Integrating Activities for Advanced Communities

D8.2 – Protocols for (target and nontarget) screening of contaminants of emerging concern at INTERACT stations

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PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
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Publishable Executive Summary

Over the past three decades, and based on increasing research and monitoring effort, bodies such as the Arctic Monitoring and Assessment Programme (AMAP) have documented the presence and effects of (chemical) environmental contaminants in the Arctic. This information has been used to inform policy- and decision-making at the national and international level aimed at reducing and where possible eliminating the sources of such contaminants.

The 2017 AMAP assessment Chemicals of Emerging Arctic Concern (CEACs) documented the presence in Arctic environmental media of a number of 'new' chemicals/groups of chemicals. Some of these CEACs have been introduced to replace banned substances, many lack information concerning their properties and possible toxic effects, and many are challenging to analyse. Some CEACs will reach the Arctic due to long-range transport, others are associated with consumer products that may be used in Arctic communities and therefore enter waste streams in the Arctic. CEACs may also have sources associated with industrial development in the Arctic, or even research activities themselves.

The Arctic is undergoing unprecedented change, primarily associated with climate warming from emissions of greenhouse gases and short-lived climate forcers. Surface air temperatures in the Arctic have increased at three times the global average over the past 50 years, resulting in cryosphere change (loss of sea- and land ice, permafrost thaw, etc.) and changes to Arctic ecosystems. Related to these environmental changes are improved access, in particular marine access, to areas that are potentially rich in natural resources. Human development of the Arctic has increased, and this trend is expected to continue. With increasing human presence in the Arctic comes increasing use of chemicals within the region. Climate change is also altering pathways and fate of environmental contaminants, potentially remobilizing contaminants that have accumulated in Arctic snow, ice, water, and sediments as well as altering their uptake and transfer through Arctic ecosystems and food webs.

The INTERACT station network, and its connectivity to local communities, provides an opportunity for enhancing research to better understand the occurrence and sources of POPs and CEACs, at the same time increasing engagement of INTERACT stations in routine monitoring programmes. Previous work has identified chemicals that could be considered for a coordinated research/monitoring effort involving the Arctic research station network, their scientific research community, and associated local communities. This deliverable builds on that earlier work to examine options for practical work that could be implemented at INTERACT stations to support environmental contaminants monitoring and research.

1. Purpose and scope of this document

The INTERACT station network, and its connectivity to local communities, provides an opportunity for enhancing research to better understand the occurrence and sources of contaminants such as Persistent Organic Pollutants (POPs) and Chemicals of Emerging Arctic Concern (CEACs), including increasing engagement of INTERACT stations in routine monitoring programmes and in particular the activities of the Arctic Monitoring and Assessment Programme (AMAP).

A previous INTERACT III project deliverable (D8.1) identified chemicals of potential interest in this context. Challenges identified in that work include the lack of availability to INTERACT station managers of relevant protocols for collection, storage and transport of samples for the purpose of POP or CEAC analysis. These protocols need to take account of significant potential for contamination of samples prior to their shipment to laboratories with appropriate capability to conduct POPs and CEACs screening analyses.

This document focusses on specific proposals for chemicals screening activities at INTERACT stations that are considered to have the greatest potential and feasibility with respect to pilot implementation. In part this reflects information regarding the current capability at stations in the INTERACT network compiled through a survey conducted as part of the WP8 activities (see Annex 1). The document aims primarily to provide practical guidance to mangers of stations that might be considering options to extend their stations involvement in this type of work.

It is beyond the scope of the INTERACT III work to prepare comprehensive protocols for all types of sample media that are collected in environmental monitoring and screening programmes, or to detail appropriate analytical methods, or their associated and required quality assurance and control (QA/QC) procedures. Such work is undertaken under the auspices of far larger programmes, for example AMAP (www.amap.no), OSPAR (www.ospar.org; OSPAR, 2022) or EMEP (www.emep.int/) in relation to monitoring for POPs and CEACS. In addition, the NORMAN network (www.norman-network.net/) provides QA/QC expertise in relation to contaminant screening. Consequently, this document is structured according to a series of options for future pilot implementation work, that include references to existing relevant documentation. As further advances are made, in particular in the rapidly developing field of contaminant screening, documentation and protocols are continually being updated, so primary sources should be consulted for more recent available information.

2. Current status of INTERACT Stations engagement in chemicals screening

Results of a survey conducted to gain insight into current engagement of INTERACT stations in contaminant (CEAC) screening activities are summarized in Annex 1. Only 4 stations (Greenland Institute of Natural Resources and Villum Research Stations on Greenland, Whapmagootsui-Kuujjuarapik Research Complex (CEN) in Canada, and the Ny-Ålesund Research Station – Sverdrup on Svalbard) reported prior involvement in such work. These and two additional stations (CNR Dirigibile Italia on Svalbard and Sonnblick Observatory Austria) also reported engagement in monitoring of legacy POPs or CEACs.

Information regarding involvement of the INTERACT stations in contaminants screening/monitoring work may be incomplete in the survey responses, as those completing the survey may not be familiar with all work undertaken by visiting researchers, including community-based monitoring work and engagement of local hunters in sample collection for monitoring programmes. Also, only ca. 40% of INTERACT stations completed the survey, which may or may not be indicative of an 'interest' in contaminants monitoring work at the other stations. It was noted that survey responses sometimes implied a lack of awareness about work conducted at or close to the station that is known to contribute to national/international monitoring programmes, including AMAP. However, the survey responses provide a useful starting point for consideration of development of protocols designed to promote greater engagement of INTERACT stations in environmental contaminant monitoring and screening.

Further aspects of the INTERACT station network are also relevant in this connection:

- INTERACT supports a community of station managers who potentially have the capacity to maintain and operate equipment located at or close to the station over extended periods of time, compared for example with visiting researchers.
- A number of the stations are located in or close to communities, offering possibilities for consultation and potentially community engagement in monitoring and research activities at the stations.

3. Context for pilot implementation of contaminant screening at INTERACT stations

Pilot implementation of contaminant screening at INTERACT stations can be viewed in relation to one or more objectives, which in turn provide a rationale for evaluating 'sampling' approaches that may be most suitable. These objectives can be formulated in questions including:

- Is the station suitable for involvement in environmental contaminant research studies or monitoring programmes – considering siting, operational aspects (staffing, visitors), on-site facilities and potential sources of on-site contamination?
- Does the station constitute a local source of POPs/CEAC contamination?
- Can the station serve as a centre for studies investigating other potential 'local sources' such as community landfill, waste lagoons, waste incineration sites, infrastructure, etc. that could be relevant for environmental screening or monitoring of POPs/CEACs?
- Can the station support monitoring programmes or research through other roles such as serving as a hub for collection and storage of samples prior to their shipment to laboratories.

In the context of the INTERACT workplan there are several further relevant considerations, not least:

(1) Access to an expert network, such as the AMAP POPs Expert Group or members of the NORMAN network that can provide advice, if this expertise is not otherwise available at the station or to the researcher using the station.
(2) Need for collaboration with a laboratory that has the capability to undertake analysis of samples (this includes arrangements to cover costs for the required analyses). No INTERACT stations possess the

laboratory facilities and equipment necessary to conduct analyses of POPs/CEACs on-site; some may have the capacity (facilities/staff) to undertake sampling and sample preparation; several have the facilities for sample storage (freezers, etc.). Costs for a single POPs analysis are typically several hundred Euros, depending on the analytes. State-of the-art screening analyses require labour-intensive complex data analysis and can be above a thousand Euros per sample.

(3) As appropriate to objectives of the work and station circumstances, needs for consultation with relevant authorities, to ensure that necessary permissions are obtained for intended work. Most INTERACT stations should have existing requirements and procedures in this respect, but collection of new sample types might need specific permissions. Shipment of samples to other countries might be prohibited or restricted or require specific export and import permissions according to national regulations or international agreements (e.g. CITES; Convention for the International Trade in Endangered Species of Wild Fauna and Flora).

(4) Where relevant, possibilities to engage/consult with local communities, especially local indigenous people, to secure their agreement to any work that would be carried out on their lands. Particularly important in this respect would be necessary permissions for any work on traditional lands and to ensure that work will not disturb culturally important sites. Ideally this would be part of a more comprehensive strategy to promote co-production of knowledge, to engage local communities and where relevant link stations to community-based research and monitoring activities. Again, where such considerations are relevant, INTERACT stations should already have awareness of these issues and possible existing mechanisms to consult with local people.

The previous deliverable (D8.1) highlighted air, water and biota as the media that are currently of most interest in connection with screening for CEACs.

4. Possible sampling approaches for pilot implementation

The objectives identified in section 3 provide a basis for selecting 'sampling' approaches that would be most feasible/promising for a pilot implementation work at INTERACT stations, and which would also be relevant to ongoing external activities. This latter point may be essential given the need to link any such pilot implementation to work that could provide access to the laboratory analyses that would hopefully be undertaken but which is outside of the scope of the INTERACT initiative. All sampling approaches have in common that sample contamination can easily occur, in particular with current-use chemicals present in equipment and consumer products. For example, for collection of samples to be analysed for POP or CEACs, all plastic materials should be avoided.

4.1.Approach 1: Passive air sampling

Passive air samplers (PAS) have the advantage of low price, simple operation, and independence of power sources, they can be deployed in both indoor and outdoor settings. However, they also have associated limitations when it comes to the groups of contaminants they sample (e.g. gaseous vs particulate associated semi-volatile organic chemicals (SVOCs)), as well as their ability to reliably quantify concentrations in air as

opposed to simple presence, especially for contaminants at low ambient concentrations. PAS include devices that rely on non-porous materials such as polymeric sheets and films and others that rely on porous materials such as polymer foams and resins. They operate as diffusion-based samplers (dependent on thermodynamic equilibrium properties), and kinetic samplers (flowthrough samplers; dependent on a sampling rate, often an assumed throughflow of air). The latter in particular have been shown to be highly dependent (and thus less suitable) for deployment in windy locations. Wania and Shunthirasingham (2020) conducted a comprehensive review of PAS that lists their use at remote locations (among these a number of Arctic sites including Ny-Ålesund and Toolik Lake, as well as Sonnblick) and to study indoor air concentrations of SVOC. The review concludes that PAS-derived air concentration for SVOCs (especially for particle-associated substances) may essentially provide only an order of magnitude estimate of air concentrations; however, that this does not invalidate the usefulness of PAS in applications where even highly uncertain data are sufficient to meet project objectives. They provide a number of recommendations in this respect.

Concerning their use at INTERACT stations, PAS could be considered for example in target/non-target screening designed to reveal presence (or confirm absence) of SVOC contamination in the stations (indoor sampling). Where conditions are suitable, PAS could also applied in studies to determine relative levels of CEACs close to local sources where air concentrations may be expected to be elevated, and potentially along transects away from such sources, to evaluate spatial extent of contamination.

4.2.Approach 2: Passive water sampling

Passive water sampling has been demonstrated to be a suitable technique for measuring concentrations of hydrophobic chemicals, such as PCBs, PAHs, and brominated flame retardants, in water and wastewaters (Booij et al., 2016; Taylor et al., 2021). Passive sampling media for hydrophobic chemicals in water include polymer sheets and films such as silicone and low density polyethylene (LDPE). Semipermeable membrane devices or SPMD, an older technique, that involves enclosing triolein, a triglyceride lipid, inside a LDPE tube have been widely used (Alvarez, 2010). SPMDs and single phase media such as silicone and PE sample the dissolved chemicals in water at a rate that is proportional to the difference in chemical concentration between sampler and medium. The uptake is controlled by passive processes (diffusion and flow rates of water), until equilibrium is attained. The equilibrium/enrichment factors on the polymers can be very high, in the range of 10^4 to $>10^6$, which means that low detection limits in the range of nanograms or picograms per liter can be achieved.

Chemicals of emerging concern such as pharmaceuticals, pesticides, plastic additives, and perfluorinated alkyl acids are more water soluble and generally not efficiently sampled with polymer sheets. Instead devices use an adsorbent phase which can be polymeric, carbonaceous or inorganic, sandwiched between a diffusive membranes. These devices include Chemcatcher® and Polar Organic Chemical Integrative Sampler (POCIS) (Taylor et al., 2020). A related device organic-diffusive gradients in thin films (o-DGT) uses a hydrogel diffusive layer covering a binding gel, with an optional membrane for protection (Guibal et al., 2019).

The passive sampling devices are generally attached to sampling frames or cages which protect them from damage and are deployed at various depths with an anchored mooring and float maintaining the line vertical.

Typical deployment times for silicone and LDPE are 1 month to 1 year. After recovery from the deployment device the samplers are solvent extracted and extracts analysed using methods similar to those for other solid environmental media. However, a key step is the conversion of the quantity of a given analyte on the polymer or absorbent device to a concentration. For polymer sheets, this requires determination of polymer phase-water partition coefficients and sampling rates of target analytes. The partition coefficients are used to estimate water concentrations (Adams et al., 2007). The sampling rate is determined from performance reference chemicals (PRCs) added to the polymer prior to deployment. The PRCs are generally mass labelled (deuterated or Carbon 13) standards which do not interfere with analysis of unlabelled native analogs. PRCs enable estimation of the exchange rate of the passive samplers under various water flow and turbulence conditions.

In the case of Chemcatcher®, o-DGT and POCIS the devices are calibrated using laboratory studies in which the water concentrations of the polar organics are known (Ahrens et al. 2015). Because passive samplers measure only dissolved concentrations results tend to be lower than samples based on whole water extractions (i.e. with suspended matter). On the other hand the dissolved concentrations enable estimates of air-water exchange when paired with passive air sampling and also are thought to reflect bioavailable concentrations in water.

A major benefit of passive sampling of water is that it can provide time averaged concentrations at a given location, unlike typical grab sampling. Passive sampling is gradually being introduced by regulatory agencies. The ISO guideline for passive water sampling has helped to standardize the methodology for hydrophobic organics (ISO, 2011). Other guidelines useful in connection with PWS include: ICES, 2012; 2013; Miège et al., 2015.

4.3.Approach 3: Collection of environmental media (biota, snow)

Many INTERACT stations are located in areas where samples are collected for environmental monitoring purposes; in a few cases the stations already participate in such activities. Perhaps more importantly, other INTERACT stations are located in areas that are identified ‘geographical gaps’ with respect to monitoring of environmental chemicals. In the case of biota, samples of fish, birds and marine mammals, in particular, are often collected with the cooperation of local hunters and trappers. Potential exists for the INTERACT stations to fulfil a role in both collection of samples (e.g., biota and media such as snow) and sample storage (in secure, refrigerated conditions) prior to their shipment to laboratories. Many stations have considerable logistical capacity and experience in shipping materials in/out from the station, and this is something that currently may be under-utilised by monitoring programmes.

5. Pilot implementation of contaminant screening at INTERACT Stations: Options (feasible) and opportunities

In Annex 2, the approaches described in section 4 are further developed in terms of a series of template 'options' that could be considered by station managers interested in undertaking pilot implementation of screening for CEACs or supporting POPs monitoring work. These options also include reference to opportunities that may exist in the near-term for linking such work to ongoing/planned screening studies or monitoring programmes.

6. Next Steps

The information contained in this deliverable will be presented to INTERACT station managers who will be encouraged to consider pilot implementation of work at stations that could facilitate new contaminants monitoring/screening activities.

This work will also be coordinated with relevant activities under AMAP and could be connected to planned work under the *Network of reference laboratories, research centres and related organisations for monitoring of emerging environmental substances* (NORMAN network, https://www.norman-network.net/), for example in the field of passive sampling, as well as other relevant ongoing and planned initiatives. One possibility would be to arrange a meeting where INTERACT station managers could meet with coordinators of some of the ongoing screening studies, Arctic contaminant research and monitoring programmes to further discuss possible collaboration in this respect.

7. Glossary

CEACs: Chemicals of Emerging Arctic Concern

FTS: flow through (passive air) sampler; wind-driven passive samplers that have higher sampling rates than diffusion-based passive samplers

LDPE: low density polyethylene

o-DGT: organic-diffusive gradients in thin films

PAS: passive air sampler

PE : polyethylene

POCIS : Polar Organic Chemical Integrative Sampler

POPs: Persistent Organic Pollutants

PRCs : performance reference chemicals

PUF: polyurethane foam

PUF-PAS: PAS using polyurethane foam (PUF) disks; suitable for detection of presence and (relative) quantification of volatile OCs (gaseous) and less volatile (particle associated) OCs; not suitable in windy locations or where flow volume is topography dependent

PWS : passive water sampler

SPMD: Semipermeable membrane device

SVOCs: semi-volatile organic chemicals; organic molecules that can occur in both the gas-phase and condensed phases; comprises a large number of commercially produced substances, including industrial chemicals, pesticides, and additives to consumer products, e.g. polychlorinated biphenyls (PCBs), polybrominated diphenylethers (PBDEs), and organochlorine pesticides (OCPs), combustion products such as the polycyclic aromatic hydrocarbons (PAHs). (Wania and Shunthirasingham, 2020)

XAD: styrene–divinylbenzene co-polymer

XAD-PAS: PAS using XAD-resin as a sorbent; suitable for detection of presence and (relative) quantification of volatile (gaseous) OCs

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Appendix 1: Summary of Results of the Survey of Chemical Contaminant Screening Activities in the INTERACT station network

As part of the work under WP8, a survey was conducted of INTERACT III stations to gain insight into their areas of work, facilities, current activities and interest in engaging in work related to contaminants monitoring and screening. The results of this work were reported at the INTERACT III General Assembly in November 2021, and are summarised in this Appendix.

On the basis of this evaluation, practicalities, protocols and proposals for possible implementation of new contaminants monitoring/screening activities will be discussed with INTERACT station managers. This work will also be coordinated with relevant activities under AMAP and other fora addressing emerging contaminants, for example the *Network of reference laboratories, research centres and related organisations for monitoring of emerging environmental substances* (NORMAN network, https://www.norman-network.net/).

The online survey can be found at:
https://docs.google.com/forms/d/e/1FAIpQLSc-LhiR584gB5HBQ57ljh5HfBYC9gEExAmjVoB7pKAO8iV7vQ/viewform?fbzx=8410588047322694722

Survey results received from (30) INTERACT stations (see Figure A1) identified limited existing engagement of INTERACT stations in contaminants screening, with only 4 of the 30 responses (from Greenland Institute of Natural Resources and Villum Research Stations on Greenland, Whapmagootsui-Kuujjuarapik Research Complex (CEN) in Canada, and the Ny-Ålesund Research Station – Sverdrup on Svalbard) reporting prior involvement in such work. Nine other stations reported involvement in contaminant monitoring work; however, the constituents monitored varied widely between responses with only the above four stations and the CNR Dirigibile Italia station (on Svalbard) and Sonnblick Observatory (Austria) reporting monitoring of legacy POPs or CEACs. In terms of media monitored for POPS and CEACs, the reported experience concerned mainly monitoring of abiotic media (air/precipitation, snow/ice, marine/river/lake-water). One station (Oulanka, Finland) reported monitoring of wastewater/drinking water, for other constituents. Four stations reported involvement in monitoring of biotic media, with a main focus on terrestrial mammals/birds and/or marine mammals/birds.

Although none of the stations have on-site laboratory facilities with the advanced analytical equipment required for analysis of POPs or CEACs, some have facilities suitable for handling, preparation and storage of samples for such analyses. These range from clean areas with limited access and basic chemical laboratory facilities to forensic standard laboratory facilities that can also be used for storage/handling of tissue samples for contaminant analyses. Several stations also reported availability of fridges and freezers suitable for sample storage, including some with generator backup and at least three stations with -80 degree freezers.

Four INTERACT stations (Arctic Station, Greenland; Oulanka, Finland; The Arctic Research Station, Russia; CEN Whapmagootsui-Kuujjuarapik Research Complex, Canada) are identified in the WP8 workplan as target stations for testing contaminant screening/monitoring implementation.

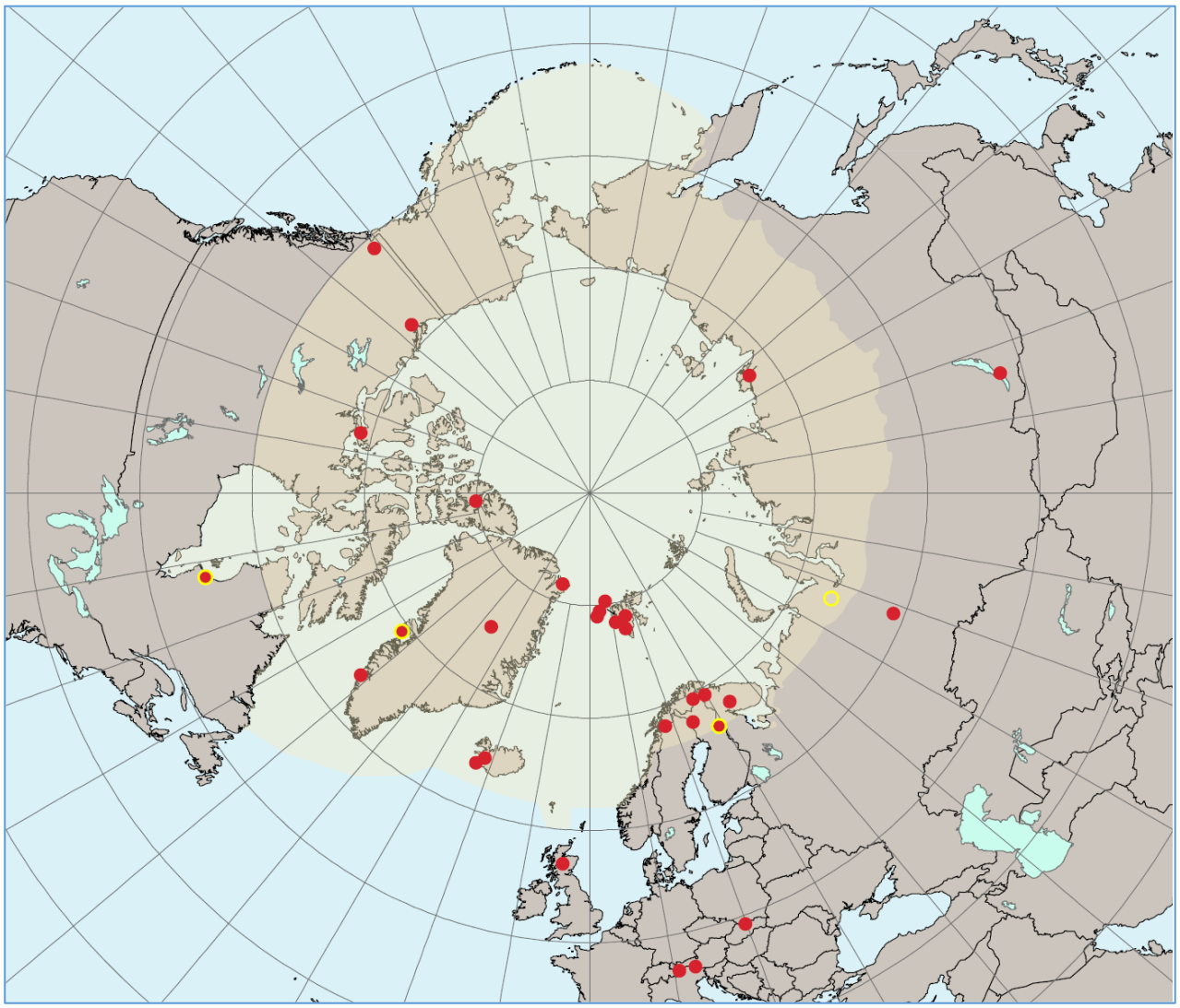

Figure A1. Stations responding to survey (yellow circles indicate WP8 core pilot implementation stations).

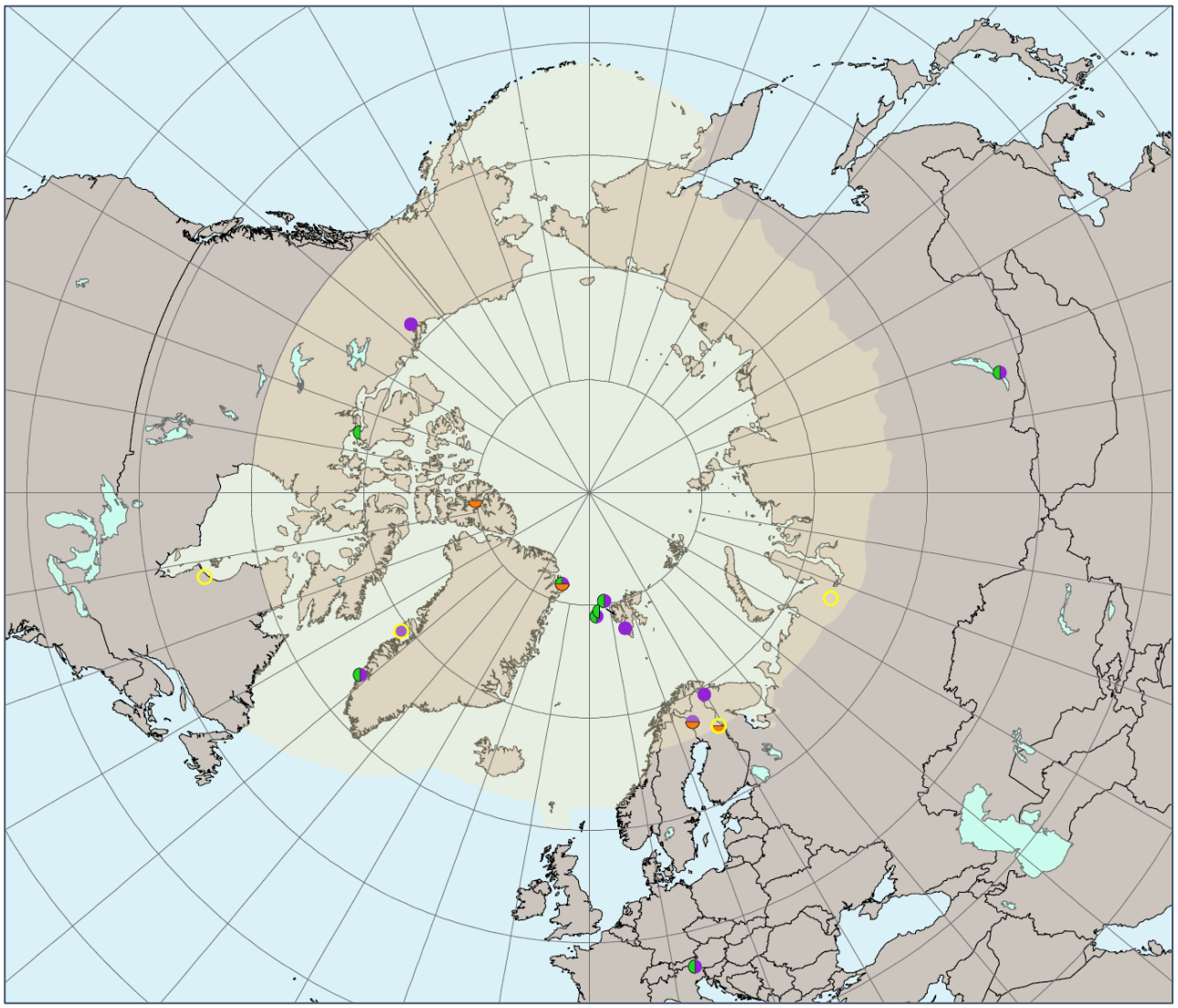

Figure A2. Stations reporting engagement in monitoring of or screening of contaminants (green indicating monitoring or screening of POPs or CEACs).

Appendix 2: Options for pilot implementation of screening for POPs and CEACs at INTERACT stations

Option 1: Evaluating possible sources of station 'on-site' contamination using passive air sampler	
Context for pilot study	Evaluating suitability of station for research or monitoring of environmental (POPs/CEAC) contaminants
Pre-requirements	
Access to relevant expertise…	Necessary/recommended if not otherwise in place
Access to laboratory services…	Required
Permissions for work…	Probably not required/relevant if work is within existing operator licence
Permissions from, engagement with and support of local community…	N/A
Type of sampler	PUF-PAS deployed for weeks/months; screening to identify SVOCs present in indoor/outdoor station environment
Related protocols/guidance	Wania and Shunthirasingham, 2020 (and references therein)
Links to ongoing/planned projects/programmes	
Contacts points	AMAP POPs EG: Hayley Hung (Environment and Climate Change Canada, ECCC); Derek Muir (ECCC, Canada); Cynthia de Wit (Stockholm University, Sweden); Katrin Vorkamp (Aarhus University, Denmark) NORMAN network: Working Group 6: Emerging substances in the indoor environment. Co-ordinators: NILU-Norway/IVM-Belgium. Pernilla Bohlin Nizzetto (NILU, Norway) Research groups that have deployed PAS at INTERACT sites (Toolik, Sonnblick, Ny-Ålesund)

Option 2: Evaluating possible sources of station 'on-site' contamination using blank exposure studies	
Context for pilot study	Evaluating suitability of station for research or monitoring of environmental (POPs/CEAC) contaminants
Pre-requirements	
Access to relevant expertise…	Necessary/recommended if not otherwise in place
Access to laboratory services…	Required
Permissions for work…	Probably not required/relevant if work is within existing operator licence
Permissions from, engagement with and support of local community…	N/A
Type of sampler	
Related protocols/guidance	
Links to ongoing/planned projects/programmes	
Possible contacts	AMAP POPs EG: Hayley Hung (Environment and Climate Change Canada, ECCC); Derek Muir (ECCC, Canada); Cynthia de Wit (Stockholm University, Sweden); Katrin Vorkamp (Aarhus University, Denmark) AMAP/NCP ILS study coordinator: Harold Malle (ECCC, Canada)

Option 3: Evaluating whether the station constitutes a local source of POPs/CEAC air contamination	
Context for pilot study	Confirming that the station is not a local source of POPs/CEAC contamination of environment
Pre-requirements	
Access to relevant expertise…	Necessary/recommended if not otherwise in place
Access to laboratory services…	Required
Permissions for work…	Depends whether work is on-site and within existing operator licence or involves sampling in (immediate) vicinity.
Permissions from, engagement with and support of local community…	Communication of results to local communities and potentially remediation would be appropriate

Type of sampler	XAD-PAS (diffusion PAS) to detect presence of gaseous SVOCs; deployed for up to 1 year
Related protocols/guidance	Wania and Shunthirasingham, 2020 (and references therein Hung pers. comm (2)
Links to ongoing/planned projects/programmes	AMAP assessment 2022/23: Local vs long-range transport sources of Arctic CEAC contamination: AMAP POPs EG contacts.
Contacts points	AMAP POPs EG: Hayley Hung (Environment and Climate Change Canada, ECCC); Derek Muir (ECCC, Canada); Cynthia de Wit (Stockholm University, Sweden); Katrin Vorkamp (Aarhus University, Denmark) NORMAN network Cross-Working Group Activity: Passive sampling for emerging contaminants Pernilla Bohlin Nizzetto (NILU, Norway) Research groups that have deployed PAS at INTERACT sites (Toolik, Sonnblick, Ny-Ålesund)

Option 4: Evaluating whether the station constitutes a local source of POPs/CEAC water contamination	
Context for pilot study	Confirming that the station is not a local source of POPs/CEAC contamination of aquatic environment
Pre-requirements	
Access to relevant expertise…	Necessary/recommended if not otherwise in place
Access to laboratory services…	Required
Permissions for work…	Depends whether work is on-site and within existing operator licence or involves sampling in (immediate) vicinity
Permissions from, engagement with and support of local community…	Communication of results to local communities and potentially remediation would be appropriate
Type of sampler	Deploy passive water sampler at station wastewater outflow
Related protocols/guidance	ICES, 2012 (for silicone PWS)
Links to ongoing/planned projects/programmes	

Possible contacts	NORMAN network Cross-Working Group Activity: Passive sampling for emerging contaminants (Ian Allan (NIVA, Norway) and Cécile Miège (INRAE, France)).

Option 5: Evaluating POPs/CEAC contamination around sources of potential contamination in the local area using passive air sampler	
Context for pilot study	Identifying local sources of POPs/CEAC contamination of the environment (e.g. landfill, sites of waste incineration; local energy sources, industrial developments), and possibly the spatial extent of such contamination
Pre-requirements	
Access to relevant expertise…	Necessary/recommended if not otherwise in place
Access to laboratory services…	Required
Permissions for work…	Depends whether work is covered by existing agreements for sampling in area concerned; may require permission from facility (e.g. landfill site) operator Communication of results to local/regional authorities
Permissions from, engagement with and support of local community…	Desirable/required depending on whether proposed deployment is close to a community and/or on indigenous lands Communication of results to local communities
Type of sampler	PUF-PAS or FTS (kinetic PAS) to sample gaseous and particulate components if situation is suitable (i.e. not influenced by high winds); deployed for up to 1 year Possible PUF-PAS transect study away from source (e.g. if ambient conditions are similar at all transect sites); deployed for up to 1 year XAD-PAS deployment to detect presence of gaseous SVOCs; deployed for up to 2 years
Related protocols/guidance	Wania and Shunthirasingham, 2020 (and references therein) Toolik Lake FTS application (Davie-Martin et al. 2016) Hung pers. comm (1) Hung pers. comm (2)
Links to ongoing/planned projects/programmes	

Contacts points	AMAP POPs EG: Hayley Hung (Environment and Climate Change Canada, ECCC); Derek Muir (ECCC, Canada); Cynthia de Wit (Stockholm University, Sweden); Katrin Vorkamp (Aarhus University, Denmark) Research groups that have deployed PAS at INTERACT sites (Toolik, Sonnblick, Ny-Ålesund)

Option 6: Evaluating POPs/CEAC contamination around sources of potential contamination in the local area using passive water sampler	
Context for pilot study	Identifying local sources of POPs/CEAC contamination of the environment (e.g. waste water outflows or lagoons, industrial developments); potentially groundwater (e.g. around airport) or confirming quality of community drinking water supply
Pre-requirements	
Access to relevant expertise…	Necessary/recommended if not otherwise in place
Access to laboratory services…	Required
Permissions for work…	Depends whether work is covered by existing agreements for sampling in area concerned; may require permission from facility (e.g. wastewater discharge/lagoon site) operator Communication of results to local/regional authorities
Permissions from, engagement with and support of local community…	Desirable/required depending on whether proposed deployment is close to a community and/or on indigenous lands Communication of results to local communities
Type of sampler	Deploy passive water sampler in community wastewater outflow, sewage lagoon or potential recipient water-body
Related protocols/guidance	ICES, 2012 (for silicone PWS)
Links to ongoing/planned projects/programmes	
Possible contacts	AMAP POPs EG: Roland Kallenborn (NMBU, Norway); Derek Muir (ECCC, Canada); Cynthia de Wit (Stockholm University, Sweden); Katrin Vorkamp (Aarhus University, Denmark) NORMAN network Cross-Working Group Activity: Passive sampling for emerging contaminants (Ian Allan (NIVA, Norway) and Cécile Miège (INRAE, France)).

Option 7: Evaluating POPs/CEAC contamination in the local area or around local sites of potential contamination using snow samples	
Context for pilot study	Identifying the spatial extent of contamination around local sources of POPs/CEAC contamination of the environment
Pre-requirements	
Access to relevant expertise…	Necessary/recommended if not otherwise in place
Access to laboratory services…	Required
Permissions for work…	Depends whether work is covered by existing agreements for sampling in area concerned Communication of results to local/regional authorities
Permissions from, engagement with and support of local community…	Desirable/required depending on whether proposed deployment is close to a community and/or on indigenous lands Communication of results to local communities
Type of sample	Typically involves sampling from a snow pit, though for INTERACT purposes surface snow collection along a transect (with modified protocols) may be adequate. Requires clean jars and tools that need to be prepared by a laboratory ahead of time. Snow samples (water equivalent volume of e.g. 2-3 L for PFASs, 4-5 L for POPs) stored frozen in cooler for shipment to laboratory Possible application in transect away from local source under investigation
Related protocols/guidance	e.g. Masclet et al., 2000; Myer et al., 2012
Links to ongoing/planned projects/programmes	Northern Contaminants Program (NCP) (Canada) (Alert 2022/23) snow sampling campaign
Possible contacts	Hayley Hung (Environment and Climate Change Canada, ECCC)

Option 8: Evaluating POPs/CEAC contamination in the local area / around local sites of potential contamination using environmental media (e.g. fish, wildlife)	
Context for pilot study	Station site participation in research, screening studies, monitoring activities for CEACs/POPs involving collection of biotic sample media

Pre-requirements	
Access to relevant expertise…	Necessary/recommended if not otherwise in place
Access to laboratory services…	Required
Permissions for work…	Depends whether work is covered by existing agreements for sampling in area concerned Permissions for shipment/export of sample materials Communication of results to local/regional authorities
Permissions from, engagement with and support of local community…	Desirable/required depending on whether proposed deployment is close to a community and/or on indigenous lands Communication of results to local communities
Type of sample	In collaboration with monitoring authorities/programmes: serve as collection centre for relevant environmental samples, including samples collected by local hunters and trappers working under contract to relevant programs, provide suitable and secure storage of samples; and logistical support for shipment, etc. Potentially stations could also host researchers involved in such work and facilities for sample preparation prior to storage/shipment
Related protocols/guidance	
Links to ongoing/planned projects/programmes	AMAP and relation national programmes
Possible contacts	AMAP POPs EG leads and KNEs