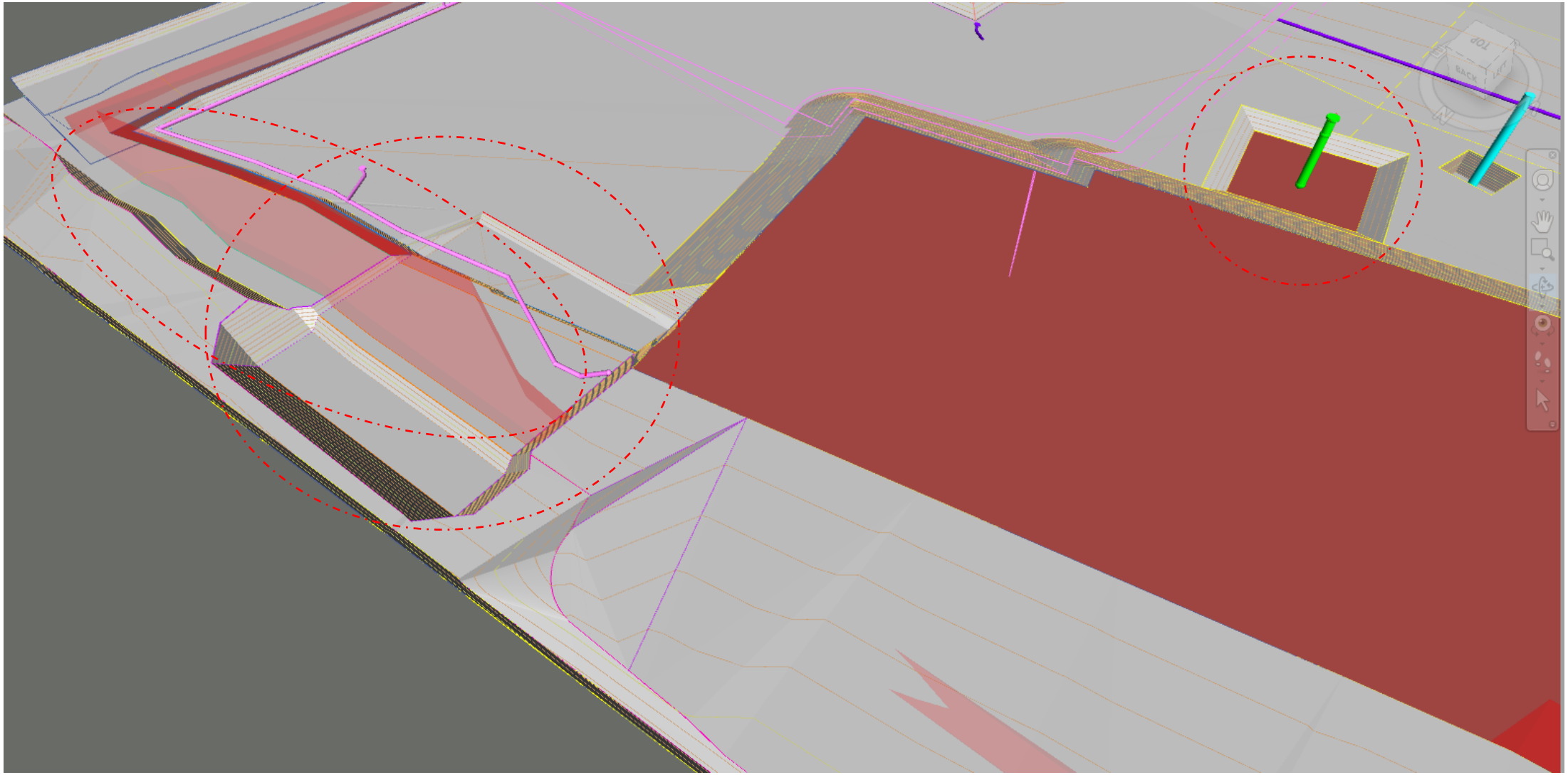
Integration Transition



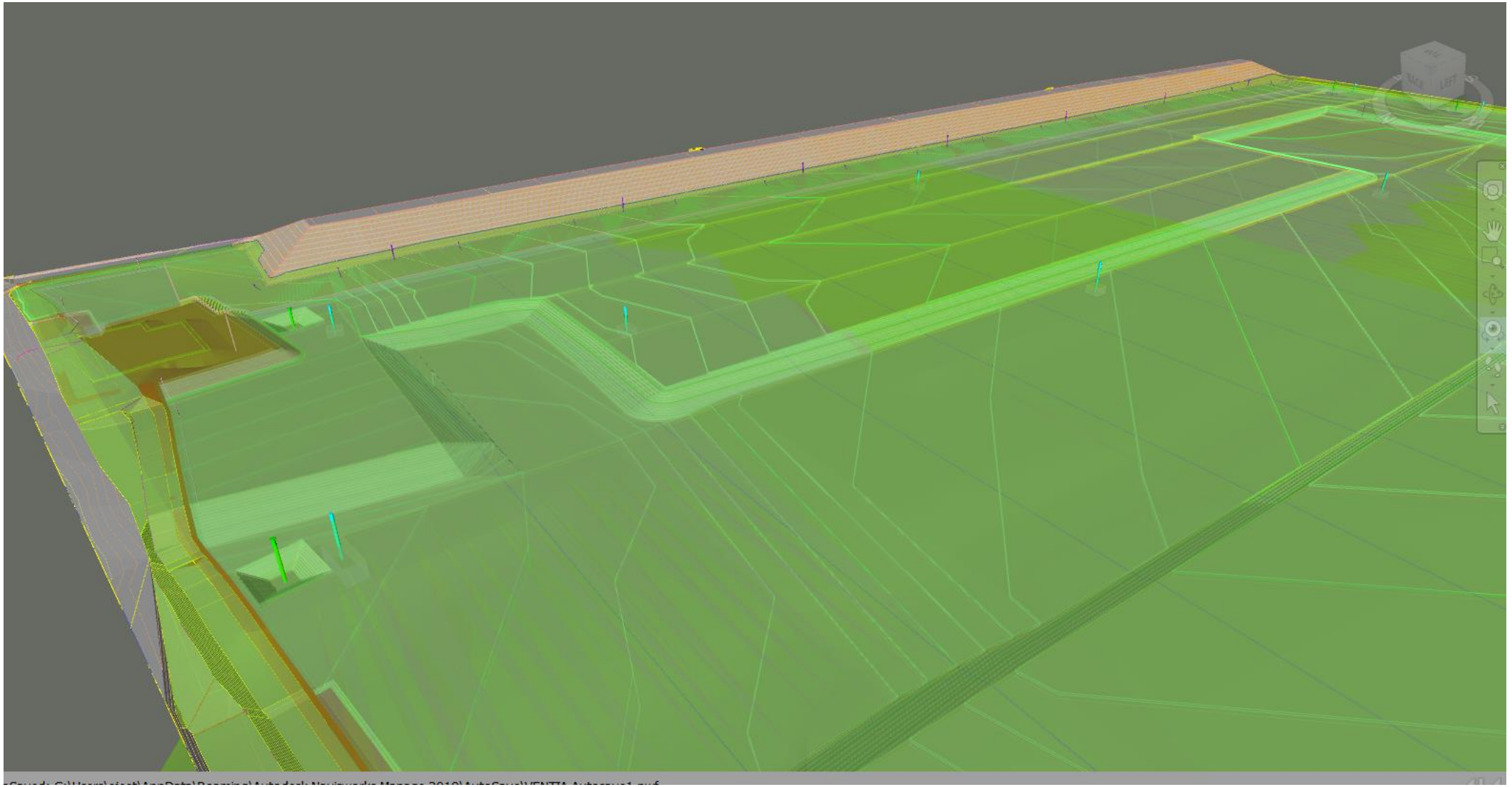
The Layered Cake Model



Complicated Transition-Pipes, Cut-off Wall and Slab



Undulation of Layers



How Digital Engineering Impacted the RS Construction

CHANGES IN PRACTICE

- The number of geometrical Non Conformances (levels/thickness/grades) decreased.
- Accuracy of the surface levels and thicknesses increased – design within tolerances.
- The contractor used an exact surface for earthworks. When it appeared that insufficient 3D information were available or re-design was required it was done on the 3D model based on real time information from site and the models updated.
- real time information from site and the models updated.

How Digital Engineering Impacted the RS Construction

CHANGES IN PRACTICE

- The requirements for clarification and relevant work stoppages decreased.
- An Inclusive Digital Model of the project expedited the process of decision making and variation in the design.
- Complicated geometries could be constructed including different interfaces between earthwork, lining and piping contractors.
- The contractor could planned the work sequencing ahead. Multiple work front were open in different area of the site to allow for construction programme acceleration.

Outcome and lessons Learnt

Outcomes

ADVANTAGES OF APPLYING DIGITAL ENGINEERING IN DIFFERENT PROJECTS

- The cost of construction is estimated to reduced around 10%-15%
- The time of project execution is estimated to reduce 15% to 20%
- The additional cost for implementation of the digital engineering is small compare to the construction savings in large scale/complex project.
- The method made the implementation of a complicated design geometry possible.

Lesson Learned

THINGS TO KEEP IN MIND

- Set up of a local total station on site to improve accuracy (using GPS alone will reduce it up to 100mm and require surveyor effort comparable to traditional approach
- Transducers are prone to damage during construction works. Repairs require special personnel which may be not ready available to site.
- Different equipment use different proprietary system. The use of multiple system require interface with different company that have different requirements making the process cumbersome. Only ne commercial system should be used.
- There are system that can upload files to the equipment remotely removing the user error in uploading and reducing the ‘upload’ time – machine ready.

Lesson Learned

WHAT WE COULD HAVE DONE BETTER

- Site Engineer should be in control the work progress (surface ladings, sequencing and orders)
- Operators are required to be trained – some operators (detailing) prefer to work with no constrains.
- The surface generated during design (TIN) are generally compatible with most of the proprietary system. 3D model need to be accurate e well defined (break lines, cringing method…)
- The contract with service supplier should be an Installation/Training/ Maintenance contract.

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Questions?

COME AND TALK TO US IF YOU ARE CURIOUS ON HOW TO IMPLEMENT COMPLEX ENGINEERING SOLUTION ON YOUR NEXT PROJECT