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DND YARROWS SHIPYARD REMEDIATION

CHALLENGES IN BARRIER WALL CONSTRUCTION AND SITE REMEDIATION ON ESQUIMALT HARBOUR

CFB Esquimalt

Victoria, British Columbia

QUANTUM MURRAY

National Defence Défense nationale

PROJECT SCOPE

- Construction of three laydown areas for site material.
- Construction of a barrier wall around the perimeter of the site
- Remediation of contaminated fill below the historic 1924 shoreline.
- Site restoration.

CFB ESQUIMALT PROPERTIES , VICTORIA, BC

Yarrows History

- Operational shipyard from 1893-1994
- Peak operations during WW2, 4300 workers
- Many HMC ships (22), Liberty Ships, and BC Ferries were built at the Yarrows Shipyards
- Insolvency in 1994; in 1996 2 acres ‘sold’ to Town of Esquimalt ($1); and 12 acres to DND ($1), with known environmental liability of $6-8 million (soil and sediment contamination)
- Acquisition was **“A ‘once in a lifetime’ opportunity to link Naden with the Dockyard “** (VAdm P.W. Cairns, Commander Maritime Command, 1992).

DND YARROWS LOCATION

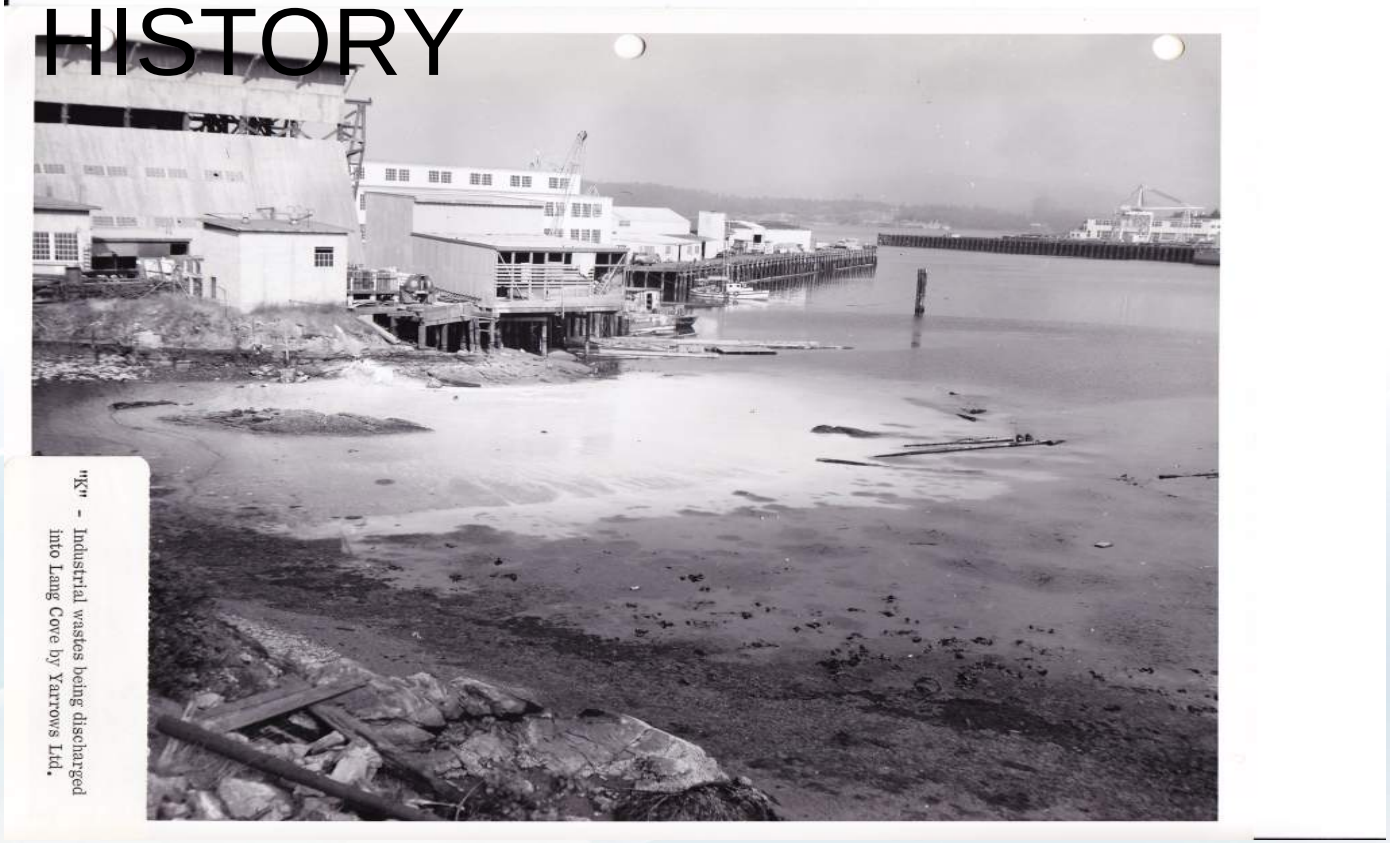
Yarrows History

- Risk management strategy employed from 1996-2006
- In 2002 the surficial debris was removed from the site and it was restored as a materials laydown and storage area.
- In 2006, high concentrations of hydrocarbons were detected in 4 monitoring wells and visible Bunker C was noted in one.
- Site was re-evaluated and determined that remediation was required (Class 1 Site)
- Funding for remediation was secured through Federal Contaminated Sites Action Plan program, with SRB oversight
- Remediation and site restoration began in 2008 and was completed in 2009.
- Yarrows Remediation Project is a true FCSAP success story

YARROWS SHIPYARD HISTORY

Yarrows Shipyard- Circa 1921

YARROWS SHIPYARD HISTORY



Yarrows Shipyard- Circa 1960's

YARROWS SHIPYARD HISTORY

Yarrows Shipyard- Circa 1979

DND YARROWS LOCATION

CONTAMINATION ISSUES

- The purpose of the remedial program was to remove all impacted fill placed below the historic 1924 shoreline.
- Based on a number of historical investigations the following volumes of material were identified for removal from the site:

Concrete	3,000 m^3
Wood Waste	1,500 m^3
Rip Rap and Boulders	3,800 m^3
Clean sand and gravel	8,800 m^3
Uncharacterized material	10,500 m^3
Industrial level metals and hydrocarbon	8,200 m^3
Suspected Hazardous Waste metals and hydrocarbons	3,200 m^3
Total Estimated Volume	**39,000 m^3**

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YARROWS PROJECT AREA

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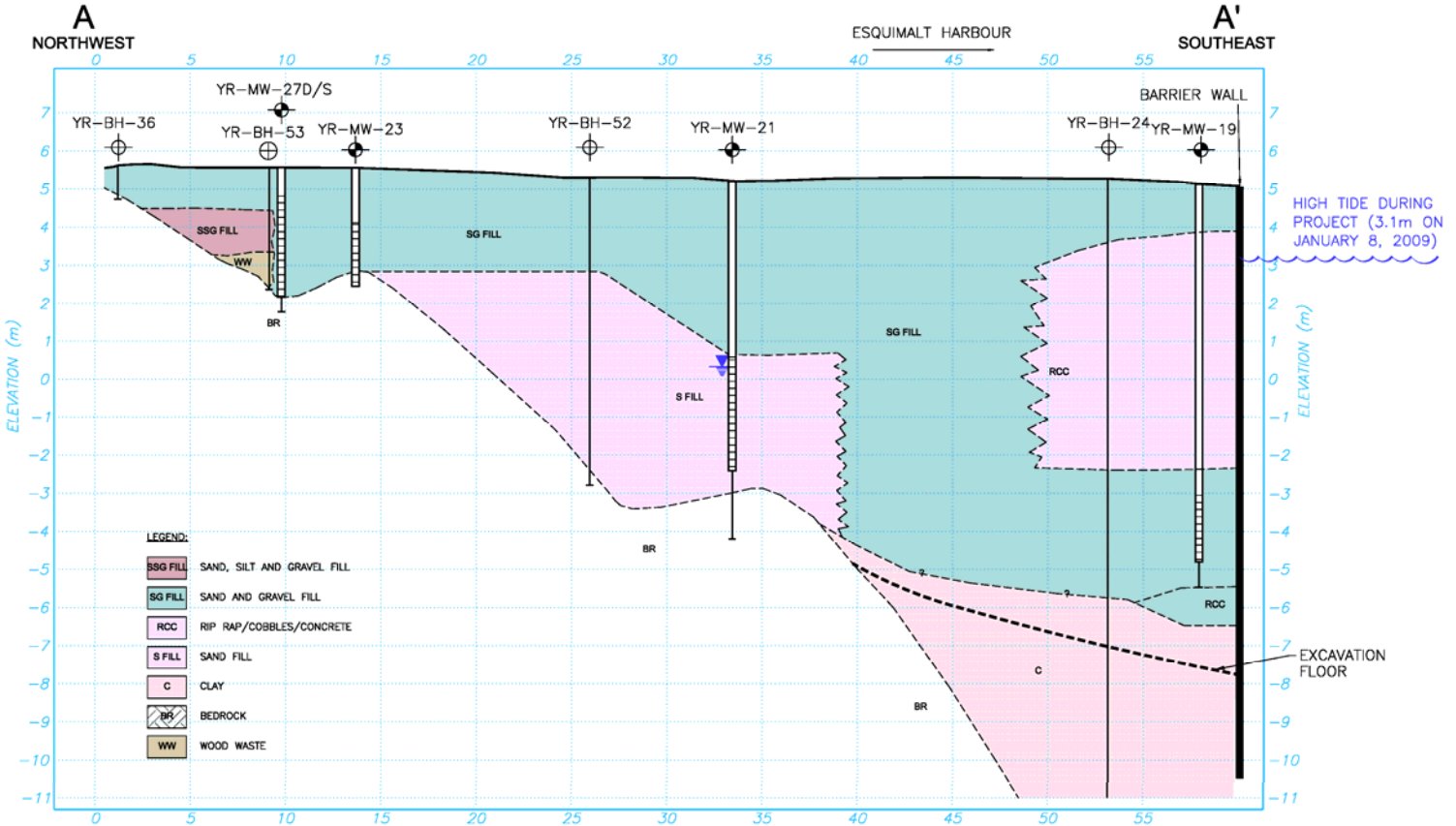
LAYDOWN AREAS - YARROWS

LAYDOWN AREA - YEW POINT

LAYDOWN AREA – WORK POINT

SITE STRATIGRAPHY



BARRIER WALL CONSTRUCTION

- The barrier wall was constructed using two different methodologies:

  1. Bentonite Slurry Wall was used in areas where bedrock was closer to the ground surface.

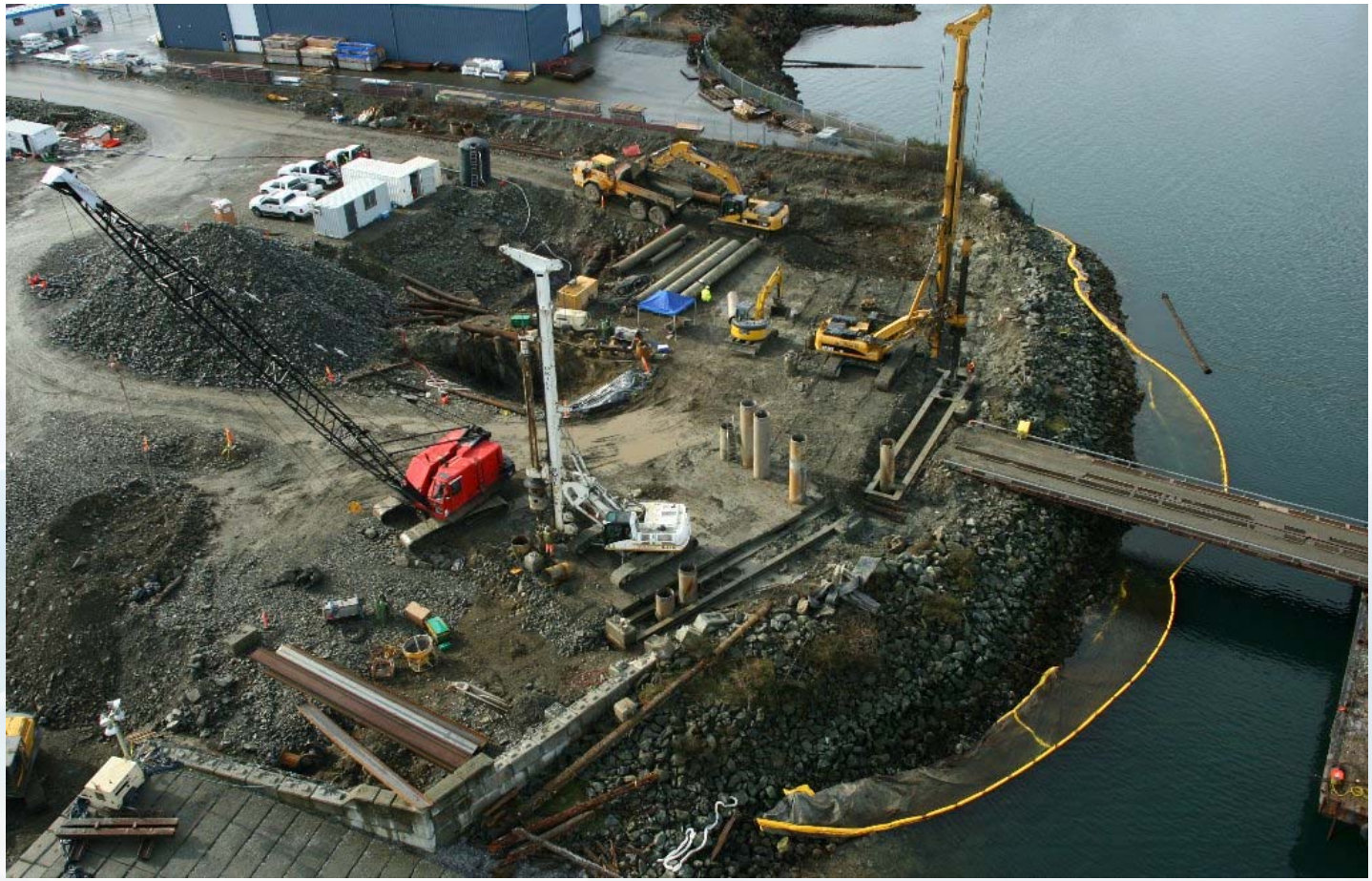
  2. Secant Pile Wall was used in deeper excavation sections.

- Prior to wall construction the top 3 m of fill and concrete was removed to minimize the constructed wall depth.

BENTONITE SLURRY WALL CONSTRUCTION

BENTONITE SLURRY WALL CONSTRUCTION

SECANT PILE WALL

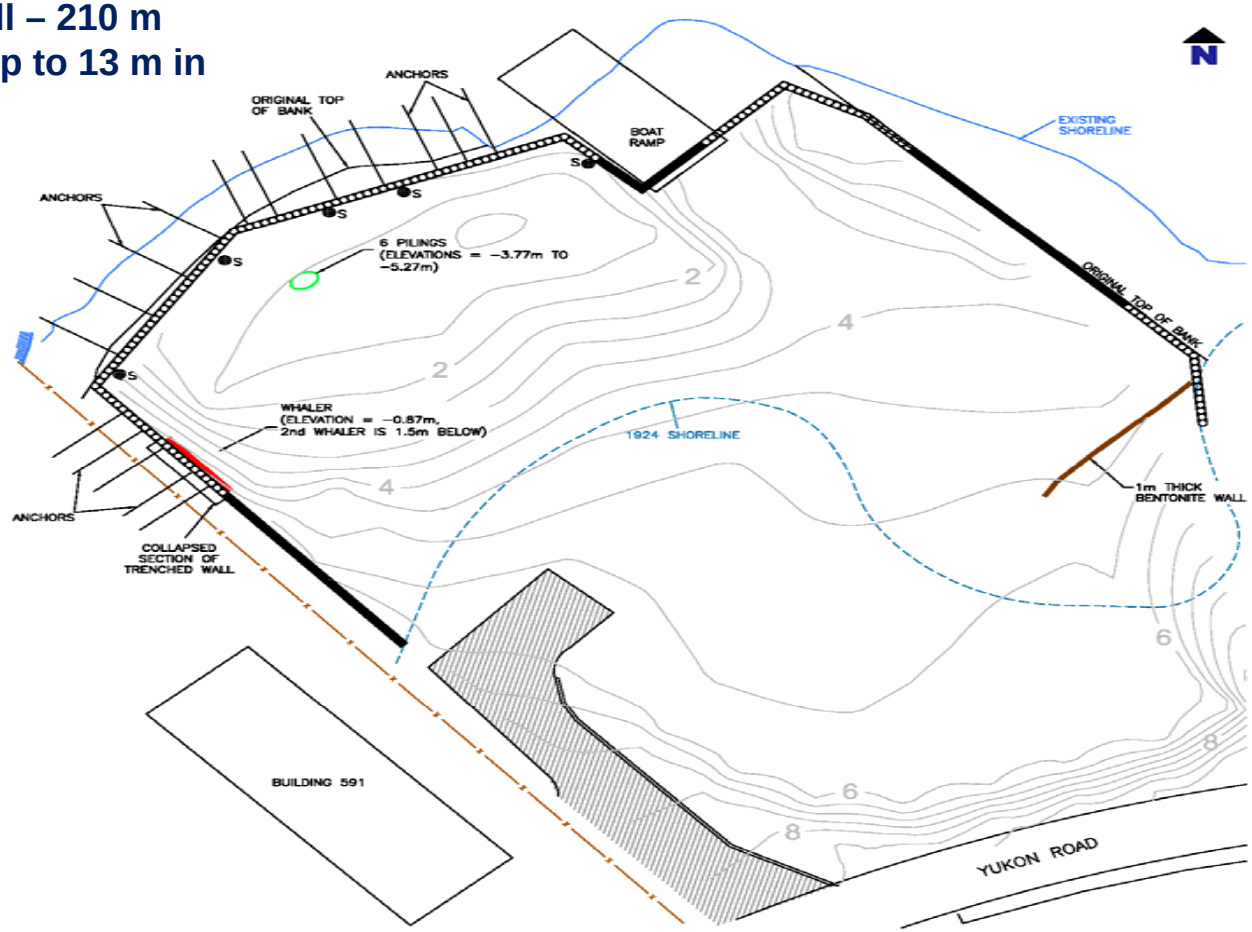


SECANT PILE WALL

ROCK ANCHORS

WALL CONSTRUCTION DETAILS

Barrier wall – 210 m long and up to 13 m in height



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SITE REMEDIATION – SLOT CUT

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SUMMARY OF REMEDIATION

- Approximately 90,000 tonnes of material was removed from the site.
- Impacted fill consisted of soil mixed with metal debris, slag, Bunker C, creosoted piles and a minor amount of asbestos.
- Approximately 60,000 tonnes of material was disposed of at permitted facilities.
- Approximately 3,000 tonnes of Hazardous Waste metals and hydrocarbons were removed from the site.
- 27,000 tonnes of coarse rock was screened from contaminated fill to reduce the disposal cost. The coarse rock was re-used on site to reduce backfill cost.

CONTAMINATED FILL

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CONTAMINATED FILL - OFFSITE

BENTONITE WALL CONSTRUCTION

PROJECT CHALLENGES

1. Subsurface Variability
2. Stockpile Handling Space and Laboratory Cost
3. Quality of Imported Fill Material
4. Regulatory Changes – Cost Implications
5. Weather Effects

SUBSURFACE VARIABILITY

- A stratigraphic model was developed based on the results from seven historic investigations.
- Coarse rock and/or rip rap was identified in zones along the perimeter of the excavation.

SUBSURFACE VARIABILITY

- Thick zones of large rock (1.5 m to 2.5 m) was interpreted as bedrock in historic investigations.

IMPLICATIONS

- Barrier wall construction methodology was altered
- Redesign of wall sections to reflect deeper excavation requirements in some areas
- Slower drilling for pile installation
- Wall failure and repair

STRATIGRAPHIC CHANGE – WALL FAILURE

STRATIGRAPHIC CHANGE - IMPLICATIONS

STOCKPILE MANAGEMENT AREA

- During periods where excavation was conducted on a 24 hour/day basis there was insufficient room for soil turnover.
- Result was increased laboratory cost to meet required turn around times.

IMPORTED FILL MATERIAL QUALITY

- Imported native backfill material did not meet federal guidelines.
- The backfill material needed to be screened to remove finer material so it could be used on site as backfill.

REGULATORY CHANGES

- As of January 1, 2009 the Province of BC enacted new sodium and chloride standards.
- The regulatory change did not impact remedial targets.
- This impacted the offsite disposal cost of material as much of the material was re-classified as Commercial level for offsite disposal.

WEATHER EFFECTS

- A large storm event occurred during the project that was atypical of Victoria weather.
  - There was three weeks of record snowfall and high winds that halted construction.

CONCLUSIONS

- Successful remediation of over 90,000 tonnes of impacted material.
- Bentonite and Secant Pile wall performed as designed.
- When barrier walls are going to be constructed – it is imperative to completely understand stratigraphy along the alignment.
- Plan for delays and unknowns. Can have large cost and time implications.

CONCLUSIONS

- Important to have a good QA/QC program in place.
  - On sites requiring backfilling understand that:
    - Backfill from native quarries may not meet federal guidelines.
    - Always establish detailed testing program for all materials leaving and coming onto the site regardless of origin.
- Have a good project risk assessment process in place to identify delays and find solutions.
- Have a strong project team that work together and has a excellent communication structure.

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