Overview

• Canal Excavation Assumptions
  – Route Selection
  – Canal Floor
  – Geotechnical Assumptions

• Schedule Assumptions

• Excavation Strategy
  – Fleet Sizes
  – Allocation of Material

• Landform and Haulage Strategy
  – Material Placement Facilities
  – Rehabilitation and Final Land Use

• Water Management Strategy
  – Irrigation Control Facilities
  – Diversion Drains and Drop Structures

• Reconciliation to Previous Design

• Next Project Development Phases
About MEC

MEC Mining is a mining/earthworks consultancy specialising in mine evaluation, design, planning, onsite management and technical services solutions.

– Formed in 2005
– Offices in Brisbane – Australia and Santiago - Chile.
– Broad client base of majors, mid-tier mine owners and contractors.
GLOBAL EXPERIENCE
Using Latest Design Technologies

MEC uses a range of software to deliver optimised earthworks solutions:

<table>
<thead>
<tr>
<th>Software</th>
<th>Strengths</th>
<th>How We Use It</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vulcan</strong></td>
<td>3D CAD package for design, volumetric calculations &amp; sectional analysis.</td>
<td>Detailed 3D design combined with project design information (e.g. Topo, geotech) to deliver short, medium and long term plans. Accurate volume calculation for scheduling.</td>
</tr>
<tr>
<td><strong>Deswik</strong></td>
<td>3D scheduling, landform design and management and haulage simulation.</td>
<td>The design outputs above are imported to develop a visual excavation sequence, detailed dumping strategy and hauling unit numbers.</td>
</tr>
<tr>
<td><strong>Talpac</strong></td>
<td>Haulage profile analysis, cycle time and equipment productivity simulation.</td>
<td>Matching equipment selection to known operating equipment performance to deliver matched truck to excavator fleets. Return haulage times &amp; haul road design optimisation.</td>
</tr>
<tr>
<td><strong>Xpac / Xact</strong></td>
<td>Detailed scheduling tool for long and short term / life of project.</td>
<td>The excavation sequence is scheduled in incremental blocks allowing for known material movement by periods. Outputs from the schedule are used to develop cost models based on material movements.</td>
</tr>
<tr>
<td><strong>3D Dig</strong></td>
<td>3D visualisation and spoil balancing tool.</td>
<td>Once an excavation sequence has been developed, this tool allows for detailed visualisation of the excavation and to understand issues with material balancing relative to surrounding topography etc.</td>
</tr>
</tbody>
</table>
CRCC base route design used (Sept 14)
280m  Base Width, 30m Deep.
Canal Design

• Primary alignment of the canal taken from CRCC design from September 2014
  – Alterations made based on advice from HKND include
    • Adjustment to East canal entrance into Lake Nicaragua further South from the San-Miguelito and Rio Tule.
    • Alteration to the placement of the CRCC designated passing lanes.
    • Relocation of the East Canal Lock to a more suitable location for constructability and environmental impact of the downstream section of the canal.

– Geotechnical Recommendations
  • 15 Degree effective angle for Northern slope of West Canal section adjacent to locks – highlights need for further geotechnical site investigation.
Geotechnical Assumptions

- Australian consultants Pells Sullivan Meynik provided an assessment of the data supplied by HKND.
- A range of material types and rock strengths have been identified during the initial site investigations.
- Additional drilling and site investigation required along the whole route to full excavation depth.

<table>
<thead>
<tr>
<th>GEOTECHNICAL UNIT</th>
<th>WEATHERING</th>
<th>CCRC SLOPE ANGLE(°)</th>
<th>PSM SLOPE ANGLE(°)</th>
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<tbody>
<tr>
<td>SOILS(^2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>silt</td>
<td>NA</td>
<td>7</td>
<td>18</td>
</tr>
<tr>
<td>silty soil</td>
<td></td>
<td>10</td>
<td>18</td>
</tr>
<tr>
<td>silty clay</td>
<td></td>
<td>27</td>
<td>18</td>
</tr>
<tr>
<td>fine sand (underwater)</td>
<td></td>
<td>14 to 18</td>
<td>10</td>
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<tr>
<td>SEDIMENTARY</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Sandstone, Argillaceous</td>
<td>strong</td>
<td>42</td>
<td>38</td>
</tr>
<tr>
<td>siltstone, shale</td>
<td>weak</td>
<td>53</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>fresh</td>
<td>63</td>
<td>46</td>
</tr>
<tr>
<td>Volcanic - extrusives</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Basalt, Andesite</td>
<td>complete</td>
<td>34</td>
<td>38</td>
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<tr>
<td></td>
<td>strong</td>
<td>51</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>weak</td>
<td>63</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>fresh</td>
<td>73</td>
<td>52</td>
</tr>
<tr>
<td>Volcanic - pyroclastics</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>volcanic breccia</td>
<td>complete</td>
<td>34</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>strong</td>
<td>42</td>
<td>38</td>
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<tr>
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<td>weak</td>
<td>53</td>
<td>42</td>
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<tr>
<td></td>
<td>fresh</td>
<td>63</td>
<td>46</td>
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<tr>
<td>Tuff</td>
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<tr>
<td></td>
<td>complete</td>
<td>34</td>
<td>38</td>
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<td></td>
<td>fresh</td>
<td>53</td>
<td>48</td>
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<tr>
<td>Intrusive rocks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ignimbrite</td>
<td>Not supplied</td>
<td>45</td>
<td>46</td>
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<tr>
<td>Diabase</td>
<td>fresh</td>
<td>79</td>
<td>52</td>
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</tbody>
</table>

\(^1\) Slope angles refer to effective slope angle or IRA
\(^2\) All slope angles in soils should be subjected to a liquefaction assessment. The proposed slopes in soils may still collapse under earthquake loading.
Excavation Strategy

- Vegetation & Site Clearing
- Strip Topsoil
- Free Dig
- Drill & Blast
- Load & Haul
- Material Placement
- Rehabilitation
Fleet Sizing

Matching the fleet size to material conditions.

Appropriate blasting, operating benches and working bench sizes for each equipment type.
Excavation Strategy

- Small Scale truck and shovel excavators used for pioneering work and creating a running surface for large fleets.
- Pillars are used to control water flow as required
  - Phase 1 will be in-between the transverse river systems
    - Diversion drains dug as required to re-position river systems away from phase 1 excavation
Excavation Strategy

• Design ramps perpendicular to the face advance where possible
  – Reduce haul lengths and supply multiple access points
Excavation Strategy

• Ramps used to excavate the pillars
  – These ramps will be installed inside the batter of the canal wall and will allow the final dirt to hauled to the surface
Excavation Strategy

• The ramps can be used to create drainage access points into the canal once the excavation is complete
  – The facing dump will be bermed and drained to ensure they lead to the nearest ramp for rain run-off to access the canal in the appropriate place and reduce erosion and sediment filling the canal unnecessarily
Excavation Strategy

• A terrace face advance system will be utilised for all advancing faces

• There will need to be at least 3 operational terrace faces to ensure all mining activities can occur in unison

• To excavate the complete canal in 5 years there will need to be a new excavation face every 1-2 km.
Excavation Strategy

- 10m bench height
- 20m Drill & Blast height
- Blast size 200m x 300m x 20m
- 40m wide 70% ramp
- Canal width 280m
Excavation Strategy
West Canal Excavation Strategy
East Canal Excavation Strategy

HKND Nicaragua Canal Project
East Canal Excavation Strategy

Area #1
Area #2

Dredge
Dry Excavation
Dredge

EXCAVATION STAGE CROSS SECTION
Lake Dredge
Lake Pillar
River Pillar
River Pillar
Lock Pillar
Dredge

Lake Atlanta

Stage 1
Stage 2
Stage 3
Stage 4
Water Management

• The water management concept strategy is based around 2 key principals:
  – Minimising the impact of the existing water sheds during the construction of the canal.
  – Providing long term water management and storage during the operation of the canal for both use in the canal and by the proposed agricultural land created adjacent to the canal.
Water Management

• East Canal Water management Stages
Water Management

1. Construct water storage facilities and drains to prevent water entering the excavation.
2. Build diversion channels.
3. Dry excavation, allow river system to flow naturally while excavation takes place between pillars.
4. Strategically excavate pillars to final level.

Landform prior to excavation

Landform after excavation
Water Management

1. Excavate between river systems without.
2. Begin material placement near dam locations to prevent water entering the excavation.

1. Construct water storage facilities and drains to prevent water entering the excavation.
2. Divert water around the town of Fonseca.

1. River flows permanently into the canal at the drop structure.
2. Excavate below Agua Zarco dam once the dam wall has been constructed.
3. Dredge the last part of the canal.
Water Management

AREA 1 - East Canal

Before

Stage 1

Flow rate:

Low (8 - 10 m³/s)

Mid (11 m³/s - 20 m³/s)

High (20+ m³/s)

Original

AREA 2 - East Canal

Before

Stage 1

Stage 3

Stage 2
Landform Strategy

• Material Placement
• Deswik software used to simulate the haulage systems of the canal
• Minimum Cycle time algorithm used to run as a simulation methodology.
## Volume Reconciliation

### Canal Volume Summary

<table>
<thead>
<tr>
<th>Section</th>
<th>Excavation (MBCM)</th>
<th>Locks (MBCM)</th>
<th>Ports (MBCM)</th>
<th>Total (MBCM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pacific Ocean Dredge</td>
<td>7</td>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Western Canal Saltwater Dredge</td>
<td>72</td>
<td>30</td>
<td></td>
<td>102</td>
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<tr>
<td>Western Canal Dry Excavation</td>
<td>478</td>
<td>-</td>
<td>39</td>
<td>439</td>
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<tr>
<td>Western Canal Fresh Water Dredge</td>
<td>14</td>
<td></td>
<td></td>
<td>14</td>
</tr>
<tr>
<td>Lake Nicaragua Dredging</td>
<td>715</td>
<td></td>
<td></td>
<td>715</td>
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<tr>
<td>Eastern Canal Fresh Water</td>
<td>10</td>
<td></td>
<td></td>
<td>10</td>
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<tr>
<td>Eastern Canal Dry Excavation</td>
<td>3,297</td>
<td>-</td>
<td>67</td>
<td>3,230</td>
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<tr>
<td>East Canal Saltwater Dredge</td>
<td>78</td>
<td></td>
<td></td>
<td>78</td>
</tr>
<tr>
<td>Atlantic Ocean Dredging</td>
<td>54</td>
<td></td>
<td></td>
<td>54</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>4,725</strong></td>
<td>-</td>
<td><strong>106</strong></td>
<td><strong>4,649</strong></td>
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<tr>
<td><strong>Cost Plan Contingency</strong></td>
<td></td>
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<td><strong>351</strong></td>
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<tr>
<td><strong>HKND Cost Plan Total Volume</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>5,000</strong></td>
</tr>
</tbody>
</table>

### Canal Chainage Volumes

![Canal Chainage Volumes Graph](chart.png)
Next Phases

• Further Detailed Site Investigation Required
  – Survey and Topography.
  – Geology and Geotechnical.
  – Hydrological – Surface and Sub-Surface

1. Completion of Conceptual Design Phase
2. Detailed Feasibility Design and Schedule
3. Construction Design and Schedule.