

## Treatment of Tailings Water and Other Process-Affected Water

COSIA Water Conference

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CANADA'S OIL SANDS  
INNOVATION ALLIANCE



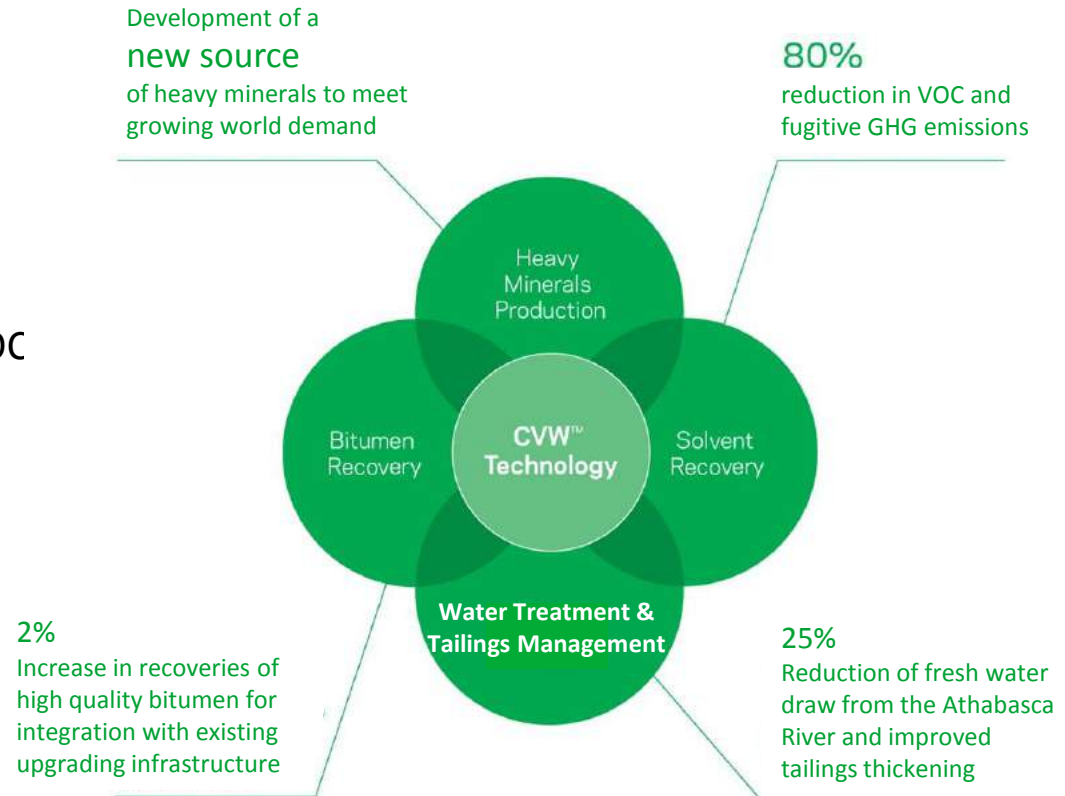
Creating Value from Waste™

# Forward-Looking Information

This presentation contains forward-looking statements and information ("forward-looking information") that involves various risks and uncertainties regarding future events. Such forward-looking information includes, without limitation, statements based on current expectations which are based on assumptions and subject to a number of risks and uncertainties and are not guarantees of future performance of the Corporation. These risks and uncertainties could cause actual results and the Corporation's plans and objectives to differ materially from those expressed in the forward-looking information. Most notably these risks and assumptions include, but are not limited to: commercialization of the CVW™ project under business models attractive to the Corporation, on the timetable anticipated or at all; the commercialization of the CVW™ process is dependent upon oil sands producers adopting and integrating the CVW™ process with their operations and providing froth treatment tailings as feedstock to the process; access to and cost of oil sands tailings necessary to carry out the project; commodity price fluctuations which are beyond our control may affect the ability or willingness of oil sands producers to enter into commercial projects with us or may have a material adverse affect on our operating results, financial position and profitability; potential fluctuations in our financial and business results make forecasting difficult and may restrict our access to funding for our commercialization plan; access to the necessary sources of capital to finance the CVW™ project or implement the business plan; uncertainty related to the cost to build and operate the CVW™ project or implement the business plan; operational execution or technical difficulties in connection with operating the project; development timeline delays and problems, including negative impacts on Titanium's technologies caused by unforeseen development costs; inadequate protection of the Company's intellectual property or potential litigation with respect to any intellectual property infringements could seriously harm the Company's business and prospects as the intellectual property is critical to the success of the CVW™ process; competitors who may develop alternate solutions to Titanium's CVW™ process; results of research activities; reliance on a small number of key people to carry out Titanium's business and research activities; changes in environmental laws and regulations which may add significant cost to or impede the permitted operation of the CVW™ project; expected future oil sands production and bitumen losses; and prospective results of operations, financial position or cash flows that are based on assumptions about future economic conditions and courses of action. The forward-looking information contained in this presentation are based on reasonable estimates, opinions and assumptions of management as at the date of this presentation and are expressly qualified in their entirety by this cautionary statement. The Corporation disclaims any intent or obligation to update any forward-looking information, whether as a result of new information, future events or results or otherwise, except as required by applicable securities laws. Forward-looking information is based upon a number of assumptions and is subject to a number of known and unknown risks and uncertainties, many of which are beyond the Corporation's control, which could cause actual results, performance or achievements to differ materially from those that are disclosed in or implied by such forward-looking information. There can be no assurance that this forward-looking information will prove to be accurate as actual results and future events could differ materially from those expected or estimated in such forward-looking information. Accordingly, readers should not place undue reliance on any forward-looking information. These factors are not intended to represent a complete list of factors that could affect the Corporation. Additional information on these and other factors and uncertainties are disclosed in the Corporation's documents filed with the Canadian securities regulatory authorities on SEDAR at [www.sedar.com](http://www.sedar.com).

# CVW™ offers sustainable benefits including enhanced water treatment and reuse

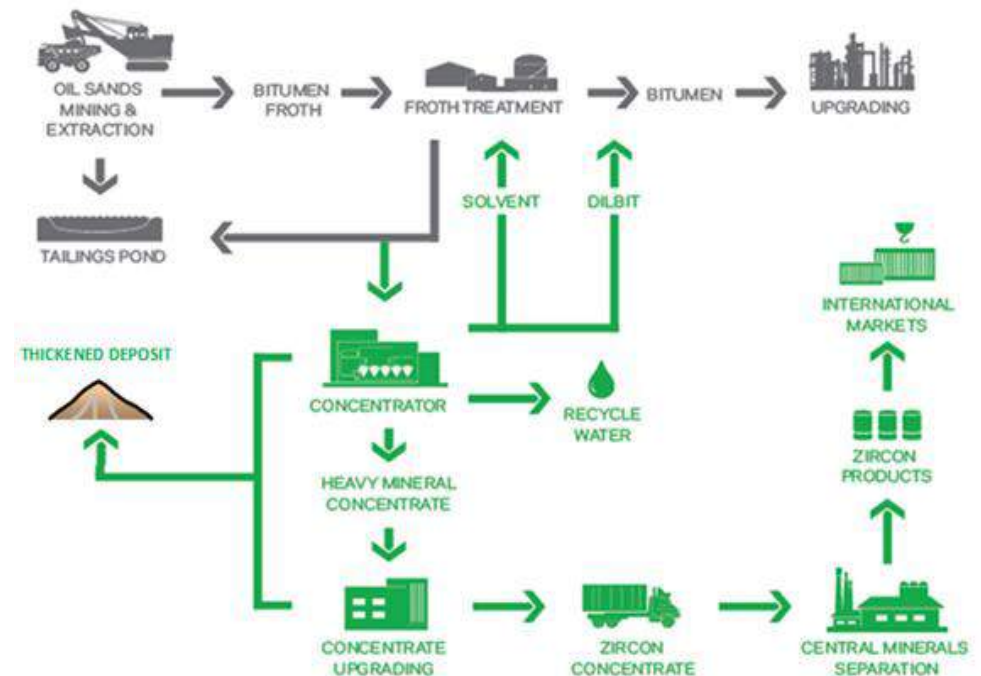
- Enables recycling of process water without pond treatment and/or offsets fresh water draw from Athabasca River
- Solves environmental issues - GHG & VOC emissions, water use, tailings management
- Creates a new minerals business (economic diversification) producing zircon, leucoxene, rare earths
- Recovers lost bitumen and solvent from tailings at reduced operating costs of less than \$7/barrel



**Sustainable benefits enabled by efficient and effective recovery of contained hydrocarbons**

# CVW™ effectively integrates into oil sands mining operations

- Recovered water can offset utility requirements (must remove fine solids and dissolved organics)
- Heat recovered from water reduces GHG emissions in water recycle applications
- Entire froth treatment tailings stream directly deposited into reclamation structure = pond avoidance
- Recovered bitumen and solvent of sufficient quality for upgrading feedstock & froth treatment use
- Diversification into green heavy minerals, compensates for oil price volatility



# Hydrocarbon recovery technologies are key to unlocking water and tailings benefits

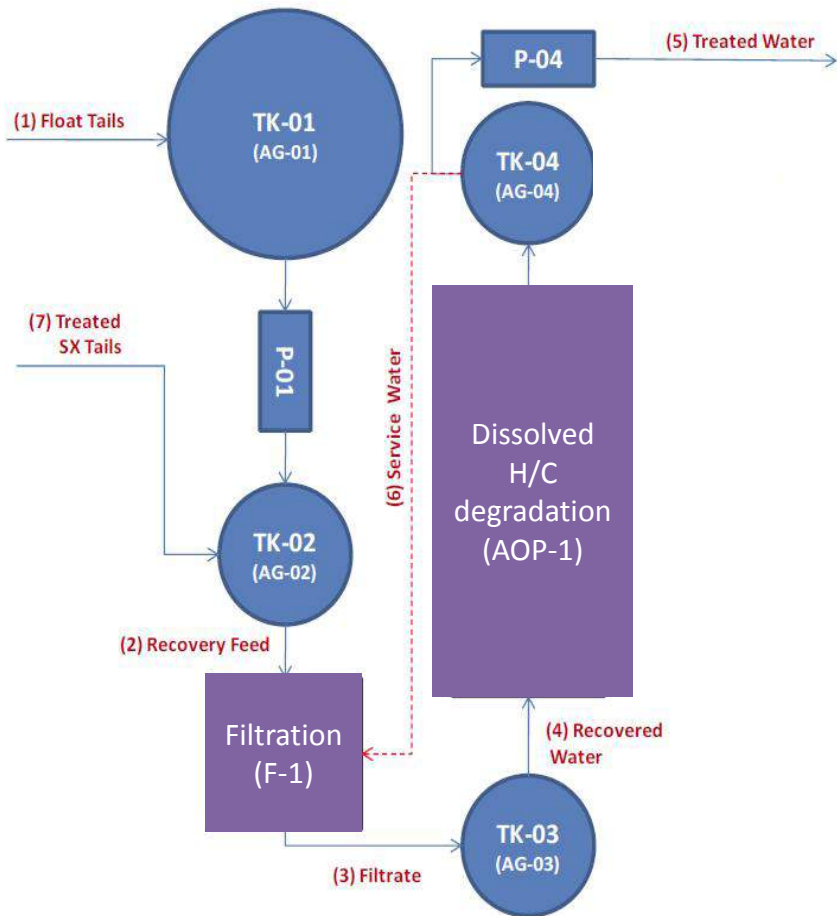
- Titanium's CVW™ patented technology has been demonstrated to recover bitumen solvents from waste, reducing GHG & VOC emissions
- Reduces solvent losses from 3-4 barrels to 0.7 barrels of solvent for every 1,000 barrels of bitumen production
- Hydrocarbons recovery is the key to improved water treatment and management of froth treatment tailings
- Efficient hydrocarbons recovery by flotation and/or solvent extraction

Titanium's solvent recovery demonstration piloting



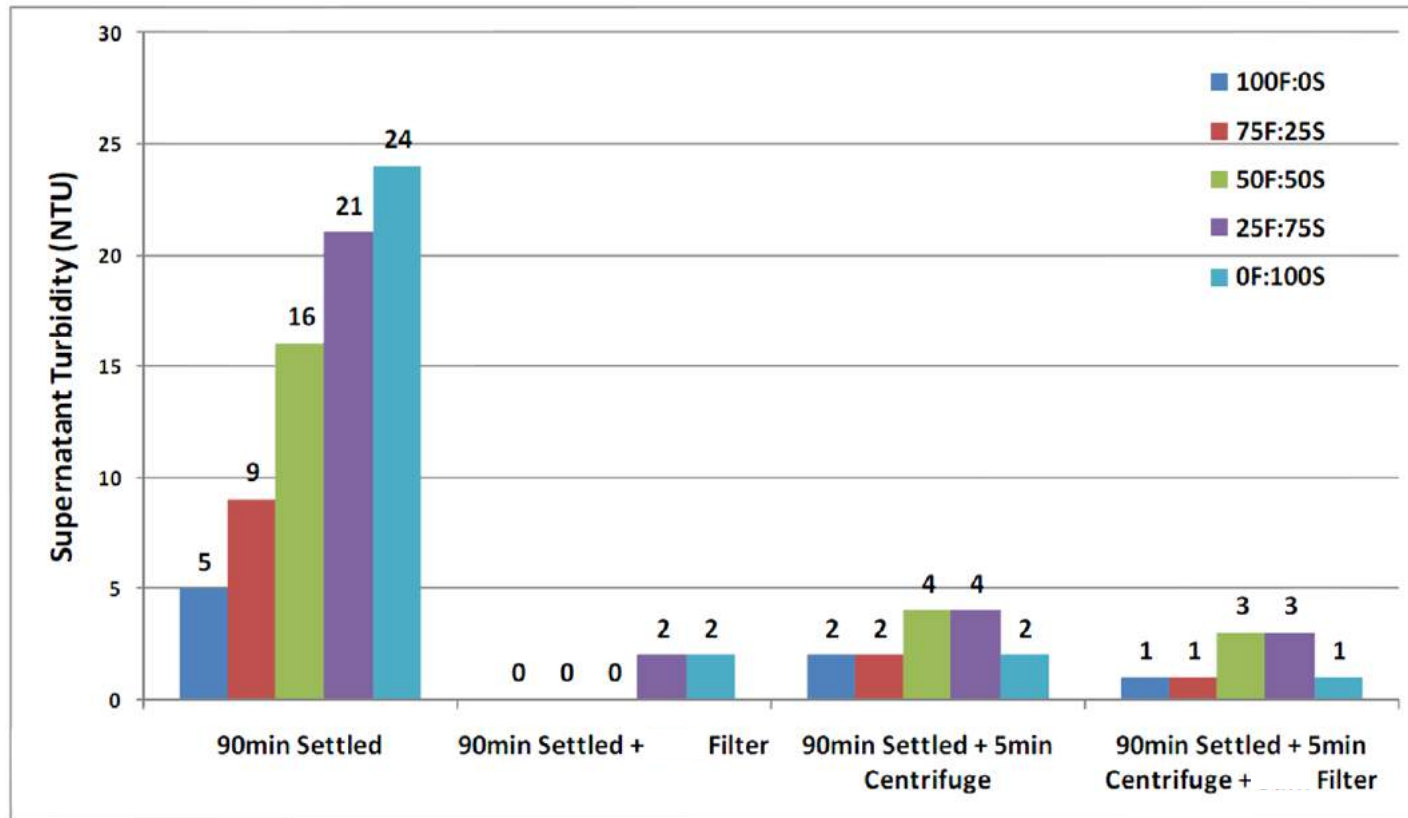
- Science based results from extensive demonstration pilots for oil sands operators and governments, verified by independent experts
- 80% hot water (hydrocarbon free) recovery
- 82% bitumen recovery from froth treatment tailings
- 95% solvent recovery (losses reduced below 1 barrel /1,000 barrels bitumen)
- 95% heavy mineral concentrate recovery

# Water treatment technologies – general testing arrangement



- Technology options developed with third party experts to remove fine solids and dissolved organics
- Solids removal via combinations of settling, filtration, centrifugation, thickening....
- H/C degradation via  $\text{TiO}_2$  catalyzed UV oxidation process...

# Removal of fine suspended particles performance



- Effective removal of suspended particles (enabled by hydrocarbon recovery from process tailings)
- Exceeded third party turbidity target of 200 NTU via settling, centrifugation, filtration

# Water quality after solids removal

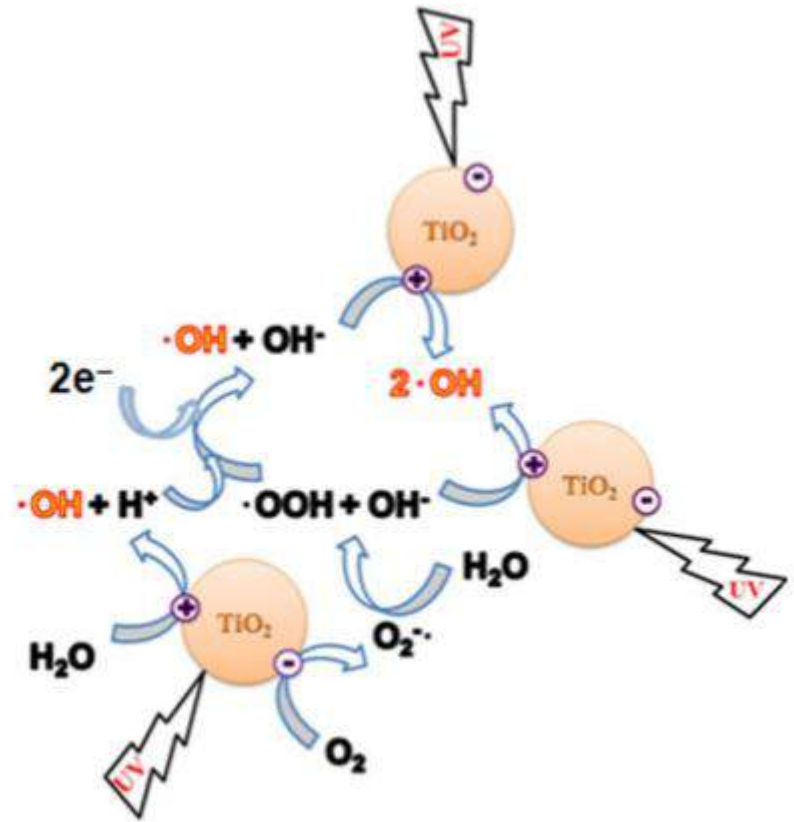
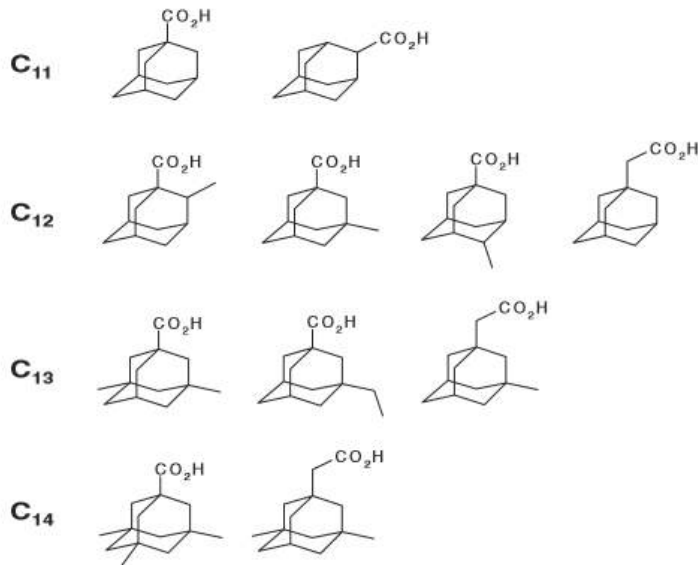
Property	FT tailings	TIC ex h/c recovery	TIC produced water ex TSS removal
pH (-)	9.25	8.15-8.69	8.0-8.58
TDS (mg/L)	2148	2173-2389	2038-2233
Conductance (mS/cm)	2.15	2.26	2.57
<b>NTU (-)</b>	<b>&gt;1000</b>	<b>&gt;1000</b>	<b>0-25</b>
<b>TSS (mg/L)</b>	<b>~170000</b>	<b>69165-162763</b>	<b>0-2</b>
TOC (mg/L)	10594	91.6	82.6
<b>O&amp;G (mg/L)</b>	<b>6870</b>	<b>316</b>	<b>52.2</b>
Surface tension (mN/m)		61.5	66.3

- Low TSS enabled by efficient hydrocarbon recovery processing of tailings
- Remaining organics are dissolved; similar concentrations to those observed in oil sands FT tailings
- Must reduce dissolved organics to eliminate toxicity, improve downstream water integration



# Removal of dissolved organics

## Polar Organic Acids

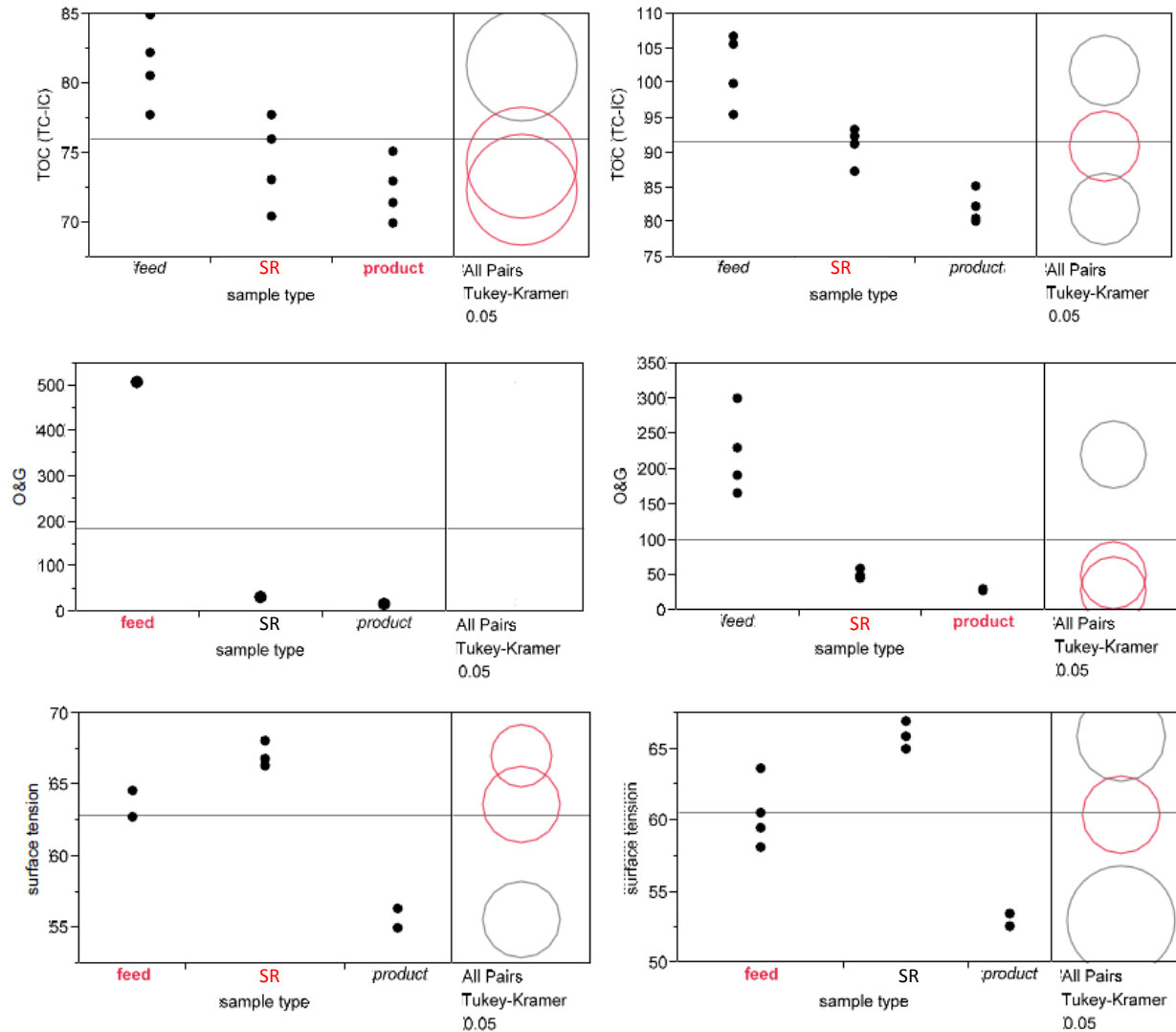


Source: Headley J.V. et al. (2013). "Chemical Fingerprinting of Naphthenic Acids and Oil Sands Process Waters – A Review of Analytical Methods for Environmental Samples", Journal of Environmental Engineering and Health, Part A, 48(10), 1145-1163.

Source: Lazar, M. A. et al. (2012). "Photocatalytic Water Treatment by Titanium Dioxide: Recent Updates", Catalysts, 2, 572-601.

- Hazardous polar organic acids (POA) are a source of oil sands process water toxicity
- TiO<sub>2</sub> catalyzed production of free radicals for oxidation reactions with POA
- Avoids using more severe oxidants like ozone, hydrogen peroxide...

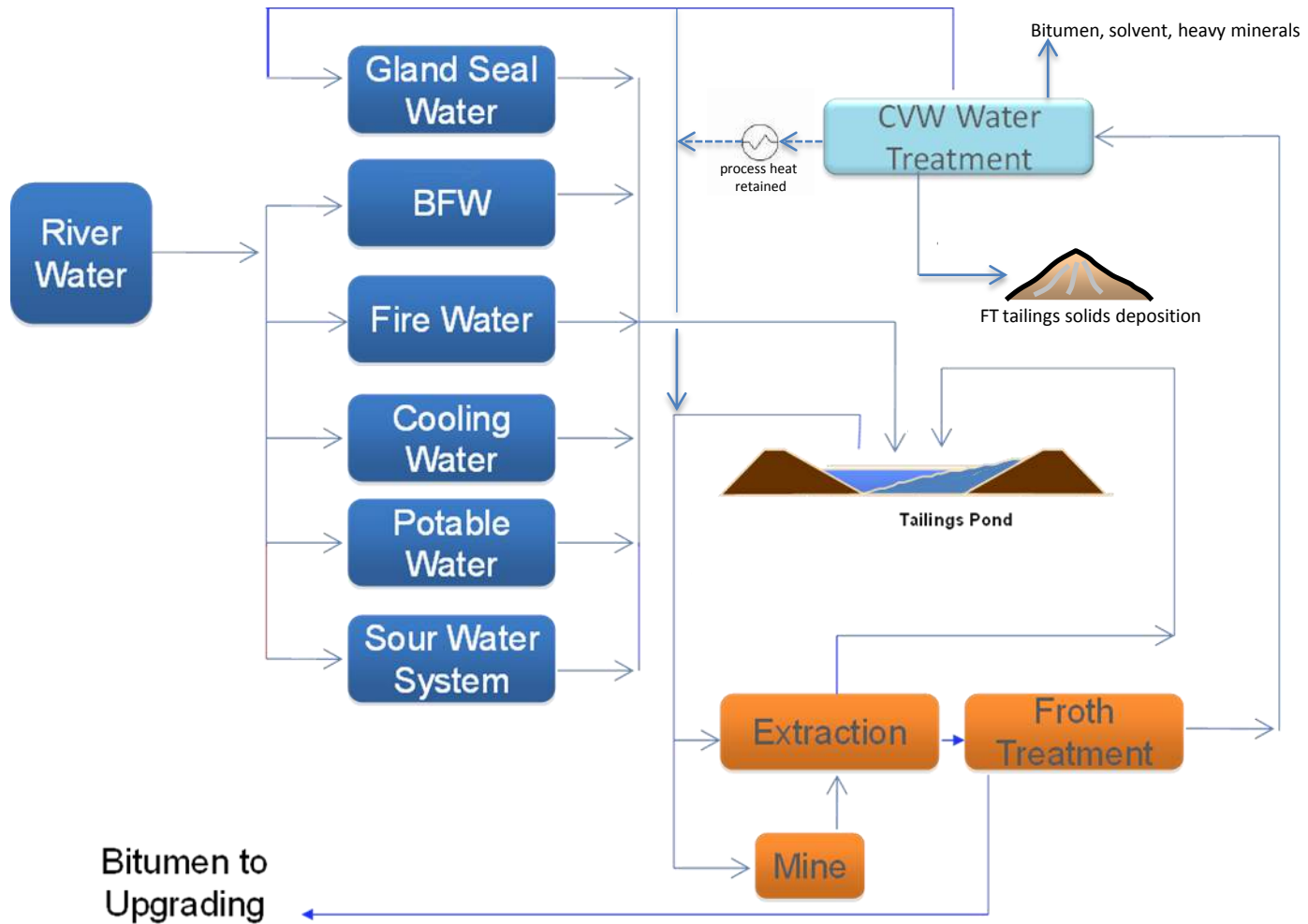
# Impact of advanced oxidation process (AOP) treatments



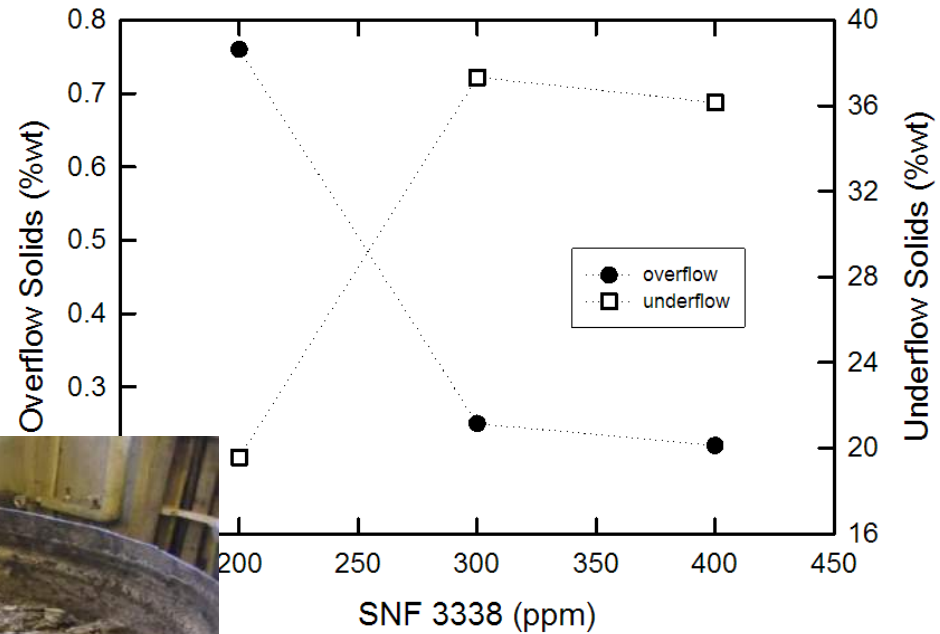
- TOC and O&G concentrations, surface tension reduced
- This process breaks down complex POA, reducing toxicity of water

# Re-use of AOP treated water

Fit-for-reuse water can deliver heat to extraction process and/or offset utility applications

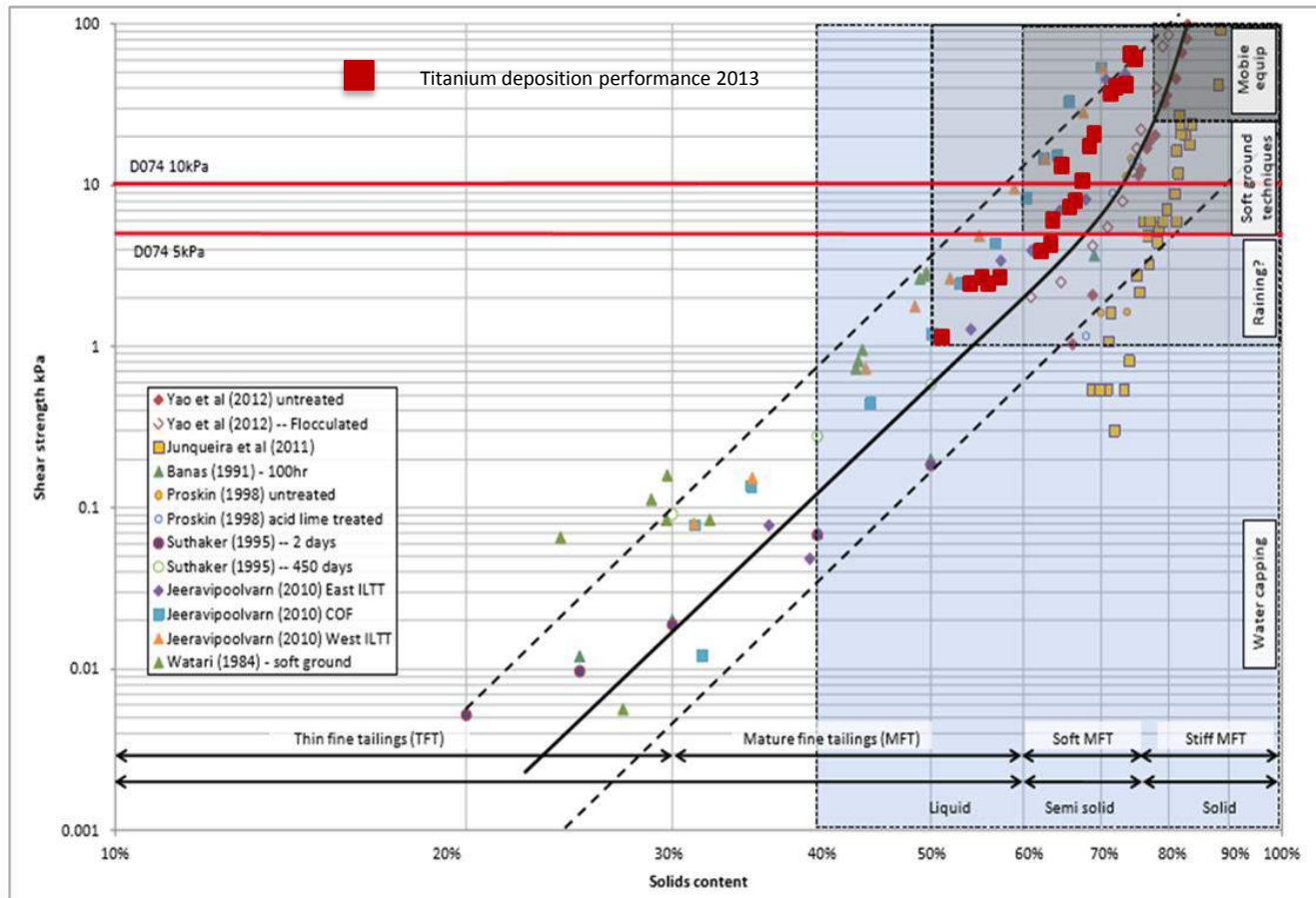


# Improves thickening and reduces polymer usage



- Efficient dewatering at low [polymer] releasing up to 80% hot water (~70°C or higher)
- Responds to a wide range of conventional tailings management operations
- Thickened underflow at 35% - 50% solids concentration

# Enhanced depositional behaviour



\*Chow, R., G. McKenna, S.M.K Win and J. Journault (2013). "Recovery of Bitumen from Oil Sands Tailings Streams and Deposits: Potential Opportunities and Benefits", HOOS-16156-2013, Alberta Innovates Technology Futures, adapted from Bromwell Engineering Inc. (1983). "Geotechnical Investigation of Mildred Lake Oil Sand Tailings Sludge Disposal, Consultants report prepared for Syncrude Canada Ltd", Lakeland, FL, pp. 119.

- Excellent thin lift response at polymer dosing of less than 400 ppmw (vs industry 800-2000 ppmw)
- Achieved solids concentrations of 75%, exceeding mandated depositional strength

# Addresses key objectives of the Alberta Tailings Management Framework

## Manage and Decrease Risk (TMF 3.5.1)

Titanium's CVW™ technology represents an end-of-pipe solution that precludes the need to discharge and store froth treatment tailings in tailings ponds, thereby better managing and decreasing the risks and liabilities associated with this tailings stream.

## Managing Both New and Legacy Tailings (TMF 3.5.2)

CVW™ represents a new technology designed to manage new tailings, intercepting fresh froth treatment tailings before they reach impoundments. The same technologies would apply to legacy tailings when they are removed from ponds for remediation.

## Holistic Approach to Tailings Management (TMF 3.5.3)

Titanium's CVW™ offers a triple bottom line “holistic” solution for froth treatment tailings management achieving:

**Economic benefits** from efficient recovery of hydrocarbons and minerals from tailings

**Environmental improvements** through improved air quality, reduced emissions of VOCs, GHGs and hazardous waste, enhanced dewatering/accelerated deposition, trafficability and reclamation

**Societal benefits** including higher royalties and taxes for government, investment and operations driven employment for workers, economic growth and diversification and enhanced reputation for environmental stewardship for Alberta, Canada and the industry.

## Technological Innovation (TMF 3.5.4)

The CVW™ process represents the best of “made-in-Alberta” technology innovation, providing sustainable solutions to oil sands froth treatment tailings. Key innovations include:

- Removal and economic recovery of bitumen and solvent from the tailings.
- Valuable heavy minerals recovery (and a new minerals export industry for Alberta and Canada); enhancement of water quality.
- Tailings thickening and overall remediation.
- Global application of these Alberta technologies to reduce environmental impacts of solvent losses, emissions and other environmental impacts in many industries.

## Pursue Cost Effective Solutions (TMF 3.5.5)

The economic recovery of valuable commodities (e.g. heavy minerals, bitumen and solvents) from tailings, delivers attractive economic returns (even in a low oil price environment) and a cost effective froth treatment tailings solution. In addition, tailings management, environmental and emissions costs would be significantly reduced even before the revenue recovery of captured lost commodities.

## Builds on Existing Legislation, Regulations and Policies (TMF 3.5.6)

Applying new technology to froth treatment tailings would build on and ensure the application of existing legislation and regulations in several areas including:

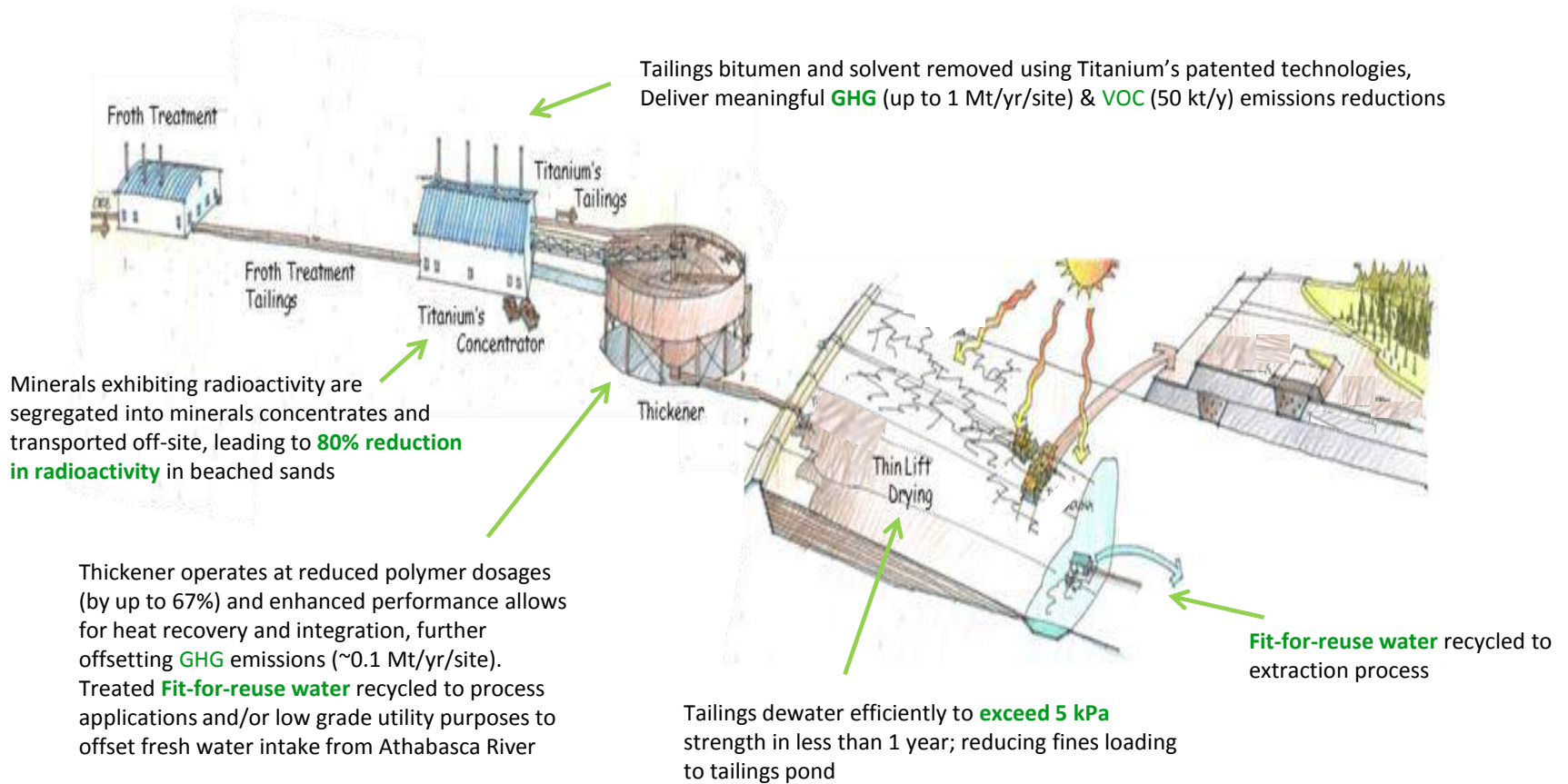
- Achieving the objectives of the Alberta Oil Sands Tenure Regulations Act, Part 3, Section 30 which provides for the recovery of minerals in oil sands.
- Reducing naphtha losses significantly to 0.7 bbl/kbbl, well below the levels historically mandated by the AER of 4 bbl/kbbl.
- Contributing to achieving more timely trafficable deposits as envisioned by Directive 74.
- Contributing to Provincial and Canadian standards and legislation governing the environment in areas of air, water, land and health.
- Providing a positive, near term contribution to Alberta and Canada's commitments and role in Climate Change reduction.

## Incorporates Flexibility and Adaptability (TMF 3.5.7)

CVW™ is an adaptable and efficient “end-of pipe” technology:

- Does not require changes to mining oil sands extraction processes.
- CVW™ has been flexibly designed and demonstrated to handle a wide range of tailing's fines concentrations, hydrocarbon content and other qualities.

# Titanium's CVW™ end-to-end tailings solution



A conceptual layout of Titanium's froth treatment tailings management operations using standard industry technologies for thickening and drying (which could include other proven technologies) is shown above adapted from: [Sobkowicz, J.\(2012\), "Oil Sands Tailings Technology Deployment Roadmaps: Project Report – Volume 1, Project Summary, Report to Alberta Innovates– Energy and Environment Solutions", File 17-235-22, Thurber Engineering.](#)

## Summary

- Recovering the bitumen and process solvent from the froth treatment tailings is the key to unlocking sustainable benefits
- Process affected water from froth treatment tailings is contaminated with hydrocarbons and toxic dissolved organics
- Advanced oxidation processes can be used to reduce toxicity by breaking down polar organic acids
- Treated water can be re-used in utility grade applications; towards fit-for-release options; cleaned tailings can be directly deposited
- Recovered bitumen and solvent of sufficient quality for upgrading feedstock and froth treatment use; valuable heavy minerals suitable for global markets



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