

Sustainable Construction in Remote Cold Regions: Methods and Knowledge Transfer

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Project and Status

- “Sustainable Construction in Remote Cold Regions: Methods and Knowledge Transfer”
- Introduction
 - Project Goals
- Discoveries to date
- Current Activities
- Future Activities

“Sustainable”

- Current buzz word
 - Many definitions
 - 211,000,000 Google hits
 - All revolve around the importance of creating and maintaining conditions under which human and natural needs can be met both in the present and in the future.
- “A sustainable society is one that can persist over generations, one that is far-seeing enough, flexible enough, and wise enough not to undermine either its physical or its social systems of support” (Meadows et al, 1992).
- “Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” (World Commission on Environment and Development, quoted in Burrow et al, 2013).

Three Dimensions

- Three dimensions : the economy, the environment and society.
- ASCE Strategic priority (<http://www.asce.org/sustainability/>)
- Sustainability is achieved only when there is a balance among those three aspects, implying the need, often, for tradeoffs and compromise among the three. Burrow (2013)
- Typically, the term is used to refer to a project life-cycle as a whole

Sustainable Construction

- Balance - present and future.
- This research emphasized environmental sustainability while recognizing the importance of the other two aspects.
- Sustainable construction: “creating construction items using best-practice clean and resource-efficient techniques from the extraction of the raw materials to the demolition and disposal of its components.” (Yates, 2014)
- Field Construction: Environmentally responsible methods for conducting field construction and maintenance operations in remote cold regions.

Vertical vs. Horizontal

- Transportation tends towards horizontal emphasis
- Sustainable, or “green,” construction has been an essential part of the building (vertical) construction process for many decades. (EPA 2014).

Two Research Realities

1. “Sustainable construction” embraces all phases of the project life cycle, but the greatest emphasis has been on the design and material specifications
2. The emphasis to date has been on buildings and other such, with much less consideration of such practices in heavy construction, such as roadways, pipelines, boardwalks, and airfields.

Research Need

- There is a need, especially in remote cold regions such as rural Alaska, for a compilation of guidelines to assist construction contractors in conducting their operations in environmentally responsible ways.

Research Goals

1. Identify and codify practical environmentally sustainable construction practices for use by contractors operating in remote cold regions, and
2. Convey the findings in useful form to those who can use them.

Research Methods

- Literature
- Preliminary outline and taxonomy
- Sorting into logical groupings
- Interviews and discussions with experts
- Collation into categories and summary into preliminary guidelines
- Meetings with other contractors, owners, agencies and other stakeholders
- Production and dissemination of guidelines

Research Methods

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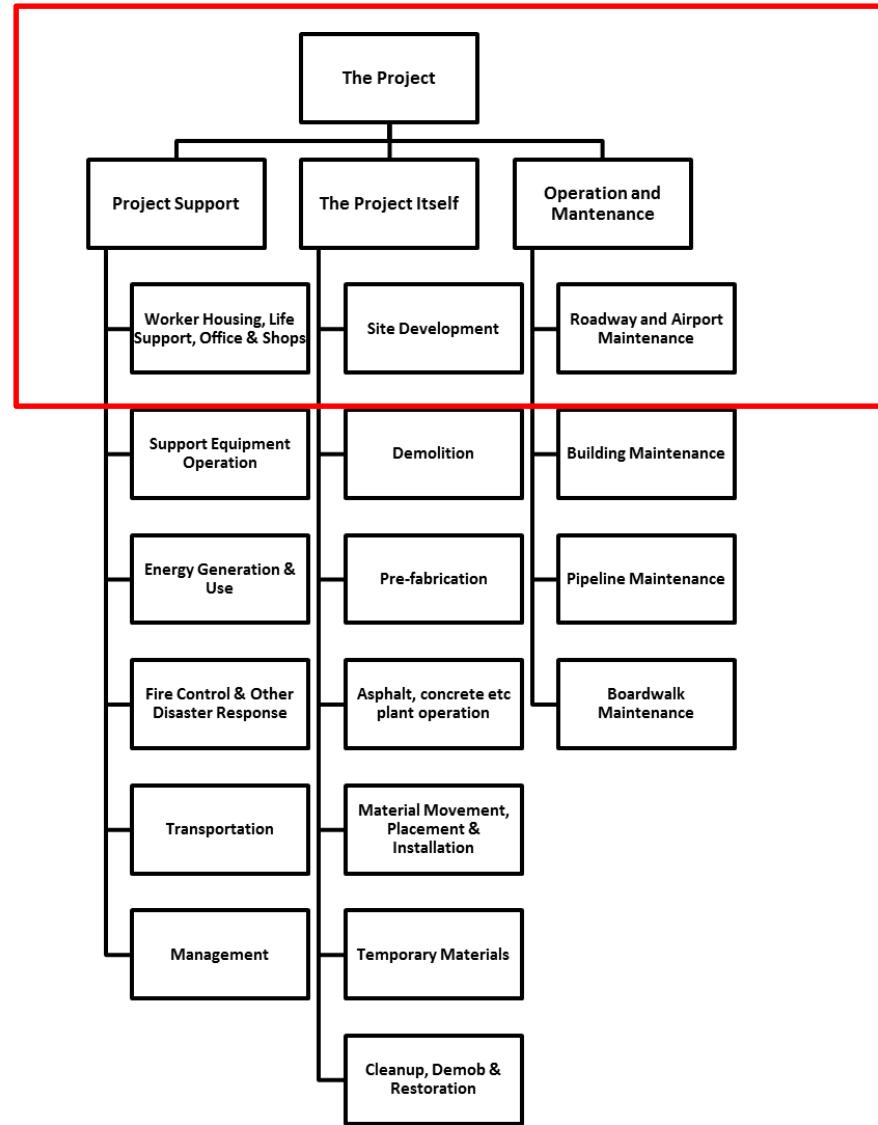
Literature search

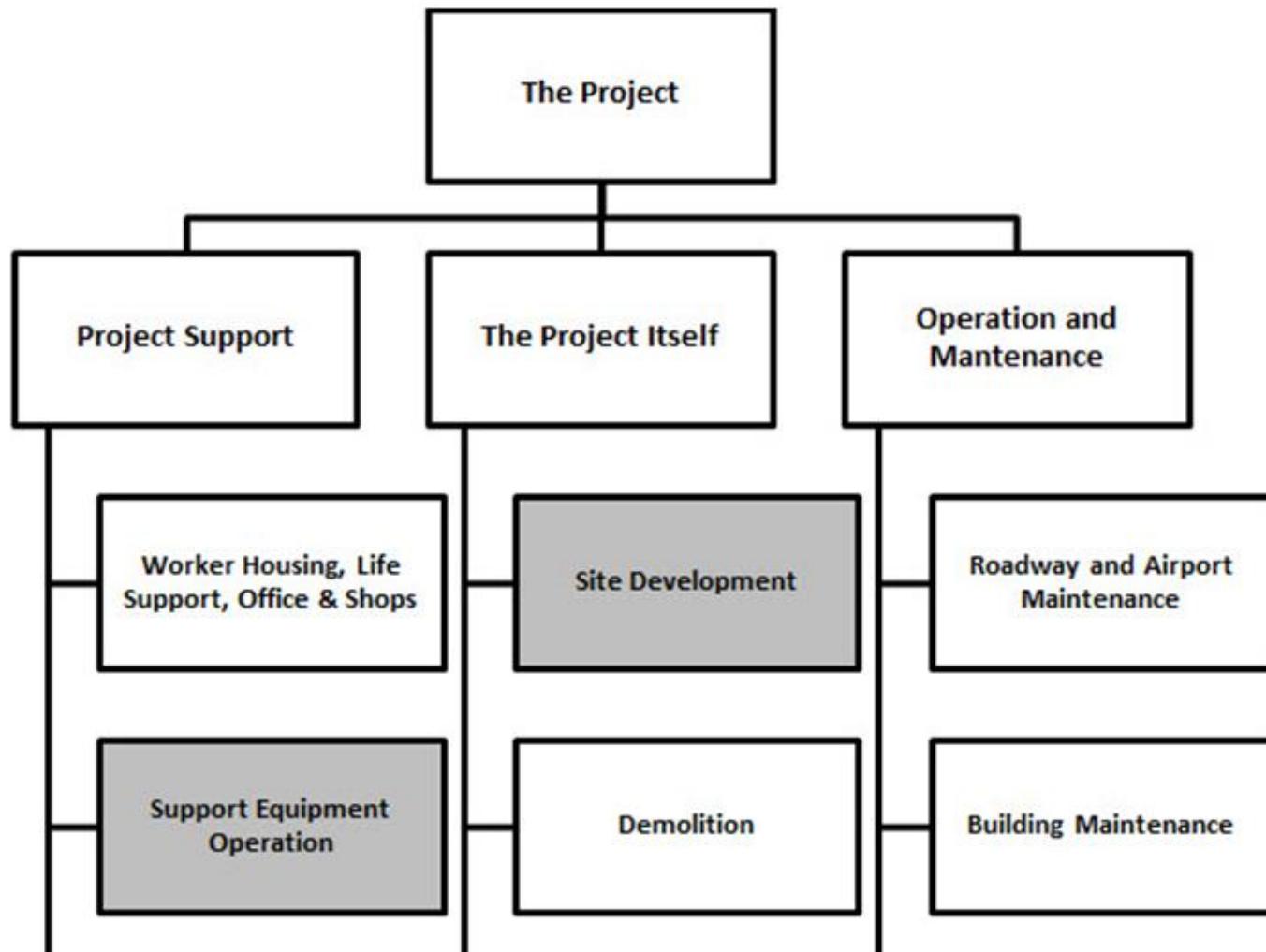
- Complete
- Extracted
 - horizontal/transportation,
 - construction,
 - remote and
 - cold
- Identified likely issues
- Organize!

Preliminary Outline and Taxonomy

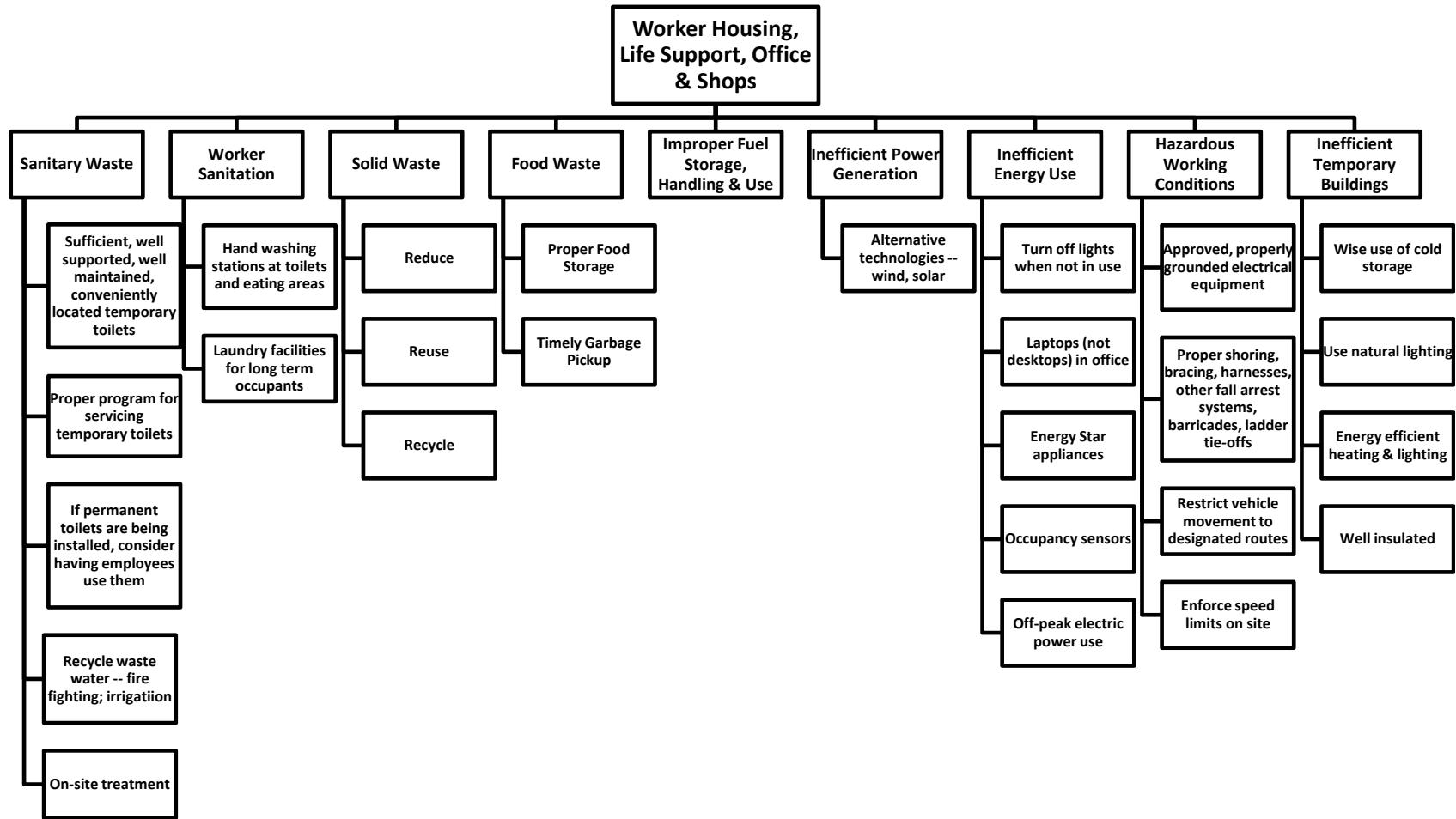
- Sorted myriad of issues into logical categories
 - Keyed to construction activities
 - Example, environmental impacts
 - Sources of impact
 - Methods to mitigate impact
- Included some points that are not CC but may bear, IAQ
- Now we have handle on issues
 - Based on literature

Examples of main rubrics:





Impacts and Mitigation – Examples from Taxonomy



Support Equipment Operation

Excessive Vibration

Limit vibration-producing activities to off-peak hours

Minimize vibration-producing activities

Conduct vibration-producing activities out of mainstream

Vibration-damping

Improper Fuel Storage, Handling & Use

Designated fueling area or off-site

Fuel area primary & secondary containment

Topping off restrictions

Pollution from vehicle & equipment cleaning, washout & storage

Designated concrete truck washout area

Proper concrete truck washout procedures

Designated equipment cleaning area

Interviews and discussions with cold regions construction experts

- Completed 22 interviews
 - Fairbanks, Anchorage,
 - Contractors, agency, environmental consultants
- Summarized by interview and organized by topic
 - e.g., Solid waste, or air pollution
- Refined with respect to taxonomy

Example Interview Summary for Clearing

Clearing

Interview 1

- Minimize cleared area, especially in permafrost area
- Might use organics from cleared area to protect disturbed areas.

Interview 2

- Unless this is done when ground is frozen, this is a permit issue. This is a “ground disturbing activity” and must be done by hand with no wheeled vehicles unless frozen. A seasonality consideration.
- Might leave cut trees and brush in place – minimize erosion; quicker regrowth.
- Chipping and using for mulch is a re-use example.
- Over a certain size (4” maybe 6”—not practical to chip) – their spec requires decking. Can then be made available locally.

Interview 3

- No permit required if you don’t disturb existing root mass.

Alyeska Manual

- Select the appropriate time of year for the project. By conducting work in winter, for example, the ground surface and vegetation can be more easily protected in its frozen condition.
- The appropriate type of equipment must be used so that impacts are minimized. Smaller equipment that can be better maneuvered or equipment that uses low impact wheels or tracks can significantly reduce impacts.
- Hand tools, rather than heavy equipment, should be used as much as possible when working in sensitive areas. Sensitive areas include wetlands, stream banks, alpine or arctic tundra, areas underlain by permafrost, or other areas of high ecological value that are slow to recover or difficult to rehabilitate.
- Use of tundra mats, Duramats, or snow/ice roads to protect the ground surface can reduce the expense of building temporary or permanent gravel access roads while allowing for quicker restoration of underlying vegetation.

- Use snow machines, tuckers, and other low-impact vehicles only after the ground surface is sufficiently frozen and covered with enough deep snow.
- Preplanning of equipment access points, traffic flow in the work area, and incorporation of site-specific features into work plans can minimize the footprint of a project.
- Use of trails, winter roads, or other existing access routes can significantly reduce impacts.
- Careful selection of staging areas, areas for dewatering basins, and work areas can minimize vegetation impacts.
- Use of previously disturbed areas, such as material sites, during a spill response, for example, reduces the amount of restoration required.
- Strict adherence to off-ROW or other permitted travel restrictions greatly reduces impacts. This includes marking boundaries and clearing limits and clearing only within approved boundaries.
- If clearing of sensitive areas cannot be avoided, it is often helpful to remove mature shrubs from the work area and stockpile them for later use. This can also be done when removing the organic layer (topsoil) when clearing a work site.
- Maintaining existing vegetative screens at highway crossings reduces the visibility of work sites from public access roads. Protection of buffer zones along water bodies eliminates the need for subsequent restoration.
- Minimize disturbance of the plant root mass as much as possible when clearing a work area. Avoid/minimize disturbance to the organic layer of the soil.
- Avoid disturbance of trees and older growth plants as much as possible. When trees must be cleared, clearing should be done so that trees and brush fall within the cleared area. Trees greater than 4 inches in diameter should be yarded such that they are available for salvage.

Main Categories

- Management, Planning and Coordination
- Logistics and Support
- Site Impacts – The Ground
- Operational Impacts
- Other

Categories and Preliminary Guidelines

- Management, Planning and Coordination
 - Local Community Issues
 - Planning and Management
- Logistics and Support
 - Construction Camp
 - Power Production and Use
 - Transportation
- Site Impacts – The Ground
 - Clearing
 - Historic Sites
 - Material Sources and Storage
 - Permafrost
 - Vegetation
 - Water Flow/ Runoff/ Erosion

- Operational Impacts
 - Air Pollution
 - Equipment
 - Fuels and Other Petroleum
 - Hazardous Waste
 - Solid Waste
- Other
 - Design Issues
 - General
 - Maintenance
 - Wildlife

Clearing Guidelines

Do not disturb the ground until just before the start of work.

Minimize the cleared area

- Consider using existing pad, roads, material sites, etc. as much as possible

Plan the use of clearing debris

- Leave in place (minimize erosion; faster regrowth), or
- Chip smaller debris and use for mulch; chipped debris might be allowed as structural fill; chipped debris might be used as insulation (permafrost)
- Deck larger ($> 4'' - 6''$) trees for use as firewood
- Use organic material to protect cleared areas

Minimize disturbance of root mass and organic layer

Remove mature shrubs, stockpile, protect, and re-use

Plan the timing of clearing operations

- Unless ground is frozen, perform clearing by hand with no wheeled vehicles (“ground disturbing activity”; permit may be required.)
- Work on frozen ground if possible

The use of hand tools and smaller equipment usually has fewer impacts.

Local Community Guidelines

Local Hire

Reduce footprint for construction camp (housing)

Knowledge of local conditions (material sites, landfills, e.g.)

Reduce transportation impacts

Local Equipment

Reduce transportation impacts

Local Laydown Area

Reduce footprint

Local Utilities

Reduce transportation impacts (generators, etc)

Possible net savings in air pollution

Leave equipment at village after project (gift or sell)

Reduce transportation impacts

Training is essential

Caution: broken, nearly unusable equipment may not be an appreciated gift.

Make clearing debris available for local use (relates to clearing and solid waste guidelines)

- Trees for firewood

- Eliminate burning – air pollution, safety risk, and labor effort to burn

- May need a fairness protocol

Make demolition debris available for local use (relates to solid waste guidelines)

- Windows, doors, lumber, other

- Reduce transportation impact (backhaul)

- Must be sorted and labeled

- May need a fairness protocol

Make leftover materials available for local use (relates to solid waste guidelines)

- Lumber, electrical, roofing, paint, adhesives, other

- Reduce transportation impact (backhaul)

- May need a fairness protocol

Guidelines are for Whom?

- Contractors
- Owners and designers
 - Specifications
 - Issues
- Constraints of Practicality
 - Cost
 - Schedule
 - Bid format



Cold Climate and Remote

- Some favorites



Management, Planning and Coordination



Planning and Management

- Seasonality – Many operations are best performed in winter – frozen ground, lake/stream ice, excavation, piling
- Permitting –early permits to allow proper scheduling of season-dependent activities
- Consider waste management during the planning phase
 - Barges limited

Local Community

- Make available for locals:
 - Clearing debris
 - Firewood
 - Building products and materials
- Reduces backhaul or disposal costs
- Fairness protocol – must have
 - Need advance planning, coordination

Logistics and Support



Construction Camp

- Hiring locally reduces camp size (first from local community; then relatives from nearby villages who can live with locals)
- Renting houses in the village (and maybe fixing them up) reduces camp size
- Build boardwalks

Power Production and Use

- Research what is available locally before starting project; contact local AVEC utility in advance re: power needs, when, how to plug into
 - May max out
 - May be “dirty” power, check IT
- Working in the warm season saves lighting and heating costs and resources.

Site Impacts – the Ground



Permafrost

- Entire section, but here are some that caught my eye:
- The key is seasonality Pre-planning, early permits, etc. to allow conducting sensitive operations on frozen active layer. This is a matter for all parties, including permit agencies.
- Wood chips to protect open permafrost (such as ice-rich cut slopes)
- Harvest the organic mat for use in protecting open permafrost
- Minimize clearing to allow shade to protect permafrost
- Consider using HDPE overlay mats (approx 3-4" thick) – laydown area, temporary roads, campsite
- Elevate temporary structures above ground.

Clearing

- Plan the timing of clearing operations
 - “Ground disturbing activities” may require a permit
- Work on frozen ground if possible
 - Equipment will not damage soil mat
 - If ground is not frozen, perform clearing by hand

Water flow/Runoff

- SWPPP covers result
- Snow berms might be used for diversion; in real cold areas they may last into summer.
- Doing work in the winter has a much smaller impact; no need for silt fencing, etc.
- Break-up: run-on as well as run-off; i.e., control the source. Divert water around where possible.

Material Sources and Storage

- Limit the size of laydown areas
 - Snow removal
- Protect materials and supplies from freezing
(High cost to replace!)
- Pay extra attention to ordering the right materials (High cost to replace!)

Operational Impacts



Air Pollution

- *Avoid leaving equipment running*
 - Tradeoff:
 - Plug-ins require energy
 - So do mechanics trucks, “elephant rigs”
 - Lost productivity
 - Versus leave running all the time
 - No downside, except cost of fuel
 - But, it is a waste, besides Ice fog, etc.
 - Sustainable point of view

Equipment

- Rent locally if possible
 - Saves transport
 - Operators available
- Avoid need for heavy equipment (Partly a design issue – smaller assemblies require smaller equipment to install)

Fuel and POL

- If you overwinter a fuel line (whether operating in winter or not), you must protect the line – it will be covered by snow!
- Check hoses, fittings and valves before and after a transfer. (Use proper grounding procedures for all transfers – remember grounding is a problem in frozen soils.)
- Monitor fueling at all times. Do not leave the fueling area or get back into the vehicle during fueling.

But sometimes



Hazardous Waste

- Assure that shipping containers that delivered hazardous materials (epoxy part B, e.g.) do not get used by local residents. Crush them, poke holes in them, etc.
- Kept from freezing (liquids)
 - Heated storage may be necessary
 - Ventilation, fire protection, etc.
 - Need planning

Solid Waste

- Time backhauls (often empty) to haul out solid waste
- Be aware of potential liability issues associated with giving away regulated waste

Wildlife

- Don't feed bears or other wildlife
- Minimize attractants
 - Food waste – Tight covered containers; frequent pick-up
 - Human waste – Pump often (Porta johns)
 - Food storage – Tight covered containers
 - Trash – Tight covered containers; frequent pick-up
 - Keep break areas clean
- Have policies regarding hunting, fishing and trapping, including making sure regulations are followed

Others

- All could be design or specification matters
- Most could be maintenance matters

Not Just Larry and Bob's Great Ideas

- Will workaday contractors be interested?
- Do they have incentives?
- Buy-in
 - Might they have other/better ideas
- Need meetings to:
 - Draw out ideas
 - Discuss incentives
 - Transmit what we learned
 - Preliminary Guidelines

Incentives

- “Why not in the spec’s?”
 - Not translatable
 - Depend on details of contractor’s operations that owner and engineer traditionally avoid – and should.
 - Below agency radar?
- Eagle Scout
 - CSR, Corporate Social Responsibility,
 - owners and major contractors
 - or sub to major contractors
 - Locals and many workers respect environment and local resources: hunting and fishing

- QBS, criteria
 - Certifications
 - Citations, good and bad
- Proactive approach is good “PR”
 - Agencies
 - NGOs
- Financial
 - New methods may save money
 - “That’s the way we’ve always done it,” may not be good business

Future of Guidelines

- Pamphlets
- Presentations
- Website
- CESTiCC webinar
- Course Syllabus and Materials
 - Construction education

Failure



Success Requires:

- Knowledge Transfer
- Acceptance by construction community
- Appropriate use in the field

Two Scheduled Meeting

- AGC in Fairbanks on 6 October
- DOT in Anchorage on 27 October

- Questions?
- Comments?
- Thanks