
# Design and Construction of a Flexible Reinforced Soil Wall (RSW)

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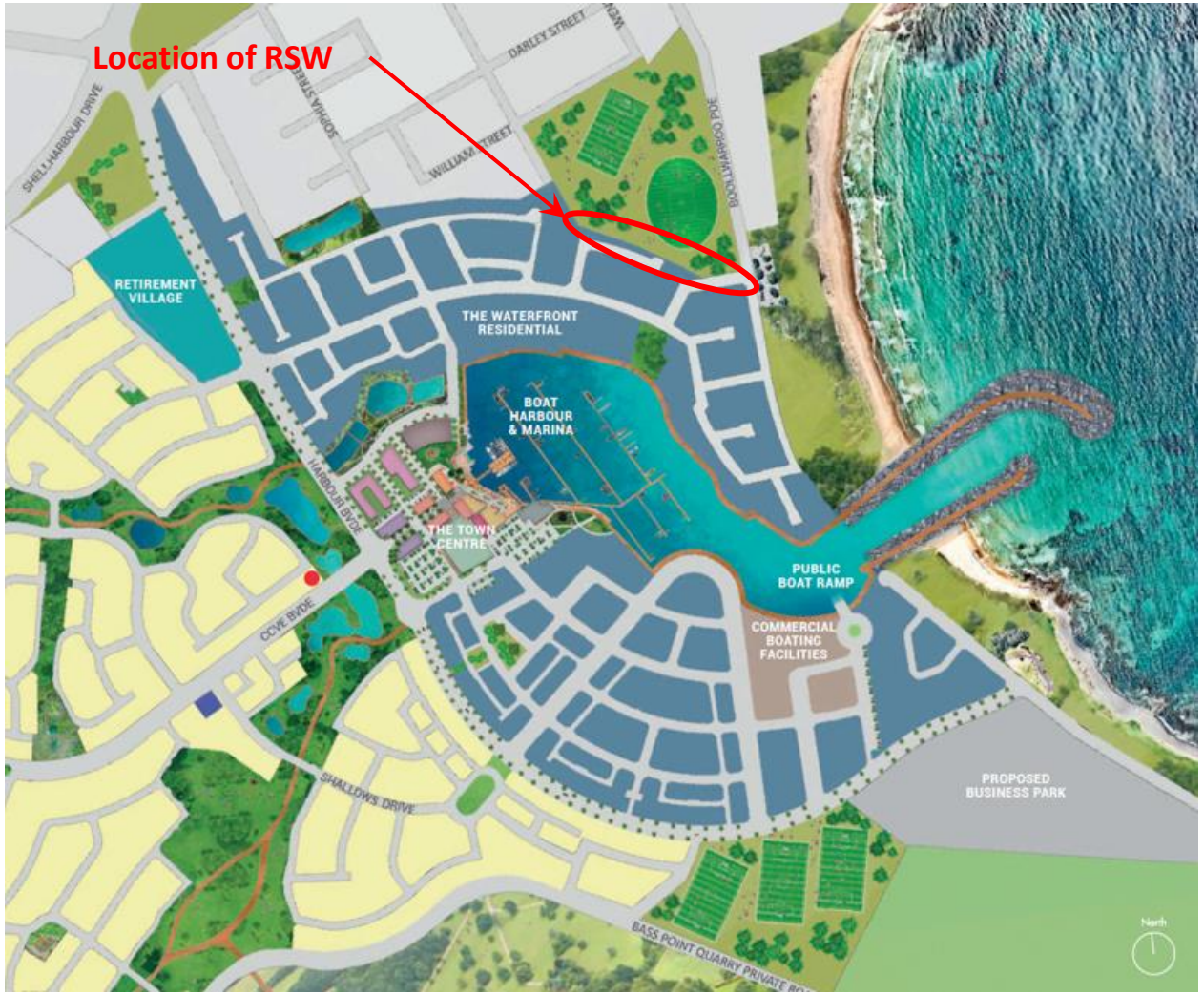
# Introduction:

**Project:** Shell Cove Boat Harbour Development (NSW)

**Information:**

- The boat harbour provides a water surface of approximately 12 hectares which is approximately 30% larger than Darling Harbour
- Study and Investigation commenced in 1984
- Construction commenced in 2013
- Presence of soft soils up to 10m thick
- Soft soil improvement mainly carried out by surcharging and installation of wick drains
- Flexible RSW:
  - Total length = 157m
  - Total height = 3m to 5.5m
  - Width = 6m to 9.5m



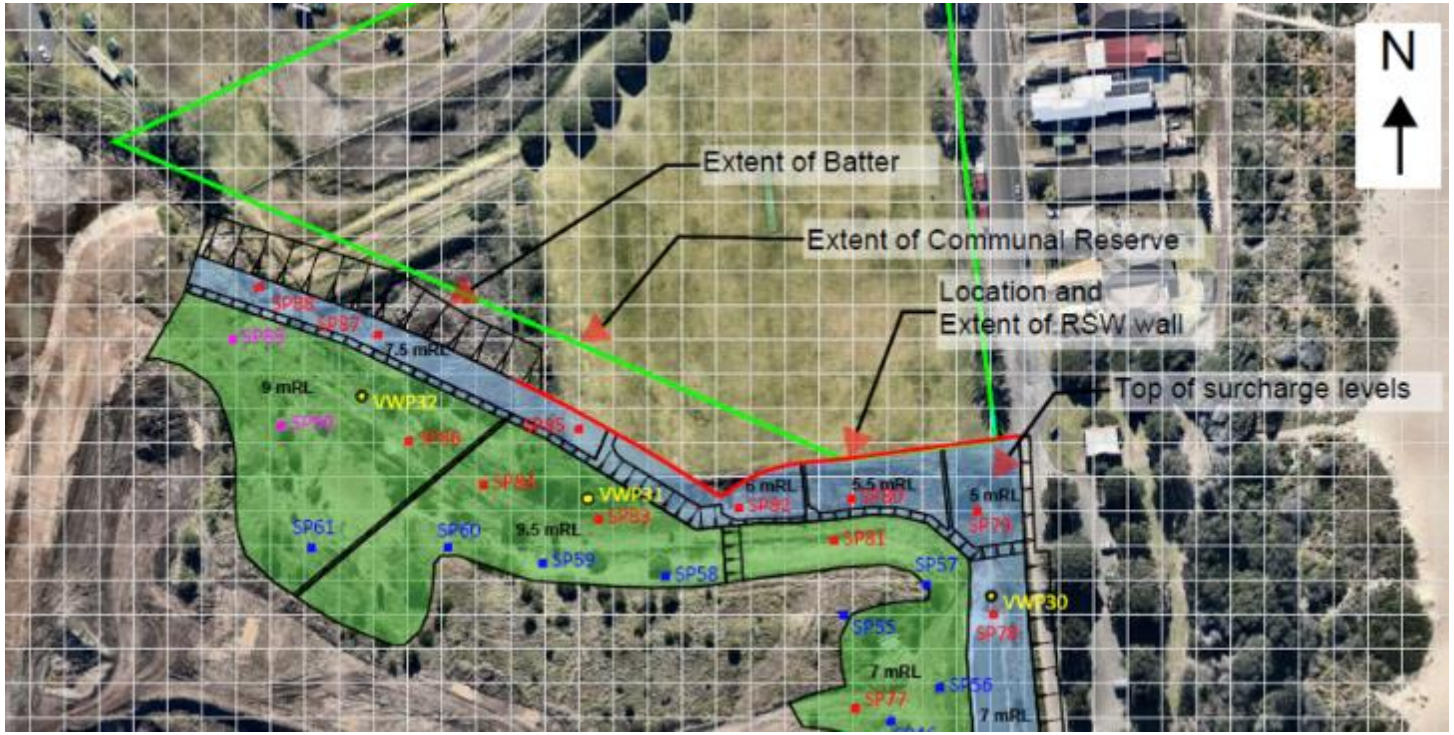
# Why RSW was chosen:

**Original Design:**

- Surcharge mound with batter
- 157m long, 18m wide batter
- Required about 2,800 $m^2$ of Communal land

**Flexible RSW:**

- Eliminating requirement for acquiring 2,800 $m^2$ of the communal land
- Providing better short-term and long-term outcome for project
- Also, redesign incorporated the results of the monitoring from previous stages resulting amendment of some of the design parameters and criteria, reducing required surcharge height



# SI and Geology:

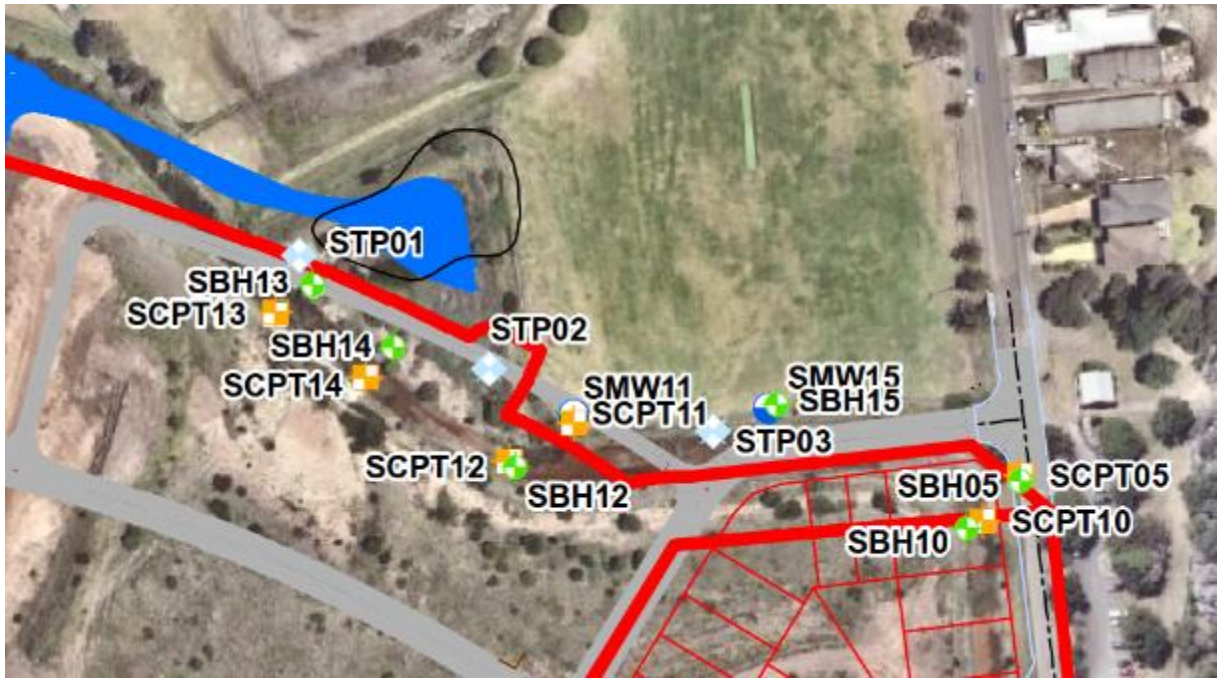



Figure 1: Location of testing

INFERRED GEOTECHNICAL UNITS

- UNIT 1A: Fill
- UNIT 2 (Littoral Sands): SAND/SILTY SAND - LOOSE TO MEDIUM DENSE
- UNIT 3b (Estuarine Sediments): CLAYEY SILT/SILTY CLAY/CLAY - SOFT - FIRM
- UNIT 4: (Alluvium) - STIFF TO VERY STIFF SILTY/SANDY/GRAVELLY CLAY
- UNIT 5: (Residual Soil/Extremely Weathered Rock) - VERY STIFF TO HARD GRAVELLY CLAY/CLAYEY GRAVEL DERIVED FROM WEATHERED LATITE
- UNIT 3a: (Estuarine Sediments) - SAND/SILTY SAND - LOOSE TO MEDIUM DENSE

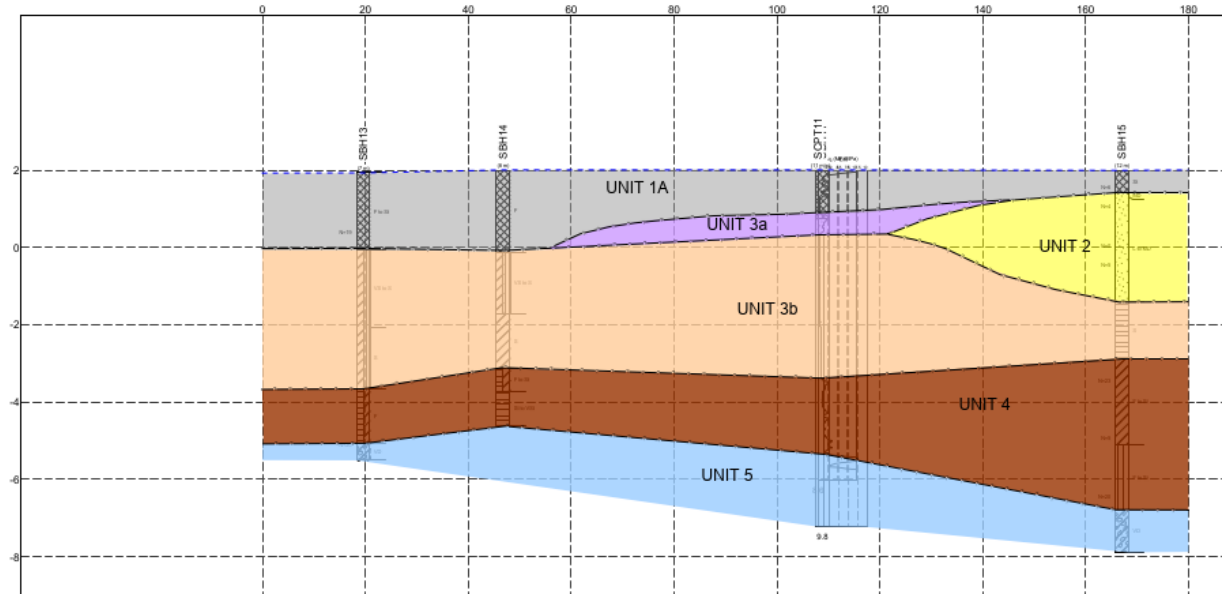



Figure 2: Geology along face of RSW

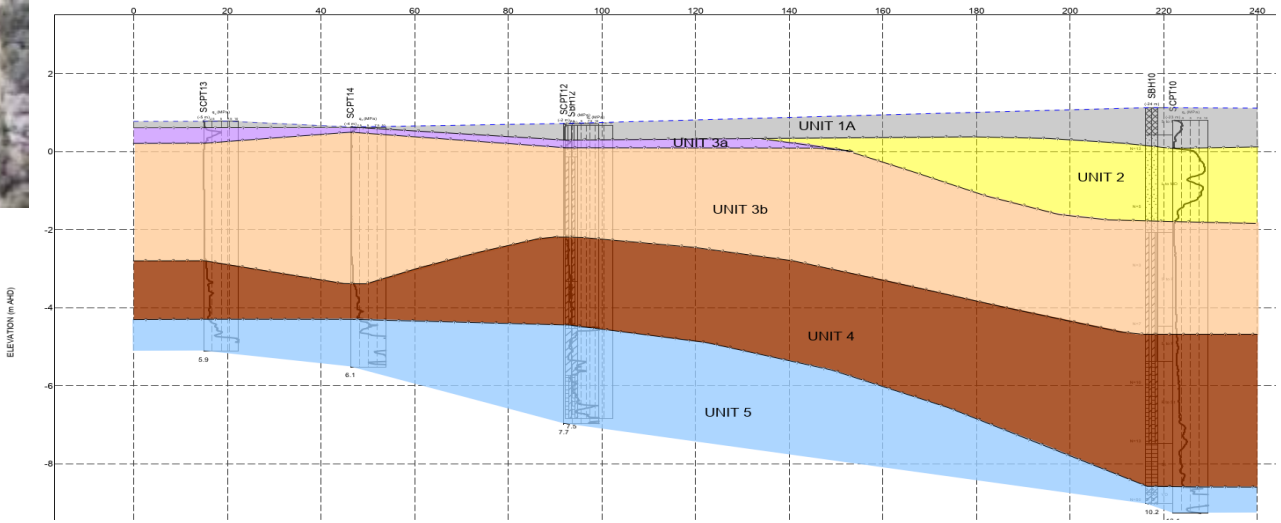



Figure 3: Geology along back of RSW

# Design Criteria and Parameters:

**Design Criteria:**

- Design life of 60 years
- Long term (post construction) settlement of less than 40 mm.
- Long term (post construction) differential settlement of less than 50 mm over a 25 m length.
- Building loads (or post construction/permanent load) of 25 kPa (considered as a uniform load over the site). The only exclusion to this was the road to the north of Precinct G where a post construction/permanent load of 10 kPa was adopted for the design (for settlement analysis).

Table: Interpreted / adopted design parameters

| Parameter | Soil Unit | | | | | |
|---|---|---|---|---|---|---|
| | Unit 3B – Upper Layer | | Unit 3B – Lower Layer | | Unit 4 | |
| Material Type | Estuarine - Sandy/Silty CLAY | | Estuarine - Sandy/Silty CLAY | | Alluvium - Gravelly CLAY | |
| Zone | Diversion Channel | Outside Diversion Channel [2] | Diversion Channel | Outside Diversion Channel [2] | Diversion Channel | Outside Diversion Channel [2] |
| $\gamma\ (kN/m^3)$ | 15 to 16 | 15 | 16 to 18 | 16 | 18 to 19 | 18 to 19 |
| $s_u(kPa)$ | 17 to 30 | 15 | 30 to 80 | 15 to 50 | 60 to 120 | 60 to 120 |
| $c_c/(1+e_0)$ | 0.25 | 0.25 | 0.25 | 0.25 | 0.10 | 0.10 |
| $c_r/(1+e_0)$ | 0.035 | 0.035 | 0.035 | 0.035 | 0.01 | 0.01 |
| $c_\alpha/(1+e_0)$ | 0.0125 | 0.0125 | 0.0125 | 0.0125 | 0.005 | 0.005 |
| $c_v\ (m^2/year)$ [1] | 5 | 5 | 5 | 5 | 5 | 5 |
| $c_h\ (m^2/year)$ [1] | 10 | 10 | 10 | 10 | 10 | 10 |
| $OCR$ | 1.1 to 11.0 | 1.2 to 1.5 | 2.0 to 6.5 | 1.5 to 4.0 | 5.0 to 20.0 | 4.0 to 20.0 |

# Designed Flexible RSW:

**Flexible RSW consisted of the following three walls over each other:**

- Gabion Wall
- Permanent Reinforced Soil Wall
- Temporary Reinforced Wall

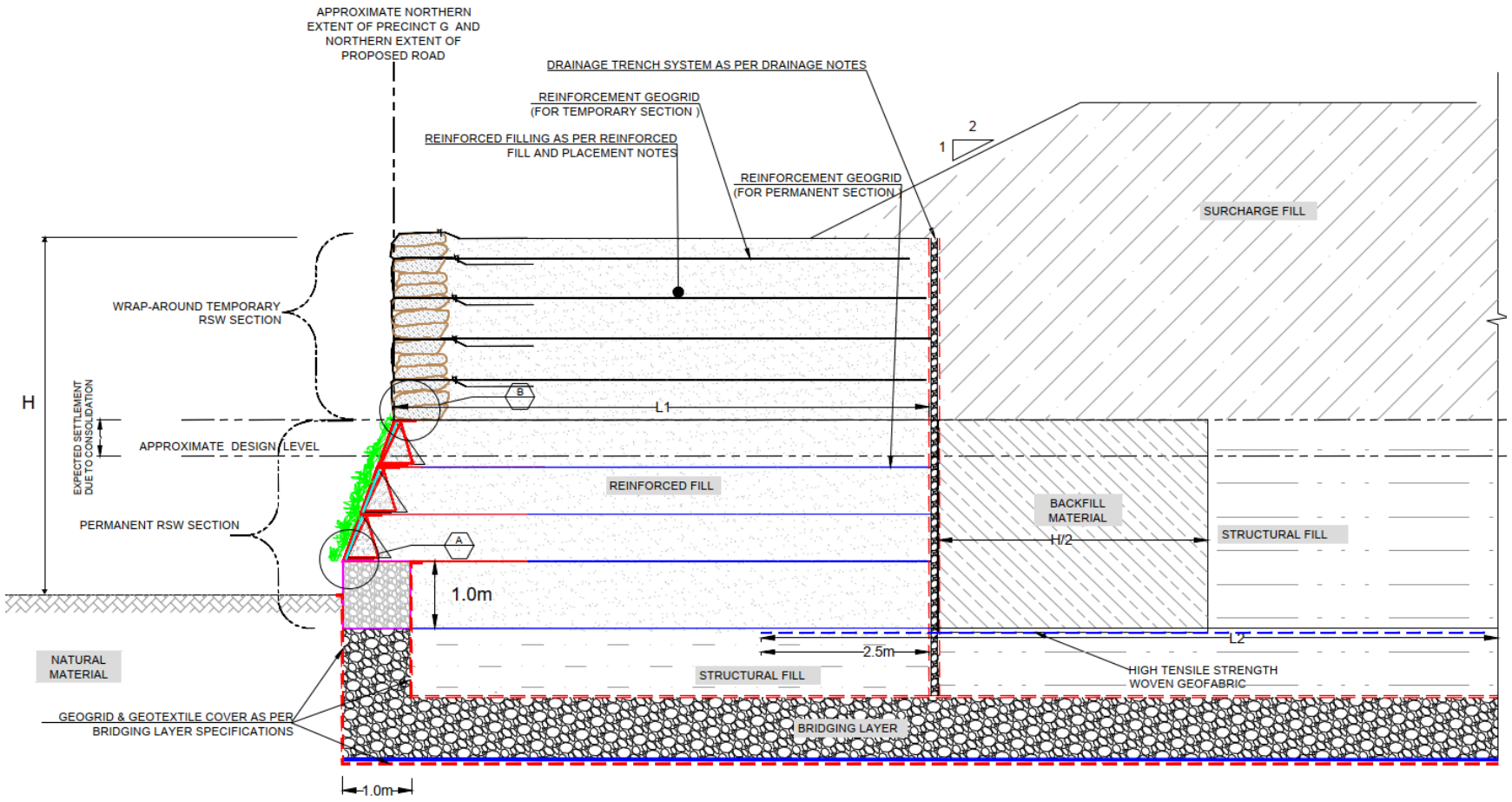



Figure: Cross section of RSW

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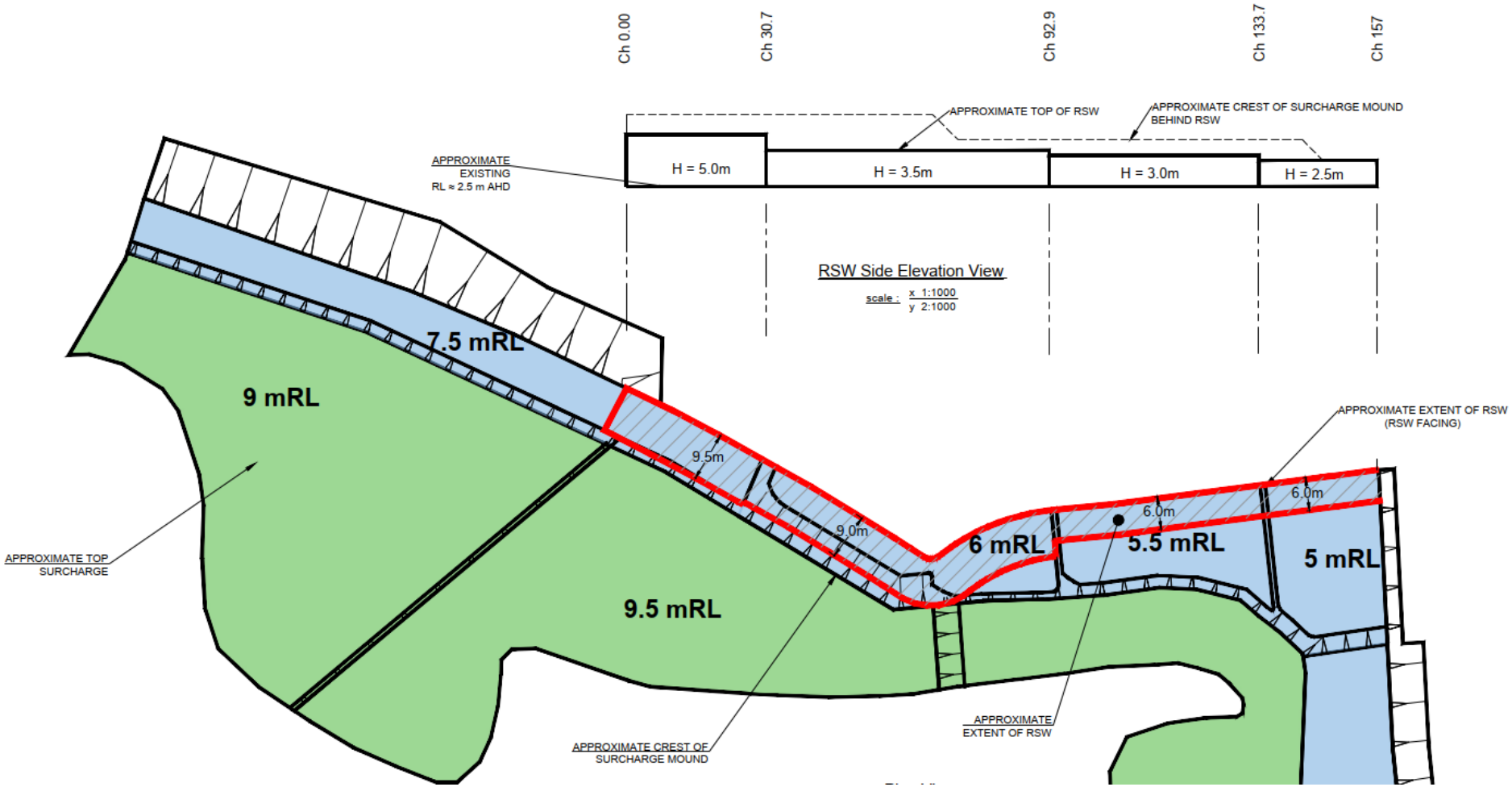
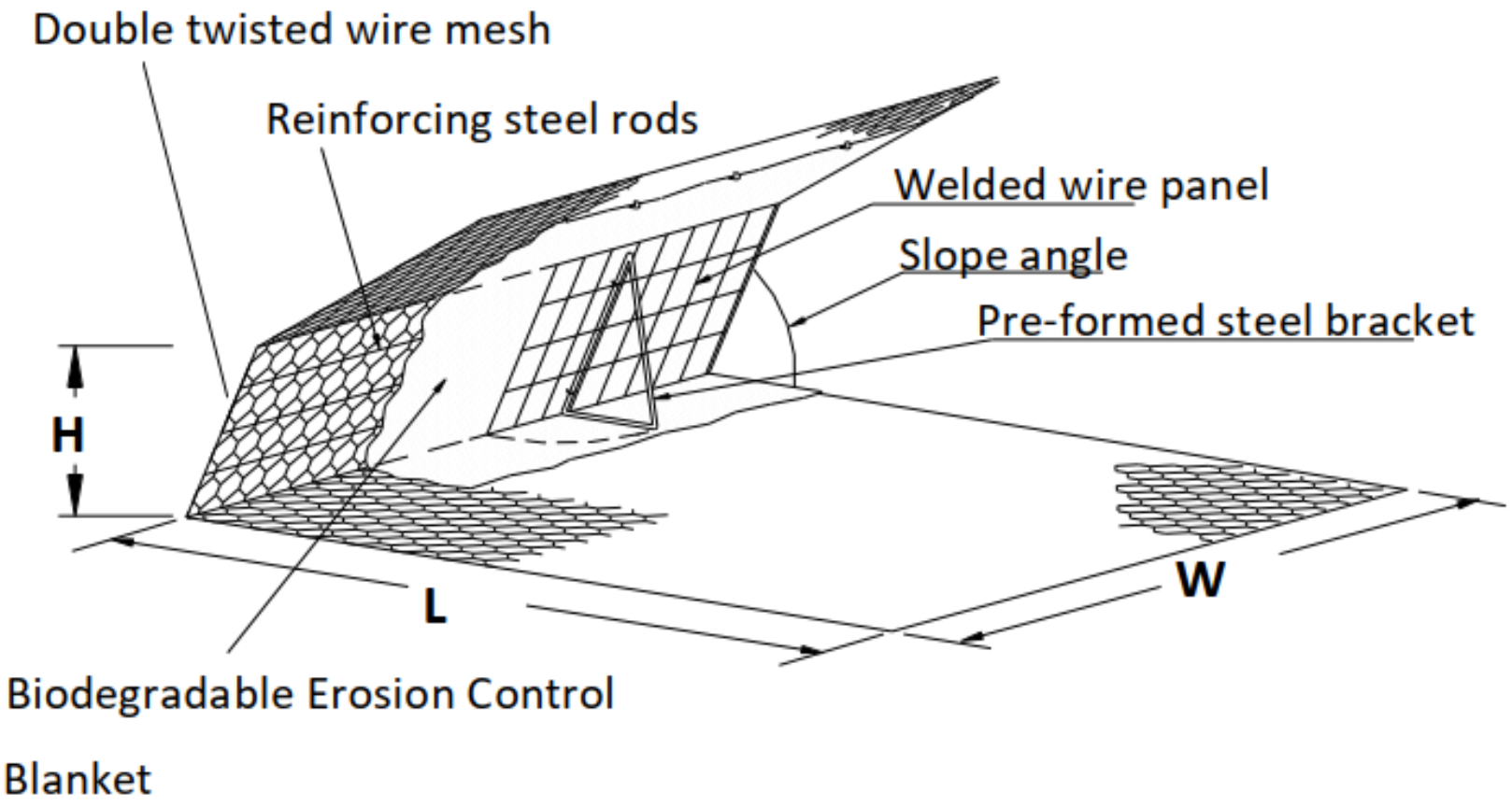



Figure: Plan and elevation view of RSW

# Permanent Section of RSW over Gabion Wall:



# Construction Photos:

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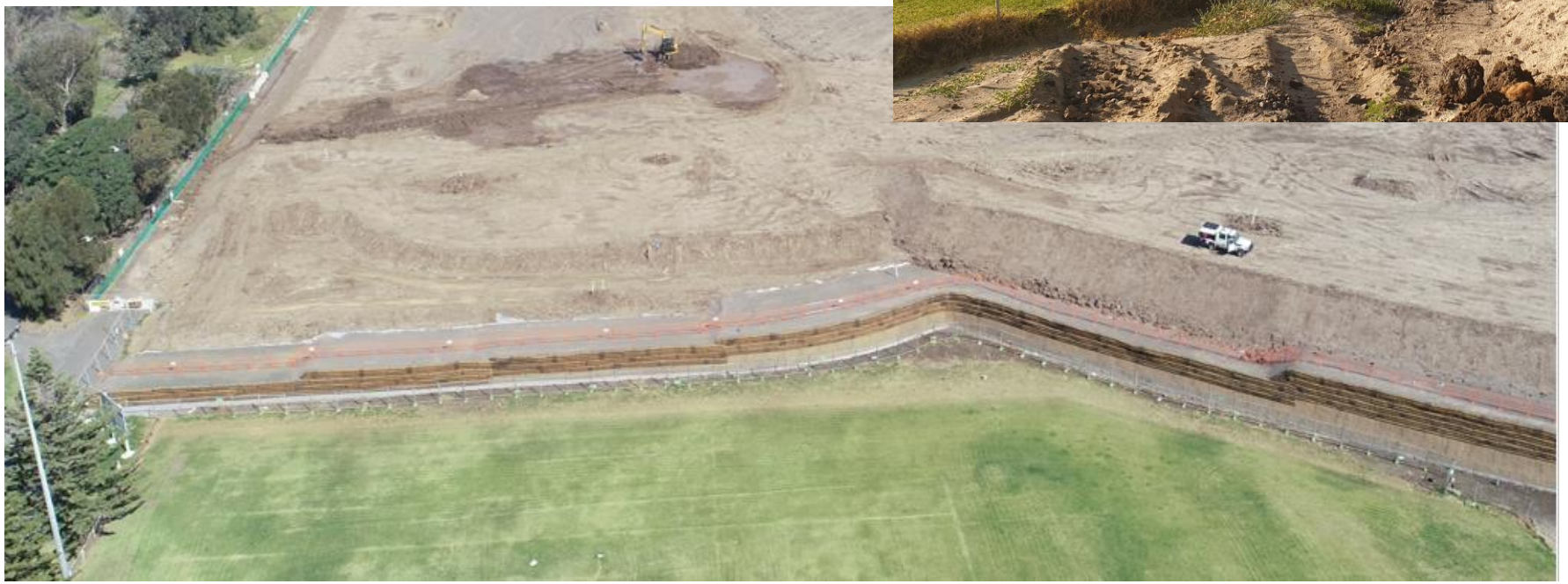
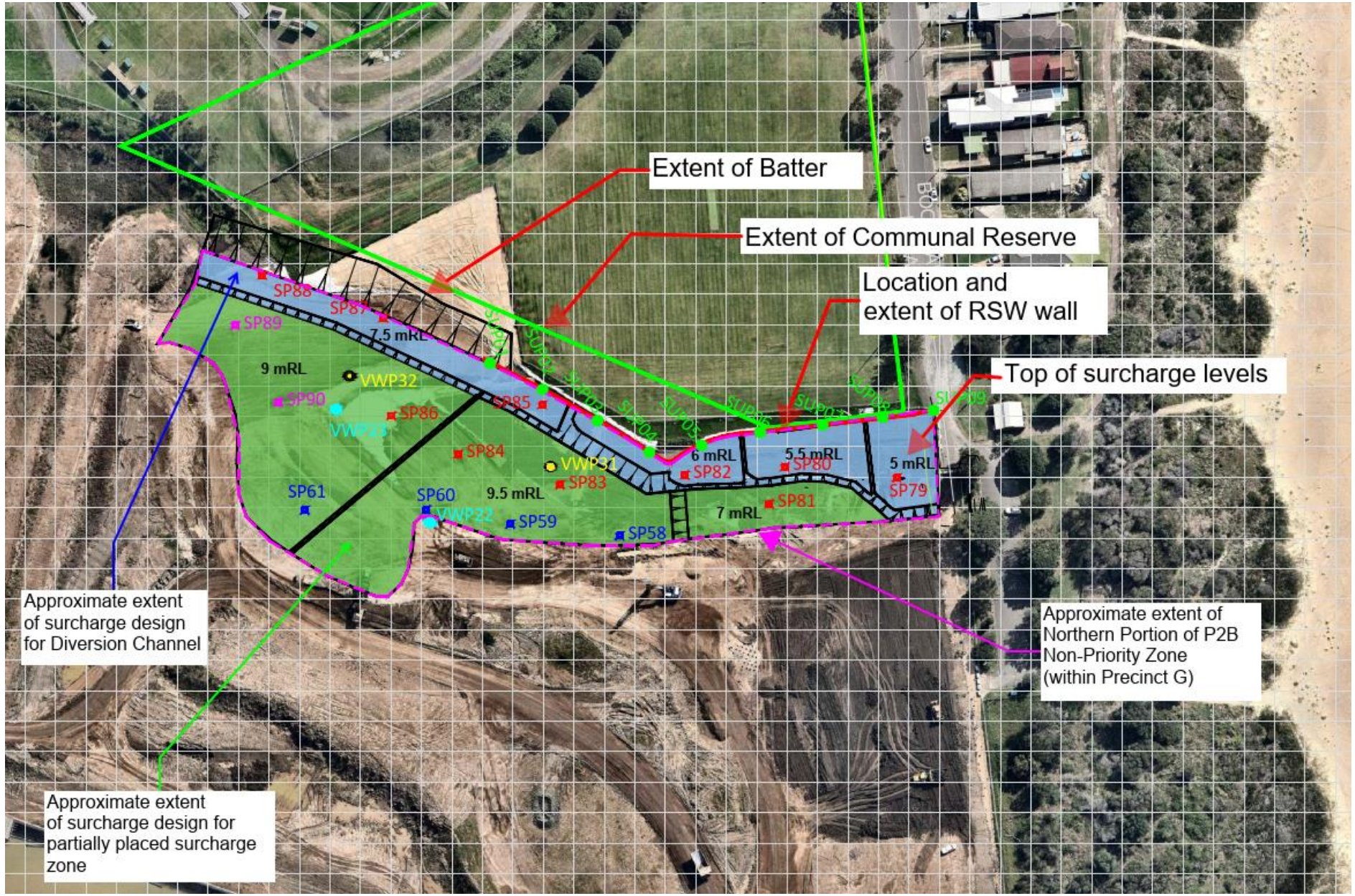


# Instrumentation and Monitoring:



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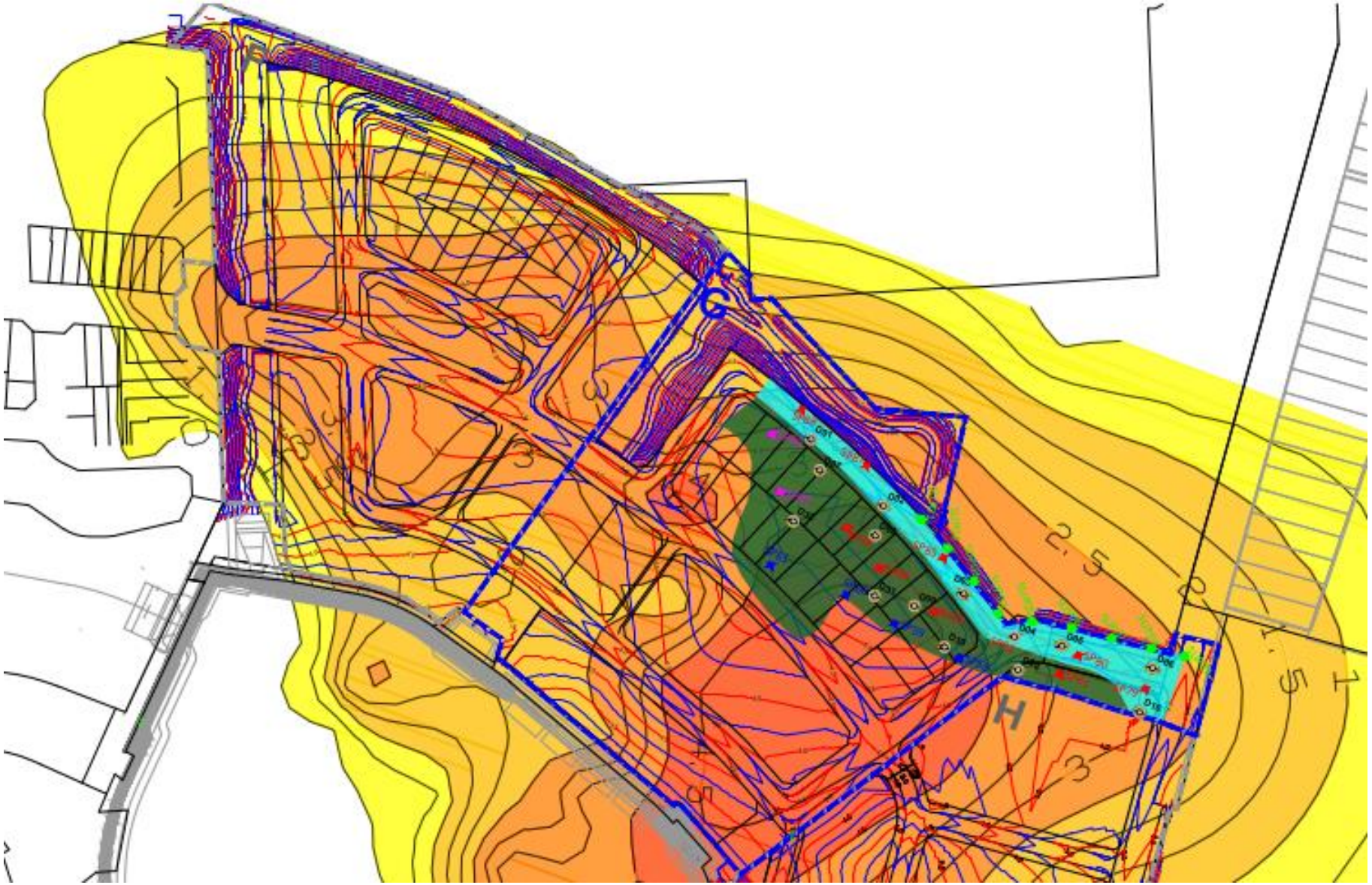

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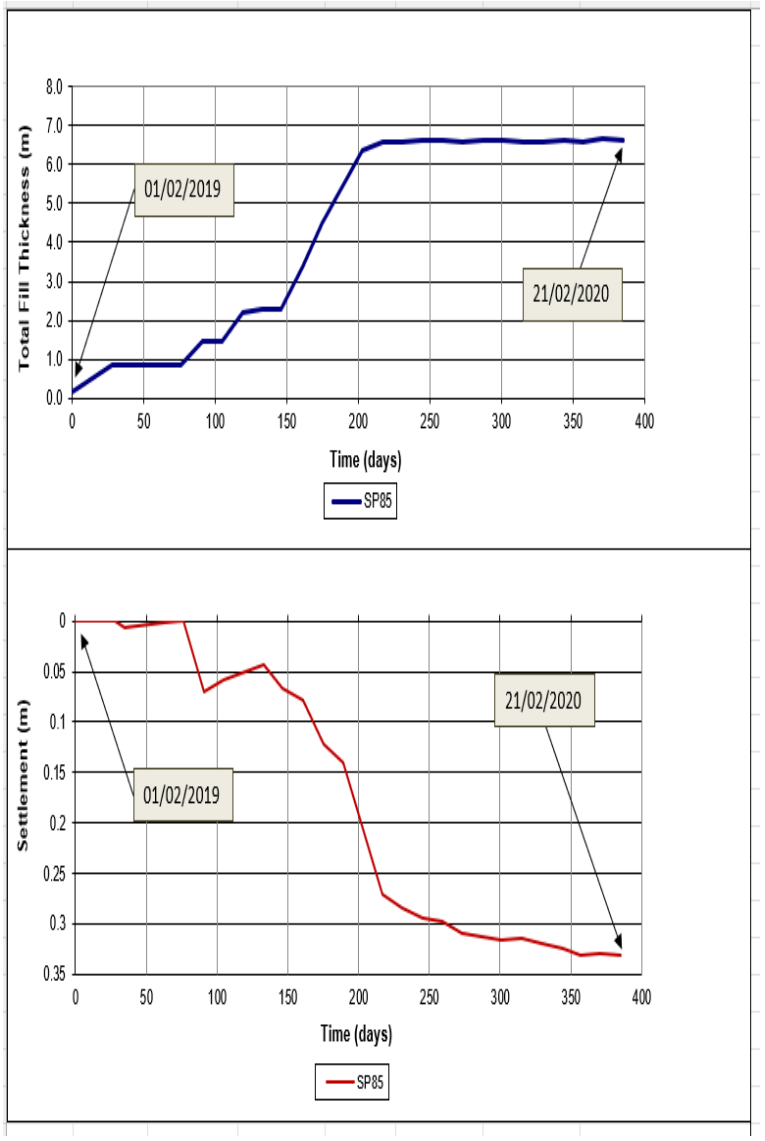


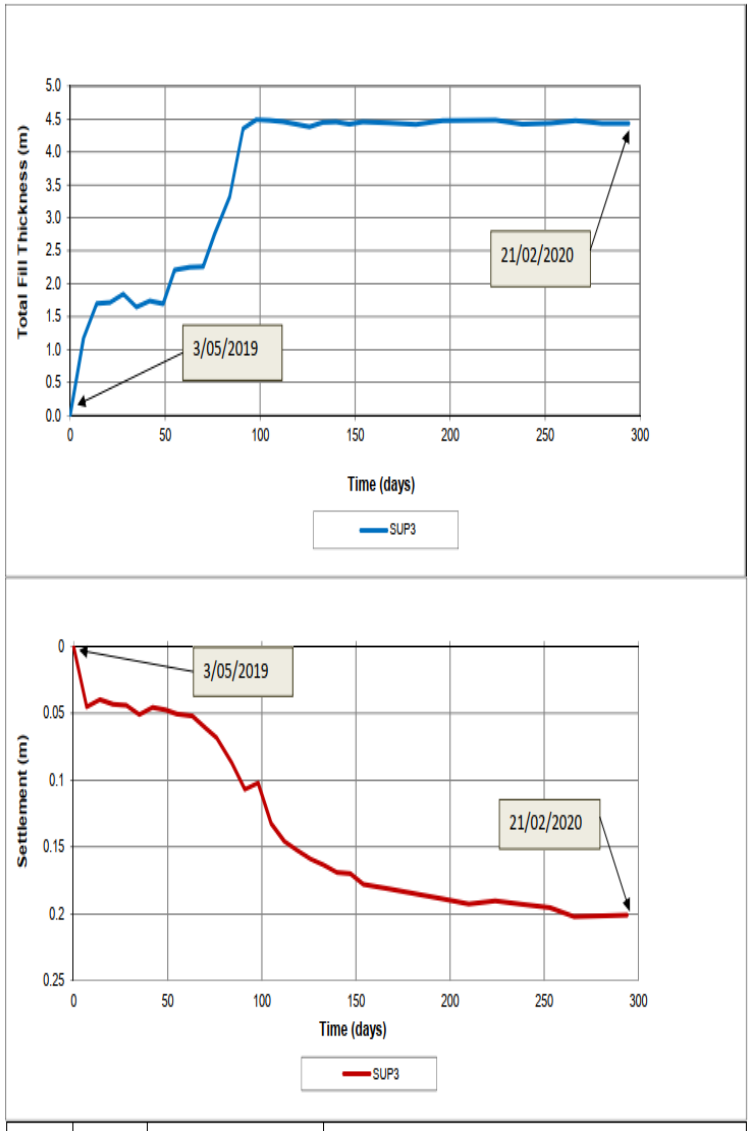

# Shell Cove Boat Harbour – March 2013:

# Shell Cove Boat Harbour – March 2022:

# Conclusion:

The combination of the three retaining walls was mainly to eliminate the requirement for acquiring about 2800 $m^2$ land, however the solution had the following advantages too:

- Gabion wall:
  - Providing a sustainable and reliable foundation for the sections above it
  - Providing drainage at the toe and underneath of the wall
  - Connecting the drainage to the underneath drainage layer
- Main (Permanent) reinforced wall:
  - Providing a flexible permanent retaining wall over consolidating/creeping soft soils
  - Providing a permanent green face aesthetically matching with the environment
  - Eliminating the requirement to install any wall facing
  - Tolerating differential settlements
  - Adjustable at the top following completion of soft soil improvement and removal of the temporary section
- Wrap-Around Wall:
  - A low-cost surcharge structure
  - Easy for construction and removal following completion of soft soil improvement