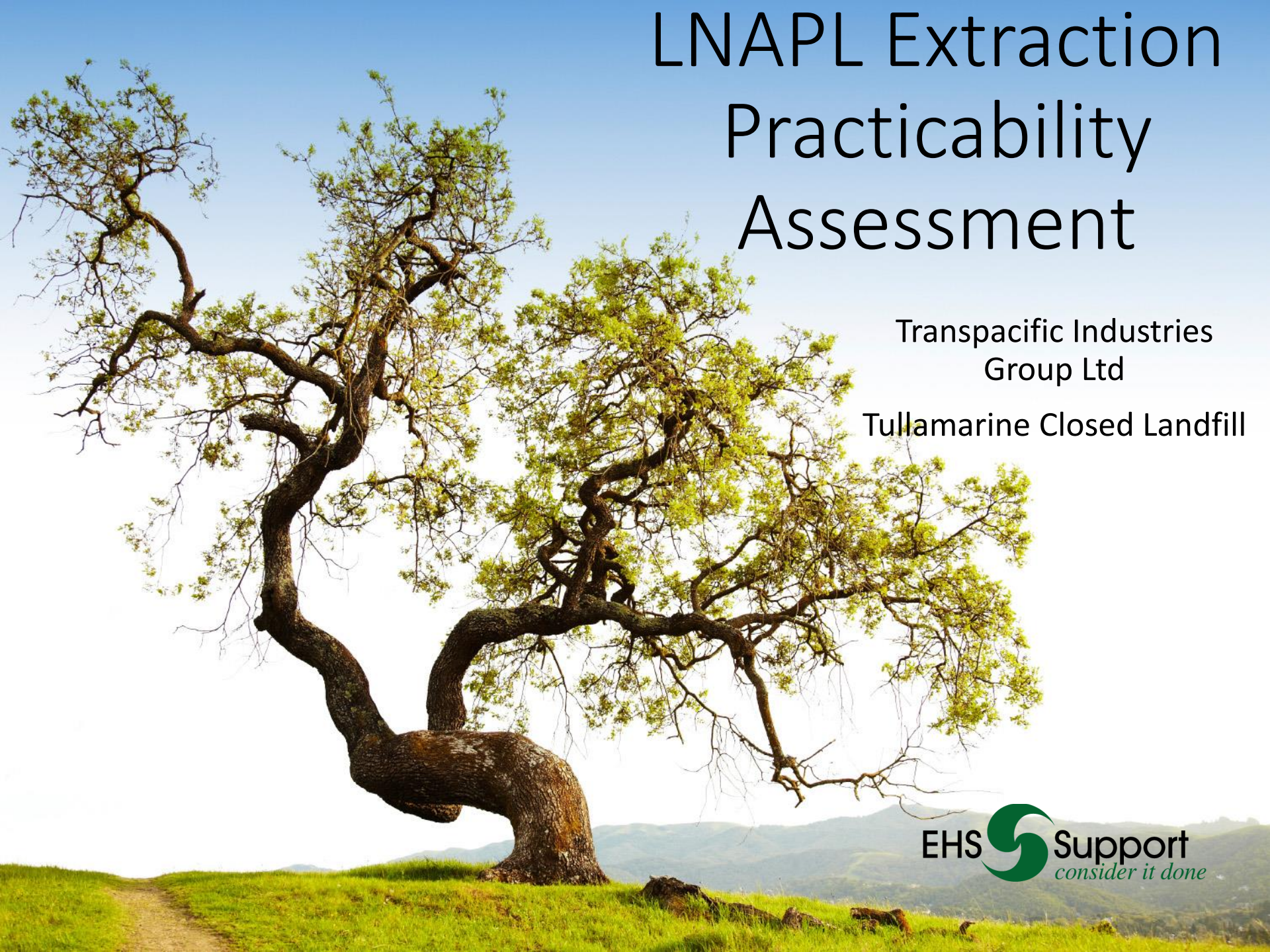
LNAPL Extraction Practicability Assessment



Transpacific Industries Group Ltd

Tullamarine Closed Landfill

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Background

- *"In the IRP's view, the Stage 1 LNAPL Extraction Trial (Baildown Tests) has been appropriately designed, implemented, analysed and reported in accordance with current industry standards of practice; it also meets the objectives of the PAN and LWMP and has satisfied the objectives of the IRP.* ***The IRP is of the view that the tested LNAPL extraction method (which is the most prospective method) is not feasible****. In order to finally determine the practicability of any further extraction,* ***an LNPAL Extraction Practicability Assessment Report should be prepared*** *for submission to EPA, with prior review by the IRP."*

LNAPL Recoverability and Mobility

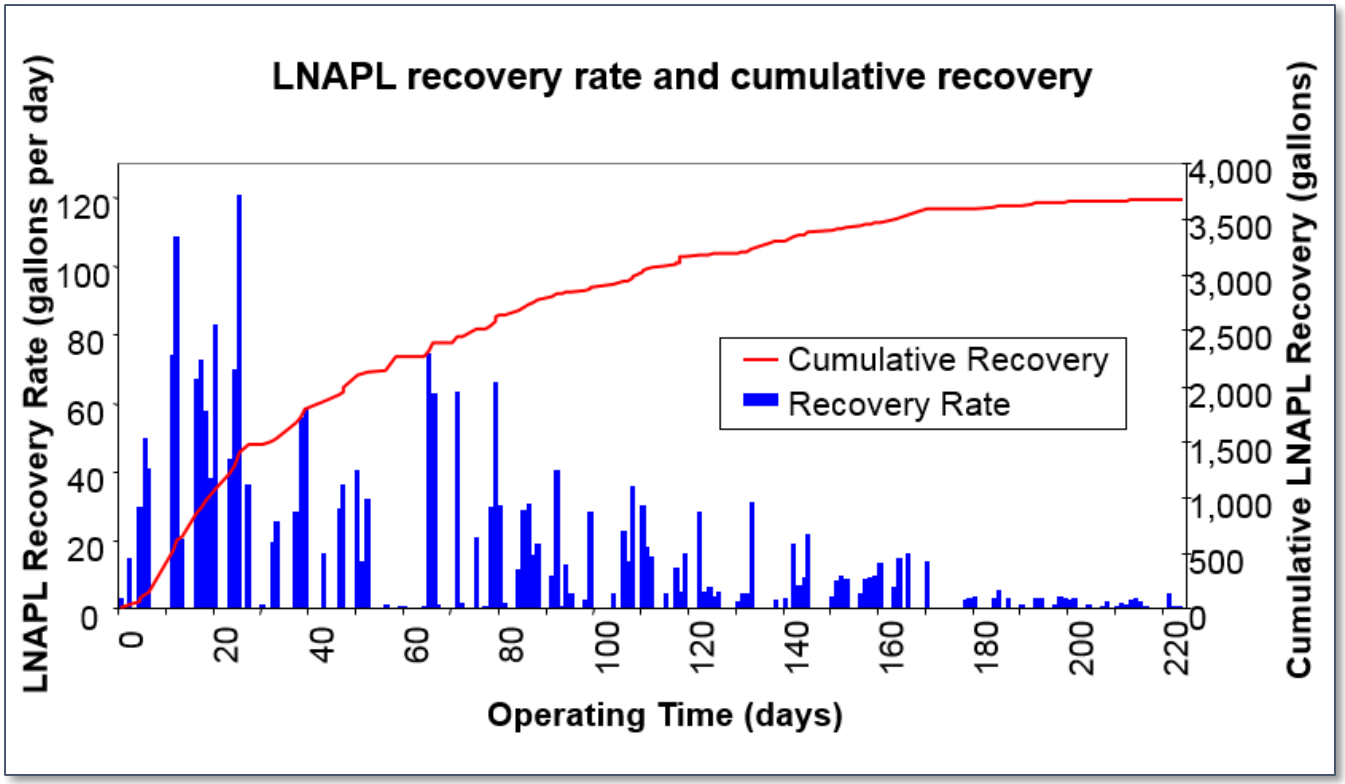
- Based on the assessment provided in EHS Support (2014) no wells qualified for extended LNAPL extraction given:
  - the low derived LNAPL transmissivity values;
  - inability to sustain pumping rates; and
  - general inability to draw LNAPL from the waste; and very slow LNAPL level recovery.
- Results indicated the inability to support long term extraction and that the LNAPL is functionally immobile and does not pose a migration risk.

LNAPL Recoverability and Mobility

- On the basis of the trial results, hypothetical scenarios were explored to assess what could be achieved by attempting further LNAPL recovery using techniques employed during the trials.
- Important to note that unless all constituents driving potential risks are removed, risk profiles will remain unchanged, even after aggressive extraction, due to presence of residual LNAPL which is unrecoverable.
- The hypothetical scenarios assumed the improbable scenario that extraction rates can be sustained long term.

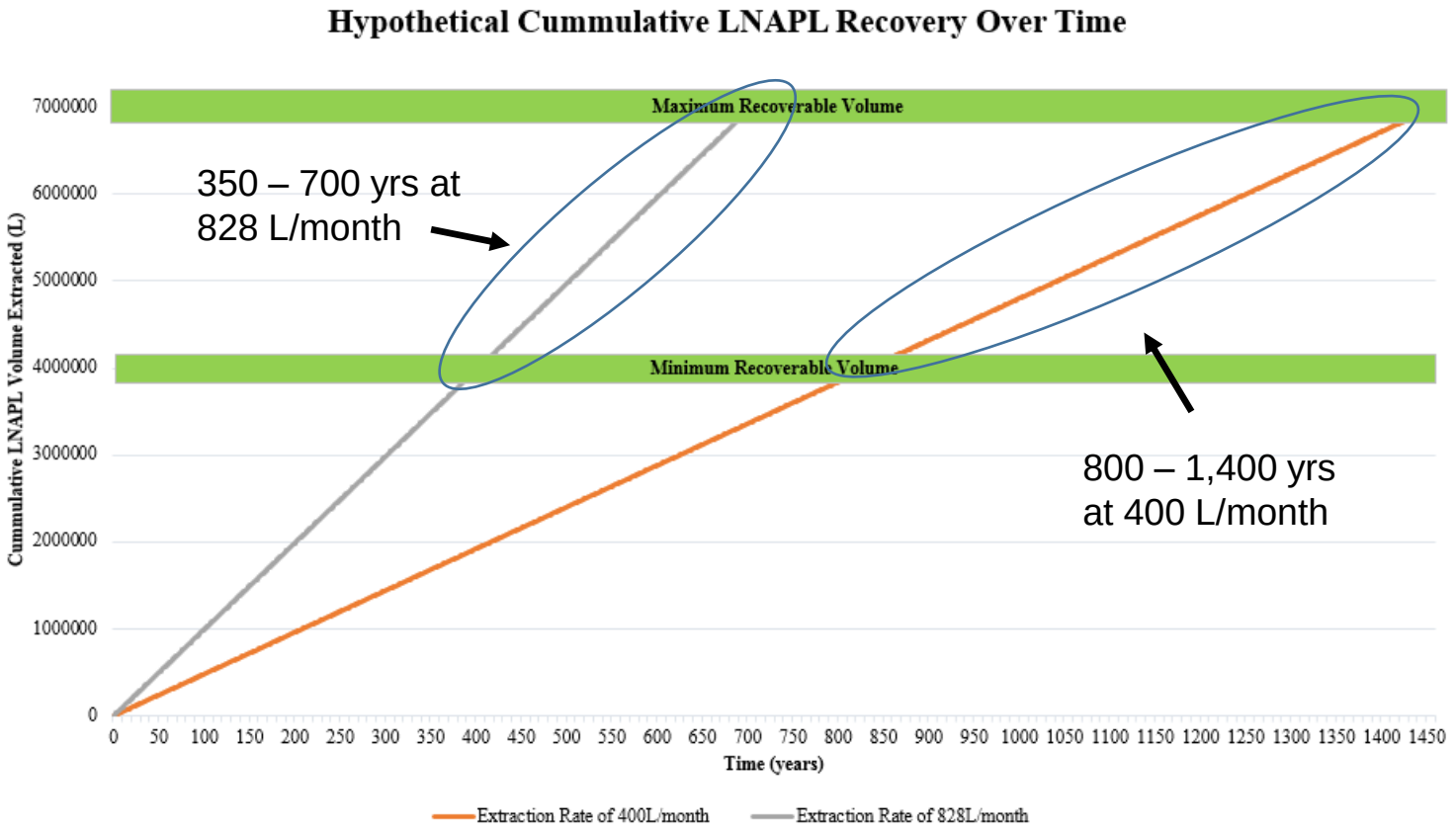
LNAPL Recoverability and Mobility

- Based on industry experience LNAPL recovery rates decline over time:



Typical cumulative recovery curve and LNAPL recovery rates (ITRC, 2009). Note: 1 gallon = 3.78L

LNAPL Recoverability and Mobility

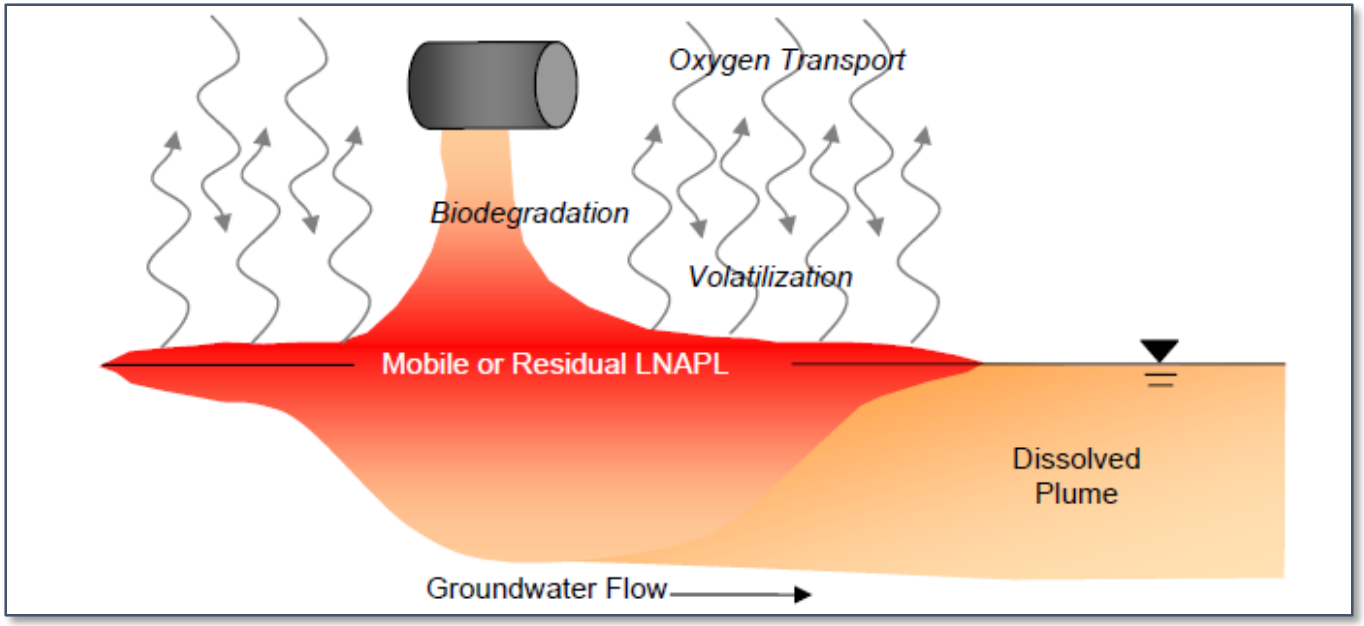


Natural Mass Losses

- Natural mass losses were not considered as a remediation approach during the initial technology evaluation undertaken by URS as the expectation from stakeholders was for aggressive recovery measures to be explored.
- A range of mechanisms contribute to the depletion of LNAPL mass:
  - dissolution of constituents in groundwater;
  - volatilisation of LNAPL constituents in the unsaturated zone; and
  - biodegradation of hydrocarbon mass both in the saturated and unsaturated zones.

Natural Mass Losses

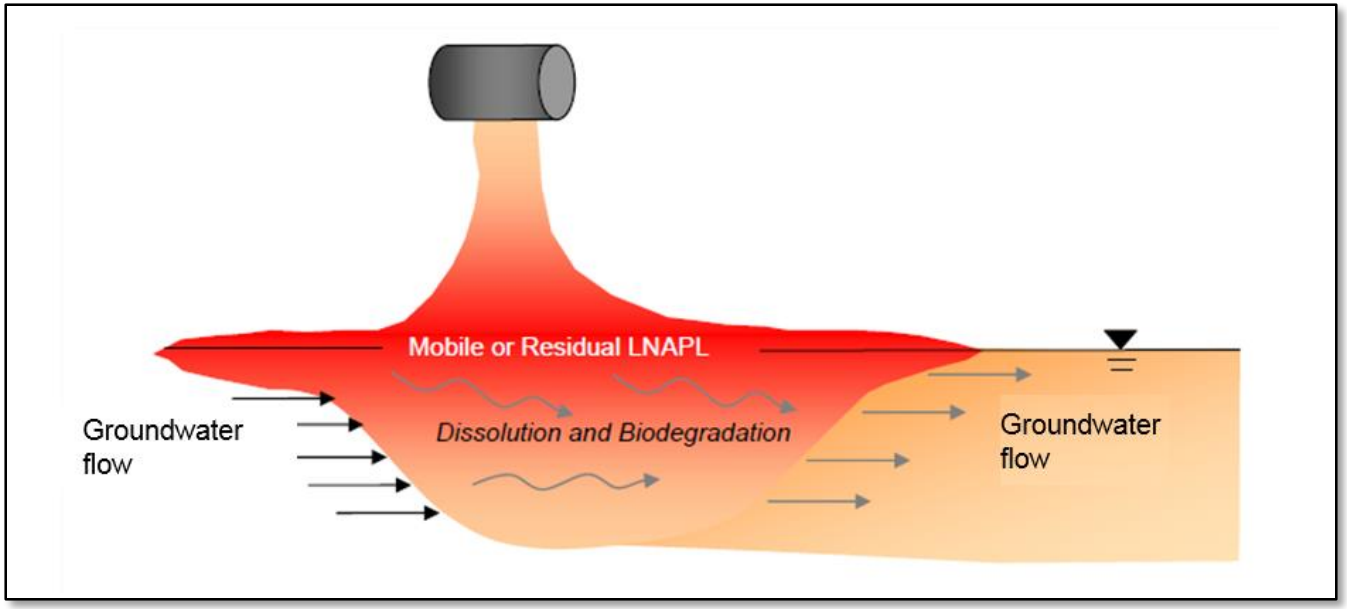
- LNAPL mass in the unsaturated zone



Zone Depletion Processes in the Unsaturated Zone (ITRC, 2009b)

Natural Mass Losses

- LNAPL mass in the saturated zone

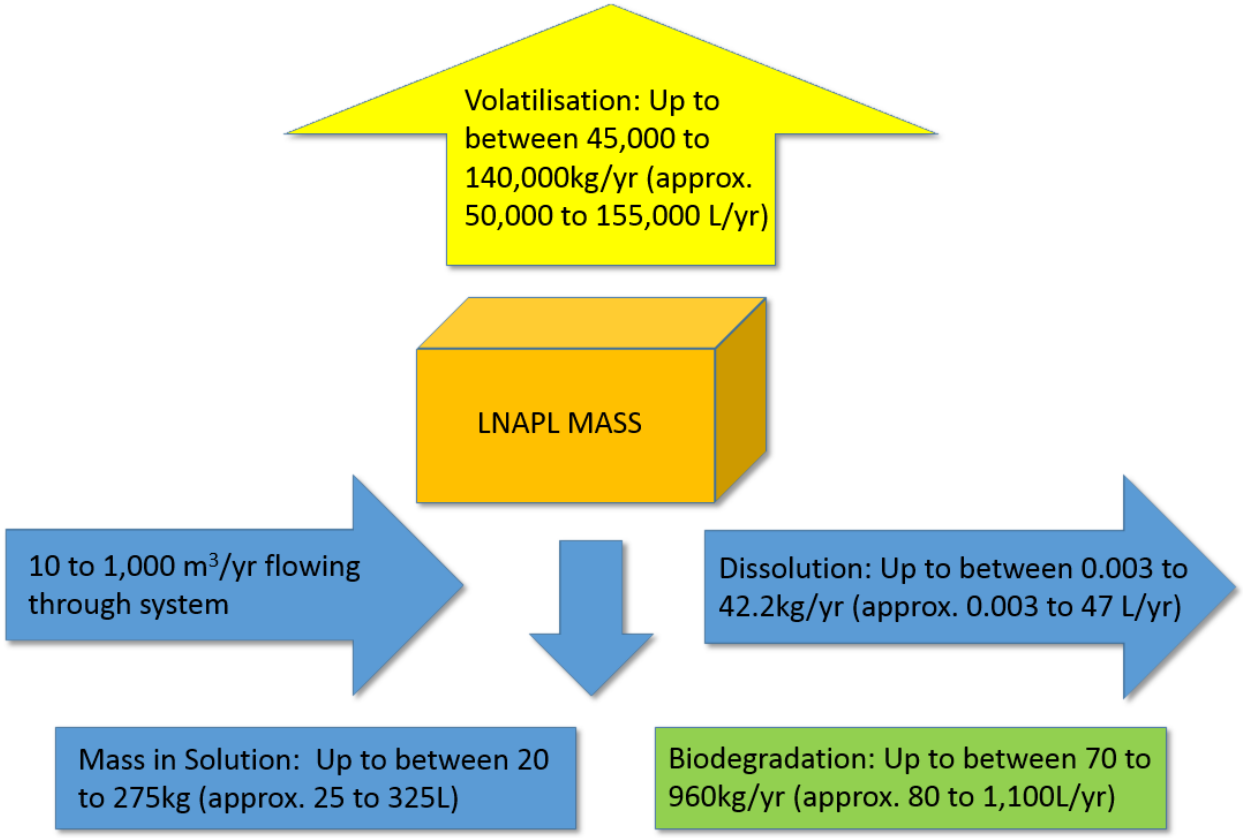


Source Zone Depletion Processes in the saturated Zone (ITRC, 2009b)

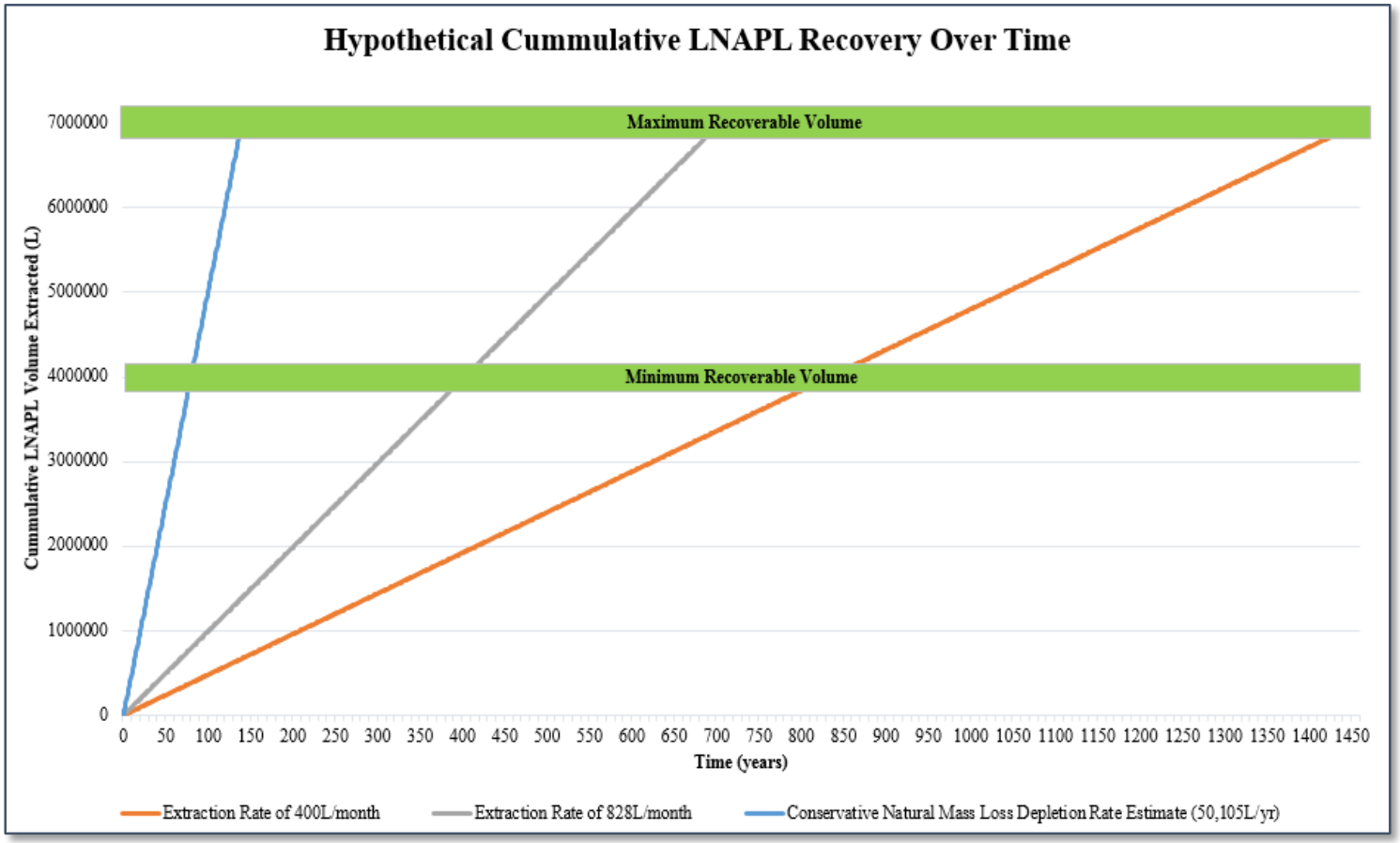
Natural Mass Losses

- The magnitude of these mass losses can be significant and in many cases natural mass losses can exceed the mass that can be removed via engineering means (active recovery).
- The magnitude of the losses depends primarily on LNAPL composition.
- To assess the magnitude of natural mass losses likely occurring at the site, LNAPL composition data (collected during the trials) was utilised together with data derived from the Landfill Gas Extraction System.

Natural Mass Losses Overview



Natural Mass Losses versus Hydraulic Recovery



LNAPL Remediation Drivers

- LNAPL composition drivers are associated with explosive risks, direct contact, ingestion and inhalation risks, dissolved and vapour phase concentrations.
- LNAPL saturation or mass drivers are primarily associated with potential migration risks.

Regulatory Remediation Drivers

- The State Environment Protection Policy, Groundwaters of Victoria, (SEPP GoV) requires that *'Where non-aqueous phase liquid is present in an aquifer, it must be removed unless the Authority (EPA Victoria) is satisfied that there is no unacceptable risk posed to any beneficial use by the non-aqueous phase liquid.'*

Historical Audit Findings

- Long Term Groundwater Risks (Lane Piper, 2007, Executive Summary page v):
  - *"Based on the available data and supported by numerical modelling undertaken by the Assessor, the Auditor considers that the **installation of a "best practice" landfill cap is likely to significantly reduce the long term flux of dissolved contaminants moving off-Site** in groundwater from the premises. The Auditor also notes that the apparently low mobility of the LNAPL suggests that the risk of off-Site movement of LNAPL is low.*
  - *Nevertheless, the Auditor is of the opinion that **the presence of LNAPL necessitated on-going risk management and monitoring, and a rigorous assessment of the feasibility for remediation of LNAPL is required**. The Auditor notes that remediation of LNAPL is not likely to be fully effective due to the proportion of oil likely to be retained by the solid material in the landfill."*

Historical Audit Findings

- *Risk to the Surface Water Environment*
- (Lane Piper, 2007, Executive Summary page vi):
  - *"The long term risk to the aquatic ecosystem and primary contact recreation use of Moonee Ponds Creek was evaluated by reference to the chemistry of the leachate and groundwater in conjunction with models of groundwater and laboratory testing of LNAPL dissolution into groundwater. This modelling indicates that the* ***long term risk to the aquatic ecosystem and primary contact recreational users of Moonee Ponds Creek is low and not likely to get worse****, assuming the aftercare management program, including capping goes to plan. However,* ***the presence of a large volume of LNAPL within the landfill …is an on-going source of contamination of groundwater and must be monitored and managed long-term****."*
- (Lane Piper, 2007, page 116):
  - *"It should be noted that it would* ***not be possible to remove all of the LNAPL****, as significant proportion of the LNAPL will be retained by the waste in the landfill. This* ***will act as an ongoing long term source for dissolved phase contamination in leachate and groundwater, and the risk profile for groundwater would therefore not change significantly in the foreseeable future, even with an aggressive NAPL removal program****."*

LNAPL Remediation Goal

- The LNAPL remediation goal for the Site was:
  - to recover LNAPL to the extent practicable.
- In the context of the trial results, it is considered that LNAPL clean up has been completed to the extent practicable and that the regulatory remediation drivers have essentially been met from a technical perspective – the most prospective method was trialled and not deemed feasible for long term implementation.

LNAPL Remediation Goal

- Whilst LNAPL extraction is not considered feasible it is important to note that:
  - The landfill cap serves to manage long term dissolution risks (which is already considered to be low);
  - The Landfill gas (LFG) extraction system is effectively serving as an active remediation measure (similar to soil vapour extraction whereby the movement of air around the LNAPL serves to enhance volatilisation with vapours captured and treated via the flare); and
  - Natural Mass losses are inferred to be occurring at an appreciable rate (based on flare feed data) mainly via volatilisation.

Net Benefit Analysis

- Whilst the regulatory driver is considered met from a technical perspective - community and intergenerational considerations are still considered relevant.
- As such the net benefits of LNAPL recovery actions were considered in the context of the potential impacts associated with the recovery activities on the environment and broader community.

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Key Net Benefit Analysis Findings

- The benefit to human health of implementing remediation is outweighed by the potential risks to human health.
- The benefit to the environment of implementing remediation is outweighed by the environmental impacts including greenhouse gas and air pollutant emissions and potential for a spill during transport of LNAPL
- The implementation of remediation requires the use of precious natural resources including fossil fuels and water.

Conclusions

- LNAPL extraction is not feasible from a technical perspective.
- The LNAPL is not moving and has limited potential to migrate.
- Direct risks from the LNAPL are considered low.
- Unless all the LNAPL is removed, the risk profile effectively remains unchanged.
- Natural mass loss are occurring at an appreciable rate.
- The LFG is serving to provide an active remediation measure.
- In this context, and supported by the findings of the net benefit analysis, the greatest benefit is to not implement further remedial measures.
- The Post Closure Management Plan serves as the key mechanisms to manage potential risks to health and the environment in the future via ongoing long term monitoring and implementation of contingency measures, as required.